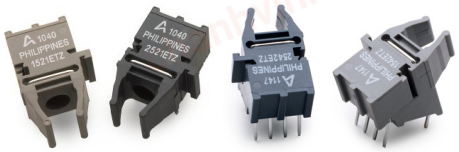
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Data Sheet

HFBR-0500ETZ Series

Versatile Link Fiber-Optic Connection



Description

The Versatile Link series is a complete family of fiber-optic link components for applications that require a low-cost solution. The HFBR-0500ETZ series includes transmitters, receivers, connectors, and cables that are specified for easy design. This series of components is ideal for solving problems with voltage isolation/insulation, EMI/RFI immunity, or data security. The optical link design is simplified by the logic-compatible receivers and complete specifications for each component. The key optical and electrical parameters of links configured with the HFBR-0500ETZ family are fully guaranteed from –40°C to 85°C.

A wide variety of package configurations and connectors provide the designer with numerous mechanical solutions to meet application requirements. The transmitter and receiver components have been designed for use in high-volume/ low-cost assembly processes such as auto-insertion and wave soldering.

Transmitters incorporate a 660-nm LED. Receivers include a monolithic DC-coupled, digital IC with an open collector Schottky output transistor. An internal pull-up resistor is available for use in the HFBR-25X1ETZ and HFBR-25X2ETZ receivers. A shield has been integrated into the receiver IC to provide additional, localized noise immunity.

Internal optics have been optimized for use with 1-mm diameter polymer optical fibers. Versatile Link specifications incorporate all connector interface losses. Therefore, optical calculations for common link applications are simplified.

Features

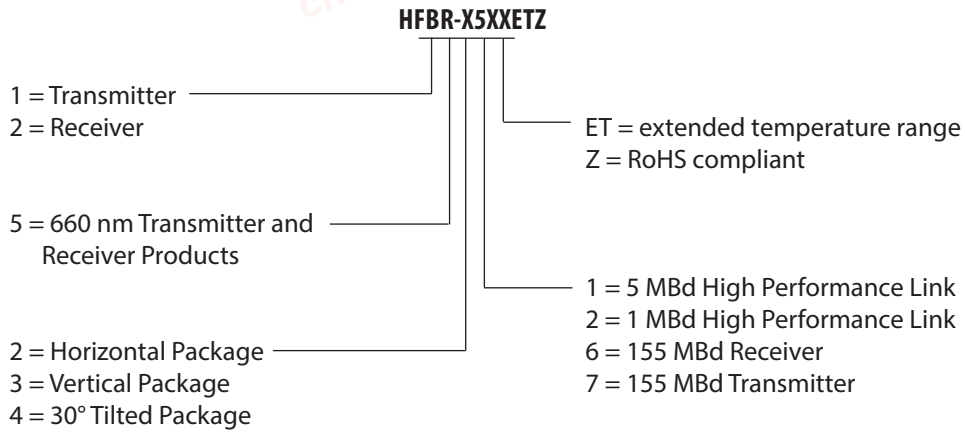
- Extended temperature range: –40 to +85°C
- RoHS compliant
- Low-cost fiber-optic components
- Enhanced digital links: DC to 5 Mbaud
- Link distance up to 43m at 1 Mbaud and 20m at 5 Mbaud
- Low-current link: 6-mA peak supply current
- Horizontal and vertical mounting
- Interlocking feature
- High noise immunity
- Easy connectoring: simplex, duplex, and latching connectors
- Flame retardant
- Transmitters with a 660-nm red LED for easy visibility
- Compatible with standard TTL circuitry

Applications

- Industrial drives/frequency inverters
- Renewable Energy (wind turbines, solar PV farms) power electronics
- Reduction of lightning/voltage transient susceptibility
- Motor controller triggering
- Data communications and local area networks
- Electromagnetic compatibility (EMC) for regulated systems such as FCC, VDE, and CSA.
- Tempest-secure data processing equipment
- Isolation in test and measurement instruments
- Error-free signaling for industrial and manufacturing equipment
- Automotive communications and control networks
- Noise- immune communication in audio and video equipment

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HFBR-0500ETZ Series Part Number Guide



Available Option	Part Number	
Horizontal Package	HFBR-x521ETZ	HFBR-x522ETZ
Vertical Package	HFBR-x531ETZ	HFBR-x532ETZ
30° Tilted Package	HFBR-x541ETZ	HFBR-x542ETZ

Link Selection Guide

(Links are specified from –40°C to 85°C, for polymer optical fiber unless specified.)

Signal Rate	Distance (m) 25°C	Distance (m)	Transmitter	Receiver
1 Mbaud	67	43	HFBR-15x2ETZ	HFBR-25x2ETZ
5 Mbaud	38	20	HFBR-15x1ETZ	HFBR-25x1ETZ

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Application Literature

Versatile Link Family: Application Note 1035 (AV02-0730EN).

Package and Handling Information

The compact Versatile Link package is made of a flame-retardant VALOX UL 94 V-0 material (UL file # E121562) and uses the same pad layout as a standard, 8-pin dual-inline package. Vertical and horizontal mountable parts are available. These low-profile Versatile Link packages are stackable and are enclosed to provide a dust-resistant seal. Snap-action simplex, simplex latching, duplex, and duplex latching connectors are offered with simplex or duplex cables.

Package Orientation

Performance and pinouts for the vertical and horizontal 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 option is not necessary.

Package Housing Color

Versatile Link components and simplex connectors are color coded to eliminate confusion when making connections. Receivers are blue, and transmitters are gray.

Handling

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

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

Recommended Chemicals for Cleaning and Degreasing

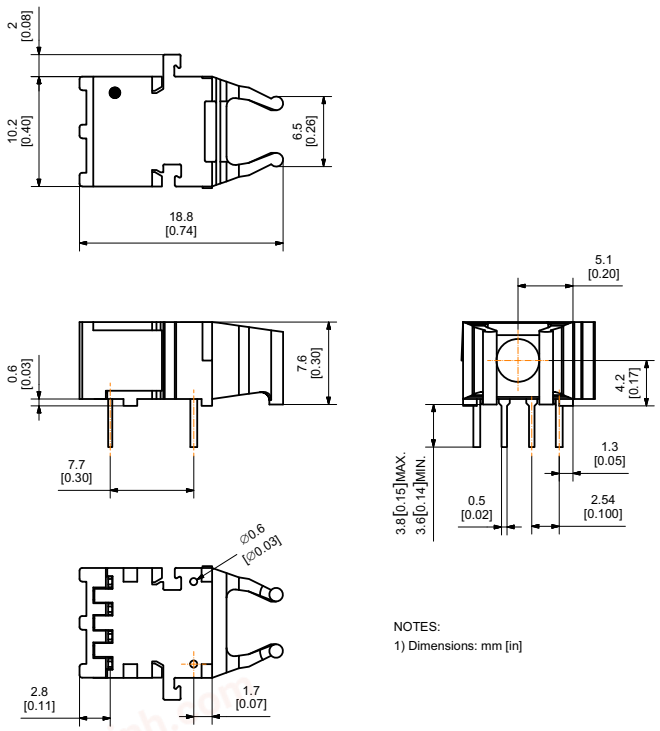
- Alcohols: methyl, isopropyl, isobutyl
- Aliphatics: hexane, heptane
- Other: soap solution, naphtha

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

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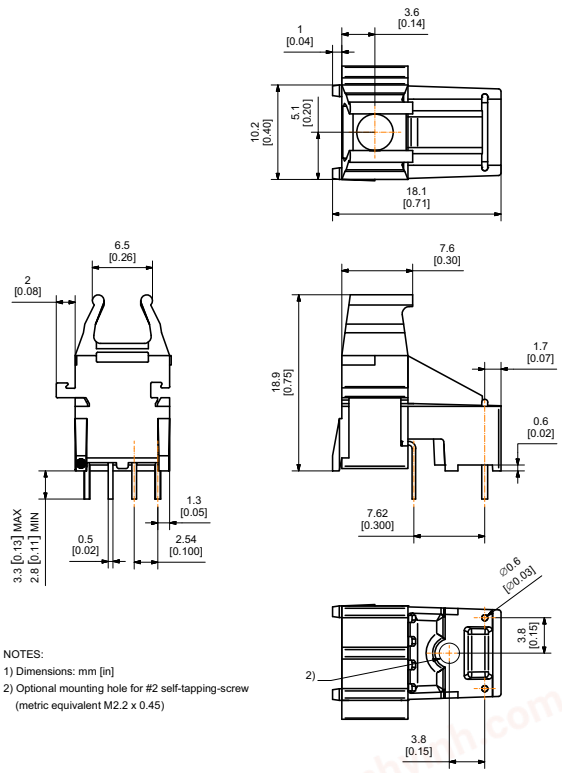
Mechanical Dimensions

Horizontal Modules



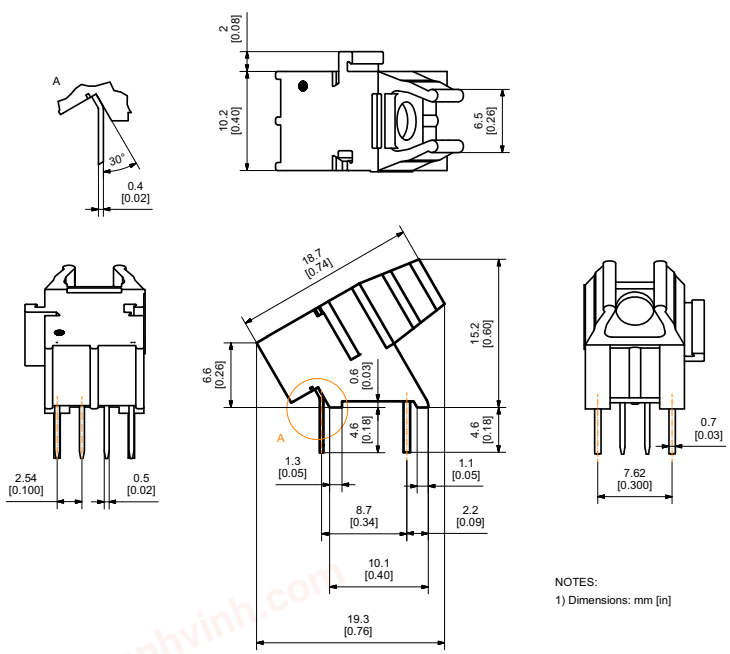
NOTES:
1) Dimensions: mm [in]

Vertical Modules



NOTES:
1) Dimensions: mm [in]
2) Optional mounting hole for #2 self-tapping-screw (metric equivalent M2.2 x 0.45)

30° Tilted Modules

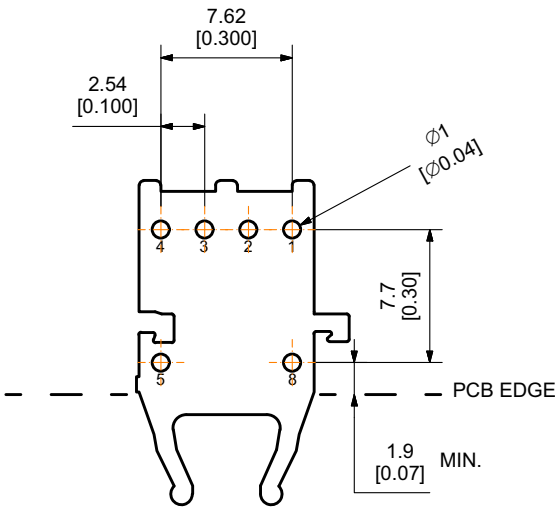


NOTES:
1) Dimensions: mm [in]

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Versatile Link Printed Board Layout Dimensions

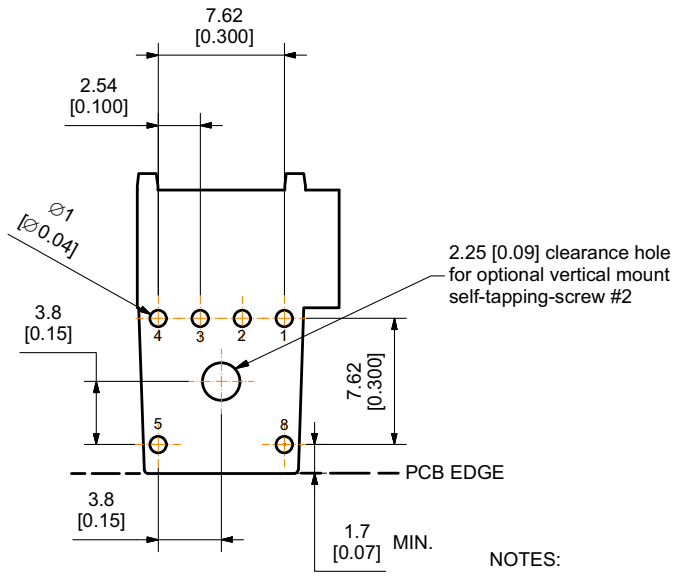
Horizontal Module



NOTES:
1) Dimensions: mm [in]

Footprint - TOP VIEW

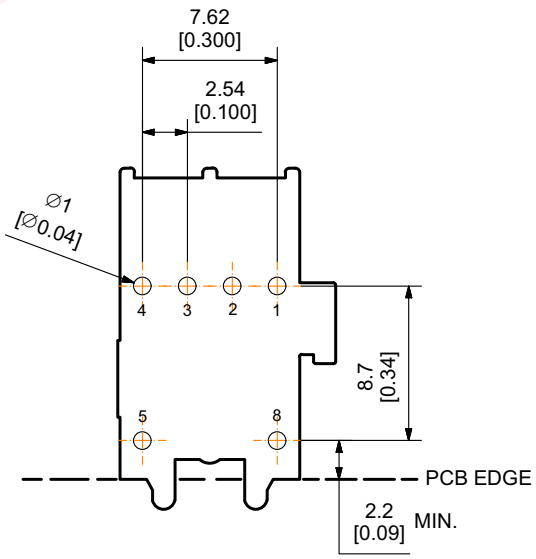
Vertical Modules



NOTES:
1) Dimensions: mm [in]

Footprint - TOP VIEW

30° Tilted Modules



NOTES:
1) Dimensions: mm [in]

Footprint - TOP VIEW

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Interlocked (Stacked) Assemblies

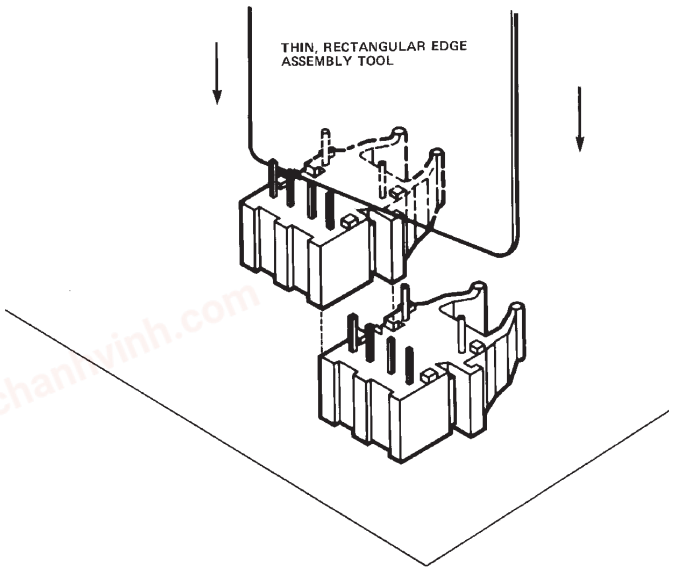
Horizontal packages may be stacked by placing units with pins facing upward. Initially engage the interlocking mechanism by sliding the L bracket body from above into the L slot body of the lower package. Use a straight edge, such as a ruler, to bring all stacked units into uniform alignment. This technique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

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

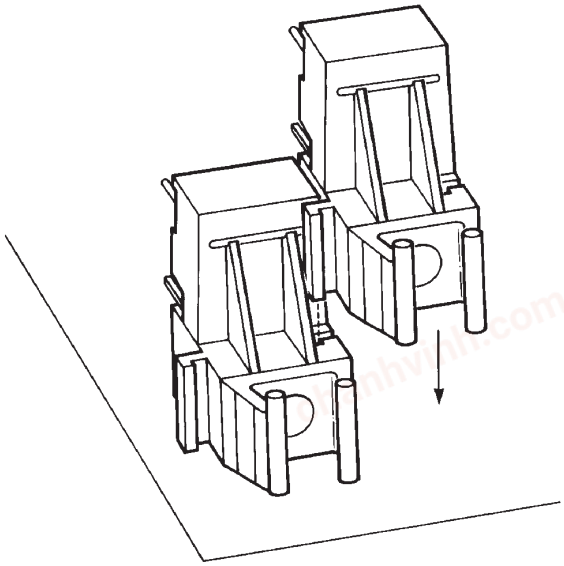
It is recommended to interlock (stack) no more than four compatible housings together.

Figure 1: Interlocked (Stacked) Horizontal, Vertical, or 30° Tilted Packages

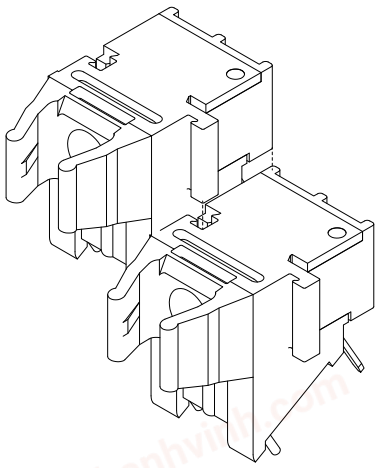
Stacking Horizontal Modules



Stacking Vertical Modules



Stacking 30° Tilted Modules



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5-Mbaud Link (HFBR-15X1ETZ/25X1ETZ)

System performance: –40°C to 85°C, unless otherwise specified.

	Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
High-Performance 5 Mbaud	Data Rate	—	dc	—	5	Mbaud	BER ≤ 10^{-9}, PRBS: 2^7–1	—
	Link Distance (Standard Cable)	d	17 33	—	—	m m	I_{Fdc} = 60 mA I_{Fdc} = 60 mA, 25°C	Note [a, b]
	Link Distance (Improved Cable)	d	20 38	— —	— —	m m	I_{Fdc} = 60 mA I_{Fdc} = 60 mA, 25°C	Note [a, b]
	Propagation Delay	t_{PLH} t_{PHL}	— —	90 50	140 140	ns ns	R_L = 560Ω, C_L = 30 pF Fiber length = 0.5m –21.6 ≤ P_R ≤ –9.5 dBm	Figures 3, 6 Note [b, c, d]
	Pulse Width Distortion t_{PLH}-t_{PHL}	t_D	—	40	—	ns	P_R = –15 dBm R_L = 560Ω, C_L = 30 pF	Figures 3, 5 Note [b]

a. The estimated typical link life expectancy at 40°C exceeds 10 years at 60 mA.

b. Optical link performance is guaranteed only with the HFBR-15x1ETZ transmitter and the HFBR-25x1ETZ receiver.

c. The propagation delay for one meter of cable is typically 5 ns.

d. Typical propagation delay is measured at P_R = –15 dBm.

Figure 2: Typical 5-Mbaud Interface Circuit

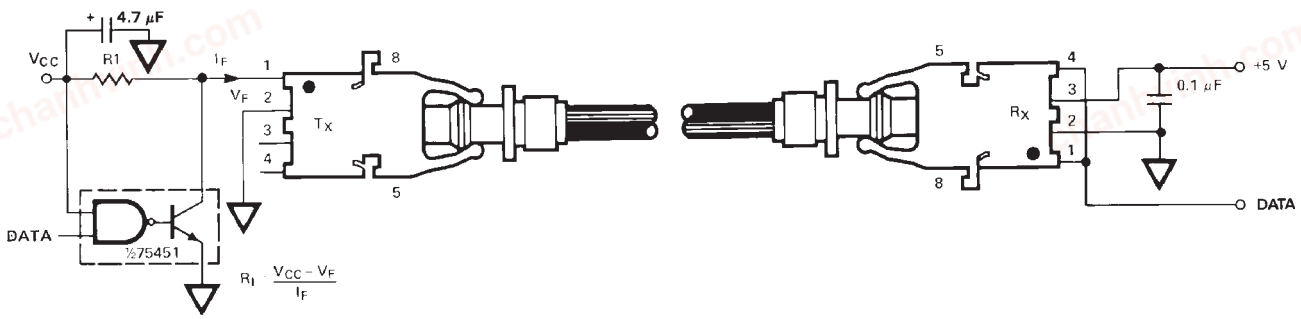
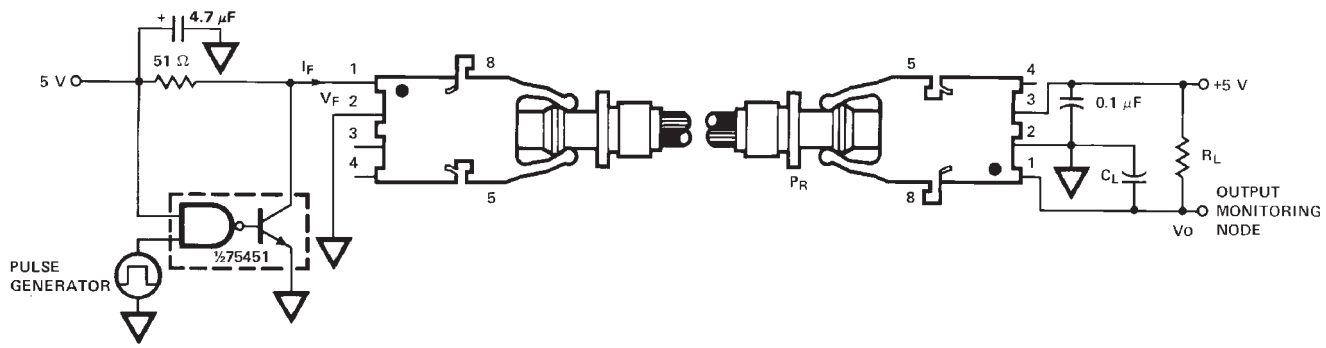


Figure 3: 5-Mbaud Propagation Delay Test Circuit



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Figure 4: Propagation Delay Test Waveforms

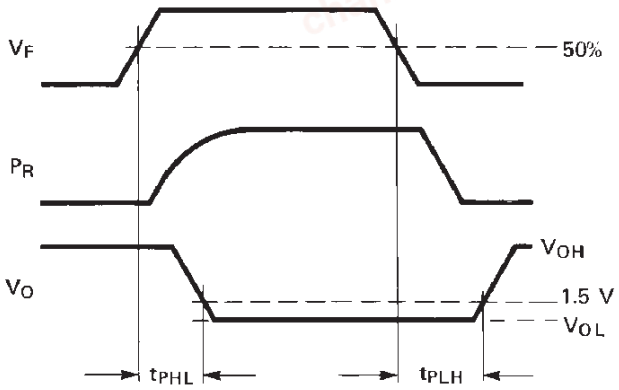


Figure 5: Typical Link Pulse Width Distortion vs. Optical Power

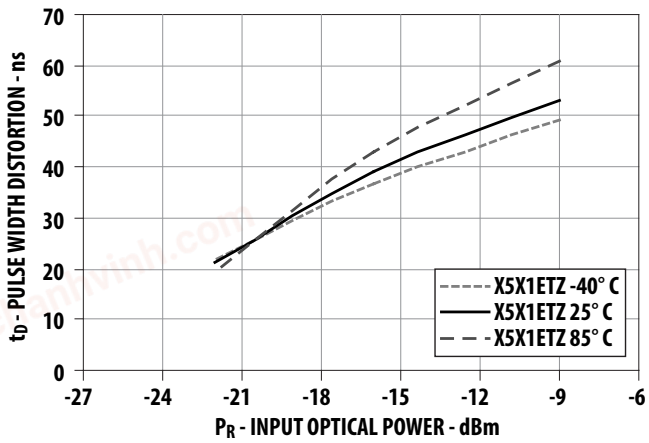
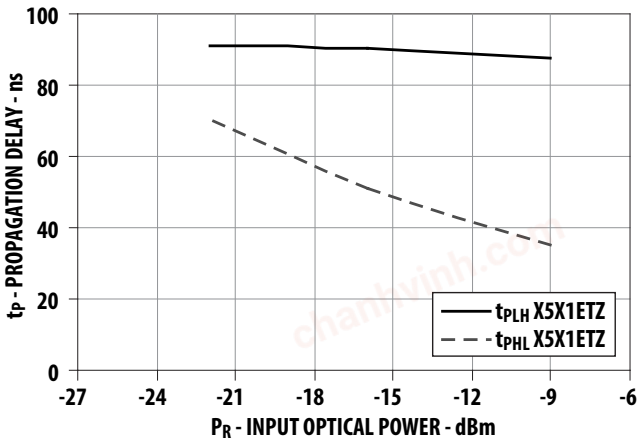
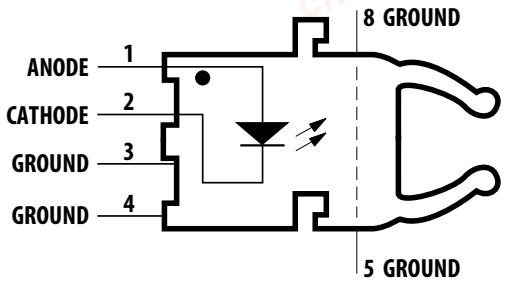


Figure 6: Typical Link Propagation Delay vs. Optical Power



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HFBR-15X1ETZ Transmitter



Pin No.	Function
1	Anode
2	Cathode
3	Ground
4	Ground
5	Ground
8	Ground

NOTE: Pins 5 and 8 are for mounting and retaining purposes only. Do not electrically connect these pins.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	–40	+85	°C	—
Operating Temperature		T_A	–40	+85	°C	—
Lead Soldering Cycle	Temperature	—	—	260	°C	Note [a, b]
	Time	—	—	10	sec	
Forward Input Current		I_{FPK}	—	1000	mA	Note [c, d]
		I_{Fdc}	—	80		—
Reverse Input Voltage		V_{BR}	—	5	V	—

a. 1.6 mm below the seating plane. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

b. The moisture sensitivity level is MSL-3.

c. The recommended operating range is between 10 mA and 750 mA.

d. 1-µs pulse, 20-µs period.

NOTE: All HFBR-15XXETZ LED transmitters are classified as IEC 825-1 Accessible Emission Limit (AEL) Class 1 based upon the proposed draft that went into effect on January 1, 1997. AEL Class 1 LED devices are considered eye safe. Contact your local Broadcom sales representative for more information.

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Transmitter Electrical/Optical Characteristics

–40°C to 85°C unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
Transmitter Output Optical Power	P_T	–16.8	—	–7.1	dBm	I_{Fdc} = 60 mA	Notes [a, b]
		–14.3	—	–8.0	dBm	I_{Fdc} = 60 mA, 25°C	—
Output Optical Power Temperature Coefficient	$\Delta P_T/\Delta T$	—	–0.85	—	%/°C	—	—
Peak Emission Wavelength	λ_{PK}	—	660	—	nm	—	—
Forward Voltage	V_F	1.43	1.67	2.05	V	I_{Fdc} = 60 mA	—
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$	—	–1.37	—	mV/°C	—	Figure 7
Effective Diameter	D	—	1	—	mm	—	—
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 = 0V, f = 1 MHz	—
Rise Time	t_r	—	20	—	ns	10% to 90%, I_F = 60 mA	Note [c]
Fall Time	t_f	—	20	—	ns		

a. Optical power is measured at the end of 0.5m of 1-mm diameter POF (NA = 0.5) with a large area detector.

b. Optical power, P (dBm) = 10 Log [P(µW)/1000 µW].

c. Rise and fall times are measured with a voltage pulse driving the transmitter driver IC (75451). A wide-bandwidth optical-to-electrical waveform analyzer, terminated to a 50Ω input of a wide-bandwidth oscilloscope, is used for this response time measurement.

Figure 7: Typical Forward Voltage vs. Drive Current

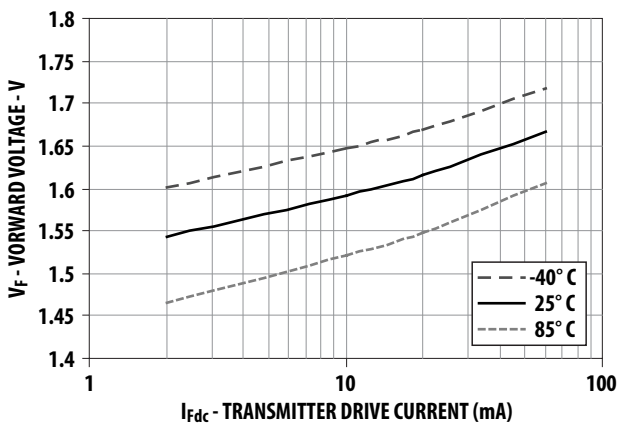
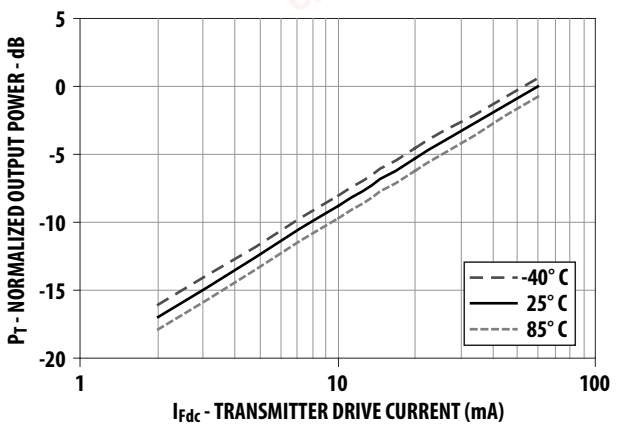
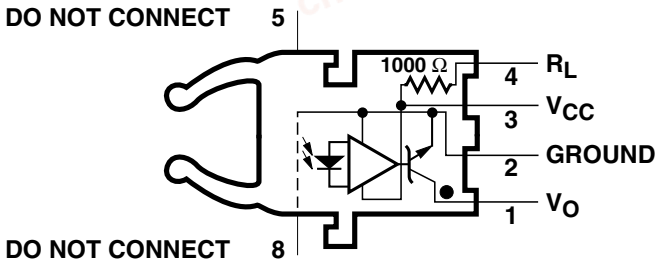


Figure 8: Normalized Typical Output Power vs. Drive Current



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HFBR-25X1ETZ Receiver



Pin No.	Function
1	V_O
2	Ground
3	V_{CC}
4	R_L
5	Ground
8	Ground

NOTE: Pins 5 and 8 are for mounting and retaining purposes only. Do not electrically connect these pins.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	–40	+85	°C	—
Operating Temperature		T_A	–40	+85	°C	—
Lead Soldering Cycle	Temperature	—	—	260	°C	Note [a, b]
	Time	—	—	10	sec	
Supply Voltage		V_{CC}	–0.5	7	V	Note [c]
Output Collector Current		I_{OAV}	—	25	mA	—
Output Collector Power Dissipation		P_{OD}	—	40	mW	—
Output Voltage		V_O	–0.5	18	V	—
Pull-Up Voltage		V_P	–5	V_{CC}	V	—
Fan-Out (TTL)		N	—	5	—	—

a. 1.6 mm below the seating plane. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

b. Moisture sensitivity level is MSL-3.

c. It is essential that a 0.1-µF bypass capacitor be connected from pin 2 to pin 3 of the receiver. The total lead length between both ends of the capacitor and the pins should not exceed 20 mm.

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Receiver Electrical/Optical Characteristics

–40°C to 85°C, 4.75V ≤ V_{CC} ≤ 5.25V, unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
Input Optical Power Level for Logic "0"	$P_{R(L)}$	–21.6	—	–9.5	dBm	V_{OL} = 0.5V I_{OL} = 8 mA	Notes a, b, c, d
		–21.6	—	–8.7		V_{OL} = 0.5V I_{OL} = 8 mA, 25°C	
Input Optical Power Level for Logic "1"	$P_{R(H)}$	—	—	–43	dBm	V_{OL} = 5.25V I_{OH} ≤ 250 µA	Notes a, d
High Level Output Current	I_{OH}	—	5	250	µA	V_O = 18V, P_R = 0	Notes d, e
Low Level Output Voltage	V_{OL}	—	0.4	0.5	V	I_{OL} = 8 mA, $P_R = P_{R(L)MIN}$	Notes d, e
High Level Supply Current	I_{CCH}	—	3.5	6.3	mA	V_{CC} = 5.25V, P_R = 0	Notes d, e
Low Level Supply Current	I_{CCL}	—	6.2	10	mA	V_{CC} = 5.25V, P_R = –12.5 dBm	Notes d, e
Effective Diameter	D	—	1	—	mm	—	—
Internal Pull-Up Resistor	R_L	680	1000	1700	Ω	—	—

a. Optical flux, P (dBm) = 10 Log [P(µW)/1000 µW].

b. Optical power is measured at the end of 1-mm diameter POF (NA = 0.5) with a large area detector.

c. 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.

d. Guaranteed only if the optical input signal to the receiver is generated by HFBR-15x1ETZ, with ideal alignment to the photodiode using 1-mm POF (NA = 0.5).

e. R_L is open.

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1-Mbaud Link (High-Performance HFBR-15X2ETZ/25X2ETZ)

System performance under the recommended operating conditions, unless otherwise specified.

	Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
High Performance 1 Mbaud	Data Rate	—	dc	—	1	Mbaud	BER ≤ 10^{-9}, PRBS: 2^7–1	—
	Link Distance (Standard Cable)	d	37 58	— —	— —	m m	I_{Fdc} = 60 mA I_{Fdc} = 60 mA, 25°C	Notes a, b, c, d
	Link Distance (Improved Cable)	d	43 67	— —	— —	m m	I_{Fdc} = 60 mA I_{Fdc} = 60 mA, 25°C	Notes a, b, c, d
	Propagation Delay	t_{PLH} t_{PHL}	—	100 80	250 140	ns ns	R_L = 560Ω, C_L = 30 pF l = 0.5 meter P_R = –24 dBm	Figures 10, 12 Notes c, d, e
	Pulse Width Distortion t_{PLH}-t_{PHL}	t_D	—	20	—	ns	P_R = –24 dBm R_L = 560Ω, C_L = 30 pF	Figures 10, 11 Notes c, d

a. 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

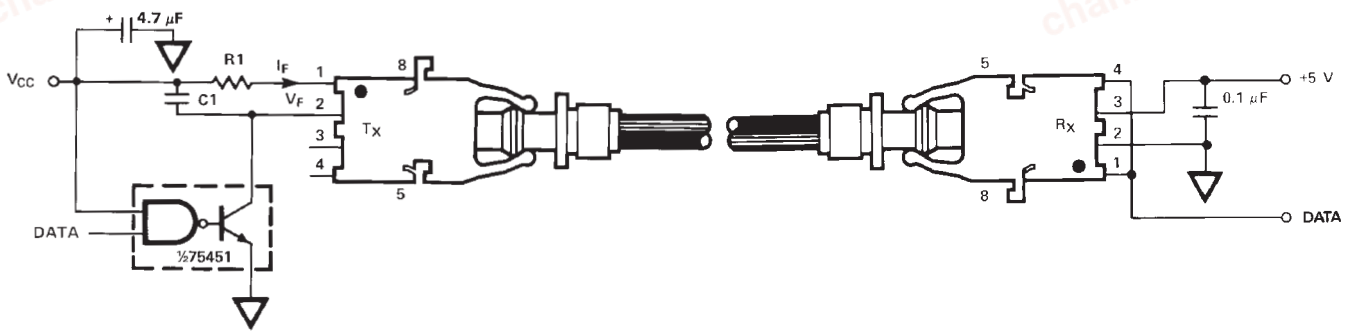
b. The estimated typical link life expectancy at 40°C exceeds 10 years at 60 mA.

c. 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.

d. Optical link performance is guaranteed only with the HFBR-15x2ETZ transmitter and the HFBR-25x2ETZ receiver.

e. The propagation delay for one meter of cable is typically 5 ns.

Figure 9: Required 1-Mbaud Interface Circuit



NOTE: The HFBR-25X2ETZ receiver cannot be overdriven when using the required interface circuit shown in Figure 9.

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Figure 10: 1-Mbaud Propagation Delay Test Circuit

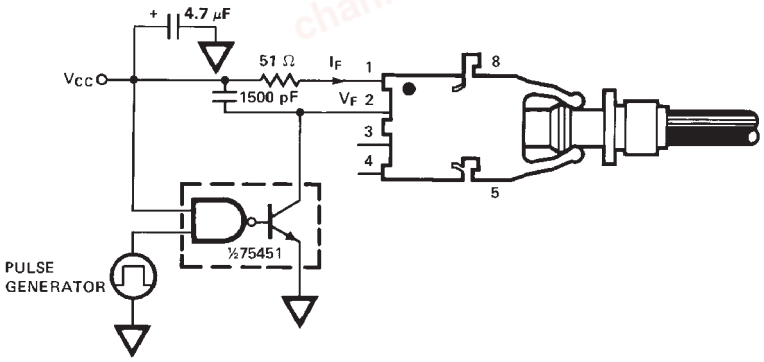


Figure 11: Typical Link Pulse Width Distortion vs. Optical Power

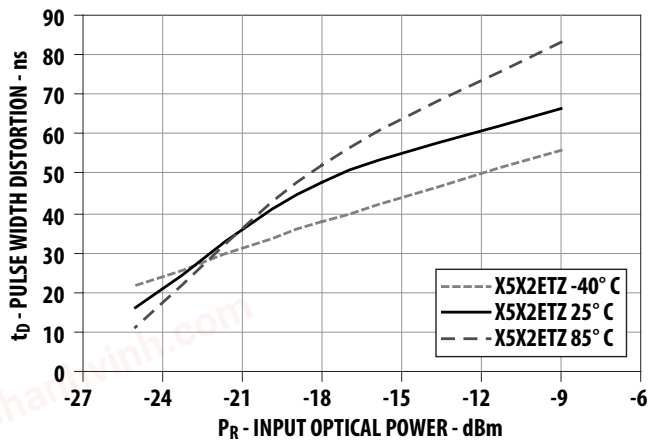


Figure 12: Typical Link Propagation Delay vs. Optical Power

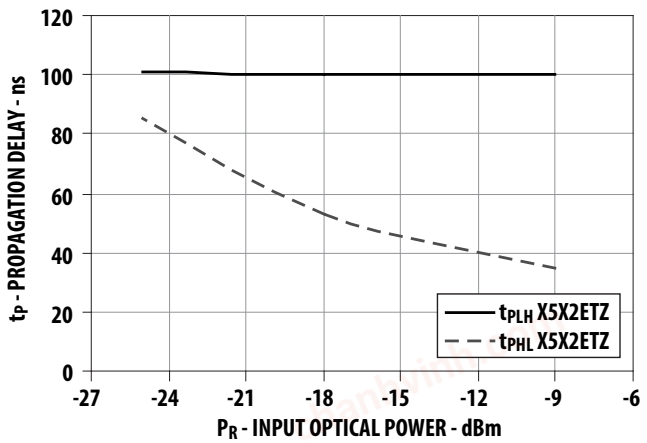
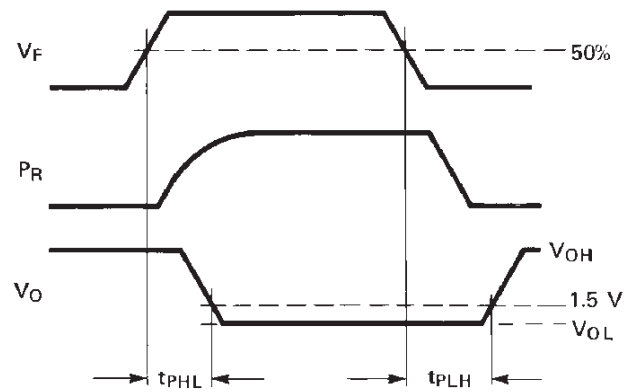
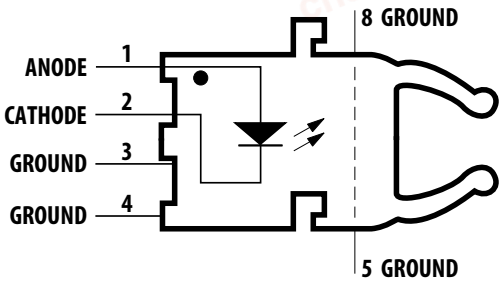


Figure 13: Propagation Delay Test Waveforms



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HFBR-15X2ETZ Transmitters



Pin No.	Function
1	Anode
2	Cathode
3	Ground
4	Ground
5	Ground
8	Ground

NOTE: Pins 5 and 8 are for mounting and retaining purposes only. Do not electrically connect these pins.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	–40	+85	°C	—
Operating Temperature		T_A	–40	+85	°C	—
Lead Soldering Cycle	Temperature	—	—	260	°C	Note [a, b]
	Time	—	—	10	sec	
Forward Input Current		I_{FPK}	—	1000	mA	Note [c, d]
		I_{Fdc}	—	80	—	—
Reverse Input Voltage		V_{BR}	—	5	V	—

a. 1.6 mm below the seating plane. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

b. Moisture sensitivity level is MSL-3.

c. Recommended operating range between 10 mA and 750 mA.

d. 1-µs pulse, 20-µs period.

NOTE: All HFBR15XXETZ LED transmitters are classified as IEC 825-1 Accessible Emission Limit (AEL) Class 1 based upon the proposed draft that went into effect on January 1, 1997. AEL Class 1 LED devices are considered eye safe. Contact your Broadcom sales representative for more information.

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Transmitter Electrical/Optical Characteristics

–40°C to 85°C unless otherwise specified.

For forward voltage and output power vs. drive current graphs.

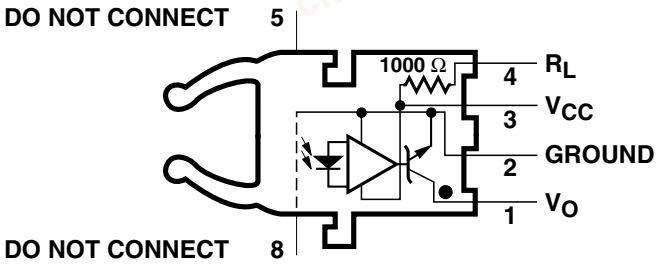
Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
Transmitter Output Optical Power	P_T	–13.9 –11.2	— —	–4.0 –5.1	dBm	I_{Fdc} = 60 mA I_{Fdc} = 60 mA, 25°C	Note [a]
Output Optical Power Temperature Coefficient	$\Delta P_T/\Delta T$	—	–0.85	—	%/°C	—	—
Peak Emission Wavelength	λ_{PK}	—	660	—	nm	—	—
Forward Voltage	V_F	1.43	1.67	2.05	V	I_{Fdc} = 60 mA	—
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$	—	–1.37	—	mV/°C	—	Figure 9
Effective Diameter	D_T	—	1	—	mm	—	—
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 = 0V, f = 1 MHz	—
Rise Time	t_r	—	20	—	ns	10% to 90%, I_F = 60 mA	Note [b]
Fall Time	t_f	—	20	—	ns		

a. Optical power is measured at the end of 0.5m of 1-mm diameter POF (NA = 0.5) with a large area detector.

b. Rise and fall times are measured with a voltage pulse driving the transmitter driver IC (75451). A wide-bandwidth optical-to-electrical waveform analyzer, terminated to a 50Ω input of a wide-bandwidth oscilloscope, is used for this response time measurement.

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HFBR-25X2ETZ Receivers



Pin No.	Function
1	V_O
2	Ground
3	V_{CC}
4	R_L
5	Ground
8	Ground

NOTE: Pins 5 and 8 are for mounting and retaining purposes only. Do not electrically connect these pins.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	–40	+85	°C	—
Operating Temperature		T_A	–40	+85	°C	—
Lead Soldering Cycle	Temperature	—	—	260	°C	Note [a, b]
	Time	—	—	10	sec	
Supply Voltage		V_{CC}	–0.5	7	V	Note [c]
Output Collector Current		I_{OAV}	—	25	mA	—
Output Collector Power Dissipation		P_{OD}	—	40	mW	—
Output Voltage		V_O	–0.5	18	V	—
Pull-Up Voltage		V_P	–5	V_{CC}	V	—
Fan-Out (TTL)		N	—	5	—	—

a. 1.6 mm below the seating plane. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

b. Moisture sensitivity level is MSL-3.

c. It is essential that a 0.1-µF bypass capacitor be connected from pin 2 to pin 3 of the receiver. The total lead length between both ends of the capacitor and the pins should not exceed 20 mm.

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Receiver Electrical/Optical Characteristics

–40°C to 85°C, 4.75V ≤ V_{CC} ≤ 5.25V, unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Ref.
Receiver Optical Input Power Level Logic 0	$P_{R(L)}$	–24	—	–9.5	dBm	V_{OL} = 0.5V I_{OL} = 8 mA	Notes [a, b, c, d]
Optical Input Power Level Logic 1	$P_{R(H)}$	—	—	–43	dBm	V_{OH} = 5.25V I_{OH} ≤ 250 µA	Notes [d, e]
High Level Output Current	I_{OH}	—	5	250	µA	V_O = 18V, P_R = 0	Notes [d, f]
Low Level Output Voltage	V_{OL}	—	0.4	0.5	V	I_{OL} = 8 mA $P_R = P_{R(L)MIN}$	Notes [d, f]
High Level Supply Current	I_{CCH}	—	3.5	6.3	mA	V_{CC} = 5.25V, P_R = 0	Notes [d, f]
Low Level Supply Current	I_{CCL}	—	6.2	10	mA	V_{CC} = 5.25V, P_R = –12.5 dBm	Notes [d, f]
Effective Diameter	D	—	1	—	mm	—	—
Internal Pull-Up Resistor	R_L	680	1000	1700	Ω	—	—

a. Optical power is measured at the end of 1-mm diameter POF (NA = 0.5) with a large area detector.

b. 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.

c. The LED drive circuit of Figure 11 is required for 1-Mbaud operation of the HFBR-25X2ETZl.

d. Guaranteed only if the optical input signal to the receiver is generated by HFBR-15x2ETZ, with ideal alignment to the photodiode using 1-mm POF (NA = 0.5).

e. Optical flux, P (dBm) = 10 Log [P(µW)/1000 µW].

f. R_L is open.

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