

# AFBR-15x1CZ and AFBR-25x1CZ

## DC to 5-Mbaud Versatile Link Fiber Optic Analog Transmitter and Digital Receiver for 1-mm POF and 200- $\mu$ m PCS



### Description

The AFBR-15x1CZ analog transmitter utilizes a 650-nm LED source, and the AFBR-25x1CZ receiver consists of an IC with an integrated photodiode that provides a TTL logic family compatible output.

AFBR-25x1CZ devices have inverted output signals, which means that light\_on leads to Data\_out low.

The transmitter and receiver housing is designed to efficiently couple into 1-mm polymer optical fiber (POF) and 200- $\mu$ m diameter plastic-clad silica (PCS). Links up to 58m are supported with 1-mm POF and up to 500m with 200- $\mu$ m PCS. The transmitter is designed to interoperate with Broadcom HFBR-25xxZ and AFBR-26xxZ receivers as well.

A link with AFBR-15x1CZ and AFBR-25x1CZ enables operating temperatures up to +95°C.

The transmitter and receiver are 4-pin devices, packed in Versatile Link housings. Versatile Link components can be interlocked (N-plexed together) to minimize space and to provide dual connections with the duplex connectors. Various simplex and duplex connectors, as well as POF cables, are available for Versatile Link components.

#### Available Transmitter AFBR-15x1CZ Options

Horizontal Package	AFBR-1521CZ
Vertical Package	AFBR-1531CZ
Tilted Package	AFBR-1541CZ

#### Available Receiver AFBR-25x1CZ Options

Horizontal Package	AFBR-2521CZ
Vertical Package	AFBR-2531CZ
Tilted Package	AFBR-2541CZ

### Features

- RoHS compliant
- Data transmission at signal rates from DC up to 5 Mbaud
- Up to 58 meters distance with 1-mm POF and up to 500 meters with 200- $\mu$ m PCS
- Operating temperature range of -40°C to +95°C
- Compatible with the Broadcom Versatile Link family of connectors, for easy termination of fiber

### Applications

- Industrial control and factory automation
- Optical transmitter and receiver for 5-Mbaud systems and below
- Serial field buses
- Intra-system links; board-to-board, rack-to-rack
- Extension of RS-232 and RS-485
- High voltage isolation
- Elimination of ground loops
- Reduction of voltage transient susceptibility
- Drivers and inverters

## 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 material and uses the same pad layout as a standard, eight-pin dual-inline package. Horizontal, vertical, and tilted (30°) packages 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 Housing Color

Versatile Link components and simplex connectors are color coded to eliminate confusion when making connections. Receiver packages are black, and transmitters are gray.

## Package Orientation

Performance and pinouts for the horizontal, vertical, and tilted (30°) packages are identical. To provide additional attachment support for the vertical Versatile Link housing, the designer has the option of using a self-tapping screw through a printed circuit board into a mounting hole at the bottom of the package. For most applications, this is not necessary.

## 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). Non-halogenated 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/Degreasing

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

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

## Interlocked (Stacked) Assemblies

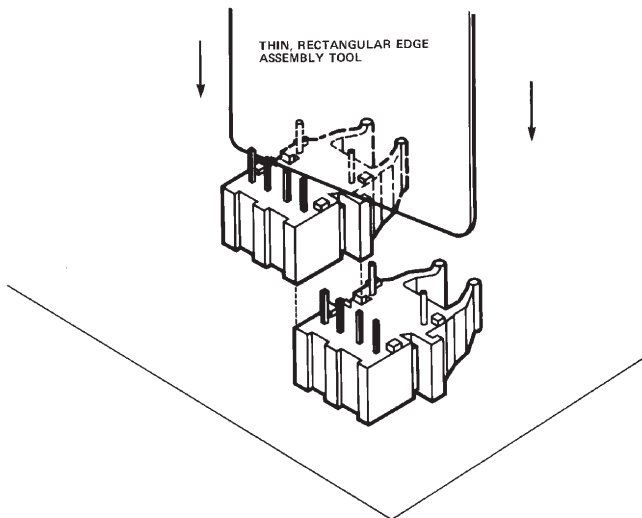
Horizontal packages can be stacked by placing units with pins facing upward. Initially engage the interlocking mechanism by sliding the L bracket body from above into the L slot body of the lower package. Use a straight edge, such as a ruler, to bring all stacked units into uniform alignment. This technique prevents potential harm that could occur to the 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.

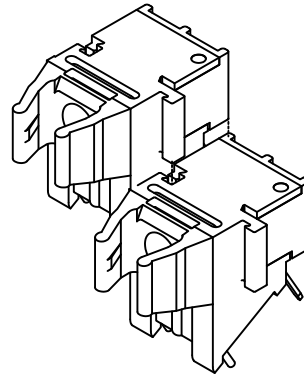
## Stacking Horizontal Modules

Figure 1: Interlocked (Stacked) Horizontal Packages



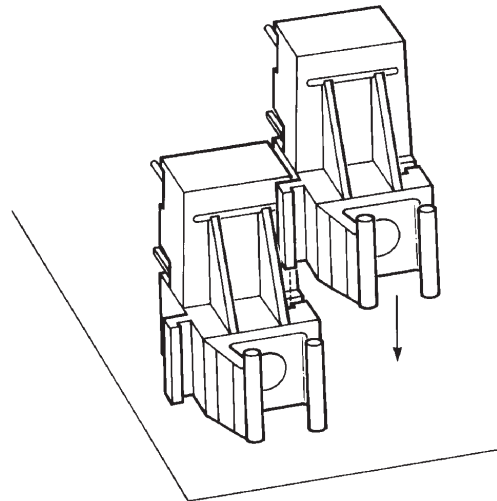
## Stacking Tilted (30°) Module

Figure 2: Interlocked (Stacked) Tilted (30°) Packages



## Stacking Vertical Modules

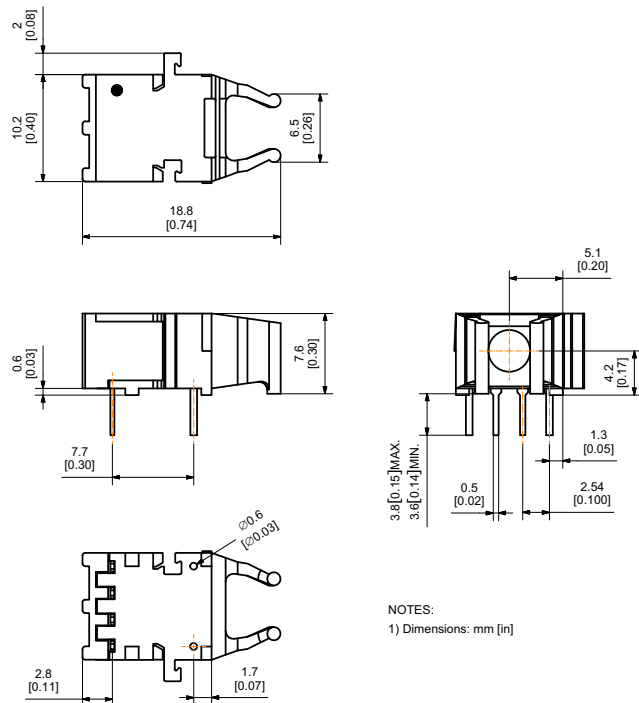
Figure 3: Interlocked (Stacked) Vertical Packages



## Mechanical Dimensions

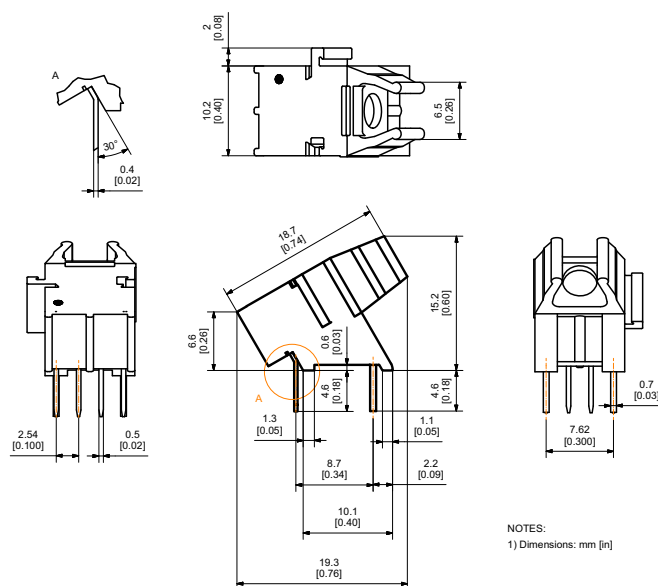
### Horizontal Module

Figure 4: Mechanical Dimensions - Horizontal Packages



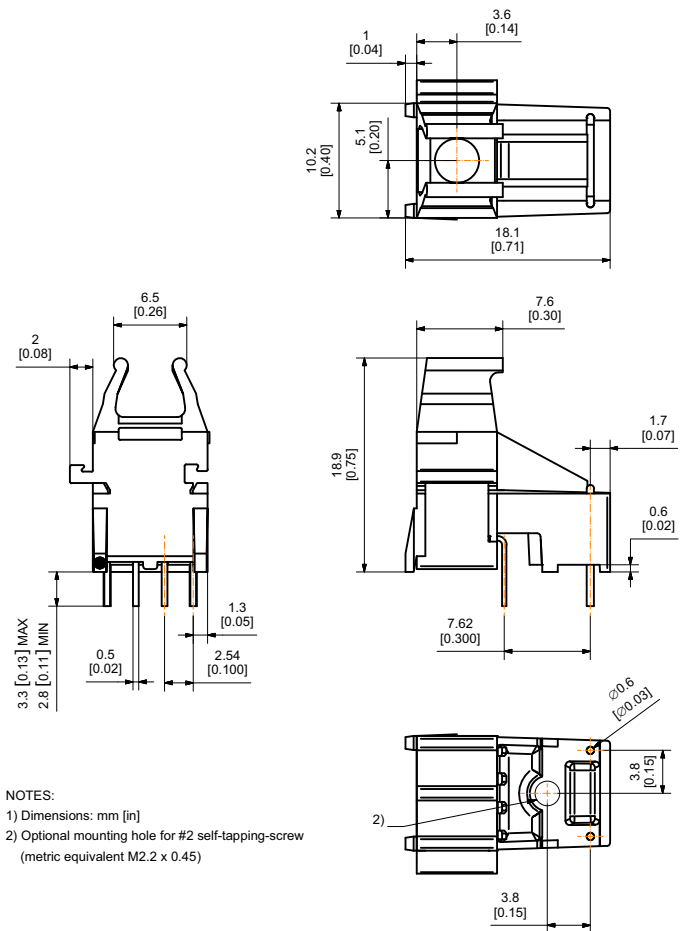
### Tilted (30°) Module

Figure 5: Mechanical Dimensions - Tilted (30°) Packages



## Vertical Module

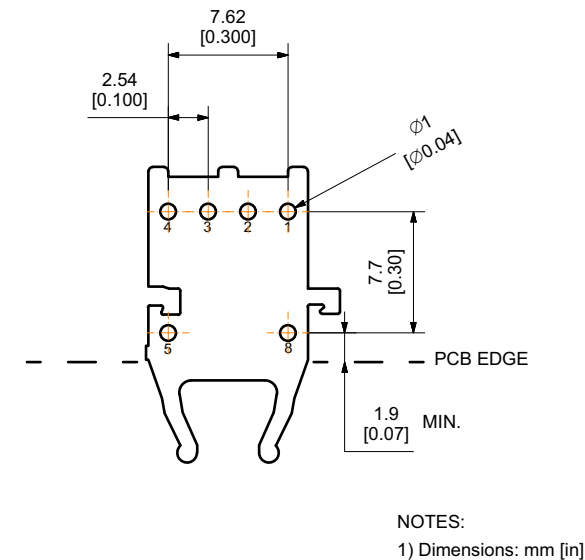
Figure 6: Mechanical Dimensions - Vertical Packages



# Versatile Link Printed Board Layout Dimensions

## Horizontal Module

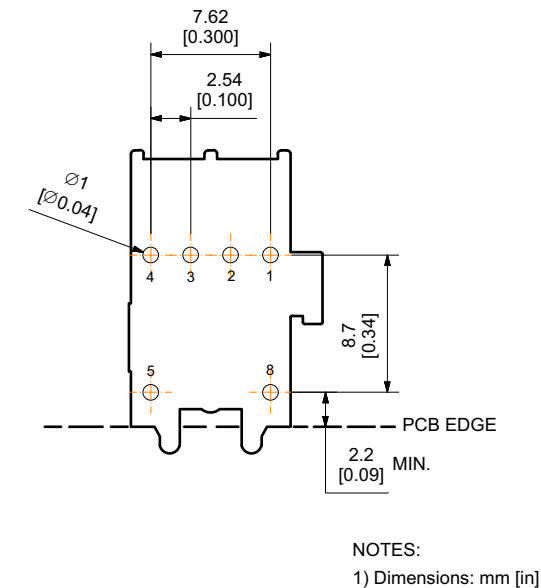
Figure 7: PCB Dimensions - Horizontal Packages



Footprint - TOP VIEW

## Tilted (30°) Module

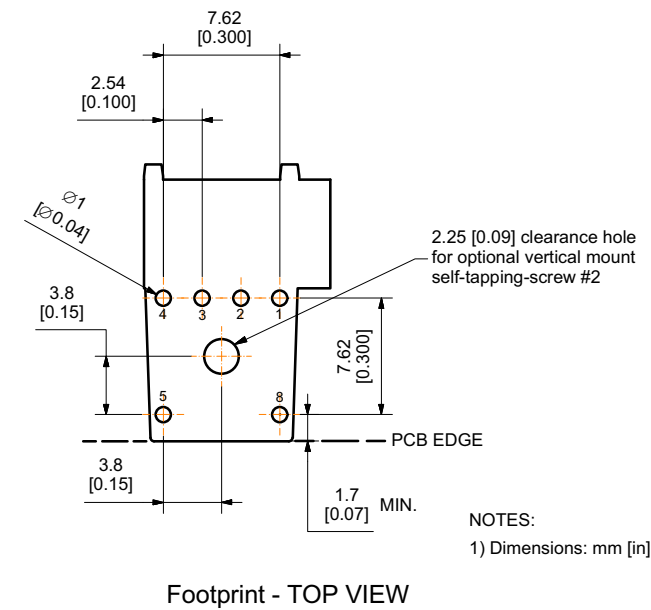
Figure 8: PCB Dimensions - Tilted (30°) Packages



Footprint - TOP VIEW

## Vertical Module

Figure 9: PCB Dimensions - Vertical Packages



Footprint - TOP VIEW

## Regulatory Compliance (AFBR-15x1CZ/AFBR-25x1CZ)

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins Human Body Model	MIL-STD-883 Method 3015	Min. $\pm$ 2000V
Eye Safety <sup>a</sup>	IEC 60825-1/-2	Class 1

a. Valid for optical transmitter AFBR-15x1CZ only.

## Process Compatibility (AFBR-15x1CZ/AFBR-25x1CZ)

Parameter	Symbol	Min.	Typical	Max.	Unit
Solder Environment <sup>a, b</sup>	T <sub>SOLD</sub>	—	—	260 <sup>c</sup>	°C
	t <sub>SOLD</sub>	—	—	10 <sup>d</sup>	sec

a. 1.6 mm below seating plane.

b. Product is Moisture Sensitive Level 3.

c. Maximum temperature refers to peak temperature.

d. Maximum time refers to time spent at peak temperature. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

## 5-Mbaud Link Performance (AFBR-15x1CZ/AFBR-25x1CZ)

For operating temperatures up to +85°C, the optical link performance is guaranteed with transmitters AFBR-15x9Z (>20 mA forward peak current) or AFBR-16x9Z. The optical link performance for operating temperatures up to +95°C is guaranteed only with transmitters AFBR-15x1CZ (>20 mA forward peak current).

Parameter	Min.	Max.	Unit	Condition
Link Distance with Extra-Low Loss POF Cable <sup>a</sup>	0.1	58	m	–40°C to +95°C
Link Distance with 200- $\mu$ m PCS Cable <sup>b</sup>	0.1	500	m	–40°C to +95°C

a. Polymer optical fiber (POF) is AFBR-HUXYYYYZ or HFBR-EXXYYYYZ for operating temperatures up to +85°C. Worst-case fiber attenuation (0.23 dB/m at 650 nm) is used for distance calculation.

b. Plastic-clad silica (PCS) fiber. A worst-case attenuation of 12 dB/km (at 650 nm) is used for distance calculation.

## Pin Description Transmitter AFBR-15x1CZ

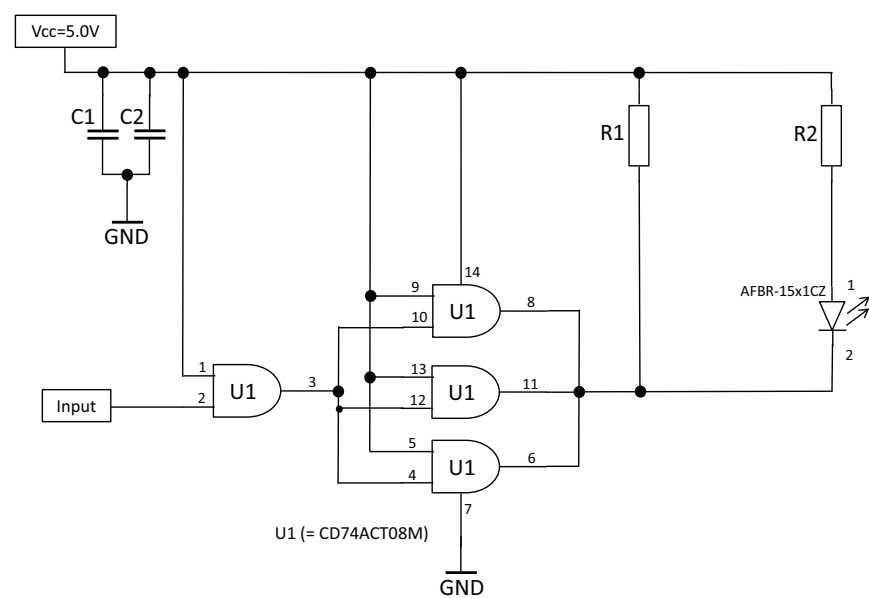
Fiber port faces front, pins downward, 1 = Rightmost pin to 4 = Leftmost pin.

Pin	Name	Function/Description
1	Anode	LED anode.
2	Cathode	LED cathode.
3	Pin	No function, physical pin available, recommended to signal GND.
4	Pin	No function, physical pin available, recommended to signal GND.
5	Housing Pin <sup>a</sup>	Physical pin available, recommended to chassis GND.
8	Housing Pin <sup>a</sup>	Physical pin available, recommended to chassis GND.

a. Pins 5 and 8 are for mounting and retaining purposes. Make sure that they are electrically connected to chassis GND.

**NOTE** This is an inverting circuit; thus, the LED is off in case of INPUT DATA high. Therefore, an inverting receiver, such as AFBR-25x1CZ, should be used accordingly.

Figure 10: Recommended Drive Circuit



**NOTE:**  $I_{F,on}$  = 30 mA nominal at  $T_A$  = 25°C;  $V_{CC}$  = 5.0V.

	Value	Tolerance
R1	2 kΩ	5%
R2	100Ω	1%
C1	0.1 μF	20%
C2	10 μF	20%

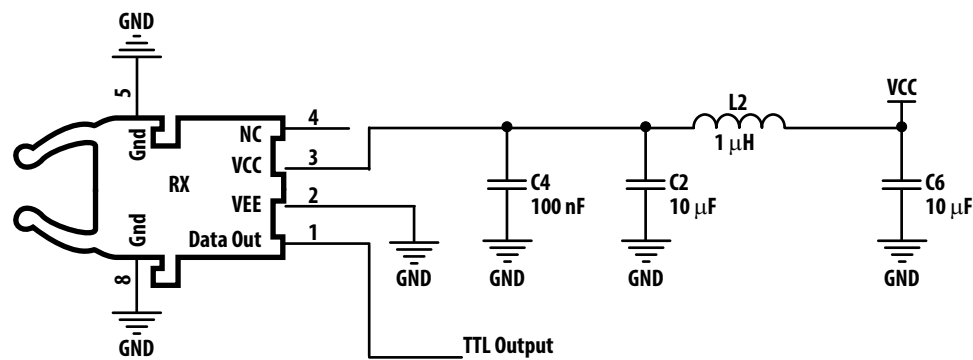
## Pin Description Receiver AFBR-25x1CZ

Fiber port faces front, pins downward, 1 = Rightmost pin to 4 = Leftmost pin.

Pin	Name	Function/Description
1	Data Out <sup>a, b</sup>	Data output.
2	V <sub>EE</sub>	Ground.
3	V <sub>CC</sub>	Power Supply 3.3V ± 5% or 5V ± 5%.
4	Pin <sup>c</sup>	No function, physical pin is available, recommended to signal GND.
5	Housing Pin <sup>d</sup>	Physical pin is available, recommended to chassis GND.
8	Housing Pin <sup>d</sup>	Physical pin is available, recommended to chassis GND.

- a. TTL compatible data output.
- b. Light on at the receiver input will lead to a “low” output signal, and light off will lead to a “high” output signal.
- c. It is recommended to connect this pin to signal GND.
- d. Pins 5 and 8 are for mounting and retaining purposes and should be connected to chassis GND.

Recommended Application Circuit



AFBR-15x1CZ Analog Transmitter

The AFBR-15x1CZ analog transmitter utilizes a 650-nm LED source in a housing that is designed to efficiently couple into 1-mm polymer optical fiber (POF) or 200-μm plastic-clad silica (PCS). Links up to 58 meters are supported with 1-mm POF. Links up to 500 meters are supported with 200-μm PCS.

Absolute Maximum Ratings (AFBR-15x1CZ)

Parameter	Symbol	Min.	Max.	Unit
Storage and Operating Temperature	T <sub>S,O</sub>	−40	95	°C
Transmitter Peaking Forward Input Current <sup>a</sup>	I <sub>F,PK</sub>	—	45	mA
Transmitter Short-Term Peaking Forward Input Current <sup>b</sup>	I <sub>F, PKshort</sub>	—	80	mA
Transmitter Average Forward Input Current	I <sub>F,AVG</sub>	—	30	mA
Transmitter Reverse Input Voltage	V <sub>R</sub>	—	3	V

- a. For I<sub>F,PK</sub> > 30 mA, the duty factor must maintain ≤30 mA I<sub>F,AVG</sub> and pulse width ≤1 μs.
- b. The maximum short-term peaking forward current to improve the rise time or to enhance the signaling rate must not exceed 5 ns. Applying a short-term peaking forward current must not result in exceeding a 30-mA average forward current.

Recommended Operating Conditions (AFBR-15x1CZ)

Parameter	Symbol	Min.	Max.	Unit
Ambient Temperature <sup>a, b</sup>	T <sub>A</sub>	−40	95	°C
Transmitter Average Forward Input Current <sup>a</sup>	I <sub>F,AVG</sub>	3	30	mA
Signaling Rate <sup>a, c</sup>	f <sub>s</sub>	DC	5	Mbaud

- a. Recommended operating conditions are those values outside of which functional performance is not intended, device reliability is not implied, and damage to the device may occur over an extended period of time. See the reliability data sheet for specific reliability performance.
- b. Measured at the housing.
- c. Using the driver circuit in [Figure 10](#) (without peaking and clamping of the electrical input signal).



## Electrical and Optical Characteristics (AFBR-15x1CZ)

$T_A = -40^\circ\text{C}$  to  $+95^\circ\text{C}$  unless otherwise stated.

Parameter	Symbol	Min.	Typical	Max.	Unit	Conditions	Notes
Peak Output Power, 1-mm POF, 30 mA	$P_T$	-6	-1	2	dBm	$I_{F,DC} = 30 \text{ mA}$	a, b, c
Peak Output Power, 200m PCS, 30 mA	$P_T$	-18	-12	-9	dBm	$I_{F,DC} = 30 \text{ mA}$	a, b, c
Peak Output Power, 1-mm POF, 10 mA	$P_T$	-11	-6	-3	dBm	$I_{F,DC} = 10 \text{ mA}$	a, b, c
Peak Output Power, 1-mm POF, 5 mA	$P_T$	-14	-9	-6	dBm	$I_{F,DC} = 5 \text{ mA}$	a, b, c
Peak Output Power, 1-mm POF, 3 mA	$P_T$	-16	-11	-8	dBm	$I_{F,DC} = 3 \text{ mA}$	a, b, c
Optical Power Temperature Coefficient	$\Delta P_T / \Delta T$	—	-0.01	—	dB/K	$-40^\circ\text{C}$ to $+25^\circ\text{C}$	c
		—	-0.02	—	dB/K	$+25^\circ\text{C}$ to $+95^\circ\text{C}$	c
Peak Emission Wavelength	$\lambda_P$	630	650	685	nm	—	c
Peak Emission Wavelength Temperature Coefficient	$\Delta \lambda / \Delta T$	—	0.16	—	nm/K	—	c
Spectral Width	FWHM	—	20	—	nm	—	c
Forward Voltage	$V_F$	1.4	—	2.3	V	$I_{F,DC} = 3 \text{ mA}$ to $30 \text{ mA}$	—
Forward Voltage Temperature Coefficient $I_{F,DC} = 30 \text{ mA}$	$\Delta V_F / \Delta T$	—	-2.8	—	mV/K	$-40^\circ\text{C}$ to $+25^\circ\text{C}$	c
		—	-1.1	—	mV/K	$+25^\circ\text{C}$ to $+95^\circ\text{C}$	c
Reverse Input Breakdown Voltage	—	9	20	—	V	—	c
Diode Capacitance	—	—	30	70	pF	—	c
Optical Rise Time (20% to 80%)	$t_r$	—	13	30	ns	—	c, d
Optical Fall Time (80% to 20%)	$t_f$	—	7	30	ns	—	c, d

- Optical power is measured with the polished connector end face at the end of 0.5 meters of 1-mm diameter POF with a numerical aperture (NA) of 0.5, or of 200- $\mu$ m diameter PCS, with NA = 0.37.
- Minimum average output power specification value includes a degradation margin of 1 dB.
- Typical values are mean values measured at  $T_A = 25^\circ\text{C}$ .
- Using the drive circuit in [Figure 10](#) for  $I_{F,DC} = 30 \text{ mA}$ ;  $V_{CC} = 5.0\text{V}$ .

Figure 11: Typical Forward Voltage vs. Drive Current

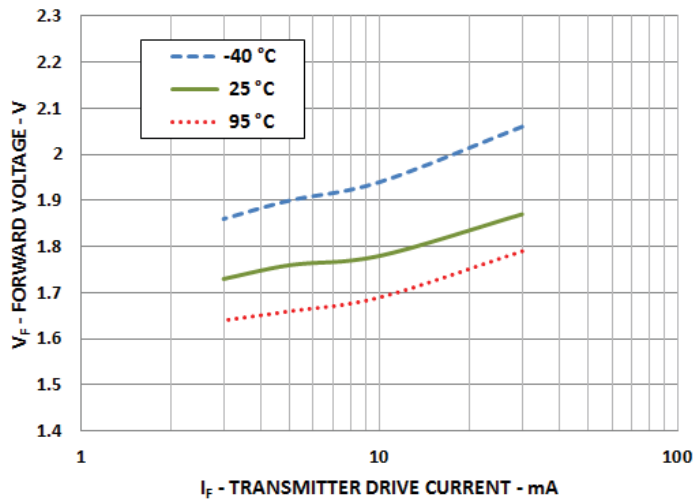
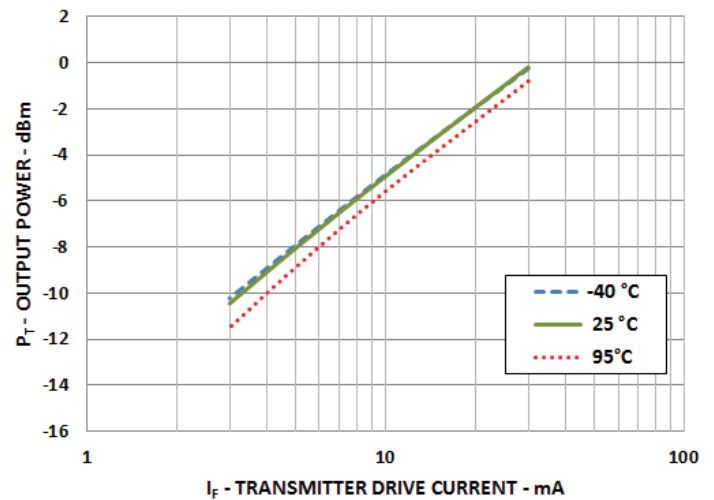


Figure 12: Typical Optical Output Power, 1-mm POF vs. Drive Current



## AFBR-25x1CZ Receiver

The AFBR-25x1CZ receiver consists of a digitalizing IC with an integrated photodiode to produce an output level that is compatible with TTL logic. The integrated photodiode and the receiver's amplifier use a fully differential approach with an active and passive area for improved EMI performance. Within the specified ranges, the AFBR-25x1CZ devices support a BER <10E-9.

## Absolute Maximum Ratings (AFBR-25x1CZ)

Parameter	Symbol	Min.	Typical	Max.	Unit
Storage and Operating Temperature <sup>a</sup>	T <sub>S,O</sub>	-40	—	95	°C
Relative Humidity <sup>a</sup>	RH	0	—	85	%
Supply Voltage <sup>a</sup>	V <sub>CC</sub>	-0.5	—	6	V
Data Output Current <sup>a</sup>	I <sub>O</sub>	—	—	10	mA

a. Absolute maximum ratings are those values beyond which damage to the device can occur if these limits are exceeded for other than a short period of time.

## Recommended Operating Conditions (AFBR-25x1CZ)

Parameter	Symbol	Min.	Typical	Max.	Unit
Ambient Temperature <sup>a, b</sup>	T <sub>A</sub>	-40	25	95	°C
Supply Voltage <sup>a</sup>	V <sub>CC</sub>	3.135	3.3	3.465	V
		4.75	5	5.25	V
Data Rate <sup>a</sup>	—	DC	—	5	Mbaud

a. Recommended operating conditions are those values outside of which functional performance is not intended, device reliability is not implied, and damage to the device may occur over an extended period of time. See the reliability data sheet for specific reliability performance.

b. Measured at the housing.

## Receiver Electrical Characteristics (AFBR-25x1CZ)

$T_A = -40^\circ\text{C}$  to  $+95^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V} \pm 5\%$  or  $5\text{V} \pm 5\%$ .

Parameter	Symbol	Min.	Typical	Max.	Unit
Supply Current <sup>a</sup>	$I_{CC}$	—	6	10	mA
Data Output Voltage – Low <sup>b</sup>	$V_{OL}$	–0.3	—	0.4	V
Data Output Voltage – High <sup>b</sup>	$V_{OH}$	2.5	—	$V_{CC} + 0.3$	V
Rise Time (10% to 90%) <sup>c</sup>	$t_R$	—	—	10	ns
Fall Time (90% to 10%) <sup>c</sup>	$t_F$	—	—	10	ns
Pulse Width Distortion <sup>c, d, e, f</sup>	PWD	–30	—	30	ns
Propagation Delay <sup>c, d</sup>	$t_D$	—	—	60	ns
Propagation Skew <sup>c, d, g</sup>	$t_{skew}$	—	—	20	ns
$V_{CC}$ Level to Deactivate POR <sup>a, h</sup>	$V_{POR\_DEACT}$	—	2.8	—	V
$V_{CC}$ Level to Activate POR <sup>a, h</sup>	$V_{POR\_ACT}$	—	2.6	—	V
POR Deactivate Delay Time <sup>a, h</sup>	$t_{POR\_DEACT\_DEL}$	—	100	—	$\mu$ s

- Typical values are mean values measured at  $T_A = 25^\circ\text{C}$  and 5V.
- Standard TTL output.
- Measured with  $R_L = 5\text{ k}\Omega$  and  $C_L = 20\text{ pF}$ .
- Guaranteed only if an optical input signal is generated by AFBR-15x9Z, AFBR-16x9Z, or AFBR-15x1CZ with ideal alignment to the photodiode using a 1-mm POF ( $NA = 0.5$ ).
- Optical input of 5-Mbaud PRBS-7 pattern and 50% duty cycle. Optical input rise time (10% to 90%)  $\leq 20\text{ ns}$ ; optical input fall time (90% to 10%)  $\leq 20\text{ ns}$ .
- Pulse width is measured at a 50% threshold using a rising-edge trigger and PRBS-7 pattern.
- Only valid for the same input signal characteristics and environmental conditions. The optical input power must be  $\geq -21\text{ dBm}$  (peak).
- The power-on reset (POR) is active below  $V_{POR\_DEACT}$ . Once  $V_{POR\_DEACT}$  is reached, the POR remains active for  $t_{POR\_DEACT\_DEL}$ . During power-down, the POR starts at  $V_{POR\_ACT}$ . See [Figure 13](#).

## Receiver Optical Characteristics (AFBR-25x1CZ)

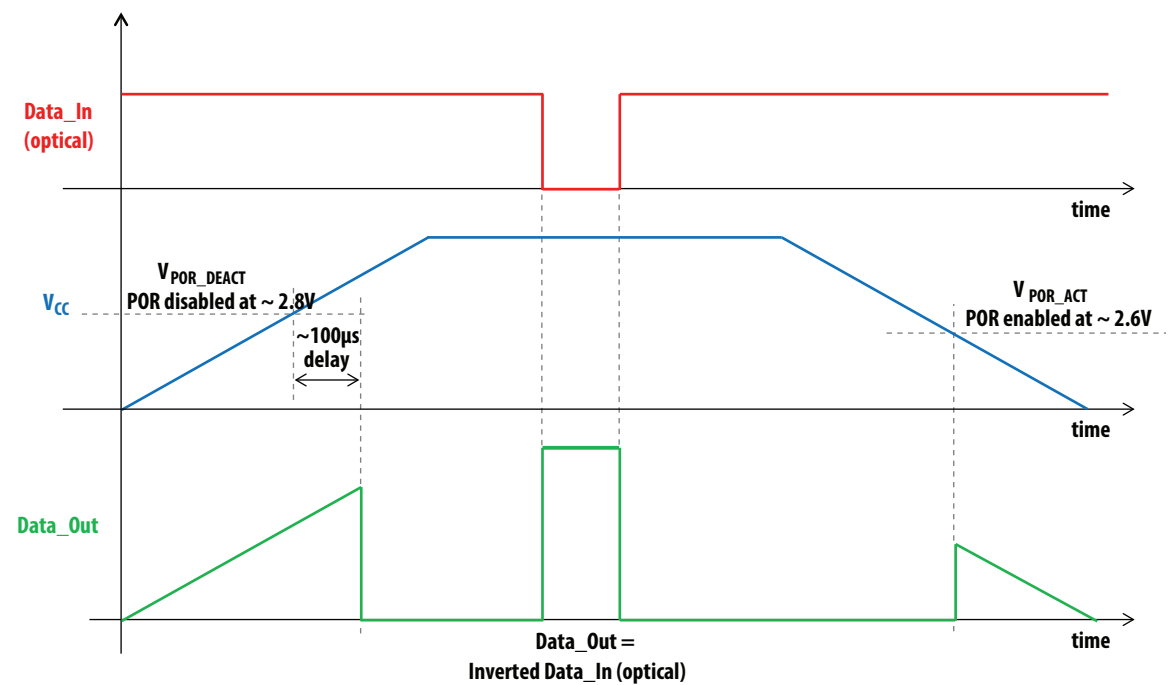
$T_A = -40^\circ\text{C}$  to  $+95^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V} \pm 5\%$  or  $5\text{V} \pm 5\%$ .

Parameter	Symbol	Min.	Typical	Max.	Unit
Input Optical Power POF (Peak) <sup>a</sup>	$P_{IN}$	–24	—	1	dBm
Input Optical Power PCS (Peak) <sup>b</sup>	$P_{IN}$	–26	—	–2	dBm
Input Optical Power Off-State POF <sup>a</sup>	$P_{IN\_Off}$	–40	—	—	dBm
Input Optical Power Off-State PCS <sup>b</sup>	$P_{IN\_Off}$	–43	—	—	dBm
Optical Spectrum Range	$\lambda$	630	—	685	nm

- Measured at the end of a 0.5m POF (1 mm, 0.5 NA) with a large area optical detector.
- Measured at the end of a 0.5m PCS (200  $\mu$ m, 0.37 NA) with a large area optical detector.

# Power-On Reset Functionality

Figure 13: Typical POR Functionality



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