

## AFBR-FS13B25

### Transceiver for Optical Wireless Communications up to 1.25 Gb/s



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### Description

The Broadcom<sup>®</sup> AFBR-FS13B25 is a transceiver that communicates data over free space and thereby allows for wireless communication in a variety of applications.

Full-duplex bidirectional communication, together with a small form factor, allows a compact system design. The device keeps full functionality over a 360° rotation around the optical axis, which reduces the complexity of alignment on the system level.

The AFBR-FS13B25, a Laser Class 1 product, is RoHS compliant and is designed for SMT solderability standard processes.

### Features

- Data rate: 125 Mb/s to 1.25 Gb/s
- Distance range: 20 mm to 100 mm
- Bidirectional full-duplex
- Full function over 360° rotation
- Small form factor
- Single 3.3V power supply
- Operational temperature range: -40°C to +85°C
- SMT solderability
- RoHS compliant
- Laser Class 1

### Applications

- Optical wireless communication
- Through-window optical wireless communication
- Rotary optical data feedthrough
- Board-to-board communication

## Transmitter

The transmitter part of the AFBR-FS13B25 uses an 850-nm VCSEL. The VCSEL is driven by an IC, which converts differential input signals into an analog drive current. The transmitter IC can be enabled and disabled by means of the Tx EN pin.

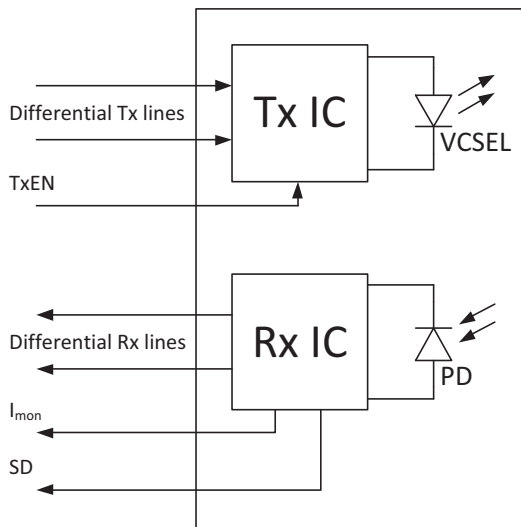
## Receiver

The receiver part of the AFBR-FS13B25 uses a high-speed PIN photodiode and an IC. The IC implements the functionality of a transimpedance amplifier followed by a limiting amplifier for the generation of the logical output. The data output is differential. The receiver IC provides a monitor current ( $I_{mon}$ ) output and a signal detect (SD) output.

## Block Diagram

Figure 1 shows the block diagram of the transceiver. The transmitter and the receiver operate independent of each other.

Figure 1: Transceiver Block Diagram



The product assembly consists of a carrier, the chipset, including the PD and VCSEL, and the lens. Figure 2 shows the geometry.

Figure 3 shows the 3D view of the transceiver. The central pad of the bottom side of the PCB is used for connecting to GND.

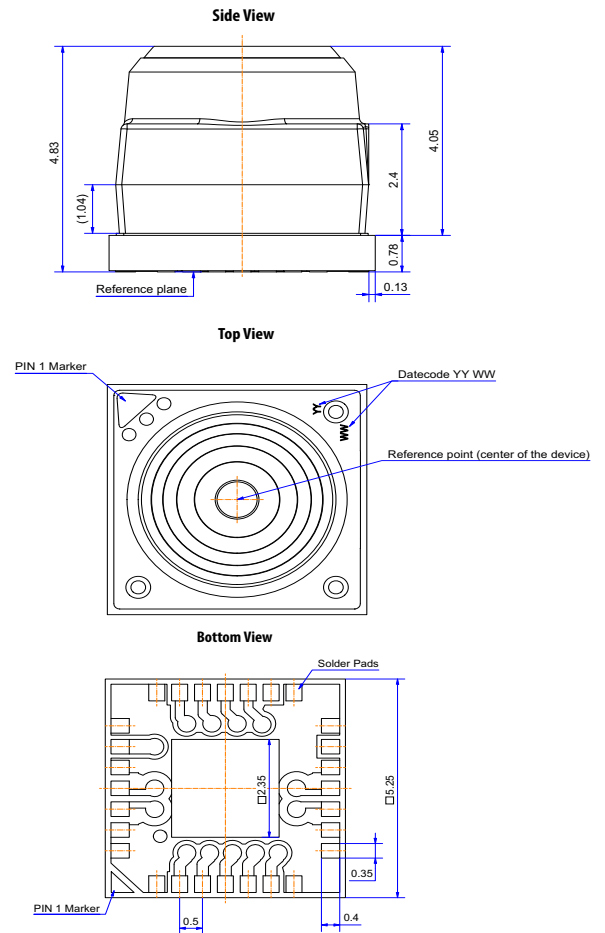
Figure 4 shows the pinout diagram of the transceiver. The diagram shows the location of the pins as seen from above (top view). Pin 1 is in the upper-left corner.

## Mechanical Dimensions

Table 1: Product Geometry

Parameter		Value
Length	L	5.25 mm
Width	W	5.25 mm
Height	H	4.83 mm

Figure 2: Package Outline Drawings



**NOTE:** Dimensions in mm.

Figure 3: 3D View of the Bottom Side of the Device

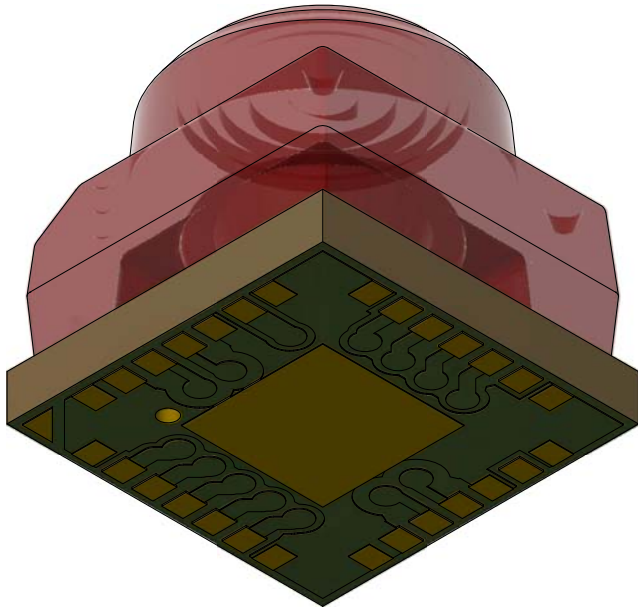


Figure 4: Pinout Diagram of the Transceiver (Top View)

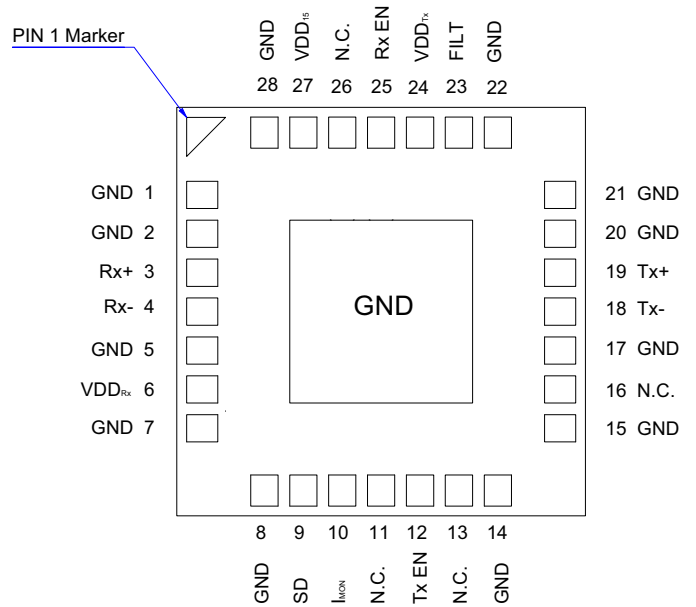


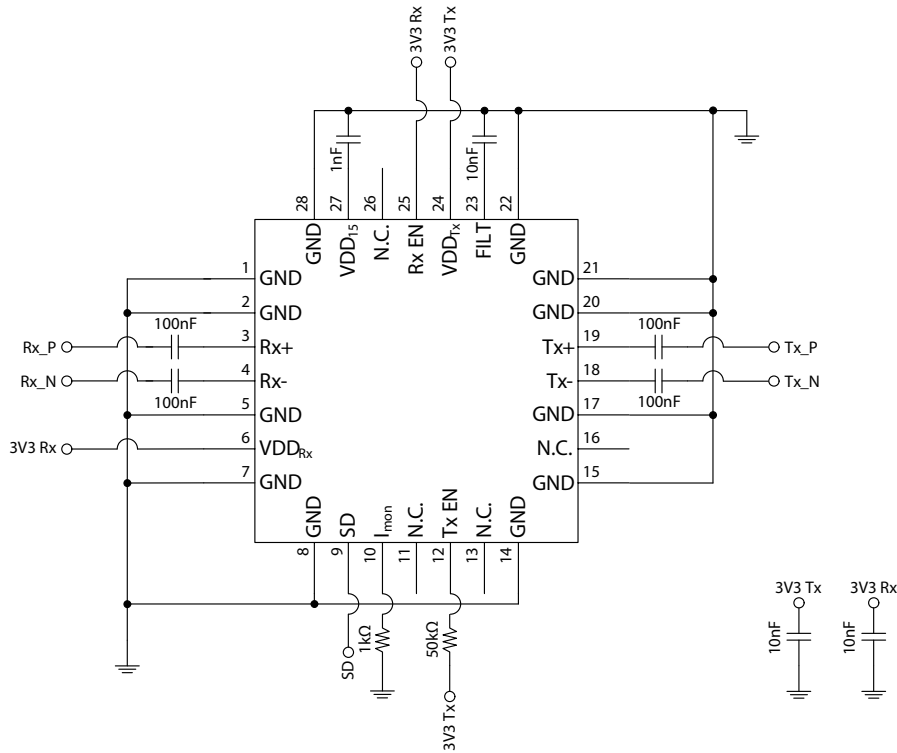
Table 2: Pin Descriptions

Pin	Name	I/O	Description
1	GND	Supply	Ground
2	GND	Supply	Ground
3	Rx+	Out	Positive differential data output
4	Rx-	Out	Negative differential data output
5	GND	Supply	Ground
6	VDD <sub>Rx</sub>	Supply	Rx power supply
7	GND	Supply	Ground
8	GND	Supply	Ground
9	SD	Out	Signal Detect: Set to HIGH when a valid data signal is detected; LOW otherwise.
10	I <sub>mon</sub>	Out	Mirrored PD current
11	—	—	N.C.
12	Tx EN	In	Activates the emitter driver—active HIGH.
13	—	—	N.C.
14	GND	Supply	Ground

Pin	Name	I/O	Description
15	GND	Supply	Ground
16	—	—	N.C.
17	GND	Supply	Ground
18	Tx-	In	Negative differential data input
19	Tx+	In	Positive differential data input
20	GND	Supply	Ground
21	GND	Supply	Ground
22	GND	Supply	Ground
23	FILT	In/Out	Power supply decoupling (Tx)
24	VDD <sub>Tx</sub>	Supply	Tx power supply
25	Rx EN	In	Activates the receiver IC—active HIGH.
26	—	—	N.C.
27	VDD <sub>15</sub>	Supply	This pin must be left open or connected to a 1-nF capacitor (recommended value).
28	GND	Supply	Ground

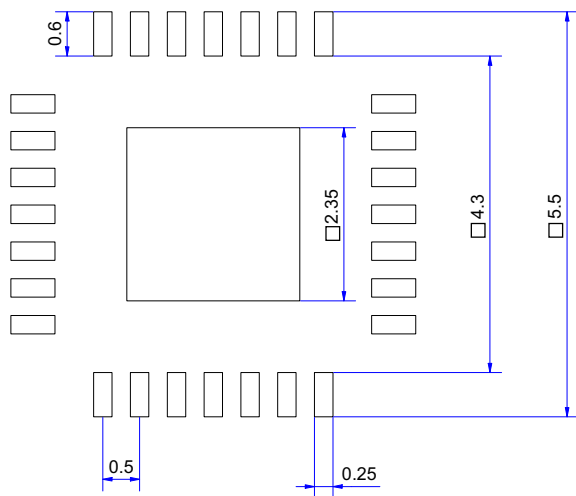
# Typical Application Circuit

Figure 5: Schematic of a Typical Application Circuit



# Recommended PCB Layout

Figure 6: Recommended PCB Solder Pads



**NOTE:** Values in mm.

# Solder Process Profile

**Figure 7: Example of Recommended Reflow Temperature Profile for a Lead-Free Solder Paste – Common Reflow with a Maximum +245°C for a Maximum 10-Second Peak**

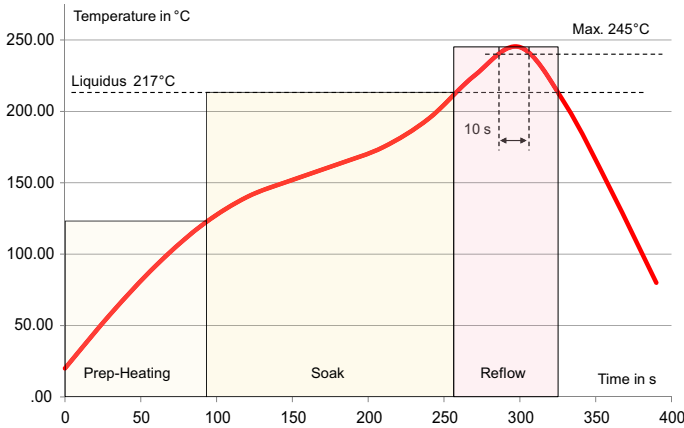


Figure 7 shows a typical reflow profile for lead-free solder pastes (temperature vs. time). Figure 7 shows an overview for common reflow with a maximum +245°C for a maximum 10-second peak.

Ensure that this range is maintained. A thermal overstress might negatively impact device performance.

## Electrostatic Discharge

Follow common ESD handling precautions for ESD-sensitive devices. These precautions include using grounded wrist straps, work benches, and floor mats in ESD-controlled areas.

## Immunity

Equipment that hosts the AFBR-FS13B25 might be subjected to radio-frequency electromagnetic fields in some environments. The transceiver has good immunity to such fields due to its compact design.

## Regulatory Compliance

**Table 3: Regulatory Compliance**

Feature	Test Method	Performance
Electrostatic Discharge (ESD)	JEDEC JS-001-2012	HBM 1 kV.
Immunity	EN 55024 EN 61000-4-3	Typically shows no measurable effect from a 10V/m field swept from 80 MHz to 6 GHz applied to the transceiver without enclosure.
Eye Safety	IEC/EN 60825-1:2014	Class 1 Laser Safety.
EMI	EN55032 EN55016-2-3	System margins are dependent on customer board design.
RoHS I and II Compliance	—	Refer to RoHS Directive 2011/65EU Annex II and RoHS RL (EU) 2015-863.

## Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause catastrophic damage to the device. Limits apply to each parameter in isolation, with all other parameters having values within the recommended operation conditions. Exposure to the absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	$T_s$	-40	85	°C	—
Transmitter Supply Voltage	$VDD_{TX}$	-0.5	4.5	V	—
Receiver Supply Voltage	$VDD_{RX}$	-0.4	4.0	V	—
Data Input Voltage at Tx+/Tx-	$V_i$	-0.5	1.8	V	—
Soldering Temperature	$T_{sold}$	—	+245	°C	a, b
Soldering Time	$t_{sold}$	—	10	seconds	a, b
Total Power Dissipation	—	—	100	mW	—

a. MSL 5a.

b. According to [Figure 7](#).

## Recommended Operating Conditions

All the data in this specification refers to the preceding operating conditions.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Ambient Operating Temperature	$T_c$	-40	25	85	°C	a
Transmitter Supply Voltage	$VDD_{TX}$	3.13	3.3	3.47	V	—
Receiver Supply Voltage	$VDD_{RX}$	3.13	3.3	3.47	V	—
Data Rate	DR	0.125	—	1.25	Gb/s	b
Link Distance	$D_{Link}$	20	—	100	mm	c, d, e

a. Electrical and optical specifications of the product are guaranteed across the recommended ambient operating temperature range only.

b. The maximum lateral misalignment from transceiver to transceiver is 1.0 mm from the reference point (see [Figure 2](#)) of the Transceiver 1 to reference point of the Transceiver 2 at a link distance of 30 mm. In this condition, a BER <  $10^{-9}$  can be reached for 8b10b coding and 1.25 Gb/s. The reference planes (see [Figure 2](#)) of the two transceivers of the optical link must be parallel to each other.

c. Top of lens to top of lens.

d. For distances below 30 mm, the impact of optical reflections by other components or the opposite device can increase, which can cause an increased bit error rate. Consult the application guide on how to mitigate the impact of reflections.

e. For distances above 60 mm, special care must be taken to avoid additional tilt while soldering the device and assembling in the system.

## Transmitter Electrical Characteristics

Typical values are for room temperature at 3.3V and 1.25 Gb/s.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply Current	$Tx I_{CC}$	—	4	7	mA	
Common Mode Input Voltage	$V_{ICM}$	150	—	340	mV	—
Differential Input Voltage (p-p)	$V_{Din}$	0.2	—	1.4	V	a
Differential Input Impedance	$Z_{IN}$	90	100	110	$\Omega$	b
Transmitter Enable Input, HIGH	$V_{TxEN,H}$	$0.4 \times VDD_{Tx}$	—	$VDD_{Tx}$	V	—
Transmitter Enable Input, LOW	$V_{TxEN,L}$	0	—	0.4	V	—

a. LVDS AC coupled.

b. Self-biasing differential input; input signal must be AC coupled.

## Transmitter Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Central Wavelength	$\lambda_c$	830	850	870	nm	—
Spectral Width – FWHM	$\Delta\lambda$	—	0.40	0.85	nm	—

## Receiver Electrical Characteristics

Typical values are for room temperature at 3.3V and 1.25 Gb/s.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply Current	$Rx I_{CC}$	—	17	24	mA	—
Common Mode Output Voltage	$V_{OCM}$	180	250	330	mV	—
Differential Output Voltage (p) or $V_p$	$V_{Dout}$	0.18	0.23	0.33	V	a
Differential Output Impedance	$Z_{out}$	90	—	110	$\Omega$	—
Data Output Rise Time (10% to 90%)	$t_r$	—	—	200	ps	b
Data Output Fall Time (90% to 10%)	$t_f$	—	—	200	ps	b
Signal Detect Output Voltage, LOW	$SD_{O,L}$	—	—	0.1	V	c
Signal Detect Output Voltage, HIGH	$SD_{O,H}$	1.1	1.5	1.55	V	d

a. With a 100 $\Omega$  differential load and AC coupling of the output signal.

b. No capacitive load, 50 $\Omega$  terminated to GND.

c. The Signal Detect pin will output a LOW voltage level if  $I_{mon} \leq 1 \mu A$ .

d. The Signal Detect pin will output a HIGH voltage level if  $I_{mon} \geq 3 \mu A$ .

## Receiver Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Wavelength	$\lambda_c$	830	850	860	nm	—

## Optical Link Performance

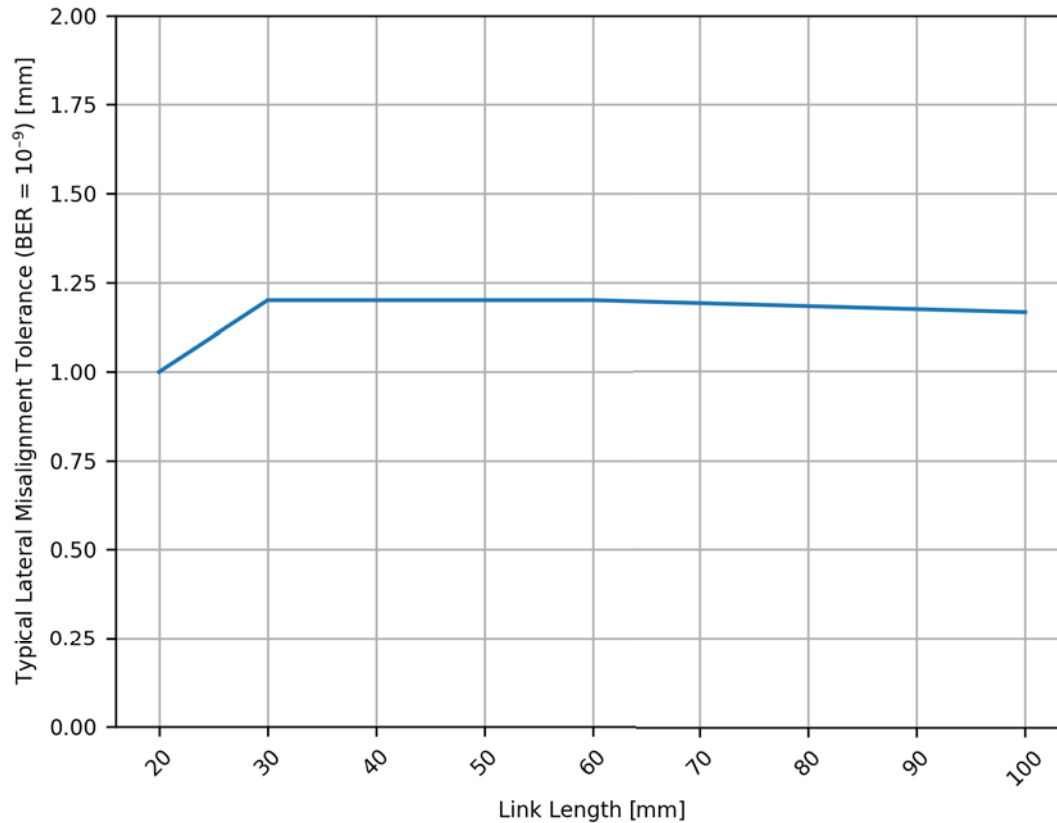
Because the transmitter and receiver are always used as a pair and the link performance is highly dependent on the lens system and interface medium, it is proposed to specify the overall link performance and power margin.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Bit Error Rate	BER	—	—	$2.5 \times 10^{-10}$	—	a, b, c
Total Jitter at the Rx at 1.25 Gb/s	$T_j$ Rx	—	—	0.35	UI	a, b, d

- a. In air.
- b. Tested with 8b10b.
- c.  $2.5 \times 10^{-10}$  for perfect alignment.
- d. Total jitter of the full link with an ideal electrical signal at the input of the Tx.

## Typical Lateral Misalignment Tolerance

Figure 8: Typical Lateral Misalignment Tolerance (BER =  $10^{-9}$ ) vs. Link Length, Measured at 1.25 Gb/s





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