

AFBR-FS13B25

Transceiver for Optical Wireless Communications up to 1.25Gb/s



Description

The Broadcom[®] AFBR-FS13B25 is a transceiver that communicates data over free space and thereby allows connector-less/cable-less 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: up to 1.25Gb/s
- Distance range: 30 mm to 60 mm
- Bidirectional full-duplex
- Full function over 360° rotation
- Small form factor
- Single 3.3V power supply
- Operational temperature range: -10°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

Functional Description

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 may be enabled and disabled by means of the pin TxEN.

Receiver

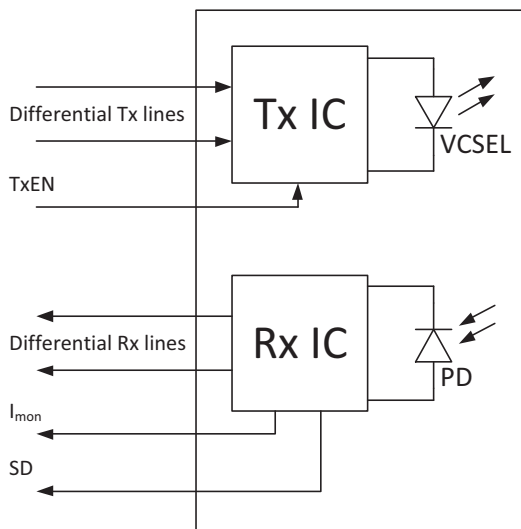
The receiver part of the AFBR-FS13B25 uses a high-speed PIN photodiode and an IC. The IC implements the functionality of a transimpedance amplifier followed by a limiting amplifier for the generation of the logical output. The data output is differential.

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: Block Diagram Transceiver



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

Figure 3 shows the 3D view of the transceiver. The central pad of the bottom side of the PCB is used for Data Matrix Code (DMC) marking. The DMC contains a unique serial number.

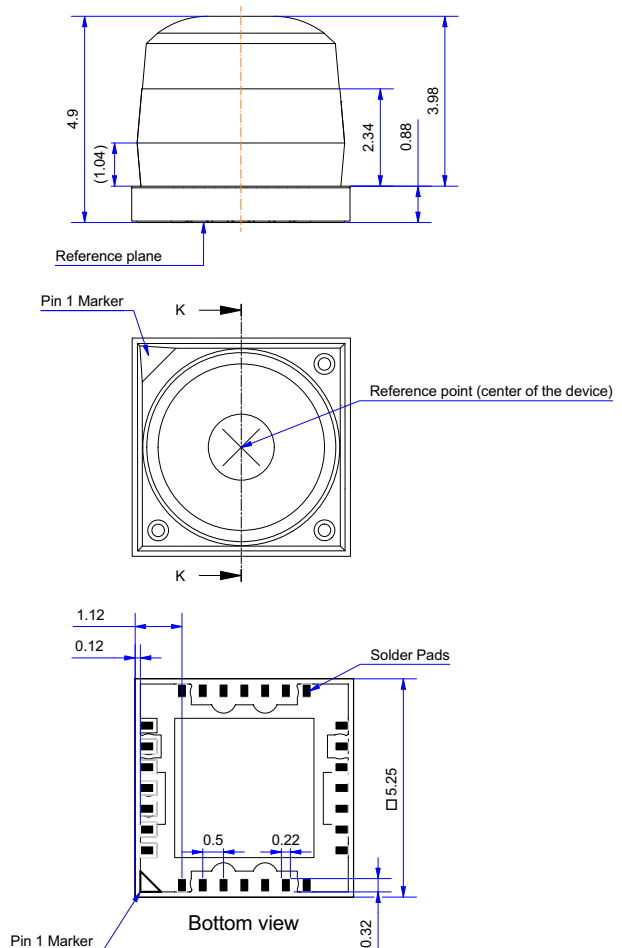
The pinout diagram of the transceiver is shown in Figure 4. The diagram shows the location of the pins as seen from above (top view). Pin 1 is in the upper-left corner.

Mechanical Dimensions

Table 1: Product Geometry

Parameter		Value
Length	L	5.25 mm
Width	W	5.25 mm
Height	H	4.90 mm

Figure 2: Package Outline Drawings



NOTE: Dimensions in mm.

Figure 3: 3D View of the Device with Data Matrix Code (DMC) Marking

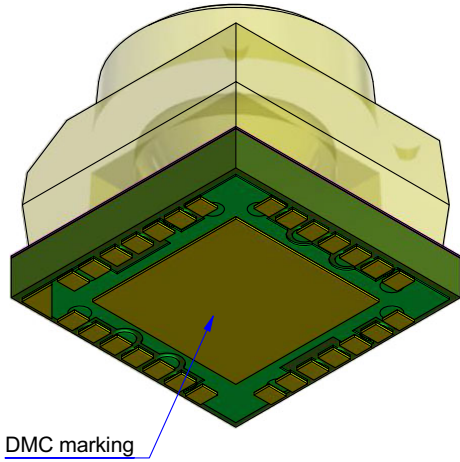


Figure 4: Pinout Diagram of the Transceiver (Top View)

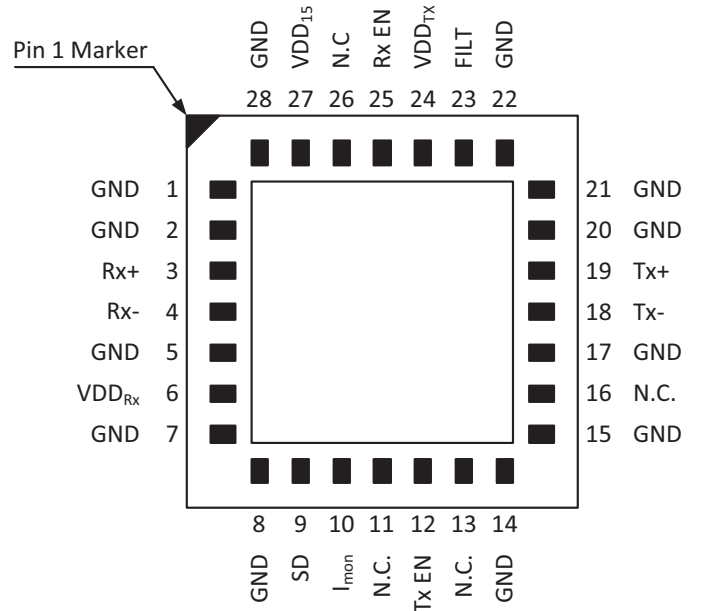


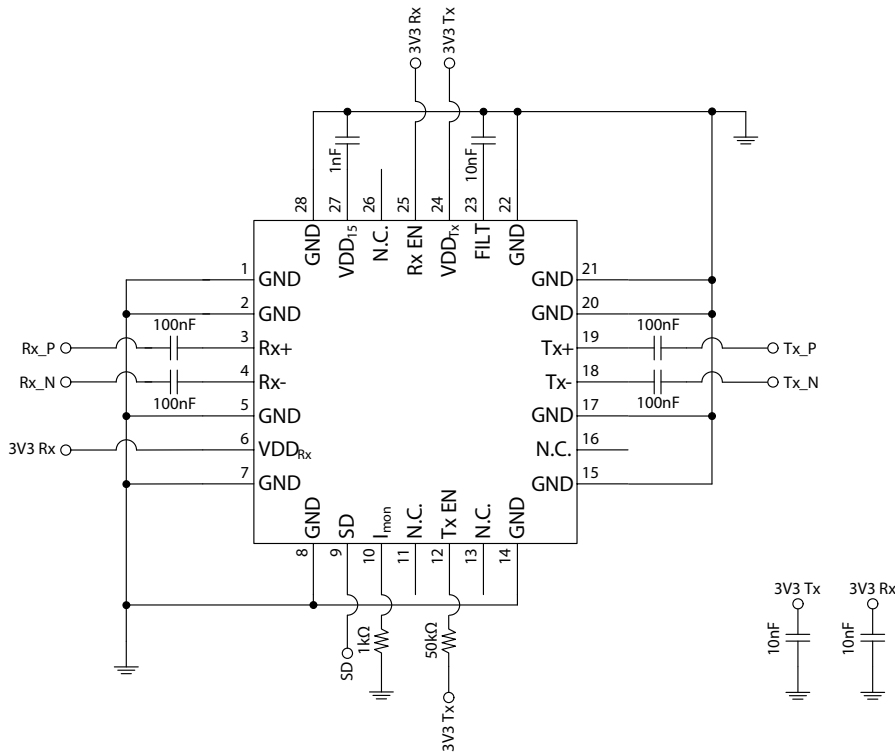
Table 2: Pin Descriptions

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 _{Rx}	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 _{mon}	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 _{Tx}	Supply	Tx Power supply
25	Rx EN	In	This pin must be connected to VDD _{Rx}
26	—	—	N.C.
27	VDD ₁₅	Supply	This pin must be left open or connected to a 1-nF capacitor (recommended value)
28	GND	Supply	Ground

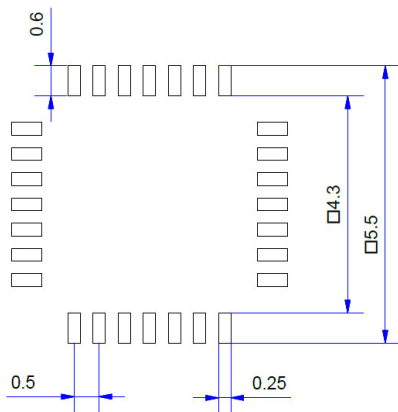
Typical Application Circuit

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 Maximum +245°C for Maximum 10-Second Peak

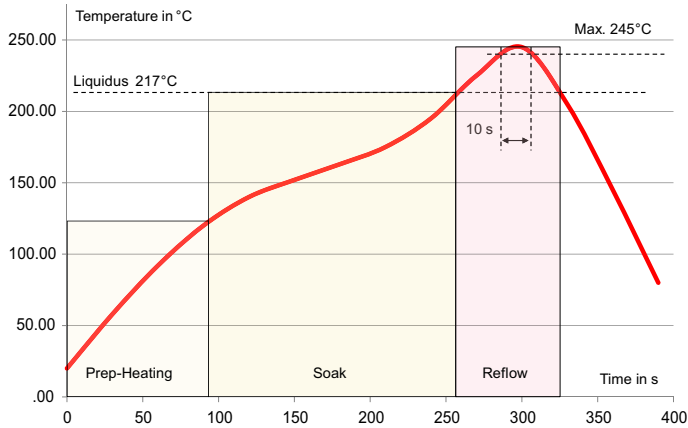


Figure 7 shows typical reflow profile for lead-free solder pastes (temperature vs. time). Figure 7 shows an overview for common reflow with a maximum +245°C for a maximum 10-second peak.

Ensure that this range is kept. A thermal overstress might impact device reliability and performance.

Electrostatic Discharge (ESD)

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.

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	-10	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}	30	—	60	mm	c

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 have to be parallel to each other.

c. Top of lens to top of lens.

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	10	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	Ω	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 shall be AC coupled.

Transmitter Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Central Wavelength	λ_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	21	mA	
Common Mode Output Voltage	V _{OCM}	180	250	330	mV	
Differential Output Voltage (p-p)	V _{Dout}	0.30	0.45	0.70	V	a
Differential Output Impedance	Z _{out}	90	—	110	Ω	—
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

- With a 100Ω differential load and AC coupling of the output signal.
- No capacitive load, 50Ω terminated to GND.
- The Signal Detect pin will output a LOW voltage level if I_{mon} ≤ 1 μA.
- The Signal Detect pin will output a HIGH voltage level if I_{mon} ≥ 3 μA.

Receiver Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Wavelength	λ _c	830	850	860	nm	—

Optical Link Performance

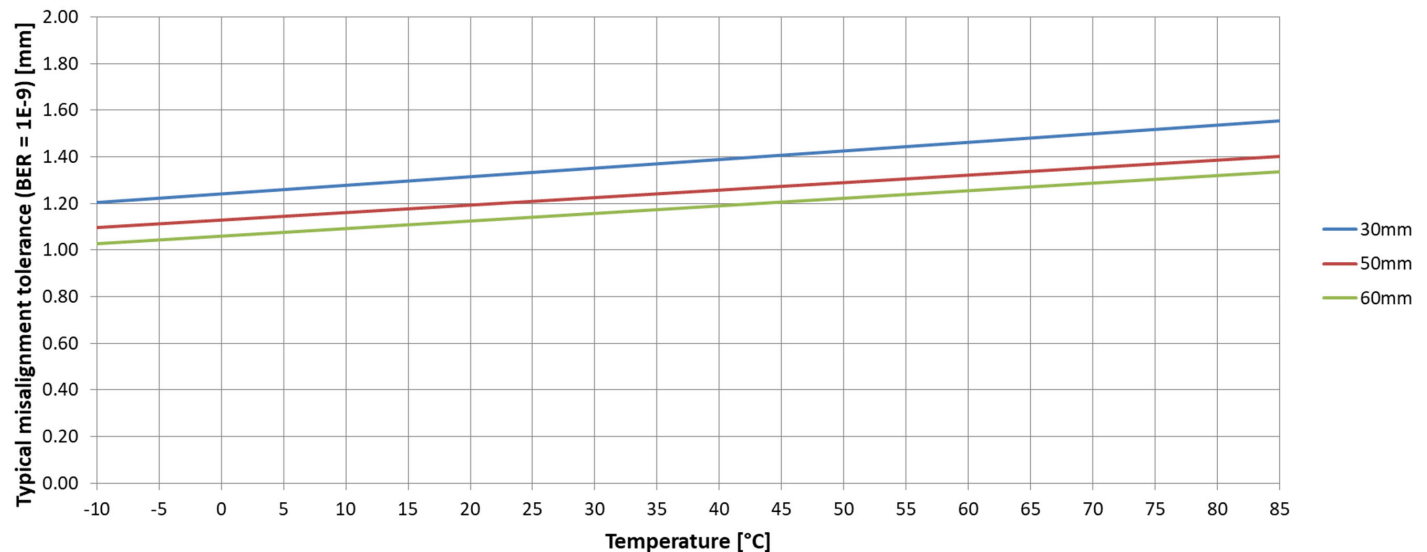
Because the transmitter and receiver are always used as a pair and the link performance is highly dependent on the lens system and interface medium, it is proposed to specify the overall link performance and power margin.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Bit Error Rate	BER	—	—	2.5×10^{-10}		a, b, c
Total jitter at the Rx at 1.25 Gb/s	T_j Rx	—	—	0.75	UI	a, b, d

- In air.
- Tested with 8B10B.
- 2.5×10^{-10} for perfect alignment.
- 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. Temperature and Link Length



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