Data Sheet

AFBR-59F2Z

250-Mbaud Compact 650-nm Transceiver for Data Communication over POF Cables with a Bare-Fiber Locking System

Overview

The Broadcom® AFBR-59F2Z transceiver provides system designers with the ability to support serial communication with baud rates of up to 250 Mbaud over 2.2-mm jacketed standard polymer optical fiber (POF).

The innovative bare-fiber locking mechanism of the transceiver allows connection of a POF cable with a simple insert-and-lock system, eliminating the need for connectors and facilitating fast installation and maintenance.

The AFBR-59F2Z is Laser Class 1, lead-free, and compliant with RoHS. The very compact design is similar to that of the well-known RJ-45 connector.

The transmitter consists of a 650-nm LED, which is controlled by a fully integrated driver IC. The LED driver operates at 3.3V. It receives low-voltage differential signaling (LVDS) electrical input and converts it into a modulated current that drives the LED. The LED and driver IC are packaged in an optical subassembly.

The optimized lens system of the optical subassembly couples the emitted optical power very efficiently into a 1-mm core POF cable.

The receiver utilizes a fully integrated single-chip solution that provides excellent immunity to EMI and fast transient dV/dt rejection. The receiver directly converts light to a digital LVDS output signal and operates at 3.3V nominal supply. The integrated receiver is packaged in an optical subassembly, which couples optical power efficiently from the POF to the receiving PIN.

The receiver features an analog monitor output of the incoming optical signal. The monitor output provides an analog voltage proportional to the average optical input power. In the absence of a receiver optical input signal, the receiver is in low-power sleep mode and the differential output signal is pulled to ground. The receiver wakes up when a valid optical input signal is detected.

Features

- Easy bare-fiber termination solution for 2.2-mm jacket POF
- EMI/EMC robust
- Link lengths up to 40m POF
- LVDS interface compatible
- Operating temperature range: –40°C to +85°C
- 3.3V power supply operation
- Analog monitor output (MON)
- Low-power sleep mode

Applications

- Factory automation
- Power generation and distribution system
- Industrial vision system
- Solar panel tracking system
- Home/office networking

Package

The transceiver package contains the two optical subassemblies, which are mounted in the housing for bare-fiber connection.

The metal shield on the bare-fiber clamp transceiver provides excellent immunity to EMI/EMC.

Pin Description and Recommended PCB Footprint

The AFBR-59F2Z has ten active signal pins (including supply voltage and ground pins), two EMI shield solder posts, two additional ground pins, and two mounting posts.

The EMI shield solder posts and the additional ground pins are isolated from the transceiver internal circuit and should be connected to the equipment chassis ground or signal ground. Connecting the two additional ground pins to ground provides EMI shielding to the front of the device. Grounding these pins also provides a ground connection of the POF jacket in order to ground small leakage currents in high-voltage applications such as HVDC installations.

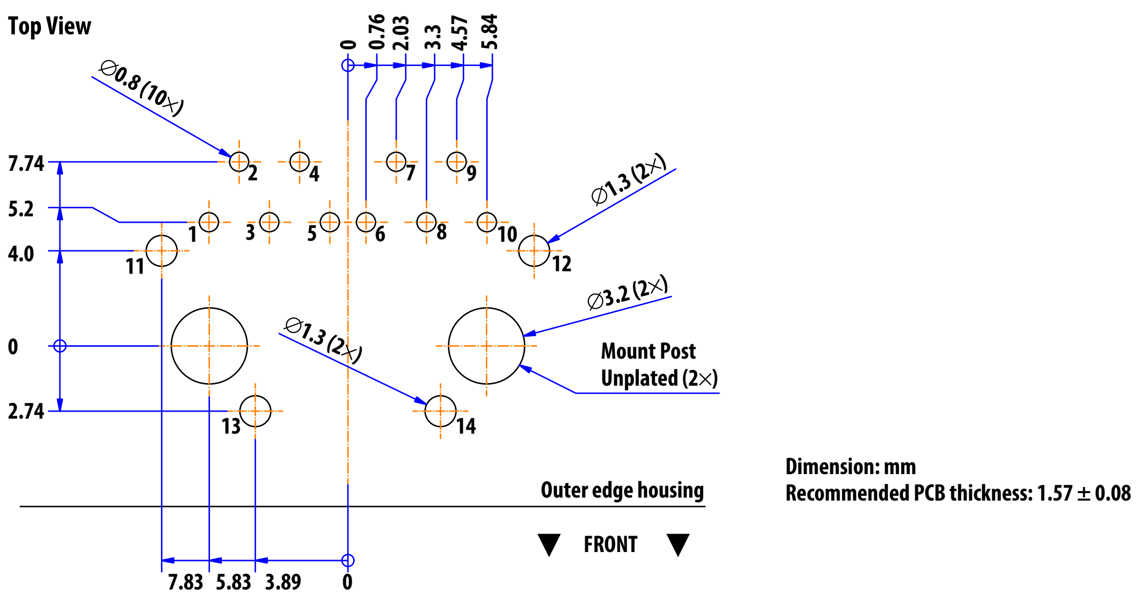
The mounting posts provide additional mechanical strength to hold the transceiver module on the application board. Figure 1 shows the top view of the PCB footprint and pinout diagram.

Pin Descriptions

Pin No.	Name	Symbol
1	Data Input (Negative)	TD–
2	Data Input (Positive)	TD+
3	Ground Tx	GND
4	DC Supply Voltage Tx	Vdd
5	(Optional) Ground Tx	GND
6	DC Supply Voltage Rx	Vdd
7	Ground Rx	GND

Pin No.	Name	Symbol
8	Monitor Output (IAVG)	MON
9	Data Output (Negative)	RD–
10	Data Output (Positive)	RD+
11	EMI Shield GND	—
12	EMI Shield GND	—
13	Additional EMI GND	—
14	Additional EMI GND	—

Figure 1: PCB Footprint and Pinout Diagram



Recommended Compliance Table

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	JESD22-A114	Withstands up to 2-kV HBM applied between the electrical pins.
Immunity	Variation of IEC 61000-4-3	Typically shows no measurable effect from a 15-V/m field swept from 80 MHz to 1 GHz applied to the transceiver when mounted on a circuit board without a chassis enclosure.
Eye Safety	EN 60825-1:2014	Laser Class 1 product (LED radiation only). TÜV certificate: R50483935. **CAUTION!** Use of controls or adjustments of performance or procedures other than those specified herein may result in hazardous radiation exposure.

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, all other parameters having values within the recommended operation conditions. It should not be assumed that limiting values of more than one parameter can be applied to the products at the same time. Exposure to the absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	$V_{dd\ Max}$	–0.5	4.5	V
Storage Temperature	T_{STG}	–40	85	°C
Lead Soldering Temperature[a]	T_{sold}	—	260	°C
Lead Soldering Time[a]	t_{sold}	—	10	s
Electrostatic Voltage Capability[b]	ESD	—	2.0	kV
Installation Temperature[c]	T_I	0	50	°C

a. The transceiver is Pb-free wave solderable. According to JEDEC J-STD-020D, the moisture sensitivity classification is MSL2a.

b. ESD capability for all pins HBM (human-body model) according JESD22-A114B.

c. Range over which fibers can be connected/disconnected to/from the bare fiber clamp.

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Temperature	T_A	–40	25	85	°C
DC Supply Voltage	V_{dd}	3.0	3.3	3.6	V
Baud Rate[a]	BR	10	—	250	Mbaud

a. Minimum baud rate for biphase coded signals. Maximum baud rate for 8b/10b coded signals, verified by a PRBS 2^7-1 test pattern. A 200-Mb/s 8b/10b coded signal has a baud rate of 250 Mbaud.

Mechanical Characteristics

Parameter	Min.	Typ.	Max.	Unit	Temp. (°C)
Fiber/Cable Retention Force[a]	—	30	—	N	25
	10	—	50	N	–40 to +85[b]
Clamp Opening Force	—	20	—	N	25
	10	—	30	N	0 to 50[b]
Clamp Closing Force	—	13	—	N	25
	5	—	20	N	0 to 50[b]

a. Measured with the Broadcom AFBR-HUDxxxZ (2.2-mm duplex-fiber, PE jacket, without connector) with 100-mm/min traction speed.

b. Range over which fibers can be connected/disconnected to/from the bare fiber clamp.

Transmitter Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
Current Consumption	I_{dd}	—	20	30	mA
External Input Termination Impedance	Z_{IN}	—	100	—	Ω
LVDS Input Voltage Range to Circuit Common	V_{IN}	0.8	—	2.2	V
LVDS Differential Input Voltage	$V_{IN\text{-}DIFF}$	200	—	1200	mV

Transmitter Optical Characteristics (with Standard POF NA = 0.5)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Central Wavelength[a]	λ_C	635	650	675	nm
Spectral Bandwidth (RMS)	λ_W	—	—	17	nm
Average Output Power[a, b]	P_O	–8.5	—	–2.0	dBm
Optical Rise Time (20% to 80%)[a]	t_r	—	1.2	3.0	ns
Optical Fall Time (80% to 20%)[a]	t_f	—	1.0	3.0	ns
Extinction Ratio[a]	R_E	10	17	—	dB
Duty Cycle Distortion[a]	DCD	—	—	1.0	ns
Random Jitter[a, c]	RJ	—	—	0.7	ns
Data Dependent Jitter[a]	DDJ	—	—	0.8	ns
Wake Up Time after Sleep State[d]	T_{WKUP}	—	—	10	μs
Time to Sleep[e]	T_{SLP}	—	3	—	μs
Sleep Current	I_{dd_slp}	—	22	—	μA

a. Measured with the ideal coupled optical signal at the end of 1m polymer optical fiber (POF) with a PRBS $2^7 - 1$ sequence.

b. Measured at $V_{IN\text{-}DIFF} \geq 400$ mV.

c. Peak-to-peak measurement, based on BER = 2.5×10^{-10}.

d. Time between the first electrical input to the first optical output.

e. The transmitter is DC capable. To start the TX sleep routine, it is recommended to disable both input lines (TRI-STATE). The sleep mode at the IC level is typically reached after 3 μs.

Receiver Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
Current Consumption	I_{dd}	—	23	30	mA
LVDS Output Common Mode Voltage	V_{CM}	—	1.2	—	V
LVDS Output Differential Voltage Swing[a]	$V_{O\text{-}DIFF}$	500	—	800	mV
Output Rise Time (10% to 90%)[a]	t_r	—	0.8	3.0	ns
Output Fall Time (90% to10%)[a]	t_f	—	0.8	3.0	ns
Duty Cycle Distortion[a]	DCD	—	—	1.0	ns
Random Jitter[a, b, c]	RJ	—	—	1.0	ns
Data Dependent Jitter[a]	DDJ	—	—	0.8	ns
Output Ratio for MON Pin (to Use the I_{AVG} Output of the IC)	$I_{MON/P}$	—	0.5	—	µA/µW
Monitor Output Voltage Range	V_{MON}	0	—	V_{dd} – 1.5	V
Wake Up Time after Sleep State[d]	T_{WKUP}	—	—	1.0	ms
Time to Sleep[e]	T_{SLP}	—	66	—	µs
Sleep Current	I_{dd_slp}	—	20	—	µA

a. The differential output signal is measured with the reference transmitter source, ideal coupled 0.5m polymer optical fiber (POF), and PRBS $2^7 – 1$ sequence.

b. Peak-to-peak measurement, based on BER = 2.5×10^{-10}.

c. The maximum random jitter at –15-dBm optical input power is 0.4 ns.

d. The time between the first optical input to the first electrical output.

e. An optical input signal (Light ON or Light OFF) typically longer than 400 ns starts the Rx sleep routine. The sleep mode at the IC level is typically reached after 66 µs.

Receiver Optical Characteristics

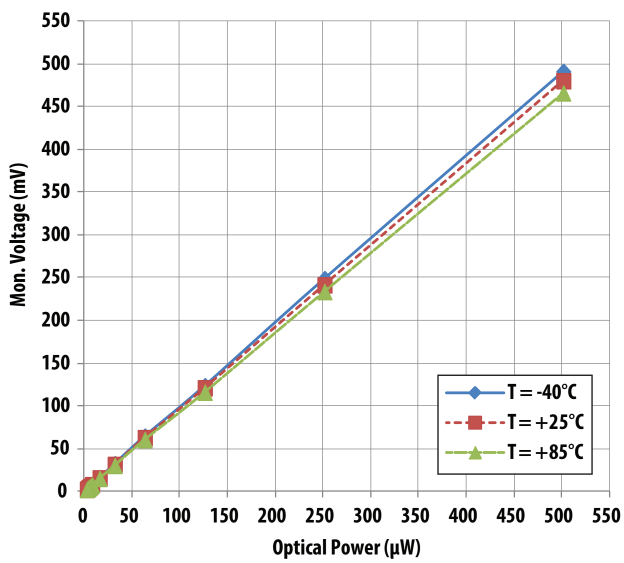
Parameter	Symbol	Min.	Typ.	Max.	Unit
Central Wavelength[a]	λ_C	635	650	675	nm
Minimum Receiver Input Power[a]	$P_{in\ Min}$	–21	—	—	dBm
Maximum Receiver Input Power[a]	$P_{in\ Max}$	—	—	–2	dBm

a. Average optical power, measured with a PRBS $2^7 – 1$ sequence, BER = 2.5×10^{-10}.

Analog Monitoring Voltage

Figure 2 shows the variation of the analog monitoring voltage as a function of the receiver optical input for the industrial temperature range. The monitoring voltage is measured across a 2K resistor as shown in Figure 3. The monitoring voltage varies linearly with the optical input power, and the variation over temperature is negligible.

Figure 2: Analog Monitoring Voltage as a Function of Optical Power



General LVDS Application Circuit

Figure 3 shows the recommended application circuit.

Board Layout - Decoupling Circuit and Ground Planes

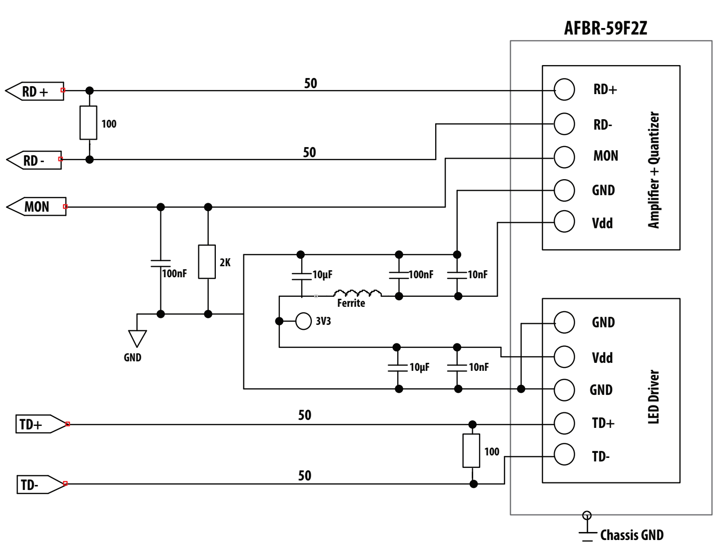
To achieve optimum performance from the AFBR-59F2Z transceiver module, it is important to take note of the following recommendations:

- A power-supply decoupling circuit should be used to filter out noise and ensure optical product performance.
- A contiguous signal ground plane should be provided directly beneath the transceiver module for low inductance ground to signal return current.
- The shield posts should be connected to chassis ground or signal ground to provide optimum EMI and ESD performance.

These recommendations are in keeping with good high-frequency board layout practices; however, the optimum grounding strategy will depend on the overall system architecture.

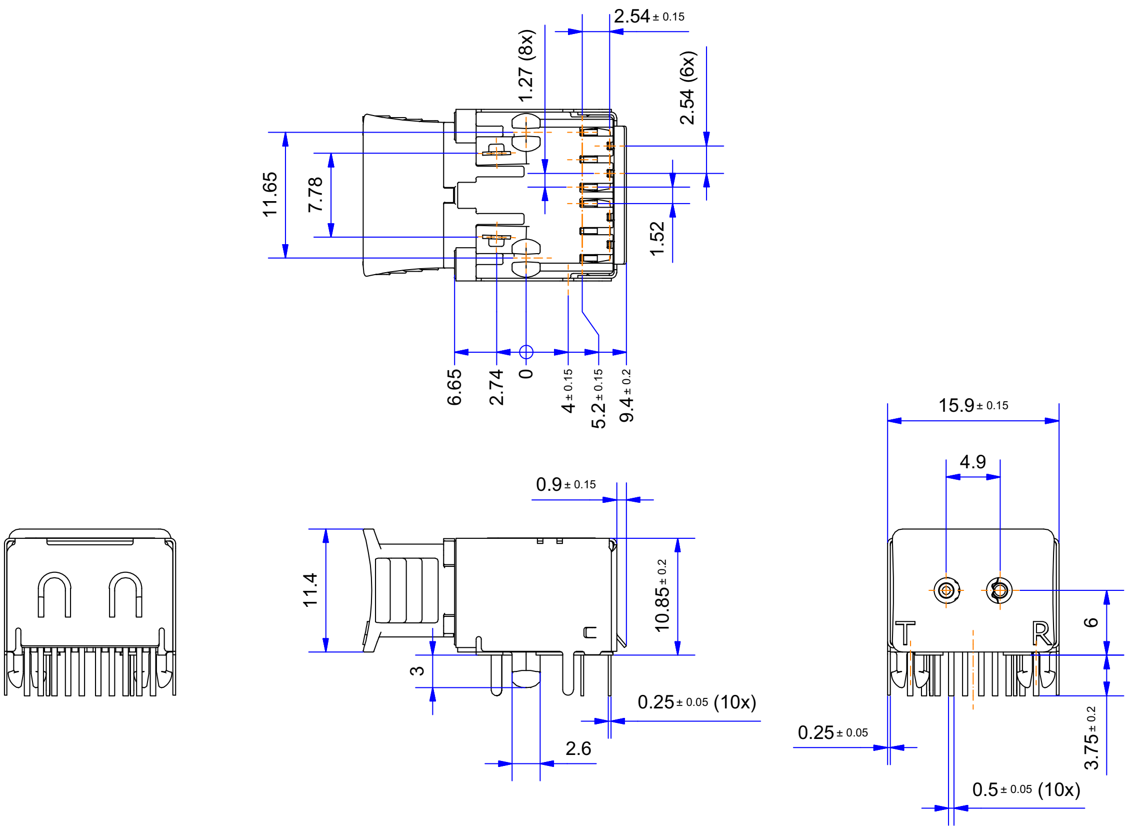
Figure 3 shows the minimum external circuitry between the AFBR-59F2Z transceiver module and a PHY chip. AC coupling would be possible, if the common mode voltage and voltage swing at the data lines are within the recommended values. Use the product information of the actual PHY chip for connecting to the AFBR-59F2Z transceiver module.

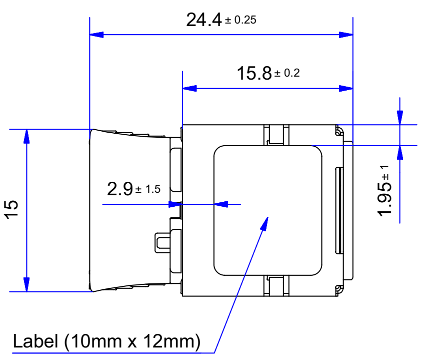
Figure 3: General Application Circuit for LVDS Configuration



Mechanical Data - Package Outline

Figure 4: Package Outline Drawing





Notes:
1. Dimension: mm
2. General tolerance: ±0.1
3. Recommended PCB thickness: 1.57 ± 0.08
4. Design related is a small gap between plastic part and dust plug possible. Function is nevertheless given.

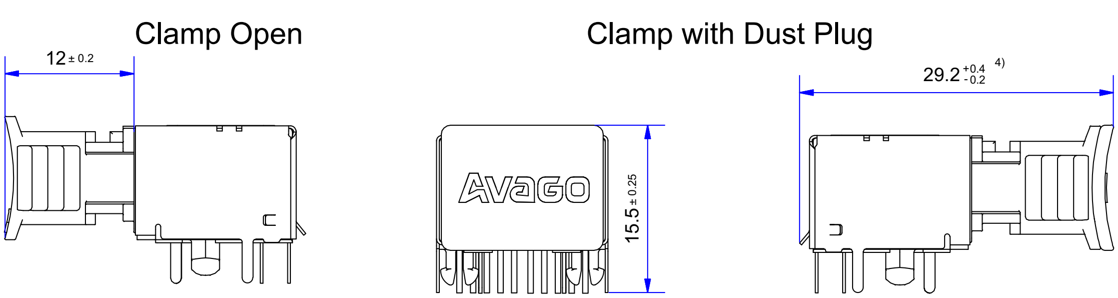


Figure 5: AFBR-59F2Z Transceiver Module with Dust Plug

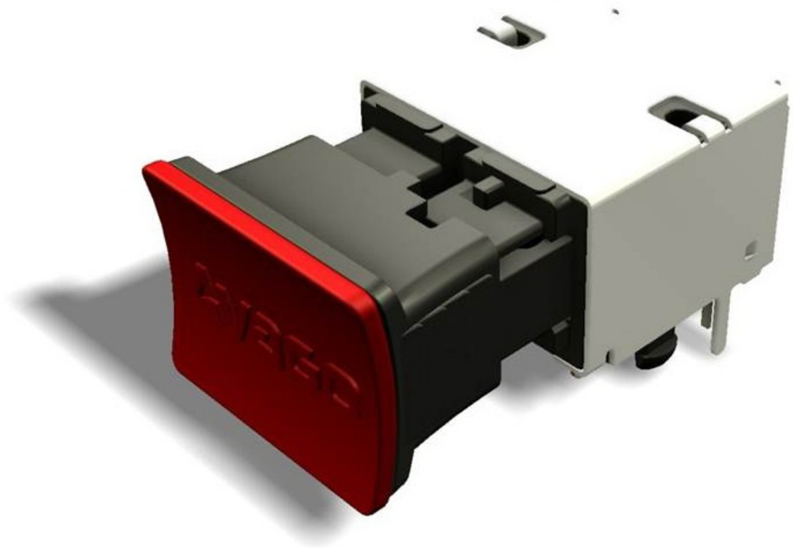
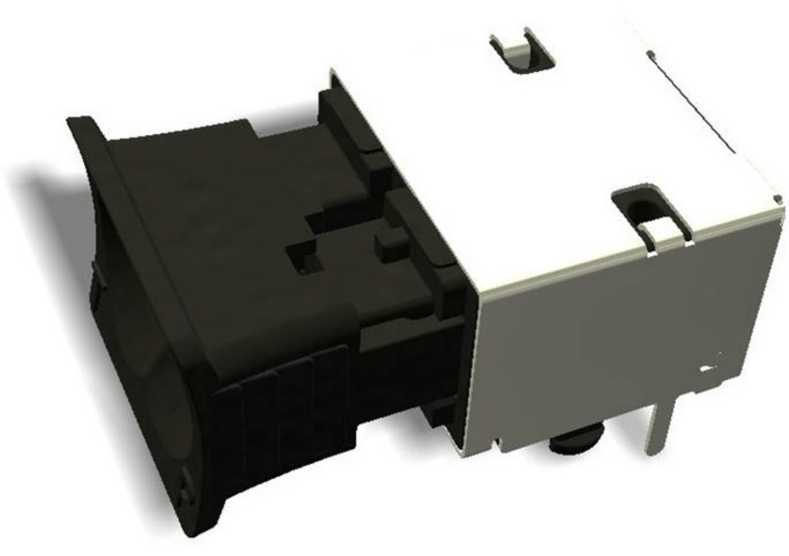


Figure 6: AFBR-59F2Z Transceiver Module without Dust Plug



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