# AFBR-1010/AFBR-2010 <br> Fiber Optic Transmitter and Receiver for 50 MBaud MOST® 

## Data Sheet



## Description

AFBR-1010 Transmitter and AFBR-2010 Receiver are packaged in 4-pin transfer molded, low-cost packages ready for assembly into plastic fiber optic connector receptacles compliant with MOST ${ }^{\circledR}$ technology. The transmitter utilizes a 650 nm LED source with integrated optics for efficient coupling into 1 mm Polymer Optical Fiber (POF), and the receiver contains a large area PIN diode to receive this light. Input/output data has TTL switching levels, compatible with MOST ${ }^{\circledR}$ Network Interface Controller ICs. These optical components are specified for operation over a wide $-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}$ extended temperature range, and meet the rigorous reliability requirements of automotive applications. In the absence of data activity, the receiver switches to very low power mode. While in this mode, the PIN diode can sense new data activity and switch the receiver back to full operation.

Features

- Optical transmitter (EOC) and receiver (OEC) for use in MOST ${ }^{\circledR}$ equipment for up to 50 M baud
- Compliant to MOST ${ }^{\circledR}$ Specification of Physical Layer Rev 1.1
- Operating temperature range of $-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}$
- Reliability performance per automotive application requirements
- Lead is flash gold


## Applications

- Optical Transmitter and Receiver for MOST® ${ }^{\circledR} 50$ M baud systems (A full description of M OST ${ }^{\circledR} 50 \mathrm{M}$ baud information and entertainment LAN system and standards are available at www.mostcooperation.com)

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## Regulatory Compliance

| Feature | Test M ethod | Performance |
| :--- | :--- | :--- |
| Electrostatic Discharge (ESD) to the | J EDEC/ EIA J ESD22-A114-B | M in $\pm 2000 \mathrm{~V}$ |
| Electrical Pins Human Body M odel | Human Body M odel |  |
| Electrostatic Discharge (ESD) to the | J EDEC/ EIA J ESD22-A115-A | M in $\pm 400 \mathrm{~V}$ |
| Electrical Pins M achine M odel | M achine M odel |  |
| Electrostatic Discharge (ESD) to the | J EDEC/ EIA J ESD22-C-101-B | M in $\pm 500 \mathrm{~V}$ |
| Electrical Pins Charged Device M odel | Charged Device M odel |  |
| Eye Safety | IEC 60825-1,2, Class 1 | TUV File \#: 30382990.001 |

Pin Description Transmitter
Front View Optics Up. $1=$ Leftmost Pin to $4=$ Rightmost Pin

| Pin | Name | Function/ Description | Notes |
| :--- | :--- | :--- | :--- |
| 1 | Data In | Transmitter Data Input | 1 |
| 2 | V $_{\text {EET }}$ | Transmitter Ground |  |
| 3 | V $_{\text {CCT }}$ | Transmitter Power 5 V $\pm 5 \%$ |  |
| 4 | CONT | Connection to LED Current Control Resistor | 2 |

## Notes:

1. Logic 1 input will turn the light on and the logic 0 will turn the light off.
2. This is a digital input for the transmitter output power selector. $\mathrm{R}_{\mathrm{CN}}<17.32 \mathrm{k} \Omega$ will set the transmitter to normal output power. $\mathrm{R}_{\mathrm{CR}}>25.65 \mathrm{k} \Omega$ will set the transmitter to reduced output power. $R_{C N} / R_{C R}$ is connected betw een CONT input and $V_{C C T}$.

## Pin Description Receiver

Front View Optics Up. 1 = Leftmost Pin to $4=$ Rightmost Pin

| Pin | Name | Function/ Description | Notes |
| :--- | :--- | :--- | :--- |
| 1 | V CCR | Receiver Power 5 V $\pm 5 \%$ |  |
| 2 | V $_{\text {EER }}$ | Receiver Ground |  |
| 3 | Mode Out | Receiver M ode Output | 1 |
| 4 | Data Out | Receiver Data Output | 2 |

Notes:

1. This output is logic 1 high if the receiver is asleep for no light input, and logic 0 low if the receiver is awake for valid light input levels.
2. TTL compatible data output.

Absolute Maximum Ratings

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Storage Temperature | Ts | -40 |  | 100 | ${ }^{\circ} \mathrm{C}$ | 1 |
| Ambient Temperature, No Air Flow | TC | -40 | 95 | ${ }^{\circ} \mathrm{C}$ | 1,2 |  |
| Relative Humidity | RH | 0 | 95 | $\%$ | 1 |  |
| Supply Voltage | $\mathrm{V}_{\mathrm{CCT}} / \mathrm{V}_{\mathrm{CCR}}$ | -0.5 | 7 | V | 1 |  |
| Data Input Voltage | $\mathrm{V}_{\mathrm{IN}}$ | -0.5 |  | $\mathrm{~V}_{\mathrm{CC}}+0.5$ | V | 1 |
| CONT Input Voltage | $\mathrm{V}_{\text {CONT }}$ | -0.5 |  | $\mathrm{~V}_{\mathrm{CC}}+0.5$ | V | 1,3 |
| Data Output Current | $\mathrm{I}_{\mathrm{O}}$ |  |  | 10 | mA | 1,4 |
| Mode Output Current | $\mathrm{I}_{\mathrm{M}}$ |  |  | 10 | mA | 1 |
| Data Rate | 8 | 45.2 | 50 | M Baud |  |  |

## Notes:

1. Absolute M aximum Ratings are those values beyond which damage to the device may occur if these limits are exceeded for other than a short period of time. See Reliability Data Sheets for specific reliability performance.
2. M easured 1 cm outside of $M O S T^{\circledR}$ optical connector housing (header) on a $M$ OST ${ }^{\circledR}$ application $P C B$. The optical components (EOC and OEC) are inside the header connector assembly composed of the plastic housing and EMI shield, that is, airflow is restricted to natural convection.
3. The CONT input is a digital function. An open circuit will select lower (normal light output -3 dB ), and a short circuit to $\mathrm{V}_{\text {cCT }}$ will select normal light output power. This makes the LED meet eye safety under this fault condition
4. A safety resistor of $50 \Omega$ (minimum) is to be connected between Data Out and the receiving circuitry. The receiving circuitry must be powered up within 50 ms after M ode Out goes low to prevent permanent damage to the OEC

Recommended Operating Conditions

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Ambient Temperature, No Air Flow | $\mathrm{T}_{\mathrm{A}}$ | -40 | 25 | 95 | ${ }^{\circ} \mathrm{C}$ | 1,2 |
| Supply Voltage | $\mathrm{V}_{\mathrm{CCT}} / \mathrm{V}_{\mathrm{CCR}}$ | 4.75 | 5 | 5.25 | V | 1 |
| CONT Input Resistor for | $\mathrm{R}_{\mathrm{CN}}$ | 0 | 13.5 | 17.32 | $\mathrm{k} \Omega$ | 1,3 |
| Normal Output Power | $\mathrm{R}_{\mathrm{CR}}$ | 25.65 | 27 | Open <br> Circuit | $\mathrm{k} \Omega$ | 1,3 |
| CONT Input Resistor for <br> Reduced Output Power |  |  |  |  |  |  |

Notes:

1. 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 Reliability Data Sheet for specific reliability performance.
2. M easured 1 cm outside of $M O S T{ }^{\circledR}$ optical connector housing (header) on a M OST ${ }^{\circledR}$ application $P C B$. The optical components (EOC and OEC) are inside the header connector assembly composed of the plastic housing and EM I shield, that is, airflow is restricted to natural convection.
3. Resistor values between $17.32 \mathrm{k} \Omega-25.65 \mathrm{k} \Omega$ are not allowed.

## Process Compatibility

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Solder Environment | $\mathrm{T}_{\text {SoLD }}$ |  |  | 260 | ${ }^{\circ} \mathrm{C}$ | $1,3,4$ |
|  | $\mathrm{t}_{\text {SoLD }}$ |  | 10 | sec | $2,3,4$ |  |

## Notes:

1. Maximum temperature refers to peak temperature.
2. Maximum time refers to time spent at peak temperature.
3. Solder surface to be at least 1 mm below lead frame stops.
4. Product is moisture sensitive level 2A. See Application Note "Avago AFBR-1010 Fiber Optic Transmitter and AFBR-2010 Receiver for 50 M baud M OST ${ }^{\circledR}$-Handling."

## Transmitter Electrical Characteristics

( $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CCT}}=5 \mathrm{~V} \pm 5 \%$ )

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Supply Current (Optical Power ON) | $\mathrm{I}_{\mathrm{CCT}}$ |  | 40 | mA | 1 |  |
| Supply Current (Optical Power OFF) | $\mathrm{I}_{\mathrm{CCT}}$ |  | 40 | mA | 2 |  |
| Optical Power ON Delay | $\mathrm{t}_{\mathrm{ON} 2}$ |  | 7 | $\mu \mathrm{~S}$ | 5 |  |
| Optical Power OFF Delay | $\mathrm{t}_{\mathrm{OFF}}$ |  | 50 | $\mu \mathrm{~S}$ | 4 |  |
| Input Voltage - Low | $\mathrm{V}_{\mathrm{IL}}$ | -0.3 | 0.8 | V | 3 |  |
| Input Voltage - High | $\mathrm{V}_{\mathrm{HH}}$ | 2.0 | $\mathrm{~V}_{\mathrm{CC}}+0.3$ | V | 3 |  |
| Data Input Capacitance | $\mathrm{C}_{\mathrm{IN}}$ |  | 7 | pF |  |  |
| Data Input Resistance | $\mathrm{R}_{\mathrm{IN}}$ | 2 |  | $\mathrm{k} \Omega$ |  |  |

## Notes:

1. For $50 \%$ duty cycle Biphase mark data and $R_{C N}=13.5 \mathrm{k} \Omega$ (normal light output control selection).
2. Data $\mathrm{In}=0 \mathrm{~V}$.
3. Standard TTL compatible inputs.
4. After a static 0 is received on Data In for $t_{0 f f 2} \mu \mathrm{~s}$, the transmitter optical output power drops to a level below -50 dBm
5. After modulated data is received on Data $\operatorname{In}$ for $t_{O N 2} \mu \mathrm{~S}$, the transmitter exits the "OFF" state to enter normal operating "ON" state.

Transmitter Optical Characteristics
( $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}, \mathrm{V}_{\text {CCT }}=5 \mathrm{~V} \pm 5 \%$ )

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Output Optical Power (Average), Normal Power | $\mathrm{P}_{\mathrm{N}}$ | -7.5 |  | -1.5 | dBm | $1,3,5$ |
| Delta B etween Reduced and Normal Optical <br> Output Power | $\Delta \mathrm{Po}$ |  | -3.0 |  | dB | 2 |
| Output Optical Power (A verage), OFF | $\mathrm{PS}_{\mathrm{S}}$ |  |  | -50 | dBm |  |
| Extinction Ratio | ER | 10 |  |  | dB |  |
| Spectrum Central W avelength | $\lambda \mathrm{C}$ | 635 | 675 | nm | 6 |  |
| Spectrum RM S | $\lambda \mathrm{w}$ |  | 17 | nm | 7 |  |
| Rise Time (20\%-80\%) | $\mathrm{t}_{\text {RT }}$ |  | 6.0 | ns | 1,3 |  |
| Fall Time (20\%-80\%) | $\mathrm{t}_{\text {FT }}$ |  | 6.0 | ns | 1,3 |  |
| Pulse W idth Variation | $\mathrm{t}_{\text {PWVT }}$ | 20.0 | 24.3 | ns | $1,3,4$ |  |
| Pulse W idth Distortion - Average | $\mathrm{t}_{\text {APWDT }}$ | -1.39 |  | +1.39 | ns | $1,3,4$ |

## Notes:

1. Resistance between $\operatorname{CONT}$ and $\mathrm{V}_{C C T}$ pin, $\mathrm{R}_{\mathrm{CN}}=13.5 \mathrm{k} \Omega$ (normal light output control selection).
2. The difference between $R_{C N}=13.5 \mathrm{k} \Omega$ and $R_{C R}=27 \mathrm{k} \Omega$ (reduced versus normal output optical power control selection).
3. Using input signal to the Transmitter as defined in SP1 M OST® Specification of Physical Layer Rev 1.1 at $45.2 \mathrm{M} \mathrm{Baud}, \mathrm{UI}=22.14 \mathrm{~ns}$.
4. Pulse width is measured at $50 \%$ threshold using a rising edge trigger and a M OST ${ }^{\circledR}$ w orst case test pattern (WCPWV).
5. M easured with ideal alignment to LED after 1 meter 0.5 NA 1mm POF with polished face using a large area detector.
6. Central wavelength is defined as:


Ref: EIA/ TIA standard FOTP-127/ 61.1, 1991.
7. Spectrum RMS is defined as:

$$
\lambda_{W}=\left(\binom{\sum_{i=1}^{N} P_{i} \lambda_{i}^{2}}{\hdashline \sum_{i=1}^{N} P_{i}}=\lambda_{C}^{2}\right)^{\frac{1}{2}}
$$

Ref: EIA/ TIA standard FOTP-127/ 61.3, 1991.

Receiver Electrical Characteristics
( $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CCR}}=5 \mathrm{~V} \pm 5 \%$ )

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Supply Current - Awake | $I_{\text {CCR }}$ |  |  | 35 | mA | 1 |
| Supply Current - Sleep | $I_{\text {CCR }}$ |  |  | 20 | $\mu \mathrm{A}$ | 2 |
| Data Output Voltage - Low | VoL | -0.3 |  | 0.4 | V | $3,10 \mathrm{~L}=1.6 \mathrm{~mA}$ |
| Data Output Voltage - High | $\mathrm{V}_{\mathrm{OH}}$ | 2.5 | 3.0 | $\mathrm{V}_{\text {CCR }}+0.3$ | V | 3 , $\mathrm{IOH}=-150 \mu \mathrm{~A}$ |
| M ode Output Voltage - Low | $V_{\text {OLM }}$ | -0.3 | 0.0 | 0.5 | V | $\mathrm{I}_{\mathrm{OL}}=2.4 \mathrm{~mA}$ |
| M ode Output Voltage - High | Vонм | $V_{\text {CCR }}-1$ |  | $\mathrm{V}_{\text {CCR }}+0.3$ | V | $\mathrm{IOH}_{\mathrm{O}}=-1 \mathrm{~mA}$ |
| Rise Time (10\%-90\%) | $t_{\text {RR }}$ |  |  | 9.9 | ns | 1,4,6 |
| Fall Time (10\%-90\%) | $\mathrm{t}_{\text {FR }}$ |  |  | 9.9 | ns | 1,4,6 |
| Pulse Width Variation | tpwvR | 16.5 |  | 31.0 | ns | 1,4,5,6 |
| Pulse W idth Distortion - Average | $\mathrm{t}_{\text {APWDR }}$ | -3.3 |  | 7.0 | ns | 1,4, 5, 6 |

## Notes:

1. M easured using Input signal condition as defined by SP3 M OST ${ }^{\circledR}$ Specification of Physical Layer Rev 1.1 at $45.2 \mathrm{M} \mathrm{Baud}, \mathrm{UI}=22.14 \mathrm{~ns}$.
2. Optical input is $<-40 \mathrm{dBm}$, and M ode Out $\mathrm{I}_{\mathrm{M}}=0$.
3. Standard TTL output.
4. $M$ easured with $R_{L}=50 \mathrm{k} \Omega$ and $C_{L}=15 \mathrm{pF}$.
5. Pulse width is measured at 1.5 V threshold using a rising edge trigger and a $\mathrm{MOST}{ }^{\circledR}$ worst case test pattern (WCPWV).
6. Optical power generated by a standard Avago Transmitter, with ideal alignment to the photodiode using a 1 mm POF ( $\mathrm{NA}=0.5$ ).

## Receiver Optical Characteristics

( $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CCR}}=5 \mathrm{~V} \pm 5 \%$ )

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Input Optical Power (Average) | $\mathrm{P}_{\mathrm{IN}}$ | -25 |  | -2 | dBm | 1 |
| Optical Spectrum Range | $\lambda \mathrm{C}$ | 630 |  | 685 | nm |  |
| Input Optical Power for light-off state | $\mathrm{P}_{\text {INSQ }}$ | -40 |  | -25 | dBm | 2 |

## Notes:

1. All Receiver input condition to be as specified in SP3 of M OST® Specification of Physical Layer Rev 1.1 at $45.2 \mathrm{M} \mathrm{Baud}, \mathrm{UI}=22.14 \mathrm{~ns}$.
2. Light-off state means M ode Output Voltage is high and Data Output Voltage is low.

## Receiver Timing Characteristics

( $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+95^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CCR}}=5 \mathrm{~V} \pm 5 \%$ )

| Parameter | Symbol | Min. | Typical | Max. | Unit |
| :--- | :--- | :--- | :--- | :--- | :--- |
| M ode Deassert Time (On to Off) | $\mathrm{t}_{\mathrm{D}}$ |  | 2 | Notes |  |
| Squelch Time (Signal OFF Delay) | $\mathrm{t}_{\text {OFF4 }}$ |  | 2 | ms |  |
| W akeup Time (Signal ON Delay) | $\mathrm{t}_{\text {ON4 }}$ |  | 3 | ms | 1 |

## Note:

1. Receiver is designed to only respond to modulated light input.

## Reference Design Schematic



Part Number Options

| Part Number | Part Description |
| :--- | :--- |
| AFBR-1010 | Transmitter |
| AFBR-2010 | Receiver |
| AFBR-1010S | Transmitter - Short Lead |
| AFBR-2010S | Receiver - Short Lead |
| AFBR-1010T | Transmitter $-90^{\circ}$ Bent Lead |
| AFBR-2010T | Receiver $-90^{\circ}$ Bent Lead |

## Package Dimensions

## Transmitter (AFBR-1010)

 UNLESS OTHERWISE SPECIFIED.

## Short Lead Option (AFBR-1010S)



NOTE:
UNIT $=\mathrm{mm}$, TOLERANCE $= \pm 0.1 \mathrm{~mm}$
UNLESS OTHERWISE SPECIFIED.

## Receiver (AFBR-2010)



UNIT $=\mathrm{mm}$, TOLERANCE $= \pm 0.1 \mathrm{~mm}$ UNLESS OTHERWISE SPECIFIED.

Short Lead Option (AFBR-2010S)
Bend Option (AFBR-2010T)


NOTE:
UNIT $=\mathrm{mm}$, TOLERANCE $= \pm 0.1 \mathrm{~mm}$ UNLESS OTHERWISE SPECIFIED.

## Device M arking



