**Description**

The IF-D92 is a high-sensitivity NPN phototransistor detector housed in a “connector-less” style plastic fiber optic package. Optical response of the IF-D92 extends from 400 to 1100 nm, making it compatible with a wide range of visible and near-infrared LEDs and laser diode sources. This includes 650 nm visible red LEDs used for optimum transmission in PMMA plastic optic fiber. The detector package features an internal micro-lens and a precision-molded PBT housing to ensure efficient optical coupling with standard 1000 μm core plastic fiber cable.

**Application Highlights**

The IF-D92 is suitable for digital data links at rates up to 20 kbps. Analog bandwidths greater than 15 kHz are possible making the IF-D92 usable for high frequency audio transmission. Phototransistor operation provides high internal gain – reducing the amount of post-amplification required in many circuits. The integrated design of the IF-D92 makes it a simple, cost-effective solution in a variety of analog and digital applications.

**Features**

- High Optical Sensitivity
- Mates with Standard 1000 μm Core, 2.2 mm Jacketed Plastic Fiber Optic Cable
- No Optical Design Required
- Inexpensive but Rugged Plastic Connector Housing
- Internal Micro-Lens for Efficient Optical Coupling
- Connector-Less Fiber Termination
- Light-Tight Housing provides Interference Free Transmission
- RoHS Compliant

**Applications**

- Low-Speed Digital Data Links
- Motor Controller Triggering
- Audio Links
- Medical Instruments
- Automotive Electronics
- Robotics Communications
- EMC/EMI Signal Isolation
- Electronic Games
- Process Control

**Maximum Ratings**

\( T_A = 25^\circ \text{C} \)

- Operating and Storage Temperature Range \( T_{\text{OP}}, T_{\text{STG}} \) ........... \(-40^\circ \text{C} \) to \( 85^\circ \text{C} \)
- Junction Temperature \( T_J \) ........... \( 85^\circ \text{C} \)
- Soldering Temperature \( 2 \text{ mm from case bottom} \) \( T_{\text{S}} \) ........... \( 240^\circ \text{C} \)
- Collector Emitter Voltage \( (V_{\text{CEO}}) \) ........... \( 30 \text{ V} \)
- Emitter Collector Voltage \( (V_{\text{ECO}}) \) ........... \( 5 \text{ V} \)
- Collector Current \( (I_C) \) ........... \( 50 \text{ mA} \)
- Collector Peak Current \( (I_{\text{CM}}) \) ........... \( 100 \text{ mA} \)

- Power Dissipation \( (P_{\text{TOT}}) \) \( T_A = 25^\circ \text{C} \) ........... \( 100 \text{ mW} \)
- De-rate Above \( 25^\circ \text{C} \) ........... \( 1.67 \text{ mW/}^\circ \text{C} \)

**Characteristics** \( (T_A = 25^\circ \text{C}) \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength for Maximum Photosensitivity</td>
<td>( \lambda_{\text{PEAK}} )</td>
<td>–</td>
<td>870</td>
<td>–</td>
<td>nm</td>
</tr>
<tr>
<td>Spectral Bandwidth ( (R=10% \text{ of RMAX}) )</td>
<td>( \Delta \lambda )</td>
<td>400</td>
<td>–</td>
<td>1100</td>
<td>nm</td>
</tr>
<tr>
<td>Switching Times ( (10% \text{ to } 90% \text{ and } 90% \text{ to } 10%) ) ( (R_L=1 \text{ kΩ}, I_C=1.0 \text{ mA}, V_{\text{CE}}=5 \text{ V}, \lambda=850 \text{ nm}) )</td>
<td>( t_r )</td>
<td>–</td>
<td>25</td>
<td>–</td>
<td>μs</td>
</tr>
<tr>
<td></td>
<td>( t_f )</td>
<td>–</td>
<td>25</td>
<td>–</td>
<td>μs</td>
</tr>
<tr>
<td>Responsivity min. ( @ 870 \text{ nm} ) ( @ 650 \text{ nm} )</td>
<td>( R )</td>
<td>–</td>
<td>450</td>
<td>–</td>
<td>μA/μW</td>
</tr>
<tr>
<td>Collector Dark Current ( (V_{\text{CEO}}=10 \text{ volts}) )</td>
<td>( I_{\text{CEO}} )</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Breakdown Voltage ( (I_C=100 \text{ μA}) )</td>
<td>( B_{\text{CEO}} )</td>
<td>30</td>
<td>–</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>Breakdown Voltage ( (I_C=-100 \text{ μA}) )</td>
<td>( B_{\text{ECO}} )</td>
<td>5</td>
<td>–</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>Saturation Voltage ( (I_C=250 \text{ μA}, P_{\text{TOT}}=100 \text{ μW}) )</td>
<td>( V_{\text{CE sat}} )</td>
<td>–</td>
<td>0.15</td>
<td>–</td>
<td>V</td>
</tr>
</tbody>
</table>

**Caution:** The IF D92 is ESD sensitive. To minimize risk of damage observe appropriate precautions during handling and processing.
**Fiber Termination Instructions**

1. Cut off the ends of the optical fiber with a single-edge razor blade or sharp knife. Try to obtain a precise 90-degree angle (square).

2. Insert the fiber through the locking nut and into the connector until the core tip seats against the internal micro-lens.

3. Screw the connector locking nut down to a snug fit, locking the fiber in place.
### Application Notes

**Digital Transmission**

The basic circuits of Figure 4 can be used for digital transmission. Figure 4A is non-inverting and Figure 4B is inverting. The output voltage for Figure 4A is $V_{out} = P_{in} \times R \times R_L$. Where $P_{in}$ is the input power from the fiber, $R$ is the responsivity of the IF-D92 at the wavelength used, and $R_L$ is the load resistance. The output voltage for Figure 4B is $V_{out} = +V - P_{in} \times R_L$. The speed of both circuits is virtually the same.

**Analog Transmission**

Sending analog information over an optical fiber is difficult. Any small change in the loop can make the received signal level change. Transmitting digital information is much more reliable, but performing an analog to digital conversion at the transmit end and a digital to analog conversion at the receiving end can be cumbersome. Below are simple circuits for transmitting analog information. They convert the analog voltage to a frequency and then convert the frequency back to analog.

The circuit shown in Figure 5 is a basic voltage to frequency converter. It uses an LM331 voltage to frequency IC and an IF-E96E as the emitter. With the supply voltage, +V, set to 15 Volts, the input range is 0 to 10 Volts. The frequency runs from approximately 200 Hz at 0 Volts input to 9 kHz at 10 Volts input. The duty cycle also changes as the input voltage changes and variable resistor RS2 should be set so that the duty cycle does not go to 0 % or 100 % at the input extremes. Resistor R1 sets the drive current for the IF-E96E at approximately 3.3 mA. It can be changed within the current limits of the IF-E96E and the LM331. The waveform driving the output can be seen at point FOUT.
Figure 5. Voltage to Frequency converter

The circuit shown in Figure 6 is a basic frequency to voltage converter. It uses an LM331 voltage to frequency converter IC and an IF-D92 to detect the signal from the emitter in the circuit of Figure 5. The supply voltage, $+V$, should be set to 15 Volts for a 0 to 10 Volt output range. In this circuit variable resistor $RS_2$ should be adjusted so that the output voltage tracks the voltage input into the circuit of Figure 5. The inverted received signal can be seen at point FIN.

Figure 6. Frequency to Voltage converter

The circuits in Figures 5 and 6 work together to transmit an analog DC voltage over a fiber optic cable. The combined circuits have a response time of 50 ms (to 1%). Refer to the LM331 datasheet for more complex circuits with higher accuracy or faster response time.