

## Product Specification

### 2.5Gbps, 850nm VCSEL, TO-46 Package

#### HFE4091-341

#### PRODUCT FEATURES

- 850nm multi-mode oxide isolated VCSEL
- Capable of modulation operation from DC to 2.5Gbps
- TO-46 flat window metal can component
- Designed for drive currents between 3-15mA average
- Packaged with a back monitor
- Attenuated window can
- Unattenuated versions also available



These products are high-performance 850nm VCSELs (Vertical Cavity Surface-Emitting Lasers) designed for high-speed data communications and packaged with a custom designed power monitor diode. The power monitor diode can be used with appropriate feedback control circuitry to set a maximum power level for the VCSEL. These combined features simplify design for high data rate communication and eye safety.

These products are high radiance VCSELs designed to convert electrical current into optical power that can be used in fiber optic communications and other applications. As the current varies above threshold, the light intensity increases proportionally.

These products are designed to be used with inexpensive silicon or gallium arsenide detectors, but excellent performance can also be achieved with some indium gallium arsenide detectors (see HFD3081-108 and HFD3081-203 product data sheets).

The low drive current requirement makes direct drive from PECL (Positive Emitter Coupled Logic) or ECL (Emitter Coupled Logic) gates possible and eases driver design.

These are designed to interface with 50/125 and 62.5/125mm multi-mode fiber. They produce circularly symmetric, non-astigmatic, narrow divergence beams that, with appropriate lensing, fiber couple all of the emitter power

#### PRODUCT SELECTION

| Part Number | Description   |
|-------------|---|
| HFE4091-341 | Attenuated TO-46 component, VCSEL with Back Monitor Photodiode, Cathode of VCSEL common with Photodiode Anode |

**I. Absolute Maximum Ratings**

| Parameter   | Rating            |
|---|-------------------|
| Storage Temperature                                       | -40 to +100°C     |
| Case Operating Temperature                                | -40* to +85°C     |
| Lead Solder Temperature                                   | 260°C, 10 sec.    |
| Laser continuous Forward Current                          | 12mA              |
| Laser peak forward current with pulse width less than 1ms | 18mA              |
| Laser Reverse voltage                                     | 5V                |
| ESD Exposure (Human Body Model)                           | 225V <sup>1</sup> |

**Notice**

INVISIBLE LASER RADIATION.  
CLASS 1 LASER PRODUCT  
AT 760-1050 nm  
PER IEC/EN 60825-1/A2:2007 AND 21  
CFR 1040.10 AND 1040.11,  
EXCEPT FOR DEVIATIONS  
PURSUANT TO LASER NOTICE NO. 50  
DATED 24 JUNE 2007

No special LASER eye safety  
precautions necessary

1201137

**Notice**

Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operations section for extended periods of time may affect reliability.

**Notice**

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation to equipment, take normal ESD precautions when handling this product

## II. Electro-Optical Characteristics ( $T_{OP} = 25\text{ }^{\circ}\text{C}$ unless otherwise stated)

| VCSEL Parameters                                    | Test Condition  | Symbol                     | Min.  | Typ.  | Max.       | Units                   | Notes  |
|---|---|----------------------------|-------|-------|------------|-------------------------|--------|
| Optical Power Output                                | $I_F = 7\text{mA}$  | $P_O$                      |       | 0.625 |            | mW                      | 2      |
| Threshold Current                                   |   | $I_{TH}$                   | 0.5   | 1.8   | 2.5        | mA                      |        |
| Threshold Current maximum deviation from 25°C value | $T_A = 0^{\circ}\text{C}$ to $70^{\circ}\text{C}$                           | $\Delta I_{TH}$            | -0.5  |       | 1          | mA                      | 3      |
|   | $T_A = 25^{\circ}\text{C}$ to $85^{\circ}\text{C}$                          | $\Delta I_{TH}$            |       |       | 1.7        | mA                      | 3      |
|   | $T_A = -40^{\circ}\text{C}$ to $25^{\circ}\text{C}$                         | $\Delta I_{TH}$            |       |       | 2.5        | mA                      | 3      |
| Temperature at minimum threshold current            |   | $T_O$                      | -20   |       | 50         | $^{\circ}\text{C}$      | 3      |
| Slope Efficiency                                    | $T_A = 25^{\circ}\text{C}$  | $\eta$                     | 0.07  |       | 0.3        | mW/mA                   | 4      |
|   | $T_A = -40^{\circ}\text{C}$   | $\eta$                     |       |       | 0.235      | mW/mA                   |        |
|   | $T_A = 85^{\circ}\text{C}$  | $\eta$                     | 0.06  |       |            | mW/mA                   |        |
| Slope Efficiency Temperature variation              | $T_A = 0^{\circ}\text{C}$ to $70^{\circ}\text{C}$                           | $\Delta\eta/\Delta T$      |       | -6000 |            | ppm/ $^{\circ}\text{C}$ | 5      |
| Peak Wavelength                                     | $I_F = 7\text{mA}$ ,<br>$T_A = 0^{\circ}\text{C}$ to $85^{\circ}\text{C}$   | $\lambda_P$                | 830   | 850   | 860        | nm                      |        |
| $\lambda_P$ Temperature Variation                   | $I_F = 7\text{mA}$ ,<br>$T_A = -40^{\circ}\text{C}$ to $85^{\circ}\text{C}$ | $\Delta\lambda_P/\Delta T$ |       | 0.06  |            | nm/ $^{\circ}\text{C}$  |        |
| Spectral Bandwidth, RMS                             | $I_F = 7\text{mA}$  | $\Delta\lambda$            |       |       | 0.65       | nm                      |        |
| Laser Forward Voltage                               | $I_F = 7\text{mA}$  | $V_F$                      |       | 1.8   | 2.0        | V                       |        |
| Rollover  |   | $P_{max}$                  | 1.25  |       |            | mW                      | 6      |
| Rise and Fall Times                                 | $P_{avg} = 0.625\text{mW}$ ,<br>Extinction Ratio = 10                       | $t_r$<br>$t_f$             |       |       | 130<br>150 | ps                      | 7      |
| Relative Intensity Noise                            | 1 GHz BW, $I_F = 7\text{mA}$  | RIN                        |       | -130  | -122       | dB/Hz                   |        |
| Series Resistance                                   | $I_F = 7\text{mA}$ , $T_A = 25^{\circ}\text{C}$                             | $R_S$                      | 25    | 35    | 50         | $\Omega$                |        |
|   | $T_A = -40^{\circ}\text{C}$   | $R_S$                      |       |       | 60         | $\Omega$                |        |
|   | $T_A = 85^{\circ}\text{C}$  | $R_S$                      | 20    |       |            | $\Omega$                |        |
| Series Resistance Temperature Coefficient           | $I_F = 7\text{mA}$ ,<br>$T_A = 0^{\circ}\text{C}$ to $70^{\circ}\text{C}$   | $\Delta R_S/\Delta T$      |       | -3000 |            | ppm/ $^{\circ}\text{C}$ | 8      |
| Beam Divergence                                     |   | $\theta$                   | 15    |       | 30         | Degrees                 | 9      |
| Beam Divergence Current Variation                   |   | $\Delta\theta/\Delta I_F$  |       | 0.45  |            | Degree/mA               |        |
| Photodiode Parameters                               | Test Condition  | Symbol                     | Min.  | Typ.  | Max.       | Units                   | Notes  |
| Monitor Current                                     | $P_O = 0.625\text{mW}$ , $T_A = 25^{\circ}\text{C}$                         | $I_{PD}$                   | 0.100 |       | 0.600      | mA                      | 10     |
|   | $P_O = 0.625\text{mW}$ , $T_A = -40^{\circ}\text{C}$                        | $I_{PD}$                   | TBD   |       | TBD        |                         | 10     |
|   | $P_O = 0.625\text{mW}$ , $T_A = +85^{\circ}\text{C}$                        | $I_{PD}$                   | TBD   |       | TBD        | mA                      | 10     |
| Monitor current Temperature Variation               | $P_O = 0.625\text{mW}$ , $0^{\circ}\text{C}$ to $70^{\circ}\text{C}$        | $\Delta I_{PD}/\Delta T$   |       | TBD   |            | %/ $^{\circ}\text{C}$   | 10     |
| Monitor Current Tracking                            |   | Deltrk                     |       | TBD   |            |                         | 10, 11 |
| Dark Current  | $P_O = 0\text{mW}$ , $V_R = 3\text{V}$                                      | $I_D$                      |       |       | 20         | nA                      |        |
| PD Capacitance                                      | $V_R = 0\text{V}$ , Freq = 1MHz   | C                          |       | 75    | 100        | pF                      |        |
|   | $V_R = 3\text{V}$ , Freq = 1MHz   |                            |       | 40    | 55         |                         |        |

Notes:

1. Reliability is a function of temperature, see [www.finisar.com](http://www.finisar.com) for details.
2. For the purpose of these tests,  $I_F$  is DC current.
3. Threshold current varies as  $(T_A - T_O)^2$ . It may either increase or decrease with temperature, depending upon relationship of  $T_A$  to  $T_O$ . The magnitude of the change is proportional to the threshold at  $T_O$ .
4. Slope efficiency is defined as  $\Delta P_O / \Delta I_F$ .
5. To compute the value of Slope Efficiency at a temperature T, use the following equation:  

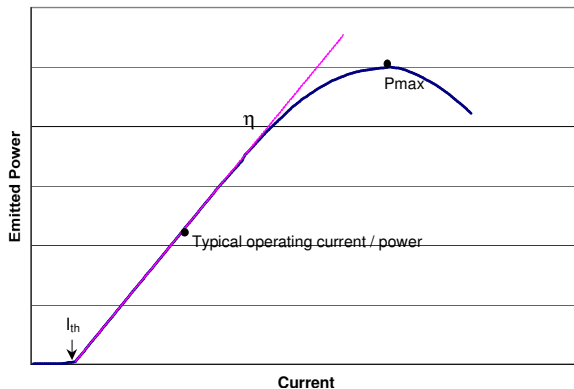
$$\eta(T) \approx \eta(25^\circ\text{C}) * [1 + (\Delta\eta / \Delta T) * (T - 25)]$$
6. Rollover is the power at which a further current increase does not result in a power increase.
7. Rise and fall times specifications are the 20% - 80%. Most of the devices will measure <135ps fall time. Rise and fall times are sensitive to drive electronics.
8. To compute the value of Series Resistance at a temperature T, use the following equation:  

$$R_S(T) \approx R_S(25^\circ\text{C}) * [1 + (\Delta R_S / \Delta T) * (T - 25)]$$
9. Beam divergence is defined as the total included angle between the  $1/e^2$  intensity points.
10. These specifications are for the TO-46 component alone. Reflections introduced by any subsequent higher level assembly may affect these values.
11. Monitor current tracking is defined as follows:

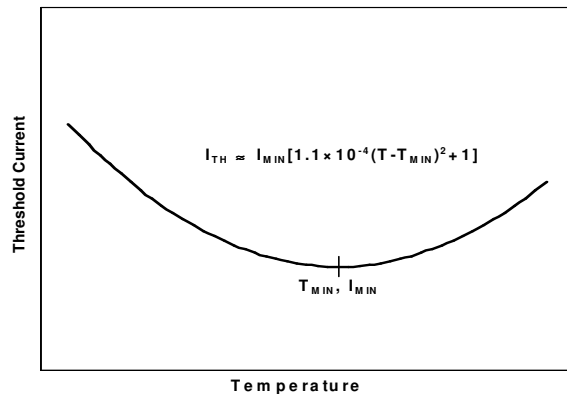
$$\text{Deltrk} = \frac{I_{PD}(P_O = 0.75\text{mW}) / 0.75\text{mW}}{I_{PD}(P_O = 0.45\text{mW}) / 0.45\text{mW}}$$

**III. Typical Performance Curves**

**Emitted Power vs. Current:** Power varies approximately linearly with current above threshold.



**Threshold Current vs. Temperature:** Threshold current varies parabolically with temperature; thus it can be nearly constant for a limited temperature range.



**IV. Environmental Specifications**

| Parameter                  | Symbol           | Min | Typ | Max | Units | Ref. |
|----------------------------|------------------|-----|-----|-----|-------|------|
| Case Operating Temperature | T <sub>op</sub>  | -40 |     | 100 | °C    |      |
| Storage Temperature        | T <sub>sto</sub> | -40 |     | 85  | °C    |      |

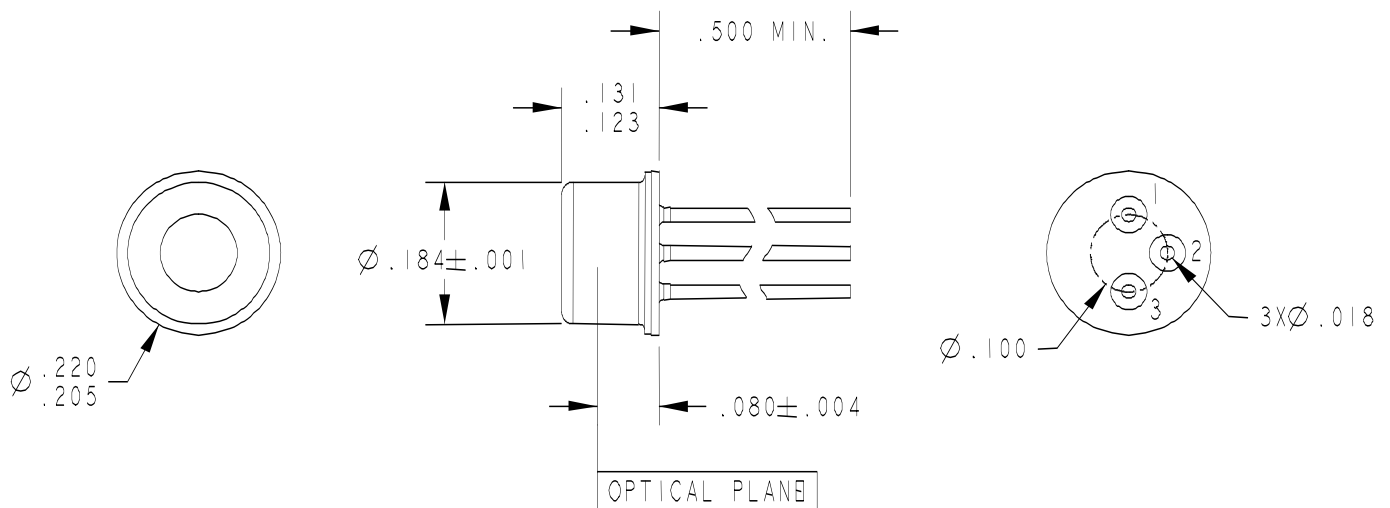
**V. Regulatory Compliance**

| Feature          | Agency   | Standard                             | Certificate Number |
|------------------|----------|--------------------------------------|--------------------|
| Laser Eye Safety | FDA/CDRH | CDRH 21 CFR 1040 and Laser Notice 50 | 9521487            |

Copies of the referenced certificates are available at Finisar Corporation upon request.

**VI. Mechanical Specifications**

| PIN | Description                       |
|-----|-----------------------------------|
| 1   | A <sub>LD</sub>                   |
| 2   | K <sub>LD</sub> , A <sub>PD</sub> |
| 3   | K <sub>PD</sub>                   |



(dimensions are in inches)

**VII. Revision History**

| <b>Revision</b> | <b>Date</b> | <b>Description</b>                  |
|-----------------|-------------|-------------------------------------|
| B00             | 8/14/2014   | • Changed to Latest Finisar format. |

**VIII. For More Information**

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