

FOD3181

0.5A Output Current, High Speed MOSFET Gate Driver Optocoupler

Features

- Guaranteed operating temperature range of -20°C to +85°C
- 0.5A minimum peak output current
- High speed response: 500ns max propagation delay over temperature range
- Wide V_{CC} operating range: 10V to 20V
- 5000Vrms, 1 minute isolation
- Minimum creepage distance of 7.0mm
- Minimum clearance distance of 7.0mm
- C-UL, UL and VDE* approved
- 10kV/ μ s minimum common mode rejection (CMR) at $V_{CM} = 1,500V$
- $R_{DS(ON)}$ of 1.5 Ω (typ.) offers lower power dissipation

Applications

- Plasma Display Panel
- High performance DC/DC convertor
- High performance switch mode power supply
- High performance uninterruptible power supply
- Isolated Power MOSFET gate drive

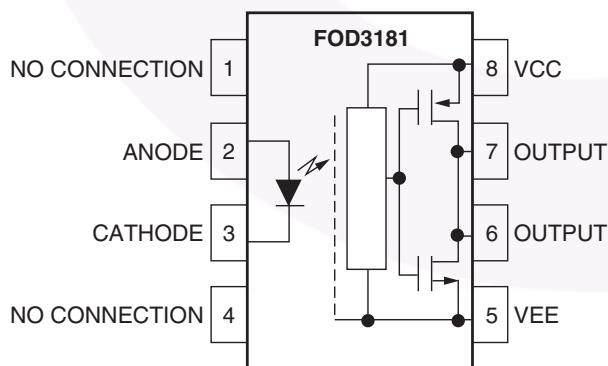
*Requires 'V' ordering option

Description

The FOD3181 is a 0.5A Output Current, High Speed MOSFET Gate Drive Optocoupler. It consists of a gallium aluminum arsenide (AlGaAs) light emitting diode optically coupled to a CMOS integrated circuit with a power stage. The power stage consists of a PMOS pull-up and a NMOS pull-down power transistor. It is ideally suited for high frequency driving of MOSFETs used in Plasma Display Panels (PDPs), motor control inverter applications, and high performance DC/DC converters.

The device is packaged in an 8-pin dual in-line housing compatible with 260°C reflow processes for lead free solder compliance.

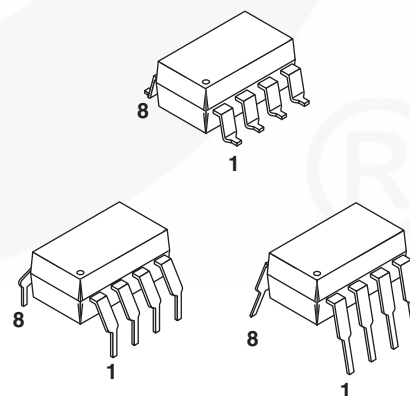
Functional Block Diagram



Note:

A 0.1 μ F bypass capacitor must be connected between pins 5 and 8.

Package Outlines



Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | Value | Units |
|-------------------|---|-----------------|-------|
| T_{STG} | Storage Temperature | -40 to +125 | °C |
| T_{OPR} | Operating Temperature | -20 to +85 | °C |
| T_J | Junction Temperature | -20 to +125 | °C |
| T_{SOL} | Lead Solder Temperature | 260 for 10 sec. | °C |
| $I_{F(AVG)}$ | Average Input Current ⁽¹⁾ | 25 | mA |
| $I_{F(tr)}$ | Minimum Rate of Rise of LED Current | 250 | ns |
| $I_{F(TRAN)}$ | Peak Transient Input Current (<1μs pulse width, 300pps) | 1.0 | A |
| V_R | Reverse Input Voltage | 5 | V |
| $I_{OH(PEAK)}$ | “High” Peak Output Current ⁽²⁾ | 1.5 | A |
| $I_{OL(PEAK)}$ | “Low” Peak Output Current ⁽²⁾ | 1.5 | A |
| $V_{CC} - V_{EE}$ | Supply Voltage | -0.5 to 25 | V |
| $V_{O(PEAK)}$ | Output Voltage | 0 to V_{CC} | V |
| P_O | Output Power Dissipation ⁽⁴⁾ | 250 | mW |
| P_D | Total Power Dissipation ⁽⁴⁾ | 300 | mW |

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol | Parameter | Value | Units |
|-------------------|-----------------------|------------|-------|
| $V_{CC} - V_{EE}$ | Power Supply | 10 to 20 | V |
| $I_{F(ON)}$ | Input Current (ON) | 12 to 18 | mA |
| $V_{F(OFF)}$ | Input Voltage (OFF) | 0 to 0.8 | V |
| T_{OPR} | Operating Temperature | -20 to +85 | °C |

Electrical-Optical Characteristics (DC) ($T_A = -20^{\circ}\text{C}$ to $+70^{\circ}\text{C}$)

Over recommended operating conditions unless otherwise specified.

| Symbol | Parameter | Test Conditions | Min. | Typ.* | Max. | Unit |
|--------------------|---|---|----------------|-------|----------------|------------------------|
| I_{OH} | High Level Output Current ⁽²⁾⁽³⁾ | $V_{OH} = (V_{CC} - V_{EE} - 1\text{V})$ | 0.5 | | | A |
| I_{OL} | Low Level Output Current ⁽²⁾⁽³⁾ | $V_{OL} = (V_{CC} - V_{EE} - 1\text{V})$ | 0.5 | | | A |
| V_{OH} | High Level Output Voltage ⁽⁵⁾⁽⁶⁾ | $I_O = -100\text{mA}$ | $V_{CC} - 0.5$ | | | V |
| V_{OL} | Low Level Output Voltage ⁽⁵⁾⁽⁶⁾ | $I_O = 100\text{mA}$ | | | $V_{EE} + 0.5$ | V |
| I_{CCH} | High Level Supply Current | Output Open $I_F = 7$ to 10mA | | 4.8 | 6.0 | mA |
| I_{CCL} | Low Level Supply Current | Output Open $V_F = 0$ to 0.8V | | 5.0 | 6.0 | mA |
| I_{FLH} | Threshold Input Current Low to High | $I_O = 0\text{mA}$, $V_O > 5\text{V}$ | | | 10 | mA |
| V_{FHL} | Threshold Input Voltage High to Low | $I_O = 0\text{mA}$, $V_O < 0.5\text{V}$ | 0.8 | | | V |
| V_F | Input Forward Voltage | $I_F = 10\text{mA}$ | 1.2 | 1.5 | 1.8 | V |
| $\Delta V_F / T_A$ | Temperature Coefficient of Forward Voltage | $I_F = 10\text{mA}$ | | -1.5 | | mV/ $^{\circ}\text{C}$ |
| BV_R | Input Reverse Breakdown Voltage | $I_R = 10\mu\text{A}$ | 5 | | | V |
| C_{IN} | Input Capacitance | $f = 1\text{MHz}$, $V_F = 0\text{V}$ | | 60 | | pF |

Switching Characteristics ($T_A = -20^{\circ}\text{C}$ to $+70^{\circ}\text{C}$)

Over recommended operating conditions unless otherwise specified.

| Symbol | Parameter | Test Conditions | Min. | Typ.* | Max. | Unit |
|-----------|--|---|------|-------|------|-------------------|
| t_{PLH} | Propagation Delay Time to High Output Level ⁽⁷⁾ | $I_F = 10\text{mA}$, $R_g = 10\Omega$, $f = 250\text{kHz}$, Duty Cycle = 50%, $C_g = 10\text{nF}$ | 50 | 135 | 500 | ns |
| t_{PHL} | Propagation Delay Time to Low Output Level ⁽⁷⁾ | | 50 | 105 | 500 | ns |
| t_r | Rise Time | $C_L = 10\text{nF}$, $R_g = 10\Omega$ | | 75 | | ns |
| t_f | Fall Time | | | 55 | | ns |
| $ CM_H $ | Output High Level Common Mode Transient Immunity ⁽⁸⁾⁽⁹⁾ | $T_A = +25^{\circ}\text{C}$, $I_F = 7$ to 10mA , $V_{CM} = 1.5\text{kV}$, $V_{CC} = 20\text{V}$ | 10 | | | kV/ μs |
| $ CM_L $ | Output Low Level Common Mode Transient Immunity ⁽⁸⁾⁽¹⁰⁾ | $T_A = +25^{\circ}\text{C}$, $V_F = 0\text{V}$, $V_{CM} = 1.5\text{kV}$, $V_{CC} = 20\text{V}$ | 10 | | | kV/ μs |

Isolation Characteristics ($T_A = -20^{\circ}\text{C}$ to $+70^{\circ}\text{C}$)

| Symbol | Parameter | Test Conditions | Min. | Typ.* | Max. | Unit |
|-----------|---|---|------|-----------|------|-----------|
| V_{ISO} | Withstand Isolation Voltage ⁽¹¹⁾⁽¹²⁾ | $T_A = 25^{\circ}\text{C}$, R.H. < 50%, $t = 1\text{min.}$, $I_{I-O} \leq 20\mu\text{A}$ | 5000 | | | V_{rms} |
| R_{I-O} | Resistance (input to output) ⁽¹²⁾ | $V_{I-O} = 500\text{V}$ | | 10^{11} | | Ω |
| C_{I-O} | Capacitance (input to output) | Freq. = 1MHz | | 1 | | pF |

* All typical values at $T_A = 25^{\circ}\text{C}$

Notes:

1. Derate linearly above +70°C free air temperature at a rate of 0.3mA/°C.
2. The output currents I_{OH} and I_{OL} are specified with a capacitive current limited load = $(3 \times 0.01\mu F) + 0.5\Omega$, frequency = 8kHz, 50% DF.
3. The output currents I_{OH} and I_{OL} are specified with a capacitive current limited load = $(3 \times 0.01\mu F) + 40\Omega$, frequency = 8kHz, 50% DF.
4. No derating required across operating temperature range.
5. In this test, V_{OH} is measured with a dc load current of 100mA. When driving capacitive load V_{OH} will approach V_{CC} as I_{OH} approaches zero amps.
6. Maximum pulse width = 1ms, maximum duty cycle = 20%.
7. t_{PHL} propagation delay is measured from the 50% level on the falling edge of the input pulse to the 50% level of the falling edge of the V_O signal. t_{PLH} propagation delay is measured from the 50% level on the rising edge of the input pulse to the 50% level of the rising edge of the V_O signal.
8. Pin 1 and 4 need to be connected to LED common.
9. Common mode transient immunity in the high state is the maximum tolerable dV_{CM}/dt of the common mode pulse V_{CM} to assure that the output will remain in the high state (i.e. $V_O > 10.0V$).
10. Common mode transient immunity in a low state is the maximum tolerable dV_{CM}/dt of the common mode pulse, V_{CM} , to assure that the output will remain in a low state (i.e. $V_O < 1.0V$).
11. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage > 6000Vrms, 60Hz for 1 second (leakage detection current limit $I_{L-O} < 5\mu A$).
12. Device considered a two-terminal device: pins on input side shorted together and pins on output side shorted together.

Typical Performance Curves

Fig. 1 Input Forward Current vs. Forward Voltage

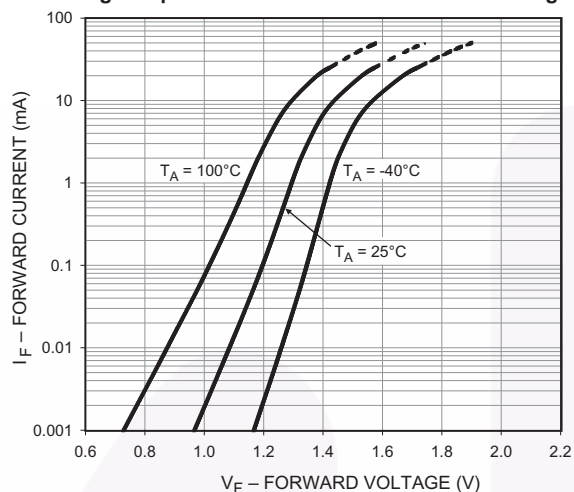


Fig. 2 Low To High Input Current Threshold vs. Ambient Temperature

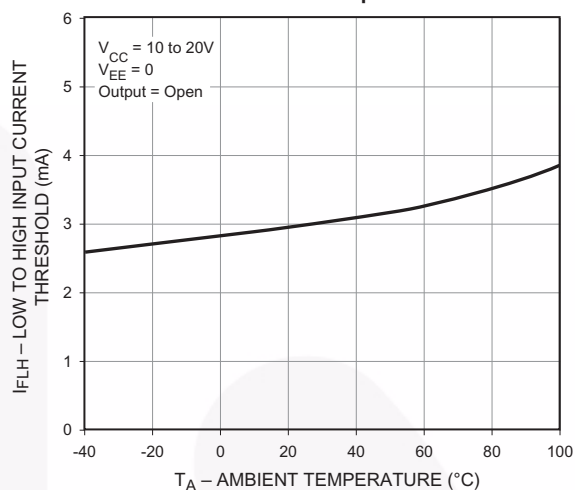


Fig. 3 Output Low Voltage vs. Ambient Temperature

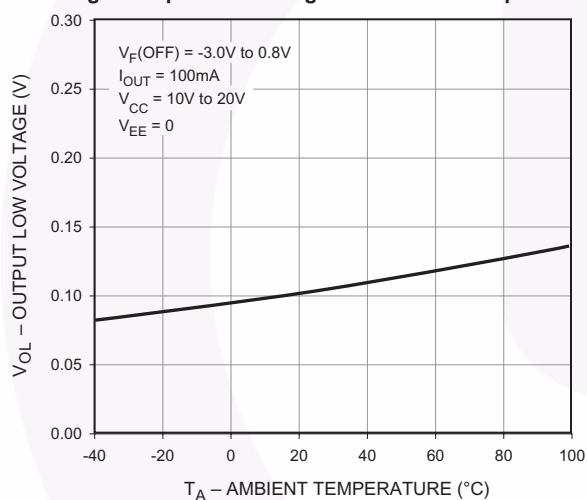


Fig. 4 High Output Voltage Drop vs. Ambient Temperature

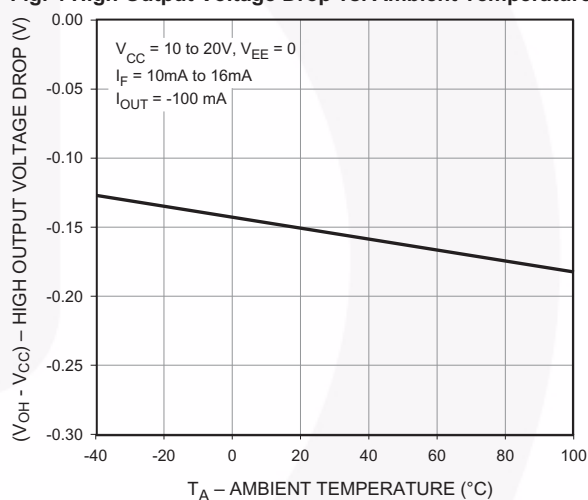


Fig. 5 Supply Current vs. Ambient Temperature

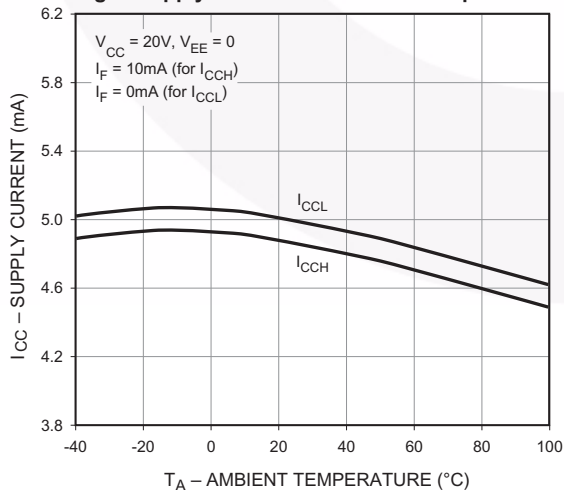
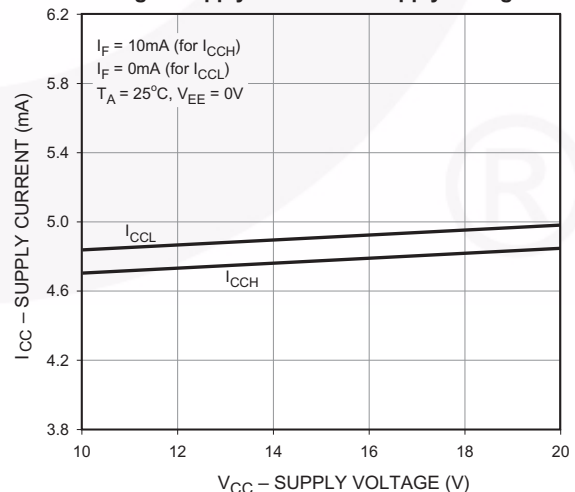


Fig. 6 Supply Current vs. Supply Voltage



Typical Performance Curves (Continued)

Fig. 7 Propagation Delay vs. Load Capacitance

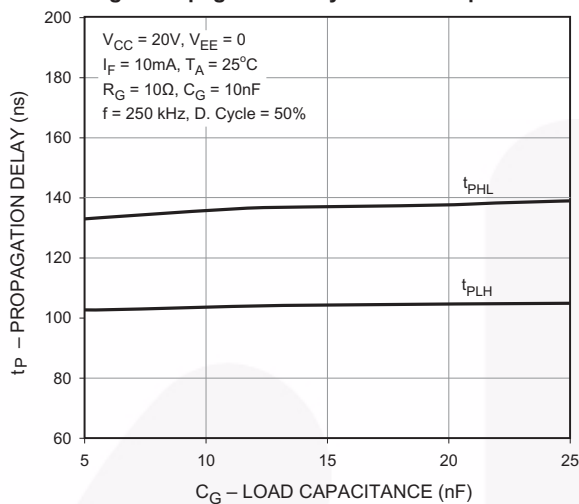


Fig. 8 Propagation Delay vs. Forward LED Current

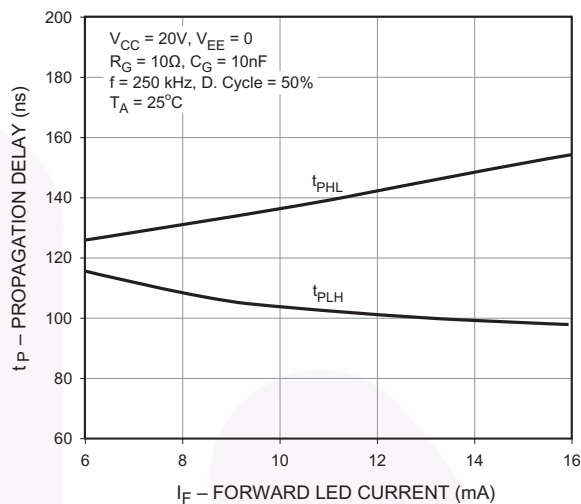


Fig. 9 Propagation Delay vs. Series Load Resistance

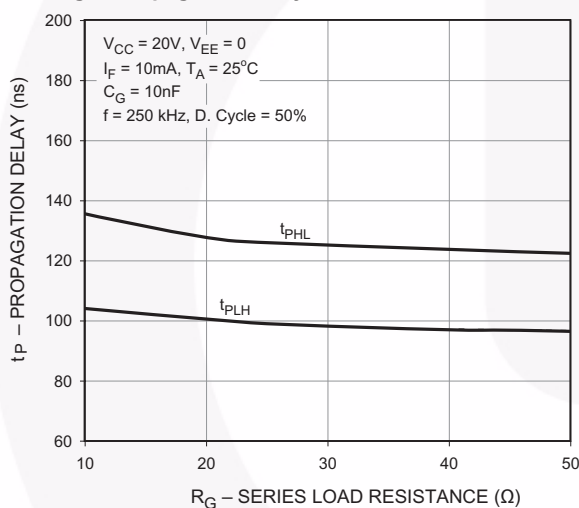


Fig. 10 Propagation Delay vs. Ambient Temperature

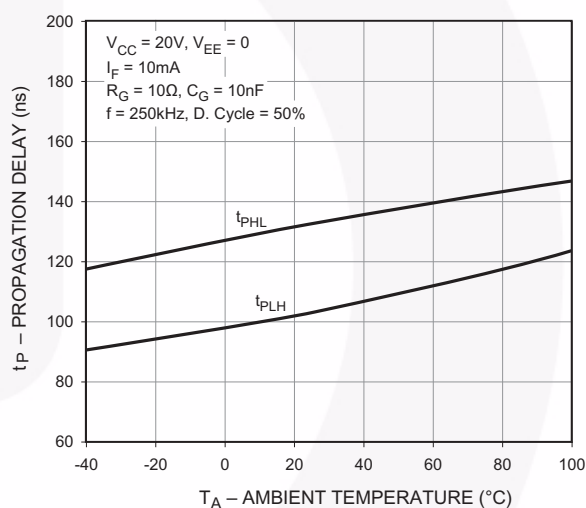
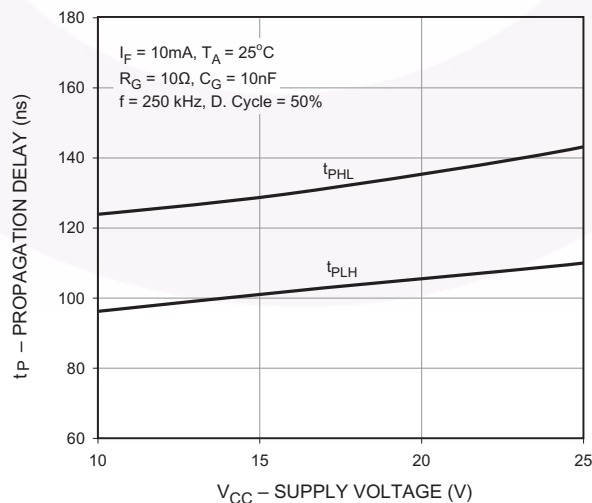
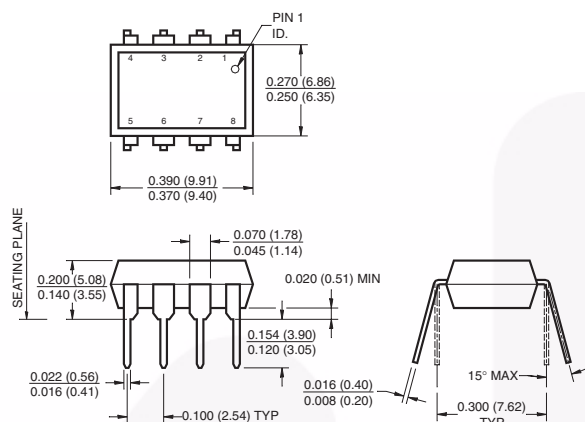


Fig. 11 Propagation Delay vs. Supply Voltage

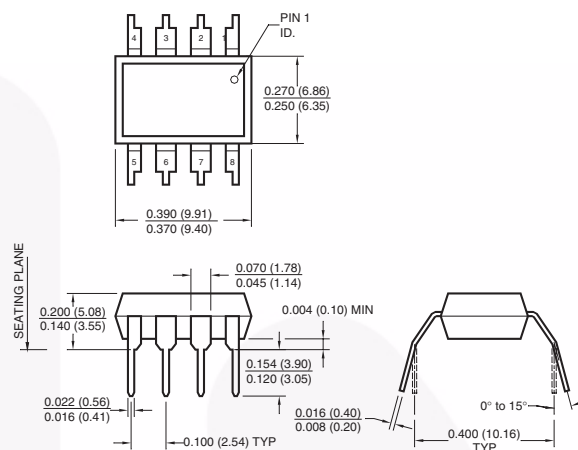


Package Dimensions

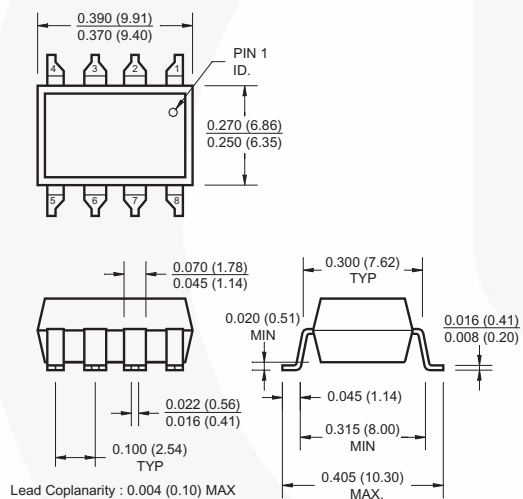
Through Hole



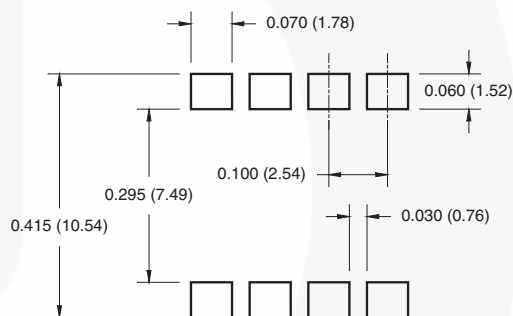
0.4" Lead Spacing



Surface Mount



8-Pin DIP – Land Pattern



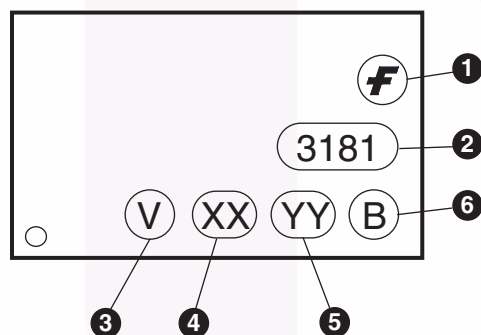
Note:

All dimensions are in inches (millimeters)

Ordering Information

| Option | Order Entry Identifier (Example) | Description |
|-----------|-------------------------------------|--|
| No option | FOD3181 | Standard Through Hole Device |
| S | FOD3181S | Surface Mount, Lead Bend |
| SD | FOD3181SD | Surface Mount, Tape and Reel |
| T | FOD3181T | 0.4" Lead Spacing |
| V | FOD3181V | VDE 0884 |
| TV | FOD3181TV | VDE 0884, 0.4" Lead Spacing |
| SV | FOD3181SV | VDE 0884, Surface Mount |
| SDV | FOD3181SDV | VDE 0884, Surface Mount, Tape and Reel |

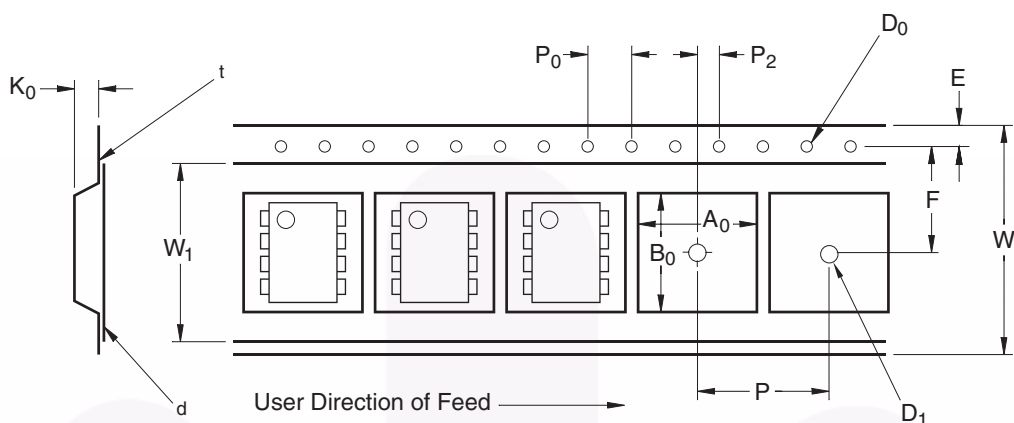
Marking Information



Definitions

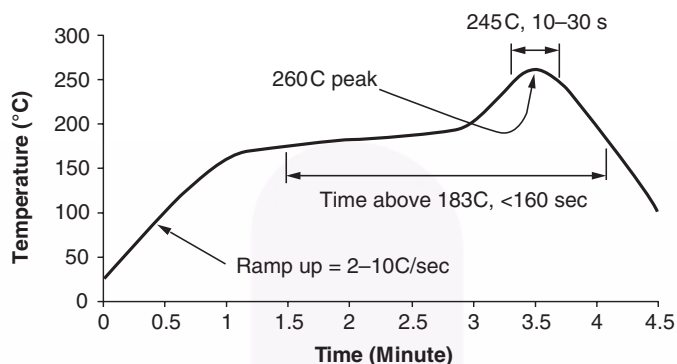
| | |
|---|--|
| 1 | Fairchild logo |
| 2 | Device number |
| 3 | VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table) |
| 4 | Two digit year code, e.g., '03' |
| 5 | Two digit work week ranging from '01' to '53' |
| 6 | Assembly package code |

Carrier Tape Specifications



| Symbol | Description | Dimension in mm |
|----------------|---------------------------------|------------------|
| W | Tape Width | 16.0 ± 0.3 |
| t | Tape Thickness | 0.30 ± 0.05 |
| P ₀ | Sprocket Hole Pitch | 4.0 ± 0.1 |
| D ₀ | Sprocket Hole Diameter | 1.55 ± 0.05 |
| E | Sprocket Hole Location | 1.75 ± 0.10 |
| F | Pocket Location | 7.5 ± 0.1 |
| P ₂ | | 4.0 ± 0.1 |
| P | Pocket Pitch | 12.0 ± 0.1 |
| A ₀ | Pocket Dimensions | 10.30 ± 0.20 |
| B ₀ | | 10.30 ± 0.20 |
| K ₀ | | 4.90 ± 0.20 |
| W ₁ | Cover Tape Width | 1.6 ± 0.1 |
| d | Cover Tape Thickness | 0.1 max |
| | Max. Component Rotation or Tilt | 10° |
| R | Min. Bending Radius | 30 |

Reflow Profile



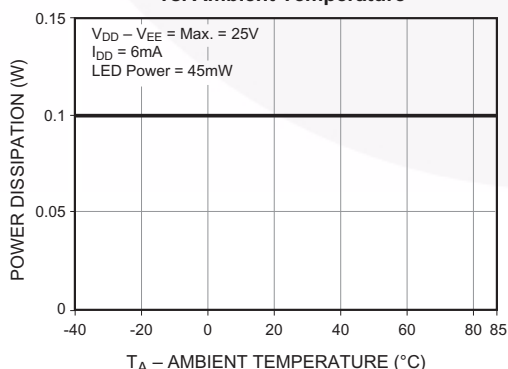
- Peak reflow temperature: 260C (package surface temperature)
- Time of temperature higher than 183C for 160 seconds or less
- One time soldering reflow is recommended

Output Power Derating

The maximum package power dissipation is 295mW. The package is limited to this level to ensure that under normal operating conditions and over extended temperature range that the semiconductor junction temperatures do not exceed 125°C. The package power is composed of three elements; the LED, static operating power of the output IC, and the power dissipated in the output power MOSFET transistors. The power rating of the output IC is 250mW. This power is divided between the static power of the integrated circuit, which is the product of I_{DD} times the power supply voltage ($V_{DD} - V_{EE}$). The maximum IC static output power is 150mW, ($V_{DD} - V_{EE}$) = 25V, I_{DD} = 6mA. This maximum condition is valid over the operational temperature range of -40°C to +100°C. Under these maximum operating conditions, the output of the power MOSFET is allowed to dissipate 100mW of power.

The absolute maximum output power dissipation versus ambient temperature is shown in Figure 12. The output driver is capable of supplying 100mW of output power over the temperature range from -40°C to 87°C. The output derates to 90mW at the absolute maximum operating temperature of 100°C.

Fig. 12 Absolute Maximum Power Dissipation vs. Ambient Temperature



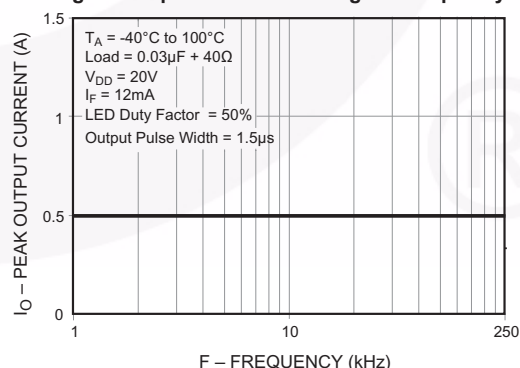
The output power is the product of the average output current squared times the output transistor's $R_{DS(ON)}$:

$$P_{O(AVG)} = I_{O(AVG)}^2 \cdot R_{DS(ON)}$$

The $I_{O(AVG)}$ is the product of the duty factor times the peak current flowing in the output. The duty factor is the ratio of the 'on' time of the output load current divided by the period of the operating frequency. An $R_{DS(ON)}$ of 2.0Ω results in an average output load current of 200mA. The load duty factor is a ratio of the average output time of the power MOSFET load circuit and period of the driving frequency.

The maximum permissible, operating frequency is determined by the load supplied to the output at its resulting output pulse width. Figure 13 shows an example of a 0.03μF gate to source capacitance with a series resistance of 40Ω. This reactive load results in a composite average pulse width of 1.5μs. Under this load condition it is not necessary to derate the absolute maximum output current out to 250kHz.

Fig. 13 Output Current Derating vs. Frequency



I_{OH} and I_{OL} Test Conditions

This device is tested and specified when driving a complex reactive load. The load consists of a capacitor in the series with a current limiting resistor. The capacitor represents the gate to source capacitance of a power MOSFET transistor. The test load is a $0.03\mu\text{F}$ capacitor in series with an 40Ω resistor. The LED test frequency is 10.0kHz with a 50% duty cycle. The combined I_{OH} and I_{OL} output load current duty factor is 0.6% at the test frequency.

Figure 14 illustrates the relationship of the LED input drive current and the device's output voltage and sourcing and sinking currents. The $0.03\mu\text{F}$ capacitor load represents the gate to source capacitance of a very large power MOSFET transistor. A single supply voltage of 20V is used in the evaluation.

Figure 15 shows the test schematic to evaluate the output voltage and sourcing and sinking capability of the device. The I_{OH} and I_{OL} are measured at the peak of their respective current pulses.

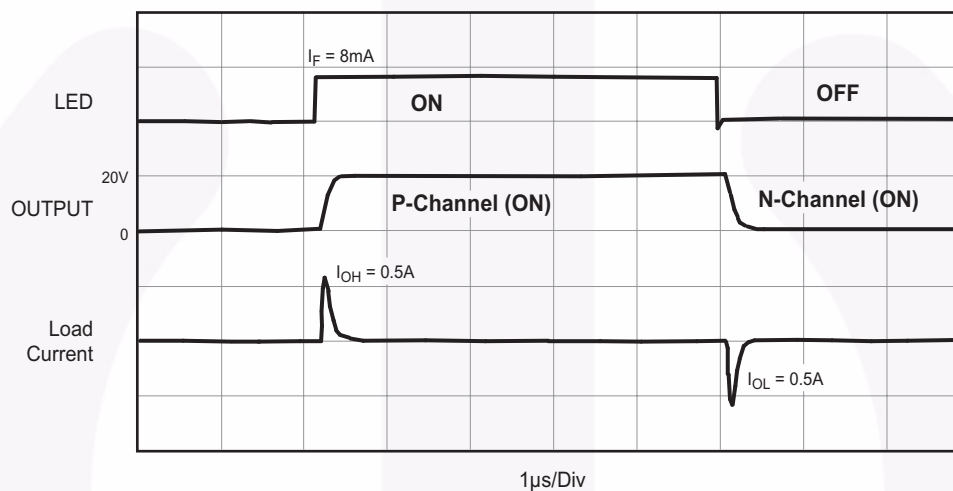


Figure 14. FOD 3180 Output Current and Output Voltage vs. LED Drive

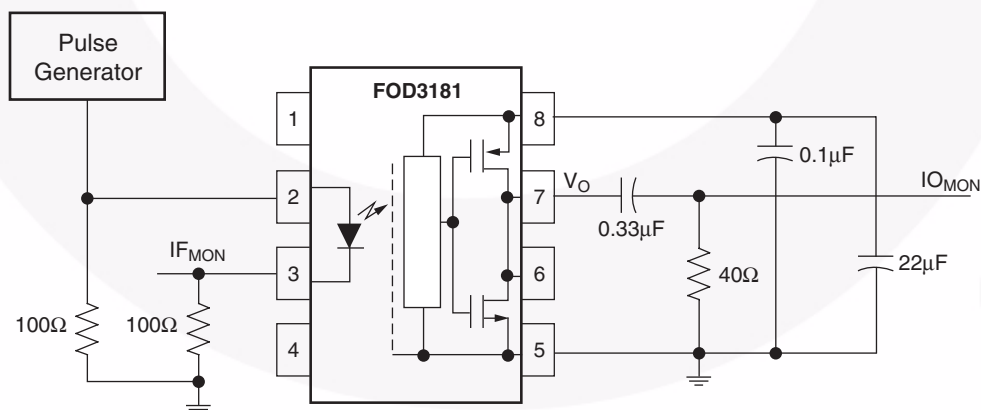




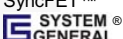


Figure 15. Test Schematic

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| EcoSPARK® | GTO™ | Quiet Series™ | TinyPower™ |
| EfficientMax™ | IntelliMAX™ | RapidConfigure™ | TinyPWM™ |
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|  | MegaBuck™ | SmartMax™ | μSerDes™ |
|  | MICROCOUPLER™ | SMART START™ |  |
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| Fairchild Semiconductor® | MicroPak™ | STEALTH™ | Ultra FRFET™ |
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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|--------------------------|-----------------------|---|
| Advance Information | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production | Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design. |
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Rev. I35