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August 2008

# FOD3180 2A Output Current, High Speed MOSFET Gate Driver Optocoupler

## Features

- Guaranteed operating temperature range of -40°C to +100°C
- 2A minimum peak output current
- High speed response: 200ns max propagation delay over temperature range
- 250kHz maximum switching speed
- 30ns typ pulse width distortion
- Wide  $V_{CC}$  operating range: 10V to 20V
- 5000Vrms, 1 minute isolation
- Under voltage lockout protection (UVLO) with hysteresis
- Minimum creepage distance of 7.0mm
- Minimum clearance distance of 7.0mm
- C-UL, UL and VDE\* approved
- $R_{DS(ON)}$  of 1.5Ω (typ.) offers lower power dissipation
- 15kV/μs minimum common mode rejection

## 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

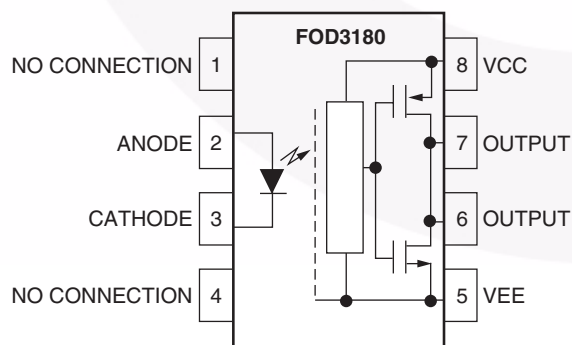
\*Requires 'V' ordering option

## Description

The FOD3180 is a 2A Output Current, High Speed MOSFET Gate Drive Optocoupler. It consists of an aluminium gallium arsenide (AlGaAs) light emitting diode optically coupled to a CMOS detector with PMOS and NMOS output power transistors integrated circuit power stage. It is ideally suited for high frequency driving of power 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.

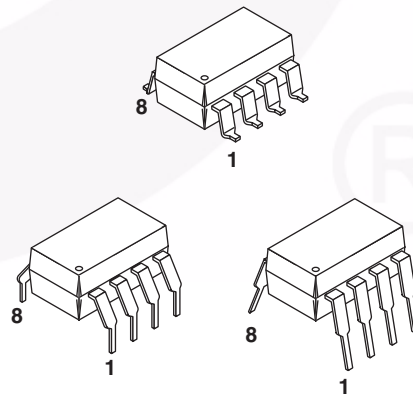
## Functional Block Diagram



### Note:

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

## Package Outlines



FOD3180 — 2A Output Current, High Speed MOSFET Gate Driver Optocoupler

**Absolute Maximum Ratings** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

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	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature	-40 to +100	$^\circ\text{C}$
$T_J$	Junction Temperature	-40 to +125	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature	260 for 10 sec.	$^\circ\text{C}$
$I_{F(AVG)}$	Average Input Current <sup>(1)</sup>	25	mA
$I_{F(tr, tf)}$	LED Current Minimum Rate of Rise/Fall	250	ns
$I_{F(TRAN)}$	Peak Transient Input Current (<1 $\mu\text{s}$ pulse width, 300pps)	1.0	A
$V_R$	Reverse Input Voltage	5	V
$I_{OH(PEAK)}$	“High” Peak Output Current <sup>(2)</sup>	2.5	A
$I_{OL(PEAK)}$	“Low” Peak Output Current <sup>(2)</sup>	2.5	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 <sup>(4)</sup>	250	mW
$P_D$	Total Power Dissipation <sup>(5)</sup>	295	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)	10 to 16	mA
$V_{F(OFF)}$	Input Voltage (OFF)	-3.0 to 0.8	V

**Electrical-Optical Characteristics (DC)**

Over recommended operating conditions unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
I <sub>OH</sub>	High Level Output Current <sup>(2)(3)</sup>	V <sub>OH</sub> = (V <sub>CC</sub> - V <sub>EE</sub> - 1V)	0.5			A
		V <sub>OH</sub> = (V <sub>CC</sub> - V <sub>EE</sub> - 3V)	2.0			
I <sub>OL</sub>	Low Level Output Current <sup>(2)(3)</sup>	V <sub>OL</sub> = (V <sub>CC</sub> - V <sub>EE</sub> - 1V)	0.5			A
		V <sub>OL</sub> = (V <sub>CC</sub> - V <sub>EE</sub> - 3V)	2.0			
V <sub>OH</sub>	High Level Output Voltage <sup>(6)(7)</sup>	I <sub>O</sub> = -100mA	V <sub>CC</sub> - 0.5			V
V <sub>OL</sub>	Low Level Output Voltage <sup>(6)(7)</sup>	I <sub>O</sub> = 100mA			V <sub>EE</sub> + 0.5	V
I <sub>CCH</sub>	High Level Supply Current	Output Open, I <sub>F</sub> = 10 to 16mA		4.8	6.0	mA
I <sub>CCL</sub>	Low Level Supply Current	Output Open, V <sub>F</sub> = -3.0 to 0.8V		5.0	6.0	mA
I <sub>FLH</sub>	Threshold Input Current Low to High	I <sub>O</sub> = 0mA, V <sub>O</sub> > 5V			8.0	mA
V <sub>FHL</sub>	Threshold Input Voltage High to Low	I <sub>O</sub> = 0mA, V <sub>O</sub> < 5V	0.8			V
V <sub>F</sub>	Input Forward Voltage	I <sub>F</sub> = 10mA	1.2	1.43	1.8	V
ΔV <sub>F</sub> /T <sub>A</sub>	Temperature Coefficient of Forward Voltage	I <sub>F</sub> = 10mA		-1.5		mV/°C
V <sub>UVLO+</sub>	UVLO Threshold	V <sub>O</sub> > 5V, I <sub>F</sub> = 10mA		8.3		V
V <sub>UVLO-</sub>		V <sub>O</sub> < 5V, I <sub>F</sub> = 10mA		7.7		V
UVLO <sub>HYST</sub>	UVLO Hysteresis			0.6		V
BV <sub>R</sub>	Input Reverse Breakdown Voltage	I <sub>R</sub> = 10μA	5			V
C <sub>IN</sub>	Input Capacitance	f = 1MHz, V <sub>F</sub> = 0V		60		pF

\*Typical values at T<sub>A</sub> = 25°C

## Switching Characteristics

Over recommended operating conditions unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
$t_{PLH}$	Propagation Delay Time to High Output Level <sup>(8)</sup>	$I_F = 10\text{mA}$ , $R_g = 10\Omega$ , $f = 250\text{kHz}$ , Duty Cycle = 50%, $C_g = 10\text{nF}$	50	135	200	ns
$t_{PHL}$	Propagation Delay Time to Low Output Level <sup>(8)</sup>		50	105	200	ns
$P_{WD}$	Pulse Width Distortion <sup>(9)</sup>				65	ns
$P_{DD}$ ( $t_{PHL} - t_{PLH}$ )	Propagation Delay Difference Between Any Two Parts <sup>(10)</sup>		-90		90	ns
$t_r$	Rise Time	$C_L = 10\text{nF}$ , $R_g = 10\Omega$		75		ns
$t_f$	Fall Time			55		ns
$t_{UVLO\ ON}$	UVLO Turn On Delay			2.0		$\mu\text{s}$
$t_{UVLO\ OFF}$	UVLO Turn Off Delay			0.3		$\mu\text{s}$
$ CM_H $	Output High Level Common Mode Transient Immunity <sup>(11) (12)</sup>	$T_A = +25^\circ\text{C}$ , $I_f = 10$ to $16\text{mA}$ , $V_{CM} = 1.5\text{kV}$ , $V_{CC} = 20\text{V}$	15			$\text{kV}/\mu\text{s}$
$ CM_L $	Output Low Level Common Mode Transient Immunity <sup>(11) (13)</sup>	$T_A = +25^\circ\text{C}$ , $V_f = 0\text{V}$ , $V_{CM} = 1.5\text{kV}$ , $V_{CC} = 20\text{V}$	15			$\text{kV}/\mu\text{s}$

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

## Isolation Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
$V_{ISO}$	Withstand Isolation Voltage <sup>(14) (15)</sup>	$T_A = 25^\circ\text{C}$ , 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) <sup>(15)</sup>	$V_{I-O} = 500\text{V}$		$10^{11}$		$\Omega$
$C_{I-O}$	Capacitance (input to output)	Freq. = 1MHz		1		pF

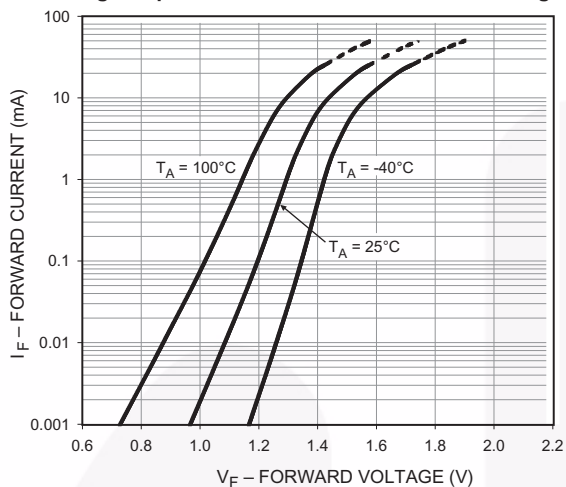
\*Typical values at  $T_A = 25^\circ\text{C}$

**Notes:**

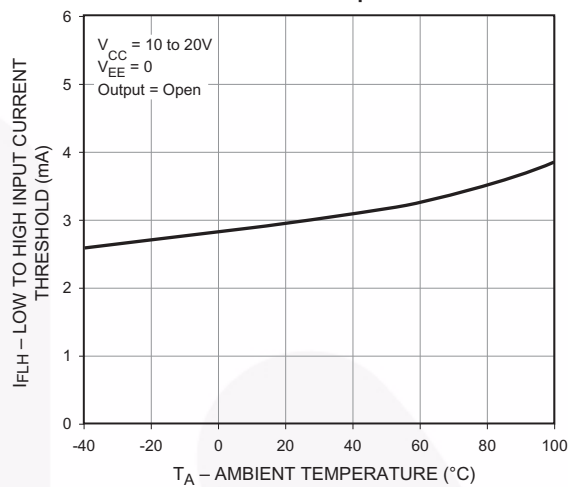
1. Derate linearly above +70°C free air temperature at a rate of 0.3mA/°C.
2. The output currents  $I_{OH}$  and  $I_{OL}$  are specified with a capacitive current limited load =  $(3 \times 0.01\mu\text{F}) + 0.5\Omega$ , frequency = 8kHz, 50% DF.
3. The output currents  $I_{OH}$  and  $I_{OL}$  are specified with a capacitive current limited load =  $(3 \times 0.01\mu\text{F}) + 8.5\Omega$ , frequency = 8kHz, 50% DF.
4. Derate linearly above +87°C, free air temperature at the rate of 0.77mW/°C. Refer to Figure 12.
5. No derating required across operating temperature range.
6. 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.
7. Maximum pulse width = 1ms, maximum duty cycle = 20%.
8.  $t_{PHL}$  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.
9. PWD is defined as  $|t_{PHL} - t_{PLH}|$  for any given device.
10. The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two FOD3180 parts under same test conditions.
11. Pin 1 and 4 need to be connected to LED common.
12. 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.  $V_O > 10.0V$ ).
13. 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.  $V_O < 1.0V$ ).
14. 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  $I_{I-O} < 5\mu\text{A}$ ).
15. Device considered a two-terminal device: pins on input side shorted together and pins on output side shorted together.

## Typical Performance Curves

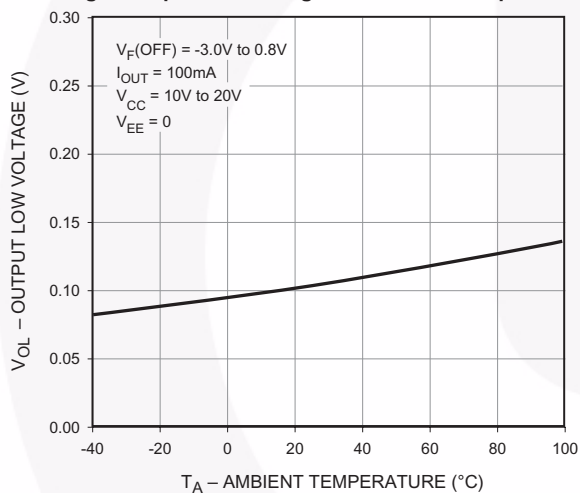
**Fig. 1 Input Forward Current vs. Forward Voltage**



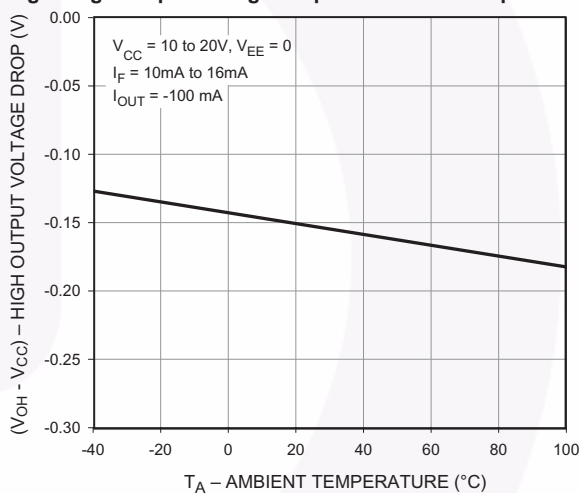
**Fig. 2 Low To High Input Current Threshold vs. Ambient Temperature**



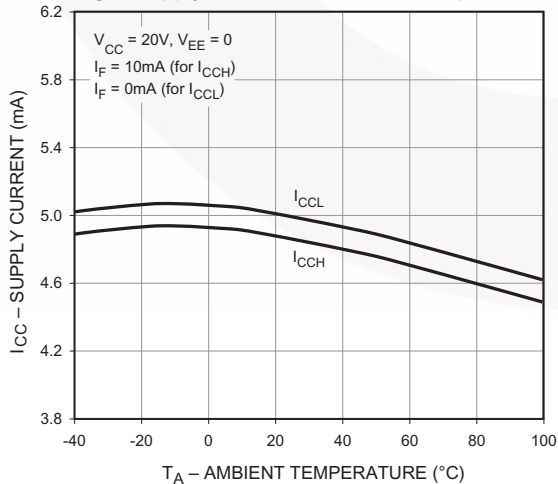
**Fig. 3 Output Low Voltage vs. Ambient Temperature**



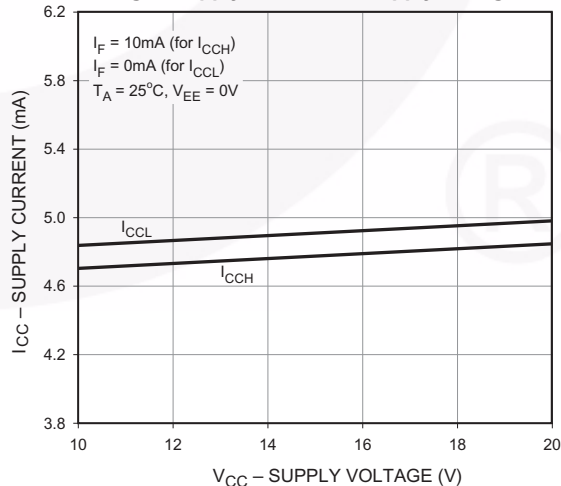
**Fig. 4 High Output Voltage Drop vs. Ambient Temperature**



**Fig. 5 Supply Current vs. Ambient Temperature**

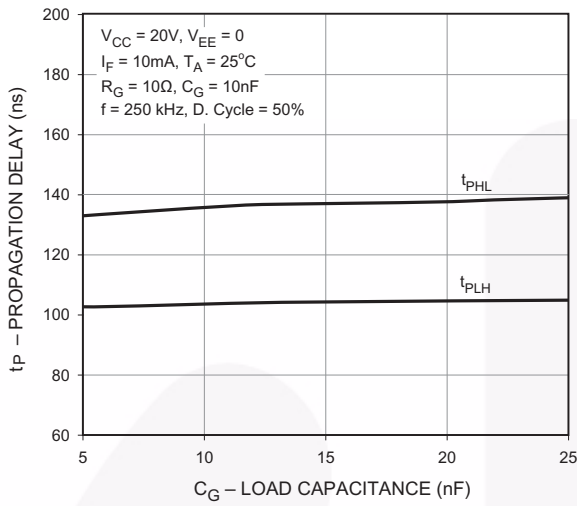


**Fig. 6 Supply Current vs. Supply Voltage**

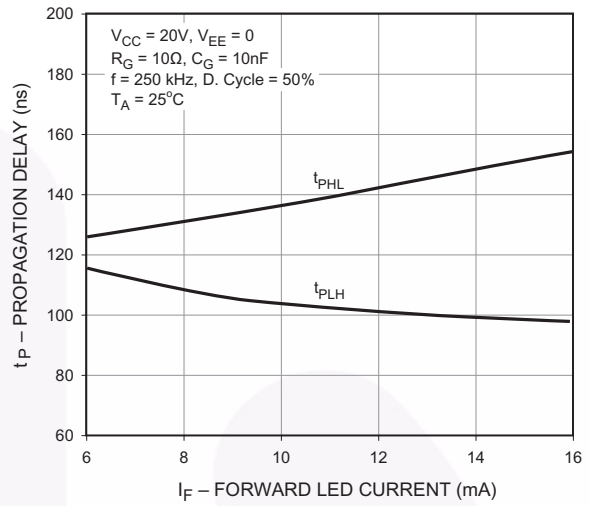


**Typical Performance Curves (Continued)**

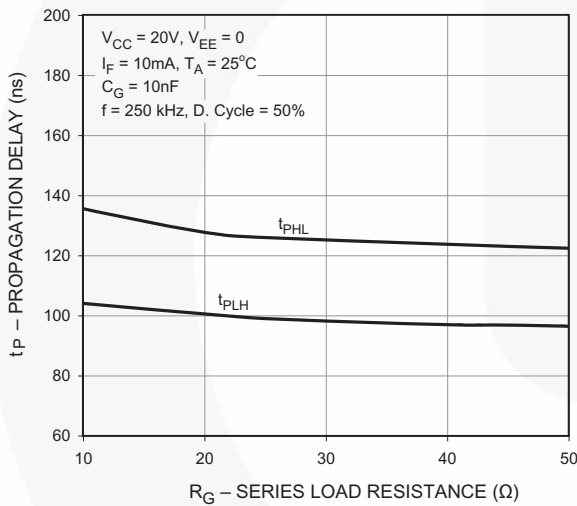
**Fig. 7 Propagation Delay vs. Load Capacitance**



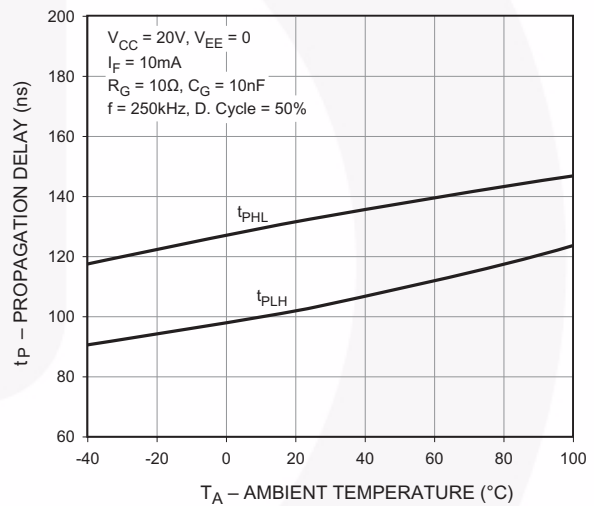
**Fig. 8 Propagation Delay vs. Forward LED Current**



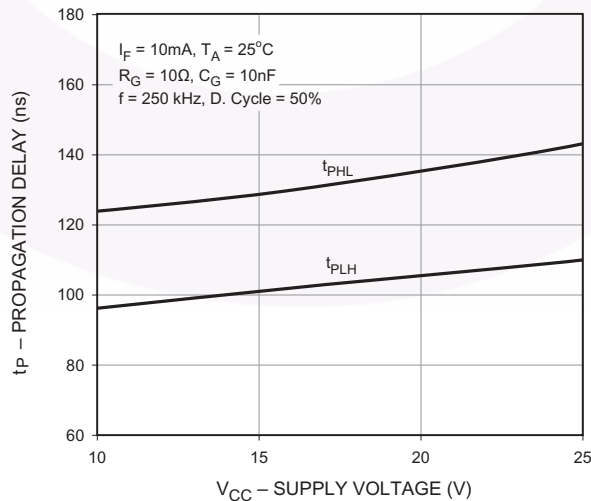
**Fig. 9 Propagation Delay vs. Series Load Resistance**



**Fig. 10 Propagation Delay vs. Ambient Temperature**



**Fig. 11 Propagation Delay vs. Supply Voltage**

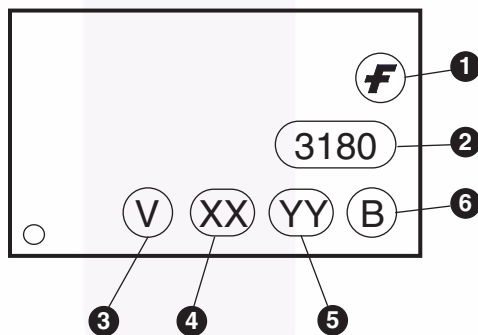




### Ordering Information

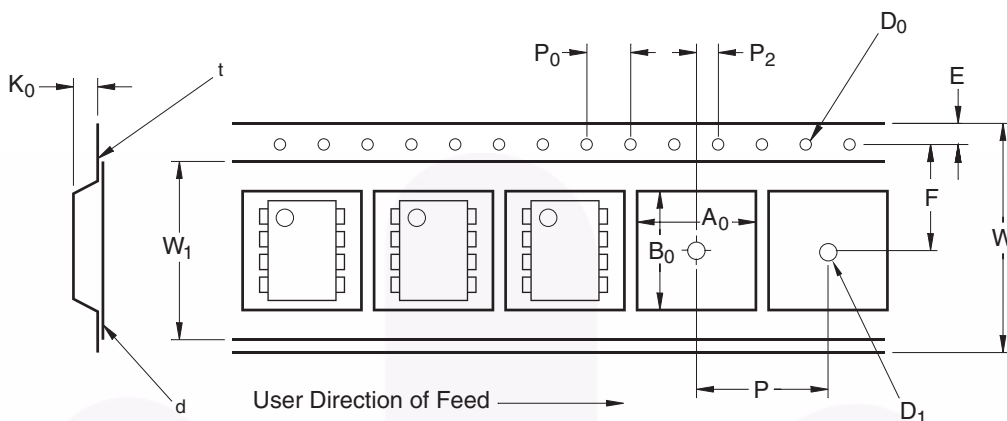
Option	Order Entry Identifier (Example)	Description
No option	FOD3180	Standard Through Hole Device
S	FOD3180S	Surface Mount, Lead Bend
SD	FOD3180SD	Surface Mount, Tape and Reel
T	FOD3180T	0.4" Lead Spacing
V	FOD3180V	VDE 0884
TV	FOD3180TV	VDE 0884, 0.4" Lead Spacing
SV	FOD3180SV	VDE 0884, Surface Mount
SDV	FOD3180SDV	VDE 0884, Surface Mount, Tape and Reel

### Marking Information



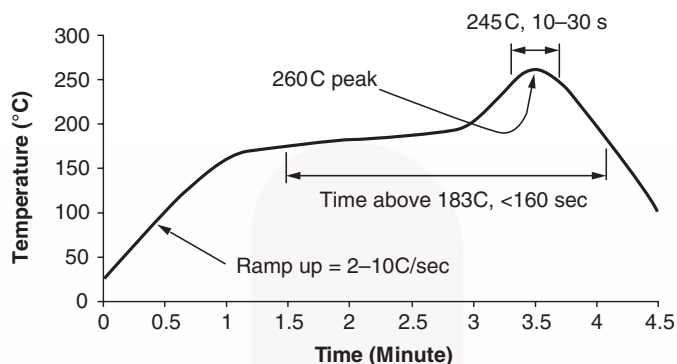
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

### Carrier Tape Specifications



Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P <sub>0</sub>	Sprocket Hole Pitch	4.0 ± 0.1
D <sub>0</sub>	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P <sub>2</sub>		4.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A <sub>0</sub>	Pocket Dimensions	10.30 ± 0.20
B <sub>0</sub>		10.30 ± 0.20
K <sub>0</sub>		4.90 ± 0.20
W <sub>1</sub>	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**



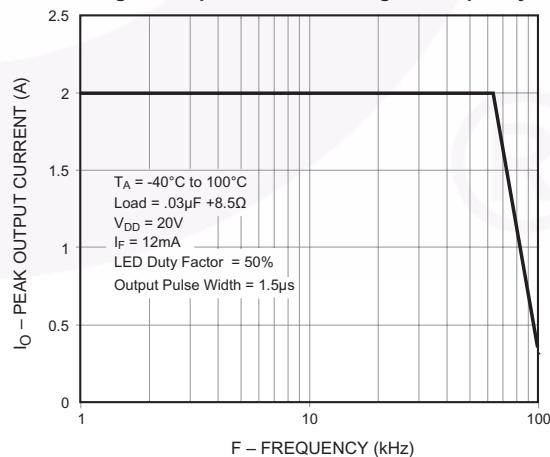
The output power is the product of the average output current squared times the output transistor's  $R_{DS(ON)}$ :

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

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 8.50Ω. 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 until the frequency of operation exceeds 63kHz.

**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  $8.5\Omega$  resistor. The LED test frequency is  $10.0\text{kHz}$  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  $20\text{V}$  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.

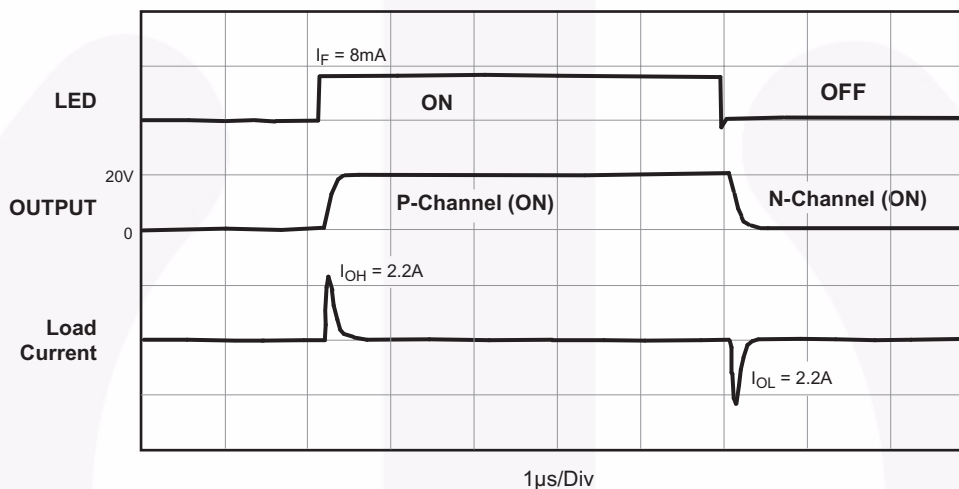


Figure 14. FOD 3180 Output Current and Output Voltage vs. LED Drive

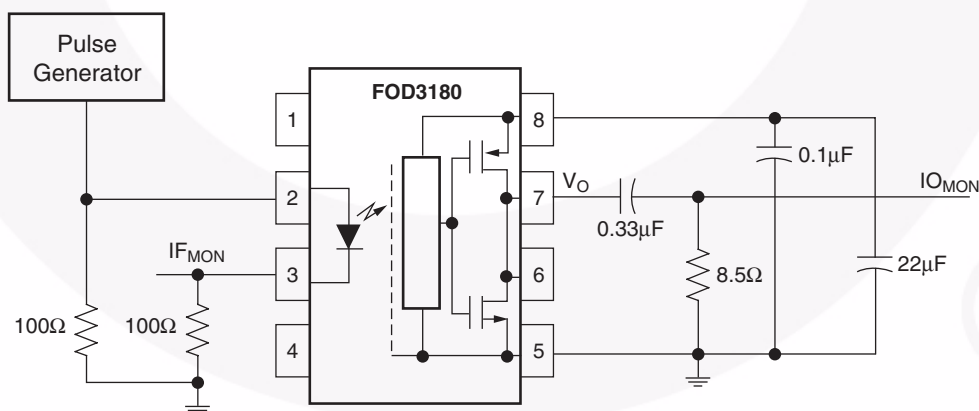


Figure 15. Test Schematic



LAND PATTERN RECOMMENDATION



NOTES:

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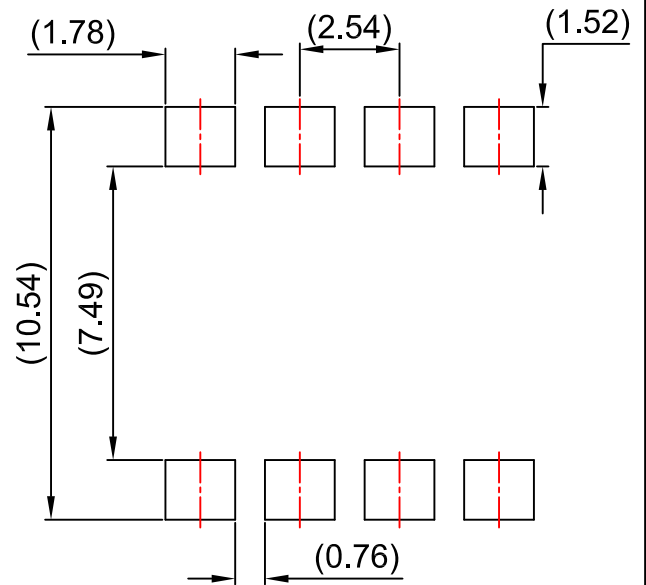




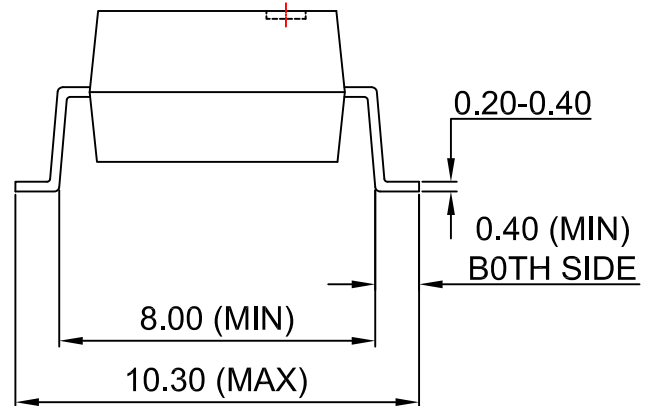
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PIN 1

15.0° (MAX)

10.16 (TYP)

0.20-0.40



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