FAIRCHILD SEMICONDUCTOR®

July 2007

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

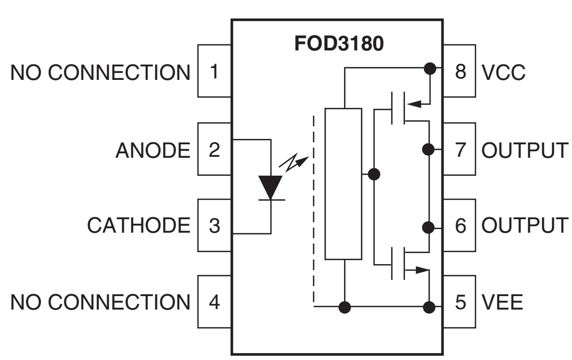
*Requires 'V' ordering option

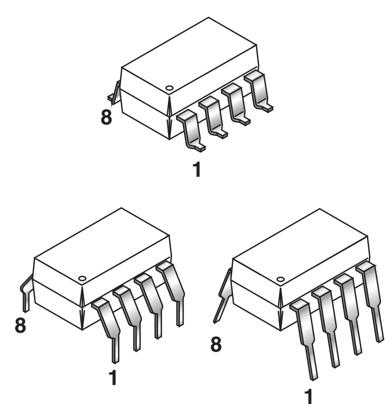
Description

The FOD3180 is a 2A Output Current, High Speed MOSFET Gate Drive Optocoupler. It consists of a 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.

Absolute Maximum Ratings (T_A = 25°C Unless otherwise specified)

Symbol	Parameter	Value	Units
T_{STG}	Storage Temperature	-40 to +125	°C
T_{OPR}	Operating Temperature	-40 to +100	°C
T_J	Junction Temperature	-40 to +125	°C
T_{SOL}	Lead Solder Temperature	260 for 10 sec.	°C
$I_{F(AVG)}$	Average Input Current[(1)]	25	mA
$I_{F(tr, tf)}$	LED Current Minimum Rate of Rise/Fall	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)]	2.5	A
$I_{OL(PEAK)}$	"Low" Peak Output Current[(2)]	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[(4)]	250	mW
P_D	Total Power Dissipation[(5)]	295	mW

Recommended Operating Conditions

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_{OH}	High Level Output Current[(2)(3)]	$V_{OH} = (V_{CC} - V_{EE} - 1V)$	0.5			A
		$V_{OH} = (V_{CC} - V_{EE} - 3V)$	2.0			
I_{OL}	Low Level Output Current[(2)(3)]	$V_{OL} = (V_{CC} - V_{EE} - 1V)$	0.5			A
		$V_{OL} = (V_{CC} - V_{EE} - 3V)$	2.0			
V_{OH}	High Level Output Voltage[(6)(7)]	I_O = -100mA	$V_{CC} - 0.5$			V
V_{OL}	Low Level Output Voltage[(6)(7)]	I_O = 100mA			$V_{EE} + 0.5$	V
I_{CCH}	High Level Supply Current	Output Open, I_F = 10 to 16mA		4.8	6.0	mA
I_{CCL}	Low Level Supply Current	Output Open, V_F = -3.0 to 0.8V		5.0	6.0	mA
I_{FLH}	Threshold Input Current Low to High	I_O = 0mA, V_O > 5V			8.0	mA
V_{FHL}	Threshold Input Voltage High to Low	I_O = 0mA, V_O < 5V	0.8			V
V_F	Input Forward Voltage	I_F = 10mA	1.2	1.43	1.8	V
$\Delta V_F / T_A$	Temperature Coefficient of Forward Voltage	I_F = 10mA		-1.5		mV/°C
V_{UVLO+}	UVLO Threshold	V_O > 5V, I_F = 10mA		8.3		V
V_{UVLO-}		V_O < 5V, I_F = 10mA		7.7		V
$UVLO_{HYST}$	UVLO Hysteresis			0.6		V
BV_R	Input Reverse Breakdown Voltage	I_R = 10µA	5			V
C_{IN}	Input Capacitance	f = 1MHz, V_F = 0V		60		pF

*Typical values at T_A = 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(8)	I_F = 10mA, R_g = 10Ω, f = 250kHz, Duty Cycle = 50%, C_g = 10nF	50	135	200	ns
t_{PHL}	Propagation Delay Time to Low Output Level(8)		50	105	200	ns
P_{WD}	Pulse Width Distortion(9)				65	ns
P_{DD} ($t_{PHL} - t_{PLH}$)	Propagation Delay Difference Between Any Two Parts(10)		-90		90	ns
t_r	Rise Time	C_L = 10nF, R_g = 10Ω		75		ns
t_f	Fall Time			55		ns
$t_{UVLO\ ON}$	UVLO Turn On Delay			2.0		µs
$t_{UVLO\ OFF}$	UVLO Turn Off Delay			0.3		µs
$\|CM_H\|$	Output High Level Common Mode Transient Immunity(11) (12)	T_A = +25°C, I_f = 10 to 16mA, V_{CM} = 1.5kV, V_{CC} = 20V	15			kV/µs
$\|CM_L\|$	Output Low Level Common Mode Transient Immunity(11) (13)	T_A = +25°C, V_f = 0V, V_{CM} = 1.5kV, V_{CC} = 20V	15			kV/µs

*Typical values at T_A = 25°C

Isolation Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
V_{ISO}	Withstand Isolation Voltage(14) (15)	T_A = 25°C, R.H. < 50%, t = 1min., $I_{I-O} \le 20\mu A$	5000			V_{rms}
R_{I-O}	Resistance (input to output)(15)	V_{I-O} = 500V		10^{11}		Ω
C_{I-O}	Capacitance (input to output)	Freq. = 1MHz		1		pF

*Typical values at T_A = 25°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 x 0.01µF) + 0.5Ω, frequency = 8kHz, 50% DF. The maximum pulse width of the output current is 300ns, maximum duty cycle = 0.48%. Output currents specified for different values of V_{DS} for $V_{CC} - V_{EE}$ = 20V with the formula:

   $V_{OH} = (V_{CC} - V_{EE}) - (I_{OH} \times R_{DS(ON)})$.

   This guarantees operation at I_O peak minimum = 2.0A for -40°C to +100°C operating temperature range.
3. The output currents I_{OH} and I_{OL} are specified with a capacitive current limited load = (3 x 0.01µF) + 8.5Ω, frequency = 8kHz, 50% DF. The maximum pulse width of the output current is 1.5µs, maximum duty cycle = 2.4%. Output currents specified for different values of V_{DS} for $V_{CC} - V_{EE}$ = 20V with the formula:

   $V_{OL} = (V_{CC} - V_{EE}) - (I_{OL} \times R_{DS(ON)})$.

   This guarantees operation at I_O peak minimum = 0.5A for -40°C to +100°C operating temperature range.
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. 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 for 1 second (leakage detection current limit I_{I-O} < 5µA).
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

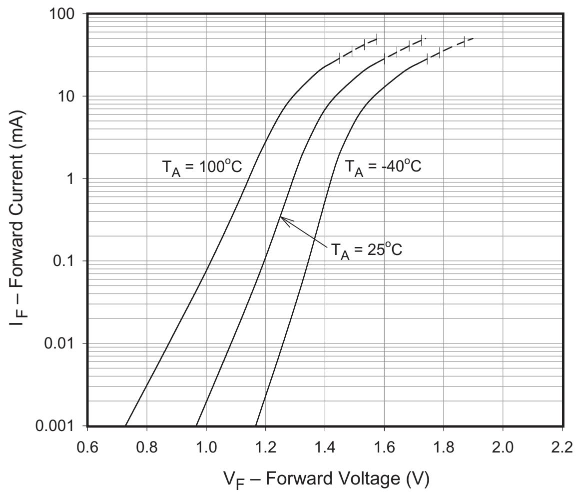


Fig. 2 Low To High Input Current Threshold vs. Ambient Temperature

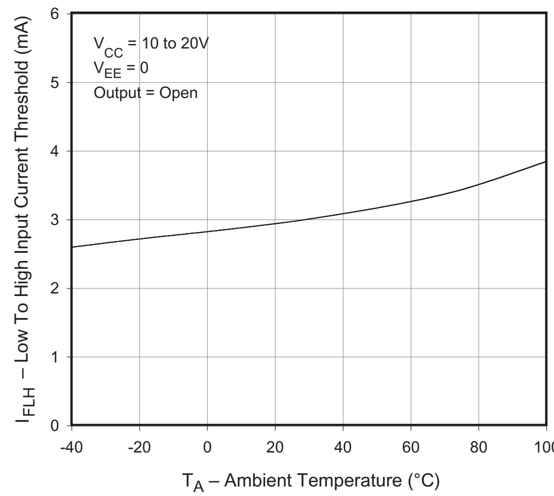


Fig. 3 Output Low Voltage vs. Ambient Temperature

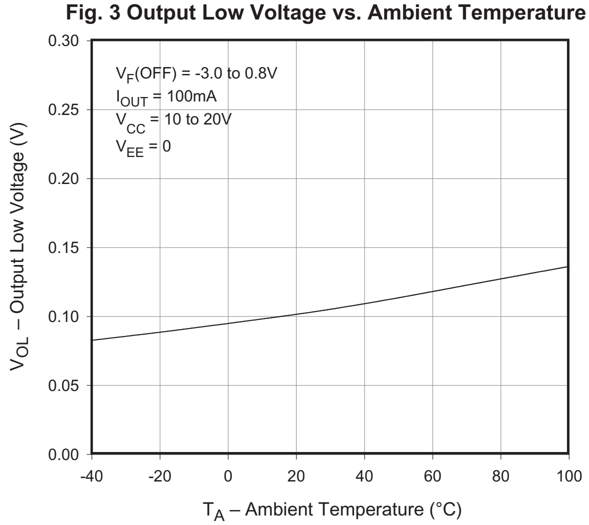


Fig. 4 High Output Voltage Drop vs. Ambient Temperature

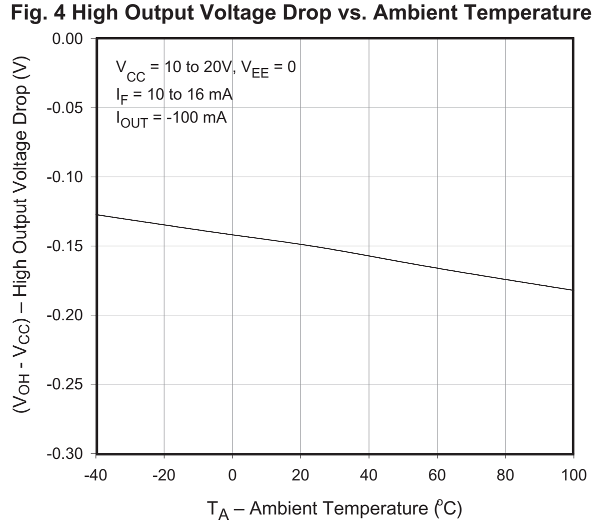


Fig. 5 Supply Current vs. Ambient Temperature

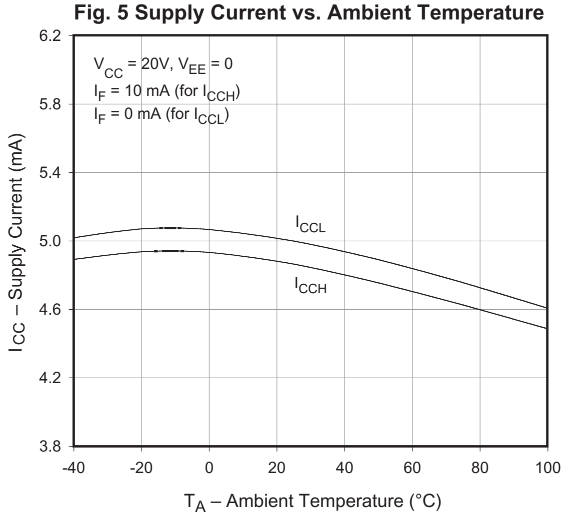


Fig. 6 Supply Current vs. Supply Voltage

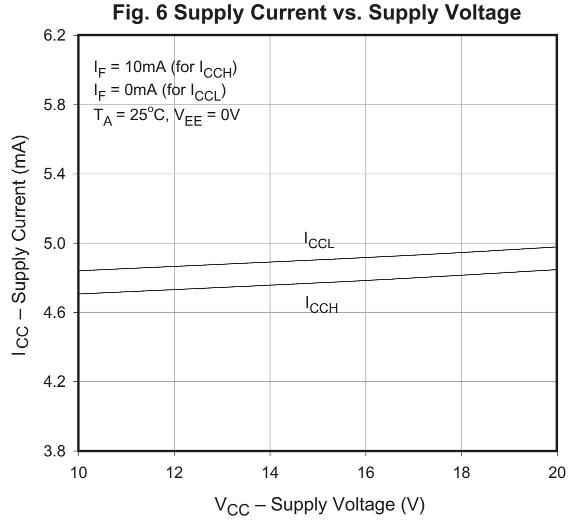


Fig. 7 Propagation Delay vs. Load Capacitance

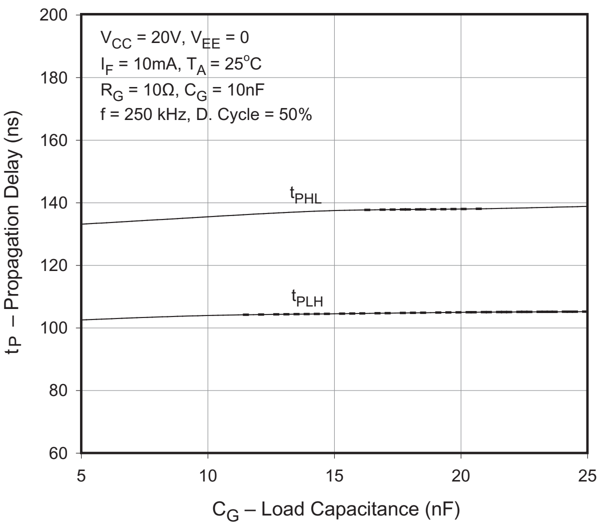


Fig. 8 Propagation Delay vs. Forward LED Current

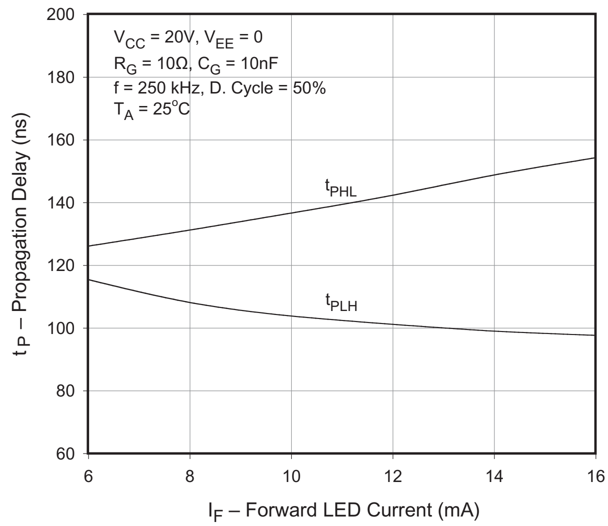


Fig. 9 Propagation Delay vs. Series Load Resistance

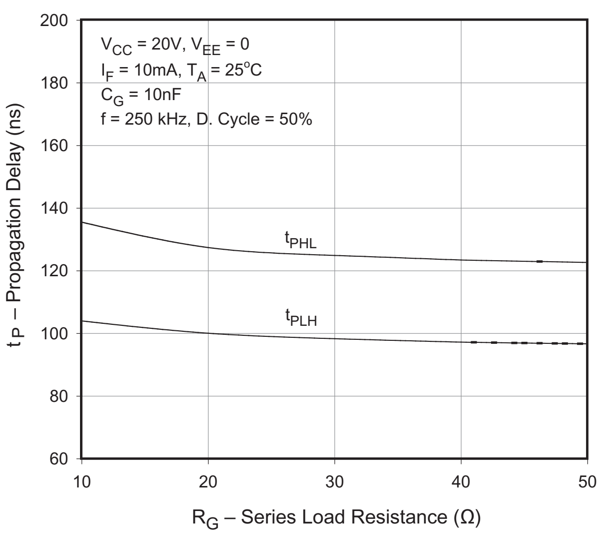


Fig. 10 Propagation Delay vs. Ambient Temperature

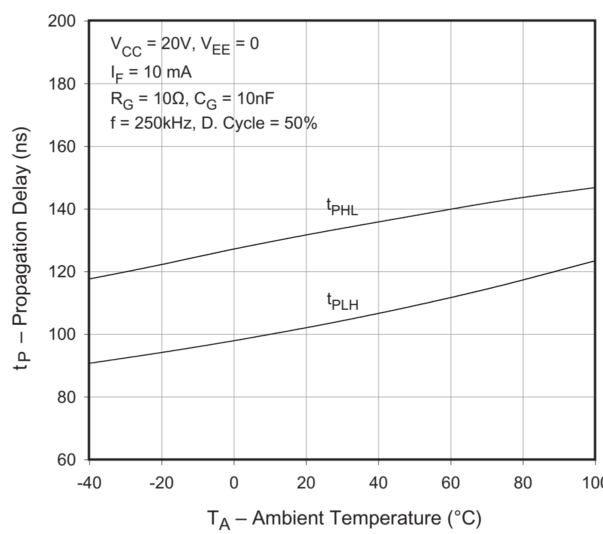
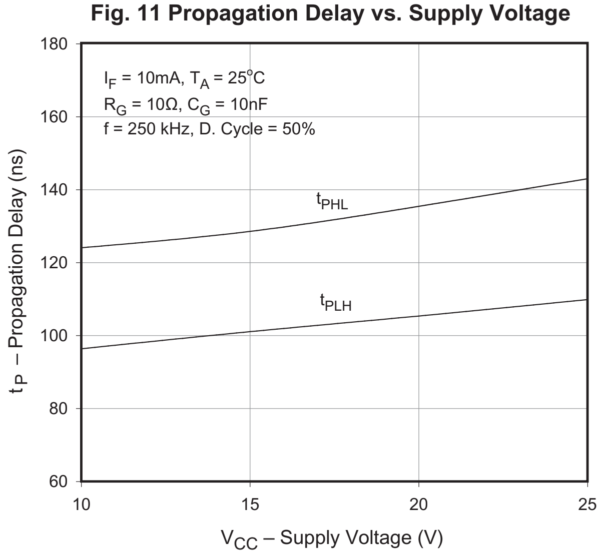
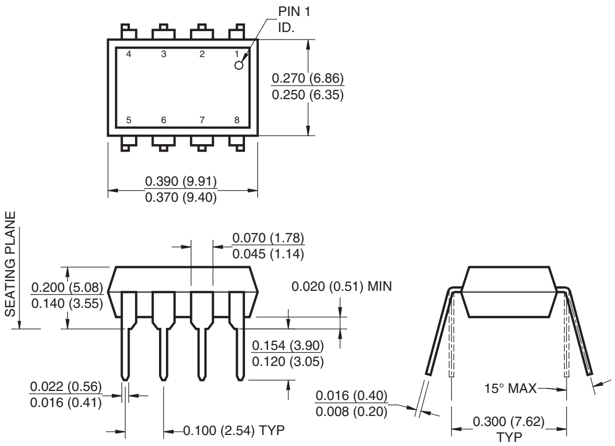


Fig. 11 Propagation Delay vs. Supply Voltage

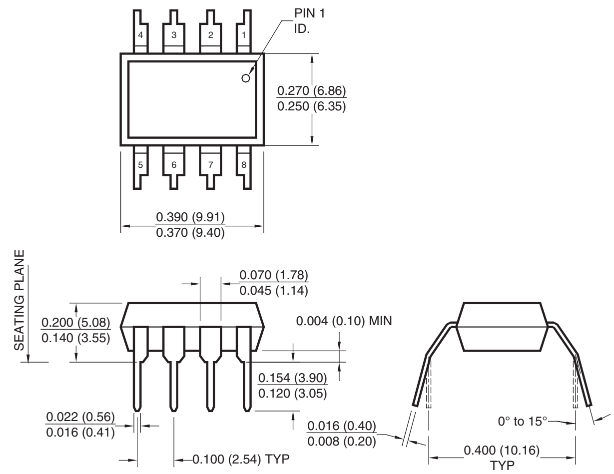


Package Dimensions

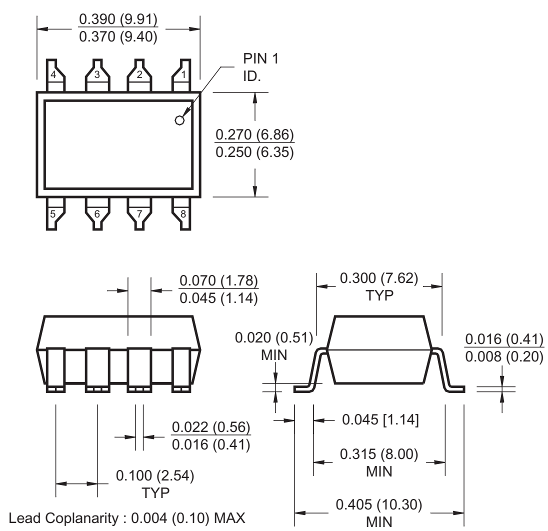
Through Hole



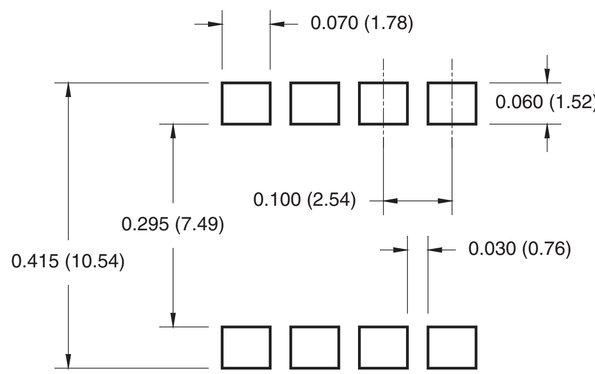
0.4" Lead Spacing



Surface Mount



8-Pin DIP – Land Pattern



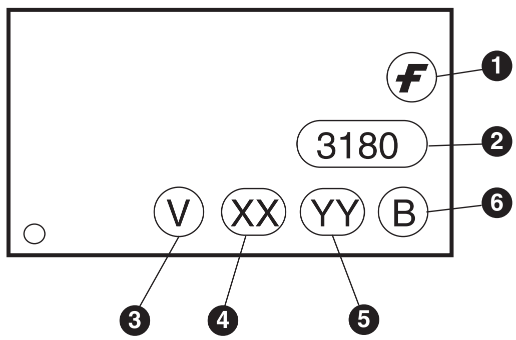
Note:
All dimensions are in inches (millimeters)

Ordering Information

Example: FOD3180 X

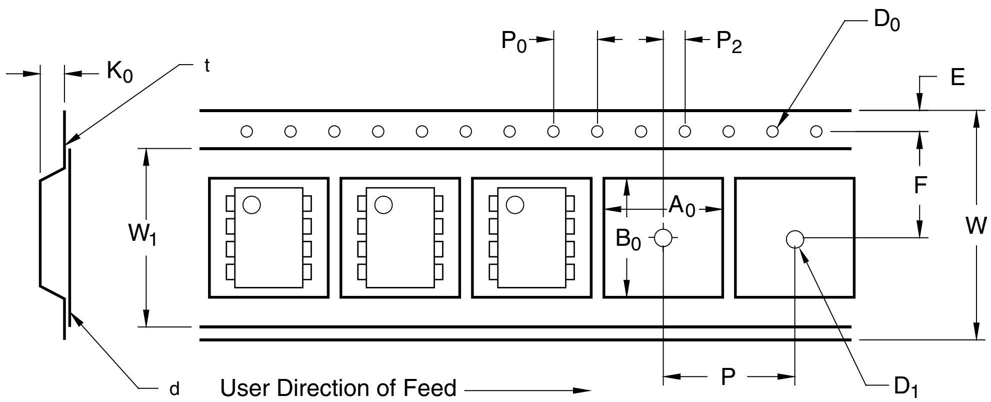
X
Packaging Option
S: Surface Mount Lead Bend
SD: Surface Mount, Tape and Reel
T: 0.4" Lead Spacing
V: VDE Approved
TV: VDE Approved, 0.4" Lead Spacing
SV: VDE Approved, Surface Mount
SDV: VDE Approved, Surface Mount, Tape and Reel

Marking Information



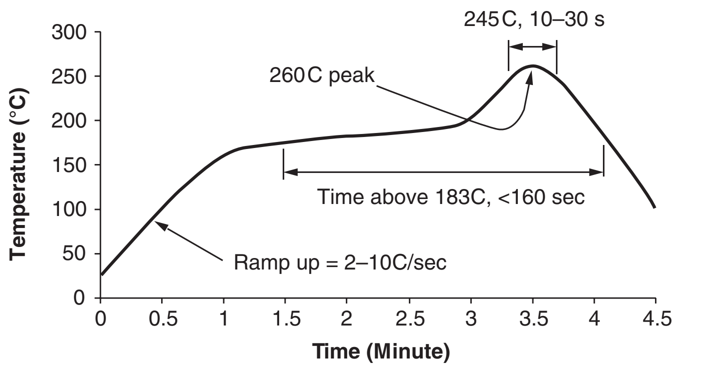
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., ‘03’
5	Two digit work week ranging from ‘01’ to ‘53’
6	Assembly package code

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



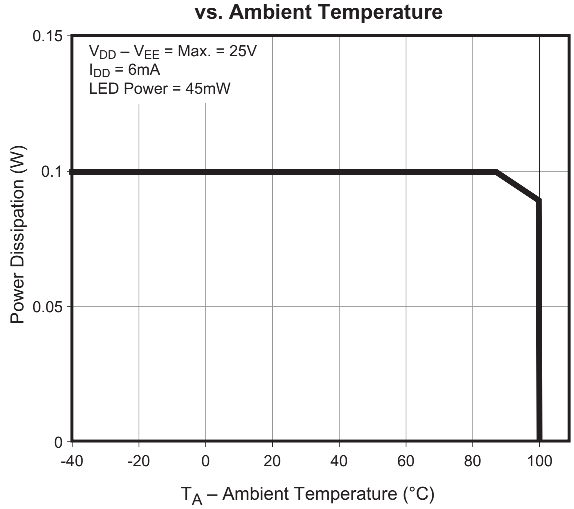
- Peak reflow temperature: 260C (package surface temperature)
- Time of temperature higher than 183C for 160 seconds or less
- One time soldering reflow is recommended

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



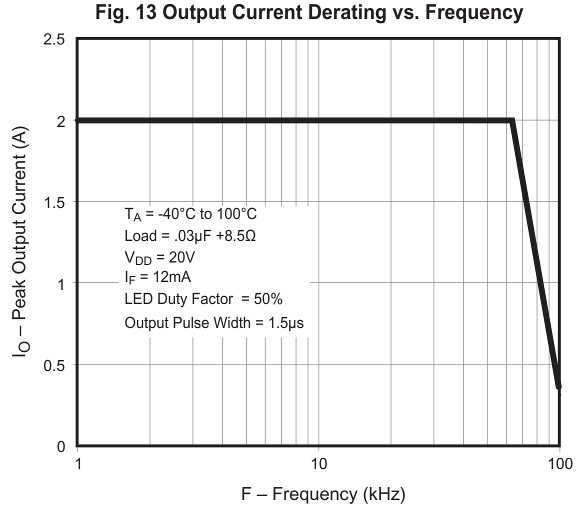
The output power is the product of the average output current squared times the output transistor's $R_{DS(ON)}$:

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

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 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 0.03uF capacitor in series with an 8.5Ω 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 0.03µF 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.

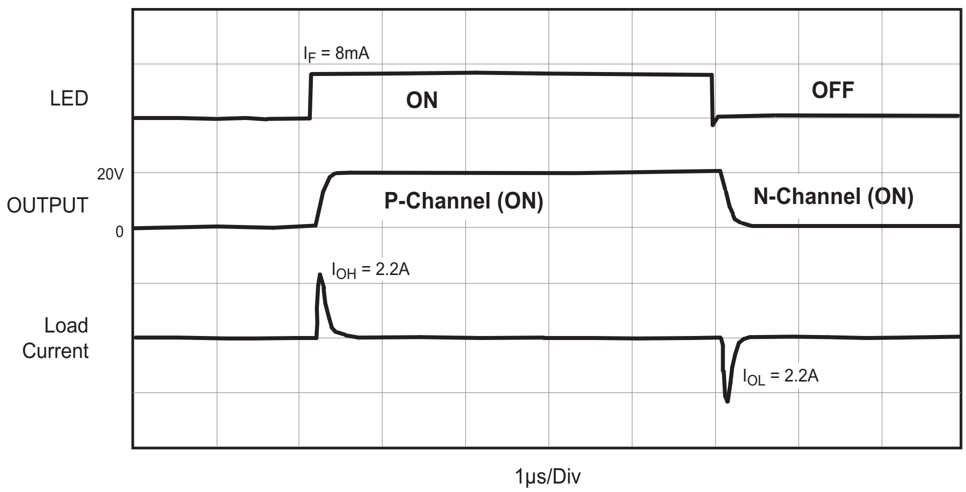


Figure 14. FOD 3180 Output Current and Output Voltage vs. LED Drive

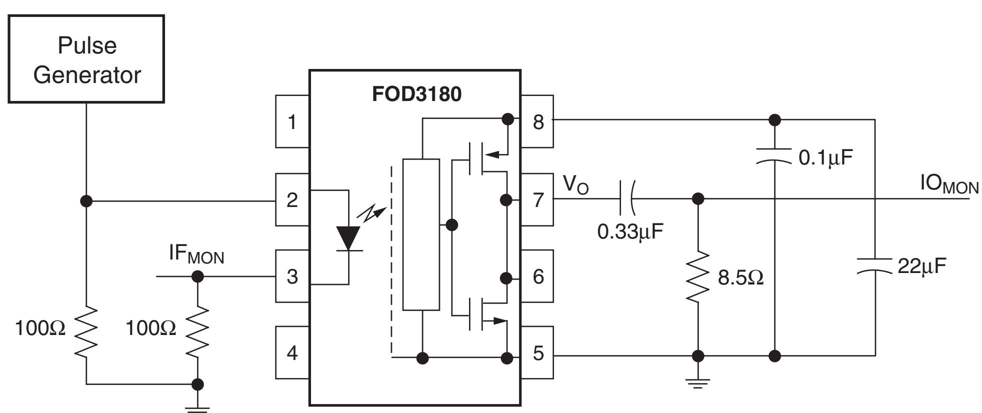


Figure 15. Test Schematic

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GTO™
i-Lo™
IntelliMAX™
ISOPLANAR™
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MICROCOUPLER™
MicroFET™
MicroPak™
Motion-SPM™
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Power220®
Power247®
POWEREDGE®
Power-SPM™
PowerTrench®
Programmable Active Droop™
QFET®
QS™
QT Optoelectronics™
Quiet Series™
RapidConfigure™
SMART START™
SPM®
STEALTH™
SuperFET™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SyncFET™
The Power Franchise®
™
TinyBoost™
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TinyPWM™
TinyWire™
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UniFET™
VCX™

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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.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This 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	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild Semiconductor. The datasheet is printed for reference information only.

Rev. I29