



# 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/ $\mu$ s minimum common mode rejection (CMR) at  $V_{CM} = 1,500V$
- $R_{DS(ON)}$  of 1.5 $\Omega$  (typ.) offers lower power dissipation

### 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.

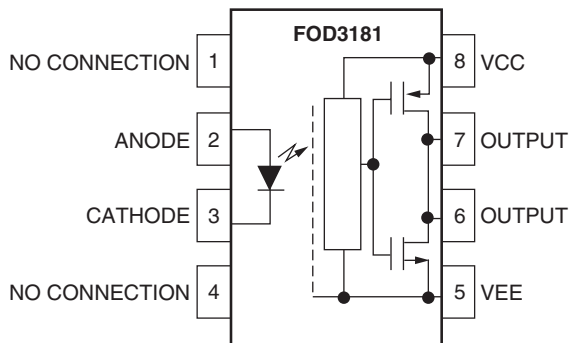
The device is packaged in an 8-pin dual in-line housing compatible with 260°C reflow processes for lead free solder compliance.

### 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

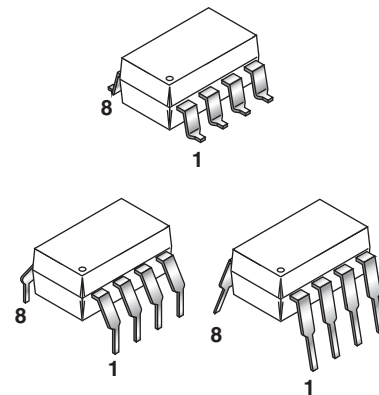
\*Requires 'V' ordering option

### Functional Block Diagram



**Note:**

A 0.1 $\mu$ F bypass capacitor must be connected between pins 5 and 8.



**Absolute Maximum Ratings**

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 <sup>(1)</sup>	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 <sup>(2)</sup>	1.5	A
$I_{OL(PEAK)}$	“Low” Peak Output Current <sup>(2)</sup>	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 <sup>(4)</sup>	250	mW
$P_D$	Total Power Dissipation <sup>(4)</sup>	300	mW

**Recommended Operating Conditions**

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 <sup>(2)(3)</sup>	$V_{OH} = (V_{CC} - V_{EE} - 1V)$	0.5			A
$I_{OL}$	Low Level Output Current <sup>(2)(3)</sup>	$V_{OL} = (V_{CC} - V_{EE} - 1V)$	0.5			A
$V_{OH}$	High Level Output Voltage <sup>(5)(6)</sup>	$I_O = -100\text{mA}$	$V_{CC} - 0.5$			V
$V_{OL}$	Low Level Output Voltage <sup>(5)(6)</sup>	$I_O = 100\text{mA}$			$V_{EE} + 0.5$	V
$I_{CCH}$	High Level Supply Current	Output Open $I_F = 7$ to $10\text{mA}$		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	$I_O = 0\text{mA}$ , $V_O > 5V$			10	mA
$V_{FHL}$	Threshold Input Voltage High to Low	$I_O = 0\text{mA}$ , $V_O < 0.5V$	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	$f = 1\text{MHz}$ , $V_F = 0V$		60		pF

\* All typical values at  $T_A = 25^{\circ}\text{C}$ **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 <sup>(7)</sup>	$I_F = 10\text{mA}$ , $R_g = 10\Omega$ , $f = 250\text{kHz}$ , Duty Cycle = 50%, $C_g = 10\text{nF}$	50	135	500	ns
$t_{PHL}$	Propagation Delay Time to Low Output Level <sup>(7)</sup>		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 <sup>(8)(9)</sup>	$T_A = +25^{\circ}\text{C}$ , $I_f = 7$ to $10\text{mA}$ , $V_{CM} = 1.5\text{kV}$ , $V_{CC} = 20V$	10			kV/ $\mu\text{s}$
$ CM_L $	Output Low Level Common Mode Transient Immunity <sup>(8)(10)</sup>	$T_A = +25^{\circ}\text{C}$ , $V_f = 0V$ , $V_{CM} = 1.5\text{kV}$ , $V_{CC} = 20V$	10			kV/ $\mu\text{s}$

\* All typical values at  $T_A = 25^{\circ}\text{C}$ **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 <sup>(11)(12)</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>(12)</sup>	$V_{I-O} = 500V$		$10^{11}$		$\Omega$
$C_{I-O}$	Capacitance (input to output)	Freq. = 1MHz		1		pF

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

**Notes:**

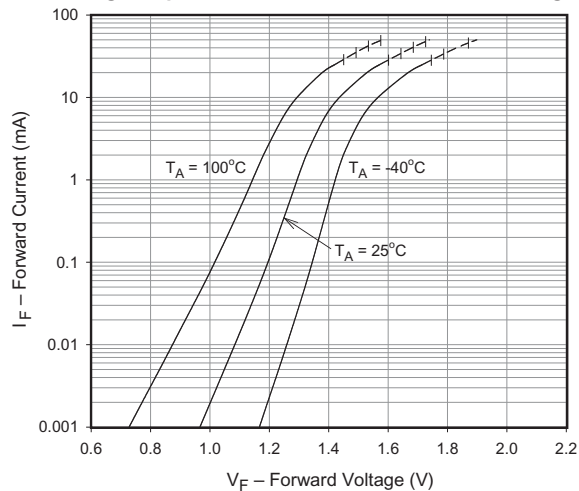
- Derate linearly above +70°C free air temperature at a rate of 0.3mA/°C.
- The output currents  $I_{OH}$  and  $I_{OL}$  are specified with a capacitive current limited load =  $(3 \times 0.01\mu\text{F}) + 0.5\Omega$ , frequency = 8kHz, 50% DF. The maximum pulse width of the output current is 300ns, maximum duty cycle = 0.48%. Output currents specified for different values of  $V_{DS}$  for  $V_{CC} - V_{EE} = 20\text{V}$  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.
- The output currents  $I_{OH}$  and  $I_{OL}$  are specified with a capacitive current limited load =  $(3 \times 0.01\mu\text{F}) + 40\Omega$ , 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  $V_{CC} - V_{EE} = 20\text{V}$  with the formula:  

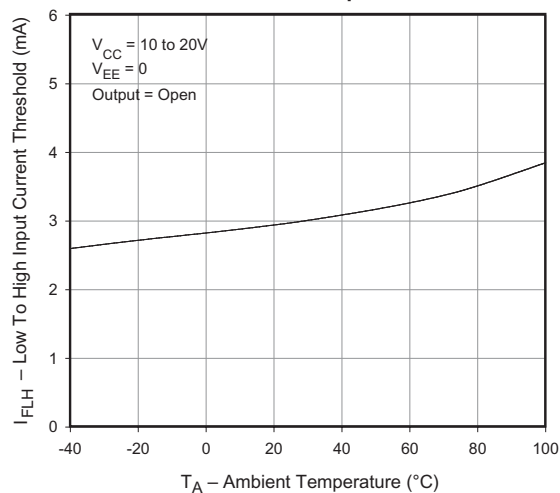
$$V_{OL} = (V_{CC} - V_{EE}) - (I_{OL} \times R_{DS(ON)})$$
 This guarantees operation at  $I_O$  peak minimum = 0.5A for -40°C to +100°C operating temperature range.
- No derating required across operating temperature range.
- In this test,  $V_{OH}$  is measured with a dc load current. When driving capacitive load  $V_{OH}$  will approach  $V_{CC}$  as  $I_{OH}$  approaches zero amps.
- Maximum pulse width = 1ms, maximum duty cycle = 20%.
- $t_{PHL}$  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.
- Pin 1 and 4 need to be connected to LED common.
- 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.  $V_O > 10.0\text{V}$ ).
- 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.  $V_O < 1.0\text{V}$ ).
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage > 6000Vrms for 1 second (leakage detection current limit  $I_{I-O} < 5\mu\text{A}$ ).
- Device considered a two-terminal device: pins on input side shorted together and pins on output side shorted together.

## Typical Performance Curves

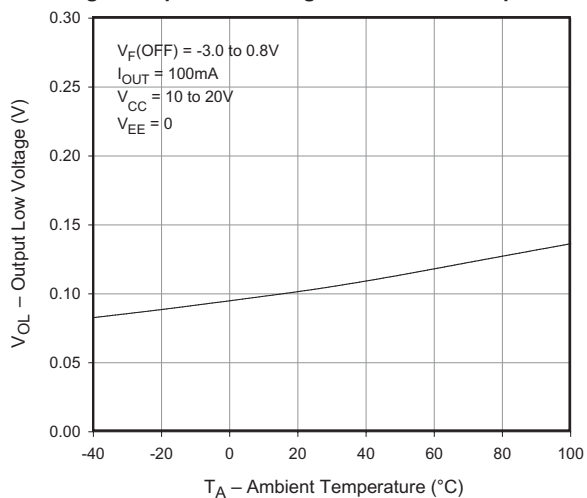
**Fig. 1 Input Forward Current vs. Forward Voltage**



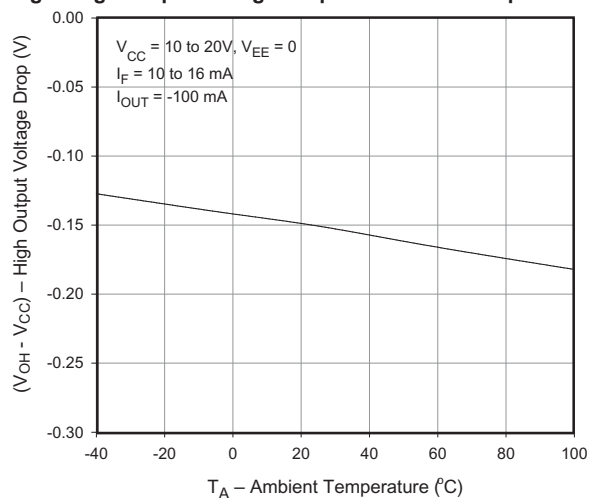
**Fig. 2 Low To High Input Current Threshold vs. Ambient Temperature**



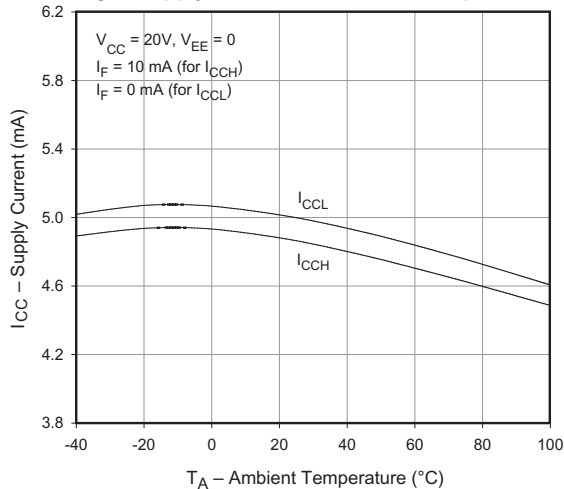
**Fig. 3 Output Low Voltage vs. Ambient Temperature**



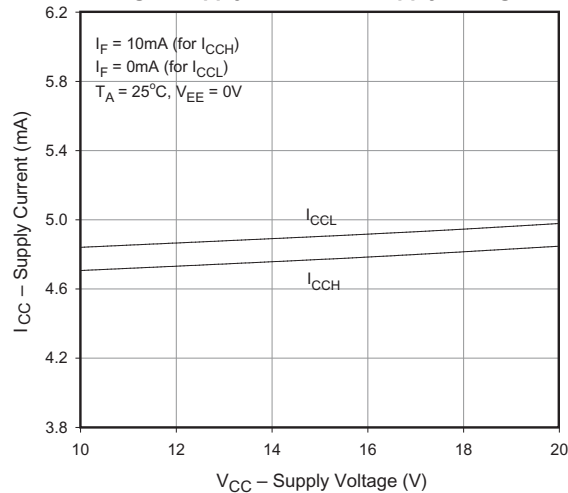
**Fig. 4 High Output Voltage Drop vs. Ambient Temperature**



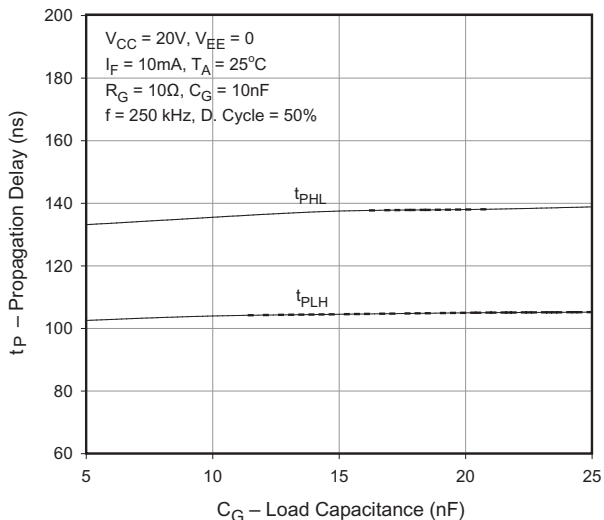
**Fig. 5 Supply Current vs. Ambient Temperature**



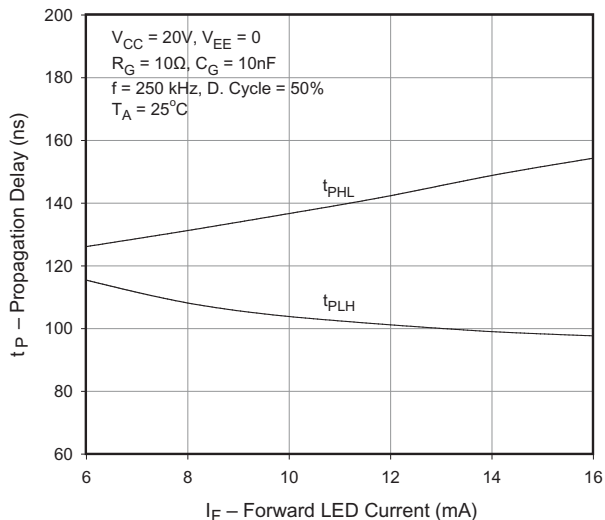
**Fig. 6 Supply Current vs. Supply Voltage**



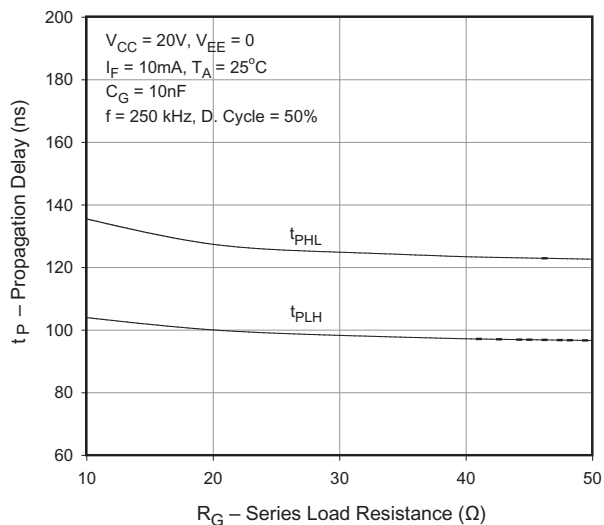
**Fig. 7 Propagation Delay vs. Load Capacitance**



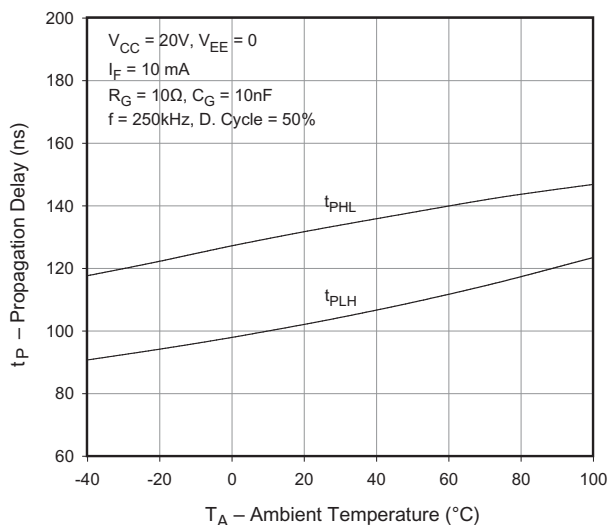
**Fig. 8 Propagation Delay vs. Forward LED Current**



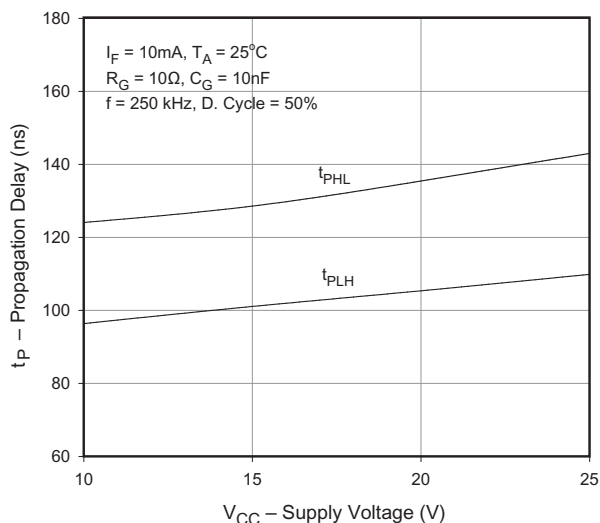
**Fig. 9 Propagation Delay vs. Series Load Resistance**



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

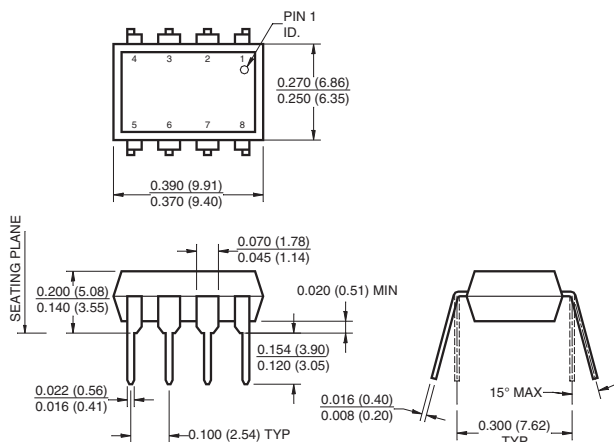


**Fig. 11 Propagation Delay vs. Supply Voltage**

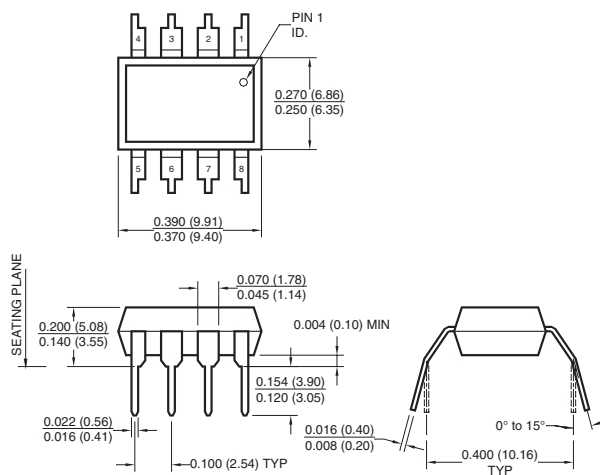


## Package Dimensions

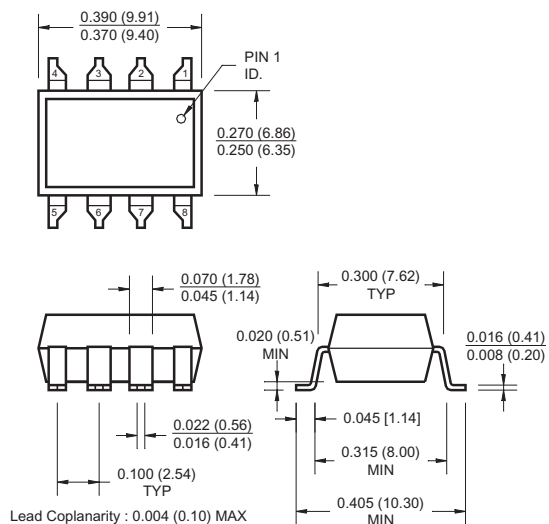
### Through Hole



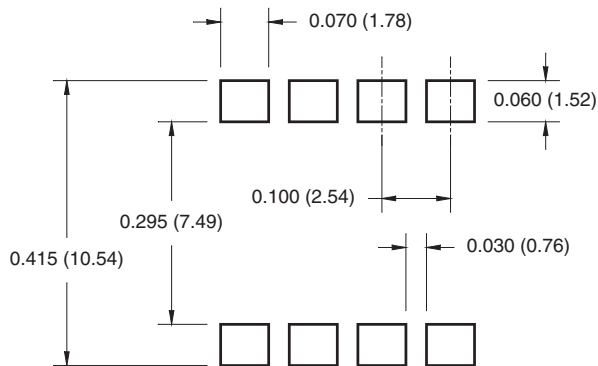
### 0.4" Lead Spacing



### Surface Mount



### 8-Pin DIP – Land Pattern



### Note:

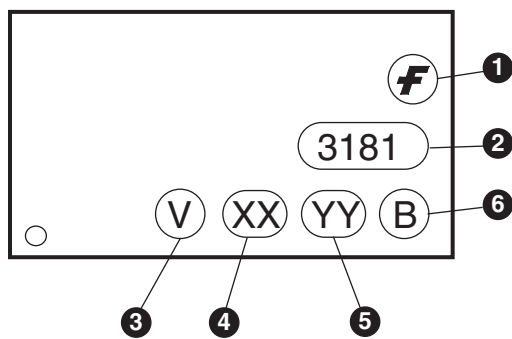
All dimensions are in inches (millimeters)

## Ordering Information

Example: FOD3181 X

<b>X</b>
<b>Packaging Option</b>
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

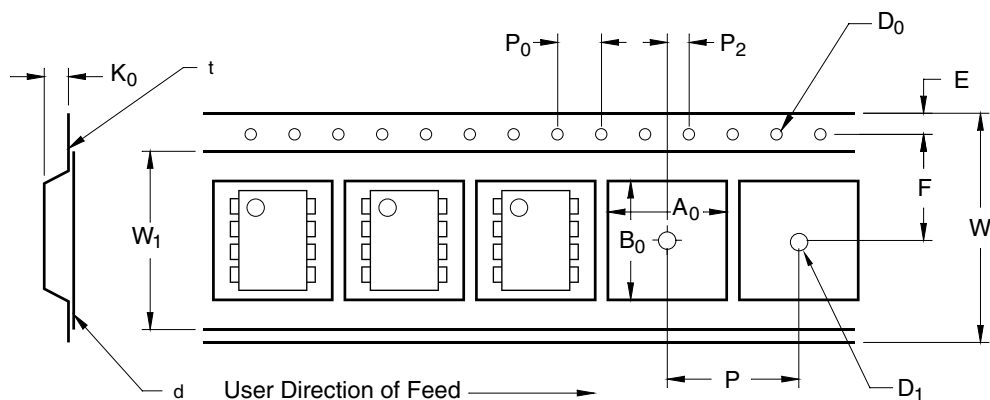
## Marking Information



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

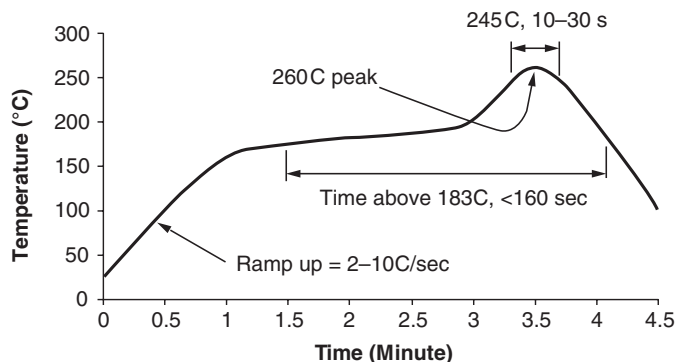


## Carrier Tape Specifications



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

## Reflow Profile

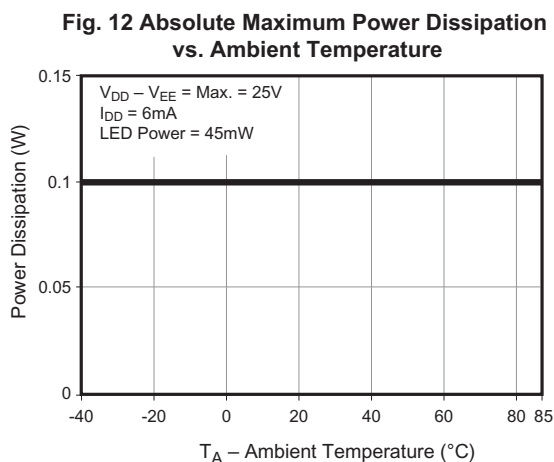


- Peak reflow temperature: 260C (package surface temperature)
- Time of temperature higher than 183C for 160 seconds or less
- One time soldering reflow is recommended

## 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.

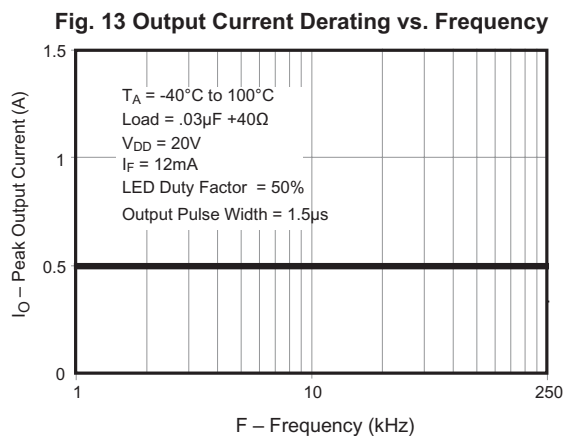


The output power is the product of the average output current squared times the output transistor's  $R_{DS(ON)}$ :

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

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.



## I<sub>OH</sub> and I<sub>OL</sub> 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 0.03μF capacitor in series with an 40Ω resistor. The LED test frequency is 10.0kHz with a 50% duty cycle. The combined I<sub>OH</sub> and I<sub>OL</sub> 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<sub>OH</sub> and I<sub>OL</sub> are measured at the peak of their respective current pulses.

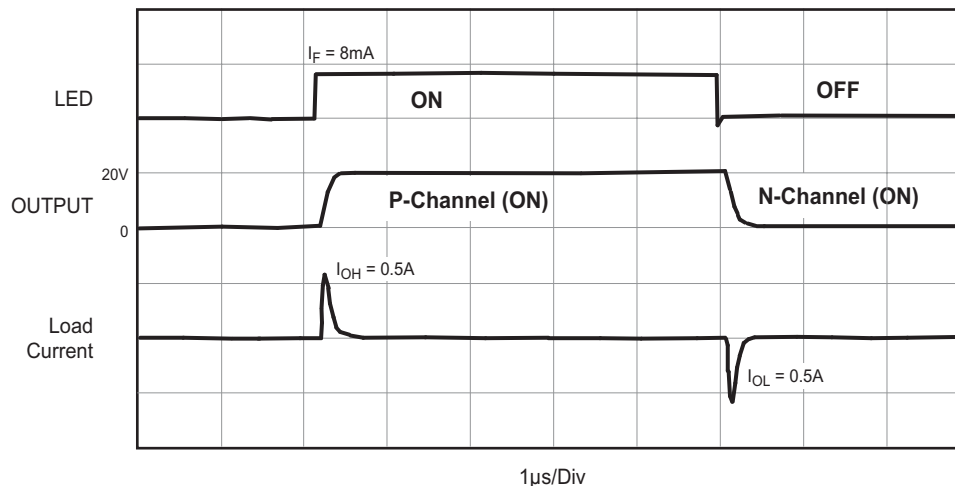


Figure 14. FOD 3180 Output Current and Output Voltage vs. LED Drive

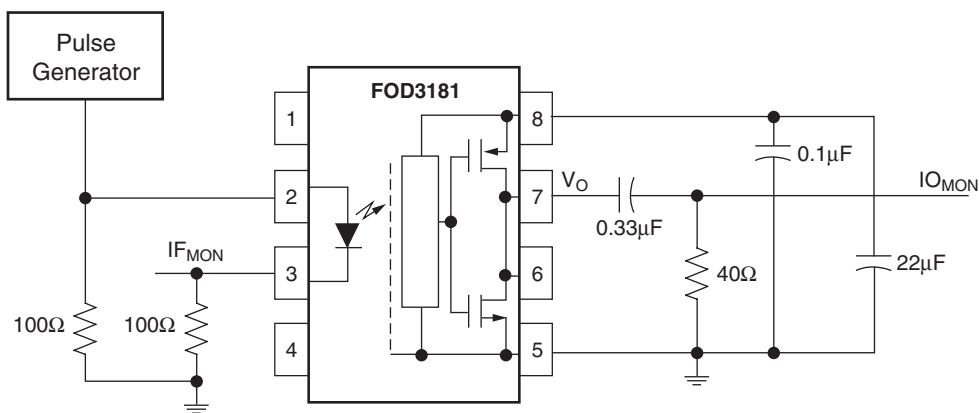


Figure 15. Test Schematic

**FAIRCHILD SEMICONDUCTOR TRADEMARKS**

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™	FACT Quiet Series™	OCX™	SILENT SWITCHER®	UniFET™
ActiveArray™	GlobalOptoisolator™	OCXPro™	SMART START™	VCX™
Bottomless™	GTO™	OPTOLOGIC®	SPM™	Wire™
Build it Now™	HiSeC™	OPTOPLANAR™	Stealth™	
CoolFET™	I <sup>2</sup> C™	PACMAN™	SuperFET™	
CROSSVOLT™	i-Lo™	POP™	SuperSOT™-3	
DOME™	ImpliedDisconnect™	Power247™	SuperSOT™-6	
EcoSPARK™	IntelliMAX™	PowerEdge™	SuperSOT™-8	
E <sup>2</sup> CMOS™	ISOPLANAR™	PowerSaver™	SyncFET™	
EnSigna™	LittleFET™	PowerTrench®	TCM™	
FACT®	MICROCOUPLER™	QFET®	TinyBoost™	
FAST®	MicroFET™	QS™	TinyBuck™	
FASTr™	MicroPak™	QT Optoelectronics™	TinyPWM™	
FPS™	MICROWIRE™	Quiet Series™	TinyPower™	
FRFET™	MSX™	RapidConfigure™	TinyLogic®	
	MSXPro™	RapidConnect™	TINYOPTO™	
Across the board. Around the world.™		µSerDes™	TruTranslation™	
The Power Franchise®		ScalarPump™	UHC®	
Programmable Active Droop™				

**DISCLAIMER**

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

**LIFE SUPPORT POLICY**

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

- Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
- A critical component is 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, and 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.