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June 2014

# FOD8384

## 2.5 A Output Current, High-Speed, MOSFET/IGBT Gate Drive Optocoupler in Optoplanar<sup>®</sup> Wide-Body SOP 5-Pin

### Features

- Reliable and High-Voltage Insulation with Greater than 8 mm Creepage and Clearance Distance and 0.5 mm Internal Insulation Distance
- 2.5 A Output Current Driving Capability for Medium-Power IGBT/MOSFET
  - P-Channel MOSFET at Output Stage Enables Output Voltage Swing Close to Supply Rail
- 35 kV/ $\mu$ s Minimum Common Mode Rejection
- Wide Supply Voltage Range: 15 V to 30 V
- Fast Switching Speed Over Full Operating Temperature Range
  - 210 ns Maximum Propagation Delay
  - 65 ns Maximum Pulse-Width Distortion
- Under-Voltage Lockout (UVLO) with Hysteresis
- Extended Industrial Temperature Range: -40°C to 100°C
- Safety and Regulatory Approvals:
  - UL1577, 5,000 VAC<sub>RMS</sub> for 1 Minute
  - DIN-EN/IEC60747-5-5, 1,414 V Peak Working Insulation Voltage

### Applications

- AC and Brushless DC Motor Drives
- Industrial Inverter
- Uninterruptible Power Supply
- Induction Heating
- Isolated IGBT/Power MOSFET Gate Drive

### Related Resources

- [FOD3184—3 A Output Current, High-Speed MOSFET/IGBT Gate Drive Optocoupler Datasheet](#)
- [www.fairchildsemi.com/products/opto/](http://www.fairchildsemi.com/products/opto/)

### Description

The FOD8384 is a 2.5 A output current gate drive optocoupler capable of driving medium-power IGBT/MOSFETs. It is ideally suited for fast-switching driving of power IGBT and MOSFET used in motor-control inverter applications and high-performance power systems.

The FOD8384 utilizes Fairchild's Optoplanar<sup>®</sup> coplanar packaging technology and optimized IC design to achieve reliable high-insulation voltage and high-noise immunity.

It consists of an Aluminum Gallium Arsenide (AlGaAs) Light-Emitting Diode (LED) optically coupled to an integrated circuit with a high-speed driver for push-pull MOSFET output stage. The device is housed in a wide body, 5-pin, small-outline, plastic package.

### Functional Schematic

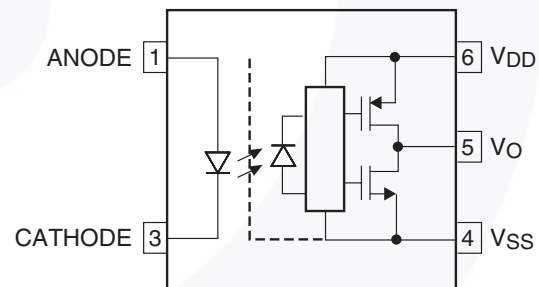


Figure 1. Schematic

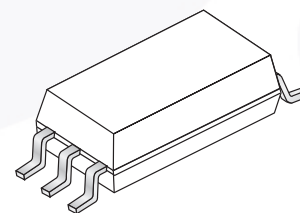


Figure 2. Package Outline

FOD8384 — 2.5 A Output Current, High-Speed, MOSFET/IGBT Gate Drive Optocoupler in Optoplanar<sup>®</sup> Wide-Body SOP 5-Pin

### Truth Table

LED	$V_{DD} - V_{SS}$ “Positive Going” (Turn-on)	$V_{DD} - V_{SS}$ “Positive Going” (Turn-off)	$V_O$
Off	0 V to 30 V	0 V to 30 V	LOW
On	0 V to 11.5 V	0 V to 10 V	LOW
On	11.5 V to 14.5 V	10 V to 13 V	Transition
On	14.5 V to 30 V	13 V to 30 V	HIGH

### Pin Configuration



Figure 3. Pin Configuration

### Pin Definitions

Pin #	Name	Description
1	Anode	LED Anode
3	Cathode	LED Cathode
4	$V_{SS}$	Negative Supply Voltage
5	$V_O$	Output Voltage
6	$V_{DD}$	Positive Supply Voltage

## Safety and Insulation Ratings

As per DIN EN/IEC60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.

Symbol	Parameter	Min.	Typ.	Max.	Unit
	Installation Classifications per DIN VDE 0110/1.89 Table 1				
	For Rated Mains Voltage < 150 V <sub>RMS</sub>		I-IV		
	For Rated Mains Voltage < 300 V <sub>RMS</sub>		I-IV		
	For Rated Mains Voltage < 450 V <sub>RMS</sub>		I-III		
	For Rated Mains Voltage < 600 V <sub>RMS</sub>		I-III		
	Climatic Classification		40/100/21		
	Pollution Degree (DIN VDE 0110/1.89)		2		
CTI	Comparative Tracking Index	175			
V <sub>PR</sub>	Input-to-Output Test Voltage, Method b, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC	2651			
	Input-to-Output Test Voltage, Method a, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC	2262			
V <sub>IORM</sub>	Maximum Working Insulation Voltage	1414			V <sub>peak</sub>
V <sub>IOTM</sub>	Highest Allowable Over Voltage	8000			V <sub>peak</sub>
	External Creepage	8.0			mm
	External Clearance	8.0			mm
	Insulation Thickness	0.5			mm
	Safety Limit Values – Maximum Values Allowed in the Event of a Failure				
T <sub>S</sub>	Case Temperature	150			°C
I <sub>S,INPUT</sub>	Input Current	200			mA
P <sub>S,OUTPUT</sub>	Output Power	600			mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V	10 <sup>9</sup>			Ω

## 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.  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Value	Units
$T_{\text{STG}}$	Storage Temperature	-40 to +125	$^\circ\text{C}$
$T_{\text{OPR}}$	Operating Temperature	-40 to +100	$^\circ\text{C}$
$T_{\text{J}}$	Junction Temperature	-40 to +125	$^\circ\text{C}$
$T_{\text{SOL}}$	Lead Solder Temperature <i>Refer to Reflow Temperature Profile on page 15.</i>	260 for 10 s	$^\circ\text{C}$
$I_{\text{F(AVG)}}$	Average Input Current	25	mA
$V_{\text{R}}$	Reverse Input Voltage	5.0	V
$I_{\text{O(PEAK)}}$	Peak Output Current <sup>(1)</sup>	3.0	A
$V_{\text{DD}} - V_{\text{SS}}$	Supply Voltage	-0.5 to 35	V
$V_{\text{O(PEAK)}}$	Peak Output Voltage	0 to $V_{\text{DD}}$	V
$\text{PD}_{\text{I}}$	Input Power Dissipation <sup>(2)(4)</sup>	45	mW
$\text{PD}_{\text{O}}$	Output Power Dissipation <sup>(3)(4)</sup>	500	mW

### Notes:

- Maximum pulse width = 10  $\mu\text{s}$ , maximum duty cycle = 0.2%.
- No derating required across operating temperature range.
- Derate linearly from  $25^\circ\text{C}$  at a rate of 5.2 mW/ $^\circ\text{C}$ .
- Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.

## 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	Min.	Max.	Unit
$T_{\text{A}}$	Ambient Operating Temperature	-40	100	$^\circ\text{C}$
$V_{\text{DD}} - V_{\text{SS}}$	Supply Voltage	15	30	V
$I_{\text{F(ON)}}$	Input Current (ON)	10	16	mA
$V_{\text{F(OFF)}}$	Input Voltage (OFF)	0	0.8	V

## Isolation Characteristics

Apply over all recommended conditions; typical value is measured at  $T_A = 25^\circ\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
$V_{ISO}$	Input-Output Isolation Voltage	$T_A = 25^\circ\text{C}$ , R.H. < 50%, $t = 60$ s, $I_{I-O} \leq 20 \mu\text{A}$ , 50 Hz <sup>(5)(6)</sup>	5,000			$V_{RMS}$
$R_{ISO}$	Isolation Resistance	$V_{I-O} = 500$ V <sup>(5)</sup>		$10^{11}$		$\Omega$
$C_{ISO}$	Isolation Capacitance	$V_{I-O} = 0$ V, Frequency = 1.0 MHz <sup>(6)</sup>		1		pF

### Notes:

- Device is considered a two-terminal device: pins 1 and 3 are shorted together and pins 4, 5 and 6 are shorted together.
- 5,000  $VAC_{RMS}$  for 1 minute duration is equivalent to 6,000  $VAC_{RMS}$  for 1 second duration.

## Electrical Characteristics

Apply over all recommended conditions, typical value is measured at  $V_{DD} = 30$  V,  $V_{SS} = \text{Ground}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
$V_F$	Input Forward Voltage	$I_F = 10$ mA	1.10	1.43	1.80	V	19
$\Delta(V_F / T_A)$	Temperature Coefficient of Forward Voltage			-1.5		mV/°C	
$BV_R$	Input Reverse Breakdown Voltage	$I_R = 10 \mu\text{A}$	5			V	
$C_{IN}$	Input Capacitance	$f = 1$ MHz, $V_F = 0$ V		60		pF	
$I_{OH}$	High Level Output Current <sup>(1)</sup>	$V_{OH} = V_{DD} - 1$ V		-0.9	-0.5	A	4, 6
		$V_{OH} = V_{DD} - 6$ V			-2.5	A	4, 6, 22
$I_{OL}$	Low Level Output Current <sup>(1)</sup>	$V_{OL} = V_{SS} + 1$ V	0.5	1.0		A	7, 9
		$V_{OL} = V_{SS} + 6$ V	2.5			A	7, 9, 21
$V_{OH}$	High Level Output Voltage <sup>(7)(8)</sup>	$I_F = 10$ mA, $I_O = -2.5$ A	$V_{DD} - 7.0$			V	4
		$I_F = 10$ mA, $I_O = -100$ mA	$V_{DD} - 0.5$			V	4, 5, 23
$V_{OL}$	Low Level Output Voltage <sup>(7)(8)</sup>	$I_F = 0$ mA, $I_O = 2.5$ A			$V_{SS} + 7.0$	V	7
		$I_F = 0$ mA, $I_O = 100$ mA			$V_{SS} + 0.5$	V	8, 24
$I_{DDH}$	High Level Supply Current	$V_O = \text{Open}$ , $I_F = 7$ to 16 mA		2.9	3.5	mA	10, 11, 25
$I_{DDL}$	Low Level Supply Current	$V_O = \text{Open}$ , $V_F = 0$ to 0.8 V		2.8	3.5	mA	10, 11, 26
$I_{FLH}$	Threshold Input Current Low-to-High	$I_O = 0$ mA, $V_O > 5$ V		3.1	7.5	mA	12, 18, 27
$V_{FHL}$	Threshold Input Voltage High-to-Low	$I_O = 0$ mA, $V_O < 5$ V	0.8			V	28
$V_{UVLO+}$	Under-Voltage Lockout Threshold	$I_F = 10$ mA, $V_O > 5$ V	11.5	13.0	14.5	V	20, 29
$V_{UVLO-}$		$I_F = 10$ mA, $V_O < 5$ V	10.0	11.5	13.0	V	20, 29
$UVLO_{HYS}$	Under-Voltage Lockout Threshold Hysteresis			1.5		V	

### Notes:

- In this test,  $V_{OH}$  is measured with a dc load current of 100 mA. When driving capacitive load  $V_{OH}$  will approach  $V_{DD}$  as  $I_{OH}$  approaches 0 A.
- Maximum pulse width = 1 ms, maximum duty cycle = 20%.

## Switching Characteristics

Apply over all recommended conditions, typical value is measured at  $V_{DD} = 30\text{ V}$ ,  $V_{SS} = \text{Ground}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise specified.

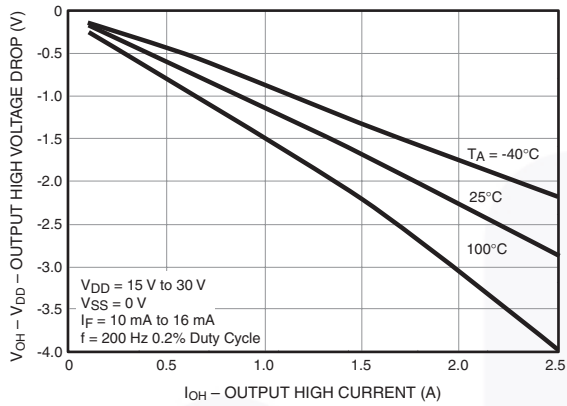
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure	
$t_{PHL}$	Propagation Delay Time to Logic LOW Output <sup>(9)</sup>	$I_F = 7\text{ mA to }16\text{ mA}$ , $R_g = 10\ \Omega$ , $C_g = 10\text{ nF}$ , $f = 250\text{ kHz}$ , Duty Cycle = 50%	50	145	210	ns	13, 14, 15, 16, 17, 30	
$t_{PLH}$	Propagation Delay Time to Logic HIGH Output <sup>(10)</sup>		50	135	210	ns	13, 14, 15, 16, 17, 30	
PWD	Pulse Width Distortion <sup>(11)</sup> $ t_{PHL} - t_{PLH} $				25	65	ns	
PDD (Skew)	Propagation Delay Difference Between Any Two Parts <sup>(12)</sup>			-90		90		
$t_R$	Output Rise Time (10% to 90%)				35		ns	30
$t_F$	Output Fall Time (90% to 10%)				25		ns	30
$t_{ULVO\ ON}$	ULVO Turn-On Delay		$I_F = 10\text{ mA}$ , $V_O > 5\text{ V}$		1.7		$\mu\text{s}$	
$t_{ULVO\ OFF}$	ULVO Turn-Off Delay	$I_F = 10\text{ mA}$ , $V_O < 5\text{ V}$		0.1		$\mu\text{s}$		
$ CM_H $	Common Mode Transient Immunity at Output HIGH	$T_A = 25^\circ\text{C}$ , $V_{DD} = 30\text{ V}$ , $I_F = 10\text{ to }16\text{ mA}$ , $V_{CM} = 1500\text{ V}$ <sup>(13)</sup>	35	50		$\text{kV}/\mu\text{s}$	31	
$ CM_L $	Common Mode Transient Immunity at Output LOW	$T_A = 25^\circ\text{C}$ , $V_{DD} = 30\text{ V}$ , $V_F = 0\text{ V}$ , $V_{CM} = 1500\text{ V}$ <sup>(14)</sup>	35	50		$\text{kV}/\mu\text{s}$	31	

### Notes:

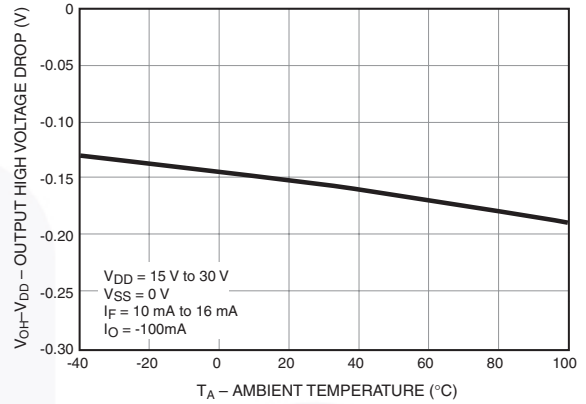
9. Propagation delay  $t_{PHL}$  is measured from the 50% level on the falling edge of the input pulse to the 50% level of the falling edge of the  $V_O$  signal.
10. Propagation delay  $t_{PLH}$  is measured from the 50% level on the rising edge of the input pulse to the 50% level of the rising edge of the  $V_O$  signal.
11. PWD is defined as  $|t_{PHL} - t_{PLH}|$  for any given device.
12. The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two FOD8384 parts under the same operating conditions, with equal loads.
13. Common mode transient immunity at output high is the maximum tolerable negative  $dV_{cm}/dt$  on the trailing edge of the common mode impulse signal,  $V_{CM}$ , to ensure that the output remains high (i.e.,  $V_O > 15.0\text{ V}$ ).
14. Common mode transient immunity at output low is the maximum tolerable positive  $dV_{cm}/dt$  on the leading edge of the common pulse signal,  $V_{CM}$ , to ensure that the output remains low (i.e.,  $V_O < 1.0\text{ V}$ ).



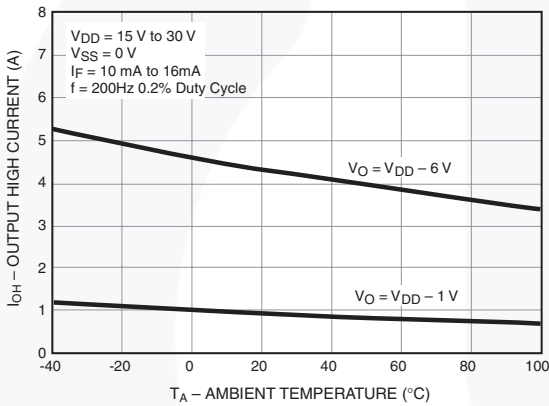
## Typical Performance Characteristics



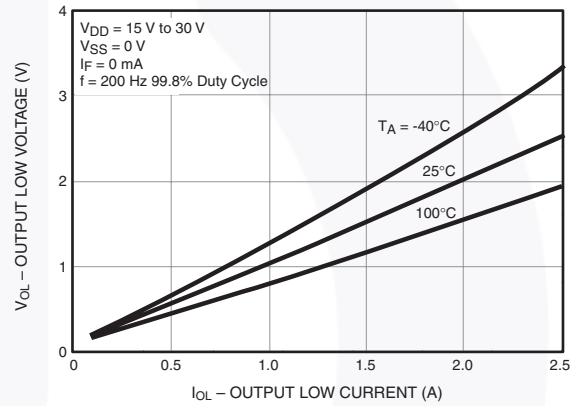
**Figure 4. Output High Voltage Drop vs. Output High Current**



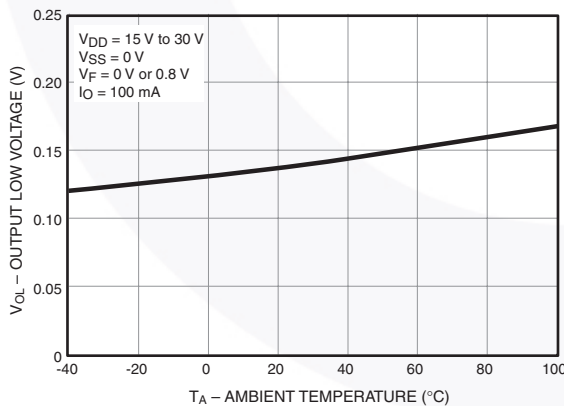
**Figure 5. Output High Voltage Drop vs. Ambient Temperature**



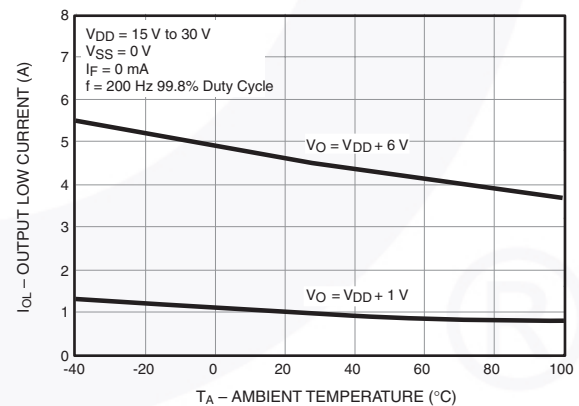
**Figure 6. Output High Current vs. Ambient Temperature**



**Figure 7. Output Low Voltage vs. Output Low Current**

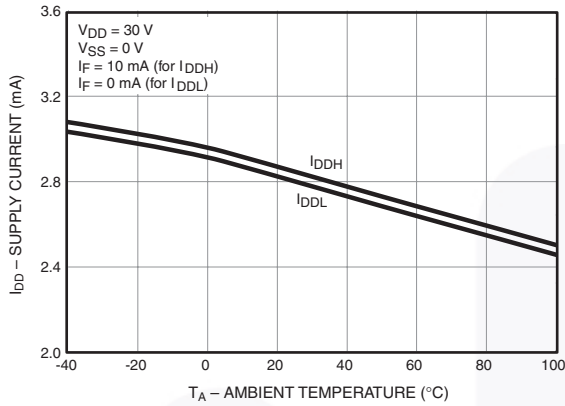


**Figure 8. Output Low Voltage vs. Ambient Temperature**

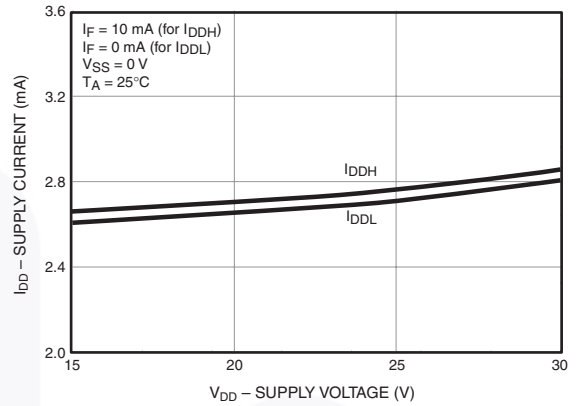


**Figure 9. Output Low Current vs. Ambient Temperature**

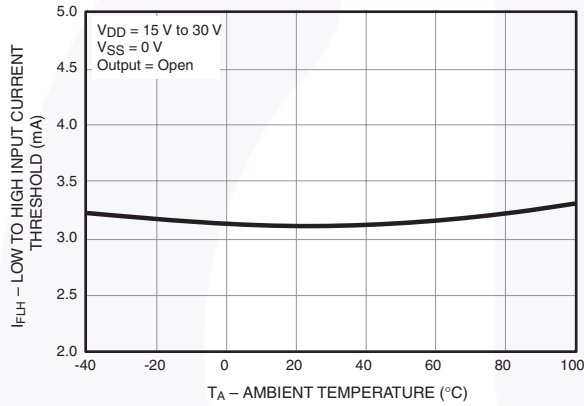
**Typical Performance Characteristics (Continued)**



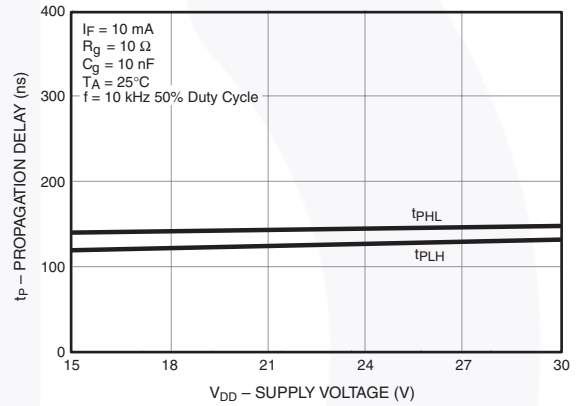
**Figure 10. Supply Current vs. Ambient Temperature**



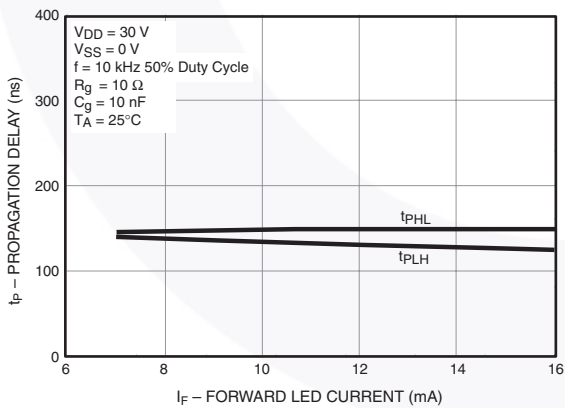
**Figure 11. Supply Current vs. Supply Voltage**



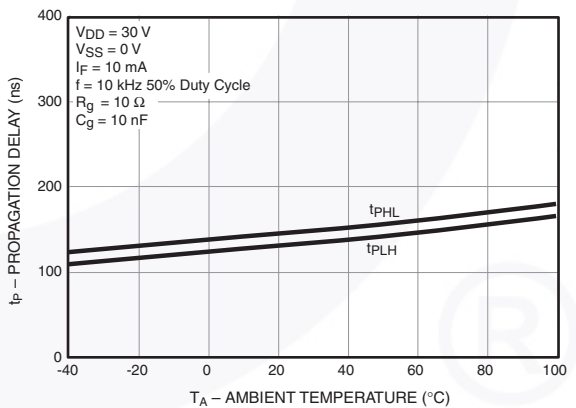
**Figure 12. Low-to-High Input Current Threshold vs. Ambient Temperature**



**Figure 13. Propagation Delay vs. Supply Voltage**

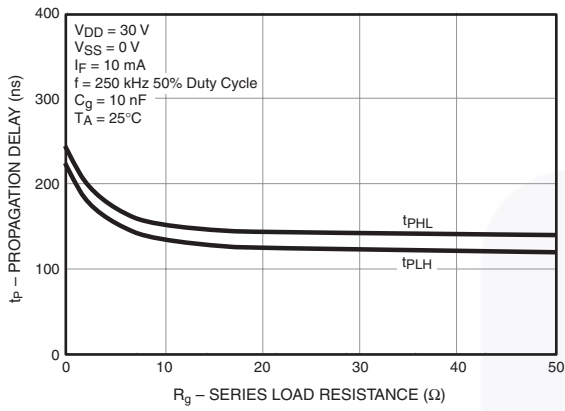


**Figure 14. Propagation Delay vs. LED Forward Current**

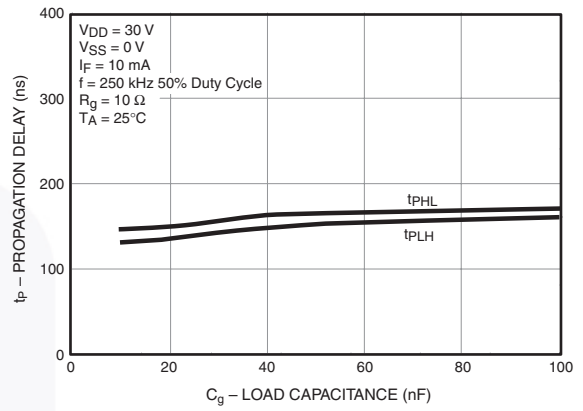


**Figure 15. Propagation Delay vs. Ambient Temperature**

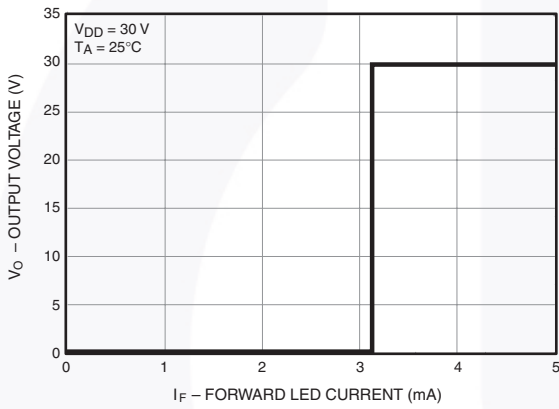
**Typical Performance Characteristics (Continued)**



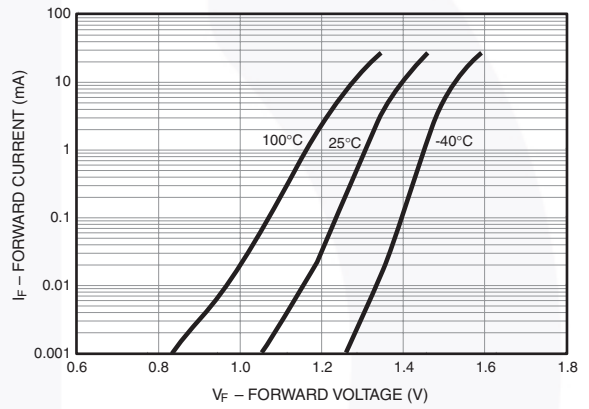
**Figure 16. Propagation Delay vs. Series Load Resistance**



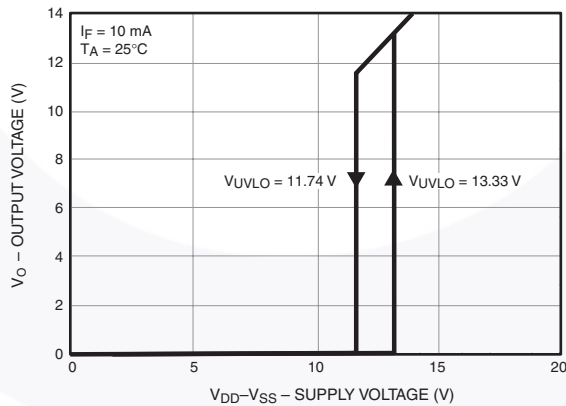
**Figure 17. Propagation Delay vs. Load Capacitance**



**Figure 18. Transfer Characteristics**



**Figure 19. Input Forward Current vs. Forward Voltage**



**Figure 20. Under-Voltage Lockout**

### Test Circuit

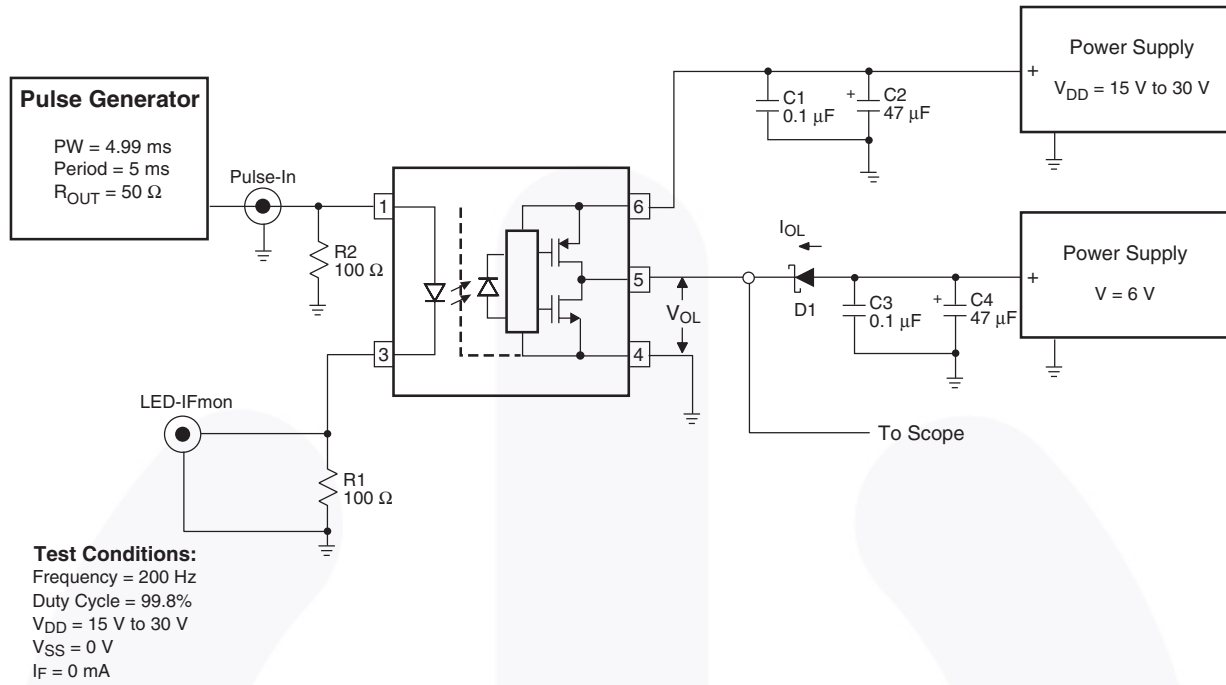


Figure 21. I<sub>OL</sub> Test Circuit

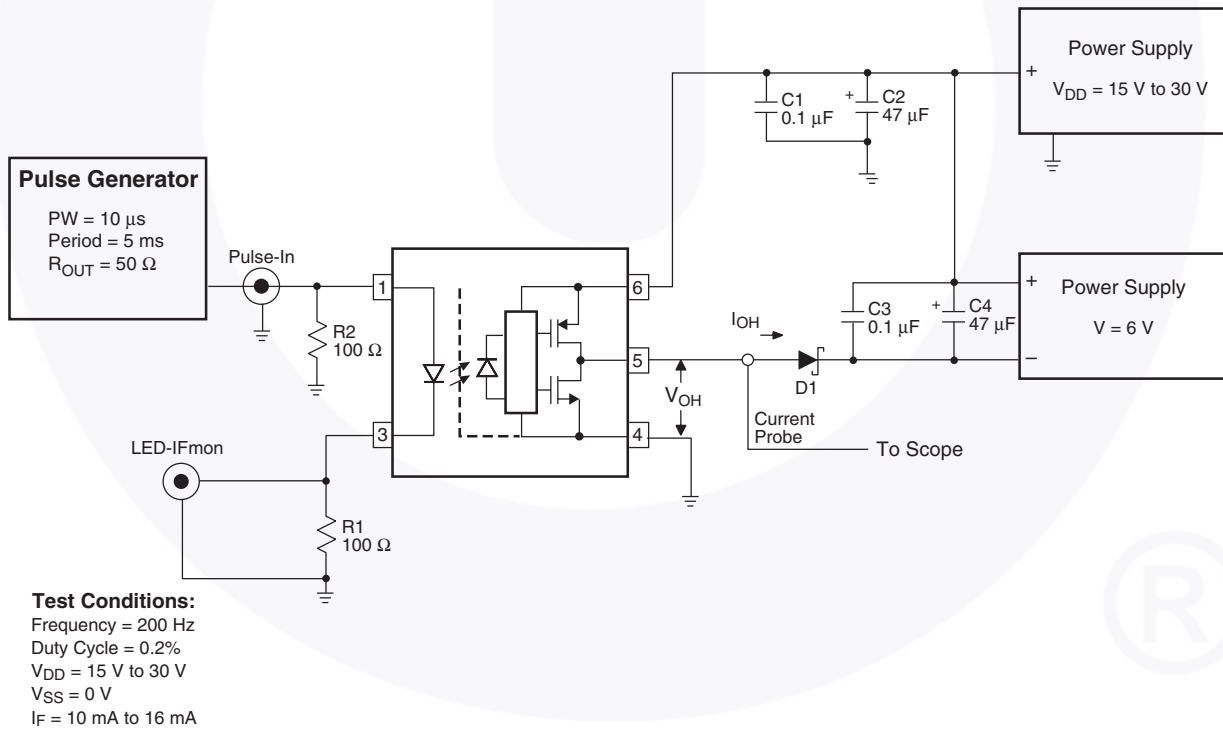
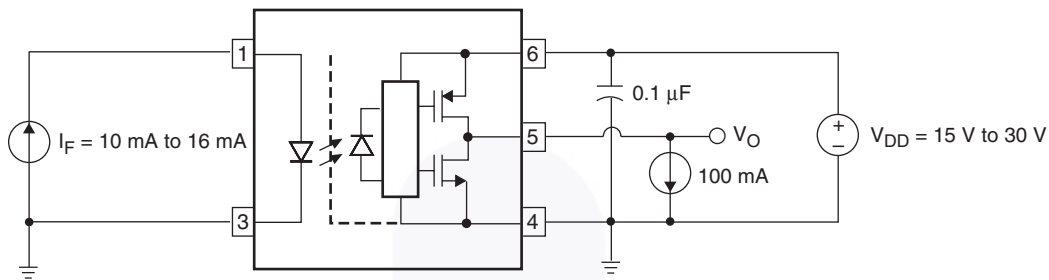
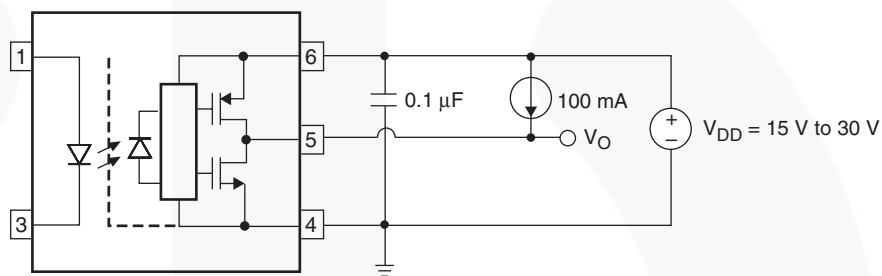


Figure 22. I<sub>OH</sub> Test Circuit

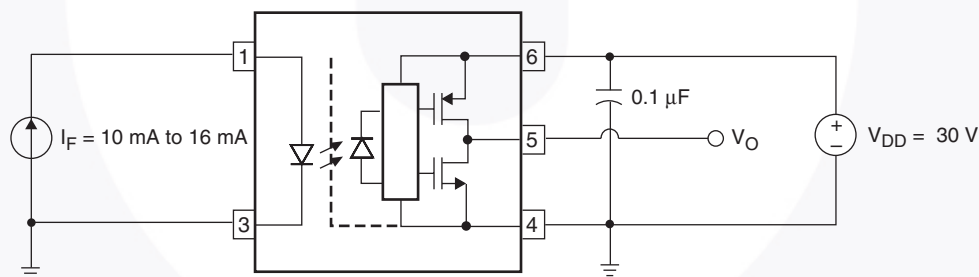
**Test Circuit** (Continued)



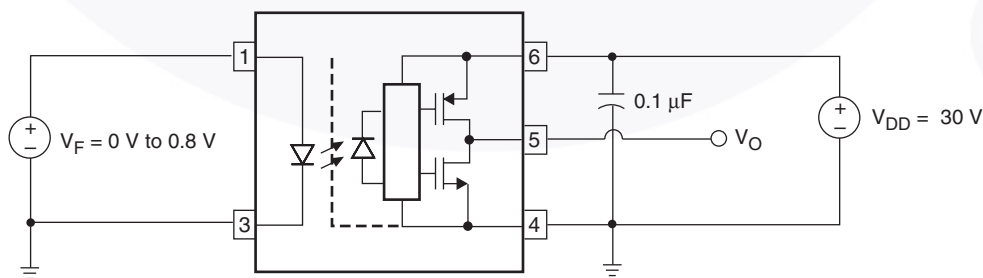
**Figure 23.  $V_{OH}$  Test Circuit**



**Figure 24.  $V_{OL}$  Test Circuit**

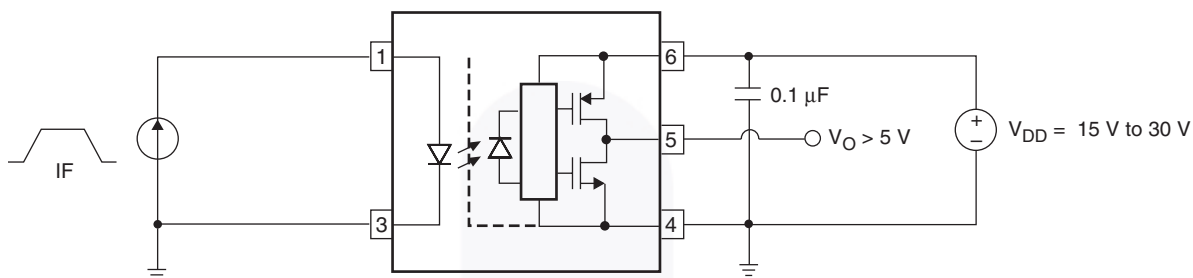


**Figure 25.  $I_{DDH}$  Test Circuit**

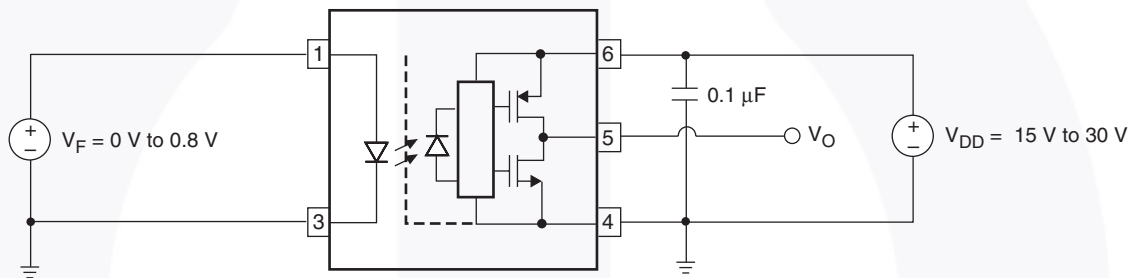


**Figure 26.  $I_{DDL}$  Test Circuit**

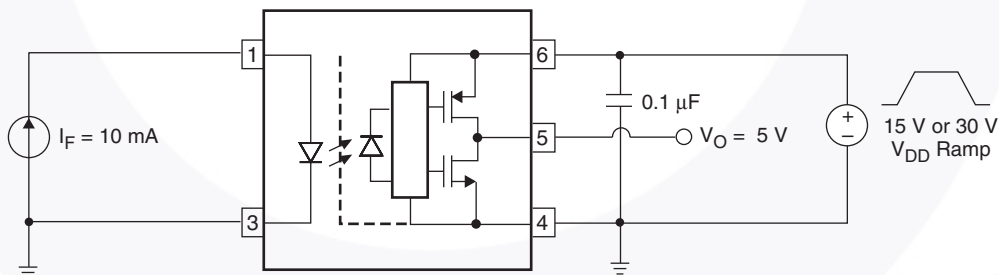
**Test Circuit** (Continued)



**Figure 27.  $I_{FLH}$  Test Circuit**

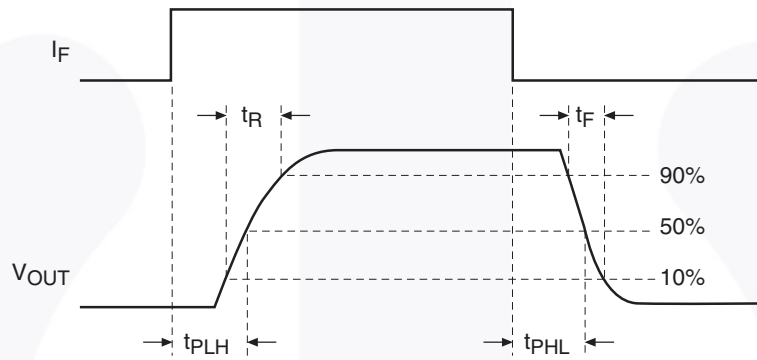
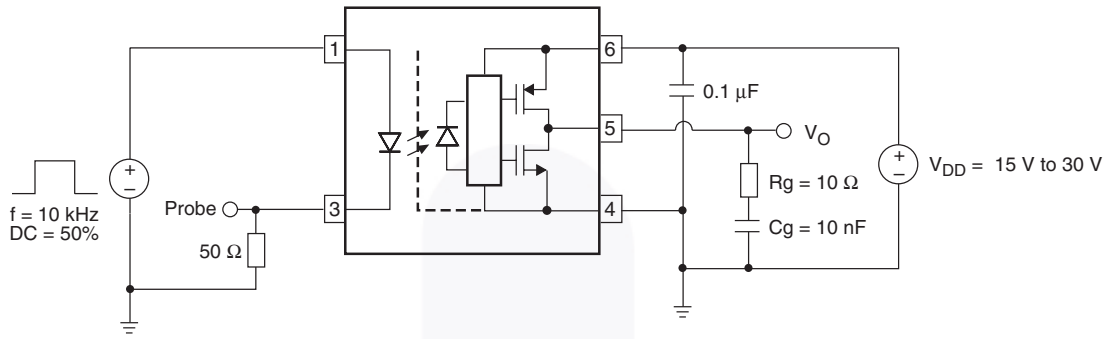


**Figure 28.  $V_{FHL}$  Test Circuit**

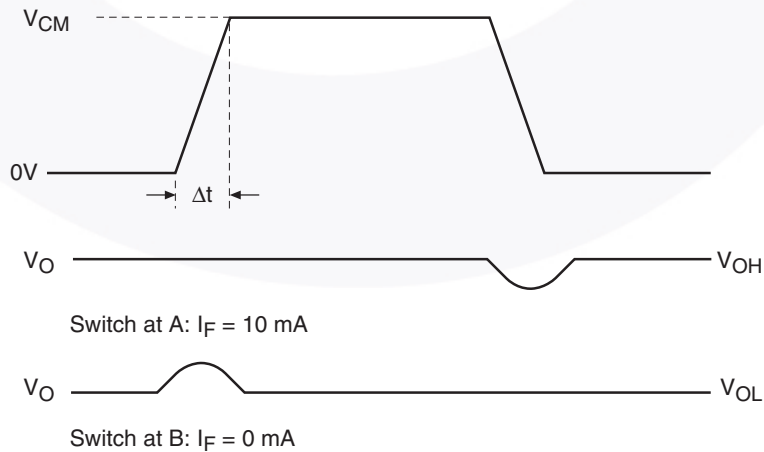
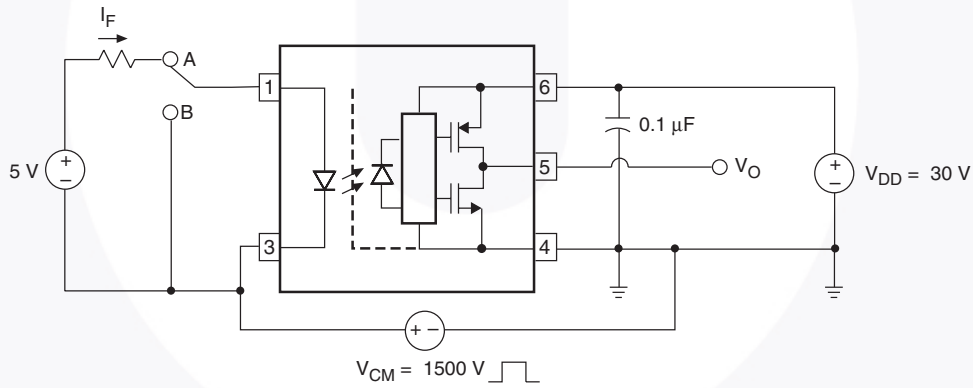


**Figure 29. UVLO Test Circuit**

**Test Circuit (Continued)**

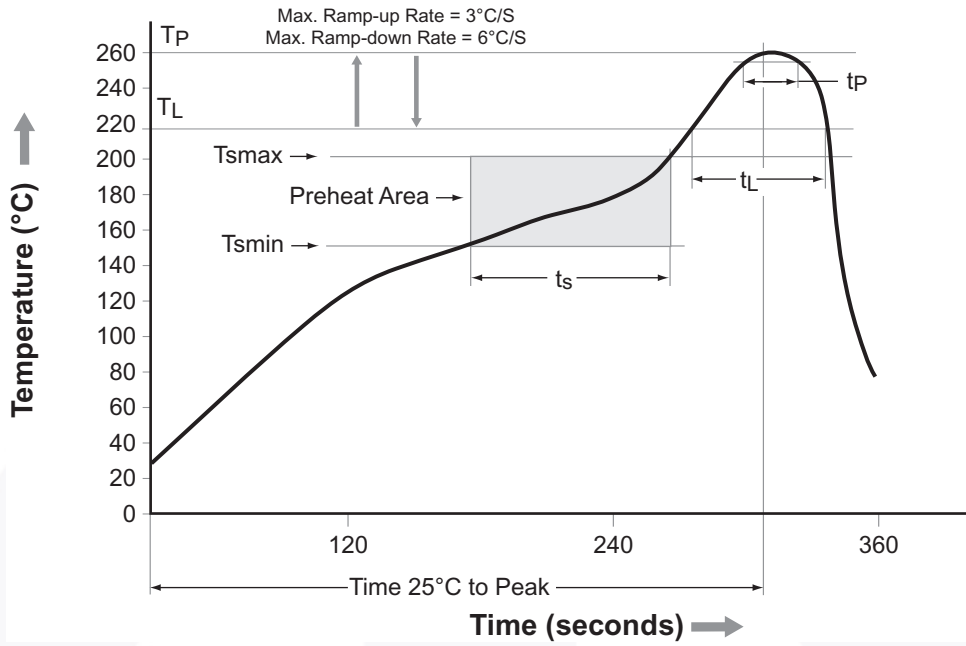


**Figure 30.  $t_{PHL}$ ,  $t_{PLH}$ ,  $t_R$ , and  $t_F$  Test Circuit and Waveforms**



**Figure 31. CMR Test Circuit and Waveforms**

### Reflow Profile




Profile Feature	Pb-Free Assembly Profile
Temperature Minimum ( $T_{smin}$ )	150°C
Temperature Maximum ( $T_{smax}$ )	200°C
Time ( $t_s$ ) from ( $T_{smin}$ to $T_{smax}$ )	60 s to 120 s
Ramp-up Rate ( $t_L$ to $t_P$ )	3°C/second maximum
Liquidous Temperature ( $T_L$ )	217°C
Time ( $t_L$ ) Maintained Above ( $T_L$ )	60 s to 150 s
Peak Body Package Temperature	260°C +0°C / -5°C
Time ( $t_P$ ) within 5°C of 260°C	30 s
Ramp-Down Rate ( $T_P$ to $T_L$ )	6°C/s maximum
Time 25°C to Peak Temperature	8 minutes maximum

Figure 32. Reflow Profile

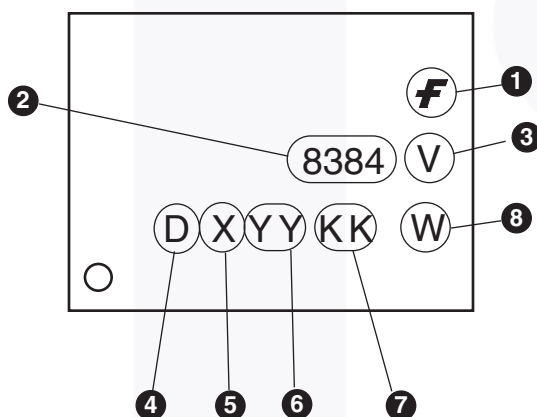


## Ordering Information

Part Number	Package	Packing Method
FOD8384	Wide Body SOP 5-Pin	Tube (100 units per tube)
FOD8384R2	Wide Body SOP 5-Pin	Tape and Reel (1,000 units per reel)
FOD8384V	Wide Body SOP 5-Pin, DIN EN/IEC60747-5-5 Option	Tube (100 units per tube)
FOD8384R2V	Wide Body SOP 5-Pin, DIN EN/IEC60747-5-5 Option	Tape and Reel (1,000 units per reel)

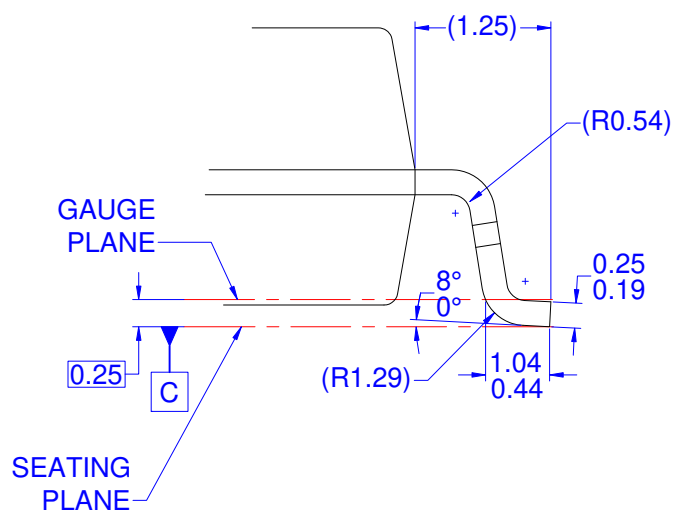
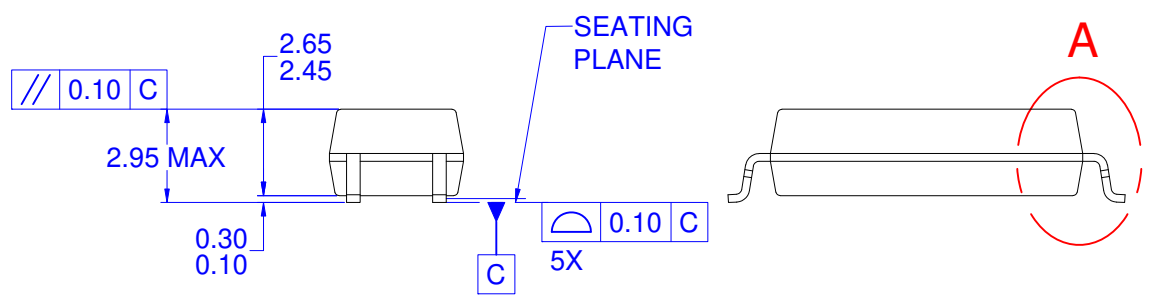
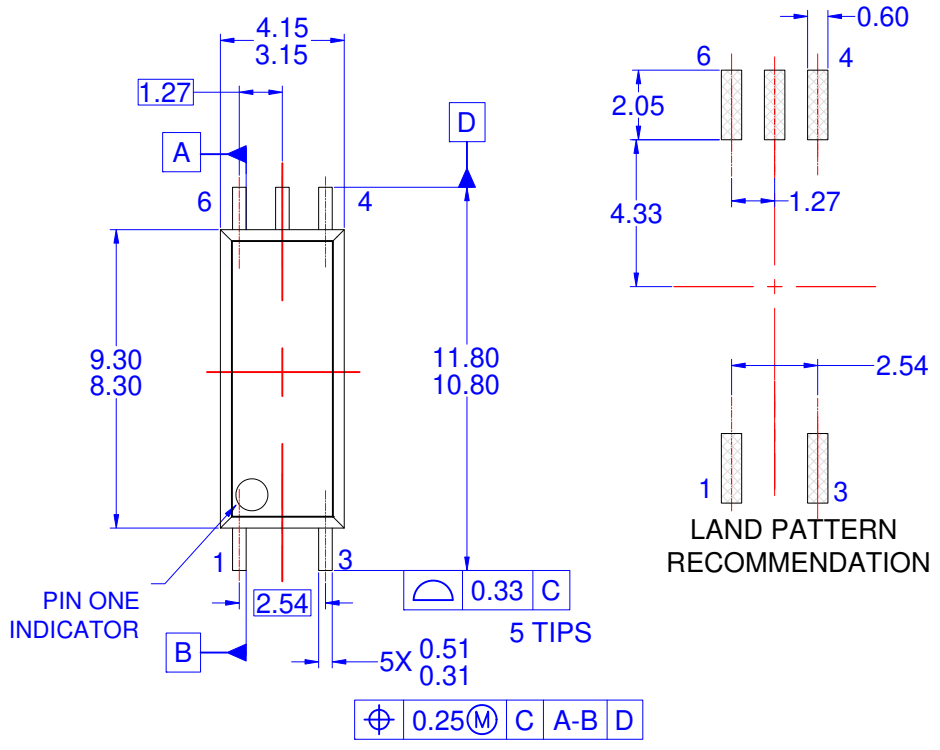
 All packages are lead free per JEDEC: J-STD-020B standard.

## Marking Information



### Definitions

1	Fairchild logo
2	Device number, e.g., '8384' for FOD8384
3	DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	Plant code, e.g., 'D'
5	Last digit year code, e.g., 'C' for 2012
6	Two-digit work week ranging from '01' to '53'
7	Lot traceability code
8	Package assembly code, W



**DETAIL A**  
SCALE: 3.2:1

- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE DOES NOT CONFORM TO ANY STANDARD.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS
  - D) DRAWING CONFORMS TO ASME Y14.5M-1994
  - E) DRAWING FILE NAME: MKT-M05BREV2

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