

# 3.3 V and 5 V High Speed Transistor Optocouplers

## FOD050L, FOD053L

### Description

The FOD050L and FOD053L optocouplers consist of an AlGaAs LED optically coupled to a high speed photodetector transistor. These devices are specified for operation at 3.3 V and 5 V supply voltages.

A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

An internal noise shield provides superior common mode rejection of  $CM_H = 50 \text{ kV}/\mu\text{s}$  (typical) and  $CM_L = 35 \text{ kV}/\mu\text{s}$  (typical).

### Features

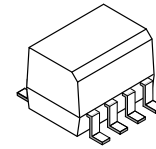
- Low Power Consumption
- High Speed
- Available in Single-Channel 8-Pin SOIC (FOD050L) or Dual-Channel 8-Pin SOIC (FOD053L)
- Superior CMR –  $CM_H = 50 \text{ kV}/\mu\text{s}$  (typical) and  $CM_L = 35 \text{ kV}/\mu\text{s}$  (typical)
- Guaranteed Performance over Temperature:  $0^\circ\text{C}$  to  $70^\circ\text{C}$
- Safety and Regulatory Approvals:
  - ♦ UL1577, 2,500 VAC<sub>RMS</sub> for 1 Minute
  - ♦ DIN-EN/IEC60747-5-5, 565 V Peak Working Insulation Voltage

### Applications

- Line Receivers
- Pulse Transformer Replacement
- High-Speed Logic Ground Isolation: LVTTTL/LVCMOS
- Wide Bandwidth Analog Coupling

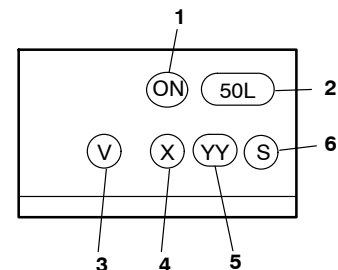
### TRUTH TABLE

LED	$V_O$
On	LOW
Off	HIGH



SOIC8  
CASE 751DZ

### MARKING DIAGRAM



1. ON = onsemi Logo
2. 50L = Device Number (50L or 53L)
3. V = DIN EN/IEC60747-5-5 Option  
(only appears on component with this option)
4. X = One-Digit Year Code, e.g. '5'
5. YY = Two Digit Work Week, Ranging from '01' to '53'
6. S = Assembly Package Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

# FOD050L, FOD053L

## Schematics

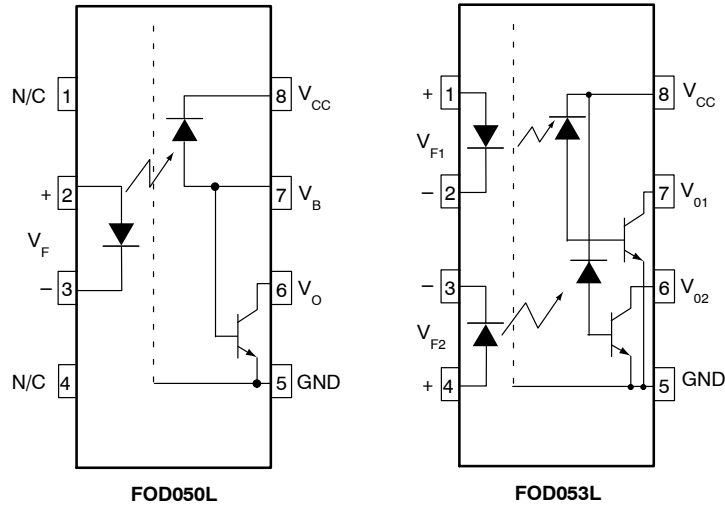


Figure 1. Schematics

## SAFETY AND INSULATION RATINGS

As per DIN EN/IEC 60747-5-5, 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.

Parameter		Characteristics
Installation Classification per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage	< 150 V <sub>RMS</sub>	I–IV
	< 300 V <sub>RMS</sub>	I–III
Climatic Classification		55/100/21
Pollution Degree (DIN VDE 0110/1.89)		2
Comparative Tracking Index		175

Symbol	Parameter	Value	Unit
V <sub>PR</sub>	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	904	V <sub>peak</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	1060	V <sub>peak</sub>
V <sub>IORM</sub>	Maximum Working Insulation Voltage	565	V <sub>peak</sub>
V <sub>IOTM</sub>	Highest Allowable Over-Voltage	4000	V <sub>peak</sub>
	External Creepage	≥ 4	mm
	External Clearance	≥ 4	mm
DTI	Distance Through Insulation (Insulation Thickness)	≥ 0.4	mm
T <sub>S</sub>	Case Temperature (Note 1)	150	°C
I <sub>S,INPUT</sub>	Input Current (Note 1)	200	mA
P <sub>S,OUTPUT</sub>	Output Power (Note 1)	300	mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V (Note 1)	> 10 <sup>9</sup>	Ω

1. Safety limit values – maximum values allowed in the event of a failure.

# FOD050L, FOD053L

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise specified)

Symbol	Parameter	Value	Unit
T <sub>STG</sub>	Storage Temperature	–40 to +125	°C
T <sub>OPR</sub>	Operating Temperature	–40 to +85	°C
T <sub>J</sub>	Junction Temperature	–40 to +125	°C
T <sub>SOL</sub>	Lead Solder Temperature	260 for 10 seconds	°C

### EMITTER

I <sub>F</sub> (avg)	DC/Average Forward Input Current	Each Channel	25	mA
I <sub>F</sub> (pk)	Peak Forward Input Current (50% duty cycle, 1 ms P.W.)	Each Channel	50	mA
I <sub>F</sub> (trans)	Peak Transient Input Current (≤1 μs P.W., 300 pps)	Each Channel	1.0	A
V <sub>R</sub>	Reverse Input Voltage	Each Channel	5	V
P <sub>D</sub>	Input Power Dissipation (No derating required up to 85°C)	Each Channel	45	mW

### DETECTOR

I <sub>O</sub> (avg)	Average Output Current	Each Channel	8	mA
I <sub>O</sub> (pk)	Peak Output Current	Each Channel	16	mA
V <sub>EBR</sub>	Emitter–Base Reverse Voltage	FOD050L only	5	V
V <sub>CC</sub>	Supply Voltage		–0.5 to 7	V
V <sub>O</sub>	Output Voltage		–0.5 to 7	V
I <sub>B</sub>	Base Current	FOD050L only	5	mA
P <sub>D</sub>	Output Power Dissipation (No derating required up to 85°C)	Each Channel	100	mW

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# FOD050L, FOD053L

## ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = 0°C to 70°C, unless otherwise specified.)

### INDIVIDUAL COMPONENT CHARACTERISTICS

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
<b>EMITTER</b>							
V <sub>F</sub>	Input Forward Voltage	I <sub>F</sub> = 16 mA, T <sub>A</sub> = 25°C	All		1.45	1.7	V
		I <sub>F</sub> = 16 mA				1.8	
B <sub>VR</sub>	Input Reverse Breakdown Voltage	I <sub>R</sub> = 10 µA	All	5.0			V

### DETECTOR

I <sub>OH</sub>	Logic High Output Current	I <sub>F</sub> = 0 mA, V <sub>O</sub> = V <sub>CC</sub> = 3.3 V & 5 V, T <sub>A</sub> = 25°C	All		0.001	1	µA
I <sub>CCL</sub>	Logic Low Supply Current	I <sub>F</sub> = 16 mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3 V & 5 V	FOD050L			200	µA
		I <sub>F1</sub> = I <sub>F2</sub> = 16 mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3 V & 5 V	FOD053L			400	
I <sub>CCH</sub>	Logic High Supply Current	I <sub>F</sub> = 0 mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3 V & 5 V, T <sub>A</sub> = 25°C	FOD050L			0.3	µA
		I <sub>F</sub> = 0 mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3 V & 5 V	FOD053L			10	

### TRANSFER CHARACTERISTICS

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
<b>COUPLED</b>							
CTR	Current Transfer Ratio (Note 2)	I <sub>F</sub> = 16 mA, V <sub>O</sub> = 0.4 V, V <sub>CC</sub> = 3.3 V & 5 V, T <sub>A</sub> = 25°C	All	15		50	%
V <sub>OL</sub>	Logic Low Output Voltage	I <sub>F</sub> = 16 mA, I <sub>O</sub> = 3 mA, V <sub>CC</sub> = 3.3 V & 5 V, T <sub>A</sub> = 25°C	All			0.3	V

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Current Transfer Ratio is defined as a ratio of output collector current, I<sub>O</sub>, to the forward LED input current, I<sub>F</sub>, times 100%.

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## ELECTRICAL CHARACTERISTICS (Continued)

( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ , unless otherwise specified.)

### SWITCHING CHARACTERISTICS ( $V_{CC} = 3.3\text{ V}$ & $5\text{ V}$ )

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$T_{PHL}$	Propagation Delay Time to Logic LOW	$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3)			1.0	$\mu\text{s}$
		(Figure 10)			2.0	
$T_{PLH}$	Propagation Delay Time to Logic HIGH	$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3)			1.0	$\mu\text{s}$
		(Figure 10)			2.0	
$ CM_H $	Common Mode Transient Immunity at Logic HIGH	$I_F = 0\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Notes 4, 5) (Figure 11)	5,000	50,000		$\text{V}/\mu\text{s}$
		$I_F = 0\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Notes 3, 5) (Figure 11)	5,000	50,000		$\text{V}/\mu\text{s}$
$ CM_L $	Common Mode Transient Immunity at Logic LOW	$I_F = 16\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Notes 4, 5) (Figure 11)	5,000	35,000		$\text{V}/\mu\text{s}$
		$I_F = 16\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Notes 3, 5) (Figure 11)	5,000	35,000		$\text{V}/\mu\text{s}$

### ISOLATION CHARACTERISTICS

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Unit
$I_{I-O}$	Input-Output Insulation Leakage Current	Relative humidity = 45%, $T_A = 25^\circ\text{C}$ , $t = 5\text{ s}$ , $V_{I-O} = 3000\text{ VDC}$ (Note 6)			1.0	$\mu\text{A}$
$V_{ISO}$	Withstand Insulation Test Voltage	$f = 60\text{ Hz}$ , $T_A = 25^\circ\text{C}$ , $t = 60\text{ s}$ (Note 6)	2500			$\text{V}_{RMS}$
$R_{I-O}$	Resistance (Input to Output)	$V_{I-O} = 500\text{ VDC}$ (Note 6)	$10^{11}$	$10^{12}$		$\Omega$
$C_{I-O}$	Capacitance (Input to Output)	$f = 1\text{ MHz}$ (Note 6)		0.2		$\text{pF}$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. The  $1.9\text{ k}\Omega$  load represents 1 TTL unit load of  $1.6\text{ mA}$  and  $5.6\text{ k}\Omega$  pull-up resistor.

4. The  $4.1\text{ k}\Omega$  load represents 1 LSTTL unit load of  $0.36\text{ mA}$  and  $6.1\text{ k}\Omega$  pull-up resistor.

5. Common mode transient immunity in logic high level is the maximum tolerable (positive)  $dV_{cm}/dt$  on the leading edge of the common mode pulse signal  $V_{CM}$ , to assure that the output will remain in a logic high state (i.e.,  $V_O > 2.0\text{ V}$ ). Common mode transient immunity in logic low level is the maximum tolerable (negative)  $dV_{cm}/dt$  on the trailing edge of the common mode pulse signal,  $V_{CM}$ , to assure that the output will remain in a logic low state (i.e.,  $V_O < 0.8\text{ V}$ ).

6. Device is considered a two terminal device: pins 1, 2, 3 and 4 are shorted together and pins 5, 6, 7 and 8 are shorted together.

TYPICAL PERFORMANCE CURVES

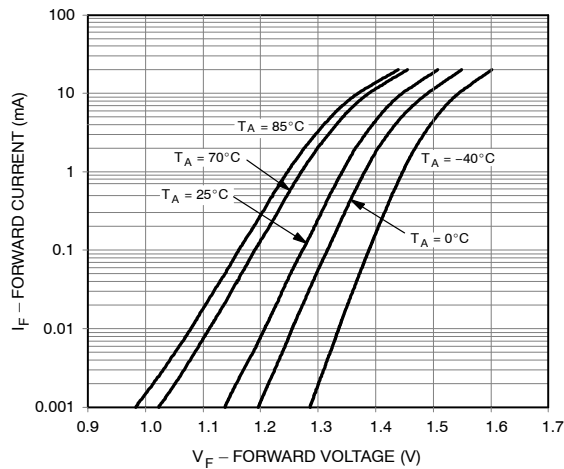


Figure 2. LED Forward Current vs. Forward Voltage

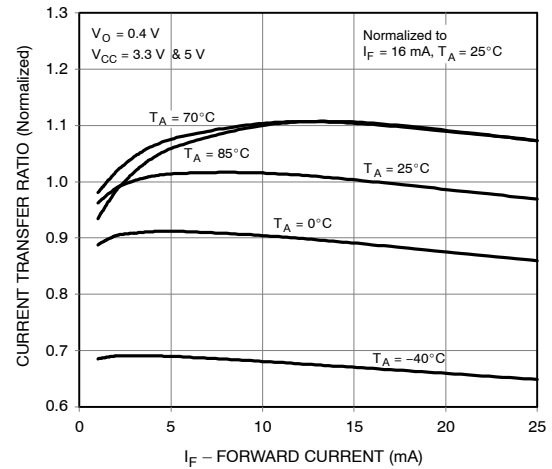


Figure 3. Current Transfer Ratio vs. Forward Current

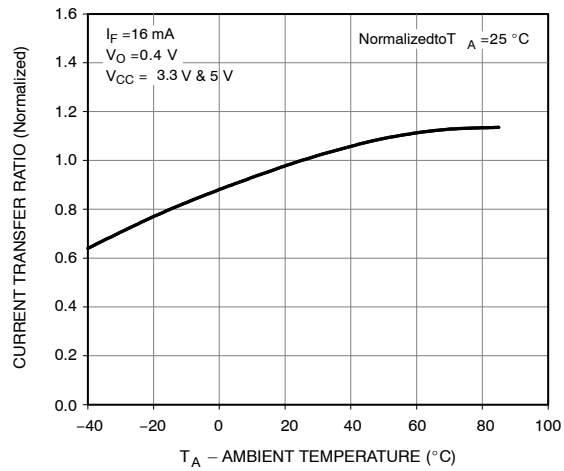


Figure 4. Current Transfer Ratio vs. Ambient Temperature

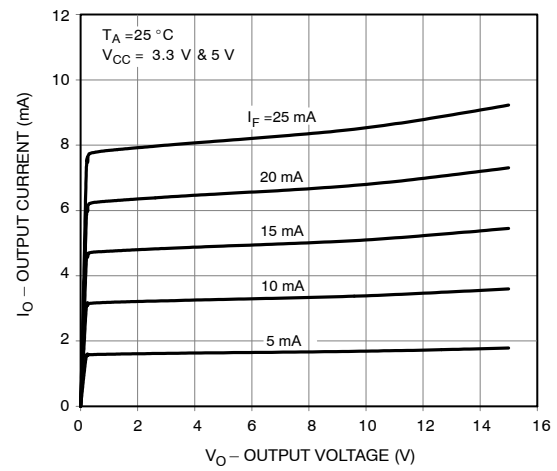


Figure 5. Output Current vs. Output Voltage

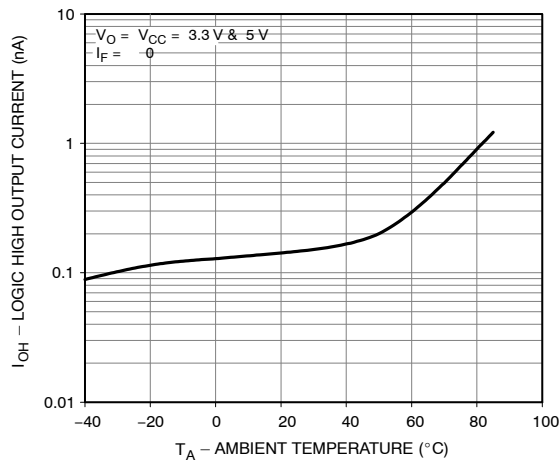


Figure 6. Logic High Output Current vs. Ambient Temperature

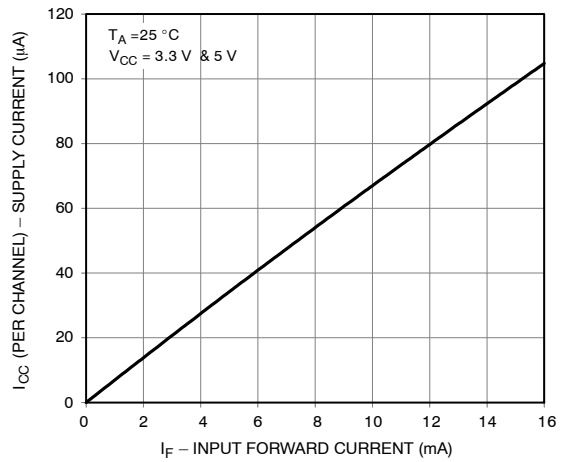


Figure 7. Supply Current vs. Input Forward Current

TYPICAL PERFORMANCE CURVES (Continued)

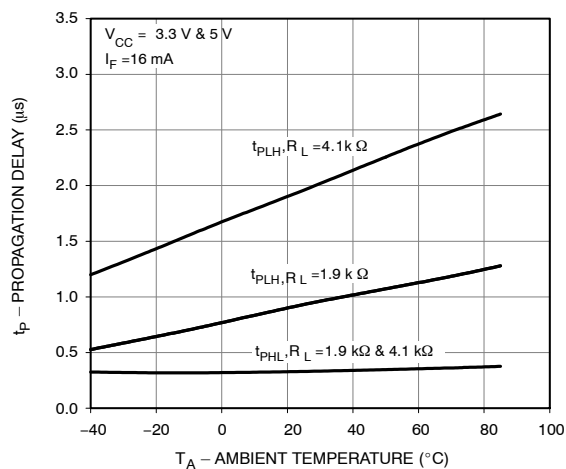


Figure 8. Propagation Delay vs. Ambient Temperature

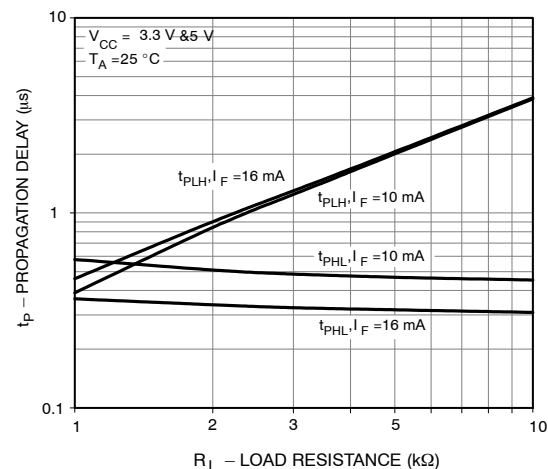
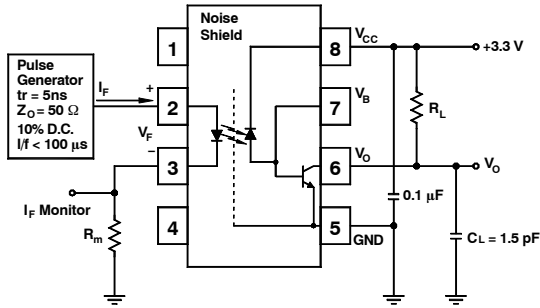


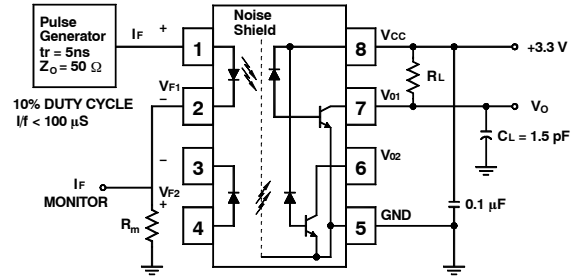
Figure 9. Propagation Delay vs. Load Resistance

# FOD050L, FOD053L

## TEST CIRCUITS



Test Circuit for FOD050L



Test Circuit for FOD053L

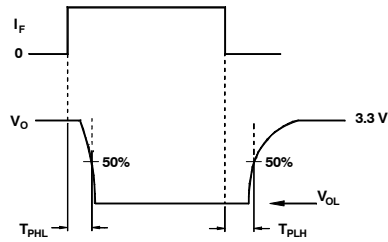
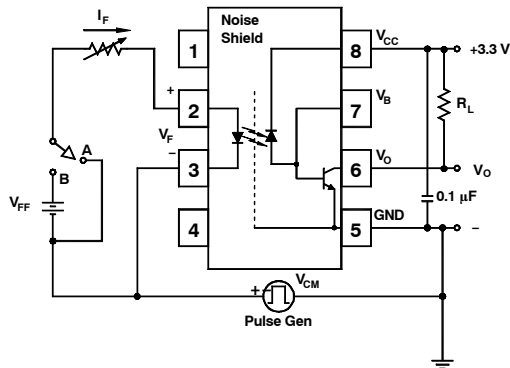
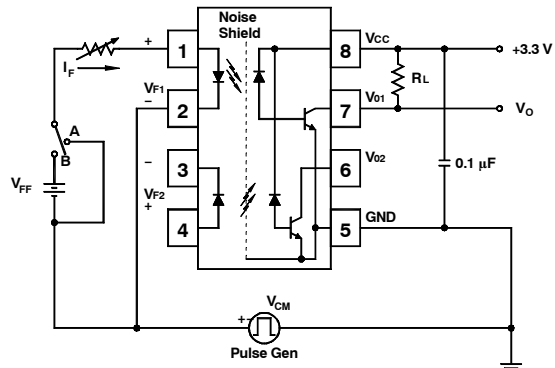


Figure 10. Switching Time Test Circuit



Test Circuit for FOD050L



Test Circuit for FOD053L

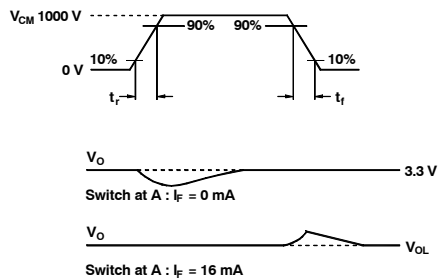


Figure 11. Common Mode Immunity Test Circuit



## REFLOW PROFILE

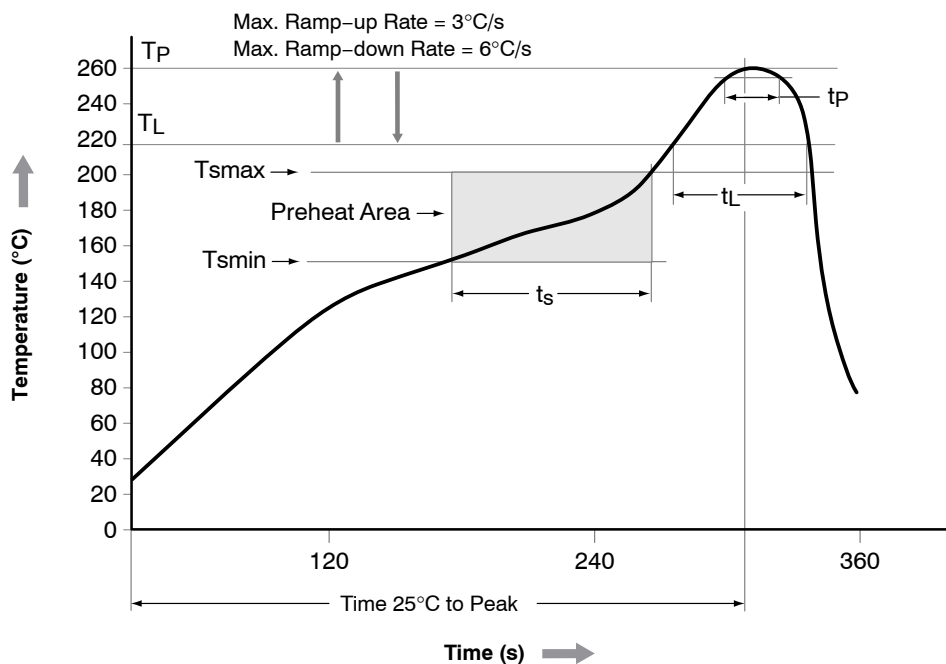


Figure 12. Reflow Profile

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 – 120 s
Ramp-up Rate ( $t_L$ to $t_P$ )	3°C/s max.
Liquidous Temperature ( $T_L$ )	217°C
Time ( $t_L$ ) Maintained Above ( $T_L$ )	60 – 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 max.
Time 25°C to Peak Temperature	8 minutes max.

## FOD050L, FOD053L

### ORDERING INFORMATION

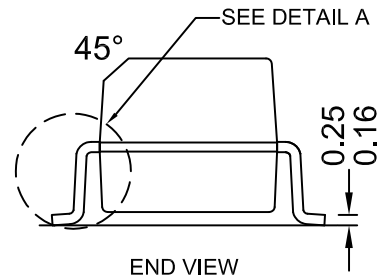
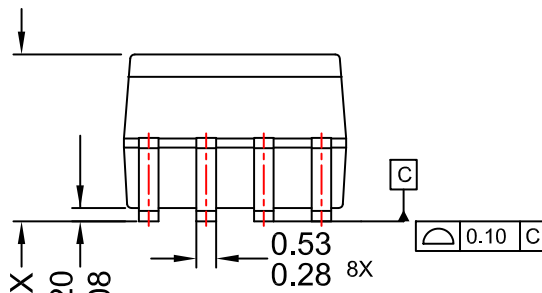
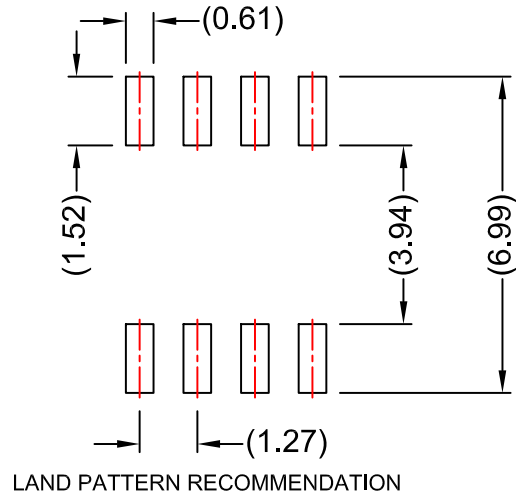
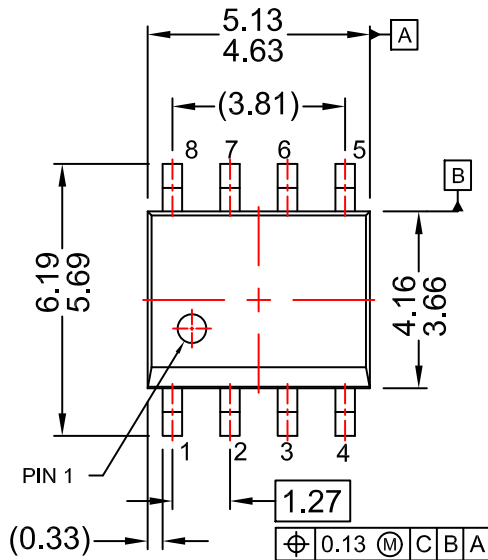
Part Number (Note 7)	Package	Packing Method†
FOD050L	SOIC8 (Pb-Free)	Tube (50 Units per Tube)
FOD050LR2	SOIC8 (Pb-Free)	Tape and Reel (1000 Units per Reel)
FOD050LV	SOIC8 (Pb-Free), DIN EN/IEC60747-5-5 Option	Tube (50 Units per Tube)
FOD050LR2V	SOIC8 (Pb-Free), DIN EN/IEC60747-5-5 Option	Tape and Reel (1000 Units per Reel)

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

7. The product orderable part number system listed in this table also applies to the FOD053L product.

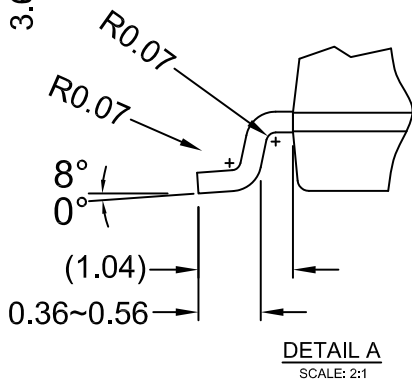
**SOIC8**  
**CASE 751DZ**  
**ISSUE O**

DATE 30 SEP 2016



**NOTES:**

- A) NO STANDARD APPLIES TO THIS PACKAGE
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) LANDPATTERN STANDARD: SOIC127P600X175-8M.



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