

# FOD050L, FOD250L: Single Channel FOD053L: Dual Channel LVTTTL/LVCMOS 3.3V High Speed Transistor Optocouplers

## Features

- Low power consumption
- High speed
- Available in single channel 8-pin DIP (FOD250L), 8-pin SOIC (FOD050L) or dual channel 8-pin SOIC (FOD053L)
- Superior CMR –  $CM_H = 50kV/\mu s$  (typical) and  $CM_L = 35kV/\mu s$  (typical)
- Guaranteed performance over temperature: 0°C to 70°C
- U.L. recognized (File # E90700)
- VDE pending

## Applications

- Line receivers
- Pulse transformer replacement
- High speed logic ground isolation: LVTTTL/LVCMOS
- Wide bandwidth analog coupling

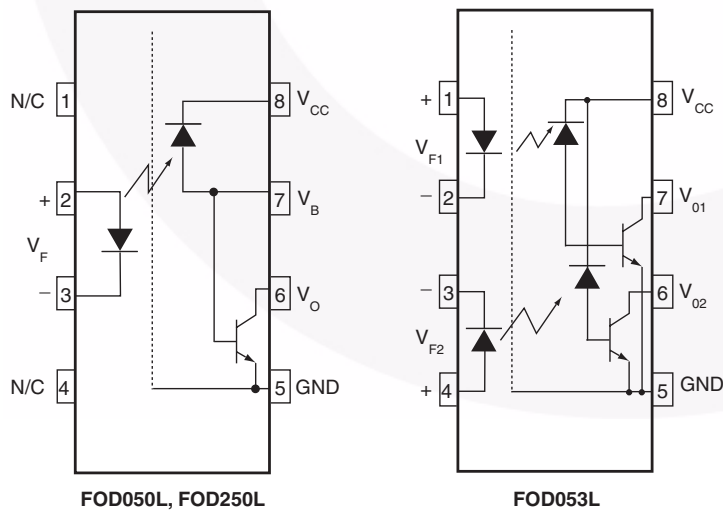
## Description

The FOD250L, FOD050L and FOD053L optocouplers consist of an AlGaAs LED optically coupled to a high speed photodetector transistor. These devices are specified for operation at a 3.3V supply voltage.

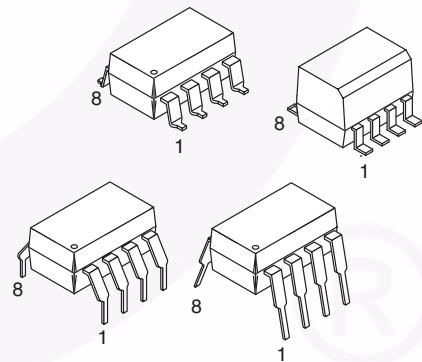
A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

An internal noise shield provides superior common mode rejection of  $CM_H = 50kV/ms$  (typical) and  $CM_L = 35kV/ms$  (typical).

## Schematics



## Package Outlines



## Truth Table

| LED | V <sub>O</sub> |
|-----|----------------|
| On  | LOW            |
| Off | HIGH           |

**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 +85     | $^\circ\text{C}$ |
| $T_{SOL}$       | Lead Solder Temperature (Wave solder only)                                   |                       | 260 for 10 sec | $^\circ\text{C}$ |
| <b>EMITTER</b>  |  |                       |                |                  |
| $I_F$ (avg)     | DC/Average Forward Input Current   | Each Channel          | 25             | mA               |
| $I_F$ (pk)      | Peak Forward Input Current<br>(50% duty cycle, 1ms P.W.)                     | Each Channel          | 50             | mA               |
| $I_F$ (trans)   | Peak Transient Input Current<br>( $\leq 1 \mu\text{s}$ P.W., 300pps)         | Each Channel          | 1.0            | A                |
| $V_R$           | Reverse Input Voltage  | Each Channel          | 5              | V                |
| $P_D$           | Input Power Dissipation<br>(No derating required up to $85^\circ\text{C}$ )  | Each Channel          | 45             | mW               |
| <b>DETECTOR</b> |  |                       |                |                  |
| $I_O$ (avg)     | Average Output Current   | Each Channel          | 8              | mA               |
| $I_O$ (pk)      | Peak Output Current  | Each Channel          | 16             | mA               |
| $V_{EBR}$       | Emitter-Base Reverse Voltage   | FOD050L, FOD250L only | 5              | V                |
| $V_{CC}$        | Supply Voltage   |                       | -0.5 to 7      | V                |
| $V_O$           | Output Voltage   |                       | -0.5 to 7      | V                |
| $I_B$           | Base Current   | FOD050L, FOD250L only | 5              | mA               |
| $P_D$           | Output Power Dissipation<br>(No derating required up to $85^\circ\text{C}$ ) | Each Channel          | 100            | mW               |

## Electrical Characteristics (T<sub>A</sub> = 0 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> = 16mA, T <sub>A</sub> = 25°C   | All                |      | 1.45  | 1.7  | V    |
|                  |                                 | I <sub>F</sub> = 16mA  |                    |      |       | 1.8  |      |
| B <sub>VR</sub>  | Input Reverse Breakdown Voltage | I <sub>R</sub> = 10μA  | All                | 5.0  |       |      | V    |
| <b>DETECTOR</b>  |                                 |  |                    |      |       |      |      |
| I <sub>OH</sub>  | Logic High Output Current       | I <sub>F</sub> = 0mA, V <sub>O</sub> = V <sub>CC</sub> = 3.3V, T <sub>A</sub> = 25°C       | All                |      | 0.001 | 1    | μA   |
| I <sub>CCL</sub> | Logic Low Supply Current        | I <sub>F</sub> = 16mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3V                       | FOD050L<br>FOD250L |      |       | 200  | μA   |
|                  |                                 | I <sub>F1</sub> = I <sub>F2</sub> = 16mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3V    | FOD053L            |      |       | 400  |      |
| I <sub>CCH</sub> | Logic High Supply Current       | I <sub>F</sub> = 0mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3V, T <sub>A</sub> = 25°C | FOD050L<br>FOD250L |      |       | 0.3  | μA   |
|                  |                                 | I <sub>F</sub> = 0mA, V <sub>O</sub> = Open, V <sub>CC</sub> = 3.3V                        | FOD053L            |      |       | 10   |      |

\*\*All Typicals at T<sub>A</sub> = 25°C

### Transfer Characteristics

| Symbol          | Parameter                               | Test Conditions  | Device | Min. | Typ.** | Max. | Unit |
|-----------------|---|--|--------|------|--------|------|------|
| <b>COUPLED</b>  |   |  |        |      |        |      |      |
| CTR             | Current Transfer Ratio <sup>(1)</sup>   | I <sub>F</sub> = 16mA, V <sub>O</sub> = 0.4 V, V <sub>CC</sub> = 3.3V, T <sub>A</sub> = 25°C | All    | 15   |        | 50   | %    |
| V <sub>OL</sub> | Logic Low Output Voltage Output Voltage | I <sub>F</sub> = 16mA, I <sub>O</sub> = 3mA, V <sub>CC</sub> = 3.3V, T <sub>A</sub> = 25°C   | All    |      |        | 0.3  | V    |

\*All Typicals at T<sub>A</sub> = 25°C

#### Note:

1. 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%.

**Electrical Characteristics** (Continued) ( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified.)

**Switching Characteristics** ( $V_{CC} = 3.3\text{V}$ )

| Symbol     | Parameter  | Test Conditions   | Device | Min.  | Typ.** | Max. | Unit                   |
|------------|--|---|--------|-------|--------|------|------------------------|
| $T_{PHL}$  | Propagation Delay<br>Time to Logic LOW             | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(2)}$<br>(Fig. 10)  | 25°C   | All   |        | 1.0  | $\mu\text{s}$          |
|            |  |   |        |       |        | 2.0  |                        |
| $T_{PLH}$  | Propagation Delay<br>Time to Logic HIGH            | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(2)}$<br>(Fig. 10)  | 25°C   | All   |        | 1.0  | $\mu\text{s}$          |
|            |  |   |        |       |        | 2.0  |                        |
| $ICM_{HI}$ | Common Mode<br>Transient Immunity<br>at Logic HIGH | $I_F = 0\text{mA}$ , $V_{CM} = 1,000\text{V}_{P-P}$ ,<br>$R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(3,4)}$ (Fig. 11)     | All    | 5,000 | 50,000 |      | $\text{V}/\mu\text{s}$ |
|            |  | $I_F = 0\text{mA}$ , $V_{CM} = 1,000\text{V}_{P-P}$ ,<br>$T_A = 25^\circ\text{C}$ , $R_L = 1.9\text{k}\Omega^{(2,4)}$ (Fig. 11)     |        | 5,000 | 50,000 |      | $\text{V}/\mu\text{s}$ |
| $ICM_{LI}$ | Common Mode<br>Transient Immunity<br>at Logic LOW  | $I_F = 16\text{mA}$ , $V_{CM} = 1,000\text{V}_{P-P}$ ,<br>$R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(3,4)}$<br>(Fig. 11) | All    | 5,000 | 35,000 |      | $\text{V}/\mu\text{s}$ |
|            |  | $I_F = 16\text{mA}$ , $V_{CM} = 1,000\text{V}_{P-P}$ ,<br>$R_L = 1.9\text{k}\Omega^{(2,4)}$ (Fig. 11)                               |        | 5,000 | 35,000 |      | $\text{V}/\mu\text{s}$ |

**Isolation Characteristics**

| Symbol    | Characteristics                               | Test Conditions  | Device             | Min.      | Typ.**    | Max. | Unit          |
|-----------|---|--|--------------------|-----------|-----------|------|---------------|
| $I_{I-O}$ | Input-Output<br>Insulation Leakage<br>Current | Relative humidity = 45%,<br>$T_A = 25^\circ\text{C}$ , $t = 5\text{s}$ ,<br>$V_{I-O} = 3000\text{VDC}^{(5)}$ | All                |           |           | 1.0  | $\mu\text{A}$ |
| $V_{ISO}$ | Withstand Insulation<br>Test Voltage          | $f = 60\text{Hz}$ , $T_A = 25^\circ\text{C}$ ,<br>$t = 1\text{ min.}^{(5)}$                                  | FOD050L<br>FOD053L | 2500      |           |      | $V_{RMS}$     |
|           |   |  | FOD250L            | 5000      |           |      |               |
| $R_{I-O}$ | Resistance<br>(input to output)               | $V_{I-O} = 500\text{VDC}^{(5)}$  | All                | $10^{11}$ | $10^{12}$ |      | $\Omega$      |
| $C_{I-O}$ | Capacitance<br>(input to output)              | $f = 1\text{MHz}^{(5)}$  | All                |           | 0.2       |      | $\text{pF}$   |

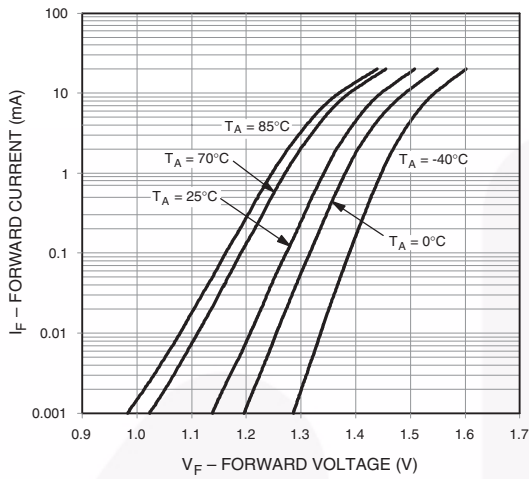
\*All Typical at  $T_A = 25^\circ\text{C}$

**Notes:**

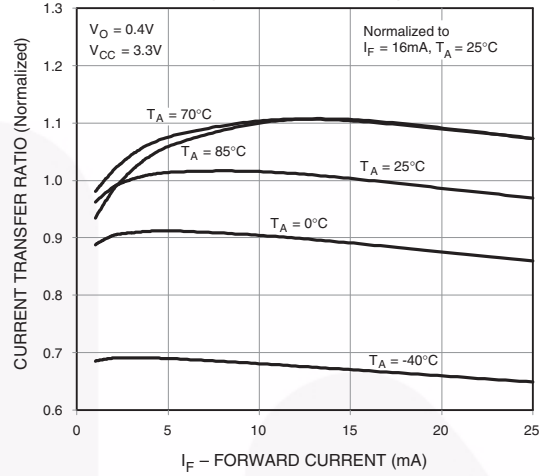
- The  $1.9\text{k}\Omega$  load represents 1 TTL unit load of  $1.6\text{mA}$  and  $5.6\text{k}\Omega$  pull-up resistor.
- The  $4.1\text{k}\Omega$  load represents 1 LSTTL unit load of  $0.36\text{mA}$  and  $6.1\text{k}\Omega$  pull-up resistor.
- Common mode transient immunity in logic high level 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.,  $V_O < 0.8\text{V}$ ).
- 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

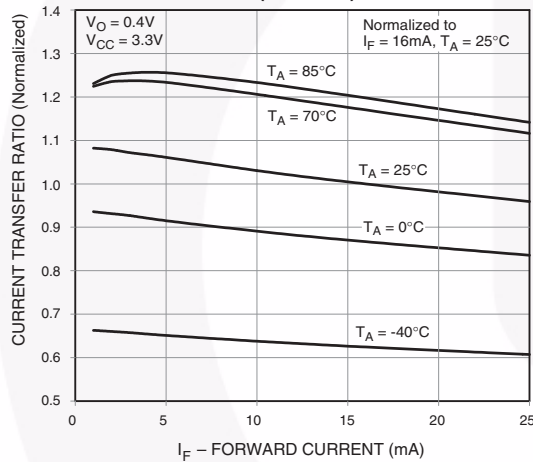
**Fig. 1 LED Forward Current vs. Forward Voltage**



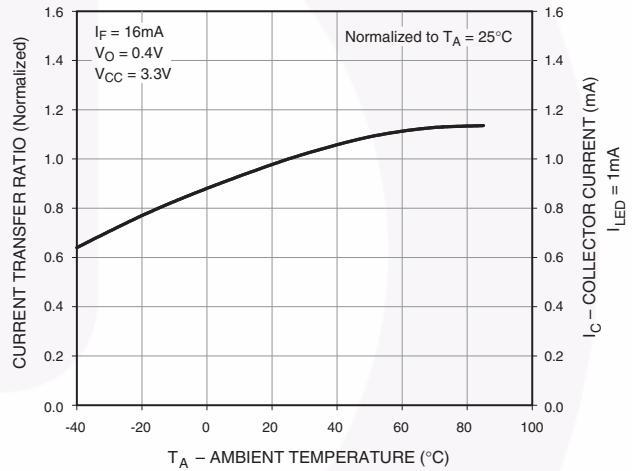
**Fig. 2 Current Transfer Ratio vs. Forward Current (FOD050L, FOD053L)**



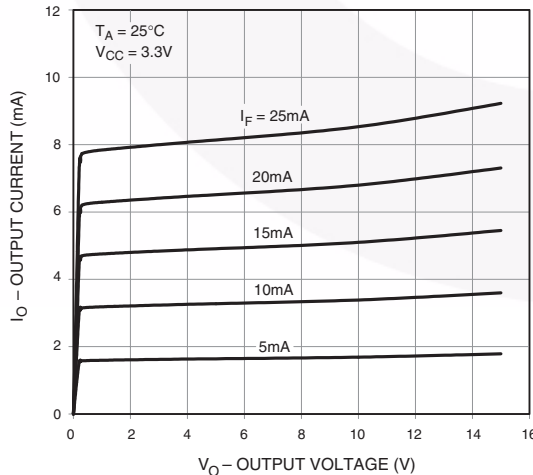
**Fig. 3 Current Transfer Ratio vs. Input Forward Current (FOD250L)**



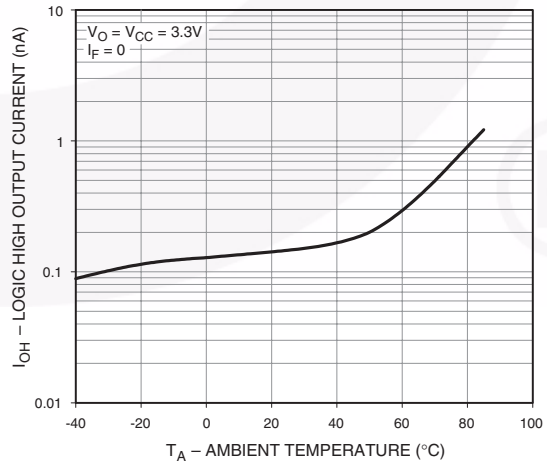
**Fig. 4 Current Transfer Ratio vs. Ambient Temperature**



**Fig. 5 Output Current vs. Output Voltage**

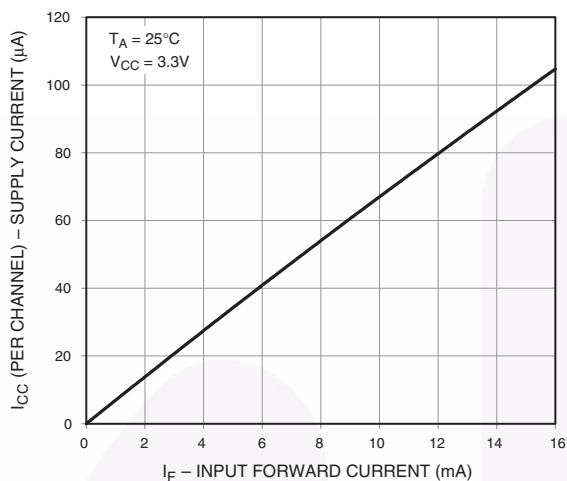


**Fig. 6 Logic High Output Current vs. Ambient Temperature**

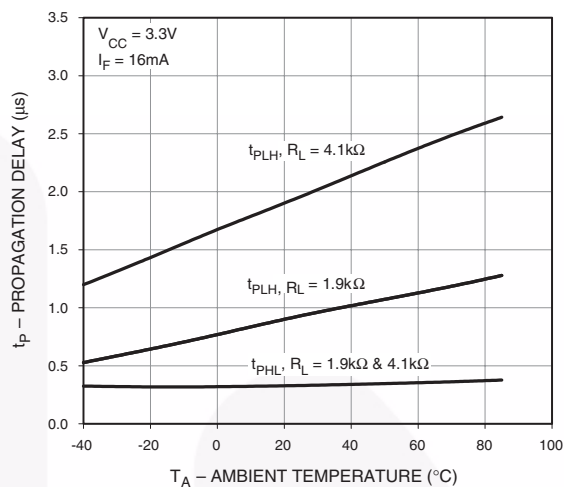


## Typical Performance Curves (Continued)

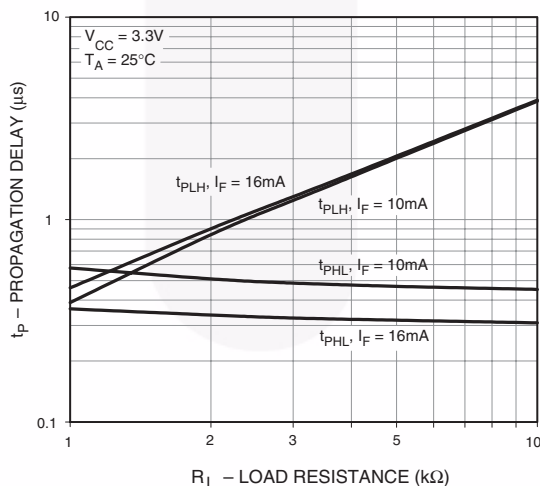
**Fig. 7 Supply Current vs. Input Forward Current**



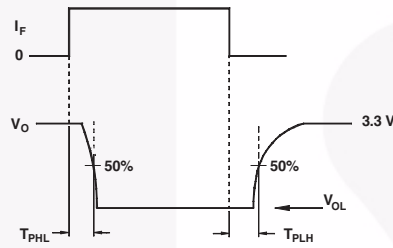
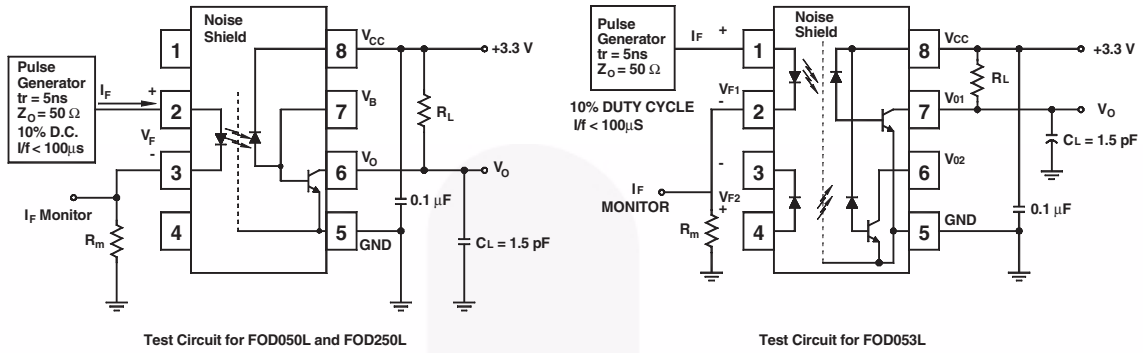
**Fig. 8 Propagation Delay vs. Ambient Temperature**



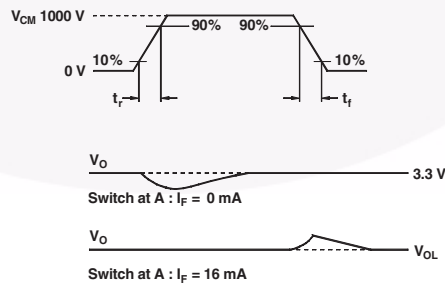
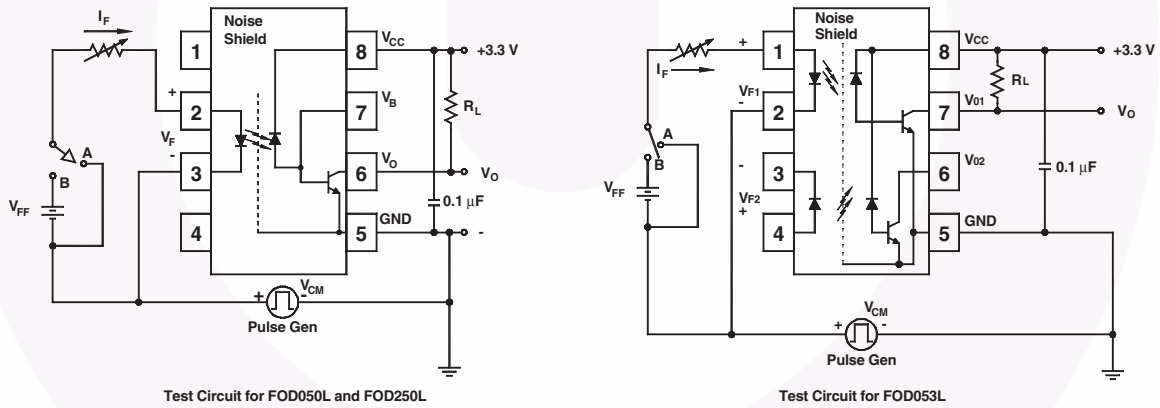
**Fig. 9 Propagation Delay vs. Load Resistance**



### Test Circuits



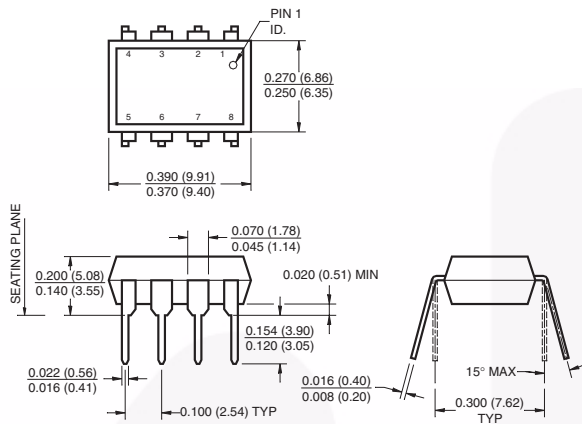
**Fig. 10 Switching Time Test Circuit**



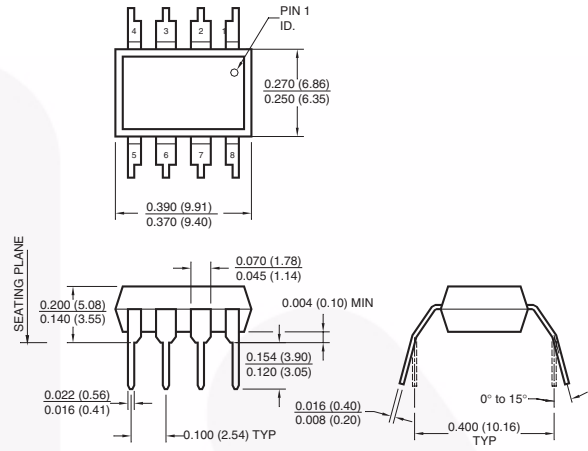
**Fig. 11 Common Mode Immunity Test Circuit**

## Package Dimensions

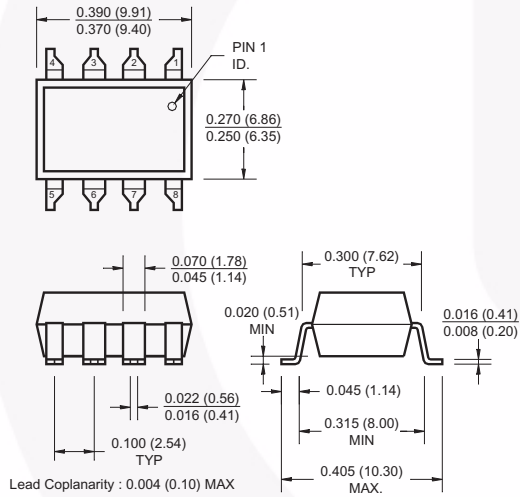
### Through Hole



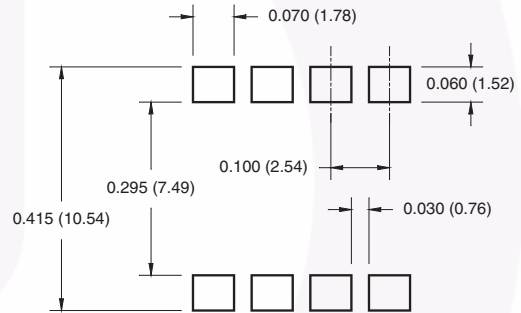
### 0.4" Lead Spacing



### Surface Mount



### 8-Pin DIP – Land Pattern



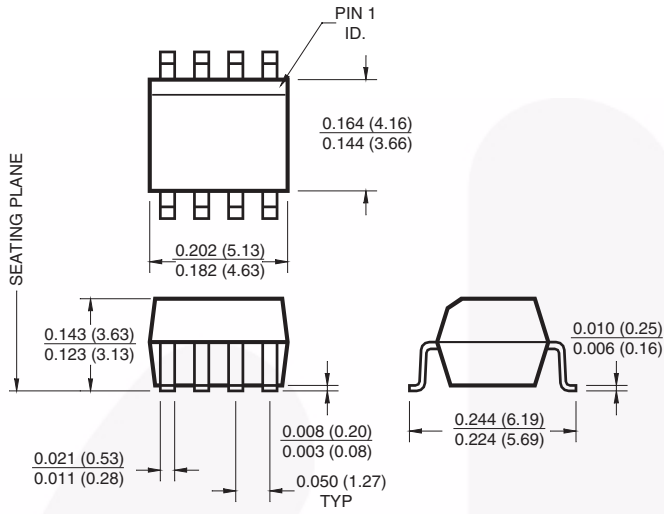
### Note:

All dimensions are in inches (millimeters)



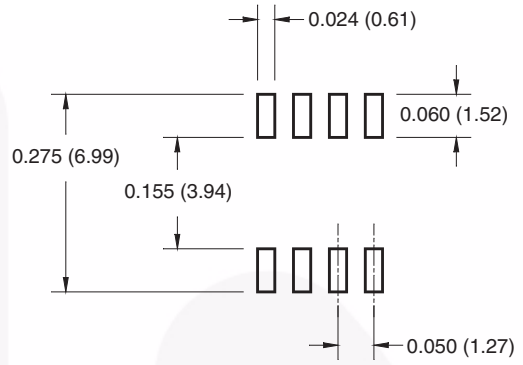
**Package Dimensions** (Continued) (8-Pin SOIC)

**Surface Mount**



Lead Coplanarity : 0.004 (0.10) MAX

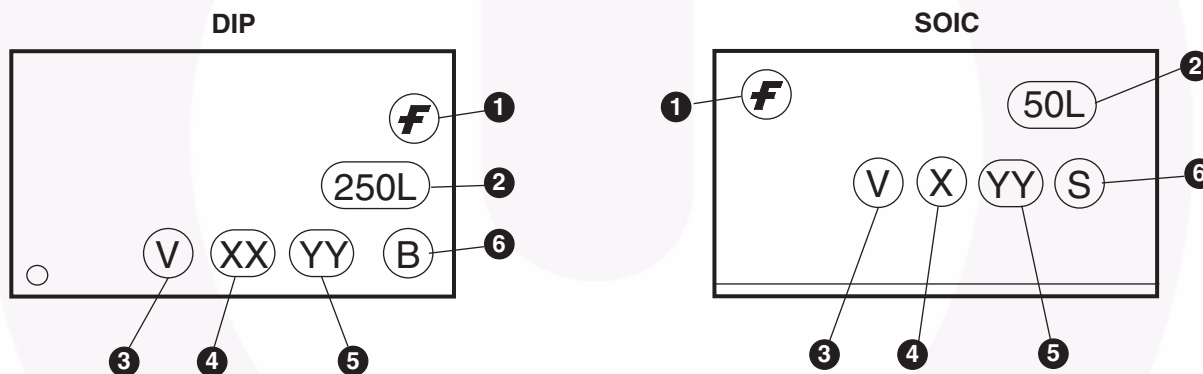
**8-Pin Small Outline**



## Ordering Information

| Option    | Order Entry Identifier | Description  |
|-----------|------------------------|--|
| No Suffix | FOD250L                | Through Hole (DIP package only)  |
|           | FOD050L                | Surface Mount Lead Form (SOIC-8 package only)                                  |
| S         | FOD250LS               | Surface Mount Lead Bend (DIP package only)                                     |
| SD        | FOD250LSD              | Surface Mount; Tape and reel (DIP package only)                                |
| SV        | Pending Approval       | Surface Mount; VDE0884 (DIP package only)                                      |
| SDV       | Pending Approval       | Surface Mount; Tape and reel, VDE0884 (1000 units per reel) (DIP package only) |
| T         | FOD250LT               | 0.4" Lead Spacing (DIP package only)   |
| TV        | Pending Approval       | 0.4" Lead Spacing, VDE0884 (DIP package only)                                  |
| R1        | FOD050LR1              | Tape and Reel (500 units per reel) (SOIC-8 package only)                       |
| R1V       | Pending Approval       | VDE, Tape and Reel (500 units per reel) (SOIC-8 package only)                  |
| R2        | FOD050LR2              | Tape and Reel (2500 units per reel) (SOIC-8 package only)                      |
| R2V       | Pending Approval       | VDE, Tape and Reel (2500 units per reel) (SOIC-8 package only)                 |
| V         | Pending Approval       | VDE (SOIC-8 package only)  |

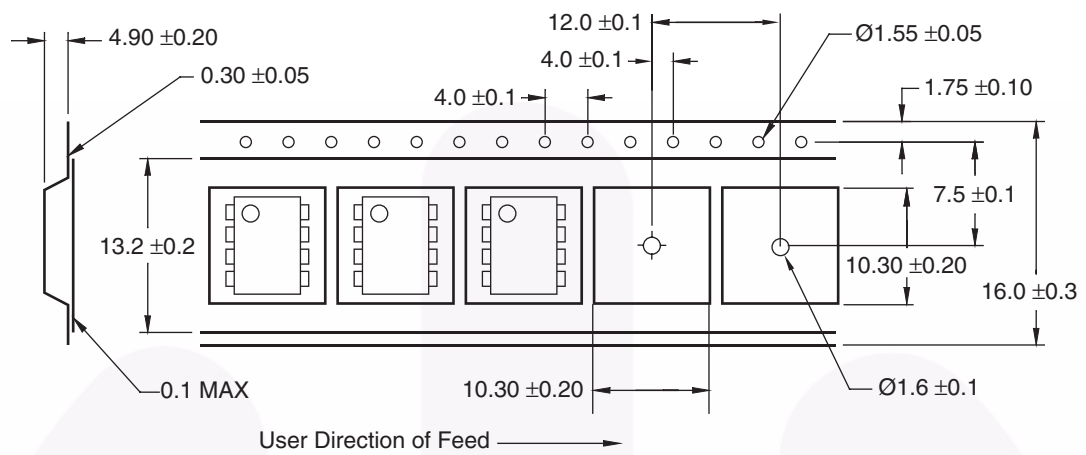
## Marking Information



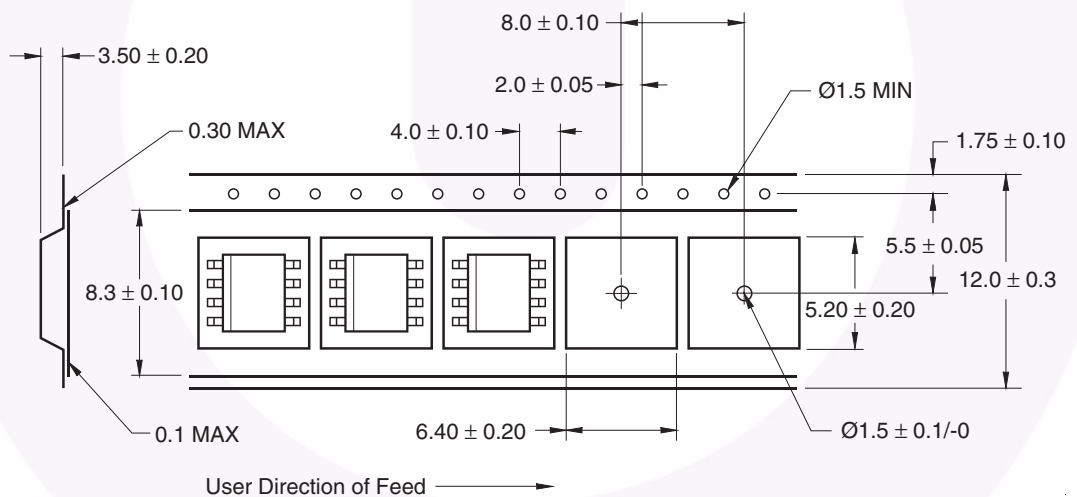
| Definitions |  |
|-------------|--|
| 1           | Fairchild logo   |
| 2           | Device number  |
| 3           | VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table) |
| 4 (DIP)     | Two digit year code, e.g., '03'  |
| 4 (SOIC)    | One digit year code, e.g.,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

### Carrier Tape Specification

#### 8-Pin DIP (FOD250L)



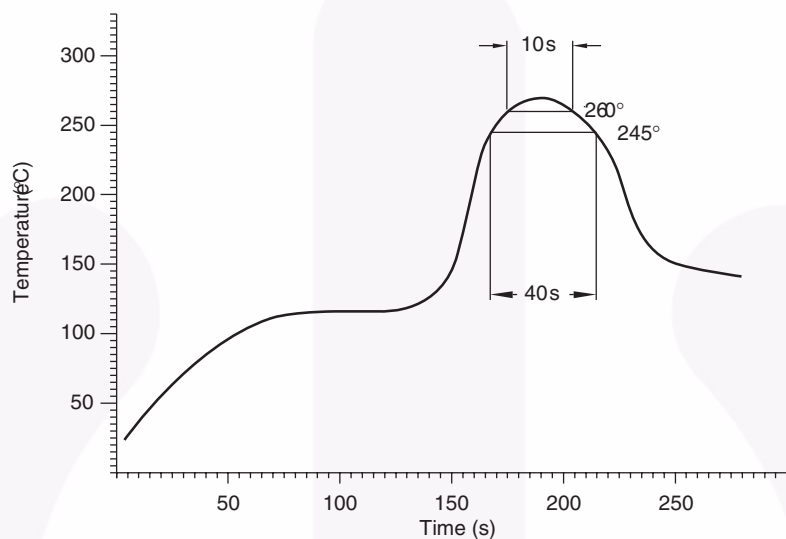
#### 8-Pin SOIC (FOD050L, FOD053L)



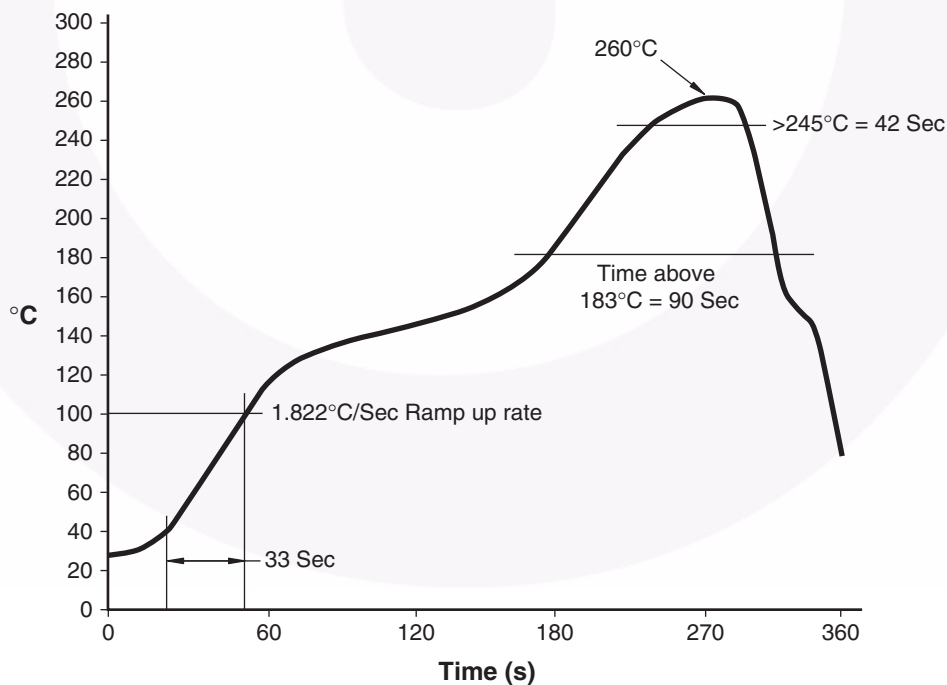
## Reflow Profile

### 8-Pin DIP (FOD250L)

- Peak reflow temperature 260°C (package surface temperature)
- Time of temperature higher than 245°C 40 seconds or less
- Number of reflows Three









### 8-Pin SOIC (FOD050L, FOD053L)





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**Definition of Terms**

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

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