

# 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

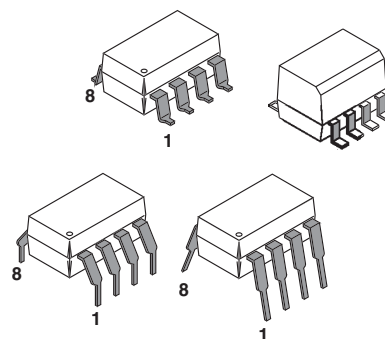
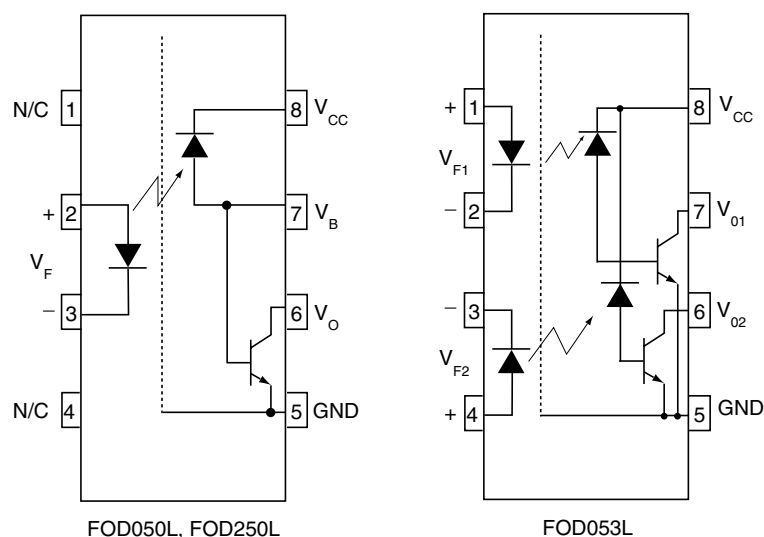
## Description

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).

## Schematic



Truth Table

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

**Absolute Maximum Ratings** ( $T_A = 25^\circ\text{C}$  Unless otherwise specified.)

| Symbol                 | Parameter                                                     |                       | Value          | Units |
|------------------------|---------------------------------------------------------------|-----------------------|----------------|-------|
| T <sub>STG</sub>       | Storage Temperature                                           |                       | -40 to +125    | °C    |
| T <sub>OPR</sub>       | Operating Temperature                                         |                       | -40 to +85     | °C    |
| T <sub>SOL</sub>       | Lead Solder Temperature (Wave solder only)                    |                       | 260 for 10 sec | °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<br>(50% duty cycle, 1ms P.W.)      | Each Channel          | 50             | mA    |
| I <sub>F</sub> (trans) | Peak Transient Input Current<br>(≤1 μs P.W., 300pps)          | Each Channel          | 1.0            | A     |
| V <sub>R</sub>         | Reverse Input Voltage                                         | Each Channel          | 5              | V     |
| P <sub>D</sub>         | Input Power Dissipation<br>(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, FOD250L 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, FOD250L only | 5              | mA    |
| P <sub>D</sub>         | Output Power Dissipation<br>(No derating required up to 85°C) | Each Channel          | 100            | mW    |

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

| Symbol          | Parameter                       | Test Conditions                                                                              | Device             | Min. | Typ.** | Max. | Unit          |
|-----------------|---------------------------------|----------------------------------------------------------------------------------------------|--------------------|------|--------|------|---------------|
| <b>EMITTER</b>  |                                 |                                                                                              |                    |      |        |      |               |
| $V_F$           | Input Forward Voltage           | $I_F = 16\text{mA}$ , $T_A = 25^\circ\text{C}$                                               | All                |      | 1.45   | 1.7  | V             |
|                 |                                 | $I_F = 16\text{mA}$                                                                          |                    |      |        | 1.8  |               |
| $B_{VR}$        | Input Reverse Breakdown Voltage | $I_R = 10\mu\text{A}$                                                                        | All                | 5.0  |        |      | V             |
| <b>DETECTOR</b> |                                 |                                                                                              |                    |      |        |      |               |
| $I_{OH}$        | Logic High Output Current       | $I_F = 0\text{mA}$ , $V_O = V_{CC} = 3.3\text{V}$ , $T_A = 25^\circ\text{C}$                 | All                |      | 0.001  | 1    | $\mu\text{A}$ |
| $I_{CCL}$       | Logic Low Supply Current        | $I_F = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{V}$                           | FOD050L<br>FOD250L |      |        | 200  | $\mu\text{A}$ |
|                 |                                 | $I_{F1} = I_{F2} = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{V}$               | FOD053L            |      |        | 400  |               |
| $I_{CCH}$       | Logic High Supply Current       | $I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{V}$ , $T_A = 25^\circ\text{C}$ | FOD050L<br>FOD250L |      |        | 0.3  | $\mu\text{A}$ |
|                 |                                 | $I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{V}$                            | FOD053L            |      |        | 10   |               |

\*\*All Typicals at  $T_A = 25^\circ\text{C}$ **Transfer Characteristics**

| Symbol         | Parameter                               | Test Conditions                                                                               | Device | Min. | Typ.** | Max. | Unit |
|----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------|--------|------|--------|------|------|
| <b>COUPLED</b> |                                         |                                                                                               |        |      |        |      |      |
| CTR            | Current Transfer Ratio <sup>(1)</sup>   | $I_F = 16\text{mA}$ , $V_O = 0.4\text{V}$ , $V_{CC} = 3.3\text{V}$ , $T_A = 25^\circ\text{C}$ | All    | 15   |        | 50   | %    |
| $V_{OL}$       | Logic Low Output Voltage Output Voltage | $I_F = 16\text{mA}$ , $I_O = 3\text{mA}$ , $V_{CC} = 3.3\text{V}$ , $T_A = 25^\circ\text{C}$  | All    |      |        | 0.3  | V    |

\*\*All Typicals at  $T_A = 25^\circ\text{C}$ **Note:**

- Current Transfer Ratio is defined as a ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$  times 100%.

**Switching Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  Unless otherwise specified,  $V_{CC} = 3.3\text{V}$ .)

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

\*\* All Typical at  $T_A = 25^\circ\text{C}$ **Isolation Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  Unless otherwise specified.)

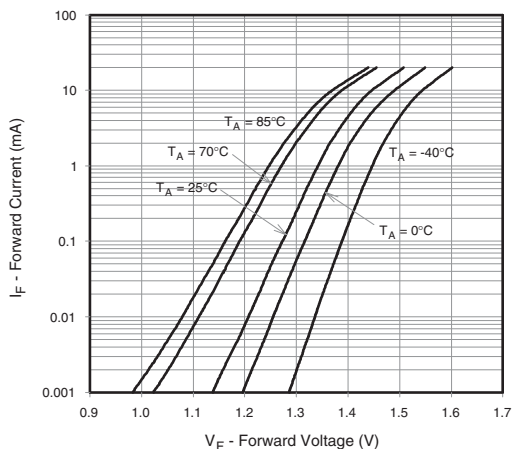
| Symbol    | Characteristics                         | Test Conditions                                                                                              | Device             | Min.      | Typ.**    | Max. | Unit          |
|-----------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------|-----------|-----------|------|---------------|
| $I_{I-O}$ | Input-Output Insulation Leakage 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 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 (input to output)            | $V_{I-O} = 500\text{VDC}^{(5)}$                                                                              | All                | $10^{11}$ | $10^{12}$ |      | $\Omega$      |
| $C_{I-O}$ | Capacitance (input to output)           | $f = 1\text{MHz}^{(5)}$                                                                                      | All                |           | 0.2       |      | $\text{pF}$   |

**Notes:**

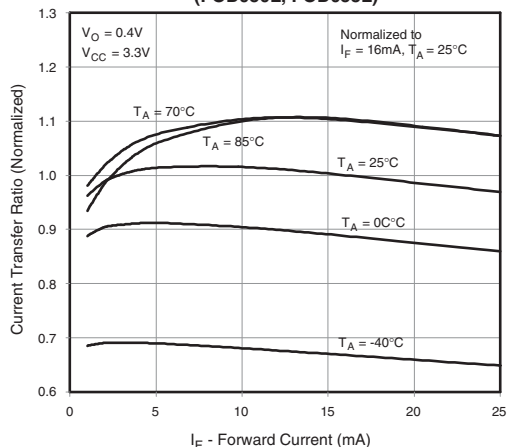
- The  $1.9\text{k}\Omega$  load represents 1 TTL unit load of  $1.6\text{mA}$  and  $5.6\text{k}\Omega$  pull-up resistor.
- The  $4.1\text{k}\Omega$  load represents 1 LSTTL unit load of  $0.36\text{mA}$  and  $6.1\text{k}\Omega$  pull-up resistor.
- Common mode transient immunity in logic high level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

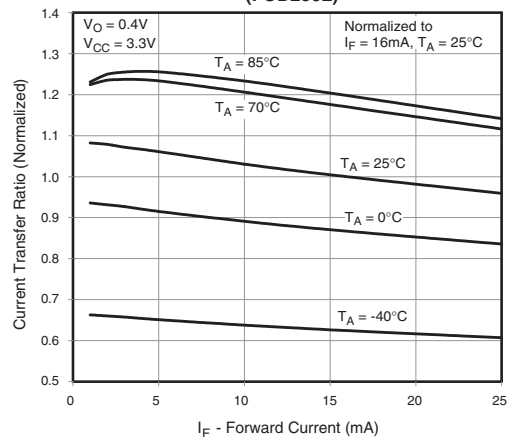
**Fig. 1 LED Forward Current vs. Forward Voltage**



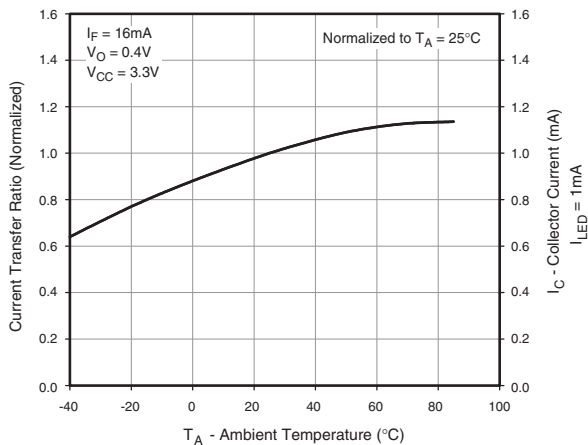
**Fig. 2 Current Transfer Ratio vs. Forward Current (FOD050L, FOD053L)**



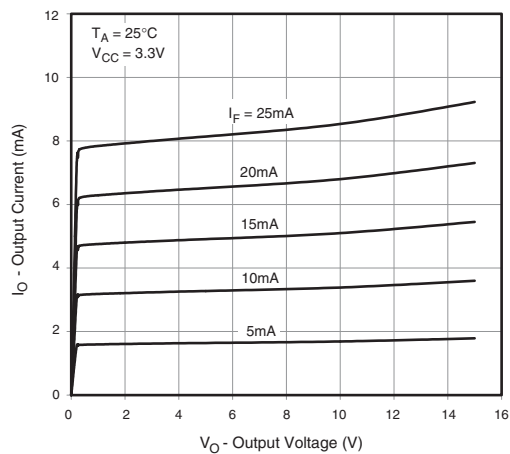
**Fig. 3 Current Transfer Ratio vs. Input Forward Current (FOD250L)**



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



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



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

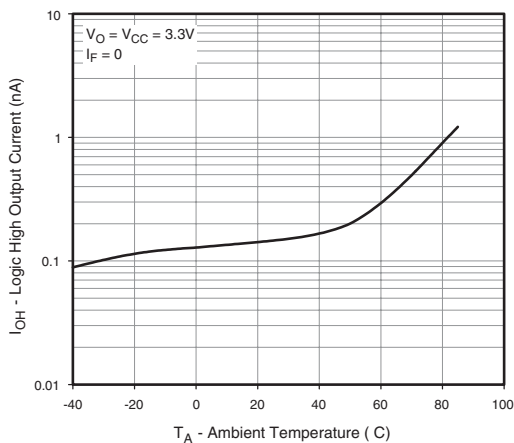


Fig. 7 Supply Current vs. Input Forward Current

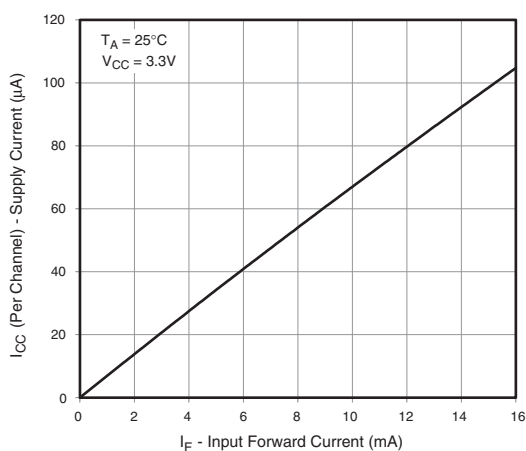


Fig. 8 Propagation Delay vs. Ambient Temperature

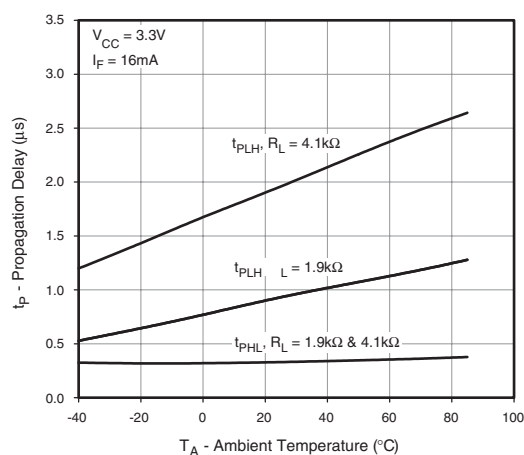


Fig. 9 Propagation Delay vs Load Resistance

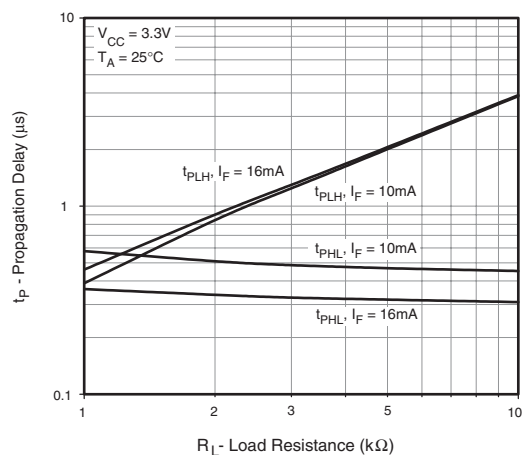


Fig. 10 Switching Time Test Circuit

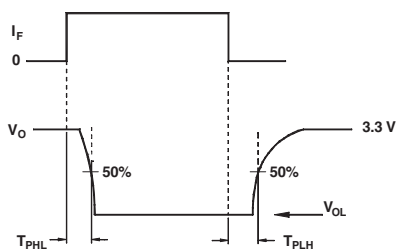
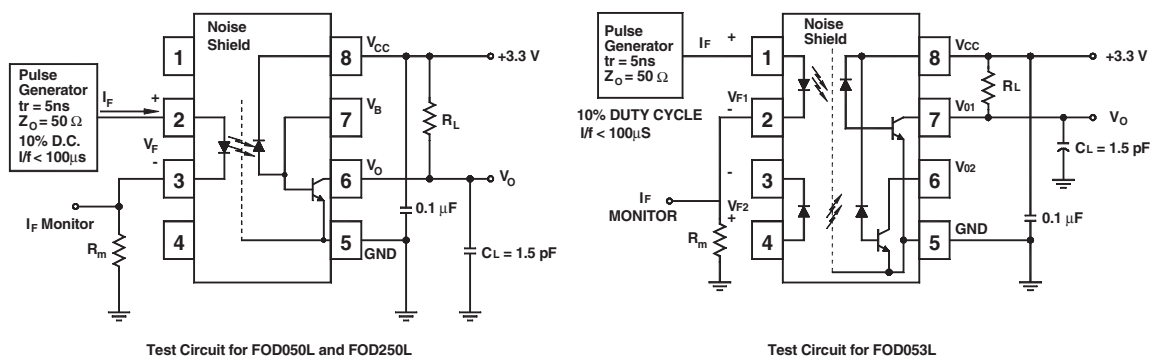
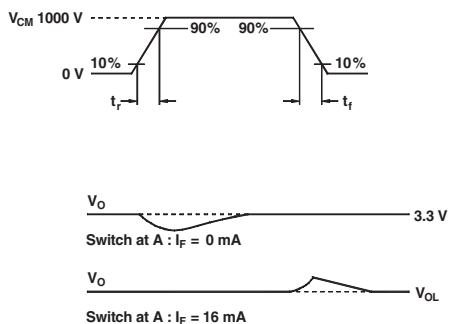
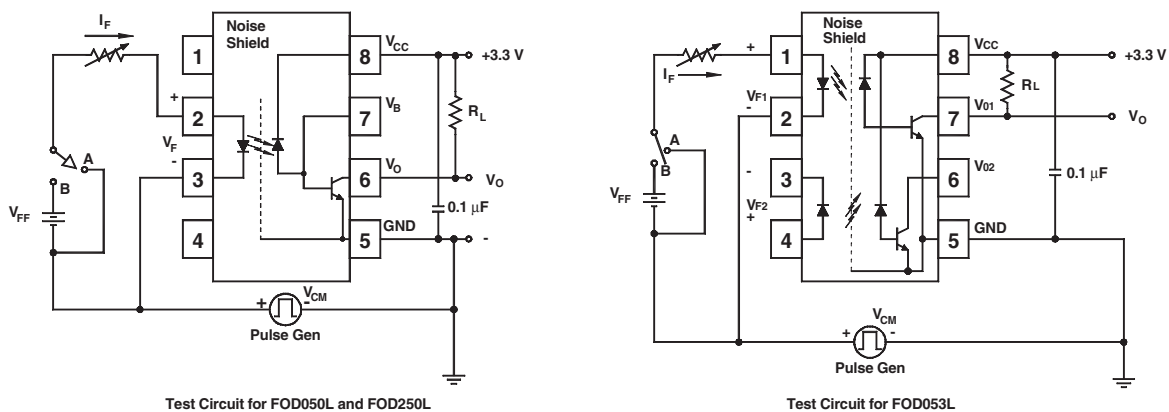


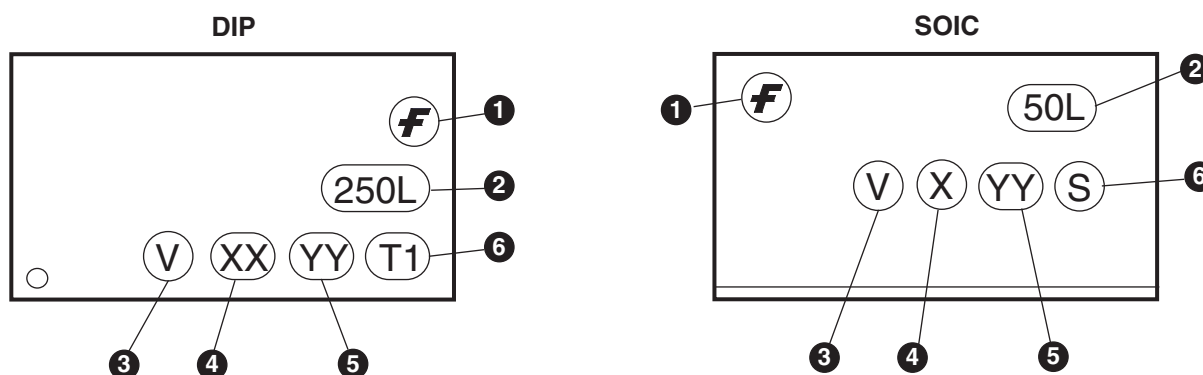
Fig. 11 Common Mode Immunity Test Circuit



## 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

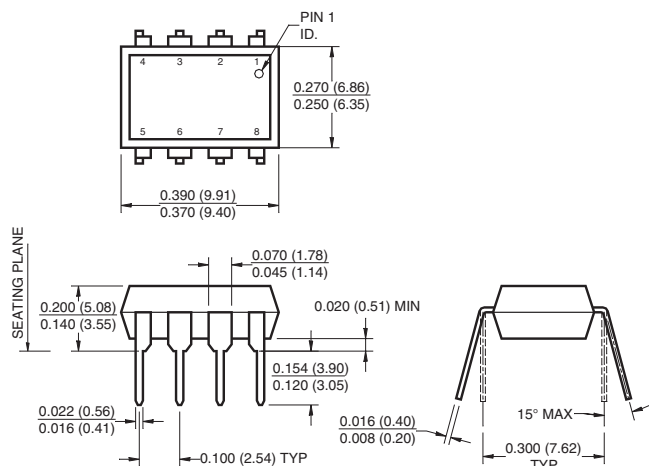


### Definitions

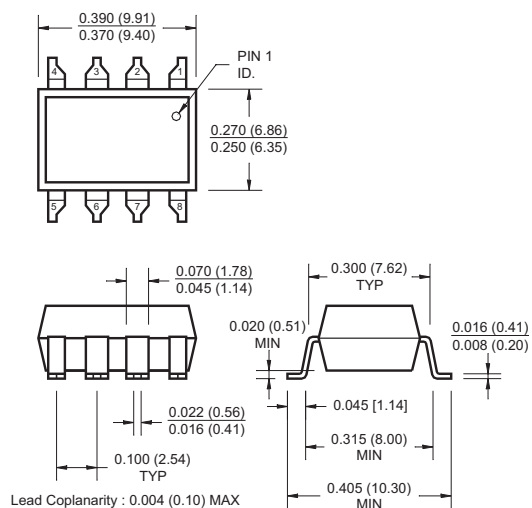
|          |                                                                                        |
|----------|----------------------------------------------------------------------------------------|
| 1        | Fairchild logo                                                                         |
| 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                                                                  |

## Package Dimensions (8-Pin DIP)

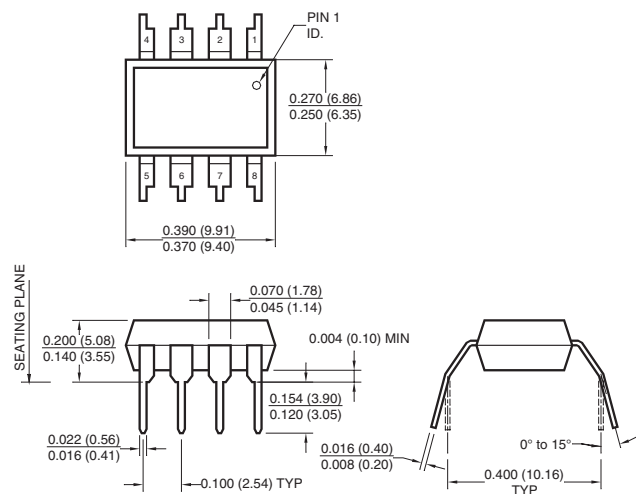
### Through Hole



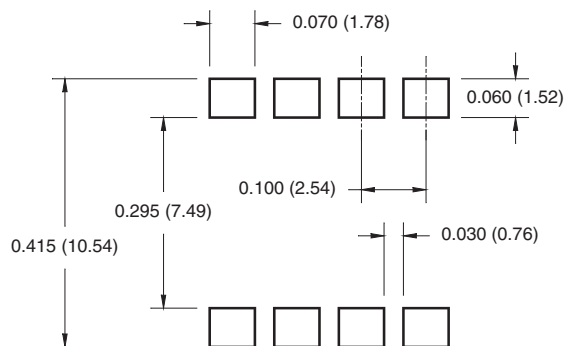
### Surface Mount



### 0.4" Lead Spacing



### 8-Pin DIP

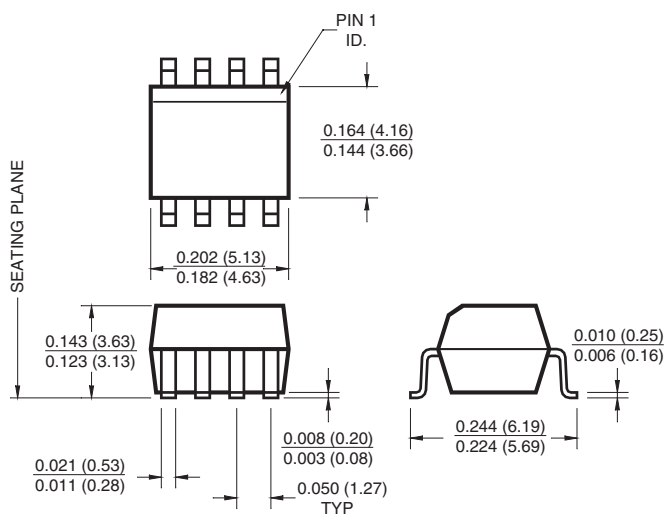


### Note:

All dimensions are in inches (millimeters)

## Package Dimensions (8-Pin SOIC)

### Surface Mount

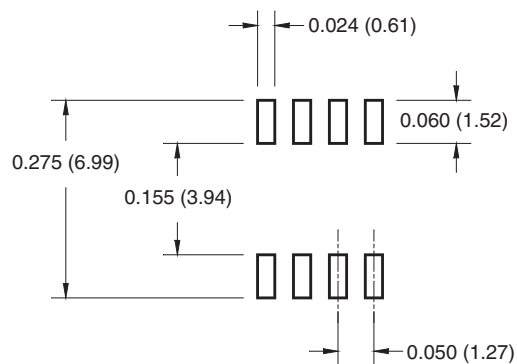


Lead Coplanarity : 0.004 (0.10) MAX

### Note:

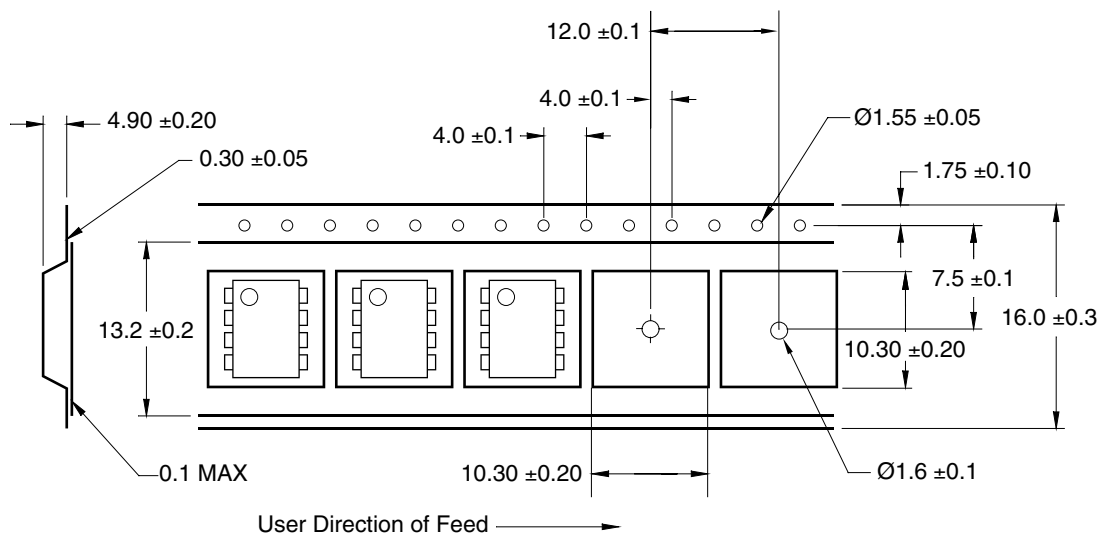
All dimensions are in inches (millimeters)

### 8-Pin Small Outline



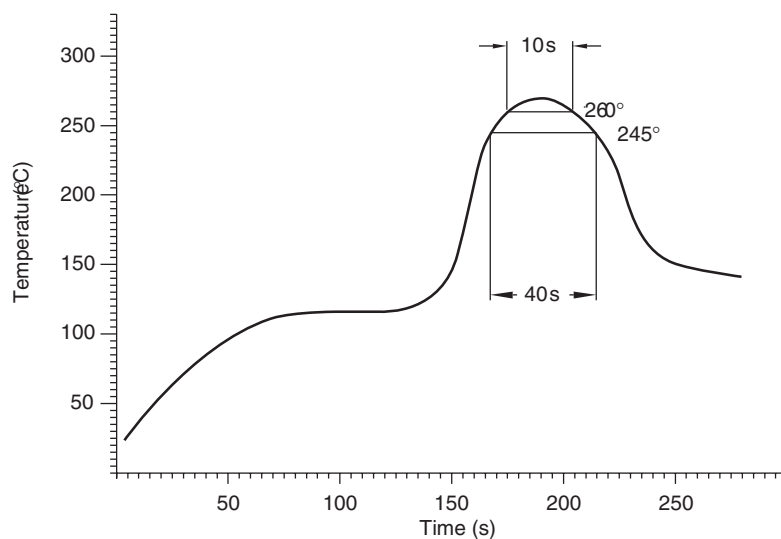
## 8-Pin DIP (FOD250L)

### Carrier Tape Specification



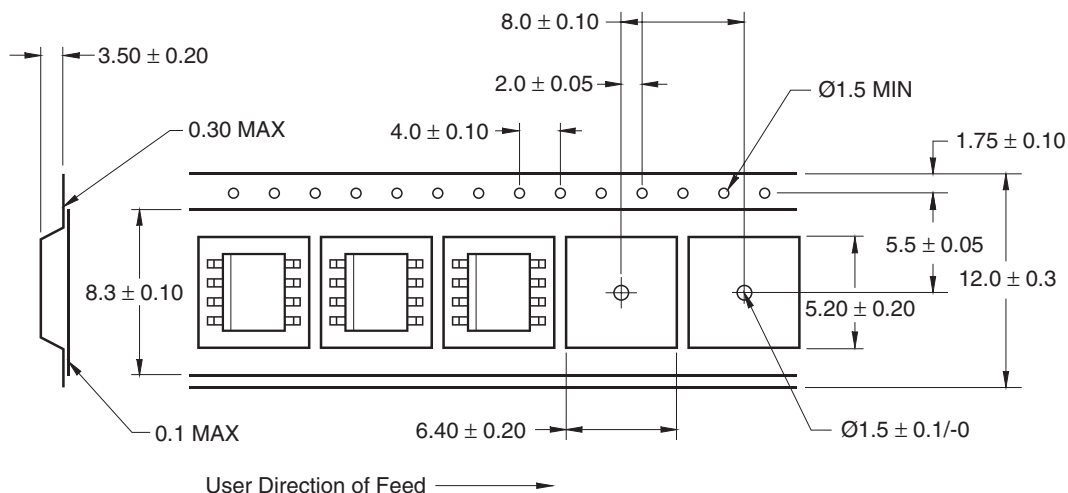
### Reflow Profile

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

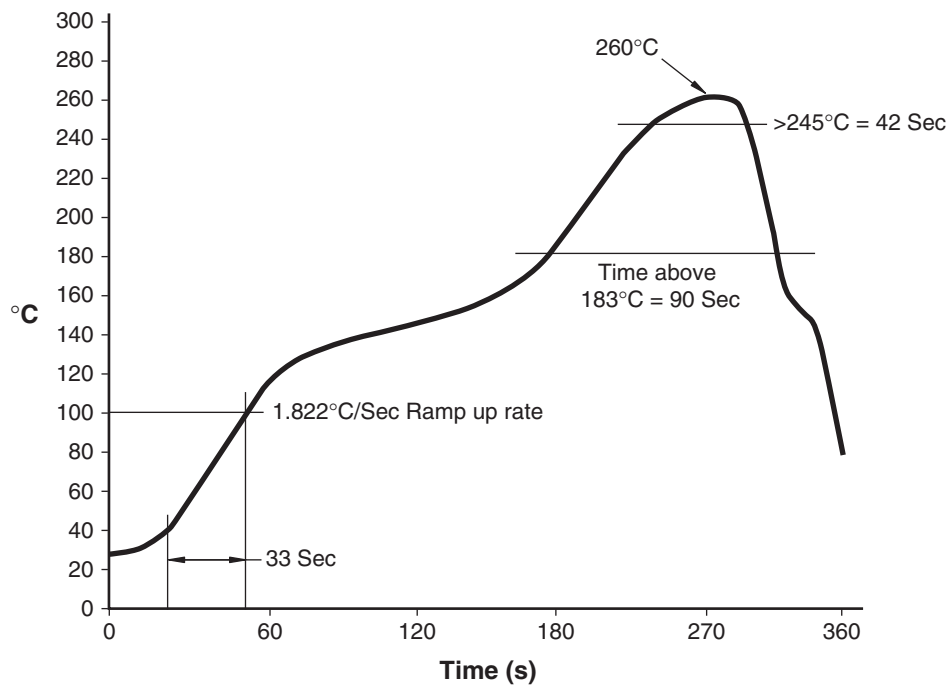


## 8-Pin SOIC (FOD050L, FOD053L)

### Carrier Tape Specification



### Reflow Profile



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| ActiveArray <sup>™</sup>                         | GlobalOptoisolator <sup>™</sup> | OCXPro <sup>™</sup>             | SMART START <sup>™</sup>     | UltraFET <sup>®</sup> |
| Bottomless <sup>™</sup>                          | GTO <sup>™</sup>                | OPTOLOGIC <sup>®</sup>          | SPM <sup>™</sup>             | VCX <sup>™</sup>      |
| Build it Now <sup>™</sup>                        | HiSeC <sup>™</sup>              | OPTOPLANAR <sup>™</sup>         | Stealth <sup>™</sup>         | Wire <sup>™</sup>     |
| CoolFET <sup>™</sup>                             | I <sup>2</sup> C <sup>™</sup>   | PACMAN <sup>™</sup>             | SuperFET <sup>™</sup>        |                       |
| CROSSVOLT <sup>™</sup>                           | i-Lo <sup>™</sup>               | POP <sup>™</sup>                | SuperSOT <sup>™</sup> -3     |                       |
| DO <sup>™</sup>                                  | ImpliedDisconnect <sup>™</sup>  | Power247 <sup>™</sup>           | SuperSOT <sup>™</sup> -6     |                       |
| EcoSPARK <sup>™</sup>                            | IntelliMAX <sup>™</sup>         | PowerEdge <sup>™</sup>          | SuperSOT <sup>™</sup> -8     |                       |
| E <sup>2</sup> CMOS <sup>™</sup>                 | ISOPLANAR <sup>™</sup>          | PowerSaver <sup>™</sup>         | SyncFET <sup>™</sup>         |                       |
| EnSigna <sup>™</sup>                             | LittleFET <sup>™</sup>          | PowerTrench <sup>®</sup>        | TCM <sup>™</sup>             |                       |
| FACT <sup>™</sup>                                | MICROCOUPLER <sup>™</sup>       | QFET <sup>®</sup>               | TinyBoost <sup>™</sup>       |                       |
| FAST <sup>®</sup>                                | MicroFET <sup>™</sup>           | QS <sup>™</sup>                 | TinyBuck <sup>™</sup>        |                       |
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| FPS <sup>™</sup>                                 | MICROWIRE <sup>™</sup>          | Quiet Series <sup>™</sup>       | TinyPower <sup>™</sup>       |                       |
| FRFET <sup>™</sup>                               | MSX <sup>™</sup>                | RapidConfigure <sup>™</sup>     | TinyLogic <sup>®</sup>       |                       |
|                                                  | MSXPro <sup>™</sup>             | RapidConnect <sup>™</sup>       | TINYOPTO <sup>™</sup>        |                       |
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| The Power Franchise <sup>®</sup>                 |                                 | ScalarPump <sup>™</sup>         | UHC <sup>™</sup>             |                       |
| Programmable Active Droop <sup>™</sup>           |                                 |                                 |                              |                       |

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1. 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.
2. 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. |
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Rev. I20