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April 2015



# FOD050L, FOD053L LVTTTL/LVCMOS 3.3 V High Speed Transistor Optocouplers

## 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

## Description

The FOD050L and FOD053L optocouplers consist of an AlGaAs LED optically coupled to a high speed photodiode transistor. These devices are specified for operation at a 3.3 V 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  $CM_H = 50\text{ kV}/\mu\text{s}$  (typical) and  $CM_L = 35\text{ kV}/\mu\text{s}$  (typical).

## Schematics

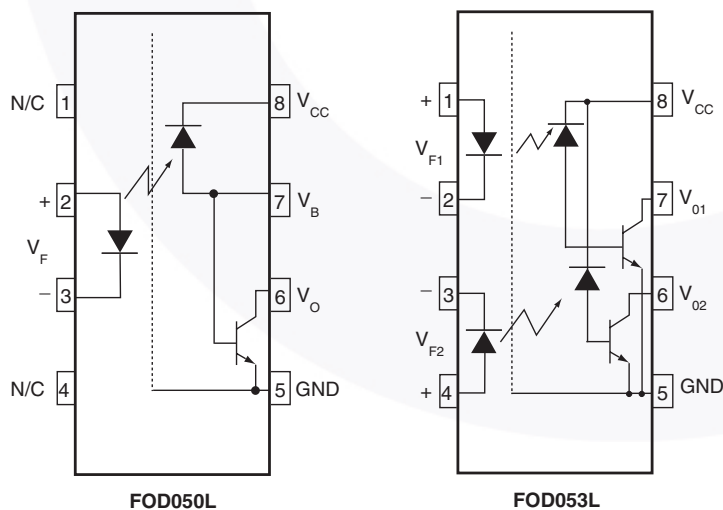


Figure 1. Schematics

## Package Outline

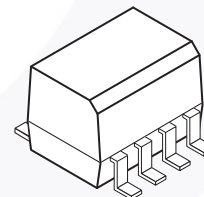


Figure 2. Package Outline

## Truth Table

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

## 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 Classifications 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 <sup>(1)</sup>	150	°C
I <sub>S,INPUT</sub>	Input Current <sup>(1)</sup>	200	mA
P <sub>S,OUTPUT</sub>	Output Power <sup>(1)</sup>	300	mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V <sup>(1)</sup>	> 10 <sup>9</sup>	Ω

**Note:**

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

## 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	Unit
$T_{STG}$	Storage Temperature		-40 to +125	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature		-40 to +85	$^\circ\text{C}$
$T_J$	Junction Temperature		-40 to +125	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature		260 for 10 seconds	$^\circ\text{C}$
<b>EMITTER</b>				
$I_F$ (avg)	DC/Average Forward Input Current	Each Channel	25	mA
$I_F$ (pk)	Peak Forward Input Current (50% duty cycle, 1 ms P.W.)	Each Channel	50	mA
$I_F$ (trans)	Peak Transient Input Current ( $\leq 1 \mu\text{s}$ P.W., 300 pps)	Each Channel	1.0	A
$V_R$	Reverse Input Voltage	Each Channel	5	V
$P_D$	Input Power Dissipation (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 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 only	5	mA
$P_D$	Output Power Dissipation (No derating required up to $85^\circ\text{C}$ )	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			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			0.3	$\mu\text{A}$
		$I_F = 0\text{ mA}, V_O = \text{Open}, V_{CC} = 3.3\text{ V}$	FOD053L			10	

### Transfer Characteristics

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
<b>COUPLED</b>							
CTR	Current Transfer Ratio <sup>(2)</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

**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%.

**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	Min.	Typ.	Max.	Unit
$T_{PHL}$	Propagation Delay Time to Logic LOW	$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}^{(3)}$ (Figure 11)	$25^\circ\text{C}$		1.0	$\mu\text{s}$
					2.0	
$T_{PLH}$	Propagation Delay Time to Logic HIGH	$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}^{(3)}$ (Figure 11)	$25^\circ\text{C}$		1.0	$\mu\text{s}$
					2.0	
$ICM_{HI}$	Common Mode Transient Immunity at Logic HIGH	$I_F = 0\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}^{(4)(5)}$ (Figure 12)	5,000	50,000		$\text{V}/\mu\text{s}$
$ICM_{LI}$	Common Mode Transient Immunity at Logic LOW	$I_F = 16\text{ mA}$ , $V_{CM} = 1,000\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}^{(4)(5)}$ (Figure 12)	5,000	35,000		$\text{V}/\mu\text{s}$

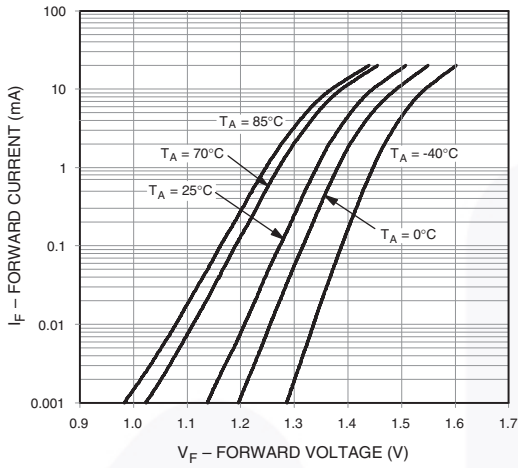
**Isolation Characteristics**

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

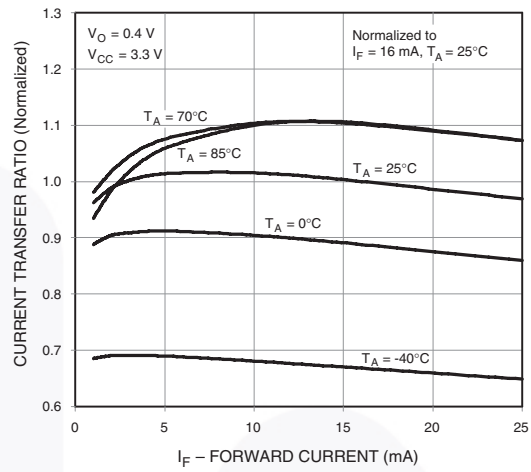
**Notes:**

- 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.

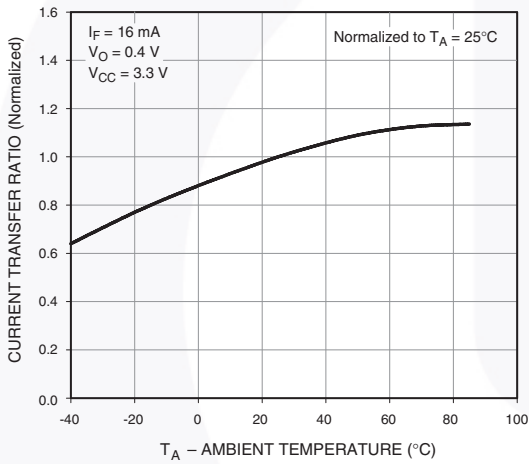
## Typical Performance Curves



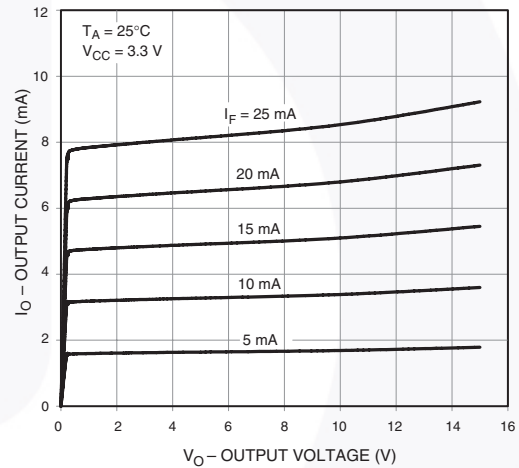
**Figure 3. LED Forward Current vs. Forward Voltage**



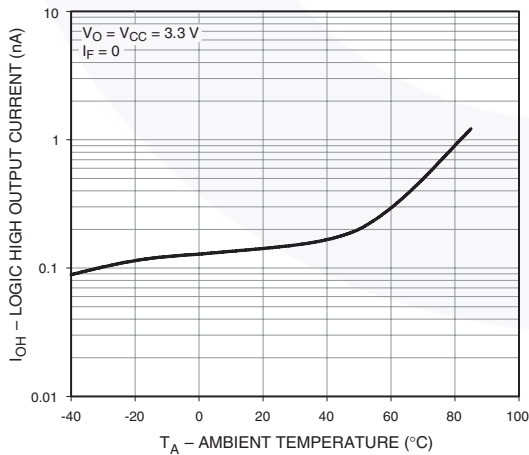
**Figure 4. Current Transfer Ratio vs. Forward Current**



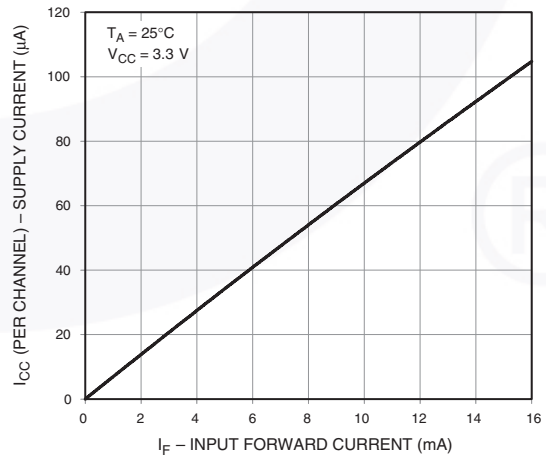
**Figure 5. Current Transfer Ratio vs. Ambient Temperature**



**Figure 6. Output Current vs. Output Voltage**

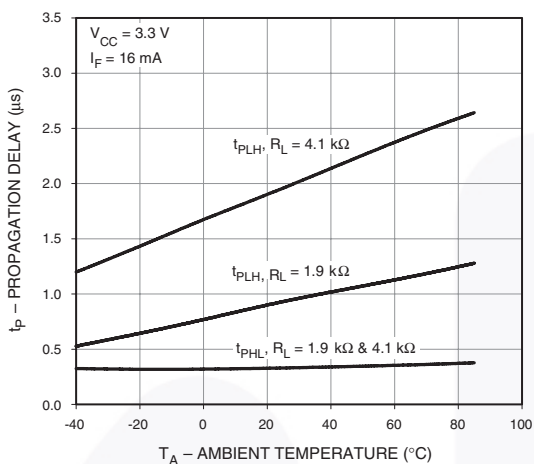


**Figure 7. Logic High Output Current vs. Ambient Temperature**

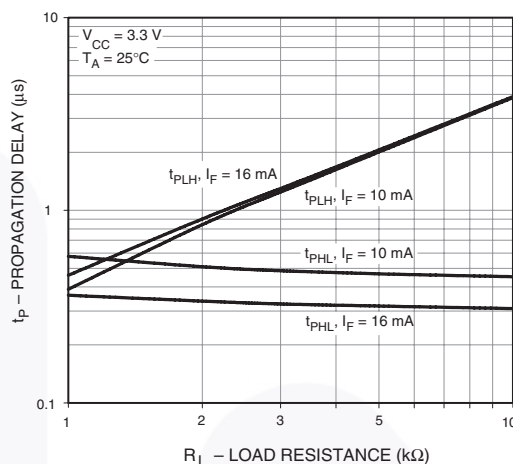


**Figure 8. Supply Current vs. Input Forward Current**

**Typical Performance Curves (Continued)**



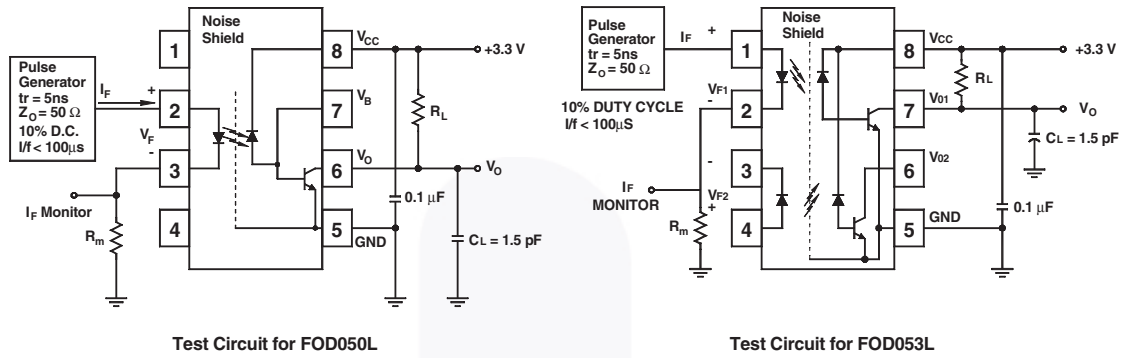
**Figure 9. Propagation Delay vs. Ambient Temperature**



**Figure 10. Propagation Delay vs. Load Resistance**



### Test Circuits



Test Circuit for FOD050L

Test Circuit for FOD053L

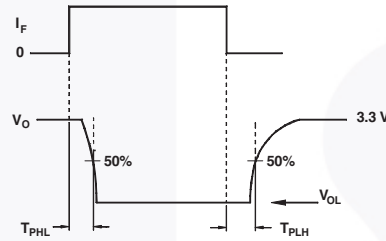
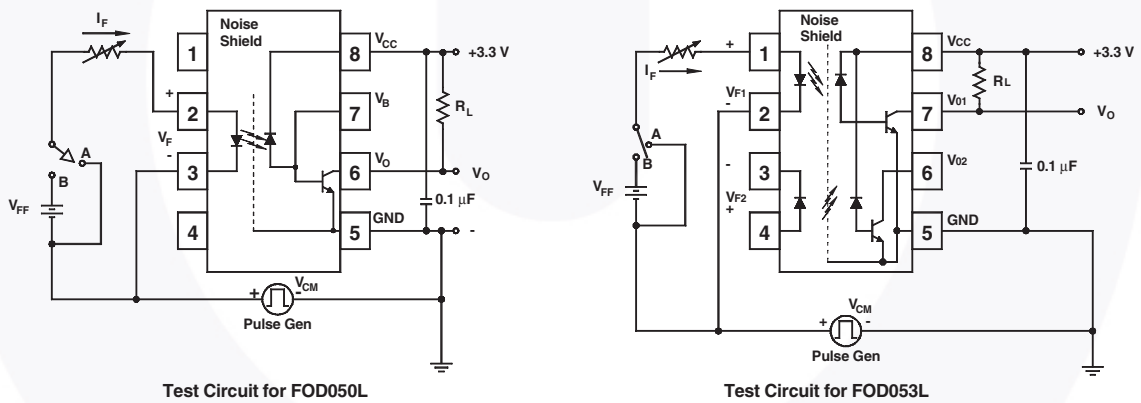


Figure 11. Switching Time Test Circuit



Test Circuit for FOD050L

Test Circuit for FOD053L

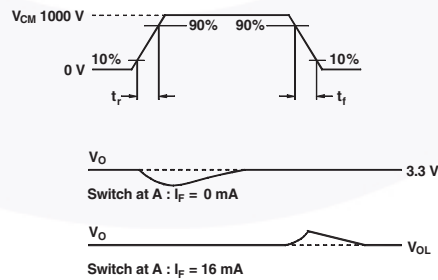


Figure 12. Common Mode Immunity Test Circuit

## Reflow Profile

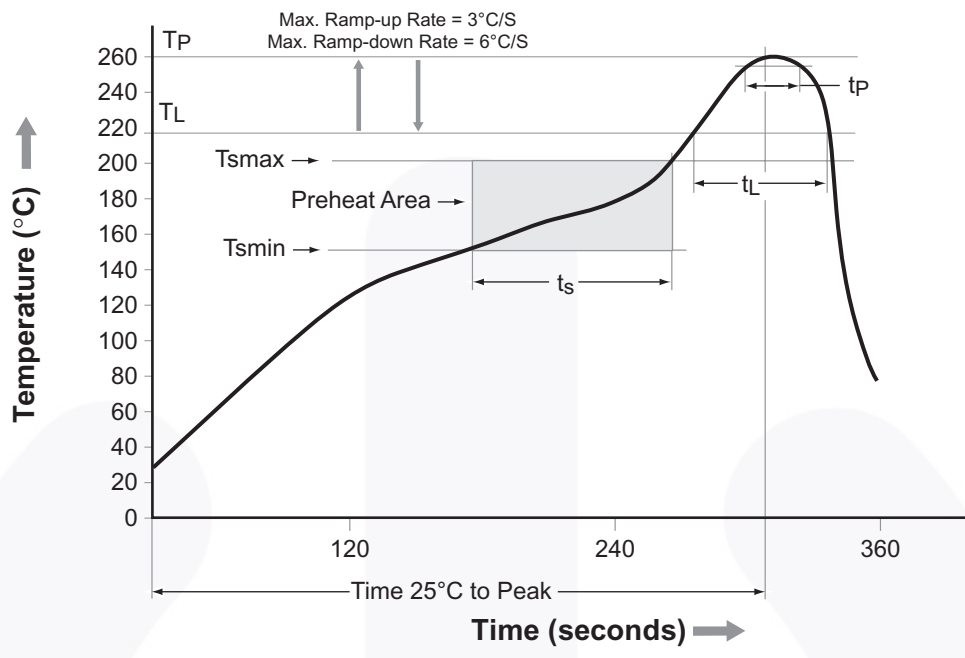


Figure 13. Reflow Profile

Profile Feature	Pb-Free Assembly Profile
Temperature Minimum (T <sub>min</sub> )	150°C
Temperature Maximum (T <sub>max</sub> )	200°C
Time (t <sub>s</sub> ) from (T <sub>min</sub> to T <sub>max</sub> )	60–120 seconds
Ramp-up Rate (t <sub>L</sub> to t <sub>p</sub> )	3°C/second maximum
Liquidous Temperature (T <sub>L</sub> )	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	60–150 seconds
Peak Body Package Temperature	260°C +0°C / -5°C
Time (t <sub>p</sub> ) within 5°C of 260°C	30 seconds
Ramp-down Rate (T <sub>p</sub> to T <sub>L</sub> )	6°C/second maximum
Time 25°C to Peak Temperature	8 minutes maximum

## Ordering Information

Part Number	Package	Packing Method
FOD050L	Small Outline 8-Pin	Tube (100 Units)
FOD050LR2	Small Outline 8-Pin	Tape and Reel (1000 Units)
FOD050LV	Small Outline 8-Pin, DIN EN/IEC60747-5-5 Option	Tube (100 Units)
FOD050LR2V	Small Outline 8-Pin, DIN EN/IEC60747-5-5 Option	Tape and Reel (1000 Units)

**Note:**

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

## Marking Information

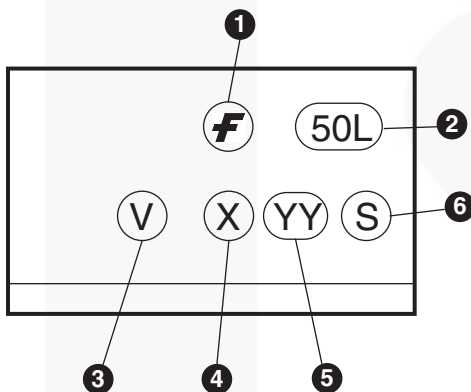


Figure 14. Top Mark

Table 1. Top Mark Definitions

1	Fairchild Logo
2	Device Number
3	DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	One-Digit Year Code, e.g., "5"
5	Digit Work Week, Ranging from "01" to "53"
6	Assembly Package Code



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.
- E) DRAWING FILENAME: MKT-M08Erev5



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