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July 2014

FOD8160
High Noise Immunity, 3.3 V / 5 V, 10 Mbit/sec, Logic Gate Optocoupler in Wide-Body SOP 5-Pin

Features

- Optoplanar® Packaging Technology Allows More Than 10 mm Creepage and Clearance Distance, and 0.5 mm Insulation Distance to Achieve Reliable and High Voltage Insulation
- High Noise Immunity Characterized by Common Mode Transient Immunity (CMTI)
  - 20 kV/μs Minimum CMTI
- Specifications Guaranteed Over 3 V to 5.5 V Supply Voltage and -40°C to 100°C Extended Industrial Temperature Range
- High-Speed, 10 Mbit/s Data Rate (NRZ)
- Safety and Regulatory Approvals
  - UL1577, 5,000 VAC_{RMS} for 1 Minute
  - DIN-EN/IEC60747-5-5, 1,414 V Peak Working Insulation Voltage

Applications

- Isolating Intelligent Power Module
- Isolating Industrial Communication Interface

Related Resources

- www.fairchildsemi.com/products/opto/
- www.fairchildsemi.com/pf/FO/FODM8061.html
- www.fairchildsemi.com/pf/FO/FODM611.html

Description

The FOD8160 is a 3.3 V / 5 V high-speed logic gate optocoupler with open-collector output, which supports isolated communications to allow digital signals to communicate between systems without conducting ground loops or hazardous voltages. The device utilizes Fairchild's prioprietary Optoplanar® coplanar packaging technology and optimized IC design to achieve high-noise immunity, characterized by high common-mode rejection specifications.

The FOD8160, packaged in a wide-body SOP 5-Pin package, consists of an aluminium gallium arsenide (AlGaAs) LED and an integrated high-speed photodetector. The output of the detector IC is an open collector Schottky-clamped transistor. The electrical and switching characteristics are guaranteed over the extended industrial temperature range of -40°C to 100°C and a V_{CC} range of 3 V to 5.5 V.

Functional Schematic

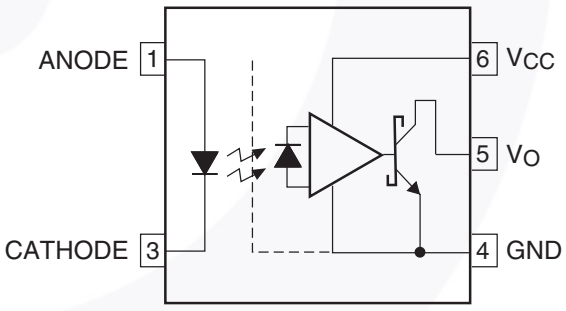

Figure 1. Functional Schematic

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Truth Table

LED	Output
Off	HIGH
On	LOW

Pin Configuration

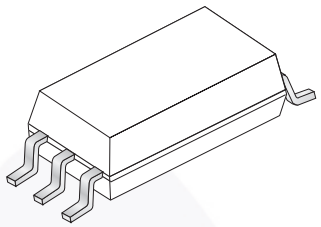

Figure 2. Pin Configuration

Pin Definitions

Pin #	Name	Description
1	Anode	Anode
3	Cathode	Cathode
4	GND	Output Ground
5	V_O	Output Voltage
6	V_{CC}	Output 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 below. 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_{RMS}		I–IV		
	For Rated Mains Voltage < 300 V_{RMS}		I–IV		
	For Rated Mains Voltage < 450 V_{RMS}		I–IV		
	For Rated Mains Voltage < 600 V_{RMS}		I–IV		
	Climatic Classification		40/100/21		
	Pollution Degree (DIN VDE 0110/1.89)		2		
CTI	Comparative Tracking Index	175			
V_{PR}	Input to Output Test Voltage, Method b, V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 s, Partial Discharge < 5 pC	2651			V_{peak}
	Input to Output Test Voltage, Method a, V_{IORM} x 1.6 = V_{PR}, Type and Sample Test with t_m = 10 s, Partial Discharge < 5 pC	2262			V_{peak}
V_{IORM}	Maximum Working Insulation Voltage	1414			V_{peak}
V_{IOTM}	Highest Allowable Over Voltage	8000			V_{peak}
	External Creepage	10.0			mm
	External Clearance	10.0			mm
	Insulation Thickness	0.5			mm
	Safety Limit Values – Maximum Values Allowed in the Event of a Failure				
T_S	Case Temperature	150			°C
$I_{S,INPUT}$	Input Current	200			mA
$P_{S,OUTPUT}$	Output Power	600			mW
R_{IO}	Insulation Resistance at T_S, V_{IO} = 500 V	10^9			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°C unless otherwise specified.

Symbol	Parameter	Value	Units
T_{STG}	Storage Temperature	-40 to +125	°C
T_{OPR}	Operating Temperature	-40 to +100	°C
T_J	Junction Temperature	-40 to +125	°C
T_{SOL}	Lead Solder Temperature *(Refer to Reflow Temperature Profile on page 12)*	260 for 10 seconds	°C
Input Characteristics			
I_F	Average Forward Input Current	25	mA
V_R	Reverse Input Voltage	5.0	V
PD_I	Input Power Dissipation(1)	45	mW
Output Characteristics			
V_{CC}	Supply Voltage	0 to 7.0	V
V_O	Output Voltage	-0.5 to V_{CC} + 0.5	V
I_O	Average Output Current	50	mA
PD_O	Output Power Dissipation(1)	85	mW

Note:

1. No derating required up to 100°C.

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_A	Ambient Operating Temperature	-40	+100	ºC
V_{CC}	Supply Voltages(2)	3.0	5.5	V
V_{FL}	Logic Low Input Voltage	0	0.8	V
I_{FL}	Logic Low Input Current		250	µA
I_{FH}	Logic High Input Current	6.0	15	mA
N	Fan Out (at R_L = 1 kΩ)		5	TTL loads
R_L	Output Pull-up Resistor	330	4000	Ω

Note:

2. 0.1 µF bypass capacitor must be connected between pins 4 and 6.

Isolation Characteristics

Apply over all recommended conditions, typical value is measured at T_A = 25°C.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{ISO}	Input-Output Isolation Voltage	T_A = 25°C, R.H. < 50%, t = 1.0 min, $I_{I-O} \le$ 20 μA[3][4]	5,000			VAC_{RMS}
R_{ISO}	Isolation Resistance	V_{I-O} = 500 V[3]		10^{11}		Ω
C_{ISO}	Isolation Capacitance	V_{I-O} = 0 V, frequency = 1.0 MHz[3]		1.0		pF

Notes:

3. Device is considered a two-terminal device: pins 1 and 3 are shorted together and pins 4, 5, and 6 are shorted together.
4. 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; T_A = -40°C to +100°C, 3.0 V ≤ V_{CC} ≤ 5.5 V; unless otherwise specified. Typical value is measured at T_A = 25°C and V_{CC} = 3.3 V or V_{CC} = 5 V.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
Input Characteristics							
V_F	Forward Voltage	I_F = 10 mA	1.05	1.45	1.80	V	3
$\Delta(V_F / T_A)$	Temperature Coefficient of Forward Voltage			-1.8		mV/°C	
BV_R	Input Reverse Breakdown Voltage	I_R = 10 μA	5.0			V	
I_{FHL}	Threshold Input Current	V_O = 0.6 V, I_{OL}(sink) = 13 mA		2.5	6.0	mA	4
Output Characteristics							
V_{OL}	Logic Low Output Voltage	I_F = rated I_{FHL}, I_{OL}(sink) = 13 mA		0.4	0.6	V	5
I_{OH}	Logic High Output Current	I_F = 250 μA, V_O = 3.3 V		8.0	50.0	μA	6
		I_F = 250 μA, V_O = 5.0 V		3.0	40.0	μA	6
I_{CCL}	Logic Low Output Supply Current	I_F = 10 mA, V_{CC} = 3.3 V		5.3	8.5	mA	7, 9
		I_F = 10 mA, V_{CC} = 5.0 V		7.1	10.0	mA	7, 9
I_{CCH}	Logic High Output Supply Current	I_F = 0 mA, V_{CC} = 3.3 V		3.5	7.0	mA	8, 9
		I_F = 0 mA, V_{CC} = 5.0 V		5.3	9.0	mA	8, 9

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Switching Characteristics

Apply over all recommended conditions; T_A = -40°C to +100°C, V_{CC} = 3.3 V, I_F = 6.0 mA; unless otherwise specified. Typical value is measured at T_A = 25°C and V_{CC} = 3.3 V.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
Data Rate		R_L = 350 Ω			10	Mbit/sec	
t_{PHL}	Propagation Delay to Logic Low Output	R_L = 350 Ω, C_L = 15 pF		40	80	ns	10, 11, 15
t_{PLH}	Propagation Delay to Logic High Output	R_L = 350 Ω, C_L = 15 pF		50	90	ns	10, 11, 15
PWD	Pulse Width Distortion, $\lvert t_{PHL} - t_{PLH} \rvert$	R_L = 350 Ω, C_L = 15 pF		10	35	ns	12, 13, 15
t_{PSK}	Propagation Delay Skew	R_L = 350 Ω, C_L = 15 pF (5)			40	ns	
t_R	Output Rise Time (10% to 90%)	R_L = 350 Ω, C_L = 15 pF		20		ns	14, 15
t_F	Output Fall Time (90% to 10%)	R_L = 350 Ω, C_L = 15 pF		10		ns	14, 15
$\lvert CM_H \rvert$	Common-Mode Transient Immunity at Output High	I_F = 0 mA, V_O > 2 V, V_{CM} = 1,000 V (6)	20	40		kV/µs	16
$\lvert CM_L \rvert$	Common-Mode Transient Immunity at Output Low	I_F = 6.0 mA, V_O < 0.8 V, V_{CM} = 1,000 V (6)	20	40		kV/µs	16

Apply over all recommended conditions; T_A = -40°C to +100°C, V_{CC} = 5 V, I_F = 6.0 mA; unless otherwise specified. Typical value is measured at T_A = 25°C and V_{CC} = 5 V.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
Data Rate		R_L = 350 Ω			10	Mbit/sec	
t_{PHL}	Propagation Delay to Logic Low Output	R_L = 350 Ω, C_L = 15 pF		37	80	ns	10, 11, 15
t_{PLH}	Propagation Delay to Logic High Output	R_L = 350 Ω, C_L = 15 pF		41	90	ns	10, 11, 15
PWD	Pulse Width Distortion, $\lvert t_{PHL} - t_{PLH} \rvert$	R_L = 350 Ω, C_L = 15 pF		4	25	ns	12, 13, 15
t_{PSK}	Propagation Delay Skew	R_L = 350 Ω, C_L = 15 pF (5)			40	ns	
t_R	Output Rise Time (10% to 90%)	R_L = 350 Ω, C_L = 15 pF		22		ns	14, 15
t_F	Output Fall Time (90% to 10%)	R_L = 350 Ω, C_L = 15 pF		9		ns	14, 15
$\lvert CM_H \rvert$	Common-Mode Transient Immunity at Output High	I_F = 0 mA, V_O > 2 V, V_{CM} = 1,000 V (6)	20	40		kV/µs	16
$\lvert CM_L \rvert$	Common-Mode Transient Immunity at Output Low	I_F = 6.0 mA, V_O < 0.8 V, V_{CM} = 1,000 V (6)	20	40		kV/µs	16

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Notes:

5. t_{PSK} is equal to the magnitude of the worst-case difference in t_{PHL} and/or t_{PLH} between any two units from the same manufacturing date code that are operated at same case temperature (±5°C), at same operating conditions, with equal loads (R_L = 350 Ω, C_L = 15 pF), and with an input rise time less than 5 ns.
6. Common-mode transient immunity at output HIGH is the maximum tolerable positive dVcm/dt on the leading edge of the common-mode impulse signal, V_{CM}, to assure that the output remains HIGH. Common-mode transient immunity at output LOW is the maximum tolerable negative dVcm/dt on the trailing edge of the common pulse signal, V_{CM}, to assure that the output remains LOW.

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Typical Performance Characteristics

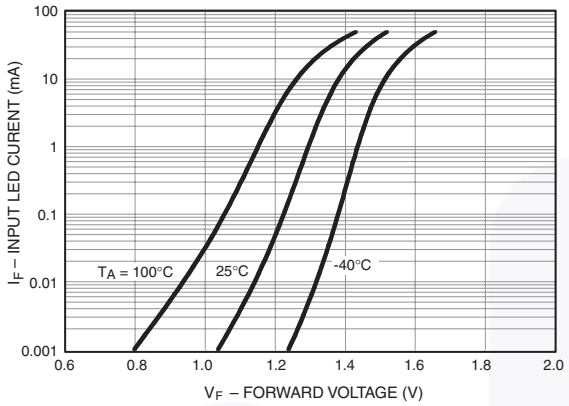

Figure 3. Input LED Current (I_F) vs. Forward Voltage (V_F)

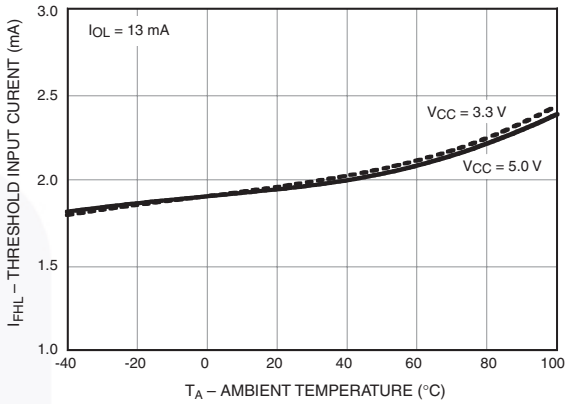

Figure 4. Threshold Input Current (I_{FHL}) vs. Ambient Temperature

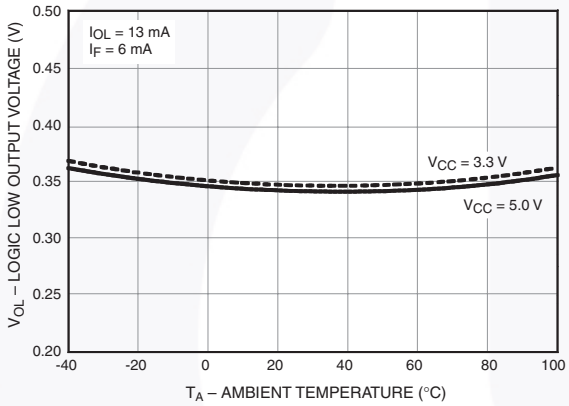

Figure 5. Logic Low Output Voltage (V_{OL}) vs. Ambient Temperature

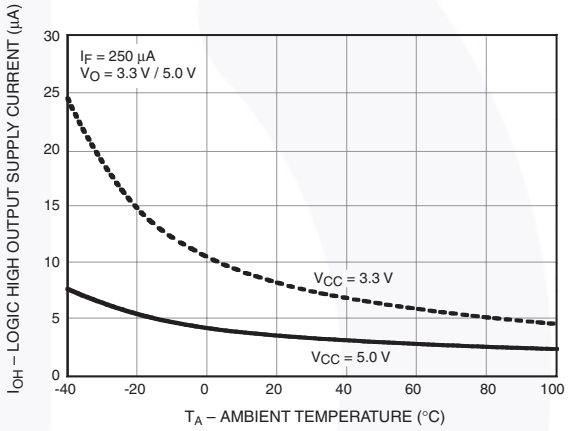

Figure 6. Logic High Output Current (I_{OH}) vs. Ambient Temperature

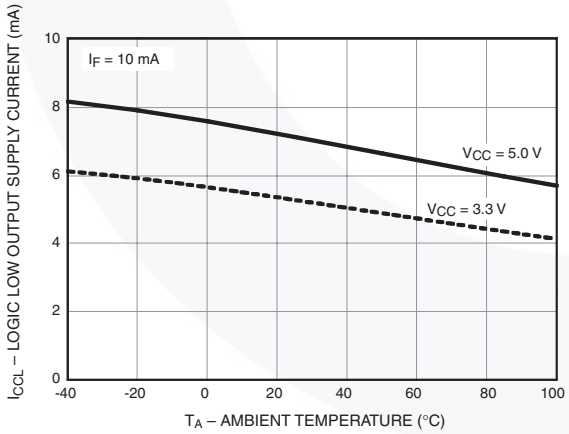

Figure 7. Logic Low Output Supply Current (I_{CCL}) vs. Ambient Temperature

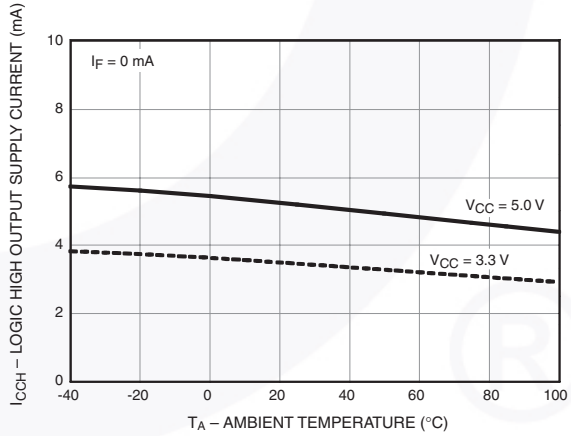

Figure 8. Logic High Output Supply Current (I_{CCH}) vs. Ambient Temperature

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Typical Performance Characteristics (Continued)

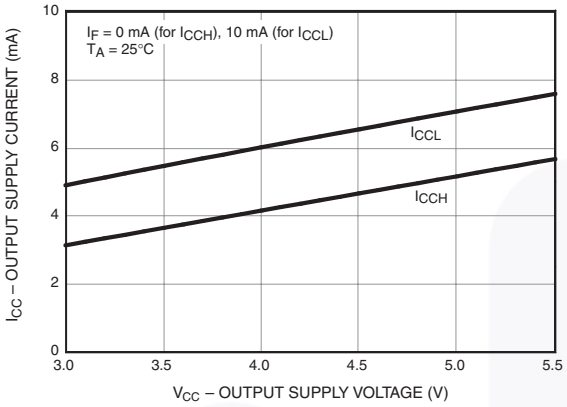


Figure 9. Output Supply Current (I_{CC}) vs. Output Supply Voltage (V_{CC})

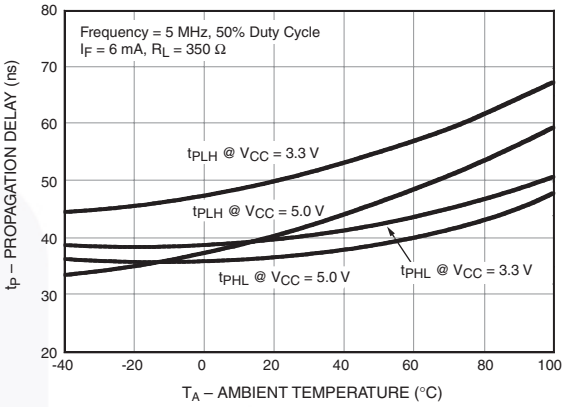


Figure 10. Propagation Delay vs. Ambient Temperature

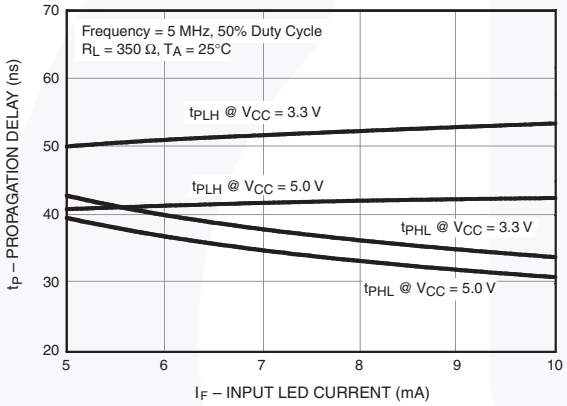


Figure 11. Propagation Delay vs. Input LED Current (I_F)

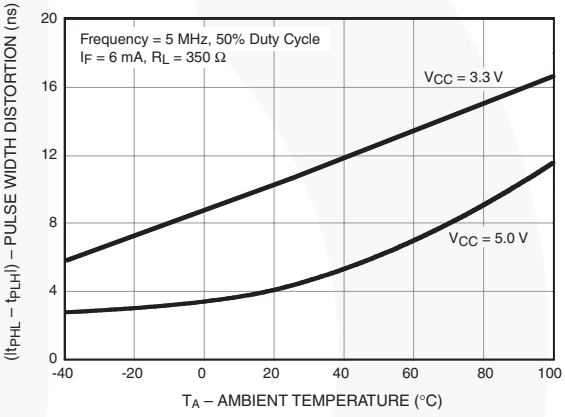


Figure 12. Pulse Width Distortion vs. Ambient Temperature

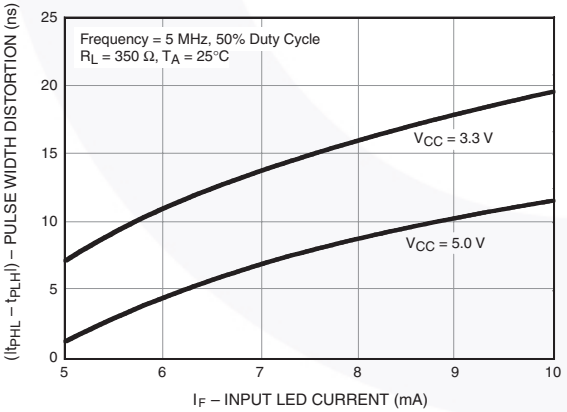


Figure 13. Pulse Width Distortion vs. Input LED Current (I_F)

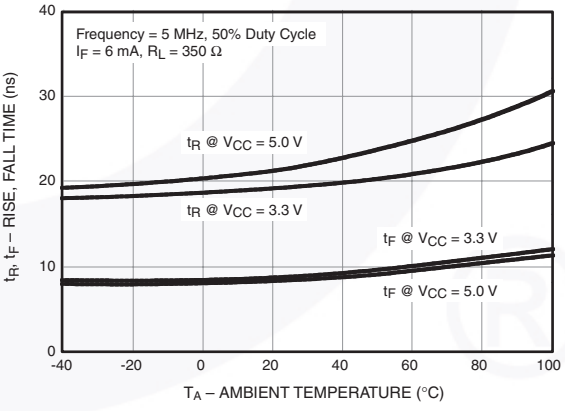


Figure 14. Rise Time (t_R) and Fall Time (t_F) vs. Ambient Temperature

Test Circuit

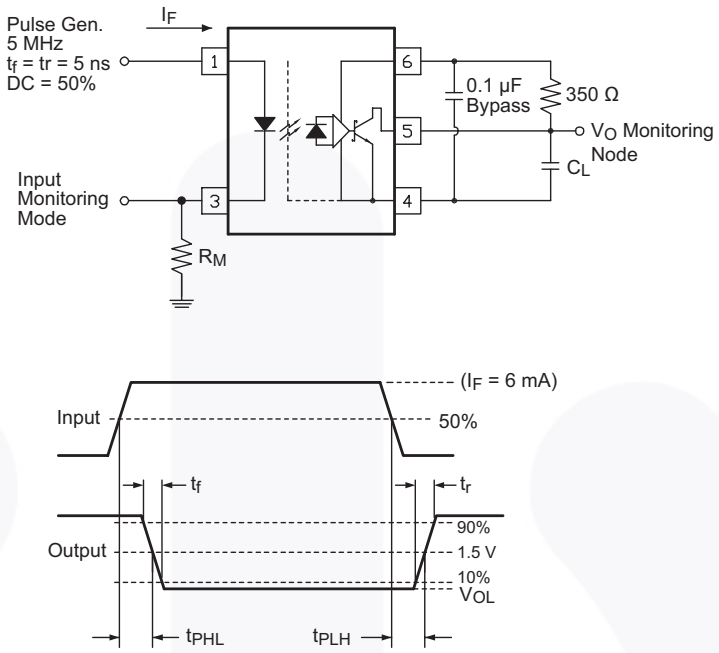


Figure 15. Test Circuit for Propagation Delay, Rise Time, and Fall Time

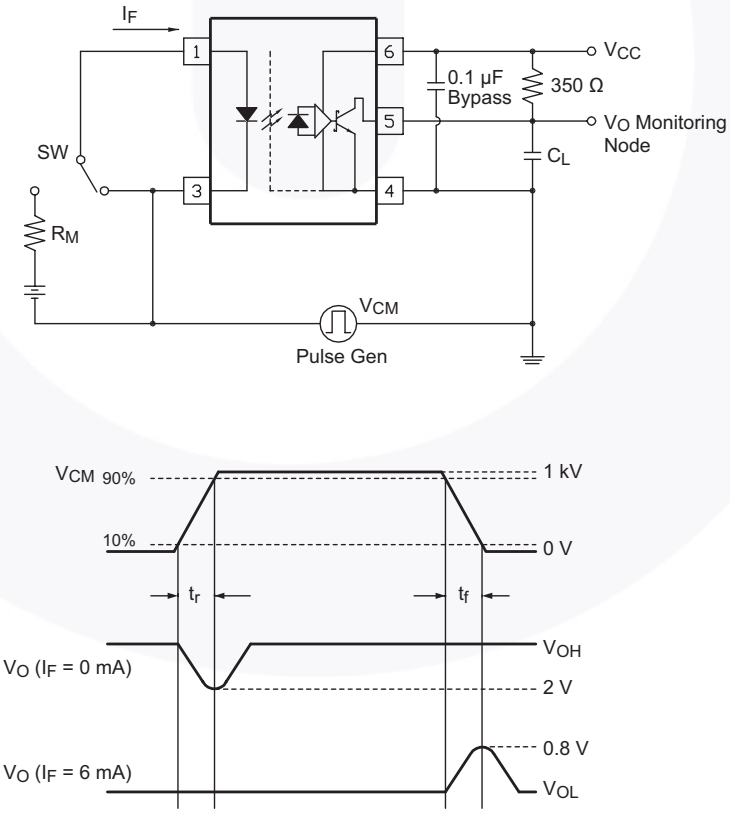


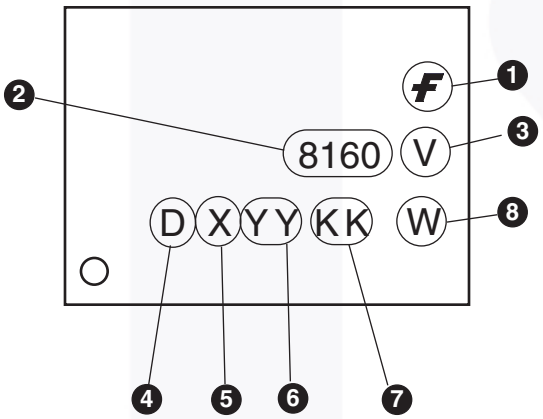
Figure 16. Test Circuit for Instantaneous Common-Mode Rejection Voltage

Ordering Information

Part Number	Package	Packing Method
FOD8160	Wide Body SOP 5-Pin	Tube (100 units per tube)
FOD8160R2	Wide Body SOP 5-Pin	Tape and Reel (1,000 units per reel)
FOD8160V	Wide Body SOP 5-Pin, DIN EN/IEC60747-5-5 Option	Tube (100 units per tube)
FOD8160R2V	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., ‘8160’ for FOD8160
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., ‘E’ for 2014
6	Two-digit work week ranging from ‘01’ to ‘53’
7	Lot-traceability code
8	Package assembly code, W

Reflow Profile

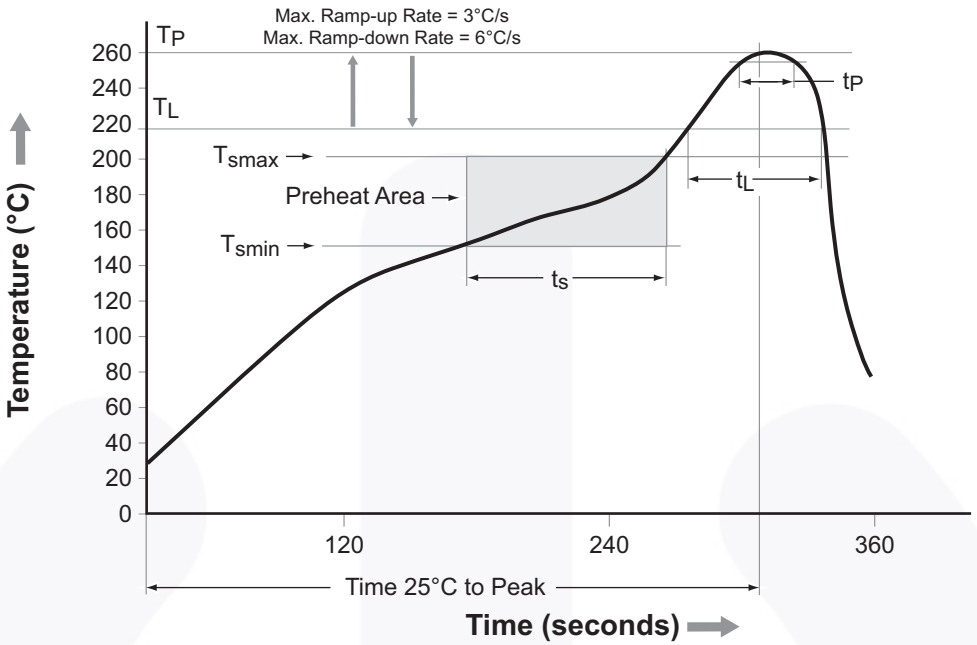
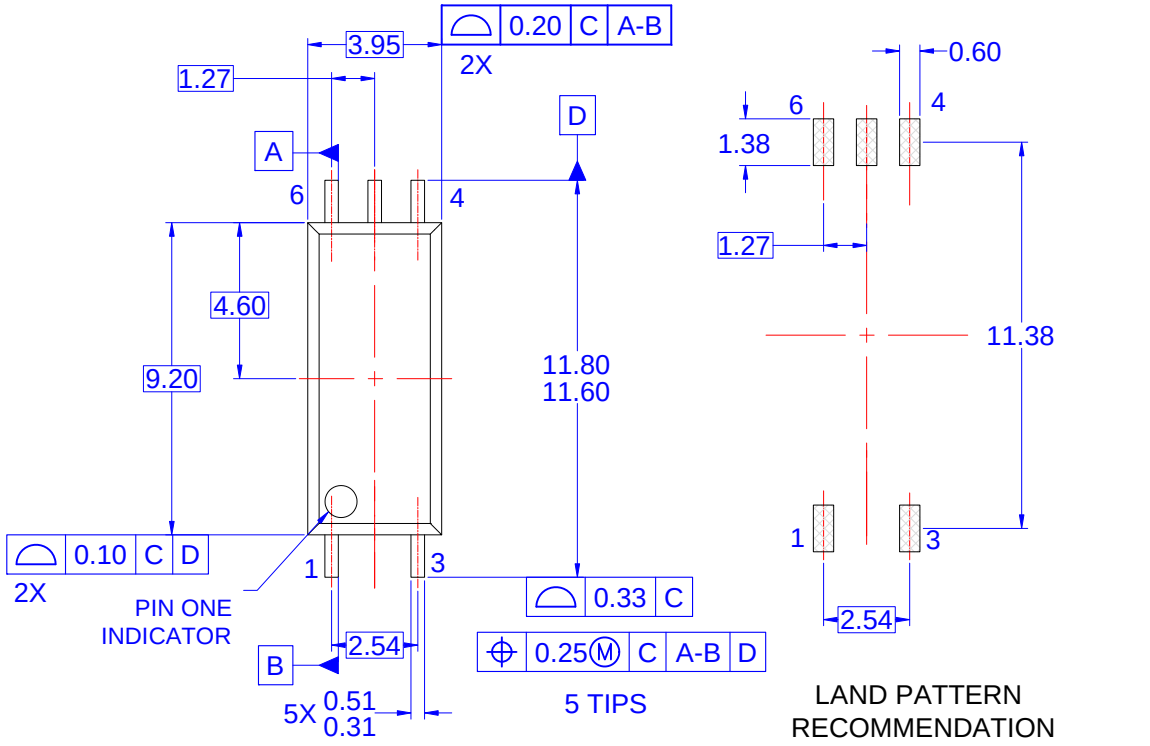
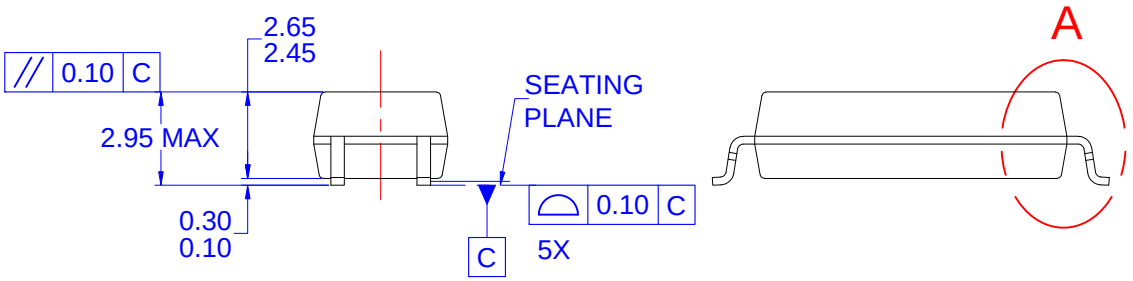
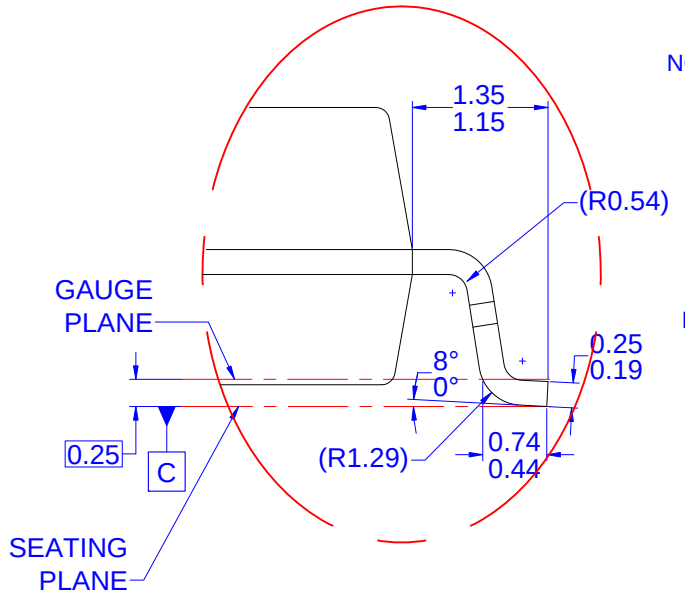


Figure 17. Reflow Profile

Profile Freature	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 to 120 seconds
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 to 150 seconds
Peak Body Package Temperature	260°C +0°C / –5°C
Time (t_P) within 5°C of 260°C	30 seconds
Ramp-Down Rate (T_P to T_L)	6°C/second maximum
Time 25°C to Peak Temperature	8 minutes maximum







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
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