

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/sec 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 (pending approval)

Applications

- Isolating intelligent power module
- Isolating industrial communication interface

Related Resources

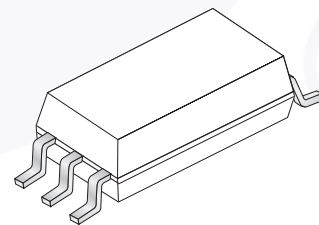
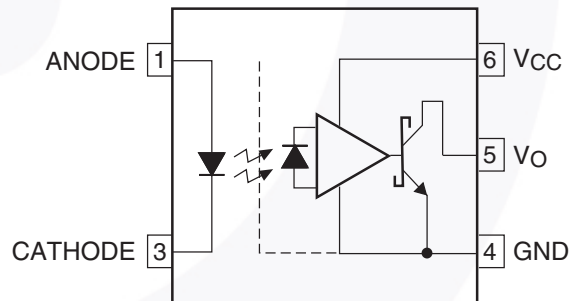
- www.fairchildsemi.com/products/opto/
- www.fairchildsemi.com/pf/FO/FODM8061.html
- www.fairchildsemi.com/pf/FO/FODM611.html

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. It utilizes Fairchild's proprietary 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



Truth Table

| LED | Output |
|-----|--------|
| Off | HIGH |
| On | LOW |

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 |

Pin Configuration



Safety and Insulation Ratings

As per DIN EN/IEC60747-5-5 (pending approval), 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 Vrms | | I-IV | | |
| | For Rated Mains Voltage < 300 Vrms | | I-IV | | |
| | For Rated Mains Voltage < 450 Vrms | | I-IV | | |
| | For Rated Mains Voltage < 600 Vrms | | 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} × 1.875 = V _{PR} , 100% Production Test with t _m = 1 s, Partial Discharge < 5 pC | 2,651 | | | V _{peak} |
| | Input to Output Test Voltage, Method a, V _{IORM} × 1.5 = V _{PR} , Type and Sample Test with t _m = 60 s, Partial Discharge < 5 pC | 2,121 | | | V _{peak} |
| V _{IORM} | Maximum Working Insulation Voltage | 1,414 | | | V _{peak} |
| V _{IOTM} | Highest Allowable Over Voltage | 8,000 | | | 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. $T_A = 25^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Value | Units |
|-------------------------------|---|------------------------|------------------|
| T_{STG} | Storage Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{OPR} | Operating Temperature | -40 to +100 | $^\circ\text{C}$ |
| T_J | Junction Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{SOL} | Lead Solder Temperature (Refer to Reflow Temperature Profile on page 12) | 260 for 10 sec | $^\circ\text{C}$ |
| 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 | $^\circ\text{C}$ |
| 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 $R_L = 1\text{ k}\Omega$) | | 5 | TTL loads |
| R_L | Output Pull-up Resistor | 330 | 4,000 | Ω |

Note:

2. $0.1\ \mu\text{F}$ bypass capacitor must be connected between pins 4 and 6.

Isolation Characteristics

Apply over all recommended conditions; typical value is measured at $T_A = 25^\circ\text{C}$.

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

Notes:

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units | Figure |
|-------------------------------|--|--|------|------|------|---------------|--------|
| INPUT CHARACTERISTICS | | | | | | | |
| V_F | Forward Voltage | $I_F = 10 \text{ mA}$ | 1.05 | 1.45 | 1.80 | V | 1 |
| $\Delta(V_F / T_A)$ | Temperature Coefficient of Forward Voltage | | | -1.8 | | mV/°C | |
| BV_R | Input Reverse Breakdown Voltage | $I_R = 10 \mu\text{A}$ | 5.0 | | | V | |
| I_{FHL} | Threshold Input Current | $V_O = 0.6 \text{ V}$, $I_{OL}(\text{sink}) = 13 \text{ mA}$ | | 2.5 | 6.0 | mA | 2 |
| OUTPUT CHARACTERISTICS | | | | | | | |
| V_{OL} | Logic Low Output Voltage | $I_F = \text{rated } I_{FHL}$, $I_{OL}(\text{sink}) = 13 \text{ mA}$ | | 0.4 | 0.6 | V | 3 |
| I_{OH} | Logic High Output Current | $I_F = 250 \mu\text{A}$, $V_O = 3.3 \text{ V}$ | | 8.0 | 50.0 | μA | 4 |
| | | $I_F = 250 \mu\text{A}$, $V_O = 5.0 \text{ V}$ | | 3.0 | 40.0 | μA | 4 |
| I_{CCL} | Logic Low Output Supply Current | $I_F = 10 \text{ mA}$, $V_{CC} = 3.3 \text{ V}$ | | 5.3 | 8.5 | mA | 5, 7 |
| | | $I_F = 10 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$ | | 7.1 | 10.0 | mA | 5, 7 |
| I_{CCH} | Logic High Output Supply Current | $I_F = 0 \text{ mA}$, $V_{CC} = 3.3 \text{ V}$ | | 3.5 | 7.0 | mA | 6, 7 |
| | | $I_F = 0 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$ | | 5.3 | 9.0 | mA | 6, 7 |

Switching Characteristics

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units | Figure |
|-----------|---|--|------|------|------|-------------------|------------|
| Data Rate | | $R_L = 350\ \Omega$ | | | 10 | Mbit/sec | |
| t_{PHL} | Propagation Delay to Logic Low Output | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 40 | 80 | ns | 8, 9, 13 |
| t_{PLH} | Propagation Delay to Logic High Output | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 50 | 90 | ns | 8, 9, 13 |
| PWD | Pulse Width Distortion, $ t_{PHL} - t_{PLH} $ | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 10 | 35 | ns | 10, 11, 13 |
| t_{PSK} | Propagation Delay Skew | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ ⁽⁵⁾ | | | 40 | ns | |
| t_R | Output Rise Time (10% to 90%) | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 20 | | ns | 12, 13 |
| t_F | Output Fall Time (90% to 10%) | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 10 | | ns | 12, 13 |
| $ CM_H $ | Common-Mode Transient Immunity at Output High | $I_F = 0\text{ mA}$, $V_O > 2\text{ V}$, $V_{CM} = 1,000\text{ V}^{(6)}$ | 20 | 40 | | kV/ μs | 14 |
| $ CM_L $ | Common-Mode Transient Immunity at Output Low | $I_F = 6.0\text{ mA}$, $V_O < 0.8\text{ V}$, $V_{CM} = 1,000\text{ V}^{(6)}$ | 20 | 40 | | kV/ μs | 14 |

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units | Figure |
|-----------|---|--|------|------|------|-------------------|------------|
| Data Rate | | $R_L = 350\ \Omega$ | | | 10 | Mbit/sec | |
| t_{PHL} | Propagation Delay to Logic Low Output | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 37 | 80 | ns | 8, 9, 13 |
| t_{PLH} | Propagation Delay to Logic High Output | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 41 | 90 | ns | 8, 9, 13 |
| PWD | Pulse Width Distortion, $ t_{PHL} - t_{PLH} $ | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 4 | 25 | ns | 10, 11, 13 |
| t_{PSK} | Propagation Delay Skew | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}^{(5)}$ | | | 40 | ns | |
| t_R | Output Rise Time (10% to 90%) | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 22 | | ns | 12, 13 |
| t_F | Output Fall Time (90% to 10%) | $R_L = 350\ \Omega$, $C_L = 15\text{ pF}$ | | 9 | | ns | 12, 13 |
| $ CM_H $ | Common-Mode Transient Immunity at Output High | $I_F = 0\text{ mA}$, $V_O > 2\text{ V}$, $V_{CM} = 1,000\text{ V}^{(6)}$ | 20 | 40 | | kV/ μs | 14 |
| $ CM_L $ | Common-Mode Transient Immunity at Output Low | $I_F = 6.0\text{ mA}$, $V_O < 0.8\text{ V}$, $V_{CM} = 1,000\text{ V}^{(6)}$ | 20 | 40 | | kV/ μs | 14 |

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 ($\pm 5^{\circ}\text{C}$), at same operating conditions, with equal loads ($R_L = 350\ \Omega$, $C_L = 15\ \text{pF}$), and with an input rise time less than 5 ns.
6. Common-mode transient immunity at output HIGH is the maximum tolerable positive dV_{cm}/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 dV_{cm}/dt on the trailing edge of the common pulse signal, V_{CM} , to assure that the output remains LOW.

Typical Performance Characteristics

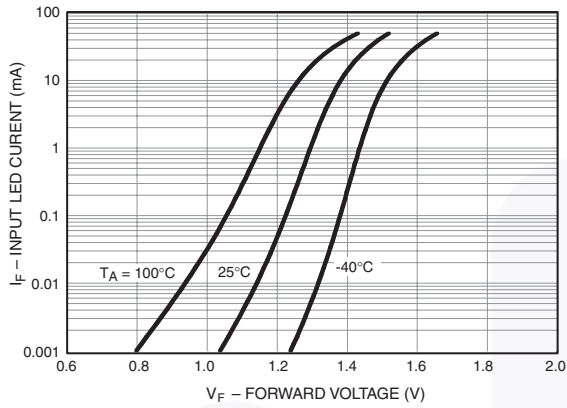


Figure 1. Input LED Current (I_F) vs. Forward Voltage (V_F)

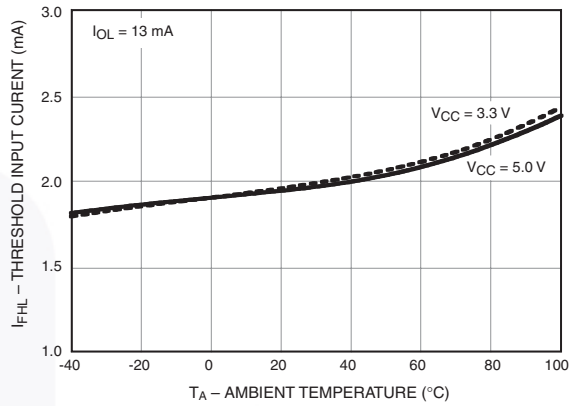


Figure 2. Threshold Input Current (I_{FHL}) vs. Ambient Temperature

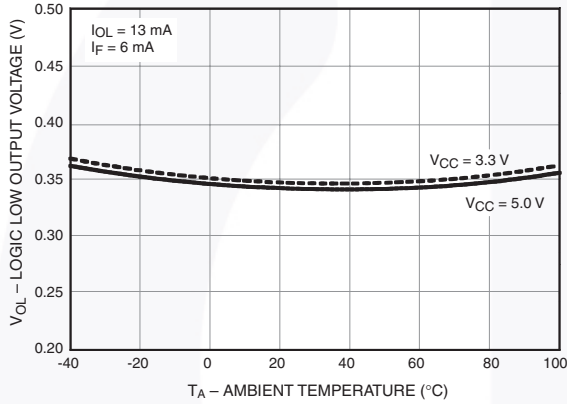


Figure 3. Logic Low Output Voltage (V_{OL}) vs. Ambient Temperature

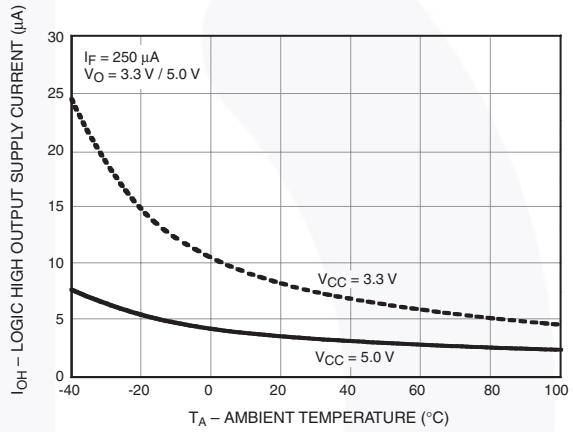


Figure 4. Logic High Output Current (I_{OH}) vs. Ambient Temperature

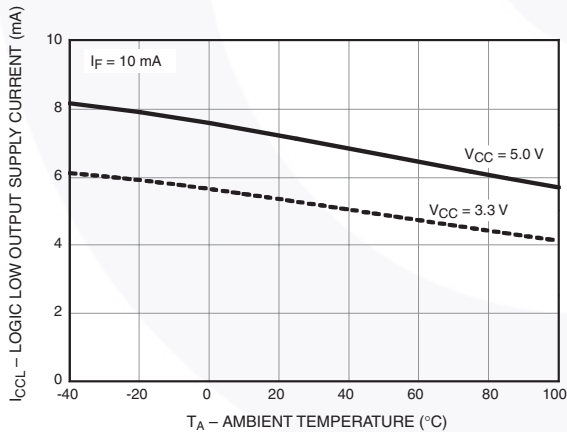


Figure 5. Logic Low Output Supply Current (I_{CCL}) vs. Ambient Temperature

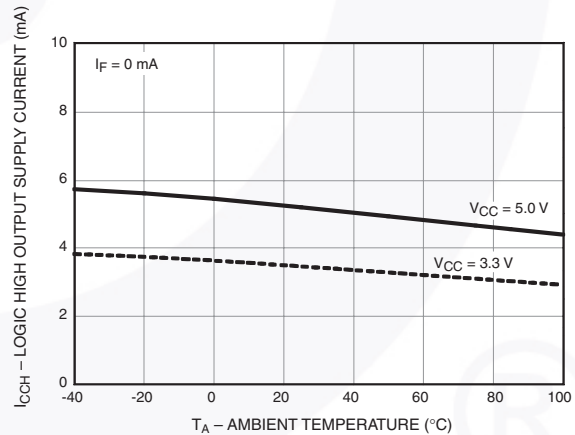


Figure 6. Logic High Output Supply Current (I_{CCH}) vs. Ambient Temperature

Typical Performance Characteristics (Continued)

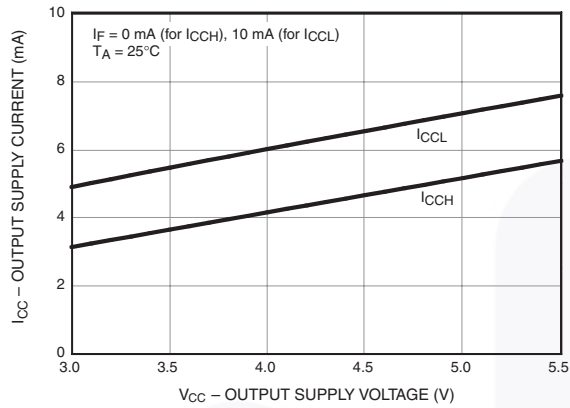


Figure 7. Output Supply Current (I_{CC}) vs. Output Supply Voltage (V_{CC})

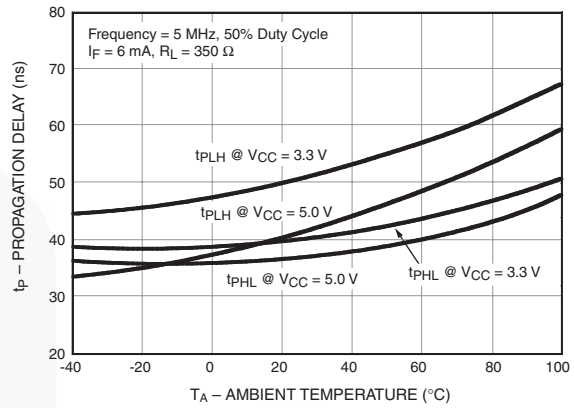


Figure 8. Propagation Delay vs. Ambient Temperature

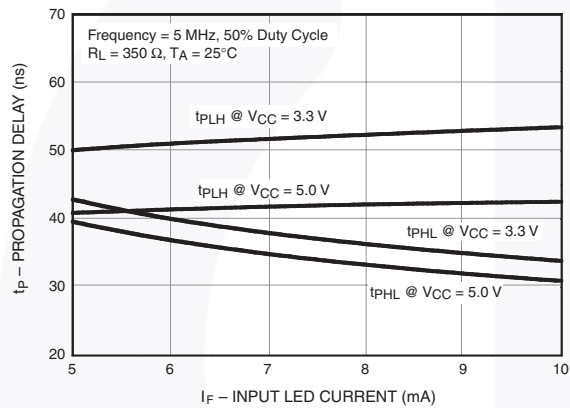


Figure 9. Propagation Delay vs. Input LED Current (I_F)

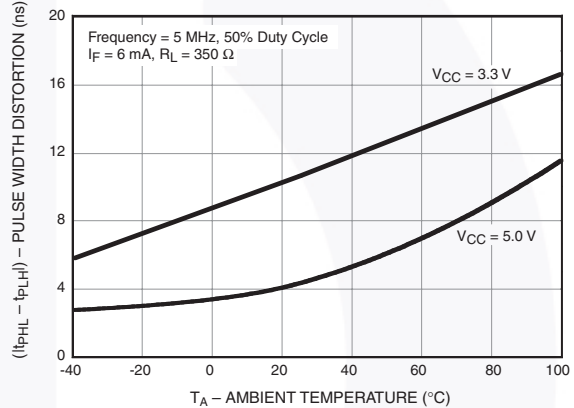


Figure 10. Pulse Width Distortion vs. Ambient Temperature

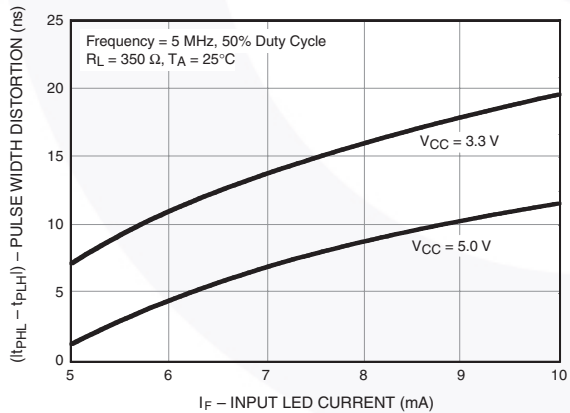


Figure 11. Pulse Width Distortion vs. Input LED Current (I_F)

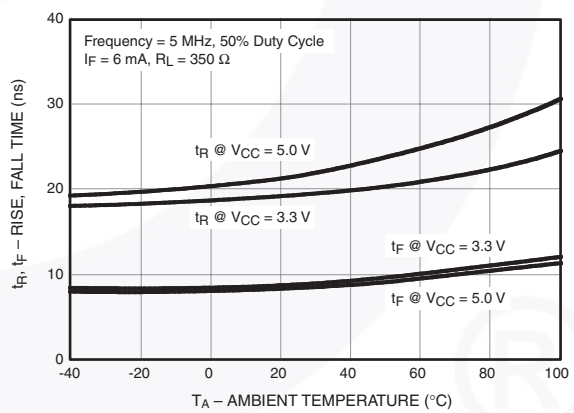


Figure 12. Rise Time (t_R) and Fall Time (t_F) vs. Ambient Temperature

Test Circuit

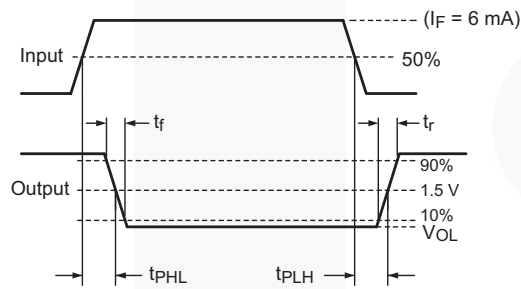
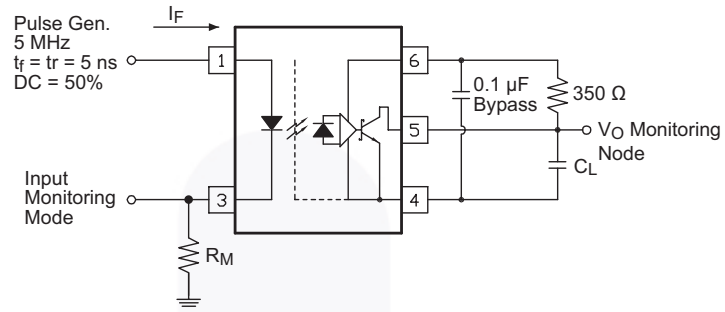


Figure 13. Test Circuit for Propagation Delay, Rise Time, and Fall Time

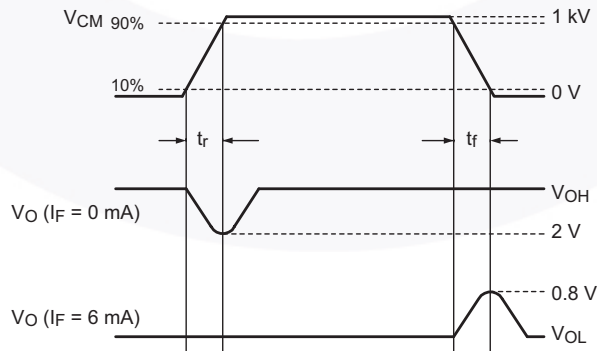
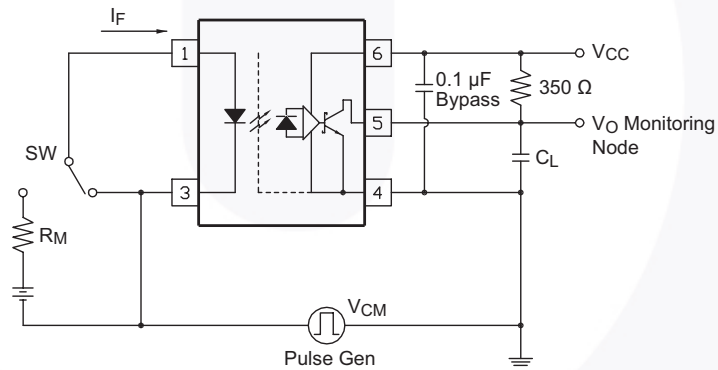


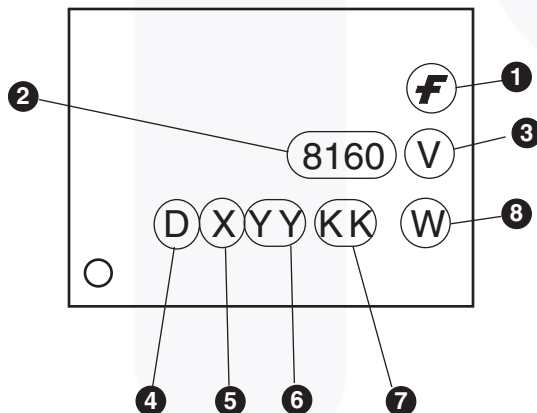
Figure 14. Test Circuit for Instantaneous Common-Mode Rejection Voltage

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 (Preliminary) | Wide Body SOP 5-Pin, DIN EN/IEC60747-5-5 Option (Pending Approval) | Tube (100 units per tube) |
| FOD8160R2V (Preliminary) | Wide Body SOP 5-Pin, DIN EN/ IEC60747-5-5 Option (Pending Approval) | Tape and Reel (1,000 units per reel) |

 All packages are lead free per JEDEC: J-STD-020B standard.

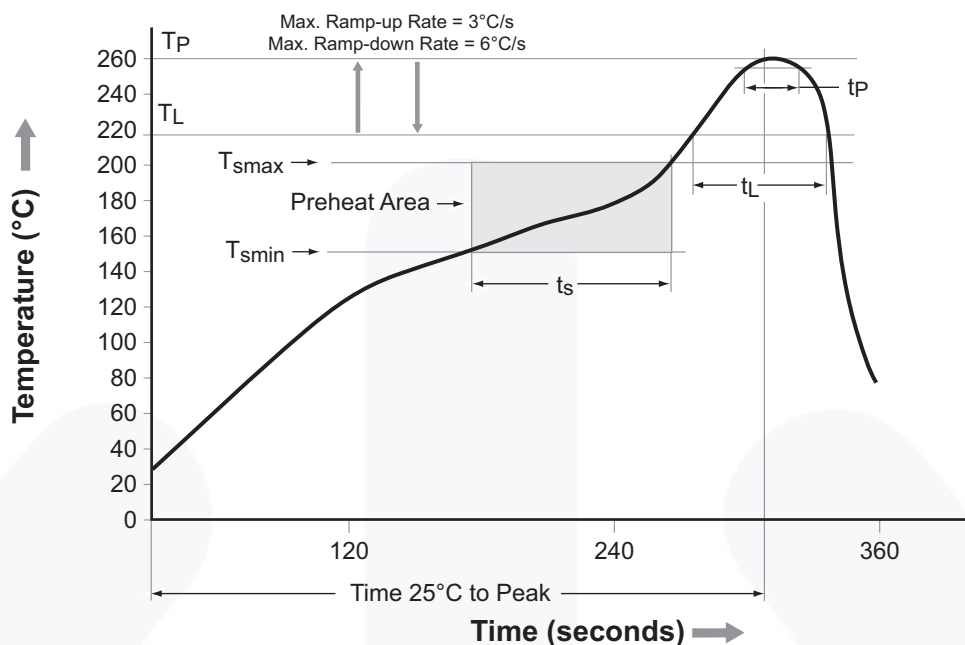
Marking Information



Definitions

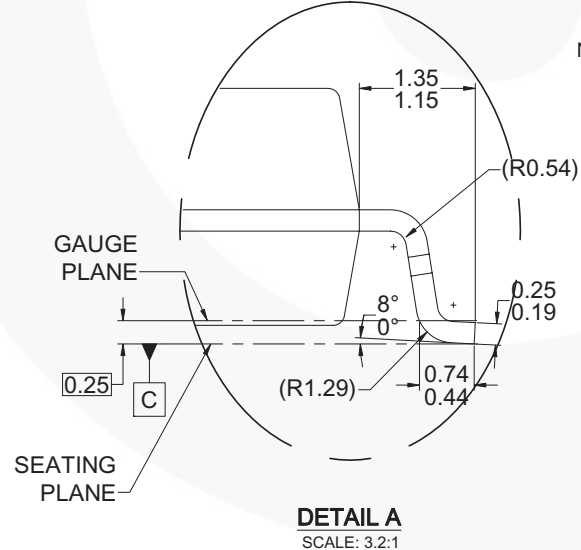
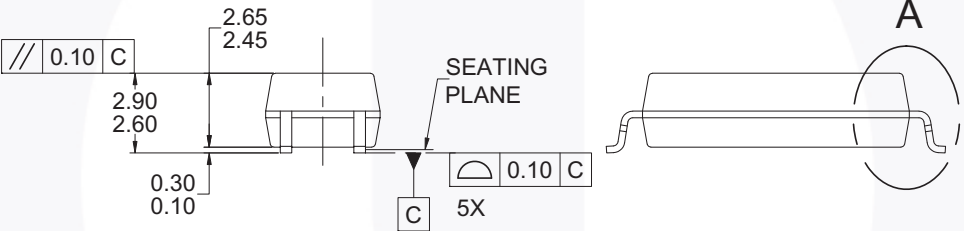
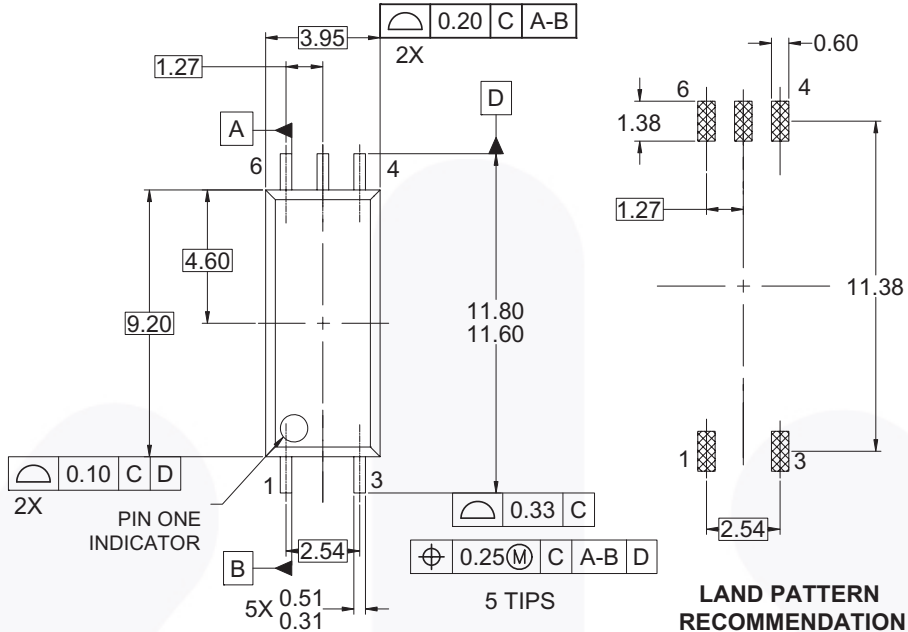
| | |
|---|---|
| 1 | Fairchild logo |
| 2 | Device number, e.g., '8160' for FOD8160 |
| 3 | DIN EN/IEC60747-5-5 option (only appears on component ordered with this option) |
| 4 | Plant code, e.g., 'D' |
| 5 | Last-digit year code, e.g., 'D' for 2013 |
| 6 | Two-digit work week ranging from '01' to '53' |
| 7 | Lot-traceability code |
| 8 | Package assembly code, W |

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 Seconds |
| Ramp-Up Rate (t_L to t_P) | 3°C/Second max. |
| Liquidous Temperature (T_L) | 217°C |
| Time (t_L) Maintained Above (T_L) | 60–150 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 max. |
| Time 25°C to Peak Temperature | 8 Minutes max. |

Package Dimensions



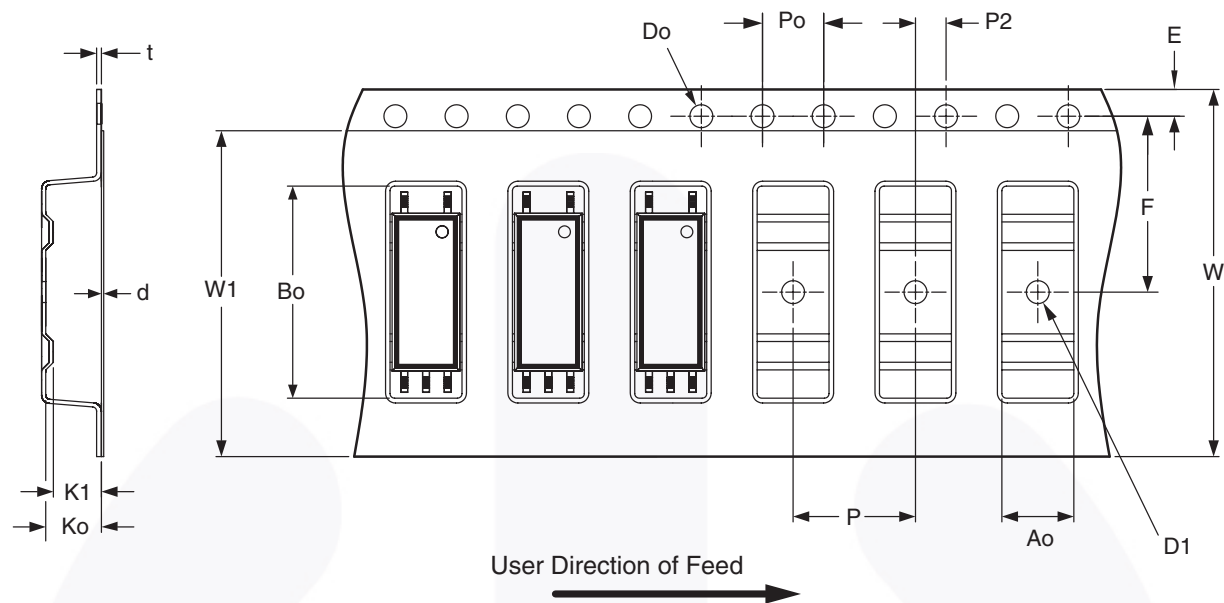
NOTES: UNLESS OTHERWISE SPECIFIED

- 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
- D) DRAWING CONFORMS TO ASME Y14.5M-1994
- E) DRAWING FILE NAME: MKT-M05AREV2

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
<http://www.fairchildsemi.com/packaging/>

Carrier Tape Specification (SOIC-5L OPTO R2 & R2V Option)







| Symbol | Description | Dimension in mm |
|--------|--------------------------------|---------------------|
| W | Tape Width | 24.00 +0.20 / -0.10 |
| t | Tape Thickness | 0.30 ±0.05 |
| Po | Sprocket Hole Pitch | 4.00 ±0.20 |
| Do | Sprocket Hole Diameter | 1.50 +0.10 / -0.00 |
| D1 | Pocket Hole Diameter | 1.50 +0.25 / -0.00 |
| E | Sprocket Hole Location | 1.75 ±0.10 |
| F | Pocket Location | 11.50 ±0.10 |
| P2 | | 2.00 ±0.10 |
| P | Pocket Pitch | 8.00 ±0.10 |
| Ao | Pocket Dimension | 4.50 ±0.10 |
| Bo | | 12.00 ±0.10 |
| Ko | | 3.35 ±0.10 |
| K1 | | 2.85 ±0.10 |
| W1 | Cover Tape Width | 21.30 ±0.10 |
| d | Cover Tape Thickness | 0.05 ±0.01 |
| | Max Component Rotation or Tilt | 10° |



TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- | | | | |
|--|--|--|---|
| 2Cool™ | F-PFS™ | PowerTrench® | The Power Franchise® |
| AccuPower™ | FRFET® | PowerXS™ | the power franchise |
| AX-CAP™* | Global Power Resource™ | Programmable Active Droop™ | TinyBoost™ |
| BitSiC™ | GreenBridge™ | QFET® | TinyBuck™ |
| Build it Now™ | Green FPS™ | QS™ | TinyCalc™ |
| CorePLUS™ | Green FPS™ e-Series™ | Quiet Series™ | TinyLogic® |
| CorePOWER™ | Gmax™ | RapidConfigure™ | TINYOPTO™ |
| CROSSVOLT™ | GTO™ |  ™ | TinyPower™ |
| CTL™ | IntelliMAX™ | Saving our world, 1mW/W/kW at a time™ | TinyPWM™ |
| Current Transfer Logic™ | ISOPLANAR™ | SignalWise™ | TinyWire™ |
| DEUXPEED® | Making Small Speakers Sound Louder and Better™ | SmartMax™ | TranSiC™ |
| Dual Cool™ | MegaBuck™ | SMART START™ | TriFault Detect™ |
| EcoSPARK® | MICROCOUPLER™ | Solutions for Your Success™ | TRUECURRENT®* |
| EfficientMax™ | MicroFET™ | SPM® | µSerDes™ |
| ESBC™ | MicroPak™ | STEALTH™ |  SerDes™ |
|  Fairchild® | MicroPak2™ | SuperFET® | UHC® |
| Fairchild Semiconductor® | MillerDrive™ | SuperSOT™-3 | Ultra FRFET™ |
| FACT Quiet Series™ | MotionMax™ | SuperSOT™-6 | UnifET™ |
| FACT® | mWSaver™ | SuperSOT™-8 | VCS™ |
| FAST® | OptoHiT™ | SupreMOS® | VisualMax™ |
| FastvCore™ | OPTOLOGIC® | SyncFET™ | VoltagePlus™ |
| FETBench™ | OPTOPLANAR® | Sync-Lock™ | XS™ |
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Definition of Terms

| Datasheet Identification | Product Status | Definition |
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