

FODM8071

3.3V/5V Logic Gate Output Optocoupler with High Noise Immunity

Features

- High noise immunity characterized by common mode rejection
 - 20kV/μs minimum common mode rejection
- High speed
 - 20Mbit/sec data rate (NRZ)
 - 55ns max. propagation delay
 - 20ns max. pulse width distortion
 - 30ns max. propagation delay skew
- 3.3V and 5V CMOS compatibility
- Specifications guaranteed over 3V to 5.5V supply voltage and -40°C to +110°C temperature range
- Safety and regulatory approvals
 - UL1577, 3750 VAC_{RMS} for 1 min.
 - IEC60747-5-2 (pending)

Applications

- Microprocessor system interface
 - SPI, I²C
- Industrial fieldbus communications
 - DeviceNet, CAN, RS485
- Programmable logic control
- Isolated data acquisition system
- Voltage level translator

Description

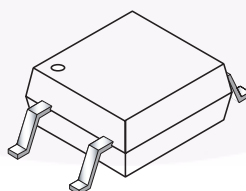
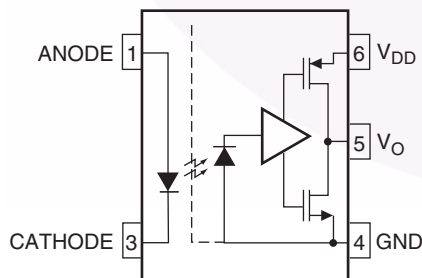
The FODM8071 is a 3.3V/5V high-speed logic gate output optocoupler, which supports isolated communications allowing digital signals to communicate between systems without conducting ground loops or hazardous voltages. It utilizes Fairchild's patented coplanar packaging technology, Optoplanar®, and optimized IC design to achieve high noise immunity, characterized by high common mode rejection specifications.

This high-speed logic gate output optocoupler, housed in a compact 5-Pin Mini-Flat package, consists of a high-speed AlGaAs LED at the input coupled to a CMOS detector IC at the output. The detector IC comprises an integrated photodiode, a high-speed transimpedance amplifier and a voltage comparator with an output driver. The CMOS technology coupled with a high efficiency LED achieves low power consumption as well as very high speed (55ns propagation delay, 20ns pulse width distortion).

Related Resources

- www.fairchildsemi.com/products/opto/
- www.fairchildsemi.com/pf/FO/FOD8001.html
- www.fairchildsemi.com/pf/FO/FOD0721.html

Functional Schematic



Truth Table

| LED | Output |
|-----|--------|
| Off | High |
| On | Low |

Pin Definitions

| Number | Name | Function Description |
|--------|-----------------|-----------------------|
| 1 | ANODE | Anode |
| 3 | CATHODE | Cathode |
| 4 | GND | Output Ground |
| 5 | V _O | Output Voltage |
| 6 | V _{DD} | Output Supply Voltage |

Safety and Insulation Ratings for Mini-Flat Package (SO5 Pin)

As per IEC60747-5-2 (Pending Certification). 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.

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-------------------|--|-----------------|-----------|------|-------------------|
| | Installation Classifications per DIN VDE 0110/1.89 Table 1 | | | | |
| | For rated main voltage < 150Vrms | | I-IV | | |
| | For rated main voltage < 300Vrms | | I-III | | |
| | Climatic Classification | | 40/110/21 | | |
| | Pollution Degree (DIN VDE 0110/1.89) | | 2 | | |
| CTI | Comparative Tracking Index | 175 | | | |
| V _{PR} | Input to Output Test Voltage, Method b, VIORM x 1.875 = V _{PR} , 100% Production Test with t _m = 1 sec, Partial Discharge < 5 pC | 1060 | | | V |
| V _{PR} | Input to Output Test Voltage, Method a, VIORM x 1.5 = V _{PR} , Type and Sample Test with t _m = 60 sec, Partial Discharge < 5 pC | 848 | | | V |
| V _{IORM} | Max Working Insulation Voltage | 565 | | | V _{peak} |
| V _{IOTM} | Highest Allowable Over Voltage | 4000 | | | V _{peak} |
| | External Creepage | 5.0 | | | mm |
| | External Clearance | 5.0 | | | mm |
| | Insulation Thickness | 0.5 | | | mm |
| T _{Case} | Safety Limit Values, Maximum Values allowed in the event of a failure, Case Temperature | 150 | | | °C |
| R _{IO} | Insulation Resistance at T _{STG} , V _{IO} = 500V | 10 ⁹ | | | Ω |

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 +110 | $^\circ\text{C}$ |
| T_J | Junction Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{SOL} | Lead Solder Temperature (Refer to Reflow Temperature Profile) | 260 for 10sec | $^\circ\text{C}$ |
| I_F | Forward Current | 20 | mA |
| V_R | Reverse Voltage | 5 | V |
| V_{DD} | Supply Voltage | 0 to 6.0 | V |
| V_O | Output Voltage | -0.5 to $V_{\text{DD}}+0.5$ | V |
| I_O | Average Output Current | 10 | mA |
| PD_I | Input Power Dissipation ⁽¹⁾⁽³⁾ | 40 | mW |
| PD_O | Output Power Dissipation ⁽²⁾⁽³⁾ | 70 | mW |

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 | +110 | $^\circ\text{C}$ |
| V_{DD} | Supply Voltages ⁽⁴⁾ | 3.0 | 5.5 | V |
| V_{FL} | Logic Low Input Voltage | 0 | 0.8 | V |
| I_{FH} | Logic High Input Current | 5 | 16 | mA |
| I_{OL} | Logic Low Output Current | 0 | 7 | mA |

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 | freq = 60Hz, $t = 1.0\text{min}$, $I_{\text{I-O}} \leq 10\mu\text{A}^{(5)(6)}$ | 3750 | | | VAC_{RMS} |
| R_{ISO} | Isolation Resistance | $V_{\text{I-O}} = 500\text{V}^{(5)}$ | 10^{11} | | | Ω |
| C_{ISO} | Isolation Capacitance | $V_{\text{I-O}} = 0\text{V}$, freq = 1.0MHz ⁽⁵⁾ | | 0.2 | | pF |

Notes:

- Derate linearly from 95°C at a rate of $-1.4\text{mW}/^\circ\text{C}$
- Derate linearly from 100°C at a rate of $-3.47\text{mW}/^\circ\text{C}$.
- Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.
- 0.1 μF bypass capacitor must be connected between 4 and 6.
- Device is considered a two terminal device: Pins 1, and 3 are shorted together and Pins 4, 5, and 6 are shorted together.
- 3,750 VAC_{RMS} for 1 minute duration is equivalent to 4,500 VAC_{RMS} for 1 second duration.

Electrical Characteristics (Apply over all recommended conditions)(T_A = -40°C to +110°C, 3.0V ≤ V_{DD} ≤ 5.5V), unless otherwise specified.Typical value is measured at T_A = 25°C and V_{DD} = 3.3V.

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|-------------------------------|----------------------------------|--|------------------------|--------|------|-------|
| INPUT CHARACTERISTICS | | | | | | |
| V _F | Forward Voltage | I _F = 10mA, Fig. 1 | 1.05 | 1.35 | 1.8 | V |
| BV _R | Input Reverse Breakdown Voltage | I _R = 10μA | 5 | 15 | | V |
| I _{FHL} | Threshold Input Current | Fig. 2 | | 2.8 | 5 | mA |
| OUTPUT CHARACTERISTICS | | | | | | |
| I _{DDL} | Logic Low Output Supply Current | V _{DD} = 3.3V, I _F = 10mA, Fig. 3, 5 | | 3.3 | 4.8 | mA |
| | | V _{DD} = 5.0V, I _F = 10mA, Fig. 3, 6 | | 4.0 | 5.0 | mA |
| I _{DDH} | Logic High Output Supply Current | V _{DD} = 3.3V, I _F = 0mA, Fig. 4 | | 3.3 | 4.8 | mA |
| | | V _{DD} = 5.0V, I _F = 0mA, Fig. 4 | | 4.0 | 5.0 | mA |
| V _{OH} | Logic High Output Voltage | V _{DD} = 3.3V, I _O = -20μA, I _F = 0mA | V _{DD} - 0.1V | 3.3 | | V |
| | | V _{DD} = 3.3V, I _O = -4mA, I _F = 0mA | V _{DD} - 0.5V | 3.1 | | V |
| | | V _{DD} = 5.0V, I _O = -20μA, I _F = 0mA | V _{DD} - 0.1V | 5.0 | | V |
| | | V _{DD} = 5.0V, I _O = -4mA, I _F = 0mA | V _{DD} - 0.5V | 4.9 | | V |
| V _{OL} | Logic Low Output Voltage | I _O = 20μA, I _F = 10mA | | 0.0027 | 0.01 | V |
| | | I _O = 4mA, I _F = 10mA | | 0.27 | 0.8 | V |

Switching Characteristics (Apply over all recommended conditions)(T_A = -40°C to +110°C, 3.0V ≤ V_{DD} ≤ 5.5V, I_F = 5mA), unless otherwise specified.Typical value is measured at T_A = 25°C and V_{DD} = 3.3V

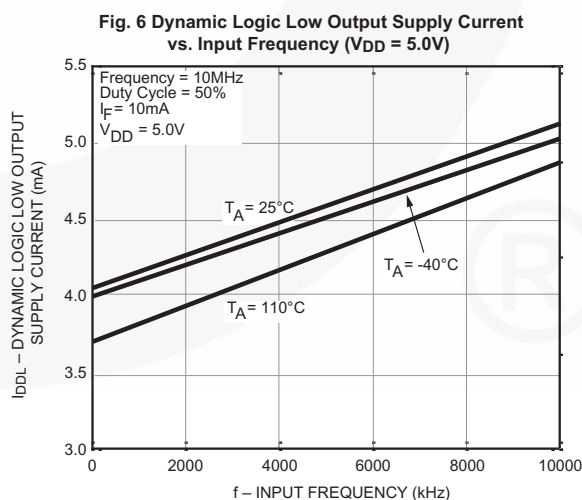
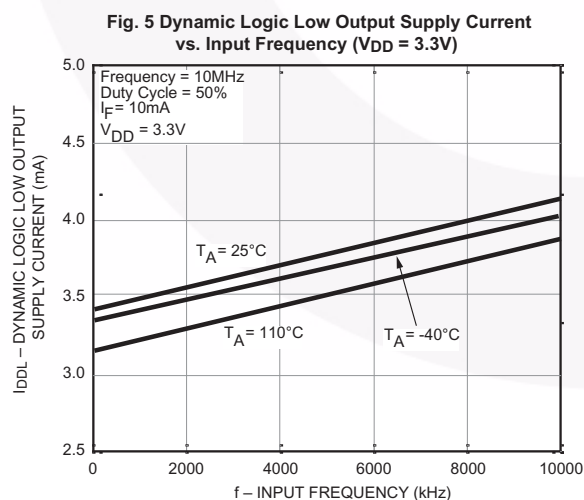
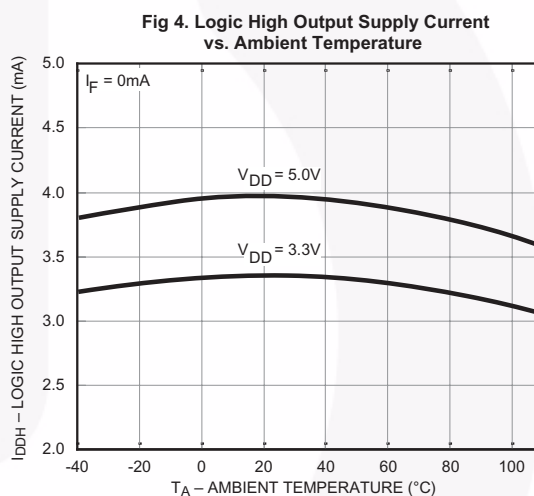
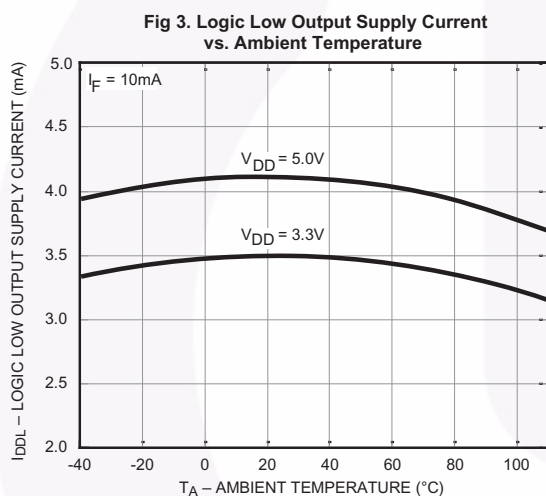
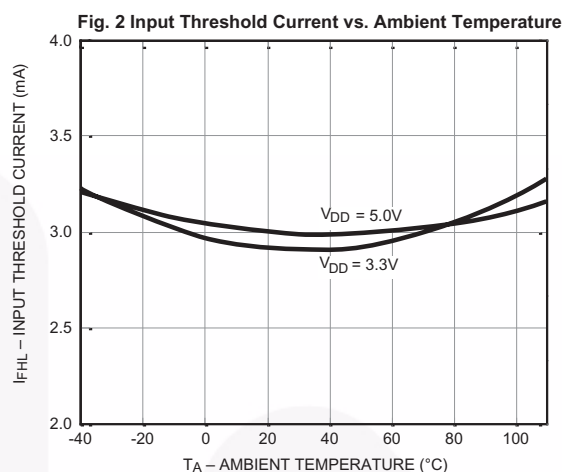
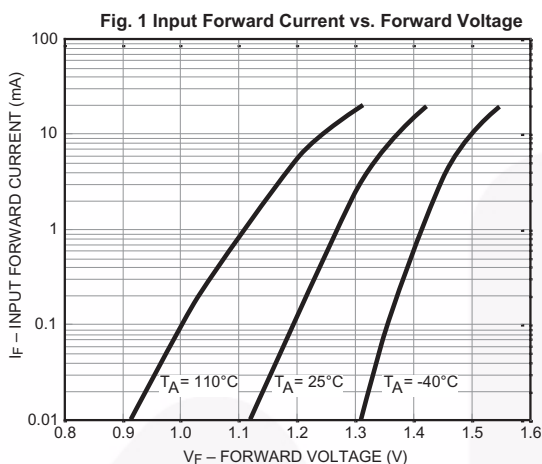
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|--------------------------|--|--|------|------|------|-------|
| Date Rate ⁽⁷⁾ | | | | | 20 | Mbps |
| t _{PW} | Pulse Width | | 50 | | | ns |
| t _{PHL} | Propagation Delay Time to Logic Low Output | C _L = 15pF, Fig. 7, 8, 12 | | 31 | 55 | ns |
| t _{PLH} | Propagation Delay Time to Logic High Output | C _L = 15pF, Fig. 7, 8, 12 | | 25 | 55 | ns |
| PWD | Pulse Width Distortion, t _{PHL} - t _{PLH} | C _L = 15pF, Fig. 9, 10 | | 5.5 | 20 | ns |
| t _{PSK} | Propagation Delay Skew | C _L = 15pF ⁽⁸⁾ | | | 30 | ns |
| t _R | Output Rise Time (10% to 90%) | Fig. 11, 12 | | 5.8 | | ns |
| t _F | Output Fall Time (90% to 10%) | Fig. 11, 12 | | 5.3 | | ns |
| CM _H | Common Mode Transient Immunity at Output High | I _F = 0mA, V _O > 0.8V _{DD} , V _{CM} = 1000V, T _A = 25°C, Fig. 13 ⁽⁹⁾ | 20 | 40 | | kV/μs |
| CM _L | Common Mode Transient Immunity at Output Low | I _F = 5mA, V _O < 0.8V, V _{CM} = 1000V, T _A = 25°C, Fig. 13 ⁽⁹⁾ | 20 | 40 | | kV/μs |
| C _{PDO} | Output Dynamic Power Dissipation Capacitance ⁽¹⁰⁾ | | | 4 | | pF |

Notes:

7. Data rate is based on 10MHz, 50% NRZ pattern with a 50nsec minimum bit time.

8. t_{PSK} is equal to the magnitude of the worst case difference in t_{PHL} and/or t_{PLH} that will be seen 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 = 350Ω and C_L = 15pF), and with an input rise time less than 5ns.9. 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 will remain 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 will remain low.10. Unloaded dynamic power dissipation is calculated as follows: C_{PD} × V_{DD} × f + I_{DD} × V_{PD} where f is switched time in MHz.

Typical Performance Curves (Continued)



Typical Performance Curves (Continued)

Fig 7. Propagation Delay vs. Ambient Temperature

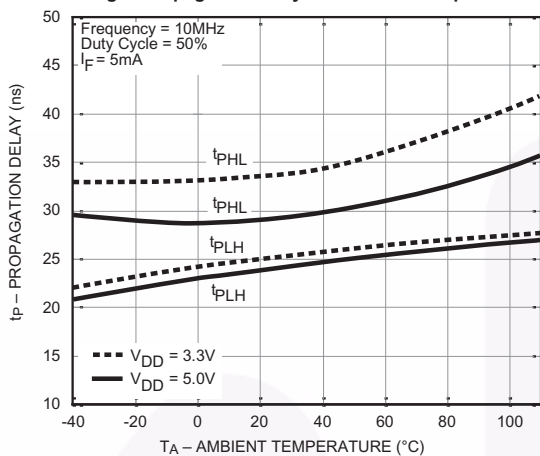


Fig 8. Propagation Delay vs. Pulse Input Current

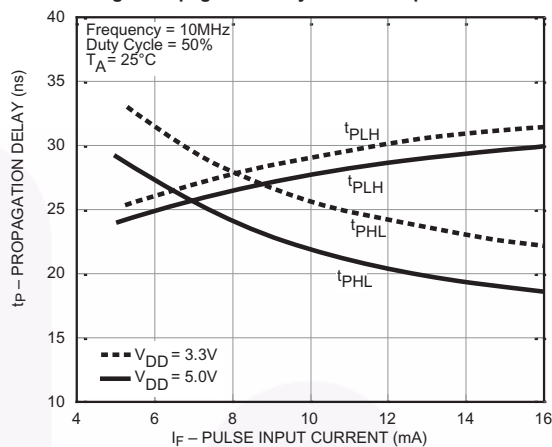


Fig 9. Pulse Width Distortion vs. Ambient Temperature

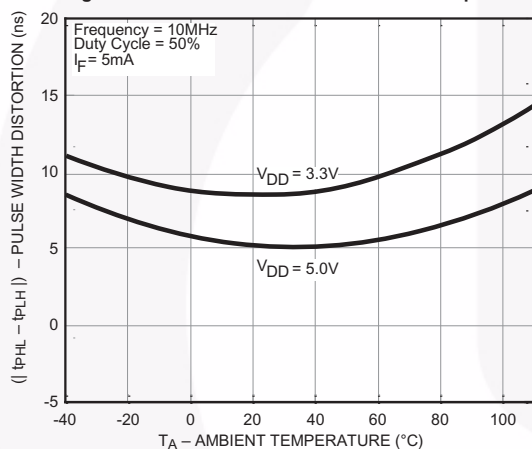


Fig 10. Pulse Width Distortion vs Pulse Input Current

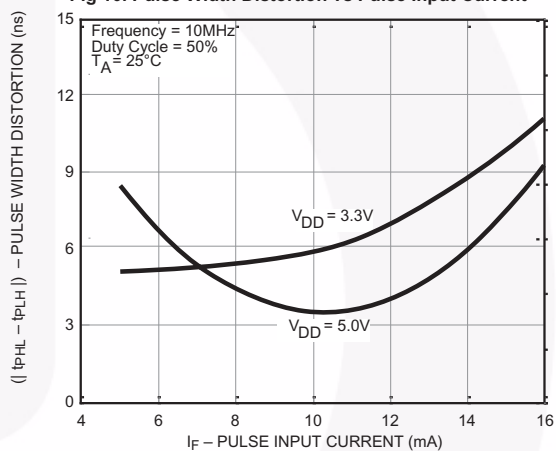
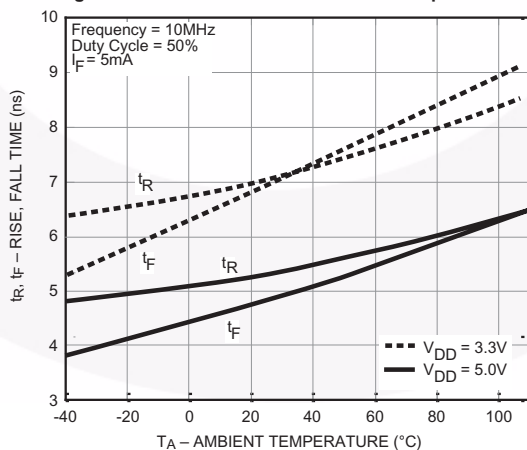


Fig 11. Rise and Fall Time vs. Ambient Temperature



Schematics

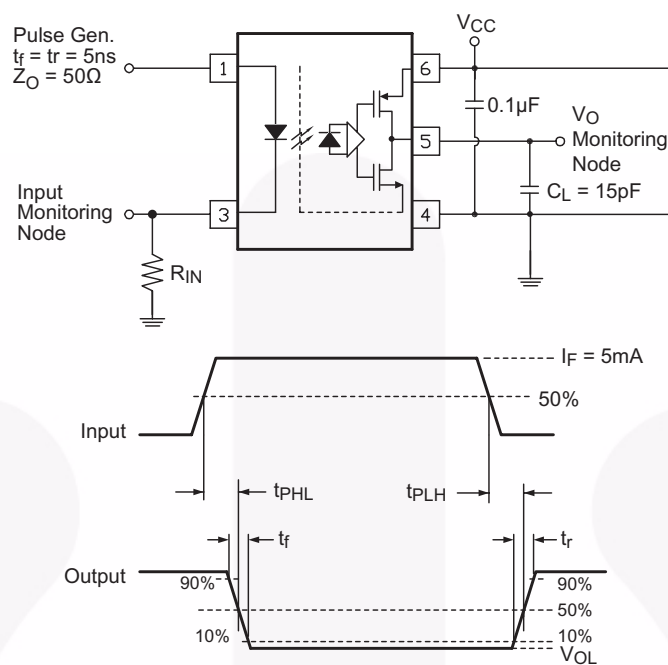


Figure 12. Test Circuit for Propagation Delay Time, Rise Time and Fall Time

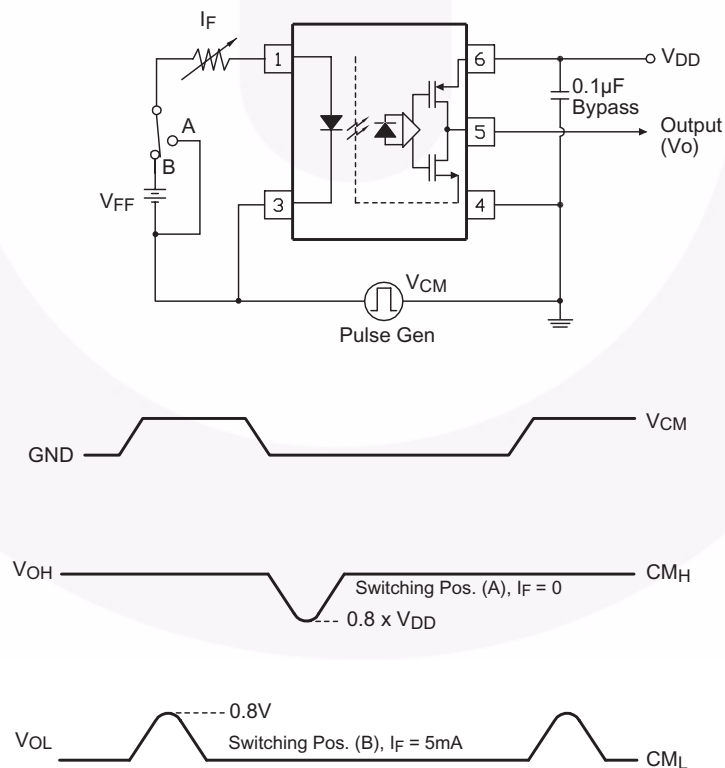


Figure 13. Test Circuit for Instantaneous Common Mode Rejection Voltage

Note:
All dimensions are in millimeters.

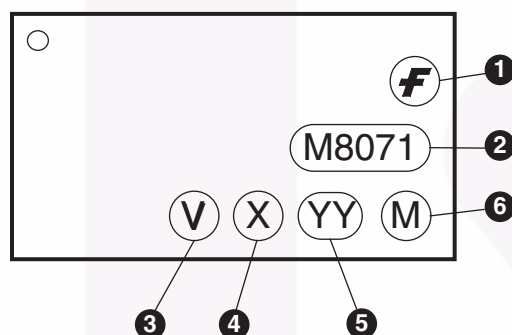
Ordering Information

| Option | Order Entry Identifier | Description |
|-----------|------------------------|--|
| No Suffix | FODM8071 | Mini-Flat 5-pin, shipped in tubes (100 units per tube) |
| R2 | FODM8071R2 | Mini-Flat 5-pin, tape and reel (2,500 units per reel) |



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

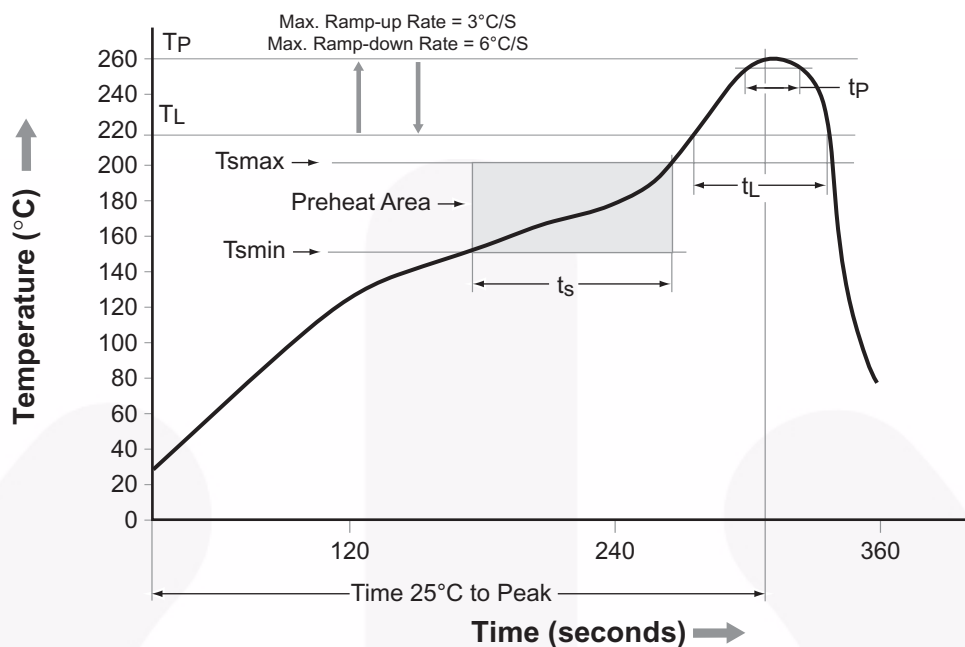
Marking Information



Definitions

| | |
|---|---|
| 1 | Fairchild logo |
| 2 | Device number |
| 3 | IEC60747-5-2 (VDE marking) |
| 4 | One digit year code, e.g., '9' |
| 5 | Two digit work week ranging from '01' to '53' |
| 6 | Assembly package code |

Reflow Profile




| Profile Feature | Pb-Free Assembly Profile |
|--|--------------------------|
| Temperature Min. (T_{smin}) | 150°C |
| Temperature Max. (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. |




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|--------------------------|-----------------------|---|
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