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February 2016

FOD3120 High Noise Immunity, 2.5 A Output Current, Gate Drive Optocoupler

Features

- High Noise Immunity Characterized by 35 kV/ μ s Minimum Common Mode Rejection
- 2.5 A Peak Output Current Driving Capability for Most 1200 V/20 A IGBT
- Use of P-channel MOSFETs at Output Stage Enables Output Voltage Swing Close to The Supply Rail
- Wide Supply Voltage Range from 15 V to 30 V
- Fast Switching Speed
 - 400 ns max. Propagation Delay
 - 100 ns max. Pulse Width Distortion
- Under Voltage LockOut (UVLO) with Hysteresis
- Extended Industrial Temperature Range, -40°C to 100°C Temperature Range
- Safety and Regulatory Approved
 - UL1577, 5000 V_{RMS} for 1 min.
 - DIN EN/IEC60747-5-5
- R_{DS(ON)} of 1 Ω (typ.) Offers Lower Power Dissipation
- >8.0 mm Clearance and Creepage Distance (Option 'T' or 'TS')
- 1,414 V Peak Working Insulation Voltage (V_{IORM})

Applications

- Industrial Inverter
- Uninterruptible Power Supply
- Induction Heating
- Isolated IGBT/Power MOSFET Gate Drive

Description

The FOD3120 is a 2.5 A Output Current Gate Drive Optocoupler, capable of driving most medium power IGBT/MOSFET. It is ideally suited for fast switching driving of power IGBT and MOSFETs used in motor control inverter applications, and high performance power system.

It utilizes Fairchild's coplanar packaging technology, Optoplanar[®], and optimized IC design to achieve high noise immunity, characterized by high common mode rejection.

It consists of a gallium aluminum arsenide (AlGaAs) light emitting diode optically coupled to an integrated circuit with a high-speed driver for push-pull MOSFET output stage.

Related Resources

- FOD3150, 1 A Output Current, Gate Drive Optocoupler Datasheet
- www.fairchildsemi.com/products/optoelectronics/

Functional Block Diagram

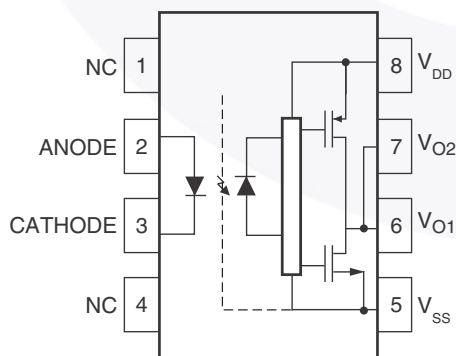


Figure 1. Functional Block Diagram⁽¹⁾

Note:

1. 0.1 μ F bypass capacitor must be connected between pins 5 and 8.

Package Outlines

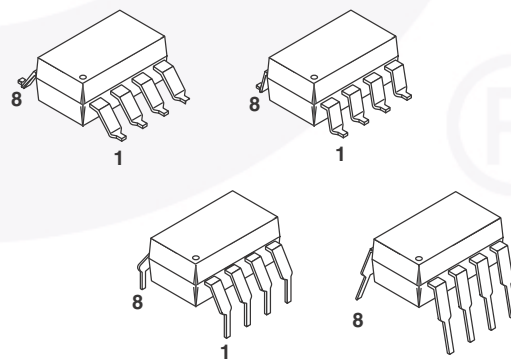


Figure 2. Package Outlines

FOD3120 — High Noise Immunity, 2.5 A Output Current, Gate Drive Optocoupler

Truth Table

| LED | $V_{DD} - V_{SS}$ "Positive Going" (Turn-on) | $V_{DD} - V_{SS}$ "Negative Going" (Turn-off) | V_o |
|-----|---|--|------------|
| Off | 0 V to 30 V | 0 V to 30 V | Low |
| On | 0 V to 11.5 V | 0 V to 10 V | Low |
| On | 11.5 V to 13.5 V | 10 V to 12 V | Transition |
| On | 13.5 V to 30 V | 12 V to 30 V | High |

Pin Definitions

| Pin # | Name | Description |
|-------|----------|--|
| 1 | NC | Not Connected |
| 2 | Anode | LED Anode |
| 3 | Cathode | LED Cathode |
| 4 | NC | Not Connected |
| 5 | V_{SS} | Negative Supply Voltage |
| 6 | V_{O2} | Output Voltage 2 (internally connected to V_{O1}) |
| 7 | V_{O1} | Output Voltage 1 |
| 8 | V_{DD} | Positive Supply Voltage |

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 _{RMS} | I–IV |
| | < 300 V _{RMS} | I–IV |
| | < 450 V _{RMS} | I–III |
| | < 600 V _{RMS} | I–III |
| | < 1000 V _{RMS} (Option T, TS) | I–III |
| Climatic Classification | 40/100/21 | |
| Pollution Degree (DIN VDE 0110/1.89) | 2 | |
| Comparative Tracking Index | 175 | |

| Symbol | Parameter | Value | Unit |
|-----------------------|--|-------------------|-------------------|
| V _{PR} | Input-to-Output Test Voltage, Method A, V _{IORM} × 1.6 = V _{PR} , Type and Sample Test with t _m = 10 s, Partial Discharge < 5 pC | 2,262 | V _{peak} |
| | 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} |
| V _{IORM} | Maximum Working Insulation Voltage | 1,414 | V _{peak} |
| V _{IOTM} | Highest Allowable Over-Voltage | 6,000 | V _{peak} |
| | External Creepage | ≥ 8.0 | mm |
| | External Clearance | ≥ 7.4 | mm |
| | External Clearance (for Option T or TS, 0.4" Lead Spacing) | ≥ 10.16 | mm |
| DTI | Distance Through Insulation (Insulation Thickness) | ≥ 0.5 | mm |
| T _S | Case Temperature ⁽²⁾ | 175 | °C |
| I _{S,INPUT} | Input Current ⁽²⁾ | 400 | mA |
| P _{S,OUTPUT} | Output Power (Duty Factor ≤ 2.7%) ⁽²⁾ | 700 | mW |
| R _{IO} | Insulation Resistance at T _S , V _{IO} = 500 V ⁽²⁾ | > 10 ⁹ | Ω |

Note:

2. Safety limit value - maximum values allowed in the event of a failure.

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 | Unit |
|------------------------|--|-----------------------------|------------------|
| T_{STG} | Storage Temperature | -55 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 Wave Solder Temperature (refer to page 21 for reflow solder profile) | 260 for 10sec | $^\circ\text{C}$ |
| $I_{F(AVG)}$ | Average Input Current | 25 | mA |
| $I_{F(PEAK)}$ | Peak Transient Forward Current ⁽³⁾ | 1 | A |
| f | Operating Frequency ⁽⁴⁾ | 50 | kHz |
| V_R | Reverse Input Voltage | 5 | V |
| $I_{O(PEAK)}$ | Peak Output Current ⁽⁵⁾ | 3.0 | A |
| $V_{DD} - V_{SS}$ | Supply Voltage | | V |
| | | $T_A \geq 90^\circ\text{C}$ | |
| $V_{O(PEAK)}$ | Peak Output Voltage | 0 to V_{DD} | V |
| $t_{R(IN)}, t_{F(IN)}$ | Input Signal Rise and Fall Time | 500 | ns |
| PD_I | Input Power Dissipation ⁽⁶⁾⁽⁸⁾ | 45 | mW |
| PD_O | Output Power Dissipation ⁽⁷⁾⁽⁸⁾ | 250 | mW |

Notes:

3. Pulse Width, $P_W \leq 1 \mu\text{s}$, 300 pps
4. Exponential Waveform, $I_{O(PEAK)} \leq |2.5 \text{ A}| (\leq 0.3 \mu\text{s})$
5. Maximum pulse width = 10 μs , maximum duty cycle = 1.1%
6. Derate linearly above 87 $^\circ\text{C}$, free air temperature at a rate of 0.77 mW/ $^\circ\text{C}$
7. No derating required across temperature range.
8. Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.

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 | Value | Unit |
|-------------------|-------------------------------|-------------|------------------|
| T_A | Ambient Operating Temperature | -40 to +100 | $^\circ\text{C}$ |
| $V_{DD} - V_{SS}$ | Power Supply | 15 to 30 | V |
| $I_{F(ON)}$ | Input Current (ON) | 7 to 16 | mA |
| $V_{F(OFF)}$ | Input Voltage (OFF) | 0 to 0.8 | V |

Isolation Characteristics

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------|--------------------------------|---|-------|-----------|------|-----------|
| V_{ISO} | Input-Output Isolation Voltage | $T_A = 25^\circ\text{C}$, R.H. < 50%, $t = 1.0\text{min}$, $I_{I-O} \leq 10 \mu\text{A}$, 50 Hz ⁽⁹⁾⁽¹⁰⁾ | 5,000 | | | V_{RMS} |
| R_{ISO} | Isolation Resistance | $V_{I-O} = 500 \text{V}^{(9)}$ | | 10^{11} | | Ω |
| C_{ISO} | Isolation Capacitance | $V_{I-O} = 0 \text{V}$, Freq = 1.0 MHz ⁽⁹⁾ | | 1 | | pF |

Notes:

9. Device is considered a two terminal device: Pins 2 and 3 are shorted together and Pins 5, 6, 7 and 8 are shorted together.

10. 5,000 V_{RMS} for 1 minute duration is equivalent to 6,000 V_{ACRMS} for 1 second duration.

Electrical Characteristics

Apply over all recommended conditions, typical value is measured at $V_{DD} = 30 \text{V}$, $V_{SS} = \text{Ground}$, $T_A = 25^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---------------------|--|---|--------------------------|-------------------------|--------------------------|----------------------|
| V_F | Input Forward Voltage | $I_F = 10 \text{mA}$ | 1.2 | 1.5 | 1.8 | V |
| $\Delta(V_F / T_A)$ | Temperature Coefficient of Forward Voltage | | | -1.8 | | mV/ $^\circ\text{C}$ |
| BV_R | Input Reverse Breakdown Voltage | $I_R = 10 \mu\text{A}$ | 5 | | | V |
| C_{IN} | Input Capacitance | $f = 1 \text{MHz}$, $V_F = 0\text{V}$ | | 60 | | pF |
| I_{OH} | High Level Output Current ⁽⁴⁾ | $V_O = V_{DD} - 3 \text{V}$ | -1.0 | -2.0 | -2.5 | A |
| | | $V_O = V_{DD} - 6 \text{V}$ | -2.0 | | -2.5 | |
| I_{OL} | Low Level Output Current ⁽⁴⁾ | $V_O = V_{SS} + 3 \text{V}$ | 1.0 | 2.0 | 2.5 | A |
| | | $V_O = V_{SS} + 6 \text{V}$ | 2.0 | | 2.5 | |
| V_{OH} | High Level Output Voltage | $I_F = 10 \text{mA}$, $I_O = -2.5 \text{A}$ | $V_{DD} - 6.25 \text{V}$ | $V_{DD} - 2.5 \text{V}$ | | V |
| | | $I_F = 10 \text{mA}$, $I_O = -100 \text{mA}$ | $V_{DD} - 0.25 \text{V}$ | $V_{DD} - 0.1 \text{V}$ | | |
| V_{OL} | Low Level Output Voltage | $I_F = 0 \text{mA}$, $I_O = 2.5 \text{A}$ | | $V_{SS} + 2.5 \text{V}$ | $V_{SS} + 6.25 \text{V}$ | V |
| | | $I_F = 0 \text{mA}$, $I_O = 100 \text{mA}$ | | $V_{SS} + 0.1 \text{V}$ | $V_{SS} + 0.25 \text{V}$ | |
| I_{DDH} | High Level Supply Current | $V_O = \text{Open}$, $I_F = 7 \text{ to } 16 \text{mA}$ | | 2.8 | 3.8 | mA |
| I_{DDL} | Low Level Supply Current | $V_O = \text{Open}$, $V_F = 0 \text{ to } 0.8 \text{V}$ | | 2.8 | 3.8 | mA |
| I_{FLH} | Threshold Input Current Low to High | $I_O = 0 \text{mA}$, $V_O > 5 \text{V}$ | | 2.3 | 5.0 | mA |
| V_{FHL} | Threshold Input Voltage High to Low | $I_O = 0 \text{mA}$, $V_O < 5 \text{V}$ | 0.8 | | | V |
| V_{UVLO+} | Under Voltage Lockout Threshold | $I_F = 10 \text{mA}$, $V_O > 5 \text{V}$ | 11.5 | 12.7 | 13.5 | V |
| V_{UVLO-} | | $I_F = 10 \text{mA}$, $V_O < 5 \text{V}$ | 10.0 | 11.2 | 12.0 | V |
| $UVLO_{HYS}$ | Under Voltage Lockout Threshold Hysteresis | | | 1.5 | | V |

Switching Characteristics

Apply over all recommended conditions, typical value is measured at $V_{DD} = 30\text{ V}$, $V_{SS} = \text{Ground}$, $T_A = 25^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------------|--|--|---|------|---------------|-------------------------|
| t_{PHL} | Propagation Delay Time to Logic Low Output | $I_F = 7\text{ mA to }16\text{ mA}$, $R_g = 10\ \Omega$, $C_g = 10\text{ nF}$, $f = 10\text{ kHz}$, Duty Cycle = 50% | 150 | 275 | 400 | ns |
| t_{PLH} | Propagation Delay Time to Logic High Output | | 150 | 255 | 400 | ns |
| PWD | Pulse Width Distortion, $ t_{PHL} - t_{PLH} $ | | 20 | 100 | ns | |
| PDD (Skew) | Propagation Delay Difference Between Any Two Parts or Channels, $(t_{PHL} - t_{PLH})^{(11)}$ | | -250 | 250 | ns | |
| t_R | Output Rise Time (10% – 90%) | | 60 | ns | | |
| t_F | Output Fall Time (90% – 10%) | | 60 | ns | | |
| $t_{UVLO\ ON}$ | UVLO Turn On Delay | | $I_F = 10\text{ mA}$, $V_O > 5\text{ V}$ | | 1.6 | μs |
| $t_{UVLO\ OFF}$ | UVLO Turn Off Delay | $I_F = 10\text{ mA}$, $V_O < 5\text{ V}$ | | 0.4 | μs | |
| $ CM_H $ | Common Mode Transient Immunity at Output High | $T_A = 25^\circ\text{C}$, $V_{DD} = 30\text{ V}$, $I_F = 7\text{ to }16\text{ mA}$, $V_{CM} = 2000\text{ V}^{(12)}$ | 35 | 50 | | $\text{kV}/\mu\text{s}$ |
| $ CM_L $ | Common Mode Transient Immunity at Output Low | $T_A = 25^\circ\text{C}$, $V_{DD} = 30\text{ V}$, $V_F = 0\text{ V}$, $V_{CM} = 2000\text{ V}^{(13)}$ | 35 | 50 | | $\text{kV}/\mu\text{s}$ |

Notes:

11. The difference between t_{PHL} and t_{PLH} between any two FOD3120 parts under same test conditions.
12. Common mode transient immunity at output high is the maximum tolerable negative dV_{cm}/dt on the trailing edge of the common mode impulse signal, V_{cm} , to assure that the output will remain high (i.e. $V_O > 15.0\text{ V}$).
13. Common mode transient immunity at output low is the maximum tolerable positive dV_{cm}/dt on the leading edge of the common pulse signal, V_{cm} , to assure that the output will remain low (i.e. $V_O < 1.0\text{ V}$).

Typical Performance Characteristics

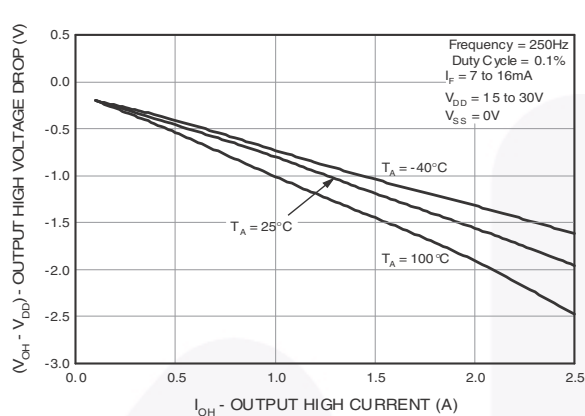


Fig. 3 Output High Voltage Drop vs. Output High Current

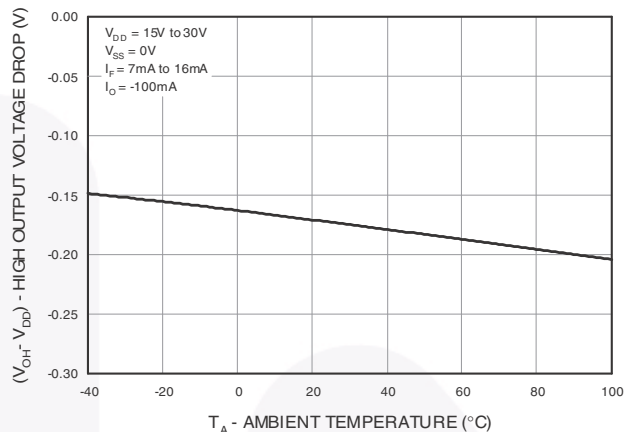


Fig. 4 Output High Voltage Drop vs. Ambient Temperature

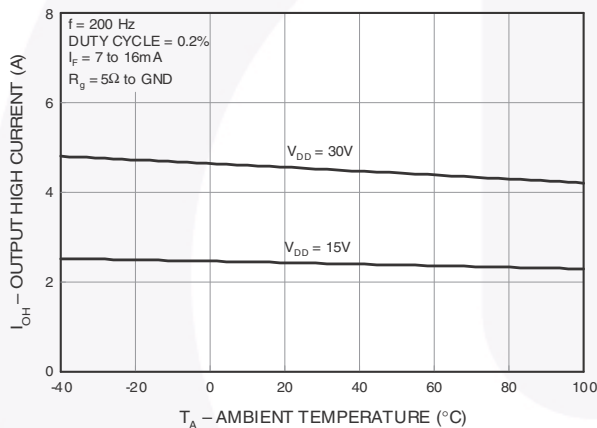


Fig. 5 Output High Current vs. Ambient Temperature

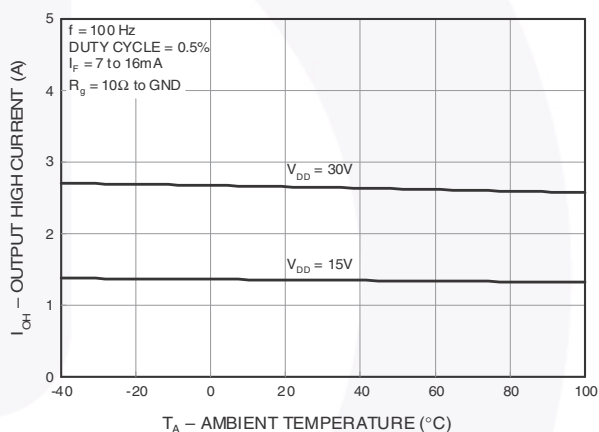


Fig. 6 Output High Current vs. Ambient Temperature

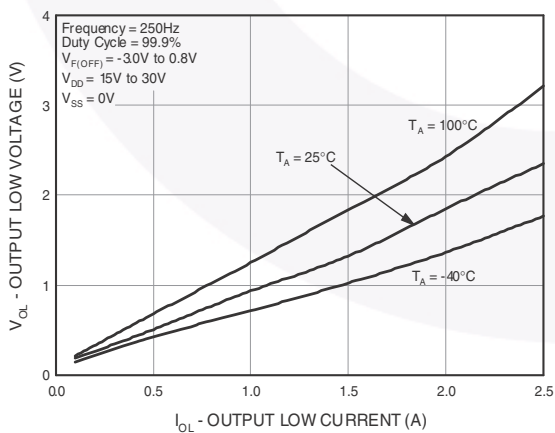


Fig. 7 Output Low Voltage vs. Output Low Current



Fig. 8 Output Low Voltage vs. Ambient Temperature

Typical Performance Characteristics (Continued)



Fig. 9 Output Low Current vs. Ambient Temperature



Fig. 10 Output Low Current vs. Ambient Temperature



Fig. 11 Supply Current vs. Ambient Temperature

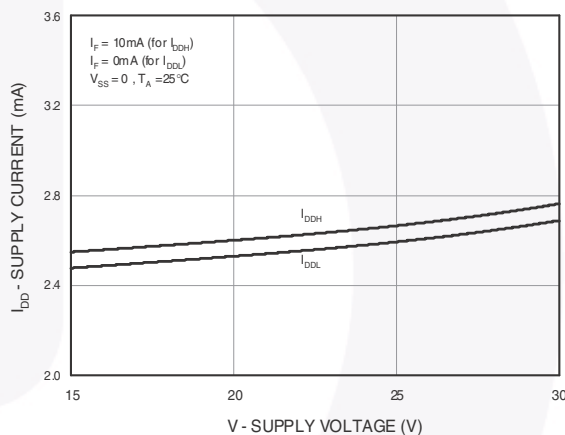


Fig. 12 Supply Current vs. Supply Voltage

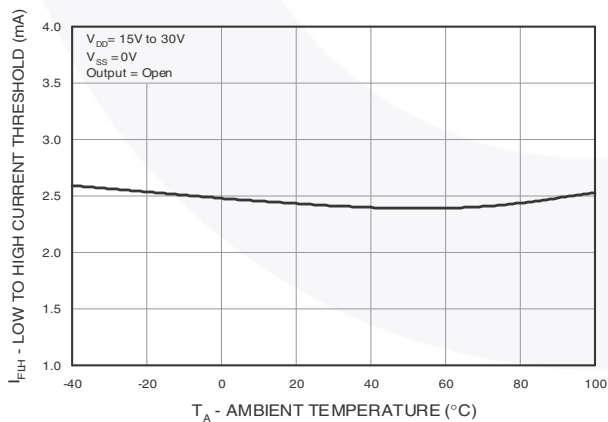


Fig. 13 Low to High Input Current Threshold vs. Ambient Temperature

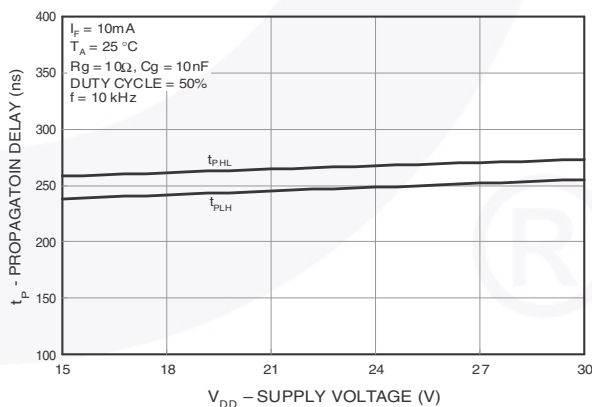


Fig. 14 Propagation Delay vs. Supply Voltage

Typical Performance Characteristics (Continued)

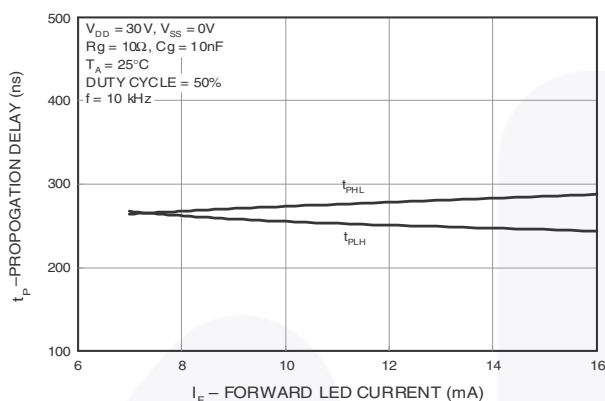


Fig. 15 Propagation Delay vs. LED Forward Current

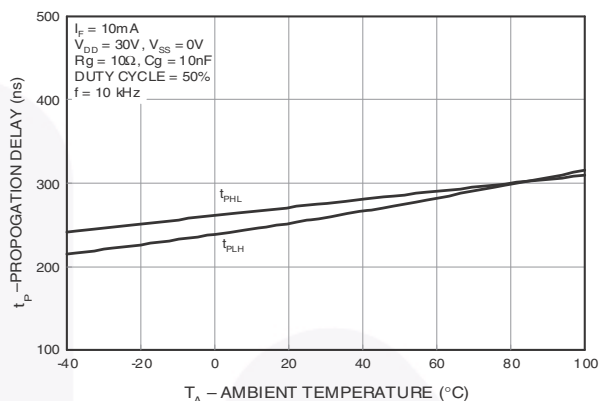


Fig. 16 Propagation Delay vs. Ambient Temperature



Fig. 17 Propagation Delay vs. Series Load Resistance

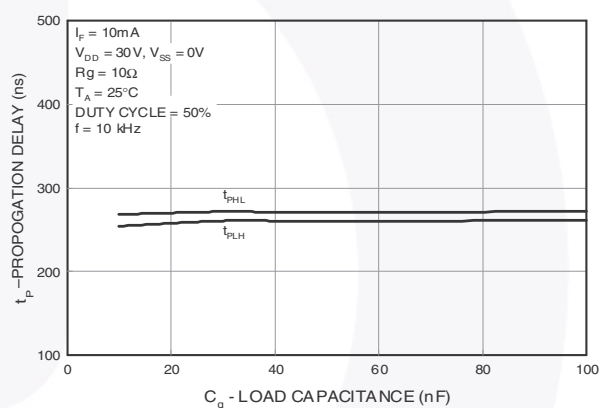


Fig. 18 Propagation Delay vs. Load Capacitance

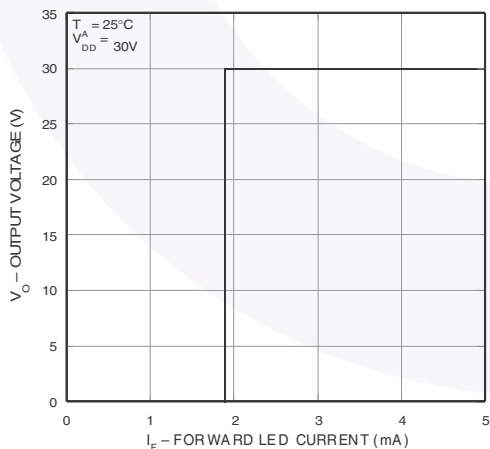


Fig. 19 Transfer Characteristics



Fig. 20 Input Forward Current vs. Forward Voltage

Typical Performance Characteristics (Continued)



Fig. 21 Under Voltage Lockout



Test Circuit

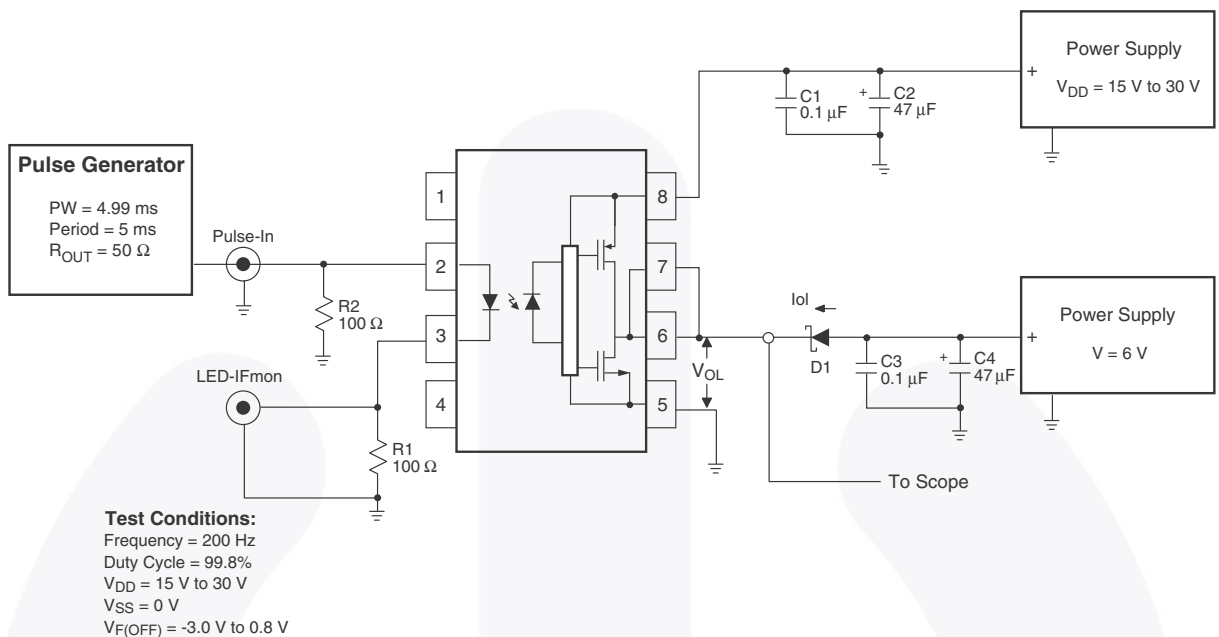


Figure 22. I_{OL} Test Circuit

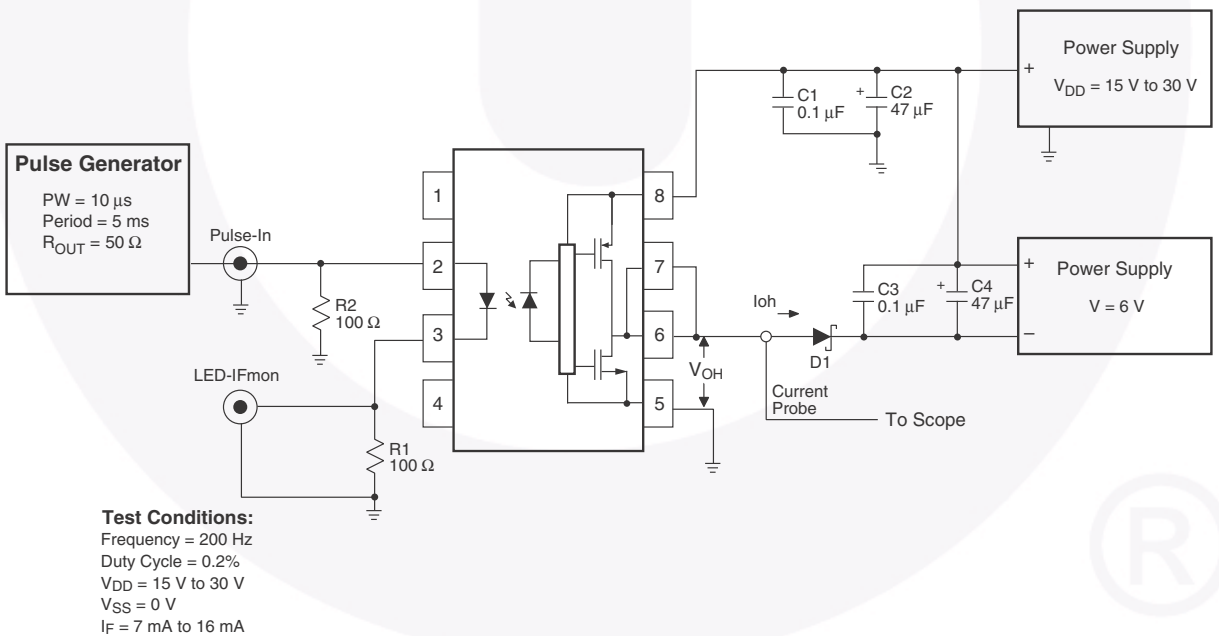


Figure 23. I_{OH} Test Circuit

Test Circuit (Continued)

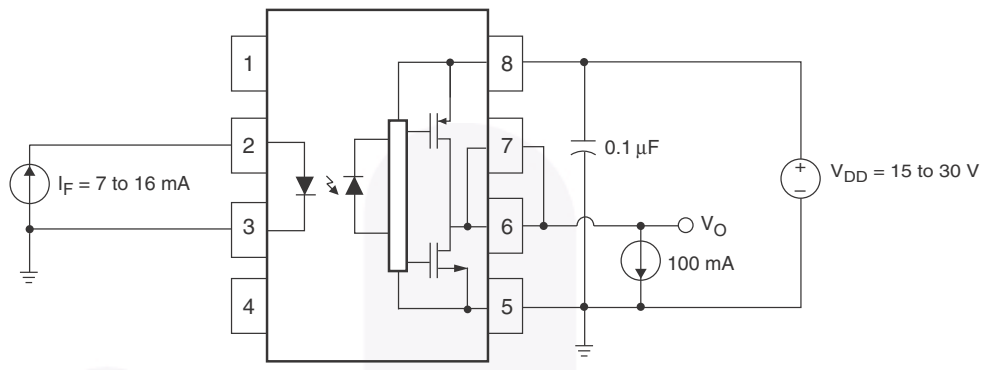


Figure 24. V_{OH} Test Circuit

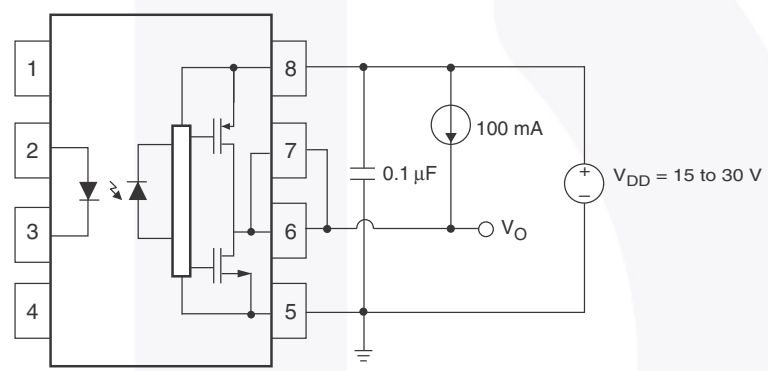


Figure 25. V_{OL} Test Circuit



Test Circuit (Continued)



Figure 26. I_{DDH} Test Circuit



Figure 27. I_{DDL} Test Circuit



Test Circuit (Continued)



Figure 28. I_{FLH} Test Circuit



Figure 29. V_{FHL} Test Circuit

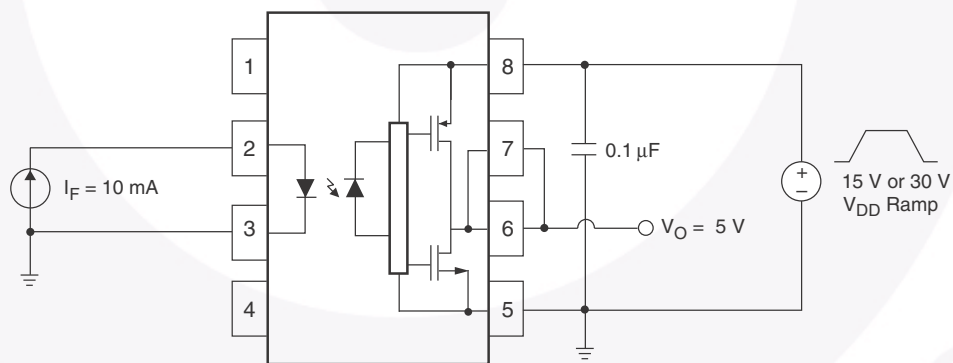


Figure 30. UVLO Test Circuit

Test Circuit (Continued)

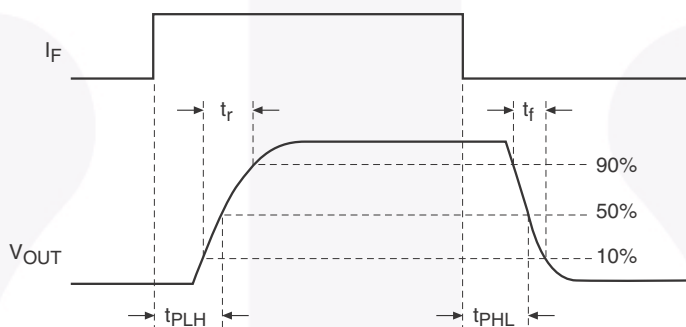


Figure 31. t_{PHL} , t_{PLH} , t_R and t_F Test Circuit and Waveforms

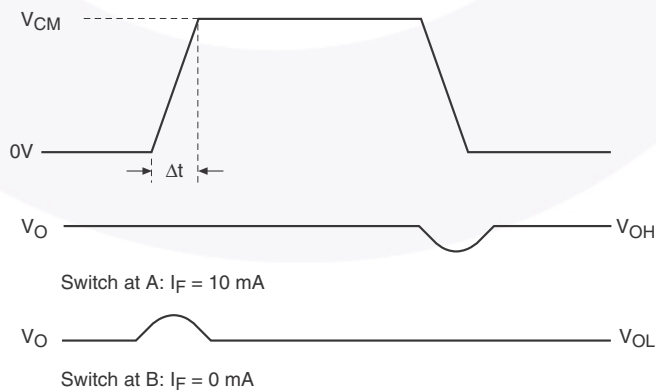
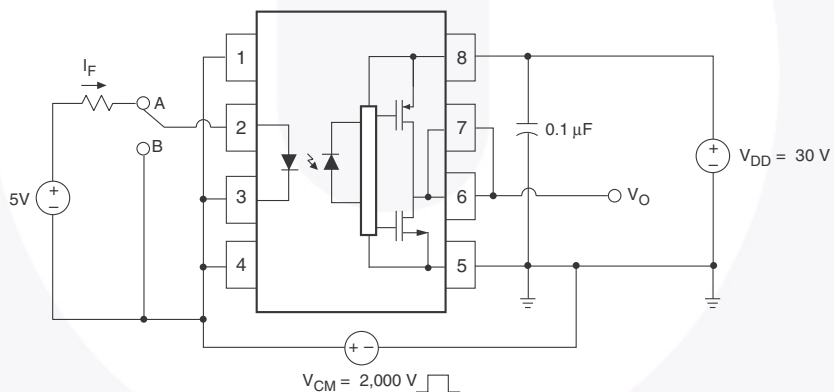


Figure 32. CMR Test Circuit and Waveforms

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. |

Ordering Information

| Part Number | Package | Packing Method |
|--------------|--|--------------------------------------|
| FOD3120 | DIP 8-Pin | Tube (50 units per tube) |
| FOD3120S | SMT 8-Pin (Lead Bend) | Tube (50 units per tube) |
| FOD3120SD | SMT 8-Pin (Lead Bend) | Tape and Reel (1,000 units per reel) |
| FOD3120V | DIP 8-Pin, DIN_EN/IEC60747-5-5 option | Tube (50 units per tube) |
| FOD3120SV | SMT 8-Pin (Lead Bend), DIN_EN/IEC60747-5-5 option | Tube (50 units per tube) |
| FOD3120SDV | SMT 8-Pin (Lead Bend), DIN_EN/IEC60747-5-5 option | Tape and Reel (1,000 units per reel) |
| FOD3120TV | DIP 8-Pin, 0.4" Lead Spacing, DIN_EN/IEC60747-5-5 option | Tube (50 units per tube) |
| FOD3120TSV | SMT 8-Pin, 0.4" Lead Spacing, DIN_EN/IEC60747-5-5 option | Tube (50 units per tube) |
| FOD3120TSR2V | SMT 8-Pin, 0.4" Lead Spacing, DIN_EN/IEC60747-5-5 option | Tape and Reel (700 units per reel) |

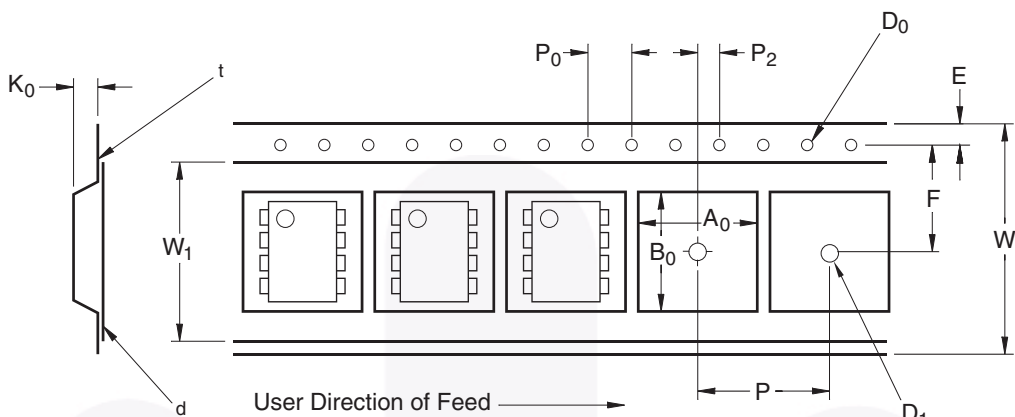
Marking Information



Figure 33. 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 | Two digit year code, e.g., '16' |
| 5 | Two digit work week ranging from '01' to '53' |
| 6 | Assembly package code |

Carrier Tape Specifications (Option SD)

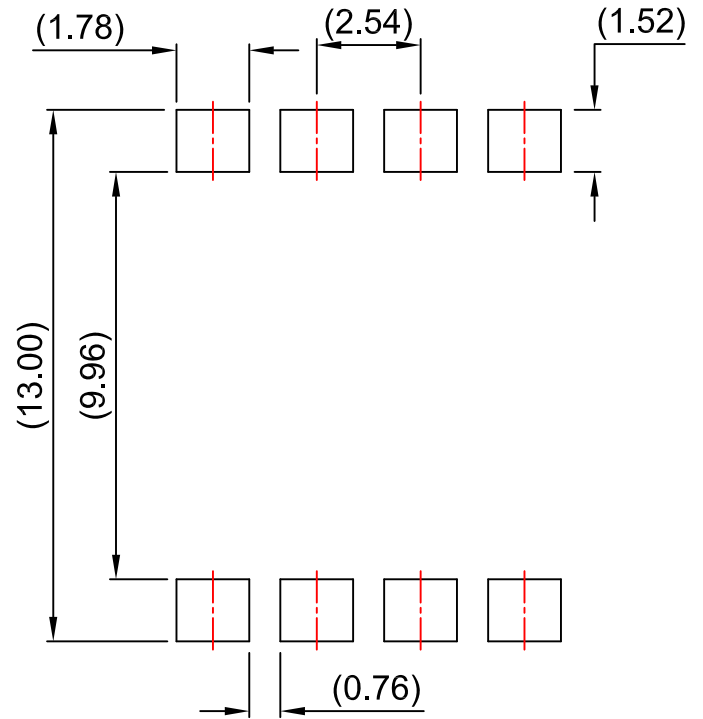


| Symbol | Description | Dimension in mm |
|----------------|---------------------------------|-----------------|
| W | Tape Width | 16.0 ± 0.3 |
| t | Tape Thickness | 0.30 ± 0.05 |
| P ₀ | Sprocket Hole Pitch | 4.0 ± 0.1 |
| D ₀ | Sprocket Hole Diameter | 1.55 ± 0.05 |
| E | Sprocket Hole Location | 1.75 ± 0.10 |
| F | Pocket Location | 7.5 ± 0.1 |
| P ₂ | | 2.0 ± 0.1 |
| P | Pocket Pitch | 12.0 ± 0.1 |
| A ₀ | Pocket Dimensions | 10.30 ± 0.20 |
| B ₀ | | 10.30 ± 0.20 |
| K ₀ | | 4.90 ± 0.20 |
| W ₁ | Cover Tape Width | 13.2 ± 0.2 |
| d | Cover Tape Thickness | 0.1 max |
| | Max. Component Rotation or Tilt | 10° |
| R | Min. Bending Radius | 30 |

Carrier Tape Specifications (Option TSR2)



| Symbol | Description | Dimension in mm |
|----------------|---------------------------------|-----------------|
| W | Tape Width | 24.0 ± 0.3 |
| t | Tape Thickness | 0.40 ± 0.1 |
| P ₀ | Sprocket Hole Pitch | 4.0 ± 0.1 |
| D ₀ | Sprocket Hole Diameter | 1.55 ± 0.05 |
| E | Sprocket Hole Location | 1.75 ± 0.10 |
| F | Pocket Location | 11.5 ± 0.1 |
| P ₂ | | 2.0 ± 0.1 |
| P | Pocket Pitch | 16.0 ± 0.1 |
| A ₀ | Pocket Dimensions | 12.80 ± 0.1 |
| B ₀ | | 10.35 ± 0.1 |
| K ₀ | | 5.7 ± 0.1 |
| W ₁ | Cover Tape Width | 21.0 ± 0.1 |
| d | Cover Tape Thickness | 0.1 max |
| | Max. Component Rotation or Tilt | 10° |
| R | Min. Bending Radius | 30 |



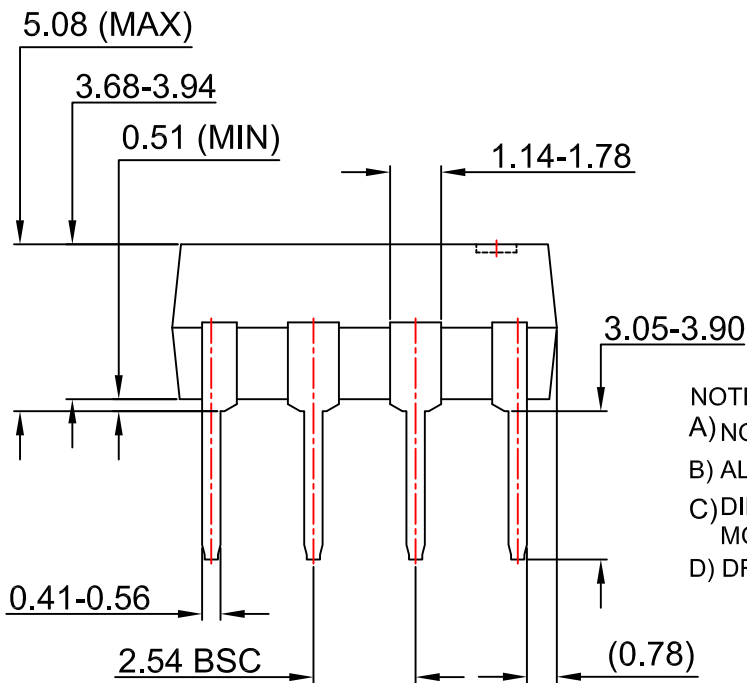
LAND PATTERN RECOMMENDATION



NOTES:

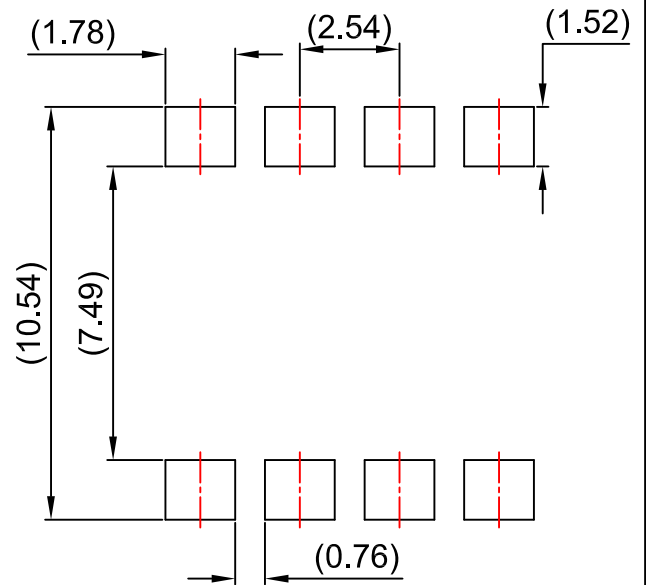
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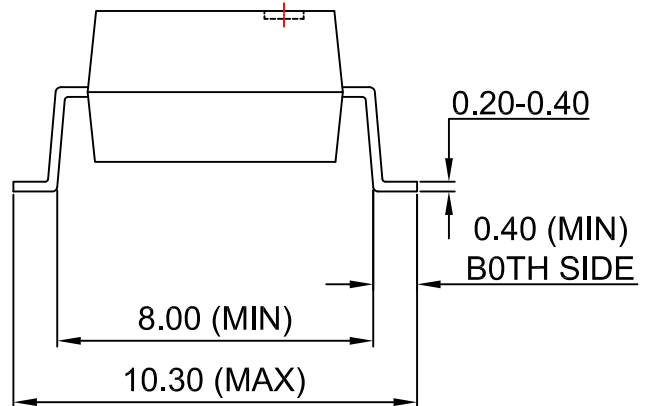


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PIN 1

15.0° (MAX)

10.16 (TYP)

0.20-0.40



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