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High Temperature, 2.5 A Output Current, Gate Drive Optocoupler



FOD3125

Description

The FOD3125 is a 2.5 A Output Current Gate Drive Optocoupler, capable of driving most medium IGBTs or MOSFETs across extended industrial temperature range, -40°C to 125°C . It is ideally suited for fast switching driving of power IGBTs and MOSFETs used in motor control inverter applications, and high performance power system.

It utilizes ON Semiconductor patented 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.

Features

- Extended Industrial Temperature Range, -40°C to 125°C
- High Noise Immunity characterized by 35 kV/ μs 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 maximum Propagation Delay
 - ◆ 100 ns maximum Pulse Width Distortion
- Under Voltage LockOut (UVLO) with Hysteresis
- Safety and Regulatory Approvals
 - ◆ UL1577, 5000 V_{RMS} for 1 minute
 - ◆ DIN EN/IEC60747-5-5 (pending approval)
- >8.0 mm Clearance and Creepage Distance (Option 'T' or 'TS')
- 1,414 V Peak Working Insulation Voltage (VIORM)
- This is a Pb-Free Device

Applications

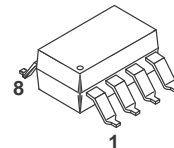
- Industrial Inverter
- Uninterruptible Power Supply
- Induction Heating
- Isolated IGBT/Power MOSFET Gate Drive

Table 1. TRUTH TABLE

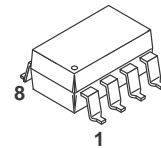
| LED | $V_{\text{DD}} - V_{\text{SS}}$ "Positive Going" (Turn-on) | $V_{\text{DD}} - V_{\text{SS}}$ "Negative Going" (Turn-off) | V_{O} |
|-----|--|---|----------------|
| Off | 0 V to 30 V | 0 V to 30 V | Low |
| On | 0 V to 11 V | 0 V to 9.7 V | Low |
| On | 11 V to 14 V | 9.7 V to 12.7 V | Transition |
| On | 14 V to 30 V | 12.7 V to 30 V | High |

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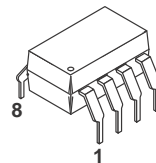
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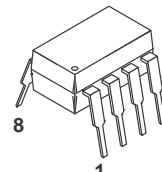
PDIP8 GW
CASE 709AD



PDIP8 GW
CASE 709AC

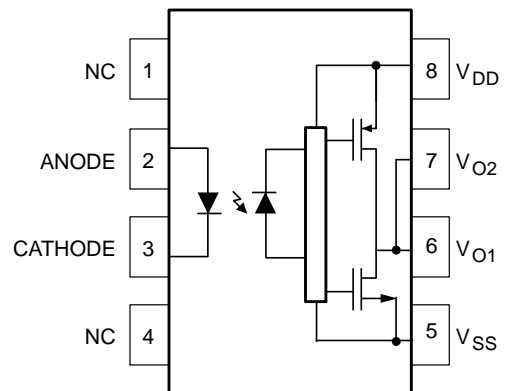


PDIP8 6.6x3.81, 2.54P
CASE 646BW



PDIP8 9.655x6.6, 2.54P
CASE 646CQ

FUNCTIONAL BLOCK DIAGRAM



Note: A 0.1 μF bypass capacitor must be connected between pins 5 and 8.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 13 of this data sheet.

FOD3125

Table 2. PIN DEFINITIONS

| Pin # | Name | Description |
|-------|---------|---|
| 1 | NC | Not Connected |
| 2 | Anode | LED Anode |
| 3 | Cathode | LED Cathode |
| 4 | NC | Not Connected |
| 5 | VSS | Negative Supply Voltage |
| 6 | VO2 | Output Voltage 2 (internally connected to V _{O1}) |
| 7 | VO1 | Output Voltage 1 |
| 8 | VDD | Positive Supply Voltage |

Table 3. SAFETY AND INSULATION RATINGS

As per DIN EN/IEC 60747-5-5 (pending approval). 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 < 150 Vrms | | I-IV | | |
| | For Rated Main Voltage < 300 Vrms | | I-IV | | |
| | For Rated Main Voltage < 450 Vrms | | I-III | | |
| | For Rated Main Voltage < 600 Vrms | | I-III | | |
| | For Rated Main Voltage < 1000 Vrms (option T, TS) | | I-III | | |
| | Climatic Classification | | 40/125/21 | | |
| | 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 second, Partial Discharge < 5 pC | 2651 | | | |
| | Input to Output Test Voltage, Method a, V _{IORM} × 1.6 = V _{PR} , Type and Sample Test with t _m = 10 second, Partial Discharge < 5 pC | 2262 | | | |
| V _{IORM} | Max Working Insulation Voltage | 1414 | | | V _{peak} |
| V _{IOTM} | Highest Allowable Over Voltage | 6000 | | | V _{peak} |
| | External Creepage | ≥ 8 | | | mm |
| | External Clearance | ≥ 7.4 | | | mm |
| | External Clearance (for Option T or TS, 0.4" Lead Spacing) | ≥ 10.16 | | | mm |
| | Insulation Thickness | ≥ 0.5 | | | mm |
| T _{Case} | Case Temperature – Maximum Values Allowed in the Event of a Failure | 175 | | | °C |
| I _{S,INPUT} | Input Current – Maximum Values Allowed in the Event of a Failure | 400 | | | mA |
| P _{S,OUTPUT} | Output Power (Duty Factor ≤ 2.7 %) – Maximum Values Allowed in the Event of a Failure | 700 | | | mW |
| R _{IO} | Insulation Resistance at T _S , V _{IO} = 500 V – Maximum Values Allowed in the Event of a Failure | > 10 ⁹ | | | Ω |

FOD3125

Table 4. ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ unless otherwise specified.)

| Symbol | Parameter | Value | Units |
|------------------------|--|-----------------------------|------------------|
| T_{STG} | Storage Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{OPR} | Operating Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_J | Junction Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{SOL} | Lead Wave Solder Temperature (refer to page 12 for reflow solder profile) | 260 for 10 sec | $^\circ\text{C}$ |
| $I_{F(AVG)}$ | Average Input Current | 25 | mA |
| f | Operating Frequency ⁽¹⁾ | 50 | kHz |
| V_R | Reverse Input Voltage | 5 | V |
| $I_{O(PEAK)}$ | Peak Output Current ⁽²⁾ | 3 | A |
| $V_{DD} - V_{SS}$ | Supply Voltage | 0 to 35 | 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 ^{(3) (5)} | 45 | mW |
| PD_O | Output Power Dissipation ^{(4) (5)} | 250 | mW |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Exponential Waveform, $I_{O(PEAK)} \leq |2.5 A| \leq 0.3 \mu\text{s}$
2. Maximum pulse width = 10 μs , maximum duty cycle = 1.1 %.
3. Derate linearly above 87 $^\circ\text{C}$, free air temperature at a rate of 0.77 mW/ $^\circ\text{C}$.
4. Derate linearly above 100 $^\circ\text{C}$, free air temperature at a rate of 5.7 mW/ $^\circ\text{C}$.
5. Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.

Table 5. RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Units |
|-------------------|-------------------------------|-------------|------------------|
| T_A | Ambient Operating Temperature | -40 to +125 | $^\circ\text{C}$ |
| $V_{DD} - V_{SS}$ | 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 |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Table 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 %, $t = 1.0$ minute, $I_{I-O} \leq 10 \mu\text{A}$, 50 Hz ^{(6) (7)} | 5000 | | | V_{RMS} |
| R_{ISO} | Isolation Resistance | $V_{I-O} = 500 \text{ V}$ ⁽⁶⁾ | | 10^{11} | | Ω |
| C_{ISO} | Isolation Capacitance | $V_{I-O} = 0 \text{ V}$, Frequency = 1.0 MHz ⁽⁶⁾ | | 1 | | pF |

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

7. 5,000 V_{RMS} for 1 minute duration is equivalent to 6,000 VAC_{RMS} for 1 second duration.

Table 7. ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---------------------|--|------------------------|------|------|------|----------------------|
| V_F | Input Forward Voltage | $I_F = 10 \text{ mA}$ | 1.1 | 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 |

FOD3125

Table 7. ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---------|--|--|---------------------------|--------------------------|---------------------------|-------|
| CIN | Input Capacitance | $f = 1 \text{ MHz}, V_F = 0 \text{ V}$ | | 20 | | pF |
| IOH | High Level Output Current ⁽¹⁾ | $V_O = V_{DD} - 3 \text{ V}$ | -1.0 | -2.0 | | A |
| | | $V_O = V_{DD} - 6 \text{ V}$ | -2.0 | | | |
| IOL | Low Level Output Current ⁽¹⁾ | $V_O = V_{SS} + 3 \text{ V}$ | 1.0 | 2.0 | | A |
| | | $V_O = V_{SS} + 6 \text{ V}$ | 2.0 | | | |
| VOH | 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 |
| | | $I_F = 10 \text{ mA}, I_O = -100 \text{ mA}$ | $V_{DD} - 0.25 \text{ V}$ | $V_{DD} - 0.1 \text{ V}$ | | |
| VOL | 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 |
| | | $I_F = 0 \text{ mA}, I_O = 100 \text{ mA}$ | | $V_{SS} + 0.1 \text{ V}$ | $V_{SS} + 0.25 \text{ V}$ | |
| IDDH | High Level Supply Current | $V_O = \text{Open}, I_F = 7 \text{ to } 16 \text{ mA}$ | | 2.8 | 3.8 | mA |
| IDDL | Low Level Supply Current | $V_O = \text{Open}, V_F = 0 \text{ to } 0.8 \text{ V}$ | | 2.8 | 3.8 | mA |
| IFLH | Threshold Input Current Low to High | $I_O = 0 \text{ mA}, V_O > 5 \text{ V}$ | | 2.3 | 5.0 | mA |
| VFHL | Threshold Input Voltage High to Low | $I_O = 0 \text{ mA}, V_O < 5 \text{ V}$ | 0.8 | | | V |
| VUVLO+ | Under Voltage Lockout Threshold | $I_F = 1 \text{ mA}, V_O > 5 \text{ V}$ | 11 | 12.7 | 14 | V |
| VUVLO- | | $I_F = 10 \text{ mA}, V_O < 5 \text{ V}$ | 9.7 | 11.2 | 12.7 | V |
| UVLOHYS | Under Voltage Lockout Threshold Hysteresis | | | 1.5 | | V |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

8. Maximum pulse width = 10 μs , maximum duty cycle = 1.1 %.

Table 8. 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. | Units | |
|-----------------|--|--|--|------|------|-------------------|---------------|
| tPHL | Propagation Delay Time to Logic Low Output | $I_F = 7 \text{ mA to } 16 \text{ mA},$ $R_g = 10 \Omega, C_g = 10 \text{ nF},$ $f = 10 \text{ kHz}, \text{ Duty Cycle} = 50 \%$ | 150 | 275 | 400 | ns | |
| tPLH | 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, $(t_{PHL} - t_{PLH})$ ⁽⁹⁾ | | | -250 | | 250 | ns |
| t _r | Output Rise Time (10% – 90%) | | | | 60 | | ns |
| t _f | Output Fall Time (90% – 10%) | | | | 60 | | ns |
| tUVLO ON | UVLO Turn On Delay | | $I_F = 10 \text{ mA}, V_O > 5 \text{ V}$ | | 1.6 | | μs |
| tUVLO 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 | $T_A = 25^\circ\text{C}, V_{DD} = 30 \text{ V},$ $I_F = 7 \text{ to } 16 \text{ mA}, V_{CM} = 2000 \text{ V}$ ⁽¹⁰⁾ | 35 | 50 | | kV/ μs | |
| CM _L | Common Mode Transient Immunity at Output Low | $T_A = 25^\circ\text{C}, V_{DD} = 30 \text{ V}, V_F = 0 \text{ V},$ $V_{CM} = 2000 \text{ V}$ ⁽¹¹⁾ | 35 | 50 | | kV/ μs | |

9. The difference between t_{PHL} and t_{PLH} between any two FOD3125 parts under same test conditions.

10. 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., $V_O > 15.0 \text{ V}$).

11. 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 CURVES

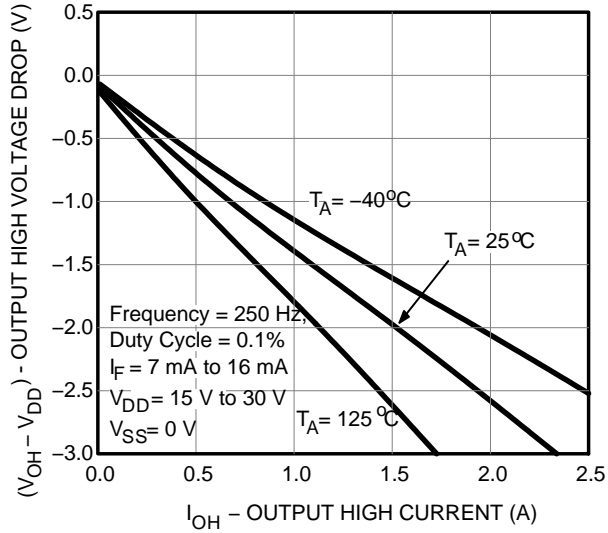


Figure 1. Output High Voltage Drop vs. Output High Current

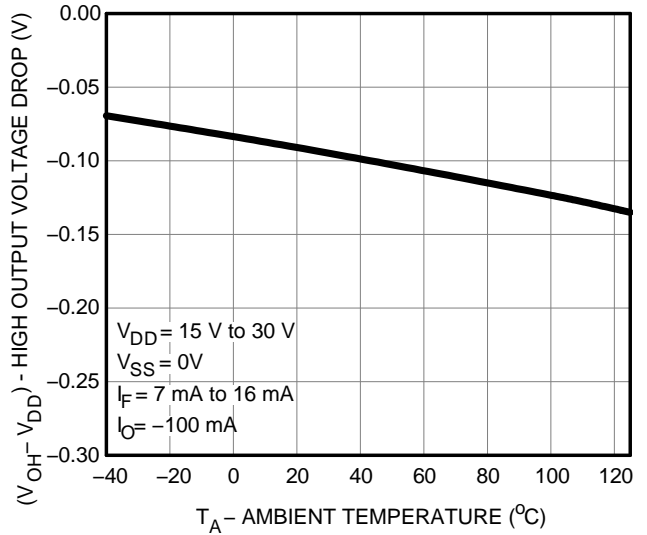


Figure 2. Output High Voltage Drop vs. Ambient Temperature

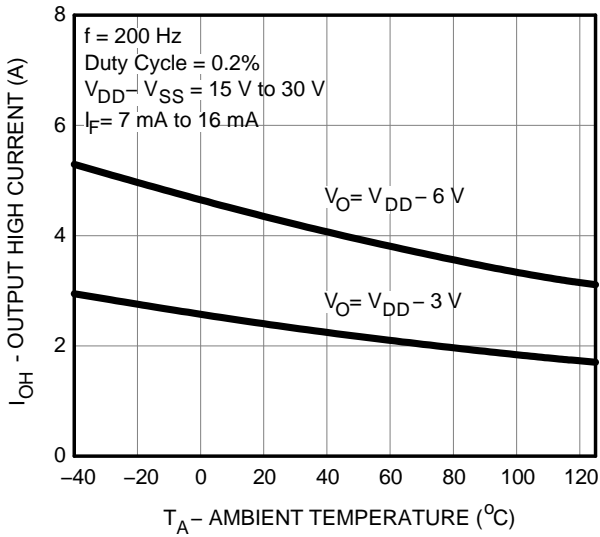


Figure 3. Output High Current vs. Ambient Temperature

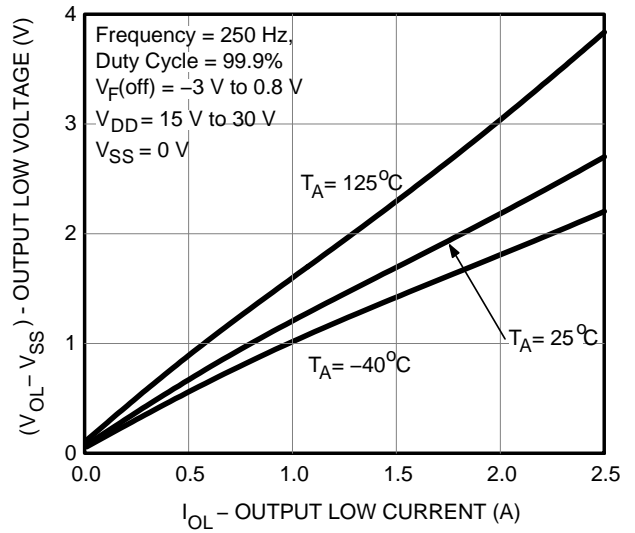


Figure 4. Output Low Voltage vs. Output Low Current

FOD3125

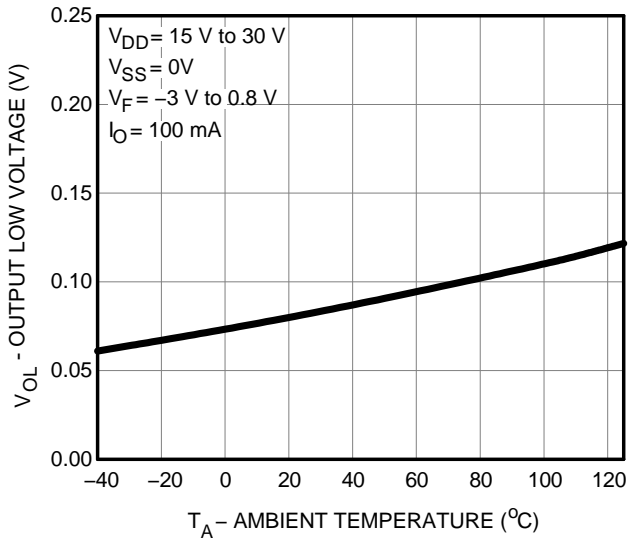


Figure 5. Output Low Voltage vs. Ambient Temperature

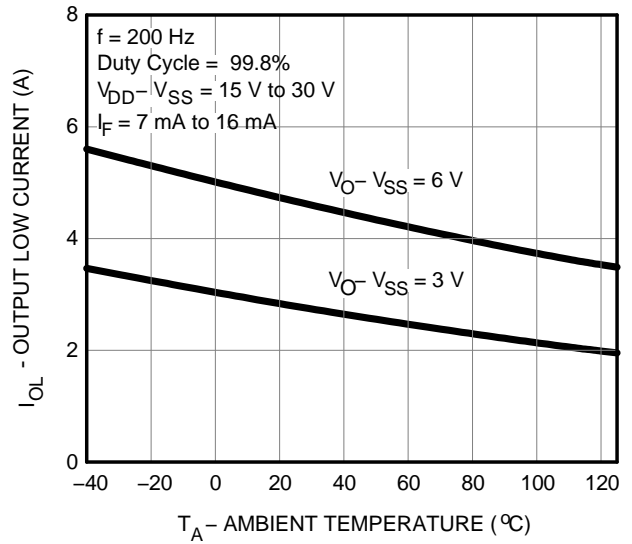


Figure 6. Output Low Current vs. Ambient Temperature

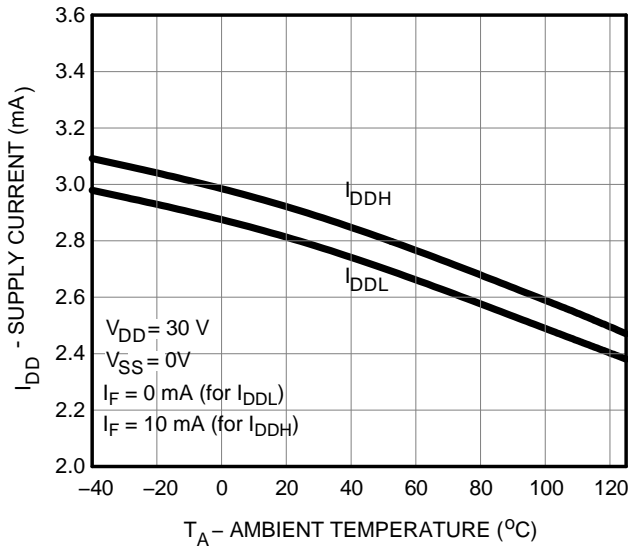


Figure 7. Supply Current vs. Ambient Temperature

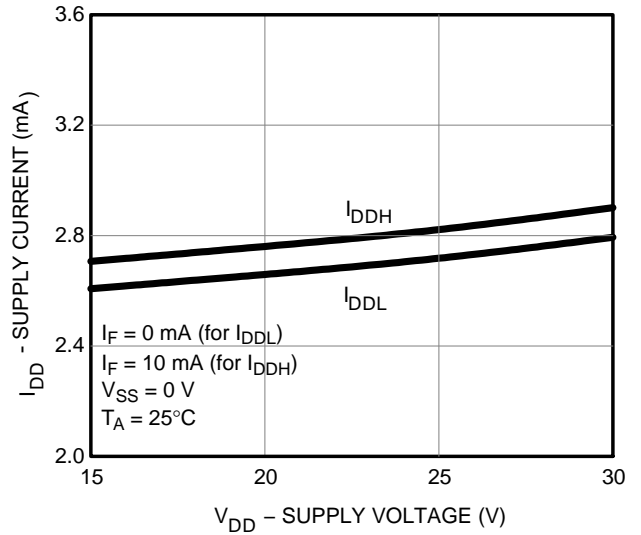


Figure 8. Supply Current vs. Supply Voltage

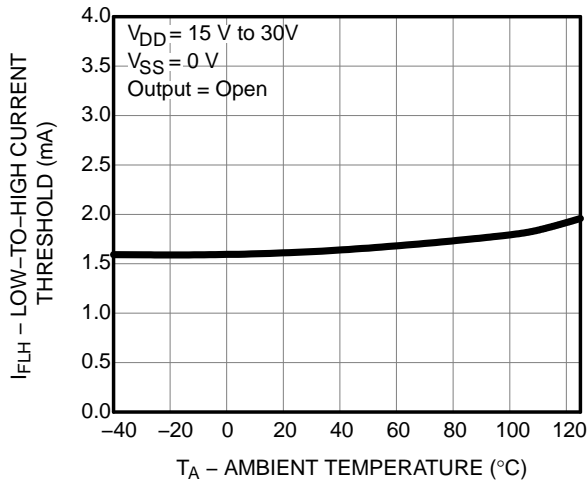


Figure 9. Low to High Input Current Threshold vs. Ambient Temperature

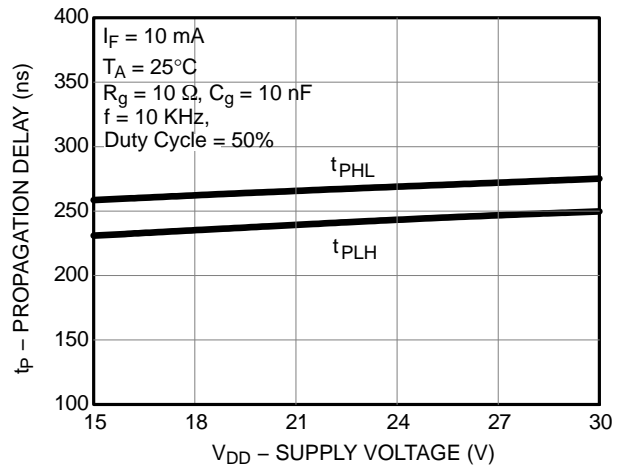


Figure 10. Propagation Delay vs. Supply Voltage

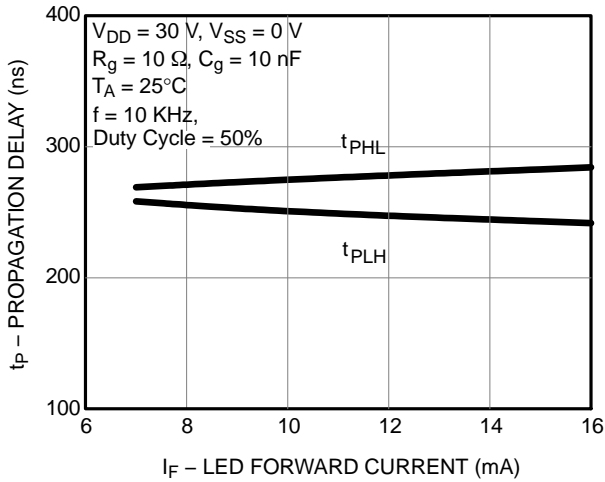


Figure 11. Propagation Delay vs. LED Forward Current

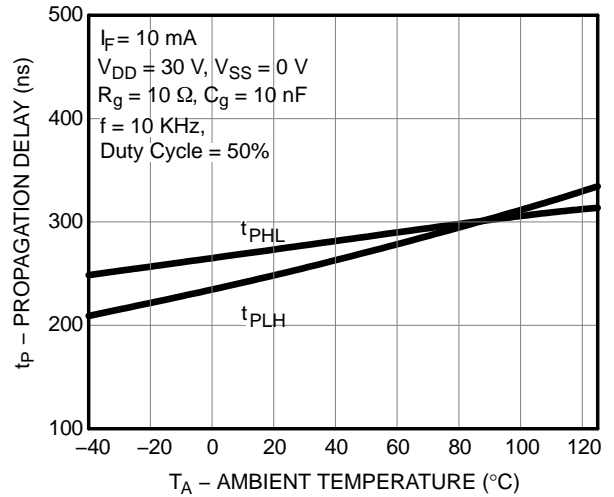


Figure 12. Propagation Delay vs. Ambient Temperature

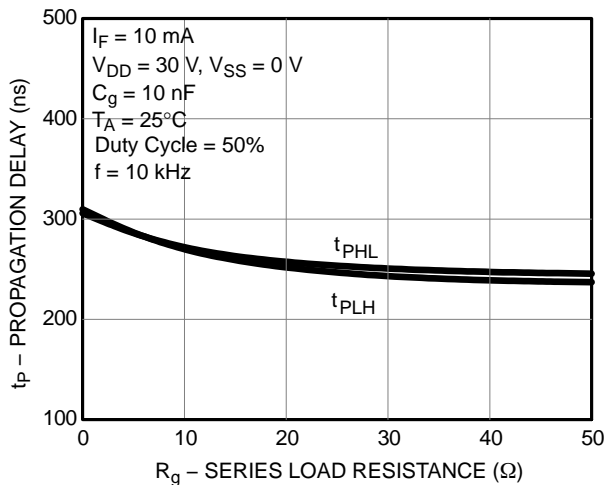


Figure 13. Propagation Delay vs. Series Load Resistance

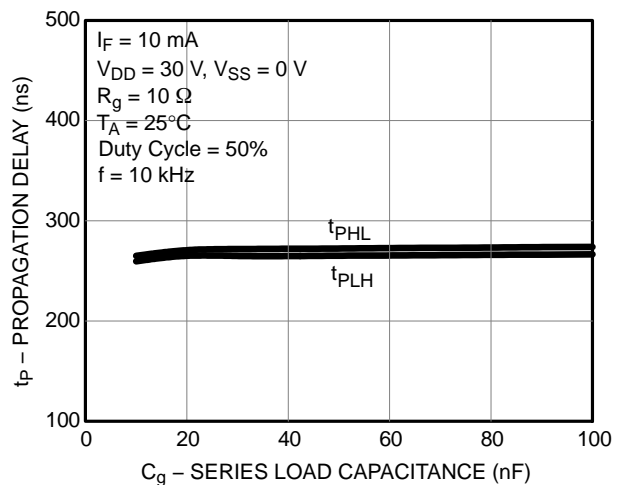


Figure 14. Propagation Delay vs. Load Capacitance

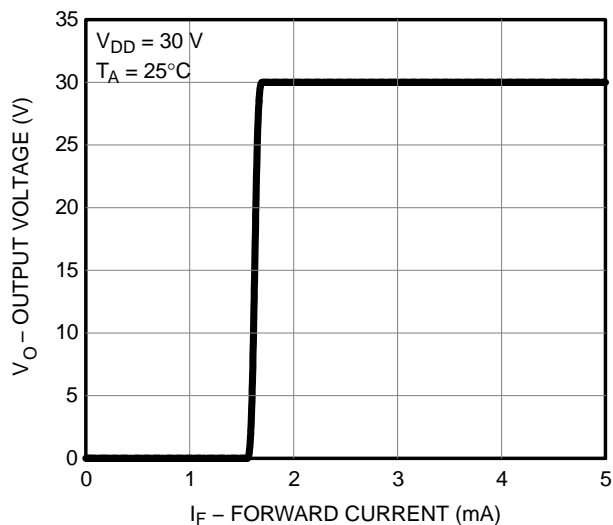


Figure 15. Transfer Characteristics

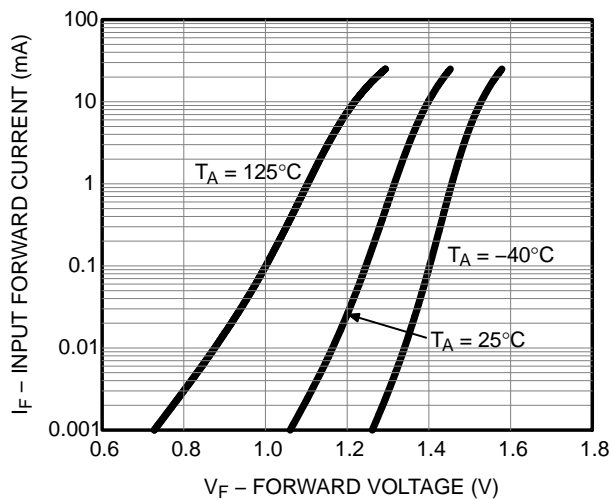


Figure 16. Input Forward Current vs. Forward Voltage

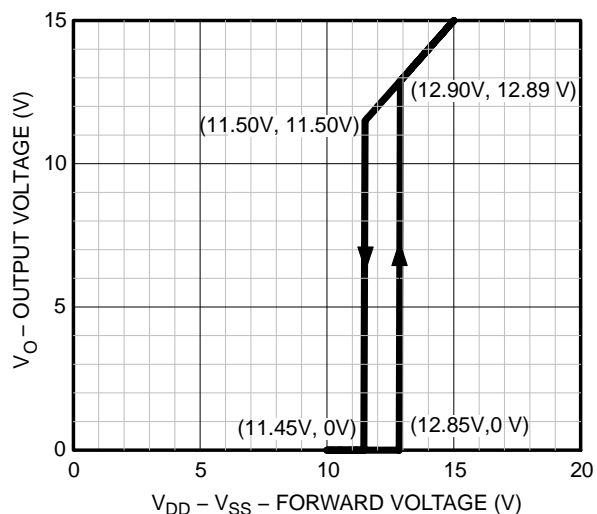


Figure 17. Under Voltage Lockout

FOD3125

TEST CIRCUIT

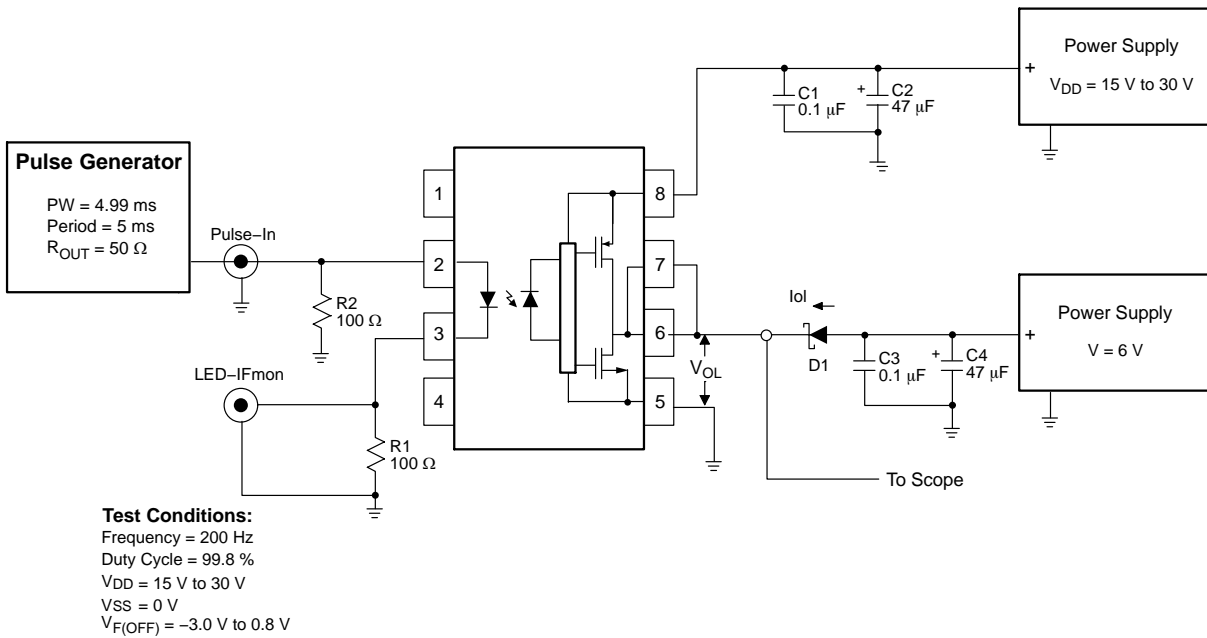


Figure 18. I_{OL} Test Circuit

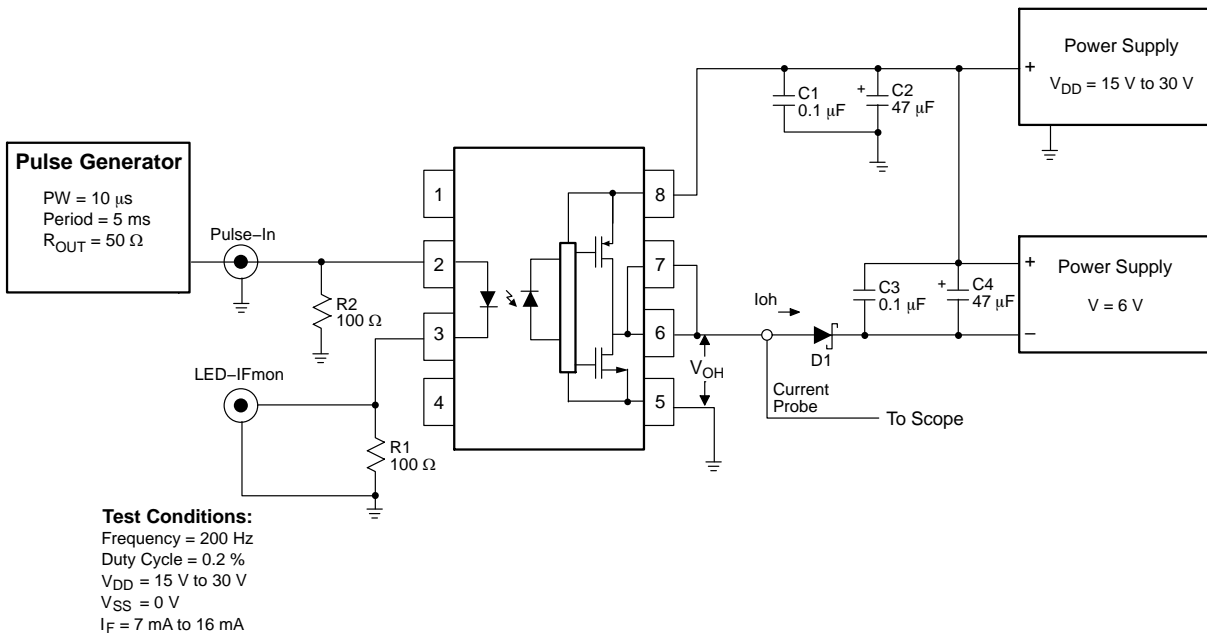


Figure 19. I_{OH} Test Circuit

FOD3125

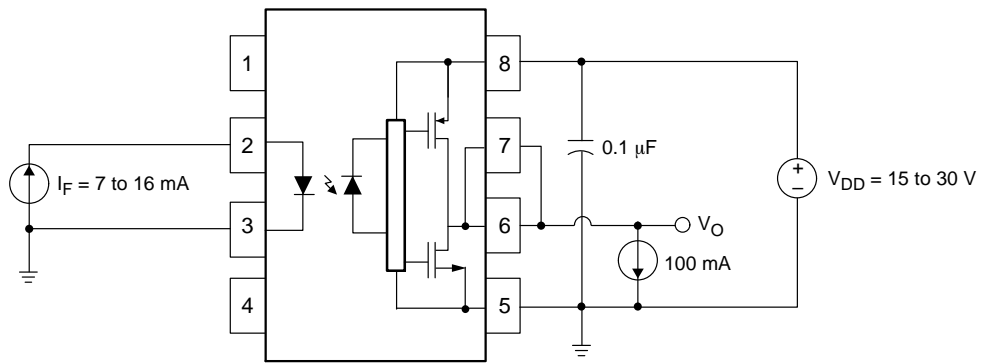


Figure 20. V_{OH} Test Circuit

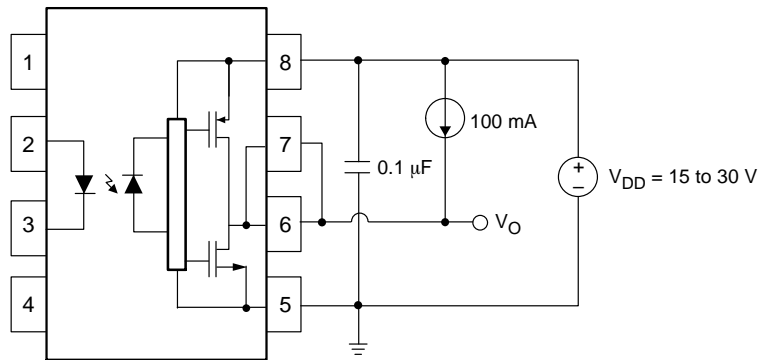


Figure 21. V_{OL} Test Circuit

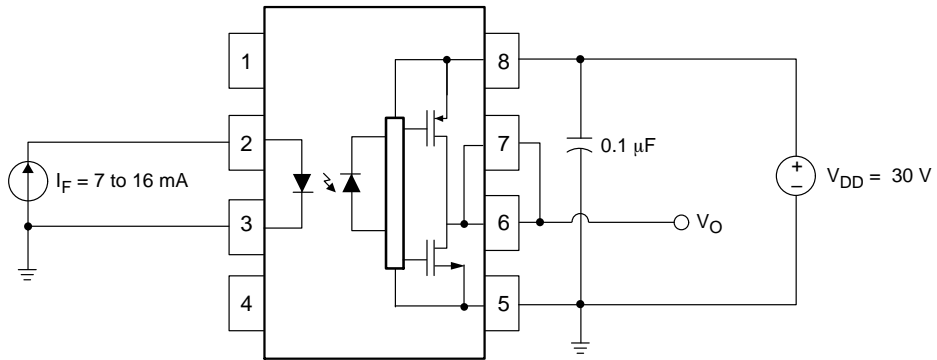


Figure 22. I_{DDH} Test Circuit

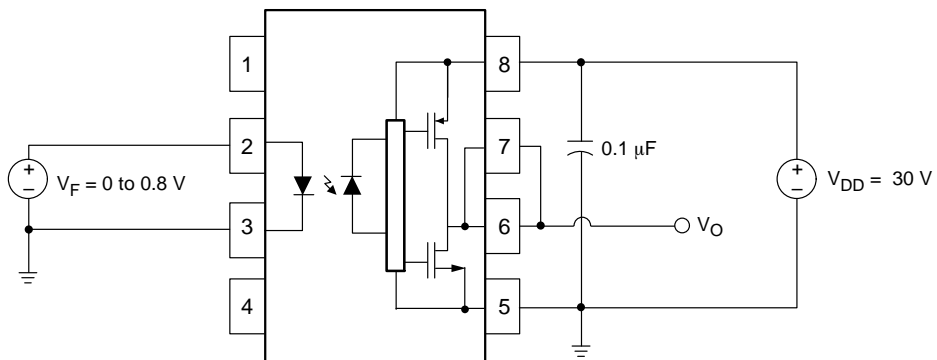


Figure 23. I_{DDL} Test Circuit

FOD3125

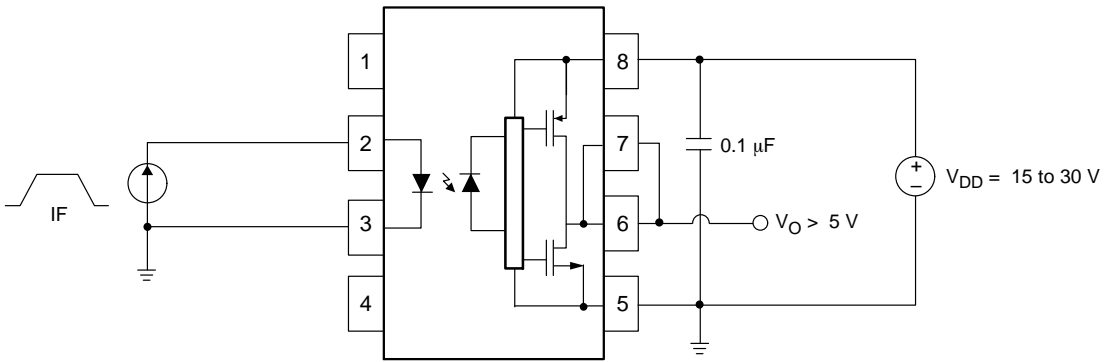


Figure 24. I_{FLH} Test Circuit

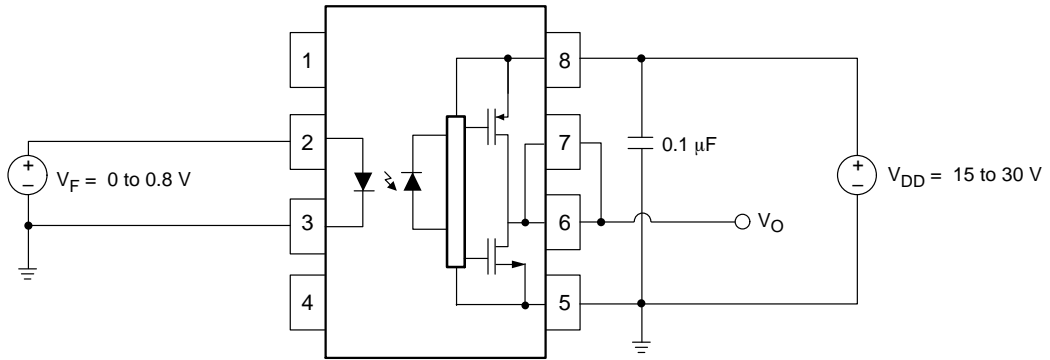


Figure 25. V_{FHL} Test Circuit

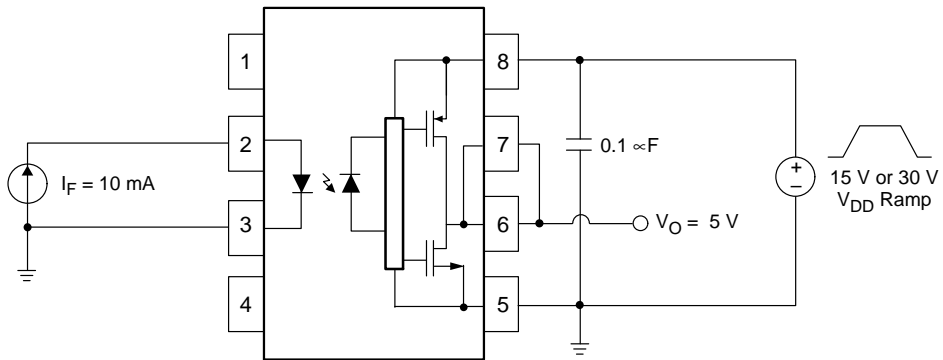


Figure 26. UVLO Test Circuit

FOD3125

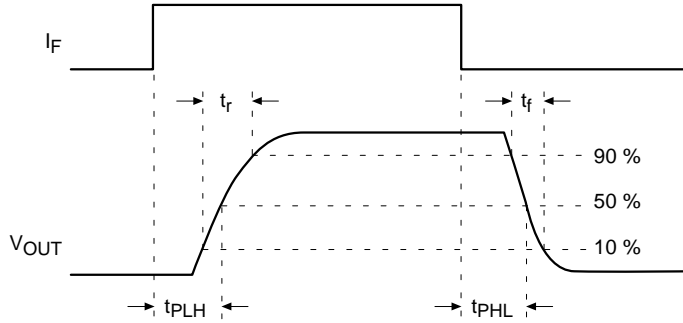
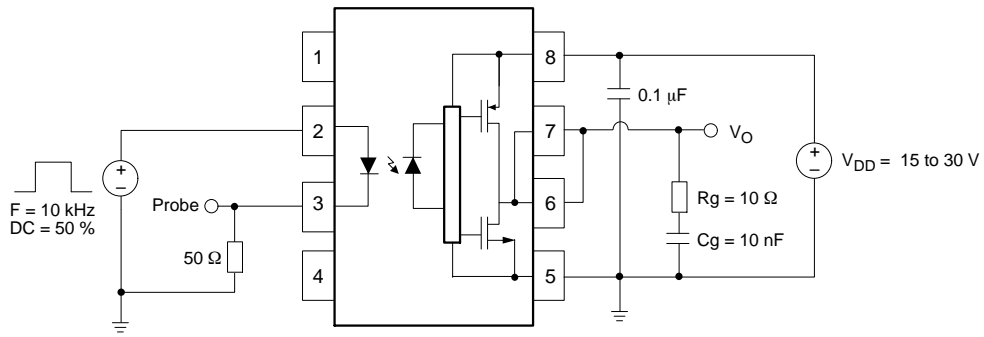


Figure 27. t_{PHL} , t_{PLH} , t_R and t_F Test Circuit and Waveforms

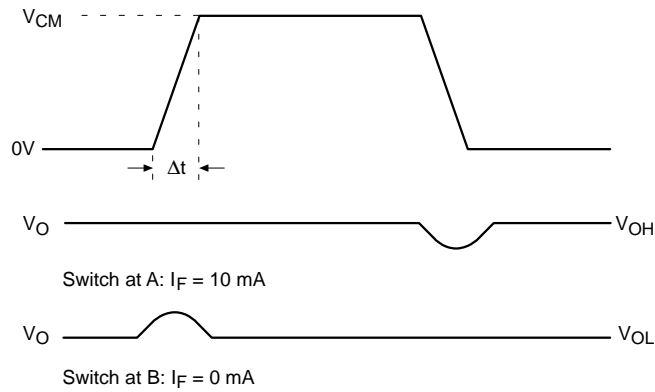
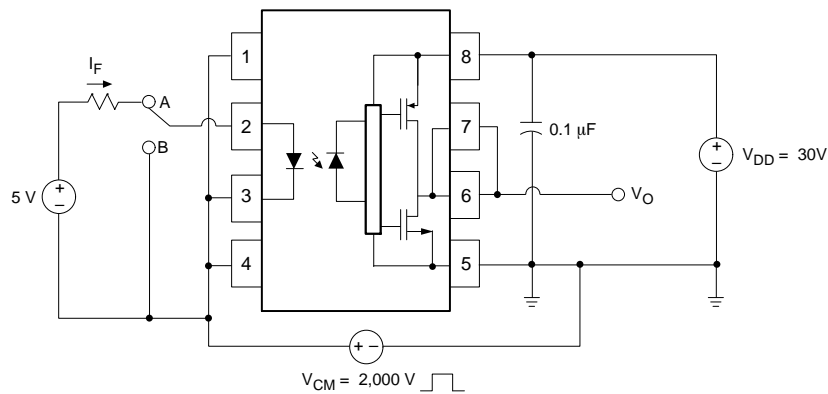
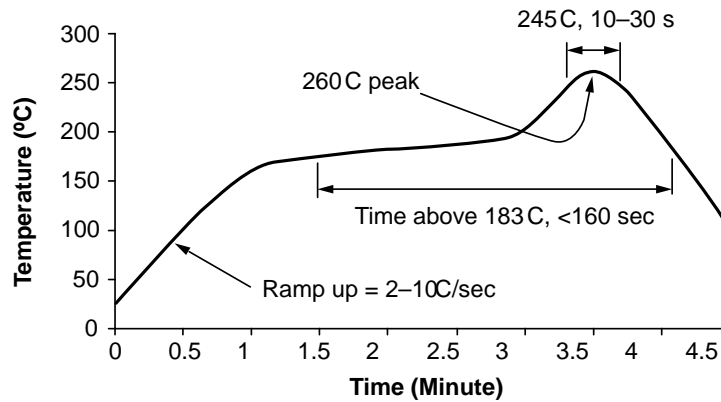


Figure 28. CMR Test Circuit and Waveforms

FOD3125

REFLOW PROFILE



Notes:

- Peak reflow temperature: 260 C (package surface temperature)
- Time of temperature higher than 183 C for 160 seconds or less
- One time soldering reflow is recommended

Figure 29. Reflow Profile

ORDERING INFORMATION

| Part Number | Package | Shipping† |
|--------------|--|---------------------|
| FOD3125 | DIP 8–Pin | 50 / Tube |
| FOD3125S | SMT 8–Pin (Lead Bend) | 50 / Tube |
| FOD3125SD | SMT 8–Pin (Lead Bend) | 1,000 / Tape & Reel |
| FOD3125V | DIP 8–Pin, DIN EN/IEC 60747–5–5 option (pending approval) | 50 / Tube |
| FOD3125SV | SMT 8–Pin (Lead Bend), DIN EN/IEC 60747–5–5 option (pending approval) | 50 / Tube |
| FOD3125SDV | SMT 8–Pin (Lead Bend), DIN EN/IEC 60747–5–5 option (pending approval) | 1,000 / Tape & Reel |
| FOD3125TV | DIP 8–Pin, 0.4" Lead Spacing, DIN EN/IEC 60747–5–5 option (pending approval) | 50 / Tube |
| FOD3125TSV | SMT 8–Pin, 0.4" Lead Spacing, DIN EN/IEC 60747–5–5 option (pending approval) | 50 / Tube |
| FOD3125TSR2V | SMT 8–Pin, 0.4" Lead Spacing, DIN EN/IEC 60747–5–5 option (pending approval) | 1,000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D

MARKING INFORMATION

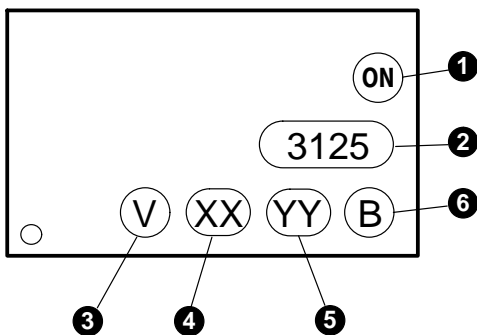


Figure 30. Device Marking

| Definitions | |
|-------------|--|
| 1 | Company logo |
| 2 | Device number |
| 3 | DIN EN/IEC60747–5–5 Option (pending approval) (only appears on component ordered with this option) |
| 4 | Two digit year code, e.g., '19' |
| 5 | Two digit work week ranging from '01' to '53' |
| 6 | Assembly package code |

CARRIER TAPE SPECIFICATIONS (OPTION SD)

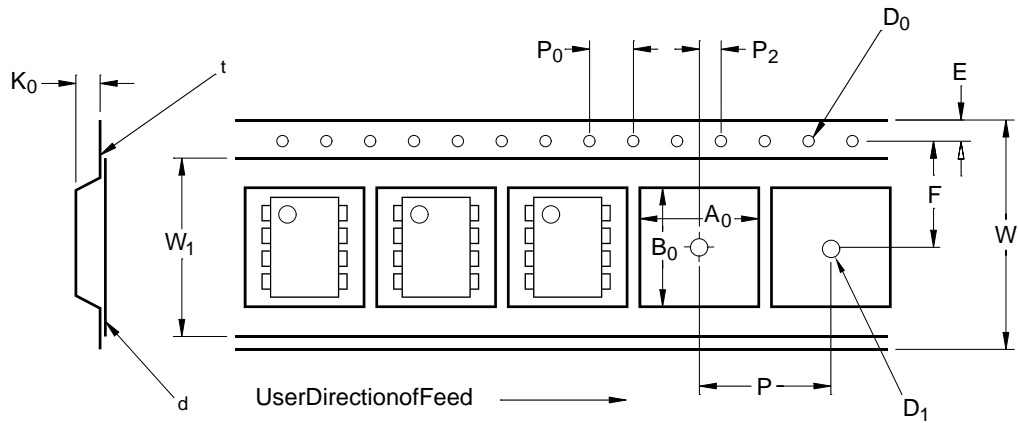


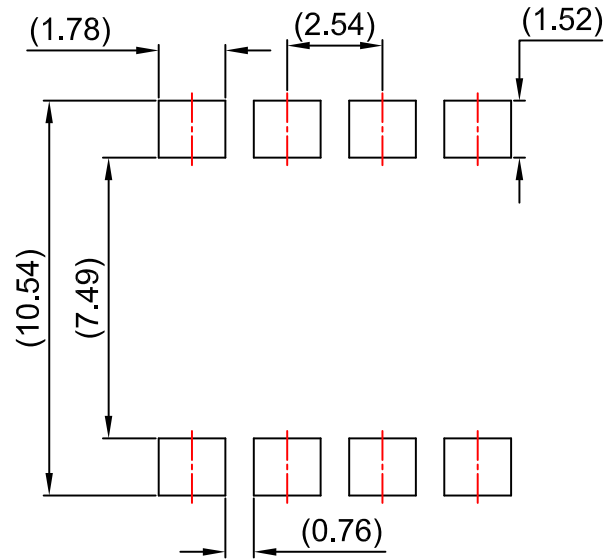
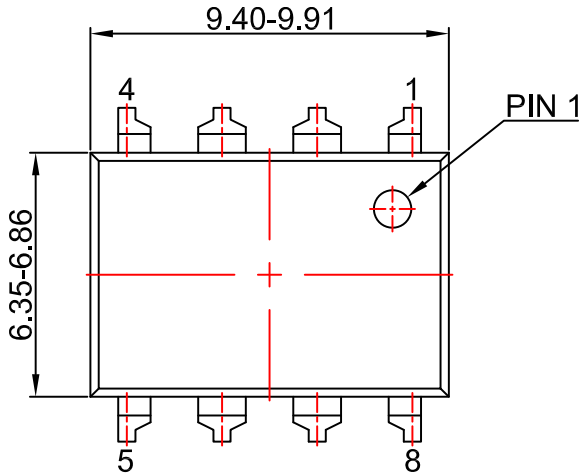
Figure 31. Carrier Tape Specifications

| 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 |

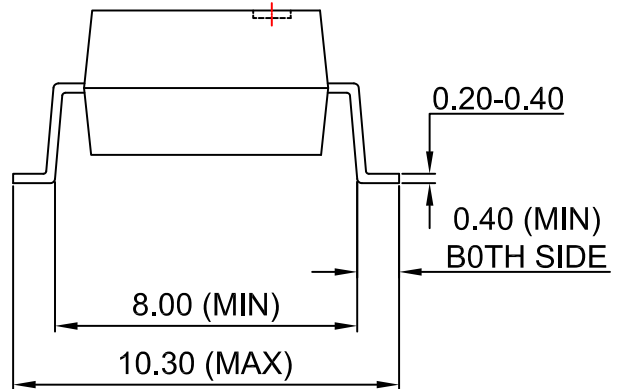
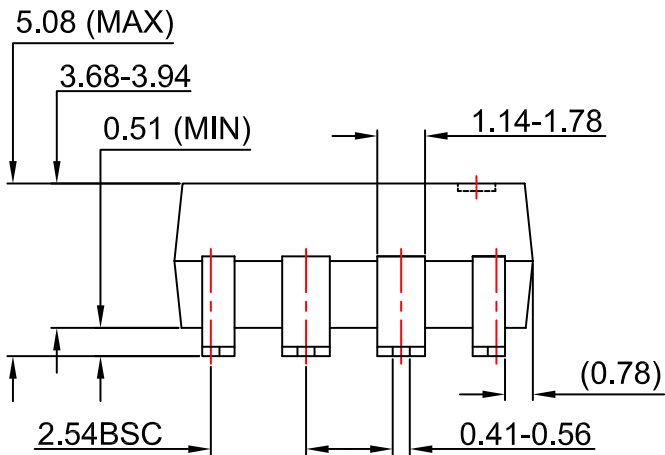
FOD3125

PACKAGE DIMENSIONS (OPTION S)

PDIP8 GW
CASE 709AC
ISSUE O



LAND PATTERN RECOMMENDATION



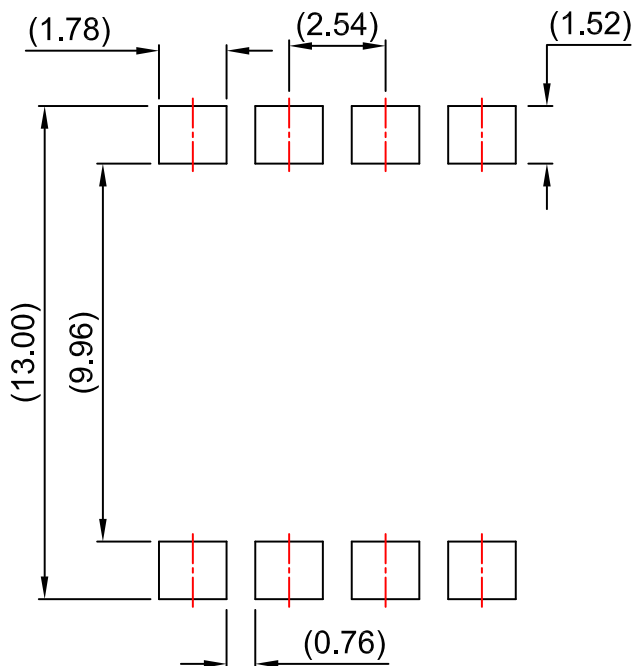
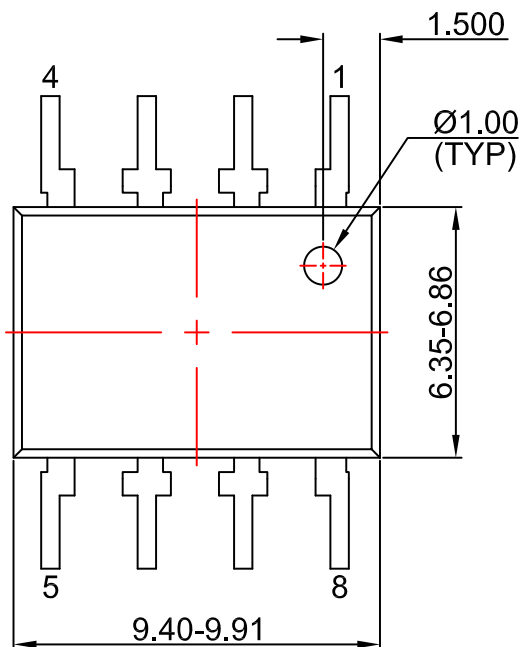
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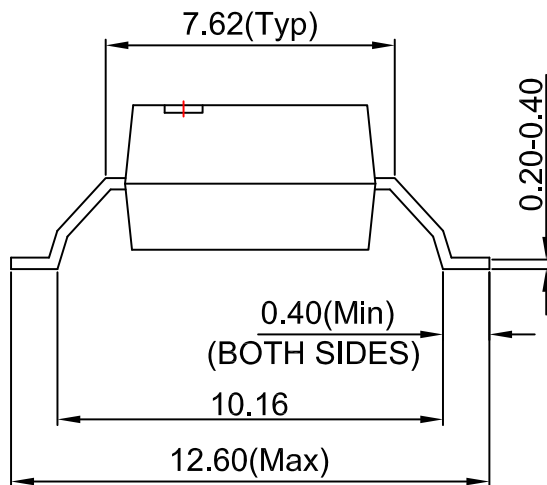
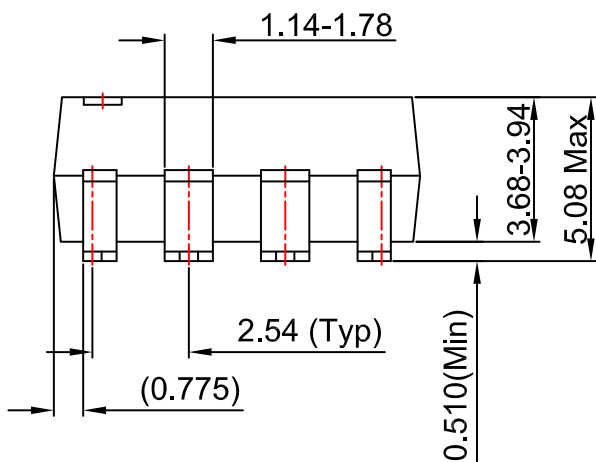
FOD3125

PACKAGE DIMENSIONS (OPTION TS)

PDIP8 GW
CASE 709AD
ISSUE O



LAND PATTERN RECOMMENDATION



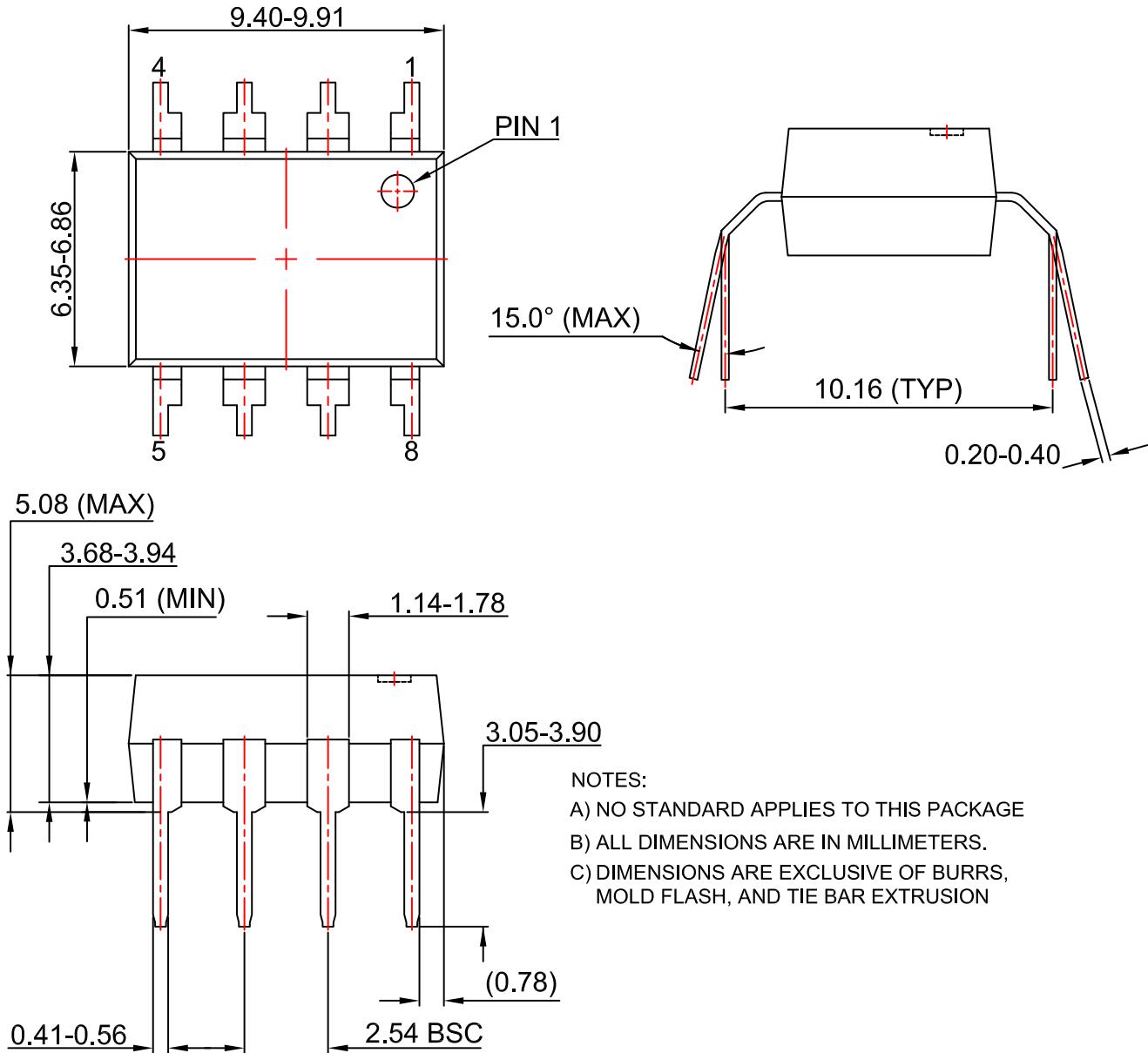
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FOD3125

PACKAGE DIMENSIONS (OPTION T)

PDIP8 6.6x3.81, 2.54P
CASE 646BW
ISSUE O

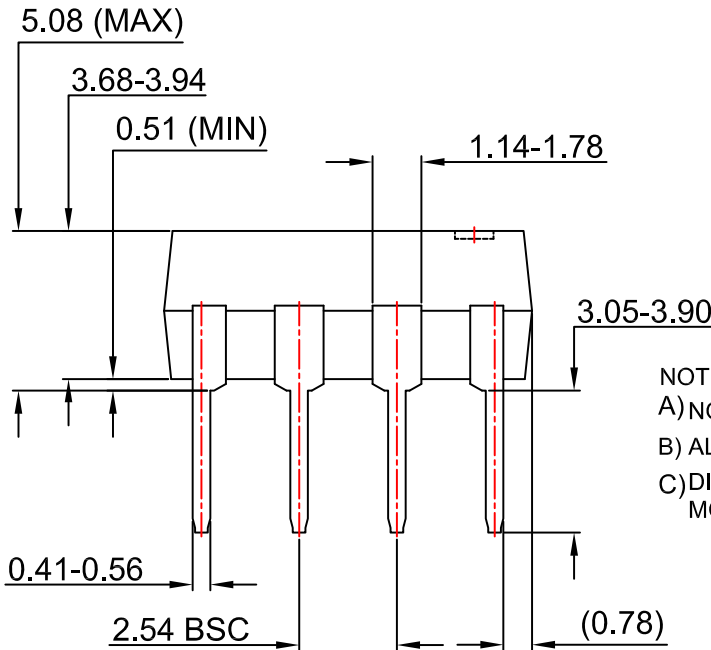
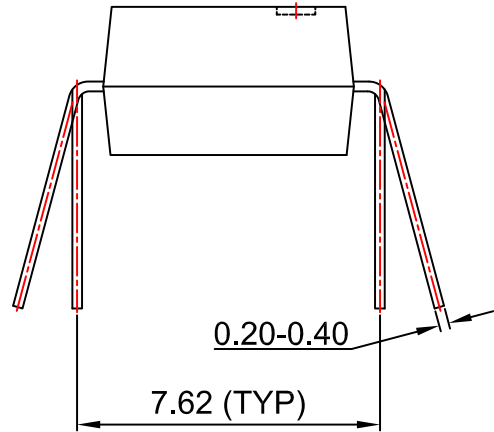
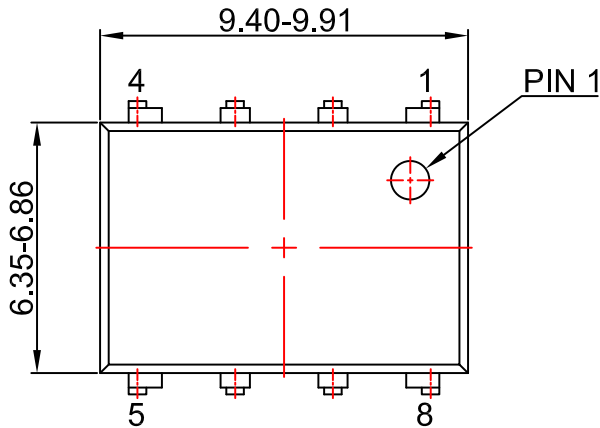


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B) ALL DIMENSIONS ARE IN MILLIMETERS.
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FOD3125


PACKAGE DIMENSIONS

PDIP8 9.655x6.6, 2.54P
CASE 646CQ
ISSUE O



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