DATA SHEET
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# Gate Drive Optocoupler, High Noise Immunity, 2.5 A Output Current

# FOD3120

### 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 **onsemi'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.

### Features

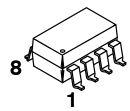
- High Noise Immunity Characterized by 35 kV/μs Minimum Common Mode Rejection
- 2.5 A Peak Output Current Driving Capability for Most 1200 V/20 A IGBT
- Use of P−Channel MOSFETs at Output Stage Enables Output Voltage Swing Close to the Supply Rail
- Wide Supply Voltage Range from 15 V to 30 V
- Fast Switching Speed
  - 400 ns maximum Propagation Delay
  - 100 ns maximum Pulse Width Distortion
- Under Voltage LockOut (UVLO) with Hysteresis
- Extended Industrial Temperate Range, −40°C to 100°C Temperature Range
- Safety and Regulatory Approvals
  - 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')
- 1414 V Peak Working Insulation Voltage ($V_{IORM}$)
- This is a Pb−Free Device

### Applications

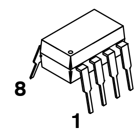
- Industrial Inverter
- Uninterruptible Power Supply
- Induction Heating
- Isolated IGBT/Power MOSFET Gate Drive

### Related Resources

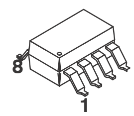
- FOD3150, 1 A Output Current, Gate Drive Optocoupler Datasheet
- https://www.onsemi.com/products/optoelectronics/



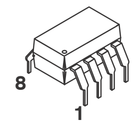

PDIP8 GW
CASE 709AC




PDIP8 9.655x6.6, 2.54P
CASE 646CQ

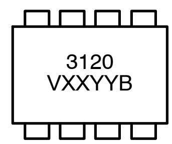



PDIP8 GW
CASE 709AD



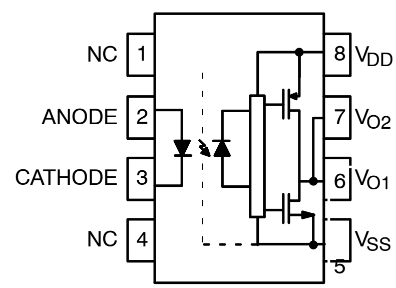

PDIP8 6.6x3.81, 2.54P
CASE 646BW

### MARKING DIAGRAM




3120 = Device Number
V = DIN_EN/IEC60747−5−5 Option (only appears on component ordered with this option)
XX = Two Digit Year Code
YY = Two Digit Work Week
B = Assembly Package Code

### 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 14 of this data sheet.

**Table 1. 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 |

**Table 2. 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 |

**Table 3. 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.

| Symbol | Parameter | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| | Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 $V_{RMS}$ | | I–IV | | |
| | | < 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 | | |
| CTI | Comparative Tracking Index | | 175 | | | |
| $V_{PR}$ | Input to Output Test Voltage, Method A, $V_{IORM}$ x 1.6 = $V_{PR}$, Type and Sample Test with $t_m$ = 10 s, Partial Discharge < 5 pC | | 2262 | | | Vpeak |
| | Input to Output Test Voltage, Method B, $V_{IORM}$ x 1.875 = $V_{PR}$, 100% Production Test with $t_m$ = 1 s, Partial Discharge < 5 pC | | 2651 | | | Vpeak |
| $V_{IORM}$ | Maximum Working Insulation Voltage | | 1414 | | | Vpeak |
| $V_{IOTM}$ | Highest Allowable Over Voltage | | 6000 | | | Vpeak |
| | 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 (Note 1) | | 175 | | | °C |
| $I_{S,INPUT}$ | Input Current (Note 1) | | 400 | | | mA |
| $P_{S,OUTPUT}$ | Output Power (Duty Factor ≤ 2.7 %) (Note 1) | | 700 | | | mW |
| $R_{IO}$ | Insulation Resistance at $T_S$, $V_{IO}$ = 500 V (Note 1) | | $10^9$ | | | Ω |

1. Safety limit value − maximum values allowed in the event of a failure.

**Table 4. ABSOLUTE MAXIMUM RATINGS** ($T_A$ = 25°C unless otherwise specified.)

| Symbol | Parameter | | Value | Units |
|---|---|---|---|---|
| $T_{STG}$ | Storage Temperature | | −55 to +125 | °C |
| $T_{OPR}$ | Operating Temperature | | −40 to +100 | °C |
| $T_J$ | Junction Temperature | | −40 to +125 | °C |
| $T_{SOL}$ | Lead Wave Solder Temperature (refer to page 13 for reflow solder profile) | | 260 for 10 s | °C |
| $I_{F(AVG)}$ | Average Input Current | | 25 | mA |
| $I_{F(Peak)}$ | Peak Transient Forward Current (Note 2) | | 1 | A |
| f | Operating Frequency (Note 3) | | 50 | kHz |
| $V_R$ | Reverse Input Voltage | | 5 | V |
| $I_{O(PEAK)}$ | Peak Output Current (Note 4) | | 3.0 | A |
| $V_{DD} - V_{SS}$ | Supply Voltage | | 0 to 35 | V |
| | | $T_A \geq 90$°C | 0 to 30 | |
| $V_{O(PEAK)}$ | 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 (Note 5, Note 7) | | 45 | mW |
| $PD_O$ | Output Power Dissipation (Note 6, Note 7) | | 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.

2. Pulse Width, PW ≤ 1 μs, 300 pps
3. Exponential Waveform, $I_{O(PEAK)} \leq |2.5\text{ A}|$ (≤0.3 μs)
4. Maximum pulse width = 10 μs, maximum duty cycle = 1.1%
5. Derate linearly above 87°C, free air temperature at a rate of 0.77 mW/°C
6. No derating required across temperature range.
7. 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 +100 | °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°C

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $V_{ISO}$ | Input−Output Isolation Voltage | $T_A$ = 25°C, R.H.< 50 %, t = 1.0 min., $I_{I-O} \leq 10$ μA, 50 Hz (Note 8, Note 9) | 5000 | | | $V_{RMS}$ |
| $R_{ISO}$ | Isolation Resistance | $V_{I-O}$ = 500 V (Note 8) | | $10^{11}$ | | Ω |
| $C_{ISO}$ | Isolation Capacitance | $V_{I-O}$ = 0 V, Frequency = 1.0 MHz (Note 8) | | 1 | | pF |

8. Device is considered a two terminal device: pins 2 and 3 are shorted together and pins 5, 6, 7 and 8 are shorted together.
9. 5000 $V_{RMS}$ for 1 minute duration is equivalent to 6000 $VAC_{RMS}$ for 1 second duration.

**Table 7. ELECTRICAL CHARACTERISTICS**

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

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

**Table 8. SWITCHING CHARACTERISTICS**

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $t_{PHL}$ | Propagation Delay Time to Logic Low Output | $I_F$ = 7 mA to 16 mA, Rg = 10 Ω, Cg = 10 nF, f = 10 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, $\lvert t_{PHL} - t_{PLH} \rvert$ | | | 20 | 100 | ns |
| PDD (Skew) | Propagation Delay Difference Between Any Two Parts or Channels, $(t_{PHL} - t_{PLH})$ (Note 10) | | −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 mA , $V_O$ > 5 V | | 1.6 | | μs |
| $t_{UVLO\ OFF}$ | UVLO Turn Off Delay | $I_F$ = 10 mA , $V_O$ < 5 V | | 0.4 | | μs |
| $\lvert CM_H \rvert$ | Common Mode Transient Immunity at Output High | $T_A$ = 25°C, $V_{DD}$ = 30 V, $I_F$ = 7 to 16 mA, $V_{CM}$ = 2000 V (Note 11) | 35 | 50 | | kV/μs |
| $\lvert CM_L \rvert$ | Common Mode Transient Immunity at Output Low | $T_A$ = 25°C, $V_{DD}$ = 30 V, $V_F$ = 0 V, $V_{CM}$ = 2000 V (Note 12) | 35 | 50 | | kV/μs |

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

## TYPICAL PERFORMANCE CHARACTERISTICS

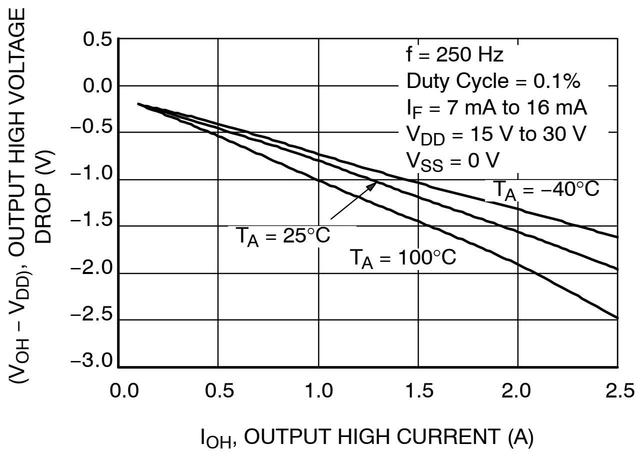



**Figure 1. Output High Voltage Drop vs. Output High Current**

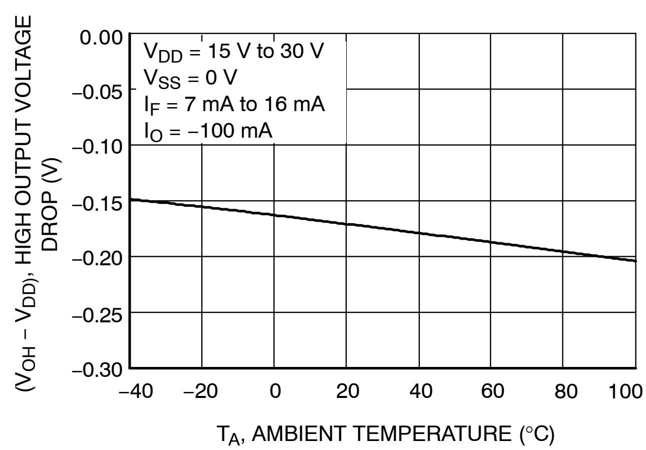



**Figure 2. Output High Voltage Drop vs. Ambient Temperature**

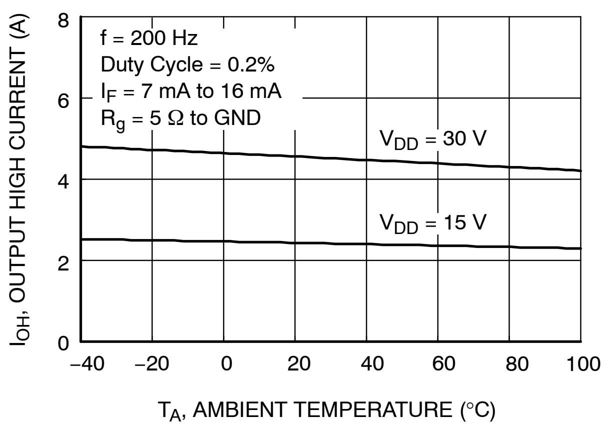



**Figure 3. Output High Current vs. Ambient Temperature**

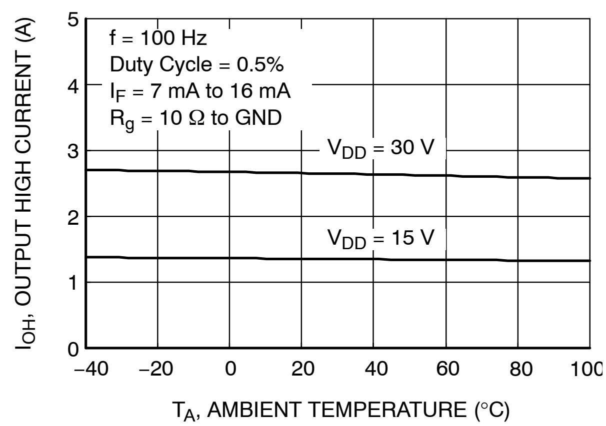



**Figure 4. Output High Current vs. Ambient Temperature**

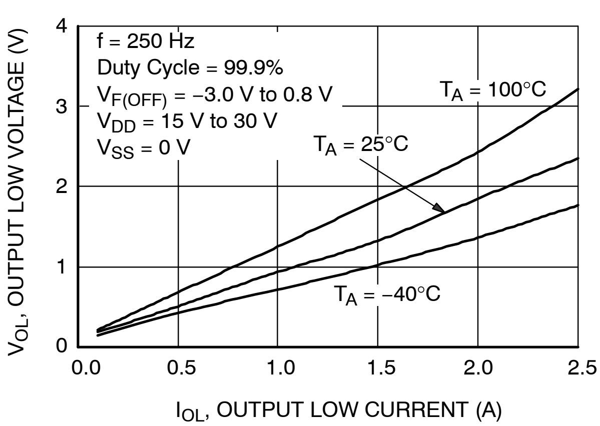



**Figure 5. Output Low Voltage vs. Output Low Current**

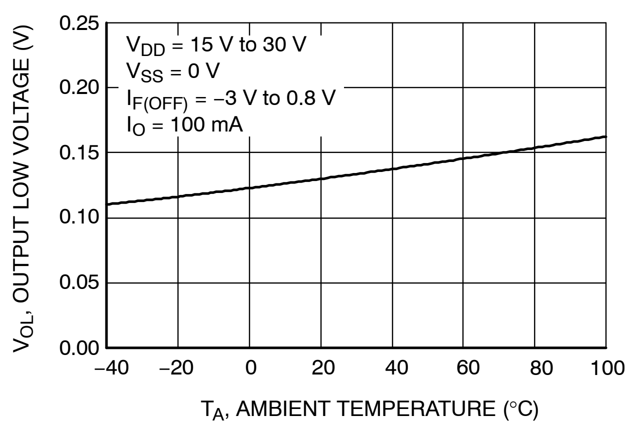



**Figure 6. Output Low Voltage vs. Ambient Temperature**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

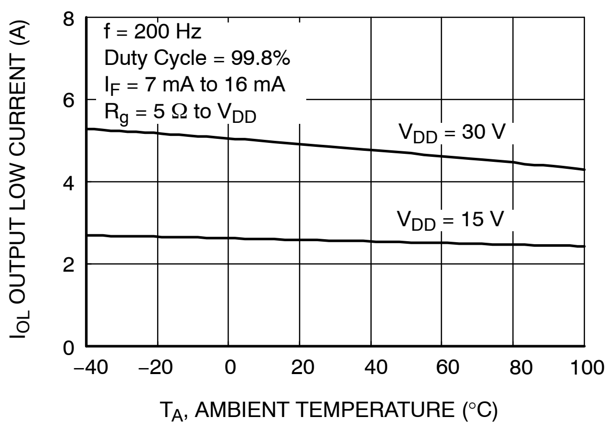



**Figure 7. Output Low Current vs. Ambient Temperature**

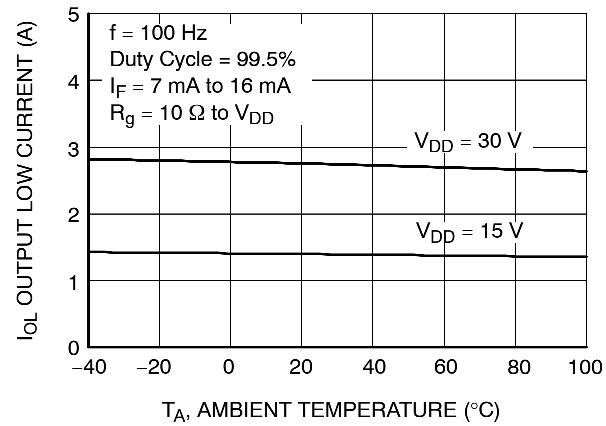



**Figure 8. Output Low Current vs. Ambient Temperature**

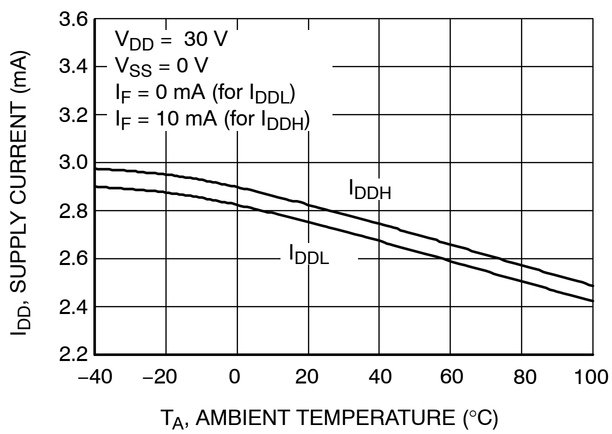



**Figure 9. Supply Current vs. Ambient Temperature**

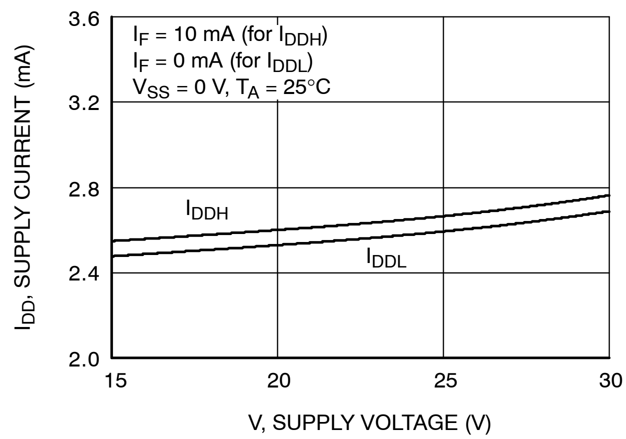



**Figure 10. Supply Current vs. Supply Voltage**

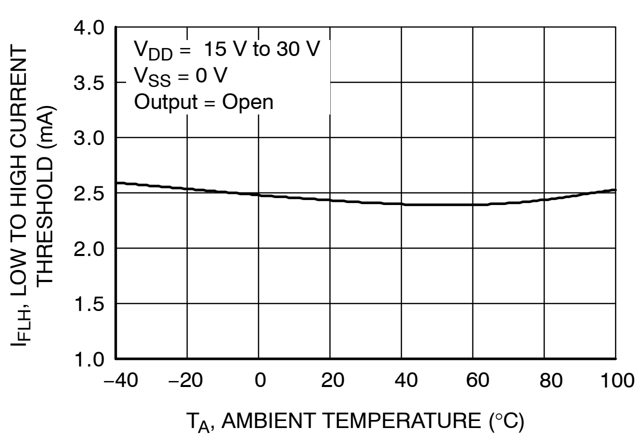



**Figure 11. Low to High Input Current Threshold vs. Ambient Temperature**

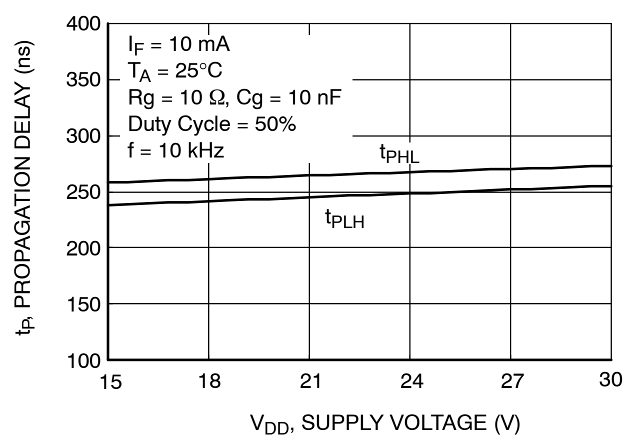



**Figure 12. Propagation Delay vs. Supply Voltage**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

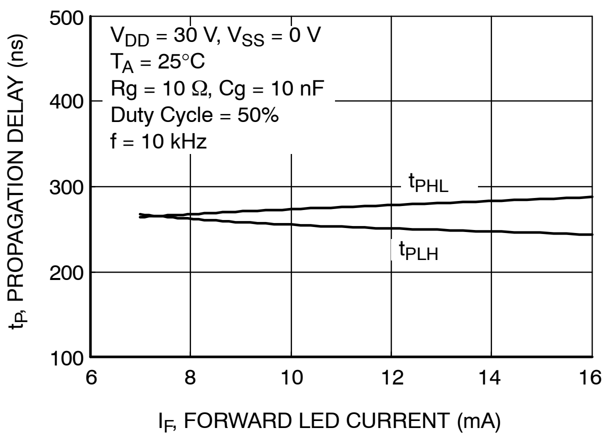



**Figure 13. Propagation Delay vs. LED Forward Current**

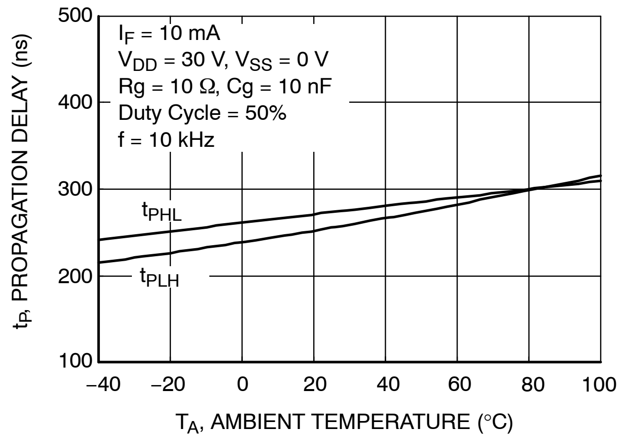



**Figure 14. Propagation Delay vs. Ambient Temperature**

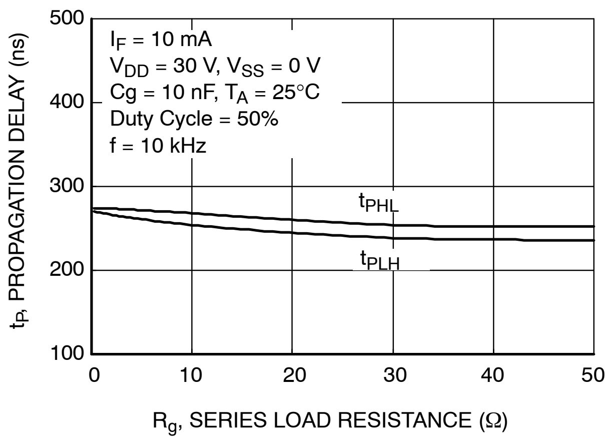



**Figure 15. Propagation Delay vs. Series Load Resistance**

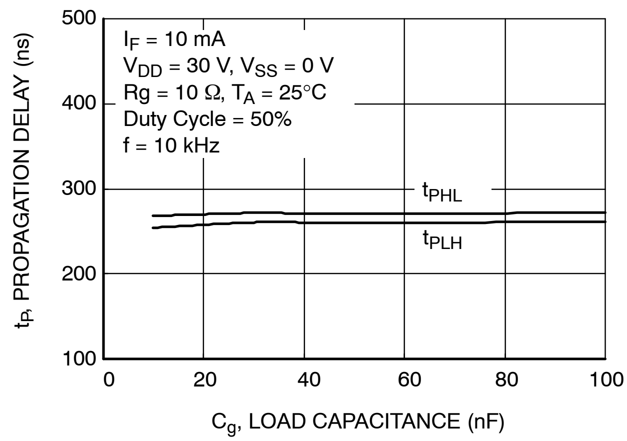



**Figure 16. Propagation Delay vs. Load Capacitance**

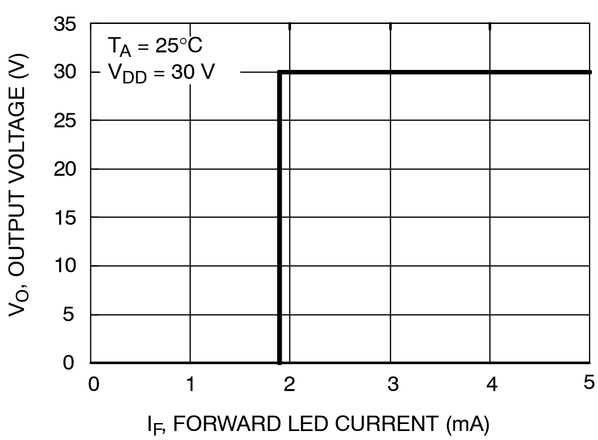



**Figure 17. Transfer Characteristics**

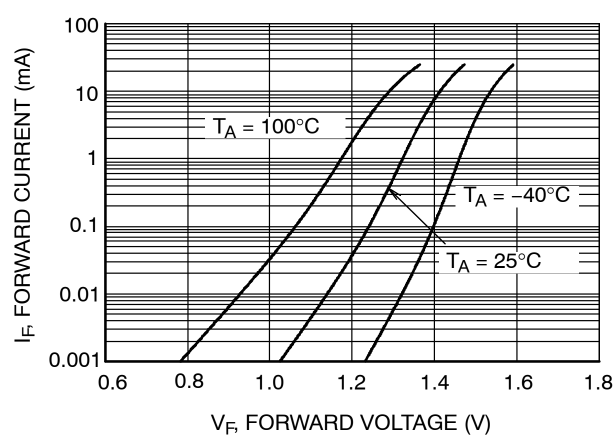



**Figure 18. Input Forward Current vs. Forward Voltage**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

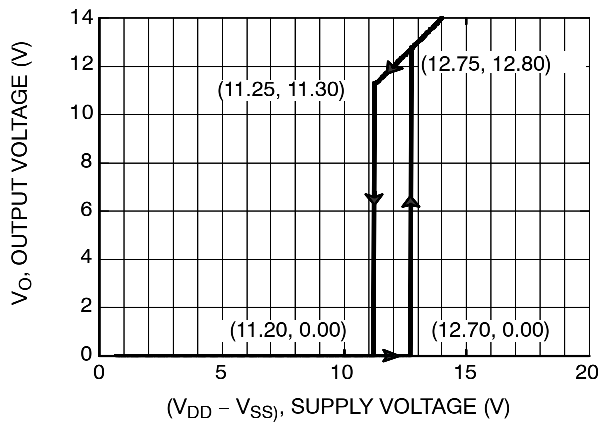
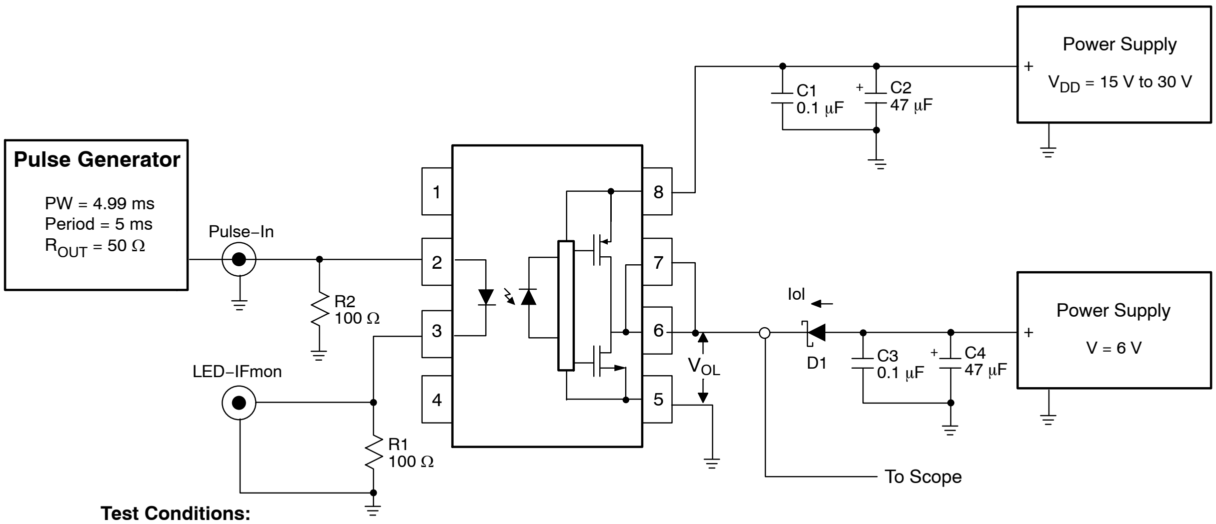


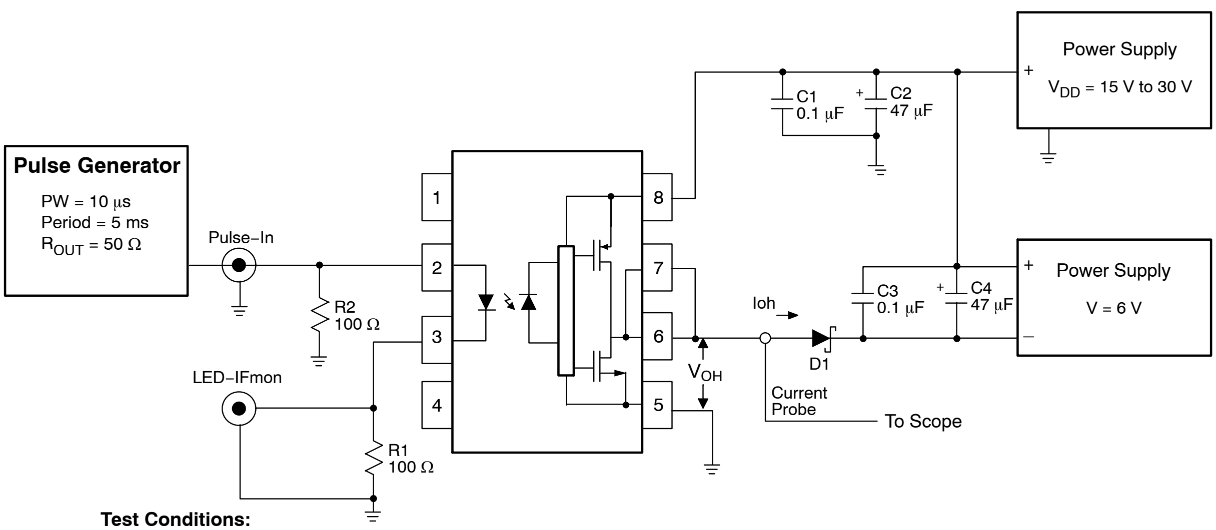

**Figure 19. Under Voltage Lockout**

## TEST CIRCUIT




**Test Conditions:**
Frequency = 200 Hz
Duty Cycle = 99.8 %
$V_{DD}$ = 15 V to 30 V
$V_{SS}$ = 0 V
$V_{F(OFF)}$ = −3.0 V to 0.8 V

**Figure 20. $I_{OL}$ Test Circuit**




**Test Conditions:**
Frequency = 200 Hz
Duty Cycle = 0.2 %
$V_{DD}$ = 15 V to 30 V
$V_{SS}$ = 0 V
$I_F$ = 7 mA to 16 mA

**Figure 21. $I_{OH}$ Test Circuit**

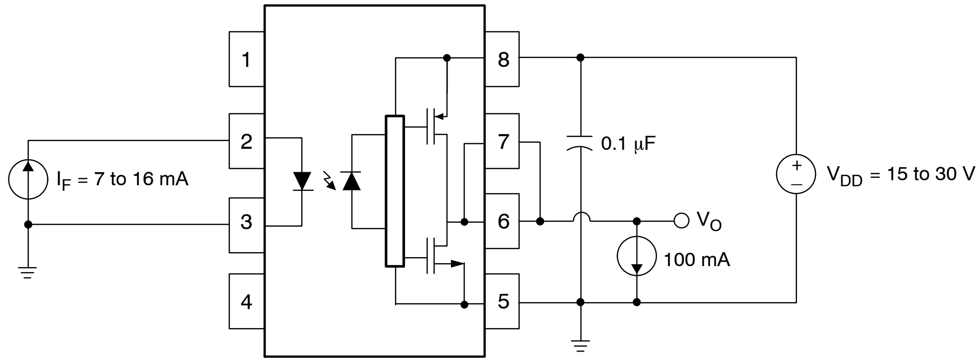



Figure 22. $V_{OH}$ Test Circuit

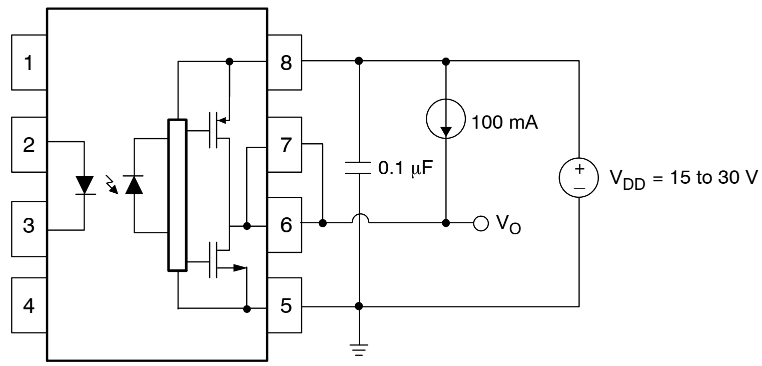



Figure 23. $V_{OL}$ Test Circuit

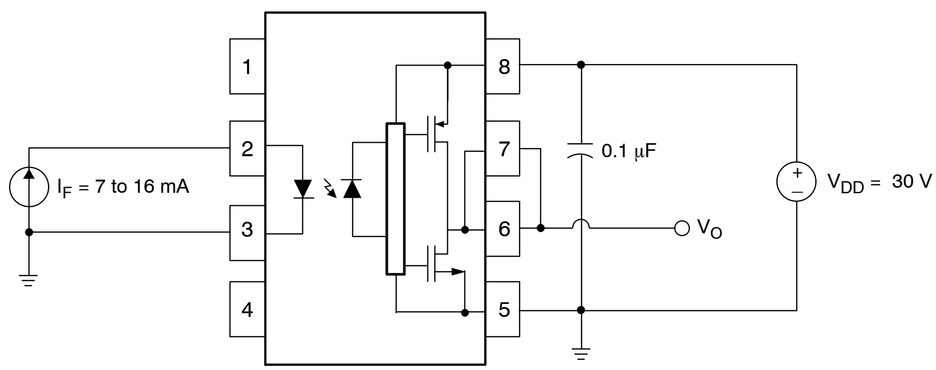



Figure 24. $I_{DDH}$ Test Circuit

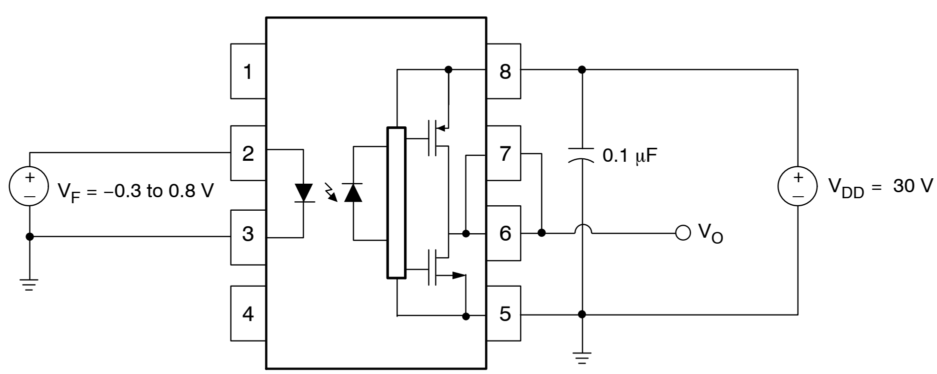



Figure 25. $I_{DDL}$ Test Circuit

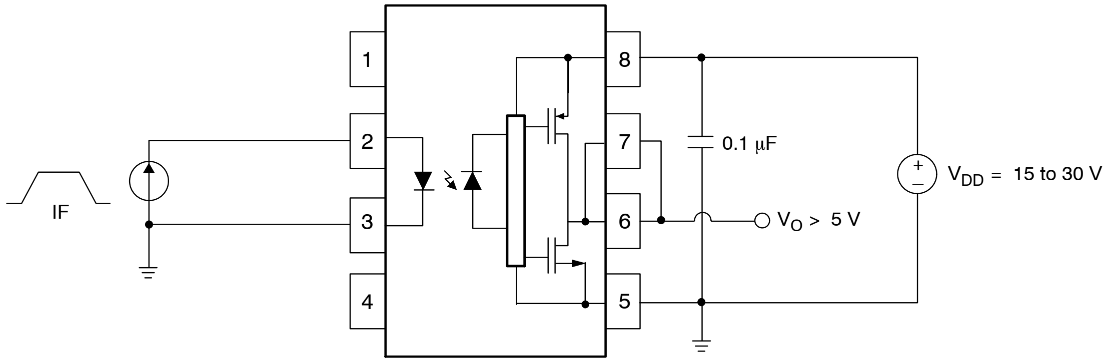



**Figure 26. $I_{FLH}$ Test Circuit**

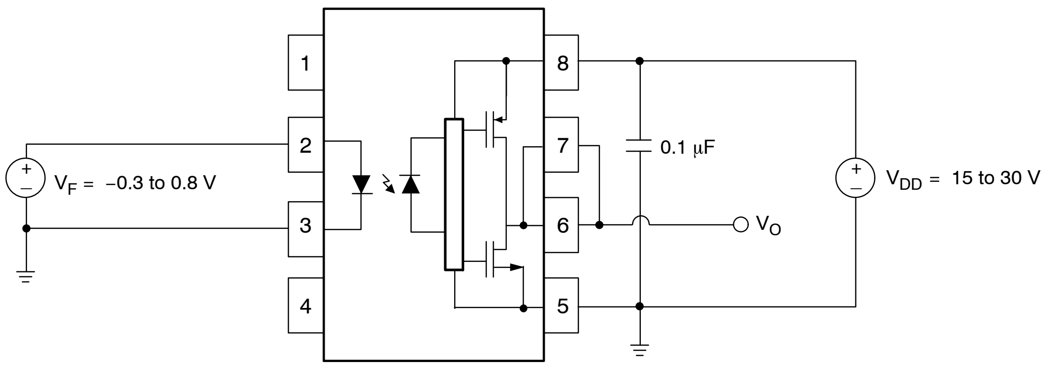



**Figure 27. $V_{FHL}$ Test Circuit**

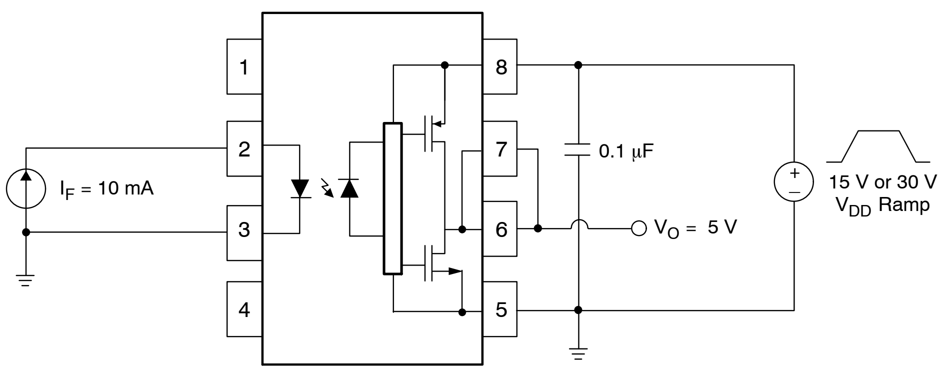



**Figure 28. UVLO Test Circuit**

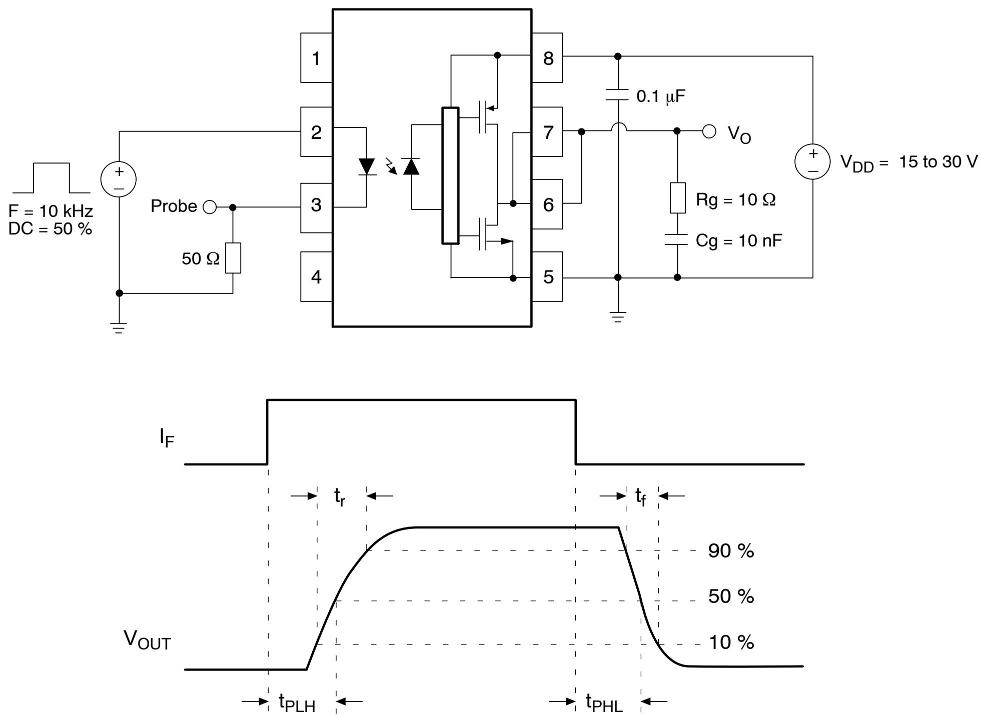



**Figure 29. $t_{PHL}$, $t_{PLH}$, $t_R$ and $t_F$ Test Circuit and Waveforms**

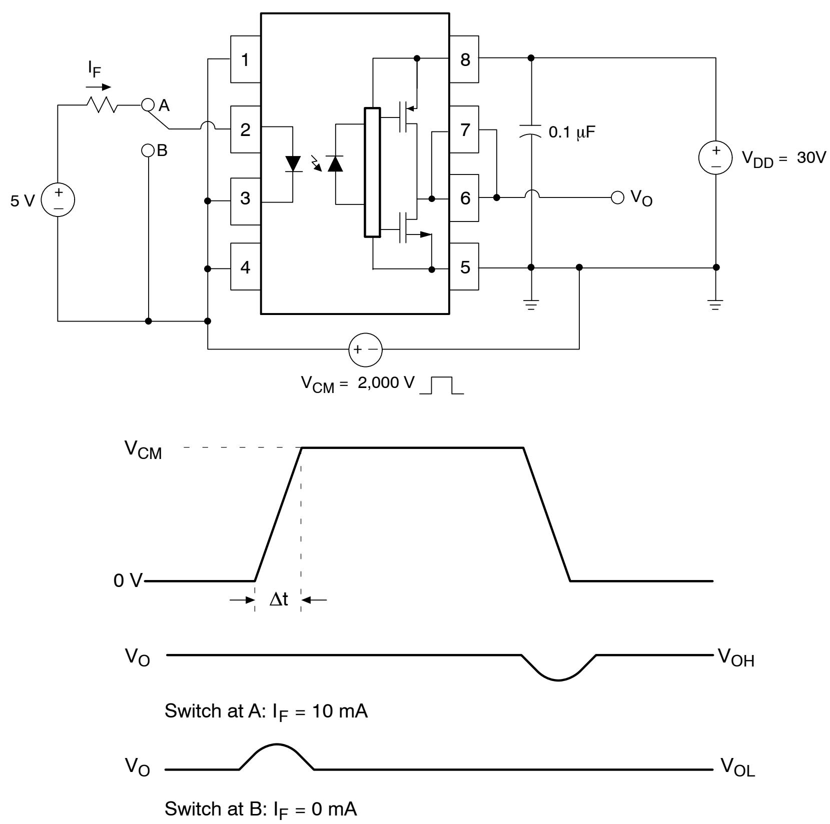



**Figure 30. CMR Test Circuit and Waveforms**

## REFLOW PROFILE

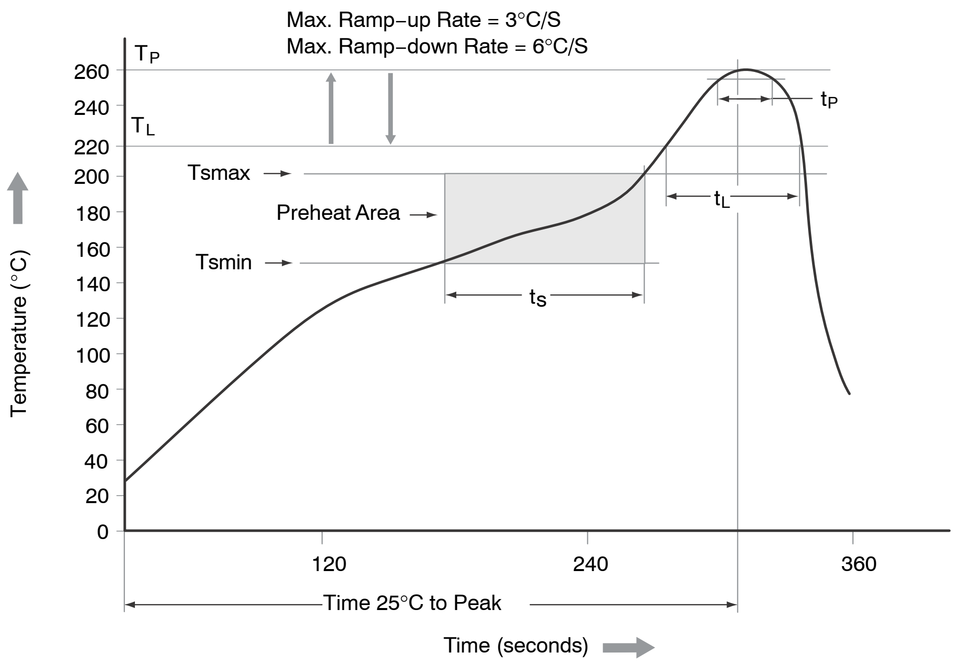



**Figure 31. Reflow Profile**

**Table 9. REFLOW PROFILE**

| Profile Feature | Pb−Free Assembly Profile |
|---|---|
| Temperature Min. (Tsmin) | 150°C |
| Temperature Max. (Tsmax) | 200°C |
| Time ($t_S$) from (Tsmin to Tsmax) | 60−120 s |
| Ramp−up Rate ($t_L$ to $t_P$) | 3°C/s max. |
| Liquidous Temperature ($T_L$) | 217°C |
| Time ($t_L$) Maintained Above ($T_L$) | 60−150 s |
| Peak Body Package Temperature | 260°C +0°C / −5°C |
| Time ($t_P$) within 5°C of 260°C | 30 s |
| Ramp−down Rate ($T_P$ to $T_L$) | 6°C/s max. |
| Time 25°C to Peak Temperature | 8 min. max. |

## ORDERING INFORMATION

| Part Number | Package | Shipping† |
|---|---|---|
| FOD3120 | DIP 8−Pin | 50 / Tube |
| FOD3120S | SMT 8−Pin (Lead Bend) | 50 / Tube |
| FOD3120SD | SMT 8−Pin (Lead Bend) | 1000 / Tape & Reel |
| FOD3120V | DIP 8−Pin, DIN EN/IEC60747−5−5 option | 50 / Tube |
| FOD3120SV | SMT 8−Pin (Lead Bend), DIN EN/IEC60747−5−5 option | 50 / Tube |
| FOD3120SDV | SMT 8−Pin (Lead Bend), DIN EN/IEC60747−5−5 option | 1000 / Tape & Reel |
| FOD3120TV | DIP 8−Pin, 0.4" Lead Spacing, DIN EN/IEC60747−5−5 option | 50 / Tube |
| FOD3120TSV | SMT 8−Pin, 0.4" Lead Spacing, DIN EN/IEC60747−5−5 option | 50 / Tube |
| FOD3120TSR2V | SMT 8−Pin, 0.4" Lead Spacing, DIN EN/IEC60747−5−5 option | 700 / 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

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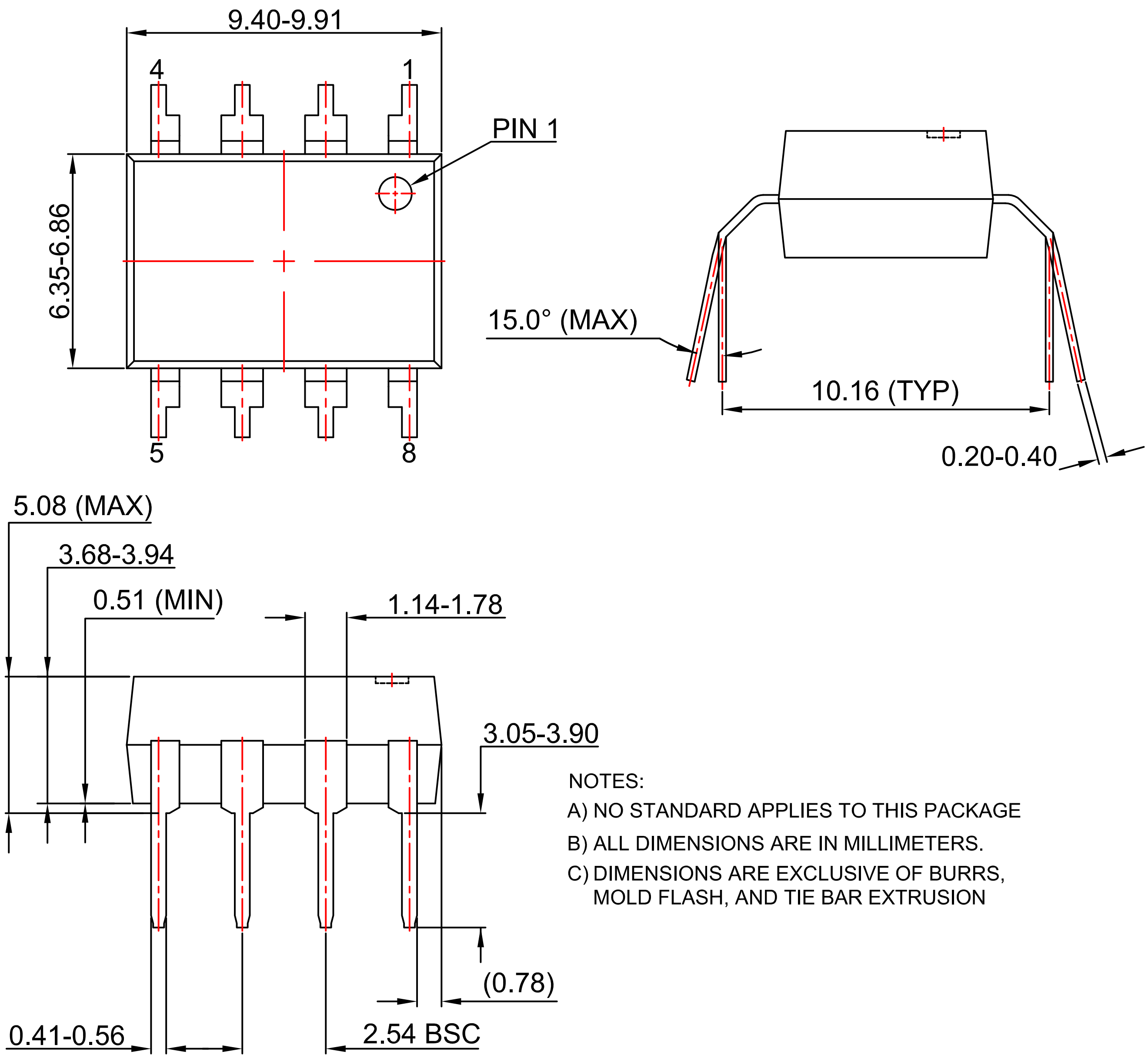
CASE 646BW
ISSUE O

DATE 31 JUL 2016

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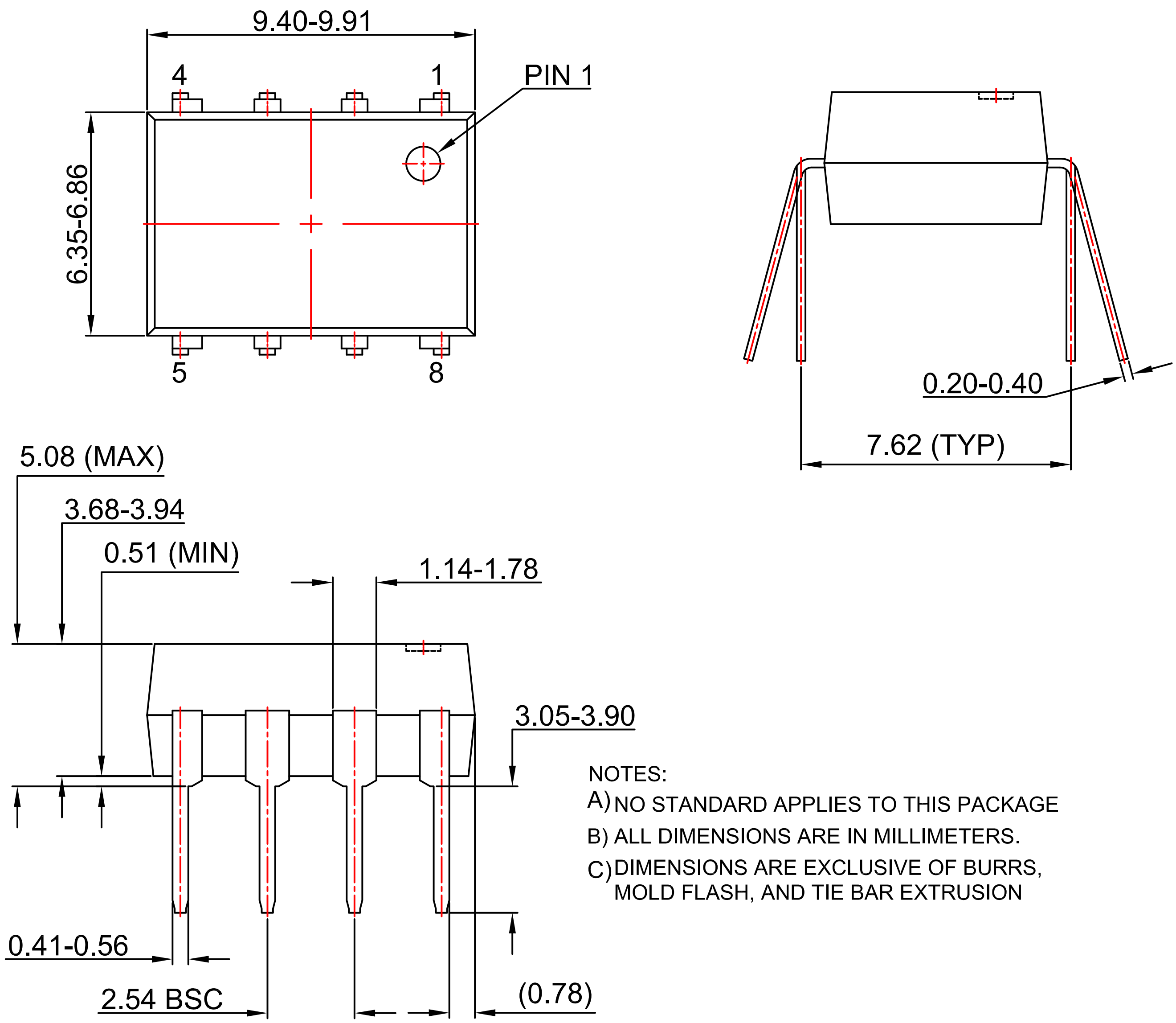


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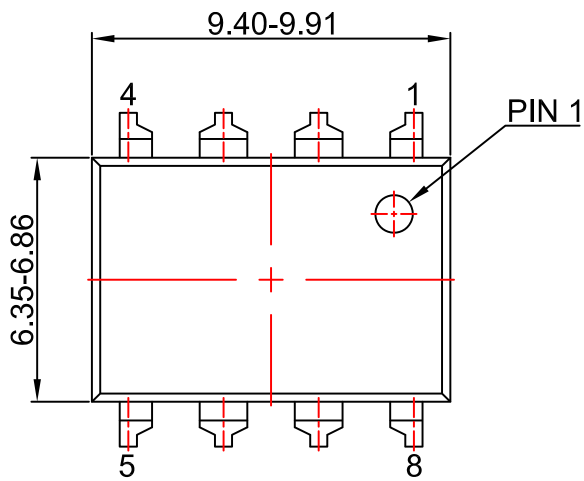


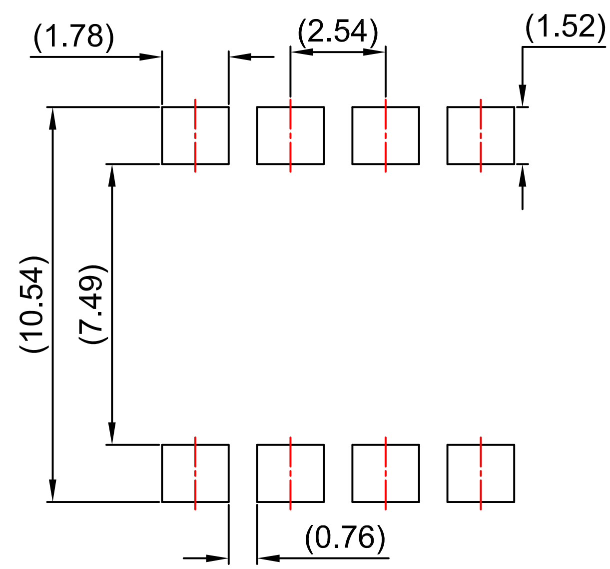


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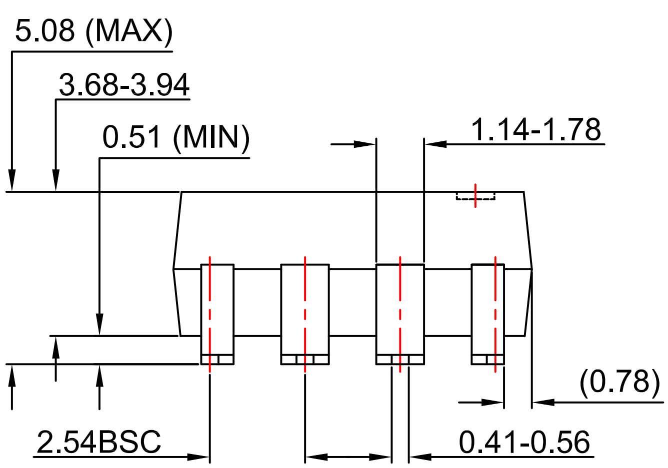


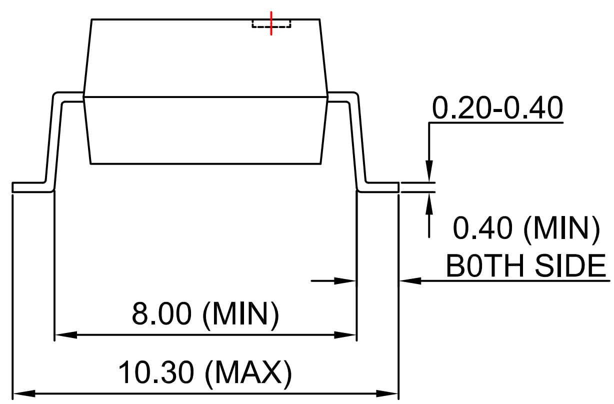


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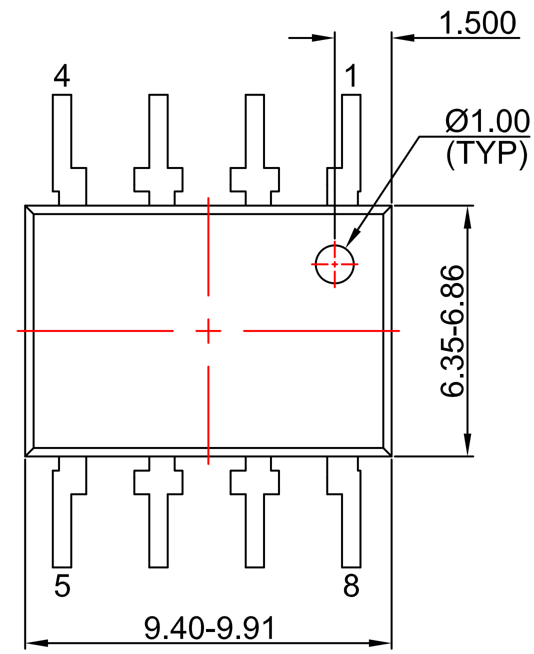


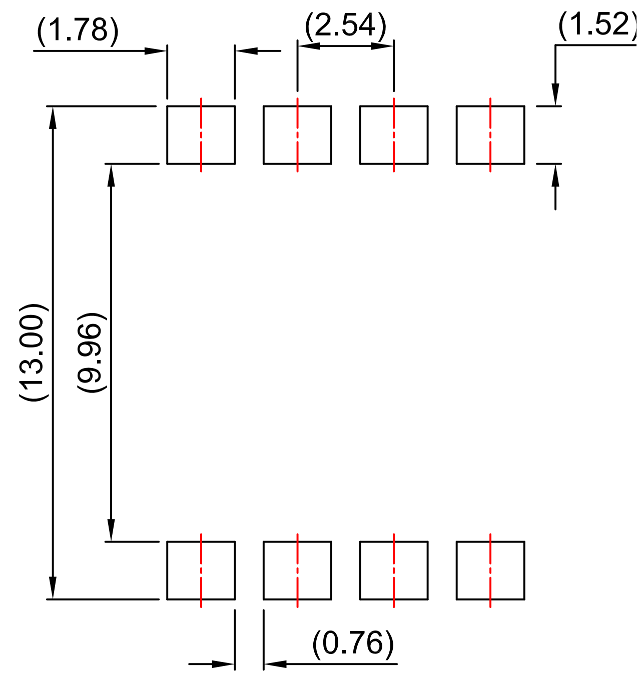


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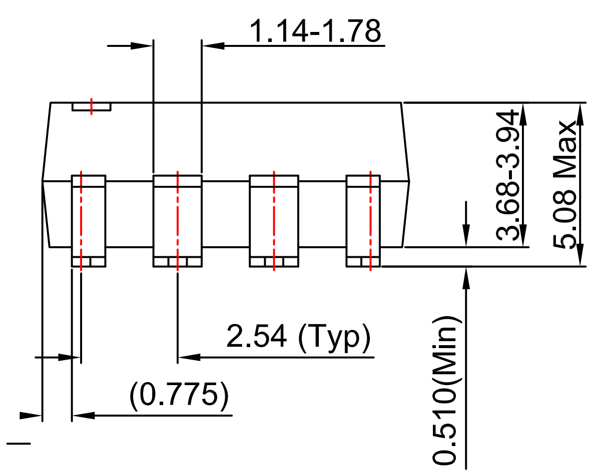


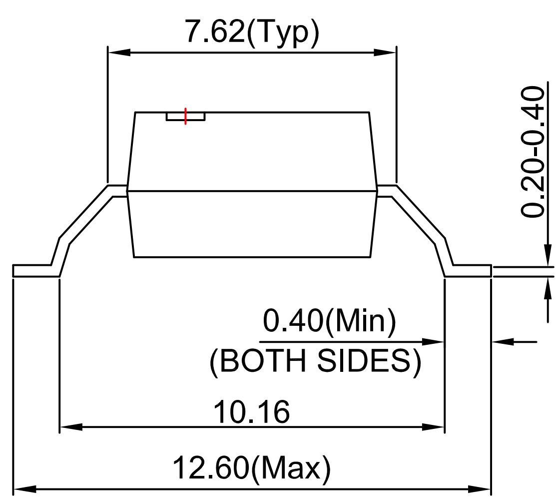


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