

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

## FOD3150A

### Description

The FOD3150A is a 2.5 A Output Current Gate Drive Optocoupler, capable of driving most 800 V / 20 A IGBTs or MOSFETs. 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

- High Noise Immunity characterized by 20 kV/μs minimum Common Mode Rejection
- 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
  - ♦ 500 ns maximum Propagation Delay
  - ♦ 300 ns maximum Pulse Width Distortion
- Under Voltage LockOut (UVLO) with Hysteresis
- Extended Industrial Temperature Range, -40°C to 100°C Temperature Range
- Safety and Regulatory Approvals
  - ♦ UL1577, 5000 V<sub>RMS</sub> for 1 minute
  - ♦ DIN EN/IEC60747-5-2
- >8.0 mm Clearance and Creepage Distance (Option 'T')
- This is a Pb-Free Device

### Applications

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

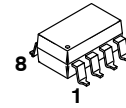
Table 1. TRUTH TABLE

| LED | V <sub>DD</sub> - V <sub>SS</sub> "Positive Going" (Turn-on) | V <sub>DD</sub> - V <sub>SS</sub> "Negative Going" (Turn-off) | V <sub>O</sub> |
|-----|--------------------------------------------------------------|---------------------------------------------------------------|----------------|
| 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           |

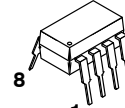


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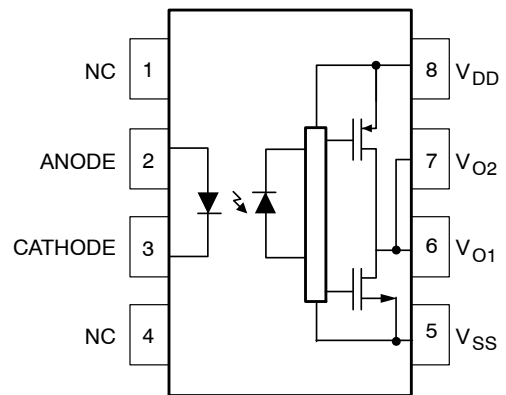


PDIP8 GW  
CASE 709AC



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 12 of this data sheet.

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**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 VO1) |
| 7     | VO1     | Output Voltage 1                               |
| 8     | VDD     | Positive Supply Voltage                        |

**Table 3. SAFETY AND INSULATION RATINGS**

As per IEC 60747-5-2. 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     |      |                   |
|                       | Climatic Classification                                                                                                                                                |                 | 55/100/21 |      |                   |
|                       | Pollution Degree (DIN VDE 0110/1.89)                                                                                                                                   |                 | 2         |      |                   |
| CTI                   | Comparative Tracking Index                                                                                                                                             | 175             |           |      |                   |
| V <sub>PR</sub>       | Input to Output Test Voltage, Method b,<br>V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 second, Partial Discharge < 5 pC | 1669            |           |      |                   |
|                       | Input to Output Test Voltage, Method a,<br>V <sub>IORM</sub> × 1.5 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 60 second, Partial Discharge < 5 pC  | 1335            |           |      |                   |
| V <sub>IORM</sub>     | Max Working Insulation Voltage                                                                                                                                         | 890             |           |      | V <sub>peak</sub> |
| V <sub>IOTM</sub>     | Highest Allowable Over Voltage                                                                                                                                         | 6000            |           |      | V <sub>peak</sub> |
|                       | External Creepage                                                                                                                                                      | 8               |           |      | mm                |
|                       | External Clearance                                                                                                                                                     | 7.4             |           |      | mm                |
|                       | External Clearance (for Option T-0.4" Lead Spacing)                                                                                                                    | 10.16           |           |      | mm                |
|                       | Insulation Thickness                                                                                                                                                   | 0.5             |           |      | mm                |
| T <sub>Case</sub>     | Safety Limit Values – Maximum Values Allowed in the Event of a Failure Case Temperature                                                                                | 150             |           |      | °C                |
| I <sub>S,INPUT</sub>  | Input Current                                                                                                                                                          | 25              |           |      | mA                |
| P <sub>S,OUTPUT</sub> | Output Power (Duty Factor ≤ 2.7 %)                                                                                                                                     | 250             |           |      | mW                |
| R <sub>IO</sub>       | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V                                                                                                      | 10 <sup>9</sup> |           |      | Ω                 |

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

| Symbol                 | Parameter                                                                    | Value          | Units            |
|------------------------|------------------------------------------------------------------------------|----------------|------------------|
| $T_{STG}$              | 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<br>(refer to page 12 for reflow solder profile) | 260 for 10 sec | $^\circ\text{C}$ |
| $I_{F(AVG)}$           | Average Input Current                                                        | 25             | mA               |
| $V_R$                  | Reverse Input Voltage                                                        | 5              | V                |
| $I_{O(PEAK)}$          | Peak Output Current <sup>(1)</sup>                                           | 3              | A                |
| $V_{DD} - V_{SS}$      | Supply Voltage                                                               | 0 to 35        | V                |
| $V_{O(PEAK)}$          | 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 <sup>(2) (4)</sup>                                   | 45             | mW               |
| $PD_O$                 | Output Power Dissipation <sup>(3) (4)</sup>                                  | 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. Maximum pulse width = 10  $\mu\text{s}$ , maximum duty cycle = 1.1 %.
2. Derate linearly above  $87^\circ\text{C}$ , free air temperature at a rate of 0.77 mW/ $^\circ\text{C}$ .
3. No derating required across temperature range.
4. 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 | $^\circ\text{C}$ |
| $V_{DD} - V_{SS}$ | 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,<br>$I_{I-O} \leq 10 \mu\text{A}$ , 50 Hz <sup>(5) (6)</sup> | 5000 |           |      | $V_{RMS}$ |
| $R_{ISO}$ | Isolation Resistance           | $V_{I-O} = 500 \text{ V}$ <sup>(5)</sup>                                                                              |      | $10^{11}$ |      | $\Omega$  |
| $C_{ISO}$ | Isolation Capacitance          | $V_{I-O} = 0 \text{ V}$ , Frequency = 1.0 MHz <sup>(5)</sup>                                                          |      | 1         |      | pF        |

5. Device is considered a two terminal device: pins 2 and 3 are shorted together and pins 5, 6, 7 and 8 are shorted together.
6. 5,000  $V_{RMS}$  for 1 minute duration is equivalent to 6,000  $V_{ACRMS}$  for 1 second duration.

**Table 7. ELECTRICAL CHARACTERISTICS**

| Symbol              | Parameter                                  | Conditions             | Min. | Typ. | Max. | Units                |
|---------------------|--------------------------------------------|------------------------|------|------|------|----------------------|
| $V_F$               | Input Forward Voltage                      | $I_F = 10 \text{ mA}$  | 1.2  | 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                    |

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**Table 7. ELECTRICAL CHARACTERISTICS**

| Symbol              | Parameter                                  | Conditions                                         | Min.                     | Typ.                    | Max.                     | Units |
|---------------------|--------------------------------------------|----------------------------------------------------|--------------------------|-------------------------|--------------------------|-------|
| C <sub>IN</sub>     | Input Capacitance                          | f = 1 MHz, V <sub>F</sub> = 0 V                    |                          | 60                      |                          | pF    |
| I <sub>OH</sub>     | High Level Output Current <sup>(7)</sup>   | V <sub>O</sub> = V <sub>DD</sub> - 3 V             | -1.0                     | -2.0                    |                          | A     |
|                     |                                            | V <sub>O</sub> = V <sub>DD</sub> - 6 V             | -2.0                     |                         |                          |       |
| I <sub>OL</sub>     | Low Level Output Current <sup>(7)</sup>    | V <sub>O</sub> = V <sub>SS</sub> + 3 V             | 1.0                      | 2.0                     |                          | A     |
|                     |                                            | V <sub>O</sub> = V <sub>SS</sub> + 6 V             | 2.0                      |                         |                          |       |
| V <sub>OH</sub>     | High Level Output Voltage                  | I <sub>F</sub> = 10 mA, I <sub>O</sub> = -2.5 A    | V <sub>DD</sub> - 6.25 V | V <sub>DD</sub> - 2.5 V |                          | V     |
|                     |                                            | I <sub>F</sub> = 10 mA, I <sub>O</sub> = -100 mA   | V <sub>DD</sub> - 0.25 V | V <sub>DD</sub> - 0.1 V |                          |       |
| V <sub>OL</sub>     | Low Level Output Voltage                   | I <sub>F</sub> = 0 mA, I <sub>O</sub> = 2.5 A      |                          | V <sub>SS</sub> + 2.5 V | V <sub>SS</sub> + 6.25 V | V     |
|                     |                                            | I <sub>F</sub> = 0 mA, I <sub>O</sub> = 100 mA     |                          | V <sub>SS</sub> + 0.1 V | V <sub>SS</sub> + 0.25 V |       |
| I <sub>DDH</sub>    | High Level Supply Current                  | V <sub>O</sub> = Open, I <sub>F</sub> = 7 to 16 mA |                          | 2.8                     | 5                        | mA    |
| I <sub>DDL</sub>    | Low Level Supply Current                   | V <sub>O</sub> = Open, V <sub>F</sub> = 0 to 0.8 V |                          | 2.8                     | 5                        | mA    |
| I <sub>FLH</sub>    | Threshold Input Current Low to High        | I <sub>O</sub> = 0 mA, V <sub>O</sub> > 5 V        |                          | 2.3                     | 5.0                      | mA    |
| V <sub>FHL</sub>    | Threshold Input Voltage High to Low        | I <sub>O</sub> = 0 mA, V <sub>O</sub> < 5 V        | 0.8                      |                         |                          | V     |
| V <sub>UVLO+</sub>  | Under Voltage Lockout Threshold            | I <sub>F</sub> = 1 0mA, V <sub>O</sub> > 5 V       | 11                       | 12.7                    | 14                       | V     |
| V <sub>UVLO-</sub>  |                                            | I <sub>F</sub> = 10 mA, V <sub>O</sub> < 5 V       | 9.7                      | 11.2                    | 12.7                     | V     |
| UVLO <sub>HYS</sub> | 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.

7. 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<sub>DD</sub> = 30 V, V<sub>SS</sub> = Ground, T<sub>A</sub> = 25°C unless otherwise specified.

| Symbol                | Parameter                                                                                                             | Conditions                                                                                                             | Min. | Typ. | Max. | Units |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------|------|------|-------|
| t <sub>PHL</sub>      | Propagation Delay Time to Logic Low Output                                                                            | I <sub>F</sub> = 7 mA to 16 mA,<br>R <sub>g</sub> = 20 Ω, C <sub>g</sub> = 10 nF,<br>f = 10 kHz, Duty Cycle = 50 %     | 100  | 275  | 500  | ns    |
| t <sub>PLH</sub>      | Propagation Delay Time to Logic High Output                                                                           |                                                                                                                        | 100  | 255  | 500  | ns    |
| PWD                   | Pulse Width Distortion,   t <sub>PHL</sub> - t <sub>PLH</sub>                                                         |                                                                                                                        |      | 20   | 300  | ns    |
| PDD (Skew)            | Propagation Delay Difference Between Any Two Parts or Channels, (t <sub>PHL</sub> - t <sub>PLH</sub> ) <sup>(8)</sup> |                                                                                                                        | -350 |      | 350  | ns    |
| t <sub>r</sub>        | Output Rise Time (10% - 90%)                                                                                          |                                                                                                                        |      | 60   |      | ns    |
| t <sub>f</sub>        | Output Fall Time (90% - 10%)                                                                                          |                                                                                                                        |      | 60   |      | ns    |
| t <sub>UVLO ON</sub>  | UVLO Turn On Delay                                                                                                    | I <sub>F</sub> = 10 mA, V <sub>O</sub> > 5 V                                                                           |      | 1.6  |      | μs    |
| t <sub>UVLO OFF</sub> | UVLO Turn Off Delay                                                                                                   | I <sub>F</sub> = 10 mA, V <sub>O</sub> < 5 V                                                                           |      | 0.4  |      | μs    |
| CM <sub>H</sub>       | Common Mode Transient Immunity at Output High                                                                         | T <sub>A</sub> = 25°C, V <sub>DD</sub> = 30 V,<br>I <sub>F</sub> = 7 to 16 mA, V <sub>CM</sub> = 2000 V <sup>(9)</sup> | 20   | 50   |      | kV/μs |
| CM <sub>L</sub>       | Common Mode Transient Immunity at Output Low                                                                          | T <sub>A</sub> = 25°C, V <sub>DD</sub> = 30 V, V <sub>F</sub> = 0 V,<br>V <sub>CM</sub> = 2000 V <sup>(10)</sup>       | 20   | 50   |      | kV/μs |

8. The difference between t<sub>PHL</sub> and t<sub>PLH</sub> between any two FOD3150A parts under same test conditions.

9. Common mode transient immunity at output high is the maximum tolerable negative dV<sub>cm</sub>/dt on the trailing edge of the common mode impulse signal, V<sub>cm</sub>, to assure that the output will remain high (i.e., V<sub>O</sub> > 15.0 V).

10. Common mode transient immunity at output low is the maximum tolerable positive dV<sub>cm</sub>/dt on the leading edge of the common pulse signal, V<sub>cm</sub>, to assure that the output will remain low (i.e., V<sub>O</sub> < 1.0 V).

TYPICAL PERFORMANCE CURVES

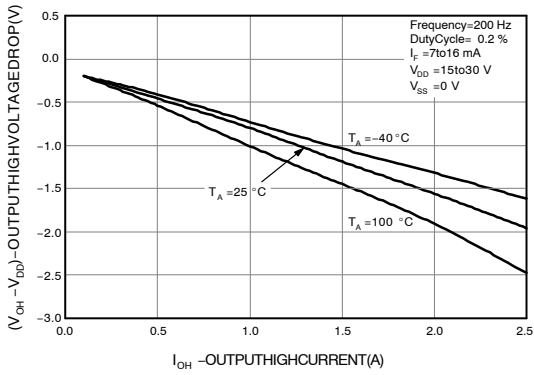


Figure 1. Output High Voltage Drop vs. Output High Current

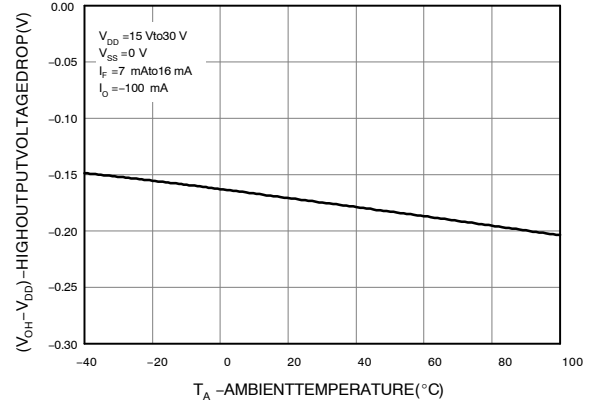


Figure 2. Output High Voltage Drop vs. Ambient Temperature

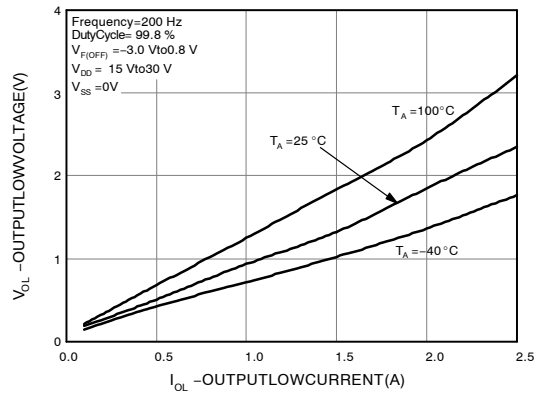


Figure 3. Output Low Voltage vs. Output Low Current

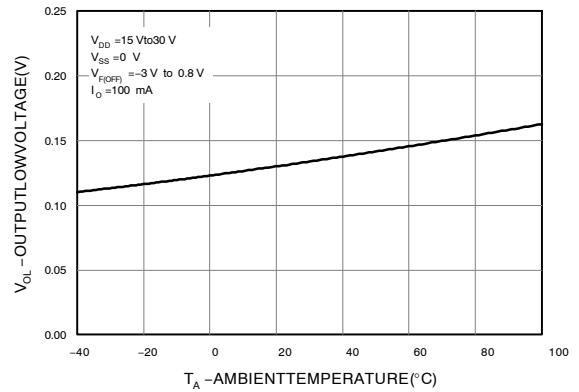


Figure 4. Output Low Voltage vs. Ambient Temperature

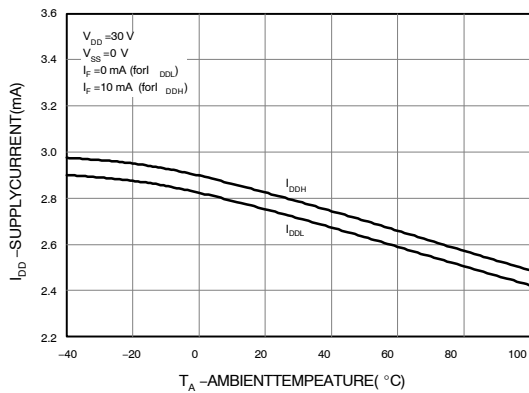


Figure 5. Supply Current vs. Ambient Temperature

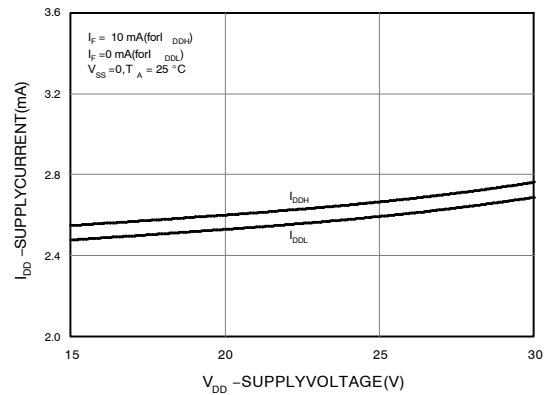
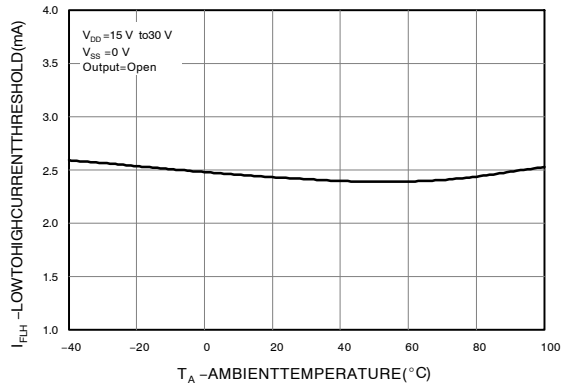
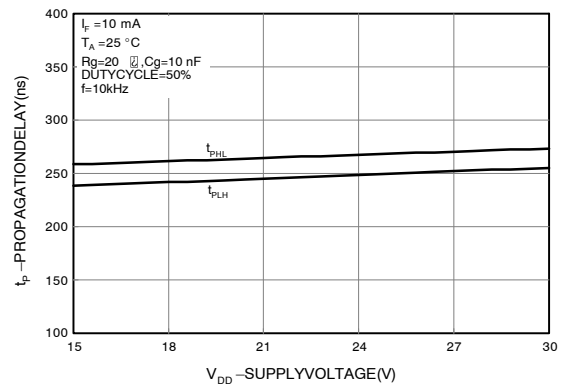


Figure 6. Supply Current vs. Supply Voltage

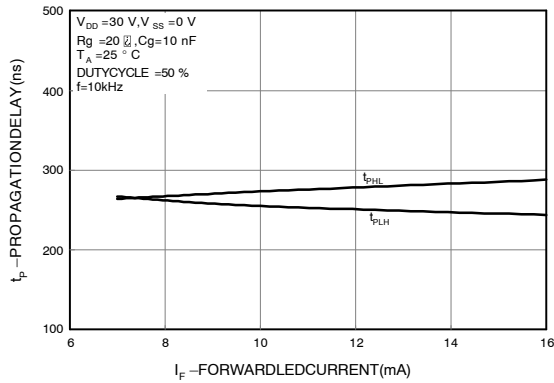
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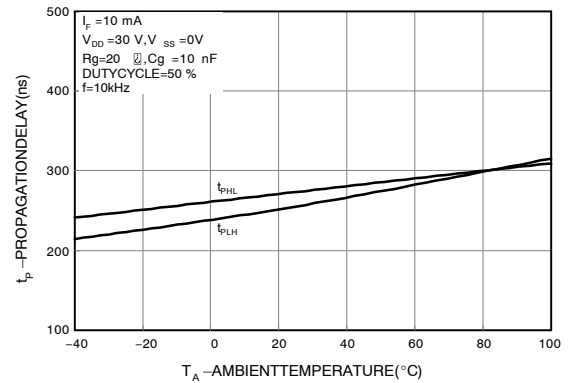
**Figure 7. Low to High Input Current Threshold vs. Ambient Temperature**



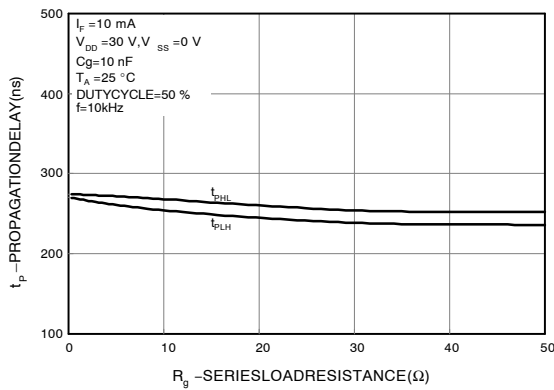
**Figure 8. Propagation Delay vs. Supply Voltage**



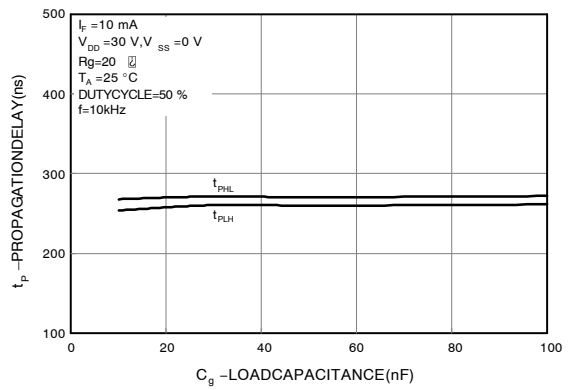
**Figure 9. Propagation Delay vs. LED Forward Current**



**Figure 10. Propagation Delay vs. Ambient Temperature**



**Figure 11. Propagation Delay vs. Series Load Resistance**



**Figure 12. Propagation Delay vs. Load Capacitance**

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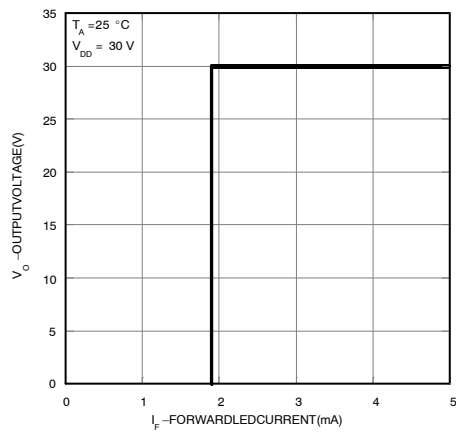


Figure 13. Transfer Characteristics

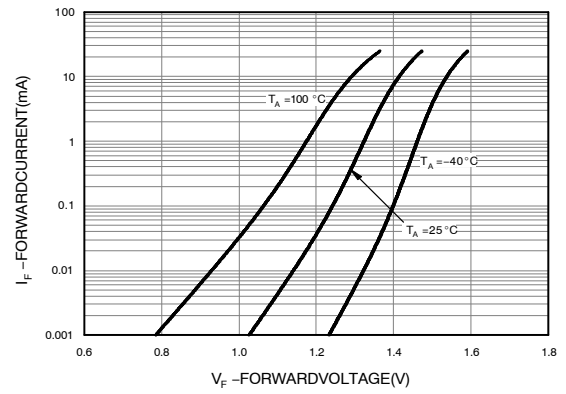


Figure 14. Input Forward Current vs. Forward Voltage

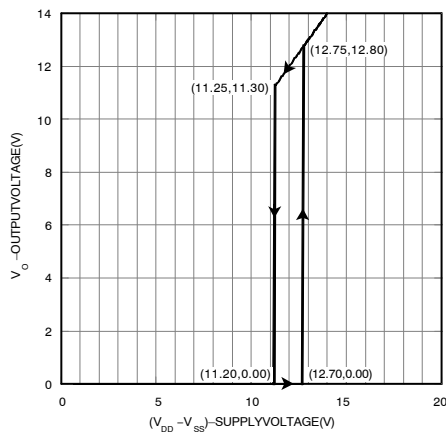


Figure 15. Under Voltage Lockout

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## TEST CIRCUIT

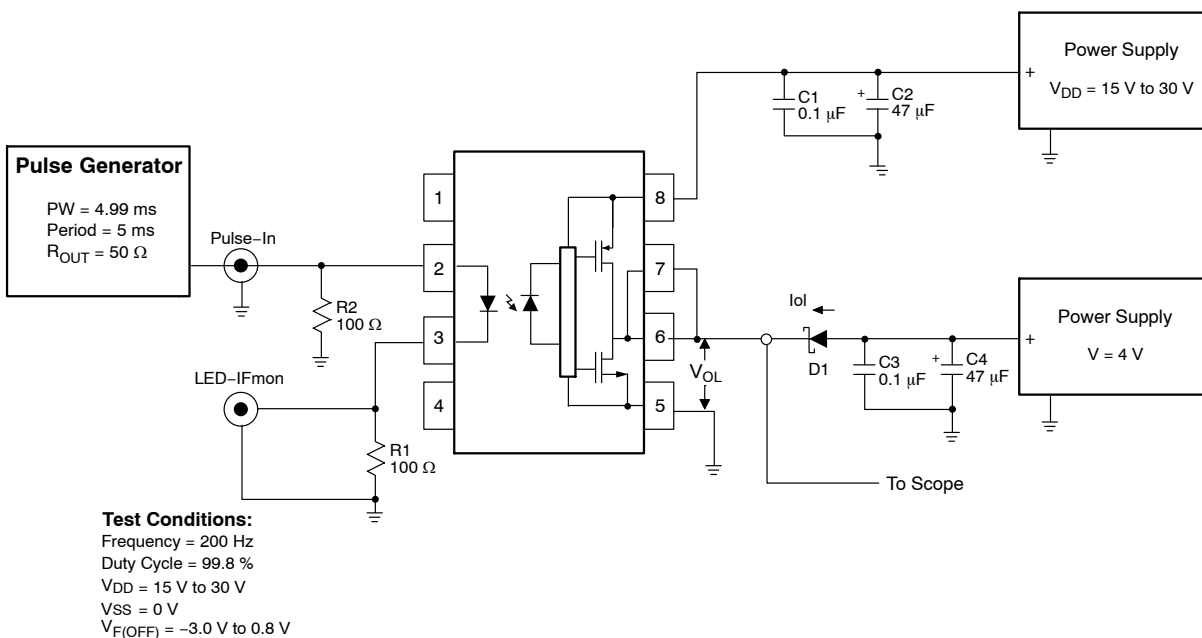


Figure 16.  $I_{OL}$  Test Circuit

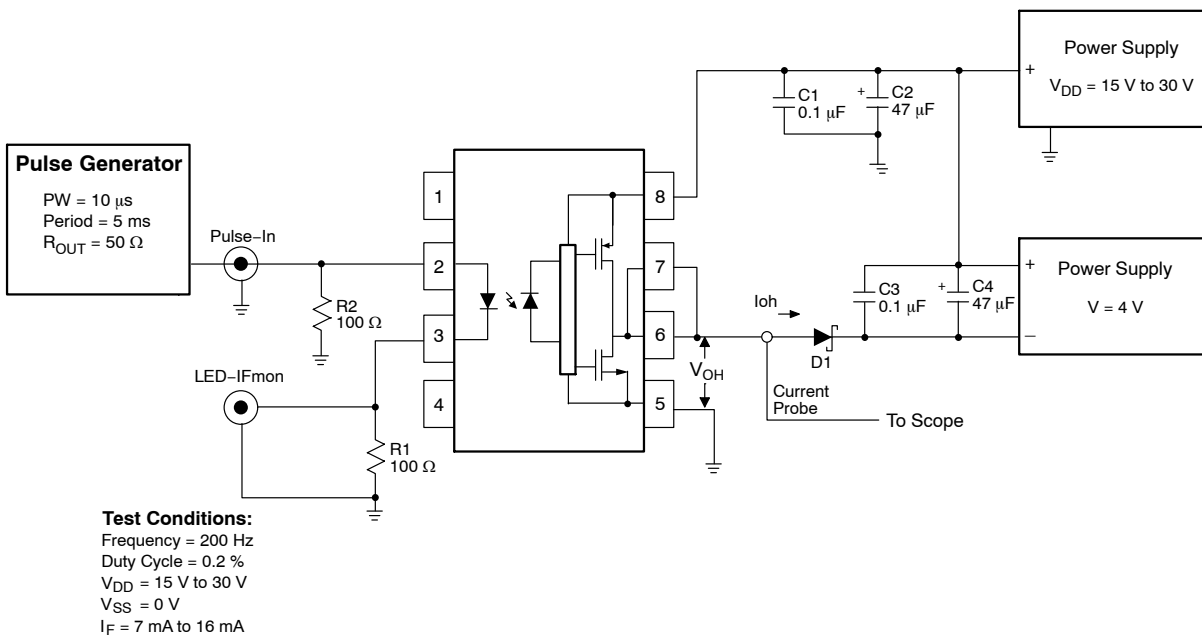


Figure 17.  $I_{OH}$  Test Circuit

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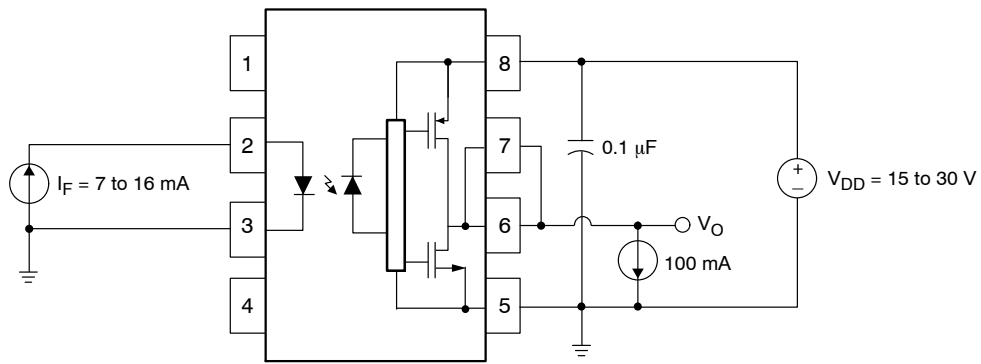


Figure 18.  $V_{OH}$  Test Circuit

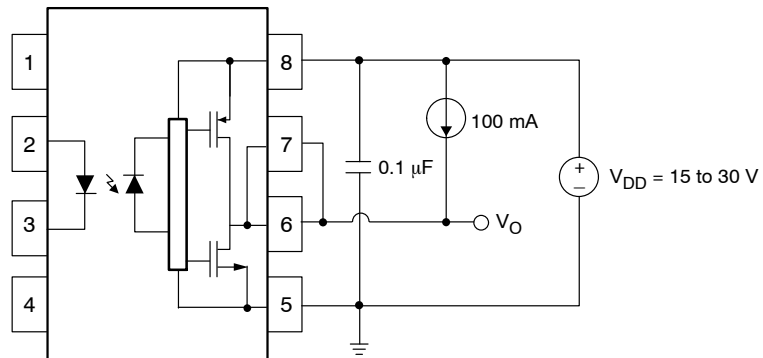


Figure 19.  $V_{OL}$  Test Circuit

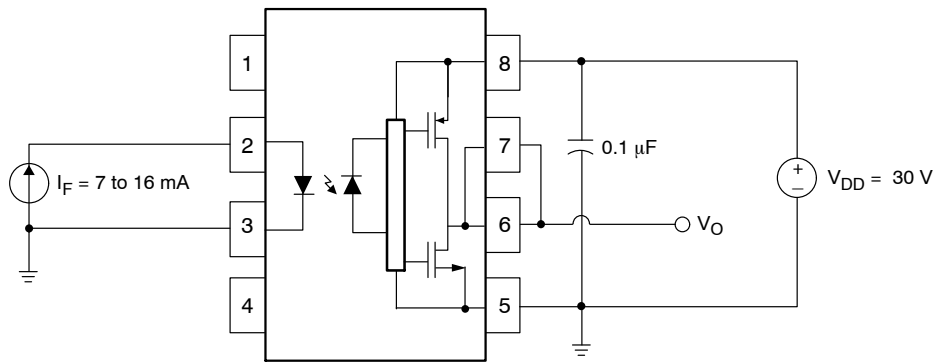


Figure 20.  $I_{DDH}$  Test Circuit

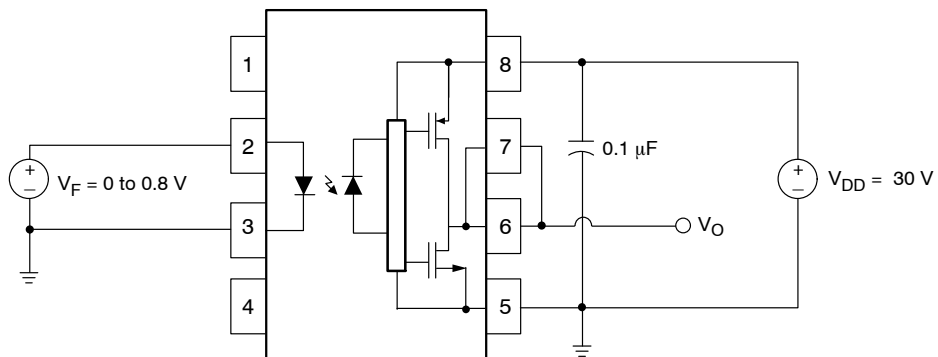


Figure 21.  $I_{DDL}$  Test Circuit

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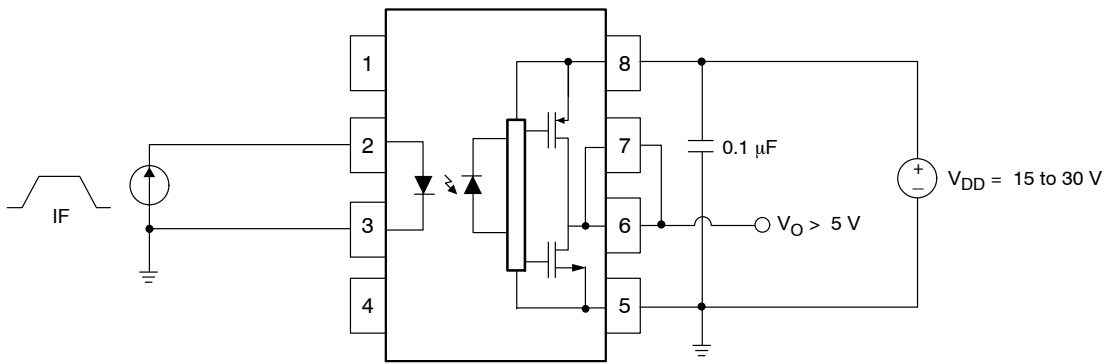


Figure 22.  $I_{FLH}$  Test Circuit

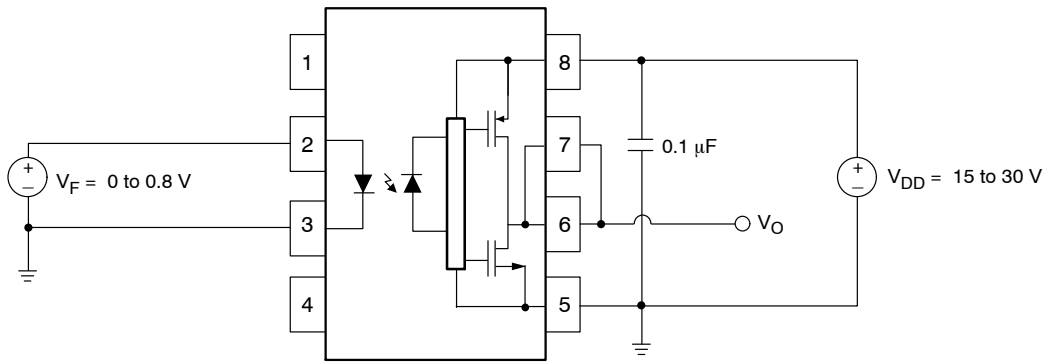


Figure 23.  $V_{FHL}$  Test Circuit

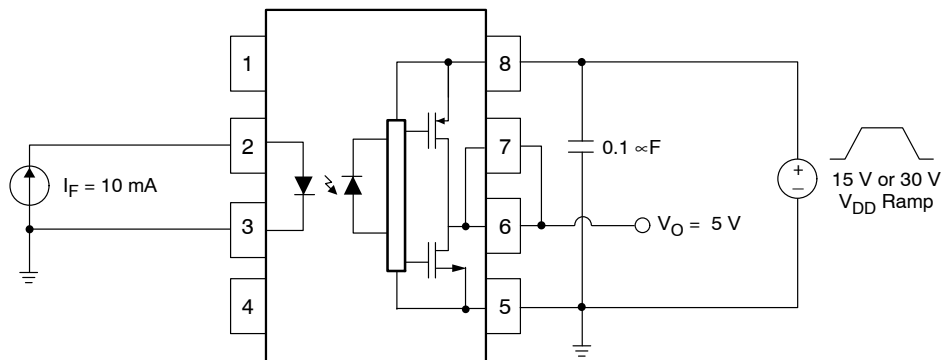
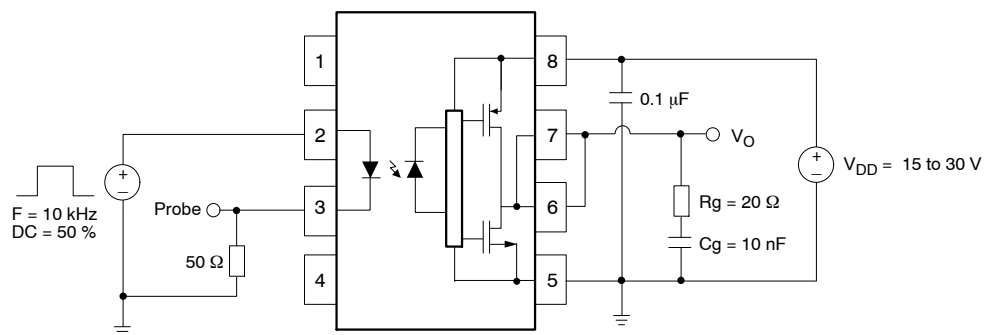
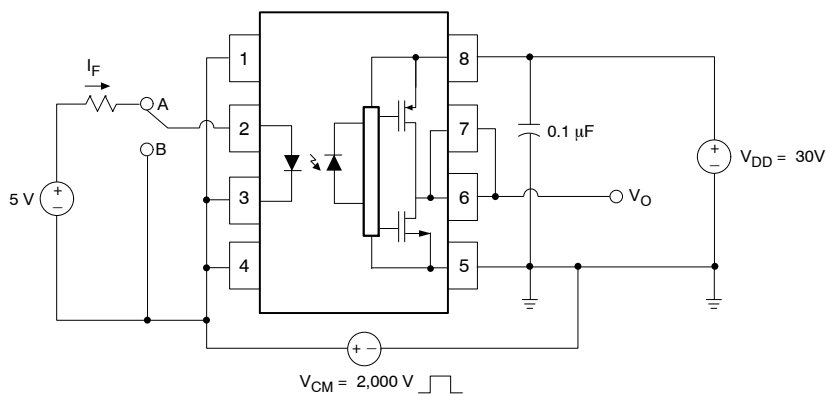


Figure 24. UVLO Test Circuit

# FOD3150A



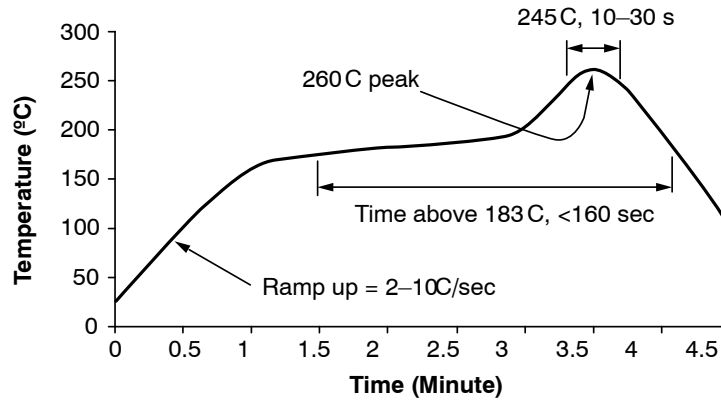
**Figure 25.  $t_{PHL}$ ,  $t_{PLH}$ ,  $t_R$  and  $t_F$  Test Circuit and Waveforms**



**Figure 26. CMR Test Circuit and Waveforms**

# FOD3150A

## 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 27. Reflow Profile

## ORDERING INFORMATION

| Part Number | Package                                                  | Shipping†           |
|-------------|----------------------------------------------------------|---------------------|
| FOD3150A    | DIP 8-Pin                                                | 50 / Tube           |
| FOD3150AS   | SMT 8-Pin (Lead Bend)                                    | 50 / Tube           |
| FOD3150ASD  | SMT 8-Pin (Lead Bend)                                    | 1,000 / Tape & Reel |
| FOD3150AV   | DIP 8-Pin, IEC60747-5-2 option                           | 50 / Tube           |
| FOD3150ASV  | SMT 8-Pin (Lead Bend), DIN EN/IEC60747-5-2 option        | 50 / Tube           |
| FOD3150ASDV | SMT 8-Pin (Lead Bend), DIN EN/IEC60747-5-2 option        | 1,000 / Tape & Reel |
| FOD3150ATV  | DIP 8-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-2 option | 50 / Tube           |

†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

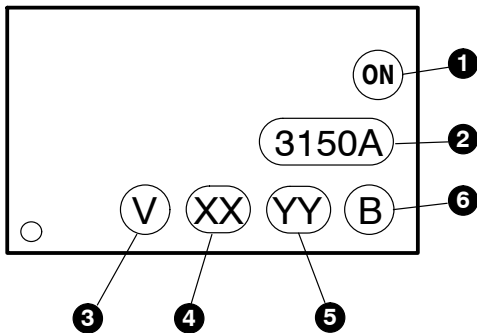


Figure 28. Device Marking

| Definitions |                                                                                 |
|-------------|---------------------------------------------------------------------------------|
| 1           | Company logo                                                                    |
| 2           | Device number                                                                   |
| 3           | DIN EN/IEC60747-5-2 Option (only appears on component ordered with this option) |
| 4           | Two digit year code, e.g., '08'                                                 |
| 5           | Two digit work week ranging from '01' to '53'                                   |
| 6           | Assembly package code                                                           |

## CARRIER TAPE SPECIFICATIONS

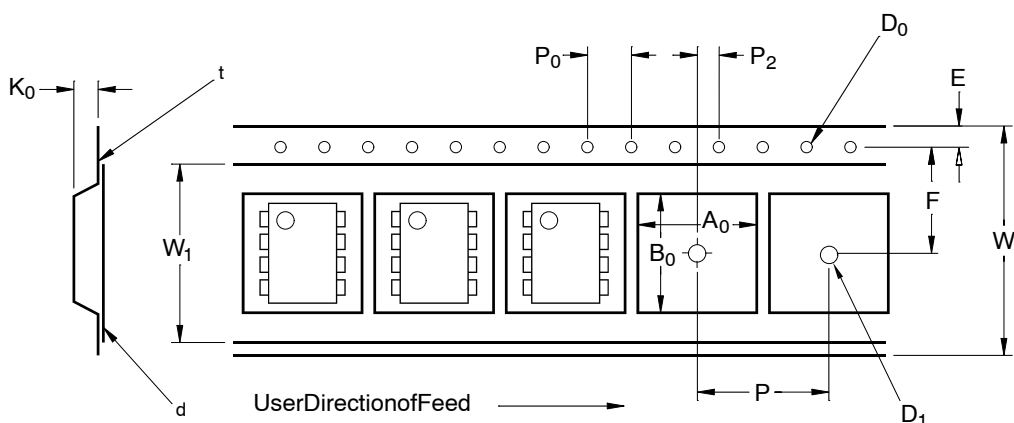


Figure 29. Carrier Tape Specifications

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

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