FAIRCHILD SEMICONDUCTOR®

August 2013

# FOD3150A
# High Noise Immunity, 2.5 A Output Current, Gate Drive Optocoupler

## 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 temperate range, -40°C to 100°C temperature range
- Safety and regulatory approvals
  - UL1577, 5000 $V_{RMS}$ for 1 minute
  - DIN EN/IEC60747-5-2
- >8.0 mm clearance and creepage distance (option 'T')

## Applications

- Industrial inverter
- Uninterruptible power supply
- Induction heating
- Isolated IGBT/Power MOSFET gate drive

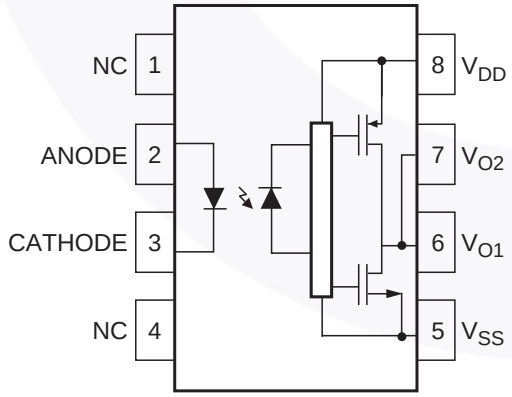
## Description

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 Fairchild's 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.

## Functional Block Diagram




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

**Figure 1. Functional Block Diagram**

## Package Outlines

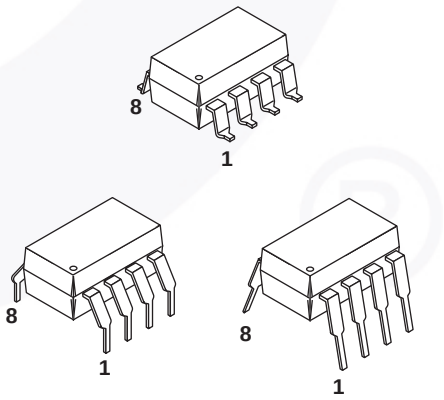



**Figure 2. Package Outlines**

## 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 V | 0 V to 9.5 V | Low |
| On | 11 V to 13.5 V | 9.5 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 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 | | | |
| $V_{PR}$ | Input to Output Test Voltage, Method b, $V_{IORM}$ x 1.875 = $V_{PR}$, 100% Production Test with tm = 1 second, Partial Discharge < 5 pC | 1669 | | | |
| | Input to Output Test Voltage, Method a, $V_{IORM}$ x 1.5 = $V_{PR}$, Type and Sample Test with tm = 60 second, Partial Discharge < 5 pC | 1335 | | | |
| $V_{IORM}$ | Max Working Insulation Voltage | 890 | | | $V_{peak}$ |
| $V_{IOTM}$ | Highest Allowable Over Voltage | 6000 | | | $V_{peak}$ |
| | External Creepage | 8 | | | mm |
| | External Clearance | 7.4 | | | mm |
| | External Clearance (for Option T-0.4” Lead Spacing) | 10.16 | | | mm |
| | Insulation Thickness | 0.5 | | | mm |
| | Safety Limit Values – Maximum Values Allowed in the Event of a Failure | | | | |
| $T_{Case}$ | Case Temperature | 150 | | | °C |
| $I_{S,INPUT}$ | Input Current | 25 | | | mA |
| $P_{S,OUTPUT}$ | Output Power (Duty Factor ≤ 2.7 %) | 250 | | | mW |
| $R_{IO}$ | Insulation Resistance at $T_S$, $V_{IO}$ = 500 V | $10^9$ | | | Ω |

## Absolute Maximum Ratings

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. $T_A$ = 25ºC unless otherwise specified.

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $T_{STG}$ | Storage Temperature | -55 to +125 | ºC |
| $T_{OPR}$ | Operating Temperature | -40 to +100 | ºC |
| $T_J$ | Junction Temperature | -40 to +125 | ºC |
| $T_{SOL}$ | Lead Wave Solder Temperature (refer to page 15 for reflow solder profile) | 260 for 10sec | ºC |
| $I_{F(AVG)}$ | Average Input Current | 25 | mA |
| $V_R$ | Reverse Input Voltage | 5 | V |
| $I_{O(PEAK)}$ | Peak Output Current(1) | 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(2)(4) | 45 | mW |
| $PD_O$ | Output Power Dissipation(3)(4) | 250 | mW |

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol | Parameter | 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 |

## Isolation Characteristics

Apply over all recommended conditions, typical value is measured at $T_A$ = 25ºC

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $V_{ISO}$ | Input-Output Isolation Voltage | $T_A$ = 25ºC, R.H.< 50 %, t = 1.0 minute, $I_{I-O} \leq$ 10 µA, 50 Hz(5)(6) | 5000 | | | $V_{RMS}$ |
| $R_{ISO}$ | Isolation Resistance | $V_{I-O}$ = 500 V(5) | | $10^{11}$ | | Ω |
| $C_{ISO}$ | Isolation Capacitance | $V_{I-O}$ = 0 V, Frequency = 1.0 MHz(5) | | 1 | | pF |

## Electrical Characteristics

Apply over all recommended conditions, typical value is measured at $V_{DD}$ = 30V, $V_{SS}$ = 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/ºC |
| $BV_R$ | 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(1) | $V_O = V_{DD} – 3$ V | -1.0 | -2.0 | -2.5 | A |
| | | $V_O = V_{DD} – 6$ V | -2.0 | | -2.5 | |
| $I_{OL}$ | Low Level Output Current(1) | $V_O = V_{SS} + 3$ 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 | 5 | mA |
| $I_{DDL}$ | Low Level Supply Current | $V_O$ = Open, $V_F$ = 0 to 0.8 V | | 2.8 | 5 | 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 | $I_F$ = 1 0mA, $V_O$ > 5 V | 11 | 12.7 | 13.5 | V |
| $V_{UVLO–}$ | | $I_F$ = 10 mA, $V_O$ < 5 V | 9.5 | 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 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 = 20 Ω, Cg =10 nF, f = 10 kHz, Duty Cycle = 50 % | 100 | 275 | 500 | ns |
| $t_{PLH}$ | Propagation Delay Time to Logic High Output | | 100 | 255 | 500 | ns |
| PWD | Pulse Width Distortion, $\lvert t_{PHL} - t_{PLH} \rvert$ | | | 20 | 300 | ns |
| PDD (Skew) | Propagation Delay Difference Between Any Two Parts or Channels, $(t_{PHL} - t_{PLH})$[7] | | -350 | | 350 | 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[8] | 20 | 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[9] | 20 | 50 | | kV/µs |

**Notes:**

1. Maximum pulse width = 10µs, maximum duty cycle = 1.1 %.
2. Derate linearly above 87°C, free air temperature at a rate of 0.77 mW/°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.
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 $VAC_{RMS}$ for 1 second duration.
7. The difference between $t_{PHL}$ and $t_{PLH}$ between any two FOD3150A parts under same test conditions.
8. 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., $V_O$ > 15.0V).
9. 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 Curves

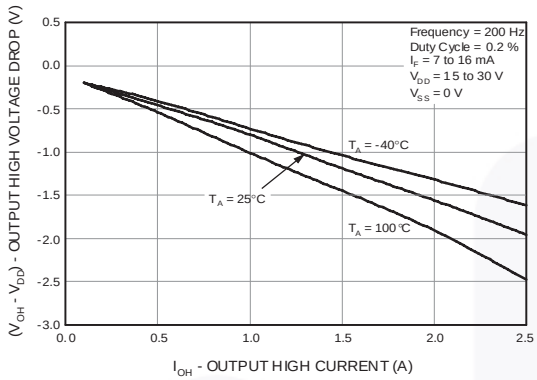



**Figure 3. Output High Voltage Drop vs. Output High Current**

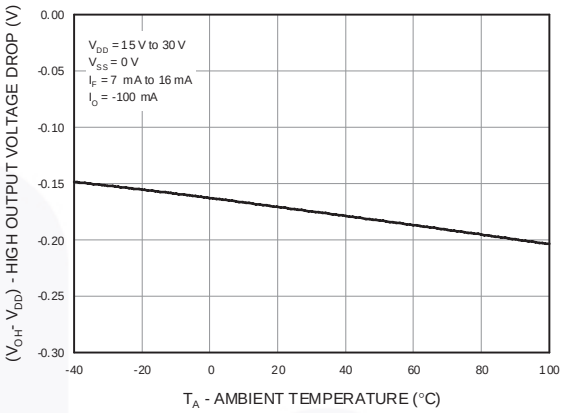



**Figure 4. Output High Voltage Drop vs. Ambient Temperature**

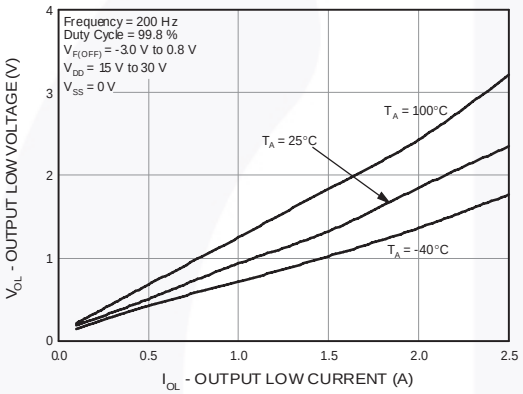



**Figure 5. Output Low Voltage vs. Output Low Current**

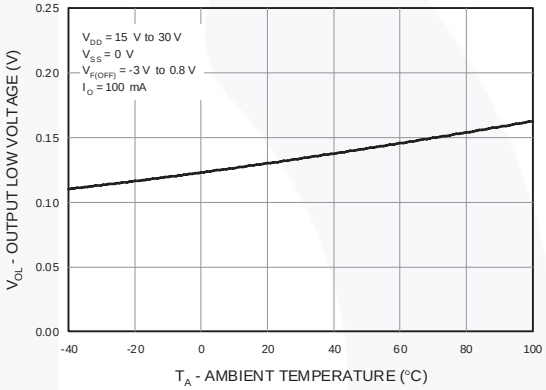



**Figure 6. Output Low Voltage vs. Ambient Temperature**

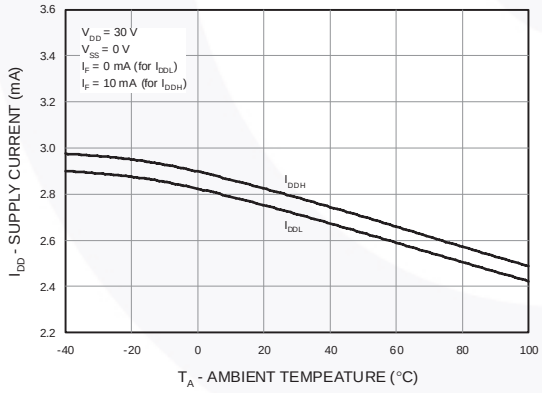



**Figure 7. Supply Current vs. Ambient Temperature**

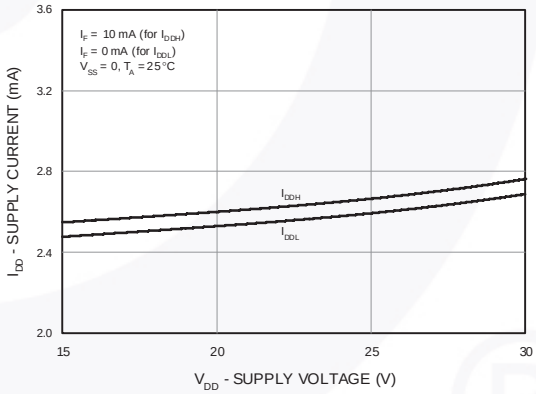



**Figure 8. Supply Current vs. Supply Voltage**

## Typical Performance Curves (Continued)

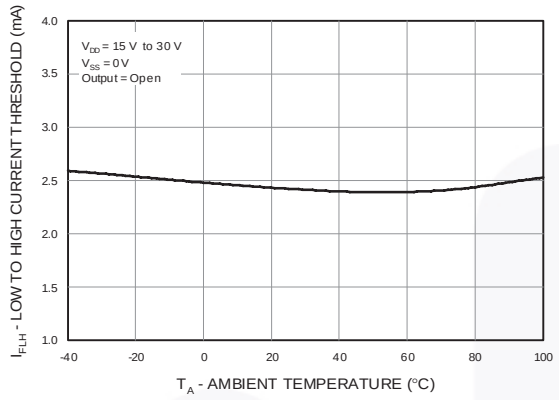



**Figure 9. Low to High Input Current Threshold vs. Ambient Temperature**

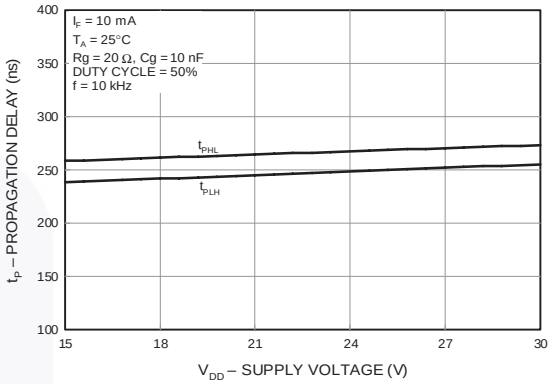



**Figure 10. Propagation Delay vs. Supply Voltage**

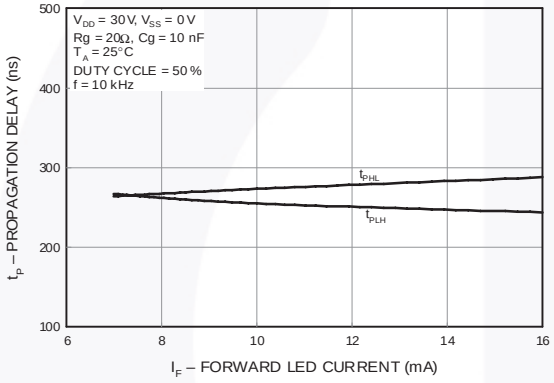



**Figure 11. Propagation Delay vs. LED Forward Current**

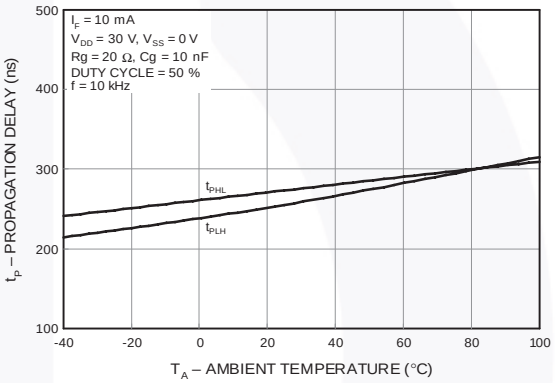



**Figure 12. Propagation Delay vs. Ambient Temperature**

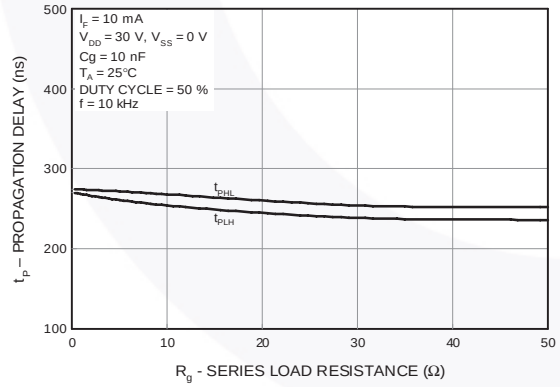



**Figure 13. Propagation Delay vs. Series Load Resistance**

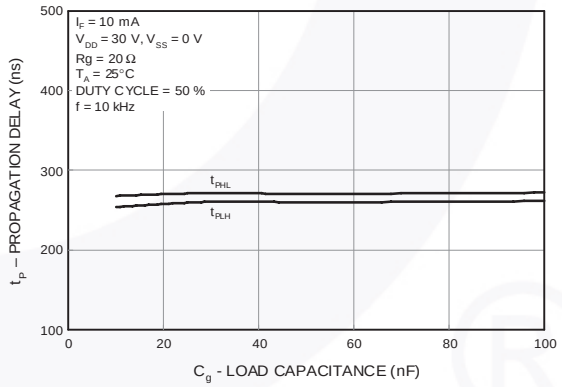



**Figure 14. Propagation Delay vs. Load Capacitance**

## Typical Performance Curves (Continued)

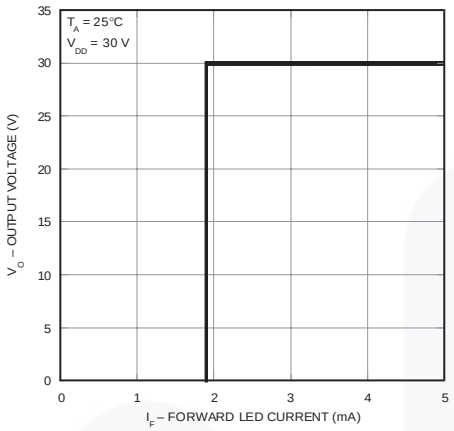



**Figure 15. Transfer Characteristics**

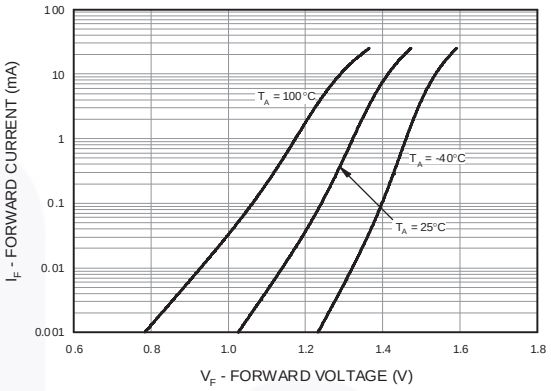



**Figure 16. Input Forward Current vs. Forward Voltage**

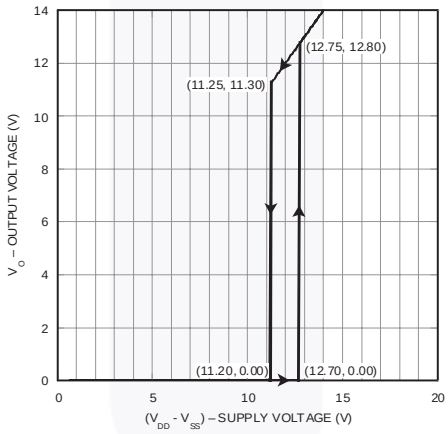
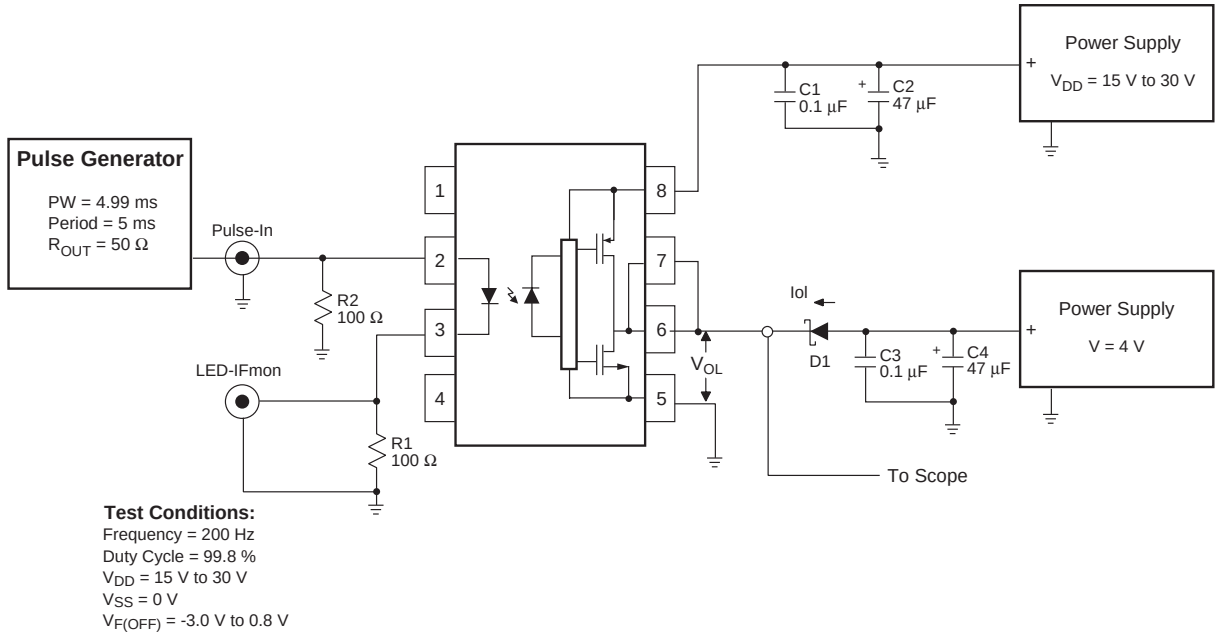


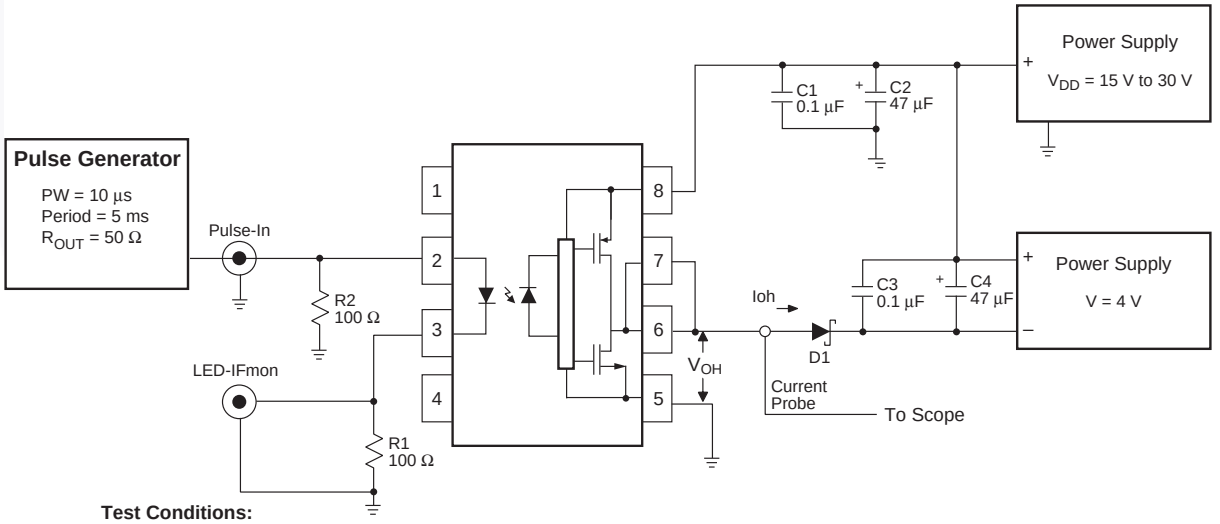

**Figure 17. Under Voltage Lockout**

## 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 18. $I_{OL}$ 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 19. $I_{OH}$ Test Circuit**

## Test Circuit (Continued)

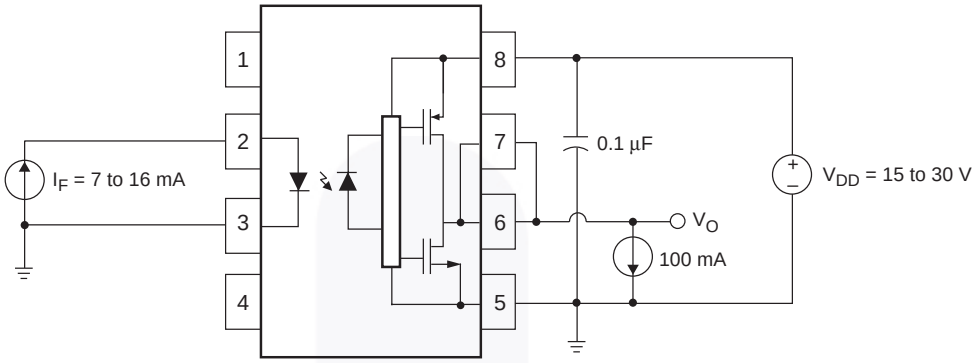



**Figure 20. $V_{OH}$ Test Circuit**

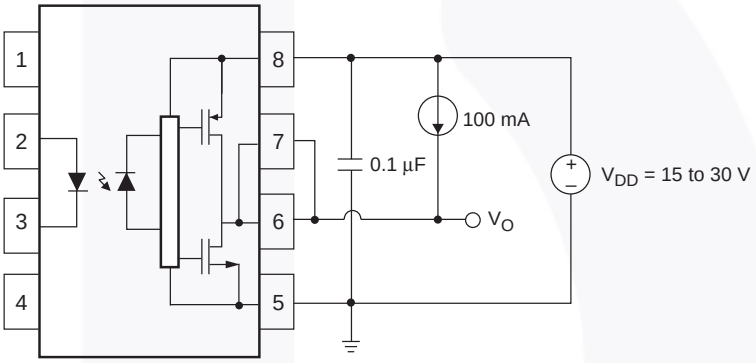



**Figure 21. $V_{OL}$ Test Circuit**

## Test Circuit (Continued)

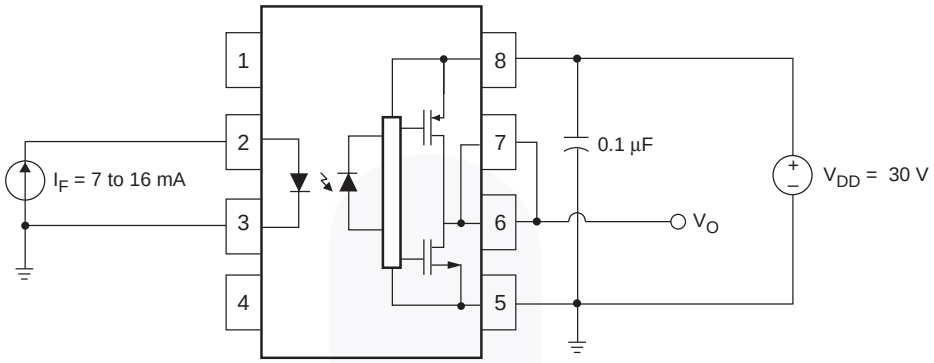



**Figure 22. $I_{DDH}$ Test Circuit**

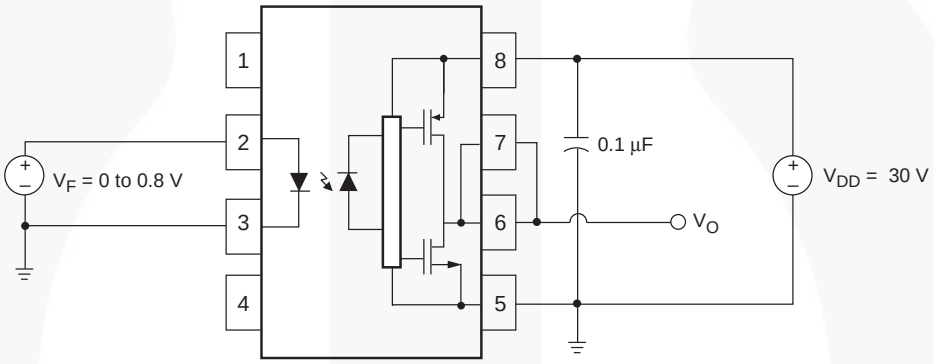



**Figure 23. $I_{DDL}$ Test Circuit**

## Test Circuit (Continued)

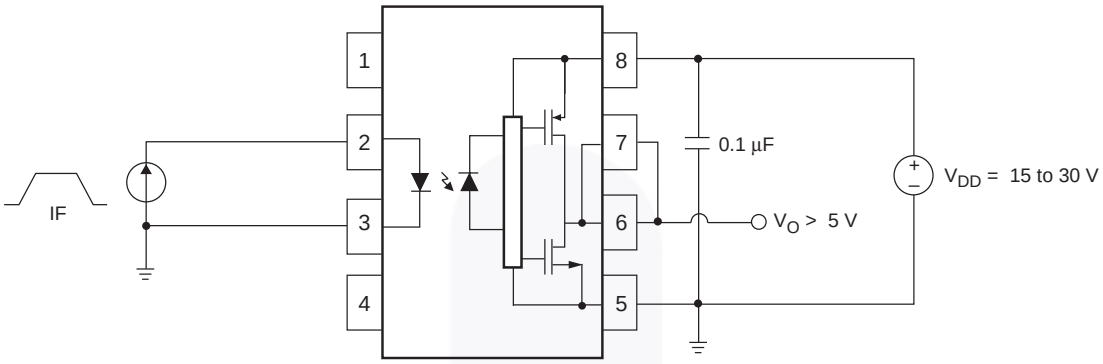



**Figure 24. $I_{FLH}$ Test Circuit**

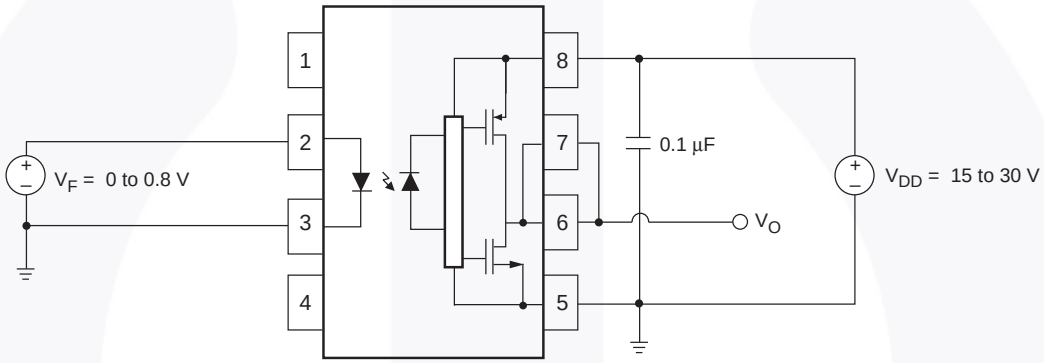



**Figure 25. $V_{FHL}$ Test Circuit**

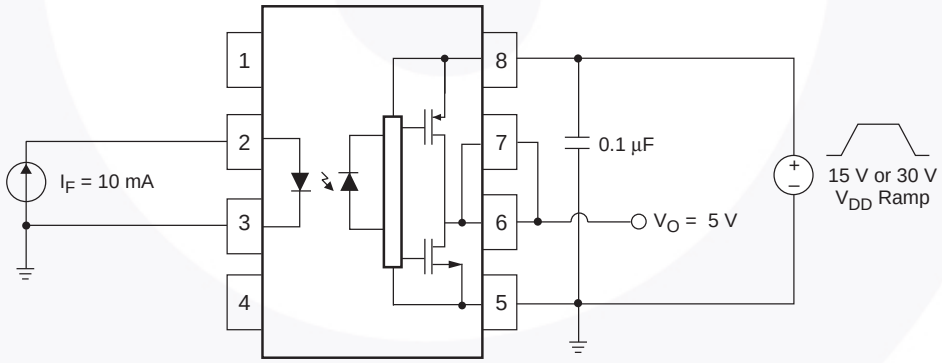



**Figure 26. UVLO Test Circuit**

## Test Circuit (Continued)

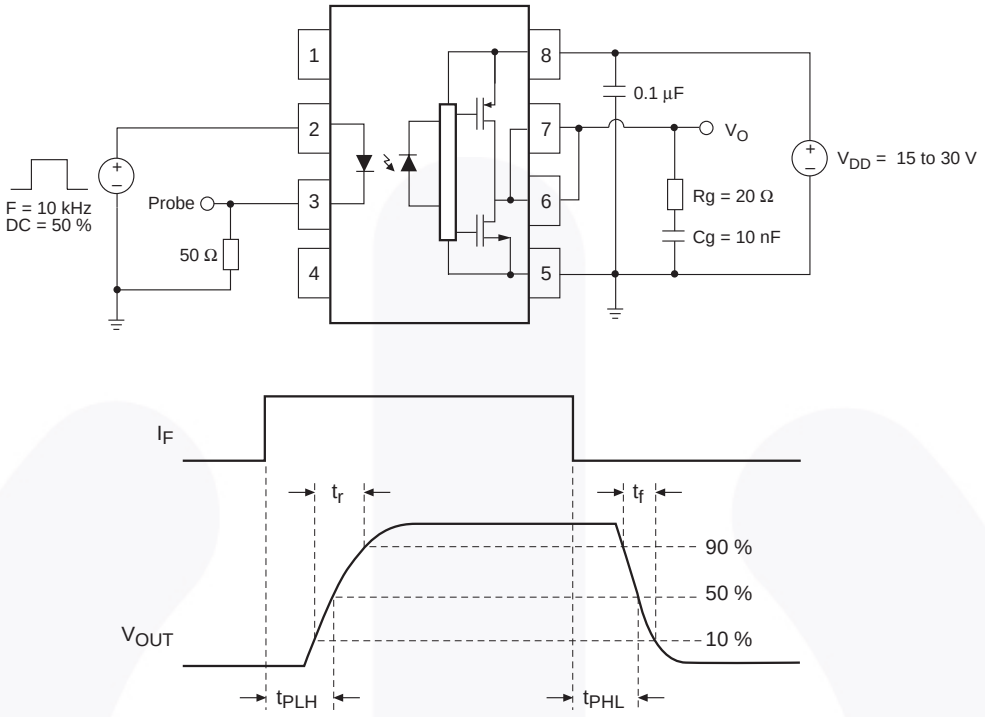



**Figure 27. $t_{PHL}$, $t_{PLH}$, $t_R$ and $t_F$ Test Circuit and Waveforms**

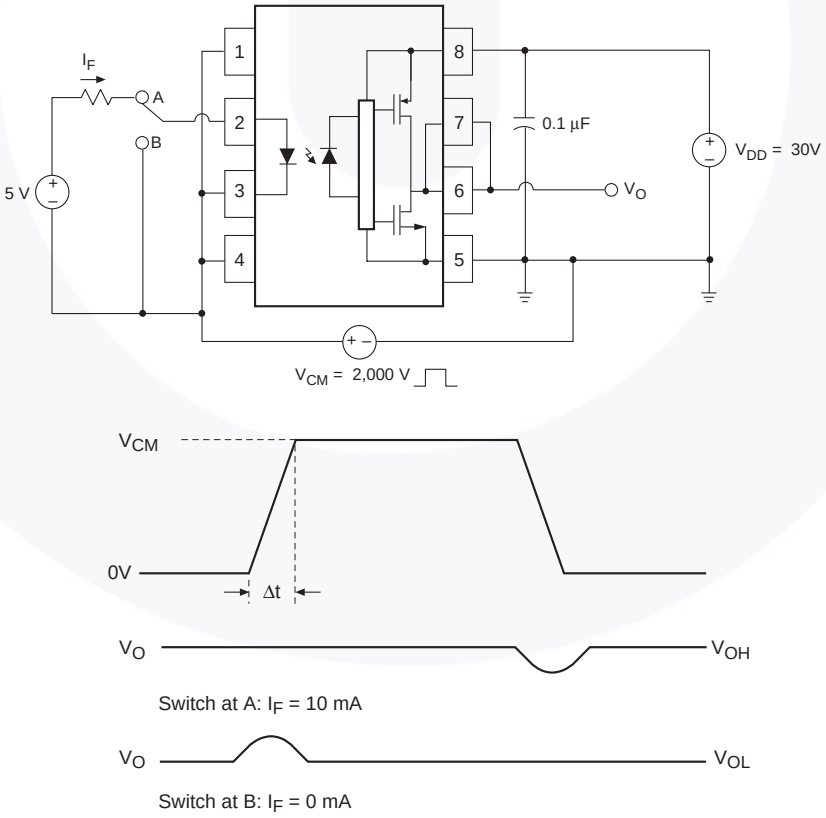
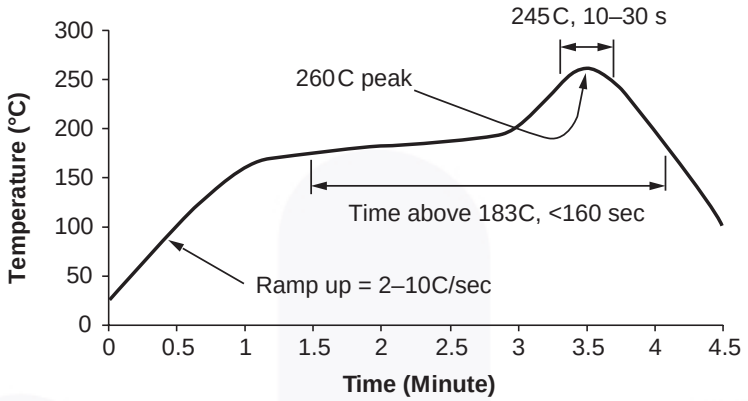



**Figure 28. CMR Test Circuit and Waveforms**

## Reflow Profile



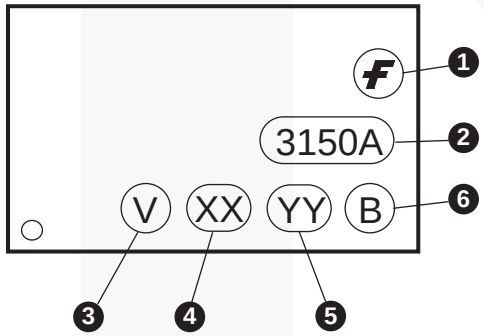

- Peak reflow temperature: 260C (package surface temperature)
- Time of temperature higher than 183C for 160 seconds or less
- One time soldering reflow is recommended

**Figure 29. Reflow Profile**

## Ordering Information

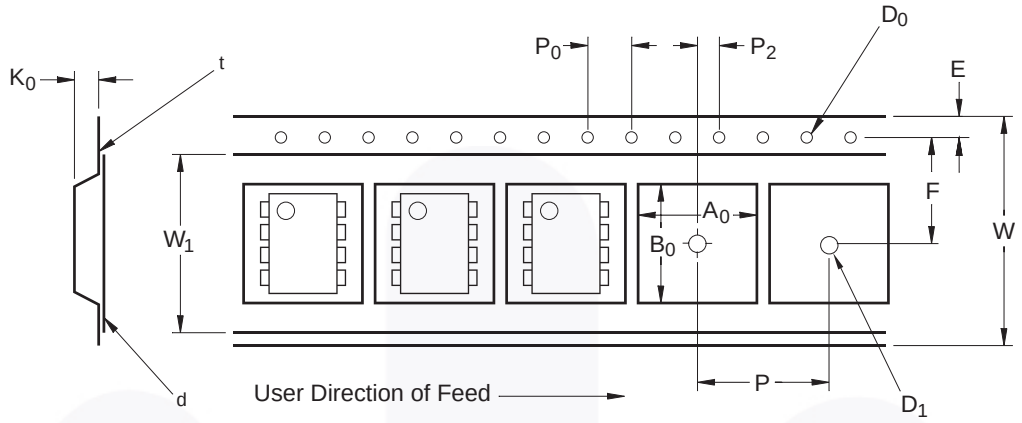
| Part Number | Package | Packing Method |
|---|---|---|
| FOD3150A | DIP 8-Pin | Tube (50 units per tube) |
| FOD3150AS | SMT 8-Pin (Lead Bend) | Tube (50 units per tube) |
| FOD3150ASD | SMT 8-Pin (Lead Bend) | Tape and Reel (1,000 units per reel) |
| FOD3150AV | DIP 8-Pin, IEC60747-5-2 option | Tube (50 units per tube) |
| FOD3150ASV | SMT 8-Pin (Lead Bend), DIN EN/IEC60747-5-2 option | Tube (50 units per tube) |
| FOD3150ASDV | SMT 8-Pin (Lead Bend), DIN EN/IEC60747-5-2 option | Tape and Reel (1,000 units per reel) |
| FOD3150AT | DIP 8-Pin, 0.4” Lead Spacing | Tube (50 units per tube) |
| FOD3150ATV | DIP 8-Pin, 0.4” Lead Spacing , DIN EN/IEC60747-5-2 option | Tube (50 units per tube) |

## Marking Information




| Definitions | |
|---|---|
| 1 | Fairchild 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 |

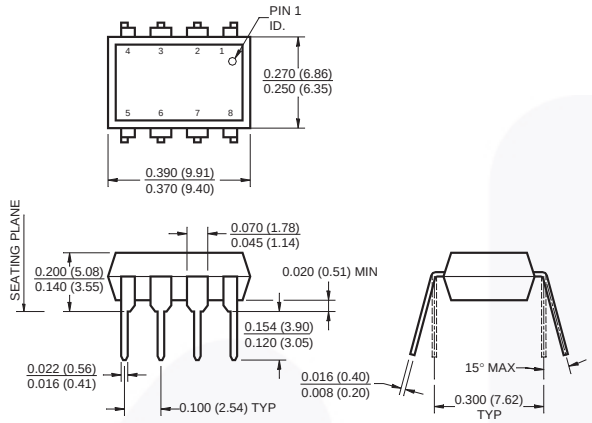
## Carrier Tape Specifications



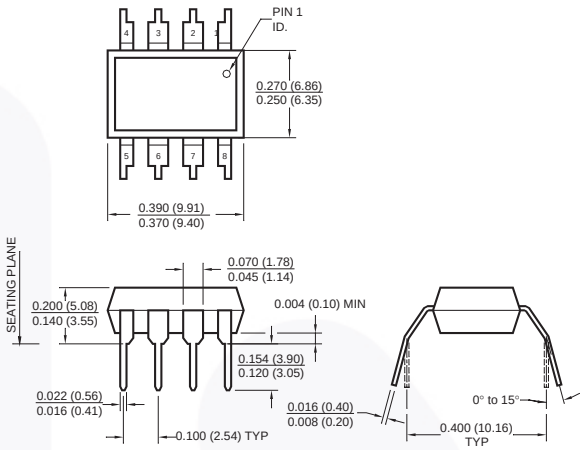

| Symbol | Description | Dimension in mm |
|---|---|---|
| W | Tape Width | 16.0 ± 0.3 |
| t | Tape Thickness | 0.30 ± 0.05 |
| $P_0$ | Sprocket Hole Pitch | 4.0 ± 0.1 |
| $D_0$ | Sprocket Hole Diameter | 1.55 ± 0.05 |
| E | Sprocket Hole Location | 1.75 ± 0.10 |
| F | Pocket Location | 7.5 ± 0.1 |
| $P_2$ | | 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 |

## Package Dimensions

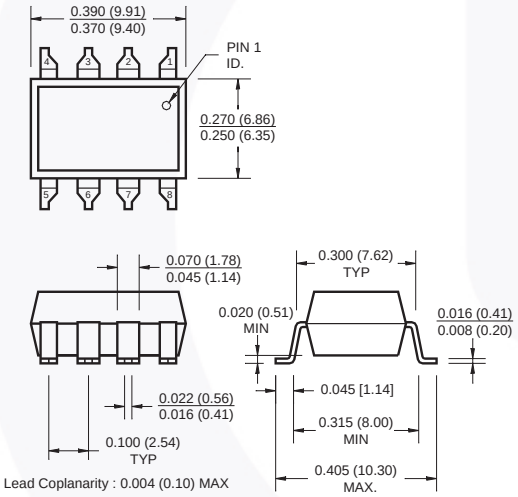
### Through Hole



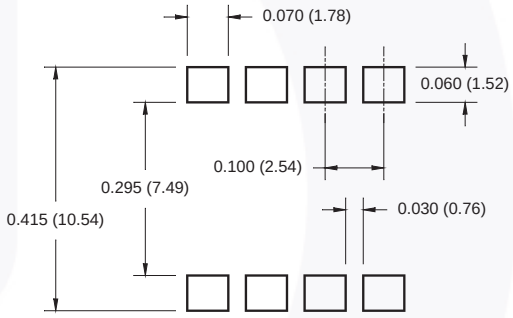

### 0.4" Lead Spacing




### Surface Mount




### 8-Pin DIP – Land Pattern




**Note:**
All dimensions are in inches (millimeters)

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