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February 2016

# FOD3120

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

### Features

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

### Applications

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

### Description

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

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

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

### Related Resources

- FOD3150, 1 A Output Current, Gate Drive Optocoupler Datasheet
- [www.fairchildsemi.com/products/optoelectronics/](http://www.fairchildsemi.com/products/optoelectronics/)

### Functional Block Diagram

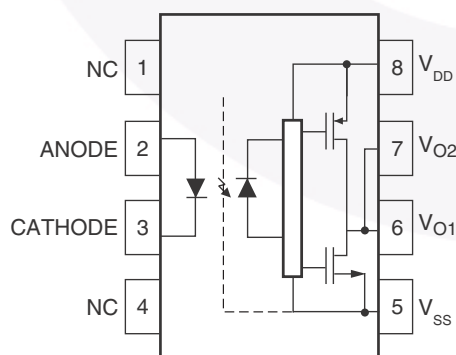


Figure 1. Functional Block Diagram<sup>(1)</sup>

#### Note:

1. 0.1  $\mu$ F bypass capacitor must be connected between pins 5 and 8.

### Package Outlines

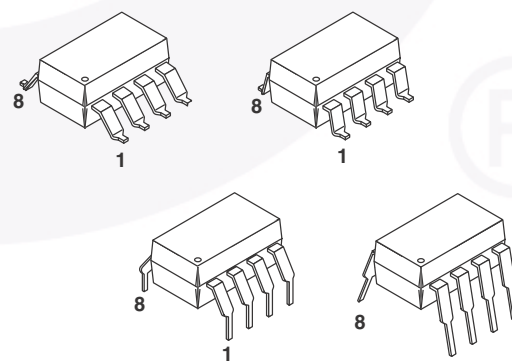


Figure 2. Package Outlines

**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 11.5 V	0 V to 10 V	Low
On	11.5 V to 13.5 V	10 V to 12 V	Transition
On	13.5 V to 30 V	12 V to 30 V	High

**Pin Definitions**

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

## Safety and Insulation Ratings

As per DIN EN/IEC 60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.

Parameter		Characteristics
Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage	< 150 V <sub>RMS</sub>	I–IV
	< 300 V <sub>RMS</sub>	I–IV
	< 450 V <sub>RMS</sub>	I–III
	< 600 V <sub>RMS</sub>	I–III
	< 1000 V <sub>RMS</sub> (Option T, TS)	I–III
Climatic Classification		40/100/21
Pollution Degree (DIN VDE 0110/1.89)		2
Comparative Tracking Index		175

Symbol	Parameter	Value	Unit
$V_{PR}$	Input-to-Output Test Voltage, Method A, $V_{IORM} \times 1.6 = V_{PR}$ , Type and Sample Test with $t_m = 10$ s, Partial Discharge $< 5$ pC	2,262	$V_{peak}$
	Input-to-Output Test Voltage, Method B, $V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ s, Partial Discharge $< 5$ pC	2,651	$V_{peak}$
$V_{IORM}$	Maximum Working Insulation Voltage	1,414	$V_{peak}$
$V_{IOTM}$	Highest Allowable Over-Voltage	6,000	$V_{peak}$
	External Creepage	$\geq 8.0$	mm
	External Clearance	$\geq 7.4$	mm
	External Clearance (for Option T or TS, 0.4" Lead Spacing)	$\geq 10.16$	mm
DTI	Distance Through Insulation (Insulation Thickness)	$\geq 0.5$	mm
$T_S$	Case Temperature <sup>(2)</sup>	175	°C
$I_{S,INPUT}$	Input Current <sup>(2)</sup>	400	mA
$P_{S,OUTPUT}$	Output Power (Duty Factor $\leq 2.7\%$ ) <sup>(2)</sup>	700	mW
$R_{IO}$	Insulation Resistance at $T_S$ , $V_{IO} = 500$ V <sup>(2)</sup>	$> 10^9$	$\Omega$

### Note:

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

**Absolute Maximum Ratings** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Value	Unit
$T_{\text{STG}}$	Storage Temperature	-55 to +125	$^\circ\text{C}$
$T_{\text{OPR}}$	Operating Temperature	-40 to +100	$^\circ\text{C}$
$T_J$	Junction Temperature	-40 to +125	$^\circ\text{C}$
$T_{\text{SOL}}$	Lead Wave Solder Temperature (refer to page 21 for reflow solder profile)	260 for 10sec	$^\circ\text{C}$
$I_{\text{F(AVG)}}$	Average Input Current	25	mA
$I_{\text{F(PEAK)}}$	Peak Transient Forward Current <sup>(3)</sup>	1	A
f	Operating Frequency <sup>(4)</sup>	50	kHz
$V_R$	Reverse Input Voltage	5	V
$I_{\text{O(PEAK)}}$	Peak Output Current <sup>(5)</sup>	3.0	A
$V_{\text{DD}} - V_{\text{SS}}$	Supply Voltage	0 to 35	V
		$T_A \geq 90^\circ\text{C}$ 0 to 30	
$V_{\text{O(PEAK)}}$	Peak Output Voltage	0 to $V_{\text{DD}}$	V
$t_{\text{R(IN)}}$ , $t_{\text{F(IN)}}$	Input Signal Rise and Fall Time	500	ns
$\text{PD}_\text{I}$	Input Power Dissipation <sup>(6)(8)</sup>	45	mW
$\text{PD}_\text{O}$	Output Power Dissipation <sup>(7)(8)</sup>	250	mW

**Notes:**

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

**Recommended Operating Conditions**

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

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

## Isolation Characteristics

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

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

### Notes:

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

10.  $5,000\text{ V}_{\text{RMS}}$  for 1 minute duration is equivalent to  $6,000\text{ VAC}_{\text{RMS}}$  for 1 second duration.

## Electrical Characteristics

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

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

## Switching Characteristics

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

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

### Notes:

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

## Typical Performance Characteristics

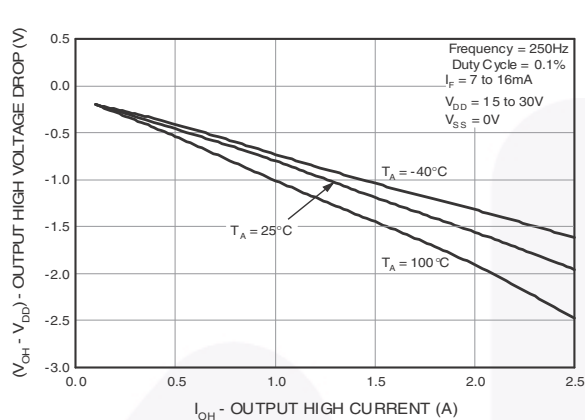


Fig. 3 Output High Voltage Drop vs. Output High Current

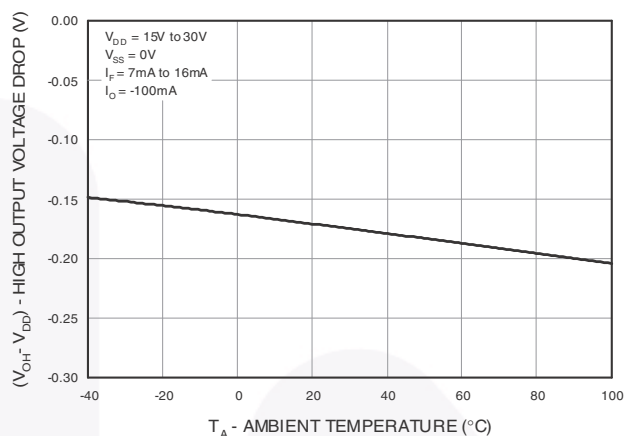


Fig. 4 Output High Voltage Drop vs. Ambient Temperature

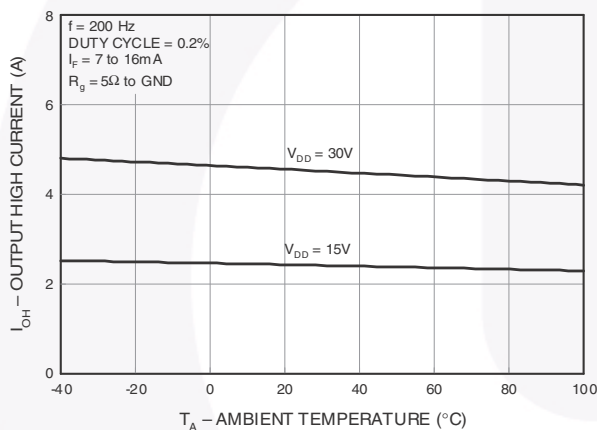


Fig. 5 Output High Current vs. Ambient Temperature

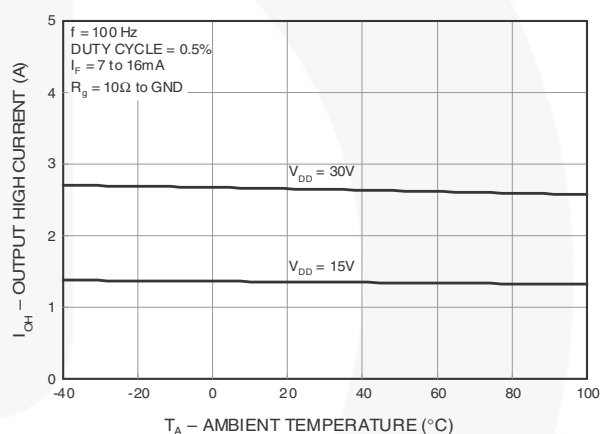


Fig. 6 Output High Current vs. Ambient Temperature

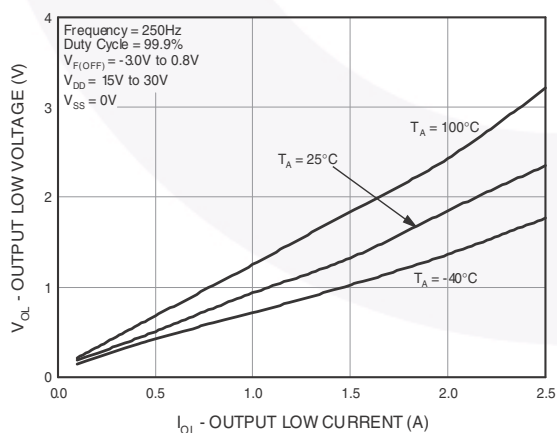


Fig. 7 Output Low Voltage vs. Output Low Current

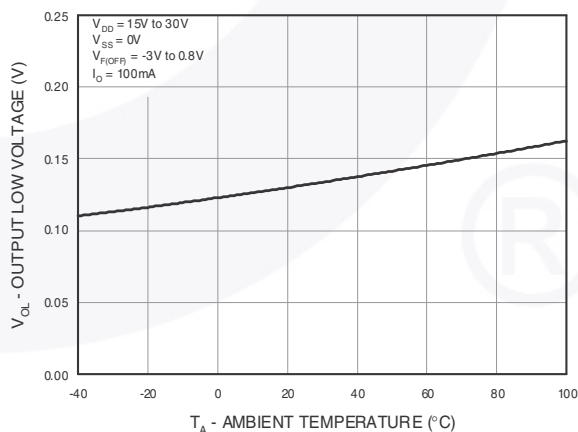


Fig. 8 Output Low Voltage vs. Ambient Temperature



## Typical Performance Characteristics (Continued)

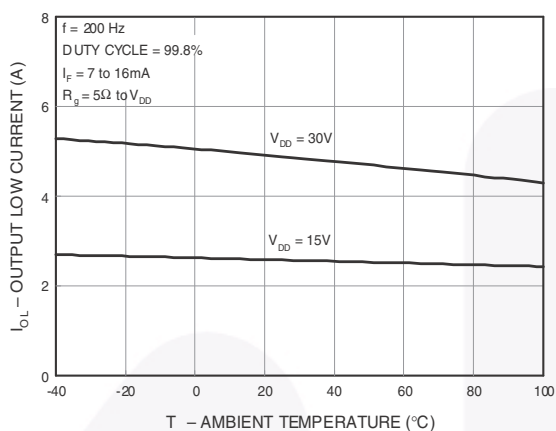


Fig. 9 Output Low Current vs. Ambient Temperature

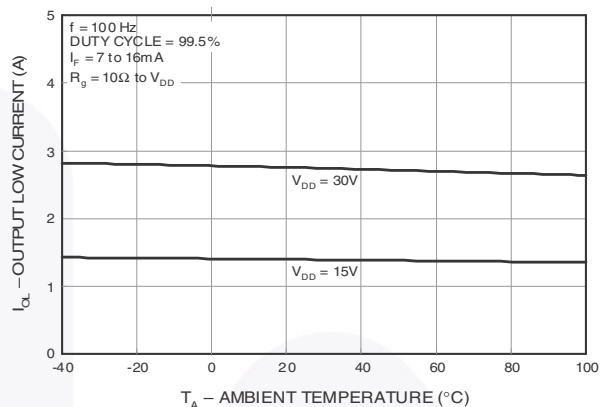


Fig. 10 Output Low Current vs. Ambient Temperature

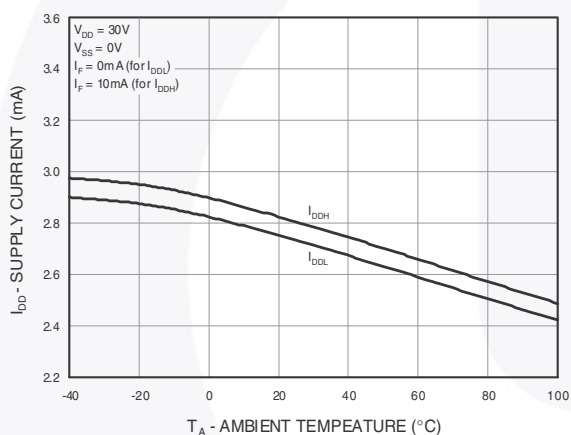


Fig. 11 Supply Current vs. Ambient Temperature

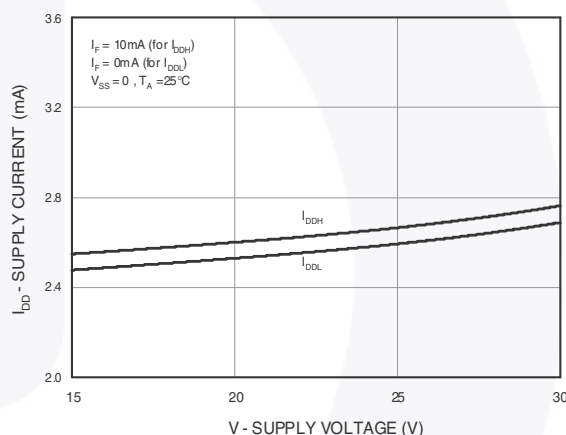


Fig. 12 Supply Current vs. Supply Voltage

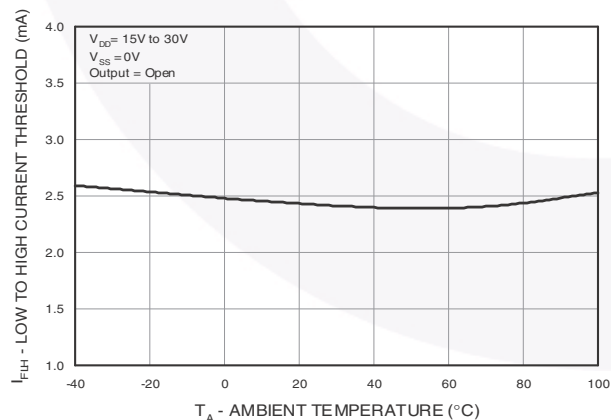


Fig. 13 Low to High Input Current Threshold vs. Ambient Temperature

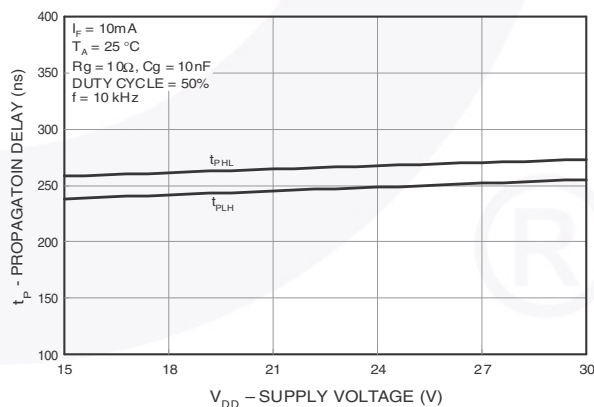


Fig. 14 Propagation Delay vs. Supply Voltage

## Typical Performance Characteristics (Continued)

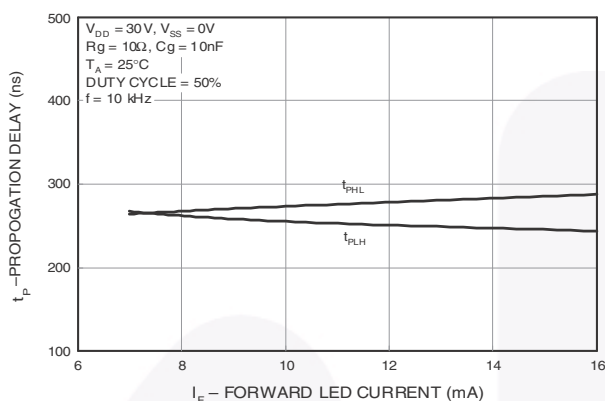


Fig. 15 Propagation Delay vs. LED Forward Current

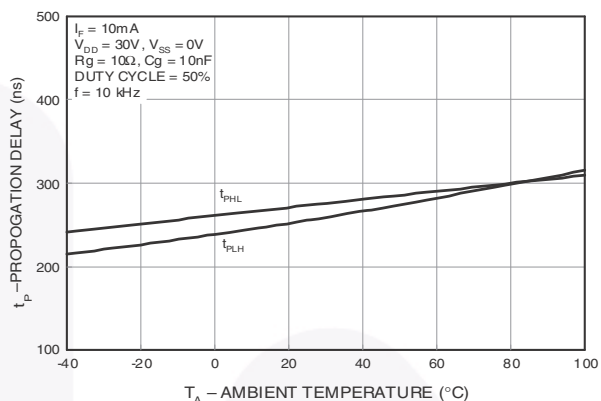


Fig. 16 Propagation Delay vs. Ambient Temperature

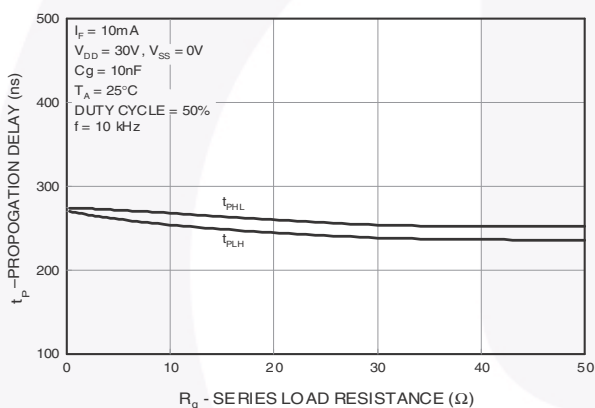


Fig. 17 Propagation Delay vs. Series Load Resistance

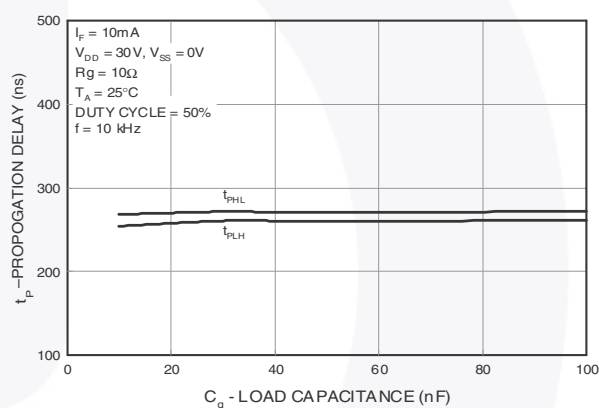


Fig. 18 Propagation Delay vs. Load Capacitance

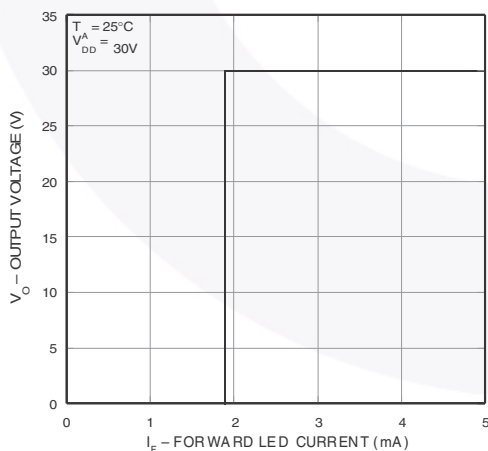


Fig. 19 Transfer Characteristics

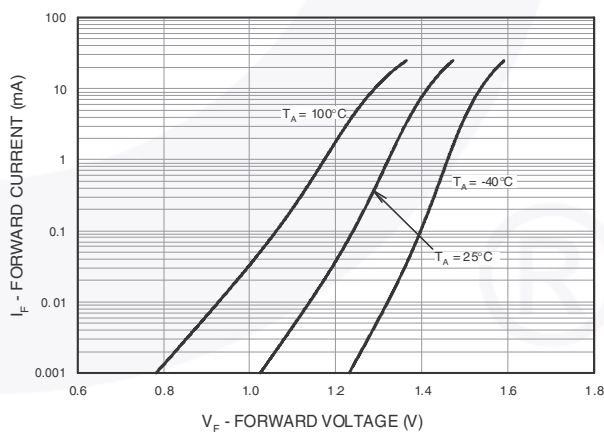


Fig. 20 Input Forward Current vs. Forward Voltage

# Typical Performance Characteristics (Continued)

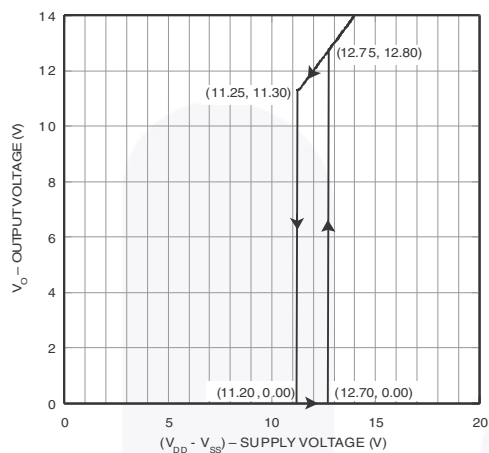
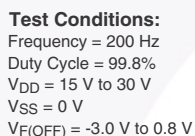
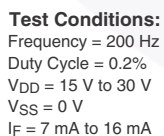


Fig. 21 Under Voltage Lockout

## Test Circuit



**Figure 22. I<sub>OL</sub> Test Circuit**



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

# Test Circuit (Continued)

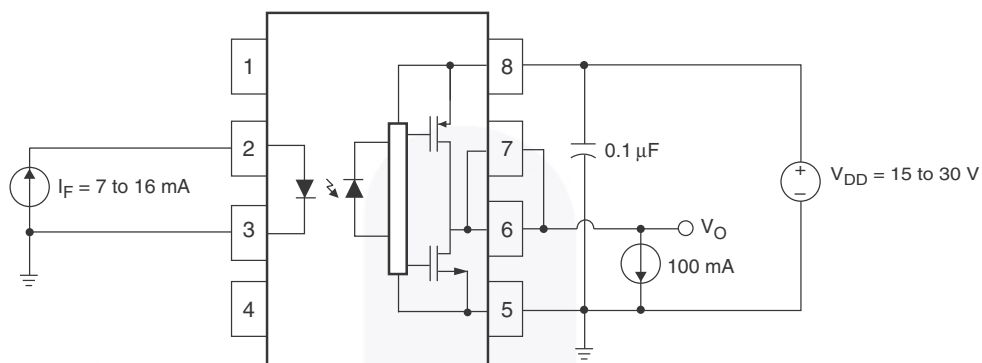


Figure 24.  $V_{OH}$  Test Circuit

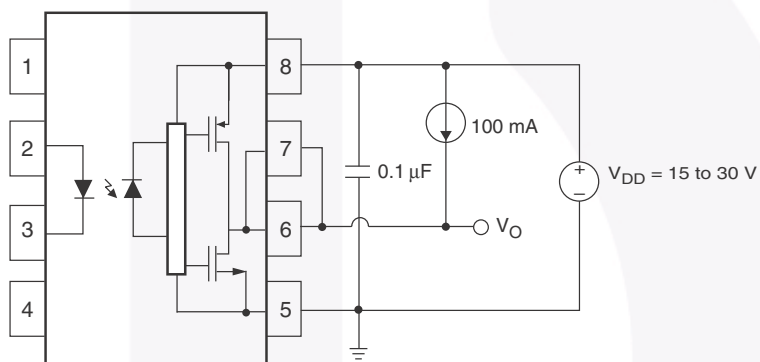


Figure 25.  $V_{OL}$  Test Circuit

# Test Circuit (Continued)

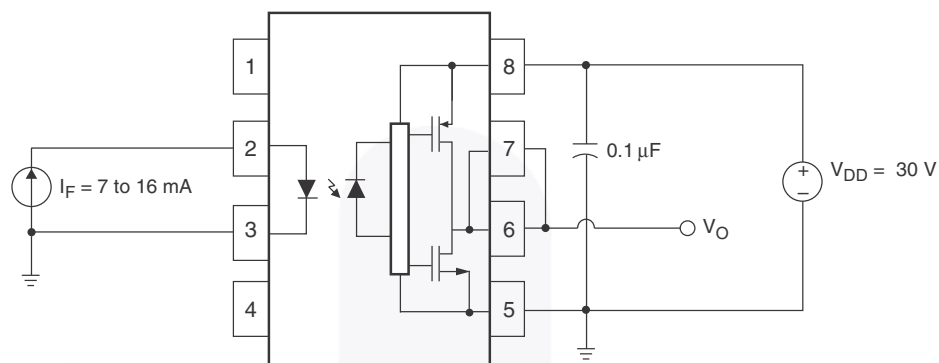


Figure 26.  $I_{DDH}$  Test Circuit

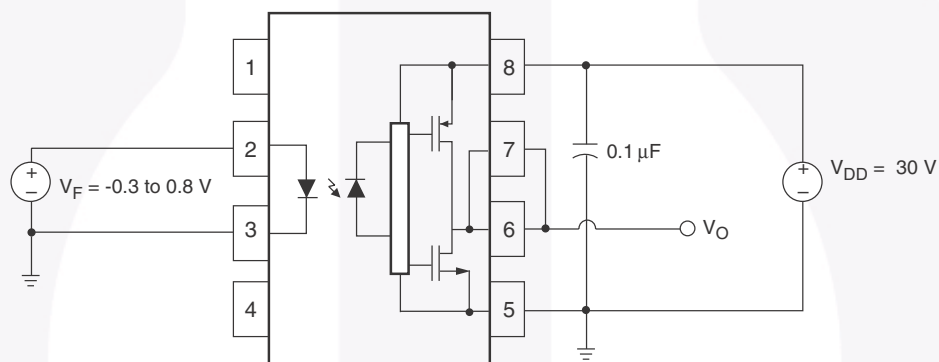


Figure 27.  $I_{DDL}$  Test Circuit

# Test Circuit (Continued)

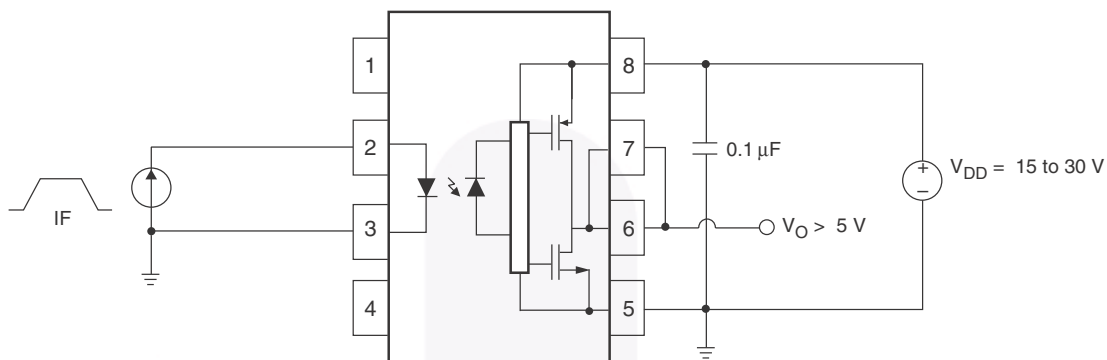


Figure 28.  $I_{FLH}$  Test Circuit

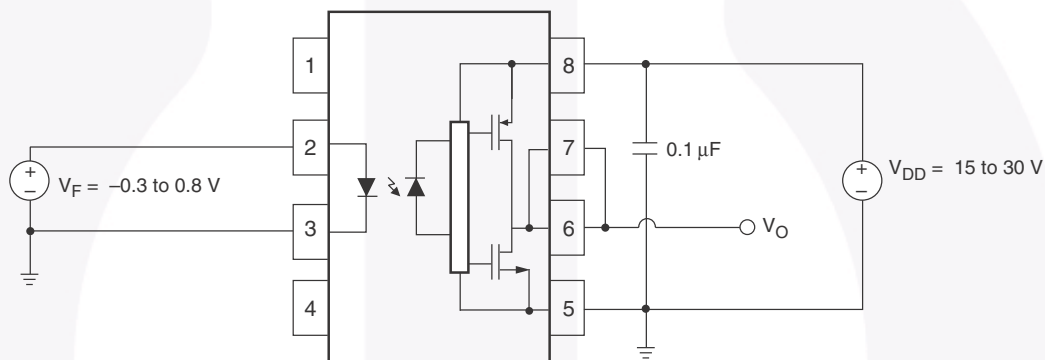


Figure 29.  $V_{FHL}$  Test Circuit

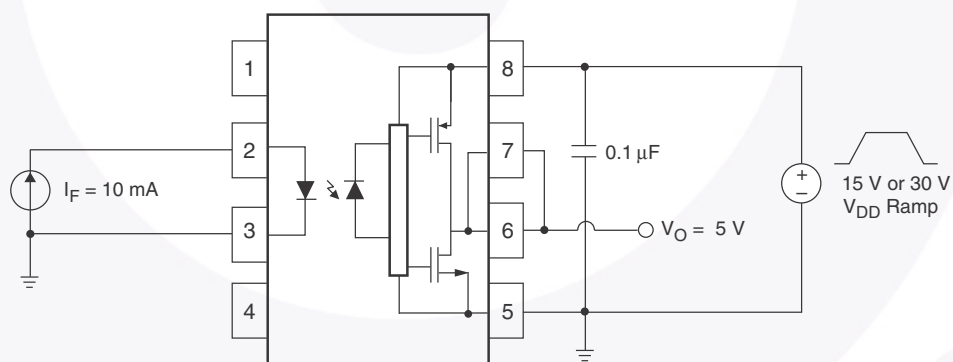


Figure 30. UVLO Test Circuit

## Test Circuit (Continued)

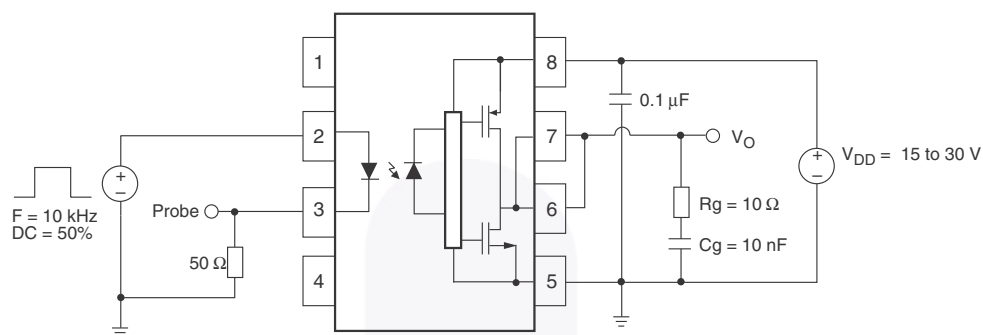


Figure 31.  $t_{PHL}$ ,  $t_{PLH}$ ,  $t_R$  and  $t_F$  Test Circuit and Waveforms

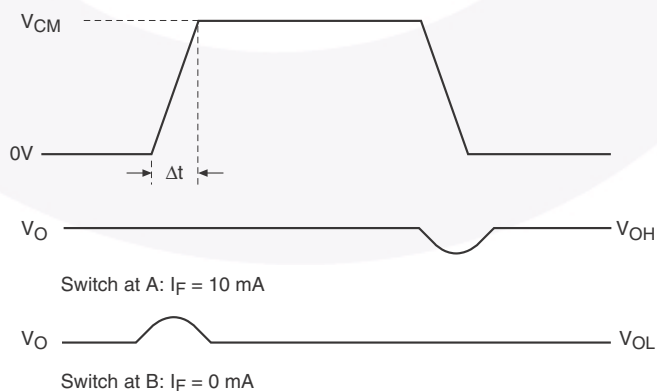
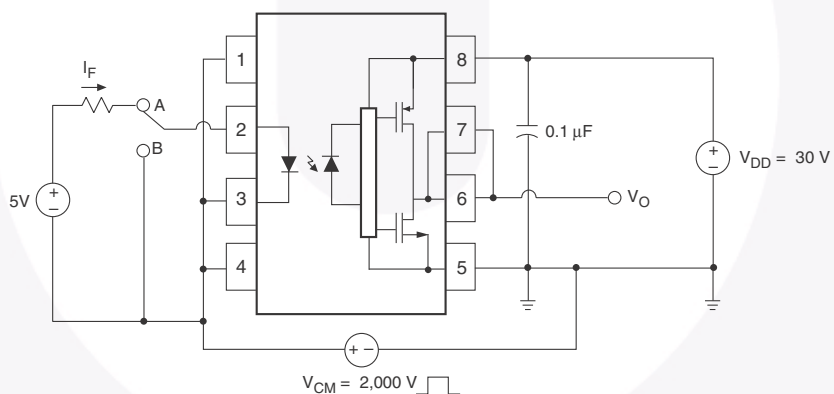
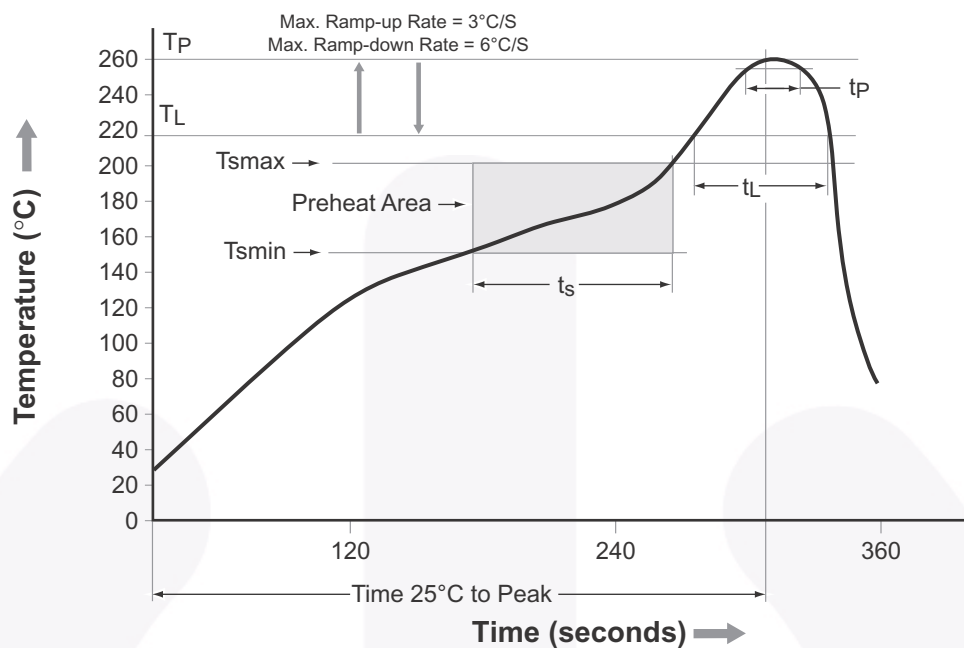


Figure 32. CMR Test Circuit and Waveforms



## Reflow Profile



Profile Feature	Pb-Free Assembly Profile
Temperature Min. (T <sub>smin</sub> )	150°C
Temperature Max. (T <sub>smax</sub> )	200°C
Time (t <sub>s</sub> ) from (T <sub>smin</sub> to T <sub>smax</sub> )	60–120 seconds
Ramp-up Rate (t <sub>L</sub> to t <sub>P</sub> )	3°C/second max.
Liquidous Temperature (T <sub>L</sub> )	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	60–150 seconds
Peak Body Package Temperature	260°C +0°C / –5°C
Time (t <sub>P</sub> ) within 5°C of 260°C	30 seconds
Ramp-down Rate (T <sub>P</sub> to T <sub>L</sub> )	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

## Ordering Information

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

## Marking Information

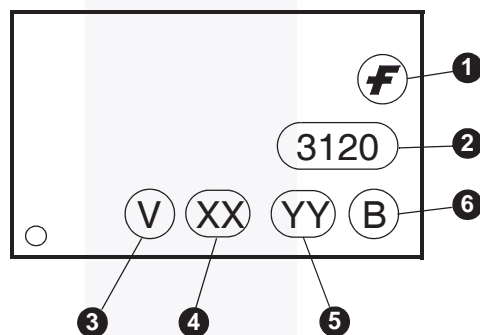
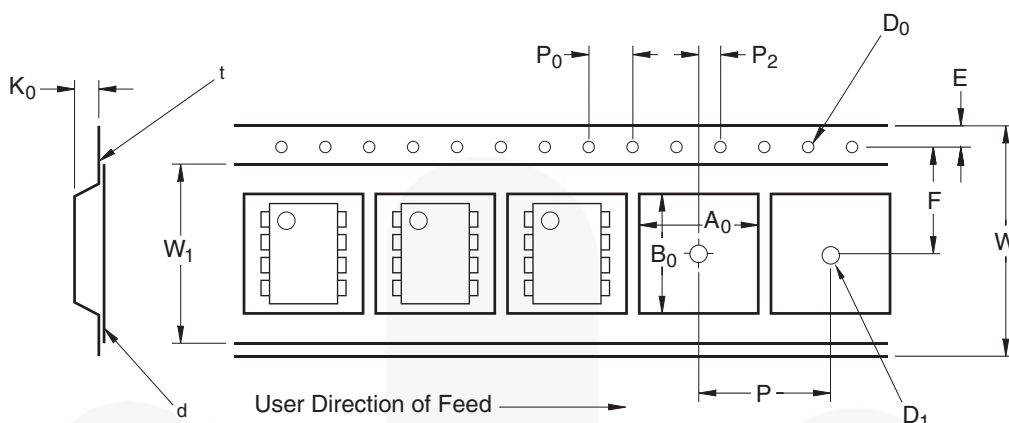


Figure 33. Top Mark

### Definitions

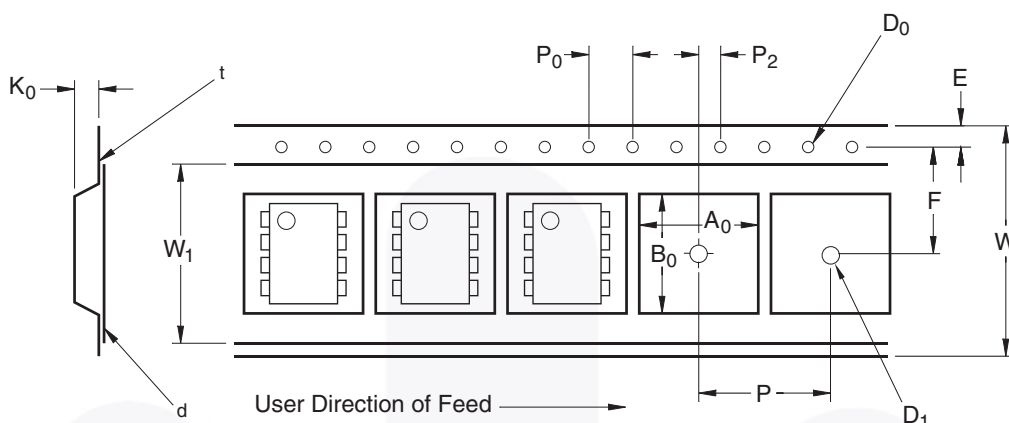
1	Fairchild logo
2	Device number
3	DIN_EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	Two digit year code, e.g., '16'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

## Carrier Tape Specifications (Option SD)

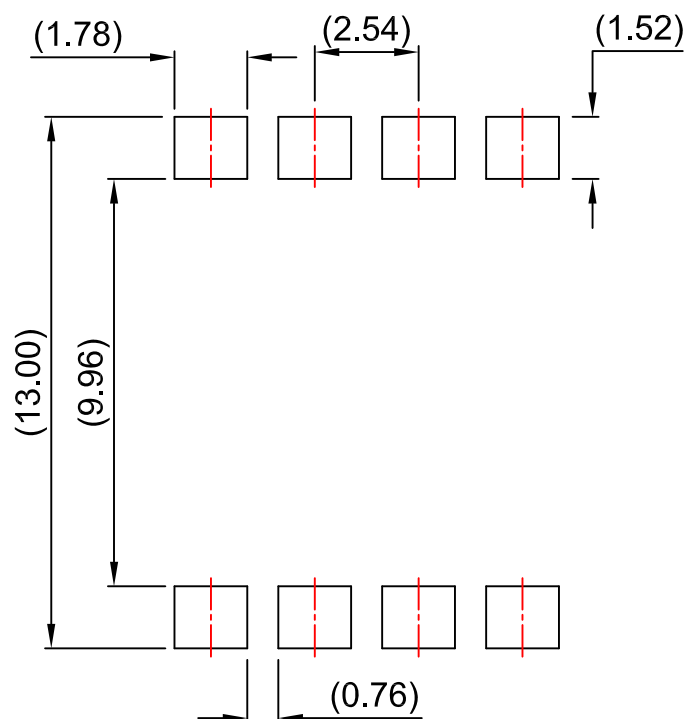
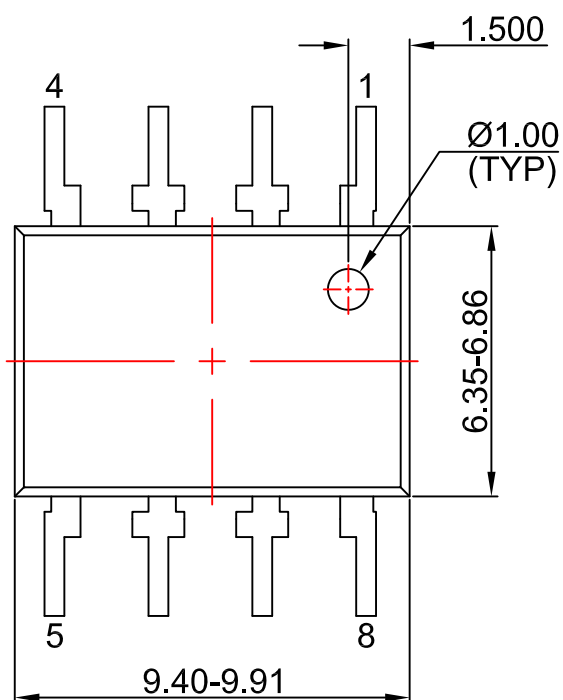


Symbol	Description	Dimension in mm
W	Tape Width	$16.0 \pm 0.3$
t	Tape Thickness	$0.30 \pm 0.05$
$P_0$	Sprocket Hole Pitch	$4.0 \pm 0.1$
$D_0$	Sprocket Hole Diameter	$1.55 \pm 0.05$
E	Sprocket Hole Location	$1.75 \pm 0.10$
F	Pocket Location	$7.5 \pm 0.1$
$P_2$		$2.0 \pm 0.1$
P	Pocket Pitch	$12.0 \pm 0.1$
$A_0$	Pocket Dimensions	$10.30 \pm 0.20$
$B_0$		$10.30 \pm 0.20$
$K_0$		$4.90 \pm 0.20$
$W_1$	Cover Tape Width	$13.2 \pm 0.2$
d	Cover Tape Thickness	0.1 max
	Max. Component Rotation or Tilt	$10^\circ$
R	Min. Bending Radius	30

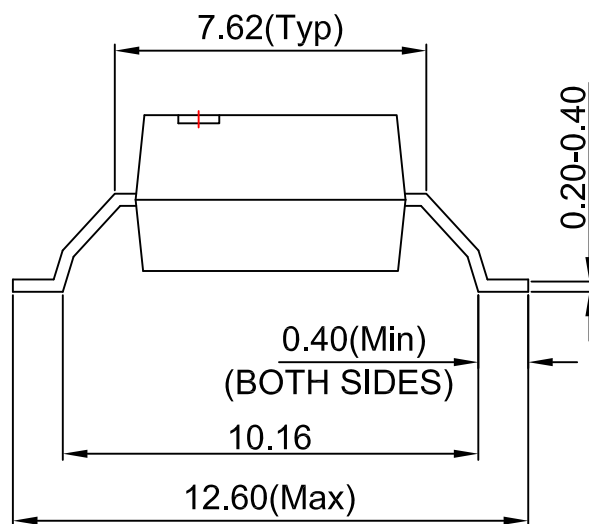
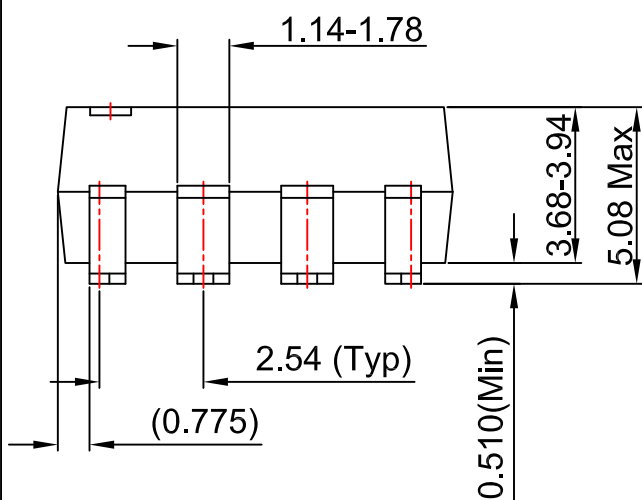
## Carrier Tape Specifications (Option TSR2)



Symbol	Description	Dimension in mm
W	Tape Width	$24.0 \pm 0.3$
t	Tape Thickness	$0.40 \pm 0.1$
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	$11.5 \pm 0.1$
P <sub>2</sub>		$2.0 \pm 0.1$
P	Pocket Pitch	$16.0 \pm 0.1$
A <sub>0</sub>	Pocket Dimensions	$12.80 \pm 0.1$
B <sub>0</sub>		$10.35 \pm 0.1$
K <sub>0</sub>		$5.7 \pm 0.1$
W <sub>1</sub>	Cover Tape Width	$21.0 \pm 0.1$
d	Cover Tape Thickness	0.1 max
	Max. Component Rotation or Tilt	10°
R	Min. Bending Radius	30



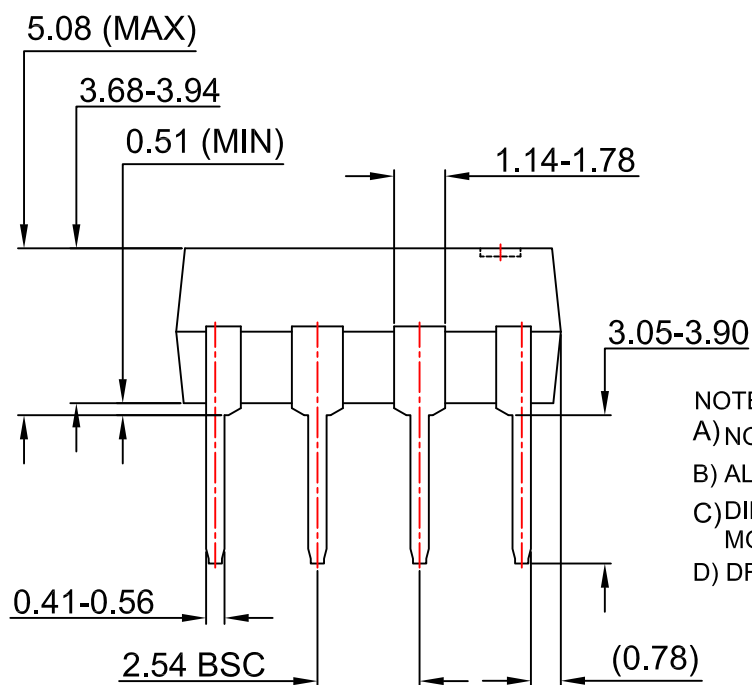
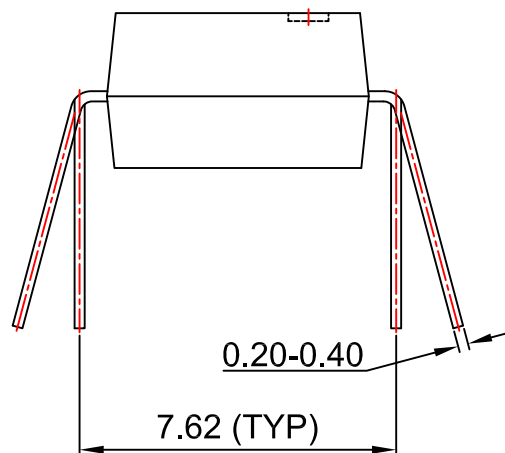
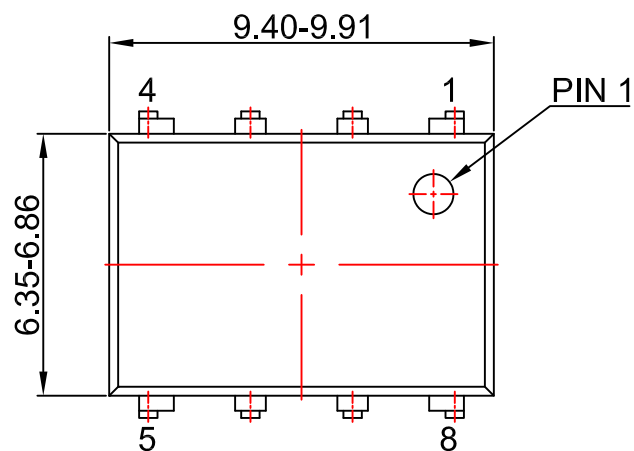
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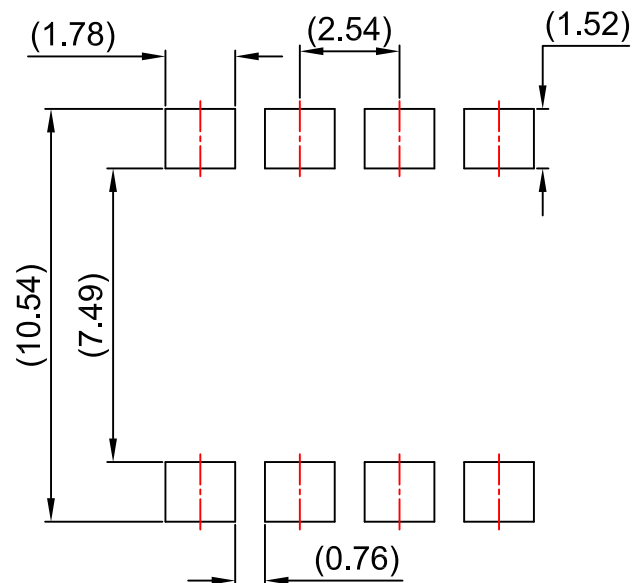
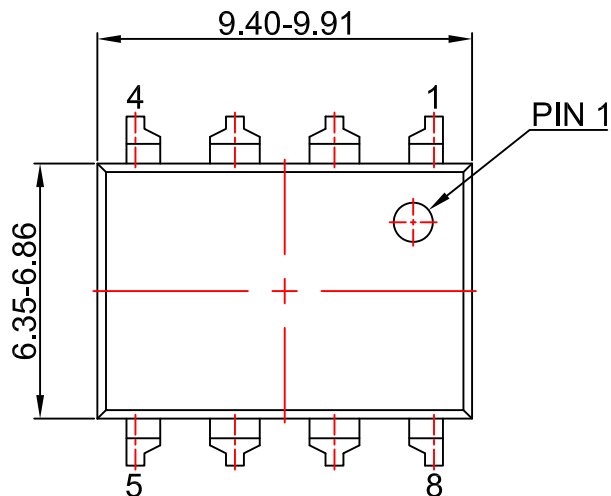




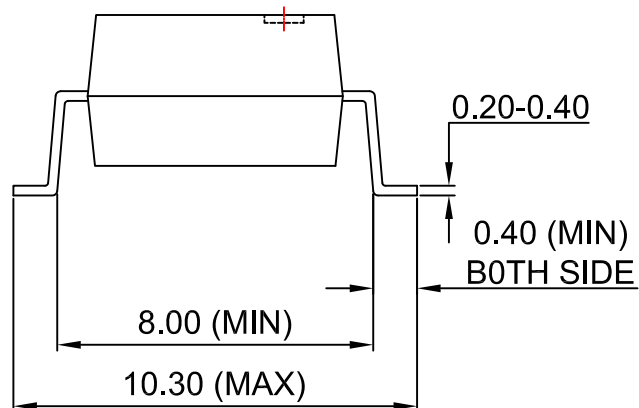
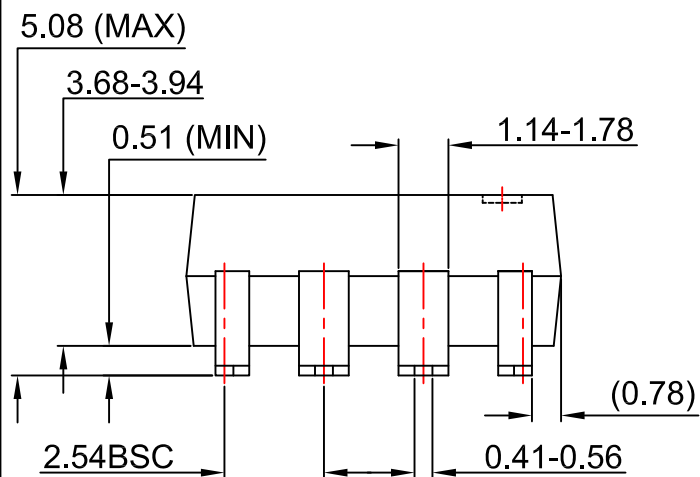
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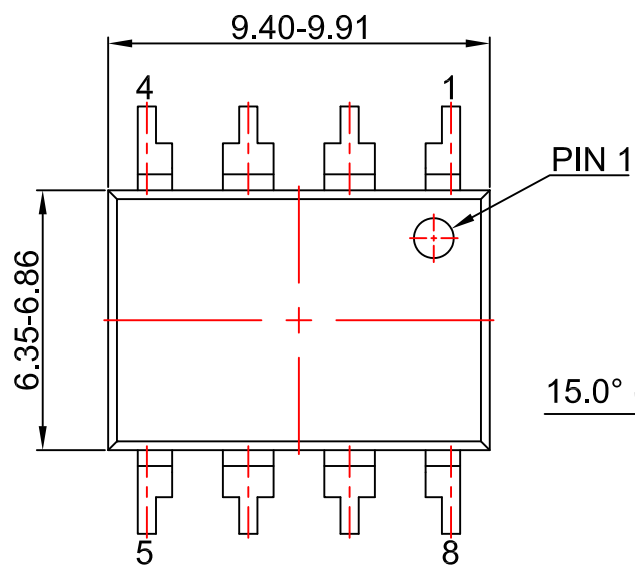
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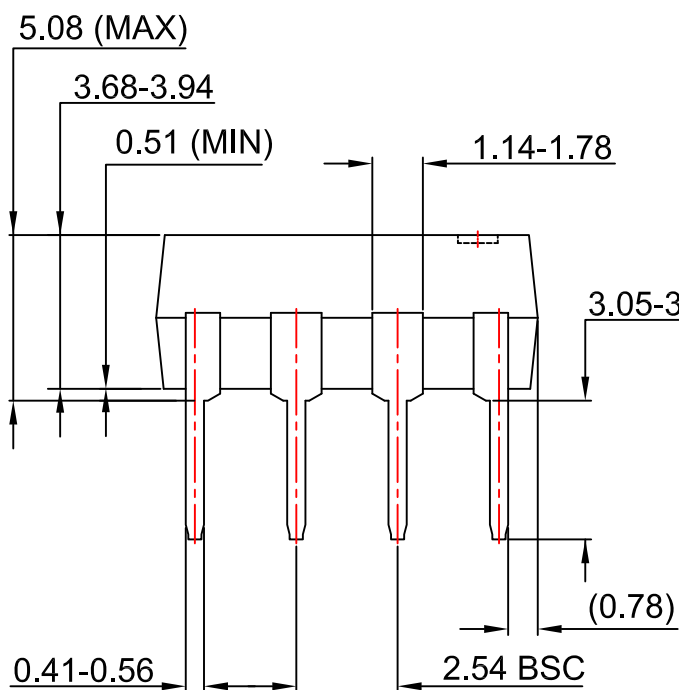
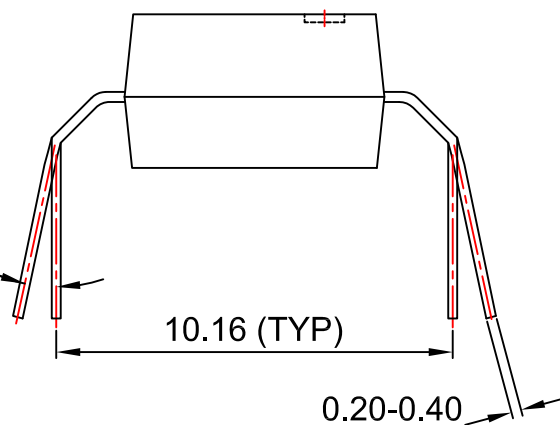
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