

FOD3120

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

Features

- High noise immunity characterized by 35kV/μs minimum common mode rejection
- 2.5A peak output current driving capability for most 1200V/20A IGBT
- Use of P-channel MOSFETs at output stage enables output voltage swing close to the supply rail
- Wide supply voltage range from 15V to 30V
- Fast switching speed
 - 400ns max. propagation delay
 - 100ns 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_{RMS} for 1 min.
 - IEC60747-5-2
- R_{DS(ON)} of 1Ω (typ.) offers lower power dissipation
- >8.0mm clearance and creepage distance (option 'T' or 'TS')
- 1,414V Peak Working Insulation Voltage (V_{IORM})

Applications

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

Description

The FOD3120 is a 2.5A Output Current Gate Drive Optocoupler, capable of driving most 1200V/20A 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.

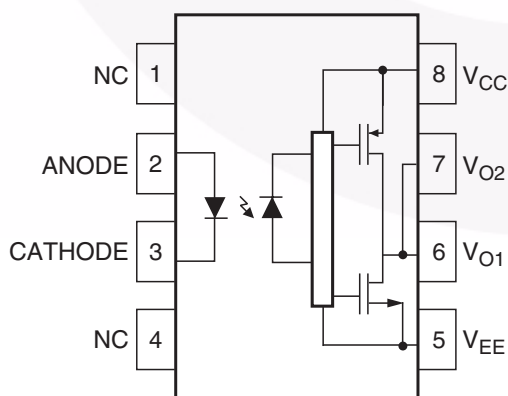
It utilizes Fairchild's proprietary coplanar packaging technology, Optoplanar®, and optimized IC design to achieve high noise immunity, characterized by high common mode rejection.

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.

Related Resources

- FOD3150, 1A Output Current, Gate Drive Optocoupler Datasheet
- www.fairchildsemi.com/products/opto/

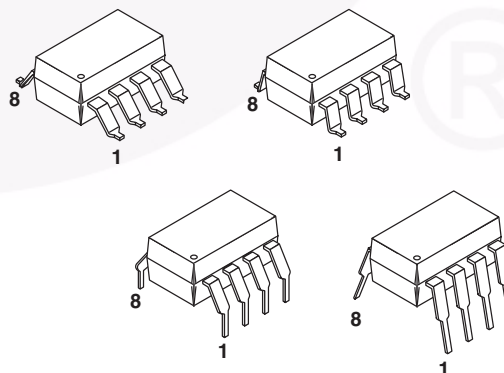
Functional Block Diagram



Note:

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

Package Outlines



Truth Table

LED	$V_{CC} - V_{EE}$ "Positive Going" (Turn-on)	$V_{CC} - V_{EE}$ "Negative Going" (Turn-off)	V_O
Off	0V to 30V	0V to 30V	Low
On	0V to 11.5V	0V to 10V	Low
On	11.5V to 13.5V	10V to 12V	Transition
On	13.5V to 30V	12V to 30V	High

Pin Definitions

Pin #	Name	Description
1	NC	Not Connected
2	Anode	LED Anode
3	Cathode	LED Cathode
4	NC	Not Connected
5	V_{EE}	Negative Supply Voltage
6	V_{O2}	Output Voltage 2 (internally connected to V_{O1})
7	V_{O1}	Output Voltage 1
8	V_{CC}	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 Mains Voltage < 150Vrms		I–IV		
	For Rated Mains Voltage < 300Vrms		I–IV		
	For Rated Mains Voltage < 450Vrms		I–III		
	For Rated Mains Voltage < 600Vrms		I–III		
	For Rated Mains Voltage < 1000Vrms (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 b, $V_{IORM} \times 1.875 = V_{PR}$, 100% Production Test with $t_m = 1$ sec., Partial Discharge < 5pC	2651			
	Input to Output Test Voltage, Method a, $V_{IORM} \times 1.5 = V_{PR}$, Type and Sample Test with $t_m = 60$ sec., Partial Discharge < 5 pC	2121			
V_{IORM}	Max Working Insulation Voltage	1,414			V_{peak}
V_{IOTM}	Highest Allowable Over Voltage	6000			V_{peak}
	External Creepage	8			mm
	External Clearance	7.4			mm
	External Clearance (for Option T or TS - 0.4" Lead Spacing)	10.16			mm
	Insulation Thickness	0.5			mm
T_{Case}	Safety Limit Values – Maximum Values Allowed in the Event of a Failure				
	Case Temperature	150			°C
$I_{S,INPUT}$	Input Current	25			mA
$P_{S,OUTPUT}$	Output Power (Duty Factor $\leq 2.7\%$)	250			mW
R_{IO}	Insulation Resistance at T_S , $V_{IO} = 500V$	10^9			Ω

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	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 (refer to page 21 for reflow solder profile)	260 for 10sec	$^\circ\text{C}$
$I_{F(AVG)}$	Average Input Current	25	mA
$I_{F(PEAK)}$	Peak Transient Forward Current ⁽¹⁰⁾	1	A
f	Operating Frequency ⁽¹¹⁾	50	kHz
V_R	Reverse Input Voltage	5	V
$I_{O(PEAK)}$	Peak Output Current ⁽¹⁾	3.0	A
$V_{CC} - V_{EE}$	Supply Voltage	0 to 35	V
		$T_A \geq 90^\circ\text{C}$ 0 to 30	
$V_{O(PEAK)}$	Peak Output Voltage	0 to V_{CC}	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	$^\circ\text{C}$
$V_{CC} - V_{EE}$	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 $T_A = 25^\circ\text{C}$

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

Electrical Characteristics

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

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
C_{IN}	Input Capacitance	$f = 1\text{MHz}$, $V_F = 0V$		60		pF
I_{OH}	High Level Output Current ⁽¹⁾	$V_O = V_{CC} - 3V$	-1	-2.0	-2.5	A
		$V_O = V_{CC} - 6V$	-2.0		-2.5	
I_{OL}	Low Level Output Current ⁽¹⁾	$V_O = V_{EE} + 3V$	1	2.0	2.5	A
		$V_O = V_{EE} + 6V$	2.0		2.5	
V_{OH}	High Level Output Voltage	$I_F = 10\text{mA}$, $I_O = -2.5\text{A}$	$V_{CC} - 6.25V$	$V_{CC} - 2.5V$		V
		$I_F = 10\text{mA}$, $I_O = -100\text{mA}$	$V_{CC} - 0.25V$	$V_{CC} - 0.1V$		
V_{OL}	Low Level Output Voltage	$I_F = 0\text{mA}$, $I_O = 2.5\text{A}$		$V_{EE} + 2.5V$	$V_{EE} + 6.25V$	V
		$I_F = 0\text{mA}$, $I_O = 100\text{mA}$		$V_{EE} + 0.1V$	$V_{EE} + 0.25V$	
I_{CCH}	High Level Supply Current	$V_O = \text{Open}$, $I_F = 7 \text{ to } 16\text{mA}$		2.8	3.8	mA
I_{CCL}	Low Level Supply Current	$V_O = \text{Open}$, $V_F = 0 \text{ to } 0.8V$		2.8	3.8	mA
I_{FLH}	Threshold Input Current Low to High	$I_O = 0\text{mA}$, $V_O > 5V$		2.3	5.0	mA
V_{FHL}	Threshold Input Voltage High to Low	$I_O = 0\text{mA}$, $V_O < 5V$	0.8			V
V_{UVLO+}	Under Voltage Lockout Threshold	$I_F = 10\text{mA}$, $V_O > 5V$	11.5	12.7	13.5	V
V_{UVLO-}		$I_F = 10\text{mA}$, $V_O < 5V$	10.0	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 $V_{CC} = 30V$, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
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, $(t_{PHL} - t_{PLH})^{(7)}$		-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	$I_F = 10\text{mA}$, $V_O > 5V$		1.6		μs
$t_{UVLO\ OFF}$	UVLO Turn Off Delay	$I_F = 10\text{mA}$, $V_O < 5V$		0.4		μs
$ CM_H $	Common Mode Transient Immunity at Output High	$T_A = 25^\circ\text{C}$, $V_{CC} = 30V$, $I_F = 7 \text{ to } 16\text{mA}$, $V_{CM} = 2000V^{(8)}$	35	50		$\text{kV}/\mu\text{s}$
$ CM_L $	Common Mode Transient Immunity at Output Low	$T_A = 25^\circ\text{C}$, $V_{CC} = 30V$, $V_F = 0V$, $V_{CM} = 2000V^{(9)}$	35	50		$\text{kV}/\mu\text{s}$

Notes:

- Maximum pulse width = $10\mu\text{s}$, maximum duty cycle = 1.1%
- Derate linearly above 87°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.
- Device is considered a two terminal device: Pins 2 and 3 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
- $5,000 V_{RMS}$ for 1 minute duration is equivalent to $6,000 V_{AC\ RMS}$ for 1 second duration.
- 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. $V_O > 15.0V$).
- 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. $V_O < 1.0V$).
- Pulse Width, $P_W \leq 1\mu\text{s}$, 300pps
- Exponential Waveform, $I_{O(PEAK)} \leq |2.5A| (\leq 0.3\mu\text{s})$

Typical Performance Curves

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

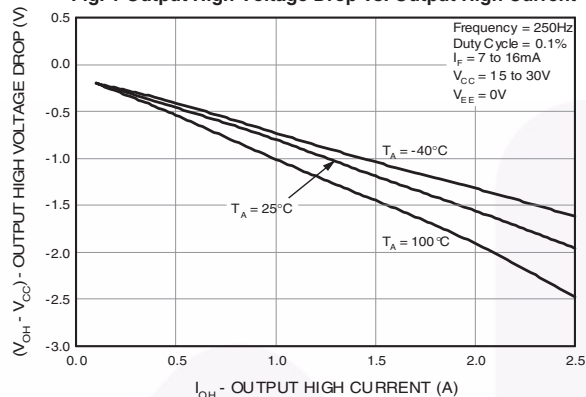


Fig. 2 Output High Voltage Drop vs. Ambient Temperature

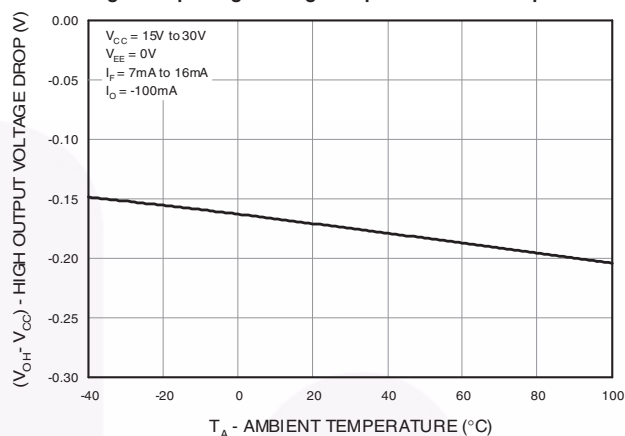


Fig. 3 Output High Current vs. Ambient Temperature

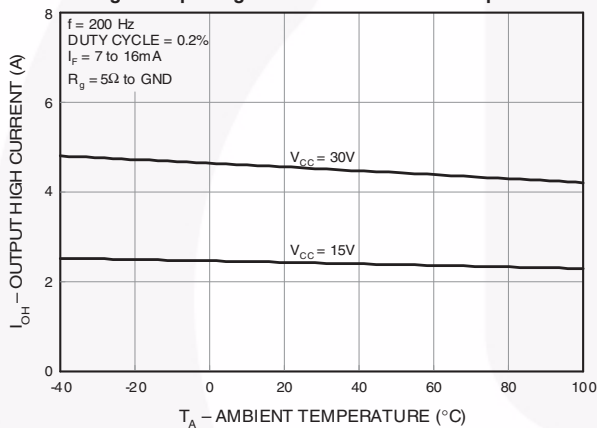


Fig. 4 Output High Current vs. Ambient Temperature

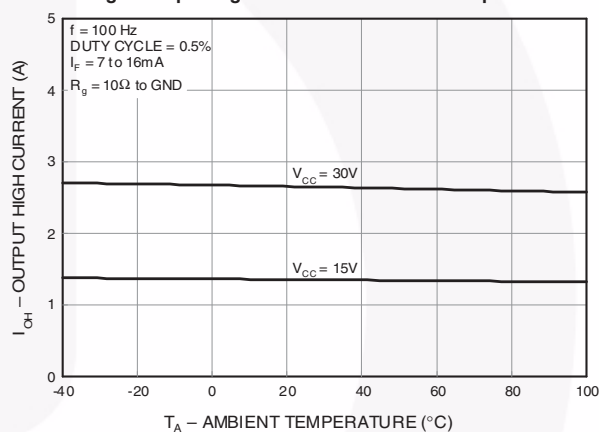


Fig. 5 Output Low Voltage vs. Output Low Current

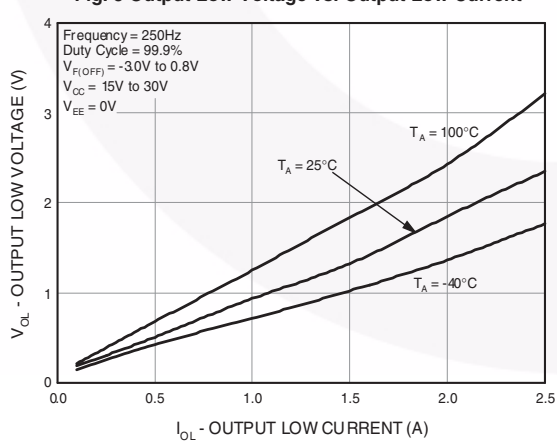
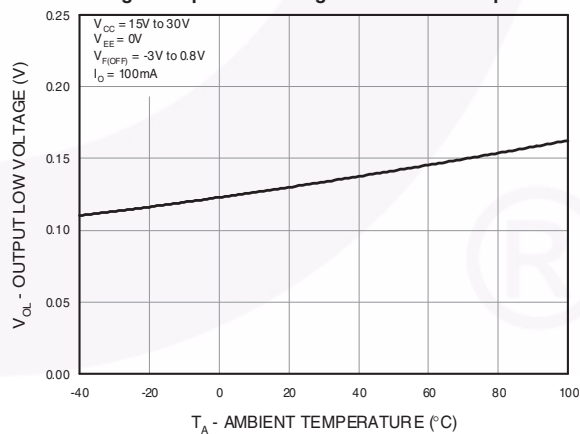


Fig. 6 Output Low Voltage vs. Ambient Temperature



Typical Performance Curves (Continued)

Fig. 7 Output Low Current vs. Ambient Temperature

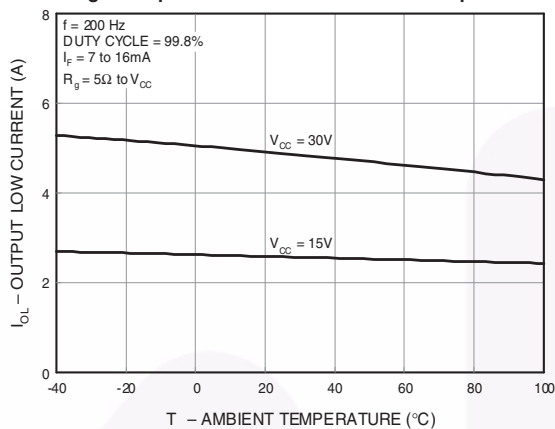


Fig. 8 Output Low Current vs. Ambient Temperature

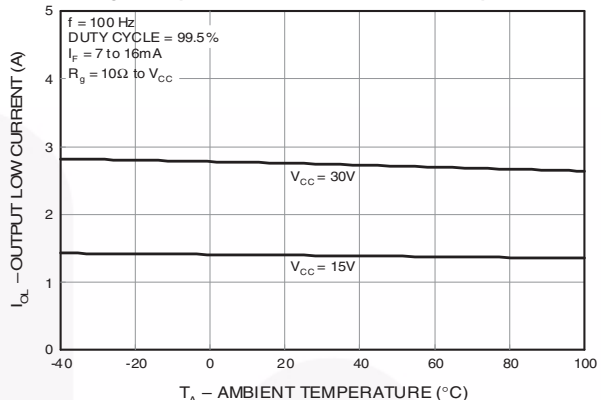


Fig. 9 Supply Current vs. Ambient Temperature

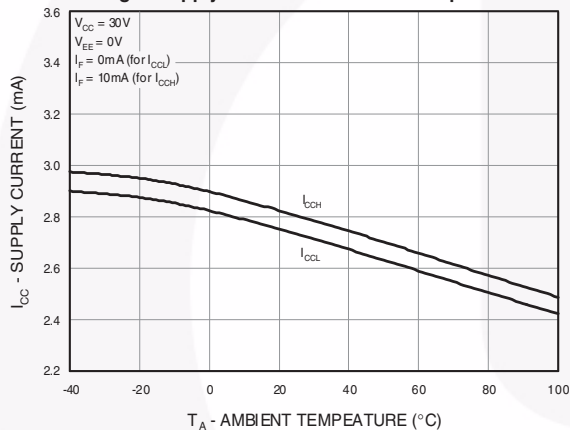


Fig. 10 Supply Current vs. Supply Voltage

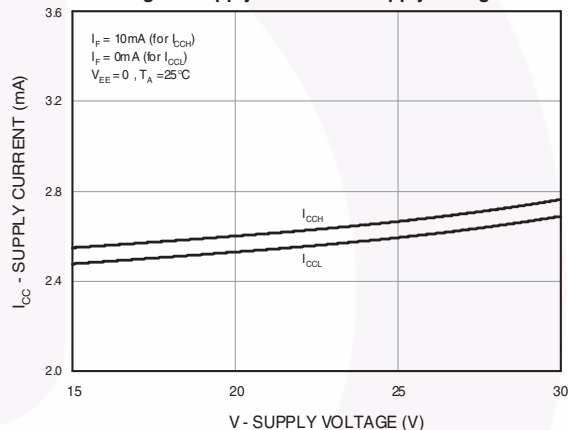


Fig. 11 Low to High Input Current Threshold vs. Ambient Temperature

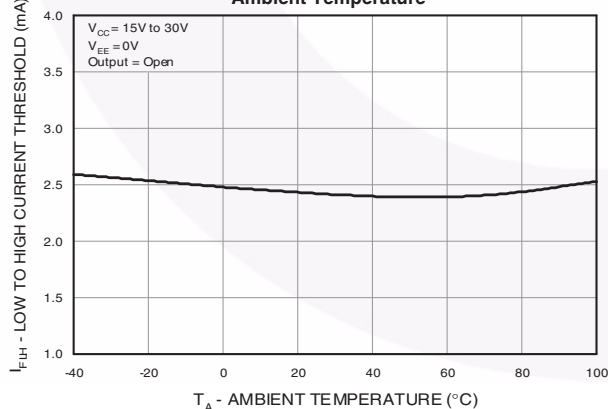
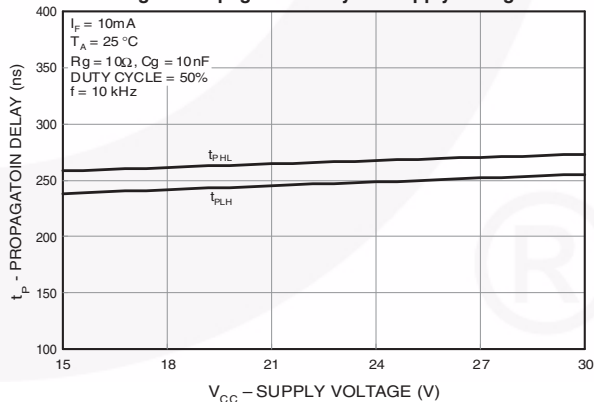


Fig. 12 Propagation Delay vs. Supply Voltage



Typical Performance Curves (Continued)

Fig. 13 Propagation Delay vs. LED Forward Current

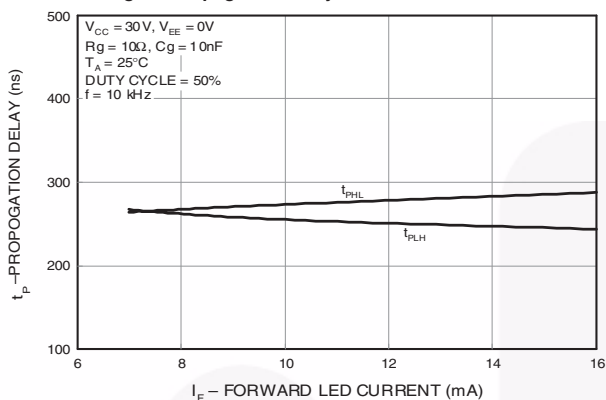


Fig. 14 Propagation Delay vs. Ambient Temperature

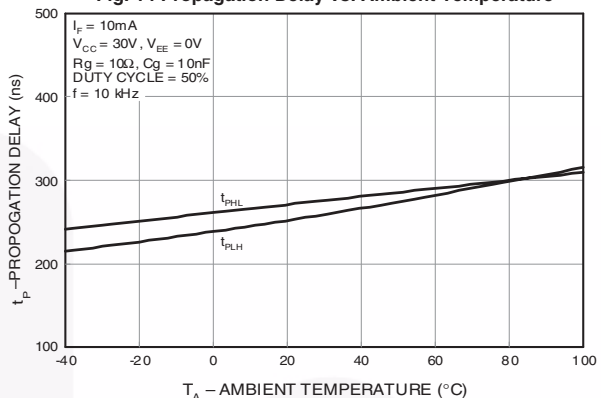


Fig. 15 Propagation Delay vs. Series Load Resistance

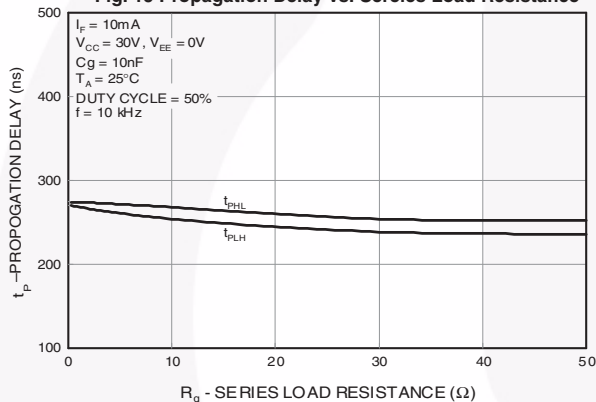


Fig. 16 Propagation Delay vs. Load Capacitance

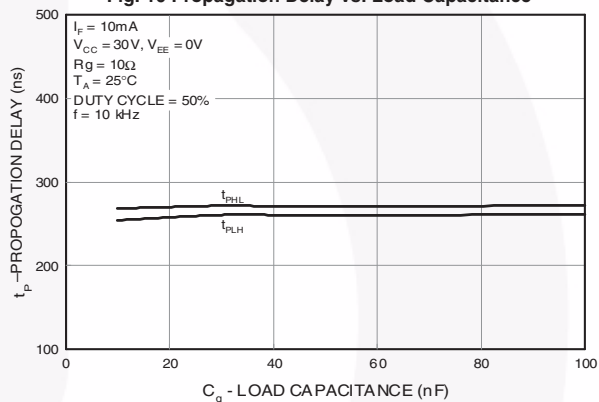


Fig. 17 Transfer Characteristics

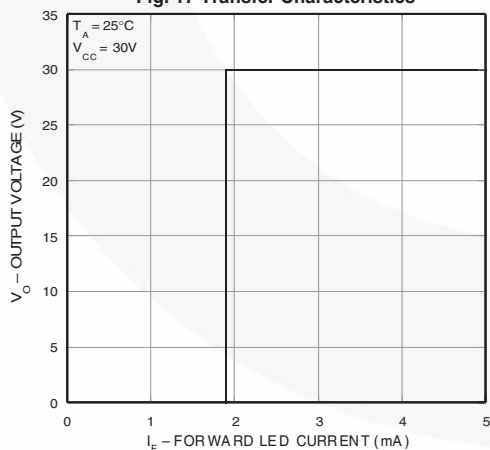
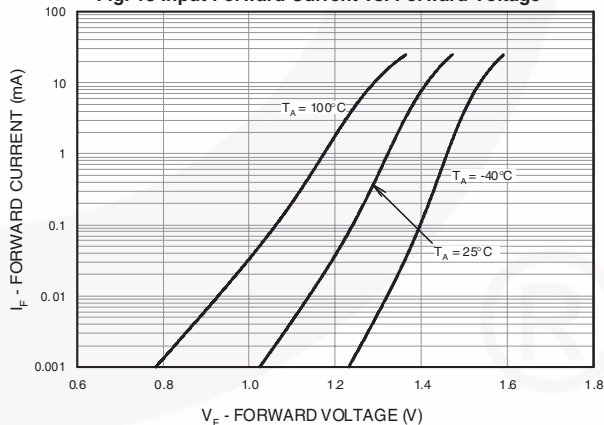
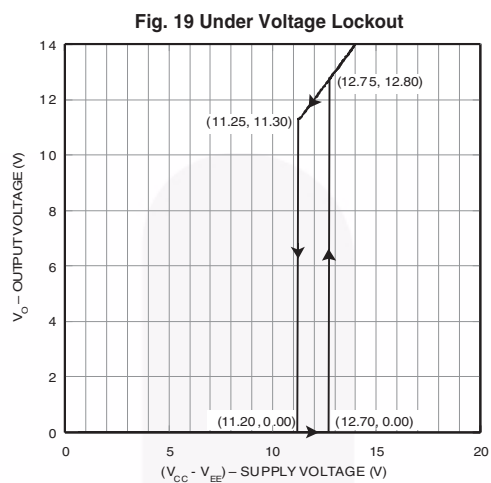


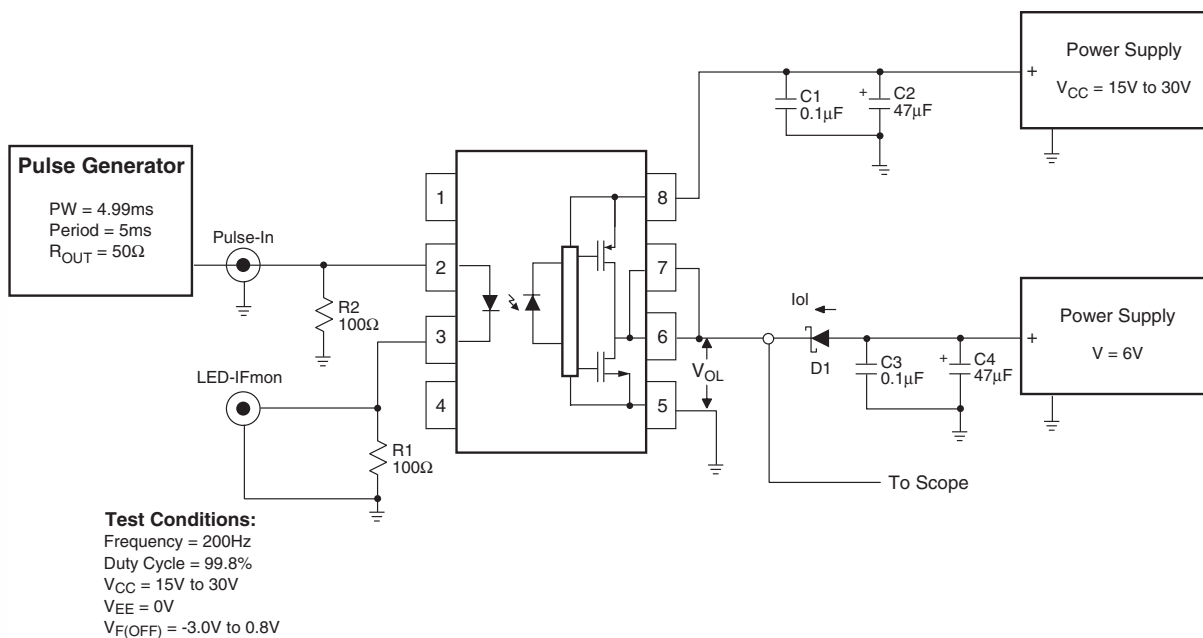
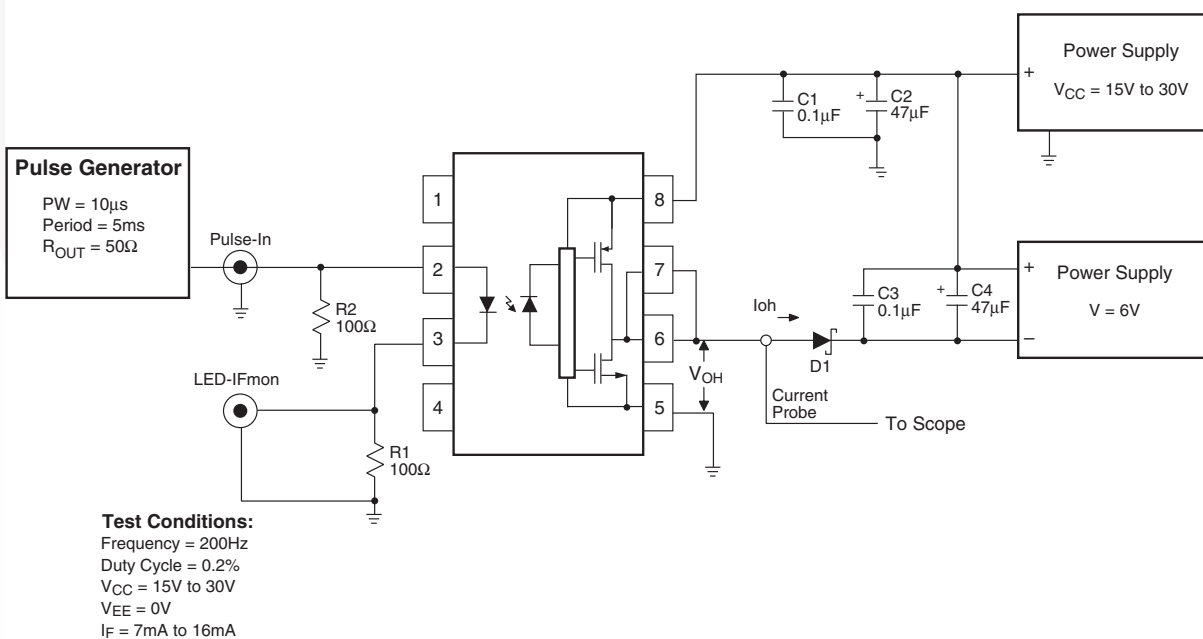
Fig. 18 Input Forward Current vs. Forward Voltage

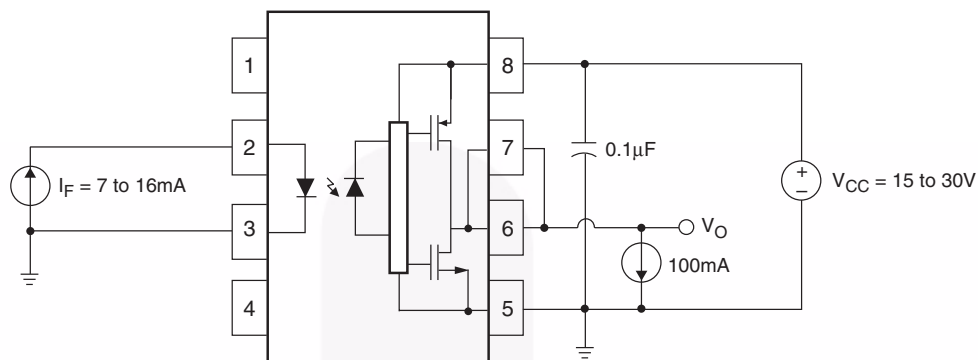
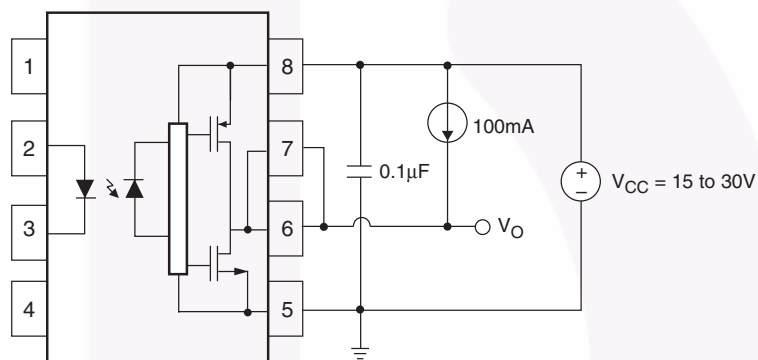


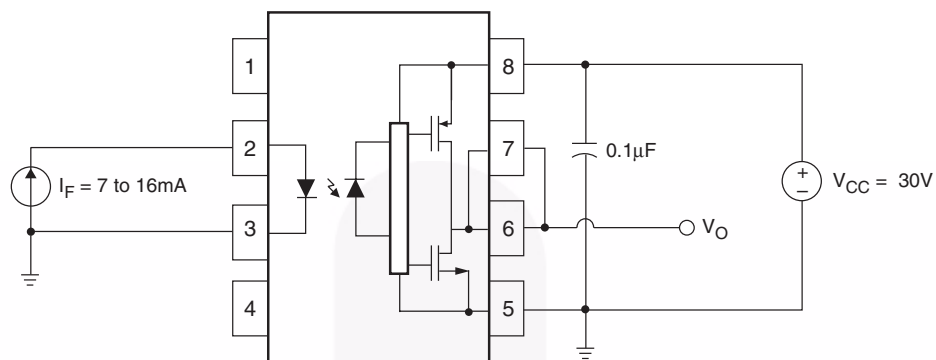
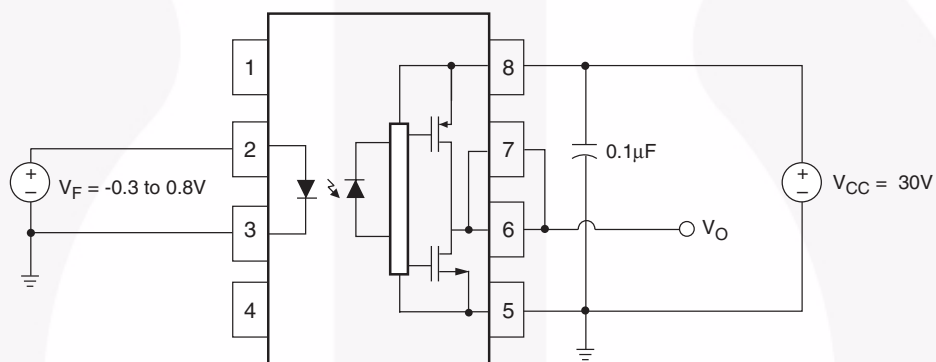
Typical Performance Curves (Continued)



Test Circuit

Figure 20. I_{OL} Test CircuitFigure 21. I_{OH} Test Circuit

Test Circuit (Continued)**Figure 22. V_{OH} Test Circuit****Figure 23. V_{OL} Test Circuit**

Test Circuit (Continued)**Figure 24. I_{CCH} Test Circuit****Figure 25. I_{CCL} Test Circuit**

Test Circuit (Continued)

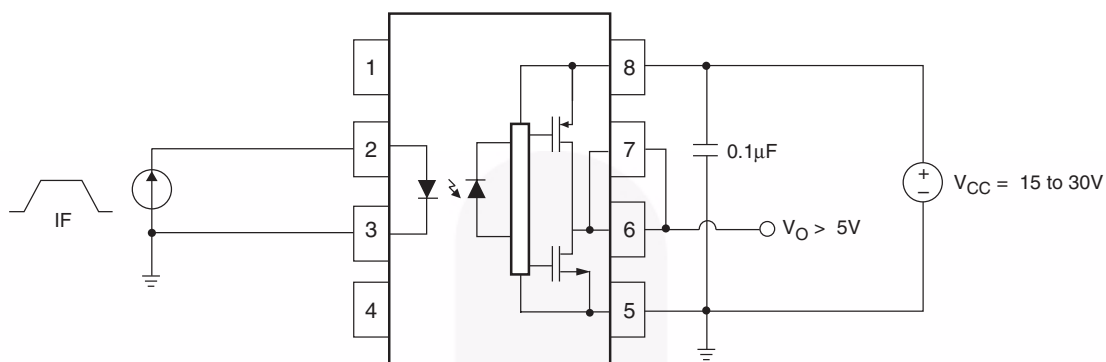


Figure 26. I_{FLH} Test Circuit

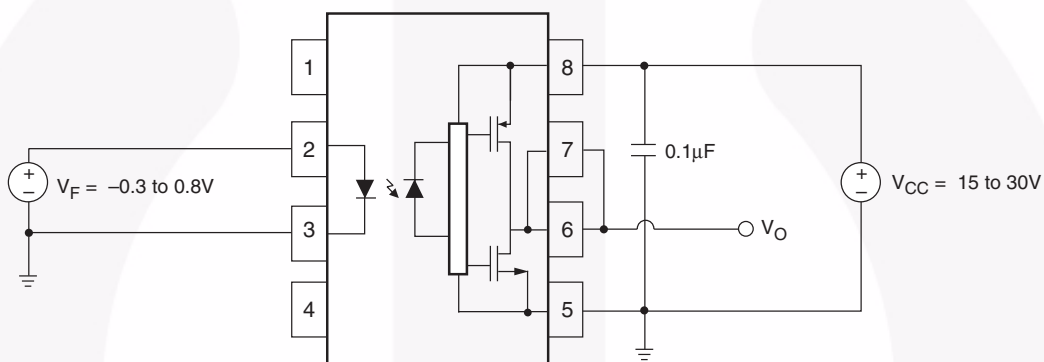


Figure 27. V_{FHL} Test Circuit

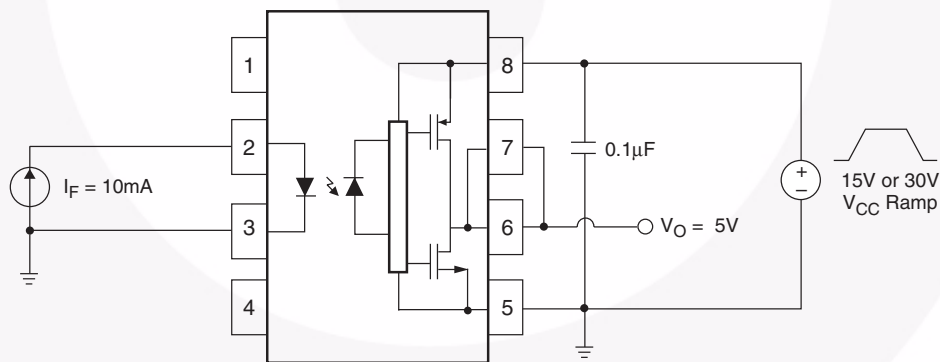


Figure 28. UVLO Test Circuit

Test Circuit (Continued)

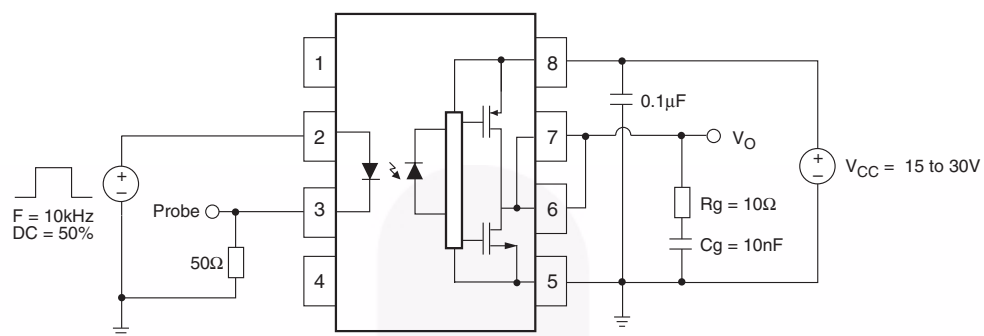


Figure 29. t_{PHL} , t_{PLH} , t_R and t_F Test Circuit and Waveforms

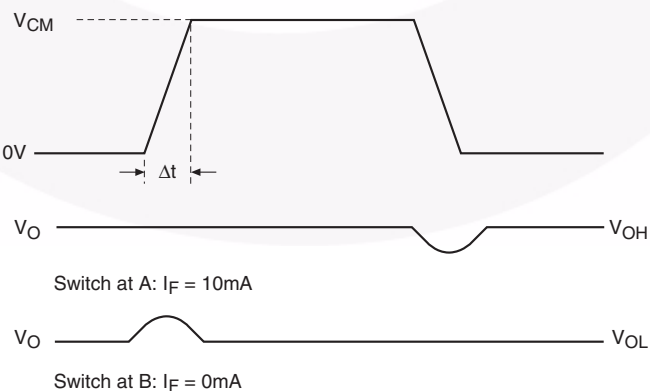
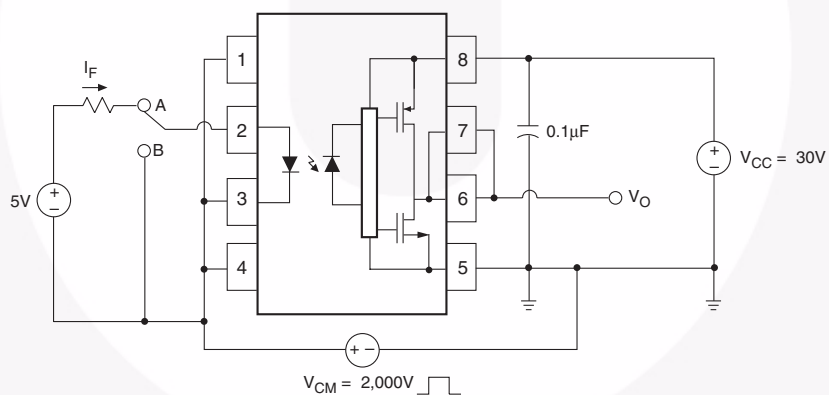
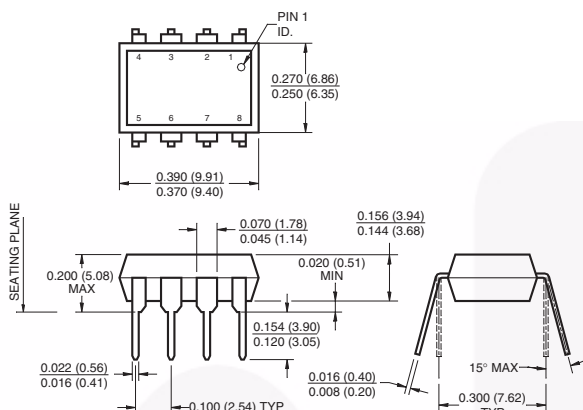


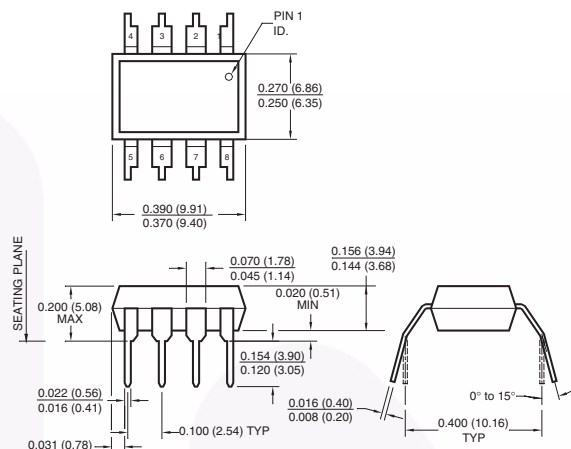
Figure 30. CMR Test Circuit and Waveforms

Package Dimensions

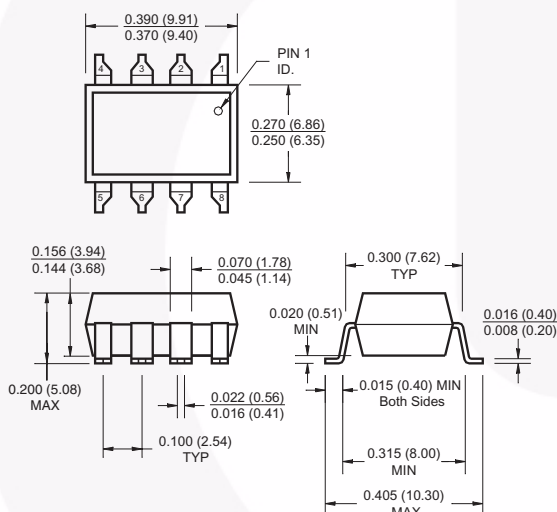
Through Hole



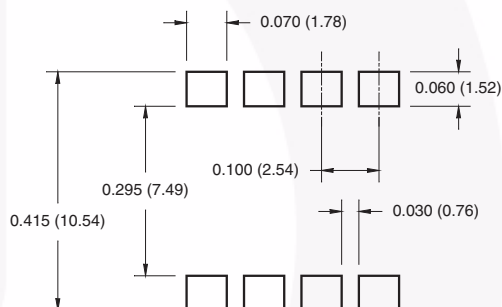
0.4" Lead Spacing (Option T)



Surface Mount – 0.3" Lead Spacing (Option S)



8-Pin Surface Mount DIP – Land Pattern (Option S)



Note:

All dimensions are in inches (millimeters)

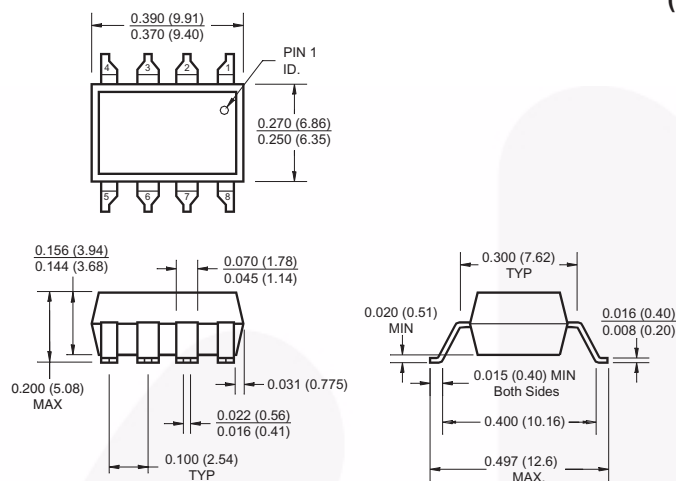
Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:

<http://www.fairchildsemi.com/packaging/>

Package Dimensions (Continued)

Surface Mount – 0.4" Lead Spacing (Option TS)



Note:

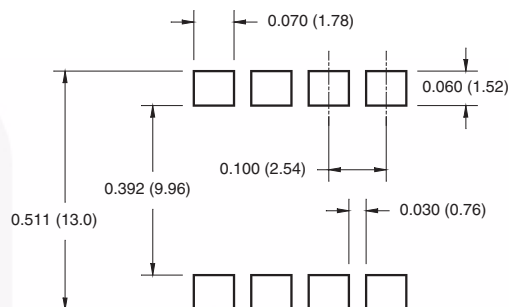
All dimensions are in inches (millimeters)

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:

<http://www.fairchildsemi.com/packaging/>

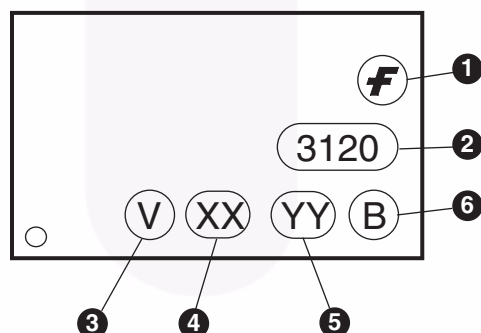
8-Pin Surface Mount DIP – Land Pattern (Option TS)



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, IEC60747-5-2 option	Tube (50 units per tube)
FOD3120SV	SMT 8-Pin (Lead Bend), IEC60747-5-2 option	Tube (50 units per tube)
FOD3120SDV	SMT 8-Pin (Lead Bend), IEC60747-5-2 option	Tape and Reel (1,000 units per reel)
FOD3120T	DIP 8-Pin, 0.4" Lead Spacing	Tube (50 units per tube)
FOD3120TV	DIP 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tube (50 units per tube)
FOD3120TS	SMT 8-Pin, 0.4" Lead Spacing	Tube (50 units per tube)
FOD3120TSV	SMT 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tube (50 units per tube)
FOD3120TSR2	SMT 8-Pin, 0.4" Lead Spacing	Tape and Reel (700 units per reel)
FOD3120TSR2V	SMT 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tape and Reel (700 units per reel)

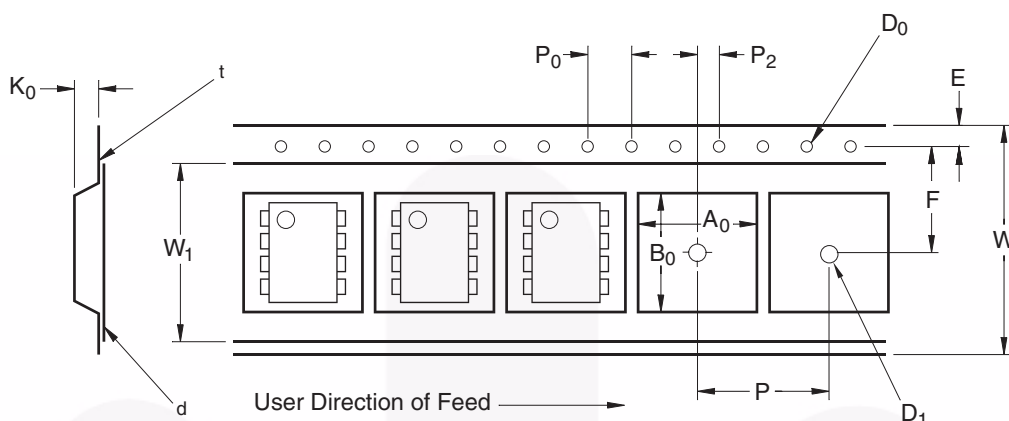
Marking Information



Definitions

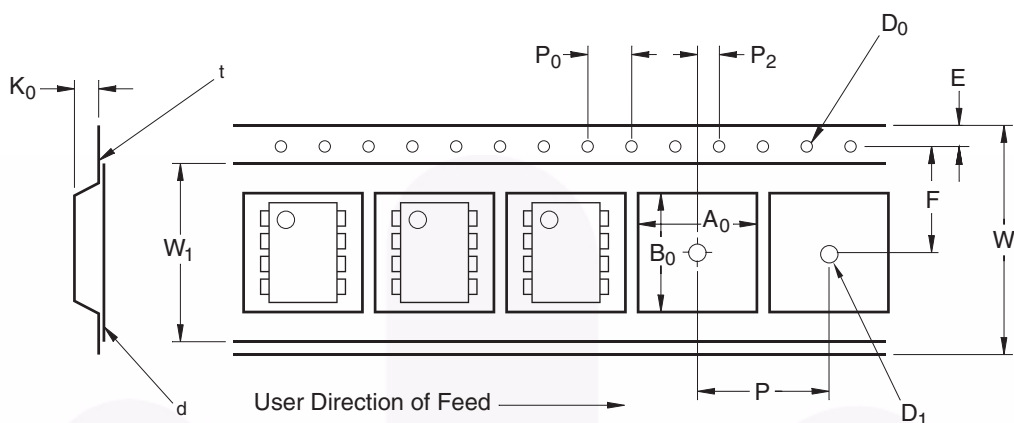
1	Fairchild logo
2	Device number
3	IEC60747-5-2 Option (only appears on component ordered with this option) (Pending approval)
4	Two digit year code, e.g., '08'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

Carrier Tape Specifications (Option SD)



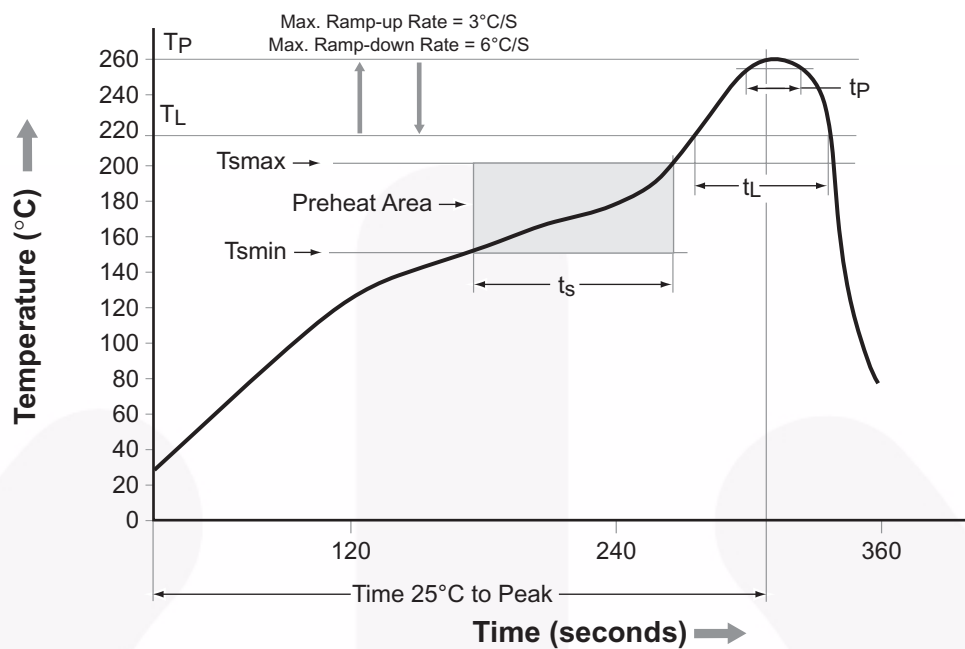
Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P_0	Sprocket Hole Pitch	4.0 ± 0.1
D_0	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P_2		2.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A_0	Pocket Dimensions	10.30 ± 0.20
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

Carrier Tape Specifications (Option TSR2)



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

Reflow Profile

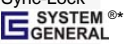


Profile Feature	Pb-Free Assembly Profile
Temperature Min. (Tsmmin)	150°C
Temperature Max. (Tsmax)	200°C
Time (ts) from (Tsmmin to Tsmax)	60–120 seconds
Ramp-up Rate (tL to tp)	3°C/second max.
Liquidous Temperature (TL)	217°C
Time (tL) Maintained Above (TL)	60–150 seconds
Peak Body Package Temperature	260°C +0°C / -5°C
Time (tp) within 5°C of 260°C	30 seconds
Ramp-down Rate (TP to TL)	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.



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Definition of Terms

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Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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