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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/µs Minimum Common Mode Rejection
- 2.5 A Peak Output Current Driving Capability for Most 1200 V/20 A IGBT
- Use of P-channel MOSFETs at Output Stage Enables Output Voltage Swing Close to The Supply Rail
- Wide Supply Voltage Range from 15 V to 30 V
- Fast Switching Speed
  - 400 ns max. Propagation Delay
  - 100 ns max. Pulse Width Distortion
- Under Voltage LockOut (UVLO) with Hysteresis
- Extended Industrial Temperate Range, -40°C to 100°C Temperature Range
- Safety and Regulatory Approved
  - UL1577, 5000 V_{RMS} for 1 min.
  - DIN EN/IEC60747-5-5
- $R_{DS(ON)}$ of 1 Ω (typ.) Offers Lower Power Dissipation
- >8.0 mm Clearance and Creepage Distance (Option 'T' or 'TS')
- 1,414 V 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 2.5 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®, 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/

Functional Block Diagram

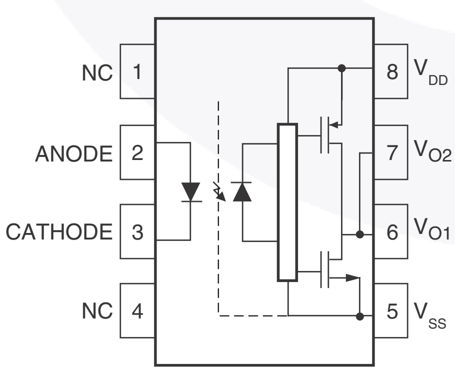


Figure 1. Functional Block Diagram(1)

Note:

1. 0.1 µF bypass capacitor must be connected between pins 5 and 8.

Package Outlines

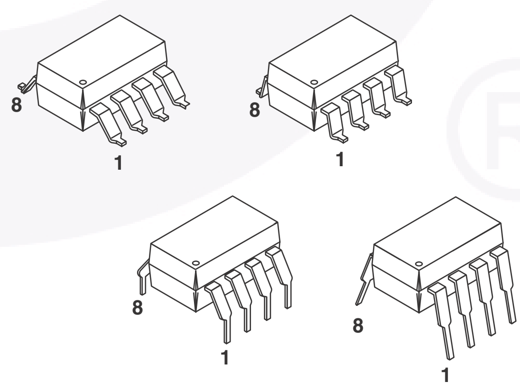


Figure 2. Package Outlines

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_{RMS}	I–IV
	< 300 V_{RMS}	I–IV
	< 450 V_{RMS}	I–III
	< 600 V_{RMS}	I–III
	< 1000 V_{RMS} (Option T, TS)	I–III
Climatic Classification		40/100/21
Pollution Degree (DIN VDE 0110/1.89)		2
Comparative Tracking Index		175

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

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

Absolute Maximum Ratings (T_A = 25ºC 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_{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 21 for reflow solder profile)		260 for 10sec	ºC
$I_{F(AVG)}$	Average Input Current		25	mA
$I_{F(PEAK)}$	Peak Transient Forward Current(3)		1	A
f	Operating Frequency(4)		50	kHz
V_R	Reverse Input Voltage		5	V
$I_{O(PEAK)}$	Peak Output Current(5)		3.0	A
$V_{DD} – V_{SS}$	Supply Voltage		0 to 35	V
		$T_A \geq 90°C$	0 to 30	
$V_{O(PEAK)}$	Peak Output Voltage		0 to V_{DD}	V
$t_{R(IN)}$, $t_{F(IN)}$	Input Signal Rise and Fall Time		500	ns
PD_I	Input Power Dissipation(6)(8)		45	mW
PD_O	Output Power Dissipation(7)(8)		250	mW

Notes:

3. Pulse Width, $P_W \leq 1$ µs, 300 pps
4. Exponential Waveform, $I_{O(PEAK)} \leq$ | 2.5 A | ($\leq$ 0.3 µs)
5. Maximum pulse width = 10 µs, maximum duty cycle = 1.1%
6. Derate linearly above 87°C, free air temperature at a rate of 0.77 mW/°C
7. No derating required across temperature range.
8. 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	°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.	Unit
V_{ISO}	Input-Output Isolation Voltage	T_A = 25ºC, R.H.< 50%, t = 1.0min, $I_{I\text{-}O} \le 10\ \mu A$, 50 Hz(9)(10)	5,000			V_{RMS}
R_{ISO}	Isolation Resistance	$V_{I\text{-}O}$ = 500 V(9)		10^{11}		Ω
C_{ISO}	Isolation Capacitance	$V_{I\text{-}O}$ = 0 V, Freq = 1.0 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 V_{RMS} for 1 minute duration is equivalent to 6,000 VAC_{RMS} for 1 second duration.

Electrical Characteristics

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
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 = 0V		60		pF
I_{OH}	High Level Output Current(4)	$V_O = V_{DD} - 3$ V	-1.0	-2.0	-2.5	A
		$V_O = V_{DD} - 6$ V	-2.0		-2.5	
I_{OL}	Low Level Output Current(4)	$V_O = V_{SS} + 3$ V	1.0	2.0	2.5	A
		$V_O = V_{SS} + 6$ V	2.0		2.5	
V_{OH}	High Level Output Voltage	I_F = 10 mA, I_O = -2.5 A	V_{DD} – 6.25 V	V_{DD} – 2.5 V		V
		I_F = 10 mA, I_O = -100 mA	V_{DD} – 0.25 V	V_{DD} – 0.1 V		
V_{OL}	Low Level Output Voltage	I_F = 0 mA, I_O = 2.5 A		V_{SS} + 2.5 V	V_{SS} + 6.25 V	V
		I_F = 0 mA, I_O = 100 mA		V_{SS} + 0.1 V	V_{SS} + 0.25 V	
I_{DDH}	High Level Supply Current	V_O = Open, I_F = 7 to 16 mA		2.8	3.8	mA
I_{DDL}	Low Level Supply Current	V_O = Open, V_F = 0 to 0.8 V		2.8	3.8	mA
I_{FLH}	Threshold Input Current Low to High	I_O = 0 mA, V_O > 5 V		2.3	5.0	mA
V_{FHL}	Threshold Input Voltage High to Low	I_O = 0 mA, V_O < 5 V	0.8			V
V_{UVLO+}	Under Voltage Lockout Threshold	I_F = 10 mA, V_O > 5 V	11.5	12.7	13.5	V
V_{UVLO-}		I_F = 10 mA, V_O < 5 V	10.0	11.2	12.0	V
$UVLO_{HYS}$	Under Voltage Lockout Threshold Hysteresis			1.5		V

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.	Unit
t_{PHL}	Propagation Delay Time to Logic Low Output	I_F = 7 mA to 16 mA, Rg = 10 Ω , Cg =10 nF, f = 10 kHz, Duty Cycle = 50%	150	275	400	ns
t_{PLH}	Propagation Delay Time to Logic High Output		150	255	400	ns
PWD	Pulse Width Distortion, $\mid t_{PHL} – t_{PLH} \mid$			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 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
$\mid CM_H \mid$	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[12]	35	50		kV/µs
$\mid CM_L \mid$	Common Mode Transient Immunity at Output Low	T_A = 25°C, V_{DD} = 30 V, V_F = 0 V, V_{CM} = 2000 V[13]	35	50		kV/µs

Notes:

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

Typical Performance Characteristics

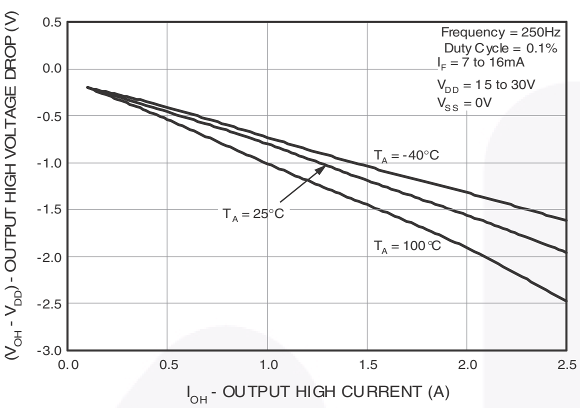


Fig. 3 Output High Voltage Drop vs. Output High Current

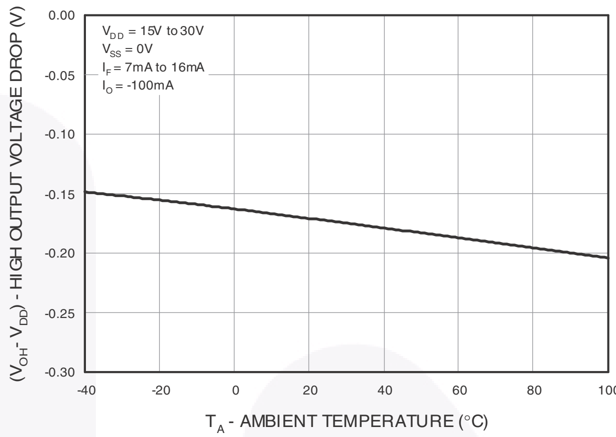


Fig. 4 Output High Voltage Drop vs. Ambient Temperature

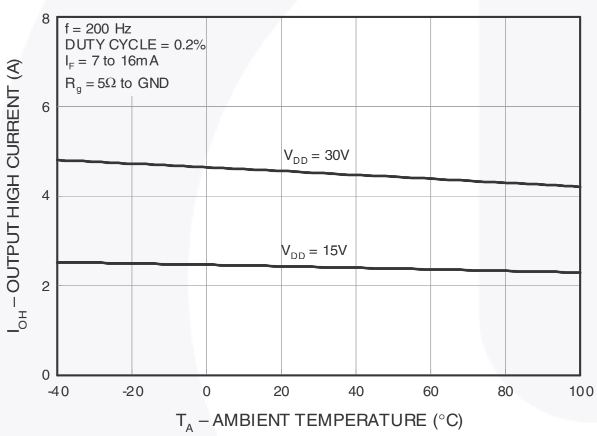


Fig. 5 Output High Current vs. Ambient Temperature

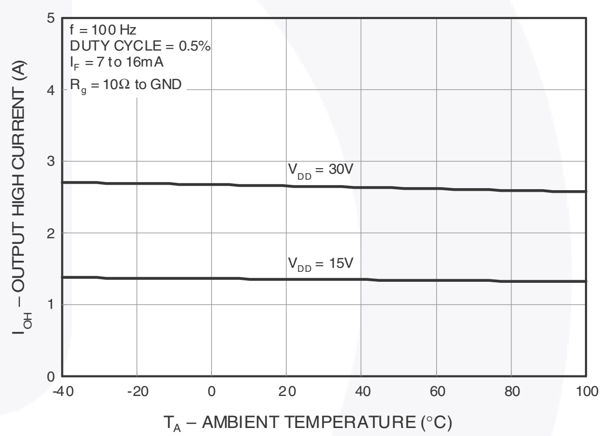


Fig. 6 Output High Current vs. Ambient Temperature

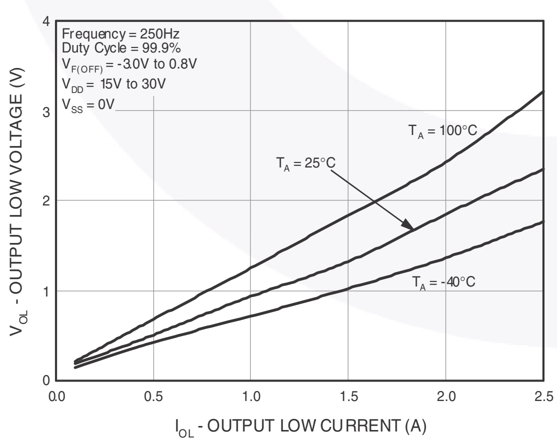


Fig. 7 Output Low Voltage vs. Output Low Current

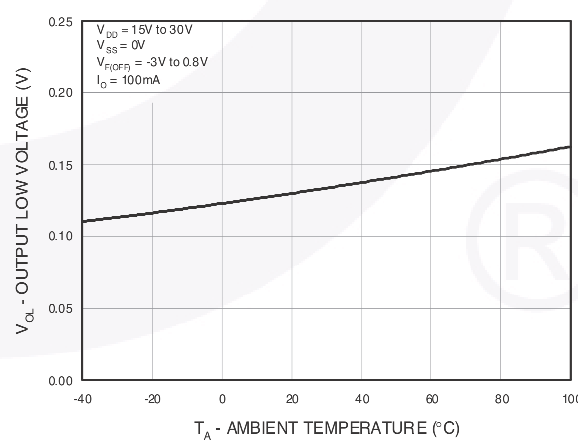


Fig. 8 Output Low Voltage vs. Ambient Temperature

Typical Performance Characteristics (Continued)

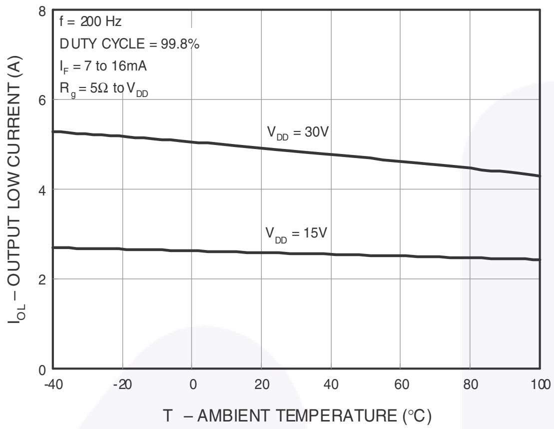


Fig. 9 Output Low Current vs. Ambient Temperature

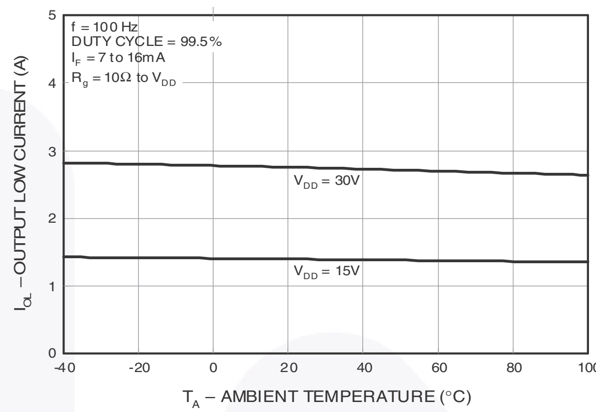


Fig. 10 Output Low Current vs. Ambient Temperature

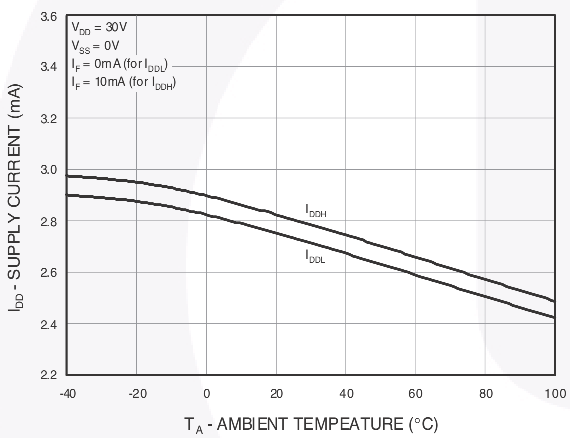


Fig. 11 Supply Current vs. Ambient Temperature

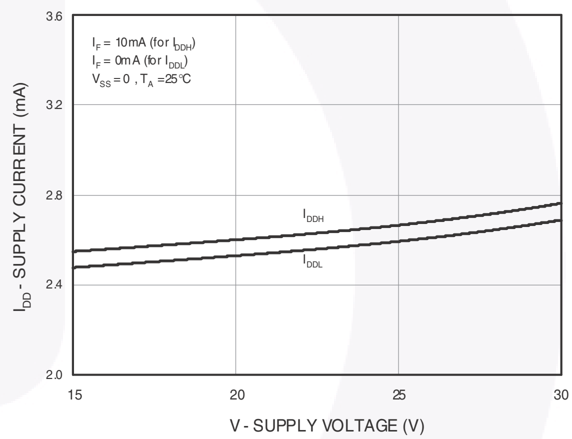


Fig. 12 Supply Current vs. Supply Voltage

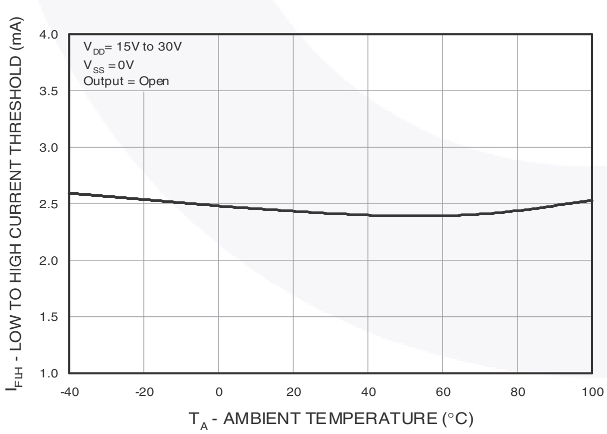


Fig. 13 Low to High Input Current Threshold vs. Ambient Temperature

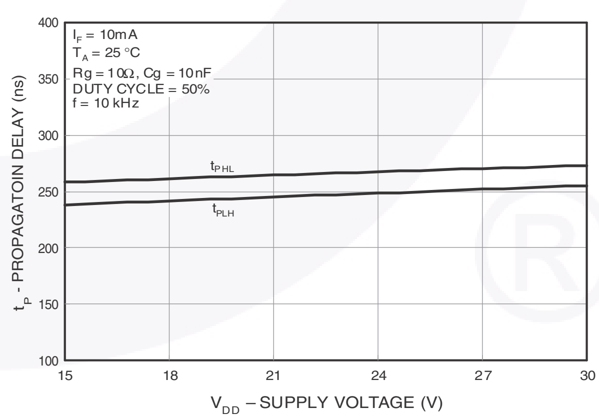


Fig. 14 Propagation Delay vs. Supply Voltage

Typical Performance Characteristics (Continued)

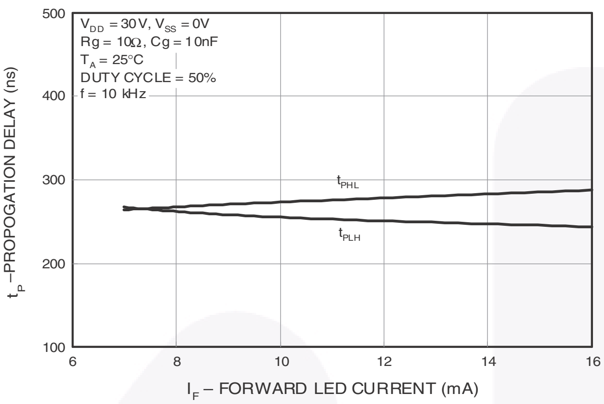


Fig. 15 Propagation Delay vs. LED Forward Current

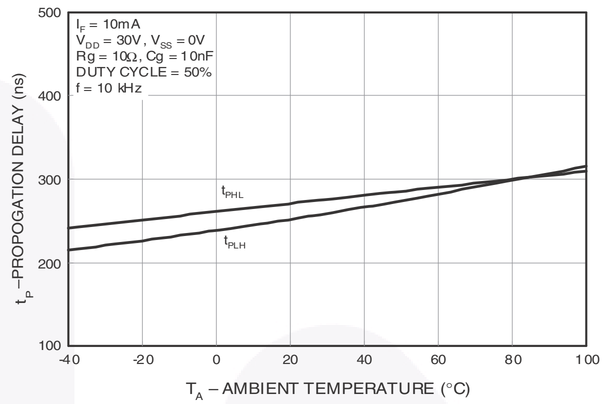


Fig. 16 Propagation Delay vs. Ambient Temperature

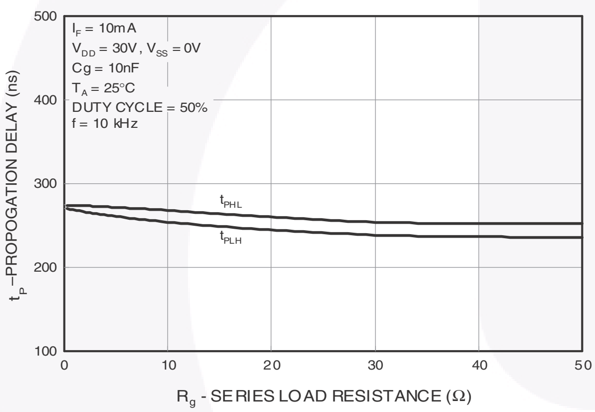


Fig. 17 Propagation Delay vs. Sereies Load Resistance

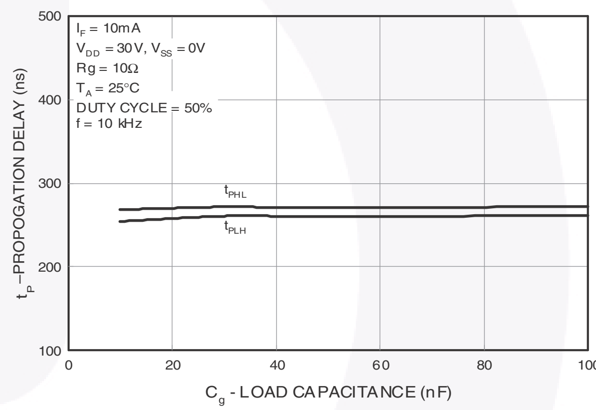


Fig. 18 Propagation Delay vs. Load Capacitance

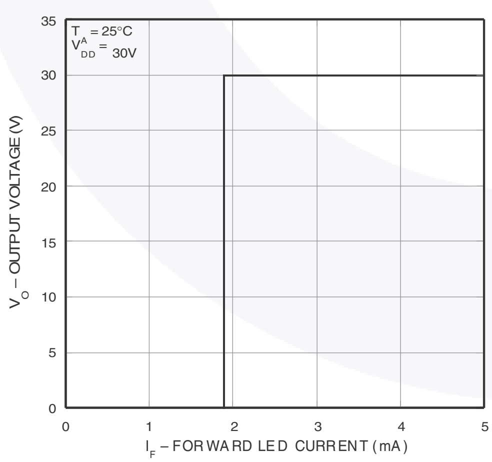


Fig. 19 Transfer Characteristics

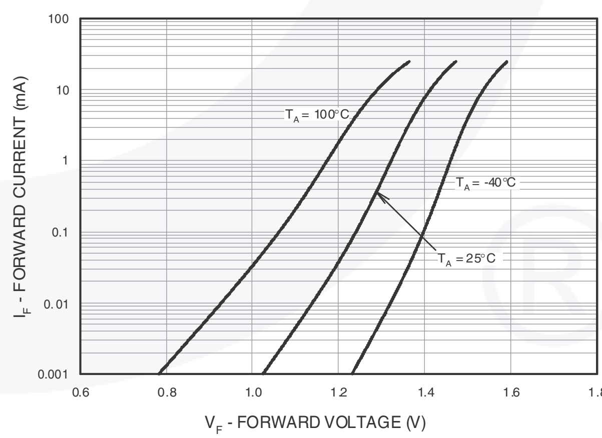


Fig. 20 Input Forward Current vs. Forward Voltage

Typical Performance Characteristics (Continued)

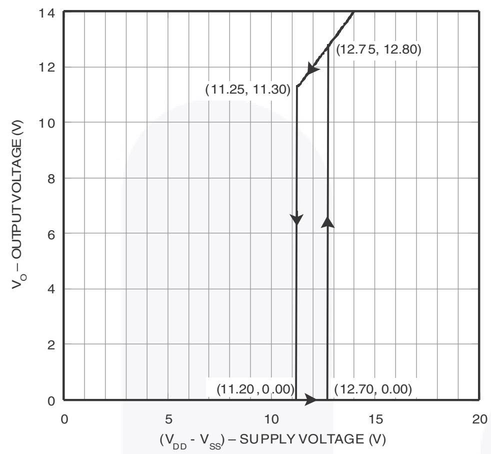
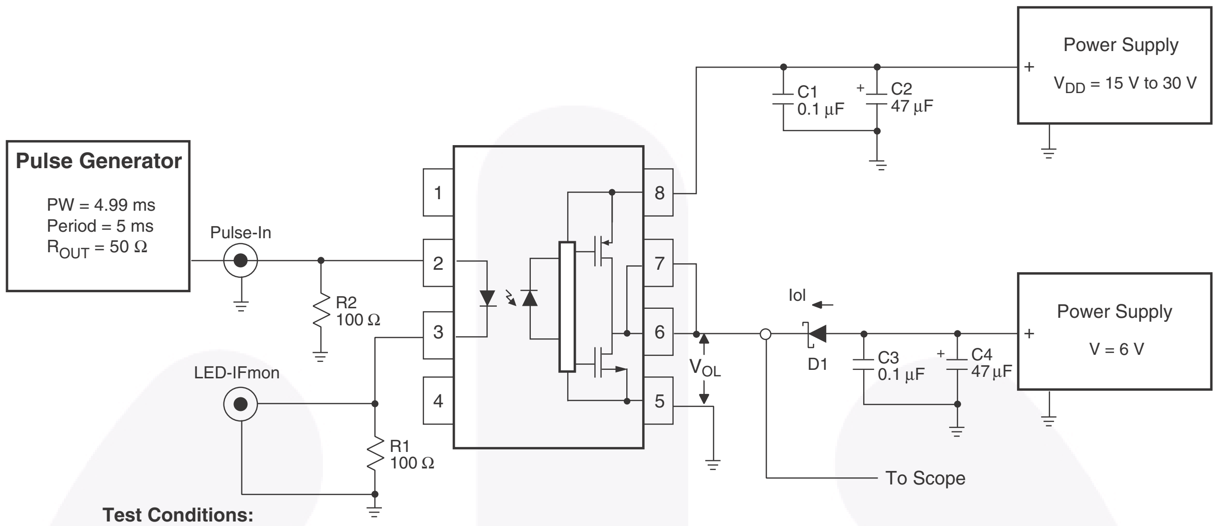


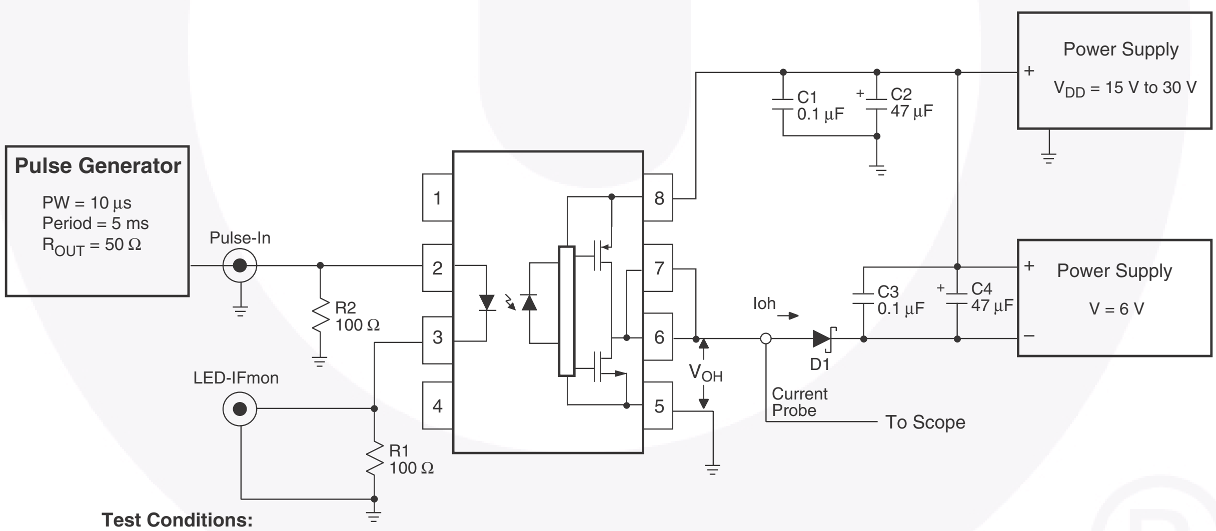
Fig. 21 Under Voltage Lockout

Test Circuit



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 22. 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 23. I_{OH} Test Circuit

Test Circuit (Continued)

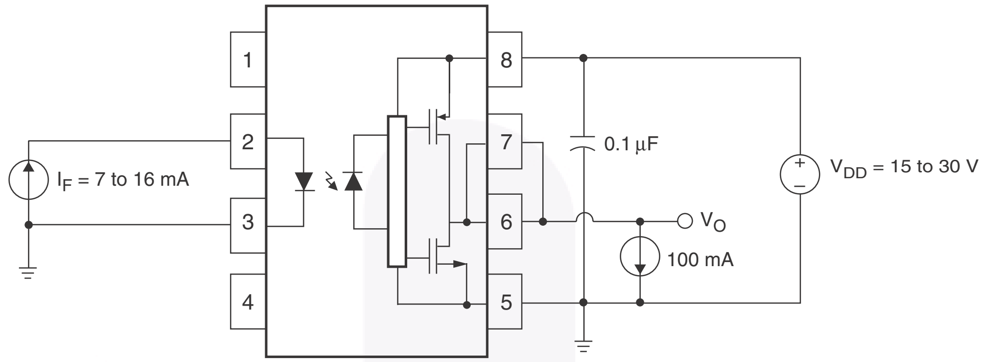


Figure 24. V_{OH} Test Circuit

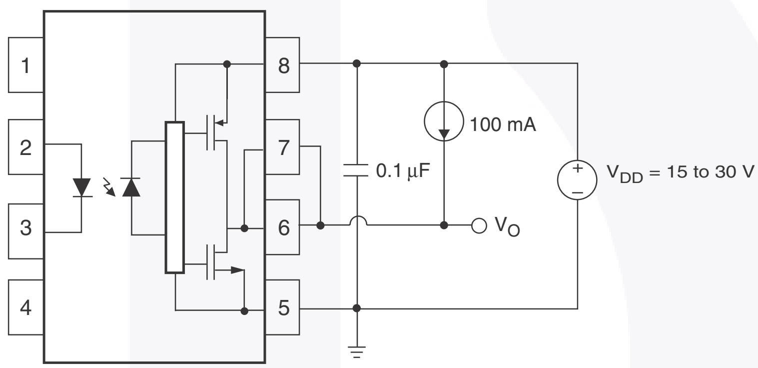


Figure 25. V_{OL} Test Circuit

Test Circuit (Continued)

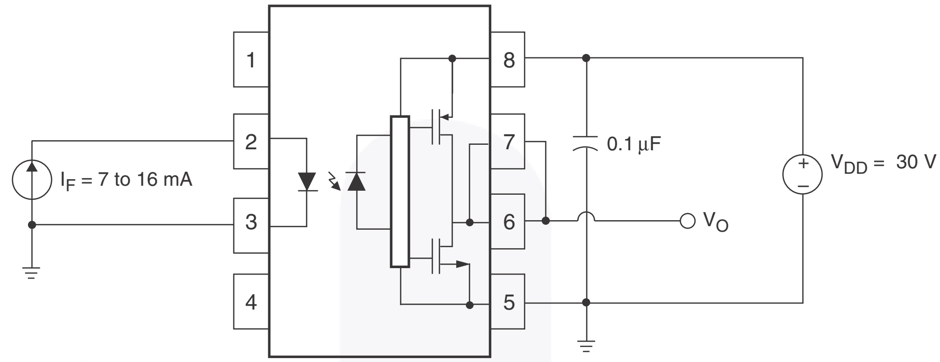


Figure 26. I_{DDH} Test Circuit

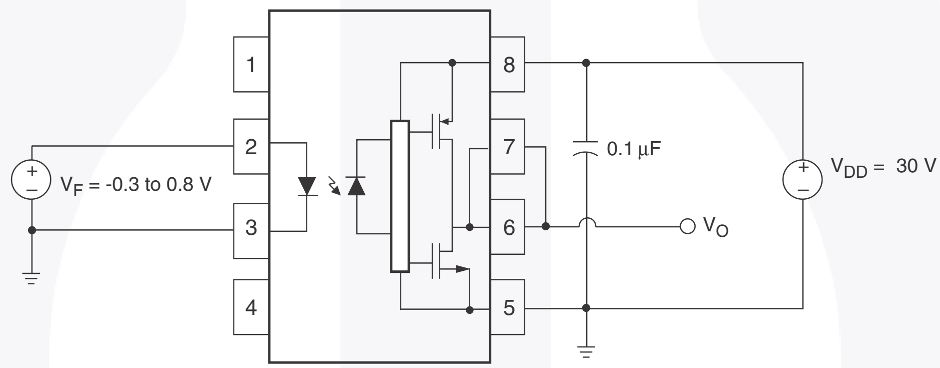


Figure 27. I_{DDL} Test Circuit

Test Circuit (Continued)

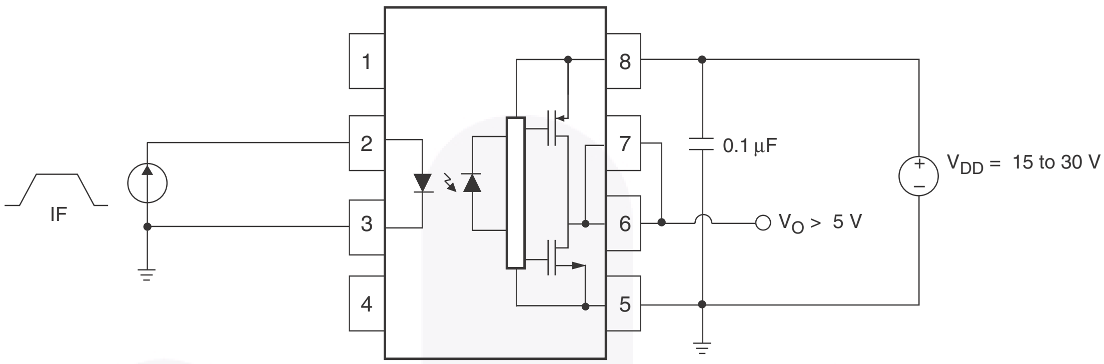


Figure 28. I_{FLH} Test Circuit

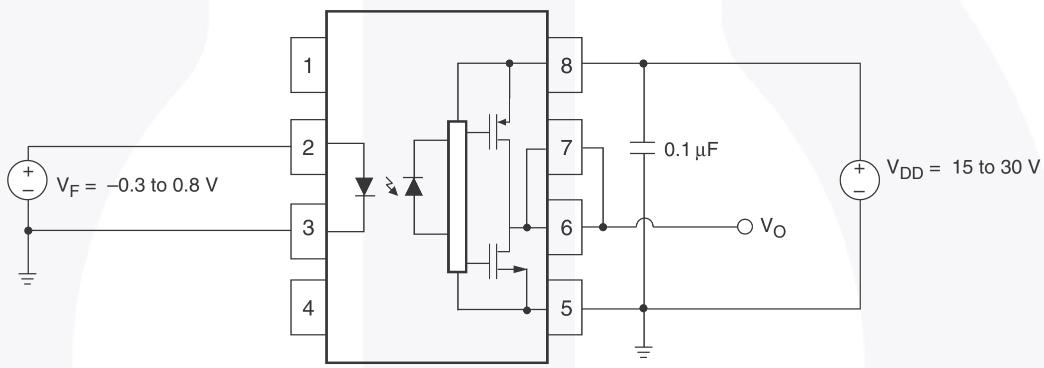


Figure 29. V_{FHL} Test Circuit

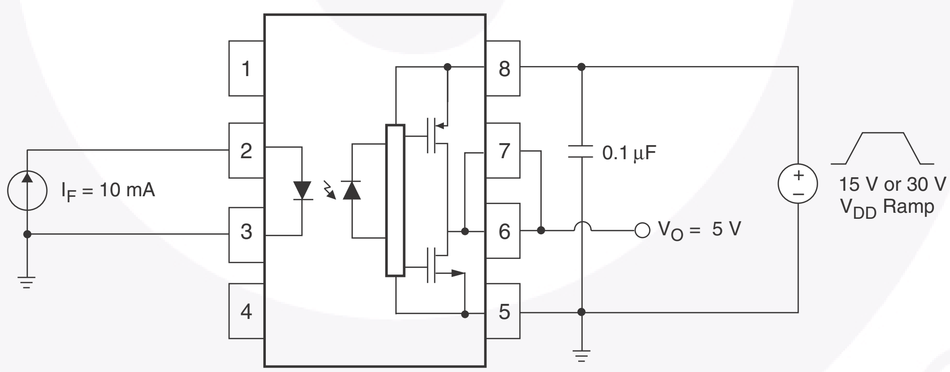


Figure 30. UVLO Test Circuit

Test Circuit (Continued)

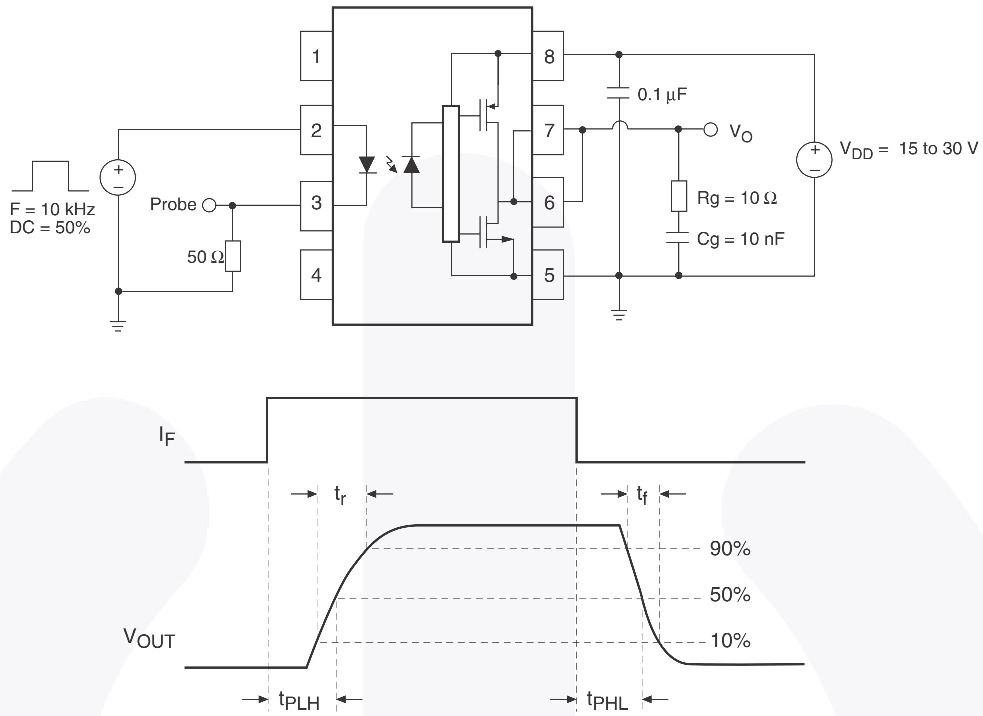


Figure 31. t_{PHL}, t_{PLH}, t_R and t_F Test Circuit and Waveforms

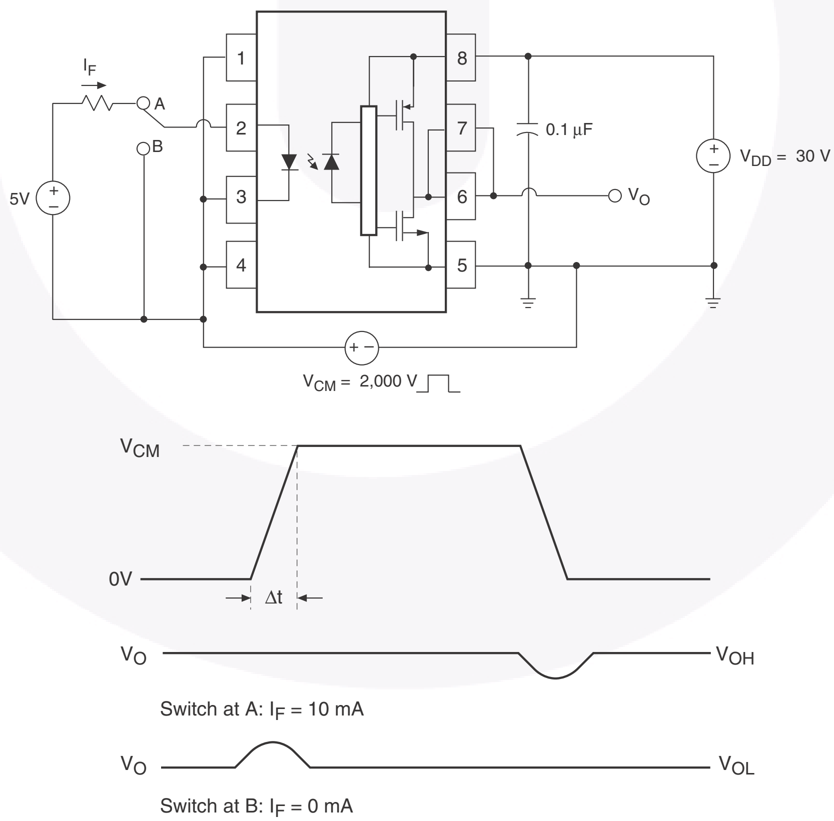
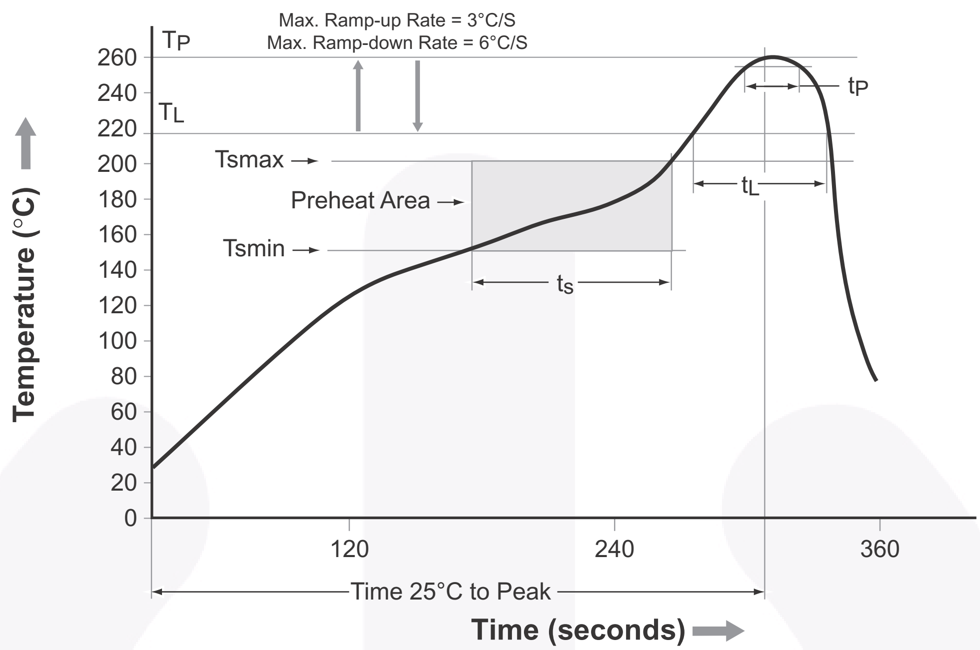


Figure 32. CMR Test Circuit and Waveforms

Reflow Profile



Profile Freature	Pb-Free Assembly Profile
Temperature Min. (Tsmin)	150°C
Temperature Max. (Tsmax)	200°C
Time (t_S) from (Tsmin to Tsmax)	60–120 seconds
Ramp-up Rate (t_L to t_P)	3°C/second max.
Liquidous Temperature (T_L)	217°C
Time (t_L) Maintained Above (T_L)	60–150 seconds
Peak Body Package Temperature	260°C +0°C / –5°C
Time (t_P) within 5°C of 260°C	30 seconds
Ramp-down Rate (T_P to T_L)	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

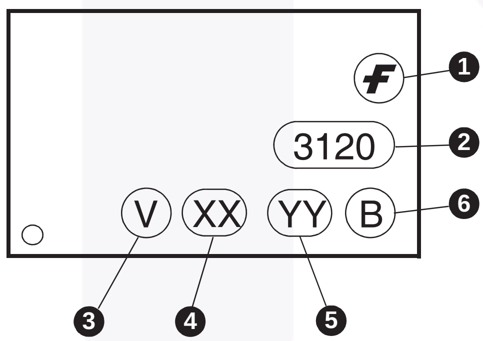
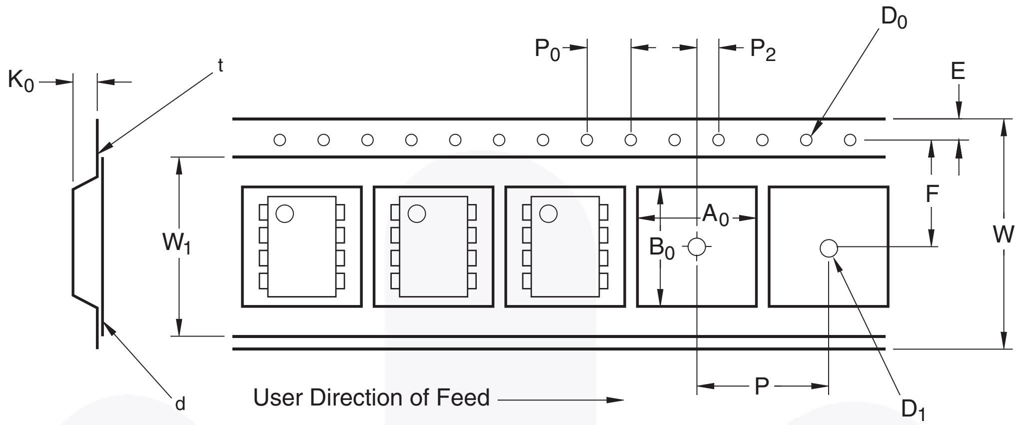


Figure 33. Top Mark

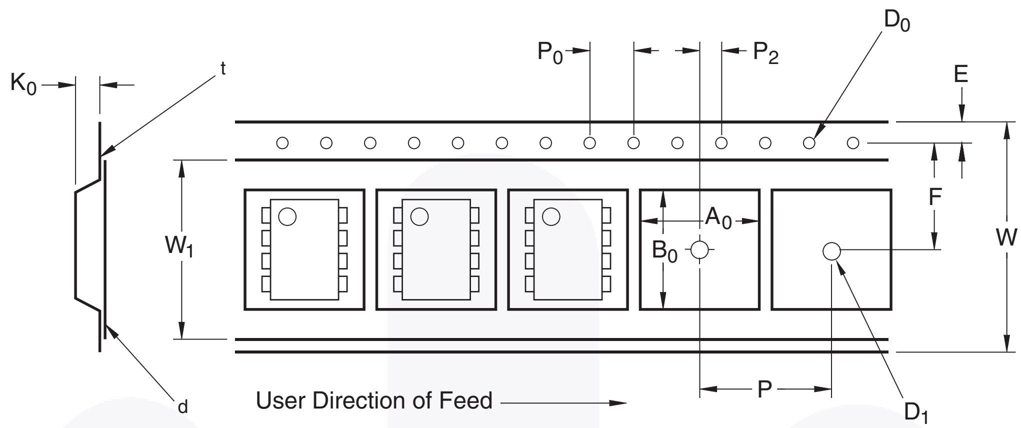
Definitions	
1	Fairchild logo
2	Device number
3	DIN_EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	Two digit year code, e.g., ‘16’
5	Two digit work week ranging from ‘01’ to ‘53’
6	Assembly package code

Carrier Tape Specifications (Option SD)

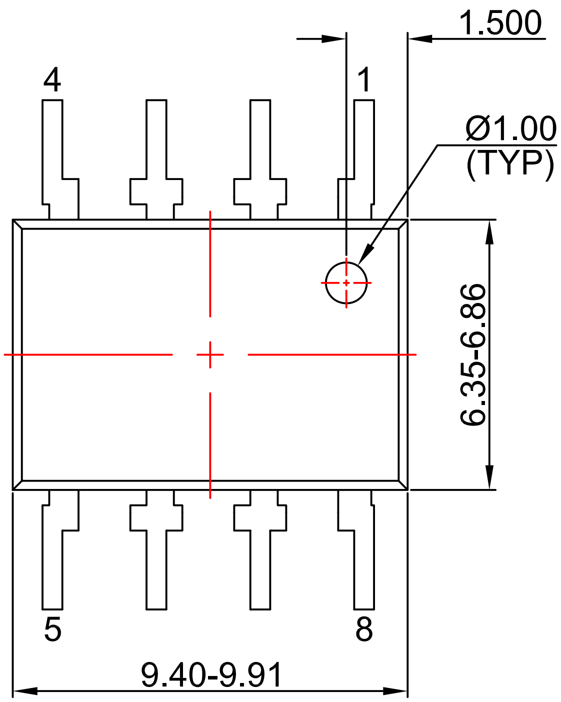


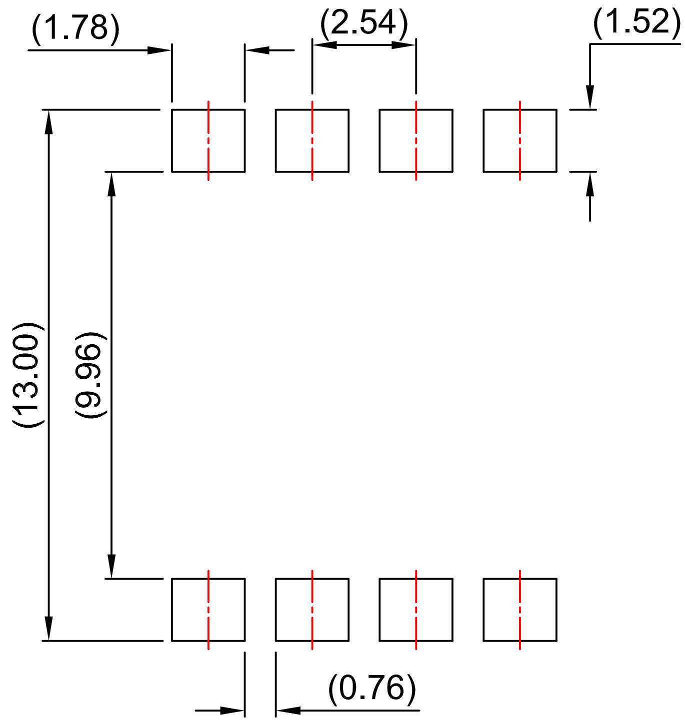
Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P_0	Sprocket Hole Pitch	4.0 ± 0.1
D_0	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P_2		2.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A_0	Pocket Dimensions	10.30 ±0.20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

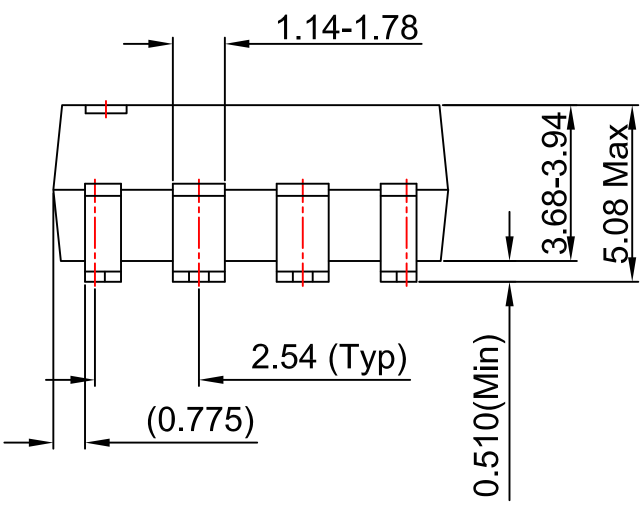


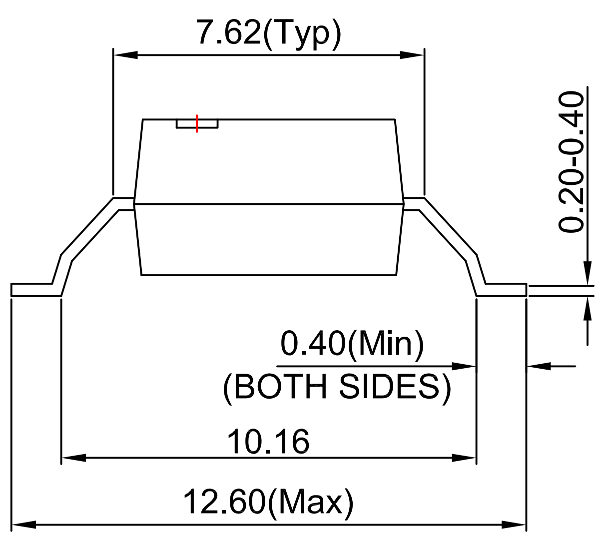
Symbol	Description	Dimension in mm
W	Tape Width	24.0 ± 0.3
t	Tape Thickness	0.40 ± 0.1
P_0	Sprocket Hole Pitch	4.0 ± 0.1
D_0	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	11.5 ± 0.1
P_2		2.0 ± 0.1
P	Pocket Pitch	16.0 ± 0.1
A_0	Pocket Dimensions	12.80 ± 0.1
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





LAND PATTERN RECOMMENDATION





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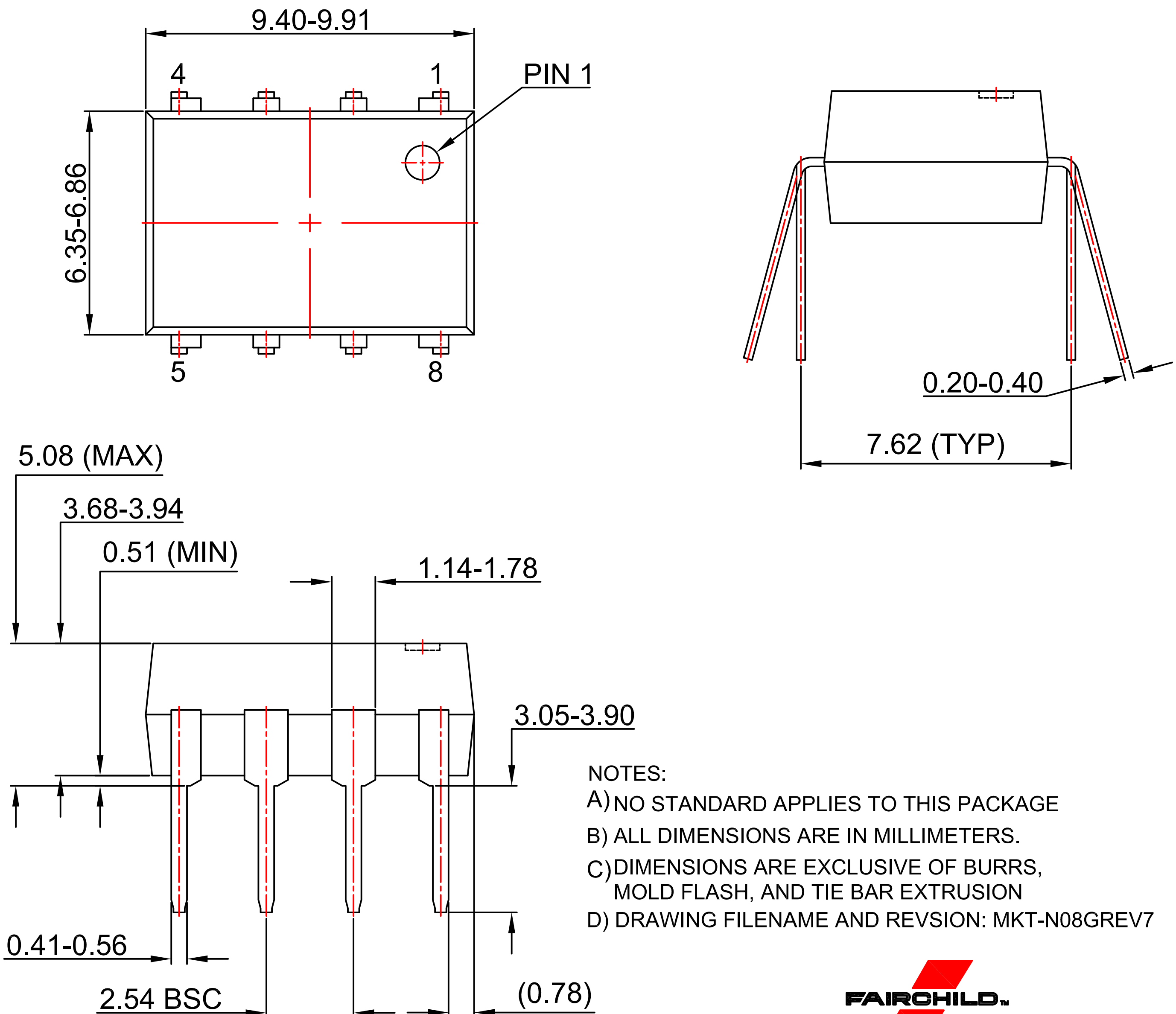

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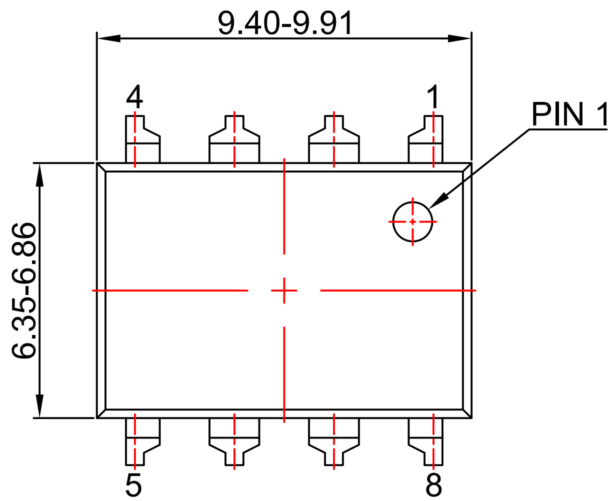
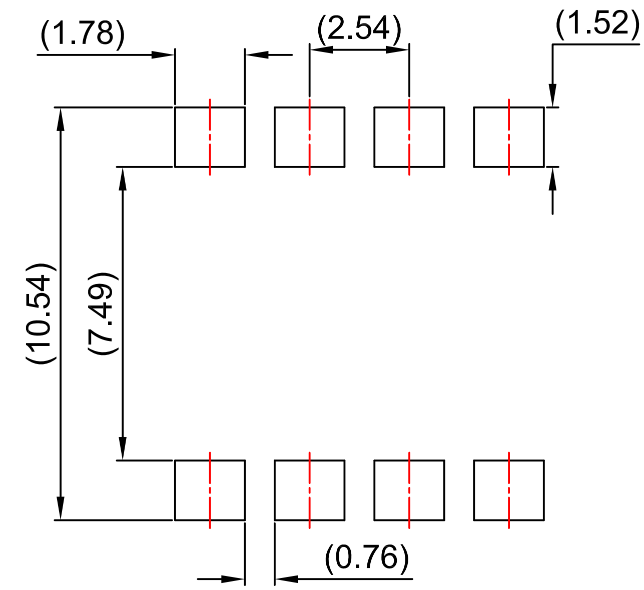
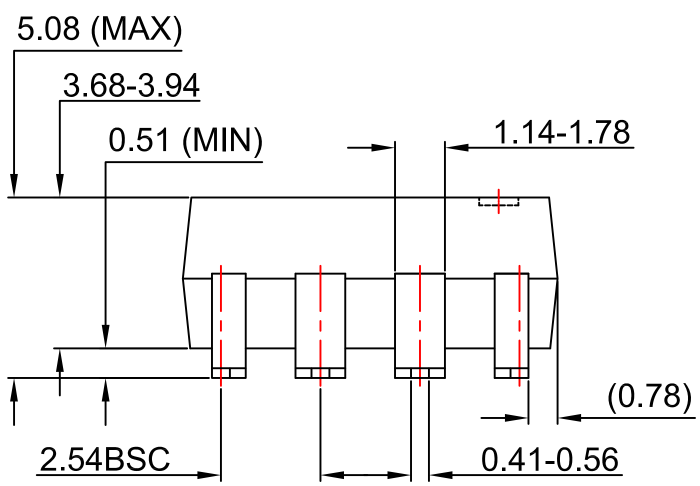
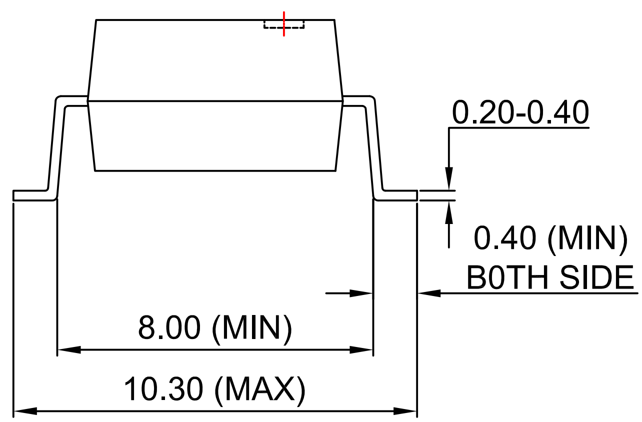




LAND PATTERN RECOMMENDATION





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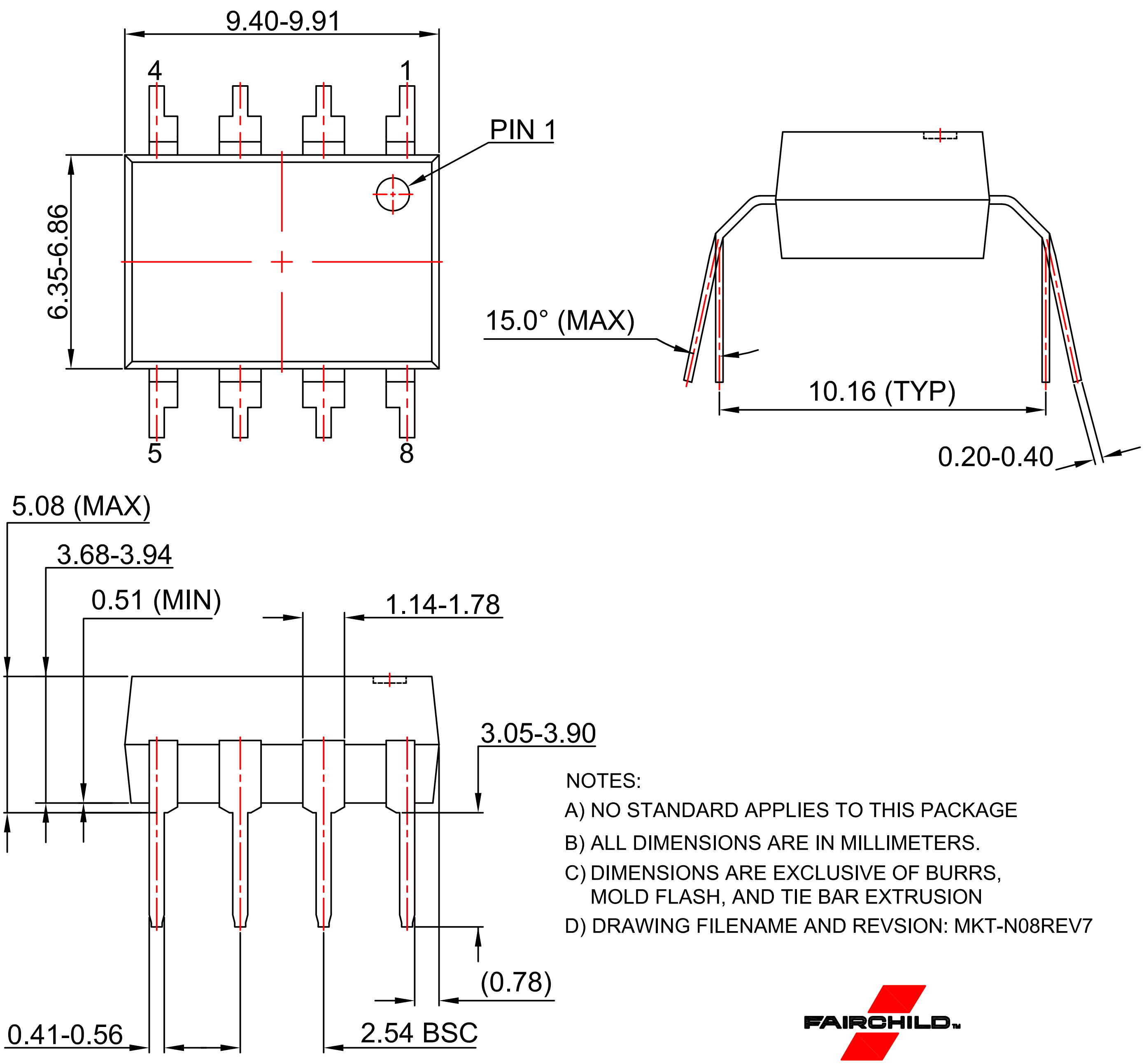

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