

FOD2200

Low Input Current Logic Gate Optocouplers

Features

- 1kV/ μ s minimum common mode rejection
- Compatible with LSTTL, TTL, and CMOS logic
- Wide V_{CC} range (4.5V to 20V)
- 2.5Mbd guaranteed over temperature
- Low input current (1.6mA)
- Three state output (no pullup resistor required)
- Guaranteed performance from 0°C to 85°C
- Hysteresis
- Safety and regulatory approved
 - UL1577, 5000 V_{RMS} for 1 min.
 - IEC60747-5-2
- >8.0mm clearance and creepage distance (option 'T' or 'TS')
- 1,414V Peak Working Insulation Voltage (V_{IORM})

Applications

- Isolation of high speed logic systems
- Computer peripheral interfaces
- Microprocessor system interfaces
- Ground loop elimination
- Pulse transformer replacement
- Isolated bus driver
- High speed line receiver

Description

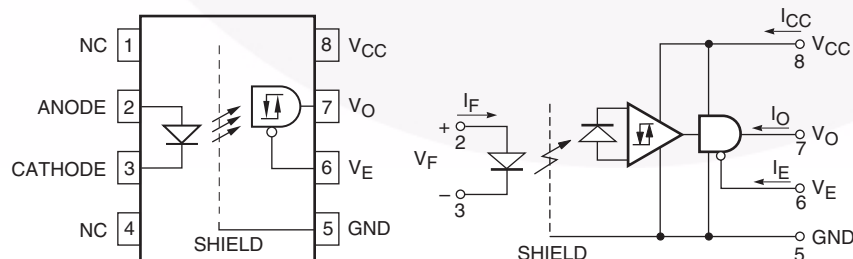
The FOD2200 is an optically coupled logic gate that combine an AlGaAs LED and an integrated high gain photo detector. The detector has a three state output stage and has a detector threshold with hysteresis. The three state output eliminates the need for a pullup resistor and allows for direct drive of data busses. The hysteresis provides differential mode noise immunity and eliminates the potential for output signal chatter.

The Electrical and Switching Characteristics of the FOD2200 are guaranteed over the temperature range of 0°C to 85°C and a V_{CC} range of 4.5V to 20V. Low I_F and wide V_{CC} range allow compatibility with TTL, LSTTL, and CMOS logic and result in lower power consumption compared to other high speed opto-couplers. Logic signals are transmitted with a maximum propagation delay of 300ns. The FOD2200 is useful for isolating high speed logic interfaces, buffering of input and output lines, and implementing isolated line receivers in high noise environments.

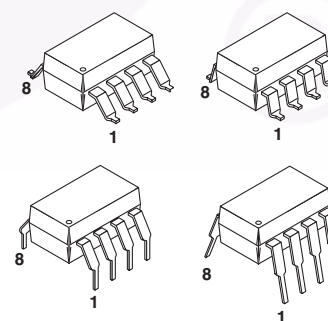
Truth Table (Positive Logic)

LED	Enable	Output
On	H	Z
Off	H	Z
On	L	H
Off	L	L

Functional Block Diagram and Schematic



Package Outlines



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		40/85/21		
	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	10			mA
$P_{S,OUTPUT}$	Output Power (Duty Factor $\leq 2.7\%$)	150			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	-40 to +125	$^\circ\text{C}$
T_{OPR}	Operating Temperature	-40 to +85	$^\circ\text{C}$
T_{SOL}	Lead Solder Temperature (1.6mm below seating plane)	260 for 10 sec	$^\circ\text{C}$
EMITTER			
$I_F (PK)$	Peak Transient Input Current ($\leq 1\mu\text{s}$ PW, 300pps)	1.0	A
I_F	Average Forward Input Current	10	mA
V_R	Reverse Input Voltage	5.0	V
P_D	Output Power Dissipation (No derating required up to 85°C)	45	mW
DETECTOR			
V_{CC}	Supply Voltage	0 to 20	V
I_O	Average Output Current	25	mA
V_E	Three State Enable Voltage	-0.5 to 20	V
V_O	Output Voltage	-0.5 to 20	V
P_D	Output Power Dissipation (No derating required up to 85°C)	150	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	Min.	Max.	Units
$I_{F(ON)}$	Forward Input Current	1.6*	5	mA
$I_{F(OFF)}$	Forward Input Current		0.1	mA
V_{CC}	Supply Voltage, Output	4.5	20	V
V_{EL}	Enable Voltage, LOW Level	0	0.8	V
V_{EH}	Enable Voltage, HIGH Level	2.0	20	V
T_A	Operating Temperature	0	+85	$^\circ\text{C}$
N	Fan Out (TTL Load)		4	

*The initial switching threshold is 1.6mA or less. It is recommended that 2.2mA be used to permit at least a 20% CTR degradation guardband.

Electrical Characteristics ($T_A = 0^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = 4.5\text{V}$ to 20V , $I_{F(ON)} = 1.6\text{mA}$ to 5mA , $V_{EH} = 2\text{V}$ to 20V , $V_{EL} = 0\text{V}$ to 0.8V , $I_{F(OFF)} = 0\text{mA}$ to 0.1mA unless otherwise specified.)⁽¹⁾

Individual Component Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
EMITTER						
V_F	Input Forward Voltage	$I_F = 5\text{mA}$ $T_A = 25^\circ\text{C}$		1.40	1.75	V
B_{VR}	Input Reverse Breakdown Voltage	$I_R = 10\mu\text{A}$	5.0			V
C_{IN}	Input Capacitance	Pins 2 & 3, $V_F = 0$, $f = 1\text{MHz}$		60		pF
$\Delta V_F/\Delta T_A$	Input Diode Temperature Coefficient	$I_F = 5\text{mA}$		-1.4		mV/°C
DETECTOR						
I_{CCH}	High Level Supply Current	$I_F = 5\text{mA}$, $I_O = \text{Open}$, $V_E = \text{Don't Care}$	$V_{CC} = 5.5\text{V}$ $V_{CC} = 20\text{V}$	3.5 4.0	4.5 6.0	mA
I_{CCL}	Low Level Supply Current	$I_F = 0$, $I_O = \text{Open}$, $V_E = \text{Don't care}$	$V_{CC} = 5.5\text{V}$ $V_{CC} = 20\text{V}$	4.4 5.2	6.0 7.5	mA
I_{EL}	Low Level Enable Current	$V_E = 0.4\text{V}$		-0.1	-0.32	mA
I_{EH}	High Level Enable Current	$V_E = 2.7\text{V}$ $V_E = 5.5\text{V}$ $V_E = 20\text{V}$			20 100 250	μA
V_{EH}	High Level Enable Voltage		2.0			V
V_{EL}	Low Level Enable Voltage				0.8	V

Switching Characteristics ($T_A = 0^\circ\text{C}$ to $+85^\circ\text{C}$, $I_{F(ON)} = 1.6\text{mA}$ to 5mA , $I_{F(OFF)} = 0$ to 0.1mA , $V_{CC} = 4.5\text{V}$ to 20V unless otherwise specified.)

Symbol	AC Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
T_{PLH}	Propagation Delay Time to Output High Level	With Peaking Capacitor ⁽²⁾⁽⁴⁾ (Fig. 1)		120	300	ns
T_{PHL}	Propagation Delay Time to Output Low Level	With Peaking Capacitor ⁽³⁾⁽⁴⁾ (Fig. 1)		180	300	ns
t_r	Output Rise Time (10% to 90%)	⁽⁵⁾ (Fig. 1)		80		ns
t_f	Output Fall Time (90% to 10%)	⁽⁶⁾ (Fig. 1)		25		ns
t_{pZH}	Enable Propagation Delay Time to Output High Level	(Fig. 2)		40		ns
t_{pZL}	Enable Propagation Delay Time to Output Low Level	(Fig. 2)		50		ns
T_{PHZ}	Disable Propagation Delay Time from Output High Level	(Fig. 2)		95		ns
T_{PLZ}	Disable Propagation Delay Time from Output Low Level	(Fig. 2)		80		ns
ICM_H	Common Mode Transient Immunity (at Output High Level)	$T_A = 25^\circ\text{C}$, $V_{OH} (\text{Min.}) = 2.0\text{V}$, $V_{CC} = 5\text{V}^{(7)}$ (Fig. 3)	$I_F = 1.6\text{mA}$, $ V_{CM} = 50\text{V}$ $I_F = 5\text{mA}$, $ V_{CM} = 1,000\text{V}$	1,000 10,000		V/ μs
ICM_L	Common Mode Transient Immunity (at Output Low Level)	$T_A = 25^\circ\text{C}$, $I_F = 0\text{mA}$ $V_{OL} (\text{Max.}) = 0.8\text{V}$, $V_{CC} = 5\text{V}^{(8)}$ (Fig. 3)	$ V_{CM} = 50\text{V}$ $ V_{CM} = 1,000\text{V}$	1,000 10,000		V/ μs

*Typical values at $T_A = 25^\circ\text{C}$, $V_{CC} = 5\text{V}$, $I_{F(ON)} = 3\text{mA}$ unless otherwise specified.

Electrical Characteristics (Continued)

Transfer Characteristics ($T_A = 0^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = 4.5\text{V}$ to 20V , $I_{F(ON)} = 1.6\text{mA}$ to 5mA , $V_{EH} = 2\text{V}$ to 20V , $V_{EL} = 0\text{V}$ to 0.8V , $I_{F(OFF)} = 0\text{mA}$ to 0.1mA unless otherwise specified.)⁽¹⁾

Symbol	DC Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
I_{OHH}	Output Leakage Current ($V_{OUT} > V_{CC}$)	$V_{CC} = 4.5\text{V}$, $I_F = 5\text{mA}$		2.0	100	μA
		$V_O = 5.5\text{V}$		2.5	500	
V_{OL}	Low Level Output Voltage	$V_{CC} = 4.5\text{V}$, $I_F = 0\text{mA}$, $V_E = 0.4\text{V}$, $I_{OL} = 6.4\text{mA}$ ⁽²⁾		0.33	0.5	V
I_{FT}	Input Threshold Current	$V_{CC} = 4.5\text{V}$, $V_O = 0.5\text{V}$, $V_E = 0.4\text{V}$, $I_{OL} = 6.4\text{mA}$			1.6	mA
V_{OH}	Logic High Output Voltage	$I_{OH} = -2.6\text{mA}$	2.4	$V_{CC} - 1.8$		V
I_{OZL}	High Impedance State Output Current	$V_O = 0.4\text{V}$, $V_{EN} = 2\text{V}$, $I_F = 5\text{mA}$			-20	μA
I_{OZH}	High Impedance State Output Current	$V_O = 2.4\text{V}$, $V_{EN} = 2\text{V}$, $I_F = 5\text{mA}$			20	μA
		$V_O = 5.5\text{V}$, $V_{EN} = 2\text{V}$, $I_F = 5\text{mA}$			100	
		$V_O = 20\text{V}$, $V_{EN} = 2\text{V}$, $I_F = 5\text{mA}$			500	
I_{OSL}	Logic Low Short Circuit Output Current ⁽¹⁰⁾	$V_O = V_{CC} = 5.5\text{V}$, $I_F = 0\text{mA}$	25			mA
		$V_O = V_{CC} = 20\text{V}$, $I_F = 0\text{mA}$	40			
I_{OSH}	Logic High Short Circuit Output Current ⁽¹⁰⁾	$V_{CC} = 5.5\text{V}$, $I_F = 5\text{mA}$, $V_O = \text{GND}$	-10			mA
		$V_{CC} = 20\text{V}$, $I_F = 5\text{mA}$, $V_O = \text{GND}$	-25			
I_{HYS}	Input Current Hysteresis	$V_{CC} = 4.5\text{V}$		0.03		mA

Isolation Characteristics ($T_A = 0^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise specified)

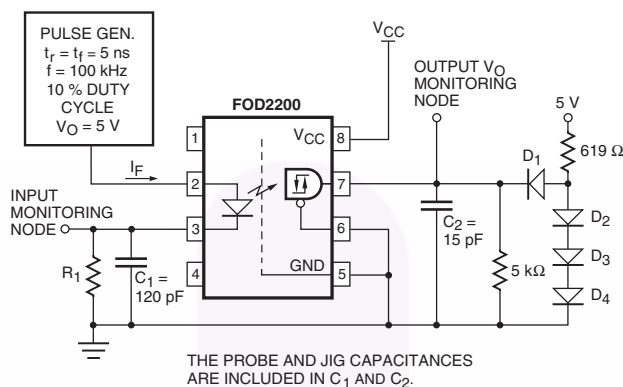
Symbol	Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
V_{ISO}	Withstand Insulation Test Voltage	$R_H < 50\%$, $T_A = 25^\circ\text{C}$, $t = 1\text{ min.}$ ⁽⁹⁾	5000			V_{RMS}
R_{I-O}	Resistance (Input to Output)	$V_{I-O} = 500\text{ VDC}$ ⁽⁹⁾		10^{12}		Ω
C_{I-O}	Capacitance (Input to Output)	$V_{I-O} = 0\text{V}$, $f = 1\text{MHz}$ ⁽⁹⁾		0.6		pF

*Typical values at $T_A = 25^\circ\text{C}$, $V_{CC} = 5\text{V}$, $I_{F(ON)} = 3\text{mA}$ unless otherwise stated.

Notes:

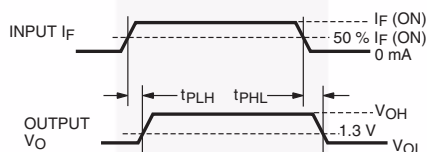
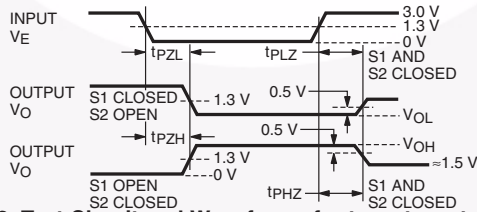
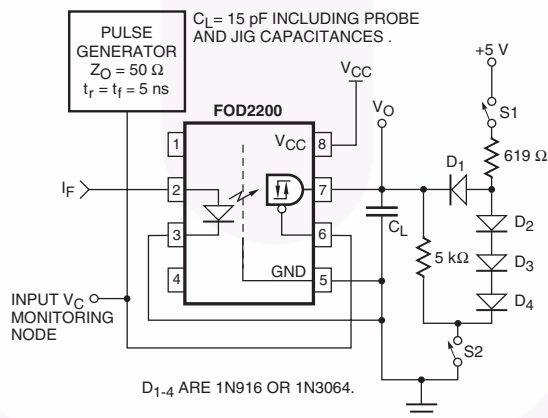
1. The V_{CC} supply to each optoisolator must be bypassed by a $0.1\mu\text{F}$ capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package V_{CC} and GND pins of each device.
2. t_{PLH} – Propagation delay is measured from the 50% level on the LOW to HIGH transition of the input current pulse to the 1.3V level on the LOW to HIGH transition of the output voltage pulse.
3. t_{PHL} – Propagation delay is measured from the 50% level on the HIGH to LOW transition of the input current pulse to the 1.3V level on the HIGH to LOW transition of the output voltage pulse.
4. When the peaking capacitor is omitted, propagation delay times may increase by 100ns.
5. t_r – Rise time is measured from the 10% to the 90% levels on the LOW to HIGH transition of the output pulse.
6. t_f – Fall time is measured from the 90% to the 10% levels on the HIGH to LOW transition of the output pulse.
7. CM_H – The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0\text{V}$).
8. CM_L – The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the low state (i.e., $V_{OUT} < 0.8\text{V}$).
9. Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.
10. Duration of output short circuit time should not exceed 10ms.

Test Circuits



R_1	2.15 k Ω	1.10 k Ω	681 Ω
I_F (ON)	1.6 mA	3 mA	5 mA

ALL DIODES ARE 1N916 OR 1N3064.

Fig. 1. Test Circuit and Waveforms for t_{PLH} , t_{PHL} , t_r and t_f Fig. 2. Test Circuit and Waveforms for t_{PHZ} , t_{PZH} , t_{PLZ} , and t_{PZL}

Test Circuits (Continued)

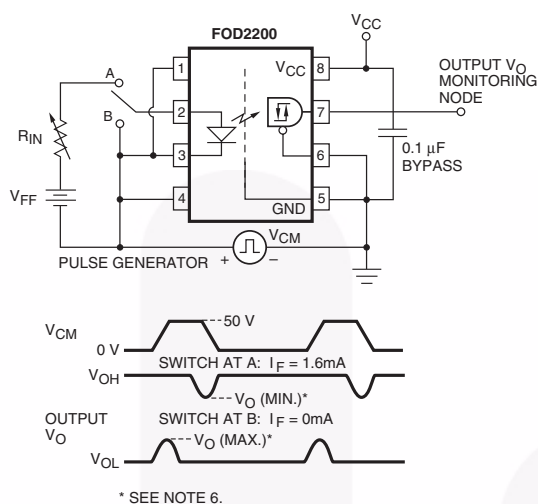


Fig. 3. Test Circuit and Typical Waveforms for Common Mode Transient Immunity

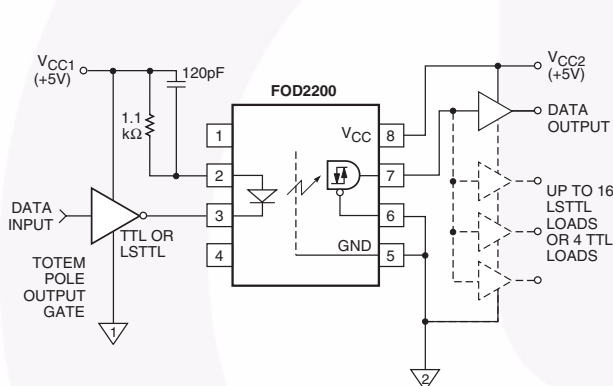


Figure 4. Recommended LSTTL to LSTTL Circuit

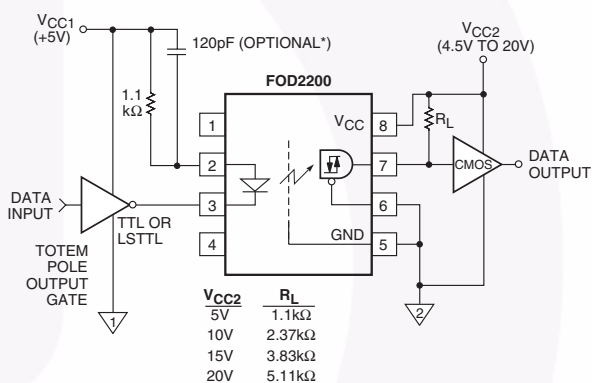


Figure 5. LSTTL to CMOS Interface Circuit

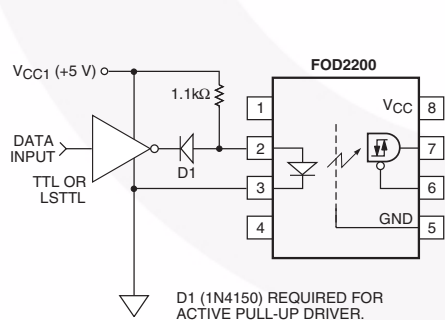
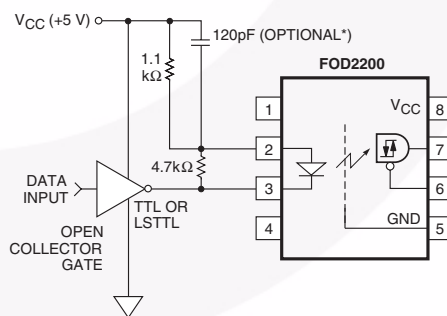


Figure 6. Recommended LED Drive Circuit

Figure 7. Series LED Drive with Open Collector Gate (4.7kΩ Resistor Shunts I_{OH} from the LED)

*The 120pF capacitor may be omitted in applications where 500ns propagation delay is sufficient.

Typical Performance Curves

Figure 8. Input Forward Current vs Forward Voltage

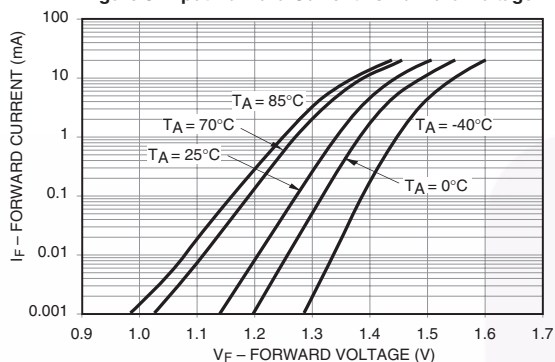


Figure 9. Output Voltage vs. Input Forward Current

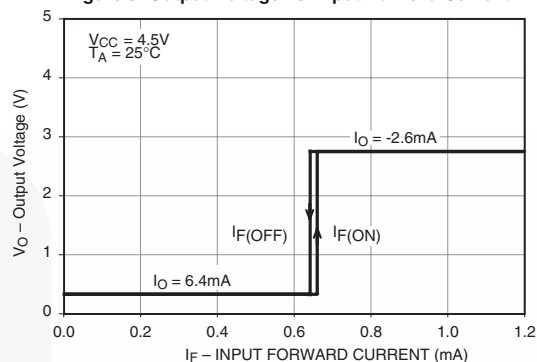


Figure 10. Input Threshold Current vs. Ambient Temperature

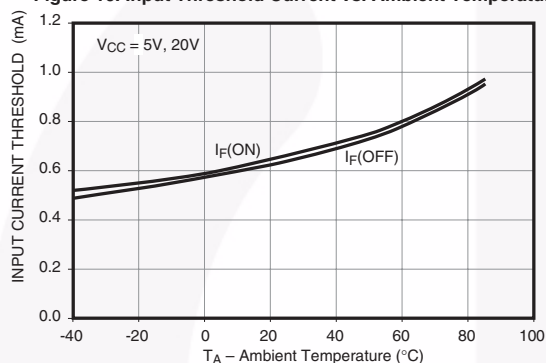


Figure 11. Logic Low Output Voltage vs. Ambient Temperature

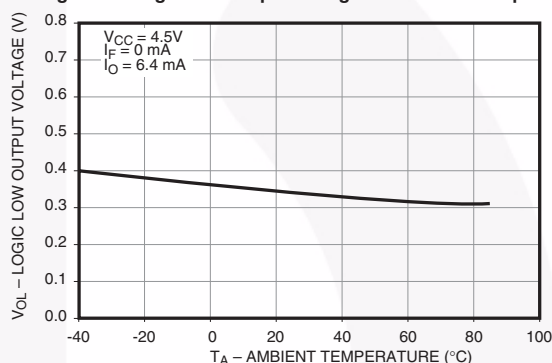


Figure 12. Logic High Output Voltage vs. Supply Voltage

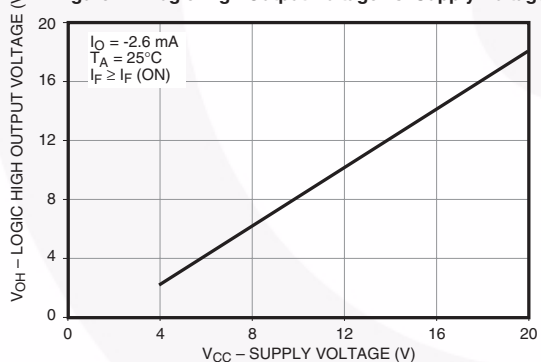


Figure 13. Logic High Output Current vs. Ambient Temperature

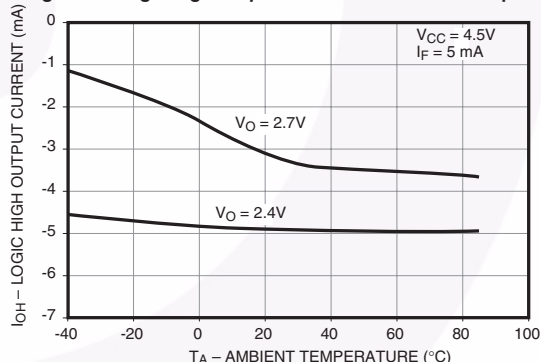


Figure 14. Propagation Delay vs Ambient Temperature

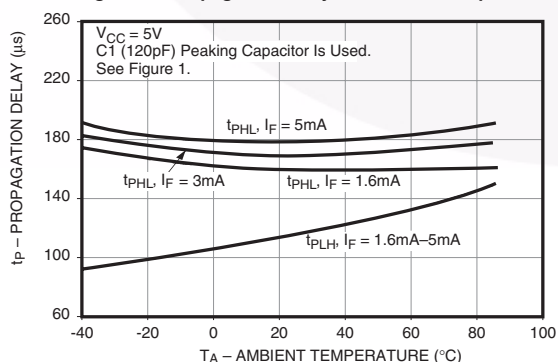
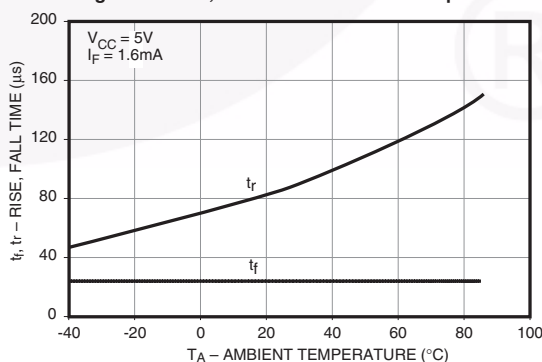
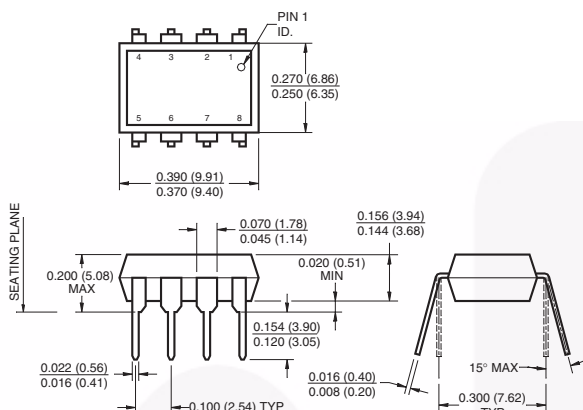


Figure 15. Rise, Fall Time vs Ambient Temperature

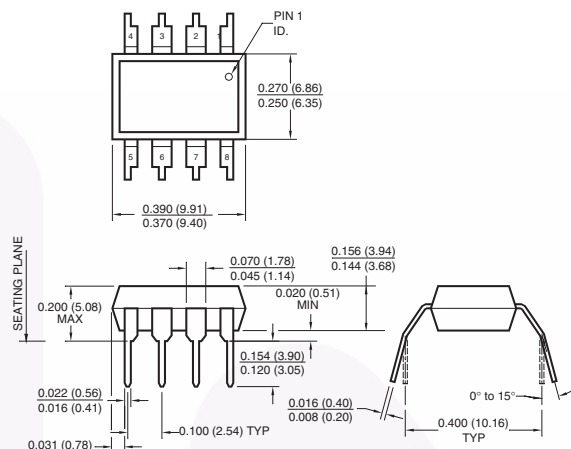


Package Dimensions

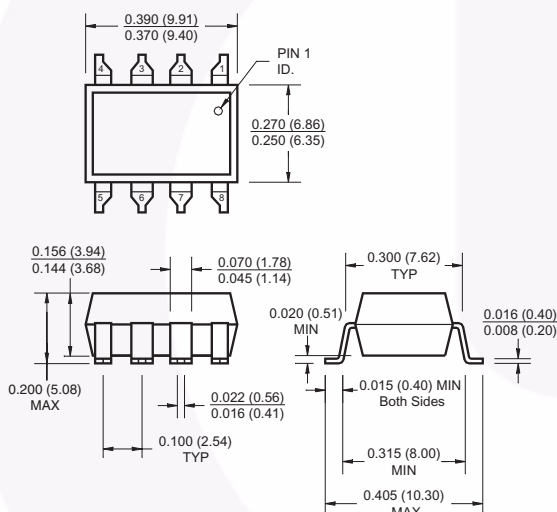
Through Hole



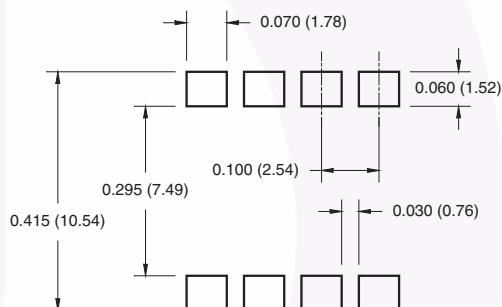
0.4" Lead Spacing (Option T)



Surface Mount – 0.3" Lead Spacing (Option S)



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



Note:

All dimensions are in inches (millimeters)

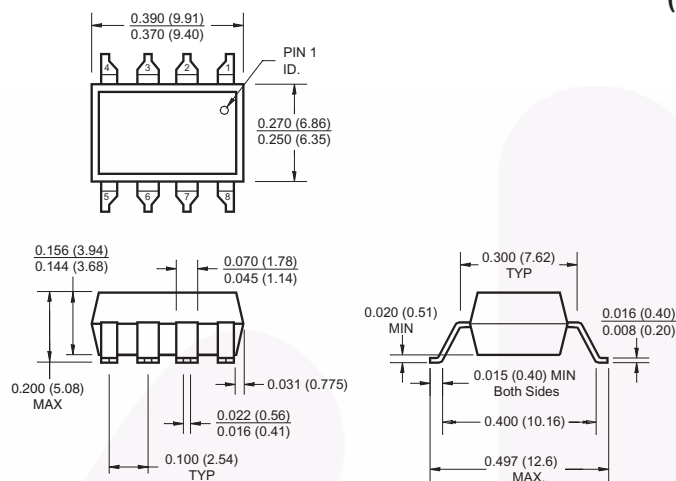
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Package Dimensions (Continued)

Surface Mount – 0.4" Lead Spacing (Option TS)



Note:

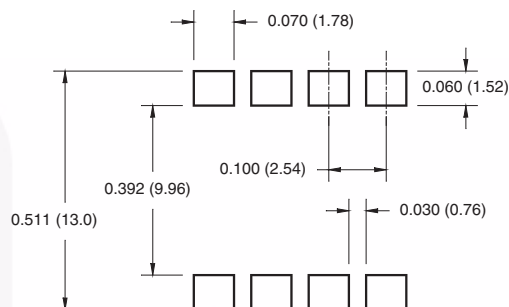
All dimensions are in inches (millimeters)

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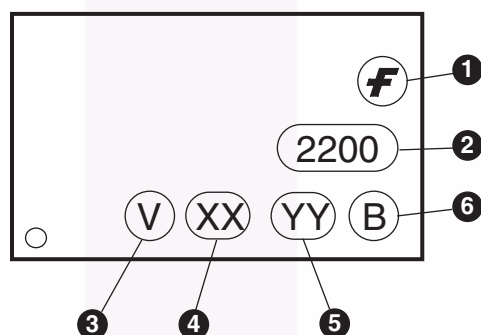
8-Pin Surface Mount DIP – Land Pattern (Option TS)



Ordering Information

Part Number	Package	Packing Method
FOD2200	DIP 8-Pin	Tube (50 units per tube)
FOD2200S	SMT 8-Pin (Lead Bend)	Tube (50 units per tube)
FOD2200SD	SMT 8-Pin (Lead Bend)	Tape and Reel (1,000 units per reel)
FOD2200V	DIP 8-Pin, IEC60747-5-2 option	Tube (50 units per tube)
FOD2200SV	SMT 8-Pin (Lead Bend), IEC60747-5-2 option	Tube (50 units per tube)
FOD2200SDV	SMT 8-Pin (Lead Bend), IEC60747-5-2 option	Tape and Reel (1,000 units per reel)
FOD2200TV	DIP 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tube (50 units per tube)
FOD2200TSV	SMT 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tube (50 units per tube)
FOD2200TSR2V	SMT 8-Pin, 0.4" Lead Spacing, IEC60747-5-2 option	Tape and Reel (700 units per reel)

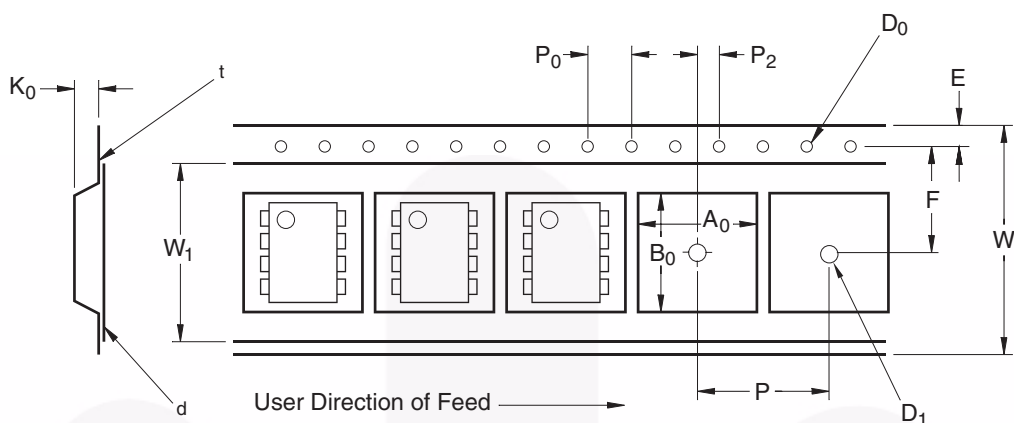
Marking Information



Definitions

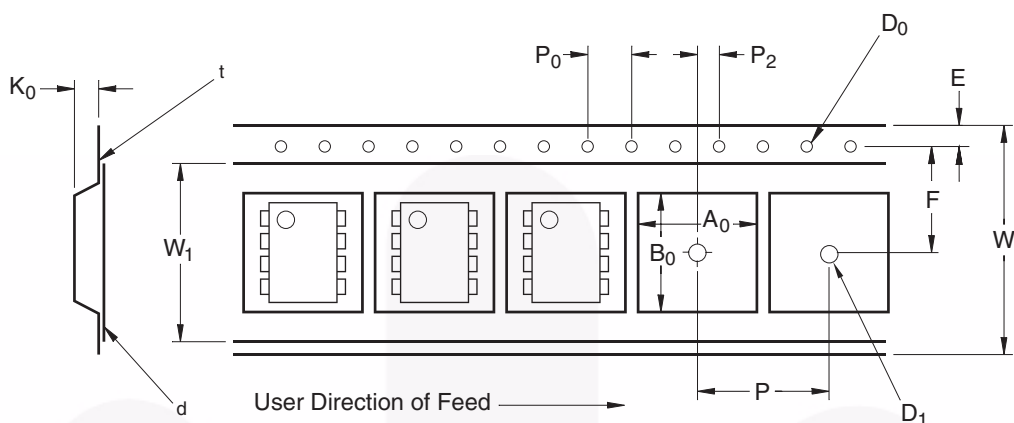
1	Fairchild logo
2	Device number
3	IEC60747-5-2 Option (only appears on component ordered with this option) (Pending approval)
4	Two digit year code, e.g., '08'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

Carrier Tape Specifications (Option SD)



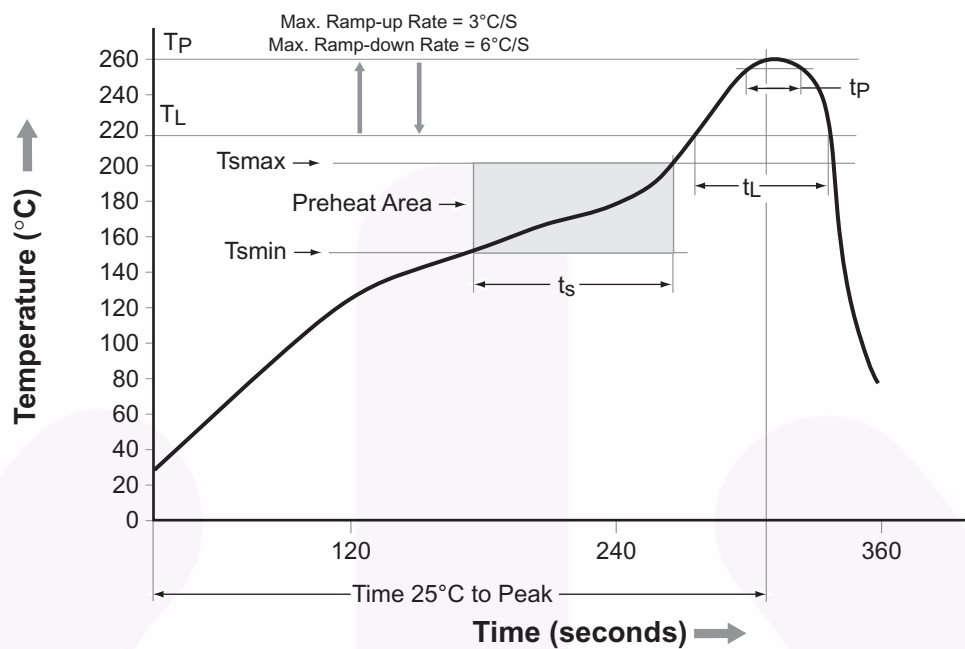
Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P ₀	Sprocket Hole Pitch	4.0 ± 0.1
D ₀	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P ₂		2.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A ₀	Pocket Dimensions	10.30 ± 0.20
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 TSR2V)



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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