FAIRCHILD SEMICONDUCTOR®

December 2009

FOD2200
Low Input Current Logic Gate Optocouplers

Features

- 1kV/µs 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 approvals – UL, CSA, VDE (pending)
- V_{ISO} = 5kVRMS

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

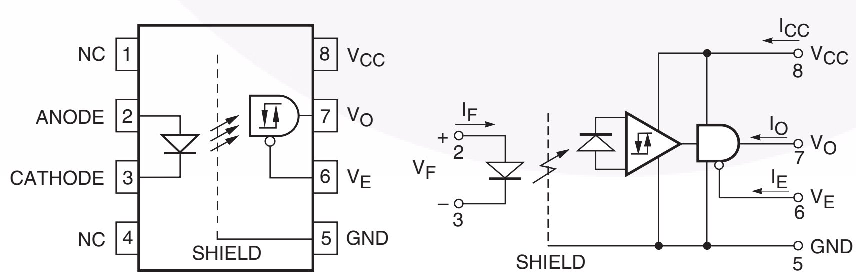
The FOD2200 is an optically coupled logic gate that combine an AlGaAs LED and an integrated high gain photo detector. The detector has a three state output stage and has a detector threshold with hysteresis. The three state output eliminates the need for a pullup resistor and allows for direct drive 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.

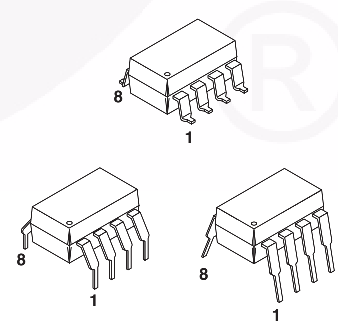
Truth Table (Positive Logic)

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

Functional Block Diagram and Schematic



Package Outlines



Absolute Maximum Ratings (T_A = 25°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	°C
T_{OPR}	Operating Temperature	-40 to +85	°C
T_{SOL}	Lead Solder Temperature (1.6mm below seating plane)	260 for 10 sec	°C
EMITTER			
$I_{F\ (PK)}$	Peak Transient Input Current (≤1μs 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	°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°C to +85°C, V_{CC} = 4.5V to 20V, $I_{F(ON)}$ = 1.6mA to 5mA, V_{EH} = 2V to 20V, V_{EL} = 0V to 0.8V, $I_{F(OFF)}$ = 0 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 = 5mA				1.75	V
			T_A = 25°C		1.40	1.7	
B_{VR}	Input Reverse Breakdown Voltage	I_R = 10µA		5.0			V
C_{IN}	Input Capacitance	Pins 2 & 3, V_F = 0, f = 1MHz			60		pF
∆VF/∆TA	Input Diode Temperature Coefficient	I_F = 5mA			-1.4		mV/°C
DETECTOR							
I_{CCH}	High Level Supply Current	I_F = 5mA, I_O = Open, V_E = Don't Care	V_{CC} = 5.5V		3.5	4.5	mA
			V_{CC} = 20V		4.0	6.0	
I_{CCL}	Low Level Supply Current	I_F = 0, I_O = Open, V_E = Don't care	V_{CC} = 5.5V		4.4	6.0	mA
			V_{CC} = 20V		5.2	7.5	
I_{EL}	Low Level Enable Current	V_E = 0.4V			-0.1	-0.32	mA
I_{EH}	High Level Enable Current	V_E = 2.7V				20	µA
		V_E = 5.5V				100	
		V_E = 20V			0.005	250	
V_{EH}	High Level Enable Voltage			2.0			V
V_{EL}	Low Level Enable Voltage					0.8	V

Switching Characteristics (T_A = 0°C to +85°C, $I_{F(ON)}$ = 1.6mA to 5mA, $I_{F(OFF)}$ = 0 to 0.1mA, V_{CC} = 4.5V 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
$\lvert CM_H \rvert$	Common Mode Transient Immunity (at Output High Level)	T_A =25°C, I_F = 1.6mA, V_{OH} (Min.) = 2.0V, V_{CC} = 5V(7) (Fig. 3)	$\lvert V_{CM} \rvert$ = 50V	1000			V/µs
$\lvert CM_L \rvert$	Common Mode Transient Immunity (at Output Low Level)	T_A =25°C, I_F = 0mA, V_{OL} (Max.) = 0.8 V, V_{CC} = 5V(8) (Fig. 3)	$\lvert V_{CM} \rvert$ = 50V	1000			V/µs

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

Electrical Characteristics (Continued)

Transfer Characteristics (T_A = 0°C to +85°C, V_{CC} = 4.5V to 20V, $I_{F(ON)}$ = 1.6mA to 5mA, V_{EH} = 2V to 20V, V_{EL} = 0V to 0.8V, $I_{F(OFF)}$ = 0mA 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} = 4.5V, I_F = 5mA	V_O = 5.5V		2.0	100	µA
			V_O = 20V		2.5	500	
V_{OL}	Low Level Output Voltage	V_{CC} = 4.5 V, I_F = 0mA, V_E = 0.4 V, I_{OL} = 6.4mA[2]			0.33	0.5	V
I_{FT}	Input Threshold Current	V_{CC} = 4.5V, V_O = 0.5V, V_E = 0.4V, I_{OL} = 6.4mA				1.6	mA
V_{OH}	Logic High Output Voltage	I_{OH} = -2.6mA		2.4	V_{CC} – 1.8		V
I_{OZL}	High Impedance State Output Current	V_O = 0.4V, V_{EN} = 2V, I_F = 5mA				-20	µA
I_{OZH}	High Impedance State Output Current	V_O = 2.4 V, V_{EN} = 2 V, I_F = 5mA				20	µA
		V_O = 5.5 V, V_{EN} = 2 V, I_F = 5mA				100	
		V_O = 20 V, V_{EN} = 2 V, I_F = 5mA				500	
I_{OSL}	Logic Low Short Circuit Output Current[10]	V_O = V_{CC} = 5.5V, I_F = 0mA		25			mA
		V_O = V_{CC} = 20V, I_F = 0mA		40			
I_{OSH}	Logic High Short Circuit Output Current[10]	V_{CC} = 5.5V, I_F = 5mA, V_O = GND		-10			mA
		V_{CC} = 20V, I_F = 5mA, V_O = GND		-25			
I_{HYS}	Input Current Hysteresis	V_{CC} = 4.5V			0.03		mA

Isolation Characteristics (T_A = 0°C to +85°C unless otherwise specified)

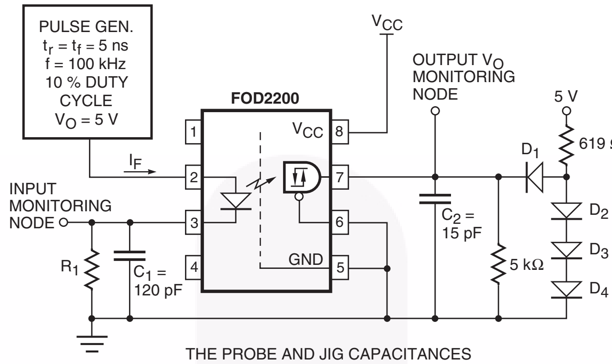
Symbol	Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
V_{ISO}	Withstand Insulation Test Voltage	R_H < 50%, T_A = 25°C, t = 1 min.[9]	5000			V_{RMS}
R_{I-O}	Resistance (Input to Output)	V_{I-O} = 500 VDC[9]		10^{12}		Ω
C_{I-O}	Capacitance (Input to Output)	V_{I-O} = 0V, f = 1MHz[9]		0.6		pF

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

Notes:

1. The V_{CC} supply to each optoisolator must be bypassed by a 0.1µF 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} > 2.0V).
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} < 0.8V).
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



THE PROBE AND JIG CAPACITANCES ARE INCLUDED IN C_1 AND C_2.

R_I	2.15 kΩ	1.10 kΩ	681 Ω
I_F (ON)	1.6 mA	3 mA	5 mA

ALL DIODES ARE 1N916 OR 1N3064.

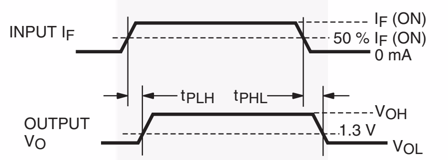
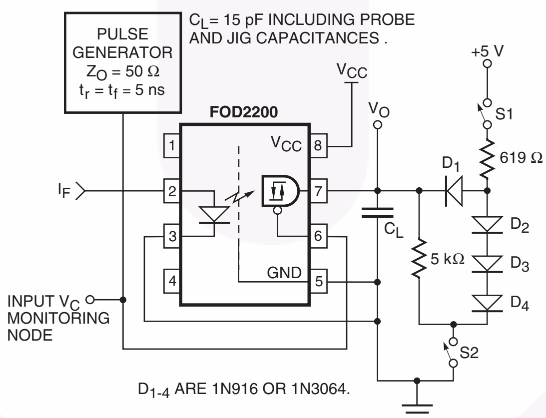


Fig. 1. Test Circuit and Waveforms for t_{PLH}, t_{PHL}, t_r and t_f



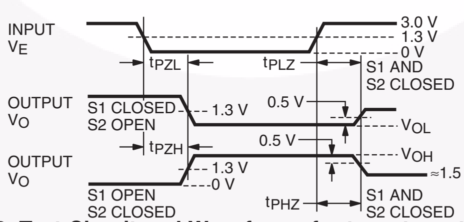


Fig. 2. Test Circuit and Waveforms for t_{PHZ}, t_{PZH}, t_{PLZ}, and t_{PZL}

Test Circuits (Continued)

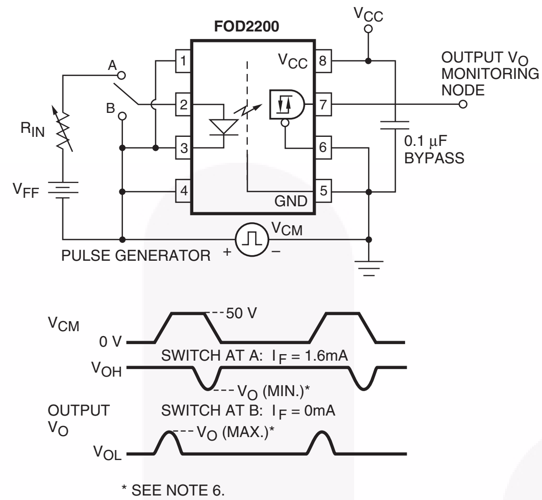


Fig. 3. Test Circuit and Typical Waveforms for Common Mode Transient Immunity

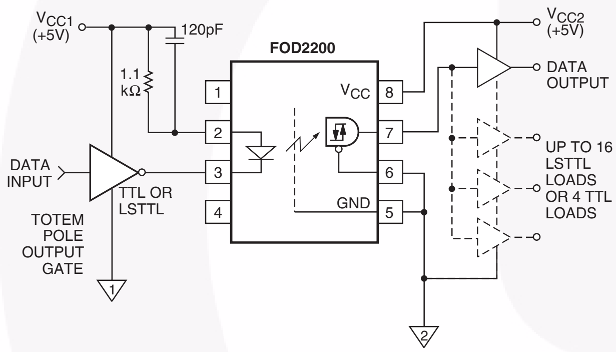


Figure 4. Recommended LSTTL to LSTTL Circuit

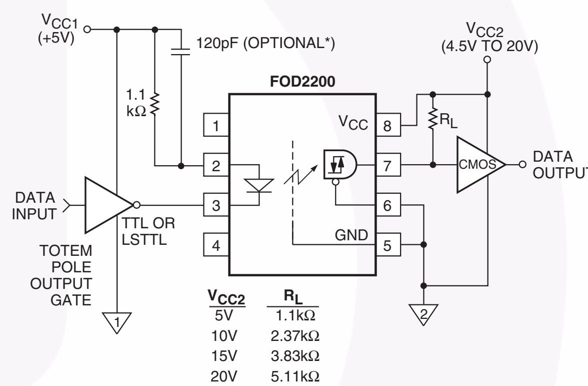


Figure 5. LSTTL to CMOS Interface Circuit

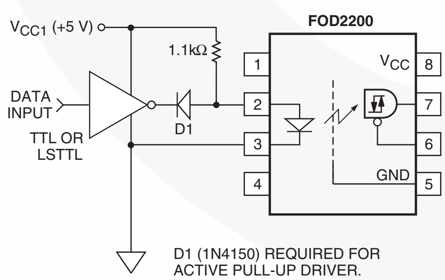


Figure 6. Recommended LED Drive Circuit

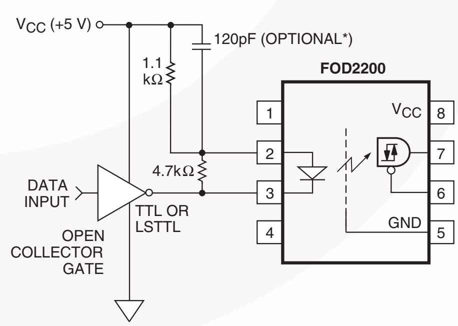


Figure 7. Series LED Drive with Open Collector Gate (4.7kΩ Resistor Shunts I_{OH} from the LED)

*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

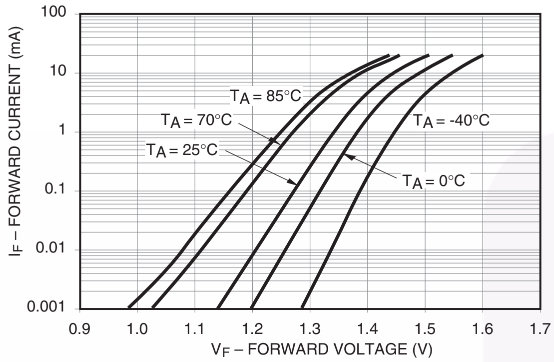


Figure 9. Output Voltage vs. Input Forward Current

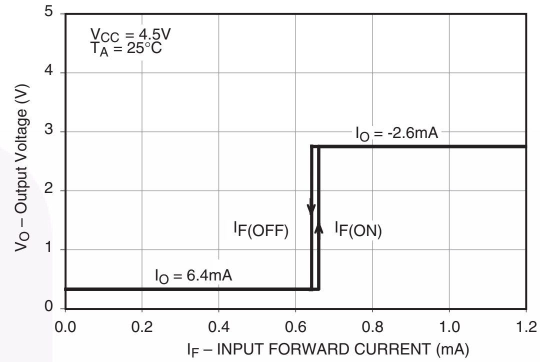


Figure 10. Input Threshold Current vs. Ambient Temperature

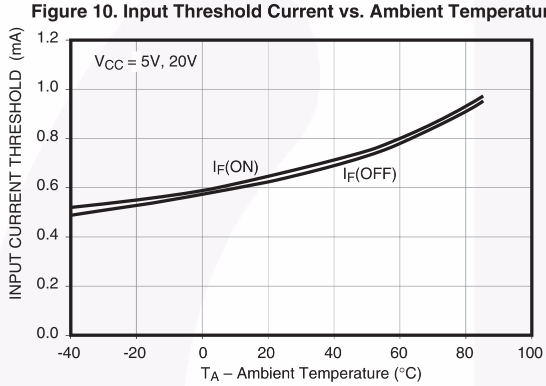


Figure 11. Logic Low Output Voltage vs. Ambient Temperature

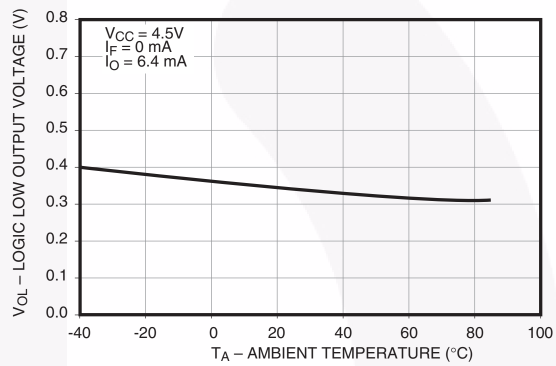


Figure 12. Logic High Output Voltage vs. Supply Voltage

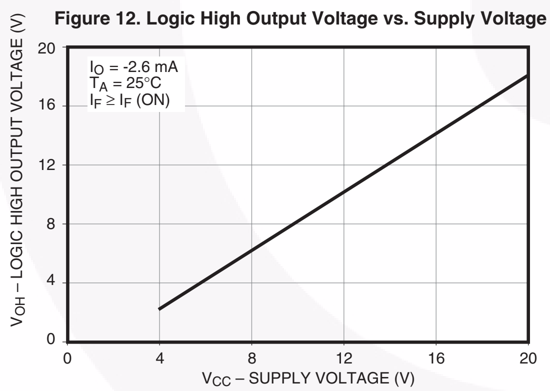


Figure 13. Logic High Output Current vs. Ambient Temperature

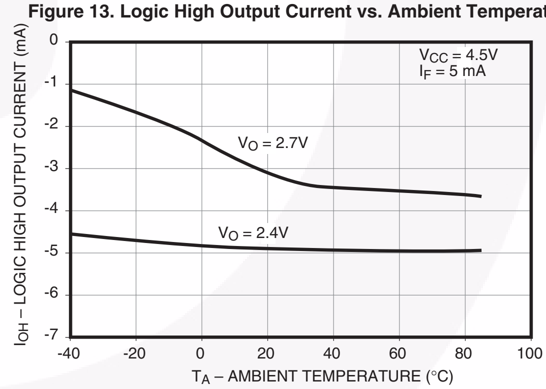


Figure 14. Propagation Delay vs Ambient Temperature

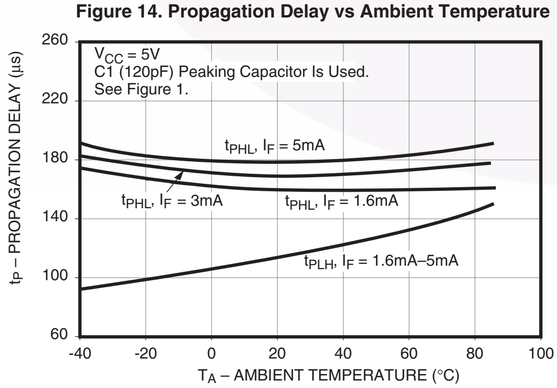
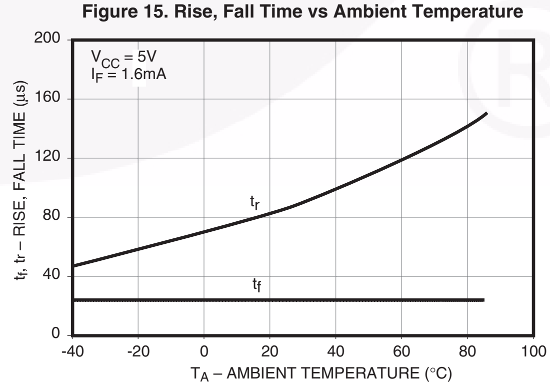
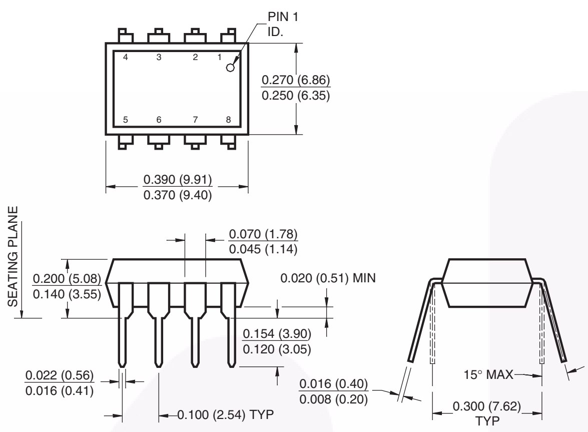


Figure 15. Rise, Fall Time vs Ambient Temperature

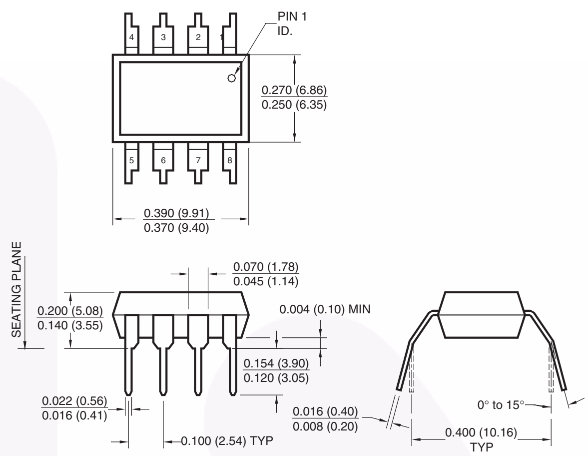


Package Dimensions

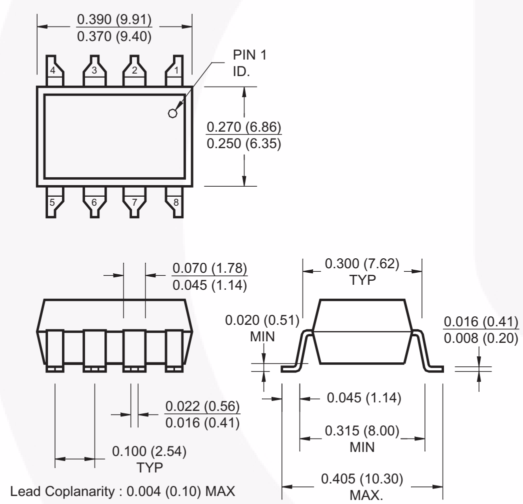
Through Hole



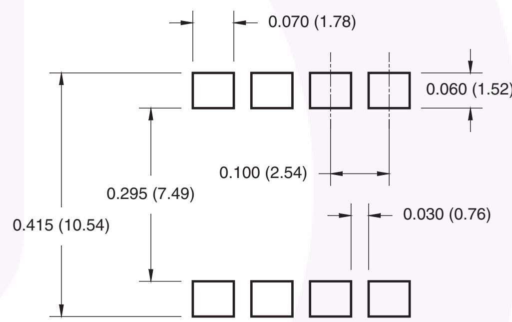
0.4" Lead Spacing



Surface Mount



8-Pin DIP – Land Pattern

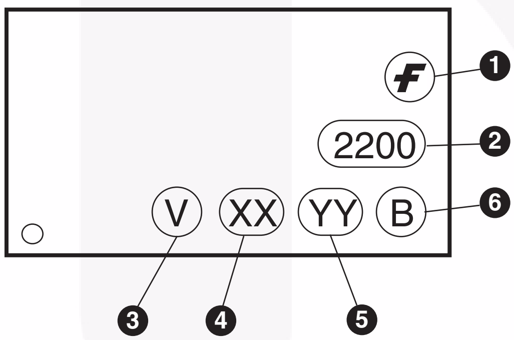


Note:
All dimensions are in inches (millimeters)

Ordering Information

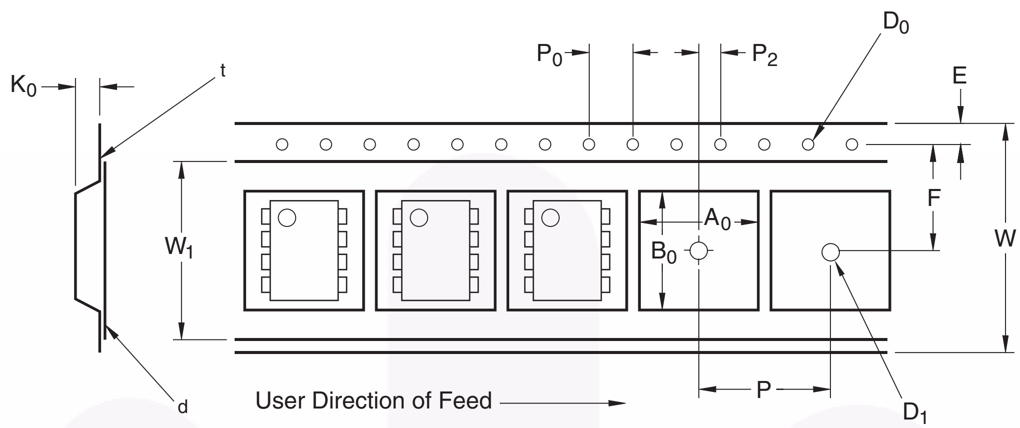
Option	Example Part Number	Description
No Option	FOD2200	Standard Through Hole
S	FOD2200S	Surface Mount Lead Bend
SD	FOD2200SD	Surface Mount; Tape and Reel
T	FOD2200T	0.4" Lead Spacing
V	FOD2200V	VDE0884
TV	FOD2200TV	VDE0884; 0.4" Lead Spacing
SV	FOD2200SV	VDE0884; Surface Mount
SDV	FOD2200SDV	VDE0884; Surface Mount; Tape and Reel

Marking Information



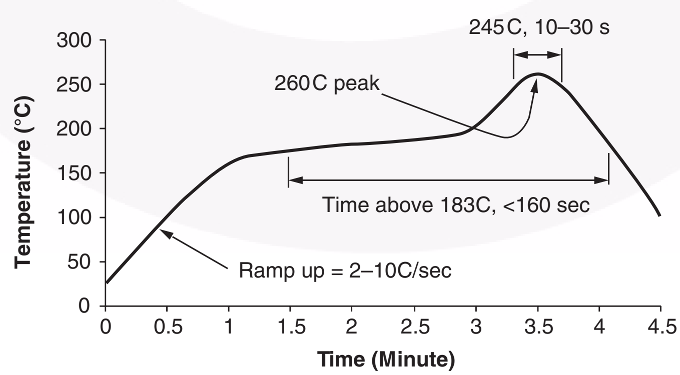
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

Carrier Tape Specifications



Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P_0	Sprocket Hole Pitch	4.0 ± 0.1
D_0	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P_2		4.0 ± 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	1.6 ± 0.1
d	Cover Tape Thickness	0.1 max
	Max. Component Rotation or Tilt	10°
R	Min. Bending Radius	30

Reflow Profile



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

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Green FPS™ e-Series™
G*max*™
GTO™
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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
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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