

# Single-Channel: 6N135, 6N136, HCPL-2503, HCPL-4502 Dual-Channel: HCPL-2530, HCPL-2531 High Speed Transistor Optocouplers

## Features

- High speed—1MBit/s
- Superior CMR—10kV/μs
- Dual-Channel HCPL-2530/HCPL-2531
- Double working voltage—480V RMS
- CTR guaranteed 0–70°C
- U.L. recognized (File # E90700)

## Applications

- Line receivers
- Pulse transformer replacement
- Output interface to CMOS-LSTTL-TTL
- Wide bandwidth analog coupling

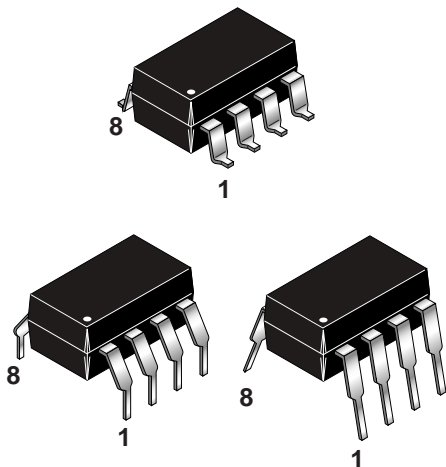
## Description

The HCPL-4502/HCPL-2503, 6N135/6 and HCPL-2530/HCPL-2531 optocouplers consist of an AlGaAs LED optically coupled to a high speed photodetector transistor.

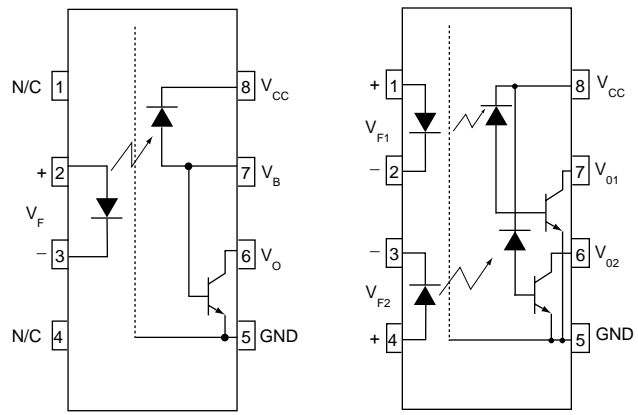
A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

An internal noise shield provides superior common mode rejection of 10kV/μs. An improved package allows superior insulation permitting a 480V working voltage compared to industry standard of 220V.

## Package



## Schematic



6N135, 6N136, HCPL-2503, HCPL-4502

HCPL-2530/HCPL-2531

Pin 7 is not connected in  
Part Number HCPL-4502

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

Symbol	Parameter	Condition	Value	Units
$T_{STG}$	Storage Temperature		-55 to +125	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature		-55 to +100	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature		260 for 10 sec	$^\circ\text{C}$
<b>EMITTER</b>				
$I_F$ (avg)	DC/Average Forward Input Current Each Channel <sup>(1)</sup>		25	mA
$I_F$ (pk)	Peak Forward Input Current Each Channel <sup>(2)</sup>	50% duty cycle, 1ms P.W.	50	mA
$I_F$ (trans)	Peak Transient Input Current Each Channel	$\leq 1 \mu\text{s}$ P.W., 300pps	1.0	A
$V_R$	Reverse Input Voltage Each Channel		5	V
$P_D$	Input Power Dissipation Each Channel	6N135/6N136 and HCPL-2503/4502	100	mW
		HCPL-2530/2531 <sup>(3)</sup>	45	
<b>DETECTOR</b>				
$I_O$ (avg)	Average Output Current Each Channel		8	mA
$I_O$ (pk)	Peak Output Current Each Channel		16	mA
$V_{EBR}$	Emitter-Base Reverse Voltage	6N135, 6N136 and HCPL-2503 only	5	V
$V_{CC}$	Supply Voltage		-0.5 to 30	V
$V_O$	Output Voltage		-0.5 to 20	V
$I_B$	Base Current	6N135, 6N136 and HCPL-2503 only	5	mA
PD	Output Power Dissipation Each Channel	6N135, 6N136, HCPL-2503, HCPL-4502 <sup>(4)</sup>	100	mW
		HCPL-2530, HCPL-2531	35	mW

**Notes:**

1. Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $0.8\text{mA}/^\circ\text{C}$ .
2. Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $1.6\text{mA}/^\circ\text{C}$ .
3. Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $0.9\text{mW}/^\circ\text{C}$ .
4. Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $2.0\text{mW}/^\circ\text{C}$ .

**Electrical Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  Unless otherwise specified)**Individual Component Characteristics**

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit
<b>EMITTER</b>							
$V_F$	Input Forward Voltage	$I_F = 16\text{mA}$ , $T_A = 25^\circ\text{C}$			1.45	1.7	V
		$I_F = 16\text{mA}$				1.8	
$B_{VR}$	Input Reverse Breakdown Voltage	$I_R = 10\ \mu\text{A}$		5.0			V
$\Delta V_F/\Delta T_A$	Temperature Coefficient of Forward Voltage	$I_F = 16\text{mA}$			-1.6		mV/ $^\circ\text{C}$
<b>DETECTOR</b>							
$I_{OH}$	Logic High Output Current	$I_F = 0\text{mA}$ , $V_O = V_{CC} = 5.5\text{V}$ , $T_A = 25^\circ\text{C}$	All		0.001	0.5	$\mu\text{A}$
		$I_F = 0\text{mA}$ , $V_O = V_{CC} = 15\text{V}$ , $T_A = 25^\circ\text{C}$	6N135 6N136 HCPL-4502 HCPL-2503		0.005	1	
		$I_F = 0\text{mA}$ , $V_O = V_{CC} = 15\text{V}$	All			50	
$I_{CCL}$	Logic Low Supply Current	$I_F = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	6N135 6N136 HCPL-4502 HCPL-2503		120	200	$\mu\text{A}$
		$I_{F1} = I_{F2} = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	HCPL-2530 HCPL-2531		200	400	
$I_{CCH}$	Logic High Supply Current	$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$ , $T_A = 25^\circ\text{C}$	6N135 6N136 HCPL-4502 HCPL-2503			1	$\mu\text{A}$
		$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	6N135 6N136 HCPL-4502 HCPL-2503			2	
		$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	HCPL-2530 HCPL-2531		0.02	4	

\*All Typical at  $T_A = 25^\circ\text{C}$

**Transfer Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  Unless otherwise specified)

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit	
<b>COUPLED</b>								
CTR	Current Transfer Ratio <sup>(5)</sup>	$I_F = 16\text{mA}$ , $V_O = 0.4\text{V}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N135 HCPL-2530	7	18	50	%	
			6N136 HCPL-4502 HCPL-2531	19	27	50	%	
			HCPL-2503	12	27		%	
		$I_F = 16\text{mA}$ , $V_{CC} = 4.5\text{V}$	$V_{OL} = 0.4\text{V}$	6N135	5	21		%
			$V_{OL} = 0.5\text{V}$	HCPL-2530				
			$V_{OL} = 0.4\text{V}$	6N136 HCPL-4502	15	30		%
			$V_{OL} = 0.5\text{V}$	HCPL-2531				
	$V_{OL} = 0.4\text{V}$	HCPL-2503	9	30		%		
$V_{OL}$	Logic LOW Output Voltage	$I_F = 16\text{mA}$ , $I_O = 1.1\text{mA}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N135		0.18	0.4	V	
			HCPL-2530		0.18	0.5		
		$I_F = 16\text{mA}$ , $I_O = 3\text{mA}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N136 HCPL-2503		0.25	0.4		
			HCPL-2531		0.25	0.5		
		$I_F = 16\text{mA}$ , $I_O = 0.8\text{mA}$ , $V_{CC} = 4.5\text{V}$	6N135 HCPL-2530			0.5		
		$I_F = 16\text{mA}$ , $I_O = 2.4\text{mA}$ , $V_{CC} = 4.5\text{V}$	HCPL-4502 HCPL-2531			0.5		

\*All Typical at  $T_A = 25^\circ\text{C}$

**Note:**

5. Current Transfer Ratio is defined as a ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$ , times 100%.

**Switching Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified.,  $V_{CC} = 5\text{V}$ )

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit
$T_{PHL}$	Propagation Delay Time to Logic LOW	$T_A = 25^\circ\text{C}$ , $R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ (Fig. 7)	6N135 HCPL-2530		0.45	1.5	$\mu\text{s}$
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}$ , $T_A = 25^\circ\text{C}^{(7)}$ (Fig. 7)	6N136 HCPL-4502 HCPL-2503 HCPL-2531		0.45	0.8	$\mu\text{s}$
		$R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ (Fig. 7)	6N135 HCPL-2530			2.0	$\mu\text{s}$
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7)	6N136 HCPL-4502 HCPL-2503 HCPL-2531			1.0	$\mu\text{s}$
$T_{PLH}$	Propagation Delay Time to Logic HIGH	$T_A = 25^\circ\text{C}$ , ( $R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ ) (Fig. 7)	6N135 HCPL-2530		0.5	1.5	$\mu\text{s}$
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7) $T_A = 25^\circ\text{C}$	6N136 HCPL-4502 HCPL-2503 HCPL-2531		0.3	0.8	$\mu\text{s}$
		$R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ (Fig. 7)	6N135 HCPL-2530			2.0	$\mu\text{s}$
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7)	6N136 HCPL-4502 HCPL-2503 HCPL-2531			1.0	$\mu\text{s}$
$CM_H$	Common Mode Transient Immunity at Logic High	$I_F = 0\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N135 HCPL-2530		10,000		$\text{V}/\mu\text{s}$
		$I_F = 0\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 1.9\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N136 HCPL-4502 HCPL-2503 HCPL-2531		10,000		$\text{V}/\mu\text{s}$
$CM_L$	Common Mode Transient Immunity at Logic Low	$I_F = 16\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N135 HCPL-2530		10,000		$\text{V}/\mu\text{s}$
		$I_F = 16\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 1.9\text{k}\Omega^{(8)}$ (Fig. 8)	6N136 HCPL-4502 HCPL-2503 HCPL-2531		10,000		$\text{V}/\mu\text{s}$

\*\* All Typicals at  $T_A = 25^\circ\text{C}$ **Notes:**

- The  $4.1\text{k}\Omega$  load represents 1 LSTTL unit load of  $0.36\text{mA}$  and  $6.1\text{k}\Omega$  pull-up resistor.
- The  $1.9\text{k}\Omega$  load represents 1 TTL unit load of  $1.6\text{mA}$  and  $5.6\text{k}\Omega$  pull-up resistor.
- Common mode transient immunity in logic high level is the maximum tolerable (positive)  $dV_{cm}/dt$  on the leading edge of the common mode pulse signal  $V_{CM}$ , to assure that the output will remain in a logic high state (i.e.,  $V_O > 2.0\text{V}$ ). Common mode transient immunity in logic low level is the maximum tolerable (negative)  $dV_{cm}/dt$  on the trailing edge of the common mode pulse signal,  $V_{CM}$ , to assure that the output will remain in a logic low state (i.e.,  $V_O < 0.8\text{V}$ ).

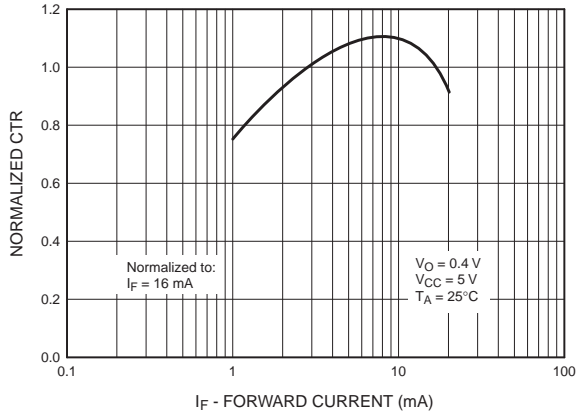
**Isolation Characteristics** ( $T_A = 0$  to  $70^\circ\text{C}$  Unless otherwise specified)

Symbol	Characteristics	Test Conditions	Min	Typ**	Max	Unit
$I_{I-O}$	Input-Output Insulation Leakage Current	Relative humidity = 45%, $T_A = 25^\circ\text{C}$ , $t = 5\text{s}$ , $V_{I-O} = 3000\text{VDC}^{(9)}$			1.0	$\mu\text{A}$
$V_{ISO}$	Withstand Insulation Test Voltage	$RH \leq 50\%$ , $T_A = 25^\circ\text{C}$ , $I_{I-O} \leq 2\ \mu\text{A}$ , $t = 1\text{ min.}^{(9)}$	2500			$V_{RMS}$
$R_{I-O}$	Resistance (Input to Output)	$V_{I-O} = 500\text{VDC}^{(9)}$		$10^{12}$		$\Omega$
$C_{I-O}$	Capacitance (Input to Output)	$f = 1\text{ MHz}^{(9)}$		0.6		$\text{pF}$
HFE	DC Current Gain	$I_O = 3\text{mA}$ , $V_O = 5\text{V}^{(9)}$		150		
$I_{I-I}$	Input-Input Insulation Leakage Current	$RH \leq 45\%$ , $V_{I-I} = 500\text{VDC}^{(10)}$ $t = 5\text{ s}$ , (HCPL-2530/2531 only)		0.005		$\mu\text{A}$
$R_{I-I}$	Input-Input Resistance	$V_{I-I} = 500\text{ VDC}^{(10)}$ (HCPL-2530/2531 only)		$10^{11}$		$\Omega$
$C_{I-I}$	Input-Input Capacitance	$f = 1\text{MHz}^{(10)}$ (HCPL-2530/2531 only)		0.03		$\text{pF}$

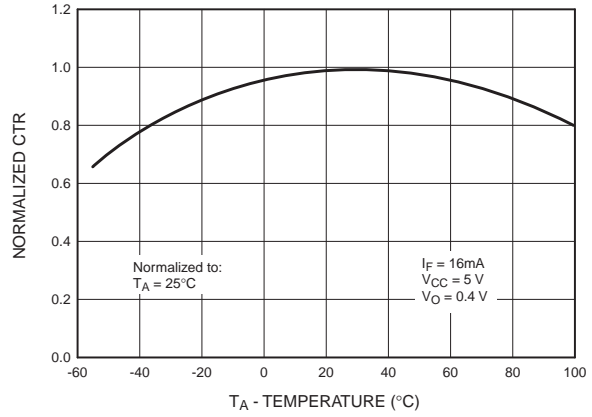
**Notes:**

9. Device is considered a two terminal device: Pins 1, 2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
10. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.

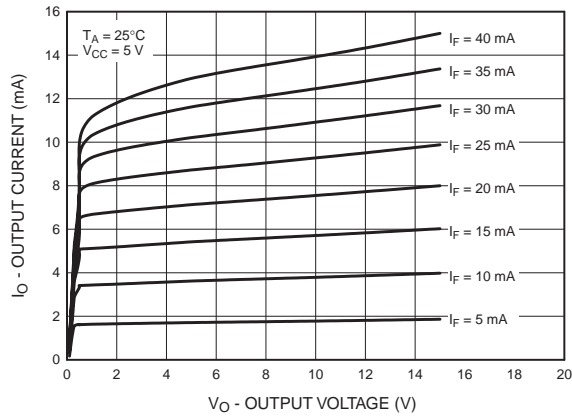
**Fig. 1 Normalized CTR vs. Forward Current**



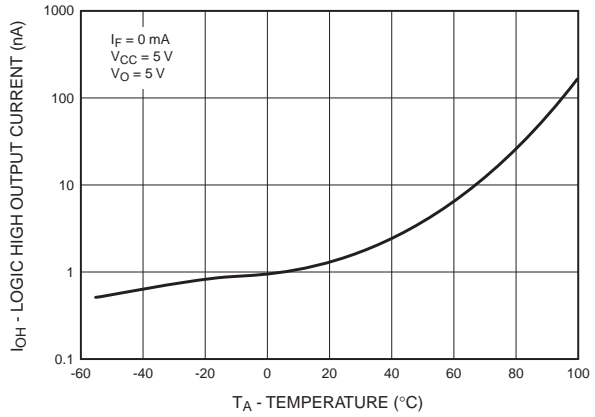
**Fig. 2 Normalized CTR vs. Temperature**



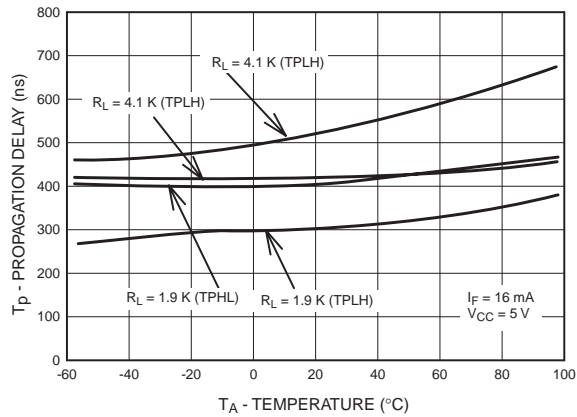
**Fig. 3 Output Current vs. Output Voltage**



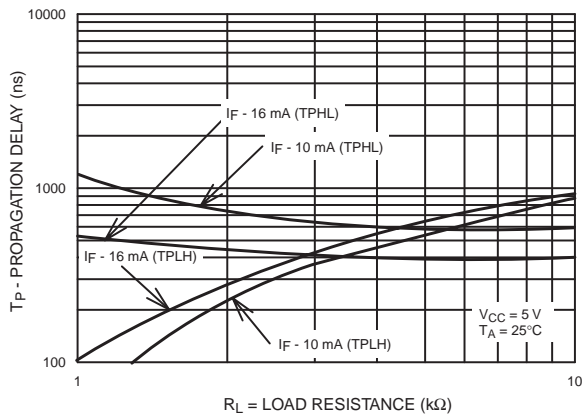
**Fig. 4 Logic High Output Current vs. Temperature**



**Fig. 5 Propagation Delay vs. Temperature**



**Fig. 6 Propagation Delay vs. Load Resistance**



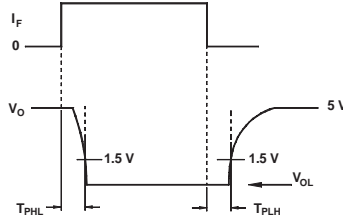
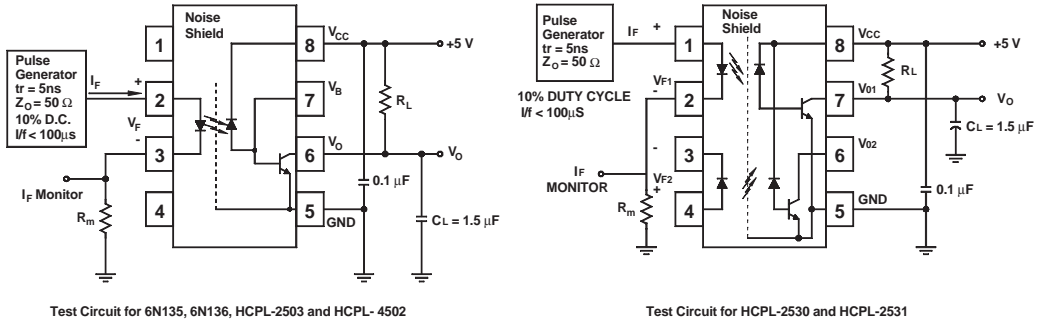


Fig. 7 Switching Time Test Circuit

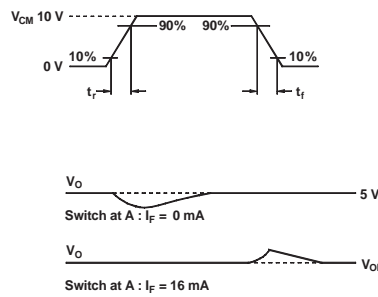
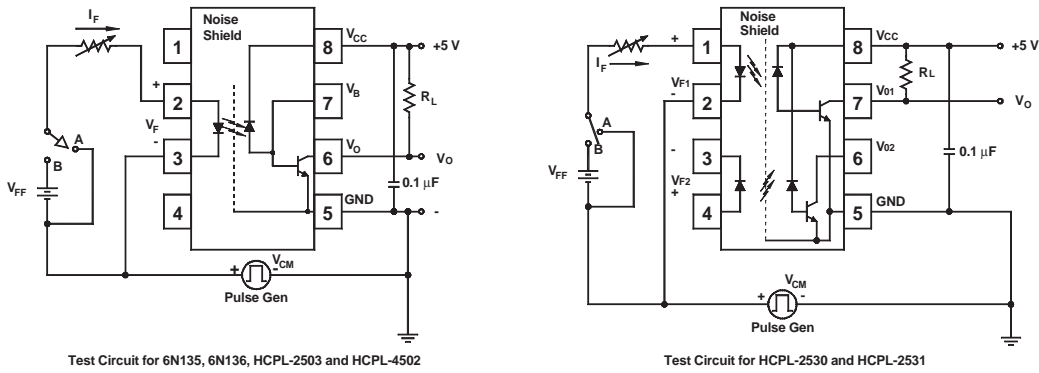
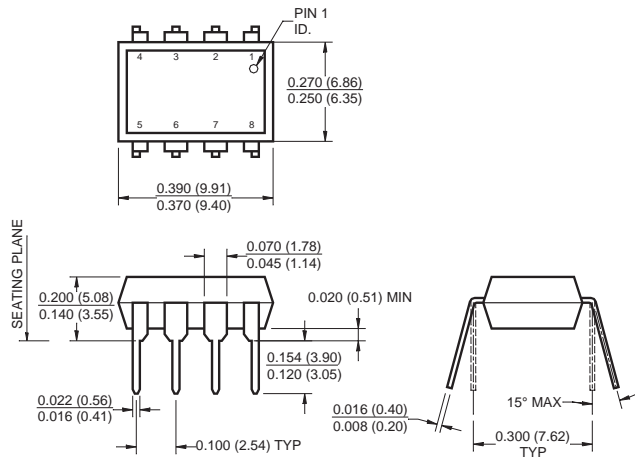


Fig. 8 Common Mode Immunity Test Circuit

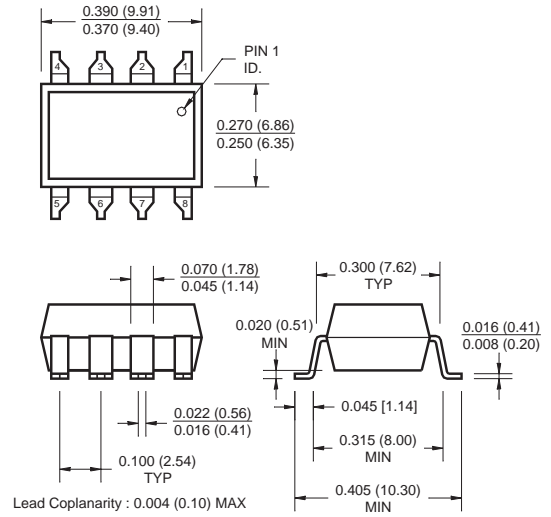


## Package Dimensions All dimensions are in inches (millimeters)

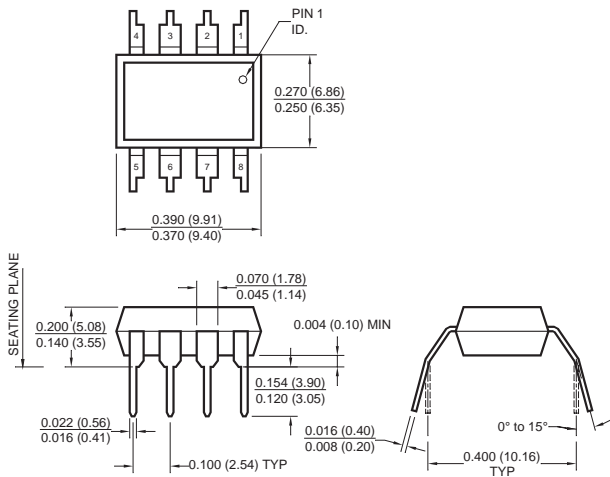
### Through Hole



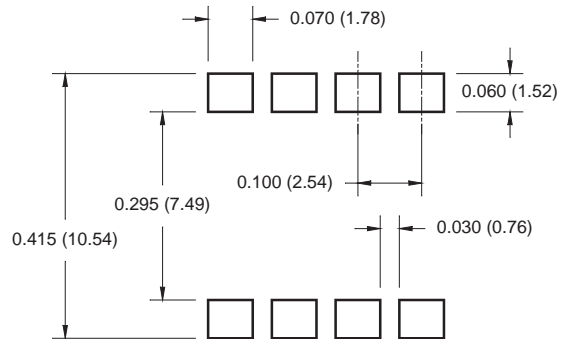
### Surface Mount



### 0.4" Lead Spacing



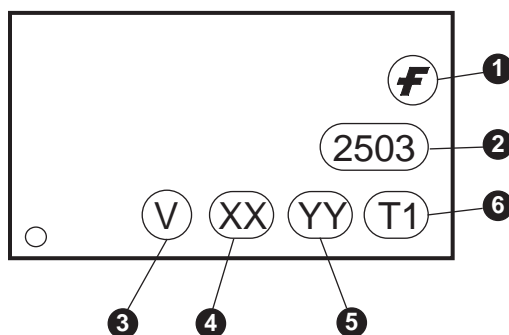
### Recommend Pad Layout for Surface Mount Leadform



## Ordering Information

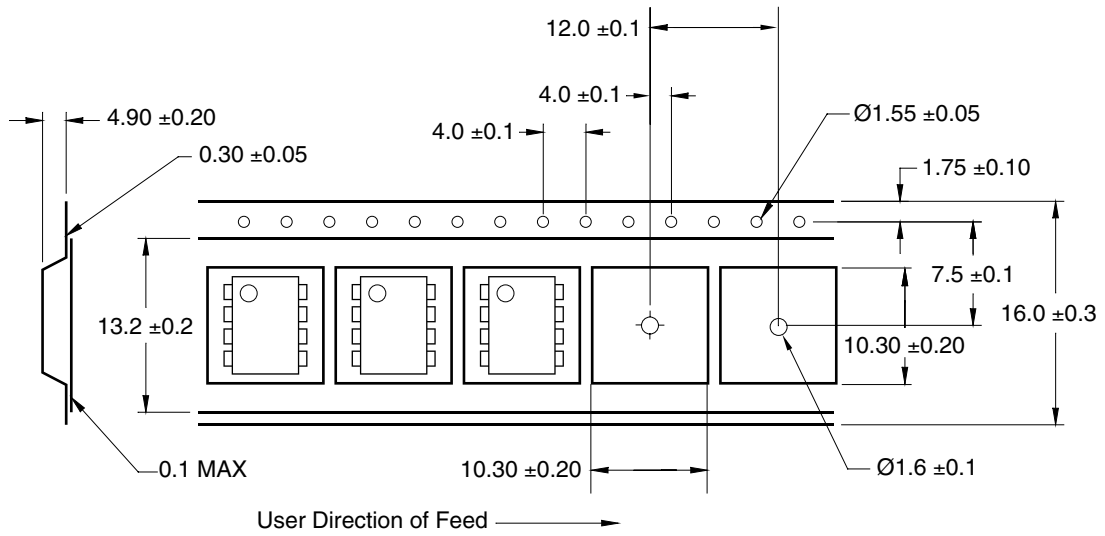
Option	Example Part Number	Description
S	6N135S	Surface Mount Lead Bend
SD	6N135SD	Surface Mount; Tape and reel
W	6N135W	0.4" Lead Spacing
V	6N135V	VDE0884
WV	6N135WV	VDE0884; 0.4" lead spacing
SV	6N135SV	VDE0884; surface mount
SDV	6N135SDV	VDE0884; surface mount; tape and reel

## Marking Information

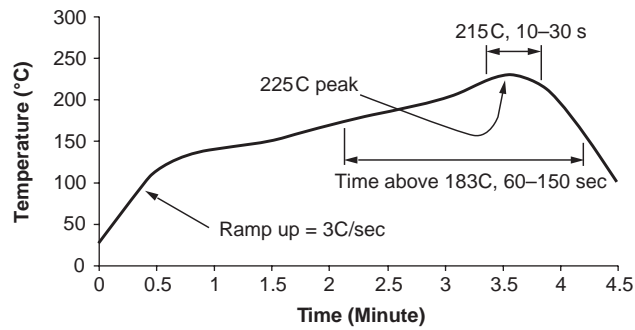


Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

### Carrier Tape Specifications



### Reflow Profile



- Peak reflow temperature: 225C (package surface temperature)
- Time of temperature higher than 183C for 60–150 seconds
- One time soldering reflow is recommended

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Build it Now™	HiSeC™	OPTOPLANAR™	Stealth™	Wire™
CoolFET™	I <sup>2</sup> C™	PACMAN™	SuperFET™	
CROSSVOLT™	i-Lo™	POP™	SuperSOT™-3	
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FASTr™	MicroPak™	QT Optoelectronics™	TinyPWM™	
FPS™	MICROWIRE™	Quiet Series™	TinyPower™	
FRFET™	MSX™	RapidConfigure™	TinyLogic®	
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Programmable Active Droop™				

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- A critical component is 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.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and 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.
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