

# Single-Channel: 6N135M, 6N136M, HCPL4503M Dual-Channel: HCPL2530M, HCPL2531M (Preliminary) High Speed Transistor Optocouplers

## Features

- High speed –1 MBit/s
- Superior CMR – 10kV/μs
- Dual-Channel HCPL2530M, HCPL2531M (Preliminary)
- CTR guaranteed 0–70°C
- U.L. recognized (File # E90700, Vol. 2)
- VDE recognition (pending)
  - Ordering option 'V', e.g., 6N135VM
- 5,000Vrms (1 minute) isolation rating
- Superior CMR of 15,000V/μs min. (HCPL4503M)
- No base connection for improved noise immunity (HCPL4503M)

## Applications

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

## Description

The HCPL4503M, 6N135M, 6N136M, HCPL2530M and HCPL2531M 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.

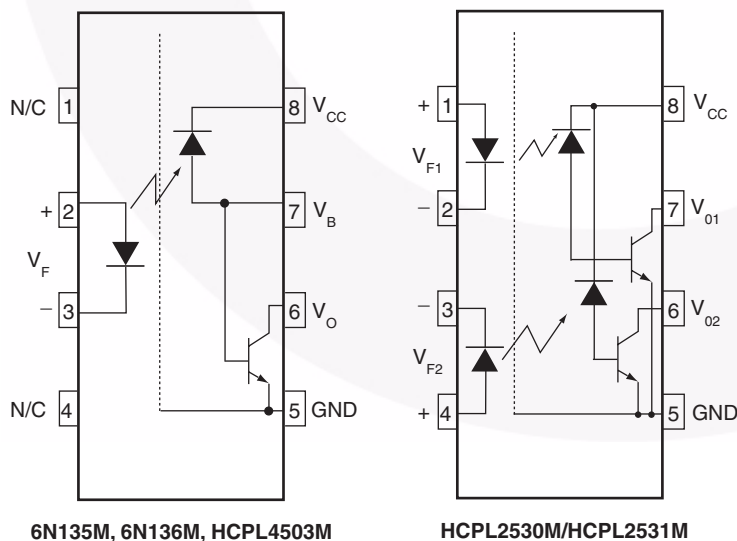
The HCPL4503M has no internal connection to the phototransistor base for improved noise immunity.

An internal noise shield provides superior common mode rejection of up to 50,000V/μs.

## Related Resources

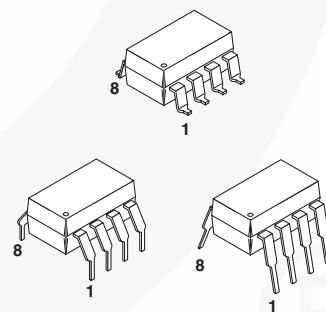
- [www.fairchildsemi.com/products/opto/](http://www.fairchildsemi.com/products/opto/)
- [www.fairchildsemi.com/pf/HC/HCPL0500.html](http://www.fairchildsemi.com/pf/HC/HCPL0500.html)
- [www.fairchildsemi.com/pf/FO/FODM452.html](http://www.fairchildsemi.com/pf/FO/FODM452.html)
- [www.fairchildsemi.com/pf/FO/FOD050L.html](http://www.fairchildsemi.com/pf/FO/FOD050L.html)

## Schematics



Pin 7 is not connected in the HCPL4503M

## Package Outlines



### 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	Condition	Value	Units
$T_{STG}$	Storage Temperature		-40 to +125	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature		-40 to +100	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature (Wave)		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 <sup>(3)</sup>	6N135M, 6N136M, HCPL4503M	45	mW
		HCPL2530M, HCPL2531M		
<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	6N135M and 6N136M 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	6N135M and 6N136M only	5	mA
PD	Output Power Dissipation Each Channel <sup>(4)</sup>	6N135M, 6N136M, HCPL4503M	100	mW
		HCPL2530M, HCPL2531M	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. Typical value is measured at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5.0\text{V}$ .)

### Individual Component Characteristics

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
<b>EMITTER</b>							
$V_F$	Input Forward Voltage	$I_F = 16\text{mA}$ , $T_A = 25^\circ\text{C}$	All		1.45	1.7	V
		$I_F = 16\text{mA}$	All			1.8	
$B_{VR}$	Input Reverse Breakdown Voltage	$I_R = 10\ \mu\text{A}$	All	5.0	21		V
$\Delta V_F/\Delta T_A$	Temperature Coefficient of Forward Voltage	$I_F = 16\text{mA}$	All		-1.7		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		0.0007	0.5	$\mu\text{A}$
		$I_F = 0\text{mA}$ , $V_O = V_{CC} = 15\text{V}$ , $T_A = 25^\circ\text{C}$	6N135M 6N136M HCPL4503M		0.0019	1	
		$I_F = 0\text{mA}$ , $V_O = V_{CC} = 15\text{V}$	All			50	
$I_{CCL}$	Logic Low Supply Current	$I_F = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	6N135M 6N136M HCPL4503M		163	200	$\mu\text{A}$
		$I_{F1} = I_{F2} = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	HCPL2530M HCPL2531M			400	
$I_{CCH}$	Logic High Supply Current	$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$ , $T_A = 25^\circ\text{C}$	6N135M 6N136M HCPL4503M		0.0002	1	$\mu\text{A}$
		$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	6N135M 6N136M HCPL4503M		0.0004	2	
		$I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$	HCPL2530M HCPL2531M			4	

## Electrical Characteristics (Continued)

( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified. Typical value is measured at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5.0\text{V}$ .)

### Transfer Characteristics

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit	
<b>COUPLED</b>								
CTR	Current Transfer Ratio <sup>(5)</sup>	$I_F = 16\text{mA}$ , $V_O = 0.4\text{V}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N135M	7	38	50	%	
			HCPL2530M					
			6N136M HCPL4503M	19	38	50	%	
			HCPL2531M					
		$I_F = 16\text{mA}$ , $V_{CC} = 4.5\text{V}$	$V_{OL} = 0.4\text{V}$	6N135M	5			%
			$V_{OL} = 0.5\text{V}$	HCPL2530M				
			$V_{OL} = 0.4\text{V}$	6N136M HCPL4503M	15			%
			$V_{OL} = 0.5\text{V}$	HCPL2531M				
$V_{OL}$	Logic LOW Output Voltage	$I_F = 16\text{mA}$ , $I_O = 1.1\text{mA}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N135M		0.12	0.4	V	
			HCPL2530M			0.5		
		$I_F = 16\text{mA}$ , $I_O = 3\text{mA}$ , $V_{CC} = 4.5\text{V}$ , $T_A = 25^\circ\text{C}$	6N136M HCPL4503M		0.20	0.4		
			HCPL2531M			0.5		
		$I_F = 16\text{mA}$ , $I_O = 0.8\text{mA}$ , $V_{CC} = 4.5\text{V}$	6N135M		0.11	0.5		
			HCPL2530M					
		$I_F = 16\text{mA}$ , $I_O = 2.4\text{mA}$ , $V_{CC} = 4.5\text{V}$	HCPL4503M		0.18	0.5		
			HCPL2531M					

**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%.

## Electrical Characteristics (Continued)

( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified. Typical values are measured at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5\text{V}$ .)

### Switching Characteristics ( $V_{CC} = 5\text{V}$ )

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)	6N135M		0.23	1.5	$\mu\text{s}$
			HCPL2530M				
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}$ , $T_A = 25^\circ\text{C}^{(7)}$ (Fig. 7)	6N136M		0.25	0.8	$\mu\text{s}$
			HCPL4503M HCPL2531M				
$t_{PLH}$	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)	6N135M		0.45	1.5	$\mu\text{s}$
			HCPL2530M				
		$R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7) $T_A = 25^\circ\text{C}$	6N136M		0.26	0.8	$\mu\text{s}$
			HCPL4503M HCPL2531M				
$ICM_H$	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)	6N135M		10,000		$V/\mu\text{s}$
			HCPL2530M				
		$I_F = 0\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 1.9\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N136M		10,000		$V/\mu\text{s}$
			HCPL2531M				
$ICM_L$	Common Mode Transient Immunity at Logic Low	$I_F = 0\text{mA}$ , $V_{CM} = 1,500V_{P-P}$ , $R_L = 1.9\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N135M	15,000	50,000		$V/\mu\text{s}$
			HCPL4503M				
		$I_F = 16\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	6N135M		10,000		$V/\mu\text{s}$
			HCPL2530M				
$ICM_L$	Common Mode Transient Immunity at Logic Low	$I_F = 16\text{mA}$ , $V_{CM} = 10V_{P-P}$ , $R_L = 1.9\text{k}\Omega^{(8)}$ (Fig. 8)	6N136M		10,000		$V/\mu\text{s}$
			HCPL2531M				
		$I_F = 0\text{mA}$ , $V_{CM} = 1,500V_{P-P}$ , $R_L = 1.9\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)	HCPL4503M	15,000	50,000		$V/\mu\text{s}$

#### 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.,  $V_O < 0.8\text{V}$ ).

## Electrical Characteristics (Continued)

( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified. Typical values are measured at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5\text{V}$ .)

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

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Unit
$V_{ISO}$	Withstand Insulation Test Voltage	$RH \leq 50\%$ , $T_A = 25^\circ\text{C}$ , $I_{I-O} \leq 10\mu\text{A}$ , $t = 1 \text{ min.}$ , $f = 50\text{Hz}^{(9)(11)}$	5,000			$V_{RMS}$
$R_{I-O}$	Resistance (Input to Output)	$V_{I-O} = 500\text{VDC}^{(9)}$		$10^{11}$		$\Omega$
$C_{I-O}$	Capacitance (Input to Output)	$f = 1\text{MHz}$ , $V_{I-O} = 0\text{V}^{(9)}$		1		pF
$I_{I-I}$	Input-Input Insulation Leakage Current	$RH \leq 45\%$ , $V_{I-I} = 500\text{VDC}^{(10)}$ $t = 5 \text{ s}$ , (HCPL2530M/2531M only)				$\mu\text{A}$
$R_{I-I}$	Input-Input Resistance	$V_{I-I} = 500 \text{ VDC}^{(10)}$ (HCPL2530M/2531M only)				$\Omega$
$C_{I-I}$	Input-Input Capacitance	$f = 1\text{MHz}^{(10)}$ (HCPL2530M/2531M only)				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.
11. 5,000Vrms for 1 minute duration is equivalent to 6,000Vrms for 1 second duration.

## Typical Performance Curves

Fig. 1 Normalized CTR vs. Forward Current

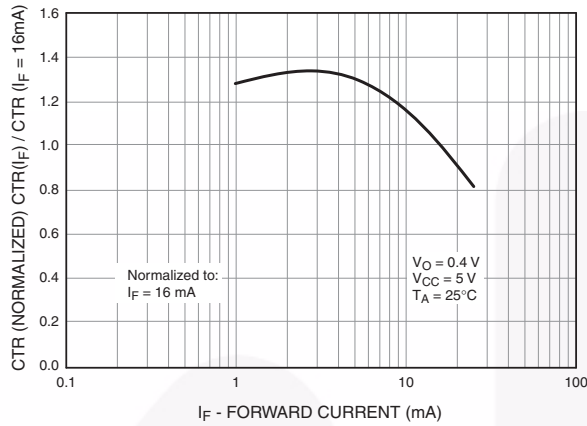


Fig. 2 Normalized CTR vs. Temperature

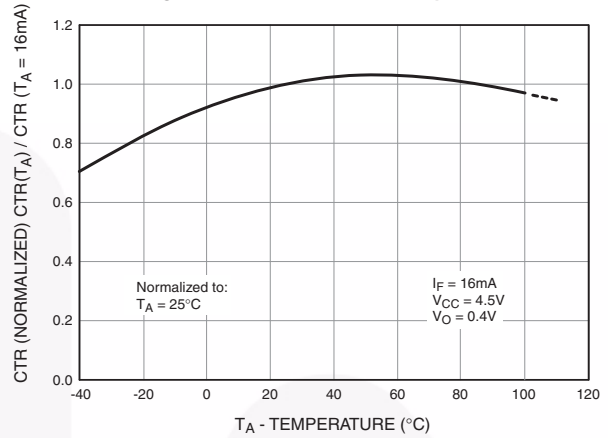


Fig. 3 Output Current vs. Output Voltage

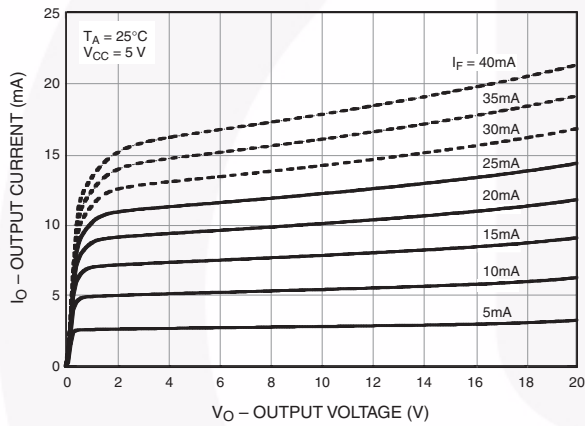


Fig. 4 Logic High Output Current vs. Temperature

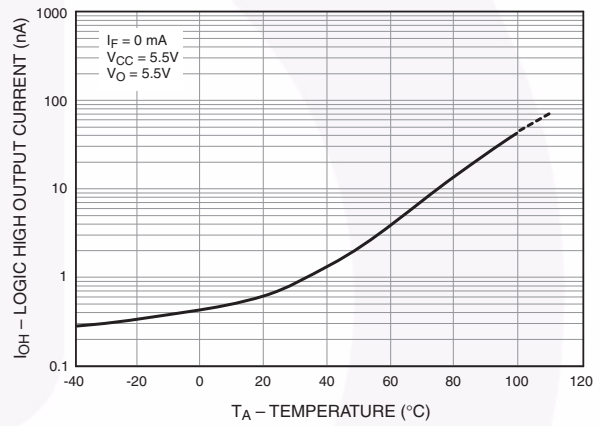


Fig. 5 Propagation Delay vs. Temperature

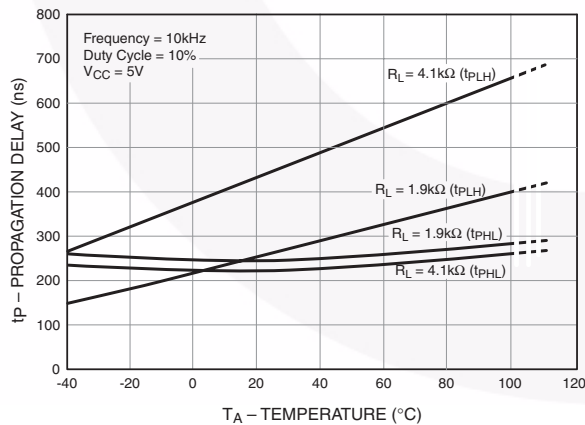
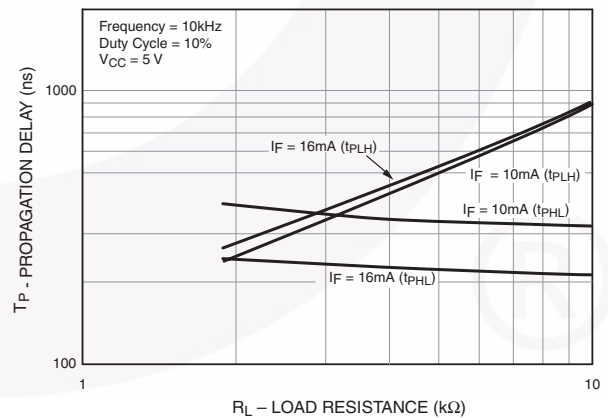
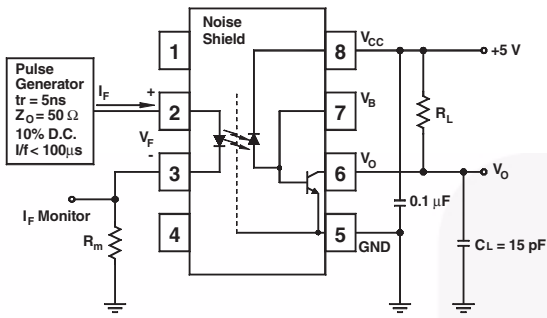


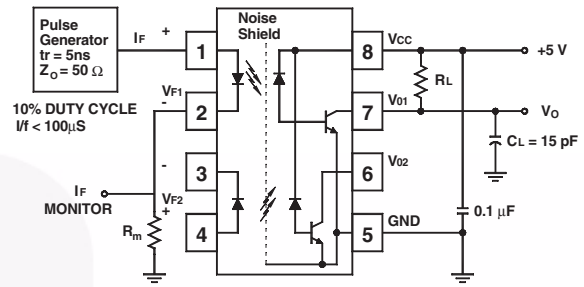
Fig. 6 Propagation Delay vs. Load Resistance



### Test Circuits



Test Circuit for 6N135M, 6N136M, and HCPL4503M



Test Circuit for HCPL2530M and HCPL2531M

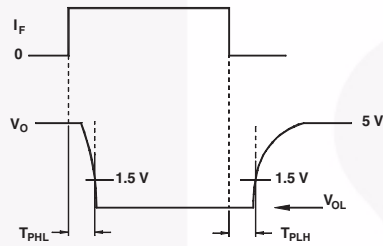
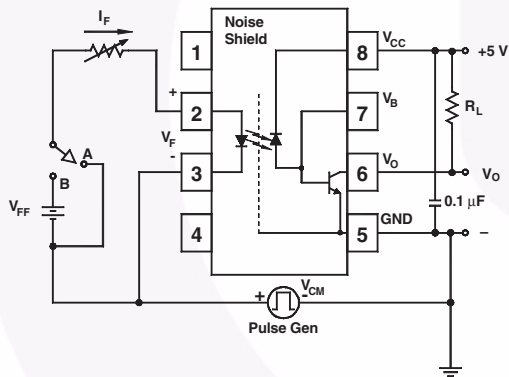
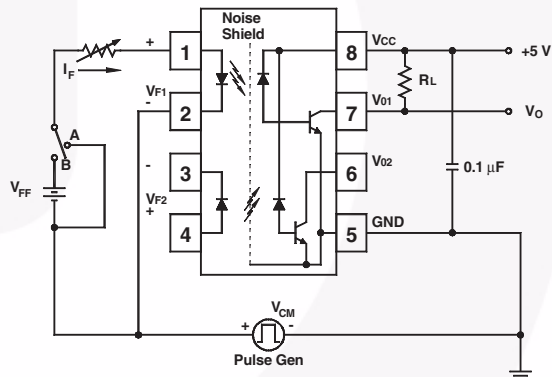


Fig. 7 Switching Time Test Circuit



Test Circuit for 6N135M, 6N136M, and HCPL4503M



Test Circuit for HCPL2530M and HCPL2531M

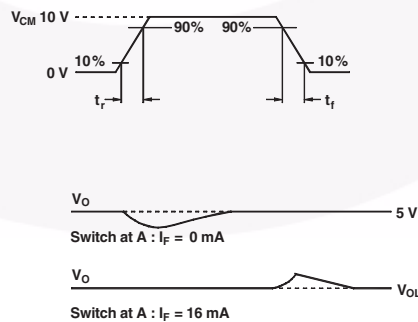
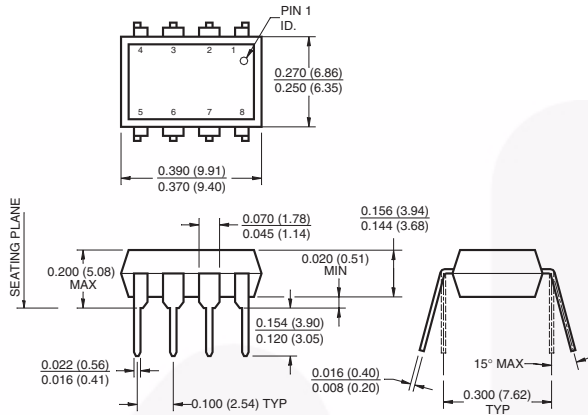


Fig. 8 Common Mode Immunity Test Circuit

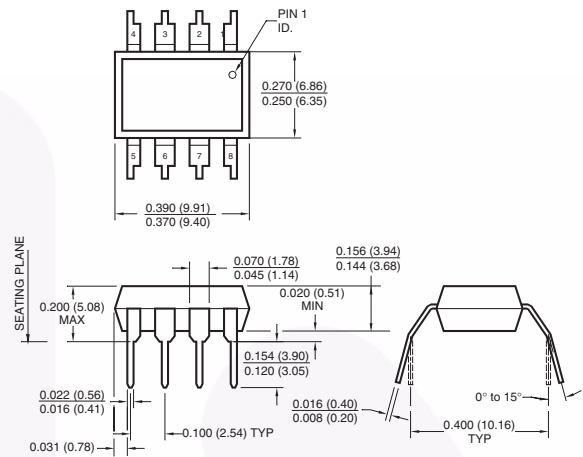


## Package Dimensions

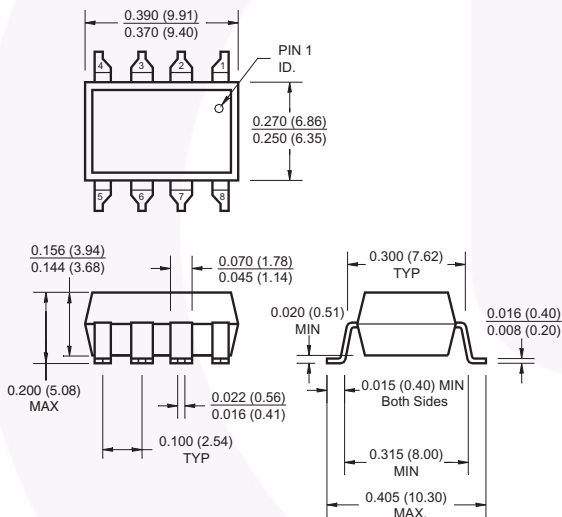
### Through Hole



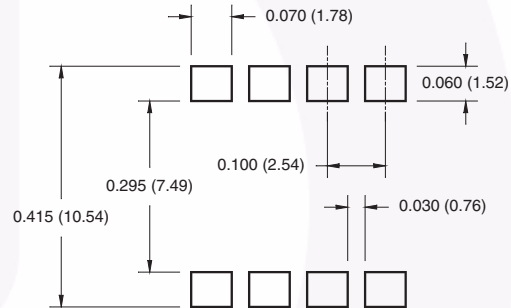
### 0.4" Lead Spacing (Option T)



### Surface Mount – 0.3" Lead Spacing (Option S)



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



**Note:**

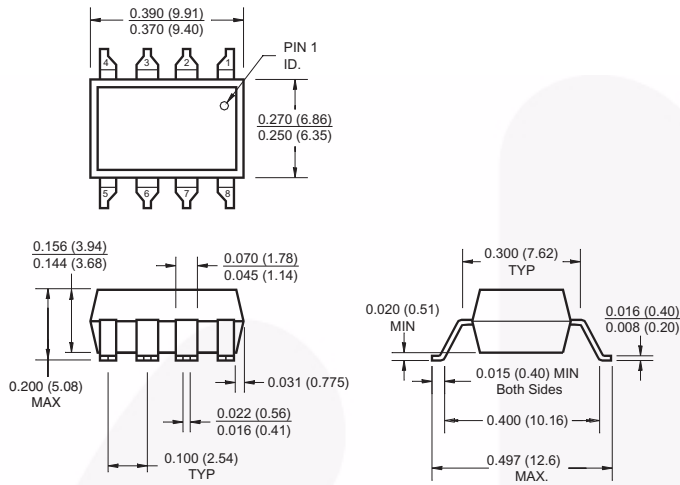
All dimensions are in inches (millimeters)

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## Package Dimensions (Continued)

### Surface Mount – 0.4" Lead Spacing (Option TS) (Pending)



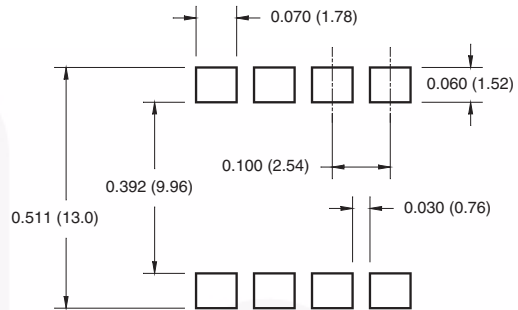
**Note:**

All dimensions are in inches (millimeters)

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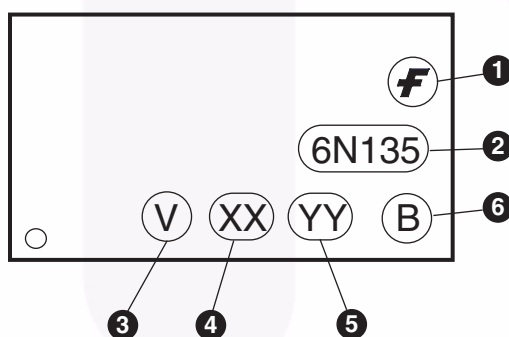
### 8-Pin Surface Mount DIP – Land Pattern (Option TS)



## Ordering Information

Option	Example Part Number	Description
No option	6N135M	Standard through hole lead form (50 units per tube)
S	6N135SM	Surface mount lead bend
SD	6N135SDM	Surface mount; tape and reel
V	6N135VM	IEC60747-5-2 (approval pending)
TSV	6N135TSVM	IEC60747-5-2 (approval pending); surface mount
TSDV	6N135TSDVM	IEC60747-5-2 (approval pending); surface mount; tape and reel
TV	6N135TVM	IEC60747-5-2 (approval pending); 0.4" lead spacing
SV	6N135SVM	IEC60747-5-2 (approval pending); surface mount
SDV	6N135SDVM	IEC60747-5-2 (approval pending); surface mount; tape and reel

## Marking Information

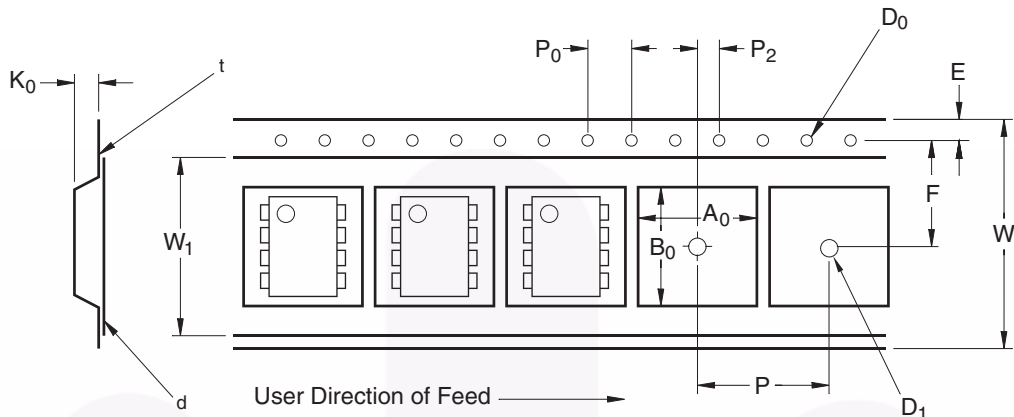


Definitions	
1	Fairchild logo
2 <sup>(1)</sup>	Device number
3	IEC60747-5-2 mark (Note: Only appears on parts ordered with this option – See order entry table)
4	Two digit year code, e.g., '08'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

### Note:

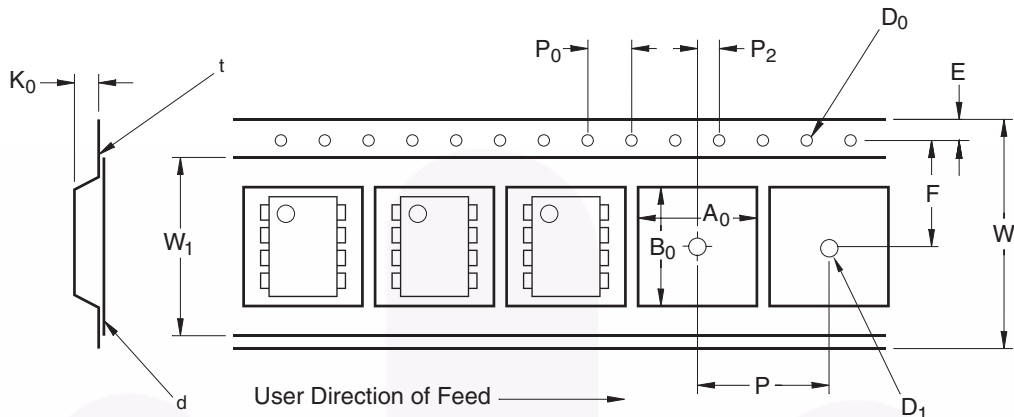
- 'HCPL' devices are marked with only the numeric characters (for example, HCPL4503M is marked as '4503').
- The 'M' suffix is an ordering identifier only. It is used to indicate the white package version. The 'M' does not appear in the top mark.

### Carrier Tape Specifications (Option SD)



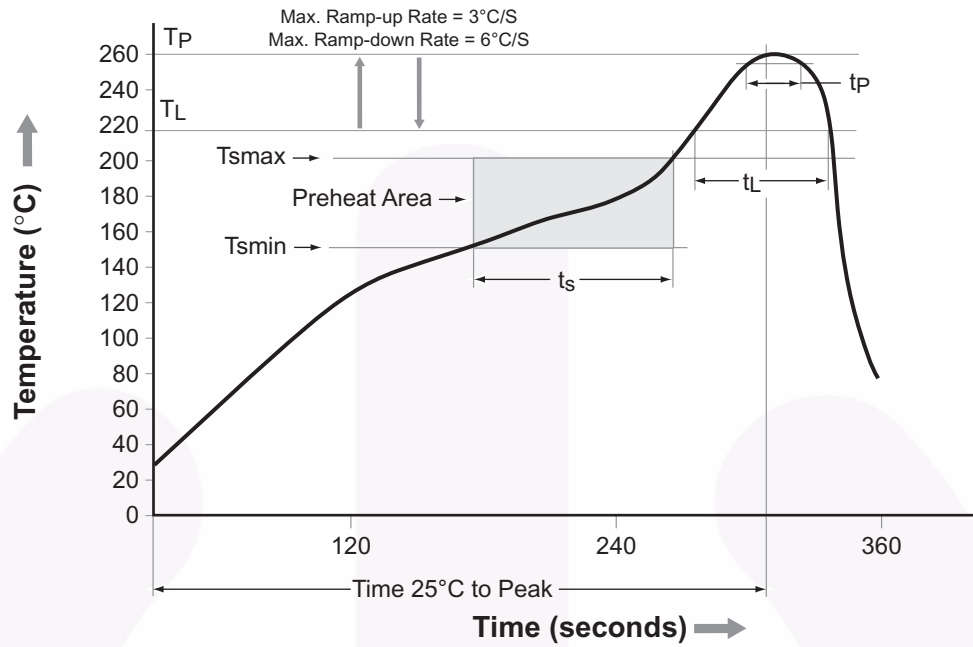
Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P <sub>0</sub>	Sprocket Hole Pitch	4.0 ± 0.1
D <sub>0</sub>	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P <sub>2</sub>		2.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A <sub>0</sub>	Pocket Dimensions	10.30 ± 0.20
B <sub>0</sub>		10.30 ± 0.20
K <sub>0</sub>		4.90 ± 0.20
W <sub>1</sub>	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) (Pending)



Symbol	Description	Dimension in mm
W	Tape Width	24.0 ± 0.3
t	Tape Thickness	0.40 ± 0.1
P <sub>0</sub>	Sprocket Hole Pitch	4.0 ± 0.1
D <sub>0</sub>	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	11.5 ± 0.1
P <sub>2</sub>		2.0 ± 0.1
P	Pocket Pitch	16.0 ± 0.1
A <sub>0</sub>	Pocket Dimensions	12.80 ± 0.1
B <sub>0</sub>		10.35 ± 0.1
K <sub>0</sub>		5.7 ± 0.1
W <sub>1</sub>	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. (T <sub>smín</sub> )	150°C
Temperature Max. (T <sub>smáx</sub> )	200°C
Time (t <sub>s</sub> ) from (T <sub>smín</sub> to T <sub>smáx</sub> )	60–120 seconds
Ramp-up Rate (t <sub>L</sub> to t <sub>p</sub> )	3°C/second max.
Liquidous Temperature (T <sub>L</sub> )	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	60–150 seconds
Peak Body Package Temperature	260°C +0°C / -5°C
Time (t <sub>p</sub> ) within 5°C of 260°C	30 seconds
Ramp-down Rate (T <sub>P</sub> to T <sub>L</sub> )	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.



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