

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.

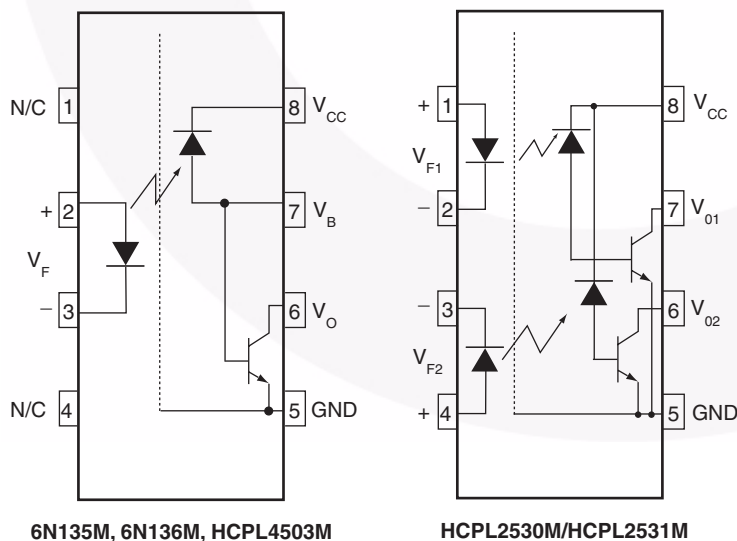
The HCPL4503M has no internal connection to the phototransistor base for improved noise immunity.

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

Related Resources

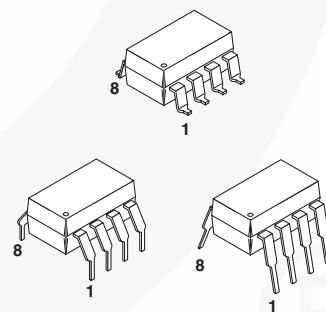
- www.fairchildsemi.com/products/opto/
- www.fairchildsemi.com/pf/HC/HCPL0500.html
- www.fairchildsemi.com/pf/FO/FODM452.html
- www.fairchildsemi.com/pf/FO/FOD050L.html

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 | $^\circ\text{C}$ |
| EMITTER | | | | |
| I_F (avg) | DC/Average Forward Input Current Each Channel ⁽¹⁾ | | 25 | mA |
| I_F (pk) | Peak Forward Input Current Each Channel ⁽²⁾ | 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 ⁽³⁾ | 6N135M, 6N136M, HCPL4503M | 45 | mW |
| | | HCPL2530M, HCPL2531M | | |
| DETECTOR | | | | |
| 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 ⁽⁴⁾ | 6N135M, 6N136M, HCPL4503M | 100 | mW |
| | | HCPL2530M, HCPL2531M | 35 | mW |

Notes:

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

Electrical Characteristics

($T_A = 0$ to 70°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 |
|-------------------------|--|---|-------------------------------|------|--------|------|----------------------|
| EMITTER | | | | | | | |
| 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/ $^\circ\text{C}$ |
| DETECTOR | | | | | | | |
| 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 | μA |
| | | $I_F = 0\text{mA}$, $V_O = V_{CC} = 15\text{V}$, $T_A = 25^\circ\text{C}$ | 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 | μA |
| | | $I_{F1} = I_{F2} = 16\text{mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{V}$ | 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 | μA |
| | | $I_F = 0\text{mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{V}$ | 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°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 | |
|----------------|---------------------------------------|---|------------------------|---------------------|------|------|------|---|
| COUPLED | | | | | | | | |
| CTR | Current Transfer Ratio ⁽⁵⁾ | $I_F = 16\text{mA}$, $V_O = 0.4\text{V}$, $V_{CC} = 4.5\text{V}$, $T_A = 25^\circ\text{C}$ | 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°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 | μs |
| | | | 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 | μs |
| | | | 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 | μs |
| | | | 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 | μs |
| | | | 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 0.36mA and $6.1\text{k}\Omega$ pull-up resistor.
- The $1.9\text{k}\Omega$ load represents 1 TTL unit load of 1.6mA 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°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°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} | | Ω |
| 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) | | | | μA |
| R_{I-I} | Input-Input Resistance | $V_{I-I} = 500 \text{ VDC}^{(10)}$ (HCPL2530M/2531M only) | | | | Ω |
| 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

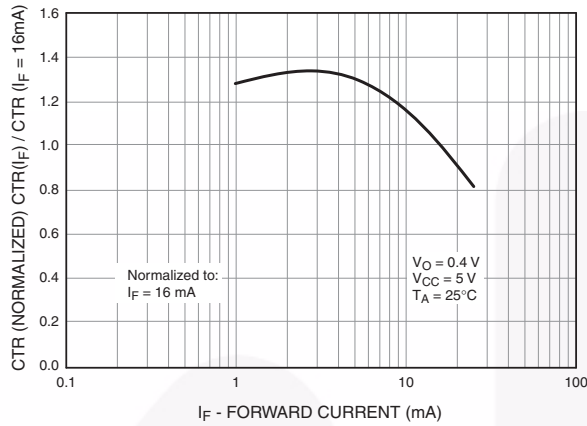


Fig. 2 Normalized CTR vs. Temperature

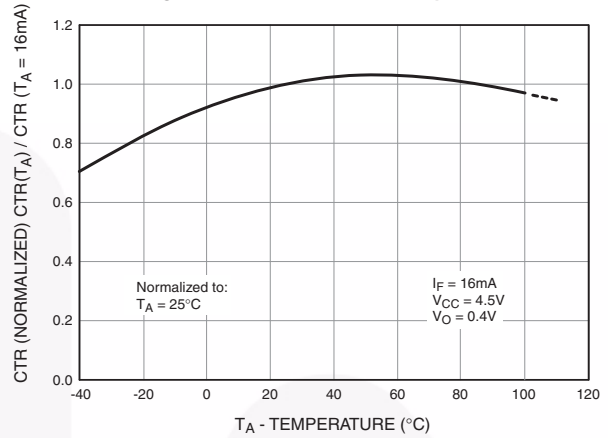


Fig. 3 Output Current vs. Output Voltage

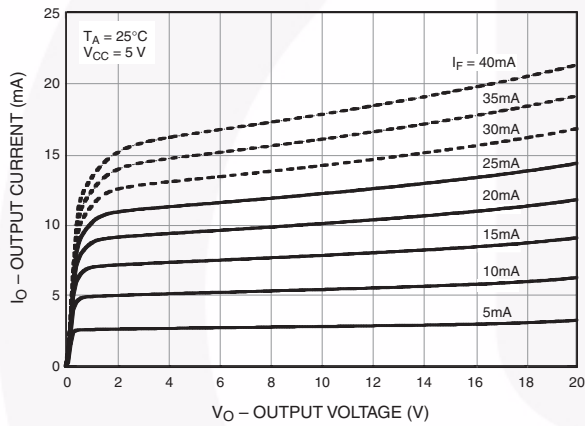


Fig. 4 Logic High Output Current vs. Temperature

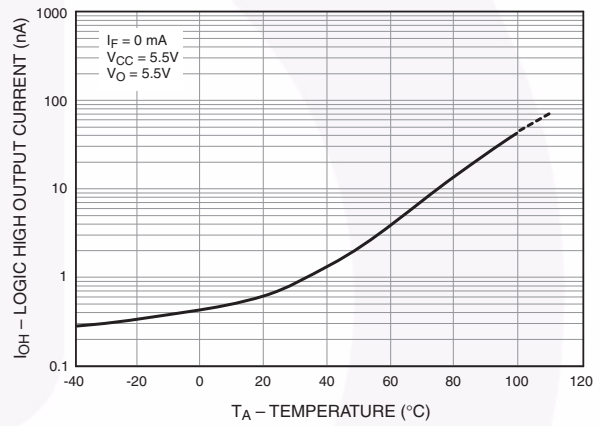


Fig. 5 Propagation Delay vs. Temperature

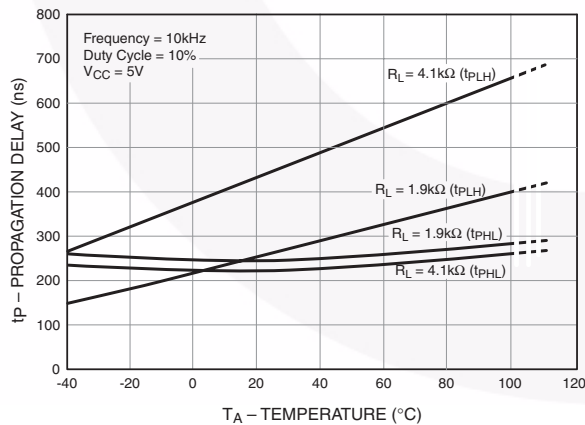
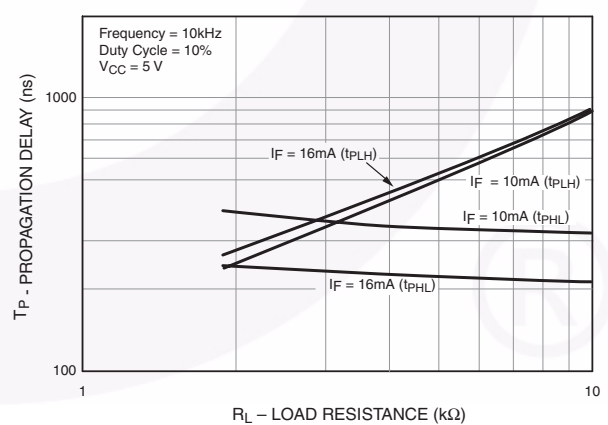
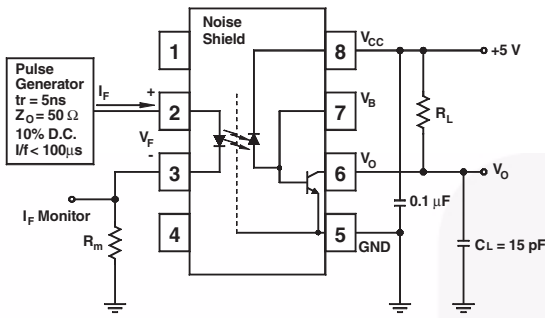


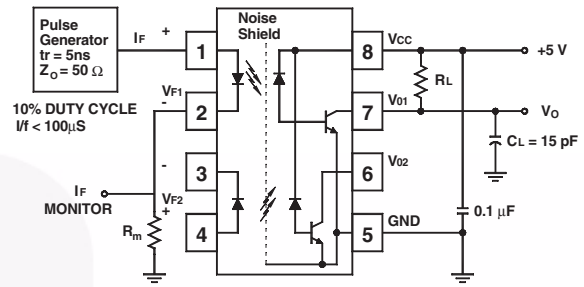
Fig. 6 Propagation Delay vs. Load Resistance



Test Circuits



Test Circuit for 6N135M, 6N136M, and HCPL4503M



Test Circuit for HCPL2530M and HCPL2531M

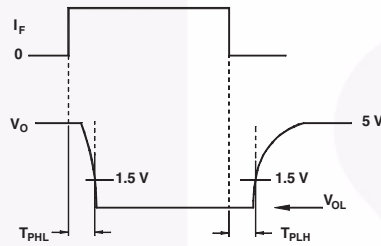
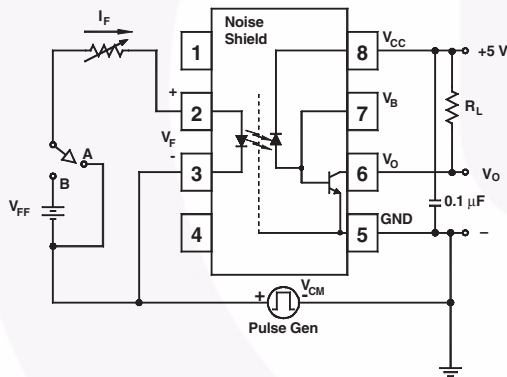
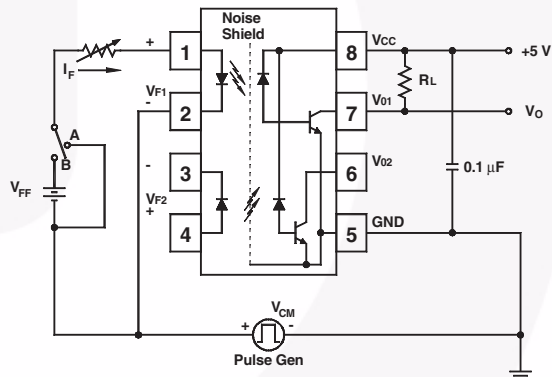


Fig. 7 Switching Time Test Circuit



Test Circuit for 6N135M, 6N136M, and HCPL4503M



Test Circuit for HCPL2530M and HCPL2531M

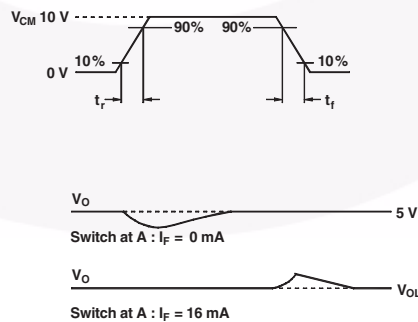
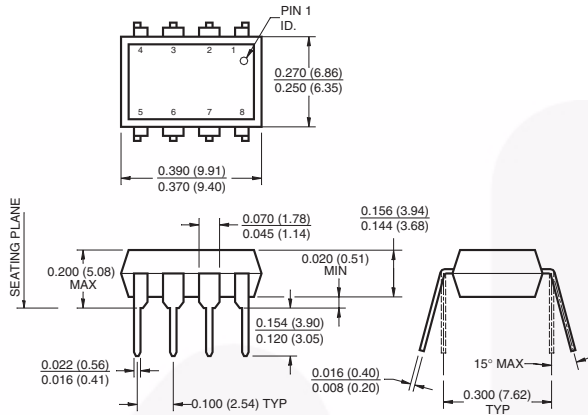


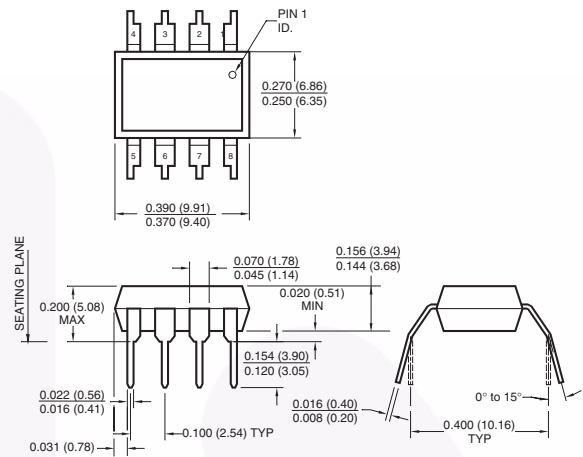
Fig. 8 Common Mode Immunity Test Circuit

Package Dimensions

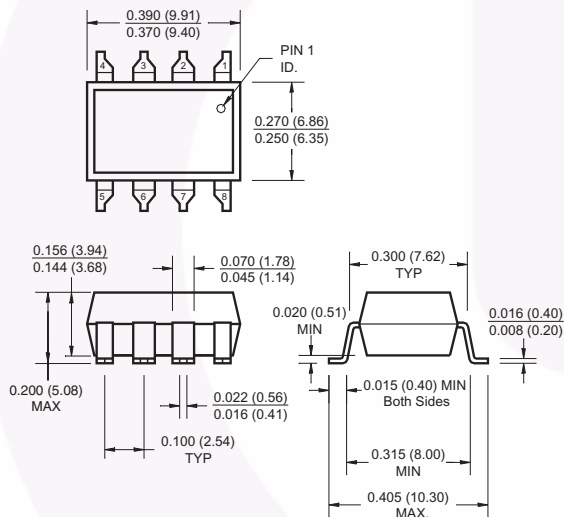
Through Hole



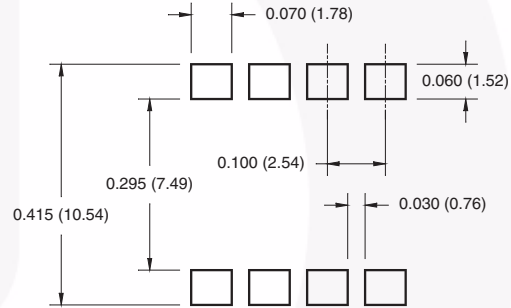
0.4" Lead Spacing (Option T)



Surface Mount – 0.3" Lead Spacing (Option S)



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



Note:

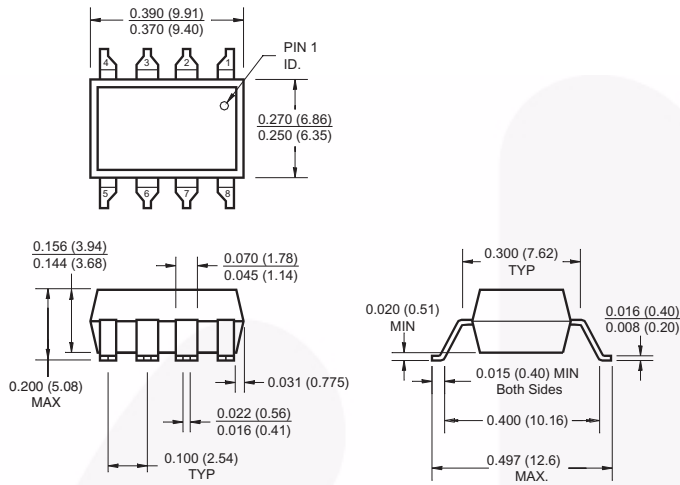
All dimensions are in inches (millimeters)

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Package Dimensions (Continued)

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



Note:

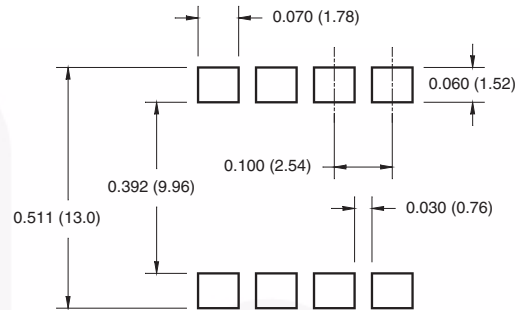
All dimensions are in inches (millimeters)

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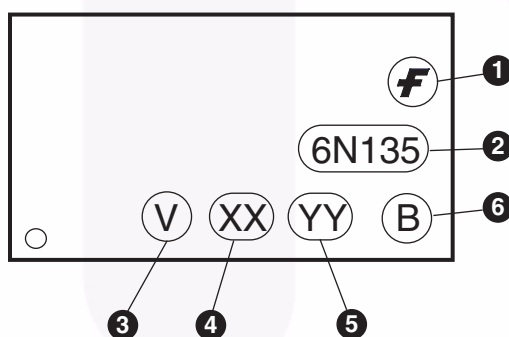
8-Pin Surface Mount DIP – Land Pattern (Option TS)



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

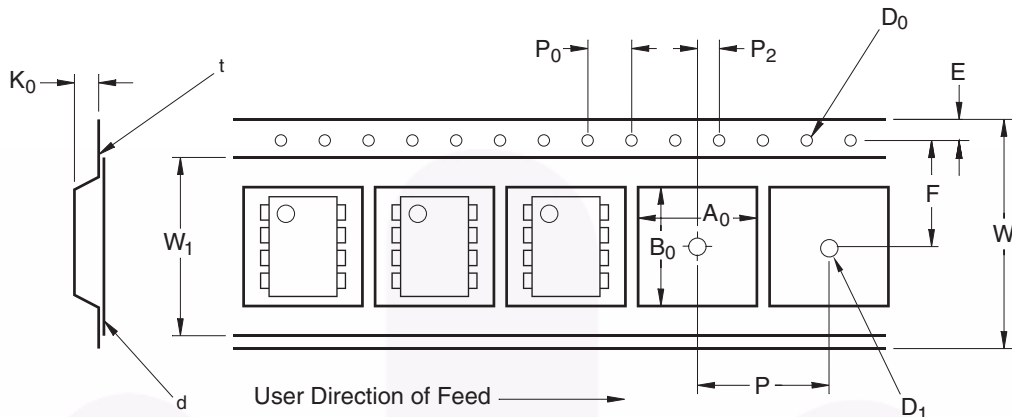


| Definitions | |
|------------------|--|
| 1 | Fairchild logo |
| 2 ⁽¹⁾ | Device number |
| 3 | IEC60747-5-2 mark (Note: Only appears on parts ordered with this option – See order entry table) |
| 4 | Two digit year code, e.g., '08' |
| 5 | Two digit work week ranging from '01' to '53' |
| 6 | Assembly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

Note:

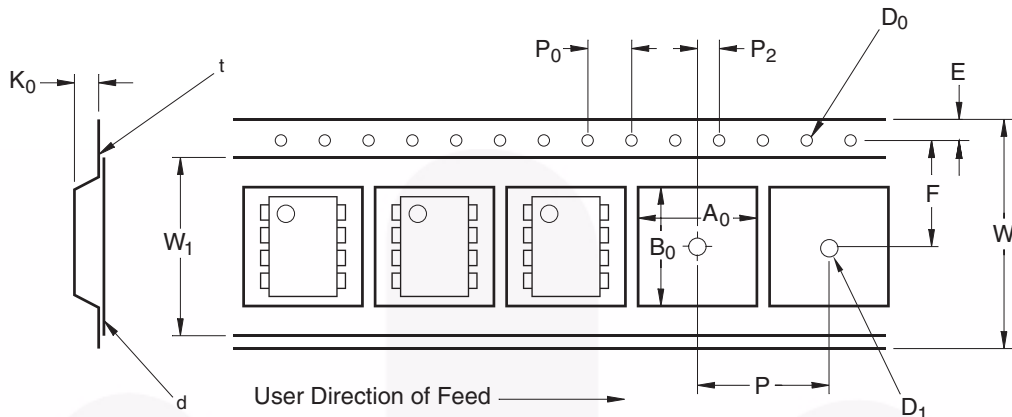
- 'HCPL' devices are marked with only the numeric characters (for example, HCPL4503M is marked as '4503').
- The 'M' suffix is an ordering identifier only. It is used to indicate the white package version. The 'M' does not appear in the top mark.

Carrier Tape Specifications (Option SD)



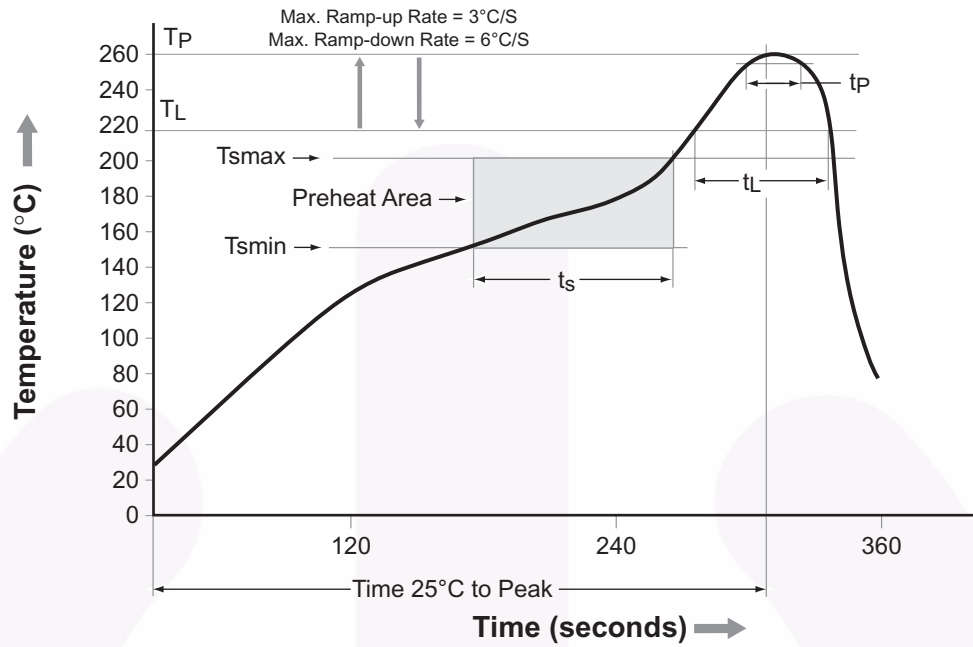
| Symbol | Description | Dimension in mm |
|----------------|---------------------------------|-----------------|
| W | Tape Width | 16.0 ± 0.3 |
| t | Tape Thickness | 0.30 ± 0.05 |
| P ₀ | Sprocket Hole Pitch | 4.0 ± 0.1 |
| D ₀ | Sprocket Hole Diameter | 1.55 ± 0.05 |
| E | Sprocket Hole Location | 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) (Pending)



| 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. (T _{smín}) | 150°C |
| Temperature Max. (T _{smáx}) | 200°C |
| Time (t _s) from (T _{smín} to T _{smáx}) | 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. |



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|--------------------------|-----------------------|---|
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