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January 2016

Single-Channel: 6N135M, 6N136M, HCPL4503M Dual-Channel: HCPL2530M, HCPL2531M 8-Pin DIP High Speed Transistor Optocouplers

Features

- High Speed – 1 MBit/s
- Dual-Channel: HCPL2530M, HCPL2531M
- CTR Guaranteed 0°C to 70°C
- No Base Connection for Improved Noise Immunity (HCPL4503M)
- Superior CMR of 15,000 V/μs Minimum (HCPL4503M)
- Safety and Regulatory Approvals
 - UL1577, 5,000 VAC_{RMS} for 1 Minute
 - DIN EN/IEC60747-5-5

Applications

- Line Receivers
- Pulse Transformer Replacement
- Output Interface to CMOS-LSTTL-TTL
- Wide-Bandwidth Analog Coupling

Description

The 6N135M, 6N136M, HCPL4503M, HCPL2530M, and HCPL2531M optocouplers consist of an AlGaAs LED optically coupled to a high speed photodetector transistor for each channel.

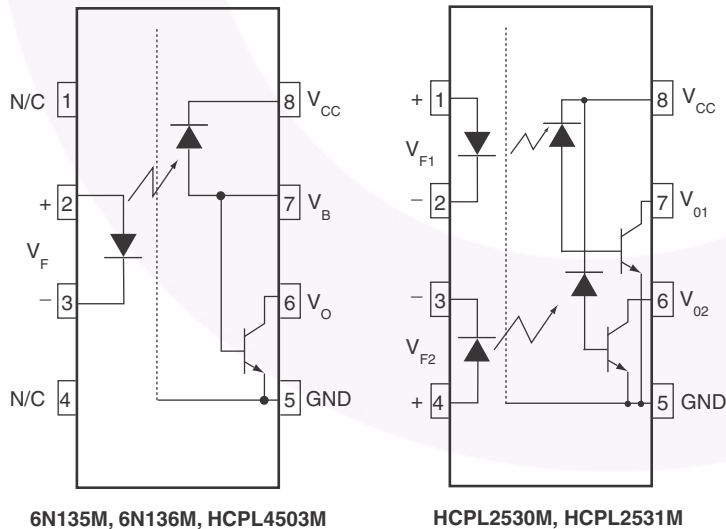
A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

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 50,000 V/μs.

Related Resources

- www.fairchildsemi.com/products/optoelectronics/
- 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

Figure 1. Schematics

Package Outlines

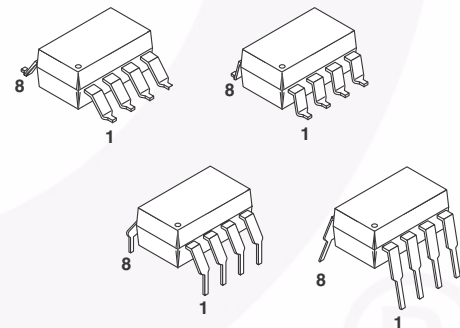


Figure 2. Package Outlines

Single-Channel: 6N135M, 6N136M, HCPL4503M
Dual-Channel: HCPL2530M, HCPL2531M — 8-Pin DIP High Speed Transistor Optocouplers

Safety and Insulation Ratings

As per DIN EN/IEC 60747-5-5, 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.

| Parameter | Characteristics | |
|---|------------------------|-------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 V _{RMS} | I-IV |
| | < 300 V _{RMS} | I-IV |
| | < 450 V _{RMS} | I-III |
| | < 600 V _{RMS} | I-III |
| Climatic Classification | 40/100/21 | |
| Pollution Degree (DIN VDE 0110/1.89) | 2 | |
| Comparative Tracking Index | 175 | |

| Symbol | Parameter | Value | Unit |
|-----------------------|--|-------------------|-------------------|
| V _{PR} | Input-to-Output Test Voltage, Method A, V _{IORM} × 1.6 = V _{PR} , Type and Sample Test with t _m = 10 s, Partial Discharge < 5 pC | 1,335 | V _{peak} |
| | Input-to-Output Test Voltage, Method B, V _{IORM} × 1.875 = V _{PR} , 100% Production Test with t _m = 1 s, Partial Discharge < 5 pC | 1,669 | V _{peak} |
| V _{IORM} | Maximum Working Insulation Voltage | 890 | V _{peak} |
| V _{IOTM} | Highest Allowable Over-Voltage | 6,000 | V _{peak} |
| | External Creepage | ≥ 8.0 | mm |
| | External Clearance | ≥ 7.4 | mm |
| | External Clearance (for Option TV, 0.4" Lead Spacing) | ≥ 10.16 | mm |
| DTI | Distance Through Insulation (Insulation Thickness) | ≥ 0.5 | mm |
| T _S | Case Temperature ⁽¹⁾ | 150 | °C |
| I _{S,INPUT} | Input Current ⁽¹⁾ | 200 | mA |
| P _{S,OUTPUT} | Output Power (Duty Factor ≤ 2.7%) ⁽¹⁾ | 300 | mW |
| R _{IO} | Insulation Resistance at T _S , V _{IO} = 500 V ⁽¹⁾ | > 10 ⁹ | Ω |

Note:

1. Safety limit value - maximum values allowed in the event of a failure.

Absolute Maximum Ratings

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. $T_A = 25^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Test Conditions | Value | Unit |
|-----------------|--|------------------------------------|----------------|------------------|
| T_{STG} | Storage Temperature | | -40 to +125 | $^\circ\text{C}$ |
| T_{OPR} | Operating Temperature | | -40 to +100 | $^\circ\text{C}$ |
| T_J | Junction Temperature | | -40 to +125 | $^\circ\text{C}$ |
| T_{SOL} | Lead Solder Temperature | | 260 for 10 sec | $^\circ\text{C}$ |
| EMITTER | | | | |
| I_F (avg) | DC/Average Forward Input Current Each Channel ⁽²⁾ | | 25 | mA |
| I_F (pk) | Peak Forward Input Current Each Channel ⁽³⁾ | 50% Duty Cycle, 1 ms P.W. | 50 | mA |
| I_F (trans) | Peak Transient Input Current Each Channel | $\leq 1 \mu\text{s}$ P.W., 300 pps | 1.0 | A |
| V_R | Reverse Input Voltage Each Channel | | 5 | V |
| P_D | Input Power Dissipation Each Channel ⁽⁴⁾ | | 45 | mW |
| 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 | 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 | 5 | mA |
| P_D | Output Power Dissipation Each Channel ⁽⁵⁾ | | 100 | mW |

Notes:

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

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. | Unit |
|----------|--|------|------|------------------|
| V_{CC} | Supply Voltage | 4.5 | 20.0 | V |
| T_A | Ambient Operating Temperature | 0 | 70 | $^\circ\text{C}$ |
| I_{FL} | Input Current, Low Level | 0 | 250 | μA |
| I_{FH} | Input Current, High Level ⁽⁶⁾ | 6.3 | 20.0 | mA |

Note:

- 6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.

Electrical Characteristics

$V_{CC} = 5.0\text{ V}$, $T_A = 0^\circ\text{C}$ to 70°C unless otherwise specified.

Individual Component Characteristics

| Symbol | Parameter | Device | Test Conditions | Min. | Typ. | Max. | Unit |
|-------------------------|--|---------------------------|---|------|--------|------|----------------------|
| EMITTER | | | | | | | |
| V_F | Input Forward Voltage | All | $I_F = 16\text{ mA}$, $T_A = 25^\circ\text{C}$ | | 1.45 | 1.70 | V |
| | | All | $I_F = 16\text{ mA}$ | | | 1.80 | |
| B_{VR} | Input Reverse Breakdown Voltage | All | $I_R = 10\ \mu\text{A}$ | 5 | 21 | | V |
| $\Delta V_F/\Delta T_A$ | Temperature Coefficient of Forward Voltage | All | $I_F = 16\text{ mA}$ | | -1.7 | | mV/ $^\circ\text{C}$ |
| DETECTOR | | | | | | | |
| I_{OH} | Logic High Output Current | All | $I_F = 0\text{ mA}$, $V_O = V_{CC} = 5.5\text{ V}$, $T_A = 25^\circ\text{C}$ | | 0.0007 | 0.5 | μA |
| | | 6N135M, 6N136M, HCPL4503M | $I_F = 0\text{ mA}$, $V_O = V_{CC} = 15\text{ V}$, $T_A = 25^\circ\text{C}$ | | 0.0019 | 1 | |
| | | All | $I_F = 0\text{ mA}$, $V_O = V_{CC} = 15\text{ V}$ | | | 50 | |
| I_{CCL} | Logic Low Supply Current | 6N135M, 6N136M, HCPL4503M | $I_F = 16\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$ | | 163 | 200 | μA |
| | | HCPL2530M, HCPL2531M | $I_{F1} = I_{F2} = 16\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$ | | | 400 | |
| I_{CCH} | Logic High Supply Current | 6N135M, 6N136M, HCPL4503M | $I_F = 0\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$ | | 0.0004 | 2 | μA |
| | | HCPL2530M, HCPL2531M | $I_F = 0\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$ | | | 4 | |

Electrical Characteristics (continued)

$T_A = 0^\circ\text{C}$ to 70°C unless otherwise specified.

Transfer Characteristics

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

Note:

7. 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)

$T_A = 0^\circ\text{C}$ to 70°C unless otherwise specified.

Switching Characteristics

| Symbol | Parameter | Device | Test Conditions | Min. | Typ. | Max. | Unit | |
|-----------|--|------------------------------------|--|--------|--------|------|------------------------|---------------|
| t_{PHL} | Propagation Delay Time to Logic LOW | 6N135M | $T_A = 25^\circ\text{C}$, $R_L = 4.1\text{ k}\Omega$, $I_F = 16\text{ mA}^{(8)}$ (Figure 15) | | 0.23 | 1.5 | μs | |
| | | HCPL2530M | | | 0.25 | | | |
| | | 6N136M, HCPL4503M | $T_A = 25^\circ\text{C}$, $R_L = 1.9\text{ k}\Omega$, $I_F = 16\text{ mA}^{(9)}$ (Figure 15) | | 0.25 | 0.8 | μs | |
| | | HCPL2531M | | | 0.28 | | | |
| | | 6N135M, HCPL2530M | $R_L = 4.1\text{ k}\Omega$, $I_F = 16\text{ mA}^{(8)}$ (Figure 15) | | | | 2.0 | μs |
| | | 6N136M, HCPL4503M, HCPL2531M | $R_L = 1.9\text{ k}\Omega$, $I_F = 16\text{ mA}^{(9)}$ (Figure 15) | | | | 1.0 | μs |
| t_{PLH} | Propagation Delay Time to Logic HIGH | 6N135M | $T_A = 25^\circ\text{C}$, $R_L = 4.1\text{ k}\Omega$, $I_F = 16\text{ mA}^{(8)}$ (Figure 15) | | 0.45 | 1.5 | μs | |
| | | HCPL2530M | | | 0.29 | | | |
| | | 6N136M, HCPL4503M | $T_A = 25^\circ\text{C}$, $R_L = 1.9\text{ k}\Omega$, $I_F = 16\text{ mA}^{(9)}$ (Figure 15) | | 0.26 | 0.8 | μs | |
| | | HCPL2531M | | | 0.18 | | | |
| | | 6N135M, HCPL2530M | $R_L = 4.1\text{ k}\Omega$, $I_F = 16\text{ mA}^{(8)}$ (Figure 15) | | | | 2.0 | μs |
| | | 6N136M, HCPL4503M, HCPL2531M | $R_L = 1.9\text{ k}\Omega$, $I_F = 16\text{ mA}^{(9)}$ (Figure 15) | | | | 1.0 | μs |
| $ CM_H $ | Common Mode Transient Immunity at Logic High | 6N135M, HCPL2530M | $I_F = 0\text{ mA}$, $V_{CM} = 10\text{ V}_{P-P}$, $R_L = 4.1\text{ k}\Omega$, $T_A = 25^\circ\text{C}^{(10)}$ (Figure 16) | | 10,000 | | $\text{V}/\mu\text{s}$ | |
| | | 6N136M, HCPL2531M | $I_F = 0\text{ mA}$, $V_{CM} = 10\text{ V}_{P-P}$, $R_L = 1.9\text{ k}\Omega$, $T_A = 25^\circ\text{C}^{(10)}$ (Figure 16) | | 10,000 | | | |
| | | HCPL4503M | $I_F = 0\text{ mA}$, $V_{CM} = 1,500\text{ V}_{P-P}$, $R_L = 4.1\text{ k}\Omega$, $T_A = 25^\circ\text{C}^{(10)}$ (Figure 16) | 15,000 | 50,000 | | | |
| $ CM_L $ | Common Mode Transient Immunity at Logic Low | 6N135M, HCPL2530M | $I_F = 16\text{ mA}$, $V_{CM} = 10\text{ V}_{P-P}$, $R_L = 4.1\text{ k}\Omega$, $T_A = 25^\circ\text{C}^{(10)}$ (Figure 16) | | 10,000 | | $\text{V}/\mu\text{s}$ | |
| | | 6N136M, HCPL2531M | $I_F = 16\text{ mA}$, $V_{CM} = 10\text{ V}_{P-P}$, $R_L = 1.9\text{ k}\Omega^{(10)}$ (Figure 16) | | 10,000 | | | |
| | | HCPL4503M | $I_F = 0\text{ mA}$, $V_{CM} = 1,500\text{ V}_{P-P}$, $R_L = 4.1\text{ k}\Omega$, $T_A = 25^\circ\text{C}^{(10)}$ (Figure 16) | 15,000 | 50,000 | | | |

Notes:

8. The 4.1 k Ω load represents 1 LSTTL unit load of 0.36 mA and 6.1 k Ω pull-up resistor.
9. The 1.9 k Ω load represents 1 TTL unit load of 1.6 mA and 5.6 k Ω pull-up resistor.
10. 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 ($T_A = 25^\circ\text{C}$ unless otherwise specified.)

| Symbol | Parameter | Device | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|--|-------------------------|--|-------|-----------|------|--------------------|
| V_{ISO} | Withstand Isolation Test Voltage | All | $RH \leq 50\%$, $I_{I-O} \leq 10 \mu\text{A}$ $t = 1 \text{ minute}$, $f = 50 \text{ Hz}^{(11)(13)}$ | 5,000 | | | VAC_{RMS} |
| R_{I-O} | Resistance (Input to Output) | All | $V_{I-O} = 500 \text{ V}_{DC}^{(11)}$ | | 10^{11} | | Ω |
| C_{I-O} | Capacitance (Input to Output) | All | $f = 1 \text{ MHz}$, $V_{I-O} = 0 \text{ V}_{DC}^{(11)}$ | | 1 | | pF |
| I_{I-I} | Input-Input Insulation Leakage Current | HCPL2530M, HCPL2531M | $RH \leq 45\%$, $V_{I-I} = 500 \text{ V}_{DC}$, $t = 5 \text{ s}^{(12)}$ | | < 1 | | nA |
| R_{I-I} | Input-Input Resistance | HCPL2530M, HCPL2531M | $V_{I-I} = 500 \text{ V}_{DC}^{(12)}$ | | 10^{12} | | Ω |
| C_{I-I} | Input-Input Capacitance | HCPL2530M, HCPL2531M | $f = 1 \text{ MHz}^{(12)}$ | | 0.2 | | pF |

Notes:

11. 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.
12. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
13. 5000 V_{RMS} for 1 minute duration is equivalent to 6000 V_{RMS} for 1 second duration.

Typical Performance Curves

For single-channel devices; 6N135M, 6N136M, and HCPL4503M.



Figure 3. Normalized CTR vs. Forward Current



Figure 4. Normalized CTR vs. Temperature



Figure 5. Output Current vs. Output Voltage



Figure 6. Logic High Output Current vs. Temperature



Figure 7. Propagation Delay vs. Temperature



Figure 8. Propagation Delay vs. Load Resistance

Typical Performance Curves (Continued)

For dual-channel devices; HCPL2530M and HCPL2531M.



Figure 9. Normalized CTR vs. Forward Current



Figure 10. Normalized CTR vs. Temperature

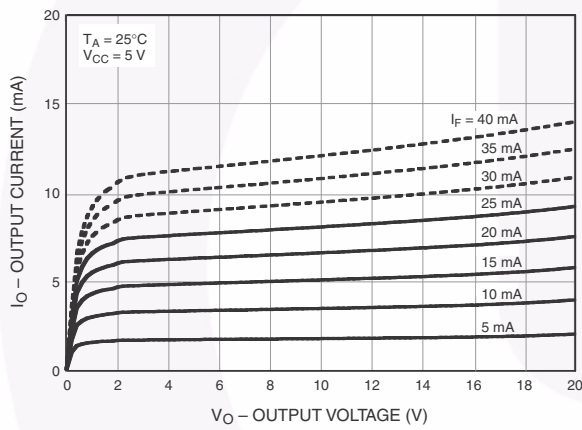


Figure 11. Output Current vs. Output Voltage

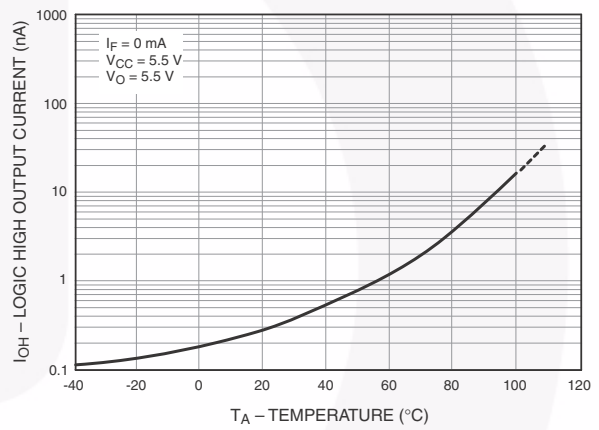


Figure 12. Logic High Output Current vs. Temperature

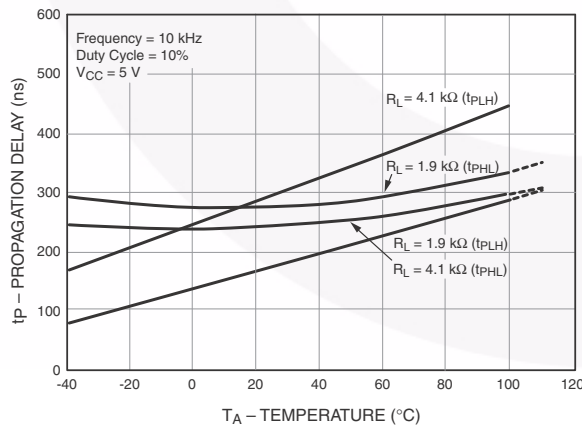


Figure 13. Propagation Delay vs. Temperature

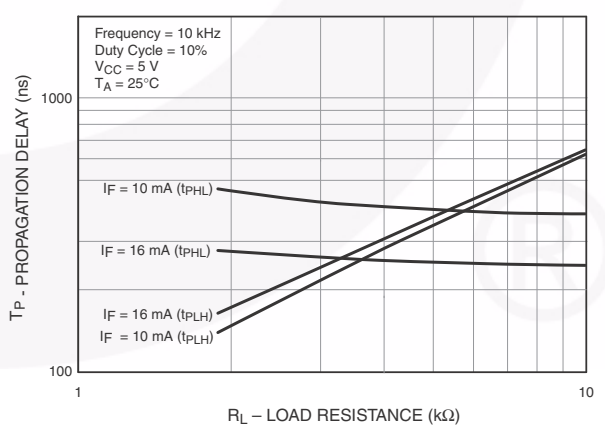


Figure 14. Propagation Delay vs. Load Resistance

Test Circuits

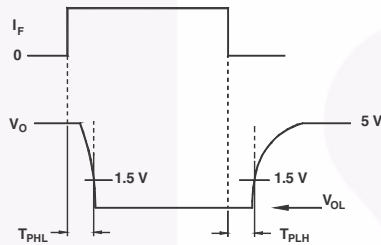
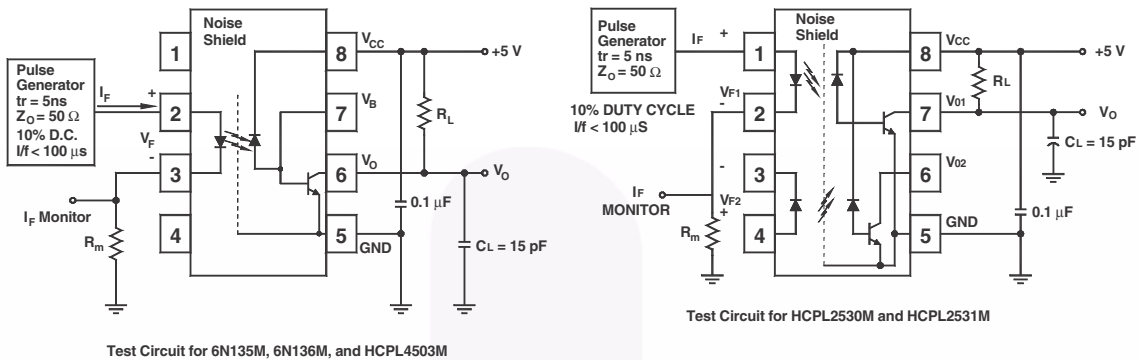


Figure 15. Switching Time Test Circuit

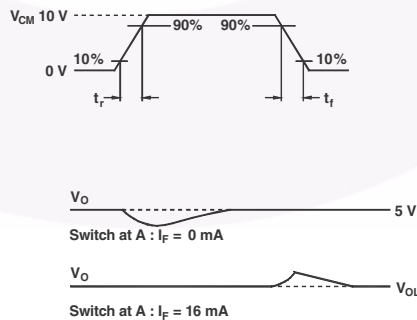
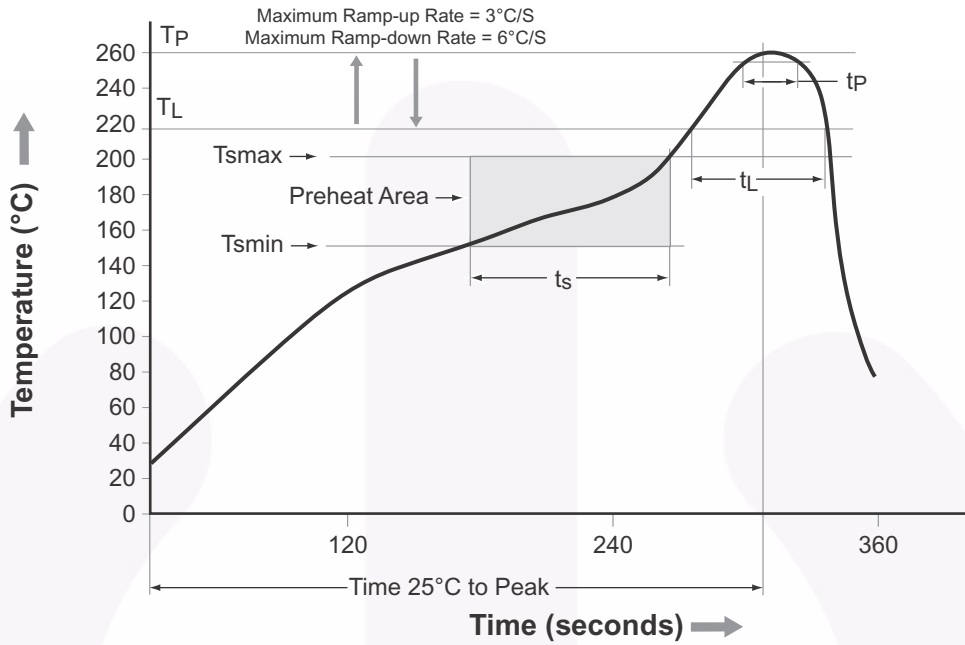


Figure 16. Common Mode Immunity Test Circuit

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 to 120 s |
| Ramp-up Rate (t _L to t _p) | 3°C/second maximum |
| Liquidous Temperature (T _L) | 217°C |
| Time (t _L) Maintained Above (T _L) | 60 to 150 s |
| Peak Body Package Temperature | 260°C +0°C / -5°C |
| Time (t _p) within 5°C of 260°C | 30 s |
| Ramp-down Rate (T _p to T _L) | 6°C/s maximum |
| Time 25°C to Peak Temperature | 8 minutes maximum |

Figure 17. Relow Profile

Ordering Information

| Part Number | Package | Packing Method |
|-------------|---|--------------------------------------|
| 6N135M | DIP 8-Pin | Tube (50 units per tube) |
| 6N135SM | SMT 8-Pin (Lead Bend) | Tube (50 units per tube) |
| 6N135SDM | SMT 8-Pin (Lead Bend) | Tape and Reel (1,000 units per reel) |
| 6N135VM | DIP 8-Pin, DIN EN/IEC 60747-5-5 Option | Tube (50 units per tube) |
| 6N135SVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 Option | Tube (50 units per tube) |
| 6N135SDVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 Option | Tape and Reel (1,000 units per reel) |
| 6N135TVM | DIP 8-Pin, 0.4" Lead Spacing, DIN EN/IEC 60747-5-5 Option | Tube (50 units per tube) |
| 6N135TSVM | SMT 8-Pin, 0.4" Lead Spacing, DIN EN/IEC 60747-5-5 Option | Tube (50 units per tube) |
| 6N135TSR2VM | SMT 8-Pin, 0.4" Lead Spacing, DIN EN/IEC 60747-5-5 Option | Tape and Reel (1,000 units per reel) |

Note:

The product orderable part number system listed in this table also applies to the 6N136M, HCPL4503M, HCPL2530M, and HCPL2531M product families.

Marking Information



Figure 14. Top Mark

| Definitions | |
|-------------|---|
| 1 | Fairchild Logo |
| 2 | Device Number |
| 3 | DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4 | Two Digit Year Code, e.g., '15' |
| 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 Maximum |
| | Maximum Component Rotation or Tilt | 10° |
| R | Minimum Bending Radius | 30 |



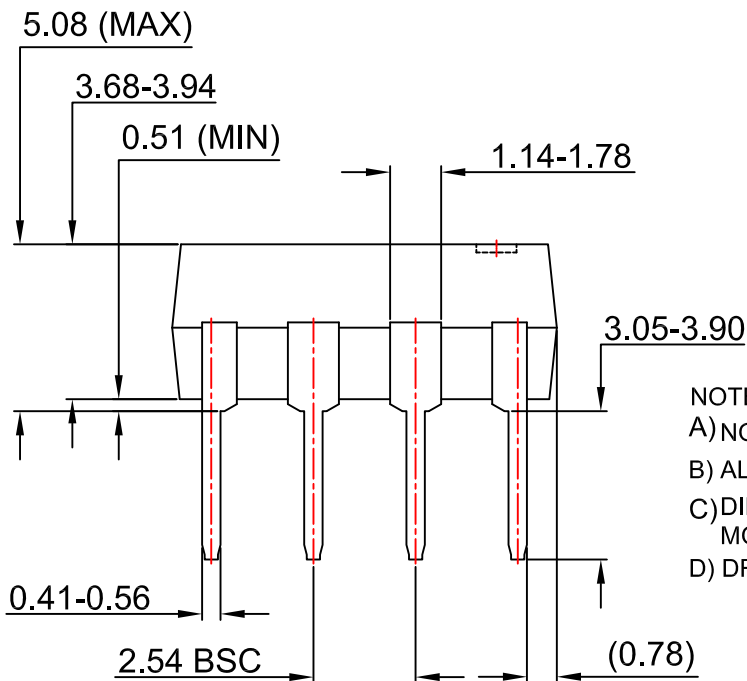
LAND PATTERN RECOMMENDATION



NOTES:

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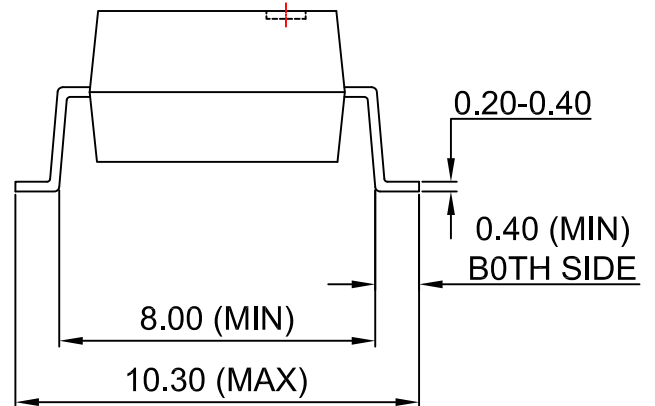


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PIN 1

15.0° (MAX)

10.16 (TYP)

0.20-0.40



NOTES:

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