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# Single-Channel: 6N135, 6N136, HCPL2503, HCPL4502 Dual-Channel: HCPL2530, HCPL2531 High Speed Transistor Optocouplers

## Features

- High speed –1 MBit/s
- Superior CMR – 10kV/μs
- Dual-Channel HCPL2530/HCPL2531
- 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

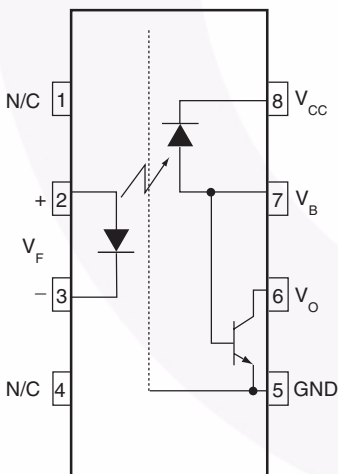
## Description

The HCPL4502, HCPL2503, 6N135, 6N136, HCPL2530 and HCPL2531 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.

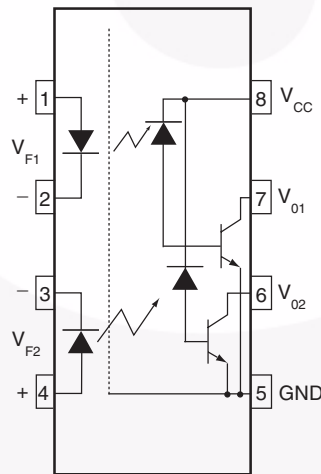
An internal noise shield provides superior common mode rejection of 10kV/μs. An improved package allows superior insulation permitting a 480V working voltage compared to industry standard of 220V.

## Schematics



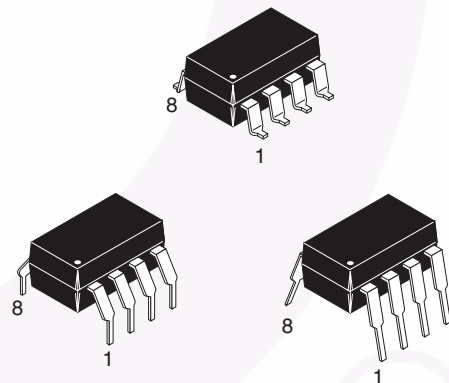
6N135, 6N136, HCPL2503, HCPL4502

Pin 7 is not connected in Part Number HCPL4502



HCPL2530/HCPL2531

## 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  |   | -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 HCPL2503/4502                   | 100            | mW               |
|                 |  | HCPL-2530/253 <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 HCPL2503 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 HCPL2503 only                  | 5              | mA               |
| PD              | Output Power Dissipation Each Channel                        | 6N135, 6N136, HCPL2503, HCPL4502 <sup>(4)</sup> | 100            | mW               |
|                 |  | HCPL2530, HCPL2531                              | 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<br>6N136<br>HCPL4502<br>HCPL2503 |      | 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<br>6N136<br>HCPL4502<br>HCPL2503 |      | 120   | 200  | $\mu\text{A}$        |
|                         |  | $I_{F1} = I_{F2} = 16\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$               | HCPL2530<br>HCPL2531                   |      | 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<br>6N136<br>HCPL4502<br>HCPL2503 |      |       | 1    | $\mu\text{A}$        |
|                         |  | $I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$                            | 6N135<br>6N136<br>HCPL4502<br>HCPL2503 |      |       | 2    |                      |
|                         |  | $I_F = 0\text{mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$                            | HCPL2530<br>HCPL2531                   |      | 0.02  | 4    |                      |

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

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

**Transfer Characteristics**

| Symbol  | Parameter                             | Test Conditions   | Device                        | Min.              | Typ.* | Max. | Unit |   |
|---|---------------------------------------|---|-------------------------------|-------------------|-------|------|------|---|
| <b>COUPLED</b>  |                                       |   |                               |                   |       |      |      |   |
| CTR   | Current Transfer Ratio <sup>(5)</sup> | $I_F = 16\text{mA}, V_O = 0.4\text{V}, V_{CC} = 4.5\text{V}, T_A = 25^\circ\text{C}$  | 6N135<br>HCPL2530             | 7                 | 18    | 50   | %    |   |
|   |                                       |   | 6N136<br>HCPL4502<br>HCPL2531 | 19                | 27    | 50   | %    |   |
|   |                                       |   | HCPL2503                      | 12                | 27    |      | %    |   |
|   |                                       | $I_F = 16\text{mA}, V_{CC} = 4.5\text{V}$   | $V_{OL} = 0.4\text{V}$        | 6N135             | 5     | 21   |      | % |
|   |                                       |   | $V_{OL} = 0.5\text{V}$        | HCPL2530          |       |      |      |   |
|   |                                       |   | $V_{OL} = 0.4\text{V}$        | 6N136<br>HCPL4502 | 15    | 30   |      | % |
| $V_{OL} = 0.5\text{V}$  | HCPL2531                              |   |                               |                   |       |      |      |   |
| $V_{OL} = 0.4\text{V}$  | HCPL2503                              | 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    |   |
|   |                                       |   | HCPL2530                      |                   | 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<br>HCPL2503             |                   | 0.25  | 0.4  |      |   |
|   |                                       |   | HCPL2531                      |                   | 0.25  | 0.5  |      |   |
|   |                                       | $I_F = 16\text{mA}, I_O = 0.8\text{mA}, V_{CC} = 4.5\text{V}$                         | 6N135<br>HCPL2530             |                   |       | 0.5  |      |   |
| $I_F = 16\text{mA}, I_O = 2.4\text{mA}, V_{CC} = 4.5\text{V}$ | HCPL4502<br>HCPL2531                  |   |                               | 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%.

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

| Symbol    | Parameter   | Test Conditions  | Device                                    | Min. | Typ.*  | Max. | Unit                   |
|-----------|---|--|---|------|--------|------|------------------------|
| $T_{PHL}$ | Propagation Delay<br>Time to Logic LOW                | $T_A = 25^\circ\text{C}$ , $R_L = 4.1\text{k}\Omega$ ,<br>$I_F = 16\text{mA}^{(6)}$ (Fig. 7)                               | 6N135<br>HCPL2530                         |      | 0.45   | 1.5  | $\mu\text{s}$          |
|           |   | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}$ ,<br>$T_A = 25^\circ\text{C}^{(7)}$ (Fig. 7)                               | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      | 0.45   | 0.8  | $\mu\text{s}$          |
|           |   | $R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ (Fig. 7)   | 6N135<br>HCPL2530                         |      |        | 2.0  | $\mu\text{s}$          |
|           |   | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7)   | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      |        | 1.0  | $\mu\text{s}$          |
| $T_{PLH}$ | Propagation Delay<br>Time to Logic HIGH               | $T_A = 25^\circ\text{C}$ , ( $R_L = 4.1\text{k}\Omega$ ,<br>$I_F = 16\text{mA}^{(6)}$ ) (Fig. 7)                           | 6N135<br>HCPL2530                         |      | 0.5    | 1.5  | $\mu\text{s}$          |
|           |   | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7)<br>$T_A = 25^\circ\text{C}$                                 | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      | 0.3    | 0.8  | $\mu\text{s}$          |
|           |   | $R_L = 4.1\text{k}\Omega$ , $I_F = 16\text{mA}^{(6)}$ (Fig. 7)   | 6N135<br>HCPL2530                         |      |        | 2.0  | $\mu\text{s}$          |
|           |   | $R_L = 1.9\text{k}\Omega$ , $I_F = 16\text{mA}^{(7)}$ (Fig. 7)   | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      |        | 1.0  | $\mu\text{s}$          |
| $ICM_H$   | Common Mode<br>Transient<br>Immunity at<br>Logic High | $I_F = 0\text{mA}$ , $V_{CM} = 10\text{V}_{P-P}$ ,<br>$R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)  | 6N135<br>HCPL2530                         |      | 10,000 |      | $\text{V}/\mu\text{s}$ |
|           |   | $I_F = 0\text{mA}$ , $V_{CM} = 10\text{V}_{P-P}$ ,<br>$R_L = 1.9\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8)  | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      | 10,000 |      | $\text{V}/\mu\text{s}$ |
| $ICM_L$   | Common Mode<br>Transient<br>Immunity at<br>Logic Low  | $I_F = 16\text{mA}$ , $V_{CM} = 10\text{V}_{P-P}$ ,<br>$R_L = 4.1\text{k}\Omega$ , $T_A = 25^\circ\text{C}^{(8)}$ (Fig. 8) | 6N135<br>HCPL2530                         |      | 10,000 |      | $\text{V}/\mu\text{s}$ |
|           |   | $I_F = 16\text{mA}$ , $V_{CM} = 10\text{V}_{P-P}$ ,<br>$R_L = 1.9\text{k}\Omega^{(8)}$ (Fig. 8)                            | 6N136<br>HCPL4502<br>HCPL2503<br>HCPL2531 |      | 10,000 |      | $\text{V}/\mu\text{s}$ |

\*\* All Typical 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.,  $V_O < 0.8\text{V}$ ).

**Electrical Characteristics** (Continued) ( $T_A = 0$  to  $70^\circ\text{C}$  unless otherwise specified)**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%,<br>$T_A = 25^\circ\text{C}$ , $t = 5\text{s}$ ,<br>$V_{I-O} = 3000\text{VDC}^{(9)}$ |      |           | 1.0 | $\mu\text{A}$ |
| $V_{ISO}$ | Withstand Insulation Test Voltage       | $RH \leq 50\%$ , $T_A = 25^\circ\text{C}$ , $I_{I-O} \leq 2\mu\text{A}$ ,<br>$t = 1\text{min.}^{(9)}$        | 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       |     | 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  | $RH \leq 45\%$ , $V_{I-I} = 500\text{VDC}^{(10)}$<br>$t = 5\text{s}$ , (HCPL2530/2531 only)                  |      | 0.005     |     | $\mu\text{A}$ |
| $R_{I-I}$ | Input-Input Resistance                  | $V_{I-I} = 500\text{VDC}^{(10)}$<br>(HCPL2530/2531 only)   |      | $10^{11}$ |     | $\Omega$      |
| $C_{I-I}$ | Input-Input Capacitance                 | $f = 1\text{MHz}^{(10)}$<br>(HCPL2530/2531 only)   |      | 0.03      |     | 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.

## Typical Performance Curves

Fig. 1 Normalized CTR vs. Forward Current

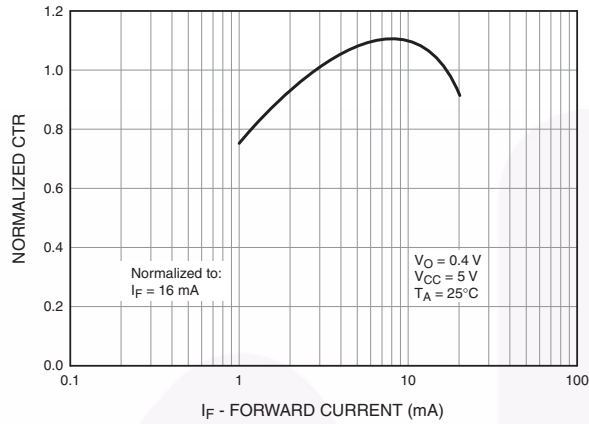


Fig. 2 Normalized CTR vs. Temperature

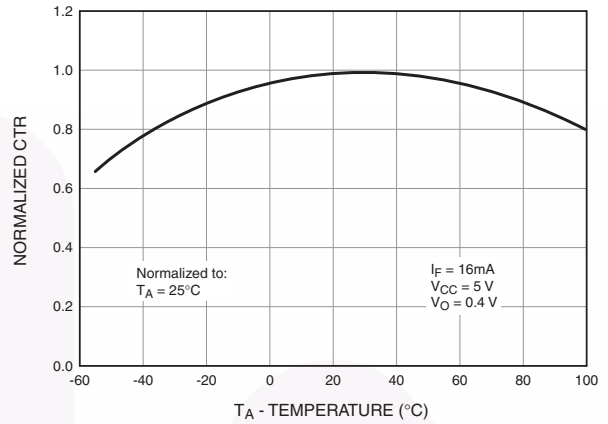


Fig. 3 Output Current vs. Output Voltage

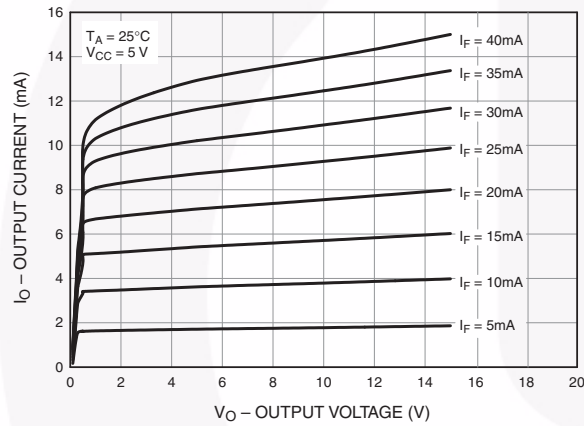


Fig. 4 Logic High Output Current vs. Temperature

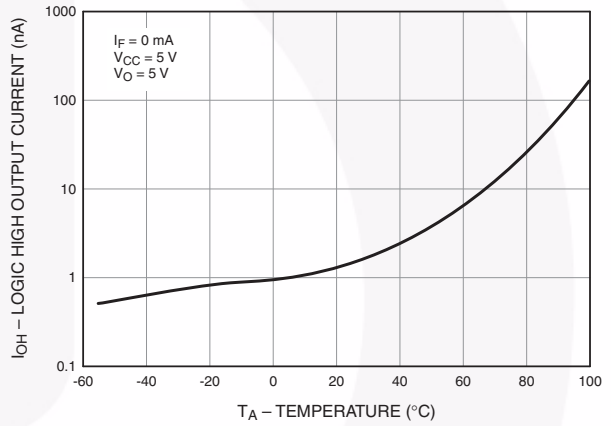


Fig. 5 Propagation Delay vs. Temperature

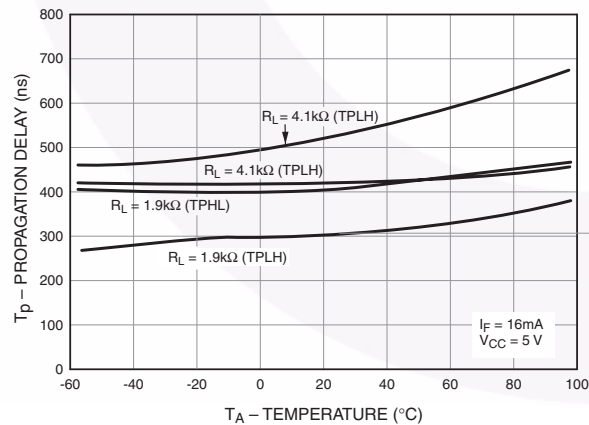
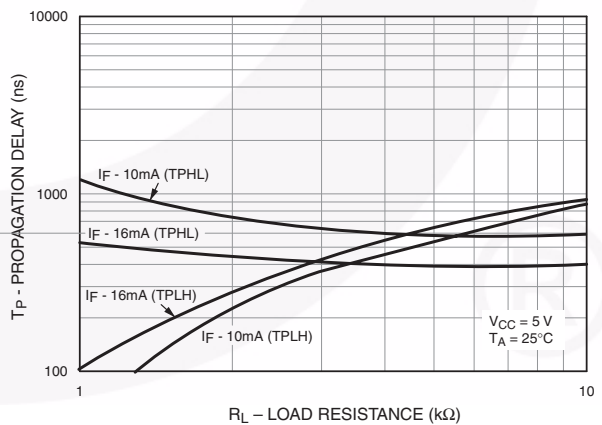
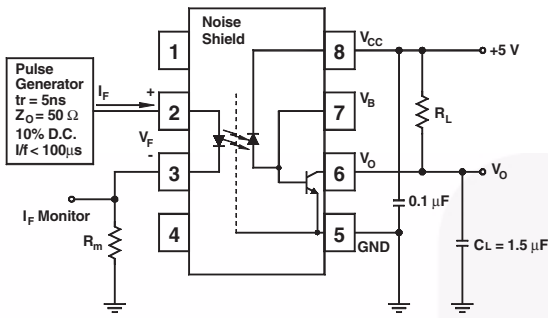


Fig. 6 Propagation Delay vs. Load Resistance

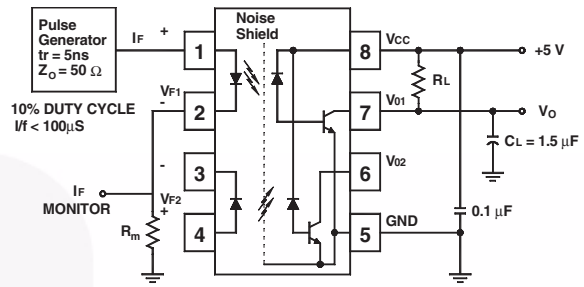




### Test Circuits



Test Circuit for 6N135, 6N136, HCPL-2503 and HCPL-4502



Test Circuit for HCPL-2530 and HCPL-2531

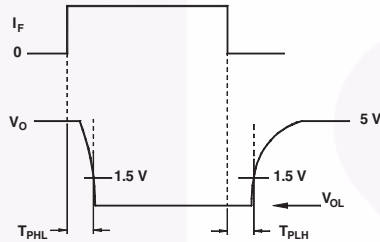
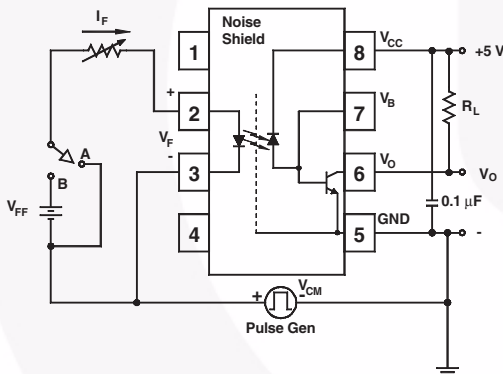
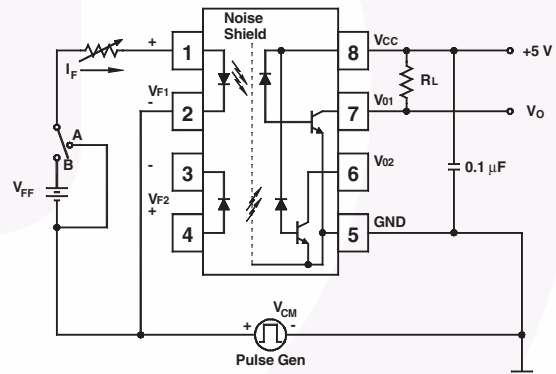


Fig. 7 Switching Time Test Circuit



Test Circuit for 6N135, 6N136, HCPL-2503 and HCPL-4502



Test Circuit for HCPL-2530 and HCPL-2531

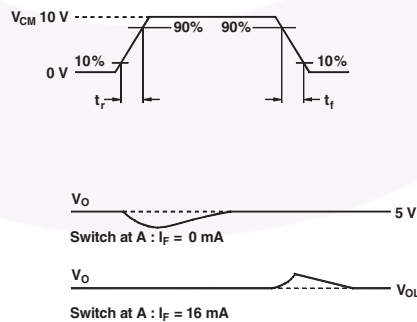


Fig. 8 Common Mode Immunity Test Circuit

## Ordering Information

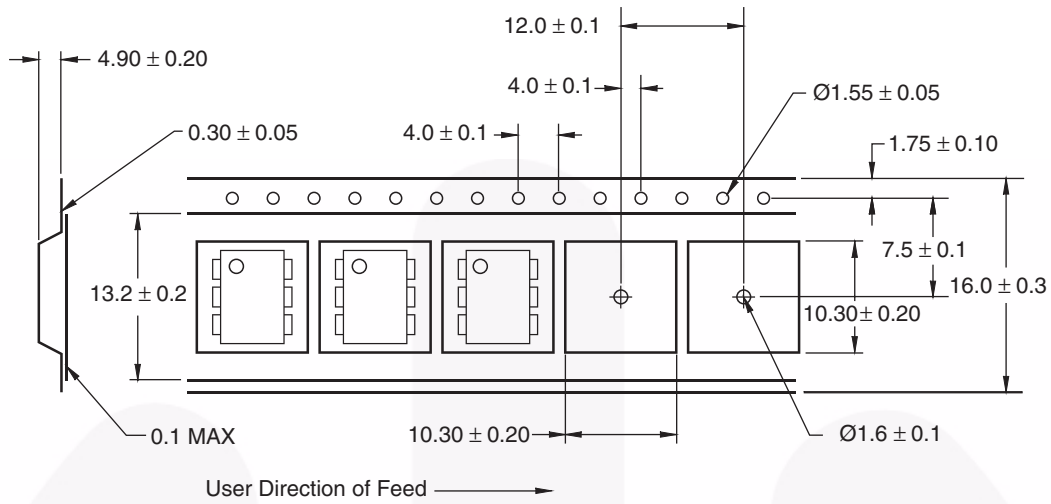
| Option | Example Part Number | Description                           |
|--------|---------------------|---------------------------------------|
| S      | 6N135S              | Surface Mount Lead Bend               |
| SD     | 6N135SD             | Surface Mount; Tape and reel          |
| W      | 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  |

## Tape Specifications



## Reflow Profile

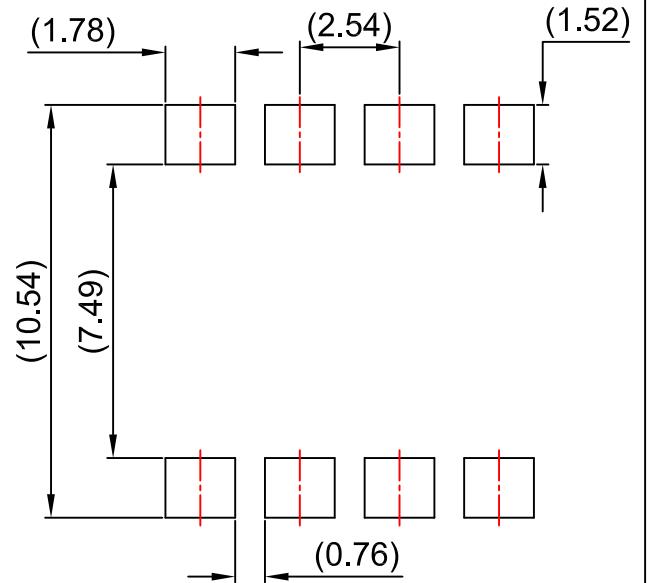
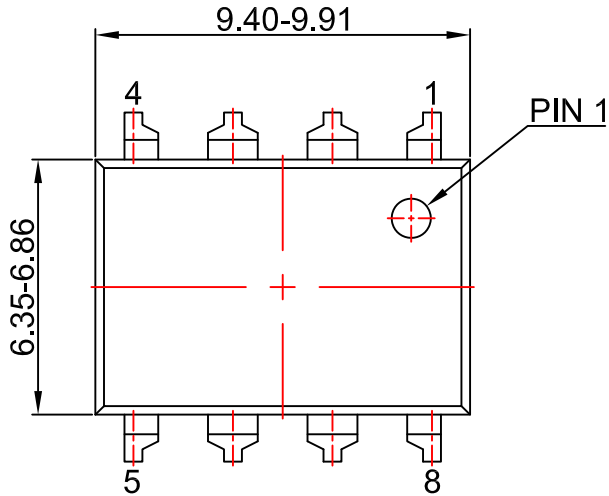


- Peak reflow temperature: 225C (package surface temperature)
- Time of temperature higher than 183C for 60-150 seconds
- One time soldering reflow is recommended

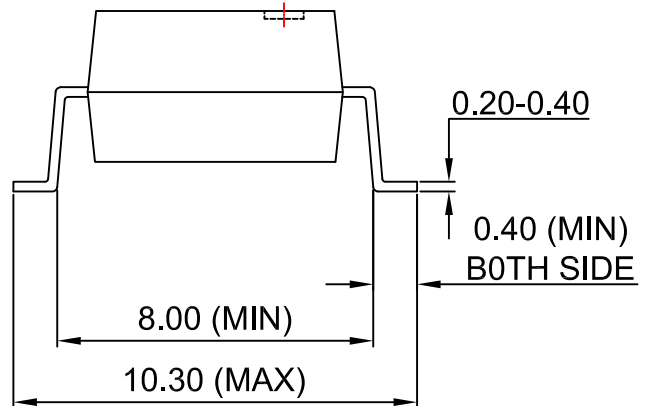
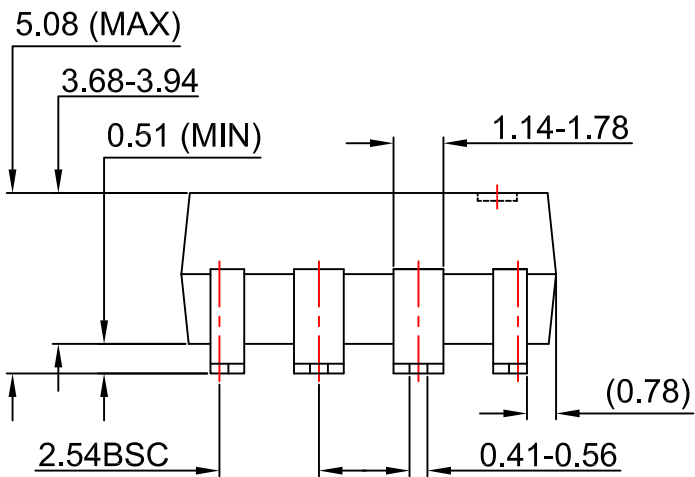


- NOTES:
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LAND PATTERN RECOMMENDATION



NOTES:

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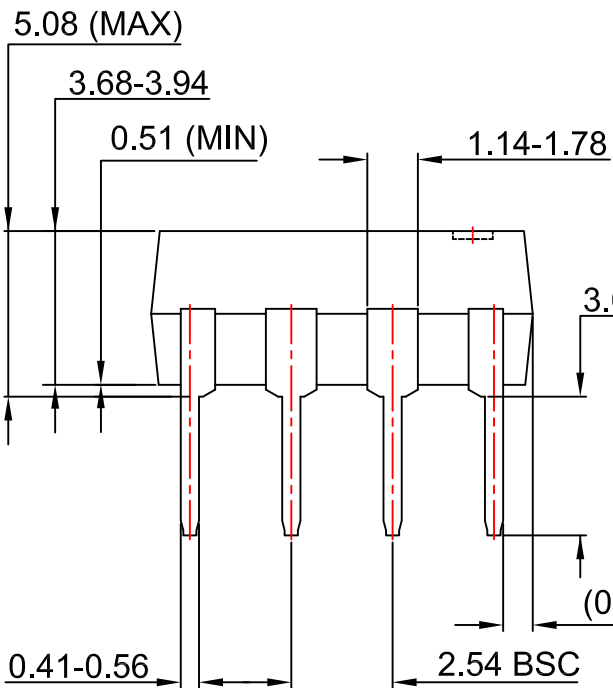


PIN 1

15.0° (MAX)

10.16 (TYP)

0.20-0.40



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