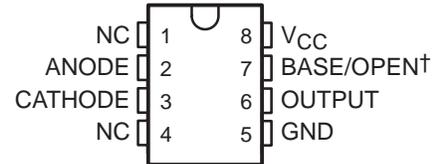


# 6N135, 6N136, HCPL4502 OPTOCOUPLEDERS/OPTOISOLATORS

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- Compatible with TTL Inputs
- High-Speed Switching . . . 1 Mbit/s Typ
- Bandwidth . . . 2 MHz Typ
- High Common-Mode Transient Immunity . . . 1000 V/ $\mu$ s Typ
- High-Voltage Electrical Insulation . . . 3000 Vdc Min
- Open-Collector Output
- UL Recognized . . . File Number 65085

6N135, 6N136, OR HCPL4502 PACKAGE  
(TOP VIEW)



† Terminal 7 is BASE on the 6N135 and 6N136 and OPEN on the HCPL4502

NC – No internal connection

## description

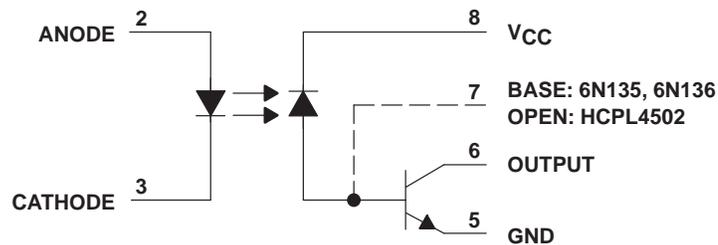
These high-speed optocouplers are designed for use in analog or digital interface applications that require high-voltage isolation between the input and output. Applications include line receivers that require high common-mode transient immunity, and analog or logic circuits that require input-to-output electrical isolation.

The 6N135, 6N136, and HCPL4502 optocouplers each consists of a light-emitting diode and an integrated photon detector composed of a photodiode and an open-collector output transistor. Separate connections are provided for the photodiode bias and the transistor-collector output. This feature, which reduces the transistor base-to-collector capacitance, results in speeds up to one hundred times that of a conventional phototransistor optocoupler.

The 6N135 is designed for TTL/CMOS, TTL/LSTTL, and wide-band analog applications.

The 6N136 and HCPL4502 are designed for high-speed TTL/TTL applications. The HCPL4502 has no base connection.

## schematic



# 6N135, 6N136, HCPL4502 OPTOCOUPERS/OPTOISOLATORS

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## absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†‡

|  |                |
|--|----------------|
| Supply and output voltage range, $V_{CC}$ and $V_O$                            | –0.5 V to 15 V |
| Reverse input voltage  | 5 V            |
| Emitter-base reverse voltage   | 5 V            |
| Peak input forward current (pulse duration = 1 ms, 50% duty cycle, see Note 1) | 50 mA          |
| Peak transient input forward current (pulse duration 1 $\mu$ s, 300 Hz)        | 1 A            |
| Average forward input current(see Note 2)                                      | 25 mA          |
| Peak output current  | 16 mA          |
| Average output current   | 8 mA           |
| Base current   | 5 mA           |
| Input power dissipation at (or below) 70°C free-air temperature (see Note 3)   | 45 mW          |
| Output power dissipation at (or below) 70°C free-air temperature (see Note 4)  | 100 mW         |
| Storage temperature range, $T_{stg}$   | –55°C to 125°C |
| Operating free-air temperature range, $T_A$                                    | –55°C to 100°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds                   | 260°C          |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

‡ JEDEC registered data for 6N135 and 6N136

- NOTES:
1. Derate linearly above 70°C free-air temperature at the rate of 1.67 mA/°C.
  2. Derate linearly above 70°C free-air temperature at the rate of 0.83 mA/°C.
  3. Derate linearly above 70°C free-air temperature at the rate of 1.50 mW/°C.
  4. Derate linearly above 70°C free-air temperature at the rate of 3.33 mW/°C.



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# 6N135, 6N136, HCPL4502 OPTOCOUPLEDERS/OPTOISOLATORS

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**electrical characteristics over operating free-air temperature range of 0°C to 70°C (unless otherwise noted)**

| PARAMETER    | TEST CONDITIONS                            | 6N135   |  |           | 6N136, HCPL4502 |                     |     | UNIT          |
|--------------|--|---|--|-----------|-----------------|---------------------|-----|---------------|
|              |  | MIN   | TYP†   | MAX       | MIN             | TYP†                | MAX |               |
| $V_F$ ‡      | Input forward voltage                      | $I_F = 16 \text{ mA}$ , $T_A = 25^\circ\text{C}$                                    |  | 1.6       | 1.7             | 1.6                 | 1.7 | V             |
| $\infty V_F$ | Temperature coefficient of forward voltage | $I_F = 16 \text{ mA}$   |  | -1.8      |                 | -1.8                |     | mV/°C         |
| $V_{BR}$ ‡   | Input breakdown voltage                    | $I_R = 10 \mu\text{A}$ , $T_A = 25^\circ\text{C}$                                   |  | 5         |                 | 5                   |     | V             |
| $V_{OL}$     | Low-level output voltage                   | $V_{CC} = 4.5 \text{ V}$ ,<br>$I_F = 16 \text{ mA}$ ,<br>$I_B = 0$                  | $I_{OL} = 1.1 \text{ mA}$                            | 0.1       |                 | 0.4                 |     | V             |
|              |  |   | $I_{OL} = 2.4 \text{ mA}$                            |           |                 | 0.1                 |     |               |
| $I_{OH}$ ‡   | High-level output current                  | $I_F = 0$ ,<br>$I_B = 0$ ,<br>$T_A = 25^\circ\text{C}$                              | $V_{CC} = V_O = 5.5 \text{ V}$                       | 3         |                 | 500                 |     | nA            |
|              |  |   | $V_{CC} = V_O = 15 \text{ V}$                        | 0.01      |                 | 1                   |     | $\mu\text{A}$ |
| $I_{OH}$     | High-level output current                  | $V_{CC} = 15 \text{ V}$ ,<br>$I_F = 0$ ,  | $V_O = 15 \text{ V}$ ,<br>$I_B = 0$                  | 50        |                 | 50                  |     | $\mu\text{A}$ |
| $I_{CCH}$ ‡  | Supply current, high-level output          | $V_{CC} = 15 \text{ V}$ ,<br>$I_F = 0$ ,<br>$T_A = 25^\circ\text{C}$                | $I_O = 0$ ,<br>$I_B = 0$ ,                           | 0.02      |                 | 1                   |     | $\mu\text{A}$ |
| $I_{CCH}$    | Supply current, high-level output          | $V_{CC} = 15 \text{ V}$ ,<br>$I_F = 0$ ,  | $I_O = 0$ ,<br>$I_B = 0$                             | 2         |                 | 2                   |     | $\mu\text{A}$ |
| $I_{CCL}$    | Supply current, low-level output           | $V_{CC} = 15 \text{ V}$ ,<br>$I_F = 16 \text{ mA}$ ,                                | $I_O = 0$ ,<br>$I_B = 0$                             | 40        |                 | 40                  |     | $\mu\text{A}$ |
| $h_{FE}$     | Transistor forward current transfer ratio  | $V_O = 5 \text{ V}$ ,   | $I_O = 3 \text{ mA}$                                 | 100       |                 | 100<br>(6N136 only) |     |               |
| $CTR$ ‡      | Current transfer ratio                     | $V_{CC} = 4.5 \text{ V}$ ,<br>$I_F = 16 \text{ mA}$ ,<br>$T_A = 25^\circ\text{C}$ , | $V_O = 0.4 \text{ V}$ ,<br>$I_B = 0$ ,<br>See Note 5 | 7% 18%    |                 | 19% 24%             |     |               |
| $CTR$        | Current transfer ratio                     | $V_{CC} = 4.5 \text{ V}$ ,<br>$I_F = 16 \text{ mA}$ ,<br>See Note 5                 | $V_O = 0.5 \text{ V}$ ,<br>$I_B = 0$ ,               | 5%        |                 | 15%                 |     |               |
| $r_{IO}$     | Input-output resistance                    | $V_{IO} = 500 \text{ V}$ ,<br>See Note 6  | $T_A = 25^\circ\text{C}$ ,                           | $10^{12}$ |                 | $10^{12}$           |     | $\Omega$      |
| $I_{IO}$ ‡   | Input-output insulation leakage current    | $V_{IO} = 3000 \text{ V}$ ,<br>$T_A = 25^\circ\text{C}$ ,<br>See Note 6             | $t = 5 \text{ s}$ ,<br>$\text{RH} = 45\%$ ,          | 1         |                 | 1                   |     | $\mu\text{A}$ |
| $C_i$        | Input capacitance                          | $V_F = 0$ ,   | $f = 1 \text{ MHz}$                                  | 60        |                 | 60                  |     | pF            |
| $C_{io}$     | Input-output capacitance                   | $f = 1 \text{ MHz}$ ,   | See Note 6   | 0.6       |                 | 0.6                 |     | pF            |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

‡ JEDEC registered data for 6N135 and 6N136

- NOTES: 5. Current transfer ratio is defined as the ratio of output collector current  $I_O$  to the forward LED input current  $I_F$  times 100%.  
6. These parameters are measured with terminals 2 and 3 shorted together and terminals 5, 6, 7, and 8 shorted together.

# 6N135, 6N136, HCPL4502 OPTOCOUPPLERS/OPTOISOLATORS

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## operating characteristics, $V_{CC} = 5\text{ V}$ , $I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER            | TEST CONDITIONS                  | 6N135 |     |     | 6N136, HCPL4502 |     |     | UNIT |
|----------------------|----------------------------------|-------|-----|-----|-----------------|-----|-----|------|
|                      |                                  | MIN   | TYP | MAX | MIN             | TYP | MAX |      |
| BW Bandwidth (–3 dB) | $R_L = 100\ \Omega$ , See Note 7 | 2     |     |     | 2               |     |     | MHz  |

NOTE 7: Bandwidth is the range of frequencies within which the ac output voltage is not more than 3 dB below the low-frequency value.

## switching characteristics at $V_{CC} = 5\text{ V}$ , $I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$

| PARAMETER                | TEST CONDITIONS   | 6N135   |     |     | 6N136, HCPL4502 |     |     | UNIT                   |
|--------------------------|---|---------|-----|-----|-----------------|-----|-----|------------------------|
|                          |   | MIN     | TYP | MAX | MIN             | TYP | MAX |                        |
| $t_{PLH}^\dagger$        | Propagation delay time, low-to-high-level output<br>$R_L = 4.1\text{ k}\Omega$ , See Figure 1   | 1 1.5   |     |     |                 |     |     | $\mu\text{s}$          |
|                          | $R_L = 1.9\text{ k}\Omega$ , See Figure 1   |         |     |     | 0.6 0.8         |     |     |                        |
| $t_{PHL}^\dagger$        | Propagation delay time, high-to-low-level output<br>$R_L = 4.1\text{ k}\Omega$ , See Figure 1   | 0.7 1.5 |     |     |                 |     |     | $\mu\text{s}$          |
|                          | $R_L = 1.9\text{ k}\Omega$ , See Figure 1   |         |     |     | 0.6 0.8         |     |     |                        |
| $\frac{dV_{CM}}{dt}$ (H) | Common-mode input transient immunity, high-level output<br>$\Delta V_{CM} = 10\text{ V}$ , $R_L = 4.1\text{ k}\Omega$ , See Figure 2                    | 1000    |     |     |                 |     |     | $\text{V}/\mu\text{s}$ |
|                          | $\Delta V_{CM} = 10\text{ V}$ , $R_L = 1.9\text{ k}\Omega$ , See Figure 2   |         |     |     | 1000            |     |     |                        |
| $\frac{dV_{CM}}{dt}$ (L) | Common-mode input transient immunity, low-level output<br>$\Delta V_{CM} = 10\text{ V}$ , See Notes 9 and 10, $R_L = 4.1\text{ k}\Omega$ , See Figure 2 | 1000    |     |     |                 |     |     | $\text{V}/\mu\text{s}$ |
|                          | $\Delta V_{CM} = 10\text{ V}$ , See Notes 9 and 10, $R_L = 1.9\text{ k}\Omega$ , See Figure 2   |         |     |     | 1000            |     |     |                        |

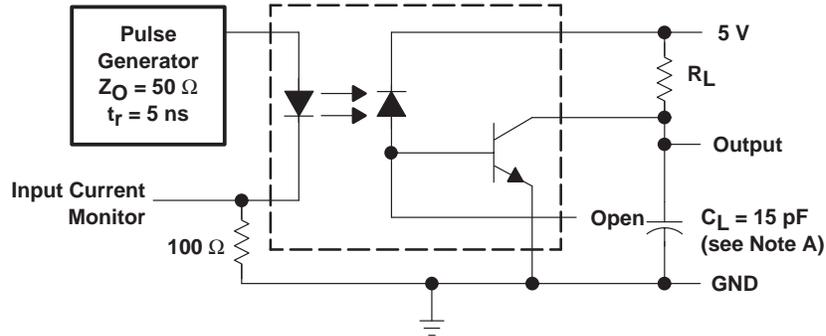
$^\dagger$  JEDEC registered data for 6N135 and 6N136

NOTES: 8. The 4.1-k $\Omega$  load represents one LSTTL unit load of 0.36 mA and a 6.1-k $\Omega$  pullup resistor.

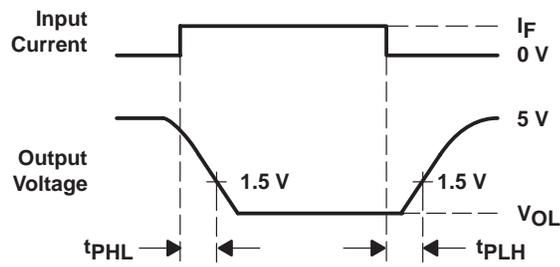
9. The 1.9-k $\Omega$  load represents one TTL unit load of 1.6 mA and a 5.6-k $\Omega$  pullup resistor.

10. Common-mode transient immunity, high-level output, is the maximum rate of rise of the common-mode input voltage that does not cause the output voltage to drop below 2 V. Common-mode input transient immunity, low-level output, is the maximum rate of fall of the common-mode input voltage that does not cause the output voltage to rise above 0.8 V.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



WAVEFORMS

NOTE A:  $C_L$  includes probe and stray capacitance.

Figure 1. Switching Test Circuit and Waveforms

# 6N135, 6N136, HCPL4502 OPTOCOUPPLERS/OPTOISOLATORS

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## PARAMETER MEASUREMENT INFORMATION

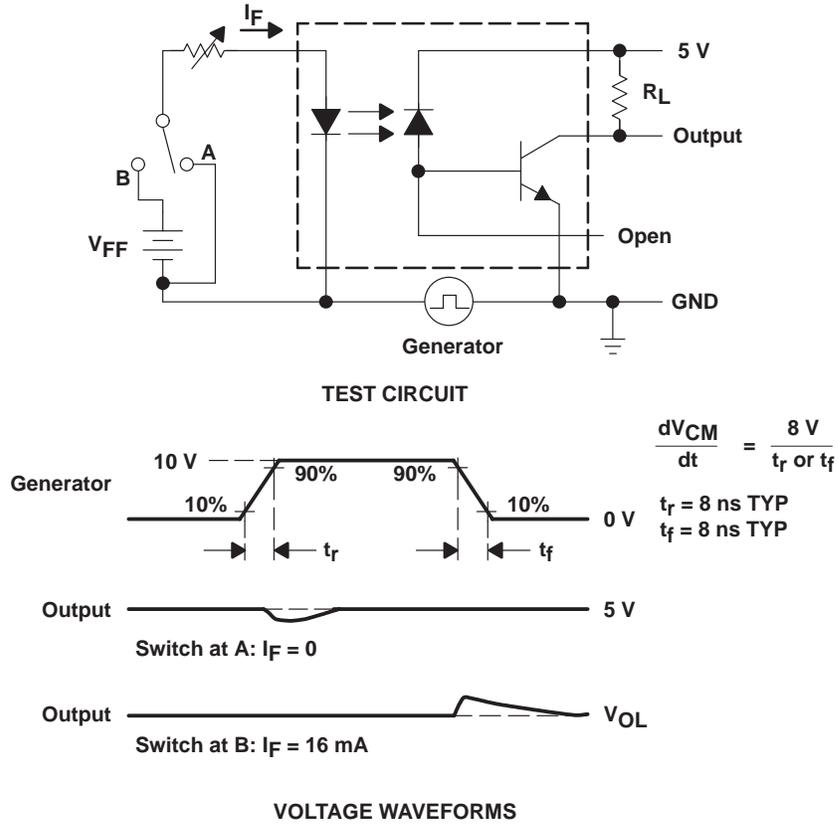
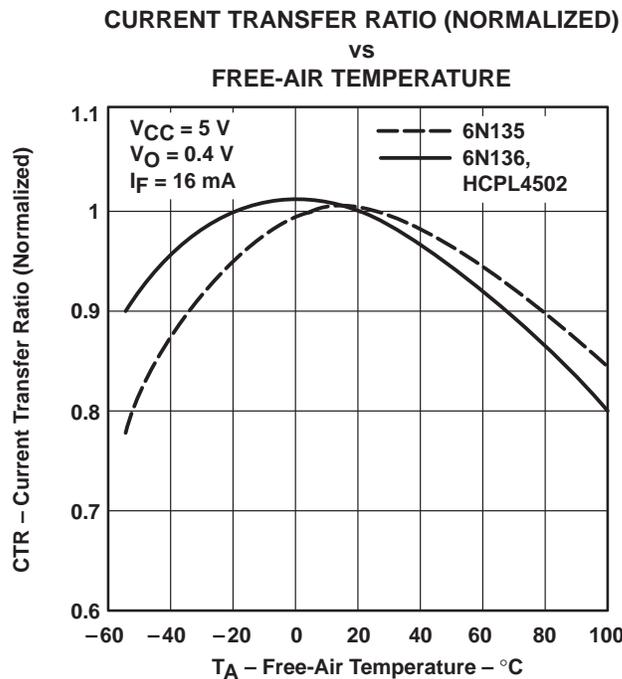
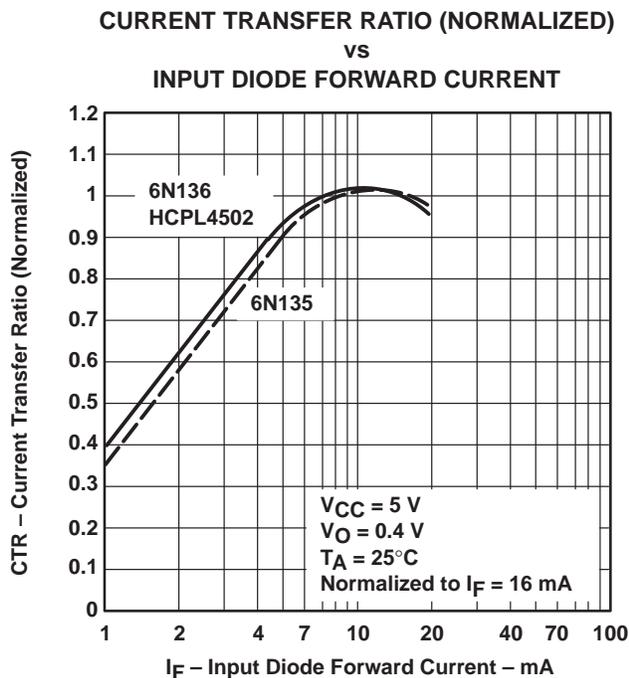
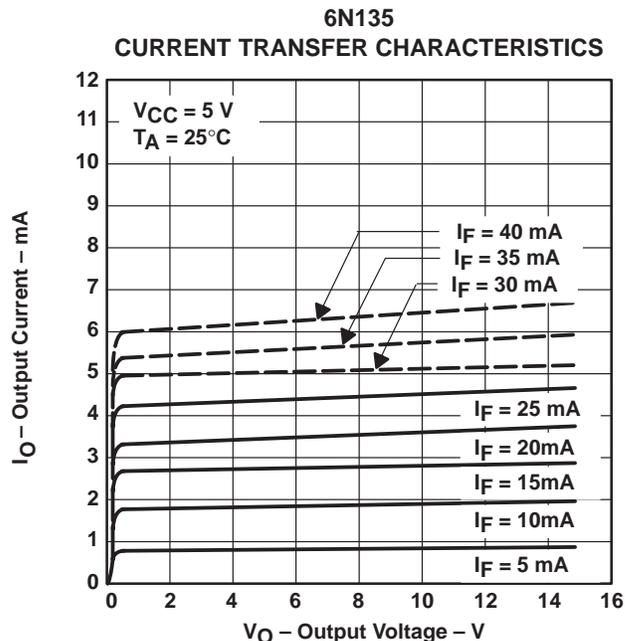
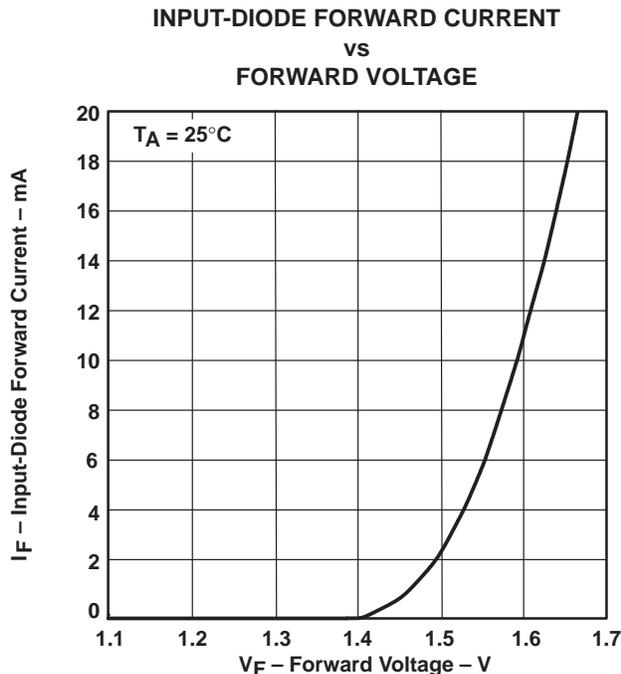


Figure 2. Transient Immunity Test Circuit and Waveforms

TYPICAL CHARACTERISTICS



# 6N135, 6N136, HCPL4502 OPTOCOUPLEDERS/OPTOISOLATORS

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## TYPICAL CHARACTERISTICS

**HIGH-LEVEL OUTPUT CURRENT  
vs  
FREE-AIR TEMPERATURE**

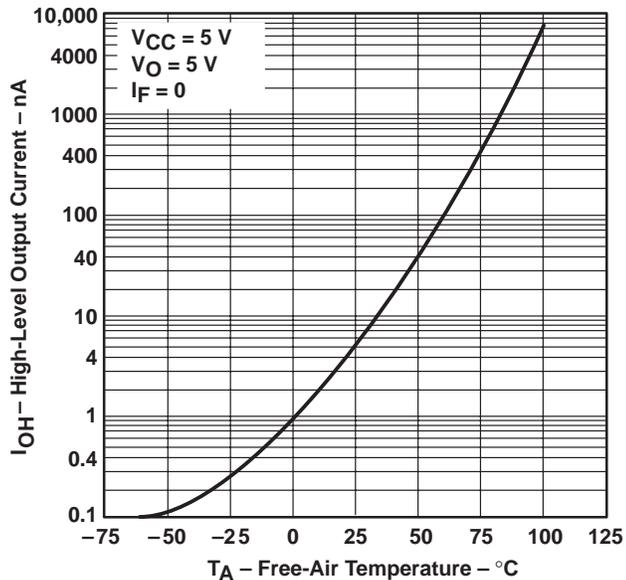


Figure 7

**DIFFERENTIAL CURRENT TRANSFER RATIO  
vs  
INPUT-DIODE QUIESCENT FORWARD CURRENT**

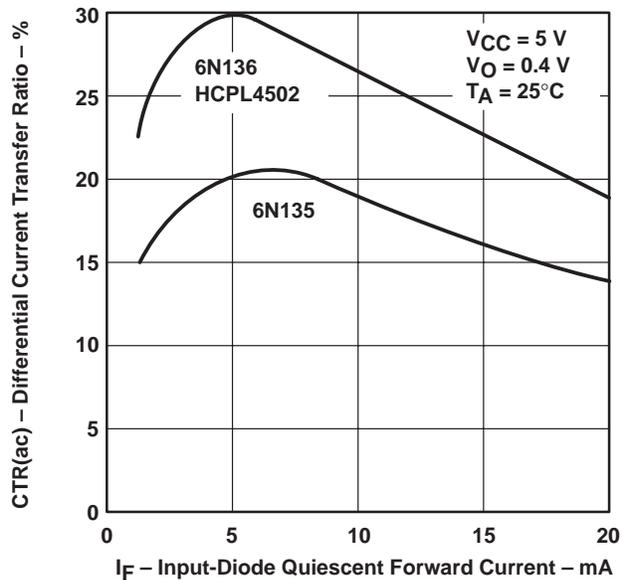


Figure 8

**FREQUENCY RESPONSE (NORMALIZED)  
vs  
FREQUENCY**

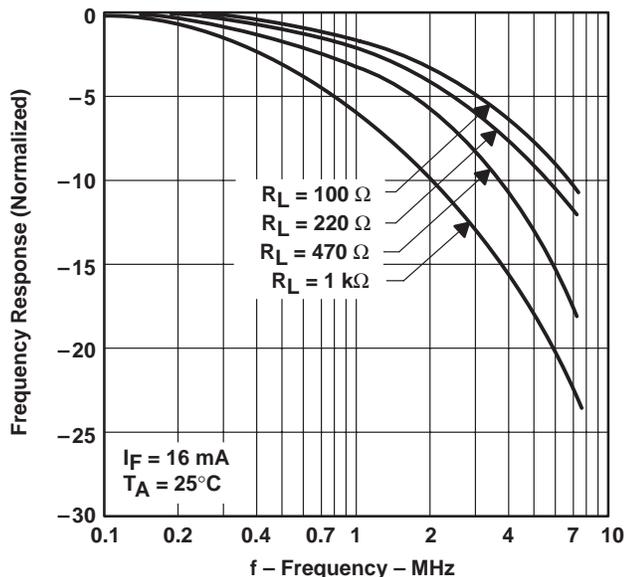


Figure 9

**PROPAGATION DELAY TIME  
vs  
FREE-AIR TEMPERATURE**

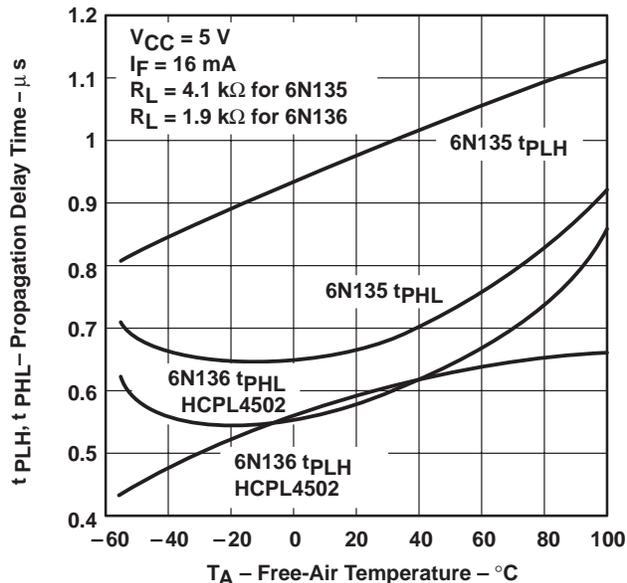
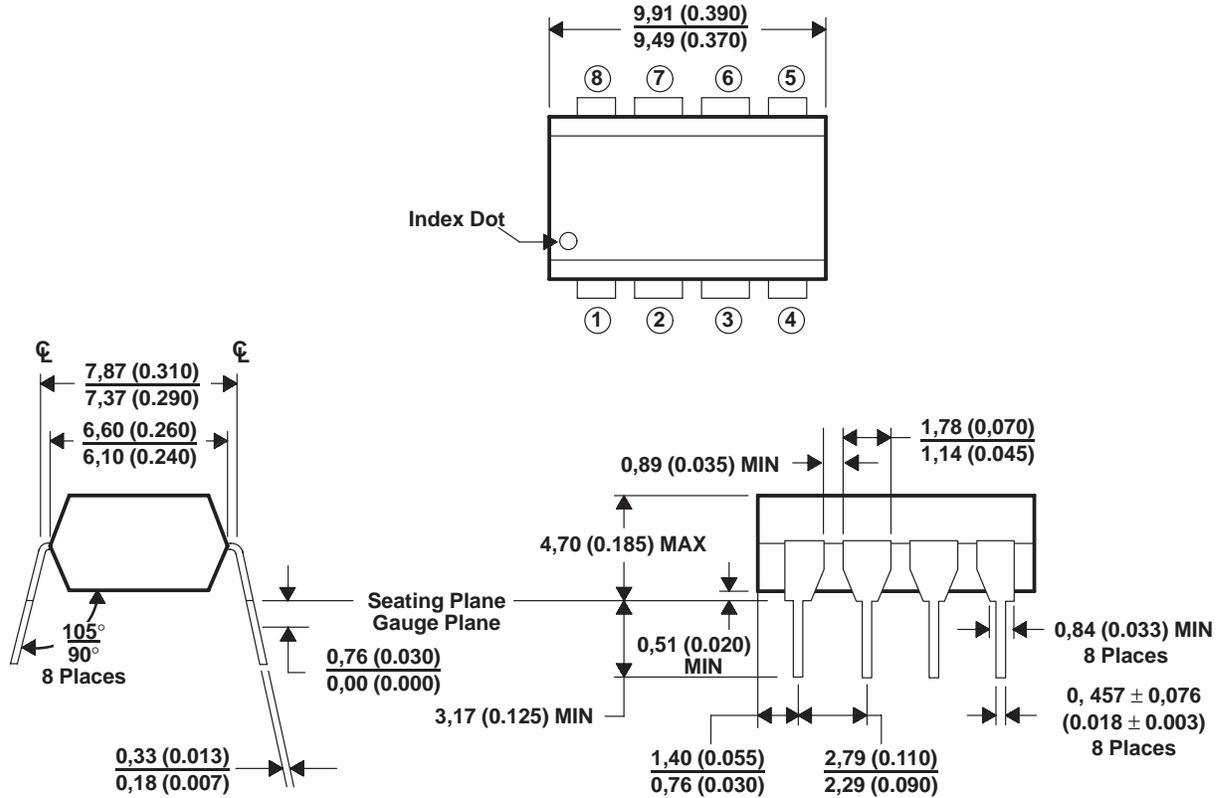


Figure 10



MECHANICAL INFORMATION



NOTES: A. JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.  
B. All linear dimensions are given in millimeters and parenthetically given in inches.

Figure 11. Packaging Specifications

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 6N135            | OBSOLETE              | PDIP         | N               | 8    |             | TBD                     | Call TI          | Call TI                      |
| 6N136            | OBSOLETE              | PDIP         | N               | 8    |             | TBD                     | Call TI          | Call TI                      |
| HCPL4502         | OBSOLETE              | PDIP         | N               | 8    |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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