

# 6N135/6, HCNW135/6, HCPL-2502/0500/ 0501

## Single-Channel, High-Speed Optocouplers

### Description

These diode-transistor optocouplers use an insulating layer between a LED and an integrated photodetector to provide electrical insulation between input and output. Separate connections for the photodiode bias and output-transistor collector increase the speed up to a hundred times that of a conventional phototransistor coupler by reducing the base-collector capacitance.

These single channel optocouplers are available in 8-pin DIP, SO-8, and Widebody package configurations.

The 6N135, HCPL-0500, and HCNW135 are for use in TTL/CMOS, TTL/LSTTL or wide-bandwidth analog applications. Current transfer ratio (CTR) for these devices is 7% minimum at  $I_F = 16$  mA.

The 6N136, HCPL-2502, HCPL-0501, and HCNW136 are designed for high-speed TTL/TTL applications. A standard 16-mA TTL sink current through the input LED will provide enough output current for 1 TTL load and a 5.6 k $\Omega$  pull-up resistor. CTR for these devices is 19% minimum at  $I_F = 16$  mA.

### Features

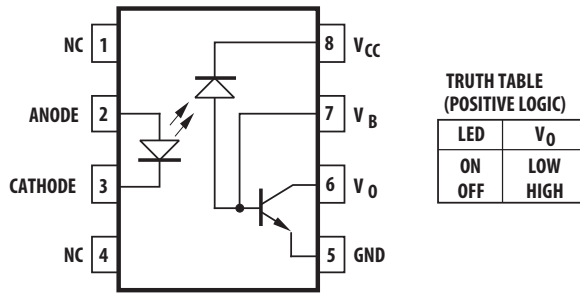
- High speed: 1 Mb/s
- TTL compatible
- Available in 8-pin DIP, SO-8, widebody packages
- Open collector output
- Safety approval
  - UL Recognized – 3750 V<sub>rms</sub> for 1 minute (5000 V<sub>rms</sub> for 1 minute for HCNW and Option 020 devices) per UL1577
  - CSA Approved
  - IEC/EN/DIN EN 60747-5-5 Approved
  - V<sub>IORM</sub> = 567V peak for SO-8 devices
  - V<sub>IORM</sub> = 630V peak for DIP 300 mil devices
  - V<sub>IORM</sub> = 1414V peak for DIP 400 mil (widebody) devices
- Dual channel version available (253X/053X/0534)

### Applications

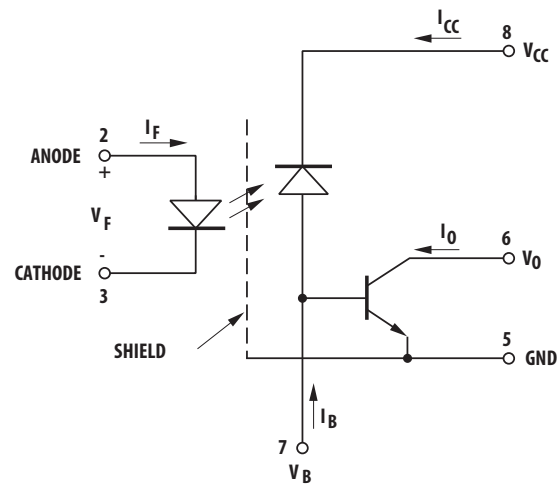
- High voltage insulation
- Video signal isolation
- Line receivers
- Feedback element in switched mode power supplies
- High speed logic ground isolation
  - TTL/TTL, TTL/CMOS, TTL/LSTTL
- Replaces pulse transformers
- Replaces slow phototransistor isolators
- Analog signal ground isolation

**CAUTION!** Take normal static precautions in handling and assembly of this component to prevent damage and/or degradation that may be induced by ESD.

## Functional Diagram



## Schematic



## Truth Table (Positive Logic)

| LED | $V_0$ |
|-----|-------|
| ON  | LOW   |
| OFF | HIGH  |

A 0.1- $\mu$ F bypass capacitor must be connected between pins 5 and 8.

## Selection Guide

| Minimum CMR        |              |                            | 8-Pin DIP (300 Mil)    |                                   | Small Outline SO-8     |                                   | Widebody (400 Mil)     |
|--------------------|--------------|----------------------------|------------------------|-----------------------------------|------------------------|-----------------------------------|------------------------|
| dV/dT (V/ $\mu$ s) | $V_{CM}$ (V) | Current Transfer Ratio (%) | Single Channel Package | Dual Channel Package <sup>a</sup> | Single Channel Package | Dual Channel Package <sup>a</sup> | Single Channel Package |
| 1000               | 10           | 7                          | 6N135                  | HCPL-2530                         | HCPL-0500              | HCPL-0530                         | HCNW135                |
|                    |              | 19                         | 6N136                  | HCPL-2531                         | HCPL-0501              | HCPL-0531                         | HCNE136                |
|                    |              | 15                         | HCPL-2502              |                                   |                        |                                   |                        |

a. Technical data for these products are on separate Broadcom publications.

## Ordering Information

6N135, 6N136, HCPL-2502, HCPL-0500, HCPL-0501 are UL Recognized with 3750  $V_{rms}$  for 1 minute per UL1577.

HCNW135 and HCNW136 are UL Recognized with 5000  $V_{rms}$  for 1 minute per UL1577. All these devices are approved under CSA Component Acceptance Notice #5, File CA 88324.

| Part Number | Option         |                    | Package                      | Surface Mount | Gull Wing | Tape and Reel | UL 3750 $V_{rms}$ / 1 Minute Rating | UL 5000 $V_{rms}$ / 1 Minute Rating | IEC/EN/DIN EN 60747-5-5 | Quantity     |               |
|-------------|----------------|--------------------|------------------------------|---------------|-----------|---------------|-------------------------------------|-------------------------------------|-------------------------|--------------|---------------|
|             | RoHS Compliant | Non RoHS Compliant |                              |               |           |               |                                     |                                     |                         |              |               |
| 6N135       | -000E          | No option          | 300mil<br>DIP-8              |               |           |               | X                                   |                                     |                         | 50 per tube  |               |
| 6N136       | -300E          | #300               |                              | X             | X         |               | X                                   |                                     |                         | 50 per tube  |               |
| HCPL-2502   | -500E          | #500               |                              | X             | X         | X             | X                                   |                                     |                         |              | 1000 per reel |
|             | -020E          | #020               |                              |               |           |               |                                     | X                                   |                         |              | 50 per tube   |
|             | -320E          | #320               |                              | X             | X         |               |                                     | X                                   |                         |              | 50 per tube   |
|             | -520E          | #520               |                              | X             | X         | X             |                                     | X                                   |                         |              | 1000 per reel |
|             | -060E          | #060               |                              |               |           |               |                                     | X                                   |                         | X            | 50 per tube   |
|             | -360E          | #360               |                              | X             | X         |               |                                     | X                                   |                         | X            | 50 per tube   |
|             | -560E          | #560               |                              | X             | X         | X             |                                     | X                                   |                         | X            | 1000 per reel |
| HCPL-0500   | -000E          | No option          | SO-8                         | X             |           |               | X                                   |                                     |                         | 100 per tube |               |
| HCPL-0501   | -500E          | #500               |                              | X             |           | X             | X                                   |                                     |                         |              | 1500 per reel |
|             | -060E          | #060               |                              | X             |           |               | X                                   |                                     | X                       |              | 100 per tube  |
|             | -560E          | #560               |                              | X             |           | X             | X                                   |                                     | X                       |              | 1500 per reel |
| HCNW135     | -000E          | No option          | 400 mil<br>Widebody<br>DIP-8 |               |           |               |                                     | X                                   | X                       | 42 per tube  |               |
| HCNW136     | -300E          | #300               |                              | X             | X         |               |                                     | X                                   | X                       | 42 per tube  |               |
|             | -500E          | #500               |                              | X             | X         | X             |                                     | X                                   | X                       | 750 per reel |               |

To order, choose a part number from the part number column and combine with the desired option from the option column to form an order entry.

### Example 1:

HCPL-2502-560E to order product of 300 mil DIP Gull Wing Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-5 Safety Approval in RoHS compliant.

### Example 2:

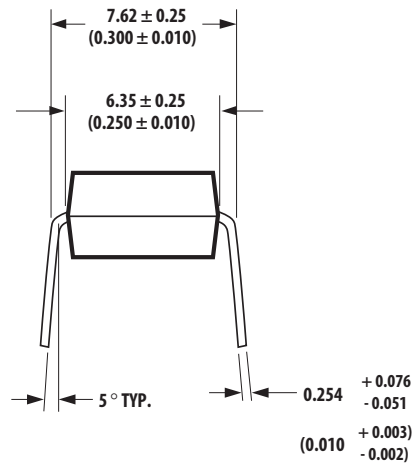
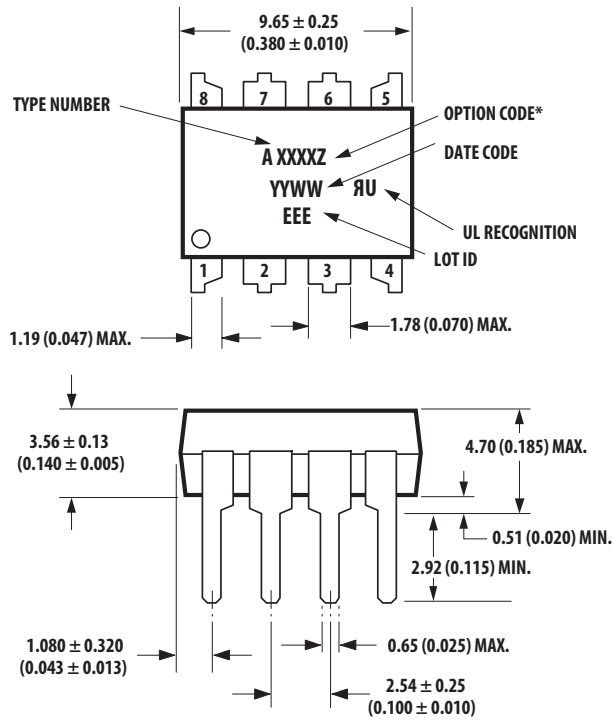
HCPL-2502 to order product of 300 mil DIP package in tube packaging and non RoHS compliant.

Optional data sheets are available. Contact your Broadcom® sales representative or authorized distributor for information.

**NOTE:** The notation '#XXX' is used for existing products, while (new) products launched since 15th July 2001 and RoHS compliant option will use '-XXE'.

# Package Outline Drawings

## 8-Pin DIP Package (6N135/6, HCPL-2502)



DIMENSIONS IN MILLIMETERS AND (INCHES).

\*MARKING CODE LETTER FOR OPTION NUMBERS

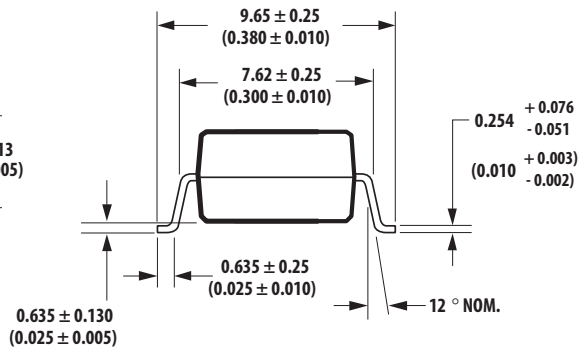
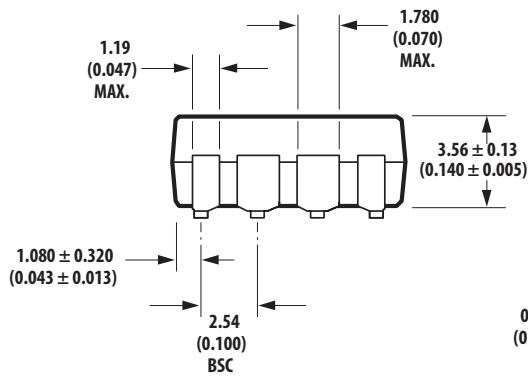
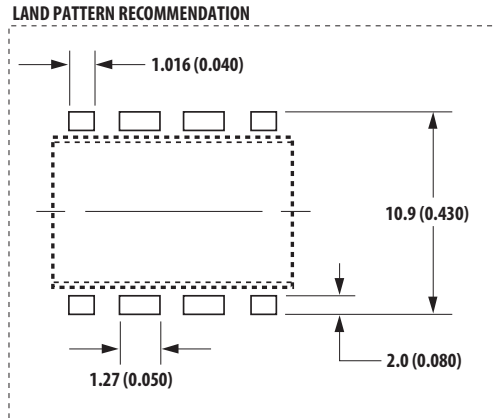
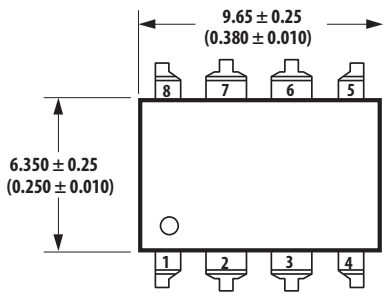
"L" = OPTION 020

"V" = OPTION 060

OPTION NUMBERS 300 AND 500 NOT MARKED.

NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

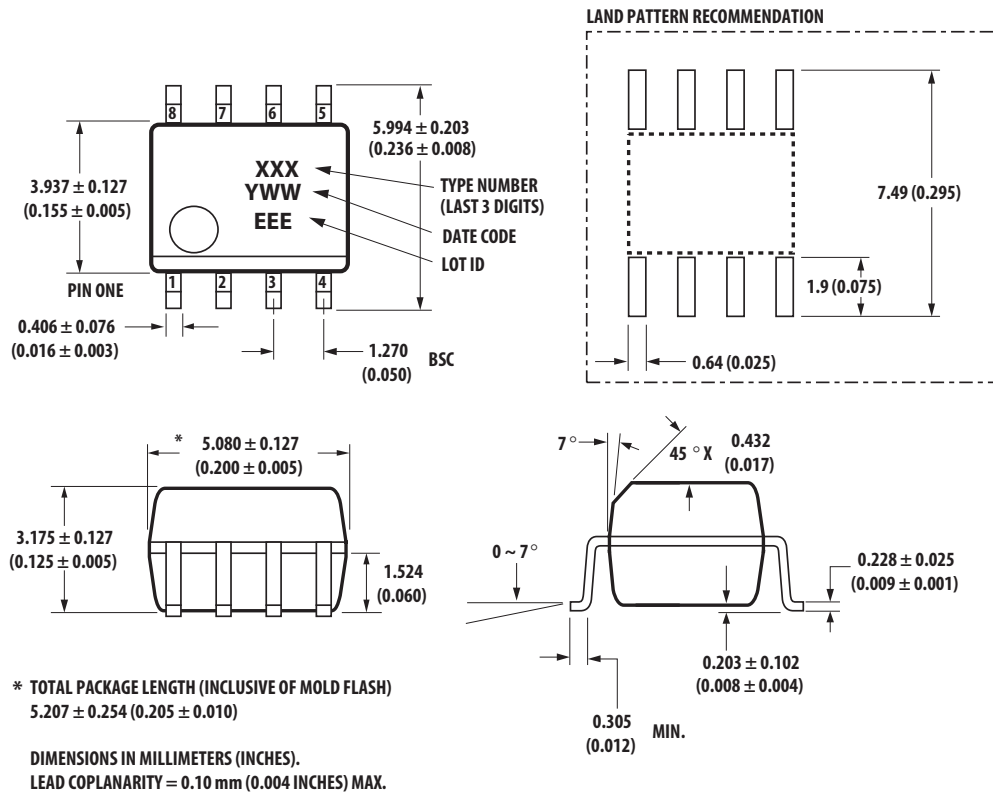
# 8-Pin DIP Package with Gull Wing Surface Mount Option 300 (6N135/6)



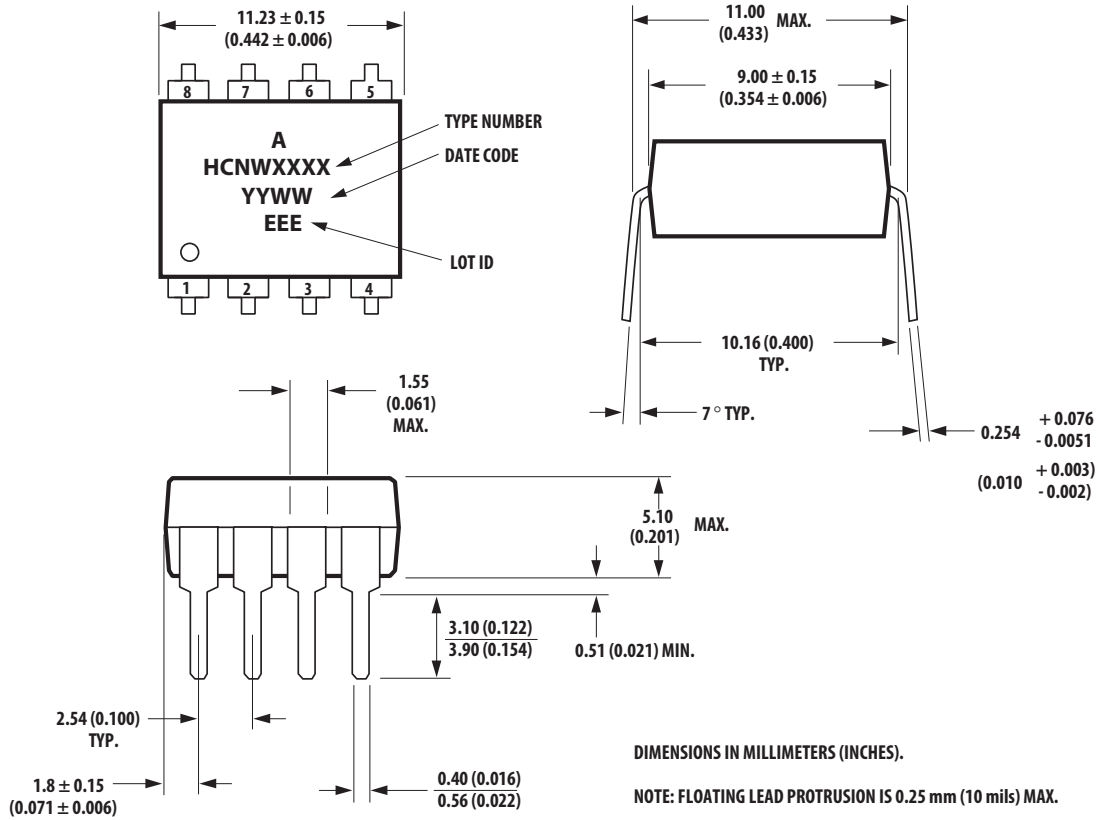
DIMENSIONS IN MILLIMETERS (INCHES).  
LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

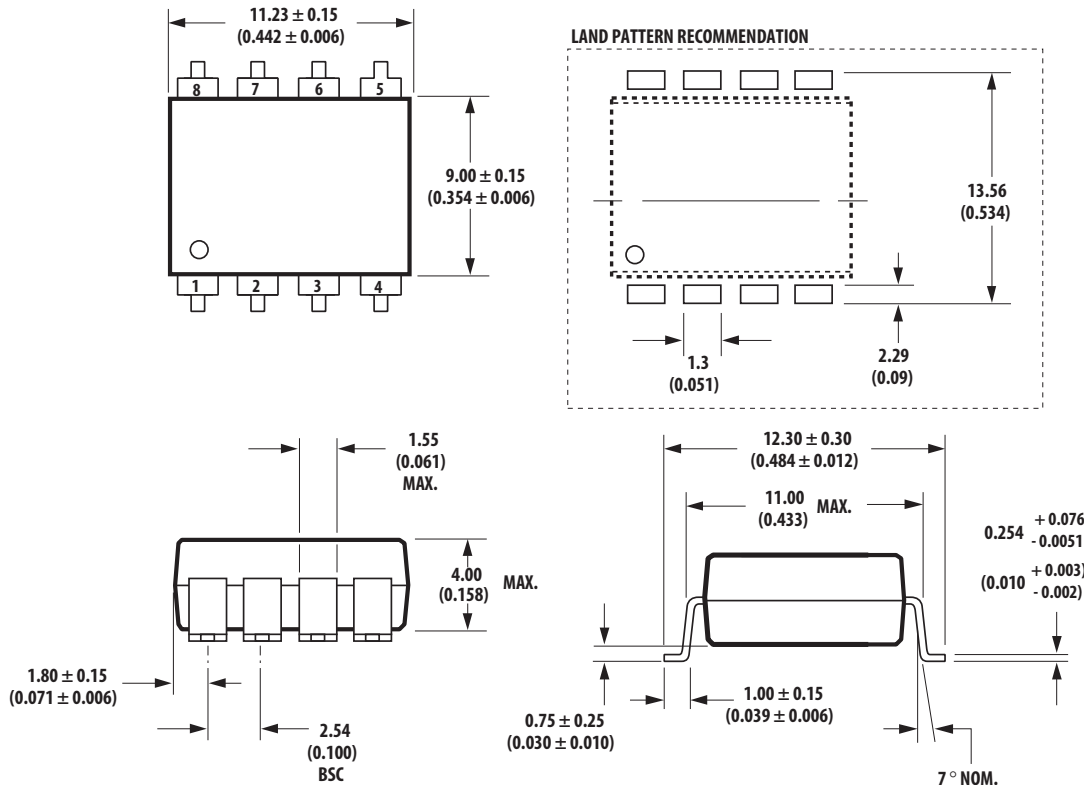
# Small Outline SO-8 Package (HCPL-0500/1)



# 8-Pin Widebody DIP Package (HCNW135/6)



## 8-Pin Widebody DIP Package with Gull Wing Surface Mount Option 300 (HCNW135/6)



DIMENSIONS IN MILLIMETERS (INCHES).

LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

## Solder Reflow Profile

Recommended reflow conditions are as per JEDEC Standard, J-STD-020 (latest revision). Non-halide flux should be used.

## Regulatory Information

The devices contained in this data sheet have been approved by the following organizations:

|                                |   |
|--------------------------------|---|
| <b>UL</b>                      | Approval under UL 1577, Component Recognition Program, File E55361. |
| <b>CSA</b>                     | Approval under CSA Component Acceptance Notice #5, File CA 88324.   |
| <b>IEC/EN/DIN EN 60747-5-5</b> | (HCNW and Option 060/360/560 only)                                  |



## Insulation and Safety Related Specifications

| Parameter  | Symbol | 8-Pin DIP<br>(300 Mil)<br>Value | SO-8 Value | Widebody<br>(400 Mil)<br>Value | Units | Conditions  |
|--|--------|---------------------------------|------------|--------------------------------|-------|---|
| Minimum External Air Gap<br>(External Clearance)     | L(101) | 7.1                             | 4.9        | 9.6                            | mm    | Measured from input terminals to output terminals, shortest distance through air.   |
| Minimum External Tracking<br>(External Creepage)     | L(102) | 7.4                             | 4.8        | 10.0                           | mm    | Measured from input terminals to output terminals, shortest distance path along body..  |
| Minimum Internal Plastic Gap<br>(Internal Clearance) |        | 0.08                            | 0.08       | 1.0                            | mm    | Through insulation distance conductor to conductor, usually the direct distance between the photoemitter and photodetector inside the optocoupler cavity. |
| Minimum Internal Tracking<br>(Internal Creepage)     |        | N/A                             | N/A        | 4.0                            | mm    | Measured from input terminals to output terminals, along internal cavity.   |
| Tracking Resistance<br>(Comparative Tracking Index)  | CTI    | 200                             | 200        | 200                            | V     | DIN IEC 112/VDE 0303 Part 1   |
| Isolation Group                                      |        | IIIa                            | IIIa       | IIIa                           |       | Material Group<br>(DIN VDE 0110, 1/89, Table 1)   |

Option 300 – Surface mount classification is Class A in accordance with CECC 00802.

## IEC/EN/DIN EN 60747-5-5 Insulation Characteristics<sup>a</sup> (Option 060 Only)

| Description  | Symbol          | 8-Pin DIP                  | SO-8                        | Units       |
|--|-----------------|----------------------------|-----------------------------|-------------|
| Installation Classification per DIN VDE 0110/39, Table 1<br>for rated mains voltage $\leq 150 V_{rms}$<br>for rated mains voltage $\leq 300 V_{rms}$<br>for rated mains voltage $\leq 600 V_{rms}$ |                 | I – IV<br>I – IV<br>I – IV | I – IV<br>I – IV<br>I – III |             |
| Climatic Classification  |                 | 0/70/21                    | 0/70/21                     |             |
| Pollution Degree (DIN VDE 0110/39)   |                 | 2                          | 2                           |             |
| Maximum Working Insulation Voltage   | $V_{IORM}$      | 630                        | 567                         | $V_{peak}$  |
| Input to Output Test Voltage, Method b <sup>a</sup><br>$V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1s$ , Partial Discharge $< 5 pC$  | $V_{PR}$        | 1181                       | 1063                        | $V_{peak}$  |
| Input to Output Test Voltage, Method a <sup>a</sup><br>$V_{IORM} \times 1.6 = V_{PR}$ , Type and Sample Test, $t_m = 10s$ , Partial Discharge $< 5 pC$   | $V_{PR}$        | 1008                       | 907                         | $V_{peak}$  |
| Highest Allowable Overvoltage <sup>a</sup> (Transient Overvoltage $t_{ini} = 60s$ )  | $V_{IOTM}$      | 8000                       | 6000                        | $V_{peak}$  |
| Safety-limiting values – Maximum Values Allowed in the Event of a Failure  |                 |                            |                             |             |
| Case Temperature   | $T_S$           | 175                        | 150                         | $^{\circ}C$ |
| Input Current  | $I_{S, INPUT}$  | 230                        | 150                         | mA          |
| Output Power   | $P_{S, OUTPUT}$ | 600                        | 600                         | mW          |
| Insulation Resistance at $T_S$ , $V_{IO} = 500V$   | $R_S$           | $\geq 10^9$                | $\geq 10^9$                 | $\Omega$    |

a. Refer to the front of the optocoupler section of the current catalog, under Product Safety Regulations section IEC/EN/DIN EN 60747-5-5, for a detailed description.

**NOTE:** Isolation characteristics are guaranteed only within the safety maximum ratings, which must be ensured by protective circuits in the application.

## IEC/EN/DIN EN 60747-5-5 Insulation Characteristics<sup>a</sup> (HCNW135/6 Option 060 Only)

| Description   | Symbol          | Characteristic                        | Units       |
|---|-----------------|---------------------------------------|-------------|
| Installation Classification per DIN VDE 0110/39, Table 1<br>for rated mains voltage $\leq 150 V_{rms}$<br>for rated mains voltage $\leq 300 V_{rms}$<br>for rated mains voltage $\leq 600 V_{rms}$<br>for rated mains voltage $\leq 1000 V_{rms}$ |                 | I – IV<br>I – IV<br>I – IV<br>I – III |             |
| Climatic Classification   |                 | 0/70/21                               |             |
| Pollution Degree (DIN VDE 0110/39)  |                 | 2                                     |             |
| Maximum Working Insulation Voltage  | $V_{IORM}$      | 1414                                  | $V_{peak}$  |
| Input to Output Test Voltage, Method b <sup>a</sup><br>$V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1s$ , Partial Discharge $< 5 pC$   | $V_{PR}$        | 2651                                  | $V_{peak}$  |
| Input to Output Test Voltage, Method a <sup>a</sup><br>$V_{IORM} \times 1.6 = V_{PR}$ , Type and Sample Test, $t_m = 10s$ , Partial Discharge $< 5 pC$  | $V_{PR}$        | 2262                                  | $V_{peak}$  |
| Highest Allowable Overvoltage <sup>a</sup> (Transient Overvoltage $t_{ini} = 60s$ )   | $V_{IOTM}$      | 8000                                  | $V_{peak}$  |
| Safety-limiting values – Maximum Values Allowed in the Event of a Failure   |                 |                                       |             |
| Case Temperature  | $T_S$           | 150                                   | $^{\circ}C$ |
| Input Current   | $I_{S, INPUT}$  | 400                                   | mA          |
| Output Power  | $P_{S, OUTPUT}$ | 700                                   | mW          |
| Insulation Resistance at $T_S$ , $V_{IO} = 500V$  | $R_S$           | $\geq 10^9$                           | $\Omega$    |

a. Refer to the front of the optocoupler section of the current catalog, under Product Safety Regulations section IEC/EN/DIN EN 60747-5-5, for a detailed description.

**NOTE:** Isolation characteristics are guaranteed only within the safety maximum ratings, which must be ensured by protective circuits in the application.

## Absolute Maximum Rating

| Parameter  | Symbol         | Device              | Min.   | Max. | Units | Note |
|--|----------------|---------------------|--|------|-------|------|
| Storage Temperature <sup>a</sup>   | $T_S$          |                     | -55  | 125  | °C    |      |
| Operating Temperature <sup>a</sup>   | $T_A$          | 8-Pin DIP SO-8      | -55  | 100  | °C    |      |
|  |                | Widebody            | -55  | 85   |       |      |
| Average Forward Input Current <sup>a</sup>   | $I_{F(AVG)}$   |                     | —  | 25   | mA    | b    |
| Peak Forward Input Current <sup>a</sup><br>(50% duty cycle, 1-ms pulse width)<br>50% duty cycle, 1 ms pulse width          | $I_{F(PEAK)}$  | 8-Pin DIP SO-8      | —  | 50   | mA    | c    |
|  |                | Widebody            | —  | 40   |       |      |
| Peak Transient Input Current <sup>a</sup> (1- $\mu$ s pulse width, 300 pps)  | $I_{F(TRANS)}$ | 8-Pin DIP SO-8      | —  | 1    | A     |      |
|  |                | Widebody            | —  | 0.1  |       |      |
| Reverse LED Input Voltage <sup>a</sup> (Pin 3-2)   | $V_R$          | 8-Pin DIP SO-8      | —  | 5    | V     |      |
|  |                | Widebody            | —  | 3    |       |      |
| Input Power Dissipation <sup>a</sup>   | $P_{IN}$       | 8-Pin DIP SO-8      | —  | 45   | mW    | d    |
|  |                | Widebody            | —  | 40   |       |      |
| Average Output Current <sup>a</sup> (Pin 6)  | $I_{O(AVG)}$   |                     | —  | 8    | mA    |      |
| Peak Output Current <sup>a</sup>   | $I_{O(PEAK)}$  |                     | —  | 16   | mA    |      |
| Emitter-Base Reverse Voltage <sup>a</sup> (Pin 5-7)  | $V_{EBR}$      |                     | —  | 5    | V     |      |
| Supply Voltage (Pin 8-5)   | $V_{CC}$       |                     | -0.5   | 30   | V     |      |
| Output Voltage (Pin 6-5)   | $V_O$          |                     | -0.5   | 20   | V     |      |
| Supply Voltage <sup>a</sup> (Pin 8-5)  | $V_{CC}$       |                     | -0.5   | 15   | V     |      |
| Output Voltage <sup>a</sup> (Pin 6-5)  | $V_O$          |                     | -0.5   | 15   | V     |      |
| Base Current <sup>a</sup> (Pin 7)  | $I_B$          |                     | —  | 5    | mA    |      |
| Output Power Dissipation <sup>a</sup>  | $P_O$          |                     | —  | 100  | mW    | e    |
| Lead Solder Temperature <sup>a</sup> (Through-Hole Parts Only)<br>1.6 mm below seating plane, 10s up to seating plane, 10s | $T_{LS}$       | 8-Pin DIP           | —  | 260  | °C    |      |
|  |                | Widebody            |  | 260  | °C    |      |
| Reflow Temperature Profile   | $T_{RP}$       | SO-8 and Option 300 | See <a href="#">Package Outline Drawings</a> |      |       |      |

a. Data has been registered with JEDEC for the 6N135/6N136.

b. Derate linearly above 70°C free-air temperature at a rate of 0.8 mA/°C (8-Pin DIP). Derate linearly above 85°C free-air temperature at a rate of 0.5 mA/°C (SO-8).

c. Derate linearly above 70°C free-air temperature at a rate of 1.6 mA/°C (8-Pin DIP). Derate linearly above 85°C free-air temperature at a rate of 1.0 mA/°C (SO-8).

d. Derate linearly above 70°C free-air temperature at a rate of 0.9 mW/°C (8-Pin DIP). Derate linearly above 85°C free-air temperature at a rate of 1.1 mW/°C (SO-8).

e. Derate linearly above 70°C free-air temperature at a rate of 2.0 mW/°C (8-Pin DIP). Derate linearly above 85°C free-air temperature at a rate of 2.3 mW/°C (SO-8).

## Electrical Specifications (DC)

Over recommended operating temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ) and unless otherwise specified. See note.

| Parameter                                  | Symbol                  | Device                            | Min. | Typ. <sup>a</sup> | Max. | Units                      | Test Conditions  |  |  | Figure  | Note |
|--|-------------------------|-----------------------------------|------|-------------------|------|----------------------------|--|--|--|---------|------|
| Current Transfer Ratio                     | CTR <sup>b</sup>        | 6N135                             | 7    | 18                | 50   | %                          | $T_A = 25^\circ\text{C}$   | $V_O = 0.4\text{V}$                          | $I_F = 16\text{ mA}$ ,<br>$V_{CC} = 4.5\text{V}$ | 1, 2, 4 | c, d |
|  |                         | HCPL-0500<br>HCNW135              | 5    | 19                | —    |                            |  | $V_O = 0.5\text{V}$                          |  |         |      |
|  |                         | HCPL-2502                         | 15   | —                 | 22   |                            | $T_A = 25^\circ\text{C}$   | $V_O = 0.4\text{V}$                          |  |         |      |
|  |                         |                                   | 15   | 25                | —    |                            |  | $V_O = 0.5\text{V}$                          |  |         |      |
|  |                         | 6N136                             | 19   | 24                | 50   |                            | $T_A = 25^\circ\text{C}$   | $V_O = 0.4\text{V}$                          |  |         |      |
|  |                         | HCPL-0501<br>HCNW136              | 15   | 25                | —    |                            |  | $V_O = 0.5\text{V}$                          |  |         |      |
| Logic Low Output Voltage                   | $V_{OL}$                | 6N135                             | —    | 0.1               | 0.4  | V                          | $T_A = 25^\circ\text{C}$   | $I_O = 1.1\text{ mA}$                        | $I_F = 16\text{ mA}$ ,<br>$V_{CC} = 4.5\text{V}$ |         |      |
|  |                         | HCPL-0500<br>HCNW135              | —    | 0.1               | 0.5  |                            |  | $I_O = 0.8\text{ mA}$                        |  |         |      |
|  |                         | 6N136                             | —    | 0.1               | 0.4  |                            | $T_A = 25^\circ\text{C}$   | $I_O = 3.0\text{ mA}$                        |  |         |      |
|  |                         | HCPL-2502<br>HCPL-0501<br>HCNW136 | —    | 0.1               | 0.5  |                            |  | $I_O = 2.4\text{ mA}$                        |  |         |      |
| Logic High Output Current                  | $I_{OH}^b$              |                                   | —    | 0.003             | 0.5  | $\mu\text{A}$              | $T_A = 25^\circ\text{C}$   | $V_O = V_{CC} = 5.5\text{V}$                 | $I_F = 0\text{ mA}$                              | 7       |      |
|  |                         |                                   | —    | 0.01              | 1    |                            | $T_A = 25^\circ\text{C}$   | $V_O = V_{CC} = 15\text{V}$                  |  |         |      |
|  |                         |                                   | —    | —                 | 50   |                            | $V_O = V_{CC} = 15\text{V}$  |  |  |         |      |
| Logic Low Supply Current                   | $I_{CCL}$               |                                   | —    | 50                | 200  | $\mu\text{A}$              | $I_F = 16\text{ mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{V}$ |  |  |         |      |
| Logic High Supply Current                  | $I_{CCH}^b$             |                                   | —    | 0.02              | 1    | $\mu\text{A}$              | $T_A = 25^\circ\text{C}$   | $I_F = 0\text{ mA}$ ,<br>$V_O = \text{Open}$ |  |         |      |
|  |                         |                                   | —    | —                 | 2    |                            |  | $V_{CC} = 15\text{V}$                        |  |         |      |
| Input Forward Voltage                      | $V_F^b$                 | 8-Pin DIP                         | —    | 1.5               | 1.7  | V                          | $T_A = 25^\circ\text{C}$   | $I_F = 16\text{ mA}$                         |  | 3       |      |
|  |                         | SO-8                              | —    | —                 | 1.8  |                            |  |  |  |         |      |
|  |                         | Widebody                          | 1.45 | 1.68              | 1.85 |                            | $T_A = 25^\circ\text{C}$   | $I_F = 16\text{ mA}$                         |  |         |      |
|  |                         |                                   | 1.35 | —                 | 1.95 |                            |  |  |  |         |      |
| Input Reverse Breakdown Voltage            | $BV_R^b$                | 8-Pin DIP                         | 5    | —                 | —    | V                          | $I_R = 10\text{ }\mu\text{A}$                                      |  |  |         |      |
|  |                         | SO-8                              |      |                   |      |                            |  |  |  |         |      |
|  |                         | Widebody                          | 3    | —                 | —    |                            | $I_R = 100\text{ }\mu\text{A}$                                     |  |  |         |      |
| Temperature Coefficient of Forward Voltage | $\Delta V_F/\Delta T_A$ | 8-Pin DIP                         | —    | –1.6              |      | $\text{mV}/^\circ\text{C}$ | $I_F = 16\text{ mA}$   |  |  |         |      |
|  |                         | SO-8                              |      |                   |      |                            |  |  |  |         |      |
|  |                         | Widebody                          | —    | –1.9              |      |                            |  |  |  |         |      |
| Input Capacitance                          | $C_{IN}$                | 8-Pin DIP                         | —    | 60                | —    | $\text{pF}$                | $f = 1\text{ MHz}$ , $V_F = 0\text{V}$                             |  |  |         |      |
|  |                         | SO-8                              |      |                   |      |                            |  |  |  |         |      |
|  |                         | Widebody                          | —    | 90                | —    |                            |  |  |  |         |      |

| Parameter                  | Symbol   | Device    | Min. | Typ. <sup>a</sup> | Max. | Units | Test Conditions                           | Figure | Note |
|----------------------------|----------|-----------|------|-------------------|------|-------|---|--------|------|
| Transistor DC Current Gain | $h_{FE}$ | 8-Pin DIP | —    | 150               | —    |       | $V_O = 5V, I_O = 3\text{ mA}$             |        |      |
|                            |          | Widebody  | —    | 180               | —    |       | $V_O = 5V, I_O = 3\text{ mA}$             |        |      |
|                            |          |           | —    | 160               | —    |       | $V_O = 0.4V, I_B = 20\text{ }\mu\text{A}$ |        |      |

a. All typicals at  $T_A = 25^\circ\text{C}$ .

b. For JEDEC registered parts.

c. CURRENT TRANSFER RATIO in percent is defined as the ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$ , times 100.

d. The JEDEC registration for the 6N136 specifies a minimum CTR of 15%. Avago guarantees a minimum CTR of 19%.

**NOTE:** Use of a 0.1- $\mu\text{f}$  bypass capacitor connected between pins 5 and 8 is recommended.

## Switching Specifications (AC)

Over recommended temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ),  $V_{CC} = 5\text{V}$ ,  $I_F = 16\text{ mA}$  unless otherwise specified.

| Parameter  | Symbol                      | Device                                     | Min. | Typ. <sup>a</sup> | Max. | Units                      | Test Conditions            |  | Figure   | Note    |
|--|-----------------------------|--|------|-------------------|------|----------------------------|----------------------------|--|----------|---------|
| Propagation Delay<br>Time to Logic Low at<br>Output                | $t_{\text{PHL}}^{\text{b}}$ | 6N135<br>HCPL-0500<br>HCNW135              | —    | 0.2               | 1.5  | $\mu\text{s}$              | $T_A = 25^\circ\text{C}$   | $R_L = 4.1\text{ k}\Omega$   | 5, 6, 11 | c, d    |
|  |                             | 6N136<br>HCPL-2502<br>HCPL-0501<br>HCNW136 | —    | 0.2               | 0.8  |                            | $T_A = 25^\circ\text{C}$   | $R_L = 1.9\text{ k}\Omega$   |          |         |
|  |                             |  | —    | —                 | 1.0  |                            |                            |  |          |         |
| Propagation Delay<br>Time to Logic High at<br>Output               | $t_{\text{PLH}}^{\text{b}}$ | 6N135<br>HCPL-0500<br>HCNW135              | —    | 1.3               | 1.5  | $\mu\text{s}$              | $T_A = 25^\circ\text{C}$   | $R_L = 4.1\text{ k}\Omega$   | 5, 6, 11 | c, d    |
|  |                             | 6N136<br>HCPL-2502<br>HCPL-0501<br>HCNW136 | —    | —                 | 2.0  |                            |                            |  |          |         |
|  |                             |  | —    | —                 | 1.0  |                            |                            |  |          |         |
| Common Mode<br>Transient Immunity at<br>Logic High Level<br>Output | $ CM_H $                    | 6N135                                      | 1    | —                 | —    | kV/ $\mu\text{s}$          | $R_L = 4.1\text{ k}\Omega$ | $I_F = 0\text{ mA}$ ,<br>$T_A = 25^\circ\text{C}$ ,<br>$V_{CM} = 10\text{ V}_{\text{p-p}}$ ,<br>$C_L = 15\text{ pF}$ | 12       | c, d, e |
|  |                             | HCPL-0500<br>HCNW135                       | —    | 1                 | —    |                            |                            |  |          |         |
|  |                             | 6N136                                      | 1    | —                 | —    | $R_L = 1.9\text{ k}\Omega$ |                            |  |          |         |
|  |                             | HCPL-2502<br>HCPL-0501                     | —    | 1                 | —    |                            |                            |  |          |         |
| Common Mode<br>Transient Immunity at<br>Logic Low Level<br>Output  | $ CM_L $                    | 6N135                                      | 1    | —                 | —    | kV/ $\mu\text{s}$          | $R_L = 4.1\text{ k}\Omega$ | $I_F = 16\text{ mA}$ ,<br>$T_A = 25^\circ\text{C}$ ,<br>$C_L = 15\text{ pF}$   | 12       | c, d, e |
|  |                             | HCPL-0500<br>HCNW135                       | —    | 1                 | —    |                            |                            |  |          |         |
|  |                             | 6N136                                      | 1    | —                 | —    | $R_L = 1.9\text{ k}\Omega$ |                            |  |          |         |
|  |                             | HCPL-2502<br>HCPL-0501                     | —    | 1                 | —    |                            |                            |  |          |         |
| Bandwidth  | BW                          | 6N135/6<br>HCPL-2502<br>HCPL-0500/1        | —    | 9                 | —    | MHz                        | See Test<br>Circuit        |  | 8, 10    | f       |
|  |                             | HCNW135/6                                  | —    | 11                | —    |                            |                            |  |          |         |

a. All typicals at  $T_A = 25^\circ\text{C}$ .

b. For JEDEC registered parts.

c. The 1.9 k $\Omega$  load represents 1 TTL unit load of 1.6 mA and the 5.6 k $\Omega$  pull-up resistor.

d. The 4.1 k $\Omega$  load represents 1 LSTTL unit load of 0.36 mA and 6.1 k $\Omega$  pull-up resistor.

e. Common mode transient immunity in a 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 (that is,  $V_O > 2.0\text{V}$ ). Common mode transient immunity in a 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 (that is,  $V_O < 0.8\text{V}$ ).

f. The frequency at which the ac output voltage is 3 dB below its mid-frequency value.

## Package Characteristics

Over recommended temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ) unless otherwise specified.

| Parameter   | Sym.      | Device                 | Min.      | Typ. <sup>a</sup> | Max. | Units         | Test Conditions   | Figure | Note    |
|---|-----------|------------------------|-----------|-------------------|------|---------------|---|--------|---------|
| Input-Output Momentary Withstand Voltage <sup>b</sup> | $V_{ISO}$ | 8-Pin DIP SO-8         | 3750      | —                 | —    | $V_{rms}$     | RH < 50%, t = 1 min., $T_A = 25^\circ\text{C}$                        |        | c, d    |
|   |           | Widebody               | 5000      | —                 | —    |               |   |        | c, e    |
|   |           | 8-Pin DIP (Option 020) | 5000      | —                 | —    |               |   |        | c, e, f |
|   | $I_{I-O}$ | 8-Pin DIP              | —         | —                 | 1    | $\mu\text{A}$ | 45% RH, t = 5s, $V_{I-O} = 3 \text{ kVdc}$ , $T_A = 25^\circ\text{C}$ |        | c, g    |
| Input-Output Resistance                               | $R_{I-O}$ | 8-Pin DIP SO-8         | —         | $10^{12}$         | —    | $\Omega$      | $V_{I-O} = 500 \text{ Vdc}$   |        | c       |
|   |           | Widebody               | $10^{12}$ | $10^{13}$         | —    |               | $T_A = 25^\circ\text{C}$  |        |         |
|   |           |                        | $10^{11}$ | —                 | —    |               | $T_A = 100^\circ\text{C}$   |        |         |
| Input-Output Capacitance                              | $C_{I-O}$ | 8-Pin DIP SO-8         | —         | 0.6               | —    | pF            | f = 1 MHz   |        | c       |
|   |           | Widebody               | —         | 0.5               | 0.6  |               |   |        |         |

a. All typicals at  $T_A = 25^\circ\text{C}$ .

b. The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating. For the continuous voltage rating refer to the IEC/EN/DIN EN 60747-5-5 Insulation Related Characteristics Table (if applicable), your equipment level safety specification or Avago Application Note 1074, *Optocoupler Input-Output Endurance Voltage*, publication number 5963-2203E.

c. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.

d. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 4500 V_{rms}$  for 1 second (leakage detection current limit,  $I_{I-O} \leq 5 \mu\text{A}$ ). This test is performed before the 100% Production test shown in the IEC/EN/DIN EN 60747-5-5 Insulation Related Characteristics Table if applicable.

e. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 6000 V_{rms}$  for 1 second (leakage detection current limit,  $I_{I-O} \leq 5 \mu\text{A}$ ). This test is performed before the 100% Production test shown in the IEC/EN/DIN EN 60747-5-5 Insulation Related Characteristics Table if applicable.

f. Refer to the Option 020 data sheet for more information.

g. This rating is equally validated by an equivalent ac proof test.



Figure 1: DC and Pulsed Transfer Characteristics

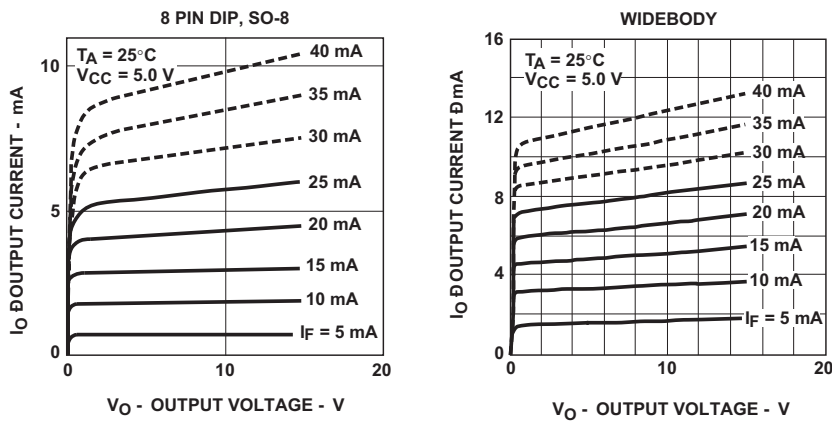


Figure 2: Current Transfer Ratio vs. Input Current

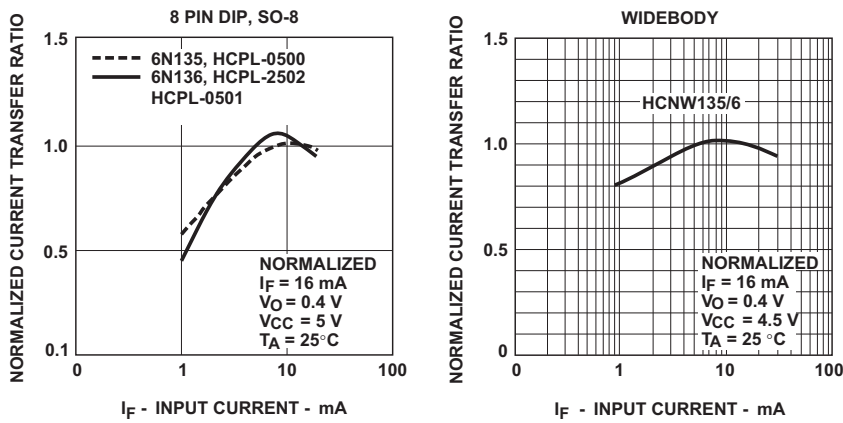


Figure 3: Input Current vs. Forward Voltage

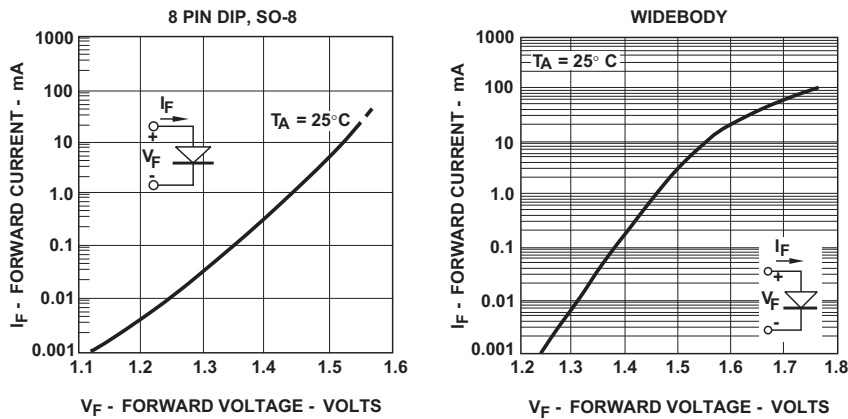


Figure 4: Current Transfer Ratio vs. Temperature

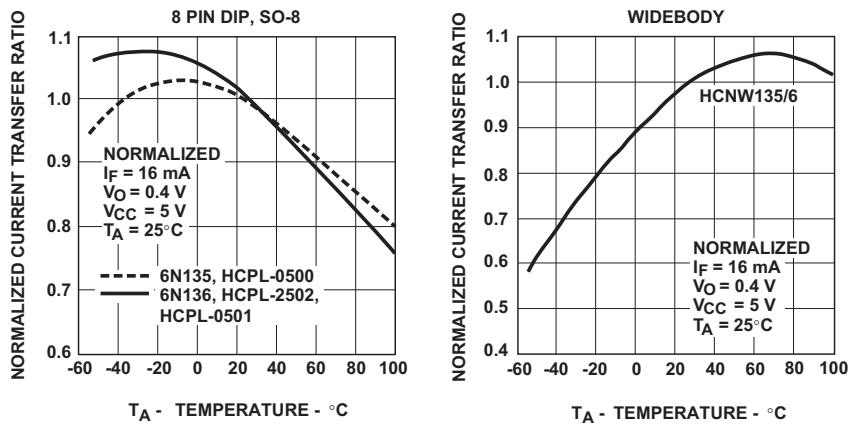


Figure 5: Propagation Delay vs. Temperature

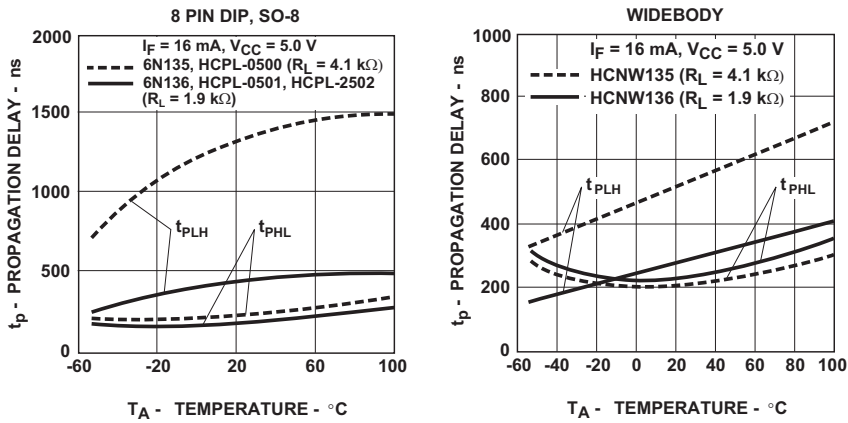


Figure 6: Propagation Delay Time vs. Load Resistance

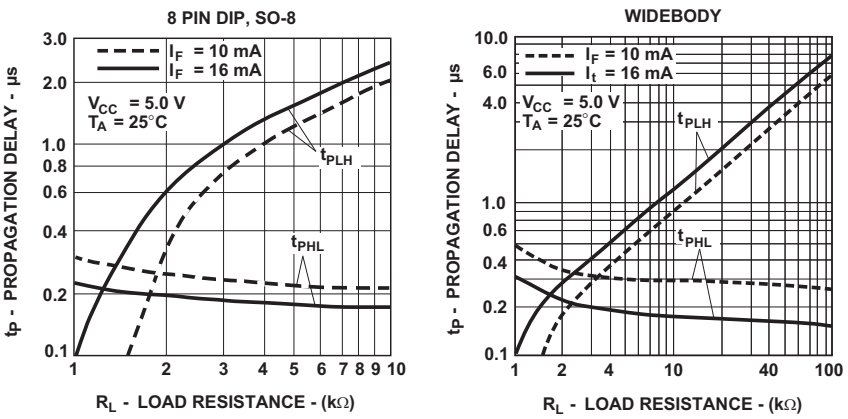


Figure 7: Logic High Output Current vs. Temperature

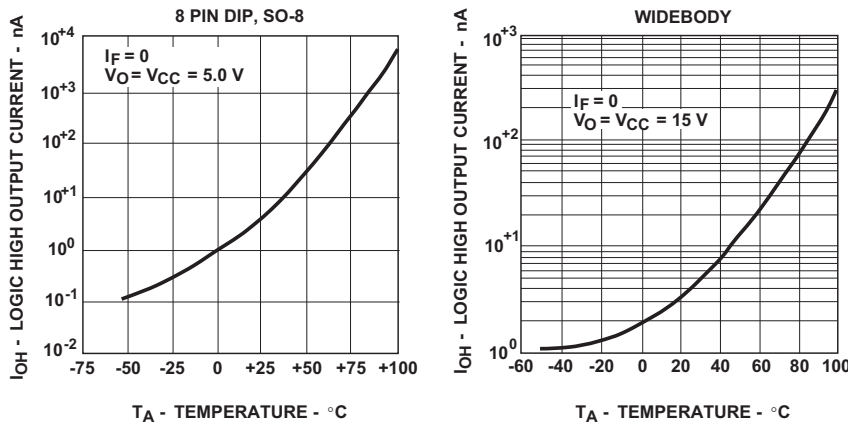


Figure 8: Small-Signal Current Transfer Ratio vs. Quiescent Input Current

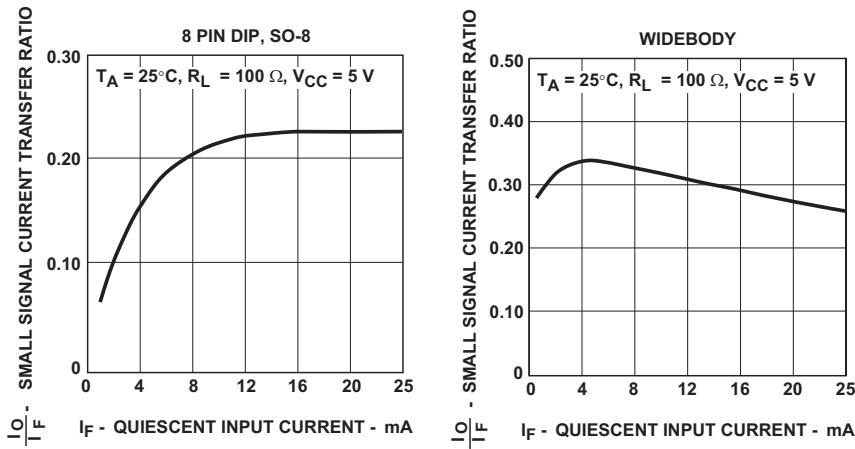


Figure 9: Thermal Derating Curve, Dependence of Safety Limiting Value with Case Temperature per IEC/EN/DIN EN 60747-5-5

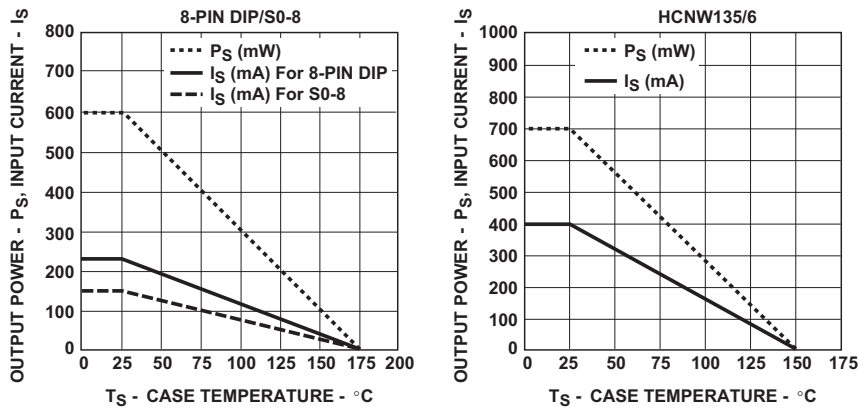


Figure 10: Frequency Response

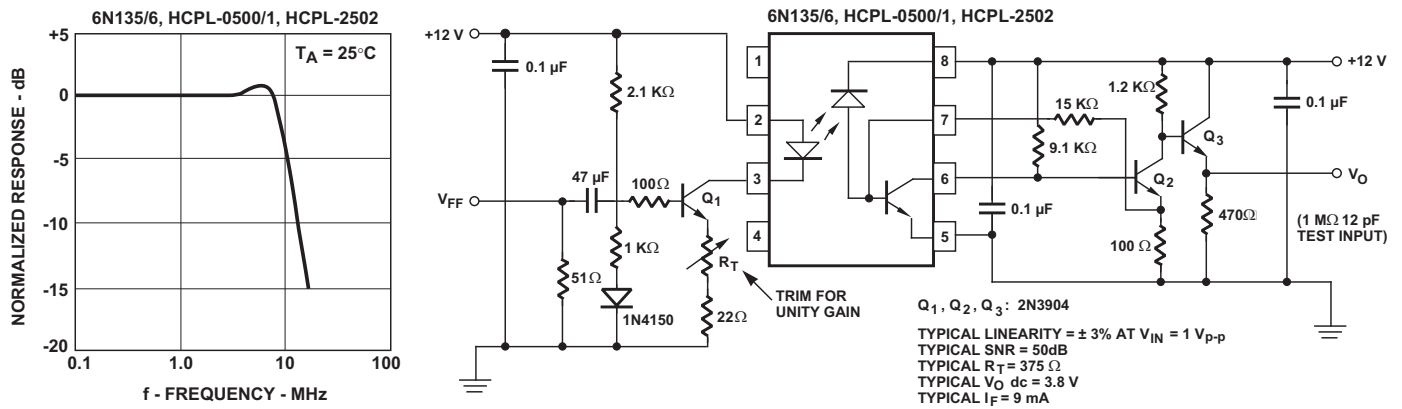


Figure 11: Switching Test Current

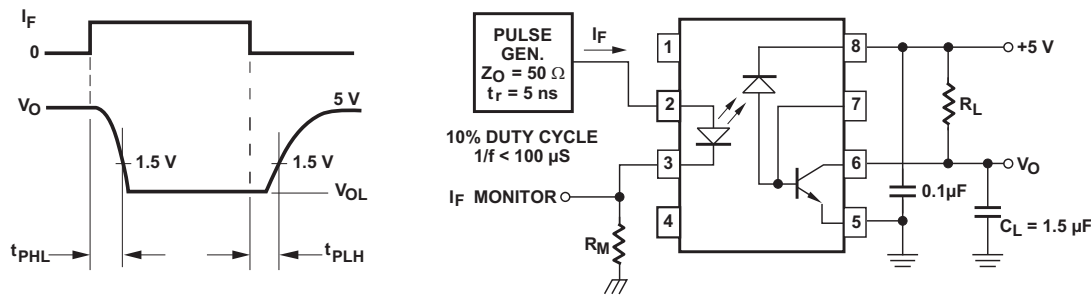
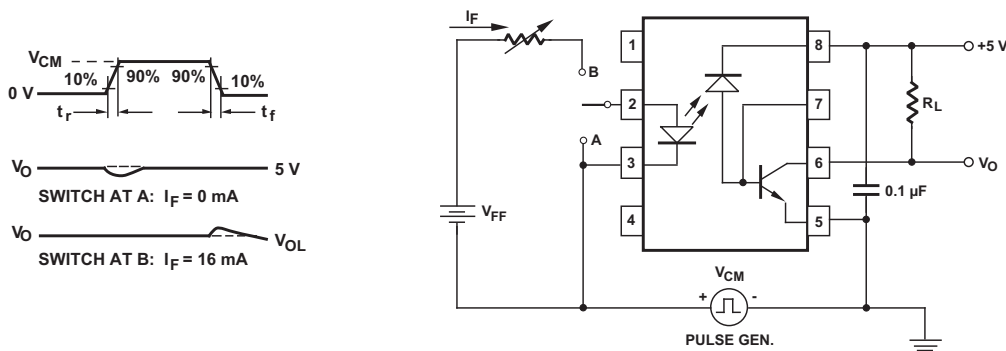


Figure 12: Test Circuit for Transient Immunity and Typical Waveforms



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