

# HCPL-2201, HCPL-2202, HCPL-2211, HCPL-2212, HCPL-2231, HCPL-2232, HCPL-0201, HCPL-0211, HCNW2201, HCNW2211

Very High CMR, Wide  $V_{CC}$  Logic Gate Optocouplers



## Data Sheet

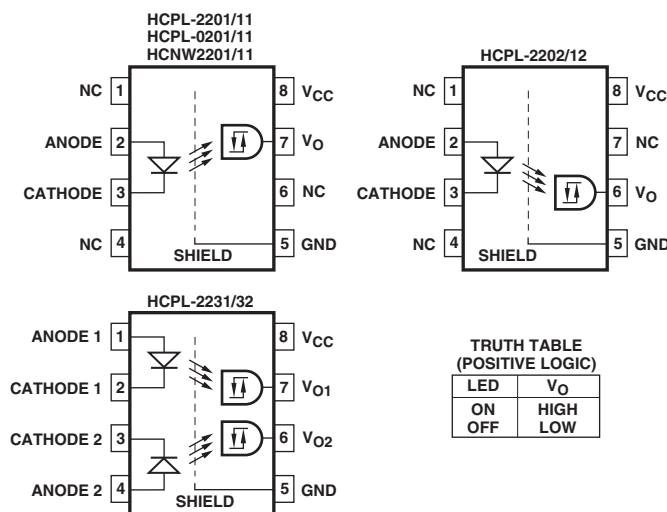


### Description

The HCPL-22XX, HCPL-02XX, and HCNW22XX are optically-coupled logic gates. The HCPL-22XX, and HCPL-02XX contain a GaAsP LED while the HCNW22XX contains an AlGaAs LED. The detectors have totem pole output stages and optical receiver input stages with built-in Schmitt trigger to provide logic-compatible waveforms, eliminating the need for additional waveshaping.

A superior internal shield on the HCPL-2211/12, HCPL-0211, HCPL-2232 and HCNW2211 guarantees common mode transient immunity of 10 kV/ $\mu$ s at a common mode voltage of 1000 volts.

### Functional Diagram



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

### Features

- 10 kV/ $\mu$ s minimum Common Mode Rejection (CMR) at  $V_{CM} = 1000$  V (HCPL-2211/2212/0211/2232, HCNW2211)
- Wide operating  $V_{CC}$  range: 4.5 to 20 Volts
- 300 ns propagation delay guaranteed over the full temperature range
- 5 Mbd typical signal rate
- Low input current (1.6 mA to 1.8 mA)
- Hysteresis
- Totem pole output (no pullup resistor required)
- Available in 8-Pin DIP, SOIC-8, widebody packages
- Guaranteed performance from -40°C to 85°C
- Safety approval
  - UL recognized -3750 V rms for 1 minute (5000V rms for 1 minute for HCNW22XX) per UL1577
  - CSA approved
  - IEC/EN/DIN EN 60747-5-2 approved with  $V_{IORM} = 630$  V<sub>peak</sub> (HCPL-2211/2212 Option 060 only) and  $V_{IORM} = 1414$  V<sub>peak</sub> (HCNW22XX only)
- MIL-PRF-38534 hermetic version available (HCPL-52XX/62XX)

### Applications

- Isolation of high speed logic systems
- Computer-peripheral interfaces
- Microprocessor system interfaces
- Ground loop elimination
- Pulse transformer replacement
- High speed line receiver
- Power control systems

**CAUTION:** It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.

The electrical and switching characteristics of the HCPL-22XX, HCPL-02XX and HCNW22XX are guaranteed from -40°C to +85°C and a  $V_{CC}$  from 4.5 volts to 20 volts. Low  $I_F$  and wide  $V_{CC}$  range allow compatibility with TTL, LSTTL,

and CMOS logic and result in lower power consumption compared to other high speed couplers. Logic signals are transmitted with a typical propagation delay of 150 ns.

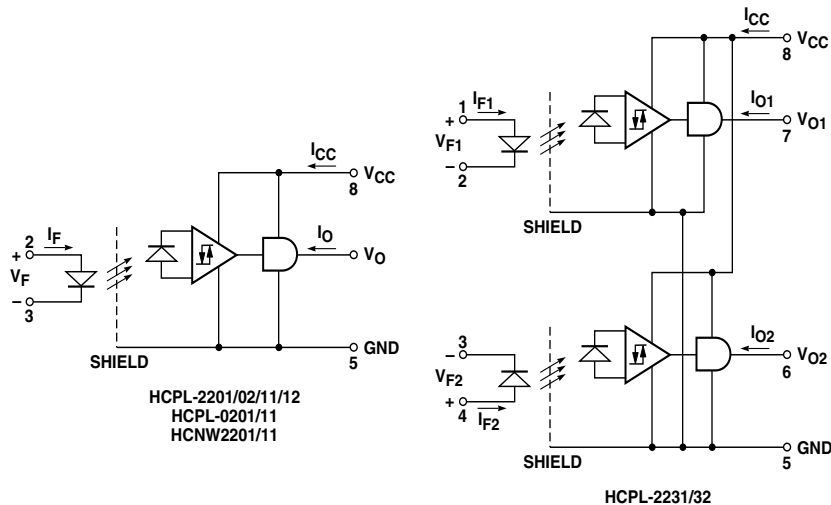
## Selection Guide

| Minimum CMR Input    |                    | 8-Pin DIP (300 Mil) |                                                      |                      | Small-Outline S0-8     | Widebody (400 Mil)     | Hermetic                                             |
|----------------------|--------------------|---------------------|------------------------------------------------------|----------------------|------------------------|------------------------|------------------------------------------------------|
| dV/dt (V/ $\mu$ s)   | $V_{CM}$ (V)       | On-Current (mA)     | Single Channel Package                               | Dual Channel Package | Single Channel Package | Single Channel Package | Single and Dual Channel Packages                     |
| 1,000                | 50                 | 1.6                 | HCPL-2200 <sup>[1,2]</sup><br>HCPL-2201<br>HCPL-2202 |                      | HCPL-0201              | HCNW2201               |                                                      |
|                      |                    | 1.8                 |                                                      | HCPL-2231            |                        |                        |                                                      |
| 2,500                | 400                | 1.6                 | HCPL-2219 <sup>[1,2]</sup>                           |                      |                        |                        |                                                      |
| 5,000 <sup>[3]</sup> | 300 <sup>[3]</sup> | 1.6                 | HCPL-2211<br>HCPL-2212                               |                      | HCPL-0211              | HCNW2211               |                                                      |
|                      |                    | 1.8                 |                                                      | HCPL-2232            |                        |                        |                                                      |
| 1,000                | 50                 | 2.0                 |                                                      |                      |                        |                        | HCPL-52XX <sup>[2]</sup><br>HCPL-62XX <sup>[2]</sup> |

### Notes:

1. HCPL-2200/2219 devices include output enable/disable function.
2. Technical data for the HCPL-2200/2219, HCPL-52XX and HCPL-62XX are on separate Avago publications.
3. Minimum CMR of 10 kV/ $\mu$ s with  $V_{CM} = 1000$  V can be achieved with input current,  $I_F$ , of 5 mA.

## Schematic



## Ordering Information

HCPL-2201, HCPL-2202, HCPL-2211, HCPL-2212, HCPL-2231, HCPL-2232, HCPL-0201, HCPL-0211 are UL Recognized with 3750 Vrms for 1 minute per UL1577.

HCNW2201 and HCNW2211 are UL Recognized with 5000 Vrms for 1 minute per UL1577.

All devices listed above are approved under CSA Component Acceptance Notice #5, File CA 88324.

| Part number                                      | Option         |                    | Package                     | Surface Mount | Gull Wing | Tape & Reel | UL 5000 Vrms/ 1 Minute rating | IEC/EN/DIN EN 60747-5-2 | Quantity      |
|--------------------------------------------------|----------------|--------------------|-----------------------------|---------------|-----------|-------------|-------------------------------|-------------------------|---------------|
|                                                  | RoHS Compliant | Non RoHS Compliant |                             |               |           |             |                               |                         |               |
| HCPL-2201<br>HCPL-2202<br>HCPL-2211<br>HCPL-2212 | -000E          | No option          | 300mil<br>DIP-8             |               |           |             |                               |                         | 50 per tube   |
|                                                  | -300E          | -300               |                             | X             | X         |             |                               |                         | 50 per tube   |
|                                                  | -500E          | -500               |                             | X             | X         | X           |                               |                         | 1000 per reel |
|                                                  | -060E          | -060               |                             |               |           |             |                               | X                       | 50 per tube   |
|                                                  | -360E          | -360               |                             | X             | X         |             |                               | X                       | 50 per tube   |
|                                                  | -560E          | -560               |                             | X             | X         | X           |                               | X                       | 1000 per reel |
| HCPL-2231<br>HCPL-2232                           | -000E          | No option          |                             |               |           |             |                               |                         | 50 per tube   |
|                                                  | -300E          | -300               |                             | X             | X         |             |                               |                         | 50 per tube   |
|                                                  | -500E          | -500               |                             | X             | X         | X           |                               |                         | 1000 per reel |
| HCPL-0201<br>HCPL-0211                           | -000E          | No option          | SO-8                        | X             |           |             |                               |                         | 100 per tube  |
|                                                  | -500E          | -500               |                             | X             |           | X           |                               |                         | 1500 per reel |
|                                                  | -060E          | -060               |                             | X             |           |             |                               | X                       | 100 per tube  |
|                                                  | -560E          | -560               |                             | X             |           | X           |                               | X                       | 1500 per reel |
| HCNW2201<br>HCNW2211                             | -000E          | No option          | 400mil<br>Widebody<br>DIP-8 |               |           |             | X                             | X                       | 42 per tube   |
|                                                  | -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-2202-560E to order product of 300mil DIP Gull Wing Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-2 Safety Approval in RoHS compliant.

Example 2:

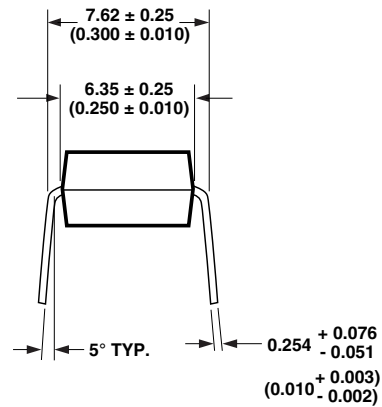
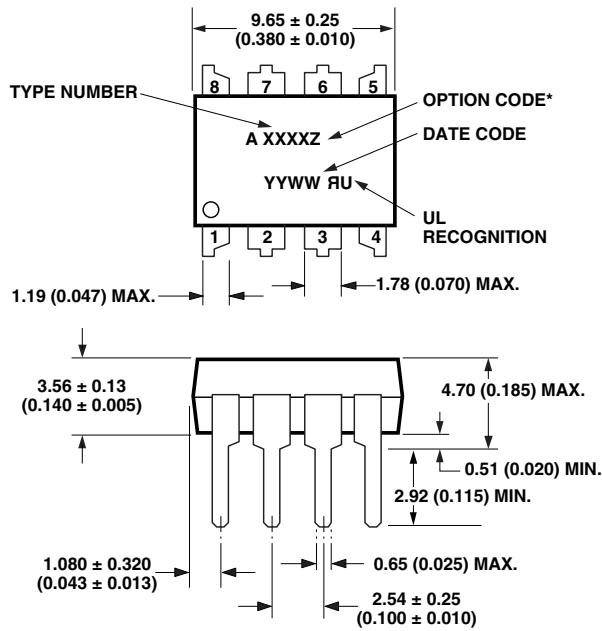
HCPL-2202 to order product of 300mil DIP package in tube packaging and non RoHS compliant.

Option datasheets are available. Contact your Avago sales representative or authorized distributor for information.

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

## Package Outline Drawings

### 8-Pin DIP Package (HCPL-2201/02/11/12/31/32)



DIMENSIONS IN MILLIMETERS AND (INCHES).

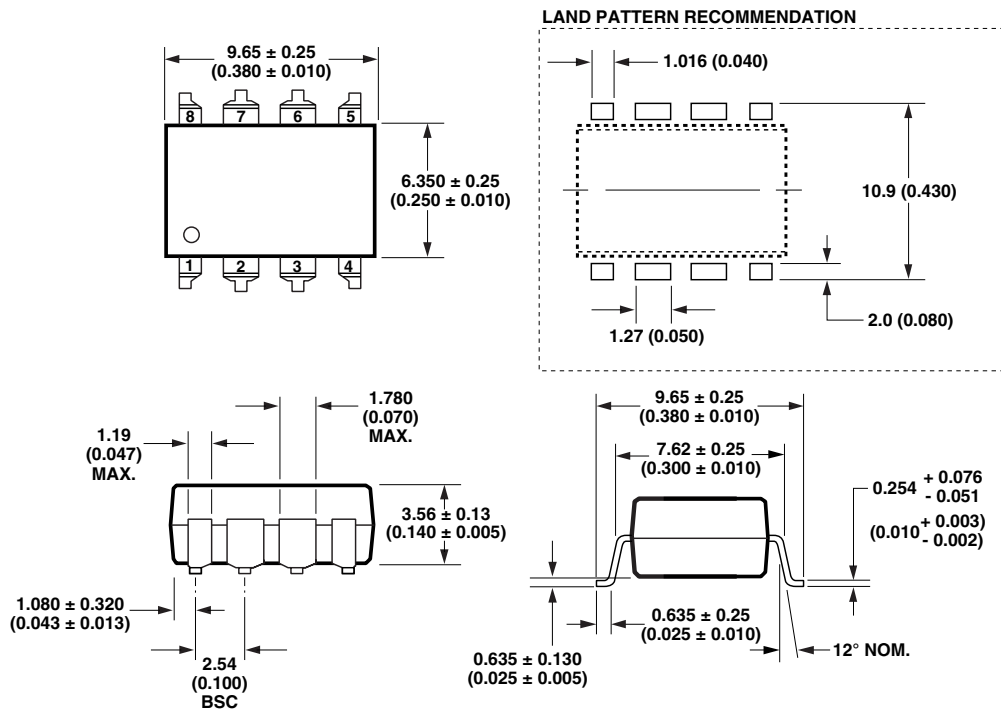
\* MARKING CODE LETTER FOR OPTION NUMBERS

"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 (HCPL-2201/02/11/12/31/32)

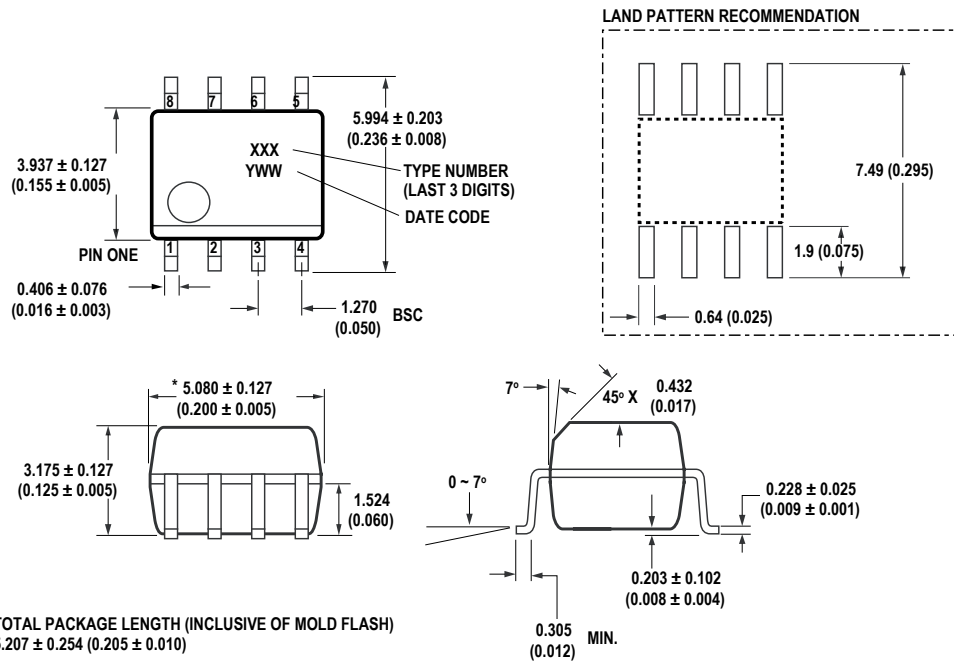


DIMENSIONS IN MILLIMETERS (INCHES).

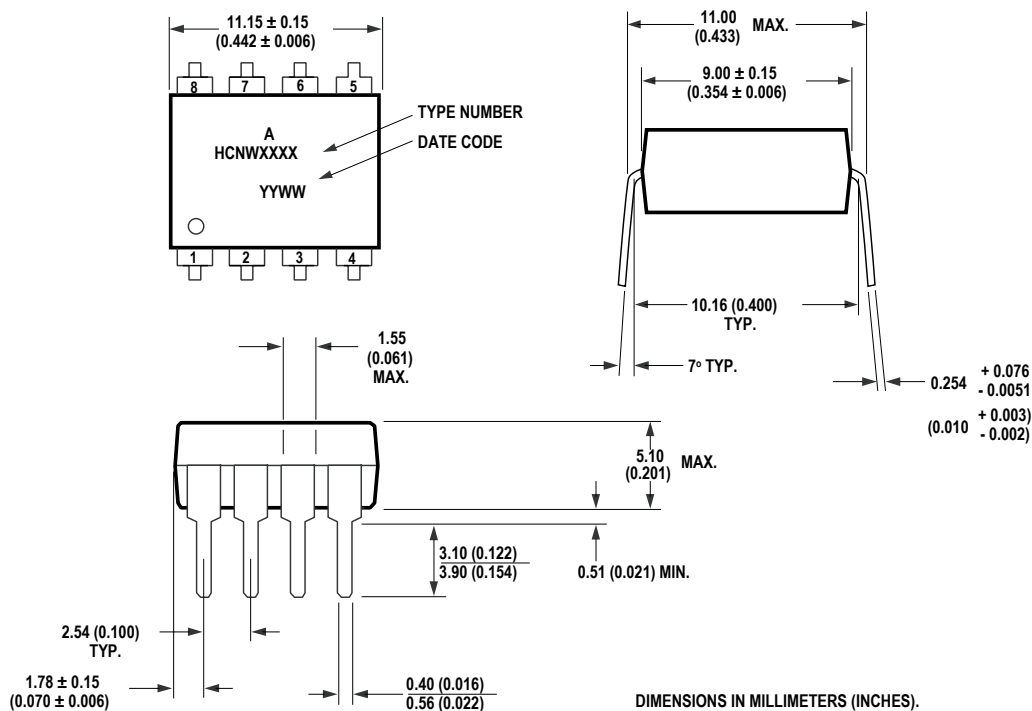
LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

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

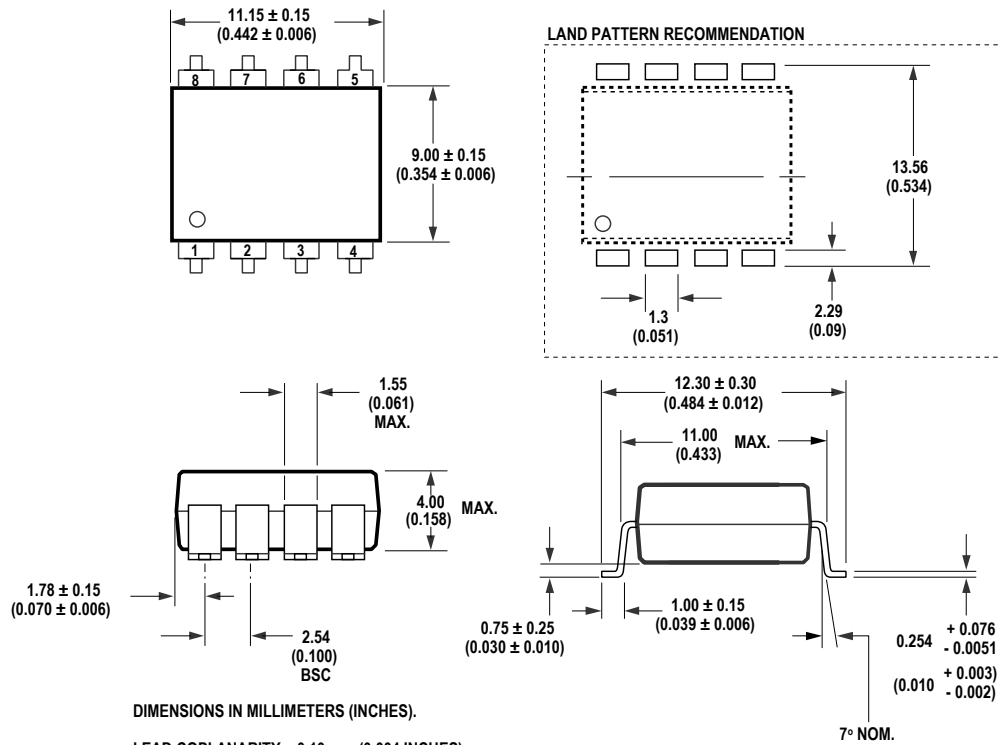
### Small-Outline SO-8 Package (HCPL-0201/11)



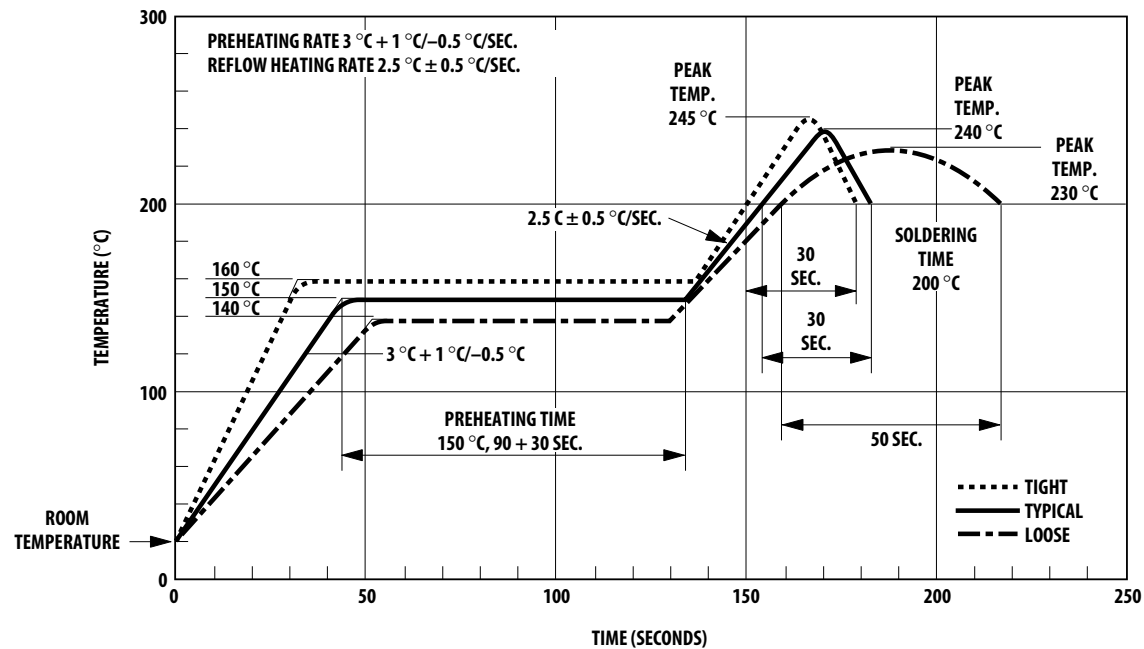
### 8-Pin Widebody DIP Package (HCNW2201/11)



## 8-Pin Widebody DIP Package with Gull Wing Surface Mount Option 300 (HCNW2201/11)

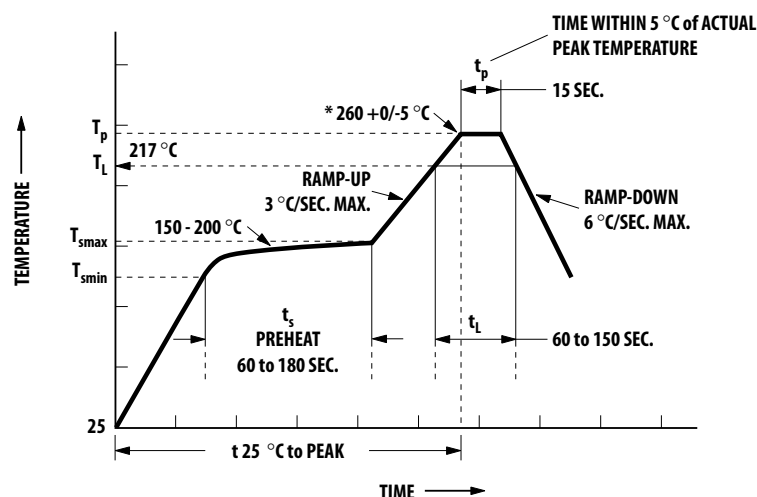


## Solder Reflow Temperature Profile



NOTE: NON-HALIDE FLUX SHOULD BE USED.

## Recommended Pb-Free IR Profile



### NOTES:

THE TIME FROM 25 °C to PEAK  
TEMPERATURE = 8 MINUTES MAX.  
 $T_{smax} = 200\text{ }^{\circ}\text{C}$ ,  $T_{smin} = 150\text{ }^{\circ}\text{C}$

NOTE: NON-HALIDE FLUX SHOULD BE USED.

\* RECOMMENDED PEAK TEMPERATURE  
FOR WIDEBODY 400mils PACKAGE IS 245 °C

## Regulatory Information

The HCPL-22XX/02XX and HCNW22XX have been approved by the following organizations:

### UL

Recognized under UL 1577, Component Recognition Program, File E55361.

### IEC/EN/DIN EN 60747-5-2

Approved under:  
IEC 60747-5-2:1997 + A1:2002  
EN 60747-5-2:2001 + A1:2002  
DIN EN 60747-5-2 (VDE 0884 Teil 2):2003-01  
(Option 060 and HCNW only)

### CSA

Approved under CSA Component Acceptance Notice #5, File CA 88324.

## Insulation and Safety Related Specifications

### 8-pin DIP Package

| Parameter                                         | Symbol | 8-Pin DIP<br>(300 Mil)<br>Value | SO-8<br>Value | Widebody<br>(400 Mil)<br>Value | Units | Conditions                                                                                                                                                 |
|---------------------------------------------------|--------|---------------------------------|---------------|--------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Minimum External Air Gap (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 (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 (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 (Internal Creepage)     |        | NA                              | NA            | 4.0                            | mm    | Measured from input terminals to output terminals, along internal cavity.                                                                                  |
| Tracking Resistance (Comparative Tracking Index)  | CTI    | 200                             | 200           | 200                            | Volts | 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 60747-5-2 Insulation Related Characteristics**  
**(HCPL-2211/2212 Option 060 ONLY)**

| Description                                                                                                                                          | Symbol         | Characteristic | Units              |
|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|--------------------|
| Installation classification per DIN VDE 0110/1.89, Table 1<br>for rated mains voltage $\leq 300$ V rms                                               |                | I-IV           |                    |
| for rated mains voltage $\leq 450$ V rms                                                                                                             |                | I-III          |                    |
| Climatic Classification                                                                                                                              |                | 55/85/21       |                    |
| Pollution Degree (DIN VDE 0110/1.89)                                                                                                                 |                | 2              |                    |
| Maximum Working Insulation Voltage                                                                                                                   | $V_{IORM}$     | 630            | $V_{peak}$         |
| Input to Output Test Voltage, Method b*<br>$V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ sec,<br>Partial Discharge $< 5$ pC | $V_{PR}$       | 1181           | $V_{peak}$         |
| Input to Output Test Voltage, Method a*<br>$V_{IORM} \times 1.5 = V_{PR}$ , Type and sample test,<br>$t_m = 60$ sec, Partial Discharge $< 5$ pC      | $V_{PR}$       | 945            | $V_{peak}$         |
| Highest Allowable Overvoltage*<br>(Transient Overvoltage, $t_{ini} = 10$ sec)                                                                        | $V_{IOTM}$     | 6000           | $V_{peak}$         |
| Safety Limiting Values<br>(Maximum values allowed in the event of a failure,<br>also see Figure 12, Thermal Derating curve.)                         |                |                |                    |
| Case Temperature                                                                                                                                     | $T_s$          | 175            | $^{\circ}\text{C}$ |
| Input Current                                                                                                                                        | $I_{S,OUTPUT}$ | 230            | mA                 |
| Output Power                                                                                                                                         | $P_{S,OUTPUT}$ | 600            | mW                 |
| Insulation Resistance at $T_s$ , $V_{IO} = 500$ V                                                                                                    | $R_s$          | $\geq 10^9$    | $\Omega$           |

\*Refer to the front of the optocoupler section of the current catalog, under Product Safety Regulations section IEC/EN/DIN EN 60747-5-2, for a detailed description.

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



**IEC/EN/DIN EN 60747-5-2 Insulation Related Characteristics  
(HCNW22XX ONLY)**

| Description                                                                                                                                          | Symbol         | Characteristic | Units              |
|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|--------------------|
| Installation classification per DIN VDE 0110/1.89, Table 1<br>for rated mains voltage $\leq 600$ V rms                                               |                | I-IV           |                    |
| for rated mains voltage $\leq 1000$ V rms                                                                                                            |                | I-III          |                    |
| Climatic Classification                                                                                                                              |                | 55/100/21      |                    |
| Pollution Degree (DIN VDE 0110/1.89)                                                                                                                 |                | 2              |                    |
| Maximum Working Insulation Voltage                                                                                                                   | $V_{IORM}$     | 1414           | $V_{peak}$         |
| Input to Output Test Voltage, Method b*<br>$V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ sec,<br>Partial Discharge $< 5$ pC | $V_{PR}$       | 2652           | $V_{peak}$         |
| Input to Output Test Voltage, Method a*<br>$V_{IORM} \times 1.5 = V_{PR}$ , Type and sample test,<br>$t_m = 60$ sec, Partial Discharge $< 5$ pC      | $V_{PR}$       | 2121           | $V_{peak}$         |
| Highest Allowable Overvoltage*<br>(Transient Overvoltage, $t_{ini} = 10$ sec)                                                                        | $V_{IOTM}$     | 8000           | $V_{peak}$         |
| Safety Limiting Values<br>(Maximum values allowed in the event of a failure,<br>also see Figure 12, Thermal Derating curve.)                         |                |                |                    |
| Case Temperature                                                                                                                                     | $T_s$          | 150            | $^{\circ}\text{C}$ |
| Current (Input Current $I_P$ , $P_S = 0$ )                                                                                                           | $I_{S,INPUT}$  | 400            | mA                 |
| Output Power                                                                                                                                         | $P_{S,OUTPUT}$ | 700            | mW                 |
| Insulation Resistance at $T_s$ , $V_{IO} = 500$ V                                                                                                    | $R_S$          | $\geq 10^9$    | $\Omega$           |

\*Refer to the front of the optocoupler section of the current catalog, under Product Safety Regulations section IEC/EN/DIN EN 60747-5-2, for a detailed description.

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

## Absolute Maximum Ratings

| Parameter                                                              | Symbol        | Min.      | Max.                                             | Units | Note |
|------------------------------------------------------------------------|---------------|-----------|--------------------------------------------------|-------|------|
| Storage Temperature                                                    | $T_S$         | -55       | 125                                              | °C    |      |
| Operating Temperature                                                  | $T_A$         | -40       | 85                                               | °C    |      |
| Average Forward Input Current                                          | $I_{F(AVG)}$  |           | 10                                               | mA    | 1    |
| Peak Transient Input Current<br>( $\leq 1 \mu s$ Pulse Width, 300 pps) | $I_{F(TRAN)}$ |           | 1.0                                              | A     | 1    |
| ( $\leq 200 \mu s$ Pulse Width,<br>< 1% Duty Cycle)                    |               | HCNW22XX  | 40                                               | mA    |      |
| Reverse Input Voltage                                                  | $V_R$         |           | 5                                                | V     | 1    |
|                                                                        |               | HCNW22XX  | 3                                                |       |      |
| Average Output Current                                                 | $I_O$         |           | 25                                               | mA    | 1    |
| Supply Voltage                                                         | $V_{CC}$      | 0         | 20                                               | V     |      |
| Output Voltage                                                         | $V_O$         | -0.5      | 20                                               | V     | 1    |
| Total Package Power Dissipation                                        | $P_T$         |           | 210                                              | mW    | 2    |
|                                                                        |               | HCPL-223X | 294                                              |       |      |
| Output Power Dissipation                                               | $P_O$         |           | See Figure 7                                     |       | 1    |
| Lead Solder Temperature (Through Hole Parts Only)                      |               |           | 260°C for 10 sec.,<br>1.6 mm below seating plane |       |      |
|                                                                        | HCNW22XX      |           | 260°C for 10 sec., up to seating plane           |       |      |
| Solder Reflow Temperature Profile<br>(Surface Mount Parts Only)        |               |           | See Package Outline Drawings section             |       |      |

## Recommended Operating Conditions

| Parameter                   | Symbol       | Min.      | Max. | Units     |
|-----------------------------|--------------|-----------|------|-----------|
| Power Supply Voltage        | $V_{CC}$     | 4.5       | 20   | V         |
| Forward Input Current (ON)  | $I_{F(ON)}$  | 1.6*      | 5    | mA        |
|                             |              | HCPL-223X | 1.8† |           |
| Forward Input Voltage (OFF) | $V_{F(OFF)}$ | -         | 0.8  | V         |
| Operating Temperature       | $T_A$        | -40       | 85   | °C        |
| Junction Temperature        | $T_J$        | -40       | 125  | °C        |
| Fan Out                     | N            |           | 4    | TTL Loads |

\*The initial switching threshold is 1.6 mA or less. It is recommended that 2.2 mA be used to permit at least a 20% LED degradation guardband.

†The initial switching threshold is 1.8 mA or less. It is recommended that 2.5 mA be used to permit at least a 20% LED degradation guardband.

## Electrical Specifications

$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ,  $4.5\text{ V} \leq V_{CC} \leq 20\text{ V}$ ,  $1.6\text{ mA} \leq I_{F(\text{ON})}^* \leq 5\text{ mA}$ ,  $0\text{ V} \leq V_{F(\text{OFF})} \leq 0.8\text{ V}$ , unless otherwise specified.  
All Typicals at  $T_A = 25^{\circ}\text{C}$ . See Note 7.

| Parameter                                           | Sym.                         | Min.       | Typ.                       | Max.                       | Units                  | Test Conditions                                                                                        | Fig.                                       | Note  | Fig  |
|-----------------------------------------------------|------------------------------|------------|----------------------------|----------------------------|------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|------|
| Logic Low Output Voltage                            | $V_{OL}$                     |            |                            | 0.5                        | V                      | $I_{OL} = 6.4\text{ mA}$ (4 TTL Loads)                                                                 |                                            | 1, 3  | 1    |
| Logic High Output Voltage<br>( $V_{OUT} < V_{CC}$ ) | $V_{OH}$                     | 2.4<br>2.7 | **                         |                            | V                      | $I_{OH} = -2.6\text{ mA}$<br>$I_{OH} = -0.4\text{ mA}$                                                 |                                            | 2, 3, | 1    |
| Output Leakage Current                              | $I_{OHH}$                    |            |                            | 100<br>500                 | $\mu\text{A}$          | $V_O = 5.5\text{ V}$<br>$V_O = 20\text{ V}$                                                            | $I_F = 5\text{ mA}$                        |       | 1    |
| Logic Low Supply<br>Current                         | $I_{CCL}$                    |            | 3.7<br>4.3<br>7.4<br>8.6   | 6.0<br>7.0<br>12.0<br>14.0 | mA                     | $V_{CC} = 5.5\text{ V}$<br>$V_{CC} = 20\text{ V}$<br>$V_{CC} = 5.5\text{ V}$<br>$V_{CC} = 20\text{ V}$ | $V_F = 0\text{ V}$<br>$I_O = \text{Open}$  |       |      |
| Logic High Supply<br>Current                        | $I_{CCH}$                    |            | 2.4<br>2.7<br>4.8<br>5.4   | 4.0<br>5.0<br>8.0<br>10.0  | mA                     | $V_{CC} = 5.5\text{ V}$<br>$V_{CC} = 20\text{ V}$<br>$V_{CC} = 5.5\text{ V}$<br>$V_{CC} = 20\text{ V}$ | $I_F = 5\text{ mA}$<br>$I_O = \text{Open}$ |       |      |
| Logic Low Short Circuit<br>Output Current           | $I_{OSL}$                    | 15<br>20   |                            |                            | mA                     | $V_O = V_{CC} = 5.5\text{ V}$<br>$V_O = V_{CC} = 20\text{ V}$                                          | $V_F = 0\text{ V}$<br>$V_O = \text{GND}$   |       | 1, 3 |
| Logic High Short Circuit<br>Output Current          | $I_{OSH}$                    |            |                            | -10<br>-20                 | mA                     | $V_{CC} = 5.5\text{ V}$<br>$V_{CC} = 20\text{ V}$                                                      | $I_F = 5\text{ mA}$                        |       | 1, 3 |
| Input Forward Voltage                               | $V_F$                        |            | 1.5<br>1.85<br>1.5<br>1.95 | 1.7                        | V                      | $T_A = 25^{\circ}\text{C}$                                                                             | $I_F = 5\text{ mA}$                        | 4     | 1    |
| Input Reverse Breakdown<br>Voltage                  | $BV_R$                       | 5<br>3     |                            |                            | V                      | $I_R = 10\text{ }\mu\text{A}$<br>$I_R = 100\text{ }\mu\text{A}$                                        |                                            |       | 1    |
| Input Diode Temperature<br>Coefficient              | $\Delta V_F$<br>$\Delta T_A$ |            | -1.7<br>-1.4               |                            | mV/ $^{\circ}\text{C}$ | $I_F = 5\text{ mA}$                                                                                    |                                            |       |      |
| Input Capacitance                                   | $C_{IN}$                     |            | 60<br>70                   |                            | pF                     | $f = 1\text{ MHz}$ , $V_F = 0\text{ V}$                                                                |                                            | 1, 4  |      |

\*For HCPL-223X,  $1.8\text{ mA} \leq I_{F(\text{ON})} \leq 5\text{ mA}$ .

\*\*Typical  $V_{OH} = V_{CC} - 2.1\text{ V}$ .

### Switching Specifications (AC)

$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ,  $4.5\text{ V} \leq V_{CC} \leq 20\text{ V}$ ,  $1.6\text{ mA} \leq I_{F(ON)}^* \leq 5\text{ mA}$ ,  $0\text{ V} \leq V_{F(OFF)} \leq 0.8\text{ V}$ .

All Typical at  $T_A = 25^{\circ}\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $I_{F(ON)} = 3\text{ mA}$  unless otherwise specified.

| Parameter                                         | Sym.      | Min. | Typ. | Max. | Units | Test Conditions           | Fig. | Note |
|---------------------------------------------------|-----------|------|------|------|-------|---------------------------|------|------|
| Propagation Delay Time to Logic Low Output Level  | $t_{PHL}$ |      | 150  |      | ns    | Without Peaking Capacitor | 5, 6 | 1, 6 |
|                                                   |           |      | 160  |      |       | HCNW22XX                  |      |      |
|                                                   |           |      | 150  | 300  |       | With Peaking Capacitor    |      |      |
| Propagation Delay Time to Logic High Output Level | $t_{PLH}$ |      | 110  |      | ns    | Without Peaking Capacitor | 5, 6 | 1, 6 |
|                                                   |           |      | 180  |      |       | HCNW22XX                  |      |      |
|                                                   |           |      | 90   | 300  |       | With Peaking Capacitor    |      |      |
| Output Rise Time (10-90%)                         | $t_r$     |      | 30   |      | ns    |                           | 5, 9 | 1    |
| Output Fall Time (90-10%)                         | $t_f$     |      | 7    |      | ns    |                           | 5, 9 | 1    |

| Parameter                                 | Sym.     | Device       | Min.   | Units            | Test Conditions Fig.           |                            | Note |      |
|-------------------------------------------|----------|--------------|--------|------------------|--------------------------------|----------------------------|------|------|
| Logic High Common Mode Transient Immunity | $ CM_H $ | HCPL-2201/02 | 1,000  | V/ $\mu\text{s}$ | $ V_{CM}  = 50\text{ V}$       | $V_{CC} = 5\text{ V}$      | 10   | 1, 7 |
|                                           |          | HCPL-0201    |        |                  | $I_F = 1.6\text{ mA}^\dagger$  | $T_A = 25^{\circ}\text{C}$ |      |      |
|                                           |          | HCPL-2231    |        |                  |                                |                            |      |      |
|                                           |          | HCNW2201     |        |                  |                                |                            |      |      |
|                                           |          | HCPL-2211/12 | 5,000  | V/ $\mu\text{s}$ | $ V_{CM}  = 300\text{ V}$      |                            |      |      |
| Logic Low Common Mode Transient Immunity  | $ CM_L $ | HCPL-0211    |        |                  | $I_F = 1.6\text{ mA}^\ddagger$ |                            | 10   | 1, 7 |
|                                           |          | HCPL-2232    | 10,000 | V/ $\mu\text{s}$ | $ V_{CM}  = 1\text{ kV}$       |                            |      |      |
|                                           |          | HCNW2211     |        |                  | $I_F = 5.0\text{ mA}$          |                            |      |      |
|                                           |          | HCPL-2201/02 | 1,000  | V/ $\mu\text{s}$ | $ V_{CM}  = 50\text{ V}$       | $V_F = 0\text{ V}$         |      |      |
|                                           |          | HCPL-0201    |        |                  |                                | $V_{CC} = 5\text{ V}$      |      |      |
| Logic Low Common Mode Transient Immunity  | $ CM_L $ | HCPL-2231    |        |                  |                                | $T_A = 25^{\circ}\text{C}$ | 10   | 1, 7 |
|                                           |          | HCNW2201     |        |                  |                                |                            |      |      |
|                                           |          | HCPL-2211/12 | 10,000 | V/ $\mu\text{s}$ | $ V_{CM}  = 1\text{ kV}$       |                            |      |      |
|                                           |          | HCPL-0211    |        |                  |                                |                            |      |      |
|                                           |          | HCPL-2232    |        |                  |                                |                            |      |      |
|                                           |          | HCNW2211     |        |                  |                                |                            |      |      |

\*For HCPL-223X,  $1.8\text{ mA} \leq I_{F(ON)} \leq 5\text{ mA}$ .

$^\dagger I_F = 1.8\text{ mA}$  for HCPL-2231.

$^\ddagger I_F = 1.8\text{ mA}$  for HCPL-2232.

## Package Characteristics

| Parameter                                 | Sym.      | Min.      | Typ.      | Max. | Units         | Test Conditions                                               | Fig. | Note  |
|-------------------------------------------|-----------|-----------|-----------|------|---------------|---------------------------------------------------------------|------|-------|
| Input-Output Momentary Withstand Voltage* | $V_{ISO}$ | 3750      |           |      | V rms         | RH < 50%, t = 1 min.                                          |      | 5, 10 |
|                                           | HCNW22XX  | 5000      |           |      |               | $T_A = 25^\circ\text{C}$                                      |      | 5, 11 |
| Input-Output Resistance                   | $R_{I-O}$ |           | $10^{12}$ |      | $\Omega$      | $V_{I-O} = 500\text{ Vdc}$                                    |      | 5     |
|                                           | HCNW22XX  | $10^{12}$ | $10^{13}$ |      |               | $T_A = 25^\circ\text{C}$                                      |      |       |
|                                           |           | $10^{11}$ |           |      |               | $T_A = 100^\circ\text{C}$                                     |      |       |
| Input-Output Capacitance                  | $C_{I-O}$ |           | 0.6       |      | pF            | f = 1 MHz,                                                    |      | 5     |
|                                           | HCNW22XX  |           | 0.5       | 0.6  |               | $T_A = 25^\circ\text{C}, V_{I-O} = 0\text{ Vdc}$              |      |       |
| Input-Input Insulation Leakage Current    | $I_{I-I}$ |           | 0.005     |      | $\mu\text{A}$ | Relative Humidity = 45%,<br>t = 5 s, $V_{I-I} = 500\text{ V}$ |      | 12    |
| Resistance (Input-Input)                  | $R_{I-I}$ |           | $10^{11}$ |      | $\Omega$      | $V_{I-I} = 500\text{ V}$                                      |      | 12    |
| Capacitance (Input-Input)                 | $C_{I-I}$ |           | 0.25      |      | pF            | f = 1 MHz                                                     |      | 12    |

\*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 60747-5-2 Insulation Characteristics Table (if applicable), your equipment level safety specification or Avago Application Note 1074 entitled "Optocoupler Input-Output Endurance Voltage," publication number 5963-2203

### Notes:

- Each channel.
- Derate total package power dissipation,  $P_T$ , linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $4.5\text{ mW}/^\circ\text{C}$ .
- Duration of output short circuit time should not exceed 10 ms.
- For single devices, input capacitance is measured between pin 2 and pin 3.
- Device considered a two-terminal device: pins 1, 2, 3, and 4 shorted together and pins 5, 6, 7, and 8 shorted together.
- The  $t_{PLH}$  propagation delay is measured from the 50% point on the leading edge of the input pulse to the 1.3 V point on the leading edge of the output pulse. The  $t_{PHL}$  propagation delay is measured from the 50% point on the trailing edge of the input pulse to the 1.3 V point on the trailing edge of the output pulse.
- $CM_H$  is the maximum slew rate of the common mode voltage that can be sustained with the output voltage in the logic high state,  $V_O > 2.0\text{ V}$ .  $CM_L$  is the maximum slew rate of the common mode voltage that can be sustained with the output voltage in the logic low state,  $V_O < 0.8\text{ V}$ .
- For HCPL-2202/12,  $V_O$  is on pin 6.
- Use of a  $0.1\text{ }\mu\text{F}$  bypass capacitor connected between pins 5 and 8 is recommended.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 4500\text{ V rms}$  for one second (leakage detection current limit,  $I_{I-O} \leq 5\text{ }\mu\text{A}$ ). This test is performed before the 100% production test for partial discharge (Method b) shown in the IEC/EN/DIN EN 60747-5-2 Insulation Characteristics Table, if applicable.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 6000\text{ V rms}$  for one second (leakage detection current limit,  $I_{I-O} \leq 5\text{ }\mu\text{A}$ ). This test is performed before the 100% production test for partial discharge (Method b) shown in the IEC/EN/DIN EN 60747-5-2 Insulation Characteristics Table.
- For HCPL-2231/32 only. Measured between pins 1 and 2, shorted together, and pins 3 and 4, shorted together.

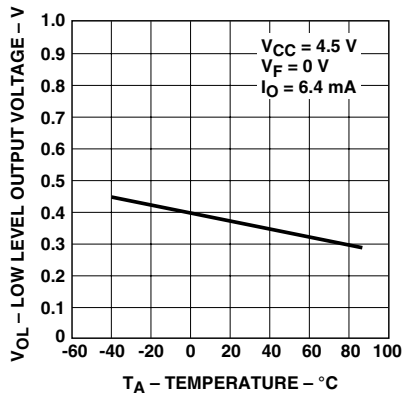


Figure 1. Typical logic low output voltage vs. temperature.

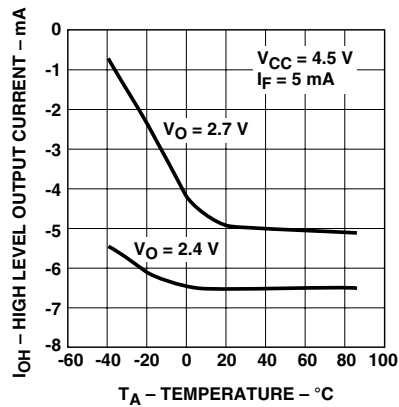


Figure 2. Typical logic high output current vs. temperature.

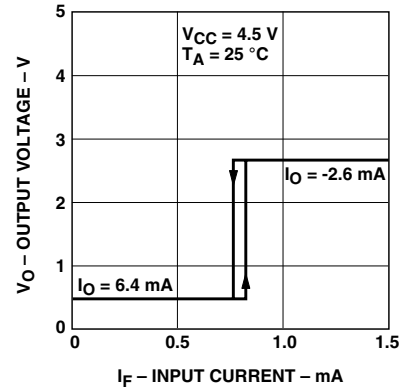


Figure 3. Typical output voltage vs. forward input current.

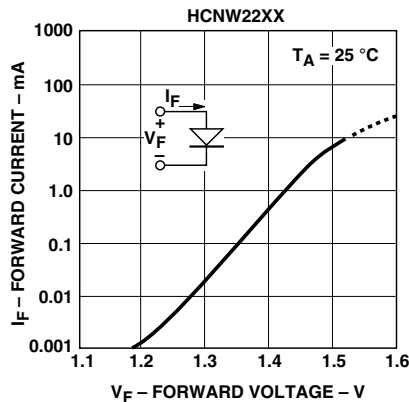
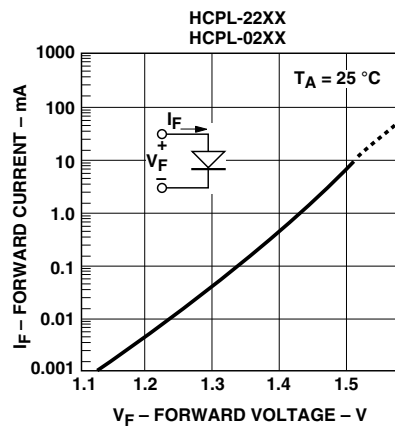


Figure 4. Typical input diode forward characteristic.

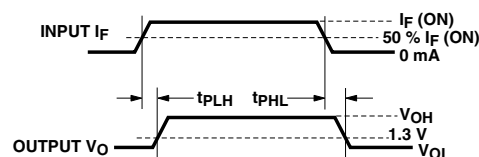
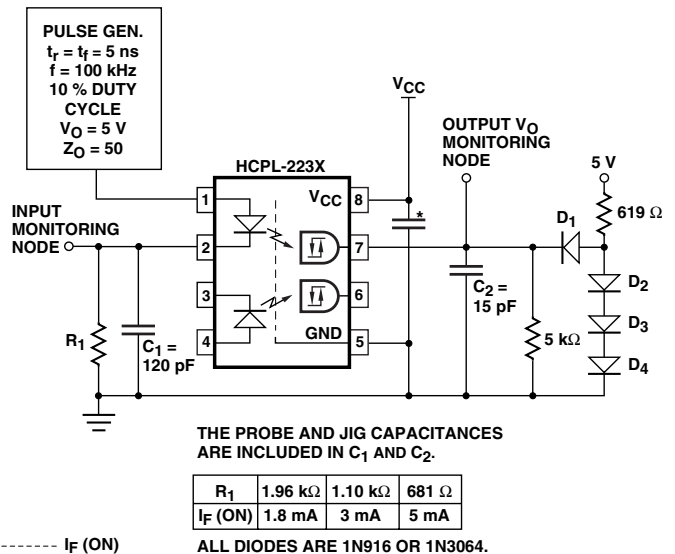
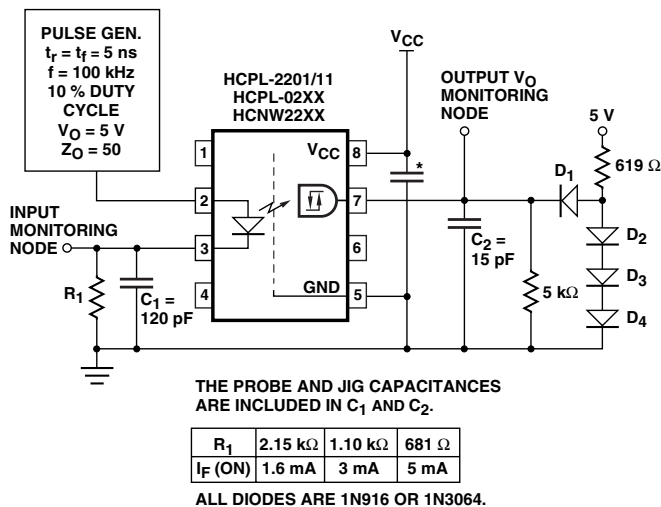


Figure 5. Circuit for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{tr}$ ,  $t_{fr}$

\* 0.1  $\mu$ F BYPASS — SEE NOTE 9.

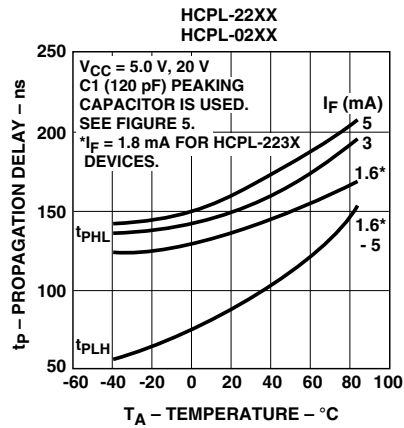


Figure 6. Typical propagation delays vs. temperature.

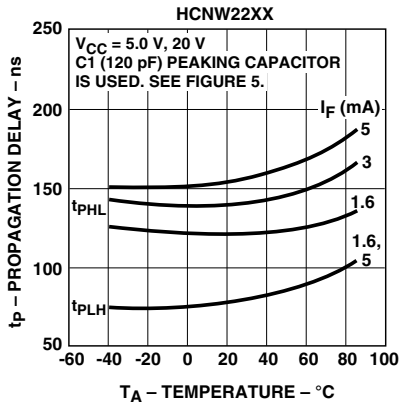


Figure 7. Maximum output power per channel vs. supply voltage.

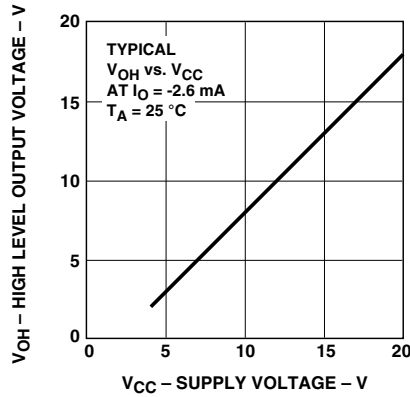


Figure 8. Typical logic high output voltage vs. supply voltage.

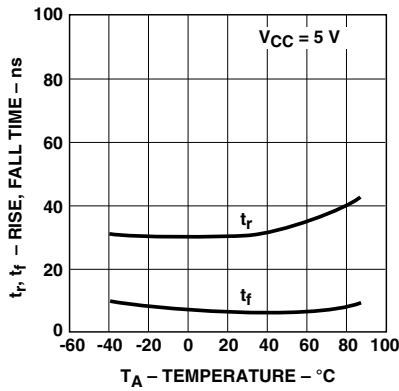


Figure 9. Typical rise, fall time vs. temperature.

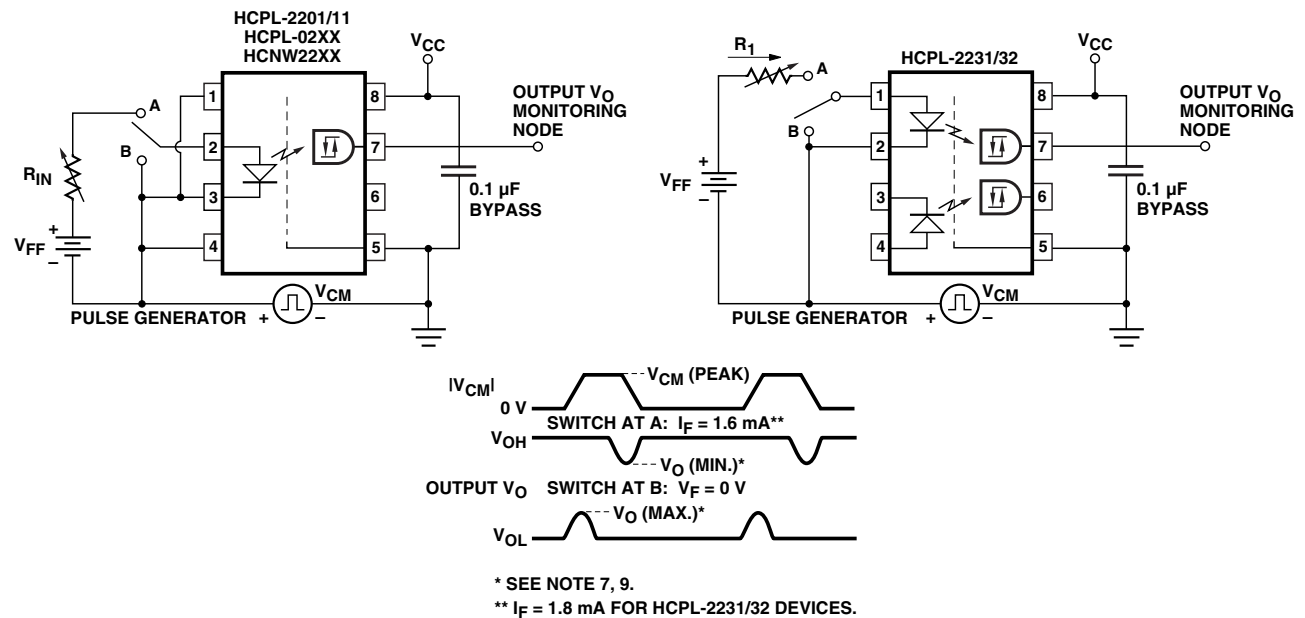


Figure 10. Test circuit for common mode transient immunity and typical waveforms.

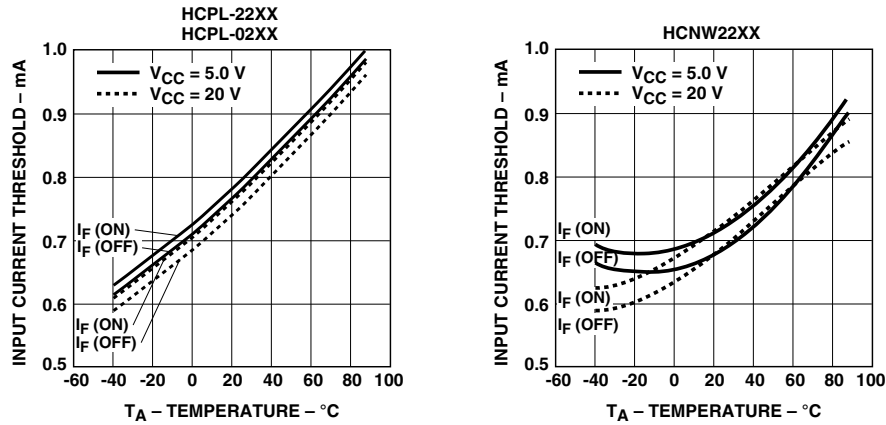


Figure 11. Typical input threshold current vs. temperature.

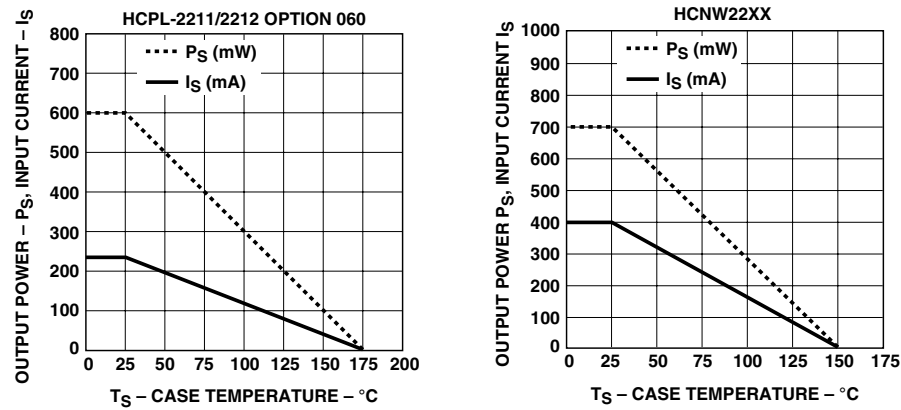


Figure 12. Thermal derating curve, dependence of safety limiting value with case temperature per IEC/EN/DIN EN

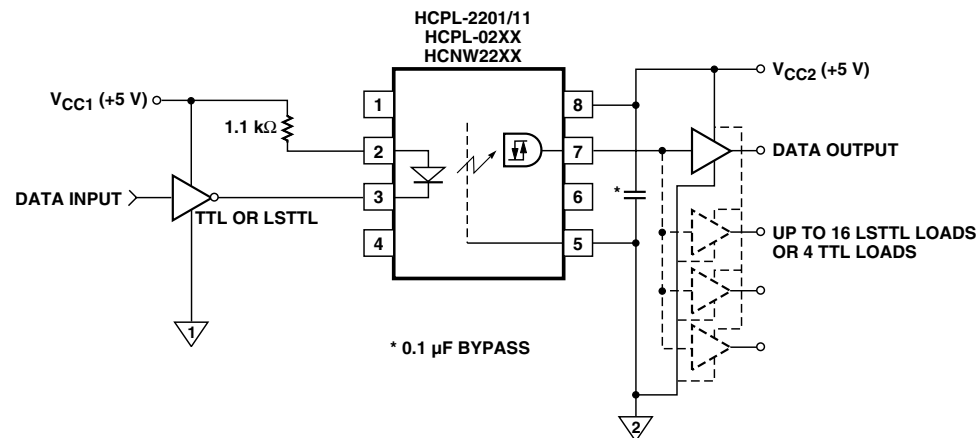


Figure 13a. Recommended LSTTL to LSTTL circuit where 500 ns propagation delay is sufficient.



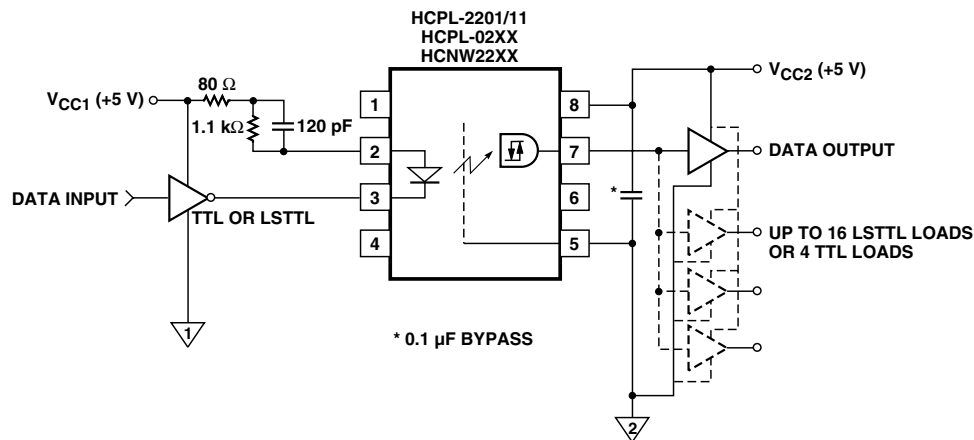


Figure 13b. Recommended LSTTL to LSTTL circuit for applications requiring a maximum allowable propagation delay of 300 ns.

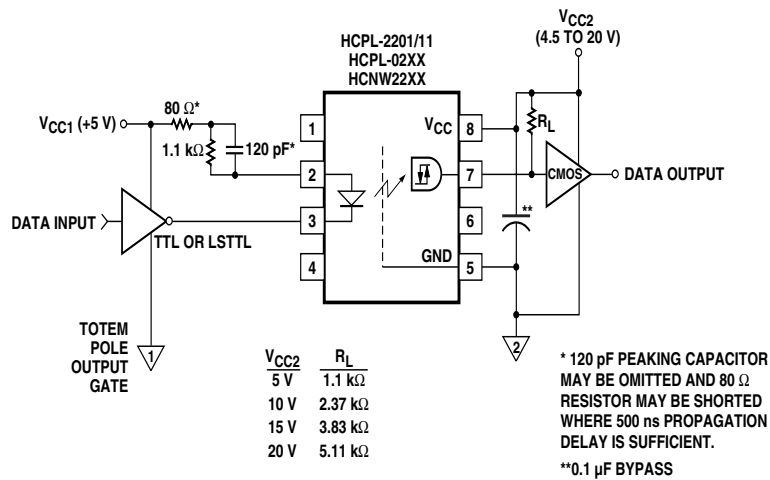


Figure 14. LSTTL to CMOS interface circuit.

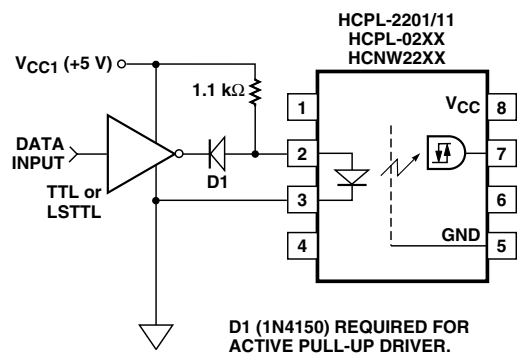


Figure 15. Alternative LED drive circuit.

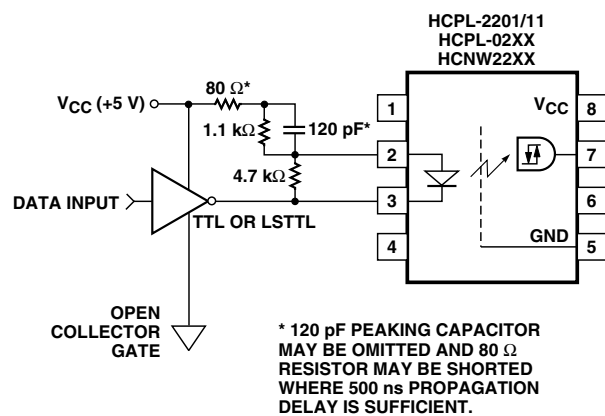


Figure 16. Series LED drive with open collector gate (4.7 k resistor shunts  $I_{OH}$  from the LED).

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AV02-0674EN - July 21, 2009

