

## Low Input Current, High Gain, LVTTTL/LVCMOS Compatible Optocouplers

### Data Sheet

#### Description

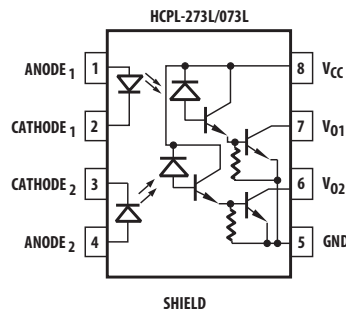
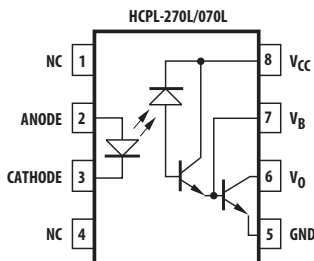
These high gain series couplers use a Light Emitting Diode and an integrated high gain photodetector to provide extremely high current transfer ratio between input and output. Separate pins for the photodiode and output stage result in LVTTTL compatible saturation voltages and high speed operation. Where desired, the  $V_{CC}$  and  $V_O$  terminals may be tied together to achieve conventional photo-darlington operation. A base access terminal allows a gain bandwidth adjustment to be made.

These optocouplers are for use in LVTTTL/LVCMOS or other low power applications. A 400% minimum current transfer ratio is guaranteed over 0 to +70 °C operating range for only 0.5 mA of LED current.

The HCPL-070L and HCPL-073L are surface-mount devices packaged in an industry-standard SOIC-8 footprint.

The SOIC-8 does not require through holes in a PCB. This package occupies approximately one-third the footprint area of the standard dual-in-line package. The lead profile is designed to be compatible with standard surface-mount processes.

#### Functional Diagram



TRUTH TABLE

LED	$V_O$
ON	LOW
OFF	HIGH

Note: A 0.1  $\mu$ F bypass capacitor connected between pins 8 and 5 is recommended.

#### 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.

#### Features

- 3.3 V/5 V dual supply voltages
- Low power consumption
- High current transfer ratio
- Low input current requirements: 0.5 mA
- LVTTTL/LVCMOS compatible output
- Performance guaranteed over temperature 0 °C to +70 °C
- Base access allows gain bandwidth adjustment
- High output current: 60 mA
- Safety approval, UL, IEC/EN/DIN EN 60747-5-2, CSA

#### Applications

- Ground isolate most logic families: LVTTTL/LVCMOS
- Low input current line receiver
- High voltage insulation
- EIA RS-232C line receiver
- Telephone ring detector
- V AC line voltage status indicator: low input power dissipation
- Low power systems: ground isolation

## Ordering Information

HCPL-270L, HCPL-273L, HCPL-070L and HCPL-073L are UL Recognized with 3750 Vrms for 1 minute per UL1577 and 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-270L	-000E	no option	300 mil DIP-8						50 per tube
HCPL-273L	-300E	-300		X	X				50 per tube
	-500E	-500		X	X	X			1000 per tube
	-060E	-060						X	100 per tube
	-560E	-560		X	X	X		X	1500 per tube
HCPL-070L	-000E	no option	SO-8	X					100 per tube
HCPL-073L	-500E	-500		X		X			1500 per tube
	-060E	-060		X				X	100 per tube
	-560E	-560		X		X		X	1500 per tube

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-273L-500E to order product of 300 mil DIP Gull Wing Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-2 Safety Approval and RoHS compliant.

Example 2:

HCPL-273L to order product of 300 mil DIP package in Tube packaging and non RoHS compliant.

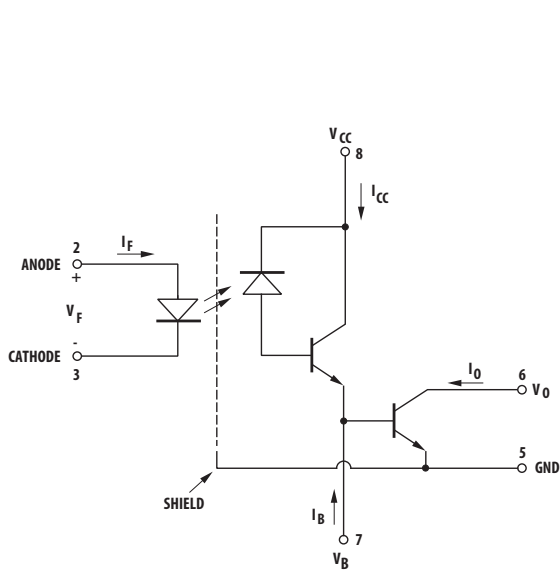
Option data sheets are available. Contact your Avago sales representative or authorized distributor for information.

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

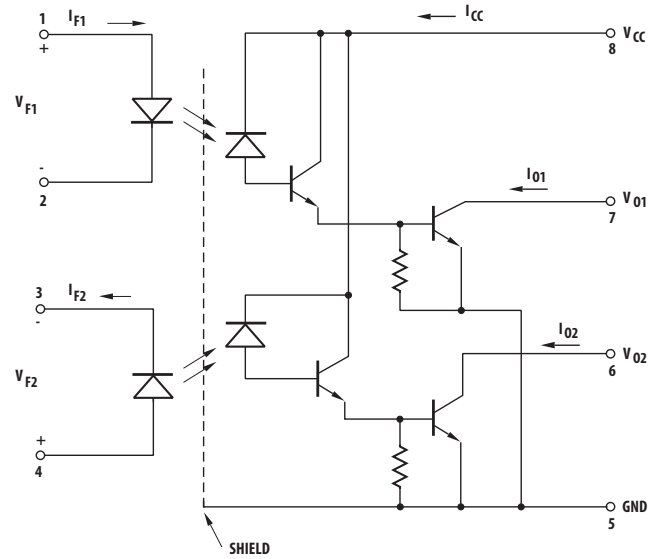
## Selection Guide

8-Pin DIP (300 Mil)		Small Outline SO-8		Minimum Input ON Current ( $I_F$ )	Minimum CTR
Single Channel Package HCPL-	Dual Channel Package HCPL-	Single Channel Package HCPL-	Dual Channel Package HCPL-		
270L	273L	070L	073L	0.5 mA	400%

## Schematic



HCPL-270L/HCPL-070L

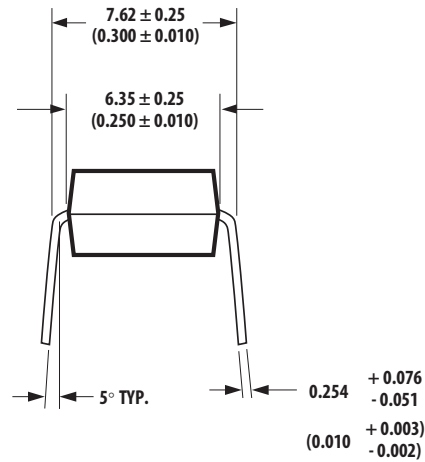
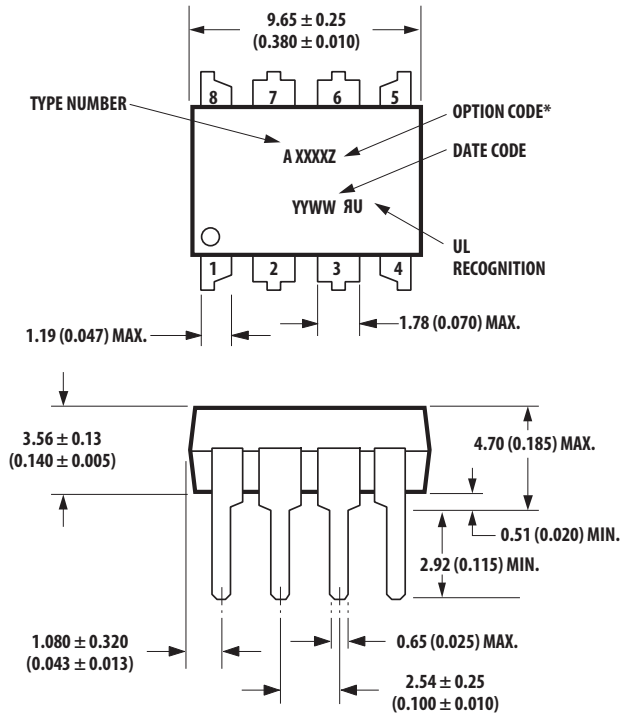


USE OF A 0.1  $\mu$ F BYPASS CAPACITOR CONNECTED BETWEEN PINS 5 AND 8 IS RECOMMENDED

HCPL-273L/HCPL-073L

## Package Outline Drawings

### 8-Pin DIP Package



DIMENSIONS IN MILLIMETERS AND (INCHES).

\* MARKING CODE LETTER FOR OPTION NUMBERS

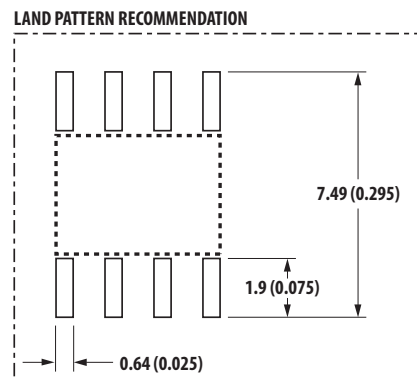
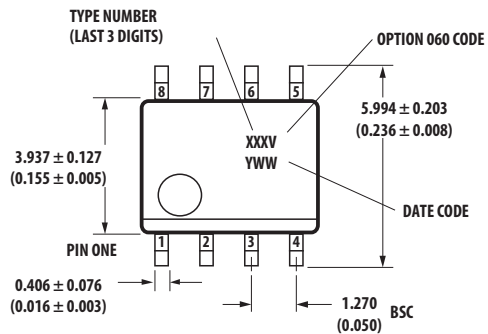
"L" = OPTION 020

"V" = OPTION 060

OPTION NUMBERS 300 AND 500 NOT MARKED.

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

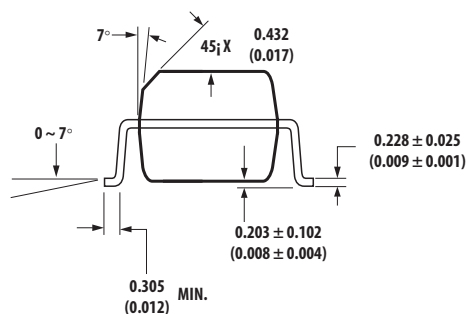
### Small Outline SO-8 Package



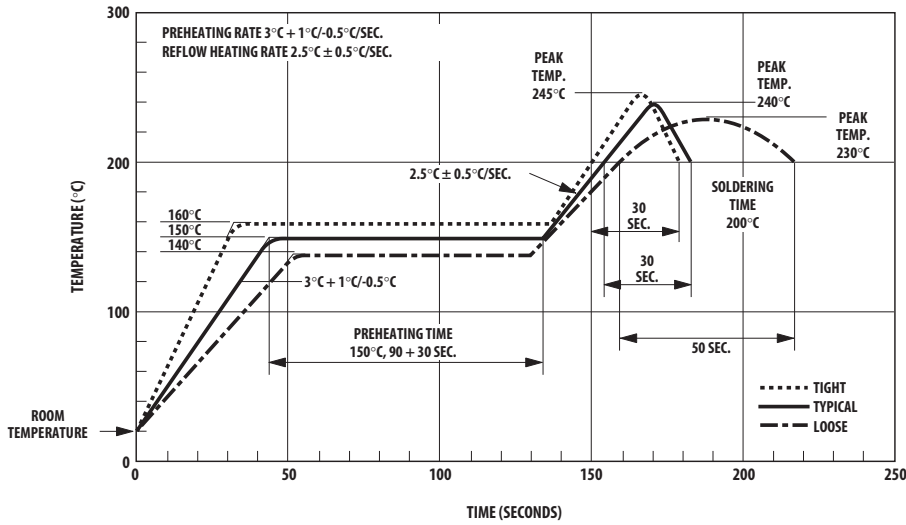
\* TOTAL PACKAGE LENGTH (INCLUSIVE OF MOLD FLASH)  
5.207 ± 0.254 (0.205 ± 0.010)

DIMENSIONS IN MILLIMETERS (INCHES).  
LEAD COPLANARITY = 0.10 mm (0.004 INCHES) MAX.  
OPTION NUMBER 500 NOT MARKED.

NOTE: FLOATING LEAD PROTRUSION IS 0.15 mm (6 mils) MAX.

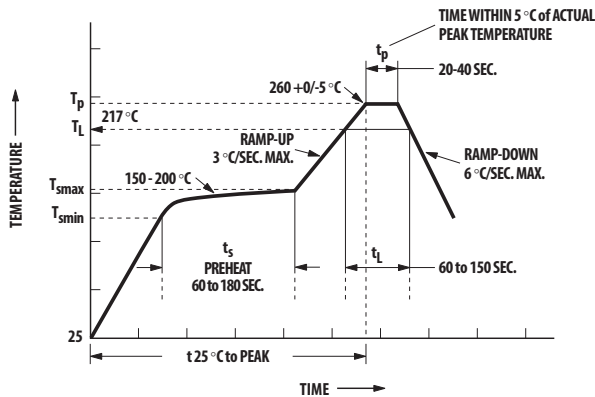


## Solder Reflow Temperature Profile



Note: Non-halide flux should be used.

## Recommended Pb-Free IR Profile



**NOTES:**

THE TIME FROM 25 °C TO PEAK TEMPERATURE = 8 MINUTES MAX.

$T_{smax} = 200^{\circ}\text{C}$ ,  $T_{smin} = 150^{\circ}\text{C}$

Note: Non-halide flux should be used.

## Regulatory Information

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

- UL Approval under UL 1577, Component Recognition Program, File E55361.
- CSA Approval under CSA Component Acceptance Notice #5, File CA 88324.
- 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 only)

## Insulation and Safety Related Specifications

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

## IEC/EN/DIN EN 60747-5-2 Insulation Related Characteristics

Description	Symbol	8-Pin DIP (300 Mil)	SO-8	Unit
Installation classification per DIN VDE 0110/1.89, Table 1	—			—
For rated mains voltage 150 V rms			I-IV	
For rated mains voltage 300 V rms		I-IV	I-III	
For rated mains voltage 600 V rms		I-III	I-II	
Climatic Classification	—	55/100/21	55/100/21	—
Pollution Degree (DIN VDE 0110/1.89)	—	2	2	—
Maximum Working Insulation Voltage	$V_{IORM}$	630	566	$V_{peak}$
Input to Output Test Voltage, Method b <sup>a</sup> $V_{PR} = 1.875 \times V_{IORM}$ , 100% Production Test with $t_p = 1$ sec, Partial Discharge < 5 pC	$V_{PR}$	1181	1063	$V_{peak}$
Input to Output Test Voltage, Method a <sup>a</sup> $V_{PR} = 1.5 \times V_{IORM}$ , Type and Sample Test, $t_p = 60$ sec, Partial Discharge < 5 pC	$V_{PR}$	945	849	$V_{peak}$
Highest Allowable Overvoltage (Transient Overvoltage, $t_{ini} = 10$ sec)	$V_{IOTM}$	6000	4000	$V_{peak}$
Safety Limiting Values (Maximum values allowed in the event of a failure.)				
Case Temperature	$T_S$	175	150	°C
Current (Input Current $I_F$ , $P_S = 0$ )	$I_{S,INPUT}$	400	150	mA
Output Power	$P_{S,OUTPUT}$	600	600	mW
Insulation Resistance at $T_S$ , $V_{IO} = 500$ V	$R_S$	$\geq 10^9$	$\geq 10^9$	$\Omega$

a. Refer to the front of the optocoupler section of the current catalog, under Product Safety Regulations section, IEC/EN/DIN EN 60747-5-2, 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 (No Derating Required up to +85 °C)

Parameter	Symbol	Min	Max	Unit
Storage Temperature	$T_S$	-55	125	°C
Operating Temperature	$T_A$	-40	85	°C
Average Forward Input Current	$I_{F(AVG)}$	—	20	mA
Peak Forward Input Current (50% Duty Cycle, 1 ms Pulse Width)	$I_{F(PEAK)}$	—	40	mA
Peak Transient Input Current ( $<1 \mu s$ Pulse Width, 300 pps)	$I_{F(TRAN)}$	—	1.0	A
Reverse Input Voltage	$V_R$	—	5	V
Input Power Dissipation	$P_I$	—	35	mW
Output Current (Pin 6)	$I_O$	—	60	mA
Emitter Base Reverse Voltage (Pin 5-7)	$V_{EB}$	—	0.5	V
Supply Voltage and Output Voltage	$V_{CC}$	-0.5	7	V
Output Power Dissipation	$P_O$	—	100	mW
Total Power Dissipation	$P_T$	—	135	mW
Lead Solder Temperature (for Through Hole Devices)	260 °C for 10 sec, 1.6 mm below seating plane.			
Reflow Temperature Profile (for SOIC-8 and Option #300)	See <a href="#">Package Outline Drawings</a> section.			

## Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Power Supply Voltage	$V_{CC}$	2.7	7.0	V
Forward Input Current (ON)	$I_{F(ON)}$	0.5	12.0	mA
Forward Input Voltage (OFF)	$V_{F(OFF)}$	0	0.8	V
Operating Temperature	$T_A$	0	70	°C

## Electrical Specifications

$0\text{ }^{\circ}\text{C} \leq T_A \leq +70\text{ }^{\circ}\text{C}$ ,  $2.7\text{ V} \leq V_{CC} \leq 3.3\text{ V}$ ,  $0.5\text{ mA} \leq I_{F(ON)} \leq 12\text{ mA}$ ,  $0\text{ V} \leq V_{F(OFF)} \leq 0.8\text{ V}$ , unless otherwise specified. All typicals at  $T_A = 25\text{ }^{\circ}\text{C}$ . (See Note 8.)

Parameter	Symbol	Device HCPL-	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Current Transfer Ratio	CTR	—	400	1300	5000	%	$I_F = 0.5\text{ mA}$ $V_{CC} = 3.3\text{ V}$ , $V_O = 0.4\text{ V}$	1, 2	2
Logic Low Output Voltage	$V_{OL}$	—	—	0.05	0.3	V	$I_F = 1.6\text{ mA}$ , $I_O = 8\text{ mA}$	—	
			—	0.05	0.4	V	$I_F = 5.0\text{ mA}$ , $I_O = 15\text{ mA}$		
Logic High Output Current	$I_{OH}$	—	—	5	25	$\mu\text{A}$	$V_O = V_{CC} = 3.3\text{ V}$ $I_F = 0\text{ mA}$		2
Logic Low Supply Current	$I_{CCL}$	270L/070L	—	0.4	1.3	mA	$V_{CC} = 3.3\text{ V}$	$I_{F1} = I_{F2} = 1.6\text{ mA}$	
		273L/073L	—	0.8	2.7	mA		$V_{O1} = V_{O2} = \text{Open}$	
Logic High Supply Current	$I_{CCH}$	270L/070L	—	0.002	1	$\mu\text{A}$	$V_{CC} = 3.3\text{ V}$	$I_{F1} = I_{F2} = 0\text{ mA}$	
		273L/073L	—	0.002	2	$\mu\text{A}$		$V_{O1} = V_{O2} = \text{Open}$	
Input Forward Voltage	$V_F$	—	—	1.5	1.7	V	$T_A = 25\text{ }^{\circ}\text{C}$ $I_F = 1.6\text{ mA}$	3, 4	
Input Reverse Breakdown Voltage	$BV_R$	—	5.0	—	—	V	$I_R = 10\text{ }\mu\text{A}$ , $T_A = 25\text{ }^{\circ}\text{C}$		2
Temperature Coefficient of Forward Voltage	$\Delta V_F/\Delta T_A$	—	—	-1.8	—	mV/ $^{\circ}\text{C}$	$I_F = 1.6\text{ mA}$		
Input Capacitance	$C_{IN}$	—	—	60	—	pF	$f = 1\text{ MHz}$ , $V_F = 0$		2

a. All typical values at  $T_A = 25\text{ }^{\circ}\text{C}$  and  $V_{CC} = 3.3\text{ V}$ , unless otherwise noted.

## Electrical Specifications

$0\text{ }^{\circ}\text{C} \leq T_A \leq +70\text{ }^{\circ}\text{C}$ ,  $4.5\text{ V} \leq V_{CC} \leq 7\text{ V}$ ,  $0.5\text{ mA} \leq I_{F(ON)} \leq 12\text{ mA}$ ,  $0\text{ V} \leq V_{F(OFF)} \leq 0.8\text{ V}$ , unless otherwise specified. All typicals at  $T_A = 25\text{ }^{\circ}\text{C}$ . (See Note 8.)

Parameter	Symbol	Device HCPL-	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Current Transfer Ratio	CTR	—	300	1600	2600	%	$I_F = 1.6\text{ mA}$ , $V_{CC} = 4.5\text{ V}$ , $V_O = 0.5\text{ V}$	2, 3	2
Logic Low Output Voltage	$V_{OL}$	—	—	0.1	0.4	V	$I_F = 1.6\text{ mA}$ , $I_O = 4.8\text{ mA}$ , $V_{CC} = 4.5\text{ V}$	1	
Logic High Output Current	$I_{OH}$	—	—	0.1	250	$\mu\text{A}$	$V_O = V_{CC} = 7\text{ V}$ , $I_F = 0\text{ mA}$		2
Logic Low Supply Current	$I_{CCL}$	—	—	0.9	3	mA	$V_{CC} = 7\text{ V}$ , $I_{F1} = I_{F2} = 1.6\text{ mA}$ , $V_{O1} = V_{O2} = \text{Open}$	5	
Logic High Supply Current	$I_{CCH}$	—	—	0.004	20	$\mu\text{A}$	$V_{CC} = 7\text{ V}$ , $I_{F1} = I_{F2} = 0\text{ mA}$ , $V_{O1} = V_{O2} = \text{Open}$	5	
Input Forward Voltage	$V_F$	—	—	1.4	1.7	V	$T_A = 25\text{ }^{\circ}\text{C}$	4	
			—	—	1.75	V	$I_F = 1.6\text{ mA}$		



Parameter	Symbol	Device HCPL-	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Input Reverse Breakdown Voltage	$BV_R$	—	5	—	—	V	$I_R = 10 \mu\text{A}$ , $T_A = 25^\circ\text{C}$		2
Temperature Coefficient of Forward Voltage	$\Delta V_F/\Delta T_A$	—	—	-1.8	—	mV/°C	$I_F = 1.6 \text{ mA}$		
Input Capacitance	$C_{IN}$	—	—	60	—	pF	$f = 1 \text{ MHz}$ , $V_F = 0$		2

a. All typical values at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5 \text{ V}$ , unless otherwise noted.

## Switching Specifications (AC)

Over recommended operating conditions ( $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ),  $V_{CC} = 3.3 \text{ V}$ , unless otherwise specified. (See Note 8.)

Parameter	Symbol	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Propagation Delay Time to Logic Low at Output	$t_{PHL}$	—	—	30	$\mu\text{s}$	$I_F = 0.5 \text{ mA}$ , $R_L = 4.7 \text{ k}\Omega$	5	2
Propagation Delay Time to Logic High at Output	$t_{PLH}$	—	—	90	$\mu\text{s}$	$I_F = 0.5 \text{ mA}$ , $R_L = 4.7 \text{ k}\Omega$	5	2
Common Mode Transient Immunity at Logic High Level Output	$ CM_H $	1000	10000	—	V/ $\mu\text{s}$	$I_F = 0 \text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_L = 2.2 \text{ k}\Omega$ , $ V_{CM}  = 10 \text{ V}_{p-p}$	6	2, 6, 7
Common Mode Transient Immunity at Logic Low Level Output	$ CM_L $	1000	10000	—	V/ $\mu\text{s}$	$I_F = 1.6 \text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_L = 2.2 \text{ k}\Omega$ , $ V_{CM}  = 10 \text{ V}_{p-p}$	6	2, 6, 7

a. All typical values at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 3.3 \text{ V}$ , unless otherwise noted.

## Switching Specifications (AC)

Over recommended operating conditions ( $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ),  $V_{CC} = 5 \text{ V}$ , unless otherwise specified. (See Note 8.)

Parameter	Symbol	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Propagation Delay Time to Logic Low at Output	$t_{PHL}$	—	—	25	$\mu\text{s}$	$I_F = 1.6 \text{ mA}$ , $R_L = 2.2 \text{ k}\Omega$	6, 7, 8, 9	2
Propagation Delay Time to Logic High at Output	$t_{PLH}$	—	—	50	$\mu\text{s}$	$I_F = 1.6 \text{ mA}$ , $R_L = 2.2 \text{ k}\Omega$	7, 8, 9	2
Common Mode Transient Immunity at Logic High Level Output	$ CM_H $	1000	10000	—	V/ $\mu\text{s}$	$I_F = 0 \text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_L = 2.2 \text{ k}\Omega$ , $ V_{CM}  = 10 \text{ V}_{p-p}$	10	2, 6, 7
Common Mode Transient Immunity at Logic Low Level Output	$ CM_L $	1000	10000	—	V/ $\mu\text{s}$	$I_F = 1.6 \text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_L = 2.2 \text{ k}\Omega$ , $ V_{CM}  = 10 \text{ V}_{p-p}$	10	2, 6, 7

a. All typical values at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5 \text{ V}$ , unless otherwise noted.

## Package Characteristics

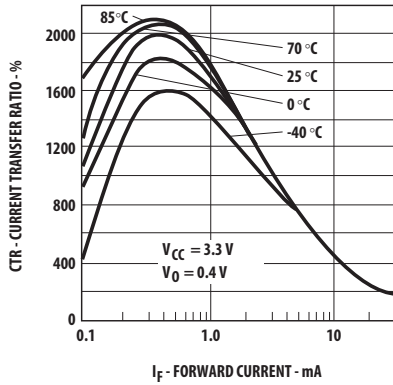
Parameter	Symbol	Device HCPL-	Min	Typ <sup>a</sup>	Max	Unit	Test Conditions	Fig	Note
Input-Output Momentary Withstand Voltage <sup>b</sup>	$V_{ISO}$	—	3750	—	—	Vrms	$RH \leq 50\%$ , $t = 1 \text{ min}$ , $T_A = 25 \text{ }^\circ\text{C}$		4, 9
Resistance (Input-Output)	$R_{I-O}$	—	—	$10^{12}$	—	$\Omega$	$V_{I-O} = 500 \text{ Vdc}$ , $RH \leq 45\%$		4
Capacitance (Input-Output)	$C_{I-O}$	—	—	0.6	—	pF	$f = 1 \text{ MHz}$		11
Input-Input Insulation Leakage Current	$I_{I-I}$	—	0.005	—	—	$\mu\text{A}$	$RH \leq 45\%$ , $V_{I-I} = 500 \text{ Vdc}$		5
Input-Input Insulation Resistance	$R_{I-I}$	—	—	$10^{11}$	—	$\Omega$	—		5
Capacitance (Input-Input)	$C_{I-I}$	270L	—	0.03	—	pF	—		5
		273L	—	—	—	pF			
		070L	—	0.25	—	pF			
		073L	—	—	—	pF			

- a. All typical values at  $T_A = 25 \text{ }^\circ\text{C}$ , unless otherwise noted.
- 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 60747-5-2 Insulation Characteristics Table (if applicable), your equipment level safety specification, or Avago Application Note 1074, *Optocoupler Input-Output Endurance Voltage*.

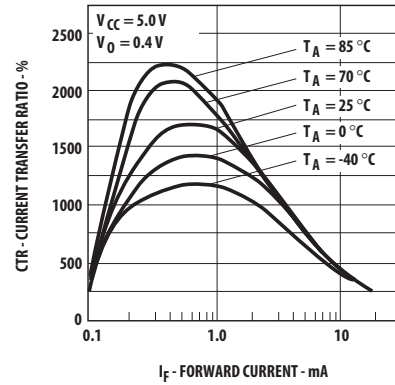
### Notes:

- Pin 5 should be the most negative voltage at the detector side.
- Each channel.
- DC Current Transfer Ratio (CTR) is defined as the ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$ , times 100%.
- Device considered a two-terminal device: pins 1, 2, 3, and 4 shorted together, and pins 5, 6, 7, and 8 shorted together.
- Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
- Common mode transient immunity in a Logic High level is the maximum tolerable (positive)  $dV_{CM}/dt$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a Logic High state (i.e.,  $V_O > 2.0 \text{ V}$ ). Common mode transient immunity in a Logic Low level is the maximum tolerable (negative)  $dV_{CM}/dt$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a Logic Low state (i.e.,  $V_O < 0.8 \text{ V}$ ).
- In applications where  $dV/dt$  may exceed  $50,000 \text{ V}/\mu\text{s}$  (such as static discharge) a series resistor,  $R_{CC}$ , should be included to protect the detector IC from destructively high surge currents. The recommended value is  $R_{CC} = 110 \text{ } \Omega$ .
- Use of a  $0.1 \text{ } \mu\text{F}$  bypass capacitor connected between pins 5 and 8 adjacent to the device is recommended.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $> 4500 \text{ Vrms}$  for 1 second (leakage detection current limit,  $I_{I-O} < 5 \text{ } \mu\text{A}$ ).
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $> 6000 \text{ Vrms}$  for 1 second (leakage detection current limit,  $I_{I-O} < 5 \text{ } \mu\text{A}$ ).
- Measured between the LED anode and cathode shorted together and pins 5 through 8 shorted together.

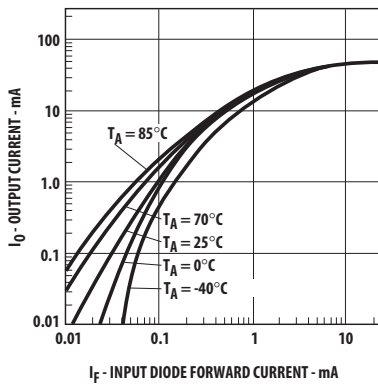
**Figure 1 Current Transfer Ratio vs. Forward Current**



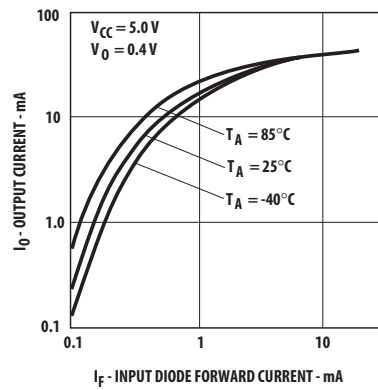
**Figure 2 Current Transfer Ratio vs. Forward Current**



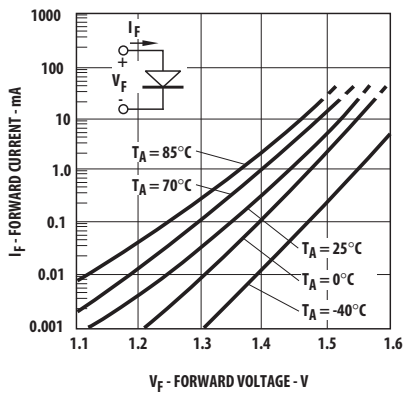
**Figure 3 Output Current vs. Input Diode Forward Current**



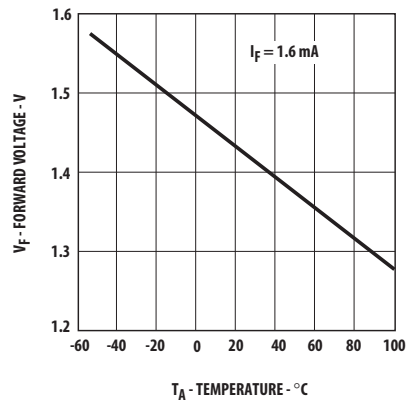
**Figure 4 Output Current vs. Input Diode Forward Current**



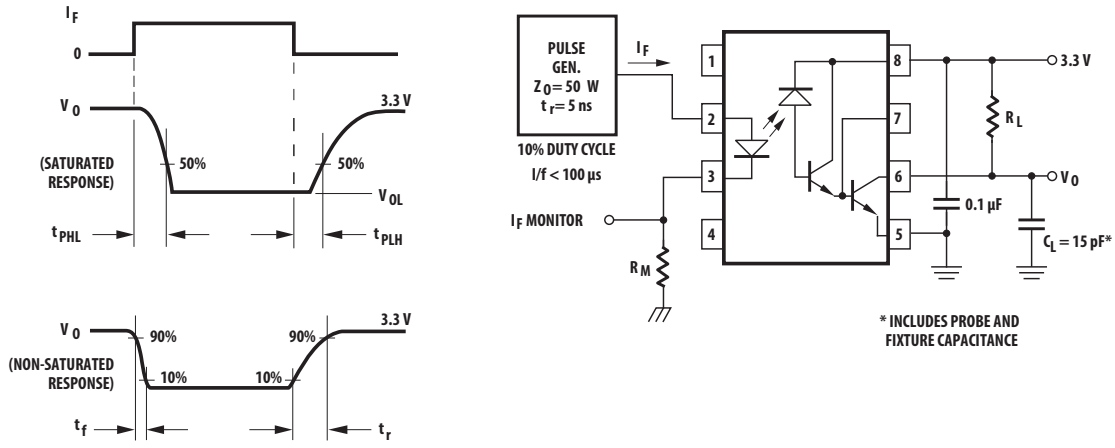
**Figure 5 Input Diode Forward Current vs. Forward Voltage**



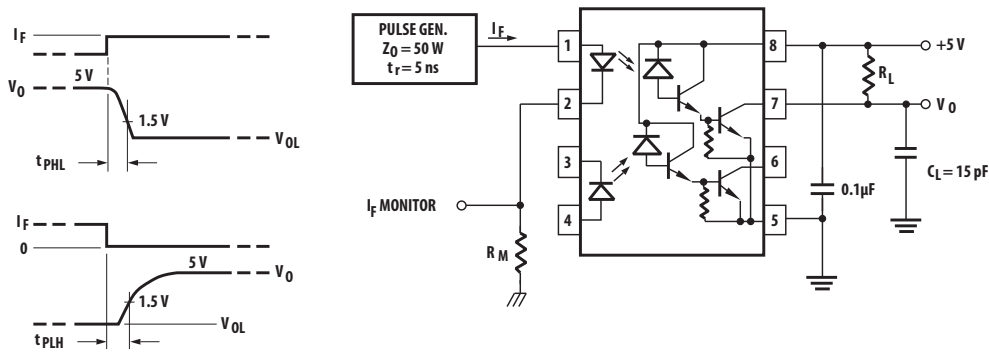
**Figure 6 Forward Voltage vs. Temperature**



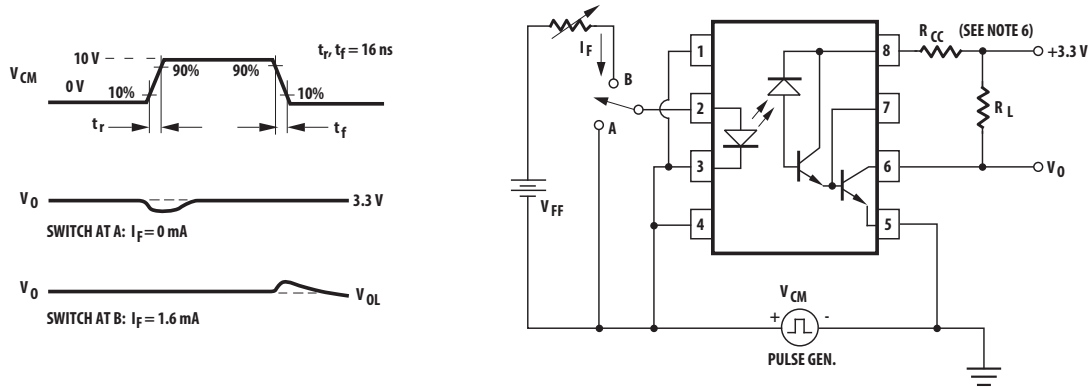
**Figure 7 Switching Test Circuit**



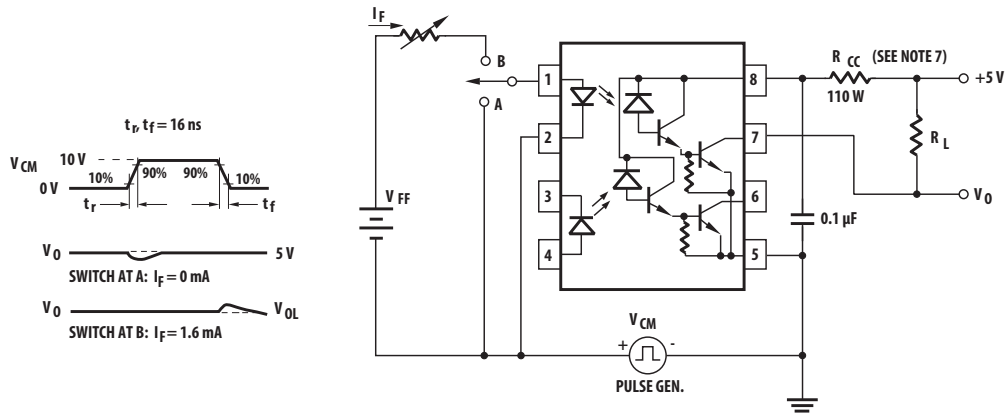
**Figure 8 Switching Test Circuit**



**Figure 9 Test Circuit for Transient Immunity and Typical Waveforms**



**Figure 10 Test Circuit for Transient Immunity and Typical Waveforms**



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