

## HCPL-2730/0730/2731/0731

### Dual-Channel Low Input Current, High-Gain Optocouplers

#### Overview

These dual-channel optocouplers contain a separated pair of GaAsP light-emitting diodes optically coupled to a pair of integrated high-gain photodetectors. They provide extremely high current transfer ratio and excellent input-output common mode transient immunity. A separate pin for the photodiodes and first gain stages ( $V_{CC}$ ) permits lower output saturation voltage and higher speed operation than possible with conventional photo-darlington type optocouplers. In addition,  $V_{CC}$  may be as low as 1.6V without adversely affecting the parametric performance.

These dual-channel optocouplers are available in an 8-pin DIP and in an industry standard SO-8 package. The following is a cross reference table listing the 8-pin DIP part number and the electrically equivalent SOIC-8 part number.

8-Pin DIP	SO-8
HCPL-2730	HCPL-0730
HCPL-2731	HCPL-0731

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

**CAUTION!** Take normal static precautions in handling and assembly of this component to prevent damage, degradation, or both that may be induced by ESD. The components featured in this data sheet are not to be used in military or aerospace applications or environments.

#### Features

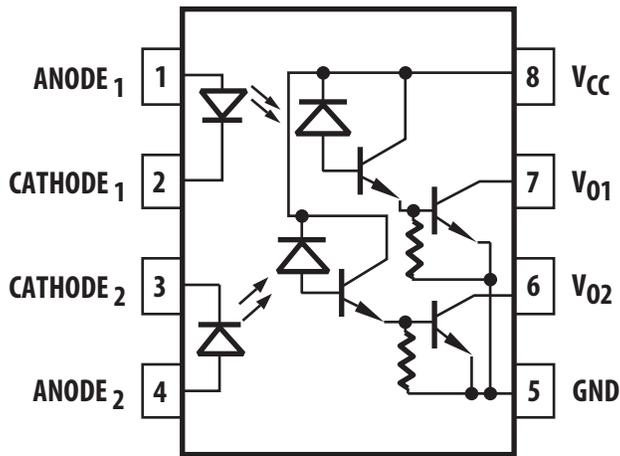
- High current transfer ratio – 1800% typical
- Low input current requirements – 0.5 mA
- Low output saturation voltage – 0.1V
- High density packaging
- Performance guaranteed over temperature 0°C to 70°C
- LSTTL compatible
- High output current – 60 mA
- Safety approval:
  - UL recognized – 3750 V rms for 1 minute and 5000 Vrms (see Note) for 1 minute
  - CSA approved
- Available in 8-pin DIP and SO-8 footprint
- MIL-PRF-38534 hermetic version available (HCPL-5730/5731)
- Surface mount gull wing option available for 8-pin DIP (Option 300)

**NOTE:** 5000 V rms/1 minute withstand voltage rating is for Option 020 (HCPL-2730, HCPL-2731) products only.

#### Applications

- Digital logic ground isolation
- Telephone ring detector
- Level shifting
- EIA RS-232C line receiver
- Polarity sensing
- Low input current line receiver – long line or party line
- Microprocessor bus isolation
- Current loop receiver
- Line voltage status indicator – low input power dissipation

# Functional Diagram



**TRUTH TABLE**

LED	V <sub>O</sub>
ON	LOW
OFF	HIGH

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

Guaranteed operation at low input currents and the high current transfer ratio (CTR) reduce the magnitude and effects of CTR degradation.

The outstanding high temperature performance of this split Darlington-type output amplifier results from the inclusion of an integrated emitter-base bypass resistor that shunts photodiode and first stage leakage currents to ground.

The HCPL-2731/0731 have a 400% minimum CTR at an input current of only 0.5 mA making it ideal for use in low input current application, such as MOS, CMOS, and low-power logic interfacing or RS232C data transmission systems. In addition, the high CTR and high output current capability make this device extremely useful in applications where a high fanout is required. Compatibility with high-voltage CMOS logic systems is guaranteed by the 18V V<sub>CC</sub> and V<sub>O</sub> specifications and by testing output high leakage (I<sub>OH</sub>) at 18V.

The HCPL-2730/0730 are specified at an input current of 1.6 mA and have a 7V V<sub>CC</sub> and V<sub>O</sub> rating. The 300% minimum CTR allows TTL to TTL interfacing at this input current.

Important specifications, such as CTR, leakage current, and output saturation voltage, are guaranteed over the 0°C to 70°C temperature range to allow trouble-free system operation. Selection for lower input currents down to 250  $\mu$ A is available upon request.

# Selection Guide

8-Pin DIP (300 Mil)		Small Outline SO-8		Wide Body Package (400 mil)	Minimum Input ON Current ( $I_F$ )	Minimum CTR	Absolute Maximum $V_{CC}$	Hermetic
Single Channel Package	Dual-Channel Package HCPL-	Single Channel Package HCPL-	Dual-Channel Package HCPL-	Single Channel Package				Single- and Dual-Channel Packages HCPL-
6N139 <sup>a</sup>	2731	0701[1]	0731	HCNW139 <sup>a</sup>	0.5 mA	400%	18V	
6N138 <sup>a</sup>	2730	0700[1]	0730	HCNW138 <sup>a</sup>	1.6 mA	300%	7V	
HCPL-4701 <sup>a</sup>	4731 <sup>a</sup>	070A[1]	073A <sup>a</sup>		40 $\mu$ A	800%	18V	
					0.5 mA	300%	20V	5701 <sup>a</sup>
								5700 <sup>a</sup>
								5731 <sup>a</sup>
								5730 <sup>a</sup>

a. Technical data are in separate Broadcom publications.

## Ordering Information

HCPL-2730, HCPL-2731, HCPL-0730 and HCPL-0731 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 and Reel	UL 5000 Vrms/ 1 Minute Rating	IEC/EN/DIN EN 60747-5-5	Quantity
	RoHS Compliant	Non-RoHS Compliant							
HCPL-2730	-000E	No option	300mil DIP-8						50 per tube
HCPL-2731	-300E	#300		X	X				50 per tube
	-500E	#500		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	50 per tube
	-360E	#360		X	X			X	50 per tube
	-560E	#560		X	X	X		X	1000 per reel
HCPL-0730	-000E	No option	SO-8						100 per tube
HCPL-0731	-500E	#500		X	X	X			1500 per reel
	-060E	#060						X	100 per tube
	-560E	#560		X	X	X		X	1500 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-2730-520E to order product of 300-mil DIP Gull Wing Surface Mount package in Tape and Reel packaging with UL 5kVrms 1-minute rating in RoHS compliant.

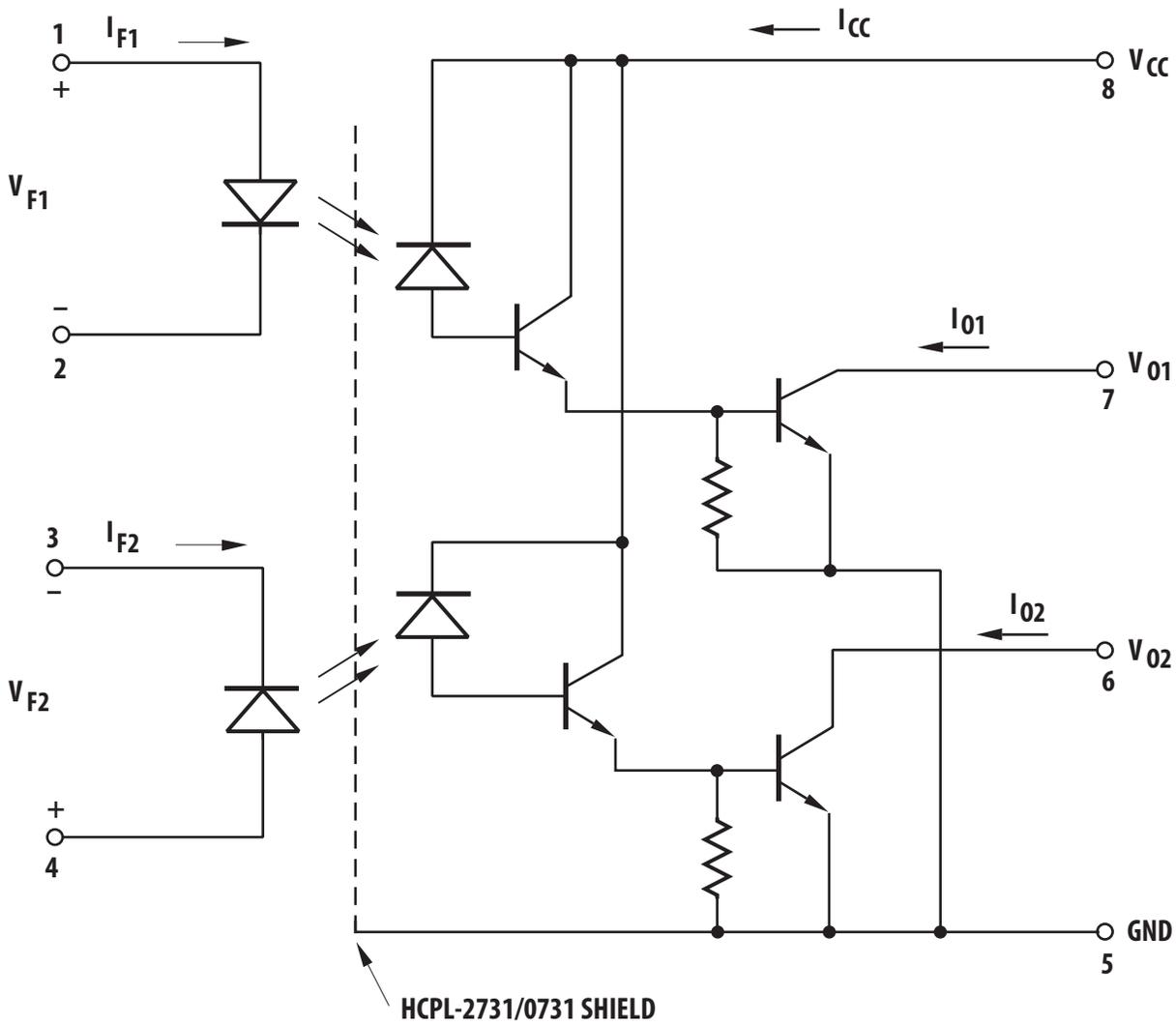
**Example 2:**

HCPL-2730 to order product of 300-mil DIP package in tube packaging and non-RoHS compliant.

Option 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 July 15, 2001 and RoHS compliant option use “-XXXE”.

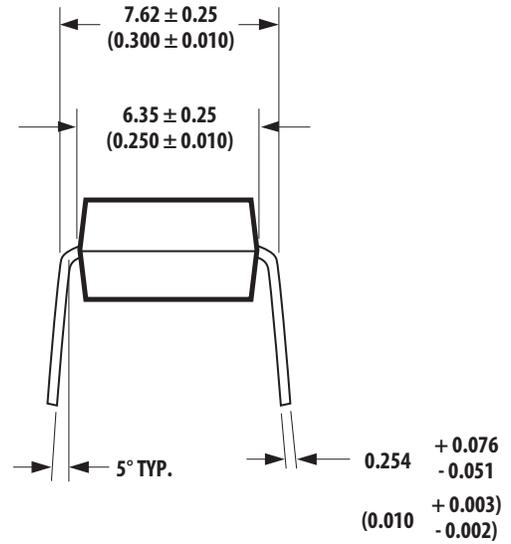
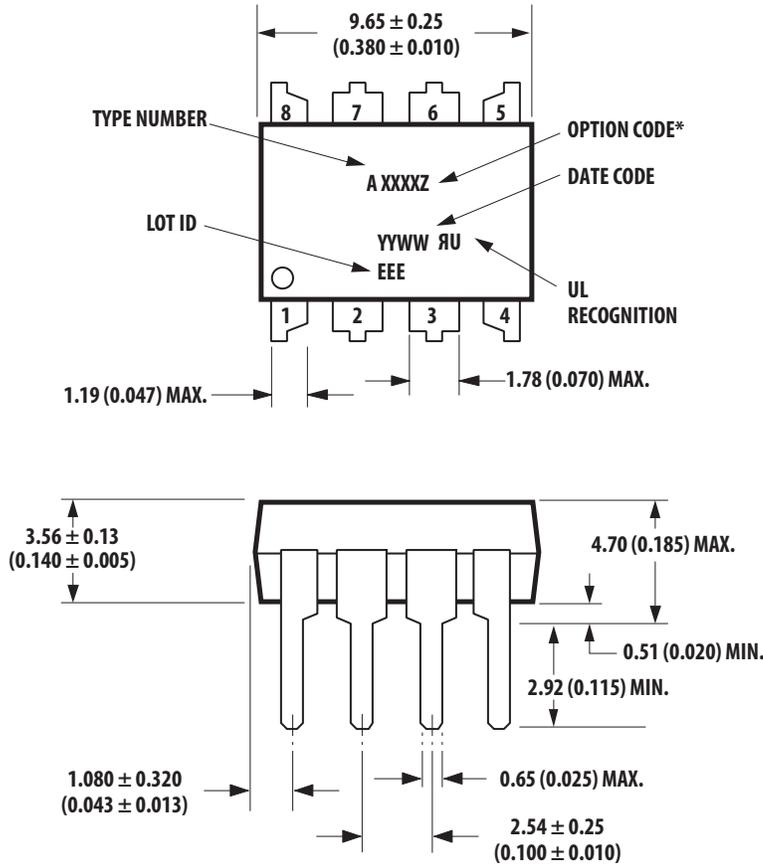
# Schematic



**USE OF A 0.1 μF BYPASS CAPACITOR CONNECTED BETWEEN PINS 5 AND 8 IS RECOMMENDED (SEE NOTE 8)**

# Package Outline Drawings

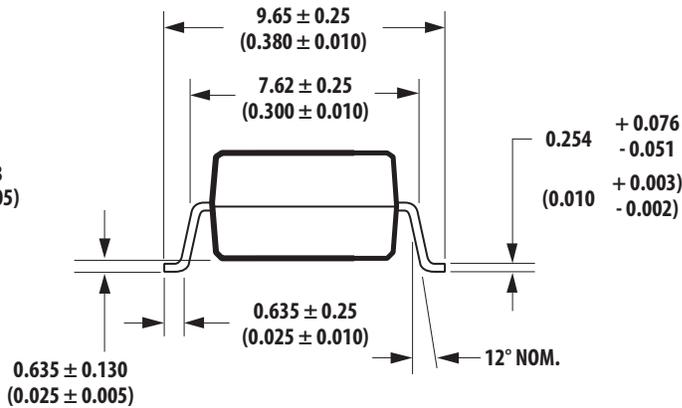
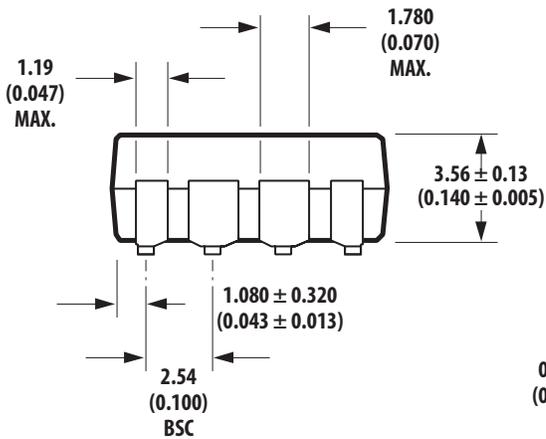
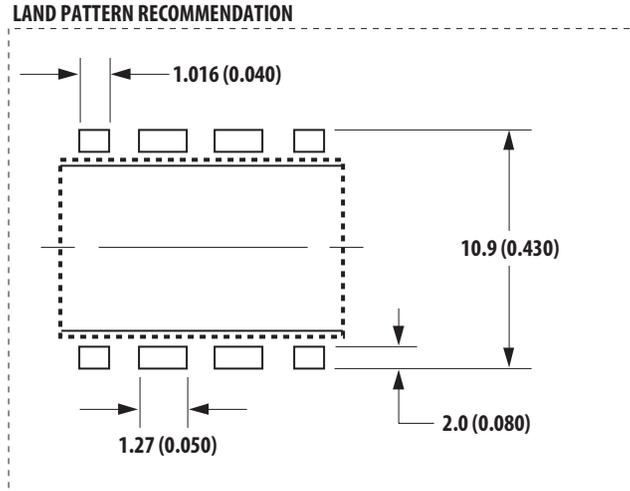
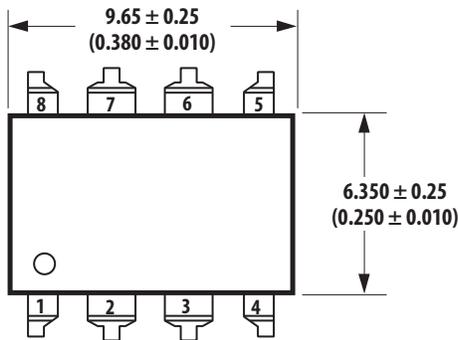
## 8-Pin DIP Package (HCPL-2731/HCPL-2730)



DIMENSIONS IN MILLIMETERS AND (INCHES).  
 \*MARKING CODE LETTER FOR OPTION NUMBERS  
 "L" = OPTION 020  
 OPTION NUMBERS 300 AND 500 NOT MARKED.

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

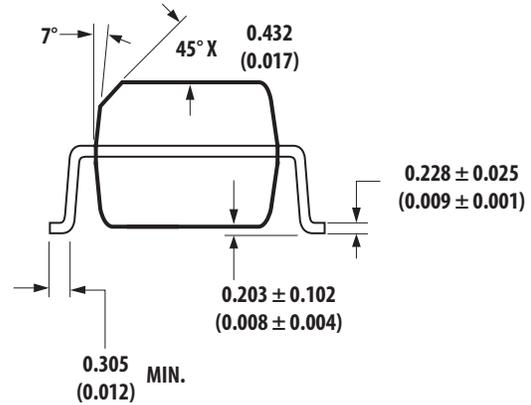
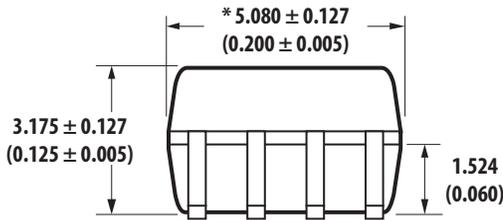
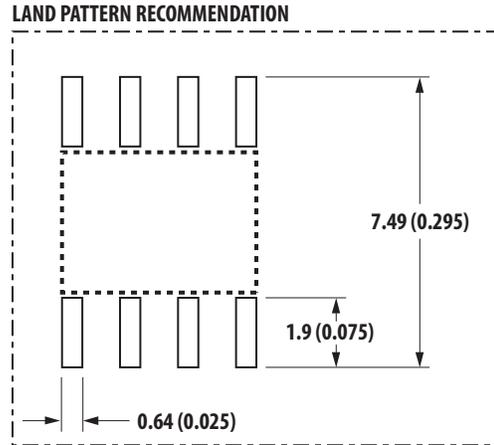
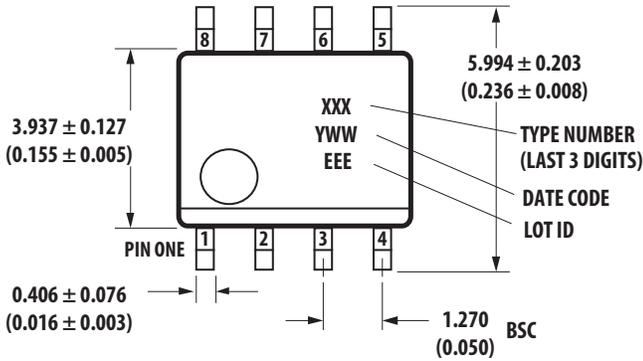
# 8-Pin DIP Package with Gull Wing Surface Mount Option 300 (HCPL-2731/HCPL-2730)



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-0731/HCPL-0730)



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

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

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

## Solder Reflow Thermal Profile

### Solder Reflow Profile

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

## Regulatory Information

The HCPL-2731/2730 have been approved by the following organizations.

UL	Recognized under UL 1577, Component Recognition Program, File E55361.
CSA	Approved under CSA Component Acceptance Notice #5, File CA 88324.
IEC/EN/DIN EN 60747-5-5	Option 060 only

## Insulation-Related Specifications (HCPL-2731/2730/0731/0730)

Parameter	Symbol	8-Pin DIP (300 Mil) Value	SO-8 Value	Units	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

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

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

Description	Symbol	Characteristic		Units
		8-Pin DIP	SO-8	
Installation Classification per DIN VDE 0110/1.89, Table 1 for rated mains voltage $\leq 150 V_{rms}$ for rated mains voltage $\leq 300 V_{rms}$ for rated mains voltage $\leq 600 V_{rms}$		I-IV I-IV 1-IV	I-IV I-IV 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> $V_{IORM} = 1.875 \times V_{PR}$ , 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> $V_{IORM} = 1.5 \times V_{PR}$ , 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	175	$^{\circ}C$
Input Current	$I_{S,INPUT}$	230	230	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 60747-5-5, 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.	Units
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)	$I_{FPK}$	—	40	mA
Reverse Input Voltage (Each Channel)	$V_R$	—	5	V
Input Power Dissipation (Each Channel)	$P_I$	—	35	mW
Output Current (Each Channel)	$I_O$	—	60	mA
Supply Voltage and Output Voltage (HCPL-2731, HCPL-0731) ( $V_{CC}$ – Pin 8-5, $V_O$ – Pin 7,6-5) <sup>a</sup>	$V_{CC}$	-0.5	18	V
Supply Voltage and Output Voltage (HCPL-2730, HCPL-0730) ( $V_{CC}$ – Pin 8-5, $V_O$ – Pin 7,6-5) <sup>a</sup>	$V_{CC}$	-0.5	7	V
Output Power Dissipation (Each Channel) <sup>b</sup>	$P_O$	—	100	mW
Total Power Dissipation (Each Channel)	$P_T$	—	135	mW
Lead Solder Temperature (for Through-Hole Devices)	260°C for 10s., 1.6 mm below seating plane			
Reflow Temperature Profile (for SOIC-8 and Option #300)	See Package Outline Drawings section			

a. Pin 5 should be the most negative voltage at the detector side.

b. Derate linearly above 65°C free-air temperature at a rate of 2.3 mW/°C for the SO-8 package.

## Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Power Supply Voltage (HCPL-2731/HCPL-0731)	$V_{CC}$	4.5	18	V
Power Supply Voltage (HCPL-2730/HCPL-0730)	$V_{CC}$	4.5	7	V
Forward Input Current (ON)	$I_{F(ON)}$	0.5	12	mA
Forward Input Voltage (OFF)	$V_{F(OFF)}$	0	0.8	V
Operating Temperature	$T_A$	0	70	°C

# Electrical Specifications

0°C ≤ T<sub>A</sub> ≤ 70°C, 4.5V ≤ V<sub>CC</sub> ≤ 18V, 0.5 mA ≤ I<sub>F(ON)</sub> ≤ 12 mA, 0V ≤ V<sub>F(OFF)</sub> ≤ 0.8 V, unless otherwise specified. All Typicals at T<sub>A</sub> = 25°C. (See note.)

Parameter	Symbol	Device HCPL-	Min.	Typ. <sup>a</sup>	Max.	Units	Test Conditions	Figure	Note	
Current Transfer Ratio	CTR	2731	400	1800	5000	%	I <sub>F</sub> = 0.5 mA	V <sub>CC</sub> = 4.5 V <sub>O</sub> = 0.4	2, 3	b
		0731	500	1600	2600		I <sub>F</sub> = 1.6 mA			
		2730/0730	300	1600	2600		I <sub>F</sub> = 1.6 mA			
Logic Low Output Voltage	V <sub>OL</sub>	2731 0731	—	0.1	0.4	V	I <sub>F</sub> = 1.6 mA, I <sub>O</sub> = 8 mA	V <sub>CC</sub> = 4.5 V	1	
			—	0.1	0.4		I <sub>F</sub> = 5.0 mA, I <sub>O</sub> = 15 mA			
			—	0.2	0.4		I <sub>F</sub> = 12 mA, I <sub>O</sub> = 24 mA			
		2730/0730	—	0.1	0.4	I <sub>F</sub> = 1.6 mA, I <sub>O</sub> = 4.8 mA				
Logic High Output Current	I <sub>OH</sub>	2731/0731	—	0.05	100	μA	V <sub>O</sub> = V <sub>CC</sub> = 18 V	I <sub>F</sub> = 0 mA		b
		2730/0731	—	0.1	250		V <sub>O</sub> = V <sub>CC</sub> = 7 V			
Logic Low Supply Current	I <sub>CCL</sub>	2731/0731	—	1.2	3	mA	V <sub>CC</sub> = 18V	I <sub>F1</sub> = I <sub>F2</sub> = 1.6 mA V <sub>O1</sub> = V <sub>O2</sub> = Open	5	
		2730/0730	—	0.9			V <sub>CC</sub> = 7V			
Logic High Supply Current	I <sub>CCH</sub>	2731/0731	—	0.005	20	μA	V <sub>CC</sub> = 18V	I <sub>F1</sub> = I <sub>F2</sub> = 0 mA, V <sub>O1</sub> = V <sub>O2</sub> = Open	5	
		2730/0730	—	0.004			V <sub>CC</sub> = 7 V			
Input Forward Voltage	V <sub>F</sub>		—	1.4	1.7	V	T <sub>A</sub> = 25°C	I <sub>F</sub> = 1.6 mA	4	
					1.75					
Input Reverse Breakdown Voltage	BV <sub>R</sub>		5.0	—	—	V	I <sub>R</sub> = 10 μA, T <sub>A</sub> = 25°C			b
Temperature Coefficient of Forward Voltage	ΔV <sub>F</sub> /ΔT <sub>A</sub>		—	-1.8	—	mV/°C	I <sub>F</sub> = 1.6 mA			
Input Capacitance	C <sub>IN</sub>		—	60	—	pF	f = 1 MHz, V <sub>F</sub> = 0			b

a. All typical values at T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V, unless otherwise noted.

b. Each channel.

**NOTE:** Use of a 0.1-μF bypass capacitor connected between pins 5 and 8 adjacent to the device is recommended.

## 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.)

Parameter	Symbol	Device HCPL-	Min.	Typ. <sup>a</sup>	Max.	Units	Test Conditions	Figure	Note	
Propagation Delay Time to Logic Low at Output	$t_{PHL}$	2731 0731	—	25	100	$\mu\text{s}$	$T_A = 25^\circ\text{C}$	$I_F = 0.5\text{ mA}$ , $R_I = 4.7\text{ k}\Omega$	6, 7, 8, 9	b
					120					
		2730 2731	—	5	20		$T_A = 25^\circ\text{C}$	$I_F = 1.6\text{ mA}$ , $R_I = 2.2\text{ k}\Omega$		
					25					
		0730 0731	—	0.5	2		$T_A = 25^\circ\text{C}$	$I_F = 12\text{ mA}$ , $R_I = 270\Omega$		
					3					
Propagation Delay Time to Logic High at Output	$t_{PLH}$	2731 0731	—	10	60	$\mu\text{s}$	$T_A = 25^\circ\text{C}$	$I_F = 0.5\text{ mA}$ , $R_I = 4.7\text{ k}\Omega$	7, 8, 9	b
					90					
		2730 2731	—	10	35		$T_A = 25^\circ\text{C}$	$I_F = 1.6\text{ mA}$ , $R_I = 2.2\text{ k}\Omega$		
					50					
		0730 0731	—	1	10		$T_A = 25^\circ\text{C}$	$I_F = 12\text{ mA}$ , $R_I = 270\Omega$		
					15					
Common Mode at Logic High Output	$ CM_H $		1000	10000	—	$\text{V}/\mu\text{s}$	$I_F = 0\text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_I = 2.2\text{ k}\Omega$ , $ V_{CM}  = 10\text{ V}_{p-p}$	10	b, c, d	
Common Mode at Logic Low Level Output	$ CM_L $		1000	10000	—	$\text{V}/\mu\text{s}$	$I_F = 1.6\text{ mA}$ , $T_A = 25^\circ\text{C}$ , $R_I = 2.2\text{ k}\Omega$ , $ V_{CM}  = 10\text{ V}_{p-p}$			

- a. All typical values at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 5\text{V}$ , unless otherwise noted.
- b. Each channel.
- c. 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 (that is,  $V_O > 2.0\text{V}$ ). Common mode transient immunity in a Logic Low level is the maximum tolerable (negative)  $dV_{CM}/dt$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a Logic Low state (that is,  $V_O < 0.8\text{V}$ ).
- d. 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  $R_{CC} = 110\Omega$ .

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

## Package Characteristics

Description	Symbol	Device HCPL-	Min.	Typ. <sup>a</sup>	Max.	Units	Test Conditions	Figure	Note
Input-Output Momentary Withstand Voltage <sup>b</sup>	V <sub>ISO</sub>		3750	—	—	Vrms	RH 50%, t = 1 minute, T <sub>A</sub> = 25°C		c, d
	Option 020	2730 2731	5000						
Resistance (Input-Output)	R <sub>I-O</sub>		—	10 <sup>12</sup>	—	Ω	VI-O = 500 VDC, RH ≤ 45%		c
Capacitance (Input-Output)	C <sub>I-O</sub>		—	0.6	—	pF	f = 1 MHz		f
Input-Input Insulation Leakage Current	I <sub>I-I</sub>		0.005	—	—	μA	RH 45%, V <sub>I-I</sub> = 500 VDC		g
Input-Input Insulation Leakage Current	R <sub>I-I</sub>		—	10 <sup>11</sup>	—	Ω			g
Capacitance (Input-Input)	C <sub>I-I</sub>	2730 2731	—	0.03	—	pF			g
		0730 0731		0.25					

- a. All Typical values at T<sub>A</sub> = 25°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 60747-5-5 Insulation Characteristics Table (if applicable), your equipment level safety specification or Broadcom Application Note 1074, "Optocoupler Input-Output Endurance Voltage."
- 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 > 4500 Vrms for 1 second (leakage detection current limit, I<sub>I-O</sub> < 5 μA)
- e. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage > 6000 Vrms for 1 second (leakage detection current limit, I<sub>I-O</sub> < 5 μA).
- f. Measured between the LED anode and cathode shorted together and pins 5 through 8 shorted together.
- g. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.

Figure 1: DC Transfer Characteristics

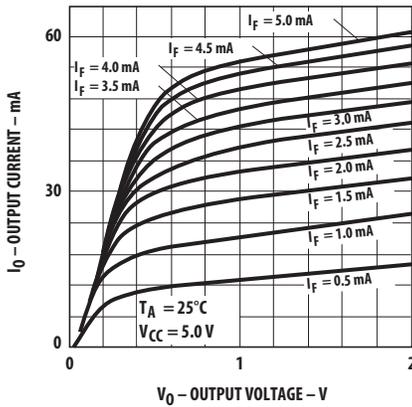


Figure 2: Current Transfer Ratio vs. Forward Current

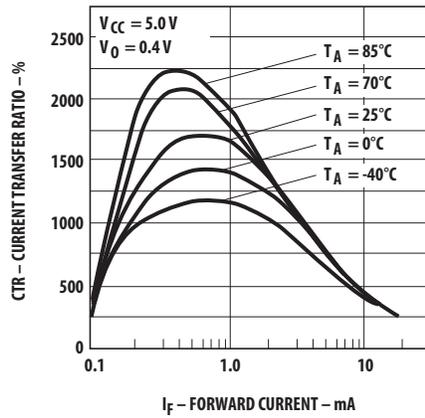


Figure 3: Output Current vs. Input Diode Forward Current

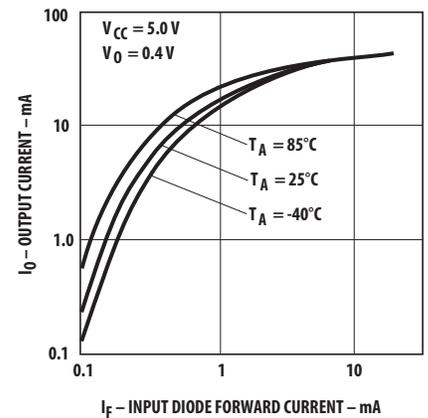


Figure 4: Input Diode Forward Current vs. Forward Voltage

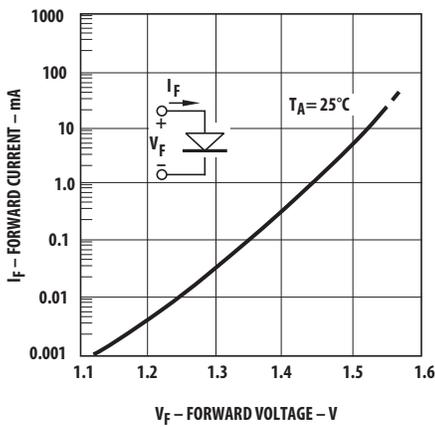


Figure 5: Supply Current per Channel vs. Input Diode Current

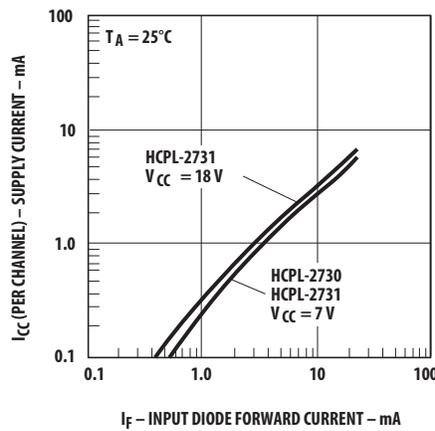


Figure 6: Propagation Delay to Logic Low vs. Pulse Period

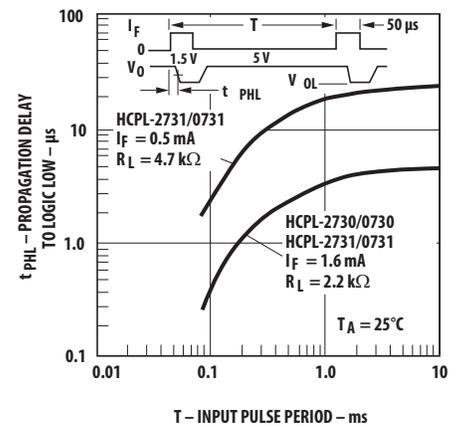


Figure 7: Propagation Delay vs. Temperature

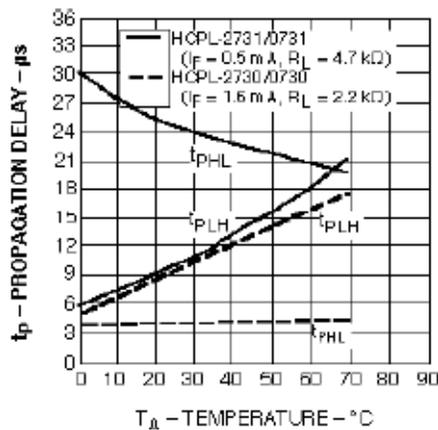


Figure 8: Propagation Delay vs. Input Diode Forward Current

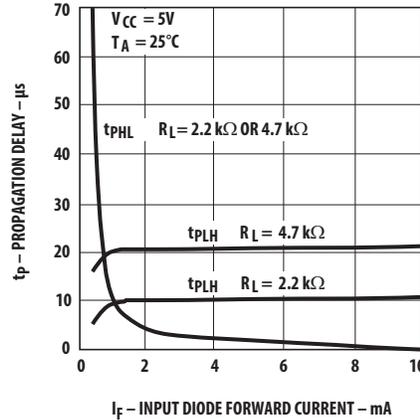


Figure 9: Switching Test Circuit

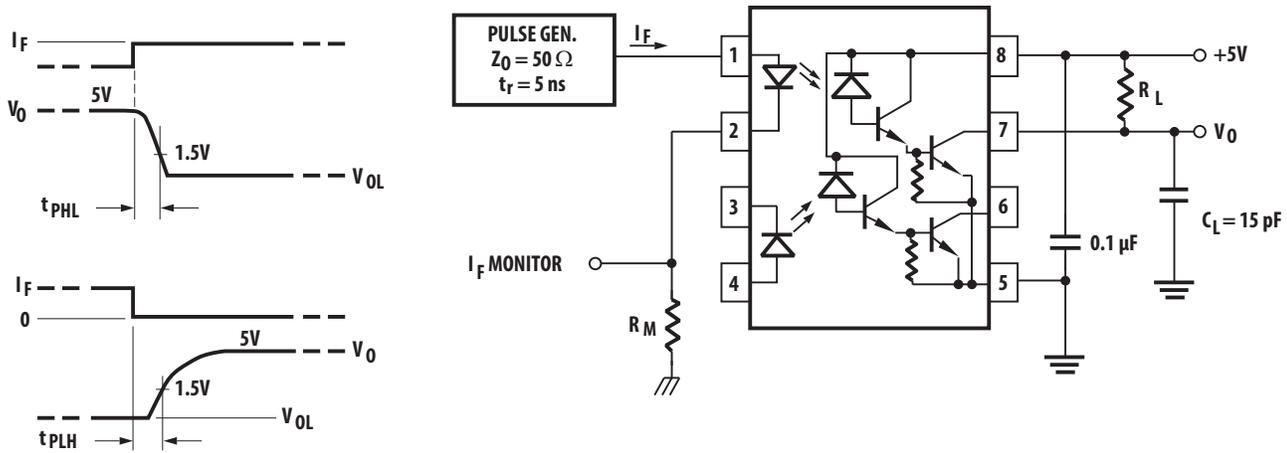
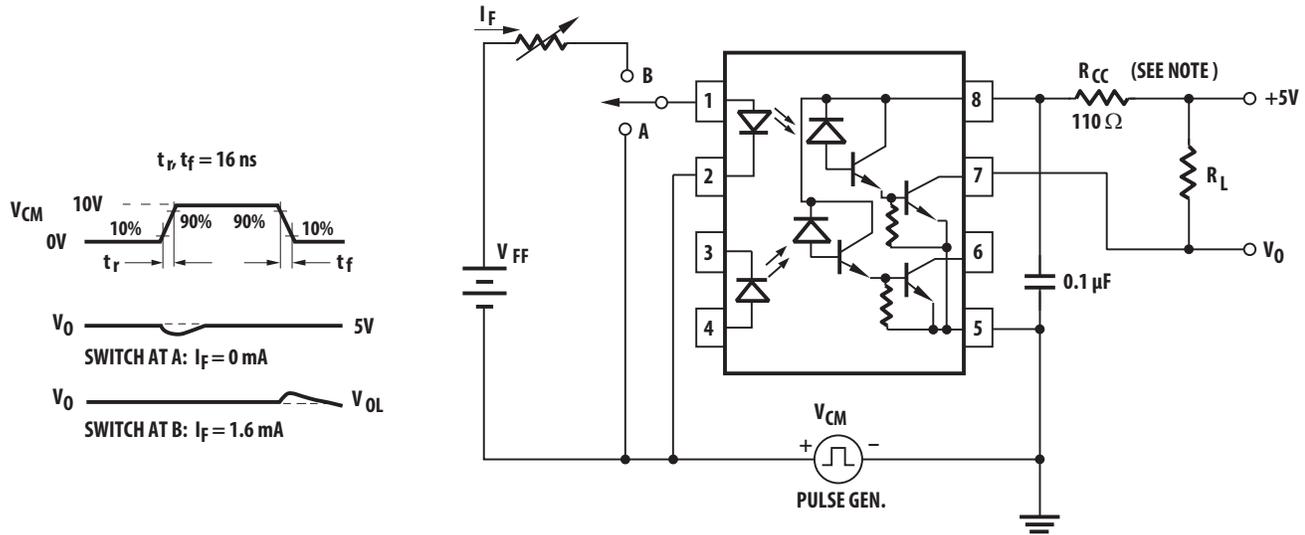


Figure 10: Test Circuit for Transient Immunity and Typical Waveforms



**NOTE:** 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  $R_{CC} = 110\Omega$ .

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