

# High Speed Transistor Optocouplers

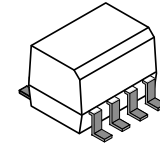
Single Channel:

HCPL0453, HCPL0500, HCPL0501

Dual Channel:

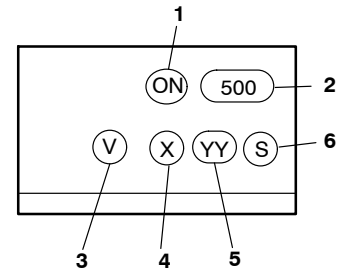
HCPL0531, HCPL0534

## HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534



SOIC8  
CASE 751DZ

### MARKING DIAGRAM



1. ON = onsemi Logo
2. 500 = Device Number
3. V = VDE mark indicates DIN EN/IEC60747-5-5 approval (Note: Only appears on parts ordered with VDE option – See Ordering Information Table)
4. X = One-Digit Year Code, e.g. '3'
5. YY = Two Digit Work Week Ranging from '01' to '53'
6. S = Assembly Package Code

### Description

The HCPL05XX, and HCPL04XX optocouplers consist of an AlGaAs LED optically coupled to a high speed photo-detector transistor housed in a compact 8-pin small outline package.

A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor. The HCPL04XX devices do not have the base bonded out to a lead for additional noise margin. The HCPL053X devices have two channels per package for optimum mounting density.

### Features

- High Speed – 1 MBit/s
- 15 kV/μs Minimum Common Mode Transient Immunity at  $V_{CM} = 1500\text{ V}$  (HCPL0453/0534)
- Open Collector Output
- Guaranteed Performance Over Temperature: 0°C to 70°C
- U.L. Recognized (File # E90700)
- VDE0884 Recognized (File # 136616)
  - ◆ Approval Pending for HCPL0531/0453
  - ◆ Ordering Option V, e.g., HCPL0500V
- BSI Recognized (File # 8661, 8662)
  - ◆ HCPL0500/0501 only

### Applications

- Line Receivers
- Pulse Transformer Replacement
- Output Interface to CMOS-LSTTL-TTL
- Wide Bandwidth Analog Coupling

### TRUTH TABLE (Positive Logic)

LED	$V_o$
ON	LOW
OFF	HIGH

### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

## HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534

**SAFETY AND INSULATION RATINGS** (As per DIN EN/IEC 60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.)

Parameter		Characteristics
Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage	<150 V <sub>RMS</sub>	I–IV
	<300 V <sub>RMS</sub>	I–III
Climatic Classification		55/100/21
Pollution Degree (DIN VDE 0110/1.89)		2
Comparative Tracking Index		175

Symbol	Parameter	Value	Unit
V <sub>PR</sub>	Input-to-Output Test Voltage, Method A, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC	904	V <sub>peak</sub>
	Input-to-Output Test Voltage, Method B, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC	1060	V <sub>peak</sub>
V <sub>IORM</sub>	Maximum Working Insulation Voltage	565	V <sub>peak</sub>
V <sub>IOTM</sub>	Highest Allowable Over-Voltage	4000	V <sub>peak</sub>
	External Creepage	≥4	mm
	External Clearance	≥4	mm
DTI	Distance Through Insulation (Insulation Thickness)	≥0.4	mm
T <sub>S</sub>	Case Temperature (Note 1)	150	°C
I <sub>S,INPUT</sub>	Input Current (Note 1)	200	mA
P <sub>S,OUTPUT</sub>	Output Power (Note 1)	300	mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V (Note 1)	>10 <sup>9</sup>	Ω

1. Safety limit values – maximum values allowed in the event of a failure.

SCHEMATICS

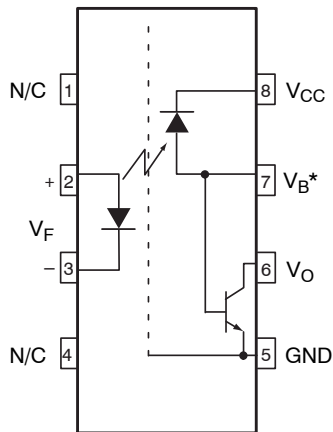


Figure 1. Single-channel Circuit Schematics (HCPL0500, HCPL0501)  
\*Base Not Connected for HCPL0453)

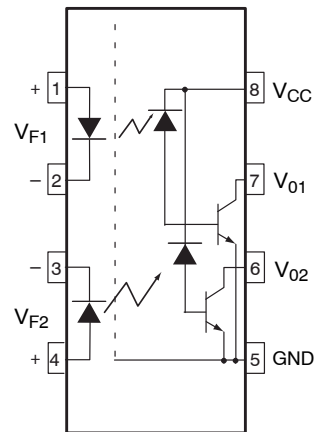


Figure 2. Dual-channel Circuit Schematics (HCPL0531, HCPL0534)

ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise specified)

Symbol	Parameter	Value	Units
T <sub>STG</sub>	Storage Temperature	-40 to +125	°C
T <sub>OPR</sub>	Operating Temperature	-40 to +85	°C
	Reflow Temperature Profile (Refer to page 8)		

EMITTER

I <sub>F</sub> (avg)	DC/Average Forward Input Current	25	mA
I <sub>F</sub> (pk)	Peak Forward Input Current (50% duty cycle, 1 ms P.W.)	50	mA
I <sub>F</sub> (trans)	Peak Transient Input Current (t ≤ 1 μs P.W., 300 pps)	1.0	A
V <sub>R</sub>	Reverse Input Voltage	5.0	V
P <sub>D</sub>	Input Power Dissipation	45	mW

DETECTOR

I <sub>O</sub> (avg)	Average Output Current (Pin 6)	8	mA
I <sub>O</sub> (pk)	Peak Output Current	16	mA
V <sub>EBR</sub>	Emitter-Base Reverse Voltage (HCPL0500/0501 only)	5	V
V <sub>CC</sub>	Supply Voltage	-0.5 to 30	V
V <sub>O</sub>	Output Voltage	-0.5 to 20	V
I <sub>B</sub>	Base Current (HCPL0500/0501 only)	5	mA
P <sub>D</sub>	Output Power Dissipation	100	mW

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534

## ELECTRICAL CHARACTERISTICS ( $T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$ unless otherwise specified)

### INDIVIDUAL COMPONENT CHARACTERISTICS

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit
<b>EMITTER</b>							
$V_F$	Input Forward Voltage	$I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$	All		1.45	1.7	V
		$I_F = 16\text{ mA}$				1.8	
$BV_R$	Input Reverse Breakdown Voltage	$I_R = 10\ \mu\text{A}$	All	5.0			V
$\Delta V_F / \Delta T_A$	Temperature Coefficient of Forward Voltage	$I_F = 16\text{ mA}$	All		-1.6		mV/ $^\circ\text{C}$

### DETECTOR

$I_{OH}$	Logic High Output Current	$I_F = 0\text{ mA}$ , $V_O = V_{CC} = 5.5\text{ V}$ , $T_A = 25^\circ\text{C}$	All		0.001	0.5	$\mu\text{A}$
		$I_F = 0\text{ mA}$ , $V_O = V_{CC} = 15\text{ V}$ , $T_A = 25^\circ\text{C}$	All		0.005	1	
		$I_F = 0\text{ mA}$ , $V_O = V_{CC} = 15\text{ V}$	All			50	
$I_{CCL}$	Logic Low Supply Current	$I_F = 16\text{ mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{ V}$	HCPL0453/ 0500/1		120	200	$\mu\text{A}$
			HCPL0531/4			400	
$I_{CCH}$	Logic High Supply Current	$I_F = 0\text{ mA}$ , $V_O = \text{Open}$ , $V_{CC} = 15\text{ V}$ , $T_A = 25^\circ\text{C}$	All		0.01	1	$\mu\text{A}$
			HCPL0453/ 0500/1			2	
				HCPL0531/4			

### TRANSFER CHARACTERISTICS

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit	
<b>COUPLED</b>								
CTR	Current Transfer Ratio (Note 2)	$I_F = 16\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 4.5\text{ V}$ , $T_A = 25^\circ\text{C}$	HCPL0500	7	27	50	%	
			HCPL0453	19	27	50		
			HCPL0501/0531					
		$I_F = 16\text{ mA}$ , $V_O = 0.5\text{ V}$ , $V_{CC} = 4.5\text{ V}$	HCPL0500	5	30			
			HCPL0453	15	30			
			HCPL0501/0534					
$V_{OL}$	Logic Low Output Voltage	$I_F = 16\text{ mA}$ , $I_O = 1.1\text{ mA}$ , $V_{CC} = 4.5\text{ V}$ , $T_A = 25^\circ\text{C}$	HCPL0500		0.18	0.4	V	
			HCPL0453			0.25		0.4
		HCPL0501/0531/4						
		$I_F = 16\text{ mA}$ , $I_O = 0.8\text{ mA}$ , $V_{CC} = 4.5\text{ V}$	HCPL0500			0.13		0.5
			HCPL0453					0.23
		HCPL0501/0531/4						

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

# HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534

## ELECTRICAL CHARACTERISTICS (CONTINUED) ( $T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$ unless otherwise specified)

### SWITCHING CHARACTERISTICS ( $V_{CC} = 5\text{ V}$ )

Symbol	Parameter	Test Conditions	Device	Min.	Typ.*	Max.	Unit
$T_{PHL}$	Propagation Delay Time to Logic LOW	$T_A = 25^\circ\text{C}$ , $R_L = 4.1\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3) (Fig. 9)	HCPL0500		0.45	1.5	$\mu\text{s}$
		$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$ (Note 4) (Fig. 9)	HCPL0453		0.45	0.8	
			HCPL0501/0531/4				
		$R_L = 4.1\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3) (Fig. 9)	HCPL0500				
$T_{PLH}$	Propagation Delay Time to Logic HIGH	$T_A = 25^\circ\text{C}$ , $R_L = 4.1\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3) (Fig. 9)	HCPL0500		0.5	1.5	$\mu\text{s}$
		$R_L = 1.9\text{ k}\Omega$ , $I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$ (Note 4) (Fig. 9)	HCPL0453		0.3	0.8	
			HCPL0501/0531/4				
		$R_L = 4.1\text{ k}\Omega$ , $I_F = 16\text{ mA}$ (Note 3) (Fig. 9)	HCPL0500				
$ CM_H $	Common Mode Transient Immunity at Logic HIGH	$I_F = 0\text{ mA}$ , $V_{CM} = 10\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Note 5) (Fig. 10)	HCPL0500	1,000	10,000		$\text{V}/\mu\text{s}$
		$I_F = 0\text{ mA}$ , $V_{CM} = 10\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Note 5) (Fig. 10)	HCPL0501/31	1,000	10,000		
			HCPL0534	15,000	40,000		
		$I_F = 0\text{ mA}$ , $V_{CM} = 1500\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Note 5) (Fig. 10)	HCPL0453	15,000	40,000		
$ CM_L $	Common Mode Transient Immunity at Logic LOW	$I_F = 16\text{ mA}$ , $V_{CM} = 10\text{ V}_{P-P}$ , $R_L = 4.1\text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (Note 5) (Fig. 10)	HCPL0500	1,000	10,000		$\text{V}/\mu\text{s}$
		$I_F = 16\text{ mA}$ , $V_{CM} = 10\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ (Note 5) (Fig. 10)	HCPL0501/31	1,000	10,000		
			HCPL0534	15,000	40,000		
		$I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$ , $V_{CM} = 1500\text{ V}_{P-P}$ , $R_L = 1.9\text{ k}\Omega$ (Note 5) (Fig. 10)	HCPL0453	15,000	40,000		

### ISOLATION CHARACTERISTICS

Symbol	Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
$V_{ISO}$	Input-Output Isolation Voltage	$f = 60\text{ Hz}$ , $t = 1.0\text{ min.}$ , $I_{I-O} \leq 2\text{ }\mu\text{A}$ (Notes 6, 7)	2500			$V_{AC_{RMS}}$
$R_{ISO}$	Isolation Resistance	$V_{I-O} = 500\text{ V}$ (Note 6)	$10^{11}$			
$C_{ISO}$	Isolation Capacitance	$V_{I-O} = 0\text{ V}$ , $f = 1.0\text{ MHz}$ (Note 6)		0.2		$\text{pF}$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

- Current Transfer Ratio is designed as a ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$ , times 100%.
- The  $4.1\text{ k}\Omega$  load represents 1 LSTTL unit load of  $0.36\text{ mA}$  and  $6.1\text{ k}\Omega$  pull-up resistor.
- The  $1.9\text{ k}\Omega$  load represents 1 TTL unit load of  $1.6\text{ mA}$  and  $5.6\text{ k}\Omega$  pull-up resistor.
- Common mode transient immunity in logic high level is the maximum tolerable (positive)  $dV_{cm}/dt$  on the leading edge of the common mode pulse signal  $V_{CM}$ , to assure that the output will remain in a logic high state (i.e.,  $V_O > 2.0\text{ V}$ ). Common mode transient immunity in logic low level is the maximum tolerable (negative)  $dV_{cm}/dt$  on the trailing edge of the common mode pulse signal,  $V_{CM}$ , to assure that the output will remain in a logic low state (i.e.,  $V_O < 0.8\text{ V}$ ).
- Device is considered a two terminal device: Pins 1, 2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
- $2500\text{ VAC RMS}$  for 1 minute duration is equivalent to  $3000\text{ VAC RMS}$  for 1 second duration.

TYPICAL PERFORMANCE CURVES

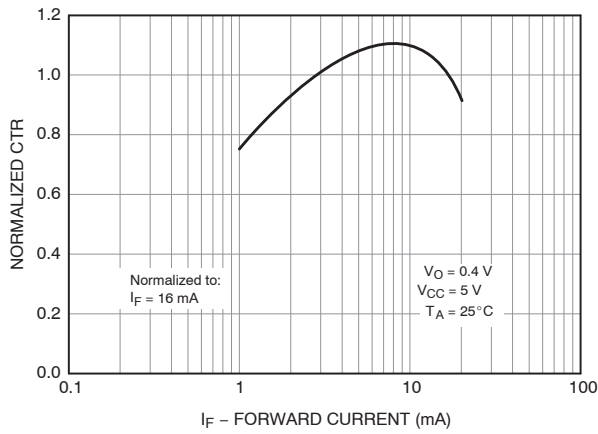


Figure 3. Normalized CTR vs. Forward Current

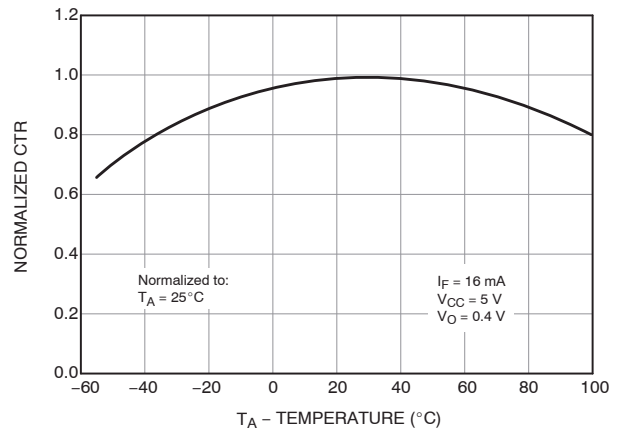


Figure 4. Normalized CTR vs. Temperature

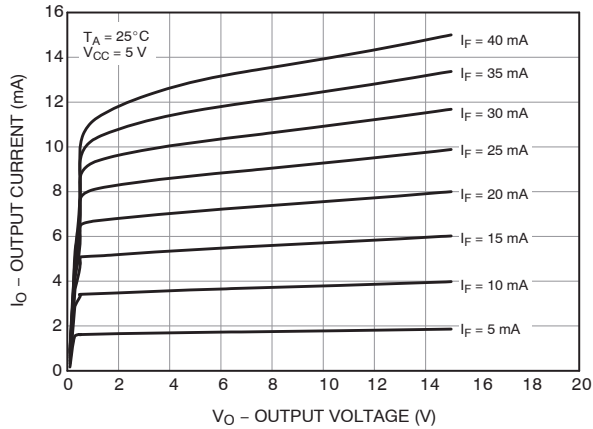


Figure 5. Output Current vs. Output Voltage

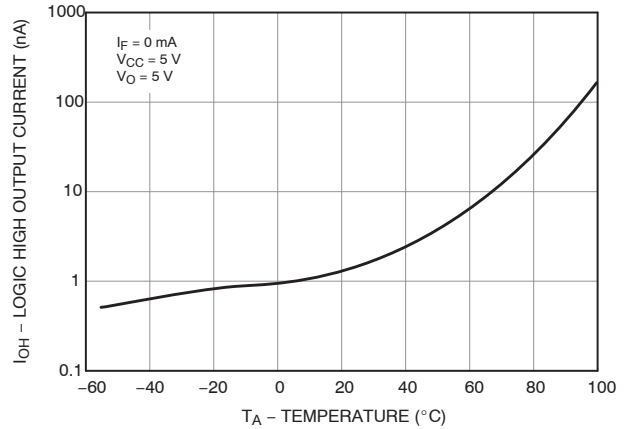


Figure 6. Logic High Output Current vs. Temperature

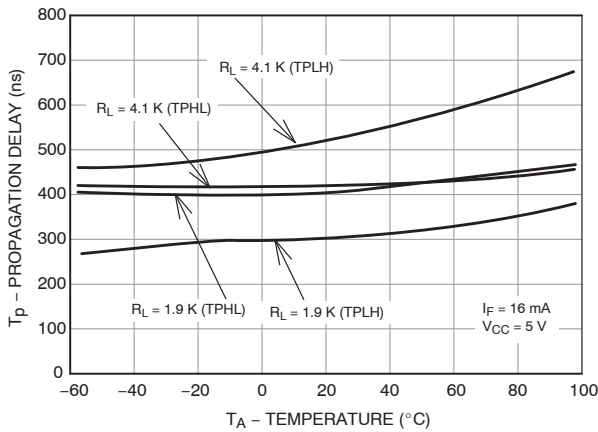


Figure 7. Propagation Delay vs. Temperature

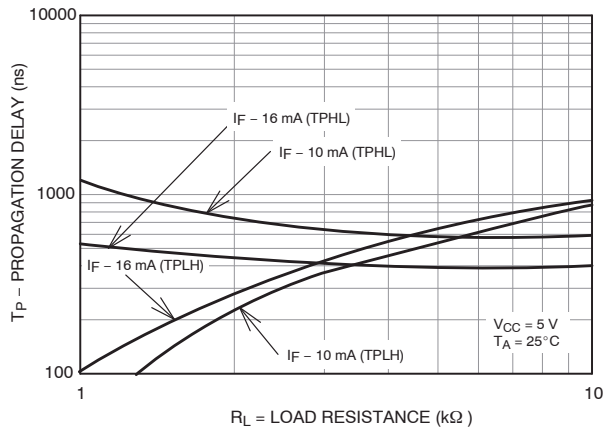
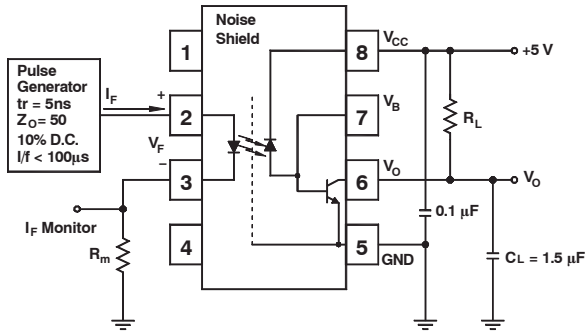
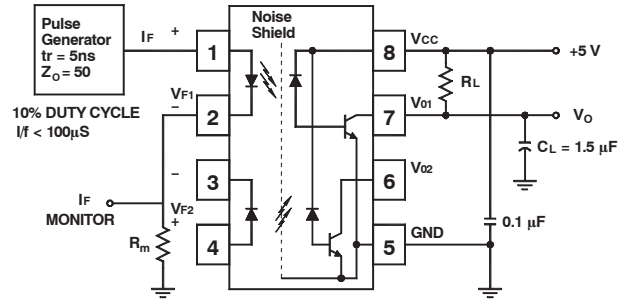


Figure 8. Propagation Delay vs. Load Resistance

# HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534



Test Circuit for HCPL0453, HCPL0500 and HCPL0501



Test Circuit for HCPL0531 and HCPL0534

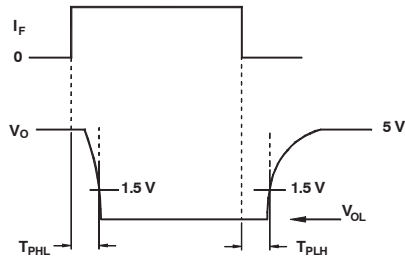
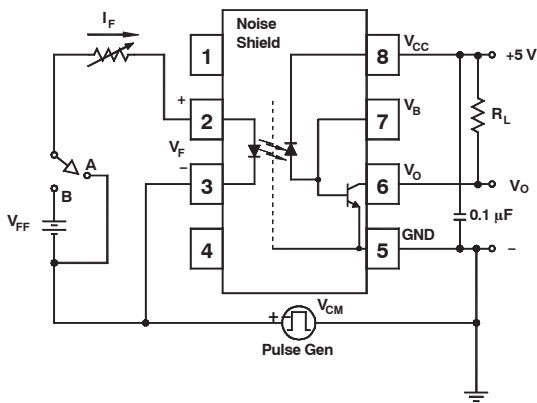
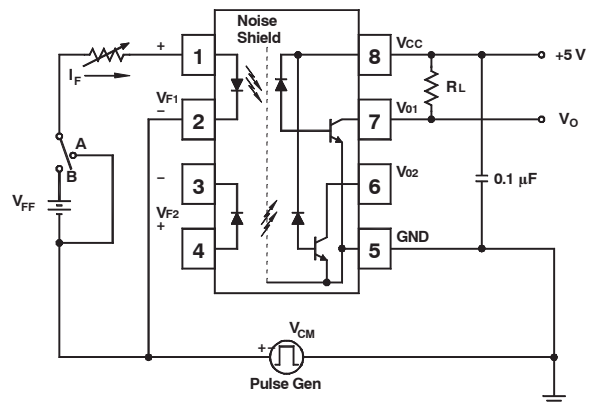


Figure 9. Switching Time Test Circuit



Test Circuit for HCPL0453, HCPL0500 and HCPL0501



Test Circuit for HCPL0531 and HCPL0534

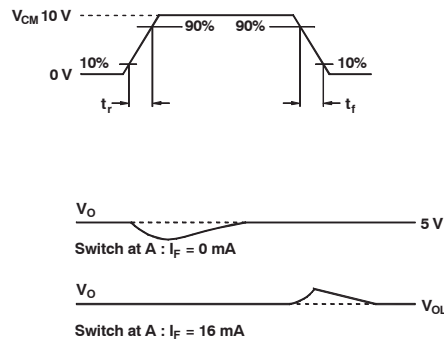


Figure 10. Common Mode Immunity Test Circuit

# HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534

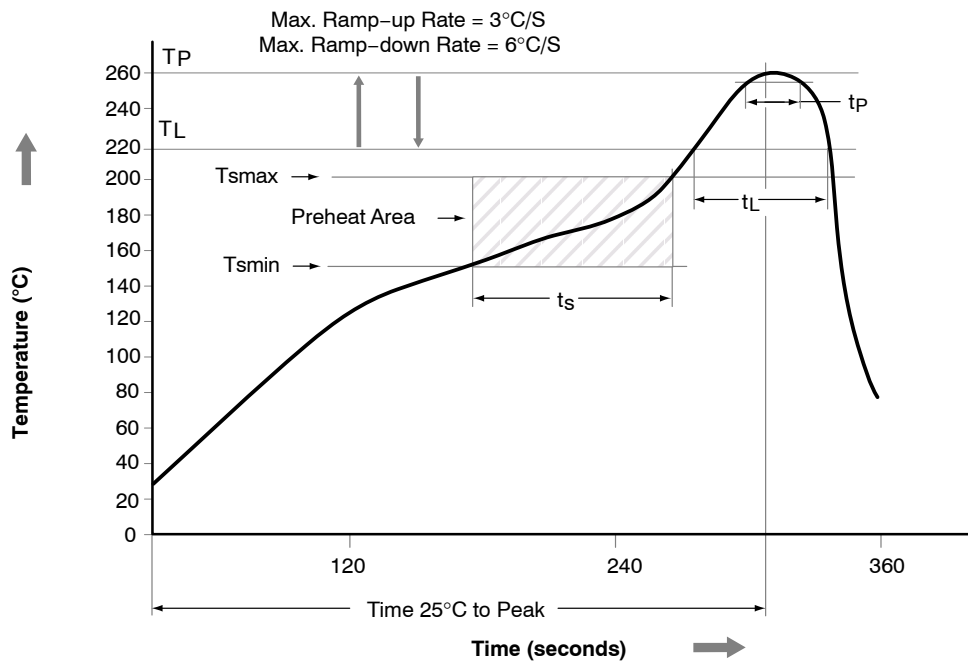
## ORDERING INFORMATION

Part Nr./ Option (Note 8)	Order Entry Identifier	Package	Description	Packing Method†
HCPL0xxxV	V	SOIC8	VDE 0884 (approval pending for HCPL0531 & HCPL0534)	Tube (3000 Units)
HCPL0xxxR2	R2	SOIC8		Tape and Reel (2500 Units)
HCPL0xxxR2V	R2V	SOIC8	VDE 0884 (approval pending for HCPL0531 & HCPL0534)	Tape and Reel (2500 Units)

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

8. The product orderable part number system listed in this table also applies to the HCPL0453, HCPL0500, HCPL0501, HCPL0531 and HCPL0534 product.

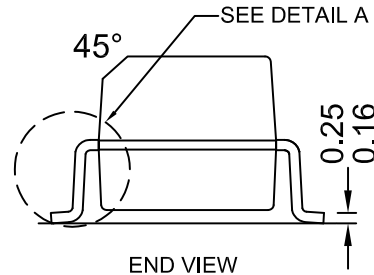
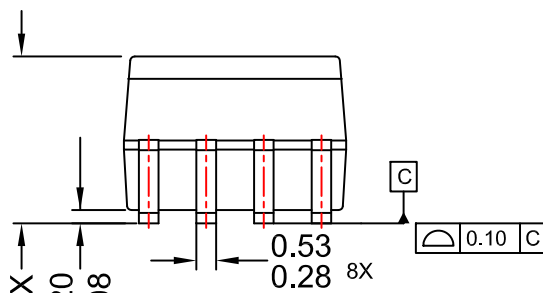
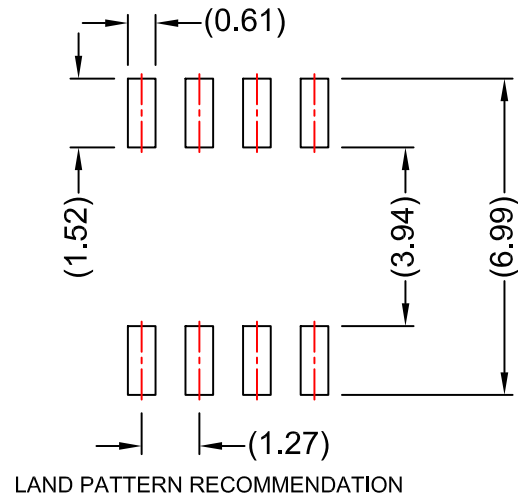
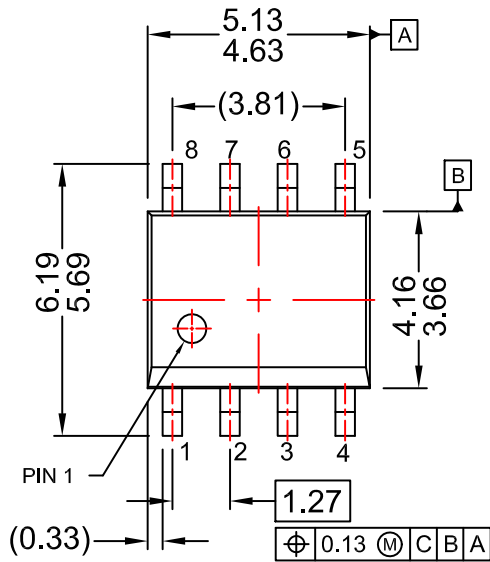
## REFLOW PROFILE



Profile Feature	Pb-Free Assembly Profile
Temperature Min. (T Amin)	150°C
Temperature Max. (Tsmax)	200°C
Time (ts) from (T Amin to Tsmax)	60–120 seconds
Ramp-up Rate (tL to tp)	3°C/second max.
Liquidous Temperature (TL)	217°C
Time (tL) Maintained Above (TL)	60–150 seconds
Peak Body Package Temperature	260°C +0°C / -5°C
Time (tp) within 5°C of 260°C	30 seconds
Ramp-down Rate (TP to TL)	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

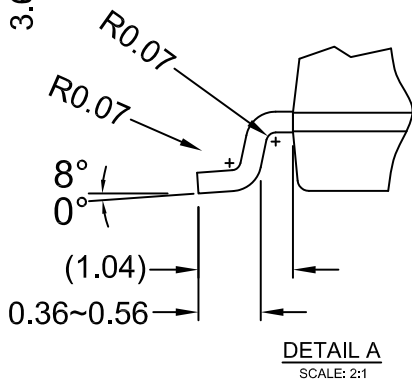
SOIC8  
CASE 751DZ  
ISSUE O

DATE 30 SEP 2016



NOTES:

- A) NO STANDARD APPLIES TO THIS PACKAGE
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) LANDPATTERN STANDARD: SOIC127P600X175-8M.



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