

# HCPL0600, HCPL0601, HCPL0611, HCPL0637, HCPL0638, HCPL0639

## High Speed-10 MBit/s Logic Gate Optocouplers

### Single Channel:

HCPL0600, HCPL0601, HCPL0611

### Dual Channel:

HCPL0637, HCPL0638, HCPL0639

#### Description

The HCPL06XX optocouplers consist of an AlGaAs LED, optically coupled to a very high speed integrated photo-detector logic gate with a strobable output (single channel devices). The devices are housed in a compact small-outline package. This output features an open collector, thereby permitting wired OR outputs. The HCPL0600, HCPL0601 and HCPL0611 output consists of bipolar transistors on a bipolar process while the HCPL0637, HCPL0638, and HCPL0639 output consists of bipolar transistors on a CMOS process for reduced power consumption. The coupled parameters are guaranteed over the temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . An internal noise shield provides superior common mode rejection.

#### Features

- Compact SO8 Package
- Very High Speed-10 MBit/s
- Superior CMR
- Logic Gate Output
- Storable Output (Single Channel Devices)
- Wired OR-open Collector

#### Safety and Regulatory Approvals

- UL1577, 3750 VAC<sub>RMS</sub> for 1 min
- DIN EN/IEC60747-5-5, 565 V Peak Working Insulation Voltage

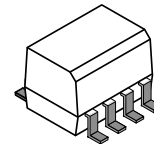
#### Typical Applications

- Ground Loop Elimination
- LSTTL to TTL, LSTTL or 5-volt CMOS
- Line Receiver, Data Transmission
- Data Multiplexing
- Switching Power Supplies
- Pulse Transformer Replacement
- Computer-peripheral Interface



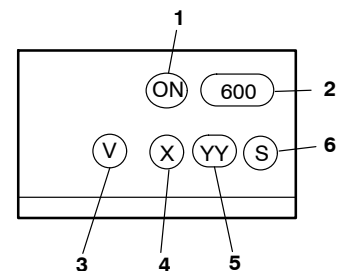
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SOIC8  
CASE 751DZ

#### MARKING DIAGRAM



1. ON = ON Semiconductor Logo
2. 600 = Device Number
3. V = VDE mark indicates  
DIN EN/IEC60747-5-2 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

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 13 of this data sheet.

HCPL0600, HCPL0601, HCPL0611, HCPL0637, HCPL0638, HCPL0639

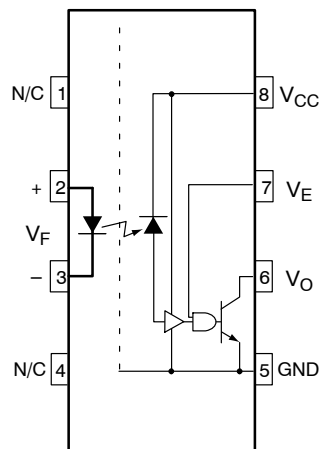


Figure 1. Single-channel Circuit Drawing  
(HCPL0600, HCPL0601 and HCPL0611)

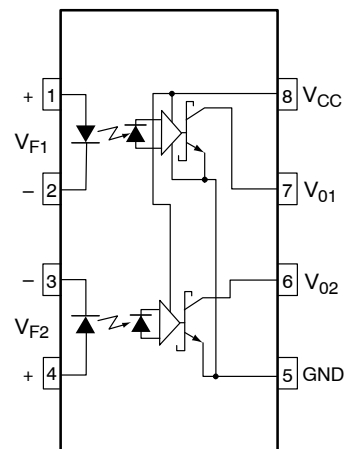


Figure 2. Dual-channel Circuit Drawing  
(HCPL0637, HCPL0638 and HCPL0639)

TRUTH TABLE (Positive Logic)

Input	Enable	Output
H	H	L
L	H	H
H	L	H
L	L	H
H*	NC*	L*
L*	NC*	H*

\*Dual channel devices or single channel devices with pin 7 not connected. A 0.1  $\mu$ F bypass capacitor must be connected between pins 8 and 5. (See Note 2)

# HCPL0600, HCPL0601, HCPL0611, HCPL0637, HCPL0638, HCPL0639

## SAFETY AND INSULATIONS RATING

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		40/85/21
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	4,000	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.

## ABSOLUTE MAXIMUM RATINGS (No Derating Required up to 85°C)

Symbol	Parameter	Value	Units
T <sub>STG</sub>	Storage Temperature	–40 to +125	°C
T <sub>OPR</sub>	Operating Temperature	–40 to +85	°C
T <sub>J</sub>	Junction Temperature	–40 to +125	°C

### EMITTER

I <sub>F</sub>	DC/Average Forward Input Current	Each Channel	50	mA
V <sub>E</sub>	Enable Input Voltage Not to exceed V <sub>CC</sub> by more than 500 mV	Single Channel Devices Only	5.5	V
V <sub>R</sub>	Reverse Input Voltage	Each Channel	5.0	V
P <sub>I</sub>	Power Dissipation	Each Channel	45	mW

### DETECTOR

V <sub>CC</sub> (1 minute max)	Supply Voltage		7.0	V
I <sub>O</sub>	Output Current	Each Channel	15	mA
V <sub>O</sub>	Output Voltage (each channel)	Each Channel	7.0	V
P <sub>O</sub>	Collector Output Power Dissipation	Each Channel	85	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.

# RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Min.	Max.	Units
$I_{FL}$	Input Current, Low Level		0	250	$\mu A$
$I_{FH}$	Input Current, High Level		*6.3	15	mA
$V_{CC}$	Supply Voltage, Output		4.5	5.5	V
$V_{EL}$	Enable Voltage, Low Level	Single Channel only	0	0.8	V
$V_{EH}$	Enable Voltage, High Level	Single Channel only	2.0	$V_{CC}$	V
$T_A$	Operating Temperature		-40	+85	$^{\circ}C$
N	Fan Out (TTL load)	Single Channel		8	TTL Loads
		Dual Channel		5	
$R_L$	Output Pull-up		330	4000	$\Omega$

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

\*6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.

# ELECTRICAL CHARACTERISTICS

( $T_A = -40^{\circ}C$  TO  $+85^{\circ}C$  UNLESS OTHERWISE SPECIFIED)

## INDIVIDUAL COMPONENT CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min.	Typ.*	Max.	Unit
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### EMITTER

$V_F$	Input Forward Voltage	$I_F = 10 \text{ mA}$			1.8	V
		$T_A = 25^{\circ}C$			1.75	
$B_{VR}$	Input Reverse Breakdown Voltage	$I_R = 10 \mu A$	5.0			V
$\Delta V_F / \Delta T_A$	Input Diode Temperature Coefficient	$I_F = 10 \text{ mA}$		-1.5		mV/ $^{\circ}C$

### DETECTOR

$I_{CCH}$	High Level Supply Current	$I_F = 0 \text{ mA}, V_E = 0.5 \text{ V}$ $V_{CC} = 5.5 \text{ V}$	Single Channel			10	mA
			Dual Channel			15	
$I_{CCL}$	Low Level Supply Current	$I_F = 10 \text{ mA}, V_E = 0.5 \text{ V}$ $V_{CC} = 5.5 \text{ V}$	Single Channel			13	mA
			Dual Channel			21	
$I_{EL}$	Low Level Enable Current	$V_{CC} = 5.5 \text{ V}, V_E = 0.5 \text{ V}$	Single Channel			-1.6	mA
$I_{EH}$	High Level Enable Current	$V_{CC} = 5.5 \text{ V}, V_E = 2.0 \text{ V}$	Single Channel			-1.6	mA
$V_{EH}$	High Level Enable Voltage	$V_{CC} = 5.5 \text{ V}, I_F = 10 \text{ mA}$	Single Channel	2.0			V
$V_{EL}$	Low Level Enable Voltage	$V_{CC} = 5.5 \text{ V}, I_F = 10 \text{ mA}$ (Note 3)	Single Channel			0.8	V

# HCPL0600, HCPL0601, HCPL0611, HCPL0637, HCPL0638, HCPL0639

## SWITCHING CHARACTERISTICS ( $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{CC} = 5\text{ V}$ , $I_F = 7.5\text{ mA}$ unless otherwise specified)

Symbol	AC Characteristics	Test Conditions	Device	Min.	*	Max.	Unit
$T_{PLH}$	Propagation Delay Time to Output High Level	$R_L = 350\ \Omega$ , $T_A = 25^{\circ}\text{C}$ $C_L = 15\text{ pF}$ (Note 4) (Fig. 22)	All	20		75	ns
						100	
$T_{PHL}$	Propagation Delay Time to Output Low Level	$R_L = 350\ \Omega$ , $T_A = 25^{\circ}\text{C}$ $C_L = 15\text{ pF}$ (Note 5) (Fig. 22)	All	25		75	ns
						100	
$ T_{PHL} - T_{PLH} $	Pulse Width Distortion	$R_L = 350\ \Omega$ , $C_L = 15\text{ pF}$ (Fig. 20)	All			35	ns
$t_r$	Output Rise Time (10–90%)	$R_L = 350\ \Omega$ , $C_L = 15\text{ pF}$ (Note 6) (Fig. 22)	Single Ch		50		ns
			Dual Ch		17		
$t_f$	Output Fall Time (90–10%)	$R_L = 350\ \Omega$ , $C_L = 15\text{ pF}$ (Note 7) (Fig. 22)	Single Ch		12		ns
			Dual Ch		5		
$t_{ELH}$	Enable Propagation Delay Time to Output High Level	$I_F = 7.5\text{ mA}$ , $V_{EH} = 3.5\text{ V}$ , $R_L = 350\ \Omega$ , $C_L = 15\text{ pF}$ (Note 8) (Fig. 23)	HCPL0600 HCPL0601 HCPL0611		20		ns
$t_{EHL}$	Enable Propagation Delay Time to Output Low Level	$I_F = 7.5\text{ mA}$ , $V_{EH} = 3.5\text{ V}$ , $R_L = 350\ \Omega$ , $C_L = 15\text{ pF}$ (Note 9) (Fig. 23)	HCPL0600 HCPL0601 HCPL0611		20		ns
$ CM_H $	Common Mode Transient Immunity (at Output High Level)	$R_L = 350\ \Omega$ , $T_A = 25^{\circ}\text{C}$ , $I_F = 0\text{ mA}$ , $V_{OH}(\text{Min.}) = 2.0\text{ V}$ (Note 10) (Fig. 24, 25)	$ V_{CM}  = 10\text{ V}$ HCPL0600 HCPL0637	5,000			$\text{V}/\mu\text{s}$
			$ V_{CM}  = 50\text{ V}$ HCPL0601 HCPL0638	10,000			
			$ V_{CM}  = 1,000\text{ V}$ HCPL0611	15,000			
			HCPL0639	25,000			
$ CM_L $	Common Mode Transient Immunity (at Output Low Level)	$R_L = 350\ \Omega$ , $T_A = 25^{\circ}\text{C}$ , $I_F = 7.5\text{ mA}$ , $V_{OL}(\text{Max.}) = 0.8\text{ V}$ (Note 11) (Fig. 24, 25)	$ V_{CM}  = 10\text{ V}$ HCPL0600 HCPL0637	5,000			$\text{V}/\mu\text{s}$
			$ V_{CM}  = 50\text{ V}$ HCPL0601 HCPL0638	10,000			
			$ V_{CM}  = 1,000\text{ V}$ HCPL0611	15,000			
			HCPL0639	25,000			

## TRANSFER CHARACTERISTICS ( $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ unless otherwise specified)

Symbol	DC Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
$I_{OH}$	High Level Output Current	$V_{CC} = 5.5\text{ V}$ , $V_O = 5.5\text{ V}$ , $I_F = 250\ \mu\text{A}$ , $V_E = 2.0\text{ V}$ (Note 3)			100	$\mu\text{A}$
$V_{OL}$	Low Level Output Voltage	$V_{CC} = 5.5\text{ V}$ , $I_F = 5\text{ mA}$ , $V_E = 2.0\text{ V}$ , $I_{OL} = 13\text{ mA}$ (Note 3)			0.6	V
$I_{FT}$	Input Threshold Current	$V_{CC} = 5.5\text{ V}$ , $V_O = 0.6\text{ V}$ , $V_E = 2.0\text{ V}$ , $I_{OL} = 13\text{ mA}$			5	mA

\*All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$ .

# HCPL0600, HCPL0601, HCPL0611, HCPL0637, HCPL0638, HCPL0639

## ISOLATION CHARACTERISTICS ( $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise specified)

Symbol	Characteristics	Test Conditions	Min.	Typ.*	Max.	Unit
$I_{I-O}$	Input-Output Insulation Leakage Current	Relative humidity = 45%, $T_A = 25^\circ\text{C}$ , $t = 5$ s, $V_{I-O} = 3000$ VDC (Note 12)			1.0*	$\mu\text{A}$
$V_{ISO}$	Withstand Insulation Test Voltage	$R_H < 50\%$ , $T_A = 25^\circ\text{C}$ , $I_{I-O} \leq 2 \mu\text{A}$ , $t = 1$ min. (Note 12)	3750			$V_{RMS}$
$R_{I-O}$	Resistance (Input to Output)	$V_{I-O} = 500$ V (Note 12)		$10^{12}$		$\Omega$
$C_{I-O}$	Capacitance (Input to Output)	$f = 1$ MHz (Note 12)		0.6		pF

\*All typical values are at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$ .

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.

### Notes:

- The  $V_{CC}$  supply to each optoisolator must be bypassed by a  $0.1 \mu\text{F}$  capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package  $V_{CC}$  and GND pins of each device.
- Enable Input – No pull up resistor required as the device has an internal pull up resistor.
- $t_{PLH}$  – Propagation delay is measured from the  $3.75$  mA level on the HIGH to LOW transition of the input current pulse to the  $1.5$  V level on the LOW to HIGH transition of the output voltage pulse.
- $t_{PHL}$  – Propagation delay is measured from the  $3.75$  mA level on the LOW to HIGH transition of the input current pulse to the  $1.5$  V level on the HIGH to LOW transition of the output voltage pulse.
- $t_r$  – Rise time is measured from the  $90\%$  to the  $10\%$  levels on the LOW to HIGH transition of the output pulse.
- $t_f$  – Fall time is measured from the  $10\%$  to the  $90\%$  levels on the HIGH to LOW transition of the output pulse.
- $t_{ELH}$  – Enable input propagation delay is measured from the  $1.5$  V level on the HIGH to LOW transition of the input voltage pulse to the  $1.5$  V level on the LOW to HIGH transition of the output voltage pulse.
- $t_{EHL}$  – Enable input propagation delay is measured from the  $1.5$  V level on the LOW to HIGH transition of the input voltage pulse to the  $1.5$  V level on the HIGH to LOW transition of the output voltage pulse.
- $CM_H$  – The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e.,  $V_{OUT} > 2.0$  V). Measured in volts per microsecond (V/ $\mu\text{s}$ ).
- $CM_L$  – The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the low output state (i.e.,  $V_{OUT} < 0.8$  V). Measured in volts per microsecond (V/ $\mu\text{s}$ ).
- Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.

# TYPICAL PERFORMANCE CURVES

(HCPL0600, HCPL0601 and HCPL0611 only)

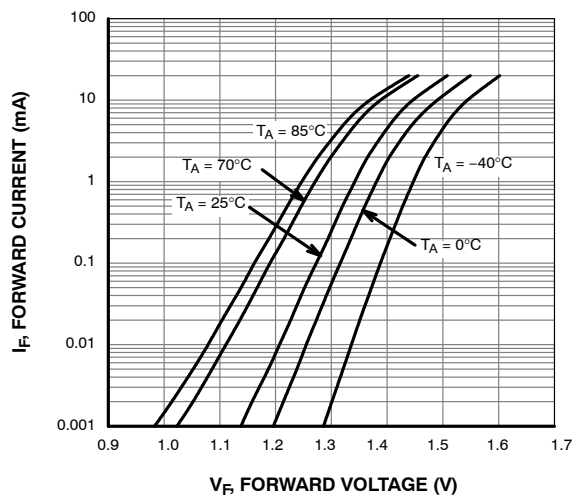


Figure 3. Forward Current vs. Input Forward Voltage

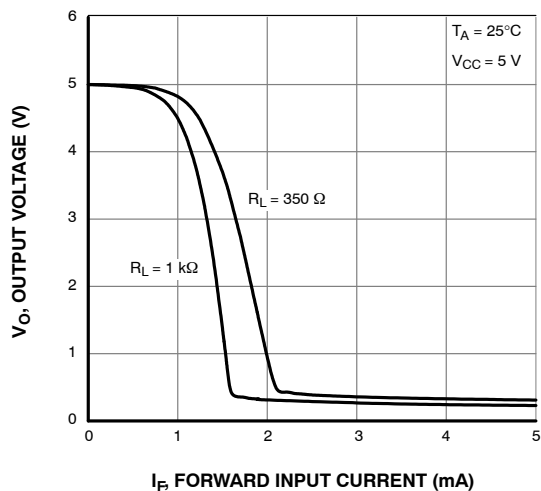


Figure 4. Output Voltage vs. Forward Current

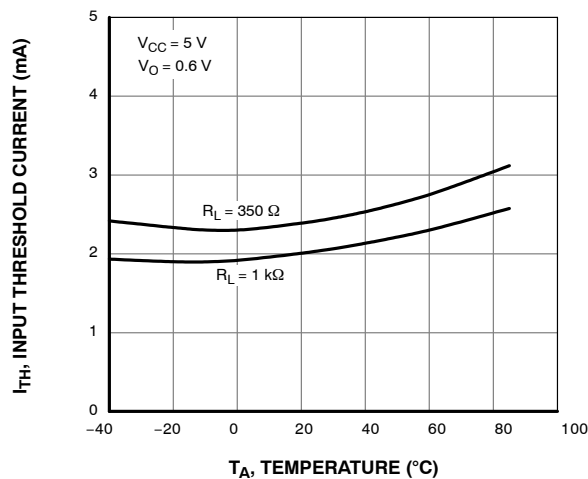


Figure 5. Input Threshold Current vs. Temperature

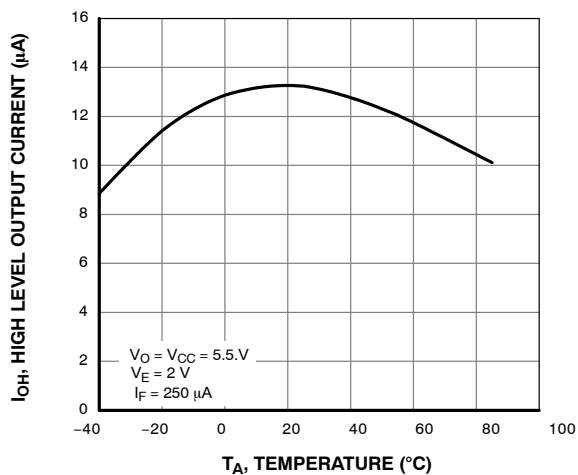


Figure 6. High Level Output Current vs. Temperature

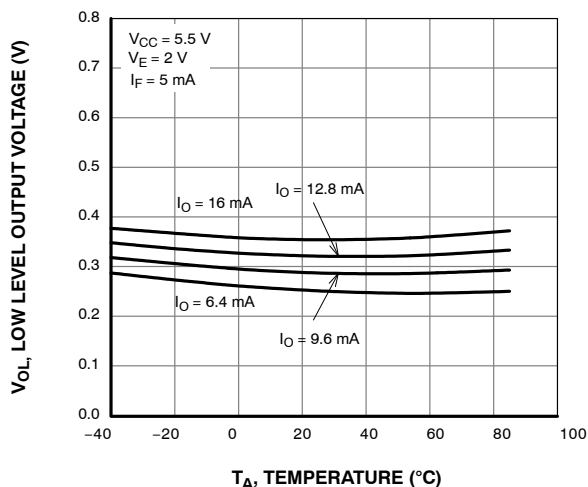


Figure 7. Low Level Output Voltage vs. Temperature

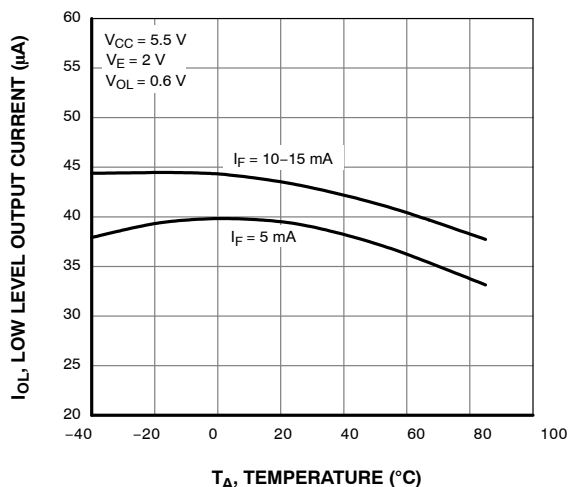


Figure 8. Low Level Output Current vs. Temperature

# TYPICAL PERFORMANCE CURVES

(HCPL0600, HCPL0601 and HCPL0611 only)

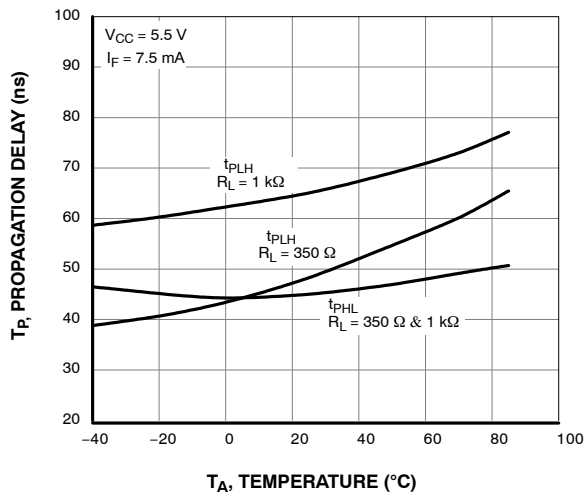


Figure 9. Propagation Delay vs. Temperature

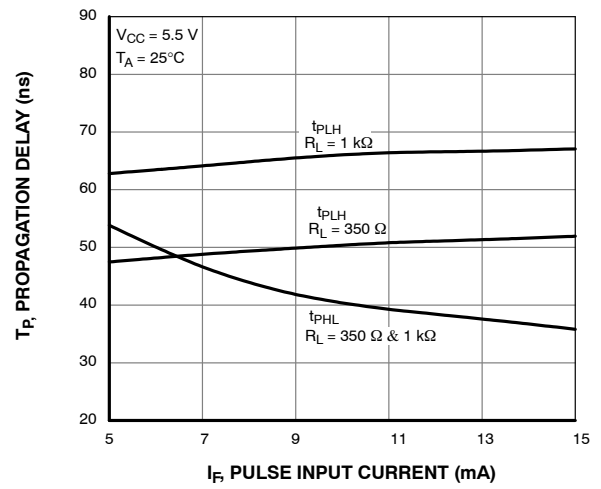


Figure 10. Propagation Delay vs. Pulse Input Current

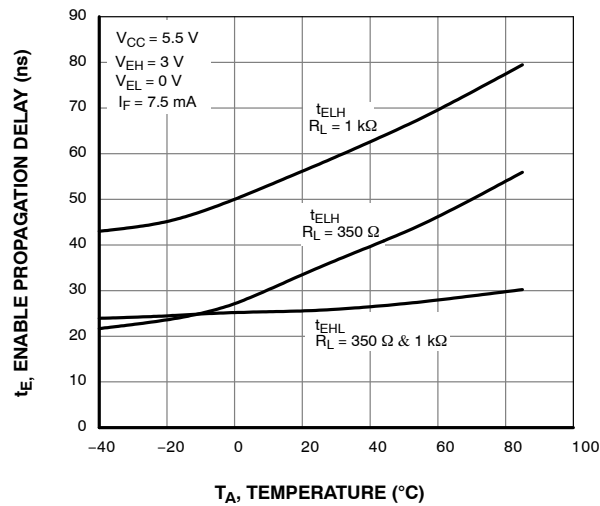


Figure 11. Typical Enable Propagation Delay vs. Temperature

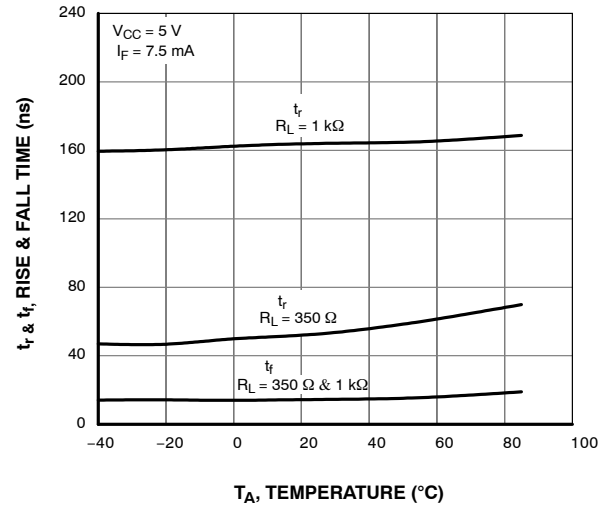


Figure 12. Typical Rise and Fall Time vs. Temperature

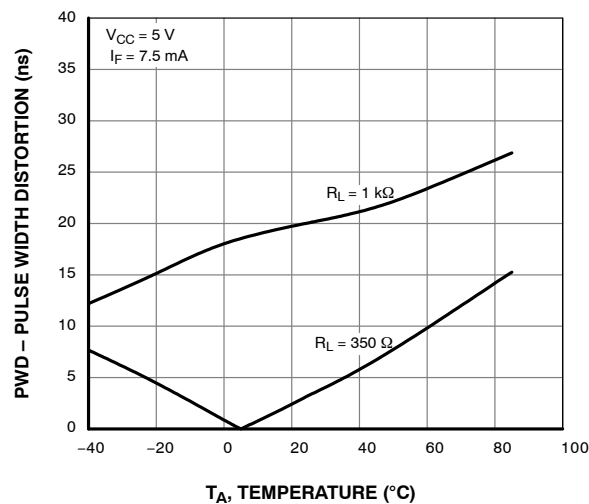


Figure 13. Typical Pulse Width Distortion vs. Temperature



# TYPICAL PERFORMANCE CURVES

(HCPL0637, HCPL0638 and HCPL0639 only)

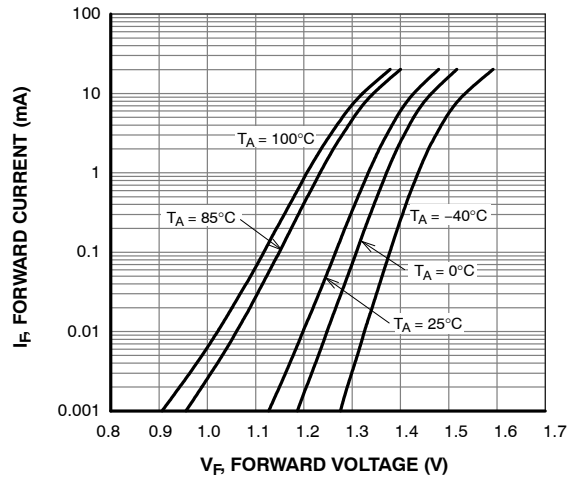


Figure 14. Input Forward Current vs. Forward Voltage

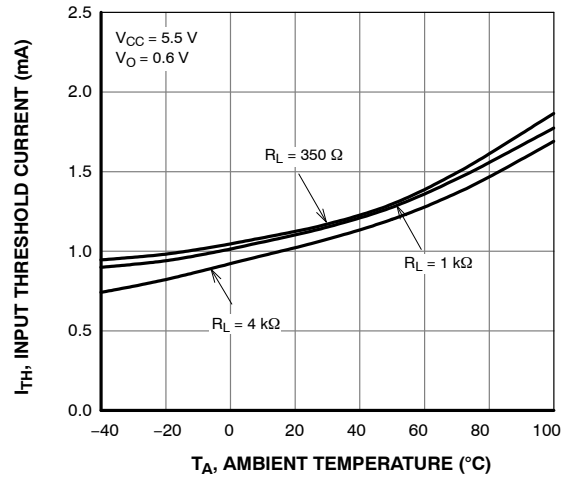


Figure 15. Input Threshold Current vs. Ambient Temperature

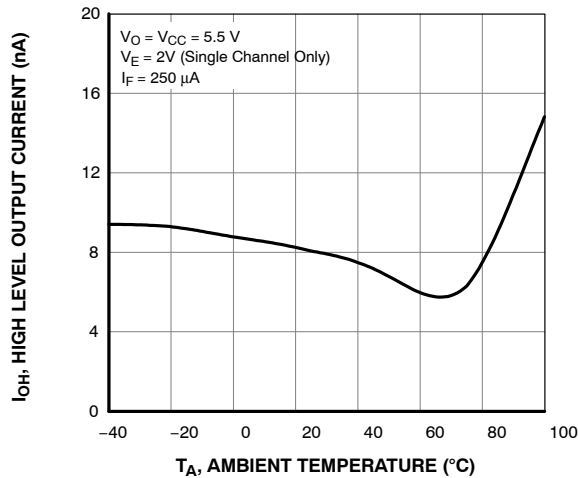


Figure 16. High Level Output Current vs. Ambient Temperature

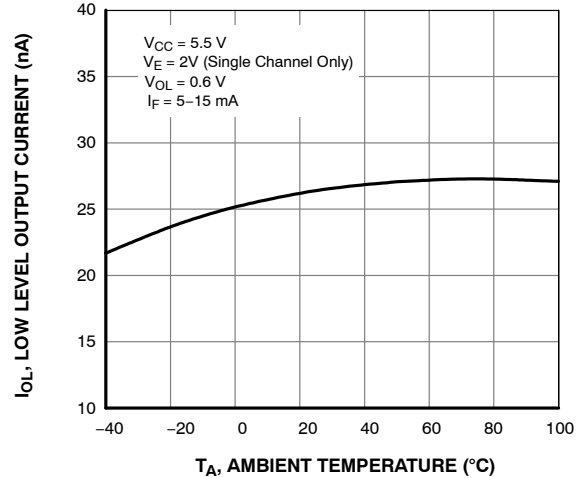


Figure 17. Low Level Output Current vs. Ambient Temperature

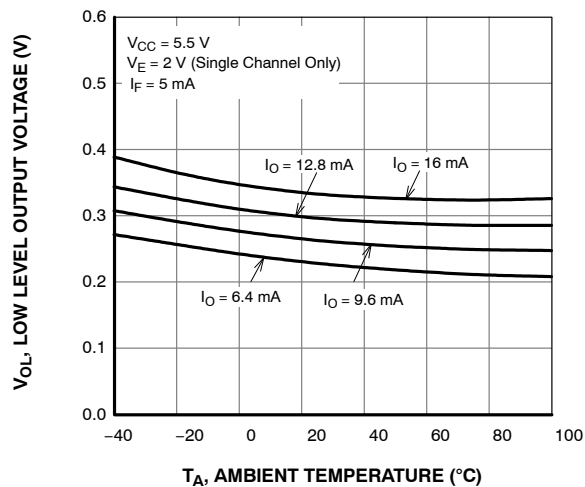


Figure 18. Low Level Output Voltage vs. Ambient Temperature

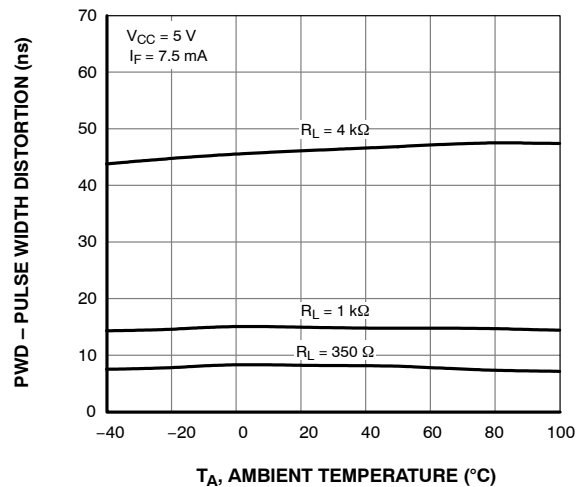


Figure 19. Pulse Width Distortion vs. Ambient Temperature

# TYPICAL PERFORMANCE CURVES

(HCPL0637, HCPL0638 and HCPL0639 only)

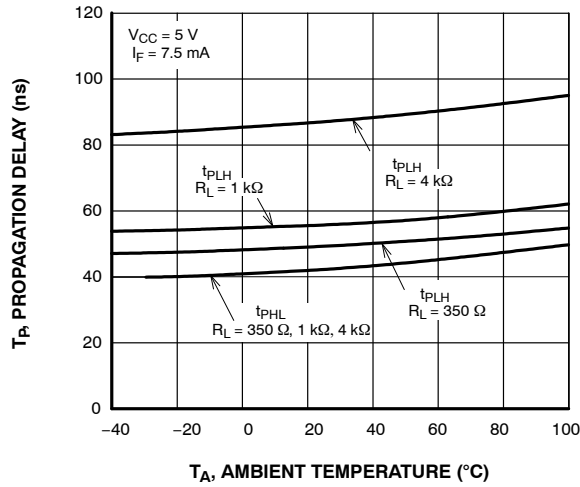


Figure 20. Propagation Delay vs. Ambient Temperature

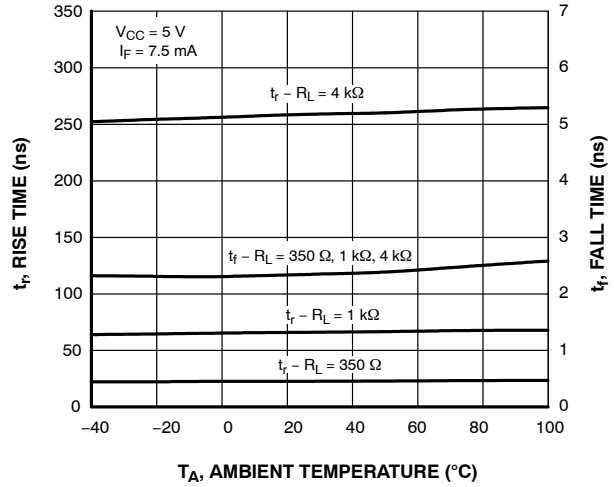


Figure 21. Rise and Fall Times vs. Ambient Temperature

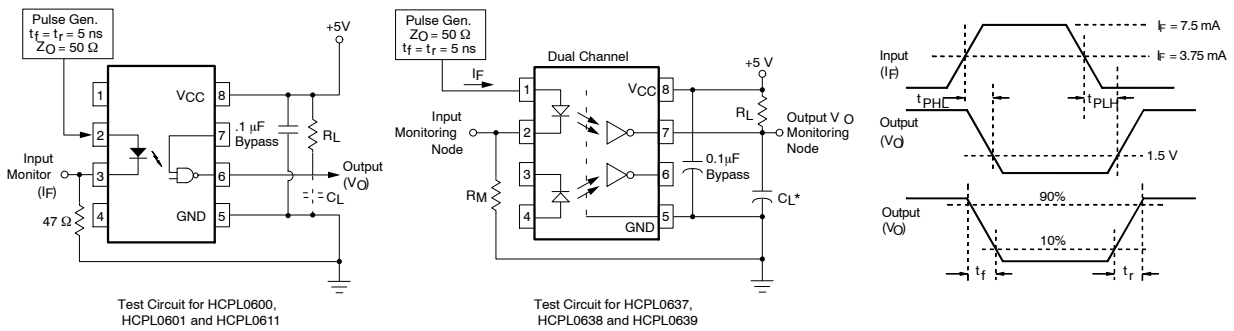


Figure 22. Test Circuit and Waveforms for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_r$  and  $t_f$

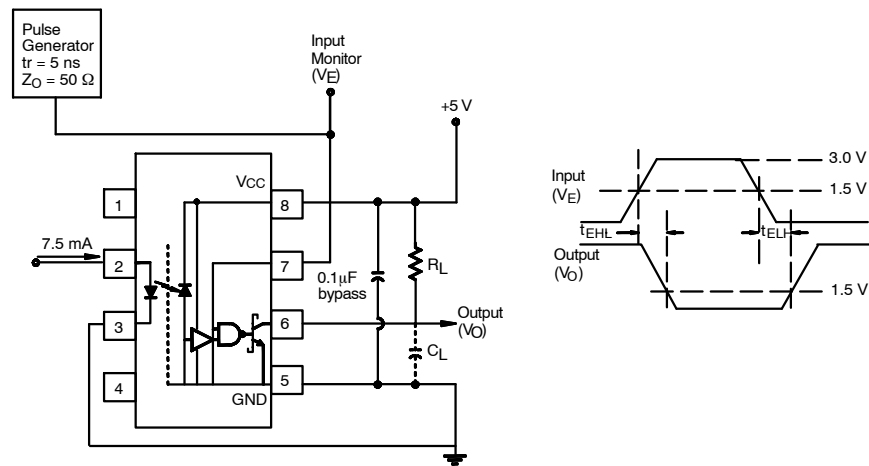
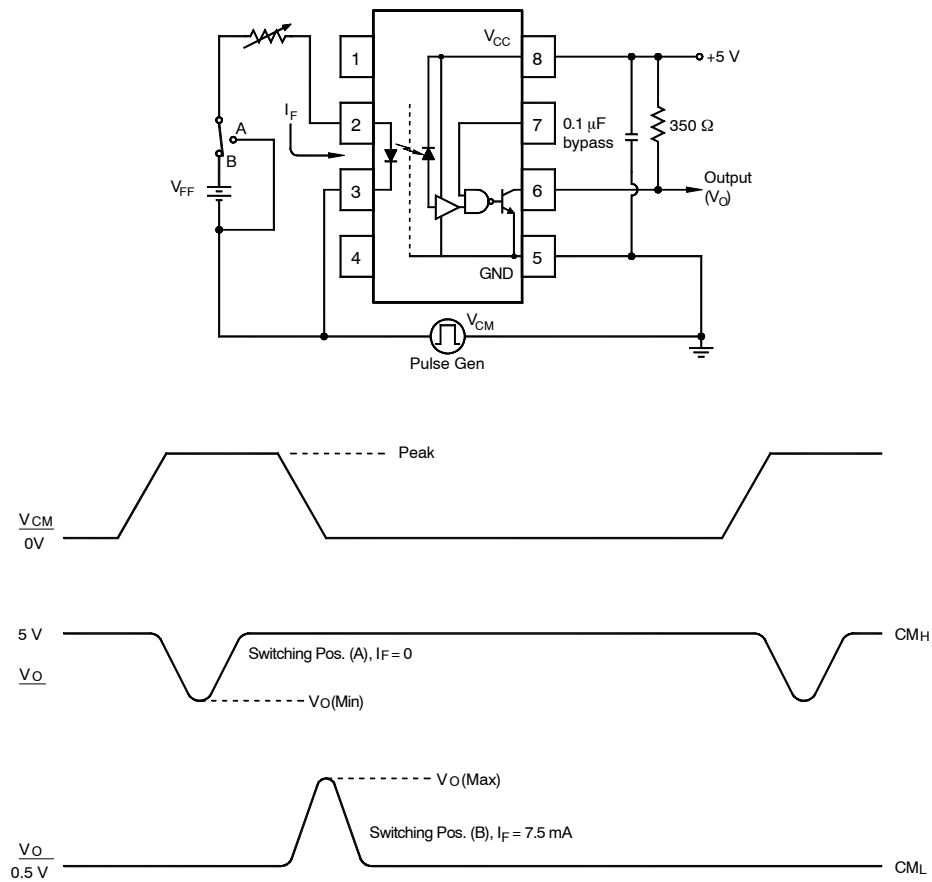
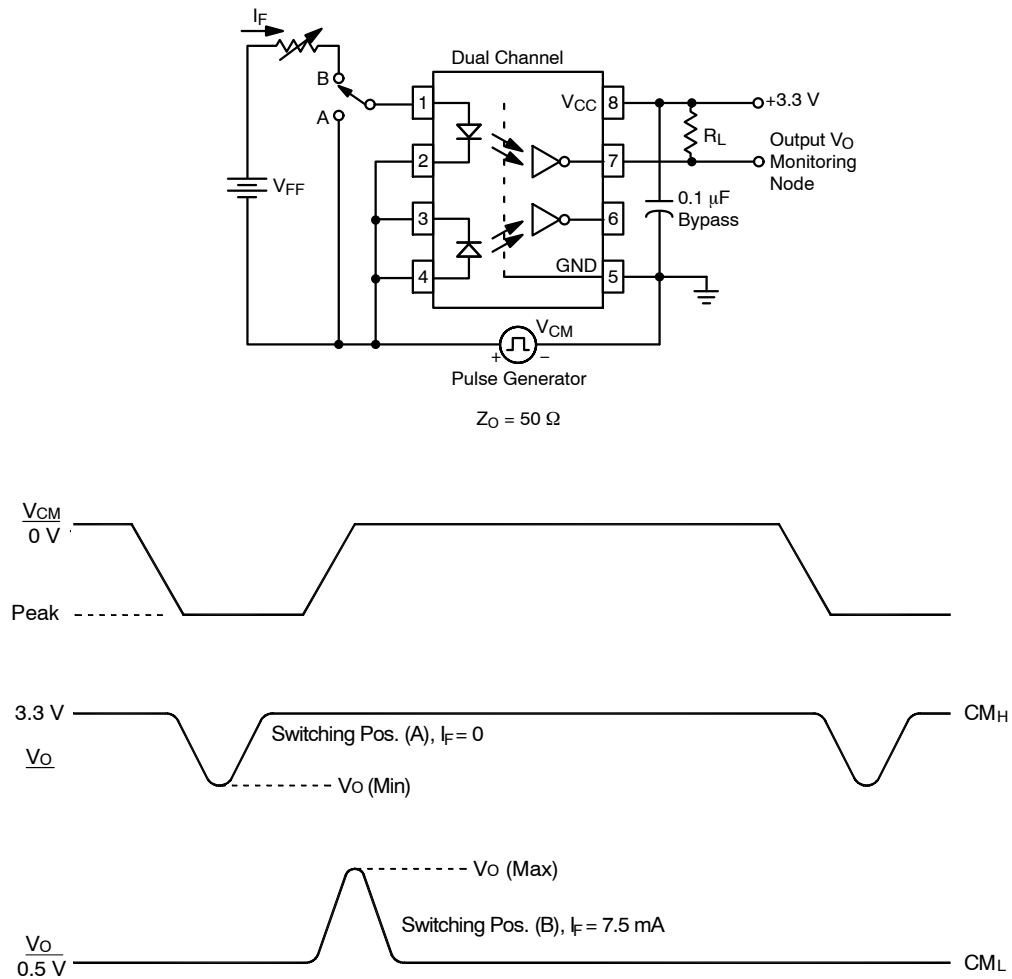


Figure 23. Test Circuit  $t_{EHL}$  and  $t_{ELH}$





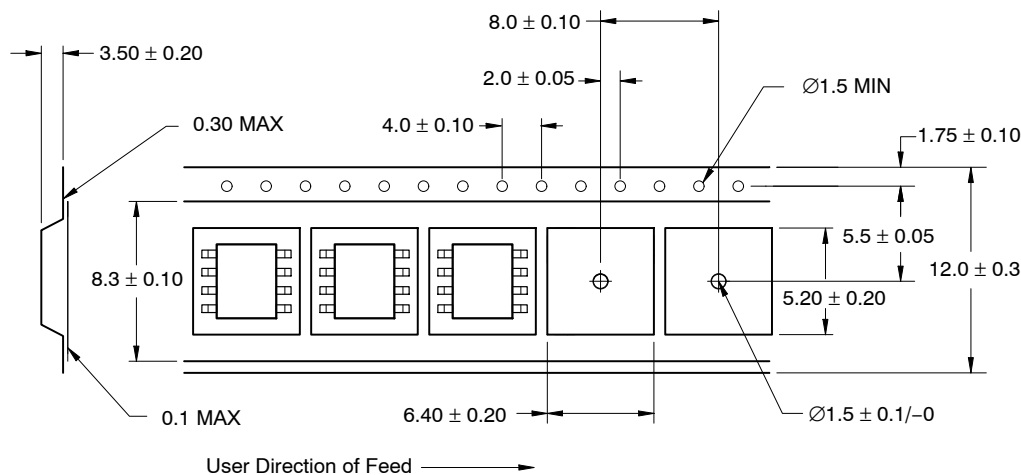
# ORDERING INFORMATION

Part Number	Package	Packing Method†
HCPL0600	Small Outline 8-Pin	Tube (50 Units)
HCPL0600R2	Small Outline 8-Pin	Tape and Reel (2500 Units)
HCPL0600V	Small Outline 8-Pin, DIN EN/IEC60747-5-5 Option	Tube (50 Units)
HCPL0600R2V	Small Outline 8-Pin, DIN EN/IEC60747-5-5 Option	Tape and Reel (2500 Units)

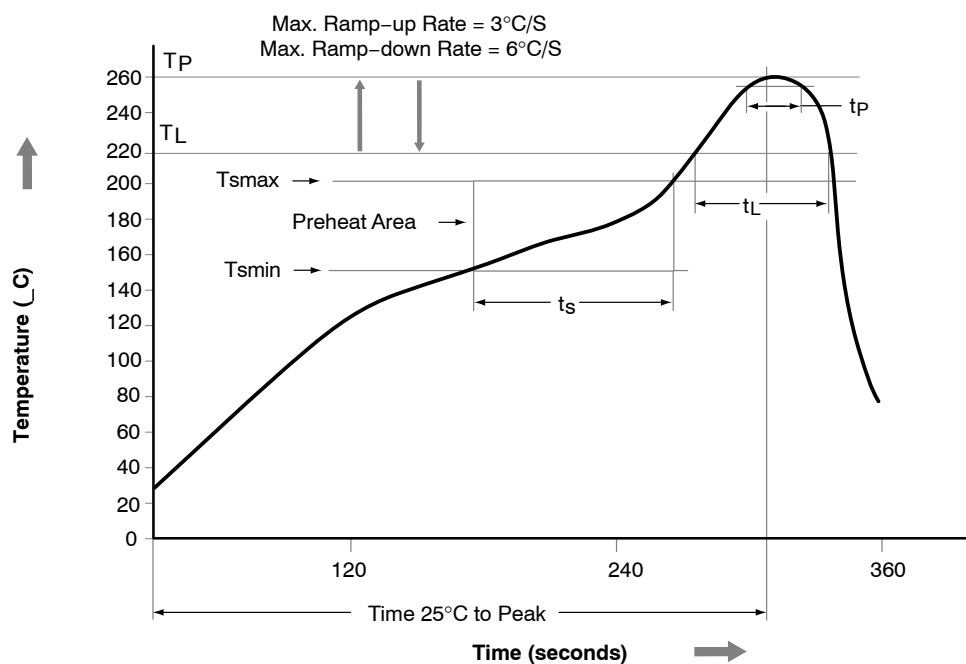
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

13. The product orderable part number system listed in this table also applies to the HCPL0601, HCPL0611, HCPL0637, HCPL0638 and HCPL0639 product.

## CARRIER TAPE SPECIFICATIONS



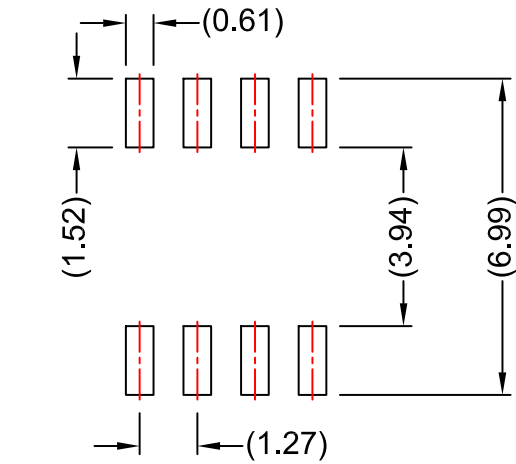
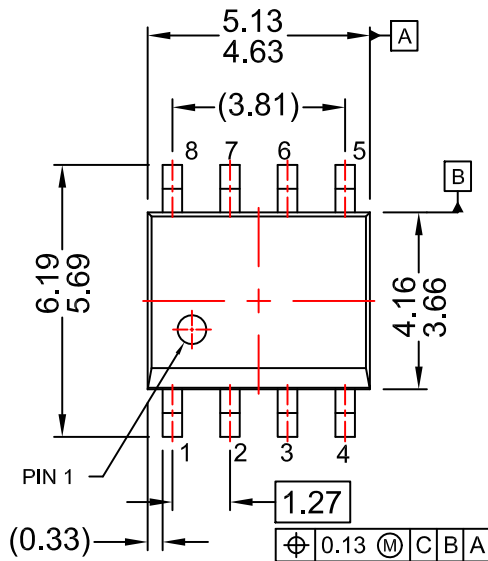
# REFLOW PROFILE



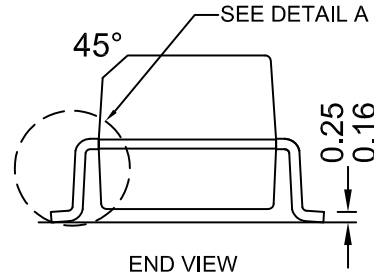
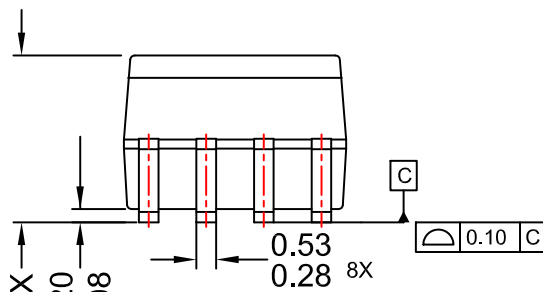
Profile Feature	Pb-Free Assembly Profile
Temperature Min. (T <sub>min</sub> )	150°C
Temperature Max. (T <sub>max</sub> )	200°C
Time (t <sub>S</sub> ) from (T <sub>min</sub> to T <sub>max</sub> )	60–120 seconds
Ramp-up Rate (t <sub>L</sub> to t <sub>P</sub> )	3°C/second max.
Liquidous Temperature (T <sub>L</sub> )	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	60–150 seconds
Peak Body Package Temperature	260°C +0°C / –5°C
Time (t <sub>P</sub> ) within 5°C of 260°C	30 seconds
Ramp-down Rate (T <sub>P</sub> to T <sub>L</sub> )	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

### SOIC8 CASE 751DZ ISSUE O

DATE 30 SEP 2016



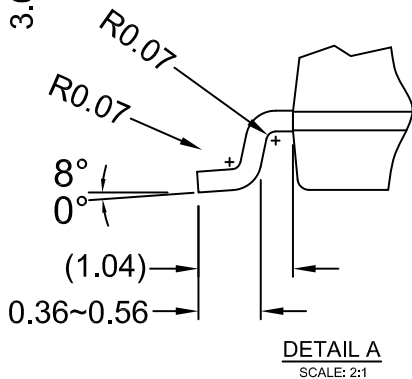
LAND PATTERN RECOMMENDATION



END VIEW

#### 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.



DETAIL A  
SCALE: 2:1

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