High CMR, High Speed Optocouplers

Technical Data

HCPL-4504
HCPL-0454
HCNW4504

Features

- **Short Propagation Delays for TTL and IPM Applications**
- **15 kV/μs Minimum Common Mode Transient Immunity at V_{CM} = 1500 V for TTL/Load Drive**
- **High CTR at T_A = 25°C**
  >25% for HCPL-4504/0454
  >23% for HCNW4504
- **Electrical Specifications for Common IPM Applications**
- **TTL Compatible**
- **Guaranteed Performance from 0°C to 70°C**
- **Open Collector Output**
- **Safety Approval**
  UL Recognized - 2500 V rms for 1 minute (5000 V rms for 1 minute for HCPL-4504#020 and HCNW4504)per UL1577
  CSA Approved
  VDE 0884 Approved
  -V_{IORM} = 630 V peak for HCPL-4504#060
  -V_{IORM} = 1414 V peak for HCNW4504
  BSI Certified (HCNW4504)
- **Available in 8-Pin DIP, SO-8, Widebody Packages**

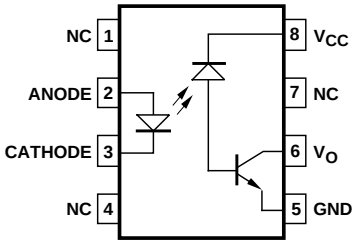
Applications

- **Inverter Circuits and Intelligent Power Module (IPM) interfacing -**
  High Common Mode Transient Immunity (> 10 kV/μs for an IPM load/drive) and (t_{PLH} - t_{PHL}) Specified (See Power Inverter Dead Time section)
- **Line Receivers -**
  Short Propagation Delays and Low Input-Output Capacitance
- **High Speed Logic Ground Isolation - TTL/TTL, TTL/CMOS, TTL/LSTTL**
- **Replaces Pulse Transformers -**
  Save Board Space and Weight
- **Analog Signal Ground Isolation -**
  Integrated Photodetector Provides Improved Linearity over Phototransistors

Description

These optocouplers are similar to HP's other high speed transistor optocouplers but with shorter propagation delays and higher CTR. The HCPL-4504/0454 and HCNW4504 also have a guaranteed propagation delay difference (t_{PLH} - t_{PHL}). These features make these optocouplers an excellent solution to IPM inverter dead time and other switching problems.

Functional Diagram



TRUTH TABLE

LED	V_O
ON	LOW
OFF	HIGH

A 0.1 μF bypass capacitor between pins 5 and 8 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.

The HCPL-4504/0454 and HCNW4504 CTR, propagation delay, and CMR are specified for both TTL and IPM load/drive conditions. Specifications and typical performance plots for both TTL and IPM conditions are provided for ease of application.

These single channel, diode-transistor optocouplers are available in 8-Pin DIP, SO-8, and Widebody package configurations. An insulating layer between a LED and an integrated photodetector provide electrical insulation between input and output. Separate connections for the photodiode bias and output-transistor collector increase the speed up to a hundred times that of a conventional phototransistor coupler by reducing the base collector capacitance.

Selection Guide

Single Channel Packages		
8-Pin DIP (300 Mil)	**Small Outline SO-8**	**Widebody (400 Mil)**
HCPL-4504	HCPL-0454	HCNW4504

Ordering Information

Specify Part Number followed by Option Number (if desired).

Example:

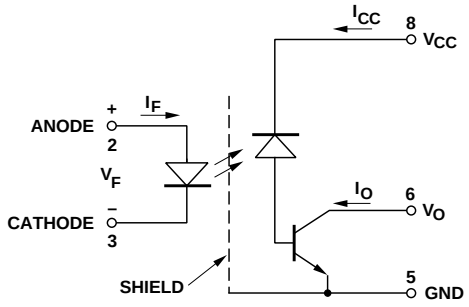
HCPL-4504#XXX

- 020 = UL 5000 V rms/1 Minute Option*
- 060 = VDE 0884 V_{IORM} = 630 V peak Option*
- 300 = Gull Wing Surface Mount Option†
- 500 = Tape and Reel Packaging Option

Option data sheets available. Contact your Hewlett-Packard sales representative or authorized distributor for information.

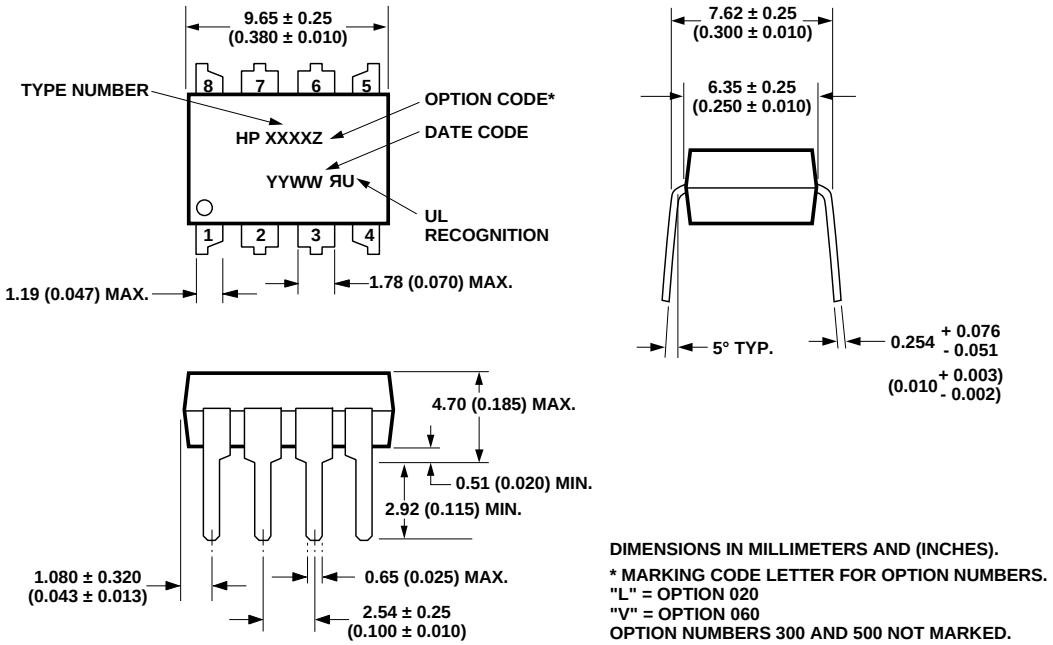
*For HCPL-4504 only. Combination of Option 020 and Option 060 is not available.
†Gull wing surface mount option applies to through hole parts only.

Schematic



Package Outline Drawings

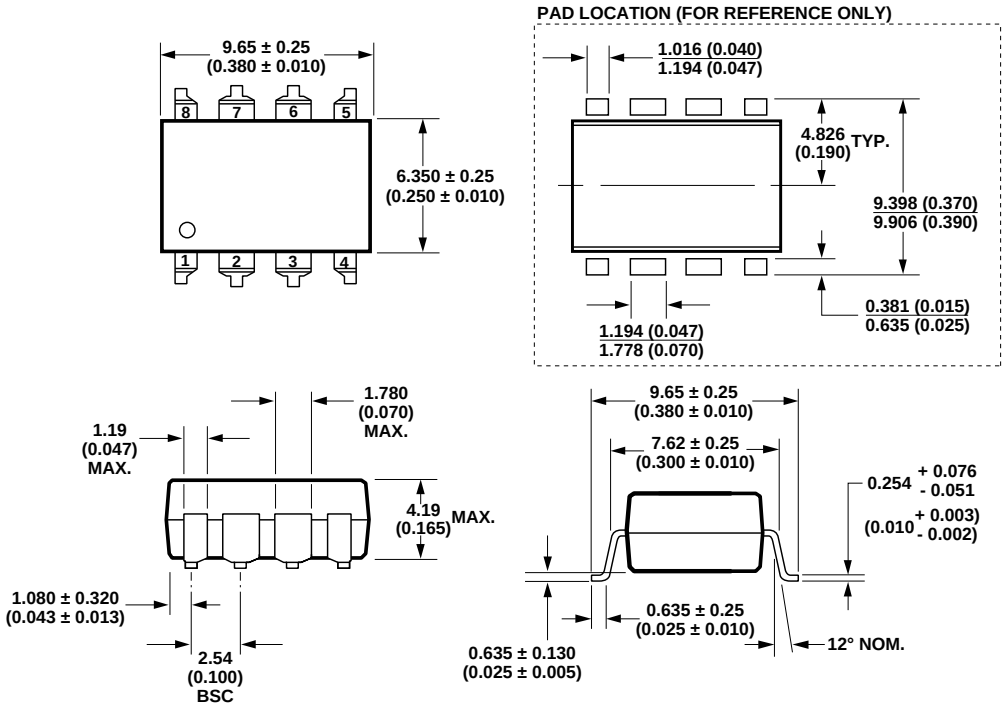
8-Pin DIP Package (HCPL-4504)



DIMENSIONS IN MILLIMETERS AND (INCHES).

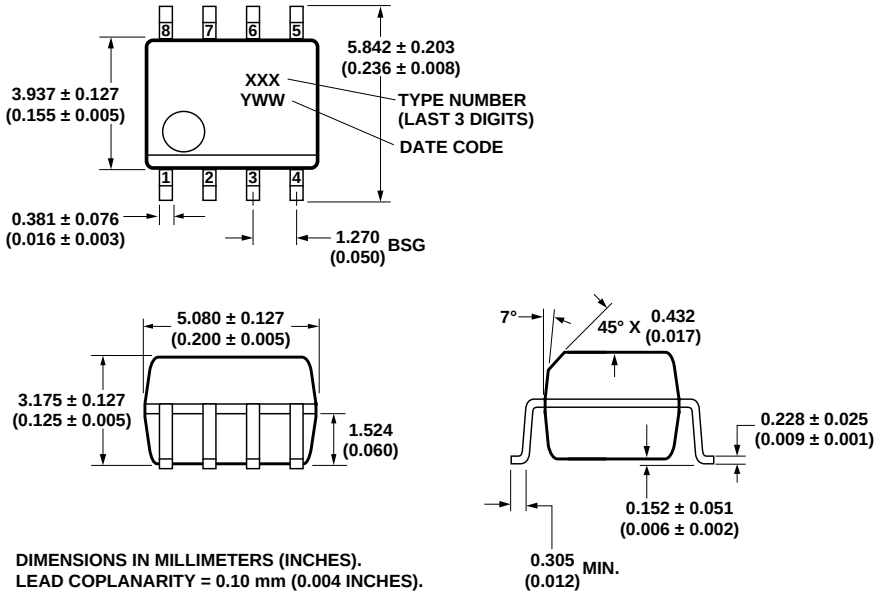
* MARKING CODE LETTER FOR OPTION NUMBERS.
"L" = OPTION 020
"V" = OPTION 060
OPTION NUMBERS 300 AND 500 NOT MARKED.

8-Pin DIP Package with Gull Wing Surface Mount Option 300 (HCPL-4504)



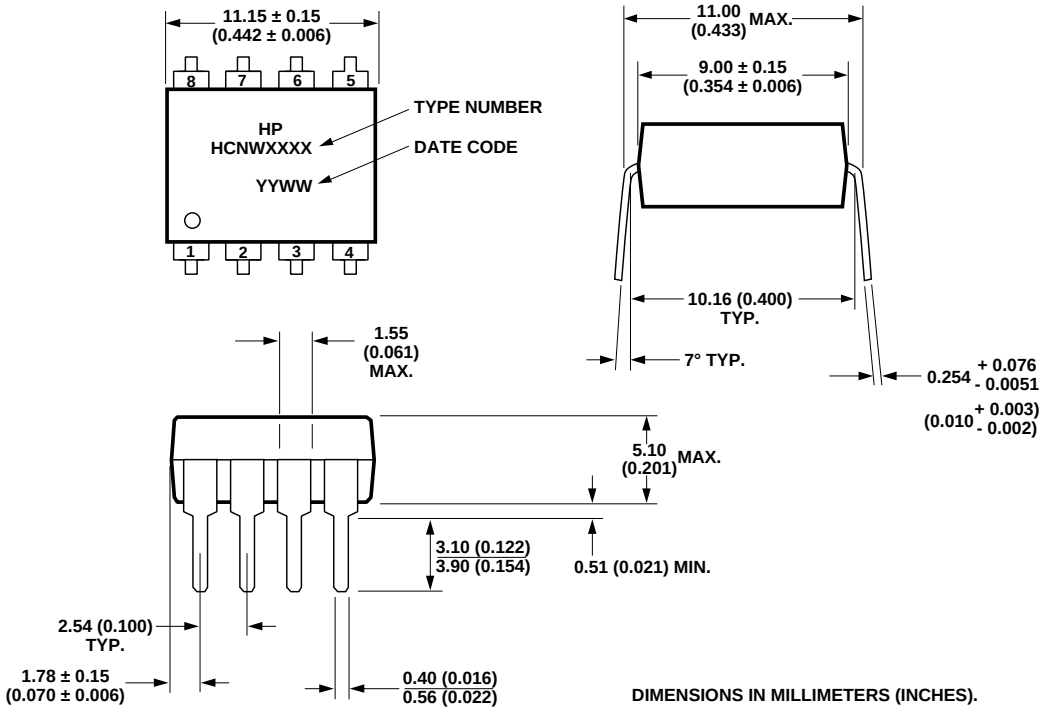
DIMENSIONS IN MILLIMETERS (INCHES).
LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

Small Outline SO-8 Package (HCPL-0454)



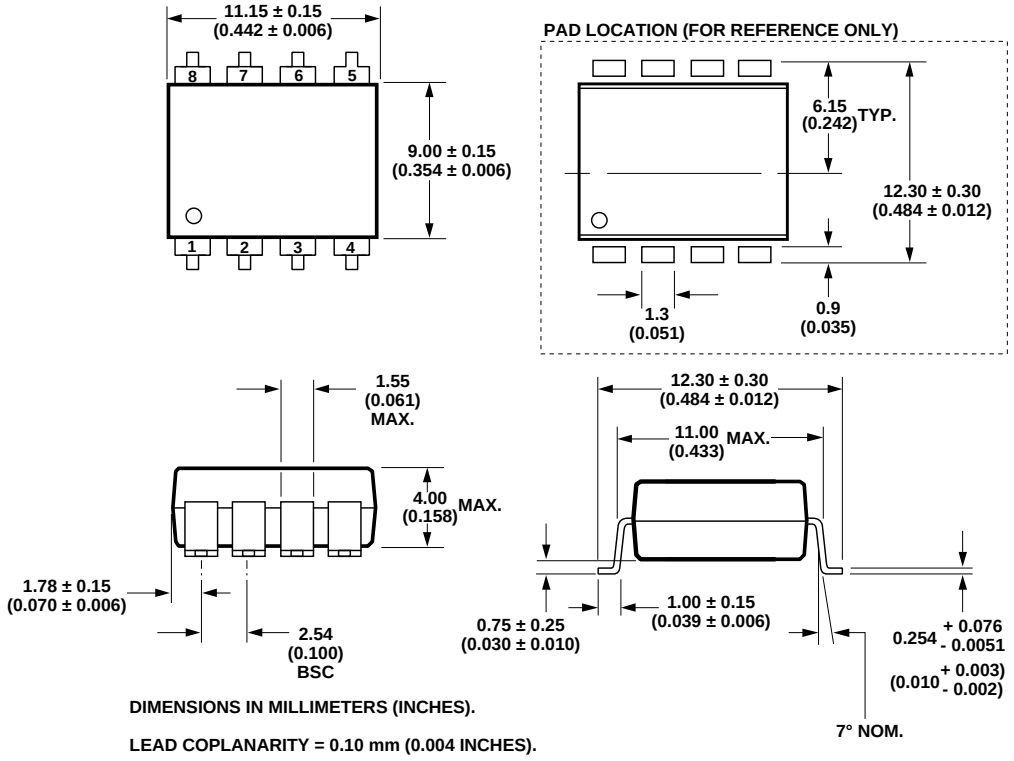
DIMENSIONS IN MILLIMETERS (INCHES).
LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

8-Pin Widebody DIP Package (HCNW4504)

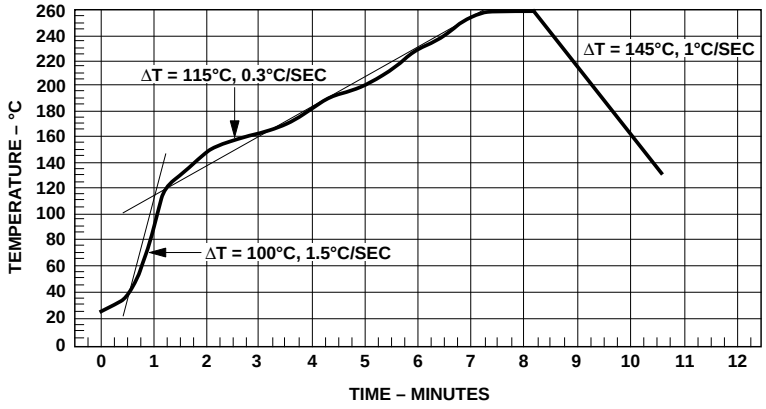


DIMENSIONS IN MILLIMETERS (INCHES).

8-Pin Widebody DIP Package with Gull Wing Surface Mount Option 300 (HCNW4504)



Solder Reflow Temperature Profile (HCPL-0454 and Gull Wing Surface Mount Option Parts)



Note: Use of nonchlorine activated fluxes is highly recommended.

Regulatory Information

The devices contained in this data sheet 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.

VDE

Approved according to VDE 0884/06.92 (HCNW4504 and HCPL-4504#060 only).

BSI

Certification according to BS451:1994, (BS EN60065:1994); BS EN60950:1992 (BS7002:1992) and EN41003:1993 for Class II applications (HCNW4504 only).

Insulation and Safety Related Specifications

Parameter	Symbol	8-Pin DIP (300 Mil) Value	SO-8 Value	Widebody (400 Mil) 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 (DIN VDE 0110, 1/89, Table 1)

Option 300 - surface mount classification is Class A in accordance with CECC 00802.

VDE 0884 Insulation Related Characteristics (HCPL-4504 OPTION 060 ONLY)

Description	Symbol	Characteristic	Units
Installation classification per DIN VDE 0110/1.89, Table 1 for rated mains voltage ≤ 300 V rms		I-IV	
for rated mains voltage ≤ 450 V rms		I-III	
Climatic Classification		55/100/21	
Pollution Degree (DIN VDE 0110/1.89)		2	
Maximum Working Insulation Voltage	V_{IORM}	630	V peak
Input to Output Test Voltage, Method b* V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 sec, Partial Discharge < 5 pC	V_{PR}	1181	V peak
Input to Output Test Voltage, Method a* V_{IORM} x 1.5 = V_{PR}, Type and sample test, t_m = 60 sec, Partial Discharge < 5 pC	V_{PR}	945	V peak
Highest Allowable Overvoltage* (Transient Overvoltage, t_{ini} = 10 sec)	V_{IOTM}	6000	V peak
Safety Limiting Values (Maximum values allowed in the event of a failure, also see Figure 15, Thermal Derating curve.)			
Case Temperature	T_S	175	°C
Input Current	$I_{S,INPUT}$	230	mA
Output Power	$P_{S,OUTPUT}$	600	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	≥ 10^9	Ω

VDE 0884 Insulation Related Characteristics (HCNW4504 ONLY)

Description	Symbol	Characteristic	Units
Installation classification per DIN VDE 0110/1.89, Table 1 for rated mains voltage ≤ 600 V rms		I-IV	
for rated mains voltage ≤ 1000 V rms		I-III	
Climatic Classification		55/85/21	
Pollution Degree (DIN VDE 0110/1.89)		2	
Maximum Working Insulation Voltage	V_{IORM}	1414	V peak
Input to Output Test Voltage, Method b* V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 sec, Partial Discharge < 5 pC	V_{PR}	2652	V peak
Input to Output Test Voltage, Method a* V_{IORM} x 1.5 = V_{PR}, Type and sample test, t_m = 60 sec, Partial Discharge < 5 pC	V_{PR}	2121	V peak
Highest Allowable Overvoltage* (Transient Overvoltage, t_{ini} = 10 sec)	V_{IOTM}	8000	V peak
Safety Limiting Values (Maximum values allowed in the event of a failure, also see Figure 15, Thermal Derating curve.)			
Case Temperature	T_S	150	°C
Input Current	$I_{S,INPUT}$	400	mA
Output Power	$P_{S,OUTPUT}$	700	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	≥ 10^9	Ω

*Refer to the front of the optocoupler section of the current catalog under Product Safety Regulations section (VDE 0884), 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	Device	Min.	Max.	Units	Note
Storage Temperature	T_S		-55	125	°C	
Operating Temperature	T_A	HCPL-4504 HCPL-0454	-55	100	°C	
		HCNW4504	-55	85		
Average Forward Input Current	$I_{F(AVG)}$			25	mA	1
Peak Forward Input Current (50% duty cycle, 1 ms pulse width)	$I_{F(PEAK)}$	HCPL-4504 HCPL-0454		50	mA	2
(50% duty cycle, 1 ms pulse width)		HCNW4504		40		
Peak Transient Input Current (≤ 1 µs pulse width, 300 pps)	$I_{F(TRANS)}$	HCPL-4504 HCPL-0454		1	A	
		HCNW4504		0.1		
Reverse LED Input Voltage (Pin 3-2)	V_R	HCPL-4504 HCPL-0454		5	V	
		HCNW4504		3		
Input Power Dissipation	P_{IN}	HCPL-4504 HCPL-0454		45	mW	3
		HCNW4504		40		
Average Output Current (Pin 6)	$I_{O(AVG)}$			8	mA	
Peak Output Current	$I_{O(PEAK)}$			16	mA	
Supply Voltage (Pin 8-5)	V_{CC}		-0.5	30	V	
Output Voltage (Pin 6-5)	V_O		-0.5	20	V	
Output Power Dissipation	P_O			100	mW	4
Lead Solder Temperature (Through-Hole Parts Only) 1.6 mm below seating plane, 10 seconds up to seating plane, 10 seconds	T_{LS}	HCPL-4504		260	°C	
		HCNW4504		260	°C	
Reflow Temperature Profile	T_{RP}	HCPL-0454 and Option 300	See **Package Outline Drawings** section			

Electrical Specifications (DC)

Over recommended temperature (T_A = 0°C to 70°C) unless otherwise specified. See note 12.

Parameter	Symbol	Device	Min.	Typ.*	Max.	Units	Test Conditions	Fig.	Note
Current Transfer Ratio	CTR	HCPL-4504	25	32	60	%	T_A = 25°C, V_O = 0.4 V, I_F = 16 mA, V_{CC} = 4.5 V	1, 2, 4	5
		HCPL-0454	21	34			V_O = 0.5 V		
		HCNW4504	23	29	60		T_A = 25°C, V_O = 0.4 V		
			19	31	63		V_O = 0.5 V		
Current Transfer Ratio	CTR	HCPL-4504	26	35	65	%	T_A = 25°C, V_O = 0.4 V, I_F = 12 mA, V_{CC} = 4.5 V	1, 2, 4	5
		HCPL-0454	22	37			V_O = 0.5 V		
		HCNW4504	25	33	65		T_A = 25°C, V_O = 0.4 V		
			21	35	68		V_O = 0.5 V		
Logic Low Output Voltage	V_{OL}	HCPL-4504		0.2	0.4	V	T_A = 25°C, I_O = 4.0 mA, I_F = 16 mA, V_{CC} = 4.5 V		
		HCPL-0454			0.5		I_O = 3.3 mA		
		HCNW4504		0.2	0.4		T_A = 25°C, I_O = 3.6 mA		
					0.5		I_O = 3.0 mA		
Logic High Output Current	I_{OH}			0.003	0.5	µA	T_A = 25°C, V_O = V_{CC} = 5.5 V, I_F = 0 mA	5	
				0.01	1		T_A = 25°C, V_O = V_{CC} = 15 V		
					50				
Logic Low Supply Current	I_{CCL}			50	200	µA	I_F = 16 mA, V_O = Open, V_{CC} = 15 V		12
Logic High Supply Current	I_{CCH}			0.02	1	µA	T_A = 25°C, I_F = 0 mA, V_O = Open, V_{CC} = 15 V		12
					2				
Input Forward Voltage	V_F	HCPL-4504		1.5	1.7	V	T_A = 25°C, I_F = 16 mA	3	
		HCPL-0454			1.8				
		HCNW4504	1.45	1.59	1.85		T_A = 25°C, I_F = 16 mA		
			1.35		1.95				
Input Reverse Breakdown Voltage	BV_R	HCPL-4504	5			V	I_R = 10 µA		
		HCPL-0454							
		HCNW4504	3				I_R = 100 µA, T_A = 25°C		
Temperature Coefficient of Forward Voltage	$\frac{\Delta V_F}{\Delta T_A}$	HCPL-4504		-1.6		mV/°C	I_F = 16 mA		
		HCPL-0454							
		HCNW4504		-1.4					
Input Capacitance	C_{IN}	HCPL-4504		60		pF	f = 1 MHz, V_F = 0 V		
		HCPL-0454							
		HCNW4504		70					

*All typicals at T_A = 25°C.

AC Switching Specifications

Over recommended temperature (T_A = 0°C to 70°C) unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions		Fig.	Note
Propagation Delay Time to Logic Low at Output	t_{PHL}		0.2	0.3	µs	T_A = 25°C	Pulse: f = 20 kHz, Duty Cycle = 10%, I_F = 16 mA, V_{CC} = 5.0 V, R_L = 1.9 kΩ, C_L = 15 pF, V_{THHL} = 1.5 V	6, 8, 9	9
			0.2	0.5					
		0.2	0.5	0.7		T_A = 25°C	Pulse: f = 10 kHz, Duty Cycle = 50%, I_F = 12 mA, V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, V_{THHL} = 1.5 V	6, 10-14	10
		0.1	0.5	1.0					
Propagation Delay Time to Logic High at Output	t_{PLH}		0.3	0.5	µs	T_A = 25°C	Pulse: f = 20 kHz, Duty Cycle = 10%, I_F = 16 mA, V_{CC} = 5.0 V, R_L = 1.9 kΩ, C_L = 15 pF, V_{THLH} = 1.5 V	6, 8, 9	9
			0.3	0.7					
		0.3	0.8	1.1		T_A = 25°C	Pulse: f = 10 kHz, Duty Cycle = 50%, I_F = 12 mA, V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, V_{THLH} = 2.0 V	6, 10-14	10
		0.2	0.8	1.4					
Propagation Delay Difference Between Any 2 Parts	t_{PLH}-t_{PHL}	-0.4	0.3	0.9	µs	T_A = 25°C	Pulse: f = 10 kHz, Duty Cycle = 50%, I_F = 12 mA, V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, V_{THHL} = 1.5 V, V_{THLH} = 2.0 V	6, 10-14	15
		-0.7	0.3	1.3					
Common Mode Transient Immunity at Logic High Level Output	$\|CM_H\|$	15	30		kV/µs	T_A = 25°C V_{CM} = 1500 V_{P-P}	V_{CC} = 5.0 V, R_L = 1.9 kΩ, C_L = 15 pF, I_F = 0 mA	7	7, 9
		15	30				V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, I_F = 0 mA	7	8, 10
Common Mode Transient Immunity at Logic Low Level Output	$\|CM_L\|$	15	30		kV/µs	T_A = 25°C V_{CM} = 1500 V_{P-P}	V_{CC} = 5.0 V, R_L = 1.9 kΩ, C_L = 15 pF, I_F = 16 mA	7	7, 9
		10	30				V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, I_F = 12 mA	7	8, 10
		15	30				V_{CC} = 15.0 V, R_L = 20 kΩ, C_L = 100 pF, I_F = 16 mA	7	8, 10

*All typicals at T_A = 25°C.