

# Agilent HCPL-250L/ 050L/253L/053L LVTTTL/LVCMOS Compatible 3.3 V Optocouplers (1 Mb/s) Data Sheet

## Description

These diode-transistor optocouplers use an insulating layer between a LED and an integrated photodetector to 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.

These 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 SO-8 part number.

The SO-8 does not require "through holes" in a PCB. This package occupies approximately one-third the footprint area of the

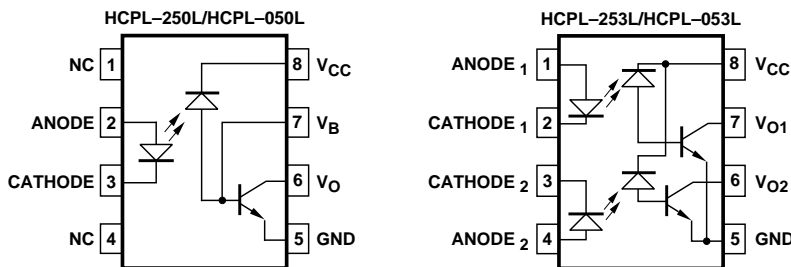
## Features

- Low power consumption
- High speed: 1 Mb/s
- LVTTTL/LVCMOS compatible
- Available in 8-pin DIP, SO-8
- Open collector output
- Guaranteed performance from temperature: 0°C to +70°C
- Safety approval, UL, CSA, VDE (pending)

## Applications

- High voltage insulation
- Video signal isolation
- Power translator isolation in motor drives
- Line receivers
- Feedback element in switched mode power supplies
- High speed logic ground isolation – LVTTTL/LVCMOS
- Replaces pulse transformers
- Replaces slow phototransistor isolators
- Analog signal ground isolation

## Functional Diagram



TRUTH TABLE  
(POSITIVE LOGIC)

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

A 0.1 μF bypass capacitor must be connected between pins 5 and 8.

**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.

standard dual-in-line package. The lead profile is designed to be compatible with standard surface mount processes.

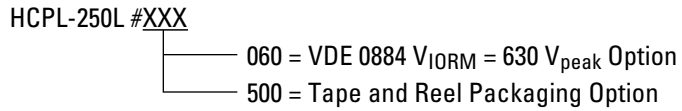
These optocouplers can be used in LVTTTL/LVCMOS or wide bandwidth analog applications.

The common mode transient immunity of 15,000 V/ $\mu$ s minimum at  $V_{CM} = 1500$  V guaranteed for these optocouplers.

**Ordering Information**

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

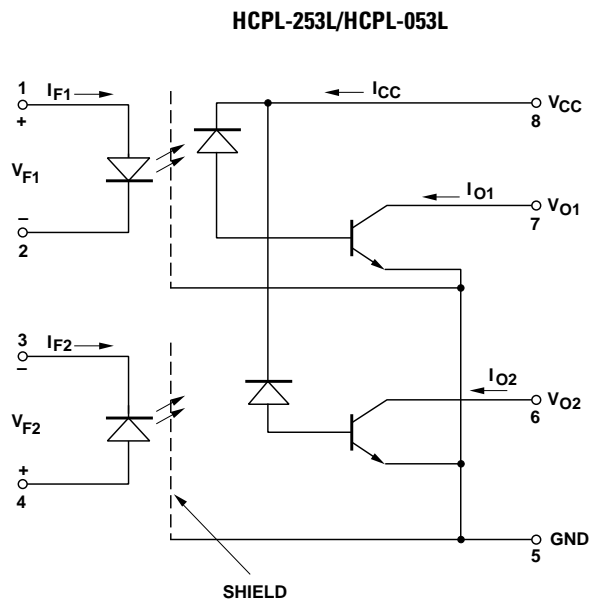
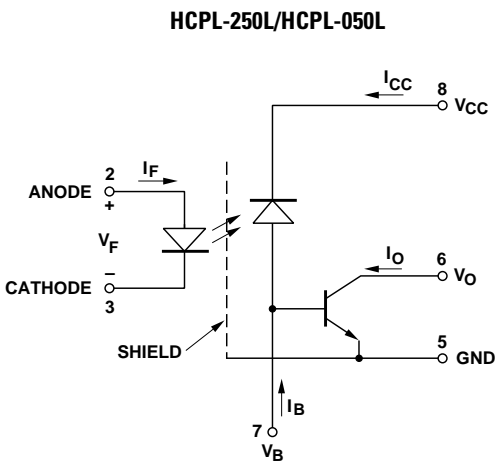
Example:



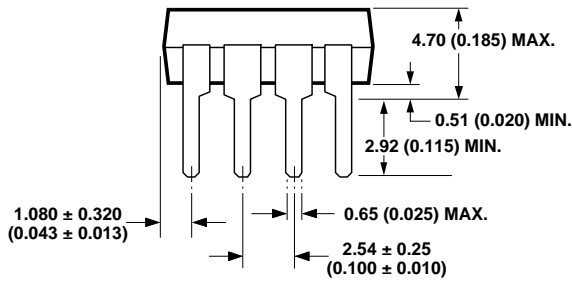
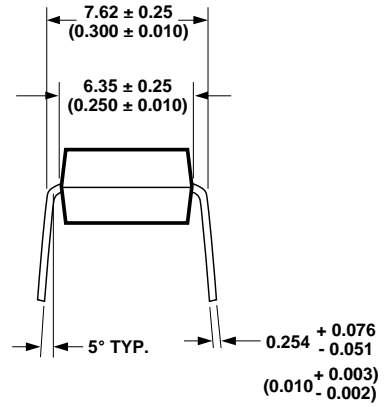
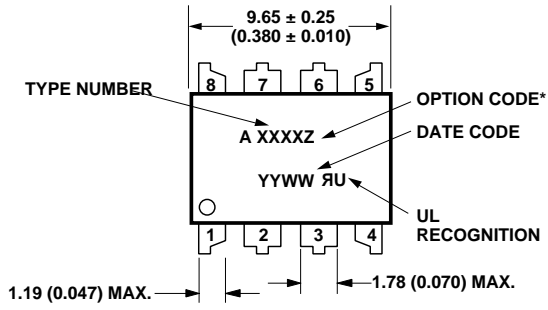
Option data sheets available. Contact Agilent sales representative or authorized distributor for information.

8-Pin DIP	SO-8 Package
HCPL-250L	HCPL-050L
HCPL-253L	HCPL-053L

**Schematic**

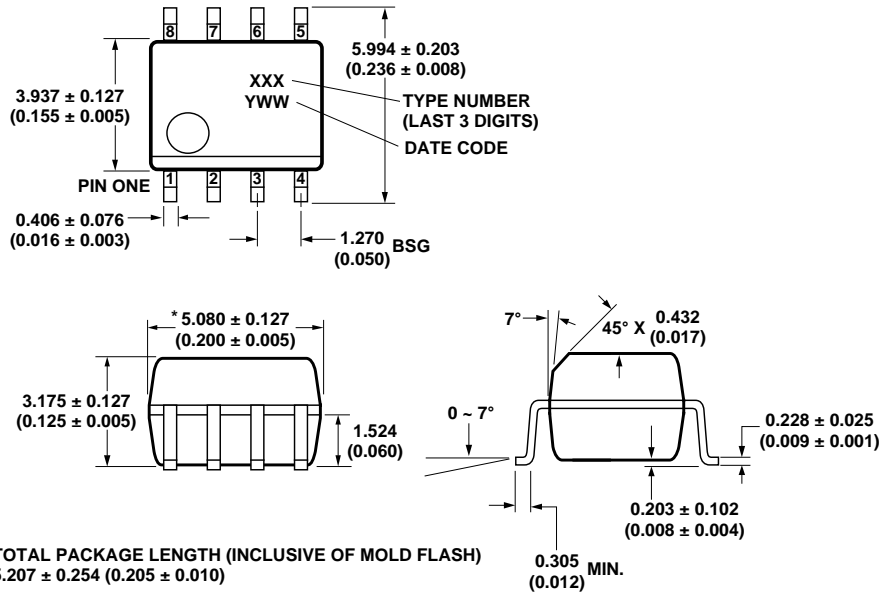


**Package Outline Drawings**  
**8-Pin DIP Package**



DIMENSIONS IN MILLIMETERS AND (INCHES).  
 \* MARKING CODE LETTER FOR OPTION NUMBERS.  
 "L" = OPTION 020  
 "V" = OPTION 060  
 OPTION NUMBERS 300 AND 500 NOT MARKED.

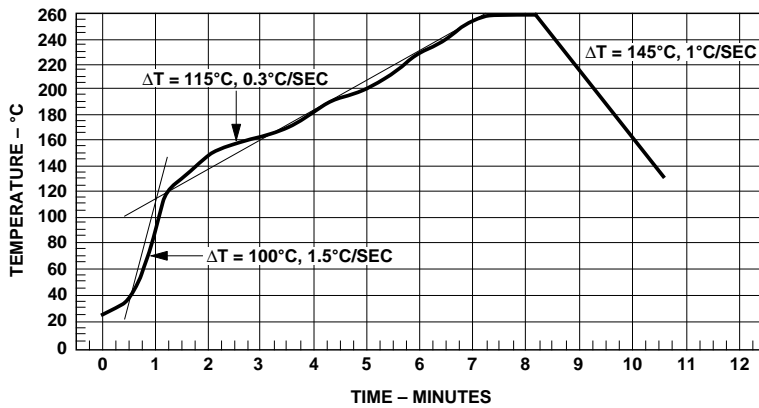
**Small Outline SO-8 Package**



\* 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.

**Solder Reflow Temperature Profile (Surface Mount Option Parts)**



(NOTE: USE OF NON-CHLORINE ACTIVATED FLUXES IS RECOMMENDED.)

**Regulatory Information**

The devices contained in this data sheet are pending by the following organizations:

**UL**

Approval (pending) under UL 1577, Component Recognition Program, File E55361.

**CSA**

Approval (pending) under CSA Component Acceptance Notice #5, File CA 88324.

**VDE**

Approval (pending) according to VDE 0884/06.92.

### Insulation and Safety Related Specifications

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.
Minimum Internal Tracking (Internal Creepage)		NA	NA	mm	Measured from input terminals to output terminals, along internal 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).

### VDE 0884 Insulation Related Characteristics

Description	Symbol	Characteristic	Units
Installation classification per DIN VDE 0110/1.89, Table 1 for rated mains voltage $\leq 300$ V rms for rated mains voltage $\leq 450$ V rms		I-IV	
		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* $V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ sec, Partial Discharge $< 5$ pC	$V_{PR}$	1181	$V_{peak}$
Input to Output Test Voltage, Method a* $V_{IORM} \times 1.5 = V_{PR}$ , 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 4, Thermal Derating curve.) Case Temperature Input Current Output Power	$T_S$ $I_{S,INPUT}$ $P_{S,OUTPUT}$	175 230 600	$^{\circ}C$ mA mW
Insulation Resistance at $T_S$ , $V_{I0} = 500$ V	$R_S$	$\geq 10^9$	$\Omega$

\*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	Min.	Max.	Units	Note
Storage Temperature	$T_S$	-55	125	°C	
Operating Temperature	$T_A$	-55	100	°C	
		-55	85		
Average Forward Input Current	$I_{F(AVG)}$		25	mA	1
Peak Forward Input Current (50% duty cycle, 1 ms pulse width) (50% duty cycle, 1 ms pulse width)	$I_{F(PEAK)}$		50	mA	2
			40		
Peak Transient Input Current ( $\leq 1 \mu s$ pulse width, 300 pps)	$I_{F(TRANS)}$		1	A	
			0.1		
Reverse LED Input Voltage (Pin 3-2)	$V_R$		5	V	
			3		
Input Power Dissipation	$P_{IN}$		45	mW	3
			40		
Average Output Current (Pin 6)	$I_{O(AVG)}$		8	mA	
Peak Output Current	$I_{O(PEAK)}$		16	mA	
Emitter-Base Reverse Voltage	$V_{EBR}$		5	V	
Supply Voltage (Pin 8-5)	$V_{CC}$	-0.5	7	V	
Output Voltage (Pin 6-5)	$V_O$	-0.5	7	V	
Base Current	$I_B$		5	mA	
Output Power Dissipation	$P_O$		100	mW	4
Lead Solder Temperature (Through Hole Parts Only) 1.6 mm below seating plane, 10 sec. up to seating plane, 10 seconds	$T_{LS}$		260	°C	
			260	°C	
Reflow Temperature Profile	$T_{RP}$	See Package Outline Drawings section			

### Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Power Supply Voltage	$V_{CC}$	2.7	3.3	V
Forward Input Current	$I_{F(ON)}$	16	20	mA
Forward Input Voltage	$V_{F(OFF)}$	0	0.8	V
Operating Temperature	$T_A$	0	85	°C

### Electrical Specifications (DC)

Over Recommended Temperature ( $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ),  $V_{CC} = 3.3\text{ V}$ ,  $I_F = 16\text{ mA}$ , unless otherwise specified. See Note 13.

Parameter	Sym.	Device	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Current Transfer Ratio	CTR		15	20	50	%	$T_A = 25^\circ\text{C}$ $V_O = 0.4\text{ V}$ $I_F = 16\text{ mA}$ , $V_{CC} = 3.3\text{ V}$	2	5, 11
Logic Low Output Voltage	$V_{OL}$			0.05	0.3	V	$T_A = 25^\circ\text{C}$ $I_O = 3.0\text{ mA}$ $I_F = 16\text{ mA}$ , $V_{CC} = 3.3\text{ V}$		
Logic High Output Current	$I_{OH}$			0.003	1	$\mu\text{A}$	$T_A = 25^\circ\text{C}$ $V_O = V_{CC} = 3.3\text{ V}$ $I_F = 0\text{ mA}$	3	
Logic Low Supply Current	$I_{CCL}$			43.0	100	$\mu\text{A}$	$I_F = 16\text{ mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{ V}$		13
	Dual				300				
Logic High Supply Current	$I_{CCH}$			0.005	0.3	$\mu\text{A}$	$T_A = 25^\circ\text{C}$ $I_F = 0\text{ mA}$ , $V_O = \text{Open}$ , $V_{CC} = 3.3\text{ V}$		13
	Dual				10				
Input Forward Voltage	$V_F$			1.52	1.7	V	$T_A = 25^\circ\text{C}$ $I_F = 16\text{ mA}$	1	
Input Reverse Breakdown Voltage	$BV_R$		5			V	$I_R = 10\ \mu\text{A}$		
Input Capacitance	$C_{IN}$			60	90	pF	$f = 1\text{ MHz}$ , $V_F = 0\text{ V}$		

### Switching Specifications (AC)

Over Recommended Temperature ( $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ),  $V_{CC} = 3.3\text{ V}$ ,  $I_F = 16\text{ mA}$  unless otherwise specified.

Parameter	Sym.	Device	Min.	Typ.*	Max.	Units	Test Conditions	Fig.	Note
Propagation Delay Time to Logic Low at Output	$t_{PHL}$			0.35	1	$\mu\text{s}$	$T_A = 25^\circ\text{C}$ $R_L = 1.9\text{ k}\Omega$	5	8, 9
Propagation Delay Time to Logic High at Output	$t_{PLH}$			0.65	1	$\mu\text{s}$	$T_A = 25^\circ\text{C}$ $R_L = 1.9\text{ k}\Omega$	5	8, 9
Common Mode Transient Immunity at Logic High Level Output	$ICM_{HL}$			1		$\text{kV}/\mu\text{s}$	$R_L = 4.1\text{ k}\Omega$ $R_L = 1.9\text{ k}\Omega$ $I_F = 0\text{ mA}$ , $T_A = 25^\circ\text{C}$ , $V_{CM} = 10\text{ V}_{p-p}$ $C_L = 15\text{ pF}$	6	7, 8, 9
Common Mode Transient Immunity at Logic Low Level Output	$ICM_{LL}$			1		$\text{kV}/\mu\text{s}$	$R_L = 4.1\text{ k}\Omega$ $R_L = 1.9\text{ k}\Omega$ $I_F = 16\text{ mA}$ , $T_A = 25^\circ\text{C}$ , $V_{CM} = 10\text{ V}_{p-p}$ $C_L = 15\text{ pF}$	6	7, 8, 9

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

## Package Characteristics

Over Recommended Temperature ( $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ) unless otherwise specified.

Parameter	Sym.	Device	Min.	Typ.*	Max.	Units	Test Conditions	Fig.	Note
Input-Output Momentary Withstand Voltage**	$V_{ISO}$	8-Pin DIP SO-8	2500			V rms	RH < 50%, t = 1 min., $T_A = 25^\circ\text{C}$		6, 14
	$I_{I-O}$	8-Pin DIP			1	$\mu\text{A}$	45% RH, t = 5 s, $V_{I-O} = 3 \text{ kVdc}$ , $T_A = 25^\circ\text{C}$		6, 16
Input-Output Resistance	$R_{I-O}$	8-Pin DIP SO-8		$10^{12}$		$\Omega$	$V_{I-O} = 500 \text{ Vdc}$		6
Input-Output Capacitance	$C_{I-O}$	8-Pin DIP SO-8		0.6		pF	f = 1 MHz		6

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

\*\*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 VDE 0884 Insulation Related Characteristics Table (if applicable), your equipment level safety specification or Agilent Application Note 1074 entitled "Optocoupler Input-Output Endurance Voltage," publication number 5963-2203E.

### Notes:

- Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $0.8 \text{ mA}/^\circ\text{C}$  (8-Pin DIP).  
Derate linearly above  $85^\circ\text{C}$  free-air temperature at a rate of  $0.5 \text{ mA}/^\circ\text{C}$  (SO-8).
- Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $1.6 \text{ mA}/^\circ\text{C}$  (8-Pin DIP).  
Derate linearly above  $85^\circ\text{C}$  free-air temperature at a rate of  $1.0 \text{ mA}/^\circ\text{C}$  (SO-8).
- Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $0.9 \text{ mW}/^\circ\text{C}$  (8-Pin DIP).  
Derate linearly above  $85^\circ\text{C}$  free-air temperature at a rate of  $1.1 \text{ mW}/^\circ\text{C}$  (SO-8).
- Derate linearly above  $70^\circ\text{C}$  free-air temperature at a rate of  $2.0 \text{ mW}/^\circ\text{C}$  (8-Pin DIP).  
Derate linearly above  $85^\circ\text{C}$  free-air temperature at a rate of  $2.3 \text{ mW}/^\circ\text{C}$  (SO-8).
- CURRENT TRANSFER RATIO in percent is defined as the ratio of output collector current,  $I_{O,C}$ , 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.
- Common mode transient immunity in a 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 a 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.,  $V_O < 0.8 \text{ V}$ ).
- The  $1.9 \text{ k}\Omega$  load represents 1 TTL unit load of  $1.6 \text{ mA}$  and the  $5.6 \text{ mA k}\Omega$  pull-up resistor.
- 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 frequency at which the AC output voltage is 3 dB below its mid-frequency value.
- The JEDEC registration for the 6N136 specifies a minimum CTR of 15%. Agilent guarantees a minimum CTR of 15%.
- See Option 020 data sheet for more information.
- Use of a  $0.1 \mu\text{F}$  bypass capacitor connected between pins 5 and 8 is recommended.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 3000 \text{ V rms}$  for 1 second (leakage detection current limit,  $I_{I-O} \leq 5 \mu\text{A}$ ). This test is performed before the 100% Production test shown in the VDE 0884 Insulation Related Characteristics Table, if applicable.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 6000 \text{ V rms}$  for 1 second (leakage detection current limit,  $I_{I-O} \leq 5 \mu\text{A}$ ). This test is performed before the 100% Production test shown in the VDE 0884 Insulation Related Characteristics Table, if applicable.
- This rating is equally validated by an equivalent AC proof test.



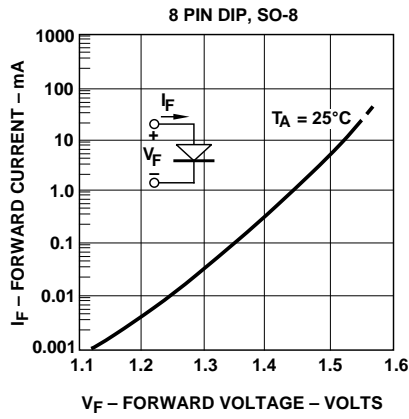


Figure 1. Input current vs. forward voltage.

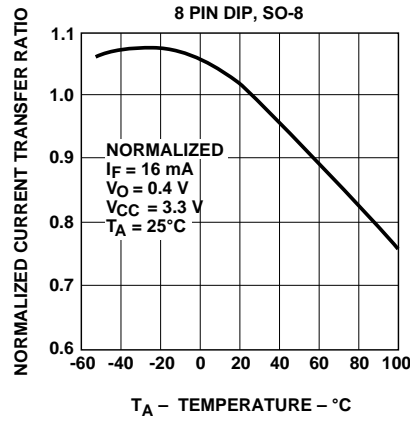


Figure 2. Current transfer ratio vs. temperature.

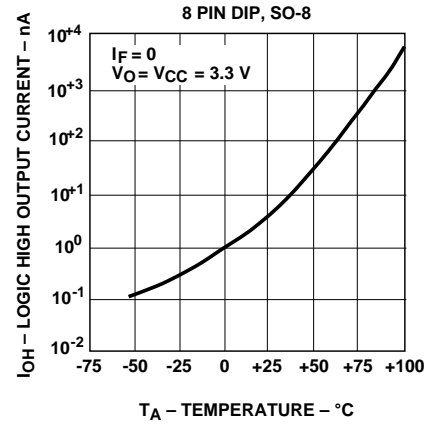


Figure 3. Logic high output current vs. temperature.

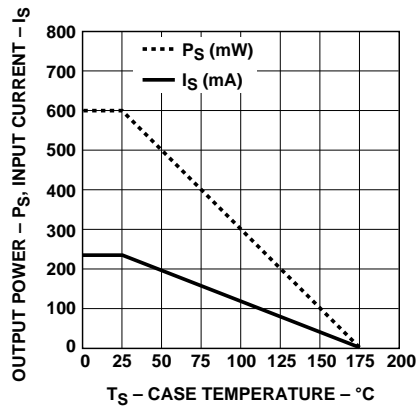


Figure 4. Thermal derating curve, dependence of safety limiting value with case temperature per VDE 0884.

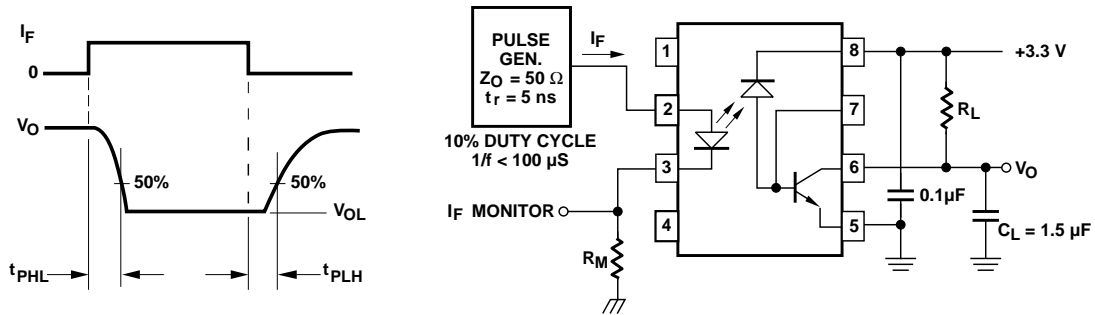


Figure 5. Switching test circuit.

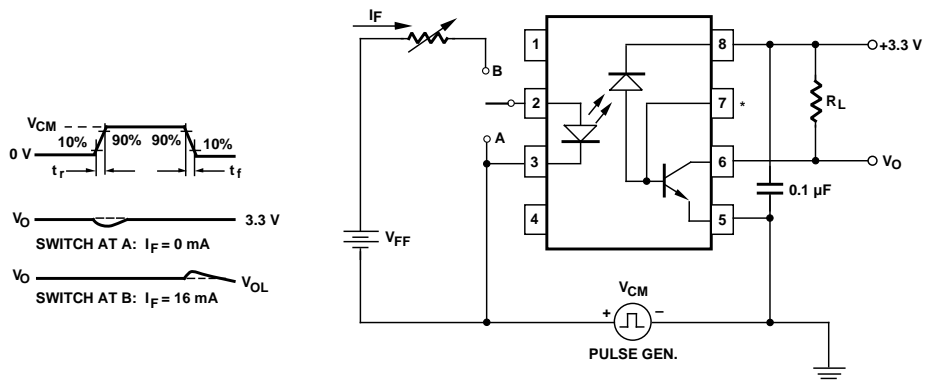


Figure 6. Test circuit for transient immunity and typical waveforms.