

Dual Channel Bi-directional High Speed Optoisolators

Technical Data

Features

- **Bi-directional Configurations in SOIC-8 Package**
- **Available Configurations:**
V_{CC} Common: HCPL-0560
Ground Common: HCPL-0561
- **High Speed: 1 MBd**
- **TTL Compatible**
- **Open Collector Output Stage**
- **Performance Guaranteed over 0°C to +70°C Temperature Range**
- **Safety Approval**
UL Recognized per UL1577 for 2500 Vrms/1 min. CSA Approved

Applications

- **Full Duplex Communication**
- **Data Communication: Isolated Transmit/Receive**
- **Bi-directional Communication**
- **PLC I/O Interface**
- **Isolated Primary/Secondary Power Supply Sensing**
- **Industrial Standard Data Interface: TIA/EIA-232-E**
- **Industrial Controls**
- **Remote Isolation Sensing**

Description

These bi-directional dual channel optoisolators, packaged in an industry standard SOIC-8 package, provide full duplex and bi-directional isolated data transfer and communication capability in a compact surface mount package.

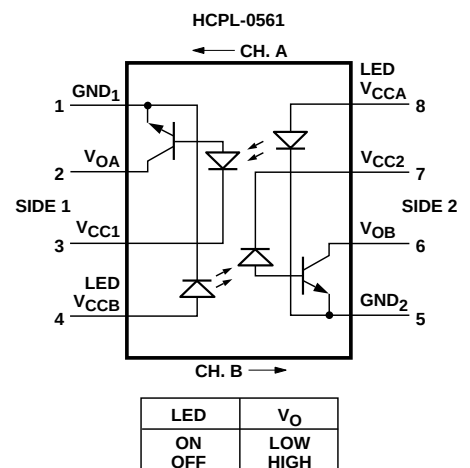
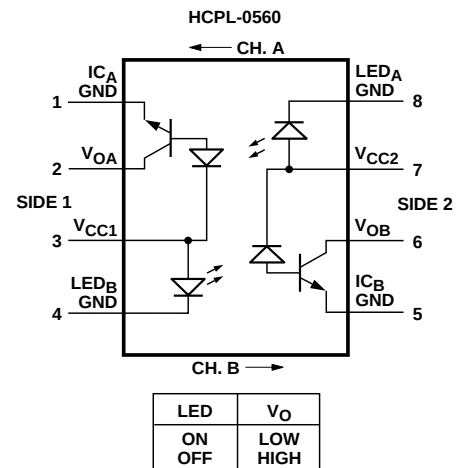
These optoisolators contain two pairs of emitters and detectors packaged in a unique configuration to allow simultaneous, isolated, bi-directional transmit and receive capability in a single package. Separate photo-detector and output stage allows a speed performance hundreds of times faster than a conventional photo-transistor coupler by minimizing the base-collector capacitance and charge storage effects.

The HCPL-0560 is a V_{CC} common configuration, in which anode of the LED of one channel is internally connected to the output side V_{CC} of the second channel. Thus, the LED input current of one channel now becomes a function of the V_{CC} of the second channel in the package, and appropriate care is required so as not to overdrive the LEDs.

HCPL-0560

HCPL-0561

Functional Diagram



A 0.1 μ F bypass capacitor must be connected between pins 1 and 3, and between pins 5 and 7.

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-0561 is a GND common configuration in which each isolated ground is common to both channels on each side of the optoisolator. Other than the internal configuration difference between the HCPL-0560 and HCPL-0561, all electrical

parameters including ac and dc are the same for the Ground Common and V_{CC} common configurations.

These optoisolators have a minimum CTR of 15% over the recommended operating

temperature range of 0°C to $+70^{\circ}\text{C}$, and maximum propagation delays of $1\ \mu\text{s}$. Minimum common mode transient immunity of $1\ \text{kV}/\mu\text{s}$ is guaranteed at a maximum common mode voltage of $10\ V_{p-p}$ at 25°C .

Selection Guide

Common Type	Small-Outline SO-8 Bi-directional Channel	Data Rate (baud)	Recommended I_F On-Current (mA)	Minimum CTR (%)	Electrical Equivalent 8-pin DIP Single Channel
V_{CC} Common	HCPL-0560	1 M	16	15	HCPL-4502
GND Common	HCPL-0561				

Ordering Information

Specify Part Number Followed by Option Number (if desired)

Example

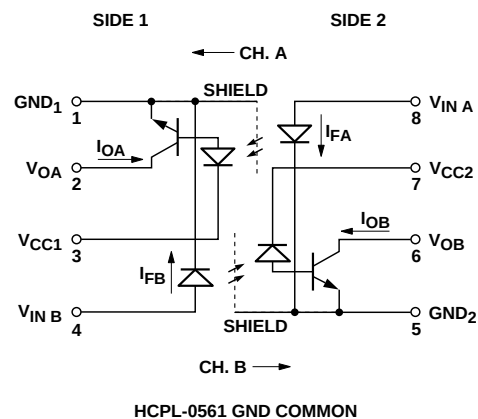
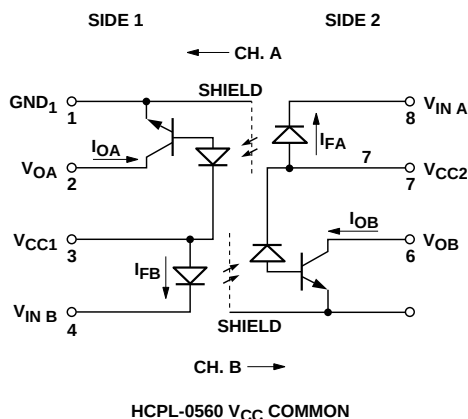
HCPL-0560# XXX

No Option = 100 per tube.

500 = Tape and Reel Packaging Option, 1000 per reel.

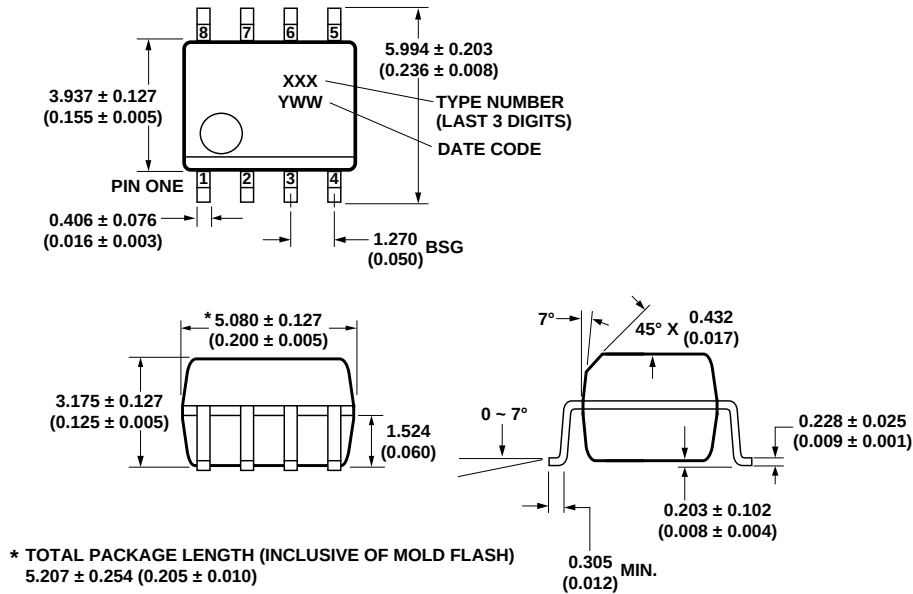
Option data sheets available. Contact Agilent sales representative or authorized distributor for information.

Schematic



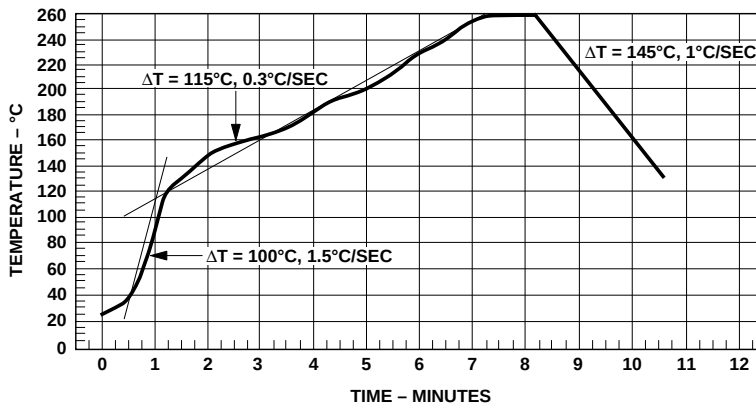
Package Outline Drawings

Surface Mount Small-Outline SOIC-8 Package



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

Solder Reflow Temperature Profile



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

Regulatory Information

The HCPL-0560 has been approved by the following regulatory organizations:

UL

Recognized under UL 1577 component recognition program, File E55361.

CSA

Approved under CSA Component Acceptance Notice No. 5, File CA 88324.

Insulation and Safety Related Specifications

Parameter	Symbol	Value	Units	Conditions
Minimum External Air Gap (Clearance)	L(101)	4.97	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	4.83	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)		0.08	mm	Through insulation distance, conductor to conductor, usually the direct distance between the photoemitter and photo-detector inside the optocoupler cavity.
Tracking Resistance (Comparative Tracking Index)	CTI	200	Volts	DIN IEC 112/VDE 0303 Part 1.
Isolation Group		IIIa		Material Group (DIN VDE 0110, 1/89, Table 1).

Absolute Maximum Ratings

(No Derating Required up to +85°C.)

Parameter	Symbol	Min.	Max.	Units	Note
Storage Temperature	T _S	-55	125	°C	
Operating Temperature	T _A	-55	100	°C	
Average Forward Input Current*	I _{F(AVG)}		25	mA	
Peak Forward Input Current* (50% duty cycle, 1 ms pulse width)	I _{FPK}		50	mA	
Peak Transient Input Current* (< 1 μs pulse width, 300 pps)	I _{F(TRAN)}		1	A	
Reverse Input Voltage*	V _R		5	V	
Output Current*	I _O		16	mA	
Supply Voltage	V _{CC1} , V _{CC2}	-0.5	30	V	
Output Voltage	V _{O1} , V _{O2}	-0.5	20	V	
Input Power Dissipation*	P _I		45	mW	2
Output Power Dissipation*	P _O		35	mW	1
Total Power Dissipation	P _T		160	mW	
Reflow Temperature Profile	See Package Outline Drawing section.				

*Each Channel.

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Power Supply Voltage	V _{CC1} , V _{CC2}	4.5	18	V
Forward Input Current (ON)	I _{F(ON)}	12	16	mA
Forward Input Voltage (OFF)	V _{F(OFF)}	0	0.8	V
Operating Temperature	T _A	0	70	°C

Electrical Specifications

Over recommended temperature ($T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$) unless otherwise specified (see Note 6). All typical values at $T_A = 25^\circ\text{C}$.

Parameter	Sym.	Min.	Typ.	Max.	Units	Test Conditions		Fig.	Note
Current Transfer Ratio	CTR	19 15	24	55	%	$T_A = 25^\circ\text{C}$	$I_F = 16\text{ mA}$ $V_{CC} = 4.5\text{ V}$ $V_O = 0.5\text{ V}$	1,2,4	3,4
Logic Low Output Voltage	V_{OL}		0.1	0.5 0.5	V	$T_A = 25^\circ\text{C}$, $I_O = 3\text{ mA}$ $I_O = 2.4\text{ mA}$	$I_F = 16\text{ mA}$ $V_{CC} = 4.5\text{ V}$	1	3
Logic High Output Current	I_{OH}		0.003	0.5 50	μA	$T_A = 25^\circ\text{C}$, $V_{CC} = 5.5\text{ V}$ $V_{CC} = 15\text{ V}$	$I_F = 0\text{ mA}$ $V_O = \text{Open}$	6	
Logic Low Supply Current	I_{CCL}		100	400	μA	$I_F = 16\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$			
Logic High Supply Current	I_{CCH}		0.05	4	μA	$I_F = 0\text{ mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{ V}$			
Input Forward Voltage	V_F		1.5	1.7 1.8	V	$T_A = 25^\circ\text{C}$	$I_F = 16\text{ mA}$	3	3
Input Reverse Breakdown Voltage	BV_R	5			V	$I_R = 10\text{ }\mu\text{A}$			
Temperature Coefficient of Forward Voltage	$\Delta V_F / \Delta T_A$		-1.6		$\text{mV}/^\circ\text{C}$	$I_F = 16\text{ mA}$			
Input Capacitance	C_{IN}		60		pF	$f = 1\text{ MHz}$, $V_F = 0\text{ V}$			3

Switching Specifications (AC)

Over recommended operating conditions ($T_A = 0$ to $+70^\circ\text{C}$), $V_{CC} = 5\text{ V}$, $I_F = 16\text{ mA}$ unless otherwise specified. All typical values at $T_A = 25^\circ\text{C}$.

Parameter	Sym.	Min.	Typ.	Max.	Units	Test Conditions		Fig.	Note
Propagation Delay Time to Logic Low at Output	t_{PHL}		0.2	0.85 1	μs	$T_A = 25^\circ\text{C}$	$R_L = 1.9\text{ k}\Omega$	5,8, 11,12	5,6
Propagation Delay Time to Logic High at Output	t_{PLH}		0.6	0.85 1	μs	$T_A = 25^\circ\text{C}$	$R_L = 1.9\text{ k}\Omega$		
Common Mode Transient Immunity at Logic High Output	$ CM_H $	1	10		$\text{kV}/\mu\text{s}$	$I_F = 0\text{ mA}$, $T_A = 25^\circ\text{C}$ $R_L = 1.9\text{ k}\Omega$, $V_{CM} = 10\text{ V p-p}$		13,14	5,6,7
Common Mode Transient Immunity at Logic Low Output	$ CM_L $	1	10		$\text{kV}/\mu\text{s}$	$I_F = 16\text{ mA}$, $T_A = 25^\circ\text{C}$ $R_L = 1.9\text{ k}\Omega$, $V_{CM} = 10\text{ V p-p}$			
Bandwidth	BW			3	MHz			9,10	6,8

Package Characteristics

All typical values at $T_A = 25^\circ\text{C}$.

Parameter	Sym.	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Side 1 – Side 2 Momentary Withstand Voltage*	V_{ISO}	2500			Vrms	$RH < 50\%$, $t = 1 \text{ min.}$, $T_A = 25^\circ\text{C}$		9,10
Side 1 – Side 2 Resistance	R_{1-2}			10^{12}	Ω	$RH \leq 45\%$, $t = 5\text{s}$, $V_{\text{I-O}} = 500 \text{ Vdc}$		9
Side 1 – Side 2 Capacitance	C_{1-2}		0.25		pF	$f = 1 \text{ MHz}$		9

* 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 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 90°C free-air temperature at a rate of $3.0 \text{ mW}/^\circ\text{C}$.
- In the V_{CC} common configuration, Input LED current is a function of the V_{CC} supply voltage. See application information section to set the proper drive currents.
- Each channel.
- DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O , to the forward LED input current I_F , times 100%.
- The $1.9 \text{ k}\Omega$ load represents 1 TTL load of 1.6 mA and $5.6 \text{ k}\Omega$ pull-up resistor.
- Use of a $0.1 \mu\text{F}$ bypass capacitor connected between pins 1 and 3, & 5 and 7 adjacent to the device is recommended.
- 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 (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 of the common mode pulse, V_{CM} , to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8 \text{ V}$).
- The frequency at which the ac output voltage of 3 dB below the low frequency asymptote.
- Device considered a two-terminal device. Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage 3000 Vrms for 1 second (leakage detection current limit, $I_{\text{I-O}} < 5 \mu\text{A}$).

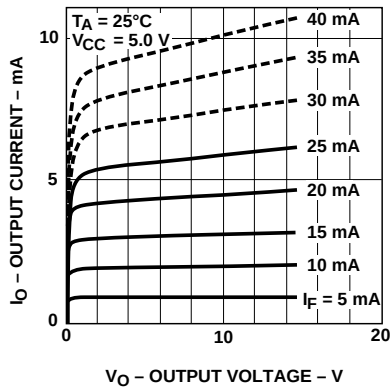


Figure 1. DC and Pulsed Transfer Characteristics.

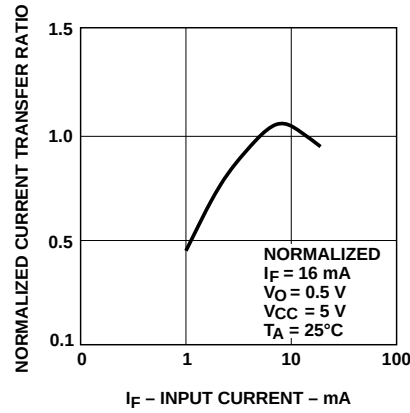


Figure 2. Current Transfer Ratio vs. Input Current.

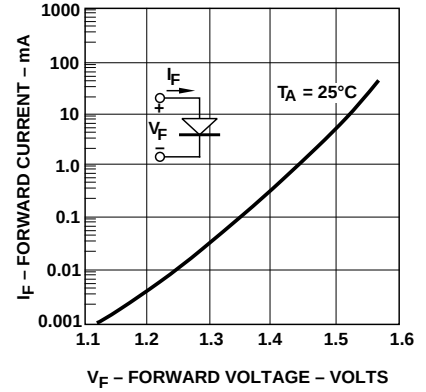


Figure 3. Input Current vs. Forward Voltage.

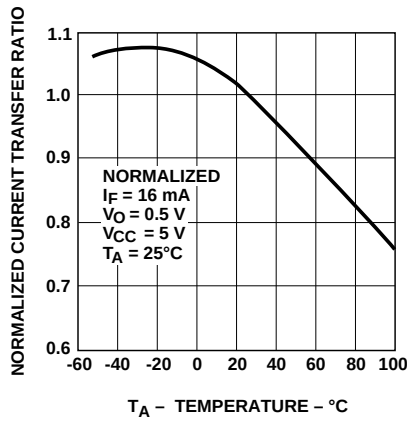


Figure 4. Current Transfer Ratio vs. Temperature.

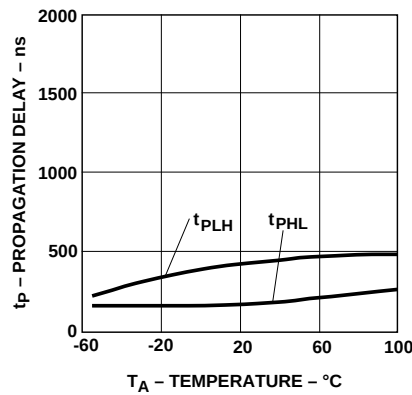


Figure 5. Propagation Delay vs. Temperature.

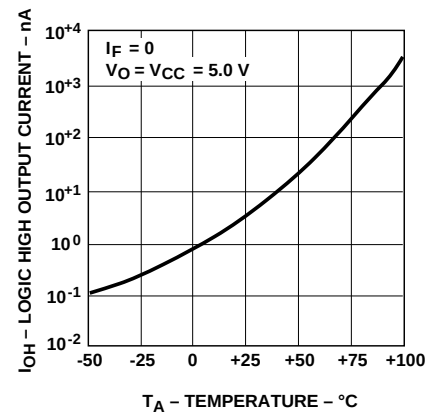


Figure 6. Logic High Output Current vs. Temperature.

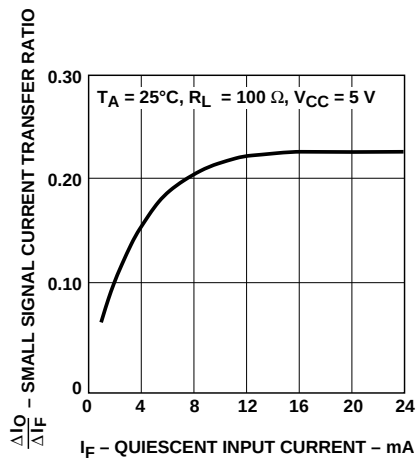


Figure 7. Small-Signal Current Transfer Ratio vs. Quiescent Input Current.

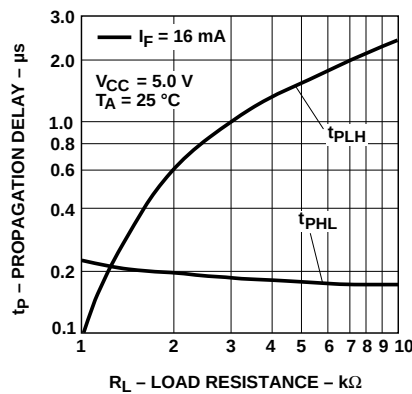


Figure 8. Propagation Delay Time vs. Load Resistance.

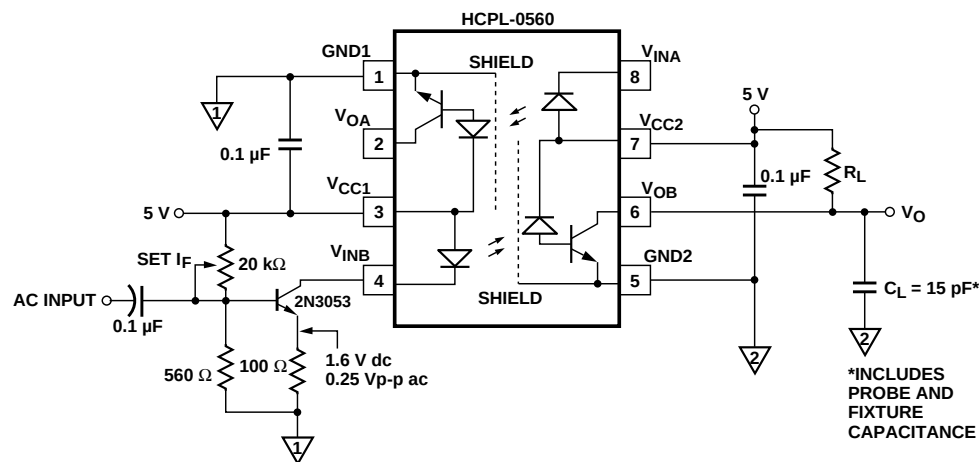
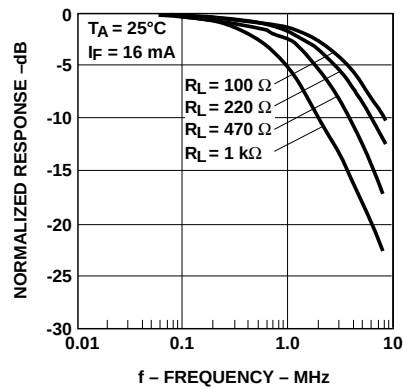


Figure 9. Frequency Response (HCPL-0560).

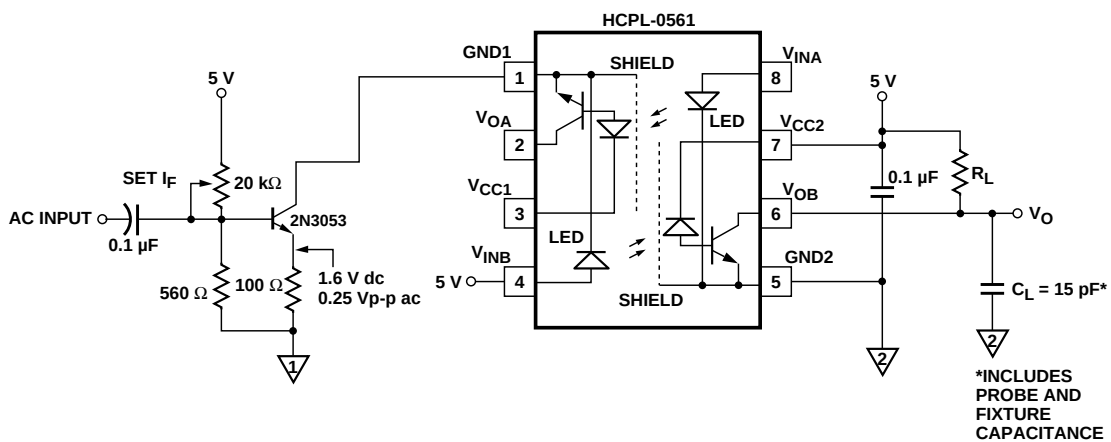


Figure 10. Frequency Response (HCPL-0561).

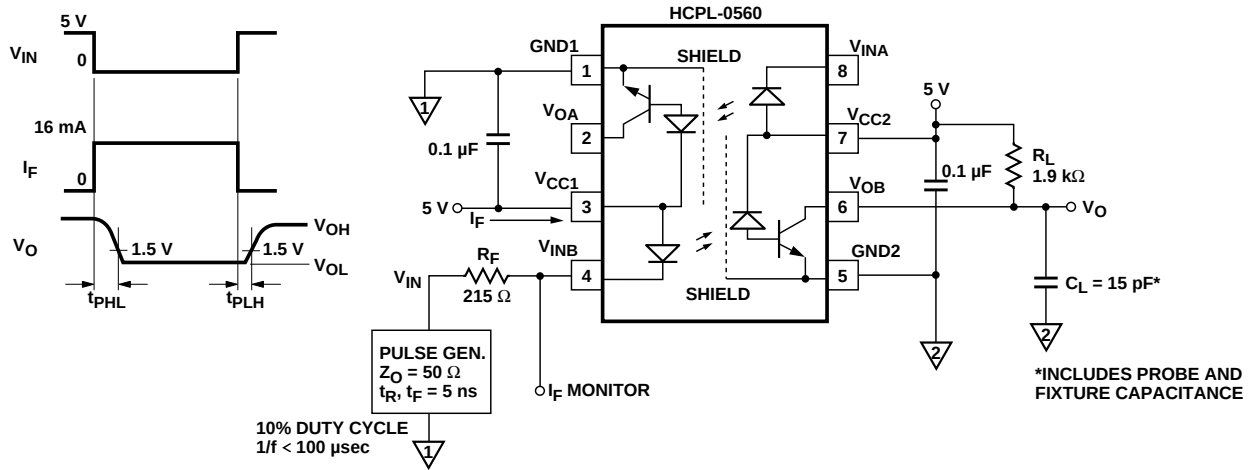


Figure 11. Switching Test Circuit (HCPL-0560).

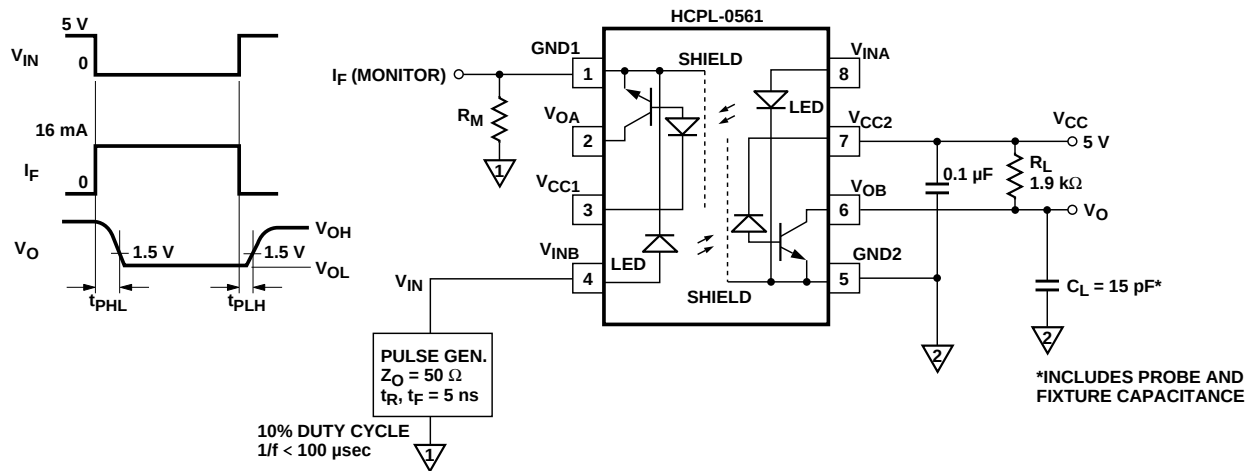


Figure 12. Switching Test Circuit (HCPL-0561).

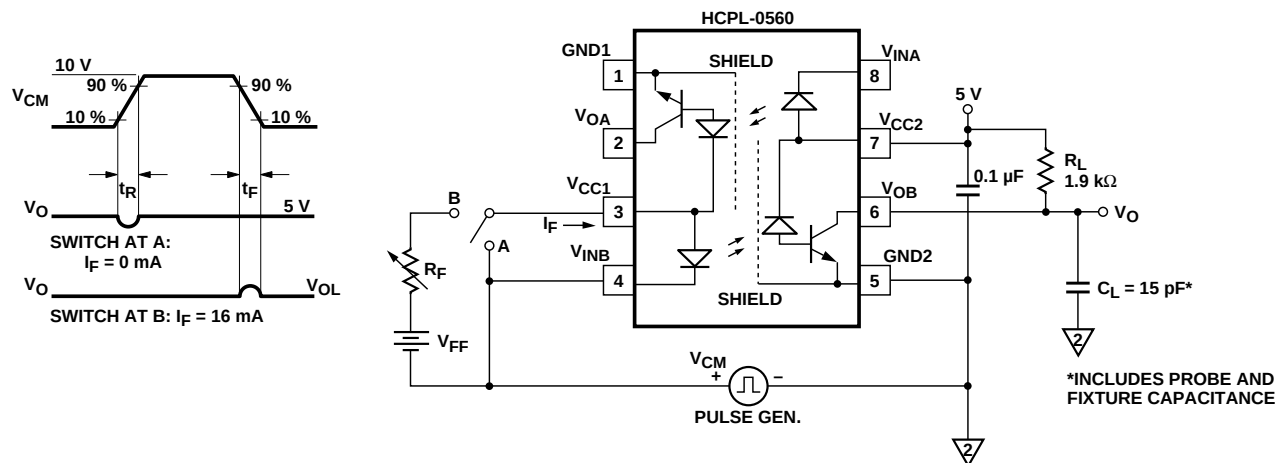


Figure 13. Test Circuit for Transient Immunity and Typical Waveforms (HCPL-0560).

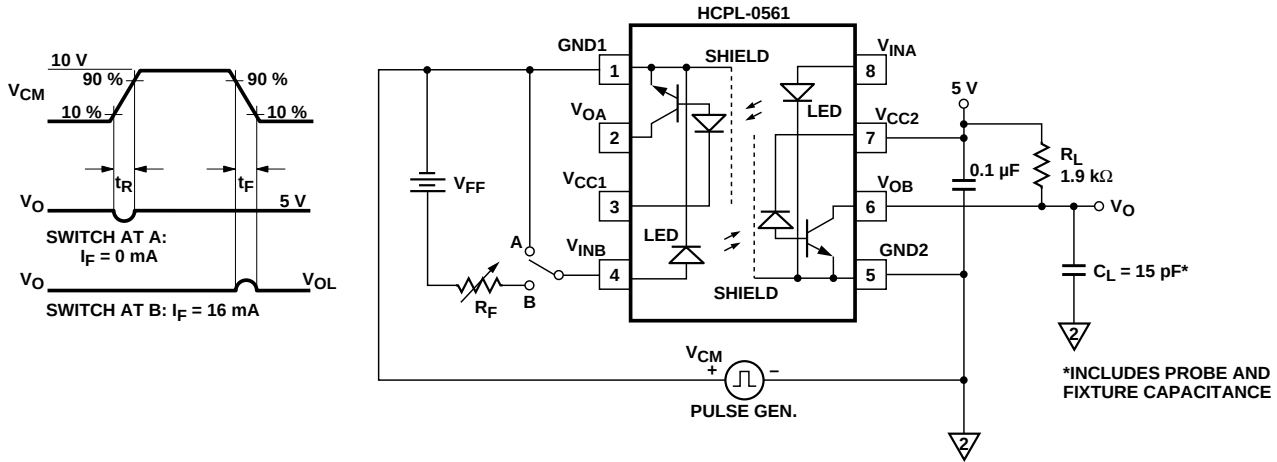


Figure 14. Test Circuit for Transient Immunity and Typical Waveforms (HCPL-0561).

Application Information

The HCPL-0560 (common V_{CC} configuration) and HCPL-0561 (common GND configuration) optoisolators are ideal for use in bi-directional data transmission and communication applications. Each of the two configurations contains two optoisolators each in an industry standard SOIC-8 package. Bi-directional here implies that there are two emitter-detector pairs assembled in opposite direction across the isolation barrier. This allows simultaneous, bi-directional, full duplex data transmission capability within a single optoisolator package.

The HCPL-0560 is internally connected in a “common V_{CC} ” configuration, which means that the LED anode of one channel is

connected to the V_{CC} pin of the second channel on each side of the isolation barrier. The HCPL-0561 is internally connected in a “common GND” configuration, which means that the LED cathode of one channel is connected to the emitter or GND of the second channel on each side of the isolation barrier.

Having a maximum guaranteed speed of 1 Mbd the HCPL-0560 and HCPL-0561 are ideal for applications involving the RS-232-E (TIA/EIA-232) data transmission standard. If these optoisolators are used in RS-232-E applications, it is understood that the optoisolators will be used in conjunction with an appropriate transceiver of the RS-232-E standard.

The common V_{CC} configuration (HCPL-0560) transmits non-inverting signal with respect to the cathode voltage of the LED pins (4,8) in the driver configuration shown Figure 15. When the input signal at the base of the driver transistor (2N3904) is high, the input LED conducts drive current, and allows the output of the optoisolator to be in the low state. Thus, when the cathode voltage is low (LED ON) the output is low, and when the cathode voltage is high (LED OFF) the output will be high. In other words, HCPL-0560 can be considered to transmit non-inverting signal. The common GND configuration (HCPL-0561) transmits inverting signal with respect to the anode voltage of the LED pins (4,8) in the driver configuration shown in Figure 16.

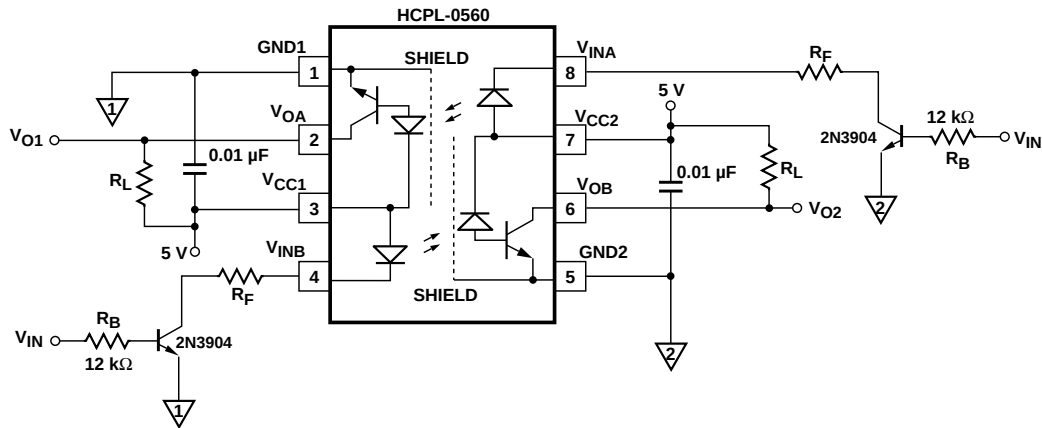


Figure 15. Input Drive Circuit HCPL-0560.

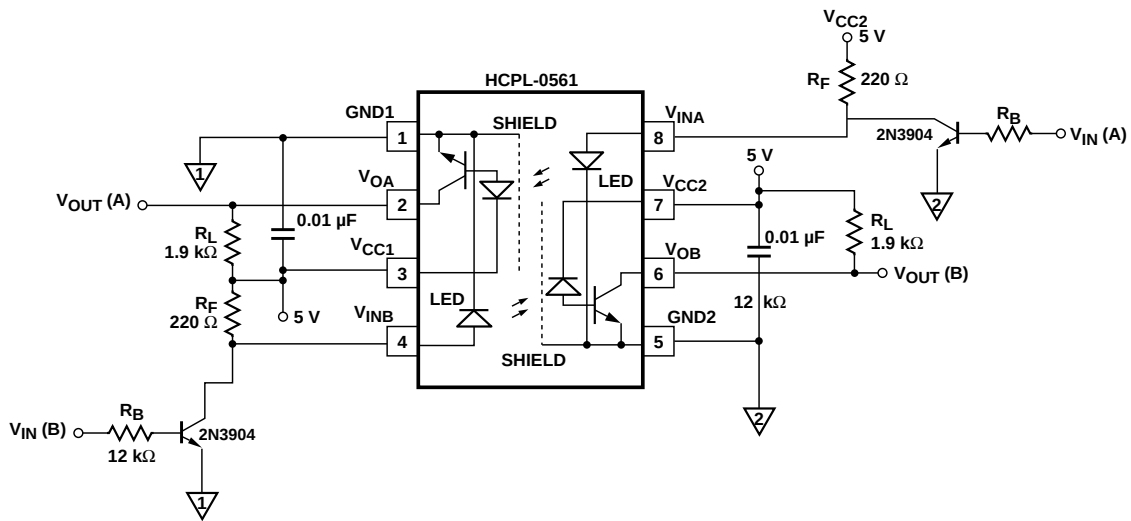


Figure 16. Input Drive Circuit HCPL-0561.

Shown in Figures 15 and 16 is the driver interface circuit using a NPN (2N3904) general-purpose transistor. Since, in a V_{CC} common configuration (HCPL-0560) LED anode for one channel is connected to the V_{CC} pin of the second channel, LED input current now becomes a direct function of the power supply voltage. Thus, care must be taken to use an appropriate current limiting resistor, the value of which will be a function of the common supply voltage.

Table A below lists the recommended R_F (series drive current limiting resistor) and R_L (output pull-up load resistor) for the HCPL-0560 optoisolator. The R_F values chosen will limit the input drive current at the minimum recommended value of 16 mA. The R_L value chosen at each supply voltage will guarantee an output current does not exceed the maximum current consistent with the minimum specified CTR of 15%. Similarly, Table B lists the recommended R_F and R_L for the HCPL-0561 configuration.

Table A. HCPL-0560 Input/Output Current Limiting Resistors

V_{CC1} or V_{CC2}	R_F (Ω)	R_L (Ω)
5	188	1.9
10	500	4.0
15	812	6.0
20	1125	8.2

Table B. HCPL-0561 Input/Output Current Limiting Resistors

V_{CC1} or V_{CC2}	R_F (Ω)	R_L (Ω)
5	218	1.9
10	531	4.0
15	843	6.0
20	1156	8.2

Figure 17 shows an RS-232-E isolated interface using the HCPL-0560. The LED is shown driven with a NPN transistor (2N3904). The input series current limiting resistor R_F (200 Ω) sets the LED current at 16 mA minimum required for the optoisolator. The pull-up resistor R_L (1.9 k Ω) assures that the optoisolator output will saturate and conduct current consistent with the minimum CTR of 15%. The output of the optoisolator is shown to interface directly with DS14C232 (transceiver for RS-232-E) driver input. The output of the transceiver is shown to drive the input of NPN Transistor (2N3904). This NPN transistor is configured to drive the LED of the optoisolator.

Similarly Figure 18 shows an RS-232-E isolated interface using the HCPL-0561. Again, NPN transistor 2N3904 is used to drive the LED of the optoisolator. And the output of the optoisolator is directly connected to the driver input of the transceiver (DC14C232).

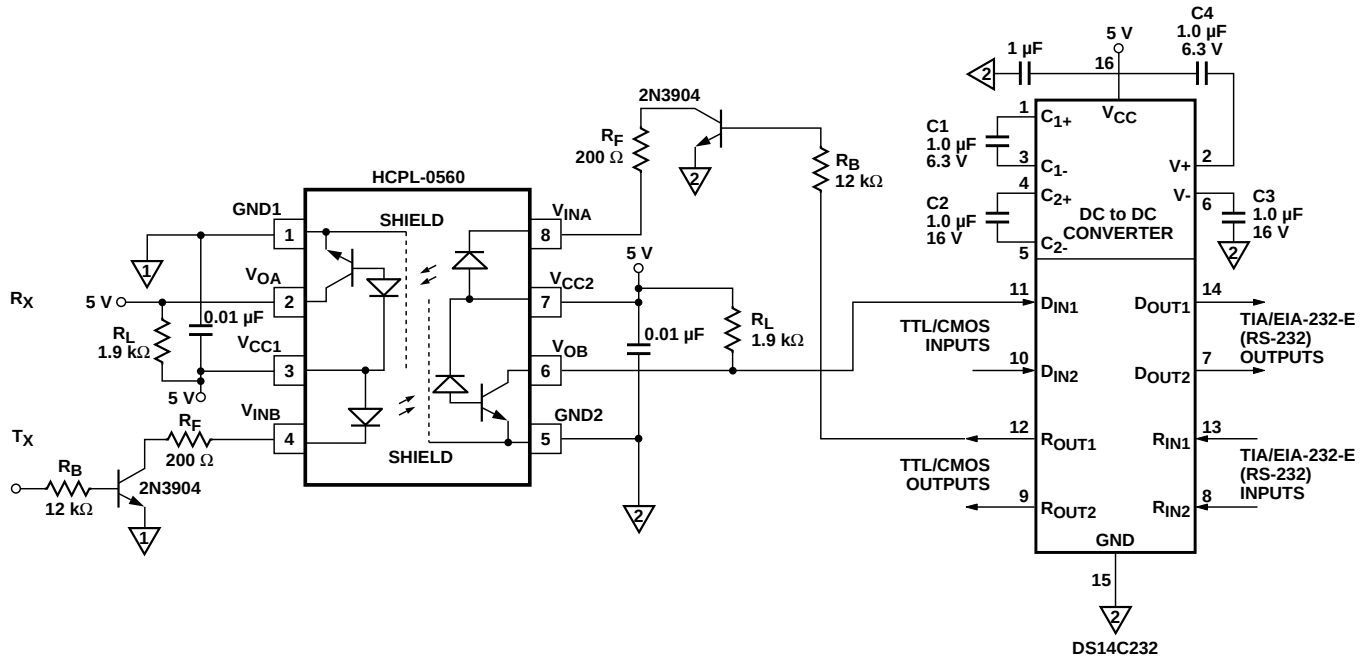


Figure 17. Isolated Full Duplex RS-232-E Communication Interface with Bi-directional Optoisolator (HCPL-0560).

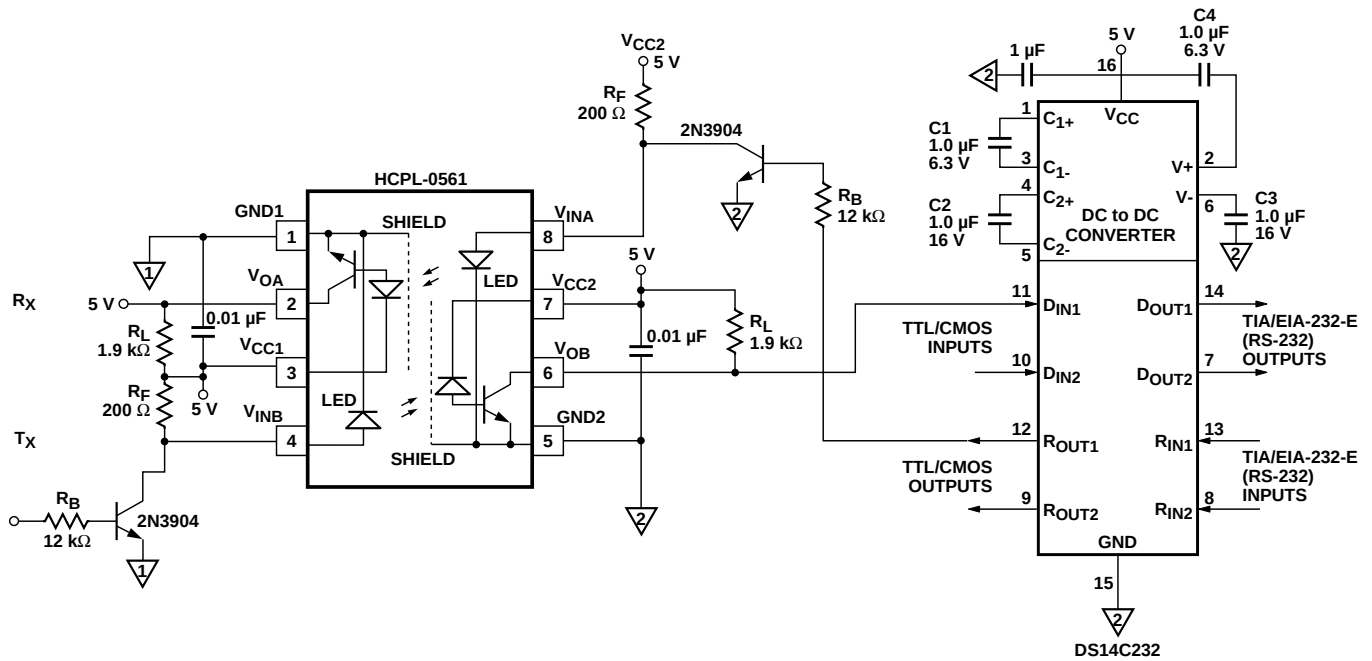
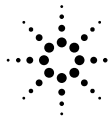


Figure 18. Isolated Full Duplex RS-232-E Communication interface with Bi-directional Optoisolator (HCPL-0561).



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