HEWLETT® PACKARD

Hermetically Sealed, Transistor Output Optocouplers for Analog and Digital Applications

Technical Data

4N55*
5962-87679 HCPL-655X
HCPL-553X 5962-90854
HCPL-653X HCPL-550X

*See matrix for available extensions.

Features

- **Dual Marked with Device Part Number and DESC Drawing Number**
- **Manufactured and Tested on a MIL-PRF-38534 Certified Line**
- **QML-38534, Class H and K**
- **Five Hermetically Sealed Package Configurations**
- **Performance Guaranteed, Over -55°C to +125°C**
- **High Speed: Typically 400 kBit/s**
- **9 MHz Bandwidth**
- **Open Collector Output**
- **2-18 Volt V_{CC} Range**
- **1500 Vdc Withstand Test Voltage**
- **High Radiation Immunity**
- **6N135, 6N136, HCPL-2530/ -2531, Function Compatibility**
- **Reliability Data**

Applications

- **Military and Space**
- **High Reliability Systems**
- **Vehicle Command, Control, Life Critical Systems**
- **Line Receivers**
- **Switching Power Supply**
- **Voltage Level Shifting**
- **Analog Signal Ground Isolation (see Figures 7, 8, and 13)**
- **Isolated Input Line Receiver**
- **Isolated Output Line Driver**
- **Logic Ground Isolation**
- **Harsh Industrial Environments**
- **Isolation for Test Equipment Systems**

Description

These units are single, dual and quad channel, hermetically sealed optocouplers. The products are capable of operation and storage over the full military temperature range and can be purchased as either standard product or with full MIL-PRF-38534 Class Level H or K testing or from the appropriate DESC Drawing. All devices are manufactured and tested on a MIL-PRF-38534 certified line and are included in the DESC Qualified Manufacturers List QML-38534 for Hybrid Microcircuits.

Each channel contains a GaAsP light emitting diode which is optically coupled to an integrated photon detector. Separate connections for the photodiodes and output transistor collectors improve the speed up to a hundred times that of a conventional phototransistor optocoupler by reducing the base-collector capacitance.

These devices are suitable for wide bandwidth analog applications, as well as for interfacing TTL to LSTTL or CMOS. Current Transfer Ratio (CTR) is 9% minimum at I_F = 16 mA. The 18 V V_{CC}

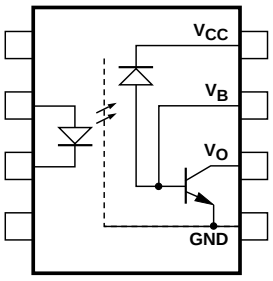
Truth Table

(Positive Logic)

Input	Output
On (H)	L
Off (L)	H

Functional Diagram

Multiple Channel Devices Available



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.

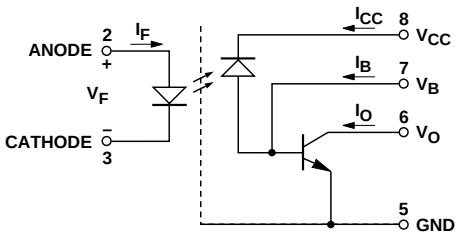
capability will enable the designer to interface any TTL family to CMOS. The availability of the base lead allows optimized gain/bandwidth adjustment in analog applications. The shallow depth of the IC photodiode provides better radiation immunity than conventional phototransistor couplers.

These products are also available with the transistor base node connected to improve common mode noise immunity and ESD susceptibility. In addition, higher CTR minimums are available by special request.

Package styles for these parts are 8 and 16 pin DIP through hole (case outlines P and E respectively), 16 pin DIP flat pack (case outline F), and leadless ceramic chip carrier (case outline 2). Devices may be purchased with a variety of lead bend and plating options, see Selection Guide Table for details. Standard Military Drawing (SMD) parts are available for each package and lead style.

Because the same functional die (emitters and detectors) are used for each channel of each device listed in this data sheet, absolute maximum ratings, recommended operating conditions, electrical specifications, and performance characteristics shown in the figures are identical for all parts. Occasional exceptions exist due to package variations and limitations and are as noted. Additionally, the same package assembly processes and materials are used in all devices. These similarities give justification for the use of data obtained from one part to represent other part's performance for die related reliability and certain limited radiation test results.

8 Pin Ceramic DIP Single Channel Schematic



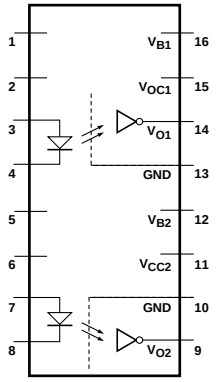
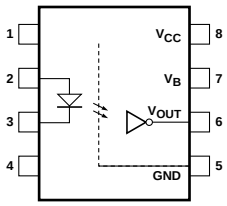
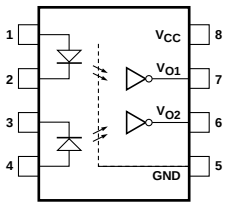
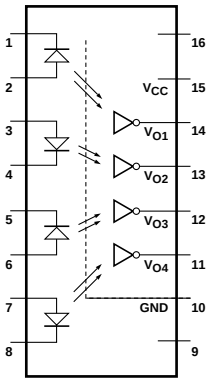
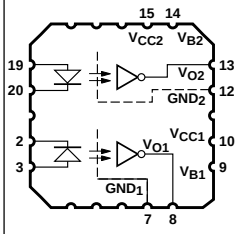
Note base pin 7.

Selection Guide–Package Styles and Lead Configuration Options

Package	16 Pin DIP	8 Pin DIP	8 Pin DIP	16 Pin Flat Pack	20 Pad LCCC
Lead Style	Through Hole	Through Hole	Through Hole	Unformed Leads	Surface Mount
Channels	2	1	2	4	2
Common Channel Wiring	None	None	V_{CC} GND	V_{CC} GND	None
HP Part # & Options					
Commercial	4N55*	HCPL-5500	HCPL-5530	HCPL-6550	HCPL-6530
MIL-PRF-38534, Class H	4N55/883B	HCPL-5501	HCPL-5531	HCPL-6551	HCPL-6531
MIL-PRF-38534, Class K	HCPL-257K	HCPL-550K	HCPL-553K	HCPL-655K	HCPL-653K
Standard Lead Finish	Gold Plate	Gold Plate	Gold Plate	Gold Plate	Solder Pads
Solder Dipped	Option #200	Option #200	Option #200		
Butt Cut/Gold Plate	Option #100	Option #100	Option #100		
Gull Wing/Soldered	Option #300	Option #300	Option #300		
SMD Part #					
Prescript for all below	5962-	5962-	5962-	5962-	5962-
Either Gold or Solder	8767901EX	9085401HPX	8767902PX	8767904FX	87679032X
Gold Plate	8767901EC	9085401HPC	8767902PC	8767904FC	
Solder Dipped	8767901EA	9085401HPA	8767902PA		87679032A
Butt Cut/Gold Plate	8767901UC	9085401HYC	8767902YC		
Butt Cut/Soldered	8767901UA	9085401HYA	8767902YA		
Gull Wing/Soldered	8767901TA	9085401HXA	8767902XA		

*JEDEC registered part.

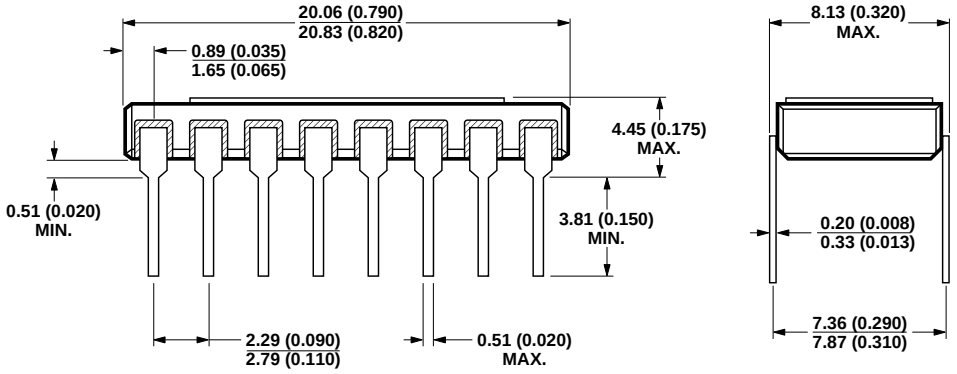
Functional Diagrams

16 Pin DIP	8 Pin DIP	8 Pin DIP	16 Pin Flat Pack	20 Pad LCCC
Through Hole	Through Hole	Through Hole	Unformed Leads	Surface Mount
2 Channels	1 Channel	2 Channels	4 Channels	2 Channels
				

Note: 8 pin DIP and flat pack devices have common V_{CC} and ground. 16 pin DIP and LCCC (leadless ceramic chip carrier) packages have isolated channels with separate V_{CC} and ground connections.

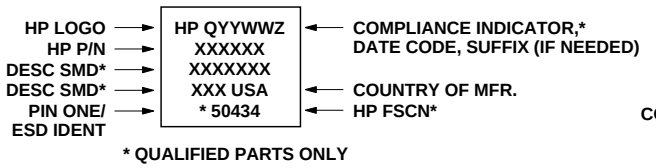
Outline Drawings

16 Pin DIP Through Hole, 2 Channels



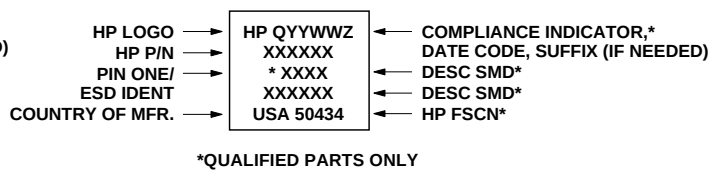
NOTE: DIMENSIONS IN MILLIMETERS (INCHES).

Leaded Device Marking



* QUALIFIED PARTS ONLY

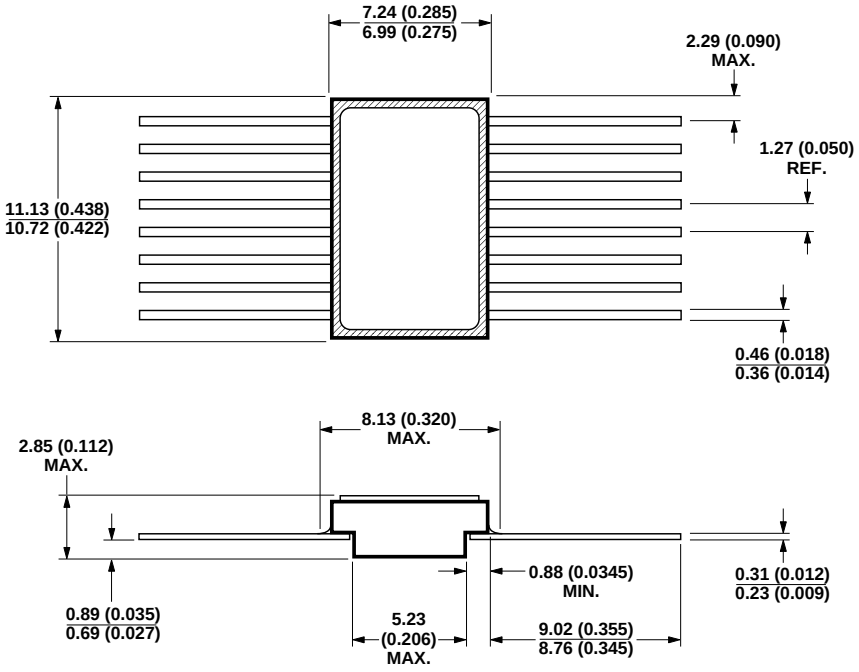
Leadless Device Marking



*QUALIFIED PARTS ONLY

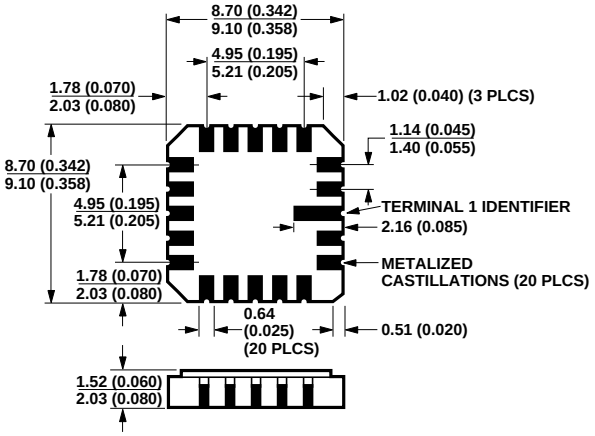
Outline Drawings (contd.)

16 Pin Flat Pack, 4 Channels



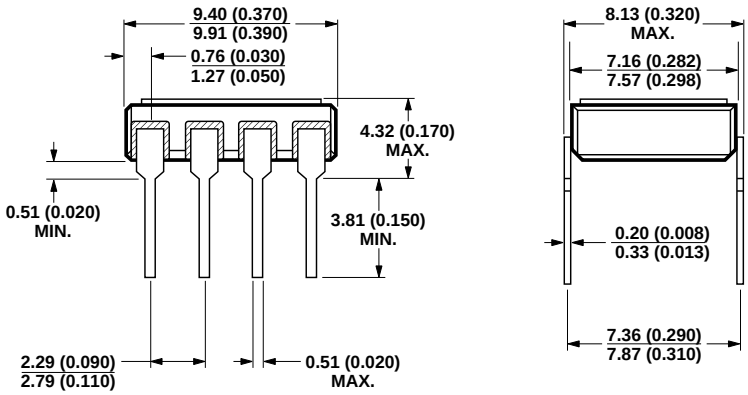
NOTE: DIMENSIONS IN MILLIMETERS (INCHES).

20 Terminal LCCC Surface Mount, 2 Channels



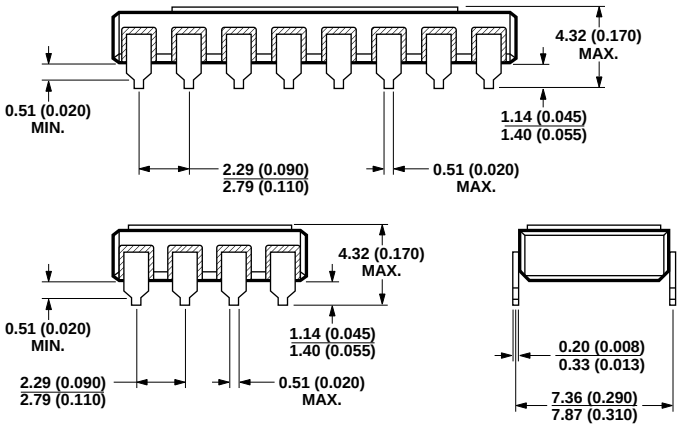
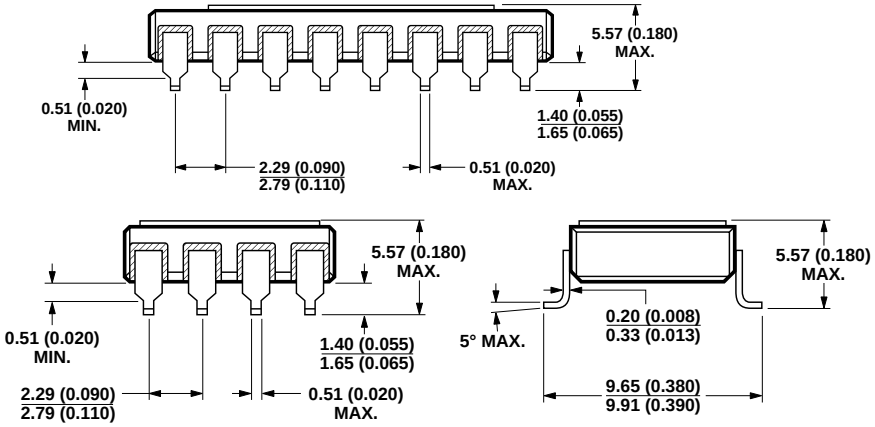
NOTE: DIMENSIONS IN MILLIMETERS (INCHES).
SOLDER THICKNESS 0.127 (0.005) MAX.

8 Pin DIP Through Hole, 1 and 2 Channel



NOTE: DIMENSIONS IN MILLIMETERS (INCHES).

Hermetic Optocoupler Options

Option	Description
100	Surface mountable hermetic optocoupler with leads trimmed for butt joint assembly. This option is available on commercial and hi-rel product in 8 and 16 pin DIP (see drawings below for details).  NOTE: DIMENSIONS IN MILLIMETERS (INCHES).
200	Lead finish is solder dipped rather than gold plated. This option is available on commercial and hi-rel product in 8 and 16 pin DIP. DESC drawing part numbers contain provisions for lead finish. All leadless chip carrier devices are delivered with solder dipped terminals as a standard feature.
300	Surface mountable hermetic optocoupler with leads cut and bent for gull wing assembly. This option is available on commercial and hi-rel product in 8 and 16 pin DIP (see drawings below for details). This option has solder dipped leads.  NOTE: DIMENSIONS IN MILLIMETERS (INCHES).

Absolute Maximum Ratings

(No derating required up to +125°C)
Storage Temperature Range, T_S ..... -65°C to +150°C
Operating Temperature, T_A ..... -55°C to +125°C
Case Temperature, T_C ..... +170°C
Junction Temperature, T_J ..... +175°C
Lead Solder Temperature ..... 260°C for 10 s
Peak Forward Input Current, (each channel,
≤ 1 ms duration), $I_{F\,PK}$ ..... 40 mA
Average Input Forward Current, $I_{F\,AVG}$ (each channel) ..... 20 mA
Reverse Input Voltage, BV_R ..... See Electrical Characteristics
Average Output Current, I_O (each channel) ..... 8 mA
Peak Output Current, I_O (each channel) ..... 16 mA
Supply Voltage, V_{CC} ..... -0.5 V to 20 V
Output Voltage, V_O (each channel) ..... -0.5 V to 20 V
Input Power Dissipation (each channel) ..... 36 mW
Output Power Dissipation (each channel) ..... 50 mW
Package Power Dissipation, P_D (each channel) ..... 200 mW

Single Channel 8 Pin, Dual Channel 16 Pin, and LCCC Only

Emitter Base Reverse Voltage, V_{EBO} ..... 3.0 V
Base Current, I_B (each channel) ..... 5 mA

ESD Classification

(MIL-STD-883, Method 3015)
4N55, 4N55/883B, HCPL-5500/01, and
HCPL-6530/31 ..... (Δ), Class 1
HCPL-5530/31, HCPL-6550/51 ..... (Dot), Class 3

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Input Current, Low Level	I_{FL}		250	µA
Input Current, High Level	I_{FH}	12	20	mA
Supply Voltage, Output	V_{CC}	2	18	V

Electrical Characteristics (T_A = -55°C to +125°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Group A[12] Sub-groups	Limits			Units	Fig.	Note
					Min.	Typ.**	Max.			
Current Transfer Ration		CTR*	V_O = 0.4 V, I_F = 16 mA, V_{CC} = 4.5 V	1, 2, 3	9	20		%	2, 3	1, 2, 10
Logic High Output Current		I_{OH}	I_F = 0, $I_{F\ (other\ channels)}$ = 20 mA, V_O = V_{CC} = 18 V	1, 2, 3		5	100	µA	4	1
Output Leakage Current		I_{OLeak}*	I_F = 250 µA, $I_{F\ (other\ channels)}$ = 20 mA, V_O = V_{CC} = 18 V	1, 2, 3		30	250	µA	4	1
Input-Output Insulation Leakage Current		I_{I-O}*	V_{I-O} = 1500 Vdc, RH = 45% T_A = 25°C, t = 5 s	1			1.0	µA		3, 9
Input Forward Voltage		V_F*	I_F = 20 mA	1, 2, 3		1.55	1.8	V	1	1, 14
							1.9			1, 13
Reverse Breakdown Voltage		BV_R*	I_R = 10 µA	1, 2, 3	5			V		1, 14
					3					1, 13
Logic High Supply Current	Single Channel	I_{CCH}*	V_{CC} = 18 V, I_F = 0 mA	1, 2, 3		0.1	10	µA		1
	Dual Channel		V_{CC} = 18 V, I_F = 0 mA (all channels)			0.2	20			1, 4
	Quad Channel		V_{CC} = 18 V, I_F = 0 mA (all channels)			0.4	40			1
Logic Low Supply Current	Single Channel	I_{CCL}*	V_{CC} = 18 V, I_F = 20 mA	1, 2, 3		35	200	µA	5	1
	Dual Channel		V_{CC} = 18 V, I_{F1} = I_{F2} = 20 mA			70	400			1, 4
	Quad Channel		V_{CC} = 18 V, I_{F1} = I_{F2} = I_{F3} = I_{F4} = 20 mA			140	800			1
Propagation Delay Time to Logic High at Output		t_{PLH}*	R_L = 8.2 kΩ, C_L = 50 pF, I_F = 16 mA, V_{CC} = 5 V	9, 10, 11		1.0	6.0	µs	6, 9	1, 6
Propagation Delay Time to Logic Low at Output		t_{PHL}*				0.4	2.0			

*For JEDEC registered parts.
**All typical values are at V_{CC} = 5 V, T_A = 25°C.

Typical Characteristics, T_A = 25°C, V_{CC} = 5 V

Parameter	Symbol	Typ.	Units	Test Conditions	Fig.	Note
Input Capacitance	C_{IN}	60	pF	V_F = 0 V, f = 1 MHz		1
Input Diode Temperature Coefficient	$\frac{\Delta V_F}{\Delta T_A}$	-1.5	mV/°C	I_F = 20 mA		1
Resistance (Input-Output)	R_{I-O}	10^{12}	Ω	V_{I-O} 500 V		3
Capacitance (Input-Output)	C_{I-O}	1.0	pF	f = 1 MHz		1, 11
Transistor DC Current Gain	h_{FE}	250	-	V_O = 5 V, I_O = 3 mA		1
Small Signal Current Transfer Ratio	$\frac{\Delta I_O}{\Delta I_F}$	21	%	V_{CC} = 5 V, V_O = 2 V	7	1
Common Mode Transient Immunity at Logic High Level Output	$\lvert CM_H \rvert$	1000	V/µs	I_F = 0 mA, R_L = 8.2 kΩ, V_O (min) = 2.0 V V_{CM} = 10 V_{P-P}	10	1, 7
Common Mode Transient Immunity at Logic Low Level Output	$\lvert CM_L \rvert$	-1000	V/µs	I_F = 16 mA, R_L = 8.2 kΩ, V_O (max) = 0.8 V V_{CM} = 10 V_{P-P}	10	1, 7
Bandwidth	BW	9	MHz		8	8

Multi-Channel Product Only

Input-Input Insulation Leakage Current	I_{I-I}	1	pA	Relative Humidity = 45% V_{I-I} = 500 V, t = 5 s		5, 9
Resistance (Input-Input)	R_{I-I}	10^{12}	Ω	V_{I-I} = 500 V		5
Capacitance (Input-Input)	C_{I-I}	0.8	pF	f = 1 MHz		5

Notes:

1. Each channel of a multi-channel device.
2. Current Transfer Ratio is defined as the ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%. CTR is known to degrade slightly over the unit's lifetime as a function of input current, temperature, signal duty cycle, and system on time. Refer to Application Note 1002 for more detail. ln short, it is recommended that designers allow at least 20-25% guardband for CTR degradation.
3. All devices are considered two-terminal devices; measured between all input leads or terminals shorted together and all output leads or terminals shorted together.
4. The 4N55, 4N55/883B, HCPL-6530 and HCPL-6531 dual channel parts function as two independent single channel units. Use the single channel parameter limits. I_F = 0 mA for channel under test and I_F = 20 mA for other channels.
5. Measured between adjacent input pairs shorted together for each multichannel device.
6. t_{PHL} propagation delay is measured from the 50% point on the leading edge of the input pulse to the 1.5 V point on the leading edge of the output pulse. The t_{PLH} propagation delay is measured from the 50% point on the trailing edge of the input pulse to the 1.5 V point on the trailing edge of the output pulse.
7. CM_L is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic low state (V_O < 0.8 V). CM_H is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic high state (V_O > 2.0 V).
8. Bandwidth is the frequency at which the ac output voltage is 3 dB below the low frequency asymptote. For the HCPL-5530 the typical bandwidth is 2 MHz.
9. This is a momentary withstand test, not an operating condition.
10. Higher CTR minimums are available to support special applications.
11. Measured between each input pair shorted together and all output connections for that channel shorted together.
12. Standard parts receive 100% testing at 25°C (Subgroups 1 and 9). SMD and 883B parts receive 100% testing at 25, 125, and -55°C (Subgroups 1 and 9, 2 and 10, 3 and 11, respectively).
13. Not required for 4N55, 4N55/883B and 5962-8767901 types.
14. Required for 4N55, 4N55/883B and 5962-8767901 types only.

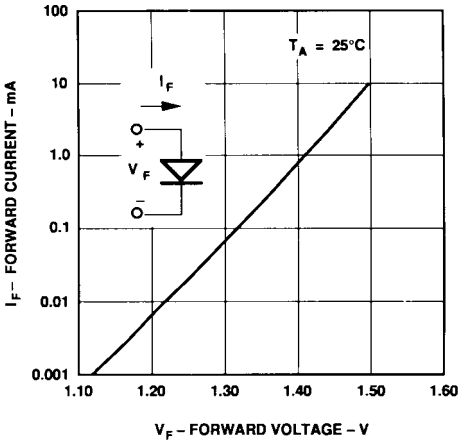


Figure 1. Input Diode Forward Current vs. Forward Voltage.

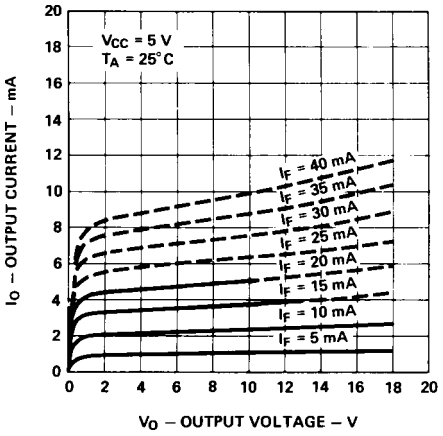


Figure 2. DC and Pulsed Transfer Characteristic.

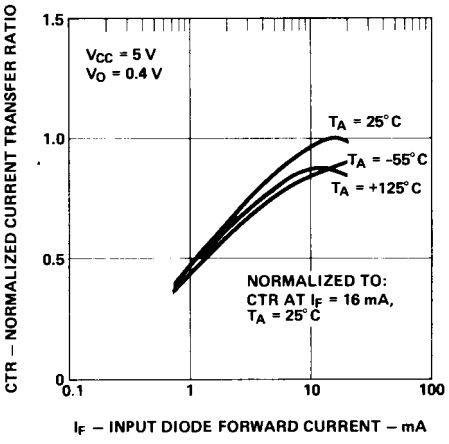


Figure 3. Normalized Current Transfer Ratio vs. Input Diode Forward Current.

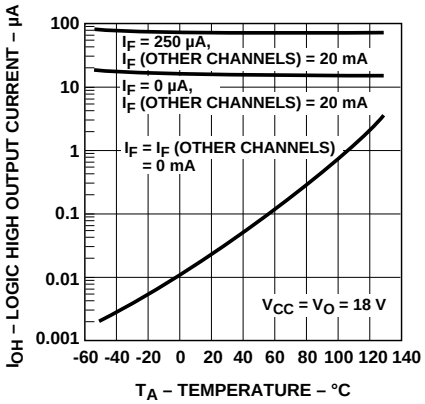


Figure 4. Logic High Output Current vs. Temperature.

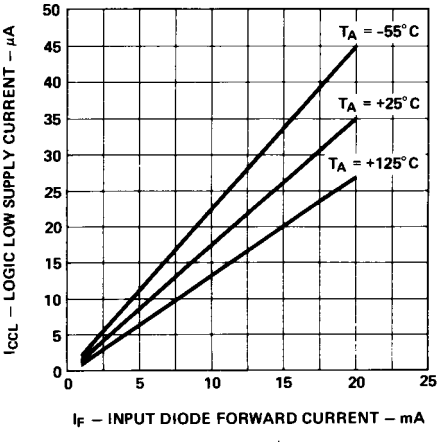


Figure 5. Logic Low Supply Current vs. Input Diode Forward Current.

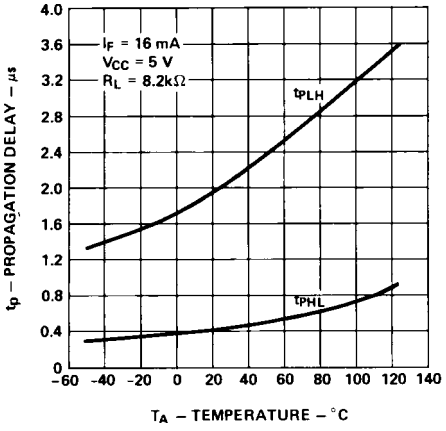


Figure 6. Propagation Delay vs. Temperature.

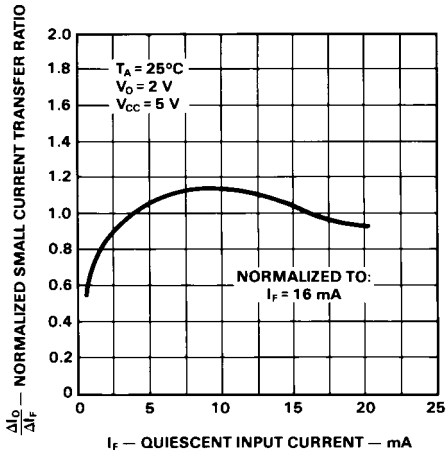
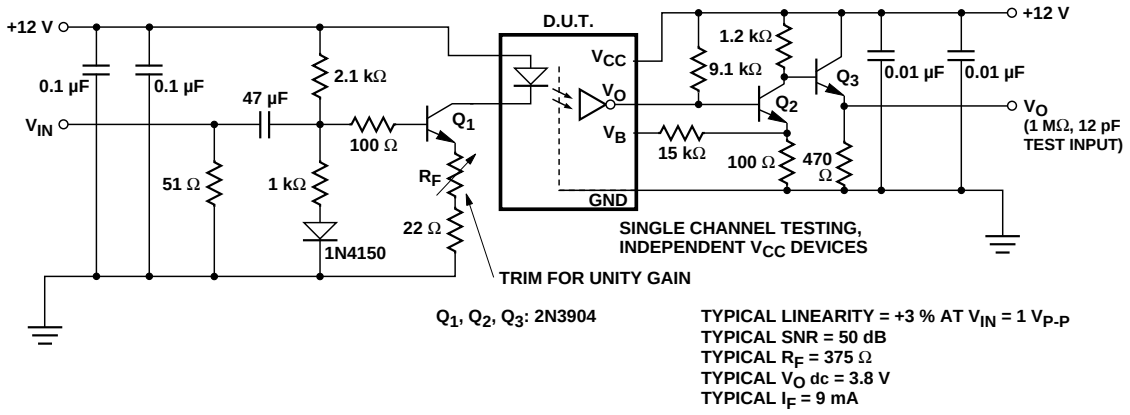


Figure 7. Normalized Small Signal Current Transfer Ratio vs. Quiescent Input Current.



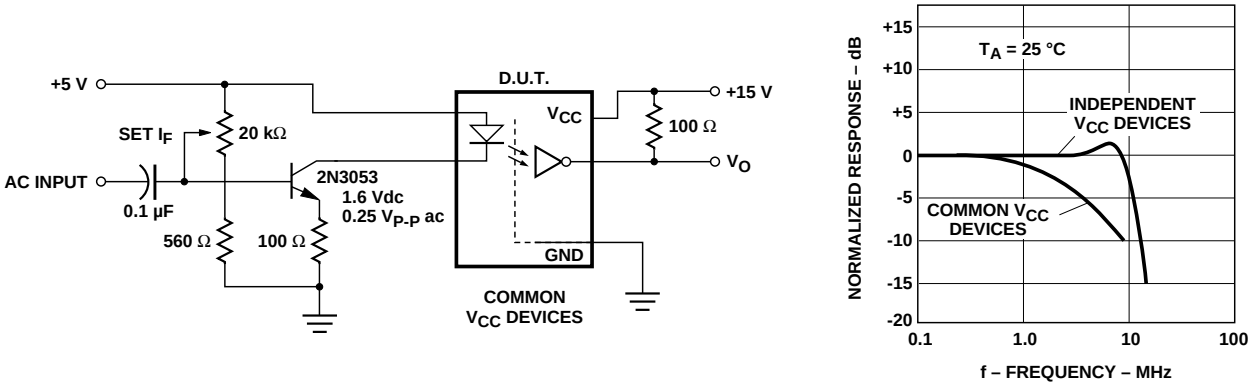
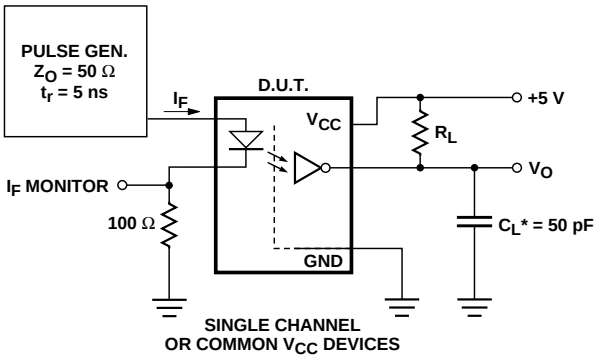
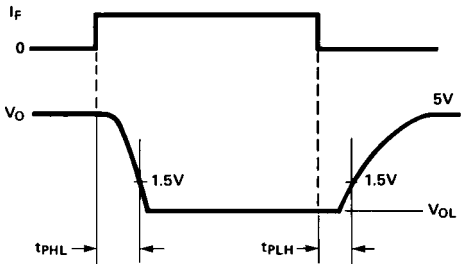


Figure 8. Frequency Response.





10 % DUTY CYCLE
1/f < 100 µs

NOTES:
* C_L INCLUDES PROBE AND STRAY WIRING CAPACITANCE.
BASE LEAD NOT CONNECTED.

Figure 9. Switching Test Circuit.*

***JEDEC Registered Data.**

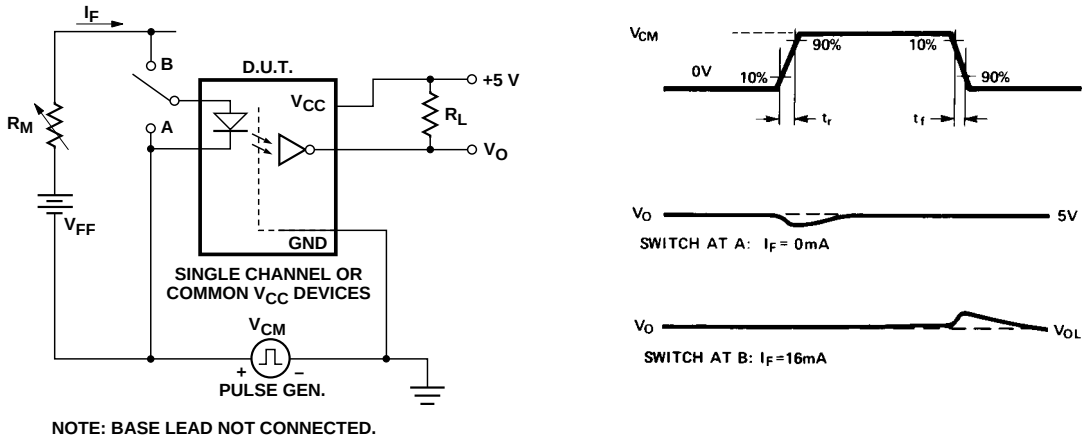
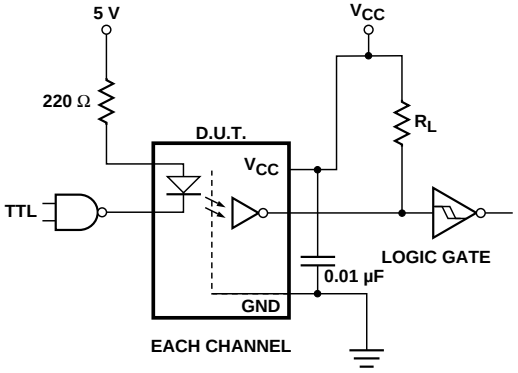


Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.



Logic Family	LSTTL	CMOS	
Device No.	54LS14	CD40106BM	
V_{CC}	5 V	5 V	15 V
R_L 5% Tolerance	18 kΩ*	8.2 kΩ	22 kΩ

*The equivalent output load resistance is affected by the LSTTL input current and is approximately 8.2 kΩ.

This is a worst case design which takes into account 25% degradation of CTR. See App. Note 1002 to assess actual degradation and lifetime.

Figure 11. Recommended Logic Interface.

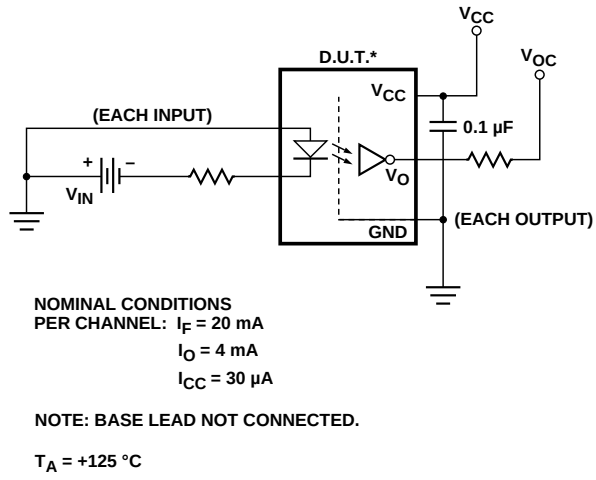


Figure 12. Operating Circuit for Burn-In and Steady State Life Tests. All Channels Tested Simultaneously.

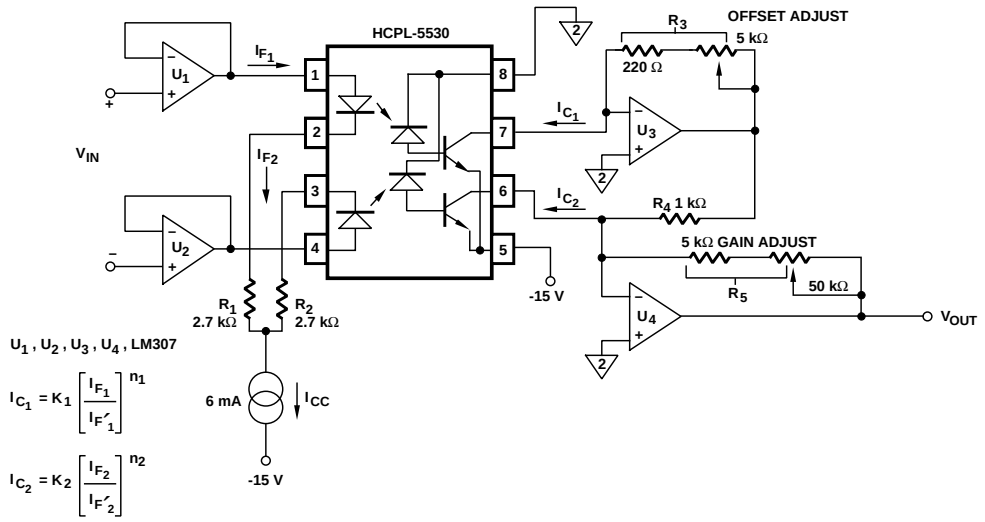


Figure 13. Isolation Amplifier Application Circuit.

Description

The schematic uses a dual-channel, high-speed optocoupler (HCPL-5530) to function as a servo type dc isolation amplifier. This circuit operates on the principle that two optocouplers will track each other if their gain changes by the same amount over a specific operating region.

Performance of Circuit

- 1% linearity for 10 V peak-to-peak dynamic range
- Gain drift: -0.03%/°C
- Offset Drift: ± 1 mV/°C
- 25 kHz bandwidth (limited by Op-Amps U1, U2)

MIL-PRF-38534 Class H, Class K, and DESC SMD Test Program

Hewlett-Packard's Hi-Rel Optocouplers are in compliance with MIL-PRF-38534 Classes H and K. Class H devices are also in compliance with DESC drawings 5962-87679, and 5962-90854.

Testing consists of 100% screening and quality conformance inspection to MIL-PRF-38534.