HEWLETT® PACKARD

Wide Body, High Bandwidth, Analog/Video Optocoupler

Technical Data

CNW4562

Features

- **5000 V_{rms}/1 Minute Insulation Withstand Capability**
- **Worldwide Safety Approval**
  UL1577 (File No. E55361)
  VDE 0884 Certification (V_{IORM} = 1 kV_{RMS})
  VDE 860/805/806/804/750-1/ IEC 950
  BSI According to BS 415/ 7002/6301
  SETI-SEMKO-NEMKO-DEMKO-According to IEC 65/380/950/335
- **Wide Bandwidth: 9 MHz[1]**
- **High Voltage Gain: 3[1]**
- **Low Temperature Coefficient (G_V): –0.3% Per °C[1]**
- **Highly Linear at Low Drive Currents**
- **Function Compatible with HCPL-4562**

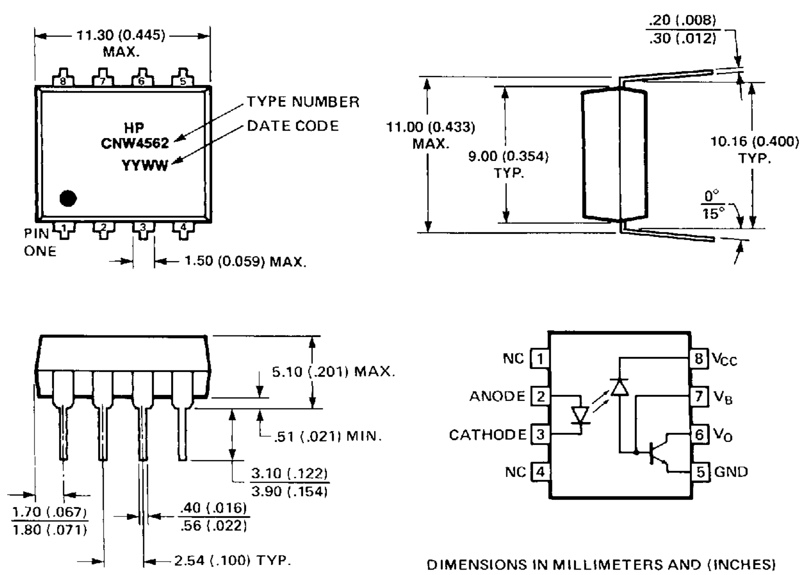
Applications

- **Video Signal Isolation for the Following Standards/ Formats: NTSC, PAL, SECAM, S-VHS, ANALOG RGB.**
- **Low-Drive-Current Feedback Element in Switching Power Supplies, e.g. for ISDN Networks**
- **A/D Converter Signal Isolation**
- **Analog Signal Ground Isolation**
- **High Voltage Insulation**

Description

The CNW4562 is a wide body optocoupler that provides wide-bandwidth isolation for analog signals. It is ideal for video isolation when combined with its application circuit (Figure 4). The wide body encapsulation provides creepage and clearance dimensions suitable for safety approval by regulatory agencies worldwide.

Package Outline



DIMENSIONS IN MILLIMETERS AND (INCHES)

Regulatory Information

The CNW4562 features a wide body eight pin DIP. This package was specifically designed to meet worldwide regulatory requirements. The CNW4562 has been approved by the following organizations:

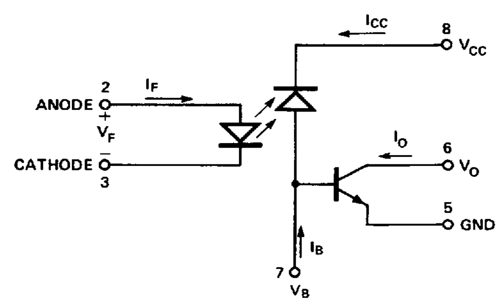
UL	Covered under UL component recognition FILE E55361
VDE	Approved according to VDE 0884/08.87 (marks License No. 70975) Complied for reinforced insulation at 250 Vac with: DIN IEC 380/VDE 0806 DIN IEC 435/VDE 0805 "ENTWURF" DW 57804/DIN VDE 0804 (isolation group C) DIN VDE 0860 (HD 195 S6) DIN IEC 601 Teil 1/VDE 0750-1 DIN VDE 0160 EN 60950/IEC 950
NORDIC	Tested for applications (reinforced insulation) - Class II applications for plugable apparatus in normal tight execution. SETI-SEMKO-NEMKO-DEMKO-According to IEC65-IEC380-IEC950-IEC335.
BSI	Certification according to BS415:1990, BS7002:1989 & BS6301:1982 for class II applications.

*Refer to the front of the optocoupler section of the 1991/1992 Optoelectronics Designer's Catalog, under Product Safety Regulations section, (VDE 0884) for a detailed description.

Absolute Maximum Ratings

Storage Temperature	-55°C to +125°C
Operating Temperature	-40°C to +85°C
Lead Solder Temperature	260°C for 10 s (up to seating plane)
Average Input Current - I_F	100 mA
Reverse Input Voltage - V_R (Pin 3-2)	5 V
Input Power Dissipation	250 mW[2]
Average Output Current - I_O (Pin 6)	10 mA
Emitter-Base Reverse Voltage (Pin 5-7)	5 V
Output Voltage - V_O (Pin 6-5)	-0.3 V to 20 V
Supply Voltage - V_{CC} (Pin 8-5)	-0.3 V to 30 V
Base Current - I_B (Pin 7)	5 mA
Output Power Dissipation	100 mW

Schematic



Recommended Operating Conditions

Quiescent Input Current - I_{FQ}	10 mA
Peak Input Current - I_F	17 mA

CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). 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.

VDE 0884 Insulation Characteristics

Description	Symbol	Characteristic	Unit
Installation classification per DIN VDE 0109/12.83, Table 1 For rated mains voltage ≤ 600 V_{rms} For rated mains voltage ≤ 1000 V_{rms}		 I-IV I-III	
Climatic Classification		55/100/21	
Pollution Degree (DIN VDE 0109/12.83)		2	
Maximum Working Insulation Voltage	V_{IORM}	1414	V_{PEAK}
		1000	V_{rms}
Input to Output Test Voltage, Method b* $V_{PR} = 1.6 \times V_{IORM}$, 100% Production Test with $t_p = 1$ sec, Partial Discharge < 5 pC	V_{PR}	2263	V_{PEAK}
		1600	V_{rms}
Input to Output Test Voltage, Method a* $V_{PR} = 1.2 \times V_{IORM}$, Type and sample test, $t_p = 60$ sec, Partial Discharge < 5 pC	V_{PR}	1697	V_{PEAK}
		1200	V_{rms}
Highest Allowable Overvoltage* (Transient Overvoltage, $t_{TR} = 10$ sec)	V_{TR}	8000	V_{PEAK}
Safety-Limiting Values (Maximum values allowed in the event of a failure, also see Figure 17) Case Temperature	T_{SI}	150	°C
Current (Input Current I_F, $P_{SI} = 0$)	I_{SI}	400	mA
Output Power (obtained by setting pin 8 = 5.5 V, pins 7,6,5 = ground)	P_{SI}, OUTPUT	700	mW
Insulation Resistance at T_{SI}, $V_{IO} = 500$ V	R_{IS}	$>10^9$	Ω

*Refer to the front of the optocoupler section of the HP Optoelectronics Designer's Catalog, under Product Safety Regulations section, (VDE 0884) for a detailed description.

Note: Insulation characteristics are guaranteed only within the safety maximum ratings, which must be ensured by protective circuits in the application.

Insulation Related Specifications

Parameter	Symbol	Value	Units	Conditions
Min. External Clearance (External Air Gap)	L(IO1)	9.6	mm	Measured from input terminals to output terminals
Min. External Creepage (External Tracking Path)	L(IO2)	10.0	mm	Measured from input terminals to output terminals
Min. Internal Clearance (Internal Plastic Gap)		1.0	mm	Through insulation distance conductor to conductor
Min. Internal Creepage (Internal Tracking Path)		4.0	mm	Measured from input terminals to output terminals
Comparative Tracking Index	CTI	200	volts	DIN IEC 112/VDE 0303 PART 1
Isolation Group (per DIN VDE 0109)		IIIa		Material group (DIN VDE 0109)

Electrical Specifications (T_A = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Fig.	Notes
Base Photo Current	I_{PB}	13	30	65	µA	I_F = 10 mA, $V_{PB} \geq 5$ V	2, 6	
I_{PB} Temp. Coefficient	$\Delta I_{PB}/\Delta T$		-0.3		%/°C	2 mA < I_F < 10 mA $V_{PB} \geq 5$ V	2	
I_{PB} Nonlinearity			0.15		%	6 mA < If < 14 mA	2, 6	3
Input Forward Voltage	V_F	1.2	1.60	1.8	V	I_F = 10 mA	5	
Input Reverse Breakdown Voltage	BV_R	5.0			V	I_R = 10 µA		
Transistor Current Gain	h_{FE}	60	170			I_C = 1 mA, V_{CE} = 1.25 V $V_{PB} \geq 5$ V		
Current Transfer Ratio	CTR		52		%	I_F = 10 mA, V_{CE} = 1.25 V $V_{PB} \geq 5$ V	8, 9	4
DC Output Voltage	V_{OUT}		5.0		V	I_{FQ} = 10 mA G_V = 2, V_{CC} = 9 V	4, 15	
Input-Output Capacitance	C_{I-O}		0.5	0.6	pF	f = 1 MHz		5
Resistance (Input-Output)	R_{I-O}	10^{12}	10^{13}		Ω	T_A = 25°C, V_{I-O} = 500 Vdc		5
		10^{11}				T_A = 100°C, V_{I-O} = 500 Vdc		
Input-Output Insulation Voltage	V_{ISO}	5000			V_{rms}	RH ≤ 50%, t = 1 min T_A = 25°C		5, 12

Small Signal Characteristics (T_A =25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Fig.	Notes
Voltage Gain	G_V (0.1 MHz)	0.8	3.0	4.2		I_{FQ} = 10 mA V_{IN} = 1 $V_{p\text{-}p}$	1	6
G_V Temperature Coefficient	$\Delta G_V/\Delta T$		-0.3		%/°C	I_{FQ} = 10 mA, V_{IN} = 1 $V_{p\text{-}p}$ f_{REF} = 0.1 MHz	1, 11	
Base Photo Current Variation	Δi_{PB} (6 MHz)		0.36	3.0	-dB	I_{FQ} = 10 mA,V_{IN} = 1 $V_{p\text{-}p}$ f_{REF} = 0.1 MHz	3, 10, 12	
-3 dB Freq (i_{PB})	i_{PB} (-3 dB)	6	13		MHz	I_{FQ} = 10 mA, V_{IN} = 1 $V_{p\text{-}p}$ f_{REF} = 0.1 MHz	3, 10, 12	7
-3 dB Freq (G_V)	G_V (-3 dB)	6	9.0		MHz	I_{FQ} = 10 mA, V_{IN} = 1 $V_{p\text{-}p}$ f_{REF} = 0.1 MHz	1, 11	7
Gain Variation	ΔG_V (6 MHz)		0.54	3.0	-dB	V_{IN} = 1 $V_{p\text{-}p}$ f_{REF} = 0.1 MHz	1, 11	
	ΔG_V (10 MHz)		2.27					
Differential Gain			±0.9		%	I_{Fac} = 1 mA pk-pk I_{Fdc} = 7 to 13 mA f = 3.58 MHz	3, 7	8
Differential Phase			±0.6		deg.	I_{Fac} = 1 mA pk-pk I_{Fdc} = 7 to 13 mA f = 3.58 MHz	3, 7	9
Total Harmonic Distortion	THD		0.75		%	f = 3.58 MHz, G_V =2, V_{IN} = 1 Vp-p I_{FQ} = 10 mA	4	10
Output Noise Voltage	V_O noise		950		μV_{rms}	10 Hz to 10 MHz	1	
Isolation Mode Rejection Ratio	IMRR		119		dB	f = 120 Hz, G_V = 2	14	11

Notes:

1. When used in the circuit of Figure 1 or Figure 4; $G_V = V_{OUT}/V_{IN}$; I_{FQ} = 10 mA.
2. Derate linearly above 65°C free-air temperature at a rate of 4.6 mW/°C to maintain $T_J \leq 125$°C.
3. Maximum variation from the best fit line of I_{PB} vs. I_F expressed as a percentage of the peak-to-peak full scale output.
4. CURRENT TRANSFER RATIO (CTR) is defined as the ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%.
5. Device considered a two terminal device: Pins 1,2,3, and 4 shorted together and pins 5,6,7, and 8 shorted together.
6. Flat-band, small-signal voltage gain.
7. The frequency at which the gain is 3 dB below the flat-band gain.
8. Differential gain is the change in the small-signal gain of the optocoupler at 3.58 MHz as the bias level is varied over a given range.
9. Differential phase is the change in the small-signal phase response of the optocoupler at 3.58 MHz as the bias level is varied over a given range.
10. TOTAL HARMONIC DISTORTION (THD) is defined as the square root of the sum of the square of each harmonic distortion component. The THD of the isolated video circuit is measured using a 2.6 kΩ load in series with the 50 Ω input impedance of the spectrum analyzer.
11. ISOLATION MODE REJECTION RATIO (IMRR), a measure of the optocoupler's ability to reject signals or noise that may exist between input and output terminals, is defined by $20 \log_{10} [(V_{OUT}/V_{IN})/(V_{OUT}/V_{IM})]$, where V_{IM} is the isolation mode voltage signal.
12. In accordance with UL 1577, each product is tested by applying an insulation test voltage of ≥ 6000 V_{rms} for 1 second (leakage detection current limit, $I_{I\text{-}O} \leq 5$ μA). This test is performed in addition to the tests shown in the VDE 0884 Insulation Characteristics Table.

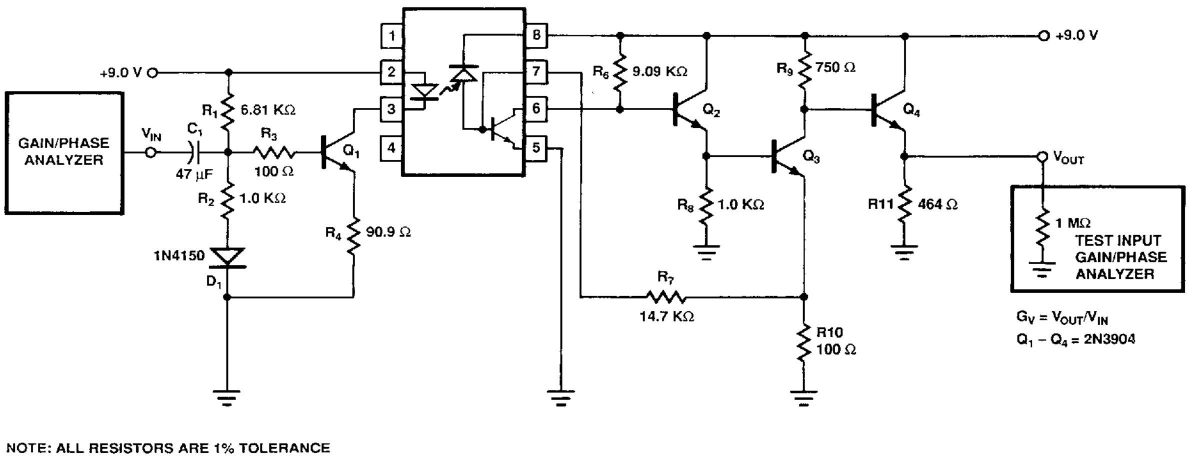


Figure 1. Gain and Bandwidth Test Circuit.

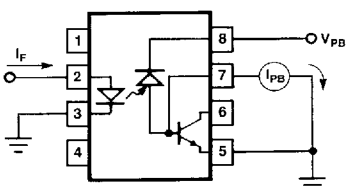


Figure 2. Base Photo Current Test Circuit.

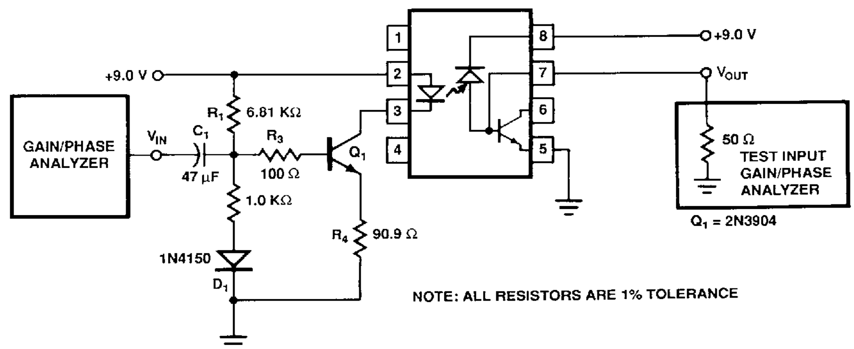


Figure 3. Base Photo Current Frequency Response Test Circuit.

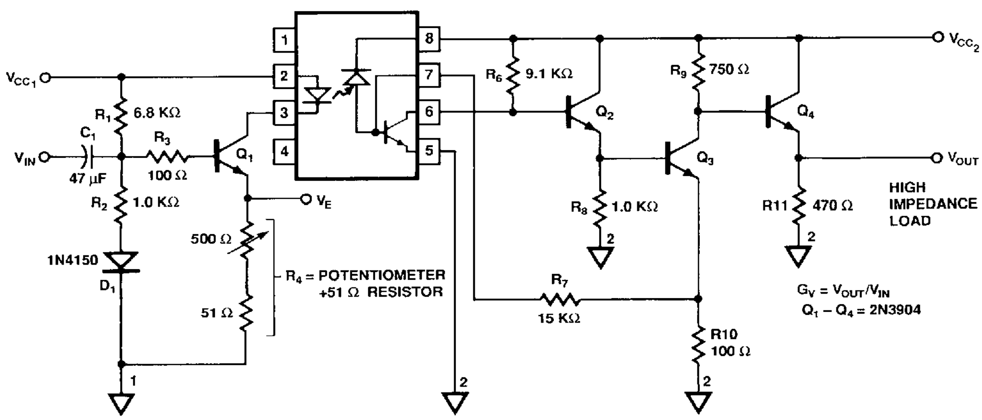


Figure 4. Recommended Isolated Video Interface Circuit.

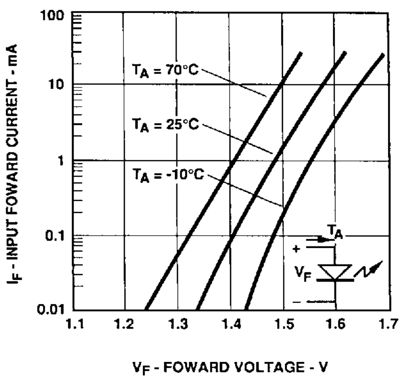


Figure 5. Input Current vs. Forward Voltage.

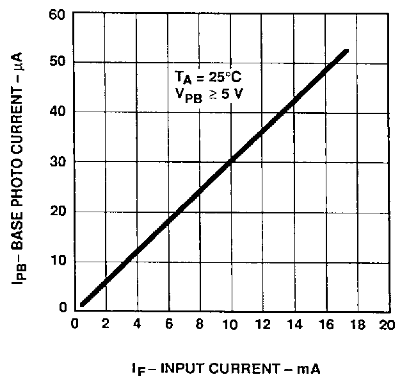


Figure 6. Base Photo Current vs. Input Current.

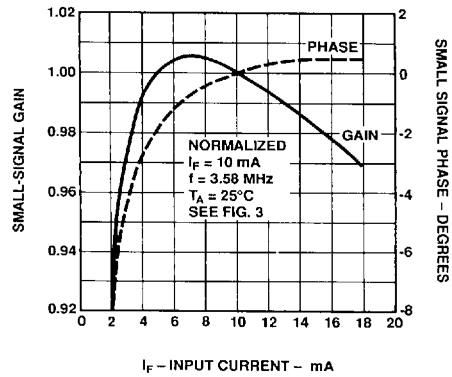


Figure 7. Small-Signal Response vs. Input Current.

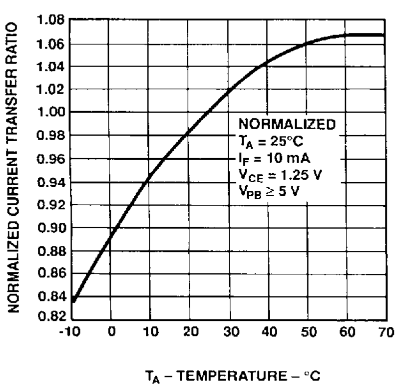


Figure 8. Current Transfer Ratio vs. Temperature.

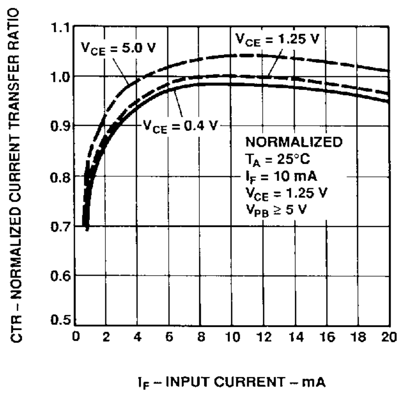


Figure 9. Current Transfer Ratio vs. Input Current.

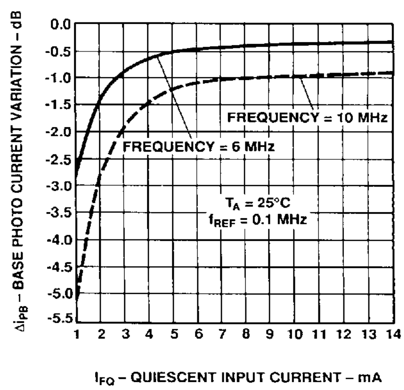


Figure 10. Base Photo Current Variation vs. Bias Conditions.

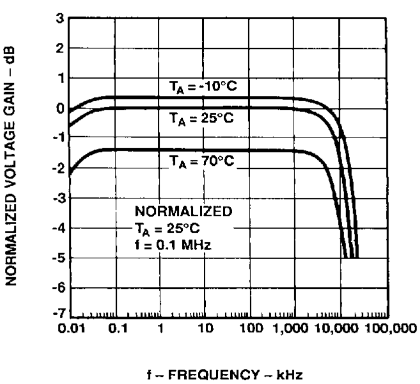


Figure 11. Normalized Voltage Gain vs. Frequency.

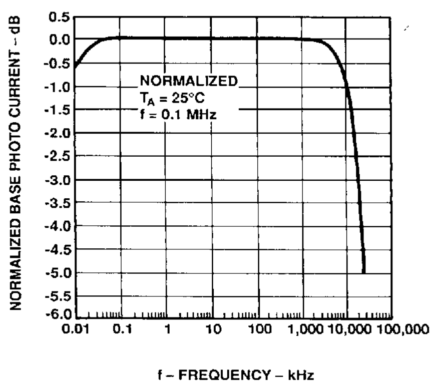


Figure 12. Normalized Base Photo Current vs. Frequency.

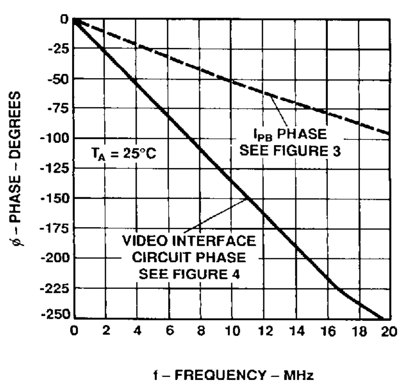


Figure 13. Phase vs. Frequency.

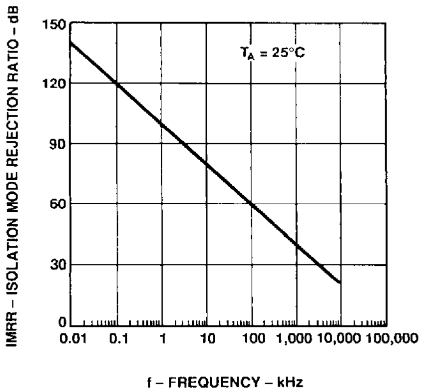


Figure 14. Isolation Mode Rejection Ratio vs. Frequency.

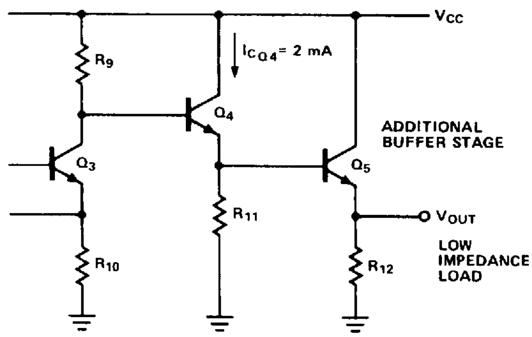


Figure 16. Output Buffer Stage for Low Impedance Loads.

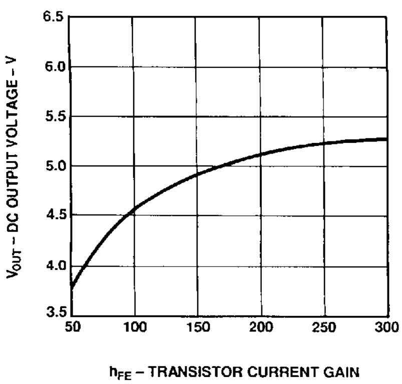


Figure 15. DC Output Voltage vs. Transistor DC Current Gain.

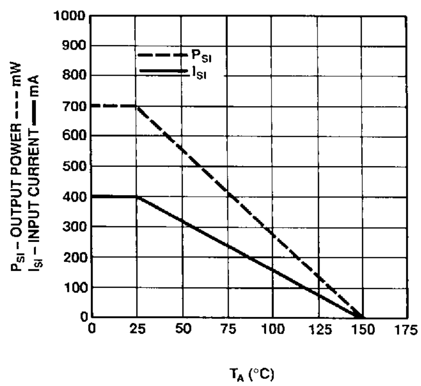


Figure 17. Dependence of Safety Maximum Ratings with Ambient Temperature.

Conversion from HCPL-4562 to CNW4562

In order to obtain similar circuit performance when converting from the HCPL-4562 to the CNW4562, it is recommended to increase the Quiescent Input Current, I_{FQ}, from 6 mA to 10 mA. If the application circuit in Figure 4 is used, then potentiometer R4 should be adjusted appropriately.

Design Considerations of the Application Circuit

The application circuit in Figure 4 incorporates several features that help maximize the bandwidth performance of the CNW4562. Most important of these features is peaked response of the detector circuit that helps extend the frequency range over which the voltage gain is relatively constant. The number of gain stages, the overall circuit topology, and the choice of DC bias points are all consequences of the desire to maximize bandwidth performance.

To use the circuit, first select R_1 to set V_E for the desired LED quiescent current by:

$$I_{FQ} = \frac{V_E}{R_4} \cong \frac{G_V V_E R_{10}}{(\partial I_{PB}/\partial I_F) R_7 R_9} \quad (1)$$

For a constant value $v_{IN_{p\text{-}p}}$, the circuit topology (adjusting the gain with R_4) preserves linearity by keeping the modulation factor (MF) dependent only on V_E.

$$i_{F_{p\text{-}p}} \cong v_{IN}/R_4 \quad (2)$$

$$\frac{i_{F_{p\text{-}p}}}{I_{FQ}} \cong \frac{i_{PB_{p\text{-}p}}}{I_{PBQ}} = \frac{v_{IN_{p\text{-}p}}}{V_E} \quad (3)$$

$$\text{Modulation Factor (MF): } \frac{i_{F(p\text{-}p)}}{2 I_{FQ}} \cong \frac{v_{IN_{p\text{-}p}}}{2 V_E} \quad (4)$$

For a given G_V, V_E, and V_{CC}, DC output voltage will vary only with h_{FEX}.

$$V_O = V_{CC} - V_{BE_4} - \frac{R_9}{R_{10}} (V_{BEX} - (I_{PBQ} - I_{BXQ}) R_7) \quad (5)$$

Where:

$$I_{PBQ} \cong \frac{G_V V_E R_{10}}{R_7 R_9} \quad (6)$$

and,

$$I_{BXQ} \cong \frac{V_{CC} - 2 V_{BE}}{R_6 \, h_{FEX}} \quad (7)$$

Figure 15 shows the dependency of the DC output voltage on h_{FEX}.

For 9 V < V_{CC} < 12 V, select the value of R_{11} such that

$$I_{C_{Q4}} \cong \frac{V_O}{R_{11}} \le \frac{4.25\,V}{470\Omega} \le 9.0\,mA \quad (8)$$

The voltage gain of the second stage (Q_3) is approximately equal to:

$$\frac{R_9}{R_{10}} * \frac{1}{1 + s R_9 \left[C_{CQ_3} + \frac{1}{2\pi R'_{11} f_{T_4}} \right]} \quad (9)$$

Increasing R'_{11} (R'_{11} includes the parallel combination of R_{11} and the load impedance) or reducing R_9 (keeping R_9/R_{10} ratio constant) will improve the bandwidth.

If it is necessary to drive a low impedance load, bandwidth may also be preserved by adding an additional emitter following the buffer stage (Q_5 in Figure 16), in which case R_{11} can be increased to set $I_{CQ4} \cong 2$ mA.

Finally, adjust R_4 to achieve the desired voltage gain.

$$G_V \cong \frac{v_{OUT}}{v_{IN}} \cong \frac{\partial I_{PB}}{\partial I_F} \left[\frac{R_7 R_9}{R_4 R_{10}} \right] \quad (10)$$

$$\text{where typically } \frac{\partial I_{PB}}{\partial I_F} = 0.0032$$

Definition:

G_V = Voltage Gain
I_{FQ} = Quiescent LED forward current
$i_{F_{p\text{-}p}}$ = Peak-to-peak small signal LED forward current
$v_{IN_{p\text{-}p}}$ = Peak-to-peak small signal input voltage
$i_{PB_{p\text{-}p}}$ = Peak-to-peak small signal base photo current
I_{PBQ} = Quiescent base photo current
V_{BEX} = Base-Emitter voltage of CNW4562 transistor
I_{BXQ} = Quiescent base current of CNW4562 transistor
h_{FEX} = Current Gain (IC/IB) of CNW4562 transistor
V_E = Voltage across emitter degeneration resistor R_4
f_{T_4} = Unity gain frequency of Q_5
C_{CQ_3} = Effective capacitance from collector of Q_3 to ground