

## LOW INPUT CURRENT, HIGH GAIN OPTOCOUPLER

### FEATURES

- High Current Transfer Ratio, 800%
- Low Input Current, 0.5mA
- High Output Current, 60mA
- Isolation Test Voltage, 2500 VAC<sub>RMS</sub>
- TTL Compatible Output, VOL=0.1 V
- High Common Mode Rejection, 500V/μsec.
- Adjustable Bandwidth—Access to Base
- Standard Molded Dip Plastic Package
- Underwriters Lab File #E52744

### APPLICATIONS

- Logic Ground Isolation—TTL/TTL, TTL/CMOS, CMOS/CMOS, CMOS/TTL
- EIA RS 232C Line Receiver
- Low Input Current Line Receiver—Long Lines, Party Lines
- Telephone Ring Detector
- 117 VAC Line Voltage Status Indication—Low Input Power Dissipation
- Low Power Systems—Ground Isolation

### DESCRIPTION

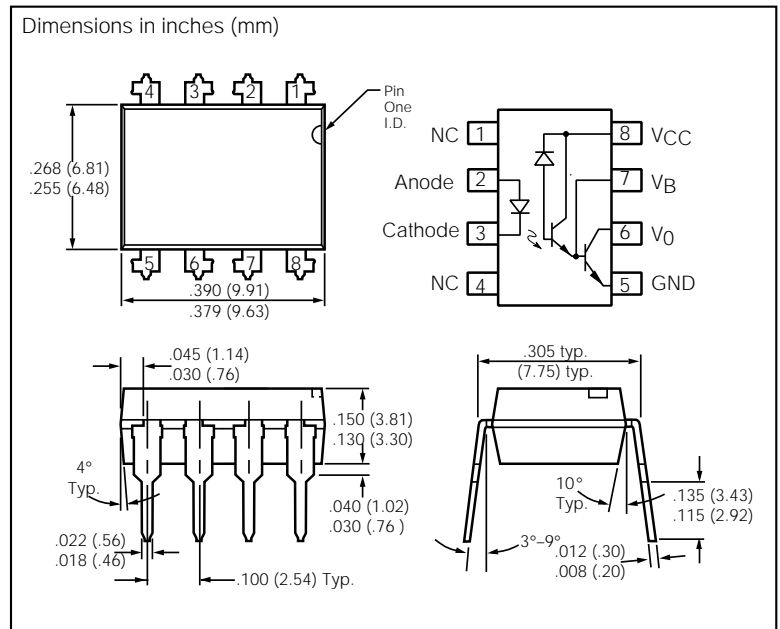
High common mode transient immunity and very high current ratio together with 2500 VAC insulation are achieved by coupling an LED with an integrated high gain photo detector in an eight pin dual-in-line package. Separate pins for the photodiode and output stage enable TTL compatible saturation voltages with high speed operation. Photodarlington operation is achieved by tying the V<sub>CC</sub> and V<sub>O</sub> terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

The 6N138 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 KΩ pull-up resistor.

The 6N139 is best suited for low power logic applications involving CMOS and low power TTL. A 400% current transfer ratio with only 0.5 mA of LED current is guaranteed from 0°C to 70°C.

#### Caution:

Due to the small geometries of this device, it should be handled with Electrostatic Discharge (ESD) precautions. Proper grounding would prevent damage further and/or degradation which may be induced by ESD.



### Maximum Ratings

Reverse Input Voltage .....	5 V
Supply and Output Voltage, V <sub>CC</sub> (pin 8-5), V <sub>O</sub> (pin 6-5)	
6N138 .....	-0.5 to 7 V
6N139 .....	-0.5 to 18 V
Emitter-Base Reverse Voltage (pin 5-7) .....	0.5 V
Average Input Current .....	20 mA
Peak Input Current (50% Duty Cycle—1 ms pulse width) .....	40 mA
Peak Transient Input Current (tp≤1 μsec, 300 pps) .....	1.0 A
Output Current I <sub>O</sub> (pin 6) .....	60 mA
Derate linearly above 25°C, free air temperature at 0.7 mA/°C	
Input Power Dissipation .....	35 mW
Derate linearly above 50%, free air temperature at 0.7 mW/°C	
Output Power Dissipation .....	100 mW
Derate linearly above 25°C, free air temperature at 0.2 mA/°C	
Isolation Test Voltage .....	2500 VAC <sub>RMS</sub>
Isolation Resistance	
V <sub>IO</sub> =500 V, T <sub>A</sub> =25°C .....	≥10 <sup>12</sup> Ω
V <sub>IO</sub> =500 V, T <sub>A</sub> =100°C .....	≥10 <sup>11</sup> Ω
Storage Temperature .....	-55°C to +125°C
Operating Temperature .....	-55°C to +100°C
Lead Soldering Temperature (t=10 sec.) .....	260°C

**Electro-Optical Characteristics** ( $T_A=0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ ,  $T_A=25^{\circ}\text{C}$ —Typical, unless otherwise specified)

Parameter	Symbol	Device	Min	Typ.	Max.	Units	Test Conditions	Note
Current Transfer Ratio	CTR	6N138	300	1600		%	$I_F=1.6\text{ mA}$ , $V_O=0.4\text{ V}$ , $V_{CC}=4.5\text{ V}$	5.6
		6N139	400 500	1600 2000		%	$I_F=0.5\text{ mA}$ , $V_O=0.4\text{ V}$ , $V_{CC}=4.5\text{ V}$ $I_F=1.6\text{ mA}$ , $V_O=0.4\text{ V}$ , $V_{CC}=4.5\text{ V}$	5.6
Logic Low	$V_{OL}$	6N138		0.1	0.4	V	$I_F=1.6\text{ mA}$ , $I_O=4.8\text{ mA}$ , $V_{CC}=4.5\text{ V}$	6
Output Voltage		6N139		0.1	0.4	V	$I_F=1.6\text{ mA}$ , $I_O=8\text{ mA}$ , $V_{CC}=4.5\text{ V}$	6
		6N139 6N139		0.15 0.25	0.4 0.4	V	$I_F=5\text{ mA}$ , $I_O=15\text{ mA}$ , $V_{CC}=4.5\text{ V}$ $I_F=12\text{ mA}$ , $I_O=24\text{ mA}$ , $V_{CC}=4.5\text{ V}$	
Logic High	$I_{OH}$	6N138		0.1	250	$\mu\text{A}$	$I_F=0\text{ mA}$ , $V_O=V_{CC}=7\text{ V}$	6
Output Current		6N139		0.05	100	$\mu\text{A}$	$I_F=0\text{ mA}$ , $V_O=V_{CC}=18\text{ V}$	6
Logic Low Supply Current	$I_{CCL}$			0.2	1.5	mA	$I_F=1.6\text{ mA}$ , $V_O=\text{OPEN}$ , $V_{CC}=18\text{ V}$	6
Logic High Supply Current	$I_{CCH}$			0.001	10	$\mu\text{A}$	$I_F=0\text{ mA}$ , $V_O=\text{OPEN}$ , $V_{CC}=18\text{ V}$	6
Input Forward Voltage	$V_F$			1.4	1.7	V	$I_F=1.6\text{ mA}$ , $T_A=25^{\circ}\text{C}$	
Input Reverse Breakdown Voltage	$BV_R$		5			V	$I_R=10\text{ }\mu\text{A}$	
Temperature Coefficient of Forward Voltage				-1.8		mV/ $^{\circ}\text{C}$	$I_F=1.6\text{ mA}$	
Input Capacitance	$C_{IN}$			25		pF	$f=1\text{ MHz}$ , $V_F=0$	
Input-Output Insulation Leakage Current	I-O				1.0	$\mu\text{A}$	45% Relative Humidity, $T_A=25^{\circ}\text{C}$ $t=5\text{ s}$ , $V_{I-O}=3000\text{ VDC}$	7
Resistance (Input-Output)	$R_{I-O}$			$10^{12}$		$\Omega$	$V_{I-O}=500\text{ VDC}$	7
Capacitance (Input-Output)	$C_{I-O}$			0.6		pF	$f=1\text{ MHz}$	7

**Switching Specifications** ( $T_A=25^{\circ}\text{C}$ )

Parameter	Symbol	Device	Min	Typ.	Max.	Units	Test Conditions	Note
Propagation Delay Time	$t_{PHL}$	6N138		2	10	$\mu\text{S}$	$I_F=1.6\text{ mA}$ , $R_L=2.2\text{ K}\Omega$	
To Logic Low at Output		6N139		6 0.6	25 1	$\mu\text{S}$	$I_F=0.5\text{ mA}$ , $R_L=4.7\text{ K}\Omega$ $I_F=12\text{ mA}$ , $R_L=270\text{ }\Omega$	6,8
Propagation Delay Time	$t_{PLH}$	6N138		2	35	$\mu\text{S}$	$I_F=1.6\text{ mA}$ , $R_L=2.2\text{ K}\Omega$	
To Logic High at Output		6N139		4 1.5	60 7	$\mu\text{S}$	$I_F=0.5\text{ mA}$ , $R_L=4.7\text{ K}\Omega$ $I_F=12\text{ mA}$ , $R_L=270\text{ }\Omega$	6,8
Common Mode Transient Immunity at Logic High Level Output	$CM_H$			500		V/ $\mu\text{S}$	$I_F=0\text{ mA}$ , $R_L=2.2\text{ K}\Omega$ $R_{CC}=0/V_{CM}=10\text{ V}_{p-p}$	9,10
Common Mode Transient Immunity at Logic Low Level Output	$CM_L$			-500		V/ $\mu\text{S}$	$I_F=1.6\text{ mA}$ , $R_L=2.2\text{ K}\Omega$ $R_{CC}=0/V_{CM}=10\text{ V}_{p-p}$	9,10

**Notes**

- Derate linearly above  $50^{\circ}\text{C}$  free-air temperature at a rate of  $0.4\text{ mA}/^{\circ}\text{C}$ .
- Derate linearly above  $50^{\circ}\text{C}$  free-air temperature at a rate of  $0.7\text{ mW}/^{\circ}\text{C}$ .
- Derate linearly above  $25^{\circ}\text{C}$  free-air temperature at a rate of  $0.7\text{ mA}/^{\circ}\text{C}$ .
- Derate linearly above  $25^{\circ}\text{C}$  free-air temperature at a rate of  $2.0\text{ mW}/^{\circ}\text{C}$ .
- 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%.
- Pin 7 open.
- Device considered a two-terminal device: pins 1, 2, 3 and 4 shorted together and pins 5, 6, 7 and 8 shorted together.
- Using a resistor between pin 5 and 7 will decrease gain and delay time.
- Common mode transient immunity in logic high level is the maximum tolerable (positive)  $dV_{CM}/dt$  on the leading edge 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 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.  $V_O<0.8\text{ V}$ ).
- In applications where  $dv/dt$  may exceed  $50,000\text{ V}/\mu\text{s}$  (such as state discharge) a series resistor,  $R_{CC}$  should be included to protect  $I_C$  from destructively high surge currents. The recommended value is

$$R_{CC} \cong \frac{IV}{0.15I_F(\text{mA})} \text{ k}\Omega$$