



6N138 6N139

Low Input Current, High Gain Optocoupler

FEATURES

- High Current Transfer Ratio, 800%
- Low Input Current, 0.5 mA
- High Output Current, 60 mA
- Isolation Test Voltage, 5300 V_{RMS}
- TTL Compatible Output, V_{OL}=0.1 V
- High Common Mode Rejection, 500 V/ μ s
- Adjustable Bandwidth—Access to Base
- Standard Molded Dip Plastic Package
- Underwriters Lab File #E52744
- VDE #0884 Approval Available with Option 1

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 5300 V_{RMS} 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.

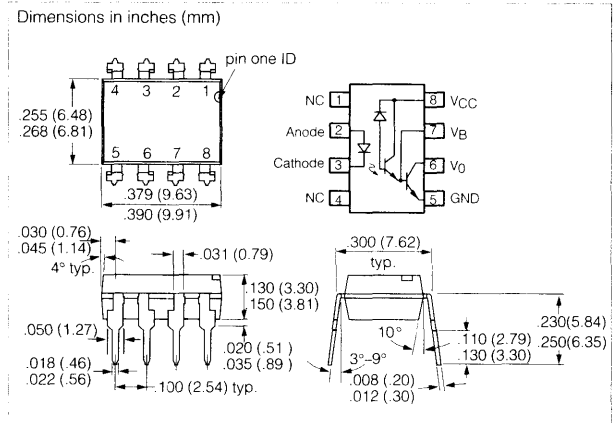
Photodarlington operation is achieved by tying the V_{CC} and V_O terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

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 k Ω 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

Emitter

Reverse Voltage..... 5.0 V

Detector

Forward Current..... 25 mA

Supply and Output Voltage, V_{CC} (pin 8-5), V_O (pin 6-5)

6N138..... -0.5 to 7.0 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—1.0 ms pulse width)..... 40 mA

Peak Transient Input Current (t_p≤1.0 μ s, 300 pps)..... 1.0 A

Output Current I_O (pin 6)..... 60 mA

Package

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 5300 V_{RMS}

Isolation Resistance

V_{I0}=500 V, T_A=25°C ≥10¹² Ω

V_{I0}=500 V, T_A=100°C ≥10¹¹ Ω

Storage Temperature -55°C to +125°C

Operating Temperature -55°C to +100°C

Lead Soldering Temperature (t=10 s)..... 260°C

Table 1. Electro-optical Characteristics $T_A=0^\circ\text{C}$ to 70°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 | 1600 | 2000 | | | |
| Logic Low, Output Voltage | 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 |
| | | 6N139 | — | 0.1 | 0.15 | | | |
| Logic High, Output Current | I_{OH} | 6N138 | — | 0.1 | 250 | μA | $I_F=0\text{ mA}$, $V_O=V_{CC}=7.0\text{ V}$ | — |
| | | 6N139 | — | 0.05 | 100 | | | |
| Logic Low Supply Current | I_{CCL} | — | — | 0.2 | 1.5 | mA | $I_F=1.6\text{ mA}$, $V_O=\text{OPEN}$, $V_{CC}=18\text{ V}$ | — |
| Logic High Supply Current | I_{CCH} | — | — | 0.001 | 10 | μA | $I_F=0\text{ mA}$, $V_O=\text{OPEN}$, $V_{CC}=18\text{ V}$ | — |
| 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 | — | 5.0 | — | — | | $I_R=10\text{ }\mu\text{A}$ | — |
| Temperature Coefficient of Forward Voltage | — | — | — | -1.8 | — | $\text{mV}/^\circ\text{C}$ | $I_F=1.6\text{ mA}$ | — |
| Input Capacitance | C_{IN} | — | — | 25 | — | pF | $f=1.0\text{ MHz}$, $V_F=0$ | — |
| Input-Output Insulation Leakage Current | I_{-O} | — | — | — | 1.0 | μA | 45% Relative Humidity, $T_A=25^\circ\text{C}$ $t=5.0\text{ s}$, $V_{1-0}=3000\text{ VDC}$ | 7 |
| Resistance (Input-Output) | R_{I-O} | — | — | 10^{12} | — | Ω | $V_{I-O}=500\text{ VDC}$ | — |
| Capacitance (Input-Output) | C_{I-O} | — | — | 0.6 | — | pF | $f=1.0\text{ MHz}$ | — |

Table 2. Switching Specifications $T_A=25^\circ\text{C}$

| Parameter | Symbol | Device | Min. | Typ. | Max. | Units | Test Conditions | Note |
|---|-----------|--------|------|------|------|------------------------|--|--|
| Propagation Delay Time, To Logic Low at Output | t_{PHL} | 6N138 | — | 2.0 | 10 | μS | $I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$ | — |
| | | 6N139 | — | 6.0 | 25 | | | $I_F=0.5\text{ mA}$, $R_L=4.7\text{ k}\Omega$ $I_F=12\text{ mA}$, $R_L=270\text{ }\Omega$ |
| Propagation Delay Time, To Logic High at Output | t_{PLH} | 6N138 | — | 2.0 | 35 | μS | $I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$ | — |
| | | 6N139 | — | 4.0 | 60 | | | $I_F=0.5\text{ mA}$, $R_L=4.7\text{ k}\Omega$ $I_F=12\text{ mA}$, $R_L=270\text{ }\Omega$ |
| Common Mode Transient Immunity, Logic High Level Output | CM_H | — | — | 500 | — | $\text{V}/\mu\text{S}$ | $I_F=0\text{ mA}$, $R_L=2.2\text{ k}\Omega$ $R_{CC}=0/V_{CM}/=10\text{ V}_{P-P}$ | 9,10 |
| Common Mode Transient Immunity, Logic Low Level Output | CM_L | — | — | -500 | — | | $I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$ $R_{CC}=0/V_{CM}/=10\text{ V}_{P-P}$ | 9,10 |

Notes

- Derate linearly above 50°C free-air temperature at a rate of $0.4\text{ mA}/^\circ\text{C}$.
- Derate linearly above 50°C free-air temperature at a rate of $0.7\text{ mW}/^\circ\text{C}$.
- Derate linearly above 25°C free-air temperature at a rate of $0.7\text{ mA}/^\circ\text{C}$.
- Derate linearly above 25°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 $R_{CC} \cong \frac{IV}{0.15I_F(\text{mA})} \text{ k}\Omega$