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/μs**
- **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.

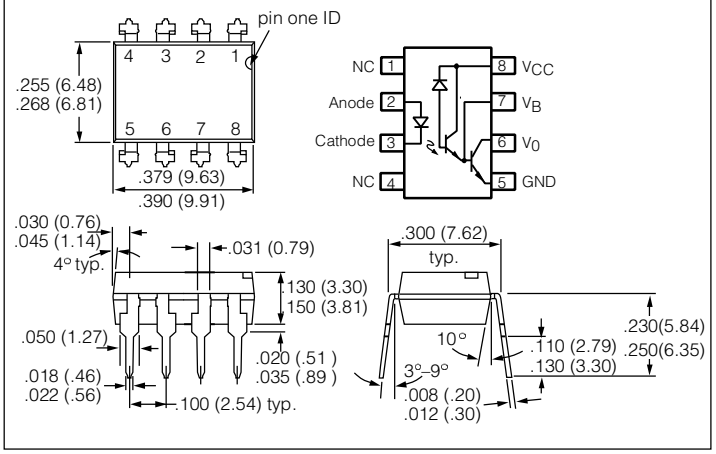
The 6N138 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 kΩ pull-up resistor.

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.

Dimensions in inches (mm)



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 μs, 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_{IO}=500 V, T_A=25°C ..... ≥10^{12} Ω

V_{IO}=500 V, T_A=100°C ..... ≥10^{11} 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°C to 70°C, T_A=25°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 mA, V_O=0.4 V, V_{CC}=4.5 V	5.6
	—	6N139	400 500	1600 2000			I_F=0.5 mA, V_O=0.4 V, V_{CC}=4.5 V I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	
Logic Low, Output Voltage	V_{OL}	6N138	—	0.1	0.4	V	I_F=1.6 mA, I_O=4.8 mA, V_{CC}=4.5 V	6
		6N139	—	0.1 0.15 0.25	0.4		I_F=1.6 mA, I_O=8.0 mA, V_{CC}=4.5 V I_F=5.0 mA, I_O=15 mA, V_{CC}=4.5 V I_F=12 mA, I_O=24 mA, V_{CC}=4.5 V	
Logic High, Output Current	I_{OH}	6N138	—	0.1	250	µA	I_F=0 mA, V_O=V_{CC}=7.0 V	
		6N139	—	0.05	100		I_F=0 mA, V_O=V_{CC}=18 V	
Logic Low Supply Current	I_{CCL}	—	—	0.2	1.5	mA	I_F=1.6 mA, V_O=OPEN, V_{CC}=18 V	
Logic High Supply Current	I_{CCH}	—	—	0.001	10	µA	I_F=0 mA, V_O=OPEN, V_{CC}=18 V	
Input Forward Voltage	V_F	—	—	1.4	1.7	V	I_F=1.6 mA, T_A=25°C	—
Input Reverse Breakdown Voltage	BV_R	—	5.0	—	—		I_R=10 µA	—
Temperature Coefficient of Forward Voltage	—	—	—	-1.8	—	mV/°C	I_F=1.6 mA	—
Input Capacitance	C_{IN}	—	—	25	—	pF	f=1.0 MHz, V_F=0	—
Input-Output Insulation Leakage Current	I-0	—	—		1.0	µA	45% Relative Humidity, T_A=25°C t=5.0 s, V_{I-0}=3000 VDC	7
Resistance (Input-Output)	R_{I-O}	—	—	10^{12}	—	Ω	V_{IO}=500 VDC	
Capacitance (Input-Output)	C_{I-O}	—	—	0.6	—	pF	f=1.0 MHz	

Table 2. Switching Specifications T_A=25°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 mA, R_L=2.2 kΩ	—
		6N139		6.0 0.6	25 1.0		I_F=0.5 mA, R_L=4.7 kΩ I_F=12 mA, R_L=270 Ω	6, 8
Propagation Delay Time, To Logic High at Output	t_{PLH}	6N138	—	2.0	35	µS	I_F=1.6 mA, R_L=2.2 kΩ	—
		6N139		4.0 1.5	60 7.0		I_F=0.5 mA, R_L=4.7 kΩ I_F=12 mA, R_L=270 Ω	6, 8
Common Mode Transient Immunity, Logic High Level Output	CM_H	—	—	500	—	V/µS	I_F=0 mA, R_L=2.2 kΩ R_{CC}=0/V_{CM}/=10 V_{P-P}	9,10
Common Mode Transient Immunity, Logic Low Level Output	CM_L	—	—	–500	—		I_F=1.6 mA, R_L=2.2 kΩ R_{CC}=0/V_{CM}/=10 V_{P-P}	9,10

Notes

1. Derate linearly above 50°C free-air temperature at a rate of 0.4 mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7 mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.7 mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 2.0 mW/°C.
5. 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%.
6. Pin 7 open.
7. Device considered a two-terminal device: pins 1, 2, 3 and 4 shorted together and pins 5, 6, 7, and 8 shorted together.
8. Using a resistor between pin 5 and 7 will decrease gain and delay time.
9. Common mode transient immunity in logic high level is the maximum tolerable (positive) dVcm/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 V) common mode transient immunity in logic low level is the maximum tolerable (negative) dVcm/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 V).
10. In applications where dv/dt may exceed 50,000 V/µs (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 $R_{CC} \cong \frac{IV}{0.15\, I_F(mA)} k\Omega$