

TOSHIBA Photocoupler GaAlAs Ired & Photo IC

## 6N138, 6N139

Current Loop Driver.

Low Input Current Line Receiver.

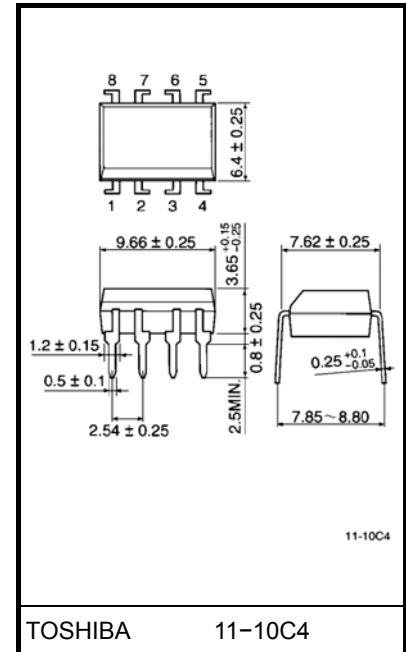
CMOS Logic Interface.

The TOSHIBA 6N138 and 6N139 consists of a GaAlAs infrared emitting diode coupled with a split-Darlington output configuration.

A high speed GaAlAs Ired manufactured with an unique LPE junction, has the virtue of fast rise and fall time at low drive current.

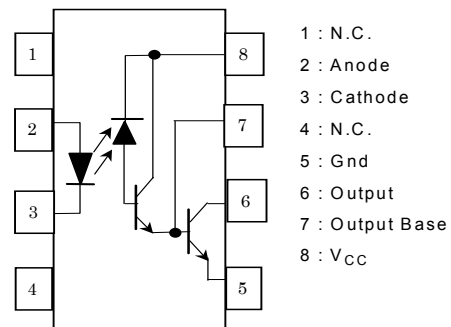
- Isolation voltage: 2500Vrms (min.)
- Current transfer ratio
  - : 6N138 – 300% (min.) ( $I_F=1.6\text{mA}$ )
  - : 6N139 – 400% (min.) ( $I_F=0.5\text{mA}$ )
- Switching time: 6N138 –  $t_{PHL}=10\mu\text{s}$  (max.)  
 –  $t_{PLH}=35\mu\text{s}$  (max.)  
 6N139 –  $t_{PHL}=1\mu\text{s}$  (max.)  
 –  $t_{PLH}=7\mu\text{s}$  (max.)
- UL recognized: UL1577, file no. E67349

Unit in mm

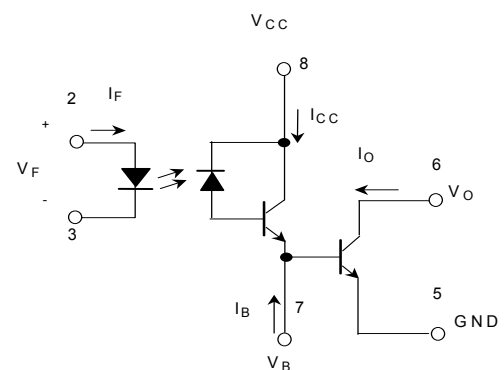


Weight: 0.54 g (typ.)

### Pin Configuration (top view)



### Schematic



## Absolute Maximum Ratings (\*) (Ta = 0°C to + 70°C)

Characteristic		Symbol	Rating	Unit
LED	Forward current (Note 1)	I <sub>F</sub>	20	mA
	Pulse forward current	I <sub>FP</sub> <sup>(*)</sup>	40	mA
	Total pulse forward current	I <sub>FP</sub> <sup>(*)</sup>	1	A
	Reverse voltage	V <sub>R</sub>	5	V
	Diode power dissipation (Note 2)	P <sub>D</sub>	35	mW
Detector	Output current (Note 3)	I <sub>O</sub>	60	mA
	Emitter-base reverse voltage	V <sub>EB</sub>	0.5	V
	Supply voltage	V <sub>CC</sub> <sup>(*)</sup>	−0.5 to 18	V
	Output voltage	V <sub>O</sub> <sup>(*)</sup>	−0.5 to 18	V
	Output power dissipation (Note 4)	P <sub>O</sub>	100	mW
Operating temperature range		T <sub>opr</sub>	0 to 70	°C
Storage temperature range		T <sub>stg</sub>	−55 to 125	°C
Lead solder temperature (10s) <sup>(*)</sup>		T <sub>sol</sub>	260	°C
Isolation voltage (1min., R.H.≤ 60%)		BV <sub>S</sub> <sup>(**)</sup>	2500	V <sub>rms</sub>
			3540	V <sub>dc</sub>

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

(\*) JEDEC registered data

(\*\*) Not registered JEDEC

(\*1) 50% duty cycle, 1ms pulse width

(\*2) Pulse width 1μs, 300pps

(\*3) 6N138... −0.5 to 7V

(\*4) 1.6mm below seating plane

## Electrical Characteristics

Over Recommended Temperature (Ta = 0°C to 70°C, unless otherwise noted)

Characteristic		Symbol	Test Condition	Min.	(*5)Typ.	Max.	Unit
Current transfer ratio (Note 5, 6)	6N139	CTR(*)	I <sub>F</sub> =0.5mA, V <sub>O</sub> =0.4V V <sub>CC</sub> =4.5V	400	800	—	%
	6N138		I <sub>F</sub> =1.6mA, V <sub>O</sub> =0.4V V <sub>CC</sub> =4.5V	500	900	—	
				300	600	—	
Logic low output voltage (Note 6)	6N139	V <sub>OL</sub>	I <sub>F</sub> =1.6mA, I <sub>O</sub> =6.4mA V <sub>CC</sub> =4.5V	—	0.1	0.4	V
			I <sub>F</sub> =5mA, I <sub>O</sub> =15mA V <sub>CC</sub> =4.5V	—	0.1	0.4	
			I <sub>F</sub> =12mA, I <sub>O</sub> =24mA V <sub>CC</sub> =4.5V	—	0.2	0.4	
	6N138		I <sub>F</sub> =1.6mA, I <sub>O</sub> =4.8mA V <sub>CC</sub> =4.5V	—	0.1	0.4	
Logic high output current (Note 6)	6N139	I <sub>OH</sub> (*)	I <sub>F</sub> =0mA, V <sub>O</sub> =V <sub>CC</sub> =18V	—	0.05	100	μA
	6N138		I <sub>F</sub> =0mA, V <sub>O</sub> =V <sub>CC</sub> =7V	—	0.05	250	
Logic low supply current (Note 6)		I <sub>CCL</sub>	I <sub>F</sub> =1.6mA, V <sub>O</sub> =Open V <sub>CC</sub> =5V	—	0.2	—	mA
Logic high supply current (Note 6)		I <sub>CCH</sub>	I <sub>F</sub> =0mA, V <sub>O</sub> =Open, V <sub>CC</sub> =5V	—	10	—	nA
Input forward voltage		V <sub>F</sub> (*)	I <sub>F</sub> =1.6mA, Ta=25°C	—	1.65	1.7	V
Input reverse breakdown voltage		BV <sub>R</sub> (*)	I <sub>R</sub> =10μA, Ta=25°C	5	—	—	V
Temperature coefficient of forward voltage		ΔV <sub>F</sub> / ΔTa	I <sub>F</sub> =1.6mA	—	−1.9	—	mV / °C
Input capacitance		C <sub>IN</sub>	f=1MHz, V <sub>F</sub> =0	—	60	—	pF
Resistance (input–output)		R <sub>I–O</sub>	V <sub>I–O</sub> =500V R.H.≤ 60% (Note 7),	—	10 <sup>12</sup>	—	Ω
Capacitance (input–output)		C <sub>I–O</sub>	f=1MHz (Note 7)	—	0.6	—	pF

(\*\*) JEDEC registered data.

(\*5) All typicals at Ta=25°C and V<sub>CC</sub>=5V, unless otherwise noted.

## Switching Specifications (Ta=25°C, VCC=5V, unless otherwise specified)

Characteristic	Symbol	Test Circuit	Test Condition	Min.	Typ.	Max.	Unit
Propagation delay time to logic low at output (Note 6, 8)	6N139	1	I <sub>F</sub> =0.5mA, R <sub>L</sub> =4.7kΩ	—	5	25	μs
			I <sub>F</sub> =12mA, R <sub>L</sub> =270Ω	—	0.2	1	
	6N138		I <sub>F</sub> =1.6mA, R <sub>L</sub> =2.2kΩ	—	1	10	
Propagation delay time to logic high at output (Note 6, 8)	6N139	1	I <sub>F</sub> =0.5mA, R <sub>L</sub> =4.7kΩ	—	5	60	μs
			I <sub>F</sub> =12mA, R <sub>L</sub> =270Ω	—	1	7	
	6N138		I <sub>F</sub> =1.6mA, R <sub>L</sub> =2.2kΩ	—	4	35	
Common mode transient immunity at logic high level output (Note 9)	CM <sub>H</sub>	2	I <sub>F</sub> =0mA, R <sub>L</sub> =2.2kΩ V <sub>CM</sub> =400V <sub>p-p</sub>	—	500	—	V / μs
Common mode transient immunity at logic low level output (Note 9)	CM <sub>L</sub>	2	I <sub>F</sub> =1.6mA R <sub>L</sub> =2.2kΩ V <sub>CM</sub> =400V <sub>p-p</sub>	—	−500	—	V / μs

(\*)JEDEC registered data.

(Note 1): Derate linearly above 50°C free-air temperature at a rate of 0.4mA / °C

(Note 2): Derate linearly above 50°C free-air temperature at a rate of 0.7mW / °C

(Note 3): Derate linearly above 25°C free-air temperature at a rate of 0.7mA / °C

(Note 4): Derate linearly above 25°C free-air temperature at a rate of 2.0mW / °C

(Note 5): DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I<sub>O</sub>, to the forward LED input current, I<sub>F</sub>, times 100%.

(Note 6): Pin 7 open.

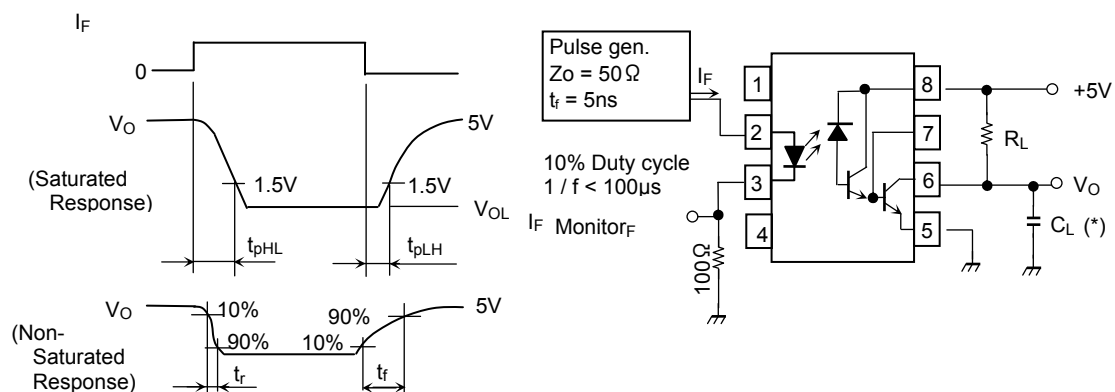
(Note 7): Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7 and 8 shorted together.

(Note 8): Use of a resistor between pin 5 and 7 will decrease gain and delay time.

(Note 9): Common mode transient immunity in logic high level is the maximum tolerable (positive) dv<sub>CM</sub> / dt on the leading edge of the common mode pulse, V<sub>CM</sub>, to assure that the output will remain in a logic high state (i.e., V<sub>O</sub> > 2.0V).

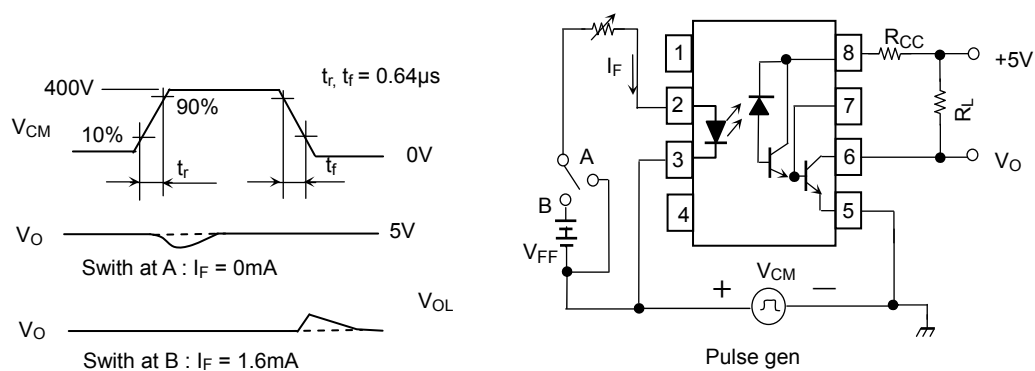
Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dv<sub>CM</sub> / dt on the trailing edge of the common mode pulse signal, V<sub>CM</sub>, to assure that the output will remain in a logic low state (i.e., V<sub>O</sub> < 0.8V).

## Test Circuit 1.



(\*) $C_L$  is approximately 15pF which includes probe and stray wiring capacitance.

## Test Circuit 2.



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