HIGH SPEED OPTICALLY COUPLED ISOLATOR
PHOTODARLINGTON OUTPUT

APPROVALS
- UL recognised, File No. E91231

DESCRIPTION
These diode-darlington optocouplers use a light emitting diode and an integrated high gain photon detector to provide 2500Volts_RMS electrical isolation between input and output. Separate connection for the photodiode bias and output darlington collector improve the speed up to a hundred times that of a conventional photo-darlington coupler by reducing the base-collector capacitance.

FEATURES
- High speed - DC to 300kBits/s operation
- High Common Mode Transient Immunity 10kV/µs typical
- TTL Compatible - 0.1V V_{OL} typical
- Base access allows Gain Bandwidth Adjustment
- Low Input Current Requirement - 0.5mA
- High Current Transfer Ratio - 1100% typ.
- Open Collector Output
- 2500V_RMS Withstand Test Voltage, 1 min
- 6N139 has improved noise shield which gives superior common mode rejection
- Options :-
  - 10mm lead spread - add G after part no.
  - Surface mount - add SM after part no.
  - Tape&Reel - add SMT&R after part no.
- All electrical parameters 100% tested
- Custom electrical selections available

APPLICATIONS
- Line receivers
- Digital logic ground isolation
- Telephone ring detector
- Current loop receiver

INPUT DIODE
- Average Forward Current 20mA (1)
- Peak Forward Current 40mA (50% duty cycle, 1ms pulse width)
- Peak Transient Current 1.0A (≤1µs P.W., 300pps)
- Reverse Voltage 5V
- Power Dissipation 35mW (2)

DETECTOR
- Output Current 60mA (3)
- Emitter-base Reverse Voltage 0.5V
- Supply and Output Voltage 6N138 -0.5 to +7V
- 6N139 -0.5 to +18V
- Power Dissipation 100mW (4)

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<thead>
<tr>
<th>PARAMETER</th>
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<th>TYP*</th>
<th>MAX</th>
<th>UNITS</th>
<th>TEST CONDITION</th>
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</thead>
<tbody>
<tr>
<td>Current Transfer Ratio (note 5, 6)</td>
<td>CTR</td>
<td>6N139</td>
<td>400</td>
<td>1100</td>
<td>%</td>
<td></td>
<td>$I_f = 0.5,mA, V_o = 0.4,V$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N139</td>
<td>500</td>
<td>1300</td>
<td>%</td>
<td></td>
<td>$I_f = 1.6,mA, V_o = 0.4,V$</td>
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<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>300</td>
<td>1300</td>
<td>%</td>
<td></td>
<td>$I_f = 1.6,mA, V_o = 0.4,V$</td>
</tr>
<tr>
<td>Logic Low Output Voltage (note 6)</td>
<td>V_{OL}</td>
<td>6N139</td>
<td>0.1</td>
<td>0.4</td>
<td>V</td>
<td></td>
<td>$I_f = 1.6,mA, I_o = 8,mA$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N139</td>
<td>0.1</td>
<td>0.4</td>
<td>V</td>
<td></td>
<td>$I_f = 5,mA, I_o = 15,mA$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N139</td>
<td>0.1</td>
<td>0.4</td>
<td>V</td>
<td></td>
<td>$I_f = 12,mA, I_o = 24,mA$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>0.1</td>
<td>0.4</td>
<td>V</td>
<td></td>
<td>$I_f = 1.6,mA, I_o = 4.8,mA$</td>
</tr>
<tr>
<td>Logic High Output Current (note 6)</td>
<td>I_{OH}</td>
<td>6N139</td>
<td>0.1</td>
<td>100</td>
<td>μA</td>
<td></td>
<td>$I_f = 0,mA$</td>
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<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>0.01</td>
<td>250</td>
<td>μA</td>
<td></td>
<td>$I_f = 0,mA$</td>
</tr>
<tr>
<td>Logic Low Supply Current (note 6)</td>
<td>I_{CCL}</td>
<td>6N139</td>
<td>0.4</td>
<td>1.5</td>
<td>mA</td>
<td></td>
<td>$I_f = 1.6,mA, V_o = \text{open}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>0.05</td>
<td>10</td>
<td>μA</td>
<td></td>
<td>$I_f = 0,mA, V_o = \text{open}$</td>
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<tr>
<td>Logic High Supply Current (note 6)</td>
<td>I_{CCH}</td>
<td>6N139</td>
<td>0.45</td>
<td>1.7</td>
<td>V</td>
<td></td>
<td>$I_f = 1.6,mA, T_A = 25^\circ C$</td>
</tr>
<tr>
<td>Input Forward Voltage</td>
<td>V_{F}</td>
<td>6N139</td>
<td>5</td>
<td></td>
<td>V</td>
<td></td>
<td>$I_f = 10,μA, T_A = 25^\circ C$</td>
</tr>
<tr>
<td>Temperature Coefficient of Forward Voltage</td>
<td>$\frac{\Delta V_F}{\Delta T_A}$</td>
<td>6N139</td>
<td>-1.8</td>
<td>mV/°C</td>
<td></td>
<td></td>
<td>$I_f = 1.6,mA$</td>
</tr>
<tr>
<td>Input Reverse Voltage</td>
<td>V_{R}</td>
<td>6N139</td>
<td>5</td>
<td></td>
<td>V</td>
<td></td>
<td>$I_f = 10,μA, T_A = 25^\circ C$</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>C_{IN}</td>
<td>6N139</td>
<td>60</td>
<td></td>
<td>pF</td>
<td></td>
<td>$f = 1,MHz, V_p = 0$</td>
</tr>
<tr>
<td>Input-output Isolation Voltage</td>
<td>V_{ISO}</td>
<td>6N139</td>
<td>2500</td>
<td>5000</td>
<td>V_{RMS}</td>
<td>R.H.equal to or less than 50%, t=1min, T_A=25°C</td>
<td></td>
</tr>
<tr>
<td>Resistance (Input to Output) (note 7)</td>
<td>R_{I-O}</td>
<td>6N139</td>
<td>10^{12}</td>
<td></td>
<td>Ω</td>
<td></td>
<td>$V_{I-O} = 500,V_{dc}$</td>
</tr>
<tr>
<td>Capacitance (Input to Output) (note 7)</td>
<td>C_{I-O}</td>
<td>6N139</td>
<td>0.6</td>
<td></td>
<td>pF</td>
<td></td>
<td>$f = 1,MHz$</td>
</tr>
</tbody>
</table>

* All typicals at $T_A=25^\circ C$
### SWITCHING SPECIFICATIONS AT $T_A = 25^\circ C$ ( $V_{CC} = 5V$ Unless otherwise noted )

<table>
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<tr>
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<th>TESTCONDITION</th>
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</thead>
<tbody>
<tr>
<td>Propagation Delay Time to Logic Low at Output ( fig 1 ) ( note6,8 )</td>
<td>$t_{PHL}$</td>
<td>6N139</td>
<td>5.0</td>
<td>25</td>
<td>µs</td>
<td></td>
<td>$I_f = 0.5mA, R_L = 4.7k\Omega$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N139</td>
<td>0.2</td>
<td>1</td>
<td>µs</td>
<td></td>
<td>$I_f = 12mA, R_L = 270\Omega$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>1.0</td>
<td>10</td>
<td>µs</td>
<td></td>
<td>$I_f = 1.6mA, R_L = 2.2k\Omega$</td>
</tr>
<tr>
<td>Propagation Delay Time to Logic High at Output ( fig 1 ) ( note6,8 )</td>
<td>$t_{PLH}$</td>
<td>6N139</td>
<td>1.0</td>
<td>60</td>
<td>µs</td>
<td></td>
<td>$I_f = 0.5mA, R_L = 4.7k\Omega$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N139</td>
<td>1.0</td>
<td>7</td>
<td>µs</td>
<td></td>
<td>$I_f = 12mA, R_L = 270\Omega$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6N138</td>
<td>4.0</td>
<td>35</td>
<td>µs</td>
<td></td>
<td>$I_f = 1.6mA, R_L = 2.2k\Omega$</td>
</tr>
<tr>
<td>Common Mode Transient Immunity at Logic High Level Output ( fig 2 ) ( note9 )</td>
<td>$CM_H$</td>
<td>1000</td>
<td>10000</td>
<td>V/µs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Mode Transient Immunity at Logic Low Level Output ( fig 2 ) ( note9 )</td>
<td>$CM_L$</td>
<td>1000</td>
<td>10000</td>
<td>V/µs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_o$, to the forward LED input current, $I_f$, multiplied by 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. Use of 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) $dV_{CM}/dt$ 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. $V_o > 2.0V$). 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 Logic Low state (i.e. $V_o < 0.8V$).

### FIG.1 SWITCHING TEST CIRCUIT

![Switching Test Circuit Diagram]
FIG. 2 TEST CIRCUIT FOR TRANSIENT IMMUNITY AND TYPICAL WAVEFORMS

Forward Current vs. Forward Voltage

Output Current vs. Output Voltage

Current Transfer Ratio vs. Forward Current

Supply Current vs. Forward Current

Switch at A: $I_F = 0\text{mA}$

Switch at B: $I_F = 1.6\text{mA}$

$V_{CM}$

$V_{CM}$

$10\%$

$90\%$

$10\%$

$0V$

$10V$

$V_o$

$V_o$

$5V$

$5V$

$V_{CM}$

$V_{CM}$

$V_{OL}$

$V_{OL}$

$PULSE\ GEN.$

$V_{PF}$

$10V$

$10\%$

$90\%$

$10\%$

$90\%$

$10\%$

$10\%$

$10\%$

$10\%$

$T_A = 25^\circ\text{C}$

$V_{CC} = 5\text{V}$

$T_A = 25^\circ\text{C}$

$I_F = 0.5\text{mA/step}$

$V_{CC} = 5\text{V}$

$T_A = 25^\circ\text{C}$

$I_F = 0.5\text{mA/step}$