

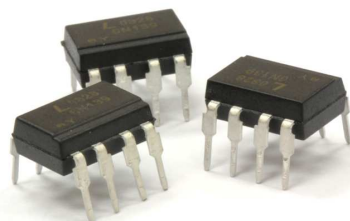


Dec.2008

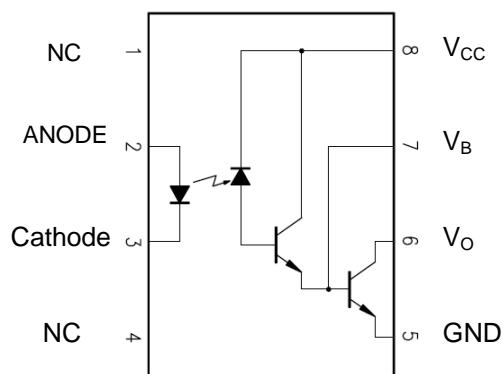
## 6N138, 6N139 Single Channel, High Speed Optocouplers

### Description

These high gain series couplers use a light emitter diode and an integrated high gain photo detector to provide extremely high current transfer ratio between input and output. Separate pins for the photodiode and output stage result in TTL compatible saturation voltage and high speed operation. Where desired the V<sub>cc</sub> and V<sub>o</sub> terminals may be tied together to achieve conventional photo darlington operation. A base access terminal allows a gain bandwidth adjustment to be made.



### Functional Diagram



6N138 / 6N139

Truth Table (Positive Logic)

| LED | OUT |
|-----|-----|
| ON  | L   |
| OFF | H   |

A 0.1 $\mu$ F bypass Capacitor must be connected between Pin8 and Pin5

### Features

- High current transfer ratio – 2000% typical.
- Low input current requirements – 0.5mA
- High output current – 60mA
- CTR guarantee – 0~70°C.
- Instantaneous common mode rejection 10KV/ $\mu$  sec
- TTL compatible output – 0.1V V<sub>OL</sub> typical
- UL, CSA approved.

### APPLICATIONS

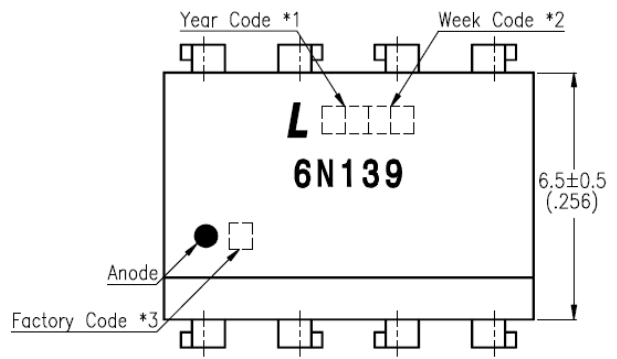
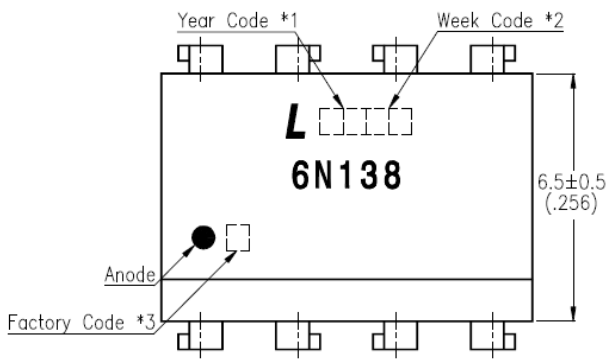
- Digital logic ground isolation
- Low input current line receiver
- Telephone ring detector
- EIA-RS-232C line receiver
- Current loop receiver
- High common mode noise line receiver

## Ordering Information

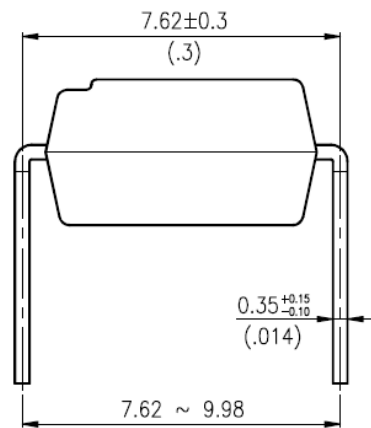
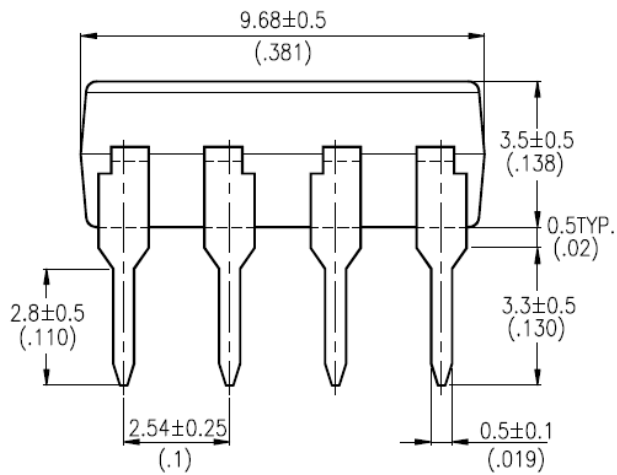
| Part  | Option | Minimum CMR           |                        | CTR | Remarks                           |
|-------|--------|-----------------------|------------------------|-----|-----------------------------------|
|       |        | dV/dt<br>(V/ $\mu$ s) | V <sub>CM</sub><br>(V) |     |                                   |
| 6N138 | M      | 1,000                 | 10                     | 400 | Single Channel, DIP-8             |
|       | S      |                       |                        |     | Single Channel, Wide Lead Spacing |
| 6N139 | M      | 1,000                 | 10                     | 300 | Single Channel, SMD-8             |
|       | S      |                       |                        |     | Single Channel, DIP-8             |
|       |        |                       |                        |     | Single Channel, Wide Lead Spacing |
|       |        |                       |                        |     | Single Channel, SMD-8             |

## OUTLINE DIMENSIONS

### 8-pin DIP Package (6N138 / 6N139)

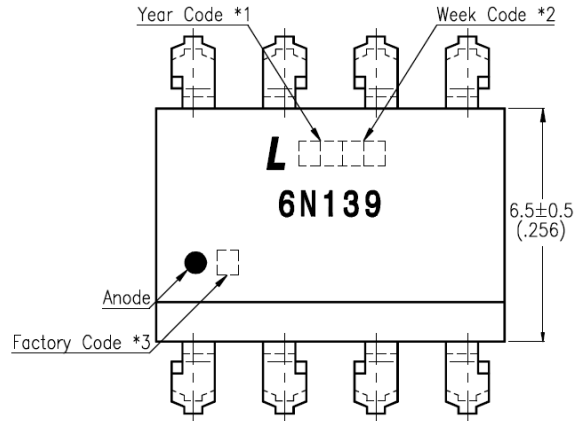
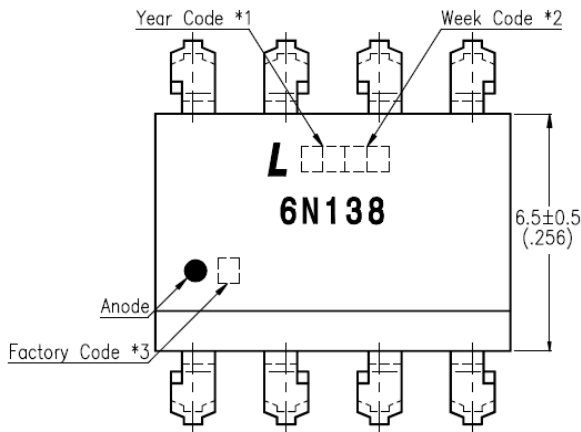


- \*1. Year date code.
  - \*2. 2-digit work week.
  - \*3. Factory identification mark  
(Z : Taiwan, Y : Thailand).
- Dimensions are in Millimeters and (Inches).



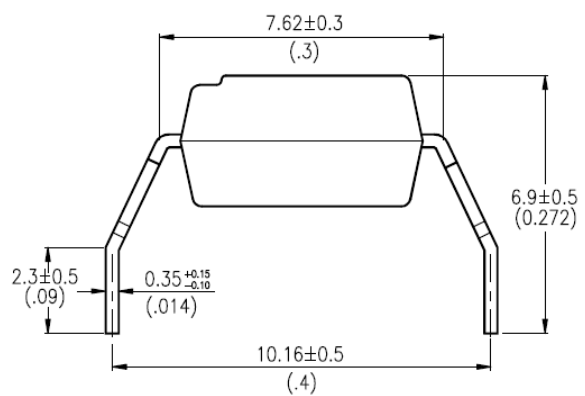
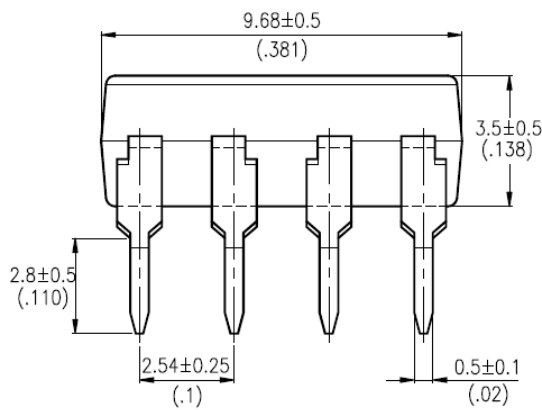
## OUTLINE DIMENSIONS

### 8-pin DIP Wide Lead Spacing Package (6N138M / 6N139M)



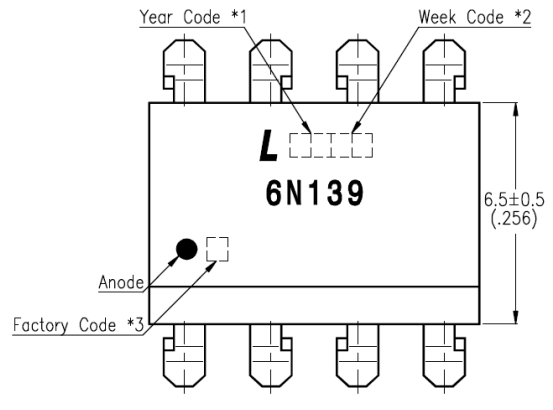
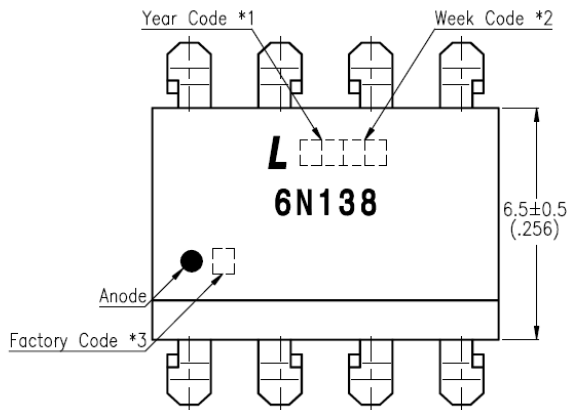
- \*1. Year date code.
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Dimensions are in Millimeters and (Inches).

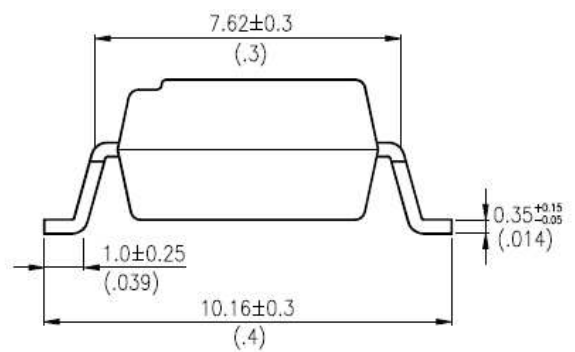
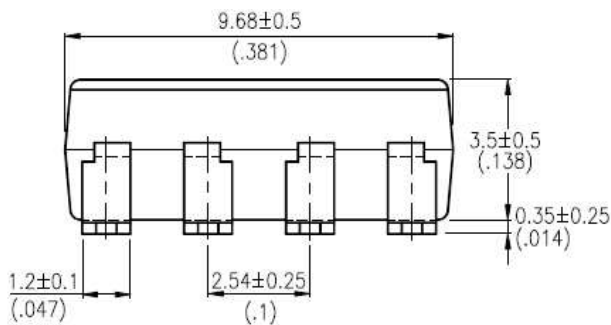


## OUTLINE DIMENSIONS

### 8-pin DIP Surface Mount Package (6N138S / 6N139S)

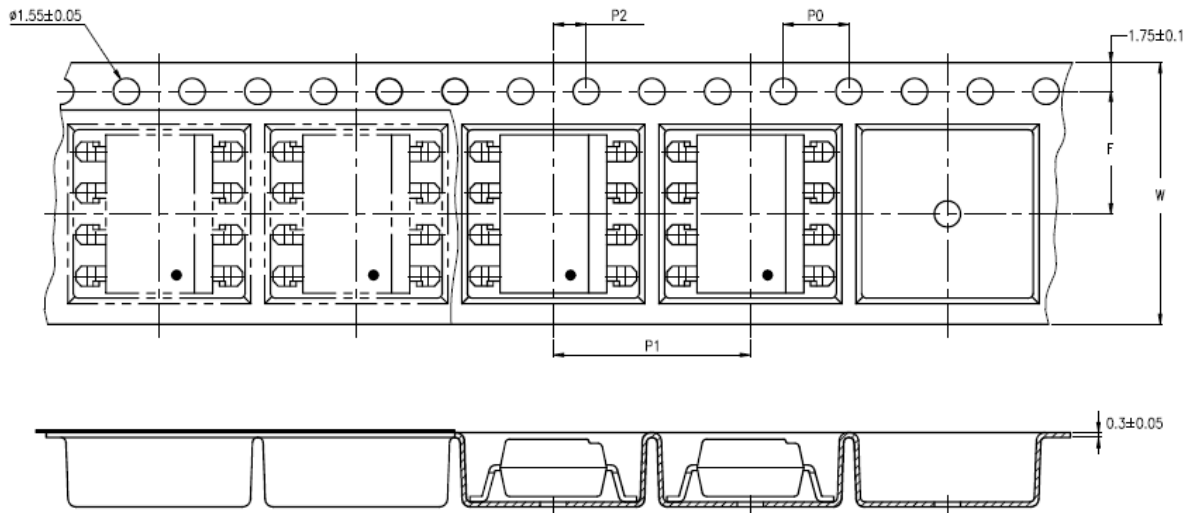


- \*1. Year date code.
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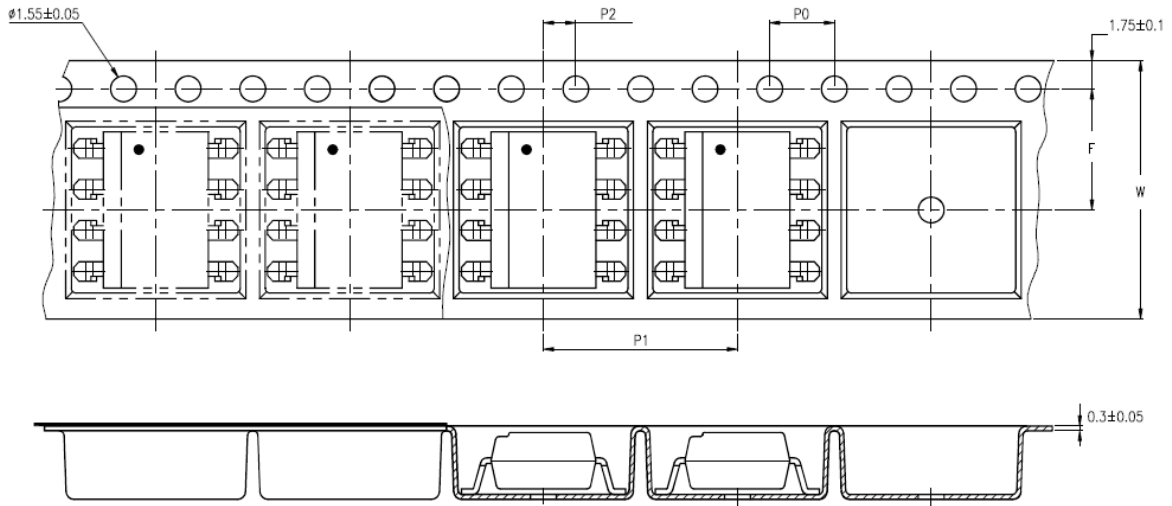


## TAPING DIMENSIONS

### 6N138S/6N139S-TA

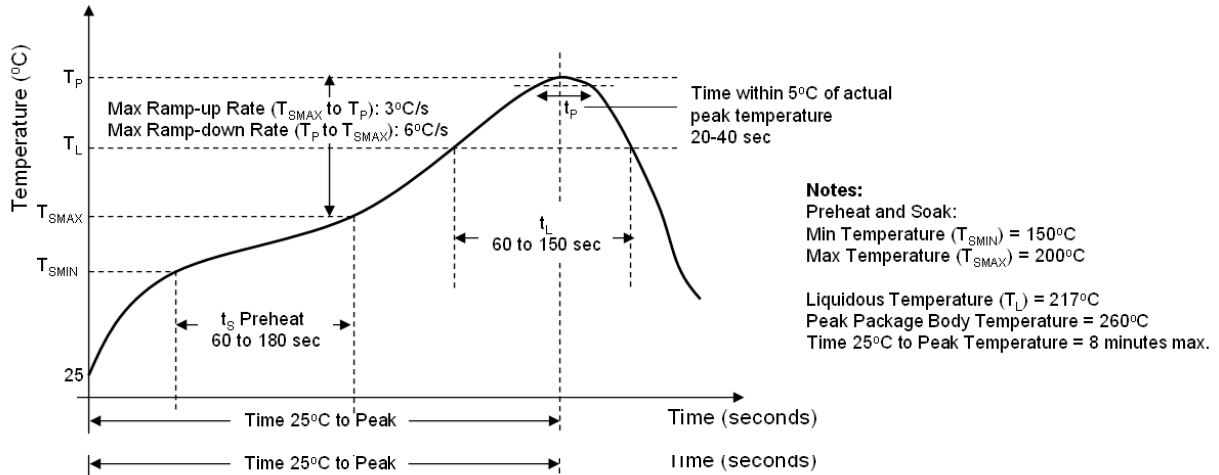


### 6N138S/6N139S-TA1



| Description                            | Symbol  | Dimensions in millimeters ( inches )           |
|--|---------|--|
| Tape wide                              | W       | $16 \pm 0.3$ ( .63 )                           |
| Pitch of sprocket holes                | P0      | $4 \pm 0.1$ ( .15 )                            |
| Distance of compartment                | F<br>P2 | $7.5 \pm 0.1$ ( .295 )<br>$2 \pm 0.1$ ( .079 ) |
| Distance of compartment to compartment | P1      | $12 \pm 0.1$ ( .472 )                          |

## Recommended Lead Free Reflow Profile



## Absolute Maximum Ratings\*1

| Parameter                          | Symbol        | Device         | Min  | TYP | Max | Units     |
|------------------------------------|---------------|----------------|------|-----|-----|-----------|
| Storage Temperature                | $T_{ST}$      | 6N138<br>6N139 | -55  |     | 125 | °C        |
| Operating Temperature              | $T_A$         |                | -20  |     | 85  | °C        |
| Isolation Voltage                  | $V_{ISO}$     |                | 5000 |     |     | $V_{RMS}$ |
| Supply Voltage                     | $V_{CC}$      |                |      |     | 15  | V         |
| Lead Solder Temperature * 2        | $T_{SOL}$     |                |      |     | 260 | °C        |
| <b>Input</b>                       |               |                |      |     |     |           |
| Average Forward Input Current      | $I_F$         | 6N138<br>6N139 |      |     | 20  | mA        |
| Reverse Input Voltage              | $V_R$         |                | 5    |     |     | V         |
| Input Power Dissipation            | $P_I$         |                | 35   |     |     | mW        |
| <b>Output</b>                      |               |                |      |     |     |           |
| Average Output Current             | $I_O$         | 6N138<br>6N139 |      |     | 50  | mA        |
| Supply Voltage, Output Voltage     | $V_{CC}, V_O$ | 6N138          | -0.5 |     | 7   | V         |
|                                    |               | 6N139          | -0.5 |     | 18  |           |
| Output Collector Power Dissipation | $P_O$         | 6N138<br>6N139 |      |     | 100 | mW        |

1. Ambient temperature = 25°C, unless otherwise specified. Stresses exceeding the absolute maximum ratings can cause permanent damage to the device. Exposure to absolute maximum ratings for long periods of time can adversely affect reliability.

2. 260°C for 10 seconds. Refer to Lead Free Reflow Profile.

## Electrical Specifications

| Parameters                                    | Test Condition   | Symbol                  | Device         | Min | Typ  | Max  | Units         |
|---|--|-------------------------|----------------|-----|------|------|---------------|
| <b>Input</b>                                  |  |                         |                |     |      |      |               |
| Input Forward Voltage                         | $I_F=1.6\text{mA}$ , $T_A=25^\circ\text{C}$  | $V_F$                   | 6N138<br>6N139 |     | 1.1  | 1.7  | V             |
| Input Forward Voltage Temperature Coefficient | $I_F=1.6\text{mA}$   | $\Delta V_F/\Delta T_A$ |                |     | -1.9 |      | mV/°C         |
| Input Reverse Voltage                         | $I_R=10\mu\text{A}$ , $T_A=25^\circ\text{C}$   | $BV_R$                  |                | 5   | -    | -    | V             |
| Input Capacitance                             | $V_F=0$ ; $f=1\text{MHz}$  | $C_{IN}$                |                | -   | 60   | -    | pF            |
| <b>Detector</b>                               |  |                         |                |     |      |      |               |
| Current transfer ratio                        | $I_F=1.6\text{mA}$ ; $V_o=0.4\text{V}$ ;<br>$V_{CC}=4.5\text{V}$                         | CTR                     | 6N138          | 300 | 1600 | 2600 | %             |
|   | $I_F=0.5\text{mA}$ ; $V_o=0.4\text{V}$ ;<br>$V_{CC}=4.5\text{V}$                         |                         | 6N139          | 400 | 2000 | 5000 |               |
|   | $I_F=1.6\text{mA}$ ; $V_{CC}=0.4\text{V}$ ;<br>$V_{CC}=4.5\text{V}$                      |                         |                | 500 | 1600 | 2600 |               |
| Logic low output voltage                      | $I_F=1.6\text{mA}$ ; $V_{CC}=4.5\text{V}$ ;<br>$I_o=4.8\text{mA}$                        | $V_{OL}$                | 6N138          | -   | 0.1  | 0.4  | V             |
|   | $I_F=0.5\text{mA}$ ; $V_{CC}=4.5\text{V}$ ;<br>$I_o=2\text{mA}$                          |                         | 6N139          | -   | 0.1  | 0.4  |               |
|   | $I_F=1.6\text{mA}$ ; $V_{CC}=4.5\text{V}$ ;<br>$I_o=8\text{mA}$                          |                         |                | -   | 0.2  |      |               |
|   | $I_F=5\text{mA}$ ; $V_{CC}=4.5\text{V}$ ;<br>$I_o=15\text{mA}$                           |                         |                |     |      |      |               |
|   | $I_F=12\text{mA}$ ; $V_{CC}=4.5\text{V}$ ;<br>$I_o=24\text{mA}$                          |                         |                |     |      |      |               |
| Logic high output current                     | $I_F=0\text{mA}$ , $V_o=V_{CC}=7\text{V}$<br>$T_A=25^\circ\text{C}$                      | $I_{OH}$                | 6N138          | -   | 0.05 | 250  | $\mu\text{A}$ |
|   | $I_F=0\text{mA}$ , $V_o=V_{CC}=18\text{V}$<br>$T_A=25^\circ\text{C}$                     |                         | 6N139          | -   | 0.1  | 100  |               |
| Logic low supply current                      | $I_F=1.6\text{mA}$ , $V_o=\text{open}$<br>( $V_{CC}=18\text{V}$ )                        | $I_{ccl}$               | 6N138<br>6N139 | -   | 0.4  | 1.5  | mA            |
| Logic high supply current                     | $I_F=0\text{mA}$ , $V_o=\text{open}$ ;<br>$T_A=25^\circ\text{C}$ ( $V_{CC}=18\text{V}$ ) | $I_{cch}$               | 6N138<br>6N139 | -   | 0.01 | 10   | $\mu\text{A}$ |

\*All Typical at  $T_A=25^\circ\text{C}$

### SWITCHING SPECIFICATIONS (AC)

$T_A=0\sim 70^{\circ}\text{C}$ ,  $V_{CC}=5\text{V}$ , unless otherwise specified.

| Parameter                                   | Test Condition  | Symbol    | Device | Min | Typ | Max | Units             |
|---|---|-----------|--------|-----|-----|-----|-------------------|
| Propagation Delay Time to Low Output Level  | $I_F=1.6\text{mA}$ ; $R_L=2.2\text{k}\Omega$                                | $t_{PHL}$ | 6N138  | -   | 1.6 | 10  | $\mu\text{s}$     |
|   | $I_F=0.5\text{mA}$ ; $R_L=4.7\text{k}\Omega$                                |           | 6N139  | -   | 5   | 25  |                   |
|   | $I_F=12\text{mA}$ ; $R_L=270\Omega$   |           |        | -   | 0.1 | 1   |                   |
| Propagation Delay Time to High Output Level | $I_F=1.6\text{mA}$ ; $R_L=2.2\text{k}\Omega$                                | $t_{PLH}$ | 6N138  | -   | 10  | 35  | $\mu\text{s}$     |
|   | $I_F=0.5\text{mA}$ ; $R_L=4.7\text{k}\Omega$                                |           | 6N139  | -   | 18  | 60  |                   |
|   | $I_F=12\text{mA}$ ; $R_L=270\Omega$   |           |        | -   | 2   | 7   |                   |
| Logic High Common Mode Transient Immunity   | $I_F=0\text{mA}$ ; $ V_{CM} =10\text{V}_{p-p}$<br>$R_L=2.2\text{k}\Omega$   | $ CM_H $  | 6N138  | 1   | 10  | -   | KV/ $\mu\text{s}$ |
|   |   |           | 6N139  |     |     |     | KV/ $\mu\text{s}$ |
| Logic Low Common Mode Transient Immunity    | $I_F=1.6\text{mA}$ ;<br>$ V_{CM} =10\text{V}_{p-p}$ $R_L=2.2\text{k}\Omega$ | $ CM_L $  | 6N138  | 1   | 10  | -   | KV/ $\mu\text{s}$ |
|   |   |           | 6N139  |     |     |     | KV/ $\mu\text{s}$ |

\*All Typical at  $T_A=25^{\circ}\text{C}$

### Isolation Characteristics

| Parameter                               | Test Condition  | Symbol           | Min  | Typ              | Max | Units            |
|---|---|------------------|------|------------------|-----|------------------|
| Input-Output Insulation Leakage Current | 45% RH, t = 5s,<br>V <sub>I-O</sub> = 3kV DC, T <sub>A</sub> = 25°C | I <sub>I-O</sub> |      |                  | 1.0 | μA               |
| Withstand Insulation Test Voltage       | RH ≤ 50%, t = 1min,<br>T <sub>A</sub> = 25°C                        | V <sub>ISO</sub> | 5000 |                  |     | V <sub>RMS</sub> |
| Input-Output Resistance                 | V <sub>I-O</sub> = 500V DC  | R <sub>I-O</sub> |      | 10 <sup>12</sup> |     | Ω                |

\*All Typical at T<sub>A</sub> = 25°C

#### Notes,

- AC For 1 Minute, R.H. = 40 ~ 60%. Isolation voltage shall be measured using the following method.
  - Short between anode and cathode on the primary side and between collector and emitter on the secondary side.
  - The isolation voltage tester with zero-cross circuit shall be used.
  - The waveform of applied voltage shall be a sine wave.
- For 10 Seconds
- Current Transfer Ratio (CTR) is defined as the ration of output collector current, I<sub>o</sub>, to the forward LED input current, I<sub>F</sub>, times 100%.
- Pin 7 open.
- Instantaneous common mode rejection voltage "output (1)" represents a common mode voltage variation that can hold the output above (1) level (V<sub>o</sub> > 2.0V). Instantaneous common mode rejection voltage "output (0)" represents a common mode voltage variation that can hold the output above (0) level (V<sub>o</sub> < 0.8V).
- Device considered a two terminal device. Pins 1, 2, 3 and 4 shorted together and Pins 5, 6, 7 and 8 shorted together.

## Switching Time Test Circuit

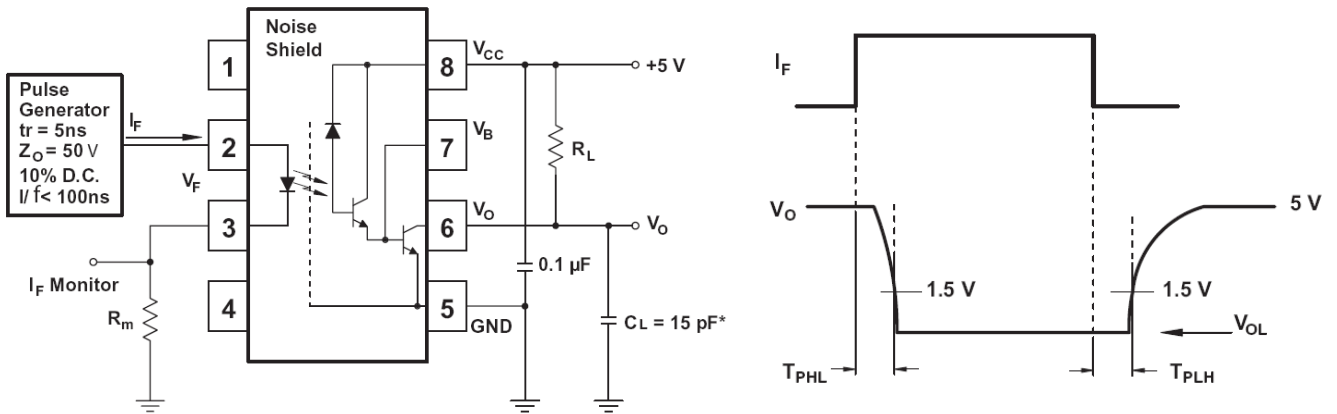


Figure 1: Single Channel Test Circuit for  $t_{PHL}$  and  $t_{PLH}$

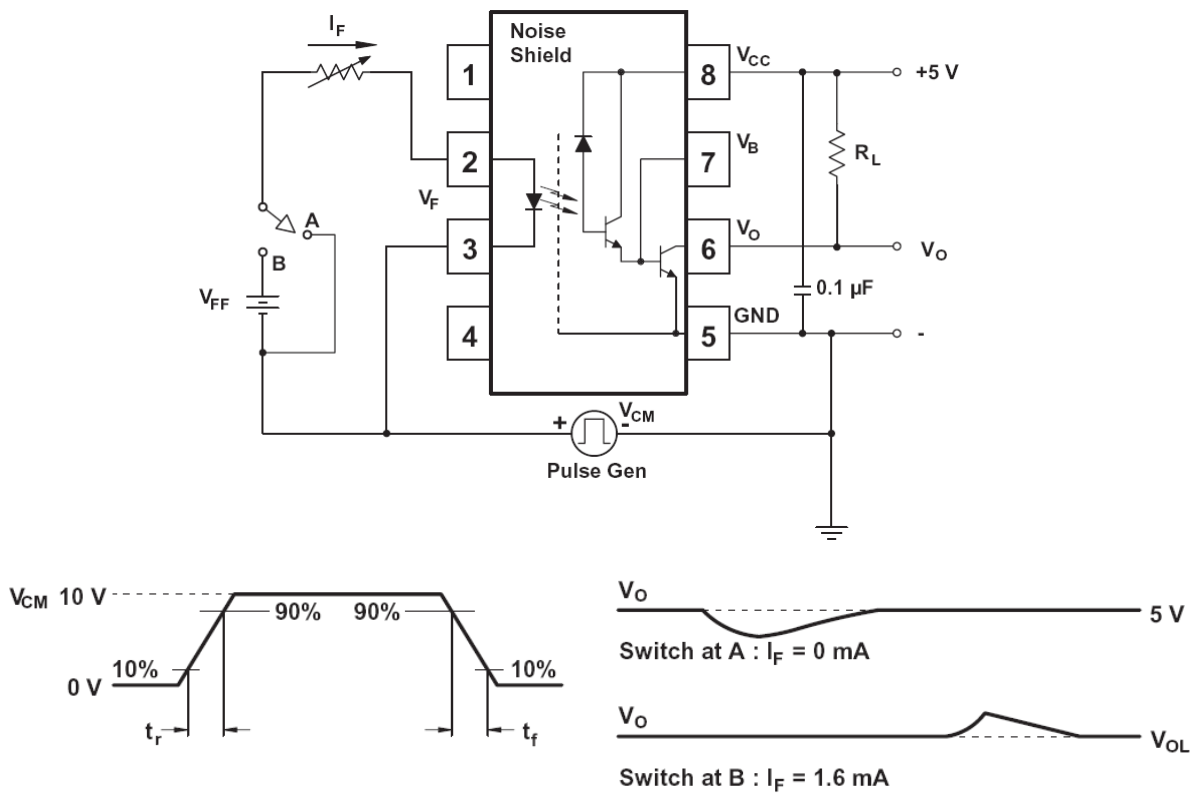


Figure 2: Single Channel Test Circuit for Common Mode Transient Immunity

## Characteristics Curves

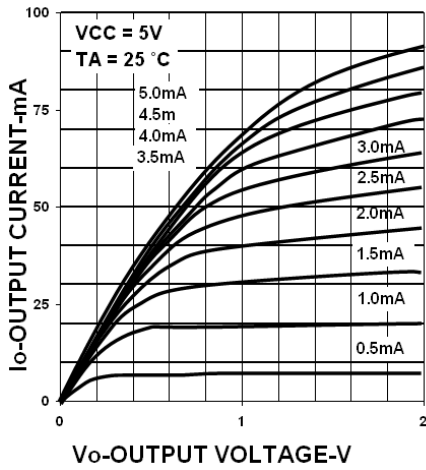


Figure 3: DC transfer characteristics

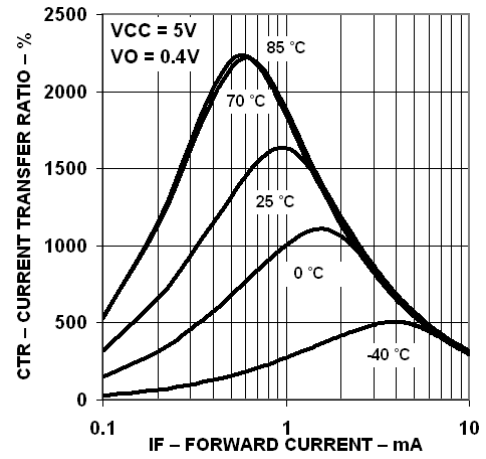


Figure 4: current transfer ratio vs. forward current

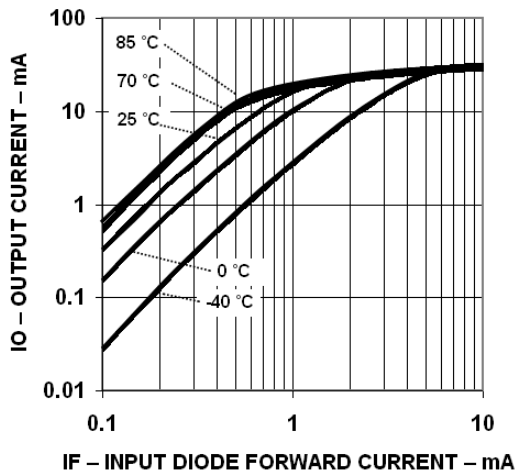


Figure 5: output current vs. input diode forward current

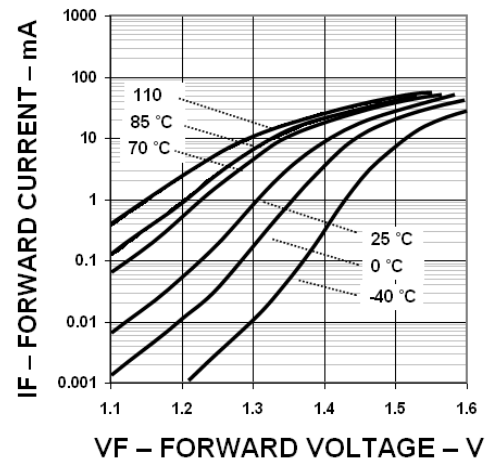


Figure 6: Input diode forward current vs. forward voltage

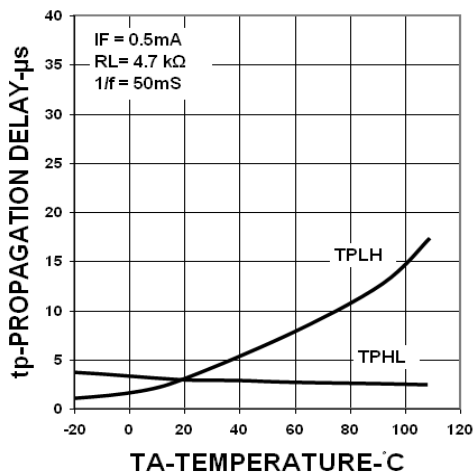


Figure 7: 6N139 propagation delay vs. temperature

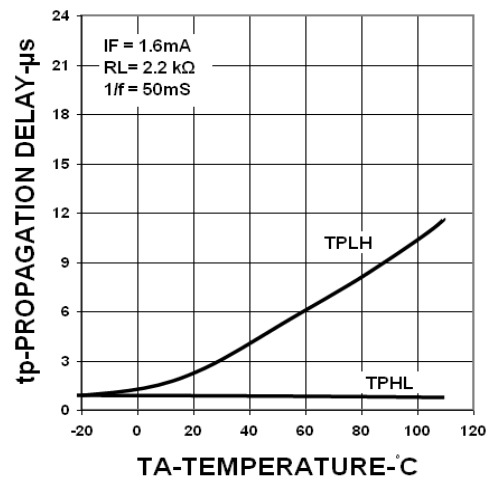


Figure 8: 6N138 propagation delay vs. temperature

## Characteristics Curves

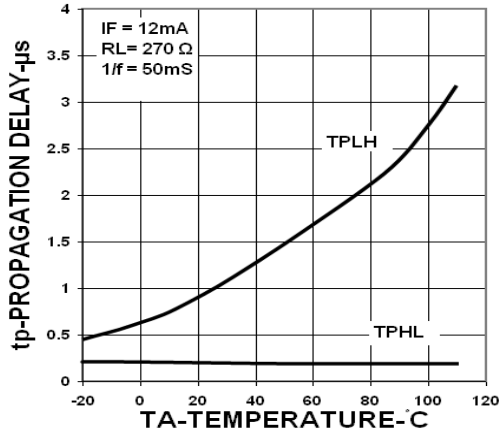


Figure 9: 6N139 propagation delay vs. temperature

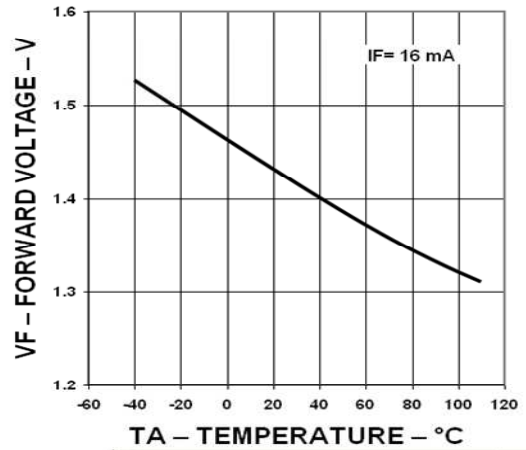


Figure 10: Forward voltage vs. temperature

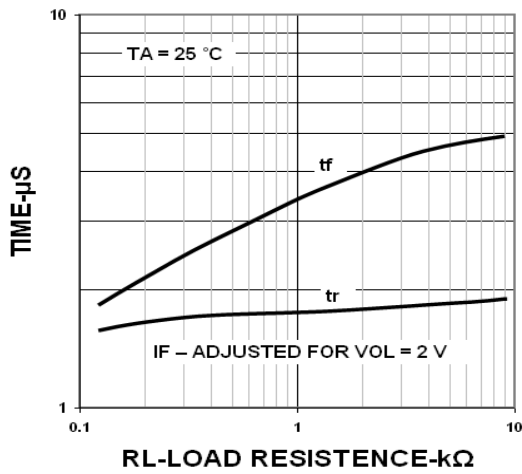


Figure 11: Non-saturated rise and fall time vs. load resistance

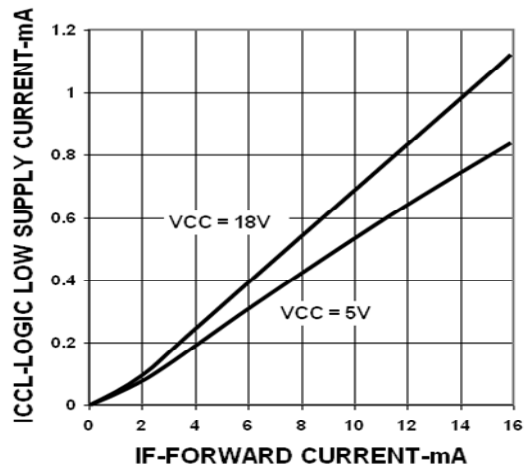


Figure 12: Logic low supply current vs. forward current

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