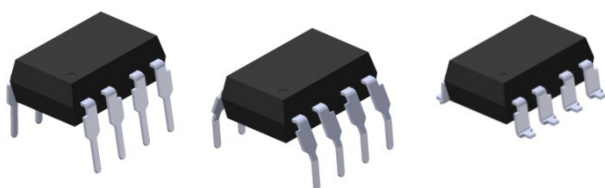


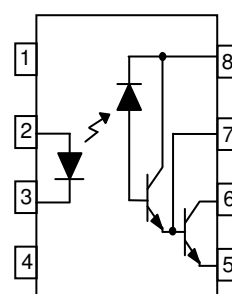
### 8 PIN DIP LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON PHOTOCOUPLER 6N138 6N139



#### Features

- High current transfer ratio—2000% typical
- High isolation voltage between input and output (Viso=5000 Vrms )
- Guaranteed performance from 0°C to 70 °C
- Pb free and RoHS compliant.
- UL approved (No. 214129)
- VDE approved (No. 132249)
- SEMKO approved
- NEMKO approved
- DEMKO approved
- FIMKO approved
- CSA approved (No. 2037145)

#### Schematic



#### Pin Configuration

1. No Connection
2. Anode
3. Cathode
4. No Connection
5. Gnd
6. Vout
7.  $V_B$
8. Vcc

#### Description

The 6N138 and 6N139 devices each consists of an infrared emitting diode, optically coupled to a high gain split Darlington photo detector. They provide extremely high current transfer ratio between input and output, with access to a base terminal to adjust the gain bandwidth. These devices are packaged in an 8-pin DIP package and available in wide-lead spacing and SMD options.

#### Applications

- Digital logic ground isolation
- RS-232C line receiver
- Low input current line receiver
- Microprocessor bus isolation
- Current loop receiver

### Absolute Maximum Ratings (Ta=25°C)

|        | Parameter                                                 | Symbol       | Rating                  | Unit  |
|--------|-----------------------------------------------------------|--------------|-------------------------|-------|
| Input  | Forward current                                           | $I_F$        | 20                      | mA    |
|        | Peak forward current<br>(50% duty, 1ms P.W)               | $I_{FP}$     | 40                      | mA    |
|        | Peak transient<br>current<br>( $\leq 1\mu s$ P.W, 300pps) | $I_{Ftrans}$ | 1                       | A     |
|        | Reverse voltage                                           | $V_R$        | 5                       | V     |
|        | Power dissipation                                         | $P_{IN}$     | 45                      | mW    |
| Output | Power dissipation                                         | $P_O$        | 100                     | mW    |
|        | Output current                                            | $I_O$        | 60                      | mA    |
|        | Emitter-Base<br>Reverse Voltage                           | $V_{ER}$     | 0.5                     | V     |
|        | Output voltage                                            | $V_O$        | -0.5 to 7<br>-0.5 to 18 | V     |
|        | Supply voltage                                            | $V_{CC}$     | -0.5 to 7<br>-0.5 to 18 | V     |
|        | Isolation voltage <sup>*1</sup>                           | $V_{ISO}$    | 5000                    | V rms |
|        | Operating temperature                                     | $T_{OPR}$    | -40 ~ +85               | °C    |
|        | Storage Temperature                                       | $T_{STG}$    | -55 ~ +125              | °C    |
|        | Soldering temperature <sup>*2</sup>                       | $T_{SOL}$    | 260                     | °C    |

#### Notes:

\*1 AC for 1 minute, R.H.= 40 ~ 60% R.H. In this test, pins 1, 2, 3, 4 are shorted together, and pins 5, 6, 7, 8 are shorted together.

\*2 For 10 seconds

**Electrical Characteristics (T<sub>A</sub>=0 to 70°C unless specified otherwise)**

**Input**

| Parameter                                  | Symbol                           | Min. | Typ. | Max. | Unit  | Condition                                   |
|--------------------------------------------|----------------------------------|------|------|------|-------|---------------------------------------------|
| Forward voltage                            | V <sub>F</sub>                   | -    | 1.3  | 1.7  | V     | I <sub>F</sub> = 1.6mA                      |
| Reverse Voltage                            | V <sub>R</sub>                   | 5.0  | -    | -    | V     | I <sub>R</sub> = 10μA, T <sub>A</sub> =25°C |
| Temperature coefficient of forward voltage | ΔV <sub>F</sub> /ΔT <sub>A</sub> | -    | -1.8 | -    | mV/°C | I <sub>F</sub> =1.6mA                       |

**Output**

| Parameter                 | Symbol                             | Min | Typ. | Max. | Unit | Condition                                                         |
|---------------------------|------------------------------------|-----|------|------|------|-------------------------------------------------------------------|
| Logic High Output Current | 6N138<br>6N139<br>I <sub>OH</sub>  | -   | 0.01 | 100  | μA   | I <sub>F</sub> =0mA, V <sub>O</sub> =V <sub>CC</sub> =18V         |
| Logic Low Supply Current  | 6N138<br>6N139<br>I <sub>CCL</sub> | -   | 0.6  | 1.5  | mA   | I <sub>F</sub> =1.6mA, V <sub>O</sub> =Open, V <sub>CC</sub> =18V |
| Logic High Supply Current | 6N138<br>6N139<br>I <sub>CCH</sub> | -   | 0.05 | 10   | μA   | I <sub>F</sub> =0mA, V <sub>O</sub> =Open, V <sub>CC</sub> =18V   |

**Transfer Characteristics (T<sub>a</sub>=0 to 70°C unless specified otherwise, V<sub>CC</sub>=4.5V)**

| Parameter                | Symbol | Min | Typ. | Max. | Unit | Condition                                                             |
|--------------------------|--------|-----|------|------|------|-----------------------------------------------------------------------|
| Current Transfer Ratio   | 6N139  | 400 | 2500 | -    | %    | I <sub>F</sub> = 0.5mA, V <sub>O</sub> = 0.4V, V <sub>CC</sub> =4.5V  |
|                          |        | 500 | 2000 | -    |      | I <sub>F</sub> = 1.6mA, V <sub>O</sub> = 0.4V, V <sub>CC</sub> =4.5V  |
|                          | 6N138  | 300 | 2000 | -    |      |                                                                       |
| Logic Low Output Voltage | 6N139  | -   | 0.05 | 0.4  | V    | I <sub>F</sub> = 0.5mA, I <sub>O</sub> = 2mA, V <sub>CC</sub> =4.5V   |
|                          |        | -   | 0.09 | 0.4  |      | I <sub>F</sub> = 1.6mA, I <sub>O</sub> = 8mA, V <sub>CC</sub> =4.5V   |
|                          |        | -   | 0.12 | 0.4  |      | I <sub>F</sub> = 5mA, I <sub>O</sub> = 15mA, V <sub>CC</sub> =4.5V    |
|                          |        | -   | 0.17 | 0.4  |      | I <sub>F</sub> = 12mA, I <sub>O</sub> = 24mA, V <sub>CC</sub> =4.5V   |
|                          |        | -   | 0.06 | 0.4  |      | I <sub>F</sub> = 1.6mA, I <sub>O</sub> = 4.8mA, V <sub>CC</sub> =4.5V |
|                          | 6N138  | -   | 0.06 | 0.4  |      |                                                                       |

**Switching Characteristics** ( $T_a=0$  to  $70^{\circ}\text{C}$  unless specified otherwise,  $V_{cc}=5\text{V}$ )

| Parameter                                                            | Symbol          | Min   | Typ. | Max. | Unit                                                                    | Condition                                                                                              |                                                                         |
|----------------------------------------------------------------------|-----------------|-------|------|------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Propagation Delay Time to Logic Low (Fig. 13)                        | 6N139           | TPHL  | -    | 5    | 25                                                                      | $\mu\text{s}$                                                                                          | $I_F = 0.5\text{mA}$ , $R_L=4.7\text{k}\Omega$ , $T_A=25^\circ\text{C}$ |
|                                                                      |                 |       | -    | -    | 30                                                                      |                                                                                                        | $I_F = 0.5\text{mA}$ , $R_L=4.7\text{k}\Omega$                          |
|                                                                      |                 |       | -    | 0.2  | 1                                                                       |                                                                                                        | $I_F = 12\text{mA}$ , $R_L=270\Omega$ , $T_A=25^\circ\text{C}$          |
|                                                                      | 6N138           | -     | -    | 2    | $I_F = 12\text{mA}$ , $R_L=270\Omega$                                   |                                                                                                        |                                                                         |
|                                                                      |                 | -     | 1.4  | 10   | $I_F = 1.6\text{mA}$ , $R_L=2.2\text{k}\Omega$ , $T_A=25^\circ\text{C}$ |                                                                                                        |                                                                         |
|                                                                      |                 | -     | -    | 15   | $I_F = 1.6\text{mA}$ , $R_L=2.2\text{k}\Omega$                          |                                                                                                        |                                                                         |
| Propagation Delay Time to Logic High (Fig. 13)                       | 6N139           | TPLH  | -    | 16   | 60                                                                      | $\mu\text{s}$                                                                                          | $I_F = 0.5\text{mA}$ , $R_L=4.7\text{k}\Omega$ , $T_A=25^\circ\text{C}$ |
|                                                                      |                 |       | -    | -    | 90                                                                      |                                                                                                        | $I_F = 0.5\text{mA}$ , $R_L=4.7\text{k}\Omega$                          |
|                                                                      |                 |       | -    | 1.7  | 7                                                                       |                                                                                                        | $I_F = 12\text{mA}$ , $R_L=270\Omega$ , $T_A=25^\circ\text{C}$          |
|                                                                      | 6N138           | -     | -    | 10   | $I_F = 12\text{mA}$ , $R_L=270\Omega$                                   |                                                                                                        |                                                                         |
|                                                                      |                 | -     | 8    | 35   | $I_F = 1.6\text{mA}$ , $R_L=2.2\text{k}\Omega$ , $T_A=25^\circ\text{C}$ |                                                                                                        |                                                                         |
|                                                                      |                 | -     | -    | 50   | $I_F = 1.6\text{mA}$ , $R_L=2.2\text{k}\Omega$                          |                                                                                                        |                                                                         |
| Common Mode Transient Immunity at Logic High (Fig. 14) <sup>*3</sup> | CM <sub>H</sub> | 1,000 | -    | -    | V/ $\mu\text{s}$                                                        | $I_F = 0\text{mA}$ ,<br>$V_{CM}=10\text{Vp-p}$ ,<br>$R_L=2.2\text{K}\Omega$ , $T_A=25^\circ\text{C}$   |                                                                         |
| Common Mode Transient Immunity at Logic Low (Fig. 14) <sup>*3</sup>  | CM <sub>L</sub> | 1,000 | -    | -    | V/ $\mu\text{s}$                                                        | $I_F = 1.6\text{mA}$ ,<br>$V_{CM}=10\text{Vp-p}$ ,<br>$R_L=2.2\text{K}\Omega$ , $T_A=25^\circ\text{C}$ |                                                                         |

\* Typical values at  $T_a = 25^{\circ}\text{C}$

## Typical Electro-Optical Characteristics Curves

Fig.1 LED Forward Current vs. Forward Voltage

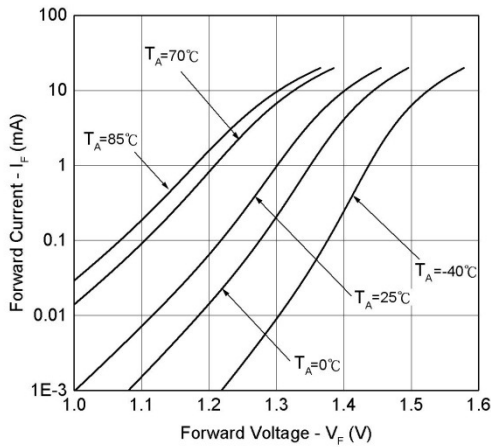


Fig.2 LED Forward Voltage vs. Temperature

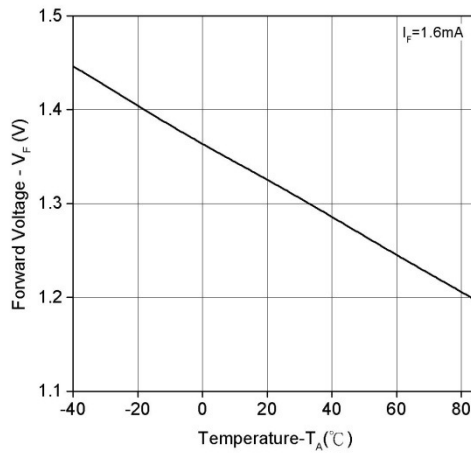


Fig.3 Output Current vs. Output Voltage

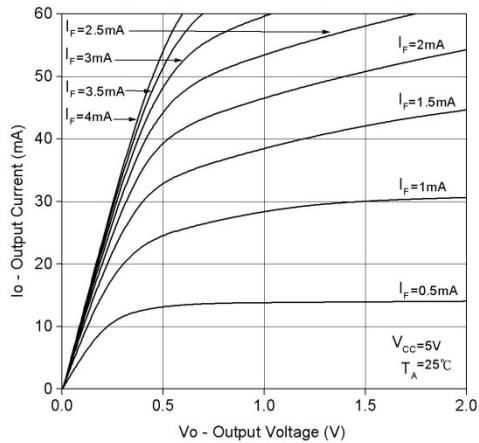


Fig.4 Output Current vs. Input Diode Forward Current

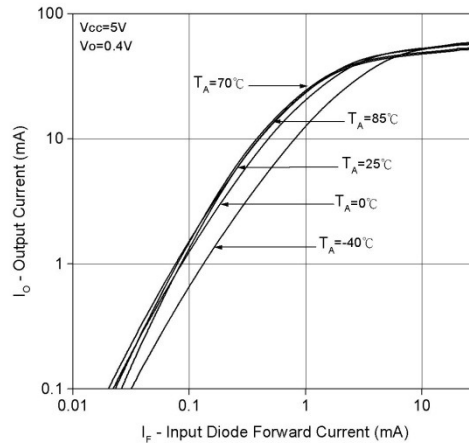


Fig.5 Current Transfer Ratio vs. Forward Current

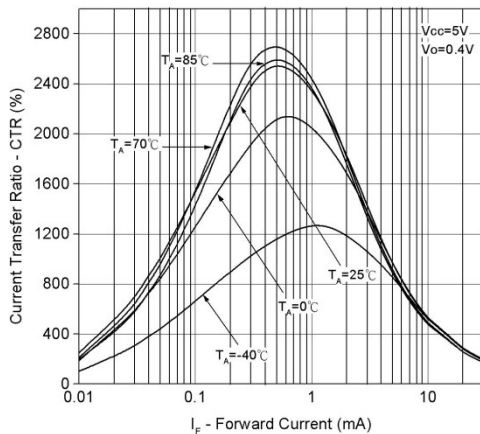


Fig.6 Current Transfer Ratio vs. Base-Emitter Resistance

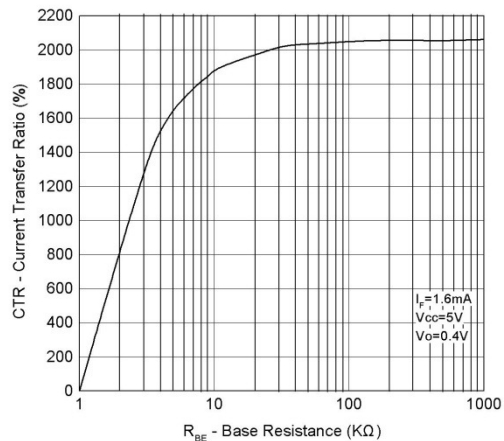


Fig.7 Non-saturated Rise and Fall Times vs. Load Resistance

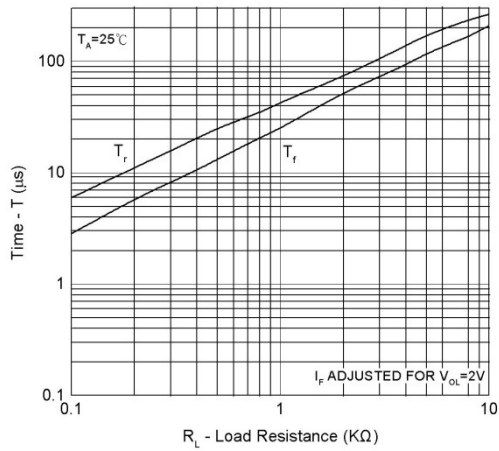


Fig.8 Propagation Delay To Logic Low vs. Base-Emitter Resistance

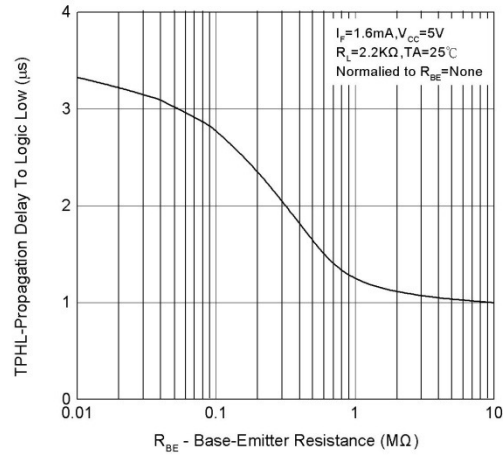


Fig.9 Propagation Delay vs. Input Diode Forward Current

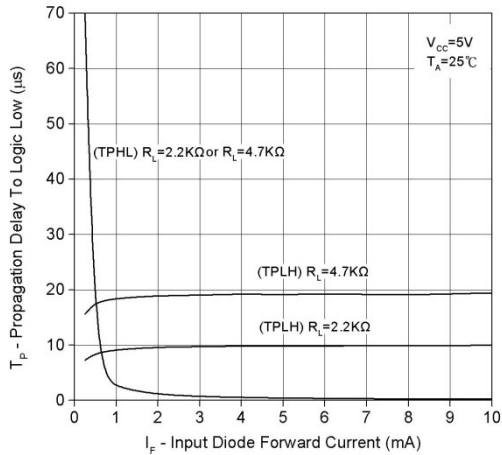


Fig.10 Propagation Delay to Logic Low vs. Pulse Period

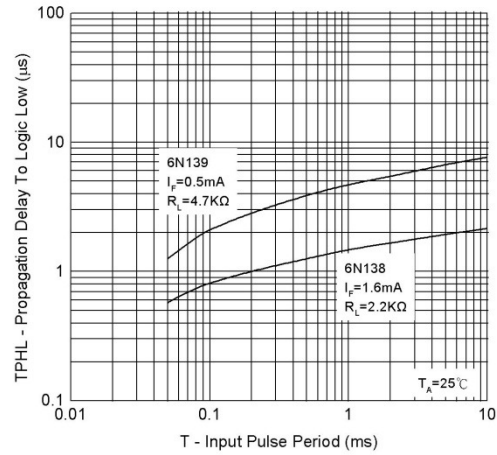


Fig.11 Propagation Delay vs. Temperature

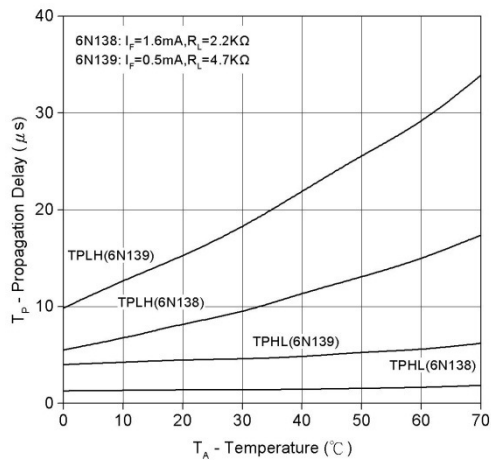


Fig.12 Logic Low Supply Current vs. Input Diode Forward Current

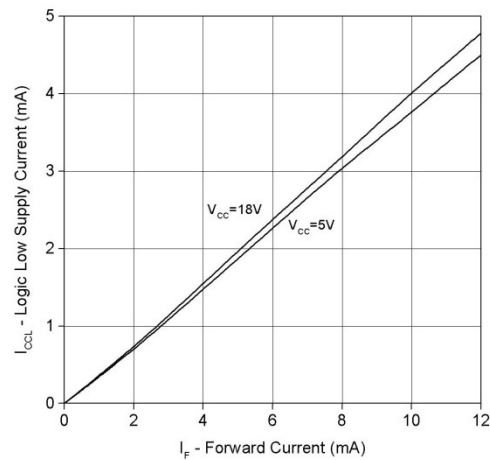


Fig. 13 Switching Time Test Circuit and Waveform

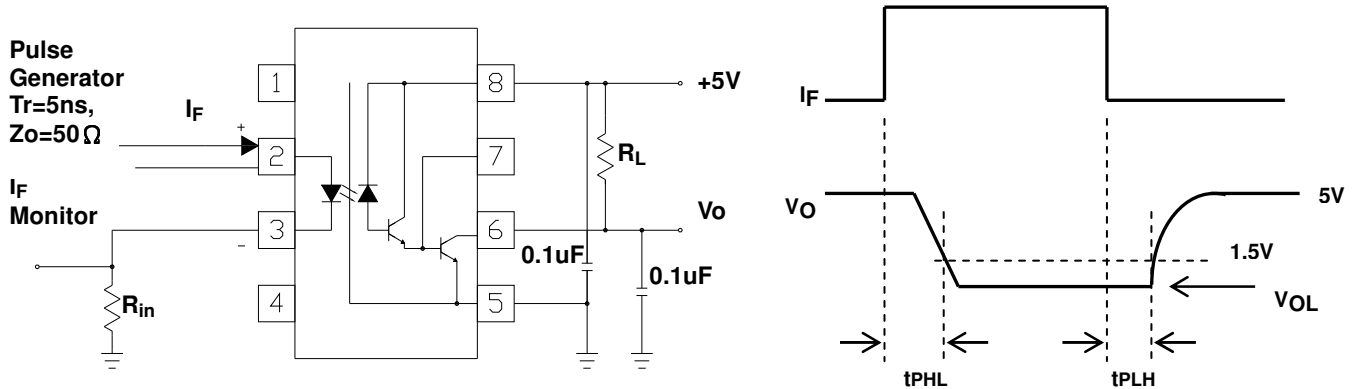
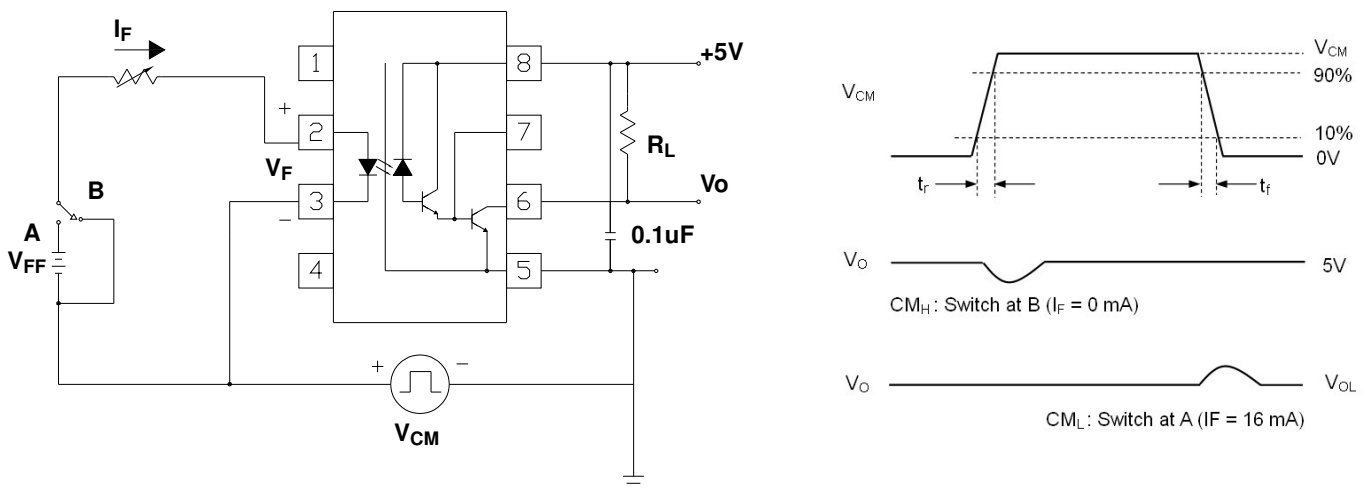


Fig. 14 Common Mode Transient Immunity Test Circuit and Waveform



**Note:**

\*3 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 signal  $V_{CM}$ , 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 a logic low state (i.e.,  $V_O < 0.8V$ ).

## Order Information

### Part Number

**6N13XY(Z)-V**

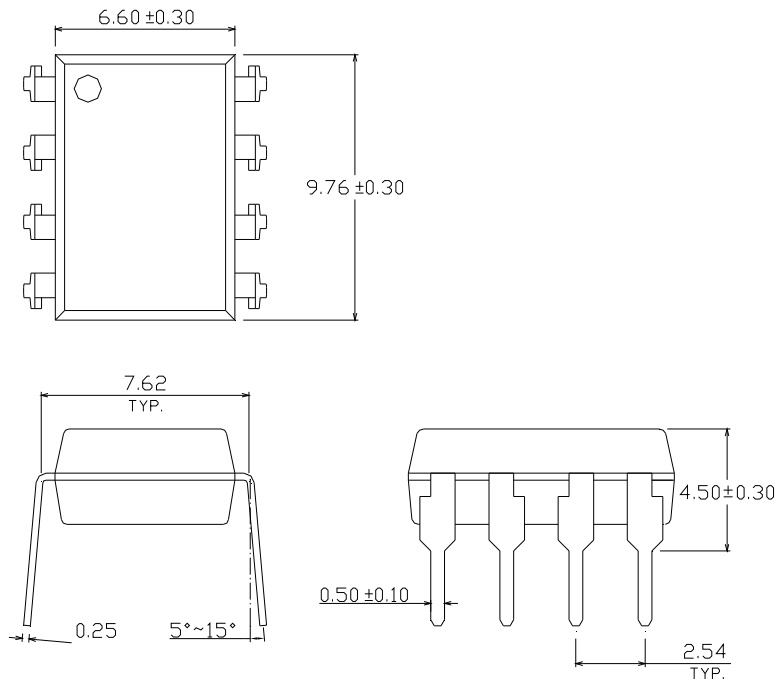
### Note

- X = Part No. (X = 8 or 9)  
Y = Lead form option (S, S1, M or none)  
Z = Tape and reel option (TA, TB or none).  
V = VDE (optional)

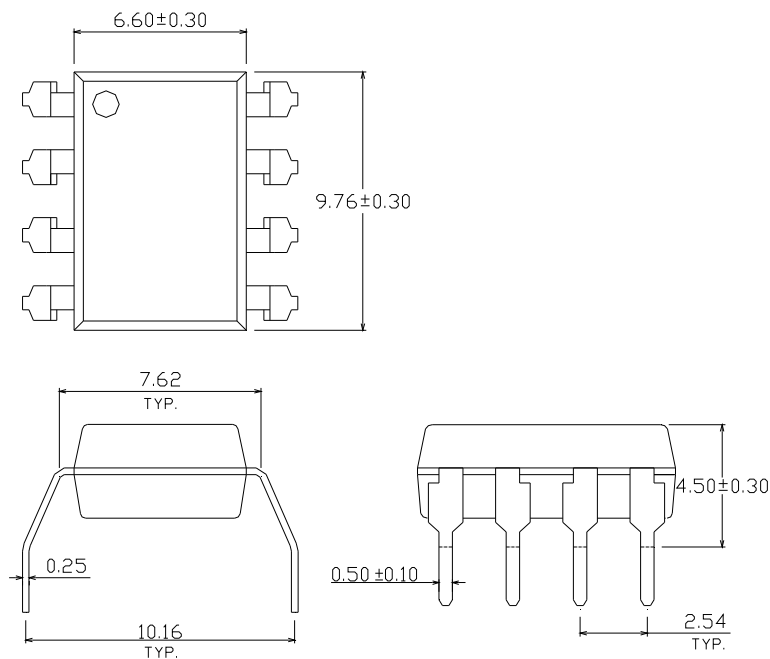
| Option  | Description                                                   | Packing quantity    |
|---------|---------------------------------------------------------------|---------------------|
| None    | Standard DIP-8                                                | 45 units per tube   |
| M       | Wide lead bend (0.4 inch spacing)                             | 45 units per tube   |
| S (TA)  | Surface mount lead form + TA tape & reel option               | 1000 units per reel |
| S (TB)  | Surface mount lead form + TB tape & reel option               | 1000 units per reel |
| S1 (TA) | Surface mount lead form (low profile) + TA tape & reel option | 1000 units per reel |
| S1 (TB) | Surface mount lead form (low profile) + TB tape & reel option | 1000 units per reel |

## Package Dimension (Dimensions in mm)

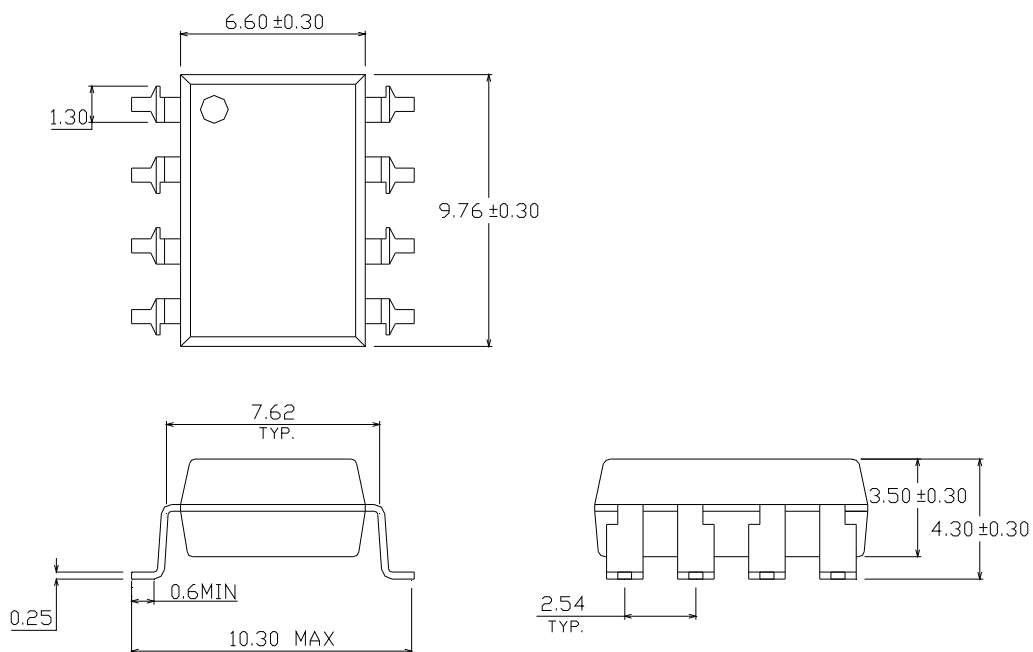
### Standard DIP Type



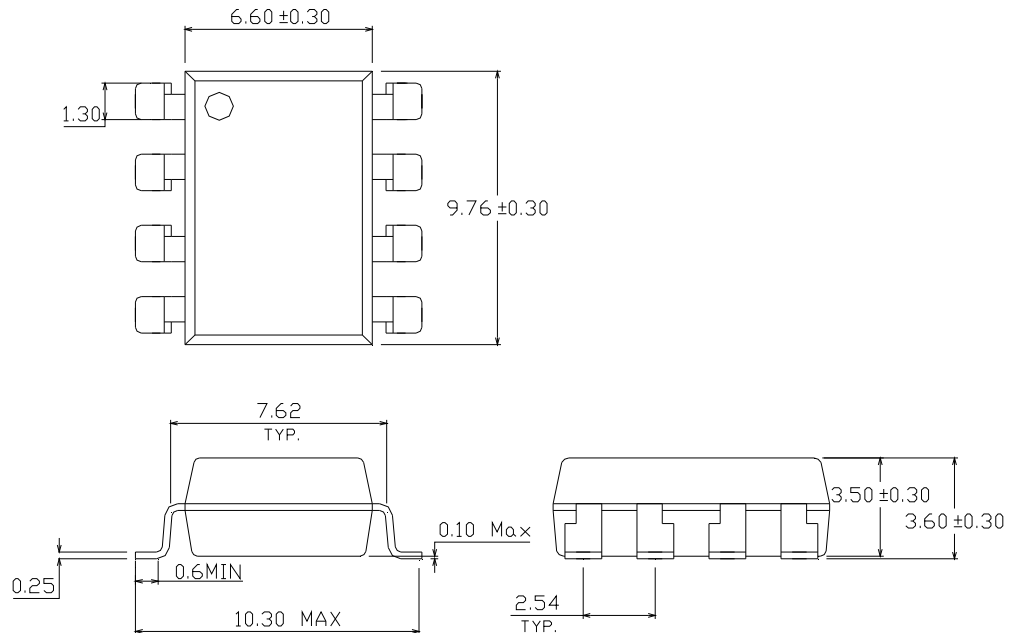
### Option M Type



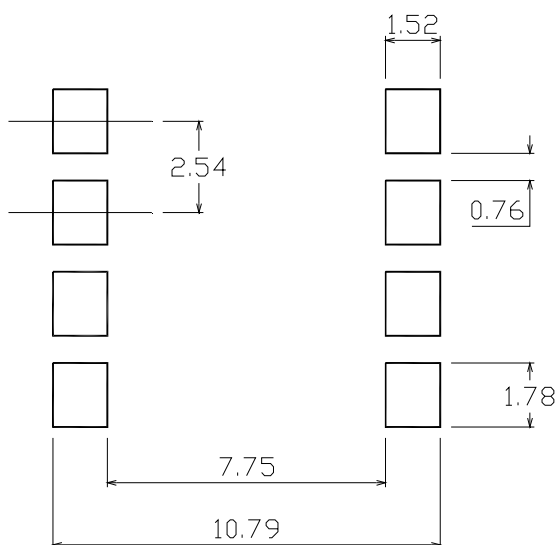
**Option S Type**



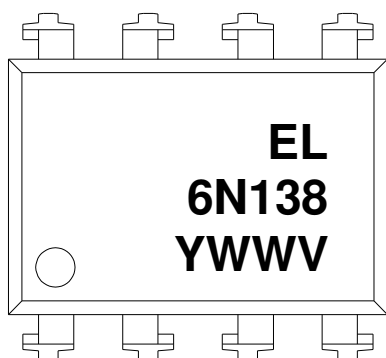
**Option S1 Type**



### Recommended pad layout for surface mount leadform



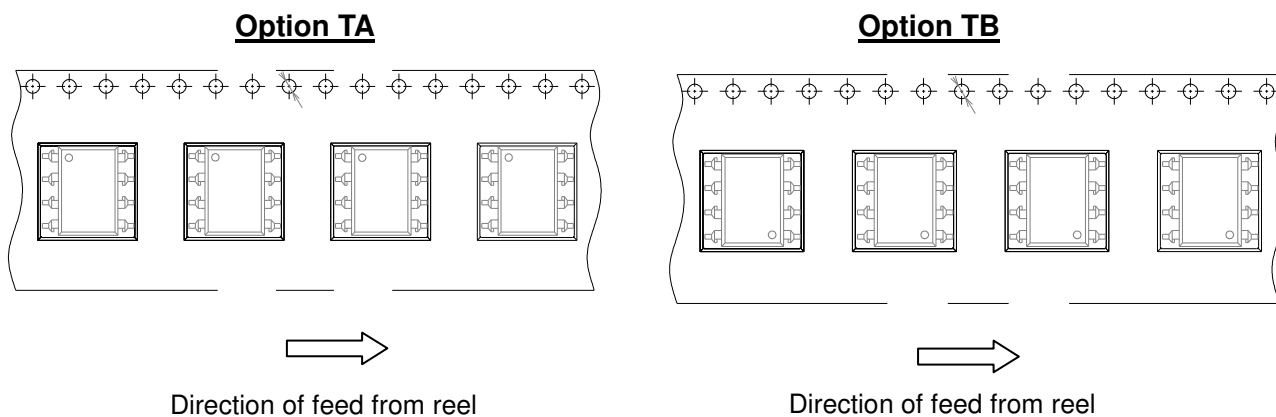
### Device Marking



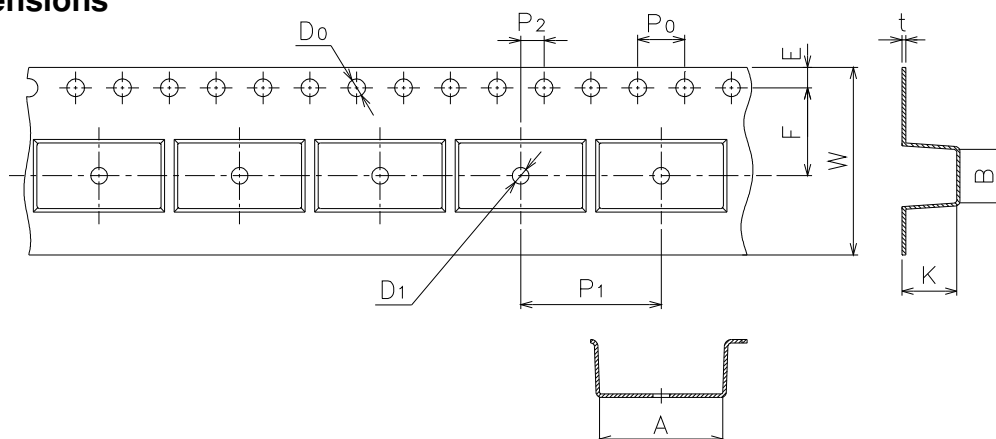
### Notes

|       |                           |
|-------|---------------------------|
| EL    | denotes EVERLIGHT         |
| 6N138 | denotes Device Number     |
| Y     | denotes 1 digit Year code |
| WW    | denotes 2 digit Week code |
| V     | denotes VDE (Optional)    |

## Tape & Reel Packing Specifications



## Tape dimensions

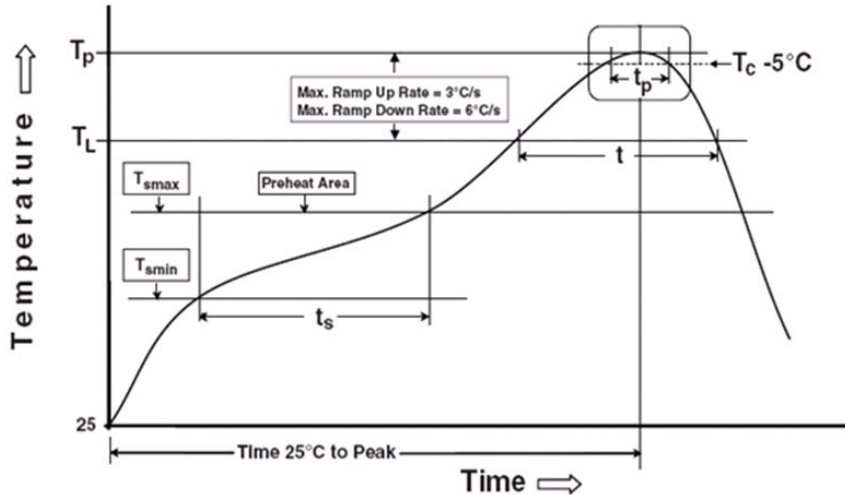


| Dimension No. | <b>A</b>  | <b>B</b>  | <b>Do</b>  | <b>D1</b>   | <b>E</b>  | <b>F</b> |
|---------------|-----------|-----------|------------|-------------|-----------|----------|
| Dimension(mm) | 10.4±0.1  | 10.0±0.1  | 1.5+0.1/-0 | 1.5±0.25/-0 | 1.75±0.1  | 7.5±0.1  |
| Dimension No. | <b>P0</b> | <b>P1</b> | <b>P2</b>  | <b>t</b>    | <b>W</b>  | <b>K</b> |
| Dimension(mm) | 4.0±0.1   | 12.0±0.1  | 2.0±0.05   | 0.4±0.05    | 16.0±0.3/ | 4.5±0.1  |

## Precautions for Use

### 1. Soldering Condition

#### 1.1 (A) Maximum Body Case Temperature Profile for evaluation of Reflow Profile



Note:

Reference: IPC/JEDEC J-STD-020D

#### Preheat

|                                              |                 |
|----------------------------------------------|-----------------|
| Temperature min ( $T_{smin}$ )               | 150 °C          |
| Temperature max ( $T_{smax}$ )               | 200 °C          |
| Time ( $T_{smin}$ to $T_{smax}$ ) ( $t_s$ )  | 60-120 seconds  |
| Average ramp-up rate ( $T_{smax}$ to $T_p$ ) | 3 °C/second max |

#### Other

|                                                                      |                  |
|----------------------------------------------------------------------|------------------|
| Liquidus Temperature ( $T_L$ )                                       | 217 °C           |
| Time above Liquidus Temperature ( $t_L$ )                            | 60-100 sec       |
| Peak Temperature ( $T_p$ )                                           | 260 °C           |
| Time within 5 °C of Actual Peak Temperature: $T_p - 5^\circ\text{C}$ | 30 s             |
| Ramp- Down Rate from Peak Temperature                                | 6°C /second max. |
| Time 25°C to peak temperature                                        | 8 minutes max.   |
| Reflow times                                                         | 3 times          |

## **DISCLAIMER**

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2. When using this product, please observe the absolute maximum ratings and the instructions for using outlined in these specification sheets. EVERLIGHT assumes no responsibility for any damage resulting from use of the product which does not comply with the absolute maximum ratings and the instructions included in these specification sheets.
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