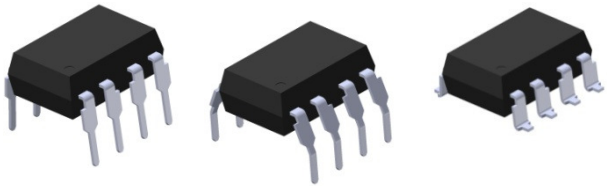
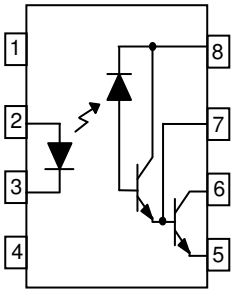
DATASHEET

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



Schematic




Pin Configuration

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

## Features

- High current transfer ratio–2000% typical
- High isolation voltage between input and output (Viso=5000 Vrms )
- Guaranteed performance from 0℃ to 70℃
- 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)

## 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


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## Absolute Maximum Ratings (Ta=25℃)

| | Parameter | | Symbol | Rating | Unit |
|---|---|---|---|---|---|
| Input | Forward current | | $I_F$ | 20 | mA |
| | Peak forward current (50% duty, 1ms P.W) | | $I_{FP}$ | 40 | mA |
| | Peak transient current (≤1μs 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 | | IO | 60 | mA |
| | Emitter-Base Reverse Voltage | | VER | 0.5 | V |
| | Output voltage | 6N138 | $V_O$ | -0.5 to 7 | V |
| | | 6N139 | | -0.5 to 18 | |
| | Supply voltage | 6N138 | $V_{CC}$ | -0.5 to 7 | V |
| | | 6N139 | | -0.5 to 18 | |
| Isolation voltage *1 | | | $V_{ISO}$ | 5000 | V rms |
| Operating temperature | | | $T_{OPR}$ | -40 ~ +85 | ℃ |
| Storage Temperature | | | $T_{STG}$ | -55 ~ +125 | ℃ |
| Soldering temperature *2 | | | $T_{SOL}$ | 260 | ℃ |

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


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## Electrical Characteristics ($T_A$=0 to 70℃ unless specified otherwise)

### Input

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| Forward voltage | $V_F$ | - | 1.3 | 1.7 | V | $I_F$ = 1.6mA |
| Reverse Voltage | $V_R$ | 5.0 | - | - | V | $I_R$ = 10μA, $T_A$=25℃ |
| Temperature coefficient of forward voltage | $\Delta V_F/\Delta T_A$ | - | -1.8 | - | mV/℃ | $I_F$ =1.6mA |

### Output

| Parameter | | Symbol | Min | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|---|
| Logic High Output Current | 6N138 | $I_{OH}$ | - | 0.01 | 100 | μA | $I_F$=0mA, $V_O$=$V_{CC}$=18V |
| | 6N139 | | - | - | 250 | | |
| Logic Low Supply Current | 6N138 | $I_{CCL}$ | - | 0.6 | 1.5 | mA | $I_F$=1.6mA, $V_O$=Open, $V_{CC}$=18V |
| | 6N139 | | | | | | |
| Logic High Supply Current | 6N138 | $I_{CCH}$ | - | 0.05 | 10 | μA | $I_F$=0mA, $V_O$=Open, $V_{CC}$=18V |
| | 6N139 | | | | | | |

## Transfer Characteristics ($T_a$=0 to 70℃ unless specified otherwise, Vcc=4.5V)

| Parameter | | Symbol | Min | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | 6N139 | CTR | 400 | 2500 | - | % | $I_F$ = 0.5mA, $V_O$ = 0.4V, $V_{CC}$=4.5V |
| | | | 500 | 2000 | - | | $I_F$ = 1.6mA, $V_O$ = 0.4V, $V_{CC}$=4.5V |
| | 6N138 | | 300 | 2000 | - | | |
| Logic Low Output Voltage | 6N139 | $V_{OL}$ | - | 0.05 | 0.4 | V | $I_F$ = 0.5mA, $I_O$ = 2mA, $V_{CC}$=4.5V |
| | | | - | 0.09 | 0.4 | | $I_F$ = 1.6mA, $I_O$ = 8mA, $V_{CC}$=4.5V |
| | | | - | 0.12 | 0.4 | | $I_F$ = 5mA, $I_O$ = 15mA, $V_{CC}$=4.5V |
| | | | - | 0.17 | 0.4 | | $I_F$ = 12mA, $I_O$ = 24mA, $V_{CC}$=4.5V |
| | 6N138 | | - | 0.06 | 0.4 | | $I_F$ = 1.6mA, $I_O$ = 4.8mA, $V_{CC}$=4.5V |


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## Switching Characteristics ($T_a$=0 to 70℃ unless specified otherwise, Vcc=5V)

| Parameter | | Symbol | Min | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low (Fig. 13) | 6N139 | TPHL | - | 5 | 25 | μs | $I_F$ = 0.5mA , $R_L$=4.7kΩ, $T_A$=25℃ |
| | | | - | - | 30 | | $I_F$ = 0.5mA , $R_L$=4.7kΩ |
| | | | - | 0.2 | 1 | | $I_F$ = 12mA , $R_L$=270Ω, $T_A$=25℃ |
| | | | - | - | 2 | | $I_F$ = 12mA , $R_L$=270Ω |
| | 6N138 | | - | 1.4 | 10 | | $I_F$ = 1.6mA , $R_L$=2.2kΩ, $T_A$=25℃ |
| | | | - | - | 15 | | $I_F$ = 1.6mA , $R_L$=2.2kΩ |
| Propagation Delay Time to Logic High (Fig. 13) | 6N139 | TPLH | - | 16 | 60 | μs | $I_F$ = 0.5mA , $R_L$=4.7kΩ, $T_A$=25℃ |
| | | | - | - | 90 | | $I_F$ = 0.5mA , $R_L$=4.7kΩ |
| | | | - | 1.7 | 7 | | $I_F$ = 12mA , $R_L$=270Ω, $T_A$=25℃ |
| | | | - | - | 10 | | $I_F$ = 12mA , $R_L$=270Ω |
| | 6N138 | | - | 8 | 35 | | $I_F$ = 1.6mA , $R_L$=2.2kΩ, $T_A$=25℃ |
| | | | - | - | 50 | | $I_F$ = 1.6mA , $R_L$=2.2kΩ |
| Common Mode Transient Immunity at Logic High (Fig. 14) *3 | | $CM_H$ | 1,000 | - | - | V/μs | $I_F$ = 0mA , $V_{CM}$=10Vp-p, $R_L$=2.2KΩ, $T_A$=25℃ |
| Common Mode Transient Immunity at Logic Low (Fig. 14) *3 | | $CM_L$ | 1,000 | - | - | V/μs | $I_F$ = 1.6mA , $V_{CM}$=10Vp-p, $R_L$=2.2KΩ, $T_A$=25℃ |

* Typical values at $T_a$ = 25℃


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## Typical Electro-Optical Characteristics Curves

Fig.1 LED Forward Current vs. Forward Voltage

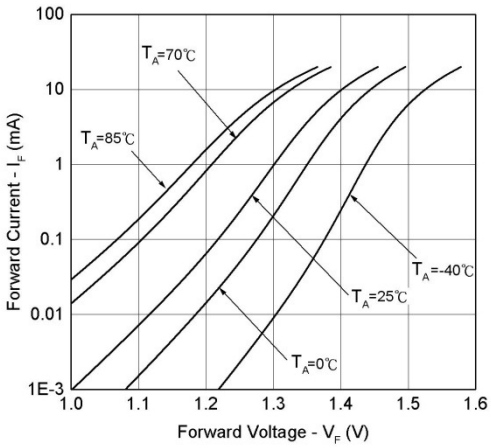



Fig.2 LED Forward Voltage vs. Temperature

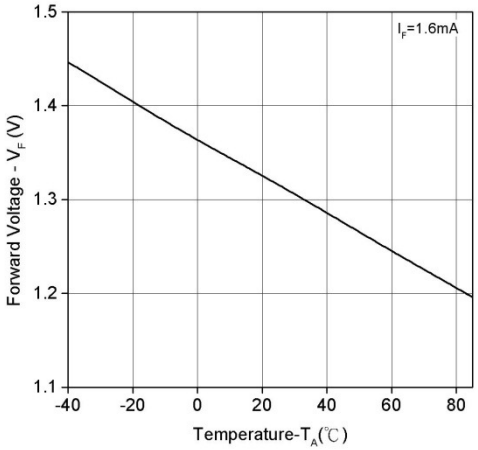



Fig.3 Output Current vs. Output Voltage

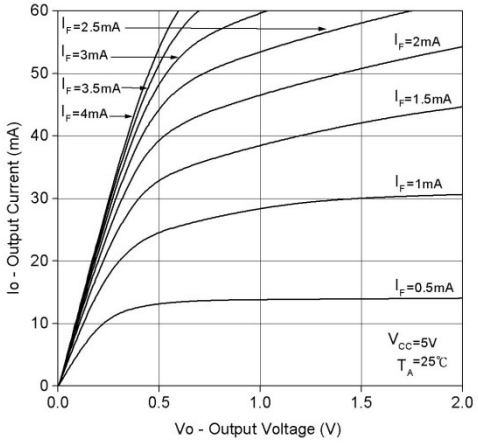



Fig.4 Output Current vs. Input Diode Forward Current

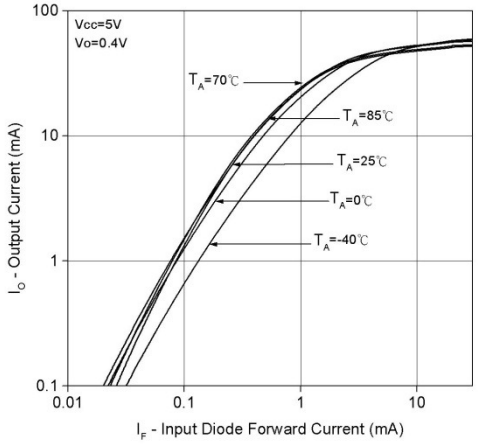



Fig.5 Current Transfer Ratio vs. Forward Current

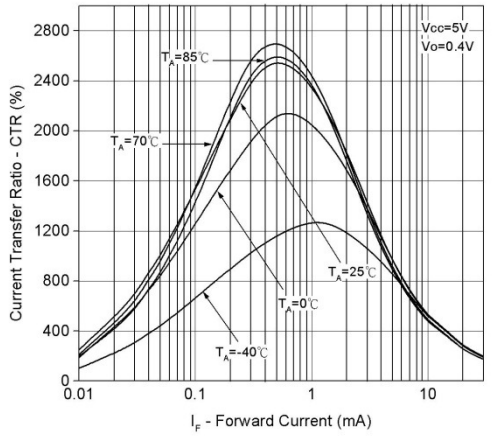
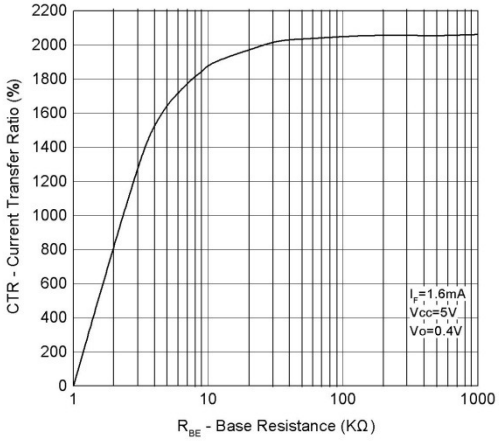



Fig.6 Current Transfer Ratio vs. Base-Emitter Resistance





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

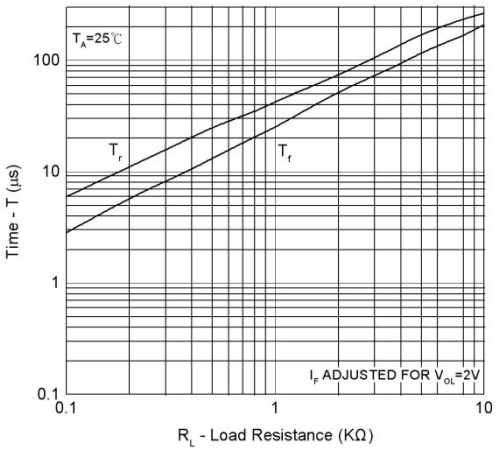



Fig.8 Propagation Delay To Logic Low vs. Base-Emitter Resistance

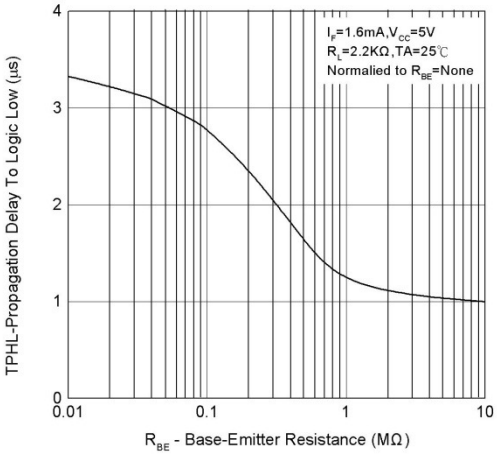



Fig.9 Propagation Delay vs. Input Diode Forward Current

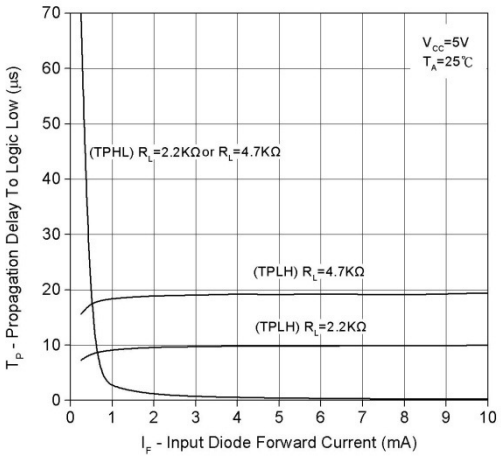



Fig.10 Propagation Delay to Logic Low vs. Pulse Period

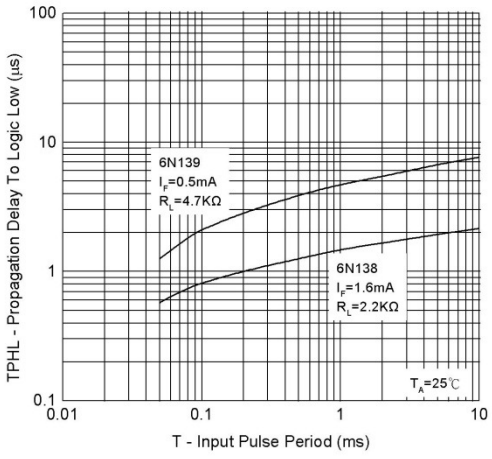



Fig.11 Propagation Delay vs. Temperature

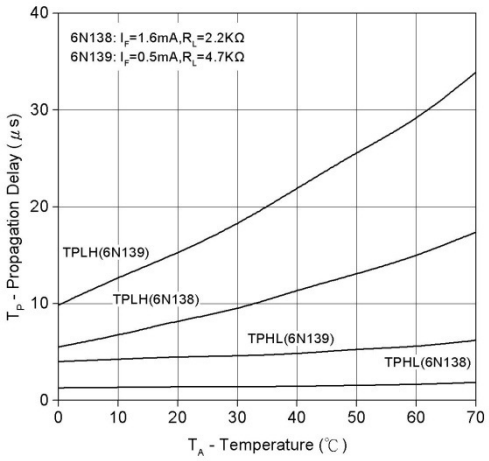
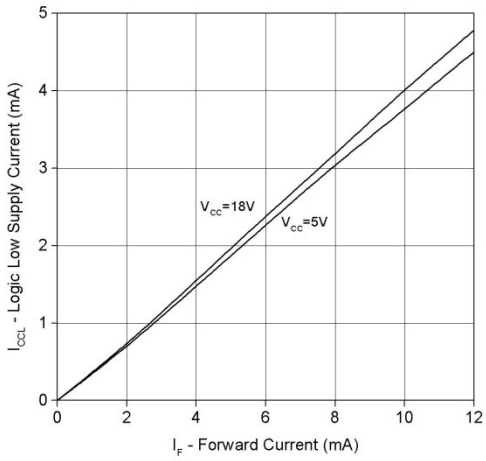


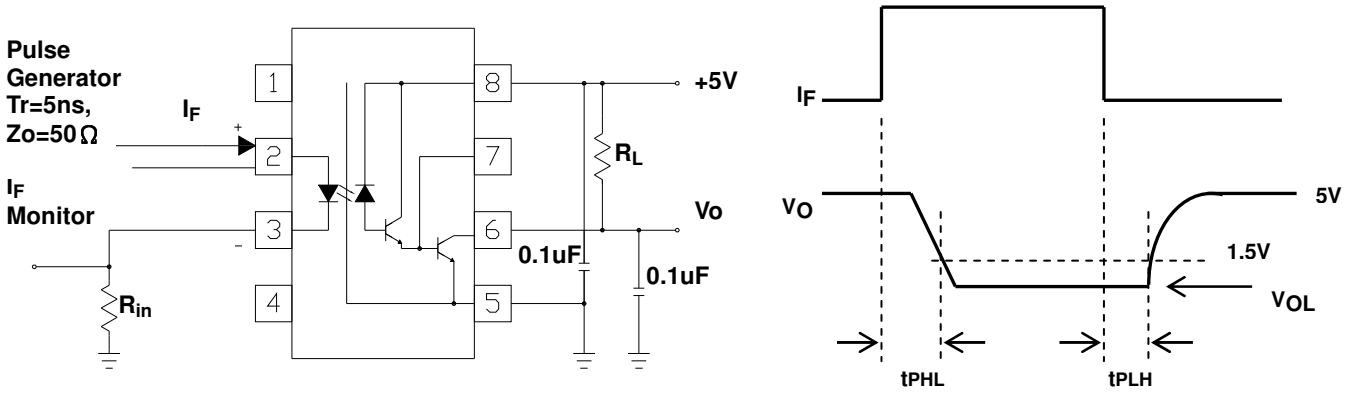

Fig.12 Logic Low Supply Current vs. Input Diode Forward Current



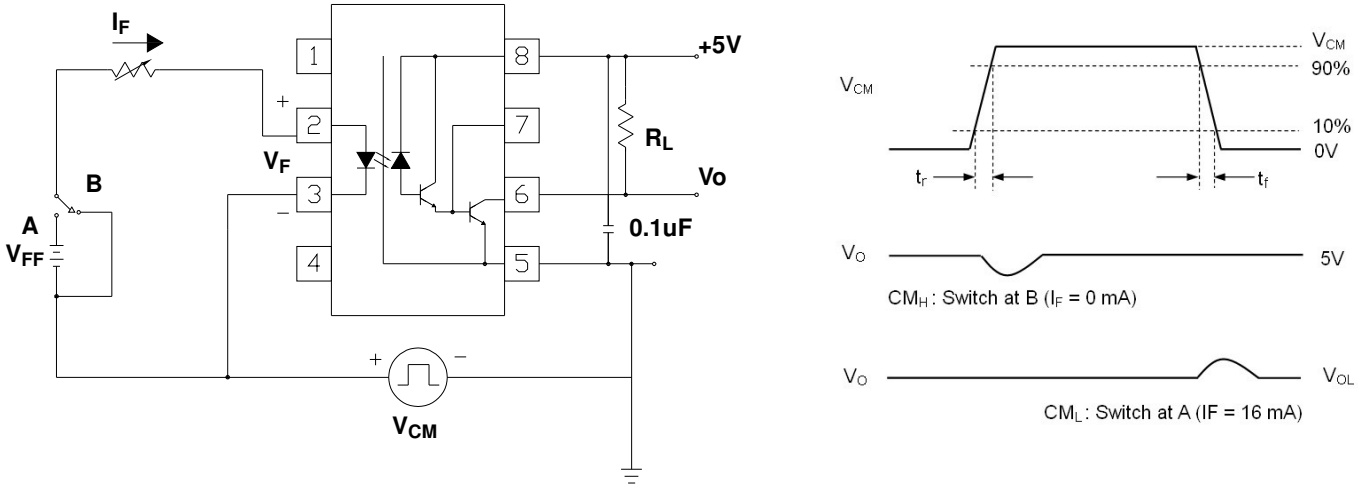


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## Fig. 13 Switching Time Test Circuit and Waveform




## 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) dVcm/dt on the leading edge of the common mode pulse signal VCM, to assure that the output will remain in a logic high state (i.e., VO > 2.0V).

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, VCM, to assure that the output will remain in a logic low state (i.e., VO < 0.8V).


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## Order Information

### Part Number

# 6N13XY(Z)-V

**Note**

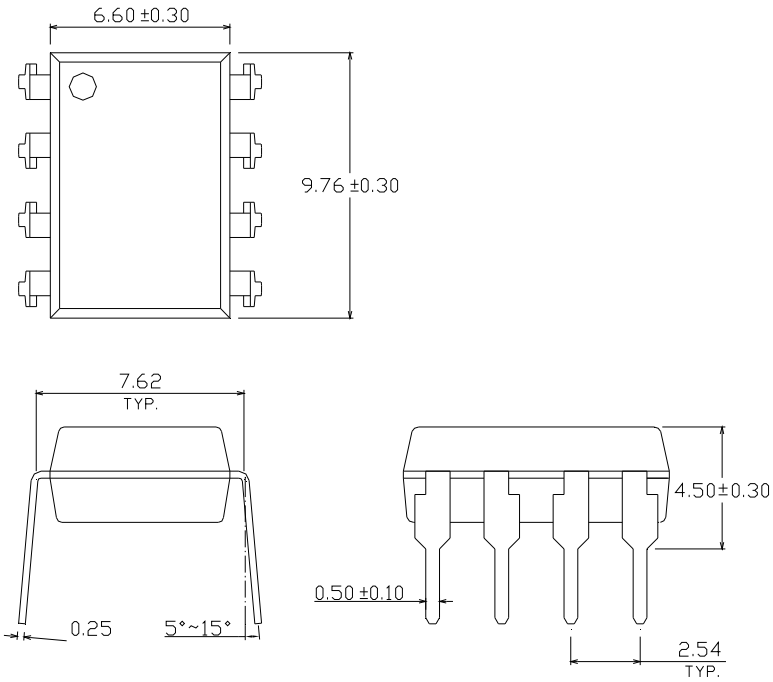
X = Part No. (X = 8 or 9)
Y = Lead form option (S, S1, M or none)
Z = Tape and reel option (TA, TB or none).
V = VDE (optional)

| 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 |

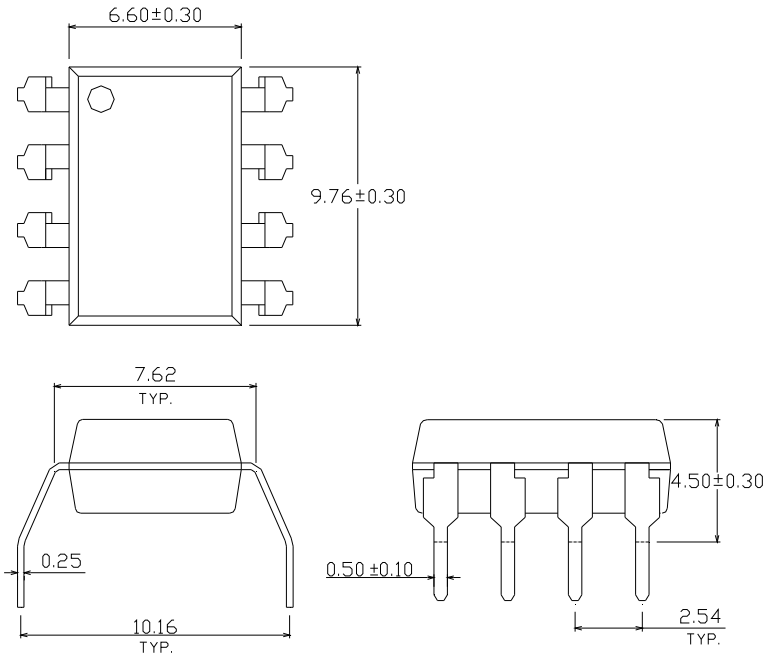

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## Package Dimension
**(Dimensions in mm)**

### Standard DIP Type



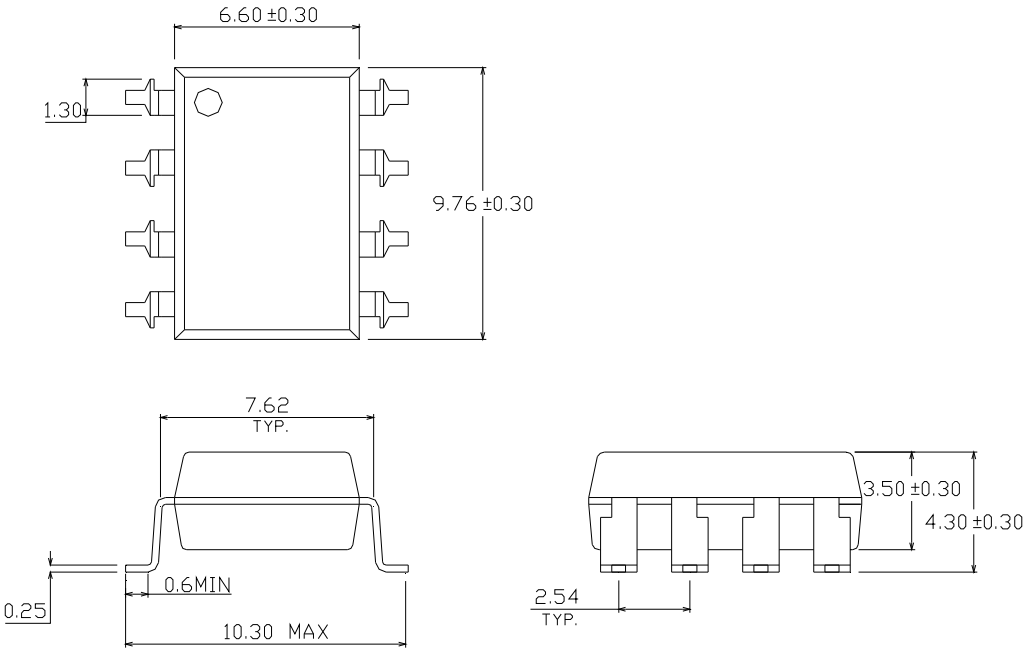

### Option M Type



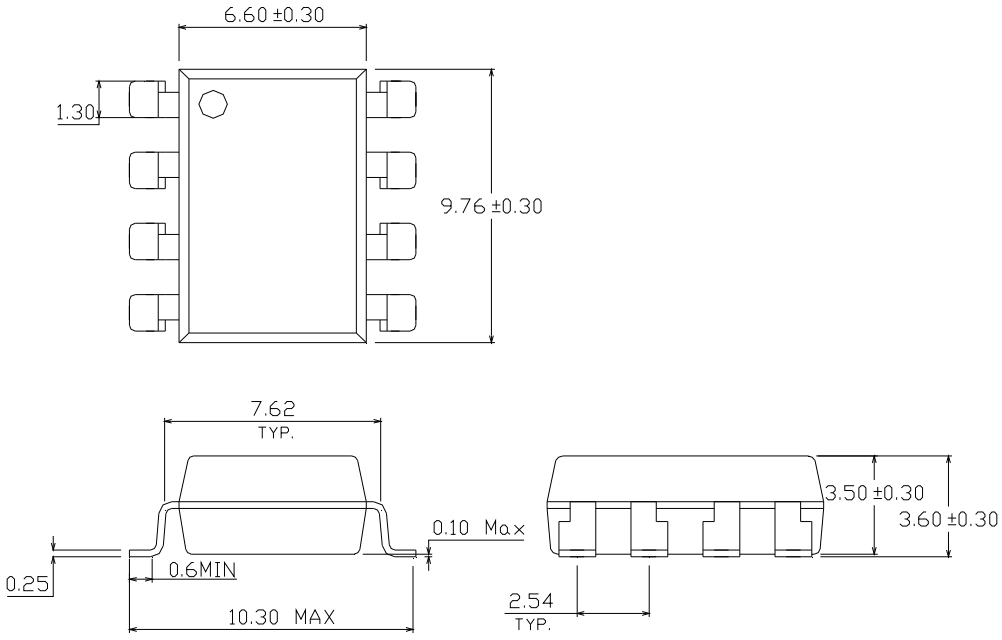


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**Option S Type**



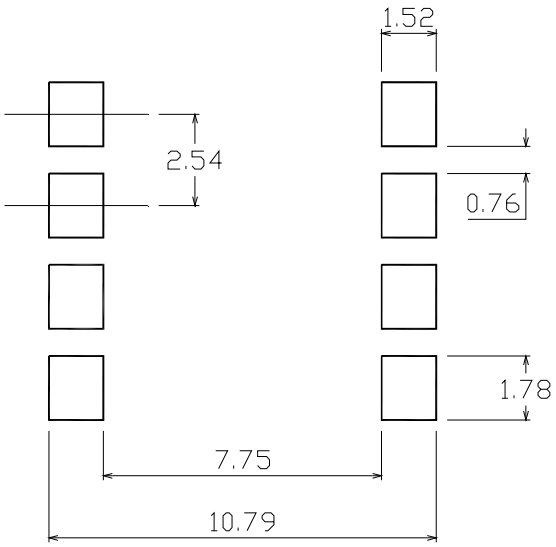

**Option S1 Type**



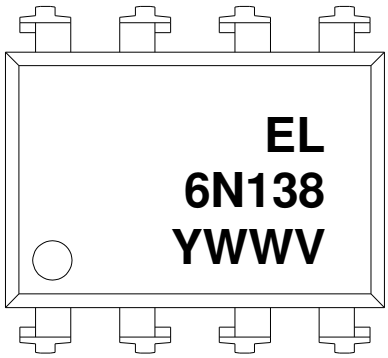


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## Recommended pad layout for surface mount leadform




## Device Marking



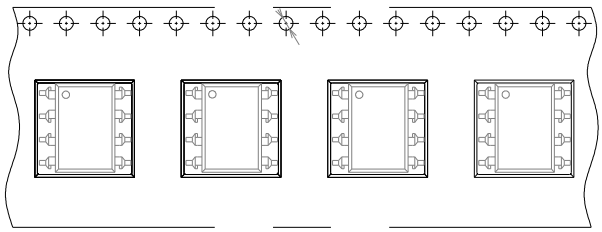

**Notes**

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


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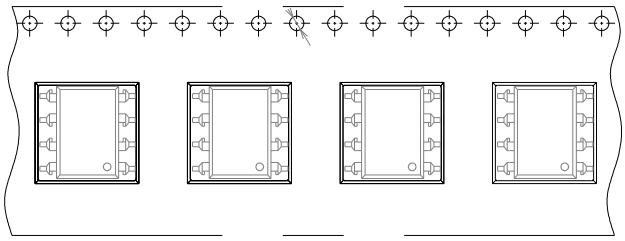
## Tape & Reel Packing Specifications

**Option TA**



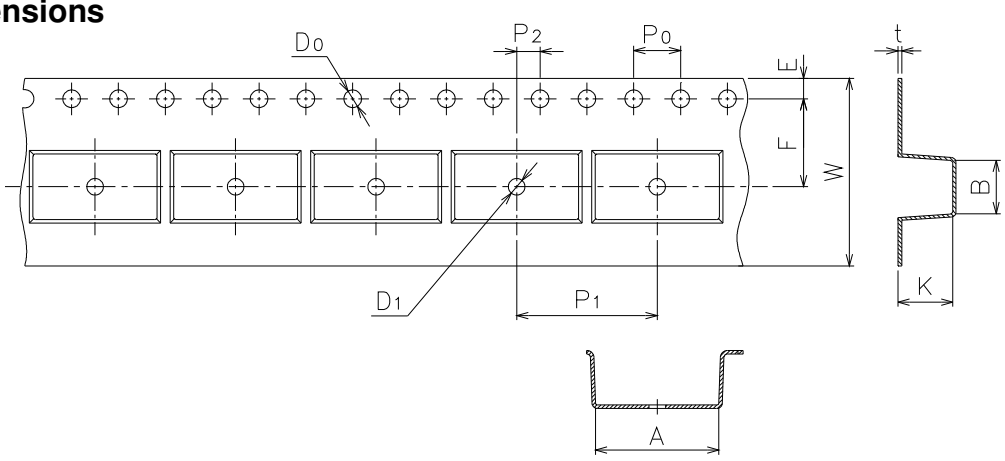
Direction of feed from reel

**Option TB**



Direction of feed from reel

## Tape dimensions



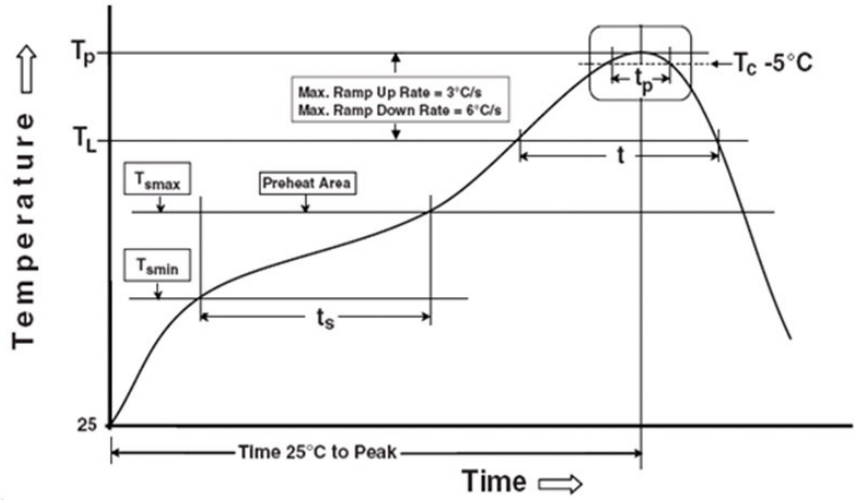

| Dimension No. | A | B | Do | D1 | E | F |
|---|---|---|---|---|---|---|
| Dimension(mm) | 10.4±0.1 | 10.0±0.1 | 1.5+0.1/-0 | 1.5±0.25/-0 | 1.75±0.1 | 7.5±0.1 |
| Dimension No. | **Po** | **P1** | **P2** | **t** | **W** | **K** |
| Dimension(mm) | 4.0±0.1 | 12.0±0.1 | 2.0±0.05 | 0.4±0.05 | 16.0±0.3/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


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## 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 ℃ |
| Temperature max ($T_{smax}$) | 200℃ |
| Time ($T_{smin}$ to $T_{smax}$) ($t_s$) | 60-120 seconds |
| Average ramp-up rate ($T_{smax}$ to $T_p$) | 3 ℃/second max |
| **Other** | |
| Liquidus Temperature ($T_L$) | 217 ℃ |
| Time above Liquidus Temperature ($t_L$) | 60-100 sec |
| Peak Temperature ($T_P$) | 260℃ |
| Time within 5 ℃ of Actual Peak Temperature: $T_P$ - 5℃ | 30 s |
| Ramp- Down Rate from Peak Temperature | 6℃ /second max. |
| Time 25℃ to peak temperature | 8 minutes max. |
| Reflow times | 3 times |

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