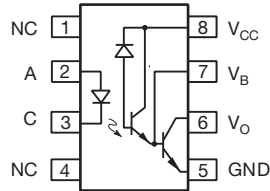
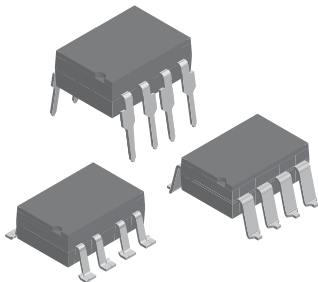


# High Speed Optocoupler, 100 kBd, Low Input Current, Photodiode Darlington Output



## FEATURES

- High current transfer ratio, 300 %
- Low input current, 0.5 mA
- High output current, 60 mA
- Isolation test voltage, 5300 V<sub>RMS</sub>
- TTL compatible output, V<sub>OL</sub> = 0.1 V
- High common mode rejection, 500 V/ $\mu$ s
- Adjustable bandwidth-access to base
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS COMPLIANT

## DESCRIPTION

High common mode transient immunity and very high current ratio together with 5300 V<sub>RMS</sub> insulation are achieved by coupling an LED with an integrated high gain photo detector in an eight pin dual-in-line package. Separate pins for the photo diode and output stage enable TTL compatible saturation voltages with high speed operation.

Access to the base terminal allows adjustment to the gain bandwidth.

The 6N138 is ideal for TTL applications since the 300 % minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 k $\Omega$  pull-up resistor.

The 6N139 is best suited for low power logic applications involving CMOS and low power TTL. A 400 % current transfer ratio with only 0.5 mA of LED current is guaranteed from 0 °C to 70 °C.

**Caution:** Due to the small geometries of this device, it should be handled with Electrostatic Discharge (ESD) precautions. Proper grounding would prevent damage further and/or degradation which may be induced by ESD.

## APPLICATIONS

- Microprocessor system interface
- PLC, ATE input / output isolation
- EIA RS232 line receiver
- TTL, CMOS voltage level translation
- Multiplexed data transmission
- Digital control power supply
- Ground loop and electrical noise elimination

## AGENCY APPROVALS

- UL1577, file no. E52744, double protection
- DIN EN 60747-5-5 available with option 1

| ORDERING INFORMATION     |                 |                         |   |
|--------------------------|-----------------|-------------------------|---|
| 6                        | N               | 1                       | 3 |
| PART NUMBER              |                 |                         |   |
| X                        | 0               | #                       | # |
| PACKAGE OPTION           |                 |                         |   |
| T                        |                 |                         |   |
| TAPE AND REEL            |                 |                         |   |
|                          |                 |                         |   |
| AGENCY CERTIFIED/PACKAGE | CTR (%)         |                         |   |
|                          | 1.6 mA          |                         |   |
| <b>UL</b>                | <b>&gt; 300</b> | <b>&gt; 500</b>         |   |
| DIP-8                    | 6N138           | 6N139, 6N139-X001       |   |
| SMD-8, option 7          | 6N138-X007T     | 6N139-X007, 6N139-X007T |   |
| SMD-8, option 9          | 6N138-X009T     | 6N139-X009, 6N139-X009T |   |
| <b>VDE</b>               | <b>&gt; 300</b> | <b>&gt; 500</b>         |   |
| SMD-8, option 7          | -               | 6N139-X017T             |   |
| SMD-8, option 9          | -               | 6N139-X019T             |   |

### Note

- For additional information on the available options refer to option information.



| ABSOLUTE MAXIMUM RATINGS (T <sub>amb</sub> = 25 °C, unless otherwise specified) |  |       |                                  |                    |                  |
|---|--|-------|----------------------------------|--------------------|------------------|
| PARAMETER   | TEST CONDITION                                     | PART  | SYMBOL                           | VALUE              | UNIT             |
| <b>INPUT</b>  |  |       |                                  |                    |                  |
| Reverse voltage   |  |       | V <sub>R</sub>                   | 5                  | V                |
| Forward current   |  |       | I <sub>F</sub>                   | 25                 | mA               |
| Average input current <sup>(1)</sup>  |  |       | I <sub>f(avg)</sub>              | 20                 | mA               |
| Input power dissipation <sup>(2)</sup>  |  |       | P <sub>diss</sub>                | 35                 | mW               |
| <b>OUTPUT</b>   |  |       |                                  |                    |                  |
| Supply and output voltage   | Pin 8 to 5, pin 6 to 5                             | 6N138 | V <sub>CC</sub> , V <sub>O</sub> | -0.5 to 7          | V                |
|   | Pin 8 to 5, pin 6 to 5                             | 6N139 | V <sub>CC</sub> , V <sub>O</sub> | -0.5 to 18         | V                |
| Emitter base reverse voltage  | Pin 5 to 7   |       |                                  | 0.5                | V                |
| Peak input current  | 50 % duty cycle - 1 ms pulse width                 |       |                                  | 40                 | mA               |
| Peak transient input current  | t <sub>p</sub> ≤ 1 μs, 300 pps                     |       |                                  | 1                  | A                |
| Output current  | Pin 6  |       | I <sub>O</sub>                   | 60                 | mA               |
| Output power dissipation <sup>(3)(4)</sup>                                      |  |       | P <sub>diss</sub>                | 100                | mW               |
| <b>COUPLER</b>  |  |       |                                  |                    |                  |
| Isolation test voltage  | t = 1 min  |       | V <sub>ISO</sub>                 | 5300               | V <sub>RMS</sub> |
| Isolation resistance  | V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 25 °C  |       | R <sub>IO</sub>                  | ≥ 10 <sup>12</sup> | Ω                |
|   | V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 100 °C |       | R <sub>IO</sub>                  | ≥ 10 <sup>11</sup> | Ω                |
| Storage temperature   |  |       | T <sub>stg</sub>                 | -55 to +150        | °C               |
| Operating temperature   |  |       | T <sub>amb</sub>                 | -55 to +100        | °C               |
| Lead soldering temperature <sup>(5)</sup>                                       | t = 10 s   |       | T <sub>slid</sub>                | 260                | °C               |

**Notes**

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.
- <sup>(1)</sup> Derate linearly above 50 °C free-air temperature at a rate of 0.333 mA/°C.
- <sup>(2)</sup> Derate linearly above 50 °C free-air temperature at a rate of 0.467 mW/°C.
- <sup>(3)</sup> Derate linearly above 25 °C free-air temperature at a rate of 0.6 mA/°C.
- <sup>(4)</sup> Derate linearly above 25 °C free-air temperature at a rate of 1 mW/°C.
- <sup>(5)</sup> Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).

| ELECTRICAL CHARACTERISTICS (T <sub>amb</sub> = 25 °C, unless otherwise specified) |   |       |                  |      |       |      |       |
|---|---|-------|------------------|------|-------|------|-------|
| PARAMETER   | TEST CONDITION  | PART  | SYMBOL           | MIN. | TYP.  | MAX. | UNIT  |
| <b>INPUT</b>  |   |       |                  |      |       |      |       |
| Input forward voltage   | I <sub>F</sub> = 1.6 mA   |       | V <sub>F</sub>   |      | 1.4   | 1.7  | V     |
| Input reverse breakdown voltage   | I <sub>R</sub> = 10 μA  |       | B <sub>VR</sub>  | 5    |       |      | V     |
| Temperature coefficient of forward voltage  | I <sub>F</sub> = 1.6 mA   |       |                  |      | -1.8  |      | mV/°C |
| <b>OUTPUT</b>   |   |       |                  |      |       |      |       |
| Logic low, output voltage <sup>(1)</sup>  | I <sub>F</sub> = 1.6 mA, I <sub>O</sub> = 4.8 mA, V <sub>CC</sub> = 4.5 V | 6N138 | V <sub>OL</sub>  |      | 0.1   | 0.4  | V     |
|   | I <sub>F</sub> = 1.6 mA, I <sub>O</sub> = 8 mA, V <sub>CC</sub> = 4.5 V   | 6N139 | V <sub>OL</sub>  |      | 0.1   | 0.4  | V     |
|   | I <sub>F</sub> = 5 mA, I <sub>O</sub> = 15 mA, V <sub>CC</sub> = 4.5 V    | 6N139 | V <sub>OL</sub>  |      | 0.15  | 0.4  | V     |
|   | I <sub>F</sub> = 12 mA, I <sub>O</sub> = 24 mA, V <sub>CC</sub> = 4.5 V   | 6N139 | V <sub>OL</sub>  |      | 0.25  | 0.4  | V     |
| Logic high, output current <sup>(1)</sup>   | I <sub>F</sub> = 0 mA, V <sub>CC</sub> = 7 V                              | 6N138 | I <sub>OH</sub>  |      | 0.1   | 250  | μA    |
|   | I <sub>F</sub> = 0 mA, V <sub>CC</sub> = 18 V                             | 6N139 | I <sub>OH</sub>  |      | 0.05  | 100  | μA    |
| Logic low supply current <sup>(1)</sup>   | I <sub>F</sub> = 1.6 mA, V <sub>O</sub> = OPEN, V <sub>CC</sub> = 18 V    |       | I <sub>CCL</sub> |      | 0.2   | 1.5  | mA    |
| Logic high supply current <sup>(1)</sup>  | I <sub>F</sub> = 0 mA, V <sub>O</sub> = OPEN, V <sub>CC</sub> = 18 V      |       | I <sub>CCH</sub> |      | 0.001 | 10   | μA    |



| ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |  |      |          |      |           |      |               |
|---|--|------|----------|------|-----------|------|---------------|
| PARAMETER   | TEST CONDITION   | PART | SYMBOL   | MIN. | TYP.      | MAX. | UNIT          |
| <b>COUPLER</b>  |  |      |          |      |           |      |               |
| Input capacitance   | $f = 1\text{ MHz}$ , $V_F = 0$   |      | $C_{IN}$ |      | 25        |      | pF            |
| Input output insulation leakage current <sup>(2)</sup>  | 45 % relative humidity,<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ , $t = 5\text{ s}$ , $V_{IO} = 3000\text{ V}_{DC}$ |      |          |      |           | 1    | $\mu\text{A}$ |
| Resistance (input to output) <sup>(2)</sup>   | $V = 500\text{ V}_{peak}$  |      | $R_{IO}$ |      | $10^{12}$ |      | $\Omega$      |
| Capacitance (input to output) <sup>(2)</sup>  | $f = 1\text{ MHz}$   |      | $C_{IO}$ |      | 0.6       |      | pF            |

**Notes**

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.

(1) Pin 7 open.

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

| CURRENT TRANSFER RATIO                   |  |       |        |      |      |      |      |
|--|--|-------|--------|------|------|------|------|
| PARAMETER                                | TEST CONDITION   | PART  | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| Current transfer ratio <sup>(1)(2)</sup> | $I_F = 1.6\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 4.5\text{ V}$ | 6N138 | CTR    | 300  | 1600 |      | %    |
| Current transfer ratio                   | $I_F = 0.5\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 4.5\text{ V}$ | 6N139 | CTR    | 400  | 1600 |      | %    |
|  | $I_F = 1.6\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 4.5\text{ V}$ | 6N139 | CTR    | 500  | 2000 |      | %    |

**Notes**(1) DC current transfer ratio is defined as the ratio of output collector current,  $I_O$ , to the forward LED input current,  $I_F$  times 100 %.

(2) Pin 7 open.

| SAFETY AND INSULATION RATINGS |                            |        |      |           |      |                    |  |
|-------------------------------|----------------------------|--------|------|-----------|------|--------------------|--|
| PARAMETER                     | TEST CONDITION             | SYMBOL | MIN. | TYP.      | MAX. | UNIT               |  |
| Climatic classification       | according to IEC 68 part 1 |        |      | 55/100/21 |      |                    |  |
| Comparative tracking index    |                            | CTI    | 175  |           | 399  |                    |  |
| $V_{IOTM}$                    |                            |        | 8000 |           |      | V                  |  |
| $V_{IORM}$                    |                            |        | 890  |           |      | V                  |  |
| $P_{SO}$                      |                            |        |      |           | 500  | mW                 |  |
| $I_{SI}$                      |                            |        |      |           | 300  | mA                 |  |
| $T_{SI}$                      |                            |        |      |           | 175  | $^{\circ}\text{C}$ |  |
| Creepage distance             | Standard DIP-8             |        | 8    |           |      | mm                 |  |
| Clearance distance            | Standard DIP-8             |        | 7    |           |      | mm                 |  |
| Creepage distance             | 400 mil DIP-8              |        | 8    |           |      | mm                 |  |
| Clearance distance            | 400 mil DIP-8              |        | 8    |           |      | mm                 |  |

**Note**

- As per IEC 60747-5-2, §7.4.3.8.1, this optocoupler is suitable for "safe electrical insulation" only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.

| SWITCHING CHARACTERISTICS                                       |  |       |           |      |      |      |               |
|---|--|-------|-----------|------|------|------|---------------|
| PARAMETER   | TEST CONDITION                                     | PART  | SYMBOL    | MIN. | TYP. | MAX. | UNIT          |
| Propagation delay time to logic low at output                   | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ | 6N138 | $t_{PHL}$ |      | 2    | 10   | $\mu\text{s}$ |
| Propagation delay time to logic low at output <sup>(1)(2)</sup> | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$ | 6N139 | $t_{PHL}$ |      | 6    | 25   | $\mu\text{s}$ |
|   | $I_F = 12\text{ mA}$ , $R_L = 270\text{ }\Omega$   | 6N139 | $t_{PHL}$ |      | 0.6  | 1    | $\mu\text{s}$ |
| Propagation delay time to logic high at output                  | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ | 6N138 | $t_{PLH}$ |      | 2    | 35   | $\mu\text{s}$ |
|   | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$ | 6N139 | $t_{PLH}$ |      | 4    | 60   | $\mu\text{s}$ |
| Propagation delay time to logic high at output <sup>(1)</sup>   | $I_F = 12\text{ mA}$ , $R_L = 270\text{ }\Omega$   | 6N139 | $t_{PLH}$ |      | 1.5  | 7    | $\mu\text{s}$ |

**Note**

(1) Using a resistor between pin 5 and 7 will decrease gain and delay time.

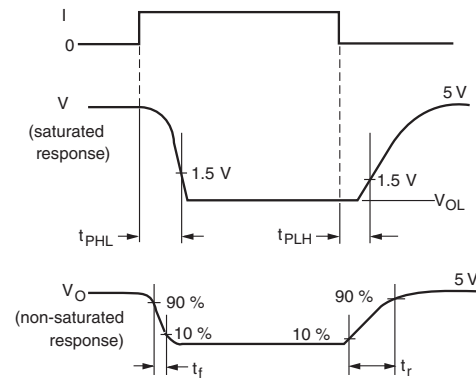
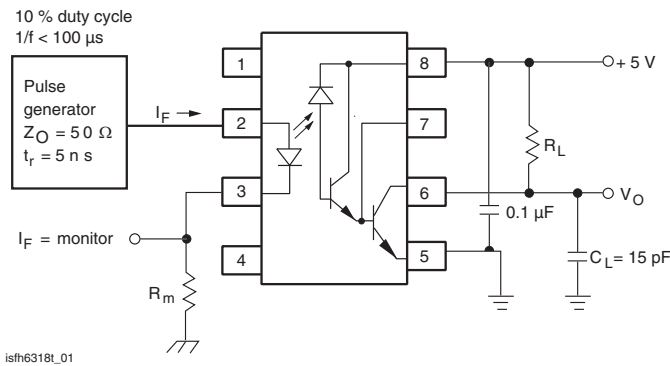


Fig. 1 - Switching Test Circuit

| COMMON MODE TRANSIENT IMMUNITY                                 |  |      |          |      |       |      |                        |
|--|--|------|----------|------|-------|------|------------------------|
| PARAMETER  | TEST CONDITION   | PART | SYMBOL   | MIN. | TYP.  | MAX. | UNIT                   |
| Common mode transient immunity, logic high level output (1)(2) | $I_F = 0 \text{ mA}$ , $R_L = 2.2 \text{ k}\Omega$ , $R_{CC} = 0$ , $ V_{CM}  = 10 \text{ V}_{P-P}$  |      | $ CM_H $ |      | 500   |      | $\text{V}/\mu\text{s}$ |
| Common mode transient immunity, logic low level output (1)(2)  | $I_F = 16 \text{ mA}$ , $R_L = 2.2 \text{ k}\Omega$ , $R_{CC} = 0$ , $ V_{CM}  = 10 \text{ V}_{P-P}$ |      | $ CM_L $ |      | - 500 |      | $\text{V}/\mu\text{s}$ |

**Notes**

- (1) 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.  $V_O > 2 \text{ V}$ ) 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.  $V_O < 0.8 \text{ V}$ ).
- (2) In applications where  $dV/dt$  may exceed  $50\,000 \text{ V}/\mu\text{s}$  (such as state discharge) a series resistor,  $R_{CC}$  should be included to protect  $I_C$  from destructively high surge currents. The recommend value is  $R_{CC} \equiv [(1 \text{ V})/(0.15 I_F (\text{mA}))] \text{ k}\Omega$

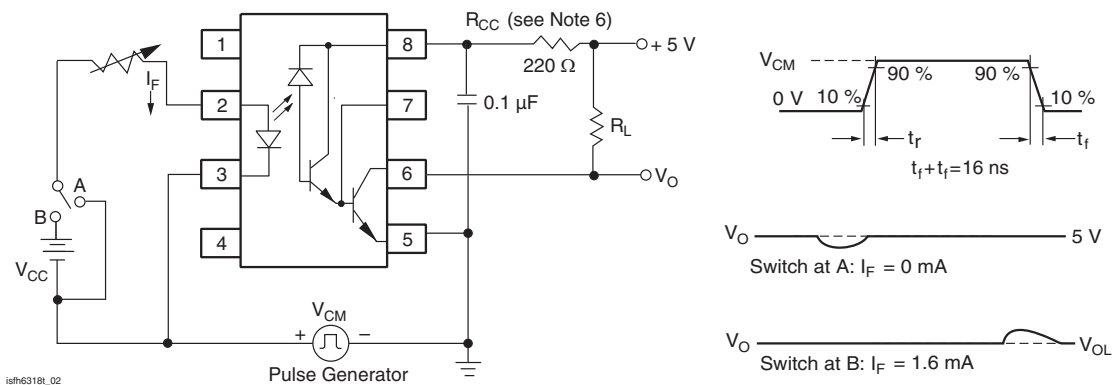


Fig. 2 - Test Circuit for Transient Immunity and Typical Waveforms

**TYPICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

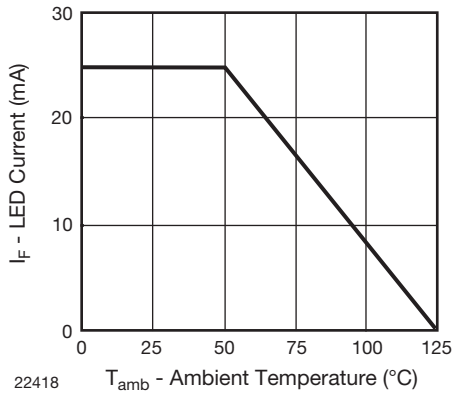


Fig. 3 - Permissible Forward LED Current vs. Temperature

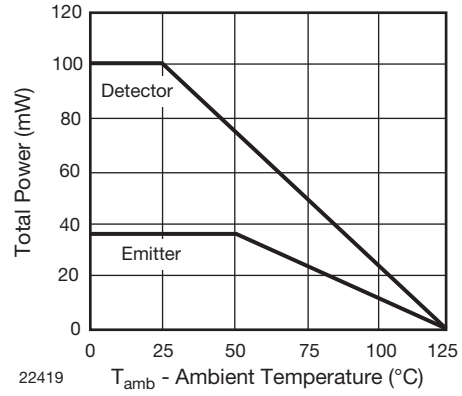
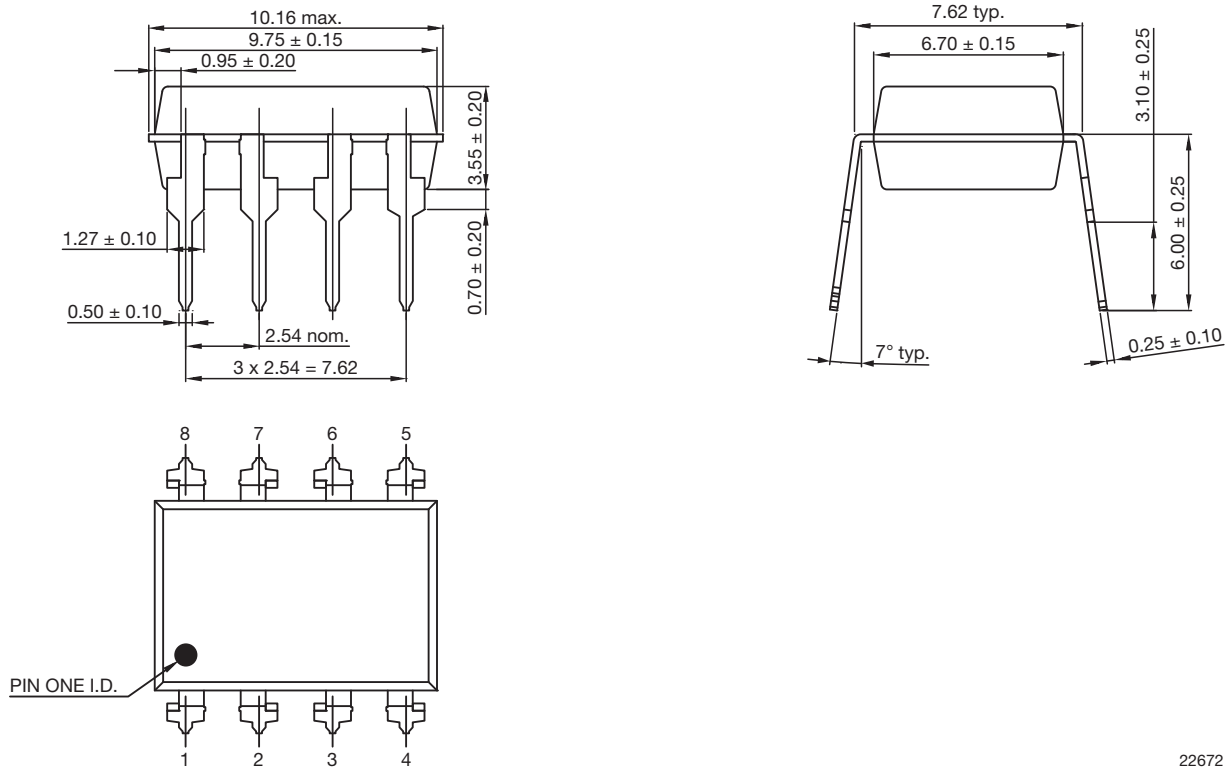


Fig. 4 - Permissible Power Dissipation vs. Temperature

**PACKAGE DIMENSIONS** in millimeters

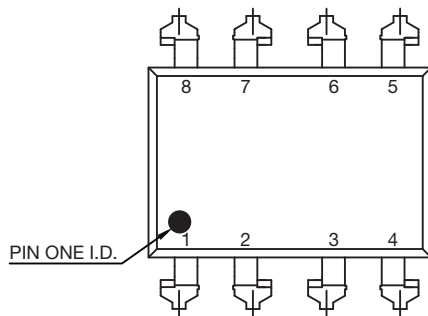
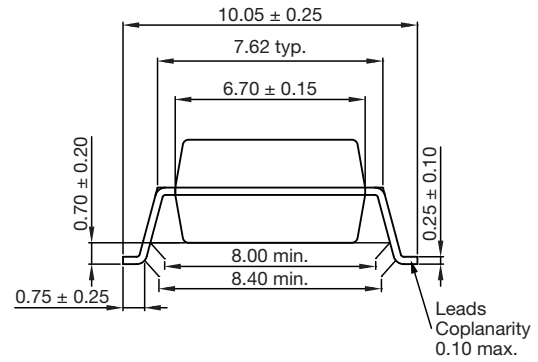
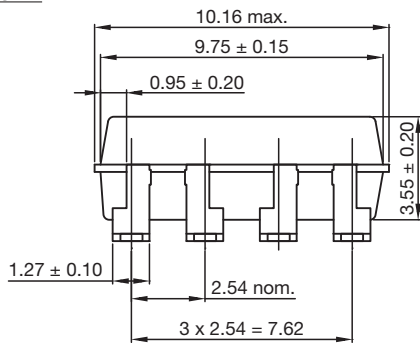
**Standard**



22672

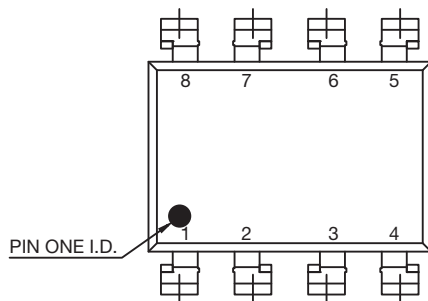
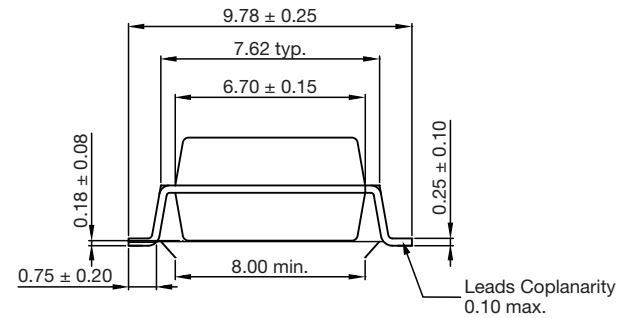
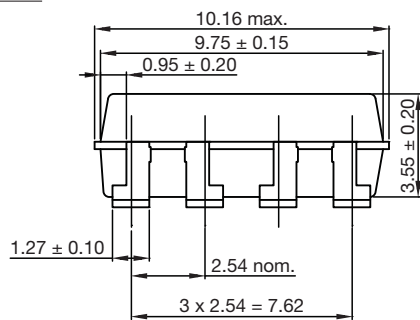


Option 7



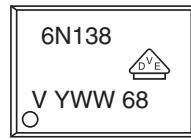
22674

Option 9



22675

**PACKAGE MARKING** (example)



**Note**

- Basic product marking only, refer to “Option Information” document ([www.vishay.com/doc?83713](http://www.vishay.com/doc?83713)) for option marking

**TAPE AND REEL DIMENSIONS** in millimeters

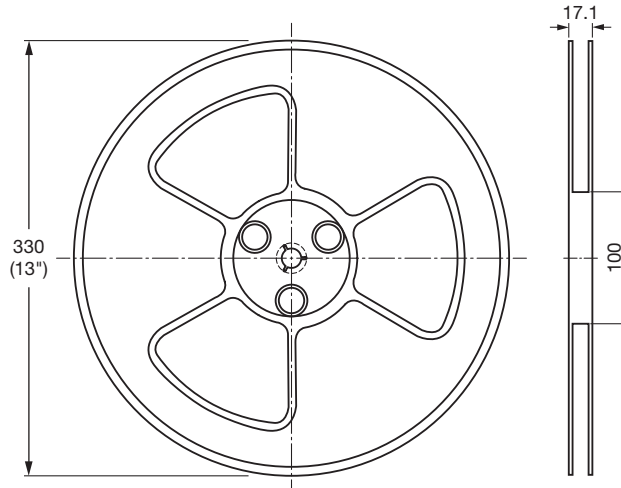


Fig. 3 - Reel Dimensions (3000 units per reel)

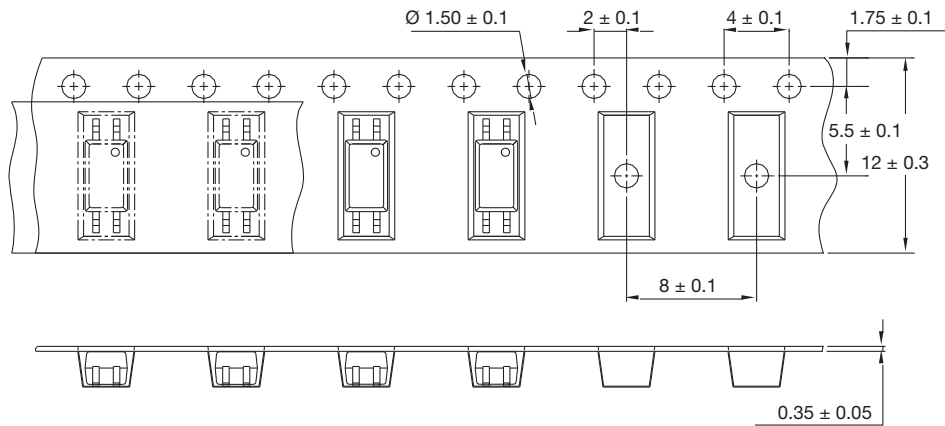


Fig. 4 - Tape Dimensions

**SOLDER PROFILES**

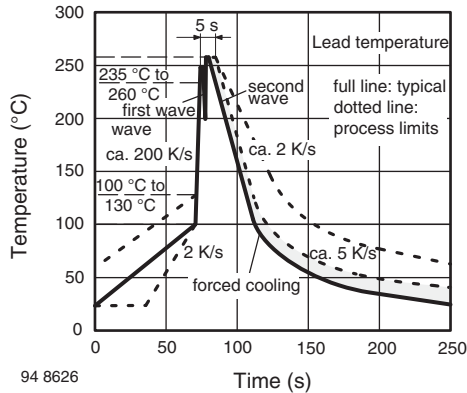


Fig. 5 - Wave Soldering Double Wave Profile According to J-STD-020 for DIP-8 Devices

**HANDLING AND STORAGE CONDITIONS**

ESD level: HBM class 2

Floor life: unlimited

Conditions:  $T_{amb} < 30\text{ °C}$ , RH < 85 %

Moisture sensitivity level 1, according to J-STD-020

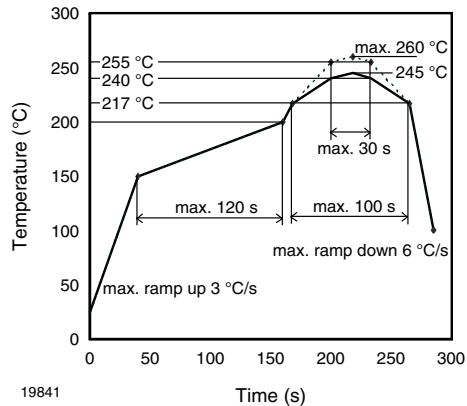


Fig. 6 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020 for SMD-8 Devices





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