

# TIL111M, TIL117M, MOC8100M

## General Purpose 6-Pin Phototransistor Optocouplers

### Features

- UL Recognized (File # E90700)
- VDE Recognized (File #102497 for white package)
  - Add Option V (e.g., TIL111VM)

### Applications

- Power Supply Regulators
- Digital Logic Inputs
- Microprocessor Inputs
- Appliance Sensor Systems
- Industrial Controls

### General Description

The MOC8100M, TIL111M, and TIL117M optocouplers consist of a gallium arsenide infrared emitting diode driving a silicon phototransistor in a 6-pin dual in-line package.

### Schematic

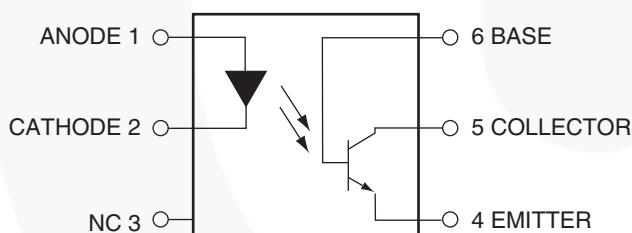


Figure 1. Schematic

### Package Outlines

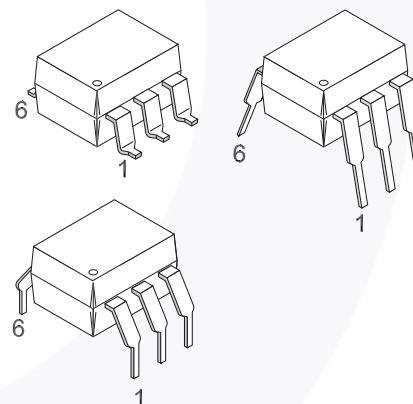


Figure 2. Package Outlines

## Safety and Insulation Ratings

As per IEC60747-5-2. This optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.

| Symbol            | Parameter                                                                                                                                                            | Min.            | Typ.      | Max. | Unit              |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------|------|-------------------|
|                   | Installation Classifications per DIN VDE 0110/1.89 Table 1<br>For Rated Mains Voltage < 150 V <sub>RMS</sub>                                                         |                 | I–IV      |      |                   |
|                   | For Rated Mains Voltage < 300 V <sub>RMS</sub>                                                                                                                       |                 | I–IV      |      |                   |
|                   | Climatic Classification                                                                                                                                              |                 | 55/100/21 |      |                   |
|                   | Pollution Degree (DIN VDE 0110/1.89)                                                                                                                                 |                 | 2         |      |                   |
| CTI               | Comparative Tracking Index                                                                                                                                           | 175             |           |      |                   |
| V <sub>PR</sub>   | Input to Output Test Voltage, Method b,<br>V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with<br>t <sub>m</sub> = 1 s, Partial Discharge < 5 pC | 1594            |           |      |                   |
|                   | Input to Output Test Voltage, Method a,<br>V <sub>IORM</sub> × 1.5 = V <sub>PR</sub> , Type and Sample Test with<br>t <sub>m</sub> = 60 s, Partial Discharge < 5 pC  | 1275            |           |      |                   |
| V <sub>IORM</sub> | Maximum Working Insulation Voltage                                                                                                                                   | 850             |           |      | V <sub>peak</sub> |
| V <sub>IOTM</sub> | Highest Allowable Over Voltage                                                                                                                                       | 6000            |           |      | V <sub>peak</sub> |
|                   | External Creepage                                                                                                                                                    | 7               |           |      | mm                |
|                   | External Clearance                                                                                                                                                   | 7               |           |      | mm                |
|                   | Insulation Thickness                                                                                                                                                 | 0.5             |           |      | mm                |
| R <sub>IO</sub>   | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V                                                                                                    | 10 <sup>9</sup> |           |      | Ω                 |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol             | Parameter                                                                   | Device            | Value          | Units |
|--------------------|-----------------------------------------------------------------------------|-------------------|----------------|-------|
| Total Device       |                                                                             |                   |                |       |
| T <sub>STG</sub>   | Storage Temperature                                                         | All               | -40 to +150    | °C    |
| T <sub>OPR</sub>   | Operating Temperature                                                       | All               | -40 to +100    | °C    |
| T <sub>SOL</sub>   | Lead Solder Temperature                                                     | All               | 260 for 10 sec | °C    |
| P <sub>D</sub>     | Total Device Power Dissipation @ T <sub>A</sub> = 25°C<br>Derate Above 25°C | All               | 250            | mW    |
|                    |                                                                             |                   | 2.94           | mW/°C |
| Emitter            |                                                                             |                   |                |       |
| I <sub>F</sub>     | DC/Average Forward Input Current                                            | All               | 60             | mA    |
| V <sub>R</sub>     | Reverse Input Voltage                                                       | TIL111M           | 3              | V     |
|                    |                                                                             | MOC8100M, TIL117M | 6              |       |
| I <sub>F(pk)</sub> | Forward Current – Peak (300 μs, 2% Duty Cycle)                              | All               | 3              | A     |
| P <sub>D</sub>     | LED Power Dissipation @ T <sub>A</sub> = 25°C<br>Derate Above 25°C          | All               | 120            | mW    |
|                    |                                                                             |                   | 1.41           | mW/°C |
| Detector           |                                                                             |                   |                |       |
| V <sub>CEO</sub>   | Collector-Emitter Voltage                                                   | All               | 30             | V     |
| V <sub>CBO</sub>   | Collector-Base Voltage                                                      | All               | 70             | V     |
| V <sub>ECO</sub>   | Emitter-Collector Voltage                                                   | TIL111M, TIL117M  | 7              | V     |
| V <sub>EBO</sub>   | Emitter-Base Voltage                                                        | All               | 7              |       |
| P <sub>D</sub>     | Detector Power Dissipation @ T <sub>A</sub> = 25°C<br>Derate Above 25°C     | All               | 150            | mW    |
|                    |                                                                             |                   | 1.76           | mW/°C |

## Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified.

### Individual Component Characteristics

| Symbol            | Parameter                           | Test Conditions                                                         |                              | Device            | Min. | Typ.* | Max. | Unit |
|-------------------|-------------------------------------|-------------------------------------------------------------------------|------------------------------|-------------------|------|-------|------|------|
| Emitter           |                                     |                                                                         |                              |                   |      |       |      |      |
| V <sub>F</sub>    | Input Forward Voltage               | I <sub>F</sub> = 16 mA                                                  | T <sub>A</sub> = 25°C        | TIL111M           |      | 1.2   | 1.4  | V    |
|                   |                                     | I <sub>F</sub> = 10 mA for MOC8100M, I <sub>F</sub> = 16 mA for TIL117M | T <sub>A</sub> = 0°C to 70°C | MOC8100M, TIL117M |      | 1.2   | 1.4  |      |
|                   |                                     |                                                                         | T <sub>A</sub> = -55°C       |                   |      | 1.32  |      |      |
|                   |                                     |                                                                         | T <sub>A</sub> = +100°C      |                   |      | 1.10  |      |      |
| I <sub>R</sub>    | Reverse Leakage Current             | V <sub>R</sub> = 3.0 V                                                  |                              | TIL111M, TIL117M  |      | 0.001 | 10   | µA   |
|                   |                                     | V <sub>R</sub> = 6.0 V                                                  |                              | MOC8100M          |      | 0.001 | 10   | µA   |
| Detector          |                                     |                                                                         |                              |                   |      |       |      |      |
| BV <sub>CEO</sub> | Collector-Emitter Breakdown Voltage | I <sub>C</sub> = 1.0 mA, I <sub>F</sub> = 0                             |                              | All               | 30   | 100   |      | V    |
| BV <sub>CBO</sub> | Collector-Base Breakdown Voltage    | I <sub>C</sub> = 10 µA, I <sub>F</sub> = 0                              |                              | All               | 70   | 120   |      | V    |
| BV <sub>EBO</sub> | Emitter-Base Breakdown Voltage      | I <sub>E</sub> = 10 µA, I <sub>F</sub> = 0                              |                              | All               | 7    | 10    |      | V    |
| BV <sub>ECO</sub> | Emitter-Collector Breakdown Voltage | I <sub>F</sub> = 100 µA, I <sub>F</sub> = 0                             |                              | TIL111M, TIL117M  | 7    | 10    |      | V    |
| I <sub>CEO</sub>  | Collector-Emitter Dark Current      | V <sub>CE</sub> = 10 V, I <sub>F</sub> = 0                              |                              | TIL111M, TIL117M  |      | 1     | 50   | nA   |
|                   |                                     | V <sub>CE</sub> = 5 V, T <sub>A</sub> = 25°C                            |                              | MOC8100M          |      | 0.5   | 25   | nA   |
|                   |                                     | V <sub>CE</sub> = 30 V, I <sub>F</sub> = 0, T <sub>A</sub> = 70°C       |                              | TIL117M, MOC8100M |      | 0.2   | 50   | µA   |
| I <sub>CBO</sub>  | Collector-Base Dark Current         | V <sub>CB</sub> = 10 V                                                  |                              | TIL111M, TIL117M  |      |       | 20   | nA   |
| I <sub>CBO</sub>  |                                     | V <sub>CB</sub> = 5 V                                                   |                              | MOC8100M          |      |       | 10   | nA   |
| C <sub>CE</sub>   | Capacitance                         | V <sub>CE</sub> = 0 V, f = 1 MHz                                        |                              | All               |      | 8     |      | pF   |

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

**Electrical Characteristics** (Continued) $T_A = 25^\circ\text{C}$  unless otherwise specified.**Transfer Characteristics**

| Symbol                | Parameter                                              | Test Conditions                                                                     | Device   | Min | Typ* | Max | Unit |
|-----------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------|----------|-----|------|-----|------|
| DC Characteristics    |                                                        |                                                                                     |          |     |      |     |      |
| CTR <sub>CE</sub>     | Current Transfer Ratio, Collector to Emitter           | I <sub>F</sub> = 10 mA, V <sub>CE</sub> = 10 V                                      | TIL117M  | 50  |      |     | %    |
|                       |                                                        | I <sub>F</sub> = 1 mA, V <sub>CE</sub> = 5 V                                        | MOC8100M | 50  |      |     | %    |
|                       |                                                        | I <sub>F</sub> = 1 mA, V <sub>CE</sub> = 5 V, T <sub>A</sub> = 0°C to +70°C         |          | 30  |      |     |      |
| I <sub>C(ON)</sub>    | On-State Collector Current (Phototransistor Operation) | I <sub>F</sub> = 16 mA, V <sub>CE</sub> = 0.4 V                                     | TIL111M  | 2   |      |     | mA   |
|                       | On-State Collector Current (Photodiode Operation)      | I <sub>F</sub> = 16 mA, V <sub>CB</sub> = 0.4 V                                     |          | 7   |      |     | μA   |
| V <sub>CE (SAT)</sub> | Collector-Emitter Saturation Voltage                   | I <sub>C</sub> = 500 μA, I <sub>F</sub> = 10 mA                                     | TIL117M  |     |      | 0.4 | V    |
|                       |                                                        | I <sub>C</sub> = 2 mA, I <sub>F</sub> = 16 mA                                       | TIL111M  |     |      | 0.4 |      |
|                       |                                                        | I <sub>C</sub> = 100 μA, I <sub>F</sub> = 1 mA                                      | MOC8100M |     |      | 0.5 |      |
| AC Characteristics    |                                                        |                                                                                     |          |     |      |     |      |
| t <sub>ON</sub>       | Turn-On Time                                           | I <sub>C</sub> = 2 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Fig. 13)     | MOC8100M |     |      | 20  | μs   |
|                       |                                                        |                                                                                     | TIL117M  |     |      | 10  |      |
| t <sub>OFF</sub>      | Turn-Off Time                                          |                                                                                     | MOC8100M |     |      | 20  | μs   |
|                       |                                                        |                                                                                     | TIL117M  |     |      | 10  |      |
| t <sub>r</sub>        | Rise Time                                              |                                                                                     | MOC8100M |     | 2    |     | μs   |
| t <sub>f</sub>        | Fall Time                                              |                                                                                     | TIL117M  |     | 2    |     |      |
| t <sub>r</sub>        | Rise Time (Phototransistor Operation)                  | I <sub>C(ON)</sub> = 2 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Fig. 13) | TIL111M  |     |      | 10  | μs   |
| t <sub>f</sub>        | Fall Time (Phototransistor Operation)                  |                                                                                     |          |     |      |     |      |

**Isolation Characteristics**

| Symbol    | Characteristic                 | Test Conditions                    | Min.      | Typ.* | Max. | Units        |
|-----------|--------------------------------|------------------------------------|-----------|-------|------|--------------|
| $V_{ISO}$ | Input-Output Isolation Voltage | $f = 60\text{ Hz}, t = 1\text{ s}$ | 7500      |       |      | $V_{AC(PK)}$ |
| $R_{ISO}$ | Isolation Resistance           | $V_{I-O} = 500\text{ V}_{DC}$      | $10^{11}$ |       |      | $\Omega$     |
| $C_{ISO}$ | Isolation Capacitance          | $V_{I-O} = 0, f = 1\text{ MHz}$    |           | 0.2   |      | pF           |

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

## Typical Performance Characteristics

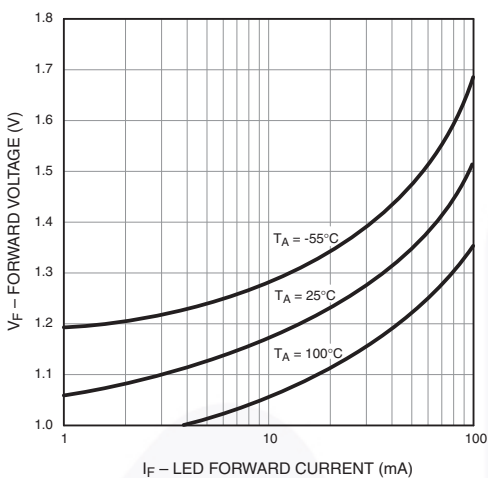


Figure 3. LED Forward Voltage vs. Forward Current

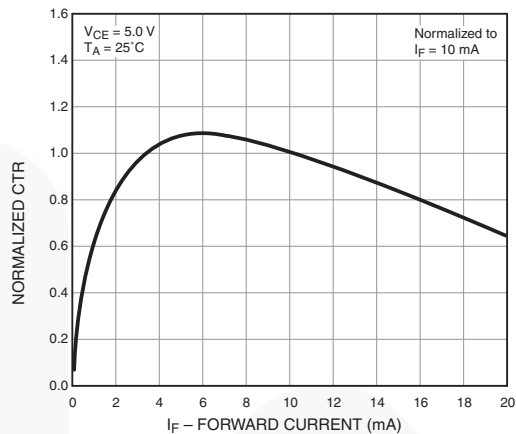


Figure 4. Normalized CTR vs. Forward Current

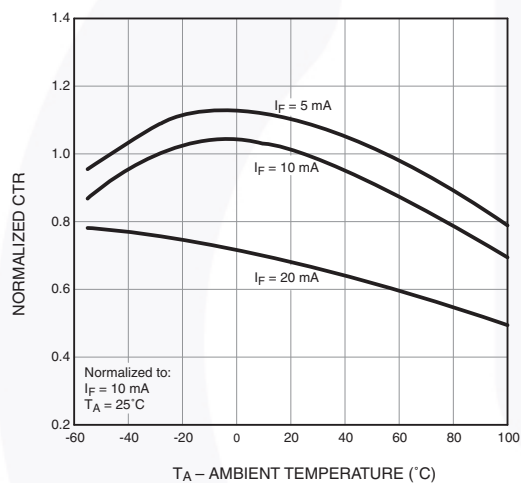


Figure 5. Normalized CTR vs. Ambient Temperature

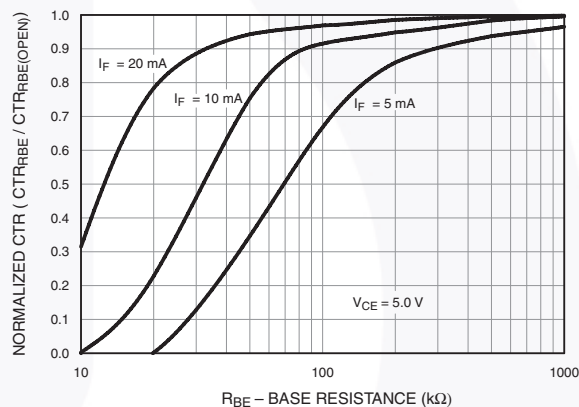


Figure 6. CTR vs. R<sub>BE</sub> (Unsaturated)

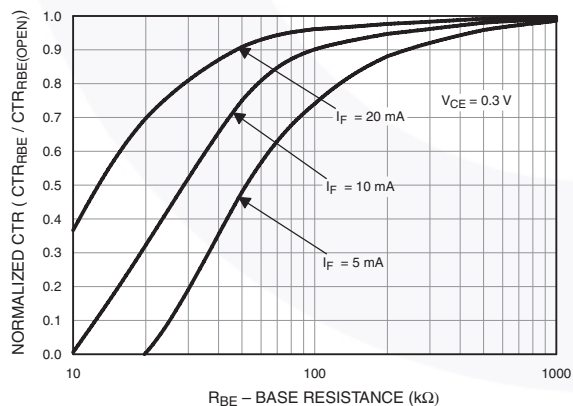


Figure 7. CTR vs. R<sub>BE</sub> (Saturated)

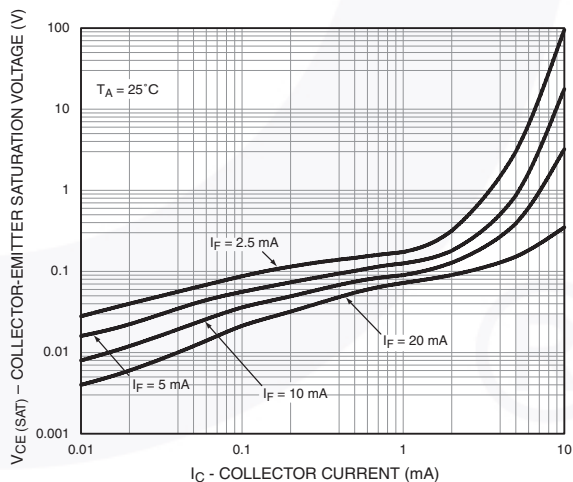


Figure 8. Collector-Emitter Saturation Voltage vs. Collector Current

## Typical Performance Characteristics (Continued)

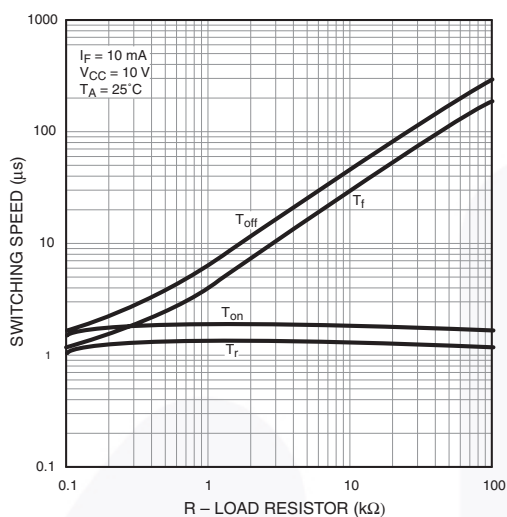


Figure 9. Switching Speed vs. Load Resistor

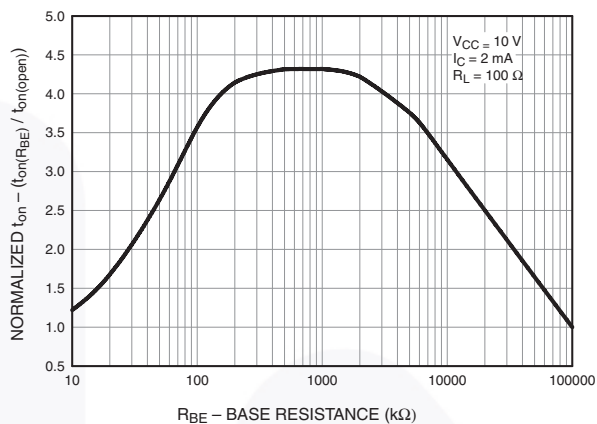


Figure 10. Normalized  $t_{\text{on}}$  vs.  $R_{BE}$

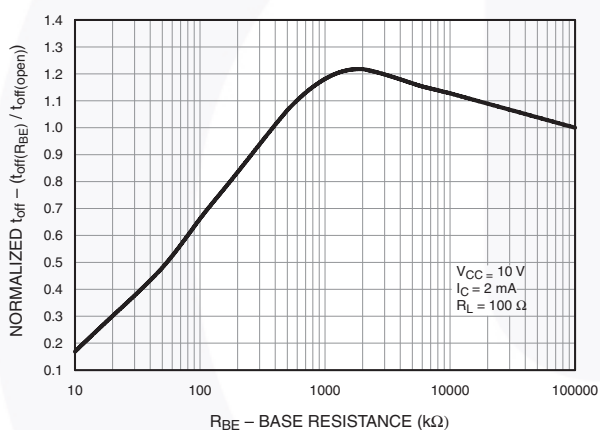


Figure 11. Normalized  $t_{\text{off}}$  vs.  $R_{BE}$

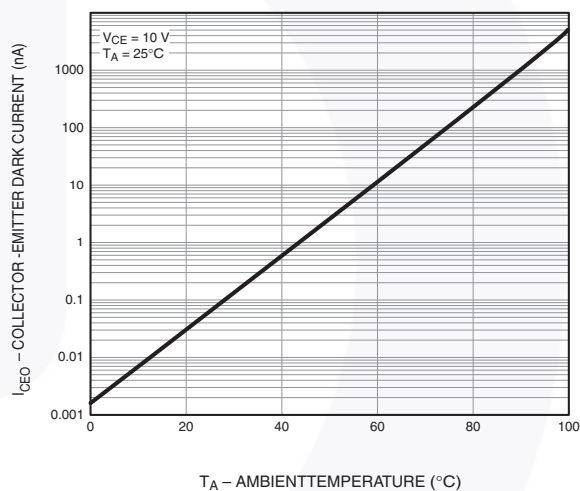


Figure 12. Dark Current vs. Ambient Temperature

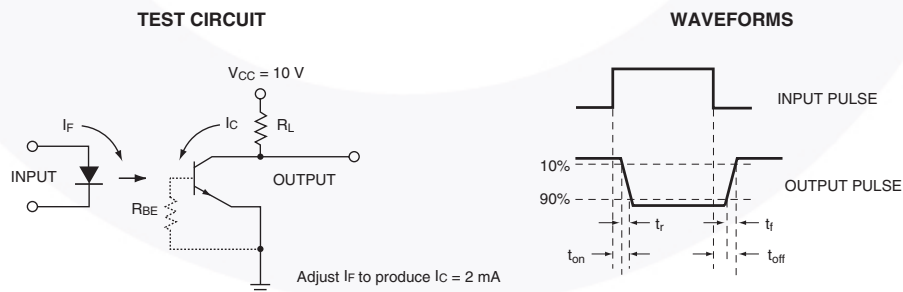


Figure 13. Switching Time Test Circuit and Waveforms

## Reflow Profile

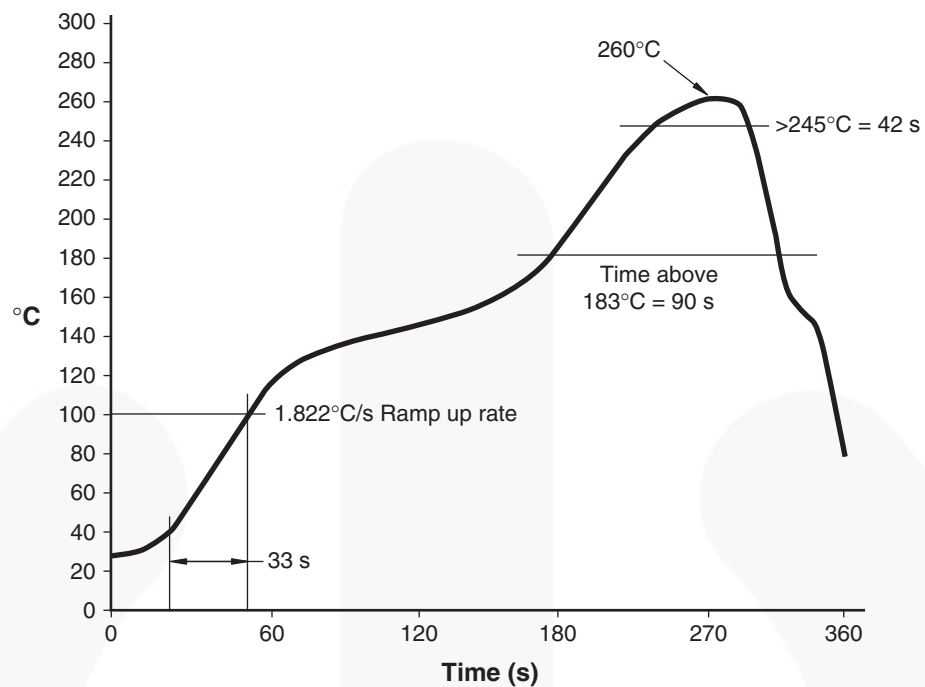


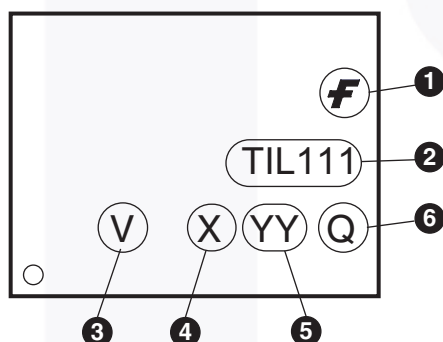
Figure 14. Reflow Profile



## Ordering Information

| Option    | Order Entry Identifier (Example) | Description                            |
|-----------|----------------------------------|----------------------------------------|
| No option | TIL111M                          | Standard Through-Hole Device           |
| S         | TIL111SM                         | Surface Mount Lead Bend                |
| SR2       | TIL111SR2M                       | Surface Mount; Tape and Reel           |
| T         | TIL111TM                         | 0.4" Lead Spacing                      |
| V         | TIL111VM                         | VDE 0884                               |
| TV        | TIL111TVM                        | VDE 0884, 0.4" Lead Spacing            |
| SV        | TIL111SVM                        | VDE 0884, Surface Mount                |
| SR2V      | TIL111SR2VM                      | VDE 0884, Surface Mount, Tape and Reel |

## Marking Information



| Definitions |                                                                                        |
|-------------|----------------------------------------------------------------------------------------|
| 1           | Fairchild logo                                                                         |
| 2           | Device number                                                                          |
| 3           | VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table) |
| 4           | One-digit year code, e.g., '3'                                                         |
| 5           | Two-digit work week ranging from '01' to '53'                                          |
| 6           | Assembly package code                                                                  |

\*Note – Parts that do not have the 'V' option (see definition 3 above) that are marked with date code '325' or earlier are marked in portrait format.

## Carrier Tape Specification

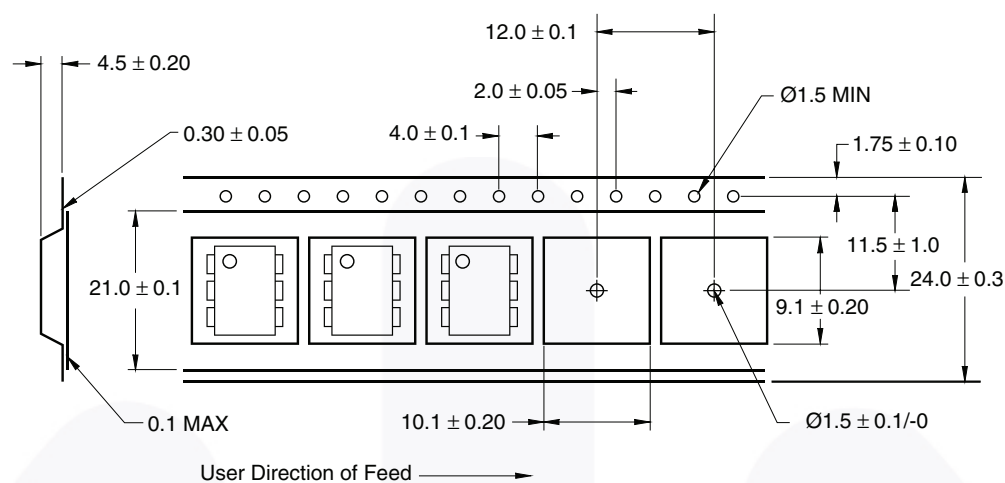
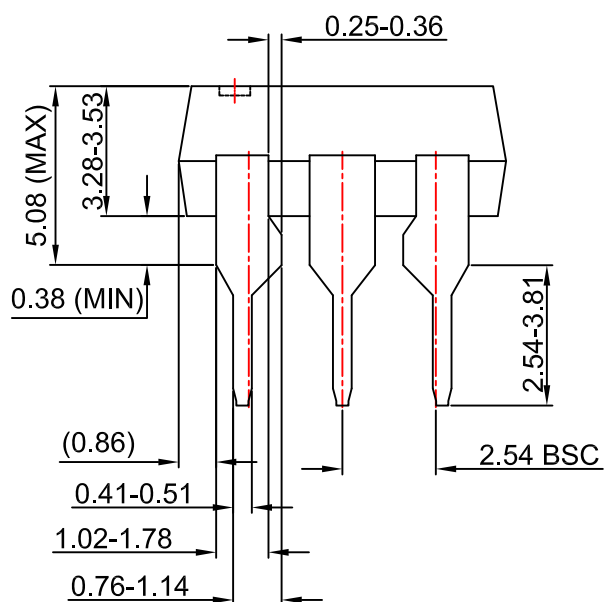
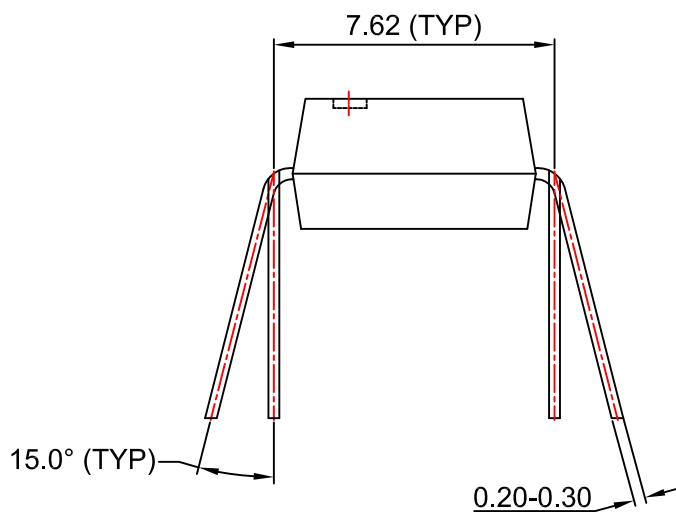
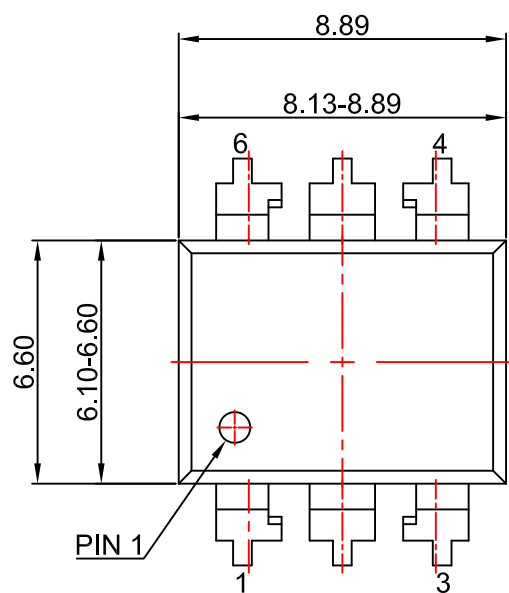


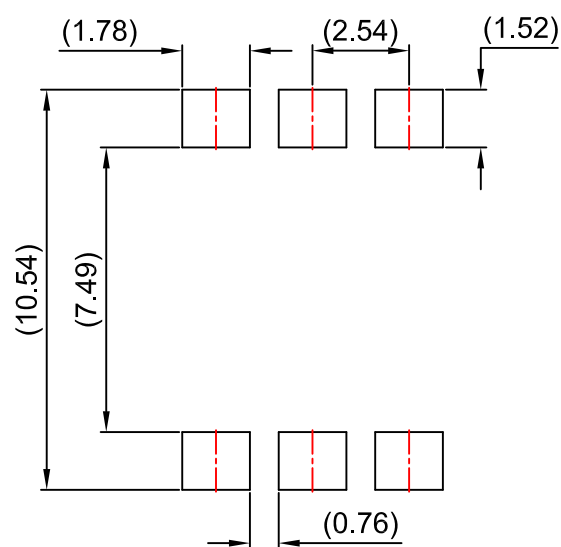
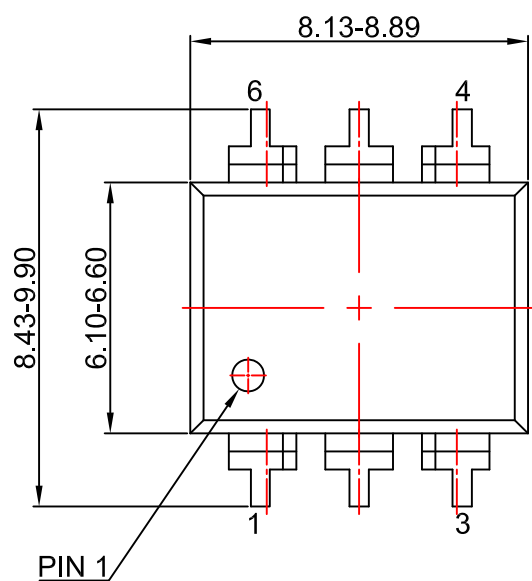
Figure 15. Carrier Tape Specification



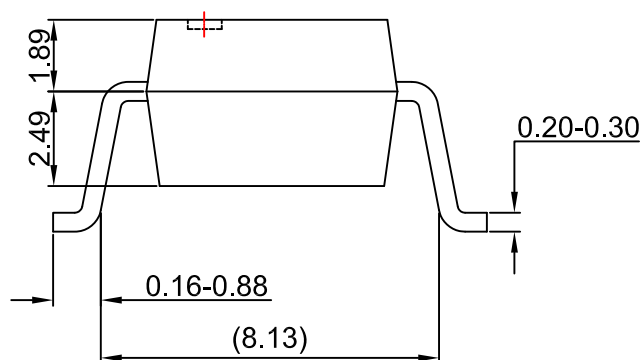
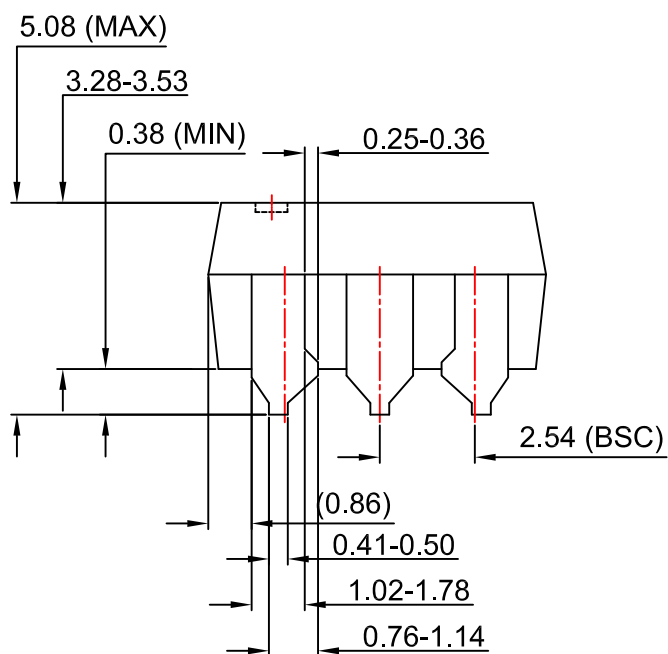
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LAND PATTERN RECOMMENDATION



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## ANTI-COUNTERFEITING POLICY

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Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status        | Definition                                                                                                                                                                                          |
|--------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                       |
| Preliminary              | First Production      | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production       | Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.                                               |
| Obsolete                 | Not In Production     | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.                                                    |

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