



# 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)

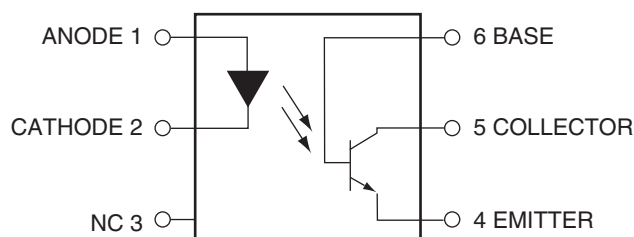
### Applications

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

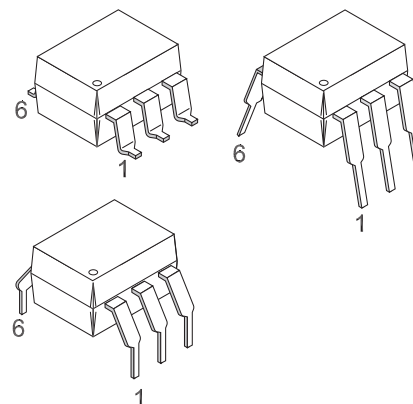
### General Description

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



### Package Outlines



## 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 (300μs, 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> = 16mA                                                  | T <sub>A</sub> = 25°C     | TIL111M           |      | 1.2   | 1.4  | V    |
|                   |                                     | I <sub>F</sub> = 10mA for MOC8100M, I <sub>F</sub> = 16mA; for TIL117M | T <sub>A</sub> = 0°C–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> = 3.0V                                                  |                           | TIL111M, TIL117M  |      | 0.001 | 10   | μA   |
|                   |                                     | V <sub>R</sub> = 6.0V                                                  |                           | MOC8100M          |      | 0.001 | 10   | μA   |
| DETECTOR          |                                     |                                                                        |                           |                   |      |       |      |      |
| BV <sub>CEO</sub> | Collector-Emitter Breakdown Voltage | I <sub>C</sub> = 1.0mA, I <sub>F</sub> = 0                             |                           | All               | 30   | 100   |      | V    |
| BV <sub>CBO</sub> | Collector-Base Breakdown Voltage    | I <sub>C</sub> = 10μA, I <sub>F</sub> = 0                              |                           | All               | 70   | 120   |      | V    |
| BV <sub>EBO</sub> | Emitter-Base Breakdown Voltage      | I <sub>E</sub> = 10μA, I <sub>F</sub> = 0                              |                           | All               | 7    | 10    |      | V    |
| BV <sub>ECO</sub> | Emitter-Collector Breakdown Voltage | I <sub>F</sub> = 100μA, I <sub>F</sub> = 0                             |                           | TIL111M, TIL117M  | 7    | 10    |      | V    |
| I <sub>CEO</sub>  | Collector-Emitter Dark Current      | V <sub>CE</sub> = 10V, I <sub>F</sub> = 0                              |                           | TIL111M, TIL117M  |      | 1     | 50   | nA   |
|                   |                                     | V <sub>CE</sub> = 5V, T <sub>A</sub> = 25°C                            |                           | MOC8100M          |      | 0.5   | 25   | nA   |
|                   |                                     | V <sub>CE</sub> = 30V, 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> = 10V                                                  |                           | TIL111M, TIL117M  |      |       | 20   | nA   |
| I <sub>CBO</sub>  |                                     | V <sub>CB</sub> = 5V                                                   |                           | MOC8100M          |      |       | 10   | nA   |
| C <sub>CE</sub>   | Capacitance                         | V <sub>CE</sub> = 0V, f = 1MHz                                         |                           | 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,<br>Collector to Emitter           | I <sub>F</sub> = 10mA, V <sub>CE</sub> = 10V                                        | TIL117M  | 50  |      |     | %    |
|                       |                                                           | I <sub>F</sub> = 1mA, V <sub>CE</sub> = 5V                                          | MOC8100M | 50  |      |     | %    |
|                       |                                                           | I <sub>F</sub> = 1mA, V <sub>CE</sub> = 5V,<br>T <sub>A</sub> = 0°C to +70°C        |          | 30  |      |     |      |
| I <sub>C(ON)</sub>    | On-State Collector Current<br>(Phototransistor Operation) | I <sub>F</sub> = 16mA, V <sub>CE</sub> = 0.4V                                       | TIL111M  | 2   |      |     | mA   |
|                       | On-State Collector Current<br>(Photodiode Operation)      | I <sub>F</sub> = 16mA, V <sub>CB</sub> = 0.4V                                       |          | 7   |      |     | μA   |
| V <sub>CE (SAT)</sub> | Collector-Emitter Saturation<br>Voltage                   | I <sub>C</sub> = 500μA, I <sub>F</sub> = 10mA                                       | TIL117M  |     |      | 0.4 | V    |
|                       |                                                           | I <sub>C</sub> = 2mA, I <sub>F</sub> = 16mA                                         | TIL111M  |     |      | 0.4 |      |
|                       |                                                           | I <sub>C</sub> = 100μA, I <sub>F</sub> = 1mA                                        | MOC8100M |     |      | 0.5 |      |
| AC CHARACTERISTICS    |                                                           |                                                                                     |          |     |      |     |      |
| T <sub>ON</sub>       | Turn-On Time                                              | I <sub>C</sub> = 2mA, V <sub>CC</sub> = 10V,<br>R <sub>L</sub> = 100Ω (Fig. 11)     | MOC8100M |     |      | 20  | μs   |
|                       |                                                           |                                                                                     | TIL117M  |     |      | 10  |      |
| T <sub>OFF</sub>      | Turn-Off Time                                             |                                                                                     | MOC8100M |     |      | 20  | μs   |
|                       |                                                           |                                                                                     | TIL117M  |     |      | 10  |      |
| t <sub>r</sub>        | Rise Time                                                 | I <sub>C(ON)</sub> = 2mA, V <sub>CC</sub> = 10V,<br>R <sub>L</sub> = 100Ω (Fig. 11) | MOC8100M |     | 2    |     | μs   |
| t <sub>f</sub>        | Fall Time                                                 |                                                                                     | TIL117M  |     | 2    |     |      |
| t <sub>r</sub>        | Rise Time<br>(Phototransistor Operation)                  |                                                                                     | TIL111M  |     |      | 10  | μs   |
| t <sub>f</sub>        | Fall Time<br>(Phototransistor Operation)                  |                                                                                     |          |     |      |     |      |

**Isolation Characteristics**

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

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

## Safety and Insulation Ratings

As per IEC 60747-5-2, 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                                                                                  |        |           |      |            |
|            | For Rated Main Voltage < 150Vrms                                                                                                            |        | I-IV      |      |            |
|            | For Rated Main voltage < 300Vrms                                                                                                            |        | I-IV      |      |            |
|            | Climatic Classification                                                                                                                     |        | 55/100/21 |      |            |
|            | Pollution Degree (DIN VDE 0110/1.89)                                                                                                        |        | 2         |      |            |
| CTI        | Comparative Tracking Index                                                                                                                  | 175    |           |      |            |
| $V_{PR}$   | Input to Output Test Voltage, Method b, $V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ sec, Partial Discharge < 5pC | 1594   |           |      | $V_{peak}$ |
|            | Input to Output Test Voltage, Method a, $V_{IORM} \times 1.5 = V_{PR}$ , Type and Sample Test with $t_m = 60$ sec, Partial Discharge < 5pC  | 1275   |           |      | $V_{peak}$ |
| $V_{IORM}$ | Max. Working Insulation Voltage                                                                                                             | 850    |           |      | $V_{peak}$ |
| $V_{IOTM}$ | Highest Allowable Over Voltage                                                                                                              | 6000   |           |      | $V_{peak}$ |
|            | External Creepage                                                                                                                           | 7      |           |      | mm         |
|            | External Clearance                                                                                                                          | 7      |           |      | mm         |
|            | Insulation Thickness                                                                                                                        | 0.5    |           |      | mm         |
| RIO        | Insulation Resistance at $T_s$ , $V_{IO} = 500V$                                                                                            | $10^9$ |           |      | $\Omega$   |

## Typical Performance Characteristics

Fig. 1 LED Forward Voltage vs. Forward Current

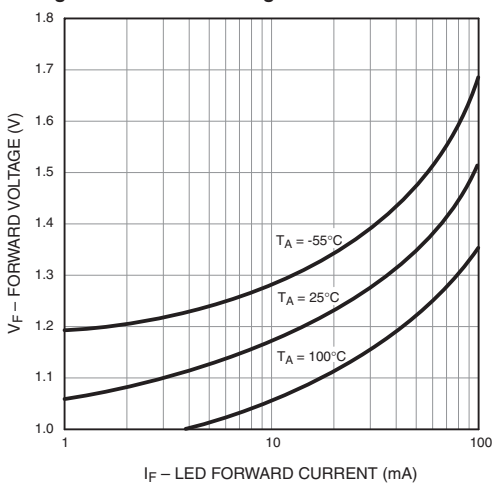


Fig. 2 Normalized CTR vs. Forward Current

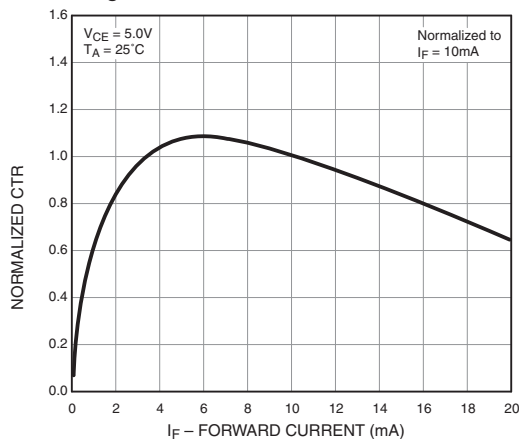


Fig. 3 Normalized CTR vs. Ambient Temperature

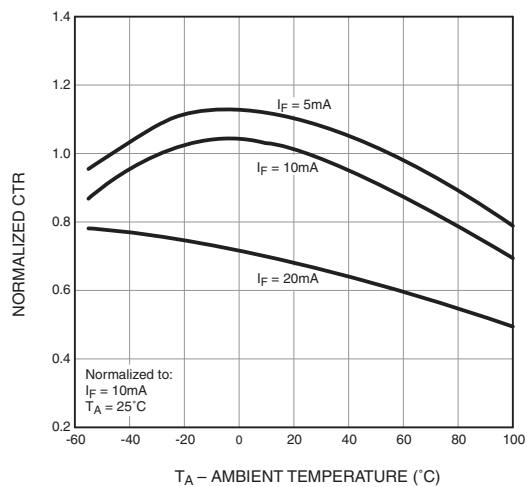


Fig. 4 CTR vs. RBE (Unsaturated)

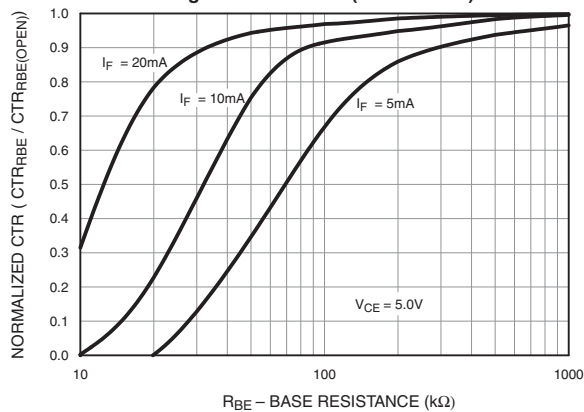


Fig. 5 CTR vs. RBE (Saturated)

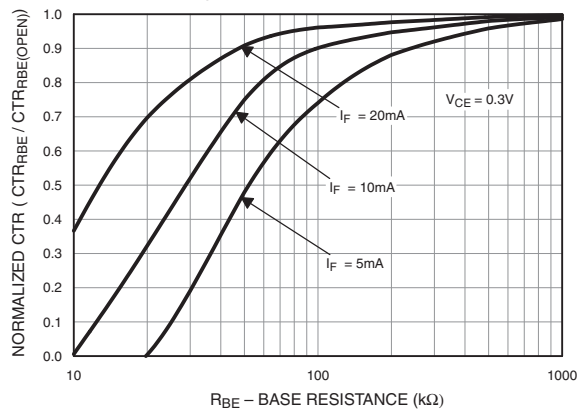
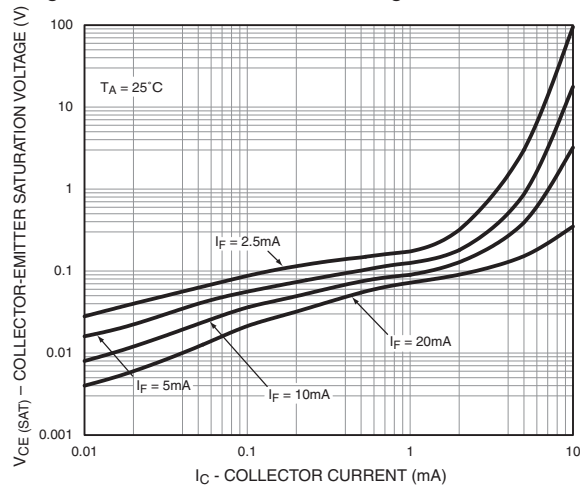


Fig. 6 Collector-Emitter Saturation Voltage vs. Collector Current



## Typical Performance Characteristics (Continued)

Fig. 7 Switching Speed vs. Load Resistor

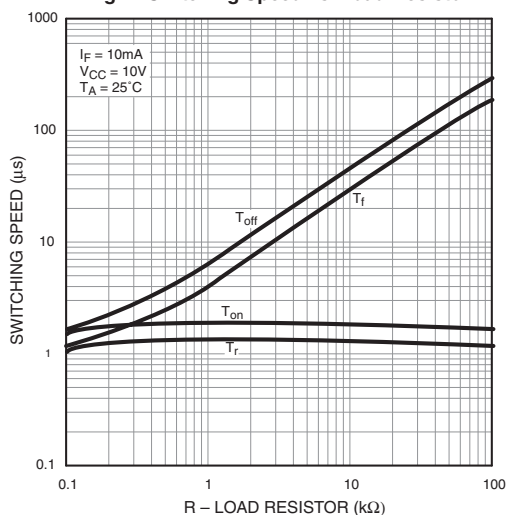


Fig. 8 Normalized  $t_{on}$  vs.  $R_{BE}$

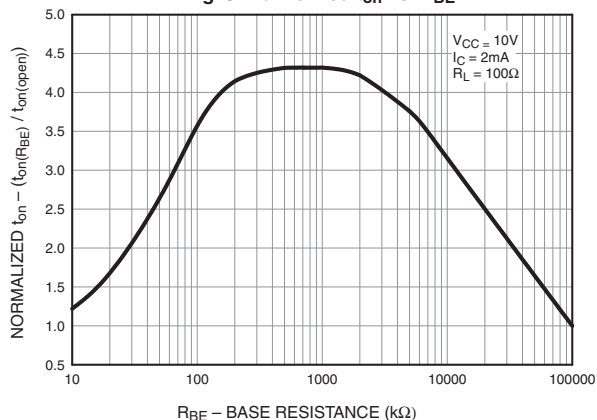


Fig. 9 Normalized  $t_{off}$  vs.  $R_{BE}$

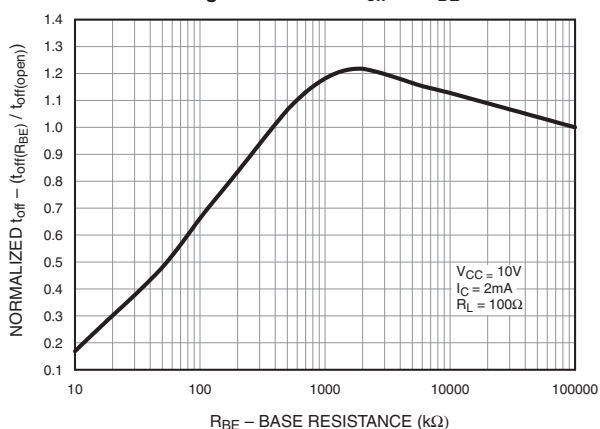
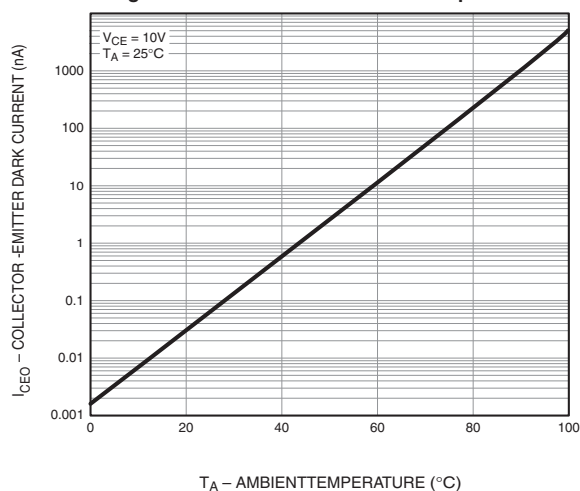
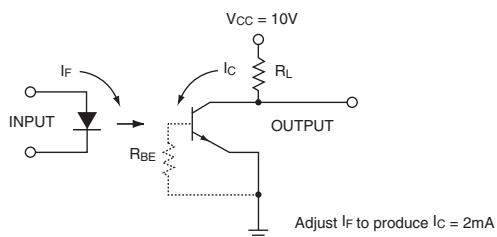


Fig. 10 Dark Current vs. Ambient Temperature



TEST CIRCUIT



WAVEFORMS

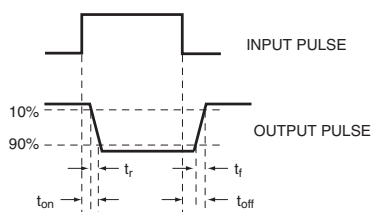
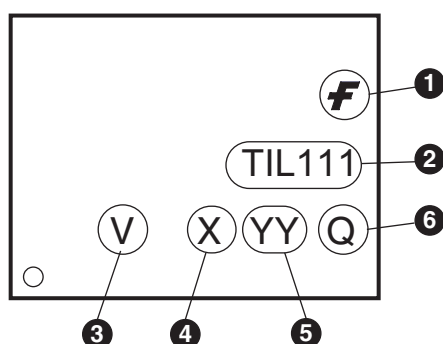


Figure 11. Switching Time Test Circuit and Waveforms

## Ordering Information

| Option    | Order Entry Identifier<br>(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., '7'                                                         |
| 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.