

# General Purpose Phototransistor Optocouplers, 6-Pin

## MCT2EM, TIL111M, TIL117M

### Description

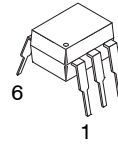
The general purpose optocouplers consist of a gallium arsenide infrared emitting diode driving a silicon photo-transistor in a standard plastic six-pin dual-in-line package.

### Features

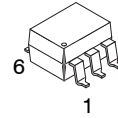
- Minimum Current Transfer Ratio at  $I_F = 10 \text{ mA}$ ,  $V_{CE} = 10 \text{ V}$ 
  - ♦ 20% for MCT2EM
  - ♦ 50% for TIL117M
- Safety and Regulatory Approvals
  - ♦ UL1577, 4,170 VAC<sub>RMS</sub> for 1 Minute
  - ♦ DIN-EN/IEC60747-5-5, 850 V Peak Working Insulation Voltage
- These are Pb-Free Devices

### Applications

- Power Supply Regulators
- Digital Logic Inputs
- Microprocessor Inputs

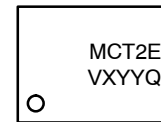


PDIP6 8.51x6.35, 2.54P  
CASE 646BX



PDIP6 8.51x6.35, 2.54P  
CASE 646BY

### MARKING DIAGRAM



MCT2E = Device Number

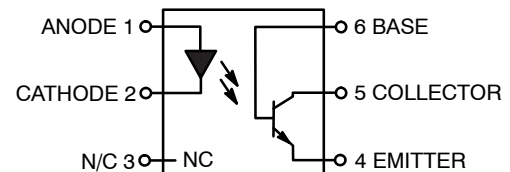
V = DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)

X = One-Digit Year Code, e.g., '5'

YY = Digit Work Week, Ranging from '01' to '53'

Q = Assembly Package Code

### SCHEMATIC



### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

## MCT2EM, TIL111M, TIL117M

**SAFETY AND INSULATION RATINGS** (As per DIN EN/IEC 60747-5-5, 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.)

| Parameter                                                                           |                       | Characteristics |
|-------------------------------------------------------------------------------------|-----------------------|-----------------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | <150 V <sub>RMS</sub> | I–IV            |
|                                                                                     | <300 V <sub>RMS</sub> | I–IV            |
| Climatic Classification                                                             |                       | 55/100/21       |
| Pollution Degree (DIN VDE 0110/1.89)                                                |                       | 2               |
| Comparative Tracking Index                                                          |                       | 175             |

| Symbol                 | Parameter                                                                                                                                                      | Value            | Unit              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------|
| V <sub>PR</sub>        | Input-to-Output Test Voltage, Method A, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC  | 1360             | V <sub>peak</sub> |
|                        | Input-to-Output Test Voltage, Method B, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC | 1594             | V <sub>peak</sub> |
| 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                |
|                        | External Clearance (for Option TV, 0.4” Lead Spacing)                                                                                                          | ≥10              | mm                |
| DTI                    | Distance Through Insulation (Insulation Thickness)                                                                                                             | ≥0.5             | mm                |
| T <sub>S</sub>         | Case Temperature (Note 1)                                                                                                                                      | 175              | °C                |
| I <sub>S, INPUT</sub>  | Input Current (Note 1)                                                                                                                                         | 350              | mA                |
| P <sub>S, OUTPUT</sub> | Output Power (Note 1)                                                                                                                                          | 800              | mW                |
| R <sub>IO</sub>        | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V (Note 1)                                                                                     | >10 <sup>9</sup> | Ω                 |

1. Safety limit values – maximum values allowed in the event of a failure.

# MCT2EM, TIL111M, TIL117M

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Device | Value | Unit |
|--------|-----------|--------|-------|------|
|--------|-----------|--------|-------|------|

### TOTAL DEVICE

|                  |                                                         |     |                    |       |
|------------------|---------------------------------------------------------|-----|--------------------|-------|
| T <sub>STG</sub> | Storage Temperature                                     | All | -40 to +125        | °C    |
| T <sub>OPR</sub> | Operating Temperature                                   | All | -40 to +100        | °C    |
| T <sub>J</sub>   | Junction Temperature Range                              | All | -40 to +125        | °C    |
| T <sub>SOL</sub> | Lead Solder Temperature                                 | All | 260 for 10 seconds | °C    |
| P <sub>D</sub>   | Total Device Power Dissipation at T <sub>A</sub> = 25°C | All | 250                | mW    |
|                  | Derate Above 25°C                                       | All | 2.94               | mW/°C |

### EMITTER

|                    |                                                |                 |      |       |
|--------------------|------------------------------------------------|-----------------|------|-------|
| I <sub>F</sub>     |                                                | All             | 60   | mA    |
| V <sub>R</sub>     | Reverse Input Voltage                          | TIL111M         | 3    | V     |
|                    |                                                | MCT2EM, TIL117M | 6    | V     |
| I <sub>F(pk)</sub> | Forward Current – Peak (300 μs, 2% Duty Cycle) | All             | 3    | A     |
| P <sub>D</sub>     | LED Power Dissipation at T <sub>A</sub> = 25°C | All             | 120  | mW    |
|                    | Derate Above 25°C                              | All             | 1.41 | mW/°C |

### DETECTOR

|                  |                                                     |     |      |       |
|------------------|-----------------------------------------------------|-----|------|-------|
| V <sub>CEO</sub> | Collector-to-Emitter Voltage                        | All | 30   | V     |
| V <sub>CBO</sub> | Collector-to-Base Voltage                           | All | 70   | V     |
| V <sub>ECO</sub> | Emitter-to-Collector Voltage                        | All | 7    | V     |
| V <sub>EBO</sub> | Emitter-to-Base Voltage                             | All | 7    | V     |
| P <sub>D</sub>   | Detector Power Dissipation at T <sub>A</sub> = 25°C | All | 150  | mW    |
|                  | Derate Above 25°C                                   | All | 1.76 | mW/°C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# MCT2EM, TIL111M, TIL117M

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C, unless otherwise noted)

| Symbol                                      | Parameter                              | Test Conditions                             | Min | Typ   | Max  | Unit |
|---------------------------------------------|----------------------------------------|---------------------------------------------|-----|-------|------|------|
| <b>INDIVIDUAL COMPONENT CHARACTERISTICS</b> |                                        |                                             |     |       |      |      |
| <b>EMITTER</b>                              |                                        |                                             |     |       |      |      |
| V <sub>F</sub>                              | Input Forward Voltage                  | I <sub>F</sub> = 10 mA                      | –   | 1.18  | 1.50 | V    |
| I <sub>R</sub>                              | Reverse Leakage Current                | V <sub>R</sub> = 6.0 V                      | –   | 0.001 | 10   | μA   |
| <b>DETECTOR</b>                             |                                        |                                             |     |       |      |      |
| BV <sub>CEO</sub>                           | Collector-to-Emitter Breakdown Voltage | I <sub>C</sub> = 1.0 mA, I <sub>F</sub> = 0 | 30  | 100   | –    | V    |
| BV <sub>CBO</sub>                           | Collector-to-Base Breakdown Voltage    | I <sub>C</sub> = 100 μA, I <sub>F</sub> = 0 | 70  | 120   | –    | V    |
| BV <sub>EBO</sub>                           | Emitter-to-Base Breakdown Voltage      | I <sub>E</sub> = 10 μA, I <sub>F</sub> = 0  | 7   | 10    | –    | V    |
| BV <sub>ECO</sub>                           | Emitter-to-Collector Breakdown Voltage | I <sub>E</sub> = 100 μA, I <sub>F</sub> = 0 | 7   | 10    | –    | V    |
| I <sub>CEO</sub>                            | Collector-to-Emitter Dark Current      | V <sub>CE</sub> = 10 V, I <sub>F</sub> = 0  | –   | 1     | 50   | nA   |
| I <sub>CBO</sub>                            | Collector-to-Base Dark Current         | V <sub>CB</sub> = 10 V                      | –   | –     | 20   | nA   |
| C <sub>CE</sub>                             | Capacitance                            | V <sub>CE</sub> = 0 V, f = 1 MHz            | –   | 8     | –    | pF   |

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C, unless otherwise noted) (continued)

| Symbol                   | Parameter                                    | Test Conditions                                                                       | Device          | Min | Typ | Max | Unit          |
|--------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|-----------------|-----|-----|-----|---------------|
| TRANSFER CHARACTERISTICS |                                              |                                                                                       |                 |     |     |     |               |
| DC CHARACTERISTICS       |                                              |                                                                                       |                 |     |     |     |               |
| CTR                      | Current Transfer Ratio, Collector-to-Emitter | $I_F = 10\text{ mA}$ , $V_{CE} = 10\text{ V}$                                         | MCT2EM          | 20  | –   | –   | %             |
|                          |                                              |                                                                                       | TIL117M         | 50  | –   | –   |               |
| $V_{CE(SAT)}$            | Collector-to-Emitter Saturation Voltage      | $I_C = 2\text{ mA}$ , $I_F = 16\text{ mA}$                                            | MCT2EM, TIL111M | –   | –   | 0.4 | V             |
|                          |                                              | $I_C = 0.5\text{ mA}$ , $I_F = 10\text{ mA}$                                          | TIL117M         | –   | –   | 0.4 |               |
| AC CHARACTERISTICS       |                                              |                                                                                       |                 |     |     |     |               |
| $T_{ON}$                 | Non-Saturated Turn-on Time                   | $I_F = 10\text{ mA}$ , $V_{CC} = 10\text{ V}$ , $R_L = 100\text{ }\Omega$ (Figure 11) | MCT2EM          | –   | 2   | –   | $\mu\text{s}$ |
|                          |                                              | $I_C = 2\text{ mA}$ , $V_{CC} = 10\text{ V}$ , $R_L = 100\text{ }\Omega$ (Figure 11)  | TIL117M         | –   | 2   | 10  | $\mu\text{s}$ |
| $T_{OFF}$                | Turn-off Time                                | $I_F = 10\text{ mA}$ , $V_{CC} = 10\text{ V}$ , $R_L = 100\text{ }\Omega$ (Figure 11) | MCT2EM          | –   | 2   | –   | $\mu\text{s}$ |
|                          |                                              | $I_F = 2\text{ mA}$ , $V_{CC} = 10\text{ V}$ , $R_L = 100\text{ }\Omega$ (Figure 11)  | TIL117M         | –   | 2   | 10  | $\mu\text{s}$ |

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C, unless otherwise noted) (continued)

| Symbol                           | Parameter                      | Test Conditions                                    | Min              | Typ | Max | Unit               |
|----------------------------------|--------------------------------|----------------------------------------------------|------------------|-----|-----|--------------------|
| <b>ISOLATION CHARACTERISTICS</b> |                                |                                                    |                  |     |     |                    |
| V <sub>ISO</sub>                 | Input-Output Isolation Voltage | t = 1 Minute                                       | 4170             | –   | –   | V <sub>ACRMS</sub> |
| C <sub>ISO</sub>                 | Isolation Capacitance          | V <sub>I-O</sub> = 0 V, f = 1 MHz                  | –                | 0.2 | –   | pF                 |
| R <sub>ISO</sub>                 | Isolation Resistance           | V <sub>I-O</sub> = ±500 VDC, T <sub>A</sub> = 25°C | 10 <sup>11</sup> | –   | –   | Ω                  |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

TYPICAL PERFORMANCE CURVES

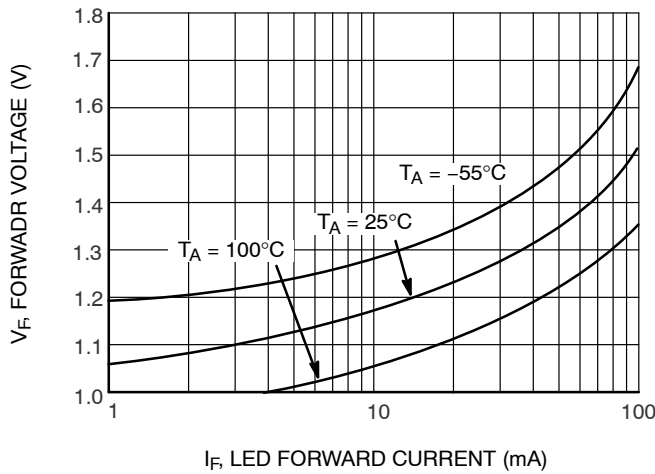


Figure 1. LED Forward Voltage vs. Forward Current

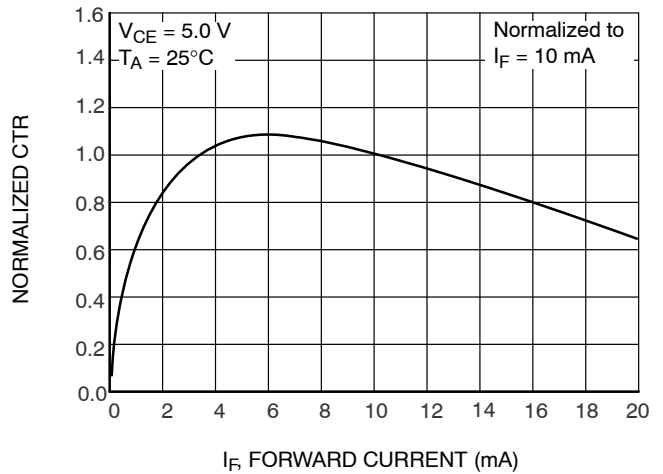


Figure 2. Normalized CTR vs. Forward Current

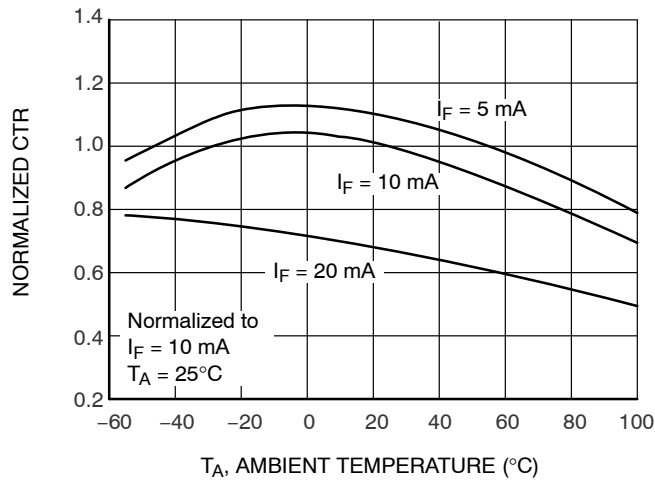


Figure 3. Normalized CTR vs. Ambient Temperature

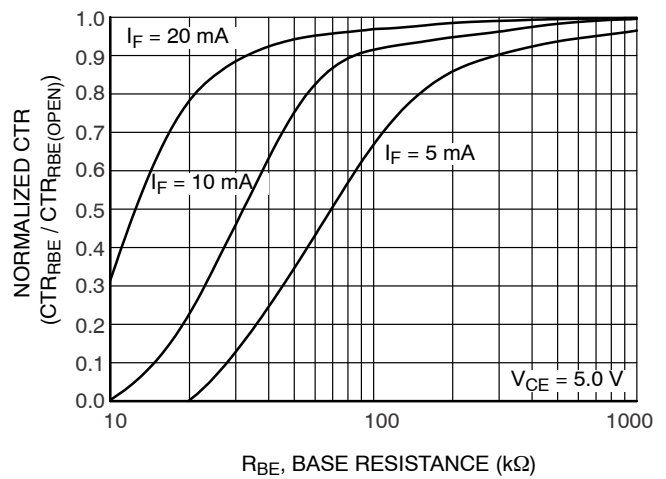


Figure 4. CTR vs.  $R_{BE}$  (Unsaturated)

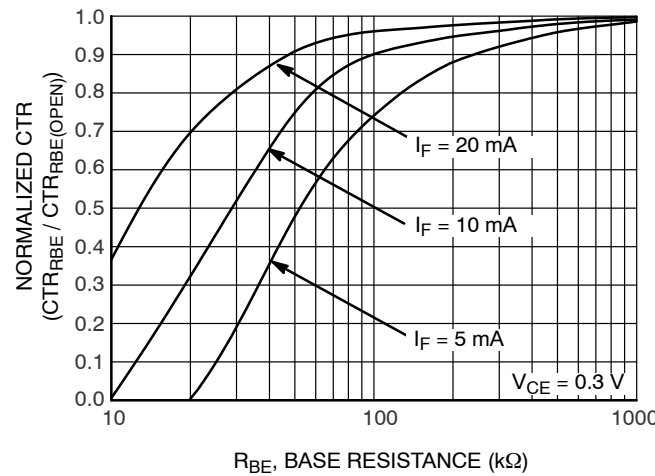


Figure 5. CTR vs.  $R_{BE}$  (Saturated)

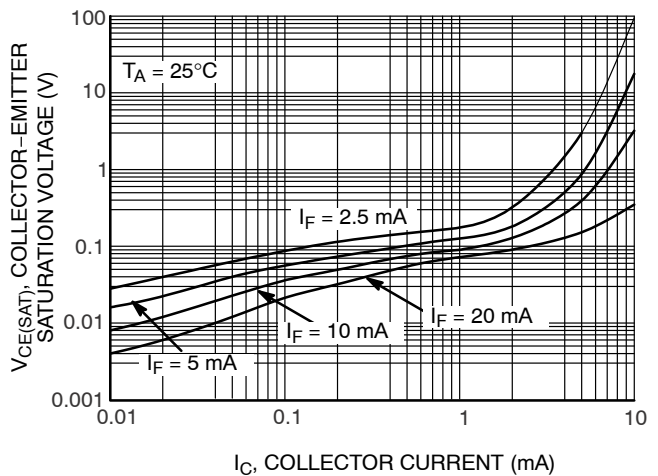


Figure 6. Collector-Emitter Saturation Voltage vs. Collector Current

TYPICAL PERFORMANCE CURVES (continued)

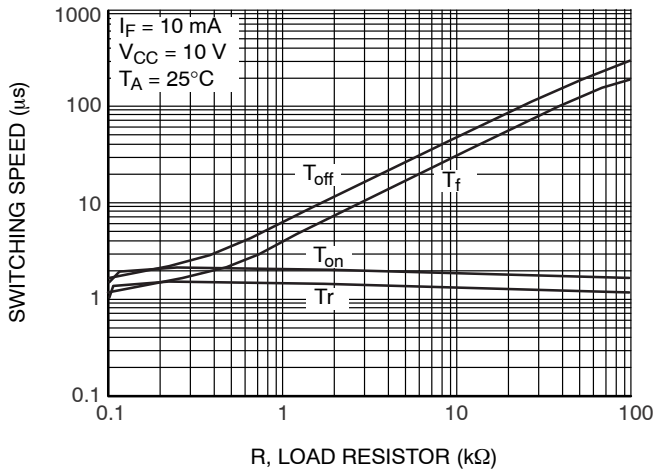


Figure 7. Switching Speed vs. Load Resistor

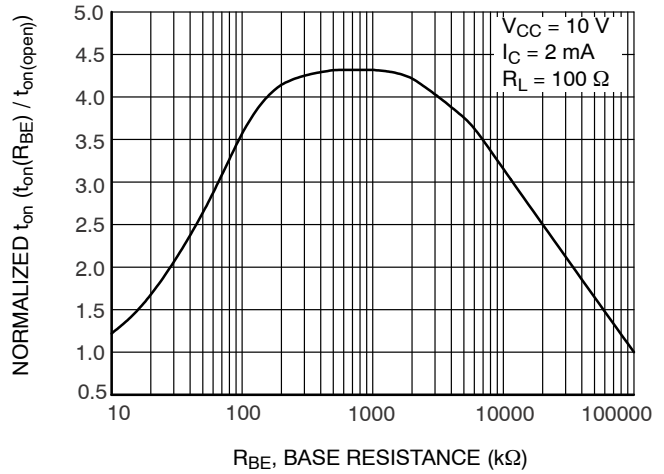


Figure 8. Normalized  $t_{on}$  vs.  $R_{BE}$

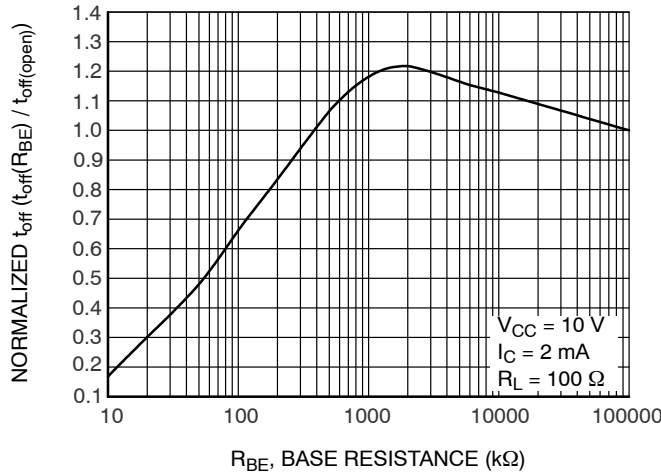


Figure 9. Normalized  $t_{off}$  vs.  $R_{BE}$

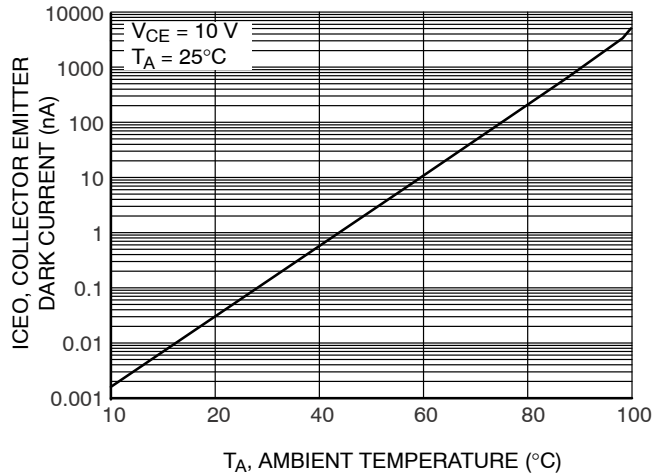


Figure 10. Dark Current vs. Ambient Temperature

SWITCHING TIME TEST CIRCUIT AND WAVEFORMS

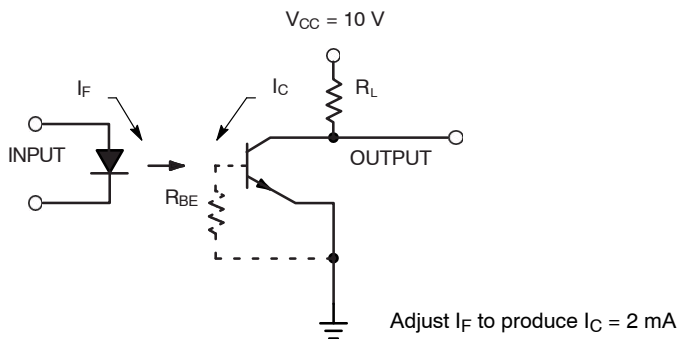


Figure 11. Switching Time Test Circuit and Waveforms

# MCT2EM, TIL111M, TIL117M

## REFLOW PROFILE

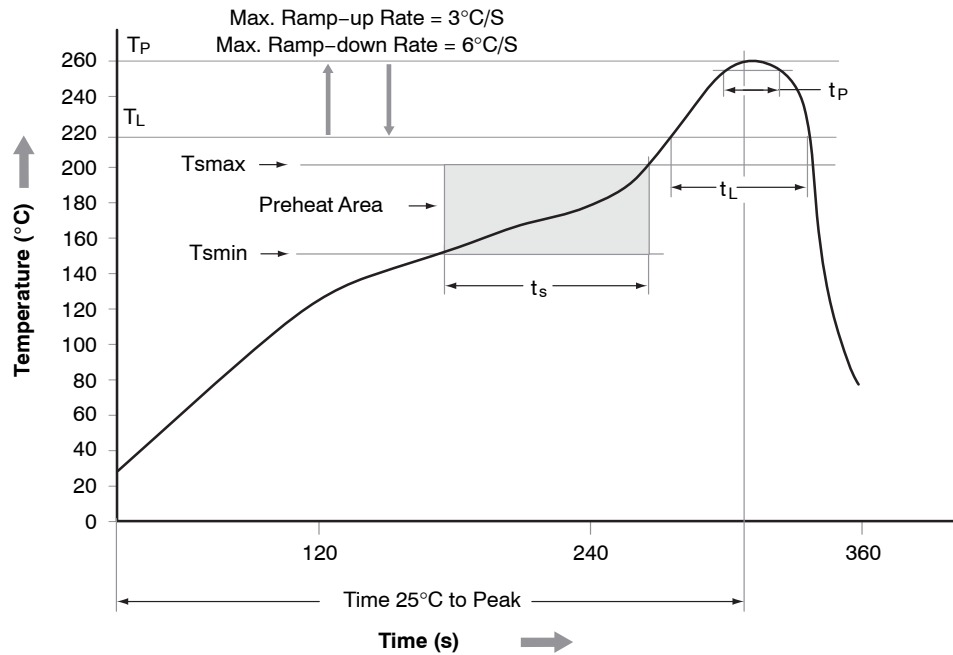


Figure 12. Reflow Profile

Table 1.

| Profile Feature                  | Pb-Free Assembly Profile |
|----------------------------------|--------------------------|
| Temperature Minimum (Tssmin)     | 150°C                    |
| Temperature Maximum (Tsmax)      | 200°C                    |
| Time (ts) from (Tssmin to Tsmax) | 60 – 120 seconds         |
| Ramp-up Rate (tL to tp)          | 3°C/second maximum       |
| Liquidous Temperature (TL)       | 217°C                    |
| Time (tL) Maintained Above (TL)  | 60 – 150 seconds         |
| Peak Body Package Temperature    | 260°C +0°C / -5°C        |
| Time (tp) within 5°C of 260°C    | 30 seconds               |
| Ramp-down Rate (TP to TL)        | 6°C/second maximum       |
| Time 25°C to Peak Temperature    | 8 minutes maximum        |

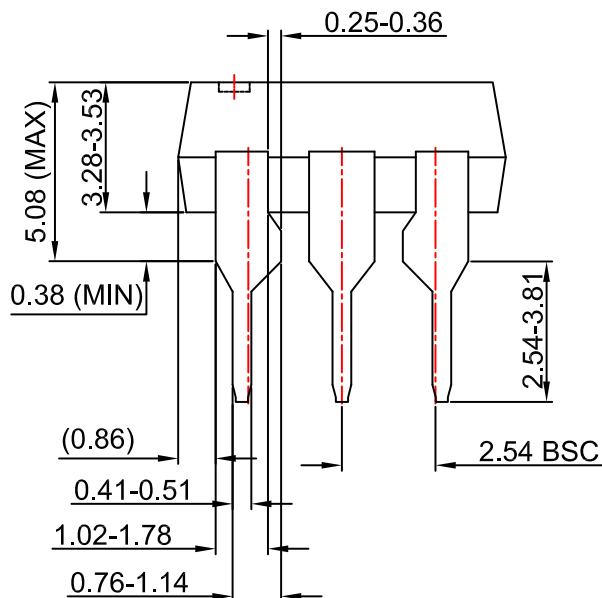
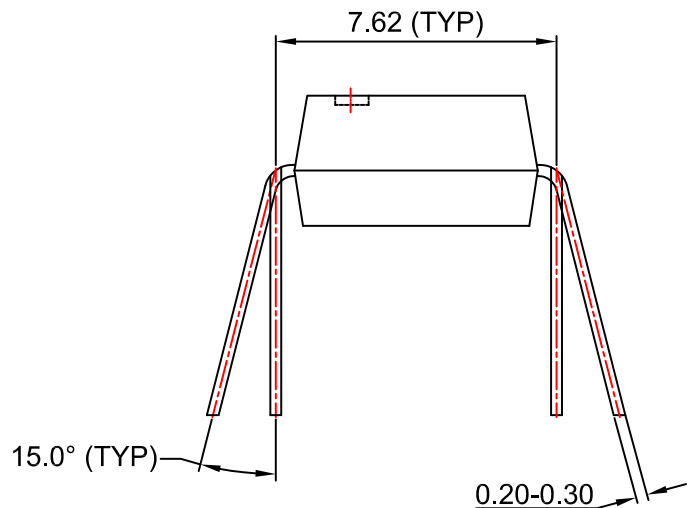
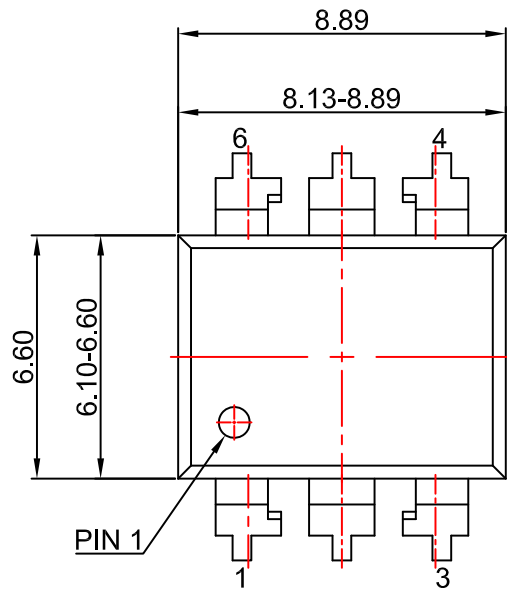
### ORDERING INFORMATION (Note 2)

| Part Number | Package                                                  | Packing Method             |
|-------------|----------------------------------------------------------|----------------------------|
| MCT2EM      | DIP 6-Pin                                                | Tube (50 Units)            |
| MCT2ESM     | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| MCT2ESR2M   | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| MCT2EVM     | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| MCT2ESVM    | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| MCT2ESR2VM  | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| MCT2ETVM    | DIP 6-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 Option | Tube (50 Units)            |

2. The product orderable part number system listed in this table also applies to the TIL111M and TIL117M devices.

**PDIP6 8.51x6.35, 2.54P**  
**CASE 646BX**  
**ISSUE O**

DATE 31 JUL 2016



**NOTES:**

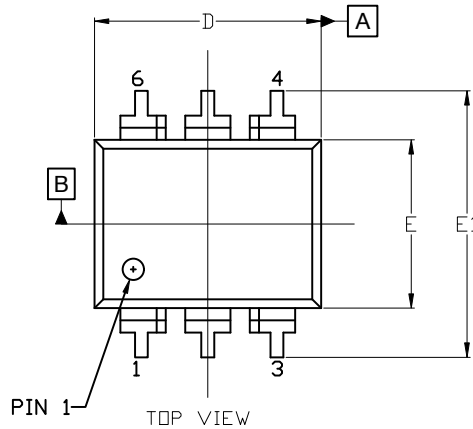
- A) NO STANDARD APPLIES TO THIS PACKAGE.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSION

|                         |                               |                                                                                                                                                                                  |
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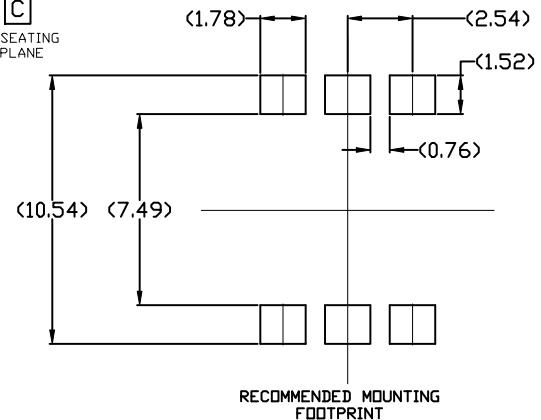
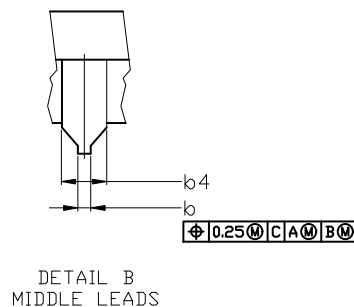
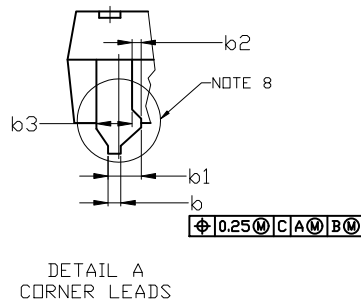
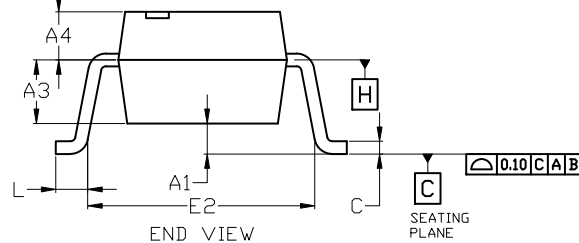
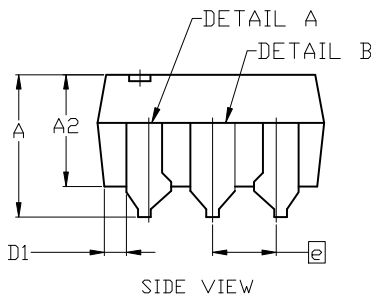
**PDIP6 8.51x6.35, 2.54P**  
**CASE 646BY**  
**ISSUE A**

DATE 15 JUL 2019


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS A, A1, AND L ARE MEASURED WITH THE PACKAGE SEATED.
4. DIMENSIONS D, D1, AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 2.54mm.
5. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).
6. CENTER LINE OF CORNER LEADS IS LOCATED BY LOCATING THE CENTER OF FEATURE b2 AND b3.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | ---         | ---  | 4.80 |
| A1  | 0.38        | ---  | ---  |
| A2  | 3.28        | 3.40 | 3.53 |
| A3  | 2.49 REF    |      |      |
| A4  | 1.89 REF    |      |      |
| b   | 0.41        | 0.46 | 0.51 |
| b1  | 0.76        | 0.92 | 1.14 |
| b2  | 0.25        | 0.28 | 0.36 |
| b3  | 1.02        | 1.40 | 1.78 |
| b4  | 1.778 REF   |      |      |
| c   | 0.20        | 0.25 | 0.30 |
| D   | 8.13        | 8.51 | 8.89 |
| D1  | 0.86 REF    |      |      |
| E   | 6.10        | 6.35 | 6.60 |
| E1  | 8.43        | 9.17 | 9.90 |
| E2  | 8.13 REF    |      |      |
| e   | 2.54 BSC    |      |      |
| L   | 0.16        | 0.52 | 0.88 |



For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

|                         |                               |                                                                                                                                                                                     |
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| <b>DESCRIPTION:</b>     | <b>PDIP6 8.51x6.35, 2.54P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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