



# THE DATASHEET OF MCT2ESM





ON Semiconductor®

# MCT2EM, TIL111M, TIL117M 6-Pin General Purpose Phototransistor Optocouplers

## 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  $V_{AC_{RMS}}$  for 1 Minute
  - DIN-EN/IEC60747-5-5, 850 V Peak Working Insulation Voltage

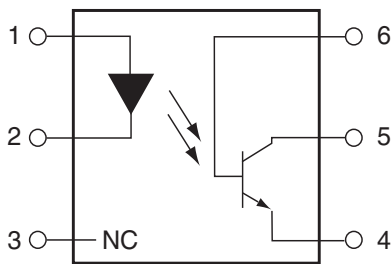
## Applications

- Power Supply Regulators
- Digital Logic Inputs
- Microprocessor Inputs

## Description

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

## Schematic



- PIN 1. ANODE
- 2. CATHODE
- 3. NO CONNECTION
- 4. EMITTER
- 5. COLLECTOR
- 6. BASE

Figure 1. Schematic

## Package Outlines

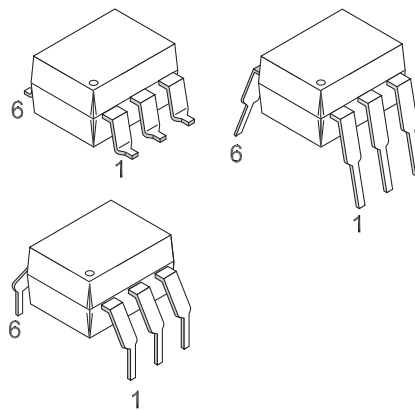


Figure 2. Package Outlines

MCT2EM, TIL111M, TIL117M — 6-Pin General Purpose Phototransistor Optocouplers

## 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 <sup>(1)</sup>	175	°C
I <sub>S,INPUT</sub>	Input Current <sup>(1)</sup>	350	mA
P <sub>S,OUTPUT</sub>	Output Power <sup>(1)</sup>	800	mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V <sup>(1)</sup>	> 10 <sup>9</sup>	Ω

**Note:**

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

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

Symbol	Parameter	Device	Value	Unit
<b>TOTAL DEVICE</b>				
$T_{STG}$	Storage Temperature	All	-40 to +125	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature	All	-40 to +100	$^\circ\text{C}$
$T_J$	Junction Temperature	All	-40 to +125	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature	All	260 for 10 seconds	$^\circ\text{C}$
$P_D$	Total Device Power Dissipation @ $T_A = 25^\circ\text{C}$	All	250	mW
	Derate Above $25^\circ\text{C}$	All	2.94	mW/ $^\circ\text{C}$
<b>EMITTER</b>				
$I_F$	DC/Average Forward Input Current	All	60	mA
$V_R$	Reverse Input Voltage	TIL111M	3	V
		MCT2EM, TIL117M	6	V
$I_F(\text{pk})$	Forward Current – Peak (300 $\mu\text{s}$ , 2% Duty Cycle)	All	3	A
$P_D$	LED Power Dissipation @ $T_A = 25^\circ\text{C}$	All	120	mW
	Derate Above $25^\circ\text{C}$	All	1.41	mW/ $^\circ\text{C}$
<b>DETECTOR</b>				
$V_{CEO}$	Collector-to-Emitter Voltage	All	30	V
$V_{CBO}$	Collector-to-Base Voltage	All	70	V
$V_{ECO}$	Emitter-to-Collector Voltage	All	7	V
$V_{EBO}$	Emitter-to-Base Voltage	All	7	V
$P_D$	Detector Power Dissipation @ $T_A = 25^\circ\text{C}$	All	150	mW
	Derate Above $25^\circ\text{C}$	All	1.76	mW/ $^\circ\text{C}$

## Electrical Characteristics

TA = 25°C unless otherwise specified.

### Individual Component Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<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

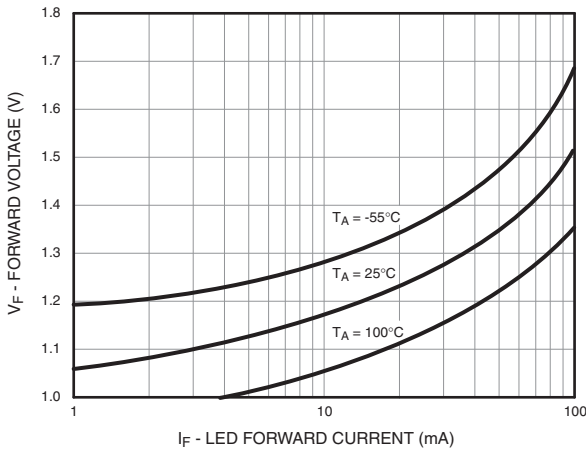
### Transfer Characteristics

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
<b>DC CHARACTERISTICS</b>							
CTR	Current Transfer Ratio, Collector-to-Emitter	I <sub>F</sub> = 10 mA, V <sub>CE</sub> = 10 V	MCT2EM	20			%
			TIL117M	50			%
V <sub>CE(SAT)</sub>	Collector-to-Emitter Saturation Voltage	I <sub>C</sub> = 2 mA, I <sub>F</sub> = 16 mA	MCT2EM, TIL111M			0.4	V
		I <sub>C</sub> = 0.5 mA, I <sub>F</sub> = 10 mA	TIL117M			0.4	V
<b>AC CHARACTERISTICS</b>							
T <sub>ON</sub>	Non-Saturated Turn-on Time	I <sub>F</sub> = 10 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Figure 13)	MCT2EM		2		μs
		I <sub>C</sub> = 2 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Figure 13)	TIL117M		2	10	μs
T <sub>OFF</sub>	Turn-off Time	I <sub>F</sub> = 10 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Figure 13)	MCT2EM		2		μs
		I <sub>C</sub> = 2 mA, V <sub>CC</sub> = 10 V, R <sub>L</sub> = 100 Ω (Figure 13)	TIL117M		2	10	μs

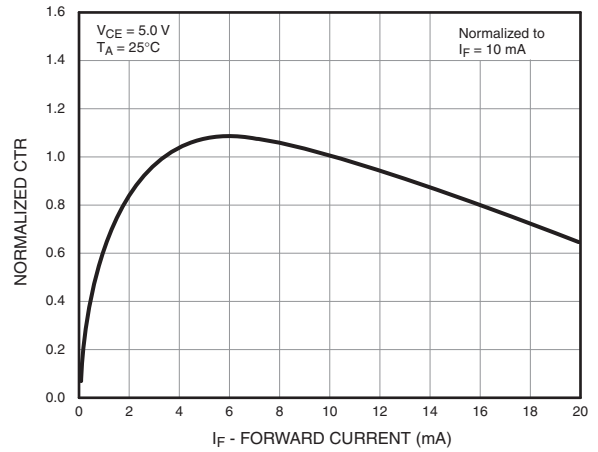
### Isolation Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>ISO</sub>	Input-Output Isolation Voltage	t = 1 Minute	4170			V <sub>AC,RMS</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

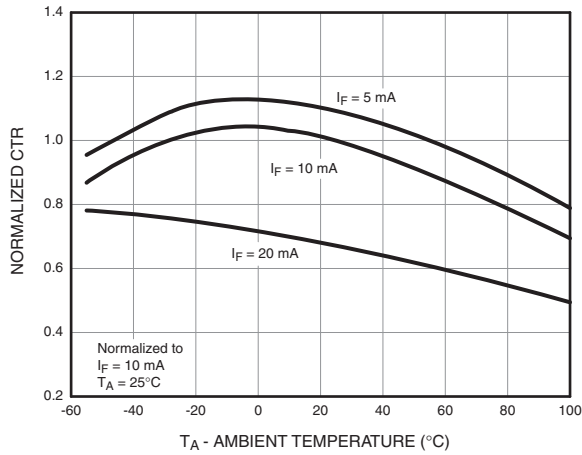
## Typical Performance Curves



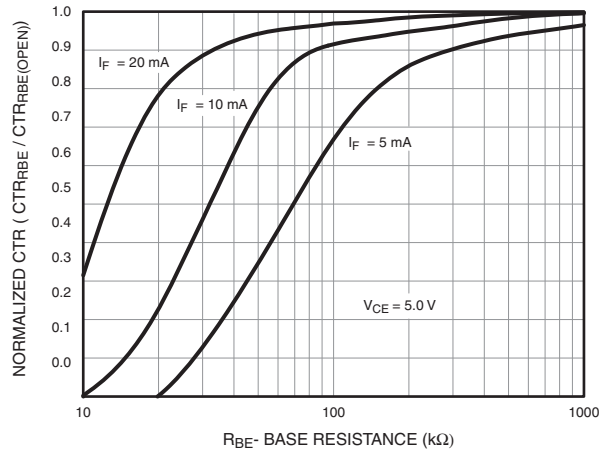
**Figure 3. LED Forward Voltage vs. Forward Current**



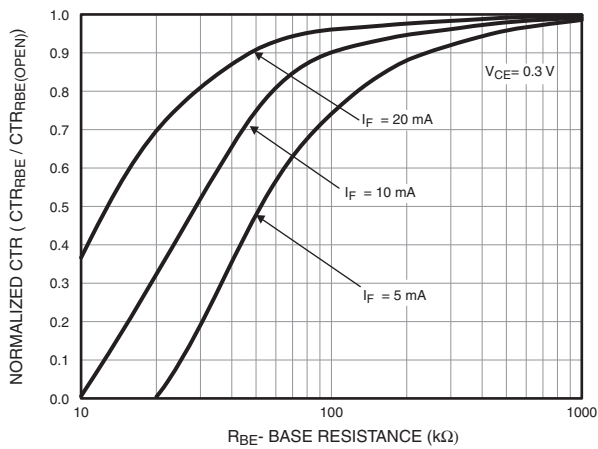
**Figure 4. Normalized CTR vs. Forward Current**



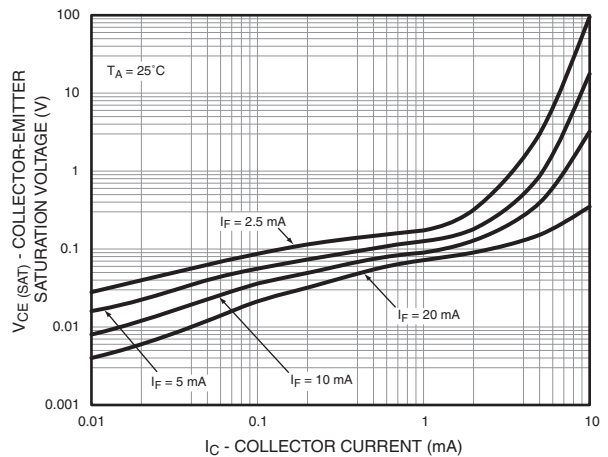
**Figure 5. Normalized CTR vs. Ambient Temperature**



**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 Curves (Continued)

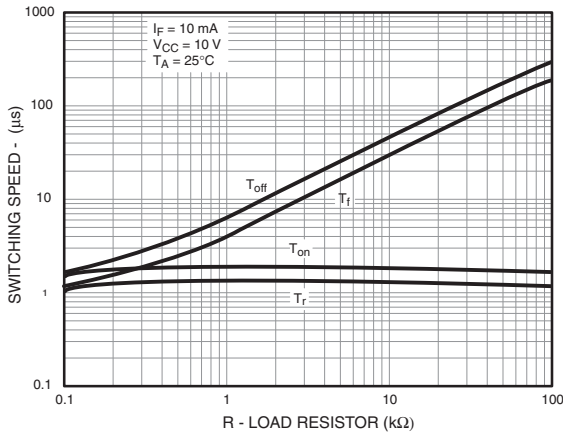


Figure 9. Switching Speed vs. Load Resistor

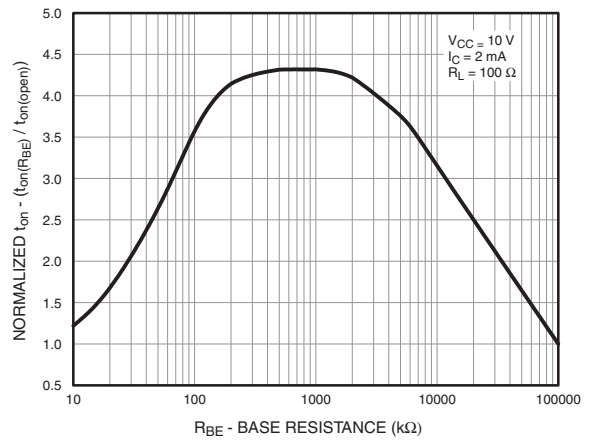


Figure 10. Normalized  $t_{on}$  vs.  $R_{BE}$

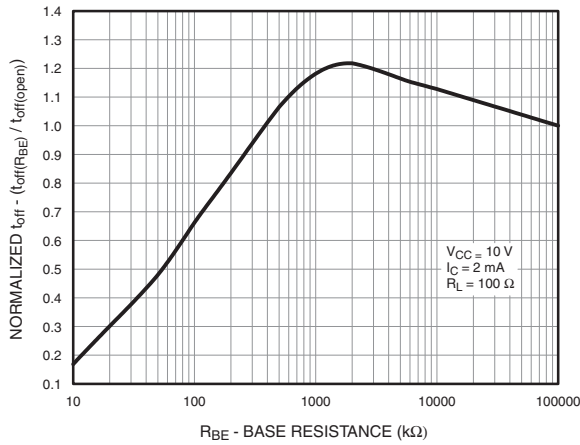


Figure 11. Normalized  $t_{off}$  vs.  $R_{BE}$

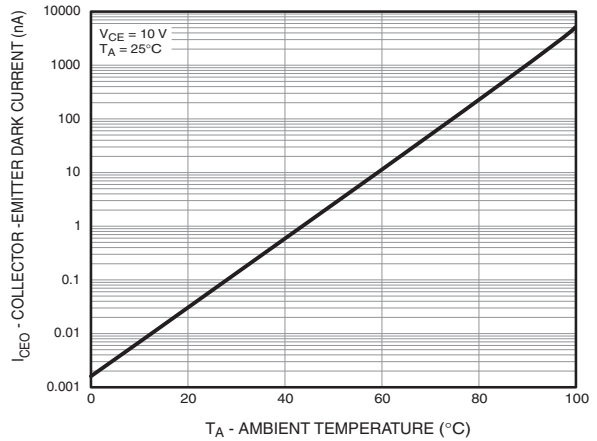


Figure 12. Dark Current vs. Ambient Temperature

### Switching Time Test Circuit and Waveforms

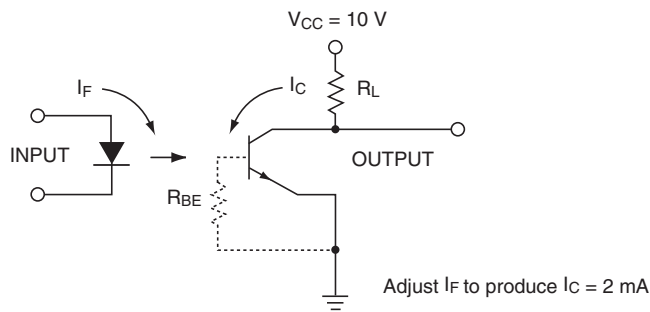


Figure 13. Switching Time Test Circuit and Waveforms

### Reflow Profile

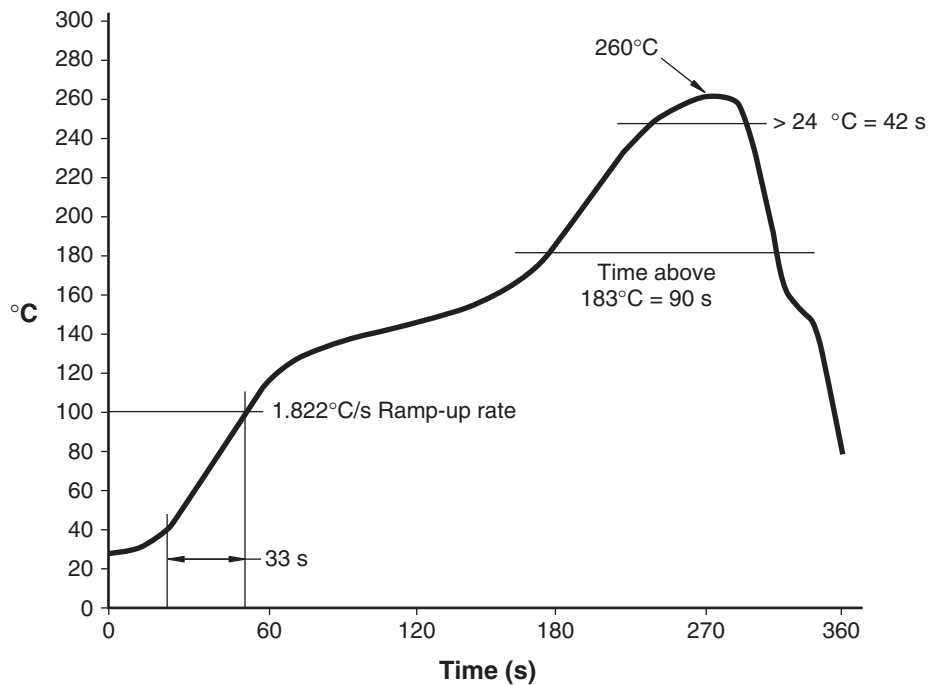


Figure 14. Reflow Profile

## Ordering Information

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)

**Note:**

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

## Marking Information

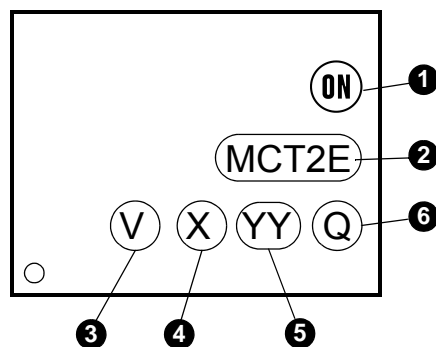


Figure 15. Top Mark

Table 1. Top Mark Definitions

1	ON Semiconductor Logo
2	Device Number
3	DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	One-Digit Year Code, e.g., "6"
5	Digit Work Week, Ranging from "01" to "53"
6	Assembly Package Code

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