

# MCT5201M, MCT5210M, MCT5211M

## Low Input Current Phototransistor Optocouplers

### Features

- High  $CTR_{CE(SAT)}$  comparable to Darlings
- $CTR$  guaranteed 0°C to 70°C
- High common mode transient rejection 5kV/μs
- Data rates up to 150kbits/s (NRZ)
- Underwriters Laboratory (UL) recognized, file #E90700, volume 2
- IEC60747-5-2 approved (ordering option V)

### Applications

- CMOS to CMOS/LSTTL logic isolation
- LSTTL to CMOS/LSTTL logic isolation
- RS-232 line receiver
- Telephone ring detector
- AC line voltage sensing
- Switching power supply

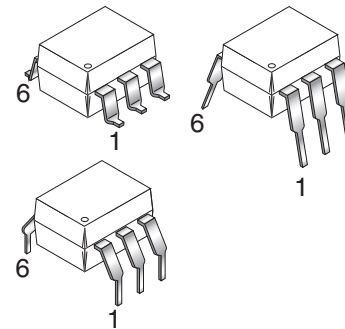
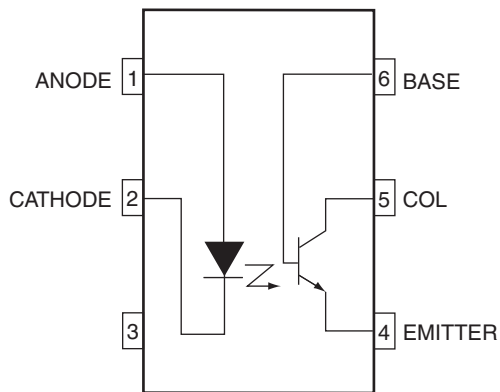
### Description

The MCT52XXM series consists of a high-efficiency AlGaAs, infrared emitting diode, coupled with an NPN phototransistor in a six pin dual-in-line package.

The MCT52XXM is well suited for CMOS to LSTT/TTL interfaces, offering 250%  $CTR_{CE(SAT)}$  with 1mA of LED input current. When an LED input current of 1.6mA is supplied data rates to 20K bits/s are possible.

The MCT52XXM can easily interface LSTTL to LSTTL/TTL, and with use of an external base to emitter resistor data rates of 100K bits/s can be achieved.

### Schematic



## 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              | Parameters  | Value          | Units |
|---------------------|---|----------------|-------|
| <b>TOTAL DEVICE</b> |   |                |       |
| T <sub>STG</sub>    | Storage Temperature                                       | -55 to +150    | °C    |
| T <sub>OPR</sub>    | Operating Temperature                                     | -40 to +100    | °C    |
| T <sub>SOL</sub>    | Lead Solder Temperature                                   | 260 for 10 sec | °C    |
| P <sub>D</sub>      | Total Device Power Dissipation @ 25°C (LED plus detector) | 260            | mW    |
|                     | Derate Linearly From 25°C                                 | 3.5            | mW/°C |
| <b>EMITTER</b>      |   |                |       |
| I <sub>F</sub>      | Continuous Forward Current                                | 50             | mA    |
| V <sub>R</sub>      | Reverse Input Voltage                                     | 6              | V     |
| I <sub>F(pk)</sub>  | Forward Current - Peak (1 μs pulse, 300 pps)              | 3.0            | A     |
| P <sub>D</sub>      | LED Power Dissipation                                     | 75             | mW    |
|                     | Derate Linearly From 25°C                                 | 1.0            | mW/°C |
| <b>DETECTOR</b>     |   |                |       |
| I <sub>C</sub>      | Continuous Collector Current                              | 150            | mA    |
| P <sub>D</sub>      | Detector Power Dissipation                                | 150            | mW    |
|                     | Derate Linearly from 25°C                                 | 2.0            | mW/°C |

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)**Individual Component Characteristics**

| Symbol                          | Parameters                          | Test Conditions   | Device | Min. | Typ.* | Max. | Units |
|---------------------------------|-------------------------------------|---|--------|------|-------|------|-------|
| <b>EMITTER</b>                  |                                     |   |        |      |       |      |       |
| $V_F$                           | Input Forward Voltage               | $I_F = 5\text{mA}$  | All    |      | 1.25  | 1.5  | V     |
| $\frac{\Delta V_F}{\Delta T_A}$ | Forward Voltage Temp. Coefficient   | $I_F = 2\text{mA}$  | All    |      | -1.75 |      | mV/°C |
| $V_R$                           | Reverse Voltage                     | $I_R = 10\mu\text{A}$   | All    | 6    |       |      | V     |
| $C_J$                           | Junction Capacitance                | $V_F = 0\text{V}, f = 1.0\text{MHz}$                          | All    |      | 18    |      | pF    |
| <b>DETECTOR</b>                 |                                     |   |        |      |       |      |       |
| $BV_{CEO}$                      | Collector-Emitter Breakdown Voltage | $I_C = 1.0\text{mA}, I_F = 0$                                 | All    | 30   | 100   |      | V     |
| $BV_{CBO}$                      | Collector-Base Breakdown Voltage    | $I_C = 10\mu\text{A}, I_F = 0$                                | All    | 30   | 120   |      | V     |
| $BV_{EBO}$                      | Emitter-Base Breakdown Voltage      | $I_C = 10\mu\text{A}, I_F = 0$                                | All    | 5    | 10    |      | V     |
| $I_{CER}$                       | Collector-Emitter Dark Current      | $V_{CE} = 10\text{V}, I_F = 0,$<br>$R_{BE} = 1\text{M}\Omega$ | All    |      | 1     | 100  | nA    |
| $C_{CE}$                        | Capacitance, Collector to Emitter   | $V_{CE} = 0, f = 1\text{MHz}$                                 | All    |      | 10    |      | pF    |
| $C_{CB}$                        | Capacitance, Collector to Base      | $V_{CB} = 0, f = 1\text{MHz}$                                 | All    |      | 80    |      | pF    |
| $C_{EB}$                        | Capacitance, Emitter to Base        | $V_{EB} = 0, f = 1\text{MHz}$                                 | All    |      | 15    |      | pF    |

**Isolation Characteristics**

| Symbol    | Characteristic                                 | Test Conditions  | Device       | Min.      | Typ.* | Max. | Units            |
|-----------|--|--|--------------|-----------|-------|------|------------------|
| $V_{ISO}$ | Input-Output Isolation Voltage <sup>(10)</sup> | $f = 60\text{Hz}, t = 1 \text{ sec.}$  | All          | 7500      |       |      | Vac(peak)        |
| $R_{ISO}$ | Isolation Resistance <sup>(10)</sup>           | $V_{I-O} = 500 \text{ VDC}, T_A = 25^\circ\text{C}$                          | All          | $10^{11}$ |       |      | $\Omega$         |
| $C_{ISO}$ | Isolation Capacitance <sup>(9)</sup>           | $V_{I-O} = 0, f = 1 \text{ MHz}$   | All          |           | 0.4   | 0.6  | pF               |
| $CM_H$    | Common Mode Transient                          | $V_{CM} = 50 \text{ V}_{P-P1}, R_L = 750\Omega,$<br>$I_F = 0$                | MCT5210M/11M |           | 5000  |      | V/ $\mu\text{s}$ |
|           | Rejection – Output HIGH                        | $V_{CM} = 50 \text{ V}_{P-P}, R_L = 1\text{K}\Omega,$<br>$I_F = 0$           | MCT5201M     |           |       |      |                  |
| $CM_L$    | Common Mode Transient                          | $V_{CM} = 50 \text{ V}_{P-P1}, R_L = 750\Omega,$<br>$I_F = 1.6\text{mA}$     | MCT5210M/11M |           | 5000  |      | V/ $\mu\text{s}$ |
|           | Rejection – Output LOW                         | $V_{CM} = 50 \text{ V}_{P-P1}, R_L = 1\text{K}\Omega,$<br>$I_F = 5\text{mA}$ | MCT5201M     |           |       |      |                  |

\*All typical  $T_A = 25^\circ\text{C}$

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

### Transfer Characteristics

| Symbol                    | Characteristics   | Test Conditions  | Device  | Min.     | Typ.* | Max. | Units         |               |
|---------------------------|---|--|---|----------|-------|------|---------------|---------------|
| <b>DC CHARACTERISTICS</b> |   |  |   |          |       |      |               |               |
| $CTR_{CE(SAT)}$           | Saturated Current Transfer Ratio <sup>(1)</sup><br>(Collector to Emitter) | $I_F = 5\text{mA}, V_{CE} = 0.4\text{V}$   | MCT5201M  | 120      |       |      | %             |               |
|                           |   | $I_F = 3.0\text{mA}, V_{CE} = 0.4\text{V}$   | MCT5210M  | 60       |       |      |               |               |
|                           |   | $I_F = 1.6\text{mA}, V_{CE} = 0.4\text{V}$   | MCT5211M  | 100      |       |      |               |               |
|                           |   | $I_F = 1.0\text{mA}, V_{CE} = 0.4\text{V}$   |   | 75       |       |      |               |               |
| $CTR_{(CE)}$              | Current Transfer Ratio<br>(Collector to Emitter) <sup>(1)</sup>           | $I_F = 3.0\text{mA}, V_{CE} = 5.0\text{V}$   | MCT5210M  | 70       |       |      | %             |               |
|                           |   | $I_F = 1.6\text{mA}, V_{CE} = 5.0\text{V}$   | MCT5211M  | 150      |       |      |               |               |
|                           |   | $I_F = 1.0\text{mA}, V_{CE} = 5.0\text{V}$   |   | 110      |       |      |               |               |
| $CTR_{(CB)}$              | Current Transfer Ratio<br>Collector to Base <sup>(2)</sup>                | $I_F = 5\text{mA}, V_{CB} = 4.3\text{V}$   | MCT5201M  | 0.28     |       |      | %             |               |
|                           |   | $I_F = 3.0\text{mA}, V_{CB} = 4.3\text{V}$   | MCT5210M  | 0.2      |       |      |               |               |
|                           |   | $I_F = 1.6\text{mA}, V_{CB} = 4.3\text{V}$   | MCT5211M  | 0.3      |       |      |               |               |
|                           |   | $I_F = 1.0\text{mA}, V_{CB} = 4.3\text{V}$   |   | 0.25     |       |      |               |               |
| $V_{CE(SAT)}$             | Saturation Voltage  | $I_F = 5\text{mA}, I_{CE} = 6\text{mA}$  | MCT5201M  |          |       | 0.4  | V             |               |
|                           |   | $I_F = 3.0\text{mA}, I_{CE} = 1.8\text{mA}$  | MCT5210M  |          |       | 0.4  |               |               |
|                           |   | $I_F = 1.6\text{mA}, I_{CE} = 1.6\text{mA}$  | MCT5211M  |          |       | 0.4  |               |               |
| <b>AC CHARACTERISTICS</b> |   |  |   |          |       |      |               |               |
| $T_{PHL}$                 | Propagation Delay<br>HIGH-to-LOW <sup>(3)</sup>                           | $R_L = 330\ \Omega, R_{BE} = \infty$   | $I_F = 3.0\text{mA},$<br>$V_{CC} = 5.0\text{V}$ | MCT5210M |       | 10   | $\mu\text{s}$ |               |
|                           |   | $R_L = 3.3\ \text{k}\Omega, R_{BE} = 39\text{k}\Omega$   |   |          |       | 7    |               |               |
|                           |   | $R_L = 750\ \Omega, R_{BE} = \infty$   | $I_F = 1.6\text{mA},$<br>$V_{CC} = 5.0\text{V}$ | MCT5211M |       | 14   |               |               |
|                           |   | $R_L = 4.7\ \text{k}\Omega, R_{BE} = 91\text{k}\Omega$   |   |          |       | 15   |               |               |
|                           |   | $R_L = 1.5\ \text{k}\Omega, R_{BE} = \infty$   | $I_F = 1.0\text{mA},$<br>$V_{CC} = 5.0\text{V}$ |          | 17    |      |               |               |
|                           |   | $R_L = 10\ \text{k}\Omega, R_{BE} = 160\text{k}\Omega$   |   |          | 24    |      |               |               |
|                           |   | $V_{CE} = 0.4\text{V}, V_{CC} = 5\text{V},$<br>$R_L = \text{fig. 13}, R_{BE} = 330\text{k}\Omega$      | $I_F = 5\text{mA}$                              | MCT5201M |       | 3    |               | 30            |
| $T_{PLH}$                 | Propagation Delay<br>LOW-to-HIGH <sup>(4)</sup>                           | $R_L = 330\ \Omega, R_{BE} = \infty$   | $I_F = 3.0\text{mA},$<br>$V_{CC} = 5.0\text{V}$ | MCT5210M |       | 0.4  | $\mu\text{s}$ |               |
|                           |   | $R_L = 3.3\ \text{k}\Omega, R_{BE} = 39\text{k}\Omega$   |   |          |       | 8    |               |               |
|                           |   | $R_L = 750\ \Omega, R_{BE} = \infty$   | $I_F = 1.6\text{mA},$<br>$V_{CC} = 5.0\text{V}$ | MCT5211M |       | 2.5  |               |               |
|                           |   | $R_L = 4.7\ \text{k}\Omega, R_{BE} = 91\text{k}\Omega$   |   |          |       | 11   |               |               |
|                           |   | $R_L = 1.5\ \text{k}\Omega, R_{BE} = \infty$   | $I_F = 1.0\text{mA},$<br>$V_{CC} = 5.0\text{V}$ |          | 7     |      |               |               |
|                           |   | $R_L = 10\ \text{k}\Omega, R_{BE} = 160\text{k}\Omega$   |   |          | 16    |      |               |               |
|                           |   | $V_{CE} = 0.4\text{V}, V_{CC} = 5\text{V},$<br>$R_L = \text{fig. 13}, R_{BE} = 330\text{k}\Omega$      | $I_F = 5\text{mA}$                              | MCT5201M |       | 12   |               | 13            |
| $t_d$                     | Delay Time <sup>(5)</sup>   | $V_{CE} = 0.4\text{V}, R_{BE} = 330\text{k}\Omega,$<br>$R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$   | $I_F = 5\text{mA}$                              | MCT5201M |       | 1.1  | 15            | $\mu\text{s}$ |
| $t_r$                     | Rise Time <sup>(6)</sup>  | $V_{CE} = 0.4\text{V}, R_{BE} = 330\text{k}\Omega,$<br>$R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$   | $I_F = 5\text{mA}$                              | MCT5201M |       | 2.5  | 20            | $\mu\text{s}$ |
| $t_s$                     | Storage Time <sup>(7)</sup>   | $V_{CE} = 0.4\text{V}, R_{BE} = 330\ \text{k}\Omega,$<br>$R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$ | $I_F = 5\text{mA}$                              | MCT5201M |       | 10   | 13            | $\mu\text{s}$ |
| $t_f$                     | Fall Time <sup>(8)</sup>  | $V_{CE} = 0.4\text{V}, R_{BE} = 330\ \text{k}\Omega,$<br>$R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$ | $I_F = 5\text{mA}$                              | MCT5201M |       | 16   | 30            | $\mu\text{s}$ |

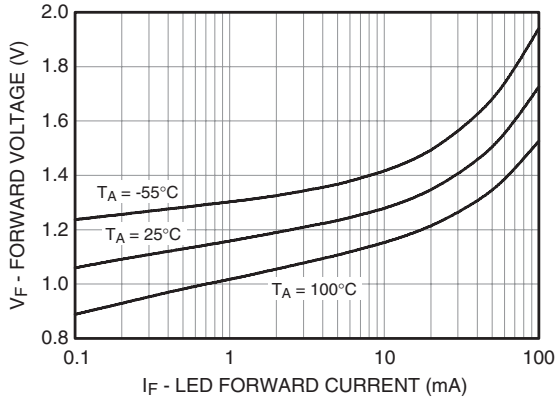
\*All typicals at  $T_A = 25^\circ\text{C}$

**Notes:**

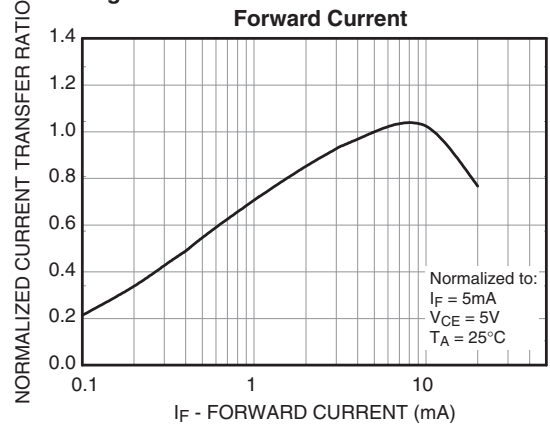
1. DC Current Transfer Ratio ( $CTR_{CE}$ ) is defined as the transistor collector current ( $I_{CE}$ ) divided by the input LED current ( $I_F$ ) x 100%, at a specified voltage between the collector and emitter ( $V_{CE}$ ).
2. The collector base Current Transfer Ratio ( $CTR_{CB}$ ) is defined as the transistor collector base photocurrent ( $I_{CB}$ ) divided by the input LED current ( $I_F$ ) time 100%.
3. Referring to Figure 14 the  $T_{PHL}$  propagation delay is measured from the 50% point of the rising edge of the data input pulse to the 1.3V point on the falling edge of the output pulse.
4. Referring to Figure 14 the  $T_{PLH}$  propagation delay is measured from the 50% point of the falling edge of data input pulse to the 1.3V point on the rising edge of the output pulse.
5. Delay time ( $t_d$ ) is measured from 50% of rising edge of LED current to 90% of  $V_o$  falling edge.
6. Rise time ( $t_r$ ) is measured from 90% to 10% of  $V_o$  falling edge.
7. Storage time ( $t_s$ ) is measured from 50% of falling edge of LED current to 10% of  $V_o$  rising edge.
8. Fall time ( $t_f$ ) is measured from 10% to 90% of  $V_o$  rising edge.
9.  $C_{ISO}$  is the capacitance between the input (pins 1, 2, 3 connected) and the output, (pin 4, 5, 6 connected).
10. Device considered a two terminal device: Pins 1, 2, and 3 shorted together, and pins 5, 6 and 7 are shorted together.

## Typical Performance Curves

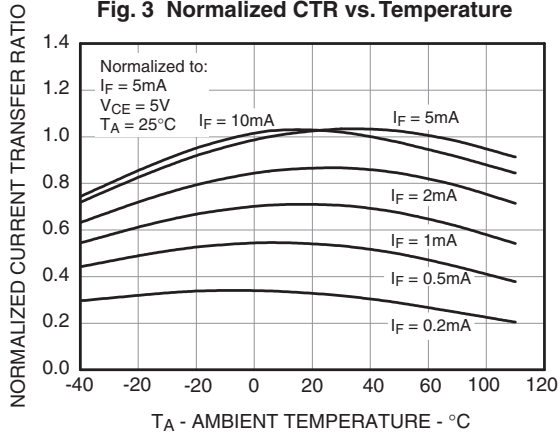
**Fig. 1 LED Forward Voltage vs. Forward Current**



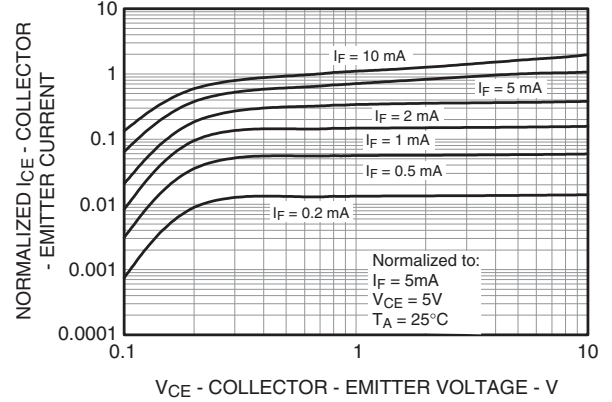
**Fig. 2 Normalized Current Transfer Ratio vs. Forward Current**



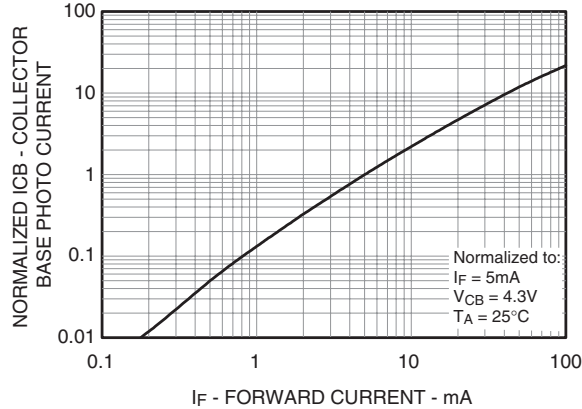
**Fig. 3 Normalized CTR vs. Temperature**



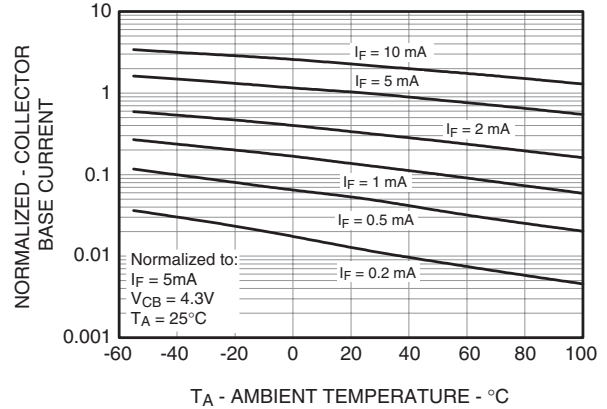
**Fig. 4 Normalized Collector vs. Collector - Emitter Voltage**



**Fig. 5 Normalized Collector Base Photocurrent Ratio vs. Forward Current**

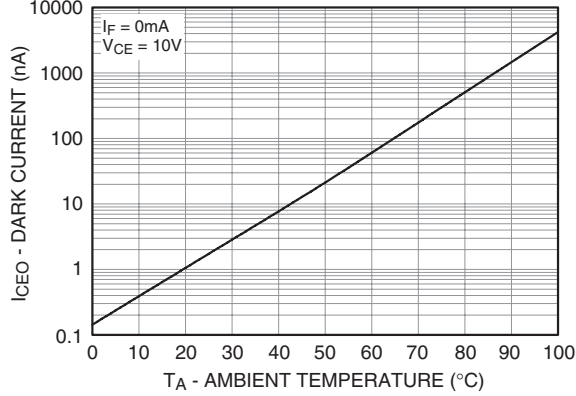


**Fig. 6 Normalized Collector - Base Current vs. Temperature**

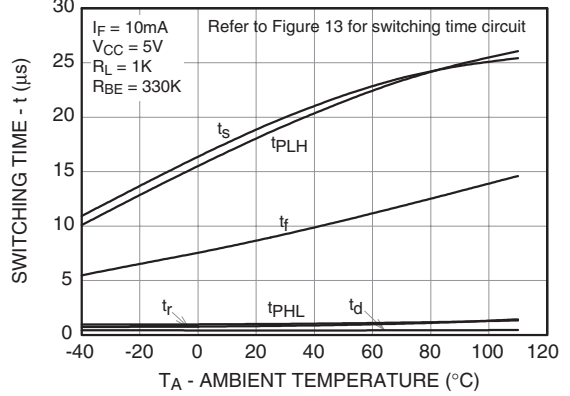


## Typical Performance Curves (Continued)

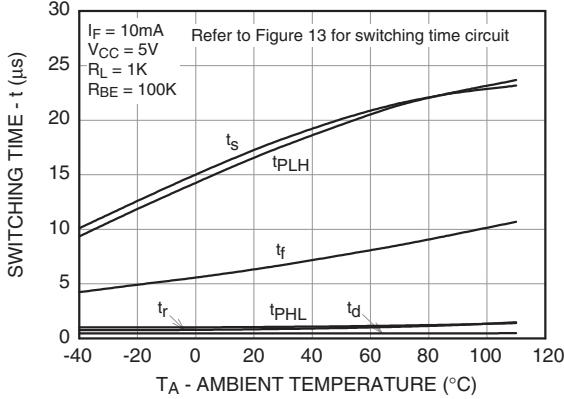
**Fig. 7 Collector-Emitter Dark Current vs. Ambient Temperature**



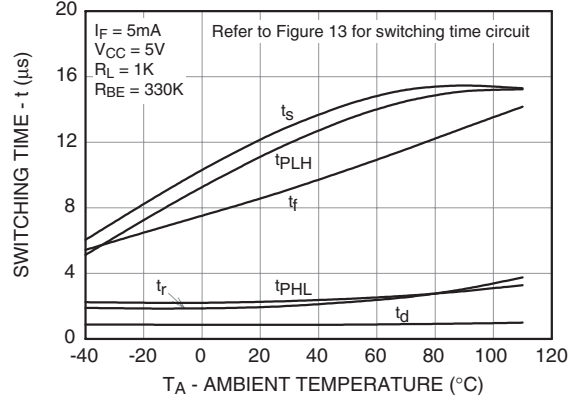
**Fig. 8 Switching Time vs. Ambient Temperature**



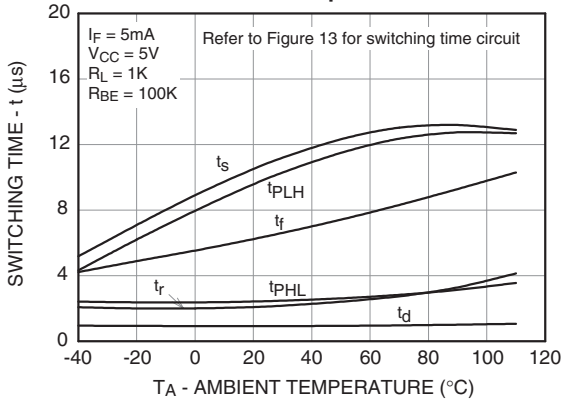
**Fig. 9 Switching Time vs. Ambient Temperature**



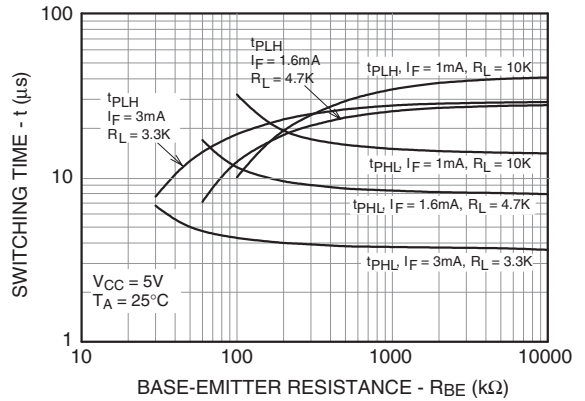
**Fig. 10 Switching Time vs. Ambient Temperature**



**Fig. 11 Switching Time vs. Ambient Temperature**



**Fig. 12 Switching Time vs. Base-Emitter Resistance**



**Typical Electro-Optical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise specified)

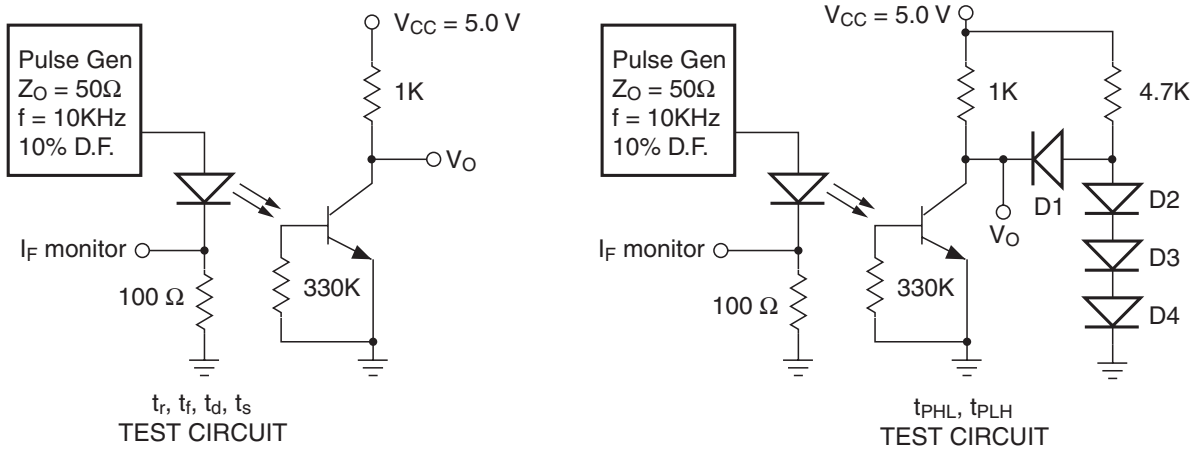


Figure 13.

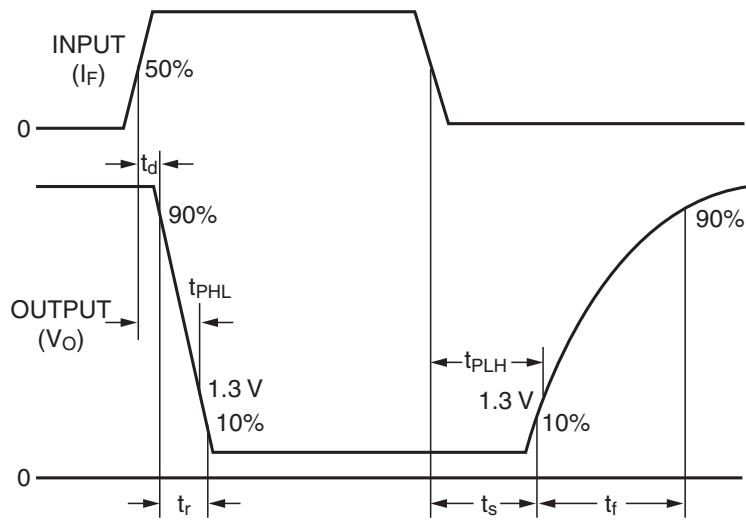
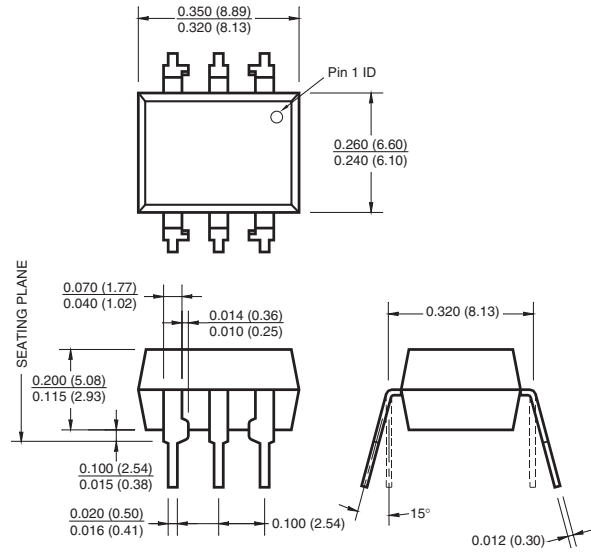


Figure 14. Switching Circuit Waveforms

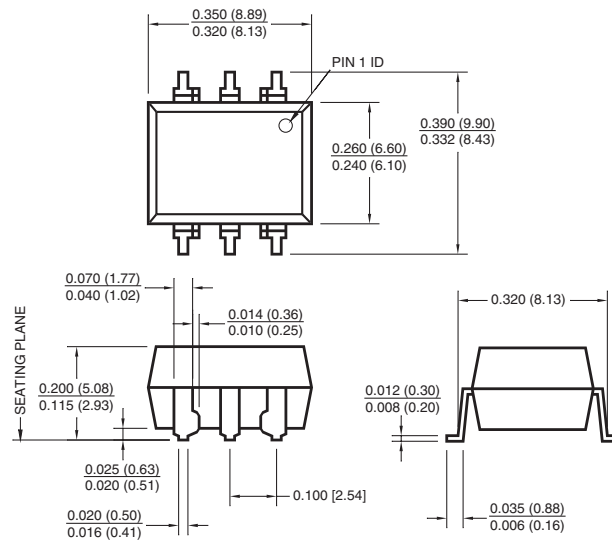


## Package Dimensions

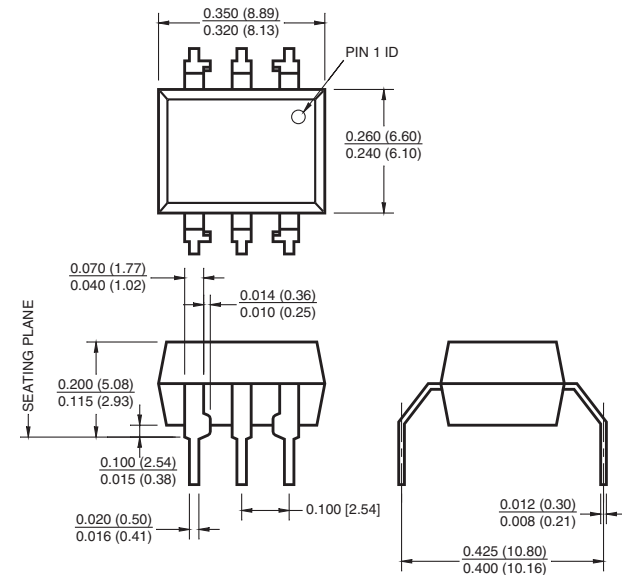
### Through Hole



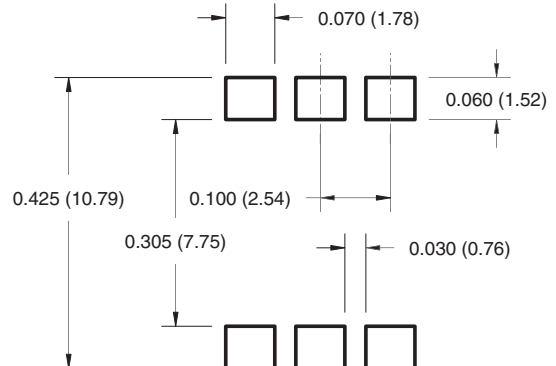
### Surface Mount



### 0.4" Lead Spacing



### Recommended Pad Layout for Surface Mount Leadform



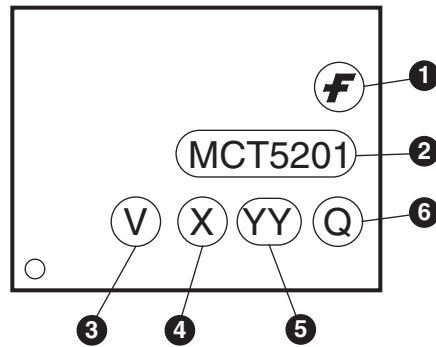
### Note:

All dimensions are in inches (millimeters)

### Ordering Information

| Option    | Order Entry Identifier (Example) | Description   |
|-----------|----------------------------------|---|
| No suffix | MCT5201M                         | Standard Through Hole Device (50 units per tube)                  |
| S         | MCT5201SM                        | Surface Mount Lead Bend   |
| SR2       | MCT5201SR2M                      | Surface Mount; Tape and Reel (1,000 units per reel)               |
| T         | MCT5201TM                        | 0.4" Lead Spacing   |
| V         | MCT5201VM                        | IEC60747-5-2  |
| TV        | MCT5201TVM                       | IEC60747-5-2, 0.4" Lead Spacing                                   |
| SV        | MCT5201SVM                       | IEC60747-5-2, Surface Mount                                       |
| SR2V      | MCT5201SR2VM                     | IEC60747-5-2, Surface Mount, Tape and Reel (1,000 units per reel) |

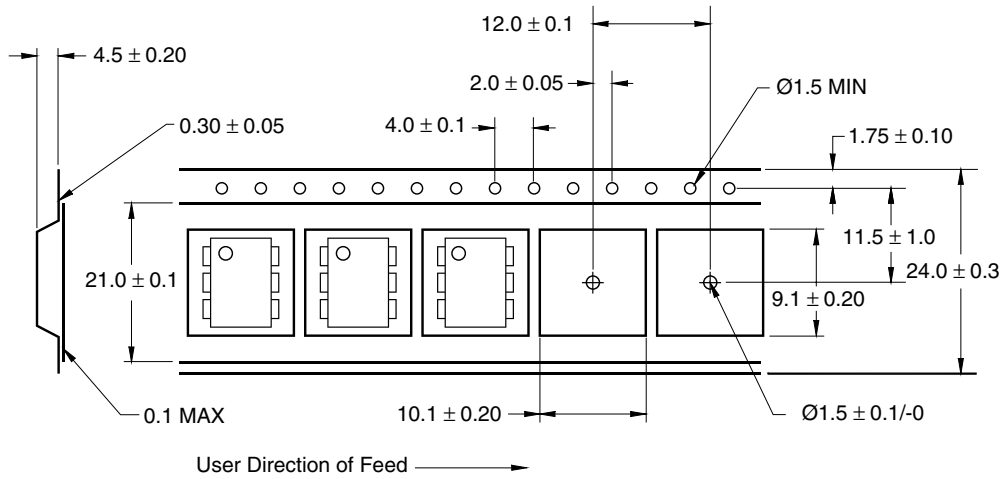
### Marking Information



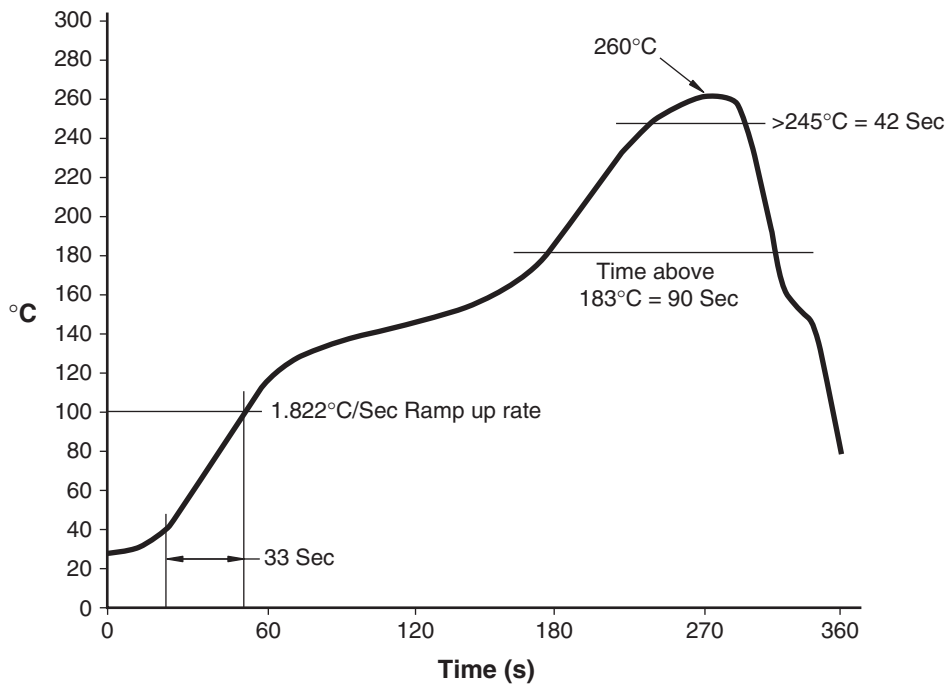
| Definitions |  |
|-------------|--|
| 1           | Fairchild logo   |
| 2           | Device number  |
| 3           | VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table) |
| 4           | One digit year code, e.g., '7'   |
| 5           | Two digit work week ranging 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.

### Carrier Tape Specification



### Reflow Profile





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- |                                      |  |  |                                  |
|--------------------------------------|--|--|----------------------------------|
| ACEx <sup>®</sup>                    | Green FPS <sup>™</sup>                       | Power247 <sup>®</sup>                  | SuperSOT <sup>™</sup> -8         |
| Build it Now <sup>™</sup>            | Green FPS <sup>™</sup> e-Series <sup>™</sup> | POWEREDGE <sup>®</sup>                 | SyncFET <sup>™</sup>             |
| CorePLUS <sup>™</sup>                | GTO <sup>™</sup>                             | Power-SPM <sup>™</sup>                 | The Power Franchise <sup>®</sup> |
| CROSSVOLT <sup>™</sup>               | <i>i-Lo</i> <sup>™</sup>                     | PowerTrench <sup>®</sup>               | the <b>power</b> <sup>®</sup>    |
| CTL <sup>™</sup>                     | IntelliMAX <sup>™</sup>                      | Programmable Active Droop <sup>™</sup> | franchise                        |
| Current Transfer Logic <sup>™</sup>  | ISOPLANAR <sup>™</sup>                       | QFET <sup>®</sup>                      | TinyBoost <sup>™</sup>           |
| EcoSPARK <sup>®</sup>                | MegaBuck <sup>™</sup>                        | QS <sup>™</sup>                        | TinyBuck <sup>™</sup>            |
| <b>F</b> <sup>®</sup>                | MICROCOUPLER <sup>™</sup>                    | QT Optoelectronics <sup>™</sup>        | TinyLogic <sup>®</sup>           |
| Fairchild <sup>®</sup>               | MicroFET <sup>™</sup>                        | Quiet Series <sup>™</sup>              | TINYOPTO <sup>™</sup>            |
| Fairchild Semiconductor <sup>®</sup> | MicroPak <sup>™</sup>                        | RapidConfigure <sup>™</sup>            | TinyPower <sup>™</sup>           |
| FACT Quiet Series <sup>™</sup>       | MillerDrive <sup>™</sup>                     | SMART START <sup>™</sup>               | TinyPWM <sup>™</sup>             |
| FACT <sup>®</sup>                    | Motion-SPM <sup>™</sup>                      | SPM <sup>®</sup>                       | TinyWire <sup>™</sup>            |
| FAST <sup>®</sup>                    | OPTOLOGIC <sup>®</sup>                       | STEALTH <sup>™</sup>                   | μSerDes <sup>™</sup>             |
| FastvCore <sup>™</sup>               | OPTOPLANAR <sup>®</sup>                      | SuperFET <sup>™</sup>                  | UHC <sup>®</sup>                 |
| FPS <sup>™</sup>                     | <sup>®</sup>                                 | SuperSOT <sup>™</sup> -3               | UniFET <sup>™</sup>              |
| FRFET <sup>®</sup>                   | PDP-SPM <sup>™</sup>                         | SuperSOT <sup>™</sup> -6               | VCX <sup>™</sup>                 |
| Global Power Resource <sup>SM</sup>  | Power220 <sup>®</sup>                        |  |                                  |

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**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

| Datasheet Identification | Product Status         | Definition   |
|--------------------------|------------------------|--|
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