

# MCT5201M, MCT5210M, MCT5211M

## Low Input Current Phototransistor Optocouplers

### Features

- High  $CTR_{CE(SAT)}$  comparable to Darlington
- CTR guaranteed 0°C to 70°C
- High common mode transient rejection 5kV/ $\mu$ s
- 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

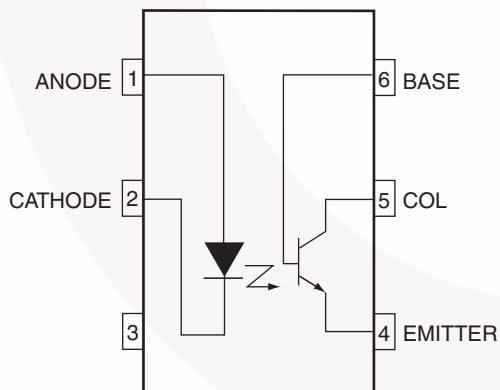
### Description

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.

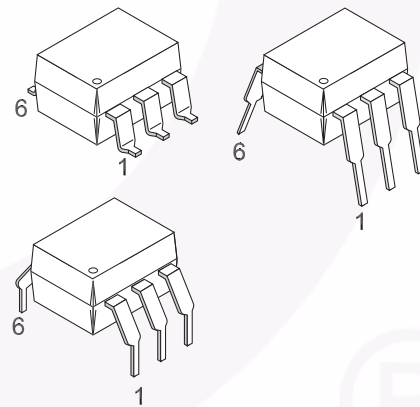
The MCT52XXM is well suited for CMOS to LSTTL/TTL interfaces, offering 250%  $CTR_{CE(SAT)}$  with 1mA of LED input current. When an LED input current of 1.6mA is supplied data rates to 20K bits/s are possible.

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



### 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	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) Derate Linearly From 25°C	260	mW
		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 Derate Linearly From 25°C	75	mW
		1.0	mW/°C
<b>DETECTOR</b>			
I <sub>C</sub>	Continuous Collector Current	150	mA
P <sub>D</sub>	Detector Power Dissipation Derate Linearly from 25°C	150	mW
		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	$I_E = 10\mu\text{A}, I_F = 0$	All	5	10		V
$I_{CER}$	Collector-Emitter Dark Current	$V_{CE} = 10\text{V}, I_F = 0,$ $R_{BE} = 1\text{M}\Omega$	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	$V_{CM} = 50 V_{P-P}, R_L = 750\Omega,$ $I_F = 0$	MCT5210M/11M		5000		V/ $\mu\text{s}$
	Rejection – Output HIGH	$V_{CM} = 50 V_{P-P}, R_L = 1\text{K}\Omega,$ $I_F = 0$	MCT5201M				
$CM_L$	Common Mode Transient	$V_{CM} = 50 V_{P-P}, R_L = 750\Omega,$ $I_F = 1.6\text{mA}$	MCT5210M/11M		5000		V/ $\mu\text{s}$
	Rejection – Output LOW	$V_{CM} = 50 V_{P-P}, R_L = 1\text{K}\Omega,$ $I_F = 5\text{mA}$	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> (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 (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 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 HIGH-to-LOW <sup>(3)</sup>	$R_L = 330\ \Omega, R_{BE} = \infty$	$I_F = 3.0\text{mA},$ $V_{CC} = 5.0\text{V}$	MCT5210M		10	$\mu\text{s}$	
		$R_L = 3.3\ \text{k}\Omega, R_{BE} = 39\text{k}\Omega$				7		
		$R_L = 750\ \Omega, R_{BE} = \infty$	$I_F = 1.6\text{mA},$ $V_{CC} = 5.0\text{V}$	MCT5211M		14		
		$R_L = 4.7\ \text{k}\Omega, R_{BE} = 91\text{k}\Omega$				15		
		$R_L = 1.5\ \text{k}\Omega, R_{BE} = \infty$	$I_F = 1.0\text{mA},$ $V_{CC} = 5.0\text{V}$		17			
		$R_L = 10\ \text{k}\Omega, R_{BE} = 160\text{k}\Omega$			24			
		$V_{CE} = 0.4\text{V}, V_{CC} = 5\text{V},$ $R_L = \text{fig. 13}, R_{BE} = 330\text{k}\Omega$	$I_F = 5\text{mA}$	MCT5201M		3		30
$T_{PLH}$	Propagation Delay LOW-to-HIGH <sup>(4)</sup>	$R_L = 330\ \Omega, R_{BE} = \infty$	$I_F = 3.0\text{mA},$ $V_{CC} = 5.0\text{V}$	MCT5210M		0.4	$\mu\text{s}$	
		$R_L = 3.3\ \text{k}\Omega, R_{BE} = 39\text{k}\Omega$				8		
		$R_L = 750\ \Omega, R_{BE} = \infty$	$I_F = 1.6\text{mA},$ $V_{CC} = 5.0\text{V}$	MCT5211M		2.5		
		$R_L = 4.7\ \text{k}\Omega, R_{BE} = 91\text{k}\Omega$				11		
		$R_L = 1.5\ \text{k}\Omega, R_{BE} = \infty$	$I_F = 1.0\text{mA},$ $V_{CC} = 5.0\text{V}$		7			
		$R_L = 10\ \text{k}\Omega, R_{BE} = 160\text{k}\Omega$			16			
		$V_{CE} = 0.4\text{V}, V_{CC} = 5\text{V},$ $R_L = \text{fig. 13}, R_{BE} = 330\text{k}\Omega$	$I_F = 5\text{mA}$	MCT5201M		12		13
$t_d$	Delay Time <sup>(5)</sup>	$V_{CE} = 0.4\text{V}, R_{BE} = 330\text{k}\Omega,$ $R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$	$I_F = 5\text{mA}$	MCT5201M		1.1	15	$\mu\text{s}$
$t_r$	Rise Time <sup>(6)</sup>	$V_{CE} = 0.4\text{V}, R_{BE} = 330\text{k}\Omega,$ $R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$	$I_F = 5\text{mA}$	MCT5201M		2.5	20	$\mu\text{s}$
$t_s$	Storage Time <sup>(7)</sup>	$V_{CE} = 0.4\text{V}, R_{BE} = 330\ \text{k}\Omega,$ $R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$	$I_F = 5\text{mA}$	MCT5201M		10	13	$\mu\text{s}$
$t_f$	Fall Time <sup>(8)</sup>	$V_{CE} = 0.4\text{V}, R_{BE} = 330\ \text{k}\Omega,$ $R_L = 1\ \text{k}\Omega, V_{CC} = 5\text{V}$	$I_F = 5\text{mA}$	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.

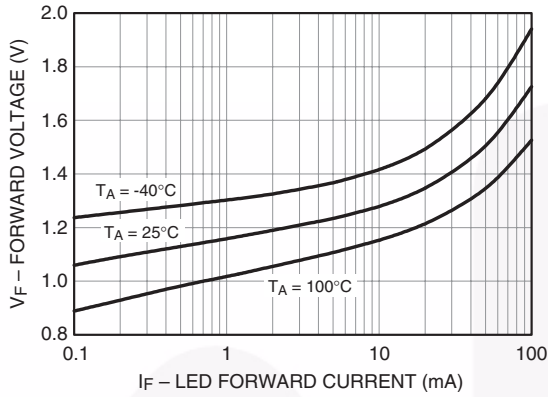
## Safety and Insulation Ratings

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.

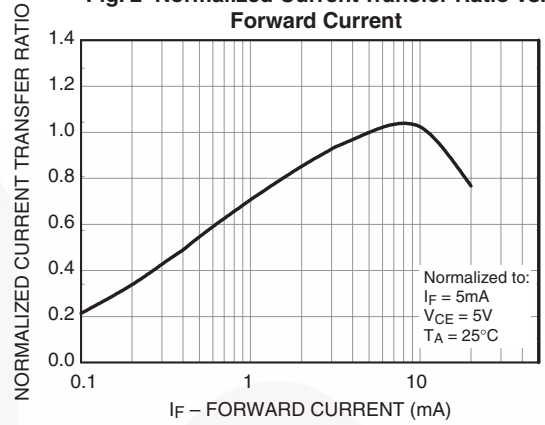
Symbol	Parameter	Min.	Typ.	Max.	Unit
	Installation Classifications per DIN VDE 0110/1.89 Table 1				
	For Rated Main Voltage < 150Vrms		I-IV		
	For Rated Main voltage < 300Vrms		I-IV		
	Climatic Classification		55/100/21		
	Pollution Degree (DIN VDE 0110/1.89)		2		
CTI	Comparative Tracking Index	175			
$V_{PR}$	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 Curves

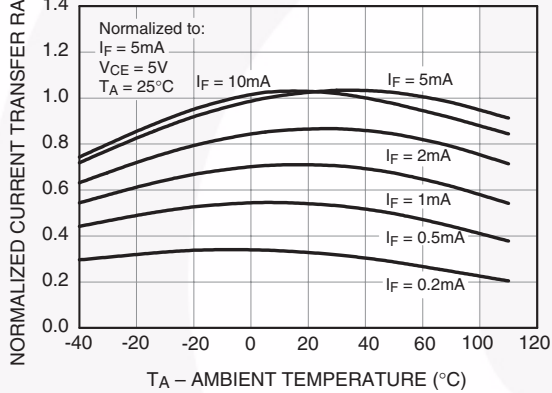
**Fig. 1 LED Forward Voltage vs. Forward Current**



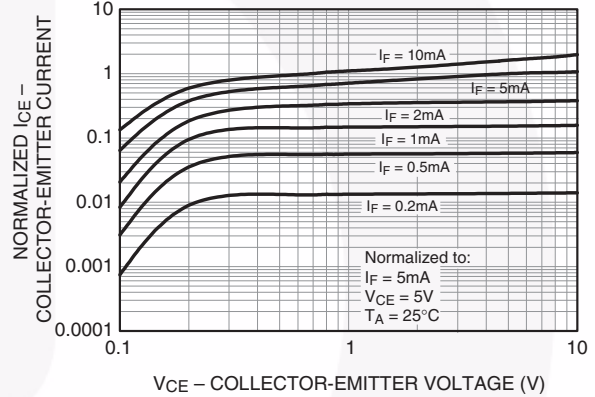
**Fig. 2 Normalized Current Transfer Ratio vs. Forward Current**



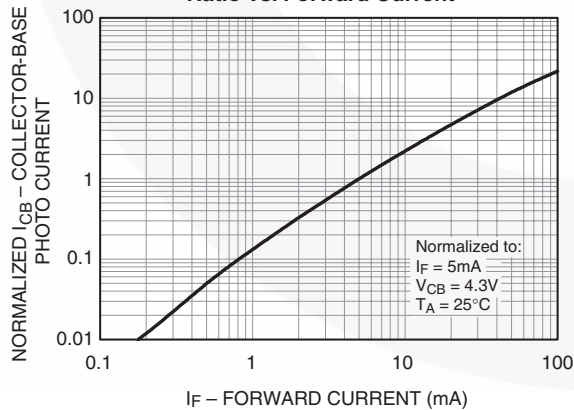
**Fig. 3 Normalized CTR vs. Temperature**



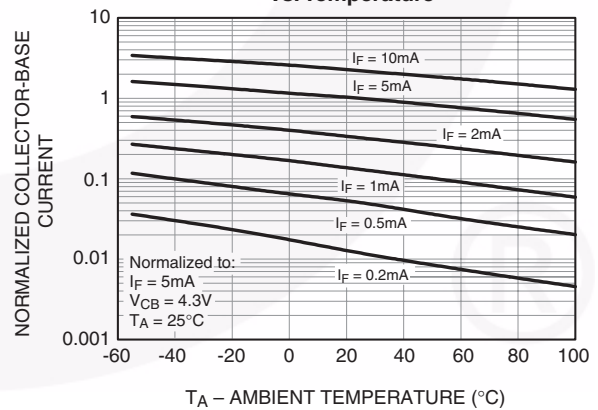
**Fig. 4 Normalized Collector vs. Collector-Emitter Voltage**



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

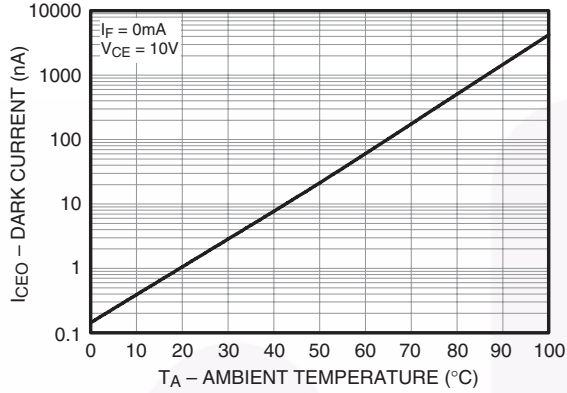


**Fig. 6 Normalized Collector-Base Current vs. Temperature**

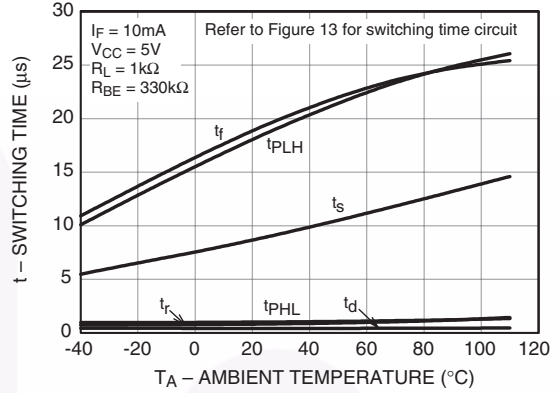


**Typical Performance Curves (Continued)**

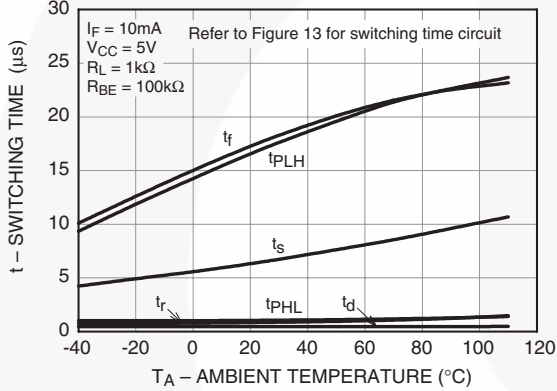
**Fig. 7 Collector-Emitter Dark Current vs. Ambient Temperature**



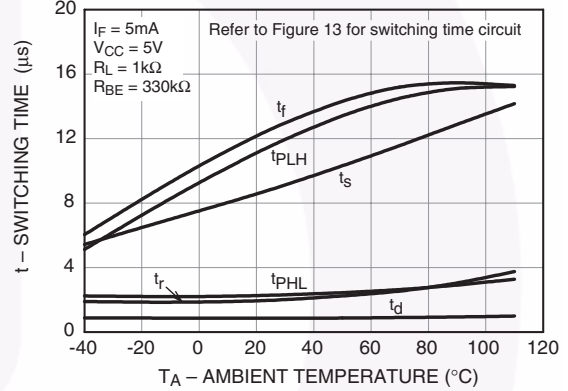
**Fig. 8 Switching Time vs. Ambient Temperature**



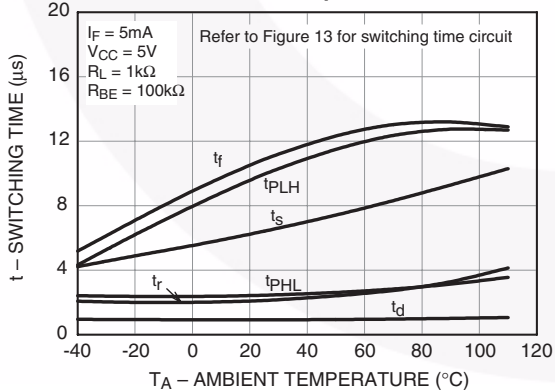
**Fig. 9 Switching Time vs. Ambient Temperature**



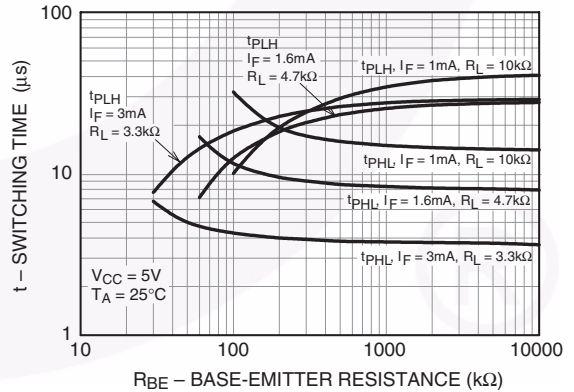
**Fig. 10 Switching Time vs. Ambient Temperature**



**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)

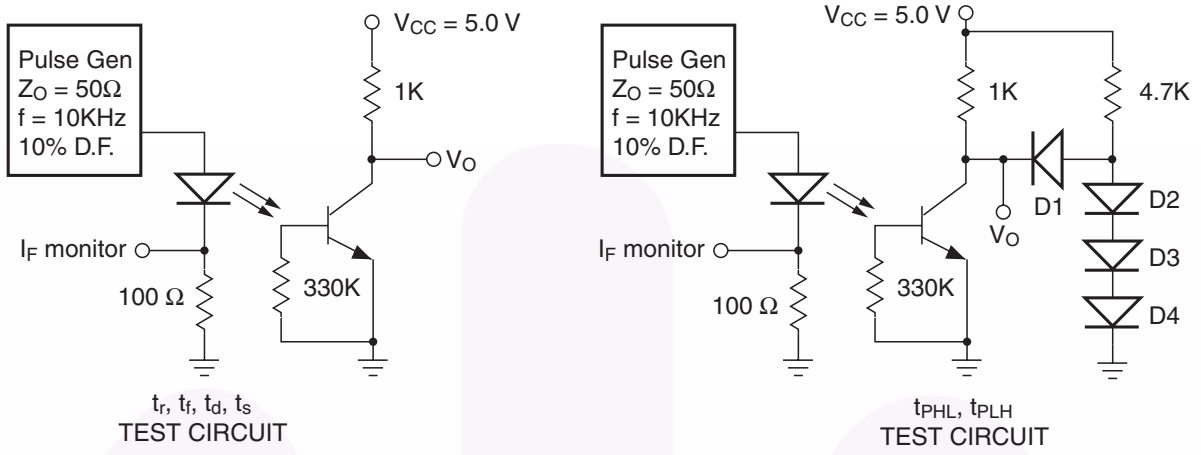


Figure 13.

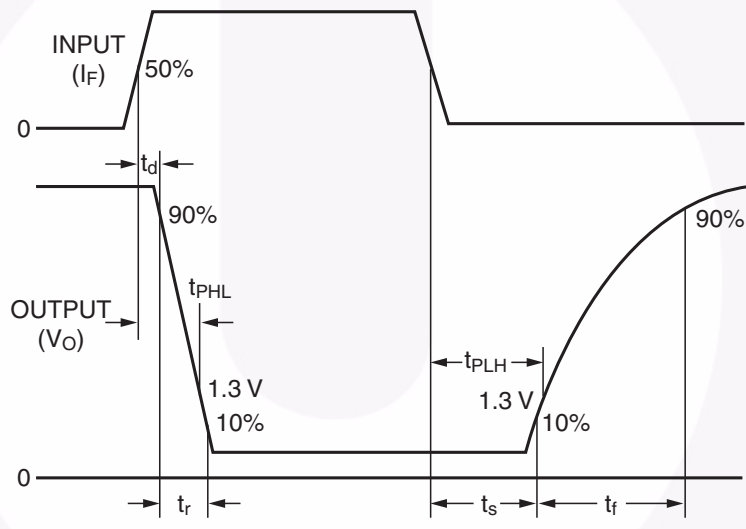
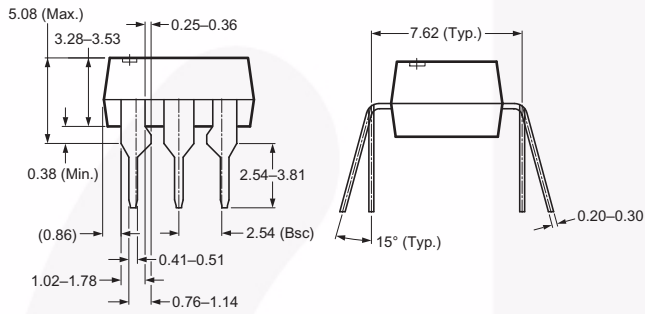
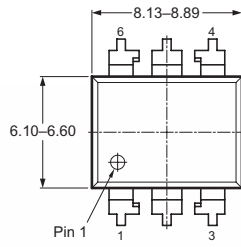


Figure 14. Switching Circuit Waveforms

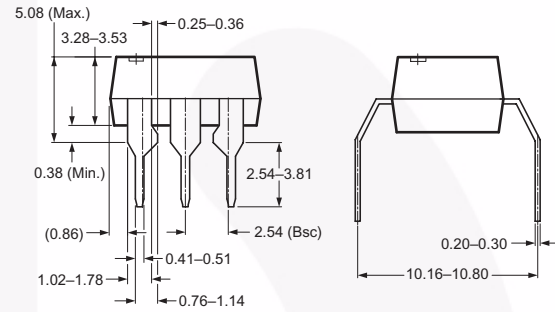
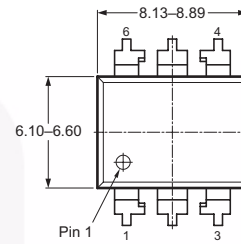


## Package Dimensions

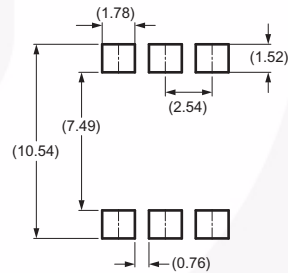
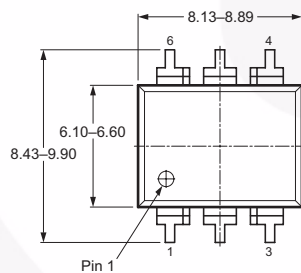
### Through Hole



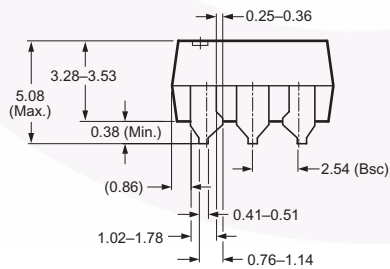
### 0.4" Lead Spacing



### Surface Mount



Recommended Pad Layout

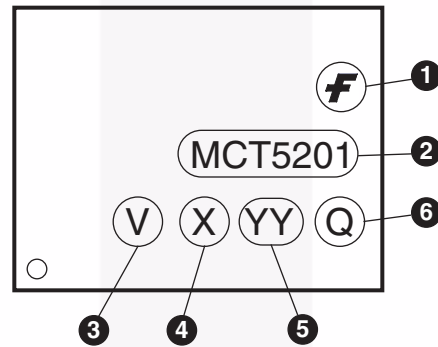


**Note:**  
All dimensions in mm.

## 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)

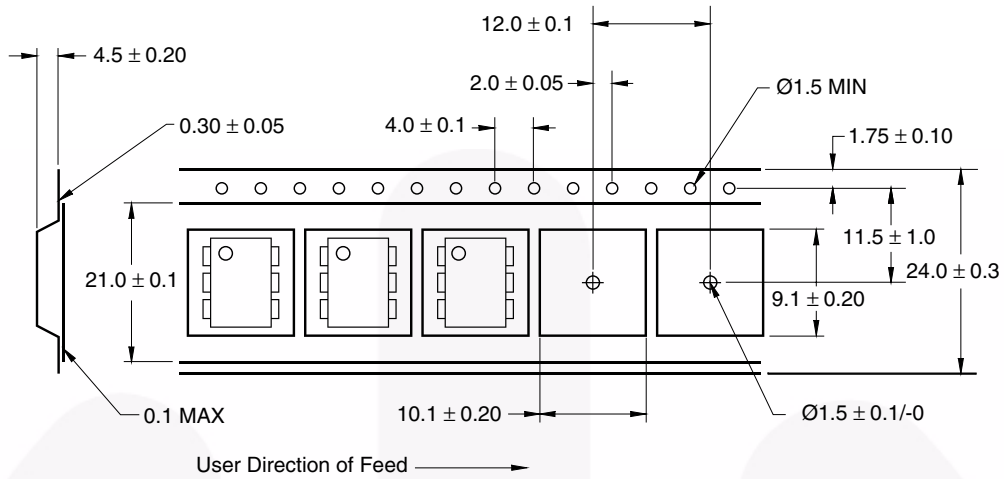
## Marking Information



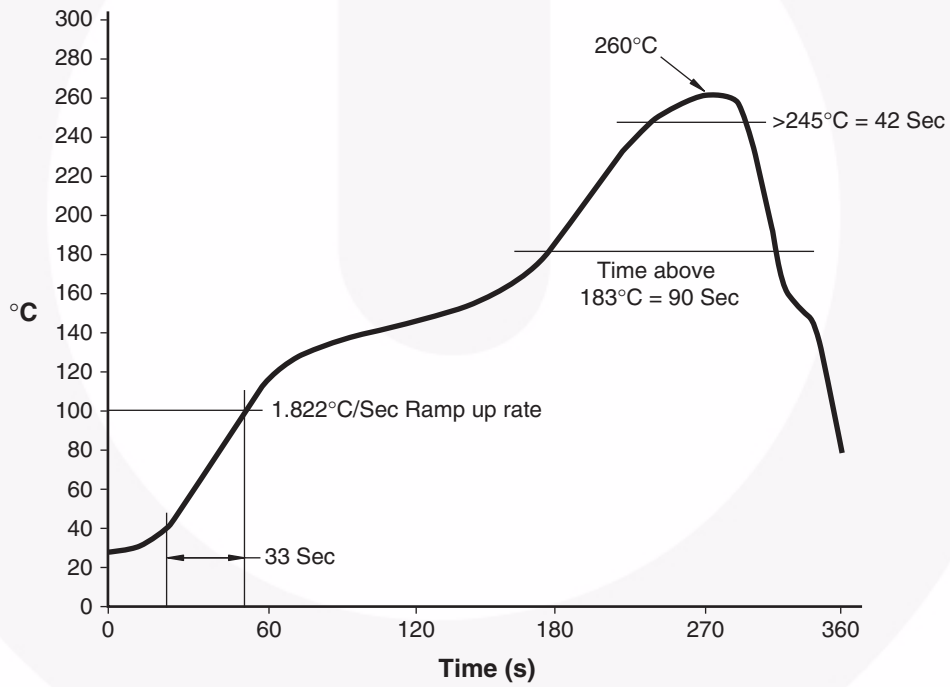
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	One digit year code, e.g., '7'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

\*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





**TRADEMARKS**

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- |  |   |  |   |
|--|---|--|---|
| Auto-SPM™  | F-PFS™  | PowerTrench®   | The Power Franchise®  |
| Build it Now™  | FRFET®  | PowerXS™   | the <b>power</b> franchise  |
| CorePLUS™  | Global Power Resource™  | Programmable Active Droop™   | TinyBoost™  |
| CorePOWER™   | Green FPS™  | QFET®  | TinyBuck™   |
| CROSSVOLT™   | Green FPS™ e-Series™  | QS™  | TinyLogic®  |
| CTL™   | Gmax™   | Quiet Series™  | TINYOPTO™   |
| Current Transfer Logic™  | GTO™  | RapidConfigure™  | TinyPower™  |
| EcoSPARK®  | IntelliMAX™   |  ™  | TinyPWM™  |
| EfficientMax™  | ISOPLANAR™  | Saving our world, 1mW/W/kW at a time™  | TinyWire™   |
| EZSWITCH™*   | MegaBuck™   | SmartMax™  | TriFault Detect™  |
|  ™* | MICROCOUPLER™   | SMART START™   | TRUECURRENT™*   |
|  ®  | MicroFET™   | SPM®   | μSerDes™  |
| Fairchild®   | MicroPak™   | STEALTH™   |  ™ |
| Fairchild Semiconductor®   | MillerDrive™  | SuperFET™  | UHC®  |
| FACT Quiet Series™   | MotionMax™  | SuperSOT™-3  | Ultra FRFET™  |
| FACT®  | Motion-SPM™   | SuperSOT™-6  | UniFET™   |
| FAST®  | OPTOLOGIC®  | SuperSOT™-8  | VCX™  |
| FastvCore™   | OPTOPLANAR®   | SupreMOS™  | VisualMax™  |
| FETBench™  |  ™ | SyncFET™   | XS™   |
| FlashWriter®*  | PDP SPM™  | Sync-Lock™   |   |
| FPS™   | Power-SPM™  |  ™* |   |

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**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.
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