

# 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/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

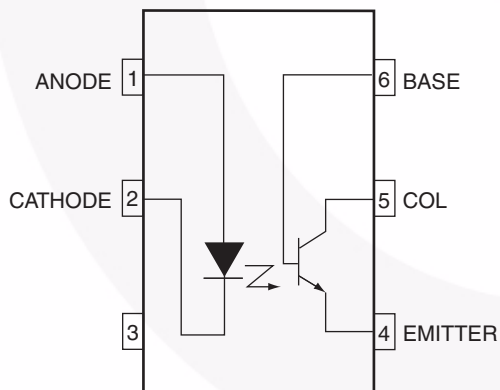
### Description

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.

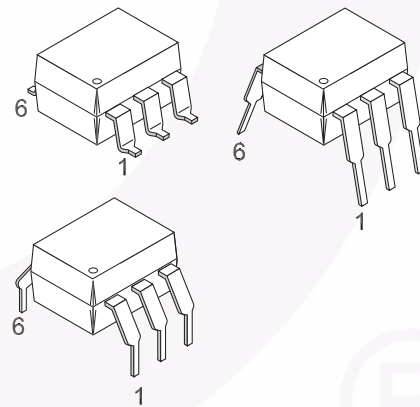
The MCT52XXM is well suited for CMOS to LSTTL/TTL interfaces, offering 250%  $CTR_{CE(SAT)}$  with 1mA of LED input current. When an LED input current of 1.6mA is supplied data rates to 20K bits/s are possible.

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)	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	$I_E = 10\mu\text{A}, I_F = 0$	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	$V_{CM} = 50 V_{P-P1}, R_L = 750\Omega,$ $I_F = 0$	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	$V_{CM} = 50 V_{P-P1}, R_L = 750\Omega,$ $I_F = 1.6\text{mA}$	MCT5210M/11M		5000		V/ $\mu\text{s}$
	Rejection – Output LOW	$V_{CM} = 50 V_{P-P1}, R_L = 1\text{K}\Omega,$ $I_F = 5\text{mA}$	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.

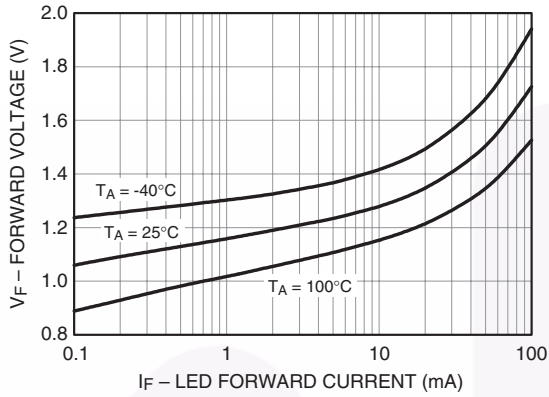
## Safety and Insulation Ratings

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.

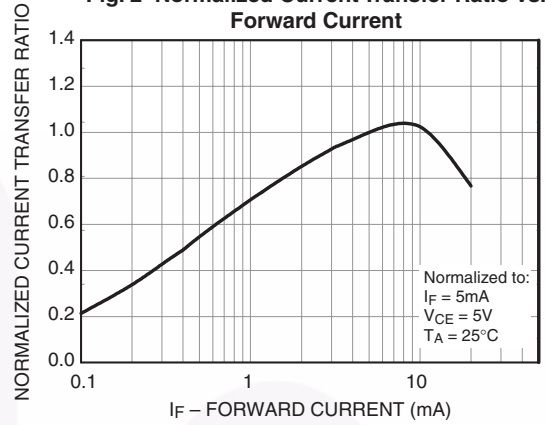
Symbol	Parameter	Min.	Typ.	Max.	Unit
	Installation Classifications per DIN VDE 0110/1.89 Table 1				
	For Rated Main Voltage < 150Vrms		I-IV		
	For Rated Main voltage < 300Vrms		I-IV		
	Climatic Classification		55/100/21		
	Pollution Degree (DIN VDE 0110/1.89)		2		
CTI	Comparative Tracking Index	175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

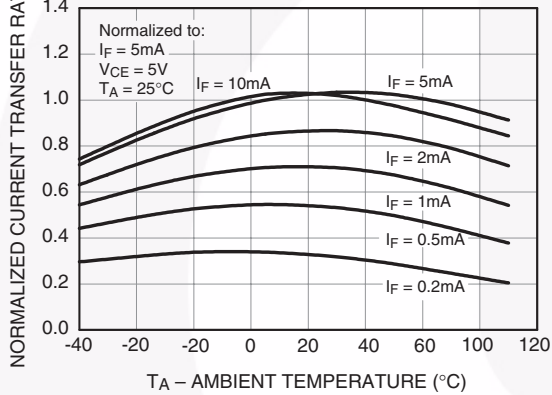
**Fig. 1 LED Forward Voltage vs. Forward Current**



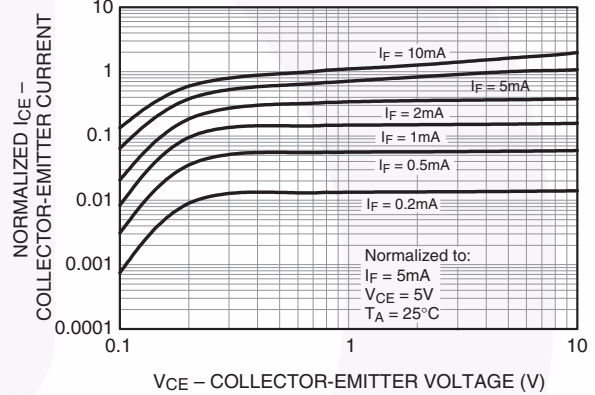
**Fig. 2 Normalized Current Transfer Ratio vs. Forward Current**



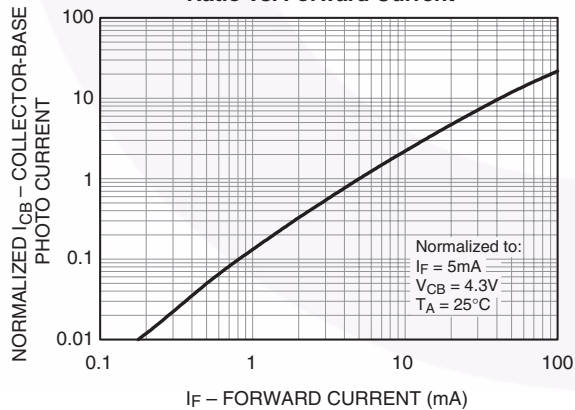
**Fig. 3 Normalized CTR vs. Temperature**



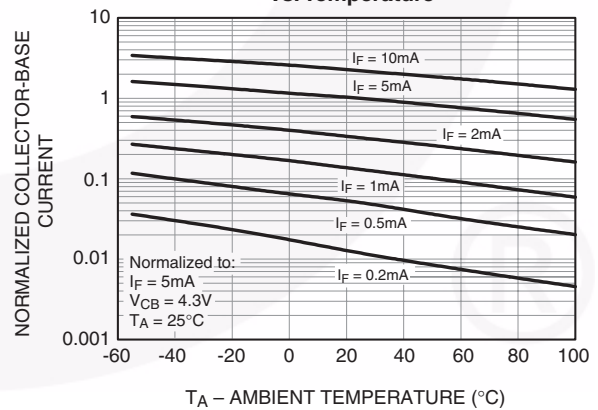
**Fig. 4 Normalized Collector vs. Collector-Emitter Voltage**



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

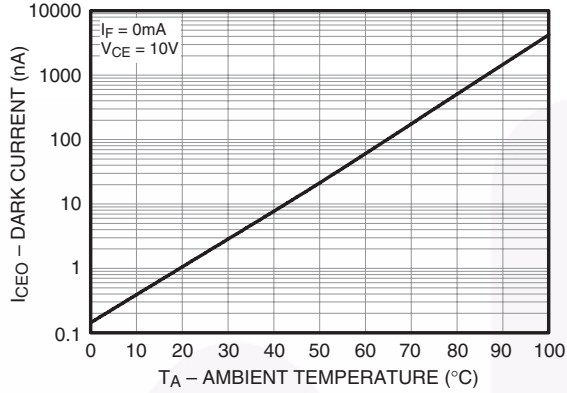


**Fig. 6 Normalized Collector-Base Current vs. Temperature**

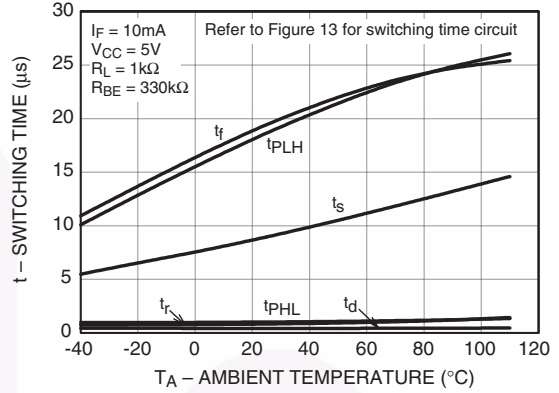


**Typical Performance Curves (Continued)**

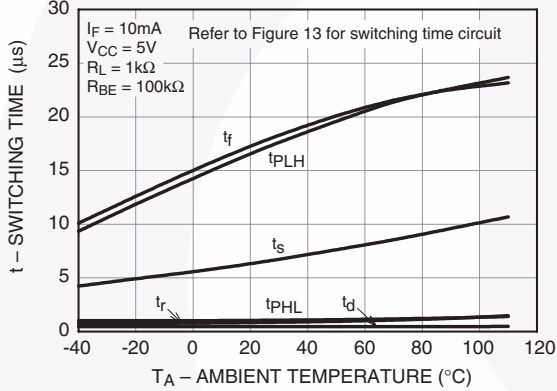
**Fig. 7 Collector-Emitter Dark Current vs. Ambient Temperature**



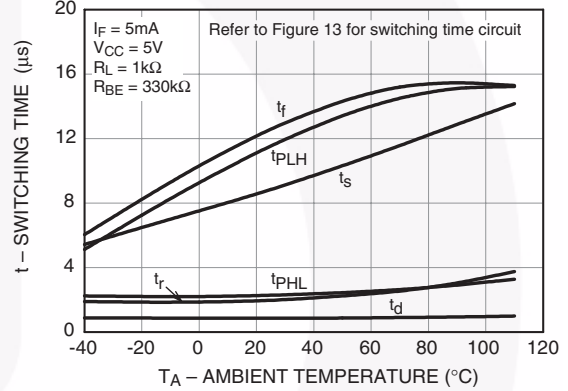
**Fig. 8 Switching Time vs. Ambient Temperature**



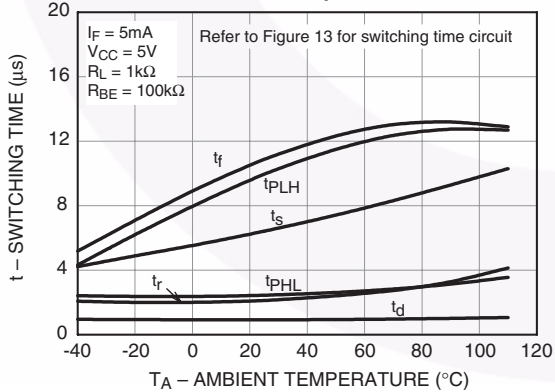
**Fig. 9 Switching Time vs. Ambient Temperature**



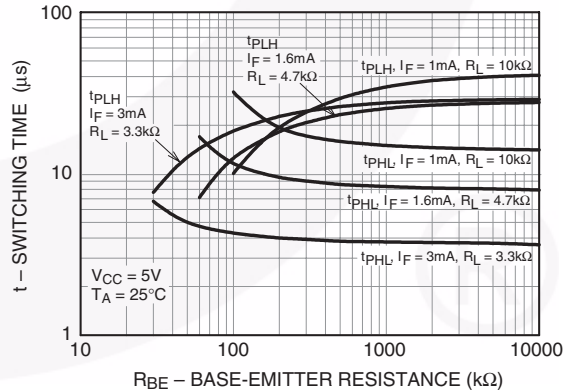
**Fig. 10 Switching Time vs. Ambient Temperature**



**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)

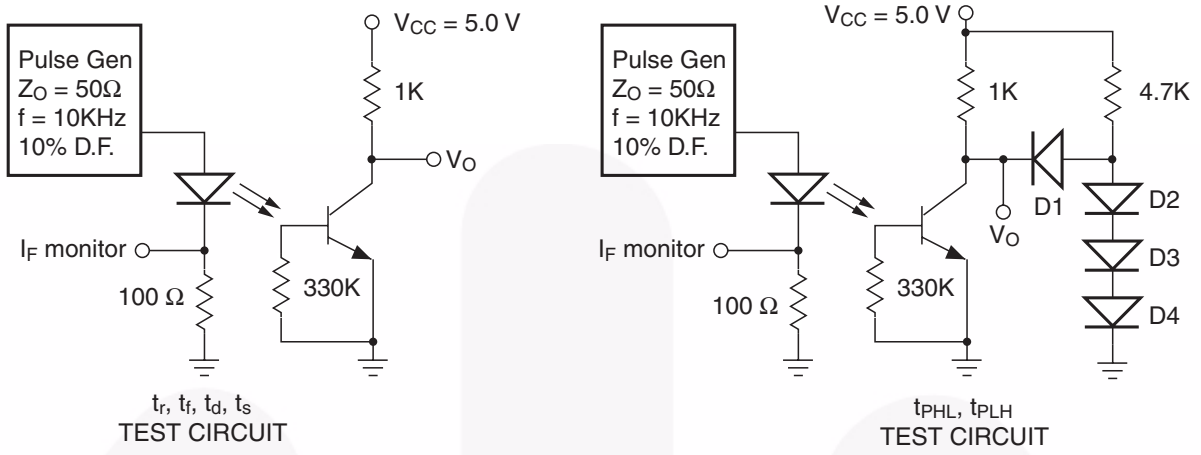


Figure 13.

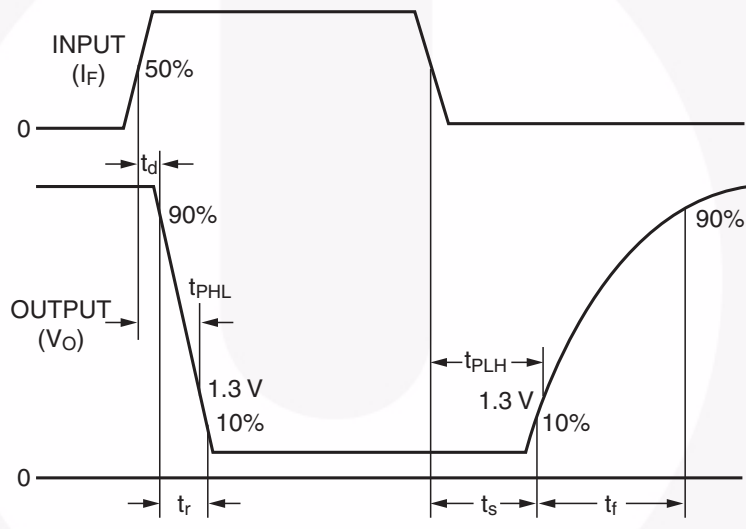
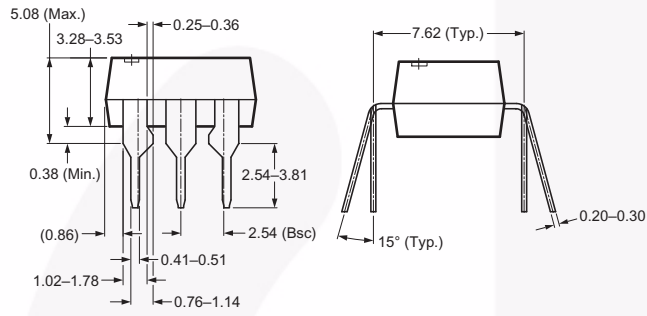
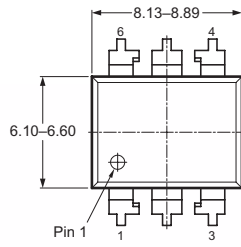


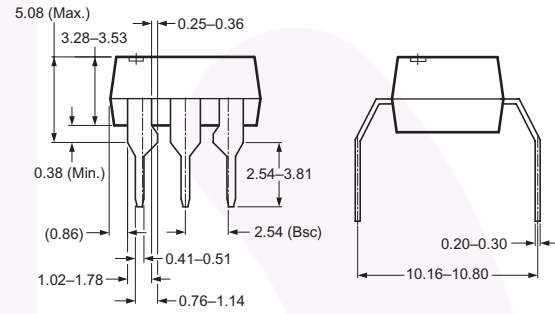
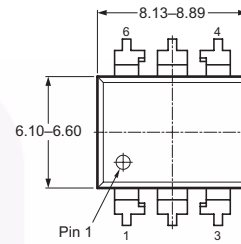
Figure 14. Switching Circuit Waveforms

## Package Dimensions

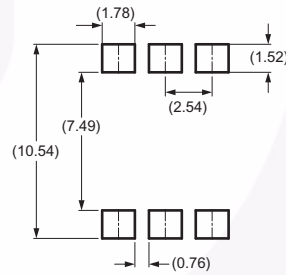
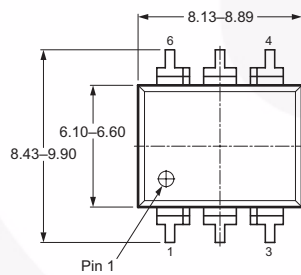
### Through Hole



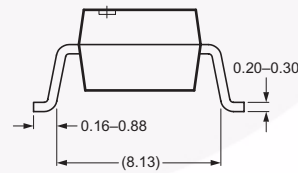
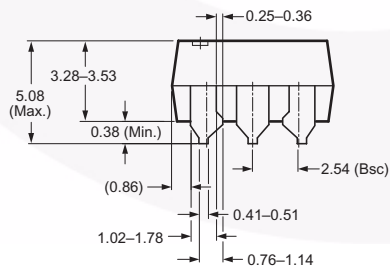
### 0.4" Lead Spacing



### Surface Mount



Recommended Pad Layout

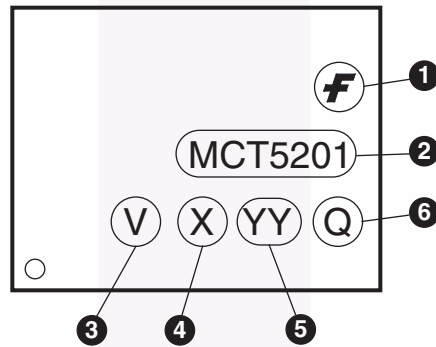


**Note:**  
All dimensions in mm.

### 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)

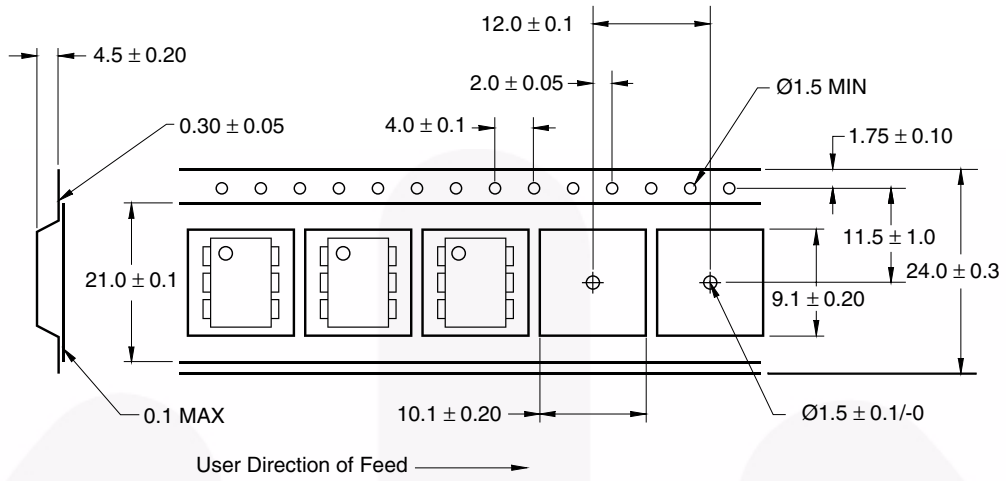
### Marking Information



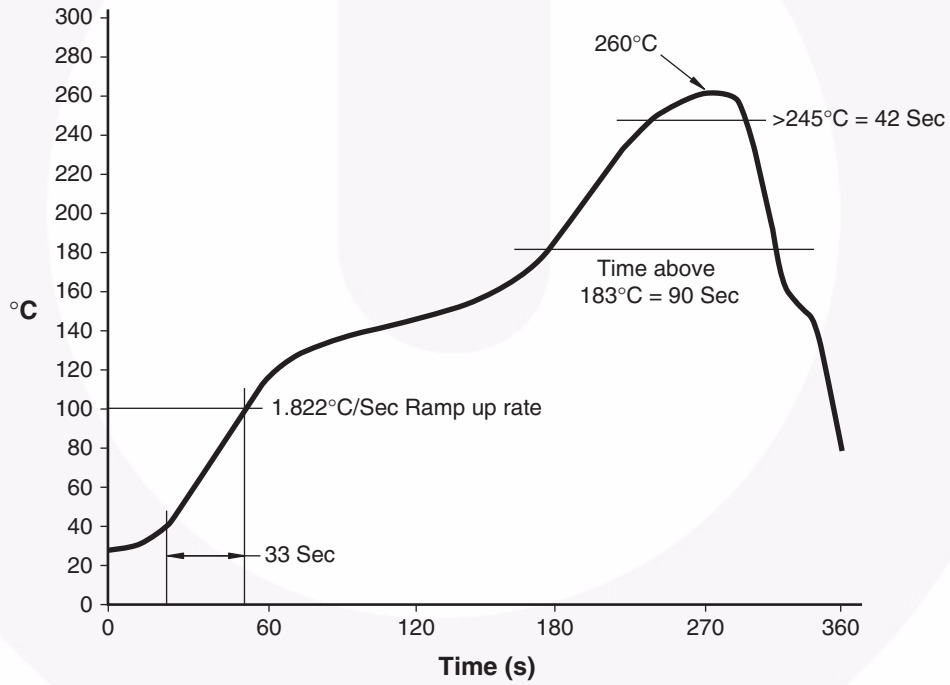
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	One digit year code, e.g., '7'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

\*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




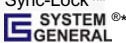
### Reflow Profile





**TRADEMARKS**

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- |  |   |  |   |
|--|---|--|---|
| 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™  |  ™* |   |

\* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

**DISCLAIMER**

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

**LIFE SUPPORT POLICY**

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**ANTI-COUNTERFEITING POLICY**

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

**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.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I40