CS5201-3

1A, 3.3V Fixed Linear Regulator

Description

The CS5201-3 linear regulator provides a 1A@ 3.3V reference at 1A with an output voltage accuracy of ±1.5%.

This regulator is intended for use as a post regulator and microprocessor supply. The fast loop response and low dropout voltage make this regulator ideal for applications where low voltage operation and good transient response are important.

The circuit is designed to operate with dropout voltages less than 1.2V at 1A output current.

The maximum quiescent current is only 10mA at full load. Device protection includes over-current and thermal shutdown.

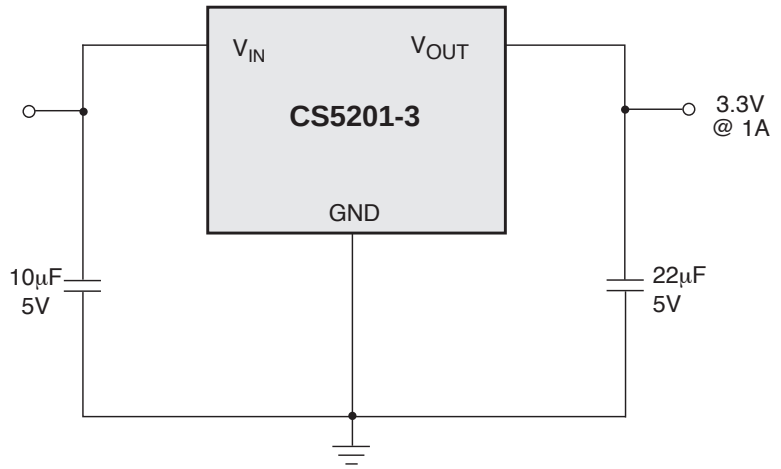
The CS5201-3 is pin compatible with the LT1086 family of linear regulators.

The regulator is available in TO-220, surface mount D^2, and SOT-223 packages.

Features

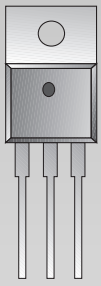
- **Output Current to 1A**
- **Output Accuracy to ±1.5% Over Temperature**
- **Dropout Voltage (typical) 1.0V @ 1A**
- **Fast Transient Response**
- **Fault Protection**
  - **Current Limit**
  - **Thermal Shutdown**

Application Diagram

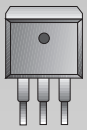


Package Options

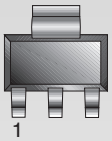
3L TO-220
Tab (V_{OUT})



3L D^2PAK
Tab (V_{OUT})



3L SOT-223
Tab (V_{OUT})



CS5201 -3
1 Gnd
2 V_{OUT} (Tab)
3 V_{IN}

Consult factory for other fixed output voltage versions.

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Absolute Maximum Ratings

Supply Voltage, V_{IN} 7V
Operating Temperature Range . . . . . -40°C to 70°C
Junction Temperature . . . . . 150°C
Storage Temperature Range . . . . . -60°C to 150°C
Lead Temperature Soldering
Wave Solder (through hole styles only) . . . . . 10 sec. max, 260°C peak
Reflow (SMD styles only) . . . . . 60 sec. max above 183°C, 230°C peak
ESD Damage Threshold (Human Body Model) 2kV

Electrical Characteristics: C_{IN} = 10µF, C_{OUT} = 22µF Tantalum, $V_{OUT} + V_{DROPOUT} < V_{IN} < 7V$, $0°C \le T_A \le 70°C$, $T_J \le +150°C$, unless otherwise specified, $I_{full\ load}$ = 1A.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
■ Fixed Output Voltage					
Output Voltage (Notes 1 and 2)	$V_{IN}-V_{OUT}$=1.5V; $0 \le I_{OUT} \le 1A$	3.250 (-1.5%)	3.300	3.350 (+1.5%)	V
Line Regulation	$2V \le V_{IN}-V_{OUT} \le 3.7V$; I_{OUT}=10mA		0.02	0.20	%
Load Regulation (Notes 1 and 2)	$V_{IN}-V_{OUT}$=2V; $10mA \le I_{OUT} \le 1A$		0.04	0.4	%
Dropout Voltage (Note 3)	I_{OUT}=1A		1.0	1.2	V
Current Limit	$V_{IN}-V_{OUT}$=3V	1.0	3.1		A
Quiescent Current	I_{OUT}=10mA		5.0	10.0	mA
Thermal Regulation (Note 4)	30ms pulse; T_A=25°C		0.002	0.020	%/W
Ripple Rejection (Note 4)	f=120Hz; I_{OUT}=1A; $V_{IN}-V_{OUT}$=3V; $V_{RIPPLE}=1V_{PP}$		80		dB
Thermal Shutdown (Note 5)		150	180	210	°C
Thermal Shutdown Hysteresis (Note 5)			25		°C

Note 1: Load regulation and output voltage are measured at a constant junction temperature by low duty cycle pulse testing. Changes in output voltage due to temperature changes must be taken into account separately.

Note 2: Specifications apply for an external Kelvin sense connection at a point on the output pin 1/4" from the bottom of the package.

Note 3: Dropout voltage is a measurement of the minimum input/output differential at full load.

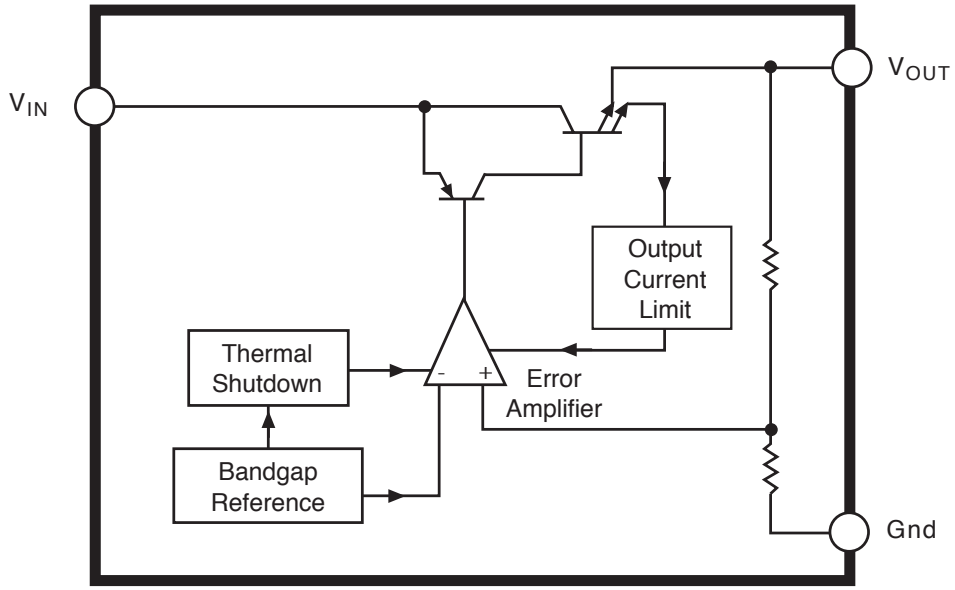
Note 4: Guaranteed by design, not tested in production.

Note 5: Thermal shutdown is 100% functionally tested in production.

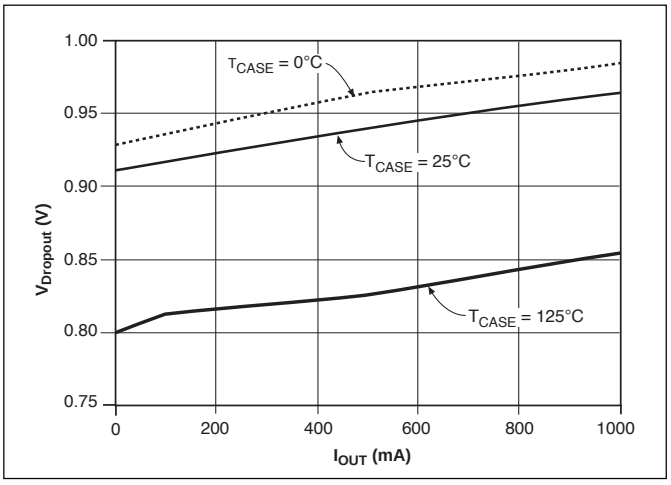
Package Pin Description

PACKAGE PIN #			PIN SYMBOL	FUNCTION
D^2PAK	TO-220	SOT-223		
1	1	1	Gnd	Ground connection.
2	2	2	V_{OUT}	Regulated output voltage (case).
3	3	2	V_{IN}	Input voltage.

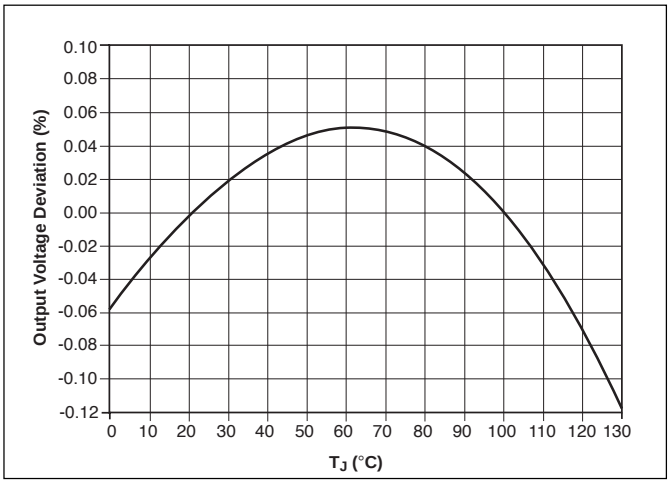
Block Diagram



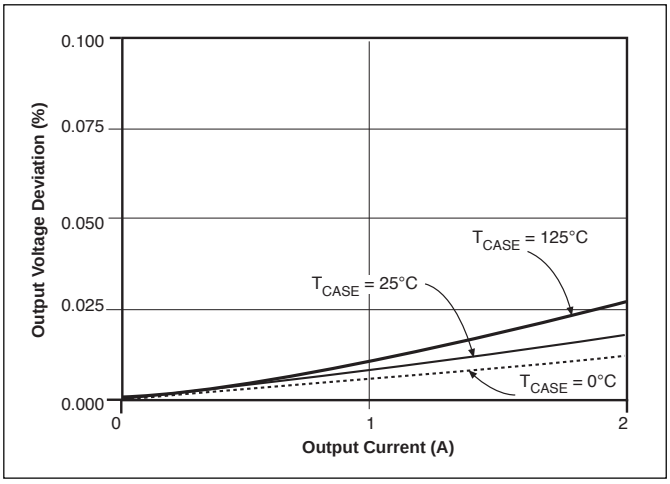
Typical Performance Characteristics



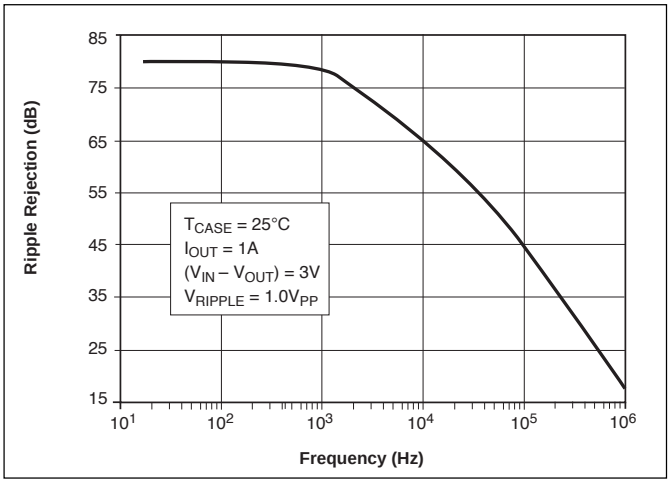
Dropout Voltage vs. Output Current



Output Voltage vs. Temperature

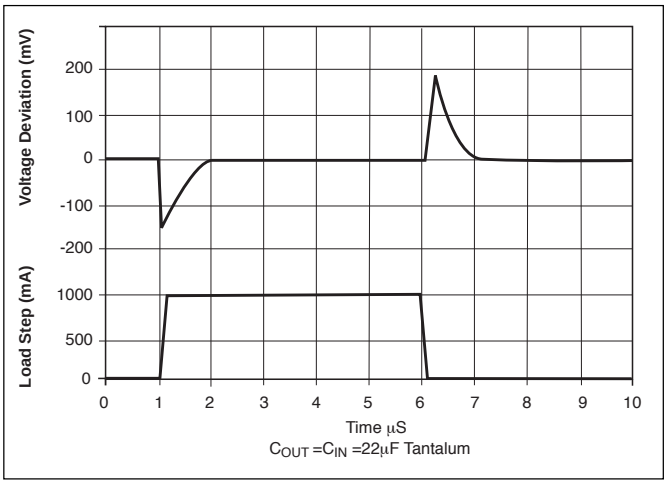


Load Regulation vs. Output Current

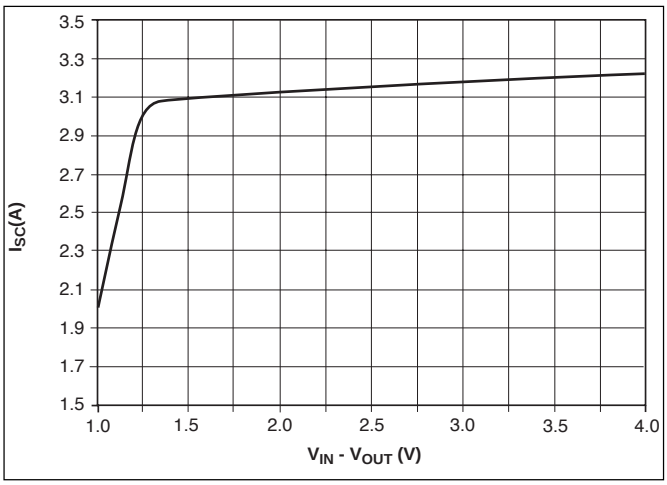


Ripple Rejection vs. Frequency

Typical Performance Characteristics: continued



Transient Response



Short Circuit Current vs. V_{IN} - V_{OUT}

Applications Information

The CS5201-3 linear regulator provides a fixed 3.3V output voltage at currents up to 1A. The regulator is protected against overcurrent conditions and includes thermal shutdown.

The CS5201-3 has a composite PNP-NPN output transistor and requires an output capacitor for stability. A detailed procedure for selecting this capacitor is included in the Stability Considerations section.

Stability Considerations

The output or compensation capacitor helps determine three main characteristics of a linear regulator: start-up delay, load transient response and loop stability.

The capacitor value and type are based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is best, since a film or ceramic capacitor with almost zero ESR can cause instability. The aluminum electrolytic capacitor is the least expensive solution. However, when the circuit operates at low temperatures, both the value and ESR of the capacitor will vary considerably. The capacitor manufacturers' data sheet provides this information.

A 22μF tantalum capacitor will work for most applications, but with high current regulators such as the CS5201-3 the transient response and stability improve with higher values of capacitance. The majority of applications for this regulator involve large changes in load current so the output capacitor must supply the instantaneous load current. The ESR of the output capacitor causes an immediate drop in output voltage given by:

$$\Delta V = \Delta I \times ESR$$

For microprocessor applications it is customary to use an output capacitor network consisting of several tantalum and ceramic capacitors in parallel. This reduces the overall ESR and reduces the instantaneous output voltage drop under load transient conditions. The output capacitor network should be as close as possible to the load for the best results.

Protection Diodes

When large external capacitors are used with a linear regulator it is sometimes necessary to add protection diodes. If the input voltage of the regulator gets shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage and the rate at which V_{IN} drops. In the CS5201-3 linear regulator, the discharge path is through a large junction and protection diodes are not usually needed. If the regulator is used with large values of output capacitance and the input voltage is instantaneously shorted to ground, damage can occur. In this case, a diode connected as shown in Figure 1 is recommended.

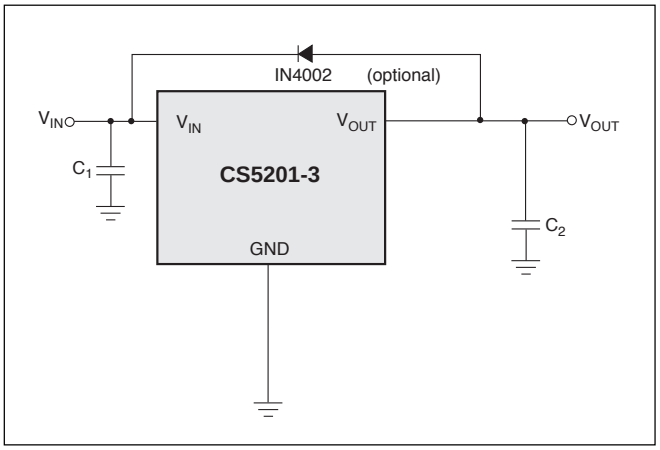


Figure 1. Protection diode scheme for large output capacitors.

Output Voltage Sensing

Since the CS5201-3 is a three terminal regulator, it is not possible to provide true remote load sensing. Load regulation is limited by the resistance of the conductors connecting the regulator to the load. For best results, the regulator should be connected as shown in figure 2.

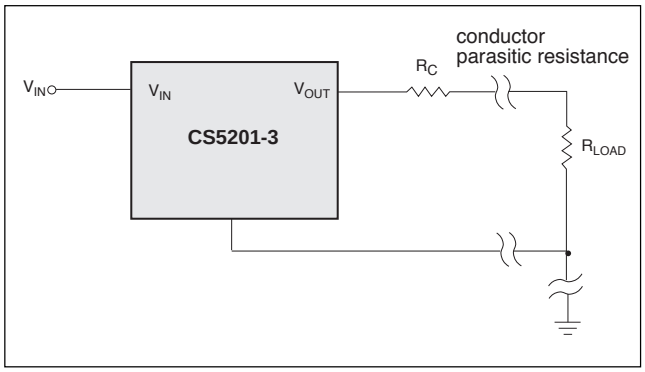


Figure 2. Conductor parasitic resistance effects can be minimized with the above grounding scheme for fixed output regulators.

Calculating Power Dissipation and Heat Sink Requirements

The CS5201-3 linear regulator includes thermal shutdown and current limit circuitry to protect the device. High power regulators such as these usually operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to ensure that an adequate heat sink is used.

The case is connected to V_{OUT} on the CS5201-3, and electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators such as these.

The thermal characteristics of an IC depend on the following four factors:

1. Maximum Ambient Temperature T_A (°C)
2. Power dissipation P_D (Watts)
3. Maximum junction temperature T_J (°C)
4. Thermal resistance junction to ambient $R_{\Theta JA}$ (C/W)

These four are related by the equation

$$T_J = T_A + P_D \times R_{\Theta JA} \quad (1)$$

The maximum ambient temperature and the power dissipation are determined by the design while the maximum junction temperature and the thermal resistance depend on the manufacturer and the package type.

The maximum power dissipation for a regulator is:

$$P_{D(max)}=\{V_{IN(max)}-V_{OUT(min)}\}I_{OUT(max)}+V_{IN(max)}I_Q \quad (2)$$

where

$V_{IN(max)}$ is the maximum input voltage,

$V_{OUT(min)}$ is the minimum output voltage,

$I_{OUT(max)}$ is the maximum output current, for the application

I_Q is the maximum quiescent current at I_{OUT}(max).

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air.

Each material in the heat flow path between the IC and the outside environment has a thermal resistance. Like series electrical resistances, these resistances are summed to determine $R_{\Theta JA}$, the total thermal resistance between the junction and the surrounding air.

1. Thermal Resistance of the junction to case, $R_{\Theta JC}$ (°C/W)
2. Thermal Resistance of the case to Heat Sink, $R_{\Theta CS}$ (°C/W)
3. Thermal Resistance of the Heat Sink to the ambient air, $R_{\Theta SA}$ (°C/W)

These are connected by the equation:

$$R_{\Theta JA} = R_{\Theta JC} + R_{\Theta CS} + R_{\Theta SA} \quad (3)$$

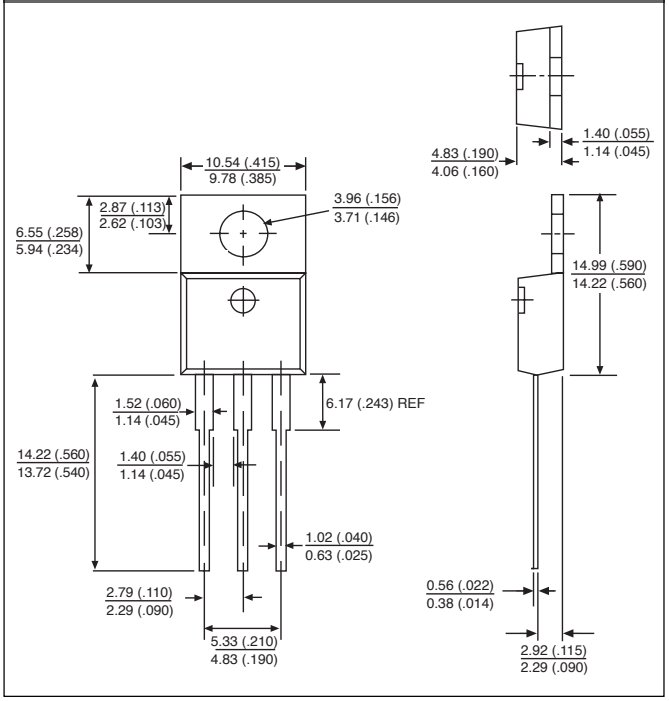
The value for $R_{\Theta JA}$ is calculated using equation (3) and the result can be substituted in equation (1).

The value for $R_{\Theta JC}$ is 3.5°C/W. For a high current regulator such as the CS5201-3 the majority of the heat is generated in the power transistor section. The value for $R_{\Theta SA}$ depends on the heat sink type, while $R_{\Theta CS}$ depends on factors such as package type, heat sink interface (is an insulator and thermal grease used?), and the contact area between the heat sink and the package. Once these calculations are complete, the maximum permissible value of $R_{\Theta JA}$ can be calculated and the proper heat sink selected. For further discussion on heat sink selection, see application note "Thermal Management for Linear Regulators."

Package Specification

PACKAGE DIMENSIONS IN mm(INCHES)

3 Lead TO-220 (T) Straight

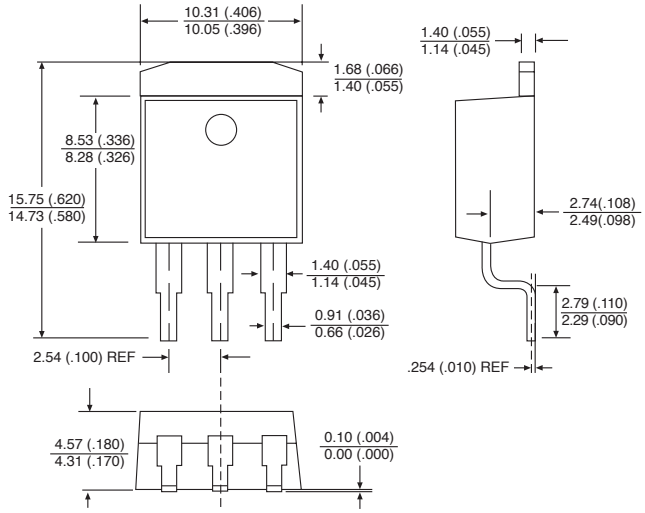


PACKAGE THERMAL DATA

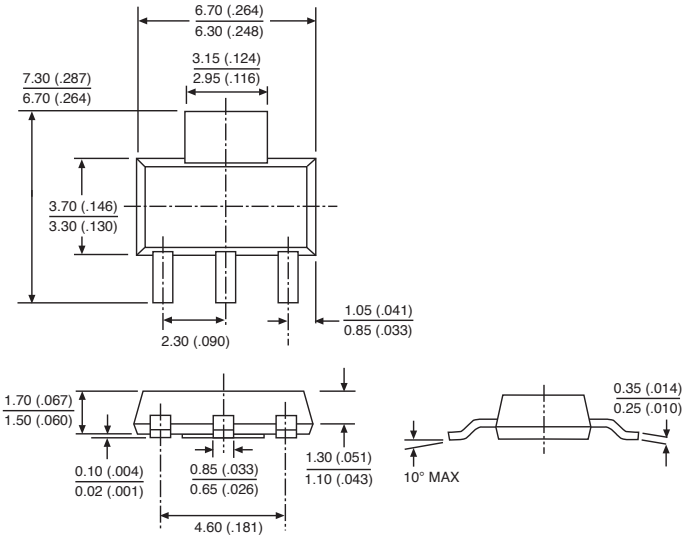
Thermal Data		3L TO-220	3L D^2PAK	3L SOT-223	
$R_{\Theta JC}$	typ	3.5	3.5	15	°C/W
$R_{\Theta JA}$	typ	50	10 - 50*	156	°C/W

**Depending on thermal properties of substrate.* $R_{\Theta JA} = R_{\Theta JC} + R_{\Theta CA}$

3 Lead D^2PAK (DP)



3 Lead SOT-223 (ST)



Ordering Information

Part Number	Type	Description
CS5201-3GT3	1A, 3.3V output	3 L TO-220 Straight
CS5201-3GDP3	1A, 3.3V output	3 L D^2PAK
CS5201-3GDPR3	1A, 3.3V output	3 L D^2PAK *(tape & reel)*
CS5201-3GST3	1A, 3.3V output	3 L SOT-223
CS5201-3GSTR3	1A, 3.3V output	3 L SOT-223 *(tape & reel)*

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