CS5204-2

4A , 1.5V Fixed Linear Regulator

Description

The CS5204-2 linear regulator provides 4A at 1.5V with an accuracy of ±2%.

The fast loop response and low dropout voltage make this regulator ideal for GTL bus termination where low voltage operation and good transient response are important.

The circuit is designed to operate with dropout voltages as low as 1V depending on the output current level. The maximum quiescent current is only 10mA at full load.

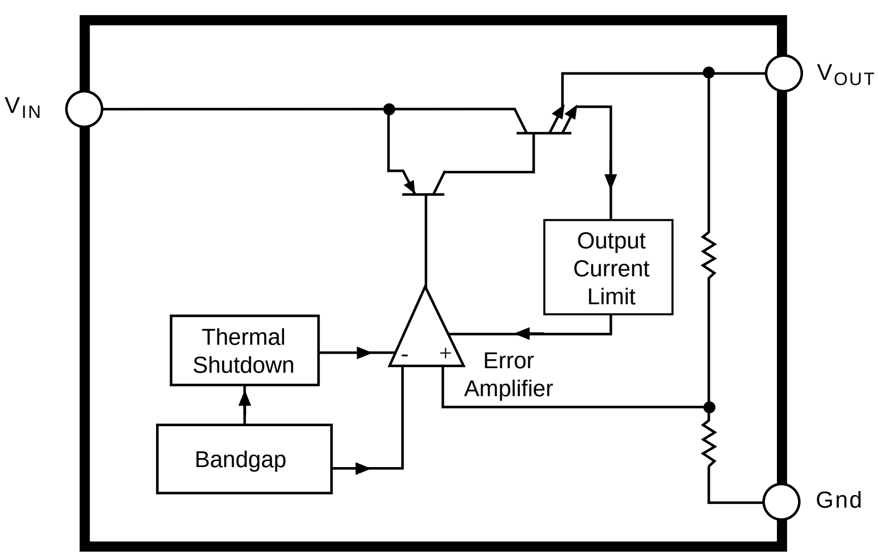
The regulator is fully protected against overload conditions with protection circuitry for Safe Operating Area (SOA), overcurrent and thermal shutdown.

The CS5204-2 is available in TO-220 and surface mount D^2 packages.

Features

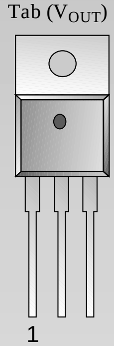
- **Output Current to 4A**
- **Output Voltage Trimmed to ± 2%**
- **Dropout Voltage 1.10V @ 4A**
- **Fast Transient Response**
- **Fault Protection Circuitry**
  - **Thermal Shutdown**
  - **Overcurrent Protection**
  - **Safe Area Protection**

Block Diagram

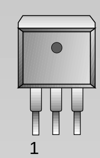


Package Options

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



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



CS5204-2

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

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Absolute Maximum Ratings

Supply Voltage, V_{CC} 17V
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

Electrical Characteristics: C_{IN} = 10µF, C_{OUT} = 22µF Tantalum, $V_{IN} – V_{OUT}$ = 3V, $V_{IN} \le$ 10V, 0°C ≤ $T_A \le$ 70°C, $T_J \le$ +150°C, unless otherwise specified, $I_{full\ load}$ = 4A.

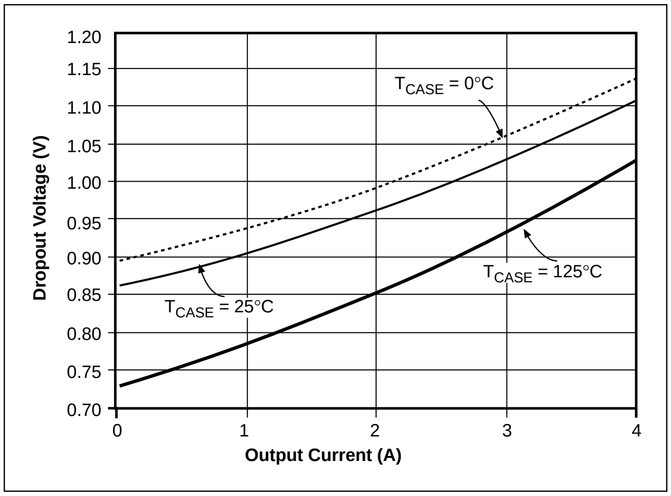
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
■ **CS5204-2**					
Output Voltage (Notes 1 and 2)	$V_{IN} – V_{OUT}$ = 1.5V; $0 \le I_{OUT} \le 4A$	1.47 (-2%)	1.50	1.53 (+2%)	V
Line Regulation	1.5V ≤ $V_{IN} – V_{OUT}$ ≤ 6V; I_{OUT} = 10mA		0.04	0.20	%
Load Regulation (Notes 1 and 2)	$V_{IN} – V_{OUT}$ = 1.5V; 10mA ≤ I_{OUT} ≤ 4A		0.05	0.4	%
Dropout Voltage (Note 3)	I_{OUT} = 4A		1.1	1.2	V
Current Limit	$V_{IN} – V_{OUT}$ = 3V; $T_J \ge$ 25°C $V_{IN} – V_{OUT}$ = 15V	4.5	8.5 2.5		A A
Quiescent Current	$V_{IN} \le$ 9V; I_{OUT} = 10mA		5.0	10.0	mA
Thermal Regulation	30ms pulse; T_A = 25°C		0.003		%/W
Ripple Rejection	f = 120Hz; I_{OUT} = 4A		75		dB
Temperature Stability			0.5		%
RMS Output Noise (%V_{OUT})	10Hz ≤ f ≤ 10kHz		0.003		%V_{OUT}
Thermal Shutdown		150	180		°C
Thermal Shutdown Hysteresis			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 thermal gradients or 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.

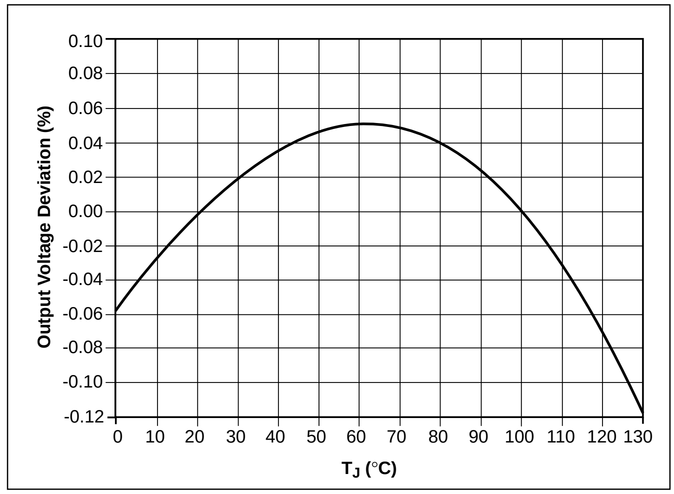
Package Pin Description

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

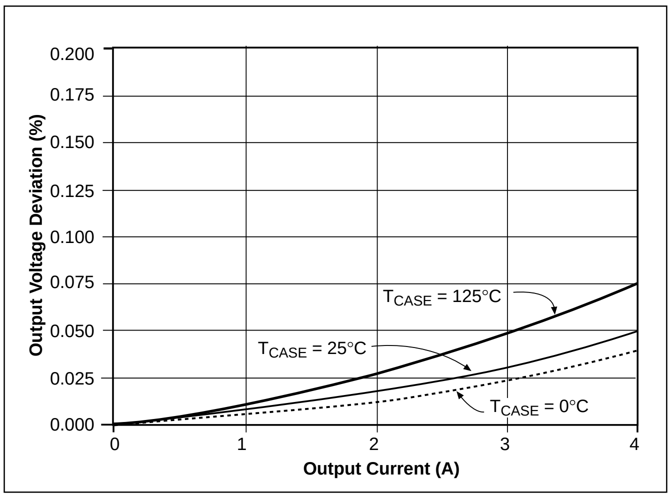
Typical Performance Characteristics



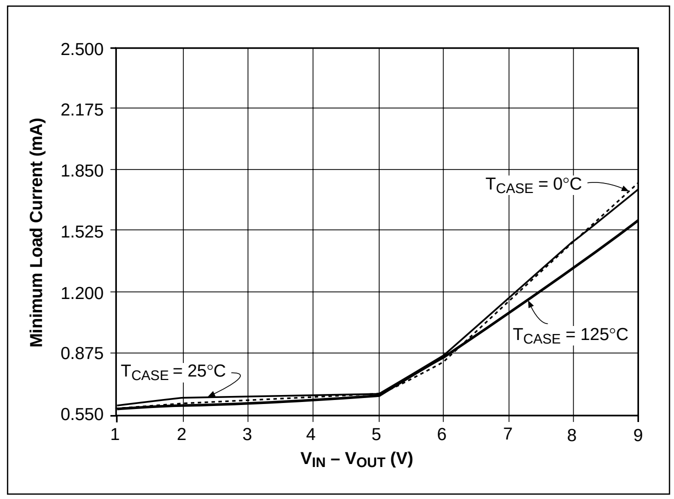
Dropout Voltage vs. Output Current



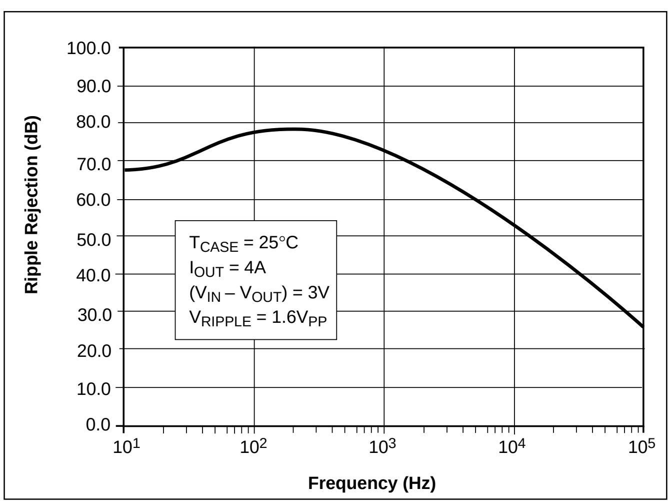
Reference Voltage vs. Temperature



Load Regulation vs. Output Current



Minimum Load Current



Ripple Rejection vs. Frequency

Applications Information

The CS5204-2 linear regulator provides fixed 1.5V voltage at currents up to 4A. The regulator is protected against short circuit, and includes thermal shutdown and safe area protection (SOA) circuitry. The SOA protection circuitry decreases the maximum available output current as the input-output differential voltage increases.

The CS5204-2 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 is 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 CS5204-2 the transient response and stability improve with higher values of capacitor. 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 Vin drops. In the CS5204-2 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 2 is recommended.

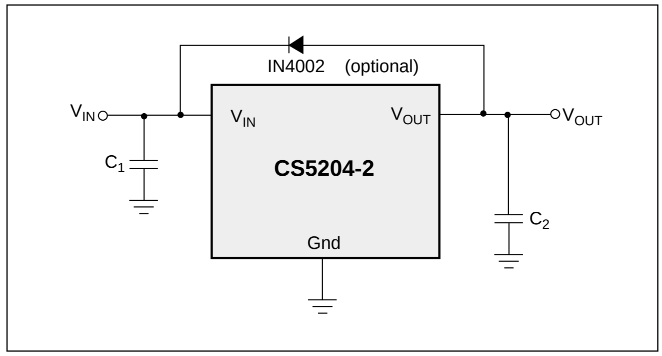


Figure 2. Protection diode scheme.

Output Voltage Sensing

Since the CS5204-2 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 3.

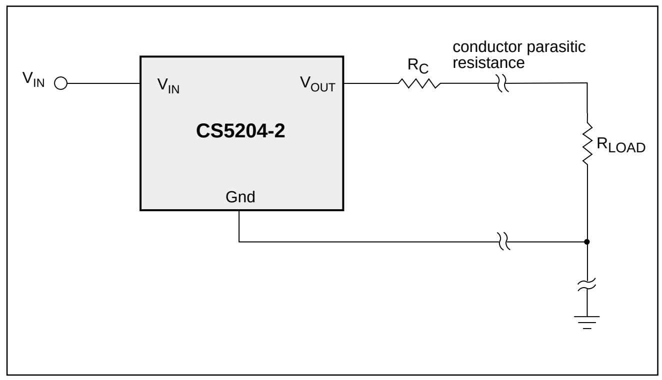


Figure 3. Conductor parasitic resistance effects can be minimized with the above grounding scheme.

Calculating Power Dissipation and Heat Sink Requirements

The CS5204-2 linear regulator includes thermal shutdown and safe operating area 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 CS5204-2, 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

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

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:

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

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:

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

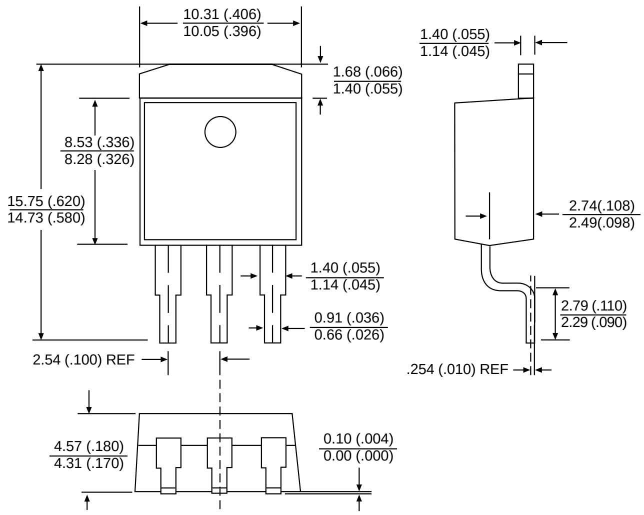
The value for $R_{\Theta JA}$ is calculated using equation (3) and the result can be substituted in equation (1).

$R_{\Theta JC}$ is 1.6°C / Watt for the CS5204-2. For a high current regulator such as the CS5204-2 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 D^2PAK (DP)

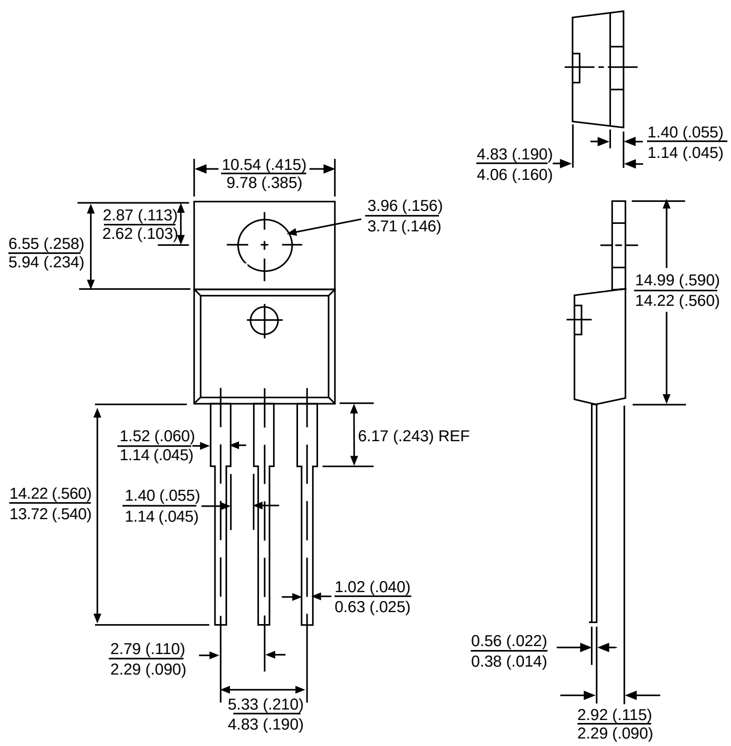


PACKAGE THERMAL DATA

Thermal Data		3L TO-220	3L D^2PAK	
$R_{\Theta JC}$	typ	1.6	1.6	°C / W
$R_{\Theta JA}$	typ	50	10 - 50*	°C / W

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

3 Lead TO-220 (T) Straight



Ordering Information

Part Number	Type	Description
CS5204-2GT3	4A, 1.5V output	3L TO-220 Straight
CS5204-2GDP3	4A, 1.5V output	3L D^2PAK
CS5204-2GDPR3	4A, 1.5V output	3L D^2PAK *(tape & reel)*

Notes

Notes