CS9201

Micropower 5V, 100mA Low Dropout Linear Regulator with NoCap™

Description

The CS9201 is a precision 5V, 100mA voltage regulator with low quiescent current (450µA typ. @ 100µA load). The 5V output is accurate within ±2% and supplies 100mA of load current with a maximum dropout voltage of only 600mV.

The regulator is protected against reverse battery, short circuit, over voltage, and over temperature conditions. The device can withstand 74V peak transients making it suitable for use in automotive environments. ON's proprietary NoCap™ solution is the first technology which allows the output to be stable without the use of an external capacitor. NoCap is suitable for slow switching or steady loads.

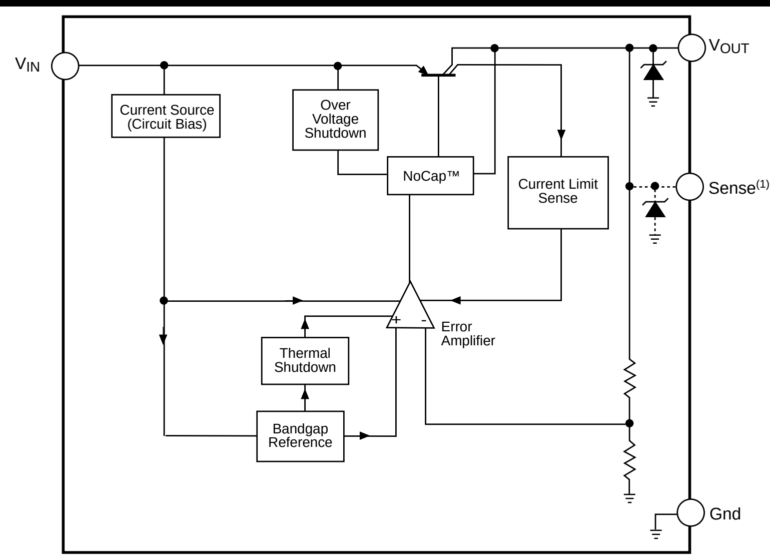
Features

- NoCap™
- Low Quiescent Current (450µA typ. @ 100µA load)
- 5V, ±2% Output
- 100mA Output Current Capability
- Fault Protection
  - 74V Peak Transient Voltage
  - –15V Reverse Voltage
  - Short Circuit
  - Thermal Shutdown
  - Overvoltage Shutdown

Absolute Maximum Ratings

Power Dissipation	Internally Limited
Transient Peak Voltage (31V Load Dump @ V_{IN} = 14V)	–15V, 74V
Output Current	Internally Limited
ESD Susceptibility (Human Body Model)	4kV
Junction Temperature	–40°C to 150°C
Storage Temperature	–55°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

Block Diagram

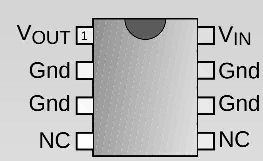


(1) Contact factory for optional Sense lead.

NoCap is a trademark of ON Semiconductor, and is patented.

Package Options

8Lead SO Narrow
(Internally Fused Leads)



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Electrical Characteristics: $6V \le V_{IN} \le 26V$, $I_{OUT} = 1mA$, $-40° \le T_A \le 125°C$, $-40° \le T_J \le 150°C$; unless otherwise specified.

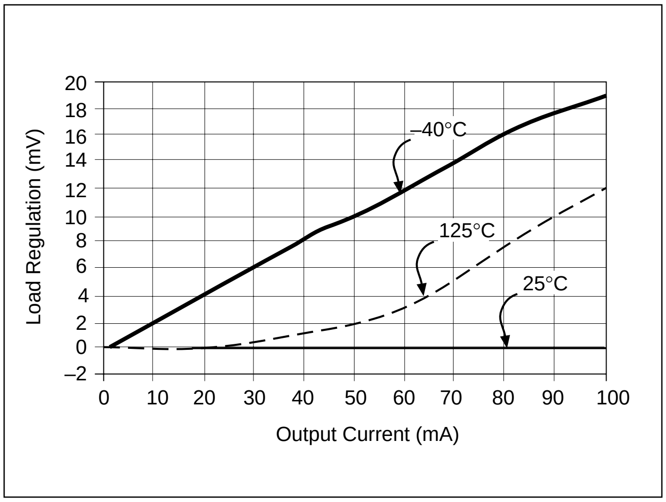
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
■ Output Stage					
Output Voltage, V_{OUT}	$9V < V_{IN} < 16V$, $100\mu A \le I_{OUT} \le 100mA$	4.90	5.00	5.10	V
	$6V \le V_{IN} \le 26V$, $100\mu A \le I_{OUT} \le 100mA$	4.85	5.00	5.15	V
Dropout Voltage (V_{IN}-V_{OUT})	$I_{OUT} = 100mA$		400	600	mV
	$I_{OUT} = 100\mu A$		100	150	mV
Load Regulation	$V_{IN} = 14V$ $100\mu A \le I_{OUT} \le 100mA$		5	50	mV
Line Regulation	$6V < V < 26V$ $I_{OUT} = 1mA$		5	50	mV
Quiescent Current, (I_Q)	$I_{OUT} = 100\mu A$, $V_{IN} = 12V$		450	750	µA
	$I_{OUT} \le 50mA$		4	6	mA
	$I_{OUT} \le 100mA$		12	20	mA
Ripple Rejection	$7V \le V_{IN} \le 17V$, $I_{OUT} = 100mA$, $f = 120Hz$	60	75		dB
Current Limit		105	200		mA
Short Circuit Output Current	$V_{OUT} = 0V$	25	125		mA
Thermal Shutdown (Note 1)		150	180		°C
Overvoltage Shutdown	$V_{OUT} \le 1V$	28	32	36	V

Note 1: This parameter is guaranteed by design, but not parametrically tested in production.

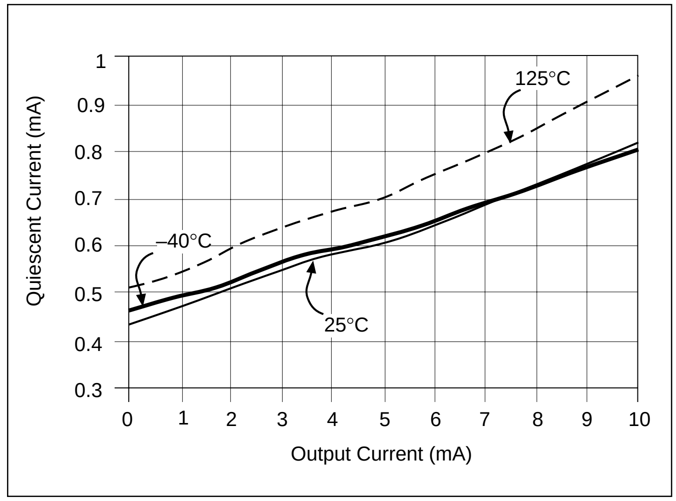
Package Lead Description

PACKAGE LEAD #	LEAD SYMBOL	FUNCTION
8 Lead SO Narrow *(Internally Fused Leads)*		
1	V_{OUT}	5V, ±2%, 100mA output.
4, 5	NC	No connection.
2, 3, 6, 7	Gnd	Ground.
8	V_{IN}	Input voltage.

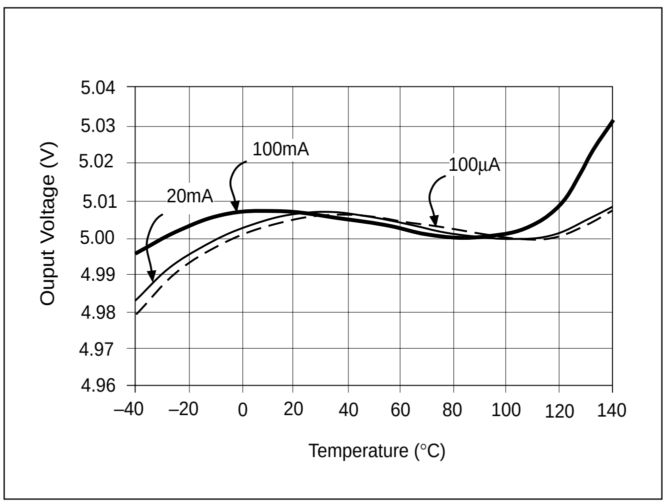
Typical Performance Characteristics



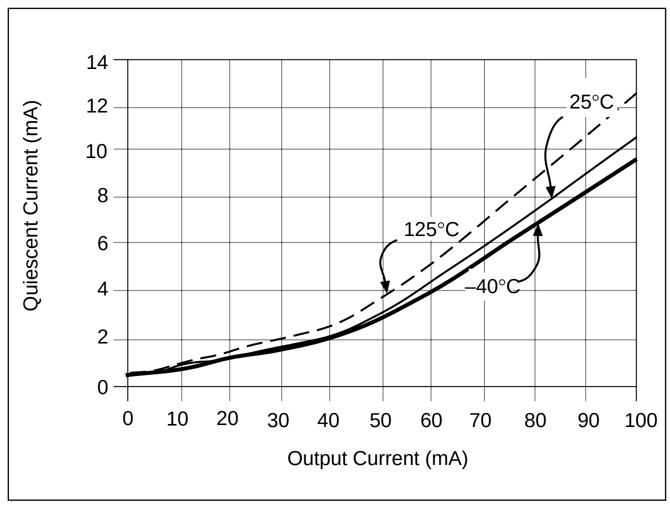
Load Regulation vs. Output Current V_{IN} = 14V



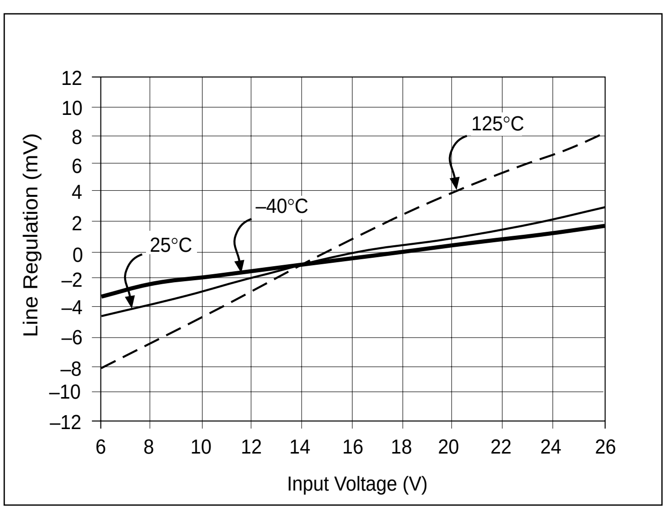
Quiescent Current vs. Output Current (Lightly Loaded) V_{IN} = 14V



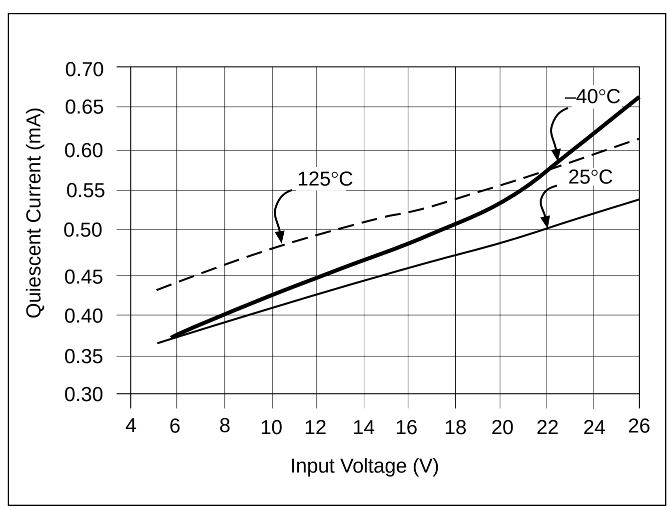
Output Voltage vs. Temperature V_{IN} = 14V



Quiescent Current vs. Output Current V_{IN} = 14V



Line Regulation vs. Input Voltage I_{OUT} = 100µA



Quiescent Current vs. Input Voltage I_{OUT} = 100µA

Circuit Description

Voltage Reference and Output Circuitry

Output Stage Protection

The output stage is protected against overvoltage, short circuit and thermal runaway conditions (Figure 1).

If the input voltage rises above 32V (typ), the output shuts down. This response protects the internal circuitry and enables the IC to survive unexpected voltage transients.

Should the junction temperature of the power device exceed 180˚C (typ) the power transistor is turned off. Thermal shutdown is an effective means to prevent die overheating since the power transistor is the principle heat source in the IC.

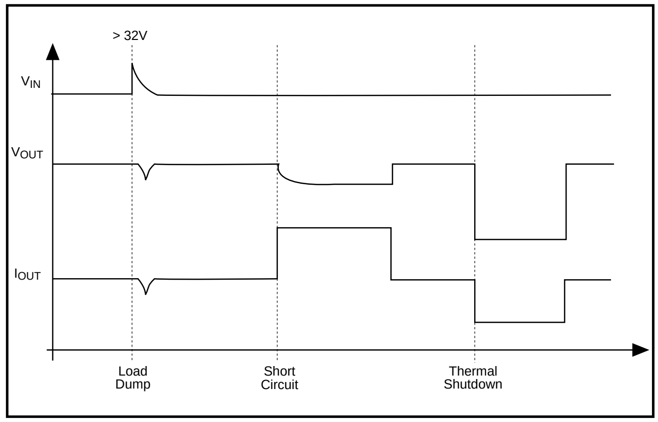
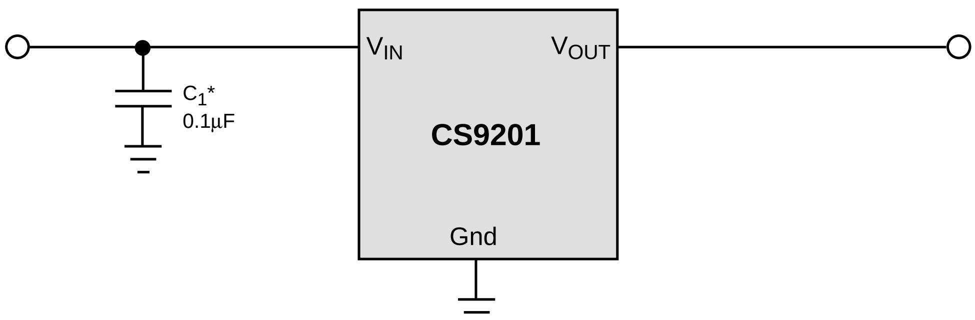


Figure 1. Typical Circuit Waveforms for Output Stage Protection.

Application & Test Diagram



*C_1 is required if regulator is distant from power source filter.

Application Notes

Stability Considerations/NoCap™

Normally a low dropout or quasi-low dropout regulator (or any type requiring a slow lateral PNP in the control loop) necessitates a large external compensation capacitor at the output of the IC. The external capacitor is also used to curtail overshoot, determine startup delay time and load transient response.

Traditional LDO regulators typically have low unity gain bandwidth, display overshoot and poor ripple rejection. Compensation is also an issue and depends on the external capacitor value, ESR (Equivalent Series Resistance) and board layout parasitics that all can create oscillations if not properly accounted for.

NoCap™ is a ON Semiconductor exclusive output stage which internally compensates the LDO regulator over temperature, load and line variations without the need for an expensive external capacitor.

NoCap™ is ideally suited for slow switching or steady loads. If the load is characterized by transient current events, an output storage capacitor may be needed. If this is the case, the capacitor should be no larger than 100nF. With loads that require greater transient suppression, a regulator with a traditional output stage (such as the CS8221) may be better suited for proper operation.

Calculating Power Dissipation in a Single Output Linear Regulator

The maximum power dissipation for a single output regulator (Figure 2) is:

$$P_{D(max)} = \{V_{IN(max)} - V_{OUT(min)}\} I_{OUT(max)} + V_{IN(max)} I_Q \quad (1)$$

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, and

I_Q is the quiescent current the regulator consumes at $I_{OUT(max)}$.

Once the value of $P_{D(max)}$ is known, the maximum permissible value of $R_{\Theta JA}$ can be calculated:

$$R_{\Theta JA} = \frac{150°C - T_A}{P_D} \quad (2)$$

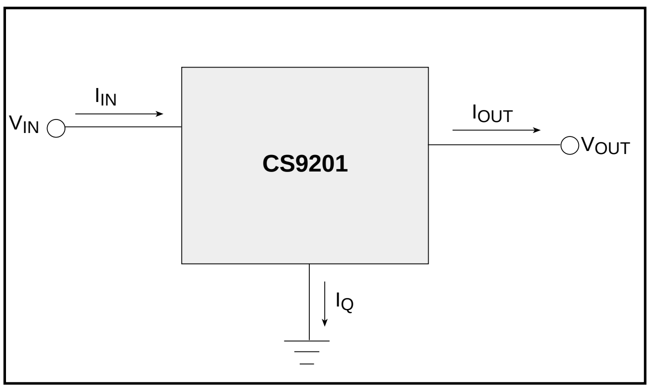


Figure 2. Single output regulator with key performance parameters labeled.

The value of $R_{\Theta JA}$ can then be compared with those in the package section of the data sheet. Those packages with $R_{\Theta JA}$'s less than the calculated value in equation 2 will keep the die temperature below 150°C.

In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heatsink will be required.

Heat Sinks

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 will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of $R_{\Theta JA}$:

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

where:

$R_{\Theta JC}$ = the junction–to–case thermal resistance,
$R_{\Theta CS}$ = the case–to–heatsink thermal resistance, and
$R_{\Theta SA}$ = the heatsink–to–ambient thermal resistance.

$R_{\Theta JC}$ appears in the package section of the data sheet. Like $R_{\Theta JA}$, it too is a function of package type. $R_{\Theta CS}$ and $R_{\Theta SA}$ are functions of the package type, heatsink and the interface between them. These values appear in heat sink data sheets of heat sink manufacturers.

Package Specification

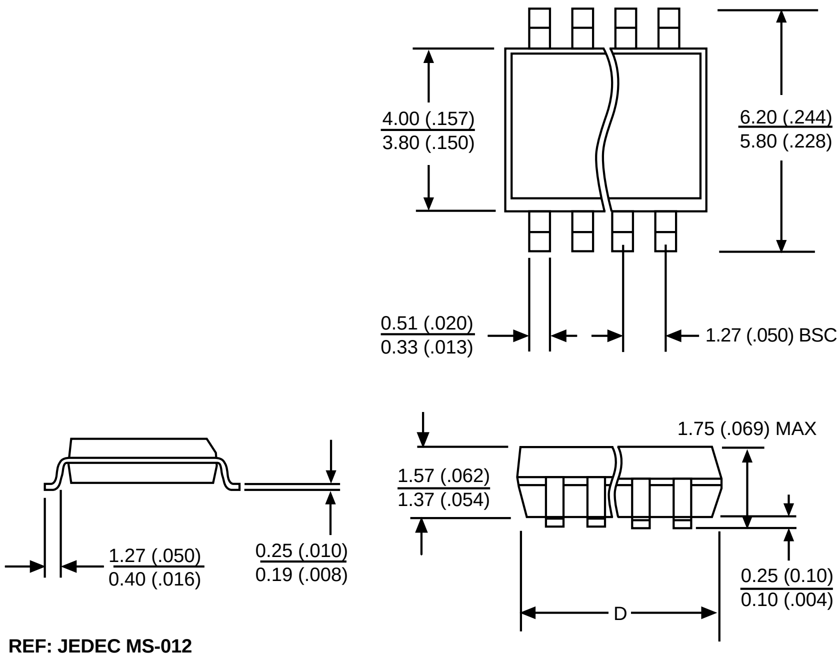
PACKAGE DIMENSIONS IN mm (INCHES)

■ Text Lead Count	D			
	Metric		English	
	Max	Min	Max	Min
8Lead SO Narrow *(Internally Fused Leads)*	5.00	4.80	.197	.189

PACKAGE THERMAL DATA

Thermal Data		8 Lead SO Narrow *(Internally Fused Leads)*	
$R_{\Theta JC}$	typ	25	˚C/W
$R_{\Theta JA}$	typ	110	˚C/W

Surface Mount Narrow Body (D); 150 mil wide



Ordering Information

Part Number	Description
CS9201YDF8	8 Lead SO Narrow *(Internally Fused Leads)*
CS9201YDFR8	8 Lead SO Narrow *(Internally Fused Leads) (tape & reel)*

Notes

Notes