THE DATASHEET OF

CS9201YDF8

CS9201

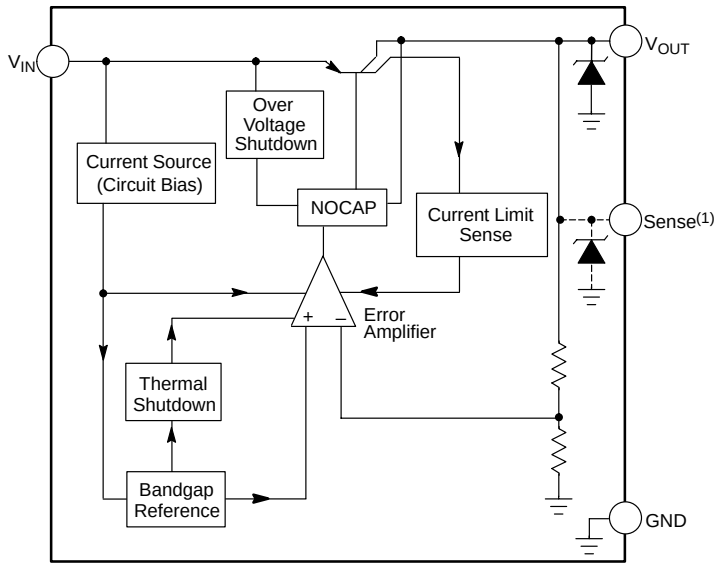
Micropower 5.0 V, 100 mA Low Dropout Linear Regulator with NOCAP™

The CS9201 is a precision 5.0 V, 100 mA voltage regulator with low quiescent current (450 μA typ. @ 100 μA load). The 5.0 V output is accurate within ±2% and supplies 100 mA of load current with a maximum dropout voltage of only 600 mV.

The regulator is protected against reverse battery, short circuit, over voltage, and over temperature conditions. The device can withstand 74 V 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 (450 μA typ. @ 100 μA load)
- 5.0 V, ±2% Output
- 100 mA Output Current Capability
- Fault Protection
  - 74 V Peak Transient Voltage
  - –15 V Reverse Voltage
  - Short Circuit
  - Thermal Shutdown
  - Overvoltage Shutdown
- Internally Fused Leads



(1) Contact factory for optional Sense lead.

Figure 1. Block Diagram

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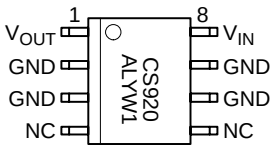
http://onsemi.com

SO–8
DF SUFFIX
CASE 751

PIN CONNECTIONS AND MARKING DIAGRAM



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

ORDERING INFORMATION

Device	Package	Shipping
CS9201YDF8	SO–8	95 Units/Rail
CS9201YDFR8	SO–8	2500 Tape & Reel

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MAXIMUM RATINGS*

Parameter	Value	Unit
Power Dissipation	Internally Limited	–
Input Voltage (V_{IN}): DC Peak Transient Voltage (60 V Load Dump @ V_{IN} = 14 V)	 –15 to 36 74	 V V
Output Current	Internally Limited	–
ESD Susceptibility (Human Body Model)	4.0	kV
Package Thermal Resistance: Junction–to–Case, $R_{\theta JC}$ Junction–to–Ambient, $R_{\theta JA}$	 25 110	 °C/W °C/W
Junction Temperature	–40 to +150	°C
Storage Temperature	–55 to +150	°C
Lead Temperature Soldering: Reflow (SMD styles only) Note 1	230 Peak	°C

1. 60 second maximum above 183°C.

*The maximum package power dissipation must be observed.

ELECTRICAL CHARACTERISTICS (6.0 V ≤ V_{IN} ≤ 26 V, I_{OUT} = 1.0 mA, –40°C ≤ T_J ≤ 125°C; unless otherwise stated.)

Parameter	Test Conditions	Min	Typ	Max	Unit
Output Stage					
Output Voltage, V_{OUT}	9.0 V < V_{IN} < 16 V, 100 uA ≤ I_{OUT} ≤ 100 mA 6.0 V < V_{IN} < 26 V, 100 uA ≤ I_{OUT} ≤ 100 mA	4.90 4.85	5.00 5.00	5.10 5.15	V V
Dropout Voltage (V_{IN}–V_{OUT})	I_{OUT} = 100 mA I_{OUT} = 100 μA	–	400 100	600 150	mV mV
Load Regulation	V_{IN} = 14 V, 100 μA ≤ I_{OUT} ≤ 100 mA	–	5	50	mV
Line Regulation	6.0 V < V < 26 V, I_{OUT} = 1.0 mA	–	5	50	mV
Quiescent Current, (I_Q)	I_{OUT} = 100 μA, V_{IN} = 12 V I_{OUT} ≤ 50 mA I_{OUT} ≤ 100 mA	–	450 4 12	750 6 20	μA mA mA
Ripple Rejection	7.0 V ≤ VI_N ≤ 17 V, I_{OUT} = 100 mA, f = 120 Hz	60	75	–	dB
Current Limit	–	105	200	–	mA
Short Circuit Output Current	V_{OUT} = 0 V	25	125	–	mA
Thermal Shutdown (Note 2)	–	150	180	–	°C
Overvoltage Shutdown	V_{OUT} ≤ 1.0 V	28	32	36	V

2. This parameter is guaranteed by design, but not parametrically tested in production.

PACKAGE LEAD DESCRIPTION

Package Lead Number		
SO–8	Lead Symbol	Function
1	V_{OUT}	5.0 V, ± 2%, 100 mA output.
4, 5	NC	No connection.
2, 3, 6, 7	GND	Ground.
8	V_{IN}	Input voltage.

TYPICAL PERFORMANCE CHARACTERISTICS

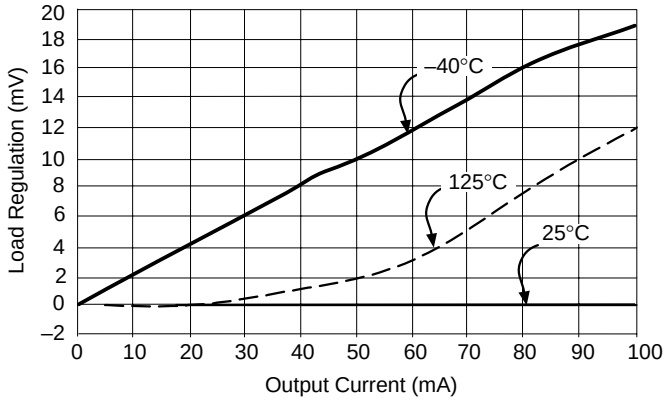


Figure 2. Load Regulation vs. Output Current V_{IN} = 14 V

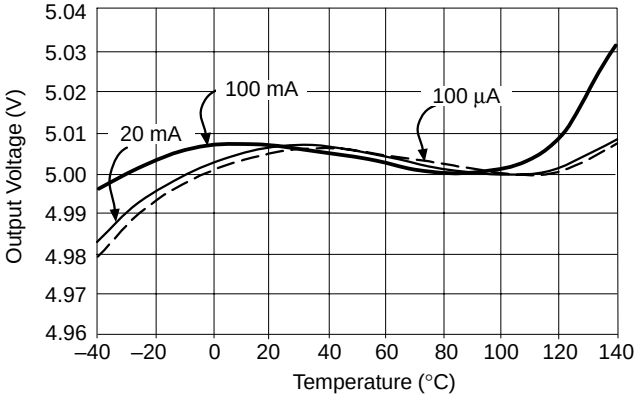


Figure 3. Output Voltage vs. Temperature V_{IN} = 14 V

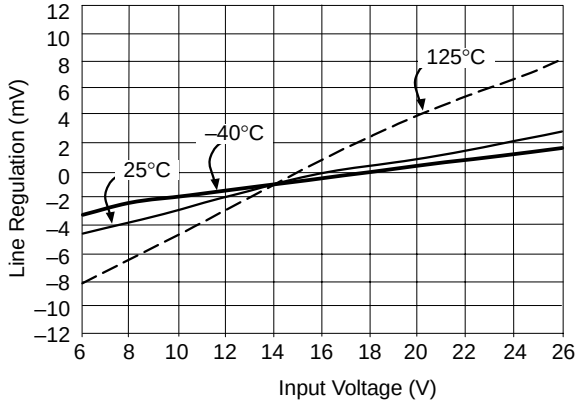


Figure 4. Line Regulation vs. Input Voltage I_{OUT} = 100 μA

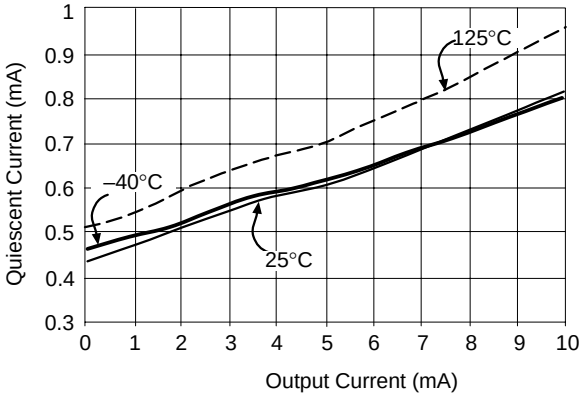


Figure 5. Quiescent Current vs. Output Current (Lightly Loaded) V_{IN} = 14 V

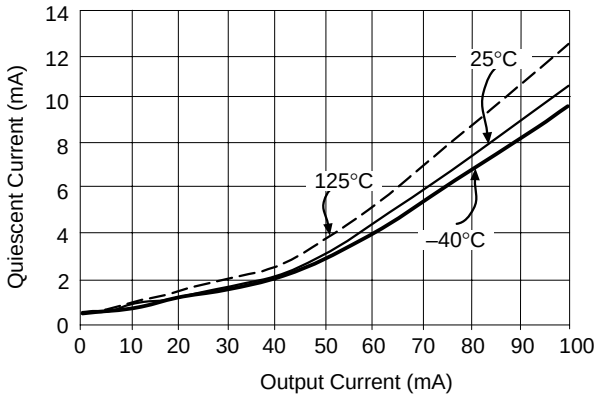


Figure 6. Quiescent Current vs. Output Current V_{IN} = 14 V

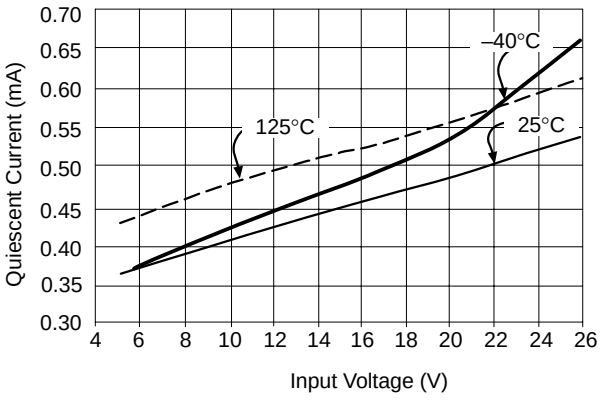


Figure 7. Quiescent Current vs. Input Voltage I_{OUT} = 100 μA

CIRCUIT DESCRIPTION

VOLTAGE REFERENCE AND OUTPUT CIRCUITRY

Output Stage Protection

The output stage is protected against overvoltage, short circuit and thermal runaway conditions (Figure 8).

If the input voltage rises above 32 V (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.

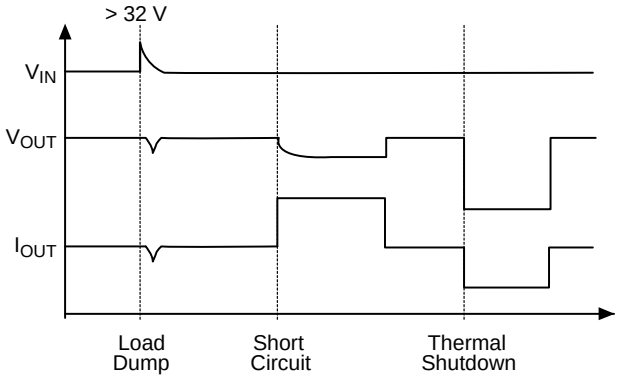
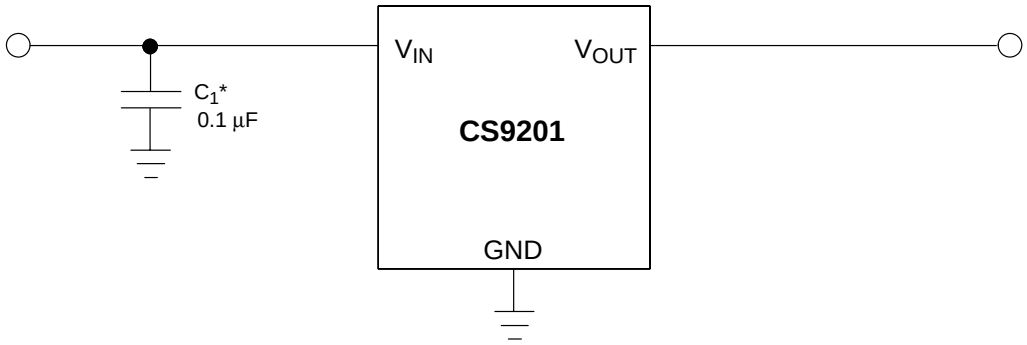


Figure 8. Typical Circuit Waveforms for Output Stage Protection



* C1 is required if regulator is distant from power source filter.

Figure 9. Application and Test Diagram

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 an 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 100 nF. 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 10) 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:

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

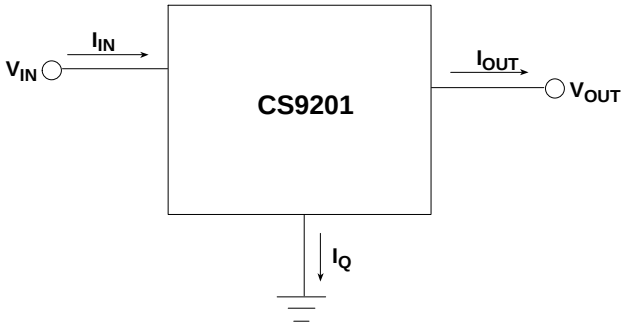


Figure 10. Single output regulator with key performance parameters labeled.

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,

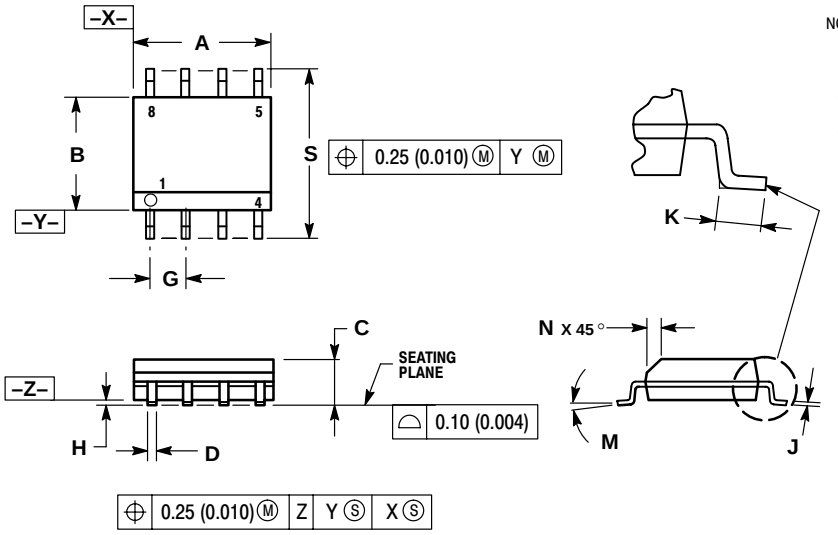
$R_{\Theta CS}$ = the case–to–heatsink thermal resistance, and

$R_{\Theta SA}$ = 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 DIMENSIONS

SO–8
DF SUFFIX
CASE 751–07
ISSUE W



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

Notes

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