National Semiconductor

LM9036
Ultra-Low Quiescent Current Voltage Regulator

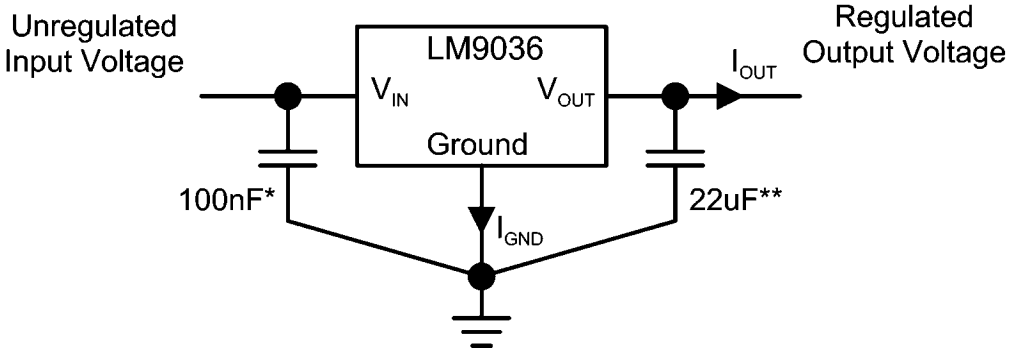
General Description

The LM9036 ultra-low quiescent current regulator features low dropout voltage and low current in the standby mode. With less than 25µA Ground Pin current at a 0.1mA load, the LM9036 is ideally suited for automotive and other battery operated systems. The LM9036 retains all of the features that are common to low dropout regulators including a low dropout PNP pass device, short circuit protection, reverse battery protection, and thermal shutdown. The LM9036 has a 40V maximum operating voltage limit, a –40°C to +125°C operating temperature range, and ±5% output voltage tolerance over the entire output current, input voltage, and temperature range.

Features

- Ultra low Ground Pin current ($I_{GND} \leq 25\mu A$ for I_{OUT} = 0.1mA)
- Fixed 5V, 3.3V, 50mA output
- Output tolerance ±5% over line, load, and temperature
- Dropout voltage typically 200mV @ I_{OUT} = 50mA
- –45V reverse transient protection
- Internal short circuit current limit
- Internal thermal shutdown protection
- 40V operating voltage limit

Typical Application



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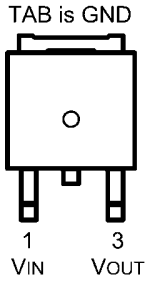
* Required if regulator is located more than 2″ from power supply filter capacitor.

** Required for stability. Must be rated over intended operating temperature range. Effective series resistance (ESR) is critical, see Electrical Characteristics. Locate capacitor as close as possible to the regulator output and ground pins. Capacitance may be increased without bound.

Connection Diagrams

TO-252



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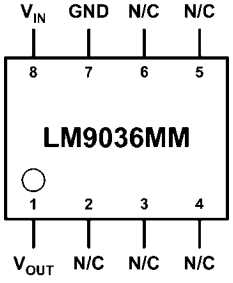
Top View
Order Number LM9036DT-5.0, LM9036DTX-5.0, LM9036DT-3.3, LM9036DTX-3.3
See NS Package Number TD03B



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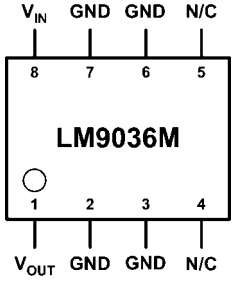
Top View
LM9036MM-3.3, , LM9036MMX-3.3, LM9036MM-5.0, LM9036MMX-5.0
See NS Package Number MUA08A



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Top View
LM9036M-3.3, LM9036MX-3.3, LM9036M-5.0, LM9036MX-5.0
See NS Package Number M08A

Ordering Information

Output Voltage	Order	Package Type	Package Drawing	Transport Media
3.3V	LM9036M-3.3	8-Lead SOIC	M08A	Rail
	LM9036MX-3.3	8-Lead SOIC	M08A	Tape/Reel
	LM9036DT-3.3	TO-252	TD03B	Rail
	LM9036DTX-3.3	TO-252	TD03B	Tape/Reel
	LM9036MM-3.3	8-Lead Mini SOIC	MUA08A	Rail
	LM9036MMX-3.3	8-Lead Mini SOIC	MUA08A	Tape/Reel
5.0V	LM9036M-5.0	8-Lead SOIC	M08A	Rail
	LM9036MX-5.0	8-Lead SOIC	M08A	Tape/Reel
	LM9036DT-5.0	TO-252	TD03B	Rail
	LM9036DTX-5.0	TO-252	TD03B	Tape/Reel
	LM9036MM-5.0	8-Lead Mini SOIC	MUA08A	Rail
	LM9036MMX-5.0	8-Lead Mini SOIC	MUA08A	Tape/Reel

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Input Voltage (Survival)	+55V, −45V
ESD Susceptibility (Note 2)	±1.9kV
Power Dissipation (Note 3)	Internally limited
Junction Temperature (T_{Jmax})	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	260°C

Operating Ratings

Operating Temperature Range	−40°C to +125°C
Maximum Input Voltage (Operational)	40V
SO-8 (M08A) θ_{JA} (Note 7)	140°C/W
TO-252 (TD03B) θ_{JA} (Note 7)	125°C/W
TO-252 (TD03B) θ_{JA} (Note 8)	50°C/W
TO-252 (TD03B) θ_{JC} (Note 7)	11°C/W
MSO-8 (MUA08A) θ_{JA} (Note 7)	200°C/W

Electrical Characteristics - LM9036-5.0

V_{IN} = 14V, I_{OUT} = 10 mA, T_J = 25°C, unless otherwise specified. **Boldface** limits apply over entire operating temperature range

Parameter	Conditions	Min (Note 5)	Typical (Note 4)	Max (Note 5)	Units
Output Voltage (V_{OUT})		4.80	5.00	5.20	V
	5.5V ≤ V_{IN} ≤ 26V, 0.1mA ≤ I_{OUT} ≤ 50mA (Note 6)	**4.75**	**5.00**	**5.25**	
Quiescent Current (I_{GND})	I_{OUT} = 0.1mA, 8V ≤ V_{IN} ≤ 24V		20	25	µA
	I_{OUT} = 1mA, 8V ≤ V_{IN} ≤ 24V		50	100	
	I_{OUT} = 10mA, 8V ≤ V_{IN} ≤ 24V		0.3	0.5	mA
	I_{OUT} = 50mA, 8V ≤ V_{IN} ≤ 24V		2.0	2.5	
Line Regulation (Δ V_{OUT})	6V ≤ V_{IN} ≤ 40V, I_{OUT} = 1mA		10	30	mV
Load Regulation (Δ V_{OUT})	0.1mA ≤ I_{OUT} ≤ 5mA		10	30	mV
	5mA ≤ I_{OUT} ≤ 50mA		10	30	mV
Dropout Voltage (Δ V_{OUT})	I_{OUT} = 0.1mA		0.05	0.10	V
	I_{OUT} = 50mA		0.20	0.40	V
Short Circuit Current (I_{SC})	V_{OUT} = 0V	65	120	250	mA
Ripple Rejection (PSRR)	V_{ripple} = 1V_{rms}, F_{ripple} = 120Hz	−40	−60		dB
Output Bypass Capacitance (C_{OUT})	0.3Ω ≤ ESR ≤ 8Ω, 0.1mA ≤ I_{OUT} ≤ 50mA	10	22		µF

Electrical Characteristics - LM9036-3.3

V_{IN} = 14V, I_{OUT} = 10 mA, T_J = 25°C, unless otherwise specified. **Boldface** limits apply over entire operating temperature range

Parameter	Conditions	Min (Note 5)	Typical (Note 4)	Max (Note 5)	Units
Output Voltage (V_{OUT})		3.168	3.30	3.432	V
	5.5V ≤ V_{IN} ≤ 26V, 0.1mA ≤ I_{OUT} ≤ 50mA (Note 6)	**3.135**	**3.30**	**3.465**	
Quiescent Current (I_{GND})	I_{OUT} = 0.1mA, 8V ≤ V_{IN} ≤ 24V		20	25	µA
	I_{OUT} = 1mA, 8V ≤ V_{IN} ≤ 24V		50	100	
	I_{OUT} = 10mA, 8V ≤ V_{IN} ≤ 24V		0.3	0.5	mA
	I_{OUT} = 50mA, 8V ≤ V_{IN} ≤ 24V		2.0	2.5	
Line Regulation (Δ V_{OUT})	6V ≤ V_{IN} ≤ 40V, I_{OUT} = 1mA		10	30	mV
Load Regulation (Δ V_{OUT})	0.1mA ≤ I_{OUT} ≤ 5mA		10	30	mV
	5mA ≤ I_{OUT} ≤ 50mA		10	30	mV
Dropout Voltage (Δ V_{OUT})	I_{OUT} = 0.1mA		0.05	0.10	V
	I_{OUT} = 50mA		0.20	0.40	V
Short Circuit Current (I_{SC})	V_{OUT} = 0V	65	120	250	mA
Ripple Rejection (PSRR)	V_{ripple} = 1V_{rms}, F_{ripple} = 120Hz	–40	–60		dB
Output Bypass Capacitance (C_{OUT})	0.3Ω ≤ ESR ≤ 8Ω, 0.1mA ≤ I_{OUT} ≤ 50mA	22	33		µF

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its specified operating ratings.

Note 2: Human body model, 100pF discharge through a 1.5kΩ resistor.

Note 3: The maximum power dissipation is a function of T_{Jmax}, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{Jmax} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM9036 will go into thermal shutdown.

Note 4: Typicals are at 25°C (unless otherwise specified) and represent the most likely parametric norm.

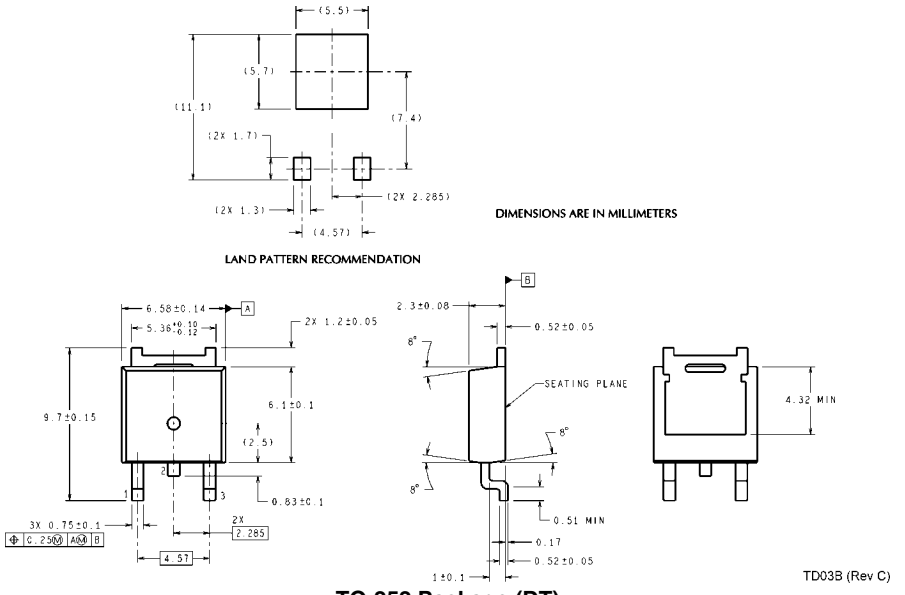
Note 5: Tested limits are guaranteed to National's AOQL (Average Outgoing Quality Level) and 100% tested.

Note 6: To ensure constant junction temperature, pulse testing is used.

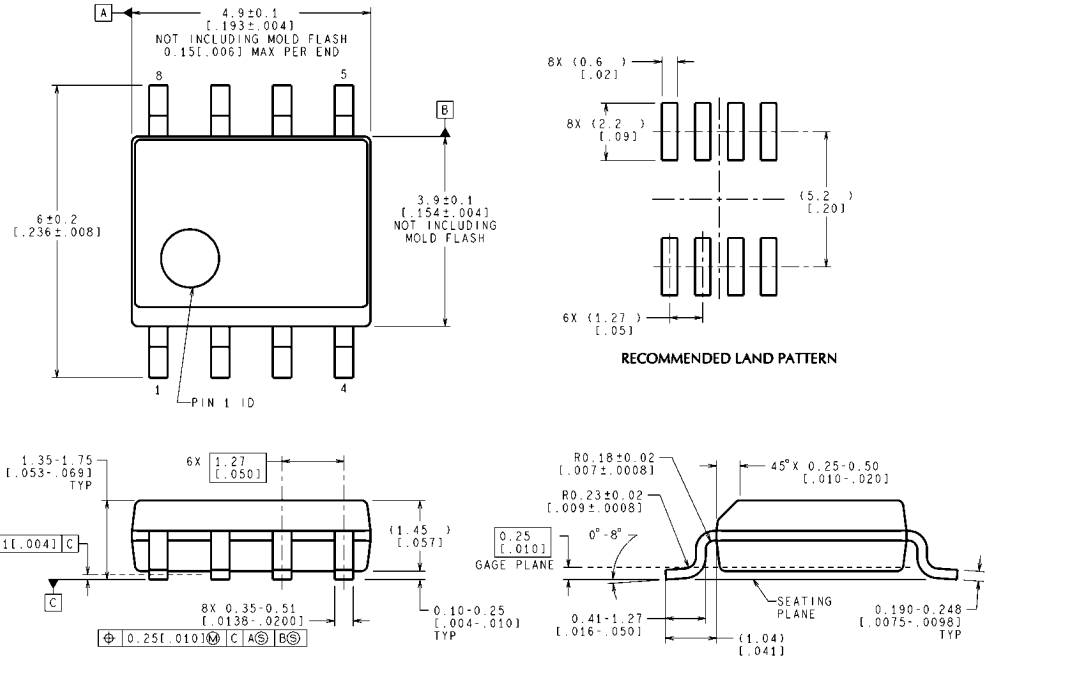
Note 7: Worst case (Free Air) per EIA / JESD51-3.

Note 8: Typical θ_{JA} with 1 square inch of 2oz copper pad area directly under the ground tab.

Physical Dimensions inches (millimeters) unless otherwise noted



TO-252 Package (DT)
NS Package Number TD03B



8 Lead Small Outline Molded Package (M)
NS Package Number M08A