

## LM9036Q

### Ultra-Low Quiescent Current Voltage Regulator

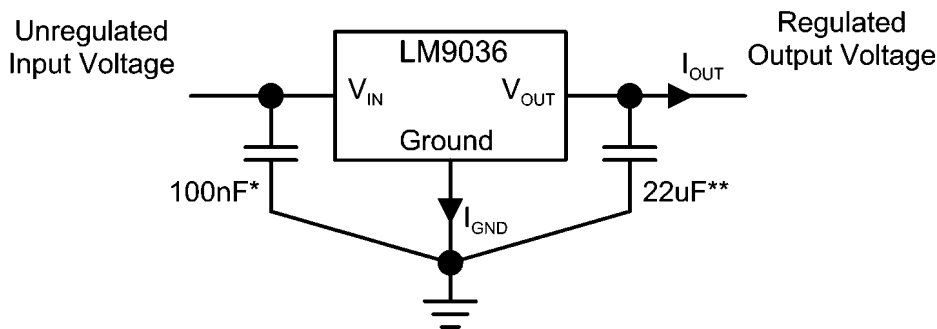
#### General Description

The LM9036Q ultra-low quiescent current regulator features low dropout voltage and low current in the standby mode. With less than 25 $\mu$ A Ground Pin current at a 0.1mA load, the LM9036Q is ideally suited for automotive and other battery operated systems. The LM9036Q 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 LM9036Q has a 40V maximum operating voltage limit, a  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  operating temperature range, and  $\pm 5\%$  output voltage tolerance over the entire output current, input voltage, and temperature range.

#### Features

- AEC-Q100 Grade 1 Qualified ( $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ )
- Ultra low Ground Pin current ( $I_{\text{GND}} \leq 25\mu\text{A}$  for  $I_{\text{OUT}} = 0.1\text{mA}$ )
- Fixed 5V, 3.3V, 50mA output
- Output tolerance  $\pm 5\%$  over line, load, and temperature
- Dropout voltage typically 200mV @  $I_{\text{OUT}} = 50\text{mA}$
- $-45\text{V}$  reverse transient protection
- Internal short circuit current limit
- Internal thermal shutdown protection
- 40V operating voltage limit

#### Typical Application

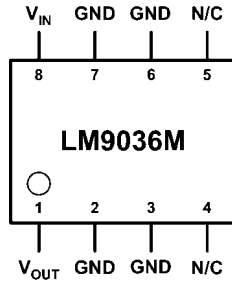


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\* Required if regulator is located more than 2 from power supply filter capacitor.

\*\* 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 Diagram



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Top View

Order Number

LM9036QM-3.3, LM9036QMX-3.3, LM9036QM-5.0, LM9036QMX-5.0  
 See NS Package Number M08A

## Ordering Information

Output Voltage	Order	Package Type	Package Drawing	Transport Media	Feature
3.3V	LM9036QM-3.3	8-Lead SOIC	M08A	Rail	AEC-Q100 Grade 1 Qualified. Automotive Grade Production Flow. *
	LM9036QMX-3.3	8-Lead SOIC	M08A	Tape/Reel	
5.0V	LM9036QM-5.0	8-Lead SOIC	M08A	Rail	
	LM9036QMX-5.0	8-Lead SOIC	M08A	Tape/Reel	

\* Automotive grade (Q) product incorporates enhanced manufacturing and support processes for the automotive market, including defect detection methodologies. Reliability qualification is compliant with the requirements

and temperature grades defined in the AEC-Q100 standard. Automotive grade products are identified with the letter Q. For more information go to <http://www.national.com/automotive>.

## 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 <i>(Note 2)</i>	±1.9kV
Power Dissipation <i>(Note 3)</i>	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) $\theta_{JA}$ <i>(Note 7)</i>	140°C/W

## Electrical Characteristics - LM9036Q-5.0

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

Parameter	Conditions	Min <i>(Note 5)</i>	Typical <i>(Note 4)</i>	Max <i>(Note 5)</i>	Units
Output Voltage ( $V_{OUT}$ )		4.80	5.00	5.20	V
	$5.5V \leq V_{IN} \leq 26V$ , $0.1\text{ mA} \leq I_{OUT} \leq 50\text{ mA}$ <i>(Note 6)</i>	<b>4.75</b>	<b>5.00</b>	<b>5.25</b>	
Quiescent Current ( $I_{GND}$ )	$I_{OUT} = 0.1\text{ mA}$ , $8V \leq V_{IN} \leq 24V$		20	25	$\mu\text{A}$
	$I_{OUT} = 1\text{ mA}$ , $8V \leq V_{IN} \leq 24V$		50	100	
	$I_{OUT} = 10\text{ mA}$ , $8V \leq V_{IN} \leq 24V$		0.3	0.5	mA
	$I_{OUT} = 50\text{ mA}$ , $8V \leq V_{IN} \leq 24V$		2.0	2.5	
Line Regulation ( $\Delta V_{OUT}$ )	$6V \leq V_{IN} \leq 40V$ , $I_{OUT} = 1\text{ mA}$		10	30	mV
Load Regulation ( $\Delta V_{OUT}$ )	$0.1\text{ mA} \leq I_{OUT} \leq 5\text{ mA}$		10	30	mV
	$5\text{ mA} \leq I_{OUT} \leq 50\text{ mA}$		10	30	mV
Dropout Voltage ( $\Delta V_{OUT}$ )	$I_{OUT} = 0.1\text{ mA}$		0.05	0.10	V
	$I_{OUT} = 50\text{ mA}$		0.20	0.40	V
Short Circuit Current ( $I_{SC}$ )	$V_{OUT} = 0V$	65	120	250	mA
Ripple Rejection (PSRR)	$V_{ripple} = 1V_{rms}$ , $F_{ripple} = 120\text{ Hz}$	-40	-60		dB
Output Bypass Capacitance ( $C_{OUT}$ )	$0.3\Omega \leq ESR \leq 8\Omega$ $0.1\text{ mA} \leq I_{OUT} \leq 50\text{ mA}$	10	22		$\mu\text{F}$

## Electrical Characteristics - LM9036Q-3.3

$V_{IN} = 14V$ ,  $I_{OUT} = 10\text{ mA}$ ,  $T_J = 25^\circ\text{C}$ , 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
	$5.5V \leq V_{IN} \leq 26V$ , $0.1mA \leq I_{OUT} \leq 50mA$ (Note 6)	<b>3.135</b>	<b>3.30</b>	<b>3.465</b>	
Quiescent Current ( $I_{GND}$ )	$I_{OUT} = 0.1mA$ , $8V \leq V_{IN} \leq 24V$		20	25	$\mu\text{A}$
	$I_{OUT} = 1mA$ , $8V \leq V_{IN} \leq 24V$		50	100	
	$I_{OUT} = 10mA$ , $8V \leq V_{IN} \leq 24V$		0.3	0.5	$\text{mA}$
	$I_{OUT} = 50mA$ , $8V \leq V_{IN} \leq 24V$		2.0	2.5	
Line Regulation ( $\Delta V_{OUT}$ )	$6V \leq V_{IN} \leq 40V$ , $I_{OUT} = 1mA$		10	30	mV
Load Regulation ( $\Delta V_{OUT}$ )	$0.1mA \leq I_{OUT} \leq 5mA$		10	30	mV
	$5mA \leq I_{OUT} \leq 50mA$		10	30	mV
Dropout Voltage ( $\Delta V_{OUT}$ )	$I_{OUT} = 0.1mA$		0.05	0.10	V
	$I_{OUT} = 50mA$		0.20	0.40	V
Short Circuit Current ( $I_{SC}$ )	$V_{OUT} = 0V$	65	120	250	$\text{mA}$
Ripple Rejection (PSRR)	$V_{ripple} = 1V_{rms}$ , $F_{ripple} = 120\text{Hz}$	-40	-60		dB
Output Bypass Capacitance ( $C_{OUT}$ )	$0.3\Omega \leq ESR \leq 8\Omega$	22	33		$\mu\text{F}$
	$0.1mA \leq I_{OUT} \leq 50mA$				

**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 1.5k $\Omega$  resistor.

**Note 3:** The maximum power dissipation is a function of  $T_{Jmax}$ ,  $\theta_{JA}$ , 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 LM9036Q will go into thermal shutdown.

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

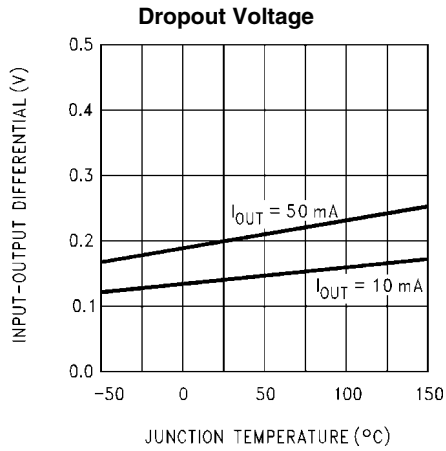
**Note 5:** Tested limits are guaranteed to National's AOQL (Average Outgoing Quality Level) and 100% tested.

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

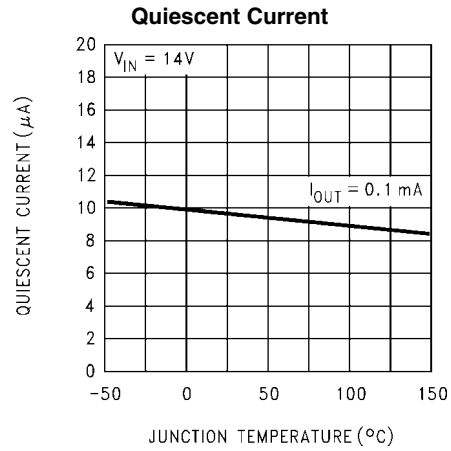
**Note 7:** Worst case (Free Air) per EIA / JESD51-3.

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

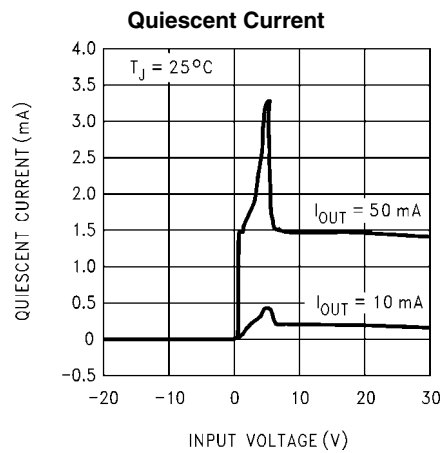
## Typical Performance Characteristics



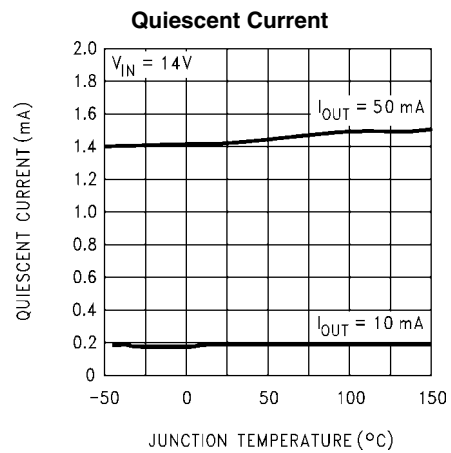
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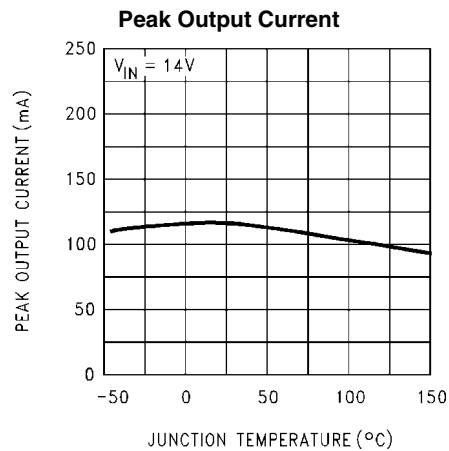
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## Applications Information

Unlike other PNP low dropout regulators, the LM9036Q remains fully operational to 40V. Owing to power dissipation characteristics of the package, full output current cannot be guaranteed for all combinations of ambient temperature and input voltage.

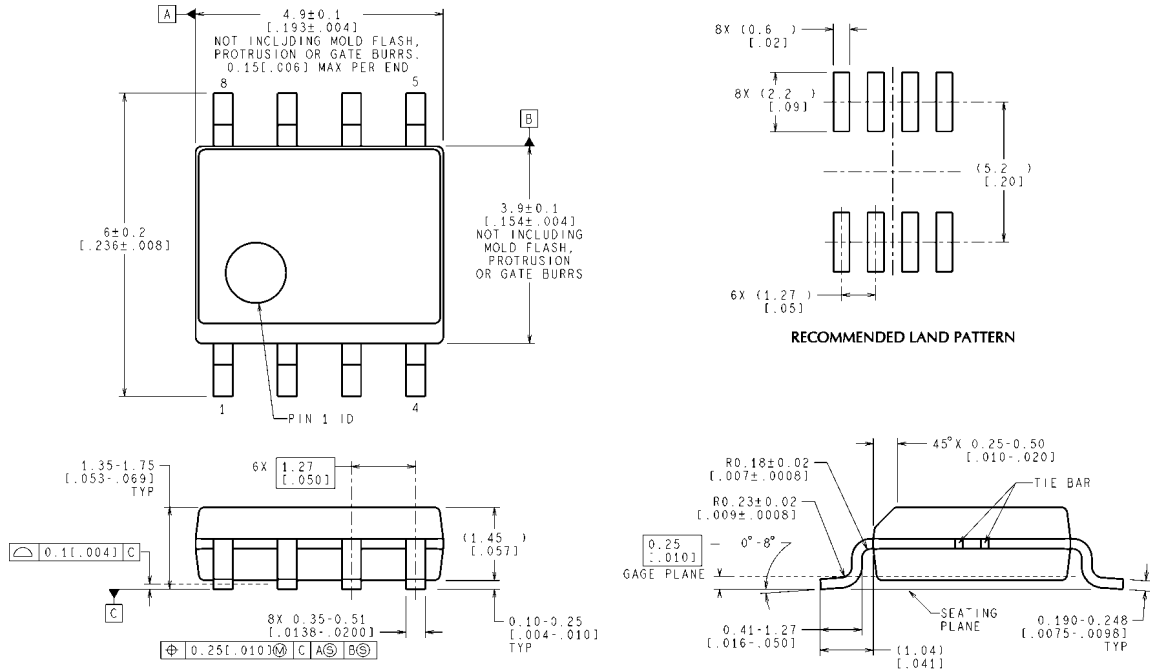
The junction to ambient thermal resistance  $\theta_{JA}$  rating has two distinct components: the junction to case thermal resistance rating  $\theta_{JC}$ ; and the case to ambient thermal resistance rating  $\theta_{CA}$ . The relationship is defined as:  $\theta_{JA} = \theta_{JC} + \theta_{CA}$ .

While the LM9036Q has an internally set thermal shutdown point of typically 150°C, this is intended as a safety feature

only. Continuous operation near the thermal shutdown temperature should be avoided as it may have a negative affect on the life of the device.

The LM9036Q maintains regulation to 55V, it will not withstand a short circuit above 40V because of safe operating area limitations in the internal PNP pass device. Above 55V the LM9036Q will break down with catastrophic effects on the regulator and possibly the load as well. Do not use this device in a design where the input operating voltage may exceed 40V, or where transients are likely to exceed 55V.

**Physical Dimensions** inches (millimeters) unless otherwise noted



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 VALUES IN [ ] ARE INCHES  
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**8 Lead Small Outline Molded Package (M)**  
**NS Package Number M08A**

M08A (Rev M)

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