

LM9036Q Ultra-Low Quiescent Current Voltage Regulator

 Check for Samples: [LM9036Q](#)

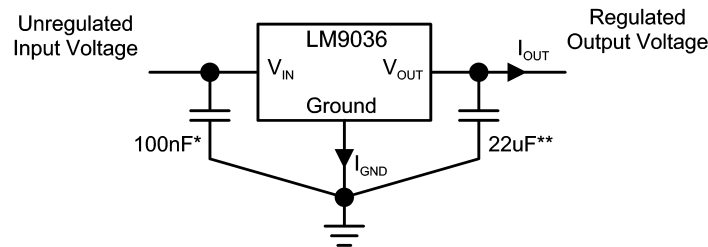
FEATURES

- AEC-Q100 Grade 1 Qualified (-40°C to 125°C)
- Ultra Low Ground Pin Current ($I_{GND} \leq 25\mu\text{A}$ for $I_{OUT} = 0.1\text{mA}$)
- Fixed 5V, 3.3V, 50mA Output
- Output Tolerance $\pm 5\%$ Over Line, Load, and Temperature
- Dropout Voltage Typically 200mV @ $I_{OUT} = 50\text{mA}$
- -45V Reverse Transient Protection
- Internal Short Circuit Current Limit
- Internal Thermal Shutdown Protection
- 40V Operating Voltage Limit

DESCRIPTION

The LM9036Q ultra-low quiescent current regulator features low dropout voltage and low current in the standby mode. With less than 25 μA 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°C to +125°C operating temperature range, and $\pm 5\%$ output voltage tolerance over the entire output current, input voltage, and temperature range.

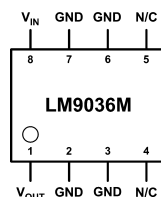
Typical Application



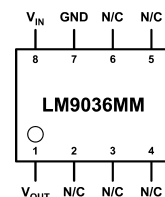
* Required if regulator is located more than 2" from power supply filter capacitor.

** 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



**Figure 1. See Package Number D0008A
Top View**



**Figure 2. See Package Number DGK0008A
Top View**



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



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Absolute Maximum Ratings ⁽¹⁾⁽²⁾

Input Voltage (Survival)	+55V, -45V
ESD Susceptibility ⁽³⁾	±1.9kV
Power Dissipation ⁽⁴⁾	Internally limited
Junction Temperature (T_{Jmax})	150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	260°C

- (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.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) Human body model, 100pF discharge through a 1.5kΩ resistor.
- (4) 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 LM9036Q will go into thermal shutdown.

Operating Ratings

Operating Temperature Range	-40°C to +125°C
Maximum Input Voltage (Operational)	40V
SOIC-8 (D0008A) θ_{JA} ⁽¹⁾⁽²⁾	140°C/W
SOIC-8 (D0008A) θ_{JC}	45°C/W
VSSOP-8 (DGK0008A) θ_{JA} ⁽¹⁾	200°C/W

- (1) Typical θ_{JA} with 1 square inch of 2 oz. copper pad area directly under the ground tab.
- (2) Worst case (Free Air) per EIA / JESD51-3.

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 ⁽¹⁾	Typical ⁽²⁾	Max ⁽¹⁾	Units
Output Voltage (V_{OUT})		4.80	5.00	5.20	V
	$5.5V \leq V_{IN} \leq 26V$, $0.1mA \leq I_{OUT} \leq 50mA$ ⁽³⁾	4.75	5.00	5.25	
Quiescent Current (I_{GND})	$I_{OUT} = 0.1mA$, $8V \leq V_{IN} \leq 24V$		20	25	μA
	$I_{OUT} = 1mA$, $8V \leq V_{IN} \leq 24V$		50	100	
	$I_{OUT} = 10mA$, $8V \leq V_{IN} \leq 24V$		0.3	0.5	mA
	$I_{OUT} = 50mA$, $8V \leq V_{IN} \leq 24V$		2.0	2.5	
Line Regulation (ΔV_{OUT})	$6V \leq V_{IN} \leq 40V$, $I_{OUT} = 1mA$		10	30	mV
Load Regulation (ΔV_{OUT})	$0.1mA \leq I_{OUT} \leq 5mA$		10	30	mV
	$5mA \leq I_{OUT} \leq 50mA$		10	30	mV
Dropout Voltage (ΔV_{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)	$V_{ripple} = 1V_{rms}$, $F_{ripple} = 120\text{Hz}$	-40	-60		dB
Output Bypass Capacitance (C_{OUT})	$0.3\Omega \leq ESR \leq 8\Omega$ $0.1mA \leq I_{OUT} \leq 50mA$	10	22		μF

- (1) Tested limits are specified to AOQL (Average Outgoing Quality Level) and 100% tested.
- (2) Typicals are at 25°C (unless otherwise specified) and represent the most likely parametric norm.
- (3) To ensure constant junction temperature, pulse testing is used.

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 (1)	Typical (2)	Max (1)	Units
Output Voltage (V_{OUT})		3.168	3.30	3.432	V
	$5.5V \leq V_{IN} \leq 26V$, $0.1\text{mA} \leq I_{OUT} \leq 50\text{mA}$ (3)	3.135	3.30	3.465	
Quiescent Current (I_{GND})	$I_{OUT} = 0.1\text{mA}$, $8V \leq V_{IN} \leq 24V$		20	25	μA
	$I_{OUT} = 1\text{mA}$, $8V \leq V_{IN} \leq 24V$		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 (ΔV_{OUT})	$6V \leq V_{IN} \leq 40V$, $I_{OUT} = 1\text{mA}$		10	30	mV
Load Regulation (ΔV_{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 (ΔV_{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)	$V_{\text{ripple}} = 1V_{\text{rms}}$, $F_{\text{ripple}} = 120\text{Hz}$	-40	-60		dB
Output Bypass Capacitance (C_{OUT})	$0.3\Omega \leq \text{ESR} \leq 8\Omega$ $0.1\text{mA} \leq I_{OUT} \leq 50\text{mA}$	22	33		μF

- (1) Tested limits are specified to AOQL (Average Outgoing Quality Level) and 100% tested.
- (2) Typicals are at 25°C (unless otherwise specified) and represent the most likely parametric norm.
- (3) To ensure constant junction temperature, pulse testing is used.

Typical Performance Characteristics

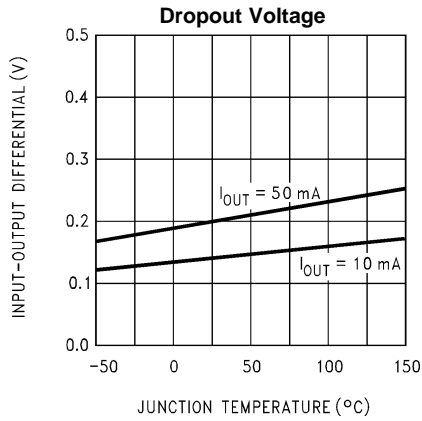


Figure 3.

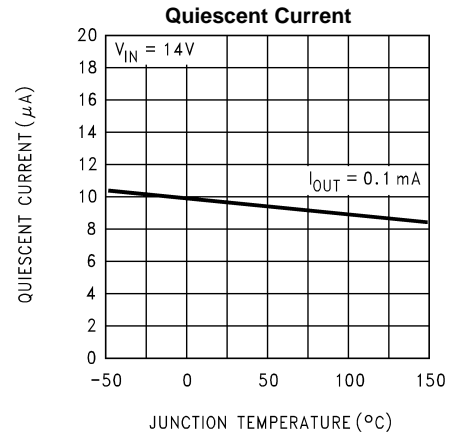


Figure 4.

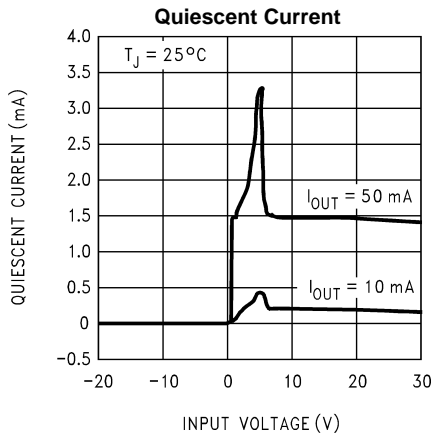


Figure 5.

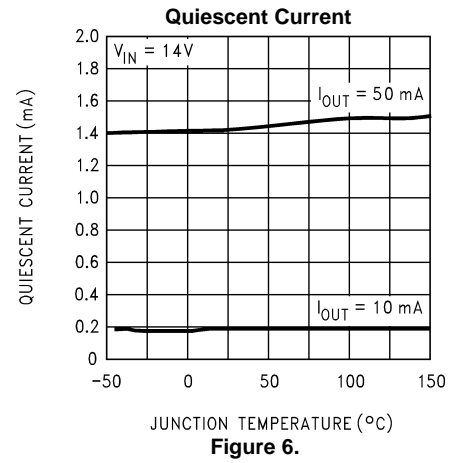


Figure 6.

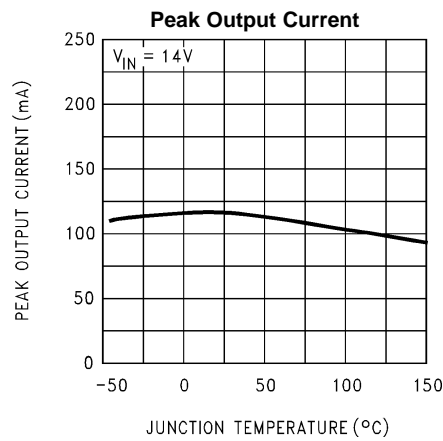


Figure 7.

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 ensured for all combinations of ambient temperature and input voltage.

The junction to ambient thermal resistance θ_{JA} rating has two distinct components: the junction to case thermal resistance rating θ_{JC} ; and the case to ambient thermal resistance rating θ_{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.

REVISION HISTORY

Changes from Revision A (March 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	5

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM9036QM-3.3/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LM903 6QM-3	Samples
LM9036QM-5.0/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LM903 6QM-5	Samples
LM9036QMM-3.3/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	KDBQ	Samples
LM9036QMM-5.0/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	KDAQ	Samples
LM9036QMMX-3.3/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	KDBQ	Samples
LM9036QMMX-5.0/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	KDAQ	Samples
LM9036QMX-3.3/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LM903 6QM-3	Samples
LM9036QMX-5.0/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LM903 6QM-5	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM9036QMM-3.3/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM9036QMM-5.0/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM9036QMMX-3.3/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM9036QMMX-5.0/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM9036QMX-3.3/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM9036QMX-5.0/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

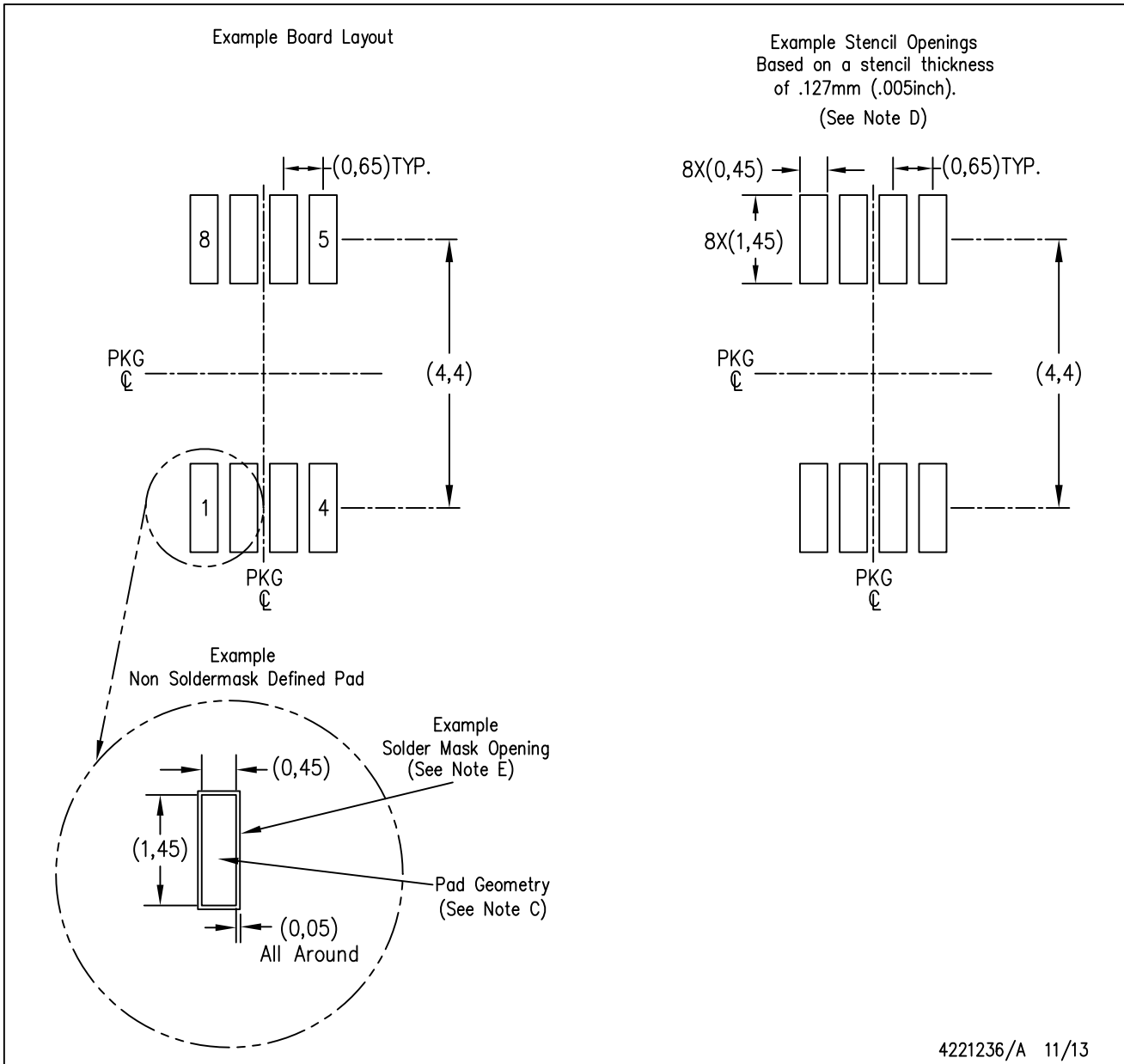
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM9036QMM-3.3/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LM9036QMM-5.0/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LM9036QMMX-3.3/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LM9036QMMX-5.0/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LM9036QMX-3.3/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM9036QMX-5.0/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
 - E. Falls within JEDEC MO-187 variation AA, except interlead flash.



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AA.

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