National Semiconductor

LM9076
150mA Ultra-Low Quiescent Current LDO Regulator with Delayed Reset Output

General Description

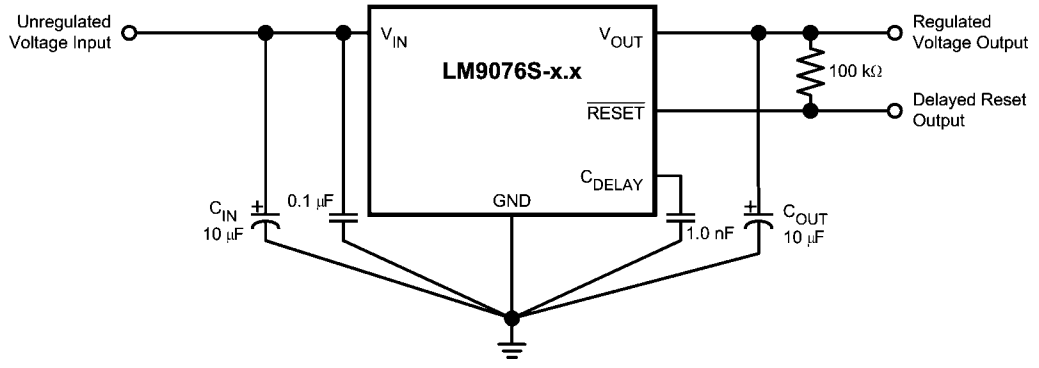
The LM9076 is a ±3%, 150 mA logic controlled voltage regulator. The regulator features an active low delayed reset output flag which can be used to reset a microprocessor system at turn-ON and in the event that the regulator output voltage falls below a minimum value. An external capacitor programs a delay time interval before the reset output pin can return high.

Designed for automotive and industrial applications, the LM9076 contains a variety of protection features such as thermal shutdown, input transient protection and a wide operating temperature range. The LM9076 uses an PNP pass transistor which allows low drop-out voltage operation.

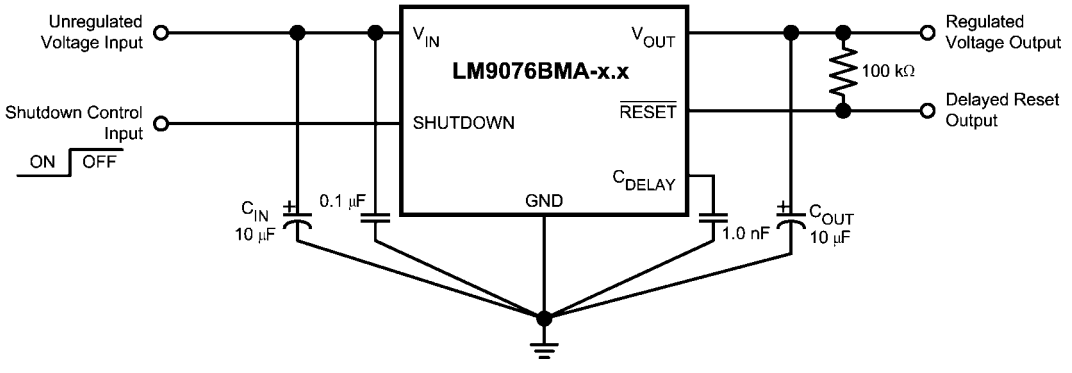
Features

- Available with 5.0V or 3.3V output voltage
- Ultra Low Ground Pin Current, 25 µA typical for 100 µA load
- V_{OUT} initial accuracy of ±1.5%
- V_{OUT} accurate to ±3% over Load and Temperature Conditions
- Low Dropout Voltage, 200 mV typical with 150 mA load
- Low Off State Ground Pin current for LM9076BMA
- Delayed $\overline{\text{RESET}}$ output pin for low V_{OUT} detection
- +70V/-50V Voltage Transients
- Operational V_{IN} up to +40V

Typical Applications

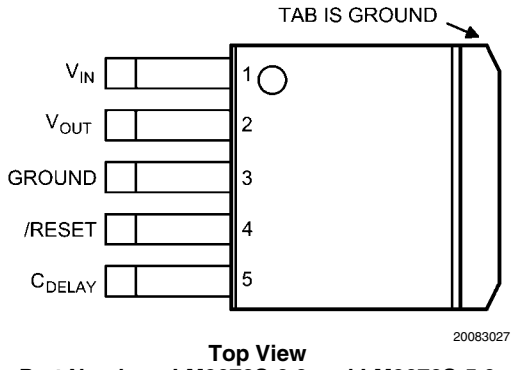


LM9076S-x.x in 5 lead TO-263 package

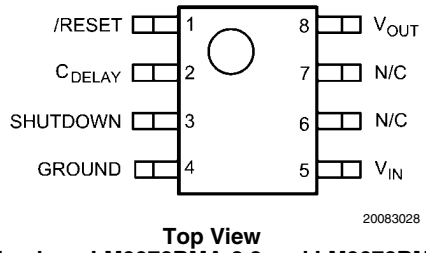


LM9076BMA-x.x in 8 lead SO package

Connection Diagrams



Top View
Part Numbers LM9076S-3.3 and LM9076S-5.0
See NS TO-263 Package Number TS5



Top View
Part Numbers LM9076BMA-3.3 and LM9076BMA-5.0
See NS SOIC Package Number M08A

Ordering Information

Output Voltage	Package Type	Order Number	Package Marking	Shipped As
3.3	TO-263–5	LM9076S-3.3	LM9076S-3.3	Rail of 45
		LM9076SX-3.3	LM9076S-3.3	Tape and Reel of 500
	SO-8	LM9076BMA-3.3	9076B MA3.3	Rail of 95
		LM9076BMAX-3.3	9076B MA3.3	Tape and Reel of 2500
5.0	TO-263–5	LM9076S-5.0	LM9076S-5.0	Rail of 45
		LM9076SX-5.0	LM9076S-5.0	Tape and Reel of 500
	SO-8	LM9076BMA-5.0	9076BMA5.0	Rail of 95
		LM9076BMAX-5.0	9076BMA5.0	Tape and Reel of 2500

Absolute Maximum Ratings (Note 1)

V_{IN}(DC)	-15V to +55V
V_{IN}(+Transient) t< 10ms, Duty Cycle <1%	+70V
V_{IN}(-Transient) t< 1ms, Duty Cycle <1%	-50V
SHUTDOWN Pin	-15V to +52V
$\overline{\text{RESET}}$ Pin	-0.3V to 20V
C_{DELAY} Pin	-0.3V to V_{OUT} +0.3V
Storage Temperature	-65°C to +150°C
Junction Temperature (T_J)	+175C
ESD, HBM, per AEC - Q100 - 002	+/-2 kV
ESD, MM, per AEC - Q100 - 003	+/-250V

Operating Ratings (Note 1)

V_{IN} Pin	5.35V to 40V
$V_{SHUTDOWN}$ Pin	0V to 40V
Junction Temperature	$-40°C < T_J < +125°C$
Thermal Resistance TS5B (Note 6)	
θja	75°C/W
θjc	2.9°C/W
Thermal Resistance M08A (Note 6)	
θja	156°C/W
θjc	59°C/W

Electrical Characteristics for LM9076–3.3

The following specifications apply for V_{IN} = 14V; I_{LOAD} = 10 mA; T_J = +25C; C_{OUT} = 10 µF, 0.5Ω < ESR < 4.0Ω; unless otherwise specified. **Bold values indicate –40°C ≤ T_J ≤ +125°C**.(Notes 5, 4) Minimum and Maximum limits are guaranteed through test, design or statistical correlation.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LM9076–3.3 REGULATOR CHARACTERISTICS						
V_{OUT}	Output Voltage		3.251	3.30	3.349	V
		–20°C ≤ T_J ≤ 85°C 1 mA ≤ I_{LOAD} ≤ 150 mA	3.234	3.30	3.366	V
		1mA ≤ I_{LOAD} ≤ 150 mA	**3.201**	**3.30**	**3.399**	V
		V_{IN} = 60V, R_{LOAD} = 1 kΩ, t ≤ 40ms	2.970	3.30	3.630	V
	Output Voltage Off LM9076 BMA only	$V_{SHUTDOWN}$ ≥ 2V, R_{LOAD} = 1 kΩ	–	0	250	mV
	Reverse Battery	V_{IN} = -15V, R_{LOAD} = 1 kΩ	–300	0	–	mV
ΔV_{OUT}	Line Regulation	9.0V ≤ V_{IN} ≤ 16V, I_{LOAD} = 10 mA	–	4	25	mV
		16V ≤ V_{IN} ≤ 40V, I_{LOAD} = 10 mA	–	17	35	mV
	Load Regulation	1 mA ≤ I_{LOAD} ≤ 150 mA	–	42	60	mV
V_{DO}	Dropout Voltage	I_{LOAD} = 10 mA	–	30	50	mV
		I_{LOAD} = 50 mA	–	80	–	mV
		I_{LOAD} = 150 mA	–	150	250	mV
I_{GND}	Ground Pin Current	9V ≤ V_{IN} ≤ 16V, I_{LOAD} = 100 uA	–	25	45	µA
		9V ≤ V_{IN} ≤ 40V, I_{LOAD} = 10 mA	–	125	160	µA
		9V ≤ V_{IN} ≤ 40V, I_{LOAD} = 50 mA	–	0.6	–	mA
		9V ≤ V_{IN} ≤ 16V, I_{LOAD} = 150 mA	–	3.6	4.5	mA
I_{SC}	V_{OUT} Short Circuit Current	V_{IN} = 14V, R_{LOAD} = 1Ω	200	400	750	mA

Electrical Characteristics for LM9076–5.0

The following specifications apply for V_{IN}= 14V; $V_{SHUTDOWN}$ = Open; I_{LOAD} = 10 mA; T_J = +25°C; C_{OUT} = 10 µF, 0.5Ω < ESR < 4.0Ω; unless otherwise specified. **Bold Values indicate −40°C ≤ T_J ≤ 125°C**. (Note 4), (Note 5) Minimum and Maximum limits are guaranteed through test, design, or statistical correlation.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LM9076–5.0 REGULATOR CHARACTERISTICS						
V_{OUT}	Output Voltage		4.925	5.00	5.075	V
		−20°C ≤ T_J ≤ 85°C 1 mA ≤ I_{LOAD} ≤ 150 mA	4.900	5.00	5.100	V
		1 mA ≤ I_{LOAD} ≤ 150 mA	**4.850**	**5.00**	**5.150**	V
		V_{IN} = 60V, R_{LOAD} = 1 kΩ, t ≤ 40ms	4.500	5.00	5.500	V
	Output Voltage Off LM9076 BMA only	$V_{SHUTDOWN}$ ≥ 2V, R_{LOAD} = 1 kΩ	–	0	250	mV
	Reverse Battery	V_{IN} = -15V, R_{LOAD} = 1 kΩ	−300	0	–	mV
ΔV_{OUT}	Line Regulation	9.0V ≤ V_{IN} ≤ 16V, I_{LOAD} = 10 mA	–	4	25	mV
		16V ≤ V_{IN} ≤ 40V, I_{LOAD} = 10 mA	–	17	35	mV
	Load Regulation	1 mA ≤ I_{LOAD} ≤ 150 mA	–	42	60	mV
V_{DO}	Dropout Voltage	I_{LOAD} = 10 mA	–	30	50	mV
		I_{LOAD} = 50 mA	–	80	–	mV
		I_{LOAD} = 150 mA	–	150	250	mV
I_{GND}	Ground Pin Current	9V ≤ V_{IN} ≤ 16V, I_{LOAD} = 100 uA	–	25	45	µA
		9V ≤ V_{IN} ≤ 40V, I_{LOAD} = 10 mA	–	125	160	µA
		9V ≤ V_{IN} ≤ 40V, I_{LOAD} = 50 mA	–	0.6	–	mA
		9V ≤ V_{IN} ≤ 16V, I_{LOAD} = 150 mA	–	3.6	4.5	mA
	Ground Pin Current in Shutdown Mode	9V ≤ V_{IN} ≤ 40V, $V_{SHUTDOWN}$ = 2V	–	15	25	µA
I_{SC}	V_{OUT} Short Circuit Current	V_{IN} = 14V, R_{LOAD} = 1Ω	200	400	750	mA
PSRR	Ripple Rejection	V_{IN} = (14V_{DC}) + (1V_{RMS} @ 120Hz) I_{LOAD} = 50 mA	50	60	–	dB
$\overline{\text{RESET}}$ PIN CHARACTERISTICS						
V_{OR}	Minimum V_{IN} for valid $\overline{\text{RESET}}$ Status	(Note 3)	–	1.3	2.0	V
V_{THR}	V_{OUT} Threshold for $\overline{\text{RESET}}$ Low	(Note 3)	0.83	0.89	0.94	X V_{OUT} (Nom)
V_{OH}	$\overline{\text{RESET}}$ pin high voltage	External pull-up resistor to V_{OUT} = 100 kΩ	V_{OUT} X 0.90	V_{OUT} X 0.99	V_{OUT}	V
V_{OL}	$\overline{\text{RESET}}$ pin low voltage	C_{DELAY} < 4.0V, I_{SINK} = 250 µA	–	0.2	0.3	V
C_{DELAY} PIN CHARACTERISTICS						

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{DELAY}	C_{DELAY} Charging Current	V_{IN} = 14V, V_{DELAY} = 0V	-0.70	-0.42	-0.25	uA
V_{OL}	C_{DELAY} pin low voltage	V_{OUT} < 4.0V, I_{SINK} = I_{DELAY}	–	0.100	–	V
t_{DELAY}	Reset Delay Time	V_{IN} = 14V, C_{DELAY} = 0.001 uF V_{OUT} rising from 0V, Δt from V_{OUT} > V_{OR} to $\overline{RESET}$ pin HIGH	7.1	11.9	20.0	ms
SHUTDOWN CONTROL LOGIC — LM9076BMA-5.0 Only						
$V_{IL(SD)}$	SHUTDOWN Pin Low Threshold Voltage	$V_{SHUTDOWN}$ pin falling from 5.0V until V_{OUT} >4.5V (V_{OUT} = On)	1	1.5	–	V
$V_{IH(SD)}$	SHUTDOWN Pin High Threshold Voltage	$V_{SHUTDOWN}$ pin rising from 0V until V_{OUT} < 0.5V (V_{OUT} = Off)	–	1.5	2	V
$I_{IH(SD)}$	SHUTDOWN Pin High Bias Current	$V_{SHUTDOWN}$ = 40V	–	35	–	µA
		$V_{SHUTDOWN}$ = 5V	–	15	35	µA
		$V_{SHUTDOWN}$ = 2V	–	6	10	µA
$I_{IL(SD)}$	SHUTDOWN Pin Low Bias Current	$V_{SHUTDOWN}$ = 0V	–	0	–	µA

Note 1: Absolute Maximum Ratings indicate the limits beyond which the device may cease to function, and/or damage to the device may occur.

Note 2: Operating Ratings indicate conditions for which the device is intended to be functional, but does not guarantee specific performance limits. For guaranteed specifications and conditions refer to the Electrical Characteristics

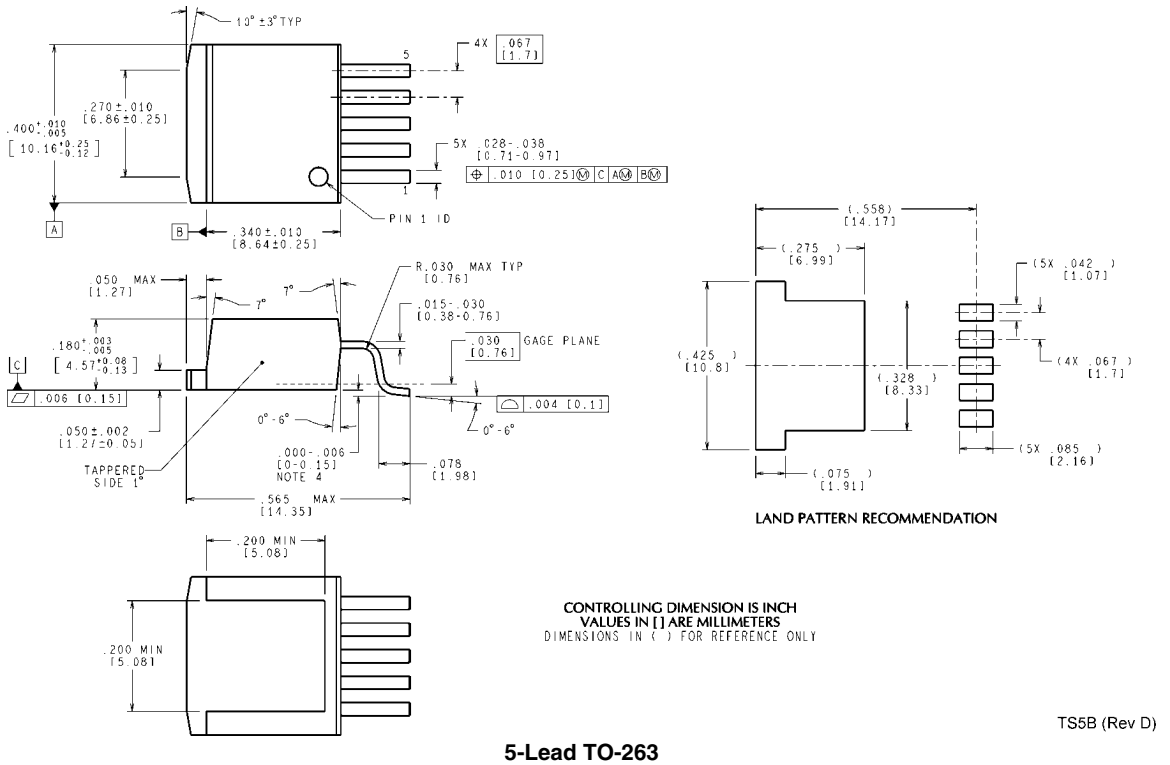
Note 3: Not Production tested, Guaranteed by Design. Minimum, Typical, and/or Maximum values are provided for informational purposes only.

Note 4: Pulse testing used maintain constant junction temperature (T_J).

Note 5: The regulated output voltage specification is not guaranteed for the entire range of V_{IN} and output loads. Device operational range is limited by the maximum junction temperature (T_J). The junction temperature is influenced by the ambient temperature (T_A), package selection, input voltage (V_{IN}), and the output load current. When operating with maximum load currents the input voltage and/or ambient temperature will be limited. When operating with maximum input voltage the load current and/or the ambient temperature will be limited.

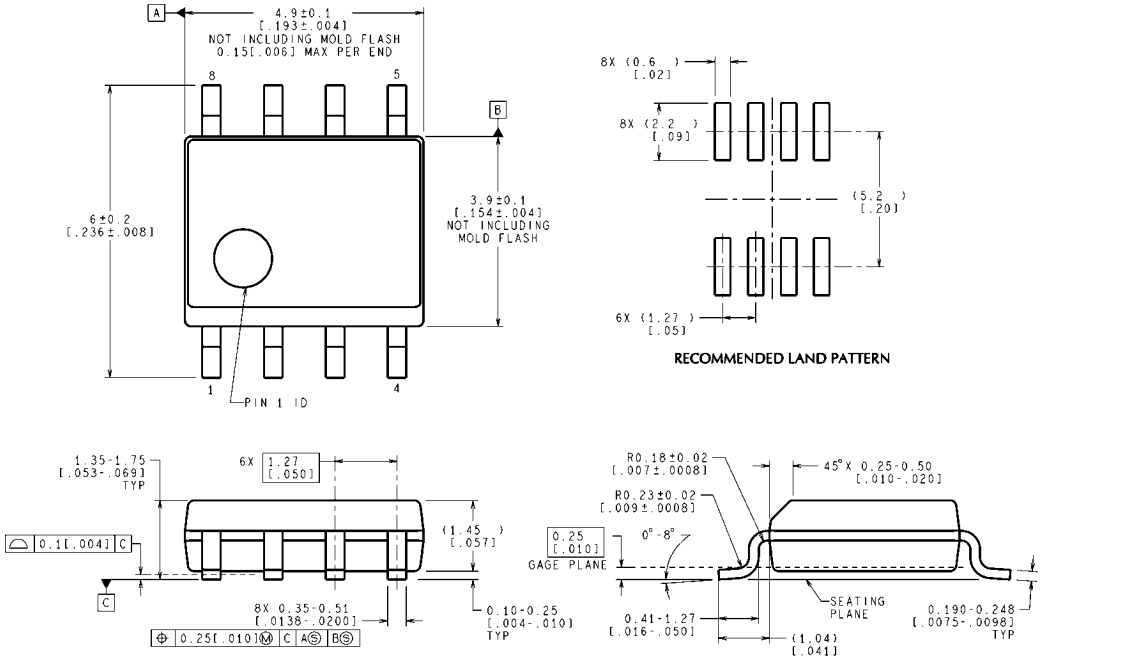
Note 6: Worst case (FREE AIR) per EIA/JESD51–3.

Physical Dimensions inches (millimeters) unless otherwise noted



TS5B (Rev D)

5-Lead TO-263
NS Package Number TS5B



M08A (Rev L)

8-Lead (0.150" Wide) Molded SO Package
NS Package Number M08A