

MAS9122

3-Output LDO Voltage Regulator IC

- Three Low Dropout Voltage Regulators
- Very Low Noise: 25 μVrms
- High Ripple Rejection: 63 dB
- Very Low Crosstalk
- Low Ground Pin Current
- Regulator Enable/Disable Control

DESCRIPTION

MAS9122 is a three-output voltage regulator. It is designed for three different output voltages, which can be modified through a mask option. Regulators operating mode is controlled by two enable/disable pins. The circuit consists of a bandgap voltage reference, an error amplifier, a current limit circuit and a thermal protection circuit.

MAS9122 features very low ground pin current: typically less than 1.5 μA sleep mode current and typical 125 μA for one regulator in active mode. Excellent noise and PSRR performance enables the use of MAS9122 in high precision portable devices. Low crosstalk between regulators provides an area efficient solution compared to single regulators.

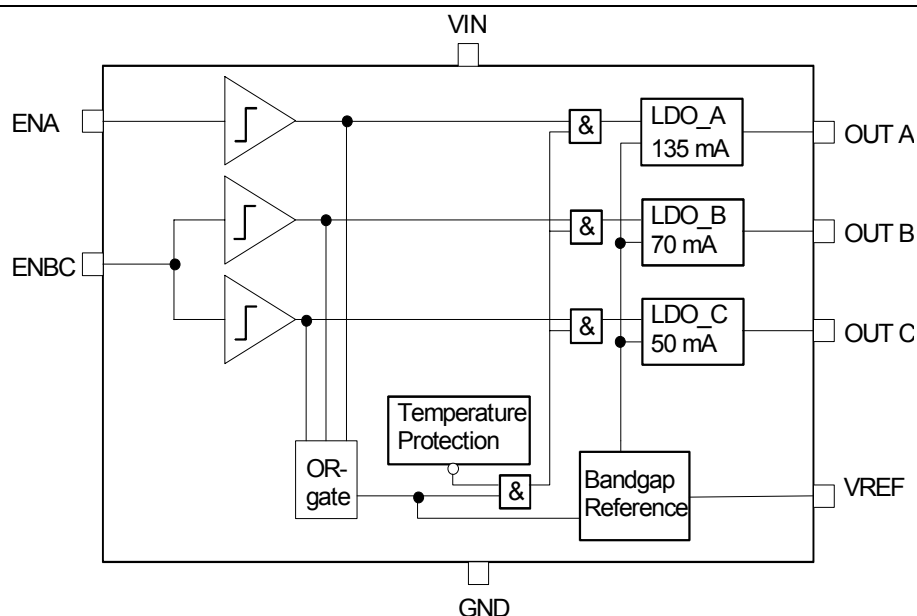
FEATURES

- Three Regulators at 135 mA, 70 mA and 50 mA
- Output Options 2.70, 2.85 and 3.00 V, see Ordering Information p. 12
- Low Noise: 20 μVrms Typical and 30 μVrms Maximum for All Regulators over Frequency Range 100 Hz...100 kHz
- Fast Dynamic Response
- Output Voltage Accuracy $< \pm 2.0\%$
- MSOP-8 Package

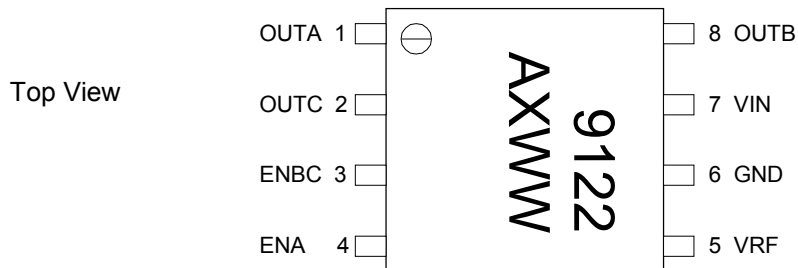
APPLICATIONS

- Systems Requiring Stabilized Power in Separate Blocks
- Cordless Phones
- Mobile Phones
- Portable Systems
- Battery Powered Systems

BLOCK DIAGRAM



PIN CONFIGURATION



Top Marking Information:
 AX = voltage version, see p.12 Ordering information
 WW = week

PIN DESCRIPTION

Pin Name	Pin	Type	Function
OUTA	1	O	135 mA Regulator Output
OUTC	2	O	50 mA Regulator Output
ENBC	3	I	Enable for Regulators B and C
ENA	4	I	Enable for Regulator A
VREF	5	O	Reference Voltage: Pin for Bypass Capacitor
GND	6	P	Ground
VIN	7	P	Positive Supply Voltage
OUTB	8	O	70 mA Regulator Output

G = Ground, I = Input, O = Output, P = Power

ABSOLUTE MAXIMUM RATINGS

All Voltages with Respect to Ground

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	V_{IN}		-0.3	6	V
Voltage Range for All Pins			-0.3	$V_{IN} + 0.3$	V
ESD Rating		HBM		2	kV
Junction Temperature	T_{Jmax}			175 (limited)	°C
Storage Temperature	T_S		-55	+150	°C

Stresses beyond those listed may cause permanent damage to the device. The device may not operate under these conditions, but will not be destroyed.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	V_{IN}		$V_{OUT(NOM)} + 0.25$	5.3	V
Operating Junction Temperature	T_J		-40	+125	°C
Operating Ambient Temperature	T_A		-40	+85	°C

ELECTRICAL CHARACTERISTICS

◆ Thermal Protection

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\ \mu\text{F}$, $C_L = 1.0\ \mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Threshold High	T_H		130	150	170	$^\circ\text{C}$
Threshold Low	T_L		120	140	160	$^\circ\text{C}$

The hysteresis of 10°C prevents the device from turning on too soon after thermal shut-down.

◆ Control Pin Parameters

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\ \mu\text{F}$, $C_L = 1.0\ \mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Voltage	ENA, ENBC		-0.3		$V_{IN} + 0.3$	V
ON-state			2.0			
OFF-state					0.3	

If CTRL-pin is not connected, the particular regulator(s) is/are in OFF state (900 k Ω pull-down resistor to ground).

◆ Current Parameters

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\ \mu\text{F}$, $C_L = 1.0\ \mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
LDO_A Continuous Output Current	I_{OUTA}		0		135	mA
LDO_B Continuous Output Current	I_{OUTB}		0		70	mA
LDO_C Continuous Output Current	I_{OUTC}		0		50	mA
Short Circuit Current for LDO_A	I_{SHORTA}			350		mA
Short Circuit Current for LDO_B	I_{SHORTB}			265		mA
Short Circuit Current for LDO_C	I_{SHORTC}			230		mA
Ground Pin Current	$I_{GND(OFF)}$	$I_{OUT} = 0\text{ A}$, $V_{ENA,ENBC} < 0.3\text{ V}$, $V_{IN} = 3.6$		2	4	μA
Ground Pin Current	$I_{GND(ONA)}$	$I_{OUT} = 0\text{ A}$, $V_{ENA} > 2\text{ V}$, $V_{ENBC} < 0.3\text{ V}$, $V_{IN} = 3.6$		125		μA
Ground Pin Current	$I_{GND(ONBC)}$	$I_{OUT} = 0\text{ A}$, $V_{ENA} < 0.3\text{ V}$, $V_{ENBC} > 2\text{ V}$, $V_{IN} = 3.6$		170		μA
Ground Pin Current	$I_{GND(ONABC)}$	$I_{OUT} = 0\text{ A}$, $V_{ENA, ENBC} > 2\text{ V}$ $V_{IN} = 3.6$		245		μA

◆ Voltage Parameters

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage: Mask option for 2.85 V	V_{OUTA}	Max $I_{OUT} = 135\text{ mA}$	2.85 – 3%	2.85	2.85 + 2%	V
	$V_{OUTA,B,C}$	Max $I_{OUTA} = 100\text{ mA}$, Max $I_{OUTB} = 70\text{ mA}$, Max $I_{OUTC} = 50\text{ mA}$	2.85 – 2%	2.85	2.85 + 2%	V
LDO_A Dropout Voltage	V_{DROPA}	$I_{OUTA} = 135\text{ mA}$ $I_{OUTA} = 100\text{ mA}$		220 180		mV
LDO_B Dropout Voltage	V_{DROPB}	$I_{OUTB} = 70\text{ mA}$		165		mV
LDO_C Dropout Volt.	V_{DROPC}	$I_{OUTC} = 50\text{ mA}$		150		mV

◆ External Capacitors

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Capacitors for all Regulators Effective Series Resistance	$C_{OUTA,B,C}$ ESR		0.8	1		μF
			0.01	0.1	2	Ω
Bypass Capacitor	C_{BYPASS}			10		nF

◆ Power Dissipation

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Junction to Case Thermal Resistance	R_{JC}			39		$^\circ\text{C/W}$
Junction to Ambient Thermal Resistance	R_{JA}	typical PC board mounting, still air		206		$^\circ\text{C/W}$
Maximum Power Dissipation	P_d	any ambient temperature	$P_{dMAX} = \frac{T_{J(MAX)} - T_A}{R_{JA}}$ Note 1			mW

Note 1: $T_{J(MAX)}$ denotes maximum operating junction temperature ($+125^\circ\text{C}$), T_A ambient temperature, and R_{JA} junction-to-ambient thermal resistance ($+206^\circ\text{C/W}$).

◆ Load Regulation

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Load Regulation LDO_A		$0\text{ mA} < I_{OUT} < 135\text{ mA}$		22	50	mV
		$0\text{ mA} < I_{OUT} < 100\text{ mA}$		22	30	
Load Regulation LDO_B		$0\text{ mA} < I_{OUT} < 70\text{ mA}$		21	25	mV
Load Regulation LDO_C		$0\text{ mA} < I_{OUT} < 50\text{ mA}$		13	22	mV

◆ Line Regulation

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = +27^\circ\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Line Regulation for all LDOs		$I_{OUT} = I_{MAX}$, V_{IN} from $V_{OUT(NOM)} + 0.35\text{ V}$ to 5.3 V		0.40	1.2	mV

◆ PSRR

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, typical values at $T_A = +27^{\circ}\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
PSRR for all LDOs		$I_{OUT} = \text{Max } I_{OUT}$ $V_{IN} = 3.6\text{ V}$ $f = 1\text{ kHz}$ $f = 10\text{ kHz}$	47	75 63		dB

◆ Noise and Crosstalk

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, typical values at $T_A = +27^{\circ}\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Noise Voltage for all LDOs	V_{NO}	$100\text{ Hz} < f < 100\text{ kHz}$		25	30	μVrms

◆ Dynamic Parameters

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, typical values at $T_A = +27^{\circ}\text{C}$, $V_{IN} = 4.5\text{ V}$, $I_{OUT} = 1.0\text{ mA}$, $C_{IN} = 1.0\text{ }\mu\text{F}$, $C_L = 1.0\text{ }\mu\text{F}$, $C_{BYPASS} = 10\text{ nF}$, $V_{CTRL} = 2.0\text{ V}$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Start-up Delay (from enabling LDO_A to 90% * $V_{OUT(NOM)}$, other LDOs at ON state) (Note 2)		V_{ENA} from $< 0.3\text{ V}$ to $> 2.0\text{ V}$, $V_{ENBC} > 2.0\text{ V}$, $I_{OUT} = \text{Max } I_{OUT}$, $C_{OUTA} = 1\text{ }\mu\text{F}$		25		μs
Overshoot		V_{ENA} from $< 0.3\text{ V}$ to $> 2.0\text{ V}$, $V_{ENBC} > 2.0\text{ V}$, $I_{OUT} = \text{Max } I_{OUT}$, $C_{OUTA} = 1\text{ }\mu\text{F}$		1		%
Settling Time (from 90% * $V_{OUT(NOM)A}$ to max $\pm 0.1\%$ fluctuation)		V_{ENA} from $< 0.3\text{ V}$ to $> 2.0\text{ V}$, $V_{ENBC} > 2.0\text{ V}$, $I_{OUT} = \text{Max } I_{OUT}$, $C_{OUTA} = 1\text{ }\mu\text{F}$, w/o C_{BYPASS}		200		μs

Note 2: When all regulators are disabled the start-up delay is a function of a bypass capacitor. Typically 0.5 ms for 10 nF capacitor.

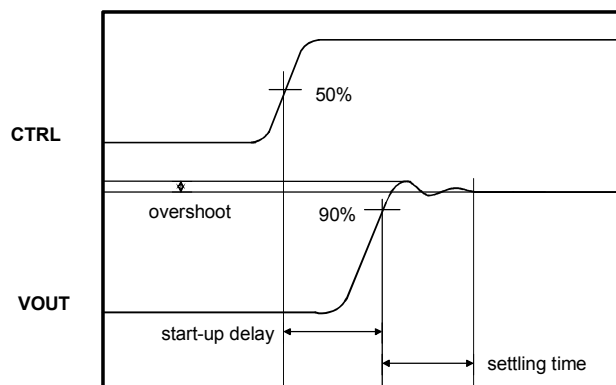
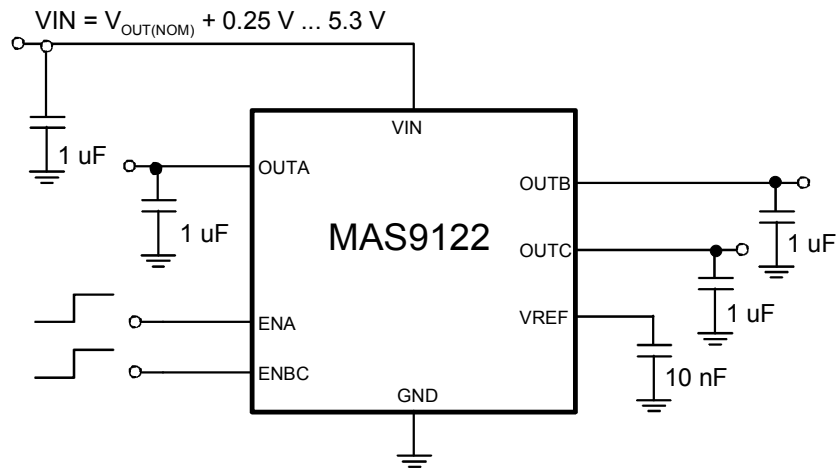


Figure 1. Definitions of start-up delay, overshoot and settling time.

APPLICATION INFORMATION



See also table External Capacitors on p. 4.

FUNCTIONS

◆ Reference voltage

The device is supplied with $V_{OUT(NOM)} + 0.25 \text{ V}$ to 5.3 V battery under normal conditions. An internal bandgap voltage reference is routed via 20 kOhm resistor to an external pin, where a filter capacitor can be connected in order to reduce noise level of all regulators. The startup time of the reference voltage is then determined by the value of the bypass capacitor at pin VREF.

◆ Enable pins

Each regulator can be enabled/disabled by two enable pins ENA and ENBC. Pin ENA controls regulator LDO_A and pin ENBC controls both

regulator LDO_B and LDO_C. If both enable pins are forced low, the whole circuit goes into power saving sleep-mode. In the table below all functional modes are presented.

◆ Regulators

The device contains three low dropout CMOS regulators, with maximum output currents of 135 mA, 70 mA and 50 mA. Three different output voltage options are available by mask option: 2.70 V, 2.85 V and 3.00 V.

◆ Logic Table for Enable Inputs

ENA	ENBC	LDO_A	LDO_B	LDO_C	VREF
1	1	ON	ON	ON	ON
1	0	ON	OFF	OFF	ON
0	1	OFF	ON	ON	ON
0	0	OFF	OFF	OFF	OFF

TYPICAL PERFORMANCE CHARACTERISTICS

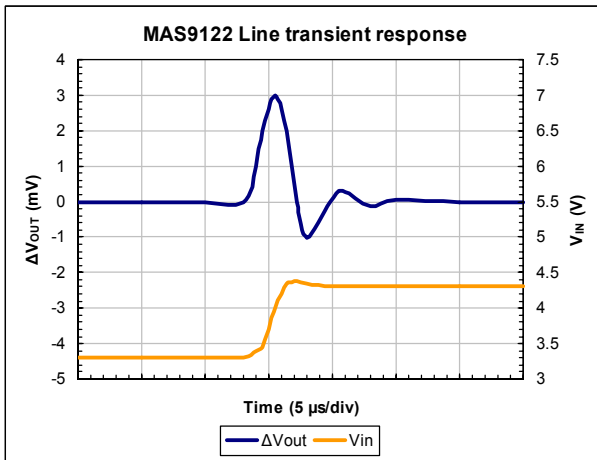


Figure 2. LDO_C line transient for a supply voltage change of 1 V, $V_{OUT} = 2.8$ V.

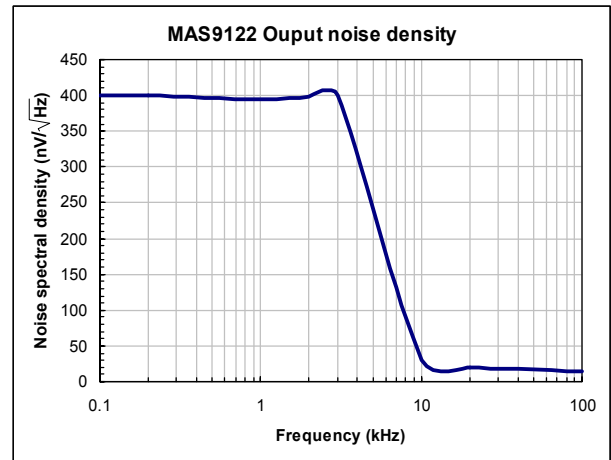


Figure 3. Regulator output noise density.

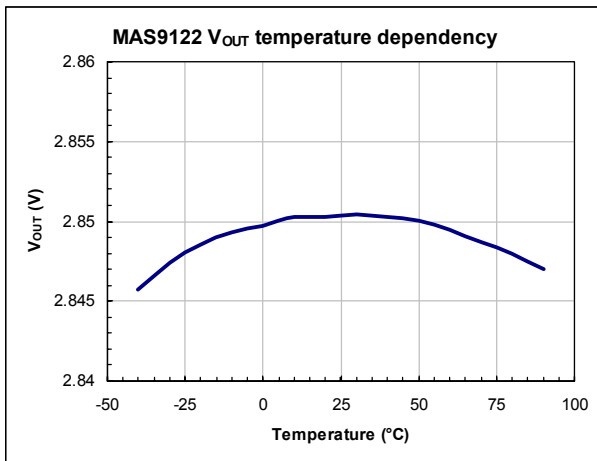


Figure 4. Regulator output voltage temperature dependency.

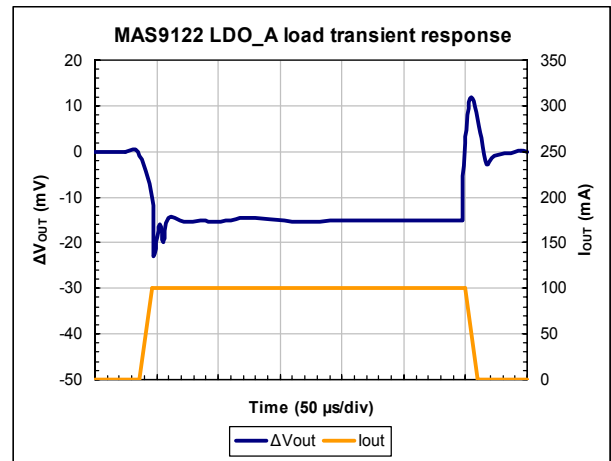


Figure 5. LDO_A load transient response to maximum output current with 10 μ s steps ($I_{OUT(MAX)} = 100$ mA).

NOTE: With 135 mA of current the overshoot values and lengths will grow by 30% compared to 100 mA of current.

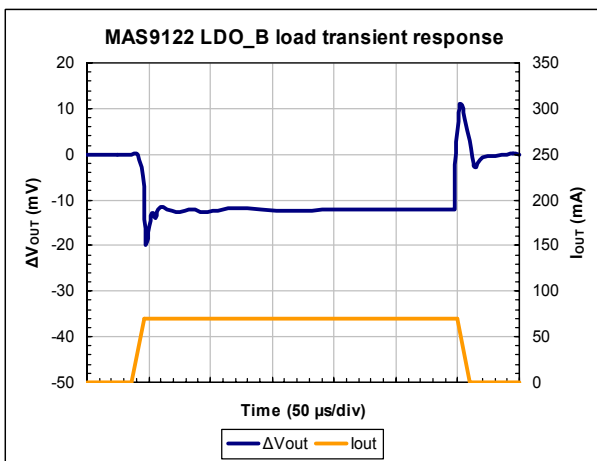


Figure 6. LDO_B load transient response to maximum output current with 10 μ s steps.

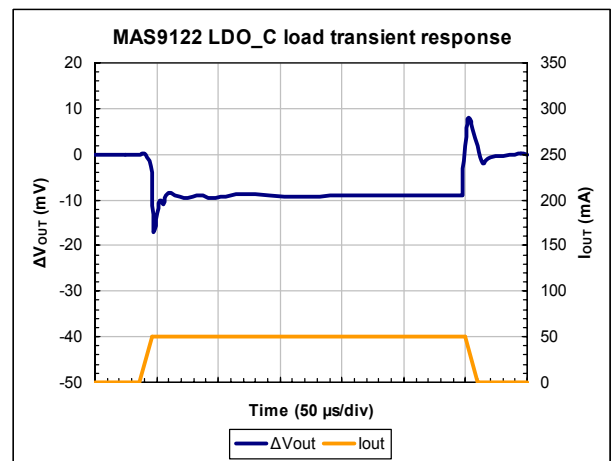


Figure 7. LDO_C load transient response to maximum output current with 10 μ s steps.

TYPICAL PERFORMANCE CHARACTERISTICS

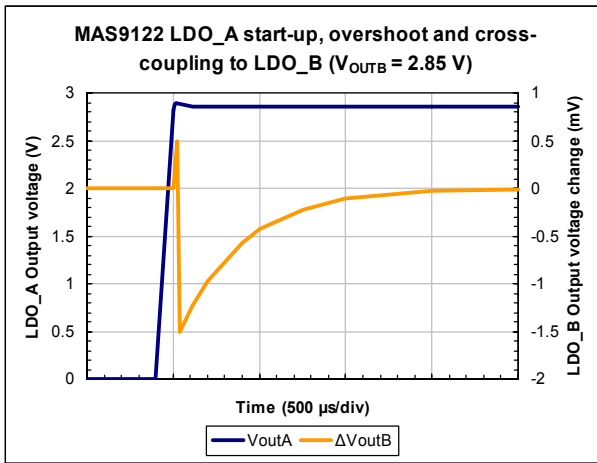


Figure 8. LDO_A start-up, overshoot and cross-coupling to LDO_B.

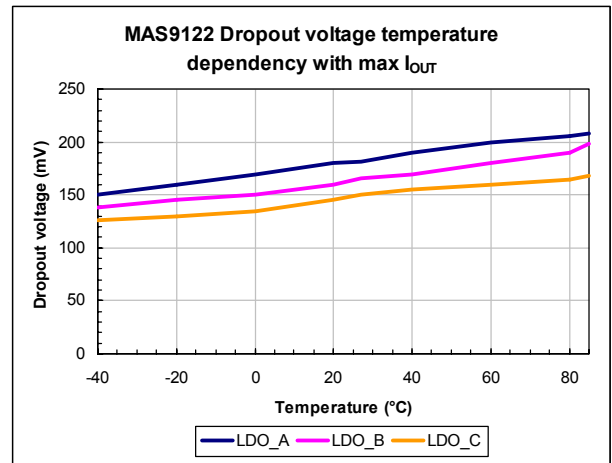


Figure 9. Dropout voltage temperature dependency with maximum output current.

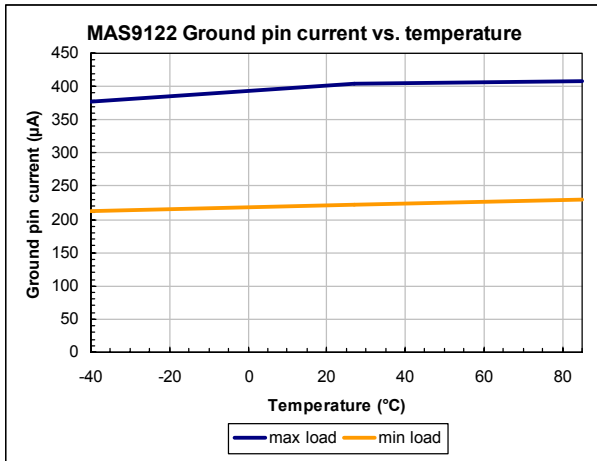


Figure 10. Total ground pin current vs. temperature.

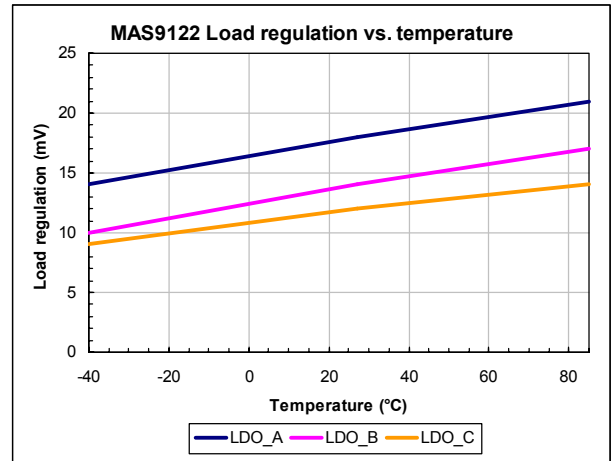


Figure 11. Load regulation vs. temperature.

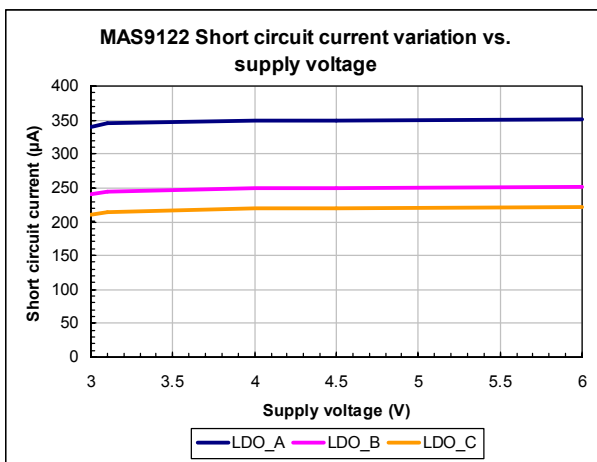


Figure 12. Short circuit current variation vs. supply voltage.

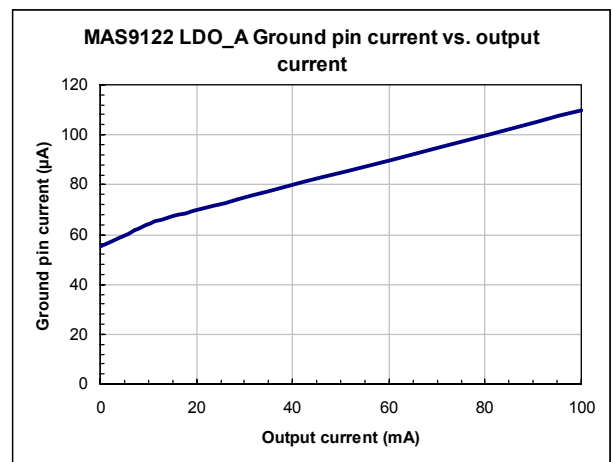
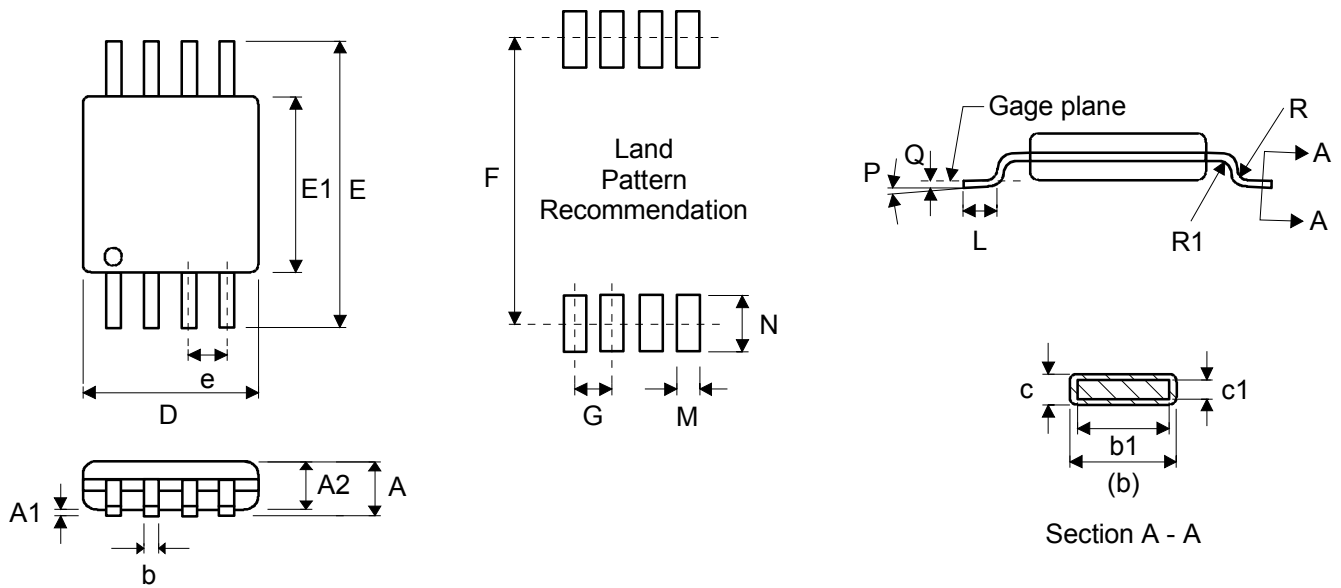


Figure 13. LDO_A ground pin current vs. output current.

PACKAGE (MSOP-8) OUTLINE


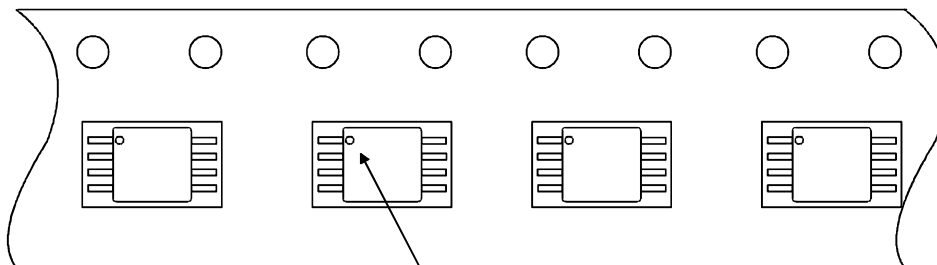
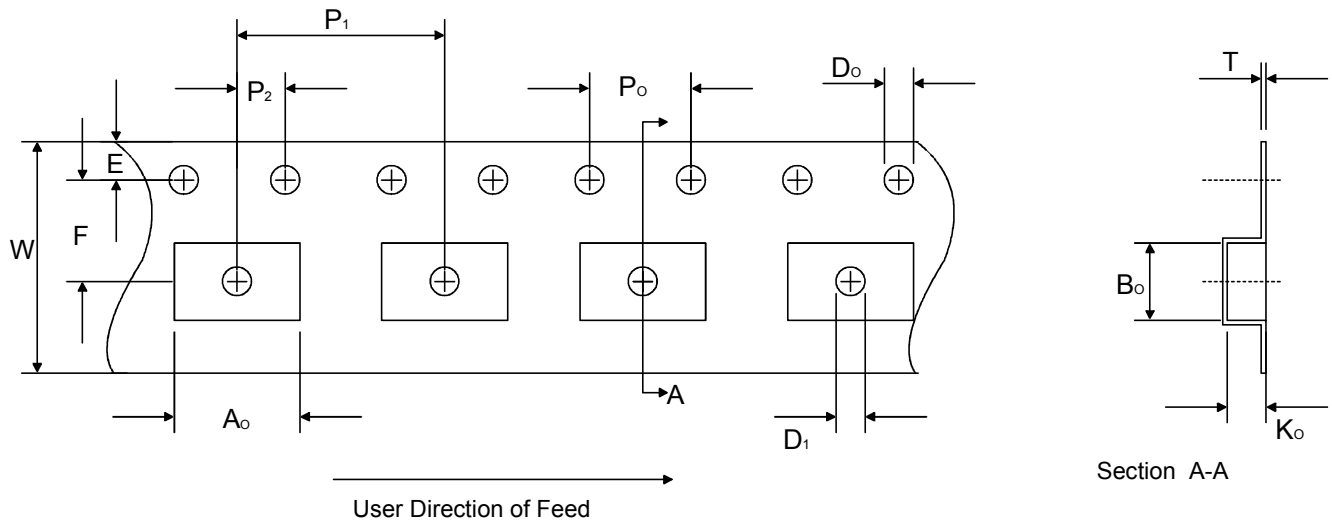
Symbol	Min	Nom	Max	Unit
A			1.10	mm
A1	0		0.15	mm
A2	0.75	0.85	0.95	mm
b	0.22		0.38	mm
b1	0.22	0.30	0.33	mm
c	0.08		0.23	mm
c1	0.08		0.18	mm
D		3.00 BSC		mm
E		4.90 BSC		mm
E1		3.00 BSC		mm
e		0.65 BSC		mm
F		4.8		mm
G		0.65		mm
L	0.40	0.60	0.80	mm
(Terminal length for soldering)				
M		0.41		mm
N		1.02		mm
P	0°		8°	
Q		0.25 BSC		mm
R	0.07			mm
R1	0.07			mm

Dimensions do not include mold or interlead flash, protrusions or gate burrs.
 All measurement according to JEDEC standard MO-187.

SOLDERING INFORMATION

Resistance to Soldering Heat	According to RSH test IEC 68-2-58/20 2*220°C
Maximum Reflow Temperature	235°C
Maximum Number of Reflow Cycles	2
Seating Plane Co-planarity	max 0.08 mm
Lead Finish	Solder plate 7.62 - 25.4 µm, material Sn 85% Pb 15%

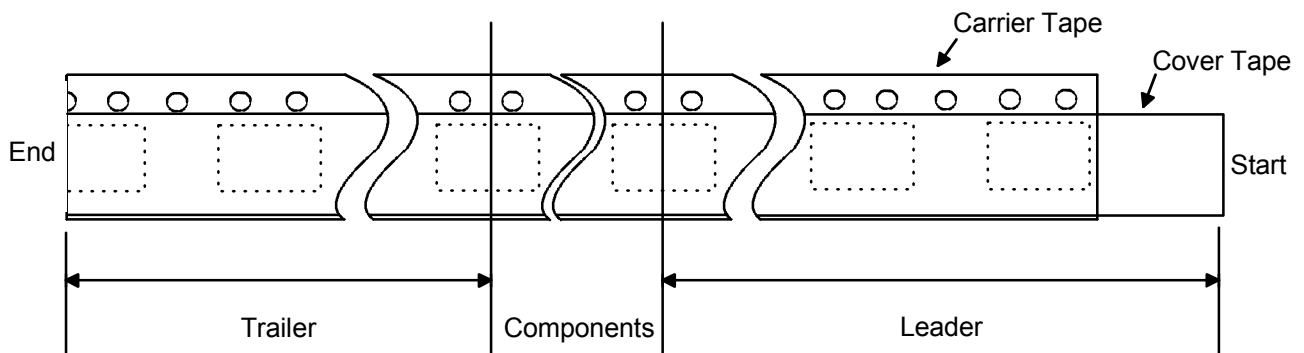
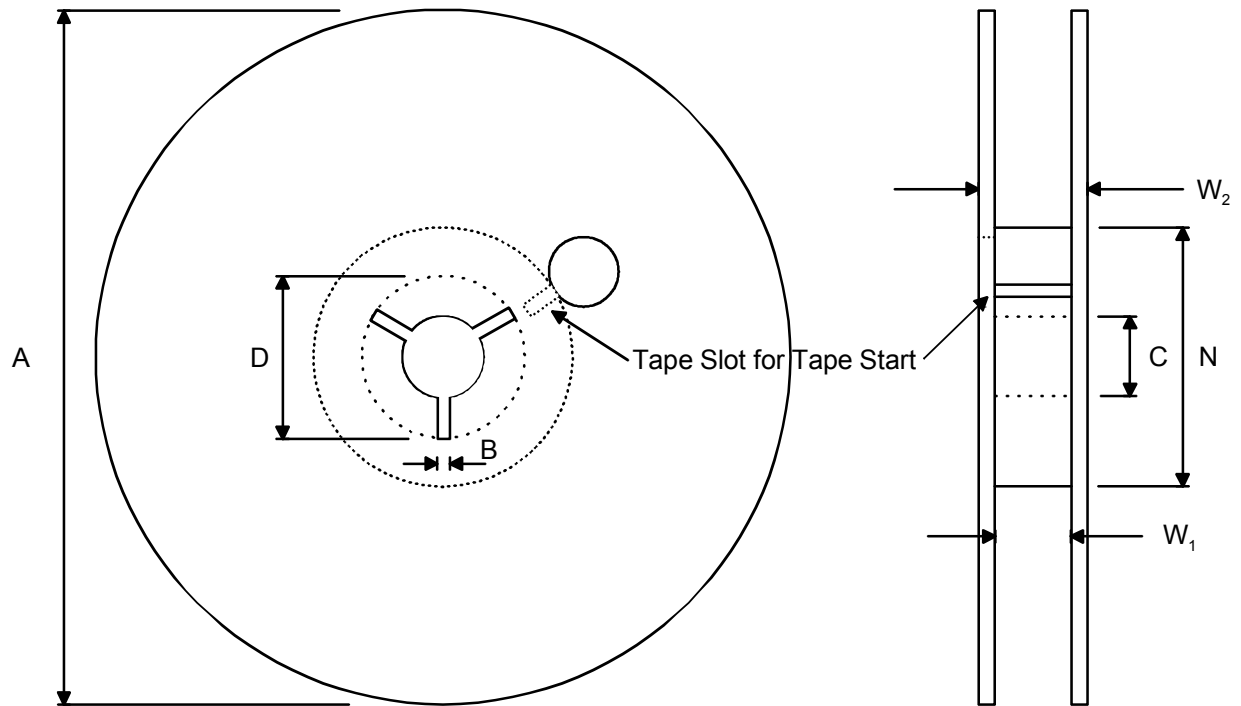
EMBOSSED TAPE SPECIFICATIONS



Pin 1 Designator

Dimension	Min/Max	Unit
A_0	5.00 ±0.10	mm
B_0	3.20 ±0.10	mm
D_0	1.50 +0.1/-0.0	mm
D_1	1.50 min	mm
E	1.75	mm
F	5.50 ±0.05	mm
K_0	1.45 ±0.10	mm
P_0	4.0	mm
P_1	8.0 ±0.10	mm
P_2	2.0 ±0.05	mm
T	0.3 ±0.05	mm
W	12.00 +0.30/-0.10	mm

REEL SPECIFICATIONS



Dimension	Min	Max	Unit
A		330	mm
B	1.5		mm
C	12.80	13.50	mm
D	20.2		mm
N	50		mm
W ₁ (measured at hub)	12.4	14.4	mm
W ₂ (measured at hub)		18.4	mm
Trailer	160		mm
Leader	390, of which minimum 160 mm of empty carrier tape sealed with cover tape		mm
Weight		1500	g

ORDERING INFORMATION

Product Code	Product	Top Marking (ax)	Package	Comments
MAS9122ASM2-T	3 x 2.70 V LDO Voltage Regulator IC	A2	MSOP-8	Tape & Reel
MAS9122ASM3-T	3 x 2.85 V LDO Voltage Regulator IC	A3	MSOP-8	Tape & Reel
MAS9122ASM4-T	3 x 3.00 V LDO Voltage Regulator IC	A4	MSOP-8	Tape & Reel

For more voltage options contact Micro Analog Systems Oy.

LOCAL DISTRIBUTOR

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