MAS9123

80 mA LDO Voltage Regulator IC

- **Very Low Noise: 9.5 µVrms**
- **Very Short Start-up Time: 20 µs**
- **Excellent Ripple Rejection: 68 dB**
- **Stable with Low-ESR Output Capacitors**
- **Low Minimum Output Capacitance Requirement: 0.22 µF**
- **Regulator Enable/Disable Control**

DESCRIPTION

MAS9123 is a low dropout voltage regulator with an enable/disable pin, which allows device to be turned off or on by pulling control to low or high.

Due to the very low noise level of only 9.5 µVrms MAS9123 is highly suitable for very sensitive circuits, e.g., in portable applications. In addition to the noise level, MAS9123 excels in dropout voltage (95 mV typical at 50 mA) and in start-up time (typically 20 µs from start-up to within ±1% of $V_{OUT(NOM)}$). Also its ripple rejection ability of 68 dB at 10 kHz exceed that of competition.

The Equivalent Series Resistance (ESR) range of output capacitors that can be used with MAS9123 is very wide. This ESR range from a few mΩ up to a couple of Ohms combined with no minimum output current requirement makes the usage of MAS9123 easier and low in cost. Also the minimum output capacitance requirement is very low. This combined with very short start-up time makes it possible to switch the regulator off and on even in timing critical and/or noise sensitive applications.

An internal thermal protection circuit prevents the device from overheating. Also the maximum output current is internally limited. In order to save power the device goes into sleep mode when the regulator is disabled.

FEATURES

- Optimized for Fast Start-up
- Very Low Noise
- Internal Thermal Shutdown
- Short Circuit Protection
- SOT23-5 Package (Pin Compatible with LP2982)
- WL-CSP Package (Pin Compatible with LP3985)
- Output Voltage Options: 2.8, 3.0 and 3.3 V, see Ordering Information p. 12

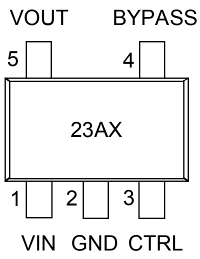
APPLICATIONS

- RF Oscillators
- Wireless Systems
- Cellular Phones
- Cordless Phones
- Pagers
- Battery Powered Systems
- Portable Systems
- Radio Control Systems

PIN CONFIGURATION

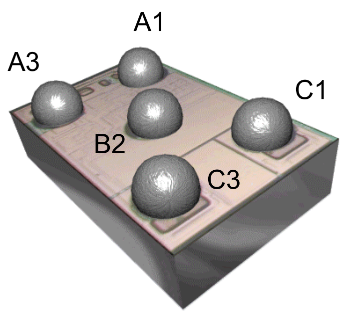
SOT23-5

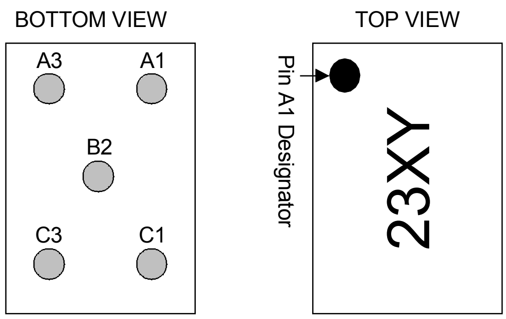
Top View



For top marking information see
ordering information p. 12

WL-CSP





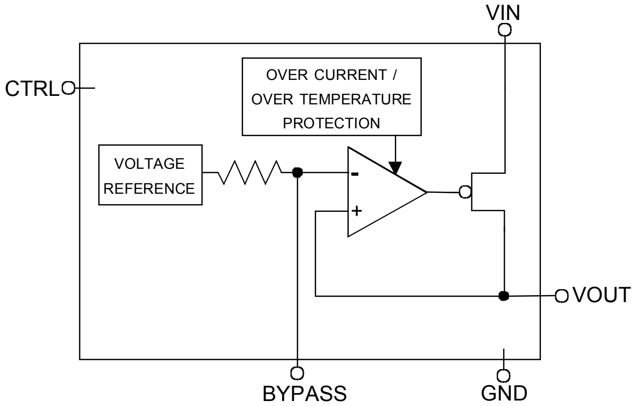
For top marking information see
ordering information p. 12

PIN DESCRIPTION

Pin Name	Pin Number in SOT23-5	Pin Number in WL-CSP	Type	Function
VIN	1	C3	P	Power Supply Voltage
GND	2	B2	G	Ground
CTRL	3	A1	I	Enable/Disable Pin for Regulator
BYPASS	4	A3	I	Pin for Bypass Capacitor
VOUT	5	C1	O	Output

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

BLOCK DIAGRAM



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 it will not be destroyed.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Max	Unit
Operating Junction Temperature	T_J		- 40	+125	°C
Operating Ambient Temperature	T_A		-40	+85	°C
Operating Supply Voltage	V_{IN}		2.5	5.3	V

ELECTRICAL CHARACTERISTICS

◆ Thermal Protection

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Threshold High	T_H		145	160	175	°C
Threshold Low	T_L		135	150	165	°C

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

◆ Control Terminal Specifications

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Control Voltage OFF State ON State	V_{CTRL}		 –0.3 1.6		 0.55 V_{IN} + 0.3	V
Control Current	I_{CTRL}	 V_{CTRL} = V_{IN} V_{CTRL} = 0 V		 5 0	 15	µA

If CTRL-pin is not connected, MAS9123 is in OFF state (900 kΩ pull-down resistor to ground).

◆ Voltage Parameters

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage Tolerance	V_{OUT}	 I_{OUT} = 0 mA I_{OUT} = 50 mA	 $V_{OUT(NOM)}$ – 0.05 $V_{OUT(NOM)}$ – 0.10		 $V_{OUT(NOM)}$ + 0.05 $V_{OUT(NOM)}$ + 0.05	V
Dropout Voltage	V_{DROP}	 I_{OUT} = 1 mA I_{OUT} = 10 mA I_{OUT} = 50 mA		 46 51 95		mV

◆ Current Parameters

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Continuous Output Current	I_{OUT}			0		80	mA
Short Circuit Current	I_{MAX}	R_L = 0 Ω			230		mA
Peak Output Current	I_{PK}	V_{OUT} > 95% * $V_{OUT(NOM)}$			180		mA
Ground Pin Current	I_{GND}	 I_{OUT} = 0 mA I_{OUT} = 10 mA I_{OUT} = 50 mA			 170 210 250		µA
Ground Pin Current, Sleep mode	I_{GND}	V_{CTRL} = 0 V	T_A = 27°C		0.02	0.5	µA
			T_A = 85°C		0.2	2	

◆ Power Dissipation

T_A = -40°C to +85°C, typical values at T_A = +27°C, $V_{IN} = V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Thermal Resistance (Junction-to-Air)	R_{JA}	typical PC board mounting, still air, SOT23-5 package		255.9		°C/W
		mounted on MAS9123 CSP evaluation board, WL-CSP package		TBD		
Maximum Power Dissipation	P_d	any ambient temperature, SOT23-5 package	$P_{dMAX} = \frac{T_{J(MAX)} - T_A}{R_{JA}}$ Note 1			W

Note 1: $T_{J(MAX)}$ denotes maximum operating junction temperature (+125°C), T_A ambient temperature, and R_{JA} junction-to-air thermal resistance (+255.9°C/W).

◆ Line and Load Regulation

T_A = -40°C to +85°C, typical values at T_A = +27°C, $V_{IN} = V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Line Regulation		$V_{OUT(NOM)}$ + 1 V < V_{IN} < 5.3 V, I_{OUT} = 50 mA		0.75	2	mV
Load Regulation		I_{OUT} = 1.0 to 50 mA		13.5	25	mV

◆ Noise and Ripple Rejection

T_A = -40°C to +85°C, typical values at T_A = +27°C, $V_{IN} = V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Noise Voltage	V_{RMS}	10 Hz < f < 100 kHz		9.5		µVrms
Noise Density	V_N	I_{OUT} = 50 mA, f = 10 kHz		24		$nV/\sqrt{Hz}$
PSRR		f = 1 kHz f = 10 kHz f = 100 kHz		70 68 58		dB

◆ Dynamic Parameters

T_A = -40°C to +85°C, typical values at T_A = +27°C, $V_{IN} = V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Start-up Delay (from start-up to 80% of $V_{OUT(NOM)}$)		V_{CTRL} = 0 to 2.4 V, I_{OUT} = 50 mA, $C_L \leq$ 1.0 µF		7.5		µs
Overshoot		V_{CTRL} = 0 to 2.4 V		1.0	8.0	%
Start-up Time (settling time of voltage transient from start-up to within ±1% of $V_{OUT(NOM)}$)		V_{CTRL} = 0 to 2.4 V, I_{OUT} = 50 mA $C_L \leq$ 1.0 µF		20		µs

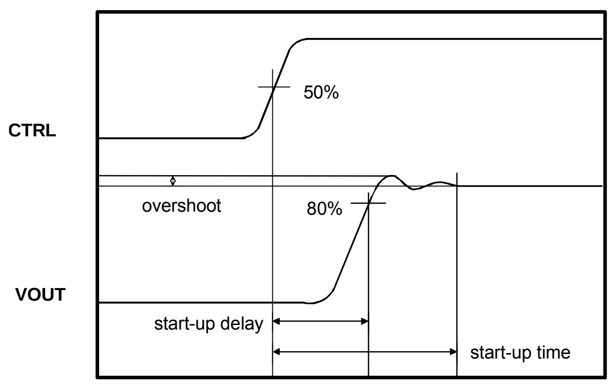


Figure1. Definitions of start-up delay, overshoot and start-up time.

TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 50 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

Start-up

MAS9123 start-up is optimized for bypass capacitor values of 3 to 20 nF. When values are lower than 3 nF the start-up settling might be unstable for about 20 µs after the start-up. The rise time increases if bypass capacitor values are bigger than 20 nF.

Start-up settling

Typically 20 µs after the start-up the output voltage drops about 10 to 20 mV in 250 µs time (figure 4). The value of this voltage drop depends on the parasitic components of the bypass capacitor. After the voltage drop the output voltage rises slowly to the final value (figure 5).

Noise reduction

MAS9123 has typically 9.5 μV_{RMS} output noise voltage with 10 nF bypass capacitor. By increasing the capacitance value, the output noise will slightly decrease, but the start-up time increases.

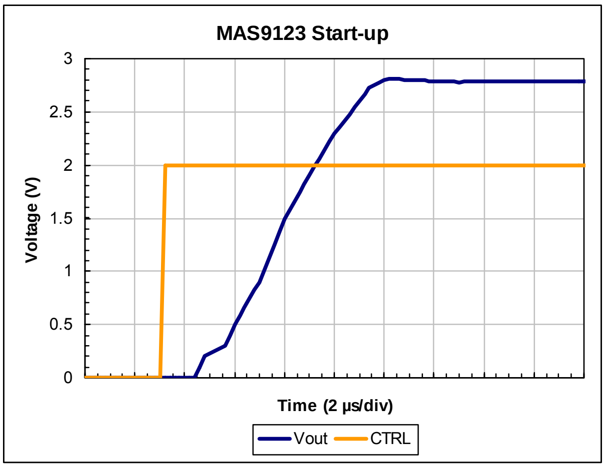


Figure 2. Typical start-up.

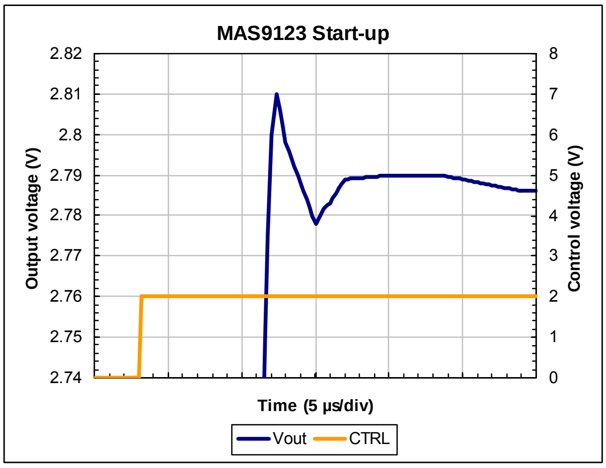


Figure 3. Typical start-up.

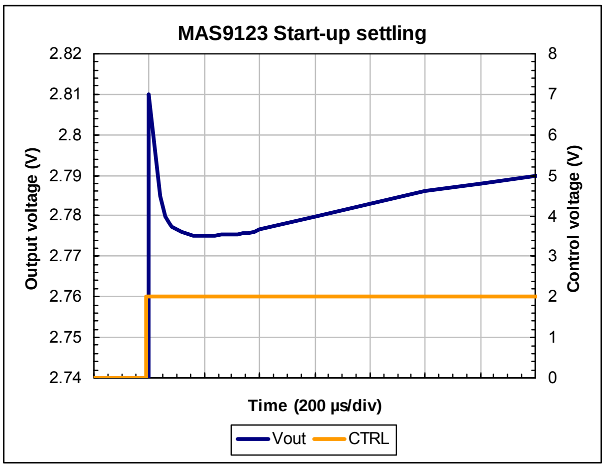


Figure 4. Typical start-up settling.

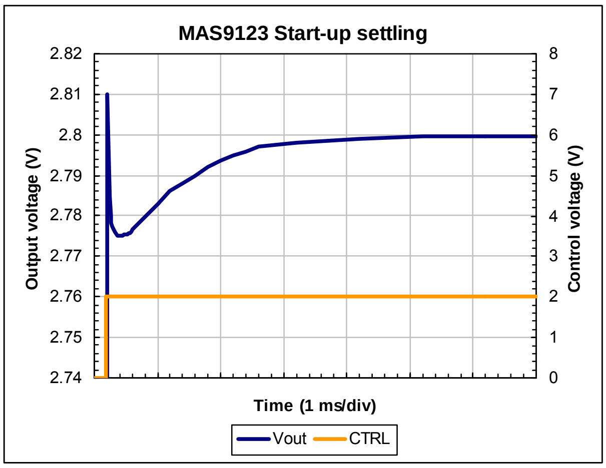


Figure 5. Typical start-up settling.

TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +27°C, $V_{IN} = V_{OUT(NOM)}$ + 1.0 V, I_{OUT} = 50 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = 2.0 V, unless otherwise specified.

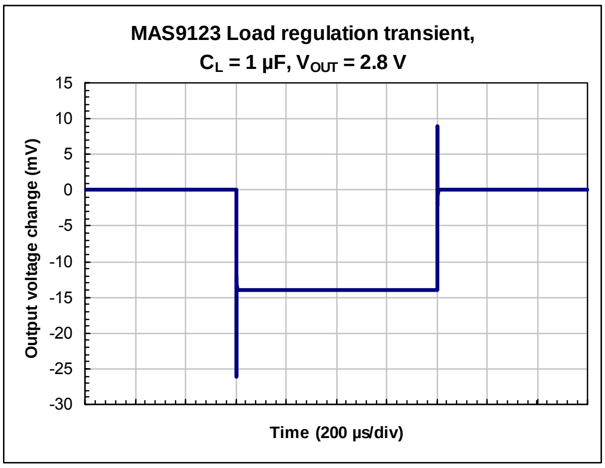


Figure 6. Typical load regulation transient. C_L = 1 µF, I_{OUT} = 0.5 mA … 50 mA in 2 µs.

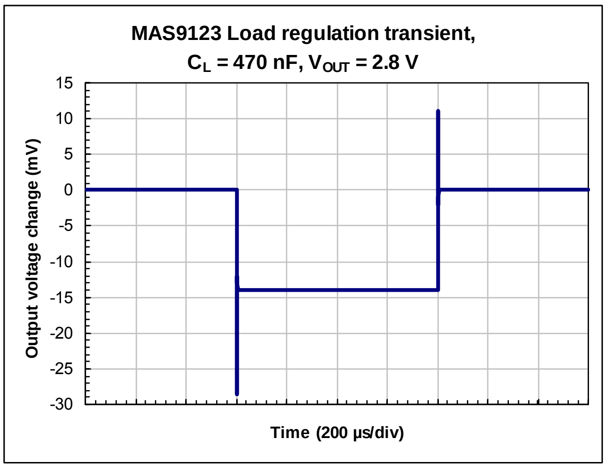


Figure 7. Typical load regulation transient. C_L = 470 nF, I_{OUT} = 0.5 mA … 50 mA in 2 µs.

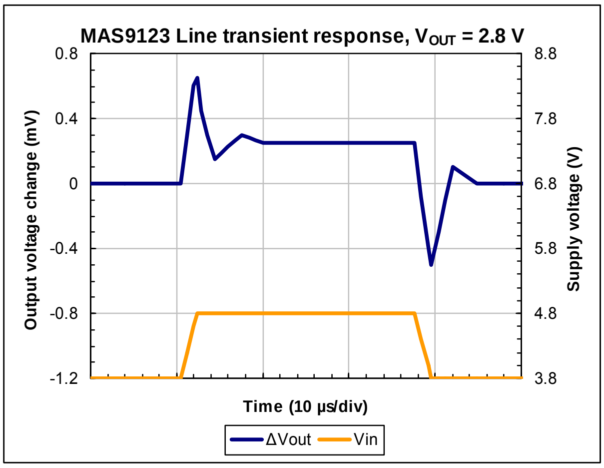


Figure 8. Line transient response. C_L = 1 µF, I_{OUT} = 10 mA.

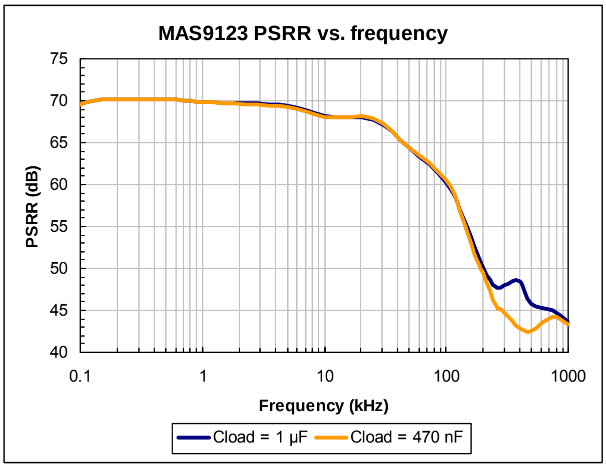


Figure 9. PSRR vs. frequency.

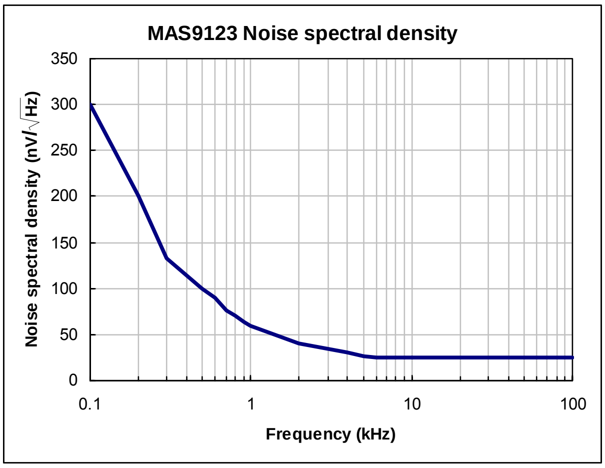


Figure 10. Noise spectral density vs. frequency.

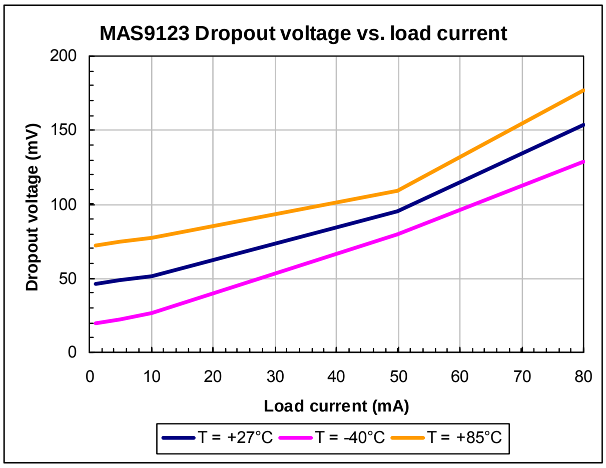
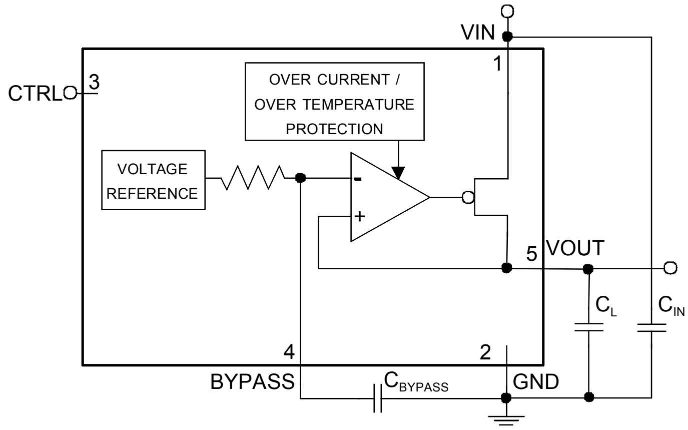


Figure 11. Dropout voltage vs. load current.

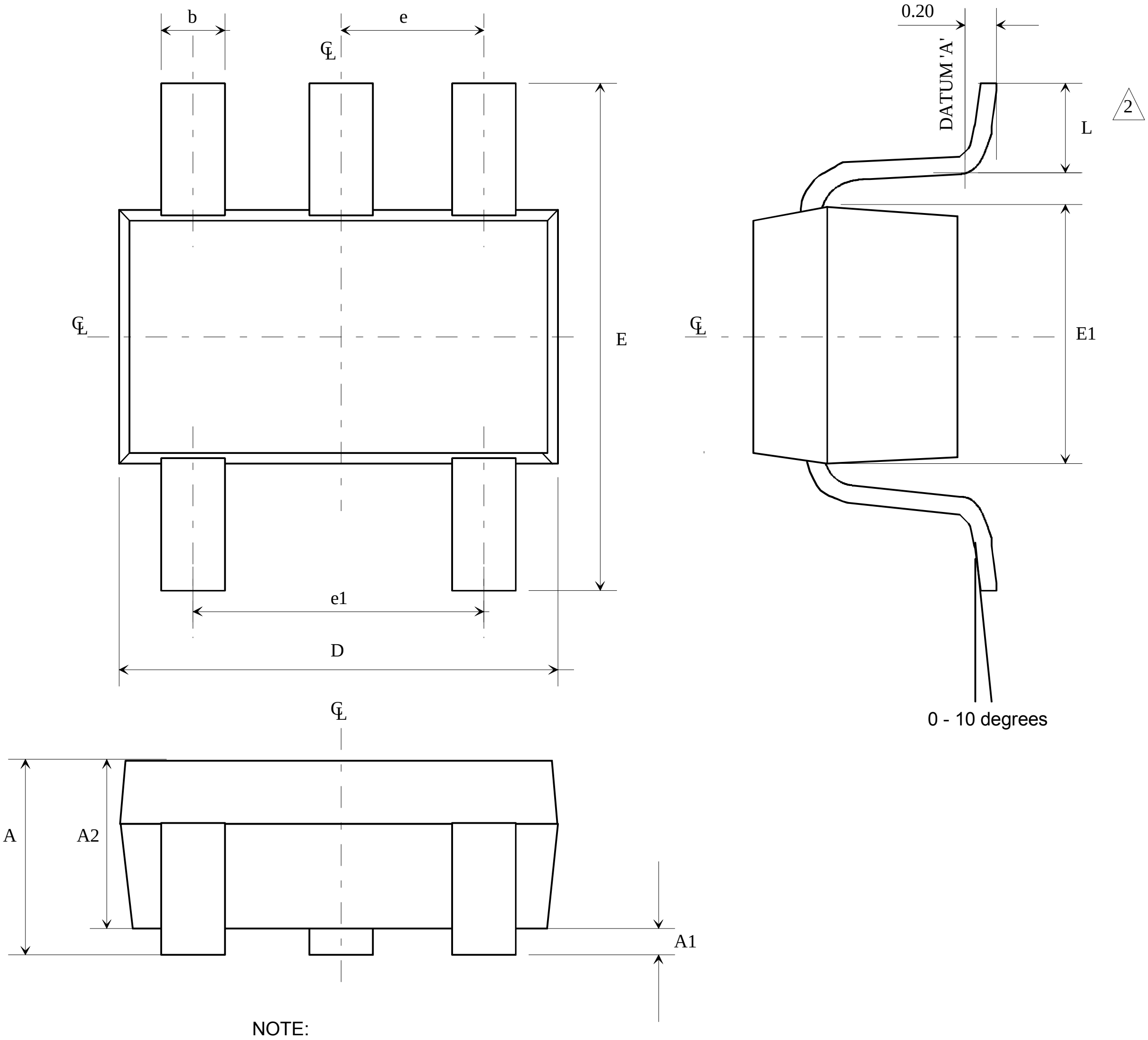
APPLICATION INFORMATION



Parameter	Symbol	Min	Typ	Max	Unit	Note
Output Capacitance	C_L	0.22	1.0		µF	1. Ceramic and film capacitors can be used. 2. The value of C_L should be smaller than or equal to the value of C_{IN}.
Effective Series Resistance	ESR	0.01		2	Ω	1. When within this range stable with all I_{OUT} = 0 mA…80 mA values.
Bypass Capacitance	C_{BYPASS}	3	10		nF	1. Ceramic and film capacitors are best suited. For maximum output voltage accuracy DC leakage current through capacitor should be kept as low as possible. In any case DC leakage current must be below 100 nA.
Input Capacitance	C_{IN}	0.5			µF	1. A big enough input capacitance is needed to prevent possible impedance interactions between the supply and MAS9123. 2. Ceramic, tantalum, and film capacitors can be used. If a tantalum capacitor is used, it should be checked that the surge current rating is sufficient for the application. 3. In the case that the inductance between a **battery** and MAS9123 is very small (< 0.1 µH), a 0.47 µF input capacitor is sufficient. 4. The value of C_{IN} should not be smaller than the value of C_L.

Values given on the table are minimum requirements unless otherwise specified. When selecting capacitors, tolerance and temperature coefficient must be considered to **make sure that the requirement is met in all potential operating conditions.**

PACKAGE (SOT23-5) OUTLINE

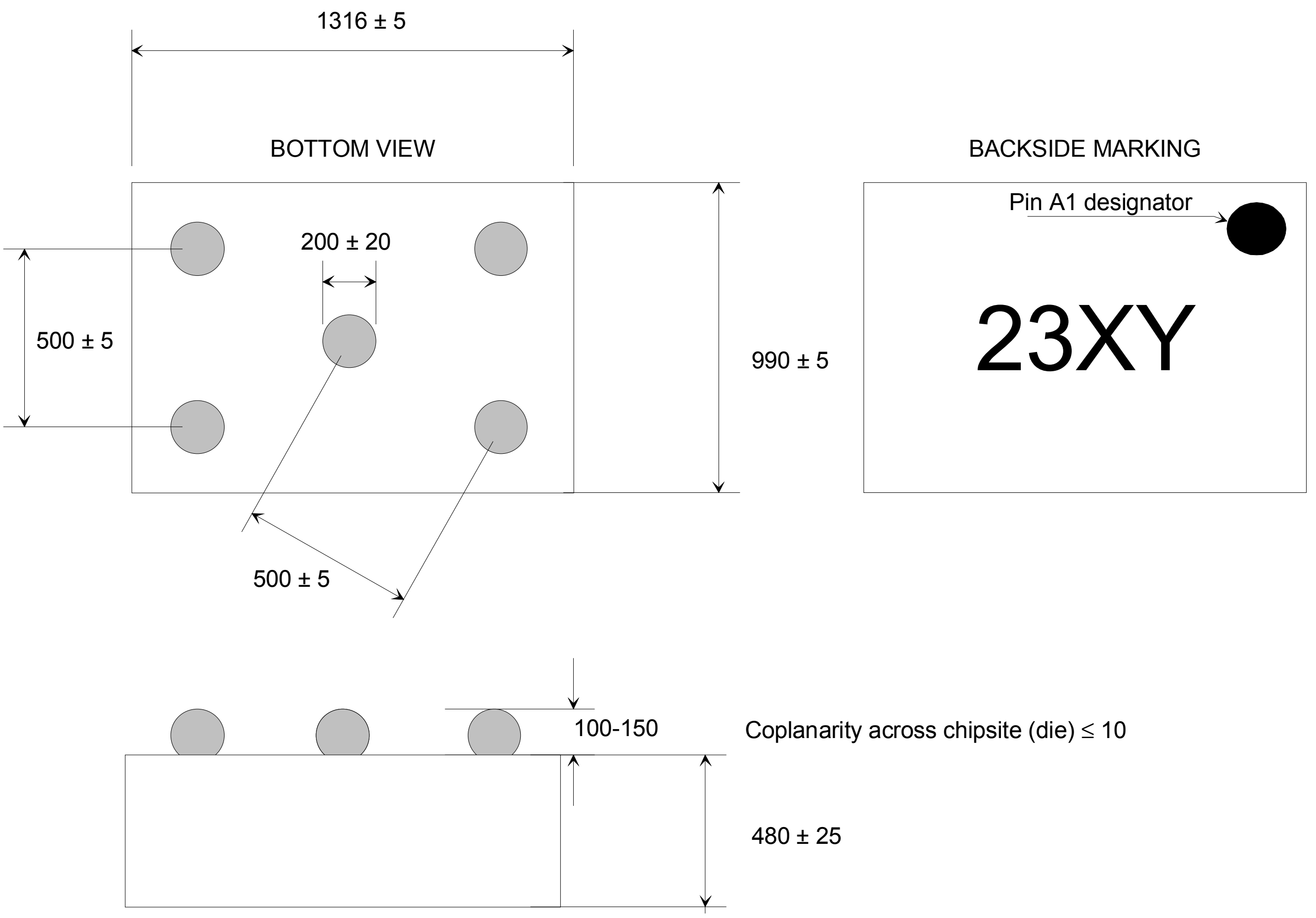


NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. FOOT LENGHT MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. COMPLY TO EIAJ SC74

Symbol	Min	Max	Unit
A	0.90	1.45	mm
A1	0.00	0.15	mm
A2	0.90	1.30	mm
b	0.25	0.50	mm
C	0.09	0.20	mm
D	2.80	3.10	mm
E	2.60	3.00	mm
E1	1.50	1.75	mm
L	0.35	0.55	mm
e	0.95ref		mm
e1	1.90ref		mm

PACKAGE (WL-CSP) OUTLINE

All dimensions in microns, drawings not to scale.



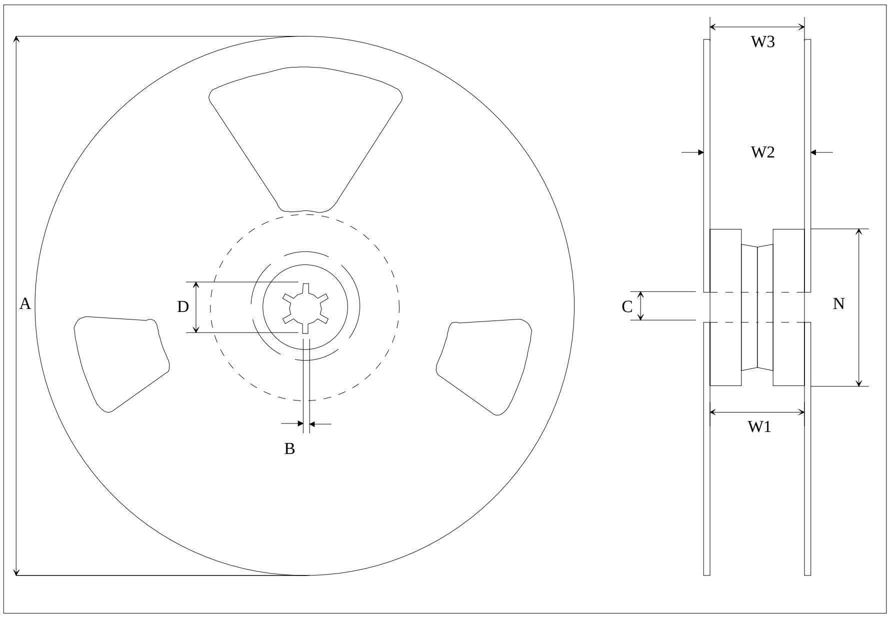
Definitions (see ordering information p. 12):

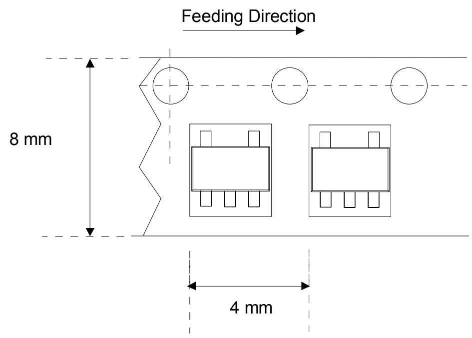
X = Package option
Y = Output voltage option

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%
WL-CSP Balls	Material Sn 63% Pb 37% (eutectic)

TAPE & REEL SPECIFICATIONS (SOT23-5)





Other Dimensions according to EIA-481 Standard.

3000 Components on Each Reel.

Dimension	Min	Max	Unit
A		178	mm
B	1.5		mm
C	12.80	13.50	mm
D	20.2		mm
N	50		mm
W_1 (measured at hub)	8.4	9.9	mm
W_2 (measured at hub)		14.4	mm
Trailer	160		mm
Leader	390, of which minimum 160 mm of empty carrier tape sealed with cover tape		mm

ORDERING INFORMATION

Product Code	Product	Top Marking	Package	Comments
MAS9123AST2-T	2.8 V Voltage Regulator IC	23A2	SOT23-5	Tape and Reel
MAS9123A2CA11	2.8 V Voltage Regulator IC	23A2	WL-CSP	Under Qualification
MAS9123AST6-T	3.0 V Voltage Regulator IC	23A6	SOT23-5	Tape and Reel
MAS9123AST1-T	3.3 V Voltage Regulator IC	23A1	SOT23-5	Tape and Reel

For more voltage options contact Micro Analog Systems Oy.

LOCAL DISTRIBUTOR

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