MAS9124

150 mA LDO Voltage Regulator IC

- **Low Noise: 20 µVrms**
- **Low Minimum Output Capacitance Requirement: 0.22 µF**
- **Excellent Ripple Rejection: 65 dB**
- **Very Low Dropout: 70 mV**
- **Regulator Enable/Disable Control**
- **Stable with Low-ESR Output Capacitors**

DESCRIPTION

MAS9124 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 low noise level of only 20 µVrms, MAS9124 is suitable for sensitive circuits, e.g., in portable applications. In addition to the noise levels, MAS9124 excels in dropout voltage (70 mV typical at 50 mA) and rise time (16 µs typical without bypass capacitor). Also its ripple rejection ability of 65 dB at 10 kHz exceeds that of competition.

The Equivalent Series Resistance (ESR) range of output capacitors that can be used with MAS9124 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 MAS9124 easier and low in cost.

In order to save power the device goes into sleep mode when the regulator is disabled. MAS9124 also includes an auto-discharge function, wherein a shutdown transistor turns on and discharges the output capacitor. An internal thermal protection circuit prevents the device from overheating. Also the maximum output current is internally limited.

FEATURES

- Low Noise
- Functionally and Pin Compatible with LP2985
- Can be used w/o C_{BYPASS}, see p. 7
- Internal Thermal Shutdown
- Short Circuit Protection
- SOT23-5/WL-CSP Package
- Several Output Voltage Options Available, see Ordering Information p. 11

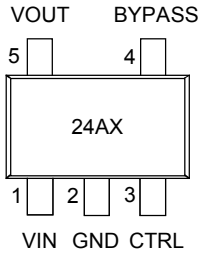
APPLICATIONS

- Cellular Phones
- Cordless Phones
- Accessories
- Pagers
- Battery Powered Systems
- Portable Systems
- Radio Control Systems
- Low Voltage Systems

PIN CONFIGURATION

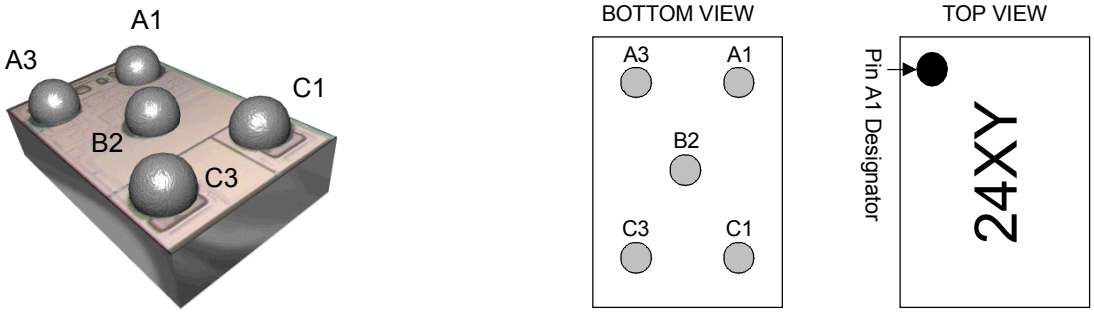
SOT23-5

Top View



For top marking information see ordering information p. 11

WL-CSP



For top marking information see ordering information p. 11

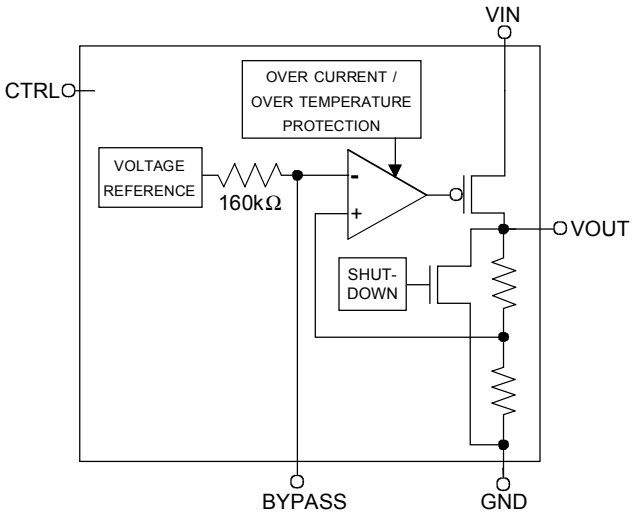
PIN DESCRIPTION

Pin Name	Pin Number in SOT23-5	Pin Number in WL-CSP Pin Order 11 Note 1	Pin Number in WL-CSP Pin Order 12 Note 2	Type	Function
VIN	1	C3	C3	P	Power Supply Voltage
GND	2	B2	A1	G	Ground
CTRL	3	A1	A3	I	Enable/Disable Pin for Regulator
BYPASS	4	A3	B2	I	Pin for Bypass Capacitor
VOUT	5	C1	C1	O	Output

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

Note 1: WL-CSP Pin Order 11 is pin compatible with LP3985.
Note 2: WL-CSP Pin Order 12 is pin compatible with LP2985.

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}	$V_{OUT(NOM)}$ < 5 V $V_{OUT(NOM)}$ = 5 V	2.5	5.3 5.8	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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, 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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Control Voltage OFF State (Note 1) 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	 10	µA

If CTRL-pin is not connected, MAS9124 is in OFF state (900 kΩ pull-down resistor to ground).
Note 1: If $V_{OUT(NOM)}$ = 5 V, the device should always be in the ON state.

◆ Voltage Parameters

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage Tolerance	V_{OUT}	 I_{OUT} = 0 mA I_{OUT} = 150 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} = 50 mA I_{OUT} = 150 mA MAS9124A4 (150 mA) MAS9124A5 (150 mA)		 1.7 70 200	 320 800 1100	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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Continuous Output Current	I_{OUT}			150		mA
Short Circuit Current	I_{MAX}	R_L = 0 Ω	200	450	675	mA
Peak Output Current	I_{PK}	V_{OUT} > 95%* $V_{OUT(NOM)}$		410		mA
Ground Pin Current	I_{GND}	 I_{OUT} = 0 mA I_{OUT} = 10 mA I_{OUT} = 50 mA I_{OUT} = 150 mA		 120 130 160 220	 200 400	µA
Ground Pin Current, Sleep Mode	I_{GND}	V_{CTRL} = 0 V		0.01	5	µA

◆ Power Dissipation

T_A = -40°C to +85°C, typical values at T_A = +27°C, V_{IN} = $V_{OUT(NOM)}$ + 1.0 V (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Junction to Case Thermal Resistance	R_{JC}	SOT23-5 package		81.0		°C/W
Junction to Ambient Thermal Resistance	R_{JA}	typical PC board mounting, still air, SOT23-5 package		255.9		°C/W
		mounted on MAS9124 CSP evaluation board, WL-CSP package		210		
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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Line Regulation		$V_{OUT(NOM)}$ + 1 V < V_{IN} < 5.3 V, I_{OUT} = 60 mA		0.7		mV
Load Regulation		I_{OUT} = 1.0 to 50 mA I_{OUT} = 1.0 to 150 mA		5 10		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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Noise Voltage	V_{RMS}	300Hz < f < 50kHz C_{BYPASS} = 10 nF w/o C_{BYPASS}		 20 110		µVrms
Noise Density	V_N	I_{OUT} = 50 mA, f = 1.0 kHz		100		nV/√Hz
PSRR		f = 1 kHz f = 10 kHz f = 100 kHz		67 65 48		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 (or min 3.8 V), I_{OUT} = 1.0 mA, C_{IN} = 1.0 µF, C_L = 1.0 µF, C_{BYPASS} = 10 nF, V_{CTRL} = V_{IN}, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Rise Time (10%…90%)		V_{CTRL} = 0 to 2.4 V, I_{OUT} = 30mA C_{BYPASS} = 10 nF w/o C_{BYPASS}		 4 16		 ms µs
Overshoot		V_{CTRL} = 0 to 2.4 V, w/o C_{BYPASS}		3	10	%
Start-up Delay		V_{CTRL} to V_{OUT} , w/o C_{BYPASS} (see figure 1 below)		17		µs

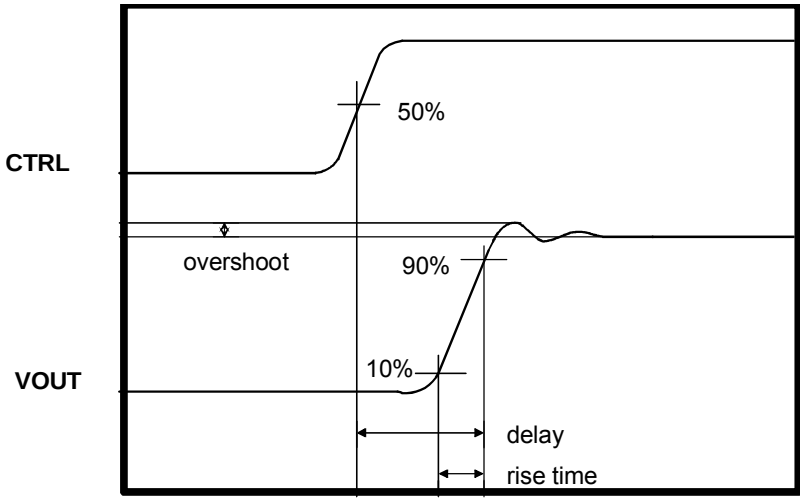
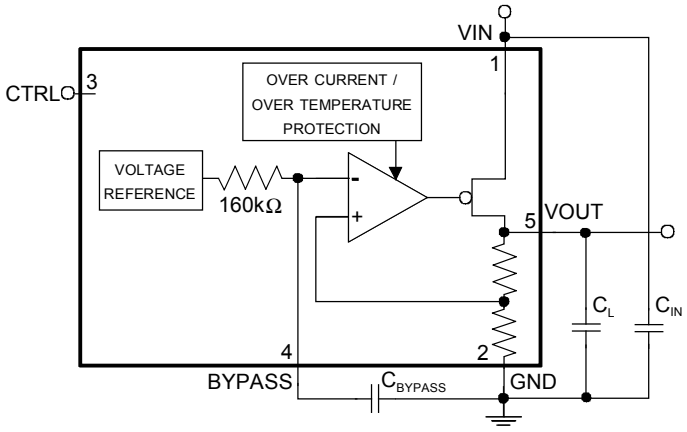


Figure1. Definitions of rise time, overshoot and start-up delay

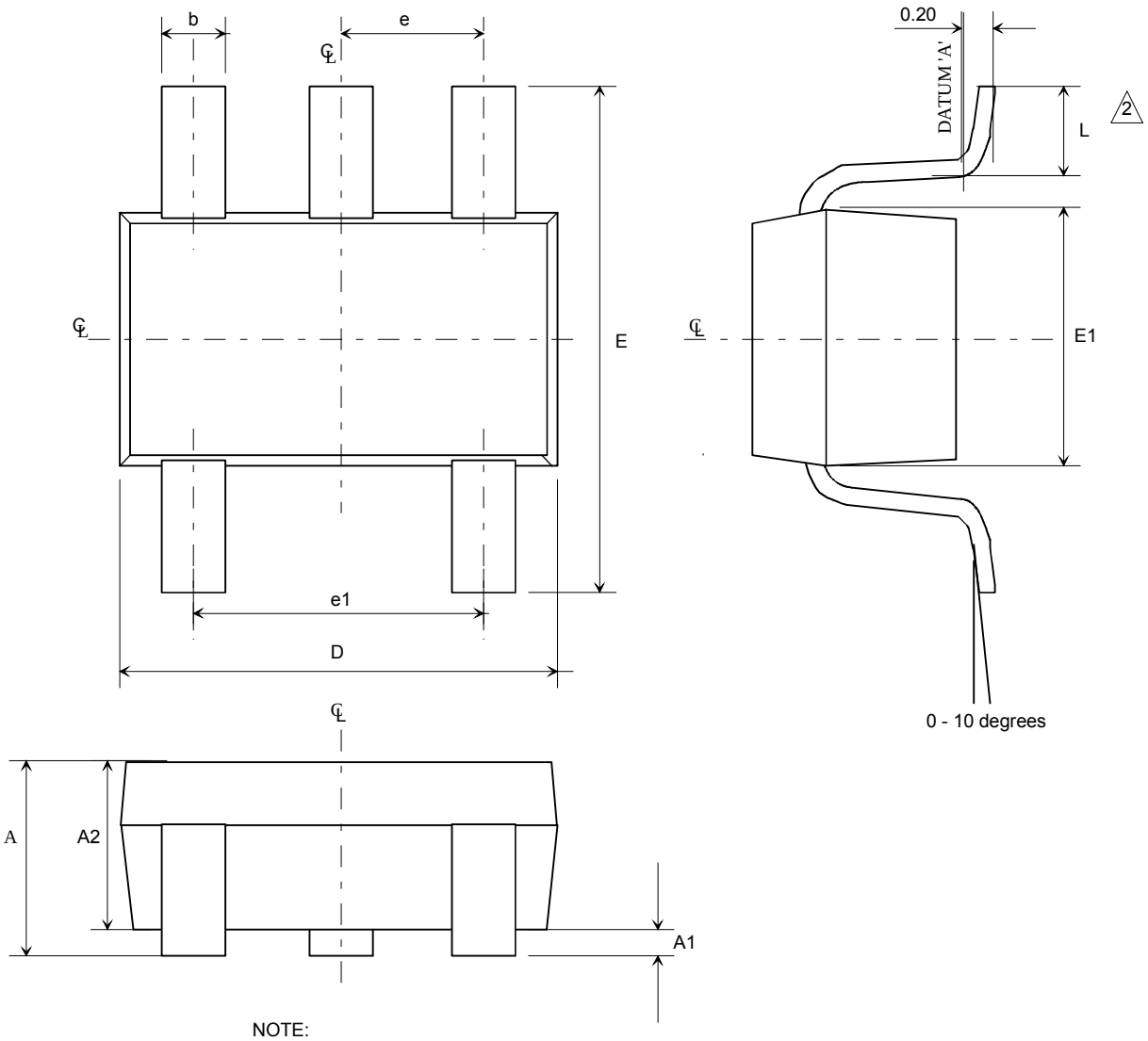
APPLICATION INFORMATION



Parameter	Symbol	Min	Max	Unit	Note
Output Capacitance	C_L	0.22		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	3	Ohm	1. When within this range, stable with all I_{OUT} = 0 mA…150 mA values.
Bypass Capacitance (Optional: if C_{BYPASS} is not used, noise performance and PSRR decline, but rise time is improved.)	C_{BYPASS}	Typically 0.01		µF	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 MAS9124. 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 MAS9124 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.
Control Voltage	V_{CTRL}	1.6	V_{IN} + 0.3	V	1. The device should always be in the ON state if $V_{OUT(NOM)}$ = 5 V.

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

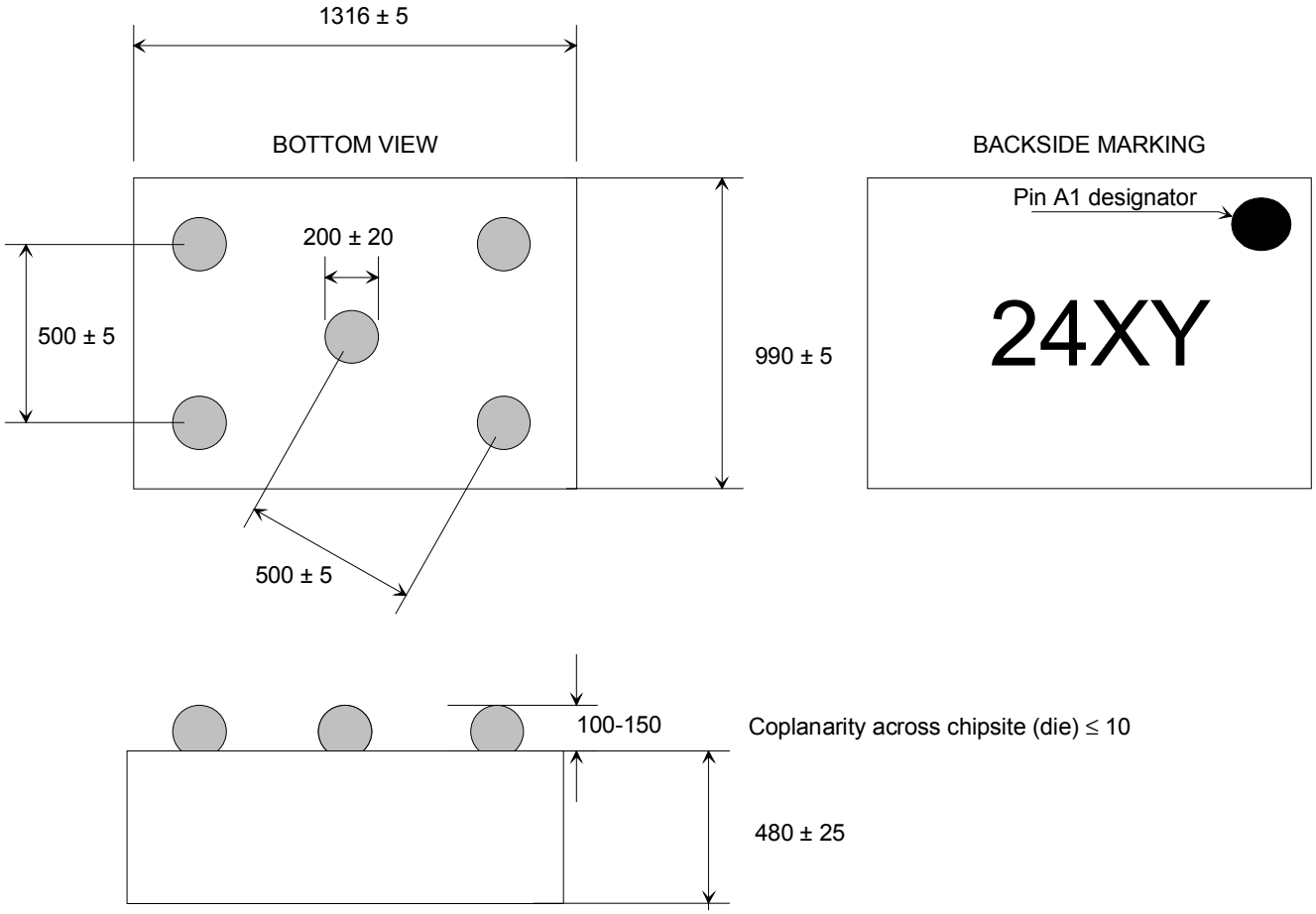


NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. FOOT LENGHT MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. COMPLY TO EIAJ SC74

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.



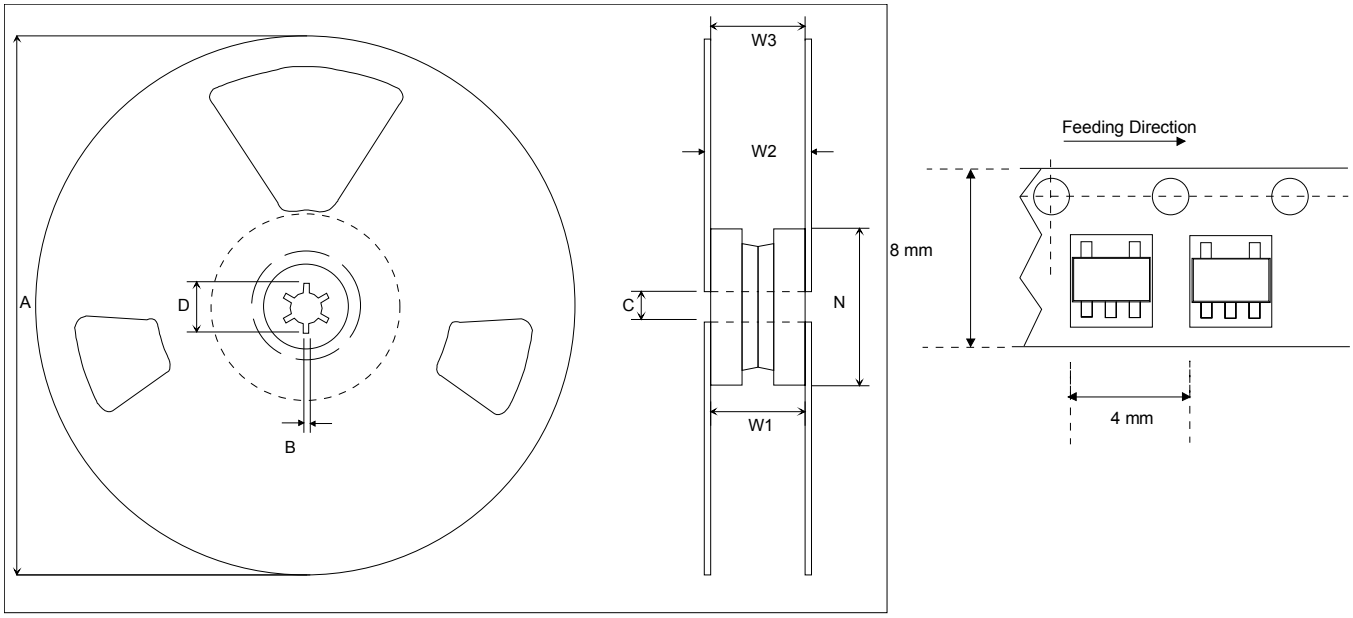
Definitions (see ordering information p. 11):

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	Pin Order Note 1	Comments
MAS9124AST5-T	1.50 V Voltage Regulator IC	24A5	SOT23-5		Tape and Reel
MAS9124AST4-T	1.80 V Voltage Regulator IC	24A4	SOT23-5		Tape and Reel
MAS9124A4CA11	1.80 V Voltage Regulator IC	24A4	WL-CSP	11	Under Qualification
MAS9124ASTA-T	2.30 V Voltage Regulator IC	24AA	SOT23-5		Tape and Reel
MAS9124ASTB-T	2.40 V Voltage Regulator IC	24AB	SOT23-5		Tape and Reel
MAS9124AST3-T	2.50 V Voltage Regulator IC	24A3	SOT23-5		Tape and Reel
MAS9124ASTC-T	2.60 V Voltage Regulator IC	24AC	SOT23-5		Tape and Reel
MAS9124ACCA11	2.60 V Voltage Regulator IC	24AC	WL-CSP	11	Under Qualification
MAS9124AST9-T	2.70 V Voltage Regulator IC	24A9	SOT23-5		Tape and Reel
MAS9124A9CA12	2.70 V Voltage Regulator IC	24Z9	WL-CSP	12	Under Qualification
MAS9124AST2-T	2.80 V Voltage Regulator IC	24A2	SOT23-5		Tape and Reel
MAS9124A2CA12	2.80 V Voltage Regulator IC	24Z2	WL-CSP	12	Under Qualification
MAS9124A2CA11	2.80 V Voltage Regulator IC	24A2	WL-CSP	11	Under Qualification
MAS9124AST8-T	2.86 V Voltage Regulator IC	24A8	SOT23-5		Tape and Reel
MAS9124A8CA12	2.86 V Voltage Regulator IC	24Z8	WL-CSP	12	Under Qualification
MAS9124A8CA11	2.86 V Voltage Regulator IC	24A8	WL-CSP	11	Under Qualification
MAS9124AST7-T	2.90 V Voltage Regulator IC	24A7	SOT23-5		Tape and Reel
MAS9124AST6-T	3.00 V Voltage Regulator IC	24A6	SOT23-5		Tape and Reel
MAS9124A6CA11	3.00 V Voltage Regulator IC	24A6	WL-CSP	11	Under Qualification
MAS9124ASTD-T	3.10 V Voltage Regulator IC	24AD	SOT23-5		Tape and Reel
MAS9124AST1-T	3.30 V Voltage Regulator IC	24A1	SOT23-5		Tape and Reel
MAS9124ASTF-T	4.00 V Voltage Regulator IC	24AF	SOT23-5		Tape and Reel
MAS9124AFCA12	4.00 V Voltage Regulator IC	24ZF	WL-CSP	12	Under Qualification
MAS9124ASTF-T	5.00 V Voltage Regulator IC	24AG	SOT23-5		Tape and Reel
MAS9124AGCA12	5.00 V Voltage Regulator IC	24ZG	WL-CSP	12	Under Qualification

Note 1: See the pin description on page 2.

For more voltage options contact Micro Analog Systems Oy.

LOCAL DISTRIBUTOR

MICRO ANALOG SYSTEMS OY CONTACTS

Micro Analog Systems Oy Kamreerintie 2, P.O.Box 51 FIN-02771 Espoo, FINLAND http://www.mas-oy.com	Tel. (09) 80 521 Tel. Int. +358 9 80 521 Telefax +358 9 805 3213 E-mail: info@mas-oy.com