AiT Semiconductor Inc.
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A6303A

CMOS LOW DROPOUT REGULATOR (LDO)
300mA ULTRA-LOW NOISE, ULTRA-FAST RESPONSE

DESCRIPTION

The A6303A is designed for portable RF and wireless applications with demanding performance and space requirements. The A6303A performance is optimized for battery-powered systems to deliver ultra low noise and low quiescent current. Regulator ground current increases only slightly in dropout, further prolonging the battery life. The A6303A also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices. The A6303A consumes less than 0.01μA in shutdown mode and has fast turn-on time less than 50μs. The other features include ultra low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio.

The A6303A is available in SOT-23, SOT-25 and SC70-5 Packages.

ORDERING INFORMATION

<table>
<tr><th>Package Type</th><th colspan="2">Part Number</th></tr>
<tr><td rowspan="2">SOT-23
SPQ: 3,000pcs/Reel</td><td rowspan="2">E3</td><td>A6303AE3R-XXZ</td></tr>
<tr><td>A6303AE3VR-XXZ</td></tr>
<tr><td rowspan="2">SOT-25
SPQ: 3,000pcs/Reel</td><td rowspan="2">E5</td><td>A6303AE5R-XXZ</td></tr>
<tr><td>A6303AE5VR-XXZ</td></tr>
<tr><td rowspan="2">SC70-5
SPQ: 3,000pcs/Reel</td><td rowspan="2">C5</td><td>A6303AC5R-XX</td></tr>
<tr><td>A6303AC5VR-XX</td></tr>
<tr><td>Note</td><td colspan="2">XX: Output Voltage
12= 1.2V, 15= 1.5V, 18= 1.8V,
25= 2.5V, 28= 2.8V, 30= 3.0V,
33= 3.3V, 50= 5.0V
Z: Output Type
A = A Type
V: Halogen free Package
R: Tape & Reel</td></tr>
<tr><td colspan="3">AiT provides all RoHS products</td></tr>
</table>

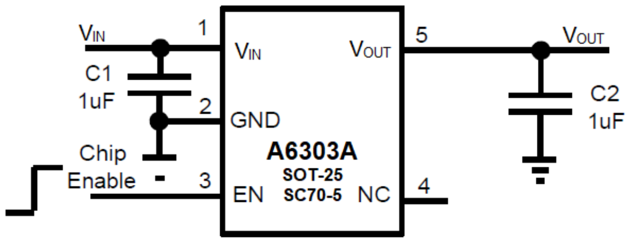
FEATURES

- Ultra-low Noise for RF Application
- Ultra-Fast Response in Line/Load Transient
- <0.01μA Standby Current When Shutdown (SOT-25, SC70-5)
- Low Dropout: 210mV@300mA
- Wide Operating Voltage Ranges: 2V to 6V
- Wide Output Voltage Range:1.2V to 5V
- TTL-logic-Controlled Shutdown Input (SOT-25, SC70-5)
- Low Temperature Coefficient
- Current Limiting Protection
- Thermal Shutdown Protection
- Only 1μF Output Capacitor Required for Stability
- High Power Supply Rejection Ratio
- Custom Voltage Available
- Fast output discharge
- Available in SOT-23, SOT-25, SC70-5 Packages

APPLICATION

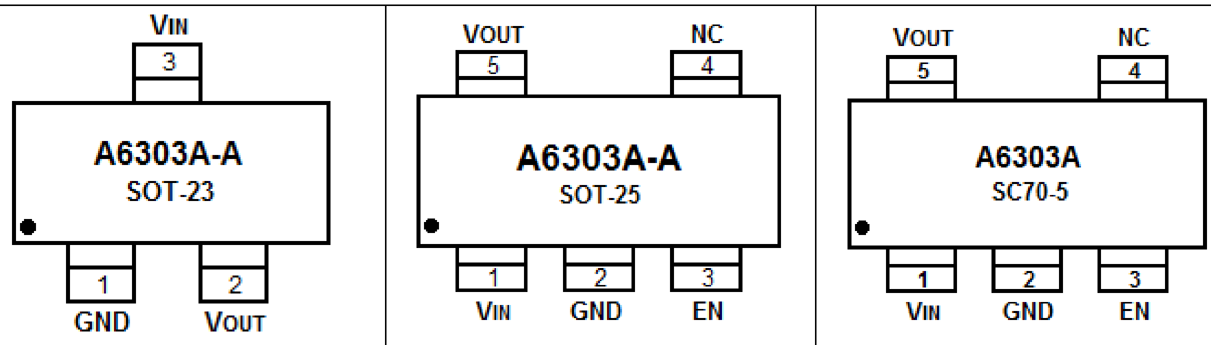
- Cellular and Smart Phones
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- PCMCIA Cards
- MP3/MP4/MP5 Players
- Portable Information Appliances

TYPICAL APPLICATION



NOTE: Output capacitor (C2 ≥ 2.2uF) is recommended in A6303A-1.2V, A6303A-1.3V, A6303A-1.5V and A6303A-1.8V application to assure the stability of circuit.

PIN DESCRIPTION



Top View Top View Top View

Package	SOT-23	SOT-25	SC70-5	Symbol	Function
Pin Type	A	A			
Pin #	3	1	1	V_{IN}	Power Input Voltage.
	1	2	2	GND	Ground
	-	3	3	EN	Chip Enable Pin. Active high with internal 8MΩ pull down
	-	4	4	NC	No Connection
	2	5	5	V_{OUT}	Output Voltage.

THERMAL RESISTANCE

Package	θ_{JA}	θ_{JC}
SOT-23	250°C/W	130°C/W
SOT-25	250°C/W	130°C/W
SC70-5	333°C/W	170°C/W

NOTE: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

ABSOLUTE MAXIMUM RATINGS[NOTE1]

V_{IN}, Input Supply Voltage	
SOT-25, SC70-5	-0.3V ~ +6V
SOT-23	-0.3V ~ +6.5V
EN Pin Input Voltage (SOT-25, SC70-5)	-0.3V ~ V_{IN}
Output Voltages	-0.3V ~ V_{IN}+0.3V
Output Current	300mA
Maximum Junction Temperature	
SOT-25, SC70-5	150°C
SOT-23	125°C
Operating Temperature Range[NOTE2]	-40°C ~ 85°C
Storage Temperature Range	-65°C ~ 125°C
Lead Temperature (Soldering, 10s)	300°C

Stresses above may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

NOTE2: The A6303A is guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

ELECTRICAL CHARACTERISTICS[NOTE3]

V_{IN} = 3.6V, EN = V_{IN} (SOT-25, SC70-5), C_{IN} = C_{OUT} = 1uF, T_A = 25°C, unless otherwise specified.

Parameter		Symbol	Conditions		Min	Typ	Max	Unit
Input Voltage		V_{IN}			2	-	6	V
Output Voltage Accuracy[NOTE4]		ΔV_{OUT}	V_{IN} = 3.6V, I_{OUT} = 1mA		-2	-	+2	%
Current Limit		I_{LIM}	R_{LOAD} = 1Ω		400	430	-	mA
Quiescent Current		I_Q	V_{EN} > 1.2V, I_{OUT} = 0mA	SOT-25 / SC70-5	-	90	130	μA
			I_{OUT} = 0mA	SOT-23				
Dropout Voltage		V_{DROP}	I_{OUT} = 200mA, V_{OUT} = 2.8V		-	130	180	mV
			I_{OUT} = 300mA, V_{OUT} = 2.8V		-	210	300	
Line Regulation[NOTE5]		ΔV_{LINE}	V_{IN} = 3.6V to 5.5V, I_{OUT} = 1mA		-	0.05	0.17	%/V
Load Regulation[NOTE6]		ΔV_{LOAD}	1mA < I_{OUT} < 300mA		-	-	2	%/A
Output Voltage[NOTE7] Temperature Coefficient		TC_{VOUT}	I_{OUT} = 1mA		-	±60	-	ppm/°C
Standby Current		I_{STBY}	V_{EN} = GND, Shutdown	SOT-25 / SC70-5	-	0.01	0.1	μA
EN Input Bias Current		I_{IBSD}	V_{EN} =GND or V_{IN}	SOT-25 / SC70-5	-	-	500	nA
EN Input Threshold	Logic Low	V_{IL}	V_{IN} = 3V to 5.5V, Shutdown	SOT-25 / SC70-5	-	-	0.4	V
	Logic High	V_{IH}	V_{IN} = 3V to 5.5V, Start up	SOT-25 / SC70-5	1.2	-	-	
Output Noise Voltage		e_{NO}	10Hz to 100kHz, I_{OUT} = 200mA		-	100	-	μV$_{RMS}$
Power Supply Rejection Ratio	f = 217Hz	PSRR	I_{OUT} = 100mA		-	-78	-	dB
	f = 1kHz					-72		
	f = 10kHz					-52		
Thermal Shutdown Temperature		T_{SD}	Shutdown, Temp increasing		-	165	-	°C
Thermal Shutdown Hysteresis		T_{SDHY}			-	30	-	°C

NOTE3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

NOTE4: Output voltage accuracy : ±2%.

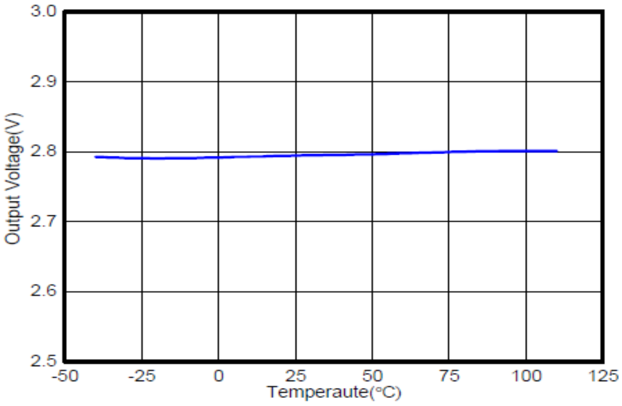
NOTE5: Line regulation is calculated by $\Delta V_{LINE} = [(V_{OUT1} - V_{OUT2}) / (\Delta V_{IN} \times V_{OUT(NORMAL)})] \times 100$. Where V_{OUT1} is the output voltage when V_{IN} = 5.5V, and V_{OUT2} is the output voltage when V_{IN} = 3.6V, ΔV_{IN} = 1.9V, $V_{OUT\ (NORMAL)}$ = 2.8V.

NOTE6: Load regulation is calculated by $\Delta V_{LOAD} = [(V_{OUT1} - V_{OUT2}) / (\Delta I_{OUT} \times V_{OUT(NORMAL)})] \times 100$. Where V_{OUT1} is the output voltage when I_{OUT} = 1mA, and V_{OUT2} is the output voltage when I_{OUT} = 300mA. ΔI_{OUT} = 0.299A, $V_{OUT(NORMAL)}$ = 2.8V.

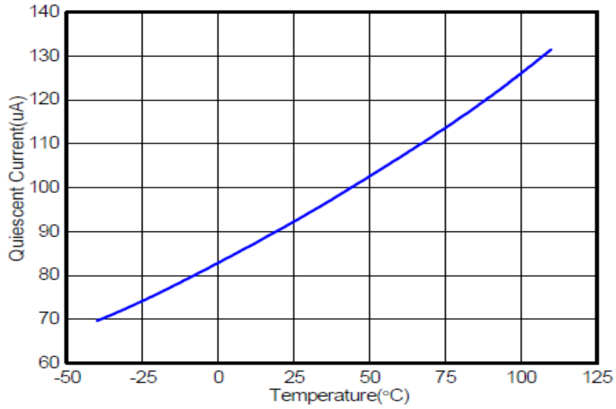
NOTE7: The temperature coefficient is calculated by $TC_{VOUT} = [\Delta V_{OUT} / (\Delta T \times V_{OUT})]$

TYPICAL PERFORMANCE CHARACTERISTICS

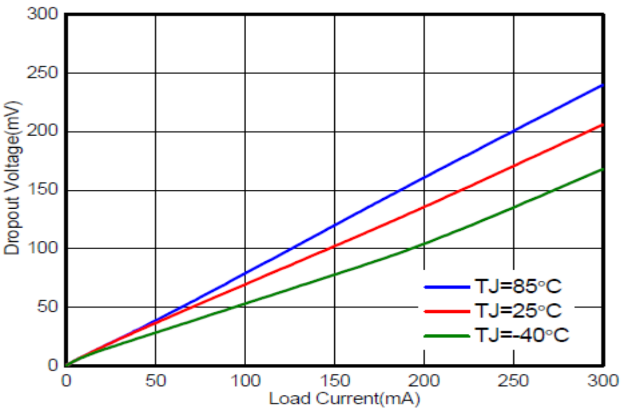
1. Output Voltabe vs. Temperature
   V_{IN} = 3.6V, C_{IN} = C_{OUT} = 1uF



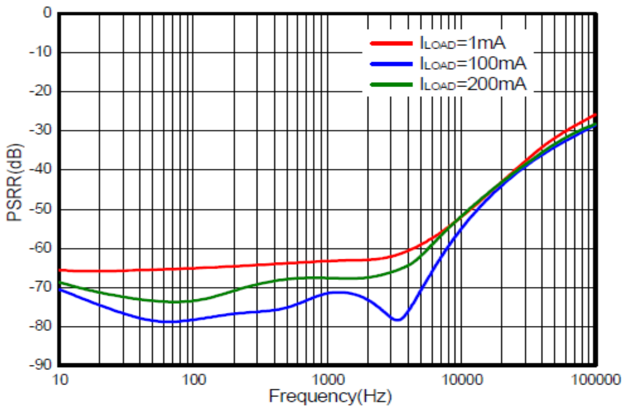
2. Quiescent Current vs. Temperature
   V_{IN}= 3.6V, C_{IN} = C_{OUT} = 1uF



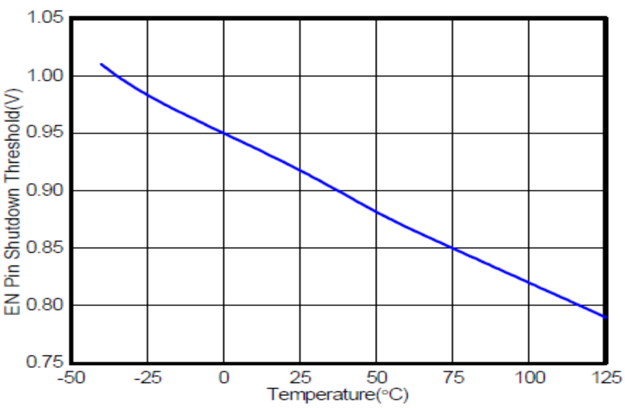
3. Dropout Voltage vs. Load Current
   V_{OUT} = 2.8V(SOT-23,), C_{IN} = C_{OUT} = 1uF



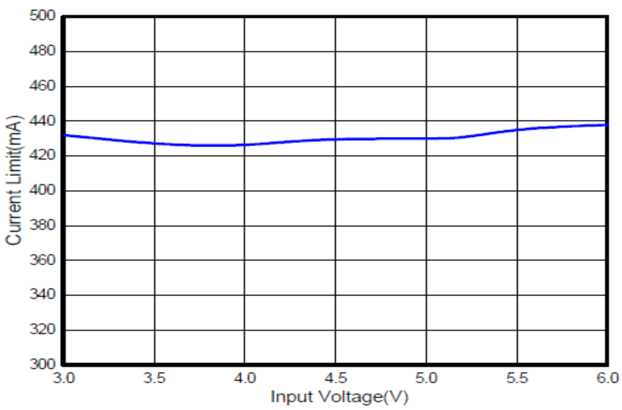
4. PSRR
   V_{IN} = 4.2V, C_{IN} = 1uF, C_{OUT} = 1uF X7R



5. EN Pin Shutdown Threshold Vs. Temperature
   (SOT-25, SC70-5) V_{IN}=3.6V, C_{IN} = C_{OUT} = 1uF

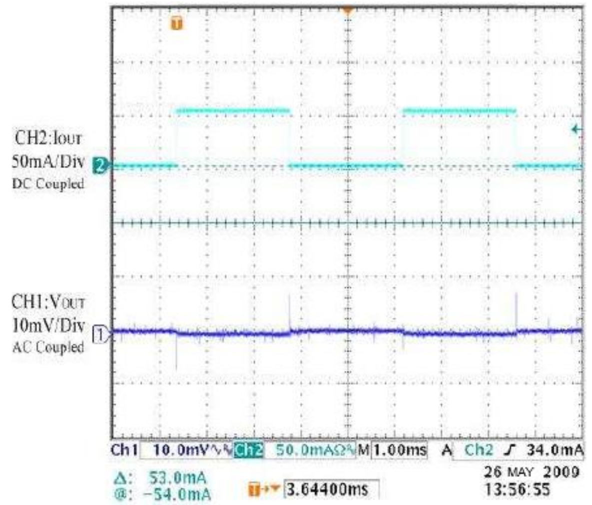


6. Current Limit Vs. Input Voltage
   C_{IN} = C_{OUT} = 1uF, V_{OUT}=2.8V



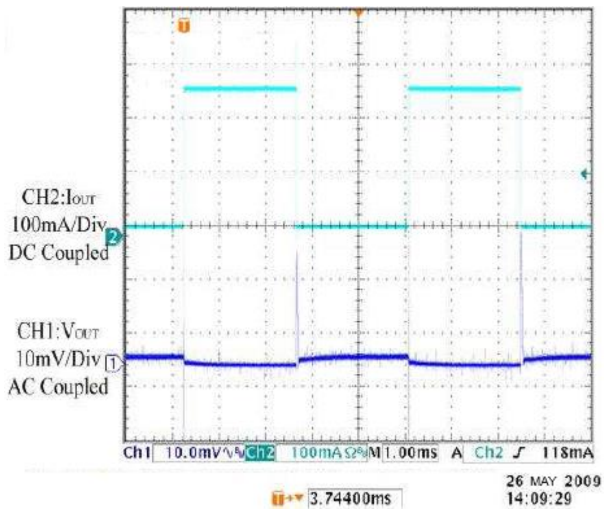
7. Load Transient Response

V_{IN}=5V, V_{OUT}=2.8V, C_{IN} = C_{OUT} = 1uF, I_{OUT}=1mA to 50mA



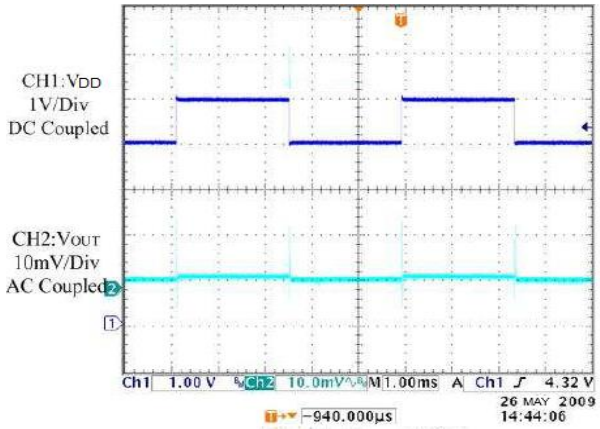
8. Load Transient Response

V_{IN}=5V, V_{OUT}=2.8V, C_{IN} = C_{OUT} = 1uF, I_{OUT}=1mA to 250mA



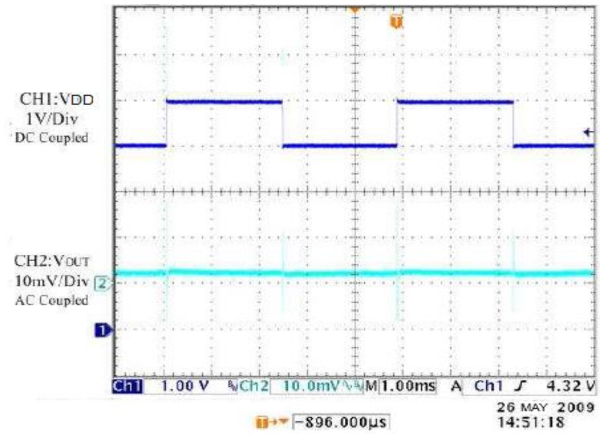
9. Line Transient Reaponse

V_{IN}=4V to 5V, V_{OUT}=2.8V, C_{IN} = C_{OUT} = 1uF, I_{OUT}=1mA



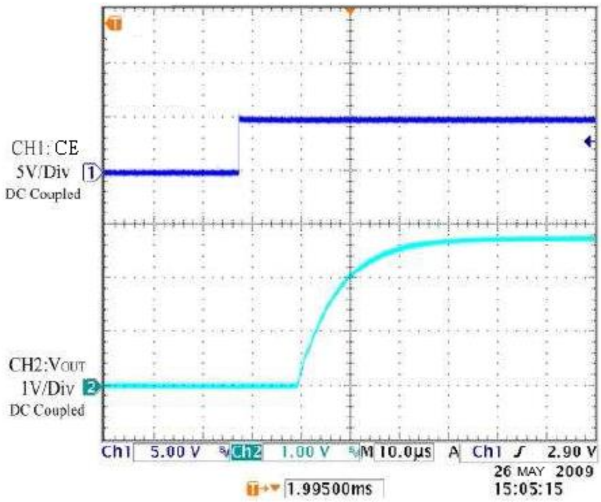
10. Line Transient Response

V_{IN}=4V to 5V, V_{OUT}=2.8V, C_{IN} = C_{OUT} = 1uF, I_{OUT}=100mA



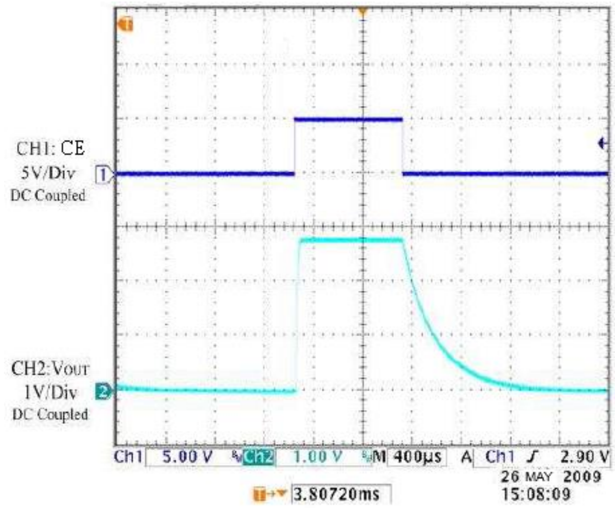
11. Start Up (SOT-25, SC70-5)

V_{IN}= 5V, V_{OUT}=2.8V, C_{IN} = C_{OUT} = 1uF, No Load



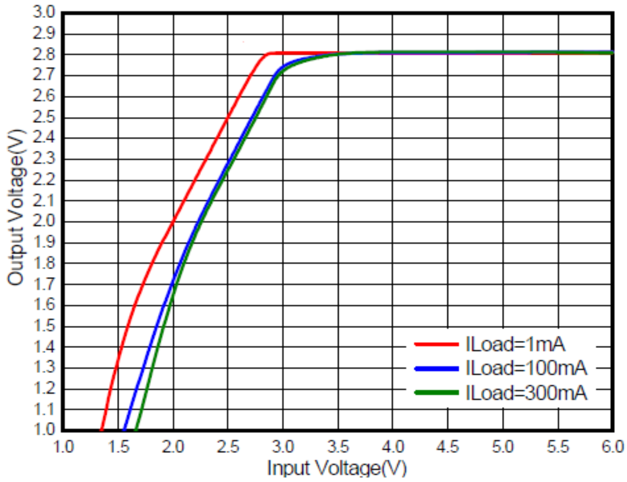
12. EN Pin Shutdown Response (SOT-25, SC70-5)

V_{IN}= 5V, V_{OUT}=2.8V , C_{IN} = C_{OUT} = 1uF, No Load

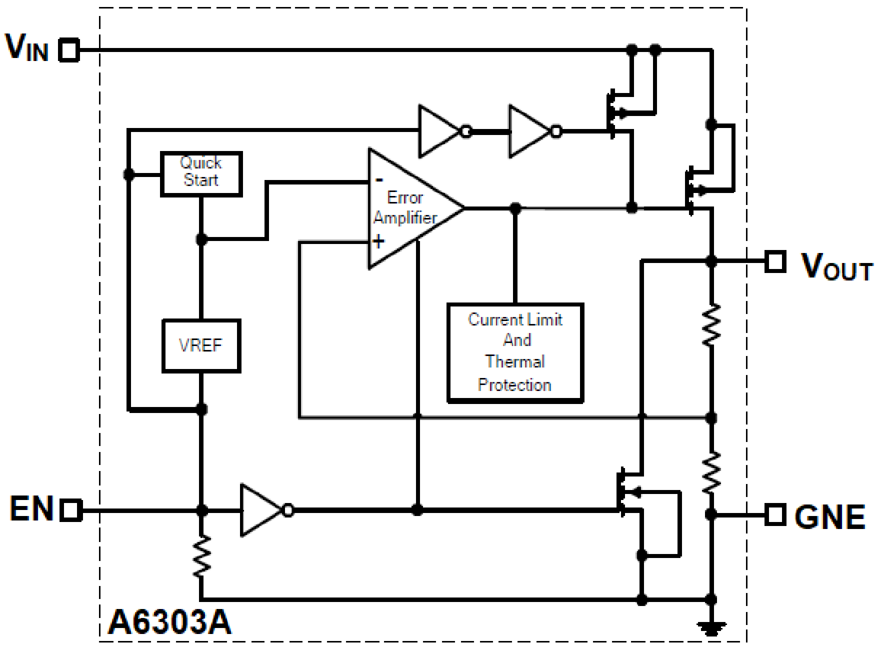


13. V_{OUT} vs. V_{IN}

V_{OUT} = 2.8V(SOT-23), C_{IN} = C_{OUT} = 1uF



BLOCK DIAGRAM



DETAILED INFORMATION

Like any low-dropout regulator, the external capacitors used with the A6303A must be carefully selected for regulator stability and performance. Using a capacitor whose value is > 1μF on the A6303A input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response. The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs application. The A6303A is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1μF with ESR is > 25mΩ on the A6303A output ensures stability. The A6303A still works well with output capacitor of other types due to the wide stable ESR range. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located not more than 0.5 inch from the V_{OUT} pin of the A6303A and returned to a clean analog ground.

Enable Function (SOT-25, SC70-5)

The A6303A features an LDO regulator enable/disable function. To assure the LDO regulator will switch on; the EN turn on control level must be greater than 1.2 volts. The LDO regulator will go into the shut down mode when the voltage on the EN pin falls below 0.4 volts. For to protect the system, the A6303A have a quick discharge function. If the enable function is not needed in a specific application, it may be tied to V_{IN} to keep the LDO regulator in a continuously on state.

Thermal Considerations

Thermal protection limits power dissipation in A6303A. When the operation junction temperature exceeds 165°C, the OTP circuit starts the thermal shutdown function turn the pass element off. The pass element turns on again after the junction temperature cools by 30°C.

For continue operation, do not exceed absolute maximum operation junction temperature 125°C. The power dissipation definition in device is:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q \text{ (SOT-23)}$$

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junction to ambient. The maximum power dissipation can be calculated by following formula：

$$P_D(MAX) = (T_J(MAX) - T_A) / \theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum operation junction temperature 125°C, T_A is the ambient temperature and the $θ_{JA}$ is the junction to ambient thermal resistance. For recommended operating conditions specification of A6303A, where T_J(MAX) is the maximum junction temperature of the die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance ($θ_{JA}$ is layout dependent) for SOT-23, SOT-25 package is 250°C/W, SC70- 5 package is 333°C/W, on standard JEDEC 51-3 thermal test board. The maximum power dissipation at T_A= 25°C can be calculated by following formula:

$$P_D(MAX) = (125°C-25°C)/250 = 400mW \ (SOT\text{-}23,\ SOT\text{-}25)$$

$$P_D(MAX) = (125°C-25°C)/333 = 300mW \ (SC70\text{-}5)$$

The maximum power dissipation depends on operating ambient temperature for fixed T_J(MAX) and thermal resistance $θ_{JA}$. It is also useful to calculate the junction of temperature of the A6303A under a set of specific conditions. In this example let the Input voltage V_{IN}=3.3V, the output current Io=300mA and the case temperature T_A=40°C measured by a thermal couple during operation. The power dissipation for the V_{OUT}=2.8V version of the A6303A can be calculated as:

$$P_D = (3.3V-2.8V) \times 300mA+3.6V \times 100uA = 150mW$$

And the junction temperature, T_J, can be calculated as follows:

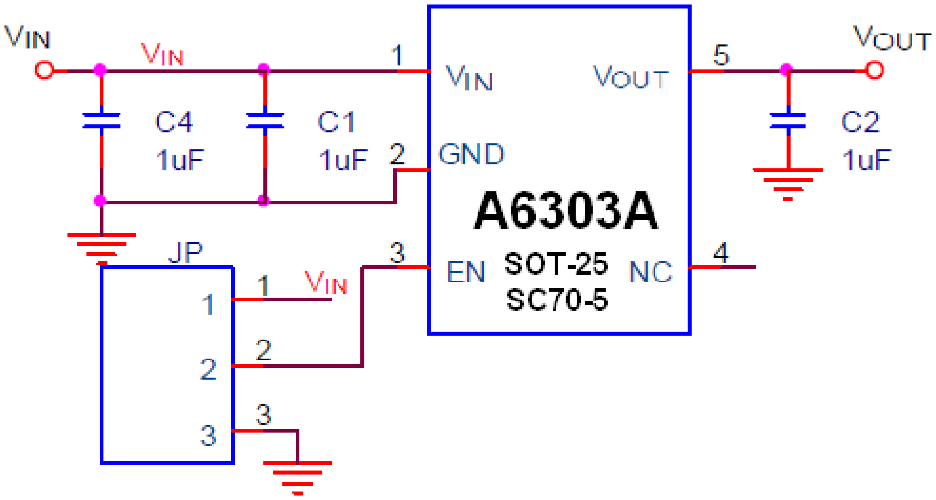
$$T_J=T_A+P_D \times θ_{JA}=40°C+0.15W \times 250°C/W$$

$$=40°C+37.5°C=77.5°C<T_J(MAX)= 150°C$$

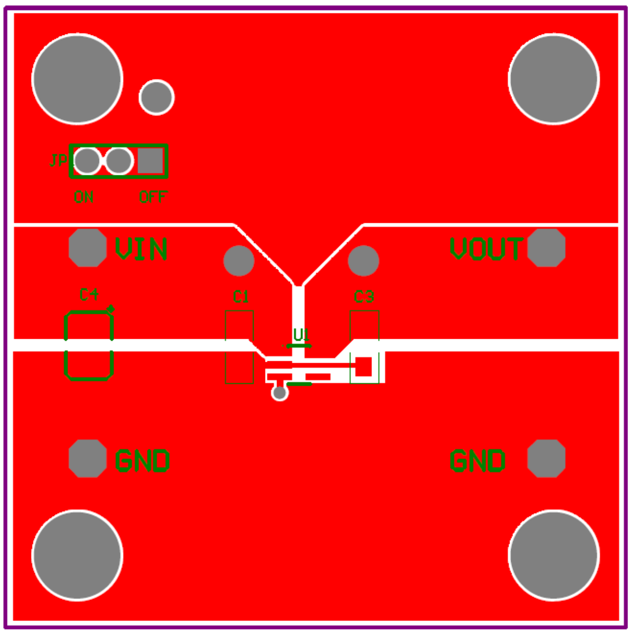
For this operating condition, T_J is lower than the absolute maximum operating junction temperature,125°C, so it is safe to use the A6303A in this configuration.

Layout considerations

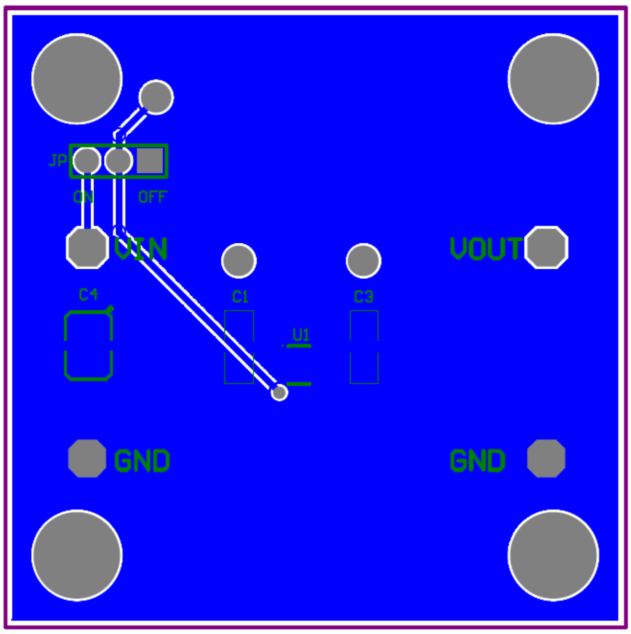
To improve ac performance such as PSRR, output noise, and transient response, it is recommended that the PCB be designed with separate ground planes for V_{IN} and V_{OUT}, with each ground plane connected only at the GND pin of the device.



A6303A-2.8V(SOT-25, SC70-5) Layout Circuit



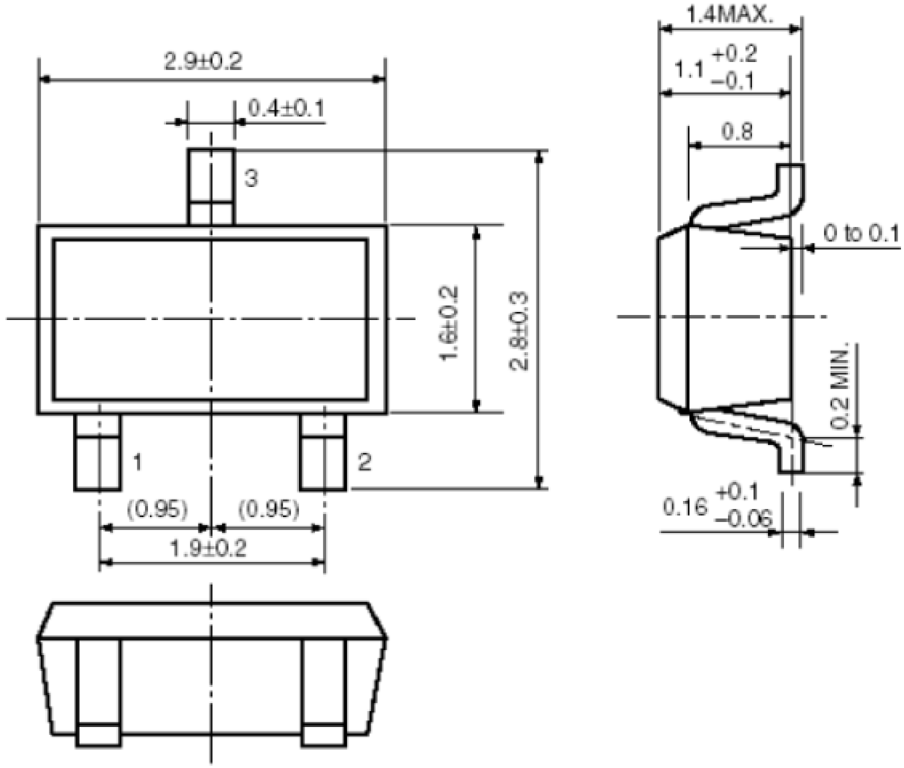
TOP Layer Layout



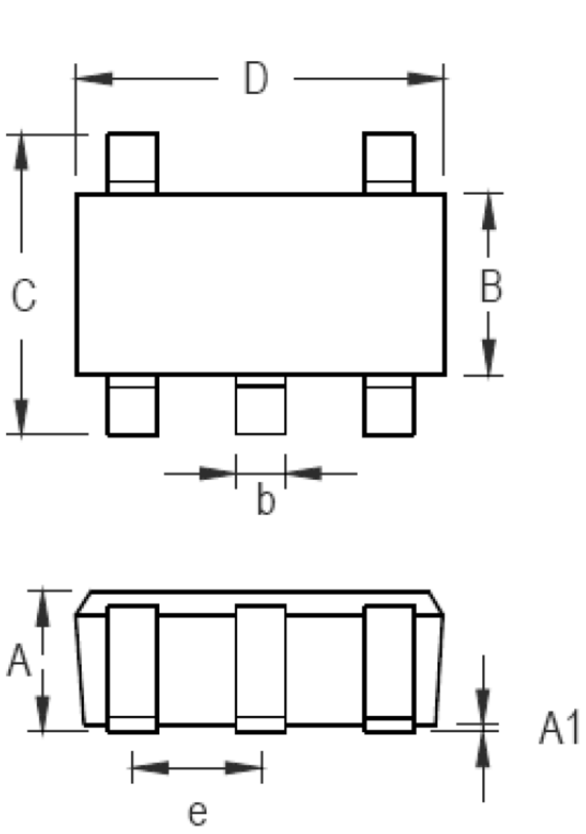
BOTTOM Layer Layout

PACKAGE INFORMATION

Dimension in SOT-23 Package (Unit: mm)

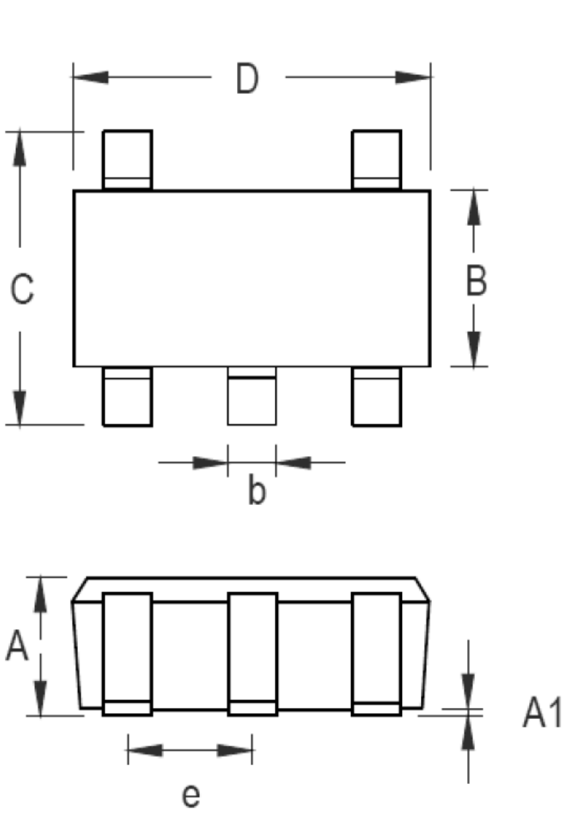


Dimension in SOT-25 (Unit: mm)



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.559	0.014	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

Dimension in SC70-5 (Unit: mm)



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.031	0.044
A1	0.000	0.100	0.000	0.004
B	1.150	1.350	0.045	0.054
b	0.150	0.400	0.006	0.016
C	1.800	2.450	0.071	0.096
D	1.800	2.250	0.071	0.089
e	0.650 TYP		0.026 TYP	
H	0.080	0.260	0.003	0.010
L	0.210	0.460	0.008	0.018

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