DESCRIPTION

The A6300 is a series of CMOS positive linear regulators features enable pin function with low dropout voltage, making them ideal for battery powered applications.

The A6300 features a fixed output voltage for 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 2.85V, 3.0V, 3.3V and 4.0V.
The A6300 has both thermal shutdown and current limiting to prevent device failure under extreme operating conditions.

The A6300 features a typical 0.8Ω P-Channel MOSFET pass transistor. It provides several advantages over similar designs using PNP pass transistors, including longer battery life.

The A6300 is available in SOT-23, SOT-25, TSOT-25 and SC70-5 package.

ORDERING INFORMATION

Package Type	Part Number	
SOT-23	E3	A6300E3R-XXZ
		A6300E3VR-XXZ
SOT-25	E5	A6300E5R-XX
		A6300E5VR-XX
TSOT-25	TE5	A6300TE5R-XX
		A6300TE5VR-XX
SC70-5	C5	A6300C5R-XX
		A6300C5VR-XX
Note	XX: Output Voltage 25=2.5V, 33=3.3V… Z: A, B (Package type, see pin description table) V: GREEN Package R: Tape & Reel	
AiT provides all Pb free products Suffix "V" means GREEN PACKAGE		

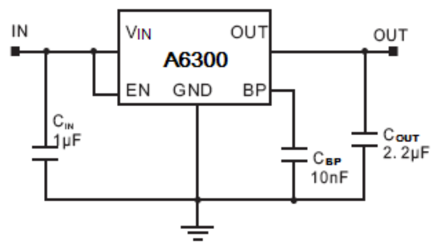
FEATURES

- Fixed Output Voltage: 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 2.85V, 3.0V, 3.3V and 4.0V (Customized 0.1V Step Output Voltage)
- Low Dropout Voltage: 0.18V@ 300mA (V_{OUT}=3.3V)
- High PSRR: 70dB @ 100Hz
- Quiescent Current: 67uA (Typ.)
- Accurate within ±2%
- Excellent Line and Load Regulation
- Fast Response
- Output Current Limit and Thermal Shutdown
- Short Circuit Protection
- Low Temperature Coefficient
- Shutdown Current: 0.5uA
- Available in SOT-23, SOT-25, TSOT-25 and SC70-5 package

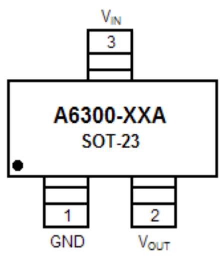
APPLICATION

- Power Source for Mobile and various kind of PCs
- Battery Powered Equipment
- Power Management of MP3, PDA, DSC, Mouse, PS2 Games
- Reference Voltage Source
- Regulation after Switching Power
- Notebook and Handheld equipment
- Wireless LAN, Bluetooth, GPS Receivers
- Cordless Phones
- Radio Communication Equipment

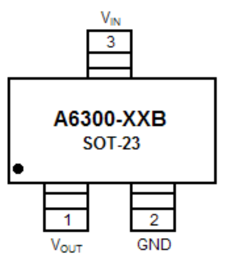
Typical Application



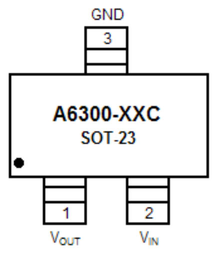
PIN DESCRIPTION



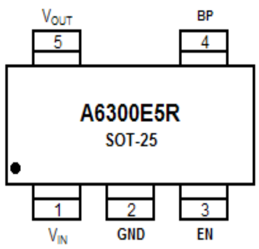
Top View



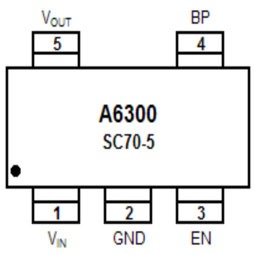
Top View



Top View



Top View



Top View

Pin #					Symbol	Function
SOT-23			TSOT-25	SC70-5		
A	B	C	SOT-25			
3	3	2	1	1	V_{IN}	Input Voltage Pin
1	2	3	2	2	GND	Ground Pin
-	-		3	3	EN	Enable Pin (Active High)
-	-		4	4	BP	Bypass Pin
2	1	1	5	5	V_{OUT}	Output Voltage Pin

ABSOLUTE MAXIMUM RATINGS

Input Voltage	6V
Output Current	300mA
Output Voltage GND	-0.3V to V_{IN} +0.3V
Lead Soldering Temperature	300℃, 10sec
Storage Temperature	-65℃~150℃
Junction Temperature	-40℃~+125℃
Ambient Temperature	-40℃~+85℃
Thermal Resistance (Junction to Case, θ_{JC})	
SOT-23	130℃/W
SOT-25	130℃/W
TSOT-25	130℃/W
Thermal Resistance (Junction to Ambient, θ_{JA})	
SOT-23	250℃/W
SOT-25	250℃/W
TSOT-25	250℃/W
SC70	300℃/W
Internal Power Dissipation (P_D)	
SOT-23	400mW
SOT-25	400mW
TSOT-25	400mW
SC70	300mW

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.

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{OUT} + 1V$, $C_{IN} = 1\mu F$, $C_{OUT} = 2.2\mu F$, $T_A = 25°C$, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{IN}	Input Voltage	$V_{OUT} \le 1.2V$		2.5		5.5 NOTE1	V
		$V_{OUT} > 1.2V$		NOTE2		5.5	
V_{OUT}	Output Voltage	I_{OUT} = 1mA		V_{OUT} -2%		V_{OUT} +2%	V
I_{OUT}	Output Current			300			mA
$V_{DROPOUT}$	Dropout Voltage	I_{OUT} = 300mA	V_{OUT}=1.5V		1150	1450	mV
			V_{OUT}=1.8V		850	1100	
			$2.5V \le V_{OUT} \le 3.3V$		375	450	
			$V_{OUT} \ge 3.3V$		180	230	
I_{LIM}	Current Limit	$V_{OUT} > 1.2V$, $V_{IN} = V_{OUT}+1V$			350		mA
I_{GND}	Ground Current	I_{OUT} = 1mA to 300mA			70	90	uA
Iq	Quiescent Current	Iq = 0mA			67	90	uA
ΔV_{LINE}	Line Regulation	I_{OUT}=10mA ,V_{OUT}=1.2V V_{IN}=2.5V to 5V		-0.15	0.1	0.15	%/V
		I_{OUT}=1mA,1.2V<V_{OUT} < 2V		-0.15	0.1	0.15	
		I_{OUT}=1mA ,2V<V_{OUT} <4V V_{IN}=V_{OUT}+0.5V to V_{OUT}+1V		-0.1	0.03	0.1	
		I_{OUT}=1mA , V_{OUT} ≥3.3V V_{IN}=V_{OUT}+0.5V to V_{OUT}+1V		-0.4	0.02	0.4	
ΔV_{LOAD}	Load Regulation	I_{OUT} = 1mA to 300mA		-1	0.2	1	%
T_C	Temperature Coefficient	I_{OUT} = 1mA			40		ppm/ ℃
T_{SD}	Over Temperature Shutdown	I_{OUT} = 1mA			150		℃
T_{HYS}	Over-Temperature Shutdown Hysteresis	I_{OUT} = 1mA			30		℃
PSRR	Power Supply Rejection	I_{OUT}= 100mA V_{OUT}=1.2V	f = 100Hz		65		dB
			f = 1kHz		60		
PSRR	Power Supply Rejection (with Bypass)	I_{OUT} =100mA V_{OUT}=2.2V, C_{BP} = 10nF	f = 100Hz		70		dB
			f = 1kHz		65		
V_N	Output Voltage Noise	f = 10kHz to 100kHz, C_{BP} = 10nF			50		μV_{RMS}
V_{IH}	EN Input High Threshold	V_{IN} = 2.5V to 5V		1.5			V
V_{IL}	EN Input Low Threshold	V_{IN} = 2.5V to 5V				0.3	V
I_{BIAS}	EN Bias Current						nA
I_{SD}	Shutdown Current	V_{EN} = 0V			0.01	1	μA

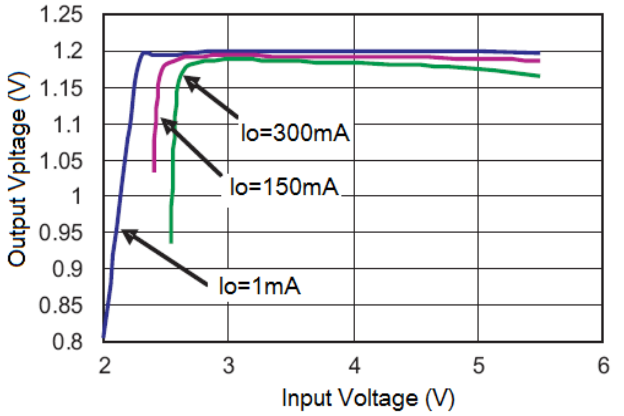
NOTE1: Output Current is limited by P_D, Maximum I_{OUT}=400mW/$V_{IN(MAX.)}$ – 1.2V

NOTE2: The minimum input voltage ($V_{IN(MIN)}$) of the A6300 is determined by output voltage and dropout voltage. The minimum input voltage is defined as: $V_{IN(MIN)} = V_{OUT} + V_{DROP}$

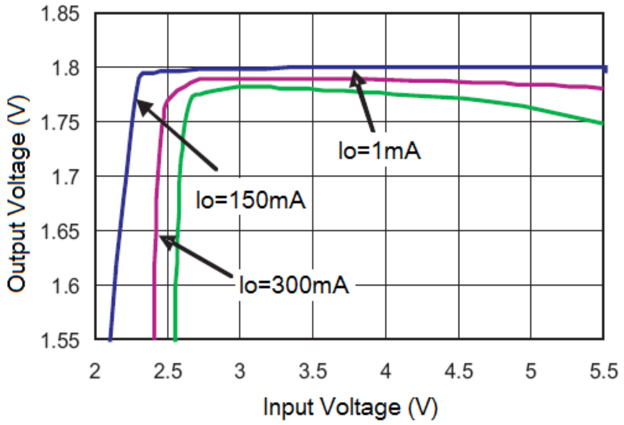
TYPICAL PERFORMANCE CHARACTERISTICS

T_A=25°C, V_{EN}=V_{IN}, C_{IN}=1μF, C_{OUT}=2.2μF, C_{BP}=10nF, unless otherwise specified.

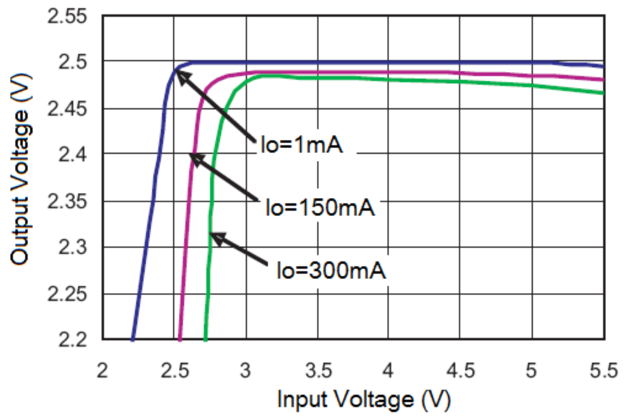
1. Output Voltage vs. Input Voltage
   V_{OUT}=1.2V



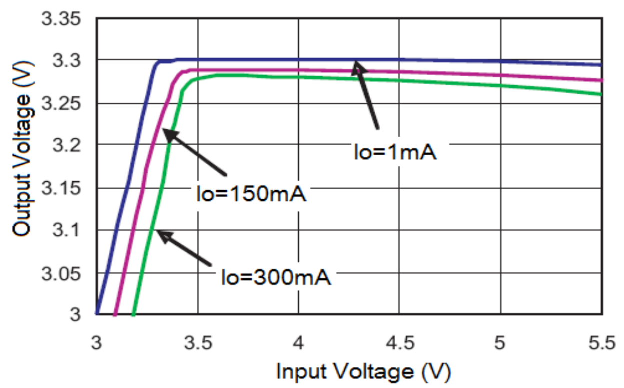
2. Output Voltage vs. Input Voltage
   V_{OUT}=1.8V



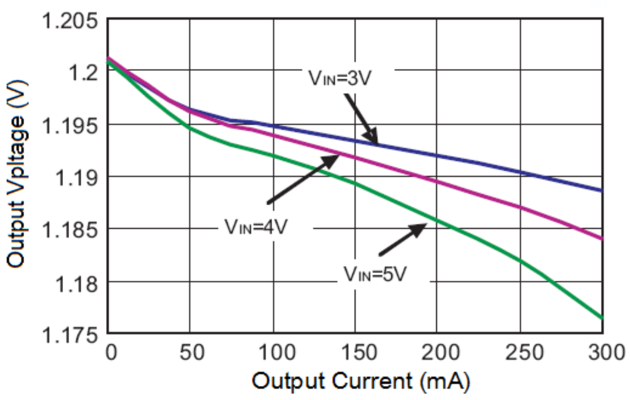
3. Output Voltage vs. Input Voltage
   V_{OUT}=2.5V



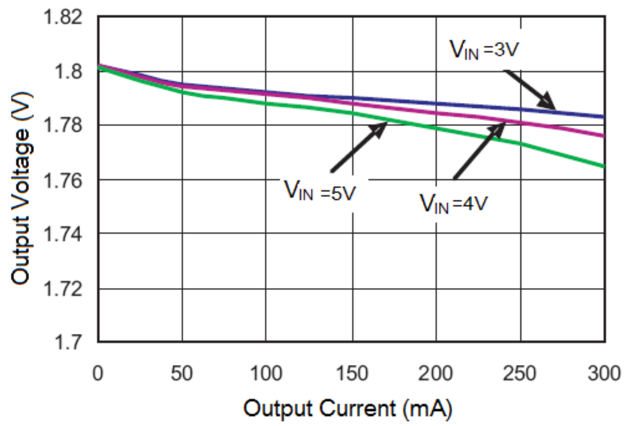
4. Output Voltage vs. Input Voltage
   V_{OUT}=3.3V



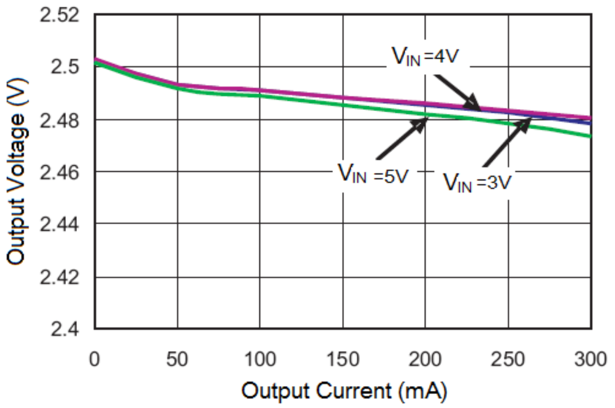
5. Output Voltage vs. Output Current
   V_{OUT}=1.2V



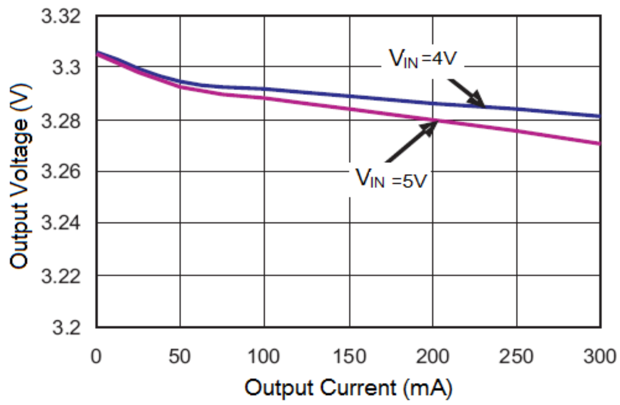
6. Output Voltage vs. Output Current
   V_{OUT}=1.8V



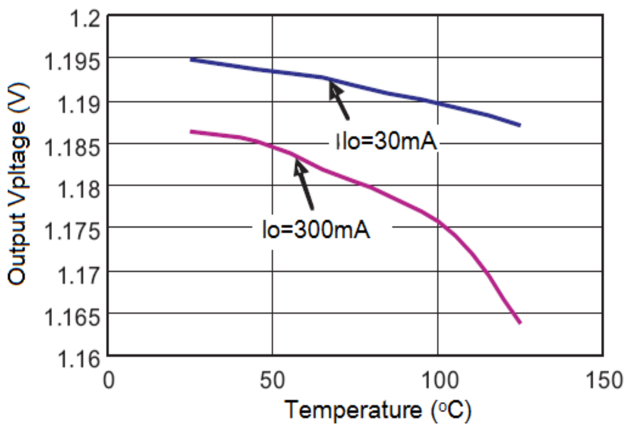
7. Output Voltage vs. Output Current
V_{OUT}=2.5V



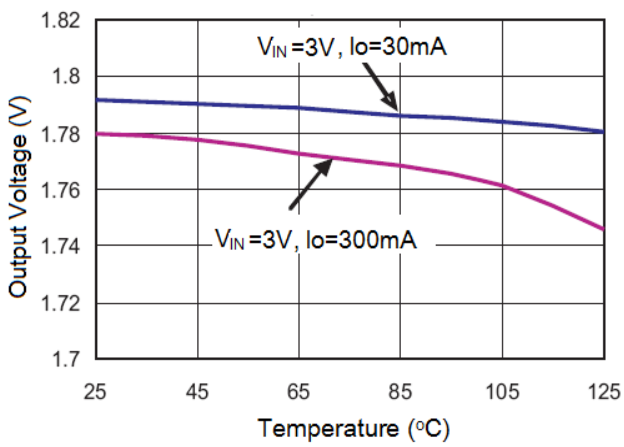
8. Output Voltage vs. Output Current
V_{OUT}=3.3V



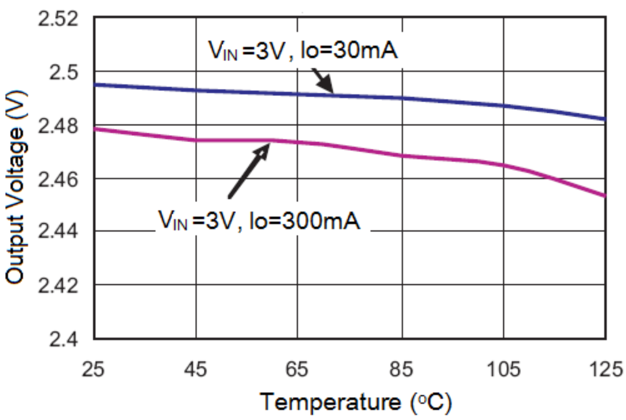
9. Output Voltage vs. Temperature
V_{OUT}=1.2V



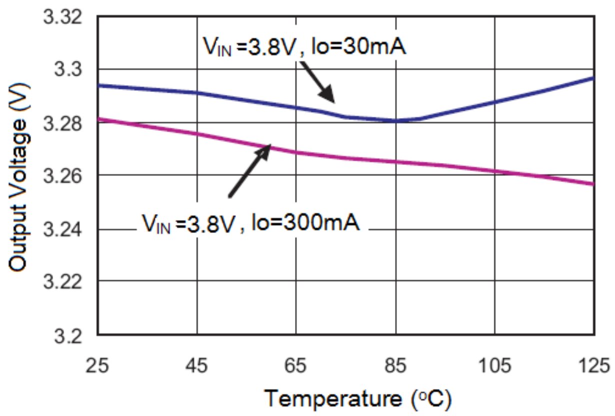
10. Output Voltage vs. Temperature
V_{OUT}=1.8V



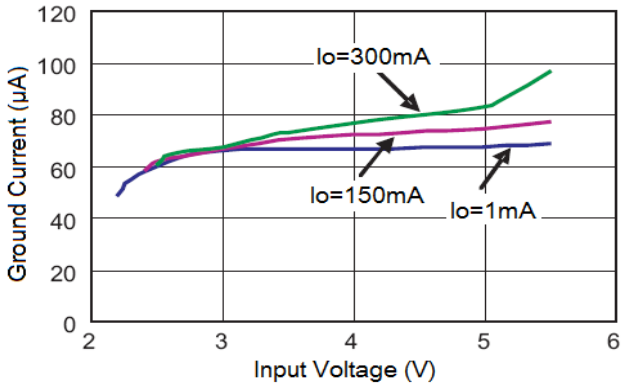
11. Output Voltage vs. Temperature
V_{OUT}=2.5V



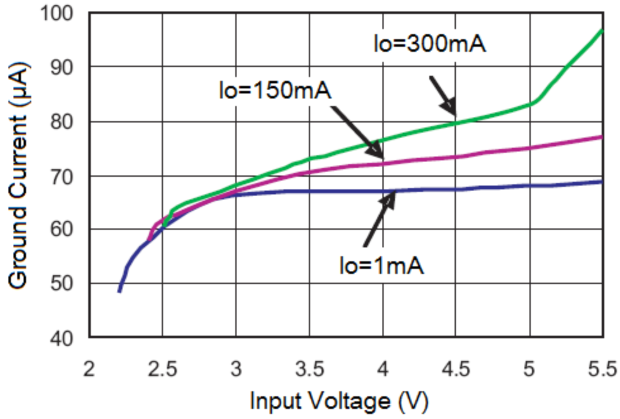
12. Output Voltage vs. Temperature
V_{OUT}=3.3V



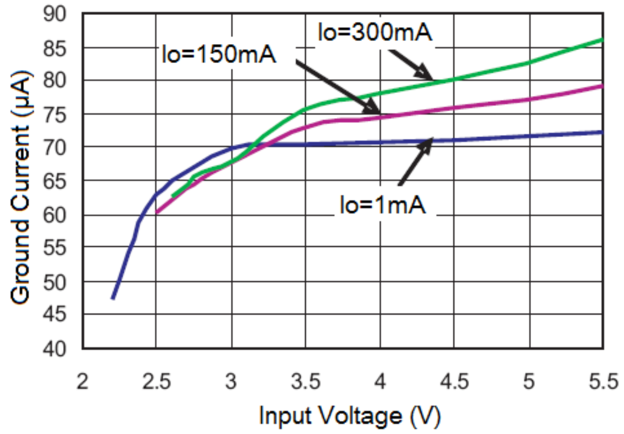
13. Ground Current vs. Input Voltage
V_{OUT}=1.2V



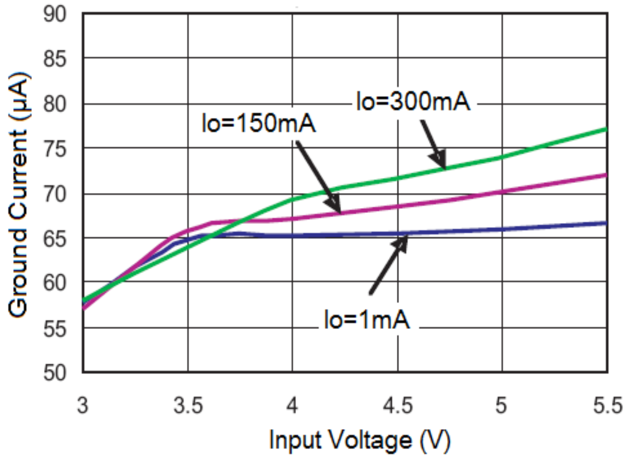
14. Ground Current vs. Input Voltage
V_{OUT}=1.8V



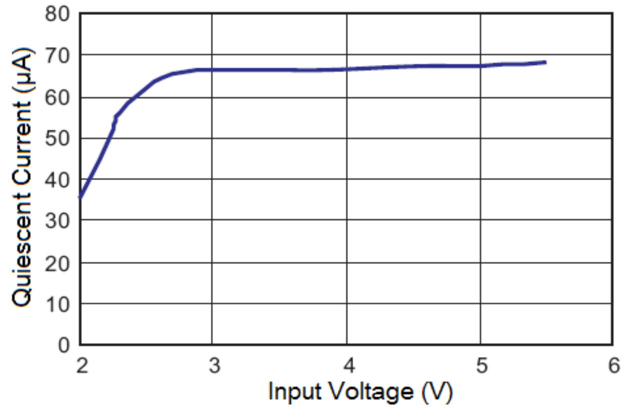
15. Ground Current vs. Input Voltage
V_{OUT}=2.5V



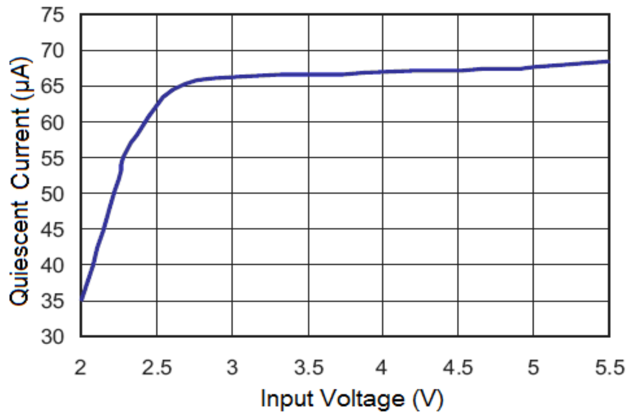
16. Ground Current vs. Input Voltage
V_{OUT}=3.3V



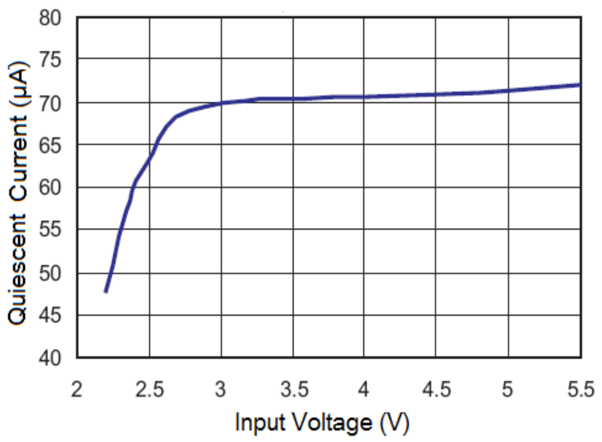
17. Quiescent Current vs. Input Voltage
V_{OUT}=1.2V



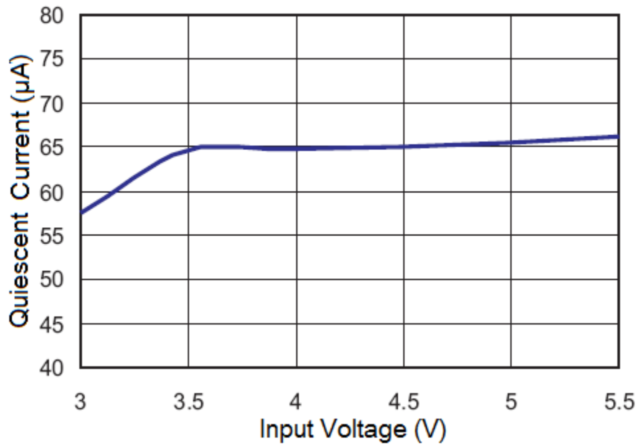
18. Quiescent Current vs. Input Voltage
V_{OUT}=1.8V



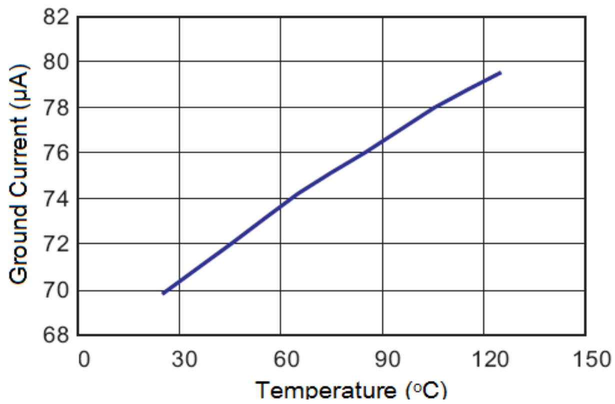
19. Quiescent Current vs. Input Current
V_{OUT}=2.5V



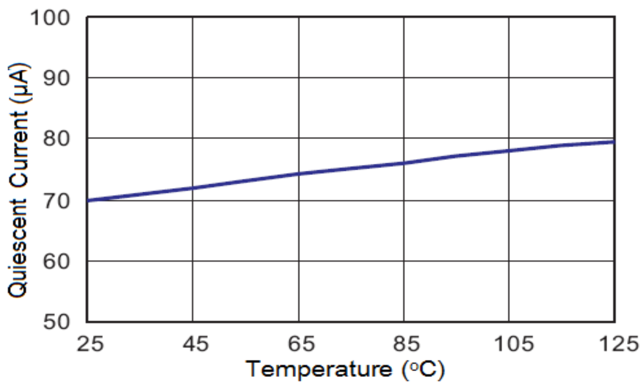
20. Quiescent Current vs. Input Current
V_{OUT}=3.3V



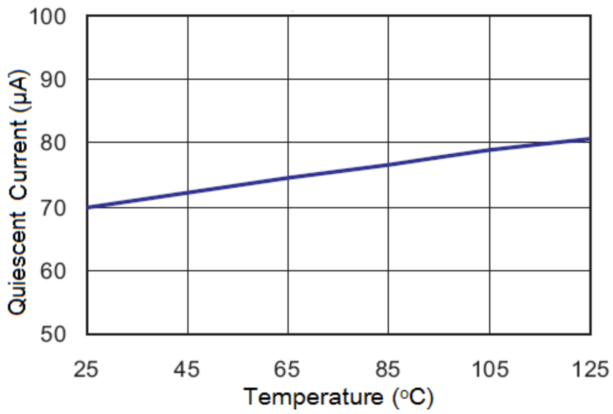
21. Ground Current vs. Temperature
V_{OUT}=1.2V



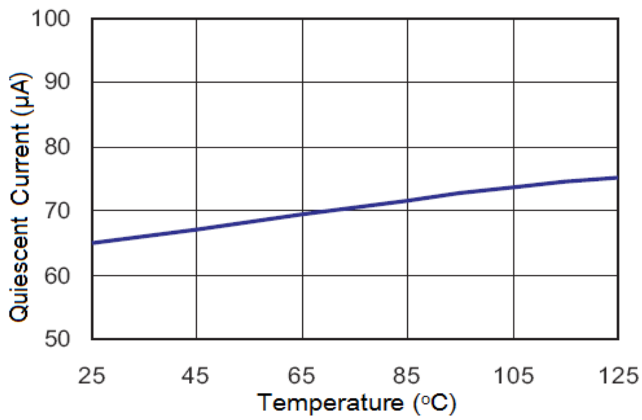
22. Quiescent Current vs. Temperature
V_{OUT}=1.8V



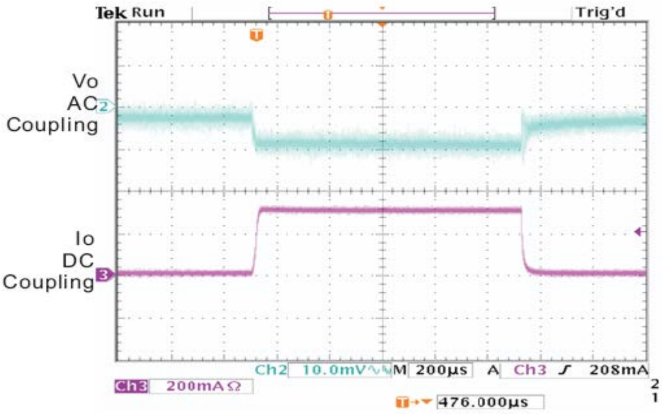
23. Quiescent Current vs. Temperature
V_{OUT}=2.5V



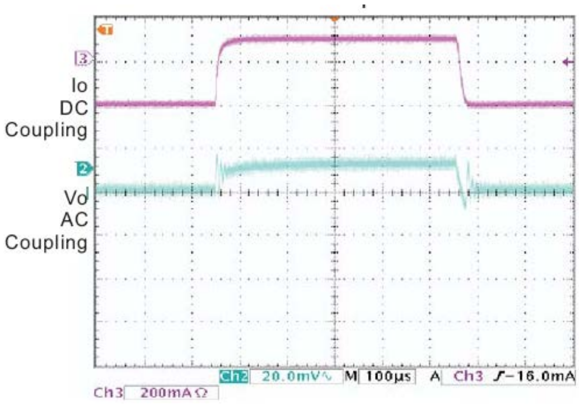
24. Quiescent Current vs. Temperature
V_{OUT}=3.3V



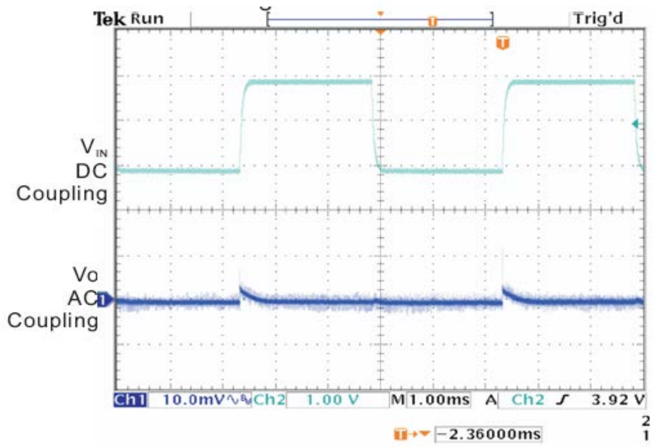
25. Load Regulation Transient Response
I_{OUT}=1mA to 300mA, V_{OUT}=1.2V



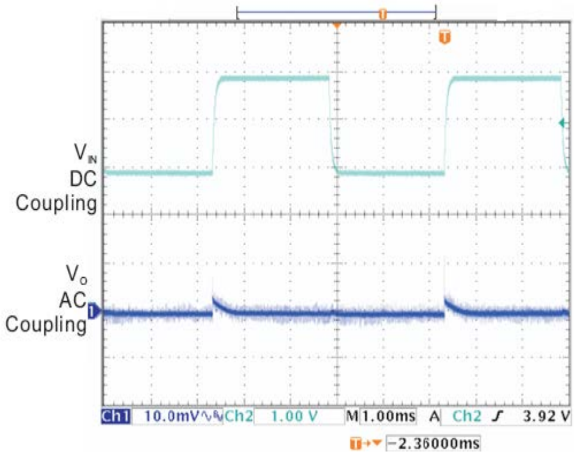
26. Load Regulation Transient Response
I_{OUT}=1mA to 300mA, V_{OUT}=2.5V



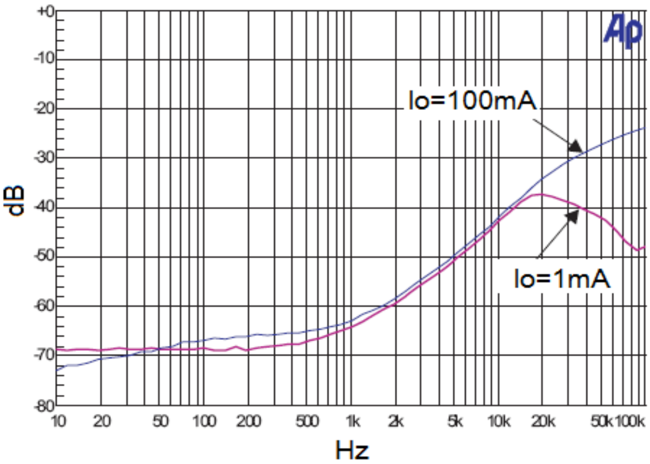
27. Line Regulation Transient Response
I_{OUT}=1mA to 100mA, V_{IN}=3 to 5V, V_{OUT}=1.2V



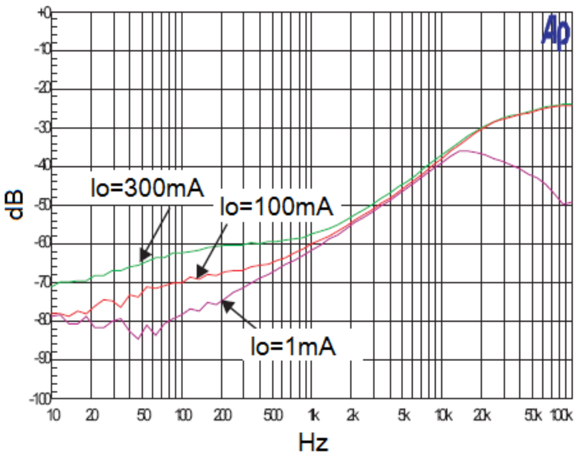
28. Line Regulation Transient Response
I_{OUT}=1mA to 100mA, V_{IN}=3 to 5V, V_{OUT}=2.5V



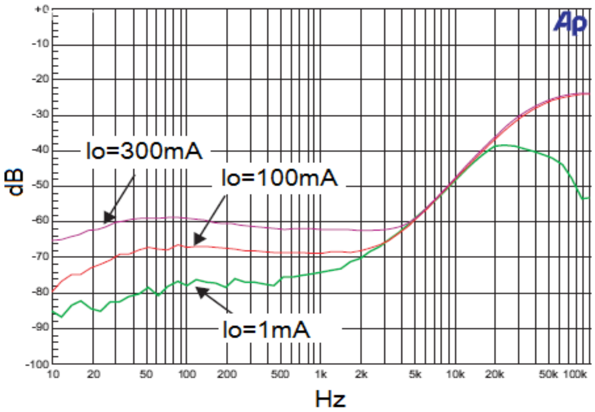
29. Power Supply Ripple Rejection
V_{OUT}=1.2V, V_{IN}=3V, V_{PP}=1V



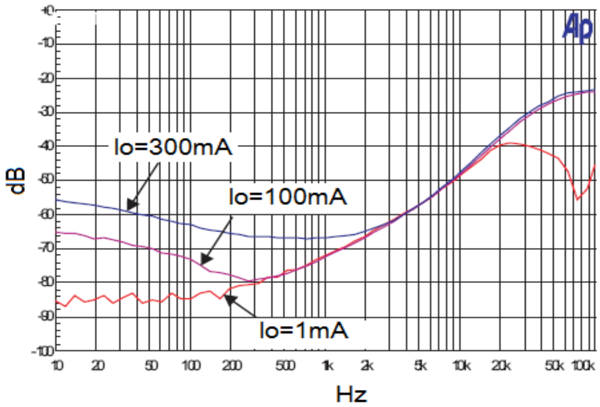
30. Power Supply Ripple Rejection
V_{OUT}=2.5V, V_{IN}=4V, V_{PP}=1V



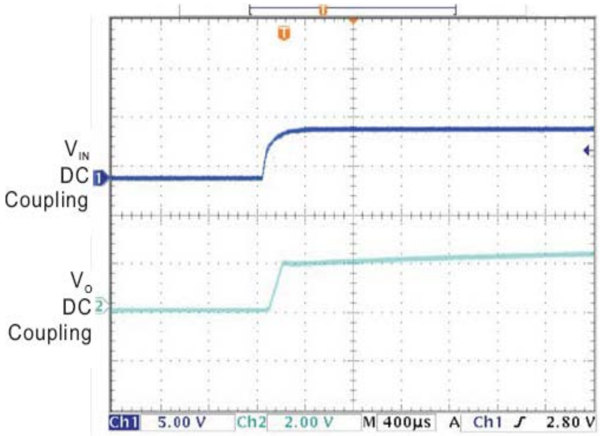
31. Power Supply Ripple Rejection
V_{OUT}=2.5V, V_{IN}=4V, V_{PP}=1V, C_{BP}=10nF



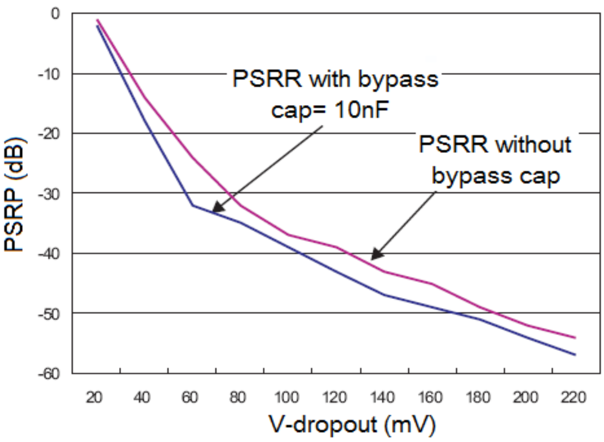
32. Power Supply Ripple Rejection
V_{OUT}=1.8V, V_{IN}=4V, V_{PP}=1V, C_{BP}=10nF



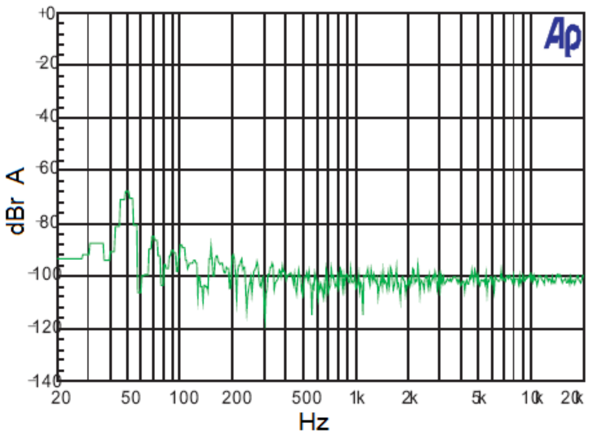
33. Turn-ON Response
V_{IN}=0 to 5V



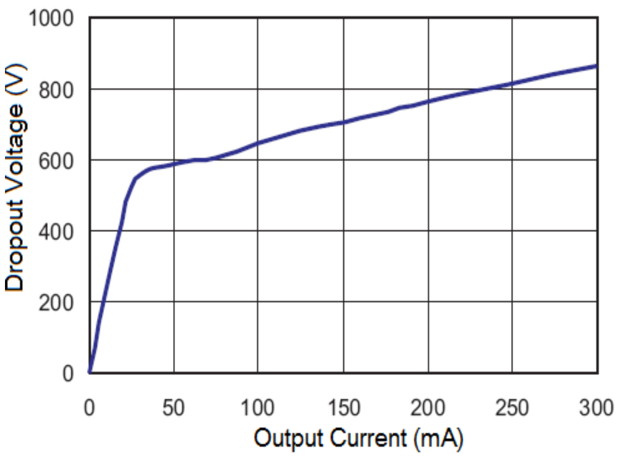
34. PSRR vs. $V_{DROPOUT}$
V_{OUT}=3.28V



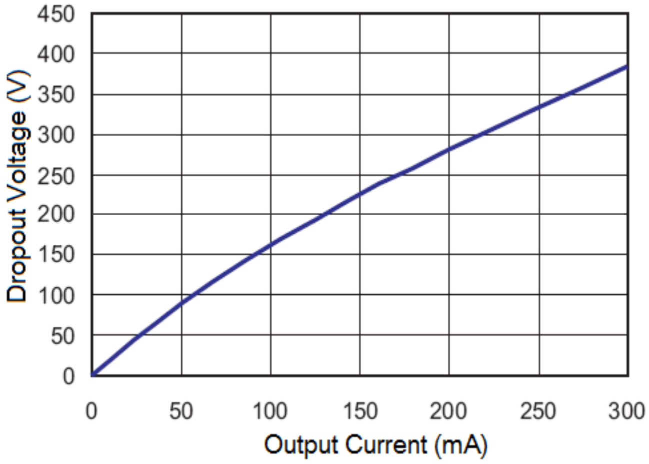
35. Noise



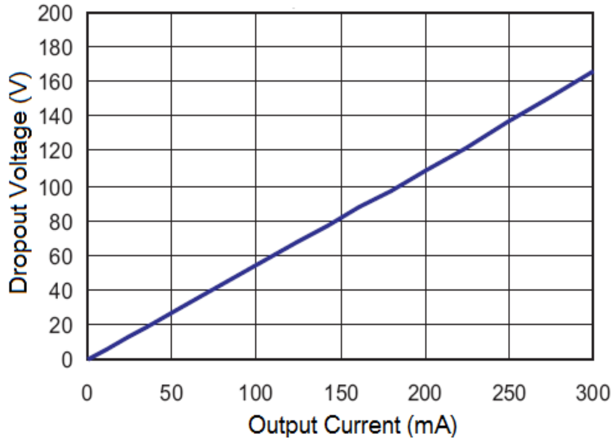
36. Dropout Voltage vs. Output Current
V_{OUT}=1.8V



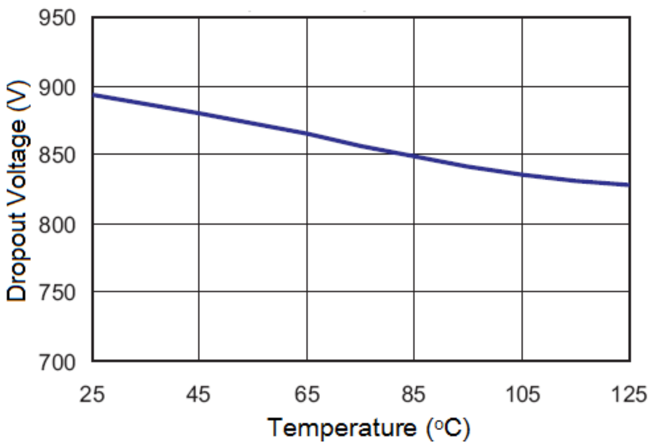
37. Dropout Voltage vs. Output Current
V_{OUT}=2.5V



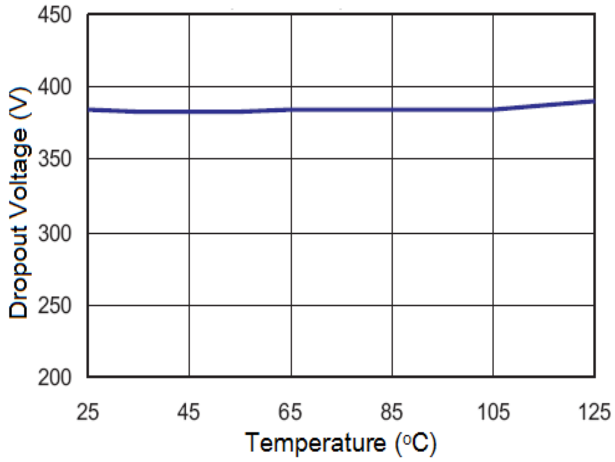
38. Dropout Voltage vs. Output Current
V_{OUT}=3.3V



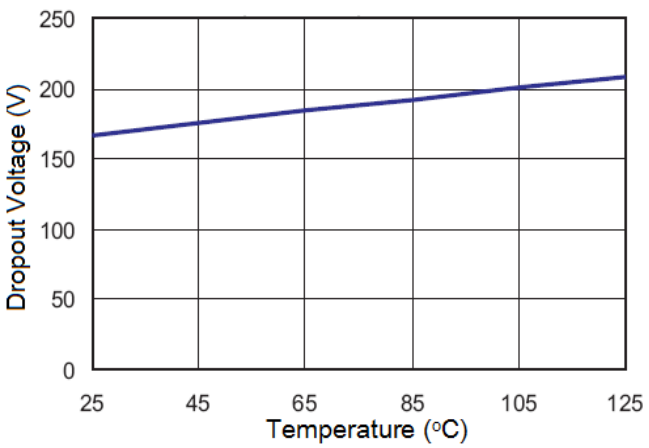
39. Dropout Voltage vs. Temperature
V_{OUT}=1.8V, I_{OUT}=300mA



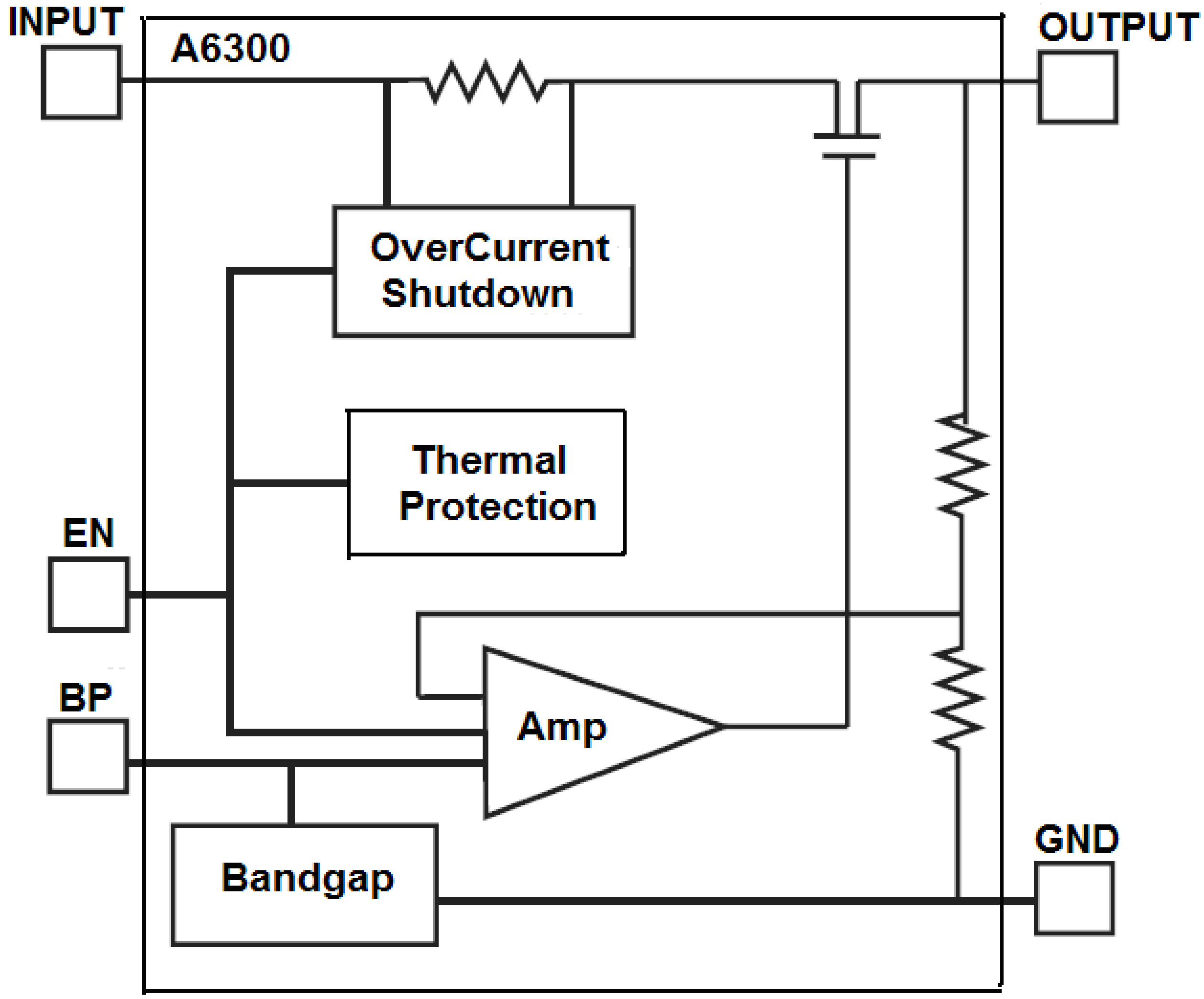
40. Dropout Voltage vs. Temperature
V_{OUT}=2.5V, I_{OUT}=300mA



41. Dropout Voltage vs. Temperature
V_{OUT}=3.3V, I_{OUT}=300mA



BLOCK DIAGRAM



DETAILED INFORMATION

Capacitor Selection and Regulator Stability

As low-dropout regulator, the external capacitors used with the A6300 must be carefully selected for regulator stability and performance.

Choose a capacitor which value is > 1μF on the A6300 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” 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 values and lower ESR (equivalent series resistance) provides better PSRR and line-transient response.

The output capacitor must meet with both requirements for minimum amount of capacitance and ESR in all LDOs application. The A6300 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor which value is at least 2.2μF with ESR is >5mΩ on the A6300 output ensures stability. The A6300 still work well with output capacitor of other types due to the wide stable ESR range.

Note at some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. It may be necessary to use 2.2μF or more to ensure stability at temperature below -10℃ in this case. Also, tantalum capacitors, 2.2μF or more may be needed to maintain capacitance and ESR in the stable region for strict application environment.

Tantalum capacitors maybe suffer failure due to surge current when it is connected to a low-impedance source of power (like a battery or very large capacitor). If a tantalum capacitor is used at the input, it must be guaranteed to have a surge current rating sufficient for the application by the manufacture.

Use 10nF bypass capacitor at BP pin for low output voltage noise. The capacitor, in conjunction with an internal 200KΩ resistor, which connects bypass pin and the band-gap reference, creates an 80Hz low-pass filter for noise reduction. Increasing the capacitance will slightly decrease the output noise, but increase the start-up time. The capacitor connected to the bypass pin for noise reduction must have very low leakage. Mentioned capacitor leakage current will cause the output voltage to decline by a proportional amount to the current due to the voltage drop on the internal 200KΩ resistor. See Fig.1 for the power on response.

Load-Transient Considerations

The A6300 Load-Transient response graphs (see Typical Characteristics) show two components of the output response: a DC shift from the output impedance due to the load current change, and the transient response. The DC shift is quite small due to excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 1mA to 300mA is 20mV, depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

Shutdown Input Operation

The A6300 is shutdown by pulling the turned on by driving the input high. If this feature is not to be used, the EN input should be tied to V_{IN} to keep the regulator on at all times (the EN input must not be left floating).
To ensure proper operation, the signal source used to be drive the EN input must be able to swing above and below the specified turn-on/turn-off voltage thresholds which guarantee and ON or OFF state. The ON/OFF signal may come from either CMOS output, or an open-collector output with pull-up resistor to the A6300 input voltage or another logic supply. The high-level voltage may exceed the A6300 input voltage, but must remain within the absolute maximum rating for the EN pin.

Internal P-Channel Pass Transistor

The A6300 features a typical 0.75Ω P-Channel MOSFET pass transistor. It provides several advantages over similar designs using PNP pass transistors, including longer battery life. The P-Channel MOSFET requires no base drive, which reduces quiescent current considerably. PNP-based regulators waste considerable current in dropout when the pass transistor saturates. They also use high base-drive currents under lager loads. The A6300 does not suffer from these problems and consume only 80uA of quiescent current whether in dropout, light-load, or heavy-load application.

Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the A6300 uses a P-Channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on-resistance $R_{DS(ON)}$ multiplied by the load current.

Reverse Current Path

The power transistor used in the A6300 has an inherent diode connected between the regulator input and output (see Fig.1). If the output is forced above the input by more than a diode-drop, this diode will become forward biased and current will follow from the V_{OUT} terminal to V_{IN}. The diode will also be turned on the by abruptly stepping the input voltage to a value below the output voltage. To prevent regulator mis-operation, a Schottky diode should be used in any applications where input/output voltage conditions can cause the internal diode to be turned on (see fig.2). As shown, the Schottky diode is connected in parallel with the internal parasitic diode and prevents it from being turned on by limiting the voltage drop across it to about 0.3V <100mA to prevent damage to the part.

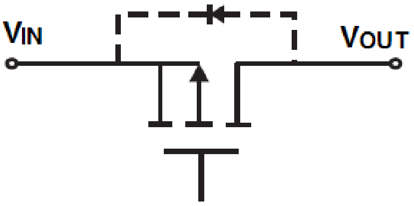


Fig.1

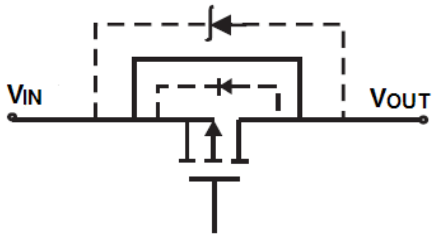


Fig.2

Operating Region and Power Dissipation

The A6300 maximum power dissipation depends of the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow.

The power dissipation across the device is:

$$P = I_{OUT} (V_{IN} - V_{OUT}).$$

The maximum power dissipation is :

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

Where $T_J - T_A$ is the temperature difference between the A6300 die junction and surrounding environment, θ_{JA} is the thermal resistance from the junction to the surrounding environment.

The GND pin of the A6300 performs the dual function of providing an electrical connection to ground and channeling heat away.

Connect the GND pin to ground using a large pad or ground plane.

Current Limit and Thermal Protection

The A6300 includes a current limit which monitors and controls the pass transistor's gate voltage limiting the output current to 350mA Typ. Thermal-overload protection limits total power dissipation in the A6300. When the junction temperature exceeds T_J = +150℃, the thermal sensor signals the shutdown logic turning off the pass transistor and allowing the IC to cool. The thermal sensor will turn the pass transistor on again after the IC's junction temperature cools by 30℃, resulting in a pulsed output during continuous thermal=overload conditions. Thermal-overload protection is designed to protect the A6300 in the event of fault conditions. Do not exceed the absolute maximum junction-temperature rating of T_J = +150℃ for continuous operation. The output can be shorted to ground for an indefinite amount of time without damaging the part by cooperation of current limit and thermal protection.

Thermal Considerations

Thermal protection limits power dissipation in A6300. When the operation junction temperature exceeds 150℃, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turns on again after the junction temperature cools by 30℃.

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

$$P_D = (V_{IN}-V_{OUT})^* I_{OUT} + V_{IN} * I_Q$$

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surrounding airflow and temperature difference between junctions 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℃, T_A is the ambient thermal resistance. For recommended operating conditions specification of A6300, where $T_{J(MAX)}$ is the maximum junction temperature of the die (125℃) and T_A is the operated ambient temperature. The junction to ambient thermal resistance θ_{JA} is layout dependent.

A6300 in SOT-25 package, the thermal resistance θ_{JA} is 250℃ on the standard JEDEC 51-3 single-layer thermal test board. The maximum power dissipation at TA = 25℃ can be calculated by following formula:

$$P_{D(MAX)} = (125℃ - 25℃) / 250 = 0.4W$$

The value of junction to case thermal resistance θ_{JC} is popular to users. This thermal parameter is convenient for users to estimate the internal junction operated temperature of packages while IC operating. It's independent of PCB layout, the surroundings airflow effects and temperature difference between junction to ambient. The operated junction temperature can be calculated by following formula:

$$T_J = T_C + P_D*\theta_{JC}$$

Where T_C is the package case temperature measured by thermal sensor, P_D is the power dissipation defined by user's function and the θ_{JC} is the junction to case thermal resistance provided by IC manufacturer. Therefore it's easy to estimate the junction temperature by any condition.

Example for Junction Temperature

To calculate the junction temperature of A6300 in SOT-25 package.

If we use input voltage V_{IN} = 3.3V, at an output current I_O = 300mA and the case temperature T_C = 70℃ measured by the thermal couple while operating, then our power dissipation is as follows:

$$P_D = (3.3V – 2.8V) * 300mA + 3.3V * 70\mu A \cong 210mW$$

And the junction temperature T_J could be calculated as following:

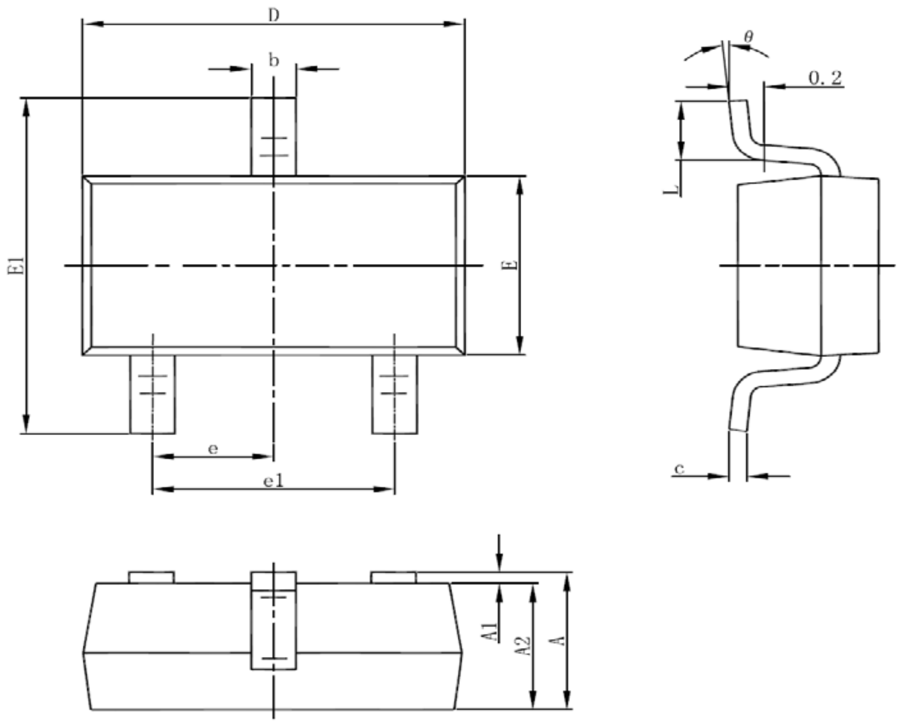
$$T_J = T_C + P_D *\theta_{JC}$$

$$T_J = 70℃ + 0.21W * 130℃/W = 70℃ + 27.3℃ = 97.3℃ < T_{J(MAX)} = 125℃$$

For this operation application, T_J is lower than absolute maximum operation junction temperature 125℃ and it's safe to use.

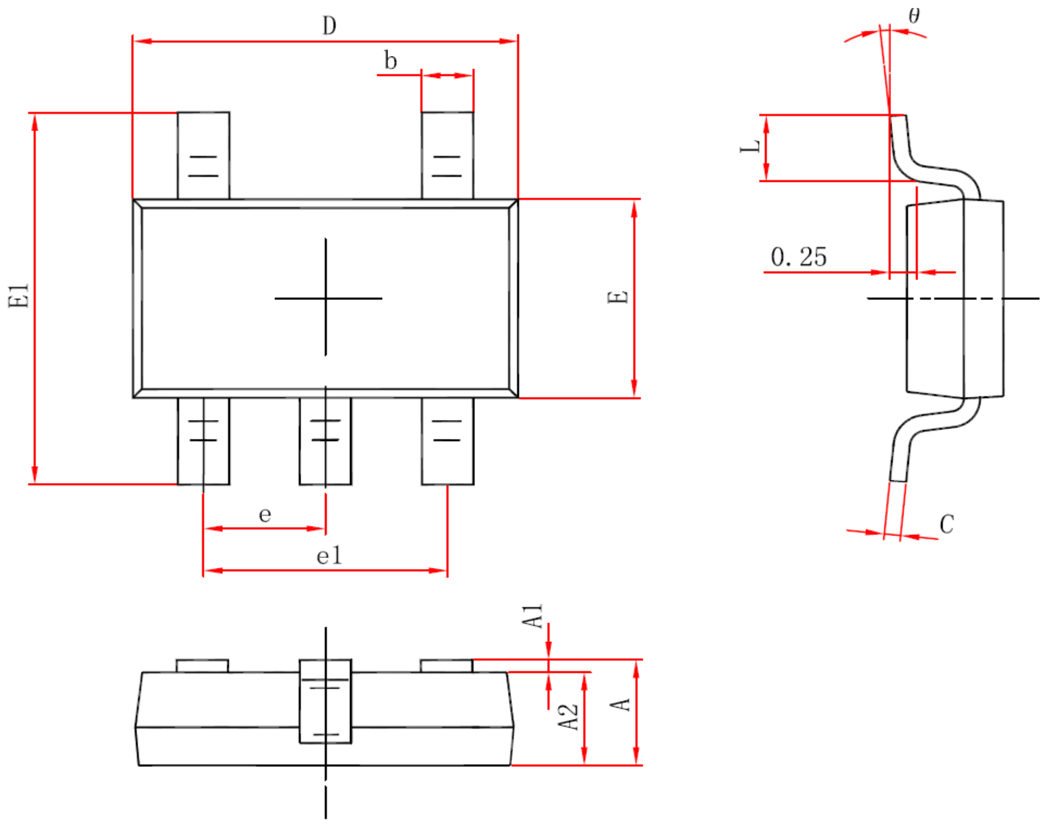
PACKAGE INFORMATION

Dimension in SOT-23 (Unit: mm)



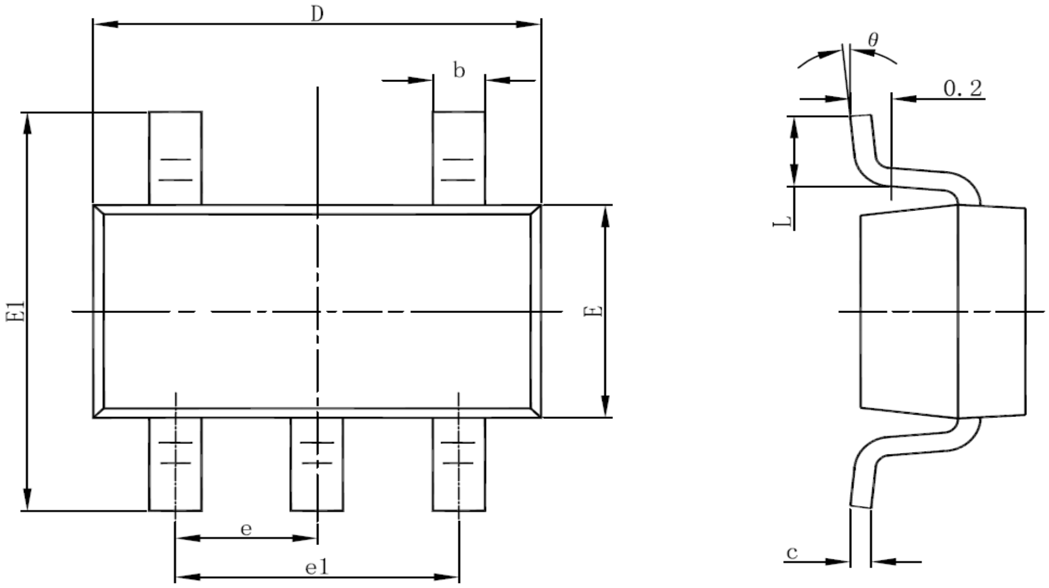
Symbol	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
E	1.500	1.700
E1	2.650	2.950
e	0.950(BSC)	
e1	1.800	2.000
L	0.300	0.600
θ	0°	8°

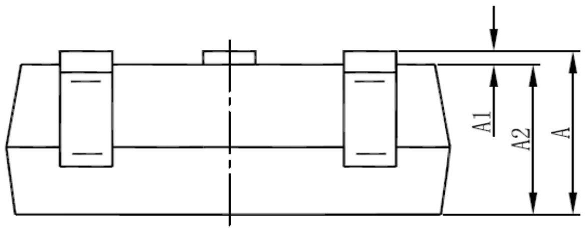
Dimension in TSOT-25 (Unit: mm)



Symbol	Min	Max
A	0.700	0.900
A1	0.000	0.100
A2	0.700	0.800
b	0.350	0.500
c	0.080	0.200
D	2.820	3.020
E	1.600	1.700
E1	2.650	2.950
e	0.95(BSC)	
e1	1.90(BSC)	
L	0.300	0.600
θ	0°	8°

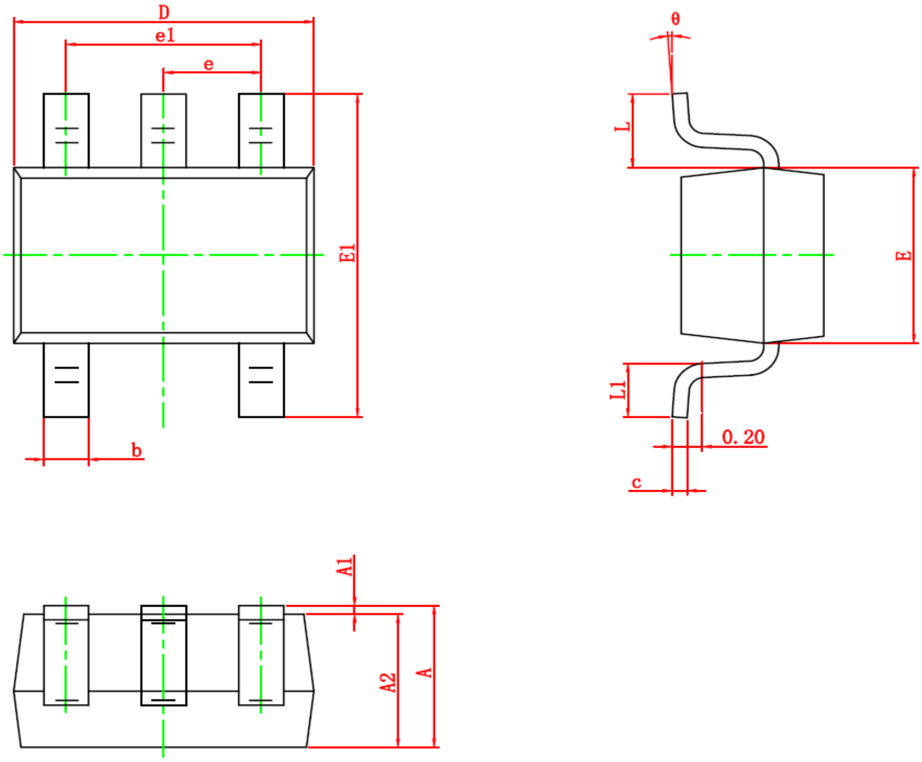
Dimension in SOT-25 (Unit: mm)





Symbol	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
E	1.500	1.700
E1	2.650	2.950
e	0.950(BSC)	
e1	1.800	2.000
L	0.300	0.600
θ	0°	8°

Dimension in SC70-5 (Unit: mm)



Symbol	Min	Max
A	0.900	1.100
A1	0.000	0.100
A2	0.900	1.000
b	0.150	0.350
c	0.080	0.150
D	2.000	2.200
E	1.150	1.350
E1	2.150	2.450
e	0.650 TYP	
e1	1.200	1.400
L	0.525 REF	
L1	0.260	0.460
θ	0°	8°

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