AP1156ADSXX

Negative Input / Output Voltage LDO Regulator

1. Genaral Description

AP1156ADS series is a negative-input negative-output regulator IC using silicon monolithic bipolar structure which can supply 150mA output current. The output voltage can be set from -1.3 to -1.5V, which is trimmed in high accuracy. AP1156ADS is supplied with ON/OFF terminal and noise reduction terminal. The ON/OFF control can be controlled directly with positive logic or CPU. The over current, thermal and reverse bias protections are integrated.

2. Features

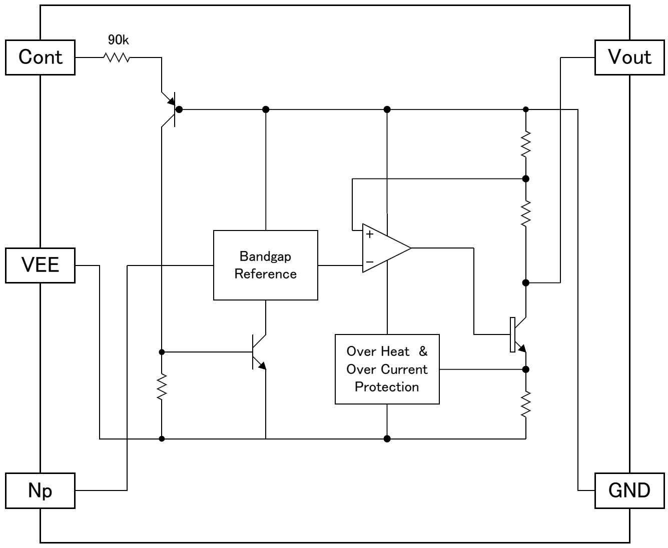
- Available to use a small 1.0μF ceramic capacitor
- Dropout Voltage V_{DROP}=160mV at 100mA
- Output Current 150mA
- High Precision output voltage ±2.0% or ±60mV
- Wide operating voltage range -2.8V to −17.0V
- Very low quiescent current I_{QUT}=155μA at I_{OUT}=0mA
- On/Off control (High active)
- Built-in Short circuit protection, thermal shutdown
- Built-in reverse bias over current protection
- Available very low noise application
- Very small surface mount package SOT23-5

3. Applications

- Battery Powered Systems
- DSC, CCD bias, GaAs bias

4. Table of Contents

5. Block Diagram



Control:High Level On

Figure 1. Block Diagram

6. Ordering Information

AP1156ADSXX -40 to 85°C SOT23-5

・ Output Voltage Code

For product name, please check the below chart. Please contact your authorized ASAHI KASEI MICRODEVICES representative for voltage availability.

AP1156ADSXX

Output voltage code

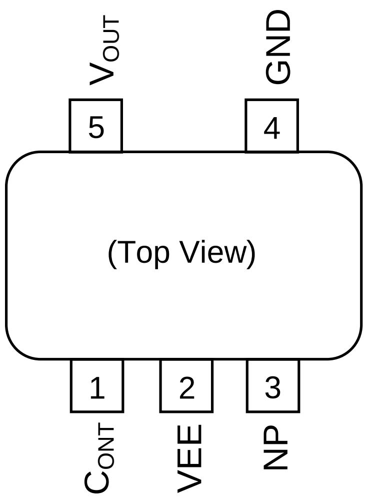
Table 1. Standard Voltage Version, Output Voltage & Voltage Code

XX	**V_{OUT}**
13	-1.3
15	-1.5

Table 2. Optional Voltage Version, Output Voltage & Voltage Code

XX	**V_{OUT}**
14	-1.4

7. Pin Configurations and Functions



8. Absolute Maximum Ratings

Parameter	Symbol	min	max	Unit	Condition
Supply Voltage	Vin	-20	0.4	V	|Vin|+|Vcont|≤20V
Cont Terminal Voltage	Vcont	-0.4	5	V	|Vin|+|Vcont|≤19V
Reverse Bias Voltage	Vrev	-20	0.3	V	Vin-Vout≤0.3V
Power Dissipation	P_D	-	500	mW	(Note 1)
Junction temperature	Tj	-	150	°C	
Storage Temperature Range	T_{STG}	-55	150	°C	

Note 1. P_D must be decreased at the rate of 4.0mW/°C for operation above 25°C.

WARNING: The maximum ratings are the absolute limitation values with the possibility of the IC breakage. When the operation exceeds this standard quality cannot be guaranteed.

9. Recommended Operating Conditions

Parameter	Symbol	min	typ	max	Unit	Condition
Operating Temperature Range	Ta	-40	-	85	°C	
Operating Voltage Range	V_{OP}	-17	-	-2.8	V	|Vin|+|Vcont|≤19V,

10. Electrical Characteristics

■ Electrical Characteristics (Ta=Tj=25°C)

The parameters with min or max values will be guaranteed at Ta=Tj=25°C.

(Vin=-3.7V, Ta=Tj=25°C)

Parameter	Symbol	Condition	min	typ	max	Unit
Vout	Vout	Iout=5mA		(Table 1)		V
Line Regulation	LinReg	ΔVin=5V	-	1	5	mV
Load Regulation	LoaReg	Iout=5mA~50mA		(Table 1)		mV
		Iout=5mA~100mA				
		Iout=5mA~150mA				
Quiescent Current	Iq	Iout=0mA	-	155	250	μA
Standby Current	Istandby	Vout Off State	-	0	1	μA
Peak Output Current	$Iout_{MAX}$	When Vout drops 10%	200	280	-	mA
Short Circuit Current	IShort		-	300	-	mA
Cont Terminal Current	Icont	Vcont=+1.8V	-	12	30	μA
Cont Terminal Voltage	Vcont	Vout ON State	1.3	-	-	V
		Vout OFF State	-	-	0.3	V

Table 1. Standard Voltage Version

Part Number	Vout			LoaReg					
				Iout=50mA		Iout=100mA		Iout=150mA	
	min	typ	max	typ	max	typ	max	typ	max
AP1156ADS13	-1.360	-1.300	-1.240	4	15	8	20	22	50
AP1156ADS15	-1.560	-1.500	-1.440	4	15	8	20	22	50

Table 2. Optional Voltage Version

Part Number	Vout			LoaReg					
				Iout=50mA		Iout=100mA		Iout=150mA	
	min	typ	max	typ	max	typ	max	typ	max
AP1156ADS14	-1.460	-1.400	-1.340	4	15	8	20	22	50

■ Electrical Characteristics (Ta=-40°C~85°C)

The parameters with min or max values will be guaranteed at Ta=-40 ~ 85°C.

(Vin=-3.7V, Ta=-40 ~ 85°C)

Parameter	Symbol	Condition	min	typ	Max	Unit
Vout	Vout	Iout=5mA	(Table 3, Table 4)			V
Line Regulation	LinReg	ΔVin=5V	-	1	8	mV
Load Regulation	LoaReg	Iout=5mA~50mA	(Table 3, Table 4)			mV
		Iout=5mA~100mA				mV
		Iout=5mA~150mA				mV
Supply Current	Icc	Iout=0mA	-	155	300	μA
Standby Current	Istandby	Vout Off State	-	0	5	μA
Peak Output Current	$Iout_{MAX}$	When Vout drops 10%	185	280	-	mA
Short Circuit Current	I_{Short}		-	300	-	mA
Vcont Terminal Current	Icont	Vcont=+1.8V	-	12	30	μA
Vcont Terminal Voltage	Vcont	Vout ON State	1.3	-	-	V
		Vout OFF State	-	-	0.3	V

Table 3. Standard Voltage Version

Part Number	Vout			LoaReg					
				Iout=50mA		Iout=100mA		Iout=150mA	
	min	typ	max	typ	max	typ	max	typ	max
AP1156ADS13	-1.390	-1.300	-1.210	4	16	8	22	22	72
AP1156ADS15	-1.590	-1.500	-1.410	4	16	8	22	22	72

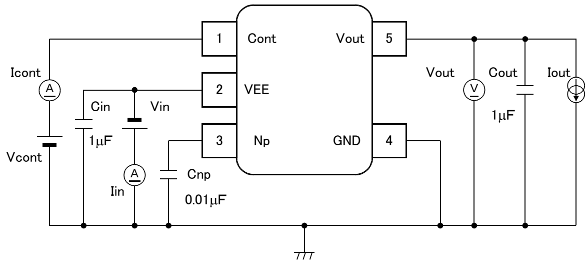
Table 4. Optional Voltage Version

Part Number	Vout			LoaReg					
				Iout=50mA		Iout=100mA		Iout=150mA	
	min	typ	max	typ	max	typ	max	typ	max
AP1156ADS14	-1.490	-1.400	-1.310	4	16	8	22	22	72

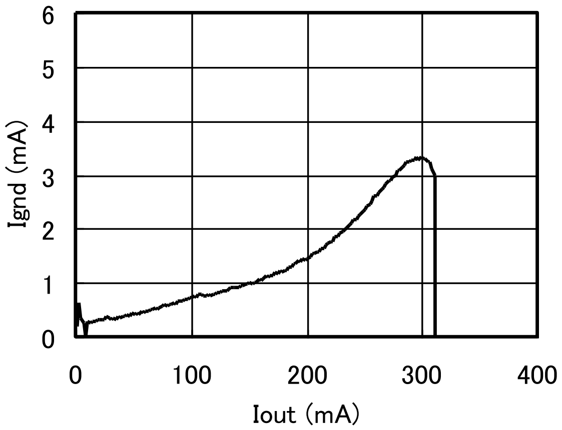
11. Description

11.1 DC Characteristics

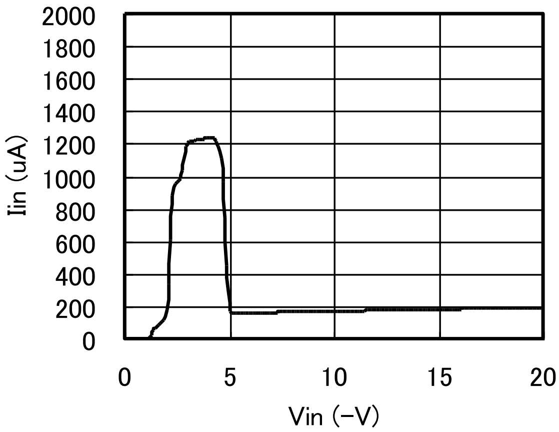
Unless otherwise specified Vin=-3.5V, Vcont=1.5V, Cin=1.0uF (MLCC),Cout=1.0uF(MLCC),Cnp=0.01uF Ta=25°C



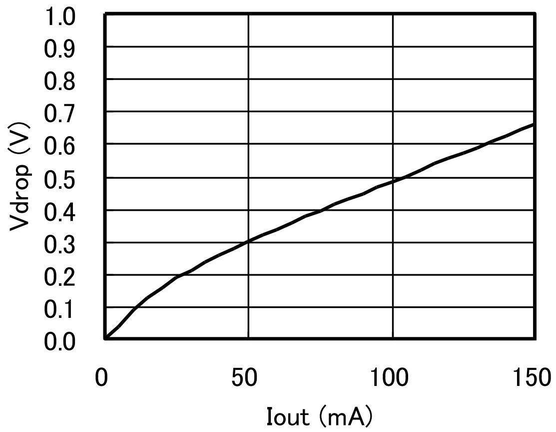
■ Ignd



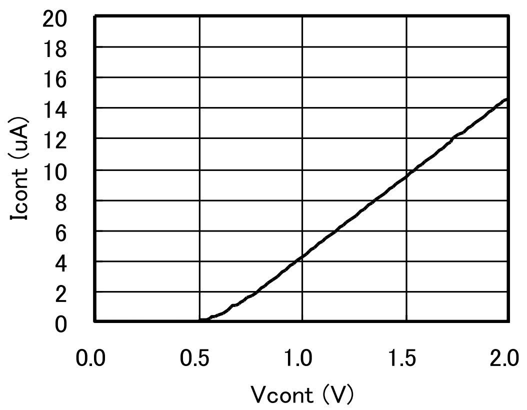
■ Iin (Iout=0mA)



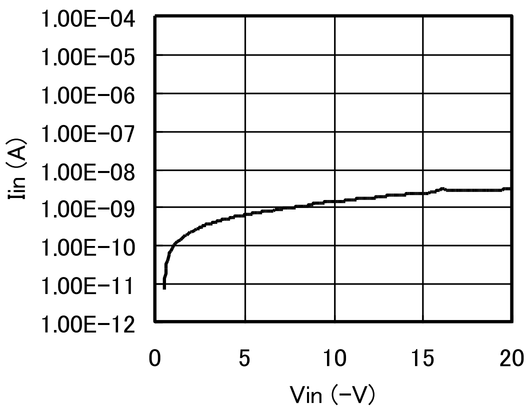
■ Dropout Voltage



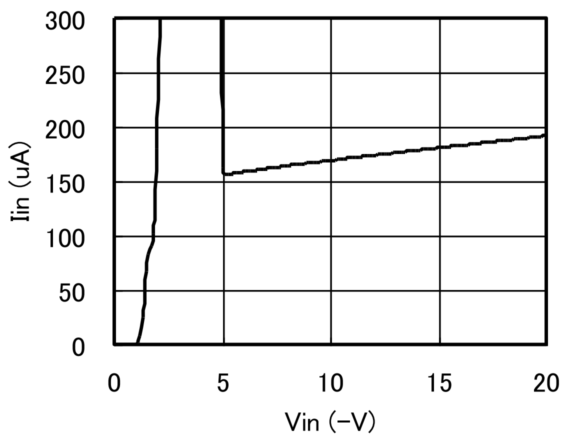
■ Icont VS Vcont (Iout=1mA)



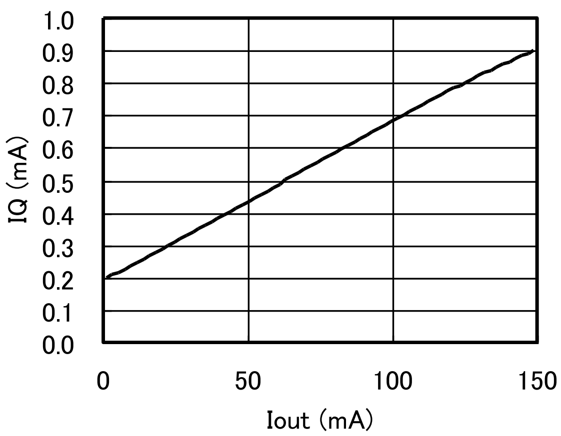
■ Icc Off Mode (Vcont=1.5V,Iout=0mA)



■ Iin (Iout=0mA) (Enlargement)

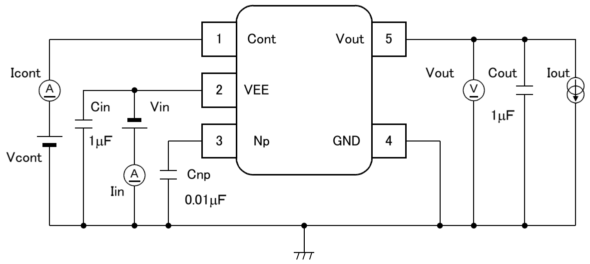


■ IQ (Enlargement)

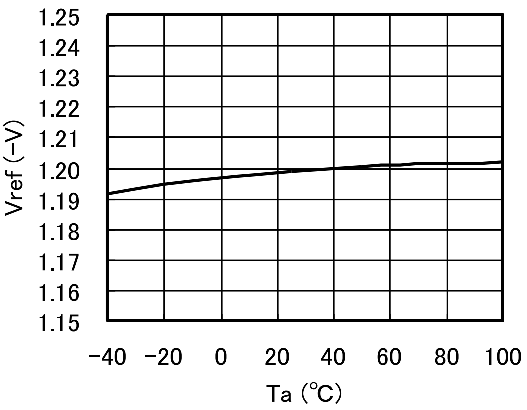


11.2 Temperature Characteristic

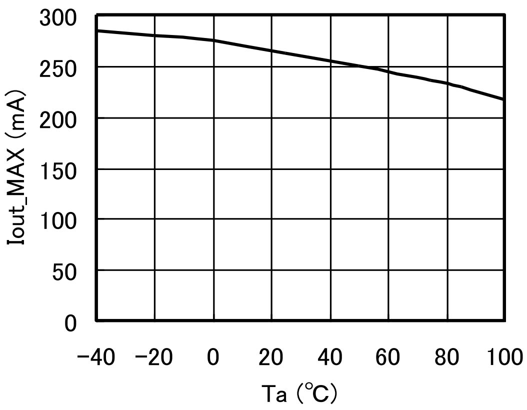
Unless otherwise specified Vin=-3.5V, Vcont=1.5V, Cin=1.0uF(MLCC),Cout=1.0uF(MLCC),Cnp=0.01uF



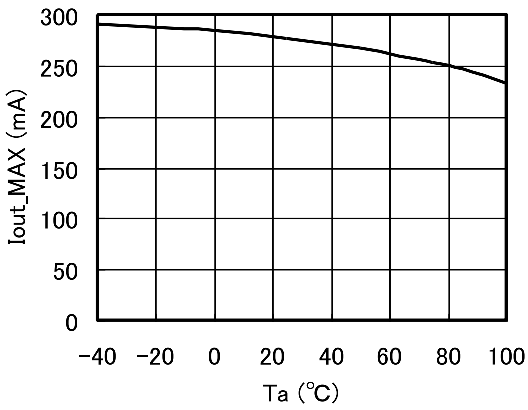
Vref



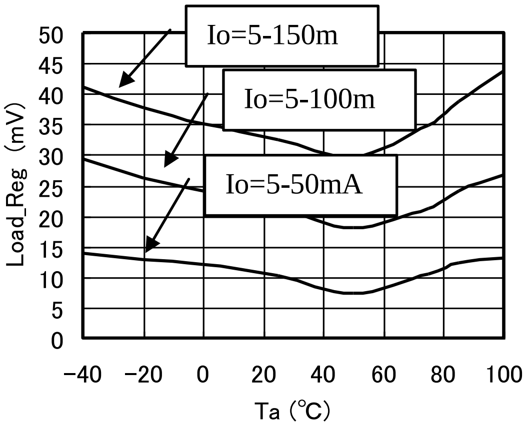
IoutMAX (Iout Nonpulse)



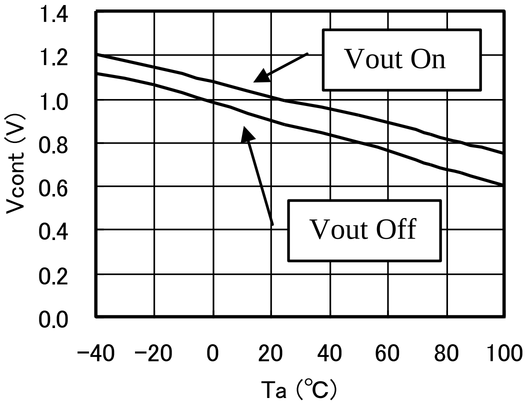
IoutMAX (Iout Pulse)



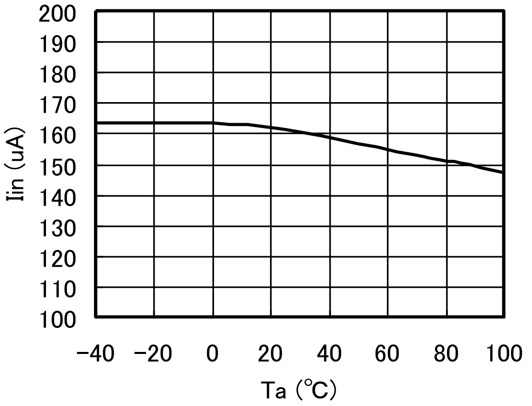
LoadReg



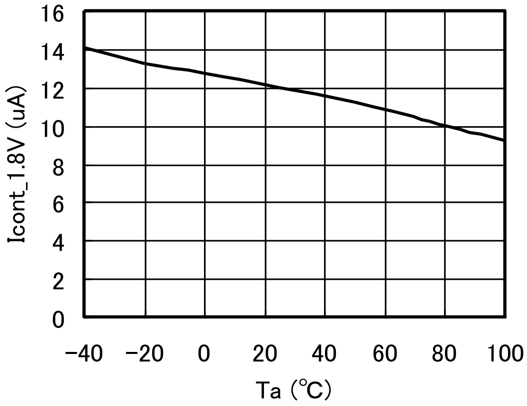
ON/OFF



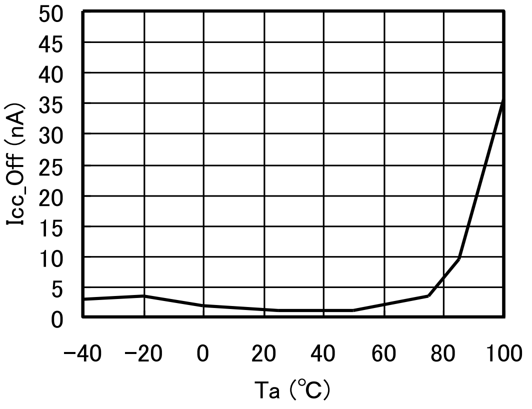
Iin(Iout=0mA)



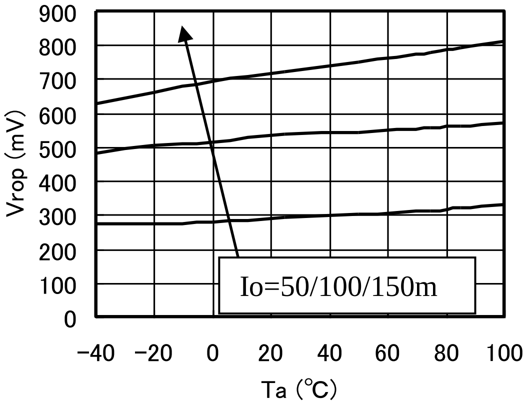
Icont



Icc OFFMode

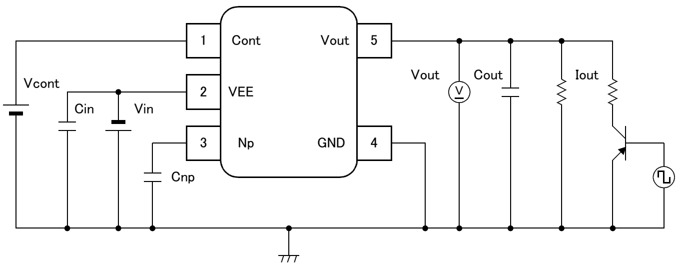


Vdrop

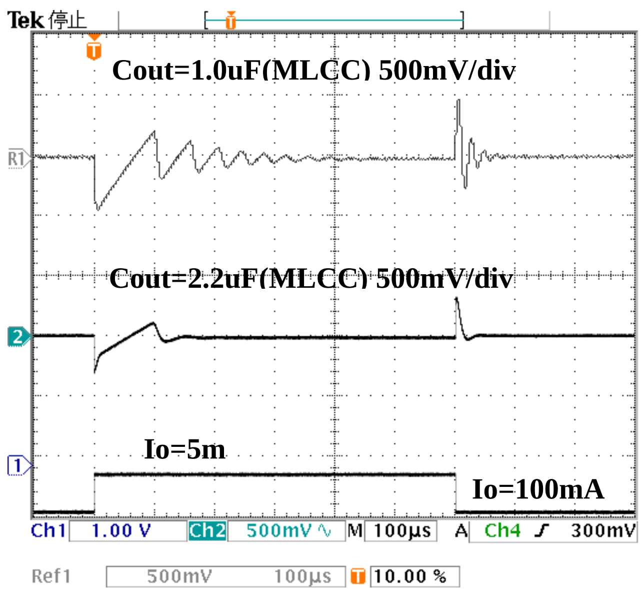


11.3 Load Transient

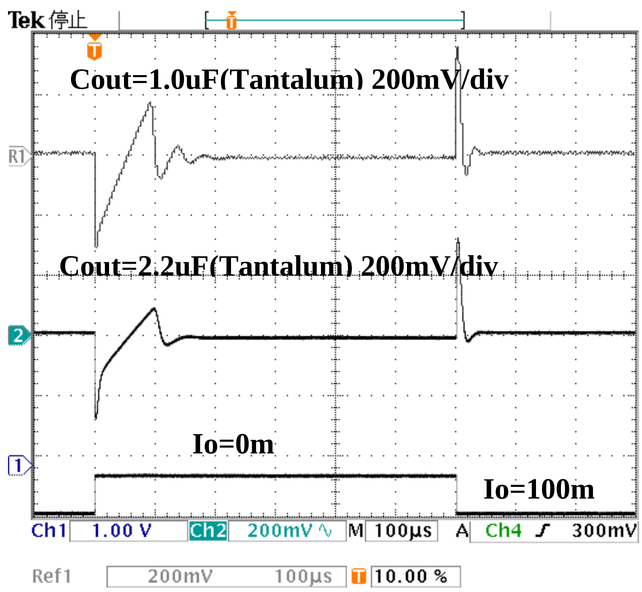
Unless otherwise specified Vin= Vout(typ)-1.5V, Vcont=1.5V,Cin=1.0uF(MLCC),Cnp=0.01uF



■Iout=5→100mA



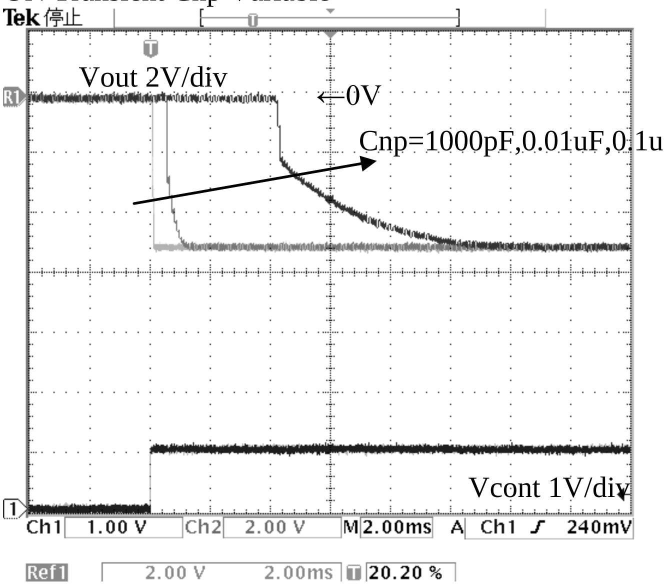
■Iout=0→100mA

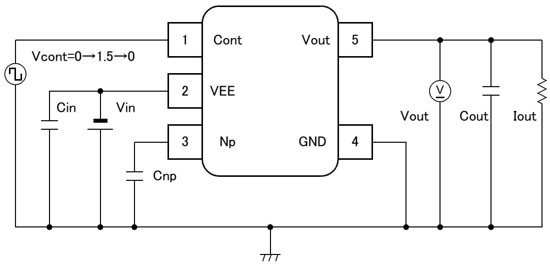


11.4 ON/OFF Transient

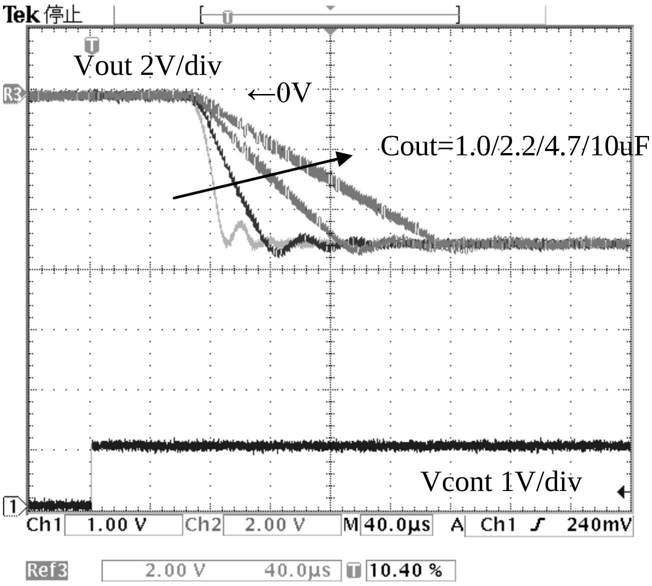
Vin= -3.5V, Cin=1.0uF (MLCC),Cnp=0.01uF,Iout=100mA, Control f=1Hz(Cnp Full discharge)

ON Transient Cnp Variable

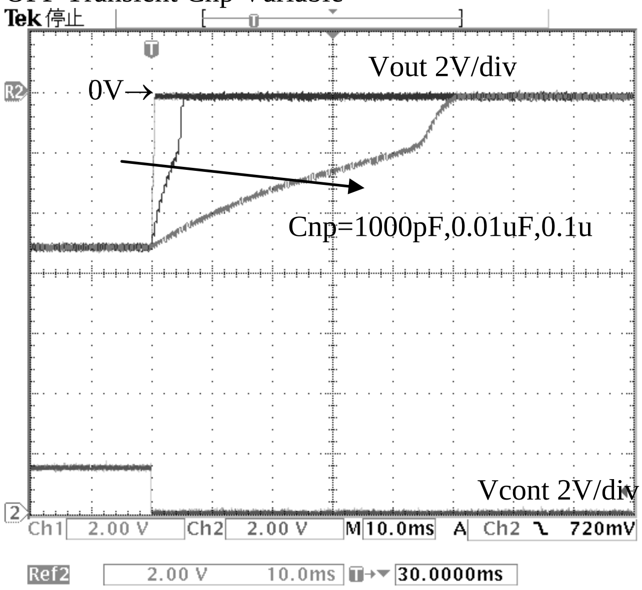




ON Transient Cout Variable



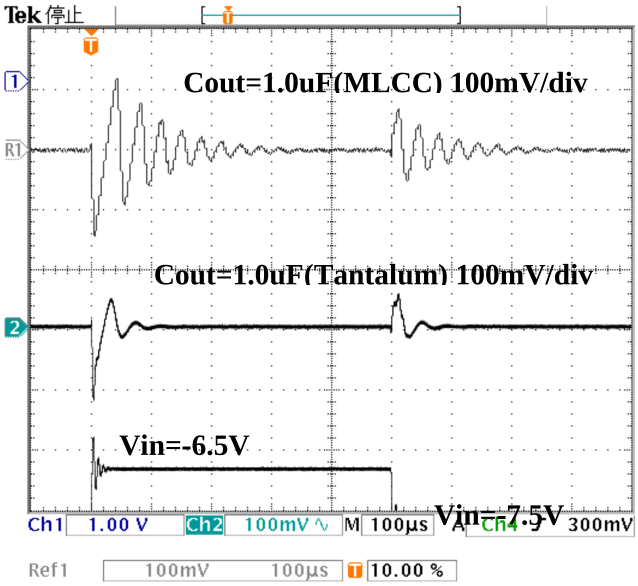
OFF Transient Cnp Variable



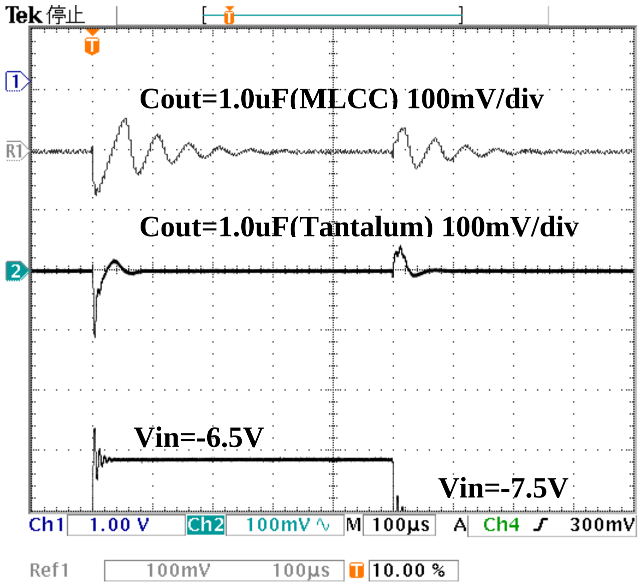
11.5 Line Transient

Vin=-Vout(typ)-1.5→-Vout(typ)-2.5V, Vcont=1.5V,Cin=1.0uF(MLCC),Cnp=0.01uF,Iout=100mA

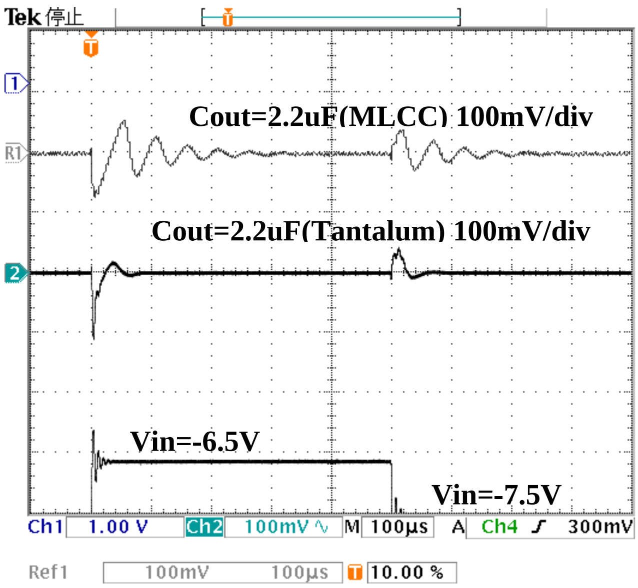
■Cin=1.0uF(MLCC) Iout=5mA



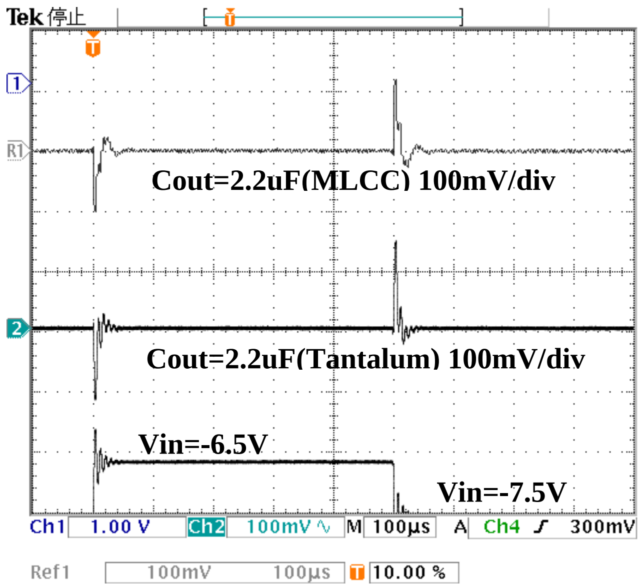
■Cin=1.0uF(MLCC) Iout=100mA



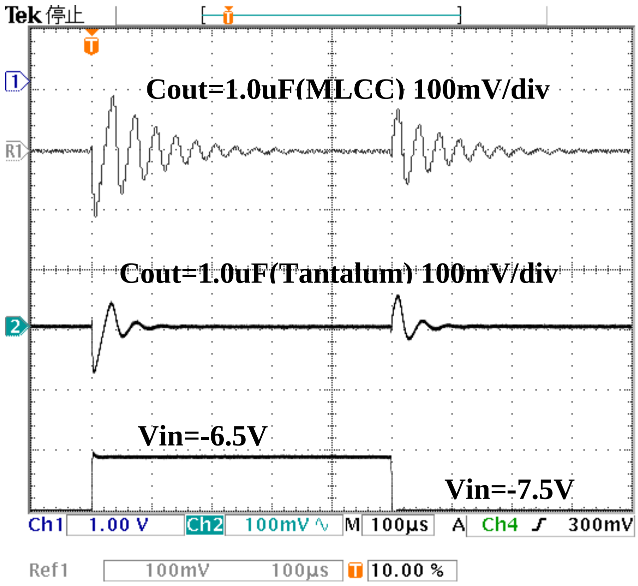
■Cin=1.0uF(MLCC) Iout=5mA



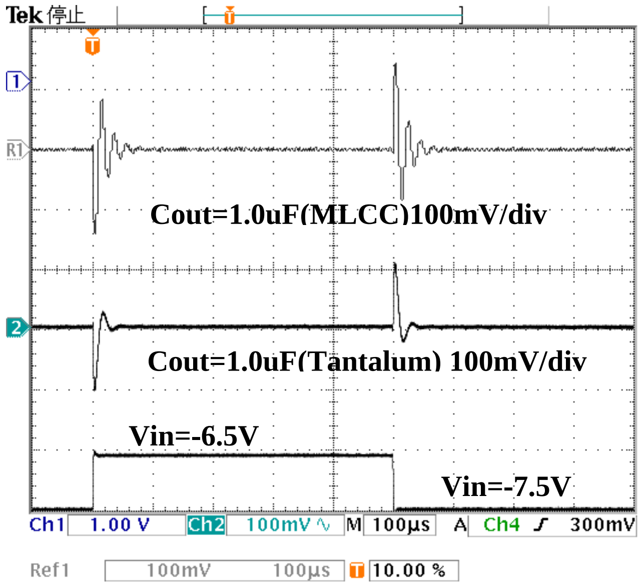
■Cin=1.0uF(MLCC) Iout=100mA



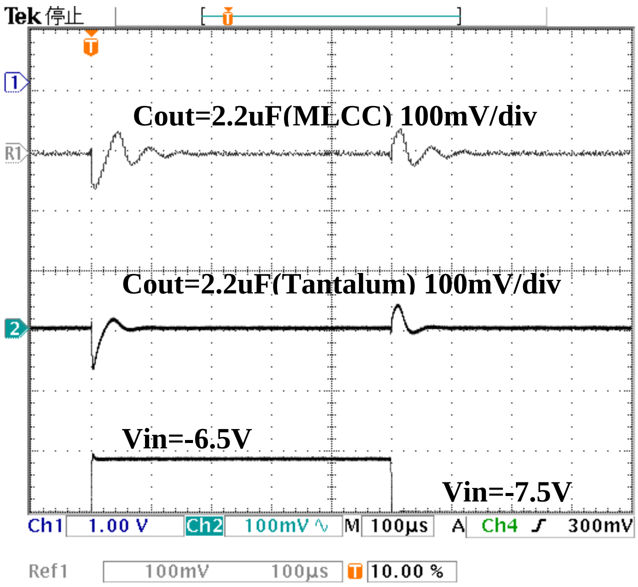
■Cin=1.0uF(Tantalum) Iout=5mA



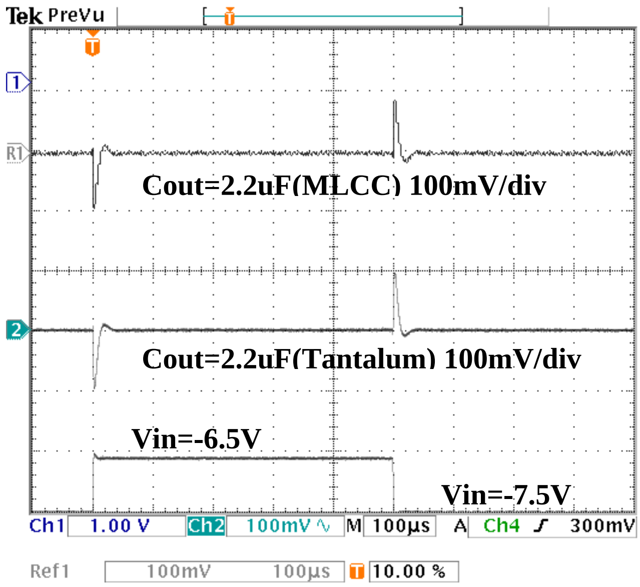
■Cin=1.0uF(Tantalum) Iout=100mA



■Cin=1.0uF(Tantalum) Iout=5mA

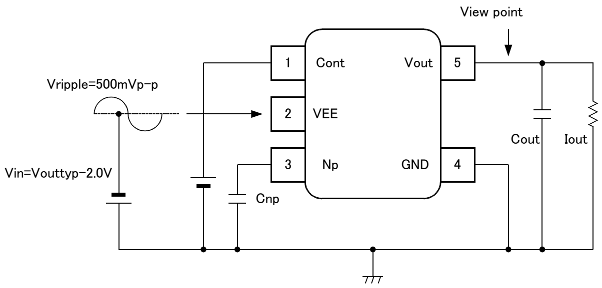


■Cin=1.0uF(Tantalum) Iout=100mA

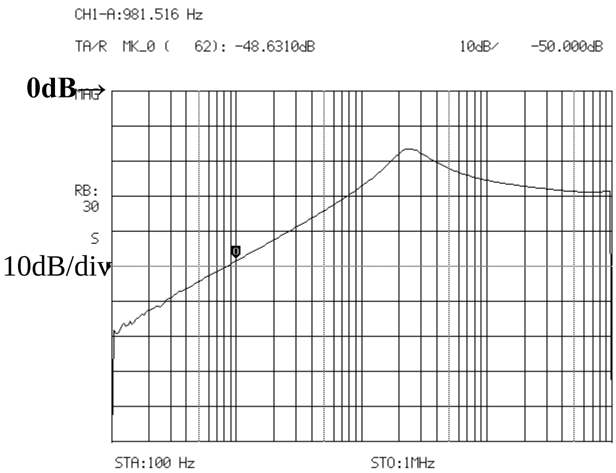


11.6 Ripple Rejection

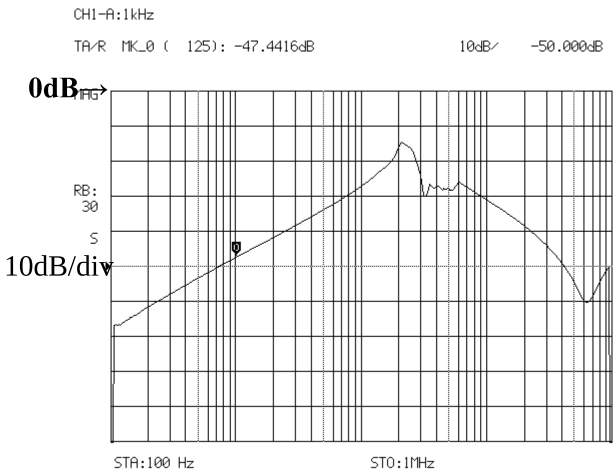
Vin=-3.5(V) Vcont=1.5V, Vripple=500mVp-p,Cnp=0.01uF,Iout=10mA



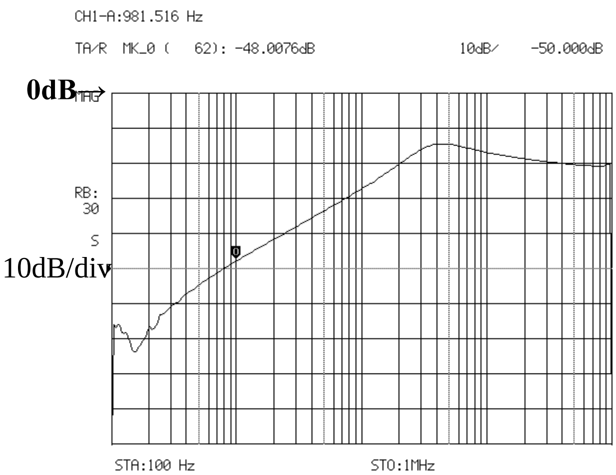
■Cout=1.0uF(Tantalum),Iout=5mA



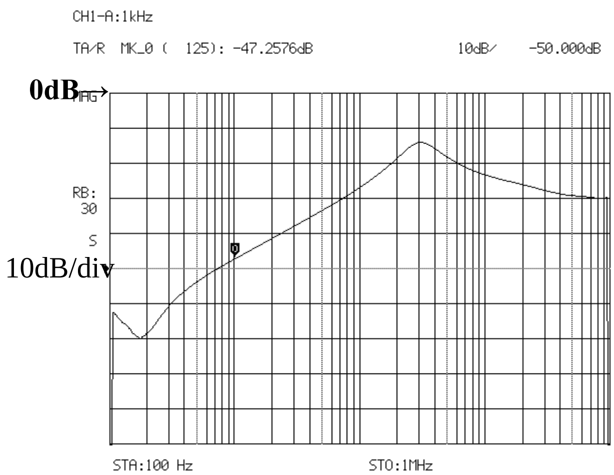
■Cout=1.0uF(MLCC),Iout=5mA



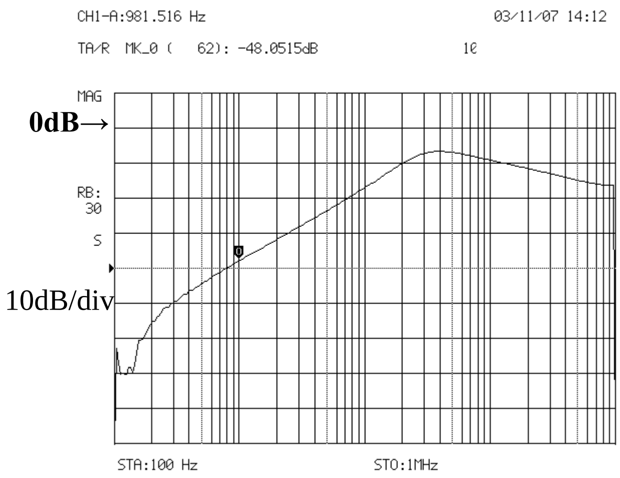
■Cout=1.0uF(Tantalum),Iout=100mA



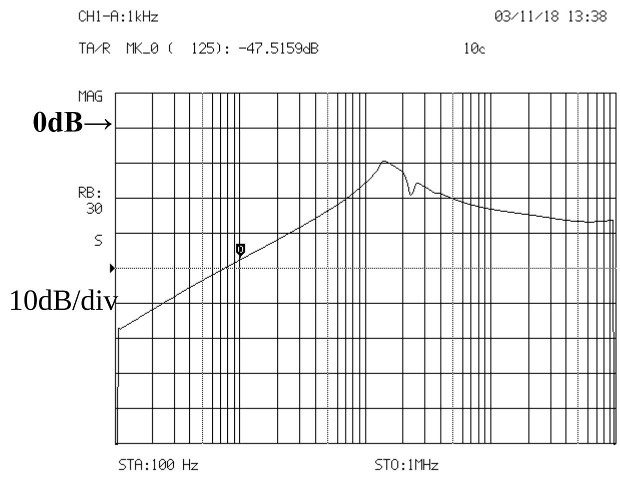
■Cout=1.0uF(MLCC),Iout=100mA



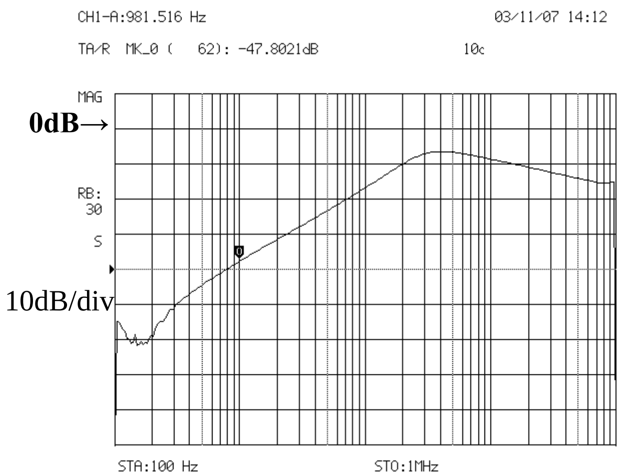
■Cout=2.2uF(Tantalum),Iout=5mA



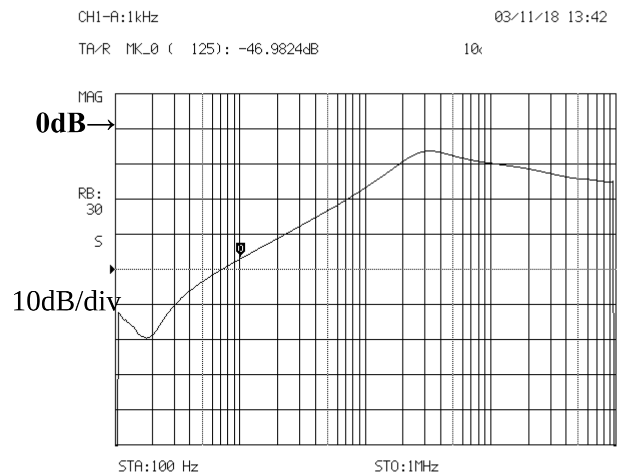
■Cout=2.2uF(MLCC),Iout=5mA



■Cout=2.2.uF(Tantalum),Iout=100mA



■Cout=2.2uF(MLCC),Iout=100mA



11.7 ESR Stability

IC does operate with 1.0uF Cout. If it is 1.0uF or larger, the capacitor of any type can be used in all range without considering ESR. But due to the parts are uneven, please enlarge the capacitance as much as possible. With larger capacity, the output noise decreases more. In addition, the response to the load change, etc. can be improved. The IC won't be damaged by enlarging the capacity.

The input capacitor is necessary in case the battery voltage drops, the power supply impedance increases, or the distance to the power supply is far. 1 input capacitor might be necessary for each 1 IC or for several ICs. It depends on circuit condition. Please confirm the stability by each circuit.

Generally, Multi-layer ceramic capacitor (MLCC) has the temperature characteristic and the voltage characteristic. Please select parts in consideration of the voltage and the temperature used.

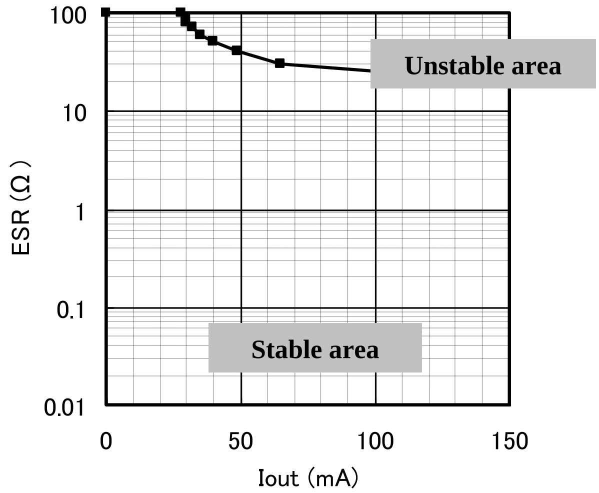


Figure 2. Stability area graph
Condition:Vin=Vout(typ)-1.5V Cin=0.1µF, Cout=1.0µF (MLCC)

The output can be seen as oscillated when the overheating protection or the overcurrent protection start operation, or the input voltage is low. In this case, please lower the power consumption, decrease the load current or make the input voltage higher.
Generally, a ceramic capacitor has the temperature characteristic and the voltage characteristic. Please select parts in consideration of the voltage and the temperature used. ASAHI KASEI TOKO POWER DEVICES recommend B characteristic type.

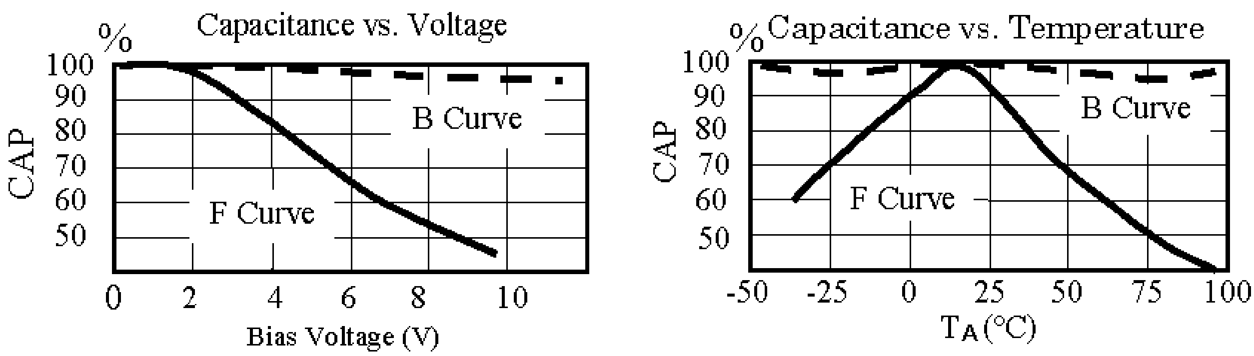


Figure 3. (Left) Capacitance vs. Voltage; (Right) Capacitance vs. Temperature

11.8 Operating Region and Power Dissipation

The power dissipation of the device is dependent on the junction temperature. Therefore, the package dissipation is assumed to be an internal limitation. The package itself does not have enough heat radiation characteristic due to the small size. Heat runs away by mounting IC on PCB. This value changes by the material, copper pattern etc. of PCB.
The overheating protection operates when there is a lot of loss inside the regulator (Ambient temperature high, heat radiation bad, etc.). The output current and the output voltage will drop when the protection circuit operates. When joint temperature (Tj) reaches the set temperature, IC stops the operation. However, operation begins at once when joint temperature (Tj) decreases.

・The thermal resistance when mounted on PCB

The chip joint temperature during operation is shown by Tj=θja×Pd+Ta. Joint part temperature (Tj) of AP1156ADSxx is limited around 150°C with the overheating protection circuit. Pd is the value when the overheating protection circuit starts operation. When you assume the ambient temperature to be 25°C,

150=θja×Pd(W)+25
θja×Pd=125
θja=125/Pd (°C/W)

・Example of mounting substrate

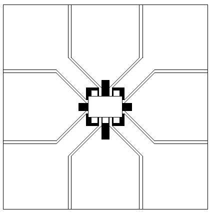


Figure 4. PCB Material: Two layer glass epoxy substrate
(x=30mm,y=30mm,t=1.0mm,Copper pattern thickness 35um)

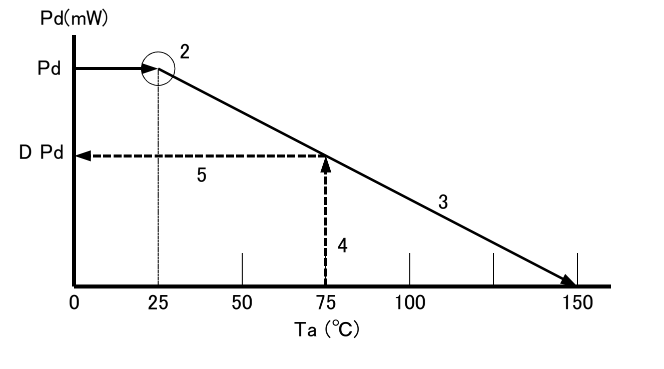
Please do derating with 5.9mW/°C at Pd=736mW and 25°C or higher. Thermal resistance is (θja=170°C/W)

・Method of obtaining Pd easily

Connect output terminal to GND(short circuited), and measure the input current by increasing the input voltage gradually up to 10V. The input current will reach the maximum output current, but will decrease soon according to the chip temperature rising, and will finally enter the state of thermal equilibrium (natural air cooling) The input current and the input voltage of this state will be used to calculate the Pd.

Pd(mW) ≅ Vin (V) × Iin (mA)

When the device is mounted, mostly achieve 600mW or more.



Procedure (When mounted on PCB).
1.Find Pd (Vin×Iin when the output is short-circuited).
2. Plot Pd against 25°C.
3. Connect Pd to the point corresponding to the 150°C with a straight line.
4. Pull a vertical line from the maximum operating temperature in your design (e.g., 75°C).
5. Read the value of Pd against the point at which the vertical line intersects the derating curve(DPd).
6.DPd÷(Vinmax-Vout)=Iout (at 75°C)

Figure 5. Method of obtaining Pd

The maximum output current at the highest operating temperature will be Iout≒DPd÷(Vinmax-Vout).
Please use the device at low temperature with better radiation. The lower temperature provides better quality.

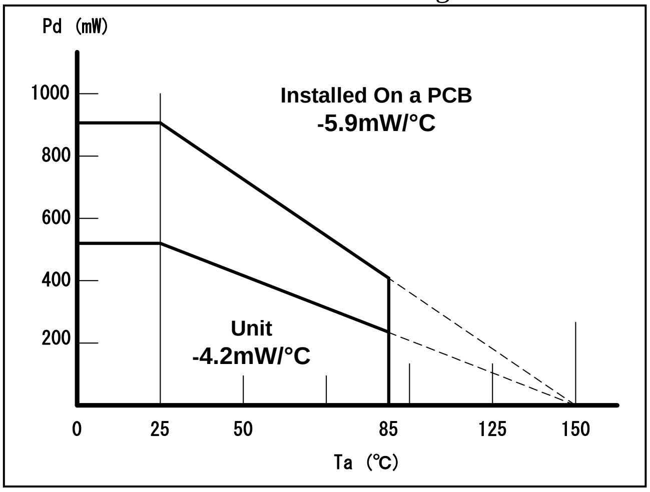
・The operation area

Pd when mounted on the substrate as shown on the Figure 4. (Ta=25°C)
SOT23-5=736mW (derating –5.9mW)
The current which can be used continuously with Ta=25°C min is calculated by the following.

$$Iout(mA) = \frac{736 - 5.9 \times (Ta - 25)}{|Vin| - |Vout|} \quad \ldots \text{ SOT23-5}$$

*Iout<150mA

The operation area is the part enclosed in the line including the "0" mentioned in graph1
The overheating sensor may operate, or the output voltage may drop outside those area.
The heat radiation characteristic changes in various conditions, so please check under your condition.



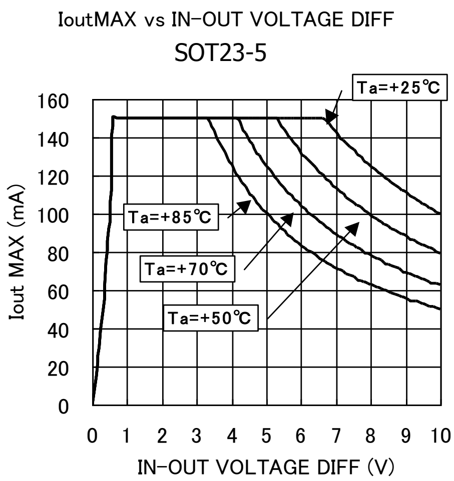


Figure 6. SOT23-5

11.9 Application hint

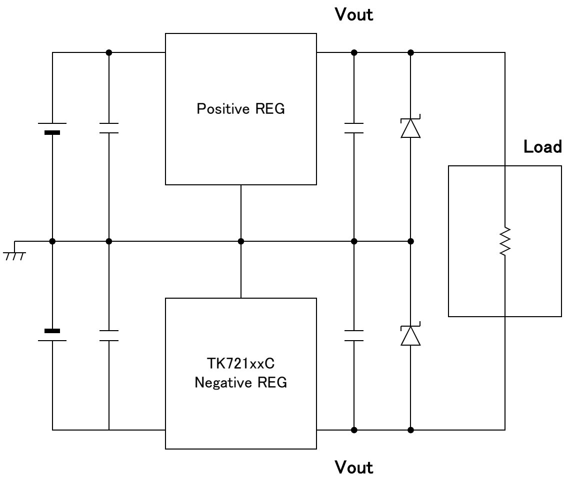


Figure 7.

When using positive output regulator together with this device, sometimes the voltage may not be outputted. To solve this problem, please connect Schottkey diode between GND and output, or change the timing of On/Off.

12. Definition of term

■Relating Characteristic

Each characteristic will be measured in a short period not to be influenced by joint temperature (Tj).

・Output voltage (Vout)

The output voltage is specified with Vin= Vout(typ)+1V and Iout=5mA

・Output current (Iout)

Output current, which can be used continuously (It is the range where overheating protection of the IC does not operate.)

・Peak output current ($Iout_{PEAK}$)

The rated output current is specified under the condition where the output voltage drops 90% by increasing the output current, compared to the value specified at Vin=Vout(typ)-1.5V.

・Dropout voltage (Vdrop)

It is an I/O voltage difference when the circuit stops the stable operation by decreasing the input voltage.
It is measured when the output voltage drops 100mV from its nominal value by decreasing the input voltage gradually.

・Line Regulation (LinReg)

It is the fluctuations of the output voltage value when the input voltage is changed.

・Load Regulation (LoaReg)

It is the fluctuations of output voltage value when the input voltage is assumed to be Vout(typ) -1.5V, and the load current is changed.

・Ripple Rejection (R.R)

Ripple rejection is the ability of the regulator to attenuate the ripple content of the input voltage at the output. It is measured with the condition of Vin=Vout-2.0V. Ripple rejection is the ratio of the ripple content between the output vs. input and is expressed in dB

・Standby current (Istandby)

It is an input current which flows to the Cont terminal, when the IC is turned off.

■Relating Protection Circuit

・Over Current Protection

It is a function to protect the IC by limiting the output current when excessive current flows to IC, such as the output is connected to GND, etc.

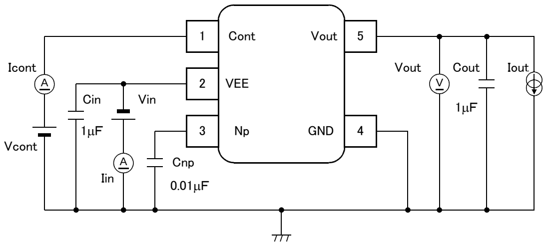
・Thermal Protection

It protects the IC not to exceed the permissible power consumption of the package in case of large power loss inside the regulator.
The output is turned off when the chip reaches around 150℃, but it turns on again when the temperature of the chip decreases.

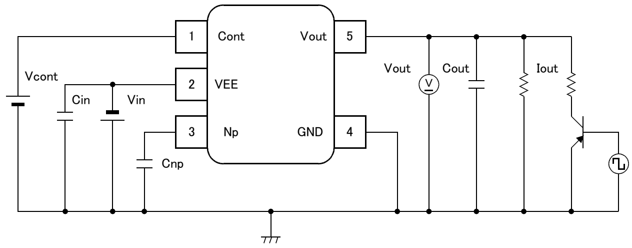
13. Test Circuit

■Test Circuit

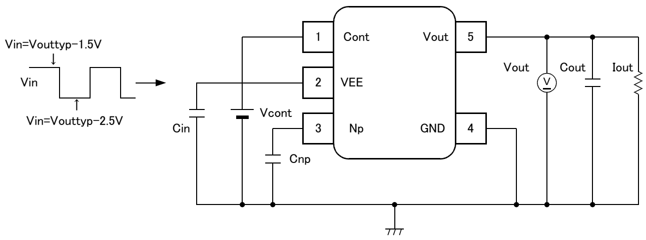
DC



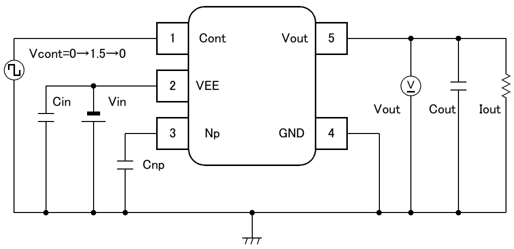
Load Transient



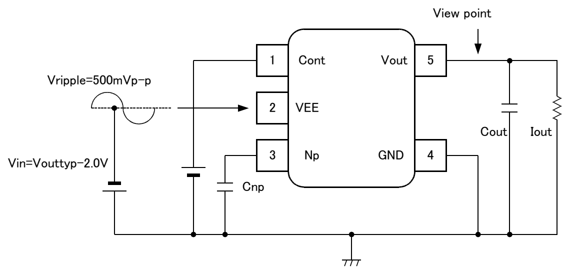
Line Transient



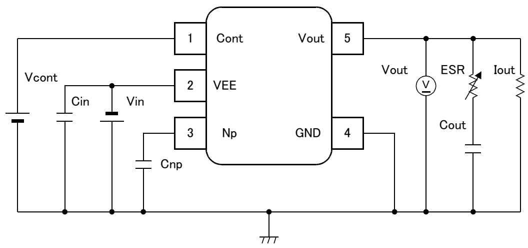
ON/OFF Transient



Ripple Rejection



ESR Stability



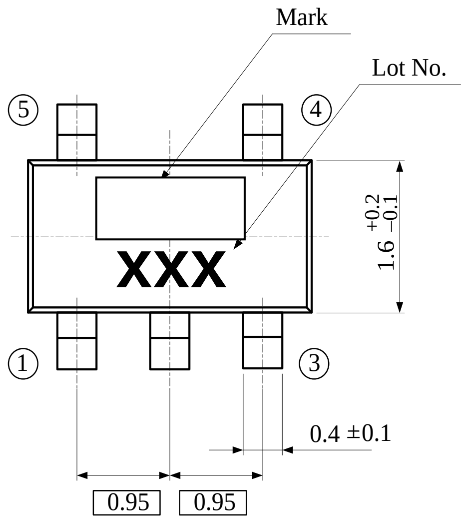
External Components
MLCC: Multi layer Ceramic Capacitor
Tantalum: Tantalum Capacitor

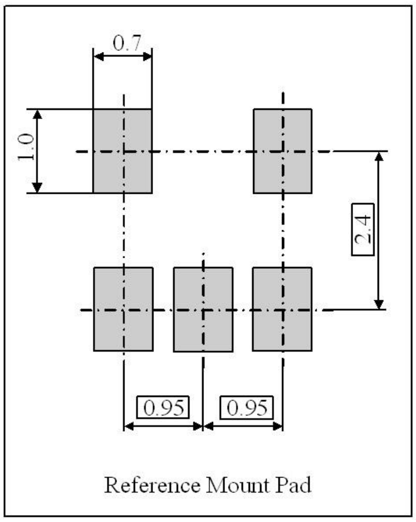
Figure 8. Test Circuit

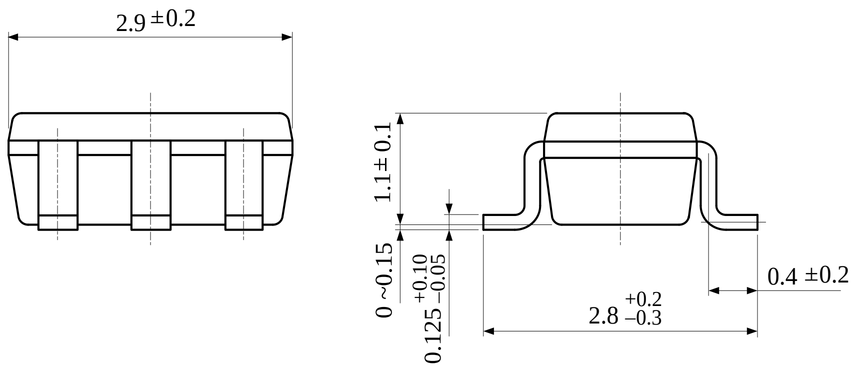
14. Package

■ Outline Dimensions

(Unit:mm)







15. Revise History

Date (YY/MM/DD)	Revision	Page	Contents
14/10/29	00	-	First Edition

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