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# AP1153ADSXX

## 14V Input / 100mA Output LDO Regulator

## 1. General Description

The AP1153ADSXX is a low dropout linear regulator with ON/OFF control, which can supply 100mA load current. The IC is an integrated circuit with a silicon monolithic bipolar structure. The output voltage, trimmed with high accuracy, is available from 1.3 to 5.0V in 0.1V steps. The output capacitor is available to use a small 0.22μF ceramic capacitor. The over current, thermal and reverse bias protections are integrated, and also the package is small and thin type. The IC is designed for space saving requirements.

## 2. Feature

- Available to use a small 0.22μF ceramic capacitor
- Dropout Voltage $V_{DROP}$=160mV at 100mA
- Output Current 100mA
- High Precision output voltage ±1.5% or ±50mV
- High ripple rejection ratio 80dB at 1kHz
  70dB at 10kHz
- Wide operating voltage range 2.1V to 14.0V
- Very low quiescent current $I_{QUT}$=75μA 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. Application

- Automotive accessory equipment
- Any Electronic Equipment
- Battery Powered Systems
- Mobile Communication

## 4. Table of Contents

# 5. Block Diagram

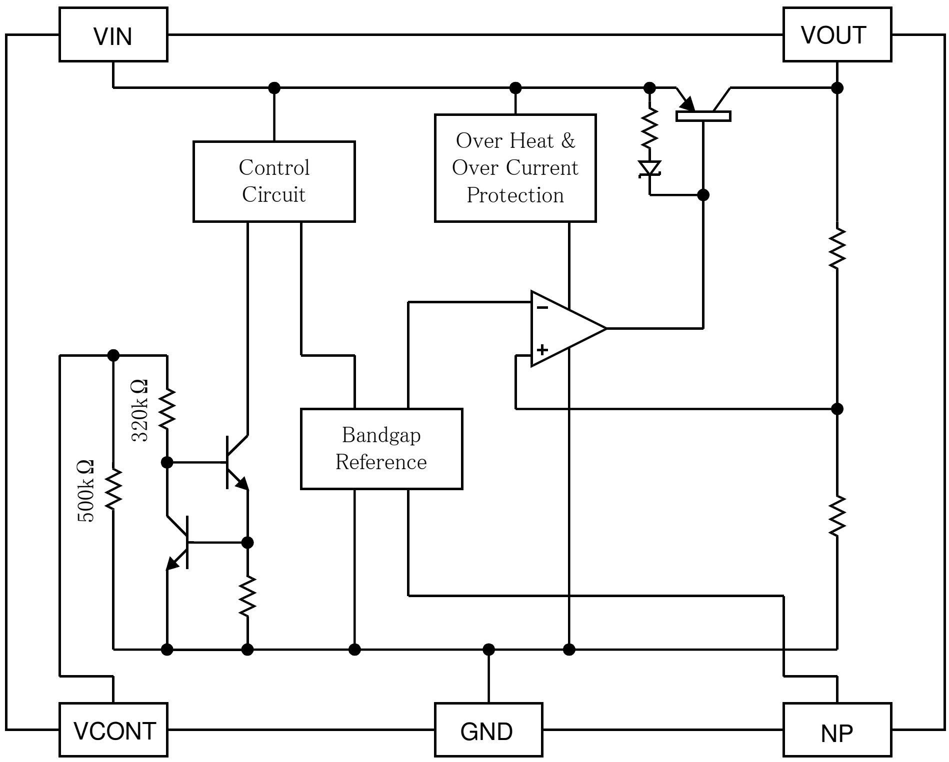



Figure 1. Block Diagram

## 6. Ordering Information

AP1153ADSXX Ta = -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.

AP1153ADSXX — XX: Output voltage code

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

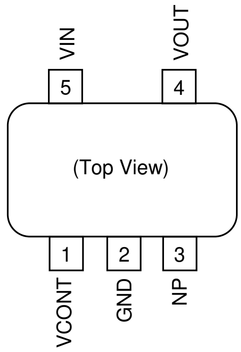
| XX | VOUT | XX | VOUT | XX | VOUT |
|---|---|---|---|---|---|
| 18 | 1.8 | 28 | 2.8 | 33 | 3.3 |
| 21 | 2.1 | 30 | 3.0 | 50 | 5.0 |

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

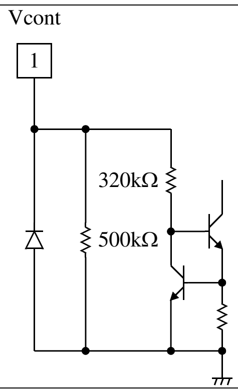
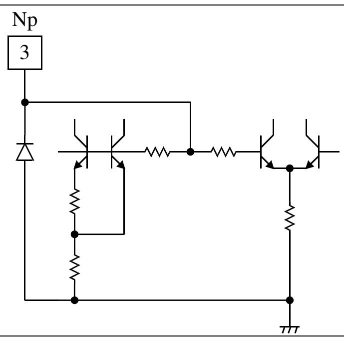
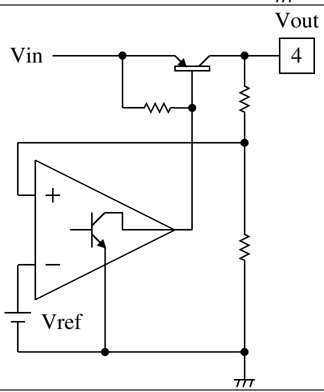
| XX | VOUT | XX | VOUT | XX | VOUT | XX | VOUT |
|---|---|---|---|---|---|---|---|
| 13 | 1.3 | 24 | 2.4 | 36 | 3.6 | 45 | 4.5 |
| 14 | 1.4 | 25 | 2.5 | 37 | 3.7 | 46 | 4.6 |
| 15 | 1.5 | 26 | 2.6 | 38 | 3.8 | 47 | 4.7 |
| 16 | 1.6 | 27 | 2.7 | 39 | 3.9 | 48 | 4.8 |
| 17 | 1.7 | 29 | 2.9 | 40 | 4.0 | 49 | 4.9 |
| 19 | 1.9 | 31 | 3.1 | 41 | 4.1 | - | - |
| 20 | 2.0 | 32 | 3.2 | 42 | 4.2 | - | - |
| 22 | 2.2 | 34 | 3.4 | 43 | 4.3 | - | - |
| 23 | 2.3 | 35 | 3.5 | 44 | 4.4 | - | - |

# 7. Pin Configurations and Functions

## ■ Pin Configurations




## ■ Functions

| Pin No. | Pin Description | Internal Equivalent Circuit | Description |
|---|---|---|---|
| 1 | VCONT |   | On/Off Control Terminal<br><br>Vcont > 1.8V : ON<br>Vcont < 0.35V : OFF<br><br>The pull-down resister (500kΩ) is built-in. |
| 2 | GND | - | GND Terminal |
| 3 | NP |   | Noise Bypass Terminal<br><br>Connect a bypass capacitor between GND. |
| 4 | VOUT |   | Output Terminal |
| 5 | VIN | - | Input Terminal |

## 8. Absolute Maximum Ratings

| Parameter | Symbol | min | max | Unit | Condition |
|---|---|---|---|---|---|
| Supply Voltage | $Vcc_{MAX}$ | -0.4 | 16 | V | |
| Reverse Bias | $Vrev_{MAX}$ | -0.4 | 6 | V | Vout≦2.0V |
| | | -0.4 | 12 | V | 2.1V≦Vout |
| Np pin Voltage | $Vnp_{MAX}$ | -0.4 | 5 | V | |
| Control pin Voltage | $Vcont_{MAX}$ | -0.4 | 16 | V | |
| Junction temperature | Tj | - | 150 | °C | |
| Storage Temperature Range | $T_{stg}$ | -55 | 150 | °C | |
| Power Dissipation | $P_D$ | - | 500 | mW | When mounted on PCB (Note 1) |

Note 1. Please do derating with 4.0mW/°C at Pd=500mW and 25°C or more. Thermal resistance θJA = 250°C/W.

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 | $V_{OP}$ | 2.1 | - | 14 | V | |

# 10. Electrical Characteristics

## ■ Electrical Characteristics of Ta=Tj=25°C

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

($V_{IN}$=Vouttyp+1V,Vcont=1.8V,Ta=Tj=25°C, unless otherwise specified.)

| Parameter | Symbol | Condition | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | Vout | Iout = 5mA | (Table 3, Table 4) | | | V |
| Line Regulation | LinReg | ΔVin = 5V | - | 0.0 | 5.0 | mV |
| Load Regulation | LoaReg | Iout = 5mA ~ 50mA | (Table 3, Table 4) | | | mV |
| | | Iout = 5mA ~ 100mA | | | | mV |
| Dropout Voltage (Note 2) | Vdrop | Iout = 50mA | - | 90 | 160 | mV |
| | | Iout = 100mA | - | 160 | 280 | mV |
| Output Current(Note 3) | Iout | | - | - | 100 | mA |
| Maximum Output Current (Note 3) | $Iout_{MAX}$ | $Vout=Vout_{TYP}\times0.9$ | 150 | 200 | - | mA |
| Supply Current | Icc | Iout = 0mA | - | 75 | 120 | µA |
| Standby Current | Istandby | Vcont = 0V | - | 0.0 | 0.1 | µA |
| Quiescent Current | Iq | Iout = 50mA | - | 1.5 | 2.7 | mA |
| Control Terminal | | | | | | |
| Control Current | Icont | Vcont = 1.8V | - | 5.0 | 15.0 | µA |
| Control Voltage | Vcont | Vout ON state | 1.8 | - | - | V |
| | | Vout OFF state | - | - | 0.35 | V |
| Reference Value | | | | | | |
| Np Terminal Voltage | Vnp | | - | 1.26 | - | V |
| Output Voltage / Temp. | Vout/Ta | | - | 35 | - | ppm /°C |
| Short Circuit Current | $I_{SHORT}$ | | - | 200 | - | mA |
| Output Noise Voltage ($Vout_{TYP}$=3.0V) | Vnoise | Cout=1.0µF, Cnp=0.01µF Iout=30mA | - | 38 | - | µV rms |
| Ripple Rejection ($Vout_{TYP}$=3.0V) | RR | Cout=1.0µF, Cnp=0.001µF Iout=10mA, f=1kHz | - | 80 | - | dB |
| | | f=10kHz | - | 70 | - | dB |
| Rise Time ($Vout_{TYP}$=3.0V) | tr | Cout=1.0µF, Cnp=0.001µF Vcont: Pulse Wave (100Hz) Vcont ON → Vout×95% point | - | 35 | - | µs |

Note 2. For Vout ≤ 2.0V , no regulations.
Note 3. The maximum output current is limited by power dissipation.

General Note:
Parameter with only typical value is for reference only.

Table 3. Standard Voltage Version

| Part Number | Output Voltage | | | Load Regulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Iout = 50mA | | Iout = 100mA | |
| | min | typ | max | typ | max | typ | max |
| | V | V | V | V | V | mV | mV |
| AP1153ADS18 | 1.750 | 1.800 | 1.850 | 5 | 12 | 11 | 26 |
| AP1153ADS21 | 2.050 | 2.100 | 2.150 | 5 | 12 | 12 | 28 |
| AP1153ADS28 | 2.750 | 2.800 | 2.850 | 6 | 14 | 14 | 34 |
| AP1153ADS30 | 2.950 | 3.000 | 3.050 | 6 | 15 | 15 | 35 |
| AP1153ADS33 | 3.250 | 3.300 | 3.350 | 7 | 16 | 16 | 37 |
| AP1153ADS50 | 4.925 | 5.000 | 5.075 | 9 | 20 | 21 | 50 |

Table 4. Optional Voltage Version

| Part Number | Output Voltage | | | Load Regulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Iout = 50mA | | Iout = 100mA | |
| | min | typ | max | typ | max | typ | max |
| | V | V | V | V | V | mV | mV |
| AP1153ADS13 | 1.250 | 1.300 | 1.350 | 5 | 10 | 10 | 22 |
| AP1153ADS14 | 1.350 | 1.400 | 1.450 | 5 | 10 | 10 | 23 |
| AP1153ADS15 | 1.450 | 1.500 | 1.550 | 5 | 11 | 10 | 24 |
| AP1153ADS16 | 1.550 | 1.600 | 1.650 | 5 | 11 | 11 | 25 |
| AP1153ADS17 | 1.650 | 1.700 | 1.750 | 5 | 11 | 11 | 25 |
| AP1153ADS19 | 1.850 | 1.900 | 1.950 | 5 | 12 | 11 | 27 |
| AP1153ADS20 | 1.950 | 2.000 | 2.050 | 5 | 12 | 12 | 28 |
| AP1153ADS22 | 2.150 | 2.200 | 2.250 | 6 | 13 | 12 | 29 |
| AP1153ADS23 | 2.250 | 2.300 | 2.350 | 6 | 13 | 13 | 30 |
| AP1153ADS24 | 2.350 | 2.400 | 2.450 | 6 | 13 | 13 | 31 |
| AP1153ADS25 | 2.450 | 2.500 | 2.550 | 6 | 14 | 13 | 31 |
| AP1153ADS26 | 2.550 | 2.600 | 2.650 | 6 | 14 | 14 | 32 |
| AP1153ADS27 | 2.650 | 2.700 | 2.750 | 6 | 14 | 14 | 33 |
| AP1153ADS29 | 2.850 | 2.900 | 2.950 | 6 | 15 | 15 | 34 |
| AP1153ADS31 | 3.050 | 3.100 | 3.150 | 7 | 15 | 15 | 36 |
| AP1153ADS32 | 3.150 | 3.200 | 3.250 | 7 | 15 | 16 | 37 |
| AP1153ADS34 | 3.349 | 3.400 | 3.451 | 7 | 16 | 16 | 38 |
| AP1153ADS35 | 3.447 | 3.500 | 3.553 | 7 | 16 | 16 | 39 |
| AP1153ADS36 | 3.546 | 3.600 | 3.654 | 7 | 17 | 17 | 40 |
| AP1153ADS37 | 3.644 | 3.700 | 3.756 | 7 | 17 | 17 | 40 |
| AP1153ADS38 | 3.743 | 3.800 | 3.857 | 7 | 17 | 17 | 41 |
| AP1153ADS39 | 3.841 | 3.900 | 3.959 | 8 | 17 | 18 | 42 |
| AP1153ADS40 | 3.940 | 4.000 | 4.060 | 8 | 18 | 18 | 43 |
| AP1153ADS41 | 4.038 | 4.100 | 4.162 | 8 | 18 | 18 | 43 |
| AP1153ADS42 | 4.137 | 4.200 | 4.263 | 8 | 18 | 19 | 44 |
| AP1153ADS43 | 4.235 | 4.300 | 4.365 | 8 | 18 | 19 | 45 |
| AP1153ADS44 | 4.334 | 4.400 | 4.466 | 8 | 19 | 19 | 46 |
| AP1153ADS45 | 4.432 | 4.500 | 4.568 | 8 | 19 | 20 | 46 |
| AP1153ADS46 | 4.531 | 4.600 | 4.669 | 8 | 19 | 20 | 47 |
| AP1153ADS47 | 4.629 | 4.700 | 4.771 | 8 | 20 | 20 | 48 |
| AP1153ADS48 | 4.728 | 4.800 | 4.872 | 9 | 20 | 21 | 49 |
| AP1153ADS49 | 4.826 | 4.900 | 4.974 | 9 | 20 | 21 | 49 |

## ■ Electrical Characteristics of Ta=-40°C~85°C

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

($V_{IN}$=$Vout_{TYP}$+1V,Vcont=1.8V,Ta=-40 ~ 85°C, unless otherwise specified.)

| Parameter | Symbol | Condition | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | Vout | Iout = 5mA | (Table 5, Table 6) | | | V |
| Line Regulation | LinReg | ΔVin = 5V | | 0.0 | 8.0 | mV |
| Load Regulation | LoaReg | Iout = 5mA ~ 50mA | (Table 5, Table 6) | | | mV |
| | | Iout = 5mA ~ 100mA | | | | mV |
| Dropout Voltage (Note 4) | Vdrop | Iout = 50mA | | 90 | 205 | mV |
| | | Iout = 100mA | | 160 | 360 | mV |
| Output Current(Note 5) | Iout | | | | 100 | mA |
| Maximum Output Current (Note 5) | $Iout_{MAX}$ | Vout=$Vout_{TYP}$×0.9 | 110 | 200 | - | mA |
| Supply Current | Icc | Iout = 0mA | | 75 | 145 | μA |
| Standby Current | Istandby | Vcont = 0V | | 0.0 | 0.5 | μA |
| Quiescent Current | Iq | Iout = 50mA | | 1.5 | 3.3 | mA |
| Control Terminal | | | | | | |
| Control Current | Icont | Vcont = 1.8V | - | 5.0 | 15.0 | μA |
| Control Voltage | Vcont | Vout ON state | 1.8 | - | - | V |
| | | Vout OFF state | - | - | 0.35 | V |
| Reference Value | | | | | | |
| Np Terminal Voltage | Vnp | | | 1.26 | | V |
| Output Voltage / Temp. | Vout/Ta | | | 35 | | ppm /°C |
| Short Circuit Current | $I_{SHORT}$ | | | 200 | | mA |
| Output Noise Voltage ($Vout_{TYP}$=3.0V) | Vnoise | Cout=1.0μF, Cnp=0.01μF Iout=30mA | | 38 | | μV rms |
| Ripple Rejection ($Vout_{TYP}$=3.0V) | RR | Cout=1.0μF, Cnp=0.001μF Iout=10mA, f=1kHz | | 80 | | dB |
| | | f=10kHz | | 70 | | dB |
| Rise Time ($Vout_{TYP}$=3.0V) | tr | Cout=1.0μF, Cnp=0.001μF Vcont: Pulse Wave (100Hz) Vcont ON → Vout×95% point | | 35 | | μs |

Note 4. For Vout ≤ 2.0V, no regulations.
Note 5. The maximum output current is limited by power dissipation.

General Note:

Parameter with only typical value is for reference only.

Table 5. Standard Voltage Version

| Part Number | Output Voltage | | | Load Regulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Iout = 50mA | | Iout = 100mA | |
| | min | typ | max | typ | max | typ | max |
| | V | V | V | V | V | mV | mV |
| AP1153ADS18 | 1.720 | 1.800 | 1.880 | 5 | 14 | 11 | 29 |
| AP1153ADS21 | 2.020 | 2.100 | 2.180 | 5 | 14 | 12 | 31 |
| AP1153ADS28 | 2.720 | 2.800 | 2.880 | 6 | 16 | 14 | 37 |
| AP1153ADS30 | 2.920 | 3.000 | 3.080 | 6 | 17 | 15 | 38 |
| AP1153ADS33 | 3.217 | 3.300 | 3.383 | 7 | 18 | 16 | 40 |
| AP1153ADS50 | 4.875 | 5.000 | 5.125 | 9 | 22 | 21 | 55 |

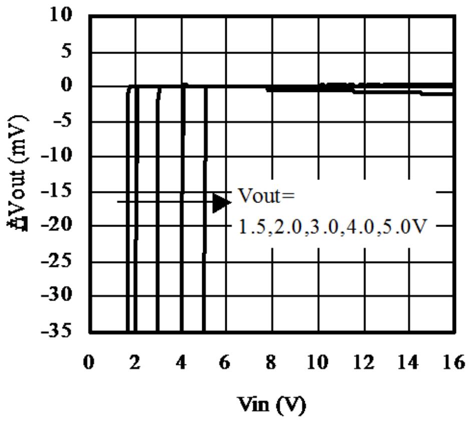
Table 6. Optional Voltage Version

| Part Number | Output Voltage | | | Load Regulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Iout = 50mA | | Iout = 100mA | |
| | min | typ | max | typ | max | typ | max |
| | V | V | V | V | V | mV | mV |
| AP1153ADS13 | 1.220 | 1.300 | 1.380 | 5 | 12 | 10 | 25 |
| AP1153ADS14 | 1.320 | 1.400 | 1.480 | 5 | 12 | 10 | 26 |
| AP1153ADS15 | 1.420 | 1.500 | 1.580 | 5 | 13 | 10 | 27 |
| AP1153ADS16 | 1.520 | 1.600 | 1.680 | 5 | 13 | 11 | 28 |
| AP1153ADS17 | 1.620 | 1.700 | 1.780 | 5 | 13 | 11 | 28 |
| AP1153ADS19 | 1.820 | 1.900 | 1.980 | 5 | 14 | 11 | 30 |
| AP1153ADS20 | 1.920 | 2.000 | 2.080 | 5 | 14 | 12 | 31 |
| AP1153ADS22 | 2.120 | 2.200 | 2.280 | 6 | 15 | 12 | 32 |
| AP1153ADS23 | 2.220 | 2.300 | 2.380 | 6 | 15 | 13 | 33 |
| AP1153ADS24 | 2.320 | 2.400 | 2.480 | 6 | 15 | 13 | 34 |
| AP1153ADS25 | 2.420 | 2.500 | 2.580 | 6 | 16 | 13 | 34 |
| AP1153ADS26 | 2.520 | 2.600 | 2.680 | 6 | 16 | 14 | 35 |
| AP1153ADS27 | 2.620 | 2.700 | 2.780 | 6 | 16 | 14 | 36 |
| AP1153ADS29 | 2.820 | 2.900 | 2.980 | 6 | 17 | 15 | 37 |
| AP1153ADS31 | 3.020 | 3.100 | 3.180 | 7 | 17 | 15 | 39 |
| AP1153ADS32 | 3.120 | 3.200 | 3.280 | 7 | 17 | 16 | 40 |
| AP1153ADS34 | 3.312 | 3.400 | 3.488 | 7 | 18 | 16 | 41 |
| AP1153ADS35 | 3.412 | 3.500 | 3.588 | 7 | 18 | 16 | 42 |
| AP1153ADS36 | 3.510 | 3.600 | 3.690 | 7 | 19 | 17 | 43 |
| AP1153ADS37 | 3.605 | 3.700 | 3.795 | 7 | 19 | 17 | 43 |
| AP1153ADS38 | 3.705 | 3.800 | 3.895 | 7 | 19 | 17 | 44 |
| AP1153ADS39 | 3.805 | 3.900 | 3.995 | 8 | 19 | 18 | 45 |
| AP1153ADS40 | 3.900 | 4.000 | 4.100 | 8 | 20 | 18 | 46 |
| AP1153ADS41 | 3.986 | 4.100 | 4.214 | 8 | 20 | 18 | 47 |
| AP1153ADS42 | 4.085 | 4.200 | 4.315 | 8 | 20 | 19 | 48 |
| AP1153ADS43 | 4.184 | 4.300 | 4.416 | 8 | 20 | 19 | 49 |
| AP1153ADS44 | 4.283 | 4.400 | 4.517 | 8 | 21 | 19 | 50 |
| AP1153ADS45 | 4.382 | 4.500 | 4.618 | 8 | 21 | 20 | 50 |
| AP1153ADS46 | 4.481 | 4.600 | 4.719 | 8 | 21 | 20 | 51 |
| AP1153ADS47 | 4.580 | 4.700 | 4.820 | 8 | 22 | 20 | 52 |
| AP1153ADS48 | 4.679 | 4.800 | 4.921 | 9 | 22 | 21 | 54 |
| AP1153ADS49 | 4.777 | 4.900 | 5.023 | 9 | 20 | 21 | 54 |

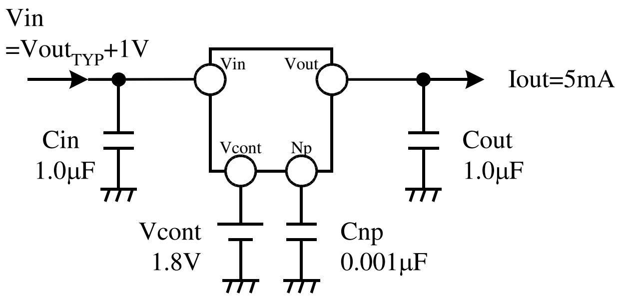
# 11. Description

## 11.1 DC Characteristics

■ Line Regulation

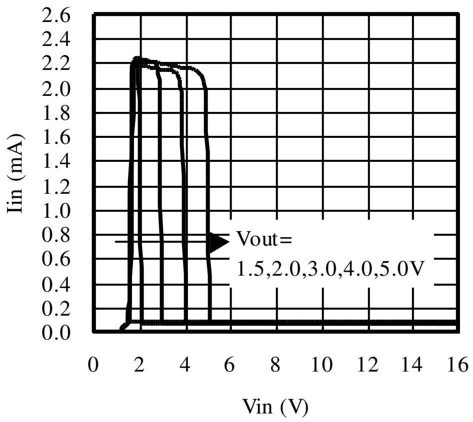



Test conditions



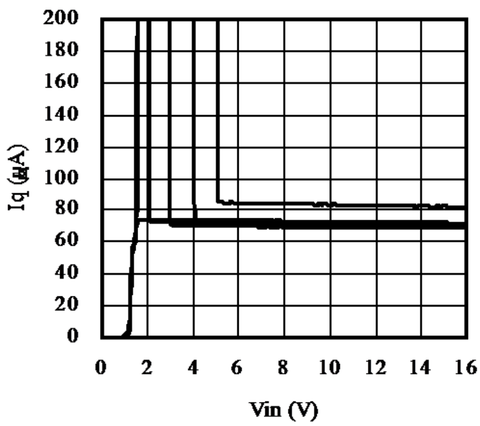

■ Iin vs $V_{IN}$

Iout=0mA

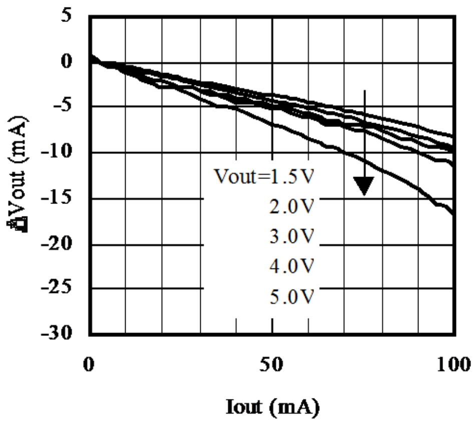



■ Quiescent Current

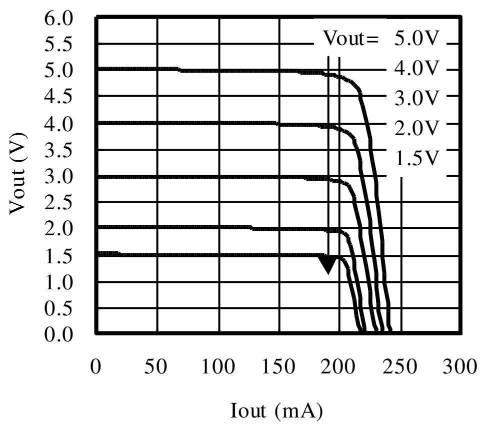
Iout=0mA



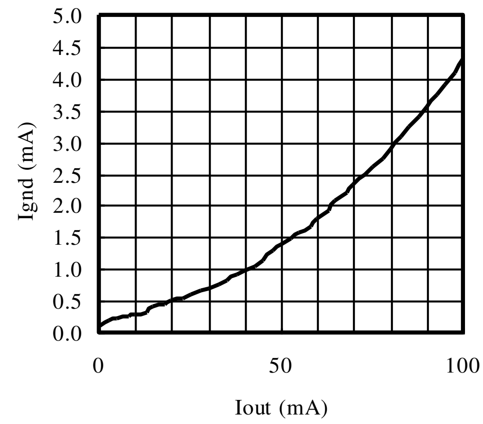

■ Load Regulation



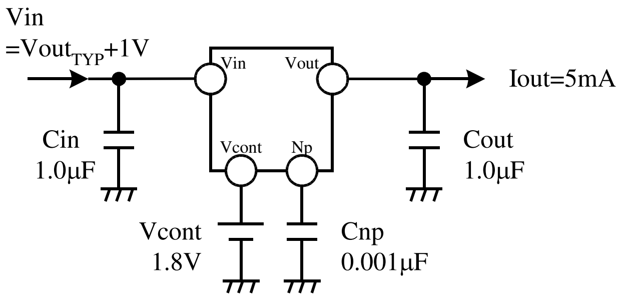

■ Peak Output Current



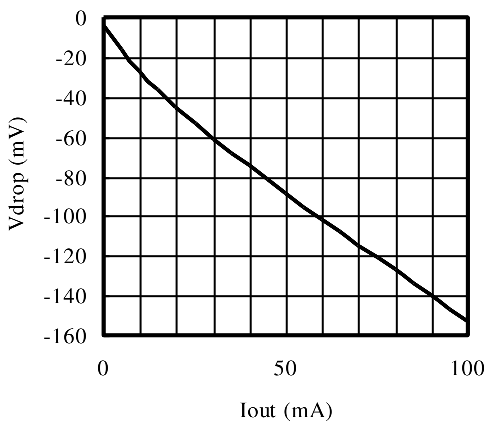
■ GND Pin Current



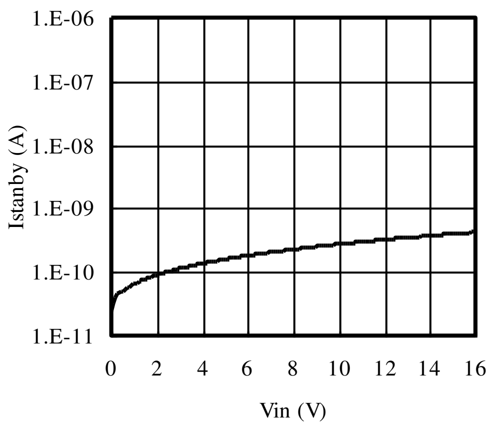

Test conditions



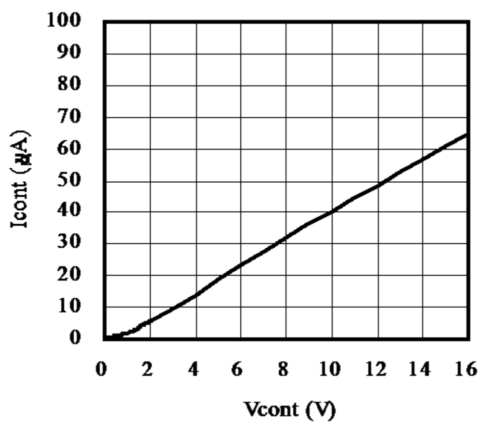

■ Dropout Voltage
2.1V ≤ Vouttyp



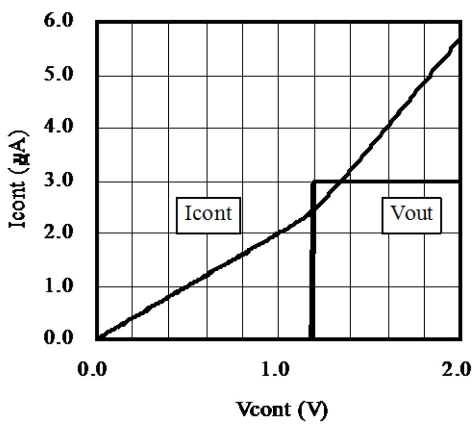

■ Standby Current (Off state)
Vcont=0V



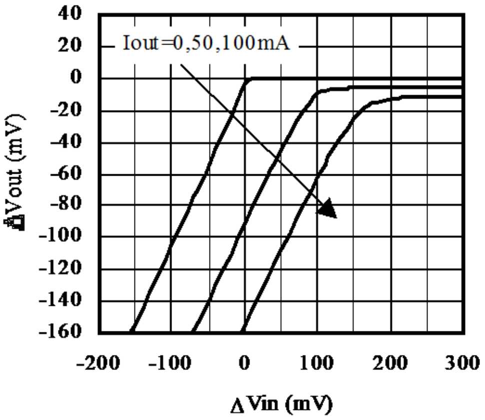

■ Control Current



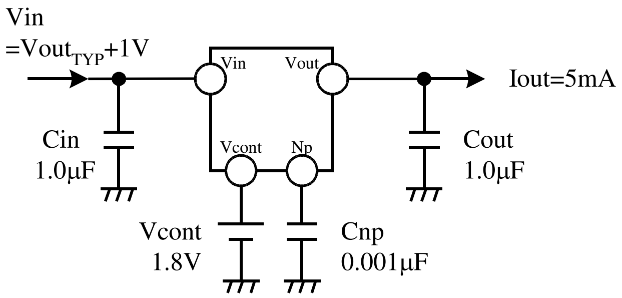

■ Control Current, ON/OFF Point



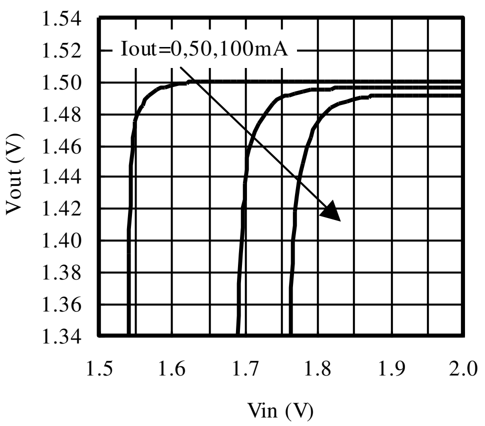
■ Vout vs $V_{IN}$ Regulation Point
2.1V ≤ Vouttyp



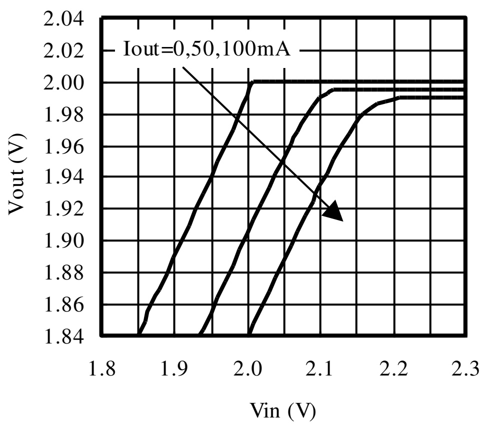

Test conditions



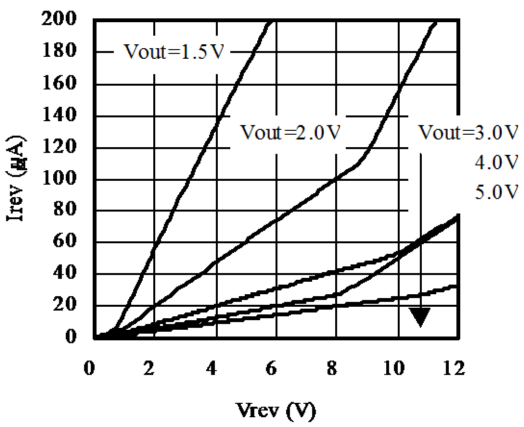

■ Vout vs $V_{IN}$ Regulation Point
Vouttyp=1.5V



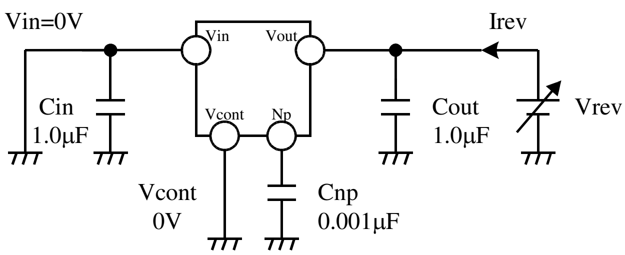

■ Vout vs $V_{IN}$ Regulation Point
Vouttyp=2.0V




■ Reverse Bias Current
$V_{IN}$=0V, Vcont=0V

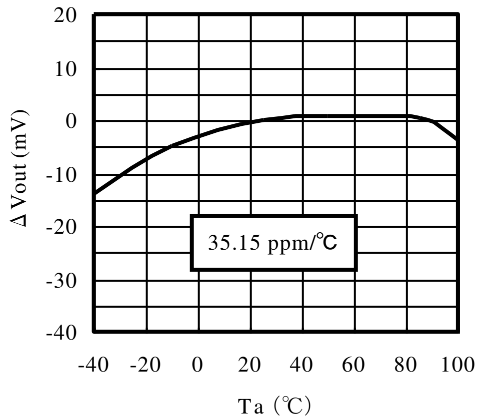



Test conditions

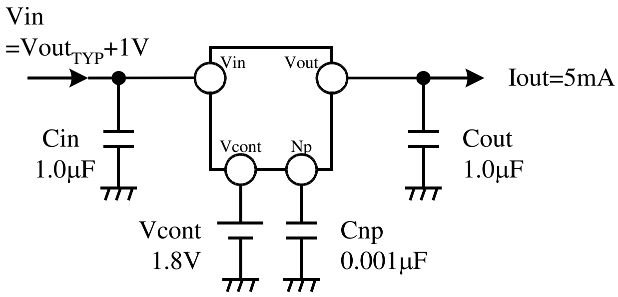


## 11.2 Temperature Characteristics

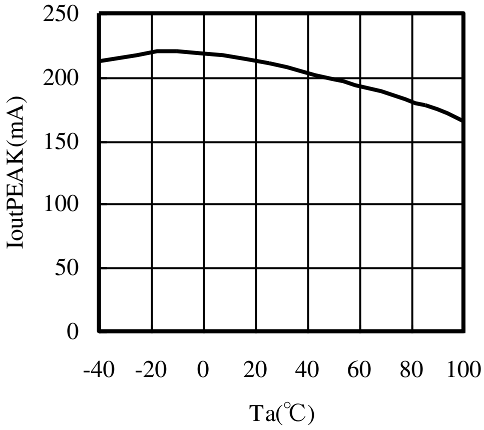
■ Vout
Vouttyp=3.0V



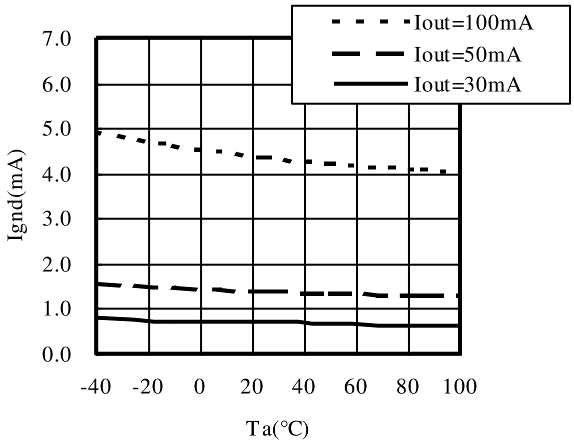

Test conditions



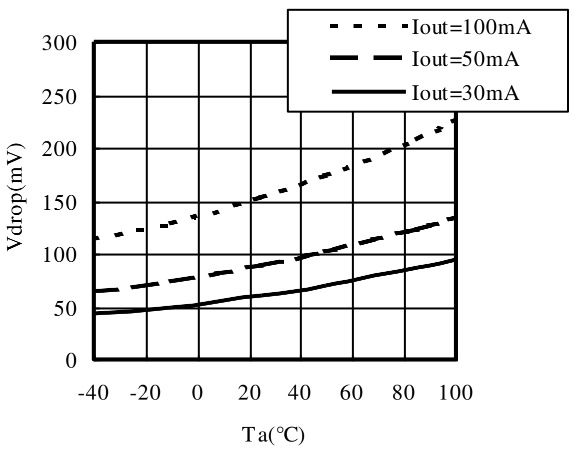

■ Peak Output Current
Vout=Vouttyp × 0.9



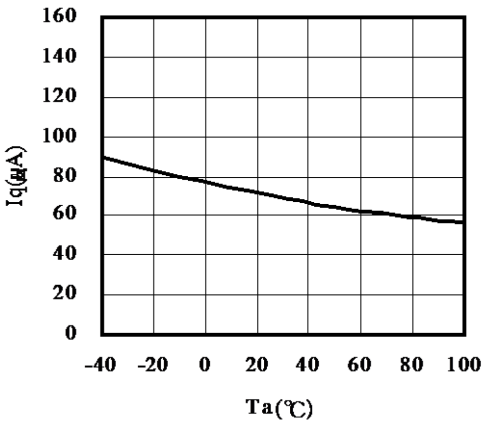

■ GND Pin Current



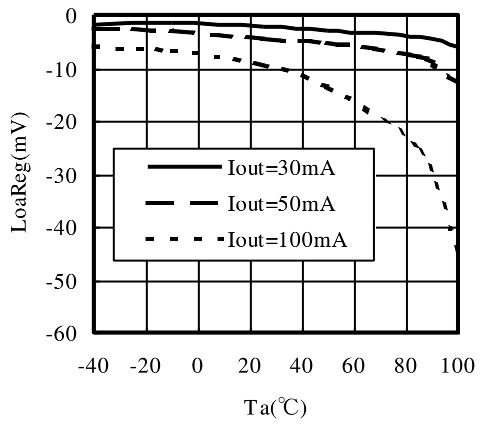

■ Dropout Voltage
2.1V ≤ Vouttyp



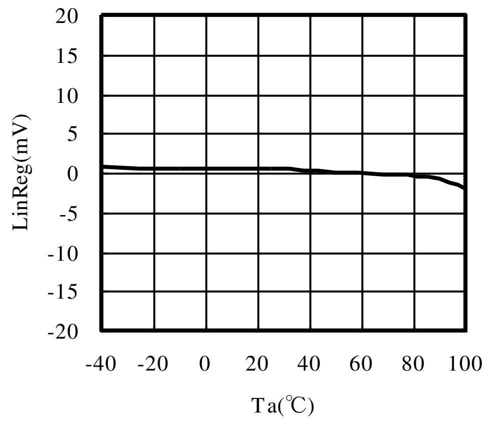

■ Quiescent Current
Iout=0mA



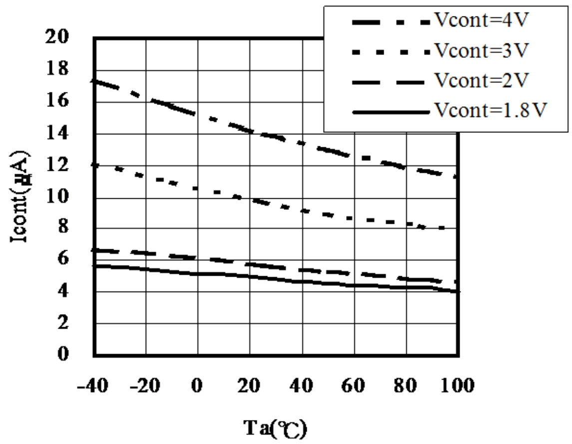
■ Load Regulation
Vouttyp=3.0V



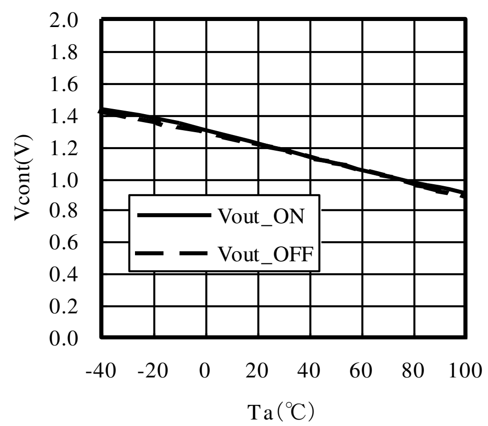

■ Line Regulation
$\Delta V_{IN}$ = 5V




■ Control Current

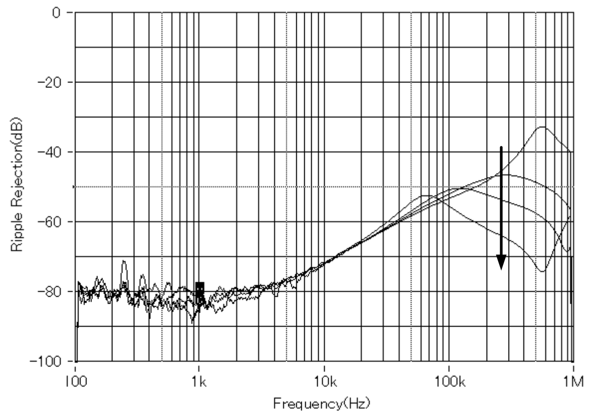



■ ON/OFF Point

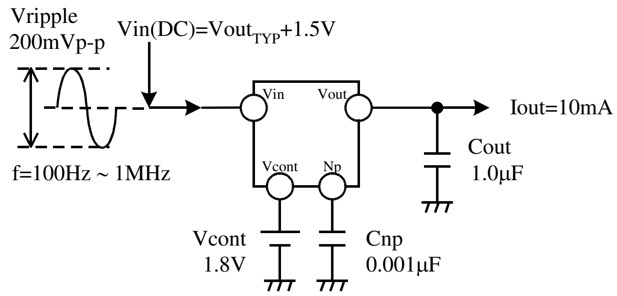


## 11.3 Ripple Rejection

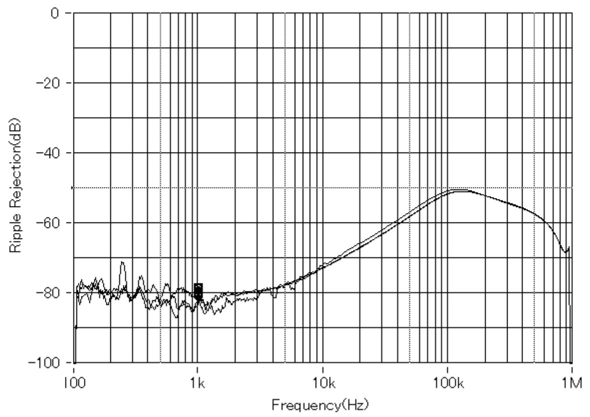
■ Cout=0.22μF, 0.47μF, 1.0μF, 2.2μF



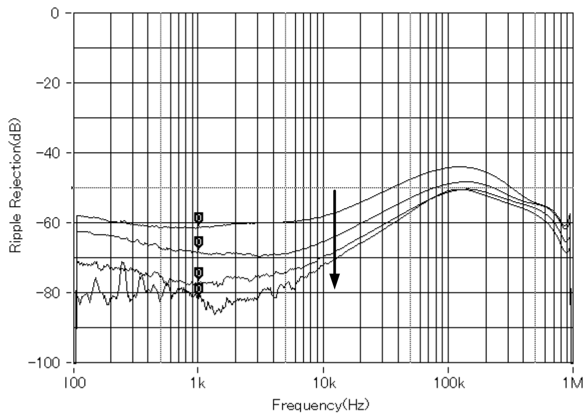

Test conditions



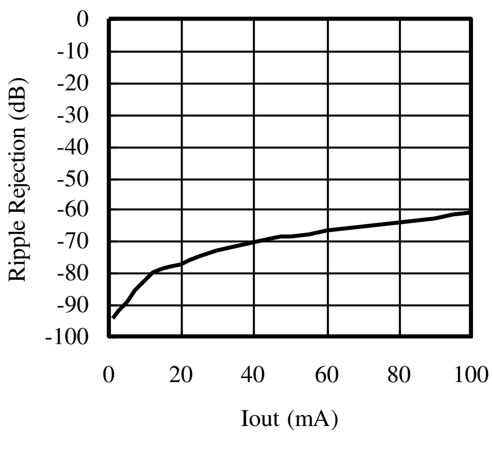

■ Cnp=0.001μF, 0.01μF, 0.1μF



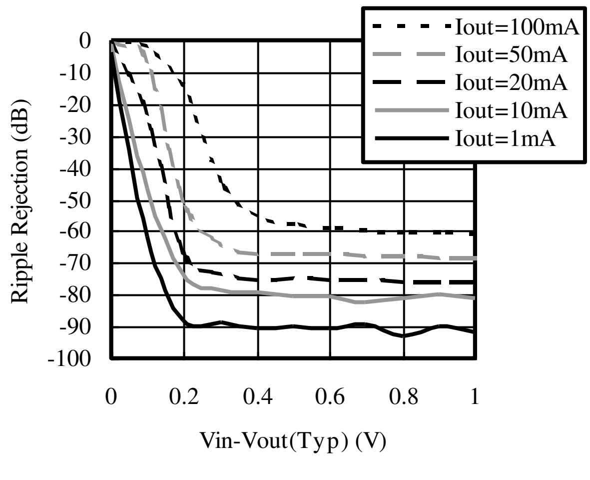

■ Iout=10mA, 20mA, 50mA, 100mA




■ R.R vs Iout : Frequency=1kHz

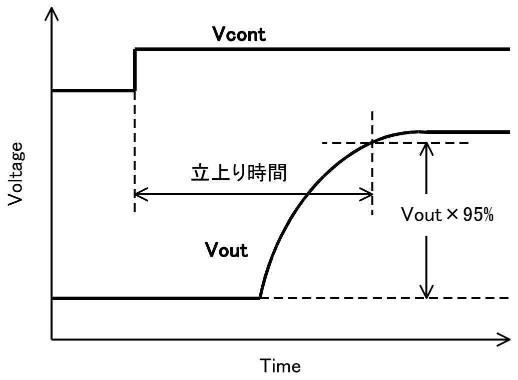



■ R.R vs Low $V_{IN}$ : Frequency=1kHz

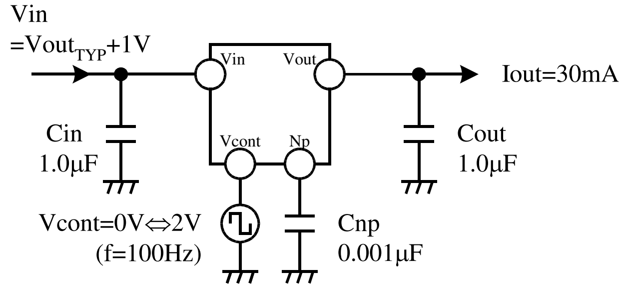



The ripple rejection (R.R) characteristic depends on the characteristic and the capacitance of the output capacitor. The R.R characteristic at 50kHz or more varies greatly with the capacitor on the output side and PCB pattern. Please check stability during operation.

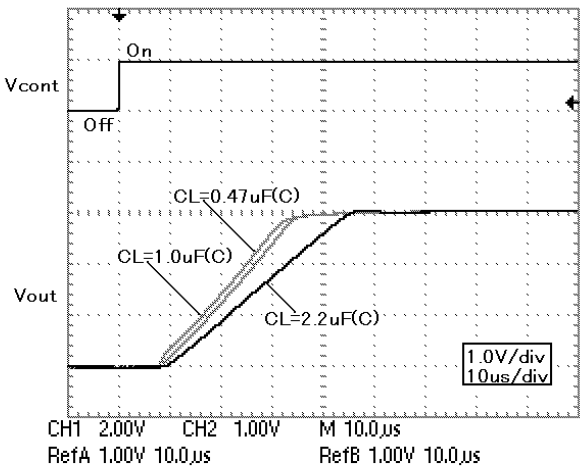
## 11.4 ON/OFF transient



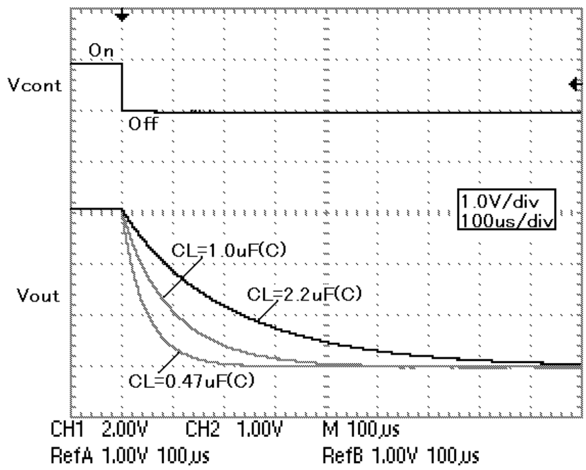

Test conditions



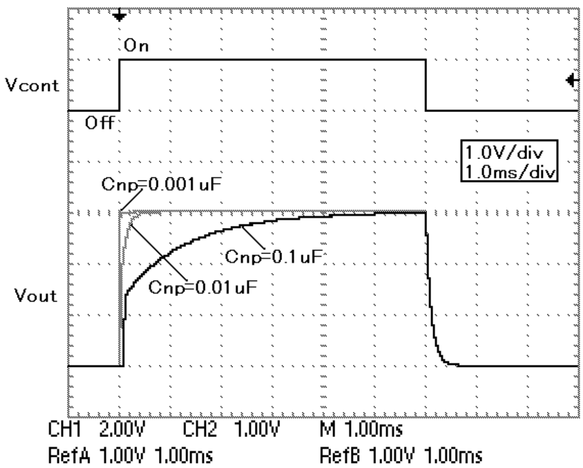

■ Cout=0.47μF, 1.0μF, 2.2μF




■ Cout=0.47μF, 1.0μF, 2.2μF



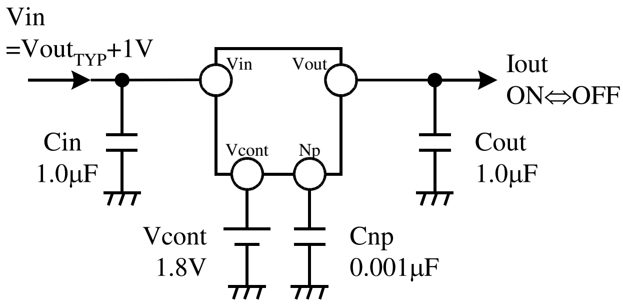

■ Cnp=0.001μF, 0.01μF, 0.1μF



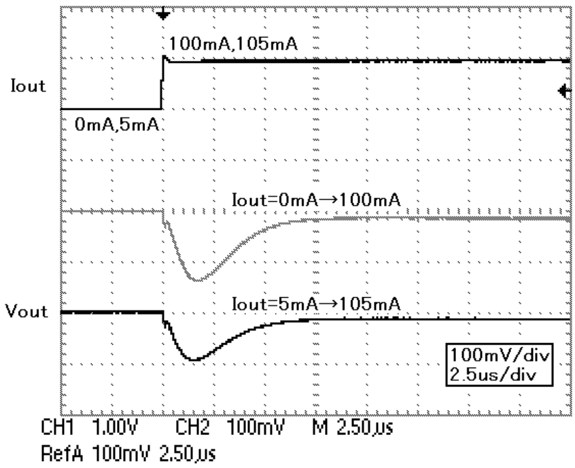

Rise time becomes longer if Cout or Cnp becomes larger.
Fall time depends on Cout.

## 11.5 ON/OFF transient

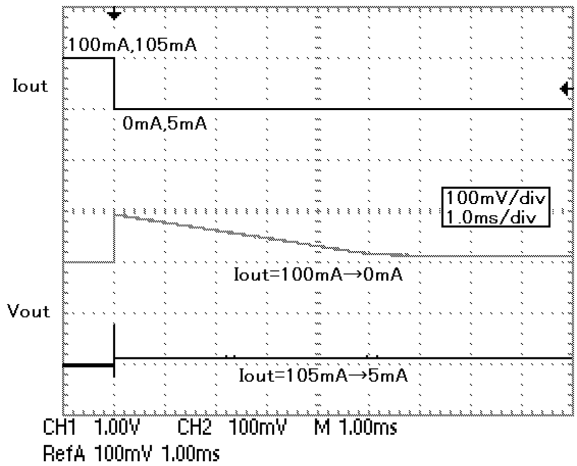
Test conditions



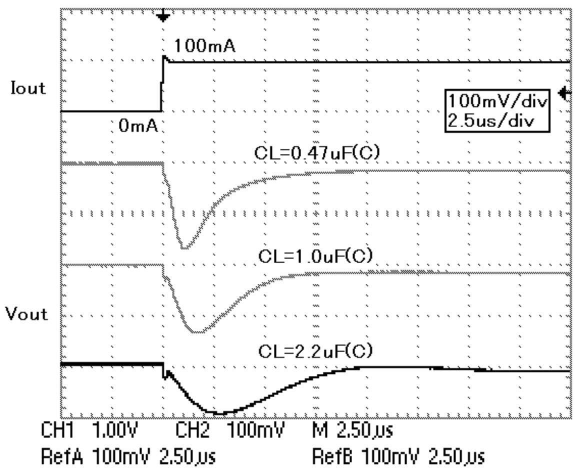

■ Iout=0⇒100mA, 5⇒105mA



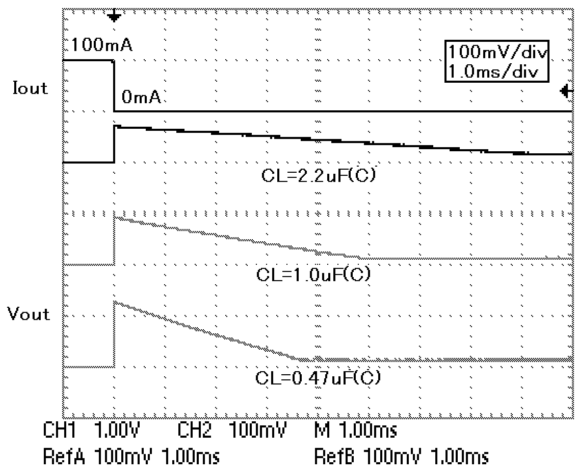

■ Iout=100mA⇒0mA, 105mA⇒5mA




■ Cout=0.47μF, 1.0μF, 2.2μF : Iout=0mA⇒100mA



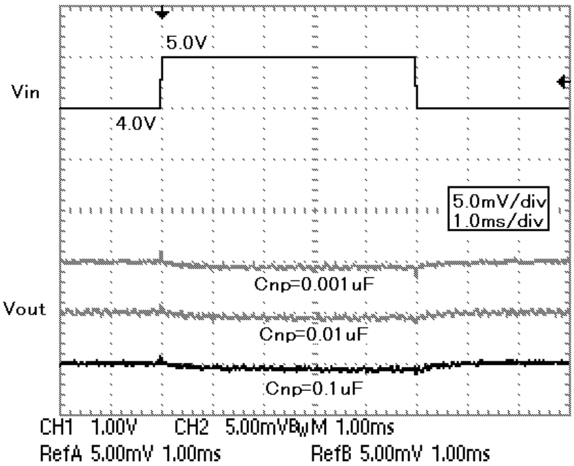

■ Cout=0.47μF, 1.0μF, 2.2μF : Iout=100mA⇒0mA



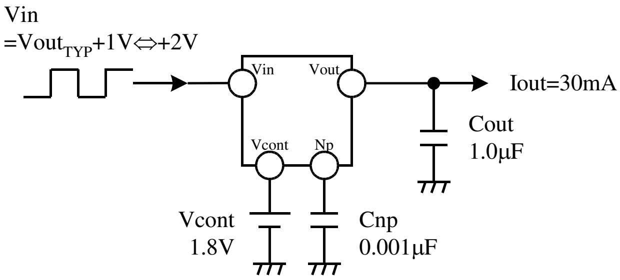

Increase the load side capacitor when the load change is fast or when there is a large current change. In addition, at no load, supplying small load current to ground can reduce the voltage change.

## 11.6 Line transient

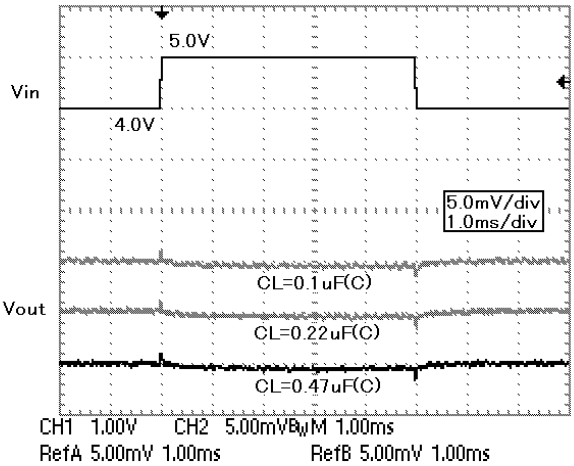
■ Cnp=0.001μF, 0.01μF, 0.1μF



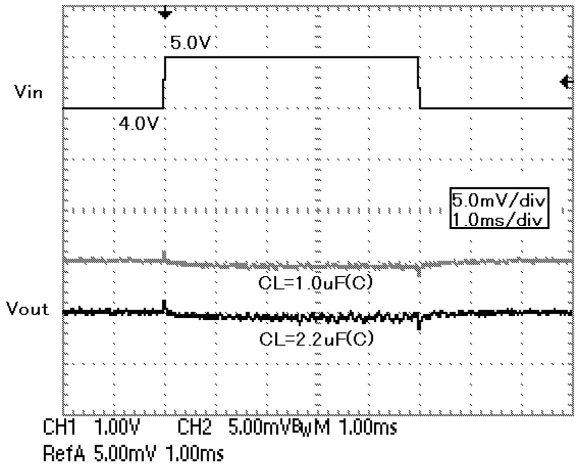

Test conditions




■ Cout=0.1μF, 0.22μF, 0.47μF

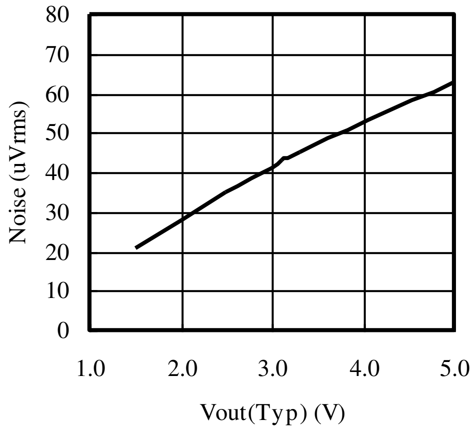



■ Cout=1.0μF, 2.2μF

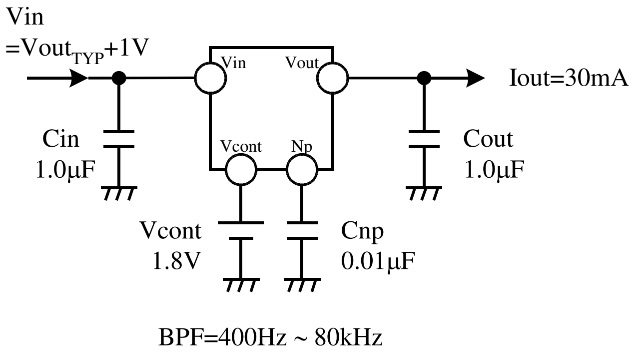


## 11.7 Output noise

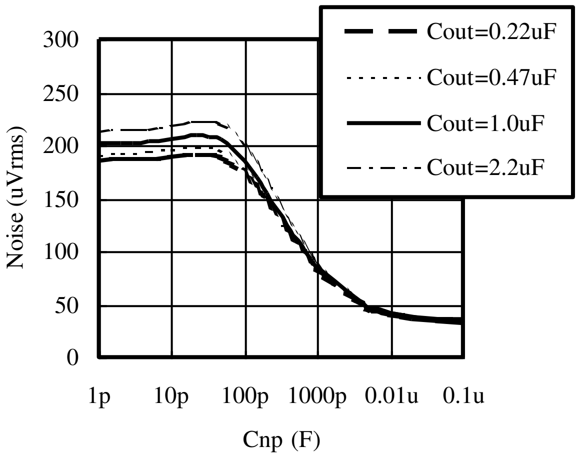
■ Vout vs Noise



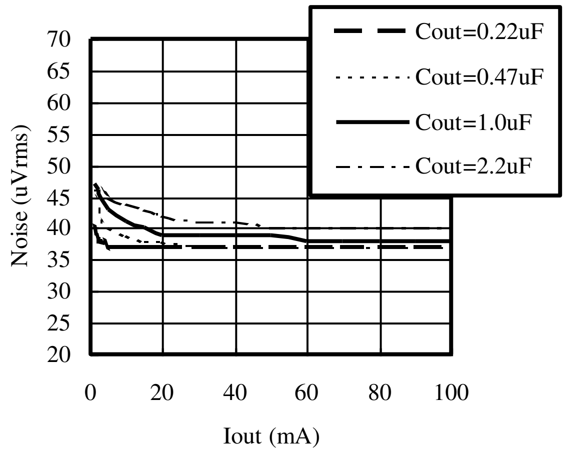

Test conditions




■ Cnp vs Noise




■ Iout vs Noise




Increase Cnp to decrease the noise. The recommended Cnp capacitance is 0.01µF ~ 0.1µF.
The amount of noise increases with the higher output voltages.

## 11.8 Stability

Linear regulators require input and output capacitors in order to maintain the regulator's loop stability. If 0.22µF or larger capacitor is connected to the output pin, the IC provides stable operation at any voltage (1.3V≤VoutTYP≤5.0V). (The capacitor must be larger than 0.22µF at all temperature and voltage range.)
If the capacitor with high Equivalent Series Resistance (ESR) is used, such as tantalum capacitor etc., the regulator may oscillate. Please select parts with low ESR. 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.
A recommended value of the application is Cin=Cout≥0.47µF Ceramic Capacitance.

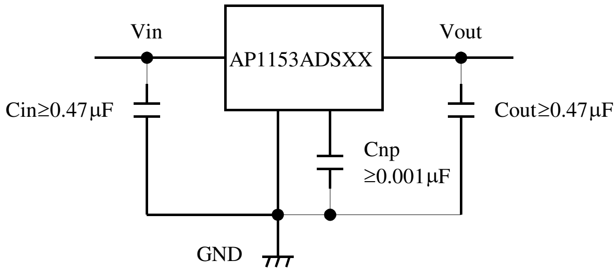
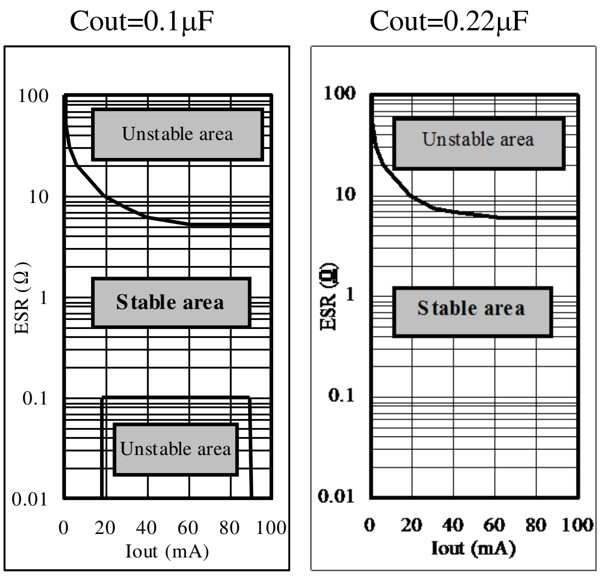



Figure 2. Recommended value




1.5V ≤ $Vout_{TYP}$ ≤ 5.0V

Figure 3. Stable operation area, Output current and ESR

Figure 3 shows stable operation with a ceramic capacitor of 0.22µF. Since it may oscillate if ESR is large, we recommend using ceramic capacitor. The stability of the regulator improves with larger output capacitor (the stable operation area extends.) Please use the capacitor with larger capacitance as possible.

For evaluation
Kyocera: CM05B104K10AB, CM05B224K10AB, CM105B104K16A, CM105B224K16A, CM21B225K10A
Murata: GRM36B104K10, GRM42B104K10, GRM39B104K25, GRM39B224K10, GRM39B105K6.3

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

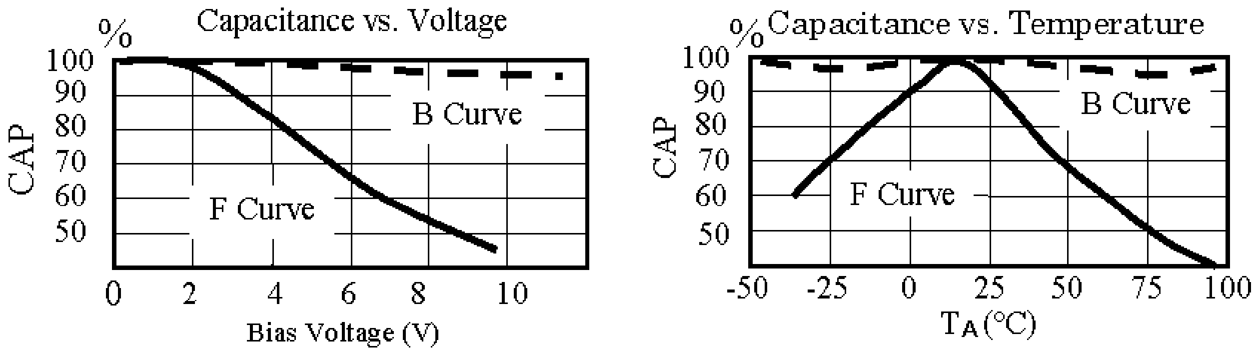



Figure 4. Example Ceramic Capacitance vs. Bias Voltage, Temperature

Generally, a ceramic capacitor has both temperature characteristic and voltage characteristic. Please consider both characteristics when selecting the part. The B curves are the recommend characteristics.

## 11.9 Operating Region and Power Dissipation

The power dissipation of the device depends 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 junction temperature during operation is shown by $Tj=\theta JA \times Pd+Ta$. Junction temperature (Tj) is limited around 140°C by the thermal protection circuit. Pd is the value when the overheating protection circuit starts operation.

When you assume the ambient temperature to be 25°C,

$140 = \theta JA \times Pd(W) + 25$

$\theta JA \times Pd = 115$

$\theta JA = 115/Pd$ (°C /W)

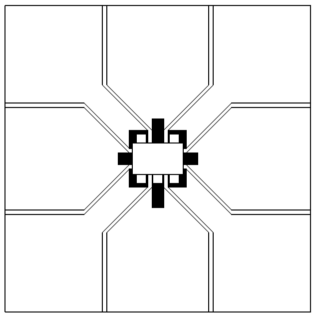


Figure 5. Example PCB layout

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

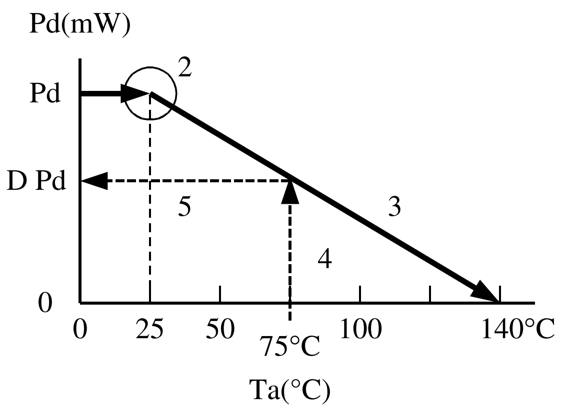
**AP1153ADSXX (SOT23-5)**
Please derate 5.4mW/°C at Pd=677mW above 25°C. Thermal resistance (θJA) is 185°C/W.

**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.

$Pd(mW) \approx Vin(V) \times Iin(mA)$

When the device is mounted, mostly achieve: 500mW or more

| | |
|---|---|
|  | Procedure (When mounted on PCB).<br><br>1.Find Pd (Vin × Iin when the output is short-circuited).<br>2. Plot Pd against 25°C.<br>3. Connect Pd to the point corresponding to the 140°C with a straight line.<br>4. Pull a vertical line from the maximum operating temperature in your design (e.g., 75°C).<br>5. Read the value of Pd against the point at which the vertical line intersects the derating curve(DPd).<br>6.DPd / (Vinmax-Vout) = Iout (at 75°C) |

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.

## 11.10 ON/OFF Control

It is recommended to turn the regulator off when the circuit following the regulator is not operating. A design with small electric power loss can be implemented.
Because the control current is small, it is possible to control it directly by CMOS logic.

| Control Terminal Voltage (Vcont) | ON/OFF State |
|---|---|
| Vcont > 1.8V | ON |
| Vcont < 0.35V | OFF |

**Parallel Connected ON/OFF Control**

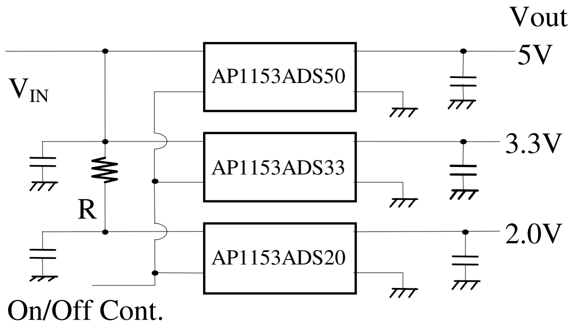



Figure 6. Parallel Connection Example

Figure 6 shows the multiple regulators being controlled by a single ON/OFF control signal. There is fear of overheating, because the power loss of the low voltage side (AP1153ADS20) is large. The series resistor (R) is put in the input line of the low output voltage regulator in order to prevent over-dissipation. The voltage dropped across the resistor reduces the large input-to-output voltage across the regulator, reducing the power dissipation in the device. When the thermal sensor works, a decrease of the output voltage, oscillation, etc. may be observed.

## 11.11 Noise Bypass

The noise characteristics depend on the capacitance on the Np terminal. A standard value is Cnp=0.001μF. Increase Cnp in a design with important output noise requirements. The IC will not be damaged even the capacitor value is increased. The on/off switching speed changes depending on the Np terminal capacitance. The switching speed slows when the capacitance is large.

## 11.12 The notes of the evaluation when output terminal is short-circuit to GND

By the resonance phenomenon by Cout (C ingredient) and the short circuit line (L ingredient), which are attached to an output terminal, an output terminal changes with minus potential. In order that Parasitism Tr arises within the IC, and a latch rise phenomenon may occur within IC when the worst if it goes into an output terminal's minus side, it results in damage by fire (white smoke) and breakage of a package. ($f0 = 1 / 2\pi\sqrt{(L C)}$)
The above-mentioned resonance phenomenon appears notably in a ceramic capacitor with the small ESR value, etc. A resonance phenomenon can be reduced by connecting resistance (around 2ohms or more) in series with a short circuit line. Thereby, the latch rise phenomenon within IC can be prevented.
Generally, when using tantalum or large electrolysis capacitor, the influence of resonance phenomenon can be reduced due to the large ESR (2ohms or more).