# 300mA HIGH SPEED, EXTREMELY LOW NOISE CMOS LDO REGULATOR AP2128

## General Description

The AP2128 series are positive voltage regulator ICs fabricated by CMOS process. The AP2128 provides two kinds of output voltage operation modes for setting the output voltage. Fixed output voltage mode senses the output voltage on $V_{OUT}$, adjustable output voltage mode needs two resistors as a voltage divider.

The AP2128 series have features of low dropout voltage, low noise, high output voltage accuracy, and low current consumption which make them ideal for use in various battery-powered devices.

AP2128 have 1.0V, 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 3.9V, 4.2V, 4.75V, 5.2V fixed voltage versions and 0.8V to 5.5V adjustable voltage version.

AP2128 series are available in SOT-23-5 package.

## Features

- Wide Operating Voltage: 2.5V to 6V
- Low Dropout Voltage:170mV@300mA for $V_{OUT}$=3.3V, 140mV@300mA for $V_{OUT}$=5.2V
- High Output Voltage Accuracy: ±2%
- High Ripple Rejection:
  68dB@ f=1kHz, 54dB@ f=10kHz
- Low Standby Current: 0.1μA
- Low Quiescent Current: 60μA Typical
- Low Output Noise: 60μVrms@$V_{OUT}$=0.8V
- Short Current Limit: 50mA
- Over Temperature Protection
- Compatible with Low ESR Ceramic Capacitor: 1μF for $C_{IN}$ and $C_{OUT}$
- Excellent Line/Load Regulation
- Soft Start Time: 50μs
- Auto Discharge Resistance: $R_{DS(ON)}$=60Ω

## Applications

- Datacom
- Notebook Computers
- Mother Board

SOT-23-5

Figure 1. Package Type of AP2128

## Pin Configuration

K Package

(SOT-23-5)

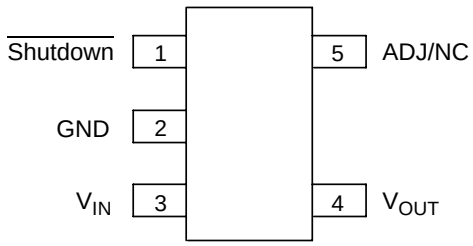
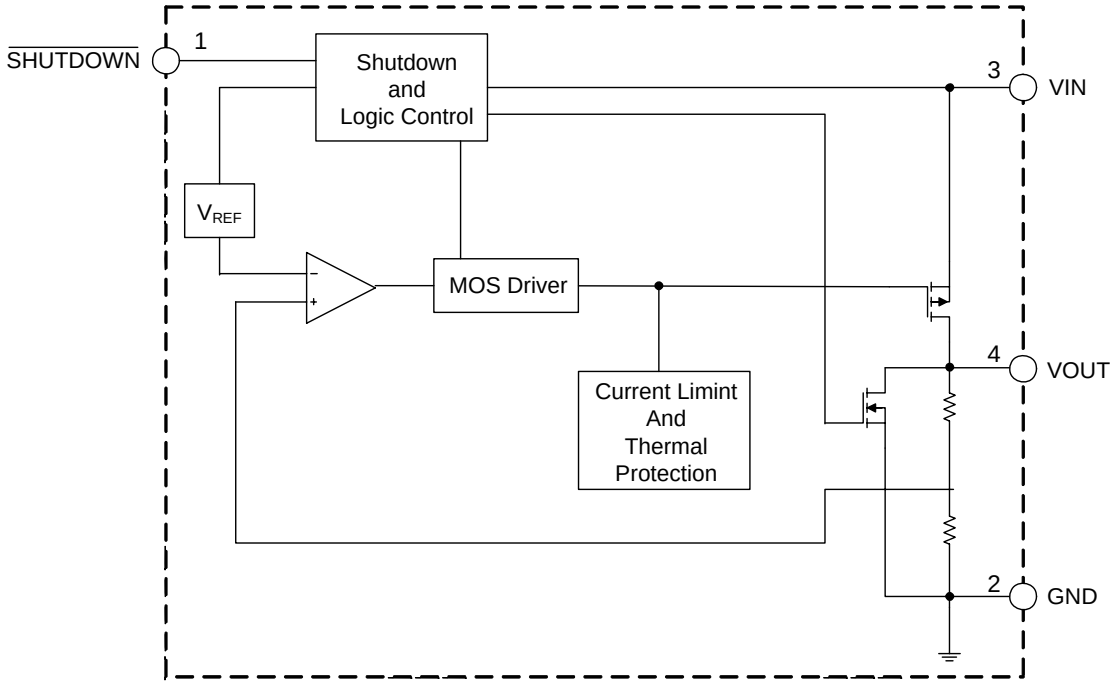


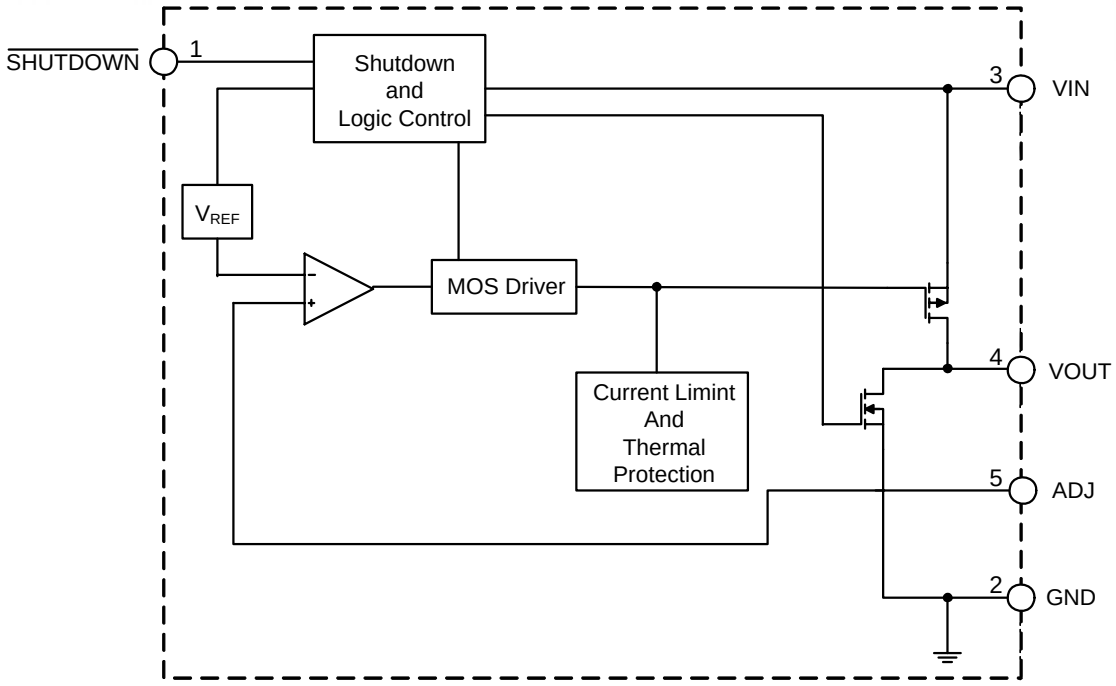

Figure 2. Pin Configuration of AP2128 (Top View)

## Functional Block Diagram




Fixed Version

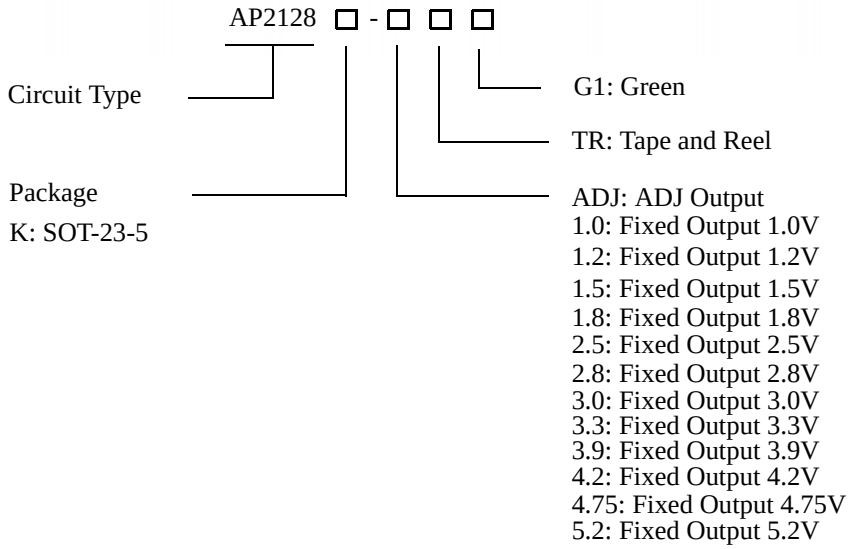
## Functional Block Diagram (Continued)




Adjustable Version

Figure 3. Functional Block Diagram of AP2128

## Ordering Information




| Product | Package | Temperature Range | Part Number | Marking ID | Packing Type |
|---|---|---|---|---|---|
| AP2128 | SOT-23-5 | -40 to 85°C | AP2128K- ADJTRG1 | FAD | Tape & Reel |
| | | | AP2128K-1.0TRG1 | FAJ | Tape & Reel |
| | | | AP2128K-1.2TRG1 | FAK | Tape & Reel |
| | | | AP2128K-1.5TRG1 | GAN | Tape & Reel |
| | | | AP2128K-1.8TRG1 | GAP | Tape & Reel |
| | | | AP2128K-2.5TRG1 | GAQ | Tape & Reel |
| | | | AP2128K-2.8TRG1 | GAR | Tape & Reel |
| | | | AP2128K-3.0TRG1 | GAW | Tape & Reel |
| | | | AP2128K-3.3TRG1 | FAL | Tape & Reel |
| | | | AP2128K-3.9TRG1 | GBU | Tape & Reel |
| | | | AP2128K-4.2TRG1 | GAZ | Tape & Reel |
| | | | AP2128K-4.75TRG1 | GFZ | Tape & Reel |
| | | | AP2128K-5.2TRG1 | GAV | Tape & Reel |

BCD Semiconductor's products, as designated with "G1" suffix in the part number, are RoHS compliant and Green.

## Absolute Maximum Ratings (Note 1)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Input Voltage | $V_{IN}$ | 6.5 | V |
| Shutdown Input Voltage | $V_{CE}$ | -0.3 to $V_{IN}$+0.3 | V |
| Output Current | $I_{OUT}$ | 450 | mA |
| Junction Temperature | $T_J$ | 150 | $^oC$ |
| Storage Temperature Range | $T_{STG}$ | -65 to 150 | $^oC$ |
| Lead Temperature (Soldering, 10sec) | $T_{LEAD}$ | 260 | $^oC$ |
| Thermal Resistance | $\theta_{JA}$ | 250 | $^oC/W$ |
| ESD (Human Body Model) | ESD | 6000 | V |
| ESD (Machine Model) | ESD | 200 | V |

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" 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 under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

## Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 2.5 | 6 | V |
| Operating Ambient Temperature Range | $T_A$ | -40 | 85 | $^oC$ |

## Electrical Characteristics

(AP2128-ADJ, $V_{IN}$ min=2.5V, $C_{IN}$=1μF, $C_{OUT}$=1μF, Bold typeface applies over -40°C≤$T_A$≤85°C, unless otherwise specified.)

| Parameter | Symbol | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Reference Voltage | $V_{REF}$ | $V_{IN}$=2.5V<br>1mA≤$I_{OUT}$≤300mA | | 0.784 | 0.8 | 0.816 | V |
| Input Voltage | $V_{IN}$ | | | 2.5 | | 6 | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$=2.5V,<br>$V_{OUT}$=98%×$V_{OUT}$ | | 300 | 400 | | mA |
| Current Limit | $I_{LIMIT}$ | $V_{IN}$=2.5V | | | 450 | | mA |
| Load Regulation | $\Delta V_{OUT}$ /($\Delta I_{OUT}$*$V_{OUT}$) | $V_{IN}$=2.5V,<br>1mA≤$I_{OUT}$≤300mA | | | | 0.6 | %/A |
| Line Regulation | $\Delta V_{OUT}$ /($\Delta V_{IN}$*$V_{OUT}$) | $V_{IN}$=2.5V to 6V<br>$I_{OUT}$=30mA | | | | 0.06 | %/V |
| Quiescent Current | $I_Q$ | $V_{IN}$=2.5V, $I_{OUT}$=0mA | | | 60 | 90 | μA |
| Standby Current | $I_{STD}$ | $V_{IN}$=2.5V,<br>$V_{\overline{SHUTDOWN}}$ in off mode | | | 0.1 | 1.0 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p<br>$V_{IN}$=3V | f=100Hz | | 68 | | dB |
| | | | f=1KHz | | 68 | | dB |
| | | | f=10KHz | | 54 | | dB |
| Output Voltage Temperature Coefficient | ($\Delta V_{OUT}$/$V_{OUT}$) /$\Delta$T | $I_{OUT}$=30mA, -40°C≤$T_A$≤85°C | | | ±100 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | | 50 | | mA |
| Soft Start Time | $t_{UP}$ | | | | 50 | | μs |
| RMS Output Noise | $V_{NOISE}$ | $T_A$=25°C, 10Hz ≤f≤100kHz,<br>$V_{OUT}$=0.8V | | | 60 | | μVrms |
| $\overline{\text{Shutdown}}$ "High" Voltage | | $\overline{\text{Shutdown}}$ input voltage "High" | | 1.5 | | 6 | V |
| $\overline{\text{Shutdown}}$ "Low" Voltage | | $\overline{\text{Shutdown}}$ input voltage "Low" | | 0 | | 0.4 | V |
| $V_{OUT}$ Discharge MOSFET $R_{DS(ON)}$ | | $\overline{\text{Shutdown}}$ input voltage "Low" | | | 60 | | Ω |
| $\overline{\text{Shutdown}}$ Pull Down Resistance | | | | | 3 | | MΩ |
| Thermal Shutdown | | | | | 165 | | °C |
| Thermal Shutdown Hysteresis | | | | | 30 | | °C |
| Thermal Resistance | $\theta_{JC}$ | SOT-23-5 | | | 150 | | °C/W |

## Electrical Characteristics (Continued)

(AP2128-1.0V/1.2V/1.5V/1.8V, $V_{IN}$min.=2.5V, $C_{IN}$=1μF, $C_{OUT}$=1μF, Bold typeface applies over -40°C≤$T_A$≤85°C, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}$=2.5V<br>1mA≤$I_{OUT}$≤300mA | 98%×$V_{OUT}$ | | 102%×$V_{OUT}$ | V |
| Input Voltage | $V_{IN}$ | | 2.5 | | 6 | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$=2.5V,<br>$V_{OUT}$=98%×$V_{OUT}$ | 300 | 400 | | mA |
| Current Limit | $I_{LIMIT}$ | $V_{IN}$=2.5V | | 450 | | mA |
| Load Regulation | $\Delta V_{OUT}$ /($\Delta I_{OUT*}V_{OUT}$) | $V_{IN}$=2.5V,<br>1mA≤$I_{OUT}$≤300mA | | | 0.6 | %/A |
| Line Regulation | $\Delta V_{OUT}$ /($\Delta V_{IN}$*$V_{OUT}$) | $V_{IN}$=2.5V to 6V<br>$I_{OUT}$=30mA | | | 0.06 | %/V |
| Dropout Voltage | $V_{DROP}$ | $V_{OUT}$=1.0V, $I_{OUT}$=300mA | | 1400 | 1500 | mV |
| | | $V_{OUT}$=1.2V, $I_{OUT}$=300mA | | 1200 | 1300 | |
| | | $V_{OUT}$=1.5V, $I_{OUT}$=300mA | | 900 | 1000 | |
| | | $V_{OUT}$=1.8V, $I_{OUT}$=300mA | | 600 | 700 | |
| Quiescent Current | $I_Q$ | $V_{IN}$=2.5V, $I_{OUT}$=0mA | | 60 | 90 | μA |
| Standby Current | $I_{STD}$ | $V_{IN}$=2.5V,<br>$V_{\overline{SHUTDOWN}}$ in off mode | | 0.1 | 1.0 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p<br>$V_{IN}$=3V, f=100Hz | | 68 | | dB |
| | | f=1KHz | | 68 | | dB |
| | | f=10KHz | | 54 | | dB |
| Output Voltage Temperature Coefficient | ($\Delta V_{OUT}$/$V_{OUT}$) /$\Delta$T | $I_{OUT}$=30mA, -40°C≤$T_A$≤85°C | | ±100 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | 50 | | mA |
| Soft Start Time | $t_{UP}$ | | | 50 | | μs |
| $\overline{\text{Shutdown}}$ "High" Voltage | | $\overline{\text{Shutdown}}$ input voltage "High" | 1.5 | | 6 | V |
| $\overline{\text{Shutdown}}$ "Low" Voltage | | $\overline{\text{Shutdown}}$ input voltage "Low" | 0 | | 0.4 | V |
| $V_{OUT}$ Discharge MOSFET $R_{DS(ON)}$ | | $\overline{\text{Shutdown}}$ input voltage "Low" | | 60 | | Ω |
| $\overline{\text{Shutdown}}$ Pull Down Resistance | | | | 3 | | MΩ |
| Thermal Shutdown | | | | 165 | | °C |
| Thermal Shutdown Hysteresis | | | | 30 | | °C |
| Thermal Resistance | $\theta_{JC}$ | SOT-23-5 | | 150 | | °C/W |

## Electrical Characteristics (Continued)

(AP2128-2.5V/2.8V/3.0V/3.3V/3.9V/4.2V/4.75V, $V_{IN}=V_{OUT}+1V$; AP2128-5.2V, $V_{IN}=6V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, Bold type-face applies over $-40^oC \le T_A \le 85^oC$, unless otherwise specified.)

| Parameter | Symbol | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}=V_{OUT}+1V$<br>$1mA \le I_{OUT} \le 300mA$ | | 98%×<br>$V_{OUT}$ | | 102%×<br>$V_{OUT}$ | V |
| Input Voltage | $V_{IN}$ | | | 2.5 | | 6 | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}-V_{OUT}=1V$,<br>$V_{OUT}=98\%\times V_{OUT}$ | | 300 | 400 | | mA |
| Current Limit | $I_{LIMIT}$ | $V_{IN}-V_{OUT}=1V$ | | | 450 | | mA |
| Load Regulation | $\Delta V_{OUT}$<br>$/(\Delta I_{OUT} * V_{OUT})$ | $V_{IN}-V_{OUT}=1V$,<br>$1mA \le I_{OUT} \le 300mA$ | | | | 0.6 | %/A |
| Line Regulation | $\Delta V_{OUT}$<br>$/(\Delta V_{IN} * V_{OUT})$ | $V_{OUT}+0.5V \le V_{IN} \le 6V$,<br>$I_{OUT}=30mA$ | | | | 0.06 | %/V |
| Dropout Voltage | $V_{DROP}$ | $V_{OUT}$=2.5V, 2.8V, 3.0V, 3.3V, 3.9V, 4.2V, $I_{OUT}$=300mA | | | 170 | 300 | mV |
| | | $V_{OUT}$=4.75V and 5.2V, $I_{OUT}$=300mA | | | 140 | 300 | |
| Quiescent Current | $I_Q$ | $V_{IN}=V_{OUT}+1V$, $I_{OUT}=0mA$ | | | 60 | 90 | μA |
| Standby Current | $I_{STD}$ | $V_{IN}=V_{OUT}+1V$,<br>$V_{\overline{SHUTDOWN}}$ in off mode | | | 0.1 | 1.0 | μA |
| Power Supply Rejection Ratio | PSRR | AP2128-2.5V to 4.2V, Ripple 1Vp-p<br>$V_{IN}=V_{OUT}+1V$ | f=100Hz | | 68 | | dB |
| | | | f=1KHz | | 68 | | |
| | | | f=10KHz | | 54 | | |
| | | AP2128-4.75V , Ripple 0.5Vp-p<br>$V_{IN}=V_{OUT}+1V$ | f=100Hz | | 63 | | |
| | | | f=1KHz | | 63 | | |
| | | | f=10KHz | | 45 | | |
| | | AP2128-5.2V , Ripple 0.5Vp-p<br>$V_{IN}=6V$ | f=100Hz | | 63 | | |
| | | | f=1KHz | | 63 | | |
| | | | f=10KHz | | 45 | | |
| Output Voltage Temperature Coefficient | $(\Delta V_{OUT}/V_{OUT})$<br>$/\Delta T$ | $I_{OUT}=30mA$, $-40^oC \le T_A \le 85^oC$ | | | ±100 | | ppm/$^o$C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}=0V$ | | | 50 | | mA |

## Electrical Characteristics (Continued)

(AP2128-2.5V/2.8V/3.0V/3.3V/3.9V/4.2V/4.75V, $V_{IN}=V_{OUT}+1V$; AP2128-5.2V, $V_{IN}=6V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, Bold type-face applies over $-40^oC \le T_A \le 85^oC$, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Soft Start Time | $t_{UP}$ | | | 50 | | μs |
| $\overline{\text{Shutdown}}$ "High" Voltage | | $\overline{\text{Shutdown}}$ input voltage "High" | 1.5 | | 6 | V |
| $\overline{\text{Shutdown}}$ "Low" Voltage | | $\overline{\text{Shutdown}}$ input voltage "Low" | 0 | | 0.4 | V |
| $V_{OUT}$ Discharge MOSFET $R_{DS(ON)}$ | | $\overline{\text{Shutdown}}$ input voltage "Low" | | 60 | | Ω |
| $\overline{\text{Shutdown}}$ Pull Down Resistance | | | | 3 | | MΩ |
| Thermal Shutdown | | | | 165 | | $^oC$ |
| Thermal Shutdown Hysteresis | | | | 30 | | $^oC$ |
| Thermal Resistance | $\theta_{JC}$ | SOT-23-5 | | 150 | | $^oC/W$ |

## Typical Performance Characteristics

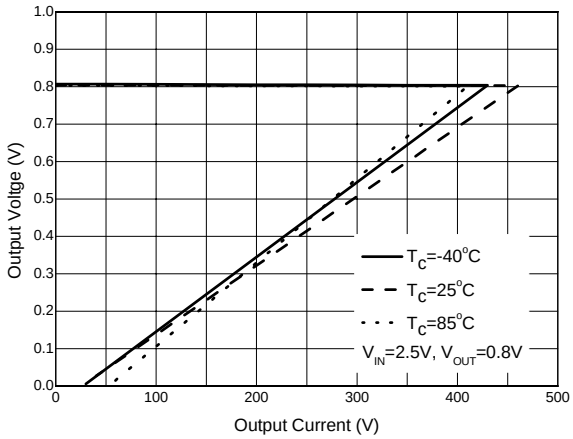



Figure 4. Output Voltage vs. Output Current

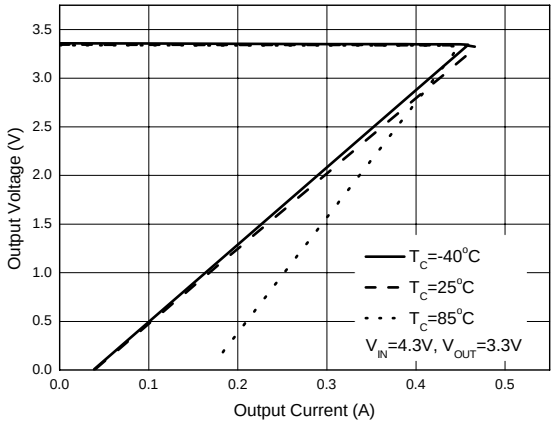



Figure 5. Output Voltage vs. Output Current

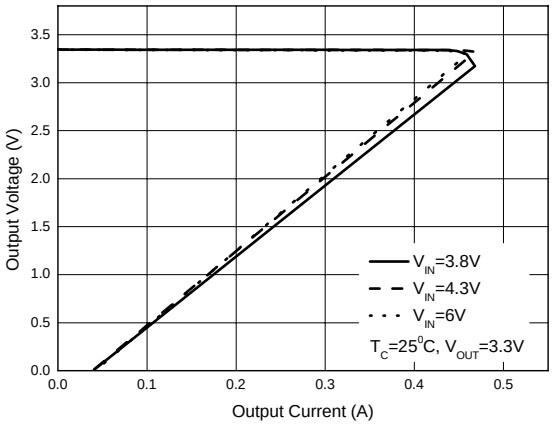



Figure 6. Output Voltage vs. Output Current

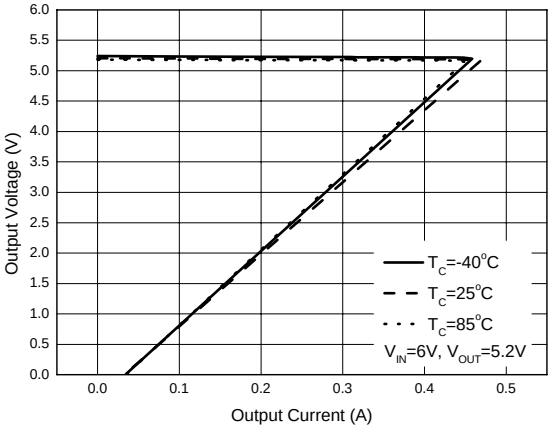



Figure 7. Output Voltage vs. Output Current

## Typical Performance Characteristics (Continued)

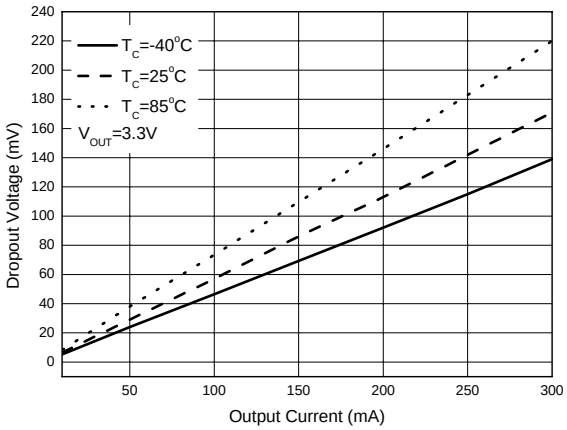



Figure 8. Dropout Voltage vs. Output Current

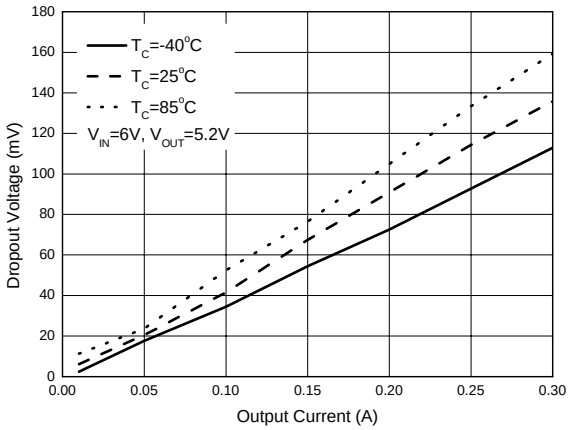



Figure 9. Dropout Voltage vs. Output Current

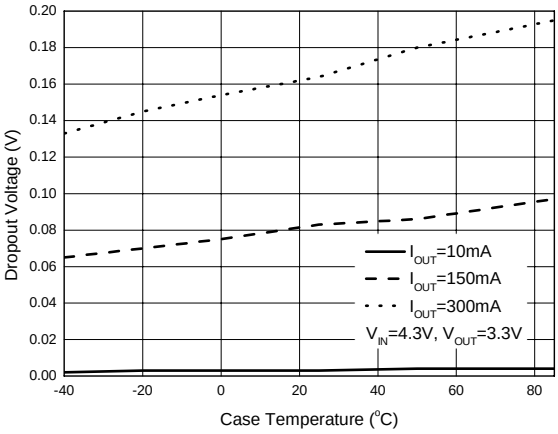



Figure 10. Dropout Voltage vs. Case Temperature

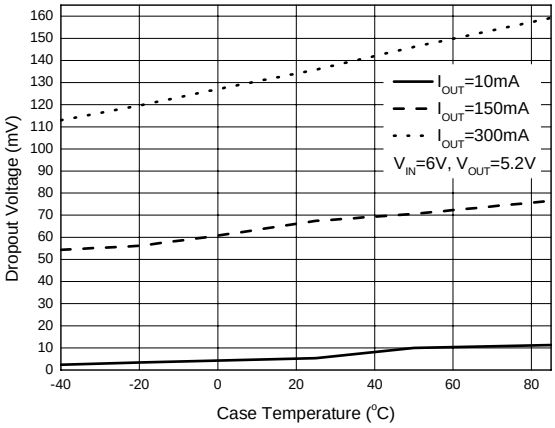



Figure 11. Dropout Voltage vs. Case Temperature

## Typical Performance Characteristics (Continued)

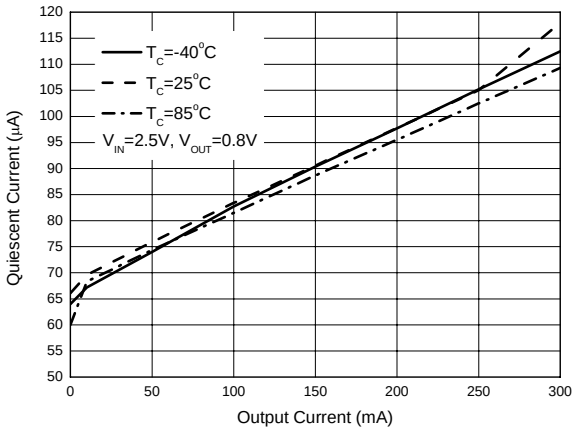



Figure 12. Quiescent Current vs. Output Current

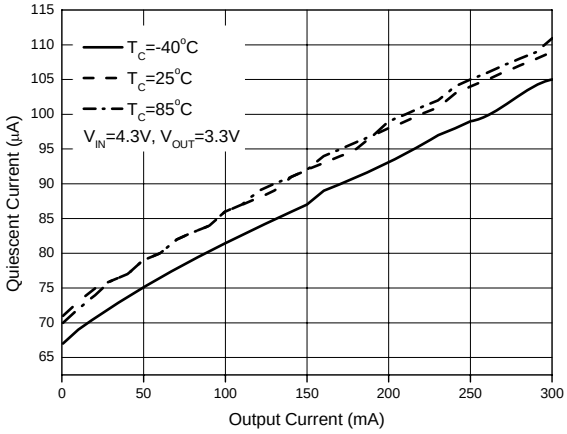



Figure 13. Quiescent Current vs. Output Current

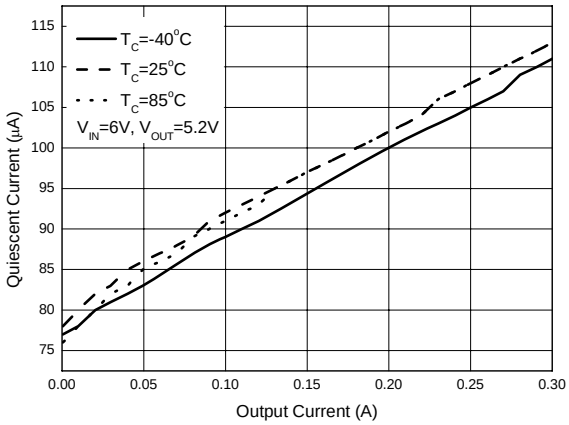



Figure 14. Quiescent Current vs. Output Current

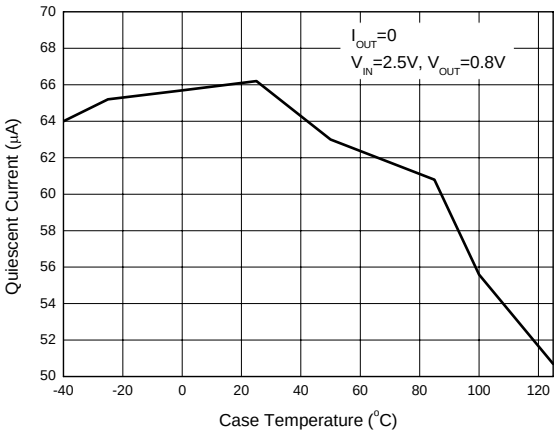



Figure 15. Quiescent Current vs. Case Temperature

## Typical Performance Characteristics (Continued)

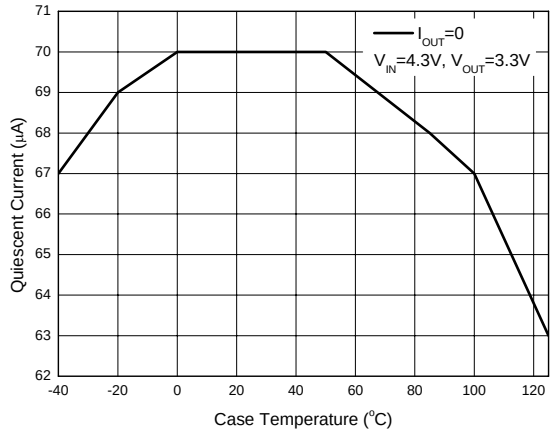



Figure 16. Quiescent Current vs. Case Temperature

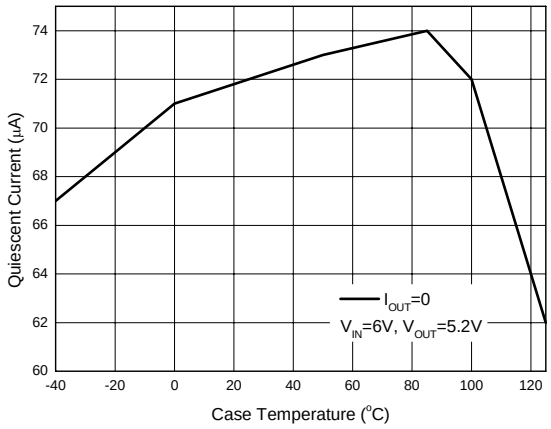



Figure 17. Quiescent Current vs. Case Temperature

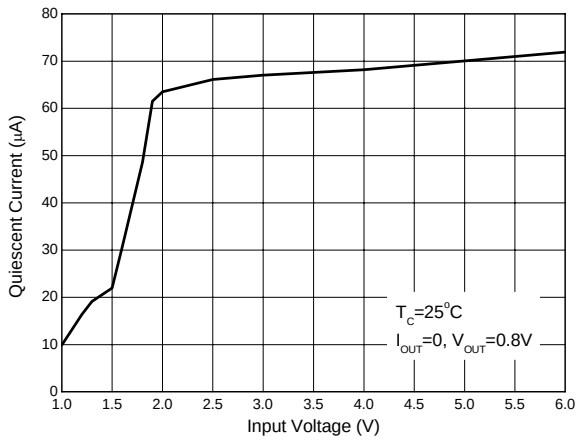



Figure 18. Quiescent Current vs. Input Voltage

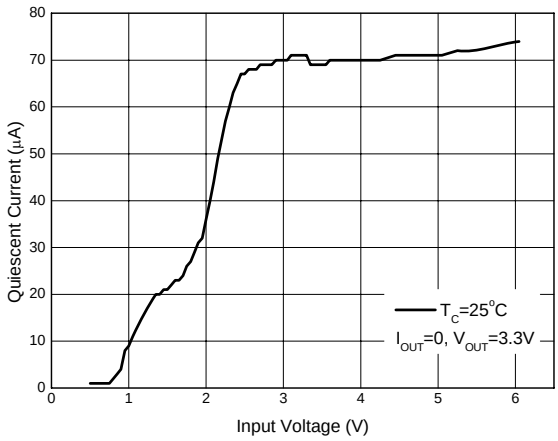



Figure 19. Quiescent Current vs. Input Voltage

## Typical Performance Characteristics (Continued)

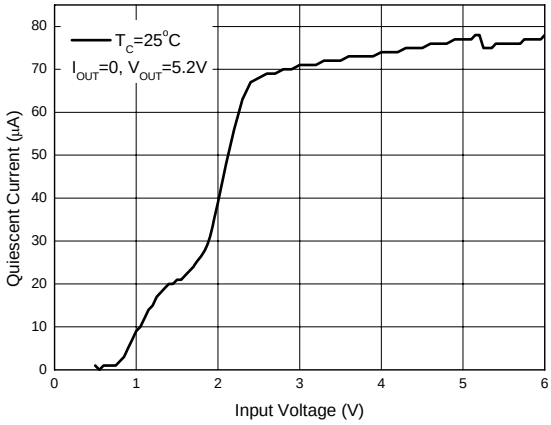



Figure 20. Quiescent Current vs. Input Voltage

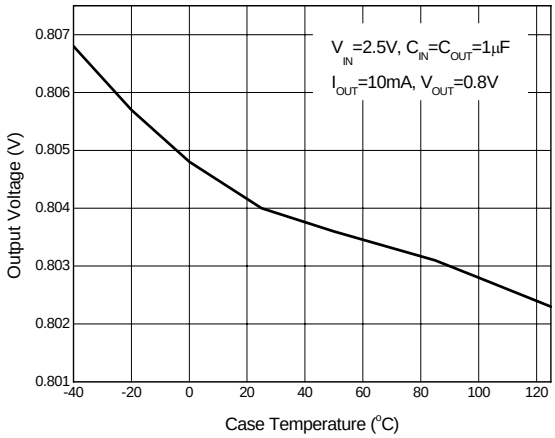



Figure 21. Output Voltage vs. Case Temperature

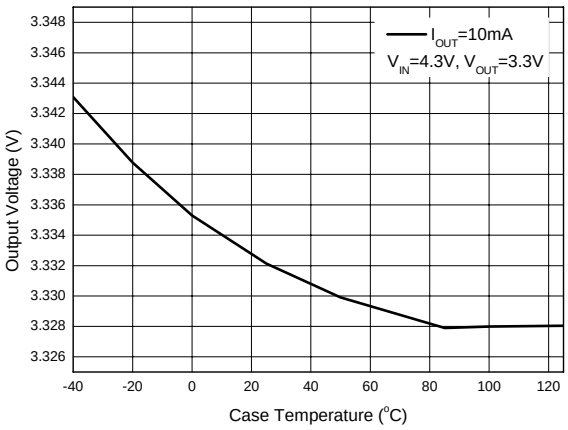



Figure 22. Output Voltage vs. Case Temperature

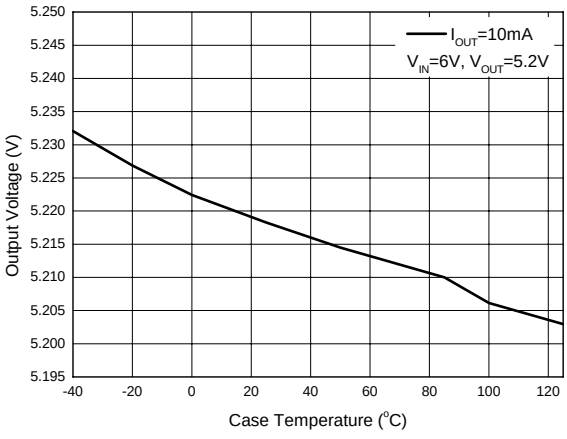



Figure 23. Output Voltage vs. Case Temperature

## Typical Performance Characteristics (Continued)

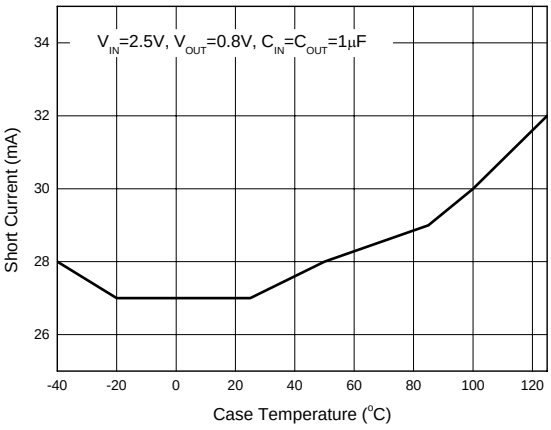



Figure 24. Short Current vs. Case Temperature

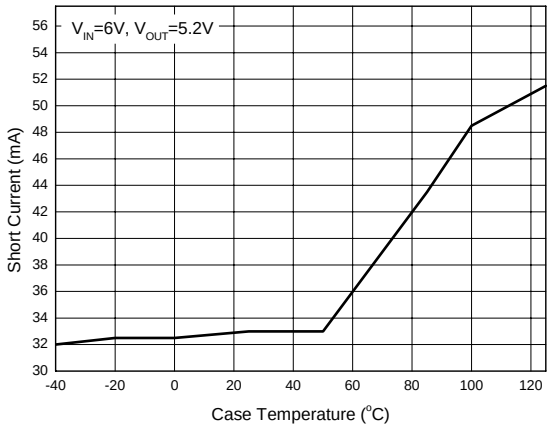



Figure 25. Short Current vs. Case Temperature

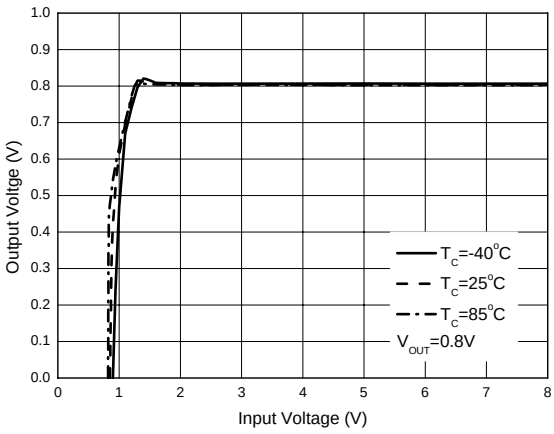



Figure 26. Output Voltage vs. Input Voltage ($I_{OUT}$=0mA)

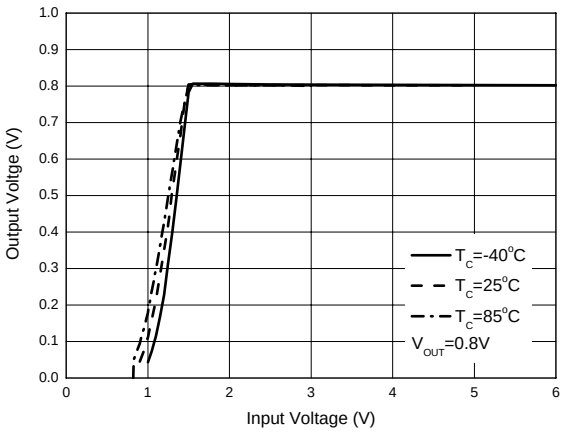



Figure 27. Output Voltage vs. Input Voltage ($I_{OUT}$=300mA)

## Typical Performance Characteristics (Continued)

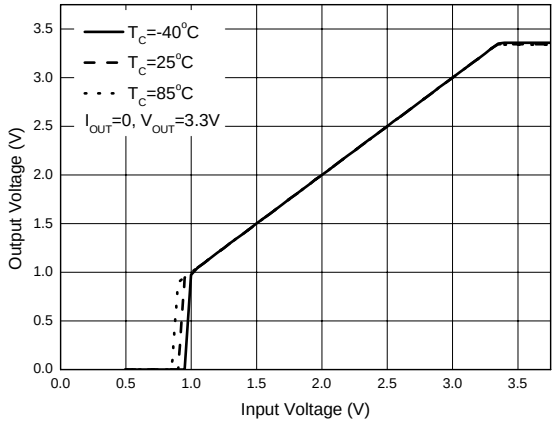



Figure 28. Output Voltage vs. Input Voltage

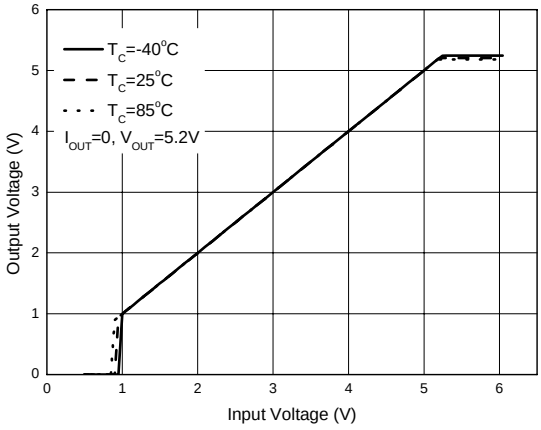



Figure 29. Output Voltage vs. Input Voltage

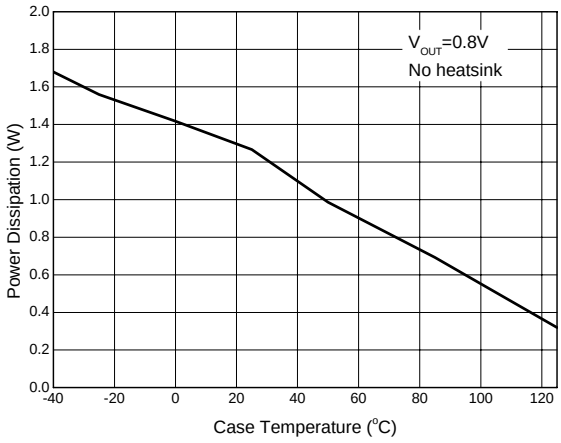



Figure 30. Power Dissipation vs. Case Temperature

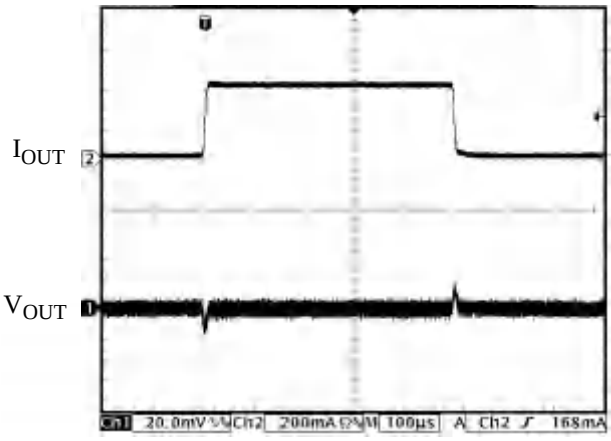



Figure 31. Load Transient

(Conditions: $C_{IN}$=$C_{OUT}$=1µF, $V_{IN}$=2.5V, $V_{OUT}$=0.8V, $I_{OUT}$=10mA to 300mA)

## Typical Performance Characteristics (Continued)

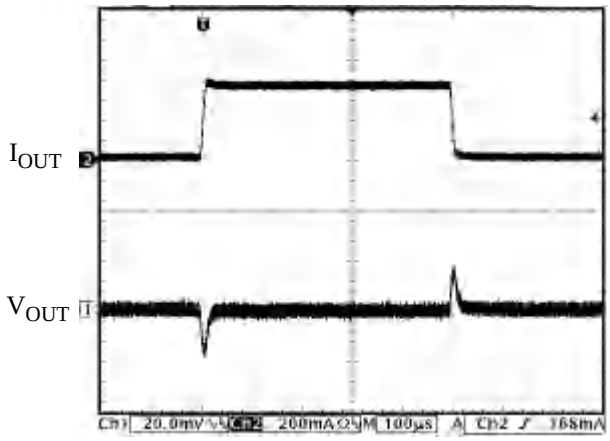



Figure 32. Load Transient

(Conditions: $C_{IN}$=$C_{OUT}$=1μF, $V_{IN}$=4.4V, $V_{OUT}$=3.3V
$I_{OUT}$=10mA to 300mA)

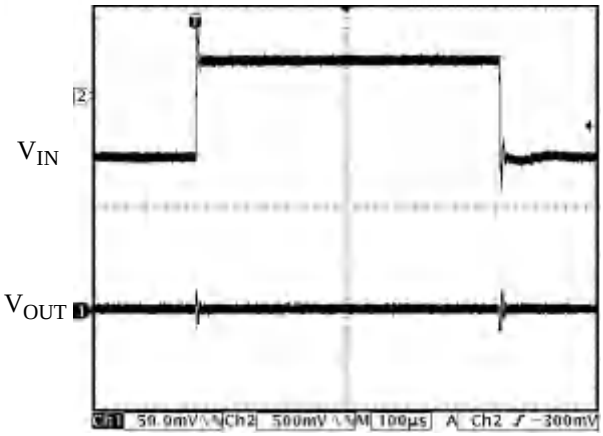



Figure 33. Line Transient

(Conditions: $I_{OUT}$=30mA, $C_{IN}$=$C_{OUT}$=1μF,
$V_{IN}$=2.5 to 3.5V, $V_{OUT}$=0.8V)

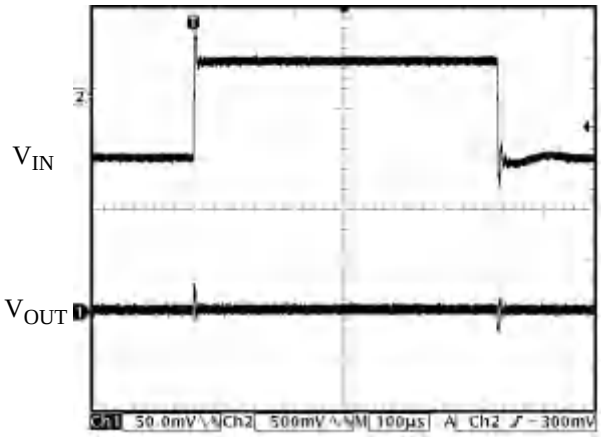



Figure 34. Line Transient

(Conditions: $I_{OUT}$=30mA, $C_{IN}$=$C_{OUT}$=1μF,
$V_{IN}$=4 to 5V, $V_{OUT}$=3.3V)

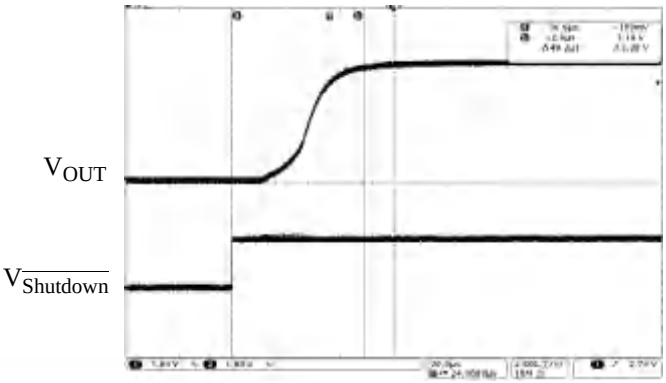



Figure 35. Soft Start Time

(Conditions: $I_{OUT}$=0mA, $C_{IN}$=$C_{OUT}$=1μF,
$V_{\overline{Shutdown}}$=0 to 2V, $V_{OUT}$=3.3V)

## Typical Performance Characteristics (Continued)

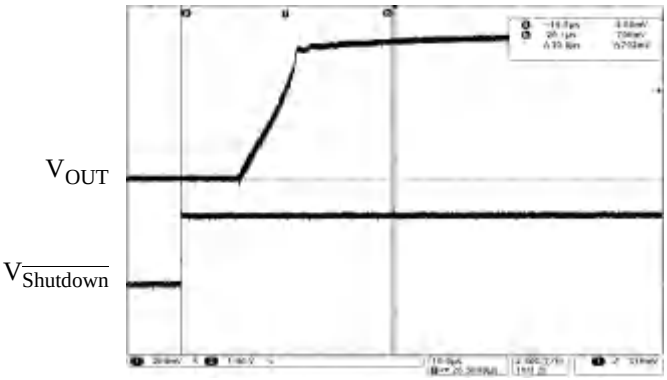



Figure 36. Soft Start Time
(Conditions: $I_{OUT}$=0mA, $C_{IN}$=$C_{OUT}$=1μF, $V_{\overline{Shutdown}}$=0 to 2V, $V_{OUT}$=0.8V)

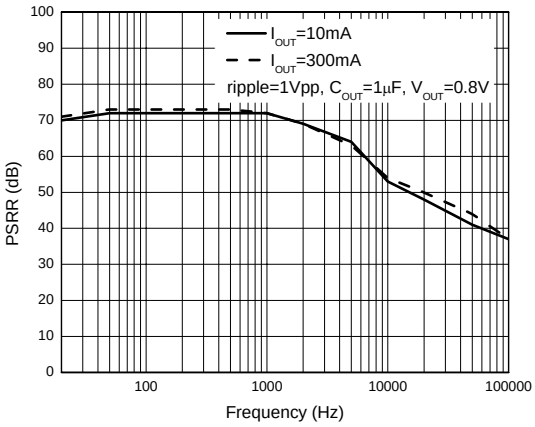



Figure 37. PSRR vs. Frequency

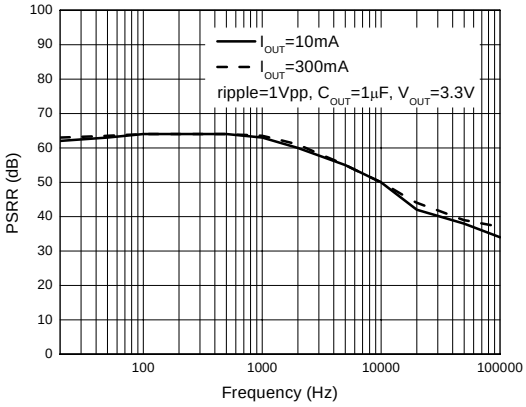



Figure 38. PSRR vs. Frequency

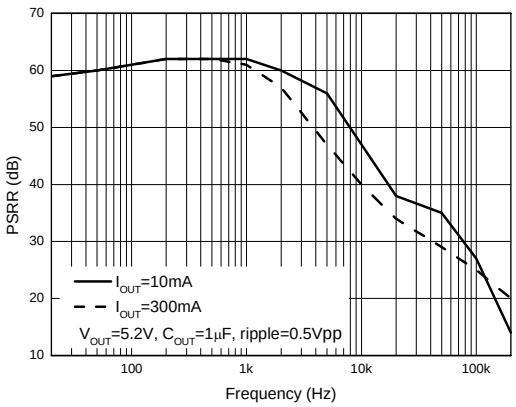
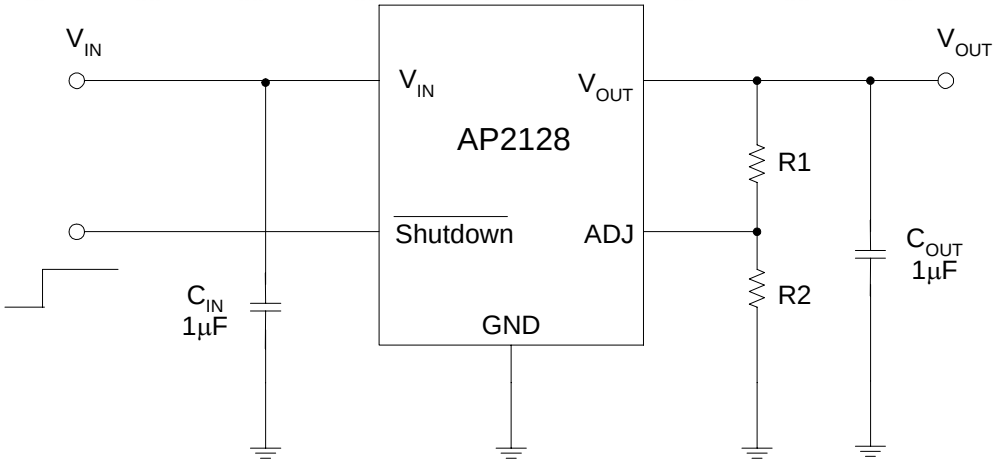
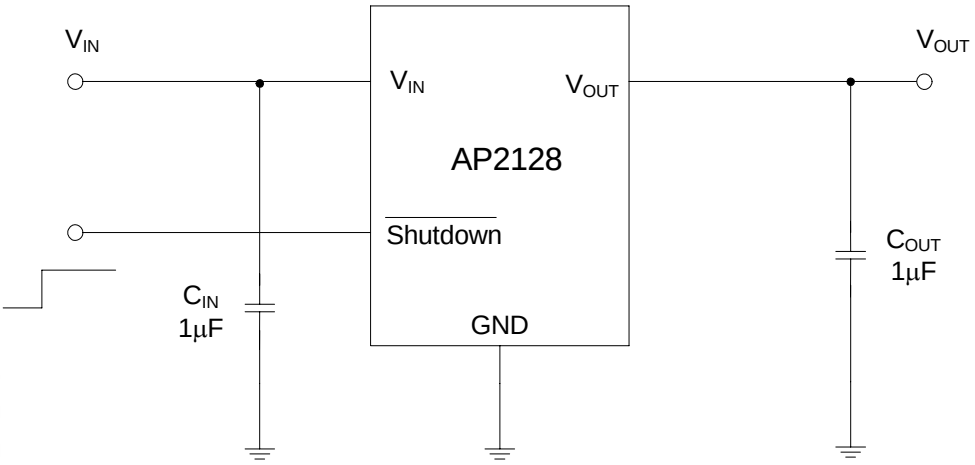



Figure 39. PSRR vs. Frequency

## Typical Application




$V_{OUT}$=0.8(1+R1/R2) V

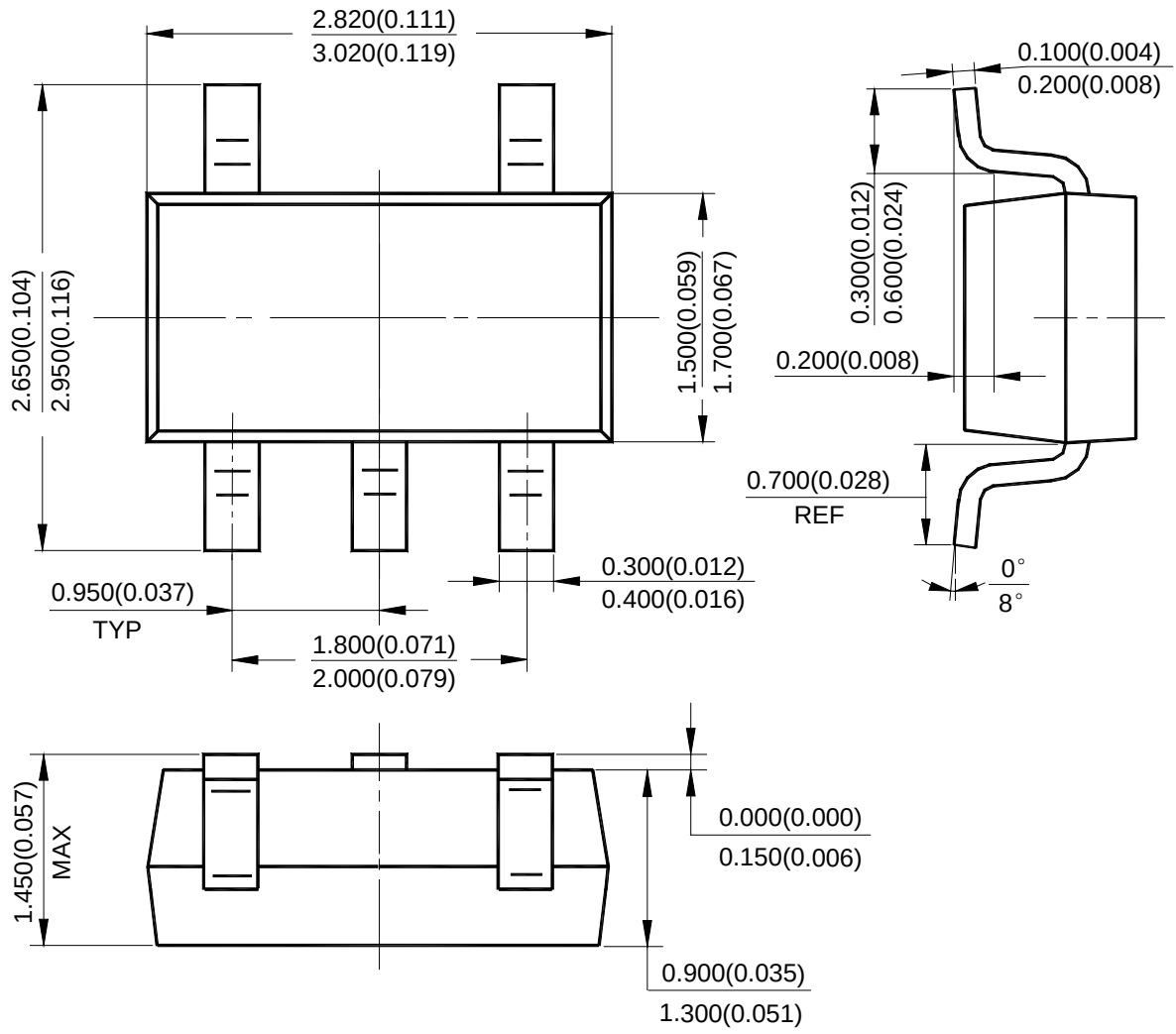



$V_{OUT}$=1.0V to 5.2V

Figure 40. Typical Application of AP2128

## Mechanical Dimensions

**SOT-23-5** **Unit: mm(inch)**



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