

# NCP4589

## 300 mA, Tri-Mode, LDO Linear Voltage Regulator

The NCP4589 is a CMOS 300 mA LDO which switches to a low power mode under light current loads. The device automatically switches back to a fast response mode as the output load increases above 3 mA (typ.). The device can be placed in permanent fast mode through a mode select pin. The family is available in a variety of packages: SC-70, SOT23 and a small, ultra thin 1.2 x 1.2 x 0.4 mm XDFN.

### Features

- Operating Input Voltage Range: 1.4 V to 5.25 V
- Output Voltage Range: 0.8 to 4.0 V (available in 0.1 V steps)
- Supply Current: Low Power Mode – 1.0  $\mu$ A at  $V_{OUT} < 1.85$  V  
Fast Mode – 55  $\mu$ A  
Standby Mode – 0.1  $\mu$ A
- Dropout Voltage: 230 mV Typ. at  $I_{OUT} = 300$  mA,  $V_{OUT} = 2.8$  V
- $\pm 1\%$  Output Voltage Accuracy ( $V_{OUT} > 2$  V,  $T_J = 25^\circ\text{C}$ )
- High PSRR: 70 dB at 1 kHz (Fast response mode)
- Line Regulation 0.02%/V Typ.
- Current Fold Back Protection
- Stable with Ceramic Capacitors
- Available in 1.2x1.2 XDFN, SC-70 and SOT23 Package
- These are Pb-free Devices

### Typical Applications

- Battery Powered Equipments
- Portable Communication Equipments
- Cameras, Image Sensors and Camcorders

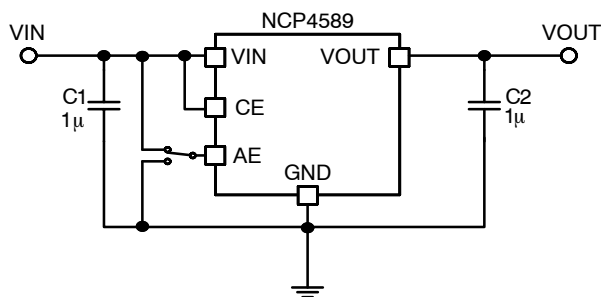


Figure 1. Typical Application Schematic



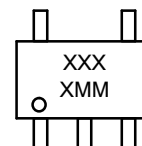
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### MARKING DIAGRAMS



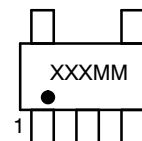
SC-70  
CASE 419A



XDFN6  
CASE 711AA



SOT-23-5  
CASE 1212



XXXX = Specific Device Code  
MM = Date Code

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 27 of this data sheet.

# NCP4589

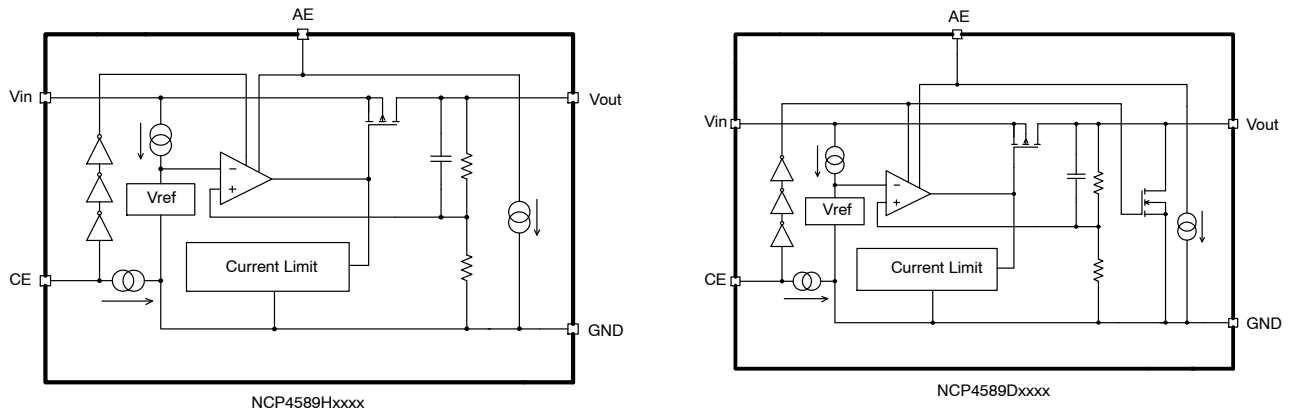


Figure 2. Simplified Schematic Block Diagram

## PIN FUNCTION DESCRIPTION

| Pin No.<br>XDFN | Pin No.<br>SC-70 | Pin No.<br>SOT23 | Pin Name | Description     |
|-----------------|------------------|------------------|----------|-----------------|
| 4               | 4                | 1                | VIN      | Input pin       |
| 2               | 2                | 2                | GND      | Ground          |
| 3               | 5                | 3                | CE       | Chip enable pin |
| 6               | 3                | 5                | VOUT     | Output pin      |
| 1               | 1                | 4                | AE       | Auto Eco Pin    |
| 5               | –                | –                | NC       | No connection   |

## ABSOLUTE MAXIMUM RATINGS

| Rating                                    | Symbol      | Value                  | Unit |
|-------------------------------------------|-------------|------------------------|------|
| Input Voltage (Note 1)                    | $V_{IN}$    | 6.0                    | V    |
| Output Voltage                            | $V_{OUT}$   | –0.3 to $V_{IN} + 0.3$ | V    |
| Chip Enable Input                         | $V_{CE}$    | –0.3 to 6.0            | V    |
| Auto Eco Input                            | $V_{AE}$    | –0.3 to 6.0            | V    |
| Output Current                            | $I_{OUT}$   | 400                    | mA   |
| Power Dissipation XDFN                    | $P_D$       | 400                    | mW   |
| Power Dissipation SC70                    |             | 380                    |      |
| Power Dissipation SOT23                   |             | 420                    |      |
| Junction Temperature                      | $T_J$       | –40 to 150             | °C   |
| Storage Temperature                       | $T_{STG}$   | –55 to 125             | °C   |
| Operation Temperature                     | $T_A$       | –40 to 85              | °C   |
| ESD Capability, Human Body Model (Note 2) | $ESD_{HBM}$ | 2000                   | V    |
| ESD Capability, Machine Model (Note 2)    | $ESD_{MM}$  | 200                    | V    |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
- This device series incorporates ESD protection and is tested by the following methods:  
ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)  
ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)  
Latchup Current Maximum Rating tested per JEDEC standard: JESD78.

## THERMAL CHARACTERISTICS

| Rating                                                                | Symbol          | Value | Unit                 |
|-----------------------------------------------------------------------|-----------------|-------|----------------------|
| Thermal Characteristics, XDFN<br>Thermal Resistance, Junction-to-Air  | $R_{\theta JA}$ | 250   | $^{\circ}\text{C/W}$ |
| Thermal Characteristics, SOT23<br>Thermal Resistance, Junction-to-Air | $R_{\theta JA}$ | 238   | $^{\circ}\text{C/W}$ |
| Thermal Characteristics, SC-70<br>Thermal Resistance, Junction-to-Air | $R_{\theta JA}$ | 263   | $^{\circ}\text{C/W}$ |

## ELECTRICAL CHARACTERISTICS

$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ;  $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ ;  $I_{OUT} = 1\text{ mA}$ ;  $C_{IN} = C_{OUT} = 1\text{ }\mu\text{F}$ ; unless otherwise noted. Typical values are at  $T_A = +25^{\circ}\text{C}$ .

| Parameter                        | Test Conditions                                                              |                                              | Symbol              | Min    | Typ  | Max    | Unit   |
|----------------------------------|------------------------------------------------------------------------------|----------------------------------------------|---------------------|--------|------|--------|--------|
| Operating Input Voltage          | (Note NO TAG)                                                                |                                              | V <sub>IN</sub>     | 1.4    |      | 5.25   | V      |
| Output Voltage (Fast Mode)       | T <sub>A</sub> = +25°C,<br>I <sub>OUT</sub> = 5 mA                           | V <sub>OUT</sub> > 2 V                       | V <sub>OUT</sub>    | x0.99  |      | x1.01  | V      |
|                                  |                                                                              | V <sub>OUT</sub> ≤ 2 V                       |                     | −20    |      | 20     | mV     |
|                                  | −40°C ≤ T <sub>A</sub> ≤ 85°C,<br>I <sub>OUT</sub> = 5 mA                    | V <sub>OUT</sub> > 2 V                       |                     | x0.975 |      | x1.015 | V      |
|                                  |                                                                              | V <sub>OUT</sub> ≤ 2 V                       |                     | −50    |      | 30     | mV     |
| Output Voltage Temp. Coefficient | T <sub>A</sub> = −40 to 85°C                                                 |                                              |                     |        | ±50  |        | ppm/°C |
| Line Regulation                  | V <sub>IN</sub> = V <sub>OUT</sub> + 0.5 V to 5 V<br>V <sub>IN</sub> ≥ 1.4 V | I <sub>OUT</sub> = 1 mA,<br>(Low Power Mode) | Line <sub>Reg</sub> |        |      | 0.50   | % /V   |
|                                  |                                                                              | I <sub>OUT</sub> = 10 mA,<br>(Fast Mode)     |                     |        | 0.02 | 0.20   |        |
| Load Regulation                  | I <sub>OUT</sub> = 1 mA to 10 mA                                             | V <sub>OUT</sub> > 2.0 V                     | Line <sub>Reg</sub> | −1.0   |      | 1.0    | %      |
|                                  |                                                                              | V <sub>OUT</sub> ≤ 2.0 V                     |                     | −20    |      | 20     | mV     |
|                                  | I <sub>OUT</sub> = 10 mA to 300 mA                                           |                                              |                     |        | 35   | 80     | mV     |
| Dropout Voltage                  | I <sub>OUT</sub> = 300 mA                                                    | 0.8 V ≤ V <sub>OUT</sub> < 0.9 V             | V <sub>DO</sub>     |        | 0.62 | 0.85   | V      |
|                                  |                                                                              | 0.9 V ≤ V <sub>OUT</sub> < 1.0 V             |                     |        | 0.55 | 0.78   |        |
|                                  |                                                                              | 1.0 V ≤ V <sub>OUT</sub> < 1.5 V             |                     |        | 0.48 | 0.70   |        |
|                                  |                                                                              | 1.5 V ≤ V <sub>OUT</sub> < 2.6 V             |                     |        | 0.34 | 0.50   |        |
|                                  |                                                                              | 2.6 V ≤ V <sub>OUT</sub> < 4.0 V             |                     |        | 0.23 | 0.35   |        |
| Output Current                   |                                                                              |                                              | I <sub>OUT</sub>    | 300    |      |        | mA     |
| Short Current Limit              | V <sub>OUT</sub> = 0 V                                                       |                                              | I <sub>SC</sub>     |        | 50   |        | mA     |
| Quiescent Current                | I <sub>OUT</sub> = 0 mA, Low Power Mode (Note 3)                             | V <sub>OUT</sub> ≤ 1.85 V                    | I <sub>Q</sub>      |        | 1.0  | 4.0    | μA     |
|                                  |                                                                              | V <sub>OUT</sub> > 1.85 V                    |                     |        | 1.5  | 4.0    |        |
| Supply Current                   | I <sub>OUT</sub> = 10 mA, Fast Mode                                          |                                              | I <sub>GND</sub>    |        | 55   |        | μA     |
| Standby Current                  | V <sub>CE</sub> = 0 V, T <sub>A</sub> = 25°C                                 |                                              | I <sub>STB</sub>    |        | 0.1  | 1      | μA     |
| Fast Mode Switch–Over Current    | I <sub>OUT</sub> = light to heavy load                                       |                                              | I <sub>OUTH</sub>   |        |      | 8.0    | mA     |
| Low Power Switch–Over Current    | I <sub>OUT</sub> = heavy to light load                                       |                                              | I <sub>OUTL</sub>   | 1.0    | 2.0  |        | mA     |
| CE Pin Threshold Voltage         | CE Input Voltage “H”                                                         |                                              | V <sub>CEH</sub>    | 1.0    |      |        | V      |
|                                  | CE Input Voltage “L”                                                         |                                              | V <sub>CEL</sub>    |        |      | 0.4    |        |
| CE Pull Down Current             |                                                                              |                                              | I <sub>CEPD</sub>   |        | 0.1  |        | μA     |
| AE Pin Threshold Voltage         | AE Input Voltage “H”                                                         |                                              | V <sub>AEH</sub>    | 1.0    |      |        | V      |
|                                  | AE Input Voltage “L”                                                         |                                              | V <sub>AEL</sub>    |        |      | 0.4    |        |

3. The value of supply current is excluding the Pull-down constant current of CE and AE Pin

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| Parameter                              | Test Conditions                                                                                                                                                              | Symbol    | Min | Typ | Max | Unit                |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----|-----|-----|---------------------|
| AE Pull Down Current                   |                                                                                                                                                                              | IAEPD     |     | 0.1 |     | $\mu\text{A}$       |
| Power Supply Rejection Ratio           | $V_{IN} = V_{OUT} + 1\text{ V}$ or $2.2\text{ V}$ whichever is higher,<br>$\Delta V_{IN} = 0.2\text{ V}_{pk-pk}$ , $I_{OUT} = 30\text{ mA}$ , $f = 1\text{ kHz}$ , Fast Mode | PSRR      |     | 70  |     | dB                  |
| Output Noise Voltage                   | $V_{OUT} = 1.0\text{ V}$ , $I_{OUT} = 30\text{ mA}$ , $f = 10\text{ Hz}$ to $100\text{ kHz}$                                                                                 | $V_N$     |     | 90  |     | $\mu\text{V}_{rms}$ |
| Low Output N-channel Tr. On Resistance | $V_{IN} = 4\text{ V}$ , $V_{CE} = 0\text{ V}$                                                                                                                                | $R_{LOW}$ |     | 50  |     | $\Omega$            |

3. The value of supply current is excluding the Pull-down constant current of CE and AE Pin

TYPICAL CHARACTERISTICS

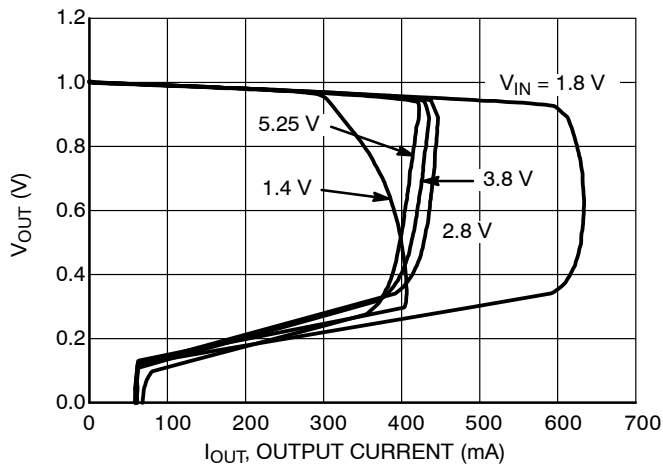


Figure 3. Output Voltage vs. Output Current  
1.0 V Version ( $T_J = 25^\circ\text{C}$ )

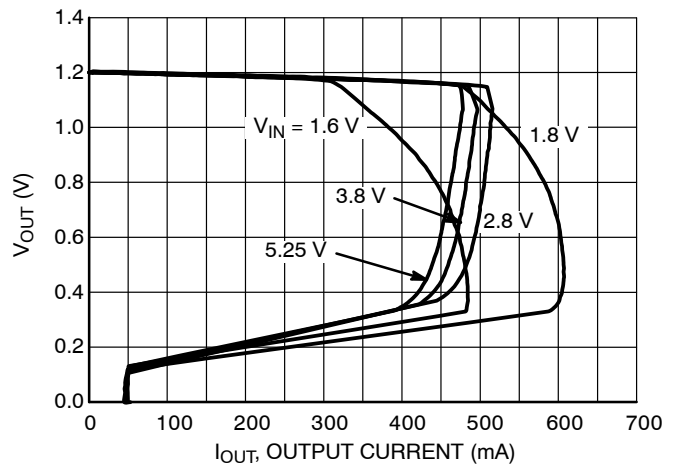


Figure 4. Output Voltage vs. Output Current  
1.2 V Version ( $T_J = 25^\circ\text{C}$ )

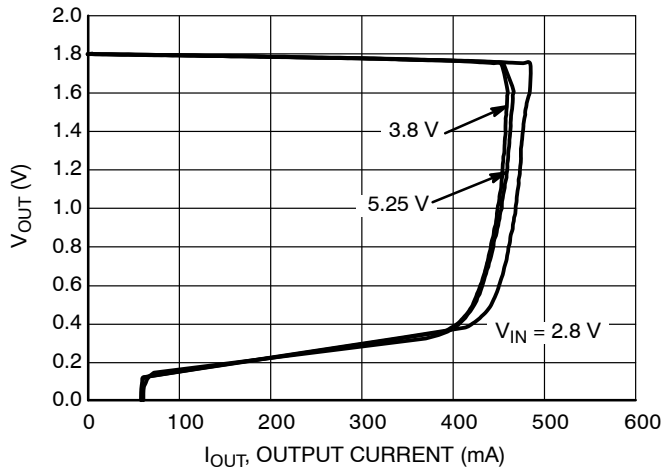


Figure 5. Output Voltage vs. Output Current  
1.8 V Version ( $T_J = 25^\circ\text{C}$ )

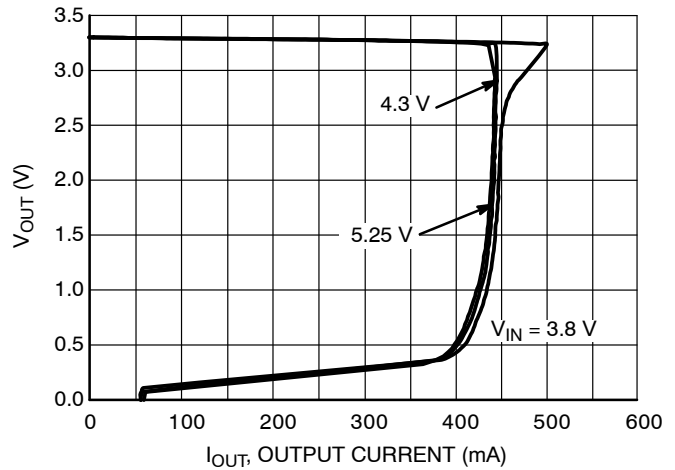


Figure 6. Output Voltage vs. Output Current  
3.3 V Version ( $T_J = 25^\circ\text{C}$ )

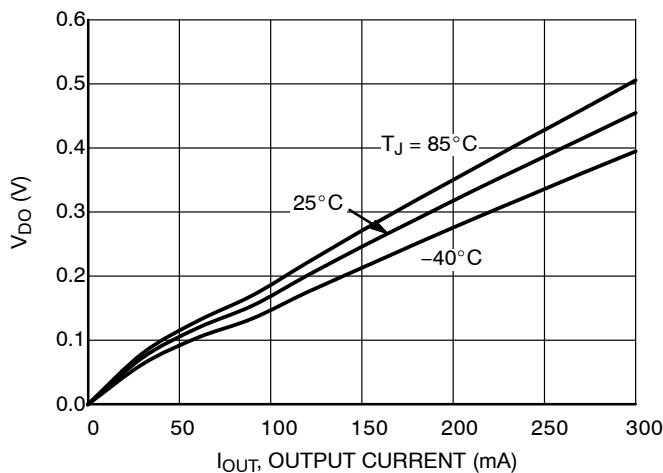


Figure 7. Dropout Voltage vs. Output Current  
1.0 V Version

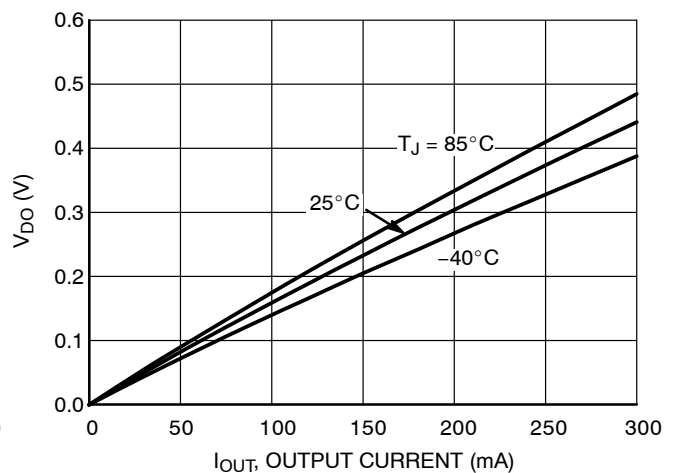


Figure 8. Dropout Voltage vs. Output Current  
1.2 V Version

TYPICAL CHARACTERISTICS

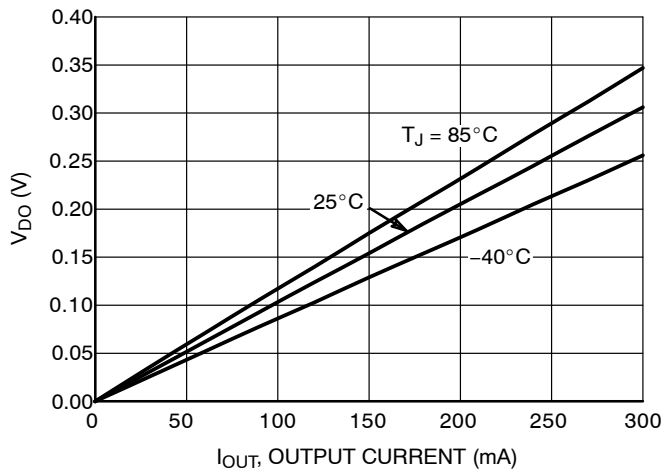


Figure 9. Dropout Voltage vs. Output Current  
1.8 V Version

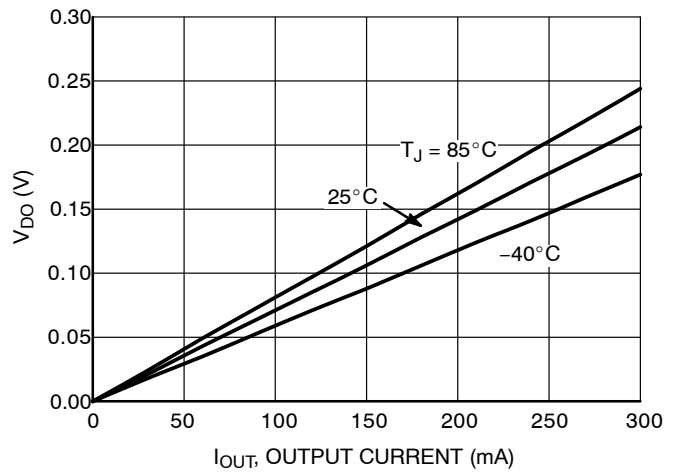


Figure 10. Dropout Voltage vs. Output Current  
3.3 V Version

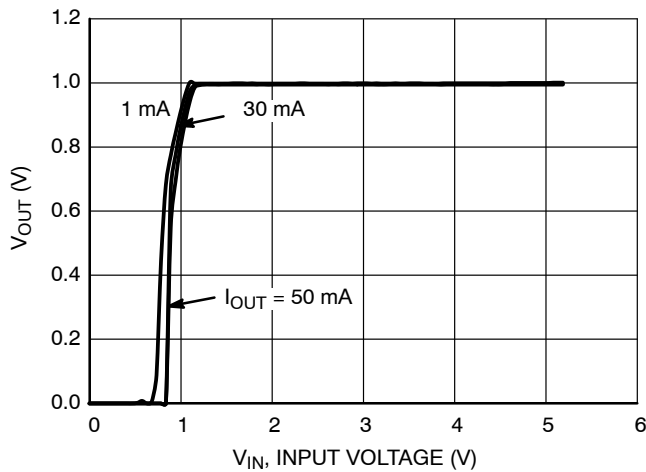


Figure 11. Output Voltage vs. Input Voltage,  
1.0 V Version

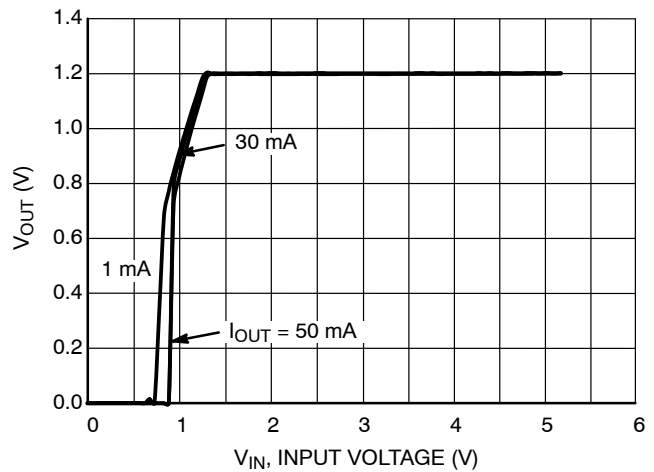


Figure 12. Output Voltage vs. Input Voltage,  
1.2 V Version

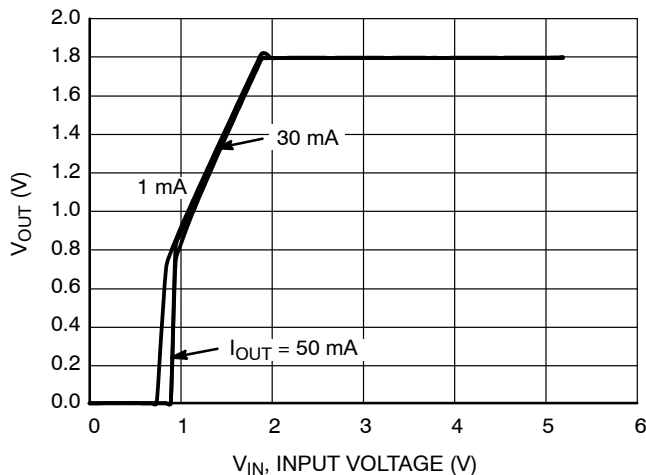


Figure 13. Output Voltage vs. Input Voltage,  
1.8 V Version

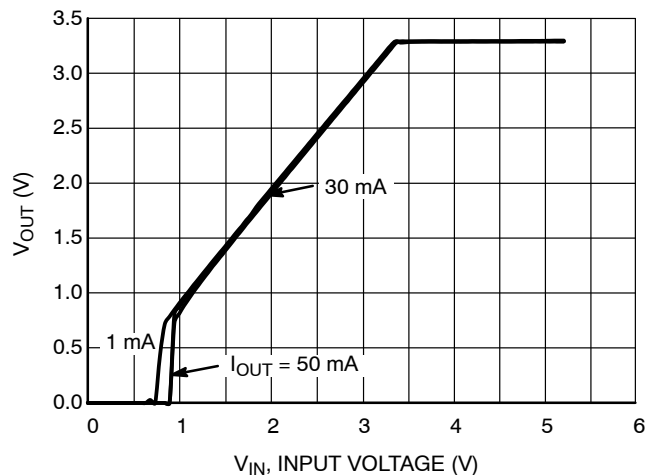


Figure 14. Output Voltage vs. Input Voltage,  
3.3 V Version

TYPICAL CHARACTERISTICS

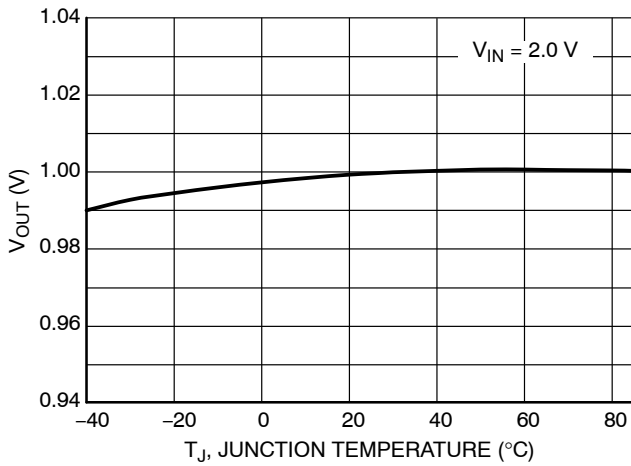


Figure 15. Output Voltage vs. Temperature, 1.0 V Version

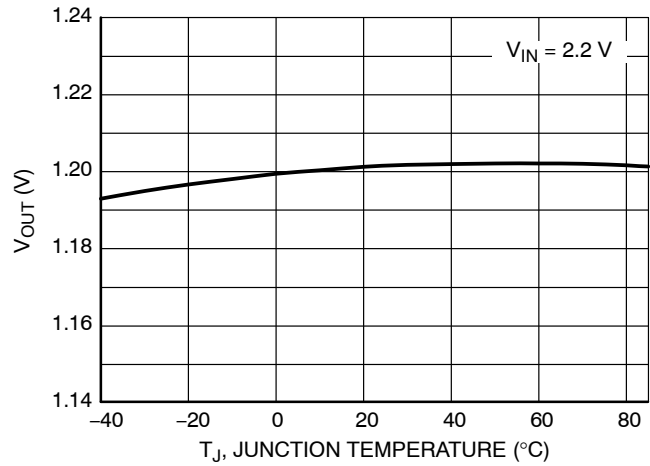


Figure 16. Output Voltage vs. Temperature, 1.2 V Version

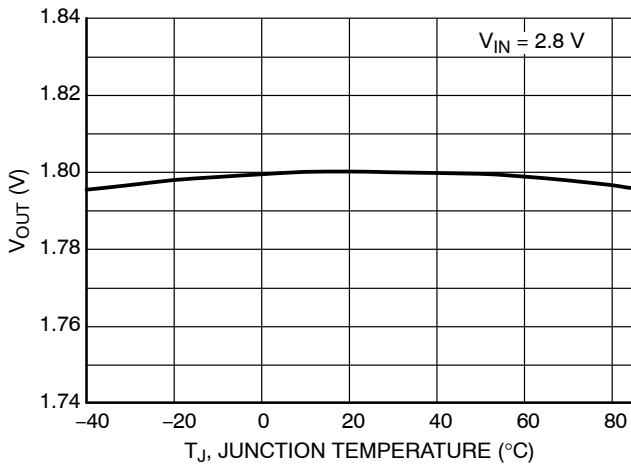


Figure 17. Output Voltage vs. Temperature, 1.8 V Version

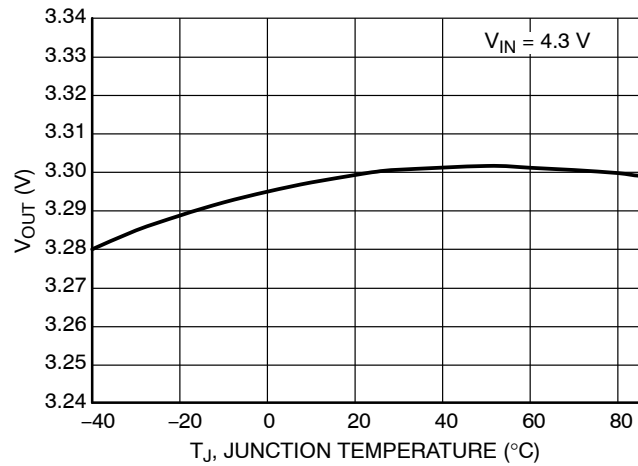


Figure 18. Supply Current vs. Input Voltage, 3.3 V Version

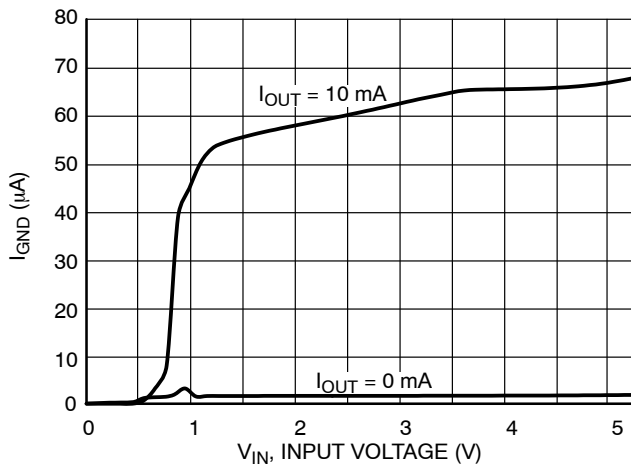


Figure 19. Supply Current vs. Input Voltage, 1.0 V Version

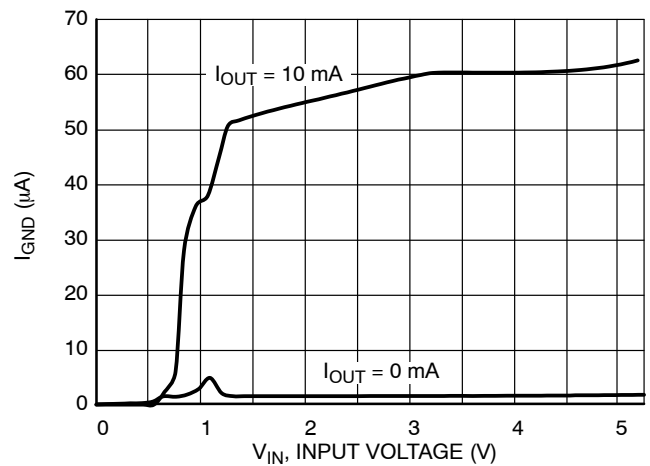


Figure 20. Supply Current vs. Input Voltage, 1.2 V Version

TYPICAL CHARACTERISTICS

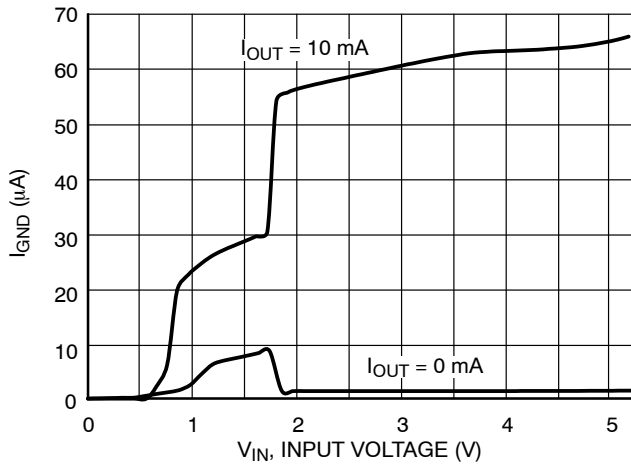


Figure 21. Supply Current vs. Input Voltage, 1.8 V Version

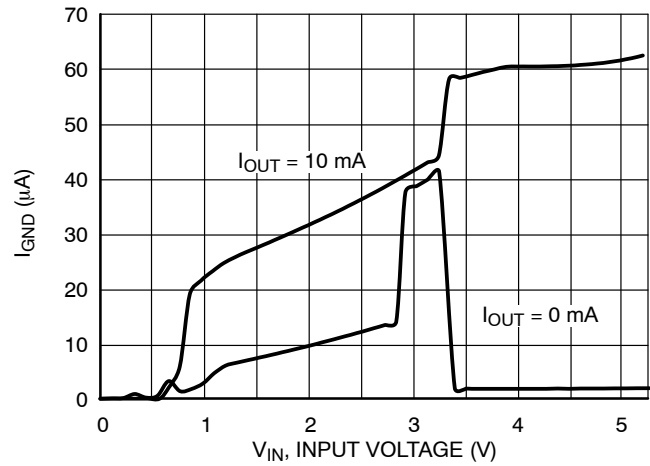


Figure 22. Supply Current vs. Input Voltage, 3.3 V Version

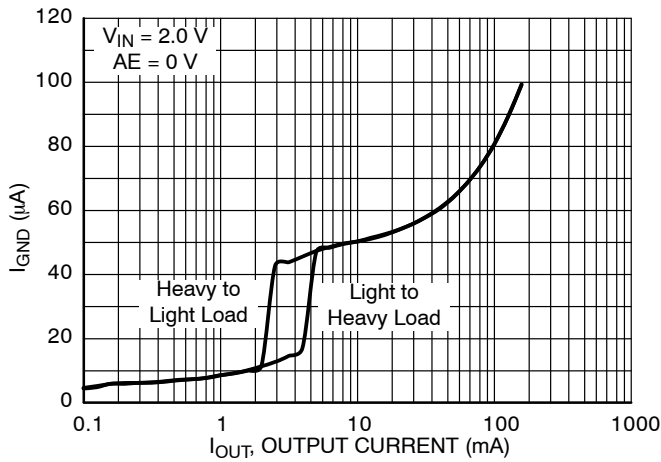


Figure 23. Supply Current vs. Output Current, 1.0 V Version

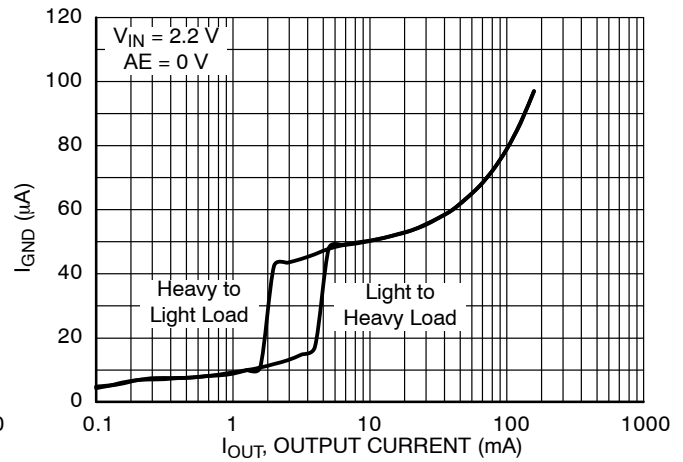


Figure 24. Supply Current vs. Output Current, 1.2 V Version

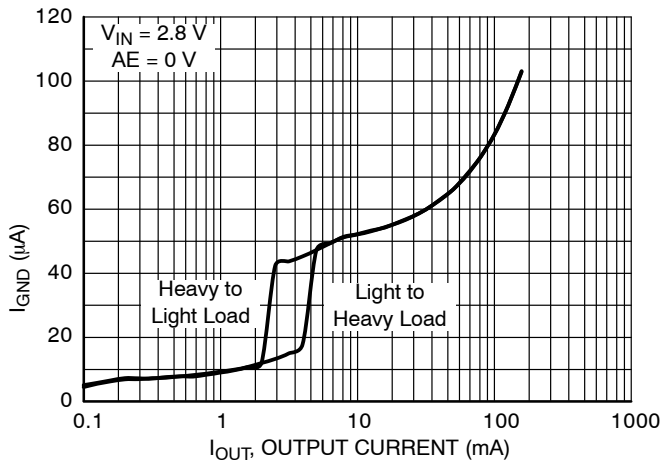


Figure 25. Supply Current vs. Output Current, 1.8 V Version

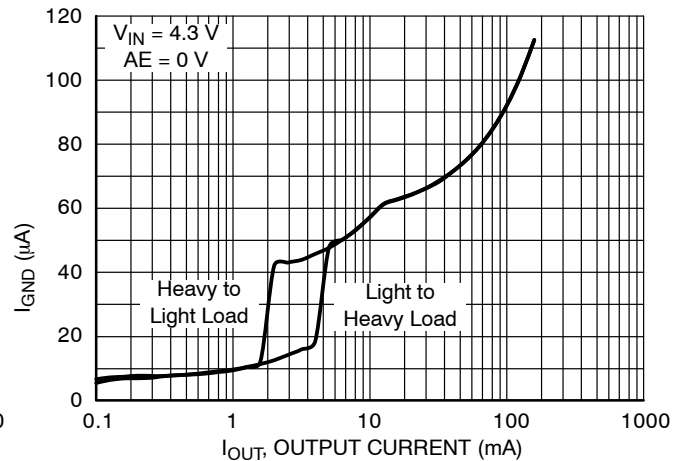
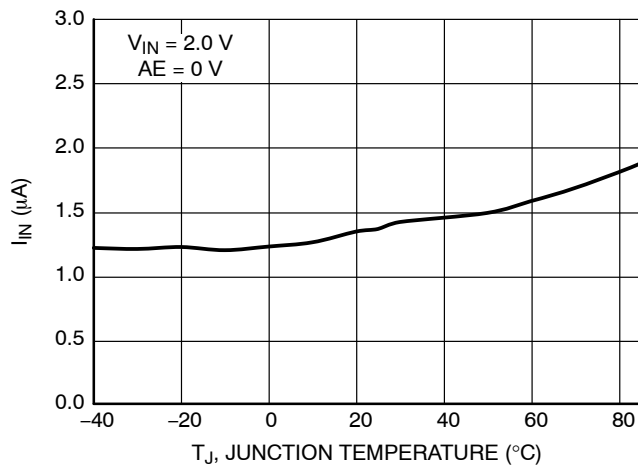
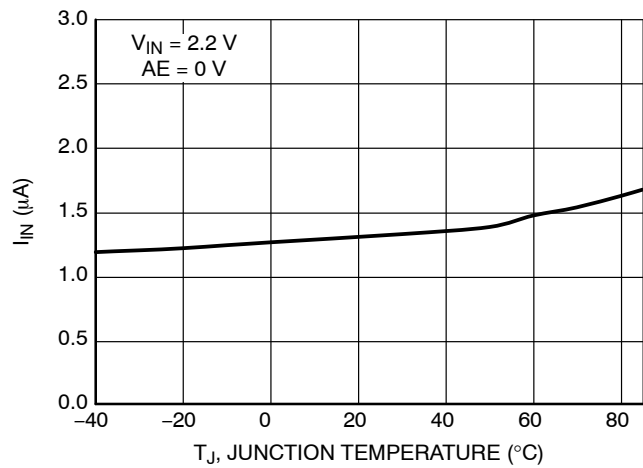


Figure 26. Supply Current vs. Output Current, 3.3 V Version

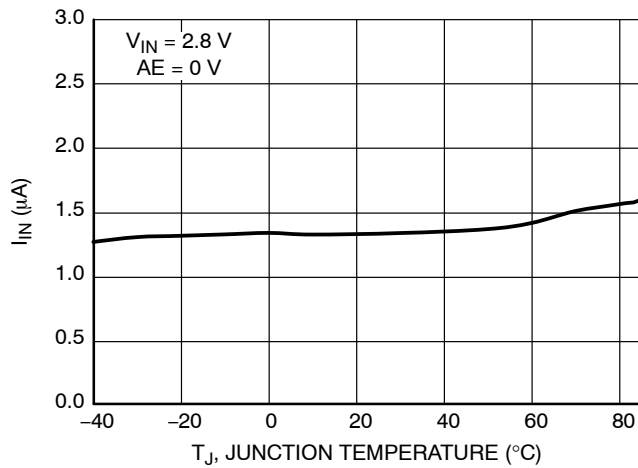
## TYPICAL CHARACTERISTICS



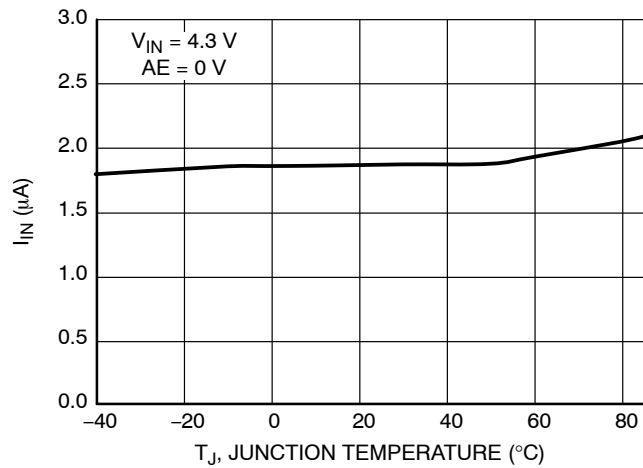
**Figure 27. Supply Current vs. Temperature,  
1.0 V Version**



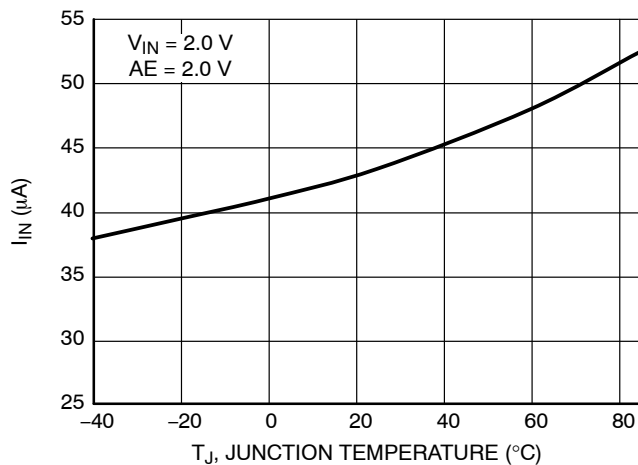
**Figure 28. Supply Current vs. Temperature,  
1.2 V Version**



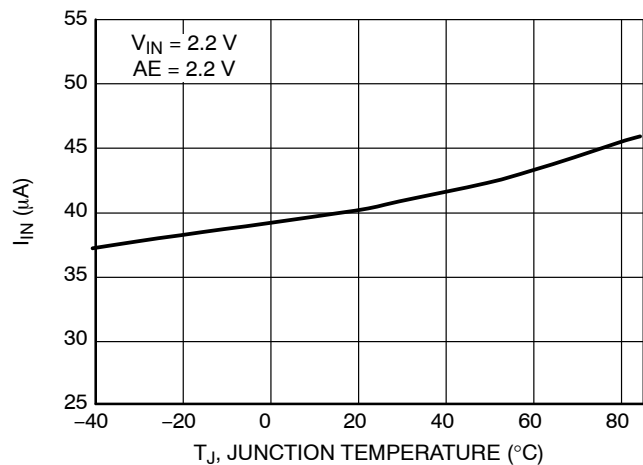
**Figure 29. Supply Current vs. Temperature,  
1.8 V Version**



**Figure 30. Supply Current vs. Temperature,  
3.3 V Version**



**Figure 31. Supply Current vs. Temperature,  
1.0 V Version**



**Figure 32. Supply Current vs. Temperature,  
1.2 V Version**

TYPICAL CHARACTERISTICS

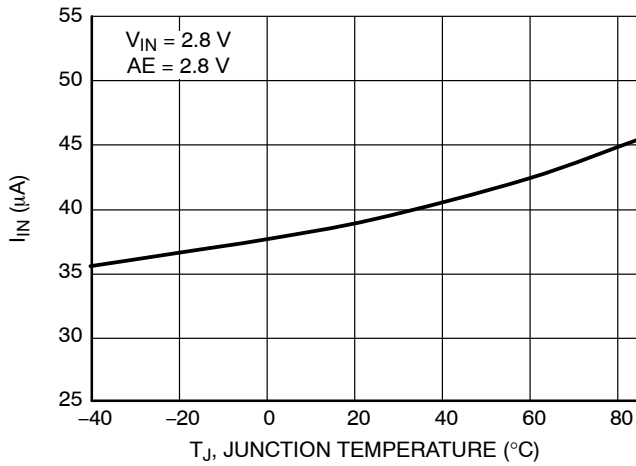


Figure 33. Supply Current vs. Temperature, 1.8 V Version

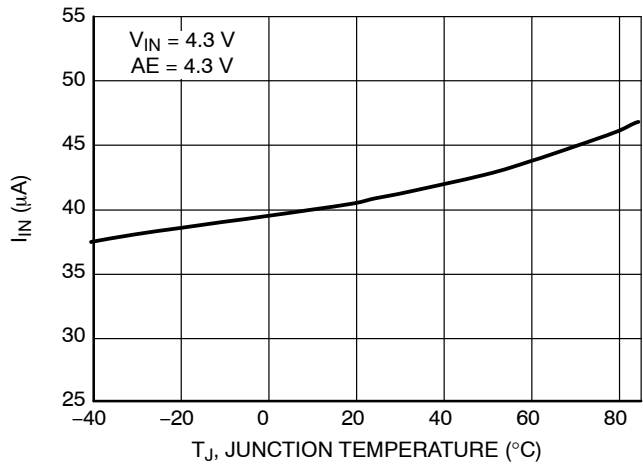


Figure 34. Supply Current vs. Temperature, 3.3 V Version

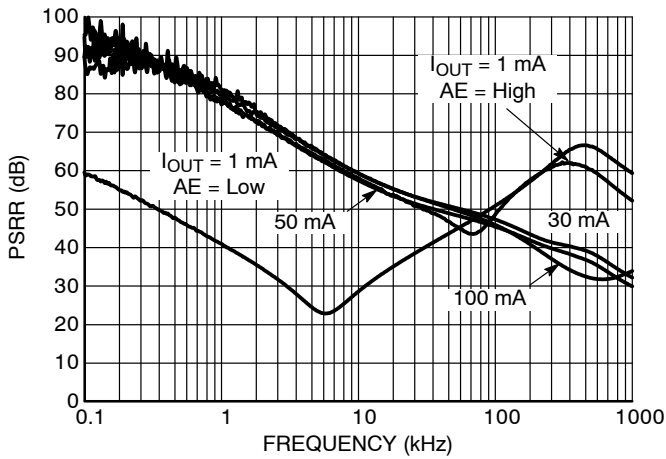


Figure 35. PSRR, 1.0 V Version,  $V_{IN} = 2.2$  V

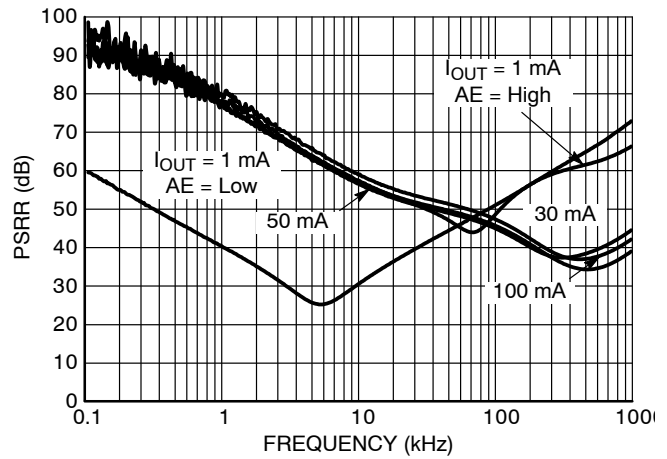


Figure 36. PSRR, 1.2 V Version,  $V_{IN} = 2.2$  V

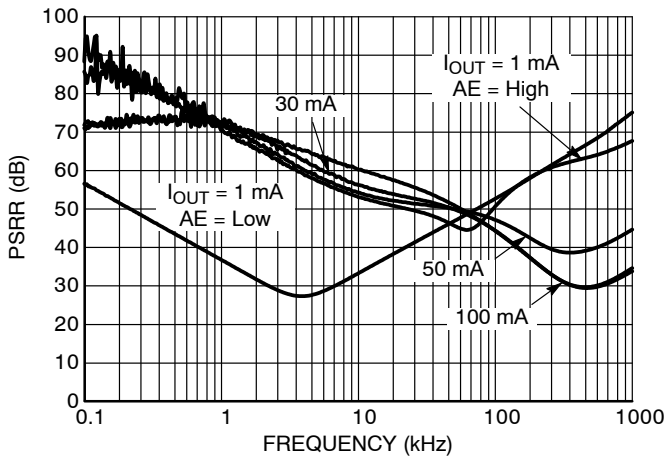


Figure 37. PSRR, 1.8 V Version,  $V_{IN} = 3.8$  V

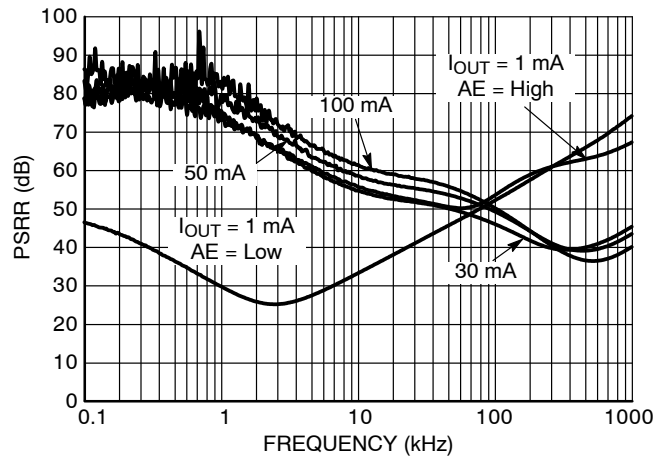


Figure 38. PSRR, 3.3 V Version,  $V_{IN} = 4.3$  V

## TYPICAL CHARACTERISTICS

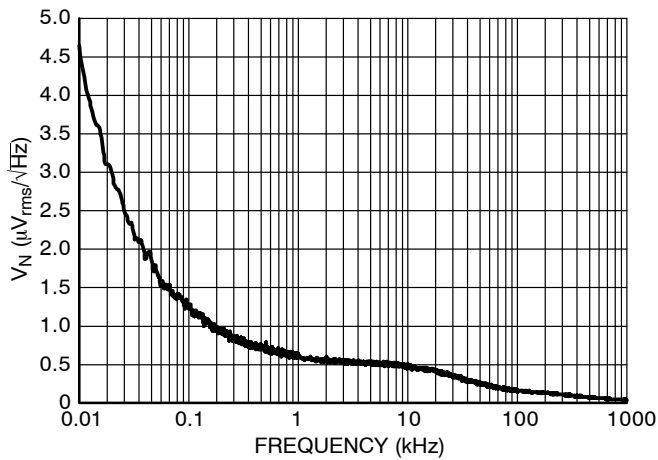


Figure 39. Output Voltage Noise, 1.0 V Version,  
 $V_{IN} = 2.0\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

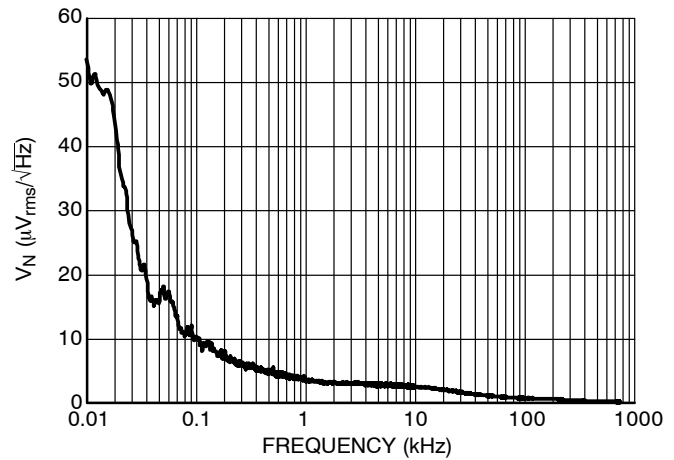


Figure 40. Output Voltage Noise, 1.2 V Version,  
 $V_{IN} = 2.2\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

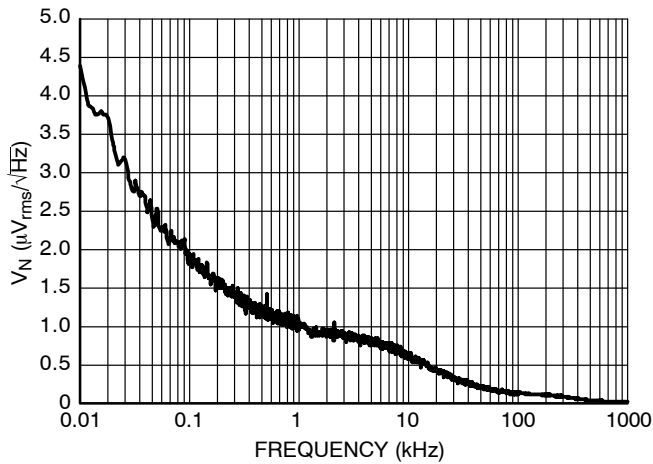


Figure 41. Output Voltage Noise, 1.8 V Version,  
 $V_{IN} = 2.8\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

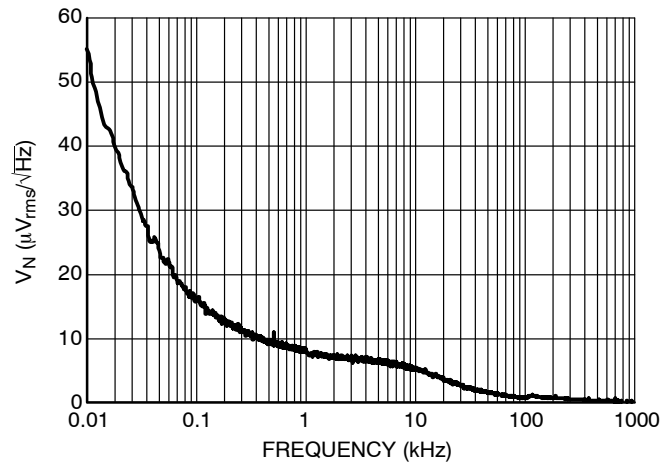


Figure 42. Output Voltage Noise, 3.3 V Version,  
 $V_{IN} = 4.3\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

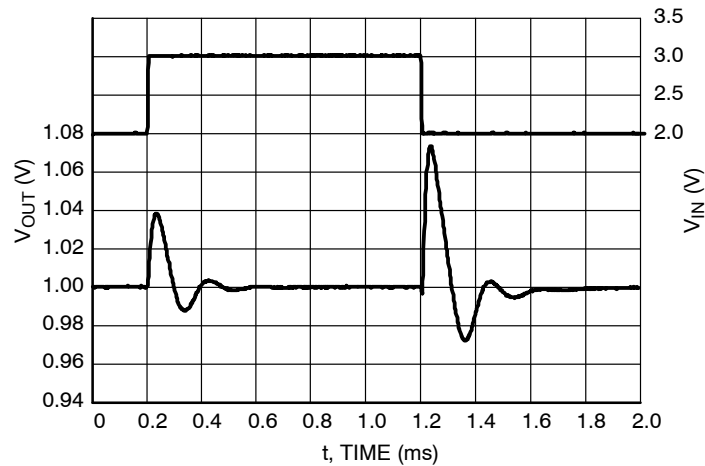
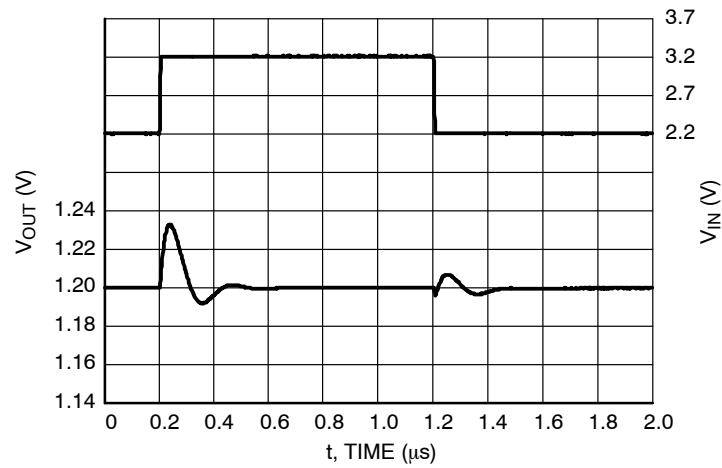
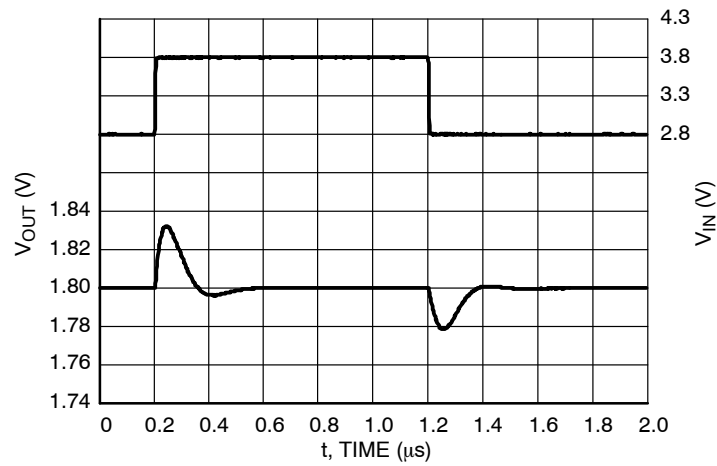


Figure 43. Line Transients, 1.0 V Version,  
 $t_R = t_F = 5\text{ }\mu\text{s}$ ,  $I_{OUT} = 1\text{ mA}$ ,  $AE = 0\text{ V}$

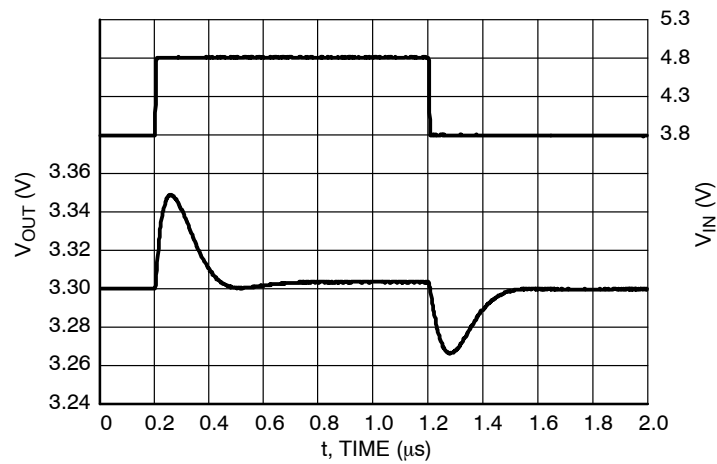
## TYPICAL CHARACTERISTICS



**Figure 44. Line Transients, 1.2 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 1$  mA,  $AE = 0$  V

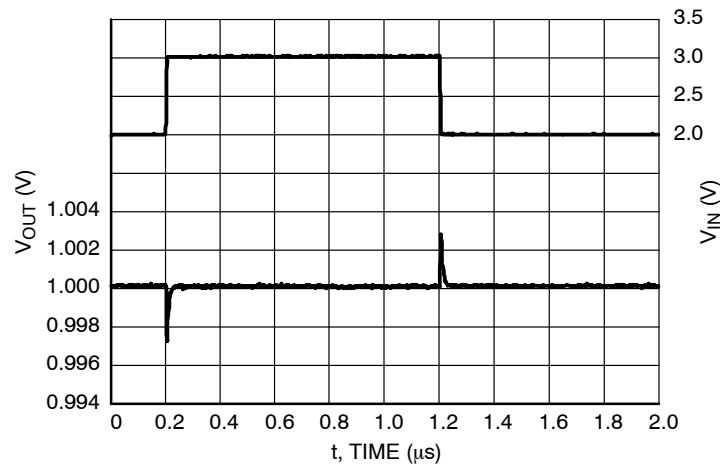


**Figure 45. Line Transients, 1.8 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 1$  mA,  $AE = 0$  V

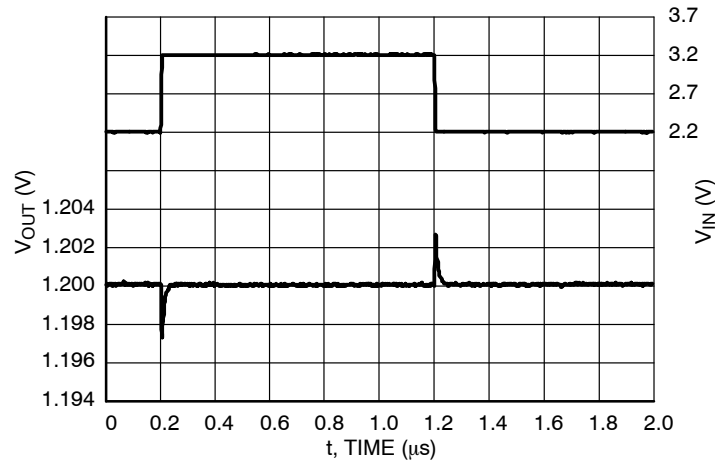


**Figure 46. Line Transients, 3.3 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 1$  mA,  $AE = 0$  V

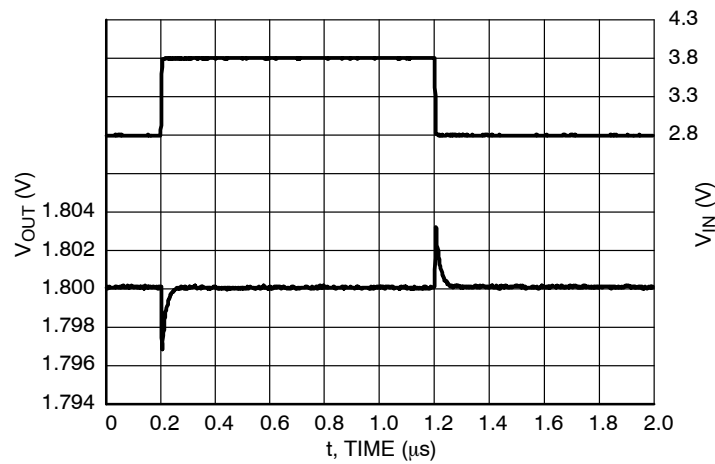
TYPICAL CHARACTERISTICS



**Figure 47. Line Transients, 1.0 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 30$  mA,  $AE = V_{IN}$  V

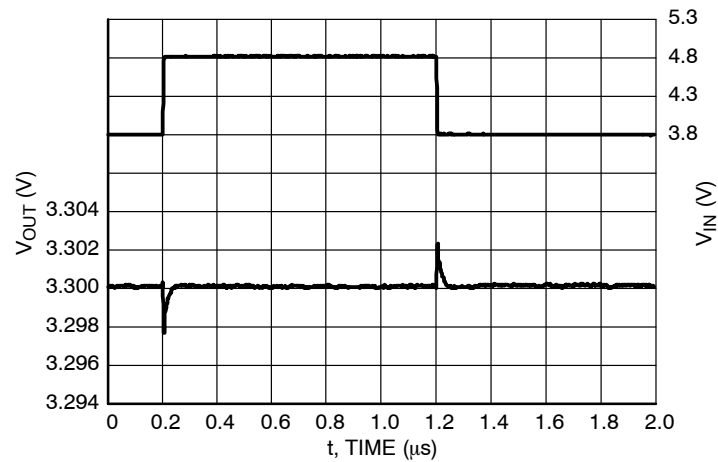


**Figure 48. Line Transients, 1.2 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 30$  mA,  $AE = V_{IN}$  V

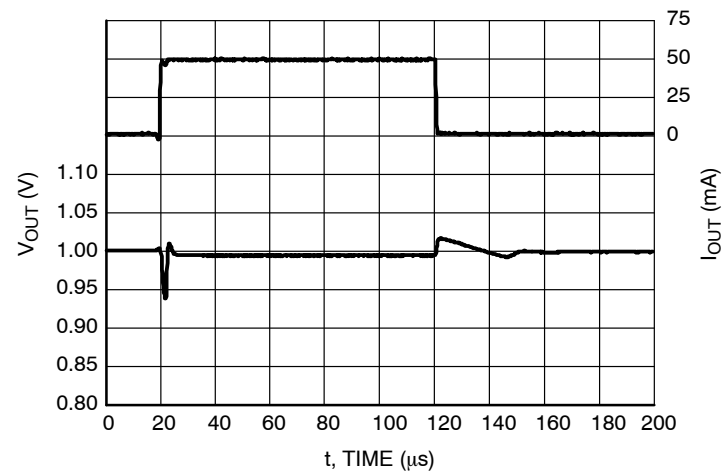


**Figure 49. Line Transients, 1.8 V Version,**  
 $t_R = t_F = 5 \mu$ s,  $I_{OUT} = 30$  mA,  $AE = V_{IN}$  V

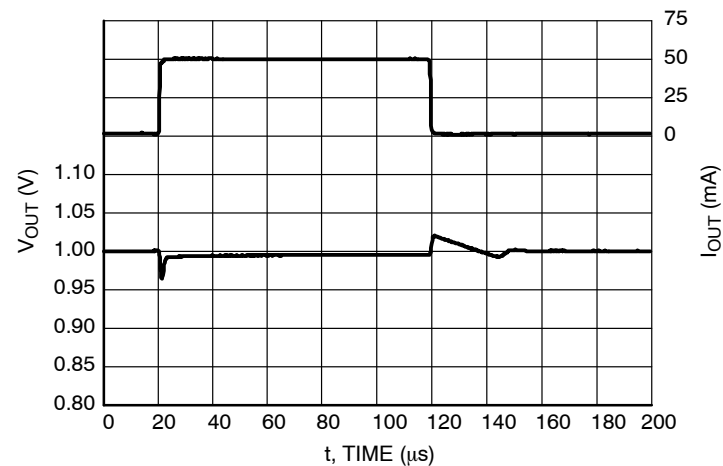
## TYPICAL CHARACTERISTICS



**Figure 50. Line Transients, 3.3 V Version,**  
 $t_R = t_F = 5 \mu s$ ,  $I_{OUT} = 30 \text{ mA}$ ,  $AE = V_{IN} \text{ V}$

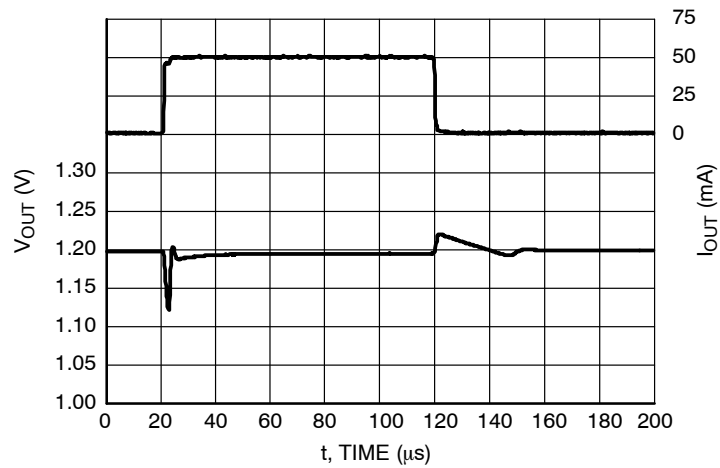


**Figure 51. Load Transients, 1.0 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu s$ ,  $V_{IN} = 2.0 \text{ V}$ ,  
 $AE = 0 \text{ V}$

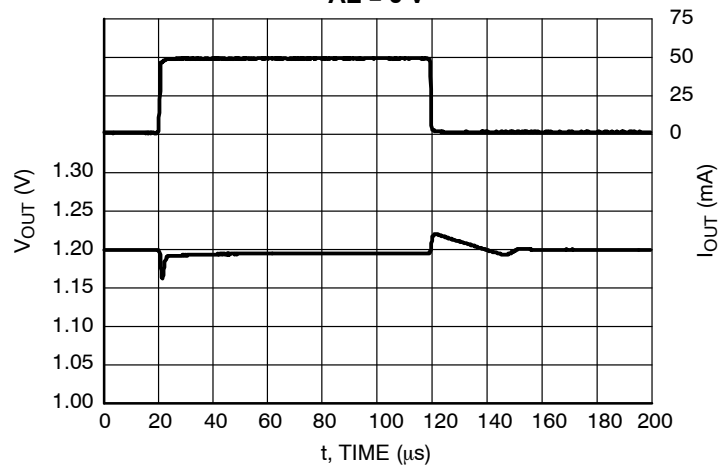


**Figure 52. Load Transients, 1.0 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu s$ ,  $V_{IN} = 2.0 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

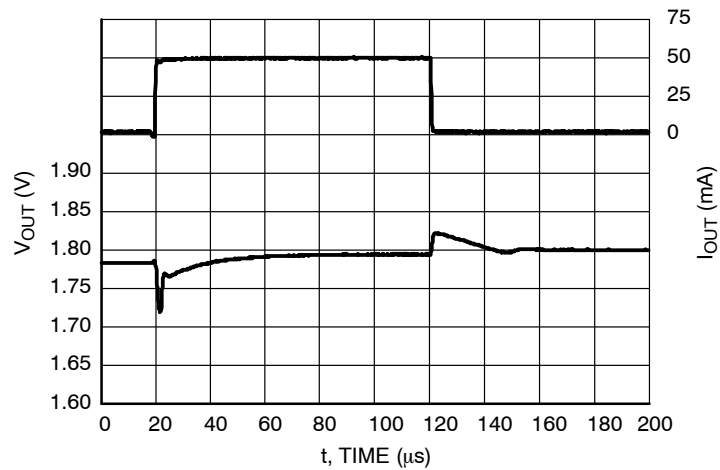
## TYPICAL CHARACTERISTICS



**Figure 53. Load Transients, 1.2 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.2 \text{ V}$ ,  
 $AE = 0 \text{ V}$

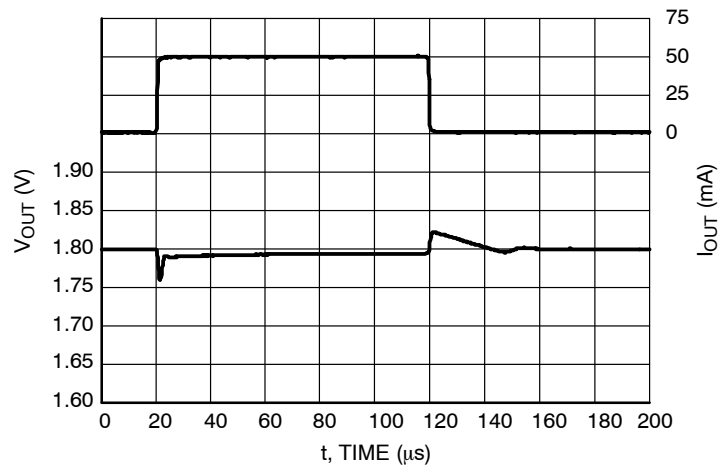


**Figure 54. Load Transients, 1.2 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.2 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

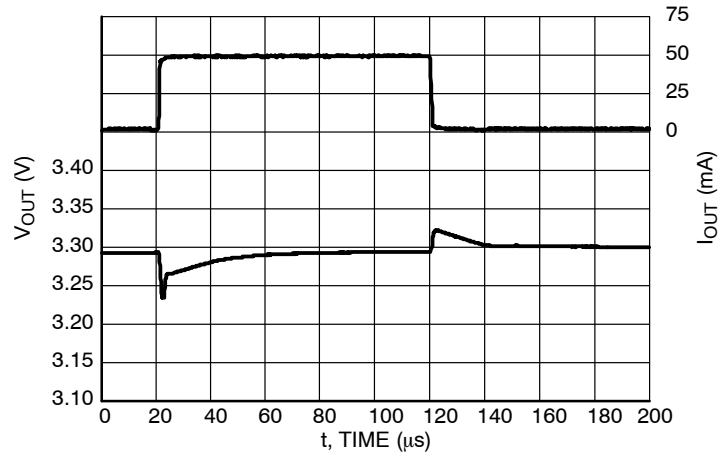


**Figure 55. Load Transients, 1.8 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.8 \text{ V}$ ,  
 $AE = 0 \text{ V}$

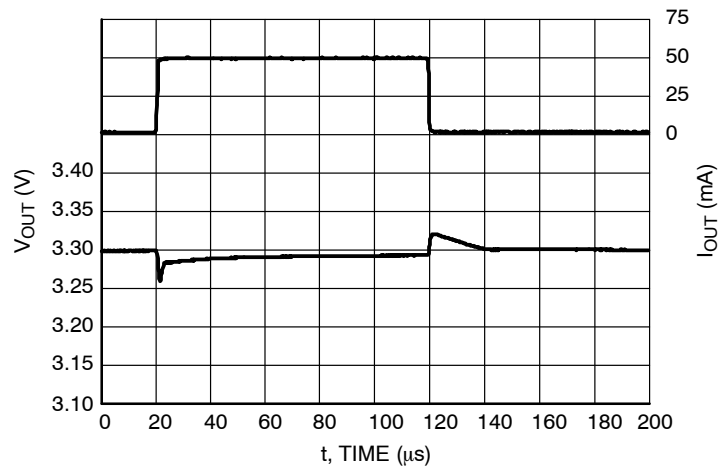
## TYPICAL CHARACTERISTICS



**Figure 56. Load Transients, 1.8 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.8 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

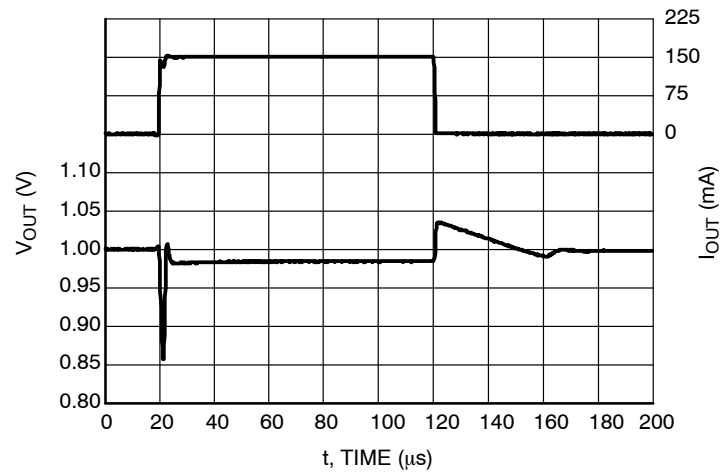


**Figure 57. Load Transients, 3.3 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 4.3 \text{ V}$ ,  
 $AE = 0 \text{ V}$

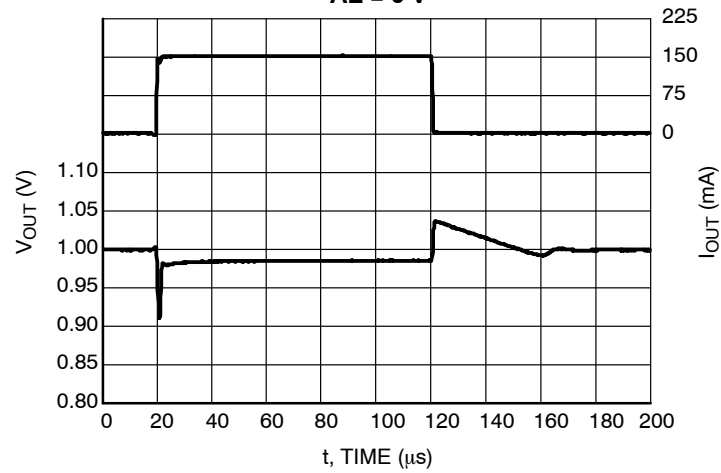


**Figure 58. Load Transients, 3.3 V Version,**  
 $I_{OUT} = 1 - 50 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 4.3 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

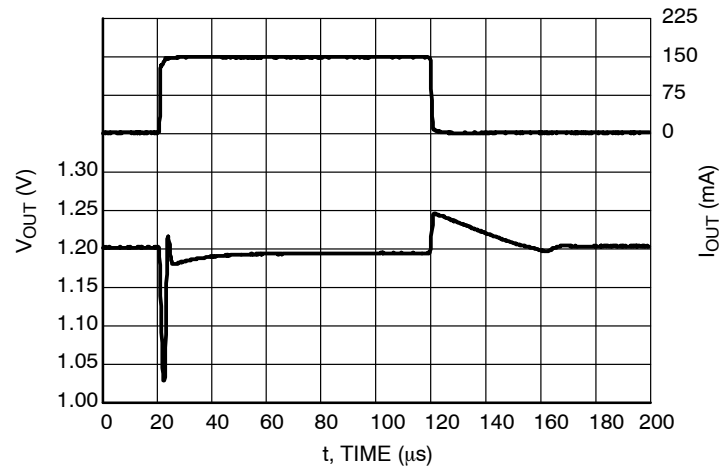
## TYPICAL CHARACTERISTICS



**Figure 59. Load Transients, 1.0 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.0 \text{ V}$ ,  
 $AE = 0 \text{ V}$

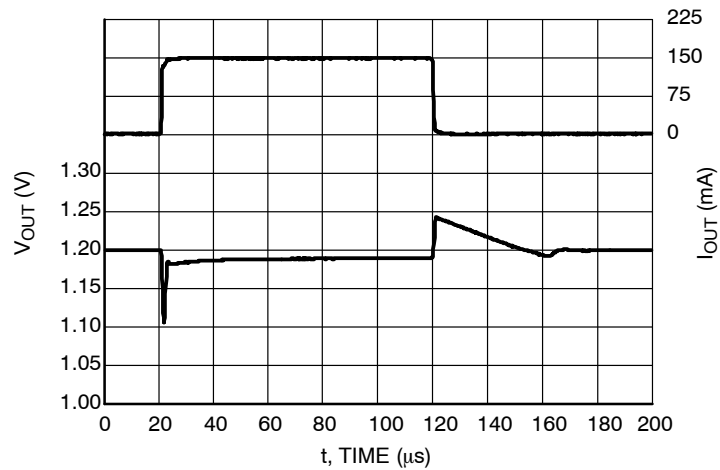


**Figure 60. Load Transients, 1.0 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.0 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

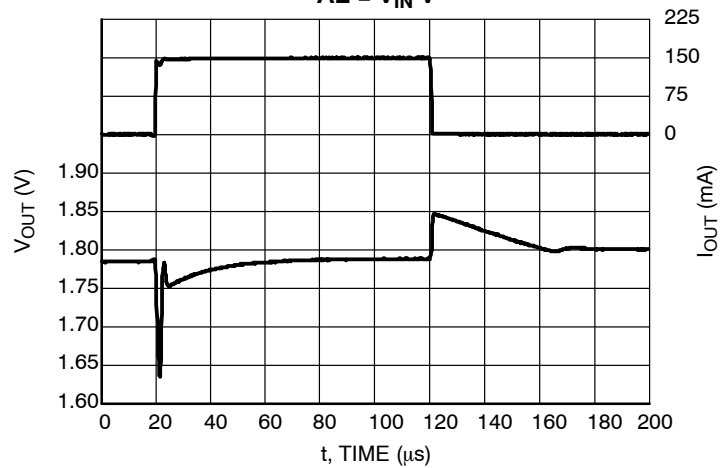


**Figure 61. Load Transients, 1.2 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.2 \text{ V}$ ,  
 $AE = 0 \text{ V}$

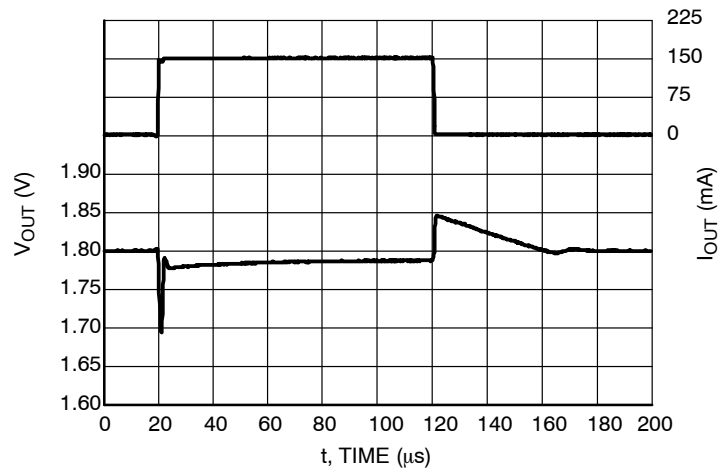
## TYPICAL CHARACTERISTICS



**Figure 62. Load Transients, 1.2 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.2 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

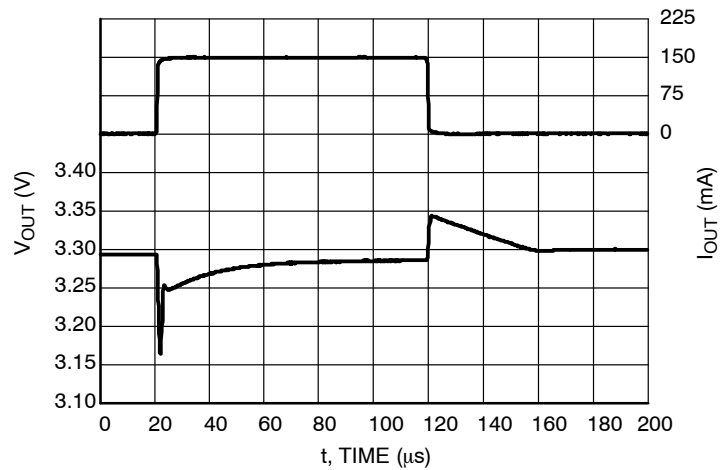


**Figure 63. Load Transients, 1.8 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.8 \text{ V}$ ,  
 $AE = 0 \text{ V}$

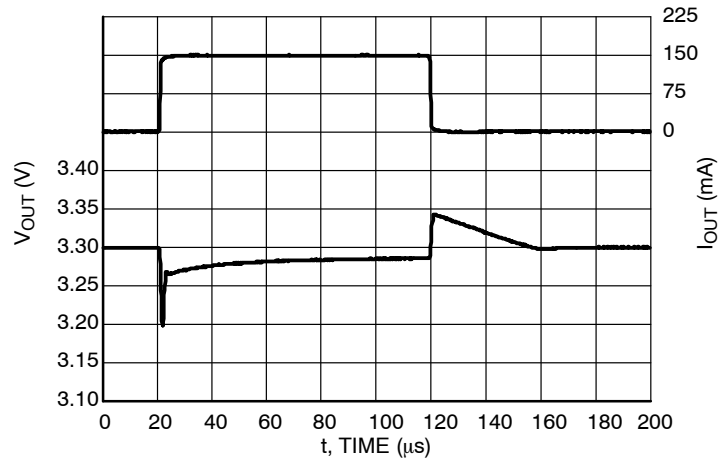


**Figure 64. Load Transients, 1.8 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.8 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

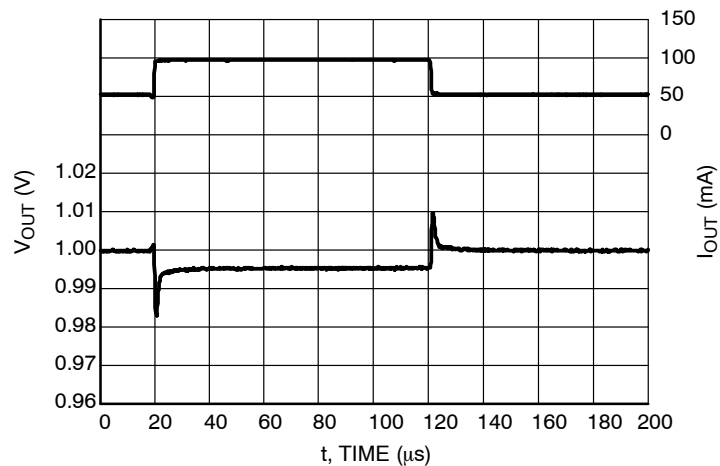
## TYPICAL CHARACTERISTICS



**Figure 65. Load Transients, 3.3 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 4.3 \text{ V}$ ,  
 $AE = 0 \text{ V}$

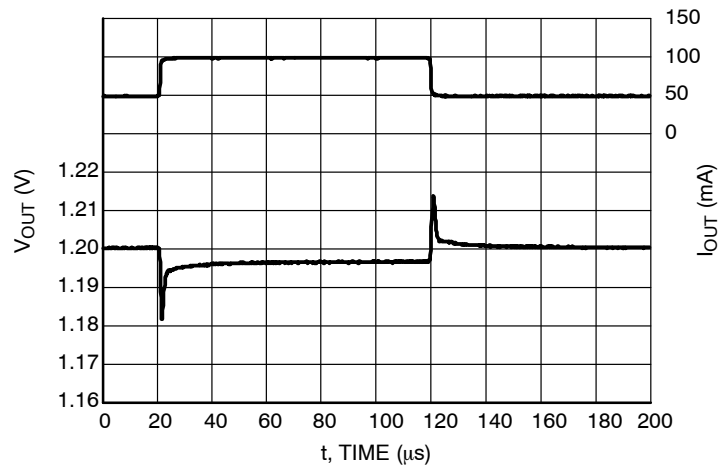


**Figure 66. Load Transients, 3.3 V Version,**  
 $I_{OUT} = 1 - 150 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 4.3 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

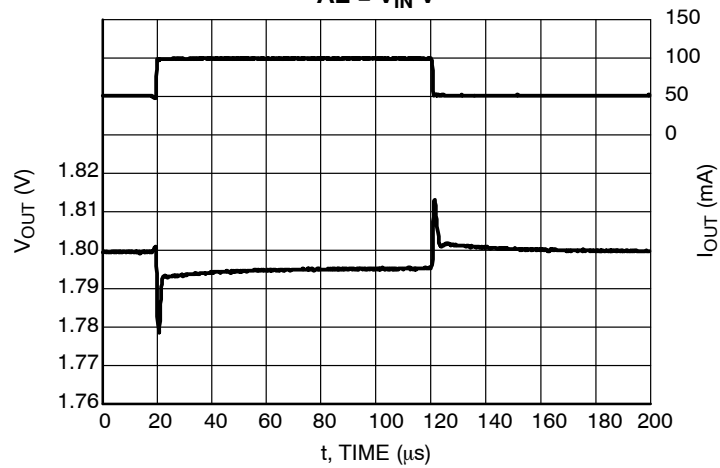


**Figure 67. Load Transients, 1.0 V Version,**  
 $I_{OUT} = 50 - 100 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.0 \text{ V}$ ,  
 $AE = 0 \text{ V}$

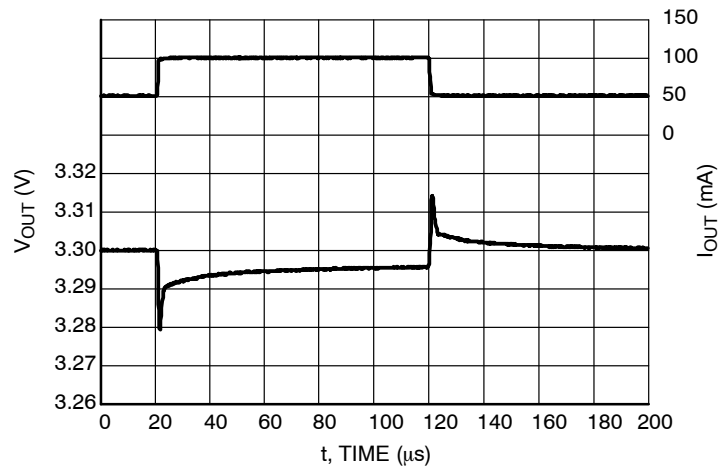
## TYPICAL CHARACTERISTICS



**Figure 68. Load Transients, 1.2 V Version,**  
 $I_{OUT} = 50 - 100 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.2 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$



**Figure 69. Load Transients, 1.8 V Version,**  
 $I_{OUT} = 50 - 100 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 2.8 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$



**Figure 70. Load Transients, 3.3 V Version,**  
 $I_{OUT} = 50 - 100 \text{ mA}$ ,  $t_R = t_F = 0.5 \mu\text{s}$ ,  $V_{IN} = 4.3 \text{ V}$ ,  
 $AE = V_{IN} \text{ V}$

## TYPICAL CHARACTERISTICS

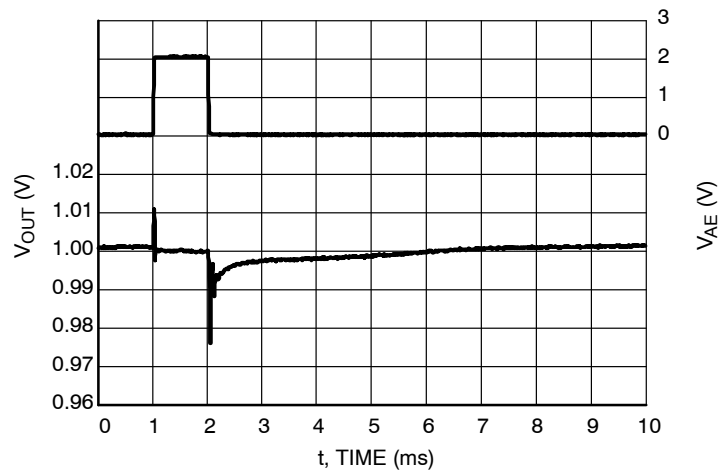


Figure 71. AE Switch Transients, 1.0 V Version,  
 $V_{IN} = 2.0 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$

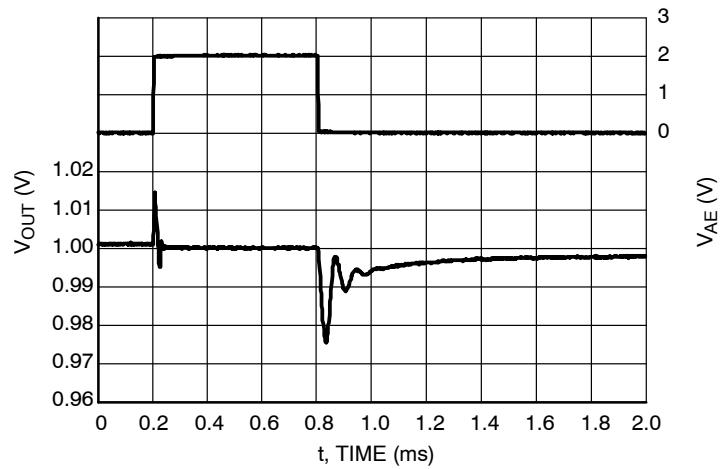


Figure 72. AE Switch Transients, 1.0 V Version,  
 $V_{IN} = 2.0 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$

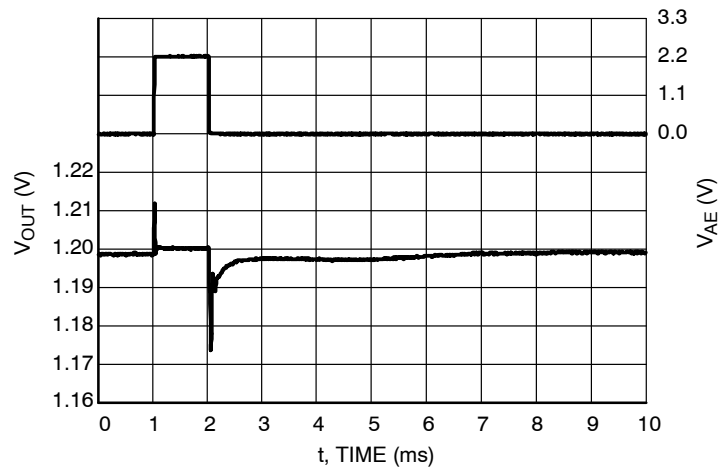
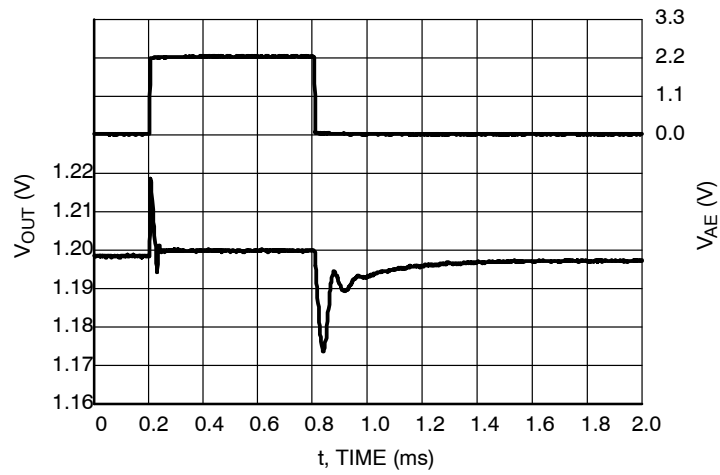
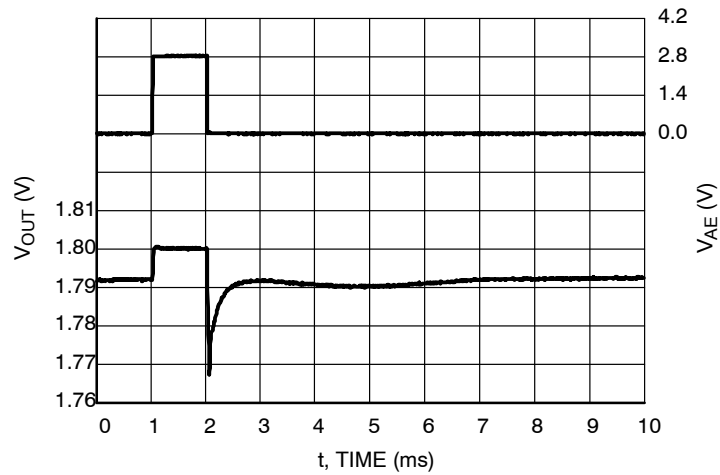


Figure 73. AE Switch Transients, 1.2 V Version,  
 $V_{IN} = 2.2 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$

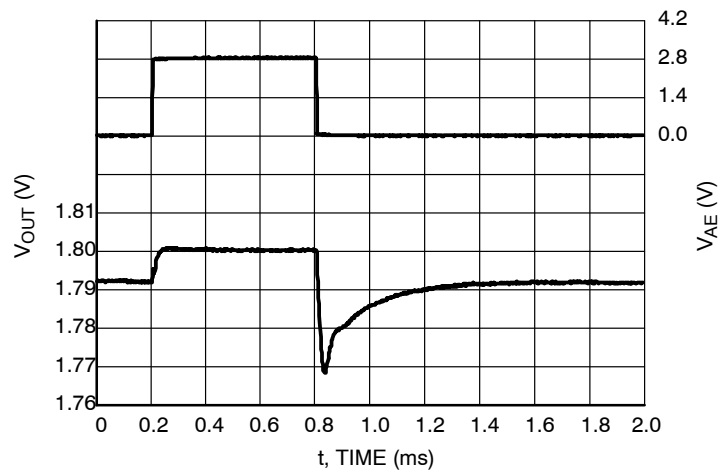
## TYPICAL CHARACTERISTICS



**Figure 74. AE Switch Transients, 1.2 V Version,  
 $V_{IN} = 2.2\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$**



**Figure 75. AE Switch Transients, 1.8 V Version,  
 $V_{IN} = 2.8\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$**



**Figure 76. AE Switch Transients, 1.8 V Version,  
 $V_{IN} = 2.8\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$**

TYPICAL CHARACTERISTICS

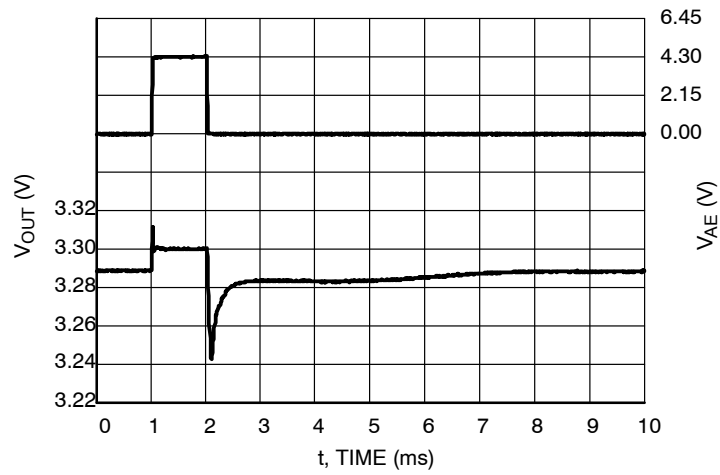


Figure 77. AE Switch Transients, 3.3 V Version,  
 $V_{IN} = 4.3 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$

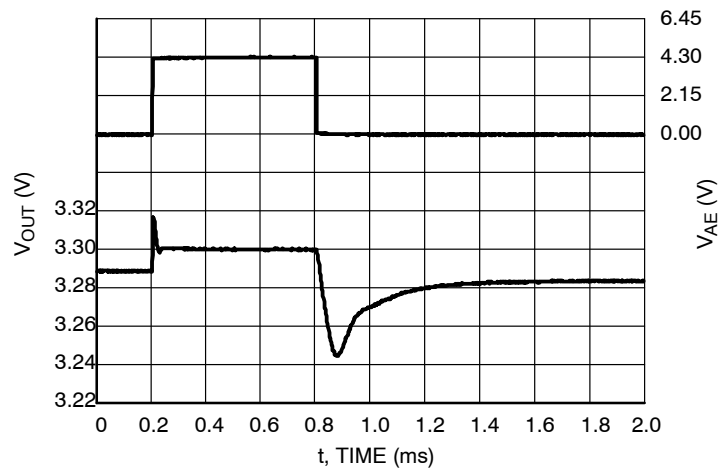


Figure 78. AE Switch Transients, 3.3 V Version,  
 $V_{IN} = 4.3 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$

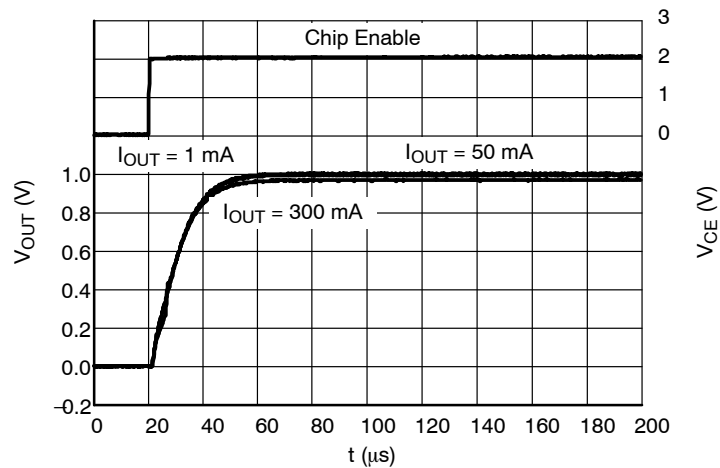


Figure 79. Start-up, 1.0 V Version,  $V_{IN} = 2.0 \text{ V}$

TYPICAL CHARACTERISTICS

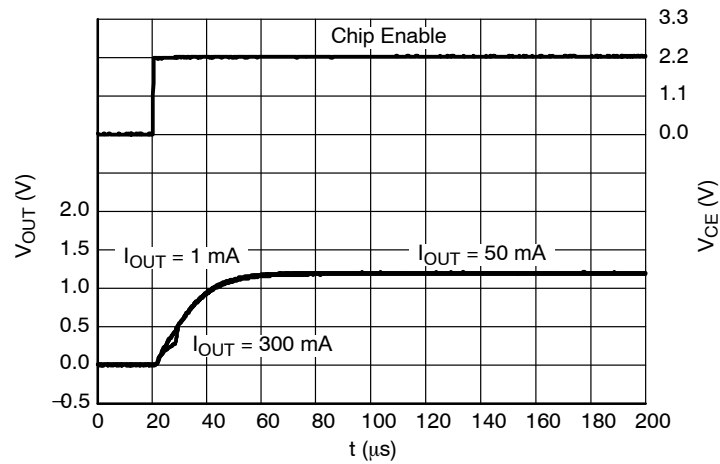


Figure 80. Start-up, 1.2 V Version,  $V_{IN} = 2.2$  V

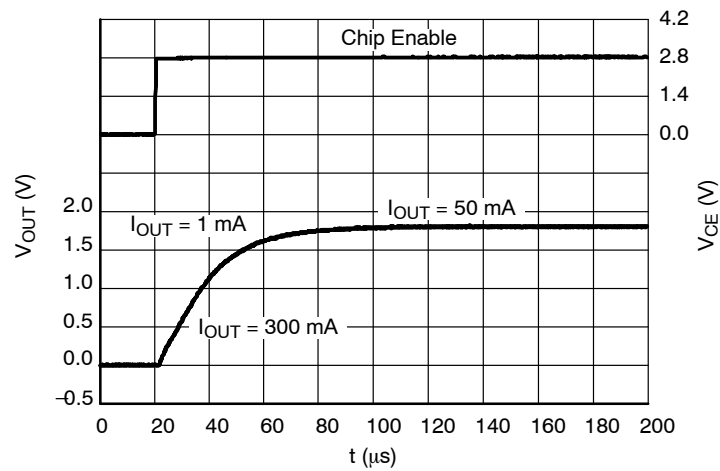


Figure 81. Start-up, 1.8 V Version,  $V_{IN} = 2.8$  V

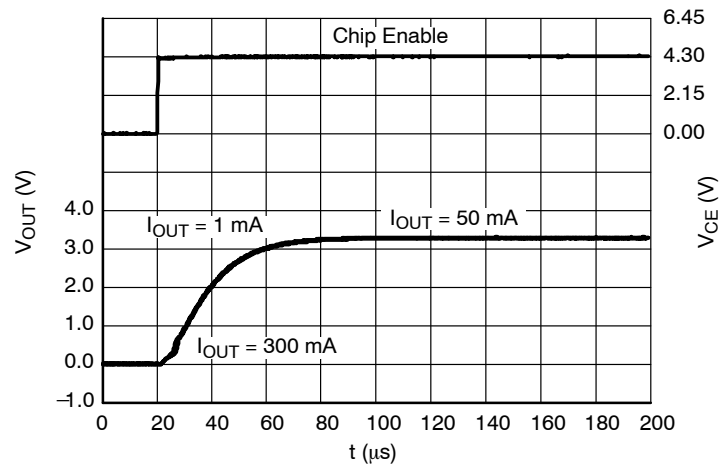


Figure 82. Start-up, 3.3 V Version,  $V_{IN} = 4.3$  V

TYPICAL CHARACTERISTICS

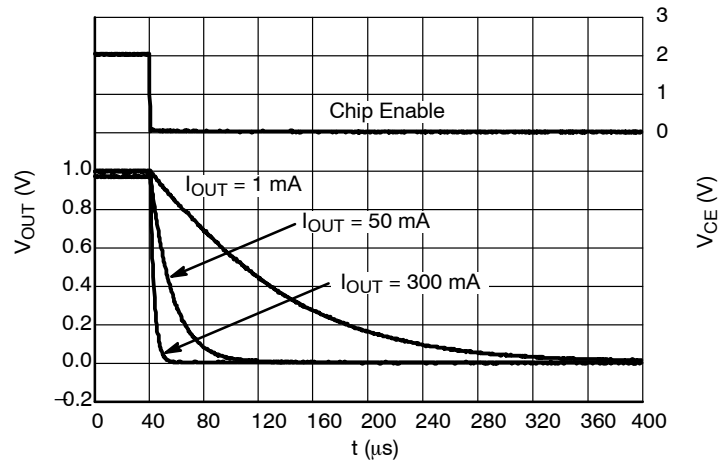


Figure 83. Shutdown, 1.0 V Version D,  
 $V_{IN} = 2.0 \text{ V}$

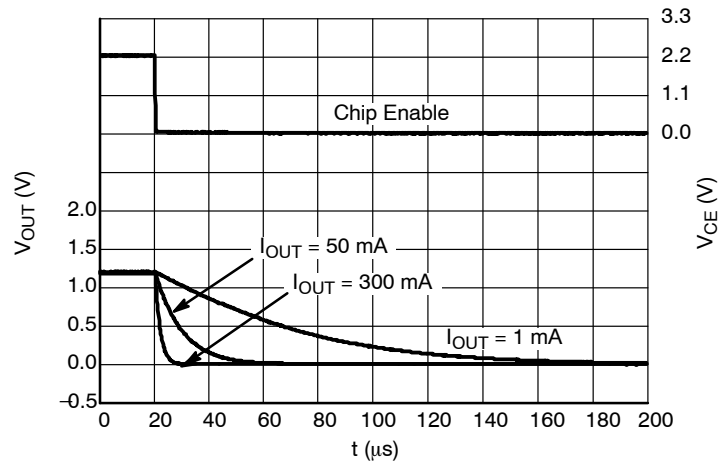


Figure 84. Shutdown, 1.2 V Version D,  
 $V_{IN} = 2.2 \text{ V}$

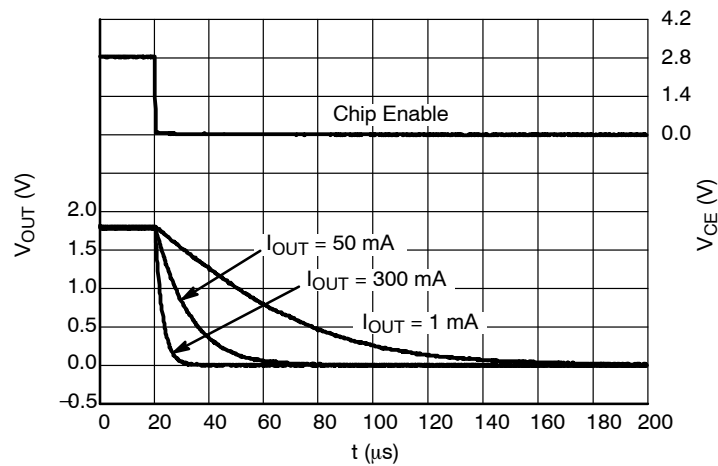


Figure 85. Shutdown, 1.8 V Version D,  
 $V_{IN} = 2.8 \text{ V}$

## TYPICAL CHARACTERISTICS

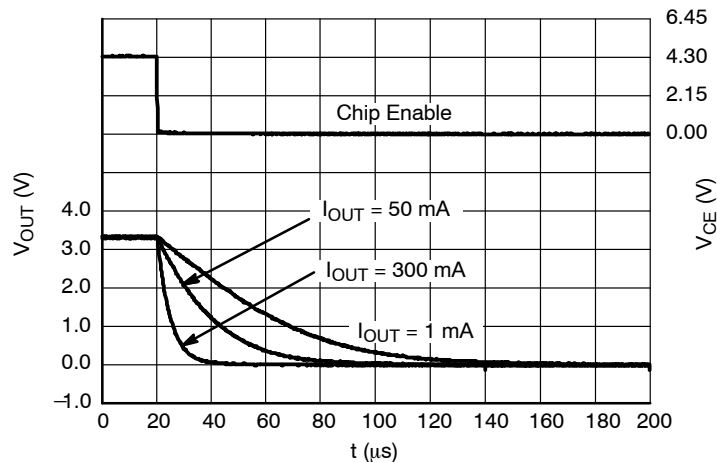


Figure 86. Shutdown, 3.3 V Version D,  
 $V_{IN} = 4.3 \text{ V}$

## APPLICATION INFORMATION

A typical application circuit for NCP4589 series is shown in Figure 87.

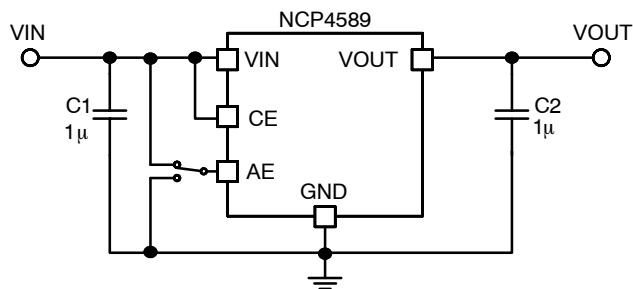


Figure 87. Typical Application Schematic

**Input Decoupling Capacitor (C1)**

A 1  $\mu\text{F}$  ceramic input decoupling capacitor should be connected as close as possible to the input and ground pin of the NCP4589. Higher values and lower ESR improves line transient response.

**Output Decoupling Capacitor (C2)**

A 1  $\mu\text{F}$  ceramic output decoupling capacitor is sufficient to achieve stable operation of the IC. If tantalum capacitor is used, and its ESR is high, the loop oscillation may result. If output capacitor is composed from few ceramic capacitors in parallel, the operation can be unstable. The capacitor should be connected as close as possible to the output and ground pin. Larger values and lower ESR improves dynamic parameters.

**Enable Operation**

The enable pin CE may be used for turning the regulator on and off. The regulator is switched on when CE pin voltage is above logic high level. The enable pin has internal pull

down current source. If enable function is not needed connect CE pin to  $V_{IN}$ .

**Current Limit**

This regulator includes fold-back type current limit circuit. This type of protection doesn't limit current up to current capability in normal operation, but when over current occurs, the output voltage and current decrease until the over current condition ends. Typical characteristics of this protection type can be observed in the Output Voltage versus Output Current graphs shown in the typical characteristics chapter of this datasheet.

**Output Discharger**

The D version includes a transistor between  $V_{OUT}$  and GND that is used for faster discharging of the output capacitor. This function is activated when the IC goes into disable mode.

**Auto ECO and Fast Mode**

The NCP4589 has two operation modes that have impact on supply current and transient response at low output current. These two modes can be selected by AE pin. If AE pin is at low level Auto ECO mode is available. Please, see supply current vs. output current charts.

**Thermal**

As power across the IC increases, it might become necessary to provide some thermal relief. The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material, and also the ambient temperature affect the rate of temperature rise for the part. That is to say, when the device has good thermal

## NCP4589

conductivity through the PCB, the junction temperature will be relatively low with high power dissipation applications.

capacitors C1 and C2 as close as possible to the IC, and make wiring as short as possible.

### PCB layout

Make  $V_{IN}$  and GND line sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect

### ORDERING INFORMATION

| Device          | Nominal Output Voltage | Description    | Marking | Package            | Shipping <sup>†</sup> |
|-----------------|------------------------|----------------|---------|--------------------|-----------------------|
| NCP4589DSQ12T1G | 1.2 V                  | Auto discharge | D012    | SC-70 (Pb-Free)    | 3000 / Tape & Reel    |
| NCP4589DSQ18T1G | 1.8 V                  | Auto discharge | D018    | SC-70 (Pb-Free)    | 3000 / Tape & Reel    |
| NCP4589DSQ25T1G | 2.5 V                  | Auto discharge | D025    | SC-70 (Pb-Free)    | 3000 / Tape & Reel    |
| NCP4589DSQ30T1G | 3.0 V                  | Auto discharge | D030    | SC-70 (Pb-Free)    | 3000 / Tape & Reel    |
| NCP4589DSQ33T1G | 3.3 V                  | Auto discharge | D033    | SC-70 (Pb-Free)    | 3000 / Tape & Reel    |
| NCP4589DSN12T1G | 1.2 V                  | Auto discharge | P1E     | SOT-23-5 (Pb-Free) | 3000 / Tape & Reel    |
| NCP4589DSN18T1G | 1.8 V                  | Auto discharge | P1L     | SOT-23-5 (Pb-Free) | 3000 / Tape & Reel    |
| NCP4589DSN25T1G | 2.5 V                  | Auto discharge | P1T     | SOT-23-5 (Pb-Free) | 3000 / Tape & Reel    |
| NCP4589DSN30T1G | 3.0 V                  | Auto discharge | P1Y     | SOT-23-5 (Pb-Free) | 3000 / Tape & Reel    |
| NCP4589DSN33T1G | 3.3 V                  | Auto discharge | Q1B     | SOT-23-5 (Pb-Free) | 3000 / Tape & Reel    |
| NCP4589DMX12TCG | 1.2 V                  | Auto discharge | 7E      | XDFN (Pb-Free)     | 5000 / Tape & Reel    |
| NCP4589DMX18TCG | 1.8 V                  | Auto discharge | 7L      | XDFN (Pb-Free)     | 5000 / Tape & Reel    |
| NCP4589DMX28TCG | 2.8 V                  | Auto discharge | 7W      | XDFN (Pb-Free)     | 5000 / Tape & Reel    |
| NCP4589DMX30TCG | 3.0 V                  | Auto discharge | 7Y      | XDFN (Pb-Free)     | 5000 / Tape & Reel    |
| NCP4589DMX33TCG | 3.3 V                  | Auto discharge | 8B      | XDFN (Pb-Free)     | 5000 / Tape & Reel    |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

NOTE: To order other package and voltage variants, please contact your ON Semiconductor sales representative.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



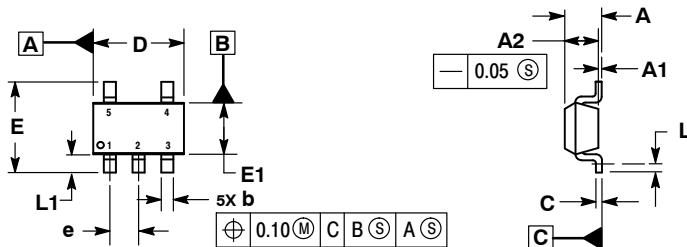
SCALE 2:1

### SOT-23 5-LEAD

#### CASE 1212-01

#### ISSUE A

DATE 28 JAN 2011

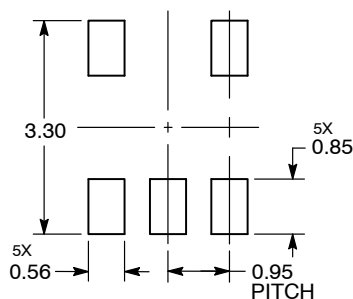


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSIONS: MILLIMETERS.
3. DATUM C IS THE SEATING PLANE.

| MILLIMETERS |          |      |
|-------------|----------|------|
| DIM         | MIN      | MAX  |
| A           | ---      | 1.45 |
| A1          | 0.00     | 0.10 |
| A2          | 1.00     | 1.30 |
| b           | 0.30     | 0.50 |
| c           | 0.10     | 0.25 |
| D           | 2.70     | 3.10 |
| E           | 2.50     | 3.10 |
| E1          | 1.50     | 1.80 |
| e           | 0.95 BSC |      |
| L           | 0.20     | ---  |
| L1          | 0.45     | 0.75 |

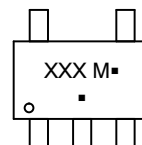
### RECOMMENDED SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

### GENERIC MARKING DIAGRAM\*



XXX = Specific Device Code

M = Date Code

▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

|                  |               |                                                                                                                                                                                  |
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| DESCRIPTION:     | SOT-23 5-LEAD | PAGE 1 OF 1                                                                                                                                                                      |

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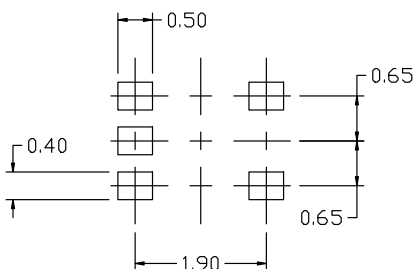
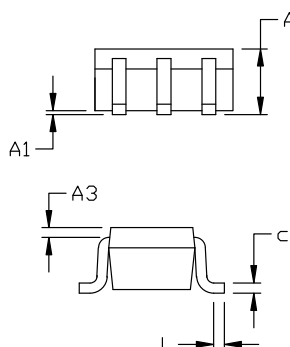
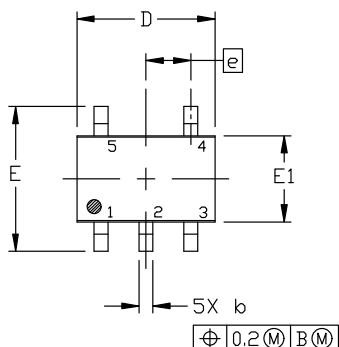
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

## SC-88A (SC-70-5/SOT-353) CASE 419A-02 ISSUE M

DATE 11 APR 2023



### RECOMMENDED MOUNTING FOOTPRINT

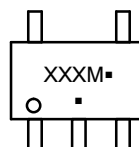
\* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.1016MM PER SIDE.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.80        | 0.95 | 1.10 |
| A1  | ---         | ---  | 0.10 |
| A3  | 0.20 REF    |      |      |
| b   | 0.10        | 0.20 | 0.30 |
| c   | 0.10        | ---  | 0.25 |
| D   | 1.80        | 2.00 | 2.20 |
| E   | 2.00        | 2.10 | 2.20 |
| E1  | 1.15        | 1.25 | 1.35 |
| e   | 0.65 BSC    |      |      |
| L   | 0.10        | 0.15 | 0.30 |

### GENERIC MARKING DIAGRAM\*



\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

XXX = Specific Device Code

M = Date Code

▪ = Pb-Free Package

(Note: Microdot may be in either location)

#### STYLE 1:

- PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR
5. COLLECTOR

#### STYLE 2:

- PIN 1. ANODE
2. EMITTER
3. BASE
4. COLLECTOR
5. CATHODE

#### STYLE 3:

- PIN 1. ANODE 1
2. N/C
3. ANODE 2
4. CATHODE 2
5. CATHODE 1

#### STYLE 4:

- PIN 1. SOURCE 1
2. DRAIN 1/2
3. SOURCE 1
4. GATE 1
5. GATE 2

#### STYLE 5:

- PIN 1. CATHODE
2. COMMON ANODE
3. CATHODE 2
4. CATHODE 3
5. CATHODE 4

#### STYLE 6:

- PIN 1. EMITTER 2
2. BASE 2
3. EMITTER 1
4. COLLECTOR
5. COLLECTOR 2/BASE 1

#### STYLE 7:

- PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR
5. COLLECTOR

#### STYLE 8:

- PIN 1. CATHODE
2. COLLECTOR
3. N/C
4. BASE
5. EMITTER

#### STYLE 9:

- PIN 1. ANODE
2. CATHODE
3. ANODE
4. ANODE
5. ANODE

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

|                  |                          |                                                                                                                                                                                     |
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| DESCRIPTION:     | SC-88A (SC-70-5/SOT-353) | PAGE 1 OF 1                                                                                                                                                                         |

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

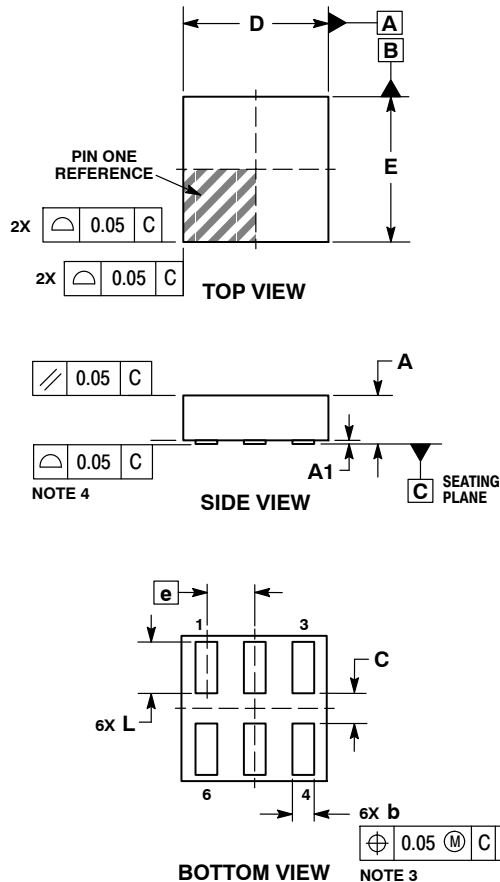
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SCALE 4:1

**XDFN6 1.2x1.2, 0.4P**  
CASE 711AA-01  
ISSUE O

DATE 12 OCT 2010



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25mm FROM TERMINAL TIPS.
4. COPLANARITY APPLIES TO ALL OF THE TERMINALS.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | ---         | 0.40 |
| A1  | 0.00        | 0.05 |
| b   | 0.13        | 0.23 |
| C   | 0.20        | 0.30 |
| D   | 1.20 BSC    |      |
| E   | 1.20 BSC    |      |
| e   | 0.40 BSC    |      |
| L   | 0.37        | 0.48 |

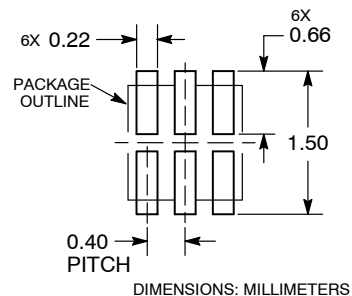
### GENERIC MARKING DIAGRAM\*



XX = Specific Device Code  
MM = Date Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

### RECOMMENDED MOUNTING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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| <b>DESCRIPTION:</b>     | <b>XDFN6, 1.2 X 1.2, 0.4 P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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