

# NCP4640

## 50 mA, Wide Input Range, Voltage Regulator

The NCP4640 is a CMOS 50 mA linear voltage regulator with high input voltage and ultra-low supply current. It incorporates multiple protection features such as peak current limit, short circuit current limit and thermal shutdown to ensure a very robust device.

A high maximum input voltage tolerance of 50 V and a wide temperature range make the NCP4640 suitable for a variety of demanding applications.

### Features

- Operating Input Voltage Range: 4 V to 36 V
- Output Voltage Range: 2.0 to 12.0 V (0.1 steps)
- $\pm 2\%$  Output Voltage Accuracy
- Output Current: min 50 mA ( $V_{IN} = 8\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ )
- Line Regulation: 0.05%/V
- Peak Current Limit Circuit
- Short Current Limit Circuit
- Thermal Shutdown Circuit
- Available in SOT-89-5 and SOIC6-TL Package
- These are Pb-Free Devices

### Typical Applications

- Power source for home appliances
- Power source for car audio equipment, navigation system
- Power source for notebooks, digital TVs, cordless phones and private LAN systems
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, projectors, etc.

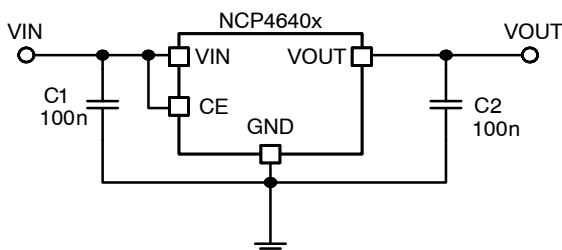


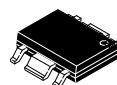
Figure 1. Typical Application Schematic



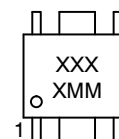
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<http://onsemi.com>

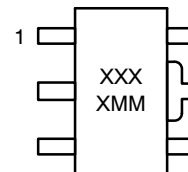
### MARKING DIAGRAMS



**SOIC6-TL  
CASE 751BR**



**SOT-89 5  
CASE 528AB**



XXXX = Specific Device Code  
MM = Date Code

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 15 of this data sheet.

# NCP4640

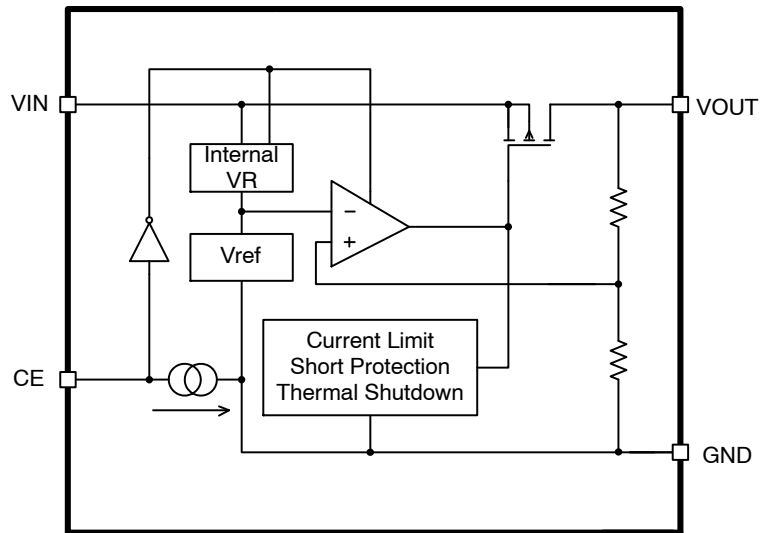


Figure 2. Simplified Schematic Block Diagram

## PIN FUNCTION DESCRIPTION

| Pin No.<br>SOT89 | Pin No.<br>SOIC6-TL | Pin Name | Description                                                                        |
|------------------|---------------------|----------|------------------------------------------------------------------------------------|
| 5                | 6                   | VIN      | Input pin                                                                          |
| 2                | 2                   | GND      | Ground pin, all ground pins must be connected together when it is mounted on board |
| 4                | 4                   | GND      | Ground pin, all ground pins must be connected together when it is mounted on board |
| –                | 5                   | GND      | Ground pin, all ground pins must be connected together when it is mounted on board |
| 3                | 3                   | CE       | Chip enable pin ("H" active)                                                       |
| 1                | 1                   | VOUT     | Output pin                                                                         |

# NCP4640

## ABSOLUTE MAXIMUM RATINGS

| Rating                                    | Symbol      | Value                          | Unit |
|-------------------------------------------|-------------|--------------------------------|------|
| Input Voltage                             | $V_{IN}$    | -0.3 to 50                     | V    |
| Peak Input Voltage (Note 1)               | $V_{IN}$    | 60                             | V    |
| Output Voltage                            | $V_{OUT}$   | -0.3 to $V_{IN} + 0.3 \leq 50$ | V    |
| Chip Enable Input                         | $V_{CE}$    | -0.3 to $V_{IN} + 0.3 \leq 50$ | V    |
| Output Current                            | $I_{OUT}$   | 150                            | mA   |
| Power Dissipation SOT-89                  | $P_D$       | 900                            | mW   |
| Power Dissipation SOIC6-TL                |             | 1700                           |      |
| Junction Temperature                      | $T_J$       | -40 to 150                     | °C   |
| Storage Temperature                       | $T_{STG}$   | -55 to 125                     | °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.

1. Duration time = 200 ms

2. 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, SOT-89<br>Thermal Resistance, Junction-to-Air   | $R_{\theta JA}$ | 111   | °C/W |
| Thermal Characteristics, SOIC6-TL<br>Thermal Resistance, Junction-to-Air | $R_{\theta JA}$ | 59    | °C/W |

# NCP4640

## ELECTRICAL CHARACTERISTICS $T_A = 25^\circ\text{C}$

| Parameter                            | Test Conditions                                                                                                                                  | Symbol           | Min           | Typ       | Max           | Unit                  |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------|-----------|---------------|-----------------------|
| Operating Input Voltage              |                                                                                                                                                  | $V_{IN}$         | 4             |           | 36            | V                     |
| Output Voltage                       | $V_{IN} = V_{OUT} + 3\text{ V}$ , $I_{OUT} = 1\text{ mA}$                                                                                        | $V_{OUT}$        | $\times 0.98$ |           | $\times 1.02$ | V                     |
| Output Voltage Temp. Coefficient     | $V_{IN} = V_{OUT} + 3\text{ V}$ , $I_{OUT} = 1\text{ mA}$ , $T_A = -40$ to $105^\circ\text{C}$                                                   |                  |               | $\pm 100$ |               | ppm/ $^\circ\text{C}$ |
| Line Regulation                      | $V_{IN} = V_{OUT} + 1.5\text{ V}$ to $36\text{ V}$ , $I_{OUT} = 1\text{ mA}$                                                                     | $\text{LineReg}$ |               | 0.05      | 0.20          | %/V                   |
| Load Regulation                      | $V_{IN} = V_{OUT} + 3\text{ V}$ , $I_{OUT} = 1\text{ mA}$ to $40\text{ mA}$                                                                      | $\text{LoadReg}$ |               | 10        | 25            | mV                    |
|                                      |                                                                                                                                                  |                  |               | 20        | 35            |                       |
| Dropout Voltage                      | $I_{OUT} = 20\text{ mA}$                                                                                                                         | $V_{DO}$         |               |           | (Note 3)      | V                     |
|                                      |                                                                                                                                                  |                  |               |           |               |                       |
|                                      |                                                                                                                                                  |                  |               |           |               |                       |
|                                      |                                                                                                                                                  |                  |               |           |               |                       |
| Output Current                       | $V_{IN} = V_{OUT} + 3\text{ V}$                                                                                                                  | $I_{OUT}$        | 50            |           |               | mA                    |
| Short Current Limit                  | $V_{OUT} = 0\text{ V}$                                                                                                                           | $I_{SC}$         |               | 50        |               | mA                    |
| Quiescent Current                    | $V_{IN} = V_{OUT} + 3\text{ V}$ , $I_{OUT} = 0\text{ mA}$                                                                                        | $I_Q$            |               | 9         | 20            | $\mu\text{A}$         |
| Standby Current                      | $V_{IN} = 36\text{ V}$ , $V_{CE} = 0\text{ V}$                                                                                                   | $I_{STB}$        |               | 0.1       | 1             | $\mu\text{A}$         |
| CE Pin Threshold Voltage             | CE Input Voltage "H"                                                                                                                             | $V_{CEH}$        | 1.5           |           | $V_{IN}$      | V                     |
|                                      | CE Input Voltage "L"                                                                                                                             | $V_{CEL}$        | 0             |           | 0.3           |                       |
| Thermal Shutdown Temperature         |                                                                                                                                                  | $T_{SD}$         |               | 150       |               | $^\circ\text{C}$      |
| Thermal Shutdown Release Temperature |                                                                                                                                                  | $T_{SR}$         |               | 125       |               | $^\circ\text{C}$      |
| Power Supply Rejection Ratio         | $V_{IN} = 5.0\text{ V}$ , $V_{OUT} = 2.0\text{ V}$ , $\Delta V_{IN\text{ PK-PK}} = 0.2\text{ V}$ , $I_{OUT} = 30\text{ mA}$ , $f = 1\text{ kHz}$ | PSRR             |               | 30        |               | dB                    |
| Output Noise Voltage                 | $V_{OUT} = 2.0\text{ V}$ , $I_{OUT} = 30\text{ mA}$ , $f = 10\text{ Hz}$ to $100\text{ kHz}$                                                     | $V_N$            |               | 80        |               | $\mu\text{V}_{rms}$   |

3. Dropout voltage for  $2.0\text{ V} \leq V_{OUT} < 3.7\text{ V}$  can be computed by this formula:  $V_{DO} = 4\text{ V} - V_{OUTSET}$

TYPICAL CHARACTERISTICS

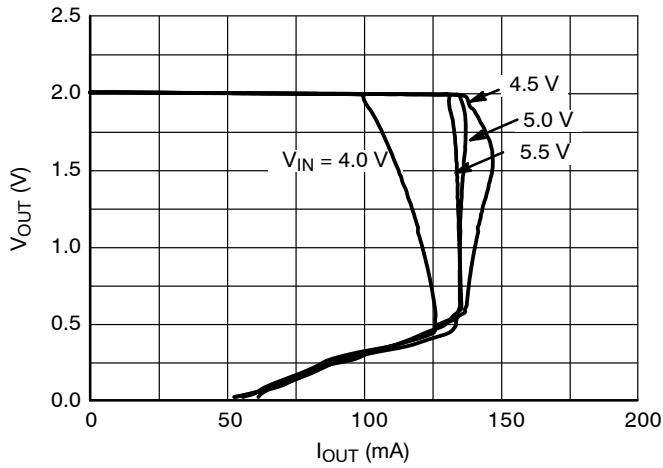


Figure 3. Output Voltage vs. Output Current  
2.0 V Version ( $T_J = 25^\circ\text{C}$ )

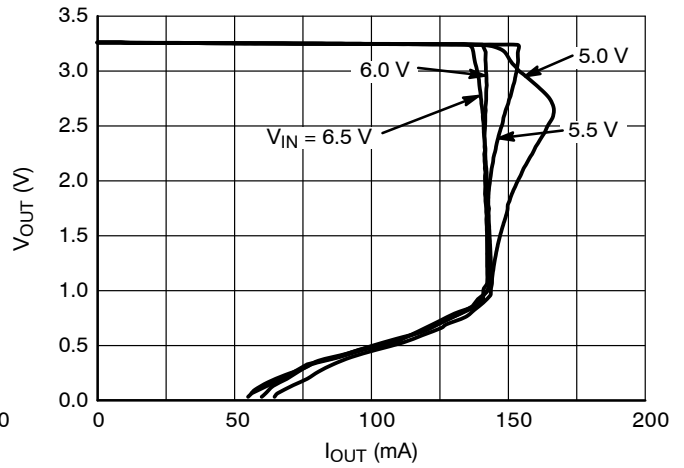


Figure 4. Output Voltage vs. Output Current  
3.3 V Version ( $T_J = 25^\circ\text{C}$ )

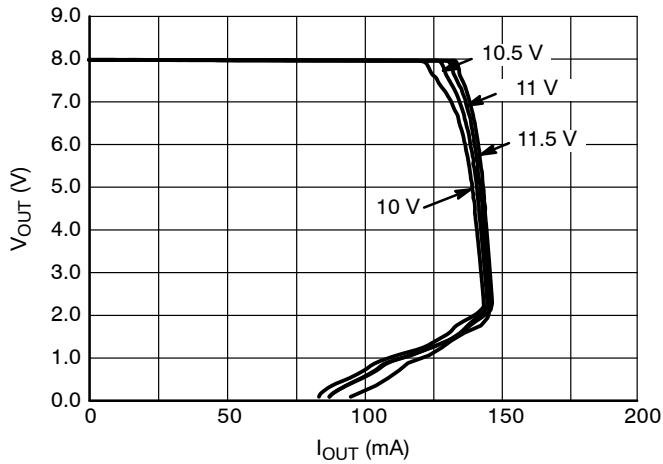


Figure 5. Output Voltage vs. Output Current  
8.0 V Version ( $T_J = 25^\circ\text{C}$ )

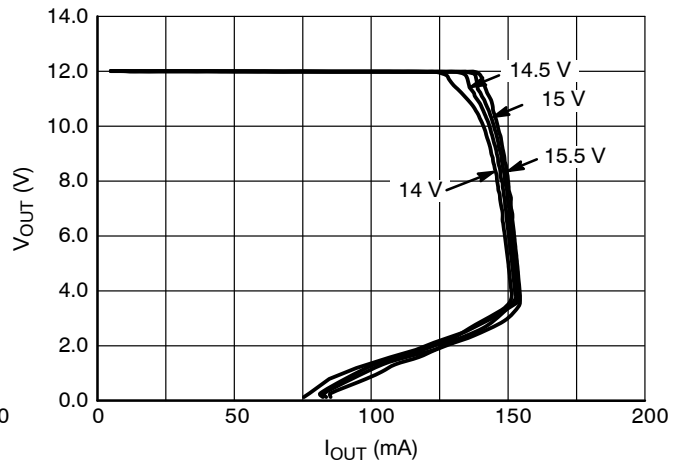


Figure 6. Output Voltage vs. Output Current  
12 V Version ( $T_J = 25^\circ\text{C}$ )

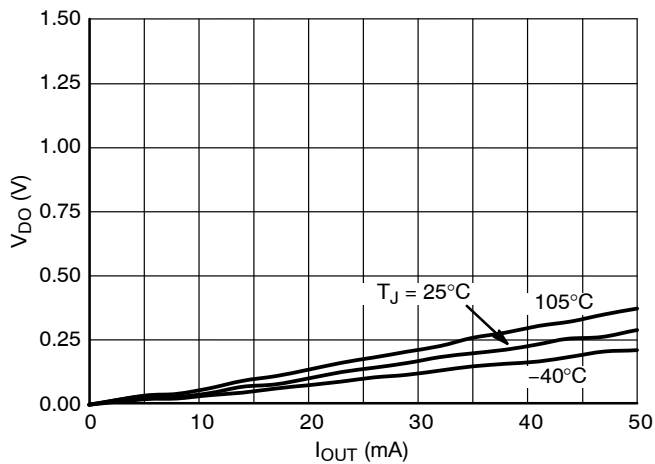


Figure 7. Dropout Voltage vs. Output Current  
8.0 V Version

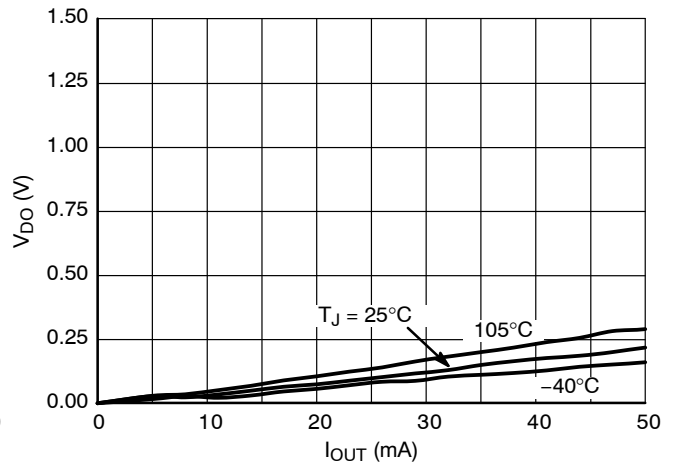


Figure 8. Dropout Voltage vs. Output Current  
12 V Version

TYPICAL CHARACTERISTICS

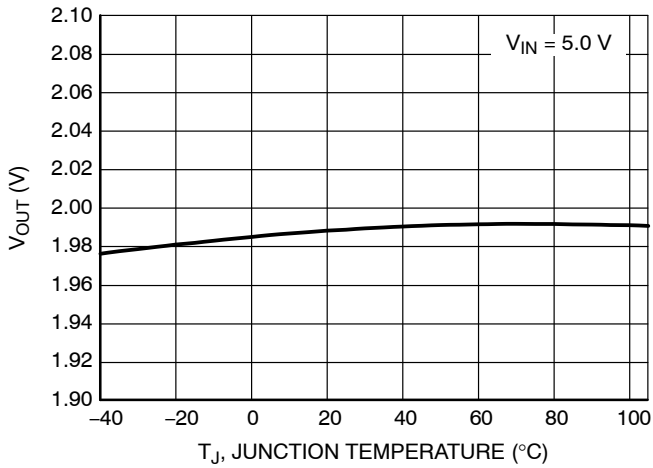


Figure 9. Output Voltage vs. Temperature, 2.0 V Version

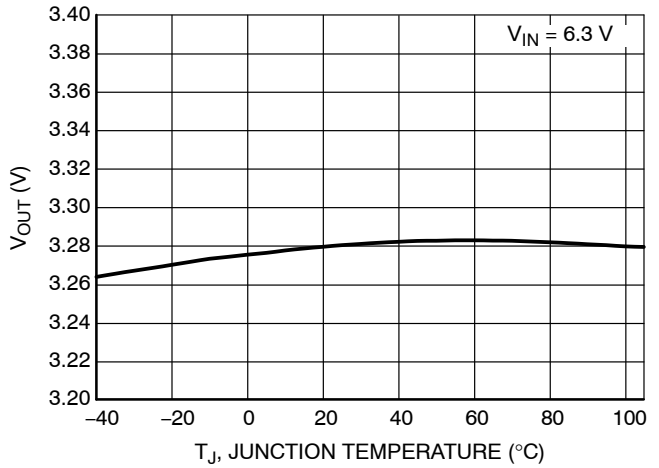


Figure 10. Output Voltage vs. Temperature, 3.3 V Version

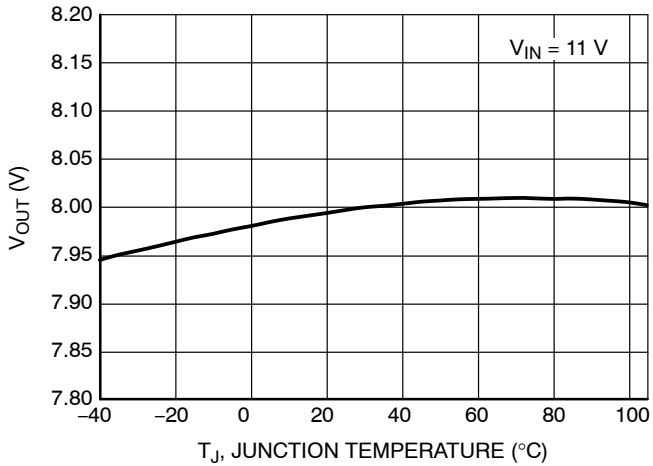


Figure 11. Output Voltage vs. Temperature, 8.0 V Version

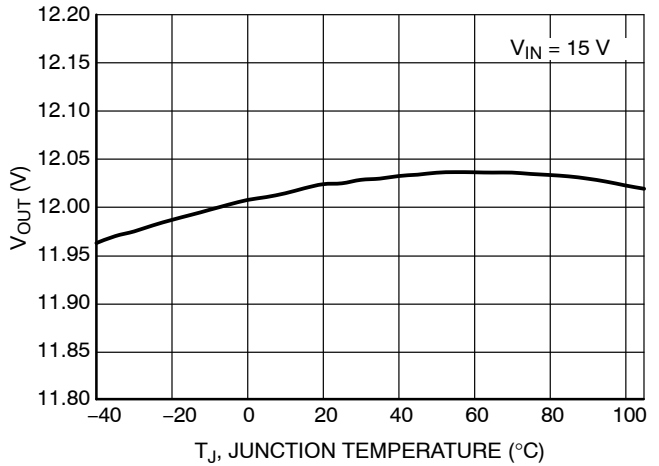


Figure 12. Output Voltage vs. Temperature, 12 V Version

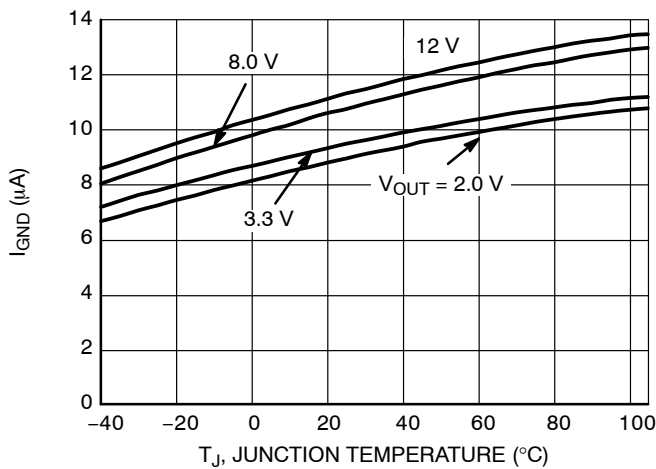


Figure 13. Supply Current vs. Temperature

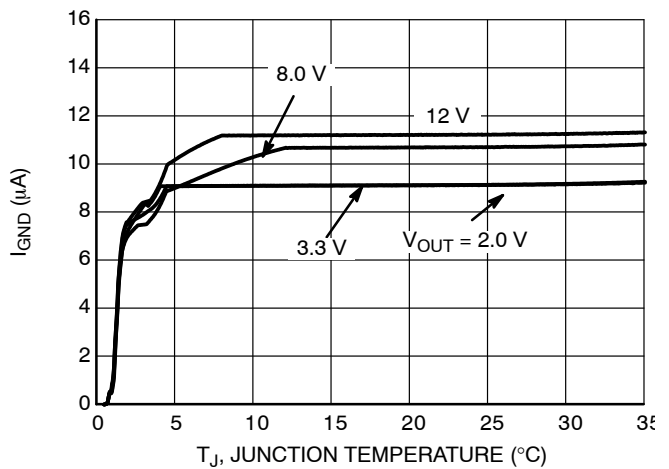


Figure 14. Supply Current vs. Input Voltage

TYPICAL CHARACTERISTICS

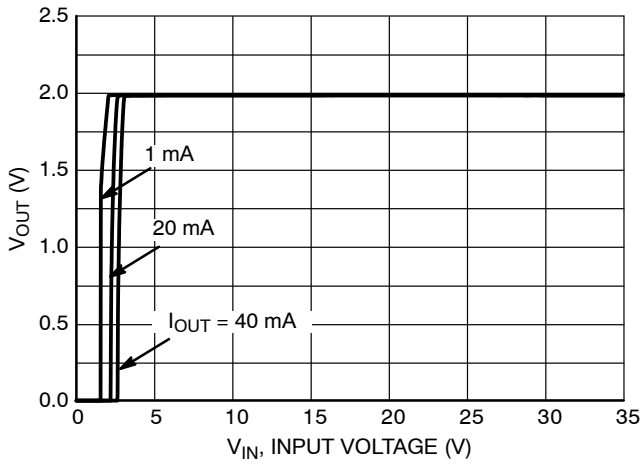


Figure 15. Output Voltage vs. Input Voltage, 2.0 V Version

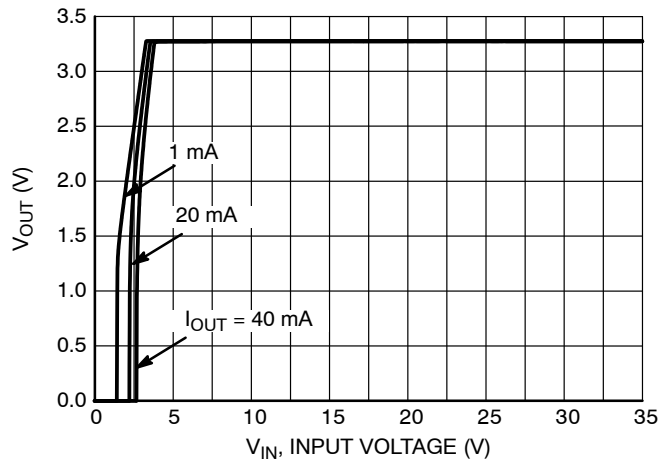


Figure 16. Output Voltage vs. Input Voltage, 3.3 V Version

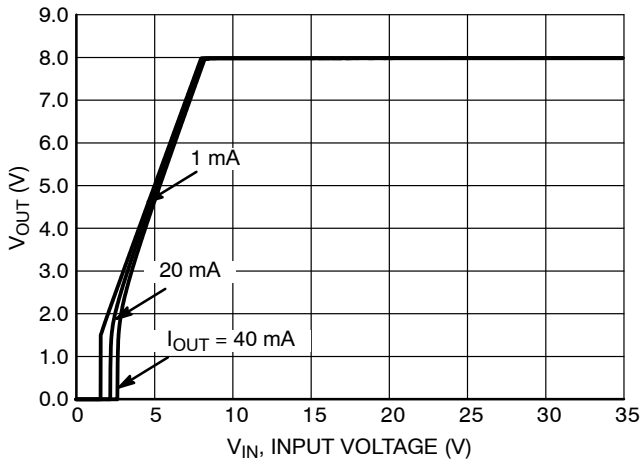


Figure 17. Output Voltage vs. Input Voltage, 8.0 V Version

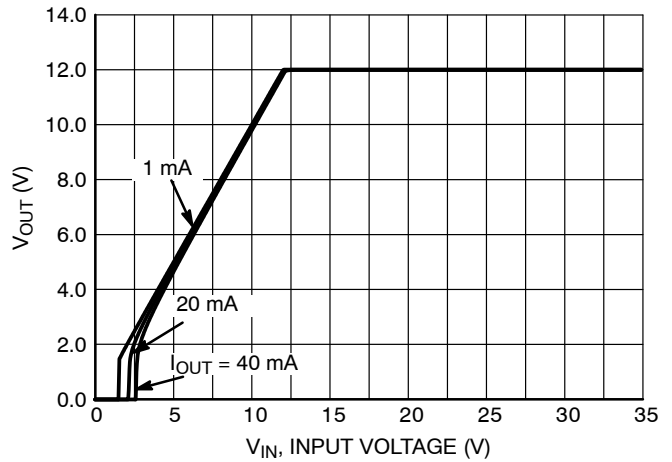


Figure 18. Output Voltage vs. Input Voltage, 12 V Version

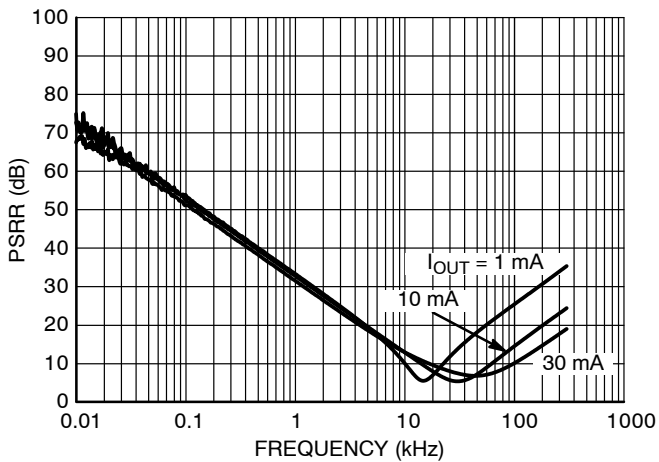


Figure 19. PSRR, 2.0 V Version,  $V_{IN} = 5.0$  V

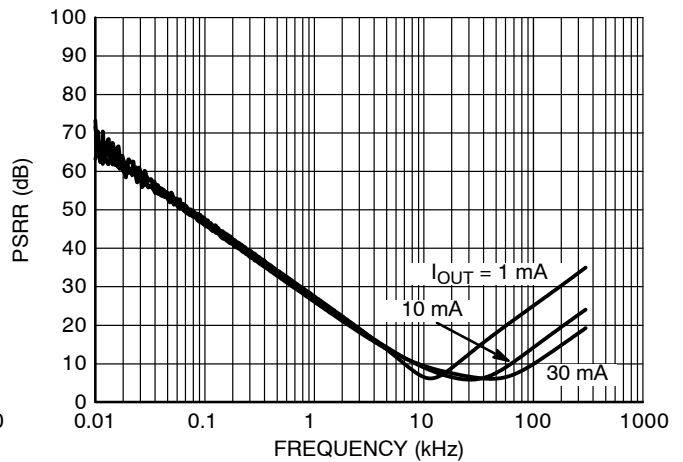


Figure 20. PSRR, 3.3 V Version,  $V_{IN} = 6.3$  V

TYPICAL CHARACTERISTICS

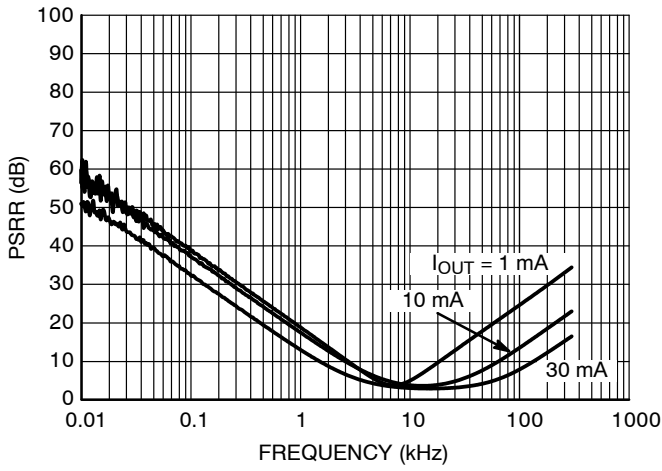


Figure 21. PSRR, 3.3 V Version,  $V_{IN} = 6.3\text{ V}$

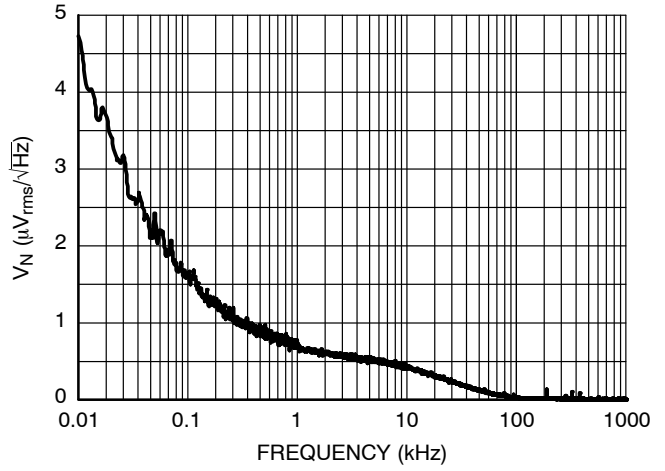


Figure 22. Output Voltage Noise, 2.0 V Version,  $V_{IN} = 5.0\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

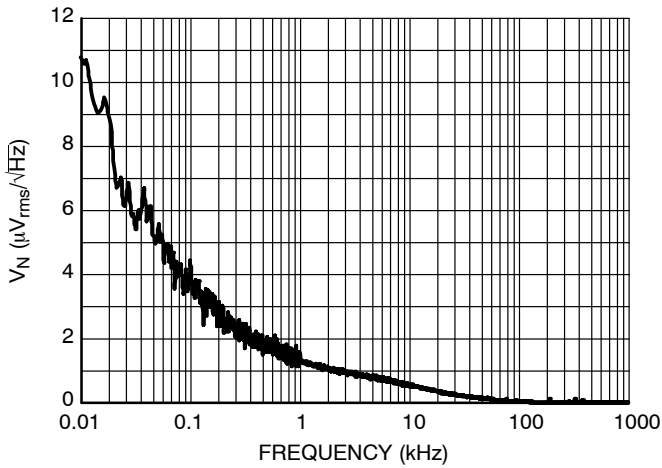


Figure 23. Output Voltage Noise, 3.3 V Version,  $V_{IN} = 6.3\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

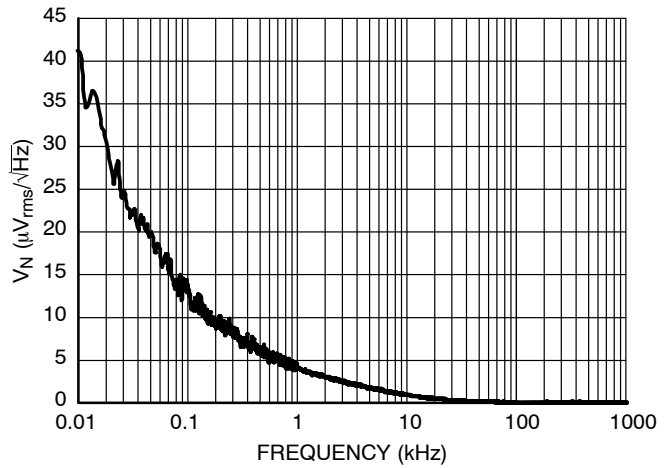


Figure 24. Output Voltage Noise, 8.0 V Version,  $V_{IN} = 11.0\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

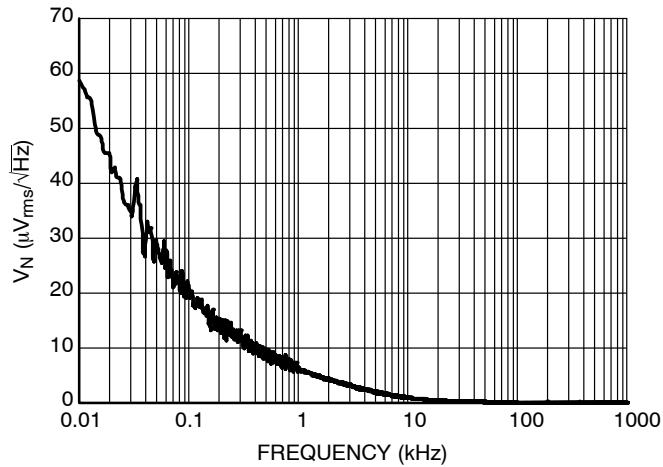


Figure 25. Output Voltage Noise, 12.0 V Version,  $V_{IN} = 15.0\text{ V}$ ,  $I_{OUT} = 30\text{ mA}$

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## TYPICAL CHARACTERISTICS

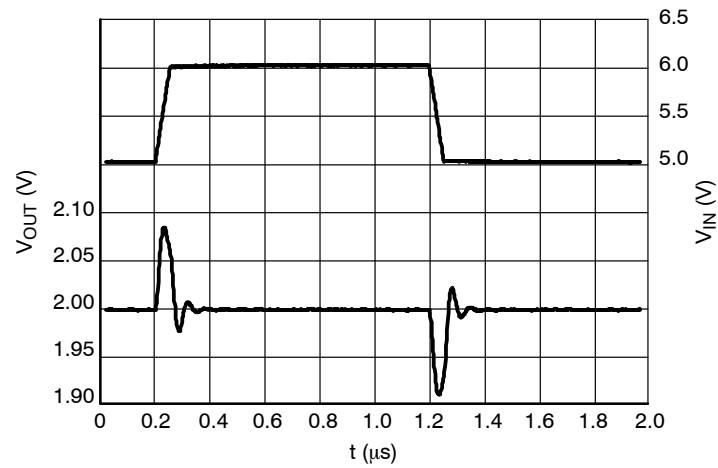


Figure 26. Line Transients, 2.0 V Version,  
 $t_R = t_F = 50 \mu$ s,  $I_{OUT} = 1$  mA

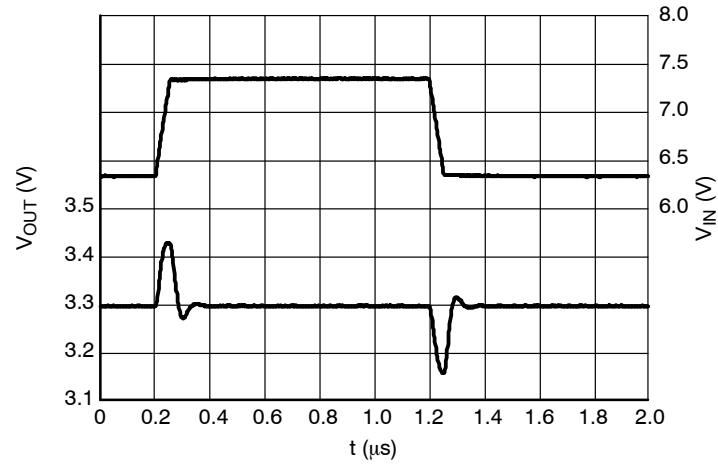


Figure 27. Line Transients, 3.3 V Version,  
 $t_R = t_F = 50 \mu$ s,  $I_{OUT} = 1$  mA

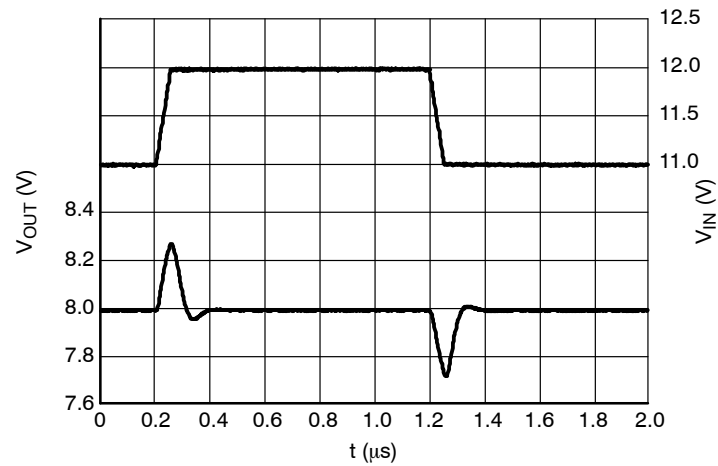


Figure 28. Line Transients, 8.0 V Version,  
 $t_R = t_F = 50 \mu$ s,  $I_{OUT} = 1$  mA

TYPICAL CHARACTERISTICS

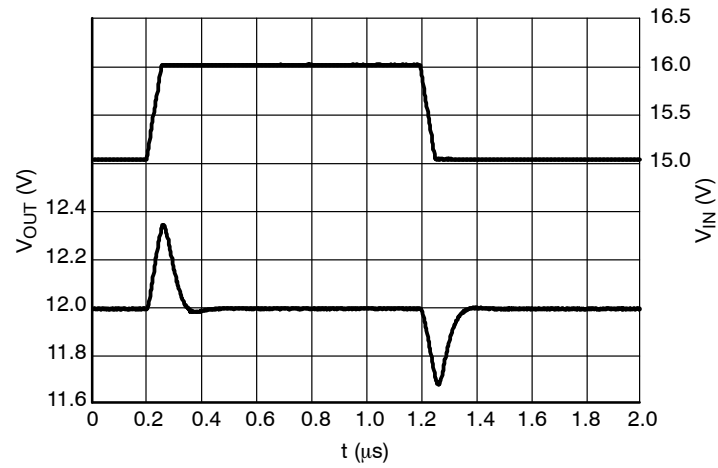


Figure 29. Line Transients, 12.0 V Version,  
 $t_R = t_F = 50 \mu s$ ,  $I_{OUT} = 1 \text{ mA}$

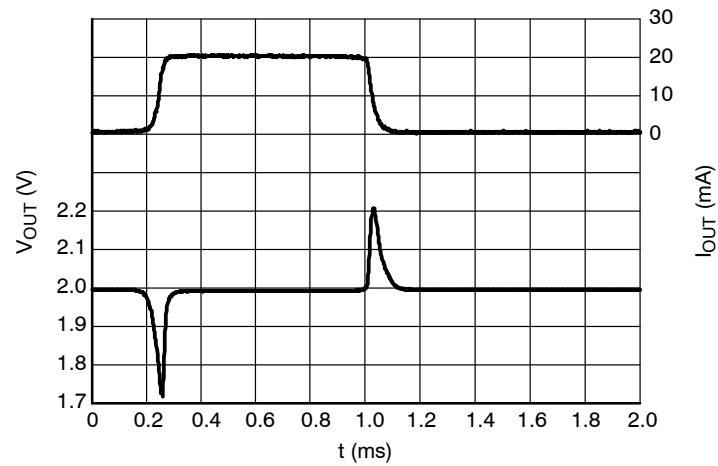


Figure 30. Load Transients, 2.0 V Version,  
 $I_{OUT} = 1 - 20 \text{ mA}$ ,  $t_R = t_F = 50 \mu s$ ,  $V_{IN} = 5.0 \text{ V}$

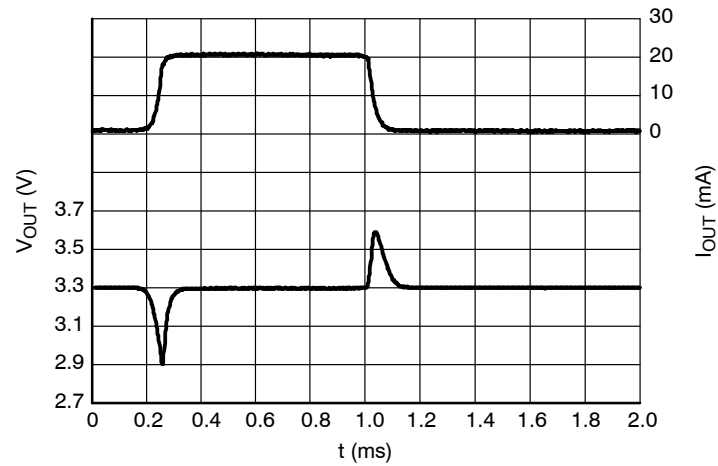
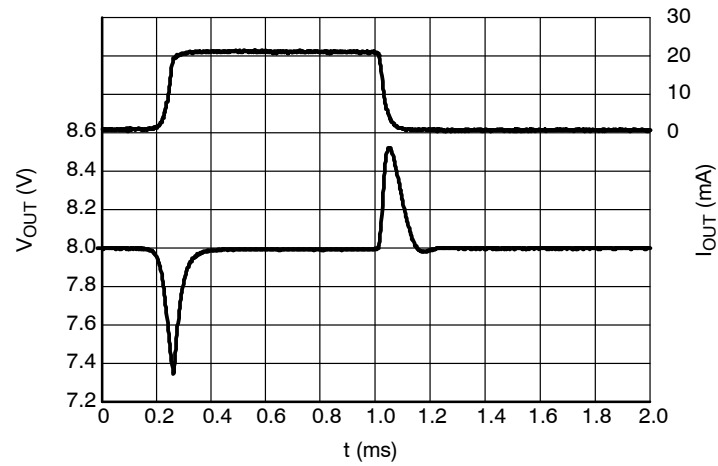


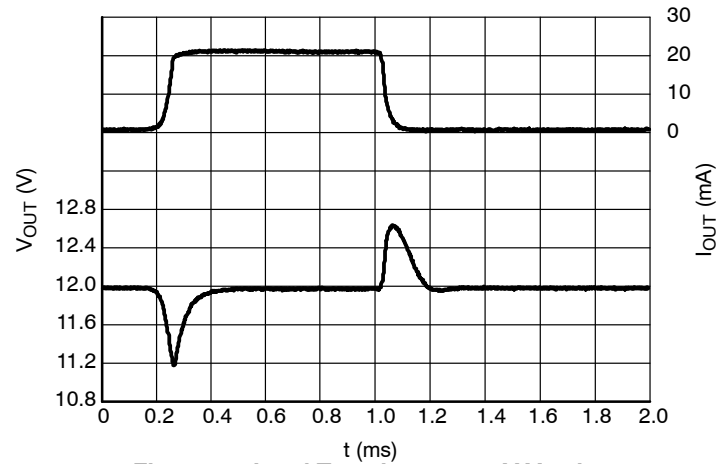
Figure 31. Load Transients, 3.3 V Version,  
 $I_{OUT} = 1 - 20 \text{ mA}$ ,  $t_R = t_F = 50 \mu s$ ,  $V_{IN} = 6.3 \text{ V}$

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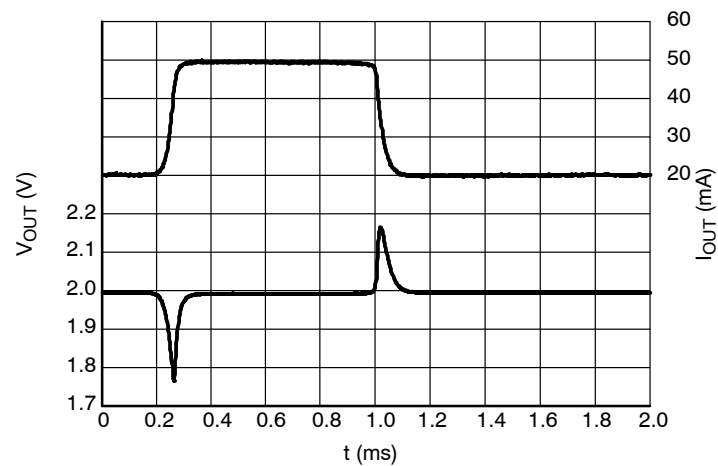
## TYPICAL CHARACTERISTICS



**Figure 32. Load Transients, 8.0 V Version,  
 $I_{OUT} = 1 - 20 \text{ mA}$ ,  $t_R = t_F = 50 \mu\text{s}$ ,  $V_{IN} = 11.0 \text{ V}$**

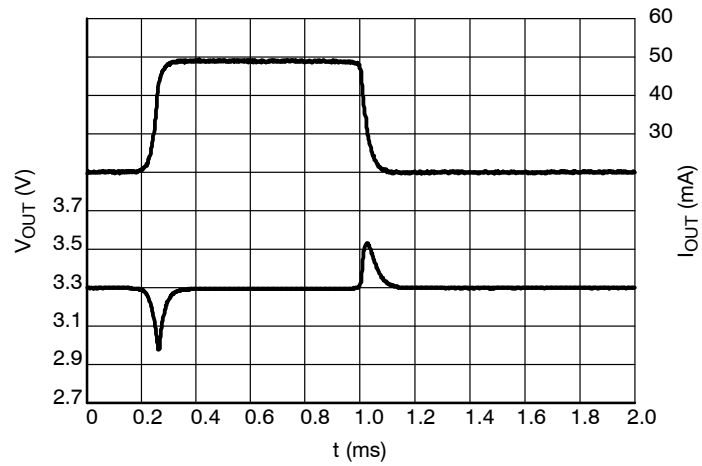


**Figure 33. Load Transients, 12.0 V Version,  
 $I_{OUT} = 1 - 20 \text{ mA}$ ,  $t_R = t_F = 50 \mu\text{s}$ ,  $V_{IN} = 15.0 \text{ V}$**

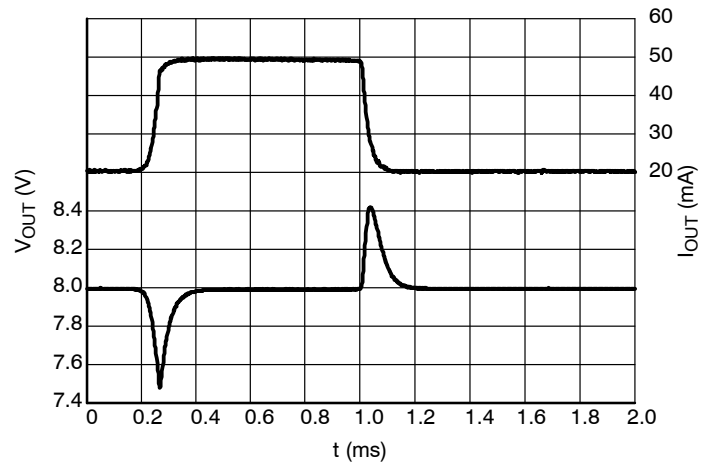


**Figure 34. Load Transients, 2.0 V Version,  
 $I_{OUT} = 20 - 50 \text{ mA}$ ,  $t_R = t_F = 50 \mu\text{s}$ ,  $V_{IN} = 5.0 \text{ V}$**

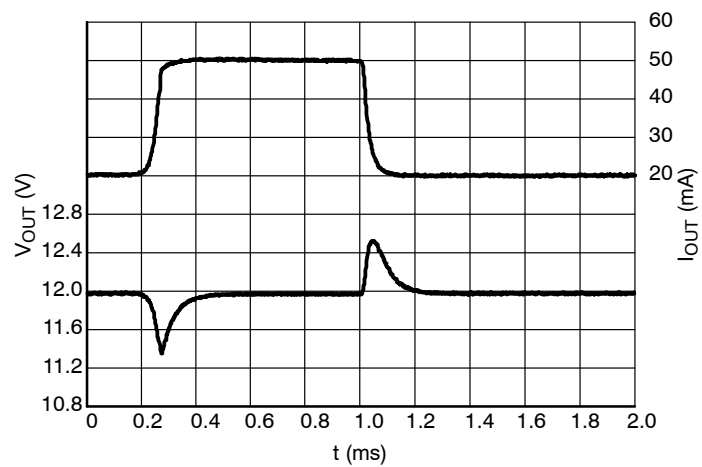
TYPICAL CHARACTERISTICS



**Figure 35. Load Transients, 3.3 V Version,  
 $I_{OUT} = 20 - 50$  mA,  $t_R = t_F = 50$   $\mu$ s,  $V_{IN} = 6.3$  V**



**Figure 36. Load Transients, 8.0 V Version,  
 $I_{OUT} = 20 - 50$  mA,  $t_R = t_F = 50$   $\mu$ s,  $V_{IN} = 11.0$  V**



**Figure 37. Load Transients, 12.0 V Version,  
 $I_{OUT} = 20 - 50$  mA,  $t_R = t_F = 50$   $\mu$ s,  $V_{IN} = 15.0$  V**

# NCP4640

## TYPICAL CHARACTERISTICS

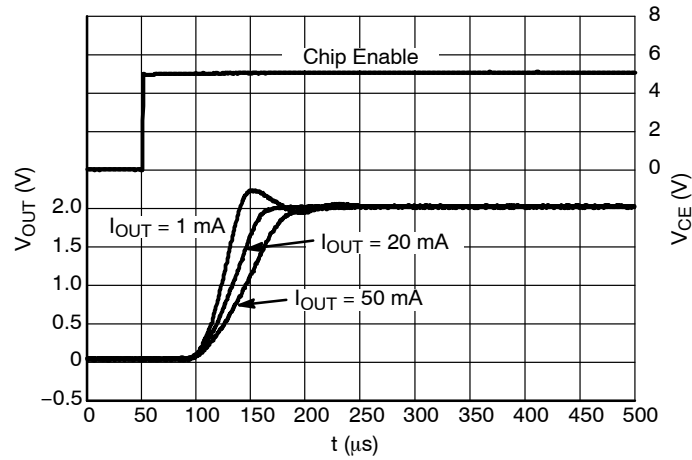


Figure 38. Start-up, 2.0 V Version,  $V_{IN} = 5.0 \text{ V}$

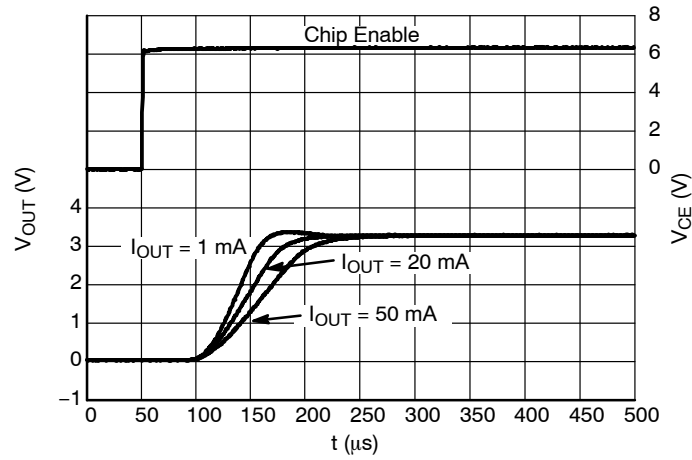


Figure 39. Start-up, 3.3 V Version,  $V_{IN} = 6.3 \text{ V}$

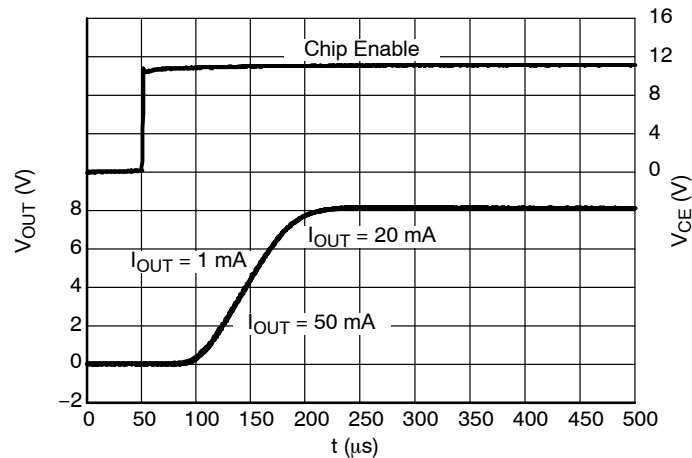


Figure 40. Start-up, 8.0 V Version,  $V_{IN} = 11.0 \text{ V}$

# NCP4640

## TYPICAL CHARACTERISTICS

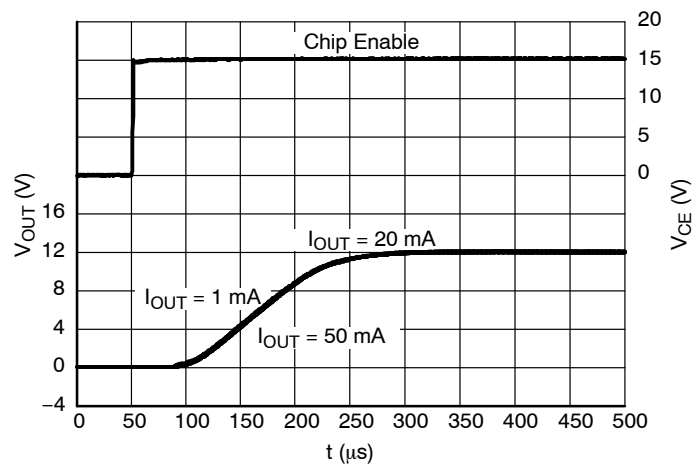


Figure 41. Start-up, 12.0 V Version,  $V_{\text{IN}} = 15.0 \text{ V}$

## APPLICATION INFORMATION

A typical application circuit for NCP4640 series is shown in Figure 42.

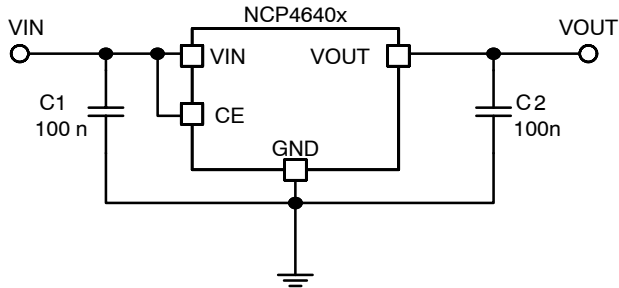


Figure 42. Typical Application Schematic

### Input Decoupling Capacitor (C1)

The device is stable without any input capacitance, but if input line is long and has high impedance or if more stable operation is needed, input capacitor C1 should be connected as close as possible to the IC. Recommended range of input capacitor value is 100 nF to 10  $\mu$ F.

### Output Decoupling Capacitor (C2)

The NCP4641 can work stable without output capacitor, but if faster response and higher stability reserve is needed, output capacitor should be connected as close as possible to the device. Recommended range of output capacitance is 100 nF to 10  $\mu$ F. Larger values of output capacitance and lower ESR improves dynamic parameters.

### Enable Operation

The enable pin CE may be used for turning the regulator on and off. The device is activated when high level is

connected to CE pin. Do not keep CE pin not connected or between VCEH and VCEL voltage levels. Otherwise output voltage would be unstable or indefinite and unexpected would flow internally.

### Thermal

As a power across the IC increase, 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 increase for the part. When the device has good thermal conductivity through the PCB the junction temperature will be relatively low in high power dissipation applications.

The IC includes internal thermal shutdown circuit that stops operation of regulator, if junction temperature is higher than 150°C. After that, when junction temperature decreases below 125°C, the operation of voltage regulator would restart. While high power dissipation condition is, the regulator starts and stops repeatedly and protects itself against overheating.

### PCB layout

Pins number 2 and 4 of SOT89-5 package and pins number 2, 4 and 5 of SOIC6-TL must be wired to the GND plane while it is mounted on board. Make VIN and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect capacitors C1 and C2 as close as possible to the IC, and make wiring as short as possible.

## ORDERING INFORMATION

| Device         | Nominal Output Voltage | Description | Marking | Package           | Shipping <sup>†</sup> |
|----------------|------------------------|-------------|---------|-------------------|-----------------------|
| NCP4640H020T1G | 2.0 V                  | Enable High | N020    | SOT89-5 (Pb-Free) | 1000 / Tape & Reel    |
| NCP4640H030T1G | 3.0 V                  | Enable High | N030    | SOT89-5 (Pb-Free) | 1000 / Tape & Reel    |
| NCP4640H033T1G | 3.3 V                  | Enable High | N033    | SOT89-5 (Pb-Free) | 1000 / Tape & Reel    |
| NCP4640H080T1G | 8.0 V                  | Enable High | N080    | SOT89-5 (Pb-Free) | 1000 / Tape & Reel    |
| NCP4640H120T1G | 12.0 V                 | Enable High | N120    | SOT89-5 (Pb-Free) | 1000 / 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.

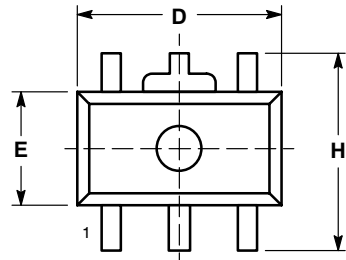
\*To order other package and voltage variants, please contact your ON Semiconductor sales representative.



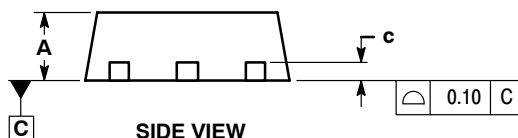
SCALE 2:1

**SOT-89, 5 LEAD**  
**CASE 528AB**  
**ISSUE O**

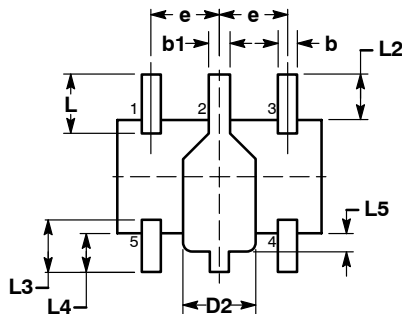
DATE 23 NOV 2009



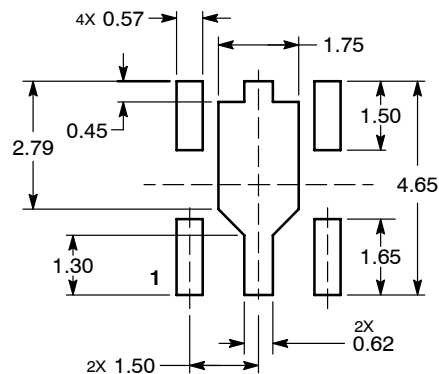
TOP VIEW



SIDE VIEW



BOTTOM VIEW

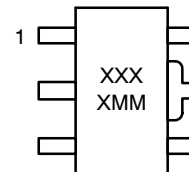
**RECOMMENDED**  
**MOUNTING FOOTPRINT\***


DIMENSIONS: MILLIMETERS

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. LEAD THICKNESS INCLUDES LEAD FINISH.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. DIMENSIONS L1, L2, L3, L4, L5, AND H ARE MEASURED AT DATUM PLANE C.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 1.40        | 1.60 |
| b   | 0.32        | 0.52 |
| b1  | 0.37        | 0.57 |
| c   | 0.30        | 0.50 |
| D   | 4.40        | 4.60 |
| D2  | 1.40        | 1.80 |
| E   | 2.40        | 2.60 |
| e   | 1.40        | 1.60 |
| H   | 4.25        | 4.45 |
| L   | 1.10        | 1.50 |
| L2  | 0.80        | 1.20 |
| L3  | 0.95        | 1.35 |
| L4  | 0.65        | 1.05 |
| L5  | 0.20        | 0.60 |

**GENERIC**  
**MARKING DIAGRAM\***


XXXX = Specific Device Code  
MM = Lot Number  
▪ = Pb-Free Package

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

\*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>SOT-89, 5 LEAD</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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