NCP4680

150 mA, Low Noise Low Dropout Regulator

The NCP4680 is a CMOS linear voltage regulator with 150 mA output current capability. The device is available in a tiny 0.8x0.8 mm XDFN, and has high output voltage accuracy, low supply current and high ripple rejection. The NCP4680 is easy to use and includes output current fold−back protection. A Chip Enable function is included to save power by lowering supply current. The line and load transient responses are very good, making this regulator ideal for use as a power supply for communication equipment.

Features

- Operating Input Voltage Range: 1.40 V to 5.25 V
- Output Voltage Range: 0.8 V to 3.6 V (available in 0.1 V steps)
- Output Voltage Accuracy: ±1.0%
- Supply Current: 50 μA typical
- Dropout Voltage: 0.25 V (I_{OUT} = 150 mA, V_{OUT} = 2.5 V)
- High PSRR: 75 dB (f = 1 kHz, V_{OUT} = 2.5 V)
- Line Regulation: 0.02%/V Typ.
- Stable with Ceramic Capacitors: 0.1 μF or more
- Current Fold Back Protection
- Available in XDFN4 0.8 x 0.8 mm, SC−70, SOT23 Packages
- These are Pb−Free Devices

Typical Applications

- Battery−powered Equipment
- Networking and Communication Equipment
- Cameras, DVRs, STB and Camcorders
- Home Appliances

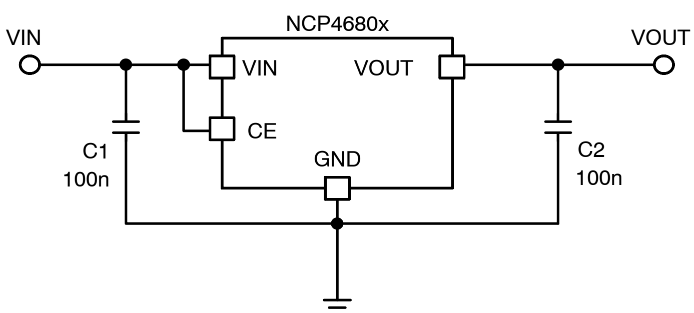
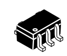


Figure 1. Typical Application Schematic

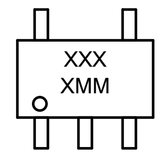
ON Semiconductor™

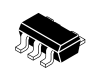
http://onsemi.com

MARKING DIAGRAMS

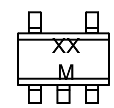


SC−70
CASE 419A





SOT−23−5
CASE 1212



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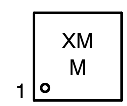
XDFN4
CASE 711AB

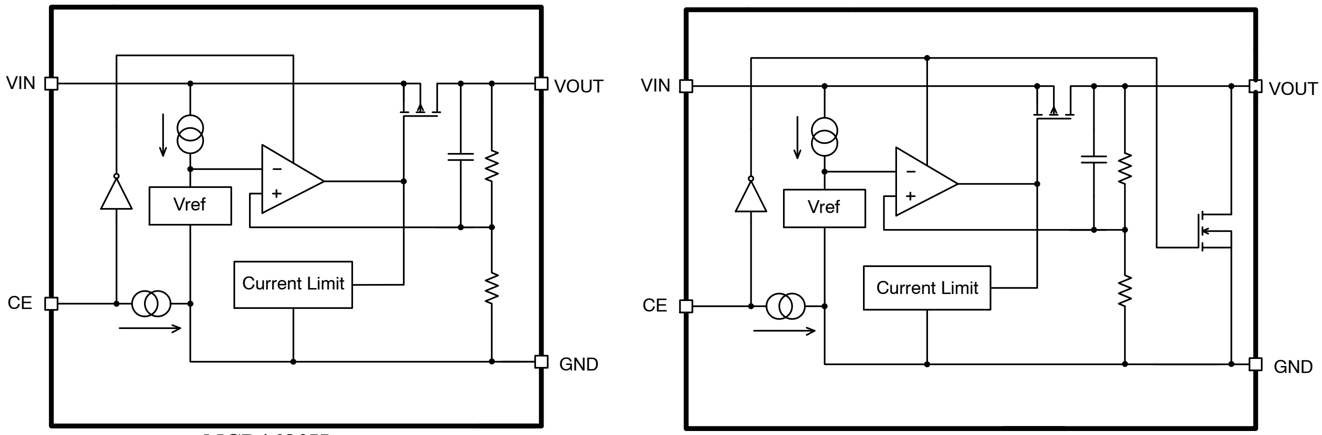


XX, XXX	= Specific Device Code
M, MM	= Date Code
A	= Assembly Location
Y	= Year
W	= Work Week
▪	= Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 17 of this data sheet.



NCP4680Hxxxx NCP4680Dxxxx

Figure 2. Simplified Schematic Block Diagram

PIN FUNCTION DESCRIPTION

Pin No. XDFN4*	Pin No. SC−70	Pin No. SOT23	Pin Name	Description
1	4	5	V_{OUT}	Output pin
2	3	2	GND	Ground
3	1	3	CE	Chip enable pin (Active “H”)
4	5	1	V_{IN}	Input pin
–	2	4	NC	No connection

*Tab is GND level. (They are connected to the reverse side of this IC.
The tab is better to be connected to the GND, but leaving it open is also acceptable.

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}	6.0	V
Output Current	I_{OUT}	180	mA
Power Dissipation XDFN0808	P_D	286	mW
Power Dissipation SC−70		380	
Power Dissipation SOT23		420	
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. Refer to ELECTRICAL CHARACTERISTIS and APPLICATION INFORMATION for Safe Operating Area.
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)
   Latch−up Current Maximum Rating tested per JEDEC standard: JESD78.

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, XDFN 0.8 x 0.8 mm Thermal Resistance, Junction−to−Air	$R_{\theta JA}$	350	°C/W
Thermal Characteristics, SOT23 Thermal Resistance, Junction−to−Air	$R_{\theta JA}$	238	°C/W
Thermal Characteristics, SC−70 Thermal Resistance, Junction−to−Air	$R_{\theta JA}$	263	°C/W

ELECTRICAL CHARACTERISTICS

−40°C ≤ T_A ≤ 85°C; V_{IN} = $V_{OUT(NOM)}$ + 1 V or 2.5 V, whichever is greater; I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 0.1 μF, unless otherwise noted. Typical values are at T_A = +25°C.

Parameter	Test Conditions		Symbol	Min	Typ	Max	Unit
Operating Input Voltage			V_{IN}	1.40		5.25	V
Output Voltage	T_A = +25 °C	V_{OUT} ≥ 1.8 V	V_{OUT}	x0.99		x1.01	V
		V_{OUT} < 1.8 V		−18		18	mV
	−40°C ≤ T_A ≤ 85°C	V_{OUT} ≥ 1.8 V		x0.985		x1.015	V
		V_{OUT} < 1.8 V		−50		50	mV
Output Voltage Temp. Coefficient	−40°C ≤ T_A ≤ 85°C	V_{OUT} ≥ 1.8 V	$\Delta V_{OUT}/\Delta T_A$		±30		ppm/°C
		V_{OUT} < 1.8 V			±100		
Line Regulation	$V_{OUT(NOM)}$ + 0.5 V ≤ V_{IN} ≤ 5.25 V, V_{IN} ≥ 1.4 V		$Line_{Reg}$		0.02	0.10	%/V
Load Regulation	I_{OUT} = 1 mA to 150 mA		$Load_{Reg}$		5	30	mV
Dropout Voltage	I_{OUT} = 150 mA	V_{OUT} = 0.8 V	V_{DO}		0.70	1.00	V
		V_{OUT} = 0.9 V			0.62	0.91	
		1.0 V ≤ V_{OUT} < 1.2 V			0.56	0.82	
		1.2 V ≤ V_{OUT} < 1.4 V			0.47	0.67	
		1.4 V ≤ V_{OUT} < 1.8 V			0.39	0.54	
		1.8 V ≤ V_{OUT} < 2.1 V			0.33	0.48	
		2.1 V ≤ V_{OUT} < 2.5 V			0.28	0.40	
		2.5 V ≤ V_{OUT} < 3.0 V			0.25	0.35	
		3.0 V ≤ V_{OUT} < 3.6 V			0.23	0.32	
Output Current			I_{OUT}	150			mA
Short Current Limit	V_{OUT} = 0 V		I_{SC}		40		mA
Quiescent Current			I_Q		50	70	μA
Standby Current	V_{CE} = 0 V, T_A = 25°C		I_{STB}		0.1	1.0	μA
CE Pin Threshold Voltage	CE Input Voltage “H”		V_{CEH}	1.0			V
	CE Input Voltage “L”		V_{CEL}			0.4	
CE Pull Down Current			I_{CEPD}		0.3		μA
Power Supply Rejection Ratio	V_{IN} = V_{OUT} + 1 V, ΔV_{IN} = 0.2 V_{pk-pk}, I_{OUT} = 30 mA, f = 1 kHz		PSRR		75		dB
Output Noise Voltage	f = 10 Hz to 100 kHz, I_{OUT} = 30 mA	V_{OUT} ≥ 1.8 V	V_N		20 x V_{OUT}		μV_{rms}
		V_{OUT} < 1.8 V			40 x V_{OUT}		
Low Output N−channel Tr. On Resistance	V_{IN} = 4 V, V_{CE} = 0 V		R_{LOW}		60		Ω
Minimum Start−up Equivalent Resistance	V_{OUT} ≤ 1.8 V (Note 3)		R_{SUMIN}		13 * V_{OUT}		Ω
	V_{OUT} > 1.8 V				6.7 * V_{OUT}		

3. See Current Limit paragraph in application part for explanation.

TYPICAL CHARACTERISTICS

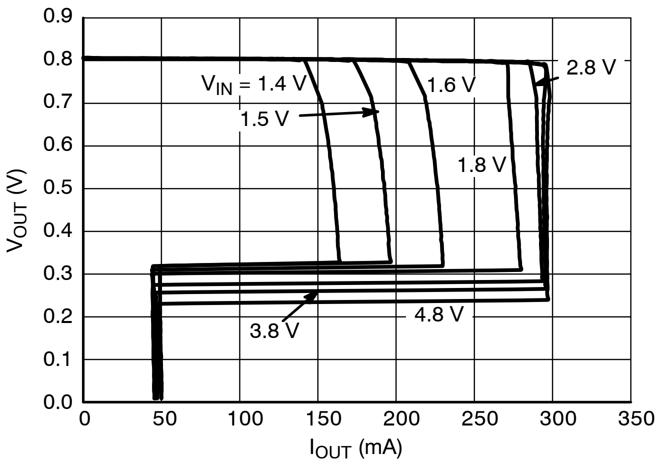


Figure 3. Output Voltage vs. Output Current 0.8 V Version (T_J = 25°C)

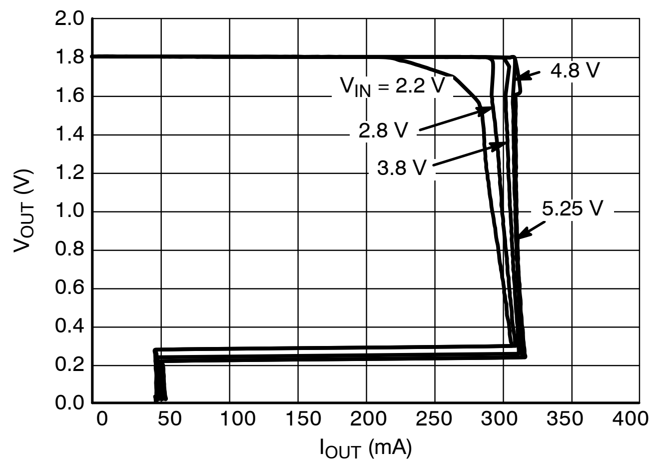


Figure 4. Output Voltage vs. Output Current 1.8 V Version (T_J = 25°C)

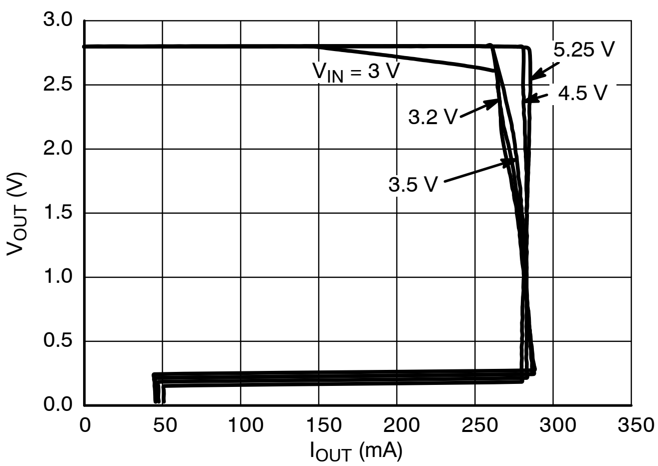


Figure 5. Output Voltage vs. Output Current 2.8 V Version (T_J = 25°C)

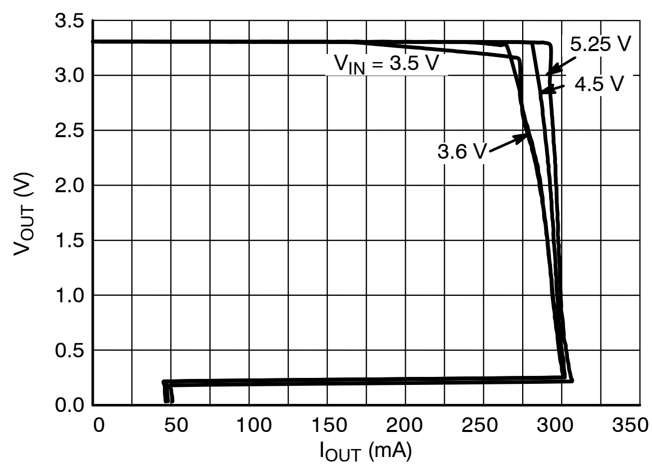


Figure 6. Output Voltage vs. Output Current 3.3 V Version (T_J = 25°C)

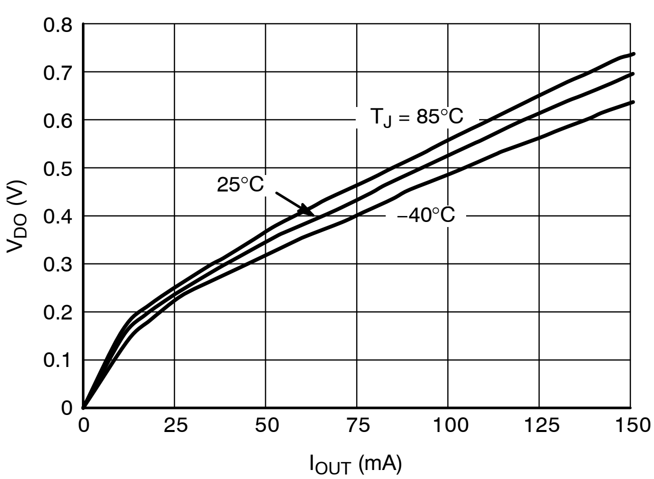


Figure 7. Dropout Voltage vs. Output Current 0.8 V Version

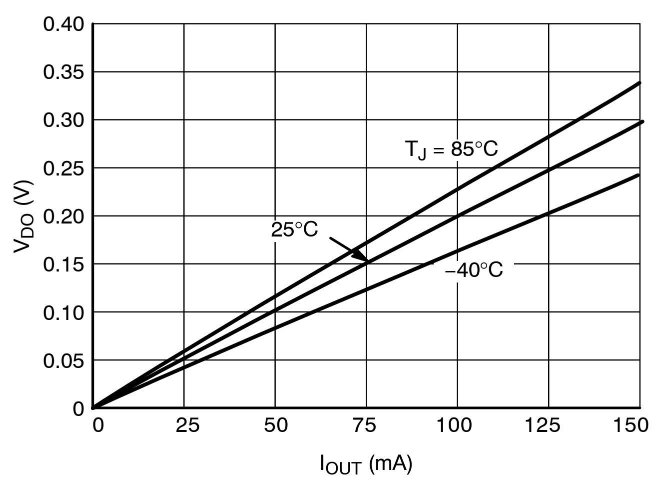


Figure 8. Dropout Voltage vs. Output Current 1.8 V Version

TYPICAL CHARACTERISTICS

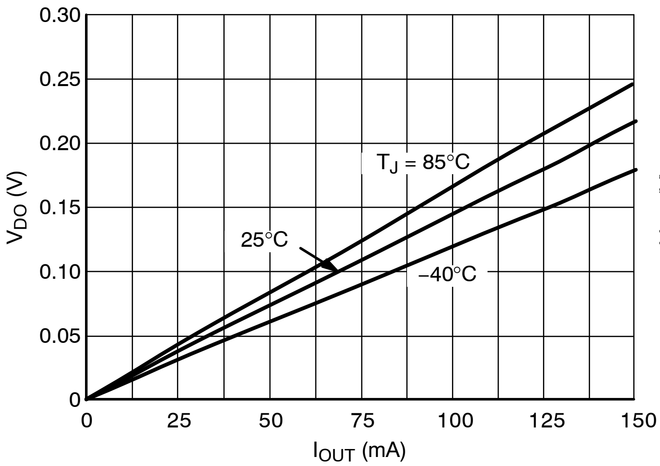


Figure 9. Dropout Voltage vs. Output Current 2.8 V Version

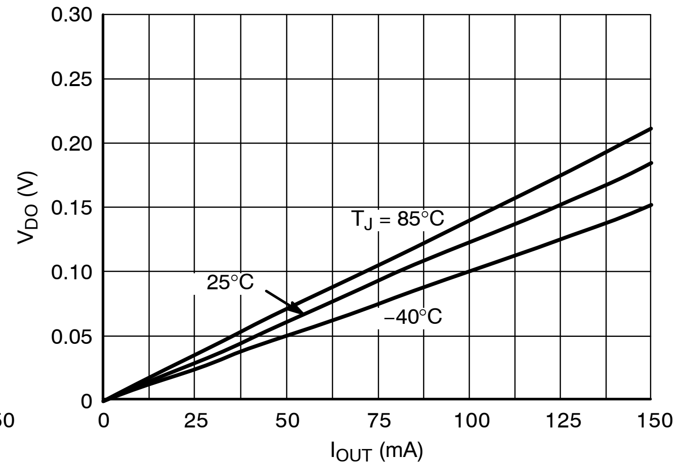


Figure 10. Dropout Voltage vs. Output Current 3.3 V Version

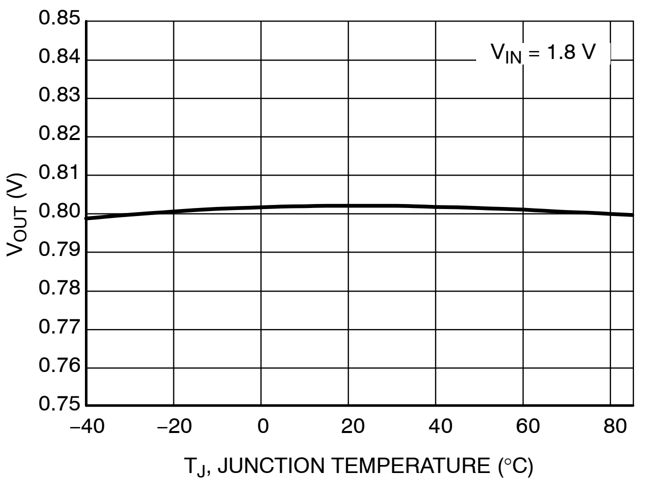


Figure 11. Output Voltage vs. Temperature, 0.8 V Version

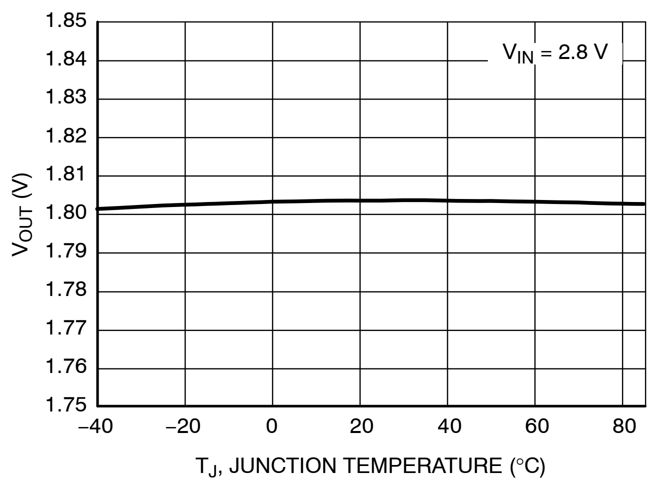


Figure 12. Output Voltage vs. Temperature, 1.8 V Version

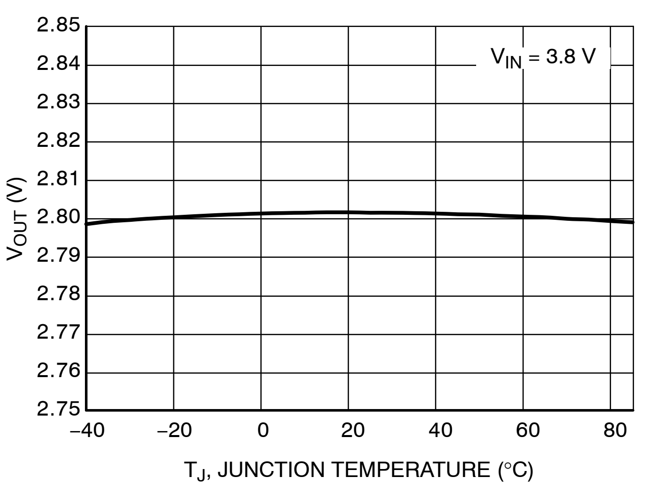


Figure 13. Output Voltage vs. Temperature, 2.8 V Version

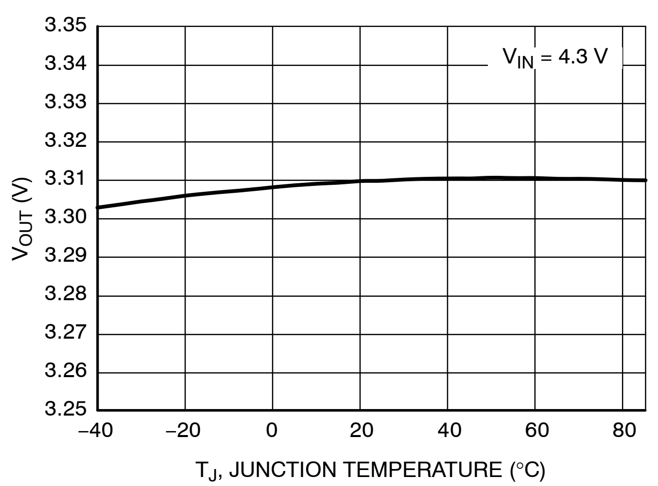


Figure 14. Output Voltage vs. Temperature, 3.3 V Version

TYPICAL CHARACTERISTICS

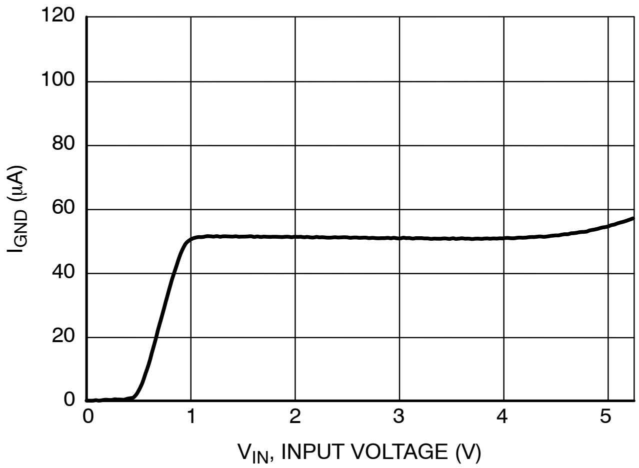


Figure 15. Supply Current vs. Input Voltage, 0.8 V Version

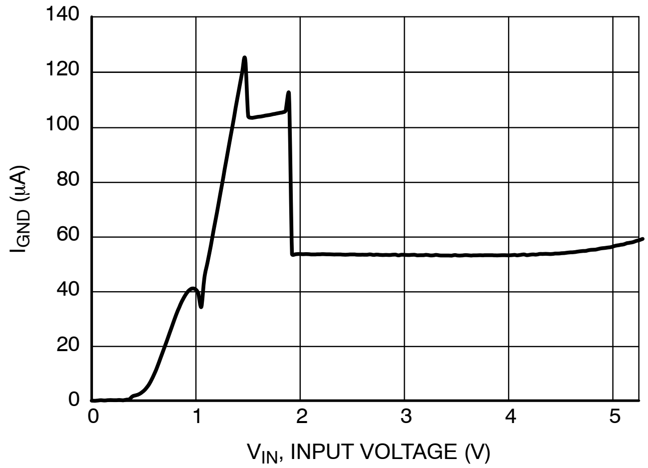


Figure 16. Supply Current vs. Input Voltage, 1.8 V Version

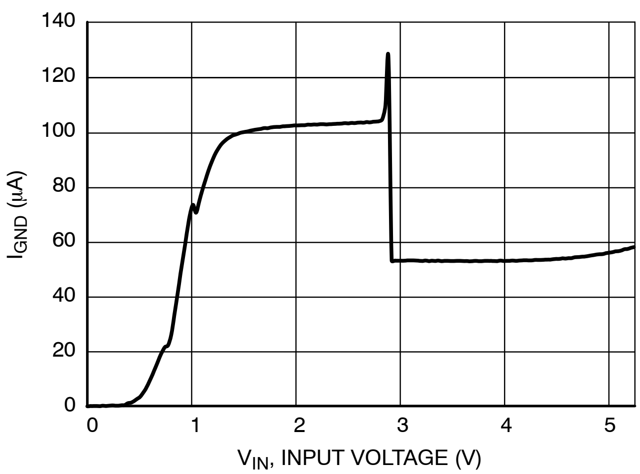


Figure 17. Supply Current vs. Input Voltage, 2.8 V Version

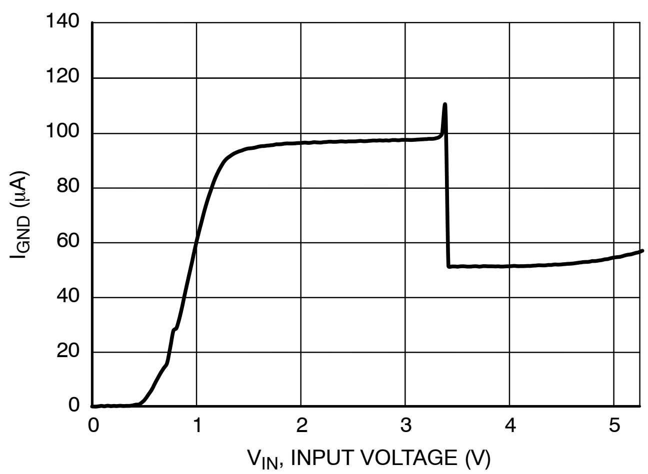


Figure 18. Supply Current vs. Input Voltage, 3.3 V Version

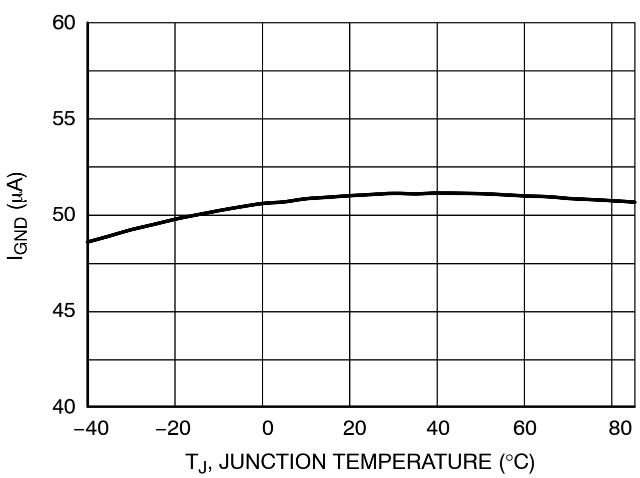


Figure 19. Supply Current vs. Temperature, 0.8 V Version

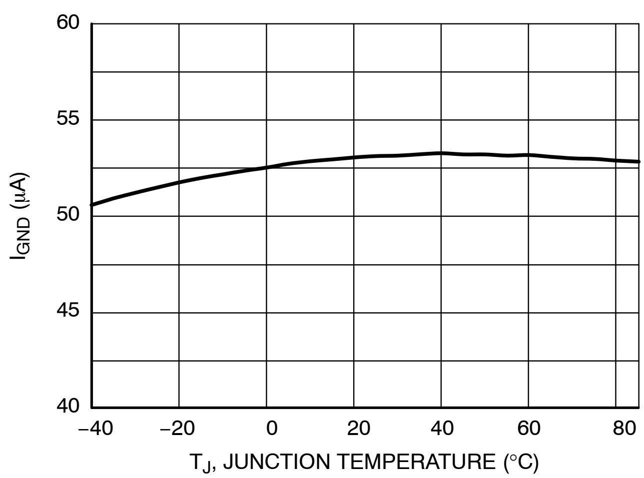


Figure 20. Supply Current vs. Temperature, 1.8 V Version

TYPICAL CHARACTERISTICS

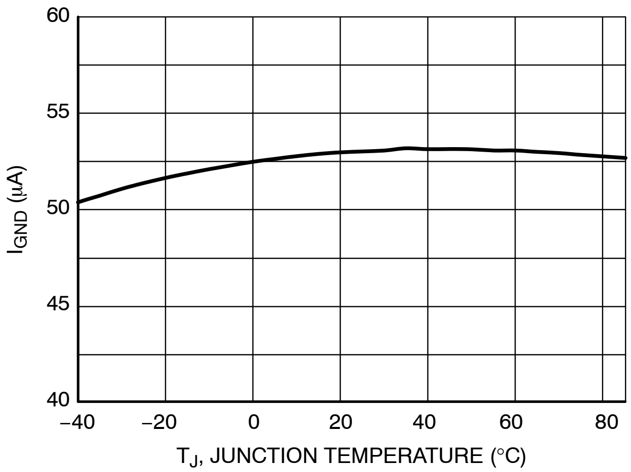


Figure 21. Supply Current vs. Temperature, 2.8 V Version

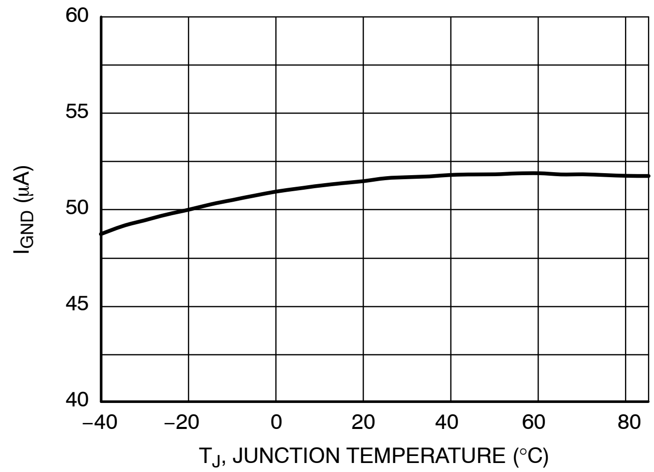


Figure 22. Supply Current vs. Temperature, 3.3 V Version

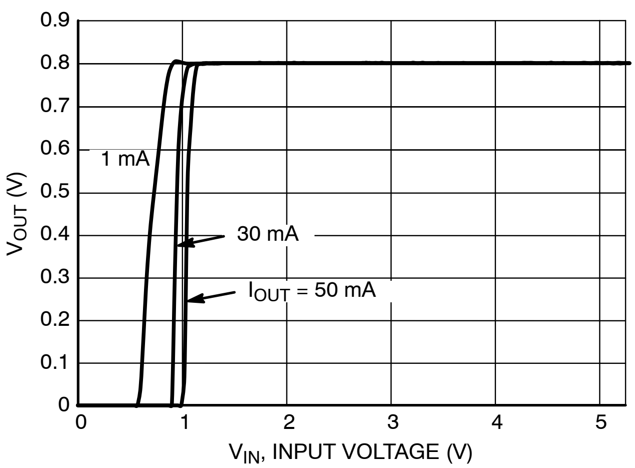


Figure 23. Output Voltage vs. Input Voltage, 0.8 V Version

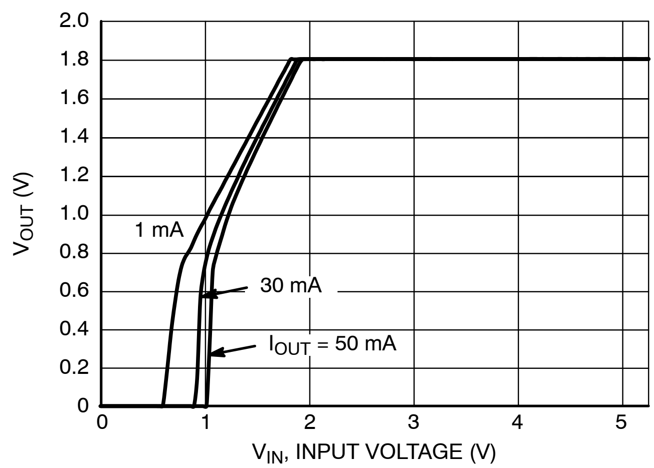


Figure 24. Output Voltage vs. Input Voltage, 1.8 V Version

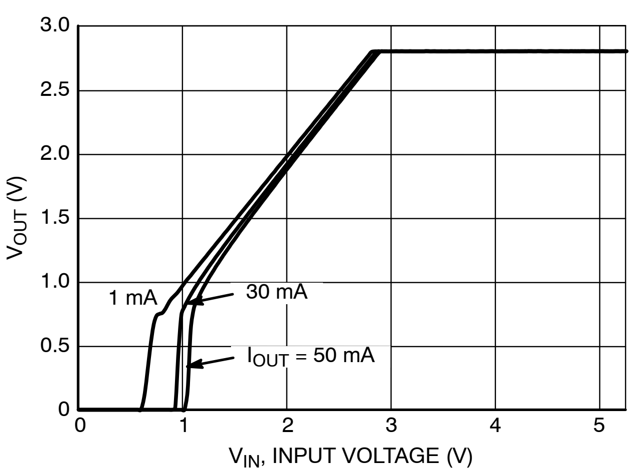


Figure 25. Output Voltage vs. Input Voltage, 2.8 V Version

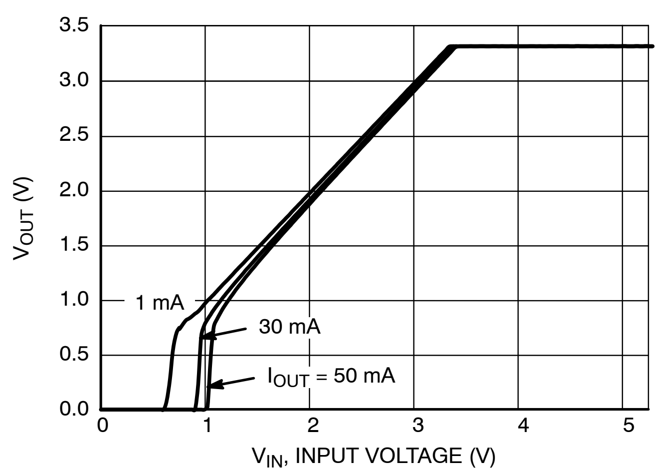


Figure 26. Output Voltage vs. Input Voltage, 3.3 V Version

TYPICAL CHARACTERISTICS

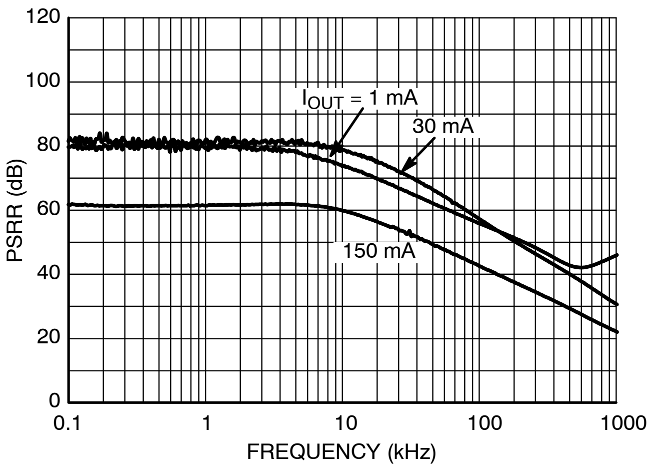


Figure 27. PSRR, 0.8 V Version, V_{IN} = 1.8 V

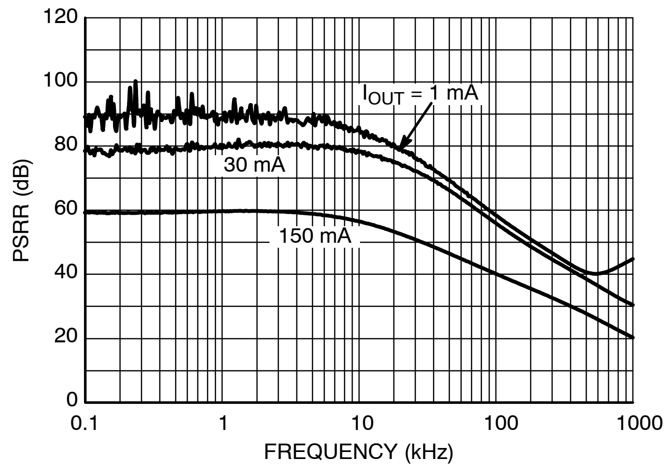


Figure 28. PSRR, 1.8 V Version, V_{IN} = 2.8 V

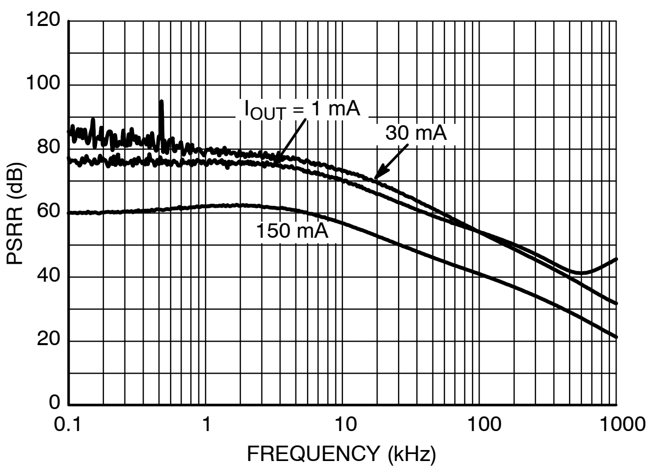


Figure 29. PSRR, 2.8 V Version, V_{IN} = 3.8 V

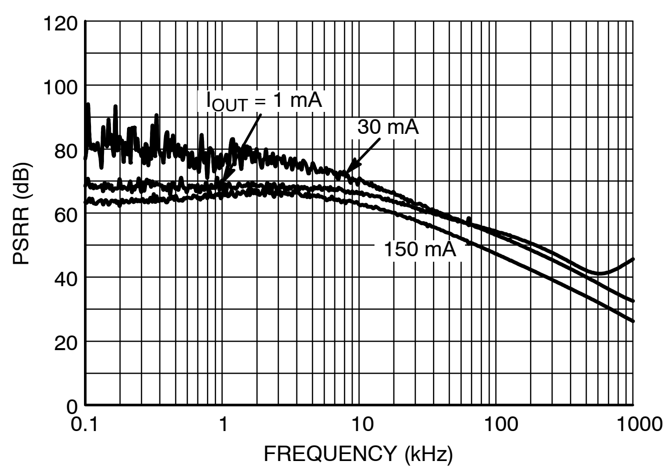


Figure 30. PSRR, 3.3 V Version, V_{IN} = 4.3 V

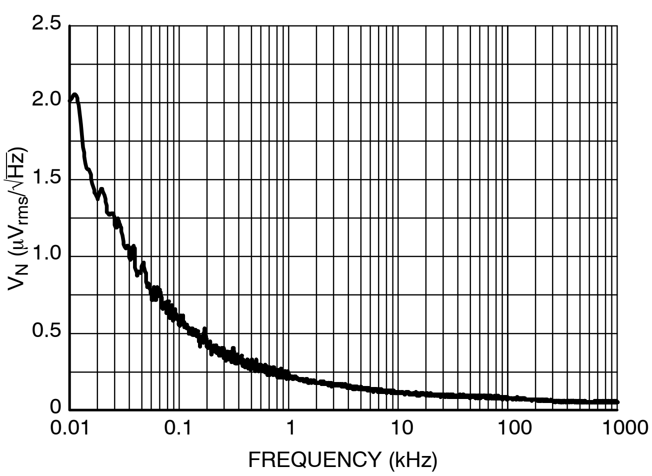


Figure 31. Output Voltage Noise, 0.8 V Version, V_{IN} = 1.8 V

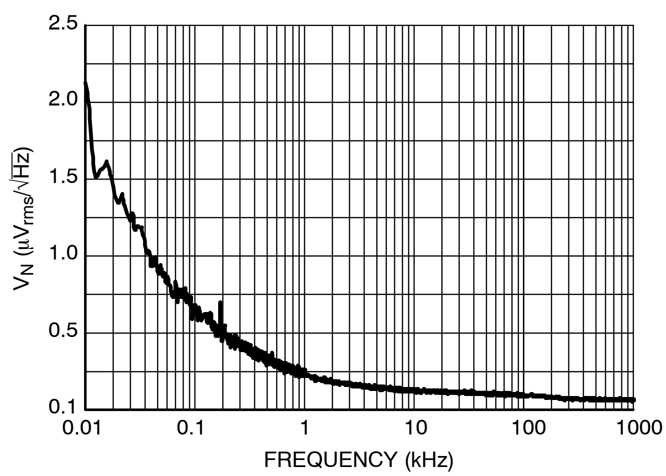


Figure 32. Output Voltage Noise, 1.8 V Version, V_{IN} = 2.8 V

TYPICAL CHARACTERISTICS

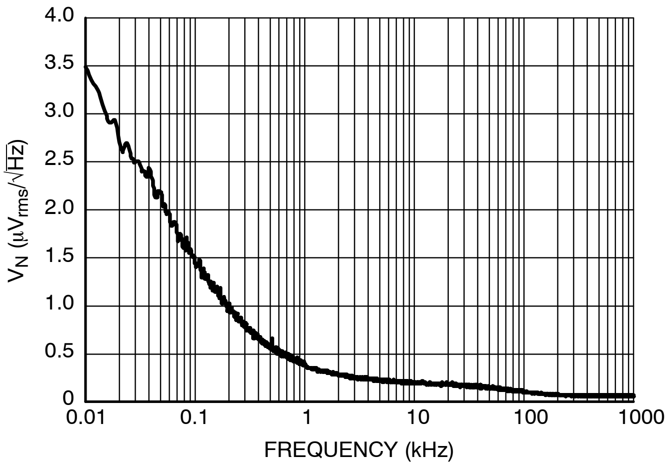


Figure 33. Output Voltage Noise, 2.8 V Version, V_{IN} = 3.8 V

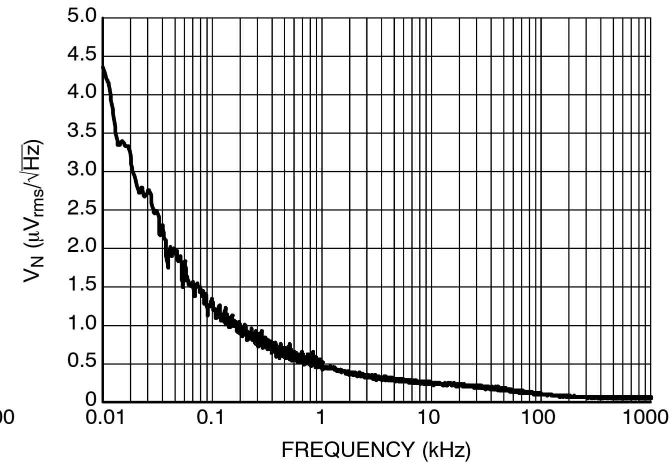


Figure 34. Output Voltage Noise, 3.3 V Version, V_{IN} = 4.3 V

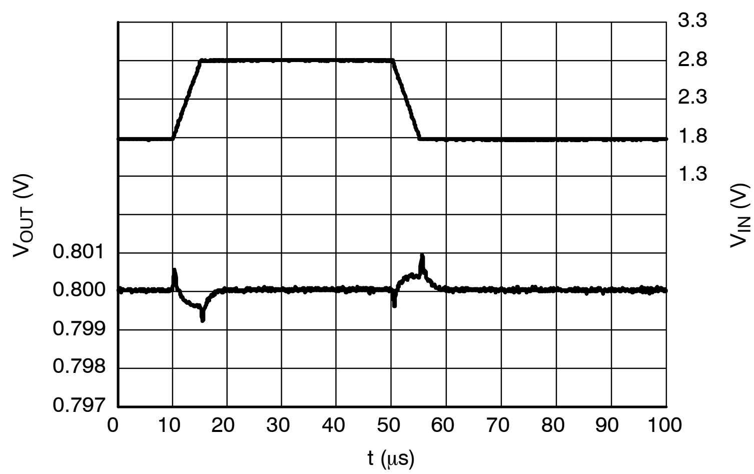


Figure 35. Line Transients, 0.8 V Version, $t_R = t_F$ = 5 μs, I_{OUT} = 30 mA

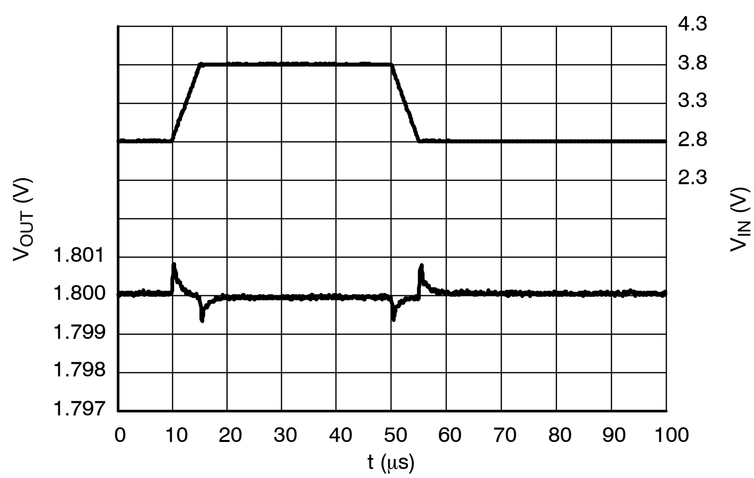


Figure 36. Line Transients, 1.8 V Version, $t_R = t_F$ = 5 μs, I_{OUT} = 30 mA

TYPICAL CHARACTERISTICS

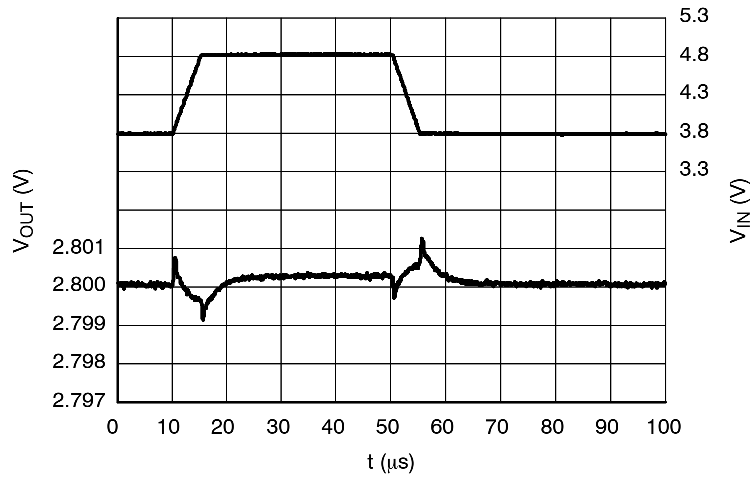


Figure 37. Line Transients, 2.8 V Version, $t_R = t_F = 5\ \mu s$, $I_{OUT} = 30$ mA

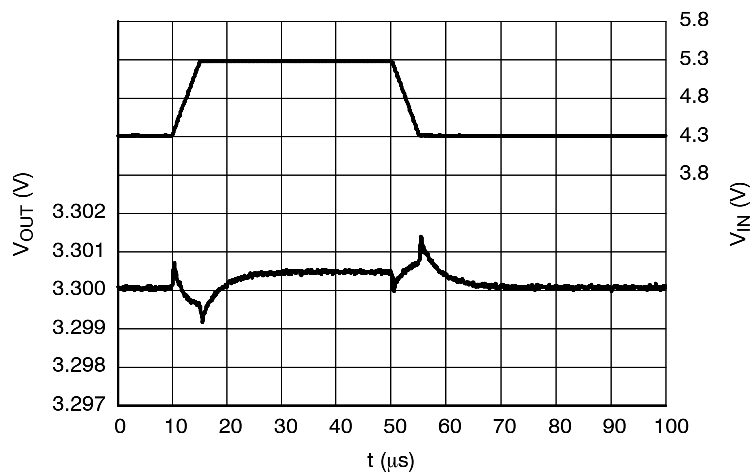


Figure 38. Line Transients, 3.3 V Version, $t_R = t_F = 5\ \mu s$, $I_{OUT} = 30$ mA

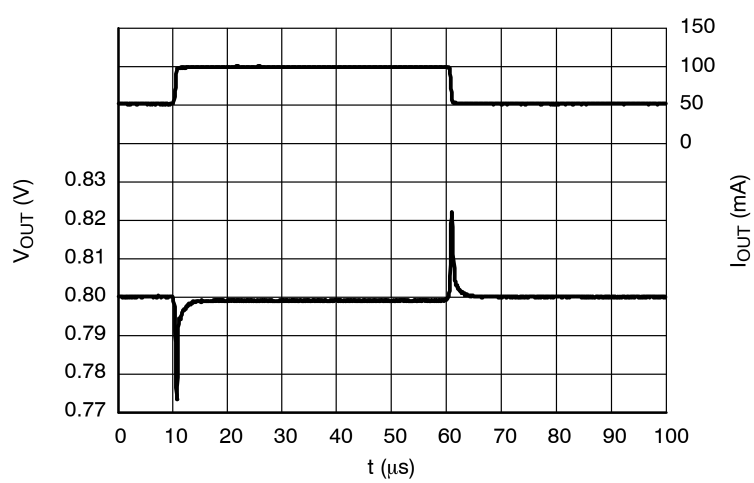


Figure 39. Load Transients, 0.8 V Version, $I_{OUT} = 50 - 100$ mA, $t_R = t_F = 0.5\ \mu s$, $V_{IN} = 1.8$ V

TYPICAL CHARACTERISTICS

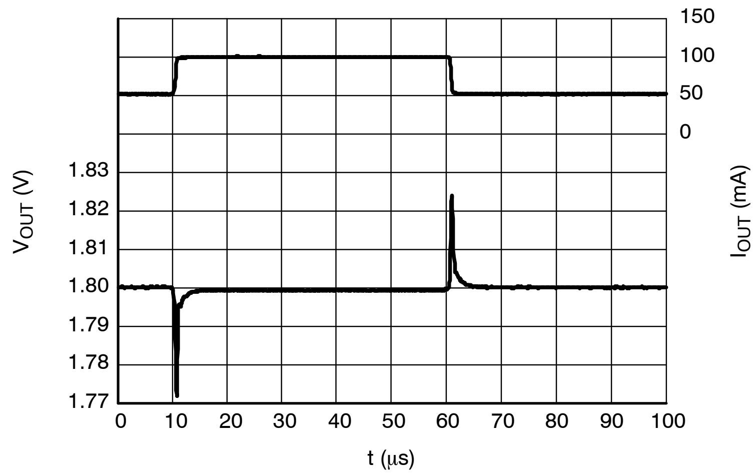


Figure 40. Load Transients, 1.8 V Version,
I_{OUT} = 50 − 100 mA, t_R = t_F = 0.5 μs, V_{IN} = 2.8 V

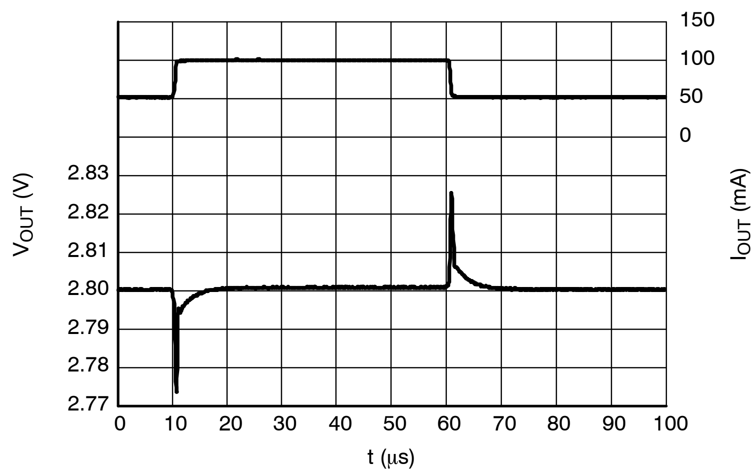


Figure 41. Load Transients, 2.8 V Version,
I_{OUT} = 50 − 100 mA, t_R = t_F = 0.5 μs, V_{IN} = 3.8 V

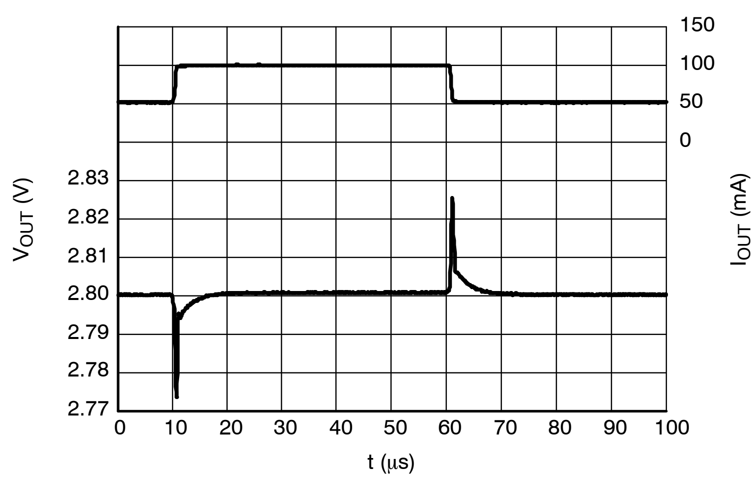


Figure 42. Load Transients, 3.3 V Version,
I_{OUT} = 50 − 100 mA, t_R = t_F = 0.5 μs, V_{IN} = 4.3 V

TYPICAL CHARACTERISTICS

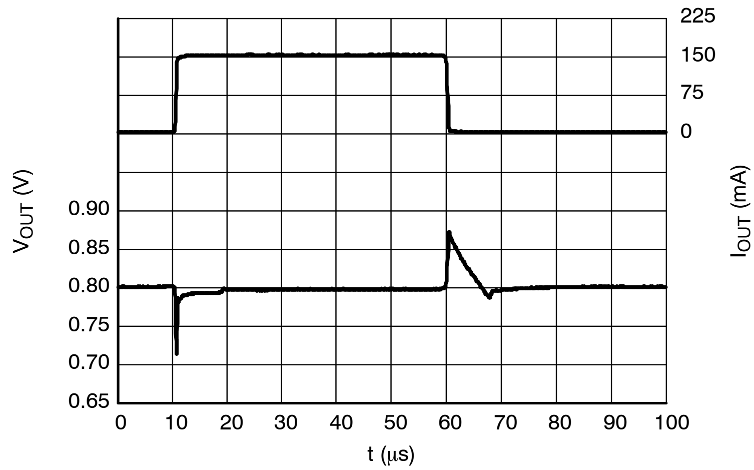


Figure 43. Load Transients, 0.8 V Version, I_{OUT} = 1 − 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 1.8 V

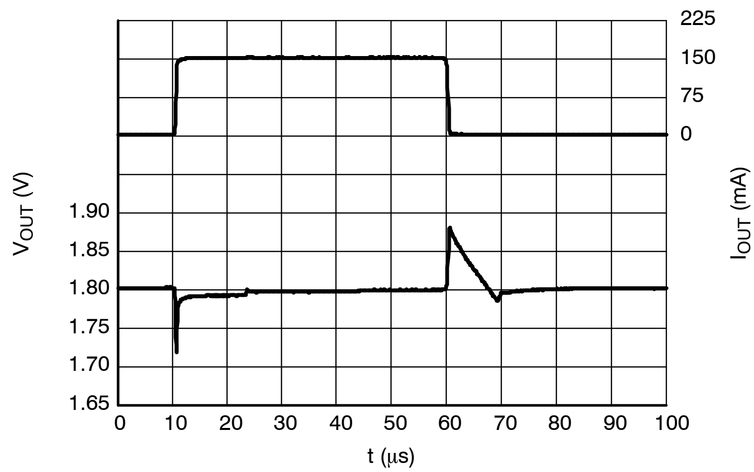


Figure 44. Load Transients, 1.8 V Version, I_{OUT} = 1 − 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 2.8 V

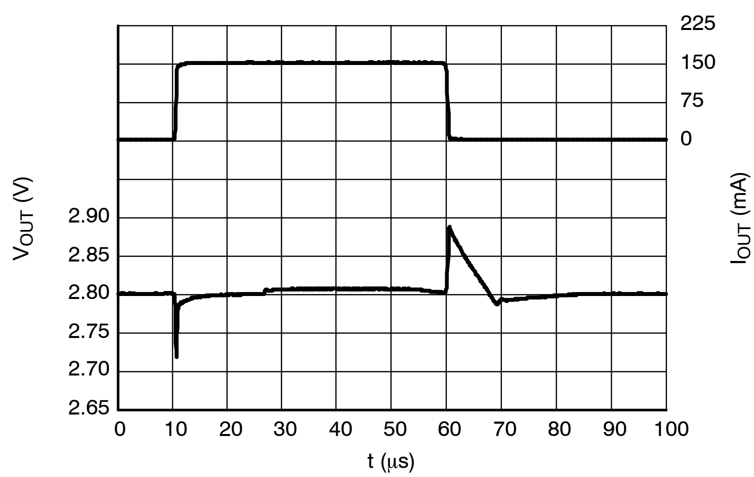


Figure 45. Load Transients, 2.8 V Version, I_{OUT} = 1 − 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 3.8 V

TYPICAL CHARACTERISTICS

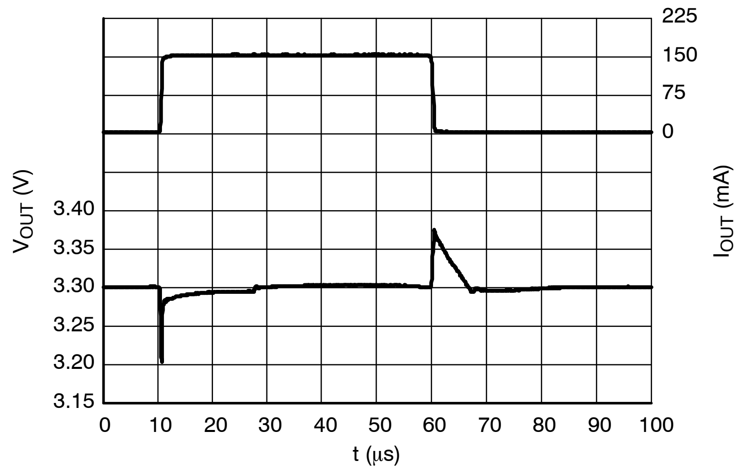


Figure 46. Load Transients, 3.3 V Version, I_{OUT} = 1 − 150 mA, t_R = t_F = 0.5 µs, V_{IN} = 4.3 V

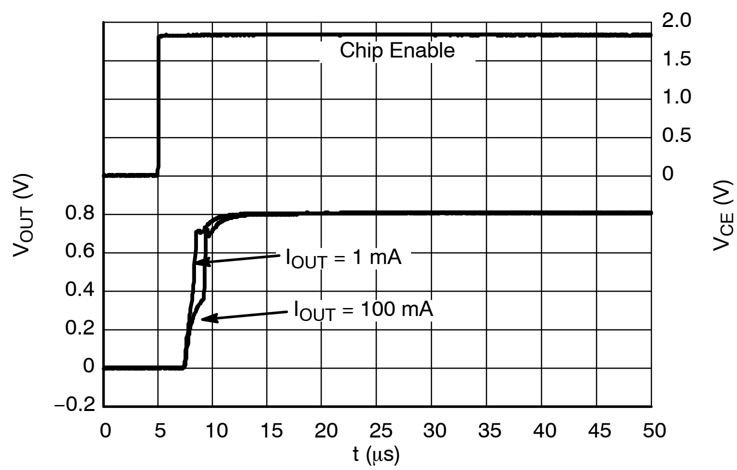


Figure 47. Start−up, 0.8 V Version, V_{IN} = 1.8 V

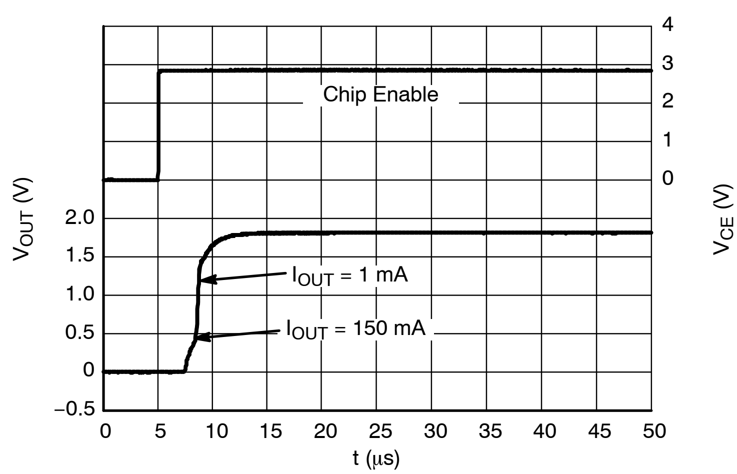


Figure 48. Start−up, 1.8 V Version, V_{IN} = 2.8 V

TYPICAL CHARACTERISTICS

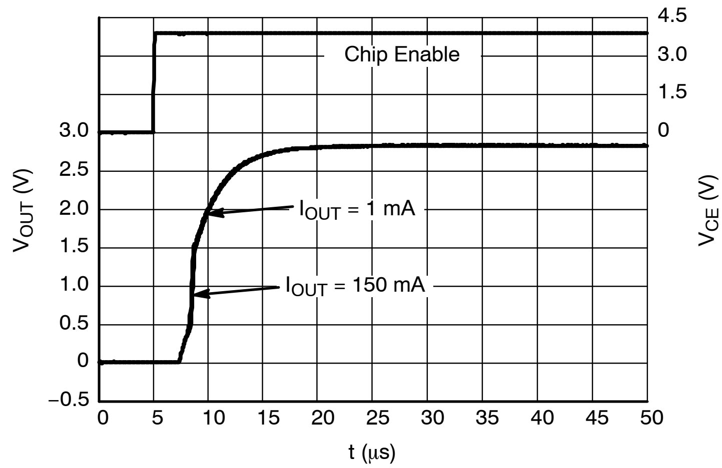


Figure 49. Start−up, 2.8 V Version, V_{IN} = 3.8 V

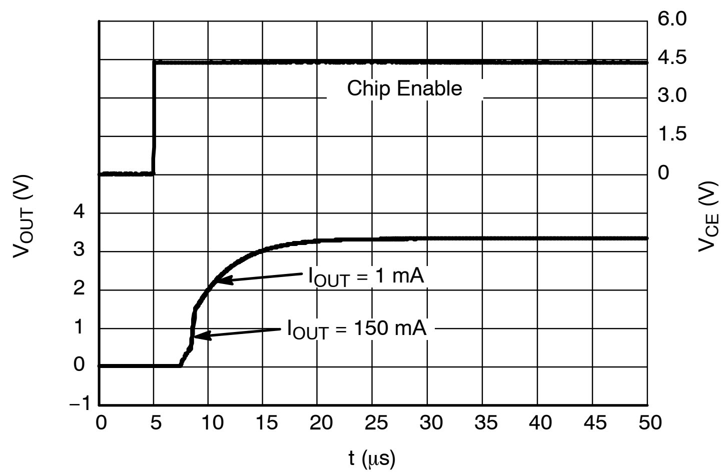


Figure 50. Start−up, 3.3 V Version, V_{IN} = 4.3 V

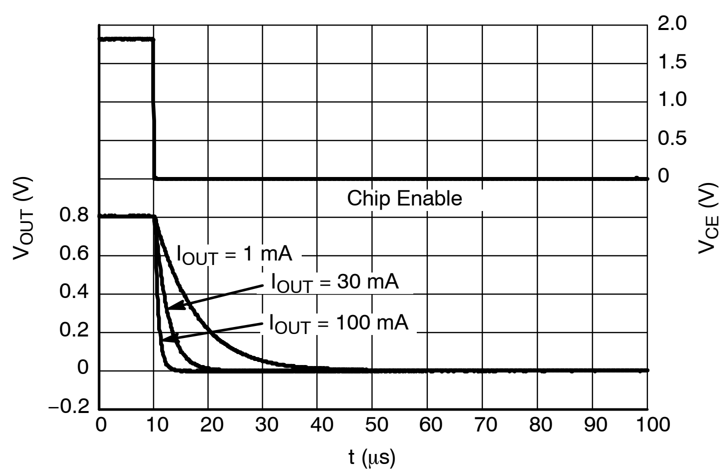


**Figure 51. Shutdown, 0.8 V Version D,
V_{IN} = 1.8 V**

TYPICAL CHARACTERISTICS

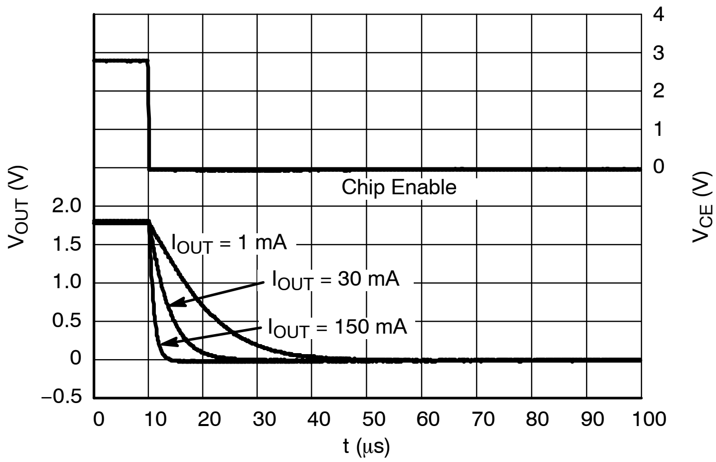


Figure 52. Shutdown, 1.8 V Version D, V_{IN} = 2.8 V

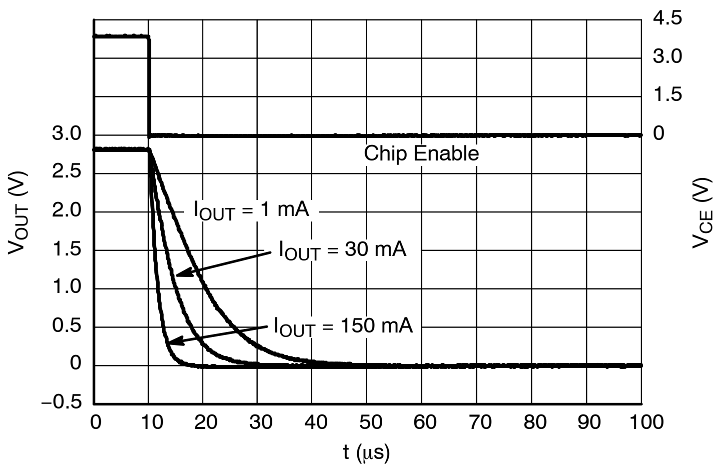


Figure 53. Shutdown, 2.8 V Version D, V_{IN} = 3.8 V

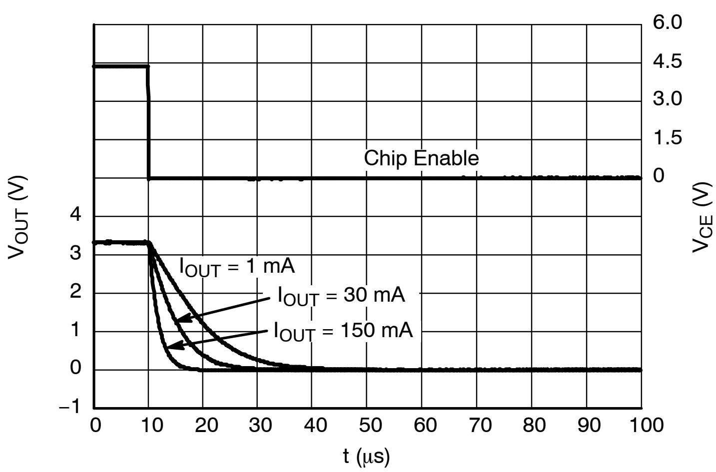


Figure 54. Shutdown, 3.3 V Version D, V_{IN} = 4.3 V

APPLICATION INFORMATION

A typical application circuit for NCP4680 series is shown in Figure 55.

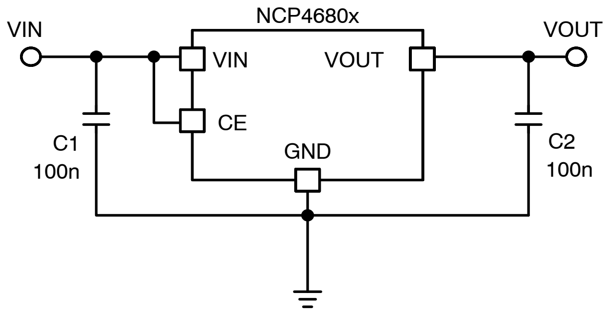


Figure 55. Typical Application Schematic

Input Decoupling Capacitor (C1)

A 0.1 μF ceramic input decoupling capacitor should be connected as close as possible to the input and ground pin of the NCP4680. Higher values and lower ESR improves line transient response.

Output Decoupling Capacitor (C2)

A 0.1 μF ceramic output decoupling capacitor is enough to achieve stable operation of the IC. If a tantalum capacitor is used, and its ESR is high, loop oscillation may result. The capacitors should be connected as close as possible to the output and ground pins. Larger values and lower ESR improves dynamic parameters.

Current Limit

The NCP4680 includes fold−back type current limit protection. Its typical characteristic for 0.8 V version is shown in Figure 3. The advantage of this protection is that power loss at the regulator is minimized at over current or short circuit conditions. When the over current or short circuit event disappears, the regulator reverts from fold back to regulation. This kind of current limit may cause issues at start−up for voltage versions below 1.8 V and some load types: for these lower voltage options it is recommended to start−up into at least double the minimum equivalent load. The minimum equivalent resistance can be computed by formula 1:

$$R_{EQMIN} = \frac{V_{OUT(NOM)}}{I_{OUTMAX}} \qquad \text{(eq. 1)}$$

This leads us to the result that the minimum equivalent start up resistance for $V_{OUT(NOM)} < 1.8$ V is:

$$R_{SUMIN} = 2 \cdot R_{EQMIN} \qquad \text{(eq. 2)}$$

Enable Operation

The enable pin CE may be used for turning the regulator on and off. The IC is switched on when a high level voltage is applied to the CE pin. The enable pin has an internal pull down current source. If the enable function is not needed connect CE pin to VIN.

Output Discharger

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

Thermal

As 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.

PCB layout

Make the VIN and GND line as large as practical. 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.

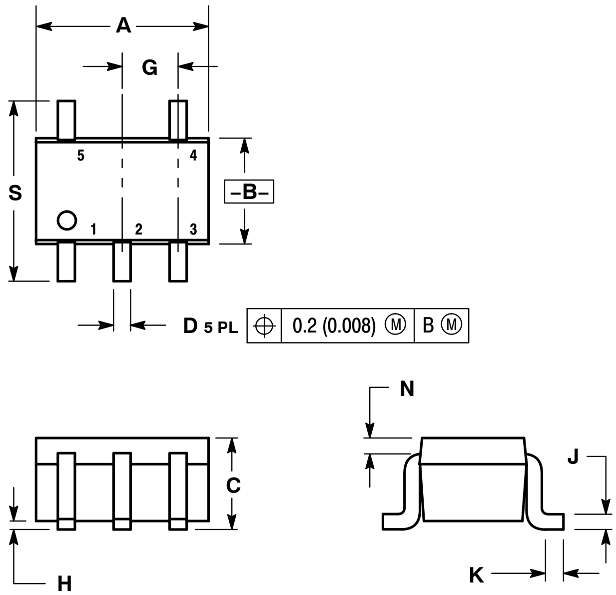
ORDERING INFORMATION

Device	Nominal Output Voltage	Description	Marking	Package	Shipping†
NCP4680DMX10TCG	1.0 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX12TCG	1.2 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX15TCG	1.5 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX18TCG	1.8 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX23TCG	2.3 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX28TCG	2.8 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX30TCG	3.0 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DMX33TCG	3.3 V	Auto discharge	A (fixed)*	XDFN4 (Pb−Free)	10000 / Tape & Reel
NCP4680DSQ08T1G	0.8 V	Auto discharge	AF08	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ09T1G	0.9 V	Auto discharge	AF09	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ12T1G	1.2 V	Auto discharge	AF12	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ15T1G	1.5 V	Auto discharge	AF15	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ18T1G	1.8 V	Auto discharge	AF18	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ25T1G	2.5 V	Auto discharge	AF25	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ28T1G	2.8 V	Auto discharge	AF28	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ30T1G	3.0 V	Auto discharge	AF30	SC−70 (Pb−Free)	3000 / Tape & Reel
NCP4680DSQ33T1G	3.3 V	Auto discharge	AF33	SC−70 (Pb−Free)	3000 / Tape & Reel

†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.
*Marking codes for XDFN0808 packages are unified.
**To order other package and voltage variants, please contact your ON Semiconductor sales representative.

PACKAGE DIMENSIONS

SC−88A (SC−70−5/SOT−353)
CASE 419A−02
ISSUE K

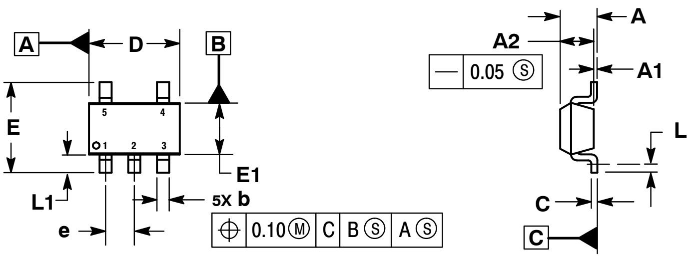


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A−01 OBSOLETE. NEW STANDARD 419A−02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

PACKAGE DIMENSIONS

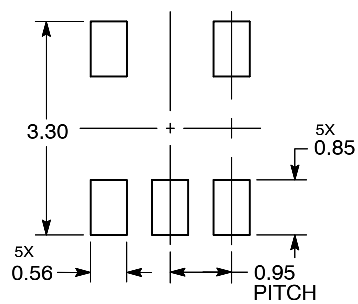
SOT−23 5−LEAD
CASE 1212−01
ISSUE A



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*

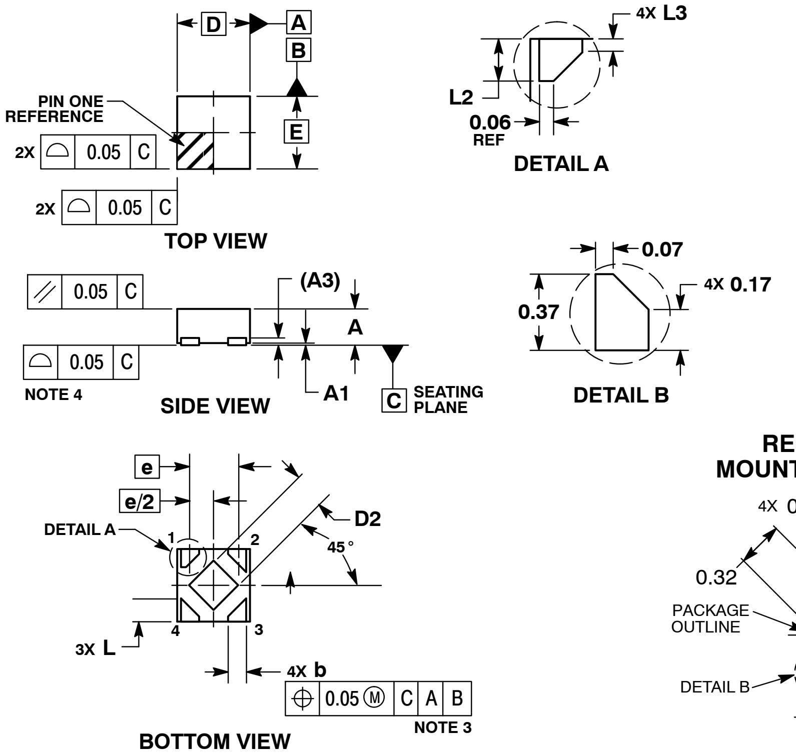


DIMENSIONS: MILLIMETERS

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

PACKAGE DIMENSIONS

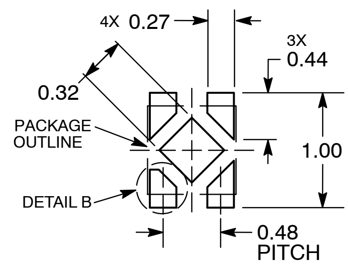
XDFN4 0.8x0.8, 0.48P
CASE 711AB−01
ISSUE O



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINALS.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	---	0.40
A1	0.00	0.05
A3	0.10 REF	
b	0.17	0.27
D	0.80 BSC	
D2	0.20	0.30
E	0.80 BSC	
e	0.48 BSC	
L	0.23	0.33
L2	0.17	0.27
L3	0.01	0.11

RECOMMENDED MOUNTING 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, SOLDERRM/D.

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