NCP4587

150 mA, Tri-Mode, LDO Linear Voltage Regulator

ON Semiconductor™

http://onsemi.com

The NCP4587 is a CMOS 150 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.) or it 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 an ultra thin (0.4 mm) small 1.2 x 1.2 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 μA
  Fast Mode – 55 μA
  Standby Mode – 0.1 μA
- Very Low Dropout: 120 mV Typ. at 150 mA (V_{out} > 2.6 V)
- ±1% Output Voltage Accuracy (V_{OUT} > 2 V, T_J = 25°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 1.2 x 1.2 XDFN, SC−70 and SOT23 Package
- These are Pb−Free Devices

Typical Applications

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

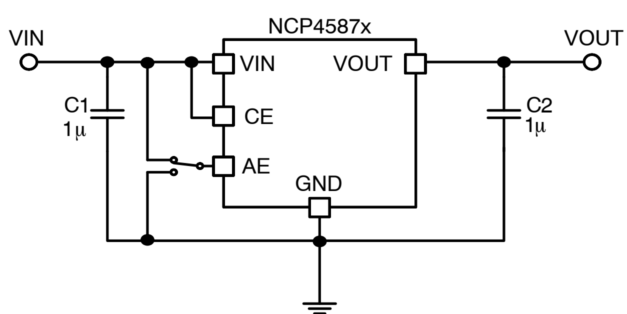
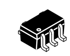
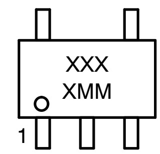


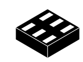
Figure 1. Typical Application Schematic

MARKING DIAGRAMS

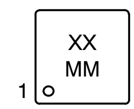


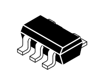
SC−70
CASE 419A



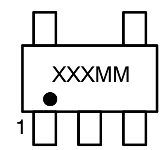


XDFN6
CASE 711AA





SOT−23−5
CASE 1212



XX, XXX = Specific Device Code
MM = Date Code

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 16 of this data sheet.

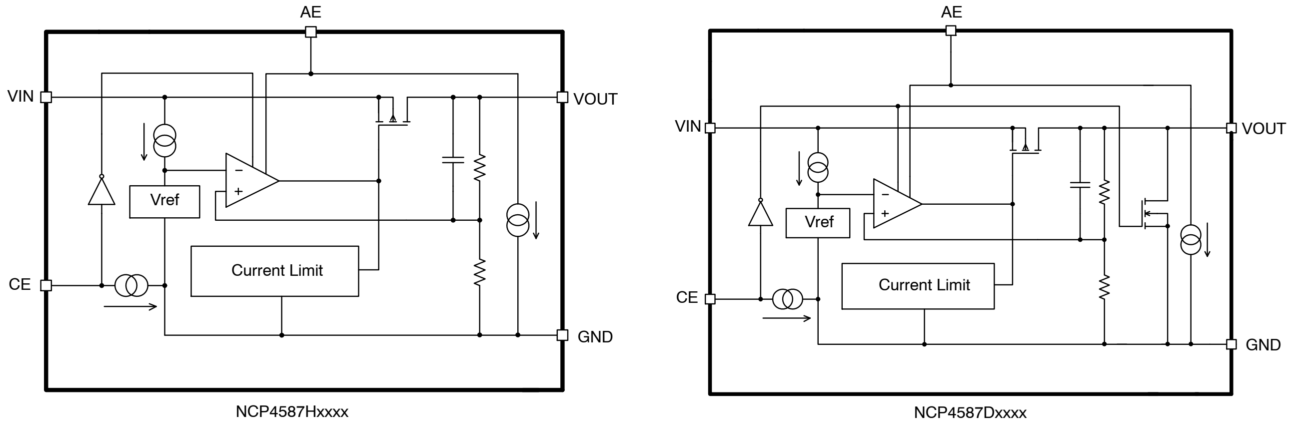


Figure 2. Simplified Schematic Block Diagram

PIN FUNCTION DESCRIPTION

Pin No. XDFN	Pin No. SC−70	Pin No. SOT23	Pin Name	Description
4	4	1	VIN	Input pin
2	2	2	GND	Ground
3	5	3	CE	Chip enable pin (active “H”)
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 SC−70		380	
Power Dissipation SOT23		420	
Maximum Junction Temperature	$T_{J(MAX)}$	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.

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)
   Latchup Current Maximum Rating tested per JEDEC standard: JESD78.

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, XDFN Thermal Resistance, Junction−to−Air	$R_{\theta JA}$	250	°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} = 0.47 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}	1.4		5.25	V
Output Voltage	T_A = +25 °C, I_{OUT} = 5 mA	V_{OUT} > 2 V	V_{OUT}	x0.99		x1.01	V
		V_{OUT} ≤ 2 V		−20		20	mV
	−40°C ≤ T_A ≤ 85°C, I_{OUT} = 5 mA	V_{OUT} > 2 V		x0.975		x1.015	V
		V_{OUT} ≤ 2 V		−50		30	mV
Output Voltage Temp. Coefficient	T_A = −40 to 85°C				±50		ppm/°C
Line Regulation	V_{IN} = V_{OUT} + 0.5 V to 5 V, V_{IN} ≥ 1.4 V	I_{OUT} = 1 mA, (Low Power Mode)	$Line_{Reg}$			0.50	%/V
		I_{OUT} = 10 mA, (Fast Mode)			0.02	0.20	
Load Regulation	I_{OUT} = 1 mA to 10 mA	V_{OUT} > 2.0 V	$Line_{Reg}$	−1.0		1.0	%
		V_{OUT} ≤ 2.0 V		−20		20	mV
	I_{OUT} = 10 mA to 150 mA				18	40	mV
Dropout Voltage	I_{OUT} = 150 mA	0.8 V ≤ V_{OUT} < 0.9 V	V_{DO}			(Note 3)	V
		0.9 V ≤ V_{OUT} < 1.0 V				(Note 3)	
		1.0 V ≤ V_{OUT} < 1.5 V			0.24	0.4	
		1.5 V ≤ V_{OUT} < 2.6 V			0.19	0.25	
		2.6 V ≤ V_{OUT} < 4.0 V			0.12	0.18	
Output Current			I_{OUT}	150			mA
Short Current Limit	V_{OUT} = 0 V		I_{SC}		50		mA
Quiescent Current	I_{OUT} = 0 mA, Low Power Mode (Note 4)	V_{OUT} ≤ 1.85 V	I_Q		1.0	4.0	μA
		V_{OUT} > 1.85 V			1.5	4.0	
Supply Current	I_{OUT} = 10 mA, Fast Mode		I_{GND}		55		μA
Standby Current	V_{CE} = 0 V, T_J = 25°C		I_{STB}		0.1	1	μA
Fast Mode Switch−Over Current	I_{OUT} = light to heavy load		I_{OUTH}			8.0	mA
Low Power Switch−Over Current	I_{OUT} = heavy to light load		I_{OUTL}	1.0	2.0		mA
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}		0.1		μA

3. V_{IN} > 1.4 V condition is dominant against this specification
4. The value of quiescent current is excluding the pull−down current of CE and AE pin

ELECTRICAL CHARACTERISTICS

$-40°C \leq T_A \leq 85°C$; $V_{IN} = V_{OUT(NOM)}$ + 1 V or 2.5 V, whichever is greater; I_{OUT} = 1 mA, $C_{IN} = C_{OUT}$ = 0.47 μF, unless otherwise noted. Typical values are at T_A = +25°C.

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
AE Pin Threshold Voltage	AE Input Voltage “H”	V_{AEH}	1.0			V
	AE Input Voltage “L”	V_{AEL}			0.4	
AE Pull Down Current		I_{AEPD}		0.1		μA
Power Supply Rejection Ratio	$V_{IN} = V_{OUT}$ + 1 V or 2.2 V whichever is higher, ΔV_{IN} = 0.2 V_{pk-pk}, I_{OUT} = 30 mA, f = 1 kHz, Fast Mode	PSRR		70		dB
Output Noise Voltage	V_{OUT} = 1.2 V, I_{OUT} = 30 mA, f = 10 Hz to 100 kHz	V_N		115		μV_{rms}
Low Output Nch Tr. On Resistance	V_{IN} = 4 V, V_{CE} = 0 V	R_{LOW}		50		Ω

3. V_{IN} > 1.4 V condition is dominant against this specification
4. The value of quiescent current is excluding the pull−down current of CE and AE pin

TYPICAL CHARACTERISTICS

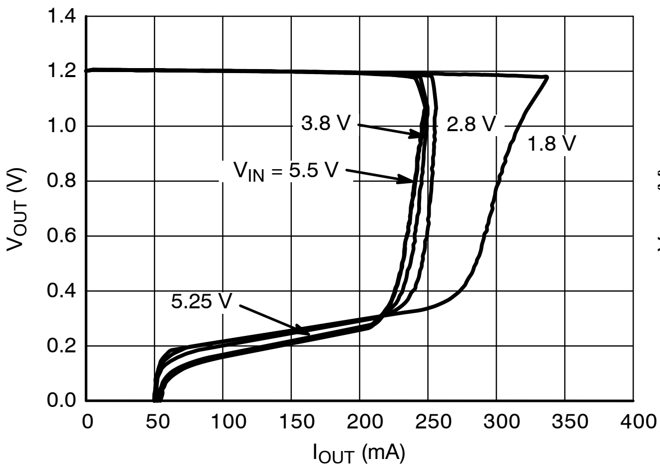


Figure 3. Output Voltage vs. Output Current 1.2 V Version (T_A = 25°C)

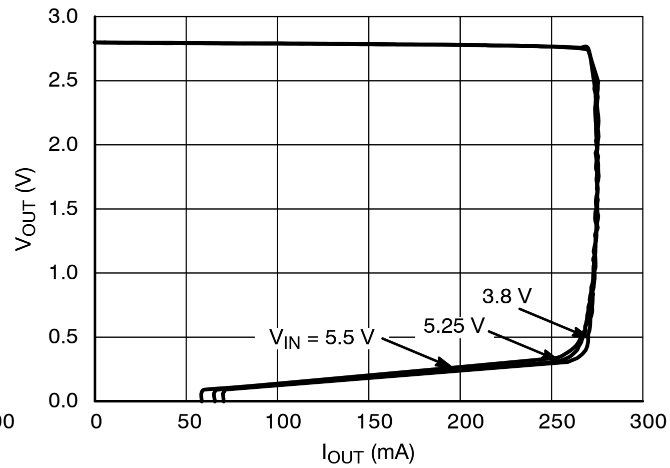


Figure 4. Output Voltage vs. Output Current 2.8 V Version (T_A = 25°C)

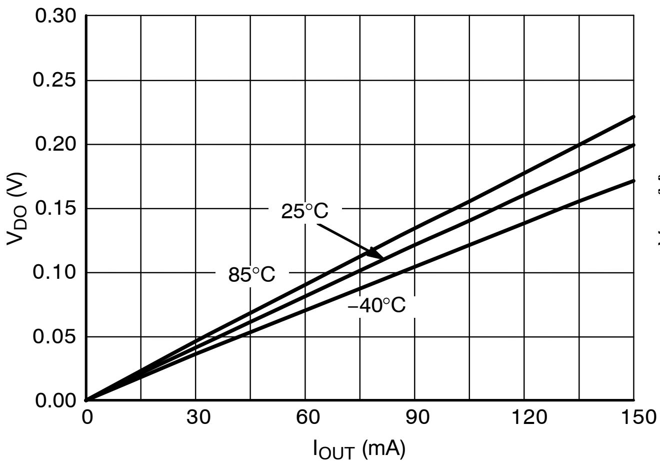


Figure 5. Dropout Voltage vs. Output Current 1.2 V Version

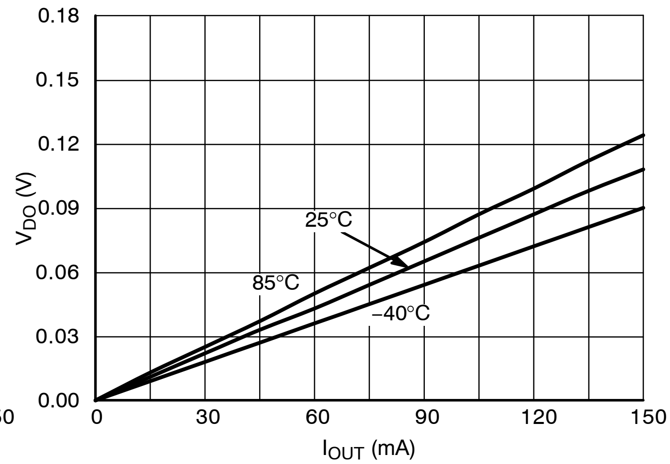


Figure 6. Dropout Voltage vs. Output Current 2.8 V Version

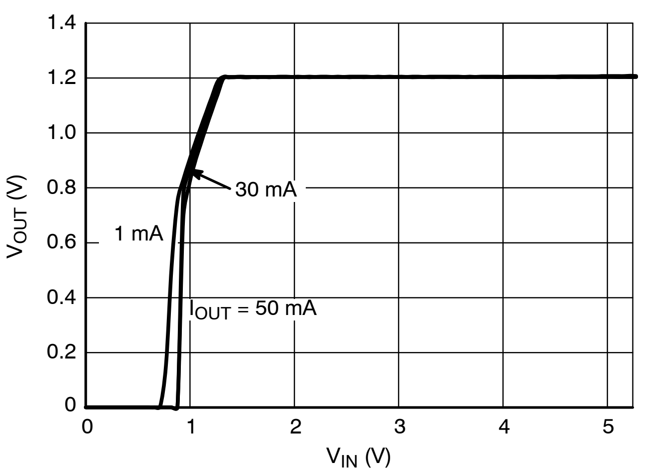


Figure 7. Input Voltage vs. Output Voltage 1.2 V Version

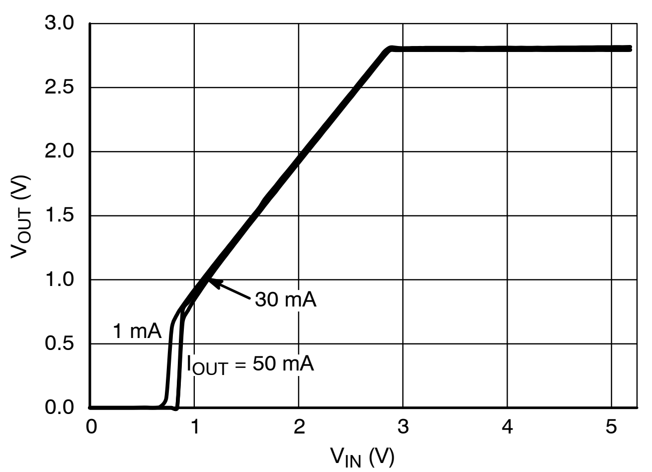


Figure 8. Input Voltage vs. Output Voltage 2.8 V Version

TYPICAL CHARACTERISTICS

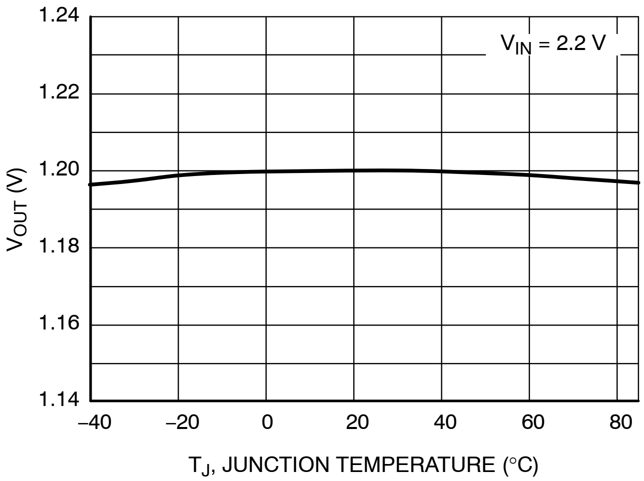


Figure 9. Output Voltage vs. Temperature, 1.2 V Version

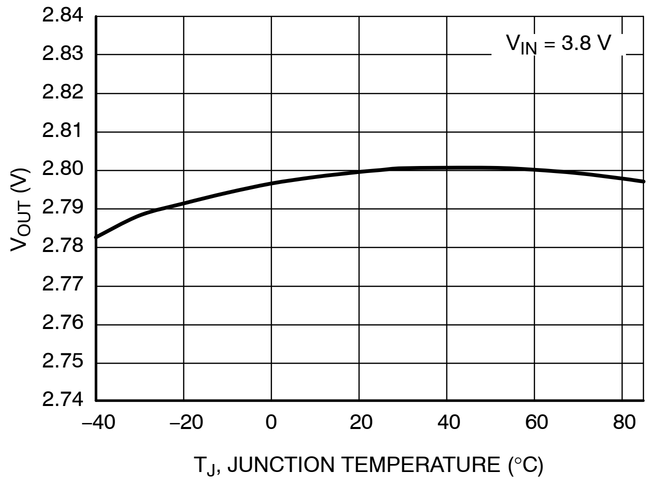


Figure 10. Output Voltage vs. Temperature, 2.8 V Version

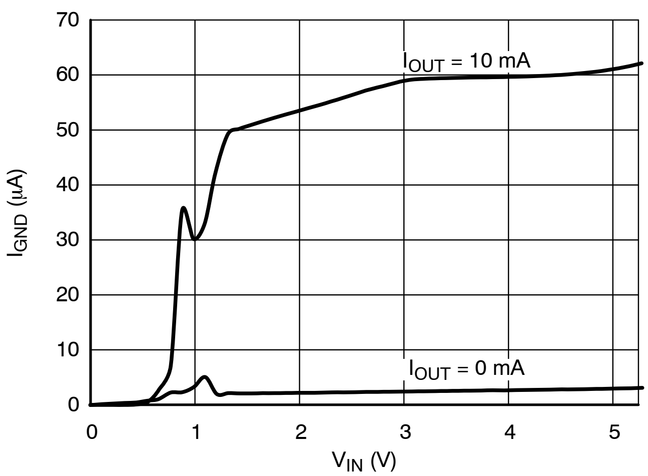


Figure 11. Supply Current vs. Input Voltage, 1.2 V Version

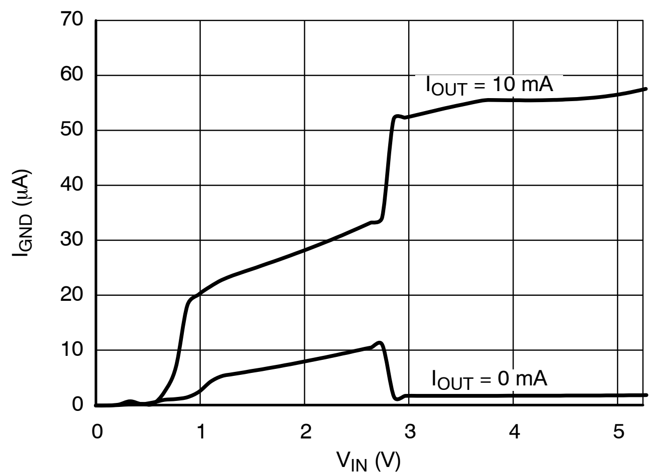


Figure 12. Supply Current vs. Input Voltage, 2.8 V Version

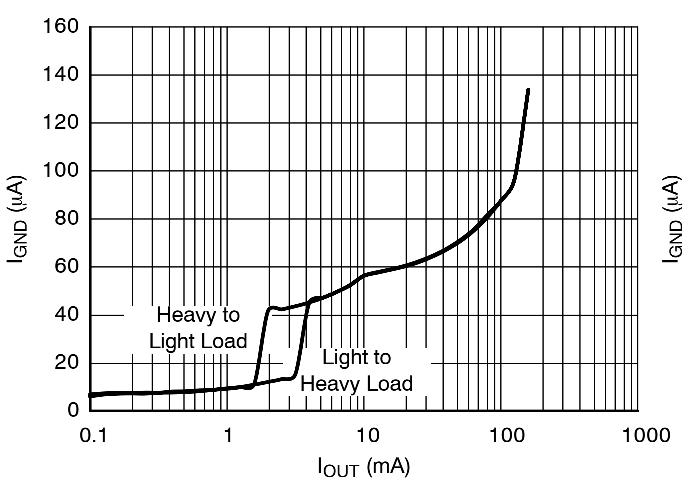


Figure 13. Supply Current vs. Output Current, 1.2 V Version, V_{IN} = 2.2 V, V_{AE} = 0 V

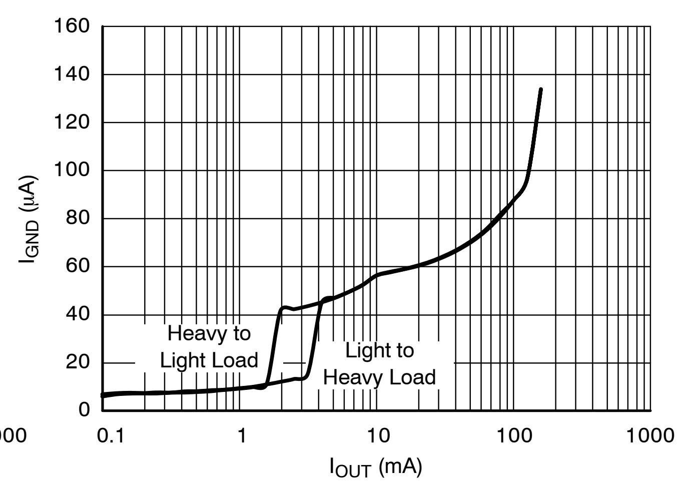


Figure 14. Supply Current vs. Output Current, 2.8 V Version, V_{IN} = 3.8 V, V_{AE} = 0 V

TYPICAL CHARACTERISTICS

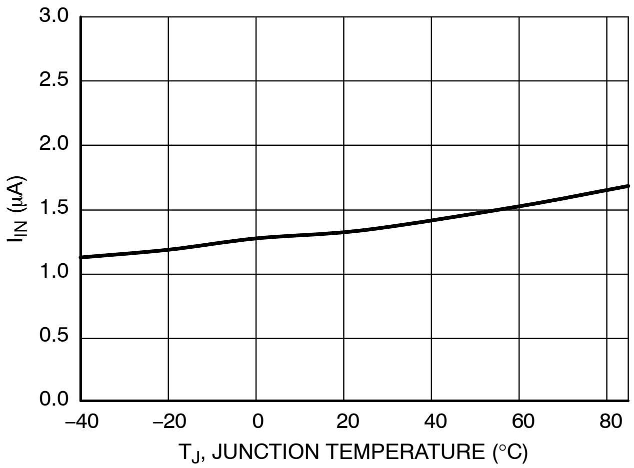


Figure 15. Supply Current vs. Temperature, 1.2 Version, V_{IN} = 2.2 V, V_{AE} = 0 V

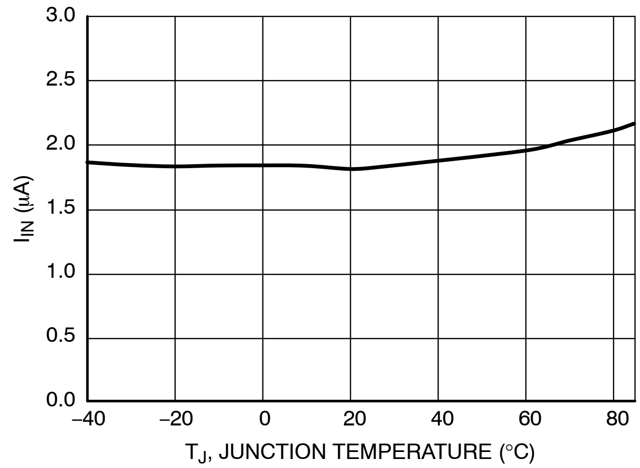


Figure 16. Supply Current vs. Temperature, 2.8 Version, V_{IN} = 3.8 V, V_{AE} = 0 V

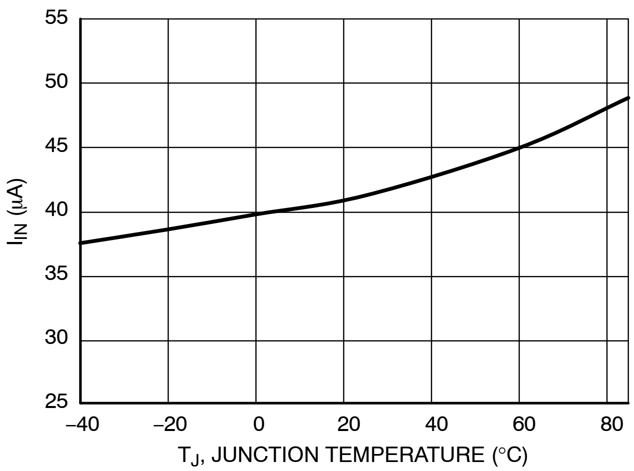


Figure 17. Supply Current vs. Temperature, 1.2 Version, V_{IN} = 2.2 V, V_{AE} = 2.2 V

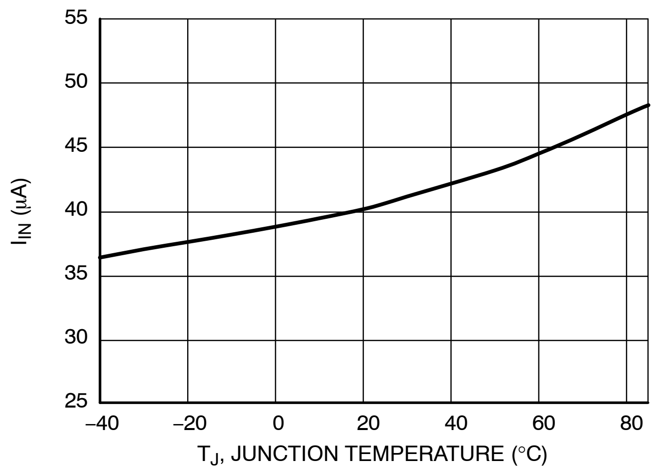


Figure 18. Supply Current vs. Temperature, 2.8 Version, V_{IN} = 3.8 V, V_{AE} = 3.8 V

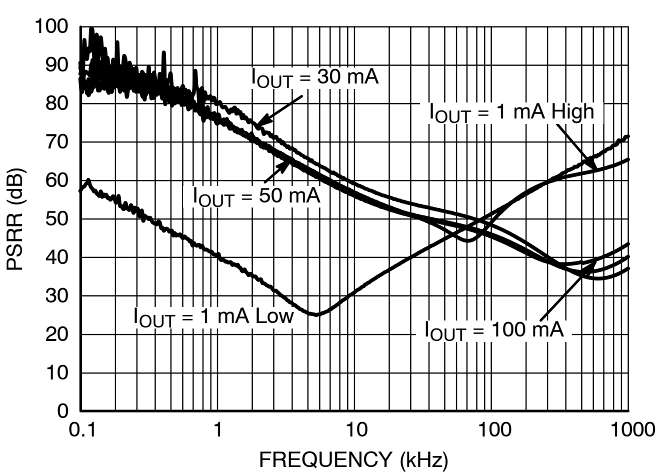


Figure 19. PSRR, 1.2 V Version, V_{IN} = 2.2 V

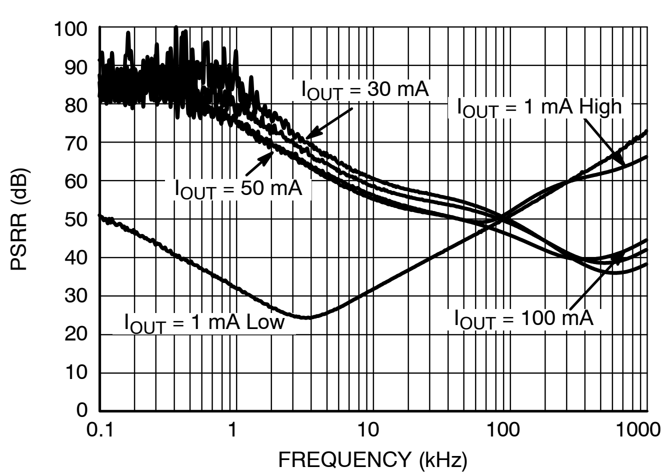


Figure 20. PSRR, 2.8 V Version, V_{IN} = 3.8 V

TYPICAL CHARACTERISTICS

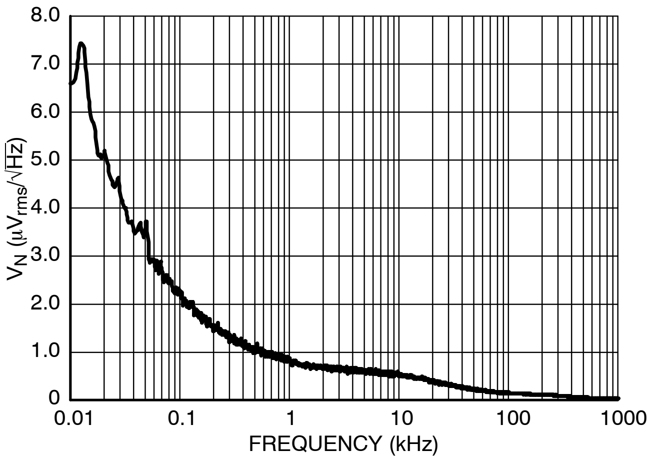


Figure 21. Output Voltage Noise, 1.2 V Version, I_{OUT} = 30 mA, , V_{IN} = 2.2 V

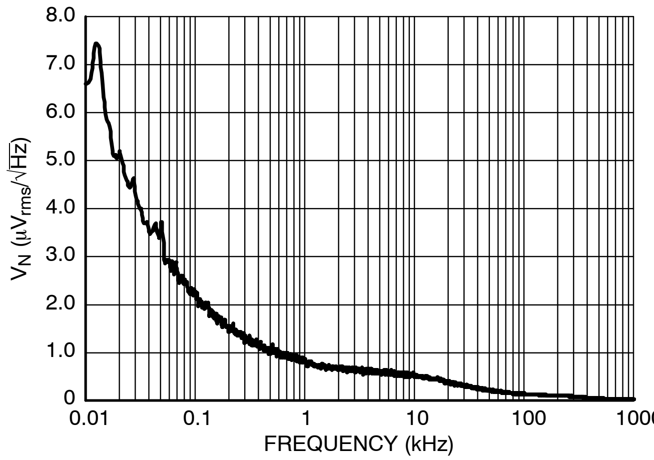


Figure 22. Output Voltage Noise, 2.8 V Version, I_{OUT} = 30 mA, V_{IN} = 3.8 V

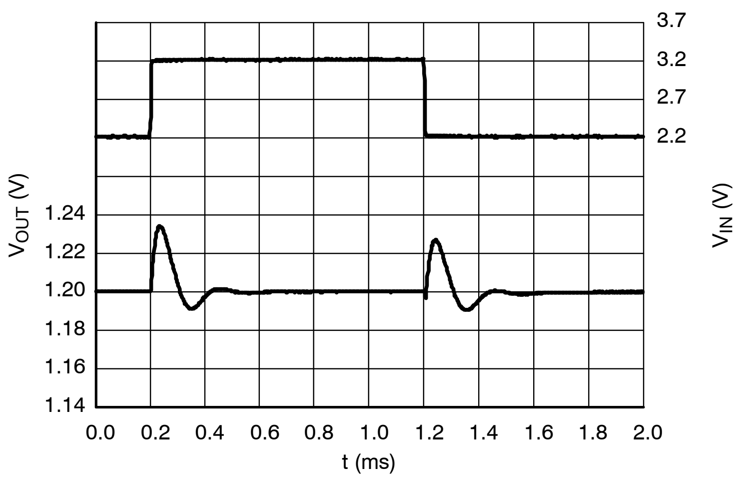


Figure 23. Line Transients, 1.2 V Version, $t_R = t_F = 5\ \mu s$, I_{OUT} = 1 mA, AE = 0 V

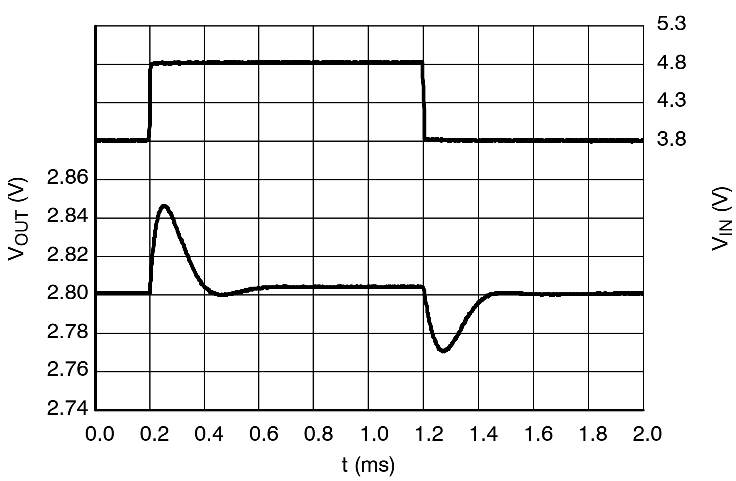


Figure 24. Line Transients, 2.8 V Version, $t_R = t_F = 5\ \mu s$, I_{OUT} = 1 mA, AE = 0 V

TYPICAL CHARACTERISTICS

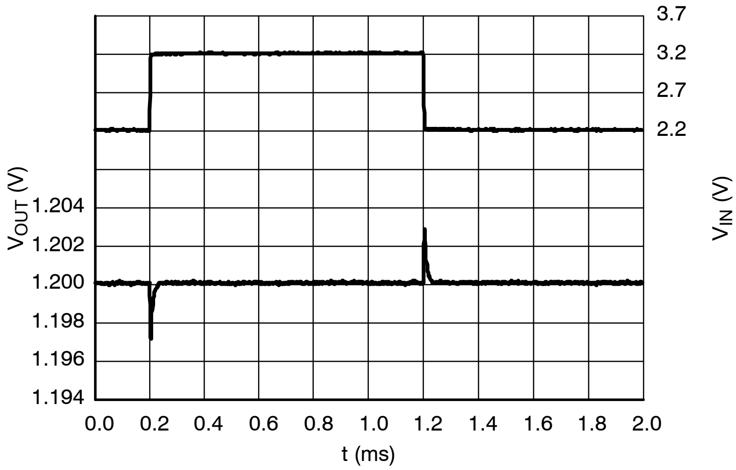


Figure 25. Line Transients, 1.2 V Version, $t_R = t_F = 5\ \mu s$, $I_{OUT} = 30$ mA, AE = V_{IN} V

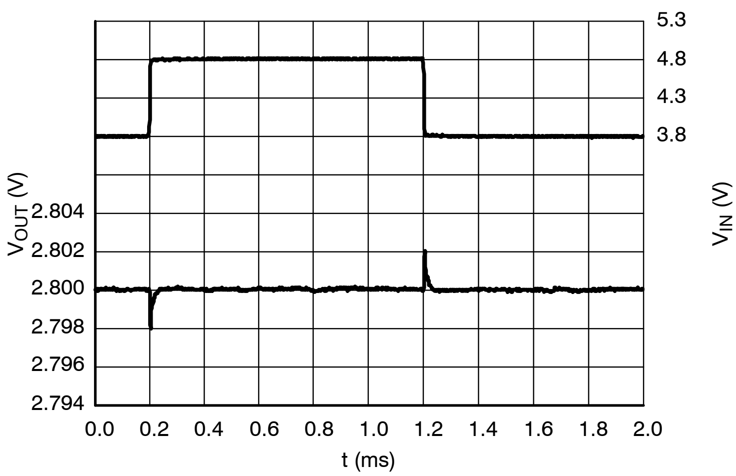


Figure 26. Line Transients, 2.8 V Version, $t_R = t_F = 5\ \mu s$, $I_{OUT} = 30$ mA, AE = V_{IN} V

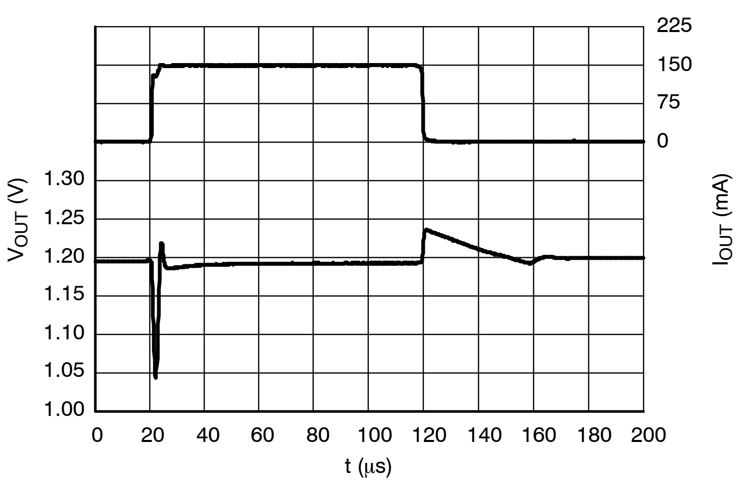


Figure 27. Load Transients, 1.2 V Version, $I_{OUT} = 1 – 150$ mA, $t_R = t_F = 0.5\ \mu s$, $V_{IN} = 2.2$ V, AE = 0 V

TYPICAL CHARACTERISTICS

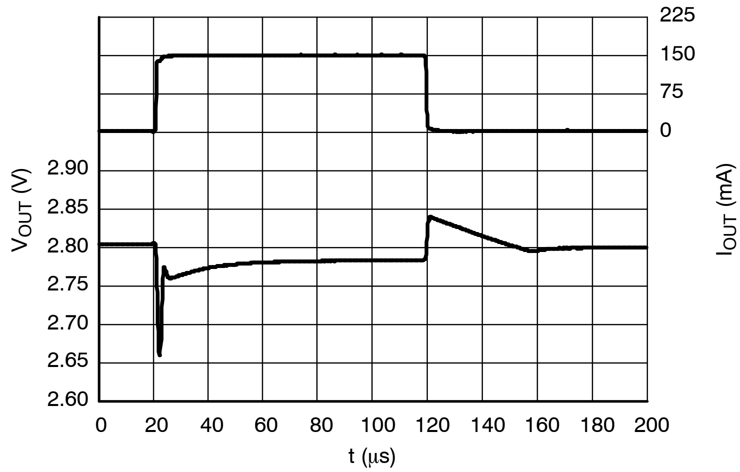


Figure 28. Load Transients, 2.8 V Version, I_{OUT} = 1 – 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 2.2 V, AE = 0 V

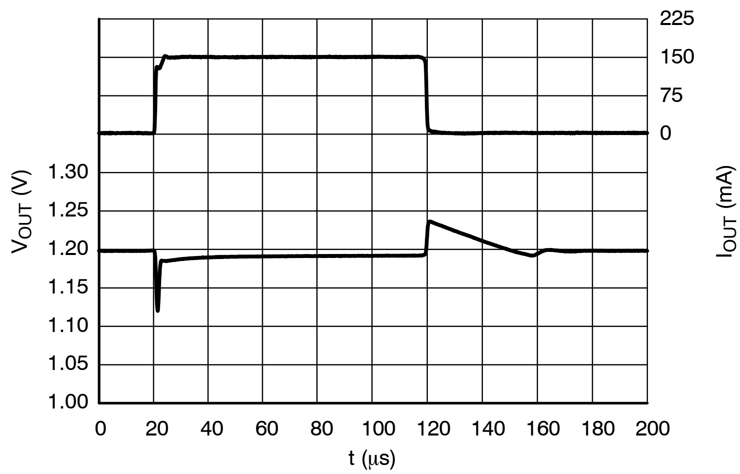


Figure 29. Load Transients, 1.2 V Version, I_{OUT} = 1 – 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 2.2 V, AE = V_{IN} V

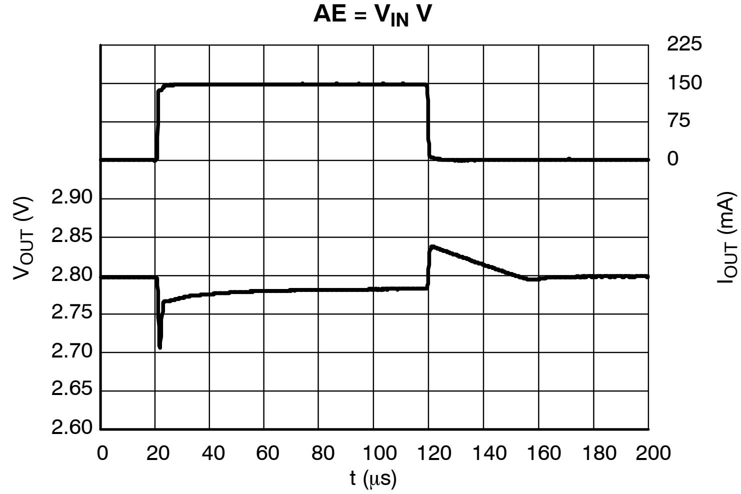


Figure 30. Load Transients, 2.8 V Version, I_{OUT} = 1 – 150 mA, $t_R = t_F$ = 0.5 μs, V_{IN} = 2.8 V, AE = V_{IN} V

TYPICAL CHARACTERISTICS

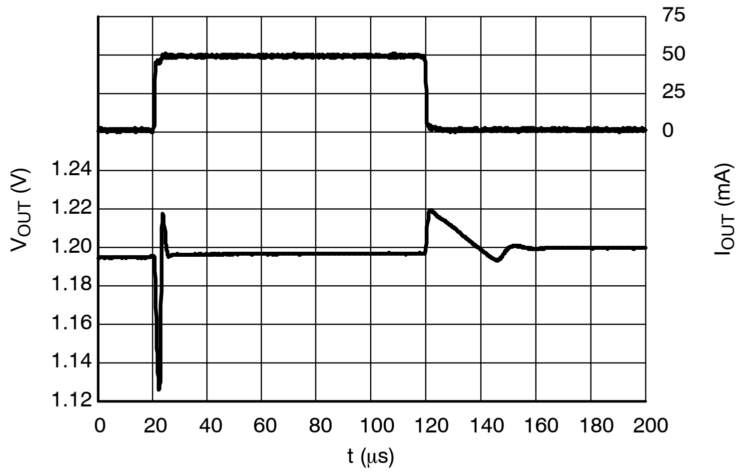


Figure 31. Load Transients, 1.2 V Version, I_{OUT} = 1 – 50 mA, $t_R = t_F$ = 0.5 µs, V_{IN} = 2.2 V, AE = 0 V

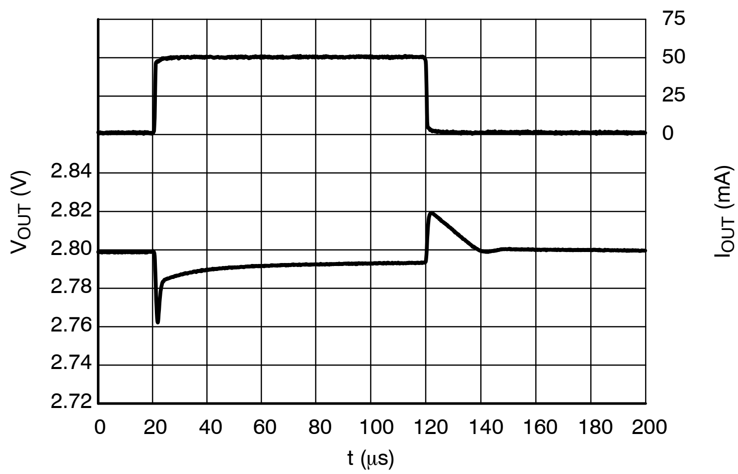


Figure 32. Load Transients, 2.8 V Version, I_{OUT} = 1 – 50 mA, $t_R = t_F$ = 0.5 µs, V_{IN} = 3.8 V, AE = 0 V

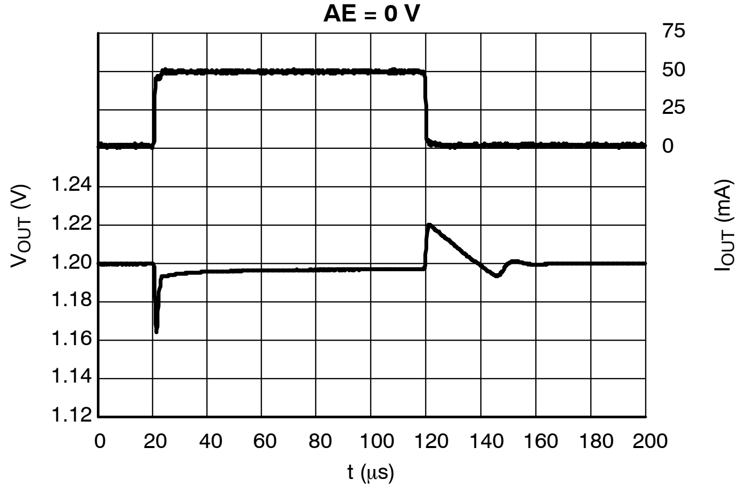


Figure 33. Load Transients, 1.2 V Version, I_{OUT} = 1 – 50 mA, $t_R = t_F$ = 0.5 µs, V_{IN} = 2.2 V, AE = V_{IN} V

TYPICAL CHARACTERISTICS

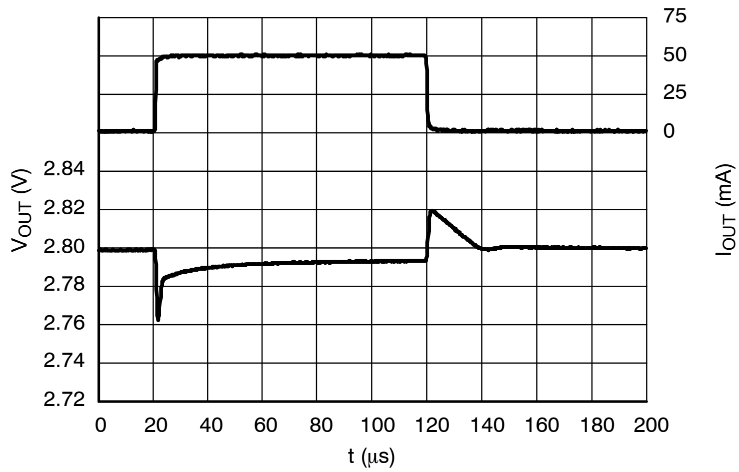


Figure 34. Load Transients, 2.8 V Version, I_{OUT} = 1 – 50 mA, t_R = t_F = 0.5 μs, V_{IN} = 3.8 V, AE = V_{IN} V

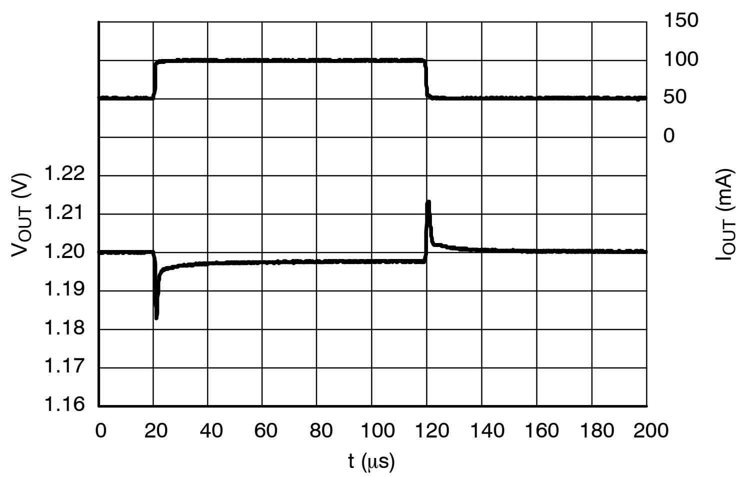


Figure 35. Load Transients, 1.2 V Version, I_{OUT} = 50 – 100 mA, t_R = t_F = 0.5 μs, V_{IN} = 2.2 V

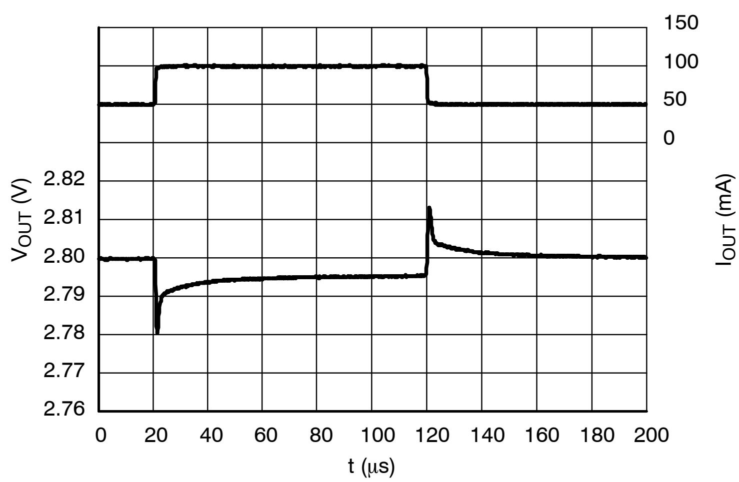


Figure 36. Load Transients, 2.8 V Version, I_{OUT} = 50 – 100 mA, t_R = t_F = 0.5 μs, V_{IN} = 3.8 V

TYPICAL CHARACTERISTICS

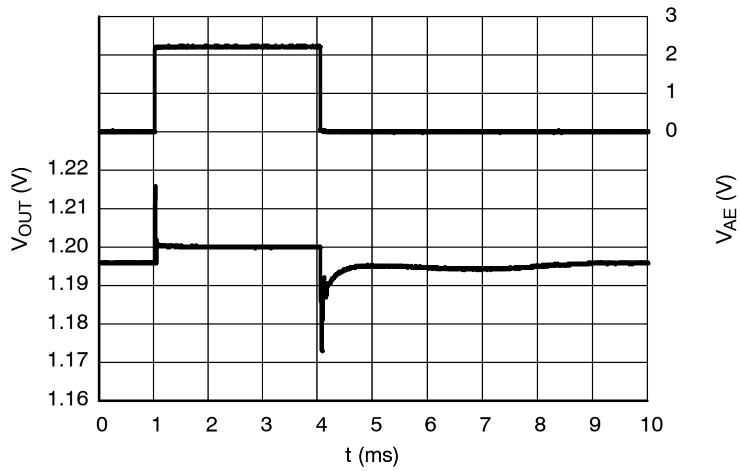


Figure 37. AE Switch Transients, 1.2 V Version, V_{IN} = 2.2 V, I_{OUT} = 1 mA

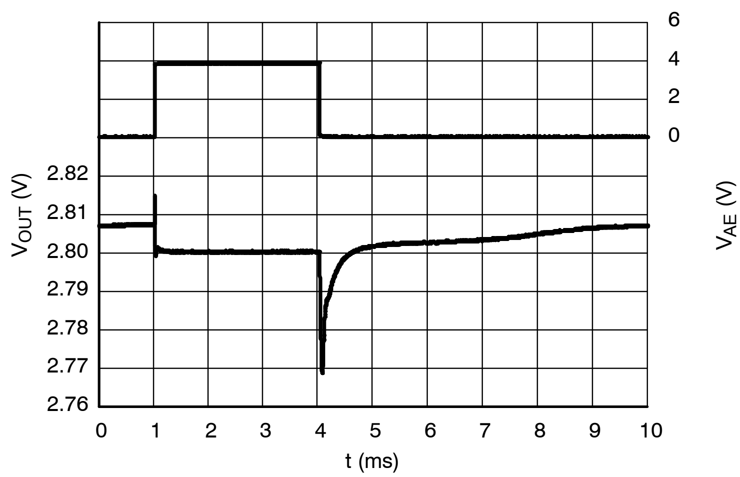


Figure 38. AE Switch Transients, 2.8 V Version, V_{IN} = 3.8 V, I_{OUT} = 1 mA

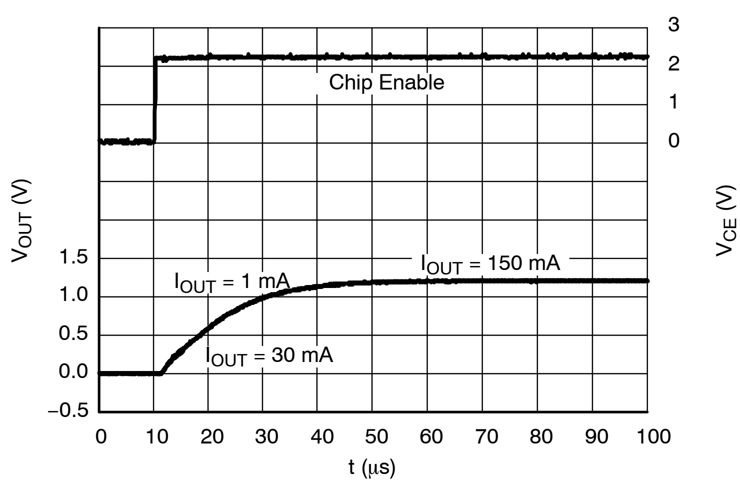


Figure 39. Start-up, 1.2 V Version, V_{IN} = 2.0 V

TYPICAL CHARACTERISTICS

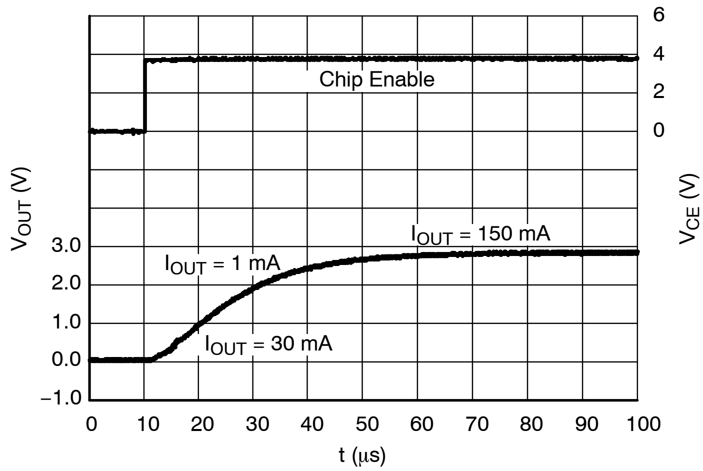


Figure 40. Start-up, 2.8 V Version, V_{IN} =3.8 V

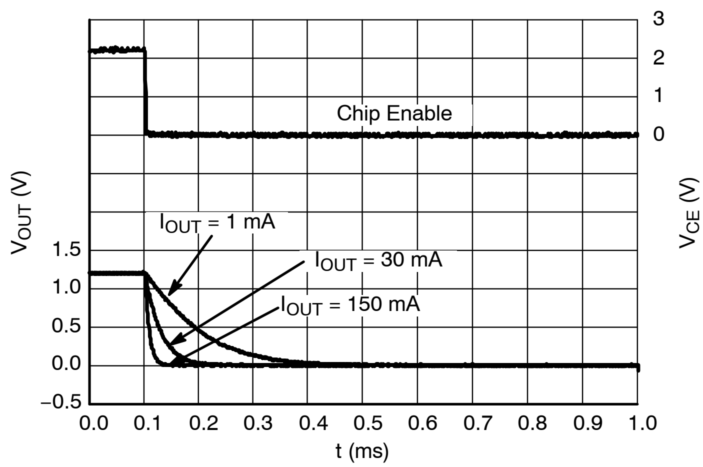


Figure 41. Shutdown, 1.2 V Version, V_{IN} = 2.2 V

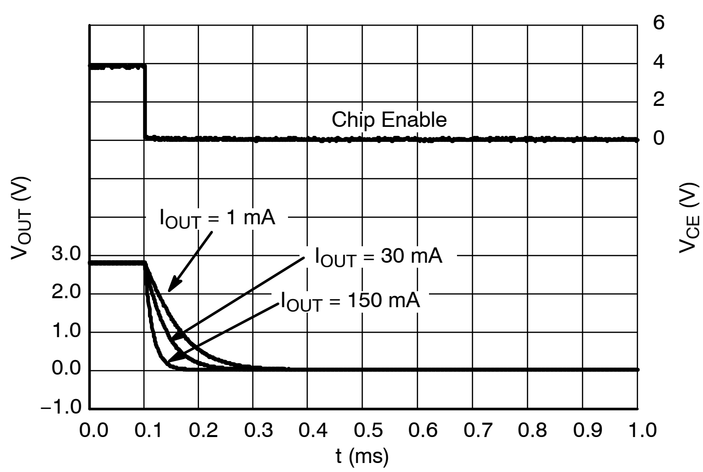


Figure 42. Shutdown, 2.8 V Version, V_{IN} = 3.8 V

APPLICATION INFORMATION

A typical application circuit for NCP4587 series is shown in Figure 43.

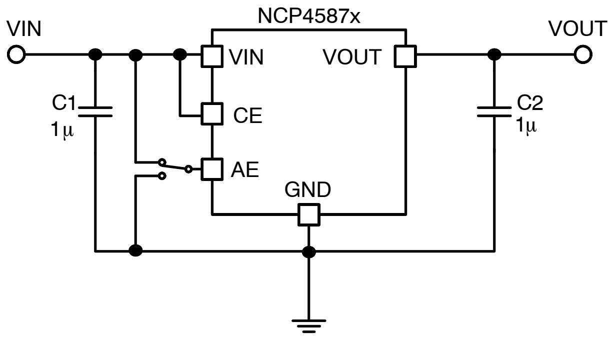


Figure 43. Typical Application Schematic

Input Decoupling Capacitor (C1)

A 1 μF ceramic input decoupling capacitor should be connected as close as possible to the input and ground pin of the NCP4587. Higher values and lower ESR improves line transient response.

Output Decoupling Capacitor (C2)

A 1 μF 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

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. Enable pin has internal pull down current source. If enable function is not needed connect CE pin to VIN.

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 VOUT 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 NCP4587 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 or floating Auto ECO mode is available. Please, see supply current vs. output current charts. If AE pin is at high level the device works in permanent Fast Transient Mode.

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

PCB layout

Make VIN and GND line 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

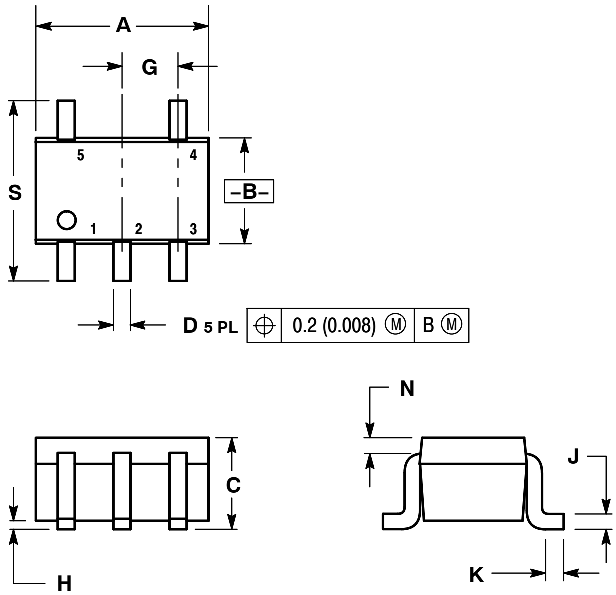
Device	Nominal Output Voltage	Description	Marking	Package	Shipping†
NCP4587DMX12TCG	1.2 V	Auto discharge	YE	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DMX18TCG	1.8 V	Auto discharge	YL	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DMX28TCG	2.8 V	Auto discharge	YW	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DMX30TCG	3.0 V	Auto discharge	YY	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DMX31TCG	3.1 V	Auto discharge	YZ	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DMX33TCG	3.3 V	Auto discharge	ZB	XDFN (Pb−Free)	5000 / Tape & Reel
NCP4587DSN12T1G	1.2 V	Auto discharge	DBE	SOT−23 (Pb−Free)	3000 / Tape & Reel
NCP4587DSN18T1G	1.8 V	Auto discharge	DBL	SOT−23 (Pb−Free)	3000 / Tape & Reel
NCP4587DSN28T1G	2.8 V	Auto discharge	DBW	SOT−23 (Pb−Free)	3000 / Tape & Reel
NCP4587DSN30T1G	3.0 V	Auto discharge	DBY	SOT−23 (Pb−Free)	3000 / Tape & Reel
NCP4587DSN33T1G	3.3 V	Auto discharge	EBB	SOT−23 (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.

NOTE: 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

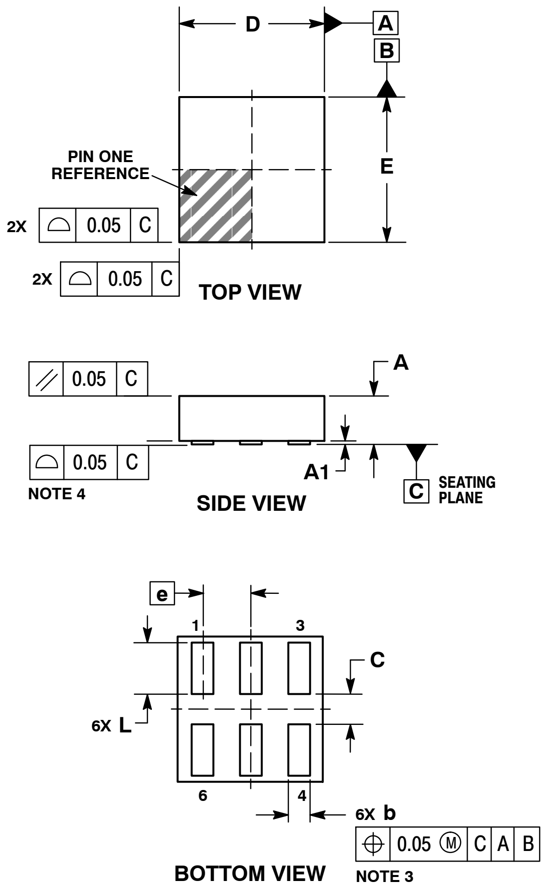


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A−01 OBSOLETE. NEW STANDARD 419A−02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

	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

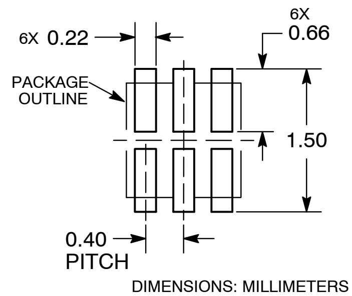
XDFN6 1.2x1.2, 0.4P
CASE 711AA−01
ISSUE O



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.

	MILLIMETERS	
DIM	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

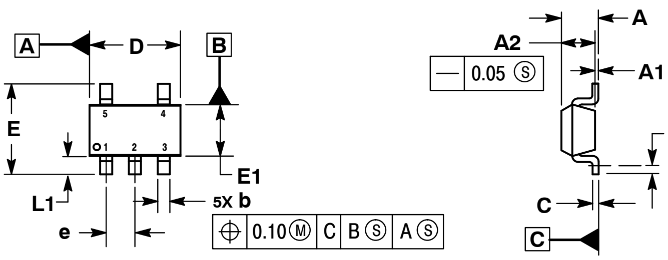
RECOMMENDED MOUNTING FOOTPRINT*



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

PACKAGE DIMENSIONS

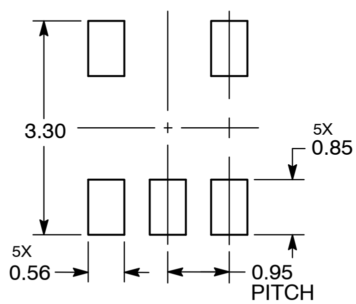
SOT−23
CASE 1212−01
ISSUE A



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.

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