



YOUSHANG SEMICONDUCTOR

设计研发新型功率器件

各类小信号开关

中低压及高压大电流等场效应管

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企业微信二维码



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Description

The NK-AP2202 is a 150mA ULDO regulator which provides very low noise, ultra-low dropout voltage (typically 165mV at 150mA), very low standby current (1µA maximum), and excellent power supply ripple rejection (PSRR 75dB at 100Hz). This device is used in battery-powered applications, such as handsets and PDAs; and in noise-sensitive applications, such as RF electronics.

The NK-AP2202 also features logic-compatible enable/shutdown control inputs, a low power shutdown mode for extended battery life, overcurrent protection, over temperature protection, and reversed current protection.

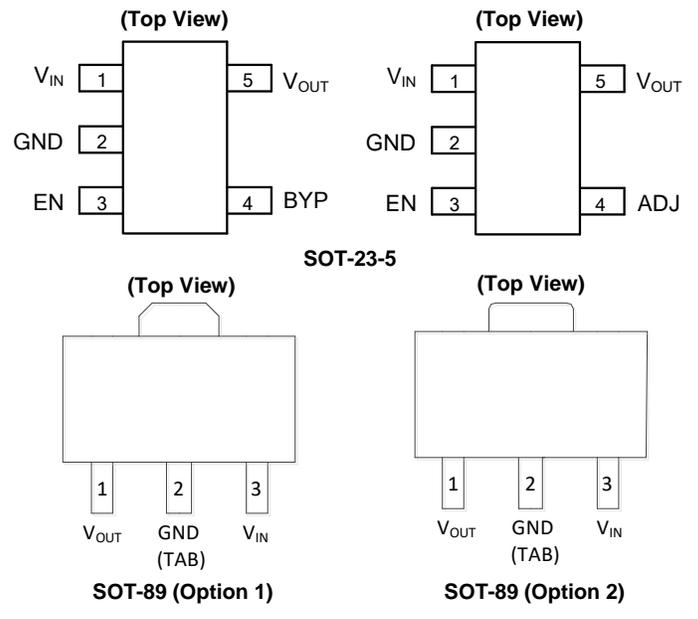
The NK-AP2202 has adjustable 2.5V, 2.6V, 2.8V, 3.0V, and 3.3V versions.

The NK-AP2202 is available in the space-saving SOT-23-5 and SOT-89 packages.

Features

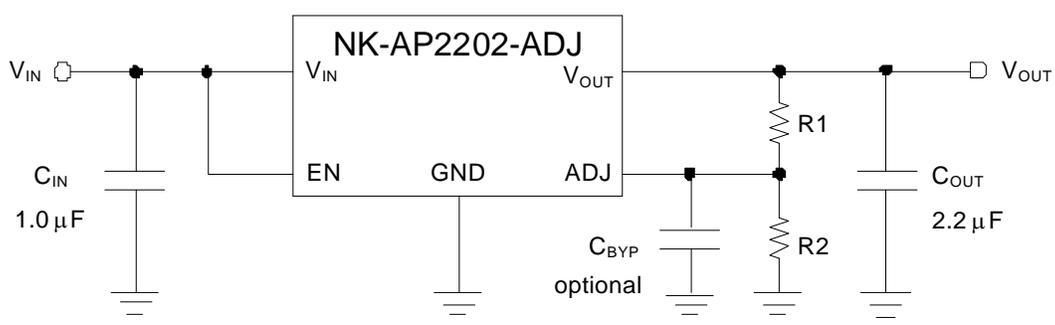
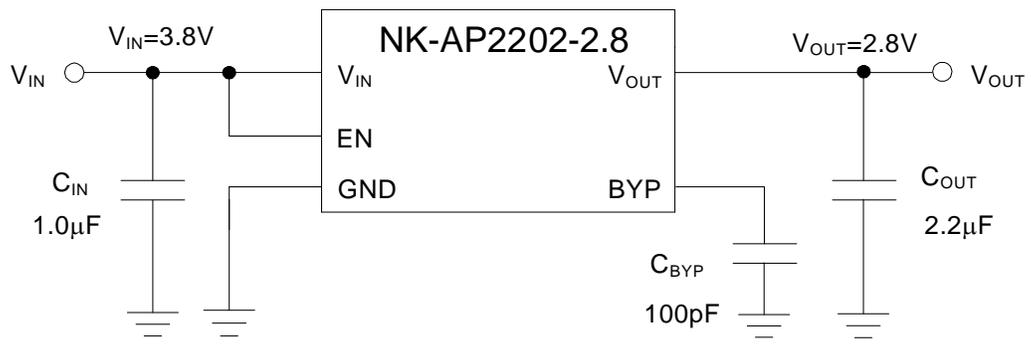
- Up to 150mA Output Current
- Low Standby Current
- Low Dropout Voltage: $V_{DROP} = 165mV$ at 150mA
- High Output Accuracy: $\pm 1\%$
- Good Ripple Rejection Ability: 75dB at 100Hz and $I_{OUT} = 100\mu A$
- Tight Load and Line Regulation
- Low Temperature Coefficient
- Overcurrent Protection
- Thermal Protection
- Reverse Current Protection
- Logic-Controlled Enable
- Lead-Free Packages: SOT-23-5, SOT-89
 - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in "Green" Molding Compound: SOT-23-5, SOT-89

Pin Assignments



Applications

- Cellular phones
- Cordless phones
- Digital still cameras
- Wireless communicators
- PDAs/palmtops
- PC mother boards
- Consumer electronics

Typical Applications Circuit (Note 4)


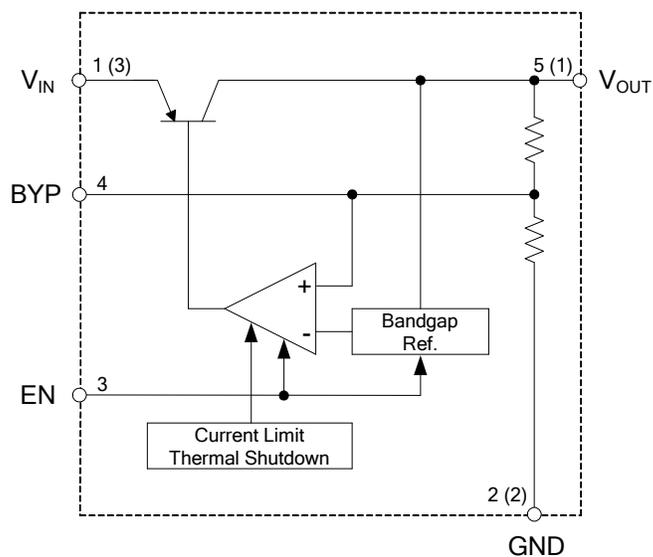
$$V_{OUT} = 1.25 * (1 + R2/R1)$$

Note: 4. Dropout voltage is 165mV when $T_A = +25^\circ\text{C}$. In order to obtain a normal output voltage, $V_{OUT} + 0.165\text{V}$ is the minimum input voltage which will result in a Low PSRR, imposing a bad influence on system. Therefore, the recommended input voltage is $V_{OUT} + 0.5\text{V}$ to 13.2V. For NK-AP2202-2.8 version, its input voltage can be set from 3.3V ($V_{OUT} + 0.5\text{V}$) to 13.2V. For that of ADJ version, any value from $V_{OUT} + 0.5\text{V}$ to 13.2V is available. R1 and R2 must be correctly selected when setting the output voltage. For example, if 3.0V output voltage is required, R1 and R2 can be set to 10k Ω and 14k Ω respectively. For ADJ version, we recommend 2.3V as minimum output voltage.

Pin Descriptions

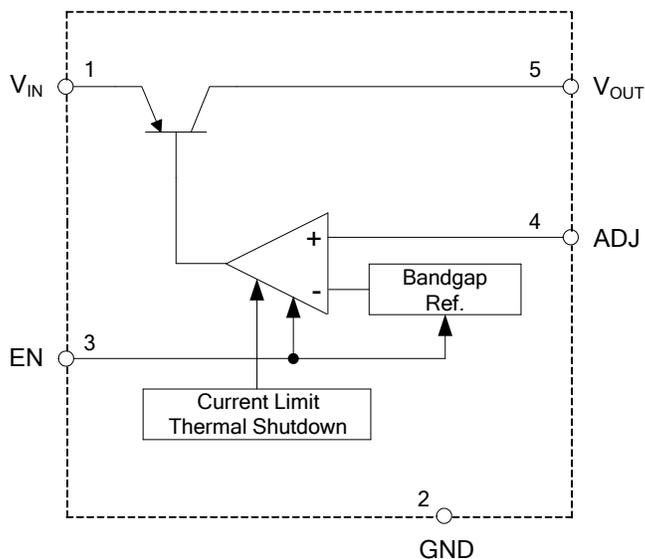
Pin Number		Pin Name	Function
SOT-23-5	SOT-89		
1	3	V_{IN}	Input voltage
2	2	GND	Ground (TAB for SOT-89)
3	—	EN	Enable input: CMOS or TTL compatible input. Logic high = enable, logic low = shutdown
4	—	BYP/ADJ	Bypass capacitor for low noise operation/Adjust output
5	1	V_{OUT}	Regulated output voltage

Functional Block Diagram



Fixed Regulator

A (B)
A for SOT-23-5
B for SOT-89



Adjustable Regulator

Absolute Maximum Ratings (Note 5)

Symbol	Parameter	Rating		Unit
V _{IN}	Supply Input Voltage	15		V
V _{EN}	Enable Input Voltage	15		V
P _D	Power Dissipation	Internally Limited (Thermal Protection)		W
T _{LEAD}	Lead Temperature (Soldering, 10sec)	+260		°C
T _J	Junction Temperature	+150		°C
T _{STG}	Storage Temperature	-65 to +150		°C
—	ESD (Machine Model)	200		V
θ _{JA}	Thermal Resistance (No Heatsink)	SOT-23-5	200	°C/W
		SOT-89	165	

Note: 5. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V _{IN}	Supply Input Voltage	2.5	13.2	V
V _{EN}	Enable Input Voltage	0	13.2	V
T _J	Operating Junction Temperature	-40	+125	°C

NK-AP2202-ADJ Electrical Characteristics (@ $V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = V_{OUT} + 1V$ to 13.2V	—	0.004	0.012	%V
			—	—	0.05	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to 150mA	—	0.02	0.2	%
			—	—	0.5	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
			—	—	70	
		$I_{OUT} = 50mA$	—	110	150	
			—	—	230	
		$I_{OUT} = 100mA$	—	140	250	
—	—	300				
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
			—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
			—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
—	—		800			
$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000			
	—	—	1500			
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900			
	—	—	2500			
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

NK-AP2202-ADJ Electrical Characteristics (continued) (@ $V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

NK-AP2202-2.5 Electrical Characteristics (@ $V_{IN} = 3.5V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	48	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 3.5V$ to $13.2V$	—	1	3	mV
			—	—	13	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $150mA$	—	1	5	mV
			—	—	13	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
			—	—	70	
		$I_{OUT} = 50mA$	—	110	150	
			—	—	230	
		$I_{OUT} = 100mA$	—	140	250	
		—	—	300		
		$I_{OUT} = 150mA$	—	165	275	
			—	—	350	
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
			—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
			—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000	
			—	—	1500	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900	
			—	—	2500	
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

NK-AP2202-2.5 Electrical Characteristics (continued) (@ $V_{IN} = 3.5V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

NK-AP2202-2.6 Electrical Characteristics (@ $V_{IN} = 3.6V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	46	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 3.6V$ to $13.2V$	—	1	3	mV
			—	—	13	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $150mA$	—	1	6	mV
			—	—	14	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
		$I_{OUT} = 50mA$	—	—	70	
		$I_{OUT} = 100mA$	—	110	150	
		$I_{OUT} = 100mA$	—	140	250	
		$I_{OUT} = 150mA$	—	165	275	
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	—	800	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000	μA
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	—	1500	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	—	2500	μA
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	—	2500	
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

NK-AP2202-2.6 Electrical Characteristics (continued) (@ $V_{IN} = 3.6V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

NK-AP2202-2.8 Electrical Characteristics (@ $V_{IN} = 3.8V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	42.8	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 3.8V$ to $13.2V$	—	1	4	mV
			—	—	14	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $150mA$	—	1	6	mV
			—	—	14	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
			—	—	70	
		$I_{OUT} = 50mA$	—	110	150	
			—	—	230	
		$I_{OUT} = 100mA$	—	140	250	
	—	—	300			
	$I_{OUT} = 150mA$	—	165	275		
		—	—	350		
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
			—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
			—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
	$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000		
		—	—	1500		
	$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900		
		—	—	2500		
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

NK-AP2202-2.8 Electrical Characteristics (continued) (@ $V_{IN} = 3.8V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

NK-AP2202-3.0 Electrical Characteristics (@ $V_{IN} = 4V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	40	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 4V$ to 13.2V	—	1	4	mV
			—	—	14	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to 150mA	—	1	7	mV
			—	—	15	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
			—	—	70	
		$I_{OUT} = 50mA$	—	110	150	
			—	—	230	
		$I_{OUT} = 100mA$	—	140	250	
		—	—	300		
		$I_{OUT} = 150mA$	—	165	275	
			—	—	350	
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
			—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
			—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000	
			—	—	1500	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900	
			—	—	2500	
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

NK-AP2202-3.0 Electrical Characteristics (continued) (@ $V_{IN} = 4V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

NK-AP2202-3.3 Electrical Characteristics (@ $V_{IN} = 4.3V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta V_{OUT}/V_{OUT}$	Output Voltage Accuracy	Variation from Specified V_{OUT}	-1	—	1	%
			-2	—	2	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient (Note 7)	—	—	120	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	36.3	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 4.3V$ to $13.2V$	—	1	5	mV
			—	—	15	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $150mA$	—	1	8	mV
			—	—	17	
V_{DROP}	Dropout Voltage (Note 9)	$I_{OUT} = 100\mu A$	—	15	50	mV
			—	—	70	
		$I_{OUT} = 50mA$	—	110	150	
			—	—	230	
		$I_{OUT} = 100mA$	—	140	250	
		—	—	300		
		$I_{OUT} = 150mA$	—	165	275	
			—	—	350	
I_{STD}	Standby Current	$V_{EN} \leq 0.4V$ (Shutdown)	—	0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)	—	—	5	
I_{GND}	Ground Pin Current (Note 10)	$V_{EN} \geq 2.0V$, $I_{OUT} = 0\mu A$	—	95	130	μA
			—	—	150	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	98	140	
			—	—	160	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 100mA$	—	600	1000	
			—	—	1500	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1300	1900	
			—	—	2500	
PSRR	Ripple Rejection	Frequency = 100Hz, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	320	550	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$ 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}

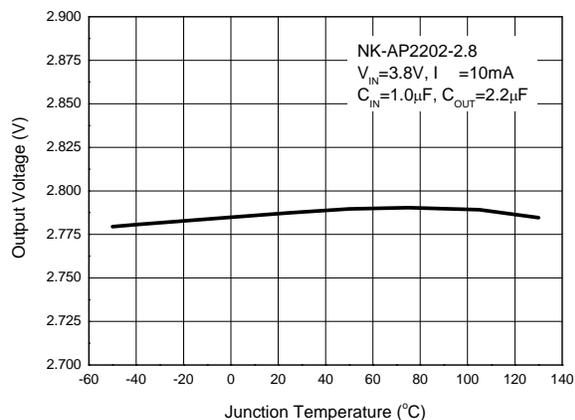
NK-AP2202-3.3 Electrical Characteristics (continued) (@ $V_{IN} = 4.3V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Enable Input Logic-Low Voltage	Regulator Shutdown	—	—	0.4	V
			—	—	0.18	
V_{IH}	Enable Input Logic-High Voltage	Regulator Enabled	2.0	—	—	V
I_{IL}	Enable Input Logic-Low Current	$V_{IL} \leq 0.4V$	—	0.01	1	μA
		$V_{IL} \leq 0.18V$	—	—	2	
I_{IH}	Enable Input Logic-High Current	$V_{IH} \geq 2.0V$	—	5	20	μA
		$V_{IH} \geq 2.0V$	—	—	25	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	$^\circ C/W$
		SOT-89	—	50	—	

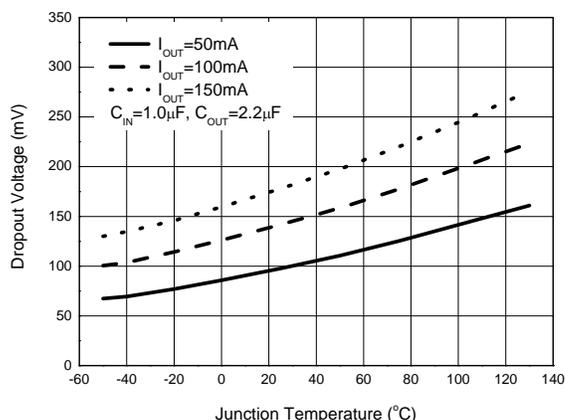
- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
 - Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ($T_J = +25^\circ C$) or 2% ($-40^\circ C \leq T_J \leq +125^\circ C$) below its nominal value measured at 1V differential.
 - Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

Performance Characteristics

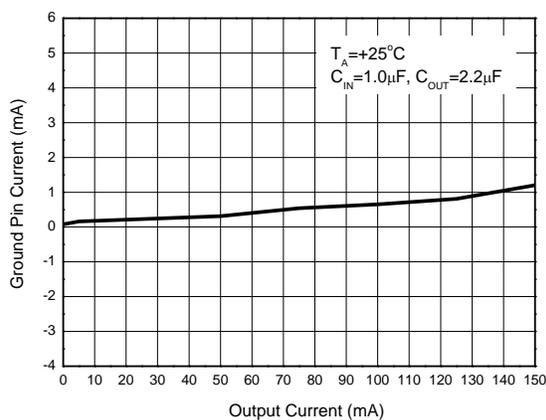
Output Voltage vs. Junction Temperature



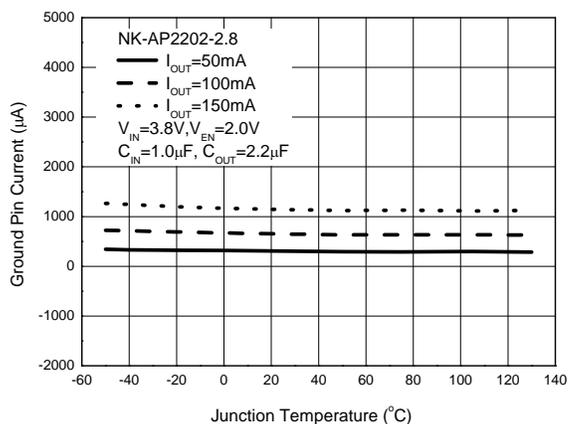
Dropout Voltage vs. Junction Temperature



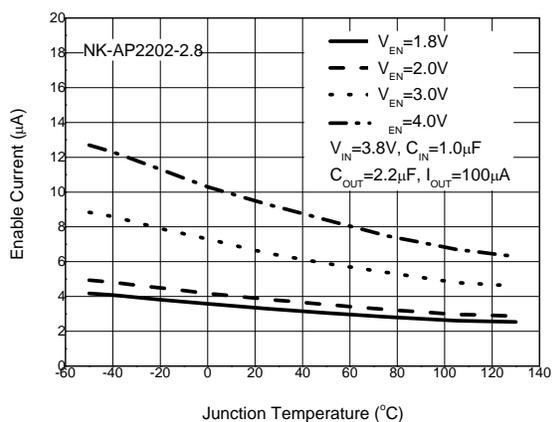
Ground Pin Current vs. Output Current



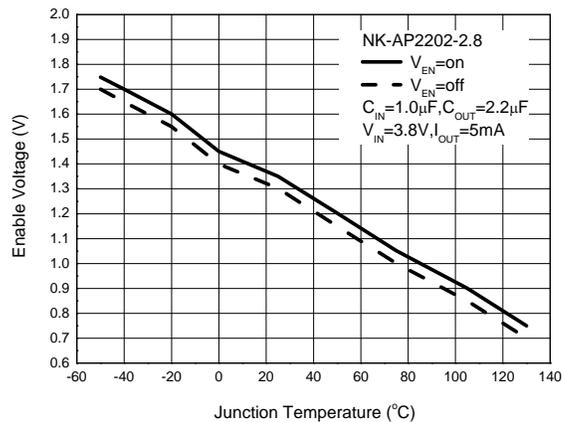
Ground Pin Current vs. Junction Temperature



Enable Current vs. Junction Temperature

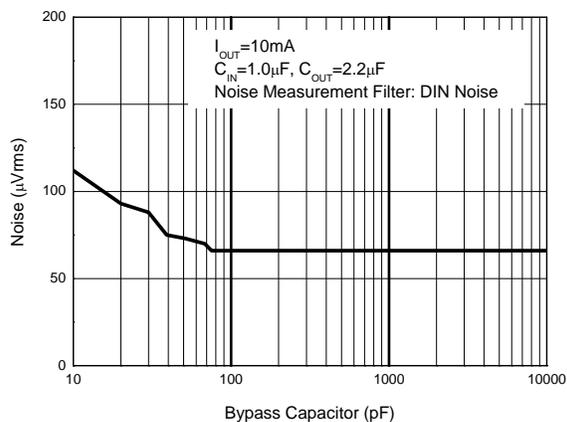


Enable Voltage vs. Junction Temperature

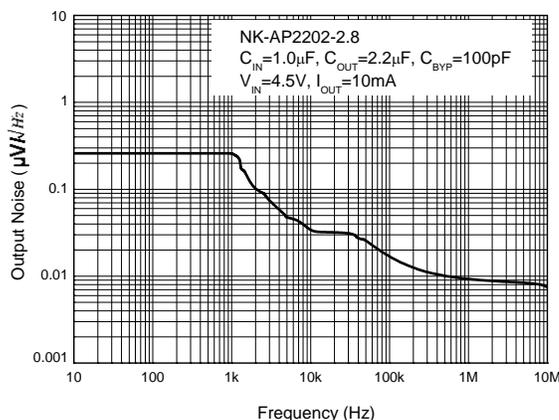


Performance Characteristics (continued)

Noise vs. Bypass Capacitor

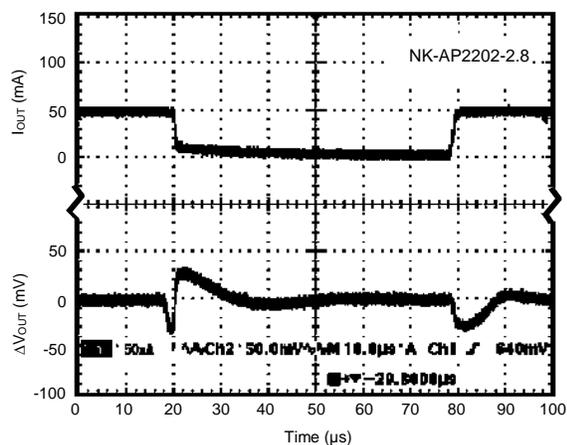


Output Noise vs. Frequency



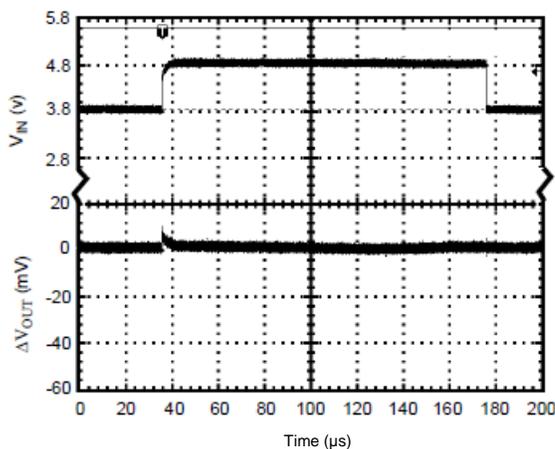
Load Transient

(Conditions: $V_{IN}=3.8V$, $C_{BYP}=100pF$, $V_{EN}=2V$, $I_{OUT}=5mA$ to $50mA$, $C_{IN}=1.0µF$, $C_{OUT}=2.2µF$)



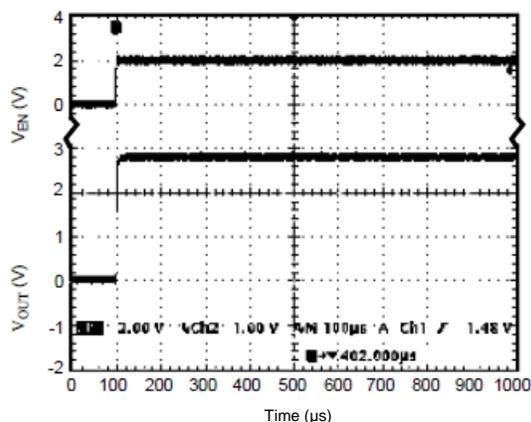
Line Transient

(Conditions: $V_{IN}=3.8V$ to $4.8V$, $V_{EN}=2V$, $I_{OUT}=100µA$, $C_{BYP}=100pF$, $C_{OUT}=10µF$)

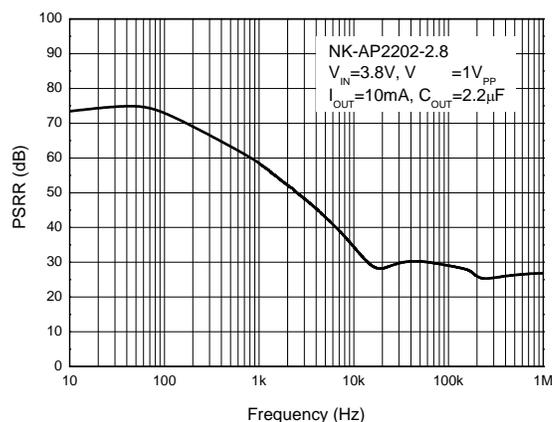


VEN(on) vs. VOUT

(Conditions: $V_{EN}=0V$ to $2V$, $V_{IN}=3.8V$, $I_{OUT}=30mA$, $C_{BYP}=open$, $C_{IN}=1.0µF$, $C_{OUT}=2.2µF$)

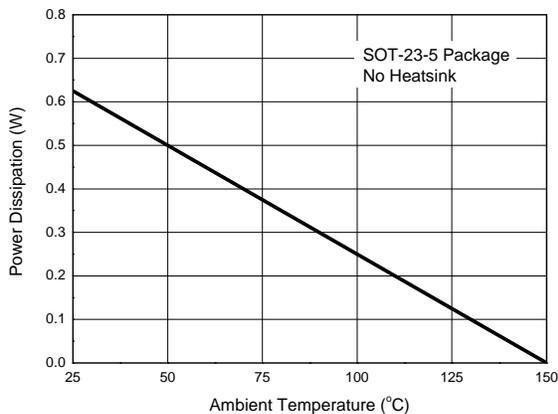


PSRR vs. Frequency

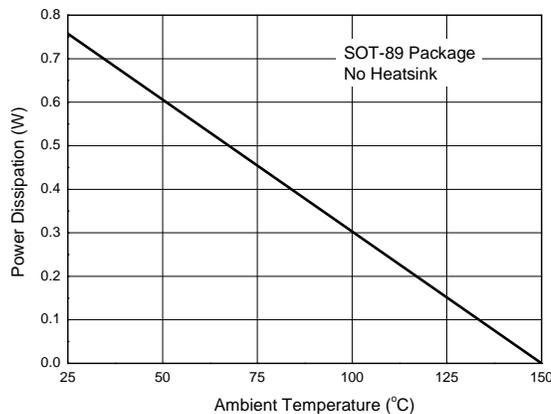


Performance Characteristics (continued)

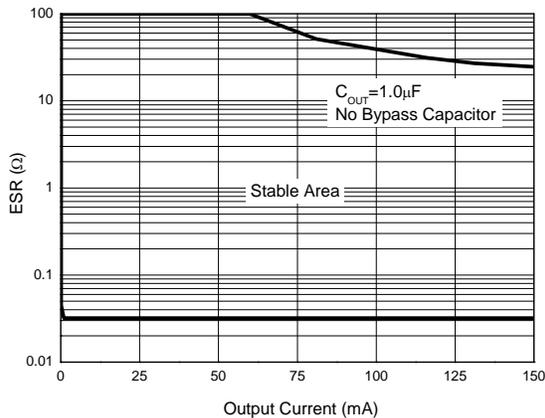
Power Dissipation vs. Ambient Temperature



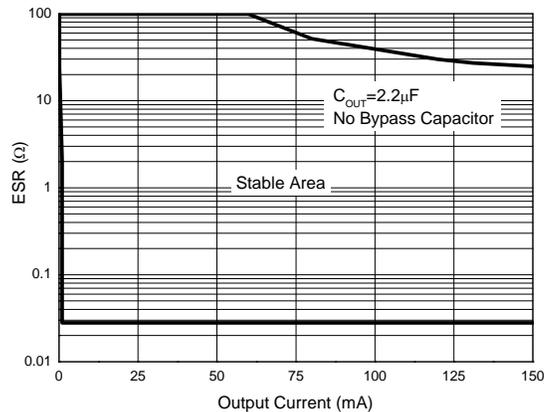
Power Dissipation vs. Ambient Temperature



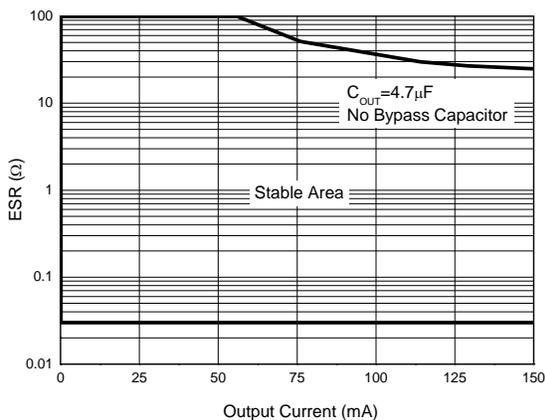
ESR vs. Output Current



ESR vs. Output Current



ESR vs. Output Current



Application Information

Input Capacitor

A 1 μ F minimum capacitor is recommended to be placed between V_{IN} and GND.

Output Capacitor

An output capacitor is required to prevent oscillation. A 1.0 μ F minimum is recommended when C_{BYP} is unused. A 2.2 μ F minimum is recommended when C_{BYP} is 100pF. The output capacitor may be increased to improve transient response.

Noise Bypass Capacitor

A bypass capacitor is connected to the internal voltage reference. A 100pF capacitor connected from BYP to GND makes this reference quiet, resulting in a significant reduction in output noise, but the ESR stable area will be narrowed.

The start-up speed of the NK-AP2202 is inversely proportional to the value of the reference bypass capacitor. In some cases, if output noise is not a major concern and rapid turn-on is necessary, omit C_{BYP} and leave BYP open.

Power Dissipation

Thermal shutdown may take place if the maximum power dissipation is exceeded in application. Under all possible operating conditions, the junction temperature must be within the range specified under absolute maximum ratings to avoid thermal shutdown.

To determine if the power dissipated in the regulator reaches the maximum power dissipation (see Figures Power Dissipation vs. Ambient Temperature (SOT-23-5 package and SOT-89 package)), use:

$$T_J = P_D \cdot \theta_{JA} + T_A$$

$$P_D = (V_{IN} - V_{OUT}) \cdot I_{OUT} + V_{IN} \cdot I_{GND}$$

Where: $T_J \leq T_{J(max)}$, $T_{J(max)}$ is absolute maximum ratings for the junction temperature; $V_{IN} \cdot I_{GND}$ can be ignored due to its small value.

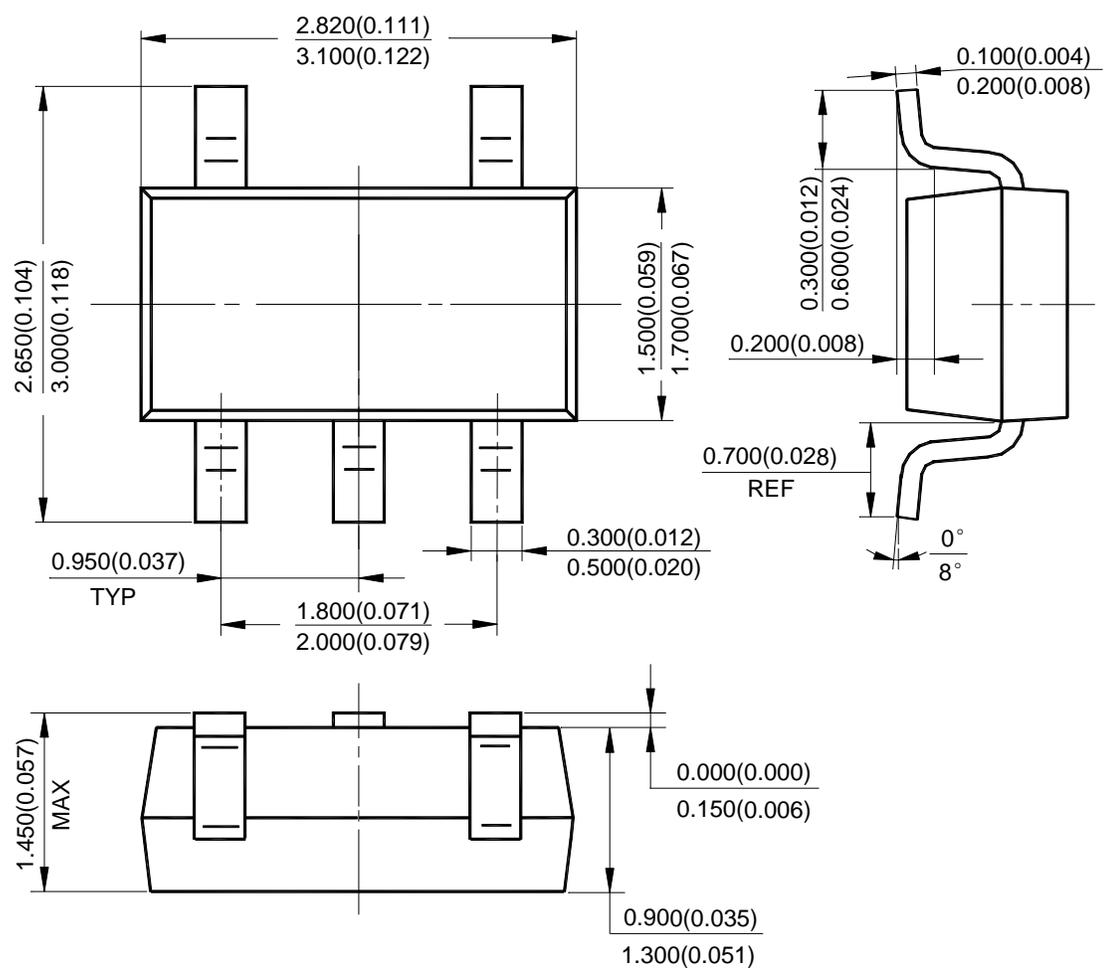
$T_{J(max)}$ is +150°C, θ_{JA} is 200°C/W for SOT-23-5 package; and 165°C/W for SOT-89 package. No heatsink is required since the package alone will dissipate enough heat to satisfy these requirements, unless the calculated value for power dissipation exceeds the limit.

Example: For 2.8V version packaged in SOT-23-5, $I_{OUT} = 150\text{mA}$, $T_A = +50^\circ\text{C}$, $V_{IN(Max)}$ is:
 $(150^\circ\text{C} - 50^\circ\text{C}) / (0.15\text{A} \cdot 200^\circ\text{C/W}) + 2.8\text{V} = 6.133\text{V}$

Therefore, for good performance, please make sure that input voltage is less than 6.133V without heatsink when $T_A = +50^\circ\text{C}$.

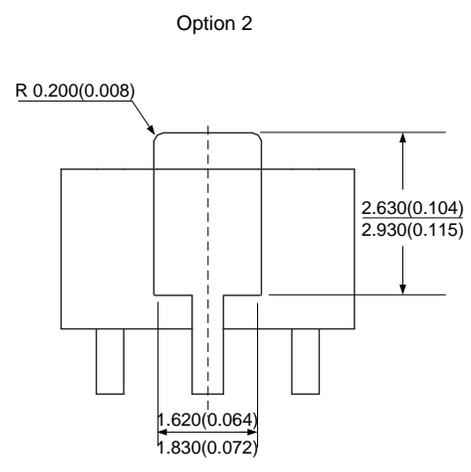
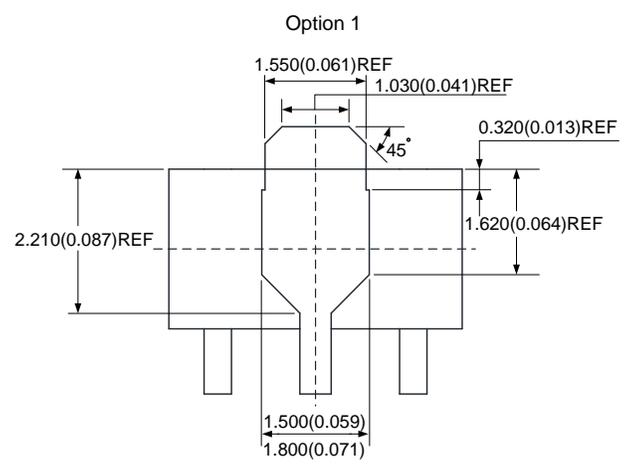
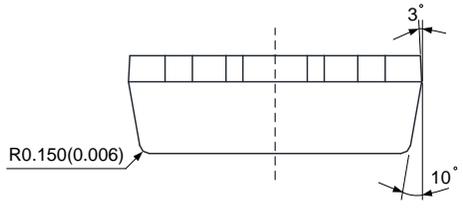
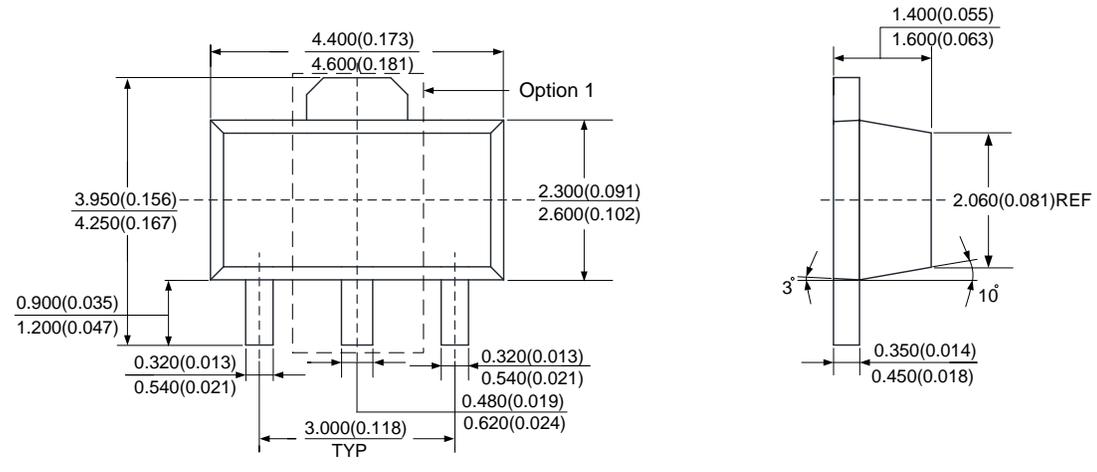
Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SOT-23-5



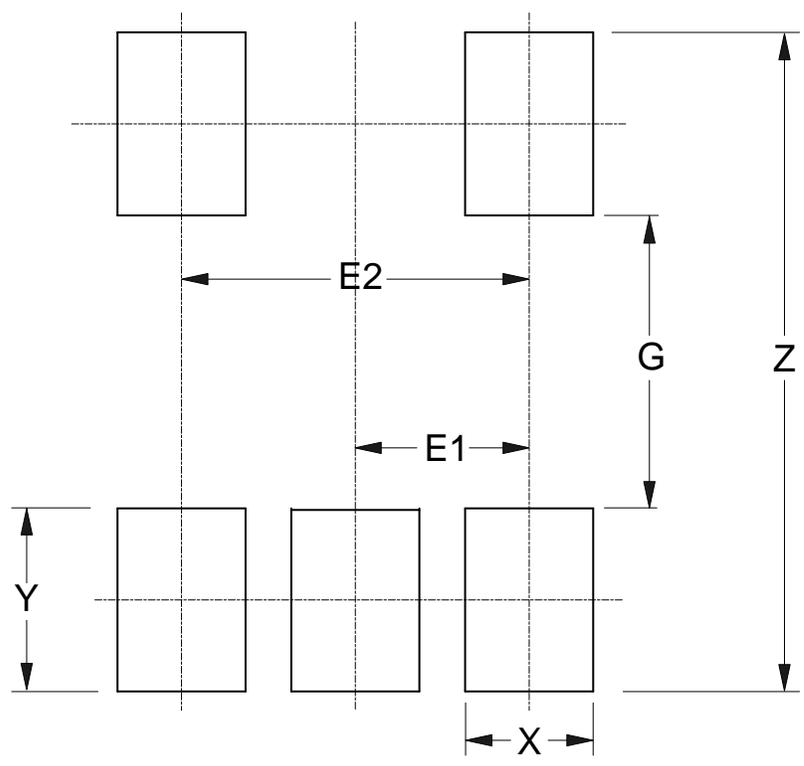
Package Outline Dimensions (continued) (All dimensions in mm(inch).)

(2) Package Type: SOT-89



Suggested Pad Layout

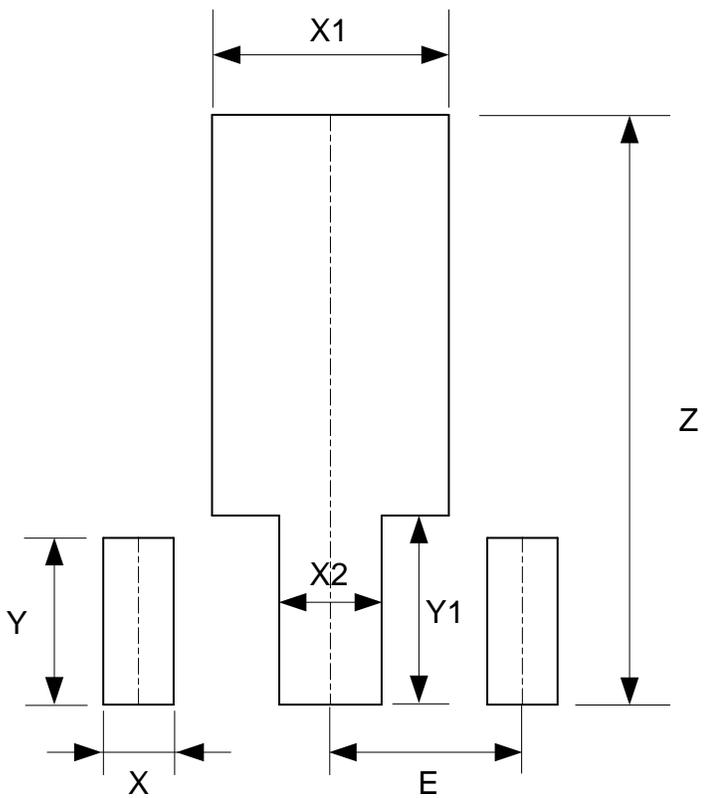
(1) Package Type: SOT-23-5



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E1 (mm)/(inch)	E2 (mm)/(inch)
Value	3.600/0.142	1.600/0.063	0.700/0.028	1.000/0.039	0.950/0.037	1.900/0.075

Suggested Pad Layout (continued)

(2) Package Type: SOT-89



Dimensions	Z (mm)/(inch)	X (mm)/(inch)	X1 (mm)/(inch)	X2 (mm)/(inch)	Y (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	4.600/0.181	0.550/0.022	1.850/0.073	0.800/0.031	1.300/0.051	1.475/0.058	1.500/0.059

Mechanical Data

- Moisture Sensitivity: Level 3 Per J-STD-020
- Terminals: SOT-23-5/SOT-89 Finish—Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 ③
- Weight:
 - SOT-23-5: 0.015 grams (Approximate)
 - SOT-89: 0.055 grams (Approximate)