



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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Description

The NK-AP2210 is a 300mA ULDO regulator which provides very low noise, ultra-low dropout voltage (typically 250mV at 300mA), 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-AP2210 also features individual logic compatible enable/shutdown control inputs, a low power shutdown mode for extended battery life, overcurrent protection, overtemperature protection, and reversed current protection.

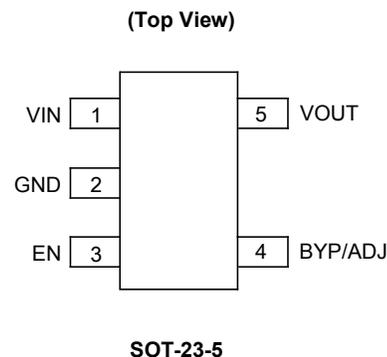
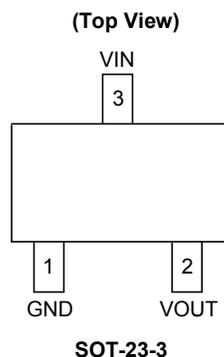
The NK-AP2210 has 2.5V, 2.8V, 3.0V, 3.3V, 3.6V, 4.0V, 5.0V, and ADJ versions.

The NK-AP2210 is available in the space saving SOT-23-3 and SOT-23-5 packages.

Features

- Up to 300mA Output Current
- Excellent ESR Stability
- Low Standby Current
- Low Dropout Voltage: $V_{DROP} = 250mV$ at 300mA
- 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
- Over-Current Protection
- Thermal Protection
- Reverse Current Protection
- Logic-controlled Enable
- Moisture Sensitivity: Level 3 Per J-STD-020
- Terminals: SOT-23-3/SOT-23-5 Finish—Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 @3
- Weight:
 - SOT-23-3: 0.014 grams (Approximate)
 - SOT-23-5: 0.015 grams (Approximate)
 - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in “Green” Molding Compound: SOT-23-3, SOT-23-5

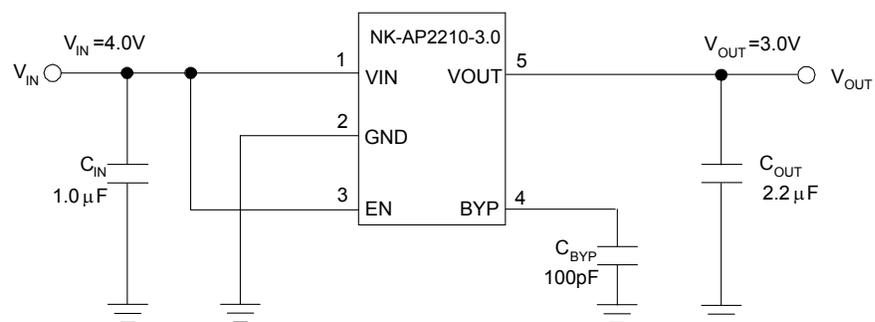
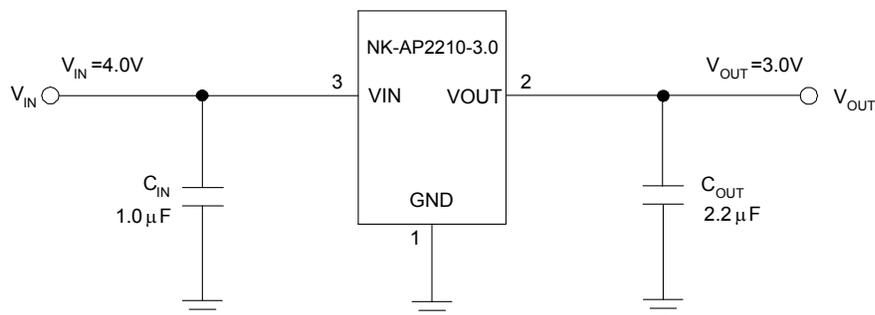
Pin Assignments



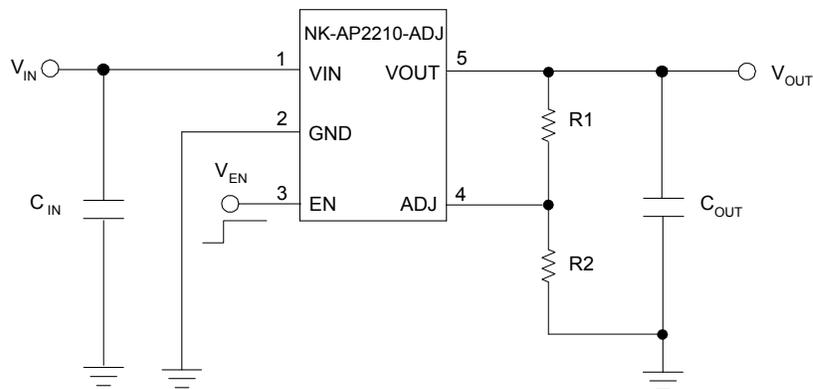
Applications

- Cellular Phones
- Cordless Phones
- Wireless Communicators
- PDAs/Palmtops
- PC Motherboards
- Consumer Electronics

Typical Applications Circuit (Note 4)



For Fixed Version



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

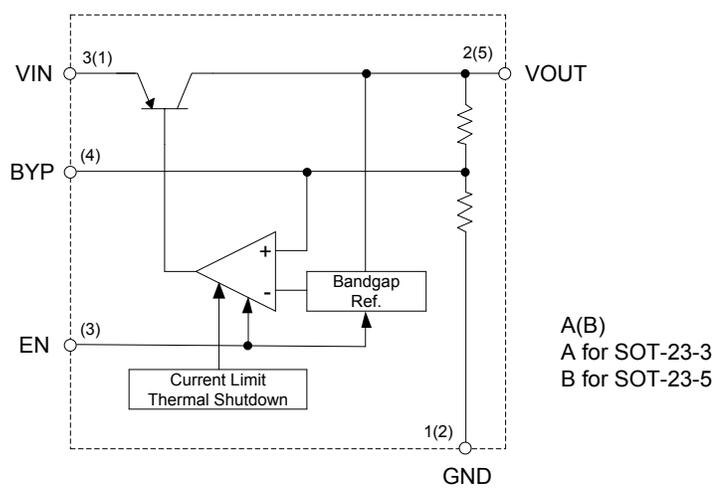
For Adjustable Version

Notes: 4. Dropout voltage is 250mV when $T_A = +25^\circ\text{C}$. In order to obtain a normal output voltage, $V_{OUT} + 0.25\text{V}$ is the minimum input voltage which will result a low PSRR, imposing a bad influence on system. Therefore, the recommended input voltage is $V_{OUT} + 1\text{V}$ to 13.2V. For NK-AP2210-3.0 version, its input voltage can be set from 4V ($V_{OUT} + 1\text{V}$) to 13.2V.

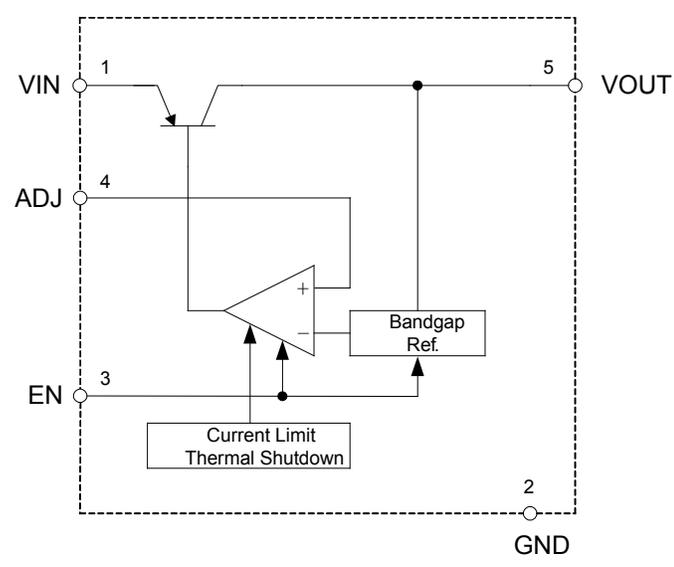
Pin Descriptions

Pin Number		Pin Name	Function
SOT23-3	SOT23-5		
1	2	GND	Ground
2	5	VOUT	Regulated output voltage
3	1	VIN	Input voltage
-	3	EN	Enable input: CMOS or TTL compatible input. Logic high=enable, logic low=shutdown
-	4	BYP/ADJ	Bypass capacitor for low noise operation/Adjustable Output

Functional Block Diagram



Fixed Version



ADJ Version (For SOT-23-5)

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	ESD (Machine Model)	300		V
θ_{JA}	Thermal Resistance (No Heatsink)	SOT-23-3	200	°C/W
		SOT-23-5	200	

Notes: 5. Stresses greater than those listed under "Absolute Maximum Ratings" may 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 may 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-AP2210-2.5 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 $13.2V$	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-2.5 Electrical Characteristics (Cont.) ($V_{IN} = 3.5V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-2.8 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 $13.2V$	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-2.8 Electrical Characteristics(Cont.) ($V_{IN} = 3.8V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV / \sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-3.0 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	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to 300mA	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-3.0 Electrical Characteristics(Cont.) ($V_{IN} = 4V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV / \sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-3.3 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	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-3.3 Electrical Characteristics(Cont.) ($V_{IN} = 4.3V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-3.6 Electrical Characteristics ($V_{IN} = 4.6V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	48	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = 4.6V$ to $13.2V$	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-3.6 Electrical Characteristics (Cont.) ($V_{IN} = 4.6V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-4.0 Electrical Characteristics ($V_{IN} = 5.0V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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	$V_{IN} = 5.0V$ to $13.2V$	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-4.0 Electrical Characteristics (Cont.) ($V_{IN} = 5.0V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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-AP2210-5.0 Electrical Characteristics ($V_{IN} = 6.0V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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	$V_{IN} = 6.0V$ to $13.2V$	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to $300mA$	—	1	6	mV
			—	—	30	
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			
$I_{OUT} = 300mA$	—	250	400			
	—	—	500			
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	
			—	—	800	
$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA		
	—	—	2.5			
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10			
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA

NK-AP2210-5.0 Electrical Characteristics(Cont.) ($V_{IN} = 6.0V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **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
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

- 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 300mA. 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.

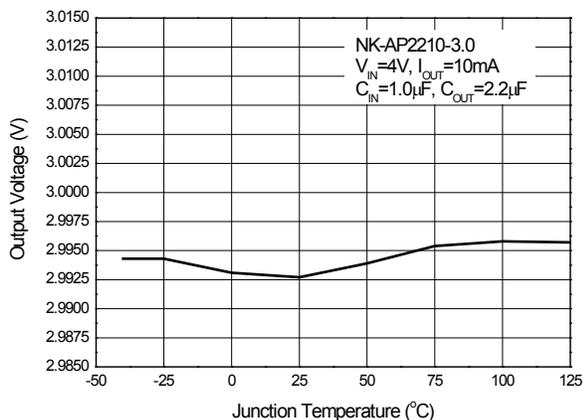
NK-AP2210-ADJ Electrical Characteristics ($V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 100\mu A$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$, $V_{EN} \geq 2.0V$, $T_J = +25^\circ C$, **Bold** typeface applies over $-40^\circ C \leq T_J \leq +125^\circ C$ (Note 6), unless otherwise specified.)

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	—	$\mu V/^\circ C$
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	48	—	ppm/ $^\circ C$
V_{RLINE}	Line Regulation	$V_{IN} = V_{OUT} + 1V$ to 13.2V	—	1.5	4.5	mV
			—	—	12	
V_{RLOAD}	Load Regulation (Note 8)	$I_{OUT} = 0.1mA$ to 300mA	—	1	6	mV
			—	—	30	
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)	$V_{EN} \geq 2.0V$, $I_{OUT} = 100\mu A$	—	100	150	μA
			—	—	180	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 50mA$	—	350	600	μA
			—	—	800	
		$V_{EN} \geq 2.0V$, $I_{OUT} = 150mA$	—	1.3	1.9	mA
			—	—	2.5	
$V_{EN} \geq 2.0V$, $I_{OUT} = 300mA$	—	4	10	mA		
	—	—	15			
PSRR	Ripple Rejection	$f = 100Hz$, $I_{OUT} = 100\mu A$	—	75	—	dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	—	450	900	mA
e_{no}	Output Noise	$I_{OUT} = 50mA$, $C_{OUT} = 2.2\mu F$, 100pF from BYP to GND	—	260	—	nV/\sqrt{Hz}
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	$V_{IL} \geq 2.0V$	—	5	20	μA
		$V_{IL} \geq 2.0V$	—	—	25	

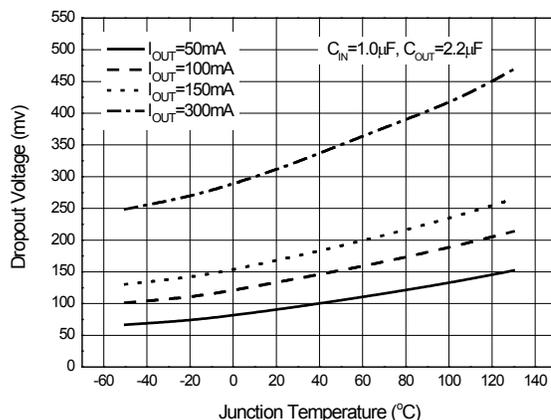
- Notes:
- Specifications in bold type are limited to $-40^\circ C \leq T_J \leq +125^\circ C$. Limits over temperature are guaranteed by design, but not tested in production.
 - Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
 - 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 300mA. 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

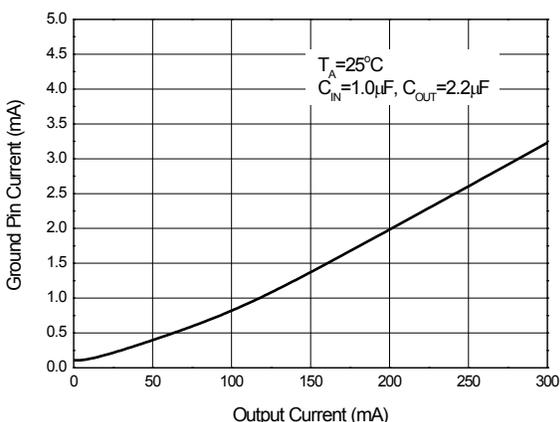
Output Voltage vs. Junction Temperature



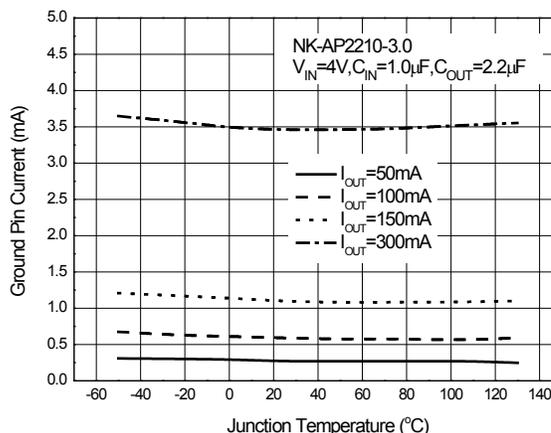
Dropout Voltage vs. Junction Temperature



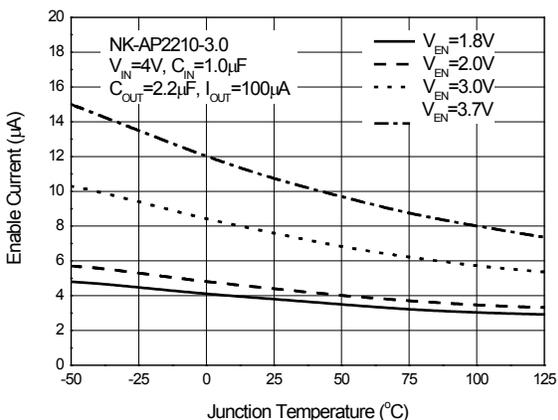
Ground Pin Current vs. Output Current



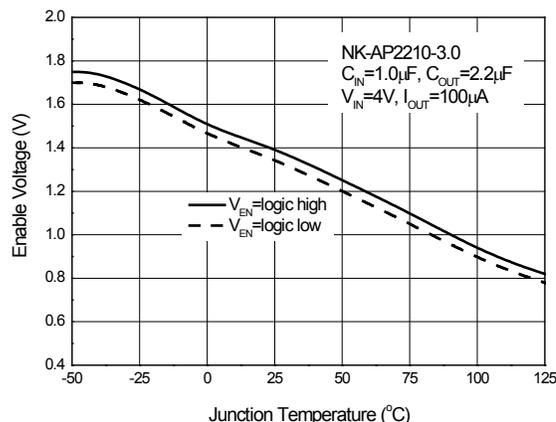
Ground Pin Current vs. Junction Temperature



Enable Current vs. Junction Temperature

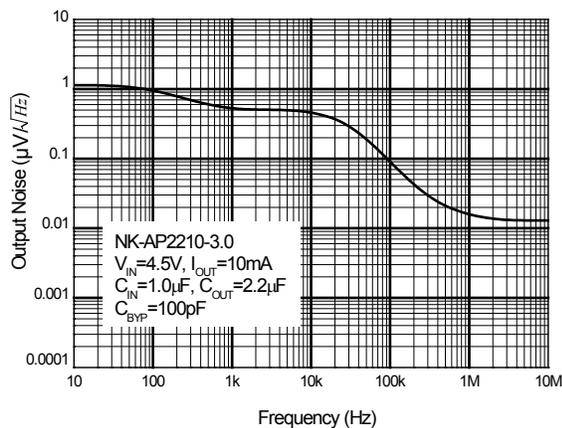


Enable Voltage vs. Junction Temperature

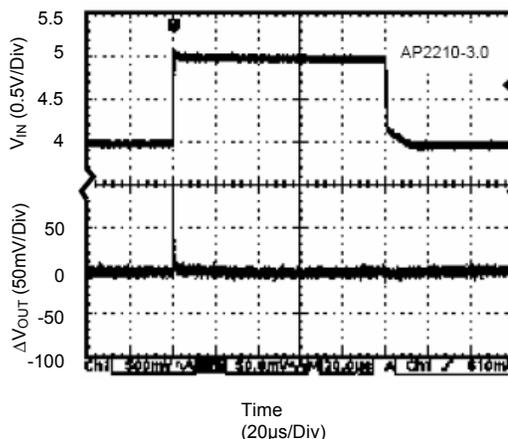


Performance Characteristics (Cont.)

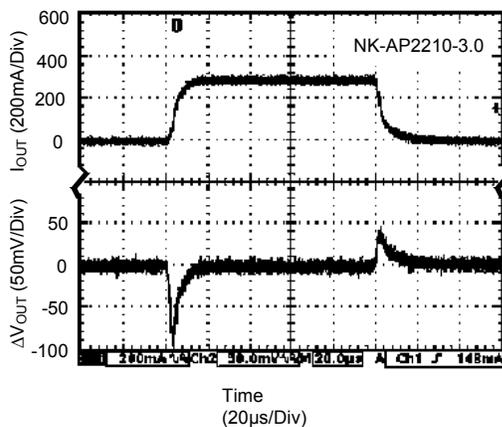
Output Noise vs. Frequency



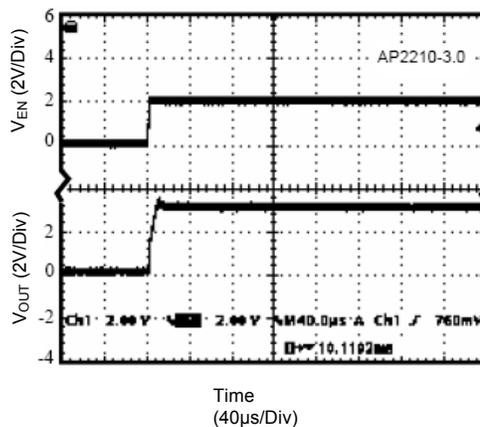
Line Transient
 (Conditions: $V_{IN} = 4$ to $5V$, $V_{EN} = 2V$,
 $I_{OUT} = 1mA$, $C_{OUT} = 2.2\mu F$)



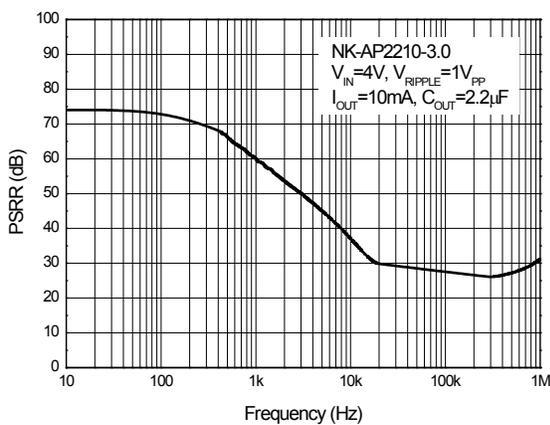
Load Transient
 (Conditions: $V_{IN} = 4V$, $V_{EN} = 2V$,
 $I_{OUT} = 10mA$ to $300mA$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$)



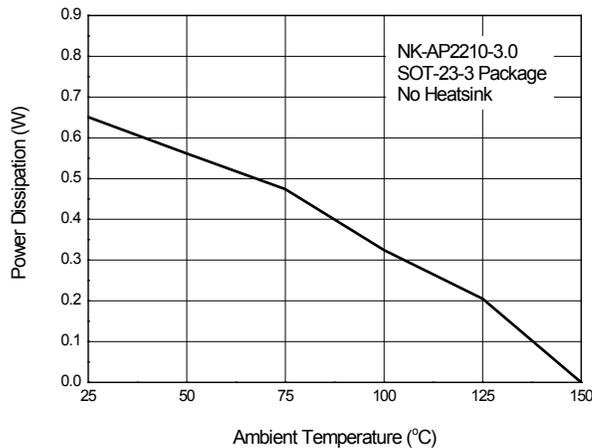
V_{EN} vs. V_{OUT}
 (Conditions: $V_{EN} = 0$ to $2V$, $V_{IN} = 4V$,
 $I_{OUT} = 30mA$, $C_{IN} = 1.0\mu F$, $C_{OUT} = 2.2\mu F$)



PSRR vs. Frequency

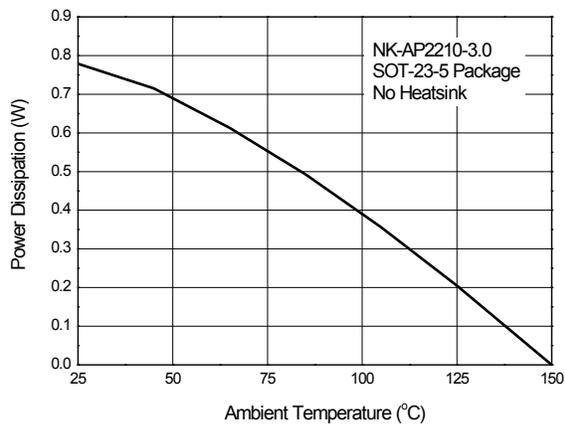


Power Dissipation vs. Ambient Temperature

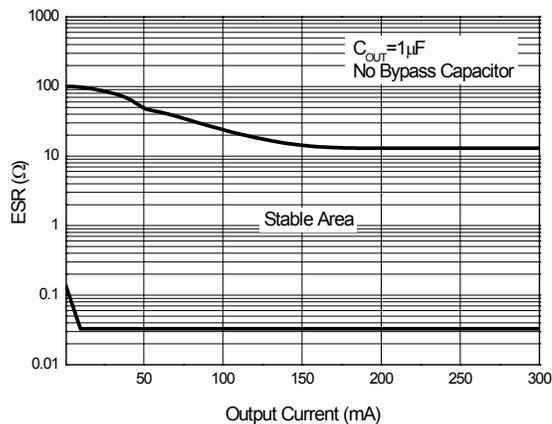


Performance Characteristics (Cont.)

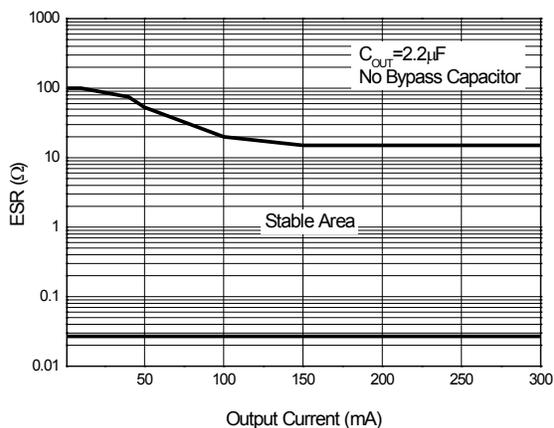
Power Dissipation vs. Ambient Temperature



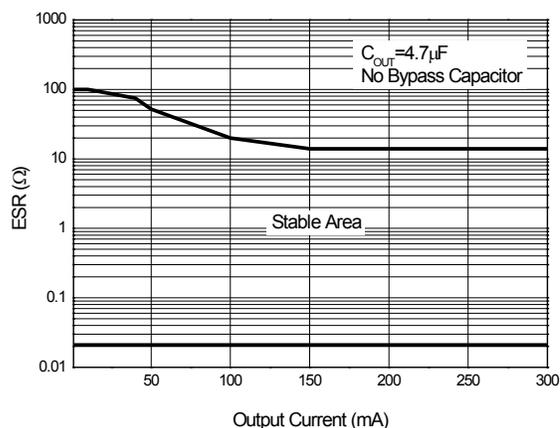
ESR vs. Output Current



ESR vs. Output Current

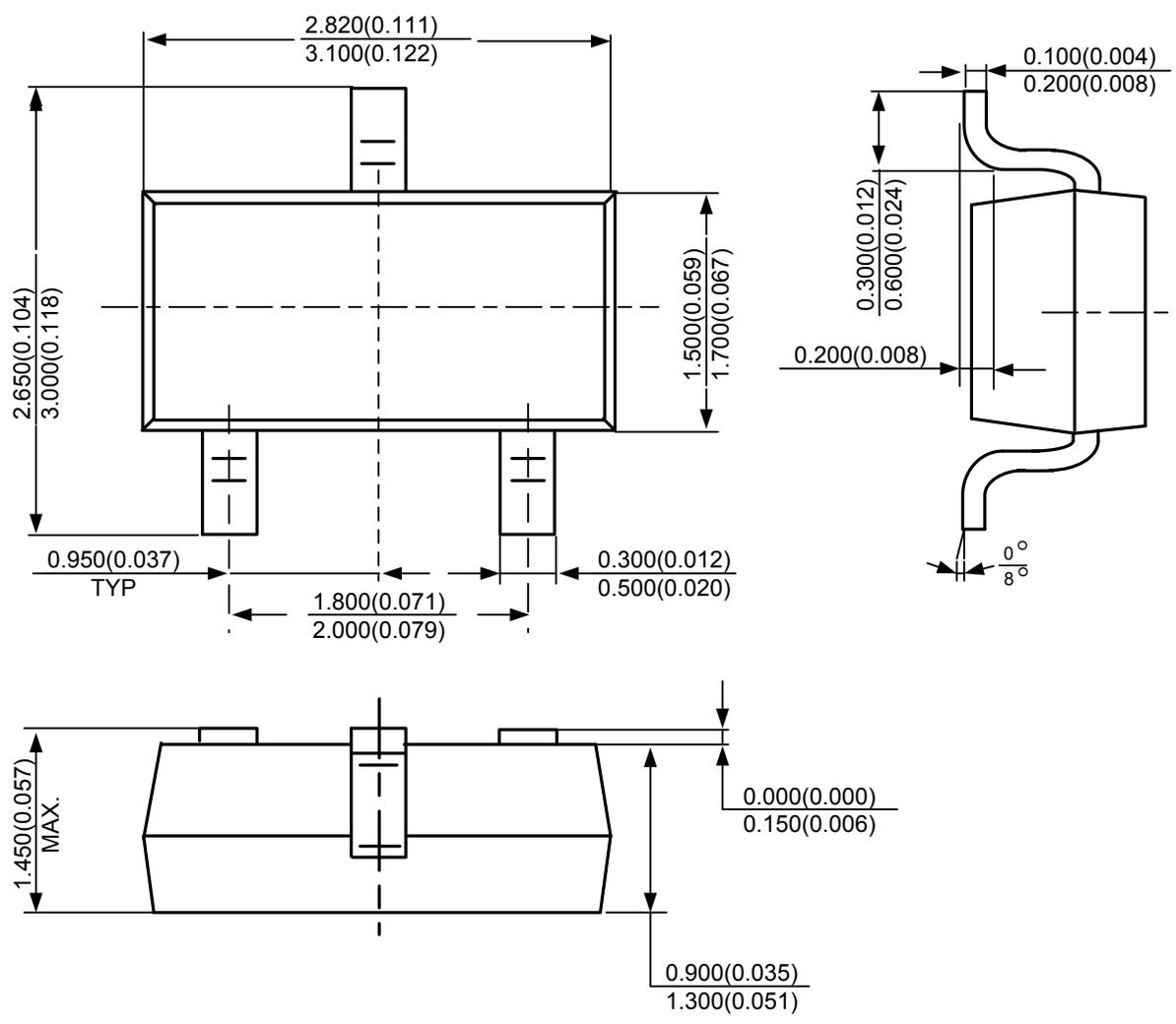


ESR vs. Output Current



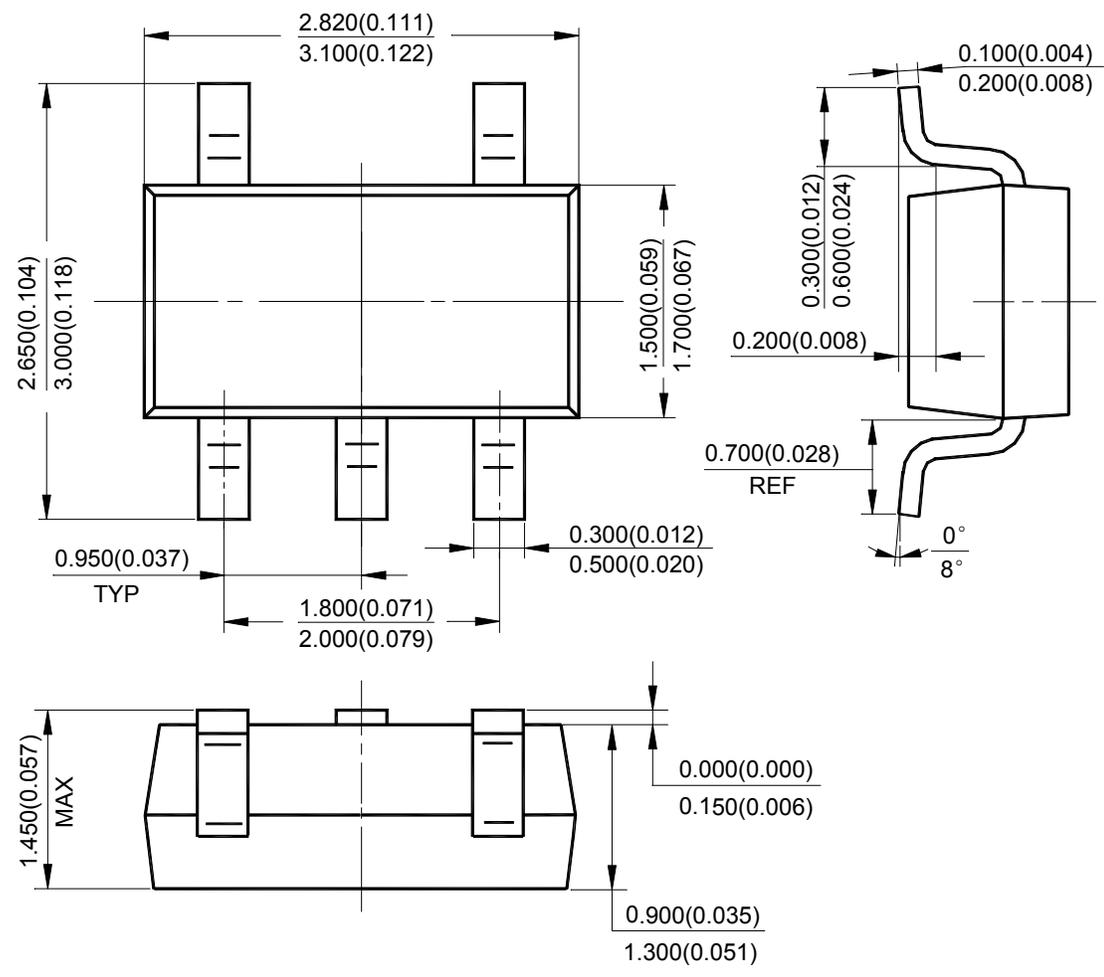
Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SOT-23-3



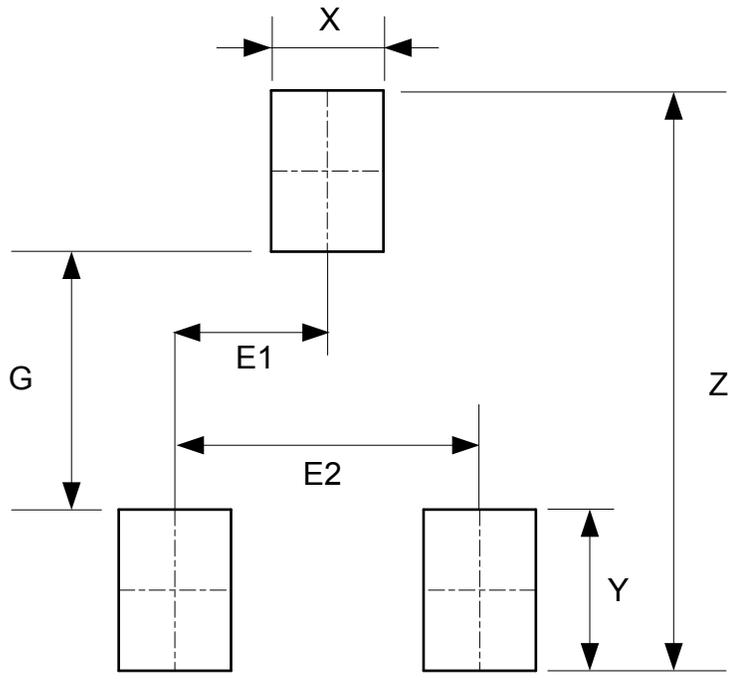
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

(2) Package Type: SOT-23-5



Suggested Pad Layout

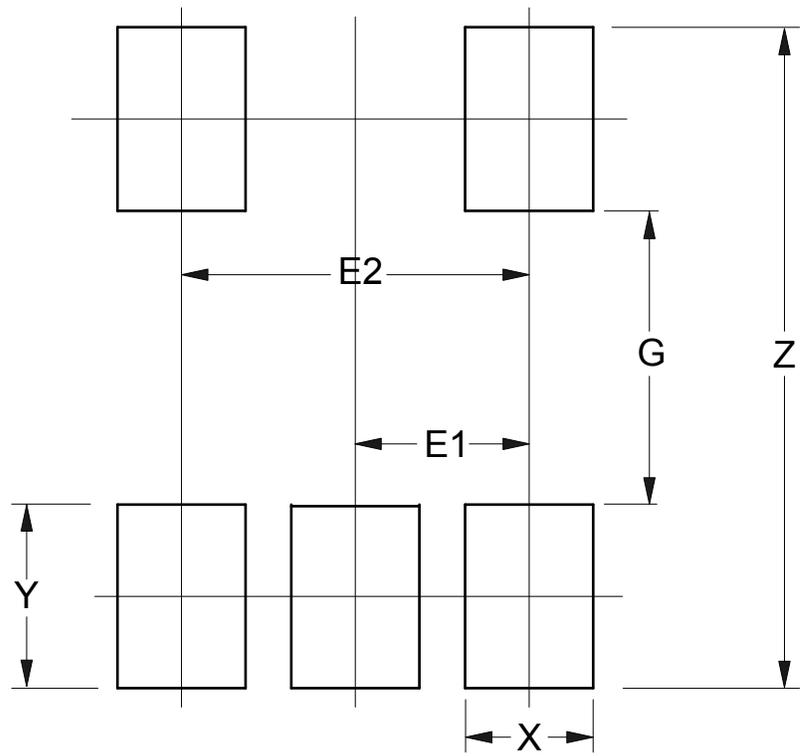
(1) Package Type: SOT-23-3



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 (Cont.)

(2) 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