Description

The 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) in battery powered applications, such as handsets and PDAs and in noise sensitive applications, such as RF electronics.

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

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

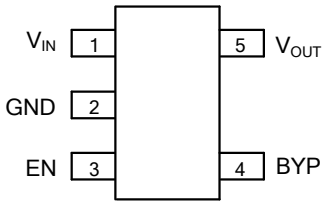
The AP2202 is available in space saving SOT-23-5 and SOT-89 packages.

Features

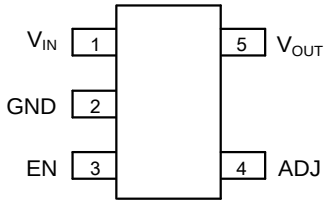
- Up to 150mA Output Current
- Low Standby Current
- Low Dropout Voltage: V_{DROP} = 165mV at 150mA
- High Output Accuracy: ±1%
- Good Ripple Rejection Ability: 75dB at 100Hz and I_{OUT} = 100µA
- Tight Load and Line Regulation
- Low Temperature Coefficient
- Over Current Protection
- Thermal Protection
- Reverse-battery 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
  - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
  - **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments

(Top View)

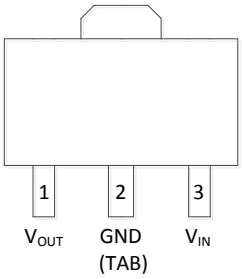


(Top View)



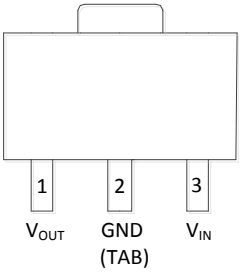
SOT-23-5

(Top View)



SOT-89 (Option 1)

(Top View)



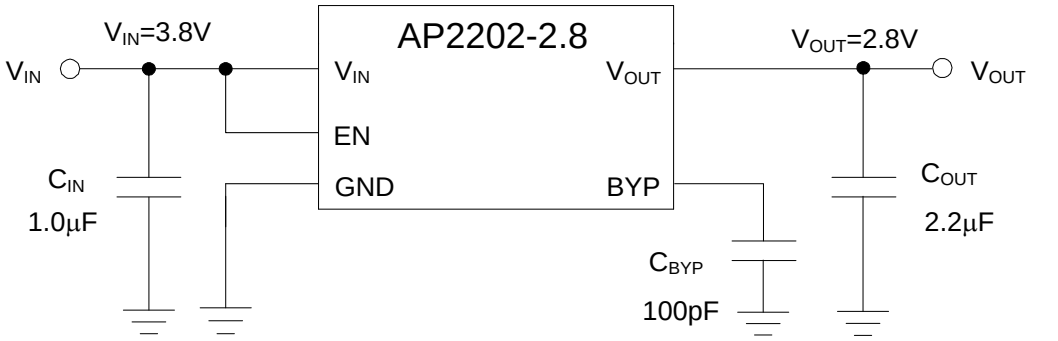
SOT-89 (Option 2)

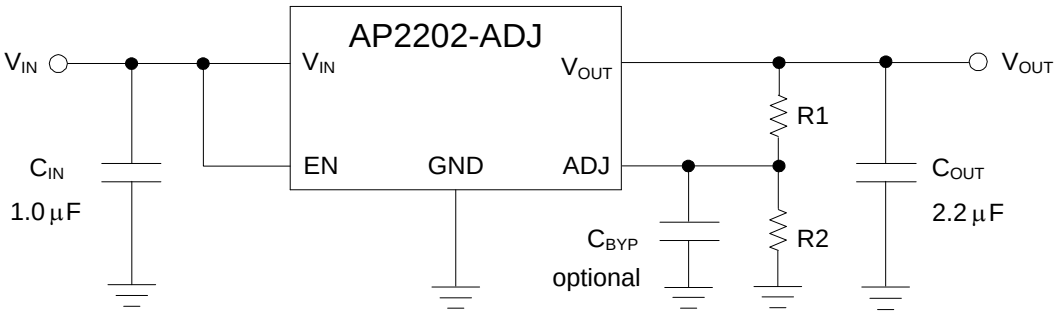
Applications

- Cellular Phones
- Cordless Phones
- Digital Still Cameras
- Wireless Communicators
- PDAs / Palmtops
- PC Mother Board
- Consumer Electronics

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit (Note 4)





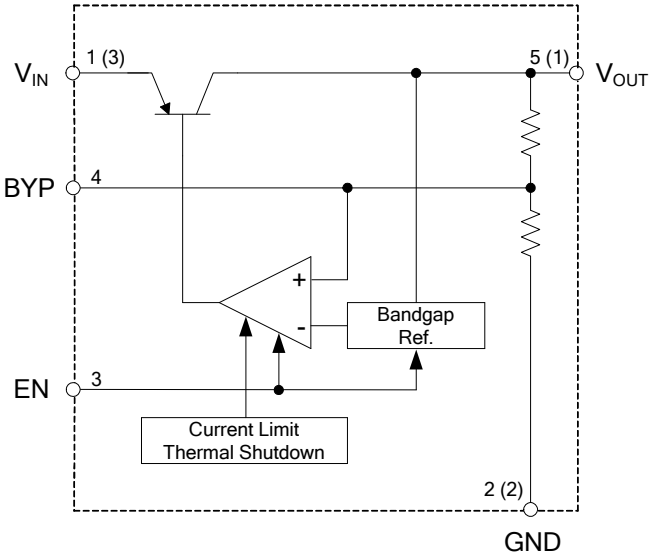
V_{OUT}=1.25* (1+R2/R1)

Note 4: Dropout voltage is 165mV when T_A=+25°C. In order to obtain a normal output voltage, V_{OUT}+0.165V 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}+0.5V to 13.2V. For AP2202-2.8 version, its input voltage can be set from 3.3V(V_{OUT}+0.5V) to 13.2V. For that of ADJ version, any value from V_{OUT}+0.5V 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 10kΩ and 14kΩ respectively. For ADJ version, we recommend 2.3V as minimum output voltage.

Pin Descriptions

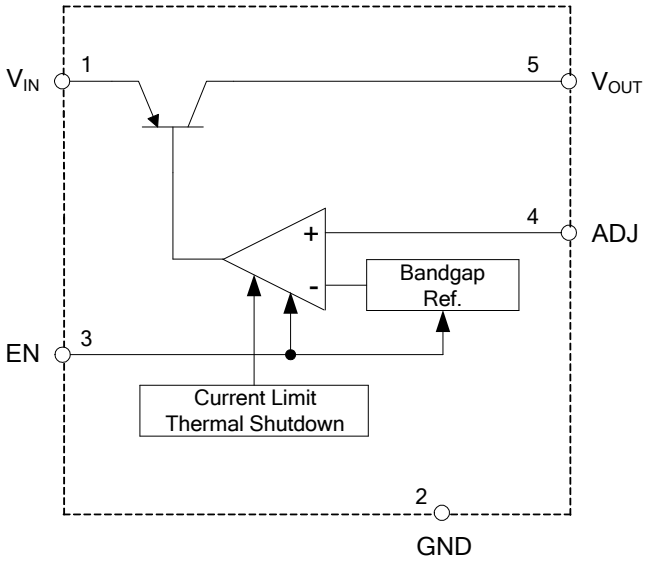
Pin Number		Pin Name	Function
SOT-23-5	SOT-89		
1	3	V_{IN}	Input voltage
2	2	GND	Ground (TAB for SOT-89)
3	—	EN	Enable input: CMOS or TTL compatible input. Logic high=enable, logic low=shutdown
4	—	BYP/ADJ	Bypass capacitor for low noise operation/Adjust output
5	1	V_{OUT}	Regulated output voltage

Functional Block Diagram



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

Fixed Regulator



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” 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

Electrical Characteristics

AP2202-ADJ Electrical Characteristics

(@V_{IN} = V_{OUT}+1V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

AP2202-ADJ Electrical Characteristics (@V_{IN} = V_{OUT}+1V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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.

Electrical Characteristics (Cont.)

AP2202-2.5 Electrical Characteristics (@V_{IN} = 3.5V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°C
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	**48**	—	ppm/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

AP2202-2.5 Electrical Characteristics (@V_{IN} = 3.5V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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.

Electrical Characteristics (Cont.)

AP2202-2.6 Electrical Characteristics (@V_{IN} = 3.6V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°C
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	**46**	—	ppm/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

AP2202-2.6 Electrical Characteristics (@V_{IN} = 3.6V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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.

Electrical Characteristics (Cont.)

AP2202-2.8 Electrical Characteristics (@V_{IN} = 3.8V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°C
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	**42.8**	—	ppm/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

AP2202-2.8 Electrical Characteristics (@V_{IN} = 3.8V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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.

Electrical Characteristics (Cont.)

AP2202-3.0 Electrical Characteristics (@V_{IN} = 4V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°C
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	**40**	—	ppm/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

AP2202-3.0 Electrical Characteristics (@V_{IN} = 4V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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.

Electrical Characteristics (Cont.)

AP2202-3.3 Electrical Characteristics (@V_{IN} = 4.3V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°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**	—	µV/°C
$(\Delta V_{OUT}/V_{OUT})/\Delta T$		—	—	**36.3**	—	ppm/°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} = 100µA	—	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} ≤ 0.4V (shutdown)	—	0.01	1	µA
		V_{EN} ≤ 0.18V (shutdown)	—	—	**5**	
I_{GND}	Ground Pin Current (Note 10)	V_{EN} ≥ 2.0V, I_{OUT} = 0µA	—	95	130	µA
			—	—	**150**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100µA	—	98	140	
			—	—	**160**	
		V_{EN} ≥ 2.0V, I_{OUT} = 50mA	—	350	600	
			—	—	**800**	
		V_{EN} ≥ 2.0V, I_{OUT} = 100mA	—	600	1000	
			—	—	**1500**	
		V_{EN} ≥ 2.0V, I_{OUT} = 150mA	—	1300	1900	
			—	—	**2500**	
PSRR	Ripple Rejection	Frequency = 100Hz, I_{OUT} = 100µA	—	75	—	dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V	—	**320**	550	mA
e_{no}	Output Noise	I_{OUT} = 50mA, C_{OUT} = 2.2µF, 100pF from BYP to GND	—	260	—	$nV/\sqrt{Hz}$

Electrical Characteristics (Cont.)

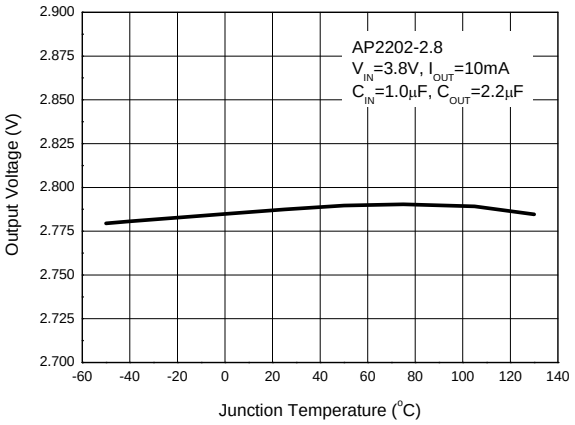
AP2202-3.3 Electrical Characteristics (@V_{IN} = 4.3V, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, V_{EN} ≥ 2.0V, T_J = +25°C, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°C (Note 6), unless otherwise specified.)

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} ≤ 0.4V	—	0.01	1	µA
		V_{IL} ≤ 0.18V	—	—	**2**	
I_{IH}	Enable Input Logic-High Current	V_{IH} ≥ 2.0V	—	5	20	µA
		V_{IH} ≥ 2.0V	—	—	**25**	
θ_{JC}	Thermal Resistance	SOT-23-5	—	63.4	—	°C/W
		SOT-89	—	50	—	

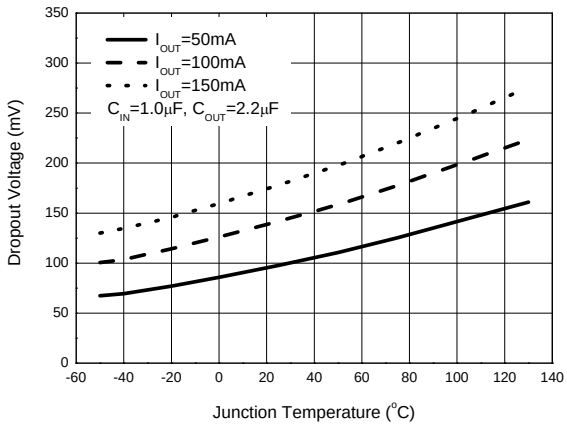
Notes:
6. Specifications in bold type are limited to -40°C ≤ T_J ≤ +125°C. Limits over temperature are guaranteed by design, but not tested in production.
7. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
8. Regulation is measured 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.
9. Dropout voltage is defined as the input to output differential at which the output voltage drops 1% (T_J = +25°C) or 2% (-40°C ≤ T_J ≤ +125°C) below its nominal value measured at 1V differential.
10. 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

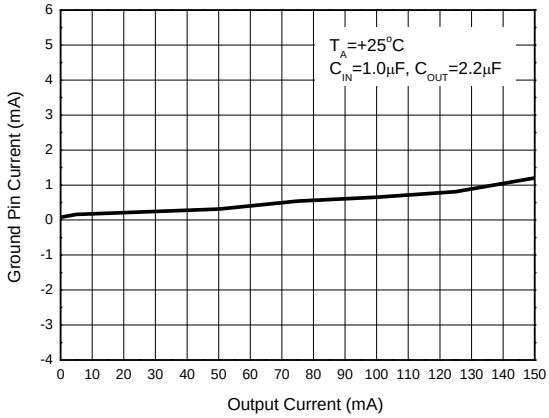
Output Voltage vs. Junction Temperature



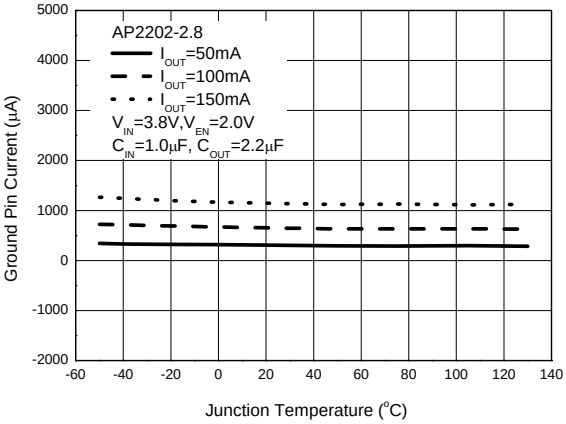
Dropout Voltage vs. Junction Temperature



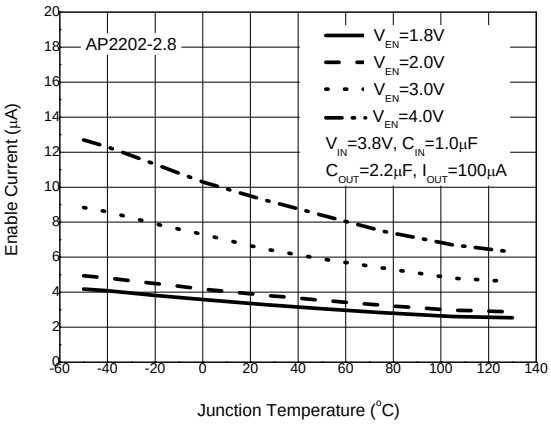
Ground Pin Current vs. Output Current



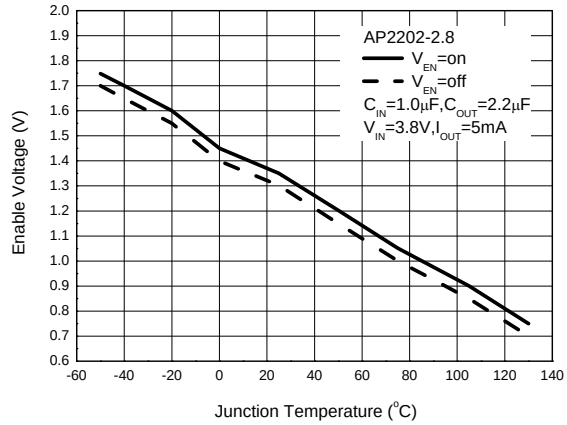
Ground Pin Current vs. Junction Temperature



Enable Current vs. Junction Temperature

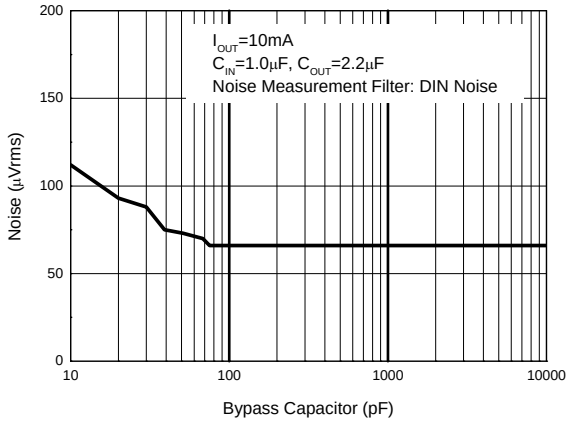


Enable Voltage vs. Junction Temperature

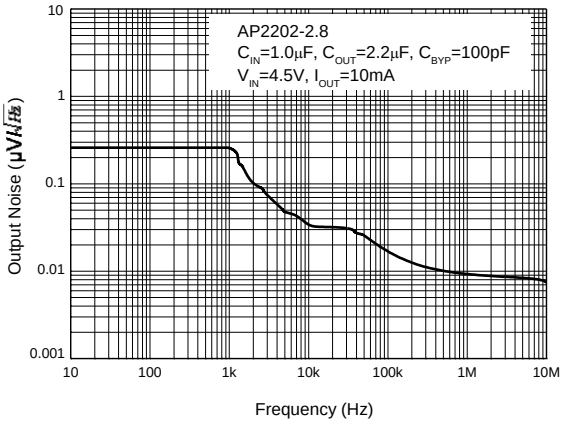


Performance Characteristics (Cont.)

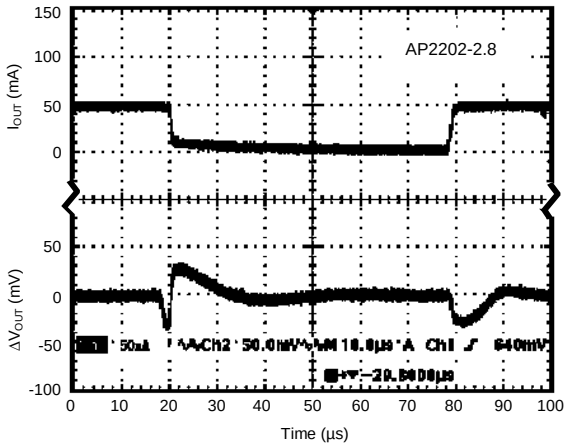
Noise vs. Bypass Capacitor



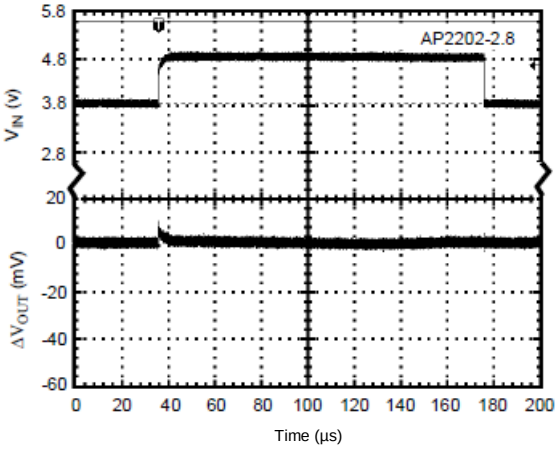
Output Noise vs. Frequency



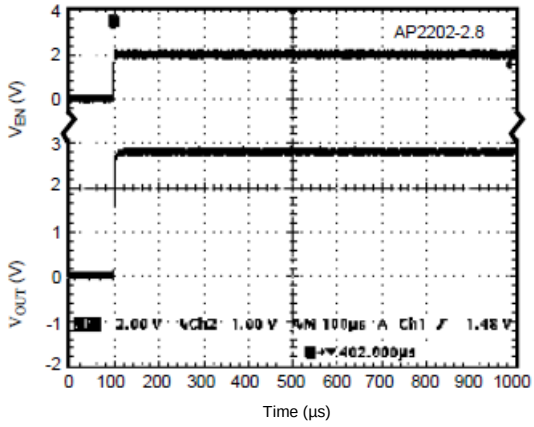
Load Transient
(Conditions: V_{IN}=3.8V, C_{BYP}=100pF, V_{EN}=2V, I_{OUT}=5mA to 50mA, C_{IN}=1.0µF, C_{OUT}=2.2µF)



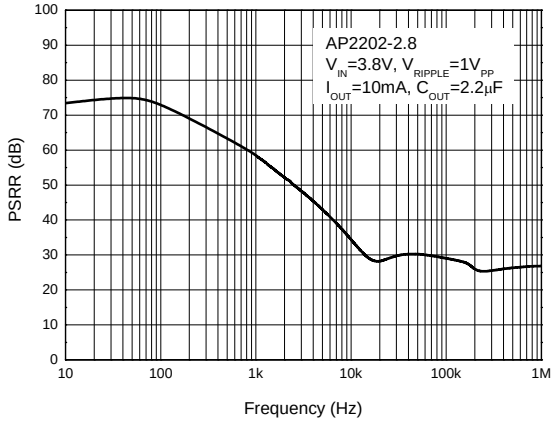
Line Transient
(Conditions: V_{IN}=3.8V to 4.8V, V_{EN}=2V, I_{OUT}=100µA C_{BYP}=100pF, C_{OUT}=10µF)



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

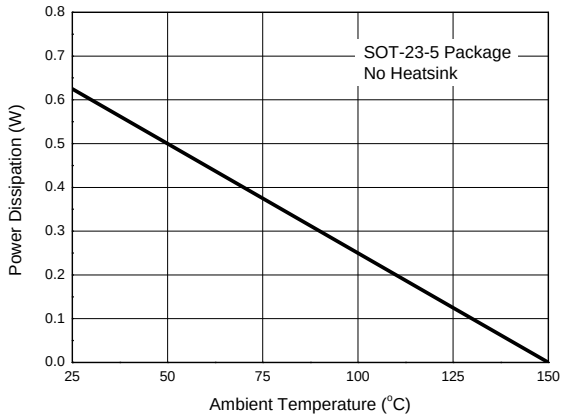


PSRR vs. Frequency

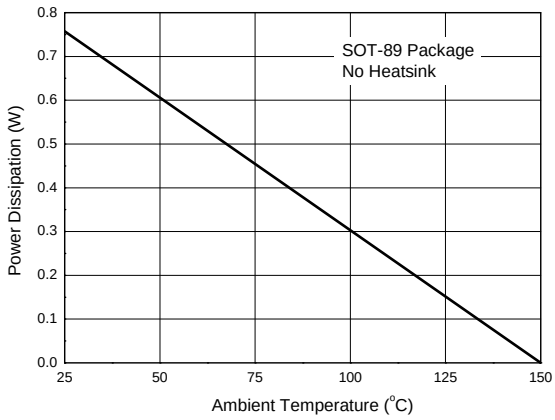


Performance Characteristics (Cont.)

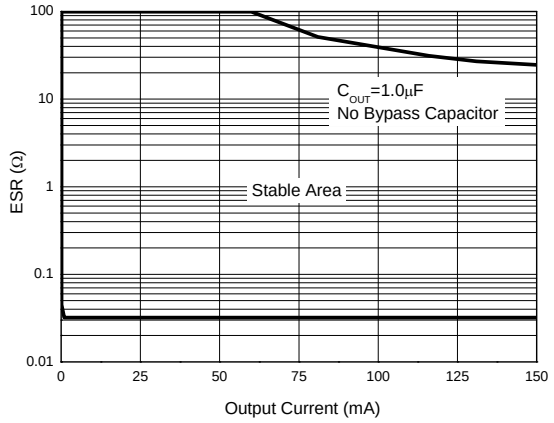
Power Dissipation vs. Ambient Temperature



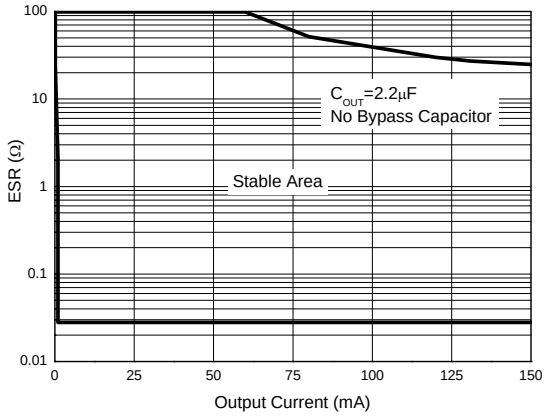
Power Dissipation vs. Ambient Temperature



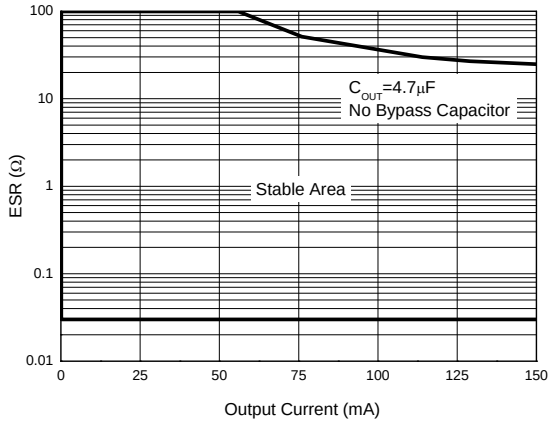
ESR vs. Output Current



ESR vs. Output Current



ESR vs. Output Current



Application Information

Input Capacitor

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

Output Capacitor

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

Noise Bypass Capacitor

Bypass capacitor is connected to the internal voltage reference. A 100pF capacitor connected from BYP to GND make 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 AP2202 is inversely proportional to the value of 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 exceeding the maximum power dissipation 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 Figure Power Dissipation vs. Ambient Temperature (SOT-23-5 package and SOT-89 package)), using:

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

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

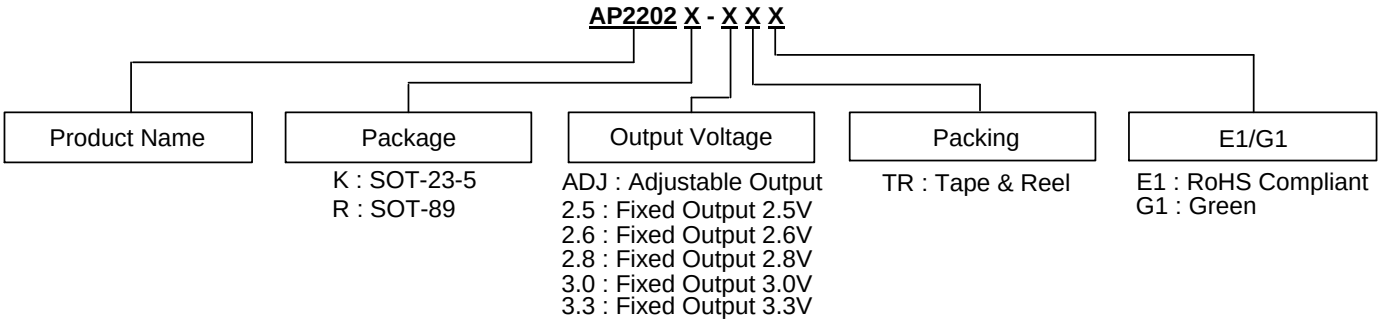
Where: $T_J \leq T_{J(max)}$, $T_{J(max)}$ is absolute maximum ratings for the junction temperature; $V_{IN}*I_{GND}$ can be ignored due to its small value.

$T_{J(max)}$ 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} = 150mA, T_A = +50°C, $V_{IN(Max)}$ is:
(150°C-50°C)/(0.15A*200°C/W)+2.8V=6.133V

Therefore, for good performance, please make sure that input voltage is less than 6.133V without heatsink when T_A = +50°C.

Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing
		RoHS Compliant (Note 11)	Green	RoHS Compliant	Green	
SOT-23-5	-40 to +125°C	AP2202K-ADJTRE1	AP2202K-ADJTRG1	E2C	G2C	3k/Tape & Reel
		AP2202K-2.5TRE1	AP2202K-2.5TRG1	E2D	G2D	3k/Tape & Reel
		AP2202K-2.6TRE1	AP2202K-2.6TRG1 (Note 11)	E2E	G2E	3k/Tape & Reel
		AP2202K-2.8TRE1	AP2202K-2.8TRG1 (Note 11)	E2G	G2G	3k/Tape & Reel
		AP2202K-3.0TRE1	AP2202K-3.0TRG1	E2I	G2I	3k/Tape & Reel
		AP2202K-3.3TRE1	AP2202K-3.3TRG1	E2L	G2L	3k/Tape & Reel
SOT-89	-40 to +125°C	AP2202R-3.3TRE1	AP2202R-3.3TRG1	E22B	G22B	3k/Tape & Reel

Lead-Free

Lead-free Green

Lead-Free

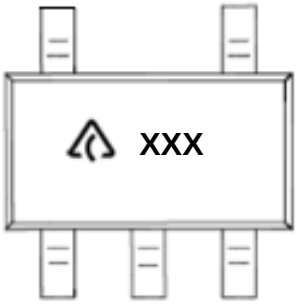
Lead-free Green

Note 11: Not recommended for new design.

Marking Information

(1) SOT-23-5

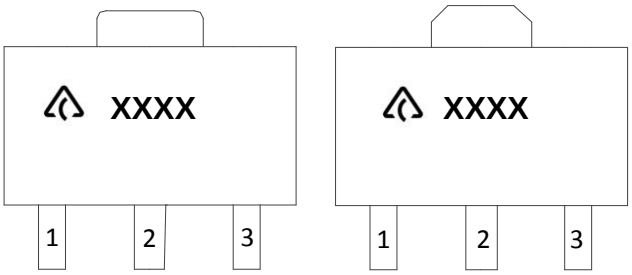
(Top View)



: Logo
XXX : Marking ID (See Ordering Information)

(2) SOT-89

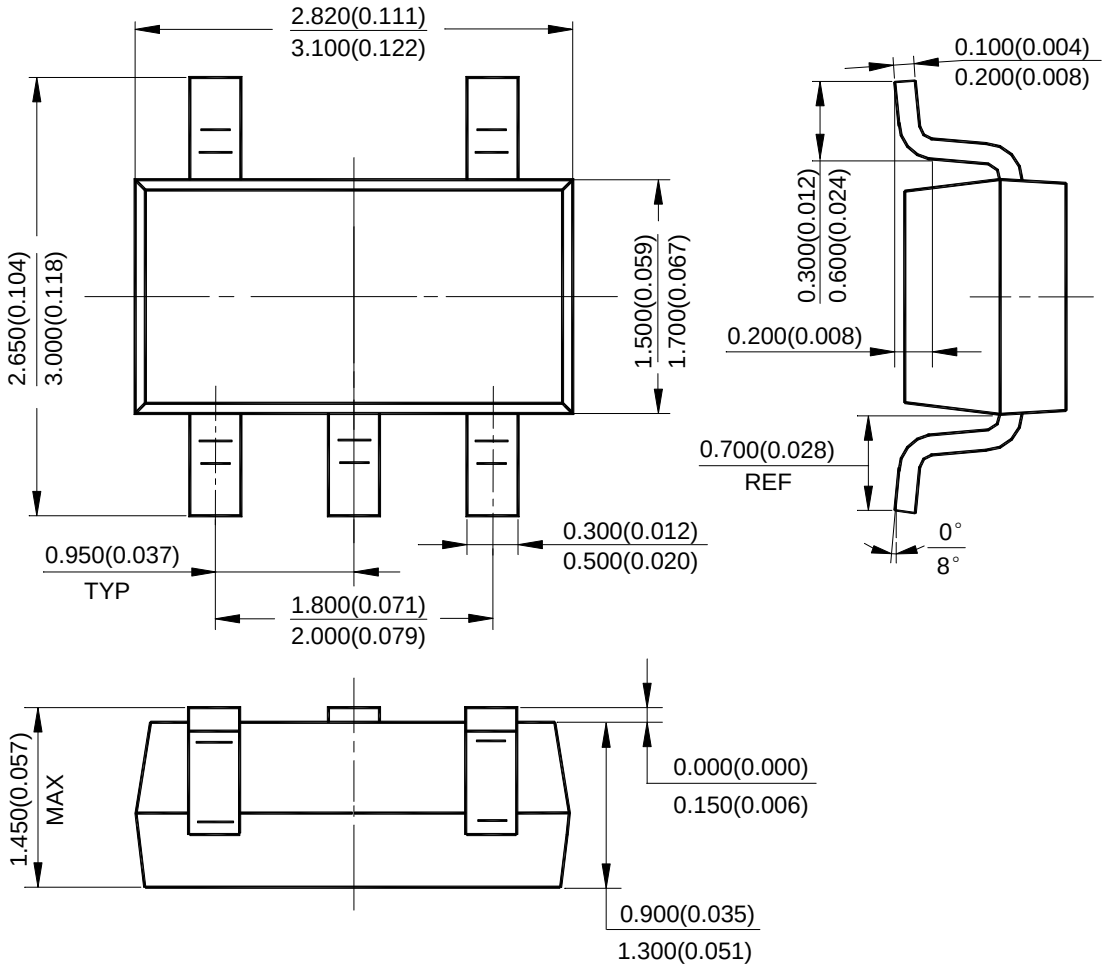
(Top View)



: Logo
XXXX : Marking ID (See Ordering Information)

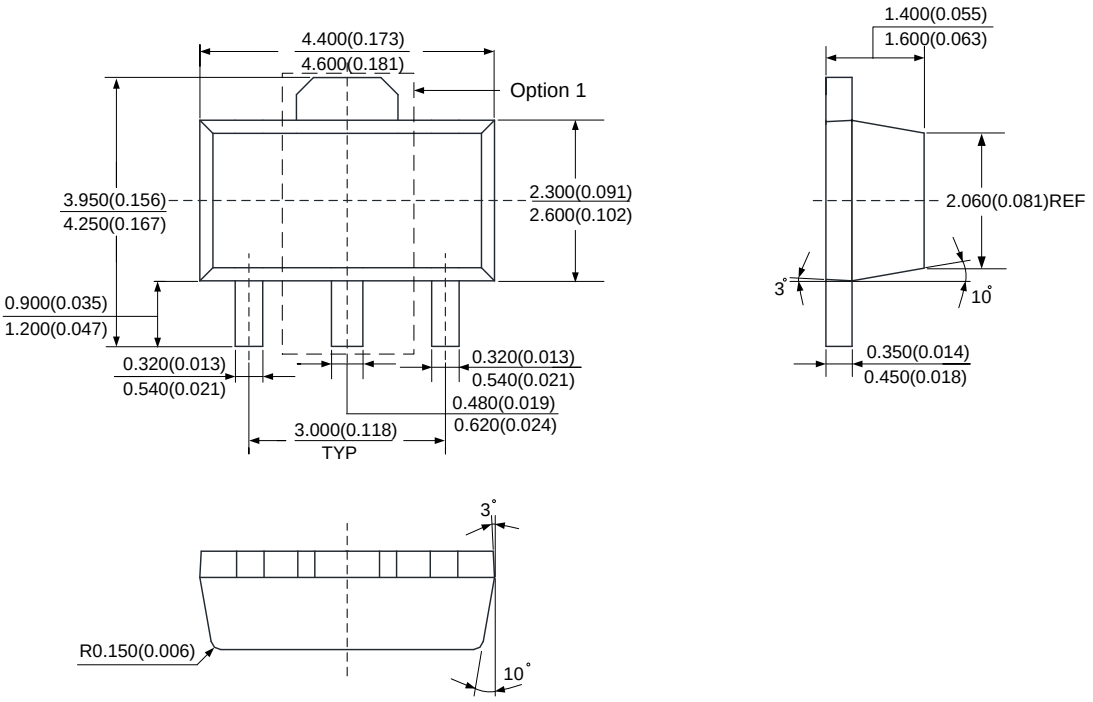
Package Outline Dimensions (All dimensions in mm(inch).)

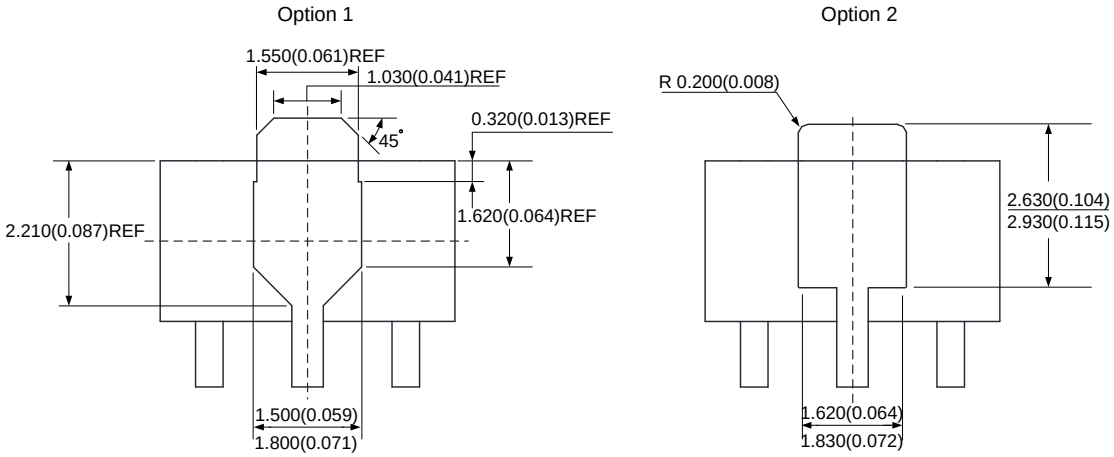
(1) Package Type: SOT-23-5



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

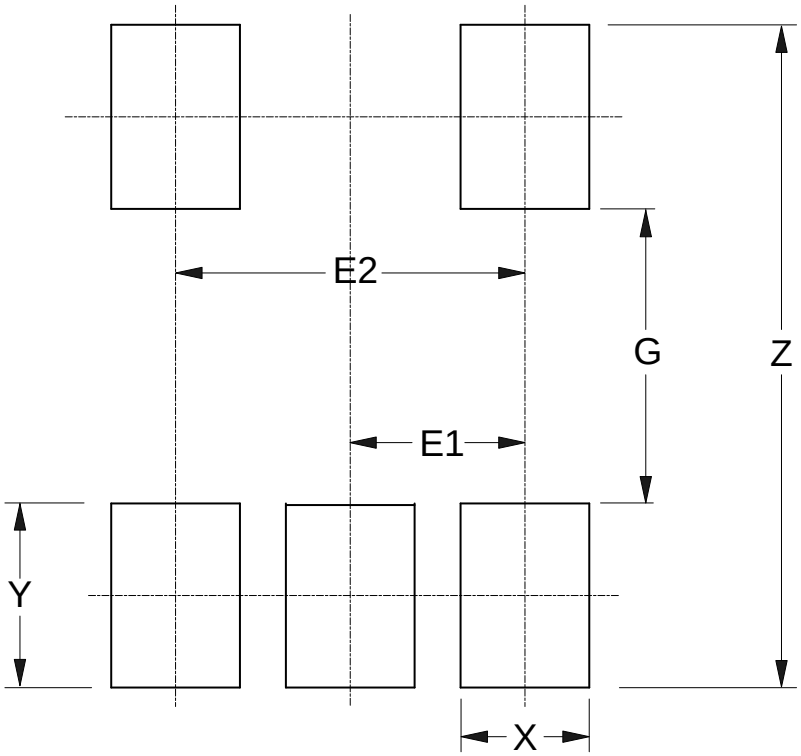
(2) Package Type: SOT-89





Suggested Pad Layout

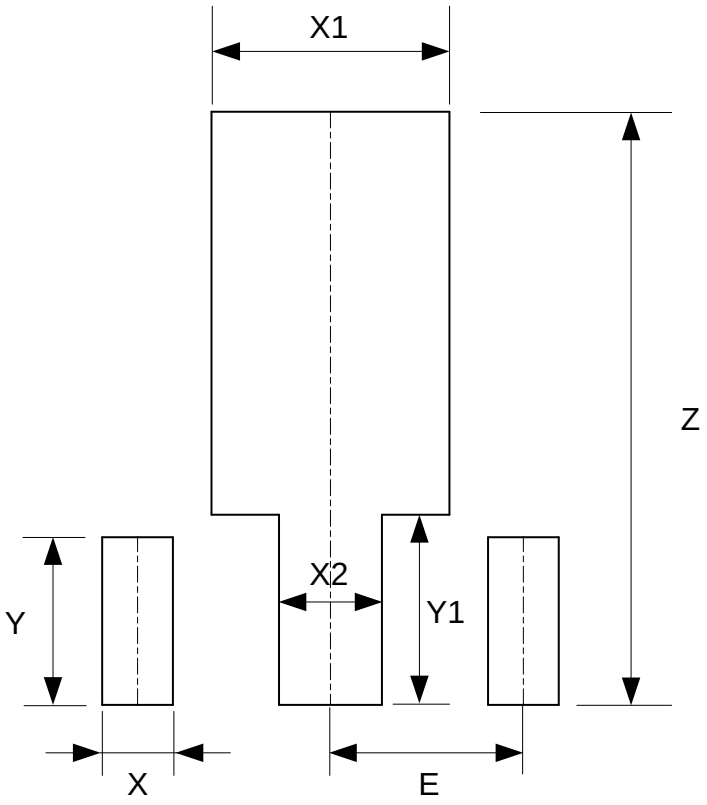
(1) Package Type: SOT-23-5



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 (Cont.)

(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

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