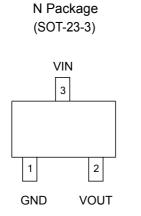
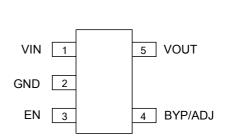


# **300mA RF ULDO REGULATOR**

AP2210

# **Pin Configuration**





K Package

(SOT-23-5)



# **Pin Description**

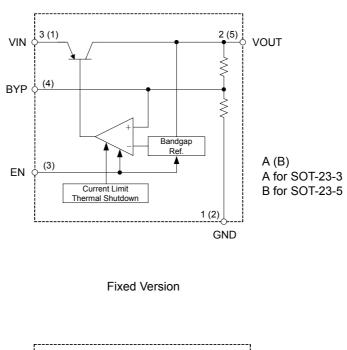
Pin Nu	umber	<b>D</b> , <b>N</b>	Function
SOT-23-3	B-3 SOT-23-5 Pin Name		runction
1	1 2 GND Ground		Ground
2	2 5 VOUT		Regulated output voltage
3	1	VIN	Input voltage
	3	EN	Enable input: CMOS or TTL compatible input. Logic high=enable, logic low=shutdown
	4	BYP/ADJ	Bypass capacitor for low noise operation/Adjustable Output

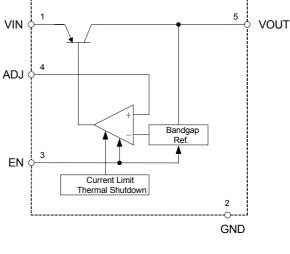


AP2210

## **300mA RF ULDO REGULATOR**

## Functional Block Diagram





ADJ Version (For SOT-23-5)

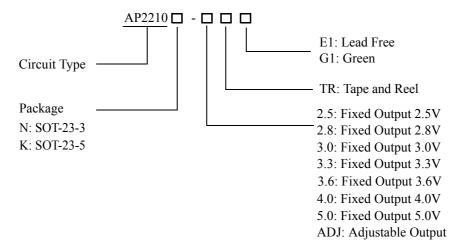




## **300mA RF ULDO REGULATOR**

#### AP2210

### **Ordering Information**



Dealessa	Temperature	Part I	Number	Mark	ting ID	Packing
Package	Range	Lead Free	Green	Lead Free	Green	Туре
		AP2210N-2.5TRE1	AP2210N-2.5TRG1	EH2	GH2	Tape & Reel
		AP2210N-2.8TRE1	AP2210N-2.8TRG1	EH3	GH3	Tape & Reel
		AP2210N-3.0TRE1	AP2210N-3.0TRG1	EH4	GH4	Tape & Reel
SOT-23-3	-40 to 125°C	AP2210N-3.3TRE1	AP2210N-3.3TRG1	EH5	GH5	Tape & Reel
			AP2210N-3.6TRG1		GB7	Tape & Reel
			AP2210N-4.0TRG1		GC7	Tape & Reel
			AP2210N-5.0TRG1		GH9	Tape & Reel
		AP2210K-2.5TRE1	AP2210K-2.5TRG1	E5C	G5C	Tape & Reel
		AP2210K-2.8TRE1	AP2210K-2.8TRG1	E5F	G5F	Tape & Reel
		AP2210K-3.0TRE1	AP2210K-3.0TRG1	E5H	G5H	Tape & Reel
SOT-23-5	10 10500	AP2210K-3.3TRE1	AP2210K-3.3TRG1	E5K	G5K	Tape & Reel
501-25-5	-40 to 125°C		AP2210K-3.6TRG1		G5I	Tape & Reel
			AP2210K-4.0TRG1		G5J	Tape & Reel
			AP2210K-5.0TRG1		G5L	Tape & Reel
			AP2210K-ADJTRG1		G5M	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.



# **300mA RF ULDO REGULATOR**

## AP2210

## Absolute Maximum Ratings (Note 1)

Parameter	Symbol		Value	Unit	
Supply Input Voltage	V <sub>IN</sub>		15	v	
Enable Input Voltage	V <sub>EN</sub>		15		
Power Dissipation	P <sub>D</sub>	Internally Limite	ed (Thermal Protection)	W	
Lead Temperature (Soldering, 10sec)	T <sub>LEAD</sub>		260		
Junction Temperature	T <sub>J</sub>		150	°C	
Storage Temperature	T <sub>STG</sub>	-(	55 to 150	°C	
ESD (Machine Model)	ESD		300		
	Â	SOT-23-3	200	0	
Thermal Resistance (No Heatsink)	$\theta_{JA}$	SOT-23-5	200	°C/W	

Note 1: 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**

Parameter	Symbol	Min	Max	Unit
Supply Input Voltage	V <sub>IN</sub>	2.5	13.2	V
Enable Input Voltage	V <sub>EN</sub>	0	13.2	V
Operating Junction Temperature	T <sub>J</sub>	-40	125	°C



### AP2210

# Electrical Characteristics (Continued) AP2210-2.5 Electrical Characteristics

 $V_{IN}=3.5V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_J=25^{o}C, \textbf{Bold} \text{ typeface applies over } -40^{o}C \leq T_J \leq 125^{o}C \text{ (Note 2)}, \text{ unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified	-1		1	%
Output voltage Accuracy		V <sub>OUT</sub>	-2		2	/0
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$	-		48		ppm/ <sup>o</sup> C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =3.5V to 13.2V		1.5	4.5	
Entertegulation	KLINE				12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	REOAD	001			30	mV
		I <sub>OUT</sub> =100μA		15	50	
Dropout Voltage (Note 5)					70	
		I <sub>OUT</sub> =50mA		110	150	
					230	mV
	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA I <sub>OUT</sub> =150mA I <sub>OUT</sub> =300mA		140	250	
	Ditor				300	
				165	275	
					350	
				250	400	
					500	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4 V \text{ (shutdown)}$		0.01	1	μΑ
		$V_{EN} \leq 0.18V \text{ (shutdown)}$			5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100µA		100	150	
					180	μA
		$V_{EN} \ge 2.0V$ , $I_{OUT} = 50mA$		350	600	
Ground Pin Current (Note 6)	I <sub>GND</sub>				800	
(11010-0)		$V_{EN} \ge 2.0V$ , $I_{OUT} = 150mA$		1.3	1.9	1
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		dB
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2µF, 100pF from BYP to GND		260		$nV/\sqrt{H_2}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Enable input Eogle four voluge	1L	regulator shatao wh			0.18	·
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μΑ
Zhuere input Zegie iew current	IL	$V_{IL} \leq 0.18V$			2	per 1
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
Endore input Eogle ingli Current	IT	V <sub>IL</sub> ≥2.0V			25	M2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.



## AP2210

# Electrical Characteristics (Continued) AP2210-2.8 Electrical Characteristics

 $V_{IN}=3.8V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_J=25^{o}C, \textbf{Bold} \text{ typeface applies over -40^{o}C} \leq T_J \leq 125^{o}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Valtage Assurage	$\Delta V_{OUT}/V_{OUT}$	Variation from specified	-1		1	%
Output Voltage Accuracy		V <sub>OUT</sub>	-2		2	- 70
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			42.8		ppm/°C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =3.8V to 13.2V		1.5	4.5	
	KEINE				12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA 1	1	6		
(Note 4)	REORD	001			30	mV
		I <sub>OUT</sub> =100μA		15	50	
					70	
Dropout Voltage (Note 5)		I <sub>OUT</sub> =50mA		110	150	
					230	mV
	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA I <sub>OUT</sub> =150mA I <sub>OUT</sub> =300mA		140	250	
	Ditor				300	
				165	275	
					350	
				250	400	
					500	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4 V \text{ (shutdown)}$		0.01	1	μA
		$V_{EN} \leq 0.18V \text{ (shutdown)}$			5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100µA		100	150	
					180	μA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =50mA		350	600	
Ground Pin Current	I <sub>GND</sub>				800	
(Note 6)	_ `	V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =150mA		1.3	1.9	
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		dB
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2μF, 100pF from BYP to GND		260		$nV/\sqrt{Hz}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Enable input Eogle four voluge	1L	regulator shatao wh			0.18	·
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μΑ
Zhuere input Zegie iew current	IL	$V_{IL} \leq 0.18V$			2	per 1
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
Endote input Eogle ingli Current	IT	V <sub>IL</sub> ≥2.0V			25	M2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.



## AP2210

# Electrical Characteristics (Continued) AP2210-3.0 Electrical Characteristics

 $V_{IN}=4V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_{J}=25^{\circ}C, \text{ Bold typeface applies over } -40^{\circ}C \leq T_{J} \leq 125^{\circ}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified	-1		1	%
Sulput Voltage Recuracy		V <sub>OUT</sub>	-2		2	/0
Output Voltage Temperature Coefficient	$\Delta V_{OUT} / \Delta T$			120		µV/°C
(Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			40		ppm/°C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =4V to 13.2V		1.5	4.5	
	KLINE	110			12       6       30       50       70       150       230       0       250       300       5       275       350	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	REOND	001			30	mV
		I <sub>OUT</sub> =100µA		15	50	
Dropout Voltage (Note 5)					70	
		I <sub>OUT</sub> =50mA		110	150	
					230	mV
	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA I <sub>OUT</sub> =150mA		140	250	
					300	
				165		
		I <sub>OUT</sub> =300mA		250	<b>350</b> 400	
					500	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4V$ (shutdown)		0.01	1	μA
		$V_{EN} \leq 0.18V$ (shutdown)			5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100μA		100	150	
					180	μA
		$V_{EN} \ge 2.0V, I_{OUT} = 50mA$		350	600	
Ground Pin Current (Note 6)	I <sub>GND</sub>				800	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =150mA		1.3	1.9	
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
D' 1 D ' /'	DCDD	C 100H J 100 A		75	15	10
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100μA		75	000	dB
Current Limit	I <sub>LIMIT</sub>	$V_{OUT}=0V$		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2µF, 100pF from BYP to GND		260		$nV/\sqrt{H_2}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	v
Enable input Logie iow voltage	1L	regulator blatte wit			0.18	
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \le 0.4 V$		0.01	1	μΑ
Endole input Eogle low Current	-IL	V <sub>IL</sub> ≤0.18V			2	pur i
Enable Input Logic-high Current	I <sub>IH</sub>	$V_{IL} \ge 2.0 V$		5	20	μA
Endore input Bogie ingli Current	Ш	V <sub>IL</sub> ≥2.0V			25	p. 2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.



### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT} / V_{OUT}$	Variation from specified	-1		1	%
Sulput Voluge Recurey		V <sub>OUT</sub>	-2		2	/0
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			36.3		ppm/ºC
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =4.3V to 13.2V		1.5	4.5	
	' KLINE	VIN 1.5 V to 15.2 V			1.5 4.5   12 1   1 6   30 30   15 50   70 10   110 150   230 230   140 250   300 300   165 275   350 250   400 500	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	REOAD	001			30	mV
		I <sub>OUT</sub> =100μA		15	50	
Dropout Voltage (Note 5)					70	
		I <sub>OUT</sub> =50mA I <sub>OUT</sub> =100mA I <sub>OUT</sub> =150mA		110	150	
					230	mV
	V <sub>DROP</sub>			140	250	
					300	
				165		
		I <sub>OUT</sub> =300mA		250	250 400	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4 V \text{ (shutdown)}$		0.01		μΑ
		$V_{EN} \leq 0.18V \text{ (shutdown)}$		100	5	
		$V_{EN} \ge 2.0V$ , $I_{OUT} = 100 \mu A$		100	150	
				250	180	μΑ
Creared Dire Comment		$V_{EN} \ge 2.0V, I_{OUT} = 50mA$		350	600	
Ground Pin Current (Note 6)	I <sub>GND</sub>			1.3	800	
		$V_{EN} \ge 2.0V$ , $I_{OUT} = 150mA$		1.3	1.9 2.5	
				4	10	mA
		$V_{EN} \ge 2.0V$ , $I_{OUT} = 300mA$			15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		dB
Current Limit	ILIMIT	$V_{OUT}=0V$		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2μF, 100pF from BYP to GND		260		$nV/\sqrt{H}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Entroite input Logie four voltage	1L	regulator shatao wh			0.18	•
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μA
Zhuere input Zegie iew current	IL	V <sub>IL</sub> ≤0.18V			2	puri
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
Endote input Eogle ingli Current	Ш	$V_{IL} \ge 2.0 V$			25	pu2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C \le T_I \le 125^{\circ}C$ ) below its nominal value measured at 1V differential.



### AP2210

# Electrical Characteristics (Continued) AP2210-3.6 Electrical Characteristics

 $V_{IN}=4.6V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_J=25^{o}C, \textbf{Bold} \text{ typeface applies over } -40^{o}C \leq T_J \leq 125^{o}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified V <sub>OUT</sub>	-1		1	%
			-2		2	/0
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			48		ppm/°C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =4.6V to 13.2V		1.5	4.5	
2	KEINE				12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	REORD	001			30	mV
		I <sub>OUT</sub> =100µA		15	50	
					70	
		I <sub>OUT</sub> =50mA		110	150	
					230	
Dropout Voltage (Note 5)	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA		140	250	mV
					300	
		I <sub>OUT</sub> =150mA		165	275	
		I <sub>OUT</sub> =300mA			350	
				250	400	1
					500	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4 V \text{ (shutdown)}$		0.01	1	μA
		$V_{EN} \leq 0.18V \text{ (shutdown)}$			5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100µA		100	150	
					180	μΑ
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =50mA		350	600	
Ground Pin Current (Note 6)	I <sub>GND</sub>				800	
(10000)		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =150mA		1.3	1.9	
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		dB
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2µF, 100pF from BYP to GND		260		$nV/\sqrt{H_{\pi}^2}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Enable input Eogle four voluge	1L				0.18	, i
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μΑ
	-IL	$V_{IL} \leq 0.18V$			2	, por 1
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
	IT	V <sub>IL</sub> ≥2.0V			25	M2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.



### AP2210

# Electrical Characteristics (Continued) AP2210-4.0 Electrical Characteristics

 $V_{IN}=5.0V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_J=25^{o}C, \textbf{Bold} \text{ typeface applies over -40^{o}C} \leq T_J \leq 125^{o}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified	-1		1	%
		V <sub>OUT</sub>	-2		2	/0
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$	-		48		ppm/°C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =5.0V to 13.2V		1.5	4.5	
	KEINE				12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	REO/ID	001			30	mV
		I <sub>OUT</sub> =100μA		15	50	
					70	
		I <sub>OUT</sub> =50mA		110	150	mV
					230	
Dropout Voltage (Note 5)	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA		140	250	mV
					300	
		I <sub>OUT</sub> =150mA		165	275	
					350	-
		I <sub>OUT</sub> =300mA		250	400	
					500	
Standby Current	I <sub>STD</sub>	$V_{EN} \leq 0.4 V \text{ (shutdown)}$		0.01	1	μA
		$V_{EN} \leq 0.18V \text{ (shutdown)}$			5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100μA		100	150	
					180	mV mV mV μA μA mA dB mA
		$V_{EN} \ge 2.0V$ , $I_{OUT} = 50mA$		350	600	
Ground Pin Current (Note 6)	I <sub>GND</sub>				800	
(11010-0)		$V_{EN} \ge 2.0V$ , $I_{OUT} = 150mA$		1.3	1.9	_
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2μF, 100pF from BYP to GND		260		$nV/\sqrt{Hz}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Enable input Eogle four voluge	1L				0.18	, i
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μΑ
	-IL	$V_{IL} \leq 0.18V$			2	, por 1
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
	IT	V <sub>IL</sub> ≥2.0V			25	M2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.

Note 6: 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.

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### AP2210

# Electrical Characteristics (Continued) AP2210-5.0 Electrical Characteristics

 $V_{IN}=6.0V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_J=25^{o}C, \textbf{Bold} \text{ typeface applies over } -40^{o}C \leq T_J \leq 125^{o}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified $V_{OUT}$	-1		1	%
			-2		2	/0
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		µV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			48		ppm/°C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =6.0V to 13.2V		1.5	4.5	
Entertegulation	KLINE				12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	
(Note 4)	illoid a	001			30	mV
		I <sub>OUT</sub> =100μA		15	50	
					70	-
		I <sub>OUT</sub> =50mA		110	150	-
					230	-
Dropout Voltage (Note 5)	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA		140	250	mV
				1.65	300	
		I <sub>OUT</sub> =150mA		165	275 350	
		25	250	400	-	
		I <sub>OUT</sub> =300mA		230	500	
Standby Current	L	V <sub>EN</sub> ≤0.4V (shutdown)		0.01	1	
Standby Current	I <sub>STD</sub>	V <sub>EN</sub> ≤0.18V (shutdown)			5	μΑ
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100µA		100	150	
		* EN-2.0 *, 1001 100µ1			180	mV μA μA MA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =50mA		350	600	μ
Ground Pin Current	I <sub>GND</sub>				800	
(Note 6)	Grid	V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =150mA		1.3	1.9	
					2.5	mA
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2µF, 100pF from BYP to GND		260		$nV/\sqrt{H_{\pi}^2}$

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#### AP2210

# Electrical Characteristics (Continued) 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,  $V_{EN}$ ≥2.0V,  $T_J$ =25°C, **Bold** typeface applies over -40°C≤ $T_J$ ≤125°C (Note 2), unless otherwise specified.

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Enable Input Logic-low Voltage	V <sub>IL</sub>	Regulator shutdown			0.4	V
Enable input Eogle four voluge	1L				0.18	, i
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			V
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \leq 0.4 V$		0.01	1	μΑ
	-IL	$V_{IL} \leq 0.18V$			2	, por 1
Enable Input Logic-high Current	I <sub>IH</sub>	V <sub>IL</sub> ≥2.0V		5	20	μA
	IT	V <sub>IL</sub> ≥2.0V			25	M2 1

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 5: Dropout voltage is defined as the input to output differential at which the output voltage drops 1% ( $T_J=25^{\circ}C$ ) or 2% (- $40^{\circ}C\leq T_{I}\leq 125^{\circ}C$ ) below its nominal value measured at 1V differential.



## AP2210

# Electrical Characteristics (Continued) AP2210-ADJ Electrical Characteristics

 $V_{IN}=V_{OUT}+1V, I_{OUT}=100\mu A, C_{IN}=1.0\mu F, C_{OUT}=2.2\mu F, V_{EN}\geq 2.0V, T_{J}=25^{o}C, \text{ Bold typeface applies over } -40^{o}C \leq T_{J} \leq 125^{o}C \text{ (Note 2), unless otherwise specified.}$ 

Parameter	Symbol	Conditions	Min	Тур	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT} / V_{OUT}$	Variation from specified	-1		1	%
		V <sub>OUT</sub>	-2		2	70
Output Voltage	$\Delta V_{OUT} / \Delta T$			120		μV/ºC
Temperature Coefficient (Note 3)	$(\Delta V_{OUT}/V_{OUT})/\Delta T$			48		ppm/ <sup>o</sup> C
Line Regulation	V <sub>RLINE</sub>	V <sub>IN</sub> =V <sub>OUT</sub> +1V to 13.2V		1.5	4.5	
					12	mV
Load Regulation	V <sub>RLOAD</sub>	I <sub>OUT</sub> =0.1mA to 300mA		1	6	- <b>- - - - - - - - - -</b>
(Note 4)					30	mV
Standby Current	I <sub>STD</sub>	V <sub>EN</sub> ≤0.4V (shutdown)		0.01	1	μA
Sumary Current	510	$V_{EN} \leq 0.18V$ (shutdown)			5	P*
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =100µA		100	150	μΑ
					180	цА
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =50mA		350	600	- mA
Ground Pin Current	I <sub>GND</sub>				800	
(Note 6)	GND	V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =150mA		1.3	1.9	
					2.5	
		V <sub>EN</sub> ≥2.0V, I <sub>OUT</sub> =300mA		4	10	IIIA
					15	
Ripple Rejection	PSRR	f=100Hz, I <sub>OUT</sub> =100µA		75		dB
Current Limit	I <sub>LIMIT</sub>	V <sub>OUT</sub> =0V		450	900	mA
Output Noise	e <sub>no</sub>	I <sub>OUT</sub> =50mA, C <sub>OUT</sub> =2.2µF, 100pF from BYP to GND		260		$nV/\sqrt{Hz}$
Enable Input Logic-low	V <sub>IL</sub>	Regulator shutdown			0.4	v
Voltage	· IL	Regulator shutdown			0.18	•
Enable Input Logic-high Voltage	V <sub>IH</sub>	Regulator enabled	2.0			v
Enable Input Logic-low Current	I <sub>IL</sub>	$V_{IL} \le 0.4 V$		0.01	1	
	*IL	V <sub>IL</sub> ≤0.18V			2	μA
Enable Input Logic-high	I <sub>IH</sub>	$V_{IL} \ge 2.0 V$		5	20	μΑ
Current	*1H	V <sub>IL</sub> ≥2.0V			25	

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#### **300mA RF ULDO REGULATOR**

AP2210

# Electrical Characteristics (Continued) AP2210-ADJ Electrical Characteristics

 $V_{IN}=V_{OUT}+1V$ ,  $I_{OUT}=100\mu A$ ,  $C_{IN}=1.0\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $V_{EN}\ge 2.0V$ ,  $T_J=25^{\circ}C$ , **Bold** typeface applies over -40°C $\le T_J \le 125^{\circ}C$  (Note 2), unless otherwise specified.

Note 2: Specifications in bold type are limited to  $-40^{\circ}C \le T_J \le 125^{\circ}C$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 3: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 4: 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.

Note 6: 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.

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#### **300mA RF ULDO REGULATOR**

**Typical Performance Characteristics** 

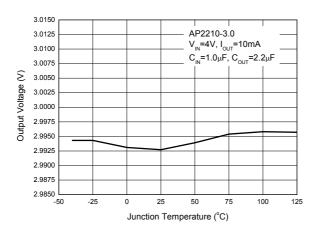


Figure 4. Output Voltage vs. Junction Temperature

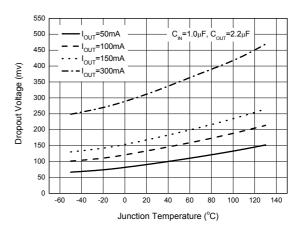


Figure 5. Dropout Voltage vs. Junction Temperature

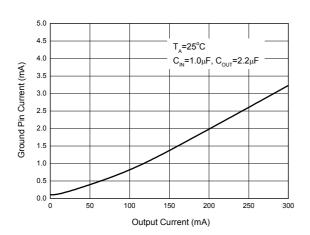


Figure 6. Ground Pin Current vs. Output Current

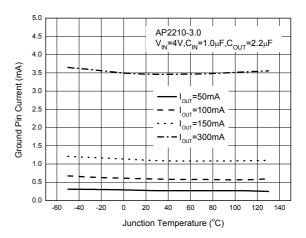


Figure 7. Ground Pin Current vs. Junction Temperature

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### **300mA RF ULDO REGULATOR**

### AP2210



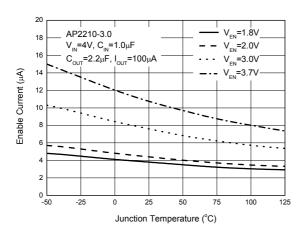


Figure 8. Enable Current vs. Junction Temperature

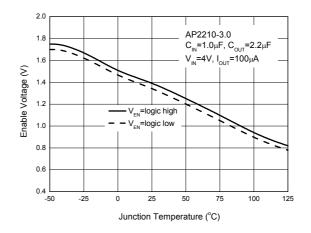


Figure 9. Enable Voltage vs. Junction Temperature

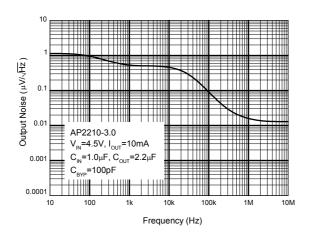
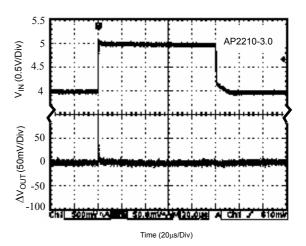
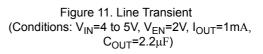


Figure 10. Output Noise vs. Frequency





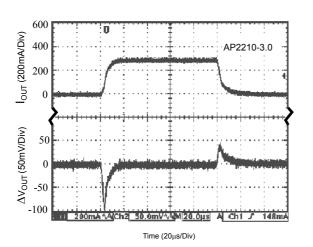
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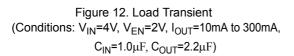


### **300mA RF ULDO REGULATOR**

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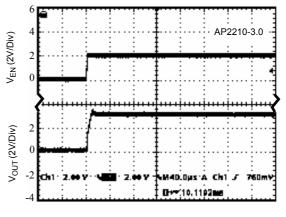




Figure 13. V<sub>EN</sub> vs. V<sub>OUT</sub> (Conditions: V<sub>EN</sub>=0 to 2V, V<sub>IN</sub>=4V, I<sub>OUT</sub>=30mA,  $C_{IN}$ =1.0 $\mu$ F,  $C_{OUT}$ =2.2 $\mu$ F)

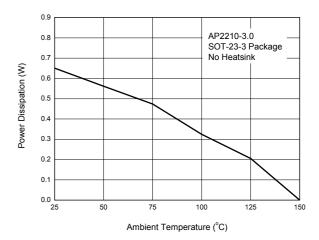


Figure 15. Power Dissipation vs. Ambient Temperature

AP2210-3.0 90  $V_{IN}$ =4V,  $V_{RIPPLE}$ =1 $V_{PP}$ 80  $I_{OUT}$ =10mA, C<sub>OUT</sub>=2.2µF 70 60 PSRR (dB) 50 40 30 20 10 0 ∟ 10 100 10k 100k 1k 1M Frequency (Hz)

Figure 14. PSRR vs. Frequency

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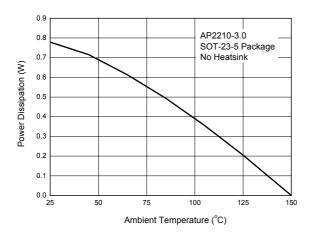
100



## **300mA RF ULDO REGULATOR**

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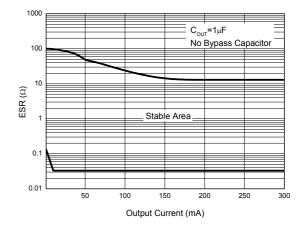


Figure 16. Power Dissipation vs. Ambient Temperature

Figure 17. ESR vs. Output Current

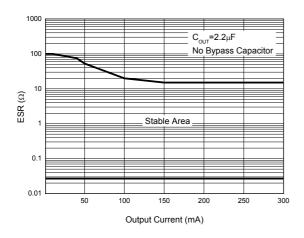


Figure 18. ESR vs. Output Current

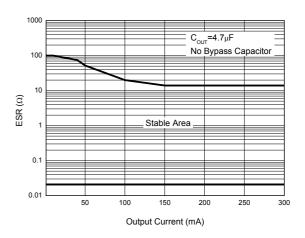


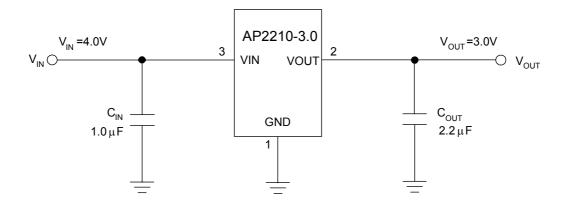
Figure 19. ESR vs. Output Current

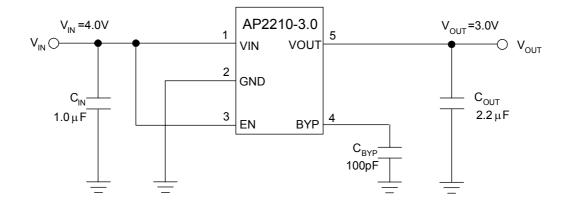


# **300mA RF ULDO REGULATOR**

# AP2210

## **Typical Application**





For Fixed Version

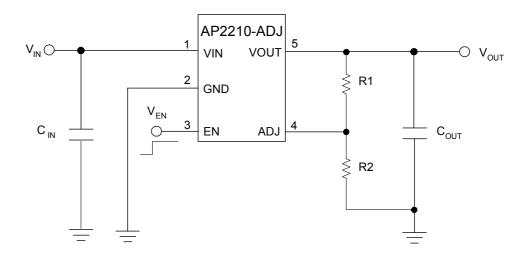
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## **300mA RF ULDO REGULATOR**

## AP2210

## **Typical Application (Continued)**



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

For Adjustable Version

Figure 20. Typical Application of AP2210 (Note 7)

Note 7: Dropout voltage is 250mV when  $T_A=25^{\circ}C$ . In order to obtain a normal output voltage,  $V_{OUT}+0.25V$  is the minimum input voltage which will results a low PSRR, imposing a bad influence on system. Therefore, the recommended input voltage is  $V_{OUT}+1V$  to 13.2V. For AP2210-3.0 version, its input voltage can be set from  $4V(V_{OUT}+1V)$  to 13.2V.

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#### **Application Information**

#### **Input Capacitor**

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

#### **Output Capacitor**

It is required to prevent oscillation.  $1.0\mu$ F minimum is recommended when C<sub>BYP</sub> is unused.  $2.2\mu$ F minimum is recommended when C<sub>BYP</sub> 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 small 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. In order to keep the output stability, it is recommended to use the bypass capacitor no more than 100pF.

The start-up speed of the AP2210 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 tempera-

ture 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 16, 17), 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,  $\theta_{JA}$  is 200°C/W, 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 (3.0V version): I<sub>OUT</sub>=300mA, T<sub>A</sub>=50°C, V<sub>IN(Max)</sub> is: (150°C-50°C)/(0.3A\*200°C/W)+3.0V=4.67V

Therefore, for good performance, please make sure that input voltage is less than 4.67V without heatsink when  $T_A=50^{\circ}C$ .



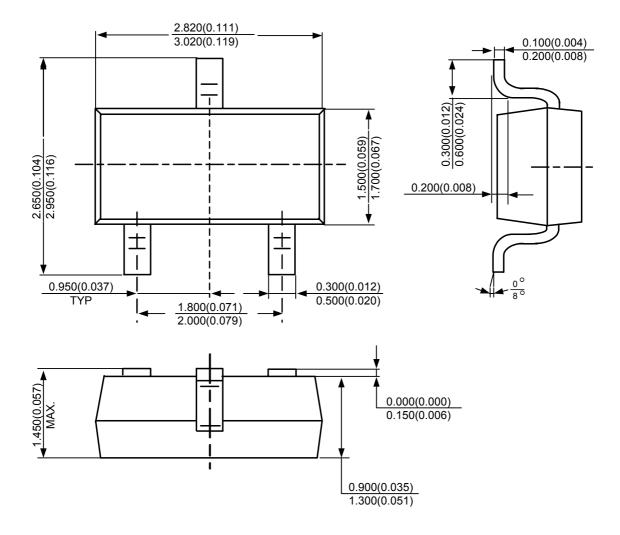
## **300mA RF ULDO REGULATOR**

AP2210

**Mechanical Dimensions** 

SOT-23-3

Unit: mm(inch)



Jan. 2012 Rev. 1. 6

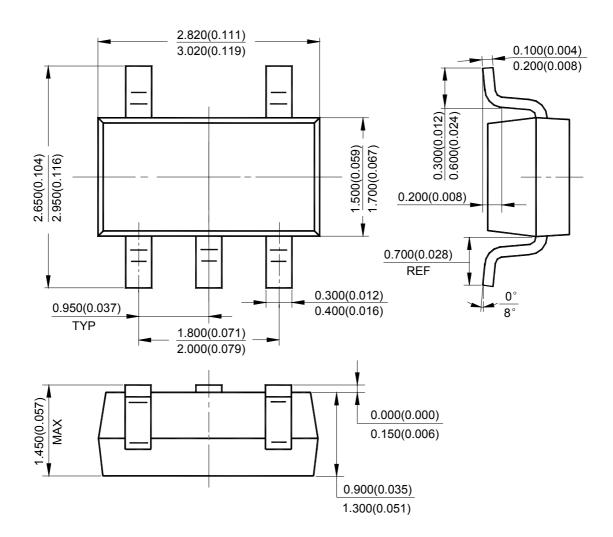


AP2210

## **300mA RF ULDO REGULATOR**

Mechanical Dimensions (Continued)

Unit: mm(inch)



SOT-23-5

Jan. 2012 Rev. 1. 6



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