150mA RF ULDO REGULATOR AP2201

General Description

The AP2201 is a 150mA output current fixed voltage regulator designed to provide very low noise (45μVrms at 80Hz-100KHz), ultra low dropout voltage (typically 165mV at 150mA), very low quiescent 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 AP2201 also features individual 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 output capacitor of 1.0μF minimum and 2.2μF minimum near its pin are recommended when C_{BYP} is not used and when C_{BYP} is 470pF respectively. The output capacitor should have 5Ω or less ESR, tantalum or aluminium electrolytic capacitors are adequate. Bypass capacitor is connected to the internal voltage reference to quiet noise. Its recommended value is from 470pF to 1nF. If output noise is not a major concern and rapid turn-on is necessary, omit C_{BYP} and leave BYP open.

The AP2201 has 2.6V, 2.8V and 3.0V versions now.

The AP2201 is available in space saving 5-pin SOT-23-5 package.

Features

- Up to 150mA Regulator Output
- Low Quiescent Current
- Low Dropout Voltage: V_D=165mV at 150mA
- High Precision Output Voltage: ±1%
- Output Noise: 45μVrms at 80Hz-100KHz
- 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
- Zero Off-mode Current
- Logic-controlled Enable

Applications

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

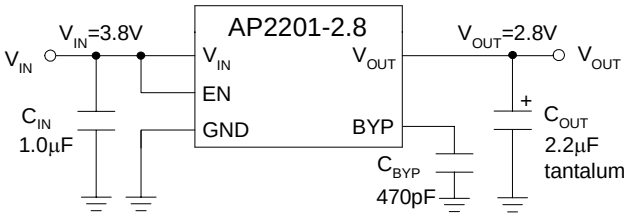


Figure 1. Typical Application of AP2201

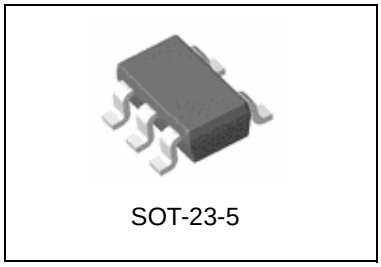


Figure 2. Package Type of AP2201

Pin Configuration

K Package
(SOT-23-5)

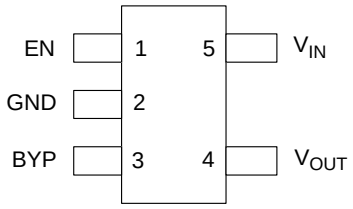


Figure 3. Pin Configuration of AP2201 (Top View)

Pin Description

Pin Number	Pin Name	Function
1	EN	Logic high enable input.
2	GND	Ground.
3	BYP	Bypass capacitor for low noise operation.
4	V_{OUT}	Regulated output voltage.
5	V_{IN}	Input voltage.

Functional Block Diagram

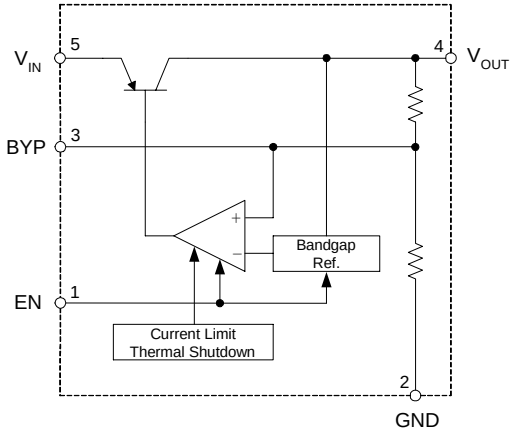
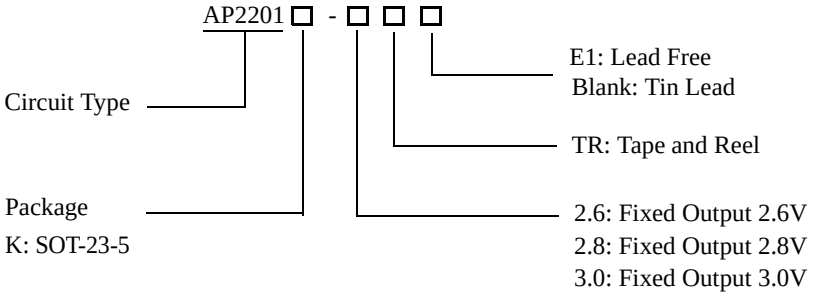


Figure 4. Functional Block Diagram of AP2201

Ordering Information



Ordering Information (Continued)

Package	Temperature Range	Part Number		Marking ID		Packing Type
		Tin Lead	Lead Free	Tin Lead	Lead Free	
SOT-23-5	-40 to 125°C	AP2201K-2.6TR	AP2201K-2.6TRE1	K1E	E1E	Tape & Reel
		AP2201K-2.8TR	AP2201K-2.8TRE1	K1G	E1G	Tape & Reel
		AP2201K-3.0TR	AP2201K-3.0TRE1	K1I	E1I	Tape & Reel

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

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value	Unit
Supply Input Voltage	V_{IN}	15	V
Enable Input Voltage	V_{EN}	15	V
Power Dissipation	P_D	Internally Limited	W
Lead Temperature (Soldering, 5sec)	T_{LEAD}	260	°C
Storage Temperature	T_{STG}	-65 to 150	°C
ESD (Machine Model)		200	V
Thermal Resistance	θ_{JA}	(Note 2)	

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.

Note 2: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its operating ratings. The maximum allowable power dissipation is a function of the maximum junction temperature, $T_{J(max)}$, the junction-to-ambient thermal resistance, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature is calculated using: $P_{D(max)}=(T_{J(max)} - T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

Recommended Operating Conditions

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

Electrical Characteristics

V_{IN}=V_{OUT} +1V, I_{OUT} = 100μA, C_L = 2.2μF, V_{EN}≥ 2.0V, T_J = 25°C, **Bold** typeface applies over -40°C<T_J<125°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage Accuracy	$\Delta V_O/V_O$	Variation from specified V_{OUT}	-1		1	%
			-2		**2**	
Output Voltage Temperature Coefficient	$\Delta V_O/\Delta T$	(Note 3)		**120**		μV/°C
Line Regulation	V_{RLINE}	AP2201-2.6V V_{IN}= V_{OUT} +1V to 13.2V		1	3	mV
					13	
		AP2201-2.8V V_{IN}= V_{OUT} +1V to 13.2V		1	4	
					14	
		AP2201-3.0V V_{IN}= V_{OUT} +1V to 13.2V		1	4	
					14	
Load Regulation (Note 4)	V_{RLOAD}	AP2201-2.6V I_{OUT}= 0.1mA to 150mA		1	8	mV
					16	
		AP2201-2.8V I_{OUT}= 0.1mA to 150mA		1	9	
					18	
		AP2201-3.0V I_{OUT}= 0.1mA to 150mA		1	9	
					18	
Dropout Voltage (Note 5)	V_{IN}-V_O	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	
Quiescent Current	I_Q	V_{EN} ≤ 0.4V (shutdown)		0.01	1	μA
		V_{EN} ≤ 0.18V (shutdown)			**5**	
Ground Pin Current (Note 6)	I_{GND}	V_{EN} ≥ 2.0V, I_{OUT}=0μA		180	245	μA
					265	
		V_{EN} ≥ 2.0V, I_{OUT}=100μA		182	250	
					270	
		V_{EN} ≥ 2.0V, I_{OUT}=50mA		350	600	
					800	
		V_{EN} ≥ 2.0V, I_{OUT}=100mA		600	1000	
					1500	

Electrical Characteristics (Continued)

$V_{IN}=V_{OUT}$ +1V, I_{OUT} = 100μA, C_L = 2.2μF, $V_{EN}\geq$ 2.0V, T_J = 25°C, **Bold** typeface applies over -40°C<T_J<125°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Ground Pin Current (Note 6)	I_{GND}	$V_{EN}\geq$ 2.0V, I_{OUT}=150mA		1300	1900	μA
					2500	
Ripple Rejection	PSRR	frequency=100Hz, I_{OUT}=100μA		75		dB
Current Limit	I_{LIMIT}	V_{OUT} = 0V		**320**	550	mA
Output Noise (Regulator B only)	e_{no}	I_{OUT}=50mA, C_L=2.2μF, 470 pF from BYP to GND		260		$nV/\sqrt{Hz}$
Enable Input Logic-Low Voltage	V_{IL}	Regulator shutdown			0.4	V
					0.18	
Enable Input Logic-High Voltage	V_{IH}	Regulator enabled	**2.0**			V
Enable Input Logic-Low Current	I_{IL}	$V_{IL}\leq$ 0.4V		0.01	-1	μA
		$V_{IL}\leq$ 0.18V			**-2**	
Enable Input Logic-High Current	I_{IH}	$V_{IL}\geq$ 2.0V		5	20	μA
		$V_{IL}\geq$ 2.0V			**25**	

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 150mA. 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 2% 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.

Typical Performance Characteristics

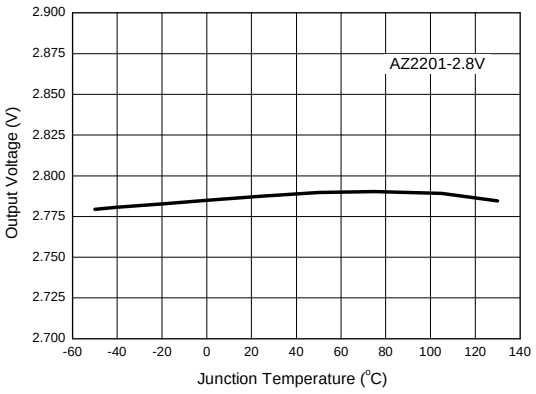


Figure 5. Output Voltage vs. Junction Temperature

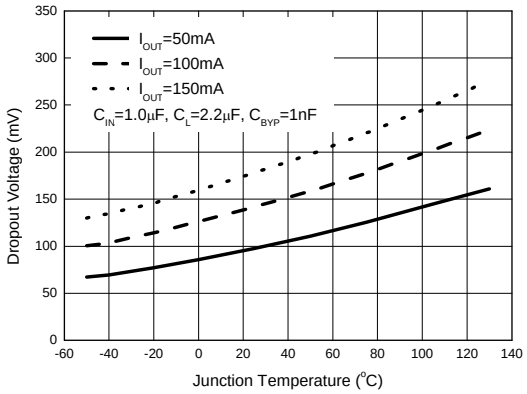


Figure 6. Dropout Voltage vs. Junction Temperature

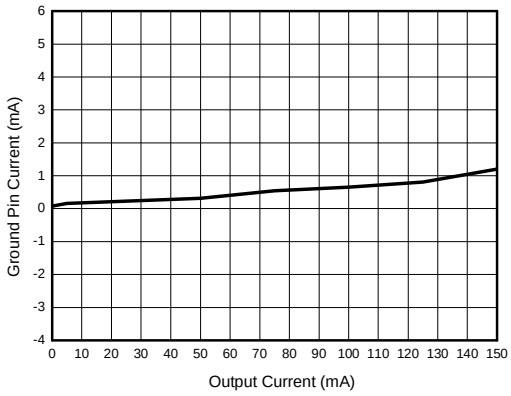


Figure 7. Ground Pin Current vs. Output Current

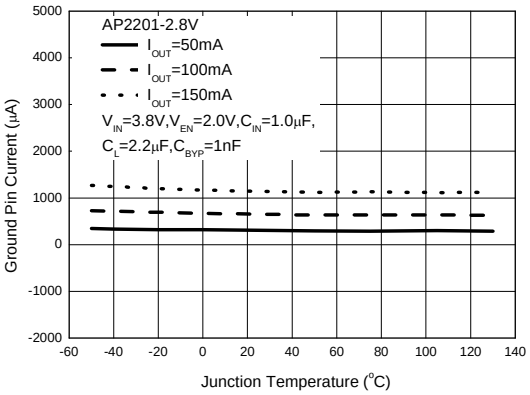


Figure 8. Ground Pin Current vs. Junction Temperature

Typical Performance Characteristics (Continued)

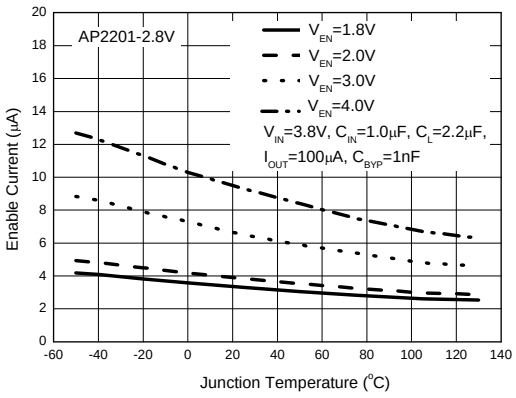


Figure 9. Enable Current vs. Junction Temperature

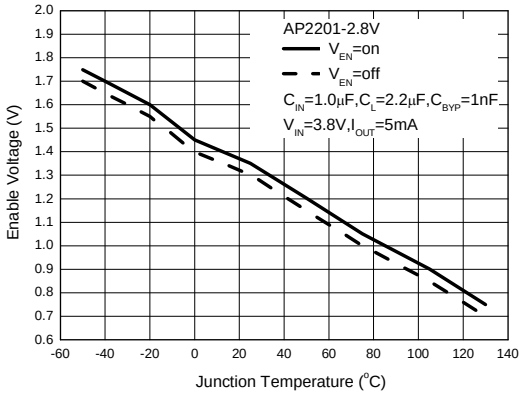


Figure 10. Enable Voltage vs. Junction Temperature

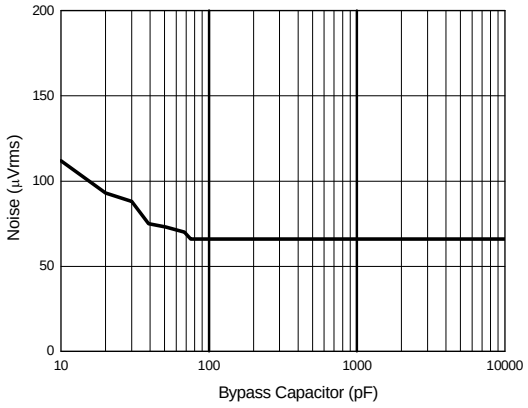


Figure 11. Noise vs. Bypass Capacitor

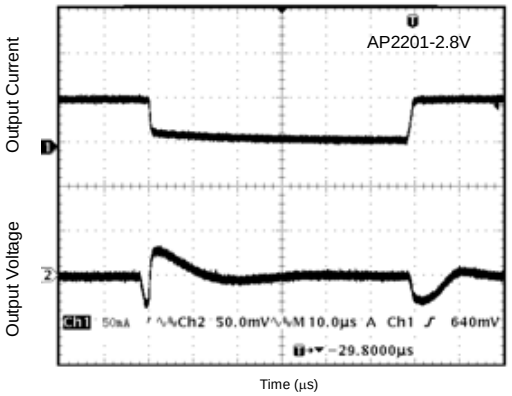


Figure 12. Load Transient
(Conditions: V_{IN}=3.8V, C_{BYP}=680pF, V_{EN}=2V, I_{OUT}=5mA to 50mA, C_L=2.2μF)

Typical Performance Characteristics (Continued)

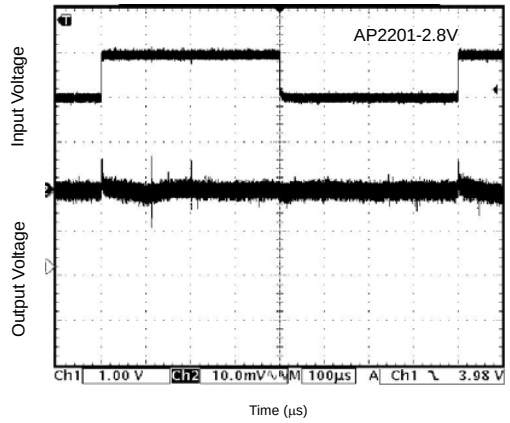


Figure 13. Line Transient
(Conditions: V_{IN}=3.8V to 4.8V, V_{EN}=2V, I_{OUT}=100µA
C_{BYP}=680pF, C_L=10µF)

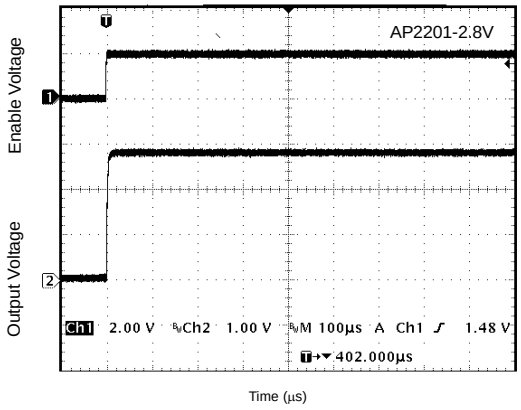


Figure 14. V_{EN}(on) vs. V_O
(Conditions: V_{EN}=0V to 2V, V_{IN}=3.8V, I_{OUT}=30mA,
C_{BYP}=open, C_L=2.2µF)

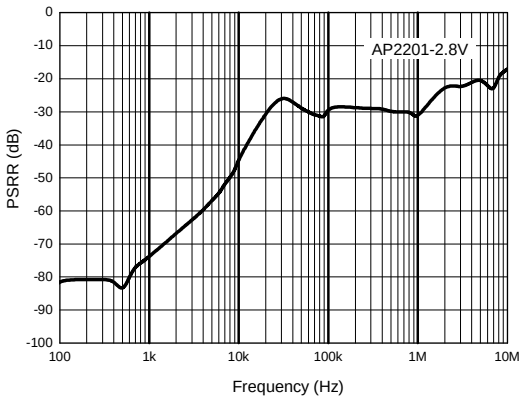


Figure 15. PSRR vs. Frequency
(Conditions: C_{IN} =1.0µF, C_L = 2.2µF, C_{BYP}= open,
V_{IN}=3.8V, I_{OUT}=10mA, V_{EN}=2V)

Application Information

External Capacitors
The AP2201 requires external capacitors for regulator stability. These capacitors must be correctly selected for good performance.

Input Capacitor
If there is more than 10 inches of wire between the input and the AC filter or if a battery is used as the input, at least a 1μF capacitor should be placed from IN to GND.

Output Capacitor
It is required to prevent oscillation. 1.0μF minimum is recommended when C_{BYP} is not used. 2.2μF minimum is recommended when C_{BYP} is 470pF. The output capacitor may be increased without limit for large values to improve transient response.

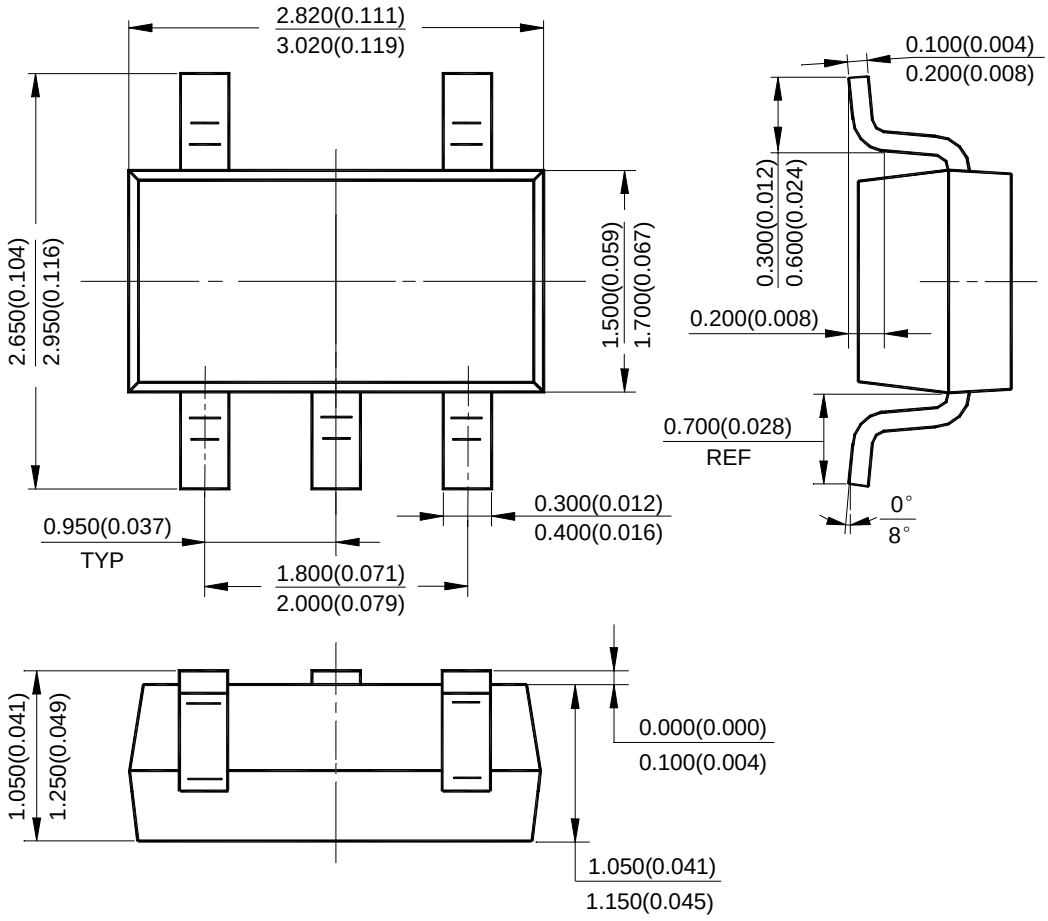
The output capacitor should have an ESR of about 5Ω or less. In most cases, tantalum or aluminium electrolytic capacitors are adequate.

Noise Bypass Capacitor
Bypass capacitor is connected to the internal voltage reference. A 680pF capacitor connected from BYP to GND make this reference quiet, resulting in a significant reduction in output noise. When using C_{BYP}, output capacitors of 2.2μF or greater are required for better stability.

The start-up speed of the AP2201 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.

Mechanical Dimensions

SOT-23-5 **Unit: mm(inch)**



BCD Semiconductor Manufacturing Limited

http://www.bcdsemi.com

BCD Semiconductor Corporation

3170 De La Cruz Blvd, Suite # 105 Santa Clara, CA 95054-2411, U.S.A Tel: +1-408-988 6388, Fax: +1-408-988 6386

Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd.

800 Yi Shan Road, Shanghai 200233, PRC Tel: +86-21-6485 1491, Fax: +86-21-5450 0008

Advanced Analog Circuits (Shanghai) Corporation

8F, B Zone, 900 Yi Shan Road, Shanghai 200233, PRC Tel: +86-21-6495 9539, Fax: +86-21-6485 9673

BCD Semiconductor (Taiwan) Company Limited

4F, 298-1 Rui Guang Road, Nei-Hu District, Taipei, Taiwan Tel: +886-2-2656-2808, Fax: +886-2-2656-2806