Features

- **DC to DC Converter 1.9V / 2.5V (DCDC1)**
- **LDO Regulator 2.7V / 2.8V (LDO1)**
- **LDO Regulator 2.8V (LDO2)**
- **LDO Regulator 2.8V (LDO3)**
- **LDO Regulator 2.47V / 2.66 (LDO4) - Backup Battery Supply**
- **LDO Regulator 1.72V / 2.66 (LDO5) - RTC Supply**
- **Reset Generator**

Power Management

AT73C211

1. Description

The AT73C211 is a power management device for digital, analog, interface, and, in some cases, RF and backup sections of add-on modules used as accessories in popular handheld devices like mobile phones, digital still cameras, PDAs and a wide range of multimedia devices. The AT73C211 can also be used to supply the CPU with a high-efficiency DC-DC Converter, a radio frequency transceiver with high power supply rejection ratio (PSRR) and noise performance low-dropout (LDO) regulators, or memories and analog sections with independent LDO channels.

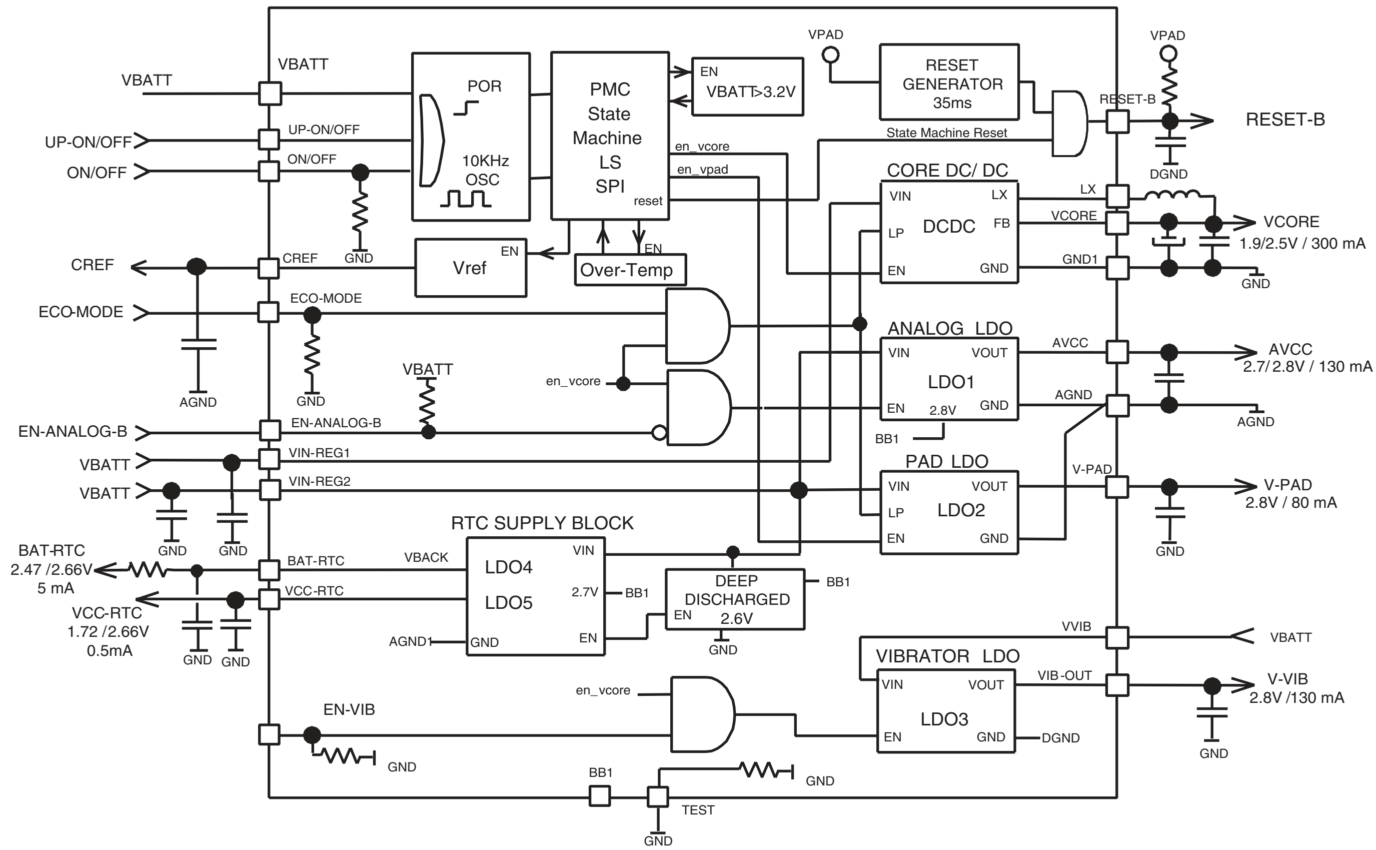
In addition, the AT73C211 integrates LDO regulators to recharge backup elements and convert its voltage to microcontroller RTC supply.

LDO regulators and DC-DC converters output voltage can be programmed by a mask change.

6199A–PMGMT–20-Sep-05

2. Functional Block Diagram

Figure 2-1. AT73C211 Block Diagram



3. Pin Description

Table 3-1. Pin Description

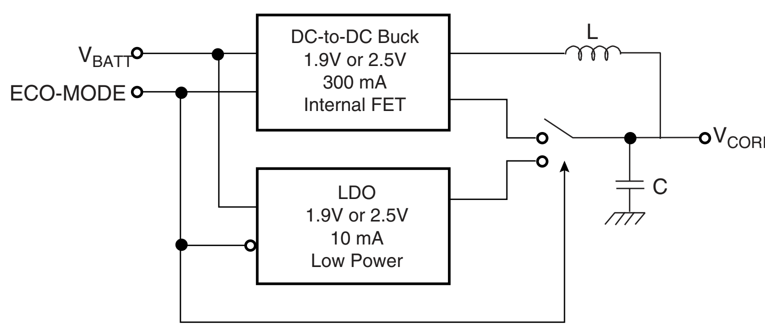
Signal	Pin	Type	A/D	Description
VBATT	E1	VBATT1		Input supply
ON/OFF	D5	IPD	D	Key ON/OFF input, 1.5M Ohm pull-down
UP-ON/OFF	C6	I	D	Hold the Power ON from MCU
RESET-B	F6	OD	D	Reset open collector output. Need external pull-up to VBATT
VIN-REG1	G6	VBATT2		Input supply for DC/DC converter
LX	F7	O	A	DC/DC converter output inductor
ECO-MODE	G5	IPD	D	Eco Mode, from MCU - sets VCORE, V-PAD in low power mode, 1.5M Ohm pull-down
VCORE	G4	O	A	DC/DC converter output (MCU core supply)
GND1	G7	Ground		Ground of DC/DC converter
VIN-REG2	A5	VBATT3		Input supply
EN-ANALOG-B	B5	IPD	D	Enable the analog LDO, active at logic 0, 1.5M Ohm pull-down
AVCC	B4	O	A	Analog LDO output (MCU chip analog supply)
AGND	A7	Ground		Ground of AVCC, V-PAD and RTC LDO
V-PAD	B6	O	A	Digital LDO output (MCU chip digital PAD supply)
VCC-RTC	B7	O	A	MCU RTC supply output
BAT-RTC	A6	I/O	A	RTC backup battery charger - must be connected through a 2.2K Ohm resistor to the backup battery
VIN-RF	A3	VBATT4		Input supply
AGND2	A2	Ground		Ground
VIN-VIB	D7	VBATT5		Input supply for vibrator LDO
EN-VIB	E6	IPD	D	Vibrator driver input (from baseband chip), 1.5M Ohm pull-down
VVIB	E7	O	A	Vibrator LDO output (Voltage regulator)
GND	D1	Ground		Ground
CREF	C7	O	A	Bandgap decoupling - 100 nF capacitor must be connected from this pin to ground
BB1	D4	I	D	BB1 = 1 => VCORE = 2.5V, BB1= 0 => VCORE = 1.9V
TEST	E5	IPD	A	Connect to AGND

4. Functional Description

4.1 DC to DC Converter 1.9V/2.5V - 300 mA for Coprocessor Core

The DC-to-DC converter is a synchronous mode DC-to-DC "buck"-switched regulator using fixed-frequency architecture (PWM) and capable of providing 300 mA of continuous current. It has two levels of voltage programming for the co-processor core (1.9V or 2.5V). The operating supply range is from 3.1V to 5.5V, making it suitable for Li-Ion, Li-polymer or Ni-MH battery applications. The DC-to-DC converter is based on pulse width modulation architecture to control the noise perturbation for switching noise sensitive applications (Wireless). The operating frequency is set to 900 kHz using an internal clock, allowing the use of a small surface inductor and moderate output voltage ripple. The controller consists of a reference ramp generator, a feedback comparator, the logic driver used to drive the internal switches, the feedback circuits used to manage the different modes of operation and the over-current protection circuits. An economic mode has been defined to reduce quiescent current. A low-dropout voltage regulator in parallel to the DC-to-DC converter minimizes standby current consumption during standby mode.

Figure 4-1. Dual-power DC-to-DC Converter



Low undershoot voltage is expected when going from PWM to LDO mode and vice-versa. The circuit is designed in order to avoid any spikes when transition between two modes is enabled.

Figure 4-2. Low-power/Full-power DC-to-DC Converter Transition

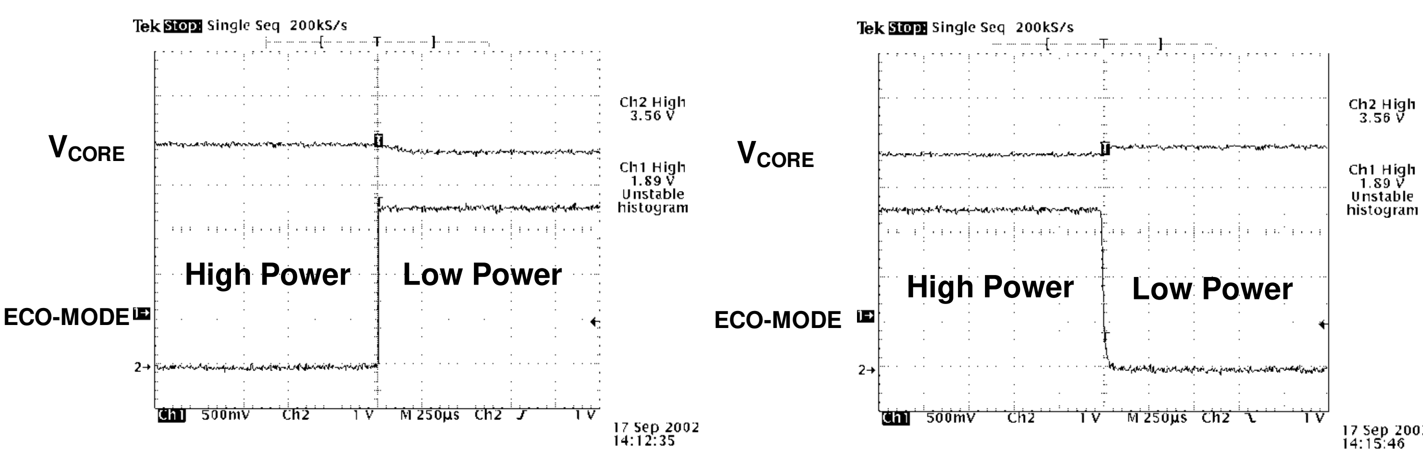
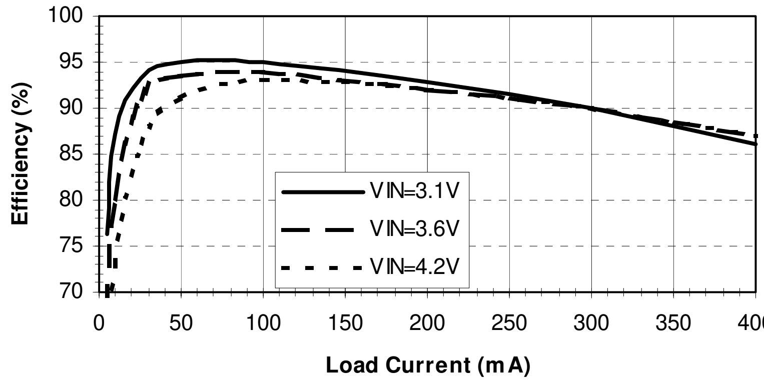


Figure 4-3 shows typical efficiency levels of the DC-to-DC converter for several input voltages.

Figure 4-3. DC-to-DC Converter with 1.9V Target Typical Case(1)



Note: 1. L = 10 µH, ESR = 0.2 Ohm, c = 22 µF, @ESR = 0.1 Ohm

4.2 LDO1, LDO3 Regulators

The PSRR measures the degree of immunity against voltage fluctuations achieved by a regulator. An example of its importance is in the case of a GSM phone when the antenna switch activates the RF power amplifier (PA). This causes a current peak of up to 2A on the battery, with an important spike on the battery voltage. The voltage regulator must filter or attenuate this spike.

Figure 4-4. Functional Diagram of LDO Single Mode

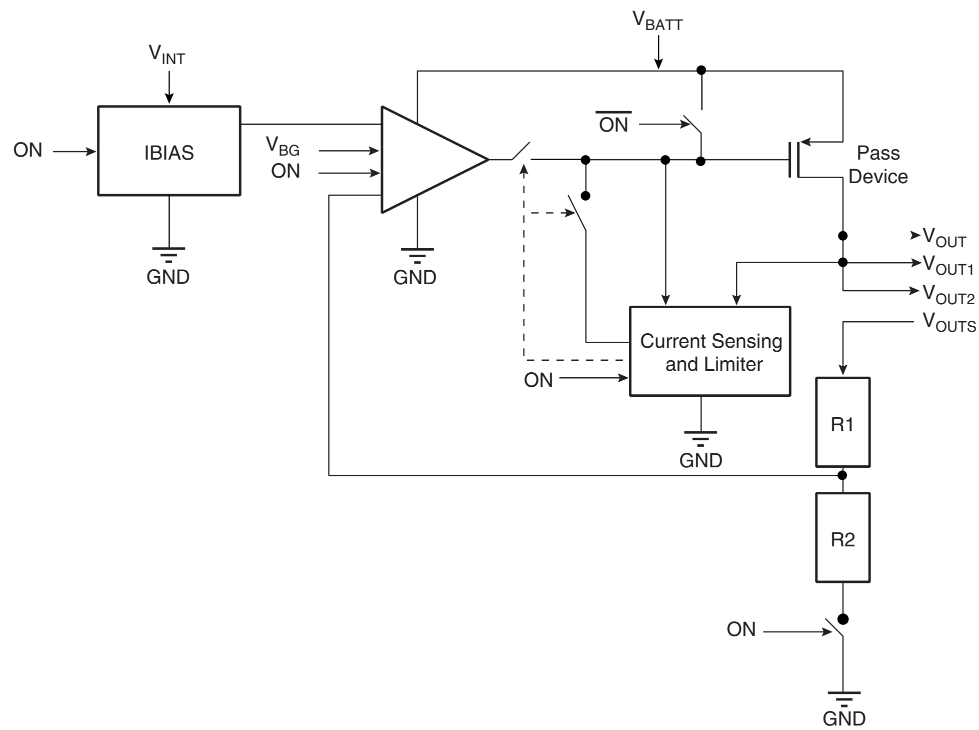
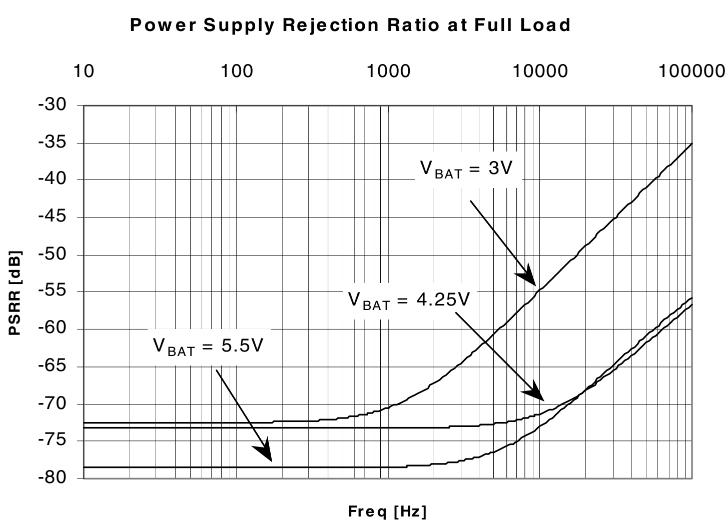
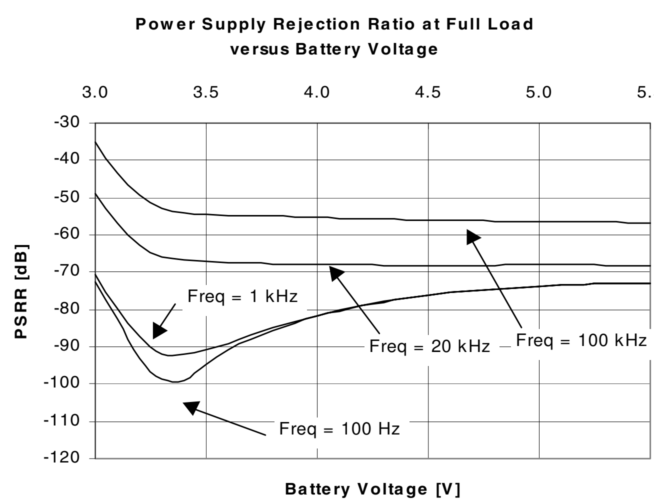


Figure 4-5 shows the Power Supply Rejection Ratio as functions of frequency and battery voltage. If a noise signal occurs at 1 kHz when the battery voltage is at 3V, the noise will be attenuated by 70 dB (divided by more than 3000) at the output of the regulator. Consequently, a 2V spike on the battery is attenuated to less than 1 mV, which is low enough to avoid any risk of malfunction by a device supplied by the regulator.

Figure 4-5. Power Supply Rejection Ratio in Function of Frequency and Battery Voltage

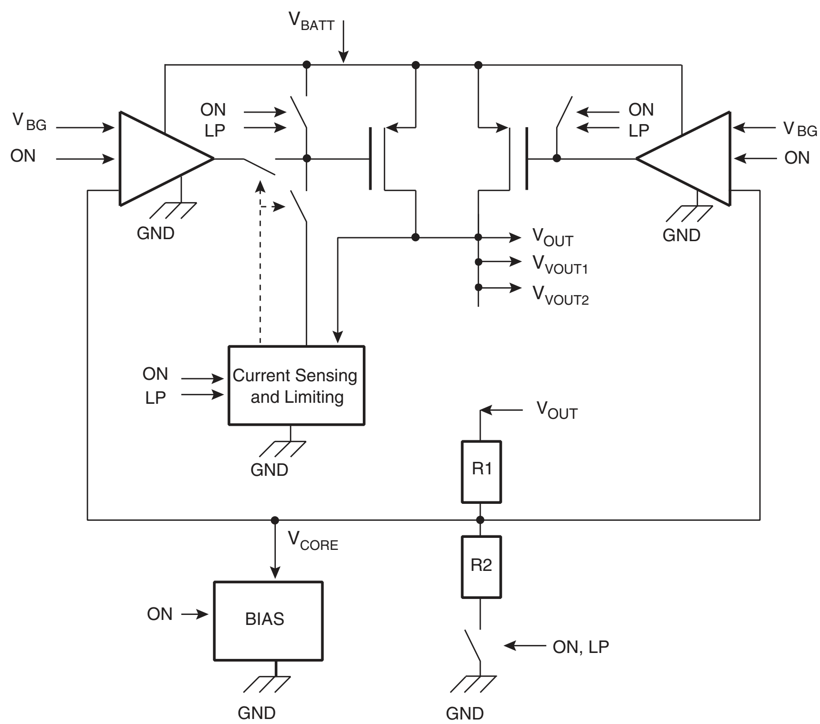




4.3 LDO2 Regulator

The first approach to reducing standby current is to decrease the standby current inside the regulators themselves. Atmel achieves this by implementing a dual mode architecture where two output transistors are used in parallel as switches in the regulation loop. Figure 4-6 illustrates this architecture.

Figure 4-6. Functional Diagram of LDO Dual Mode



In Figure 4-6, the left-hand output transistor is sized large enough for the required output current under full load, for example, 100 mA. In order to achieve a sufficient margin of stability, the current sensing block uses a bias cell where the current consumption is linked to the required output current. The higher the output current, the higher the bias current needed to stabilize the loop.

The right-hand output transistor delivers a very small output current, typically less than 1 mA, sufficient only to maintain the output voltage with enough current to cover the leakage current of the supplied device. This requires a much smaller bias current and, consequently, a smaller standby current inside the regulator.

5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Operating Temperature (Industrial) .... -40° C to +85° C Storage Temperature .... -55°C to +150°C Power Supply Input Pads .... -0.3V to +5.5V I/O Input (all except to power supply) .... -0.3V to +3.3V	*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

5.2 DC to DC Converter

Table 5-1. DC to DC Converter Electrical Characteristics (t_{AMB} = -20° C to 85° C, VIN = 3.2V to 4.2V unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage	BB1 = 0		1.9		V
		BB1 = 1		2.5		V
I_{OUT}	Output Current	PWM Mode (ECO-MODE = 0)		150	300	mA
		LDO Mode (ECO-MODE = 1)			5	mA
I_{OFF}	Standby Current			0.1	1	µA
E_{FF}	Efficiency	I_{OUT} = 10 mA to 200 mA @1.9V		90		%
ΔV_{DCLD}	Static Load Regulation	10% to 90% of $I_{OUT(MAX)}$		7		mV
ΔV_{TRLD}	Transient Load Regulation	10% to 90% of $I_{OUT(MAX)}$, $T_R = T_F$ = 5µs		30		mV
ΔV_{DCLE}	Static Line Regulation	10% to 90% of $I_{OUT(MAX)}$, VIN = 3.2V to 4.2V		20		mV
ΔV_{TRLE}	Transient Line Regulation	10% to 90% of $I_{OUT(MAX)}$, VIN = 3.2V to 4.2V		35		mV
PSRR	Ripple Rejection	LDO Mode up to 1 KHz	40	45		dB
ΔV_{LPFP}	Overshoot Voltage	Voltage drop from LDO (ECO-MODE = 1) to PWM (ECO-MODE = 0)		0	10	mV
ΔV_{FPLP}	Undershoot Voltage	Voltage drop from PWM (ECO-MODE = 0) to LDO (ECO-MODE = 1)	-15	0		mV

Table 5-2. DC to DC Converter External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		17	22	26	µF
C_{ESR}	Output Capacitor ESR				100	mOhm
L_{OUT}	Output Inductor Value		8	10	12	µH
L_{ESR}	Output Inductor ESR	At 100 kHz			1.1	Ohm

5.3 LDO1 Regulator Electrical Characteristics

Table 5-3. LDO1 Electrical Characteristics (t_{AMB} = -20°C to 85°C, VIN = 3.2V to 4.2V unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage	BB1 = 0		2.7		V
		BB1 = 1		2.8		V
I_{OUT}	Output Current			80	130	mA
I_{QC}	Quiescent Current			195		µA
ΔV_{OUT}	Line Regulation	V_{IN}: 3V to 3.4V, I_{OUT} = 130 mA		1	2	mV
ΔV_{PEAK}	Line Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.5	2.85	mV
ΔV_{OUT}	Load Regulation	10% - 90% I_{OUT}			3	mV
ΔV_{PEAK}	Load Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.2	2.4	mV
PSRR	Ripple rejection	F = 217 Hz; VIN = 3.6V	70	73		dB
V_N	Output Noise	BW: 10 Hz to 100 kHz		29	37	μV_{RMS}
T_R	Rise Time	100% I_{OUT}, 10% - 90% V_{OUT}			50	µs
I_{SD}	Shut Down Current				1	µA

Table 5-4. LDO1 External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		1.98	2.2	2.42	µF
C_{ESR}	Output Capacitor ESR	100 kHz			50	mOhm

5.4 LDO2 Regulator Electrical Characteristics

Table 5-5. LDO2 Electrical Characteristics (t_{AMB} = -20°C to 85°C, VIN = 3.2V to 4.2V unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage			2.8		V
I_{OUT}	Output Current	PWM Mode (ECO-MODE = 0)			80	mA
		LDO Mode (ECO-MODE = 1)			5	mA
I_{QC}	Quiescent Current	PWM Mode (ECO-MODE = 0)		100		µA
		LDO Mode (ECO-MODE = 1)			10	µA
ΔV_{OUT}	Line Regulation	V_{IN}: 3V to 3.4V, I_{OUT} = 80 mA		1	2	mV
ΔV_{PEAK}	Line Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.5	2.85	mV
ΔV_{OUT}	Load Regulation	10% - 90% $I_{OUT,}$ VIN = 3V			3	mV
ΔV_{PEAK}	Load Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.2	2.4	mV
PSRR	Ripple rejection	F = 217 Hz; VIN = 3.6V	70	73		dB
V_N	Output Noise	BW: 10 Hz to 100 kHz		29	37	μV_{RMS}
T_R	Rise Time	100% I_{OUT}, 10% - 90% V_{OUT}			50	µs
I_{SD}	Shut Down Current				1	µA

Table 5-6. LDO2 External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		1.98	2.2	2.42	µF
C_{ESR}	Output Capacitor ESR	100 kHz			50	mOhm

5.5 LDO3 Regulator Electrical Characteristics

Table 5-7. LDO3 Electrical Characteristics (t_{AMB} = -20°C to 85°C, VIN = 3.2V to 4.2V unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage			2.8		V
I_{OUT}	Output Current			80	130	mA
I_{QC}	Quiescent Current			195		µA
ΔV_{OUT}	Line Regulation	V_{IN}: 3V to 3.4V, I_{OUT} = 130 mA		1	2	mV
ΔV_{PEAK}	Line Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.5	2.85	mV
ΔV_{OUT}	Load Regulation	10% - 90% $I_{OUT,}$ VIN = 3V			3	mV
ΔV_{PEAK}	Load Regulation Transient	Same as above, $T_R = T_F$ = 5 µs		1.2	2.4	mV
PSRR	Ripple rejection	F = 217 Hz; VIN = 3.6V	70	73		dB
V_N	Output Noise	BW: 10 Hz to 100 kHz		29	37	μV_{RMS}
T_R	Rise Time	100% I_{OUT}, 10% - 90% V_{OUT}			50	µs
I_{SD}	Shut Down Current				1	µA

Table 5-8. LDO3 External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		1.98	2.2	2.42	µF
C_{ESR}	Output Capacitor ESR	100 kHz			50	mOhm

5.6 LDO4 Regulator Electrical Characteristics

Table 5-9. LDO4 Electrical Characteristics (t_{AMB} = -20°C to 85°C, VIN = 3.2V to 4.2V unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage	BB1 = 0		2.47		V
		BB1 = 1		2.66		V
I_{OUT}	Output Current				2	mA
I_{QC}	Quiescent Current				10	µA
ΔV_{OUT}	Line Regulation	V_{IN}: 3V to 3.4V, I_{OUT} = 2 mA			15	mV
ΔV_{PEAK}	Line Regulation Transient	Same as above, $T_R = T_F$ = 5 µs			30	mV
ΔV_{OUT}	Load Regulation	10% - 90% $I_{OUT,}$ VIN = 3V			15	mV
ΔV_{PEAK}	Load Regulation Transient	Same as above, $T_R = T_F$ = 5 µs			20	mV
PSRR	Ripple rejection	F = 217 Hz; VIN = 3.6V		50		dB
I_{SD}	Shut Down Current				1	µA

Table 5-10. LDO4 External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		1.98	2.2	2.42	µF
C_{ESR}	Output Capacitor ESR	100 kHz			100	mOhm

5.7 LDO5 Regulator Electrical Characteristics

Table 5-11. LDO5 Electrical Characteristics (t_{AMB} = -20°C to 85°C, VIN = 3.2V to 4.2V unless otherwise specified)

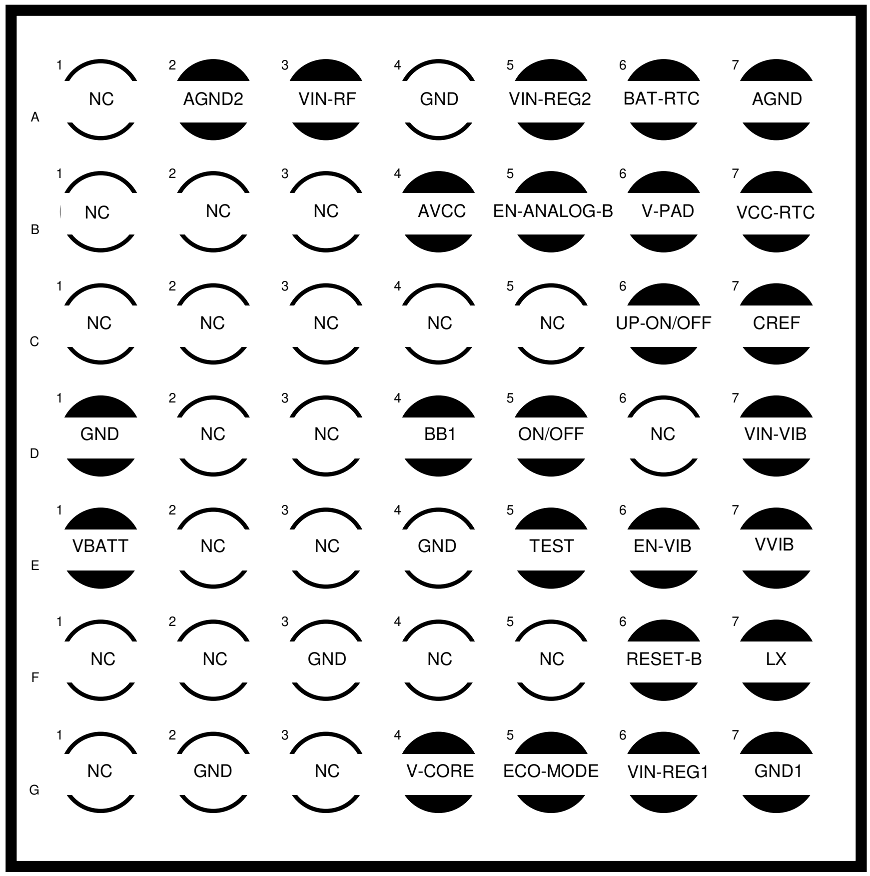
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage	BB1 = 0		1.72		V
		BB1 = 1		2.66		V
I_{OUT}	Output Current				0.5	mA
I_{QC}	Quiescent Current				5	µA
ΔV_{OUT}	Line Regulation	V_{IN}: 3V to 3.4V, I_{OUT} = 0.5 mA			15	mV
ΔV_{PEAK}	Line Regulation Transient	Same as above, $T_R = T_F$ = 5 µs			30	mV
ΔV_{OUT}	Load Regulation	10% - 90% $I_{OUT,}$ VIN = 3V			15	mV
ΔV_{PEAK}	Load Regulation Transient	Same as above, $T_R = T_F$ = 5 µs			20	mV
PSRR	Ripple rejection	F = 217 Hz; VIN = 3.6V		50		dB
I_{SD}	Shut Down Current				1	µA

Table 5-12. LDO4 External Components

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{OUT}	Output Capacitor Value		65	100	135	nF
C_{ESR}	Output Capacitor ESR	100 kHz	20		100	mOhm

5.8 Package Outline (Top view)

Figure 5-1. Forty-nine Ball FBGA Package (Top View)



6. Revision History

Table 6-1. Revision History

Doc. Rev.	Comments	Change Request Ref.
6199A	**First issue.**	

Atmel Corporation

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

Regional Headquarters

Europe
Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Switzerland
Tel: (41) 26-426-5555
Fax: (41) 26-426-5500

Asia
Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimshatsui
East Kowloon
Hong Kong
Tel: (852) 2721-9778
Fax: (852) 2722-1369

Japan
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
Tel: (81) 3-3523-3551
Fax: (81) 3-3523-7581

Atmel Operations

Memory
2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

Microcontrollers
2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
Tel: (33) 2-40-18-18-18
Fax: (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards
Zone Industrielle
13106 Rousset Cedex, France
Tel: (33) 4-42-53-60-00
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
Tel: (44) 1355-803-000
Fax: (44) 1355-242-743

RF/Automotive
Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
Tel: (49) 71-31-67-0
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
Tel: (33) 4-76-58-30-00
Fax: (33) 4-76-58-34-80

Literature Requests
www.atmel.com/literature

6199A–PMGMT–20-Sep-05