Appendix B - ATmega88 Automotive Specification at 1.8V

This document contains information specific to devices operating at voltage between 1.8V and 3.6V. Only deviations with standard operating characteristics are covered in this appendix, all other information can be found in the complete Automotive datasheet. The complete ATmega88 automotive datasheet can be found on www.atmel.com

8-bit AVR® Microcontroller with 8K Bytes In-System Programmable Flash

ATmega88

Appendix B

Preliminary

7738A–AVR–07/07

Electrical Characteristics

Absolute Maximum Ratings*

Operating Temperature	-55°C to +150°C
Storage Temperature	-65°C to +175°C
Voltage on any Pin except $\overline{\text{RESET}}$ with respect to Ground	-0.5V to V_{CC}+0.5V
Voltage on $\overline{\text{RESET}}$ with respect to Ground	-0.5V to +13.0V
Maximum Operating Voltage	6.0V
DC Current per I/O Pin	30.0 mA
DC Current V_{CC} and GND Pins	200.0 mA

*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.

DC Characteristics

T_A = -40°C to 85°C, V_{CC} = 1.8V to 3.6V (unless otherwise noted)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IL}	Input Low Voltage, except XTAL1 and $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V - 3.6V	-0.5		$0.1V_{CC}$[1]	V
V_{IH}	Input High Voltage, except XTAL1 and $\overline{\text{RESET}}$ pins	V_{CC} = 1.8V - 3.6V	$0.75V_{CC}$[2]		V_{CC} + 0.5	V
V_{IL1}	Input Low Voltage, XTAL1 pin	V_{CC} = 1.8V - 3.6V	-0.5		$0.1V_{CC}$[1]	V
V_{IH1}	Input High Voltage, XTAL1 pin	V_{CC} = 1.8V - 3.6V	$0.9V_{CC}$[2]		V_{CC} + 0.5	V
V_{IL2}	Input Low Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V - 3.6V	-0.5		$0.1V_{CC}$[1]	V
V_{IH2}	Input High Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V - 3.6V	$0.9V_{CC}$[2]		V_{CC} + 0.5	V
V_{IL3}	Input Low Voltage, $\overline{\text{RESET}}$ pin as I/O	V_{CC} = 1.8V - 3.6V	-0.5		$0.1V_{CC}$[1]	V
V_{IH3}	Input High Voltage, $\overline{\text{RESET}}$ pin as I/O	V_{CC} = 1.8V - 3.6V	$0.6V_{CC}$[2]		$+0.7V_{CC}$	V
V_{OL}	Output Low Voltage[3], I/O pin except RESET	I_{OL} = 0.5mA, V_{CC} = 1.8V			0.25	V
V_{OH}	Output High Voltage[4], I/O pin except RESET	I_{OH} = -0.5mA, V_{CC} = 1.8V	1.25			V
I_{IL}	Input Leakage Current I/O Pin	V_{CC} = 3.6V, pin low (absolute value)			1	µA
I_{IH}	Input Leakage Current I/O Pin	V_{CC} = 3.6V, pin high (absolute value)			1	µA
R_{RST}	Reset Pull-up Resistor		30		60	kΩ
R_{PU}	I/O Pin Pull-up Resistor		20		50	kΩ

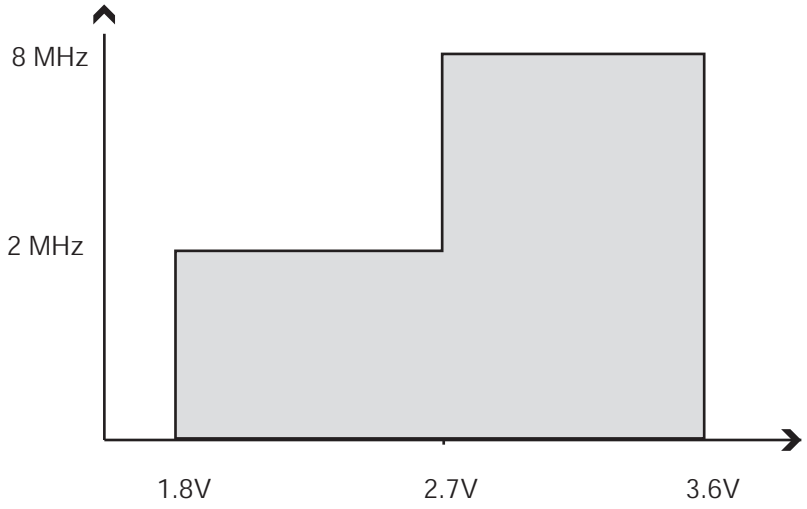
T_A = -40°C to 85°C, V_{CC} = 1.8V to 3.6V (unless otherwise noted) (Continued)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{CC}	Power Supply Current[5]	Active 2MHz, V_{CC} = 1.8V		0.8	1.2	mA
		Idle 2MHz, V_{CC} = 1.8V		0.2	0.4	mA
	Power-down mode	WDT disabled, V_{CC} = 1.8V WDT enabled, V_{CC} = 1.8V		0.2 4	18 24	µA
V_{ACIO}	Analog Comparator Input Offset Voltage	V_{CC} = 2.7V V_{in} = V_{CC}/2		<10	40	mV
I_{ACLK}	Analog Comparator Input Leakage Current	V_{CC} = 2.7V V_{in} = V_{CC}/2	-50		50	nA
t_{ACPD}	Analog Comparator Propagation Delay	V_{CC} = 2.7V		500		ns

Maximum Speed vs. V_{CC}

Maximum frequency is dependent on V_{CC}. As shown in Figure 1, the Maximum Frequency vs. V_{CC} curve is linear between 1.8V < V_{CC} < 3.6V.

Figure 1. Maximum Frequency vs. V_{CC}



ADC Characteristics[6] Preliminary

T_A = -40°C to 85°C, V_{CC} = 1.8V to 3.6V (unless otherwise noted)

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Resolution			8		Bits
	Absolute accuracy (Including INL, DNL, quantization error, gain and offset error)	V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz		2	3.5	LSB
		V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz Noise Reduction Mode		2	3.5	LSB
	Integral Non-Linearity (INL)	V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz		0.6	2.5	LSB
	Differential Non-Linearity (DNL)	V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz		0.30	1.0	LSB
	Gain Error	V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz	-3.5	-1.3	3.5	LSB
	Offset Error	V_{REF} = 2.7V, V_{CC} = 2.7V, ADC clock = 200 kHz		1.8	3.5	LSB
	Conversion Time	Free Running Conversion	13 cycles			µs
	Clock Frequency		50		200	kHz
AV_{CC}	Analog Supply Voltage		V_{CC} - 0.3		V_{CC} + 0.3	V
V_{REF}	Reference Voltage		1.0		AV_{CC}	V
V_{IN}	Input Voltage		GND		V_{REF}-50mV	V
	Input Bandwidth			38.5		kHz
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
R_{REF}	Reference Input Resistance		22.4	32	41.6	kΩ
R_{AIN}	Analog Input Resistance			100		MΩ

Notes:
1. “Max” means the highest value where the pin is guaranteed to be read as low
2. “Min” means the lowest value where the pin is guaranteed to be read as high
3. Although each I/O port can sink more than the test conditions (0.5mA at V_{CC} = 1.8V) under steady state conditions (non-transient), the following must be observed:
   1] The sum of all IOL, for ports B0 - B5, should not exceed 50 mA.
   If IOL exceeds the test condition, VOL may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
4. Although each I/O port can source more than the test conditions (0.5mA at Vcc = 1.8V) under steady state conditions (non-transient), the following must be observed:
   1] The sum of all IOH, for ports B0 - B5 should not exceed 50 mA.
   If IOH exceeds the test condition, VOH may exceed the related specification. Pins are not guaranteed to source current greater than the listed test condition.
5. Minimum V_{CC} for Power-down is 2.5V.
6. Based on standard voltage range (2.7V - 5.5V) characterization results. To be confirmed after actual silicon characterization.

Ordering Information

Power Supply	Speed (MHz)	ISP Flash	Ordering Code	Package	Operation Range
1.8 - 3.6V	2-8	8KB	ATmega88V-15AT	MA	Automotive (-40°C to +85°C)
1.8 - 3.6V	2-8	8KB	ATmega88V-15MT	PN	Automotive (-40°C to +85°C)

:

Package Type	
MA	32-lead, Thin (1.0 mm) Plastic Quad Flat Package (TQFP)
PN	32-pad, 5 x 5 x 1.0 body, Lead Pitch 0.50 mm Quad Flat No Lead (QFN): E2/D2 3.1 +/- 0.1mm

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
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13106 Rousset Cedex, France
Tel: (33) 4-42-53-60-00
Fax: (33) 4-42-53-60-01

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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

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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

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