Appendix B - ATmega88 Automotive Specification at 1.8V

DATASHEET

Description

This document contains information specific to devices operating at voltage between 1.8V and 5.5V. 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

1. Electrical Characteristics

1.1 Absolute Maximum Ratings

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 any 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.

Parameters	Test Conditions	Unit
Operating Temperature	–55 to +150	°C
Storage Temperature	–65 to +175	°C
Voltage on any Pin except $\overline{\text{RESET}}$ with respect to Ground	–0.5 to V_{CC}+0.5	V
Voltage on $\overline{\text{RESET}}$ with respect to Ground	–0.5 to +13.0	V
Maximum Operating Voltage	6.0	V
DC Current per I/O Pin DC Current V_{CC} and GND	30 200.0	mA

1.2 DC Characteristics

T_A = –40°C to +85°C, V_{CC} = 1.8V to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Input Low Voltage, except XTAL1 and $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V to 5.5V	V_{IL}	-0.5		$0.1V_{CC}$(1)	V
Input High Voltage, except XTAL1 and $\overline{\text{RESET}}$ pins	V_{CC} = 1.8V to 5.5V	V_{IH}	$0.75V_{CC}$(2)		V_{CC} + 0.5	V
Input Low Voltage, XTAL1 pin	V_{CC} = 1.8V to 5.5V	V_{IL1}	–0.5		$+0.1V_{CC}$(1)	V
Input High Voltage, XTAL1 pin	V_{CC} = 1.8V to 5.5V	V_{IH1}	$0.9V_{CC}$(2)		V_{CC} + 0.5	V
Input Low Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V to 5.5V	V_{IL2}	–0.5		$+0.1V_{CC}$(1)	V
Input High Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8V to 5.5V	V_{IH2}	$0.9V_{CC}$(2)		V_{CC} + 0.5	V
Input Low Voltage, $\overline{\text{RESET}}$ pin as I/O	V_{CC} = 1.8V to 5.5V	V_{IL3}	–0.5		$+0.1V_{CC}$(1)	V
Input High Voltage, $\overline{\text{RESET}}$ pin as I/O	V_{CC} = 1.8V to 5.5V	V_{IH3}	$0.6V_{CC}$(2)		$0.7V_{CC}$	V

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 50mA.
   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 V_{CC} = 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 50mA.
   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.

1.2 DC Characteristics (Continued)

T_A = –40°C to +85°C, V_{CC} = 1.8V to 5.5V (unless otherwise noted) (Continued)

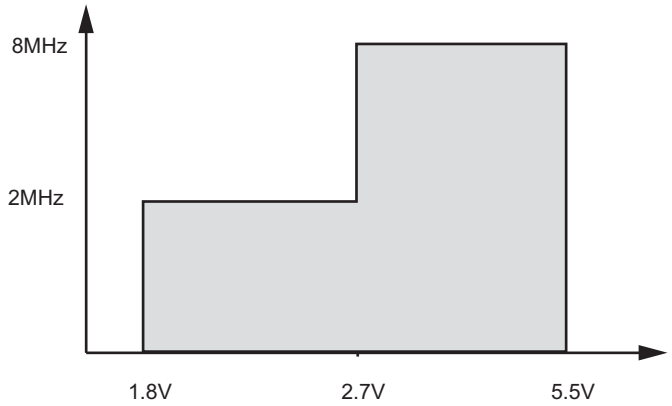
Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Output Low Voltage[3], I/O pin except RESET	I_{OL} = 0.5mA, V_{CC} = 1.8V	V_{OL}			0.25	V
Output High Voltage[4], I/O pin except RESET	I_{OH} = –0.5mA, V_{CC} = 1.8V	V_{OH}	1.25			V
Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin low (absolute value)	I_{IL}			1	µA
Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin high (absolute value)	I_{IH}			1	µA
Reset Pull-up Resistor		R_{RST}	30		60	kΩ
I/O Pin Pull-up Resistor		R_{PU}	20		50	kΩ
Power Supply Current[5]	Active 2MHz, V_{CC} = 1.8V	I_{CC}		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
Analog Comparator Input Offset Voltage	V_{CC} = 2.7V V_{in} = V_{CC}/2	V_{ACIO}		<10	40	mV
Analog Comparator Input Leakage Current	V_{CC} = 2.7V V_{in} = V_{CC}/2	I_{ACLK}	–50		+50	nA
Analog Comparator Propagation Delay	V_{CC} = 2.7V	t_{ACPD}		500		ns

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 50mA.
   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 V_{CC} = 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 50mA.
   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.

1.3 Maximum Speed versus V_{CC}

Maximum frequency is dependent on V_{CC}.

Figure 1-1. Maximum Frequency versus V_{CC}



1.4 ADC Characteristics

T_A = –40°C to +85°C, V_{CC} = 1.8V to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Resolution	–40°C to +85°C - 1.8V to 2.7V ADC clock = 125kHz			10		Bits
	–40°C to +85°C - 2.7V to 5.5V ADC clock = 200kHz			10		Bits
Absolute accuracy	V_{CC} = 1.8V, V_{Ref} = 1.8V	TUE		2.2	3.5	LSB
	V_{CC} = 4.0V, V_{Ref} = 4.0V			2.1	3.5	LSB
Integral Non Linearity	V_{CC} = 1.8V, V_{Ref} = 1.8V	INL		0.6	2.0	LSB
	V_{CC} = 4.0V, V_{Ref} = 4.0V			0.5	1.5	LSB
Differential Non Linearity	V_{CC} = 1.8V, V_{Ref} = 1.8V	DNL		0.4	1.0	LSB
	V_{CC} = 4.0V, V_{Ref} = 4.0V			0.3	0.7	LSB
Gain error			–3.5	–1.5	3.5	LSB
Offset error			–3.5	2.0	3.5	LSB
Clock frequency	V_{CC} = 1.8V to 2.7V		50		125	kHz
	V_{CC} = 2.7V to 5.5V		50		200	kHz
Analog Supply Voltage		AV_{CC}	V_{CC} – 0.3		V_{CC} + 0.3	V
Reference Voltage		V_{REF}	1.0		AV_{CC}	V
Input Voltage		V_{IN}	GND		V_{REF} – 50mV	V
Input Bandwidth				38.5		kHz
Internal Voltage Reference		V_{INT}	1.0	1.1	1.2	V
Reference Input Resistance		R_{REF}	22.4	32	41.6	kΩ
Analog Input Resistance		R_{AIN}		100		MΩ

2. Ordering Information

Table 2-1. ATmega88

Speed (MHz)	Power Supply	ISP Flash	Ordering Code	Package	Operation Range
2-8	1.8V to 5.5V	8KB	ATmega88V-15MT	PN	Automotive (–40°C to +85°C)
2-8	1.8V to 5.5V	8KB	ATmega88V-15AT	MA	Automotive (–40°C to +85°C)

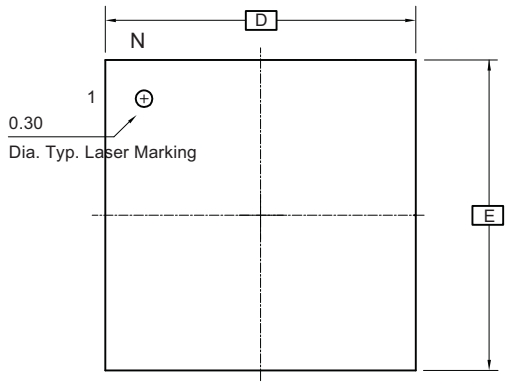
3. Package Information

Table 3-1. Package Types

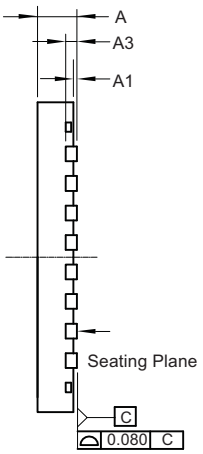
Package Type	
PN	32-pad, 5 × 5 ×1.0mm body, lead pitch 0.50mm, quad flat no-lead/micro lead frame package (QFN/MLF): E2/D2 3.1 ±0.1mm
MA	MA, 32 - lead, 7 × 7mm body size, 1.0mm body thickness 0.5mm lead pitch, thin profile plastic quad flat package (TQFP)

Figure 3-1. PN

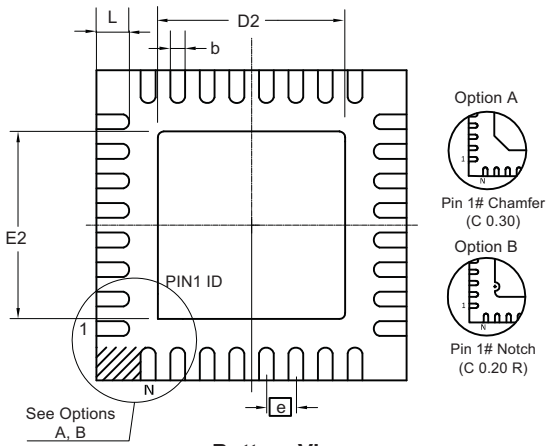
Drawings not scaled



Top View



Side View



Bottom View

COMMON DIMENSIONS (Unit of Measure = mm)				
Symbol	**MIN**	**NOM**	**MAX**	**NOTE**
A	0.80	0.85	0.90	
A1	0.00	----	0.05	
A3		0.20 REF		
D/E		5.00 BSC		
D2/E2	3.00	3.10	3.20	
L	0.30	0.40	0.50	
b	0.18	0.25	0.30	2
e		0.50 BSC		
n		32		

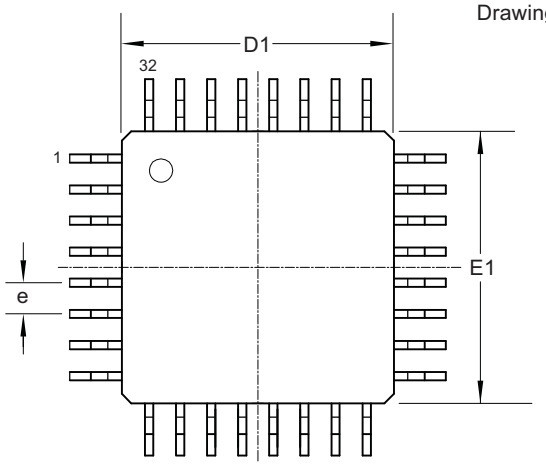
Notes: 1. This drawing is for general information only. Refer to JEDEC Drawing MO-220, Variation VHHD-2, for proper dimensions, tolerances, datums, etc.
2. Dimensions b applies to metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip. If the terminal has the optical radius on the other end of the terminal, the dimensions should not be measured in that radius area.

01/31/12

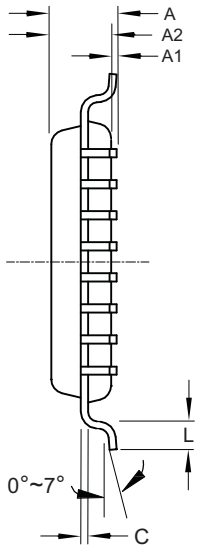
Atmel **Package Drawing Contact:** packagedrawings@atmel.com	TITLE	GPC	DRAWING NO.	REV.
	PN, 32 Leads - 0.50mm Pitch, 5x5mm Very Thin Quad Flat no Lead Package (VQFN) Sawn	ZMF	PN	I

Figure 3-2. MA

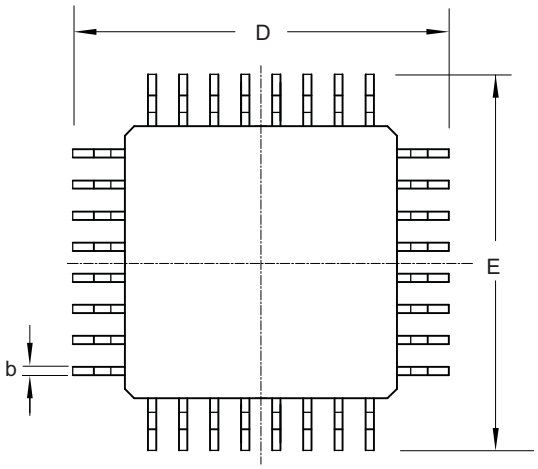
Drawings not scaled



Top View



Side View



Bottom View

COMMON DIMENSIONS (Unit of Measure = mm)				
Symbol	**MIN**	**NOM**	**MAX**	**NOTE**
A	----	----	1.20	
A1	0.05	----	0.15	
A2	0.95	1.00	1.05	
D/E	8.75	9.00	9.25	
D1/E1	6.90	7.00	7.10	2
C	0.09	----	0.20	
L	0.45	----	0.75	
b	0.30	----	0.45	
e	0.80 TYP.			
n	32			

Notes:
1. This drawing is for general information only. Refer to JEDEC Drawing MS-026, Variation ABA.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
3. Lead coplanarity is 0.10mm maximum.

02/29/12

Atmel **Package Drawing Contact:** packagedrawings@atmel.com	TITLE	GPC	DRAWING NO.	REV.
	MA, 32 Lds - 0.80mm Pitch, 7x7x1.00mm Body size Thin Profile Plastic Quad Flat Package (TQFP)	AUT	MA	C

4. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
7738E-AVR-07/14	• Put datasheet in the latest template
7738D-AVR-03/12	• Package PN updated • Package MA updated
7738C-AVR-11/09	• ADC specification updates
7738B-AVR-07/09	• Package MA updated
7738A-AVR-07/07	• Document Creation

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