

---

# Appendix A - ATmega16M1/ATmega32M1/ ATmega32C1/ATmega64M1/ATmega64C1 Automotive Specification at 150°C

This document contains information specific to devices operating at temperatures up to 150°C. Only deviations are covered in this appendix, all other information can be found in the complete Automotive datasheet. The complete Automotive datasheet can be found on [www.atmel.com](http://www.atmel.com)



---

**8-bit AVR<sup>®</sup>  
Microcontroller  
with 32K Bytes  
In-System  
Programmable  
Flash**

---

**ATmega16M1  
ATmega32M1  
ATmega32C1  
ATmega64M1  
ATmega64C1**

**Automotive**

**Appendix A**

7781D-AVR-01/10



## 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 $V_{\text{CC}}+0.5$	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	30	mA
DC Current $V_{\text{CC}}$ and GND	200.0	

### 1.2 DC Characteristics

$T_A = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ ,  $V_{\text{CC}} = 4.5\text{V}$  to  $5.5\text{V}$  (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Input Low Voltage, except XTAL1 and $\overline{\text{RESET}}$ pin	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IL}}$	-0.5		$+0.2V_{\text{CC}}^{(1)}$	V
Input High Voltage, except XTAL1 and $\overline{\text{RESET}}$ pins	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IH}}$	$0.6V_{\text{CC}}^{(2)}$		$V_{\text{CC}} + 0.5$	V
Input Low Voltage, XTAL1 pin	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IL1}}$	-0.5		$+0.1V_{\text{CC}}^{(1)}$	V
Input High Voltage, XTAL1 pin	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IH1}}$	$0.8V_{\text{CC}}^{(2)}$		$V_{\text{CC}} + 0.5$	V
Input Low Voltage, $\overline{\text{RESET}}$ pin	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IL2}}$	-0.5		$+0.2V_{\text{CC}}^{(1)}$	V
Input High Voltage, $\overline{\text{RESET}}$ pin	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IH2}}$	$0.9V_{\text{CC}}^{(2)}$		$V_{\text{CC}} + 0.5$	V
Input Low Voltage, $\overline{\text{RESET}}$ pin as I/O	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IL3}}$	-0.5		$+0.2V_{\text{CC}}^{(1)}$	V
Input High Voltage, $\overline{\text{RESET}}$ pin as I/O	$V_{\text{CC}} = 4.5\text{V}$ to $5.5\text{V}$	$V_{\text{IH3}}$	$0.8V_{\text{CC}}^{(2)}$		$V_{\text{CC}} + 0.5$	V

- Notes:
- “Max” means the highest value where the pin is guaranteed to be read as low
  - “Min” means the lowest value where the pin is guaranteed to be read as high
  - Although each I/O port can sink more than the test conditions (20 mA at  $V_{\text{CC}} = 5\text{V}$ ) under steady state conditions (non-transient), the following must be observed:
    - The sum of all IOL, for all ports, should not exceed 400 mA.
    - The sum of all IOL, for ports C0 - C5, should not exceed 200 mA.
    - The sum of all IOL, for ports C6, D0 - D4, should not exceed 300 mA.
    - The sum of all IOL, for ports B0 - B7, D5 - D7, should not exceed 300 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.
  - For temperature range  $+125^\circ\text{C}$  to  $+150^\circ\text{C}$  only. For  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , refer to ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 Automotive datasheet.

## 1.2 DC Characteristics (Continued)

$T_A = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ ,  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$  (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Output Low Voltage <sup>(3)</sup> , I/O pin except RESET	$I_{OL} = 10\text{ mA}$ , $V_{CC} = 5\text{V}$	$V_{OL}$			0.8	V
Output High Voltage <sup>(4)</sup> , I/O pin except RESET	$I_{OH} = -10\text{ mA}$ , $V_{CC} = 5\text{V}$	$V_{OH}$	4.1			V
Output High Voltage (Reset pin)	$I_{OH} = 0.6\text{ mA}$ , $V_{CC} = 5\text{V}$	$V_{OH3}$	3			V
Input Leakage Current I/O Pin	$V_{CC} = 5.5\text{V}$ , pin low (absolute value)	$I_{IL}$			1	$\mu\text{A}$
Input Leakage Current I/O Pin	$V_{CC} = 5.5\text{V}$ , pin high (absolute value)	$I_{IH}$			1	$\mu\text{A}$
Reset Pull-up Resistor		$R_{RST}$	30		200	$\text{k}\Omega$
I/O Pin Pull-up Resistor		$R_{PU}$	20		50	$\text{k}\Omega$
Power Supply Current <sup>(4)</sup>	Active 16 MHz, $V_{CC} = 5\text{V}$ , External Clock, PRR = 0xFF,	$I_{CC}$		14	30	mA
	Idle 16 MHz, $V_{CC} = 5\text{V}$ , External Clock	$I_{CC\text{ IDLE}}$		5.5	15	mA
Power-down mode	WDT enabled, $V_{CC} = 5\text{V}$	$I_{CC\text{ PWD}}$		80	330	$\mu\text{A}$
	WDT disabled, $V_{CC} = 5\text{V}$			70	310	$\mu\text{A}$
Analog Comparator Input Leakage Current	$V_{CC} = 5\text{V}$ $V_{in} = V_{CC}/2$	$I_{ACLK}$	-200		+200	nA

- 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 (20 mA at  $V_{CC} = 5\text{V}$ ) under steady state conditions (non-transient), the following must be observed:
    - 1] The sum of all IOL, for all ports, should not exceed 400 mA.
    - 2] The sum of all IOL, for ports C0 - C5, should not exceed 200 mA.
    - 3] The sum of all IOL, for ports C6, D0 - D4, should not exceed 300 mA.
    - 4] The sum of all IOL, for ports B0 - B7, D5 - D7, should not exceed 300 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. For temperature range  $+125^\circ\text{C}$  to  $+150^\circ\text{C}$  only. For  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , refer to ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 Automotive datasheet.

### 1.3 ADC Characteristics in Single-ended Mode

$T_A = -40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ ,  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$  (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Resolution	Single ended, Temp = $-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$			10		Bit
Absolute accuracy	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 1 MHz	TUE		3.2	6.0	LSB
	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			3.2	6.0	
Integral Non Linearity	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 1 MHz	INL		0.7	3.0	LSB
	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.8	3.0	
Differential Non Linearity	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 1 MHz	DNL		0.5	1.5	LSB
	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.6	1.5	
Gain error	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 1 MHz		-10.0	-5.0	+0.0	LSB
	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-10.0	-5.0	+0.0	
Offset error	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 1 MHz		-2.0	+2.5	+6.0	LSB
	$V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-2.0	+2.5	+6.0	
Reference voltage		$V_{REF}$	2.56		AVCC	V

### 1.4 ADC Characteristics in Differential Mode

$T_A = -40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ ,  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$  (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Resolution	Differential conversion, gain = 5x, Temp = $-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$			8		Bit
	Differential conversion, gain = 10x, Temp = $-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$			8		
	Differential conversion, gain = 20x, Temp = $-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$			8		
	Differential conversion, gain = 40x, Temp = $-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$			8		

## 1.4 ADC Characteristics in Differential Mode (Continued)

$T_A = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ ,  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$  (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Absolute accuracy	Gain = 5x, 10x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz	TUE		1.5	3.5	LSB
	Gain = 20x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			1.5	4.0	
	Gain = 40x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			1.5	6.0	
Integral Non Linearity	Gain = 5x, 10x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz	INL		0.1	1.5	LSB
	Gain = 20x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.2	2.5	
	Gain = 40x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.7	4.5	
Differential Non Linearity	Gain = 5x, 10x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz	DNL		0.1	1.5	LSB
	Gain = 20x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.2	2.0	
	Gain = 40x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz			0.3	4.0	
Gain error	Gain = 5x, 10x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-3.0		+3.0	LSB
	Gain = 20x, 40x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-3.0		+3.0	
Offset error	Gain = 5x, 10x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-3.0		+3.0	LSB
	Gain = 20x, 40x, $V_{CC} = 5\text{V}$ , $V_{Ref} = 2.56\text{V}$ , ADC clock = 2 MHz		-4.0		+4.0	
Reference voltage		$V_{REF}$	2.56		$AVCC - 0.5$	V

## 1.5 Memory Endurance

EEPROM endurance: 50,000 Write/Erase cycles.

Flash endurance: 10,000 Write/Erase cycles.

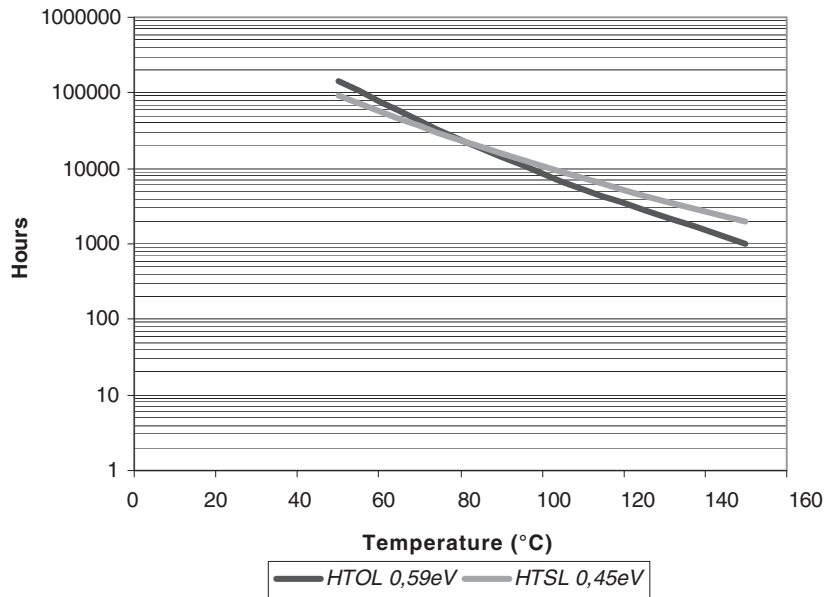
## 2. Grade 0 Qualification

The ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 has been developed and manufactured according to the most stringent quality assurance requirements of ISO-TS-16949 and verified during product qualification as per AEC-Q100 grade 0.

AEC-Q100 qualification relies on temperature accelerated stress testing. High temperature field usage however may result in less significant stress test acceleration. In order to prevent the risk that ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 lifetime would not satisfy the application end-of-life reliability requirements, Atmel® has extended the testing, whenever applicable (High Temperature Operating Life Test, High Temperature Storage Life, Data Retention, Thermal Cycles), far beyond the AEC-Q100 requirements. Thereby, Atmel verified the ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 has a long safe lifetime period after the grade 0 qualification acceptance limits.

The valid domain calculation depends on the activation energy of the potential failure mechanism that is considered. Therefore any temperature mission profile which could exceed the AEC-Q100 equivalence domain shall be submitted to Atmel for a thorough reliability analysis

**Figure 2-1.** AEC-Q100 Lifetime Equivalence



## 3. Ordering Information

**Table 3-1.** ATmega16/32/64/M1/C1 Ordering Code

Speed is 16 MHz and Power Supply is 4.5V to 5.5V for all devices. Operating range is the same for all devices too Extended (–40°C to +150°C).

Speed (MHz)	Power Supply	Ordering Code	Package <sup>(1)</sup>	Operation Range
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega16M1-15MD	PV	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega16M1-15AD	MA	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32M1-ESMD	PV	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32M1-ESAD	MA	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32M1-15MD	PV	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32M1-15AD	MA	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32C1-15MD	PV	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega32C1-15AD	MA	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64M1-ESMD	PV	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64M1-ESAD	MA	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64C1-ESMD	PV	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64C1-ESAD	MA	Engineering samples
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64M1-15MD	PV	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64M1-15AD	MA	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64C1-15MD	PV	Extended (–40°C to +150°C)
16 <sup>(2)</sup>	4.5V to 5.5V	ATmega64C1-15AD	MA	Extended (–40°C to +150°C)

- Notes: 1. Pb-free packaging, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.  
2. For Speed versus  $V_{cc}$ , see complete datasheet.

## 4. Package Information

**Table 4-1.** Package Types

Package Type	
<b>PV</b>	32-lead, 7.0 × 7.0 mm Body, 0.65 mm Pitch, Quad Flat No Lead Package (QFN)
<b>MA</b>	MA, 32 - Lead, 7 × 7 mm Body Size, 1.0 mm Body Thickness 0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)



Figure 4-1. PV

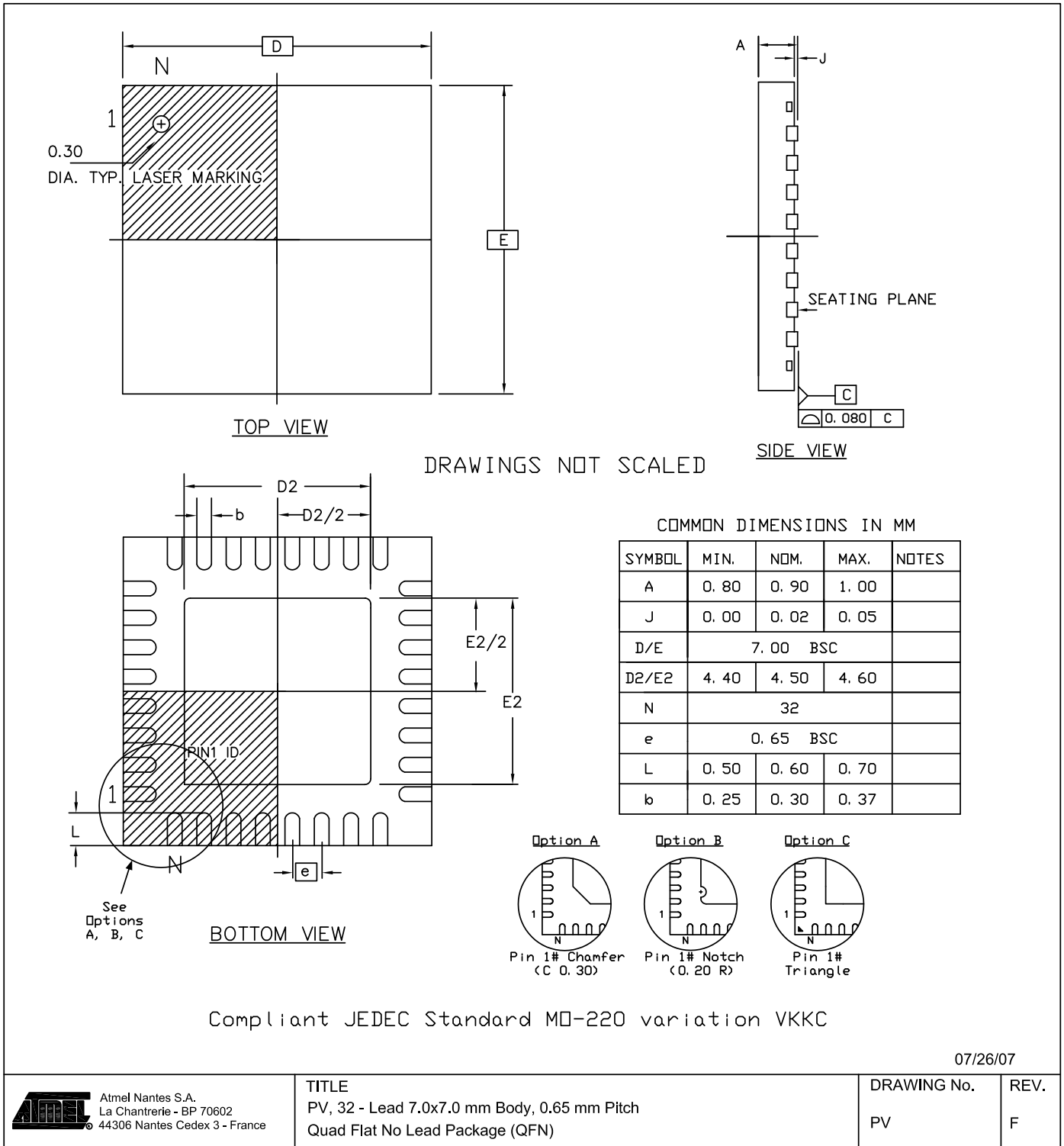
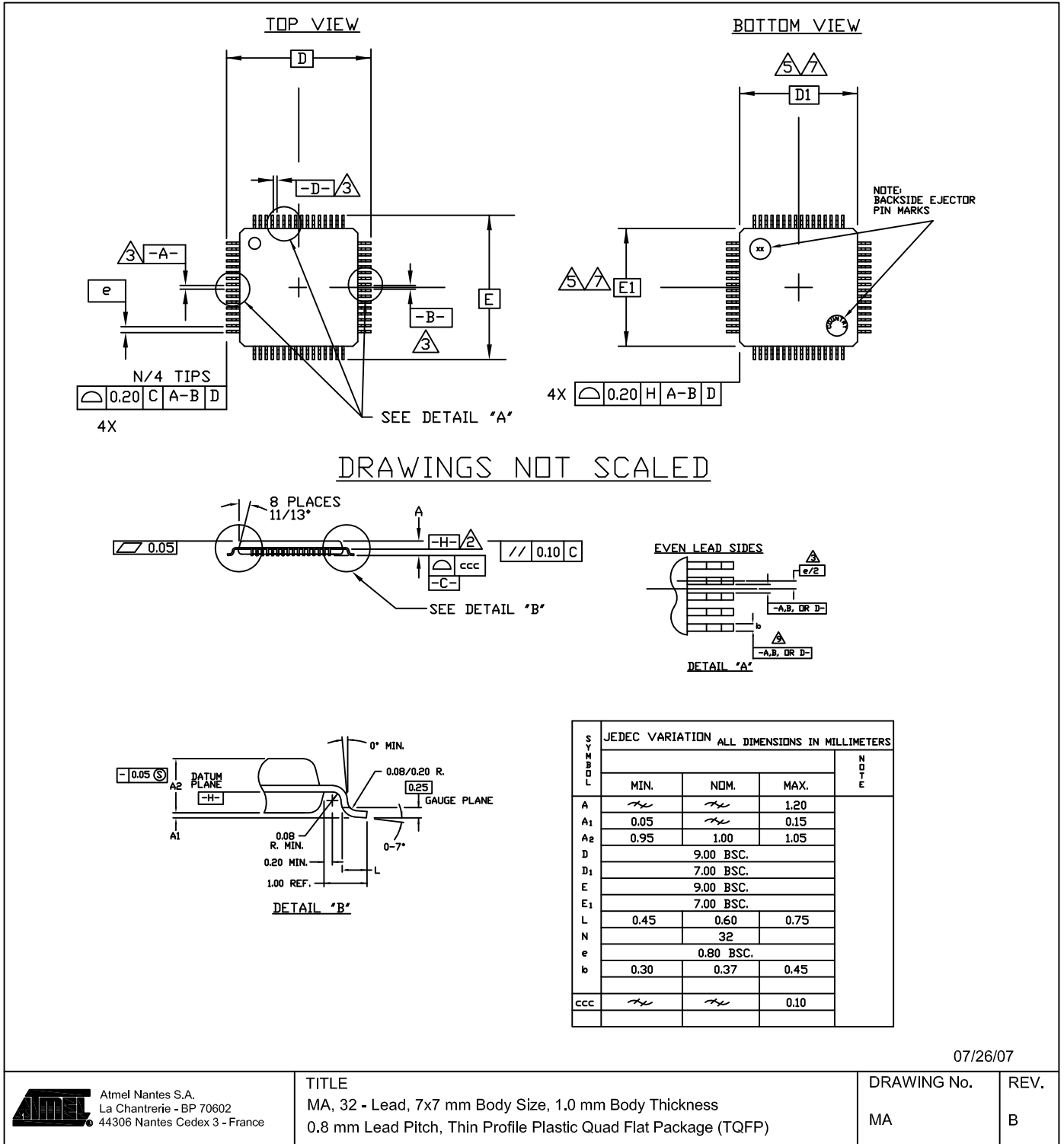


Figure 4-2. MA



07/26/07



Atmel Nantes S.A.  
La Chantrerie - BP 70602  
44306 Nantes Cedex 3 - France

TITLE  
MA, 32 - Lead, 7x7 mm Body Size, 1.0 mm Body Thickness  
0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

DRAWING No.	REV.
MA	B

## 5. 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
7781D-AVR-01/10	<ul style="list-style-type: none"><li>• Section 1.2 “DC Characteristics” on page 3 changed</li></ul>
7781C-AVR-04/09	<ul style="list-style-type: none"><li>• DC characteristics updated</li><li>• ADC characteristics updated</li><li>• Memory endurance added</li><li>• Ordering code added</li></ul>
7781B-AVR-05/08	<ul style="list-style-type: none"><li>• Added AEC-Q100 Lifetime Equivalence graph, page 4</li></ul>
7781A-AVR-03/08	<ul style="list-style-type: none"><li>• Document Creation</li></ul>



## Headquarters

---

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

## International

---

**Atmel Asia**  
Unit 1-5 & 16, 19/F  
BEA Tower, Millennium City 5  
418 Kwun Tong Road  
Kwun Tong, Kowloon  
Hong Kong  
Tel: (852) 2245-6100  
Fax: (852) 2722-1369

**Atmel Europe**  
Le Krebs  
8, Rue Jean-Pierre Timbaud  
BP 309  
78054  
Saint-Quentin-en-Yvelines Cedex  
France  
Tel: (33) 1-30-60-70-00  
Fax: (33) 1-30-60-71-11

**Atmel 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

## Product Contact

---

**Web Site**  
[www.atmel.com](http://www.atmel.com)

**Technical Support**  
[avr@atmel.com](mailto:avr@atmel.com)

**Sales Contact**  
[www.atmel.com/contacts](http://www.atmel.com/contacts)

**Literature Requests**  
[www.atmel.com/literature](http://www.atmel.com/literature)

---

**Disclaimer:** The information in this document is provided in connection with Atmel products. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document or in connection with the sale of Atmel products. **EXCEPT AS SET FORTH IN ATMEL'S TERMS AND CONDITIONS OF SALE LOCATED ON ATMEL'S WEB SITE, ATMEL ASSUMES NO LIABILITY WHATSOEVER AND DISCLAIMS ANY EXPRESS, IMPLIED OR STATUTORY WARRANTY RELATING TO ITS PRODUCTS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT SHALL ATMEL BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE, SPECIAL OR INCIDENTAL DAMAGES (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF PROFITS, BUSINESS INTERRUPTION, OR LOSS OF INFORMATION) ARISING OUT OF THE USE OR INABILITY TO USE THIS DOCUMENT, EVEN IF ATMEL HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.** Atmel makes no representations or warranties with respect to the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice. Atmel does not make any commitment to update the information contained herein. Unless specifically provided otherwise, Atmel products are not suitable for, and shall not be used in, automotive applications. Atmel's products are not intended, authorized, or warranted for use as components in applications intended to support or sustain life.

© 2010 Atmel Corporation. All rights reserved. Atmel®, Atmel logo and combinations thereof, AVR®, AVR® logo and others are registered trademarks or trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be trademarks of others.