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 +150°C, V_{CC} = 4.5V 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} = 4.5V to 5.5V	V_{IL}	–0.5		+0.2V_{CC}(1)	V
Input High Voltage, except XTAL1 and $\overline{\text{RESET}}$ pins	V_{CC} = 4.5V to 5.5V	V_{IH}	0.6V_{CC}(2)		V_{CC} + 0.5	V
Input Low Voltage, XTAL1 pin	V_{CC} = 4.5V to 5.5V	V_{IL1}	–0.5		+0.1V_{CC}(1)	V
Input High Voltage, XTAL1 pin	V_{CC} = 4.5V to 5.5V	V_{IH1}	0.8V_{CC}(2)		V_{CC} + 0.5	V
Input Low Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 4.5V to 5.5V	V_{IL2}	–0.5		+0.2V_{CC}(1)	V
Input High Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 4.5V 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} = 4.5V to 5.5V	V_{IL3}	–0.5		+0.2V_{CC}(1)	V
Input High Voltage, $\overline{\text{RESET}}$ pin as I/O	V_{CC} = 4.5V to 5.5V	V_{IH3}	0.8V_{CC}(2)		V_{CC} + 0.5	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 (20mA at V_{CC} = 5V) under steady state conditions (non-transient), the following must be observed:
   1] The sum of all IOL, for all ports, should not exceed 400mA.
   2] The sum of all IOL, for ports C0 - C5, should not exceed 200mA.
   3] The sum of all IOL, for ports C6, D0 - D4, should not exceed 300mA.
   4] The sum of all IOL, for ports B0 - B7, D5 - D7, should not exceed 300mA.
   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°C to +150°C only. For –40°C to +125°C, refer to ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 Automotive datasheet.

1.2 DC Characteristics (Continued)

T_A = –40°C to +150°C, V_{CC} = 4.5V to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Output Low Voltage[3], I/O pin except RESET	I_{OL} = 10mA, V_{CC} = 5V	V_{OL}			0.8	V
Output High Voltage[4], I/O pin except RESET	I_{OH} = –10mA, V_{CC} = 5V	V_{OH}	4.1			V
Output High Voltage (Reset pin)	I_{OH} = 0.6mA, V_{CC} = 5V	V_{OH3}	3			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		200	kΩ
I/O Pin Pull-up Resistor		R_{PU}	20		50	kΩ
Power Supply Current[4]	Active 16MHz, V_{CC} = 5V, External Clock, PRR = 0xFF,	I_{CC}		14	30	mA
	Idle 16MHz, V_{CC} = 5V, External Clock	$I_{CC\ IDLE}$		5.5	15	mA
Power-down mode	WDT enabled, V_{CC} = 5V	$I_{CC\ PWD}$		80	330	µA
	WDT disabled, V_{CC} = 5V			70	310	µA
Analog Comparator Input Leakage Current	V_{CC} = 5V 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 (20mA at V_{CC} = 5V) under steady state conditions (non-transient), the following must be observed:
   1] The sum of all IOL, for all ports, should not exceed 400mA.
   2] The sum of all IOL, for ports C0 - C5, should not exceed 200mA.
   3] The sum of all IOL, for ports C6, D0 - D4, should not exceed 300mA.
   4] The sum of all IOL, for ports B0 - B7, D5 - D7, should not exceed 300mA.
   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°C to +150°C only. For –40°C to +125°C, refer to ATmega16M1/ATmega32M1/ATmega32C1/ATmega64M1/ATmega64C1 Automotive datasheet.

1.3 ADC Characteristics in Single-ended Mode

T_A = –40°C to +150°C, V_{CC} = 4.5V to 5.5V (unless otherwise noted)

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

1.4 ADC Characteristics in Differential Mode

T_A = –40°C to +150°C, V_{CC} = 4.5V to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Resolution	Differential conversion, gain = 5x, Temp = –40°C to 150°C			8		Bit
	Differential conversion, gain = 10x, Temp = –40°C to 150°C			8		
	Differential conversion, gain = 20x, Temp = –40°C to 150°C			8		
	Differential conversion, gain = 40x, Temp = –40°C to 150°C			8		

1.4 ADC Characteristics in Differential Mode (Continued)

T_A = –40°C to +150°C, V_{CC} = 4.5V to 5.5V (unless otherwise noted)

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

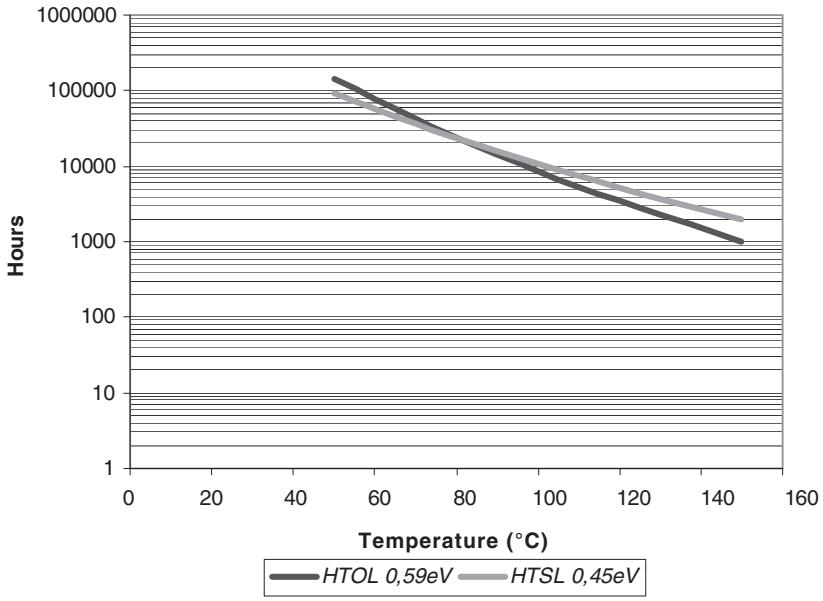
2. Grade 0 Qualification

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 16MHz 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[1]	Operation Range
16[2]	4.5V to 5.5V	ATmega16M1-15MD	PV	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega16M1-15AD	MA	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega32M1-ESMD	PV	Engineering samples
16[2]	4.5V to 5.5V	ATmega32M1-ESAD	MA	Engineering samples
16[2]	4.5V to 5.5V	ATmega32M1-15MD	PV	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega32M1-15AD	MA	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega32C1-15MD	PV	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega32C1-15AD	MA	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega64M1-ESMD	PV	Engineering samples
16[2]	4.5V to 5.5V	ATmega64M1-ESAD	MA	Engineering samples
16[2]	4.5V to 5.5V	ATmega64C1-ESMD	PV	Engineering samples
16[2]	4.5V to 5.5V	ATmega64C1-ESAD	MA	Engineering samples
16[2]	4.5V to 5.5V	ATmega64M1-15MD	PV	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega64M1-15AD	MA	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega64C1-15MD	PV	Extended (–40°C to +150°C)
16[2]	4.5V to 5.5V	ATmega64C1-15AD	MA	Extended (–40°C to +150°C)

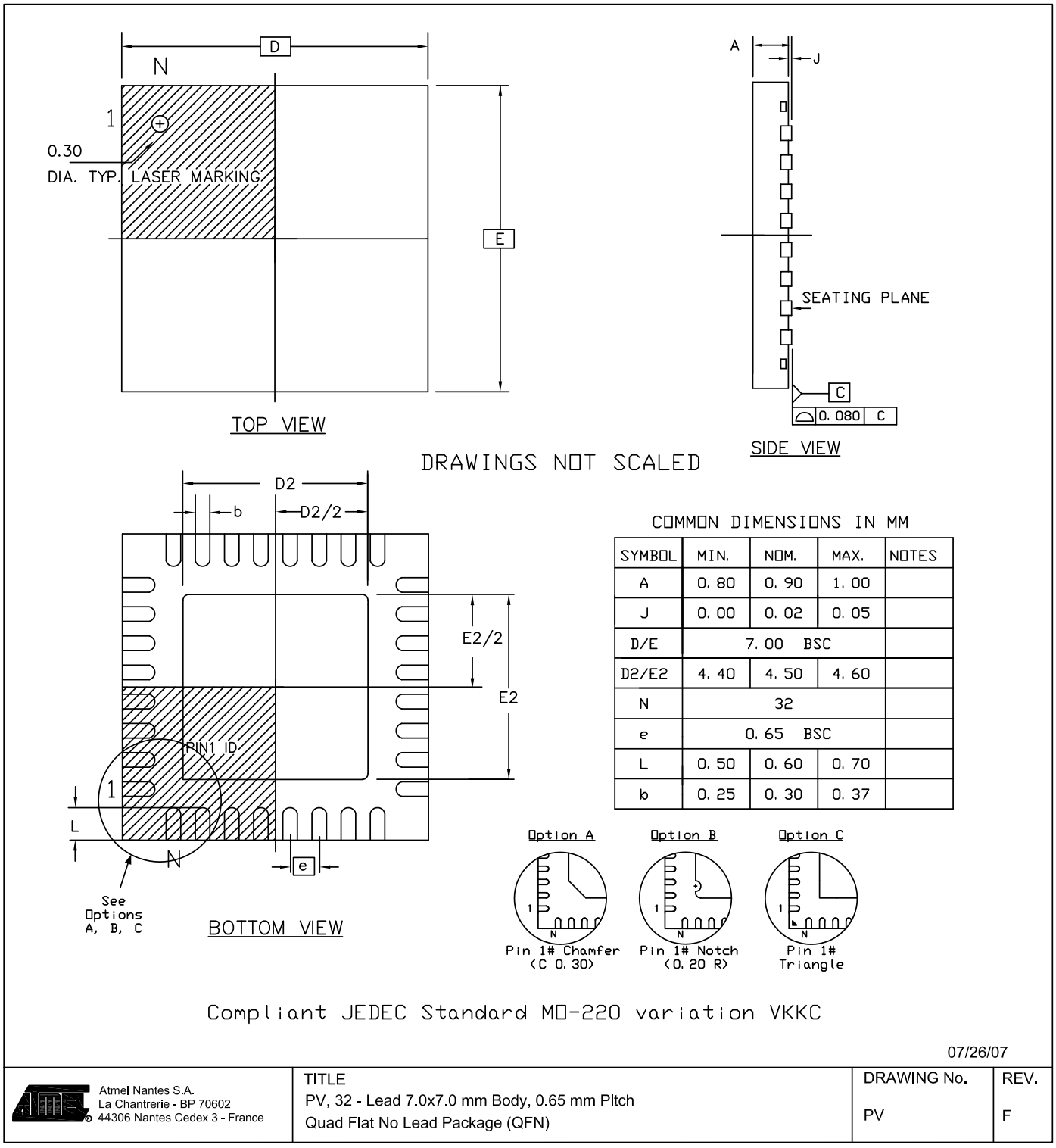
Notes:
1. Pb-free packaging, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.
2. For Speed versus V_{cc}, see complete datasheet.

4. Package Information

Table 4-1. Package Types

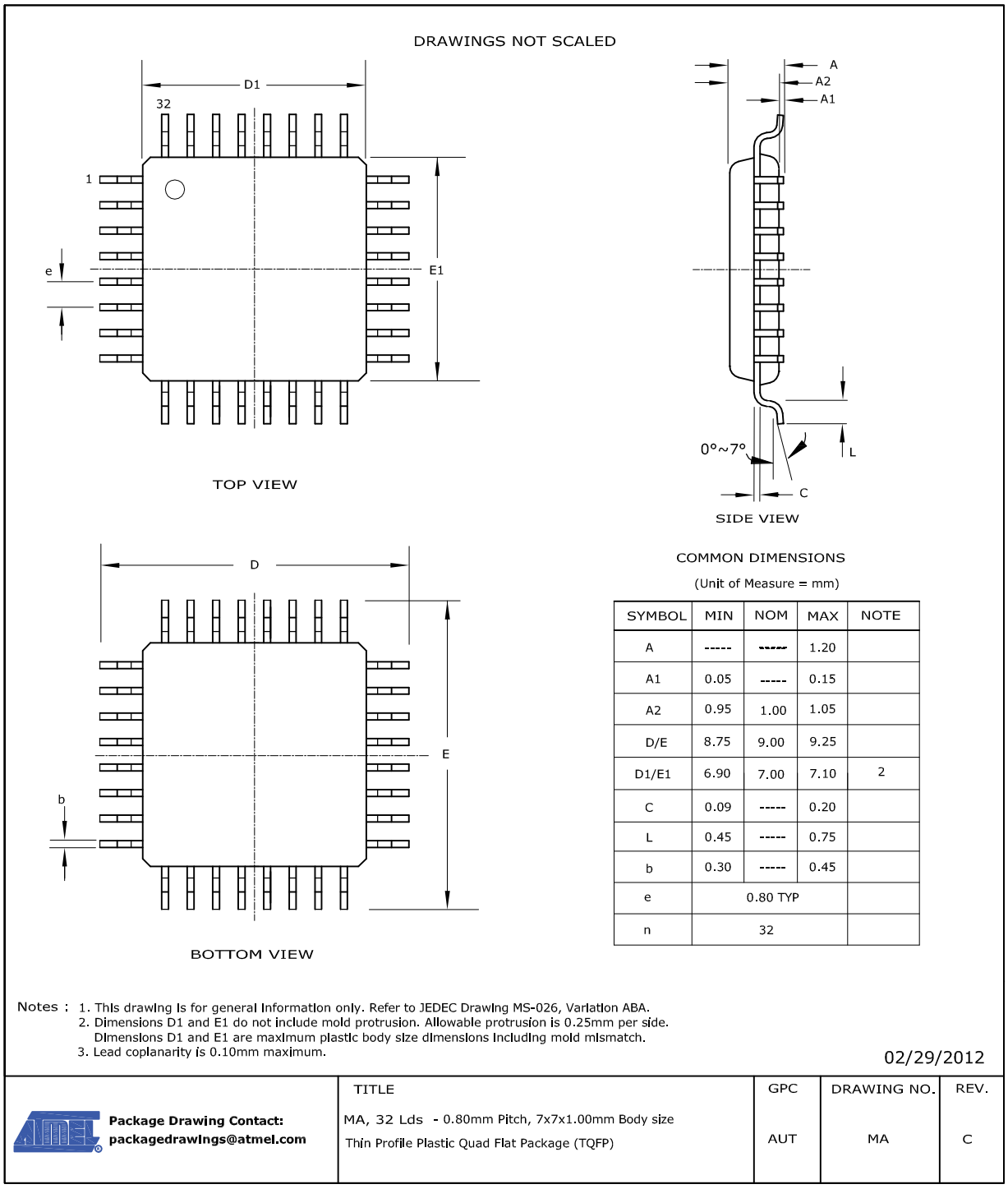
	Package Type
PV	32-lead, 7.0mm × 7.0mm Body, 0.65mm Pitch, Quad Flat No Lead Package (QFN)
MA	MA, 32 - Lead, 7mm × 7mm Body Size, 1.0mm Body Thickness 0.8mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

Figure 4-1. PV



SYMBOL	MIN.	NOM.	MAX.	NOTES
A	0.80	0.90	1.00	
J	0.00	0.02	0.05	
D/E		7.00 BSC		
D2/E2	4.40	4.50	4.60	
N		32		
e		0.65 BSC		
L	0.50	0.60	0.70	
b	0.25	0.30	0.37	

Figure 4-2. MA



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.

02/29/2012

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

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
7781E-AVR-03/12	• Package MA updated
7781D-AVR-01/10	• Section 1.2 “DC Characteristics” on page 3 changed
7781C-AVR-04/09	• DC characteristics updated • ADC characteristics updated • Memory endurance added • Ordering code added
7781B-AVR-05/08	• Added AEC-Q100 Lifetime Equivalence graph, page 4
7781A-AVR-03/08	• Document Creation

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Atmel Corporation
2325 Orchard Parkway
San Jose, CA 95131
USA
Tel: (+1) (408) 441-0311
Fax: (+1) (408) 487-2600
www.atmel.com

Atmel Asia Limited
Unit 01-5 & 16, 19F
BEA Tower, Millennium City 5
418 Kwun Tong Roa
Kwun Tong, Kowloon
HONG KONG
Tel: (+852) 2245-6100
Fax: (+852) 2722-1369

Atmel Munich GmbH
Business Campus
Parkring 4
D-85748 Garching b. Munich
GERMANY
Tel: (+49) 89-31970-0
Fax: (+49) 89-3194621

Atmel Japan G.K.
16F Shin-Osaki Kangyo Building
1-6-4 Osaki
Shinagawa-ku, Tokyo 141-0032
JAPAN
Tel: (+81) (3) 6417-0300
Fax: (+81) (3) 6417-0370