Appendix A - ATtiny45 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

8-bit AVR® Microcontroller with 4K Bytes In-System Programmable Flash

ATtiny45

Automotive

Appendix A

PRELIMINARY

7696B–AUTO–04/08

Electrical Characteristics

Absolute Maximum Ratings*

Operating Temperature .... -55°C to +150°C
Storage Temperature .... -65°C to +175°C
Voltage on any Pin except RESET with respect to Ground ....-0.5V to V_{CC}+0.5V
Voltage on 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 150°C, V_{CC} = 2.7V to 5.5V (unless otherwise noted)(6)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IL}	Input Low Voltage, except XTAL1 and RESET pin	V_{CC} = 2.7V - 5.5V	-0.5		$0.3V_{CC}$(1)	V
V_{IH}	Input High Voltage, except XTAL1 and RESET pins	V_{CC} = 2.7V - 5.5V	$0.6V_{CC}$(2)		V_{CC} + 0.5	V
V_{IL1}	Input Low Voltage, XTAL1 pin	V_{CC} = 2.7V - 5.5V	-0.5		$0.1V_{CC}$(1)	V
V_{IH1}	Input High Voltage, XTAL1 pin	V_{CC} = 2.7V - 5.5V	$0.7V_{CC}$(2)		V_{CC} + 0.5	V
V_{IL2}	Input Low Voltage, RESET pin	V_{CC} = 2.7V - 5.5V	-0.5		$0.2V_{CC}$(1)	V
V_{IH2}	Input High Voltage, RESET pin	V_{CC} = 2.7V - 5.5V	$0.9V_{CC}$(2)		V_{CC} + 0.5	V
V_{IL3}	Input Low Voltage, RESET pin as I/O	V_{CC} = 2.7V - 5.5V	-0.5		$0.3V_{CC}$(1)	V
V_{IH3}	Input High Voltage, RESET pin as I/O	V_{CC} = 2.7V - 5.5V	$0.6V_{CC}$(2)		V_{CC} + 0.5	V
V_{OL}	Output Low Voltage(3), I/O pin except RESET	I_{OL} = 10mA, V_{CC} = 5V I_{OL} = 5mA, V_{CC} = 3V			0.8 0.5	V
V_{OH}	Output High Voltage(4), I/O pin except RESET	I_{OH} = -10mA, V_{CC} = 5V I_{OH} = -5mA, V_{CC} = 3V	4.0 2.2			V
I_{IL}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin low (absolute value)			1	µA
I_{IH}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, 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 150°C, V_{CC} = 2.7V to 5.5V (unless otherwise noted)[6]

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{CC}	Power Supply Current[6]	Active 4MHz, V_{CC} = 3V Active 8MHz, V_{CC} = 5V Active 16MHz, V_{CC} = 5V			8 16 25	mA
$I_{CC\ IDLE}$		Idle 4MHz, V_{CC} = 3V Idle 8MHz, V_{CC} = 5V Idle 16MHz, V_{CC} = 5V			6 12 14	mA
$I_{CC\ PWD}$[5]	Power-down mode	WDT enabled, V_{CC} = 3V WDT enabled, V_{CC} = 5V			90 140	µA
		WDT disabled, V_{CC} = 3V WDT disabled, V_{CC} = 5V			80 120	µA
V_{ACIO}	Analog Comparator Input Offset Voltage	V_{CC} = 5V V_{in} = V_{CC}/2		<10	40	mV
I_{ACLK}	Analog Comparator Input Leakage Current	V_{CC} = 5V V_{in} = V_{CC}/2	-50		50	nA
t_{ACPD}	Analog Comparator Propagation Delay	V_{CC} = 4.0V		500		ns

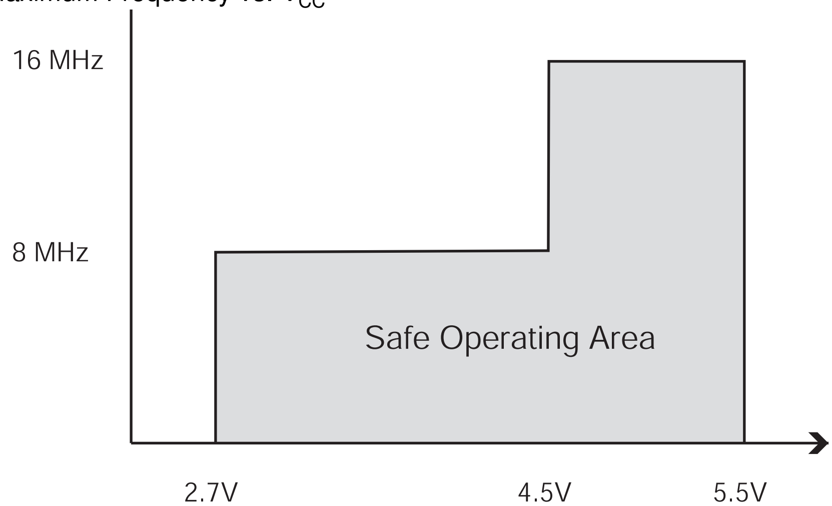
Memory Endurance

EEPROM endurance: 50,000 Write/Erase cycles.

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 2.7V < V_{CC} < 4.5V[6].

Figure 1. Maximum Frequency vs. V_{CC}



ADC Characteristics(6)

T_A = +125°C to 150°C, V_{CC} = 4.5V to 5.5V (unless otherwise noted)

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Resolution			10		Bits
	Absolute accuracy (Including INL, DNL, quantization error, gain and offset error)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		2	3.5	LSB
		V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz Noise Reduction Mode		2	3.5	LSB
	Integral Non-Linearity (INL)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		0.6	2.5	LSB
	Differential Non-Linearity (DNL)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		0.30	1.0	LSB
	Gain Error	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz	-3.5	-1.3	3.5	LSB
	Offset Error	V_{REF} = 4V, V_{CC} = 4V, 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		25.6	32	38.4	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 (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 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. Although each I/O port can source more than the test conditions (20mA at Vcc = 5V) under steady state conditions (non-transient), the following must be observed:
   1] The sum of all IOH, for all ports, should not exceed 400 mA.
   2] The sum of all IOH, for ports C0 - C5, should not exceed 200 mA.
   3] The sum of all IOH, for ports C6, D0 - D4, should not exceed 300 mA.
   4] The sum of all IOH, for ports B0 - B7, D5 - D7, should not exceed 300 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. For temperature range +125°C to +150°C only. For -40°C to +125°C, refer to ATtiny45 Automotive datasheet. Data for 2.7V to 4.5V are given for information only. Products are shipped tested at 5.0V±10% only.

ATtiny45 Typical Characteristics

Active Supply Current

Figure 2. Active Supply Current vs. Frequency (1 - 20 MHz)

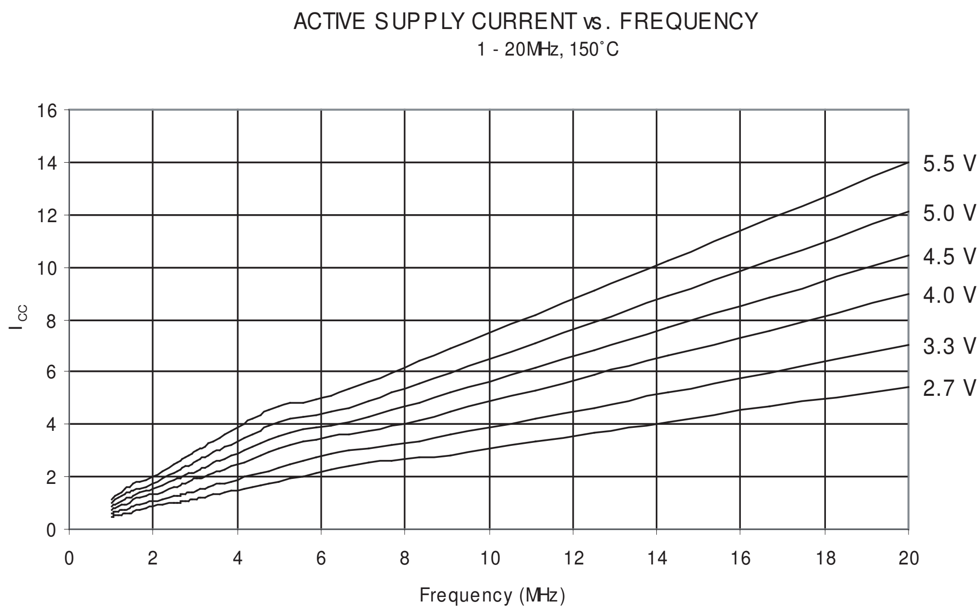
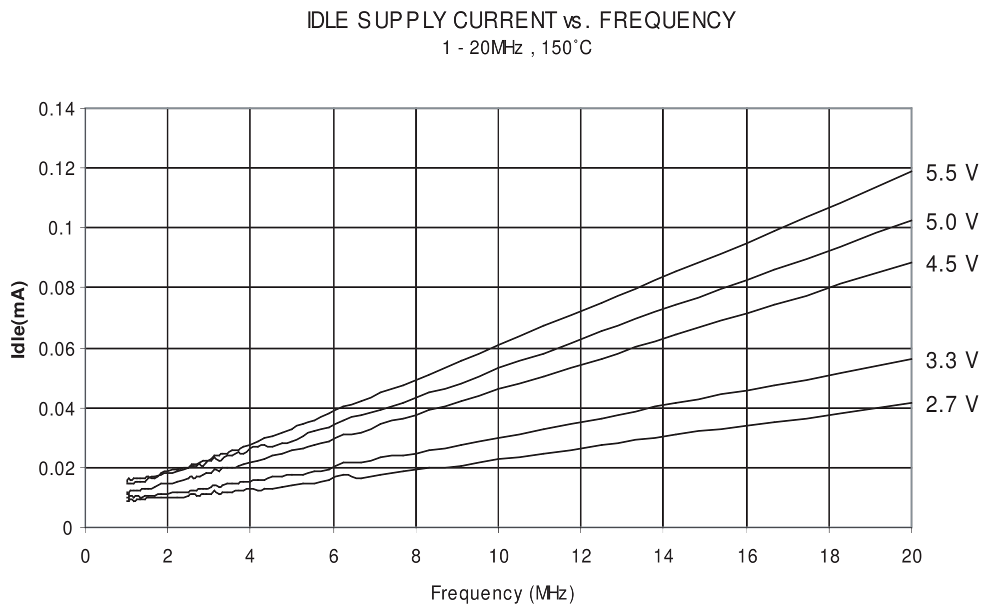


Figure 3. Idle Supply Current vs. Frequency (1 - 20 MHz)



Power-Down Supply Current

Figure 4. Power-Down Supply Current vs. V_{CC} (Watchdog Timer Disabled)

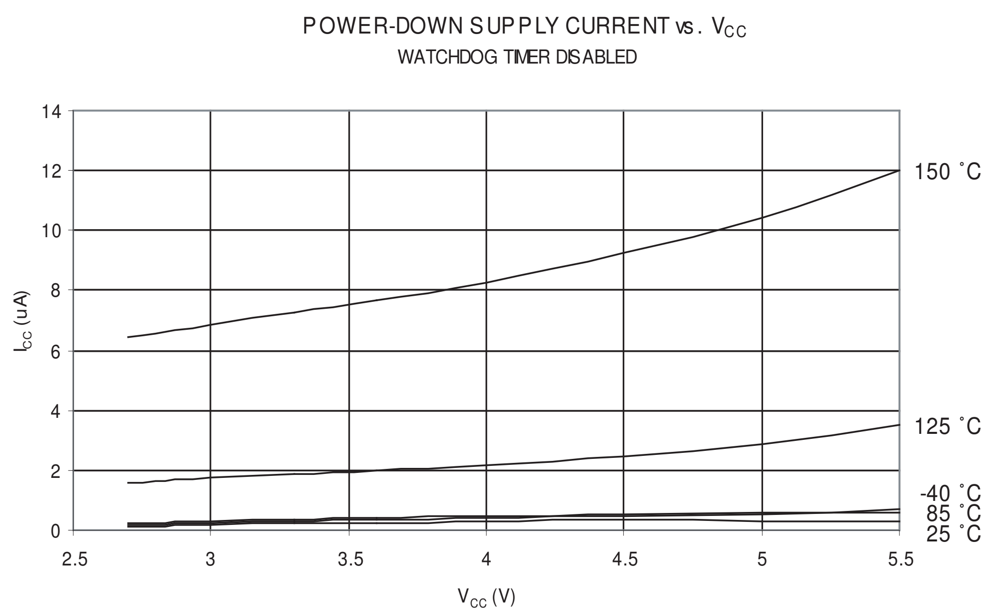
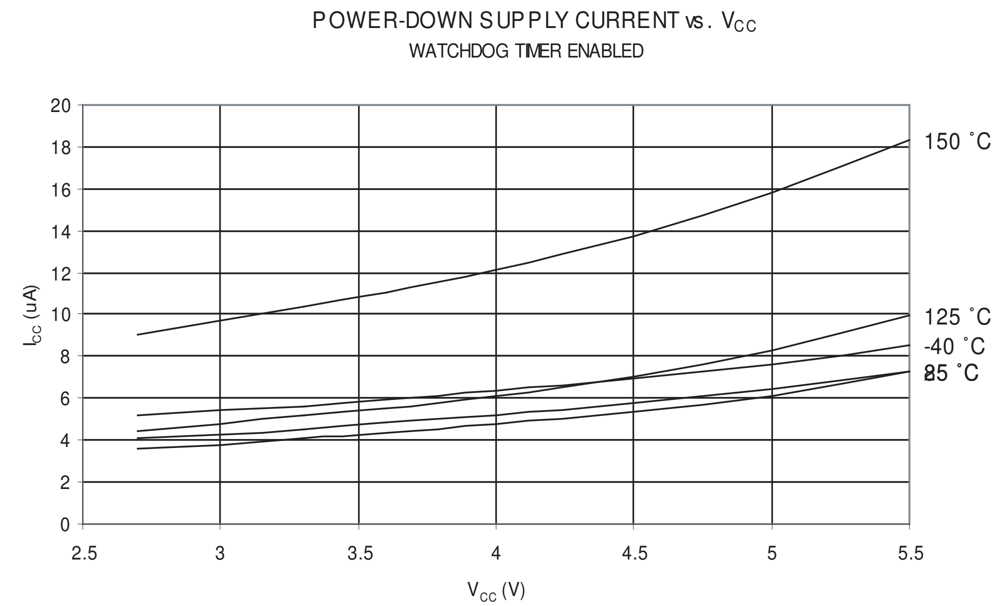


Figure 5. Power-Down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



Pin Pull-up

Figure 6. I/O Pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 5V)

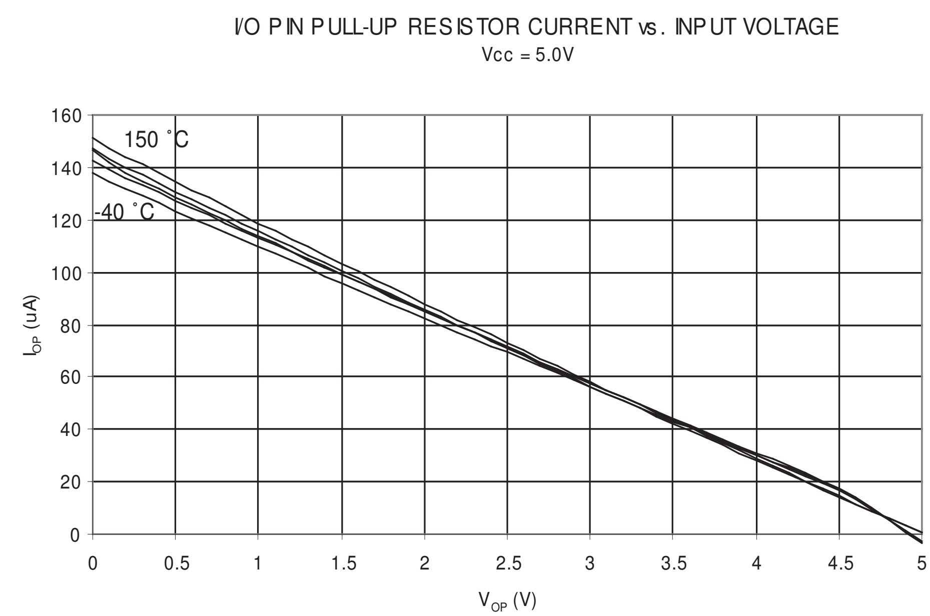


Figure 7. Output Low Voltage vs. Output Low Current (V_{CC} = 5V)

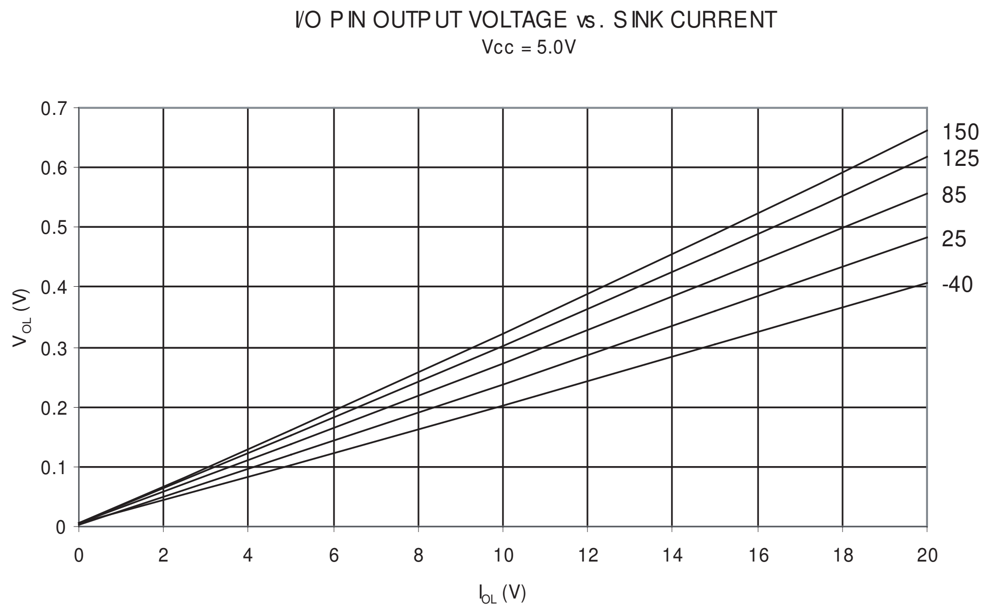


Figure 8. Output Low Voltage vs. Output Low Current (V_{CC} = 3V)

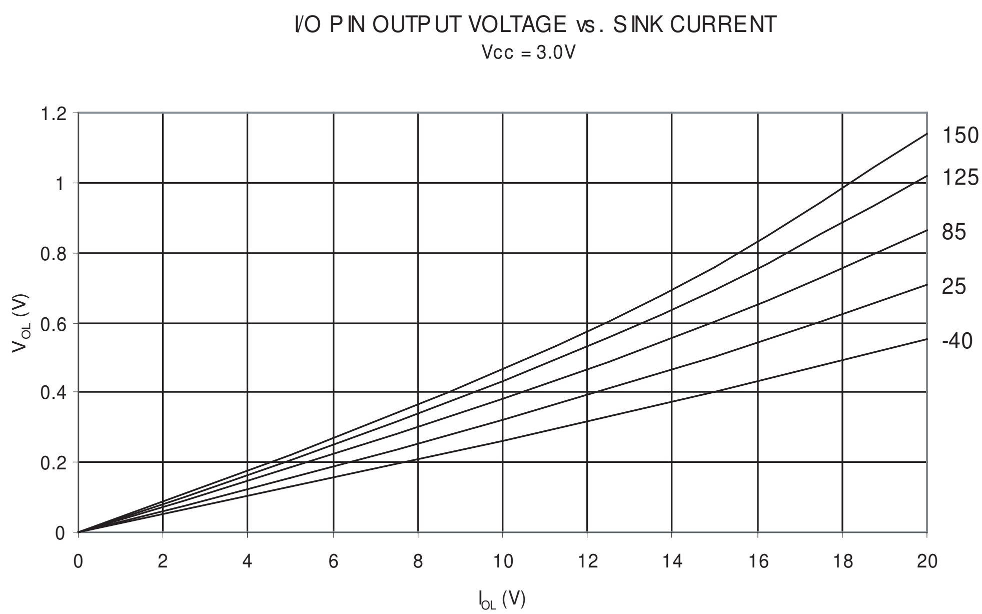


Figure 9. Output High Voltage vs. Output High Current (V_{CC} = 5V)

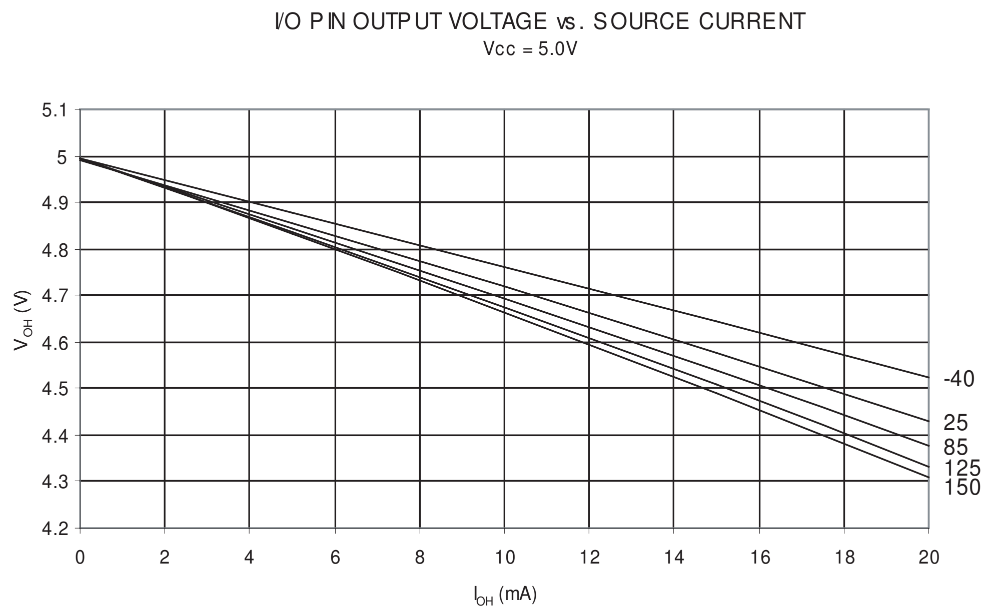


Figure 10. Output High Voltage vs. Output High Current (V_{CC} = 3V)

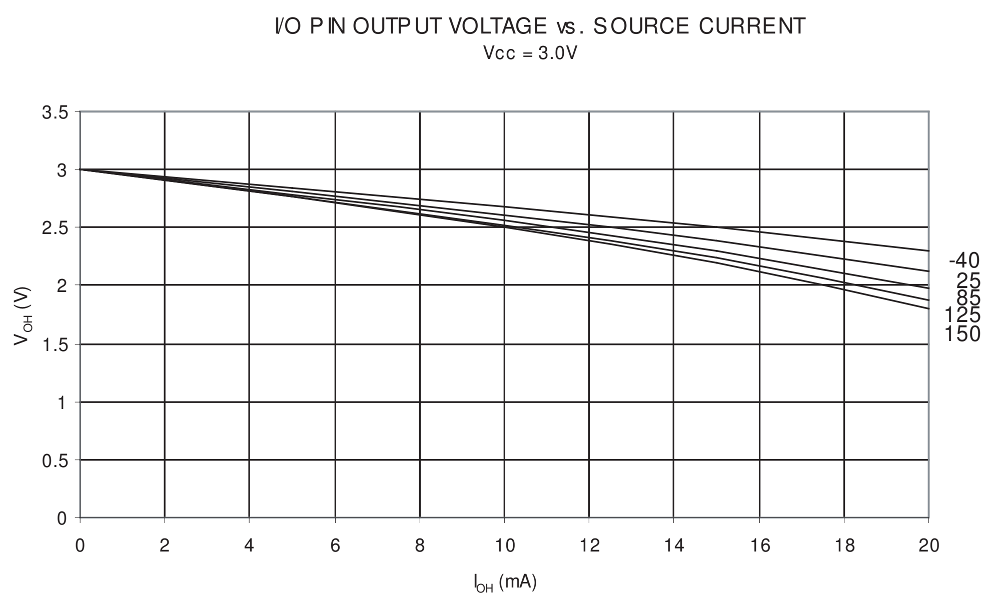
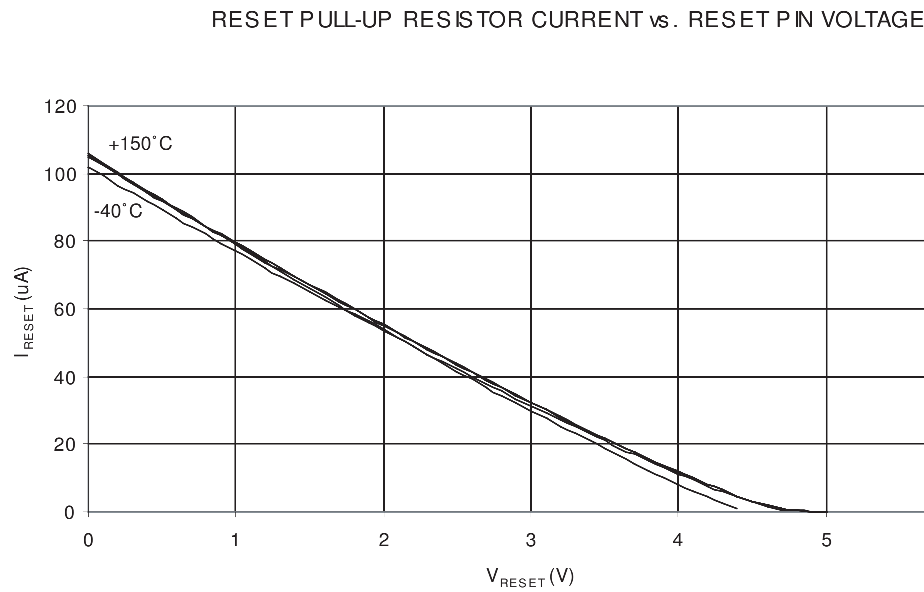


Figure 11. Reset Pull-Up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



Pin Thresholds and Hysteresis

Figure 12. I/O Pin Input Threshold vs. V_{CC} (VIH, I/O Pin Read as '1')

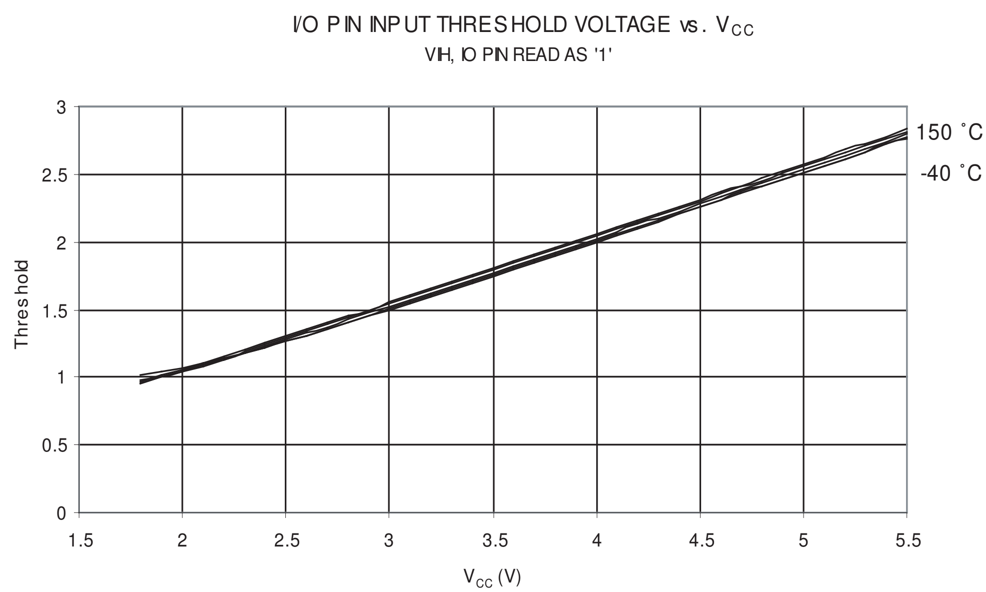


Figure 13. I/O Pin Input Threshold vs. V_{CC} (VIL, I/O Pin Read as '0')

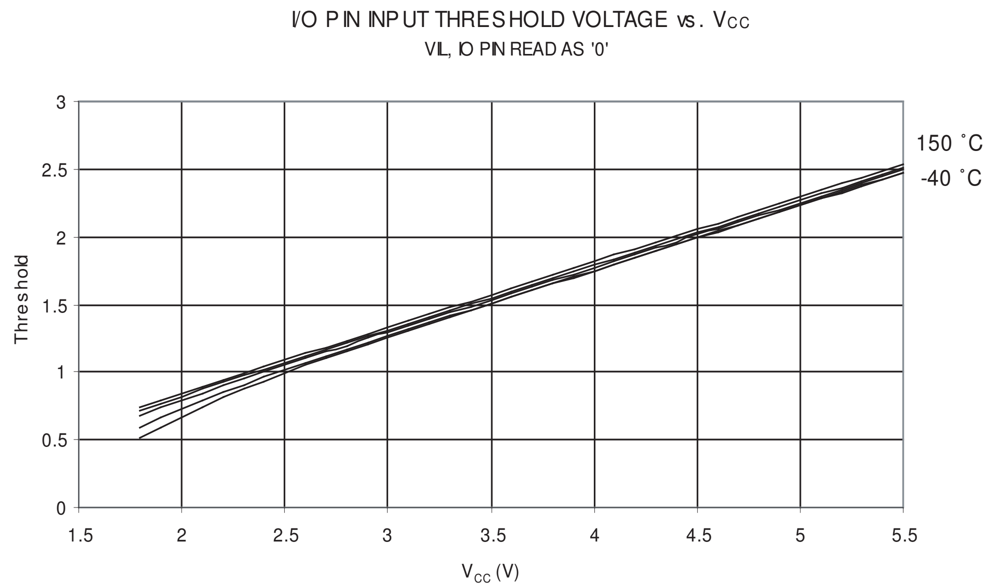


Figure 14. Reset Input Threshold Voltage vs. V_{CC} (VIH, Reset Pin Read as '1')

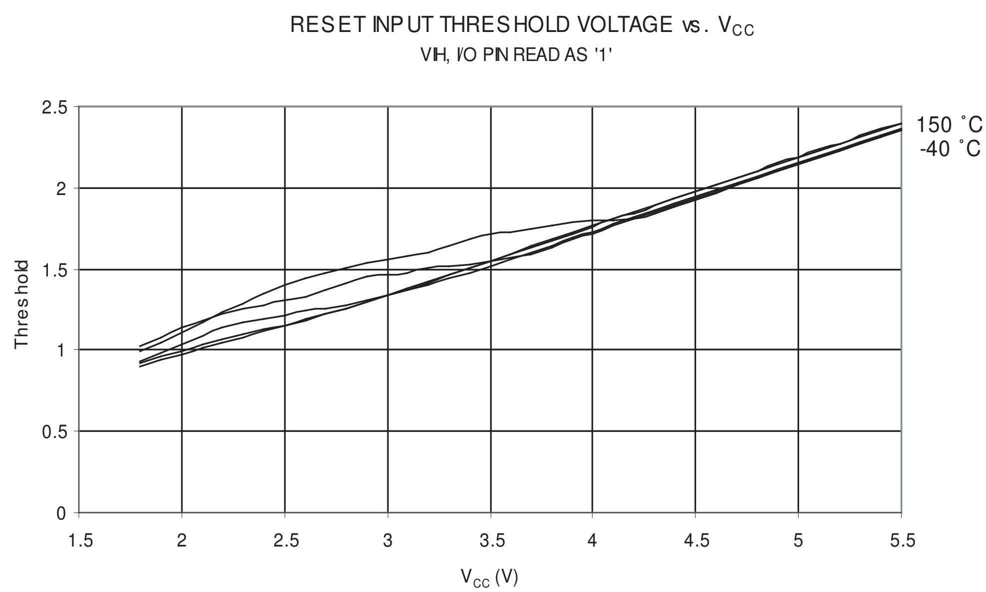
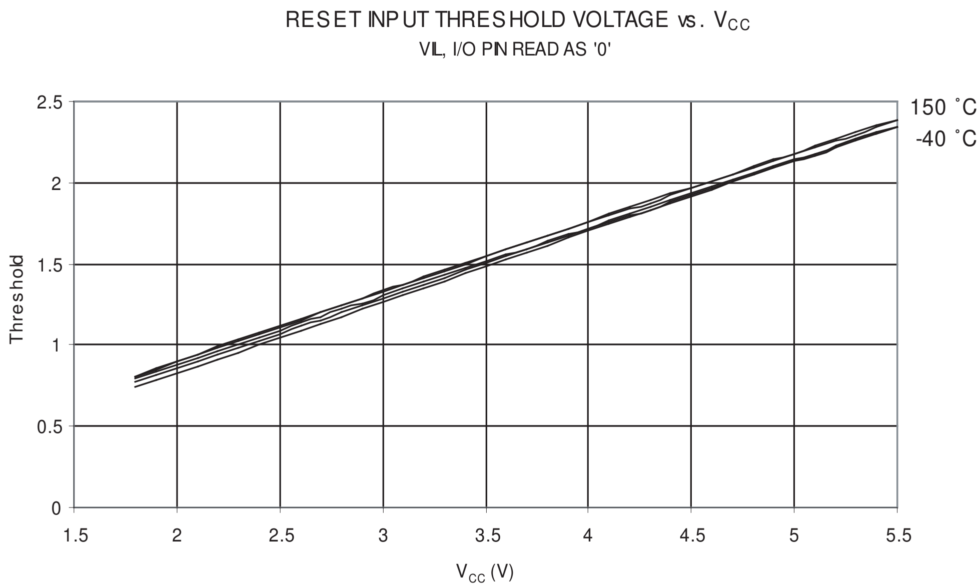


Figure 15. Reset Input Threshold Voltage vs. V_{CC} (VIL, Reset Pin Read as '0')



Internal Oscillator Speed

Figure 16. Watchdog Oscillator Frequency vs. V_{CC}

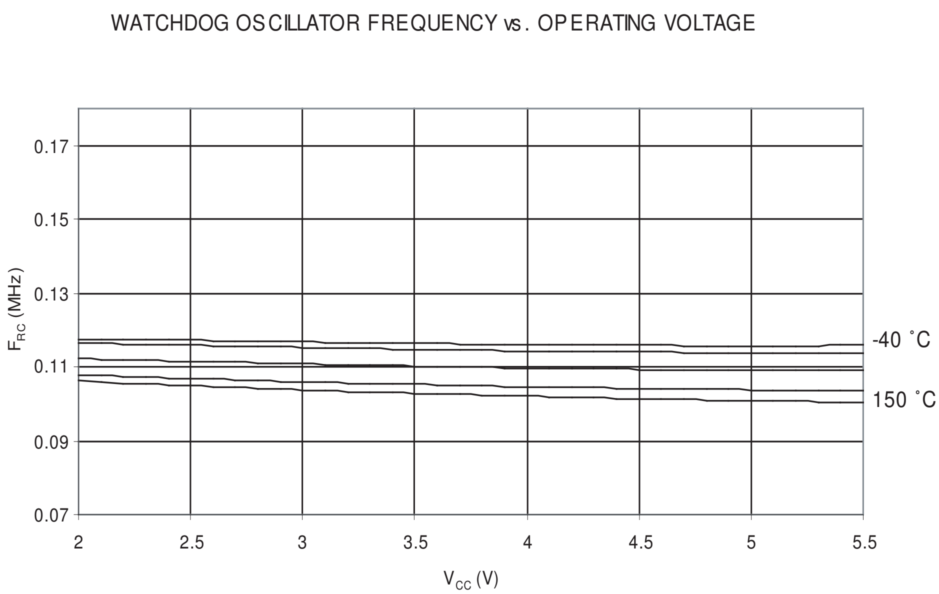


Figure 17. Calibrated 8 MHz RC Oscillator Frequency vs. Temperature

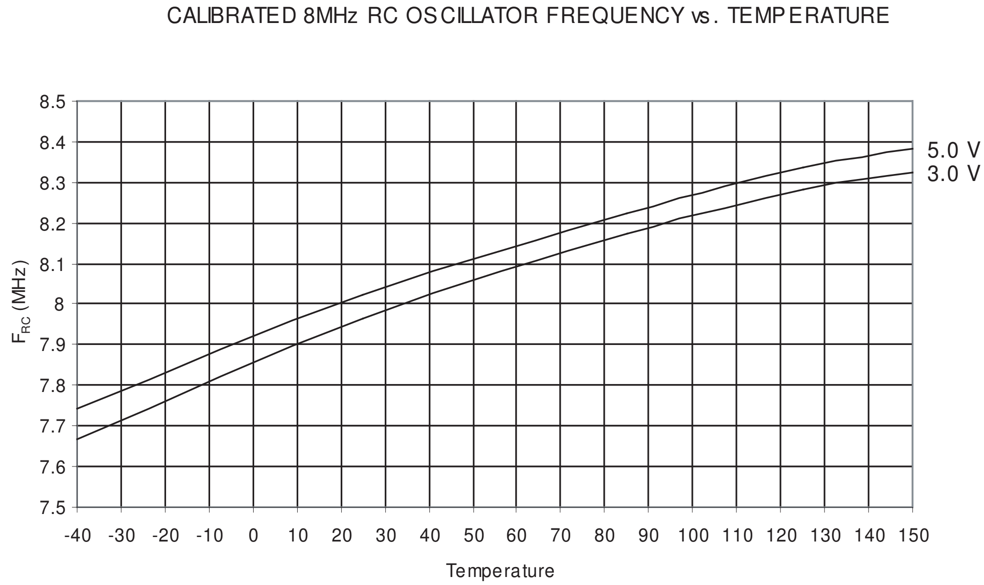


Figure 18. Calibrated 8 MHz RC Oscillator Frequency vs. V_{CC}

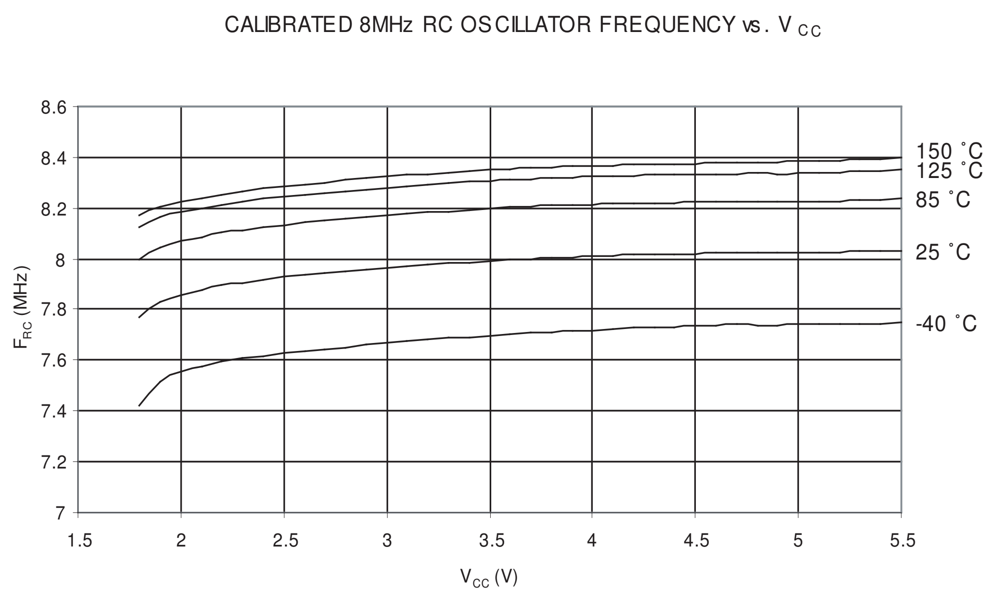
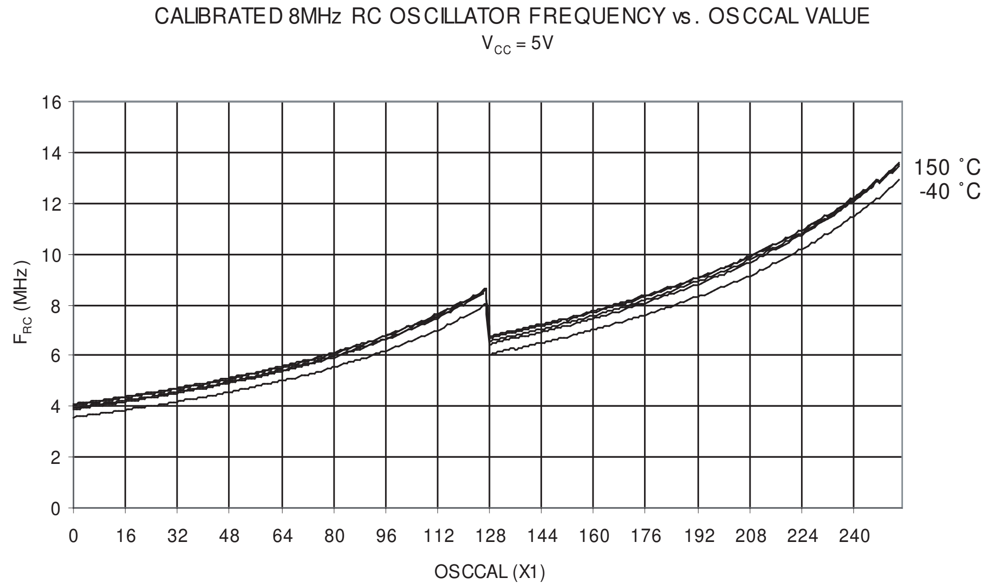


Figure 19. Calibrated 8 MHz RC Oscillator Frequency vs. OSCCAL Value



BOD Thresholds and Analog Comparator Offset

Figure 20. BOD Threshold vs. Temperature (BODLEVEL is 4.3V)

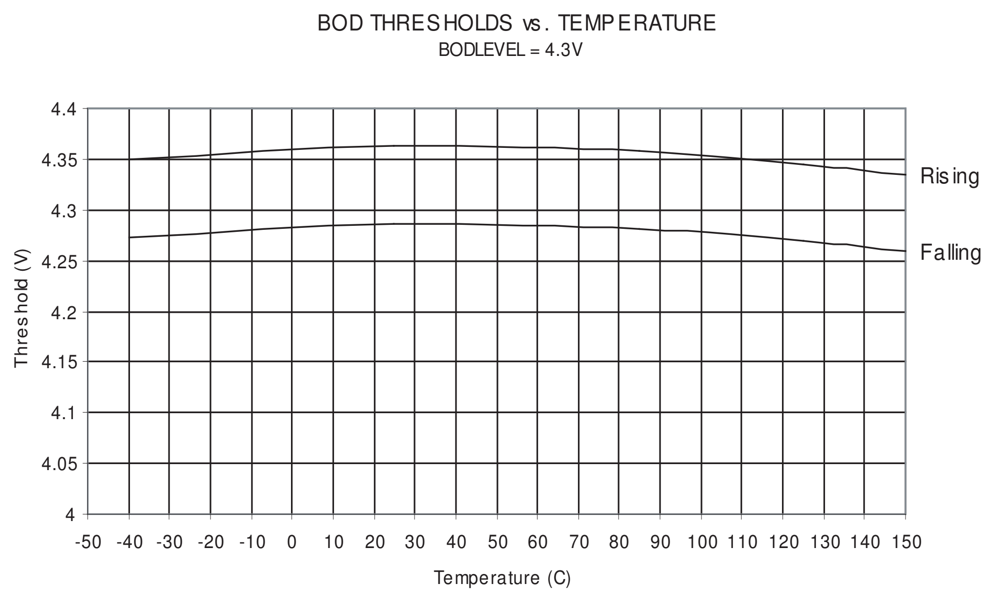


Figure 21. BOD Threshold vs. Temperature (BODLEVEL is 2.7V)

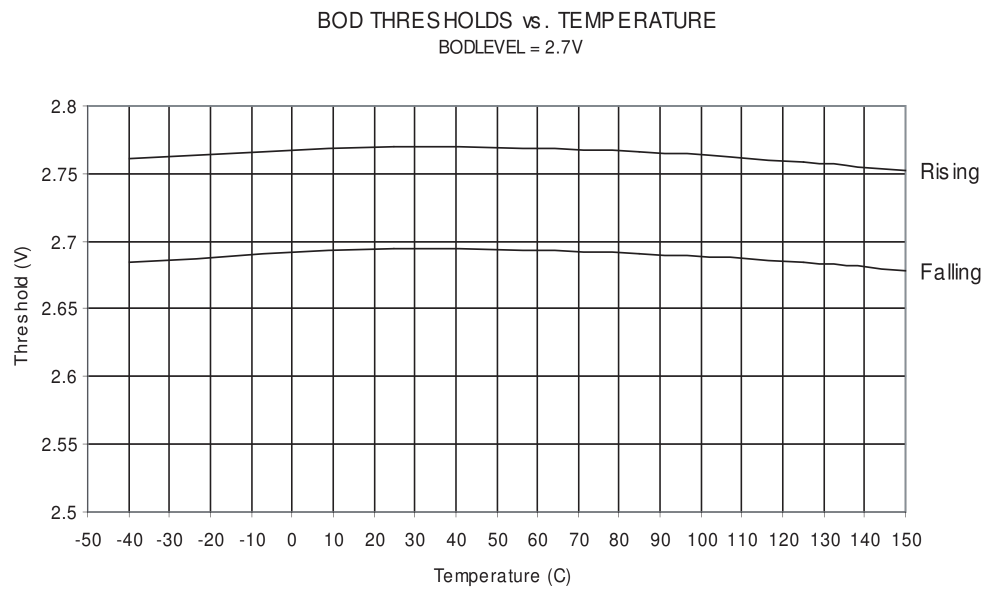
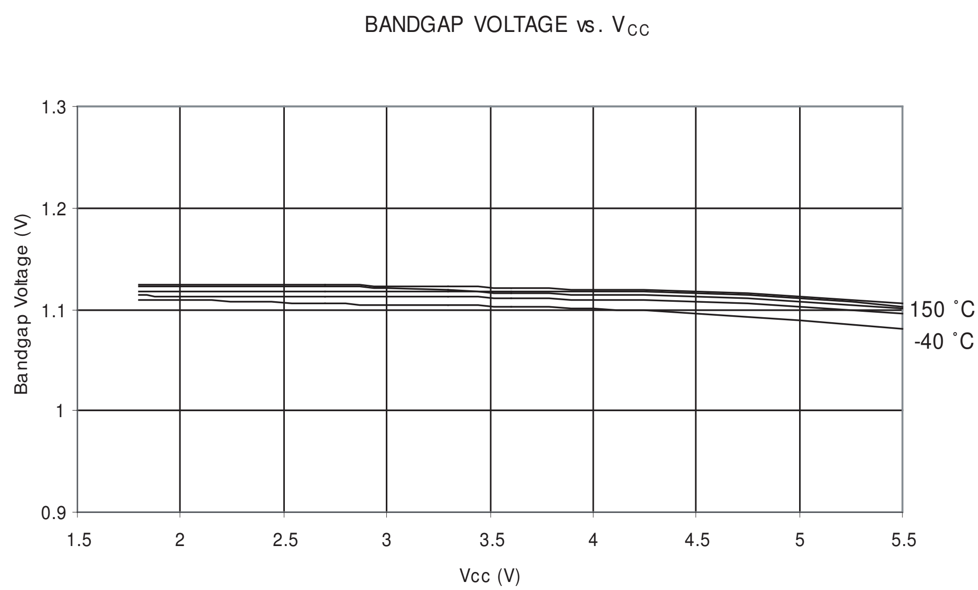


Figure 22. Bandgap Voltage vs. V_{CC}



Peripheral Units

Figure 23. Analog to Digital Converter GAIN vs. Temperature, Single Ended

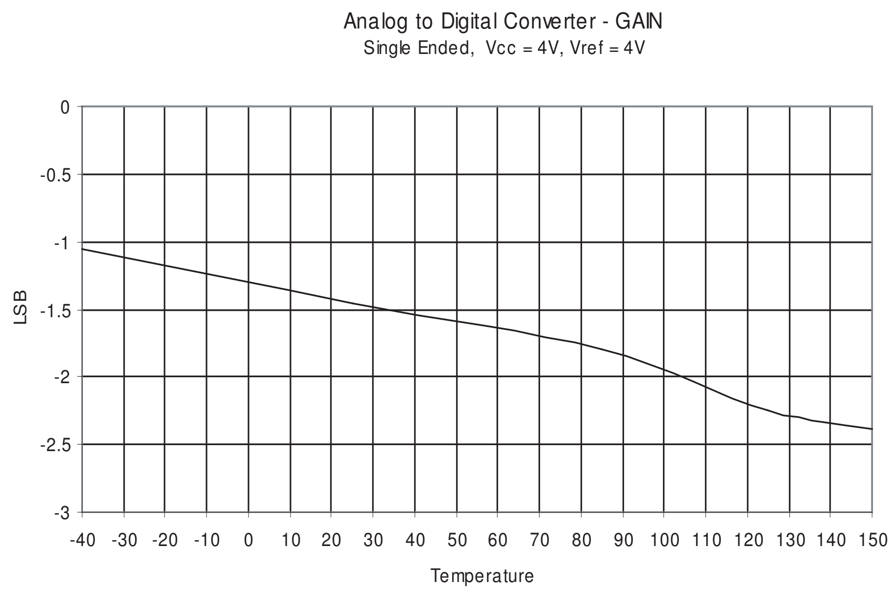


Figure 24. Analog to Digital Converter GAIN vs. Temperature, Differential Mode

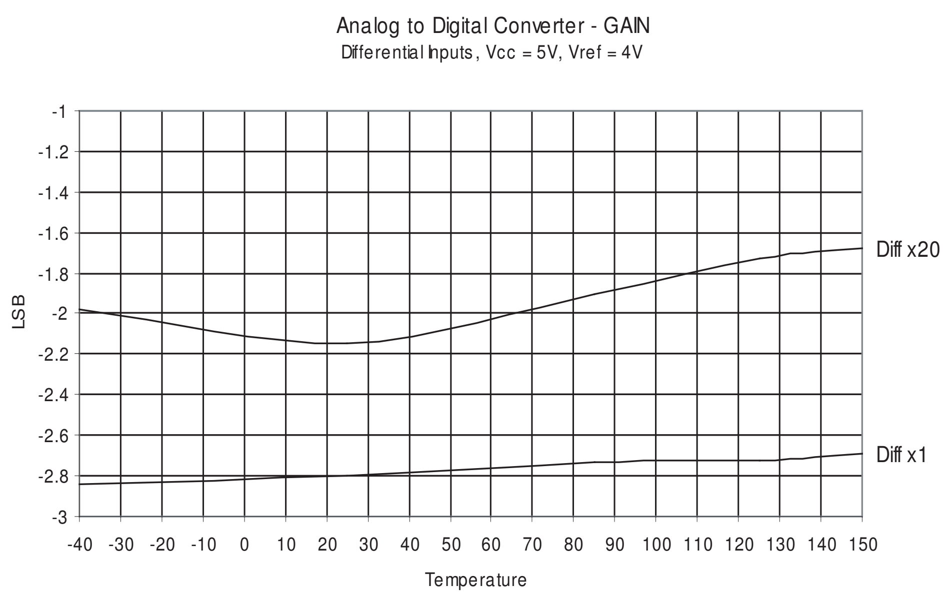


Figure 25. Analog to Digital Converter OFFSET vs. Temperature, Single Ended

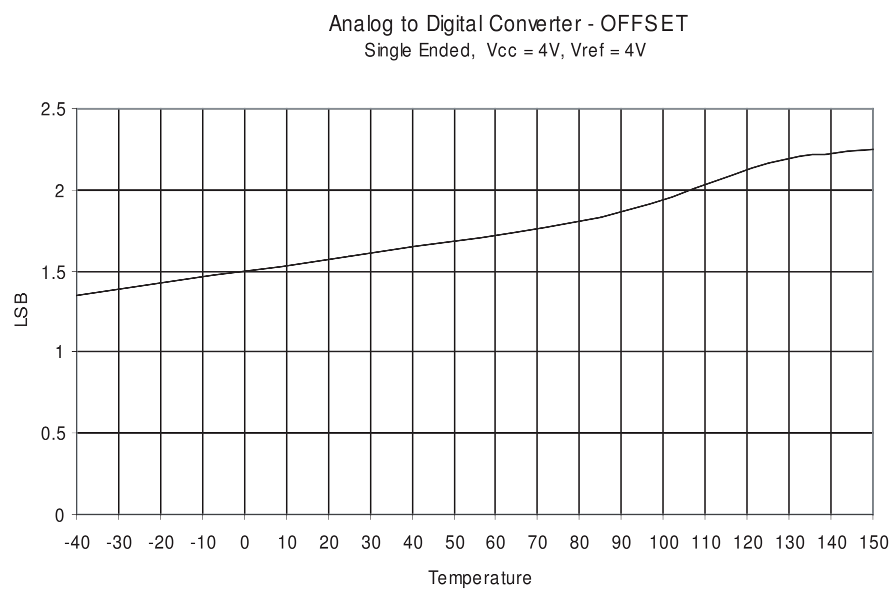


Figure 26. Analog to Digital Converter OFFSET vs. Temperature, Differential Mode

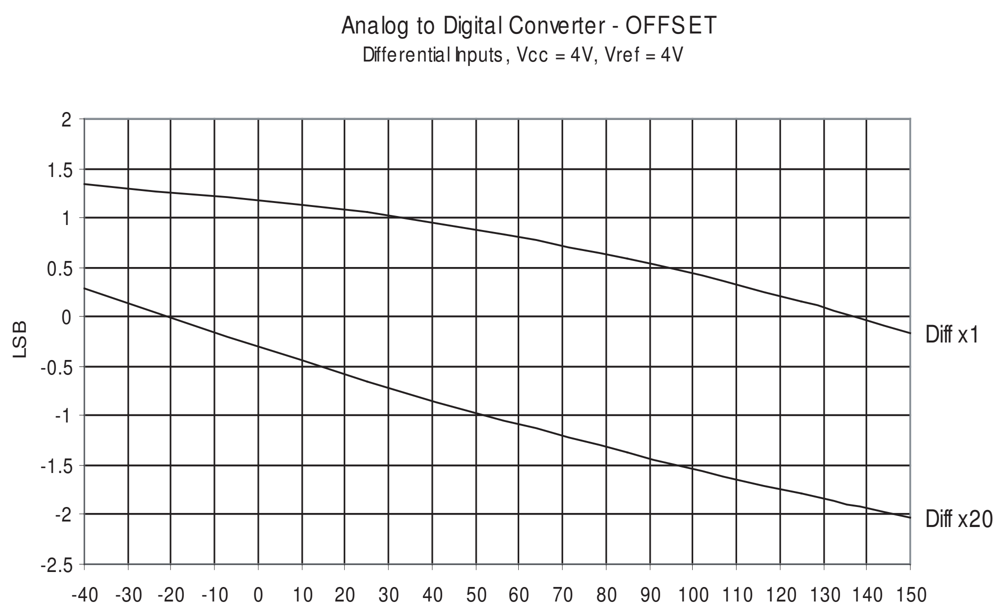


Figure 27. Analog to Digital Converter DNL vs. Temperature, Single Ended

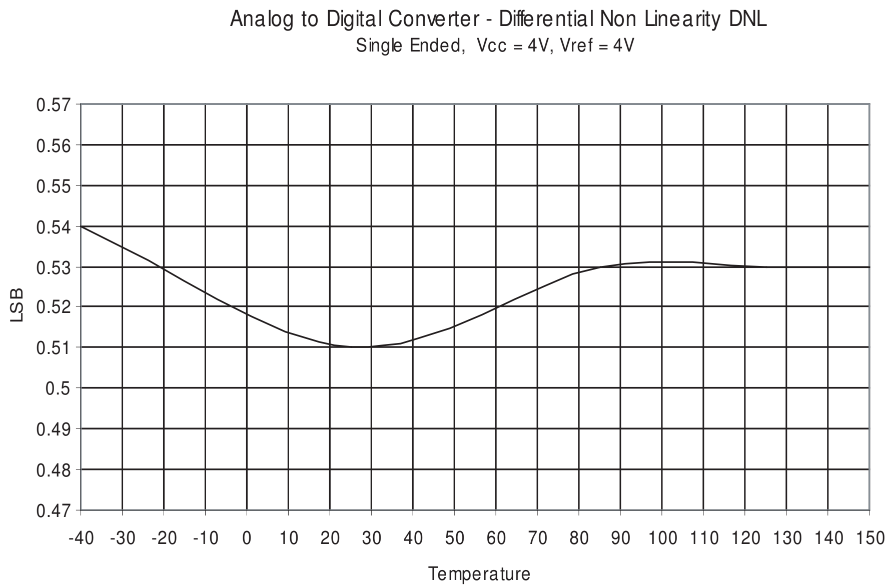


Figure 28. Analog to Digital Converter DNL vs. Temperature,Differential Mode

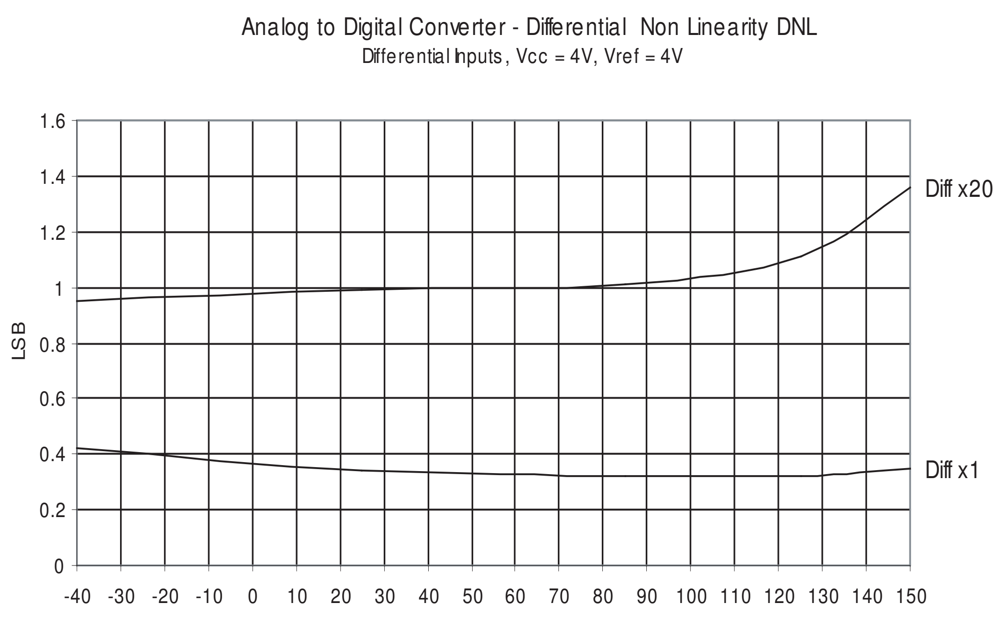


Figure 29. Analog to Digital Converter INL vs. Temperature, Single Ended

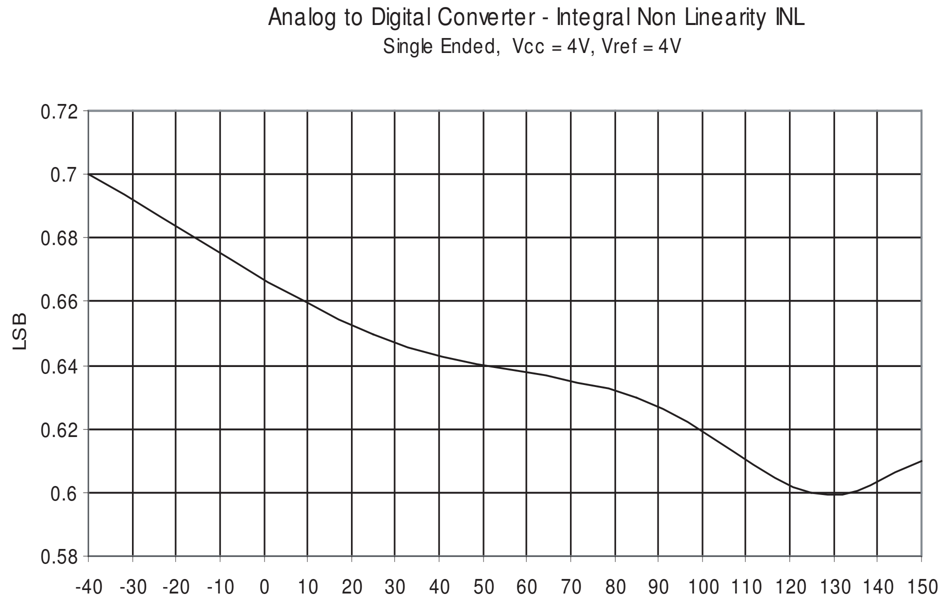
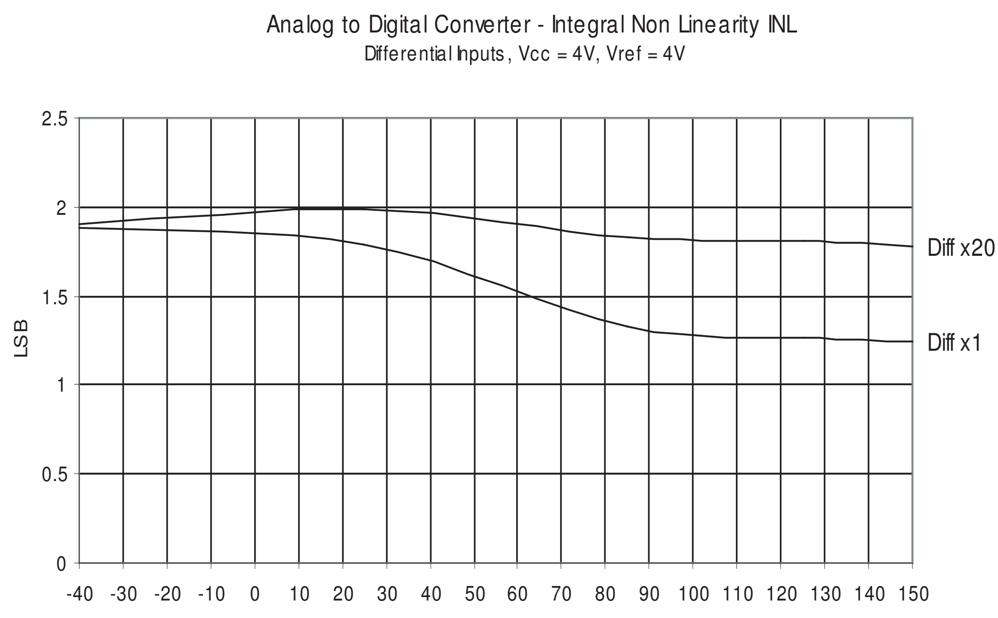


Figure 30. Analog to Digital Converter INL vs. Temperature, Differential Mode

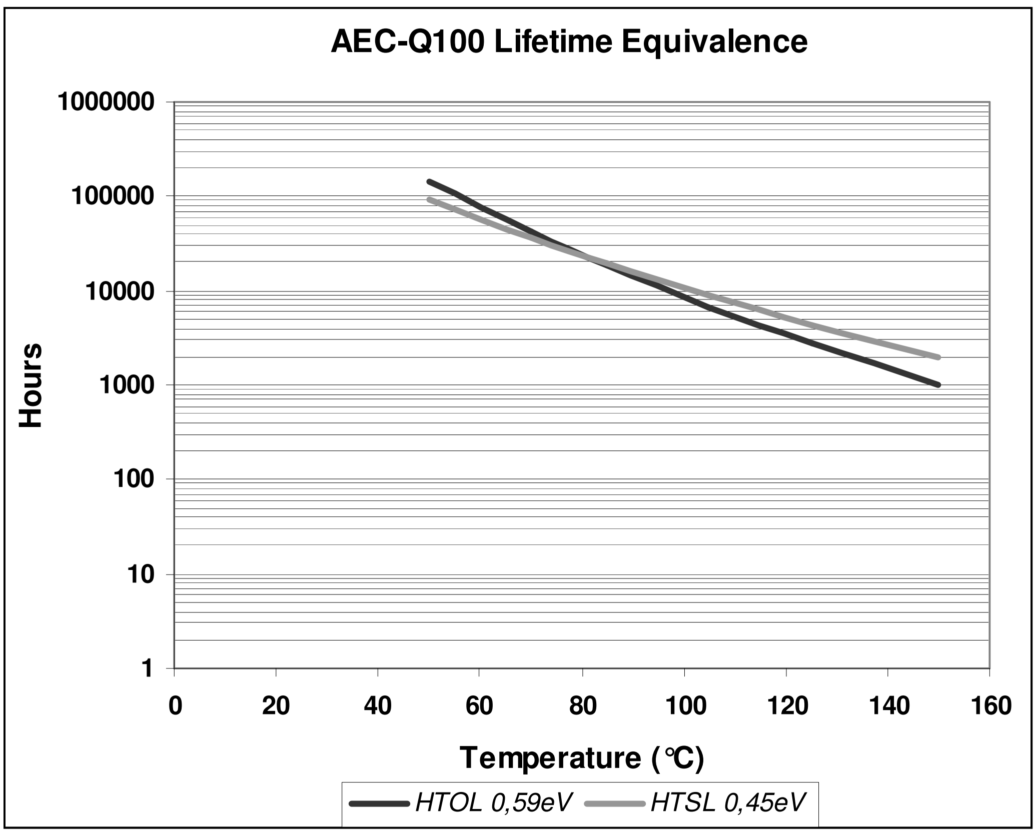


Grade 0 Qualification

The ATtiny45 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 ATtiny45 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 ATtiny45 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. Examples are given in figure 1. Therefore any temperature mission profile which could exceed the AEC-Q100 equivalence domain shall be submitted to Atmel for a thorough reliability analysis



Ordering Information

ATtiny45

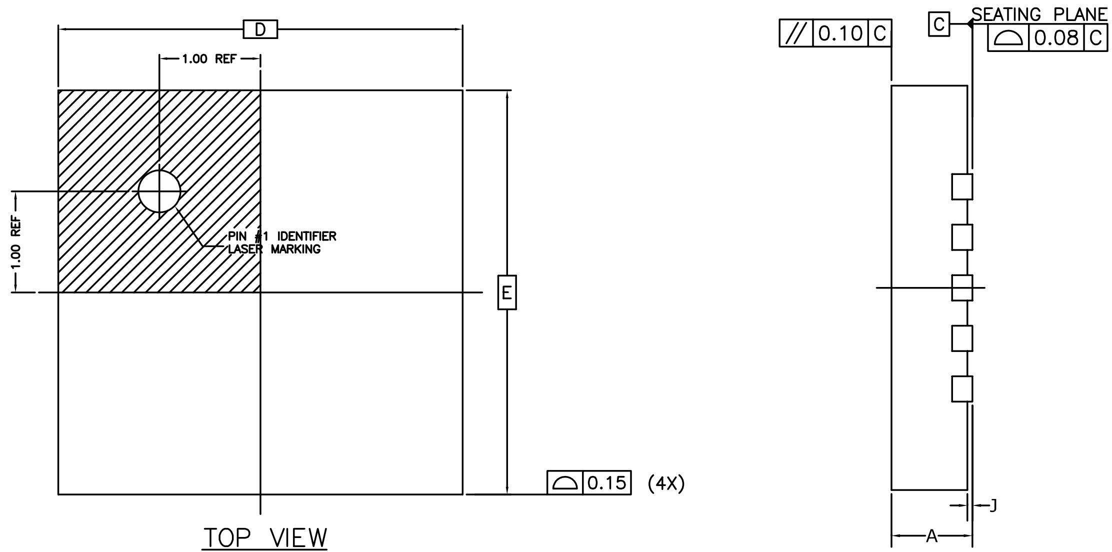
Speed (MHz)	Power Supply	Ordering Code	Package(1)	Operation Range
16(2)	2.7 - 5.5V	ATtiny45-15MT2	PC	Extended (-40°C to 150°C)

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 vs. V_{CC}, see Figure 1 on page 4 and complete product datasheet.

Package Type	
PC	20-lead, 4.0x 4.0 mm body, lead pitch 0.60 mm, Quad Flat No-Lead Package (QFN)

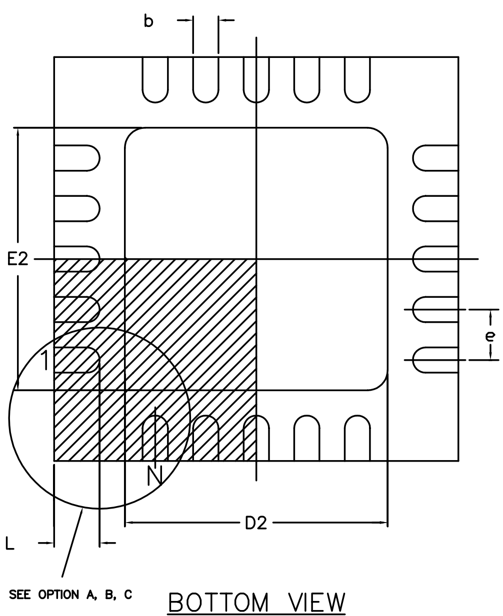
PC



TOP VIEW

SIDE VIEW

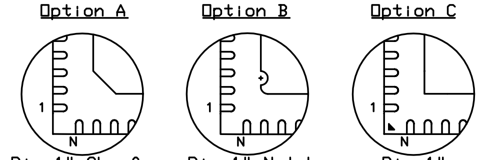
DRAWINGS NOT SCALED



BOTTOM VIEW

COMMON DIMENSIONS IN MM

SYMBOL	MIN.	NOM.	MAX.	NOTES
A	0. 70	0. 75	0. 80	
J	0. 00	----	0. 05	
D/E		4. 00 BSC		
D2/E2	2. 50	----	2. 80	
N		20		
e		0. 50 BSC		
L	0. 35	----	0. 55	
b	0. 18	0. 25	0. 30	



Compliant JEDEC Standard MO-220 variation WGGD-5

07/26/07

	TITLE	DRAWING No.	REV.
Atmel Nantes S.A. La Chantrerie - BP 70602 44306 Nantes Cedex 3 - France	PC, 20 - Lead 4.0x4.0 mm Body, 0.50 mm Pitch Quad Flat No Lead Package (QFN)	PC	G

Document Revision History

7696A to 7696B

1. Added EEPROM endurance. See “Memory Endurance” on page 4.

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7696B–AUTO–04/08