ATtiny24A, ATtiny44A, ATtiny84A

8-bit AVR Microcontroller with 2K/4K/8K Bytes In-System Programmable Flash

DATASHEET APPENDIX B

Appendix B – ATtiny24A/44A/84A Specification at 125°C

This document contains information specific to devices operating at temperatures up to 125°C. Only deviations are covered in this appendix, all other information can be found in the complete datasheet. The complete datasheet can be found at www.atmel.com.

1. Memories

1.1 EEPROM Data Memory

The EEPROM has an endurance of at least 50,000 write/erase cycles.

2. Electrical Characteristics

2.1 Absolute Maximum Ratings*

Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°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	40.0 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.

2.2 DC Characteristics

Table 2-1. DC Characteristics. TA = -40°C to +125°C

Symbol	Parameter	Condition	Min	Typ[1]	Max	Units
V_{IL}	Input Low Voltage	V_{CC} = 1.8V - 2.4V	-0.5		$0.2V_{CC}$[3]	V
		V_{CC} = 2.4V - 5.5V	-0.5		$0.3V_{CC}$[3]	V
	Input Low Voltage, RESET Pin as Reset [4]	V_{CC} = 1.8V - 5.5	-0.5		$0.2V_{CC}$[3]	
V_{IH}	Input High-voltage Except RESET pin	V_{CC} = 1.8V - 2.4V	$0.7V_{CC}$[2]		V_{CC} +0.5	V
		V_{CC} = 2.4V - 5.5V	$0.6V_{CC}$[2]		V_{CC} +0.5	V
	Input High-voltage RESET pin as Reset [4]	V_{CC} = 1.8V to 5.5V	$0.9V_{CC}$[2]		V_{CC} +0.5	V
V_{OL}	Output Low Voltage [5] Except RESET pin [7]	I_{OL} = 10 mA, V_{CC} = 5V			0.6	V
		I_{OL} = 5 mA, V_{CC} = 3V			0.5	V
V_{OH}	Output High-voltage [6] Except RESET pin [7]	I_{OH} = -10 mA, V_{CC} = 5V	4.3			V
		I_{OH} = -5 mA, V_{CC} = 3V	2.5			V
I_{LIL}	Input Leakage Current I/O Pin	Vcc = 5.5V, pin low (absolute value)		< 0.05	1 [8]	µA
I_{LIH}	Input Leakage Current I/O Pin	Vcc = 5.5V, pin high (absolute value)		< 0.05	1 [8]	µA
R_{PU}	Pull-up Resistor, I/O Pin	V_{CC} = 5.5V, input low	20		50	kΩ
	Pull-up Resistor, Reset Pin	V_{CC} = 5.5V, input low	30		60	kΩ

Symbol	Parameter	Condition	Min	Typ[1]	Max	Units
I_{CC}	Supply Current, Active Mode [9]	f = 1MHz, V_{CC} = 2V		0.25	0.5	mA
		f = 4MHz, V_{CC} = 3V		1.2	2	mA
		f = 8MHz, V_{CC} = 5V		4.4	7	mA
	Supply Current, Idle Mode [9]	f = 1MHz, V_{CC} = 2V		0.04	0.2	mA
		f = 4MHz, V_{CC} = 3V		0.25	0.6	mA
		f = 8MHz, V_{CC} = 5V		1.3	2	mA
	Supply Current, Power-Down Mode [10]	WDT enabled, V_{CC} = 3V		4	20	µA
		WDT disabled, V_{CC} = 3V		0.2	10	µA

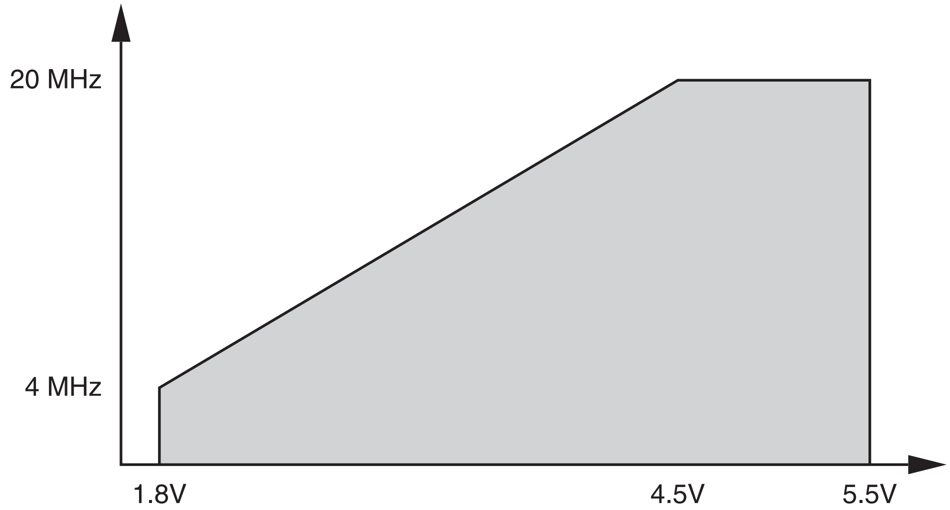
Notes:
1. Typical values at 25°C.
2. “Min” means the lowest value where the pin is guaranteed to be read as high.
3. “Max” means the highest value where the pin is guaranteed to be read as low.
4. Not tested in production.
5. Although each I/O port can sink more than the test conditions (10 mA at V_{CC} = 5V, 5 mA at V_{CC} = 3V) under steady state conditions (non-transient), the sum of all I_{OL} (for all ports) should not exceed 60 mA. If I_{OL} exceeds the test conditions, V_{OL} may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
6. Although each I/O port can source more than the test conditions (10 mA at V_{CC} = 5V, 5 mA at V_{CC} = 3V) under steady state conditions (non-transient), the sum of all I_{OH} (for all ports) should not exceed 60 mA. If I_{OH} exceeds the test condition, V_{OH} may exceed the related specification. Pins are not guaranteed to source current greater than the listed test condition.
7. The $\overline{\text{RESET}}$ pin must tolerate high voltages when entering and operating in programming modes and, as a consequence, has a weak drive strength as compared to regular I/O pins. See figures, for ATtiny24A, from Figure 3-22 on page 21 to Figure 3-25 on page 23, and for ATtiny44A, from Figure 3-67 on page 44 to Figure 3-70 on page 45.
8. These are test limits, which account for leakage currents of the test environment. Actual device leakage currents are lower.
9. Values are with external clock using methods described in “Minimizing Power Consumption”. Power reduction is enabled (PRR = 0xFF) and there is no I/O drive.
10. BOD disabled.

2.3 Speed

2.3.1 ATtiny24A and ATtiny44A

The maximum operating frequency of the device depends on $V_{CC.}$ As shown in Figure 2-1, the relationship between maximum frequency and V_{CC} is linear in the region 1.8V < V_{CC} < 4.5V.

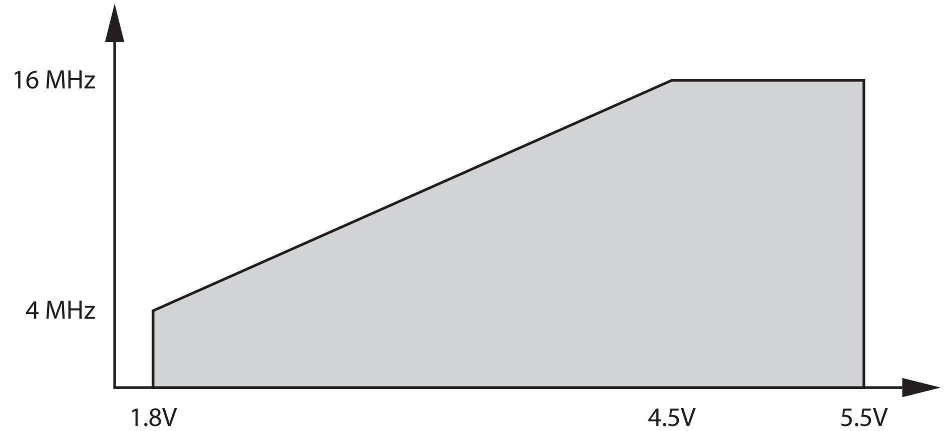
Figure 2-1. Maximum Frequency vs. V_{CC}. T_A = -40°C to +125°C



2.3.2 ATtiny84A

The maximum operating frequency of the device depends on $V_{CC.}$ As shown in Figure 2-1, the relationship between maximum frequency and V_{CC} is linear in the region 1.8V < V_{CC} < 4.5V.

Figure 2-2. Maximum Frequency vs. V_{CC}. T_A = -40°C to +125°C



2.4 Clock Characteristics

2.4.1 Accuracy of Calibrated Internal Oscillator

It is possible to manually calibrate the internal oscillator to be more accurate than default factory calibration. Note that oscillator frequency depends on temperature and voltage. Voltage and temperature characteristics can be found in Figure 3-45 on page 33.

Table 2-2. Calibration Accuracy of Internal RC Oscillator

Calibration Method	Target Frequency	V_{CC}	Temperature	Accuracy at given voltage & temperature[1]
Factory Calibration	8.0 MHz	3V	25°C	±10%
User Calibration	Fixed frequency: 7.3 – 8.1 MHz	Fixed voltage: 1.8V – 5.5V	Fixed temperature: -40°C to +125°C	±1%

Note: 1. Accuracy of oscillator frequency at calibration point (fixed temperature and fixed voltage).

2.5 System and Reset Characteristics

2.5.1 Power-On Reset

Table 2-3. Characteristics of Enhanced Power-On Reset. TA = -40 to +125°C

Symbol	Parameter	Min[1]	Typ[1]	Max[1]	Units
V_{POR}	Release threshold of power-on reset [2]	1.1	1.4	1.7	V
V_{POA}	Activation threshold of power-on reset [3]	0.6	1.3	1.7	V
SR_{ON}	Power-On Slope Rate	0.01			V/ms

Notes: 1. Values are guidelines, only
2. Threshold where device is released from reset when voltage is rising
3. The Power-on Reset will not work unless the supply voltage has been below V_{POA}

2.6 Analog Comparator Characteristics

Table 2-4. Analog Comparator Characteristics, TA = -40°C to +125°C

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{AIO}	Input Offset Voltage	V_{CC} = 5V, V_{IN} = V_{CC} / 2		< 10	40	mV
I_{LAC}	Input Leakage Current	V_{CC} = 5V, V_{IN} = V_{CC} / 2	-0.5		0.5	µA
t_{APD}	Analog Propagation Delay (from saturation to slight overdrive)	V_{CC} = 2.7V		750		ns
		V_{CC} = 4.0V		500		
	Analog Propagation Delay (large step change)	V_{CC} = 2.7V		100		
		V_{CC} = 4.0V		75		
t_{DPD}	Digital Propagation Delay	V_{CC} = 1.8V - 5.5		1	2	CLK

Note: All parameters are based on simulation results and are not tested in production

2.7 ADC Characteristics

Table 2-5. ADC Characteristics, Single Ended Channels. T = -40°C to +125°C

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Resolution				10	Bits
	Absolute accuracy (Including INL, DNL, and Quantization, Gain and Offset Errors)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		2.0		LSB
		V_{REF} = 4V, V_{CC} = 4V, ADC clock = 1 MHz		2.5		LSB
		V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz Noise Reduction Mode		1.5		LSB
		V_{REF} = 4V, V_{CC} = 4V, ADC clock = 1 MHz Noise Reduction Mode		2.0		LSB
	Integral Non-Linearity (INL) (Accuracy after Offset and Gain Calibration)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		1.0		LSB
	Differential Non-linearity (DNL)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		0.5		LSB
	Gain Error	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		2.0		LSB
	Offset Error (Absolute)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		1.5		LSB
	Conversion Time	Free Running Conversion	14		280	µs
	Clock Frequency		50		1000	kHz
V_{IN}	Input Voltage		GND		V_{REF}	V
	Input Bandwidth			38.5		kHz
A_{REF}	External Voltage Reference		2.0		V_{CC}	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
R_{REF}	Reference Input Resistance			32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Conversion Output		0		1023	LSB

Table 2-6. ADC Characteristics, Differential Channels (Unipolar Mode), TA = -40°C to +125°C

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Resolution	Gain = 1x			10	Bits
		Gain = 20x			10	Bits
	Absolute accuracy (Including INL, DNL, and Quantization, Gain and Offset Errors)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		10		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		15		LSB
	Integral Non-Linearity (INL) (Accuracy after Offset and Gain Calibration)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		10		LSB
	Gain Error	Gain = 1x		10		LSB
		Gain = 20x		15		LSB
	Offset Error	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		3		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4		LSB
	Conversion Time	Free Running Conversion	70		280	µs
	Clock Frequency		50		200	kHz
V_{IN}	Input Voltage		GND		V_{CC}	V
V_{DIFF}	Input Differential Voltage				V_{REF}/Gain	V
	Input Bandwidth			4		kHz
A_{REF}	External Reference Voltage		2.0		V_{CC} - 1.0	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
R_{REF}	Reference Input Resistance			32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Conversion Output		0		1023	LSB

Table 2-7. ADC Characteristics, Differential Channels (Bipolar Mode), TA = -40°C to +125°C

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Resolution	Gain = 1x			10	Bits
		Gain = 20x			10	Bits
	Absolute accuracy (Including INL, DNL, and Quantization, Gain and Offset Errors)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		8		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		8		LSB
	Integral Non-Linearity (INL) (Accuracy after Offset and Gain Calibration)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		5		LSB
	Gain Error	Gain = 1x		4		LSB
		Gain = 20x		5		LSB
	Offset Error	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		3		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4		LSB
	Conversion Time	Free Running Conversion	70		280	µs
	Clock Frequency		50		200	kHz
V_{IN}	Input Voltage		GND		V_{CC}	V
V_{DIFF}	Input Differential Voltage				V_{REF}/Gain	V
	Input Bandwidth			4		kHz
A_{REF}	External Reference Voltage		2.0		V_{CC} - 1.0	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
R_{REF}	Reference Input Resistance			32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Conversion Output		-512		511	LSB

2.8 Serial Programming Characteristics

2.8.1 ATtiny24A and ATtiny44A

Table 2-8. Serial Programming Characteristics, TA = -40°C to +125°C, VCC = 1.8 - 5.5V (Unless Otherwise Noted)

Symbol	Parameter	Min	Typ	Max	Units
$1/t_{CLCL}$	Oscillator Frequency	0		4	MHz
t_{CLCL}	Oscillator Period	250			ns
$1/t_{CLCL}$	Oscillator Frequency (V_{CC} = 4.5V - 5.5V)	0		20	MHz
t_{CLCL}	Oscillator Period (V_{CC} = 4.5V - 5.5V)	50			ns
t_{SHSL}	SCK Pulse Width High	2 t_{CLCL} [(1)]			ns
t_{SLSH}	SCK Pulse Width Low	2 t_{CLCL} [(1)]			ns
t_{OVSH}	MOSI Setup to SCK High	t_{CLCL}			ns
t_{SHOX}	MOSI Hold after SCK High	2 t_{CLCL}			ns

Note: 1. 2 t_{CLCL} for f_{ck} < 12 MHz, 3 t_{CLCL} for f_{ck} >= 12 MHz

2.8.2 ATtiny84A

Table 2-9. Serial Programming Characteristics, TA = -40°C to +125°C, VCC = 1.8 - 5.5V (Unless Otherwise Noted)

Symbol	Parameter	Min	Typ	Max	Units
$1/t_{CLCL}$	Oscillator Frequency	0		4	MHz
t_{CLCL}	Oscillator Period	250			ns
$1/t_{CLCL}$	Oscillator Frequency (V_{CC} = 4.5V - 5.5V)	0		16	MHz
t_{CLCL}	Oscillator Period (V_{CC} = 4.5V - 5.5V)	62.5			ns
t_{SHSL}	SCK Pulse Width High	2 t_{CLCL} [(1)]			ns
t_{SLSH}	SCK Pulse Width Low	2 t_{CLCL} [(1)]			ns
t_{OVSH}	MOSI Setup to SCK High	t_{CLCL}			ns
t_{SHOX}	MOSI Hold after SCK High	2 t_{CLCL}			ns

Note: 1. 2 t_{CLCL} for f_{ck} < 12 MHz, 3 t_{CLCL} for f_{ck} >= 12 MHz

3. Typical Characteristics

3.1 ATtiny24A

3.1.1 Current Consumption in Active Mode

Figure 3-1. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

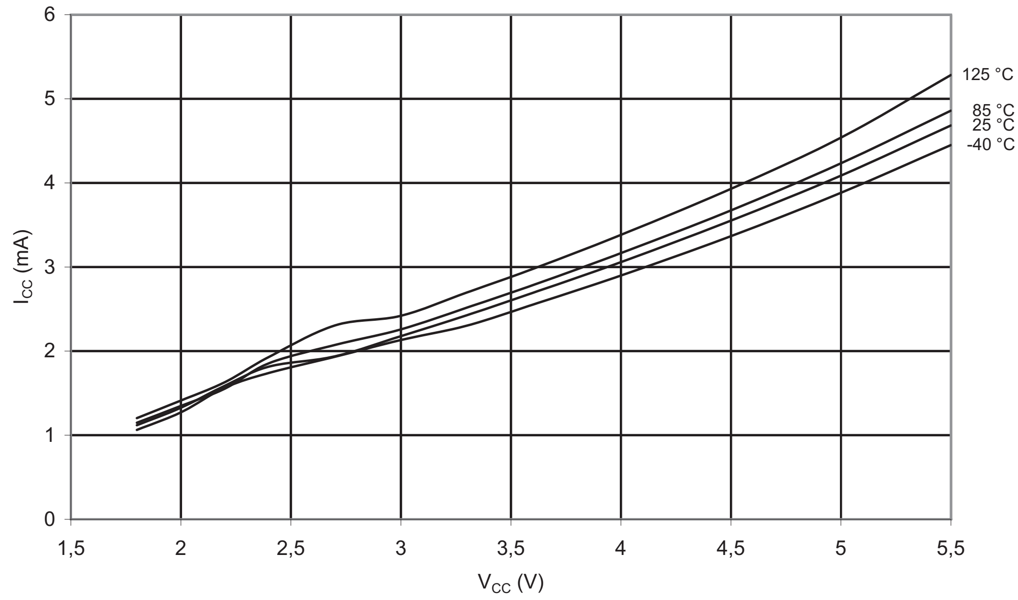


Figure 3-2. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

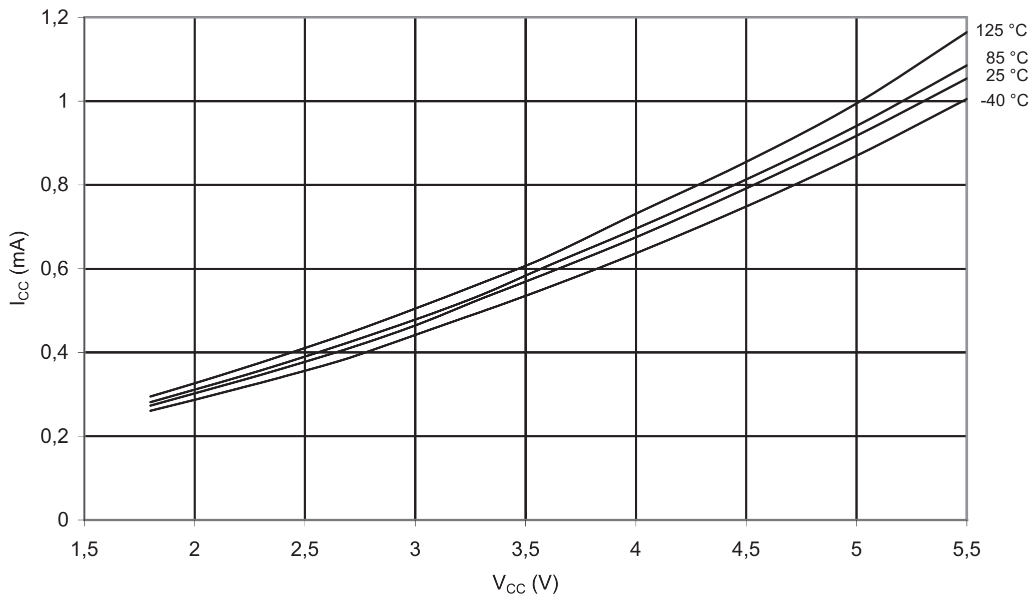
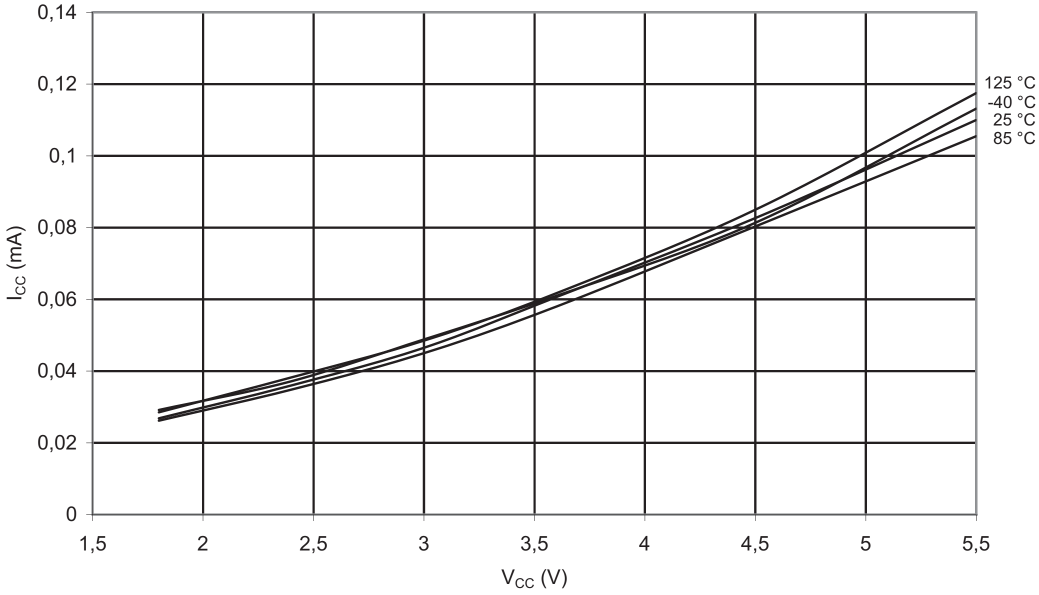


Figure 3-3. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.1.2 Current Consumption in Idle Mode

Figure 3-4. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

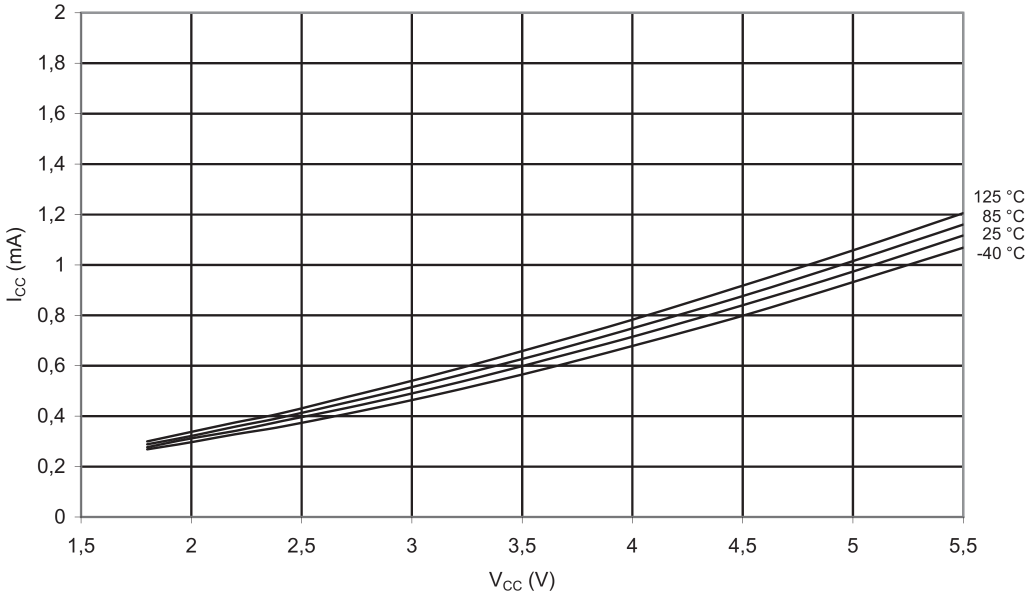


Figure 3-5. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

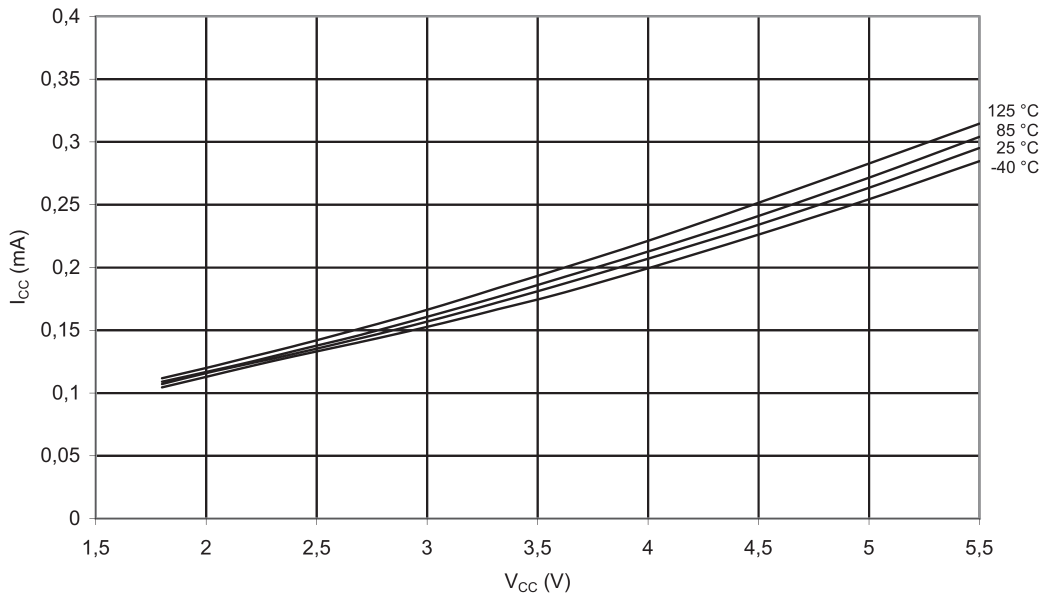
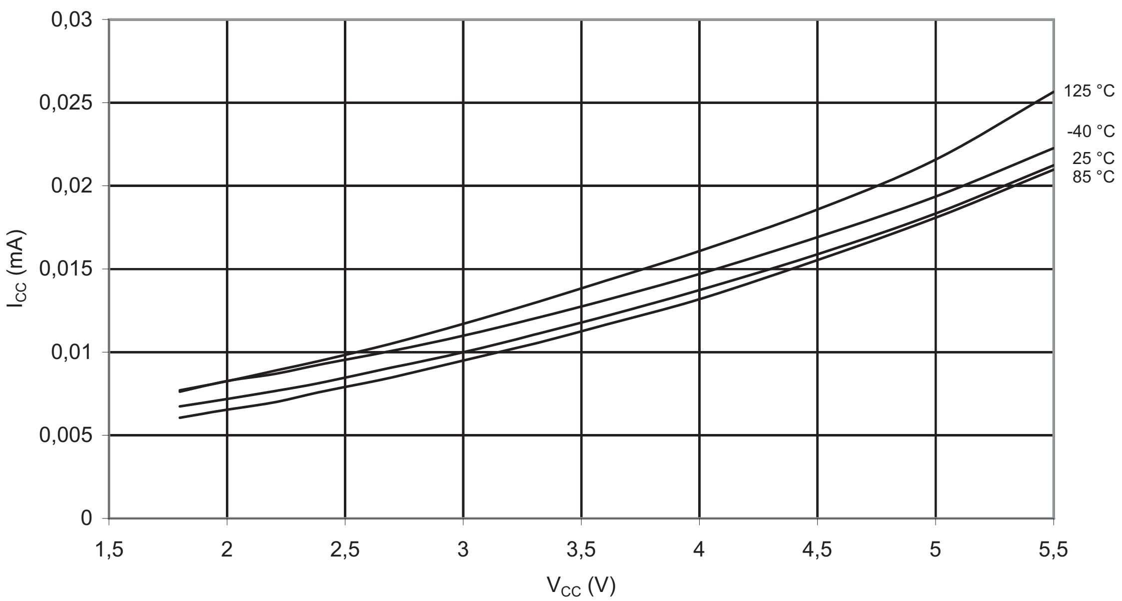


Figure 3-6. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.1.3 Current Consumption in Power-down Mode

Figure 3-7. Power-down Supply Current vs. V_{CC} (Watchdog Timer Disabled)

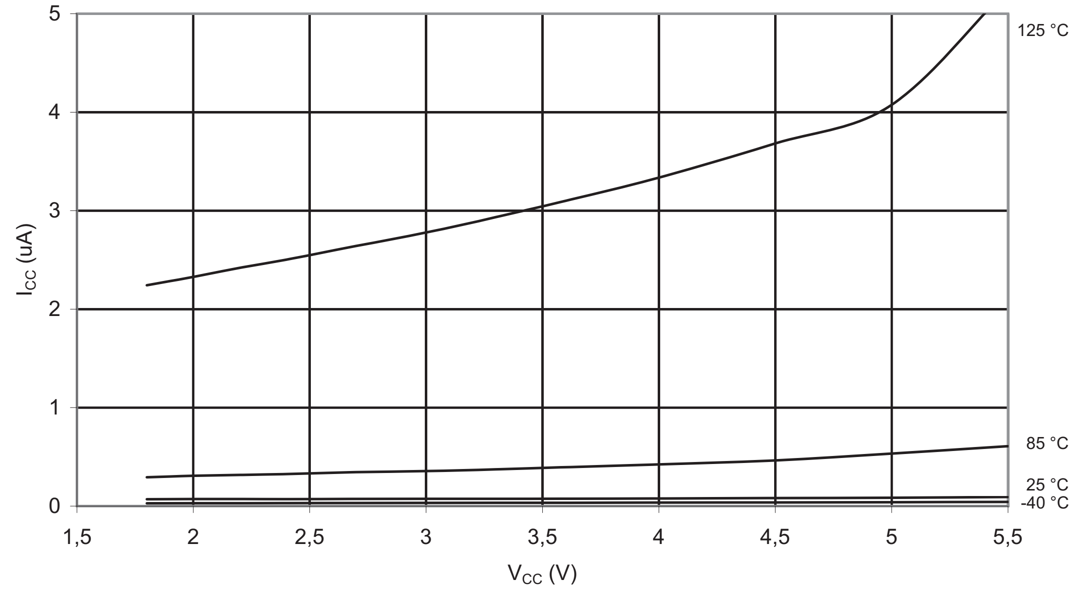
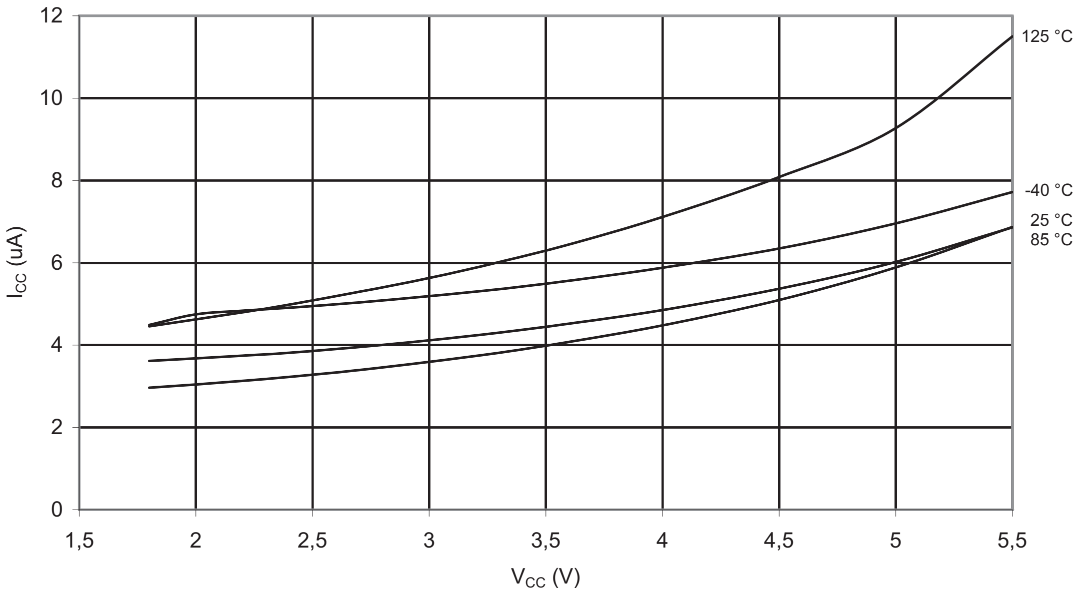


Figure 3-8. Power-down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



3.1.4 Current Consumption of Peripheral Units

Figure 3-9. Programming Current vs. V_{CC}

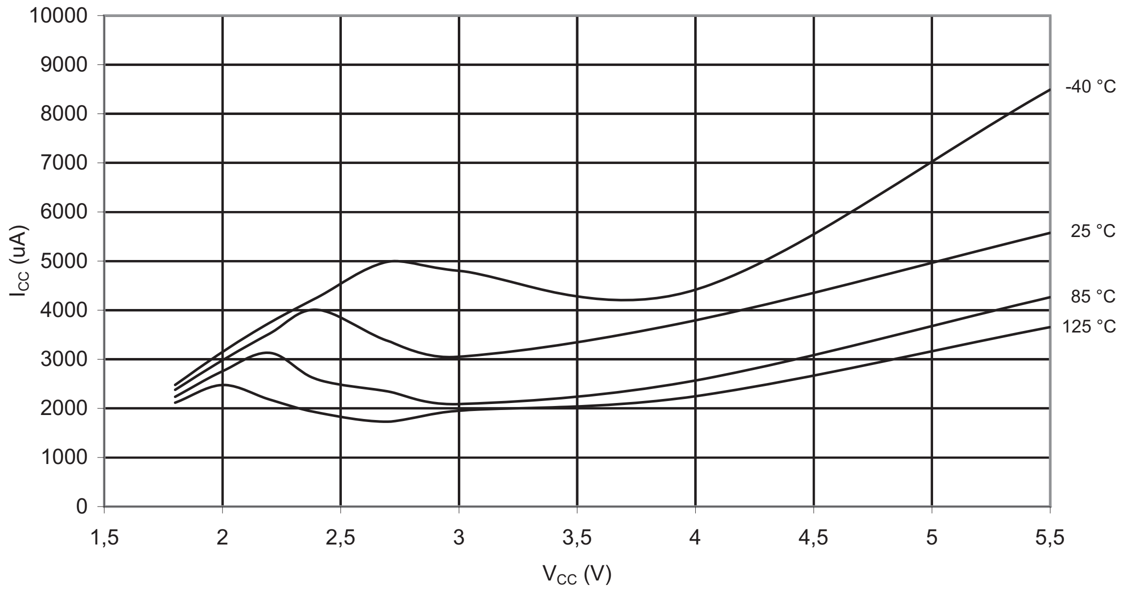


Figure 3-10. Brownout Detector Current vs. V_{CC} (BOD Level = 1.8V)

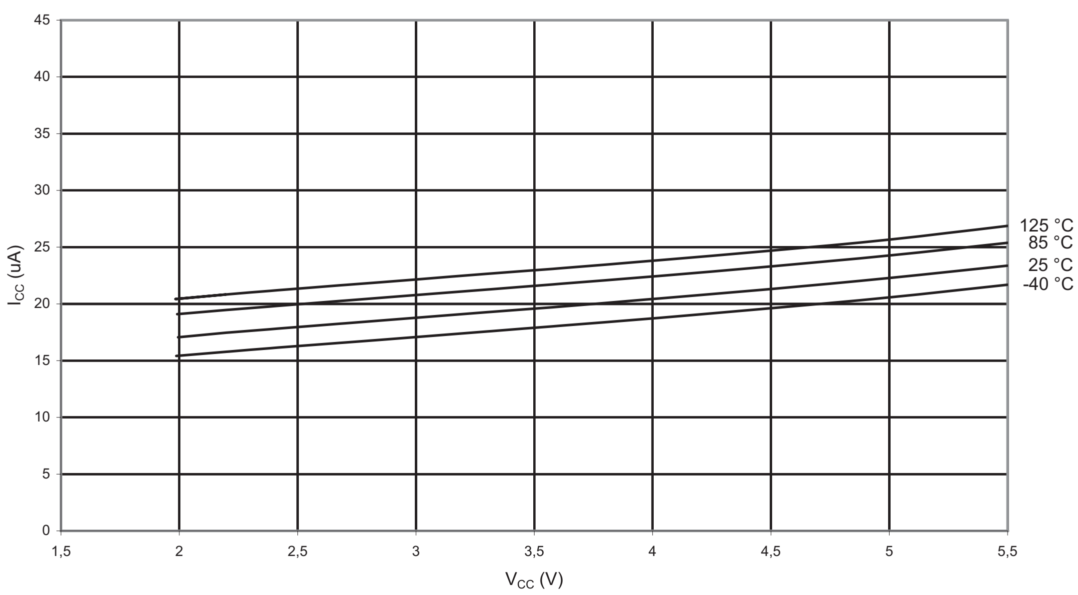
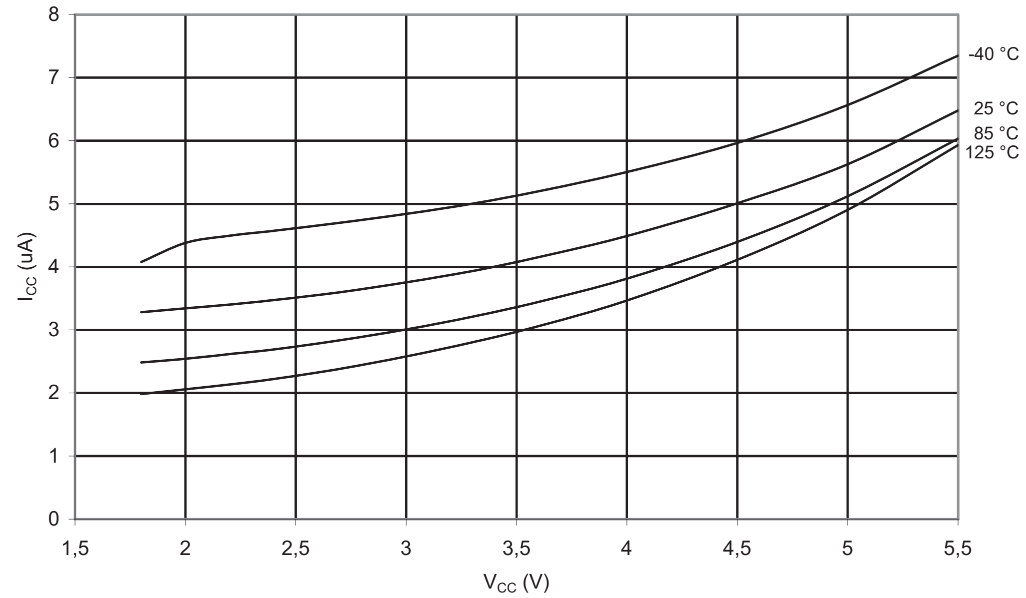


Figure 3-11. Watchdog Timer Current vs. V_{CC}



3.1.5 Pull-up Resistors

Figure 3-12. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 1.8V)

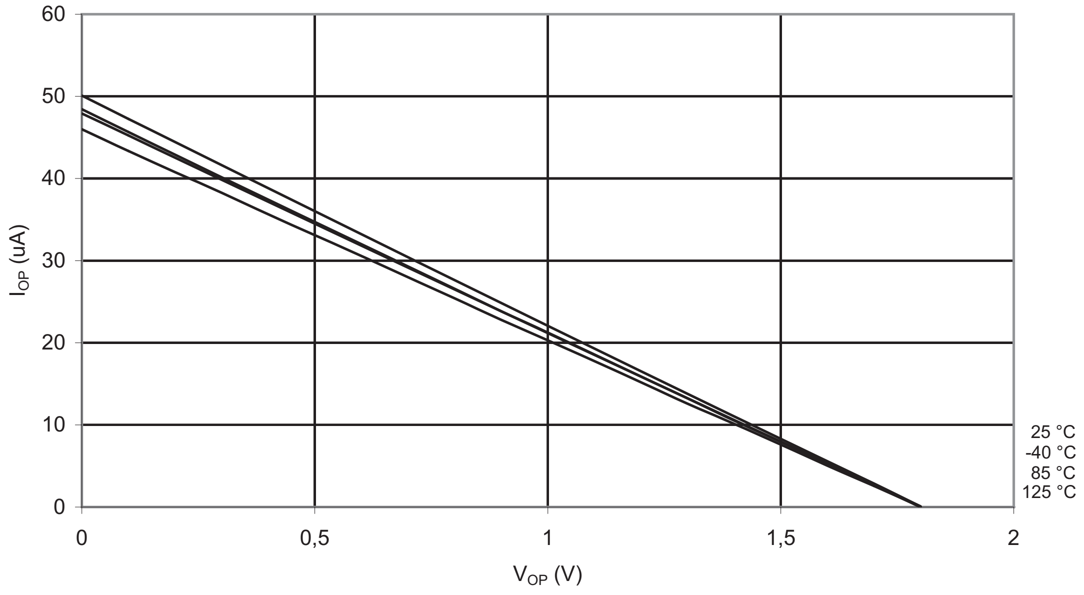


Figure 3-13. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 2.7V)

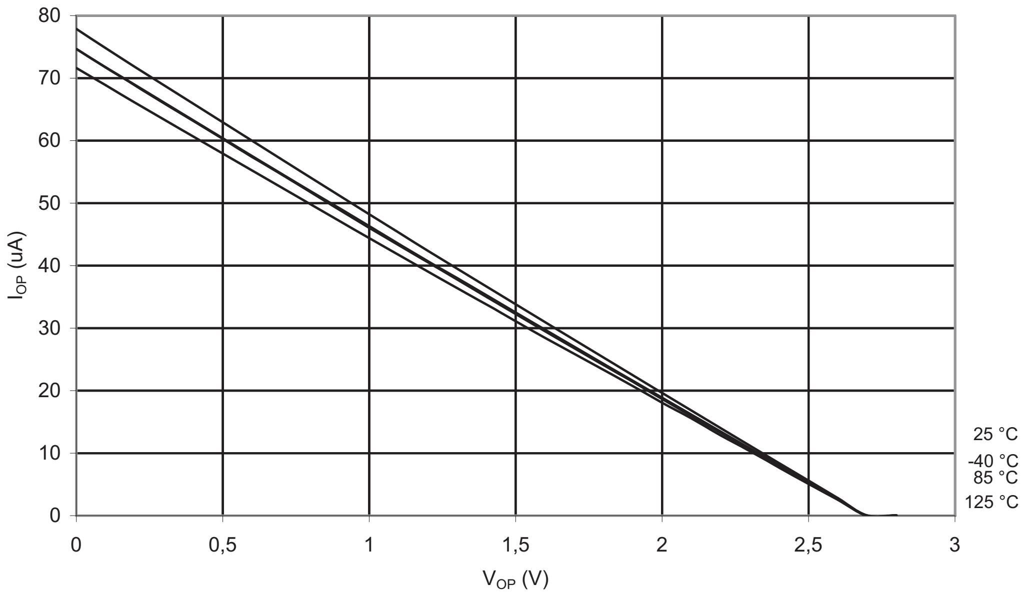


Figure 3-14. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 5V)

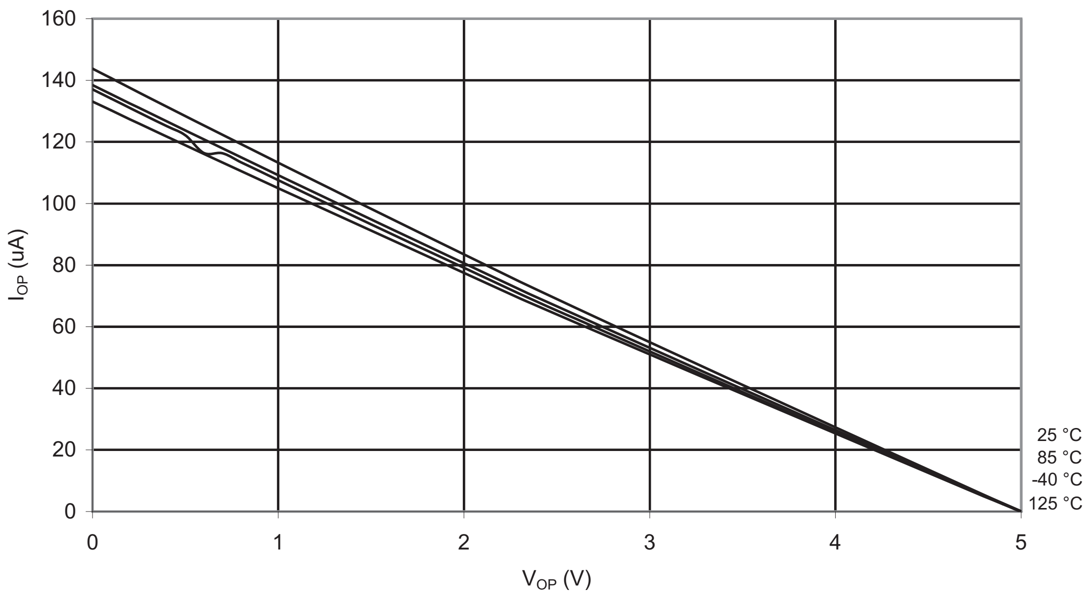


Figure 3-15. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 1.8V)

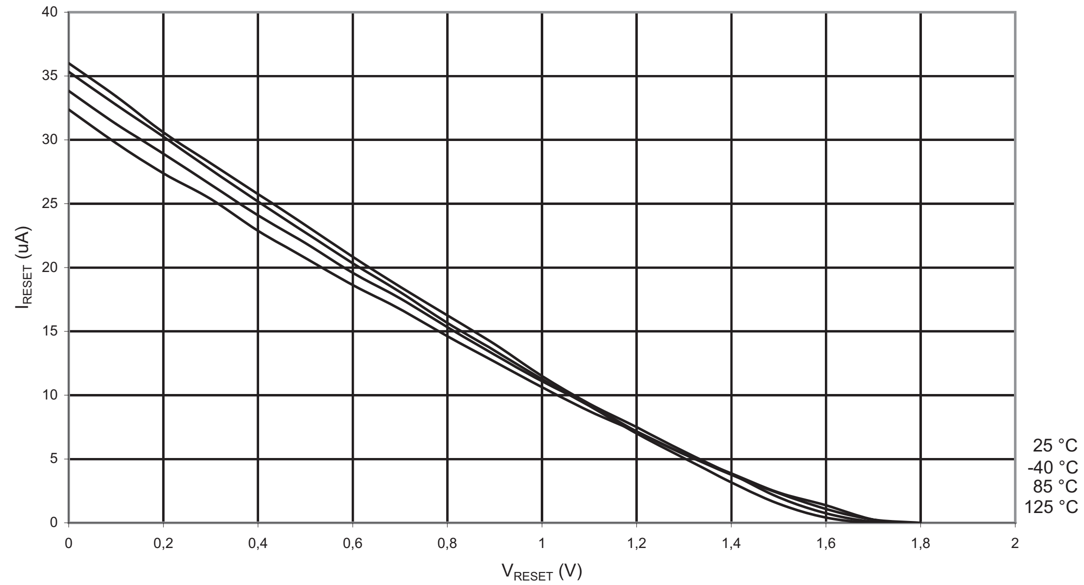


Figure 3-16. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 2.7V)

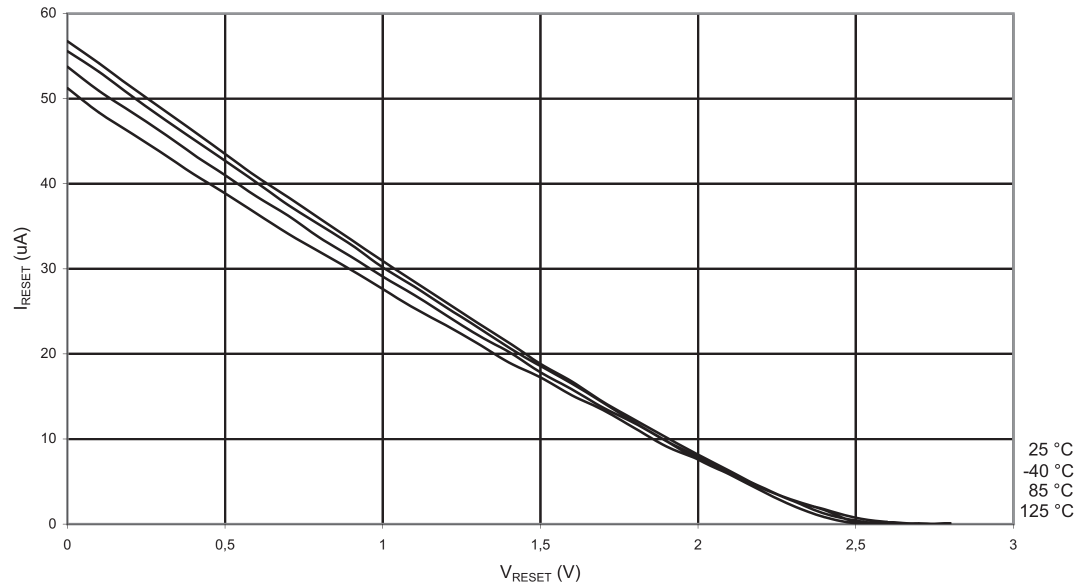
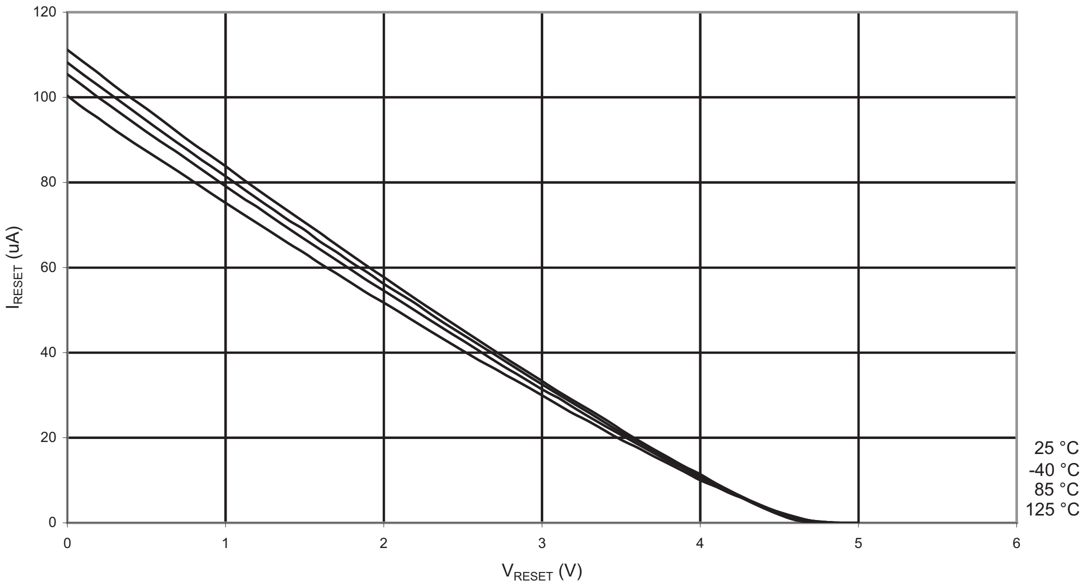


Figure 3-17. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



3.1.6 Output Driver Strength

Figure 3-18. V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 1.8V)

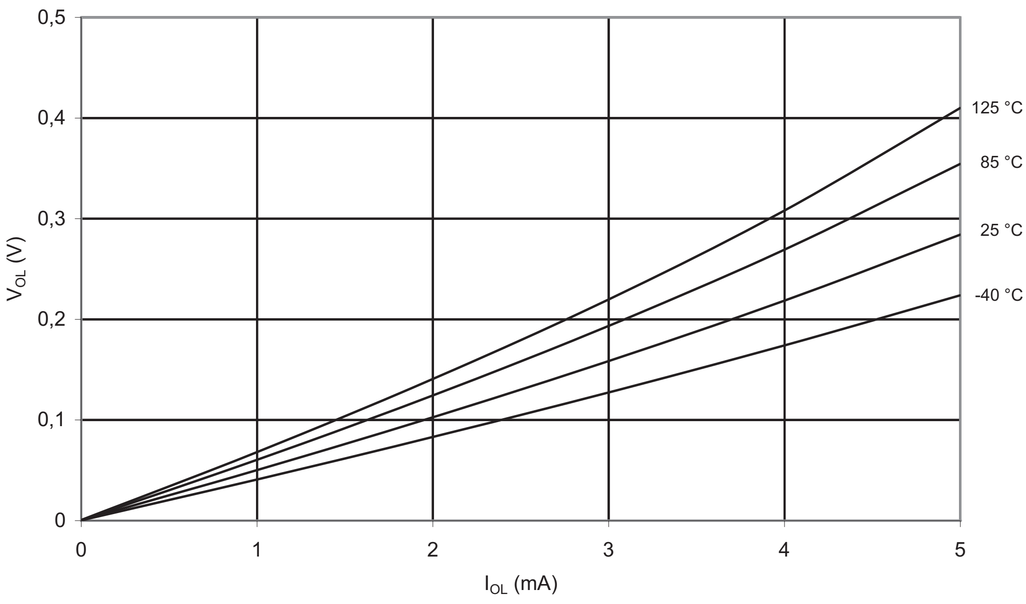


Figure 3-19. V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 3V)

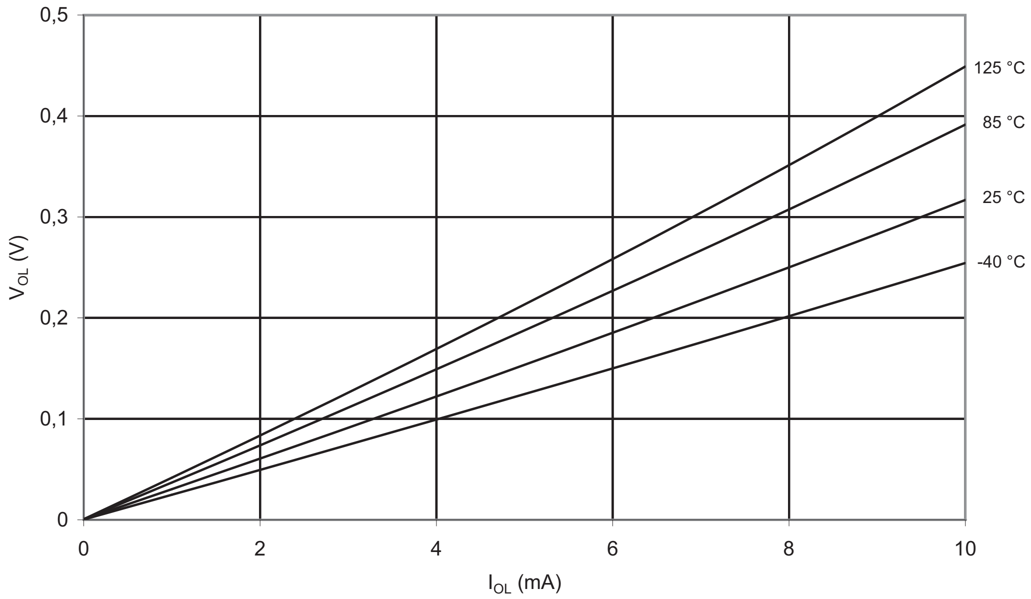


Figure 3-20. V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 5V)

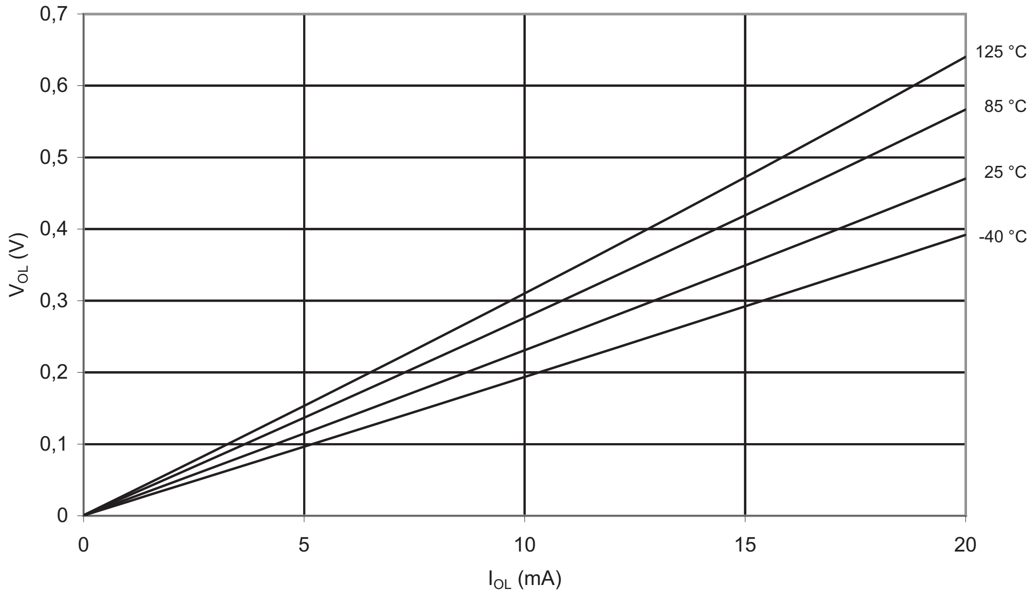


Figure 3-21. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 1.8V)

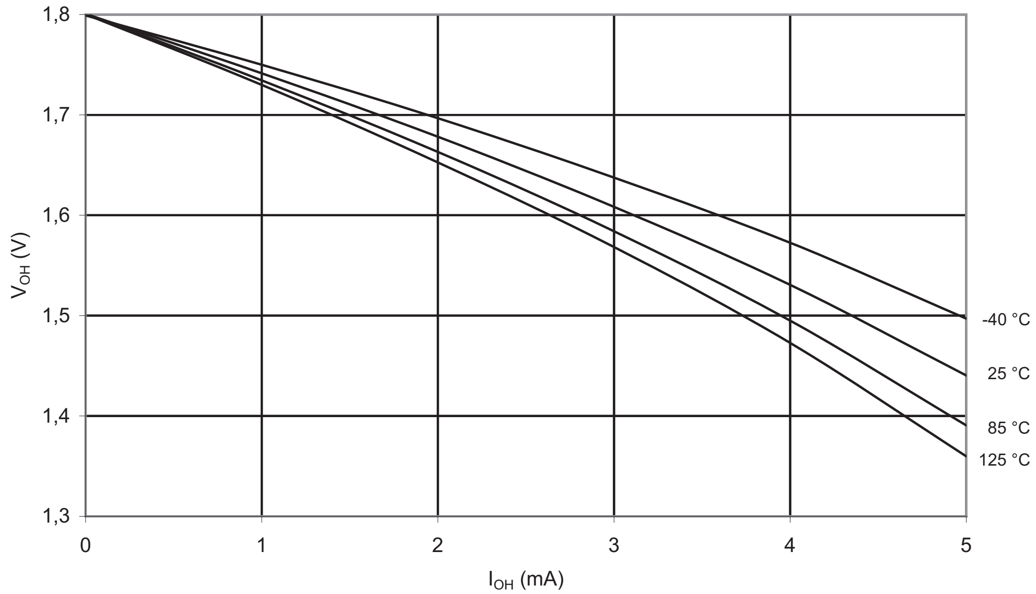


Figure 3-22. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 3V)

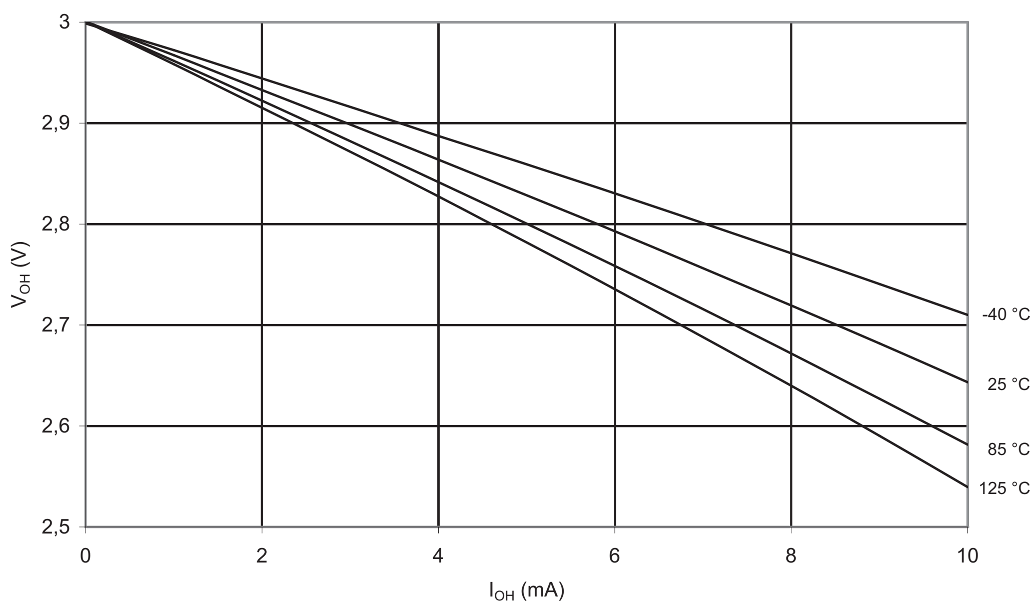


Figure 3-23. V_{OH}**: Output Voltage vs. Source Current (I/O Pin,** V_{CC} **= 5V)**

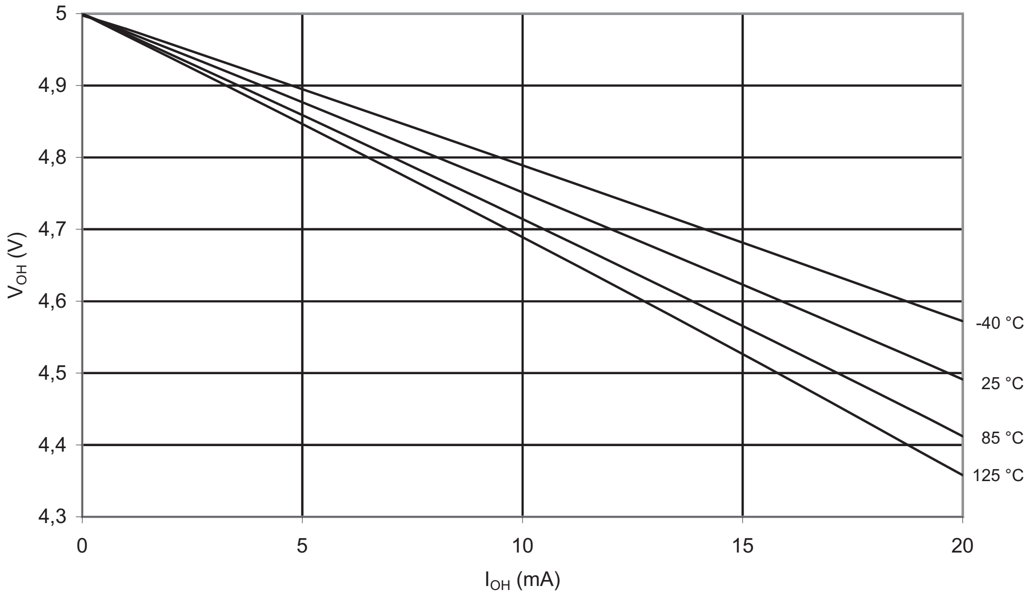


Figure 3-24. V_{OL}**: Output Voltage vs. Sink Current (Reset Pin as I/O,** V_{CC} **= 3V)**

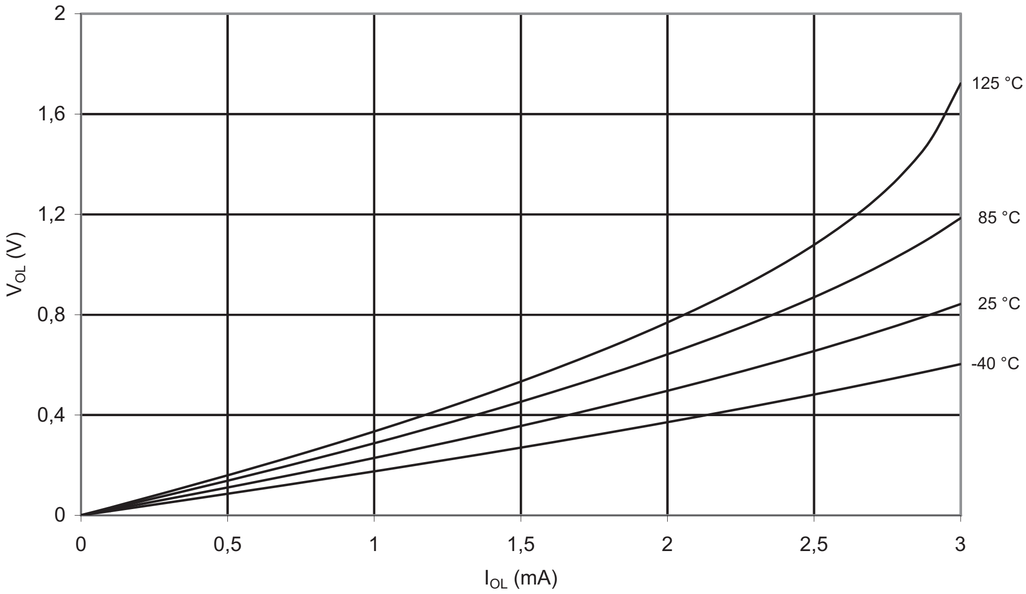


Figure 3-25. V_{OL}: Output Voltage vs. Sink Current (Reset Pin as I/O, V_{CC} = 5V)

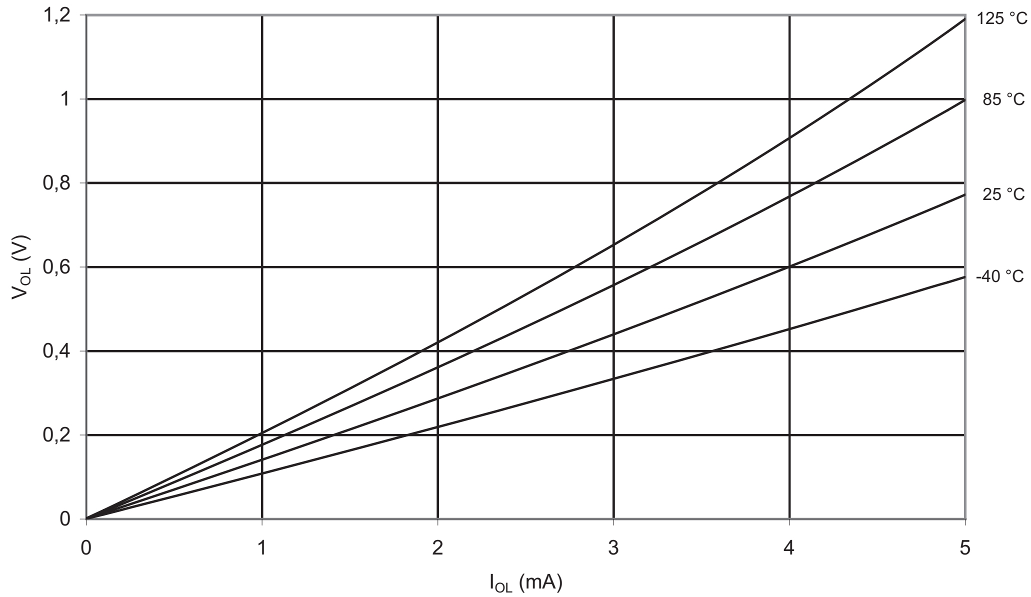


Figure 3-26. V_{OH}: Output Voltage vs. Source Current (Reset Pin as I/O, V_{CC} = 3V)

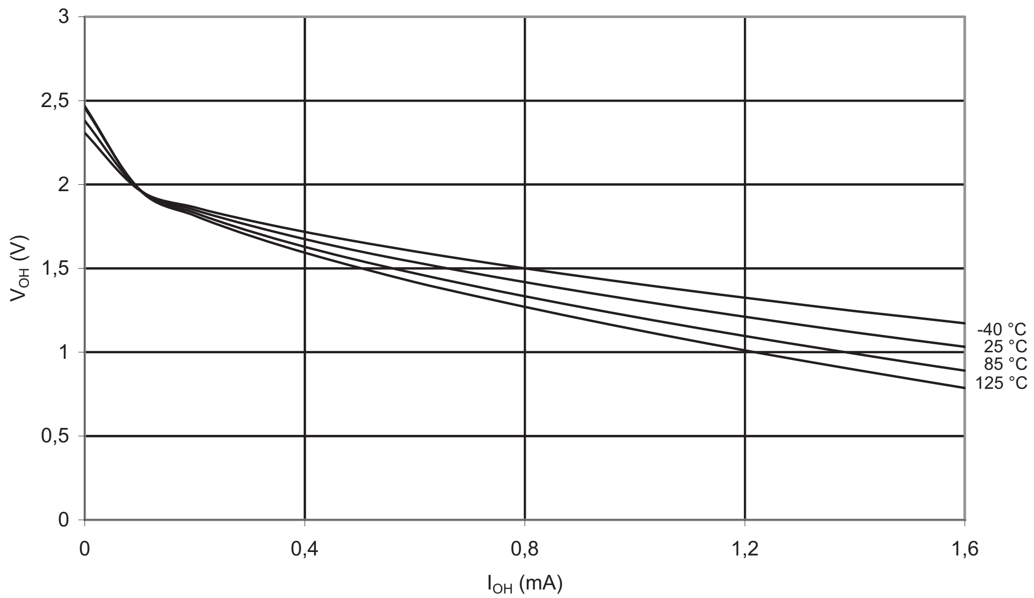
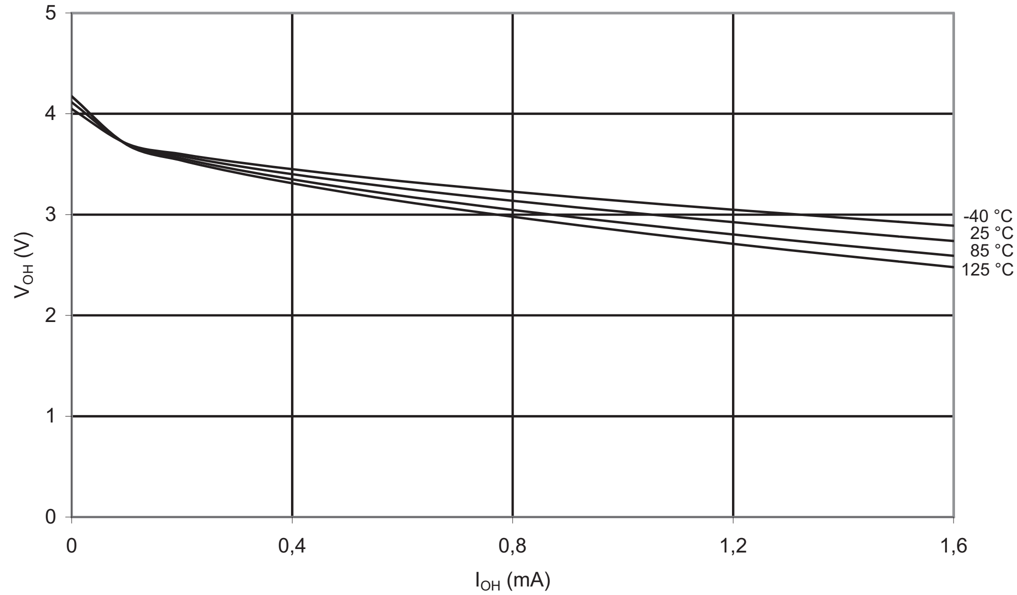


Figure 3-27. V_{OH}**: Output Voltage vs. Source Current (Reset Pin as I/O,** V_{CC} **= 5V)**



3.1.7 Input Threshold and Hysteresis (for I/O Ports)

Figure 3-28. V_{IH}**: Input Threshold Voltage vs.** V_{CC} **(IO Pin, Read as '1')**

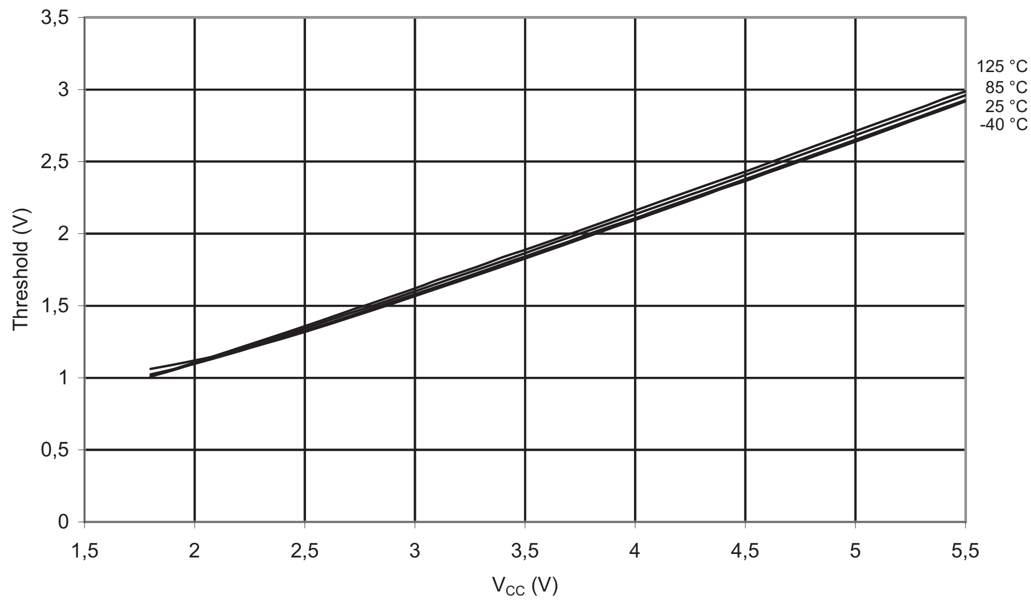


Figure 3-29. V_{IL}**: Input Threshold Voltage vs.** V_{CC} **(I/O Pin, Read as '0')**

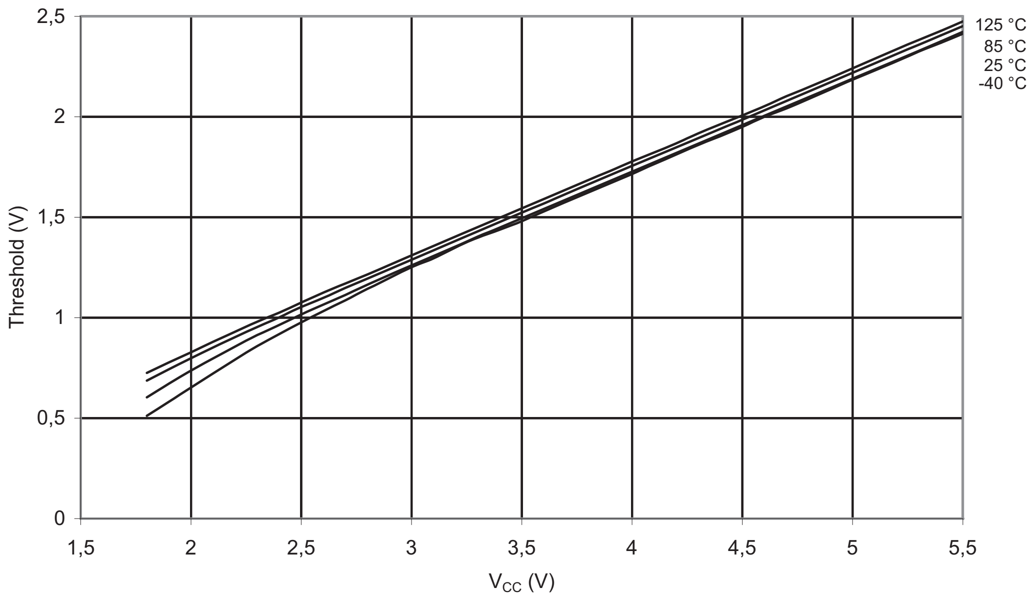


Figure 3-30. V_{IH}-V_{IL}**: Input Hysteresis vs.** V_{CC} **(I/O Pin)**

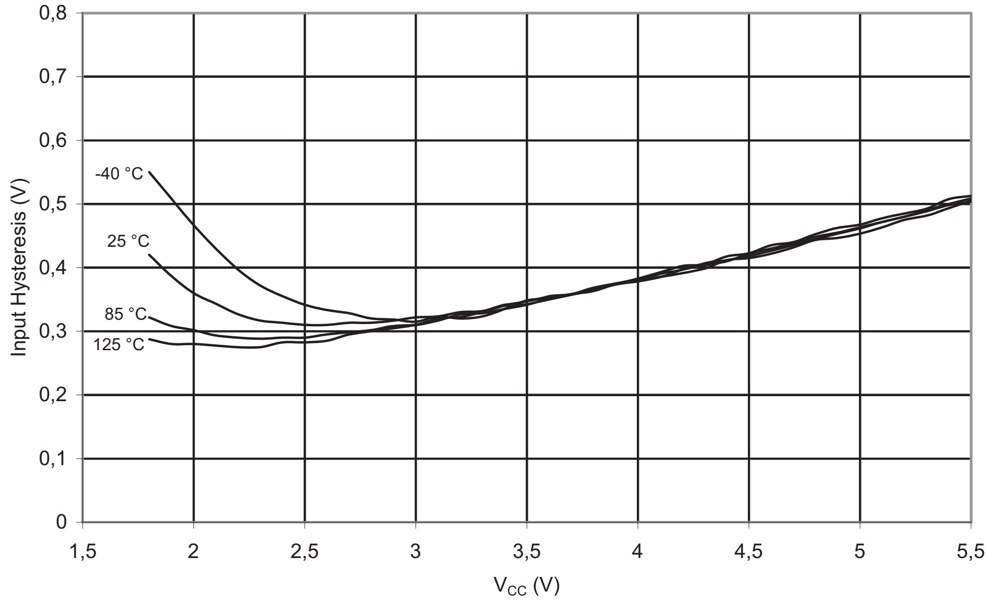


Figure 3-31. V_{IH}: **Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '1')**

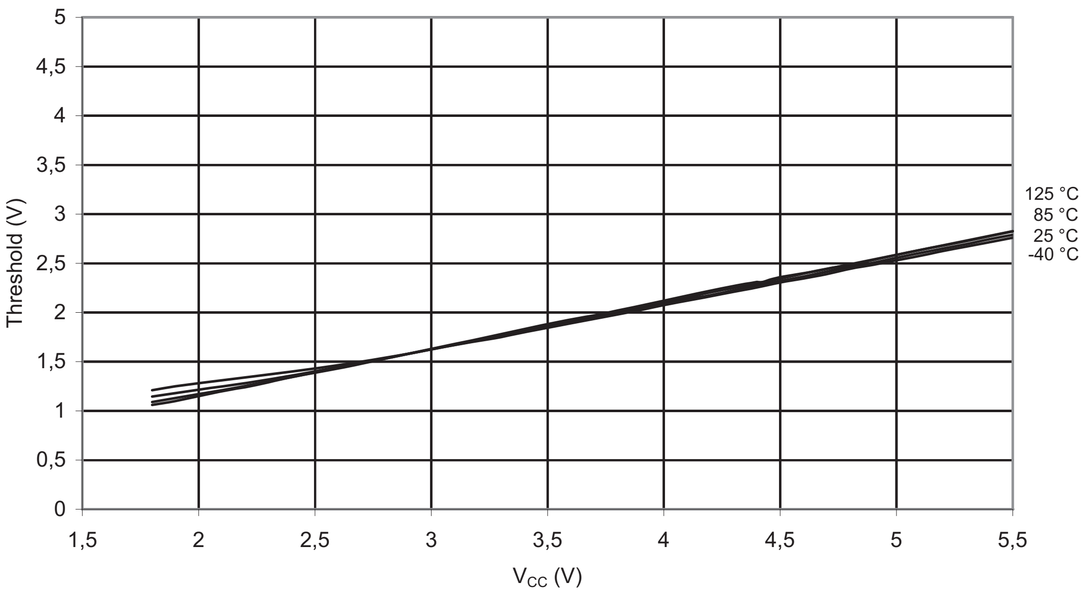


Figure 3-32. V_{IL}: **Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '0')**

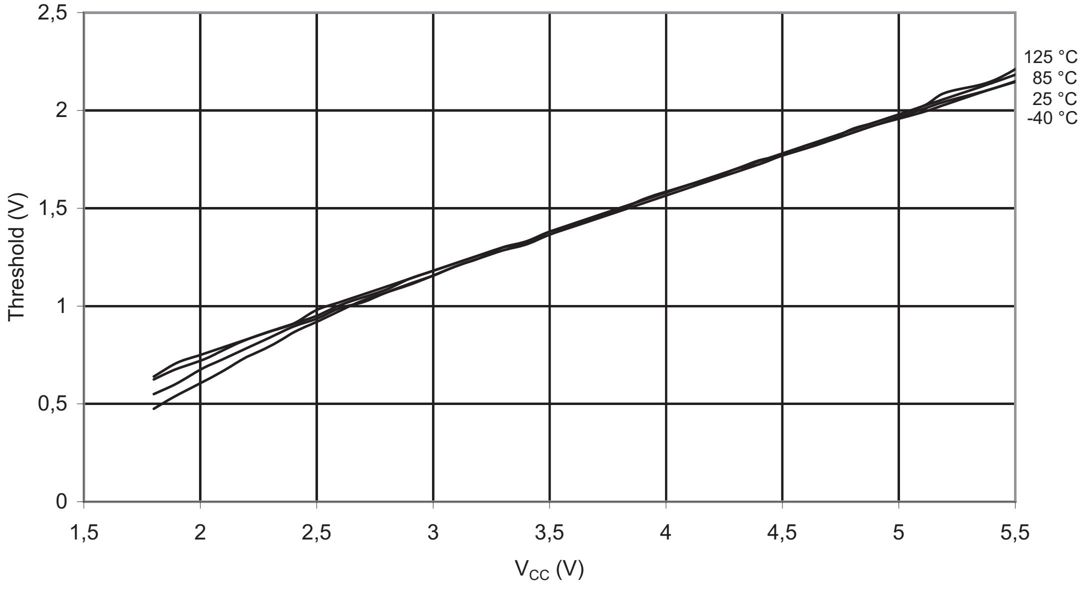
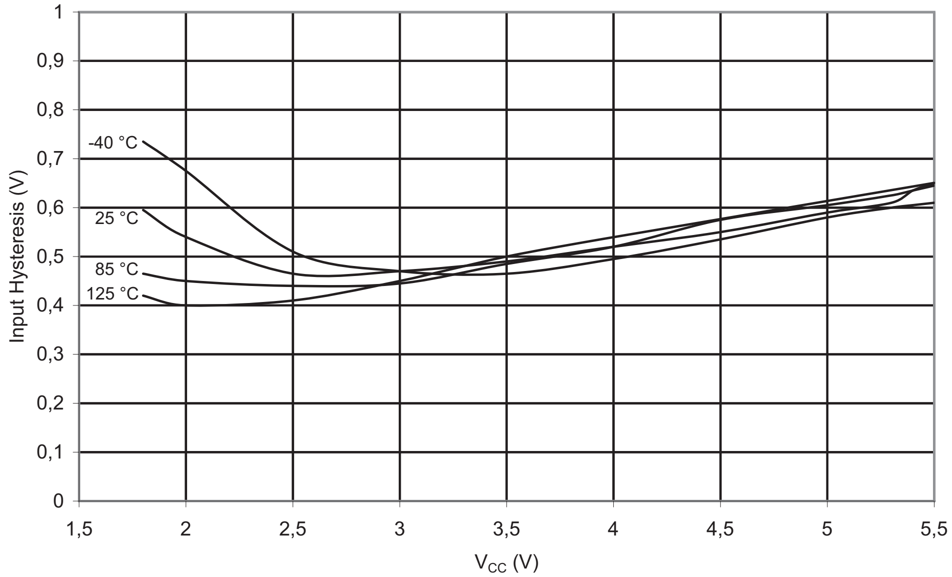


Figure 3-33. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin as I/O)



3.1.8 BOD, Bandgap and Reset

Figure 3-34. BOD Threshold vs. Temperature (BODLEVEL is 4.3V)

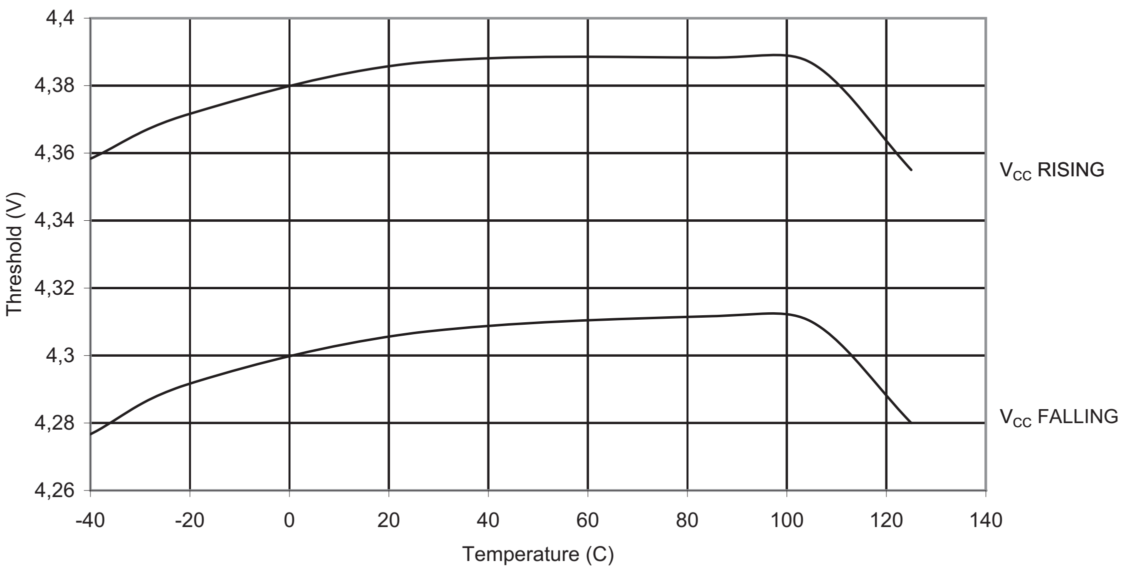


Figure 3-35. BOD Threshold vs. Temperature (BODLEVEL is 2.7V)

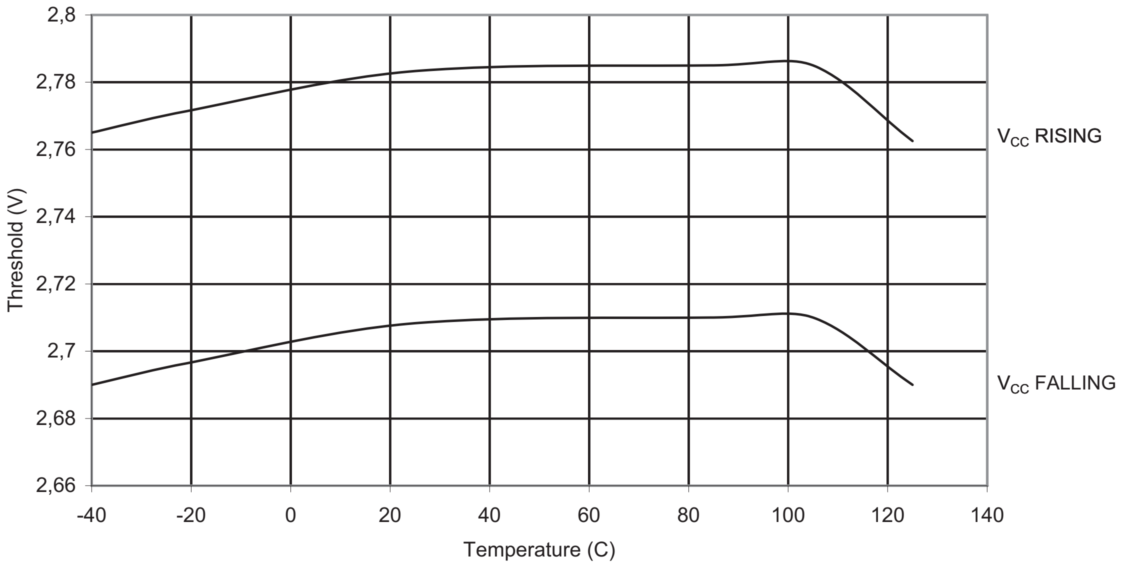


Figure 3-36. BOD Threshold vs. Temperature (BODLEVEL is 1.8V)

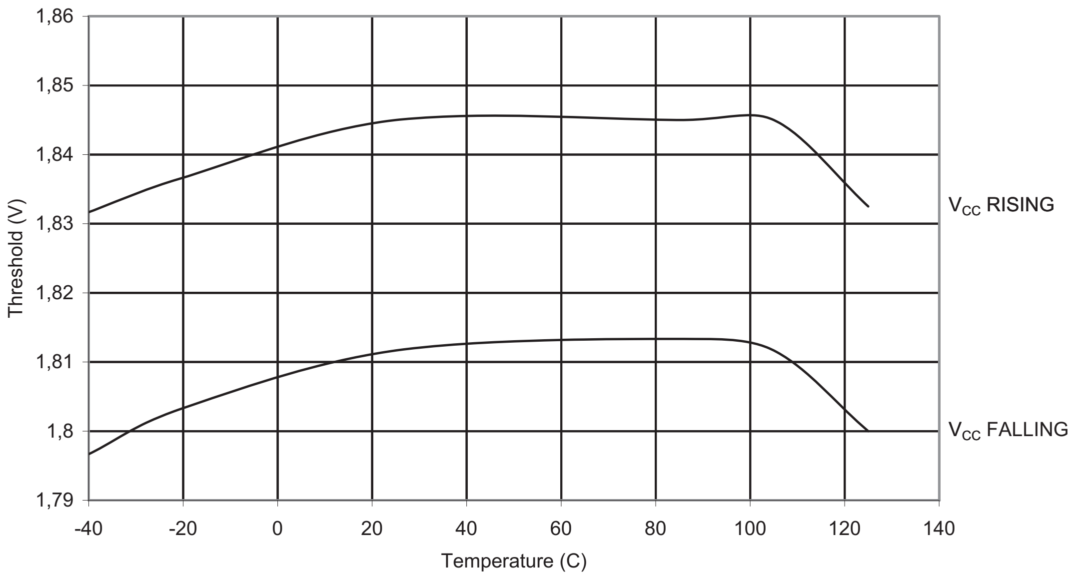


Figure 3-37. **Bandgap Voltage vs. Temperature (V_{CC} = 5V)**

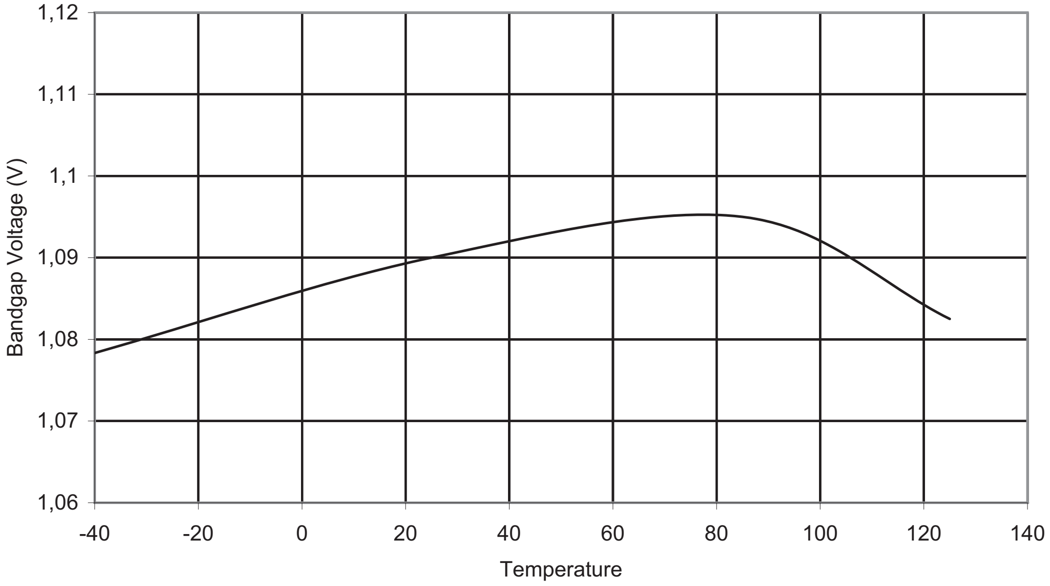


Figure 3-38. **V_{IH}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '1')**

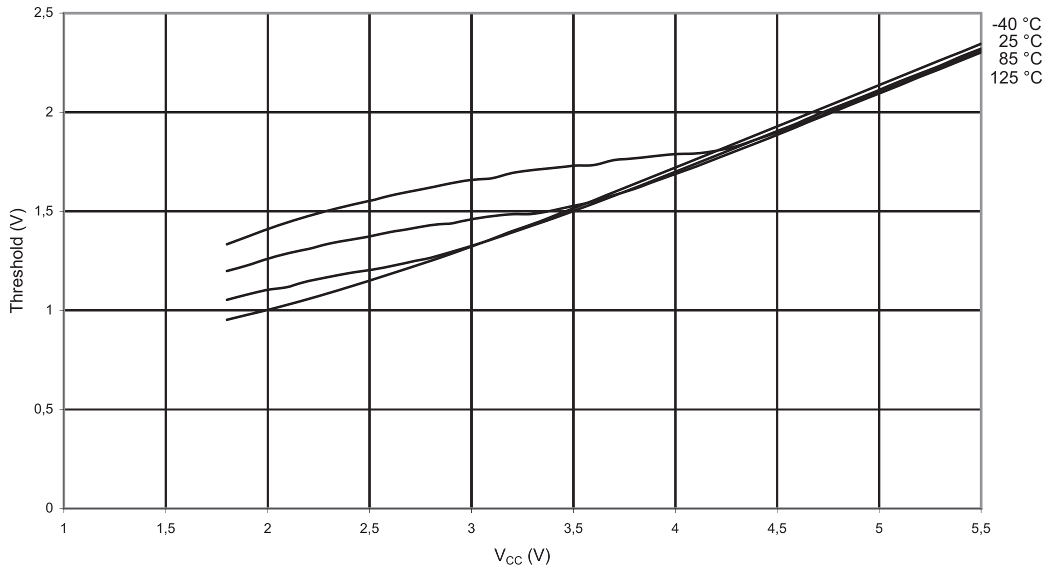


Figure 3-39. V_{IL}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '0')

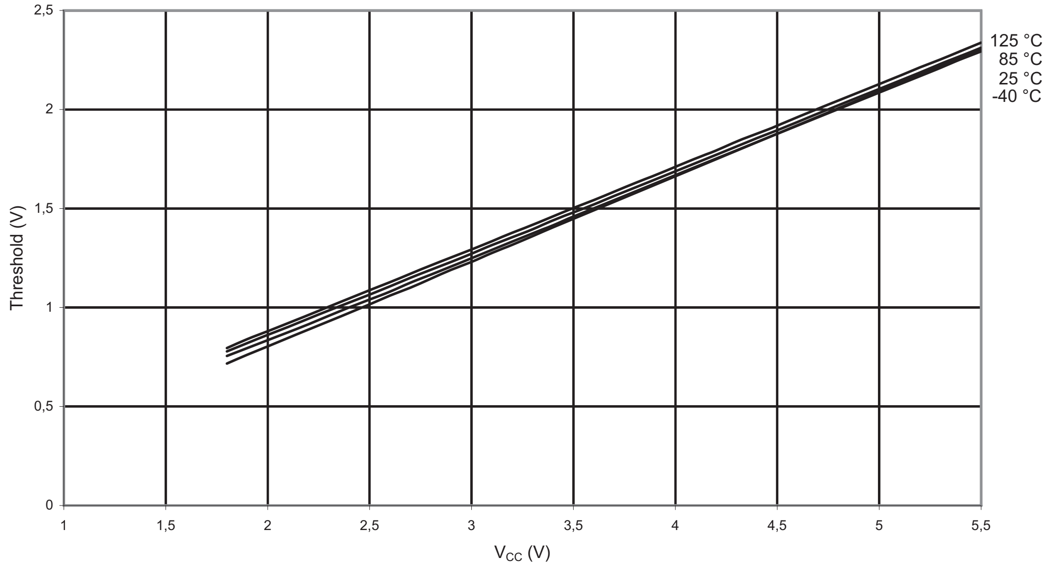


Figure 3-40. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin)

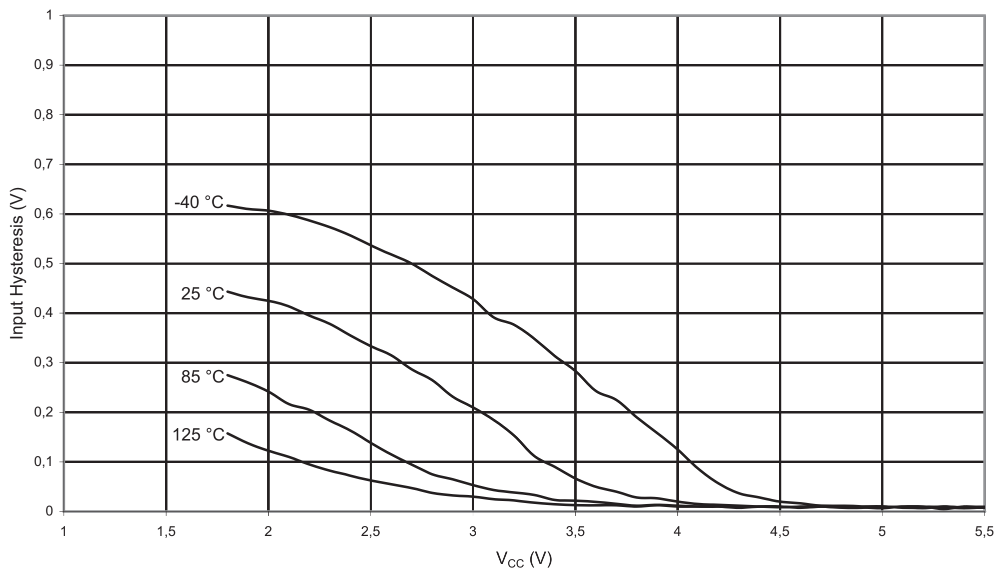
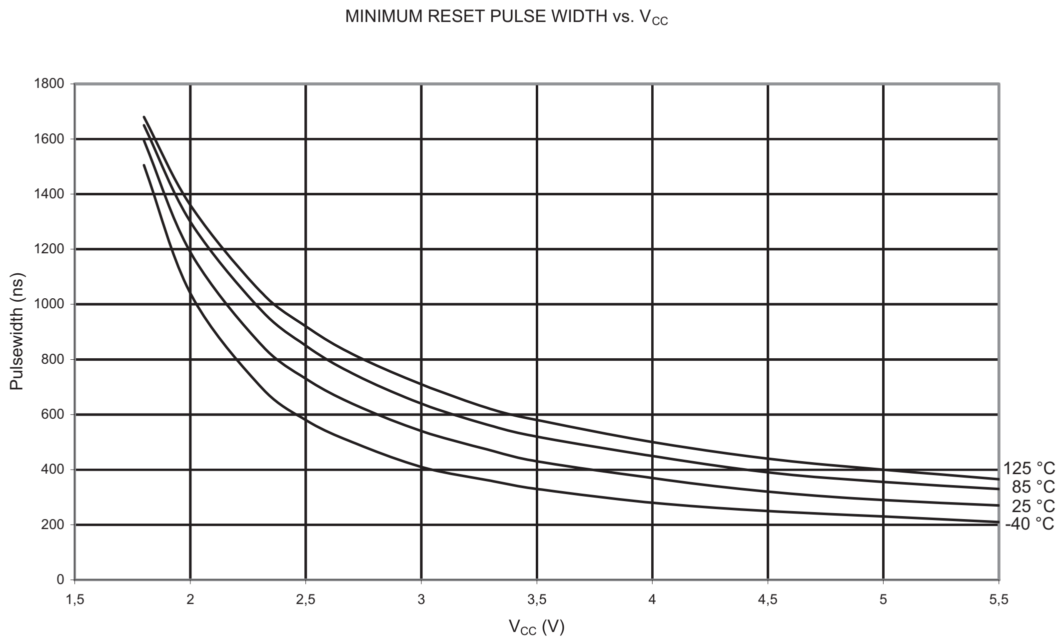
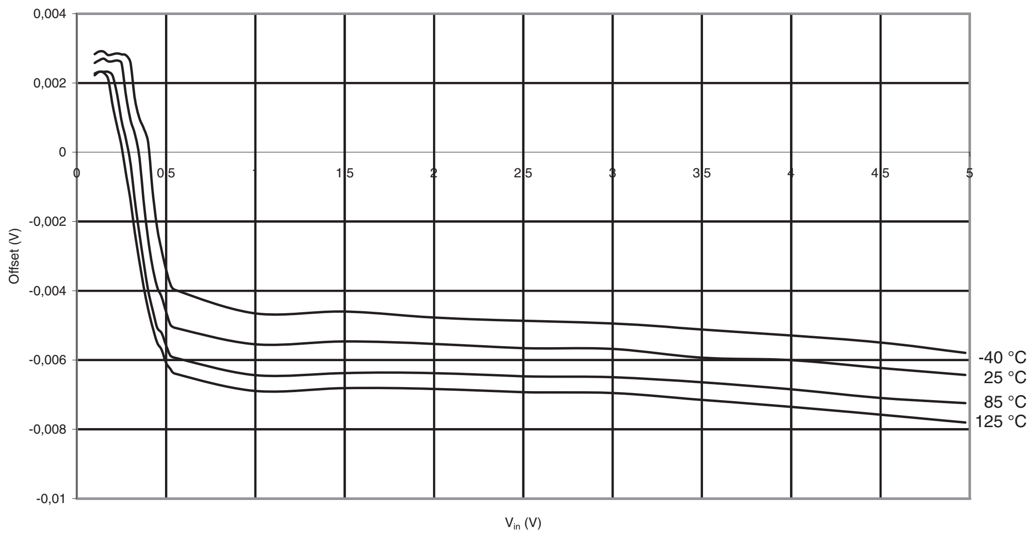


Figure 3-41. Minimum Reset Pulse Width vs. V_{CC}



3.1.9 Analog Comparator Offset

Figure 3-42. Analog Comparator Offset (V_{CC} = 5V)



3.1.10 Internal Oscillator Speed

Figure 3-43. Watchdog Oscillator Frequency vs. V_{CC}

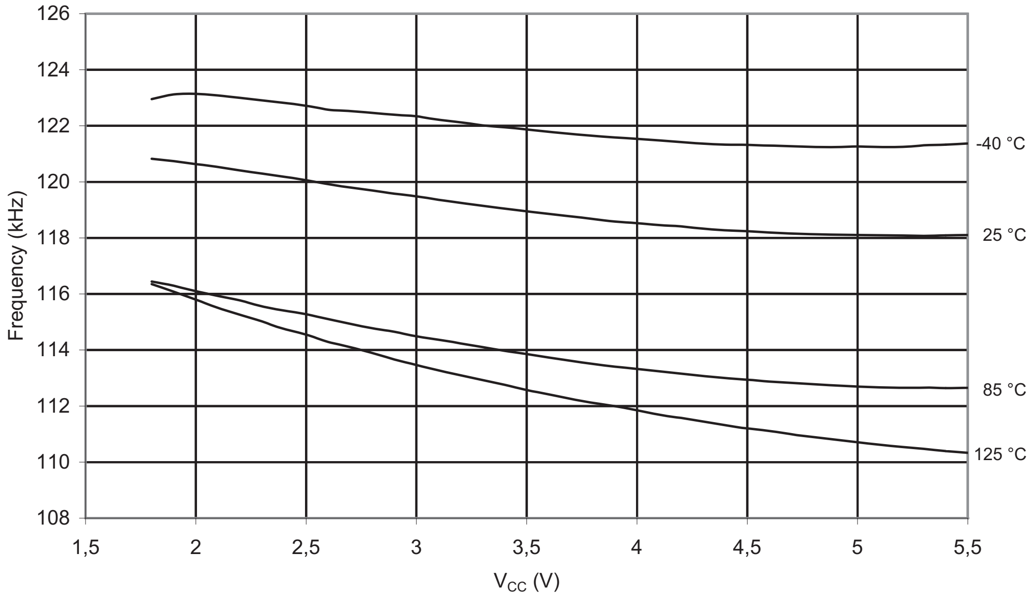


Figure 3-44. Watchdog Oscillator Frequency vs. Temperature

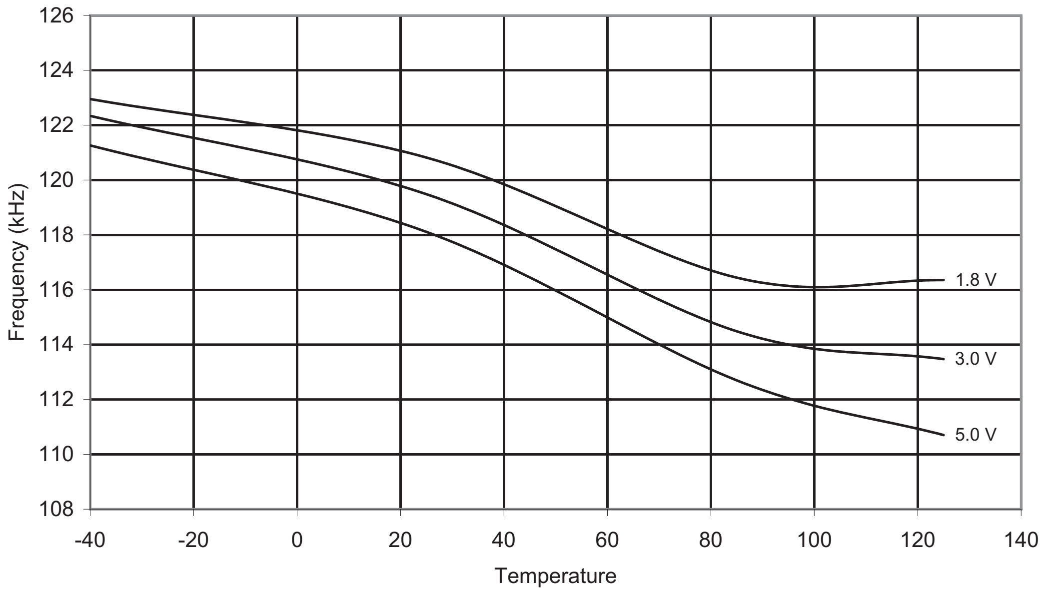


Figure 3-45. Calibrated 8 MHz RC Oscillator Frequency vs. Temperature

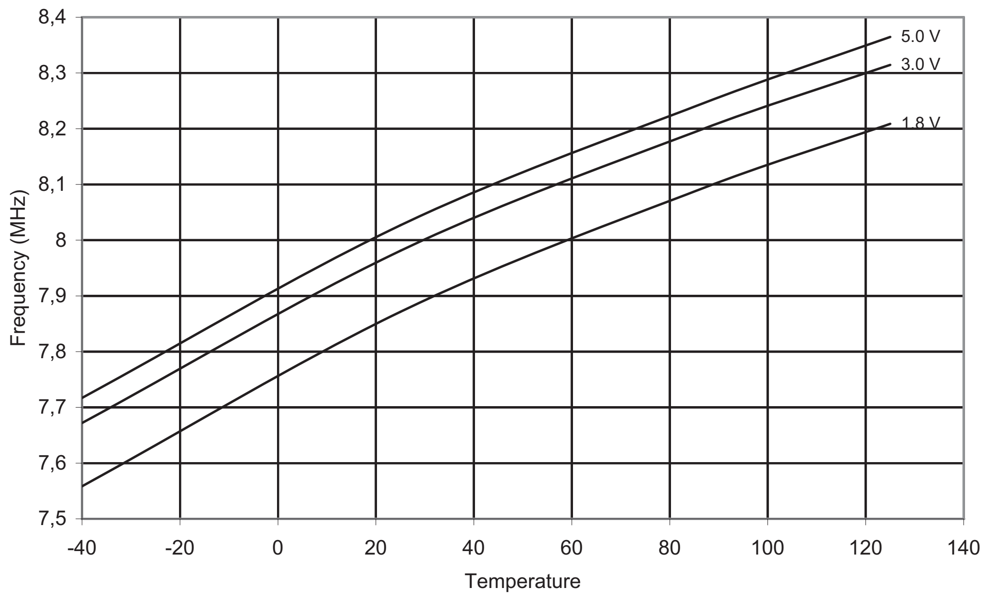
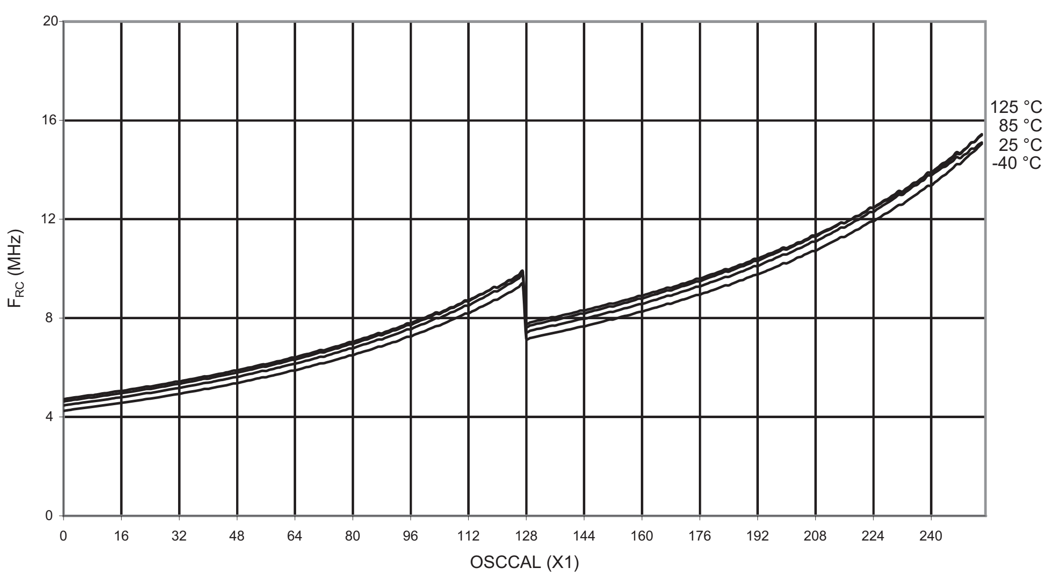


Figure 3-46. Calibrated 8 MHz RC Oscillator Frequency vs. OSCCAL Value (V_{CC} = 3V)



3.2 ATtiny44A

3.2.1 Current Consumption in Active Mode

Figure 3-47. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

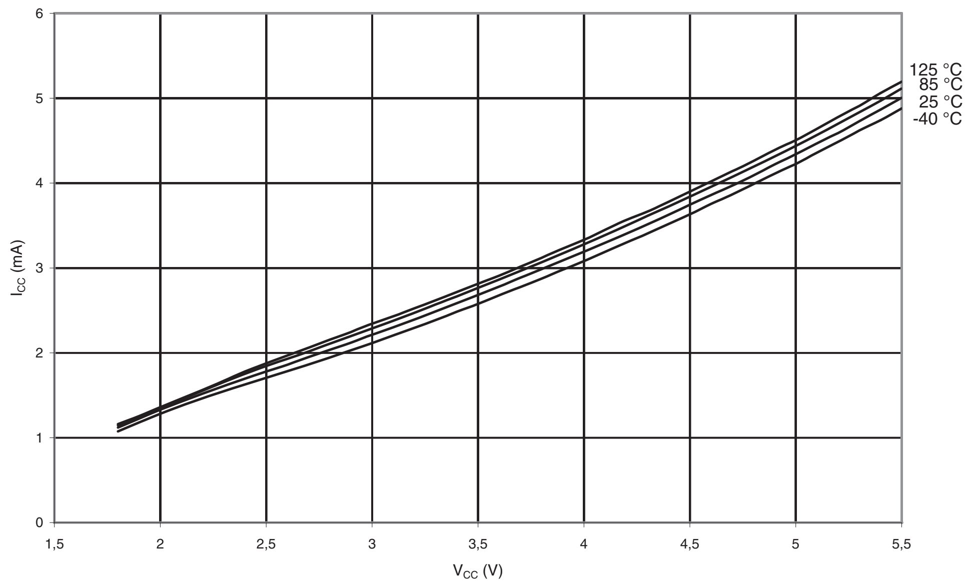


Figure 3-48. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

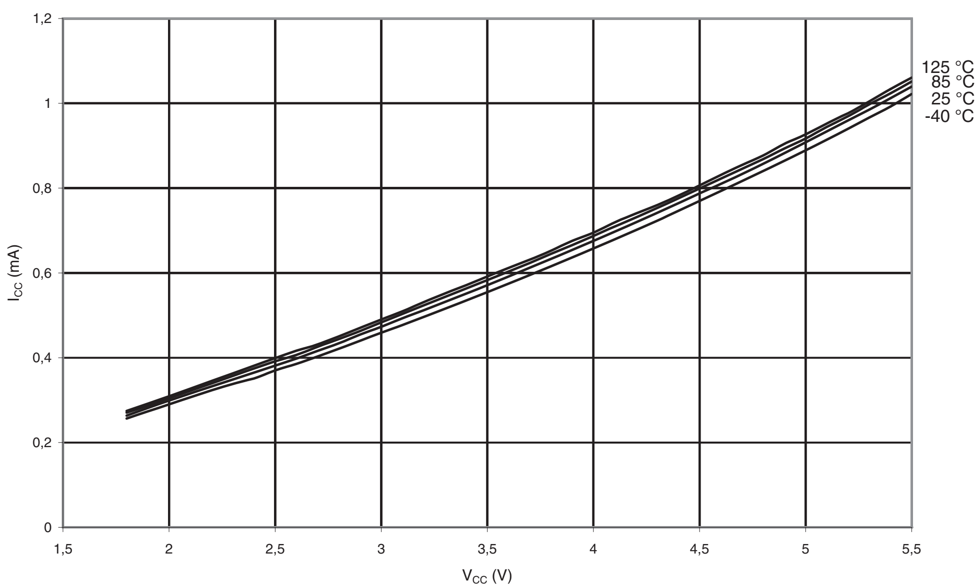
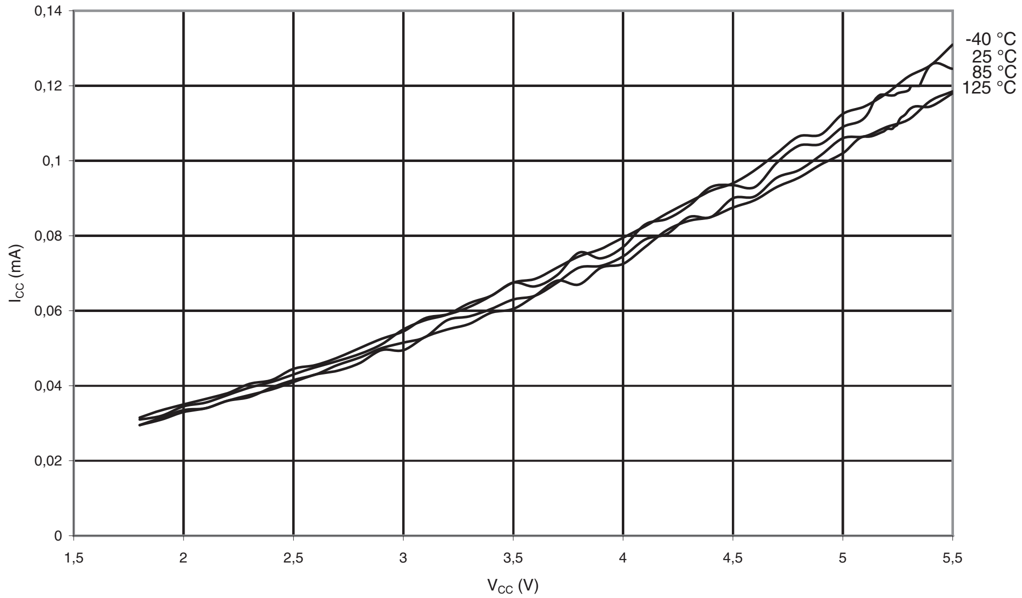


Figure 3-49. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.2.2 Current Consumption in Idle Mode

Figure 3-50. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

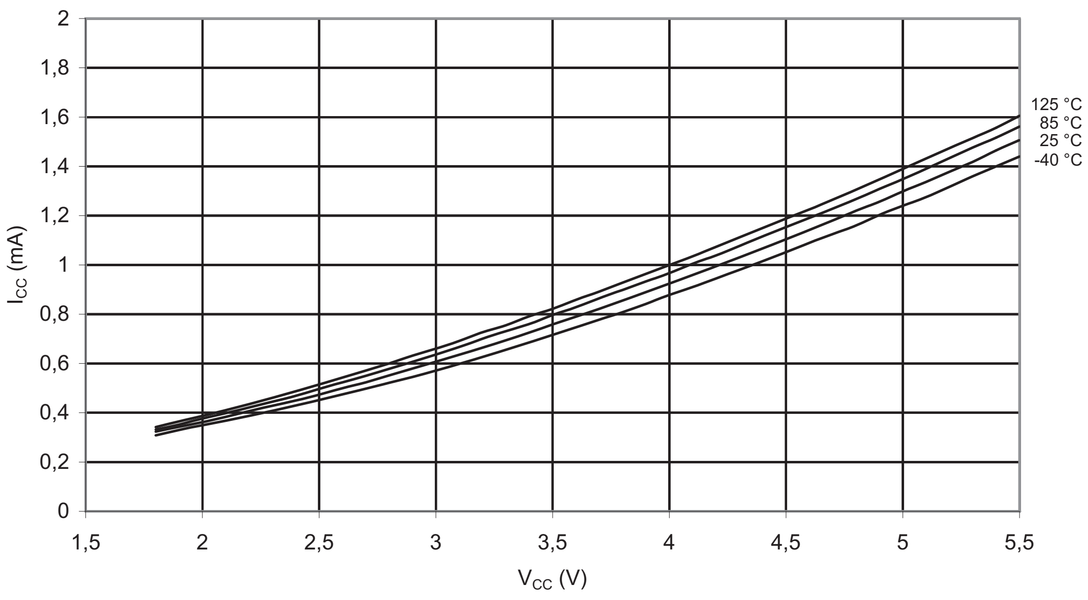


Figure 3-51. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

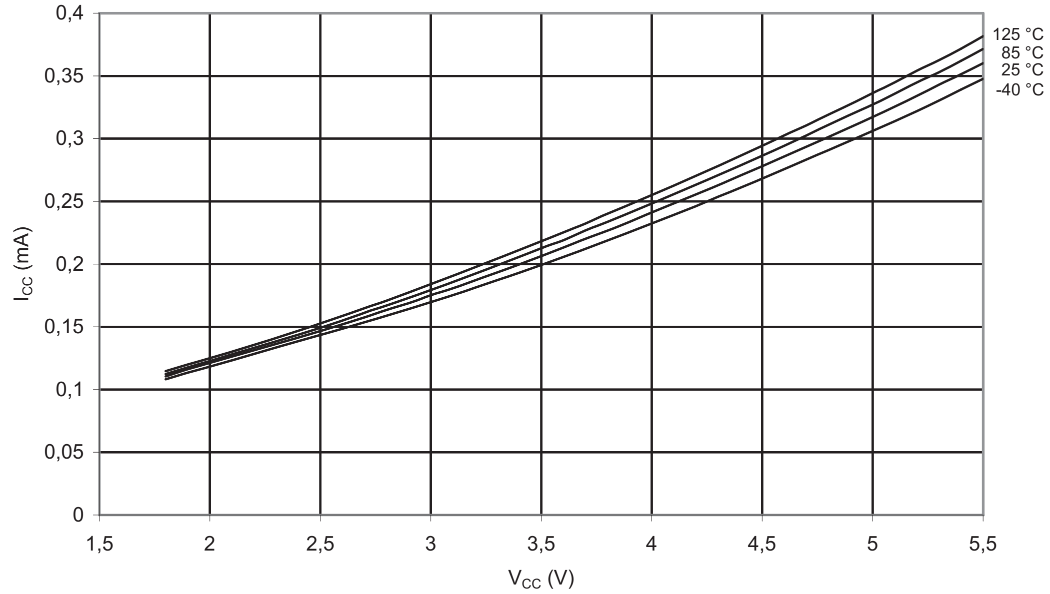
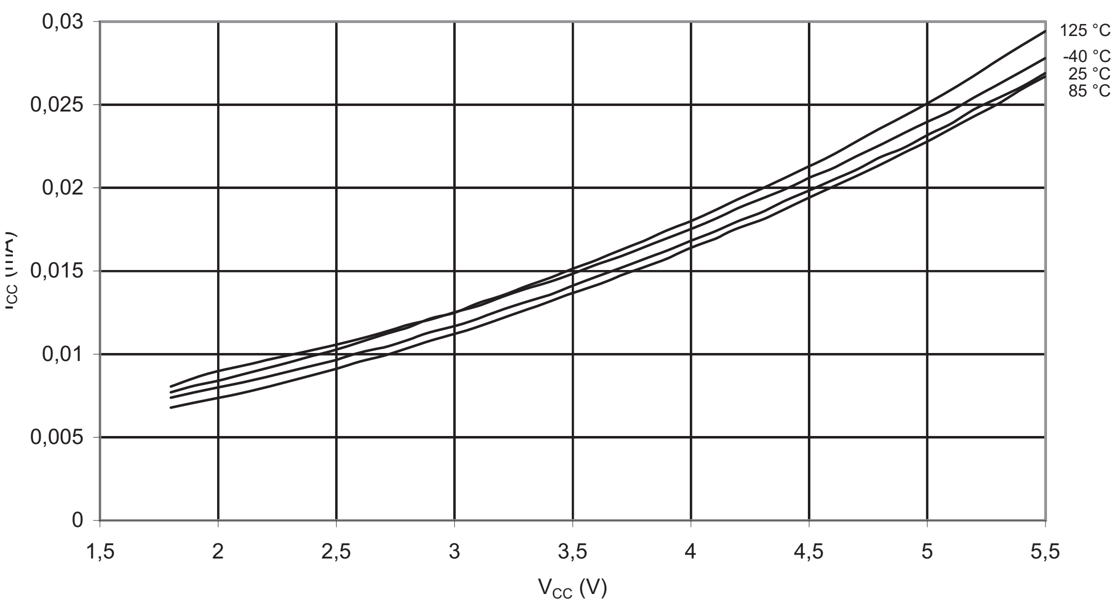


Figure 3-52. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.2.3 Current Consumption in Power-down Mode

Figure 3-53. Power-down Supply Current vs. V_{CC} (Watchdog Timer Disabled)

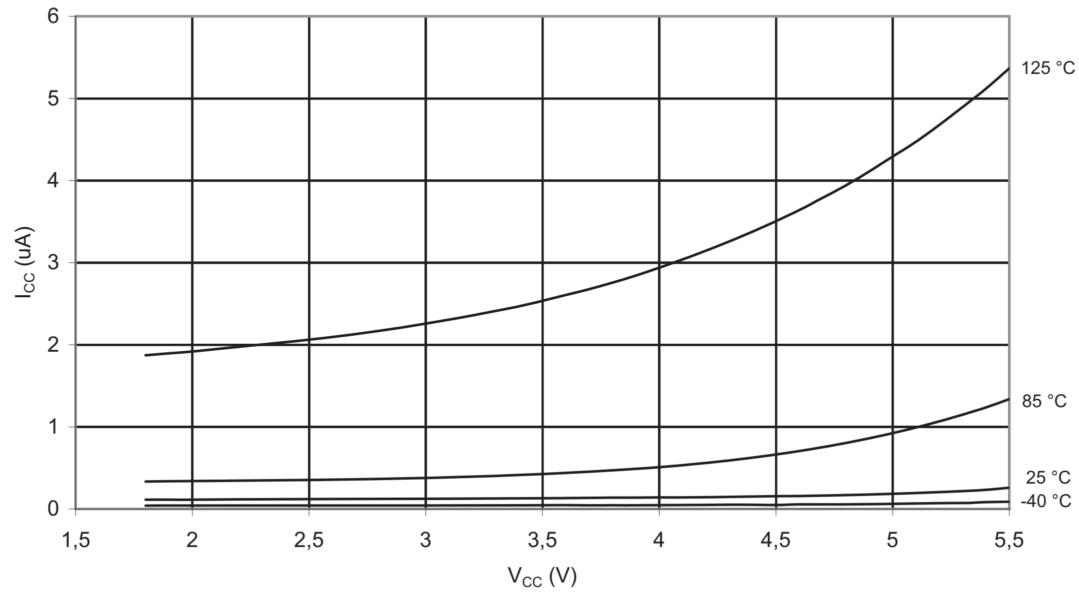
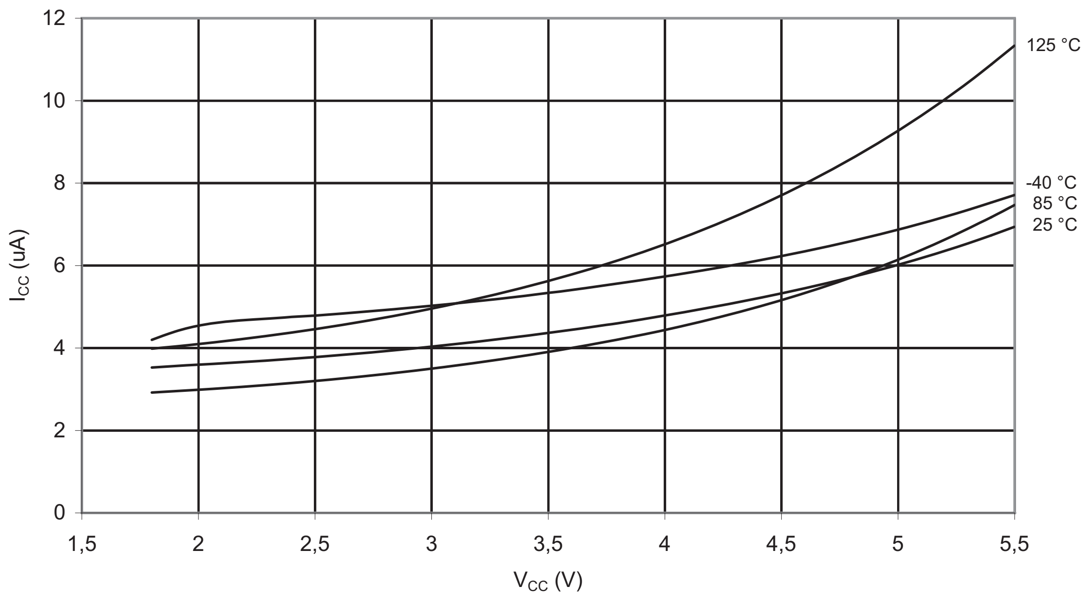


Figure 3-54. Power-down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



3.2.4 Current Consumption of Peripheral Units

Figure 3-55. Programming Current vs. V_{CC}

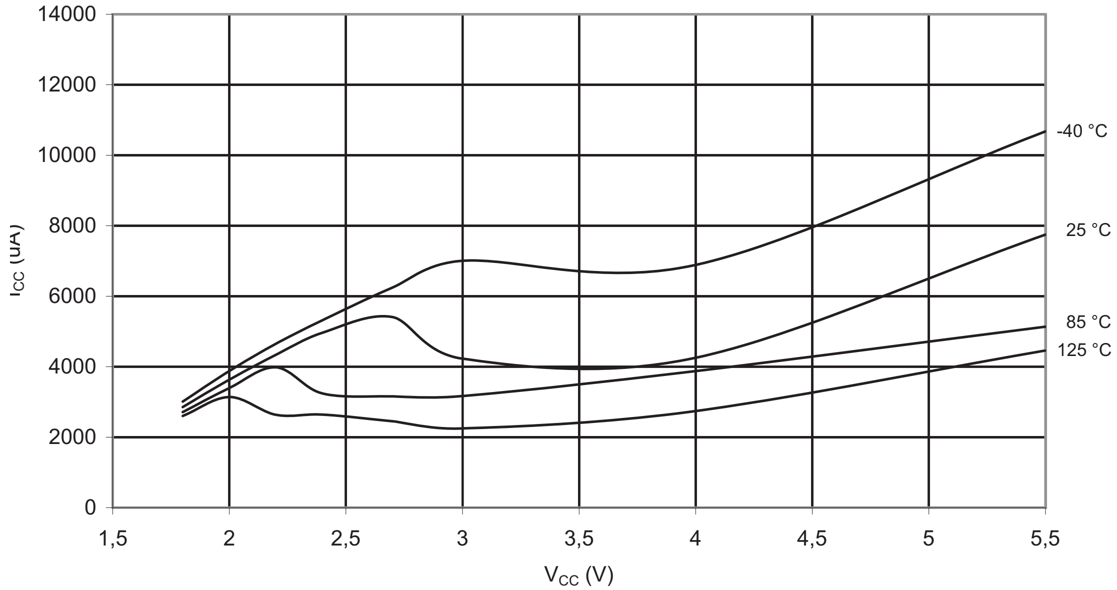


Figure 3-56. Brownout Detector Current vs. V_{CC} (BOD Level = 1.8V)

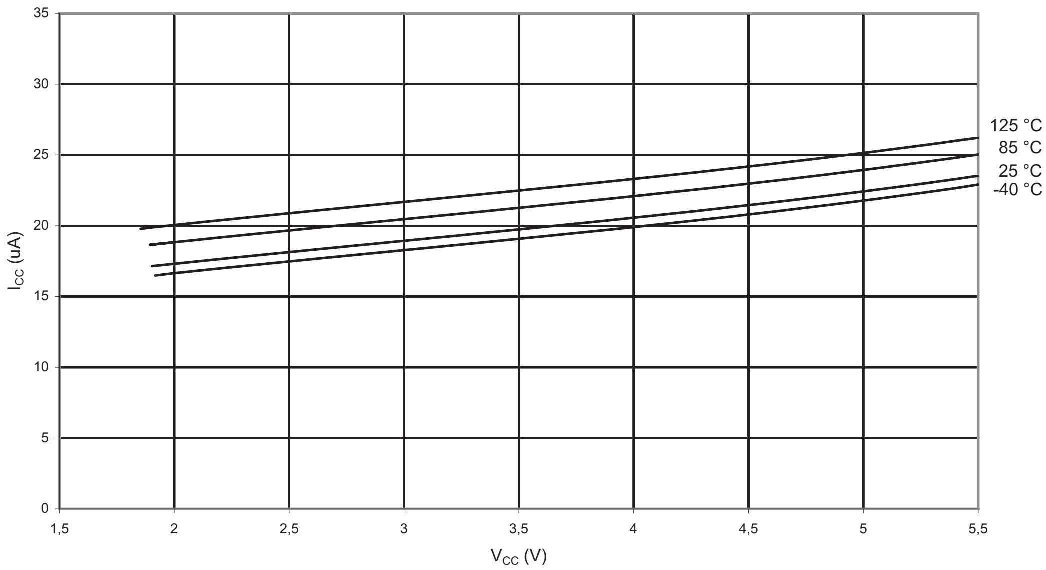
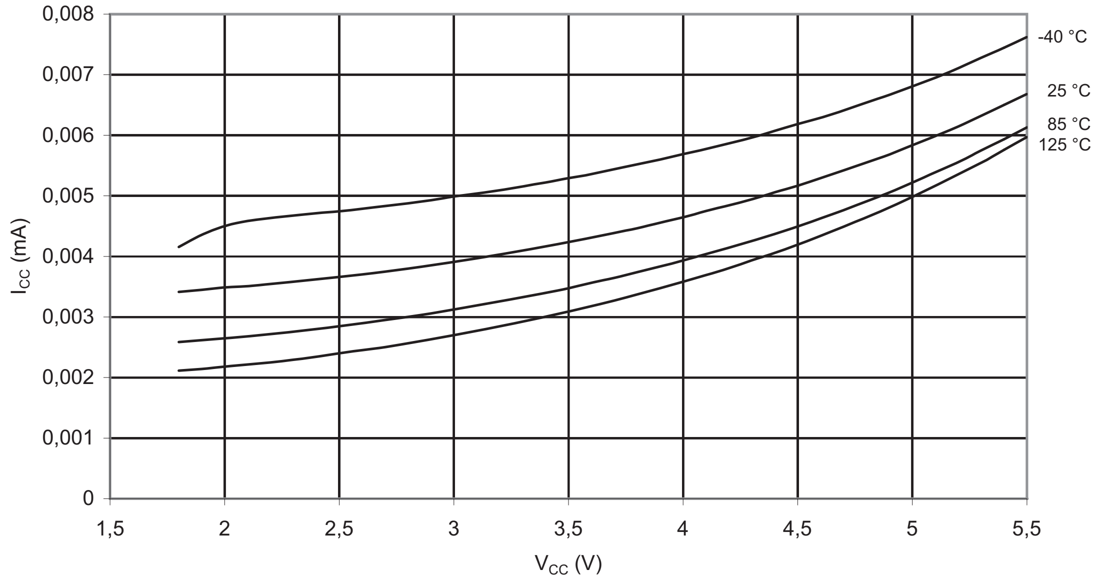


Figure 3-57. Watchdog Timer Current vs. V_{CC}



3.2.5 Pull-up Resistors

Figure 3-58. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 1.8V)

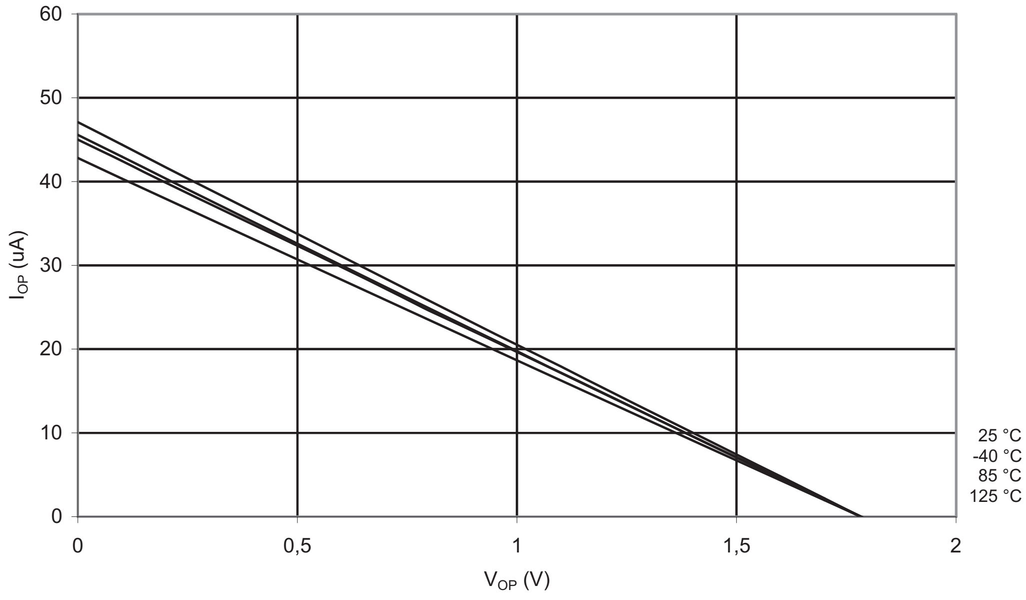


Figure 3-59. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 2.7V)

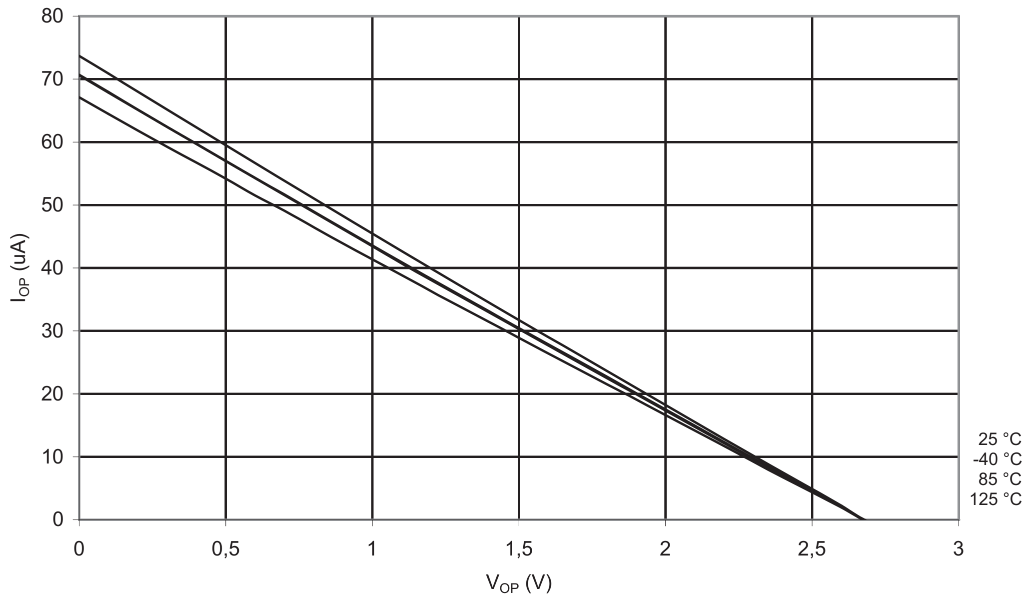


Figure 3-60. Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 5V)

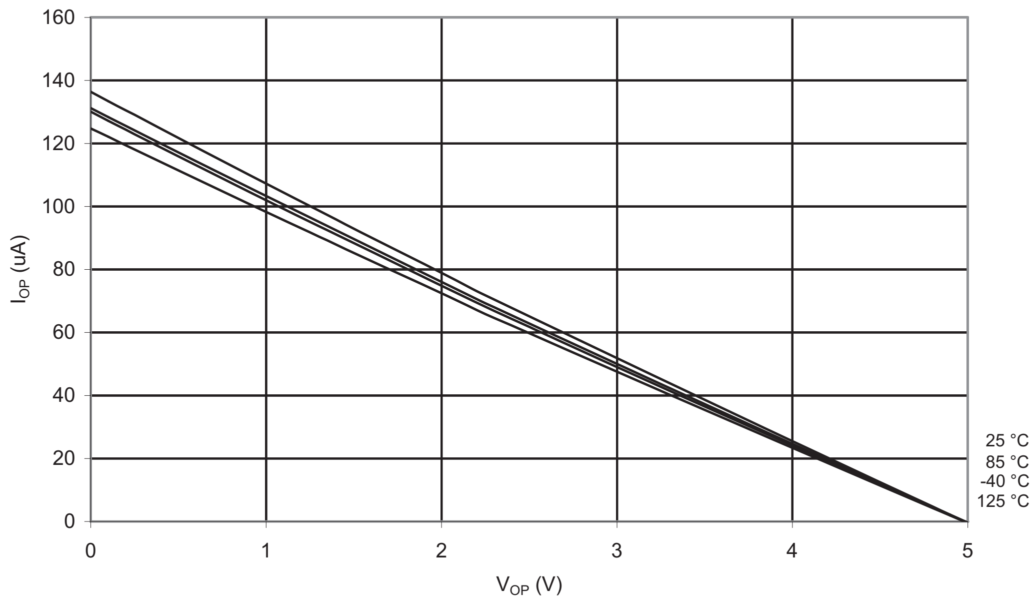


Figure 3-61. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 1.8V)

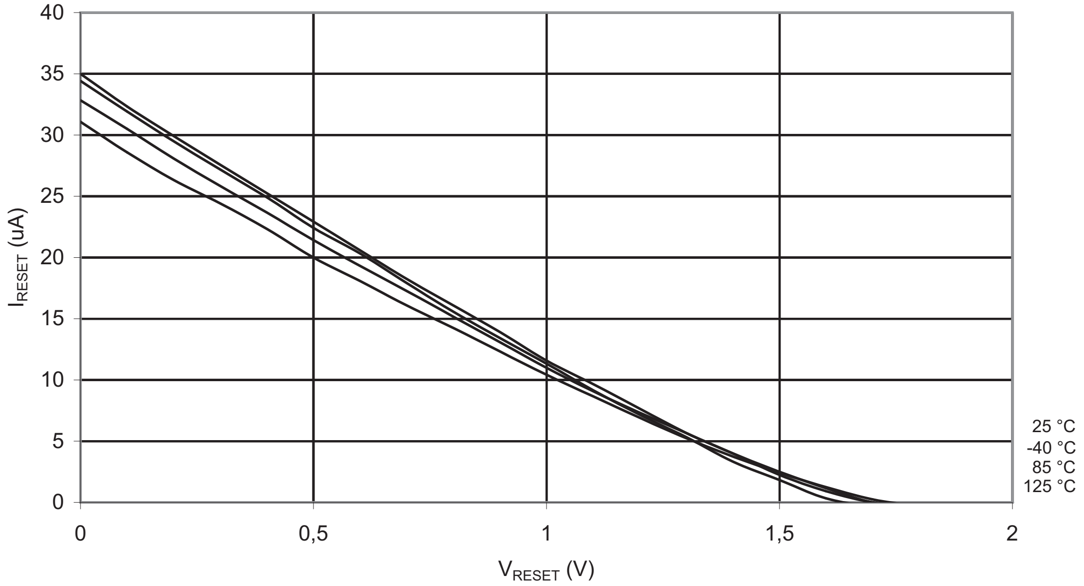


Figure 3-62. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 2.7V)

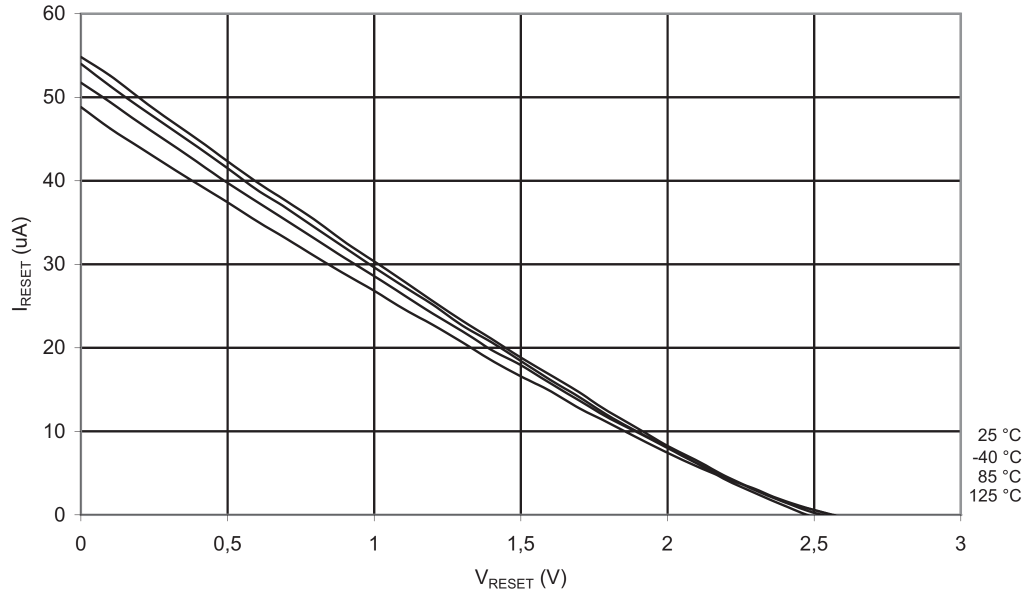
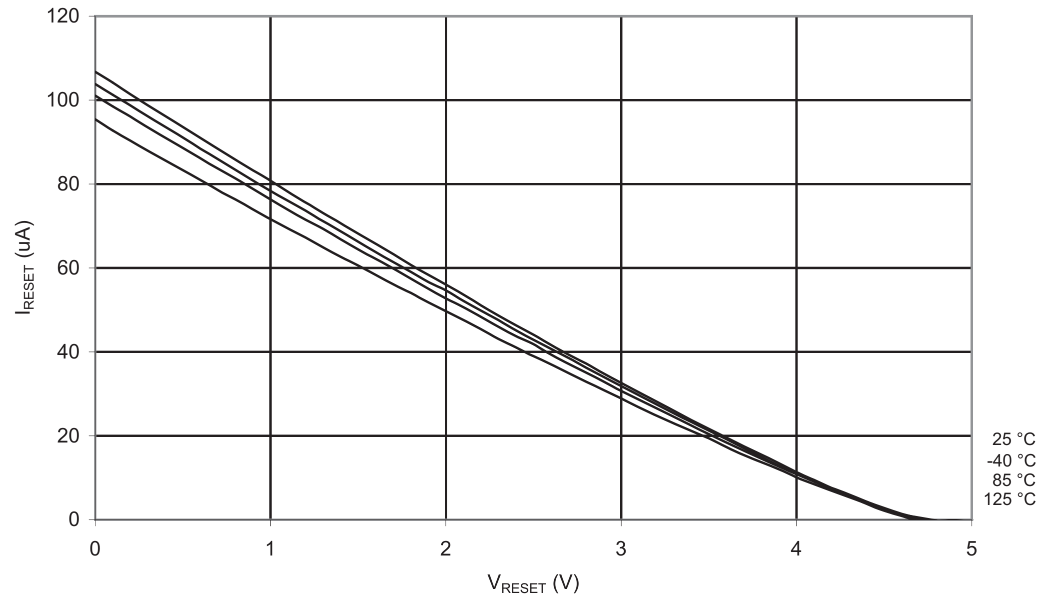


Figure 3-63. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



3.2.6 Output Driver Strength

Figure 3-64. V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 1.8V)

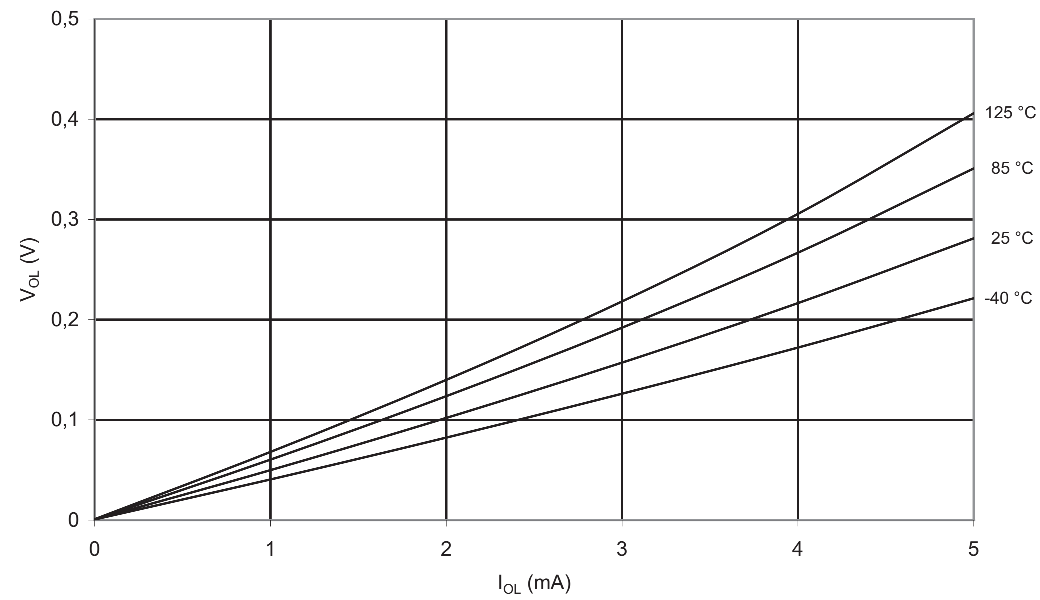


Figure 3-65. V_{OL}**: Output Voltage vs. Sink Current (I/O Pin,** V_{CC} **= 3V)**

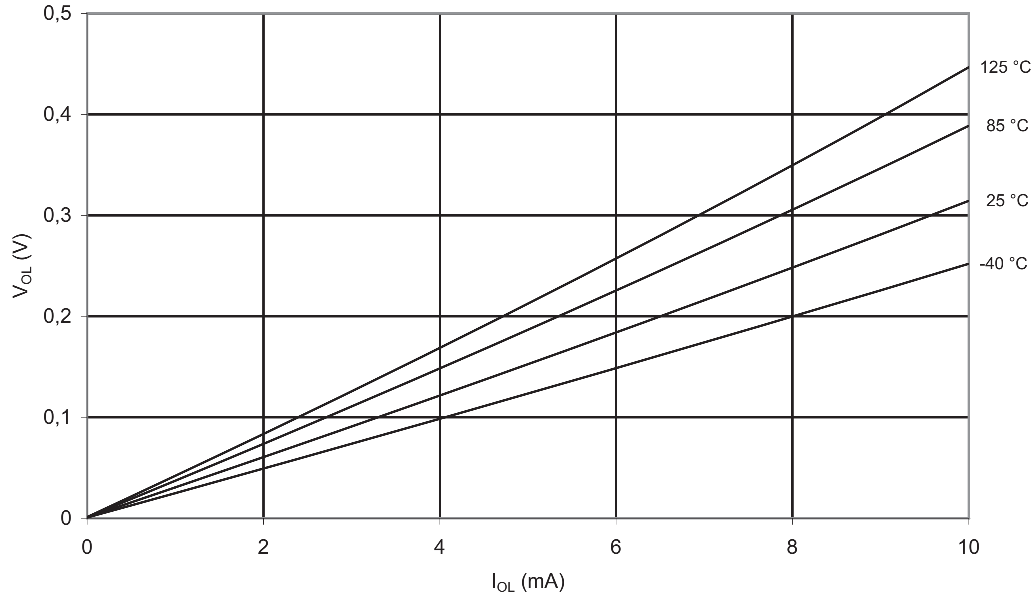


Figure 3-66. V_{OL}**: Output Voltage vs. Sink Current (I/O Pin,** V_{CC} **= 5V)**

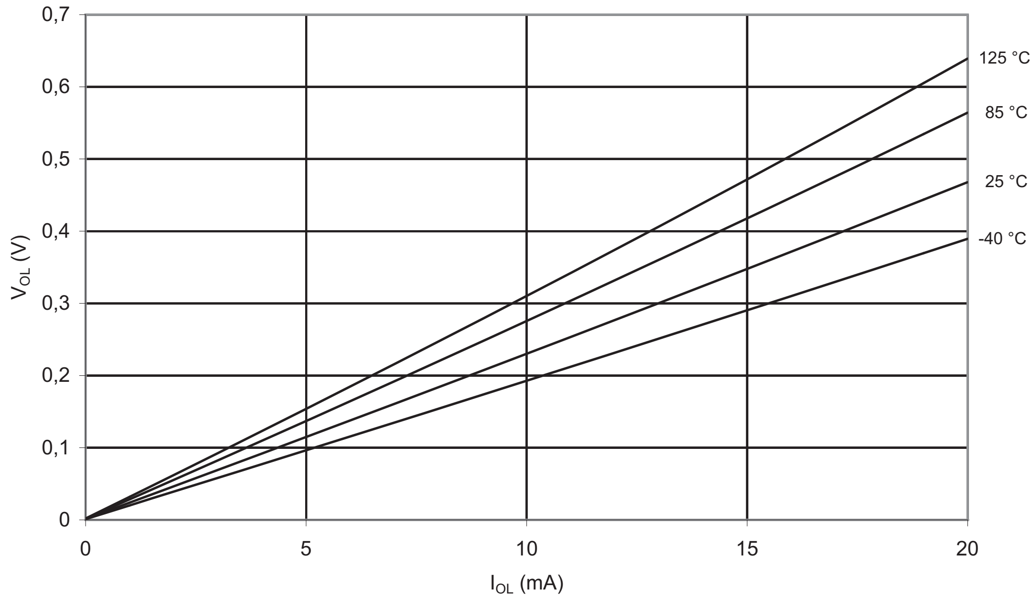


Figure 3-67. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 1.8V)

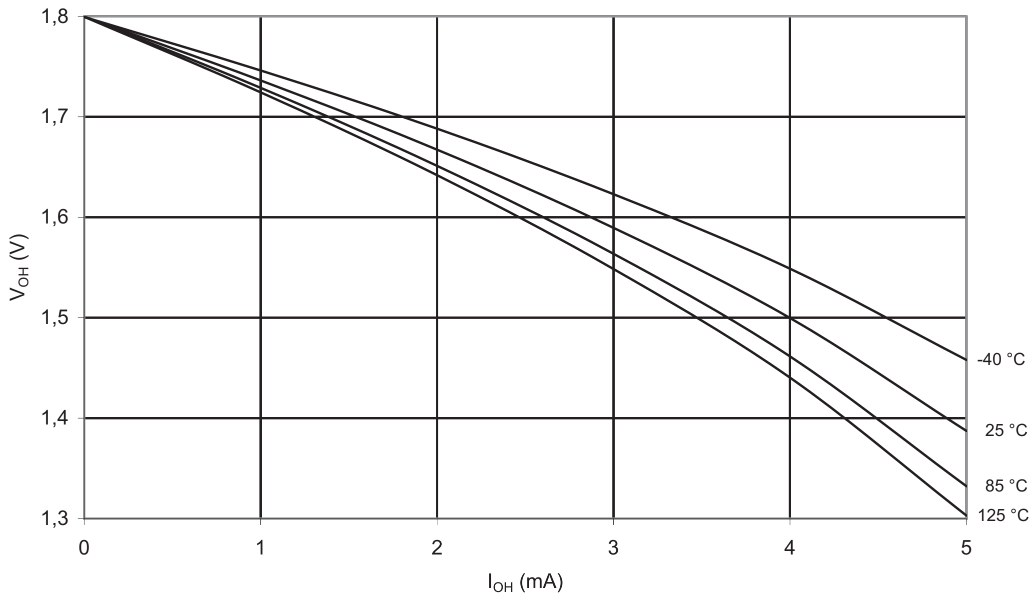


Figure 3-68. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 3V)

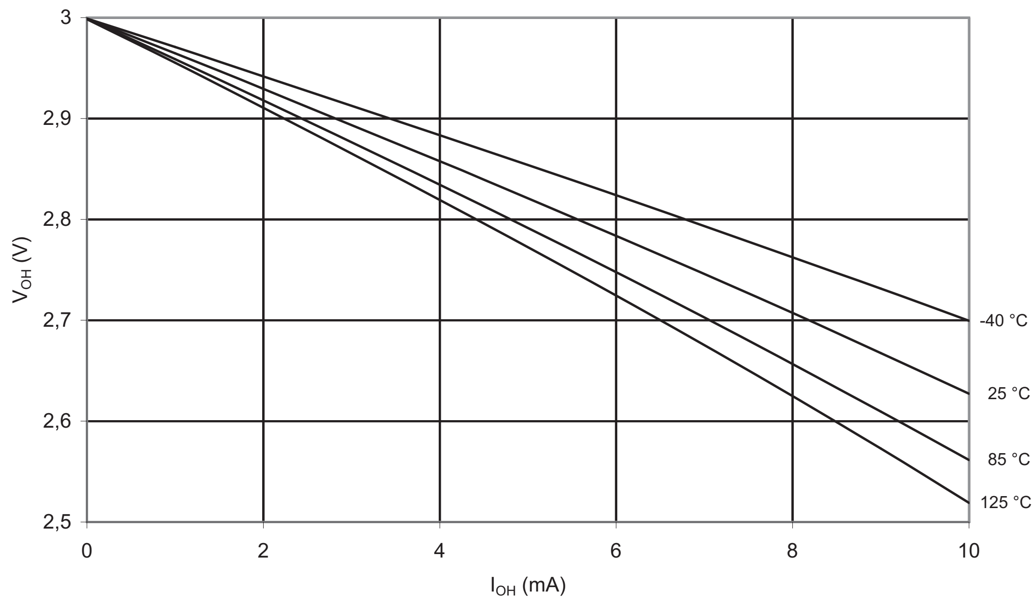


Figure 3-69. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 5V)

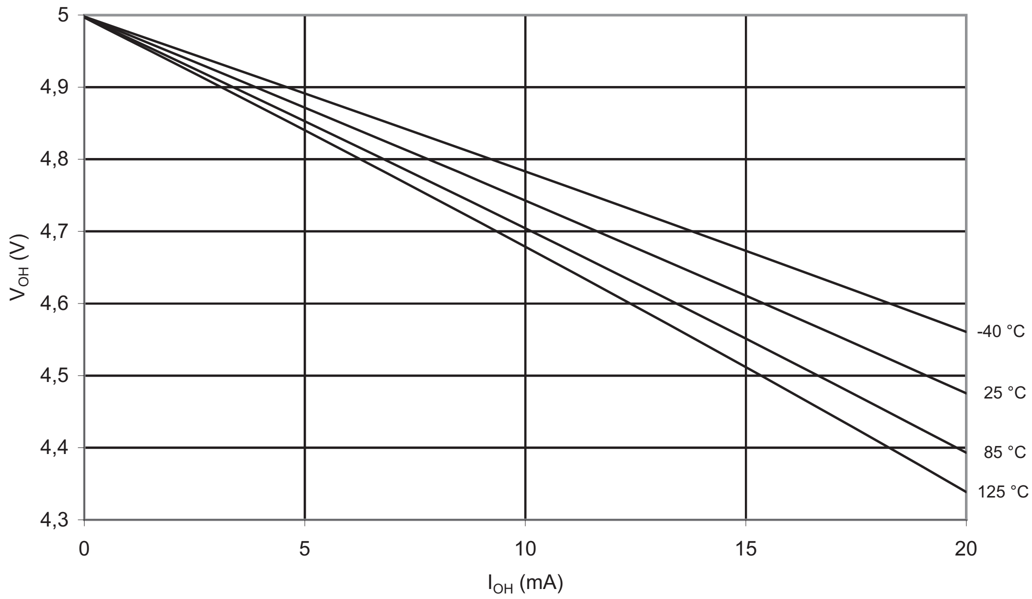


Figure 3-70. V_{OL}: Output Voltage vs. Sink Current (Reset Pin as I/O, V_{CC} = 3V)

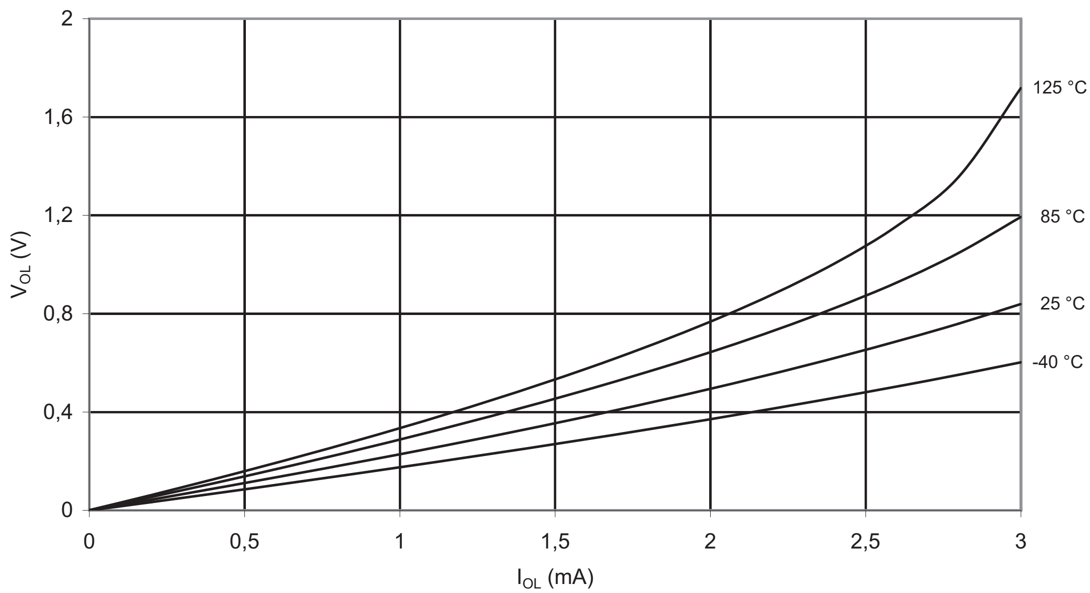


Figure 3-71. V_{OL}**: Output Voltage vs. Sink Current (Reset Pin as I/O,** V_{CC} **= 5V)**

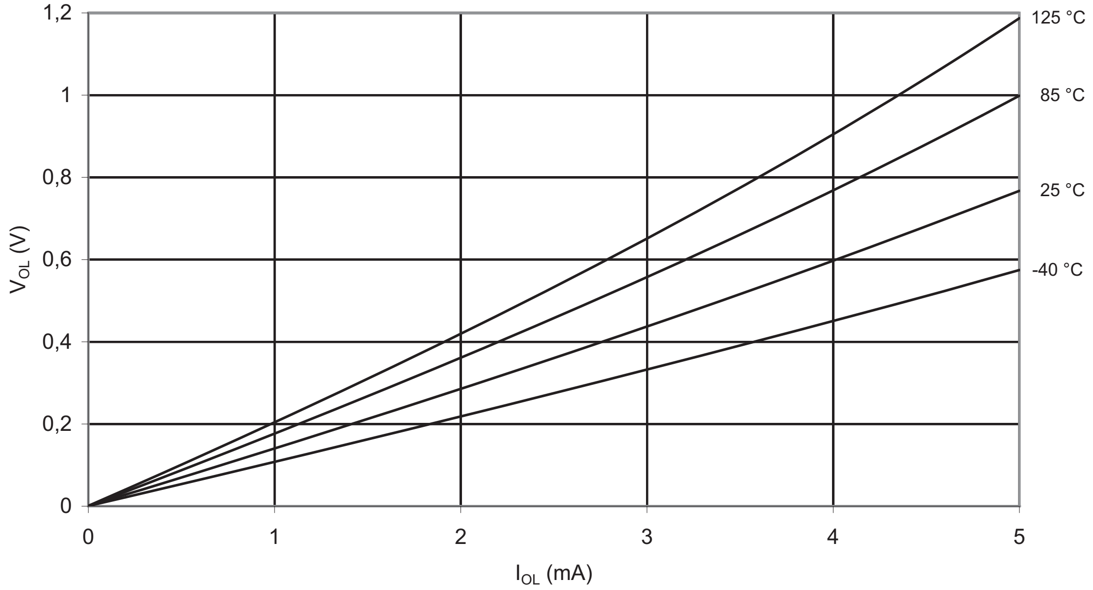


Figure 3-72. V_{OH}**: Output Voltage vs. Source Current (Reset Pin as I/O,** V_{CC} **= 3V)**

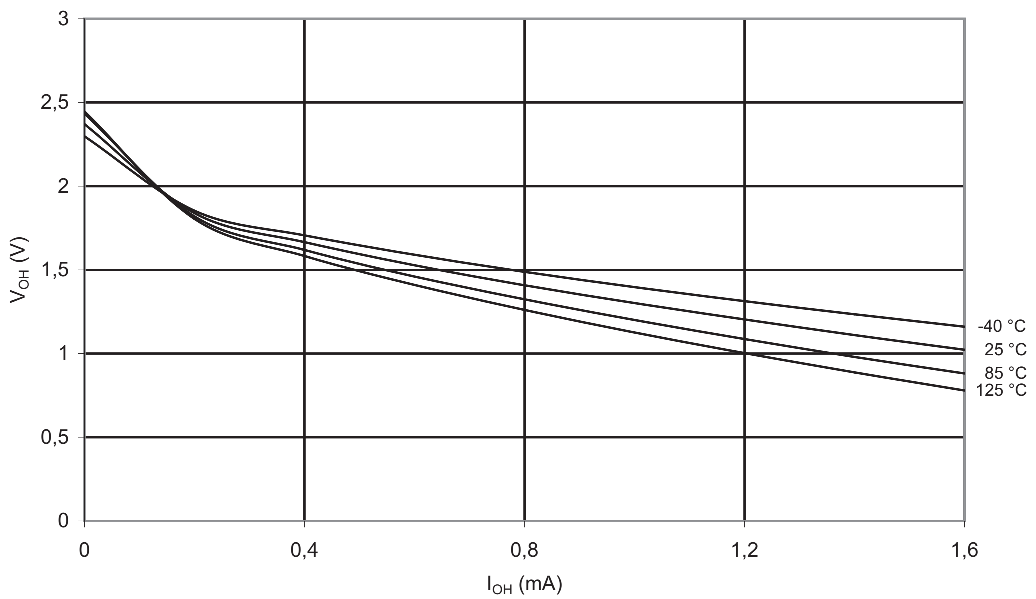
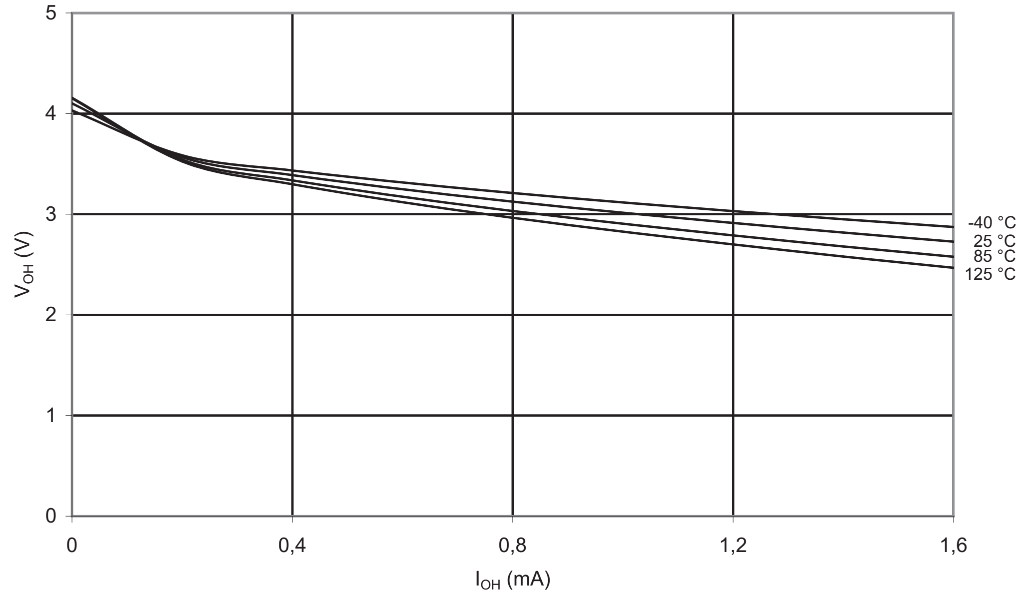


Figure 3-73. V_{OH}: Output Voltage vs. Source Current (Reset Pin as I/O, V_{CC} = 5V)



3.2.7 Input Threshold and Hysteresis (for I/O Ports)

Figure 3-74. V_{IH}: Input Threshold Voltage vs. V_{CC} (IO Pin, Read as '1')

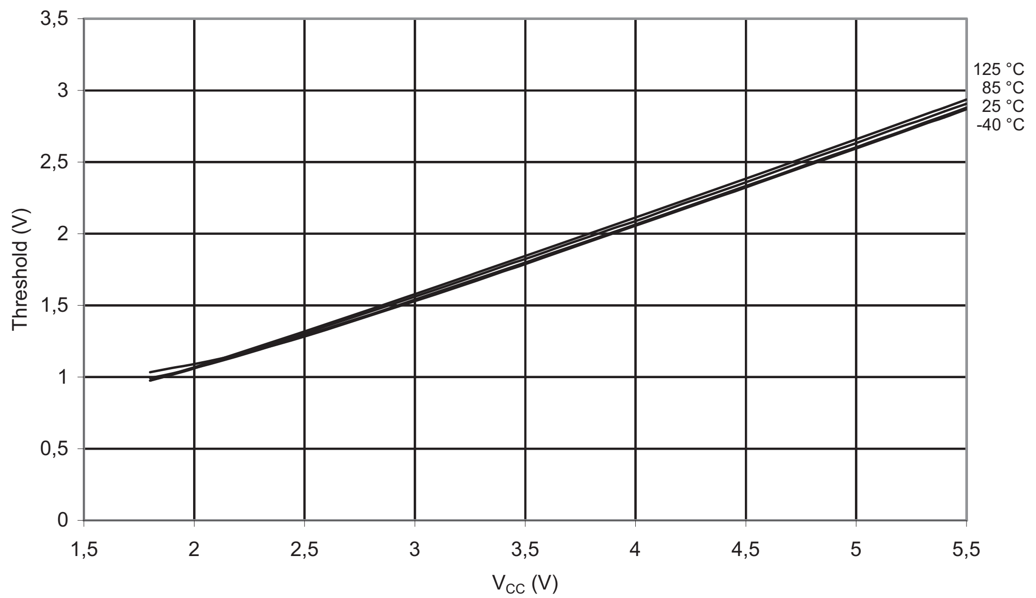


Figure 3-75. V_{IL}: Input Threshold Voltage vs. V_{CC} (I/O Pin, Read as '0')

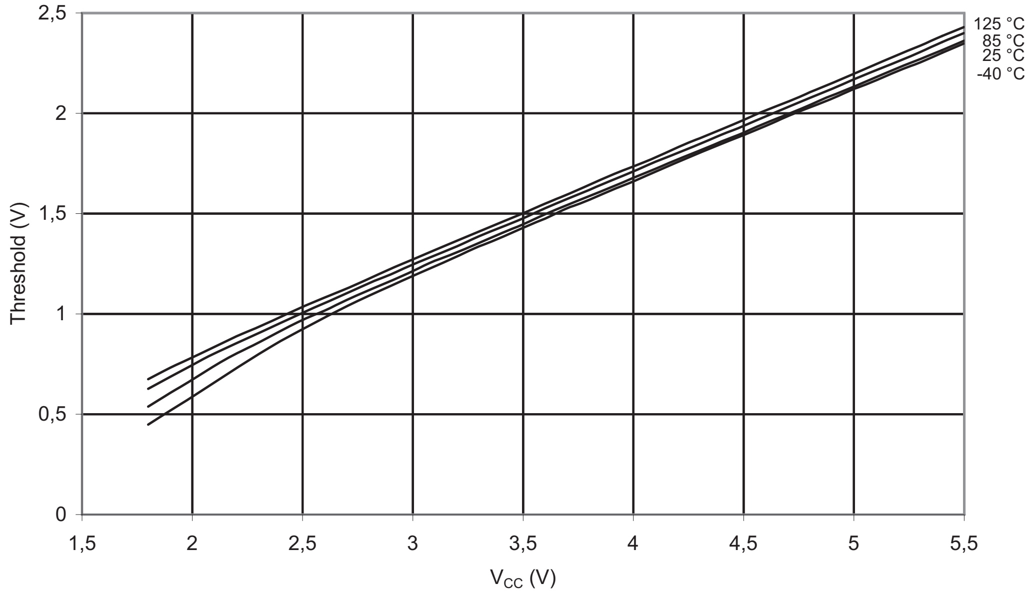


Figure 3-76. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (I/O Pin)

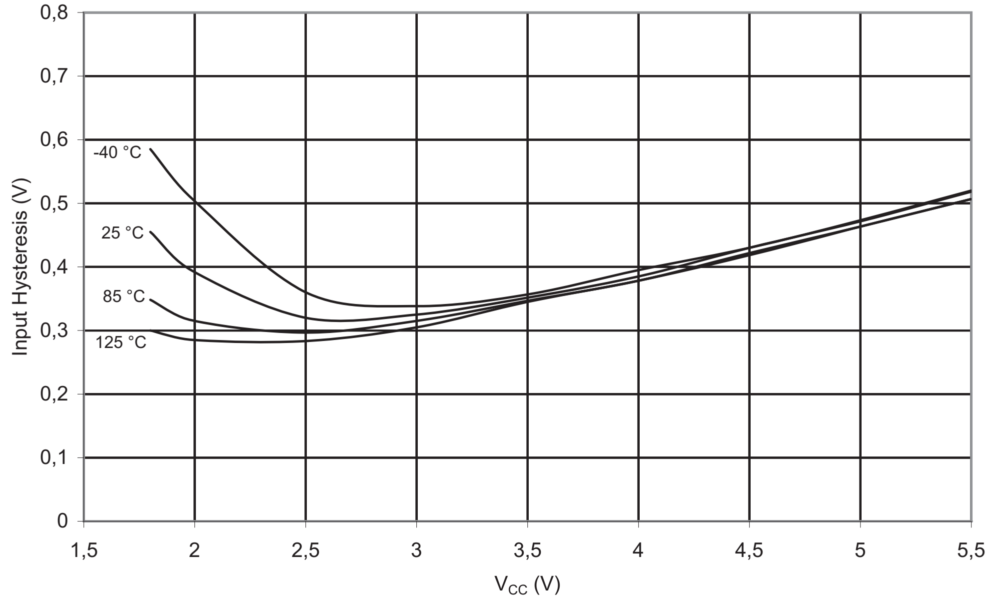


Figure 3-77. V_{IH}**: Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '1')**

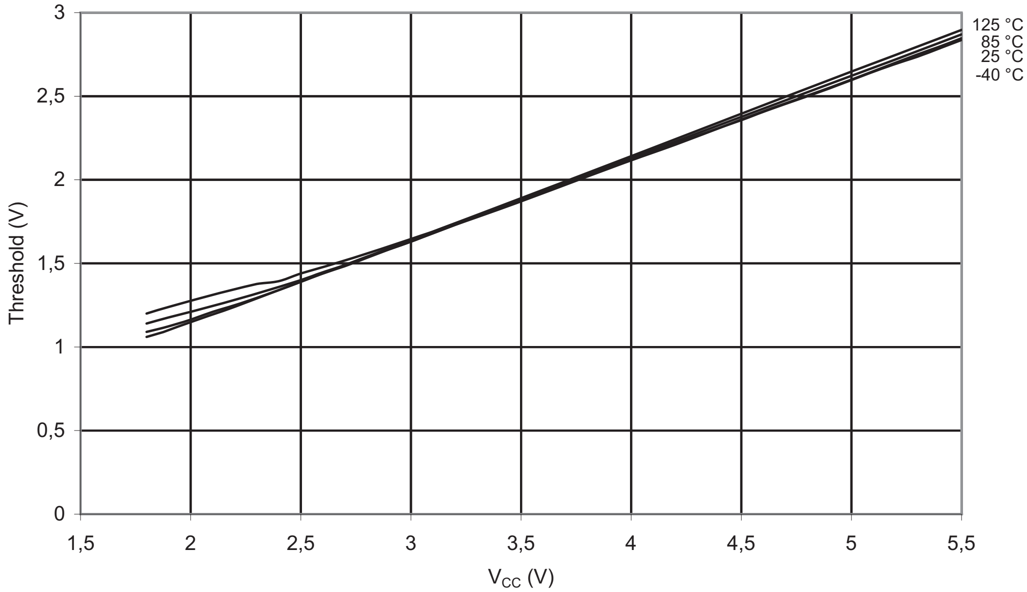


Figure 3-78. V_{IL}**: Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '0')**

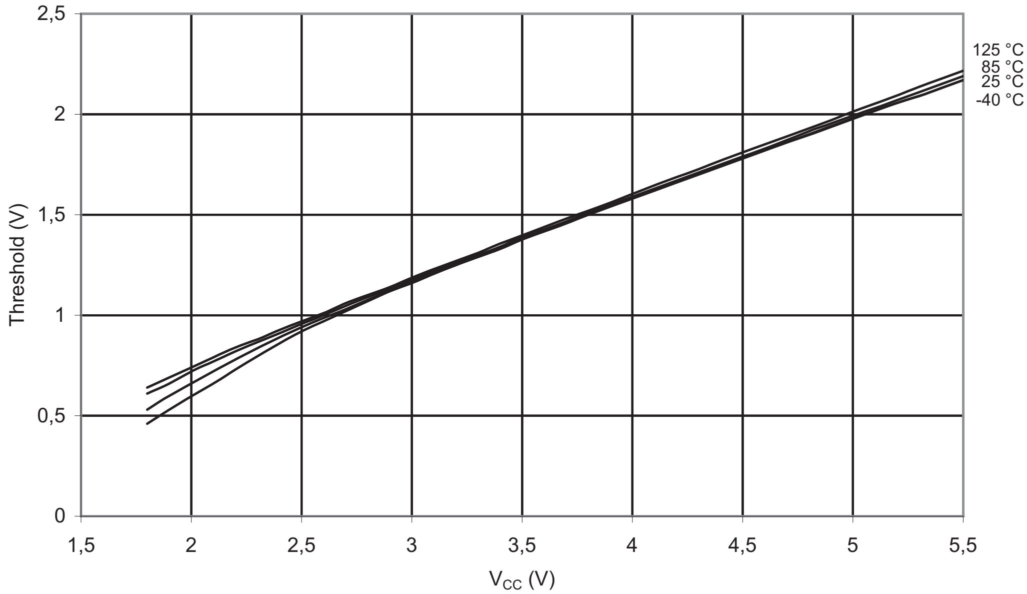
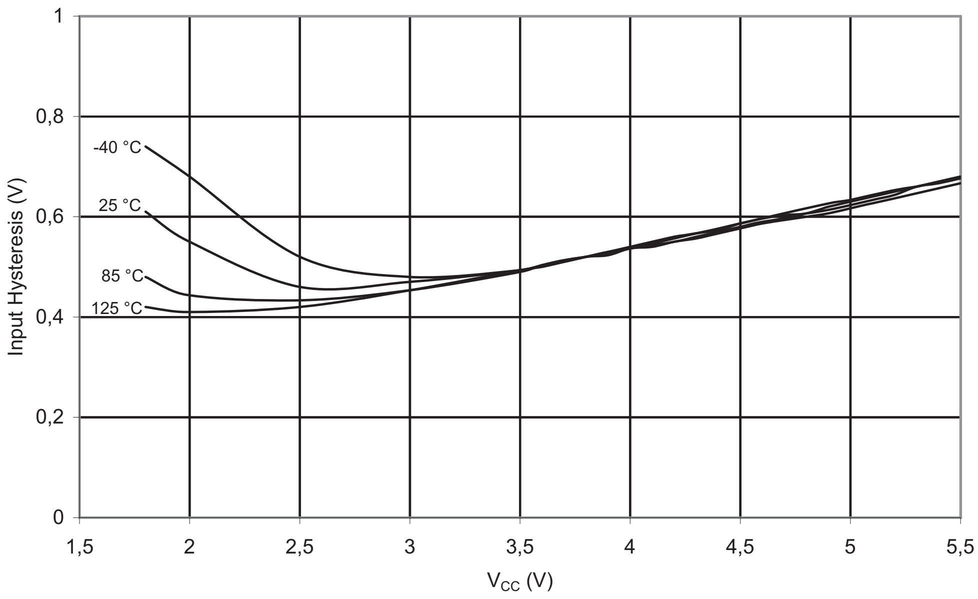


Figure 3-79. V_{IH}-V_{IL}**: Input Hysteresis vs.** V_{CC} **(Reset Pin as I/O)**



3.2.8 BOD, Bandgap and Reset

Figure 3-80. BOD Threshold vs. Temperature (BODLEVEL = 4.3V)

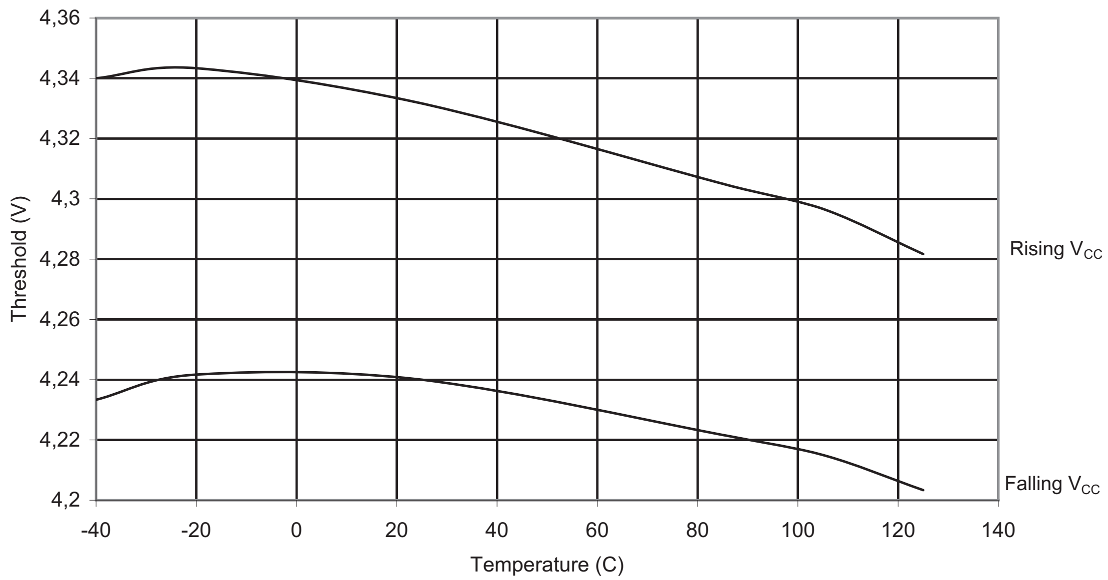


Figure 3-81. BOD Threshold vs. Temperature (BODLEVEL = 2.7V)

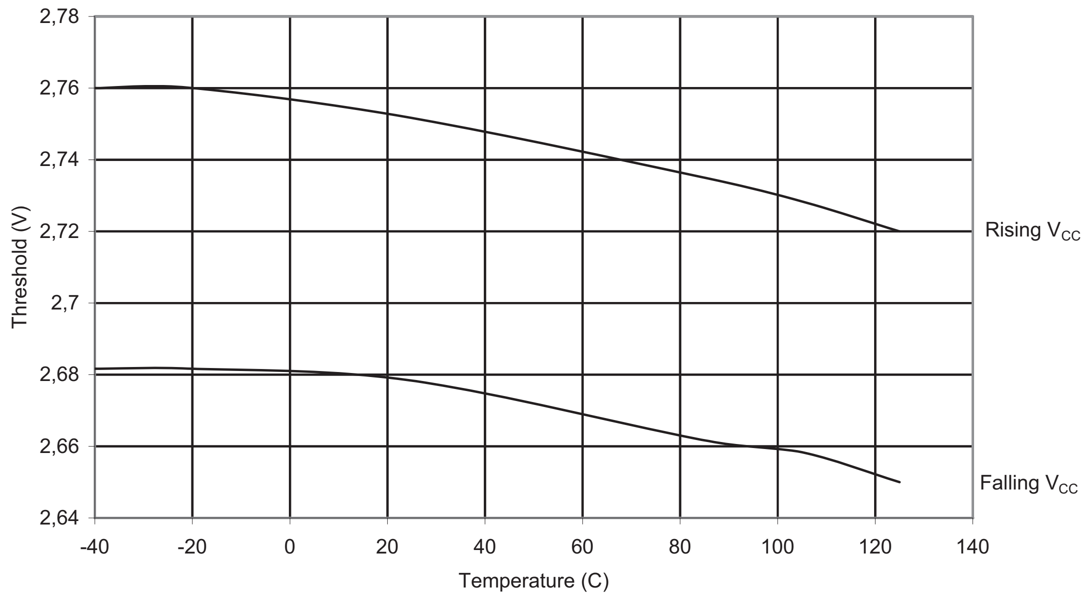


Figure 3-82. BOD Threshold vs. Temperature (BODLEVEL =1.8V)

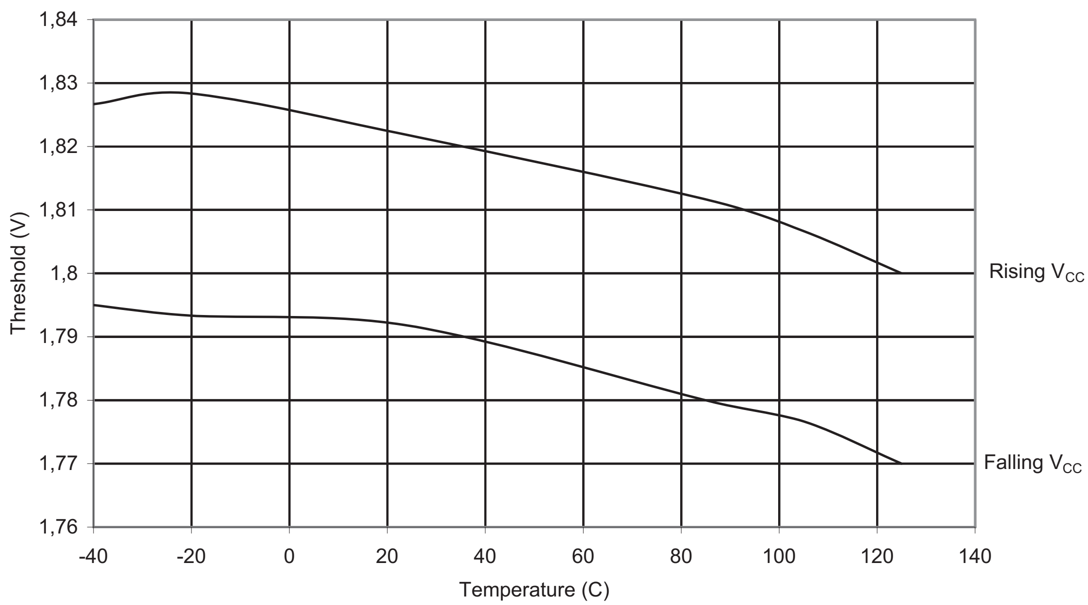


Figure 3-83. Bandgap Voltage vs. Temperature (V_{CC} =5V)

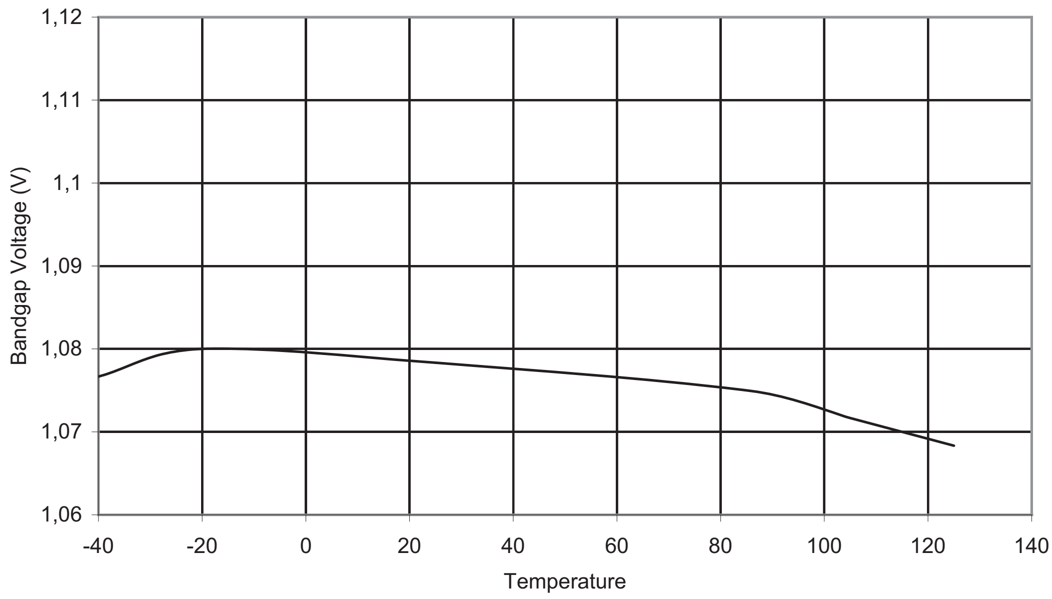


Figure 3-84. V_{IH}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '1')

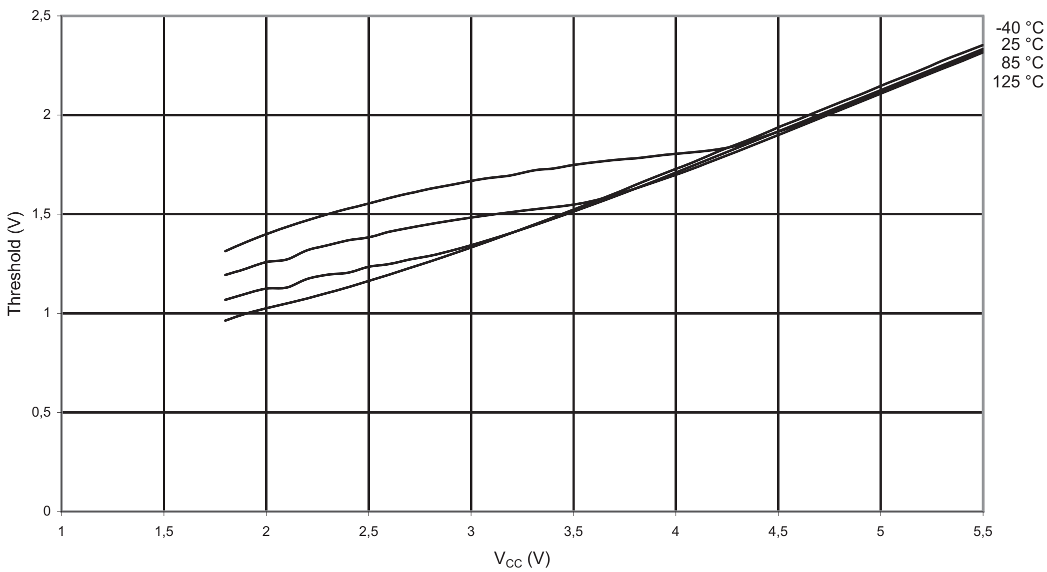


Figure 3-85. V_{IL}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '0')

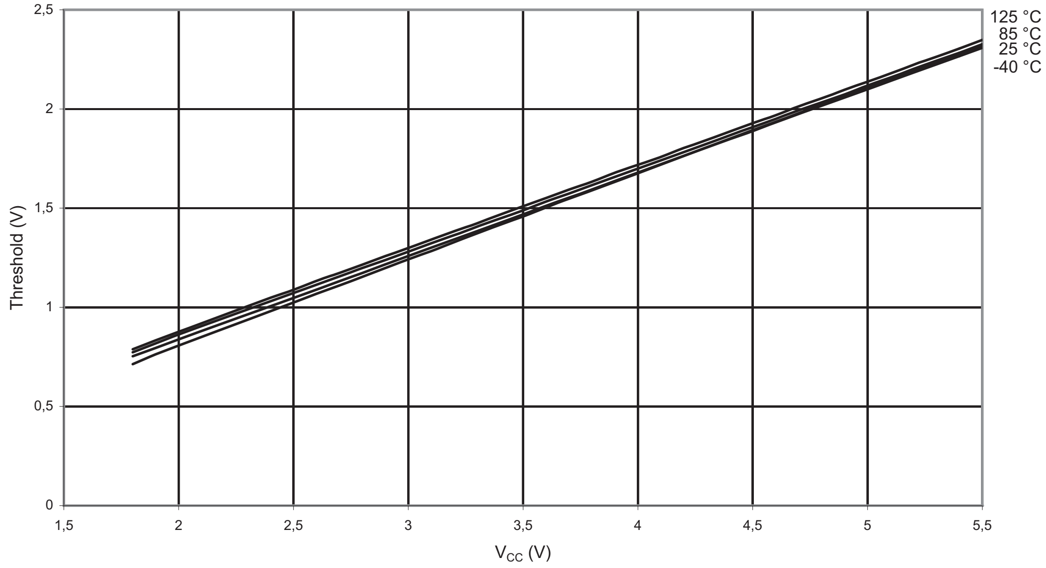


Figure 3-86. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin)

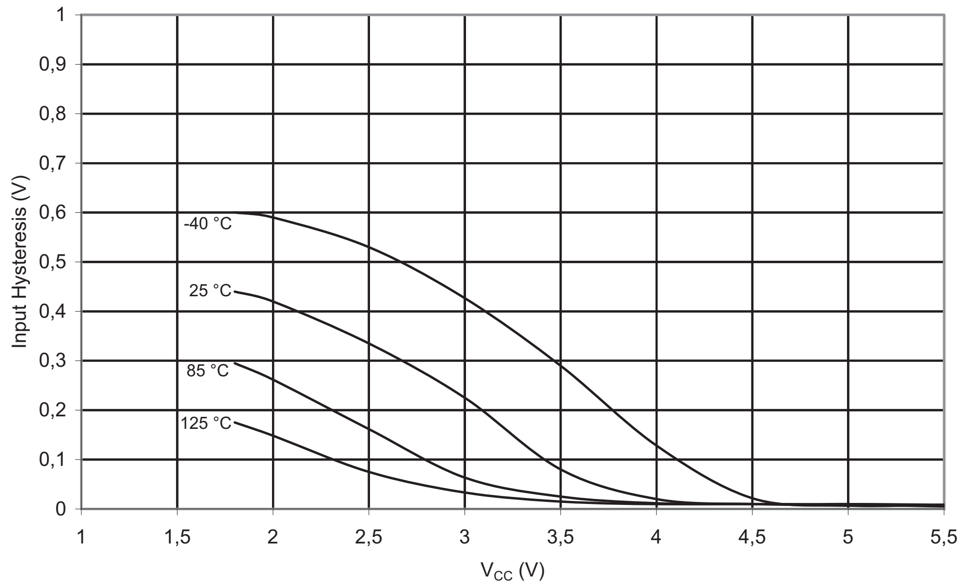
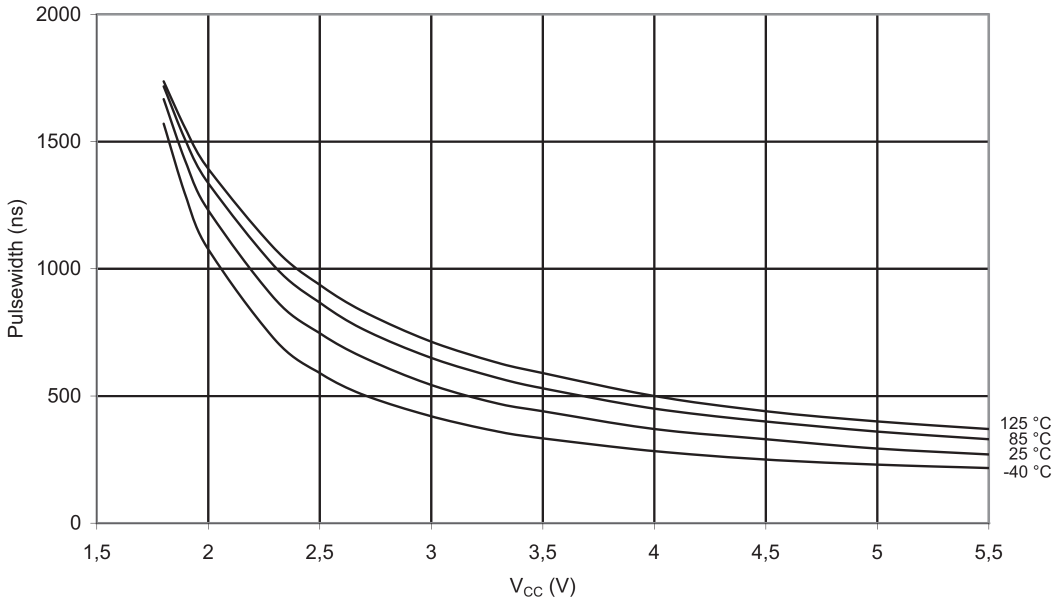
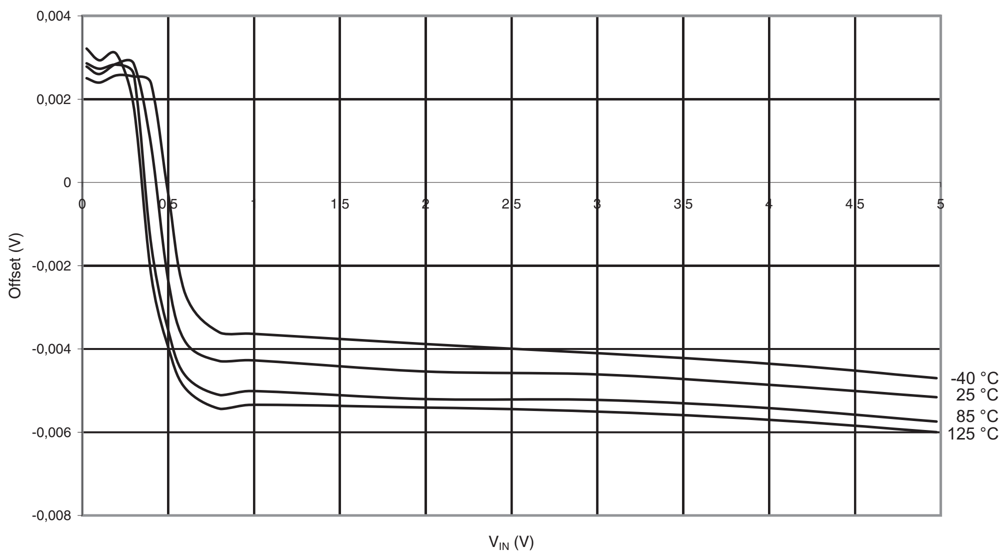


Figure 3-87. Minimum Reset Pulse Width vs. V_{CC}



3.2.9 Analog Comparator Offset

Figure 3-88. Analog Comparator Offset (V_{CC} = 5V)



3.2.10 Internal Oscillator Speed

Figure 3-89. Watchdog Oscillator Frequency vs. V_{CC}

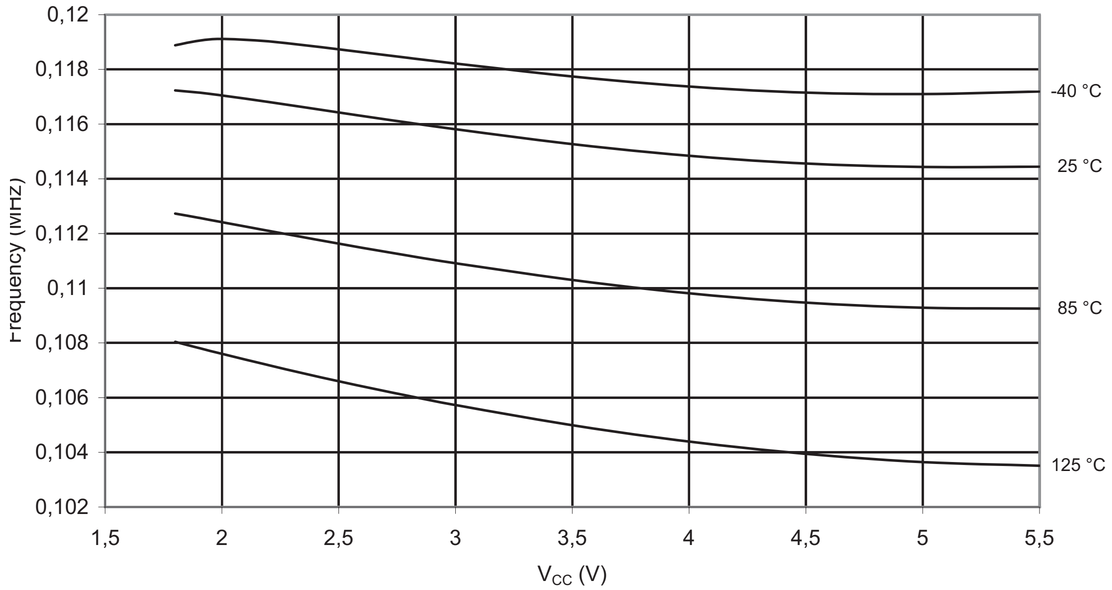


Figure 3-90. Watchdog Oscillator Frequency vs. Temperature

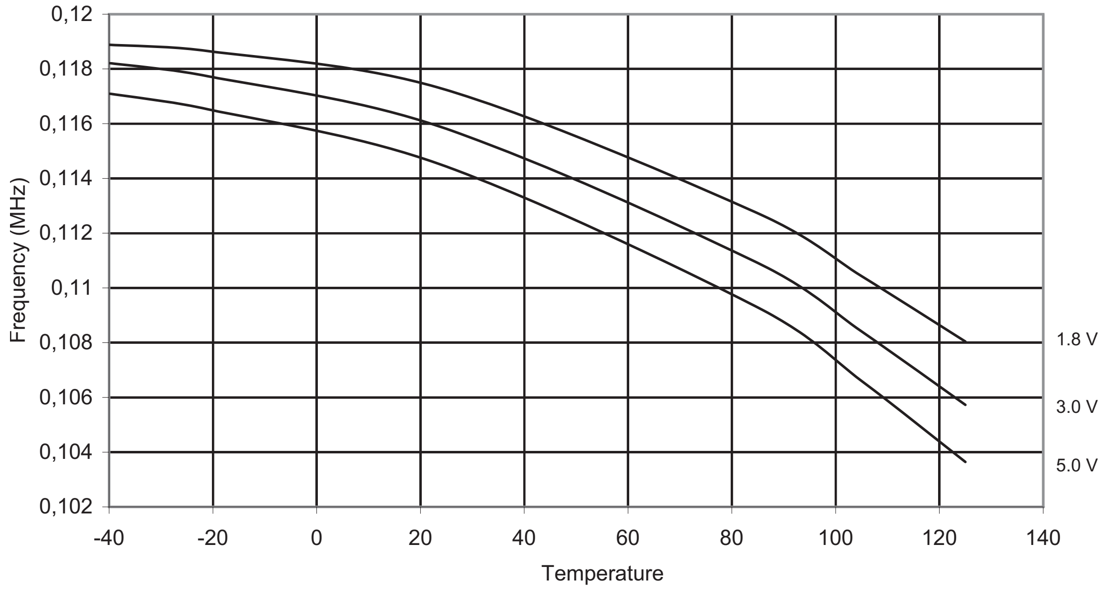


Figure 3-91. Calibrated 8 MHz RC Oscillator Frequency vs. Temperature

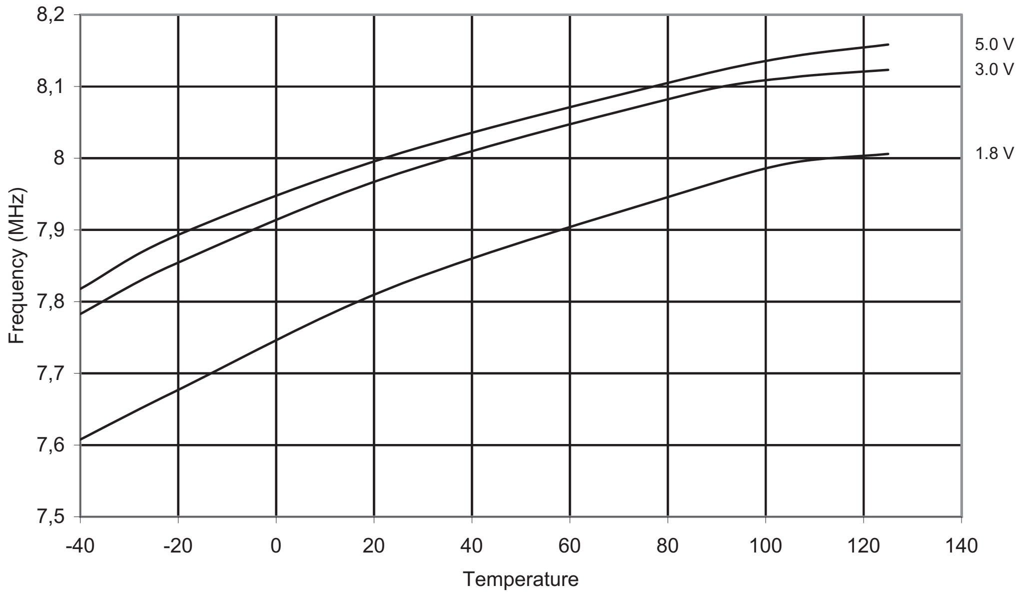
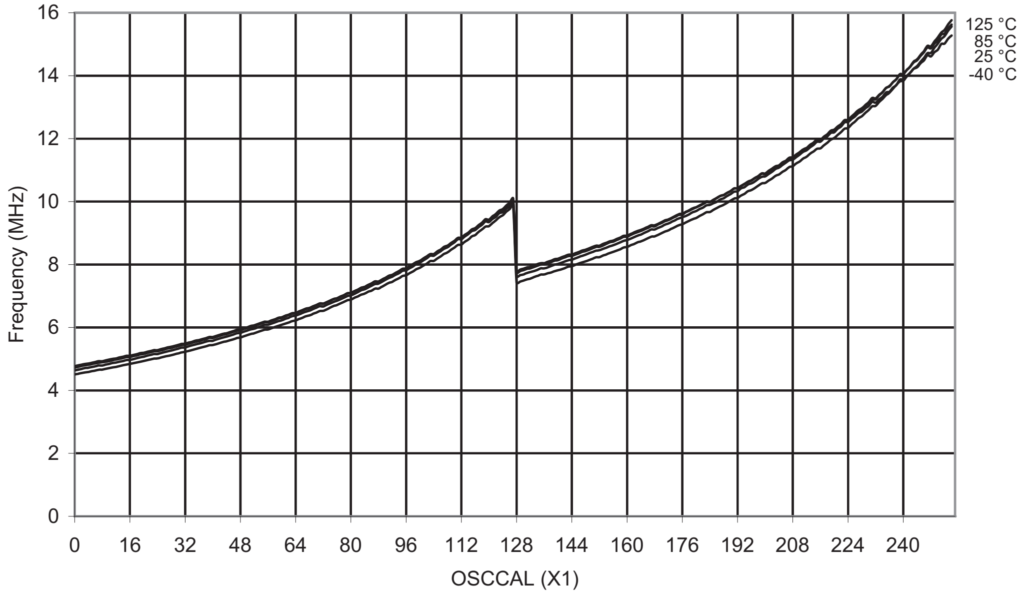


Figure 3-92. Calibrated 8 MHz RC Oscillator Frequency vs. OSCCAL Value



3.3 ATtiny84A

3.3.1 Current Consumption in Active Mode

Figure 3-93. Active Supply Current vs. Frequency (1 - 16 MHz, PRR = 0xFF)

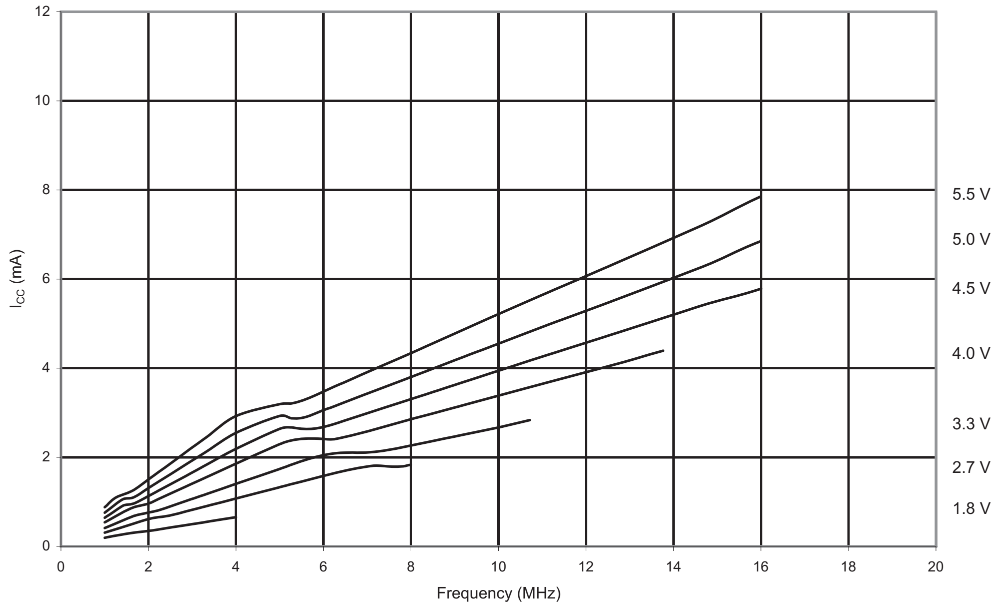


Figure 3-94. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

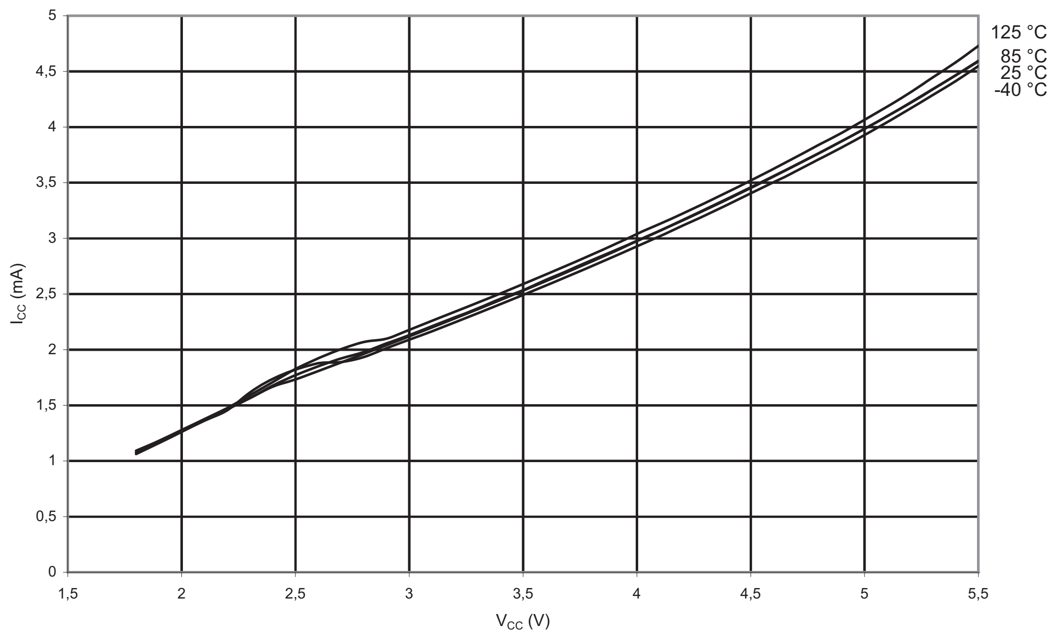


Figure 3-95. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

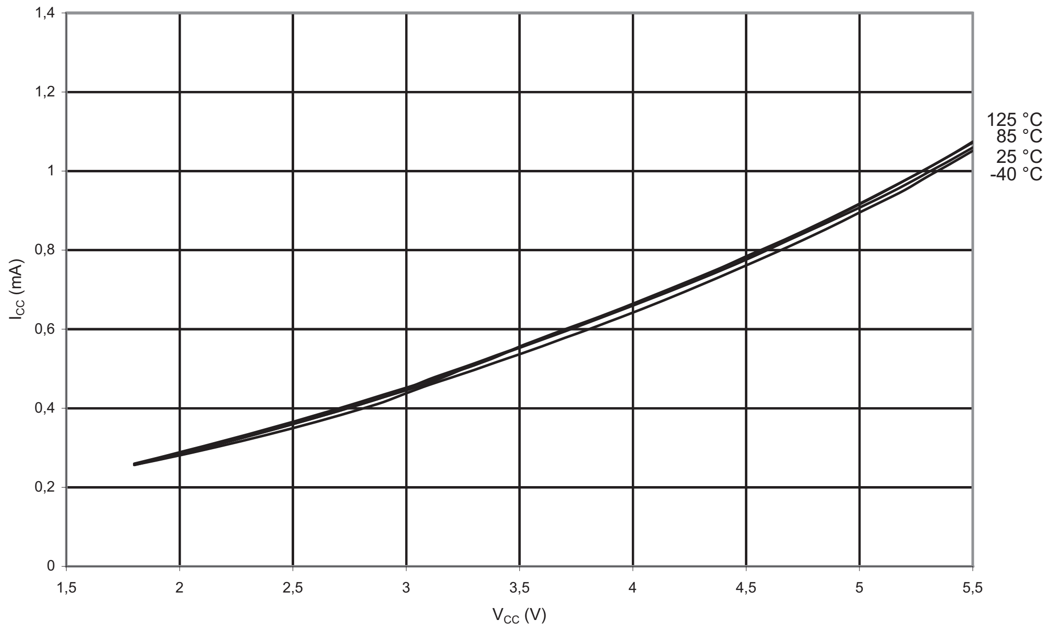
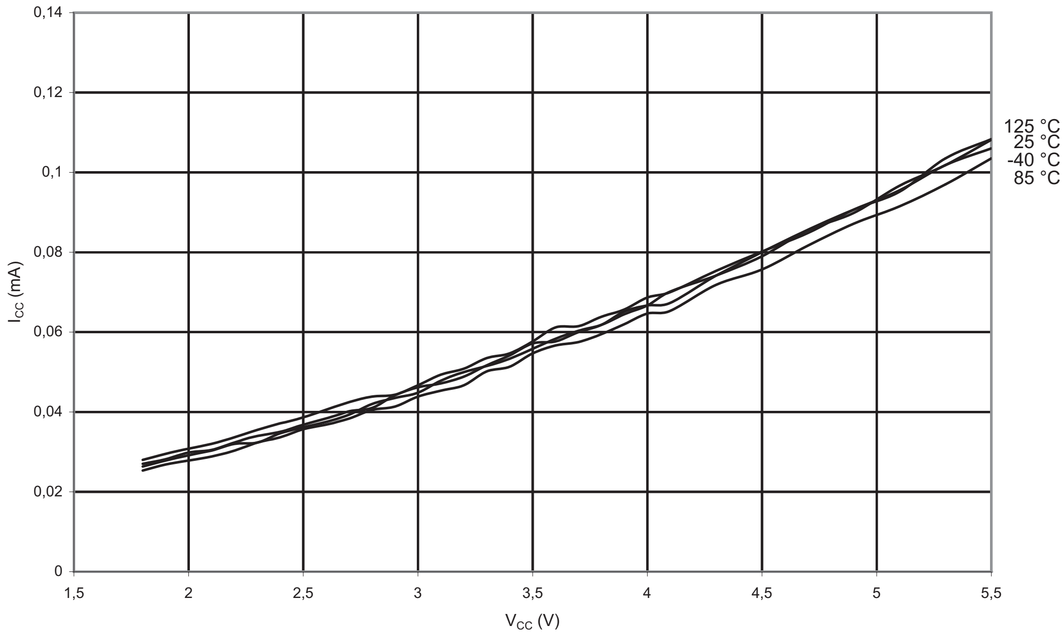


Figure 3-96. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.3.2 Current Consumption in Idle Mode

Figure 3-97. Idle Supply Current vs. Frequency (1 - 16MHz, PRR = 0xFF)

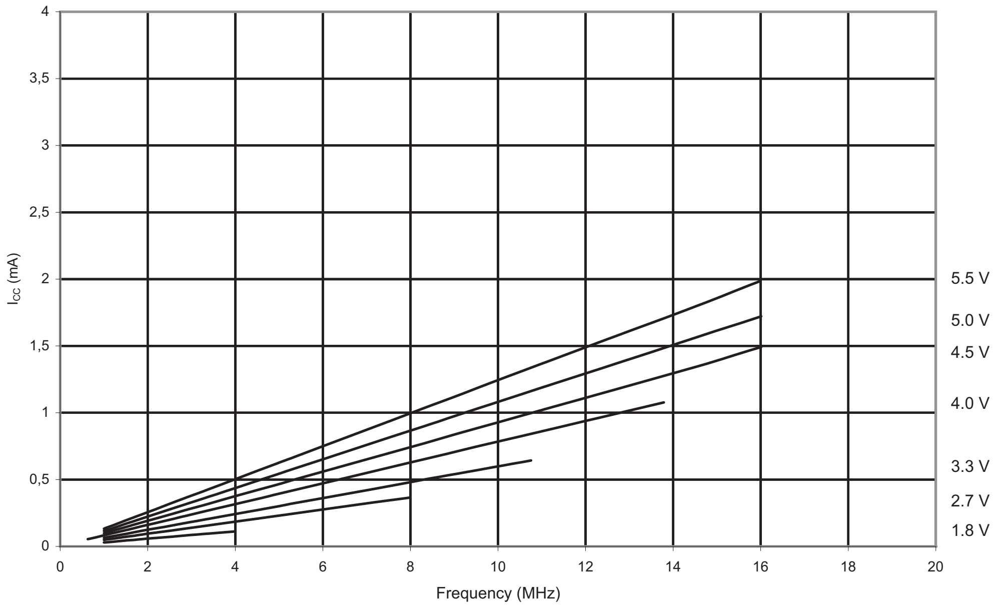


Figure 3-98. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 8 MHz)

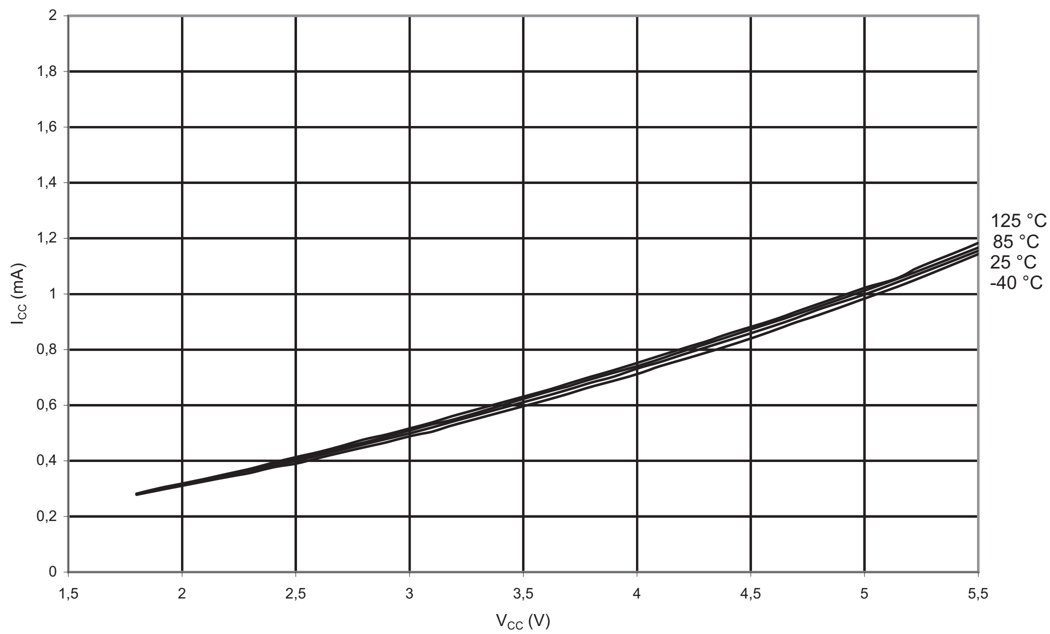


Figure 3-99. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

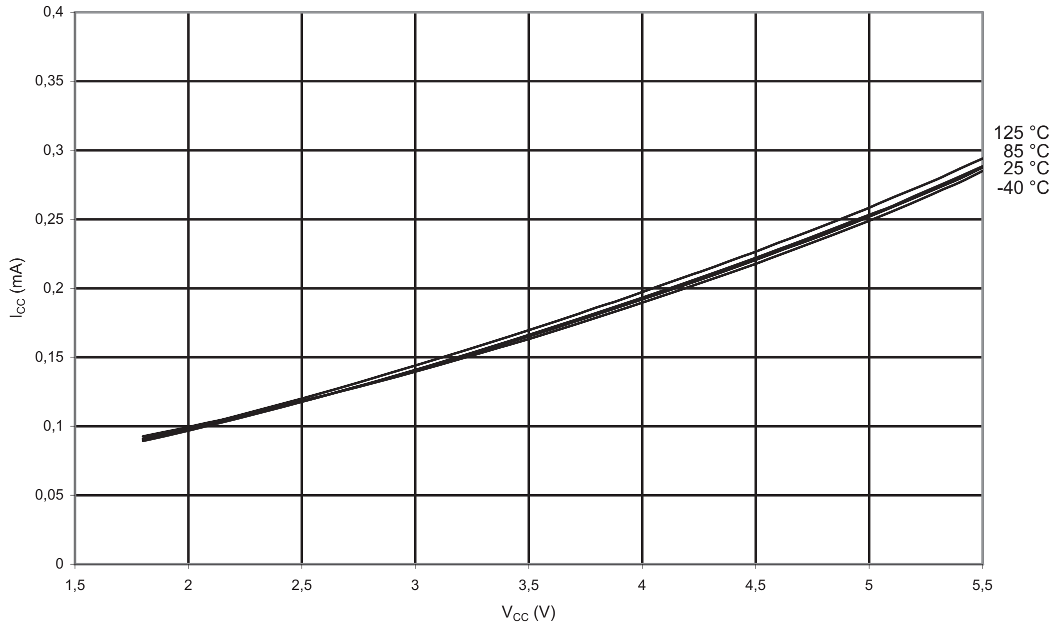
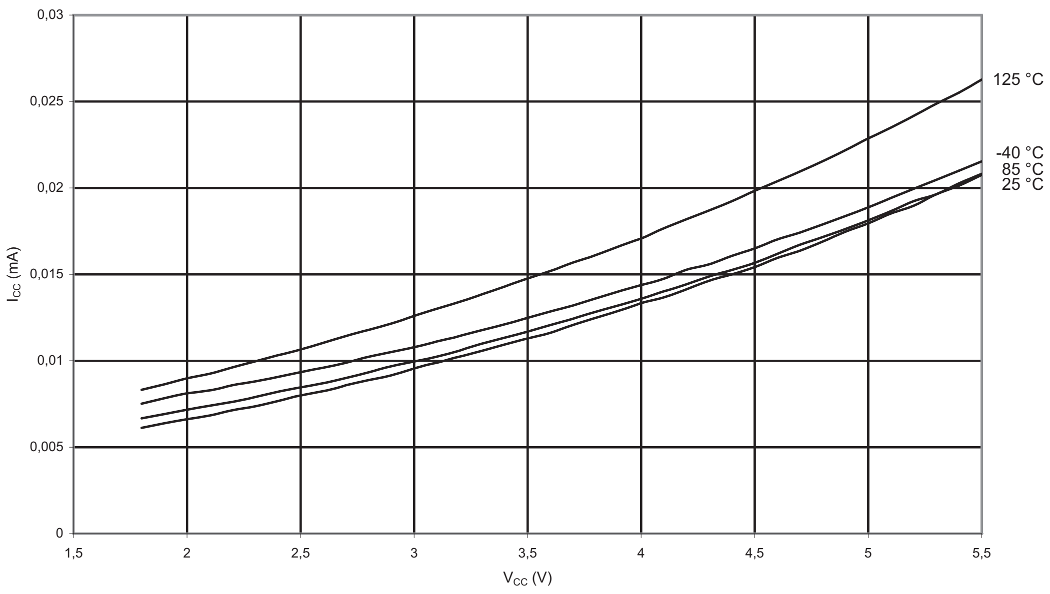


Figure 3-100.Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.3.3 Current Consumption in Power-down Mode

Figure 3-101.Power-down Supply Current vs. V_{CC} (Watchdog Timer Disabled)

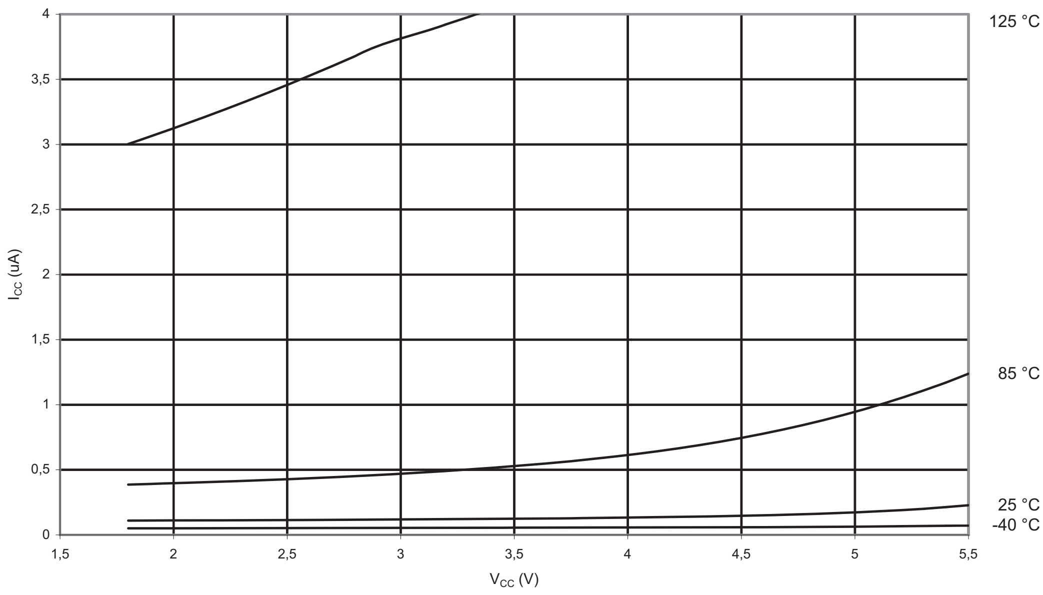
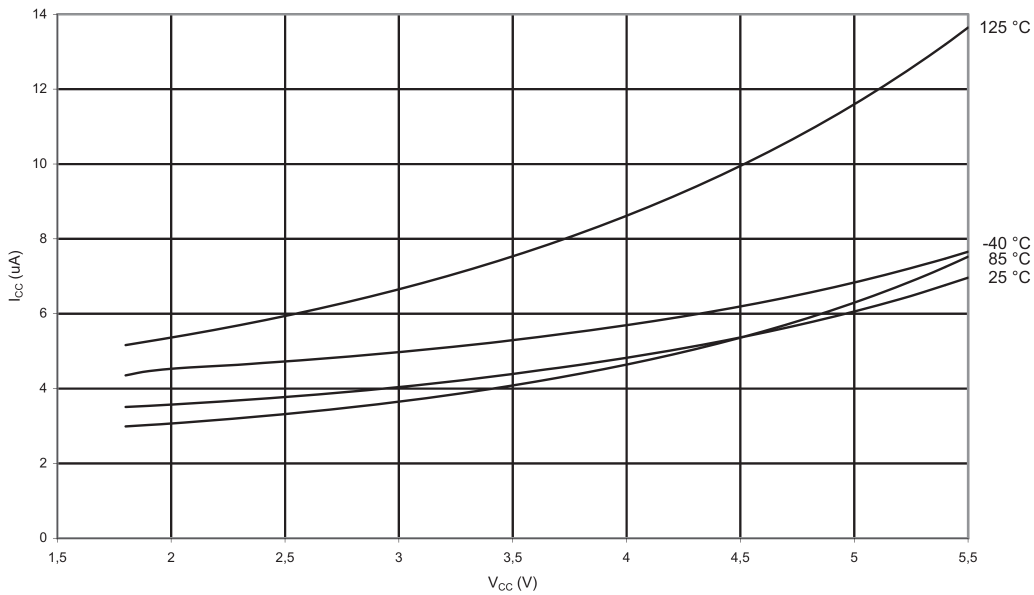
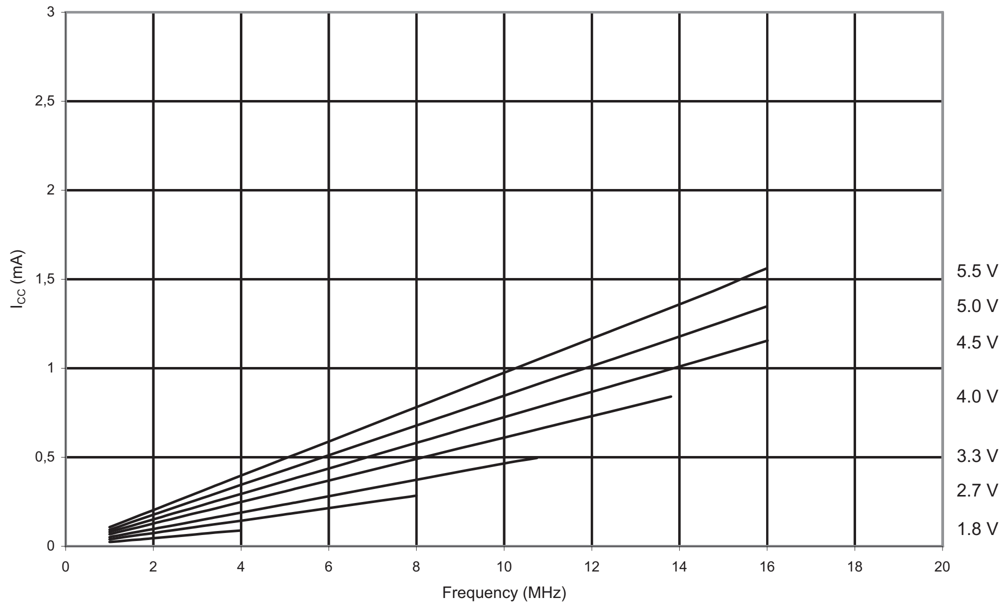


Figure 3-102.Power-down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



3.3.4 Current Consumption in Reset

Figure 3-103.Reset Supply Current vs. V_{CC} (1 - 16 MHz, Excluding Current through Reset Pull-up)



3.3.5 Current Consumption of Peripheral Units

Figure 3-104.Programming Current vs. V_{CC}

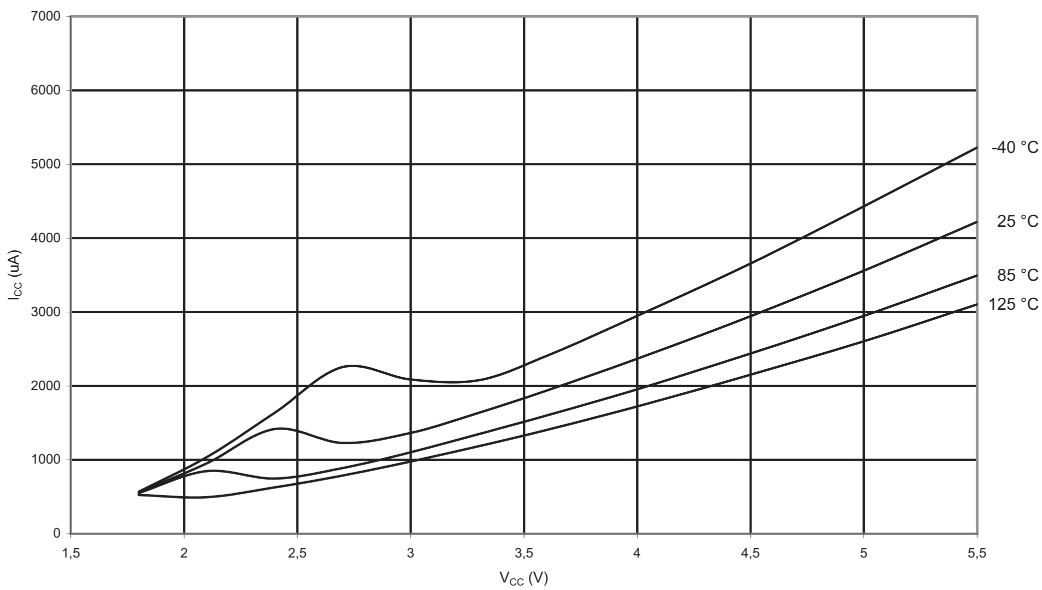
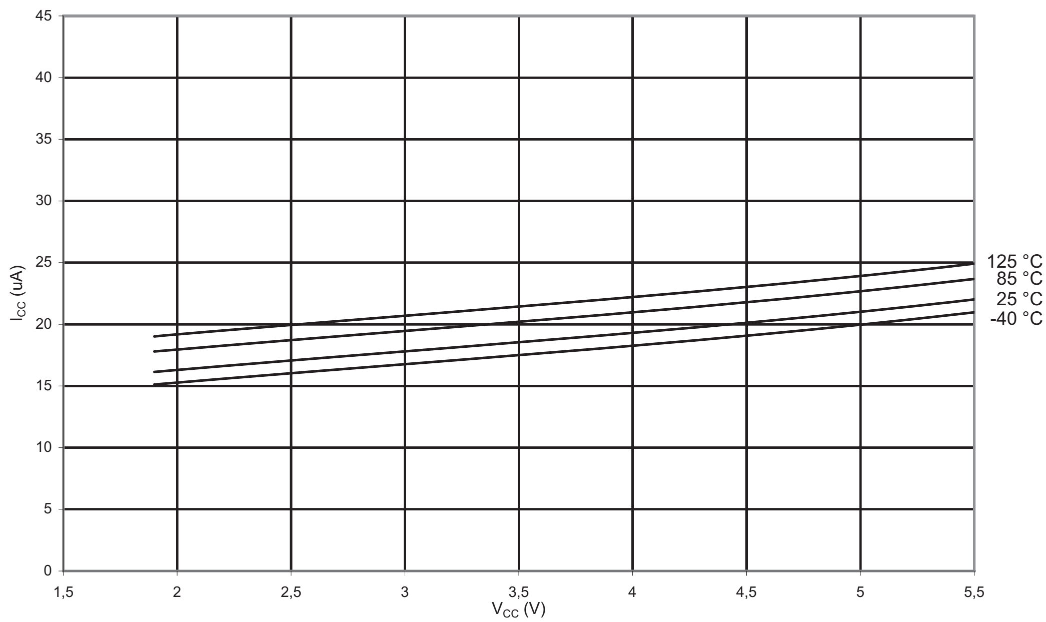


Figure 3-105.Brownout Detector Current vs. V_{CC} (BOD Level = 1.8V)



3.3.6 Pull-up Resistors

Figure 3-106.Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 1.8V)

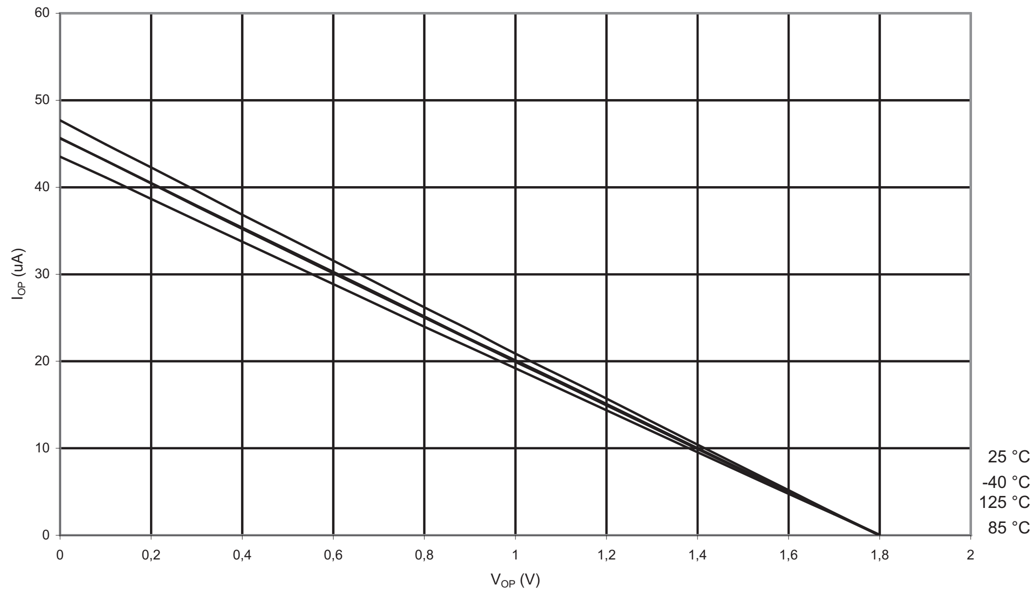


Figure 3-107.Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 2.7V)

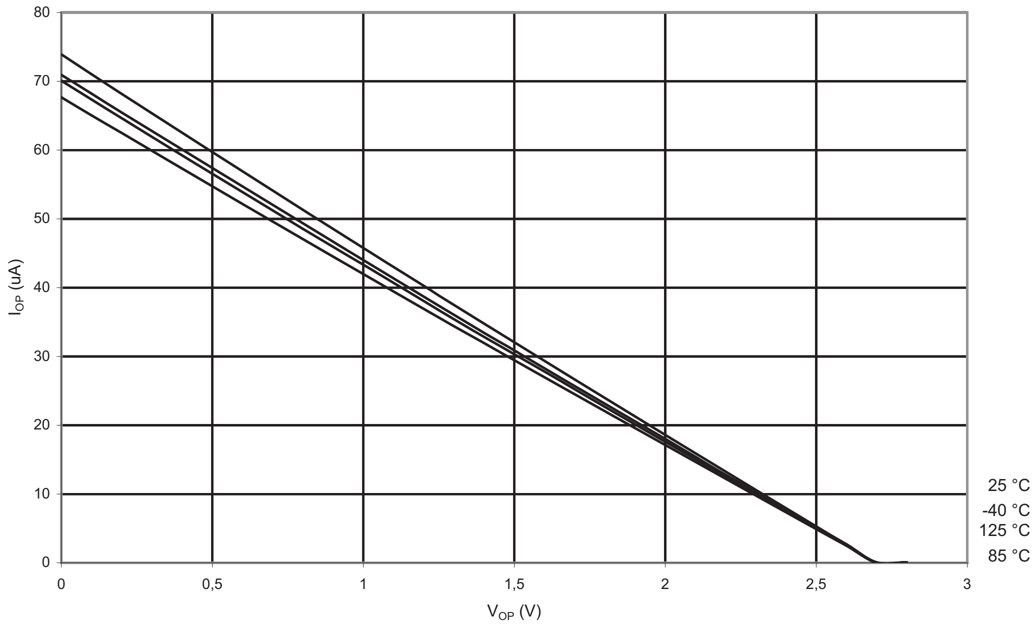


Figure 3-108.Pull-up Resistor Current vs. Input Voltage (I/O Pin, V_{CC} = 5V)

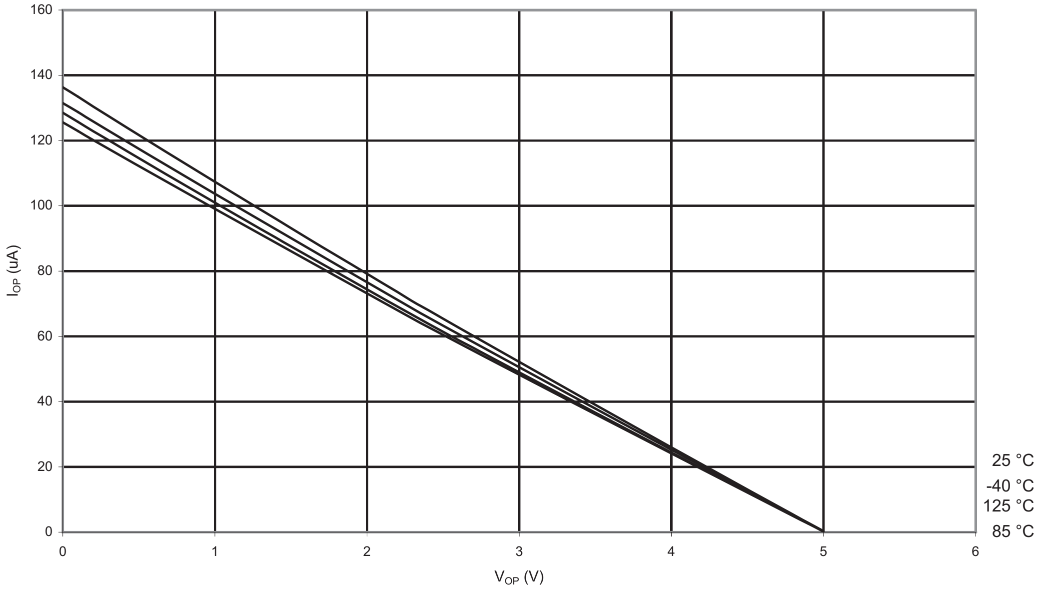


Figure 3-109.Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 1.8V)

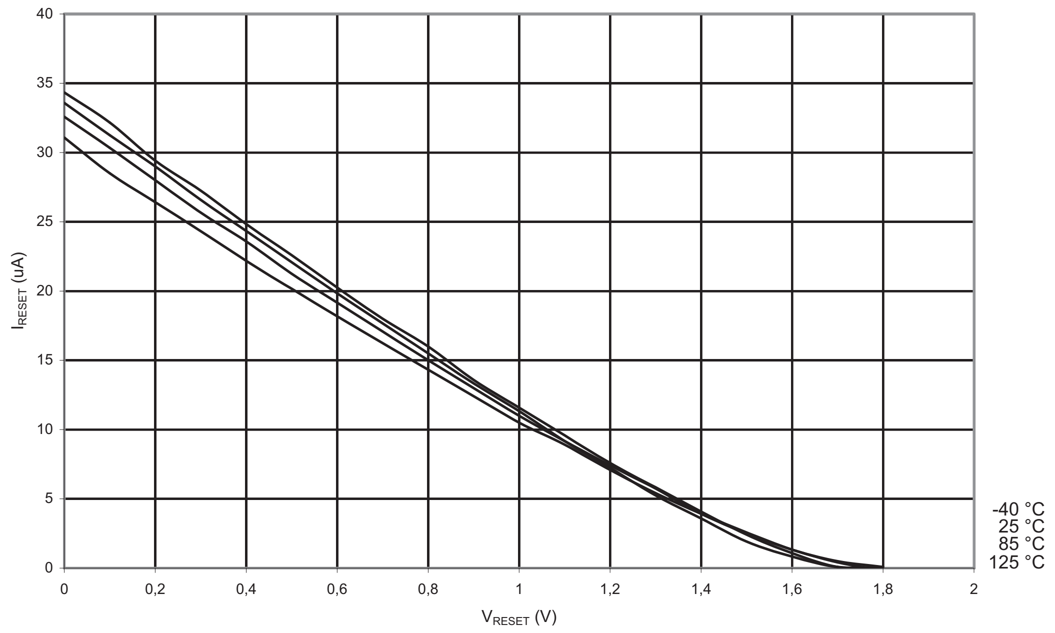


Figure 3-110.Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 2.7V)

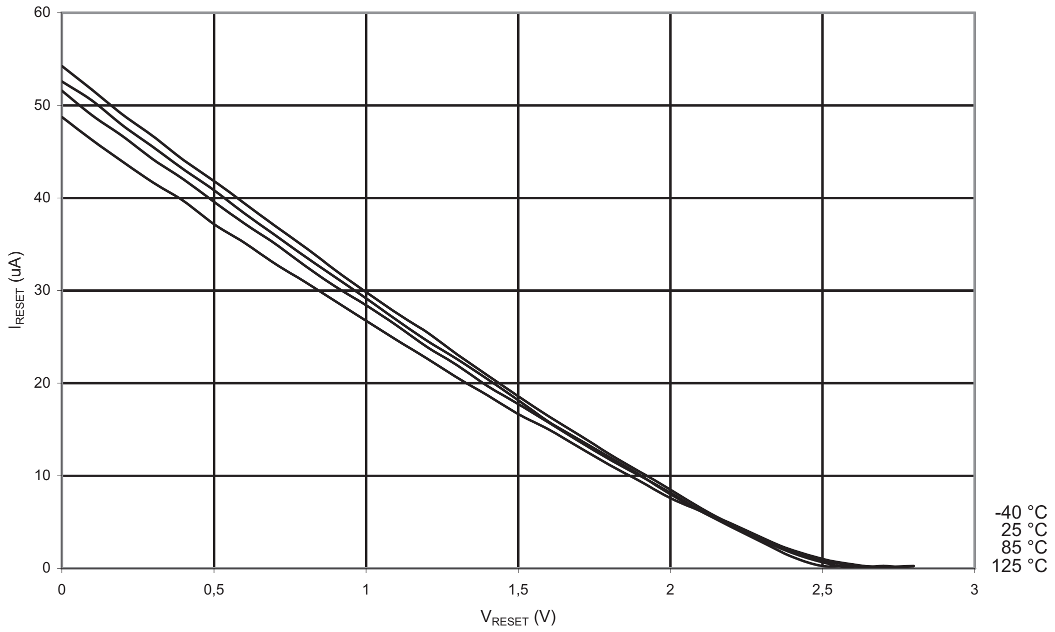
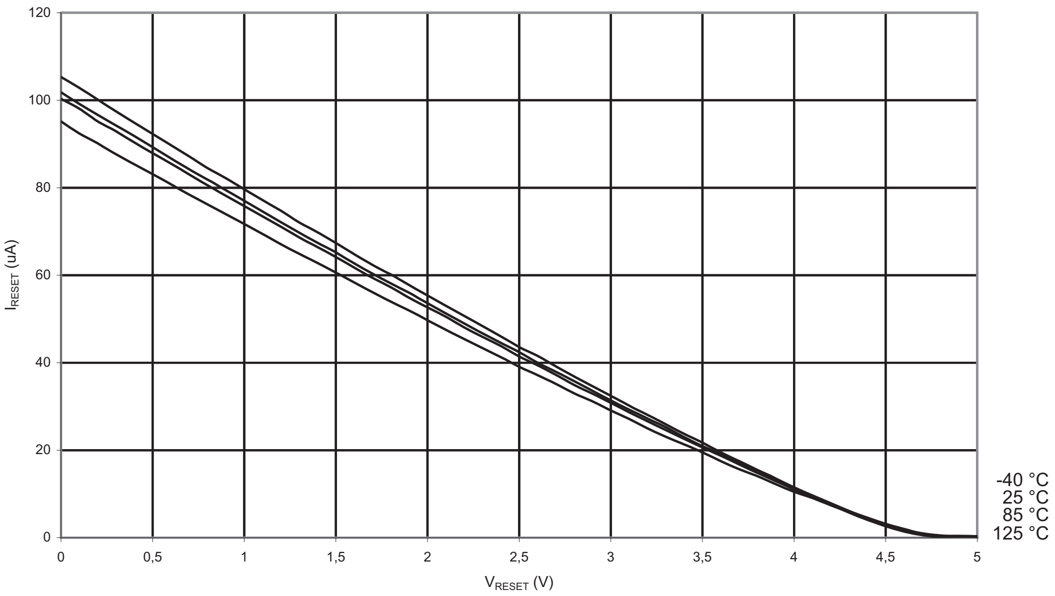


Figure 3-111.Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



3.3.7 Output Driver Strength

Figure 3-112.V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 3V)

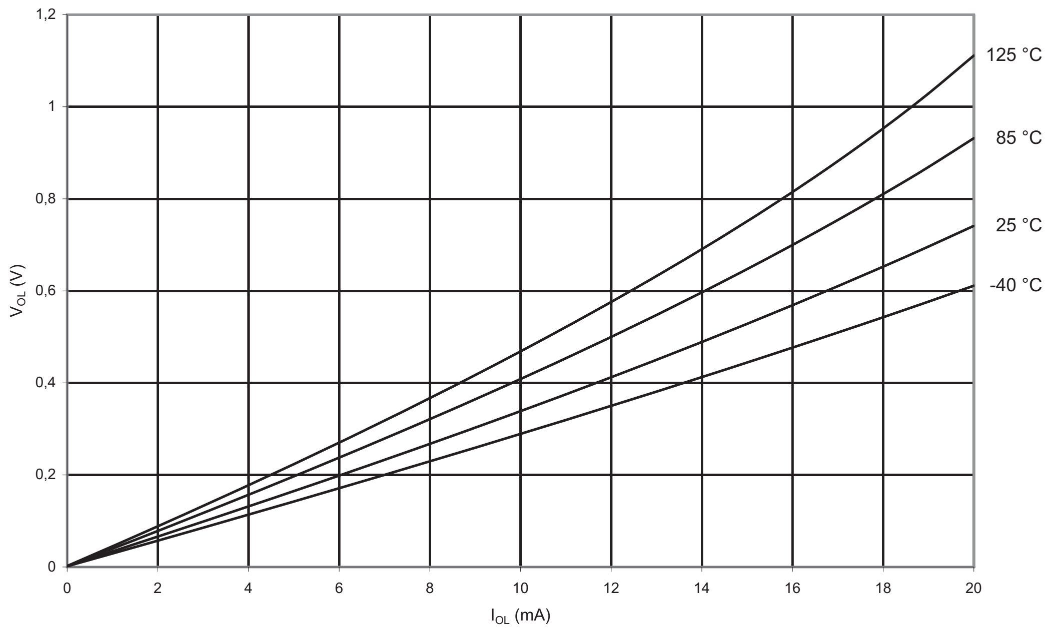


Figure 3-113.V_{OL}: Output Voltage vs. Sink Current (I/O Pin, V_{CC} = 5V)

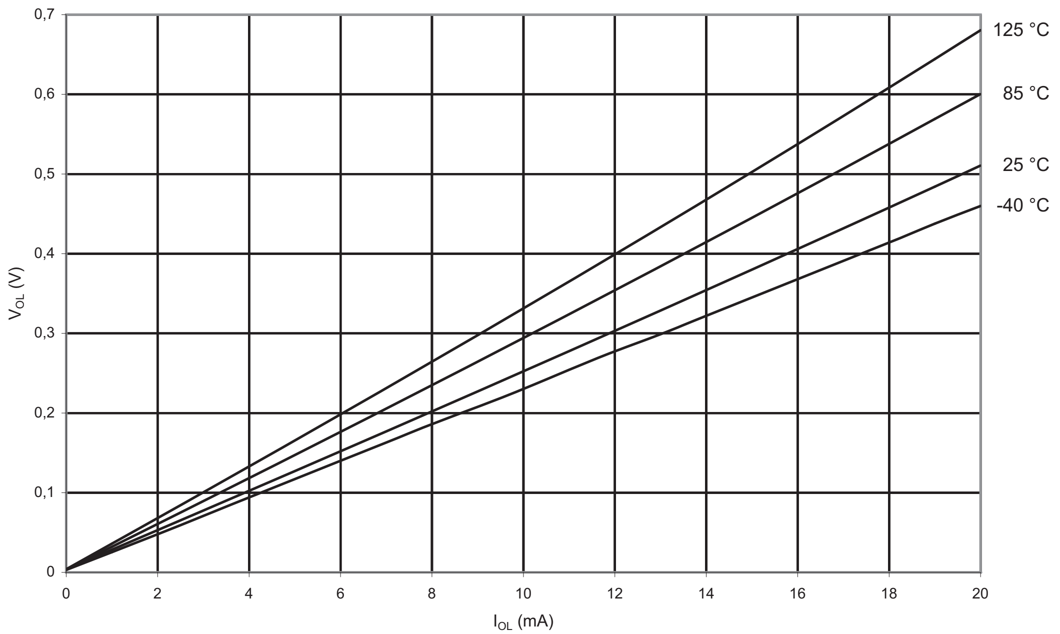


Figure 3-114.V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 3V)

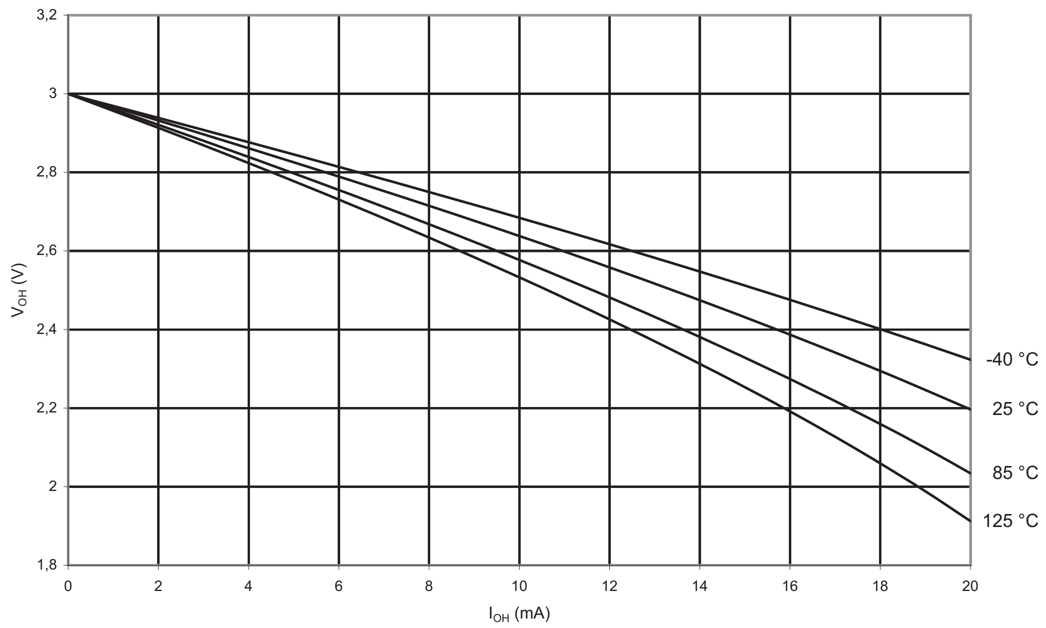


Figure 3-115. V_{OH}**: Output Voltage vs. Source Current (I/O Pin,** V_{CC} **= 5V)**

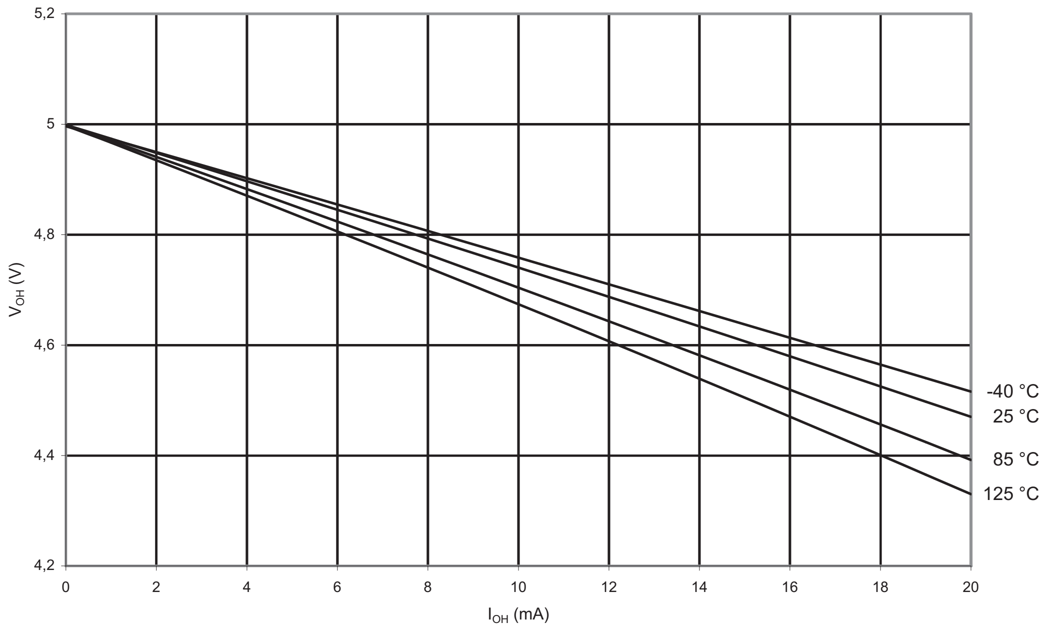


Figure 3-116. V_{OL}**: Output Voltage vs. Sink Current (Reset Pin as I/O,** V_{CC} **= 3V)**

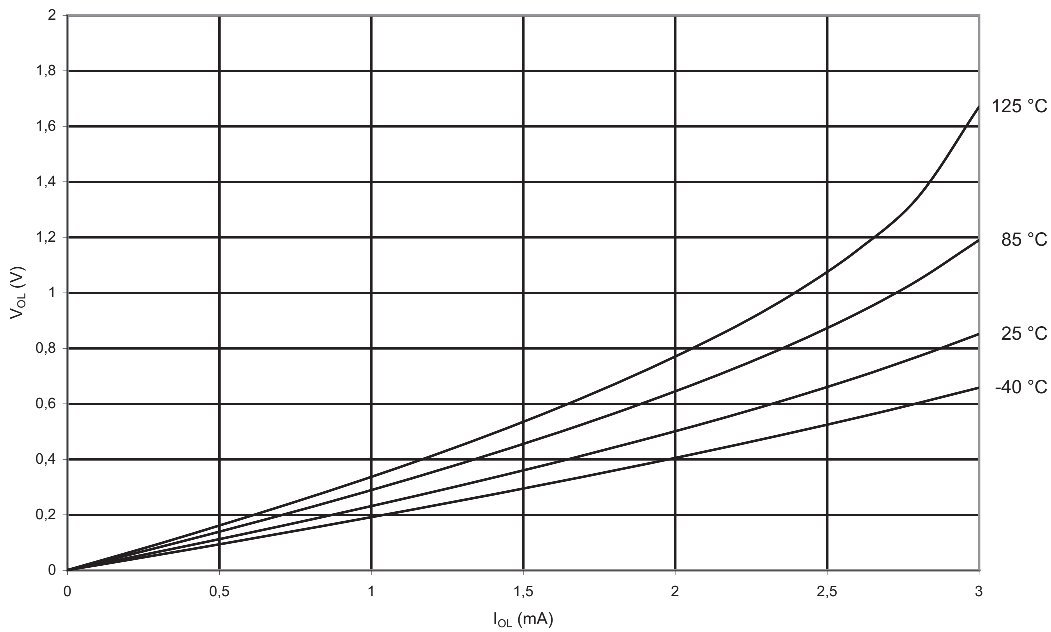


Figure 3-117.V_{OL}: Output Voltage vs. Sink Current (Reset Pin as I/O, V_{CC} = 5V)

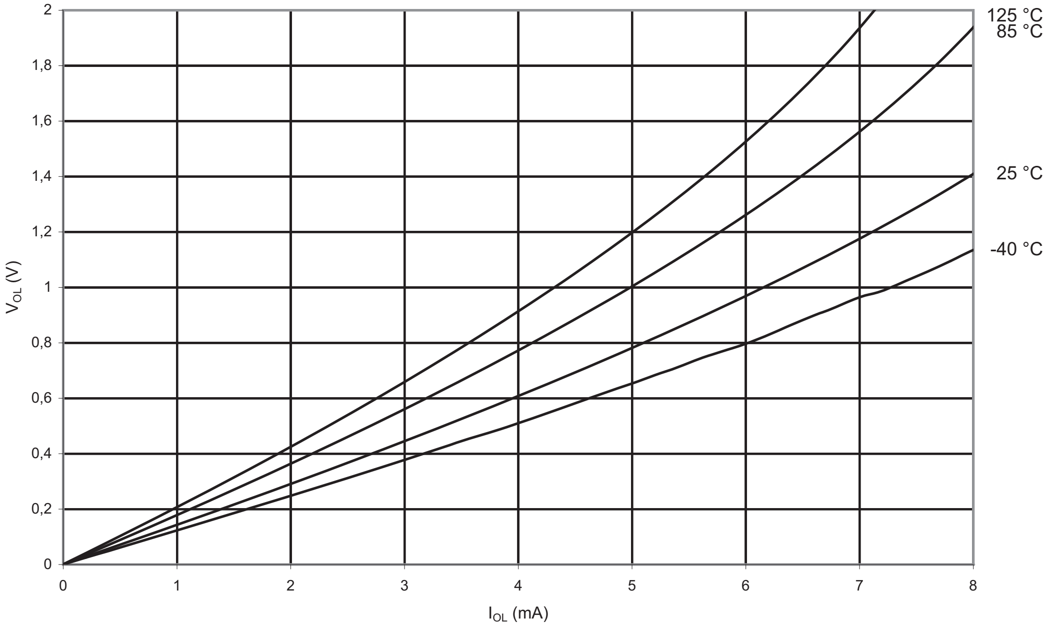


Figure 3-118.V_{OH}: Output Voltage vs. Source Current (Reset Pin as I/O, V_{CC} = 3V)

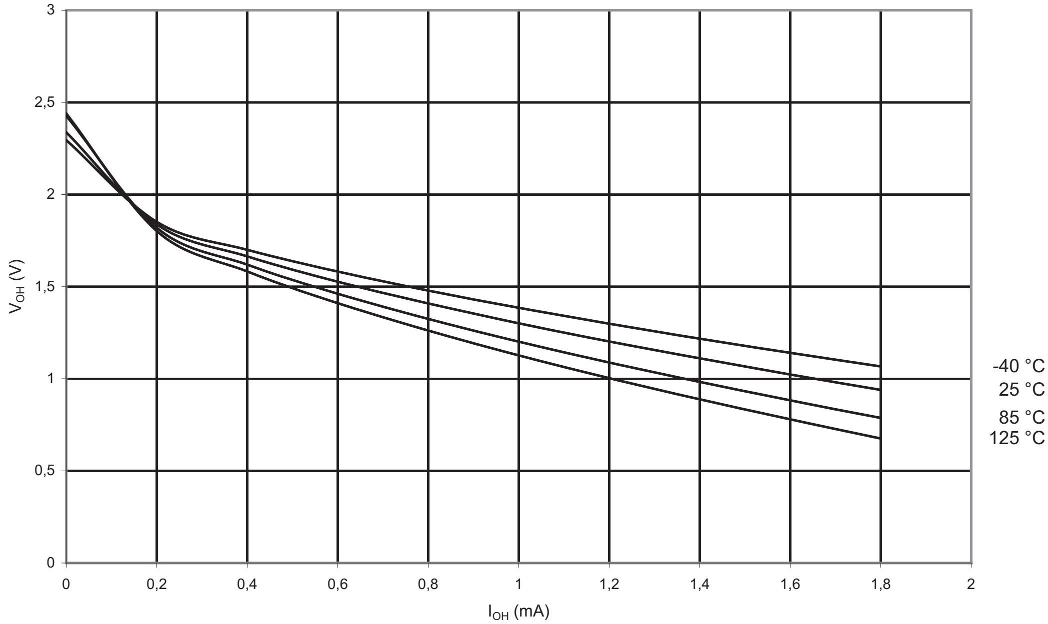
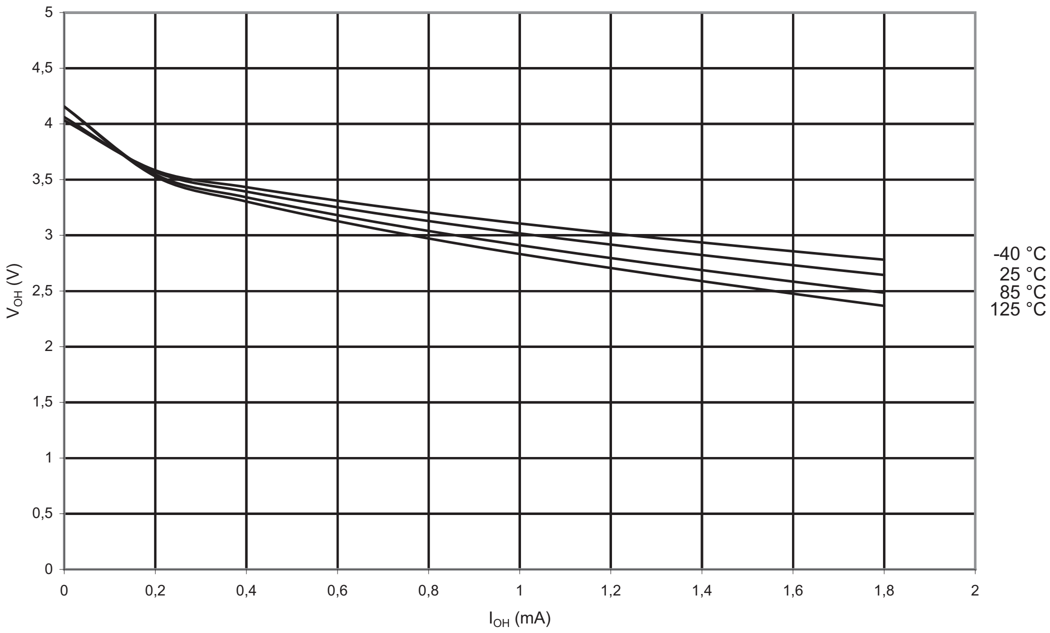


Figure 3-119.V_{OH}: Output Voltage vs. Source Current (Reset Pin as I/O, V_{CC} = 5V)



3.3.8 Input Threshold and Hysteresis (for I/O Ports)

Figure 3-120.V_{IH}: Input Threshold Voltage vs. V_{CC} (I/O Pin, Read as '1')

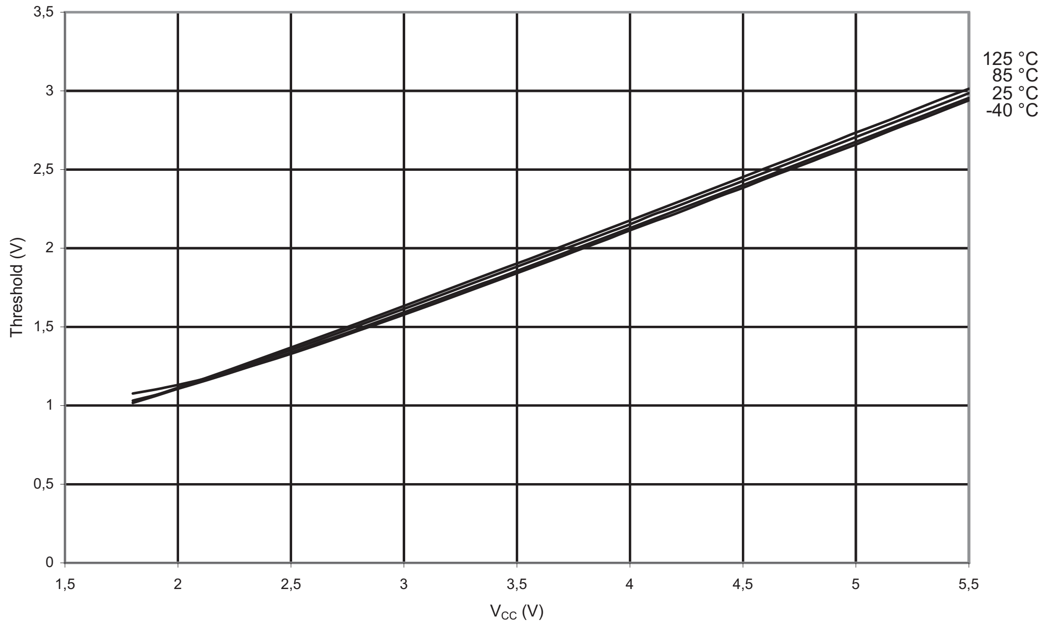


Figure 3-121. V_{IL}**: Input Threshold Voltage vs.** V_{CC} **(I/O Pin, Read as '0')**

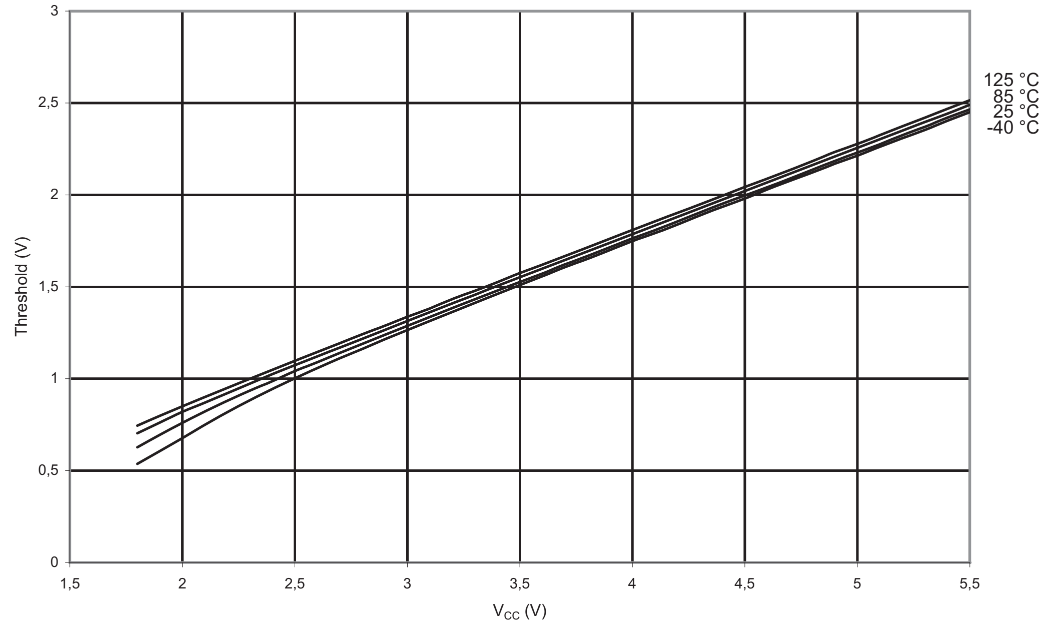


Figure 3-122. V_{IH}-V_{IL}**: Input Hysteresis vs.** V_{CC} **(I/O Pin)**

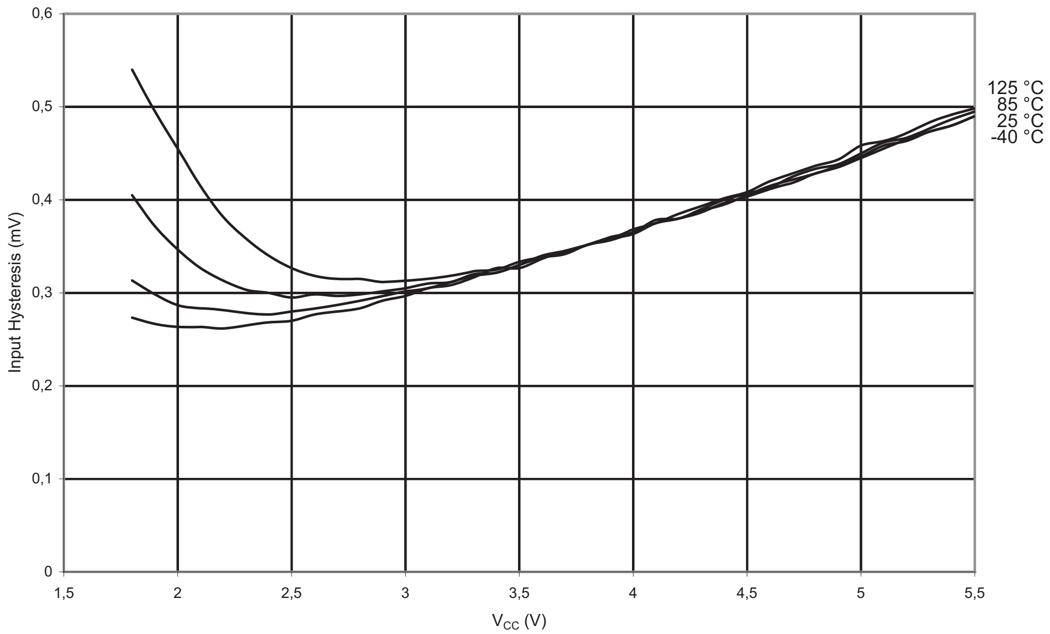


Figure 3-123.V_{IH}: Input Threshold Voltage vs. V_{CC} (Reset Pin as I/O, Read as ‘1’)

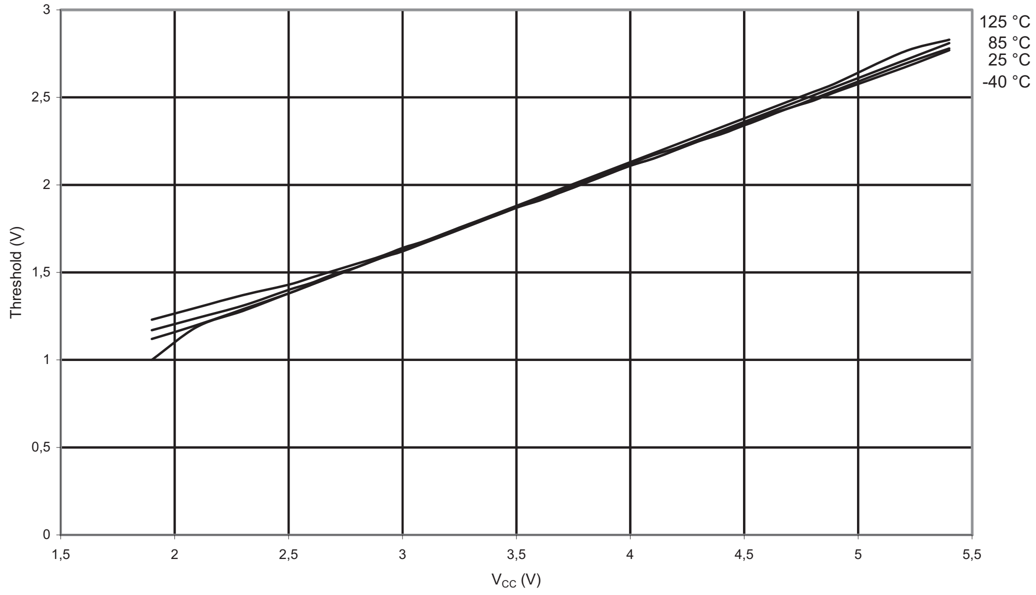


Figure 3-124.V_{IL}: Input Threshold Voltage vs. V_{CC} (Reset Pin as I/O, Read as ‘0’)

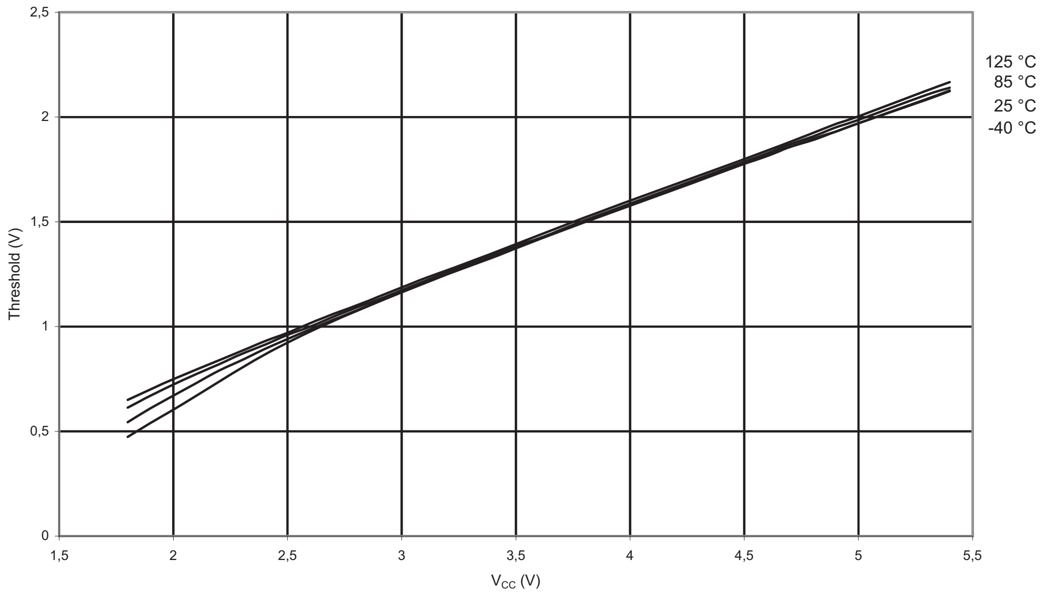
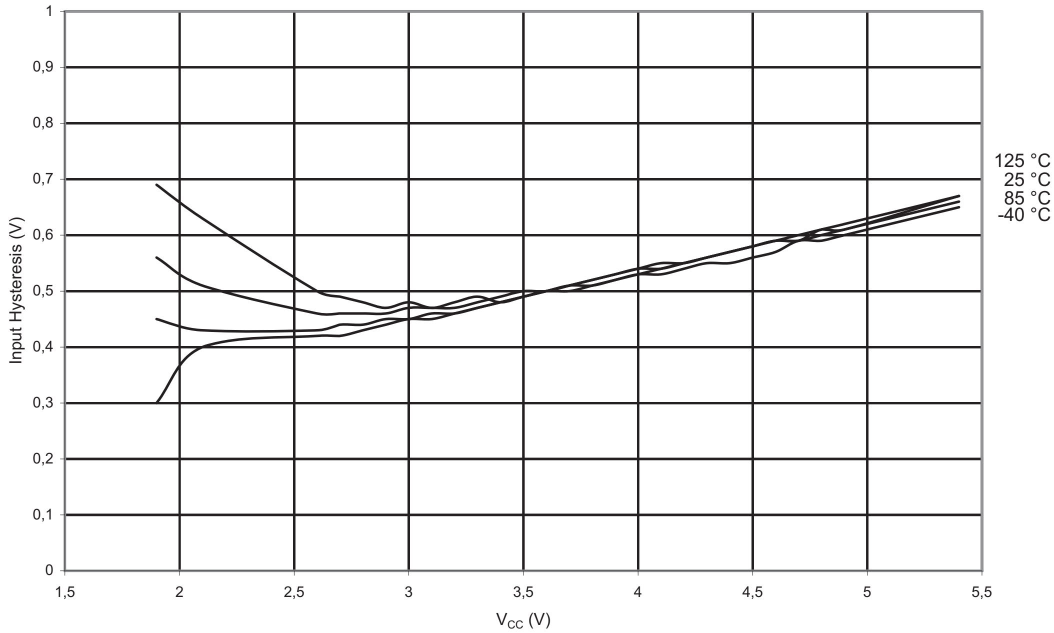


Figure 3-125.V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin as I/O)



3.3.9 BOD, Bandgap and Reset

Figure 3-126.BOD Threshold vs. Temperature (BODLEVEL = 4.3V)

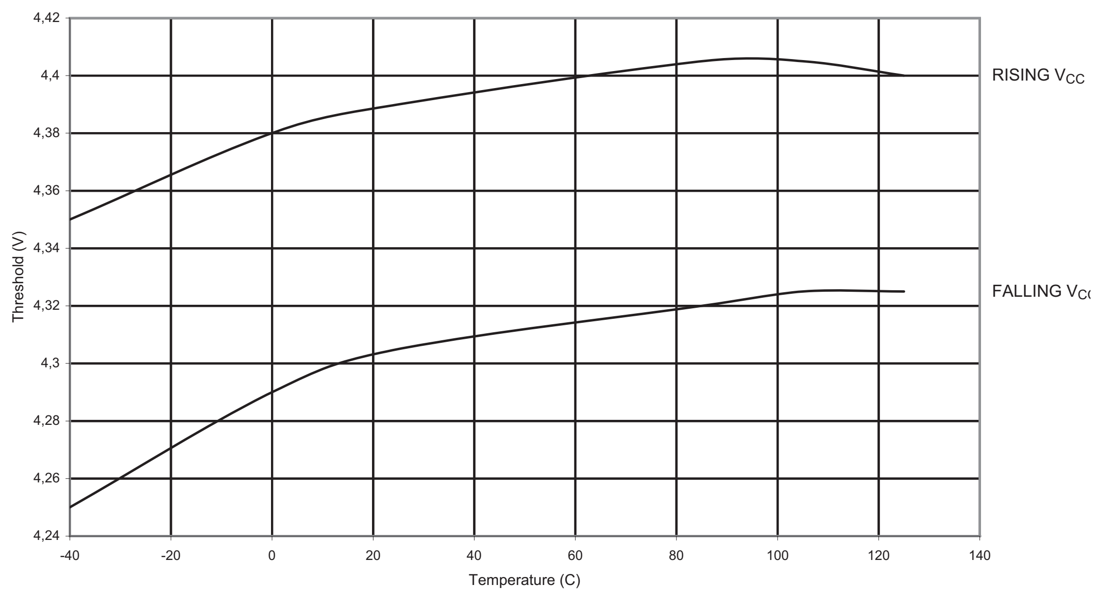


Figure 3-127.BOD Threshold vs. Temperature (BODLEVEL = 2.7V)

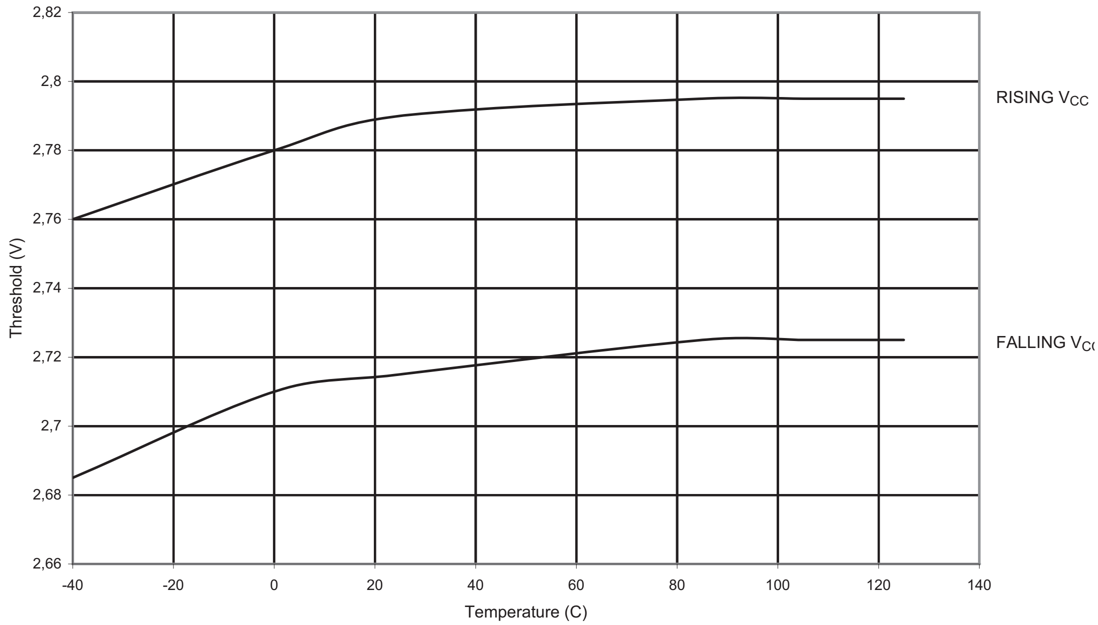


Figure 3-128.Bandgap Voltage vs. Temperature (V_{CC} =5V)

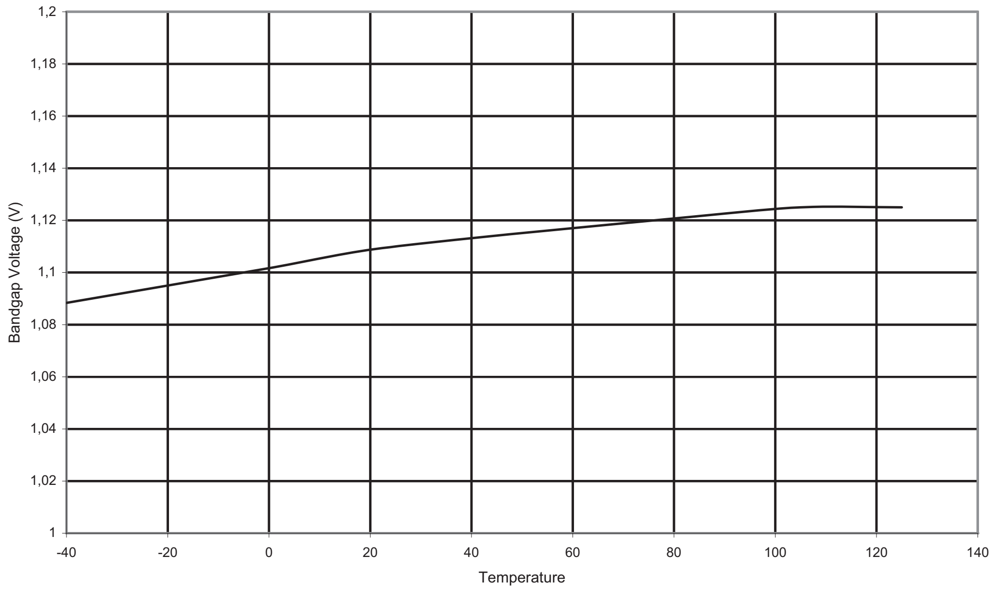


Figure 3-129. V_{IH}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '1')

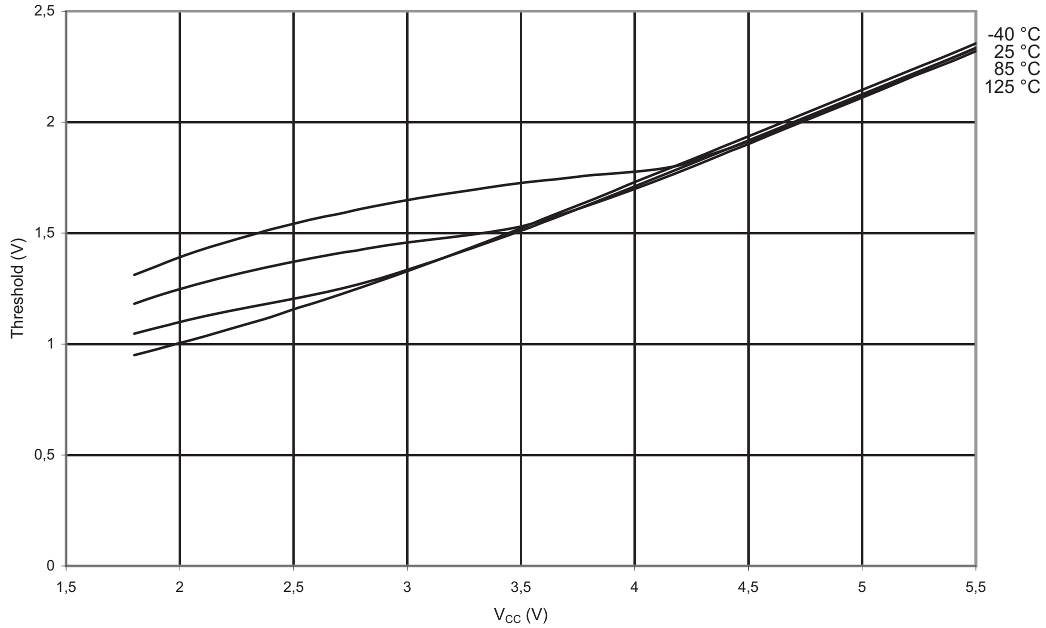


Figure 3-130. V_{IL}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '0')

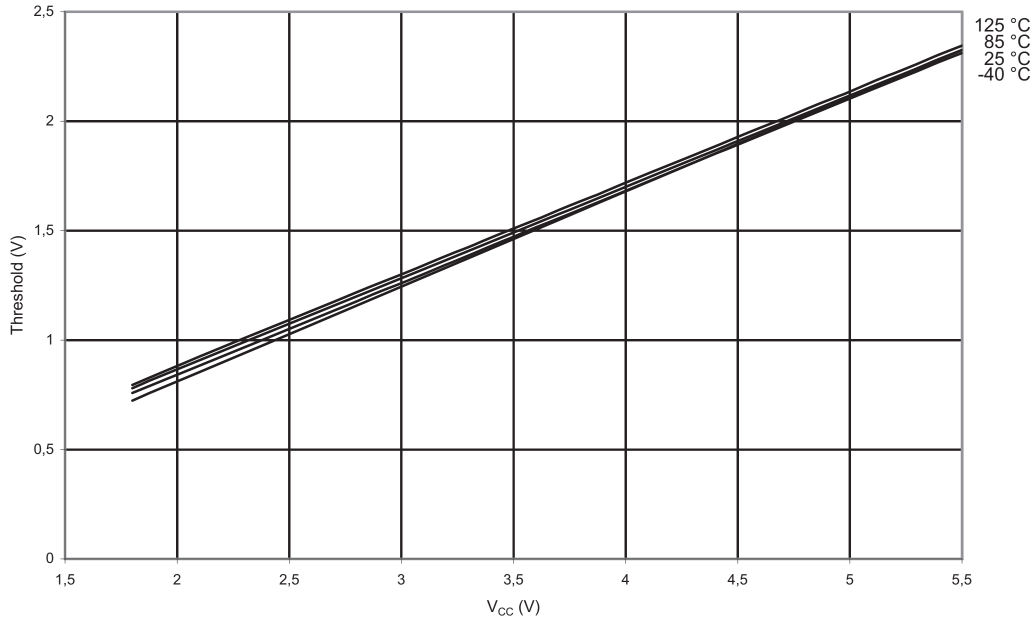


Figure 3-131.V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin)

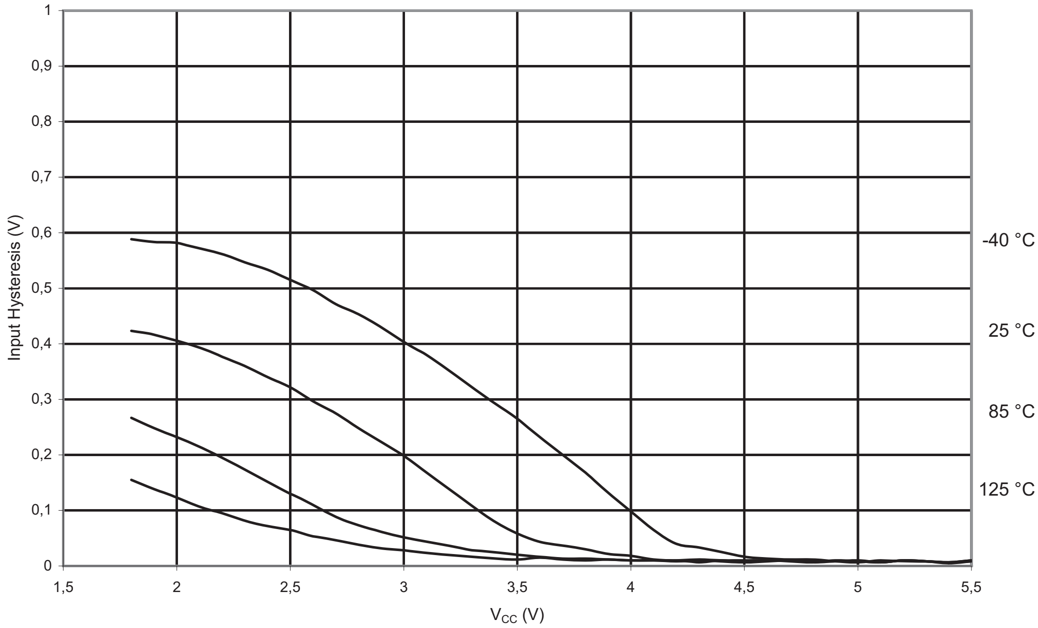
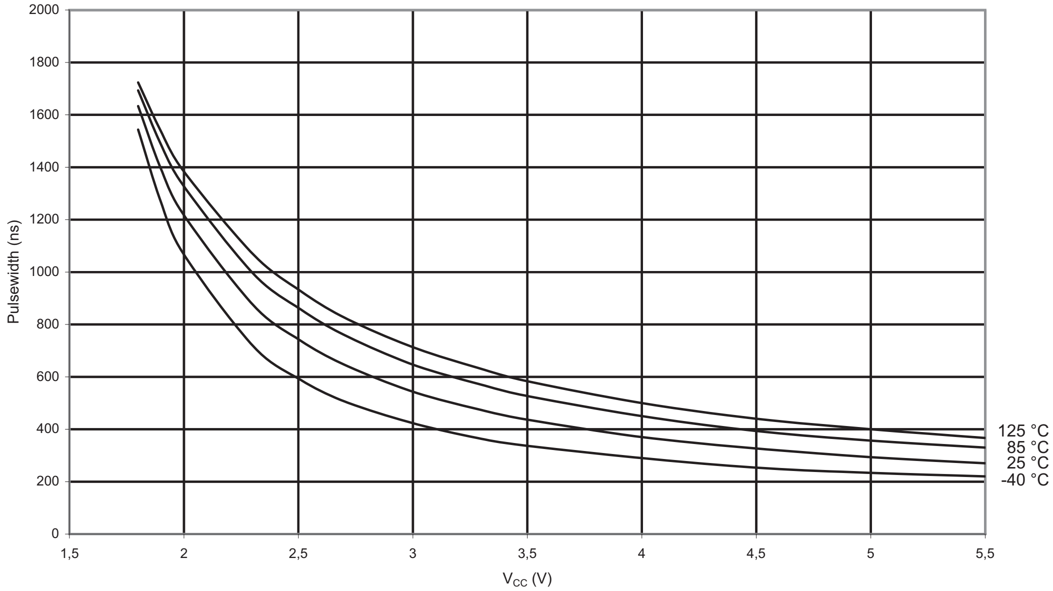
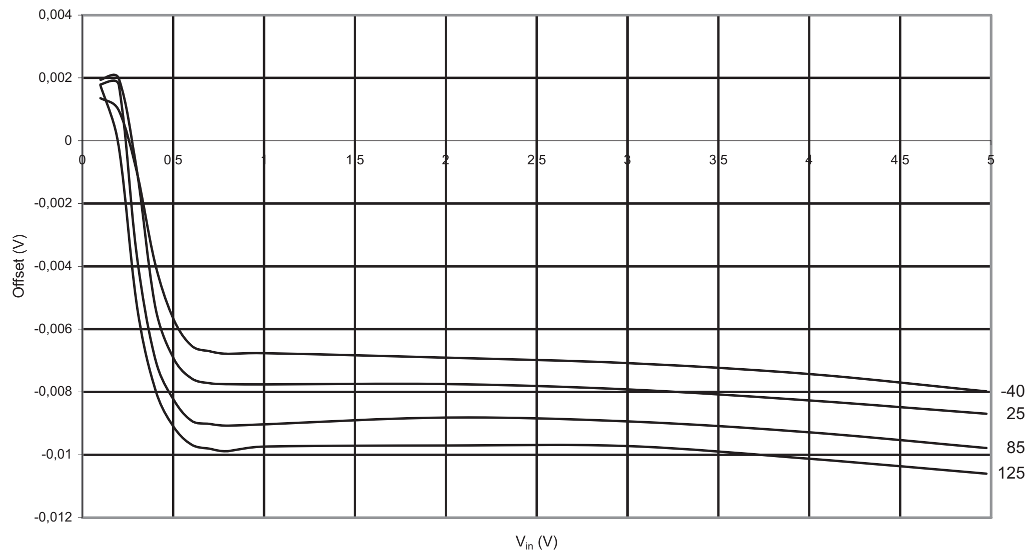


Figure 3-132.Minimum Reset Pulse Width vs. V_{CC}



3.3.10 Analog Comparator Offset

Figure 3-133.Analog Comparator Offset (V_{CC} = 5V)



3.3.11 Internal Oscillator Speed

Figure 3-134.Watchdog Oscillator Frequency vs. V_{CC}

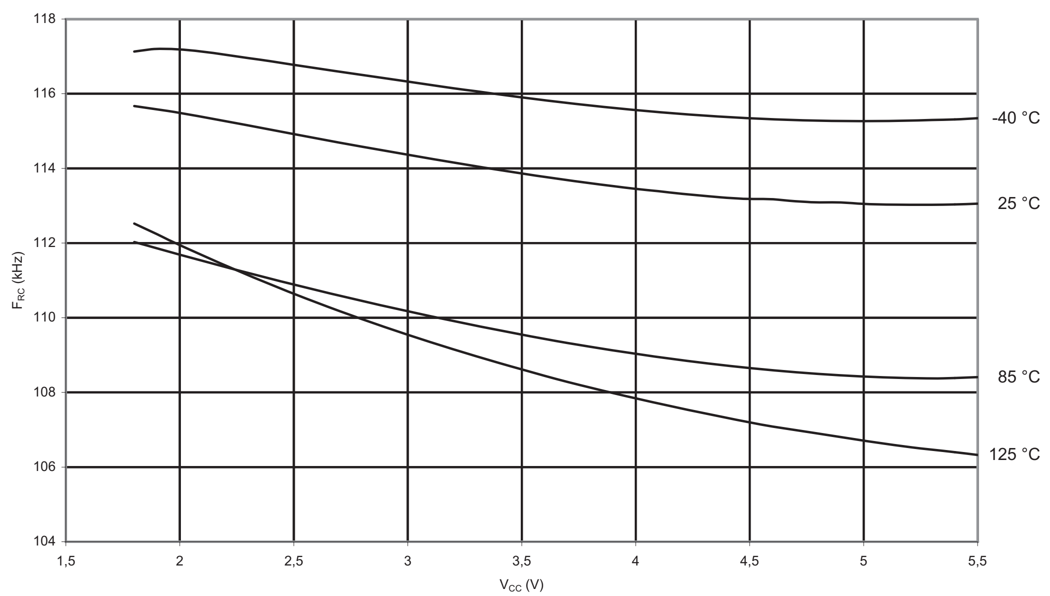


Figure 3-135.Watchdog Oscillator Frequency vs. Temperature

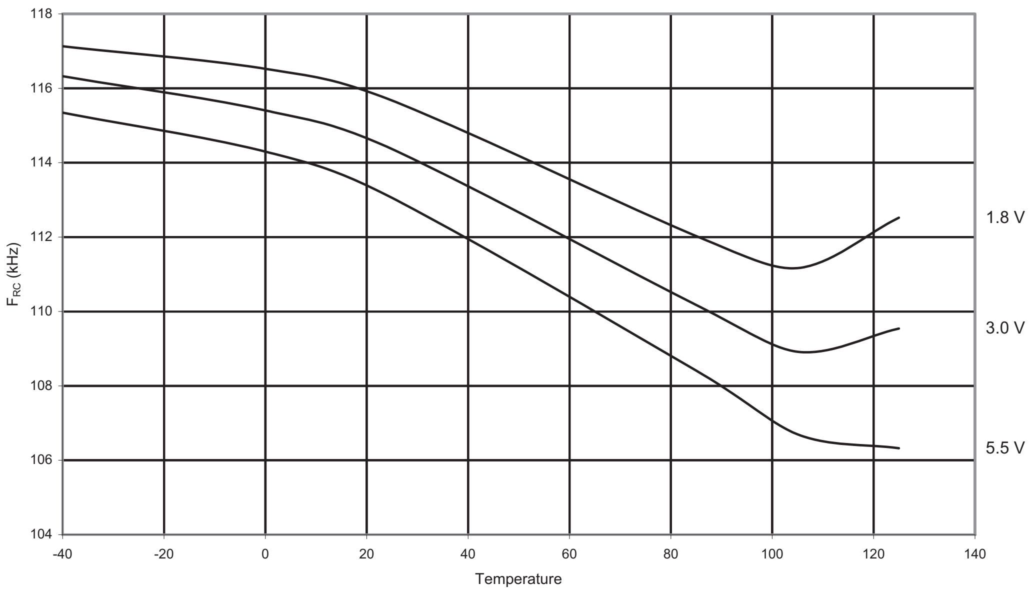


Figure 3-136.Calibrated 8 MHz RC Oscillator Frequency vs. V_{CC}

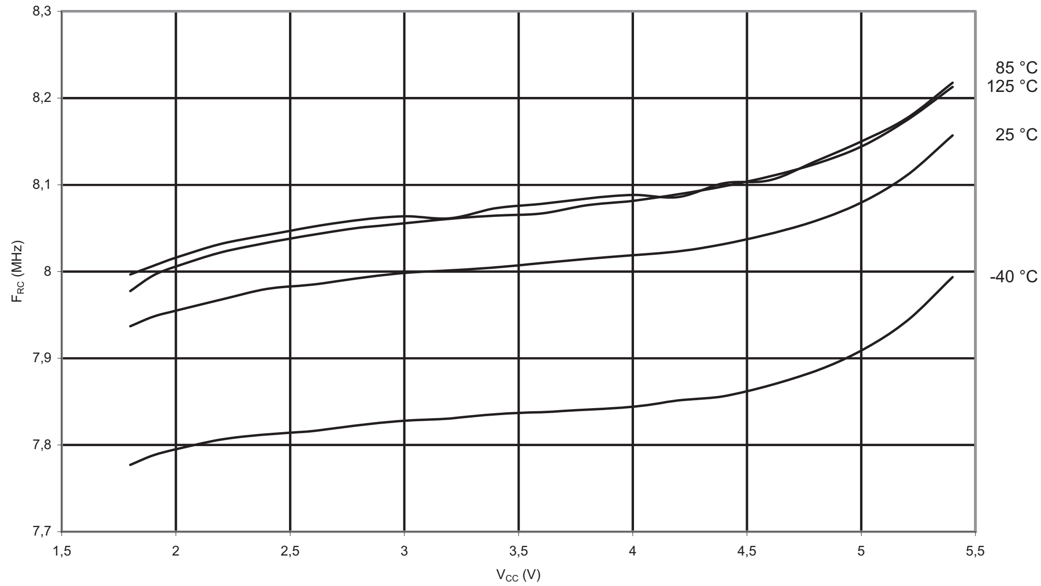


Figure 3-137.Calibrated 8 MHz RC Oscillator Frequency vs. Temperature

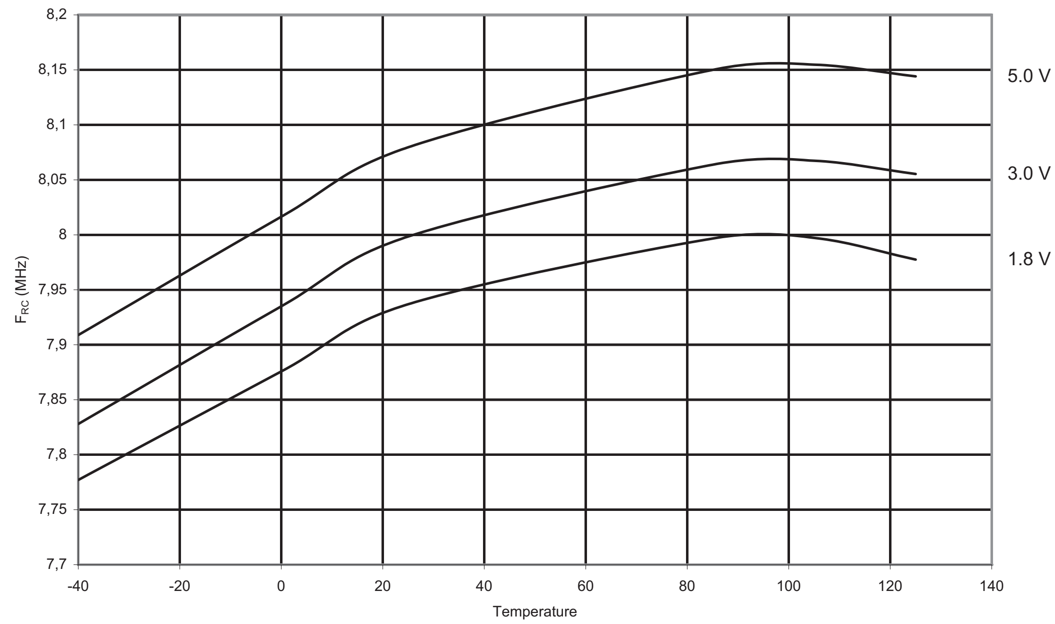
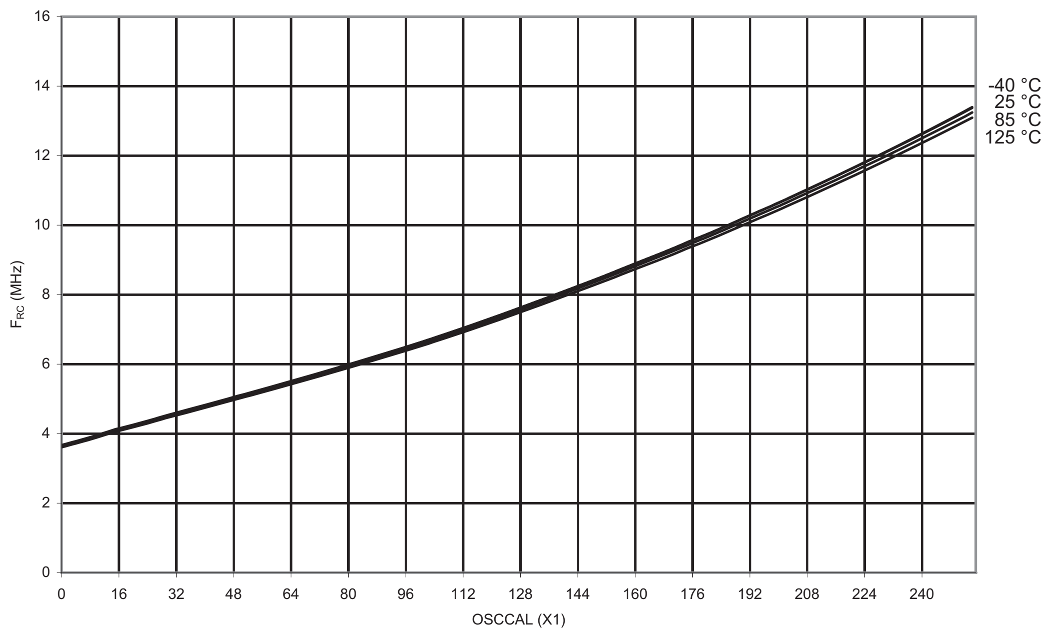


Figure 3-138.Calibrated 8 MHz RC Oscillator Frequency vs. OSCCAL Value



4. Ordering Information

4.1 ATtiny24A

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
20	1.8 – 5.5V	Industrial (-40°C to +125°C)	14S1	ATtiny24A-SSF
				ATtiny24A-SSFR
			20M1	ATtiny24A-MF
				ATtiny24A-MFR
			20M2	ATtiny24A-MM8
				ATtiny24A-MM8R

Notes:
1. For speed vs. supply voltage, see section 2.3 “Speed” on page 5.
2. All packages are Pb-free, halide-free and fully green and they comply with the European directive for Restriction of Hazardous Substances (RoHS).
3. Code indicators:
   - F: matte tin
   - R: tape & reel

Package Type	
14S1	14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No Lead / Micro Lead Frame Package (QFN/MLF)
20M2	20-pad, 3 x 3 x 0.85 mm Body, Very Thin Quad Flat No Lead Package (VQFN)

4.2 ATtiny44A

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
20	1.8 – 5.5V	Industrial (-40°C to +125°C)	14S1	ATtiny44A-SSF
				ATtiny44A-SSFR
			20M1	ATtiny44A-MF
				ATtiny44A-MFR

Notes:
1. For speed vs. supply voltage, see section 2.3 “Speed” on page 5.
2. All packages are Pb-free, halide-free and fully green and they comply with the European directive for Restriction of Hazardous Substances (RoHS).
3. Code indicators:
   - F: matte tin
   - R: tape & reel

Package Type	
14S1	14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No Lead / Micro Lead Frame Package (QFN/MLF)

4.3 ATtiny84A

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
16	1.8 – 5.5V	Industrial (-40°C to +125°C)	14S1	ATtiny84A-SSF
				ATtiny84A-SSFR
			20M1	ATtiny84A-MF
				ATtiny84A-MFR

Notes: 1. For speed vs. supply voltage, see section 2.3 “Speed” on page 5.

2. All packages are Pb-free, halide-free and fully green and they comply with the European directive for Restriction of Hazardous Substances (RoHS).

3. Code indicators:

- F: matte tin
- R: tape & reel

Package Type	
14S1	14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No Lead / Micro Lead Frame Package (QFN/MLF)

5. Revision History

Revision No.	History
8183A: Appendix B–AVR–12/10	Initial revision
8183D: Appendix B–AVR–08/11	Added tape&reel order codes
8183E: Appendix B–AVR–01/12	Added ATtiny84A
8183F: Appendix B–AVR–06/12	Updated order codes for ATtiny24A
8183G: Appendix B–AVR–10/12	Relaxed ATtiny84A speed limits (Section 2.3 on page 5, Table 2-8 on page 10, Section 2.8 on page 10, Figure 3-93 on page 57, Figure 3-97 on page 59, Figure 3-103 on page 62, and Section 4.3 on page 82). Updated document template.
8183H: Appendix B-AVR-10/13	Updated ordering codes for ATtiny84A: -MF and -MFR options added.

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