Appendix B — ATtiny25/V 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.

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

ATtiny25
ATtiny25V

Appendix B

Rev. 2586N-Appendix B–AVR–08/11

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 DC Characteristics

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

Symbol	Parameter	Condition	Min.	Typ.[1]	Max.	Units
V_{IL}	Input Low-voltage, except XTAL1 and $\overline{RESET}$ pin	V_{CC} = 1.8V - 2.4V V_{CC} = 2.4V - 5.5V	-0.5 -0.5		$0.2V_{CC}$[3] $0.3V_{CC}$[3]	V V
V_{IH}	Input High-voltage, except XTAL1 and $\overline{RESET}$ pin	V_{CC} = 1.8V - 2.4V V_{CC} = 2.4V - 5.5V	$0.7V_{CC}$[2] $0.6V_{CC}$[2]		V_{CC} +0.5 V_{CC} +0.5	V V
V_{IL1}	Input Low-voltage, XTAL1 pin, External Clock Selected	V_{CC} = 1.8V - 5.5V	-0.5		$0.1V_{CC}$[3]	V
V_{IH1}	Input High-voltage, XTAL1 pin, External Clock Selected	V_{CC} = 1.8V - 2.4V V_{CC} = 2.4V - 5.5V	$0.8V_{CC}$[2] $0.7V_{CC}$[2]		V_{CC} +0.5 V_{CC} +0.5	V V
V_{IL2}	Input Low-voltage, $\overline{RESET}$ pin	V_{CC} = 1.8V - 5.5V	-0.5		$0.2V_{CC}$[3]	V V
V_{IH2}	Input High-voltage, $\overline{RESET}$ pin	V_{CC} = 1.8V - 5.5V	$0.9V_{CC}$[2]		V_{CC} +0.5	V
V_{IL3}	Input Low-voltage, $\overline{RESET}$ pin as I/O	V_{CC} = 1.8V - 2.4V V_{CC} = 2.4V - 5.5V	-0.5 -0.5		$0.2V_{CC}$[3] $0.3V_{CC}$[3]	V V
V_{IH3}	Input High-voltage, $\overline{RESET}$ pin as I/O	V_{CC} = 1.8V - 2.4V V_{CC} = 2.4V - 5.5V	$0.7V_{CC}$[2] $0.6V_{CC}$[2]		V_{CC} +0.5 V_{CC} +0.5	V V
V_{OL}	Output Low-voltage,[4] Port B (except $\overline{RESET}$) [6]	I_{OL} = 10 mA, V_{CC} = 5V I_{OL} = 5 mA, V_{CC} = 3V			0.6 0.5	V V
V_{OH}	Output High-voltage, [5] Port B (except $\overline{RESET}$) [6]	I_{OH} = -10 mA, V_{CC} = 5V I_{OH} = -5 mA, V_{CC} = 3V	4.3 2.5			V V
I_{IL}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin low (absolute value)		< 0.05	1	µA
I_{IH}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin high (absolute value)		< 0.05	1	µA
R_{RST}	Reset Pull-up Resistor	V_{CC} = 5.5V, input low	30		60	kΩ
R_{pu}	I/O Pin Pull-up Resistor	V_{CC} = 5.5V, input low	20		50	kΩ
I_{CC}	Power Supply Current [7]	Active 1 MHz, V_{CC} = 2V		0.3	0.55	mA
		Active 4 MHz, V_{CC} = 3V		1.5	2.5	mA
		Active 8 MHz, V_{CC} = 5V		5	8	mA
		Idle 1 MHz, V_{CC} = 2V		0.1	0.2	mA
		Idle 4 MHz, V_{CC} = 3V		0.35	0.6	mA
		Idle 8 MHz, V_{CC} = 5V		1.2	2	mA
	Power-down mode [8]	WDT enabled, V_{CC} = 3V		4	20	µA
		WDT disabled, V_{CC} = 3V		0.2	14	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. 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 condition, V_{OL} may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
5. 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.
6. 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 Figure 3-19, Figure 3-20, Figure 3-21, and Figure 3-22 (starting on page 18).
7. Values are with external clock using methods described in "Minimizing Power Consumption" on page 37. Power Reduction is enabled (PRR = 0xFF) and there is no I/O drive.
8. Brown-Out Detection (BOD) disabled.

2.2 Clock Characteristics

2.2.1 Calibrated Internal RC Oscillator Accuracy

It is possible to manually calibrate the internal oscillator to be more accurate than default factory calibration. Please note that the oscillator frequency depends on temperature and voltage. Voltage and temperature characteristics can be found in Figure 3-36 on page 27 and Figure 3-37 on page 27.

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 [2]	3V	25°C	±10%
User Calibration	Fixed frequency within: 6 – 8 MHz	Fixed voltage within: 1.8V - 5.5V [3] 2.7V - 5.5V [4]	Fixed temperature within: -40°C to +125°C	±1%

Notes:
1. Accuracy of oscillator frequency at calibration point (fixed temperature and fixed voltage).
2. 6.4 MHz in ATtiny15 Compatibility Mode.
3. Voltage range for ATtiny25V.
4. Voltage range for ATtiny25.

2.3 System and Reset Characteristics

2.3.1 Power-On Reset

Table 2-3. Characteristics of Power-On Reset. T_A = -40°C 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

Note:
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_{POT} (falling)

2.4 Brown-Out Detection

Table 2-4. BODLEVEL Fuse Coding. T_A = -40°C to +125°C

BODLEVEL[2:0] Fuses	Min[1]	Typ[1]	Max[1]	Units
111	BOD Disabled			
110	1.7	1.8	2.0	V
101	2.5	2.7	2.9	
100	4.1	4.3	4.5	
0XX	Reserved			

Note: 1. V_{BOT} may be below nominal minimum operating voltage for some devices. For devices where this is the case, the device is tested down to $V_{CC} = V_{BOT}$ during the production test. This guarantees that a Brown-out Reset will occur before V_{CC} drops to a voltage where correct operation of the microcontroller is no longer guaranteed.

2.5 Serial Programming Characteristics

Table 2-5. Serial Programming Characteristics, T_A = -40°C to +125°C, V_{CC} = 1.8 - 5.5V (Unless Otherwise Noted)

Symbol	Parameter	Min	Typ	Max	Units
$1/t_{CLCL}$	Oscillator Frequency (V_{CC} = 1.8 - 5.5V)	0		4	MHz
t_{CLCL}	Oscillator Period (V_{CC} = 1.8 - 5.5V)	250			ns
$1/t_{CLCL}$	Oscillator Frequency (V_{CC} = 2.7 - 5.5V)	0		10	MHz
t_{CLCL}	Oscillator Period (V_{CC} = 2.7 - 5.5V)	100			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*}			ns
t_{SLSH}	SCK Pulse Width Low	2 t_{CLCL*}			ns
t_{OVSH}	MOSI Setup to SCK High	t_{CLCL}			ns
t_{SHOX}	MOSI Hold after SCK High	2 t_{CLCL}			ns
t_{SLIV}	SCK Low to MISO Valid			100	ns

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

2.6 ADC Characteristics

Table 2-6. ADC Characteristics, Single Ended Channels. T_A = -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		LSB
		V_{REF} = 4V, V_{CC} = 4V, ADC clock = 1 MHz		3		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		2.5		LSB
	Integral Non-linearity (INL) (Accuracy after offset and gain calibration)	V_{REF} = 4V, V_{CC} = 4V, ADC clock = 200 kHz		1		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		2.5		LSB
	Offset Error	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			38.4		kHz
AREF	External Reference Voltage		2.0		V_{CC}	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
	Internal 2.56V Reference [1]	V_{CC} > 3.0V	2.3	2.56	2.8	V
R_{REF}				32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Output		0		1023	LSB

Note: 1. Values are guidelines only.

Table 2-7. ADC Characteristics, Differential Channels (Unipolar Mode). T_A = -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		10.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		20.0		LSB
	Integral Non-Linearity (INL) (Accuracy after Offset and Gain Calibration)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		10.0		LSB
	Gain Error	Gain = 1x		10.0		LSB
		Gain = 20x		15.0		LSB
	Offset Error	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		3.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4.0		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
AREF	External Reference Voltage		2.0		V_{CC} - 1.0	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
	Internal 2.56V Reference [(1)]	V_{CC} > 3.0V	2.3	2.56	2.8	V
R_{REF}	Reference Input Resistance			32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Conversion Output		0		1023	LSB

Note: 1. Values are guidelines only.

Table 2-8. ADC Characteristics, Differential Channels (Bipolar Mode). T_A = -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		8.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		8.0		LSB
	Integral Non-Linearity (INL) (Accuracy after Offset and Gain Calibration)	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		5.0		LSB
	Gain Error	Gain = 1x		4.0		LSB
		Gain = 20x		5.0		LSB
	Offset Error	Gain = 1x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		3.0		LSB
		Gain = 20x V_{REF} = 4V, V_{CC} = 5V ADC clock = 50 - 200 kHz		4.0		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
AREF	External Reference Voltage		2.0		V_{CC} - 1.0	V
V_{INT}	Internal Voltage Reference		1.0	1.1	1.2	V
	Internal 2.56V Reference [(1)]	V_{CC} > 3.0V	2.3	2.56	2.8	V
R_{REF}	Reference Input Resistance			32		kΩ
R_{AIN}	Analog Input Resistance			100		MΩ
	ADC Conversion Output		-512		511	LSB

Note: 1. Values are guidelines only.

3. Typical Characteristics

The data contained in this section is largely based on simulations and characterization of similar devices in the same process and design methods. Thus, the data should be treated as indications of how the part will behave.

The following charts show typical behavior. These figures are not tested during manufacturing. All current consumption measurements are performed with all I/O pins configured as inputs and with internal pull-ups enabled. A sine wave generator with rail-to-rail output is used as clock source.

The power consumption in Power-down mode is independent of clock selection.

The current consumption is a function of several factors such as: operating voltage, operating frequency, loading of I/O pins, switching rate of I/O pins, code executed and ambient temperature. The dominating factors are operating voltage and frequency.

The current drawn from capacitive loaded pins may be estimated (for one pin) as C_L*V_{CC}*f where C_L = load capacitance, V_{CC} = operating voltage and f = average switching frequency of I/O pin.

The parts are characterized at frequencies higher than test limits. Parts are not guaranteed to function properly at frequencies higher than the ordering code indicates.

The difference between current consumption in Power-down mode with Watchdog Timer enabled and Power-down mode with Watchdog Timer disabled represents the differential current drawn by the Watchdog Timer.

3.1 Active Supply Current

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

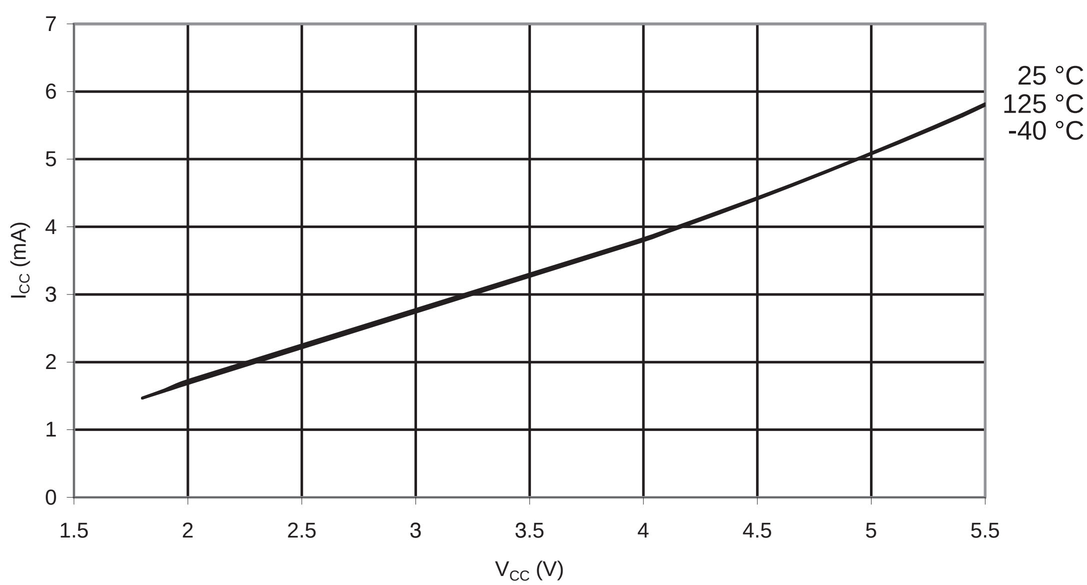


Figure 3-2. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 1 MHz)

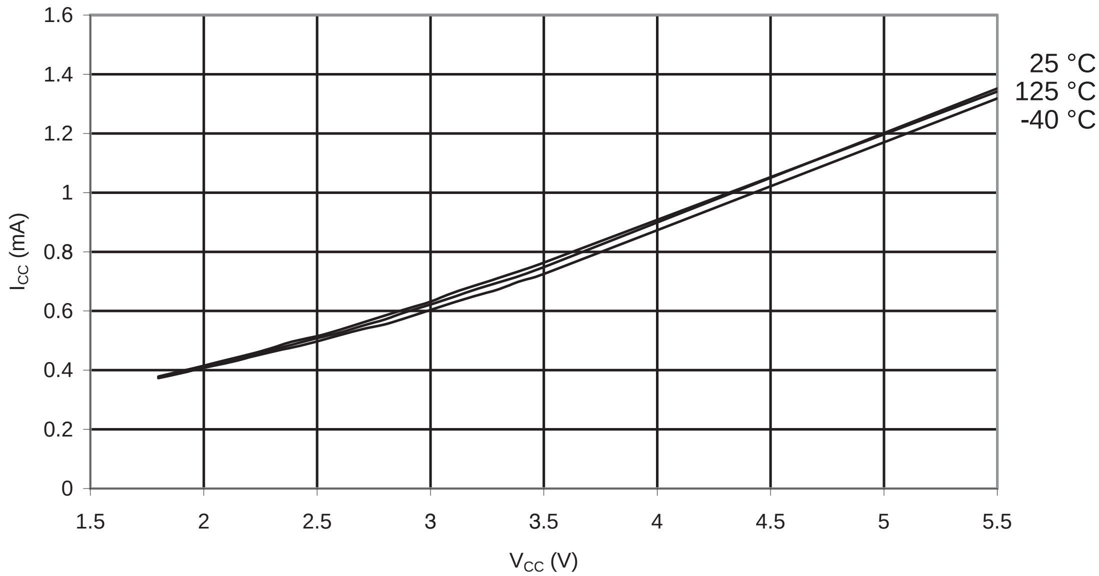
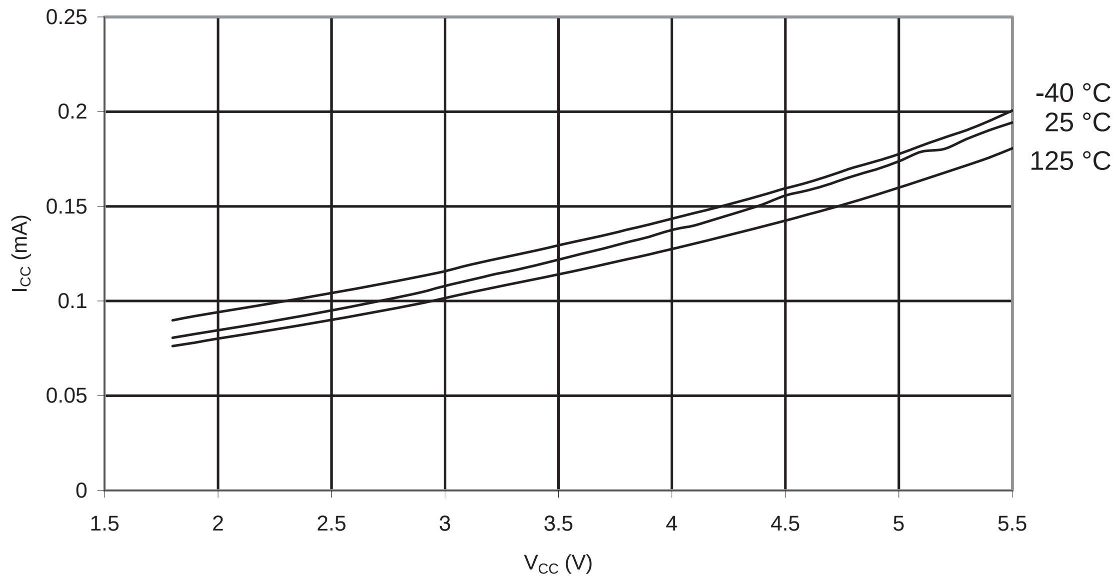


Figure 3-3. Active Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.2 Idle Supply Current

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

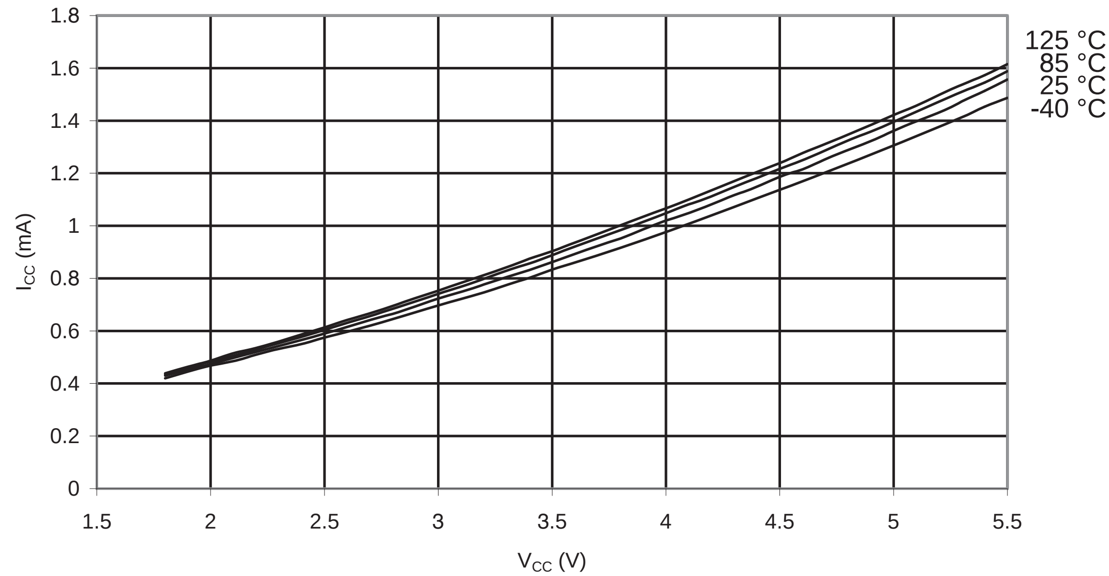


Figure 3-5. Idle Supply Current vs. V_{CC} (Internal RC Oscilllator, 1 MHz)

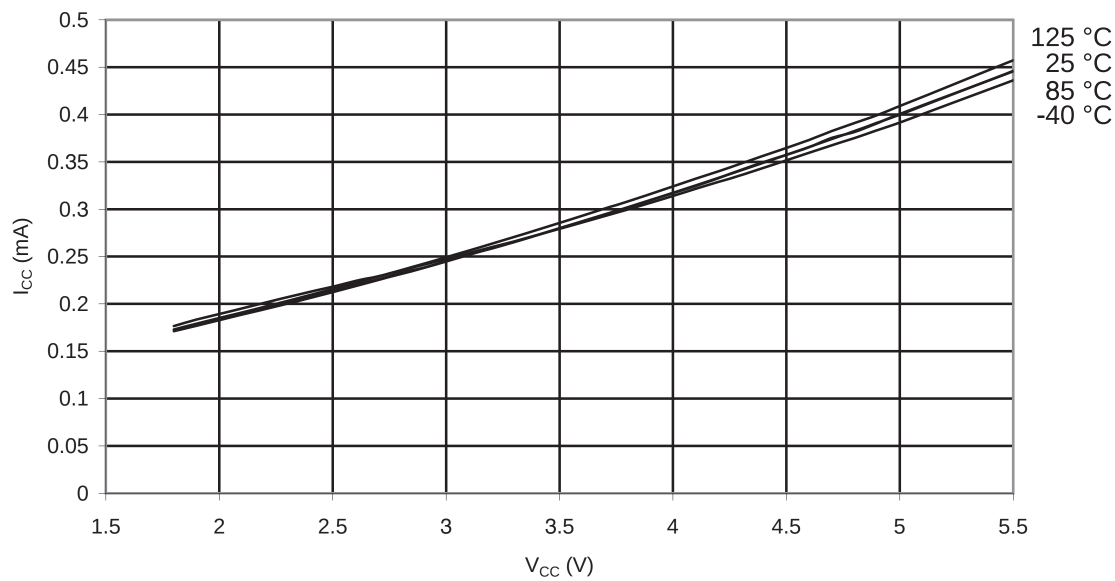
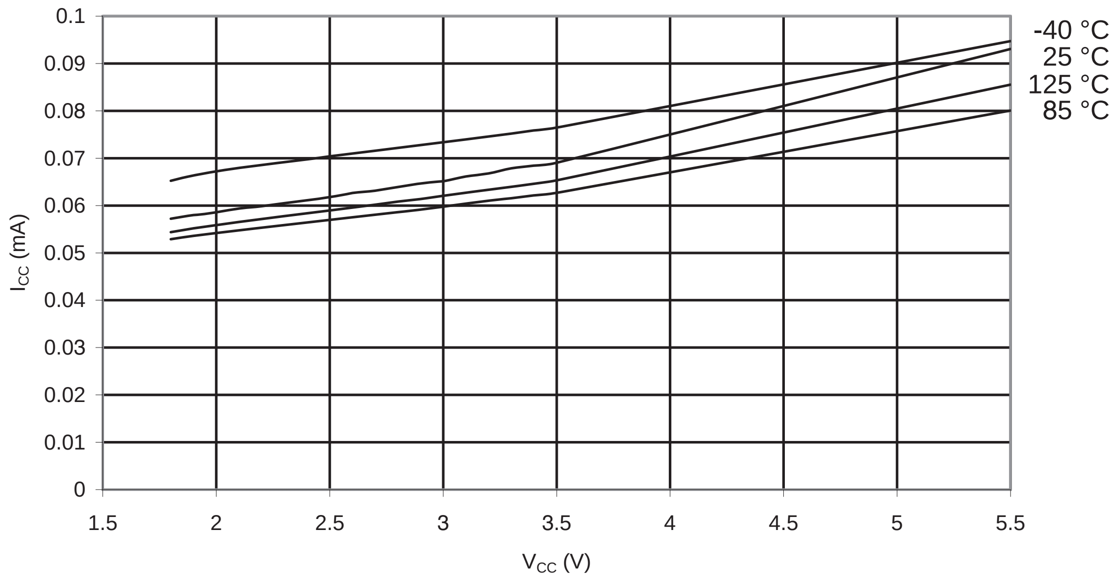


Figure 3-6. Idle Supply Current vs. V_{CC} (Internal RC Oscillator, 128 kHz)



3.3 Power-down Supply Current

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

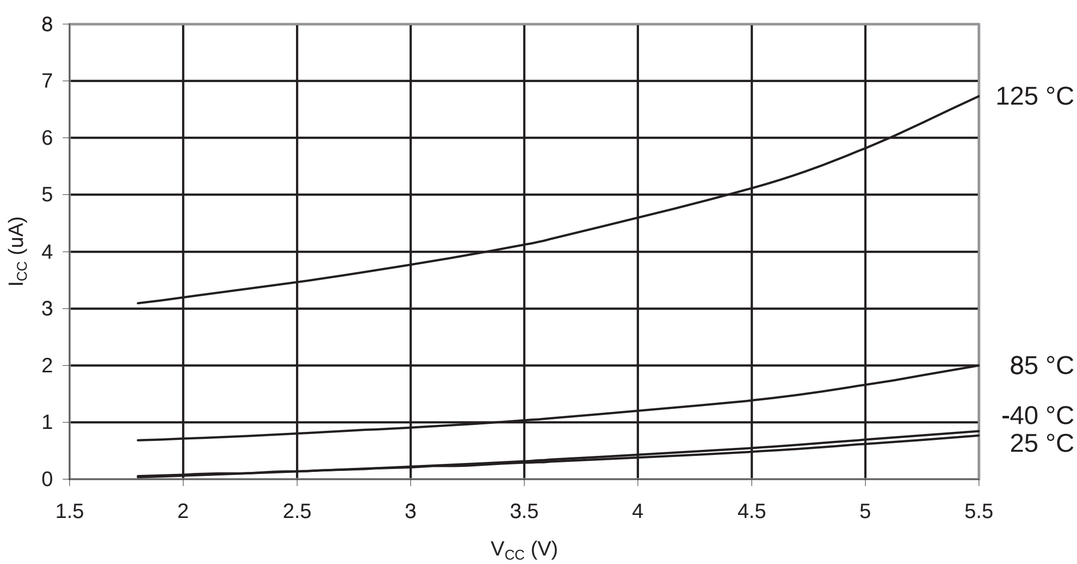
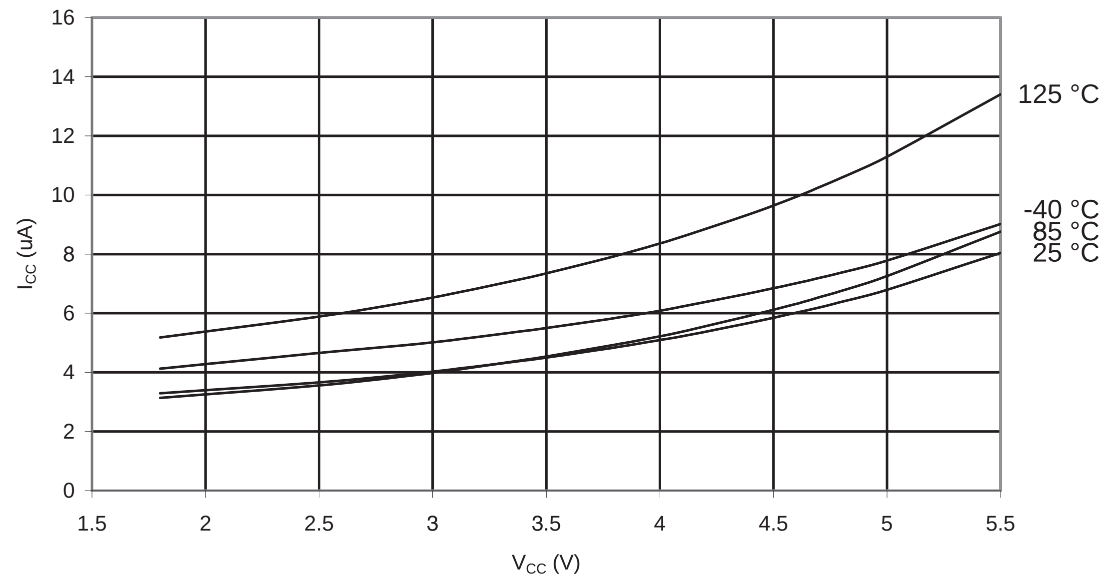


Figure 3-8. Power-down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



3.4 Pin Pull-up

Figure 3-9. I/O Pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 1.8V)

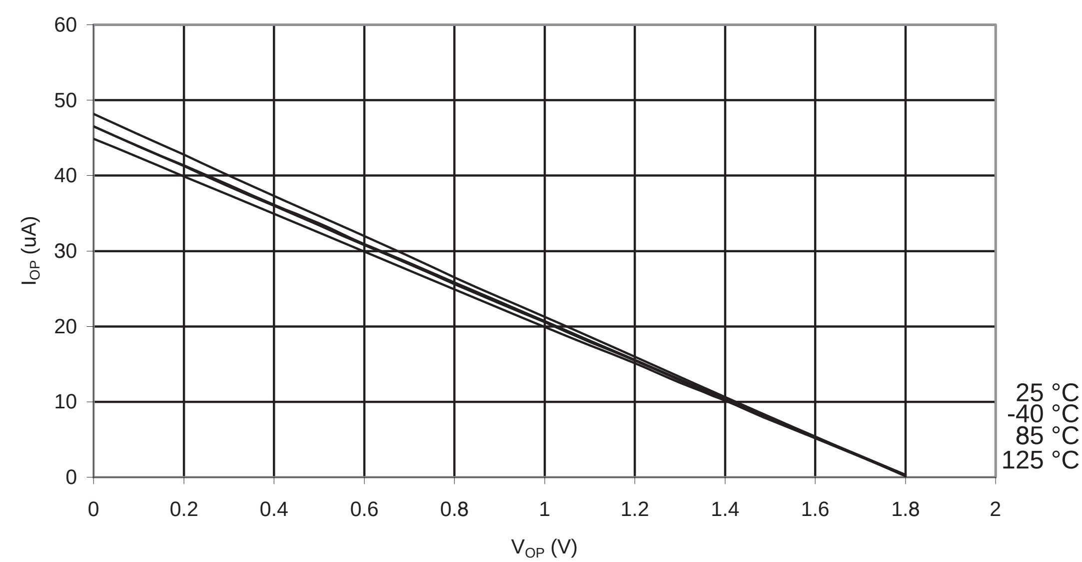


Figure 3-10. I/O Pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 2.7V)

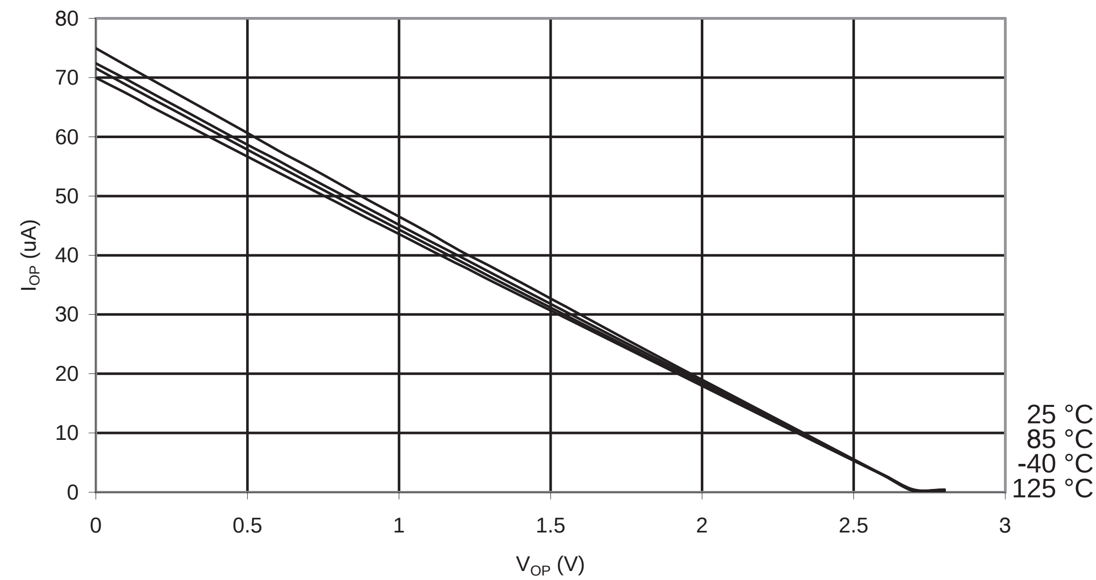


Figure 3-11. I/O Pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 5V)

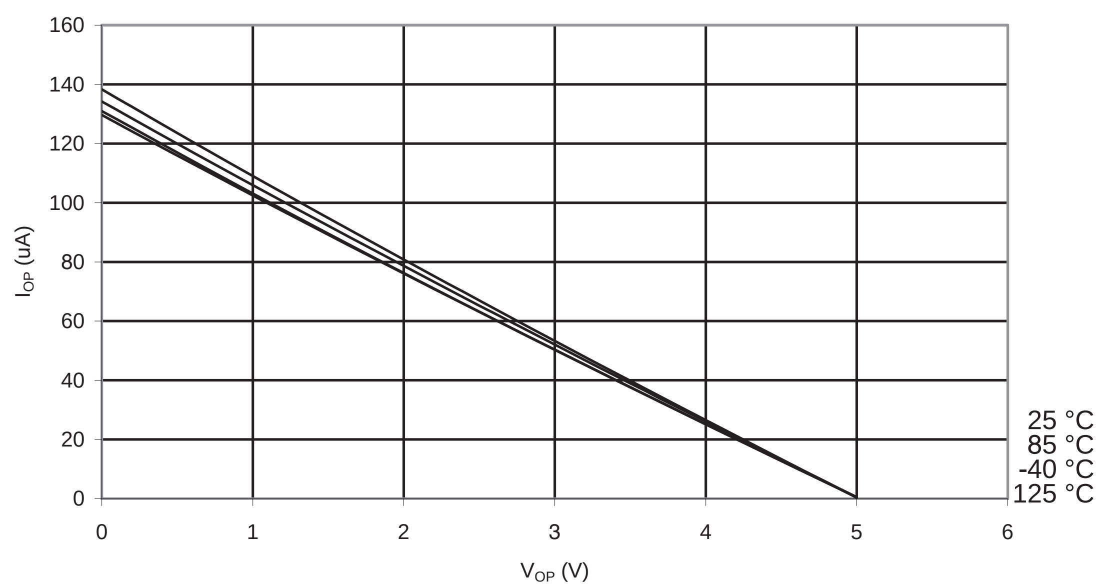


Figure 3-12. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 1.8V)

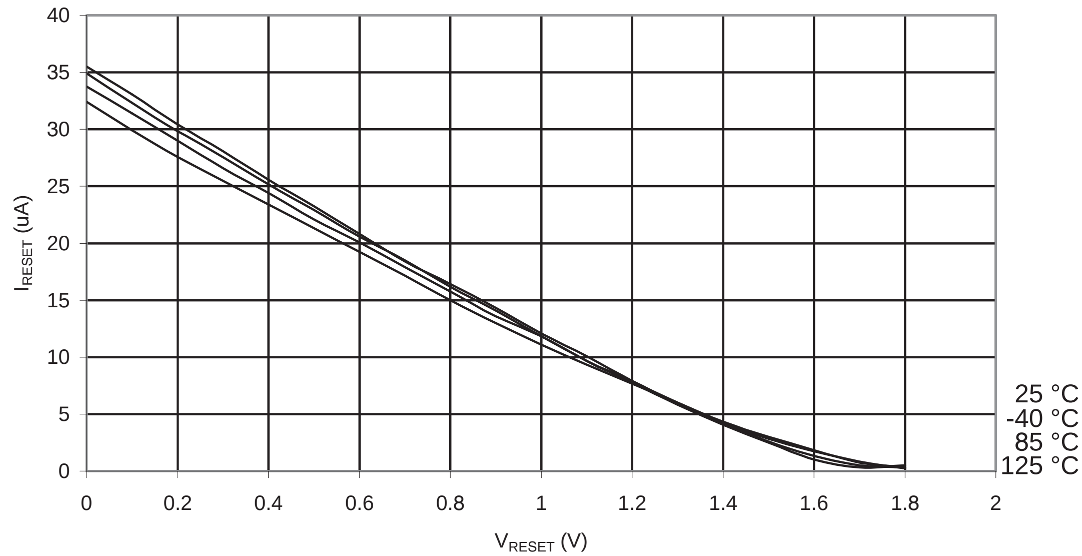


Figure 3-13. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 2.7V)

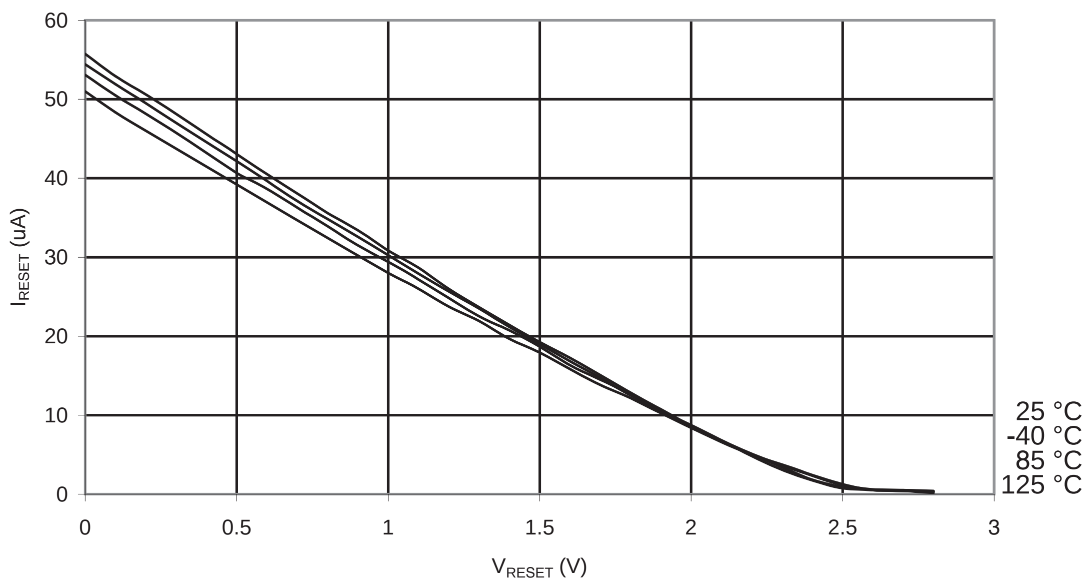
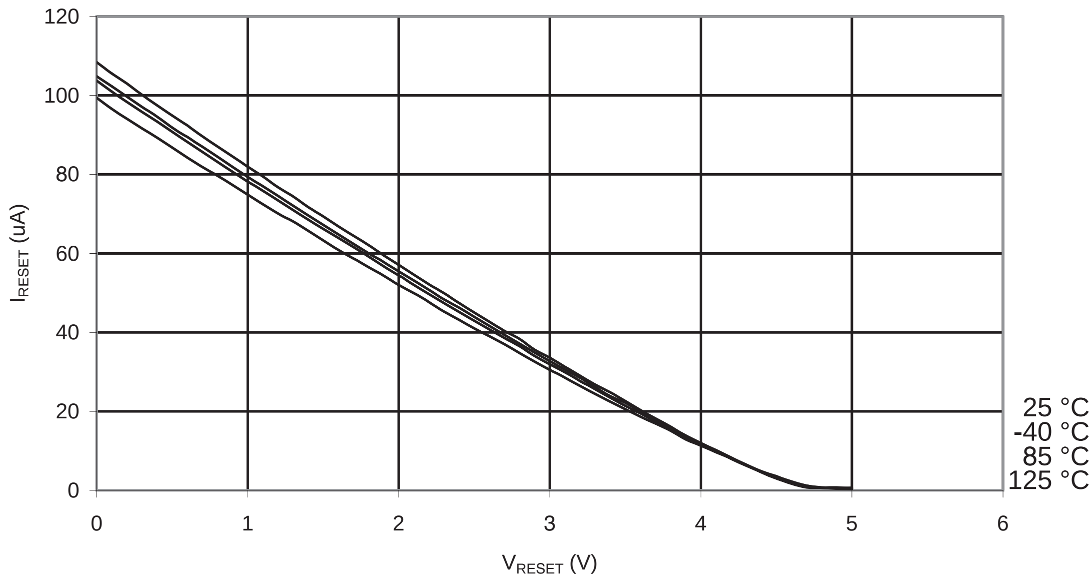


Figure 3-14. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



3.5 Pin Driver Strength

Figure 3-15. I/O Pin Output Voltage vs. Sink Current (V_{CC} = 3V)

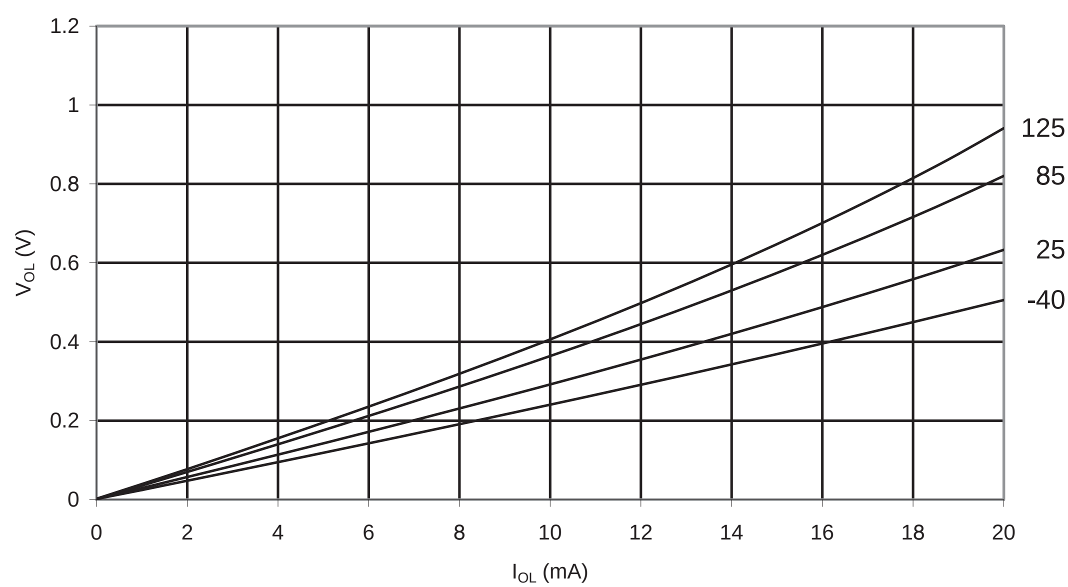


Figure 3-16. I/O Pin Output Voltage vs. Sink Current (V_{CC} = 5V)

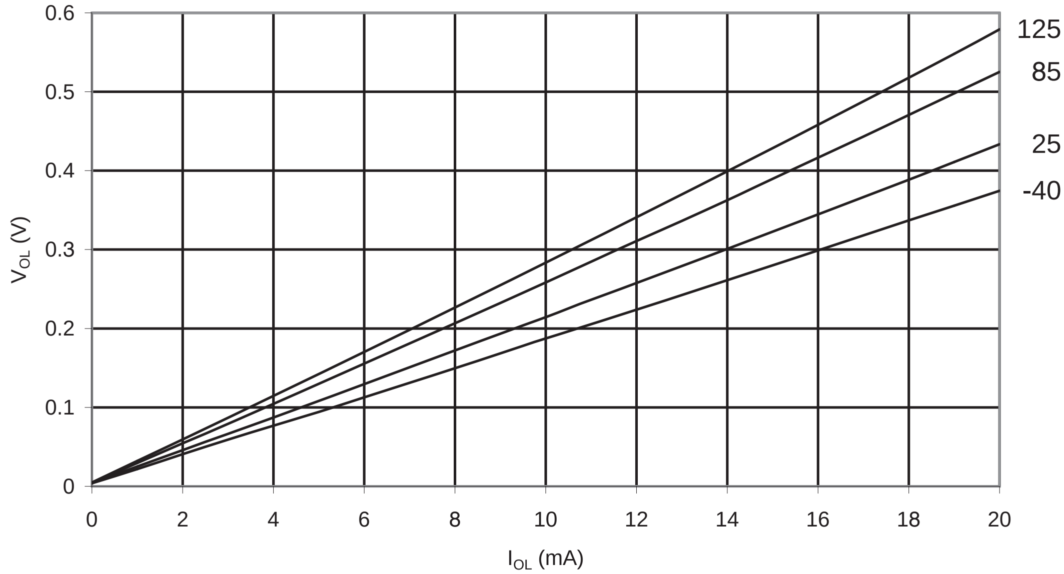


Figure 3-17. I/O Pin Output Voltage vs. Source Current (V_{CC} = 3V)

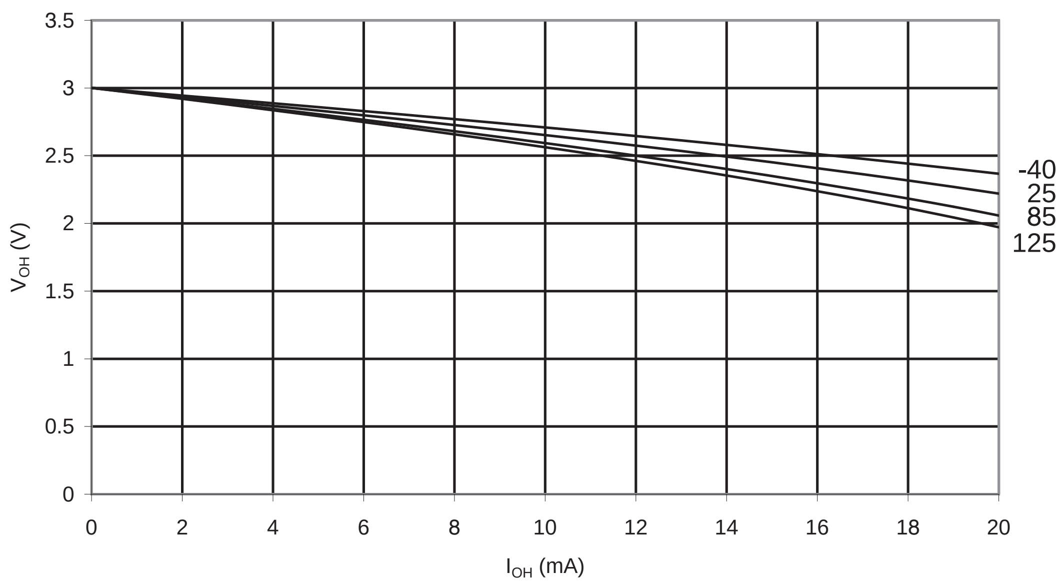


Figure 3-18. I/O Pin Output Voltage vs. Source Current (V_{CC} = 5V)

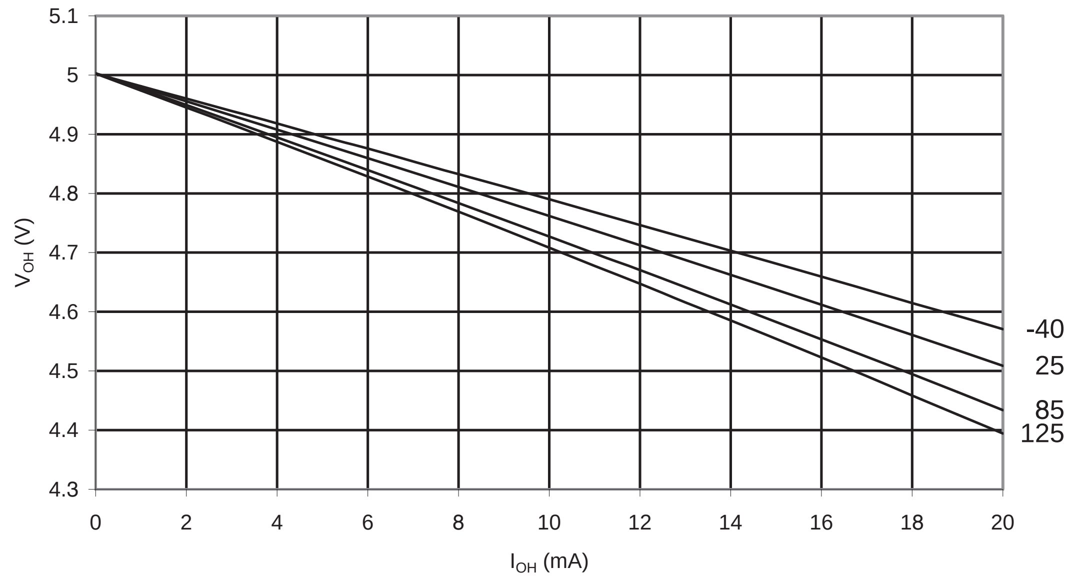


Figure 3-19. Reset Pin Output Voltage vs. Sink Current (V_{CC} = 3V)

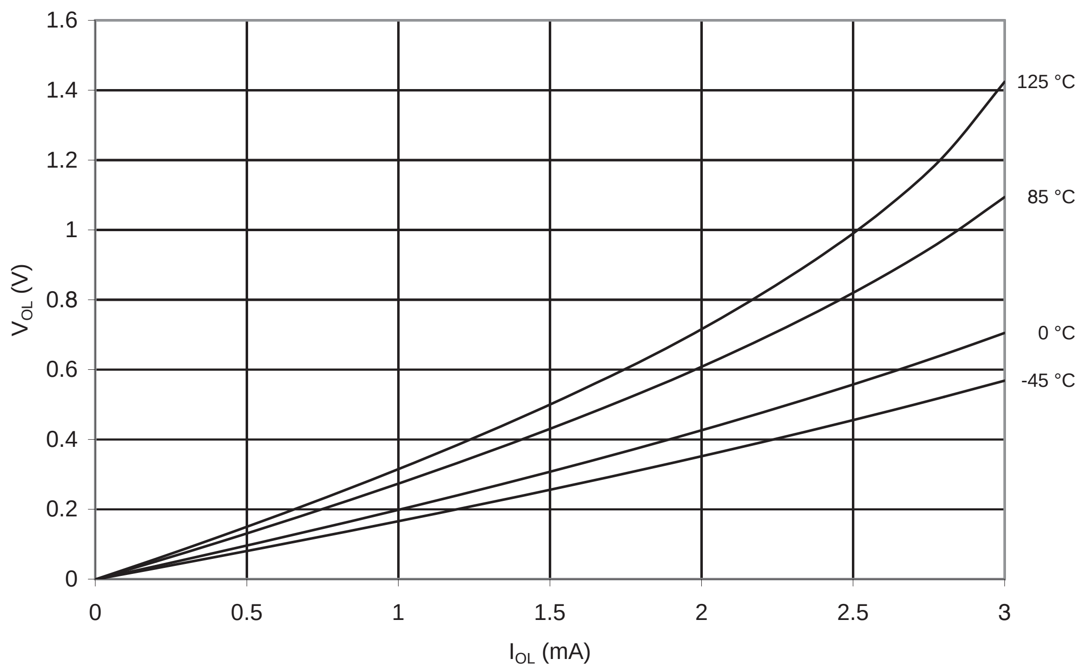


Figure 3-20. Reset Pin Output Voltage vs. Sink Current (V_{CC} = 5V)

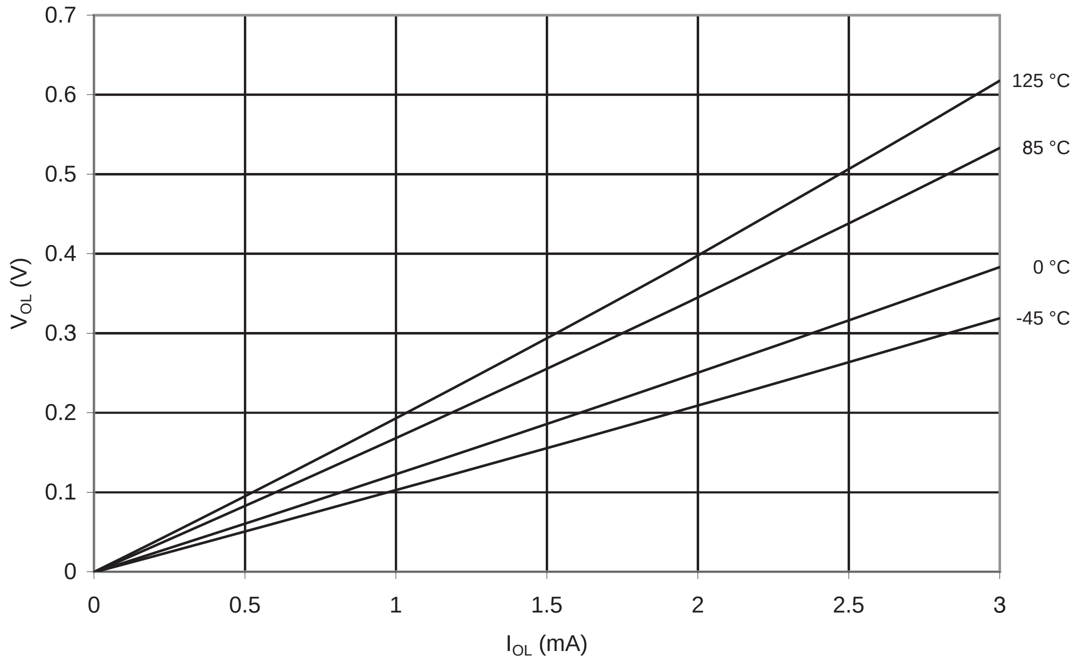


Figure 3-21. Reset Pin Output Voltage vs. Source Current (V_{CC} = 3V)

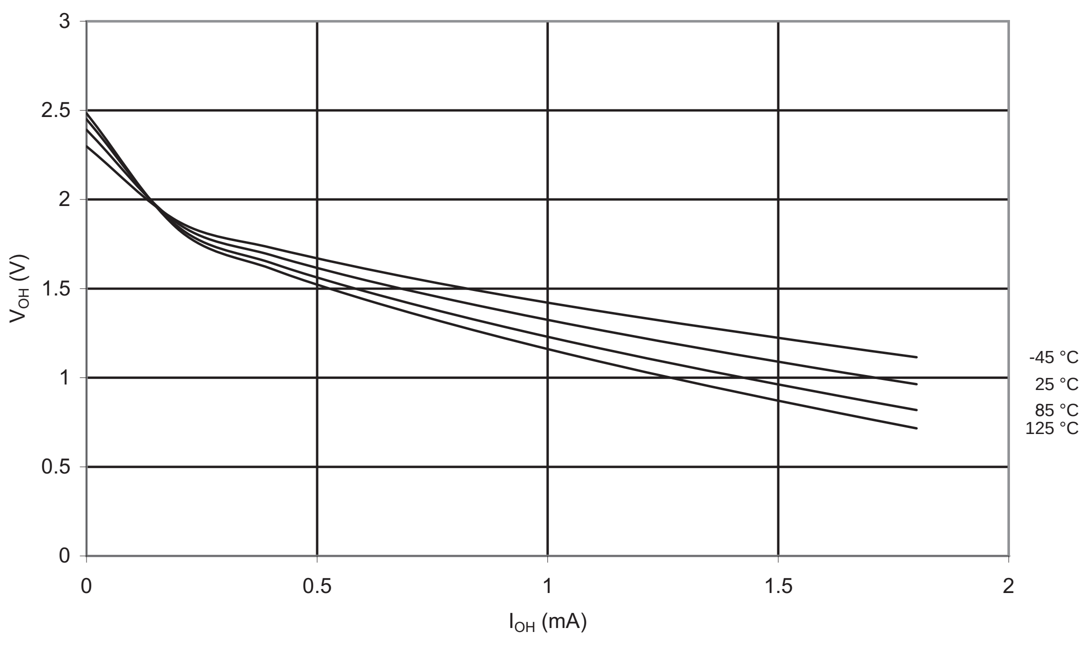
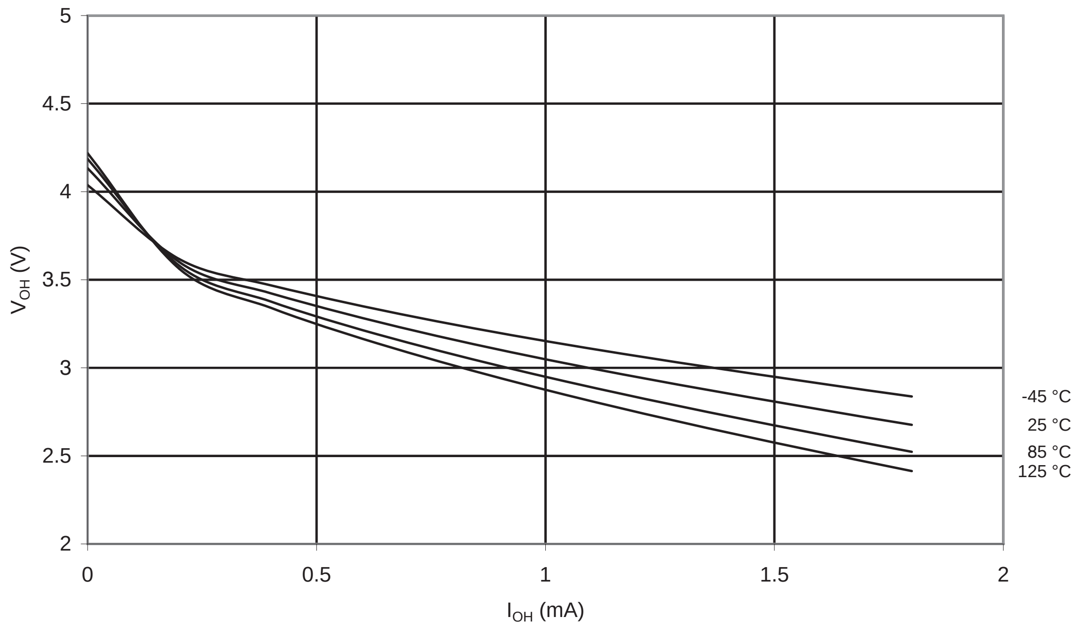


Figure 3-22. Reset Pin Output Voltage vs. Source Current (V_{CC} = 5V)



3.6 Pin Threshold and Hysteresis

Figure 3-23. I/O Pin Input Threshold Voltage vs. V_{CC} (V_{IH}, IO Pin Read as '1')

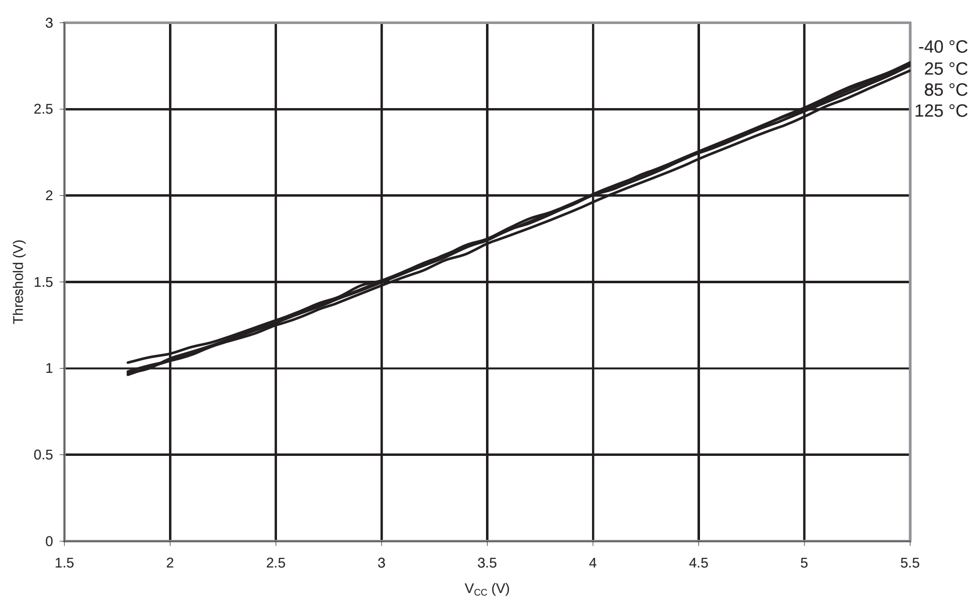


Figure 3-24. I/O Pin Input Threshold Voltage vs. V_{CC} (V_{IL}, IO Pin Read as ‘0’)

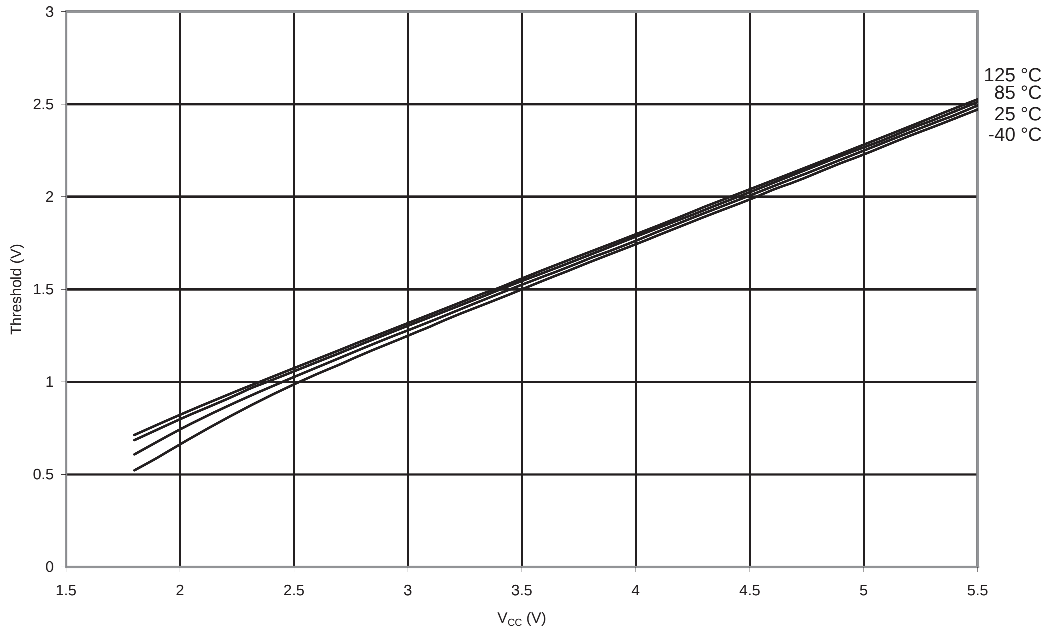


Figure 3-25. I/O Pin Input Hysteresis vs. V_{CC}

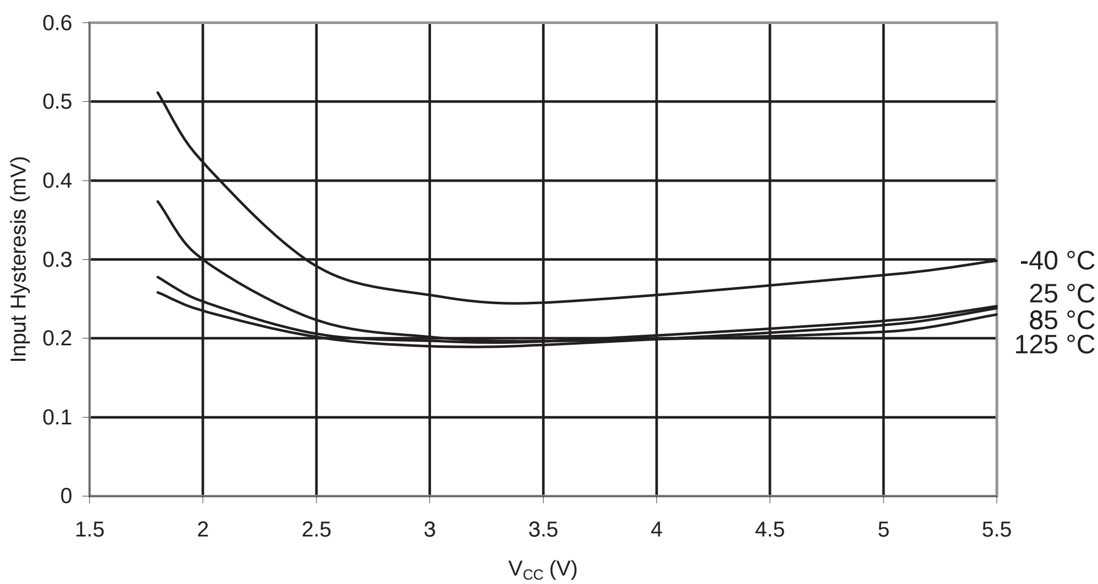


Figure 3-26. Reset Input Threshold Voltage vs. V_{CC} (V_{IH}, IO Pin Read as '1')

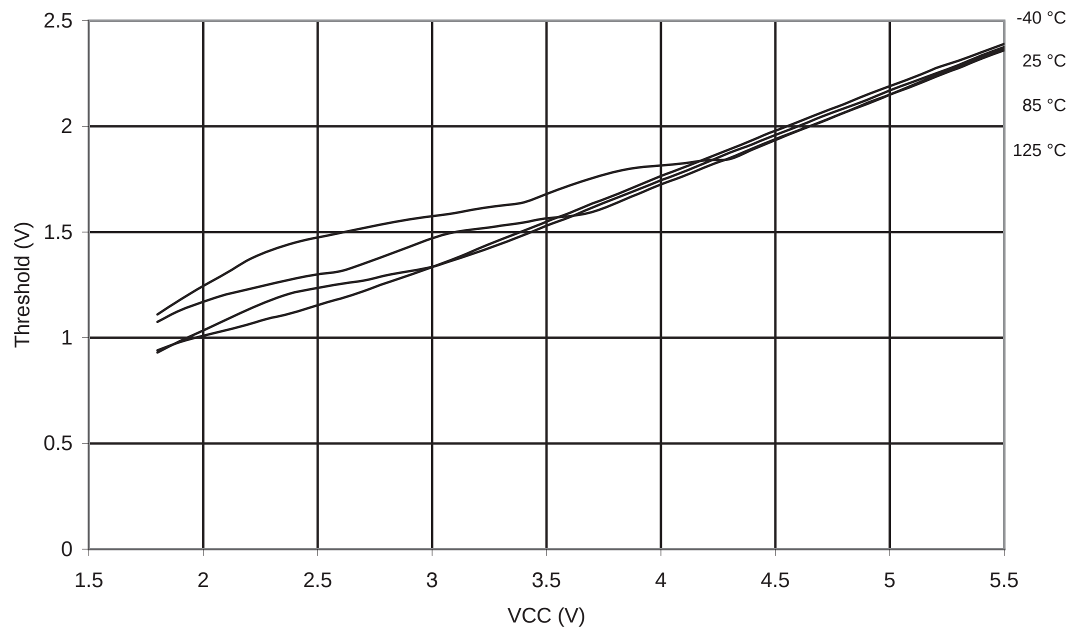


Figure 3-27. Reset Input Threshold Voltage vs. V_{CC} (V_{IL}, IO Pin Read as '0')

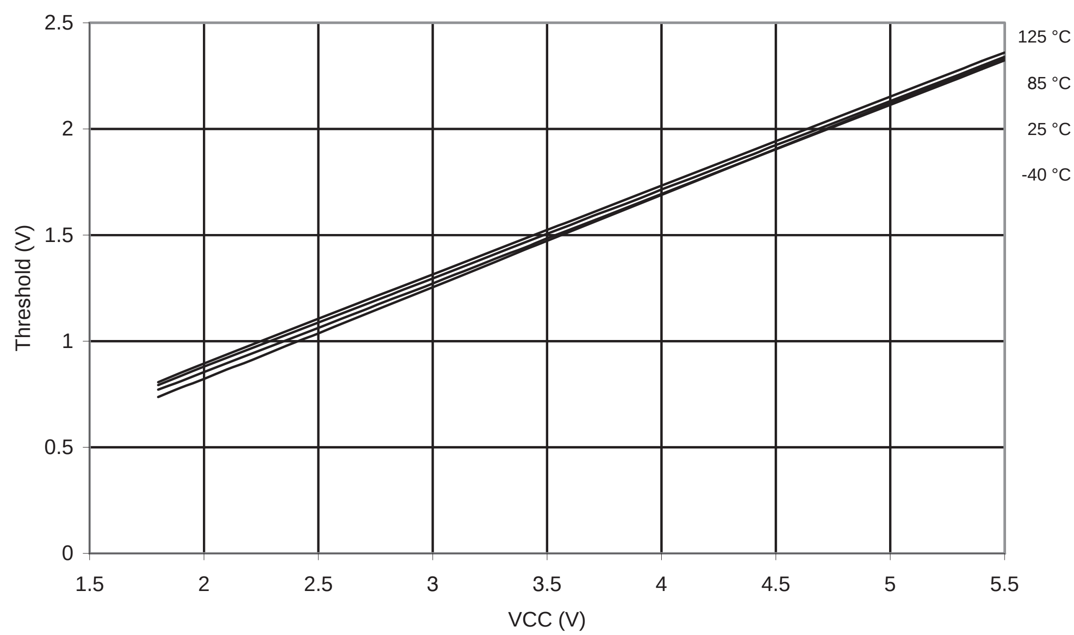
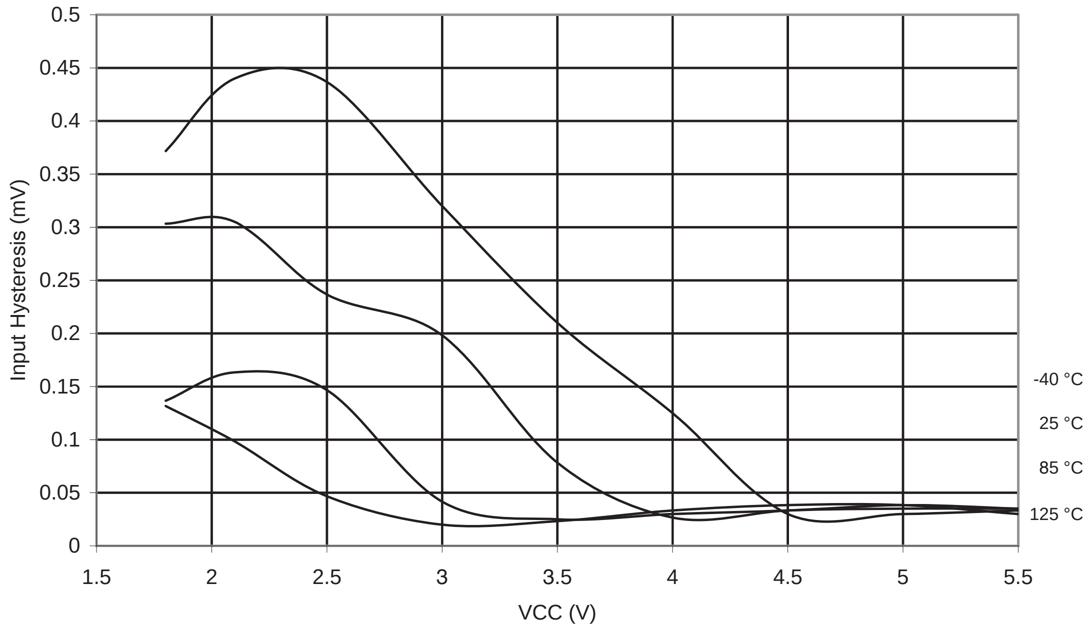


Figure 3-28. Reset Pin Input Hysteresis vs. V_{CC}



3.7 BOD Threshold

Figure 3-29. BOD Threshold vs. Temperature (BOD Level is 4.3V)

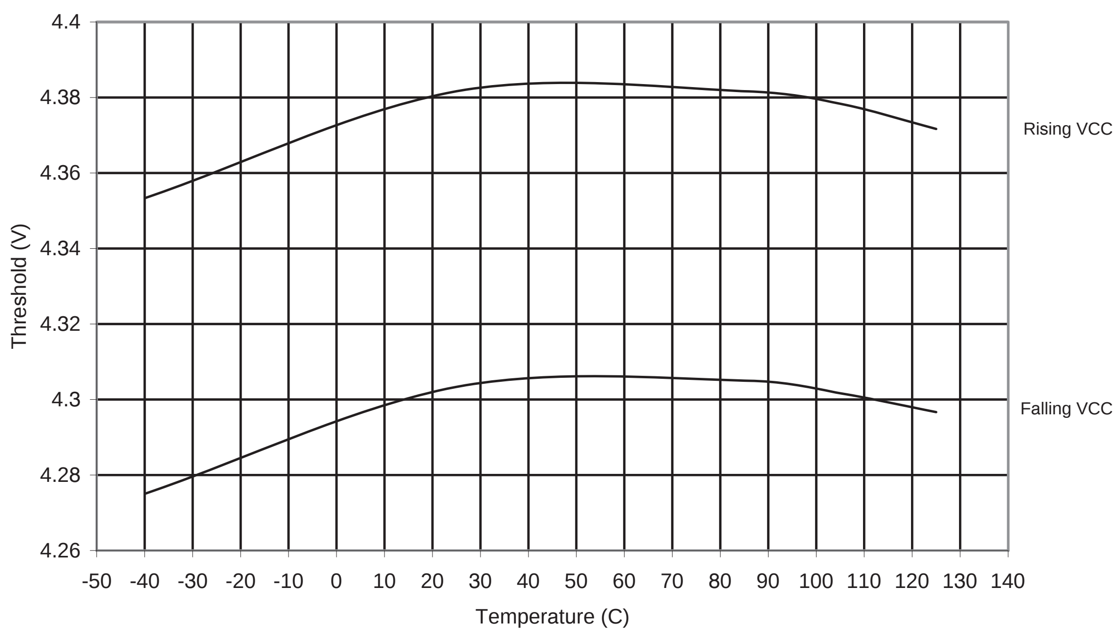


Figure 3-30. BOD Threshold vs. Temperature (BOD Level is 2.7V)

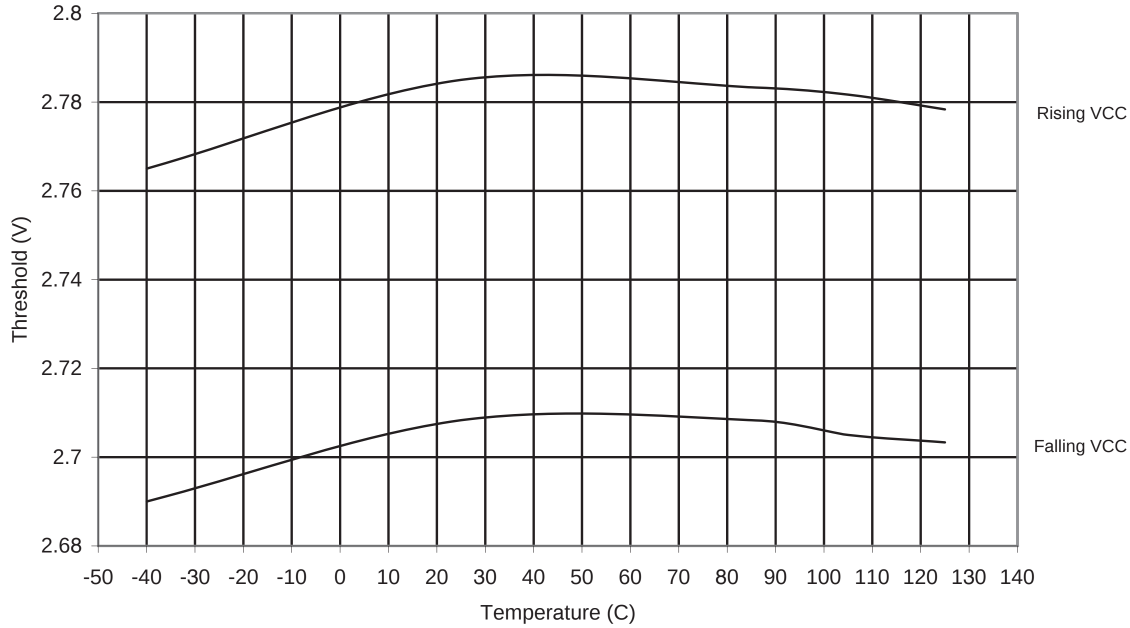


Figure 3-31. BOD Threshold vs. Temperature (BOD Level is 1.8V)

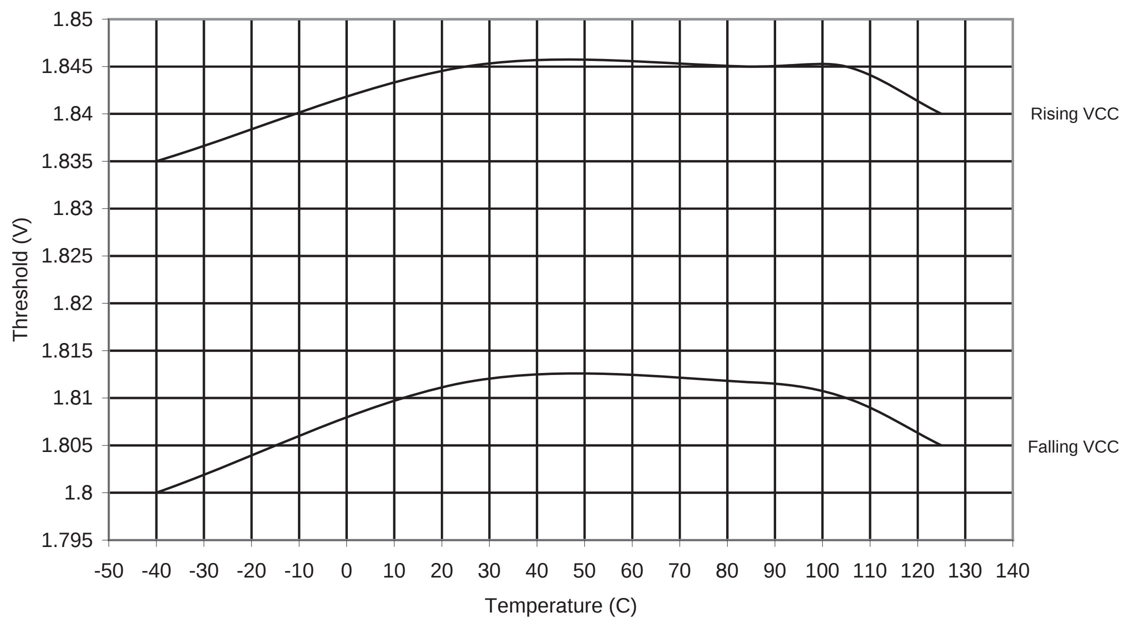


Figure 3-32. Bandgap Voltage vs. Supply Voltage

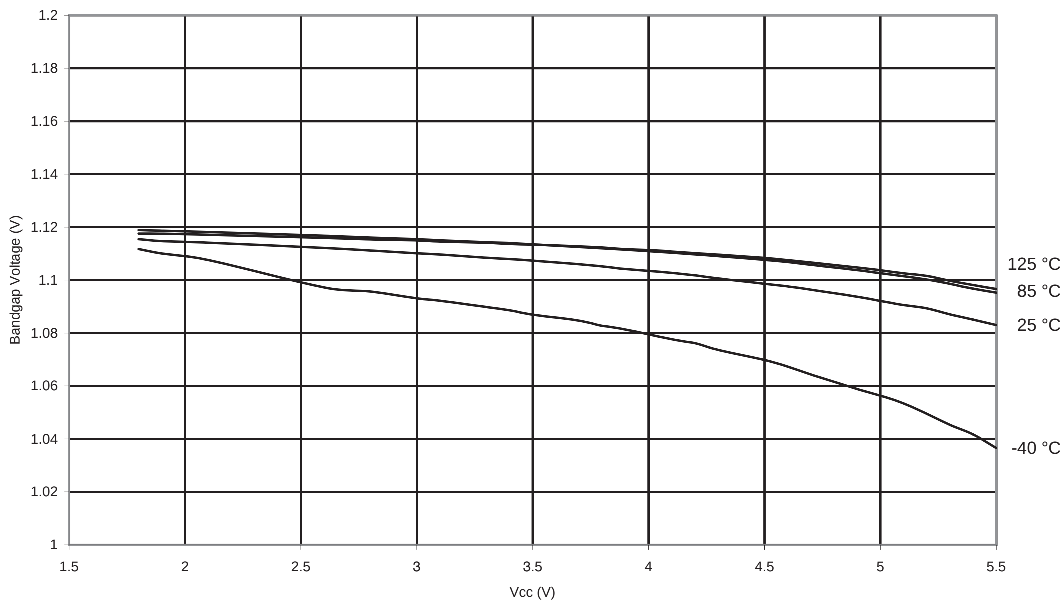
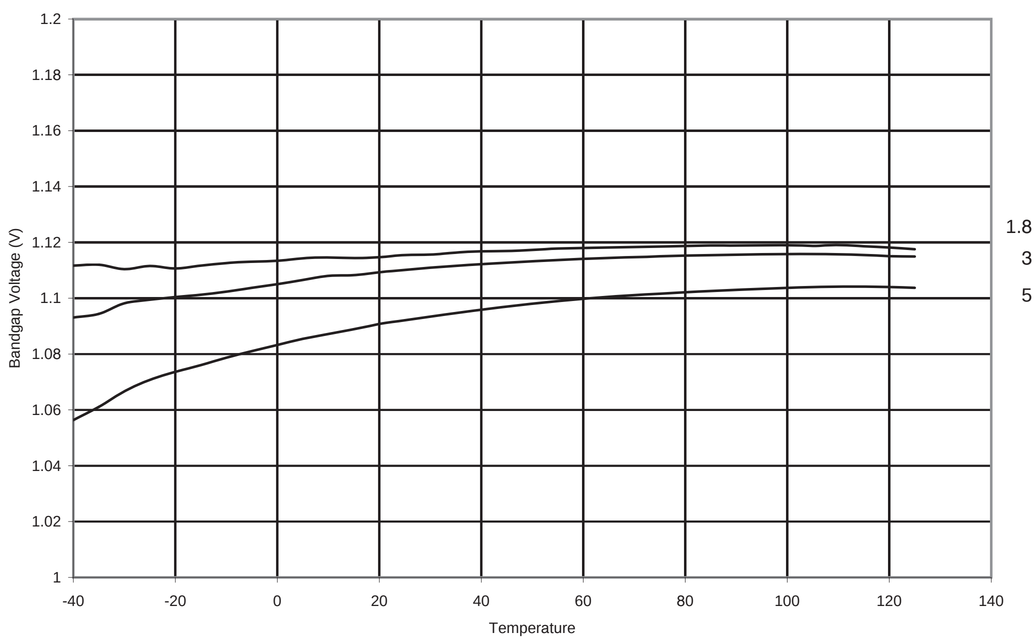


Figure 3-33. Bandgap Voltage vs. Temperature



3.8 Internal Oscillator Speed

Figure 3-34. Watchdog Oscillator Frequency vs. V_{CC}

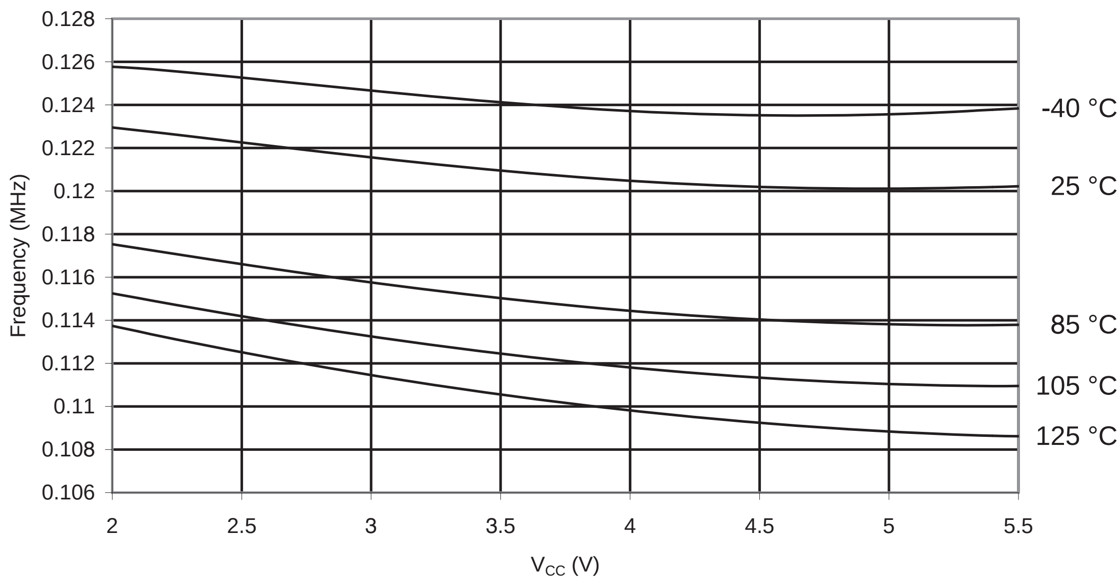


Figure 3-35. Watchdog Oscillator Frequency vs. Temperature

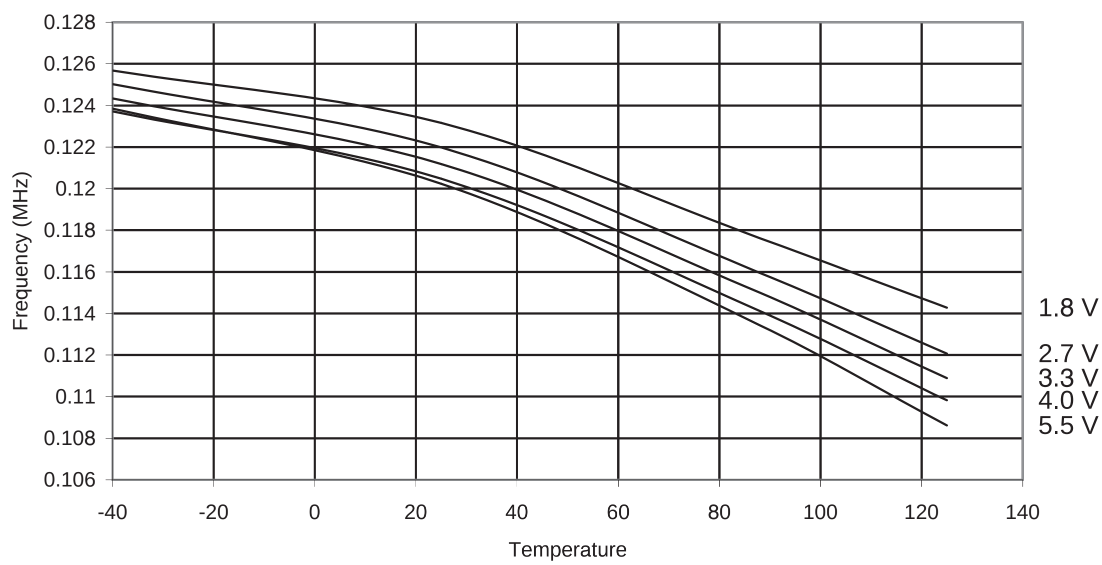


Figure 3-36. Calibrated 8 MHz RC Oscillator Frequency vs. V_{CC}

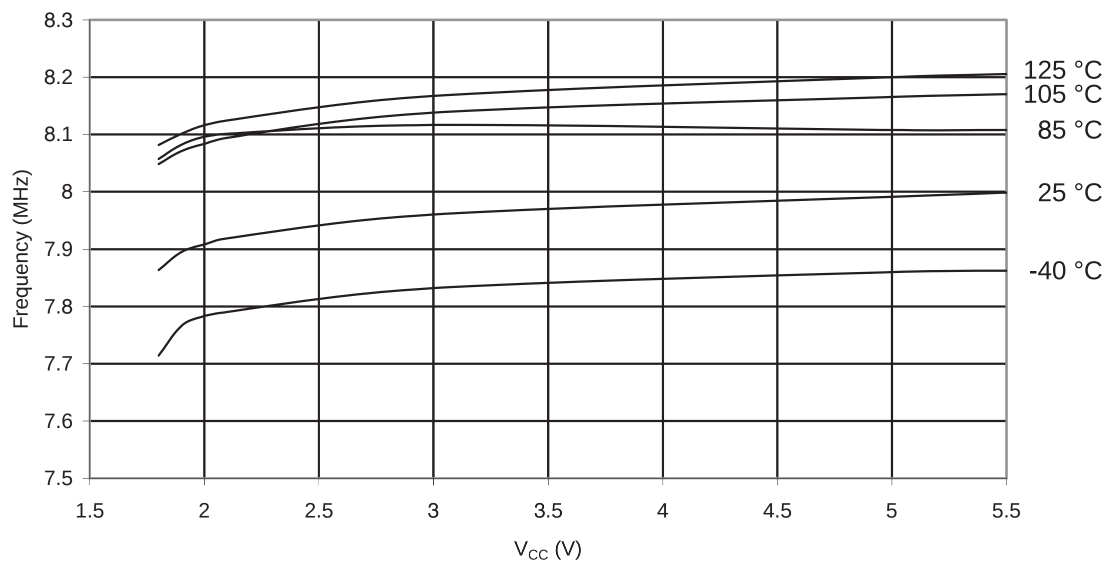


Figure 3-37. Calibrated 8 MHz RC Oscillator Frequency vs. Temperature

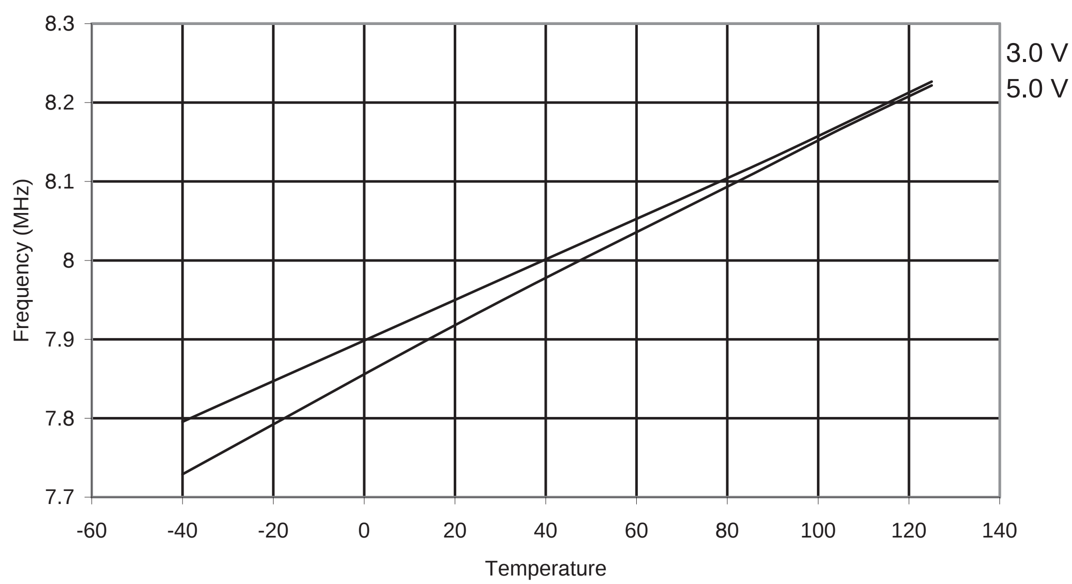
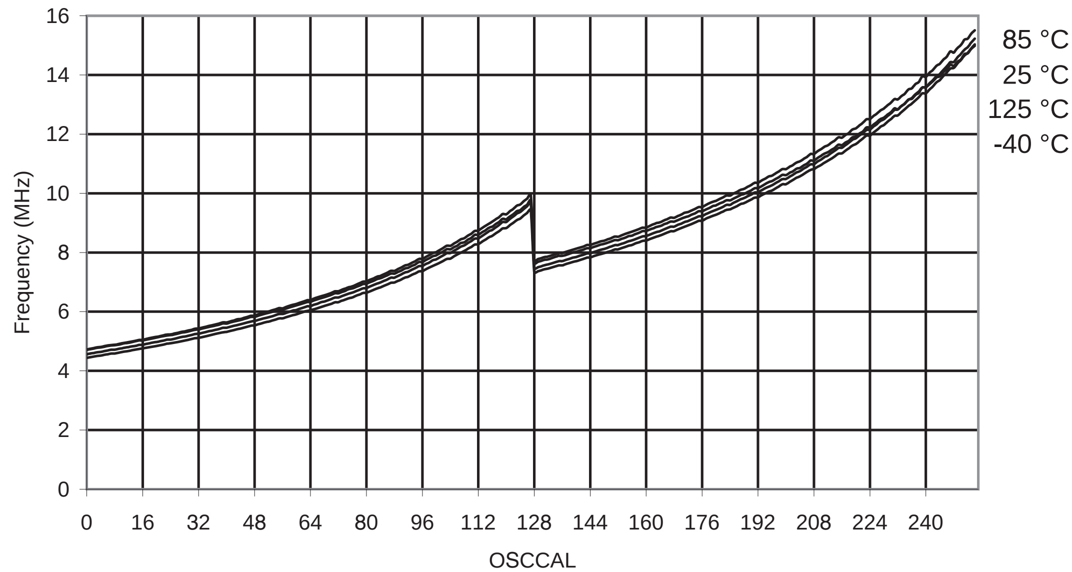


Figure 3-38. Calibrated 8 MHz RC Oscillator Frequency vs. OSCCAL Value



3.9 Current Consumption of Peripheral Units

Figure 3-39. Brownout Detector Current vs. V_{CC}

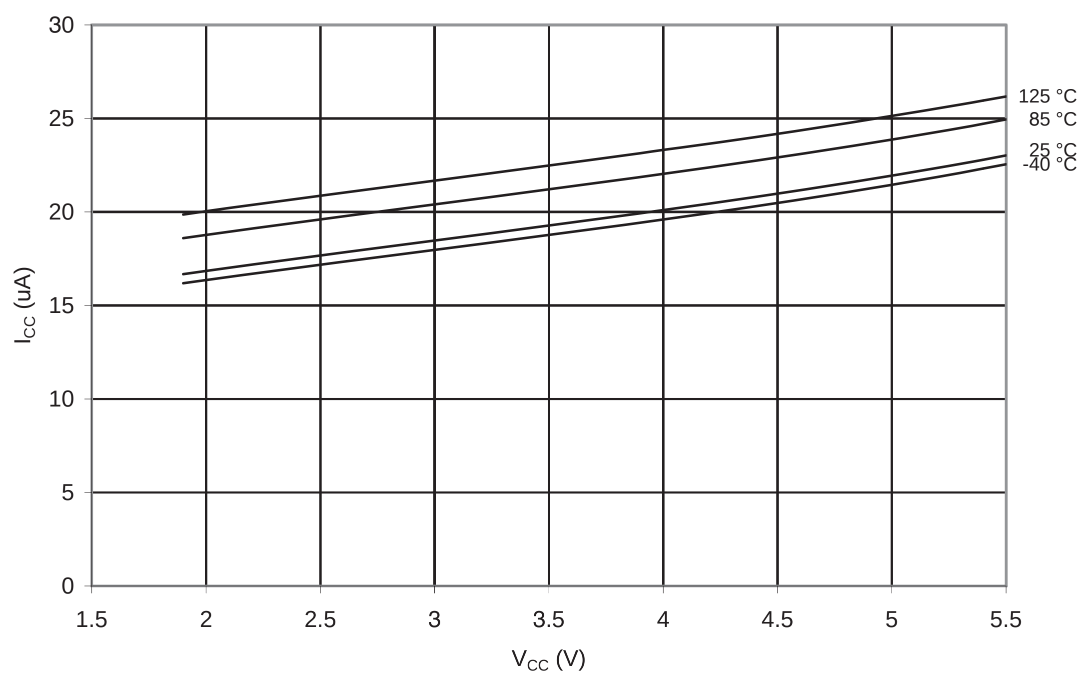


Figure 3-40. ADC Current vs. V_{CC} (AREF = AV_{CC})

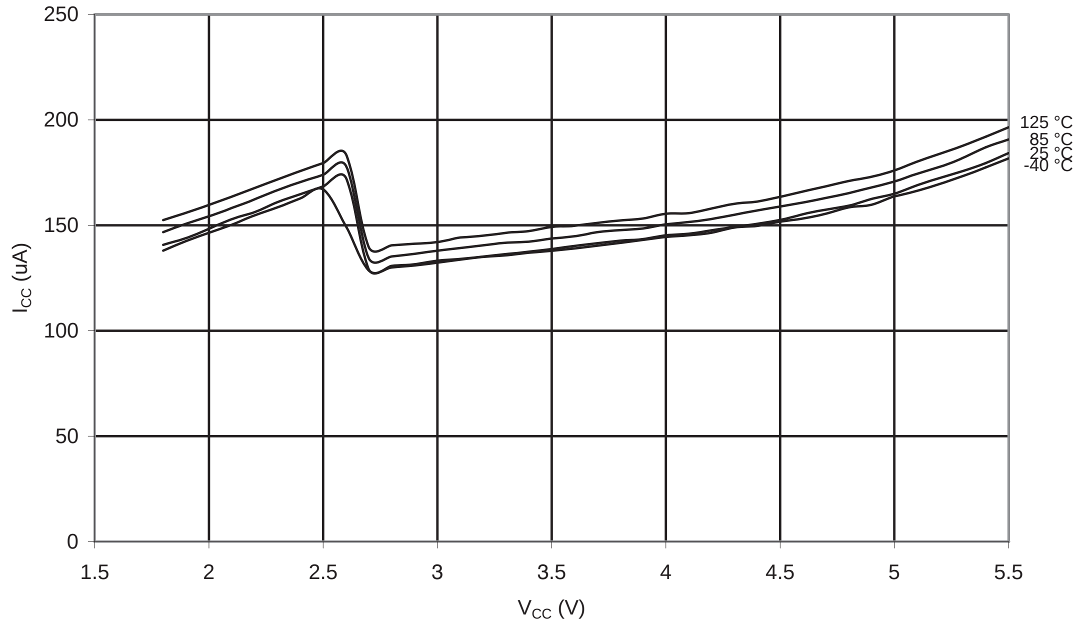


Figure 3-41. Analog Comparator Current vs. V_{CC}

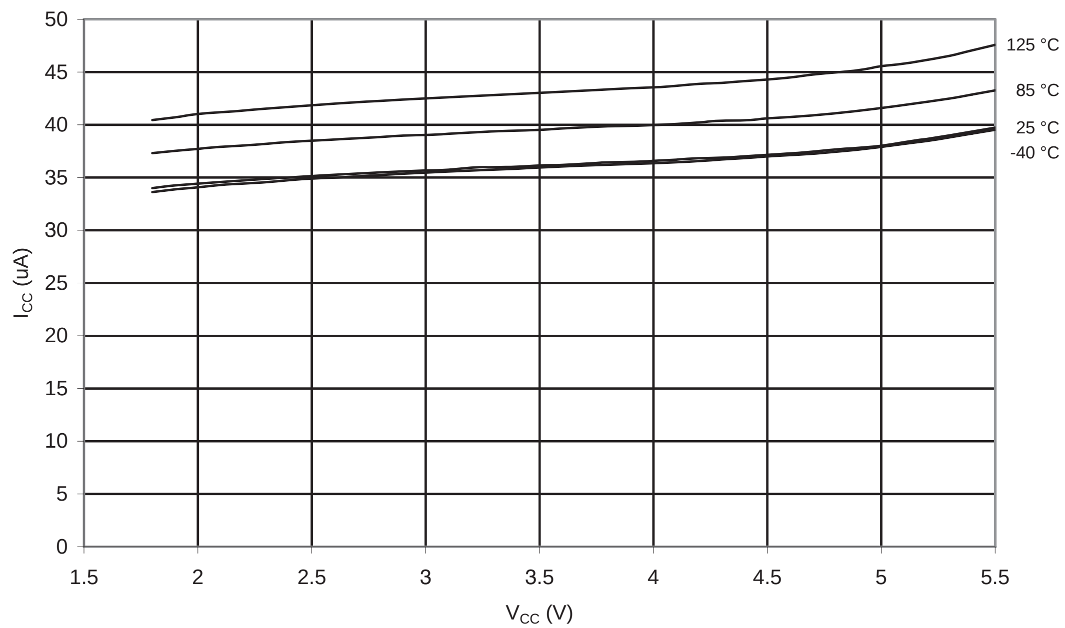
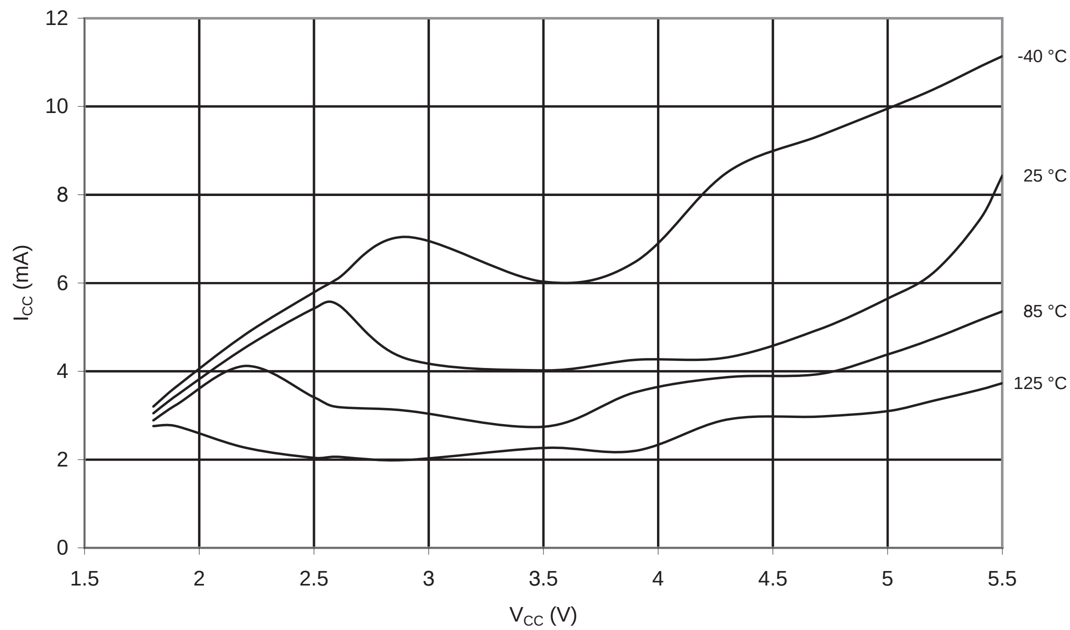


Figure 3-42. Programming Current vs. V_{CC}



3.10 Current Consumption in Reset and Reset Pulsewidth

Figure 3-43. Reset Supply Current vs. V_{CC} (0.1 - 1.0 MHz, Excluding Current Through The Reset Pull-up)

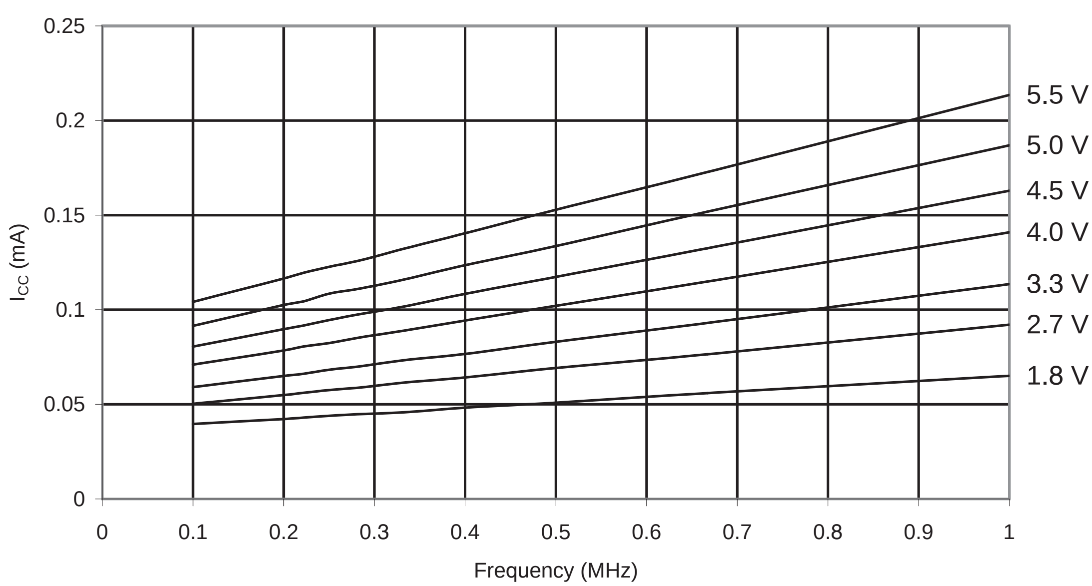


Figure 3-44. Reset Supply Current vs. V_{CC} (1 - 20 MHz, Excluding Current Through The Reset Pull-up)

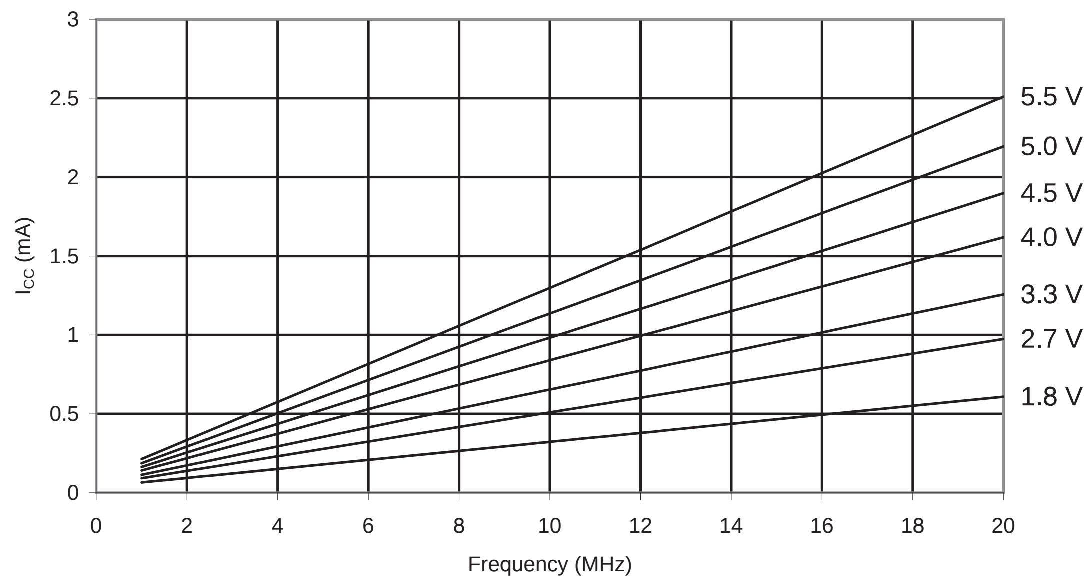
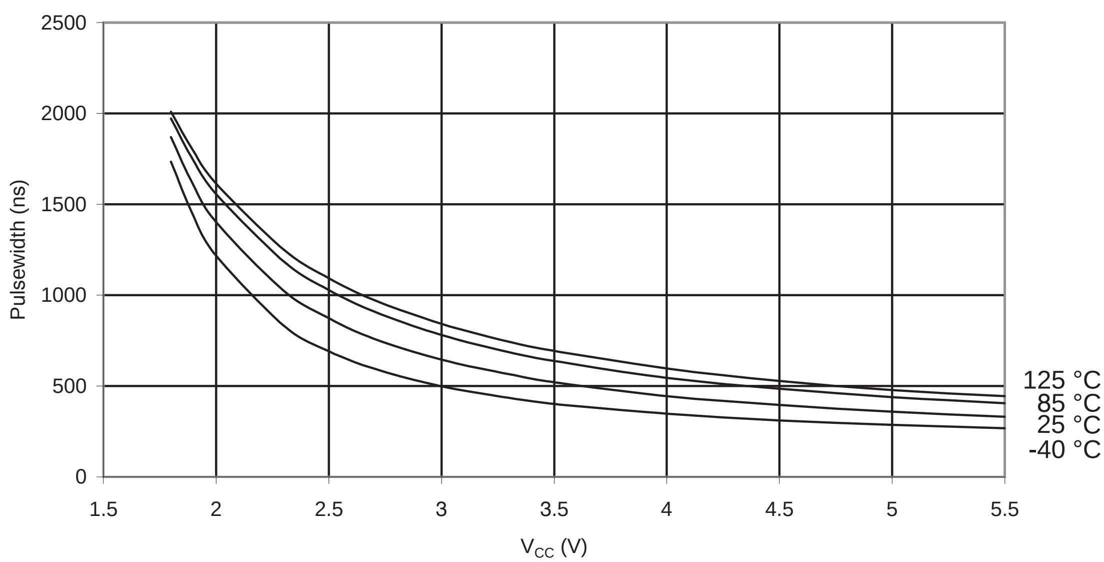


Figure 3-45. Minimum Reset Pulse Width vs. V_{CC}



4. Ordering Information

4.1 ATtiny25

Speed (MHz)	Supply Voltage (V)	Temperature Range	Package [1]	Ordering Code [2]
10	1.8 – 5.5	Extended (-40°C to +125°C)	20M1	ATTINY25V-10MF
				ATTINY25V-10MFR
20	2.7 – 5.5	Extended (-40°C to +125°C)	20M1	ATTINY25-20MF
				ATTINY25-20MFR

Notes:
1. All packages are Pb-free, halide-free and fully green, and they comply with the European directive for Restriction of Hazardous Substances (RoHS).
2. Code indicator:
   – R: tape & reel

Package Types	
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

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