ATtiny1634

8-bit AVR® Microcontroller
with 16K Bytes In-System Programmable Flash

DATASHEET APPENDIX B

Appendix B – ATtiny1634 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

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

EEPROM may not be programmed at supply voltages below 2V.

2. Lock Bits, Fuse Bits and Device Signature

Fuse bits may not be programmed at supply voltages below 2V.

3. Electrical Characteristics

3.1 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.

3.2 DC Characteristics

Table 3-1. DC Characteristics. T_A = -40 to +125°C

Symbol	Parameter	Condition	Min	Typ [1]	Max	Units
V_{IL}	Input Low Voltage	V_{CC} = 1.8 - 2.4V	-0.5		$0.2V_{CC}$ [2]	V
		V_{CC} = 2.4 - 5.5V	-0.5		$0.3V_{CC}$ [2]	V
	Input Low Voltage, RESET Pin as Reset [4]	V_{CC} = 1.8 - 5.5V	-0.5		$0.2V_{CC}$ [2]	
V_{IH}	Input High-voltage Except RESET pin	V_{CC} = 1.8 - 2.4V	$0.7V_{CC}$ [3]		V_{CC} +0.5	V
		V_{CC} = 2.4 - 5.5V	$0.6V_{CC}$ [3]		V_{CC} +0.5	V
	Input High-voltage RESET pin as Reset [4]	V_{CC} = 1.8 - 5.5V	$0.9V_{CC}$ [3]		V_{CC} +0.5	V
V_{OL}	Output Low Voltage[5] Except RESET pin[7]	Standard I/O: I_{OL} = 10 mA, V_{CC} = 5V			0.6	V
		High-sink I/O: I_{OL} = 20 mA, V_{CC} = 5V				
		Standard I/O: I_{OL} = 5 mA, V_{CC} = 3V			0.5	V
		High-sink I/O: I_{OL} = 10 mA, V_{CC} = 3V				
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	V_{CC} = 5.5V, pin low (absolute value)		< 0.05	1 [8]	µA
I_{LIH}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin high (absolute value)		< 0.05	1 [8]	µA

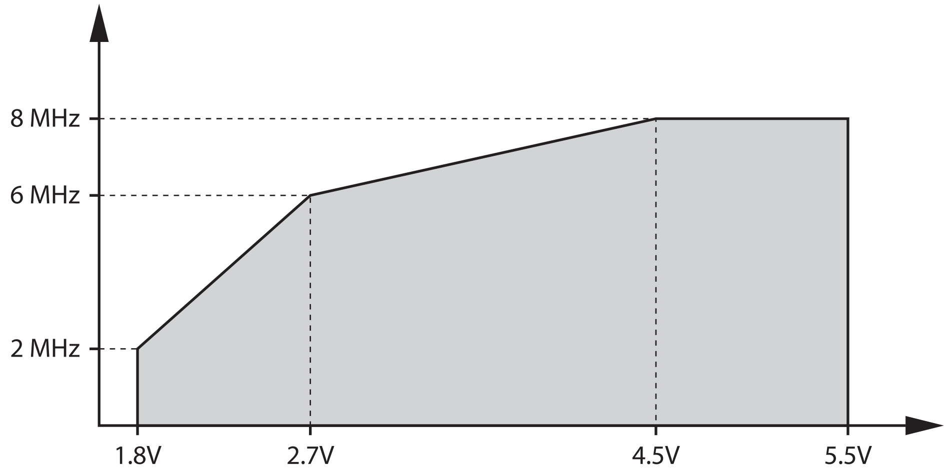
Symbol	Parameter	Condition	Min	Typ [1]	Max	Units
R_{PU}	Pull-up Resistor, I/O Pin	V_{CC} = 5.5V, input low	20		50	kΩ
	Pull-up Resistor, Reset Pin	V_{CC} = 5.5V, input low	30		60	kΩ
I_{CC}	Supply Current, Active Mode [9]	f = 1MHz, V_{CC} = 2V		0.23	0.4	mA
		f = 4MHz, V_{CC} = 3V		1.3	1.7	mA
		f = 8MHz, V_{CC} = 5V		4.3	6	mA
	Supply Current, Idle Mode [9]	f = 1MHz, V_{CC} = 2V		0.04	0.1	mA
		f = 4MHz, V_{CC} = 3V		0.26	0.4	mA
		f = 8MHz, V_{CC} = 5V		1.1	1.7	mA
	Supply Current, Power-Down Mode [10]	WDT enabled, V_{CC} = 3V		1.7	12	µA
		WDT disabled, V_{CC} = 3V		0.1	8	µA

Notes:
1. Typical values at +25°C.
2. "Max" means the highest value where the pin is guaranteed to be read as low.
3. "Min" means the lowest value where the pin is guaranteed to be read as high.
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 100 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 100 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 "Output Driver Strength" on page 20.
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" on page 39. Power Reduction is enabled (PRR = 0xFF) and there is no I/O drive.
10. Bod Disabled.

3.3 Speed

The maximum operating frequency of the device is dependent on supply voltage, V_{CC} . The relationship between supply voltage and maximum operating frequency is piecewise linear, as shown in Figure 3-1.

Figure 3-1. Maximum Frequency vs. V_{CC}



3.4 Clock

Table 3-2. Accuracy of Calibrated 8MHz Oscillator

Calibration Method	Target Frequency	V_{CC}	Temperature	Accuracy
Factory Calibration	8.0MHz	2.7 – 4V	25°C to +85°C	±10% (1)
User Calibration	Within: 7.3 – 8.1MHz	Within: 1.8 – 5.5V	Within: -40°C to +85°C	±1% (2)

Notes: 1. See device ordering codes on page 37 for alternatives.

2. Accuracy of oscillator frequency at calibration point (fixed temperature and fixed voltage).

Table 3-3. Accuracy of Calibrated 32kHz Oscillator

Calibration Method	Target Frequency	V_{CC}	Temperature	Accuracy
Factory Calibration	32kHz	1.8 – 5.5V	-40°C to +85°C	±35%

Table 3-4. External Clock Drive

Symbol	Parameter	V_{CC} = 1.8 - 5.5V		V_{CC} = 2.7 - 5.5V		V_{CC} = 4.5 - 5.5V		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
$1/t_{CLCL}$	Clock Frequency	0	2	0	8	0	10	MHz
t_{CLCL}	Clock Period	500		125		100		ns
t_{CHCX}	High Time	200		40		20		ns
t_{CLCX}	Low Time	200		40		20		ns
t_{CLCH}	Rise Time		2.0		1.6		0.5	μs
t_{CHCL}	Fall Time		2.0		1.6		0.5	μs
Δt_{CLCL}	Change in period from one clock cycle to next		2		2		2	%

3.5 System and Reset

Table 3-5. Enhanced Power-On Reset

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_{POA}.

4. Typical Characteristics

4.1 Current Consumption in Active Mode

Figure 4-1. Active Supply Current vs. V_{CC} (Internal Oscillator, 8 MHz)

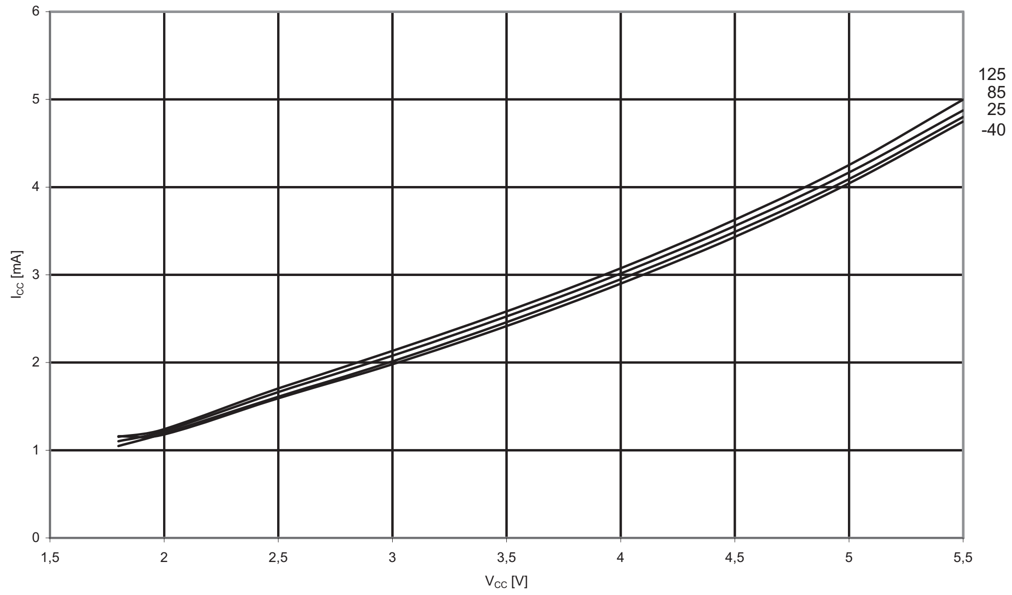


Figure 4-2. Active Supply Current vs. V_{CC} (Internal Oscillator, 1 MHz)

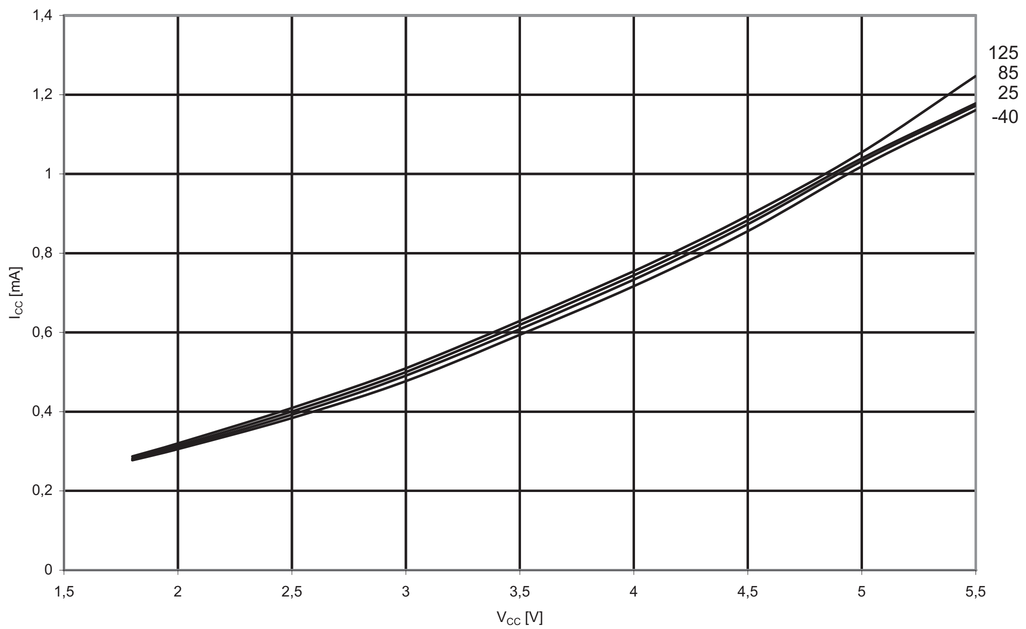
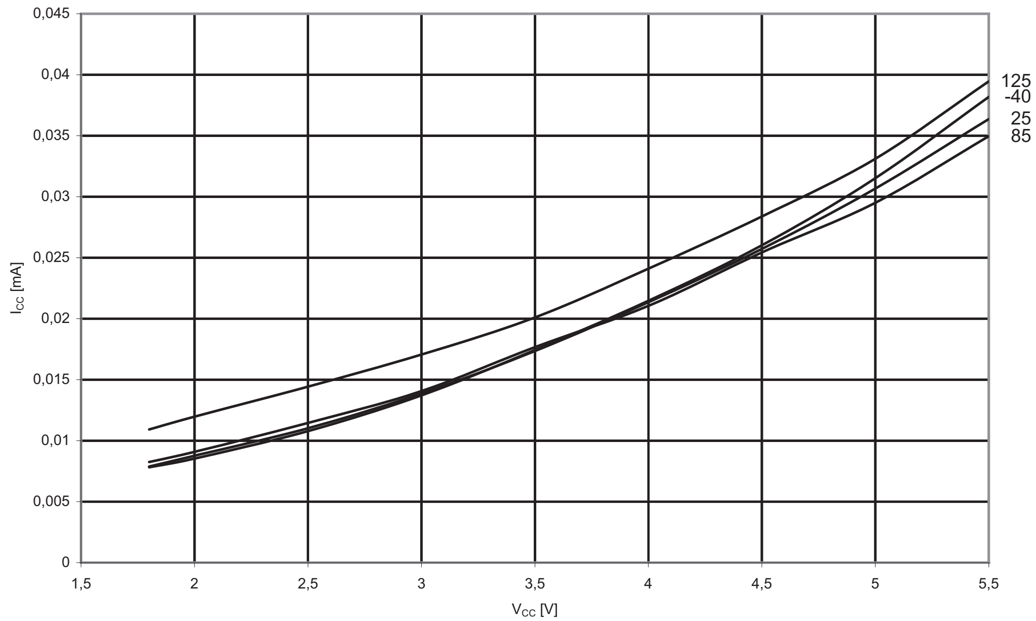


Figure 4-3. Active Supply Current vs. V_{CC} (Internal Oscillator, 32kHz)



4.2 Current Consumption in Idle Mode

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

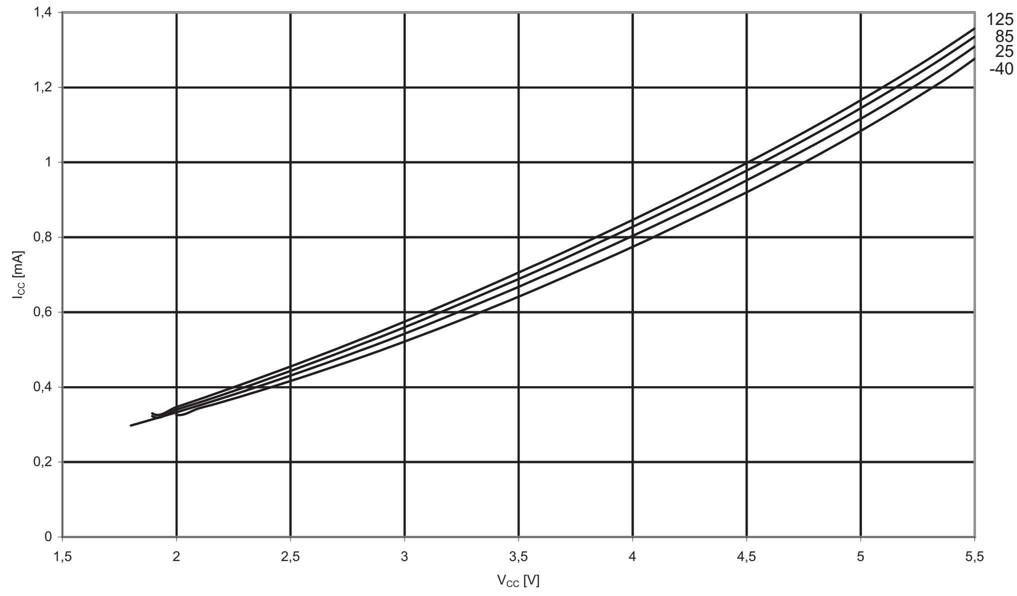


Figure 4-5. Idle Supply Current vs. V_{CC} (Internal Oscillator, 1 MHz)

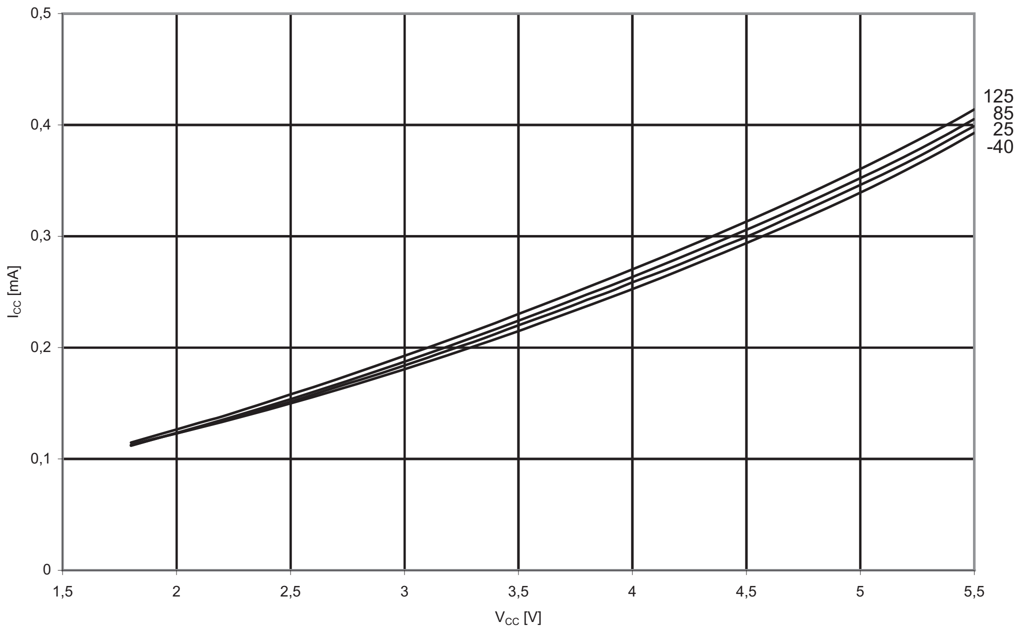
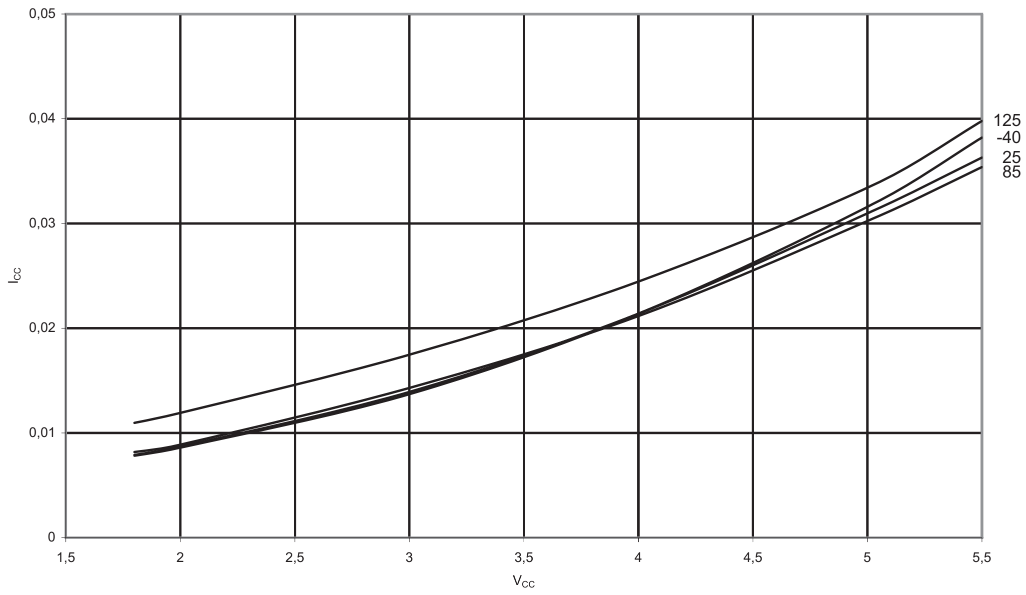


Figure 4-6. Idle Supply Current vs. V_{CC} (Internal Oscillator, 32kHz)



4.3 Current Consumption in Power-down Mode

Figure 4-7. Power-down Supply Current vs. V_{CC} (Watchdog Timer Disabled)

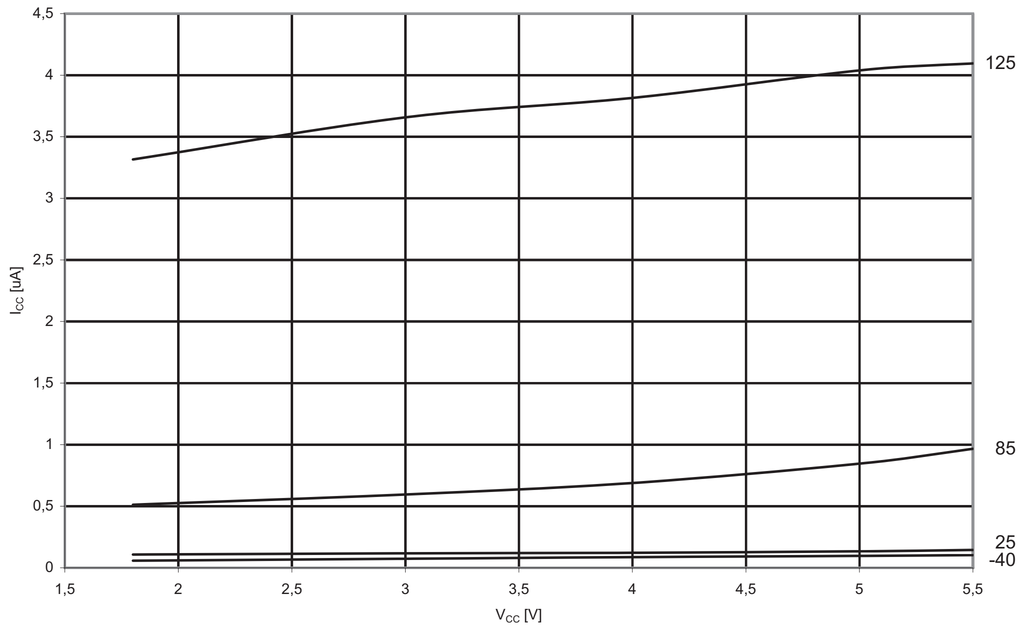
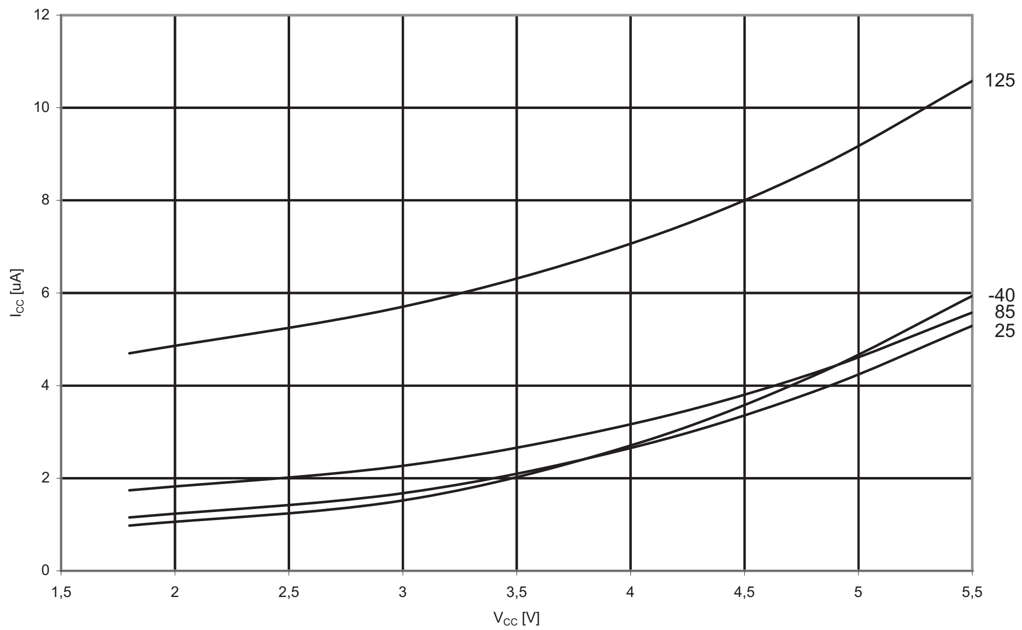
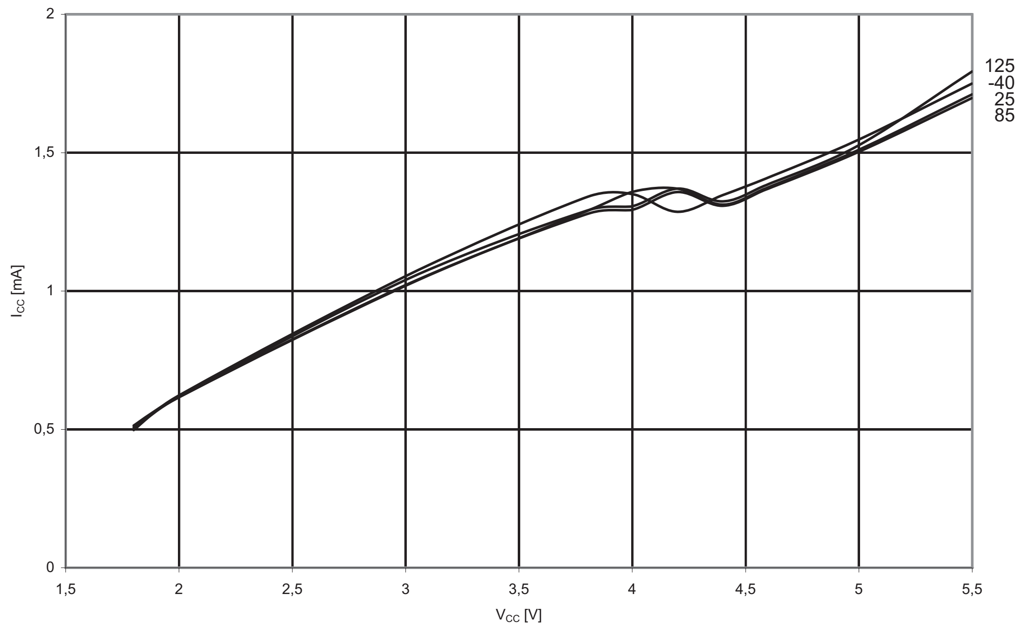


Figure 4-8. Power-down Supply Current vs. V_{CC} (Watchdog Timer Enabled)



4.4 Current Consumption in Reset

Figure 4-9. Reset Current vs. V_{CC} (No Clock, excluding Reset Pull-Up Current)



4.5 Current Consumption of Peripheral Units

Figure 4-10. Watchdog Timer Current vs. V_{CC}

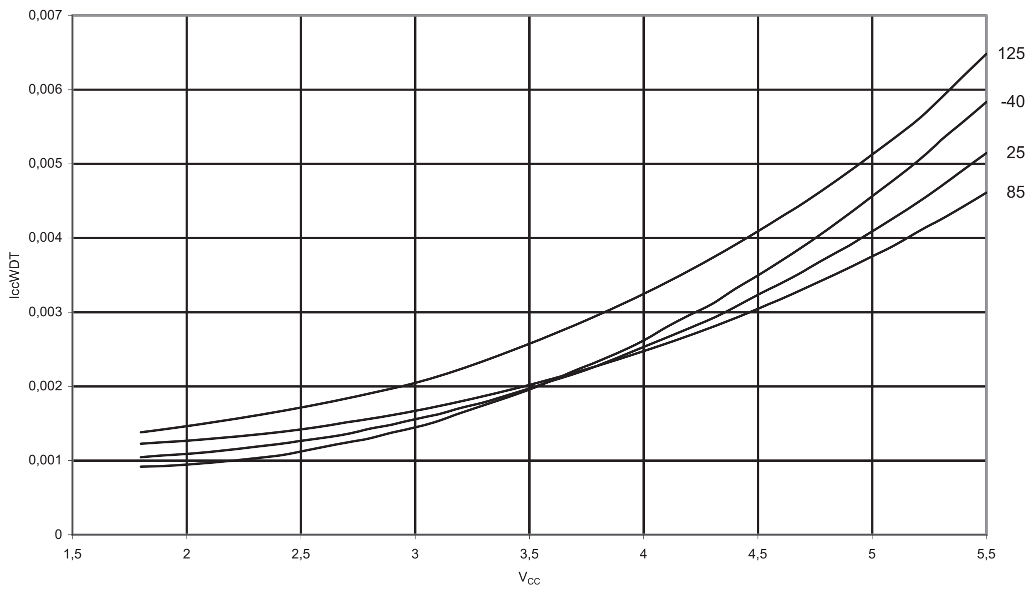


Figure 4-11. Brownout Detector Current vs. V_{CC}

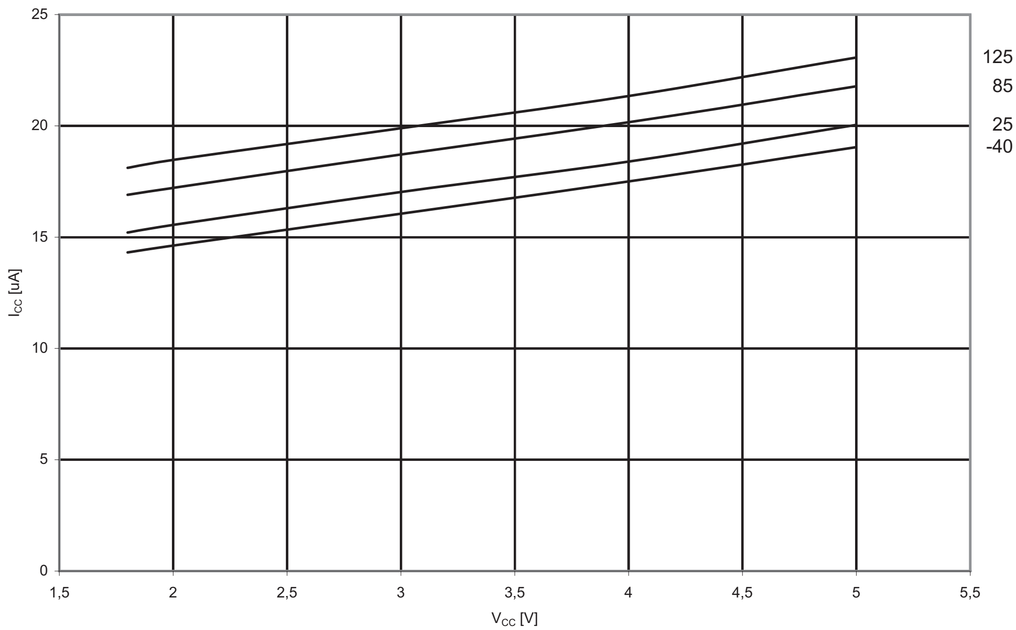


Figure 4-12. Sampled Brownout Detector Current vs. V_{CC}

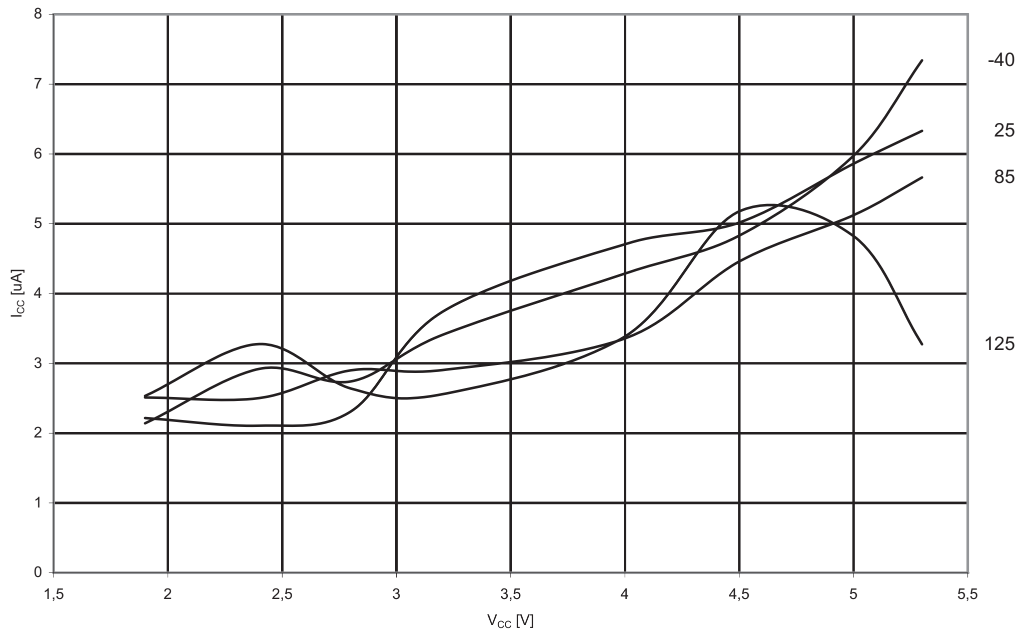
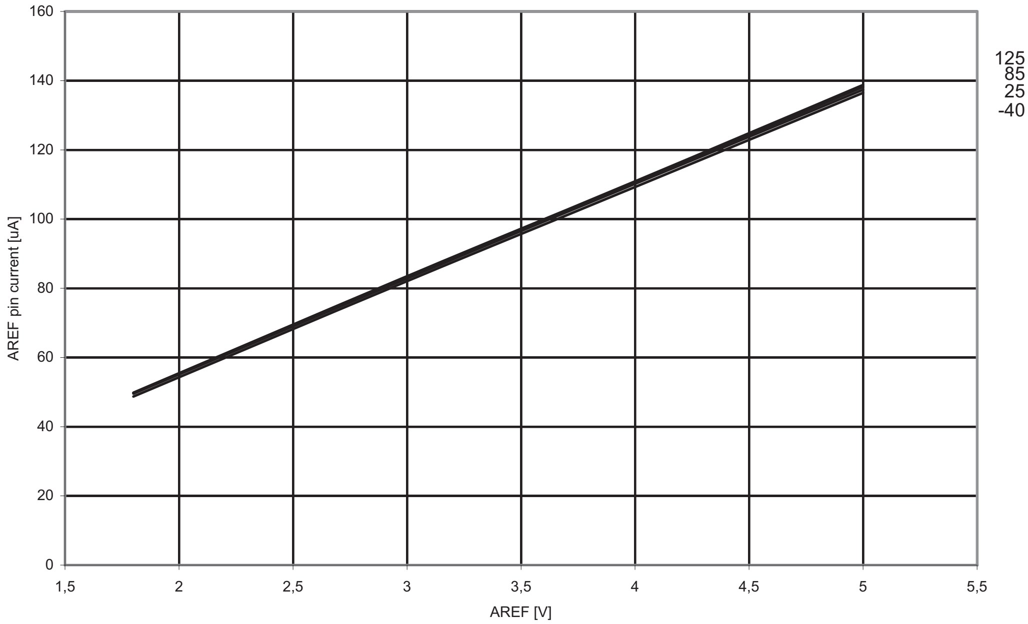


Figure 4-13. AREF External Reference Pin Current (V_{CC} = 5V)



4.6 Pull-up Resistors

Figure 4-14. I/O pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 1.8V)

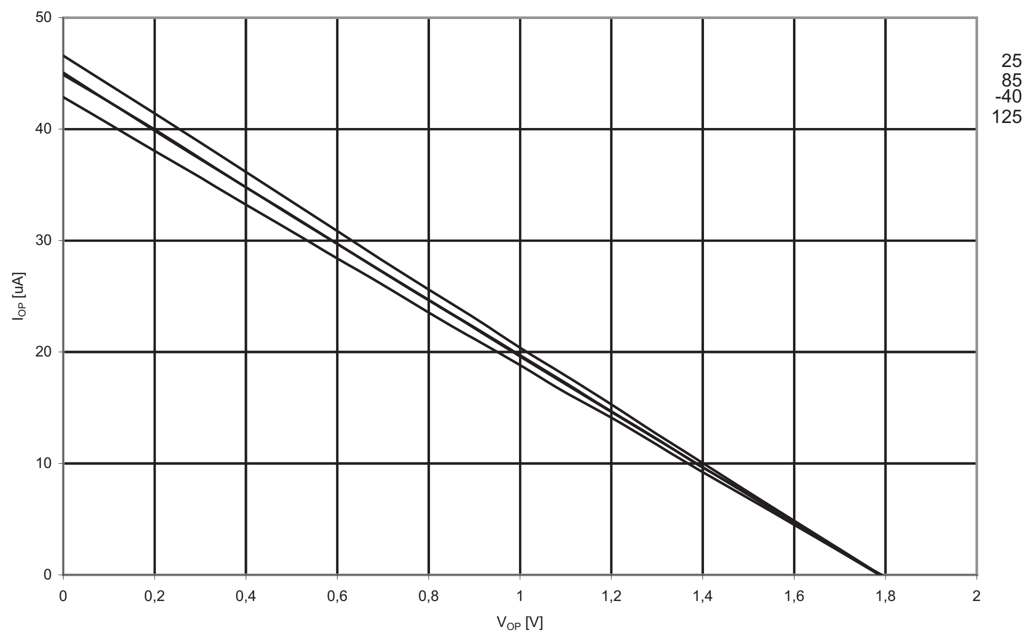


Figure 4-15. I/O Pin Pull-up Resistor Current vs. input Voltage (V_{CC} = 2.7V)

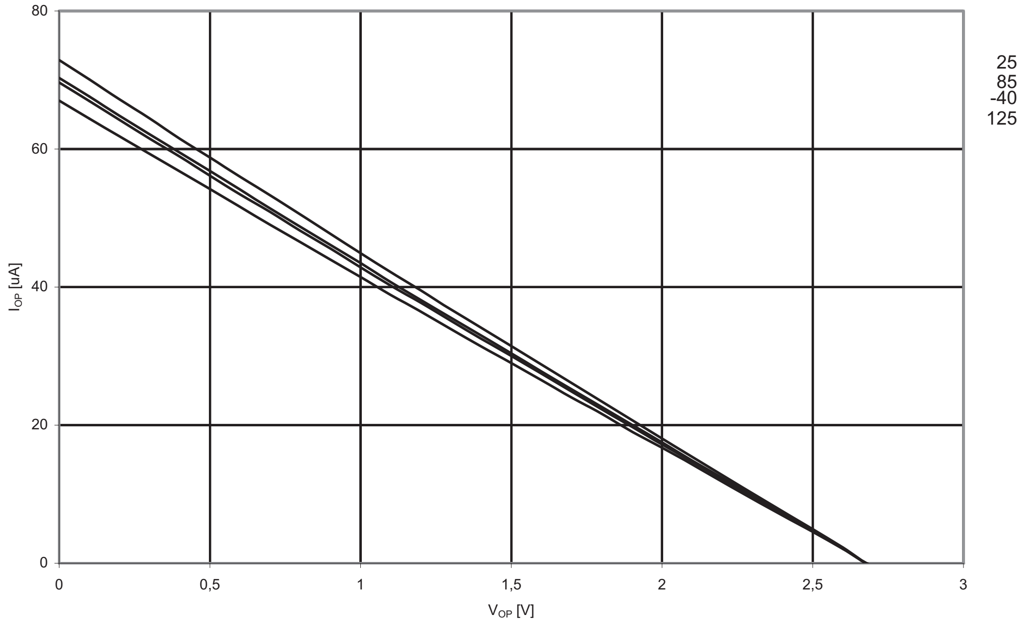


Figure 4-16. I/O pin Pull-up Resistor Current vs. Input Voltage (V_{CC} = 5V)

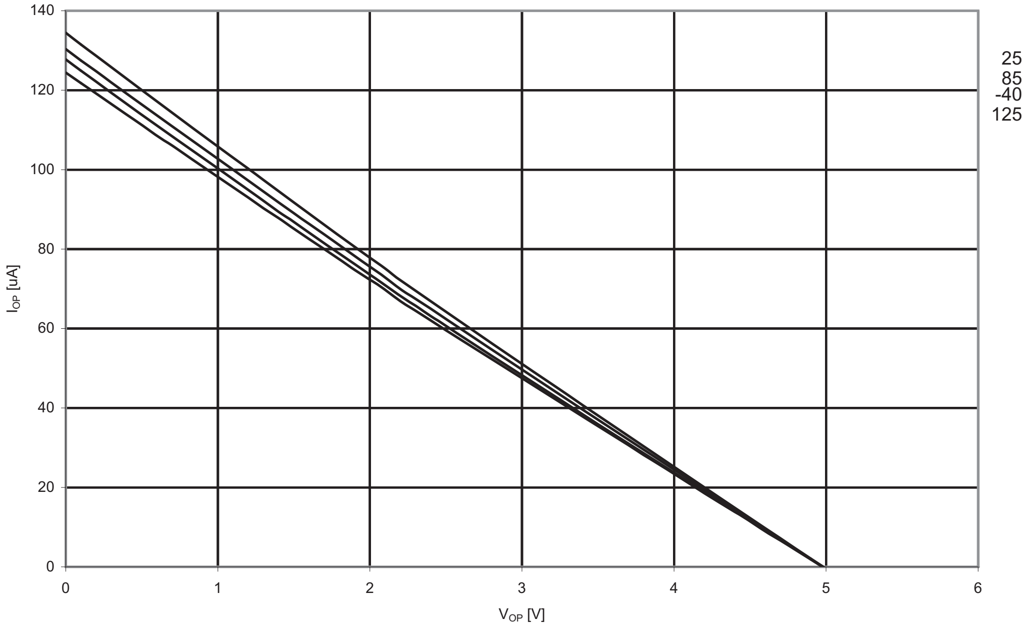


Figure 4-17. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 1.8V)

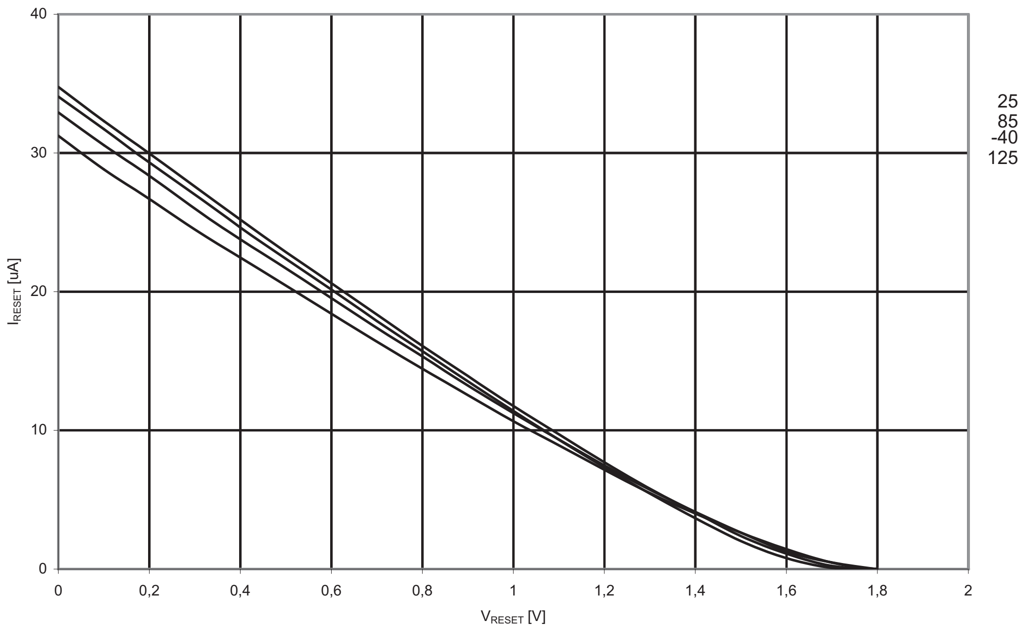


Figure 4-18. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 2.7V)

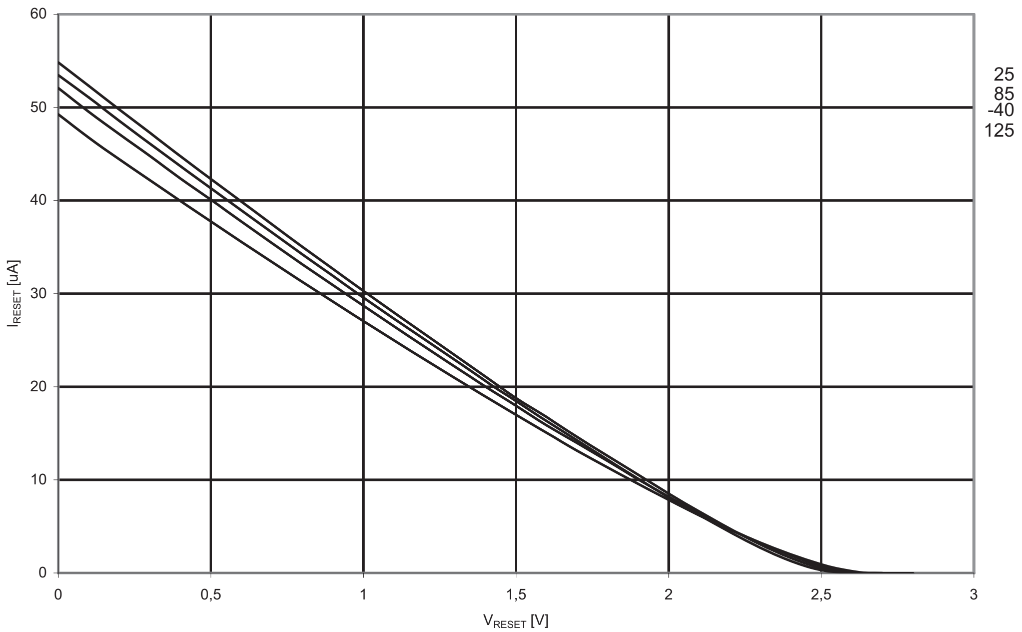
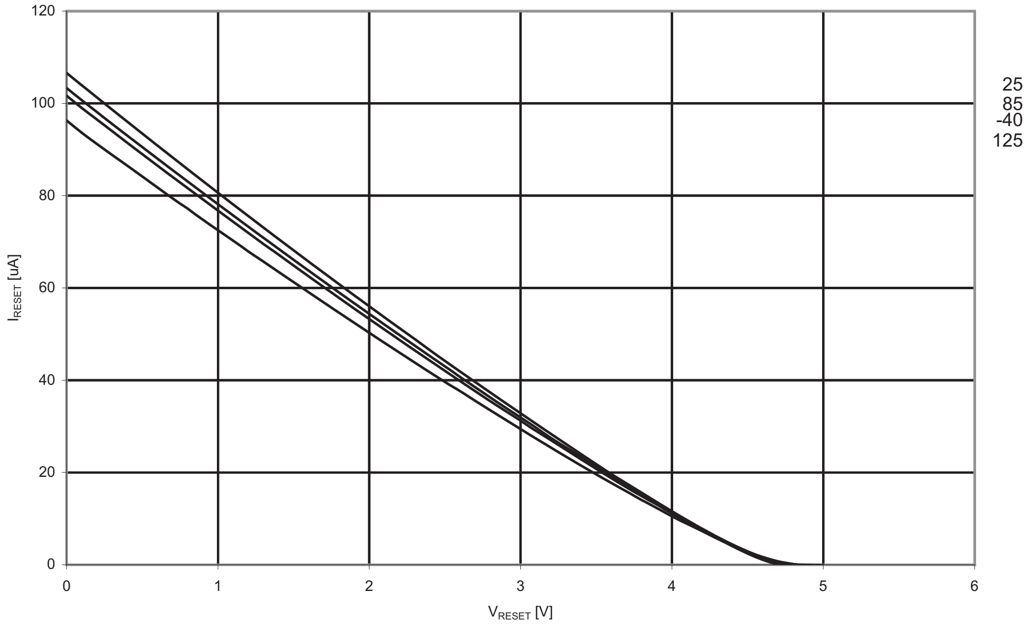


Figure 4-19. Reset Pull-up Resistor Current vs. Reset Pin Voltage (V_{CC} = 5V)



4.7 Input Thresholds

Figure 4-20. V_{IH}: Input Threshold Voltage vs. V_{CC} (I/O Pin, Read as '1')

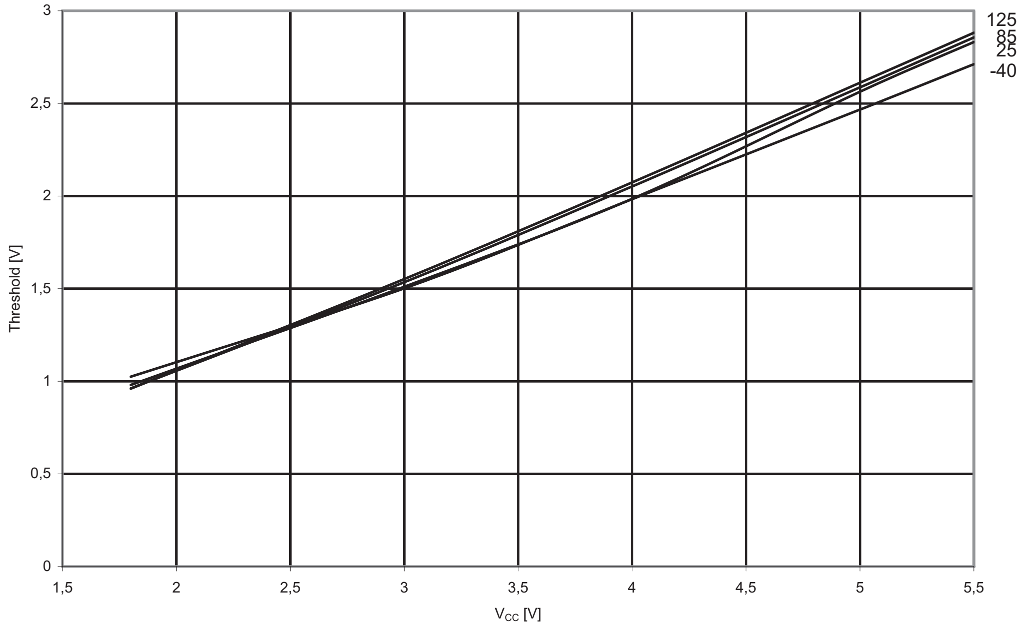


Figure 4-21. V_{IL}: Input Threshold Voltage vs. V_{CC} (I/O Pin, Read as '0')

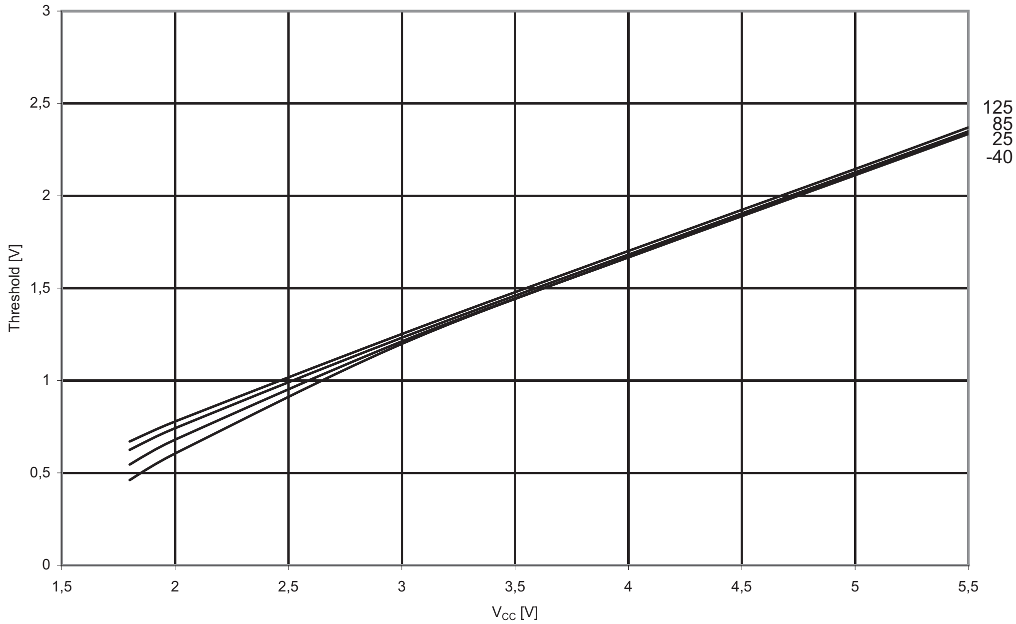


Figure 4-22. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (I/O Pin)

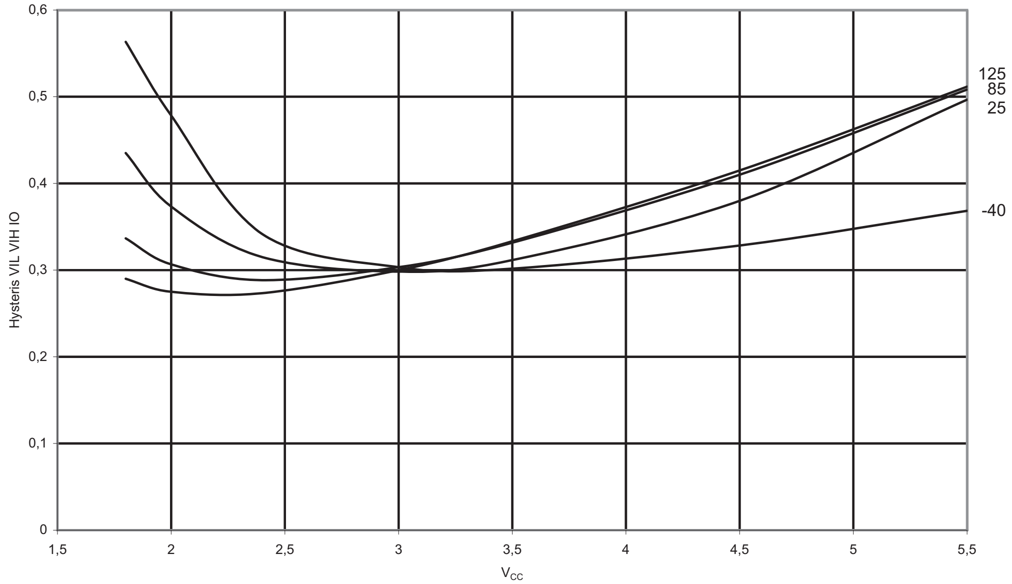


Figure 4-23. V_{IH}**: Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '1')**

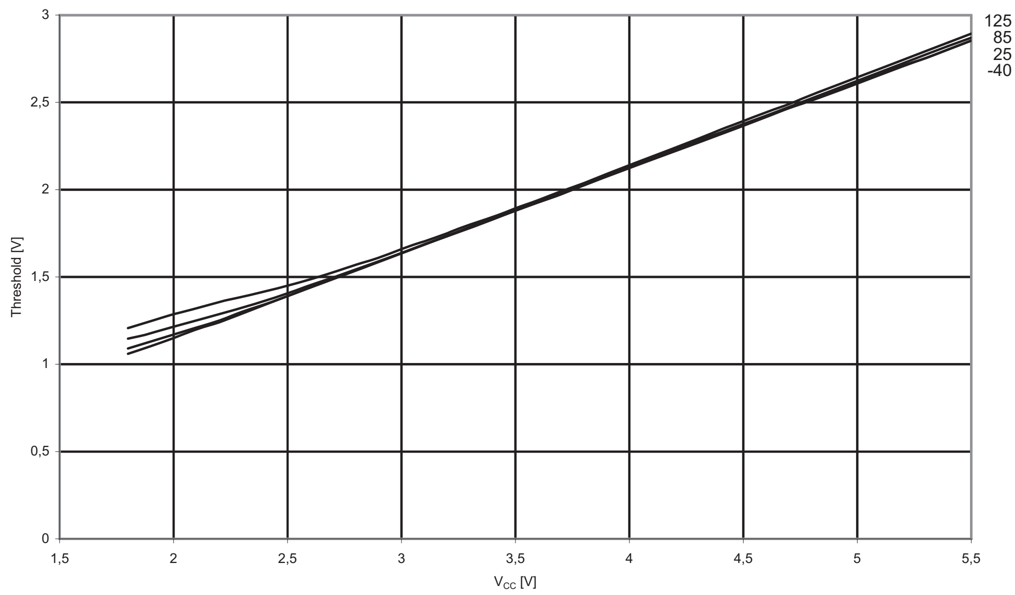


Figure 4-24. V_{IL}**: Input Threshold Voltage vs.** V_{CC} **(Reset Pin as I/O, Read as '0')**

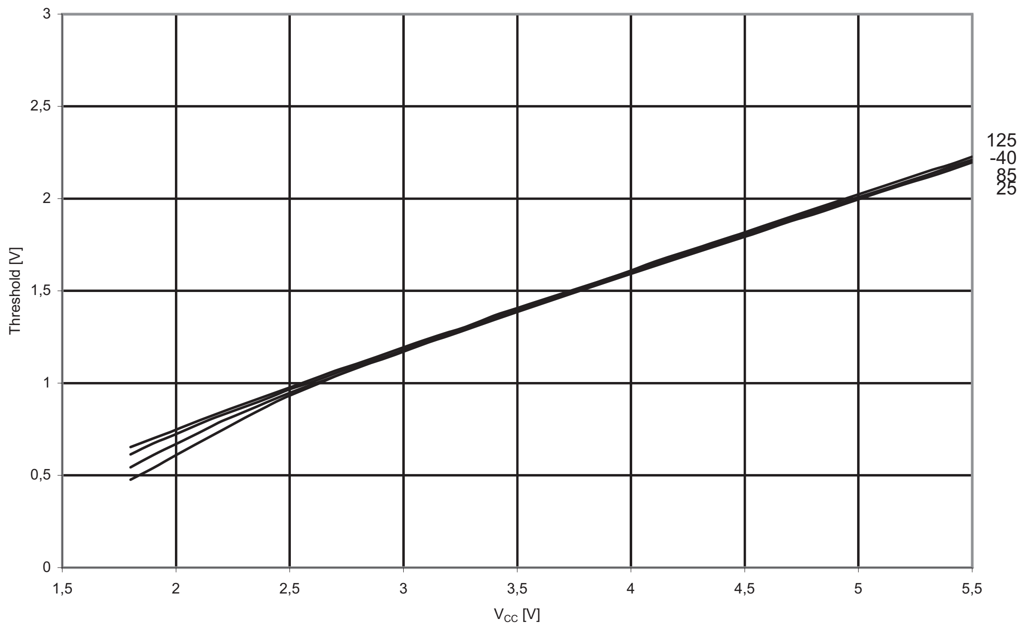
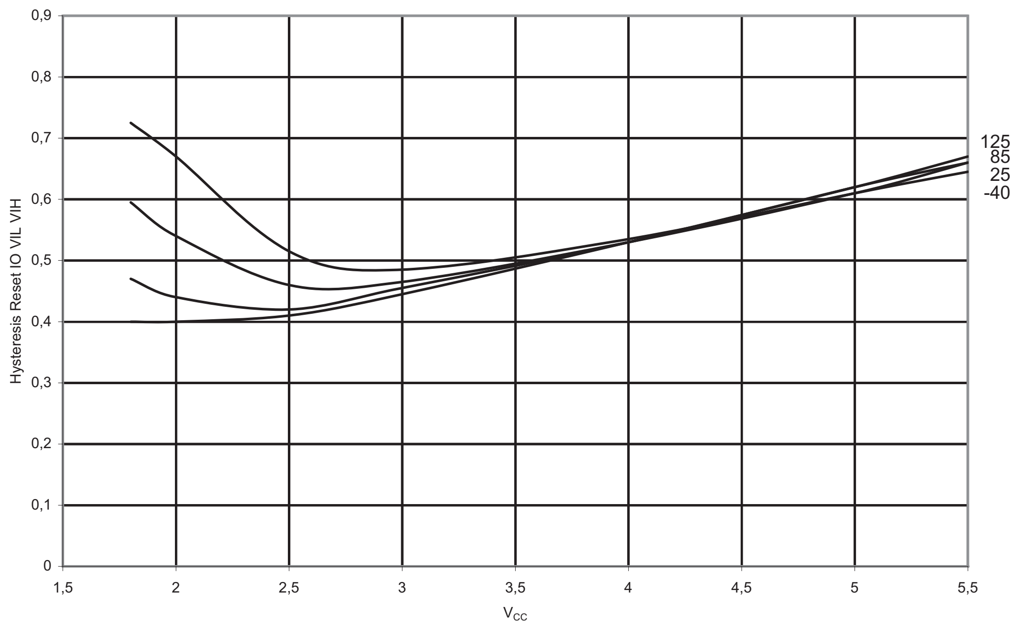


Figure 4-25. V_{IH}-V_{IL}: Input Hysteresis vs. V_{CC} (Reset Pin as I/O)



4.8 Output Driver Strength

Figure 4-26. V_{OH}: Output Voltage vs. Source Current (I/O Pin, V_{CC} = 1.8V)

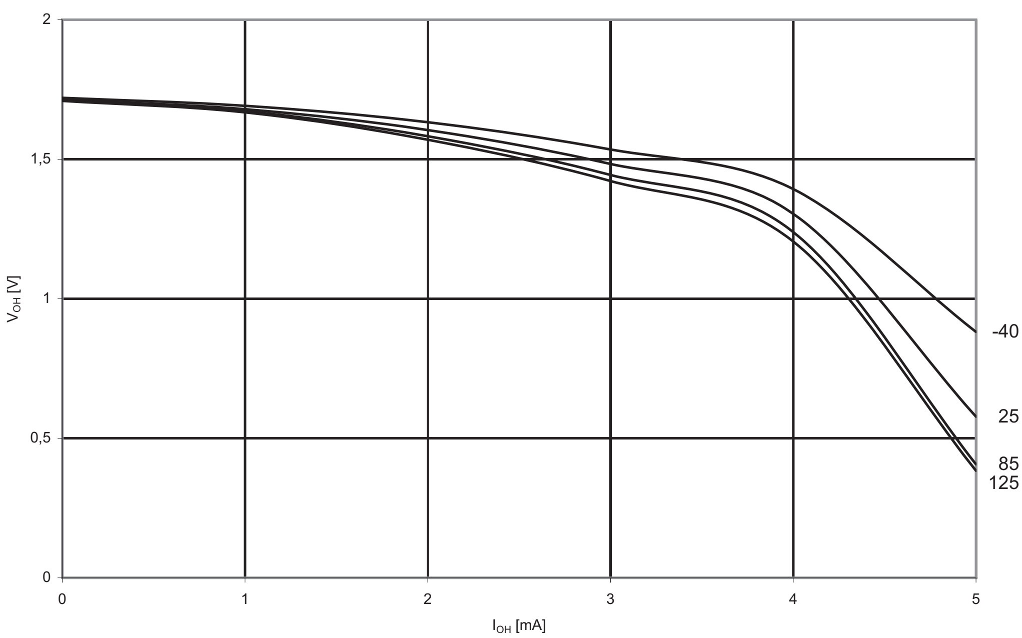


Figure 4-27. V_{OH}**: Output Voltage vs. Source Current (I/O Pin,** V_{CC} **= 3V)**

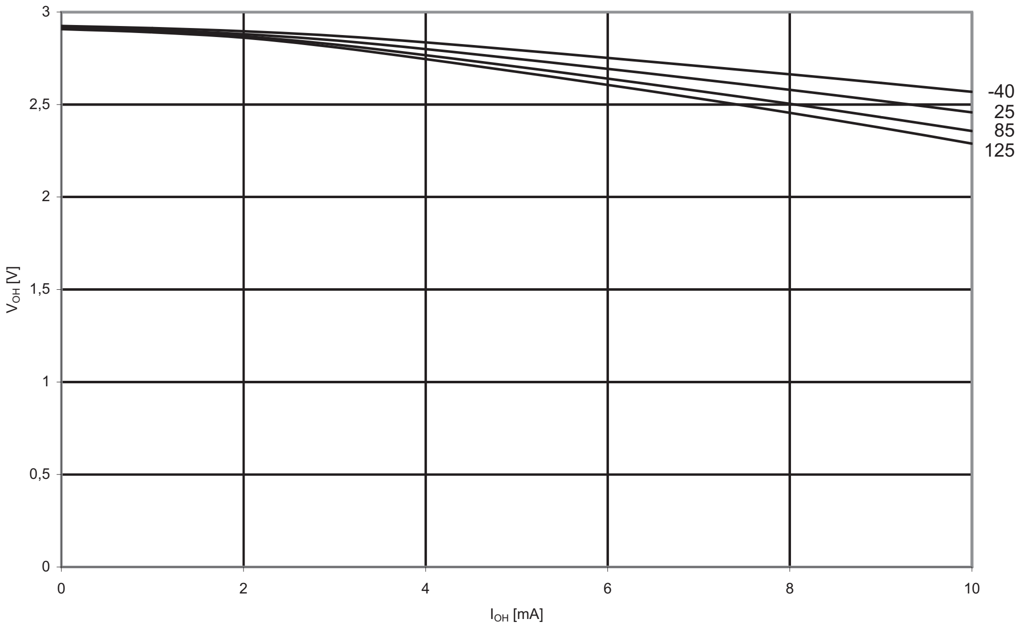


Figure 4-28. V_{OH}**: Output Voltage vs. Source Current (I/O Pin,** V_{CC} **= 5V)**

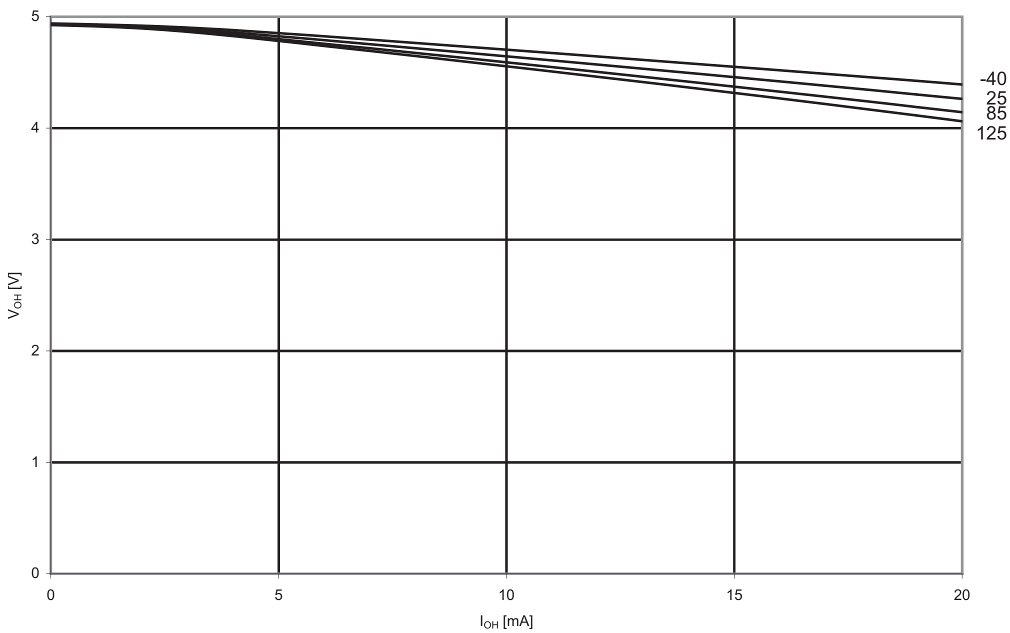


Figure 4-29. V_{OL}**: Output Voltage vs. Sink Current (I/O Pin,** V_{CC} **= 1.8V)**

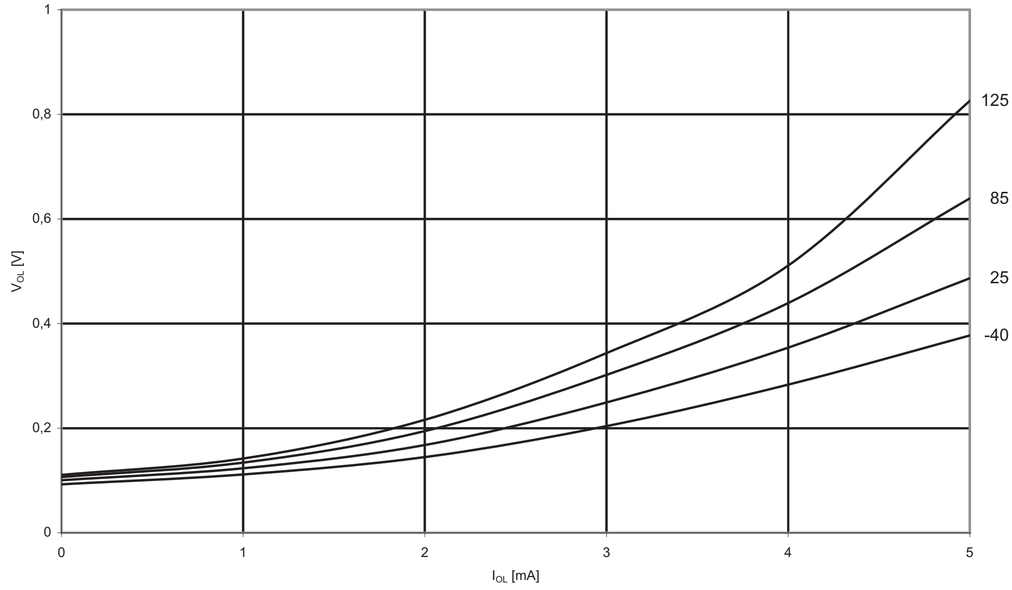


Figure 4-30. V_{OL}**: Output Voltage vs. Sink Current (I/O Pin,** V_{CC} **= 3V)**

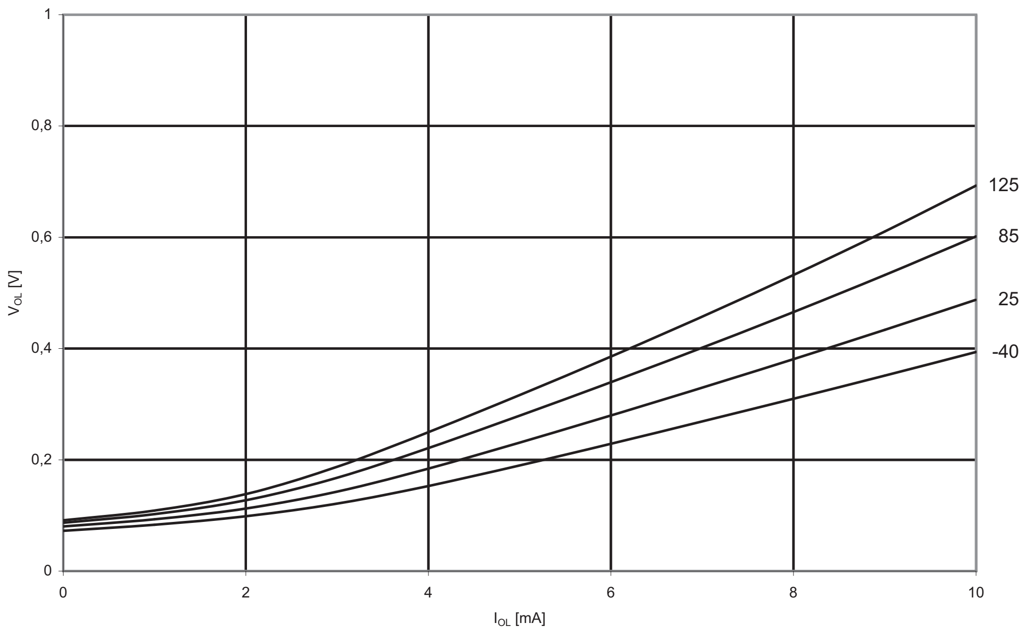


Figure 4-31. V_{OL}**: Output Voltage vs. Sink Current (I/O Pin,** V_{CC} **= 5V)**

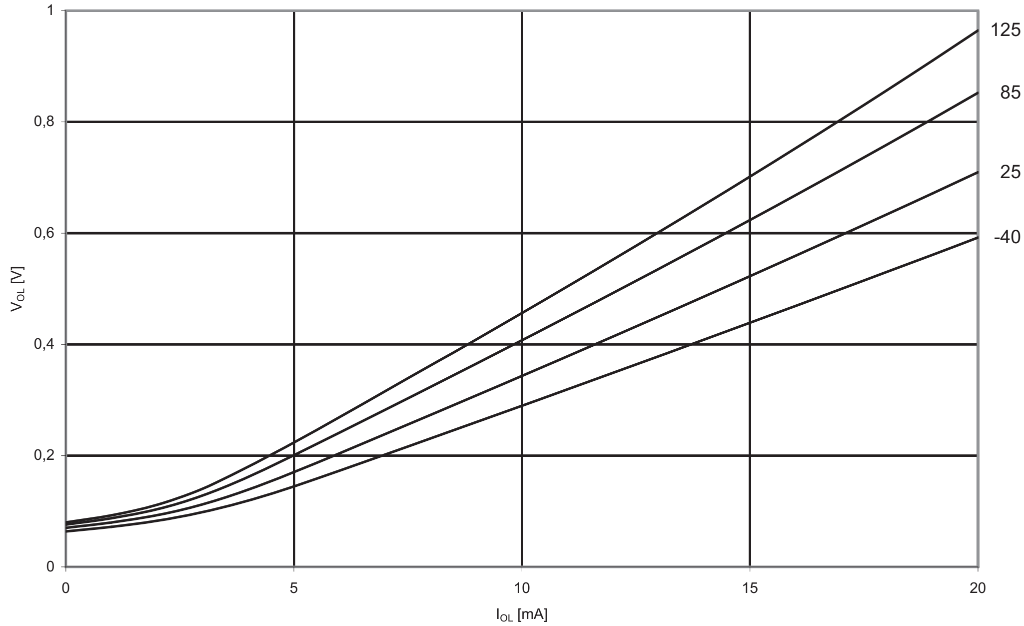


Figure 4-32. V_{OH}**: Output Voltage vs. Source Current (Reset Pin as I/O,** V_{CC} **= 1.8V**

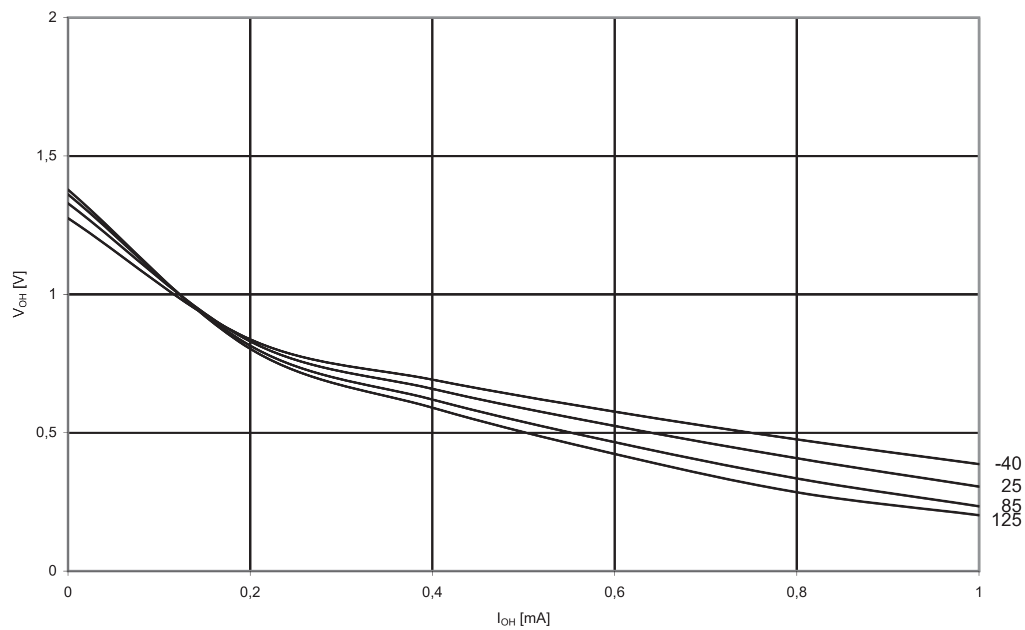


Figure 4-33. V_{OH}: **Output Voltage vs. Source Current (Reset Pin as I/O,** V_{CC} **= 3V**

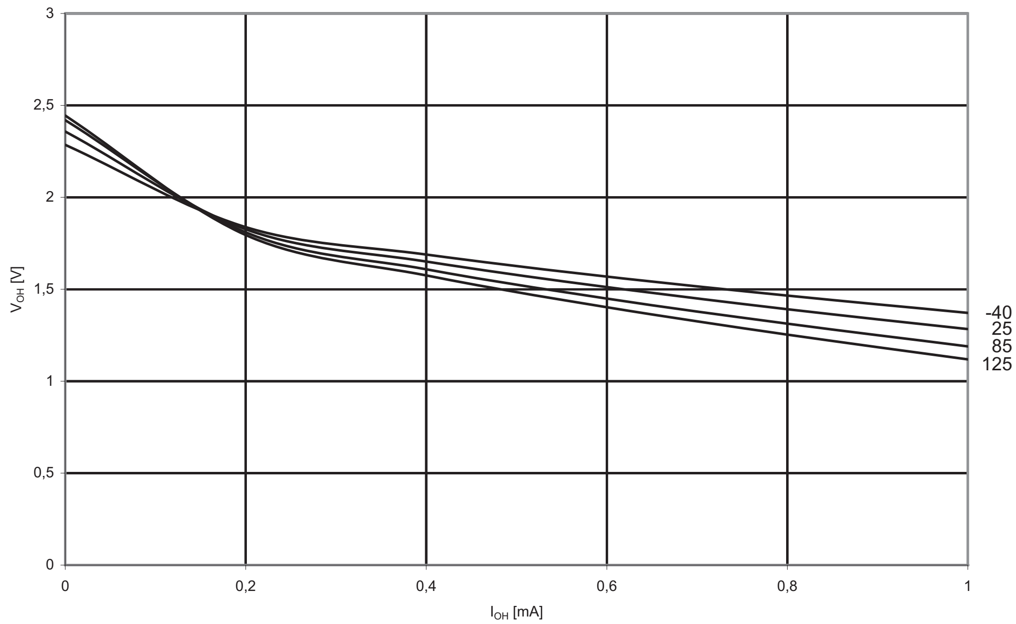


Figure 4-34. V_{OH}: **Output Voltage vs. Source Current (Reset Pin as I/O,** V_{CC} **= 5V**

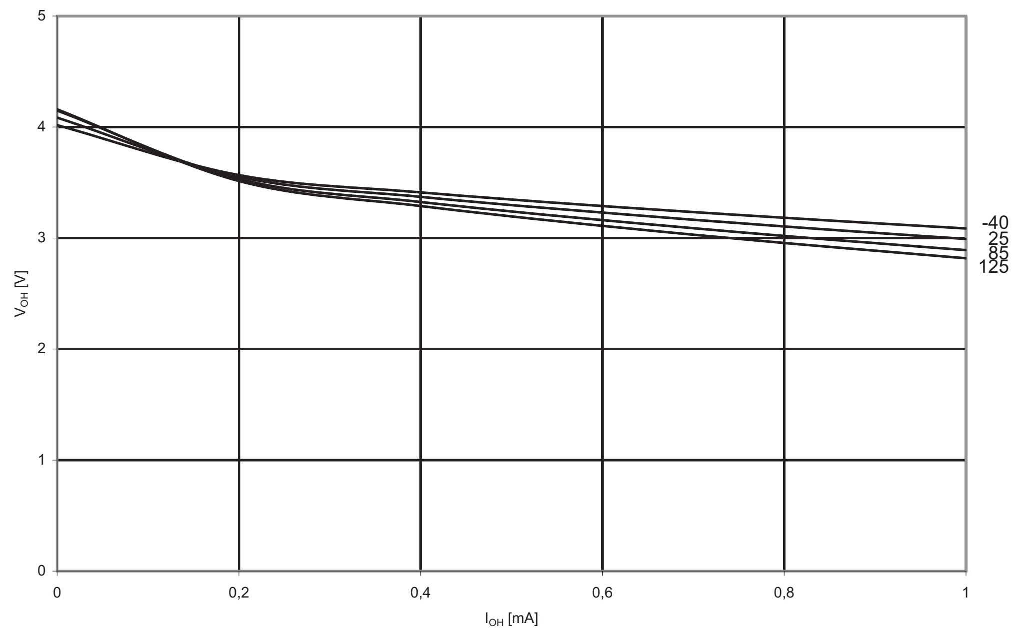


Figure 4-35. V_{OL}: Output Voltage vs. Sink Current (Reset Pin as I/O, V_{CC} = 1.8V)

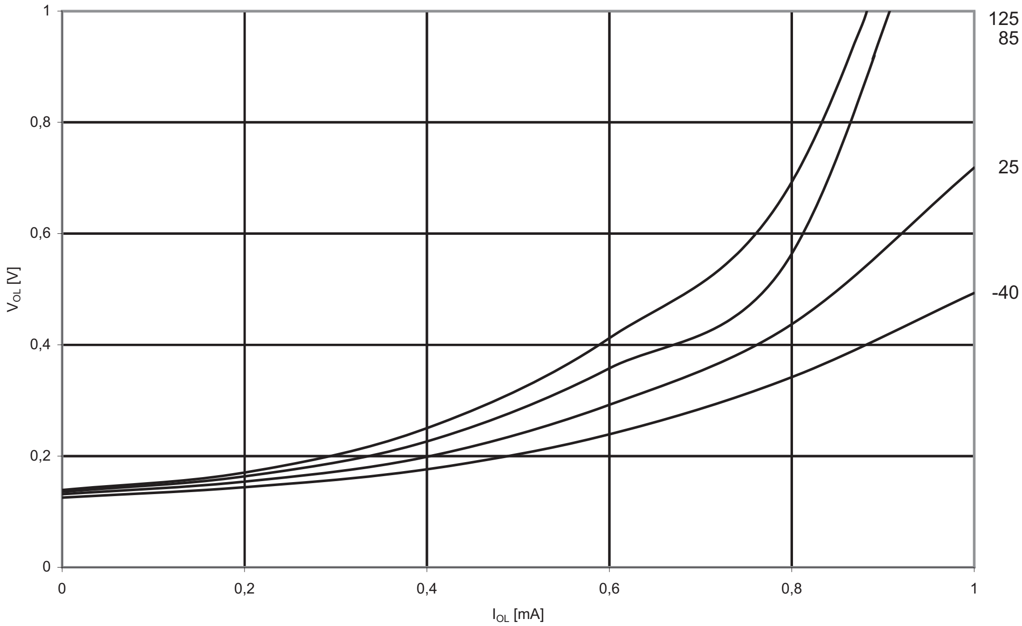


Figure 4-36. V_{OL}: Output Voltage vs. Sink Current (Reset Pin as I/O, V_{CC} = 3V)

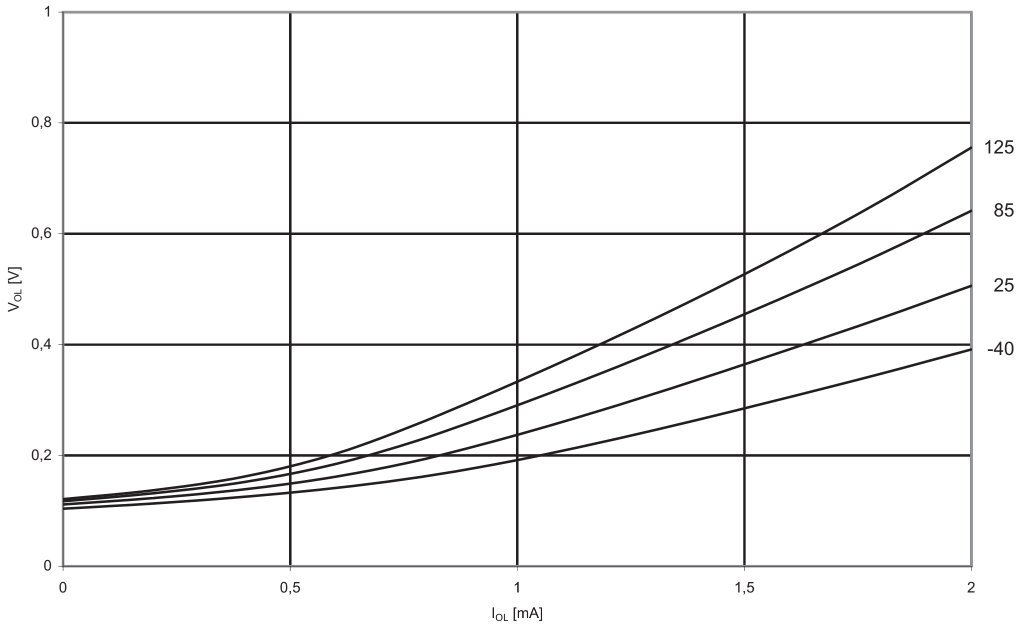
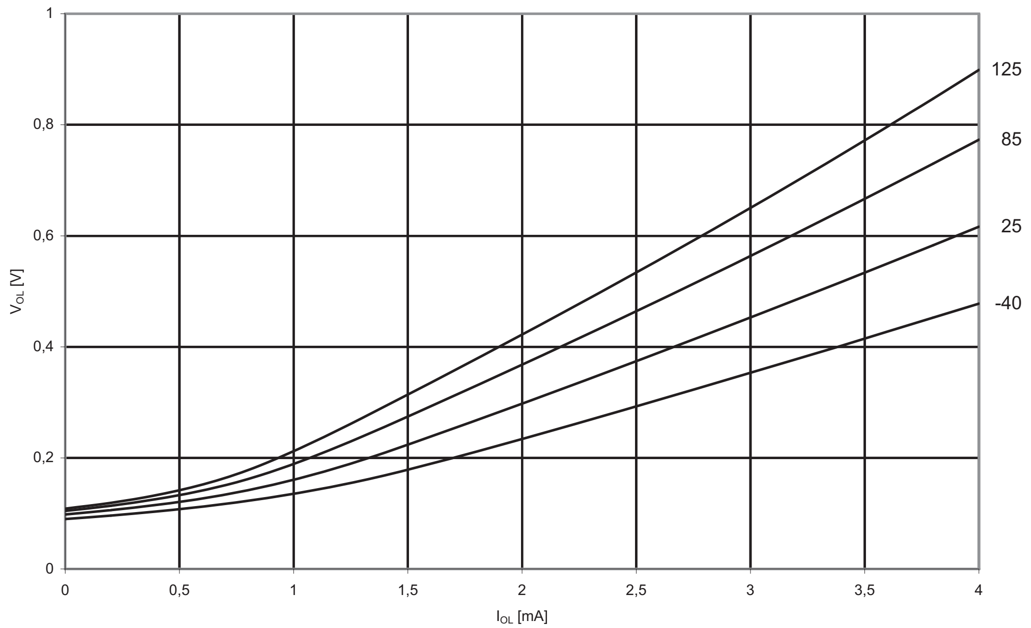


Figure 4-37. V_{OL}**: Output Voltage vs. Sink Current (Reset Pin as I/O,** V_{CC} **= 5V)**



4.9 BOD

Figure 4-38. BOD Threshold vs Temperature (BODLEVEL = 4.3V)

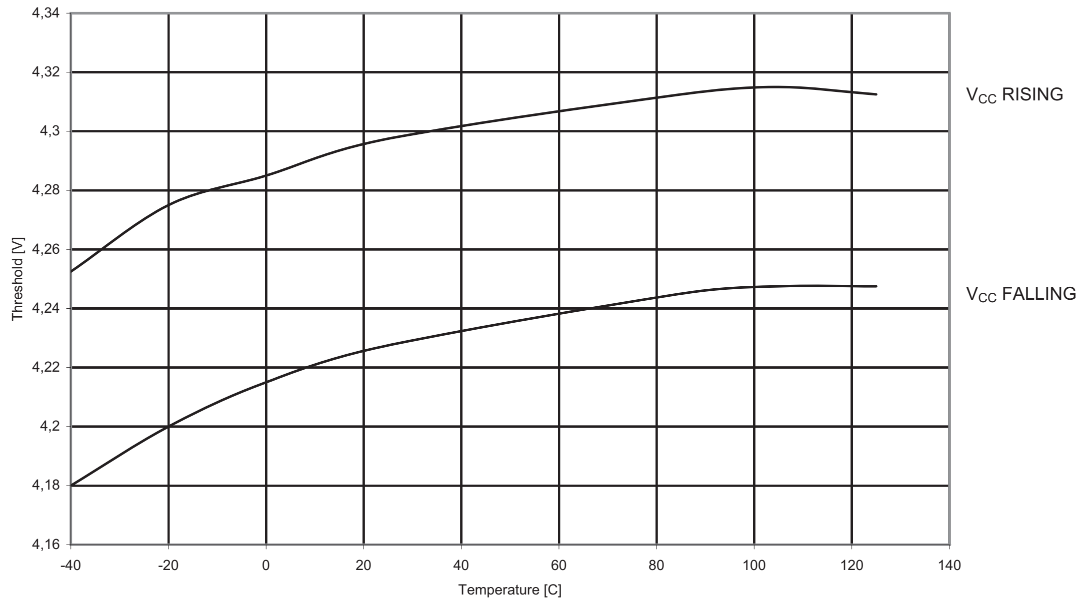


Figure 4-39. BOD Threshold vs Temperature (BODLEVEL = 2.7V)

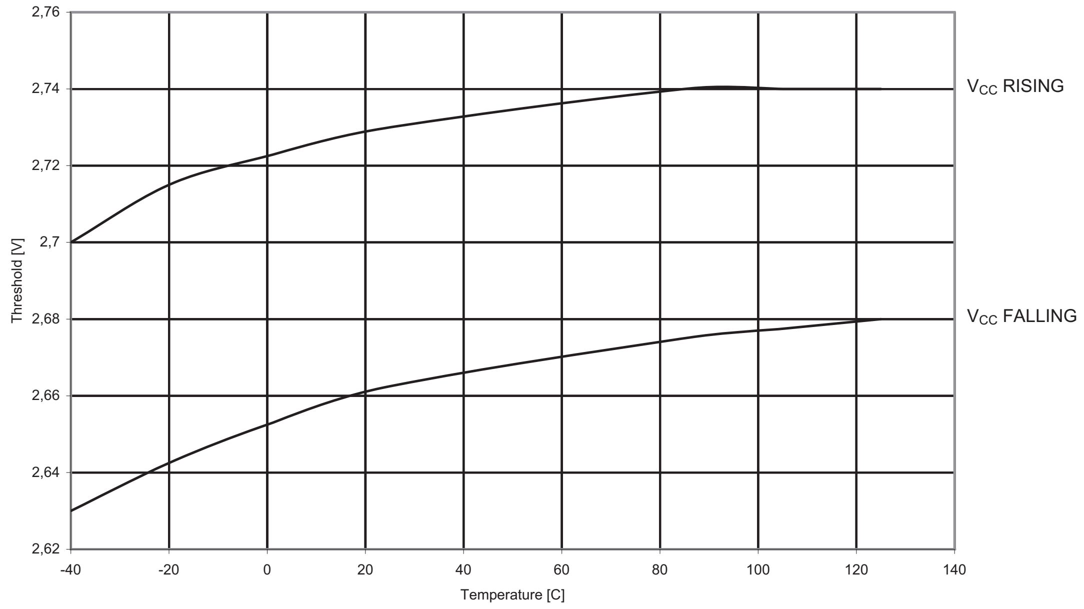


Figure 4-40. BOD Threshold vs Temperature (BODLEVEL = 1.8V)

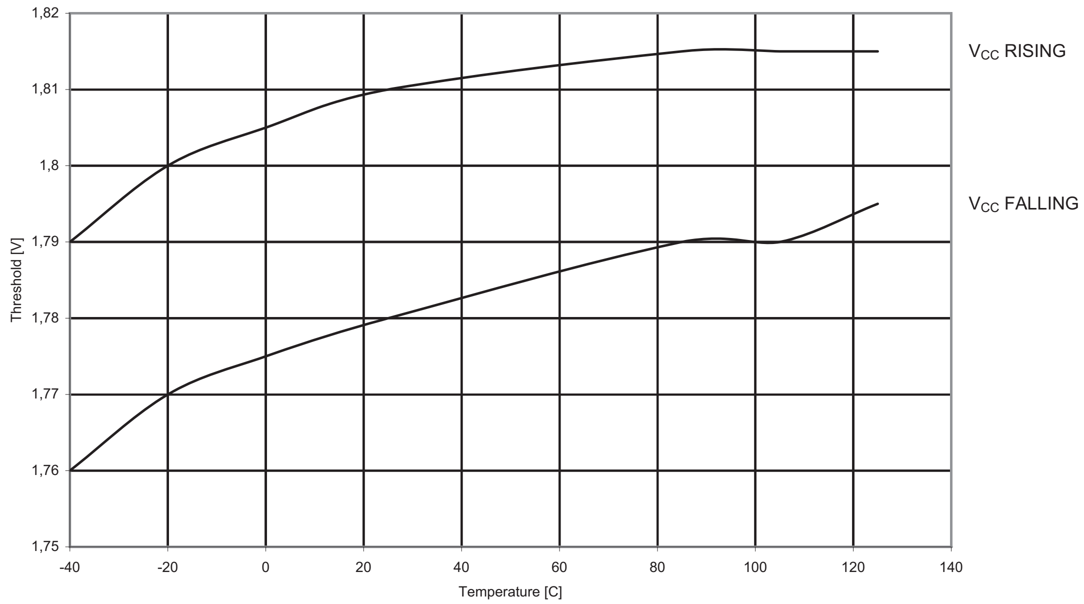


Figure 4-41. Sampled BOD Threshold vs Temperature (BODLEVEL = 4.3V)

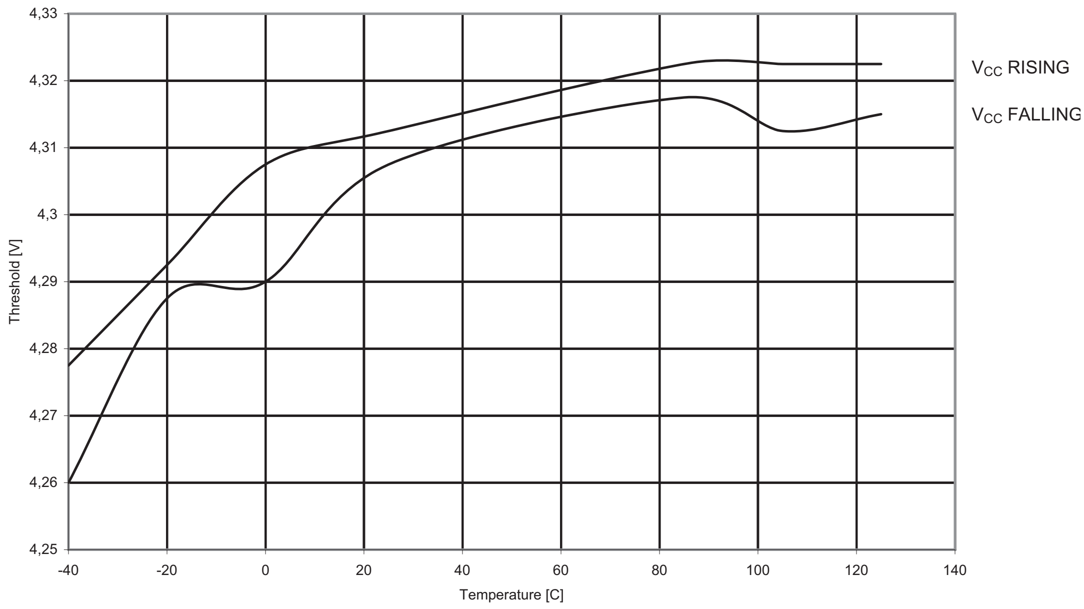


Figure 4-42. Sampled BOD Threshold vs Temperature (BODLEVEL = 2.7V)

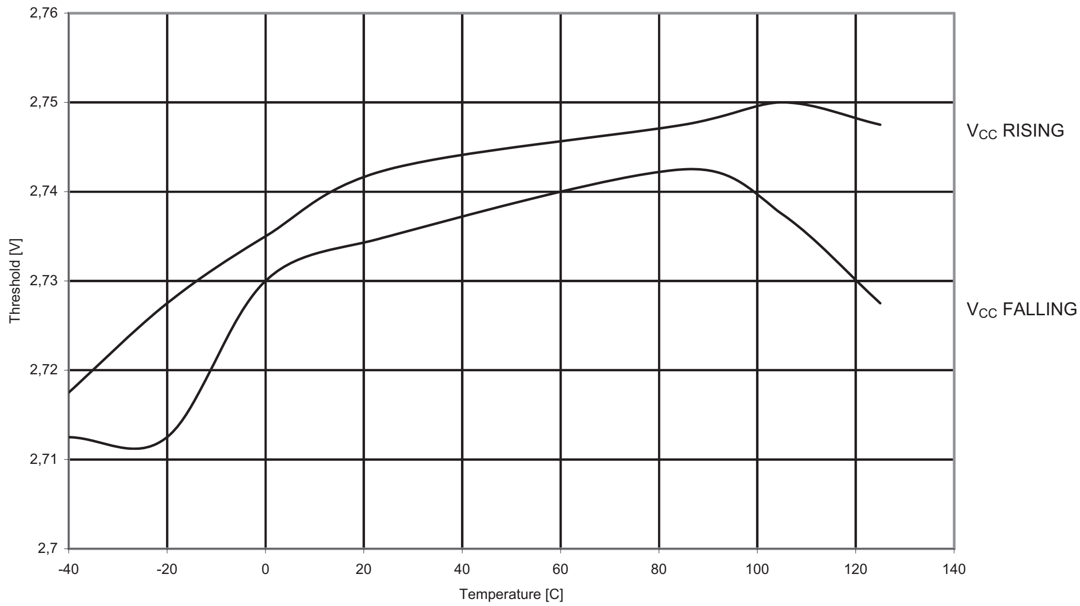
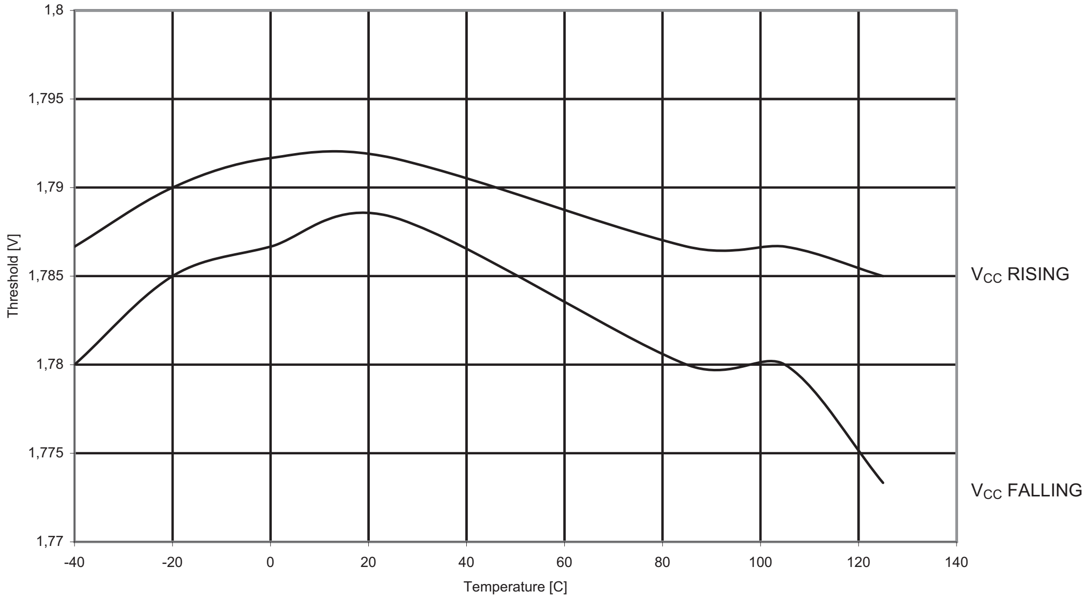


Figure 4-43. Sampled BOD Threshold vs Temperature (BODLEVEL = 1.8V)



4.10 Bandgap Voltage

Figure 4-44. Bandgap Voltage vs. Supply Voltage

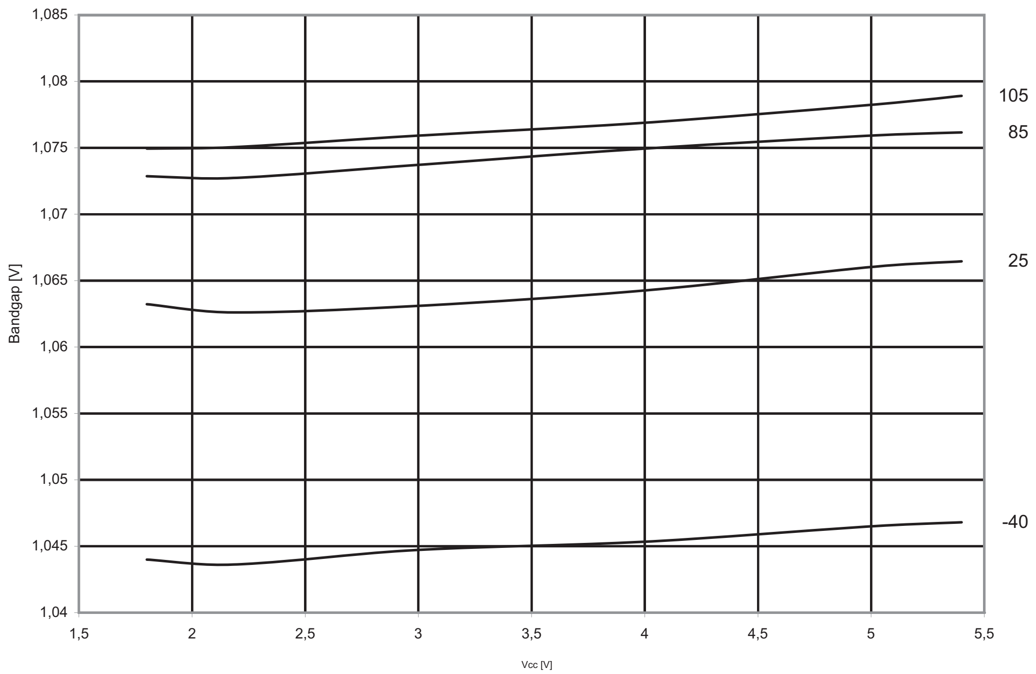
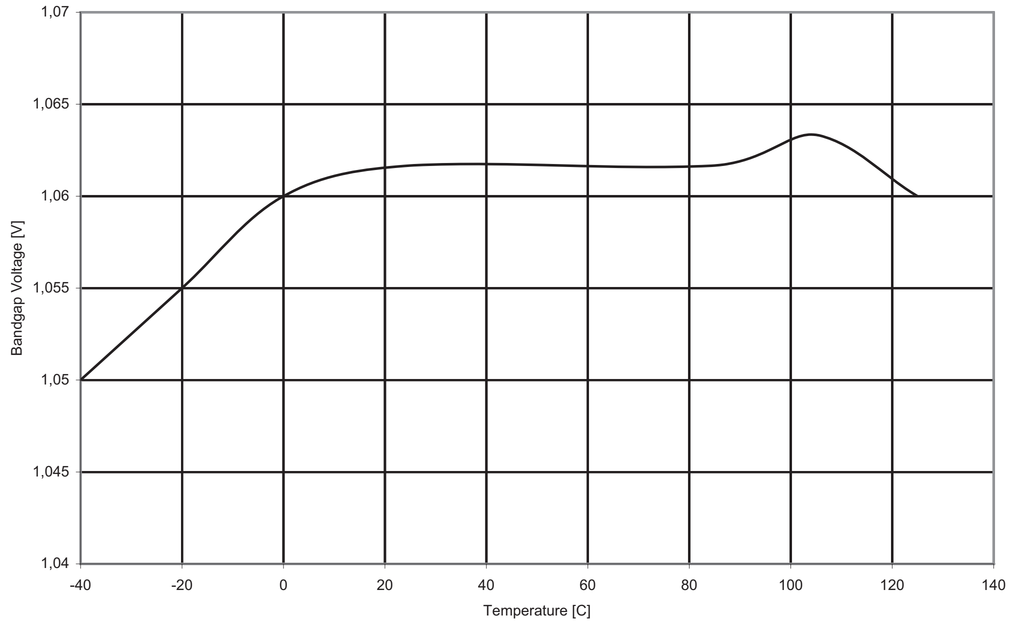


Figure 4-45. Bandgap Voltage vs. Temperature (V_{CC} = 3.3V)



4.11 Reset

Figure 4-46. V_{IH}: Input Threshold Voltage vs. V_{CC} (Reset Pin, Read as '1')

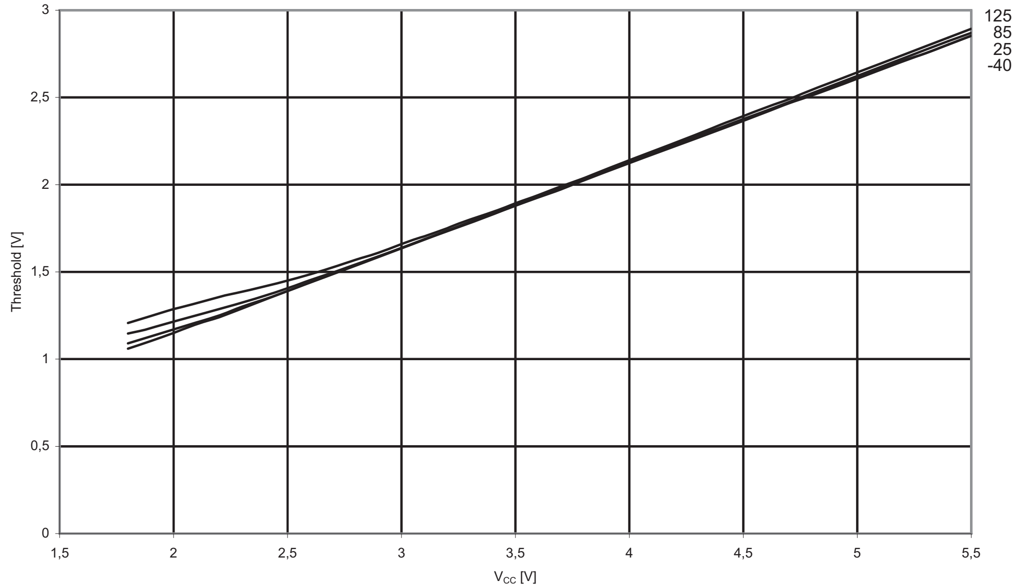


Figure 4-47. V_{IL}**: Input Threshold Voltage vs.** V_{CC} **(Reset Pin, Read as '0')**

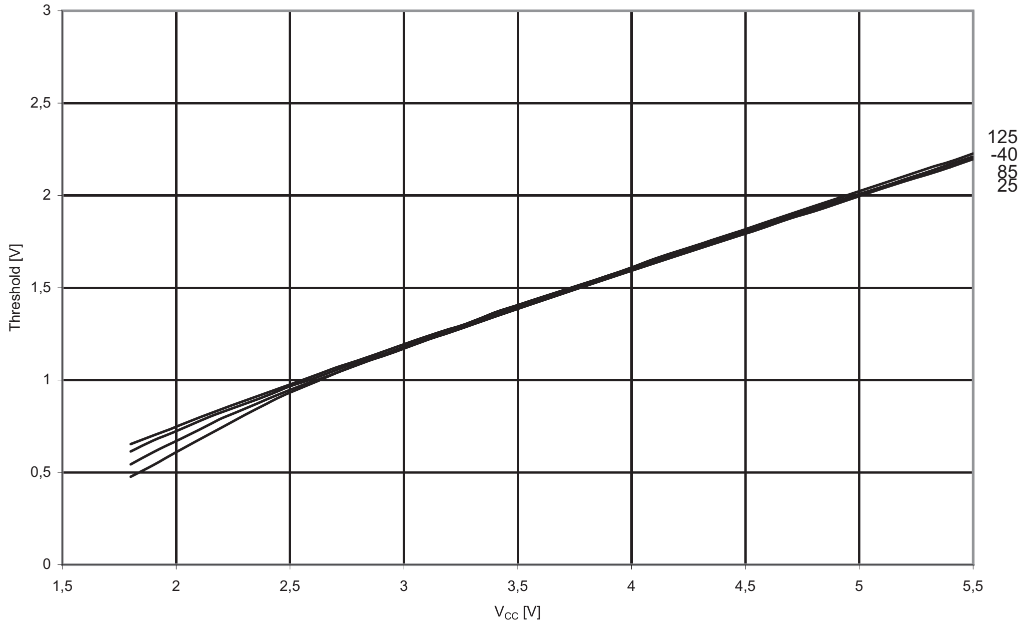


Figure 4-48. V_{IH}-V_{IL}**: Input Hysteresis vs.** V_{CC} **(Reset Pin)**

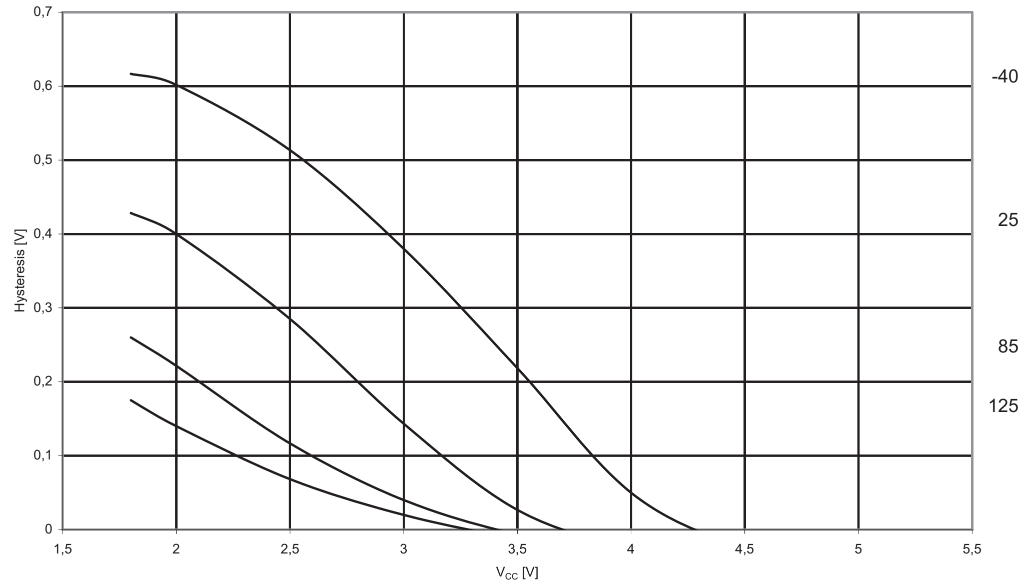
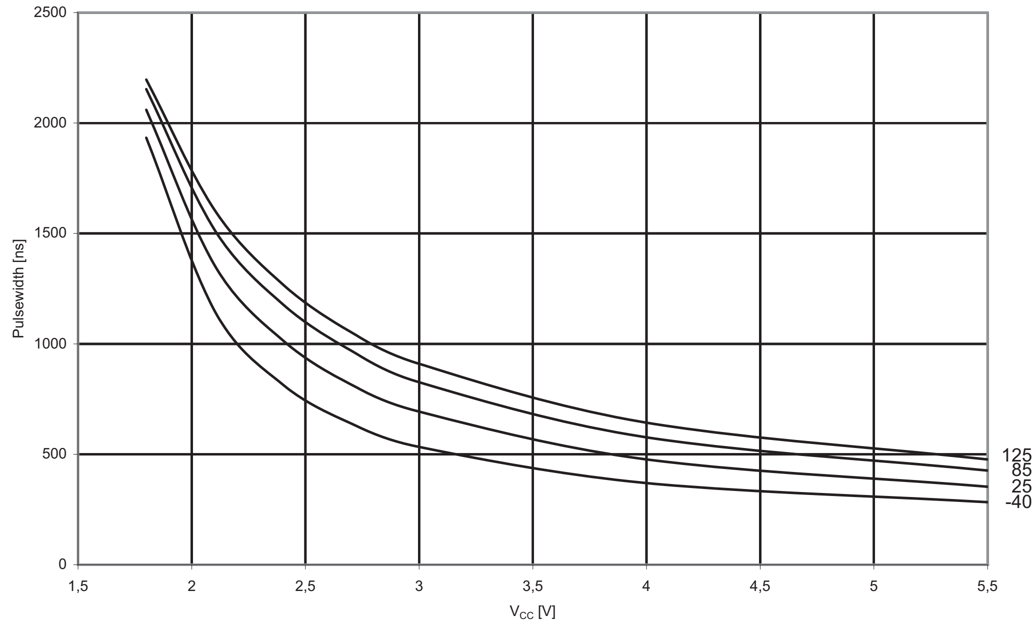


Figure 4-49. Minimum Reset Pulse Width vs. V_{CC}



4.12 Analog Comparator Offset

Figure 4-50. Analog Comparator Offset vs. V_{IN} (V_{CC} = 5V)

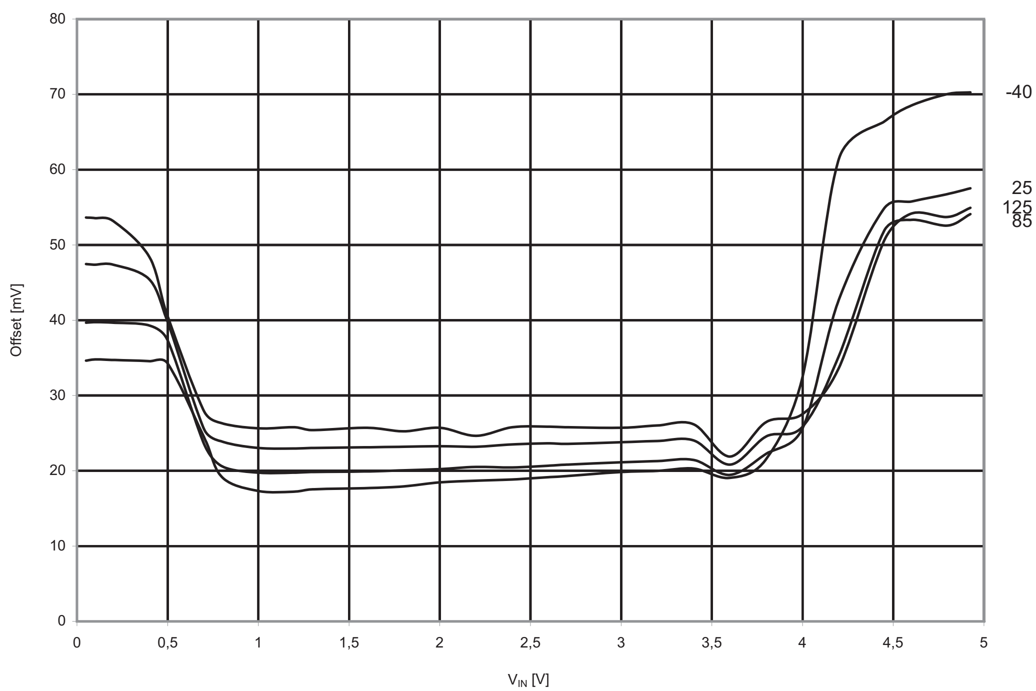


Figure 4-51. Analog Comparator Offset vs. V_{CC} (V_{IN} = 1.1V)

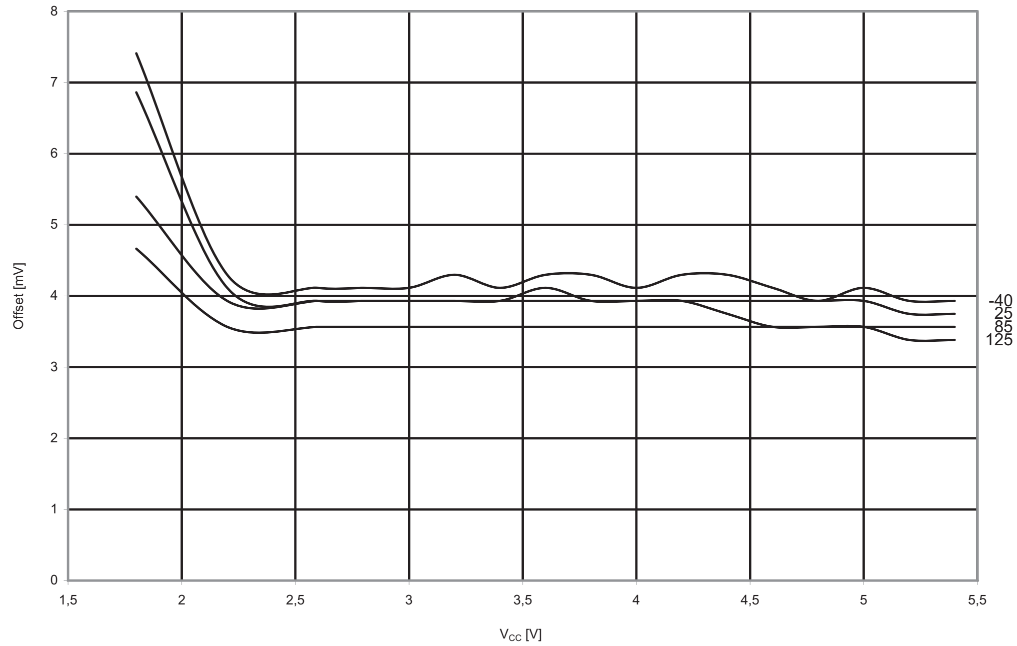
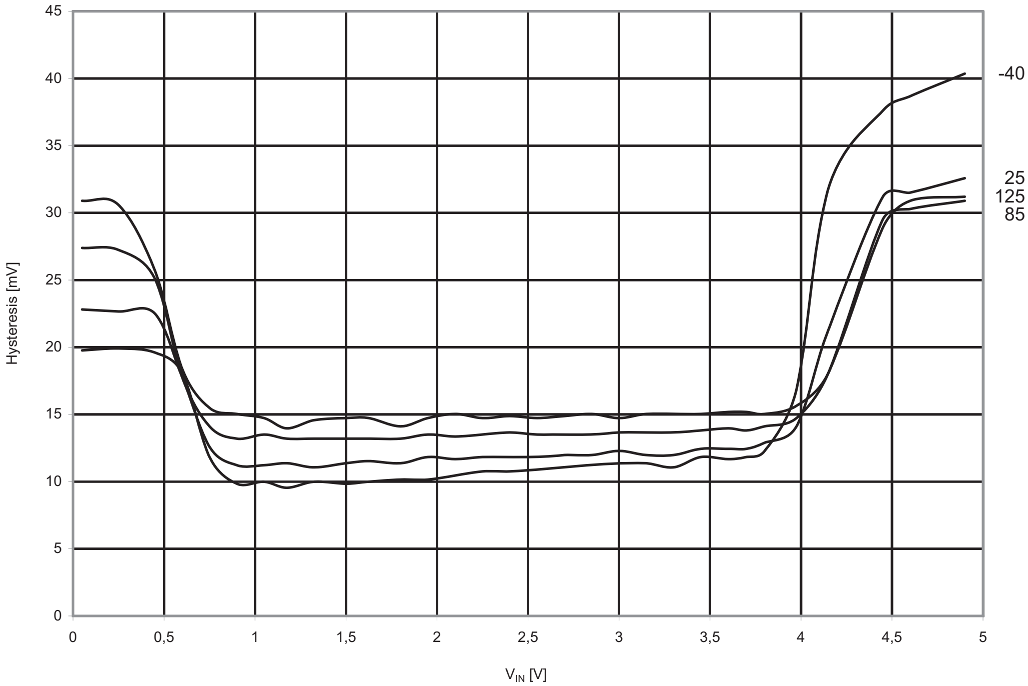


Figure 4-52. Analog Comparator Hysteresis vs. V_{IN} (V_{CC} = 5.0V)



4.13 Internal Oscillator Speed

Figure 4-53. Calibrated Oscillator Frequency (Nominal = 8MHz) vs. V_{CC}

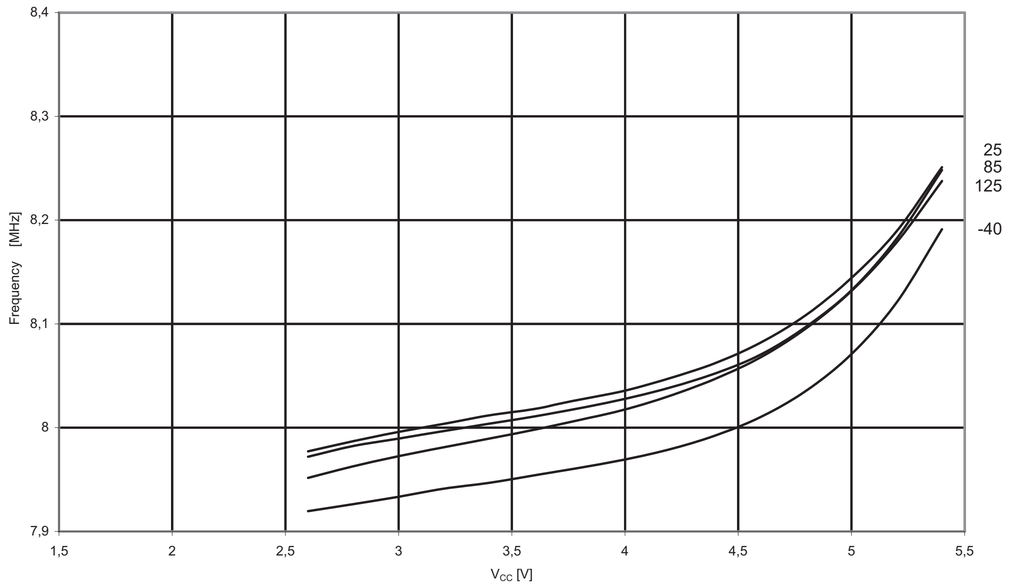


Figure 4-54. Calibrated Oscillator Frequency (Nominal = 8MHz) vs. Temperature

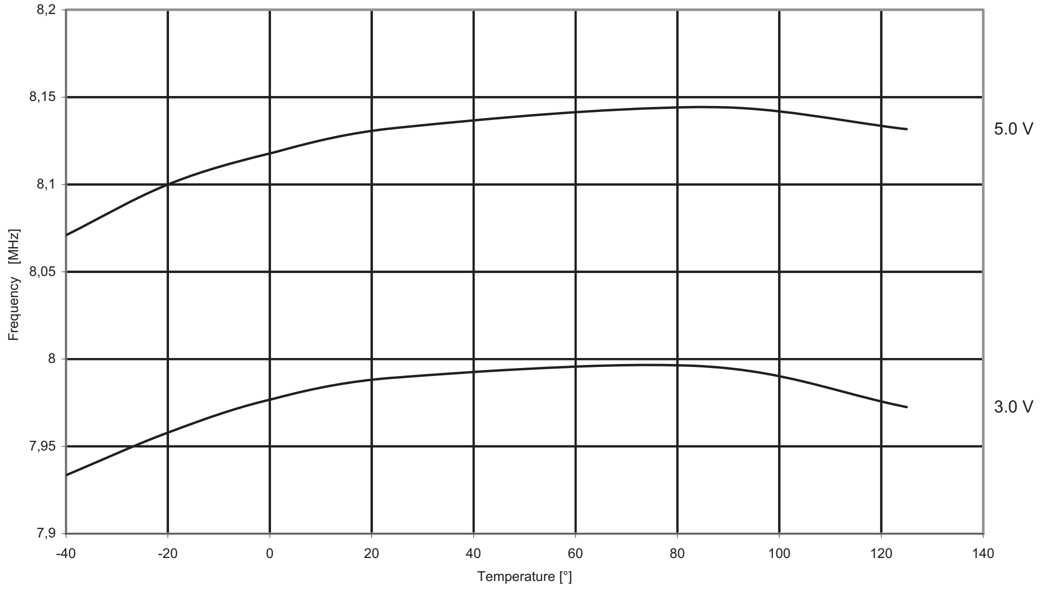


Figure 4-55. Calibrated Oscillator Frequency (Nominal = 1MHz) vs. V_{CC}

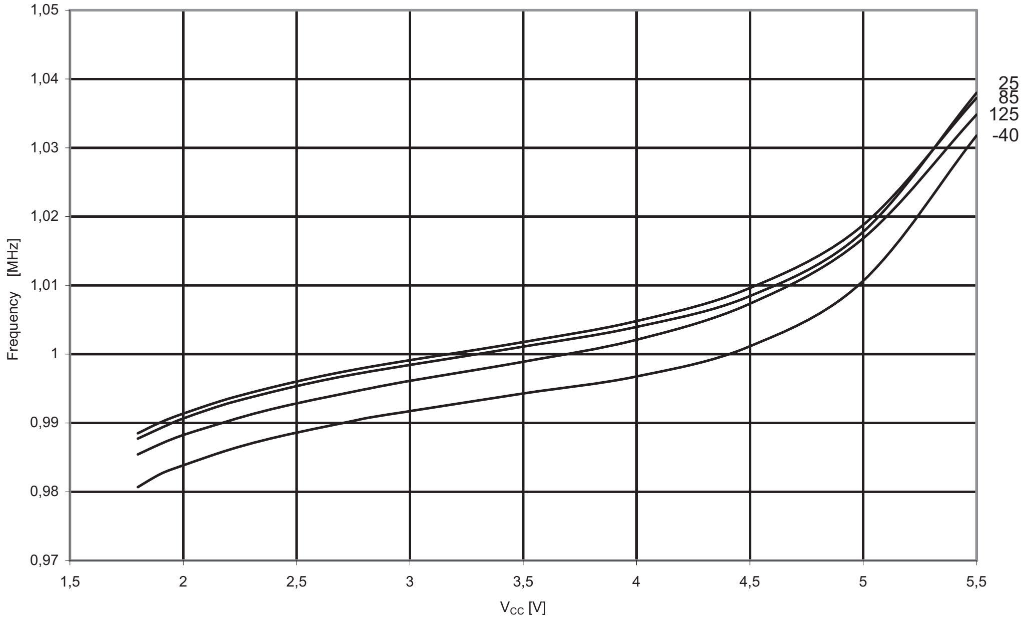


Figure 4-56. Calibrated Oscillator Frequency (Nominal = 1MHz) vs. Temperature

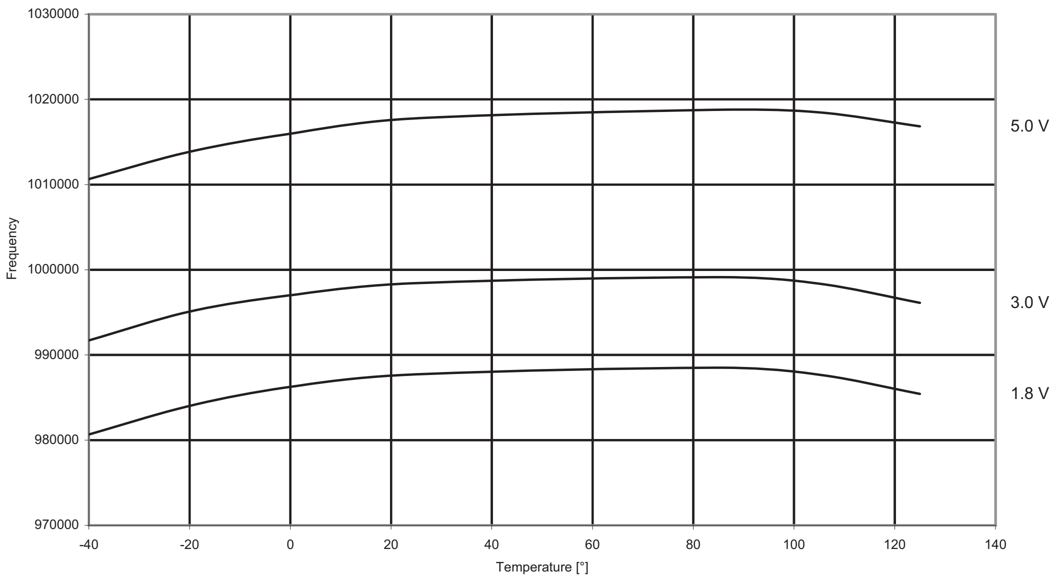


Figure 4-57. ULP Oscillator Frequency (Nominal = 32kHz) vs. V_{CC}

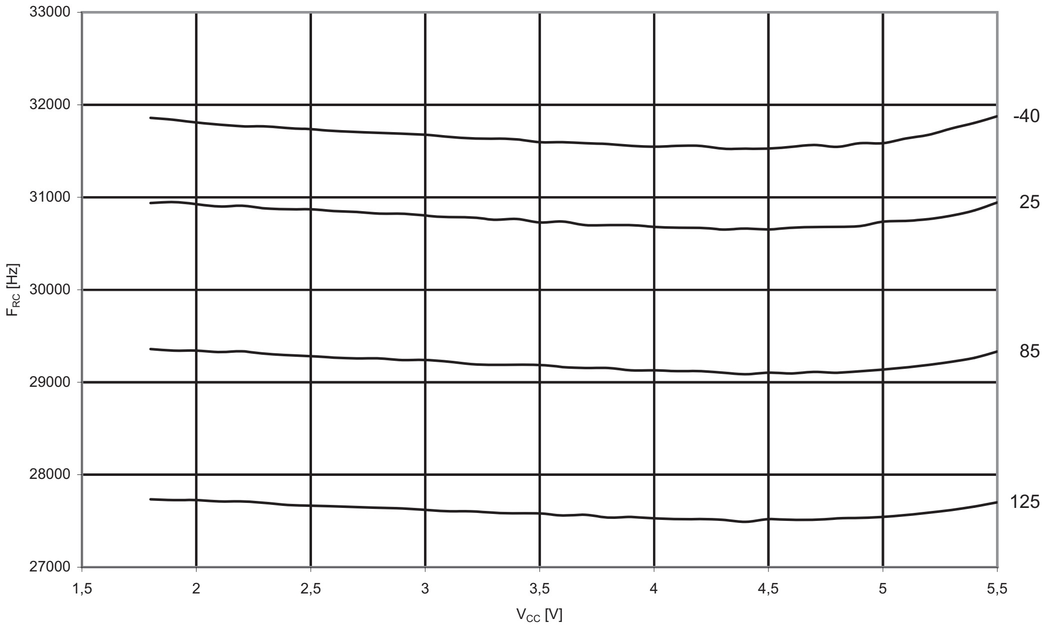
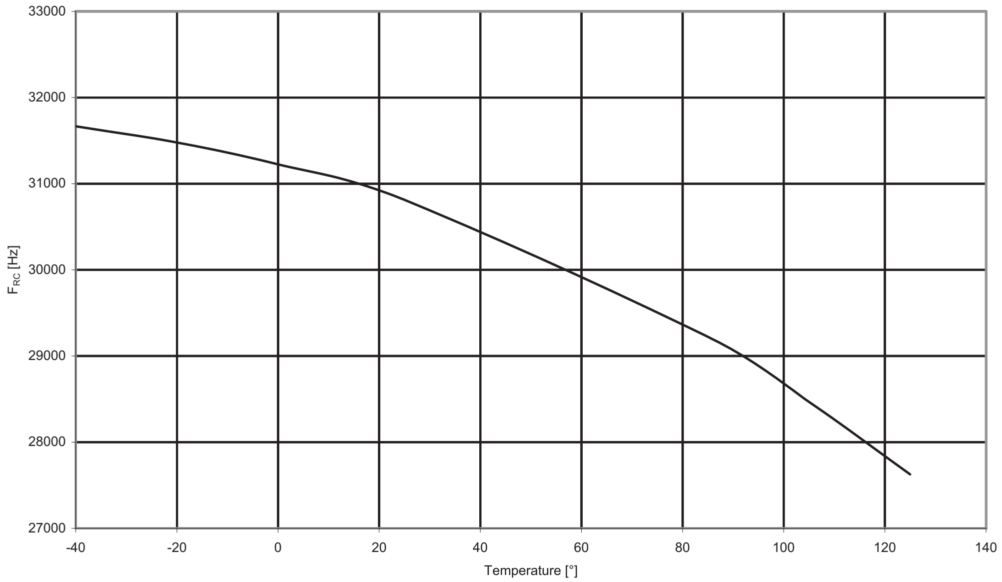


Figure 4-58. ULP Oscillator Frequency (Nominal = 32kHz) vs. Temperature



5. Ordering Information

5.1 ATtiny1634

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Accuracy [3]	Ordering Code [4]
12	1.8 – 5.5	Industrial (-40°C to +125°C) [5]	20M1	±10%	ATtiny1634-MF
				±10%	ATtiny1634-MFR

Notes:
1. For speed vs. supply voltage, see section 3.3 “Speed” on page 6.
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. Denotes accuracy of the internal oscillator. See Table 3-2 on page 6.
4. Code indicators:
   - F: matte tin
   - R: tape & reel
5. Can also be supplied in wafer form. Contact your local Atmel sales office for ordering information and minimum quantities.

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

6. Datasheet Revision History

Revision	History
8303D: Appendix B – 10/12	Initial revision

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