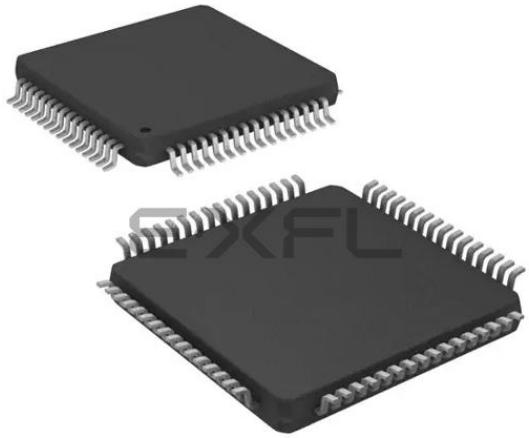

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	AVR
Core Size	8/16-Bit
Speed	32MHz
Connectivity	I²C, IrDA, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	50
Program Memory Size	384KB (384K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 3.6V
Data Converters	A/D 16x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-TQFP
Supplier Device Package	64-TQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atxmega384d3-au

26. AC – Analog Comparator

26.1 Features

- Two analog comparators (AC)
- Selectable hysteresis
  - No
  - Small
  - Large
- Analog comparator output available on pin
- Flexible input selection
  - All pins on the port
  - Bandgap reference voltage
  - A 64-level programmable voltage scaler of the internal AV_{CC} voltage
- Interrupt and event generation on:
  - Rising edge
  - Falling edge
  - Toggle
- Window function interrupt and event generation on:
  - Signal above window
  - Signal inside window
  - Signal below window
- Constant current source with configurable output pin selection

26.2 Overview

The analog comparator (AC) compares the voltage levels on two inputs and gives a digital output based on this comparison. The analog comparator may be configured to generate interrupt requests and/or events upon several different combinations of input change.

The analog comparator hysteresis can be adjusted in order to achieve the optimal operation for each application.

The input selection includes analog port pins, several internal signals, and a 64-level programmable voltage scaler. The analog comparator output state can also be output on a pin for use by external devices.

A constant current source can be enabled and output on a selectable pin. This can be used to replace, for example, external resistors used to charge capacitors in capacitive touch sensing applications.

The analog comparators are always grouped in pairs on each port. These are called analog comparator 0 (AC0) and analog comparator 1 (AC1). They have identical behavior, but separate control registers. Used as pair, they can be set in window mode to compare a signal to a voltage range instead of a voltage level.

PORTA has one AC pair. Notation is ACA.

32.3.11 Power-on Reset Characteristics

Table 32-74. Power-on Reset Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{POT-} (1)	POR threshold voltage falling V_{CC}	V_{CC} falls faster than 1V/ms	0.4	1.0		V
		V_{CC} falls at 1V/ms or slower	0.8	1.3		
V_{POT+}	POR threshold voltage rising V_{CC}			1.3	1.59	

Note: 1. V_{POT-} values are only valid when BOD is disabled. When BOD is enabled $V_{POT-} = V_{POT+}$.

32.3.12 Flash and EEPROM Memory Characteristics

Table 32-75. Endurance and Data Retention

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
	Flash	Write/Erase cycles	25°C	10K			Cycle
			85°C	10K			
			105°C	2K			
		Data retention	25°C	100			Year
			85°C	25			
			105°C	10			
	EEPROM	Write/Erase cycles	25°C	100K			Cycle
			85°C	100K			
			105°C	30K			
		Data retention	25°C	100			Year
			85°C	25			
			105°C	10			

Table 32-76. Programming Time

Symbol	Parameter	Condition	Min.	Typ. (1)	Max.	Units
	Chip erase (2)	128KB Flash, EEPROM		75		ms
	Application erase	Section erase		6		
	Flash	Page erase		4		
		Page write		4		
		Atomic page erase and write		8		
	EEPROM	Page erase		4		
		Page write		4		
		Atomic page erase and write		8		

Notes: 1. Programming is timed from the 2MHz internal oscillator.
2. EEPROM is not erased if the EESAVE fuse is programmed.

Table 32-98. Gain Stage Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
R_{in}	Input resistance	Switched in normal mode		4.0		kΩ
C_{sample}	Input capacitance	Switched in normal mode		4.4		pF
	Signal range	Gain stage output	0		AV_{CC} - 0.6	V
	Propagation delay	ADC conversion rate	1/2	1	3	Clk_{ADC} cycles
	Clock frequency	Same as ADC	100		1800	kHz
	Gain error	0.5× gain, normal mode		-1		%
		1× gain, normal mode		-1		
		8× gain, normal mode		-1		
		64× gain, normal mode		5		
	Offset error, input referred	0.5× gain, normal mode		10		mV
		1× gain, normal mode		5		
		8× gain, normal mode		-20		
		64× gain, normal mode		-126		

32.4.7 Analog Comparator Characteristics

Table 32-99. Analog Comparator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{off}	Input offset voltage			10		mV
I_{lk}	Input leakage current			<10	50	nA
	Input voltage range		-0.1		AV_{CC}	V
	AC startup time			50		µs
V_{hys1}	Hysteresis, none	V_{CC} = 1.6V - 3.6V		0		mV
V_{hys2}	Hysteresis, small	V_{CC} = 1.6V - 3.6V		15		
V_{hys3}	Hysteresis, large	V_{CC} = 1.6V - 3.6V		30		
t_{delay}	Propagation delay	V_{CC} = 3.0V, T = 85°C		20	40	ns
		V_{CC} = 3.0V		17		
	64-level voltage scaler	Integral non-linearity (INL)		0.3	0.5	lsb
	Current source accuracy after calibration			5		%
	Current source calibration range	Single mode	4		6	µA

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
C_{XTAL1}	Parasitic capacitance XTAL1 pin				5.9		pF
C_{XTAL2}	Parasitic capacitance XTAL2 pin				8.3		
C_{LOAD}	Parasitic capacitance load				3.5		

Notes: 1. Numbers for negative impedance are not tested in production but guaranteed from design and characterization.

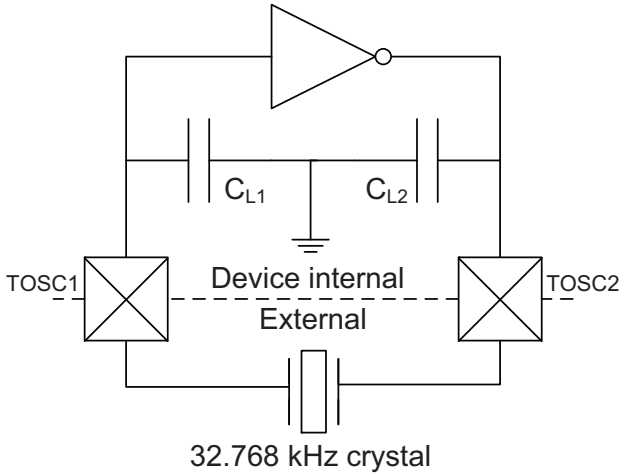
32.4.13.8 External 32.768kHz Crystal Oscillator and TOSC Characteristics

Table 32-114. External 32.768kHz Crystal Oscillator and TOSC Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
ESR/R1	Recommended crystal equivalent series resistance (ESR)	Crystal load capacitance 6.5pF			60	kΩ
		Crystal load capacitance 9.0pF			35	
		Crystal load capacitance 12pF			28	
C_{TOSC1}	Parasitic capacitance TOSC1 pin			3.5		pF
C_{TOSC2}	Parasitic capacitance TOSC2 pin			3.5		
	Recommended safety factor	Capacitance load matched to crystal specification	3			

Note: See Figure 32-25 for definition.

Figure 32-25. TOSC Input Capacitance



The parasitic capacitance between the TOSC pins is C_{L1} + C_{L2} in series as seen from the crystal when oscillating without external capacitors.

Table 32-141.External Clock with Prescaler [1] for System Clock

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$1/t_{CK}$	Clock Frequency [2]	V_{CC} = 1.6 - 1.8V	0		90	MHz
		V_{CC} = 2.7 - 3.6V	0		142	
t_{CK}	Clock Period	V_{CC} = 1.6 - 1.8V	11			ns
		V_{CC} = 2.7 - 3.6V	7			
t_{CH}	Clock High Time	V_{CC} = 1.6 - 1.8V	4.5			
		V_{CC} = 2.7 - 3.6V	2.4			
t_{CL}	Clock Low Time	V_{CC} = 1.6 - 1.8V	4.5			
		V_{CC} = 2.7 - 3.6V	2.4			
t_{CR}	Rise Time (for maximum frequency)	V_{CC} = 1.6 - 1.8V			1.5	
		V_{CC} = 2.7 - 3.6V			1.0	
t_{CF}	Fall Time (for maximum frequency)	V_{CC} = 1.6 - 1.8V			1.5	
		V_{CC} = 2.7 - 3.6V			1.0	
Δt_{CK}	Change in period from one clock cycle to the next				10	%

Notes:
1. System Clock Prescalers must be set so that maximum CPU clock frequency for device is not exceeded.
2. The maximum frequency vs. supply voltage is linear between 1.6V and 2.7V, and the same applies for all other parameters with supply voltage conditions.

32.5.13.7 External 16MHz Crystal Oscillator and XOSC Characteristics

Table 32-142. External 16MHz Crystal Oscillator and XOSC Characteristics

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
	Cycle to cycle jitter	XOSCPWR=0	FRQRANGE=0		0		ns
			FRQRANGE=1, 2, or 3		0		
		XOSCPWR=1			0		
	Long term jitter	XOSCPWR=0	FRQRANGE=0		0		
			FRQRANGE=1, 2, or 3		0		
		XOSCPWR=1			0		
	Frequency error	XOSCPWR=0	FRQRANGE=0		0.03		%
			FRQRANGE=1		0.03		
			FRQRANGE=2 or 3		0.03		
		XOSCPWR=1			0.003		
	Duty cycle	XOSCPWR=0	FRQRANGE=0		50		
			FRQRANGE=1		50		
			FRQRANGE=2 or 3		50		
		XOSCPWR=1			50		

Figure 33-43. Analog Comparator Hysteresis vs. V_{CC}

Large hysteresis

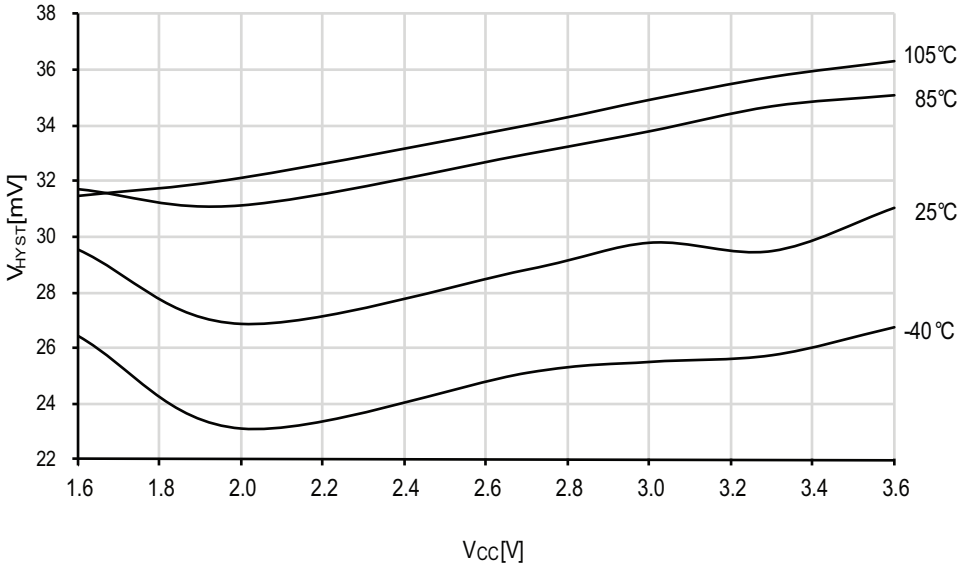
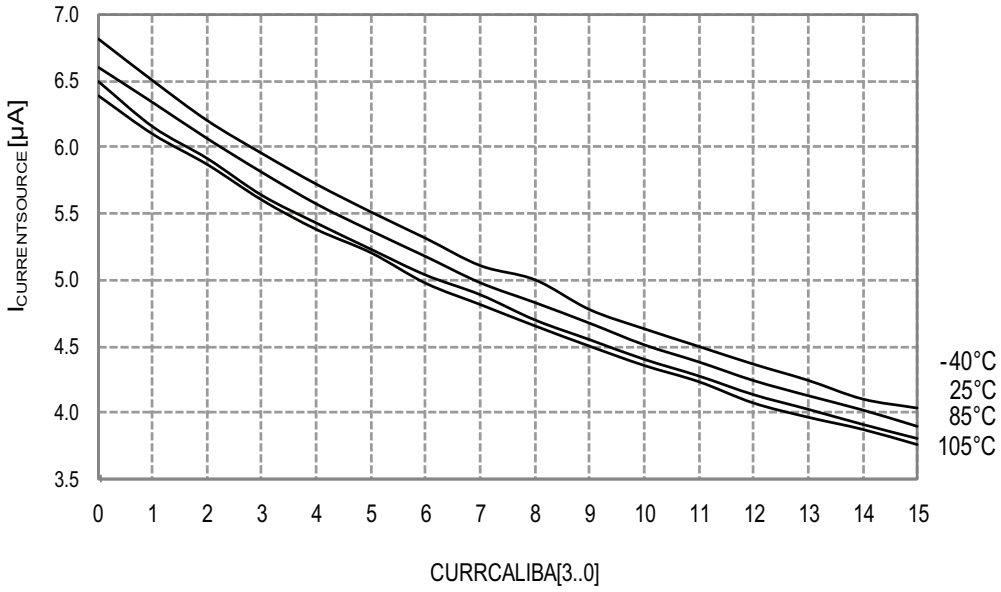


Figure 33-44. Analog Comparator Current Source vs. Calibration Value

V_{CC} = 3.0V



33.1.6 BOD Characteristics

Figure 33-47. BOD Thresholds vs. Temperature

BOD level = 1.6V

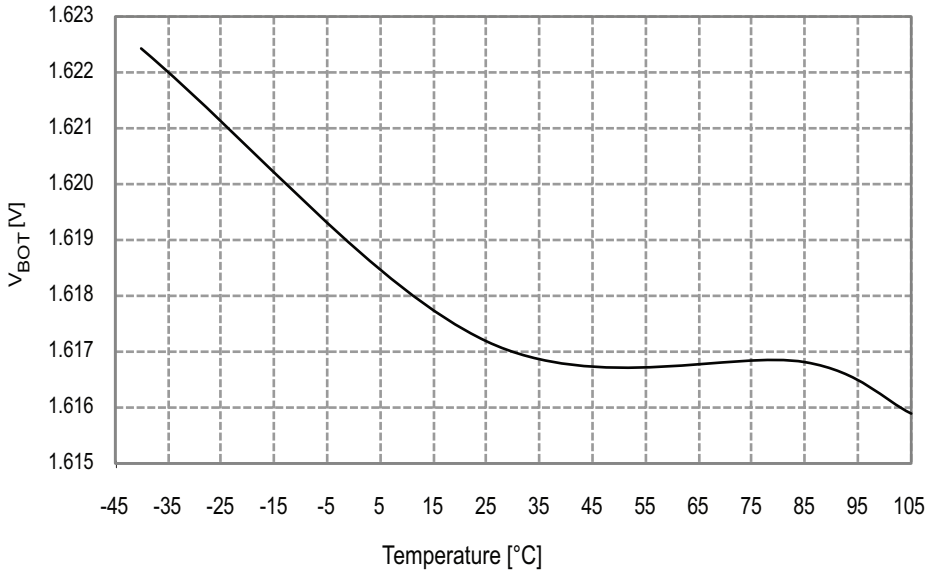


Figure 33-48. BOD Thresholds vs. Temperature

BOD level = 3.0V

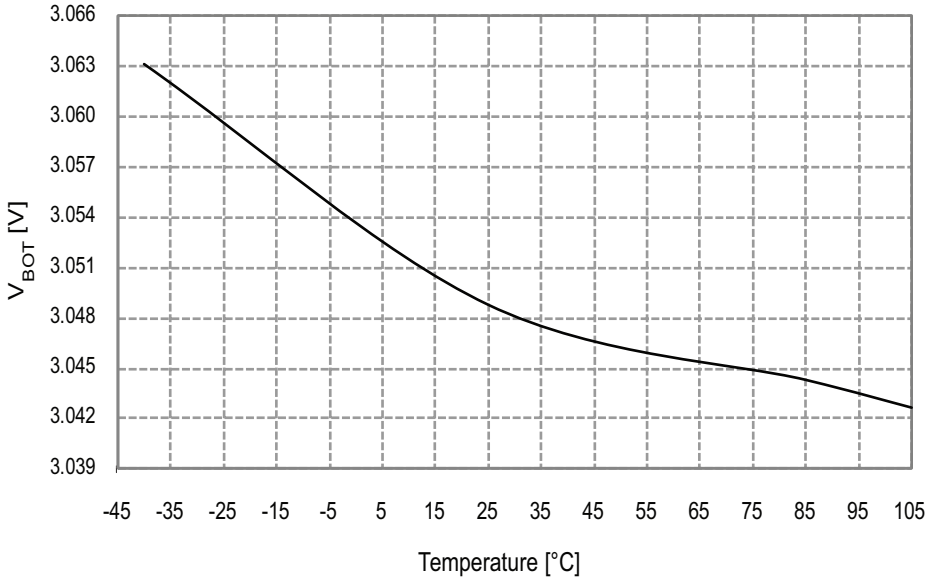
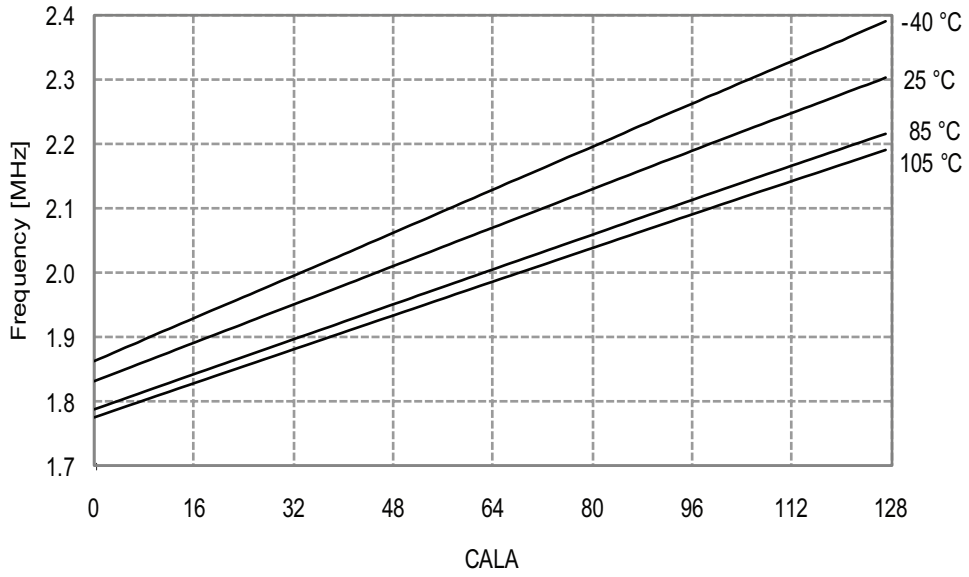


Figure 33-59. 2MHz Internal Oscillator Frequency vs. CALA Calibration Value

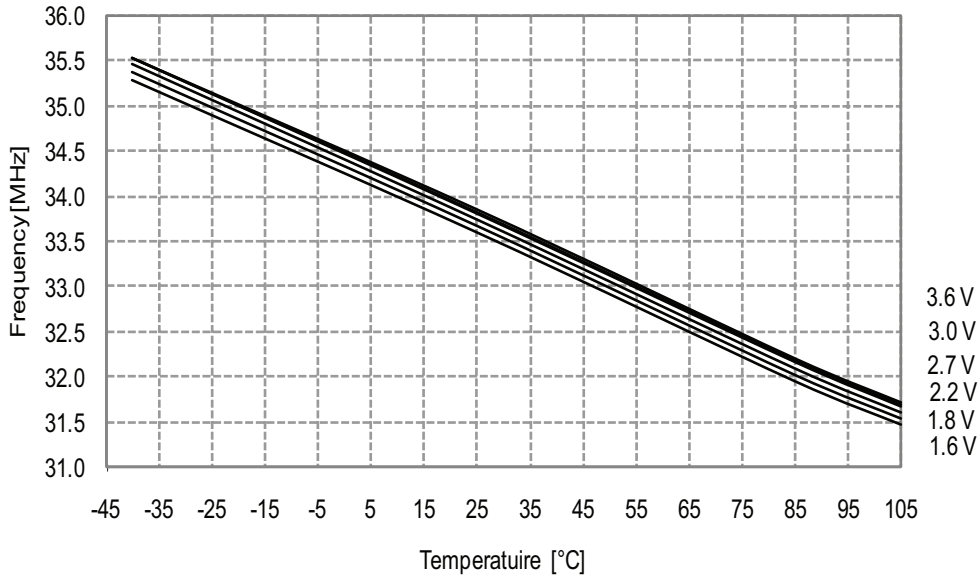
V_{CC} = 3V



33.1.8.4 32MHz Internal Oscillator

Figure 33-60. 32MHz Internal Oscillator Frequency vs. Temperature

DFLL disabled



33.1.9 Two-Wire Interface Characteristics

Figure 33-69. SDA Hold Time vs. Temperature

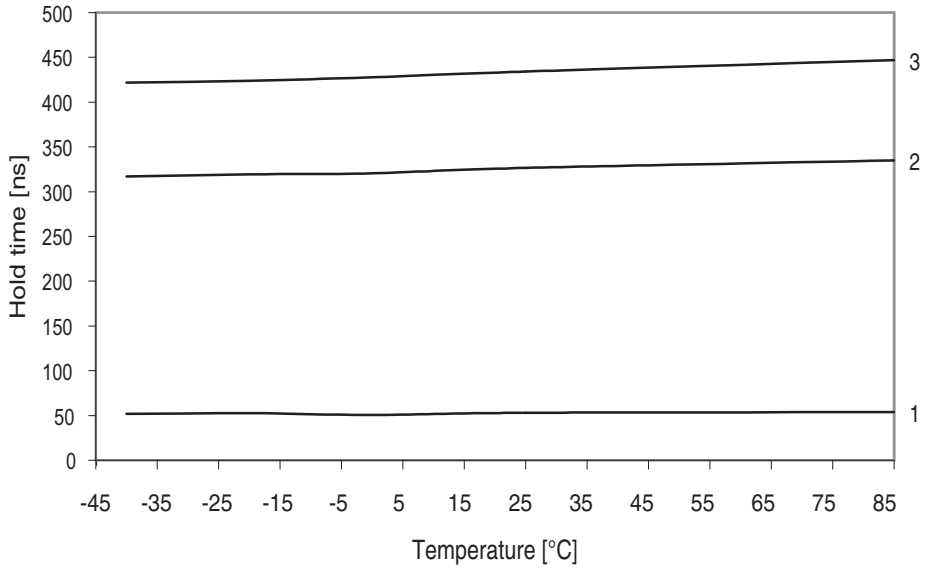


Figure 33-70. SDA Hold Time vs. Supply Voltage

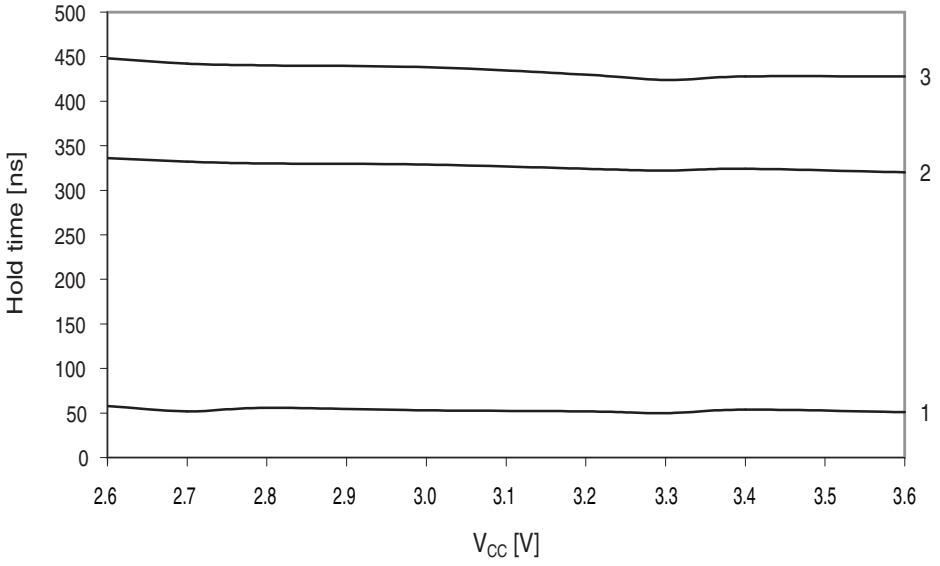


Figure 33-76. Active Mode Supply Current vs. V_{CC}

f_{SYS} = 2MHz internal oscillator

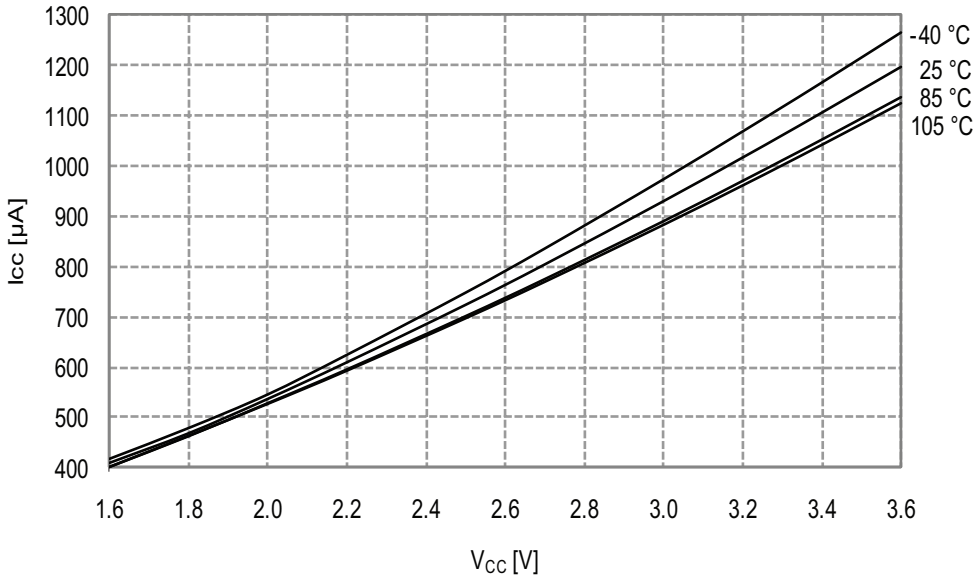


Figure 33-77. Active Mode Supply Current vs. V_{CC}

f_{SYS} = 32MHz internal oscillator prescaled to 8MHz

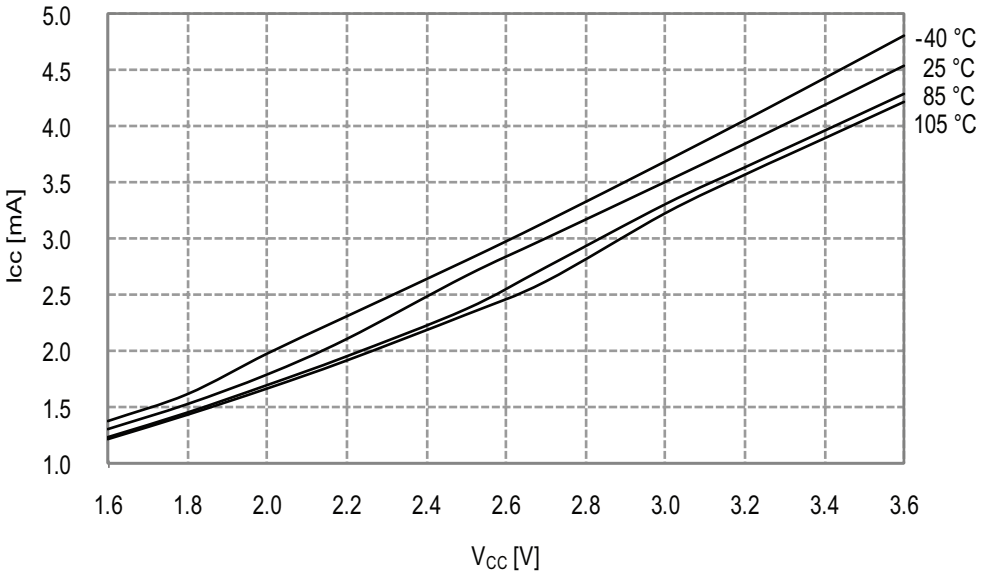


Figure 33-84. Idle Mode Supply Current vs. V_{CC}

f_{SYS} = 32MHz internal oscillator prescaled to 8MHz

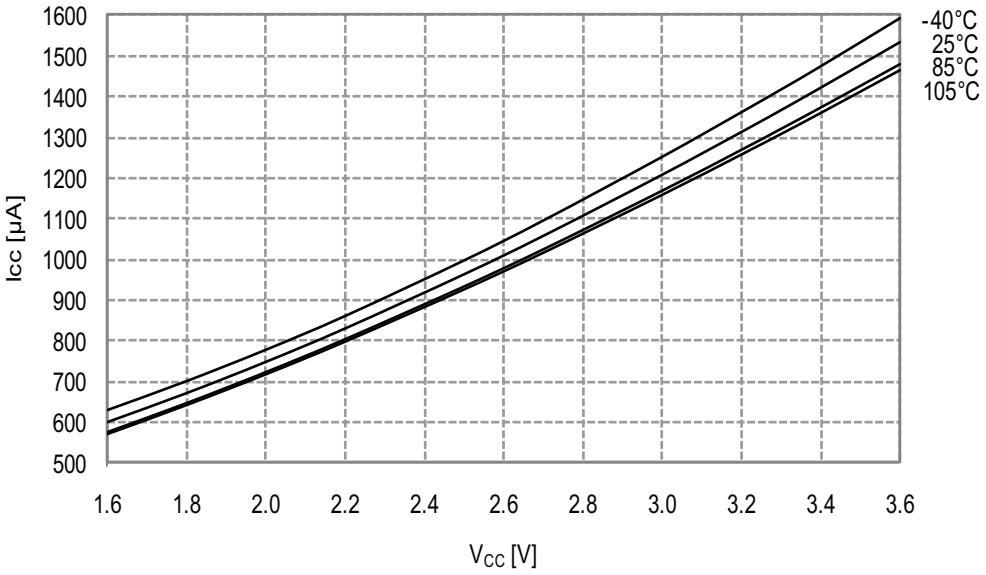
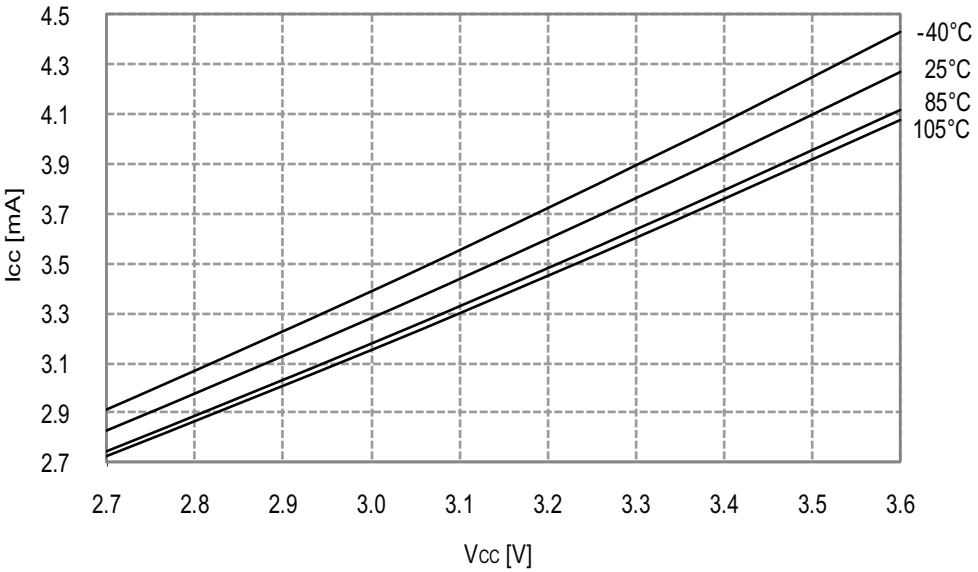


Figure 33-85. Idle Mode Current vs. V_{CC}

f_{SYS} = 32MHz internal oscillator



33.2.8.3 2MHz Internal Oscillator

Figure 33-128. 2MHz Internal Oscillator Frequency vs. Temperature

DFLL disabled

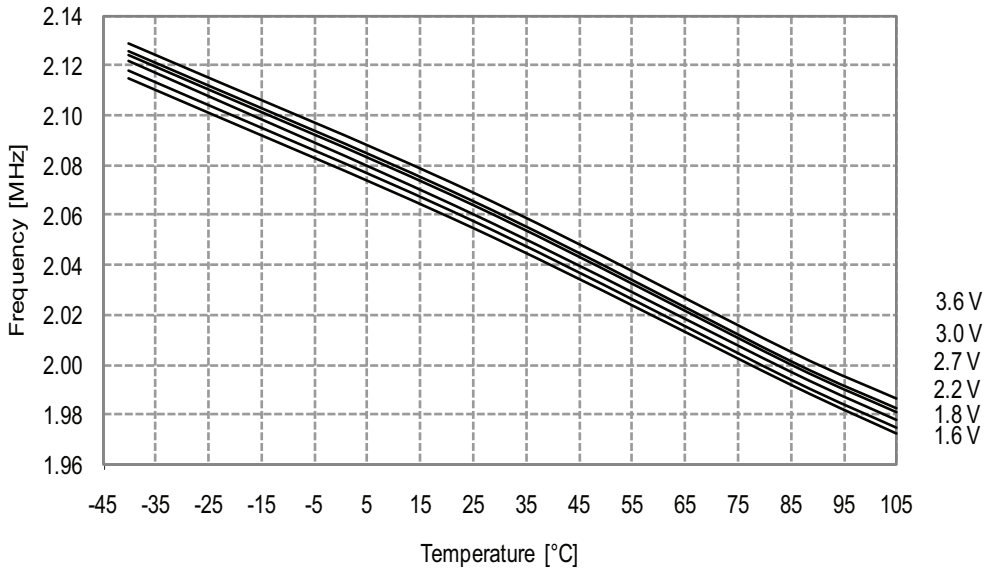
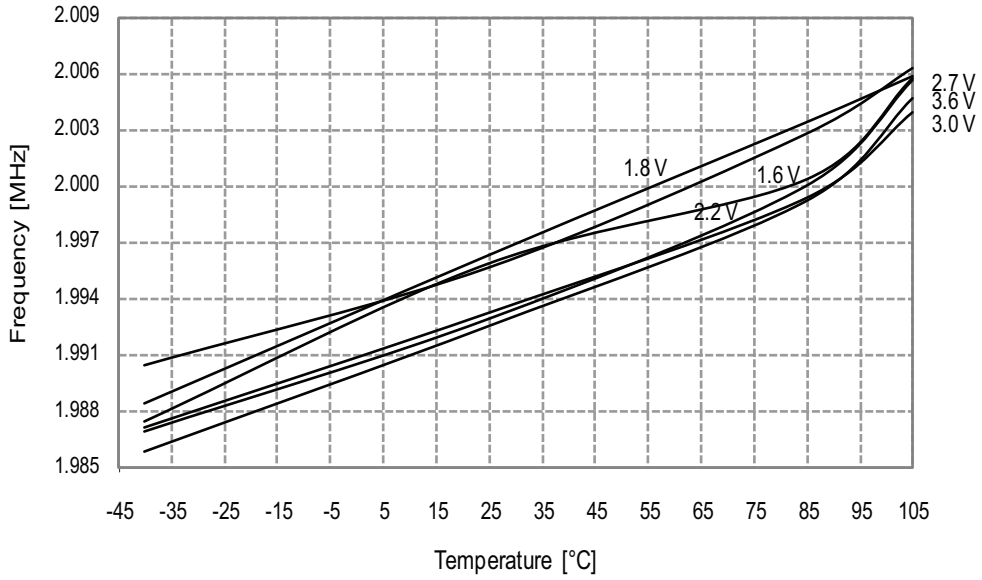


Figure 33-129. 2MHz Internal Oscillator Frequency vs. Temperature

DFLL enabled, from the 32.768kHz internal oscillator



33.3.2.2 Output Voltage vs. Sink/Source Current

Figure 33-163. I/O Pin Output Voltage vs. Source Current

V_{CC} = 1.8V

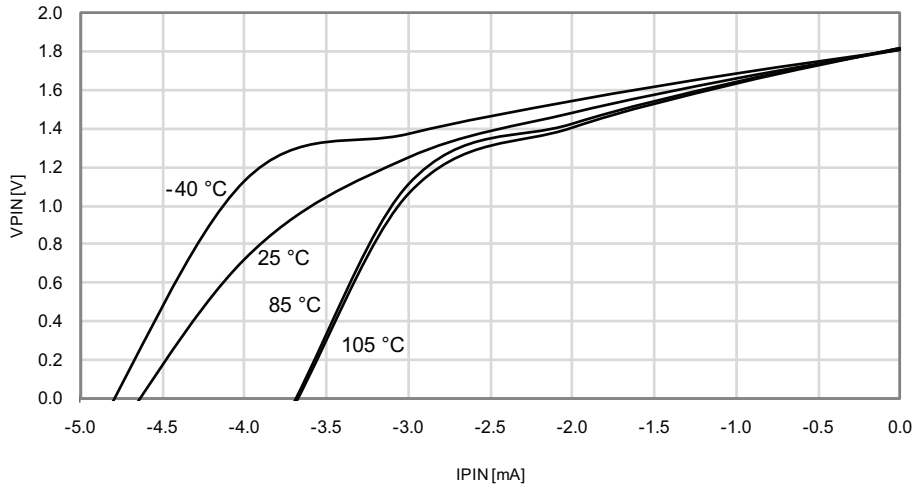


Figure 33-164. I/O Pin Output Voltage vs. Source Current

V_{CC} = 3.0V

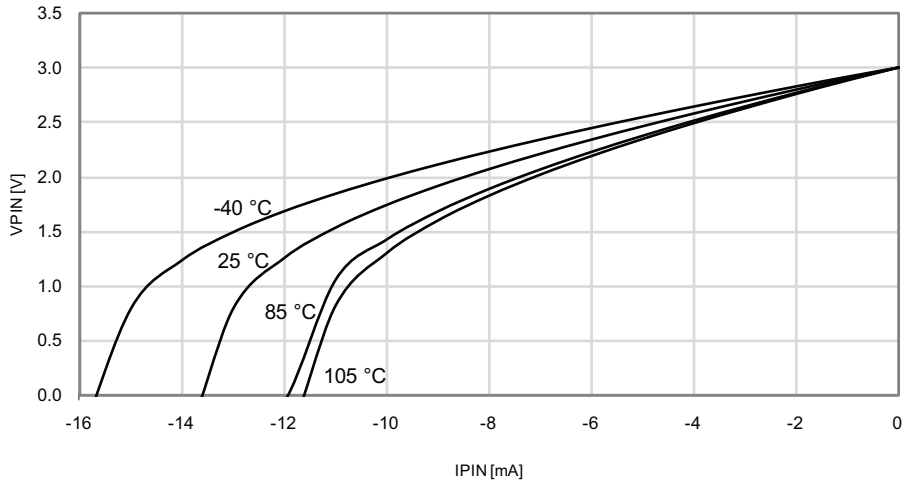


Figure 33-175. DNL Error vs. External V_{REF}

T = 25°C, V_{CC} = 3.6V, external reference

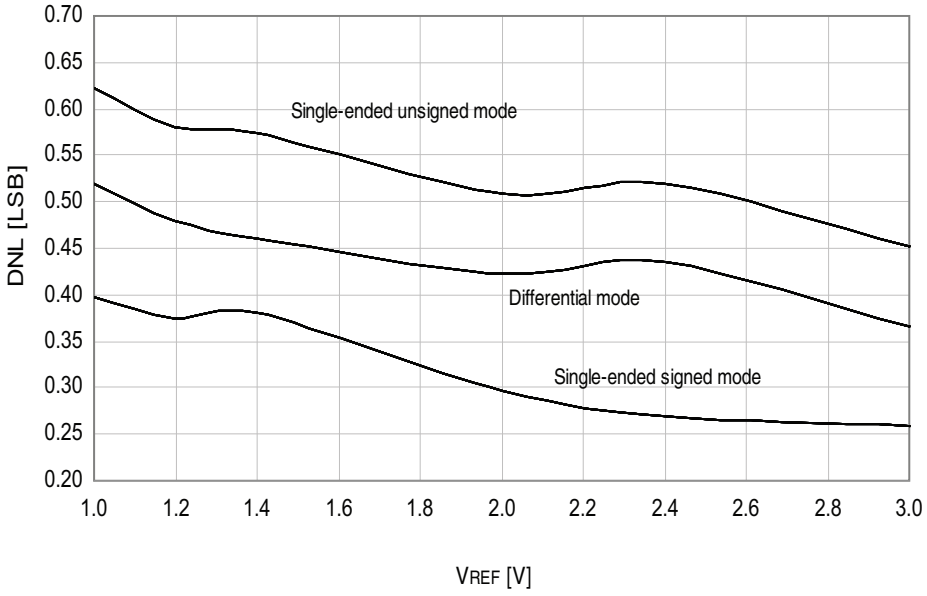


Figure 33-176. DNL Error vs. Sample Rate

T = 25°C, V_{CC} = 3.6V, V_{REF} = 3.0V external

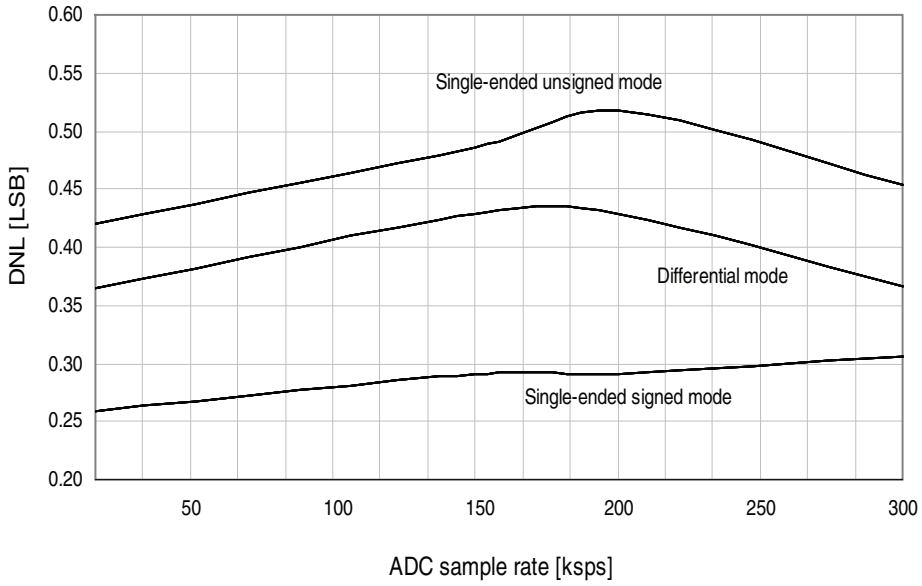


Figure 33-203. 32MHz Internal Oscillator CALA Calibration Step Size

T = -40°C, V_{CC} = 3.0V

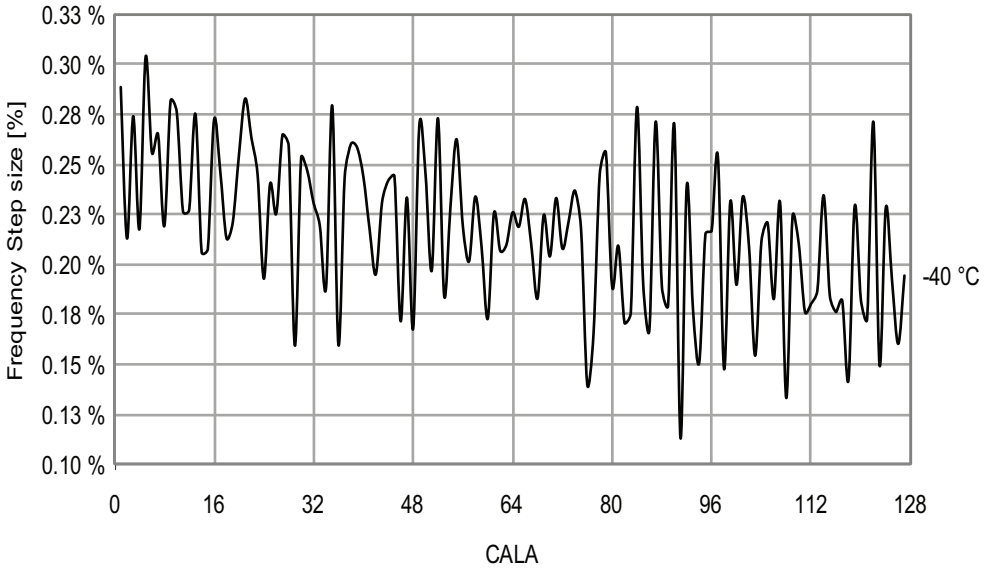


Figure 33-204. 32MHz Internal Oscillator CALA Calibration Step Size

T = 25°C, V_{CC} = 3.0V

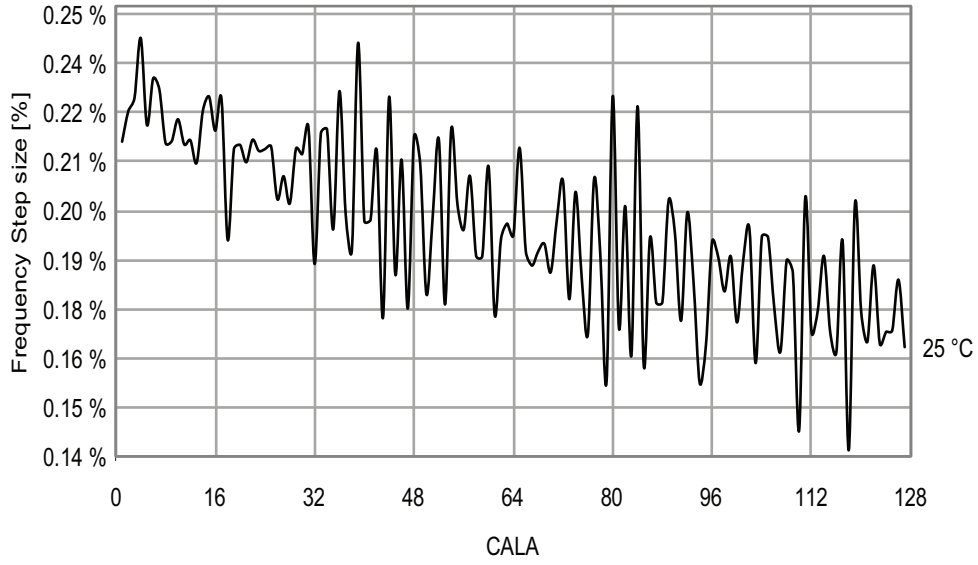
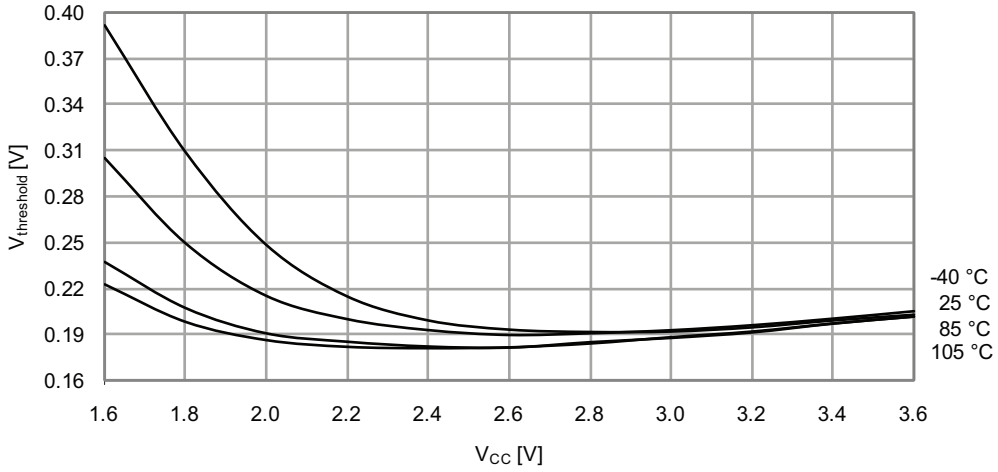


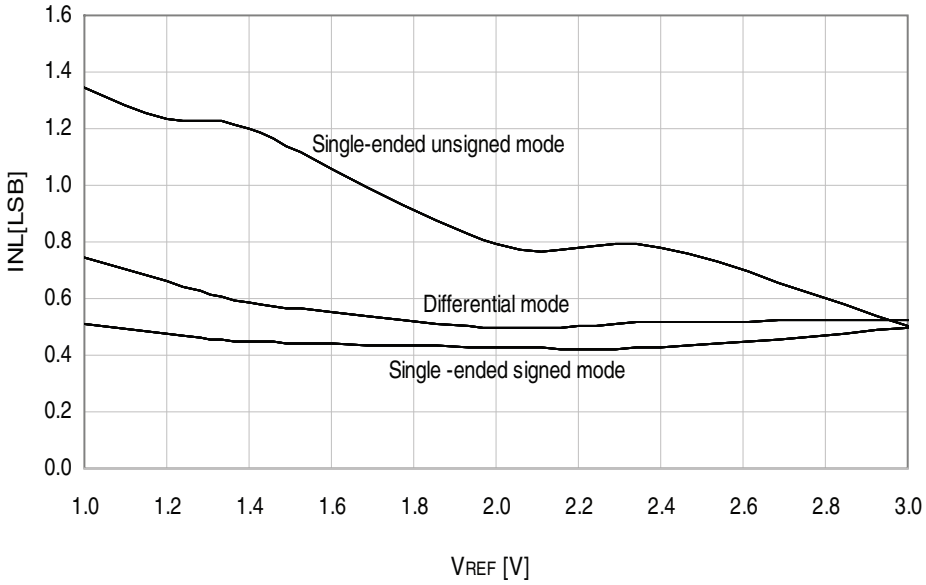
Figure 33-241.I/O Pin Input Hysteresis vs. V_{CC}



33.4.3 ADC Characteristics

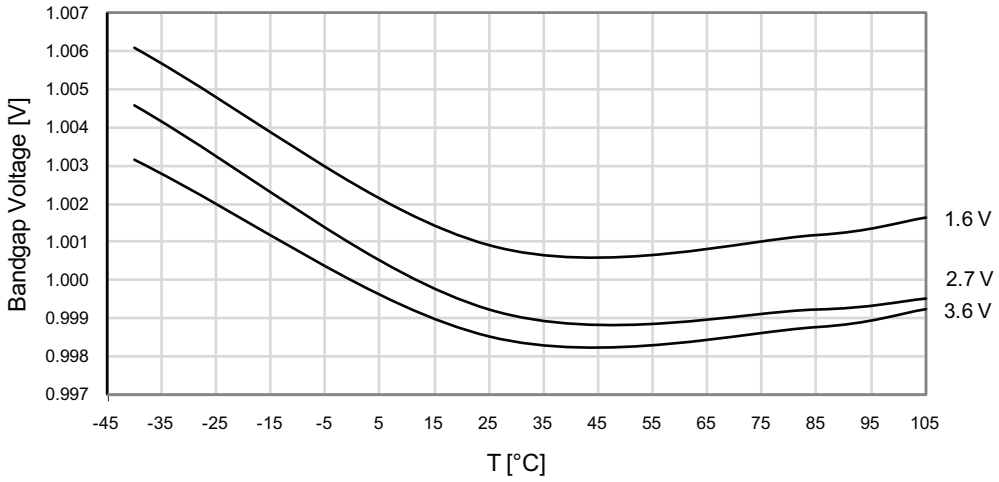
Figure 33-242.INL Error vs. External V_{REF}

T = 25°C, V_{CC} = 3.6V, external reference



33.4.5 Internal 1.0V Reference Characteristics

Figure 33-257.ADC Internal 1.0V Reference vs. Temperature



33.4.6 BOD Characteristics

Figure 33-258.BOD Thresholds vs. Temperature

BOD level = 1.6V

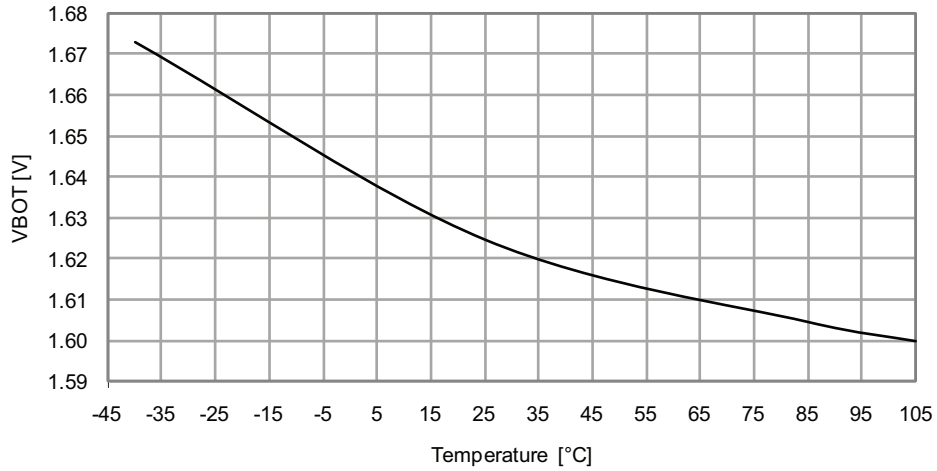


Figure 33-273. 32MHz Internal Oscillator CALA Calibration Step Size

T = -40°C, V_{CC} = 3.0V

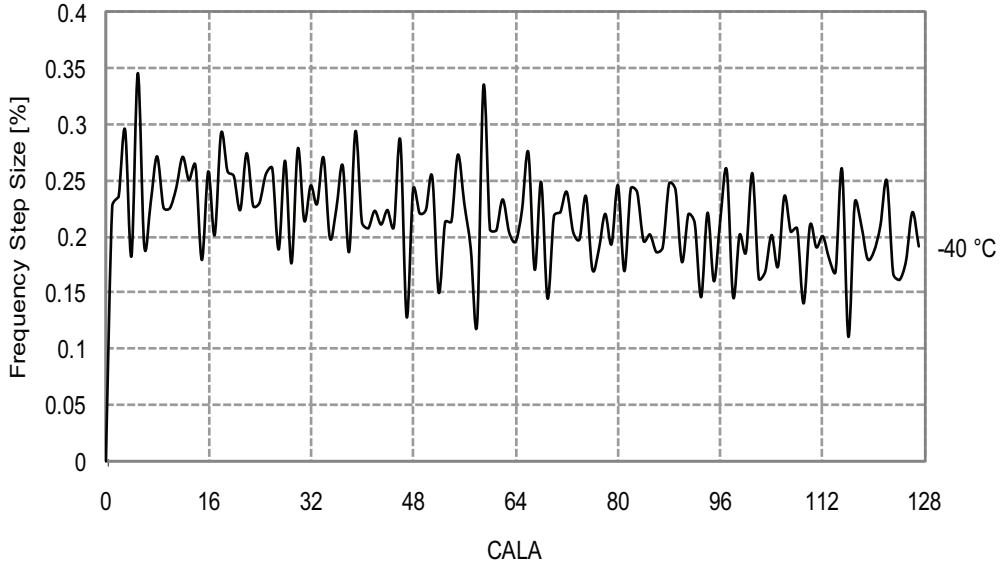


Figure 33-274. 32MHz Internal Oscillator CALA Calibration Step Size

T = 25°C, V_{CC} = 3.0V

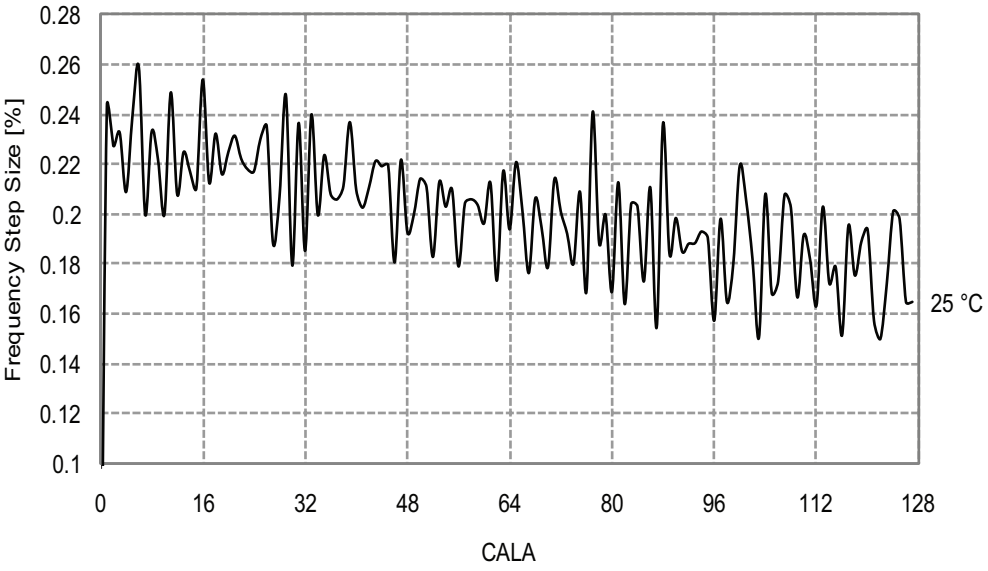
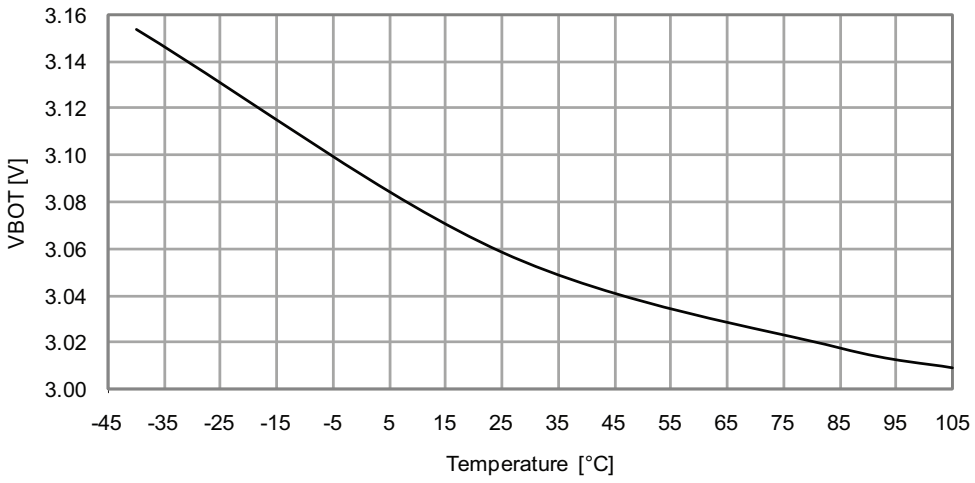


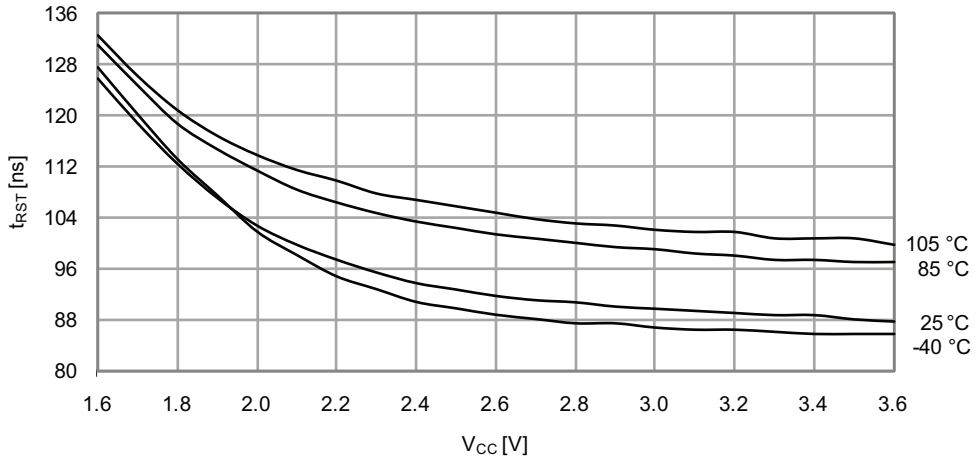
Figure 33-329. BOD Thresholds vs. Temperature

BOD level = 3.0V



33.5.7 External Reset Characteristics

Figure 33-330. Minimum Reset Pin Pulse Width vs. V_{CC}



33.6.9 Two-Wire Interface Characteristics

Figure 33-417. SDA Hold Time vs. Temperature

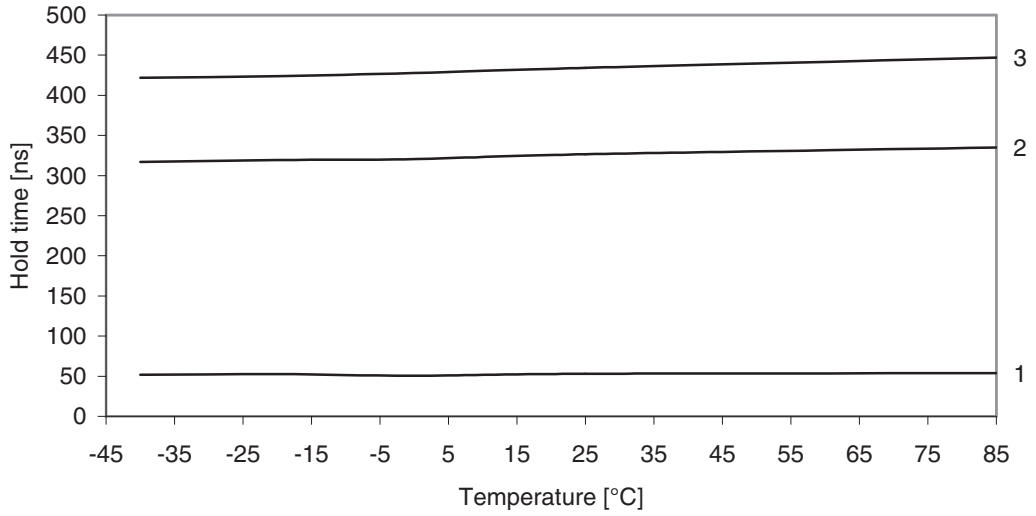


Figure 33-418. SDA Hold Time vs. Supply Voltage