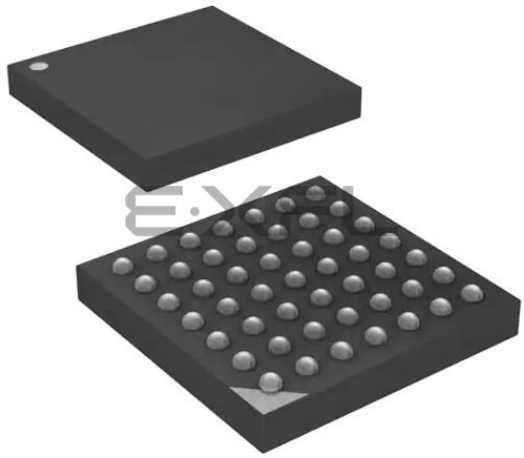

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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

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, POR, PWM, WDT
Number of I/O	34
Program Memory Size	32KB (16K x 16)
Program Memory Type	FLASH
EEPROM Size	1K x 8
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 3.6V
Data Converters	A/D 12x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	49-VFBGA
Supplier Device Package	49-VFBGA (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atxmega32d4-cur

14. I/O Ports

14.1 Features

- 34 general purpose input and output pins with individual configuration
- Output driver with configurable driver and pull settings:
  - Totem-pole
  - Wired-AND
  - Wired-OR
  - Bus-keeper
  - Inverted I/O
- Input with synchronous and/or asynchronous sensing with interrupts and events
  - Sense both edges
  - Sense rising edges
  - Sense falling edges
  - Sense low level
- Optional pull-up and pull-down resistor on input and Wired-OR/AND configurations
- Asynchronous pin change sensing that can wake the device from all sleep modes
- Two port interrupts with pin masking per I/O port
- Efficient and safe access to port pins
  - Hardware read-modify-write through dedicated toggle/clear/set registers
  - Configuration of multiple pins in a single operation
  - Mapping of port registers into bit-accessible I/O memory space
- Peripheral clocks output on port pin
- Real-time counter clock output to port pin
- Event channels can be output on port pin
- Remapping of digital peripheral pin functions
  - Selectable USART, SPI, and timer/counter input/output pin locations

14.2 Overview

One port consists of up to eight port pins: pin 0 to 7. Each port pin can be configured as input or output with configurable driver and pull settings. They also implement synchronous and asynchronous input sensing with interrupts and events for selectable pin change conditions. Asynchronous pin-change sensing means that a pin change can wake the device from all sleep modes, included the modes where no clocks are running.

All functions are individual and configurable per pin, but several pins can be configured in a single operation. The pins have hardware read-modify-write (RMW) functionality for safe and correct change of drive value and/or pull resistor configuration. The direction of one port pin can be changed without unintentionally changing the direction of any other pin.

The port pin configuration also controls input and output selection of other device functions. It is possible to have both the peripheral clock and the real-time clock output to a port pin, and available for external use. The same applies to events from the event system that can be used to synchronize and control external functions. Other digital peripherals, such as USART, SPI, and timer/counters, can be remapped to selectable pin locations in order to optimize pin-out versus application needs.

The notation of the ports are PORTA, PORTB, PORTC, PORTD, PORTE, and PORTR.

18. Hi-Res – High Resolution Extension

18.1 Features

- Increases waveform generator resolution up to 8x (three bits)
- Supports frequency, single-slope PWM, and dual-slope PWM generation
- Supports the AWeX when this is used for the same timer/counter

18.2 Overview

The high-resolution (hi-res) extension can be used to increase the resolution of the waveform generation output from a timer/counter by four or eight. It can be used for a timer/counter doing frequency, single-slope PWM, or dual-slope PWM generation. It can also be used with the AWeX if this is used for the same timer/counter.

The hi-res extension uses the peripheral 4x clock (Clk_{PER4}). The system clock prescalers must be configured so the peripheral 4x clock frequency is four times higher than the peripheral and CPU clock frequency when the hi-res extension is enabled.

There is one hi-res extension that can be enabled for each timer/counter on PORTC. The notation of this is HIRESC.

28.2 Alternate Pin Functions

The tables below show the primary/default function for each pin on a port in the first column, the pin number in the second column, and then all alternate pin functions in the remaining columns. The head row shows what peripheral that enable and use the alternate pin functions.

For better flexibility, some alternate functions also have selectable pin locations for their functions, this is noted under the first table where this apply.

Table 28-1. Port A - Alternate Functions

PORT A	PIN#	INTERRUPT	ADCA POS/GAINPOS	ADCA NEG	ADCA GAINNEG	ACAPOS	ACANEG	ACAOUT	REFA
GND	38								
AVCC	39								
PA0	40	SYNC	ADC0	ADC0		AC0	AC0		AREF
PA1	41	SYNC	ADC1	ADC1		AC1	AC1		
PA2	42	SYNC/ASYNC	ADC2	ADC2		AC2			
PA3	43	SYNC	ADC3	ADC3		AC3	AC3		
PA4	44	SYNC	ADC4		ADC4	AC4			
PA5	1	SYNC	ADC5		ADC5	AC5	AC5		
PA6	2	SYNC	ADC6		ADC6	AC6			
PA7	3	SYNC	ADC7		ADC7		AC7	AC0OUT	

Table 28-2. Port B - Alternate Functions

PORT B	PIN#	INTERRUPT	ADCAPOS/GAINPOS	REFB
PB0	4	SYNC	ADC8	AREF
PB1	5	SYNC	ADC9	
PB2	6	SYNC/ASYNC	ADC10	
PB3	7	SYNC	ADC11	

2. EEPROM is not erased if the EESAVE fuse is programmed.

32.1.13 Clock and Oscillator Characteristics

32.1.13.1 Calibrated 32.768kHz Internal Oscillator Characteristics

Table 32-19. 32.768kHz Internal Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Frequency			32.768		kHz
	Factory calibration accuracy	T = 85°C, V_{CC} = 3.0V	-0.5		0.5	%
	User calibration accuracy		-0.5		0.5	

32.1.13.2 Calibrated 2MHz RC Internal Oscillator Characteristics

Table 32-20. 2MHz Internal Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Frequency range	DFLL can tune to this frequency over voltage and temperature	1.8		2.2	MHz
	Factory calibrated frequency			2.0		
	Factory calibration accuracy	T = 85°C, V_{CC}= 3.0V	-1.5		1.5	%
	User calibration accuracy		-0.2		0.2	
	DFLL calibration stepsize			0.18		

32.1.13.3 Calibrated and Tunable 32MHz Internal Oscillator Characteristics

Table 32-21. 32MHz Internal Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Frequency range	DFLL can tune to this frequency over voltage and temperature	30	32	55	MHz
	Factory calibrated frequency			32		
	Factory calibration accuracy	T = 85°C, V_{CC}= 3.0V	-1.5		1.5	%
	User calibration accuracy		-0.2		0.2	
	DFLL calibration step size			0.19		

32.1.13.4 32kHz Internal ULP Oscillator Characteristics

Table 32-22. 32kHz Internal ULP Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Factory calibrated frequency			32		kHz
	Factory calibration accuracy	T = 85°C, V_{CC}= 3.0V	-12		12	%
	Accuracy		-30		30	

32.2.11 Power-on Reset Characteristics

Table 32-44. 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	1.0		
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 $V_{POT-} = V_{POT+}$.

32.2.12 Flash and EEPROM Memory Characteristics

Table 32-45. 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			

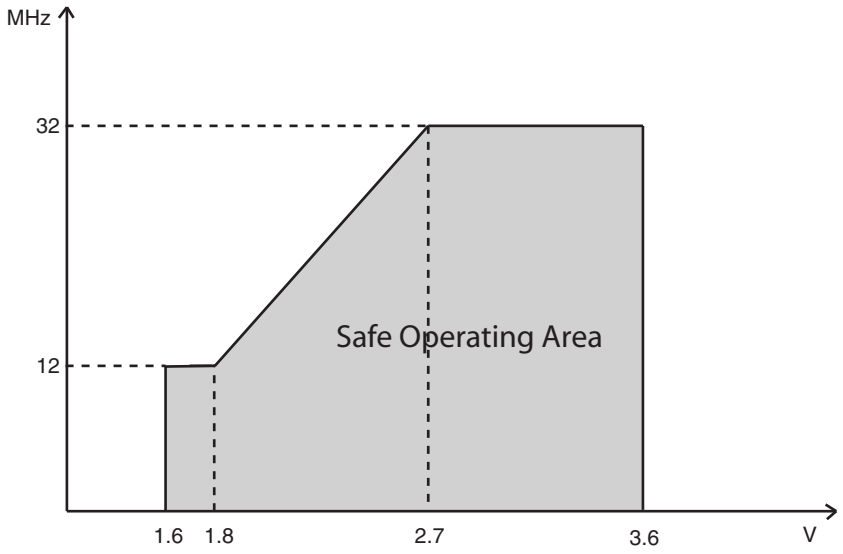
Table 32-46. Programming Time

Symbol	Parameter	Condition	Min.	Typ.(1)	Max.	Units
	Chip erase(2)	32KB Flash, EEPROM		50		ms
	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.

The maximum CPU clock frequency depends on V_{CC}. As shown in Figure 32-15 the Frequency vs. V_{CC} curve is linear between $1.8V < V_{CC} < 2.7V$.

Figure 32-15.Maximum Frequency vs. V_{CC}



32.3.13.3 Calibrated and Tunable 32MHz Internal Oscillator Characteristics

Table 32-77. 32MHz Internal Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Frequency range	DFLL can tune to this frequency over voltage and temperature	30		55	MHz
	Factory calibrated frequency			32		
	Factory calibration accuracy	T = 85°C, V_{CC}= 3.0V	-1.5		1.5	%
	User calibration accuracy		-0.2		0.2	
	DFLL calibration step size			0.22		

32.3.13.4 32kHz Internal ULP Oscillator Characteristics

Table 32-78. 32kHz Internal ULP Oscillator Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
	Factory calibrated frequency			32		kHz
	Factory calibration accuracy	T = 85°C, V_{CC}= 3.0V	-12		12	%
	Accuracy		-30		30	

32.3.13.5 Internal Phase Locked Loop (PLL) Characteristics

Table 32-79. Internal PLL Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
f_{IN}	Input frequency	Output frequency must be within f_{OUT}	0.4		64	MHz
f_{OUT}	Output frequency(1)	V_{CC}= 1.6 - 1.8V	20		48	
		V_{CC}= 2.7 - 3.6V	20		128	
	Start-up time			25		µs
	Re-lock time			25		

Note: 1. The maximum output frequency vs. supply voltage is linear between 1.8V and 2.7V, and can never be higher than four times the maximum CPU frequency.

32.3.14 SPI Characteristics

Figure 32-19.SPI Timing Requirements in Master Mode

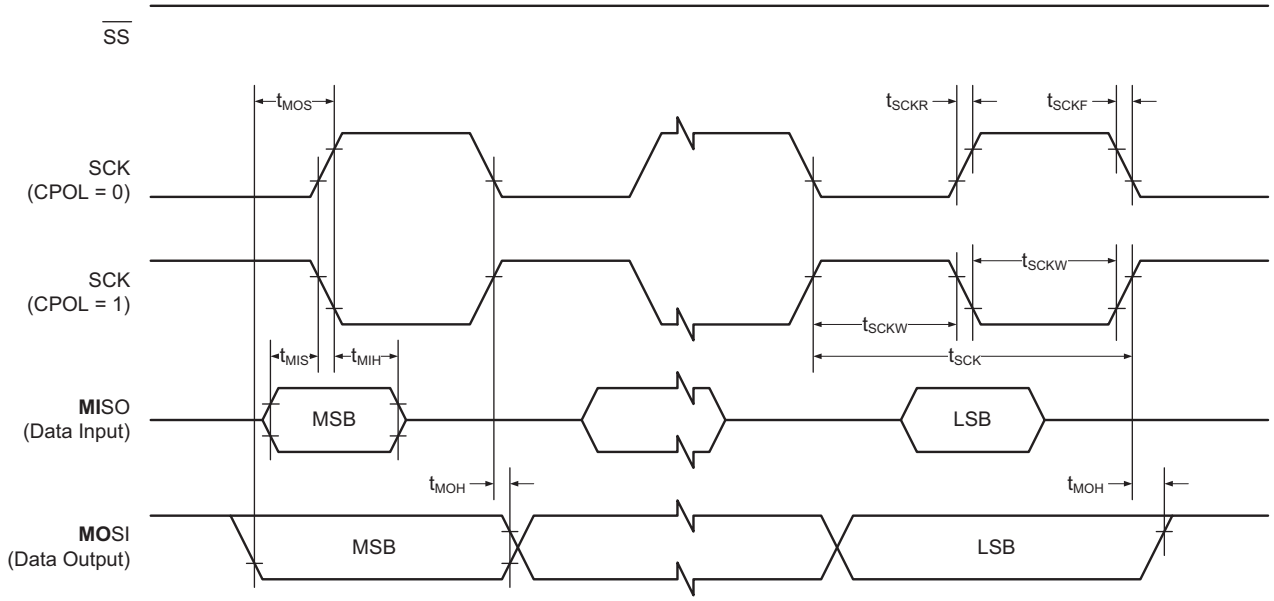


Figure 32-20.SPI Timing Requirements in Slave Mode

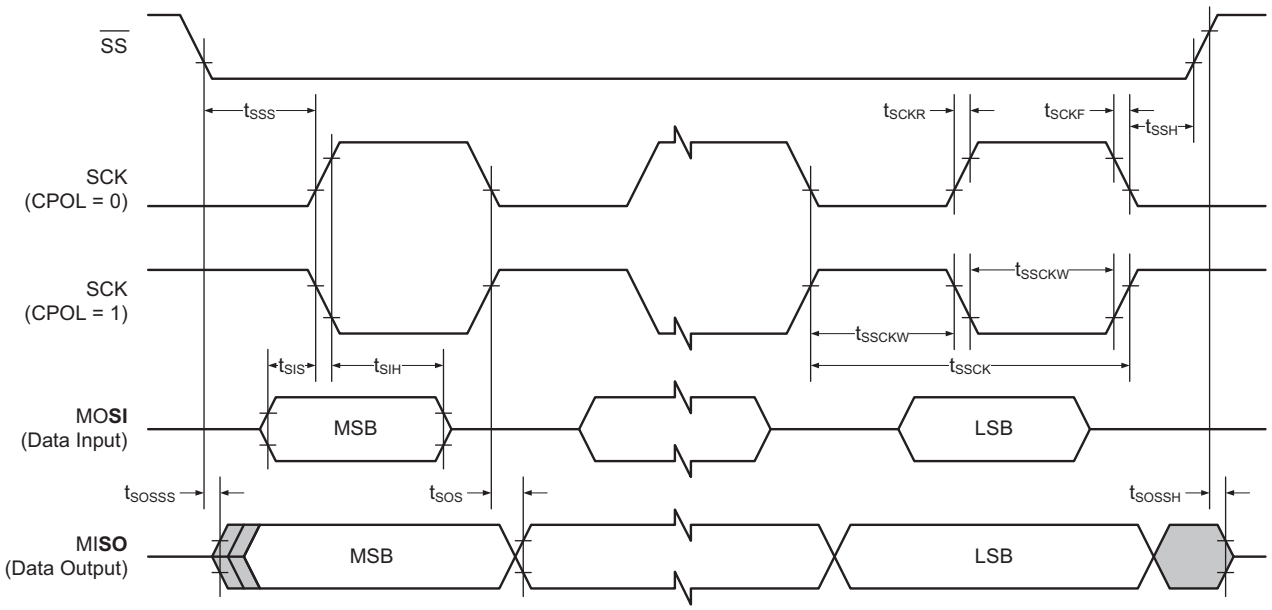


Figure 33-61. Reset Pin Input Threshold Voltage vs. V_{CC}

V_{IH} - Reset pin read as "1"

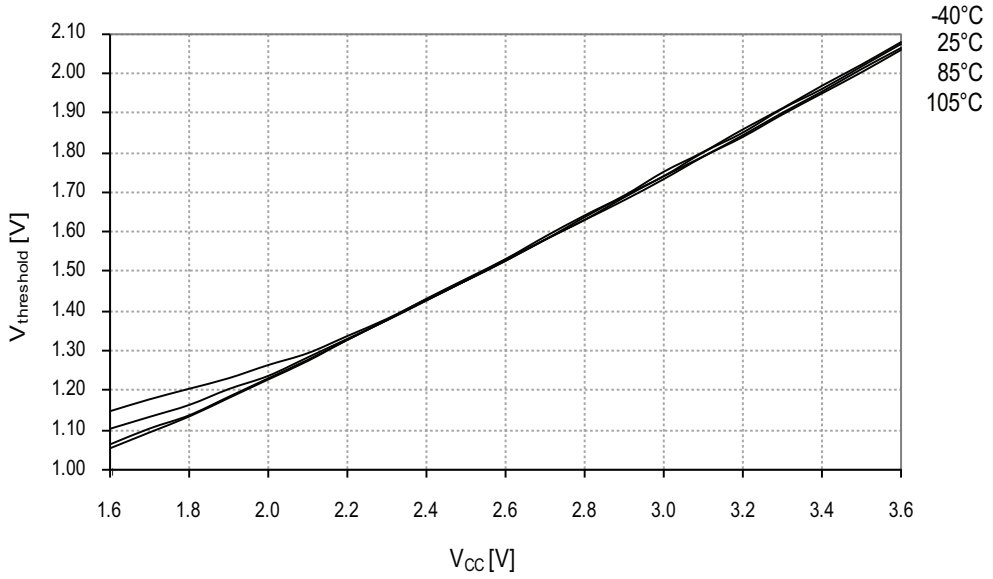


Figure 33-62. Reset Pin Input Threshold Voltage vs. V_{CC}

V_{IL} - Reset pin read as "0"

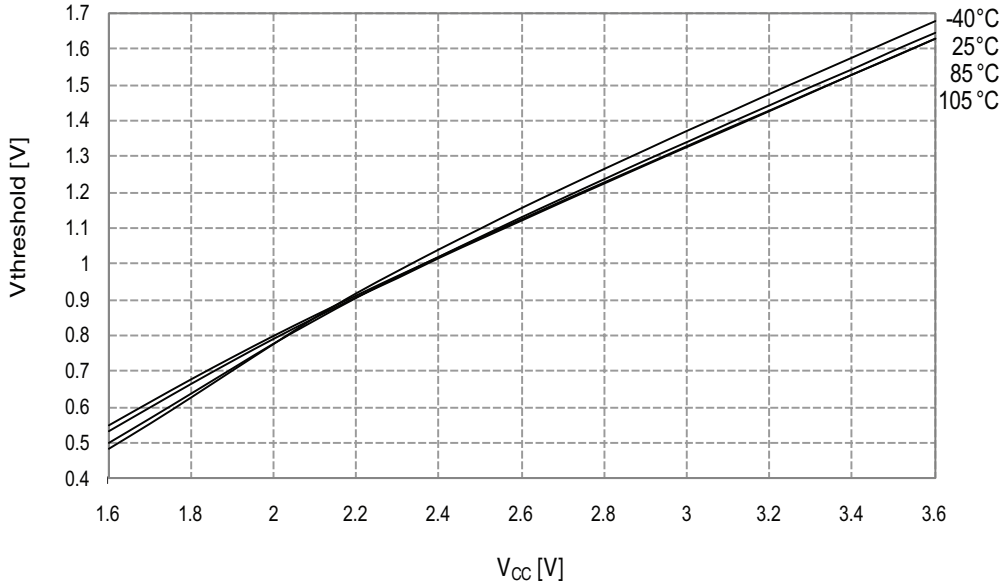


Figure 33-130. Analog Comparator Current Source vs. Calibration Value

T = 25°C

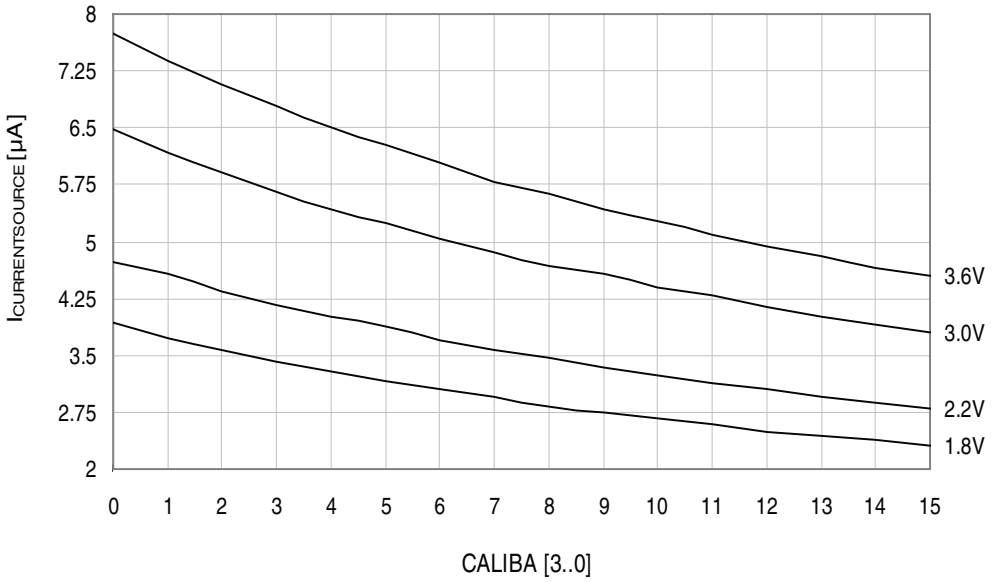
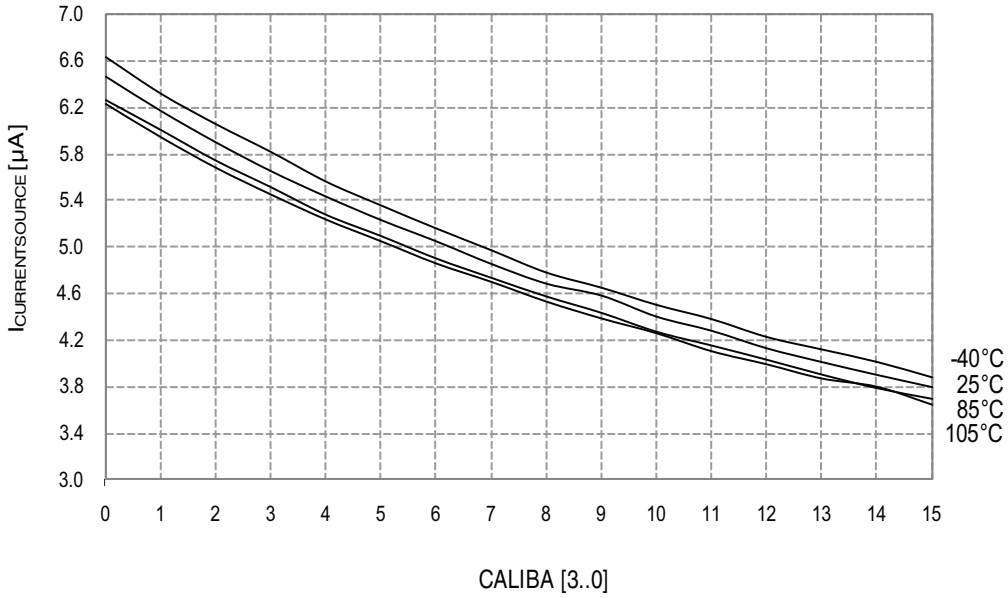


Figure 33-131. Analog Comparator Current Source vs. Calibration Value

V_{CC} = 3.0V



33.2.9.4 32MHz Internal Oscillator

Figure 33-150. 32MHz Internal Oscillator Frequency vs. Temperature

DFLL disabled

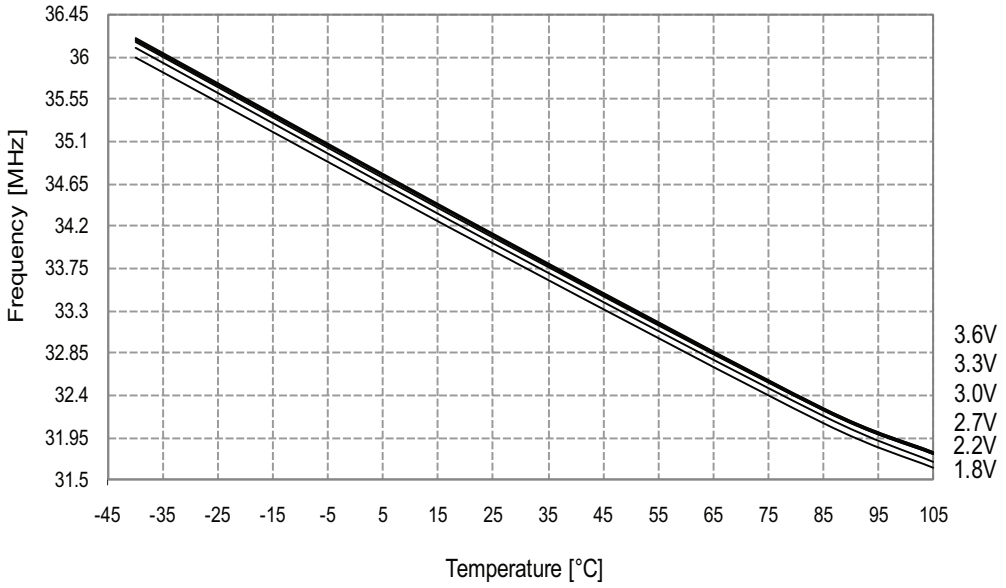


Figure 33-151. 32MHz Internal Oscillator Frequency vs. Temperature

DFLL enabled, from the 32.768kHz internal oscillator

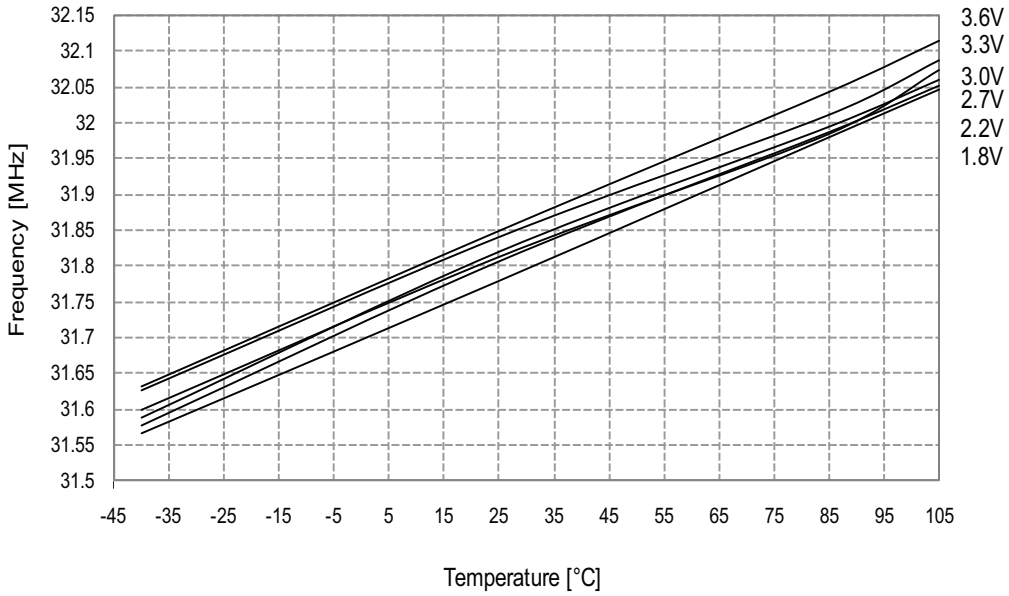
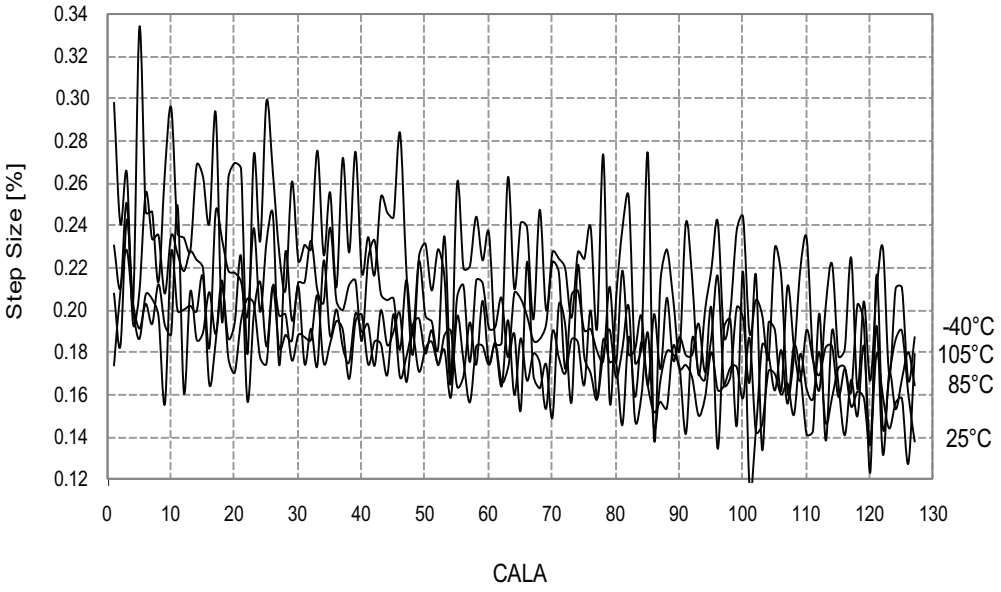


Figure 33-152. 32MHz Internal Oscillator CALA Calibration Step Size

V_{CC} = 3.0V



33.2.9.5 32MHz Internal Oscillator Calibrated to 48MHz

Figure 33-153. 48MHz Internal Oscillator Frequency vs. Temperature

DFLL disabled

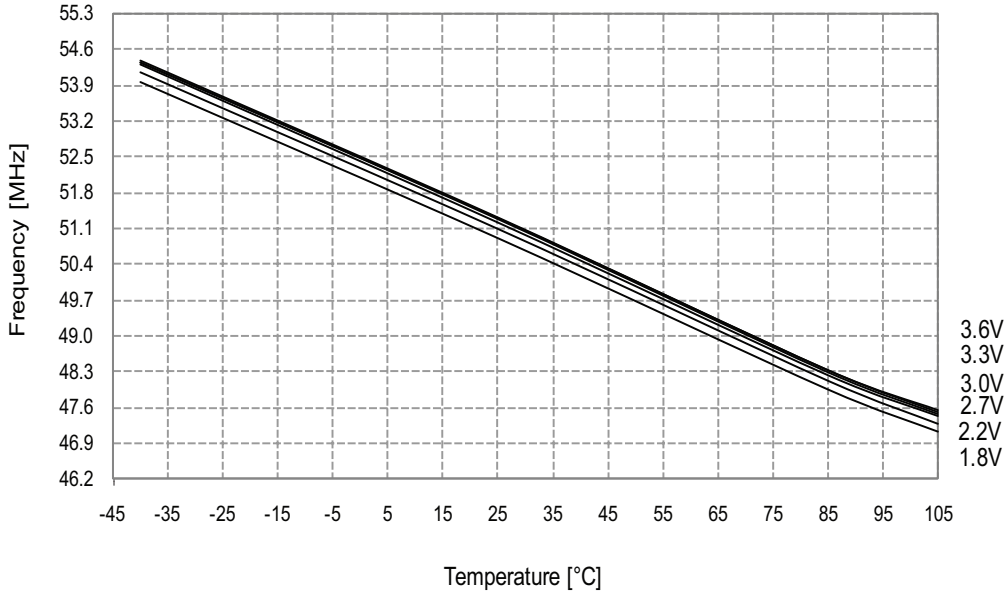


Figure 33-167. Idle Mode Supply Current vs. Frequency

f_{SYS} = 1 - 32MHz external clock, T = 25°C

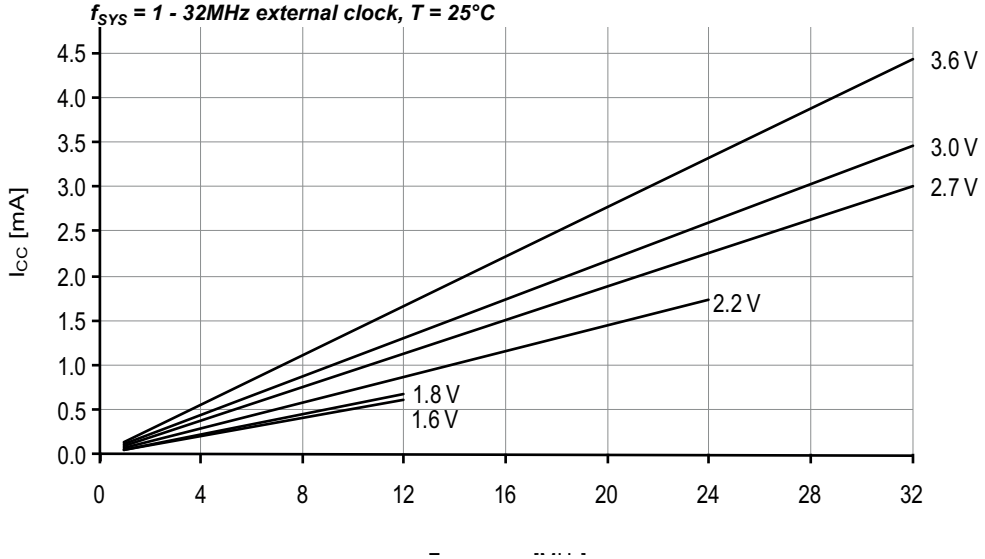


Figure 33-168. Idle Mode Supply Current vs. V_{CC}

f_{SYS} = 32.768kHz internal oscillator

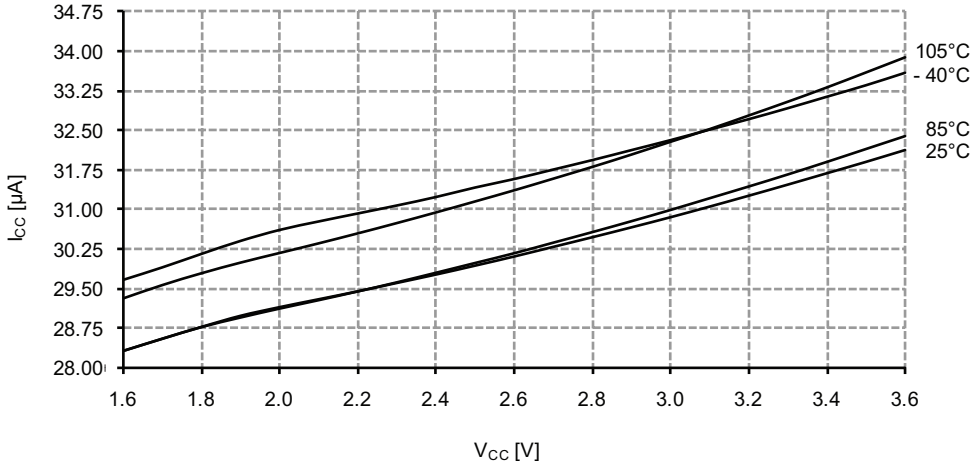


Figure 33-171. Idle Mode Supply Current vs. V_{CC}

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

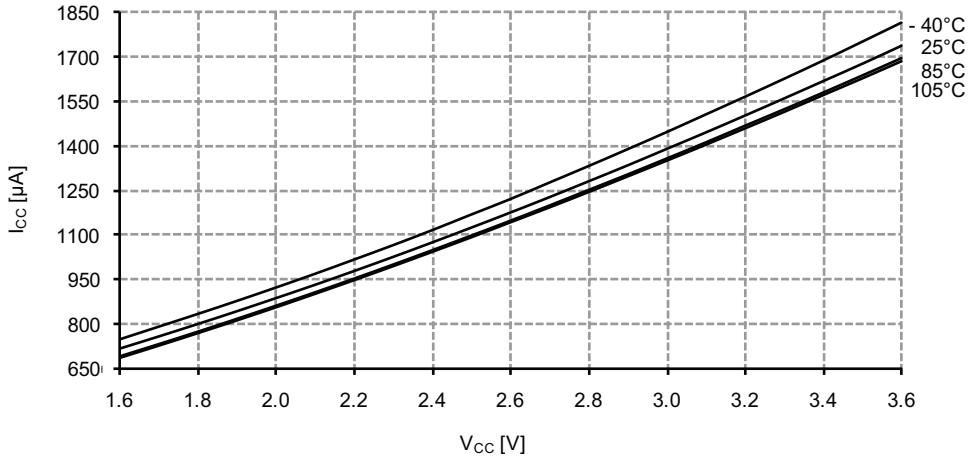
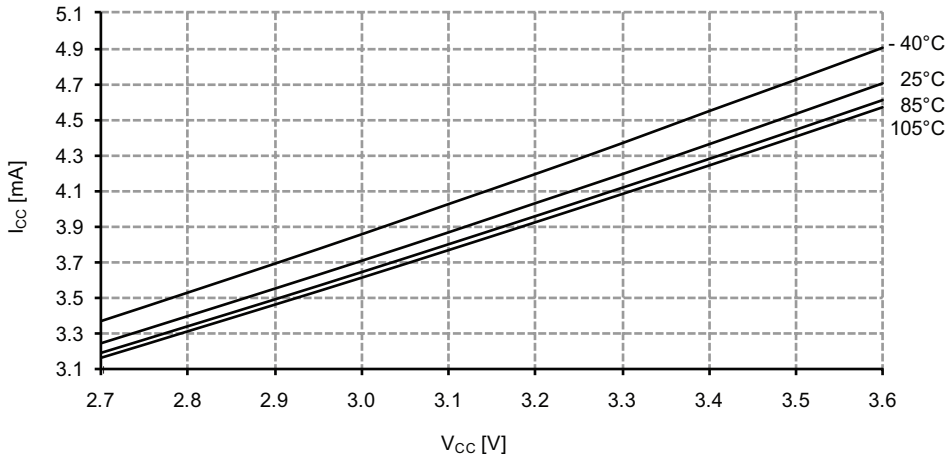


Figure 33-172. Idle Mode Current vs. V_{CC}

f_{SYS} = 32MHz internal oscillator



33.3.1.3 Power-down Mode Supply Current

Figure 33-173. Power-down Mode Supply Current vs. Temperature

All functions disabled

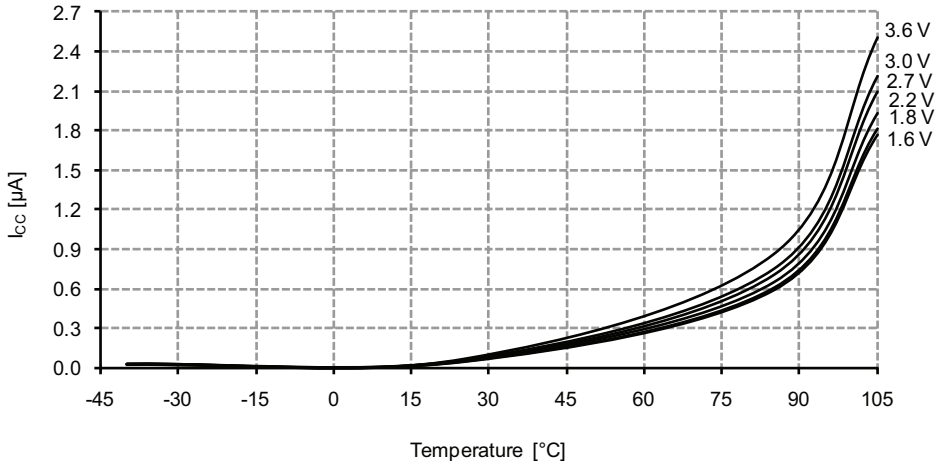


Figure 33-174. Power-down Mode Supply Current vs. V_{CC}

All functions disabled

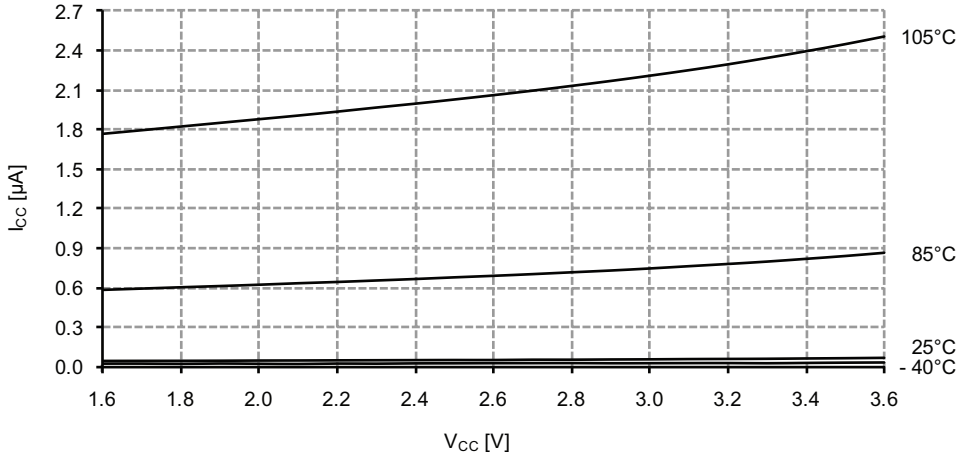
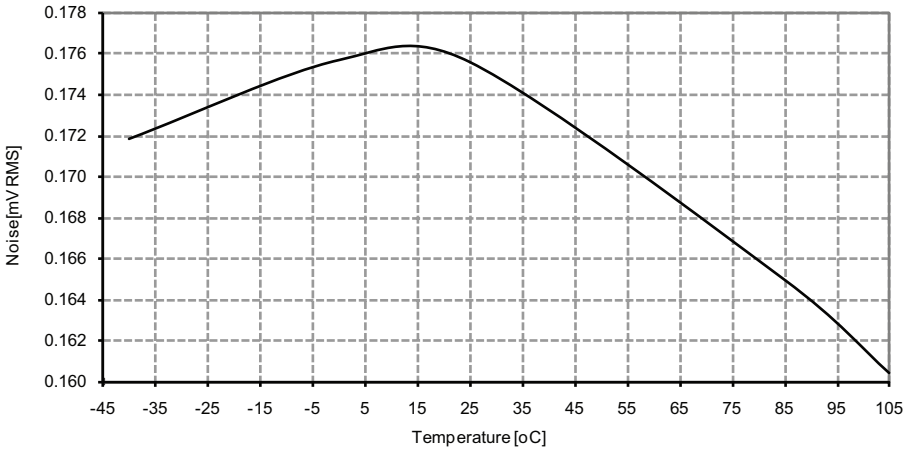


Figure 33-209. DAC Noise vs. Temperature

V_{CC} = 2.7V, V_{REF} = 1.0V



33.3.5 Analog Comparator Characteristics

Figure 33-210. Analog Comparator Hysteresis vs. V_{CC}

High-speed, small hysteresis

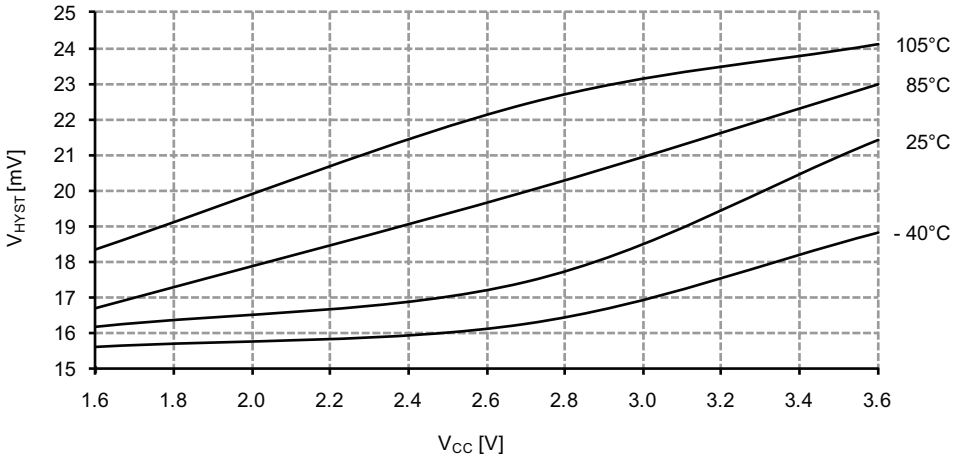


Figure 33-223. Reset Pin Pull-up Resistor Current vs. Reset Pin Voltage

V_{CC} = 3.3V

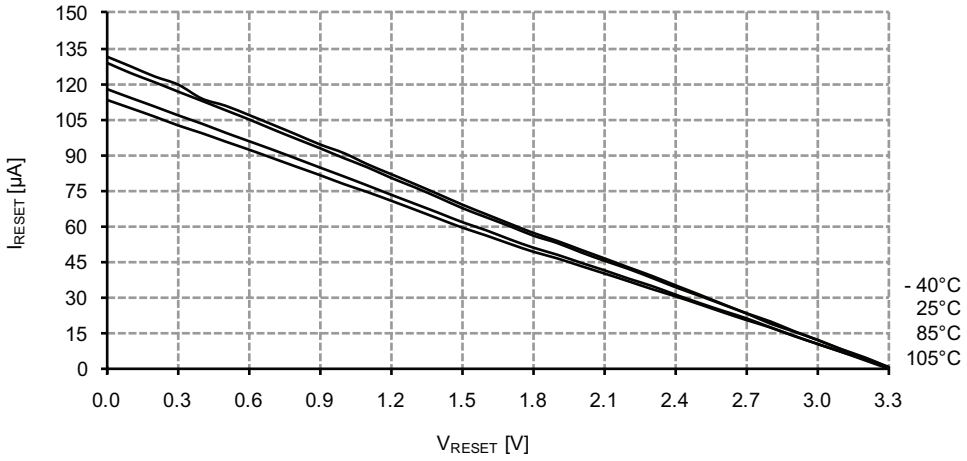


Figure 33-224. Reset Pin Input Threshold Voltage vs. V_{CC}

V_{IH} - Reset pin read as "1"

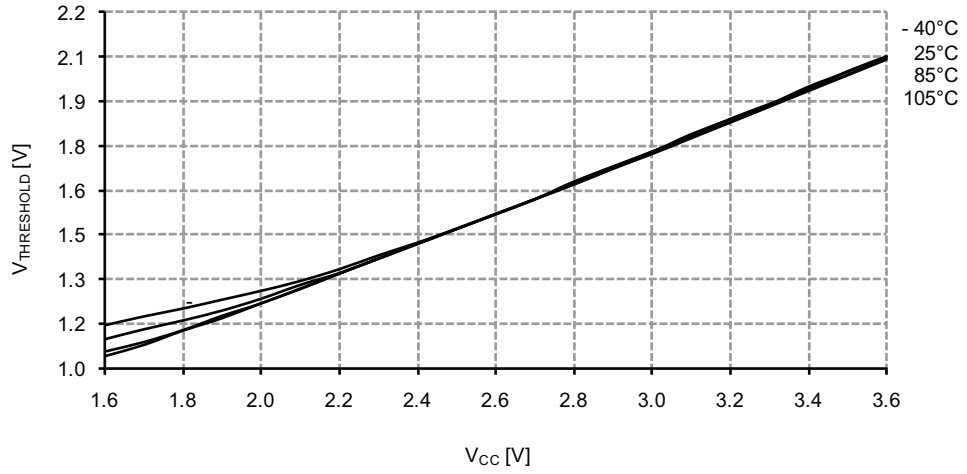


Figure 33-247. Active Mode Supply Current vs. V_{CC}

f_{SYS} = 2MHz internal oscillator

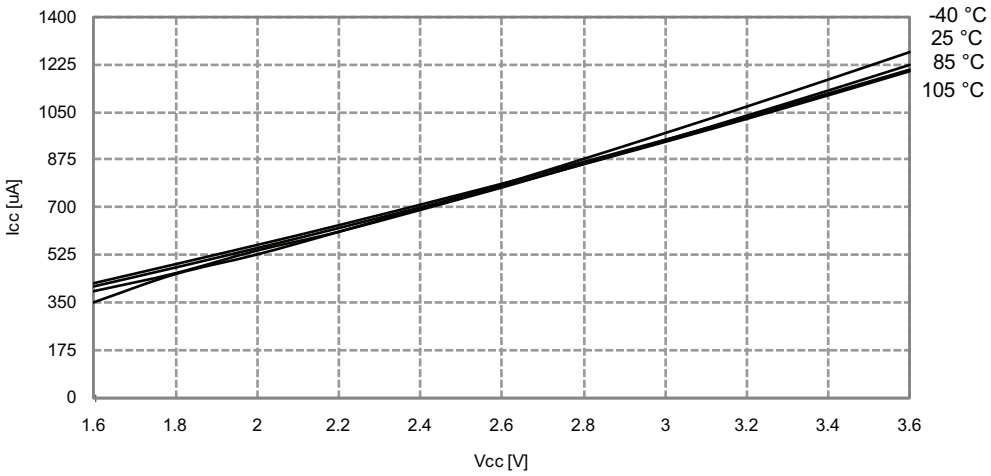


Figure 33-248. Active Mode Supply Current vs. V_{CC}

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

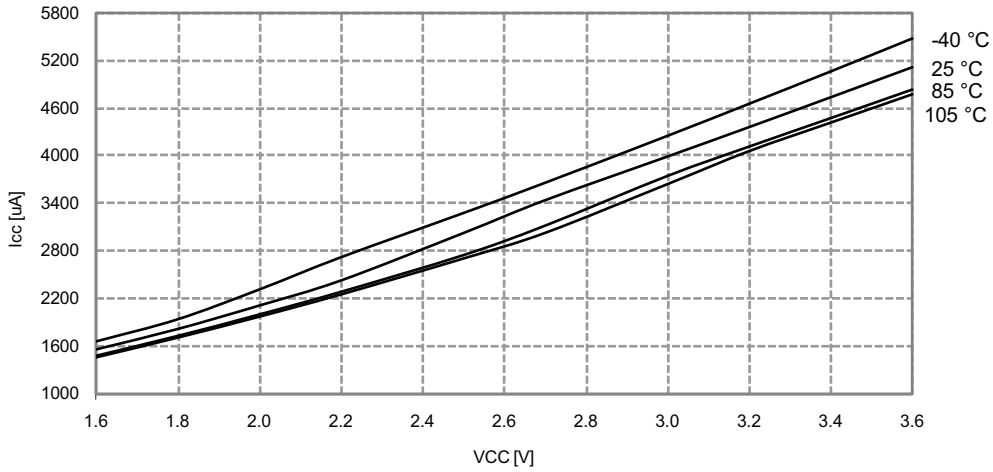


Figure 33-279. INL Error vs. Sample rate

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

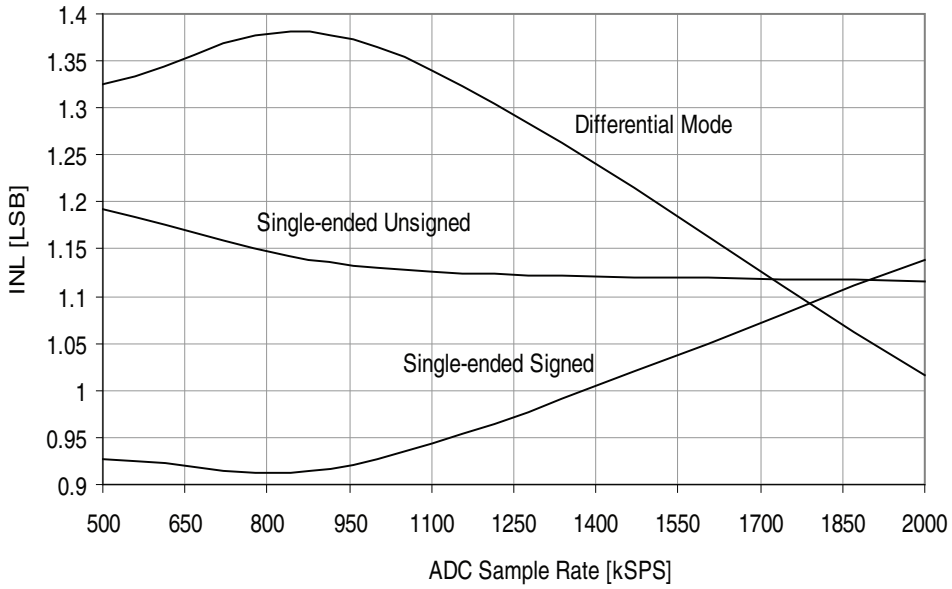


Figure 33-280. INL Error vs. Input code