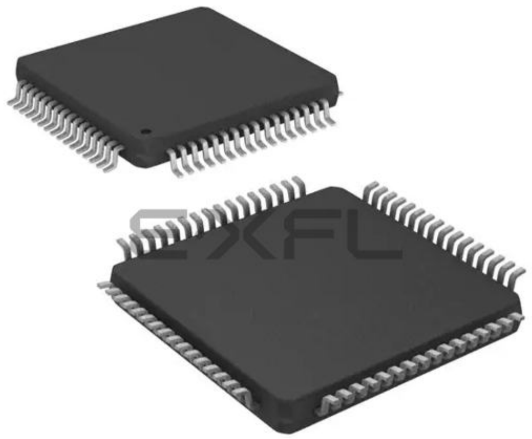

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What is "Embedded - Microcontrollers"?

"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, USB
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	50
Program Memory Size	64KB (32K x 16)
Program Memory Type	FLASH
EEPROM Size	2K x 8
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 3.6V
Data Converters	A/D 16x12b; D/A 2x12b
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/atxmega64a3u-au

28. ADC – 12-bit Analog to Digital Converter

28.1 Features

- Two Analog to Digital Converters (ADCs)
- 12-bit resolution
- Up to two million samples per second
  - Two inputs can be sampled simultaneously using ADC and 1x gain stage
  - Four inputs can be sampled within 1.5µs
  - Down to 2.5µs conversion time with 8-bit resolution
  - Down to 3.5µs conversion time with 12-bit resolution
- Differential and single-ended input
  - Up to 16 single-ended inputs
  - 16x4 differential inputs without gain
  - 8x4 differential input with gain
- Built-in differential gain stage
  - 1/2x, 1x, 2x, 4x, 8x, 16x, 32x, and 64x gain options
- Single, continuous and scan conversion options
- Four internal inputs
  - Internal temperature sensor
  - DAC output
  - AV_{CC} voltage divided by 10
  - 1.1V bandgap voltage
- Four conversion channels with individual input control and result registers
  - Enable four parallel configurations and results
- Internal and external reference options
- Compare function for accurate monitoring of user defined thresholds
- Optional event triggered conversion for accurate timing
- Optional DMA transfer of conversion results
- Optional interrupt/event on compare result

28.2 Overview

The ADC converts analog signals to digital values. The ADC has 12-bit resolution and is capable of converting up to two million samples per second (msps). The input selection is flexible, and both single-ended and differential measurements can be done. For differential measurements, an optional gain stage is available to increase the dynamic range. In addition, several internal signal inputs are available. The ADC can provide both signed and unsigned results.

This is a pipelined ADC that consists of several consecutive stages. The pipelined design allows a high sample rate at a low system clock frequency. It also means that a new input can be sampled and a new ADC conversion started while other ADC conversions are still ongoing. This removes dependencies between sample rate and propagation delay.

The ADC has four conversion channels (0-3) with individual input selection, result registers, and conversion start control. The ADC can then keep and use four parallel configurations and results, and this will ease use for applications with high data throughput or for multiple modules using the ADC independently. It is possible to use DMA to move ADC results directly to memory or peripherals when conversions are done.

32. Pinout and Pin Functions

The device pinout is shown in "Pinout/Block Diagram" on page 5. In addition to general purpose I/O functionality, each pin can have several alternate functions. This will depend on which peripheral is enabled and connected to the actual pin. Only one of the pin functions can be used at time.

32.1 Alternate Pin Function Description

The tables below show the notation for all pin functions available and describe its function.

32.1.1 Operation/Power Supply

V_{CC}	Digital supply voltage
AV_{CC}	Analog supply voltage
GND	Ground

32.1.2 Port Interrupt functions

SYNC	Port pin with full synchronous and limited asynchronous interrupt function
ASYNC	Port pin with full synchronous and full asynchronous interrupt function

32.1.3 Analog functions

ACn	Analog Comparator input pin n
ACnOUT	Analog Comparator n Output
ADCn	Analog to Digital Converter input pin n
DACn	Digital to Analog Converter output pin n
A_{REF}	Analog Reference input pin

32.1.4 Timer/Counter and AWEX functions

OCnxLS	Output Compare Channel x Low Side for Timer/Counter n
OCnxHS	Output Compare Channel x High Side for Timer/Counter n

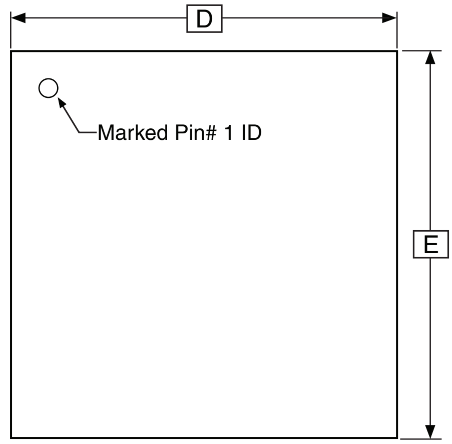
32.1.5 Communication functions

SCL	Serial Clock for TWI
SDA	Serial Data for TWI
SCLIN	Serial Clock In for TWI when external driver interface is enabled
SCLOUT	Serial Clock Out for TWI when external driver interface is enabled
SDAIN	Serial Data In for TWI when external driver interface is enabled
SDAOUT	Serial Data Out for TWI when external driver interface is enabled
XCKn	Transfer Clock for USART n
RXDn	Receiver Data for USART n

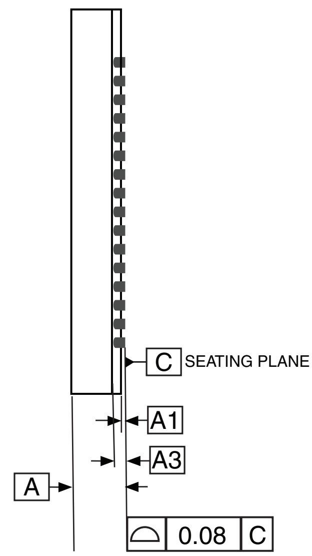
Mnemonics	Operands	Description	Operation	Flags	#Clocks
SEV		Set Two's Complement Overflow	V ← 1	V	1
CLV		Clear Two's Complement Overflow	V ← 0	V	1
SET		Set T in SREG	T ← 1	T	1
CLT		Clear T in SREG	T ← 0	T	1
SEH		Set Half Carry Flag in SREG	H ← 1	H	1
CLH		Clear Half Carry Flag in SREG	H ← 0	H	1
MCU control instructions					
BREAK		Break	(See specific descr. for BREAK)	None	1
NOP		No Operation		None	1
SLEEP		Sleep	(see specific descr. for Sleep)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR)	None	1

Notes: 1. Cycle times for Data memory accesses assume internal memory accesses, and are not valid for accesses via the external RAM interface.
2. One extra cycle must be added when accessing Internal SRAM.

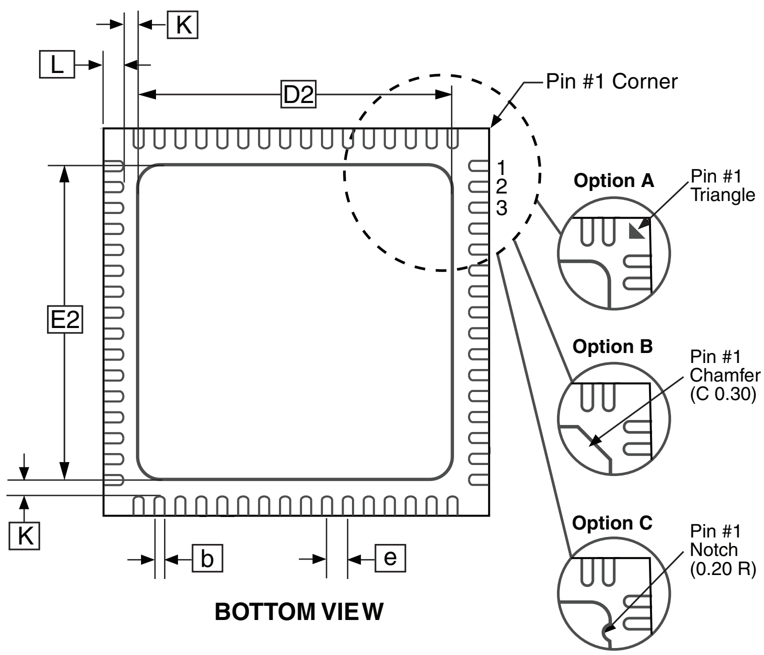
35.2 64M2



TOP VIEW



SIDE VIEW



BOTTOM VIEW

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	–	0.02	0.05	
A3		0.20 REF		
b	0.18	0.25	0.30	
D	8.90	9.00	9.10	
D2	7.50	7.65	7.80	
E	8.90	9.00	9.10	
E2	7.50	7.65	7.80	
e		0.50 BSC		
L	0.35	0.40	0.45	
K	0.20	0.27	0.40	

Notes: 1. JEDEC Standard MO-220, (SAW Singulation) Fig. 1, VMMD.
2. Dimension and tolerance conform to ASMEY14.5M-1994.

2014-05-30

	TITLE	DRAWING NO.	REV.
Atmel 2325 Orchard Parkway San Jose, CA 95131	**64M2**, 64-pad, 9 x 9 x 1.0mm Bod y, Lead Pitch 0.50mm , 7.65mm Exposed Pad,Quad Flat No Lead Package (QFN)	64M2	F

Table 36-5. Current consumption for modules and peripherals.

Symbol	Parameter	Condition[1]	Min.	Typ.	Max.	Units
I_{CC}	ULP oscillator			1.0		µA
	32.768kHz int. oscillator			26		µA
	2MHz int. oscillator			85		µA
		DFLL enabled with 32.768kHz int. osc. as reference		115		
	32MHz int. oscillator			270		µA
		DFLL enabled with 32.768kHz int. osc. as reference		460		
	PLL	20x multiplication factor, 32MHz int. osc. DIV4 as reference		220		µA
	Watchdog Timer			1		µA
	BOD	Continuous mode		138		µA
		Sampled mode, includes ULP oscillator		1.2		
	Internal 1.0V reference			100		µA
	Temperature sensor			95		µA
	ADC	250ksps V_{REF} = Ext ref		3.0		mA
		CURRLIMIT = LOW		2.6		
		CURRLIMIT = MEDIUM		2.1		
		CURRLIMIT = HIGH		1.6		
	DAC	250ksps V_{REF} = Ext ref No load Normal mode		1.9		mA
		Low Power mode		1.1		
	AC	High Speed Mode		330		µA
		Low Power Mode		130		
	DMA	615KBps between I/O registers and SRAM		115		µA
	Timer/Counter			16		µA
	USART	Rx and Tx enabled, 9600 BAUD		2.5		µA
	Flash memory and EEPROM programming			4		mA

Note: 1. All parameters measured as the difference in current consumption between module enabled and disabled. All data at V_{CC} = 3.0V, Clk_{SYS} = 1MHz external clock without prescaling, T = 25°C unless other conditions are given.

The maximum CPU clock frequency depends on V_{CC}. As shown in Figure 36-1 the Frequency vs. V_{CC} curve is linear between 1.8V < V_{CC} < 2.7V.

Figure 36-8. Maximum Frequency vs. V_{CC}.

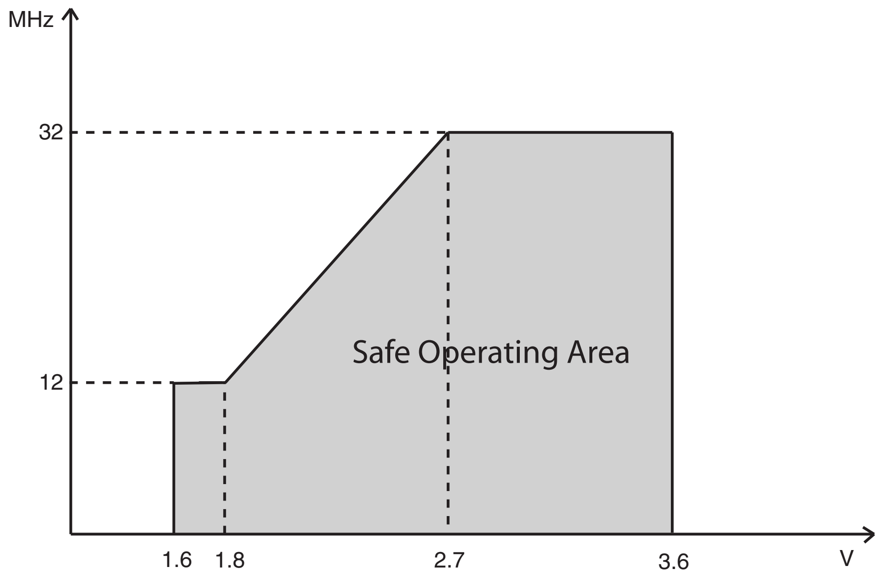


Table 36-46. Accuracy characteristics.

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
RES	Input Resolution					12	Bits
INL [1]	Integral non-linearity	V_{REF}= Ext 1.0V	V_{CC} = 1.6V		±2.0	±3	lsb
			V_{CC} = 3.6V		±1.5	±2.5	
		V_{REF}=AV_{CC}	V_{CC} = 1.6V		±2.0	±4	
			V_{CC} = 3.6V		±1.5	±4	
		V_{REF}=INT1V	V_{CC} = 1.6V		±5.0		
			V_{CC} = 3.6V		±5.0		
DNL [1]	Differential non-linearity	V_{REF}=Ext 1.0V	V_{CC} = 1.6V		±1.5	3	lsb
			V_{CC} = 3.6V		±0.6	1.5	
		V_{REF}=AV_{CC}	V_{CC} = 1.6V		±1.0	3.5	
			V_{CC} = 3.6V		±0.6	1.5	
		V_{REF}=INT1V	V_{CC} = 1.6V		±4.5		
			V_{CC} = 3.6V		±4.5		
	Gain error	After calibration			<4		lsb
	Gain calibration step size				4		lsb
	Gain calibration drift	V_{REF}= Ext 1.0V			<0.2		mV/K
	Offset error	After calibration			<1		lsb
	Offset calibration step size				1		

Note: 1. Maximum numbers are based on characterisation and not tested in production, and valid for 5% to 95% output voltage range.

36.2.8 Analog Comparator Characteristics

Table 36-47. Analog Comparator characteristics.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{off}	Input Offset Voltage			<±10		mV
I_{lk}	Input Leakage Current			<1		nA
	Input voltage range		-0.1		AV_{CC}	V
	AC startup time			100		µs
V_{hys1}	Hysteresis, None			0		mV
V_{hys2}	Hysteresis, Small	mode = High Speed (HS)		13		mV
		mode = Low Power (LP)		30		
V_{hys3}	Hysteresis, Large	mode = HS		30		mV
		mode = LP		60		

37.1.2.2 Output Voltage vs. Sink/Source Current

Figure 37-23. I/O pin output voltage vs. source current.

V_{CC} = 1.8V.

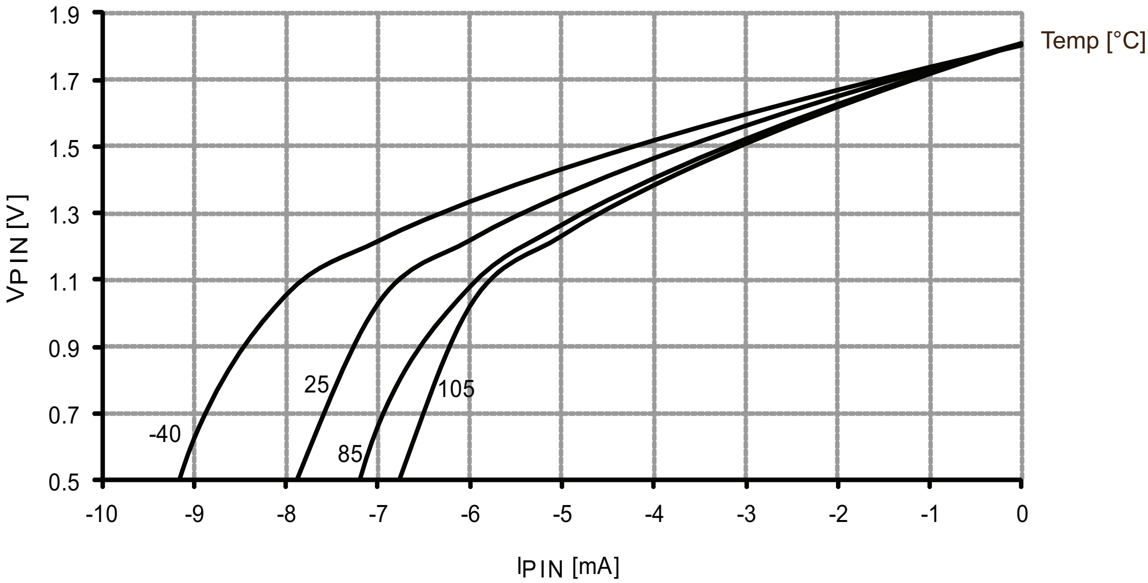


Figure 37-24. I/O pin output voltage vs. source current.

V_{CC} = 3.0V.

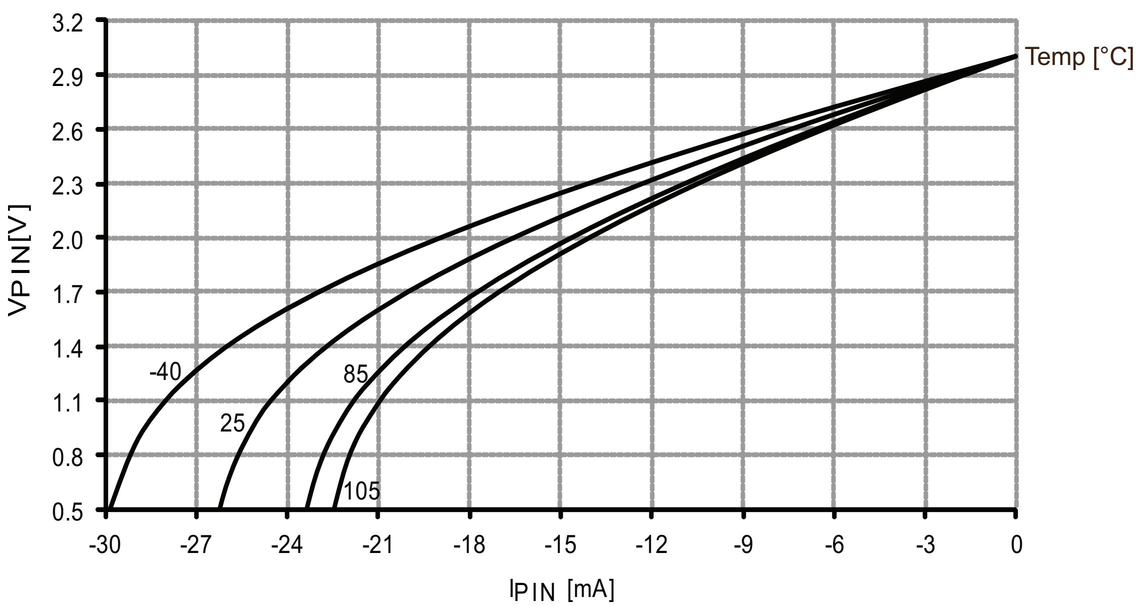


Figure 37-29. I/O pin output voltage vs. sink current.

V_{CC} = 3.3V.

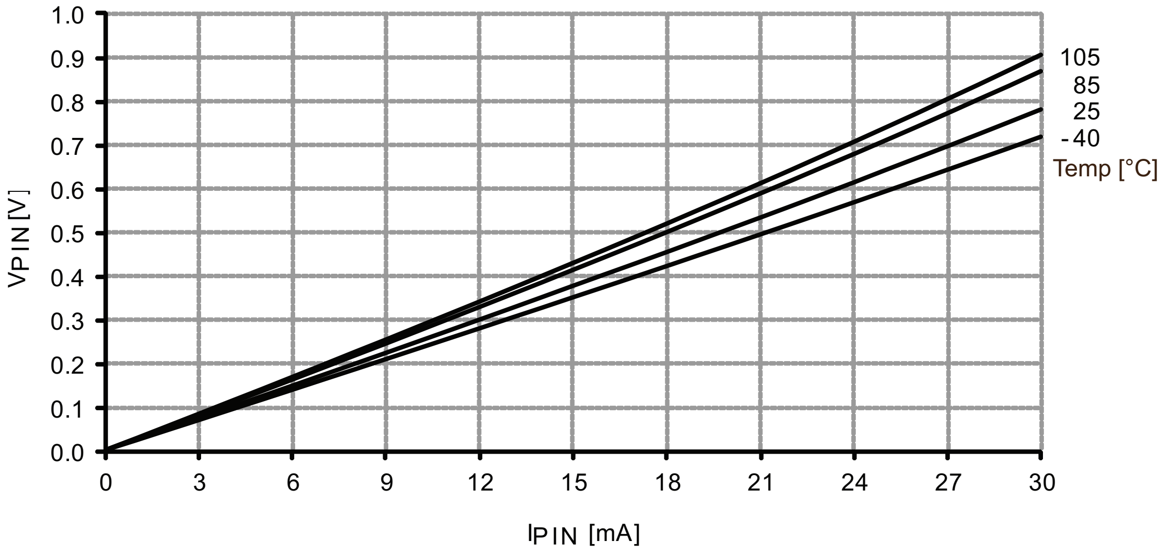


Figure 37-30. I/O pin output voltage vs. sink current.

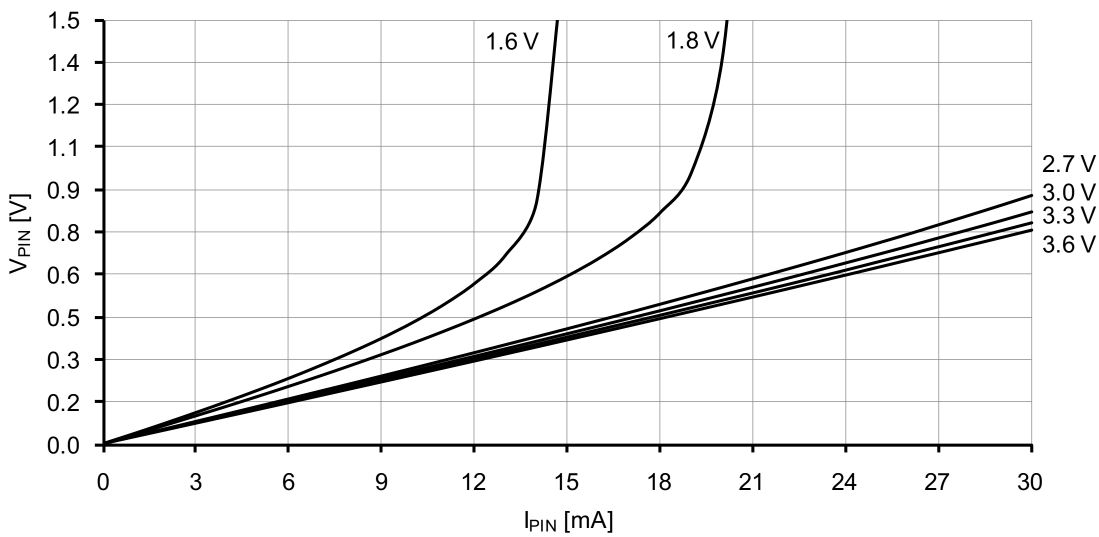


Figure 37-96. Idle mode supply current vs. V_{CC}.

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

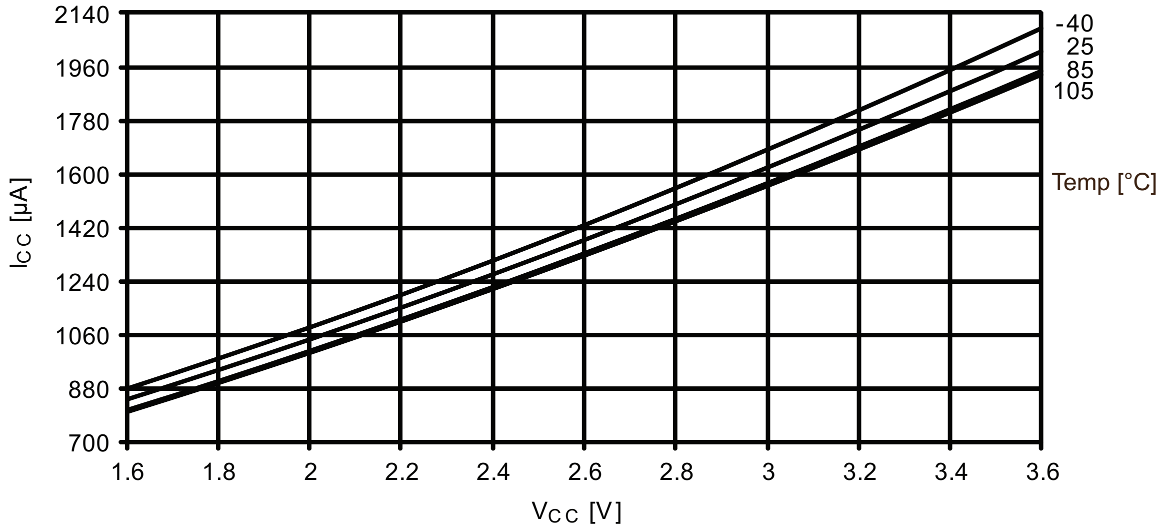


Figure 37-97. Idle mode current vs. V_{CC}.

f_{SYS} = 32MHz internal oscillator.

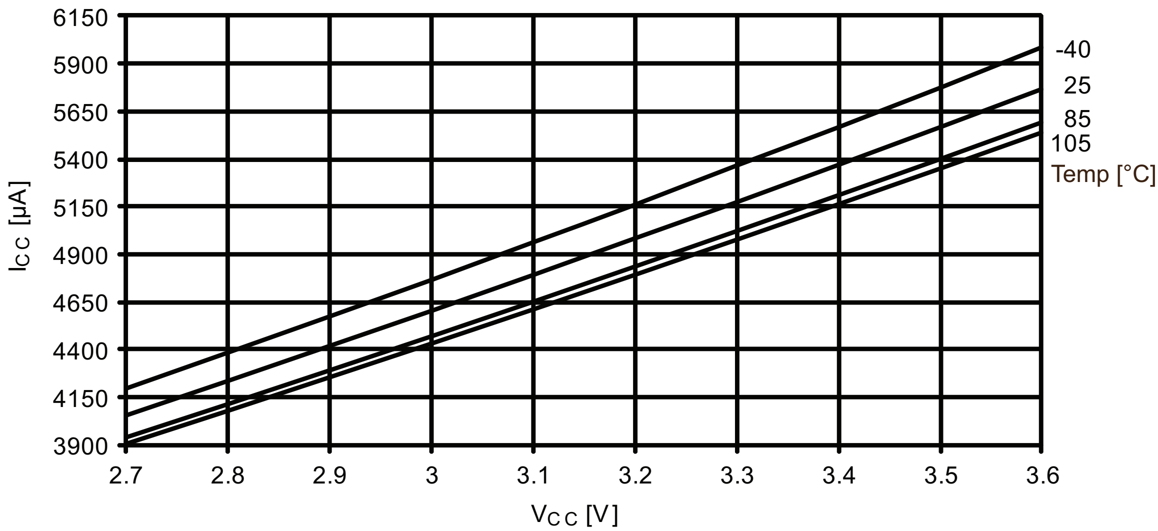
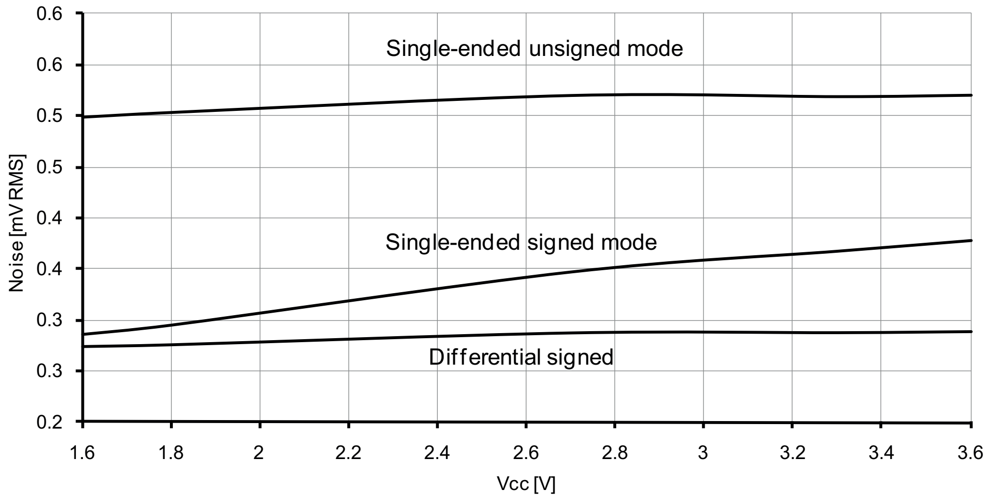


Figure 37-130. Noise vs. V_{CC}.

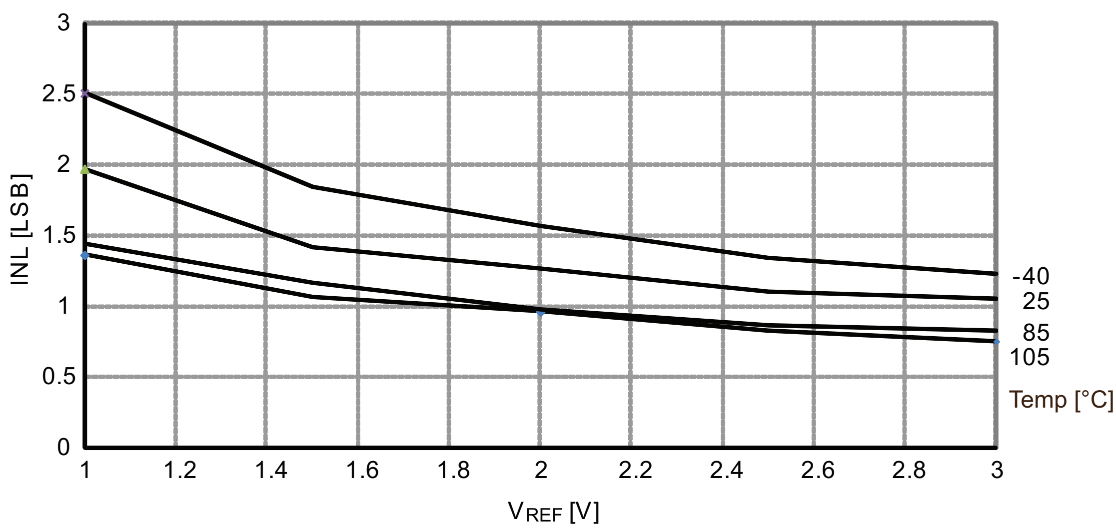
$T = 25°C$, V_{REF} = external 1.0V, ADC sampling speed = 500ksps.



37.2.4 DAC Characteristics

Figure 37-131. DAC INL error vs. V_{REF}.

V_{CC} = 3.6V.



37.2.7 BOD Characteristics

Figure 37-142. BOD thresholds vs. temperature.
BOD level = 1.6V.

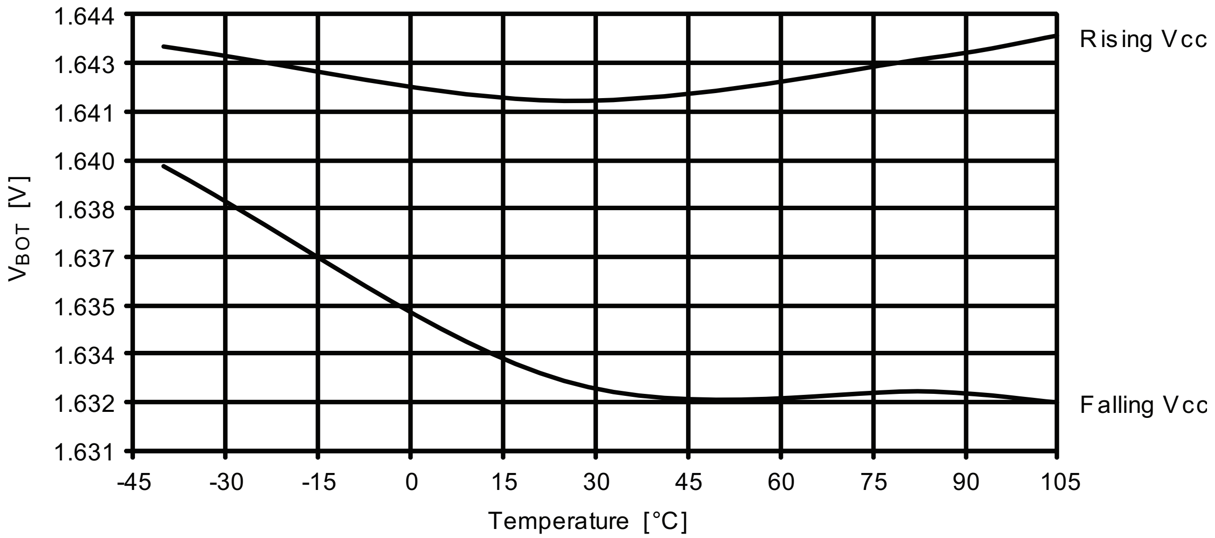


Figure 37-143. BOD thresholds vs. temperature.
BOD level = 3.0V.

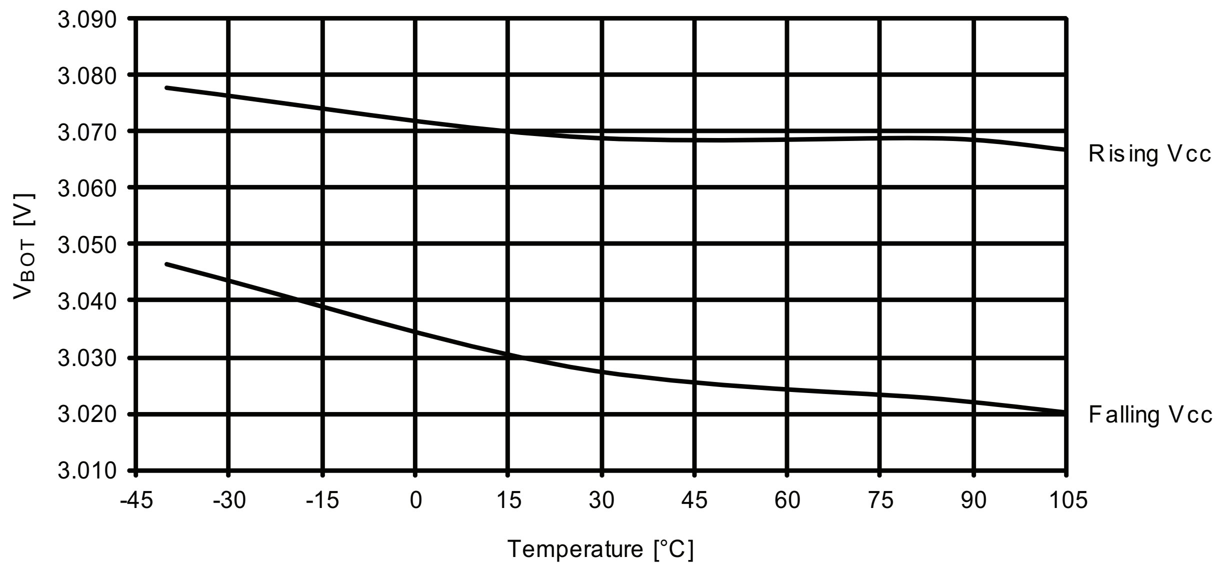
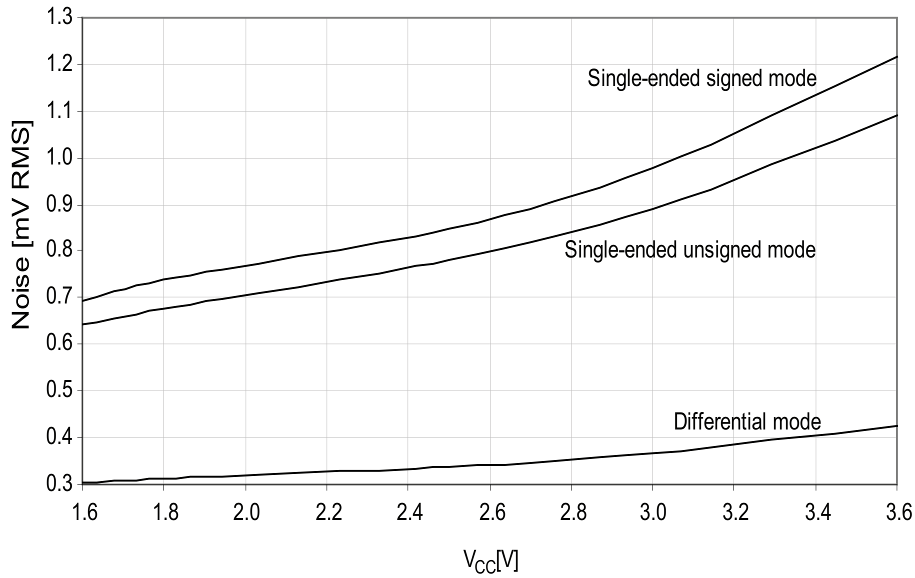


Figure 37-213. Noise vs. V_{CC}.

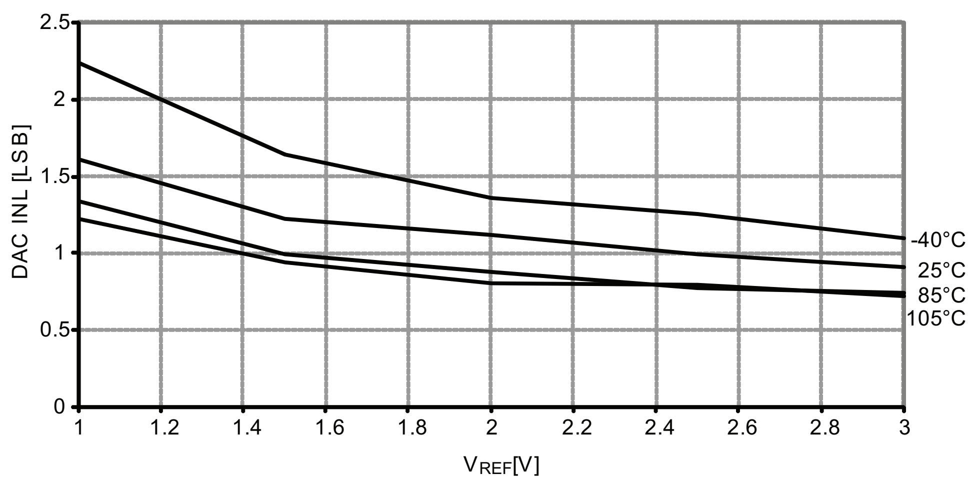
T = 25°C, V_{REF} = external 1.0V, ADC sampling speed = 500ksps.



37.3.4 DAC Characteristics

Figure 37-214. DAC INL error vs. V_{REF}.

V_{CC} = 3.6V.



37.3.7 BOD Characteristics

Figure 37-225. BOD thresholds vs. temperature.
BOD level = 1.6V.

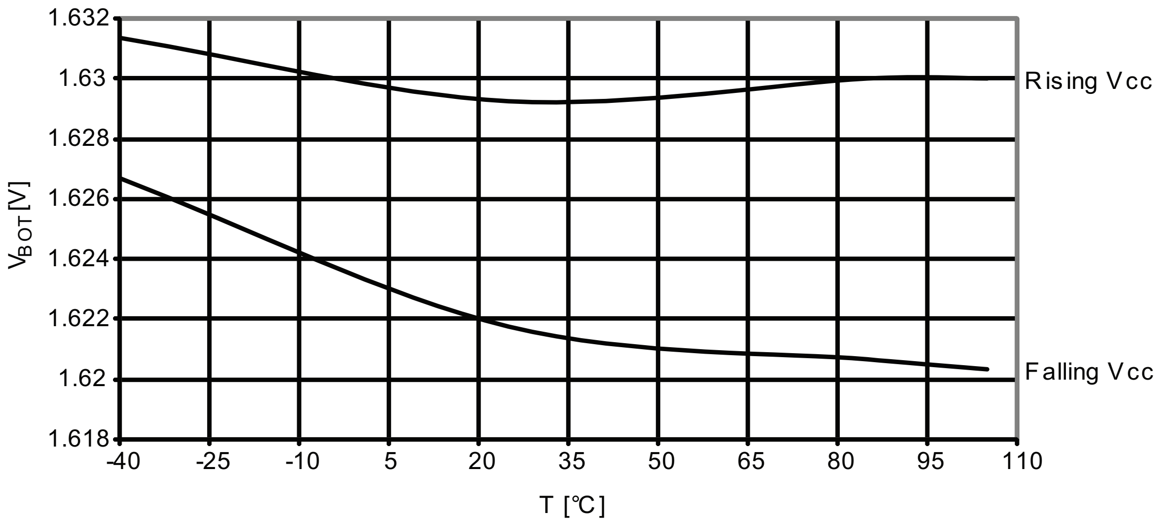
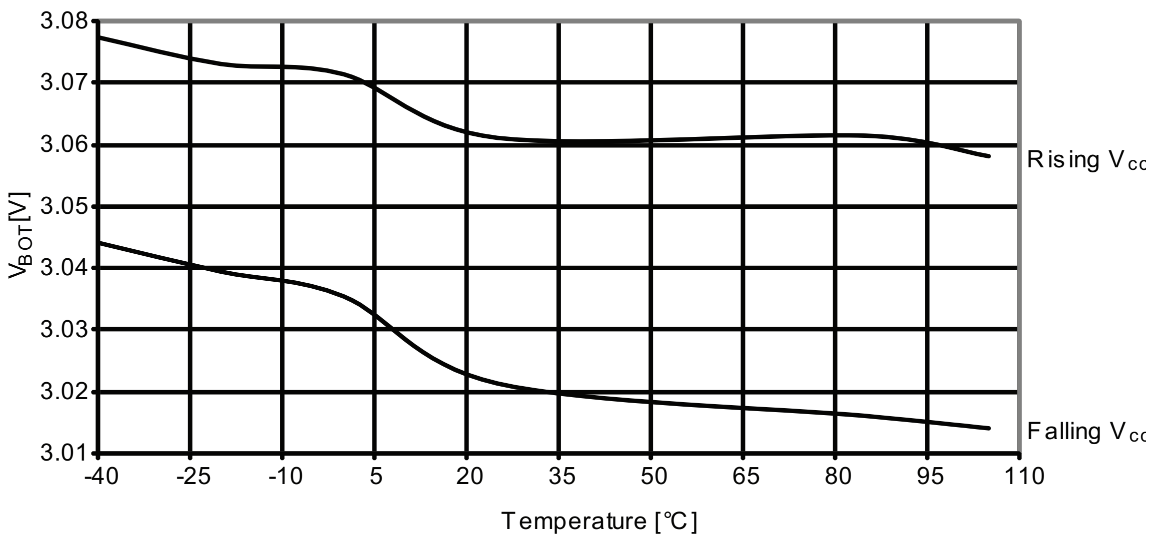


Figure 37-226. BOD thresholds vs. temperature.
BOD level = 3.0V.



37.3.8 External Reset Characteristics

Figure 37-227. Minimum Reset pin pulse width vs. V_{CC}.

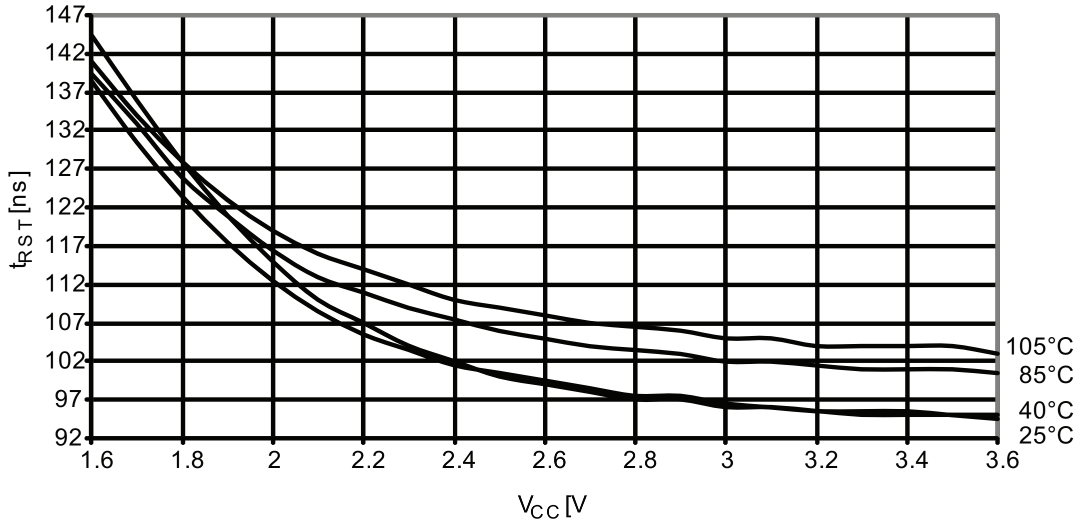


Figure 37-228. Reset pin pull-up resistor current vs. reset pin voltage.

V_{CC} = 1.8V.

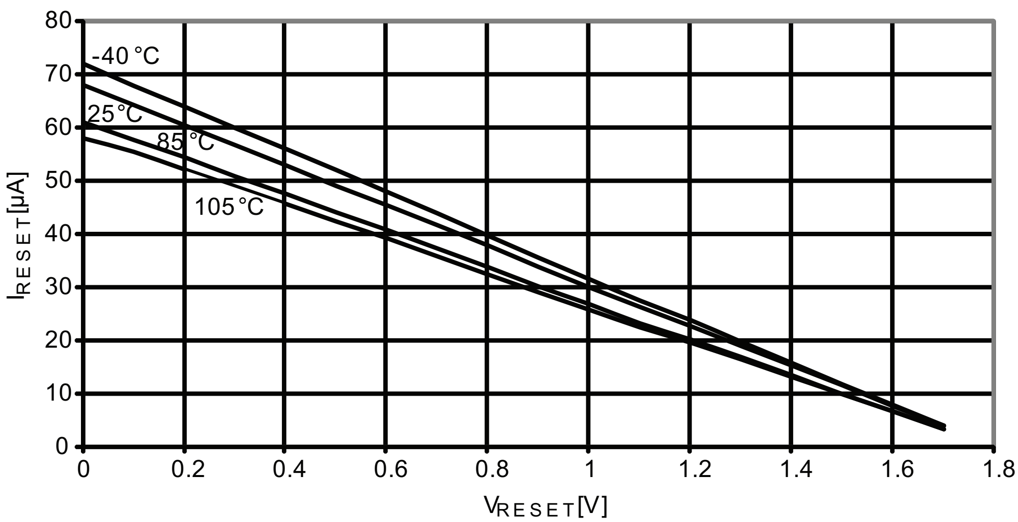


Figure 37-231. Reset pin input threshold voltage vs. V_{CC}

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

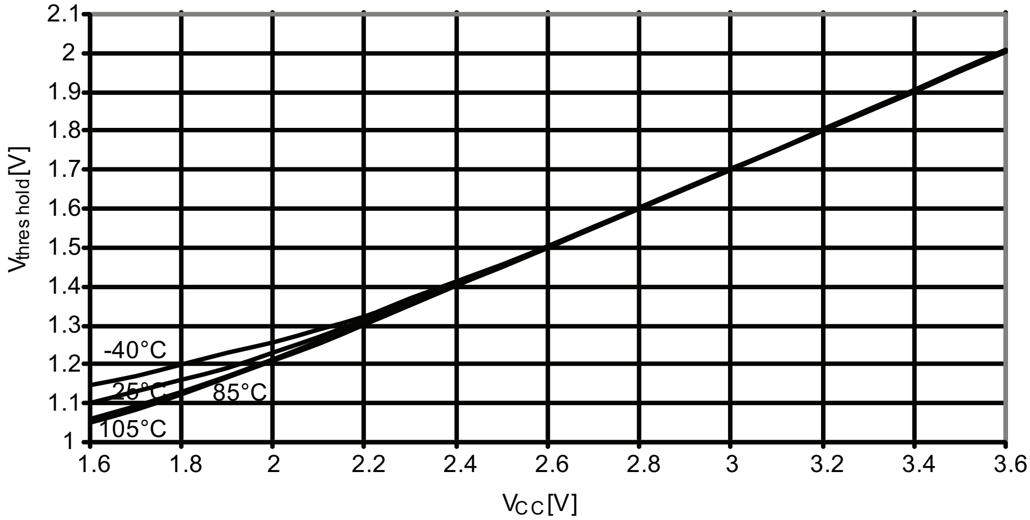


Figure 37-232. Reset pin input threshold voltage vs. V_{CC}.

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

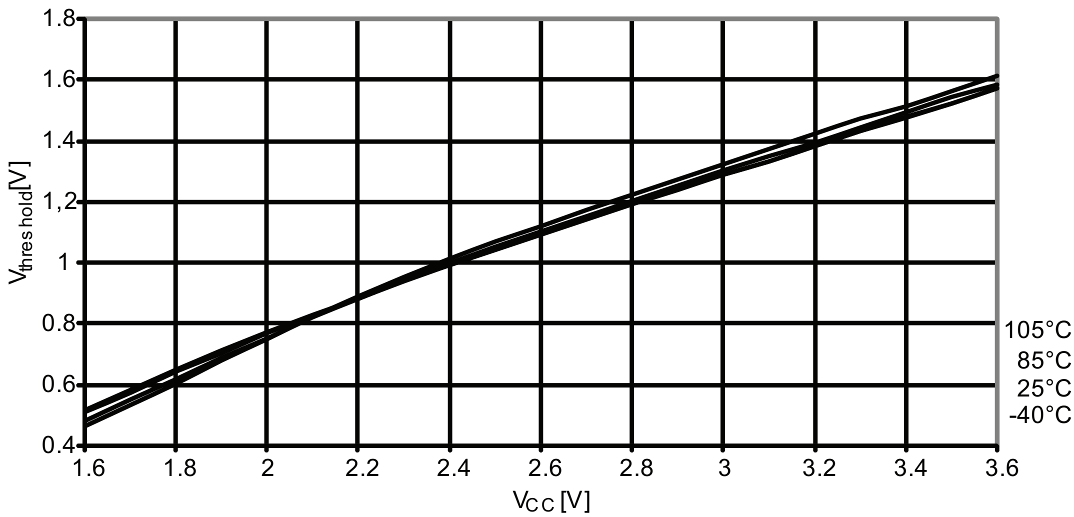


Figure 37-242. 32MHz internal oscillator CALA calibration step size.

V_{CC} = 3.0V.

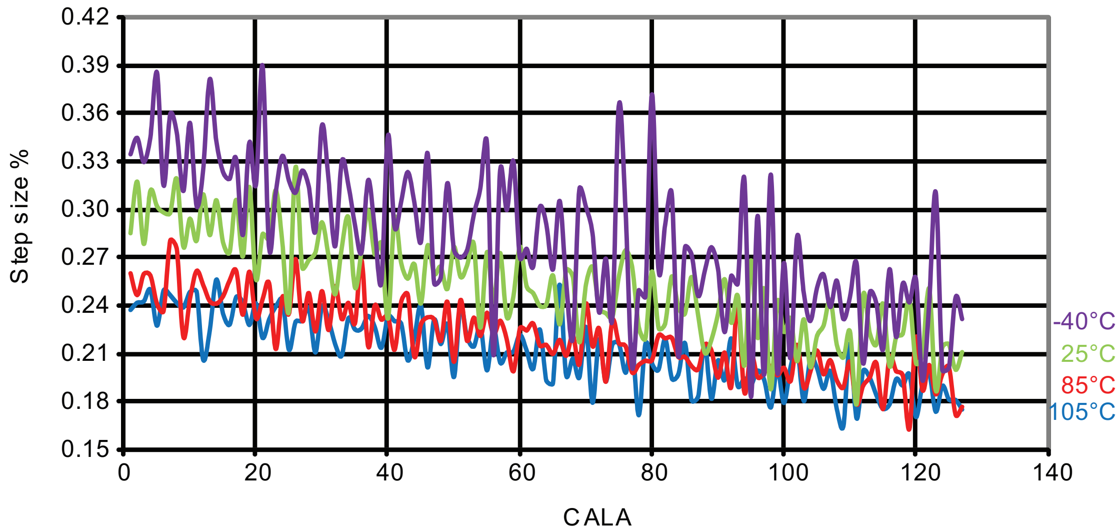


Figure 37-243. 32MHz internal oscillator frequency vs. CALB calibration value.

V_{CC} = 3.0V.

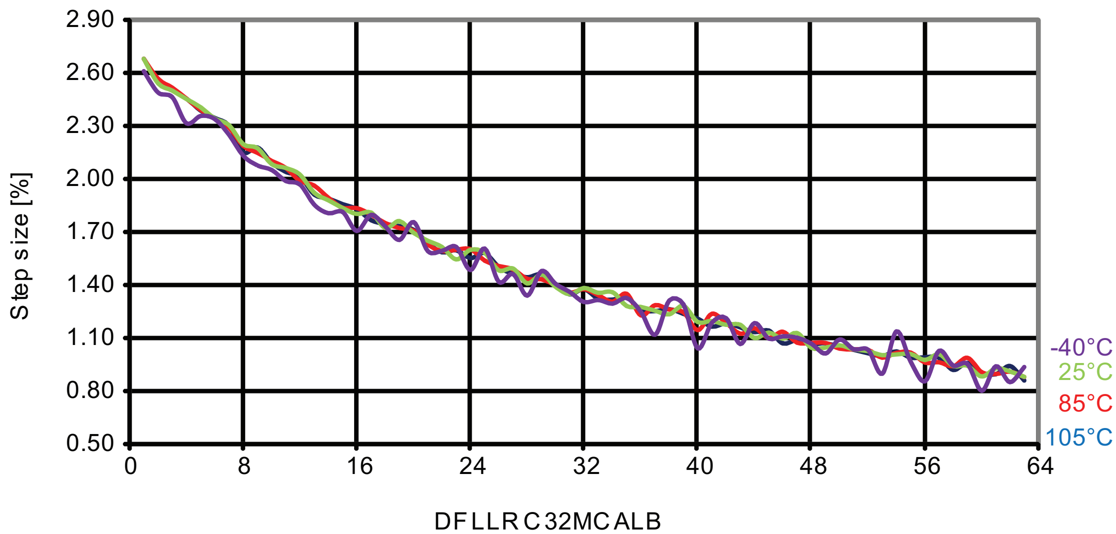


Figure 37-270. I/O pin pull-up resistor current vs. input voltage.

V_{CC} = 3.0V.

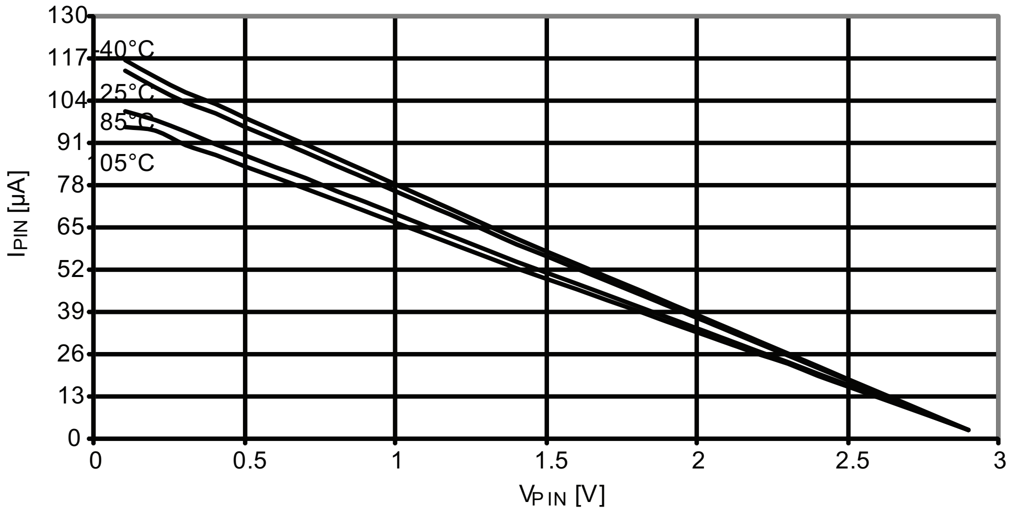


Figure 37-271. I/O pin pull-up resistor current vs. input voltage.

V_{CC} = 3.3V.

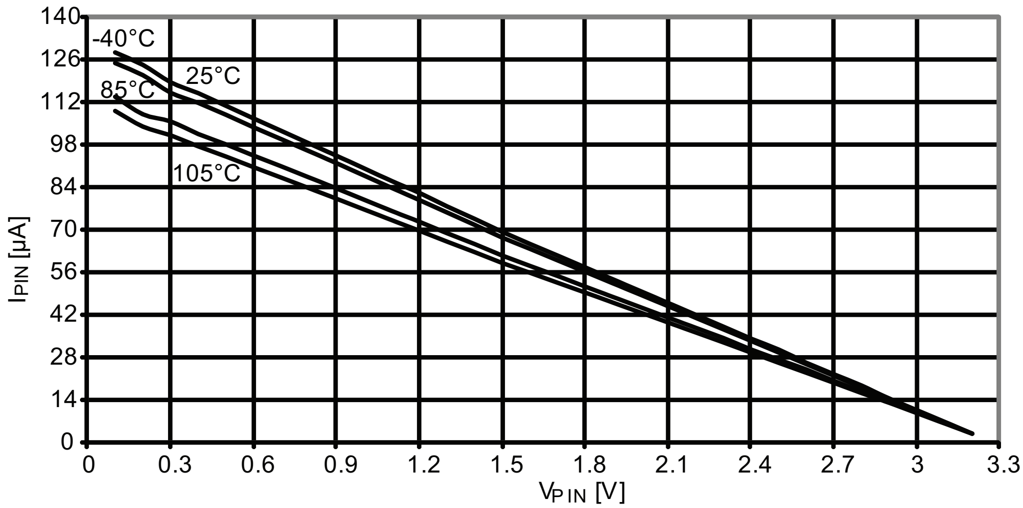


Figure 37-292. Offset error vs. V_{REF}.

$T = 25°C$, $V_{CC} = 3.6V$, ADC sampling speed = 500ksps.

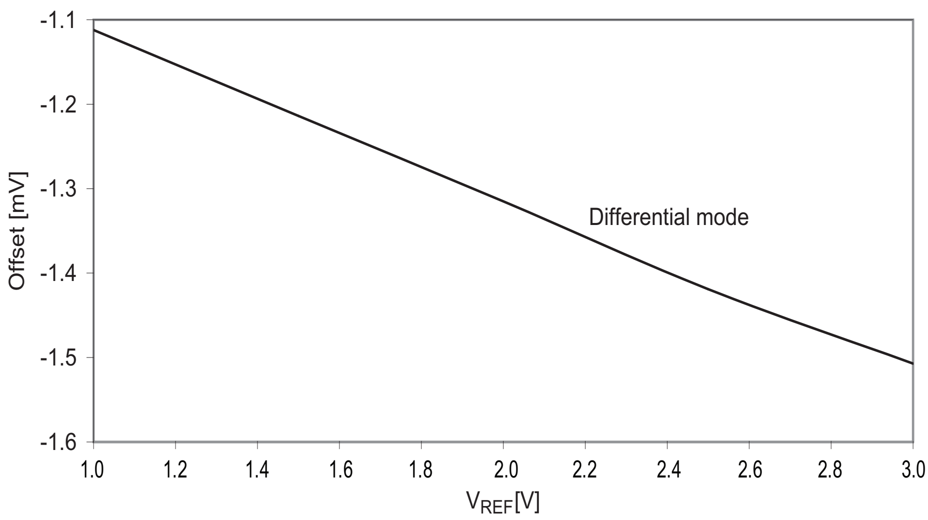
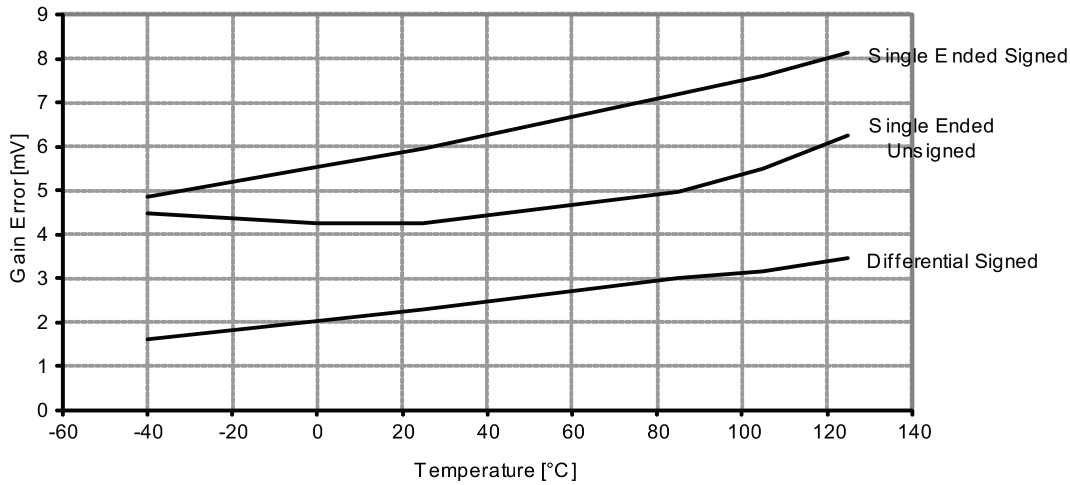


Figure 37-293. Gain error vs. temperature.

$V_{CC} = 3.0V$, V_{REF} = external 2.0V.



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