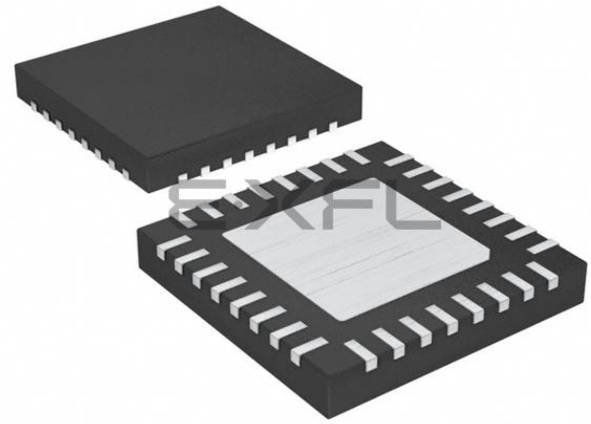


What is "Embedded - Microcontrollers"?

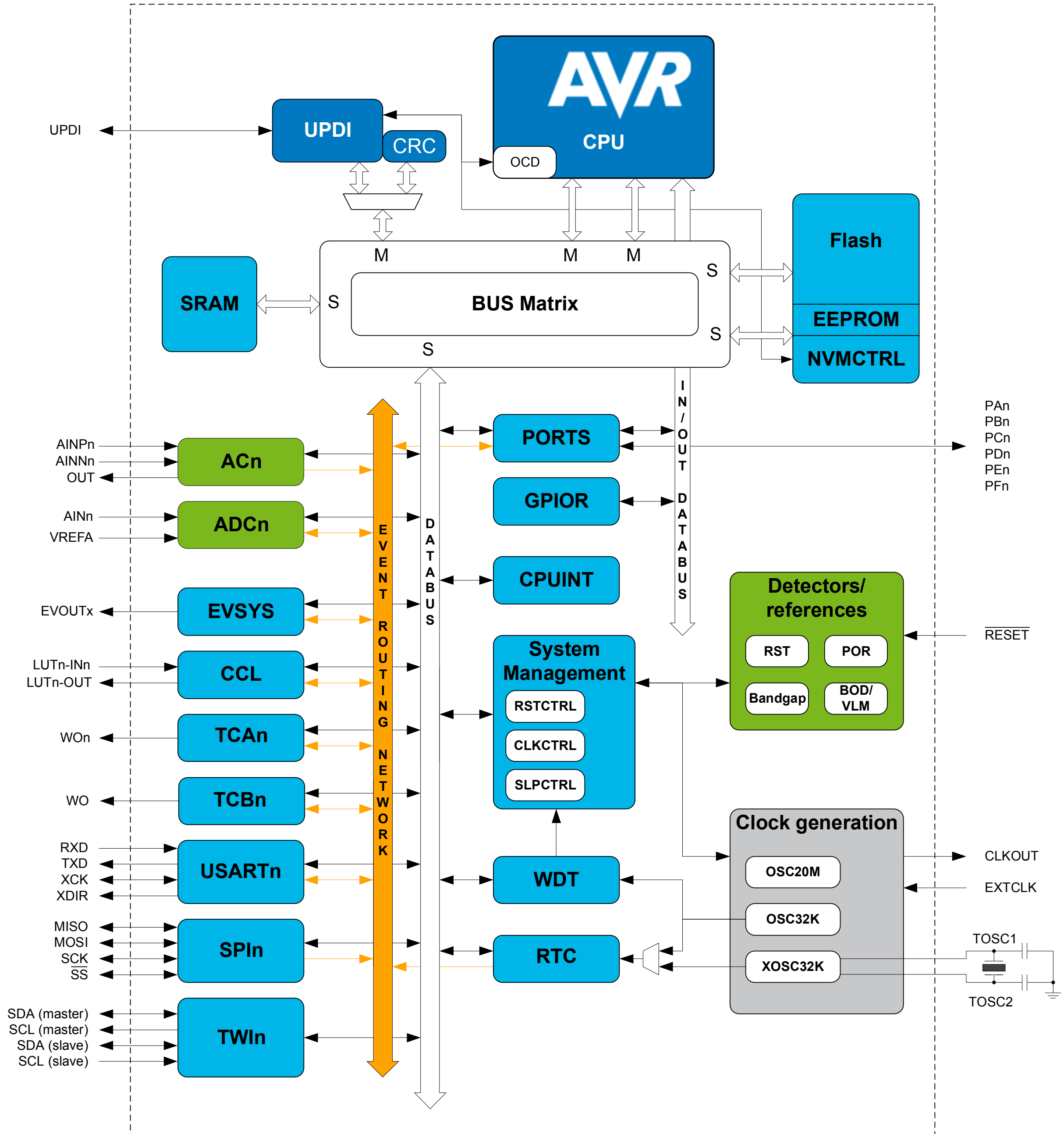
"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" 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-Bit
Speed	20MHz
Connectivity	I²C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, WDT
Number of I/O	23
Program Memory Size	48KB (24K x 16)
Program Memory Type	FLASH
EEPROM Size	256 x 8
RAM Size	6K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 12x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	32-VFQFN Exposed Pad
Supplier Device Package	32-VFQFN (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atmega4808-mfr

    - SleepWalking peripherals
  - Power Down with limited wake-up functionality
- Peripherals
  - One 16-bit Timer/Counter type A with dedicated period register, three compare channels (TCA)
  - Three 16-bit Timer/Counter type B with input capture (TCB)
  - One 16-bit Real Time Counter (RTC) running from external crystal or internal RC oscillator
  - Three USART with fractional baud rate generator, autobaud, and start-of-frame detection
  - Master/slave Serial Peripheral Interface (SPI)
  - Dual mode Master/Slave TWI with dual address match
    - Standard mode (Sm, 100 kHz)
    - Fast mode (Fm, 400 kHz)
    - Fast mode plus (Fm+, 1 MHz)
  - Event System for CPU independent and predictable inter-peripheral signaling
  - Configurable Custom Logic (CCL) with up to four programmable Lookup Tables (LUT)
  - One Analog Comparator (AC) with scalable reference input
  - One 10-bit 150 ksps Analog to Digital Converter (ADC)
  - Five selectable internal voltage references: 0.55V, 1.1V, 1.5V, 2.5V, and 4.3V
  - CRC code memory scan hardware
    - Optional automatic scan after reset
  - Watchdog Timer (WDT) with Window Mode, with separate on-chip oscillator
  - External interrupt on all general purpose pins
- I/O and Packages:
  - 27 programmable I/O lines
  - 32-pin VQFN 5x5 and TQFP 7x7
- Temperature Range: -40°C to 125°C
- Speed Grades:
  - 0-5 MHz @ 1.8V – 5.5V
  - 0-10 MHz @ 2.7V – 5.5V
  - 0-20 MHz @ 4.5V – 5.5V, -40°C to 105°C

2. Block Diagram



5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Stresses beyond those listed in this section 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.

Table 5-1. Absolute Maximum Ratings

Symbol	Description	Conditions	Min.	Max.	Unit
V_{DD}	Power Supply Voltage		-0.5	6	V
I_{VDD}	Current into a V_{DD} pin	T_A=[-40, 85]°C	-	200	mA
		T_A=[85, 125]°C	-	100	mA
I_{GND}	Current out of a GND pin	T_A=[-40, 85]°C	-	200	mA
		T_A=[85, 125]°C	-	100	mA
V_{PIN}	Pin voltage with respect to GND		-0.5	V_{DD}+0.5	V
I_{PIN}	I/O pin sink/source current		-40	40	mA
I_{c1}(1)	I/O pin injection current except for the RESET pin	V_{pin}<GND-0.6V or 5.5V<V_{pin}≤6.1V 4.9V<V_{DD}≤5.5V	-1	1	mA
I_{c2}(1)	I/O pin injection current except for the RESET pin	V_{pin}<GND-0.6V or V_{pin}≤5.5V V_{DD}≤4.9V	-15	15	mA
$T_{storage}$	Storage temperature		-65	150	°C

Note:

1. – If V_{PIN} is lower than GND-0.6V, then a current limiting resistor is required. The negative DC injection current limiting resistor is calculated as R = (GND-0.6V – V_{pin})/I_{Cn}.
   – If V_{PIN} is greater than V_{DD}+0.6V, then a current limiting resistor is required. The positive DC injection current limiting resistor is calculated as R = (V_{pin}-(V_{DD}+0.6))/I_{Cn}.

5.2 General Operating Ratings

The device must operate within the ratings listed in this section in order for all other electrical characteristics and typical characteristics of the device to be valid.

Table 5-2. General Operating Conditions

Symbol	Description	Condition	Min.	Max.	Unit
V_{DD}	Operating Supply Voltage		1.8(1)	5.5	V
T_A	Operating temperature range	Standard temperature range	-40	125	°C

Note:

1. Operation is guaranteed down to 1.8V or VBOD with BODLEVEL=1.8V, whichever is lower.

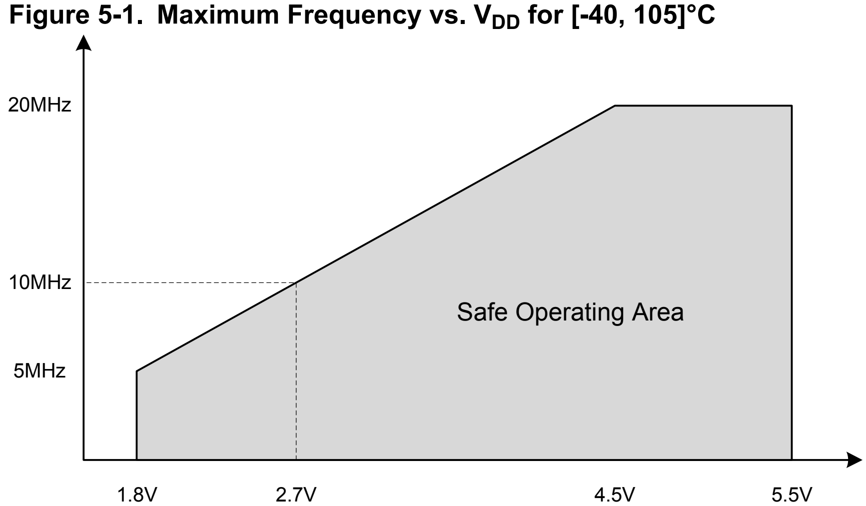
Table 5-3. Operating Voltage and Frequency

Symbol	Description	Condition	Min.	Max.[1]	Unit
f_{CLK_CPU}	Nominal operating system clock frequency	V_{DD}=[1.8, 5.5]V T_A=[-40, 105]°C[2]	0	5	MHz
		V_{DD}=[2.7, 5.5]V T_A=[-40, 105]°C[3]	0	10	
		V_{DD}=[4.5, 5.5]V T_A=[-40, 105]°C[4]	0	20	
		V_{DD}=[2.7, 5.5]V T_A=[-40, 125]°C[3]	0	8	
		V_{DD}=[4.5, 5.5]V T_A=[-40, 125]°C[3]	0	16	

Note:
1. Operation is guaranteed 5% above the maximum frequency.
2. Operation is guaranteed down to BOD triggering level, V_{BOD} with BODLEVEL=1.8V.
3. Operation is guaranteed down to BOD triggering level, V_{BOD} with BODLEVEL=2.7V.
4. Operation is guaranteed down to BOD triggering level, V_{BOD} with BODLEVEL=4.3V.

The maximum CPU clock frequency depends on V_{DD}. As shown in the following figure, the Maximum Frequency vs. V_{DD} is linear between 1.8V < V_{DD} < 2.7V and 2.7V < V_{DD} < 4.5V

Figure 5-1. Maximum Frequency vs. V_{DD} for [-40, 105]°C



5.3 Power Considerations

The average die junction temperature, T_J (in °C) is given from the formula

$T_J = T_A + P_D * R_{\theta JA}$

where P_D is the total power dissipation.

The total thermal resistance of a package ($R_{\theta JA}$) can be separated into two components, $R_{\theta JC}$ and $R_{\theta CA}$, representing the barrier to heat flow from the semiconductor junction to the package (case) surface ($R_{\theta JC}$) and from the case to the outside ambient air ($R_{\theta CA}$). These terms are related by the equation:

$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$.

$R_{\theta JC}$ is device related and cannot be influenced by the user. However, $R_{\theta CA}$ is user dependent and can be minimized by thermal management techniques such as heat sinks, ambient air cooling, and thermal convection. Thus, good thermal management on the part of the user can significantly reduce $R_{\theta CA}$ so that $R_{\theta JA}$ approximately equals $R_{\theta JC}$.

The power dissipation curve is negatively sloped as ambient temperature increase. The maximum power dissipation is therefore at minimum ambient temperature while the highest junction temperature occurs at the maximum ambient temperature.

Table 5-4. Power Dissipation and Junction Temperature vs Temperature

Package	T_A Range	$R_{\theta JA}$ (°C/W)	P_D (W) typical	T_J - T_A(°C) typical
VQFN32	-40°C to 125°C		1.0	
TQFP32	-40°C to 125°C		1.0	

5.4 Power Consumption

The values are measured power consumption under the following conditions, except where noted:

- V_{DD}=3V
- T_A=25°C
- OSC20M used as system clock source, except where otherwise specified
- System power consumption measured with peripherals disabled and without I/O drive.

Table 5-5. Power Consumption in Active and Idle Mode

Mode	Description	Condition		Typ.	Max.	Unit
Active	Active power consumption	f_{CLK_CPU}=20 MHz (OSC20M)	V_{DD}=5V	8.5	-	mA
		f_{CLK_CPU}=10 MHz (OSC20M div2)	V_{DD}=5V	4.3	-	mA
			V_{DD}=3V	2.3	-	mA
		f_{CLK_CPU}=5 MHz (OSC20M div4)	V_{DD}=5V	2.15	-	mA
			V_{DD}=3V	1.2	-	mA
			V_{DD}=2V	0.75	-	mA
		f_{CLK_CPU}=32 KHz (OSCULP32K)	V_{DD}=5V	16.4	-	μA
			V_{DD}=3V	9.0	-	μA
			V_{DD}=2V	6.0	-	μA
Idle	Idle power consumption	f_{CLK_CPU}=20 MHz (OSC20M)	V_{DD}=5V	2.8	-	mA
		f_{CLK_CPU}=10 MHz (OSC20M div2)	V_{DD}=5V	1.4	-	mA

Symbol	Description	Condition		Min.	Typ.	Max.	Unit
	Factory calibration accuracy		T_A=25°C, 3.0V	TBD	±0.75	TBD	%
E_{TOTAL}	Total error with 16 MHz frequency selection	From target frequency	T_A=[0, 70]°C, V_{DD}=[1.8, 3.6]V	TBD	±2	TBD	%
			Full operation range	TBD	±3	TBD	
	Total error with 20 MHz frequency selection	From target frequency	T_A=[0, 70]°C, V_{DD}=[1.8, 3.6]V	TBD	±2	TBD	
			Full operation range	TBD	±3	TBD	
E_{DRIFT}	Accuracy with 16 MHz Frequency Selection relative to the factory-stored frequency value	Factory calibrated V_{DD}=3V(1)	T_A=[0, 70]°C, V_{DD}=[1.8, 5.5]V	TBD	±1.5	TBD	%
	Accuracy with 20 MHz Frequency Selection relative to the factory-stored frequency value	Factory calibrated V_{DD}=3V(1)	T_A=[0, 70]°C, V_{DD}=[1.8, 5.5]V	TBD	±1.5	TBD	
Δf_{OSC20M}	Calibration step size			-	0.75	-	%
D_{OSC20M}	Duty cycle			-	50	-	%
$t_{startup}$	Start-up time	Within 2% accuracy		-	12	-	µs

Note:

1. See also the description of OSC20M on calibration.
2. Oscillator Frequencies above speed specification must be divided so that CPU clock always is within specification.

Table 5-13. 32.768 kHz Internal Oscillator (OSCULP32K) Characteristics

Symbol	Description	Condition	Condition	Min.	Typ.	Max.	Unit
$f_{OSCULP32K}$	Factory calibration frequency				32.768		kHz
	Factory calibration accuracy		T_A=25°C, 3.0V	-3	±2	3	%
E_{TOTAL}	Total error from target frequency	Factory calibrated	T_A=[0, 70]°C, V_{DD}=[1.8, 3.6]V	-10	±5	+10	%
			Full operation range	-30	±10	+30	
$D_{OSCULP32K}$	Duty cycle				50		%
$t_{startup}$	Start-up time			-	250	-	µs

Note:

1. Pin group A (PA[7:0]), PF[6:2]), pin group B (PB[7:0], PC[7:0]), pin group C (PD:7:0, PE[3:0], PF[1:0]). For 28-pin and 32-pin devices pin group A and B should be seen as a single group. The combined continuous sink/source current for each individual group should not exceed the limits.

5.10 VREF

Table 5-17. Internal Voltage Reference Characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
t_{start}	Start-up time	-	25	-	µs
$V_{DDINT055V}$	Power supply voltage range for INT055V	1.8	-	5.5	V
$V_{DDINT11V}$	Power supply voltage range for INT11V	1.8	-	5.5	
$V_{DDINT15V}$	Power supply voltage range for INT15V	1.8	-	5.5	
$V_{DDINT25V}$	Power supply voltage range for INT25V	3.0	-	5.5	
$V_{DDINT43V}$	Power supply voltage range for INT43V	4.8	-	5.5	

Table 5-18. ADC Internal Voltage Reference Characteristics(1)

Symbol(2)	Description	Condition	Min.	Typ.	Max.	Unit
INT11V	Internal reference voltage	V_{DD}=[1.8V, 3.6V] T=[0 - 105]°C	-2.0		2.0	%
INT055V INT15V INT25V	Internal reference voltage	V_{DD}=[1.8V, 3.6V] T=[0 - 105]°C	-3.0		3.0	
INT055V INT11V INT15V INT25V INT43V	Internal reference voltage	V_{DD}=[1.8V, 5.5V] T=[-40 - 125]°C	-5.0		5.0	

Note:

1. These values are based on characterization and not covered by production test limits.
2. The symbols INTxxV refer to the respective values of the ADC0REFSEL bit field in the VREF.CTRLA register.

Table 5-19. AC Internal Voltage Reference Characteristics(1)

Symbol(2)	Description	Condition	Min.	Typ.	Max.	Unit
INT055V INT11V	Internal reference voltage	V_{DD}=[1.8V, 3.6V] T=[0 - 105]°C	-3.0		3.0	%

Symbol	Description	Conditions		Min.	Typ.	Max.	Unit
		REFSEL = INTERNAL $1.1V \leq V_{REF}$	f_{ADC}=115 ksps	-	0.5	-	
		REFSEL = VDD $1.8V \leq V_{REF}$	f_{ADC}=115 ksps	-	0.9	-	
EABS	Absolute accuracy	REFSEL = INTERNAL V_{REF} = 1.1V	T=[0-105]°C V_{DD} = [1.8V-3.6V]	-	<10	-	LSB
			V_{DD} = [1.8V-3.6V]	-	<15	-	
		REFSEL = V_{DD}		-	2	-	
		REFSEL = INTERNAL		-	<35	-	
EGAIN	Gain error	REFSEL = INTERNAL V_{REF} = 1.1V	T=[0-105]°C V_{DD} = [1.8V-3.6V]	-	±15	-	LSB
			V_{DD} = [1.8V-3.6V]	-	±20	-	
		REFSEL = V_{DD}		-	2	-	
		REFSEL = INTERNAL		-	±35	-	
EOFF	Offset error	REFSEL = INTERNAL V_{REF} = 0.55V		-	-0.5	-	LSB
		REFSEL = INTERNAL $1.1V \leq V_{REF}$		-	-0.5	-	LSB

Note:

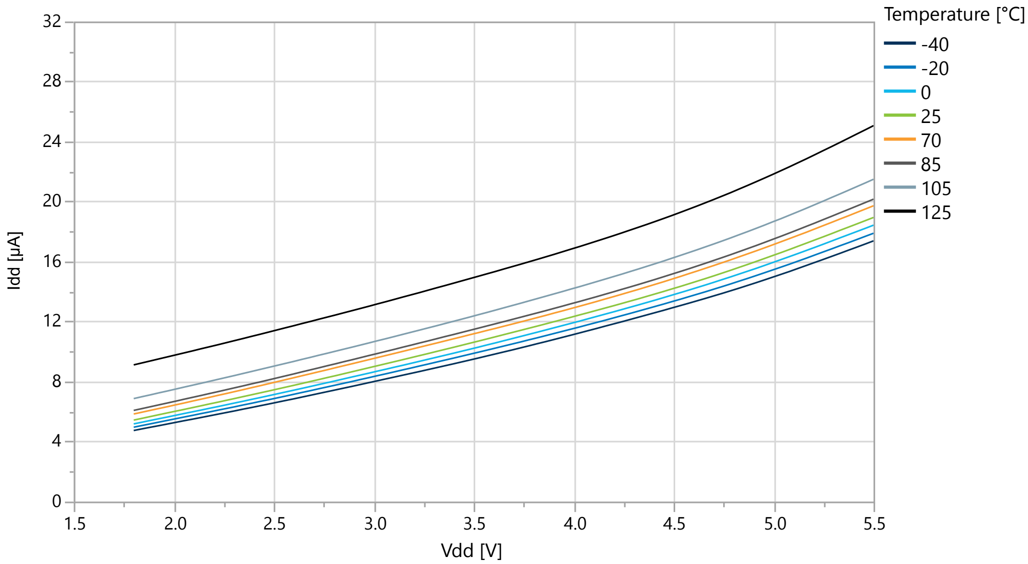
1. A DNL error of less than or equal to 1 LSB ensures a monotonic transfer function with no missing codes.
2. These values are based on characterization and not covered by production test limits.
3. Reference setting and f_{ADC} must fulfill the specification in "Clock and Timing Characteristics" and "Power supply, Reference, and Input Range" tables.

5.11.2 External Reference Characteristics

Operating conditions:

- V_{DD} = 1.8 to 5.5V
- Temperature = -40°C to 125°C
- DUTYCYC = 25%
- CLK_{ADC} = 13 * f_{ADC}
- SAMPCAP is 5 pF

Figure 6-5. Active Supply Current vs. V_{DD} (f=32 KHz OSCULP32K)



6.1.2 Supply Currents in Idle Mode

Figure 6-6. Idle Supply Current vs. Frequency (1-20 MHz) at T=25°C

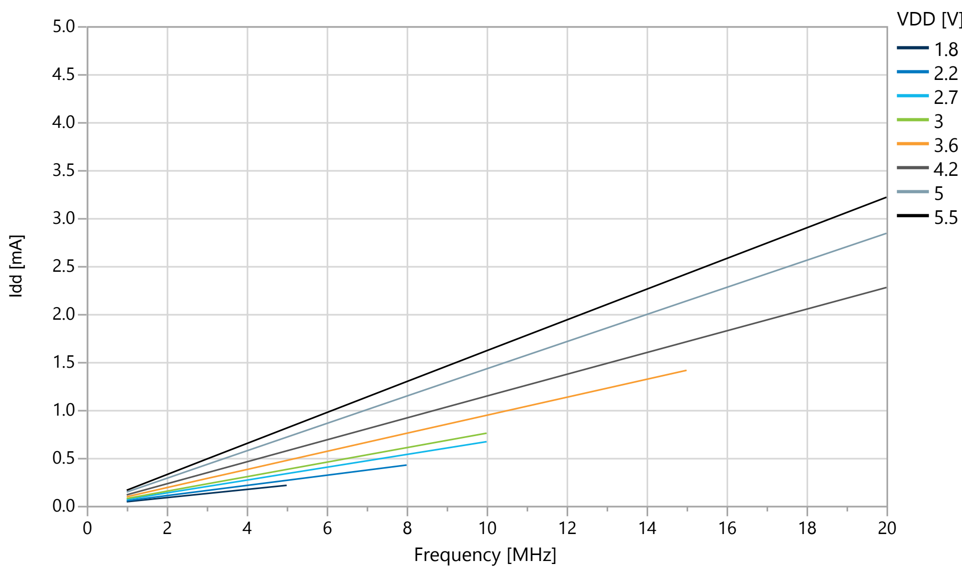
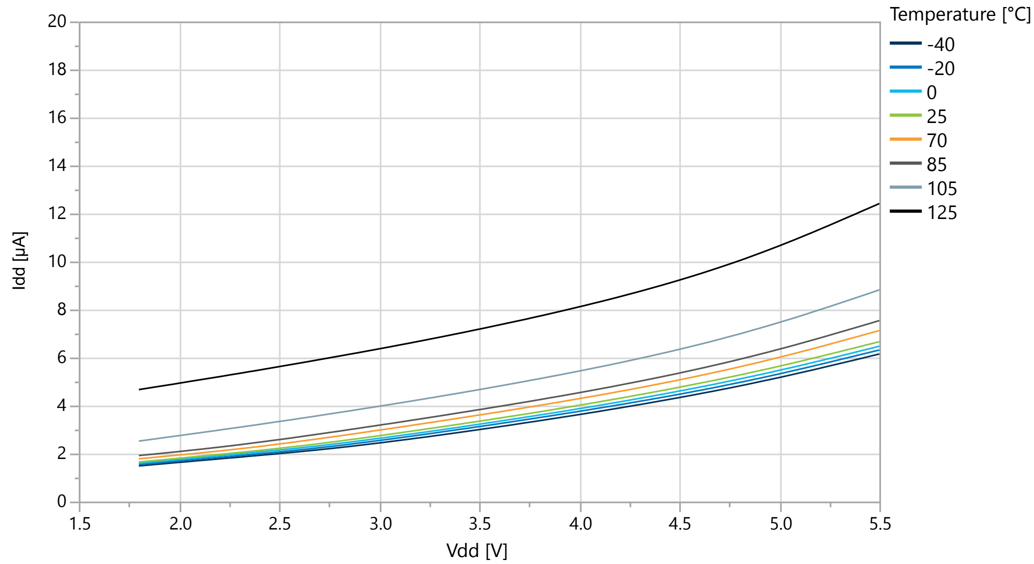


Figure 6-9. Idle Supply Current vs. V_{DD} (f=32 KHz OSCULP32K)



6.1.3 Supply Currents in Power-Down Mode

Figure 6-10. Power-Down Mode Supply Current vs. Temperature (all functions disabled)

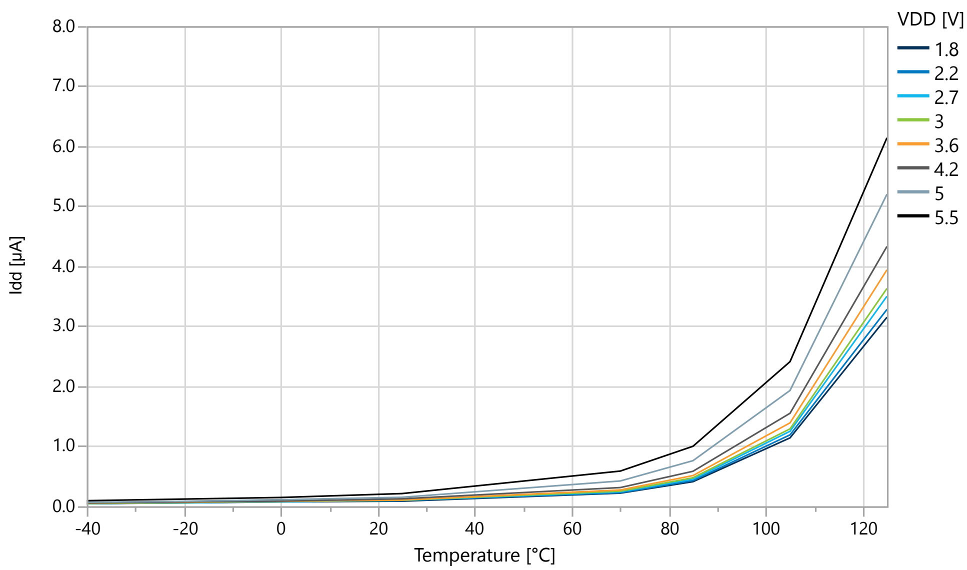
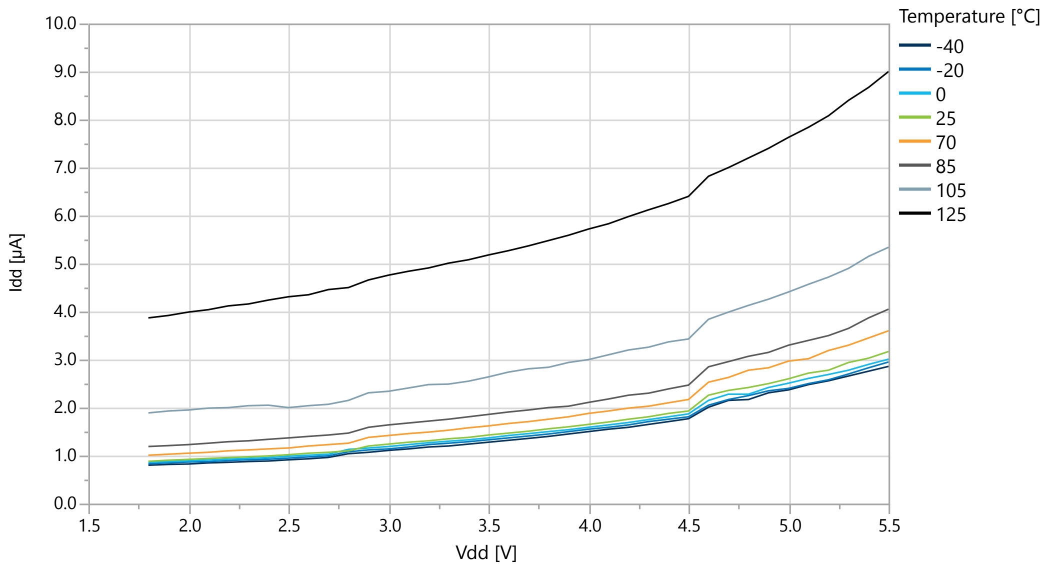
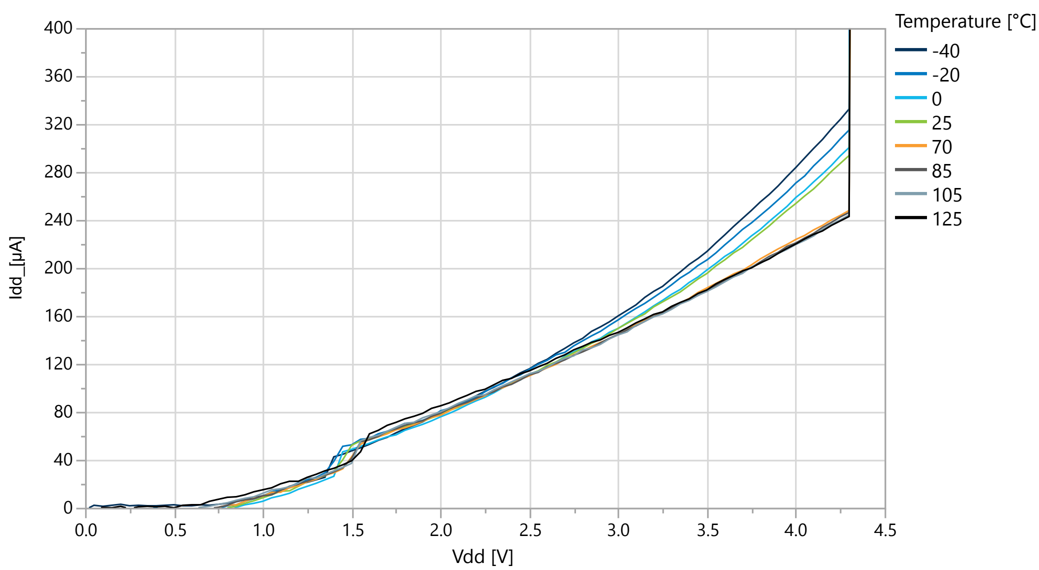


Figure 6-15. Standby Mode Supply Current vs. V_{DD} (Sampled BOD running at 1 kHz)



6.1.5 Power on Supply Currents

Figure 6-16. Power-on Supply Current vs. V_{DD} (BOD enabled at 4.3V level)



6.2 GPIO

GPIO Input Characteristics

Figure 6-17. I/O Pin Input Hysteresis vs. V_{DD}

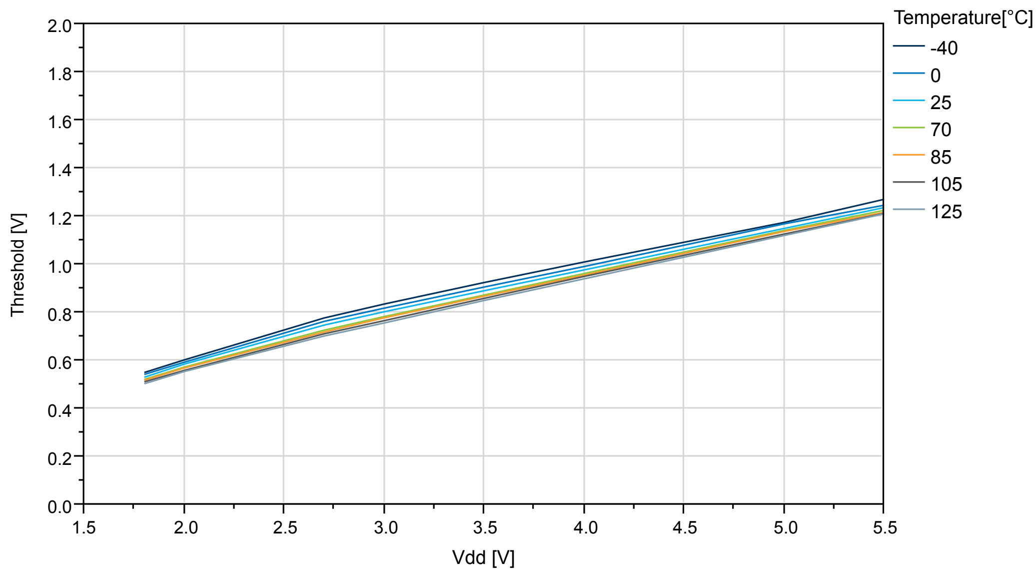


Figure 6-18. I/O Pin Input Threshold Voltage vs. V_{DD} (T=25°C)

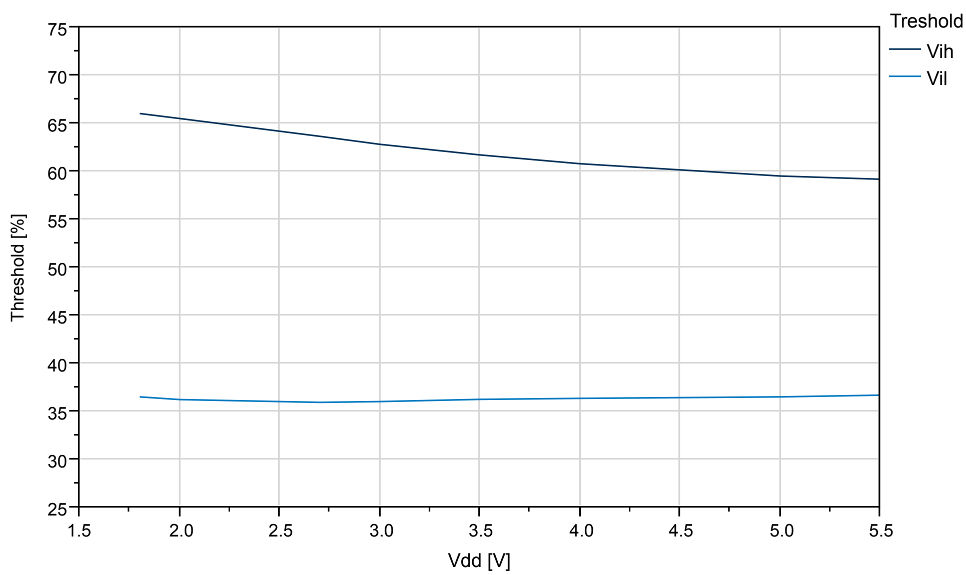


Figure 6-19. I/O Pin Input Threshold Voltage vs. V_{DD} (V_{IH})

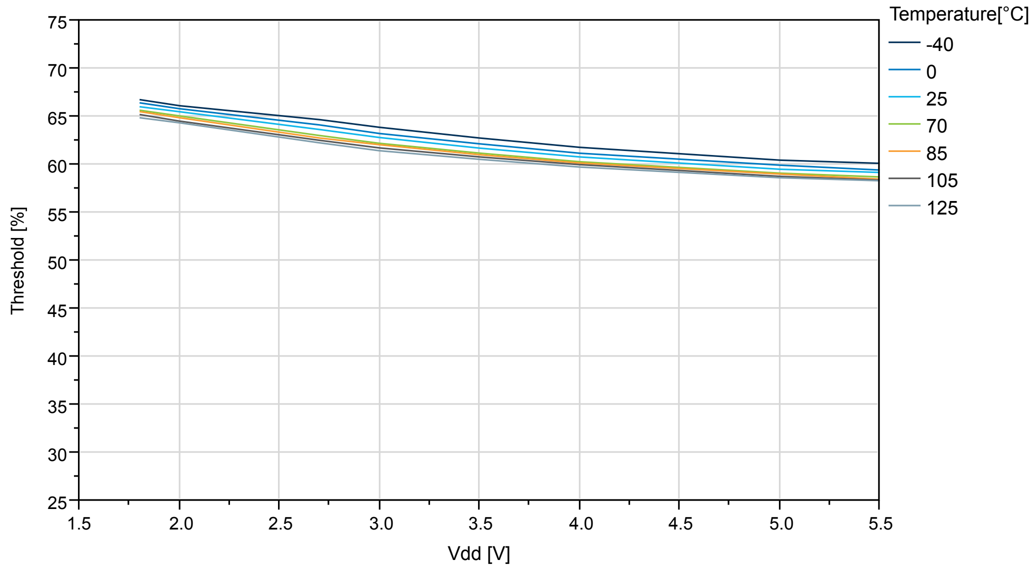


Figure 6-20. I/O Pin Input Threshold Voltage vs. V_{DD} (V_{IL})

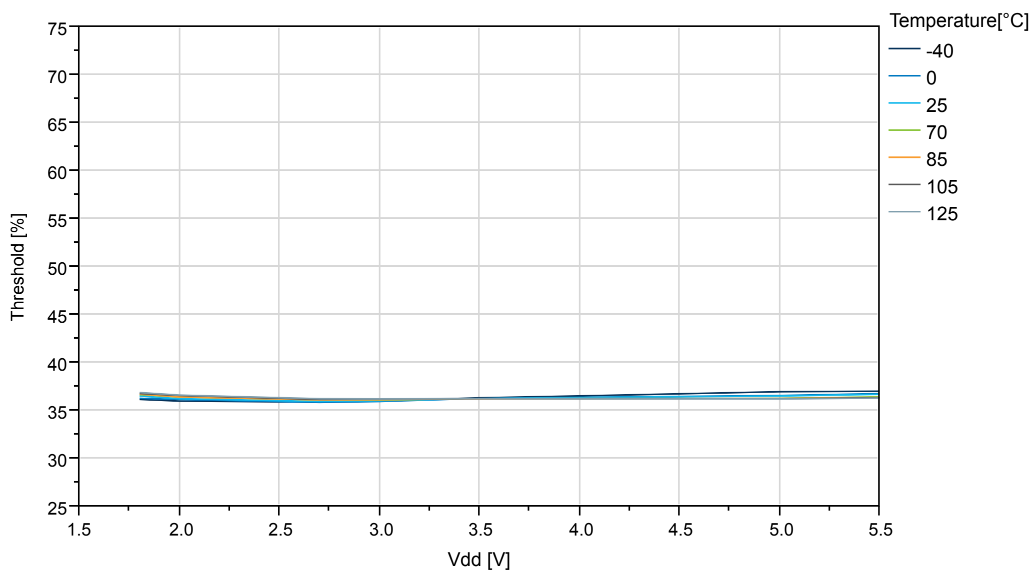
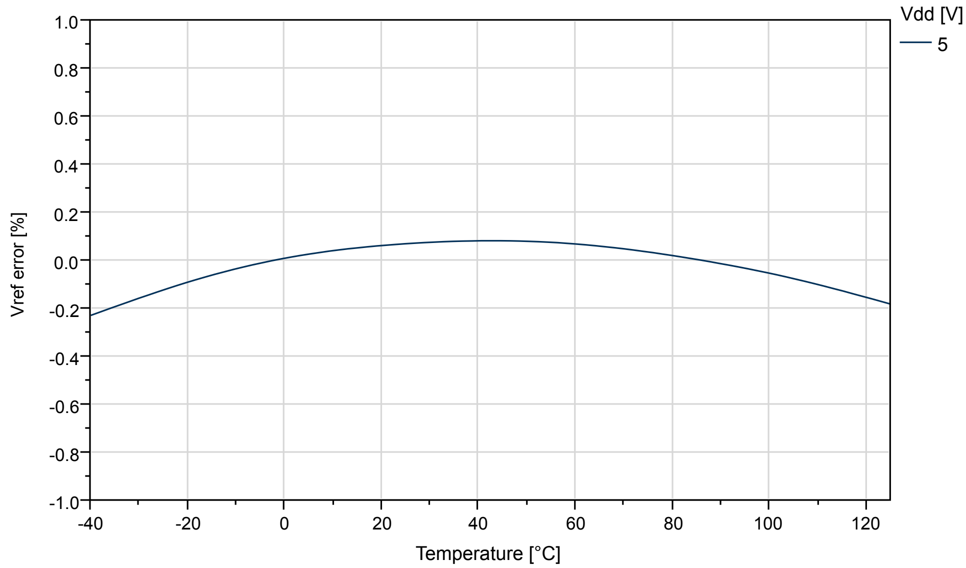


Figure 6-35. Internal 4.3V Reference vs. Temperature



6.4 BOD Characteristics

BOD Current vs. V_{DD}

Figure 6-36. BOD Current vs. V_{DD} (Continuous Mode Enabled)

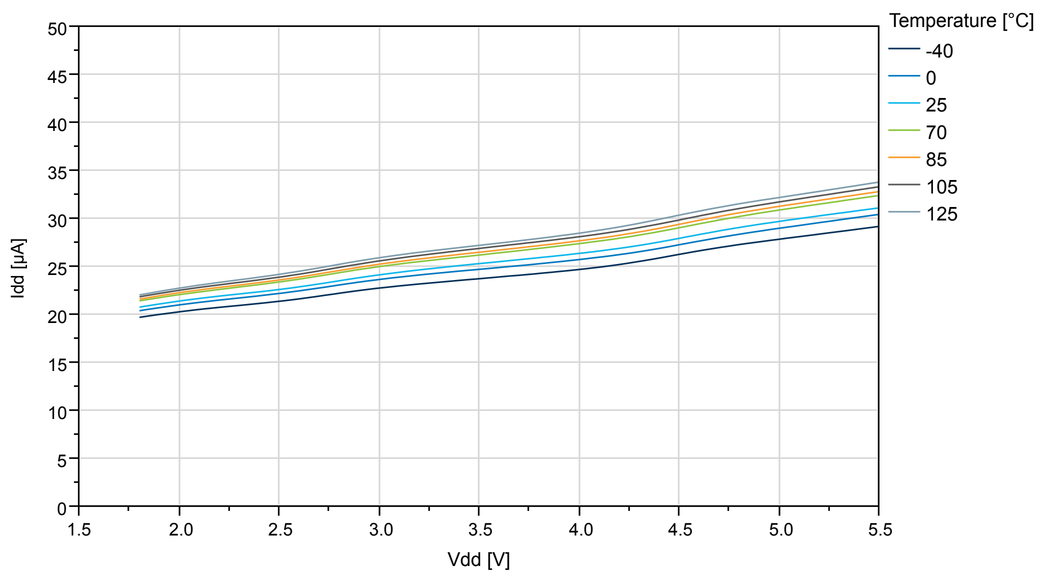
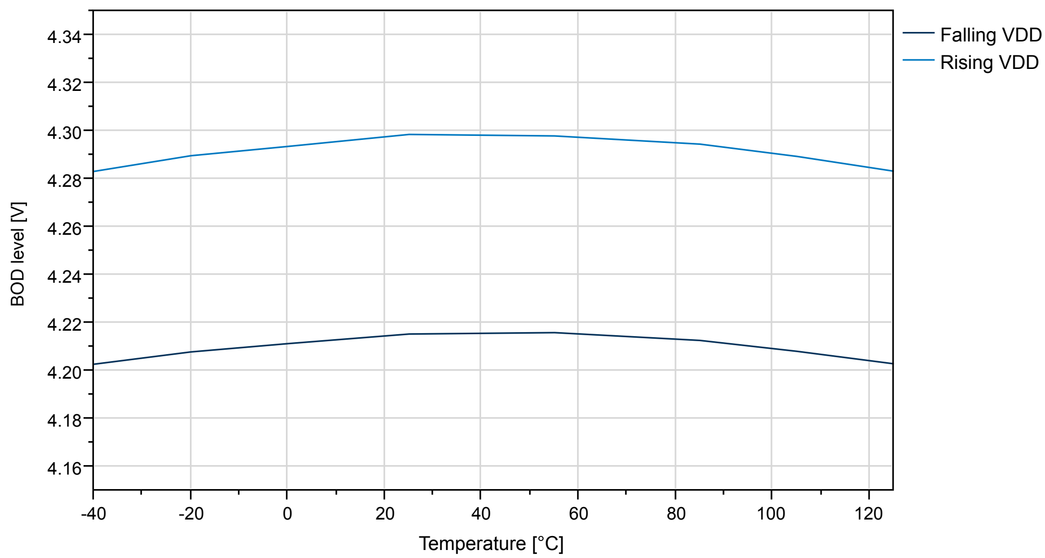


Figure 6-41. BOD Threshold vs. Temperature (Level 4.3V)



6.5 ADC Characteristics

Figure 6-42. Absolute Accuracy vs. V_{DD} (f_{ADC}=115 ksps) at T=25°C, REFSEL = Internal Reference

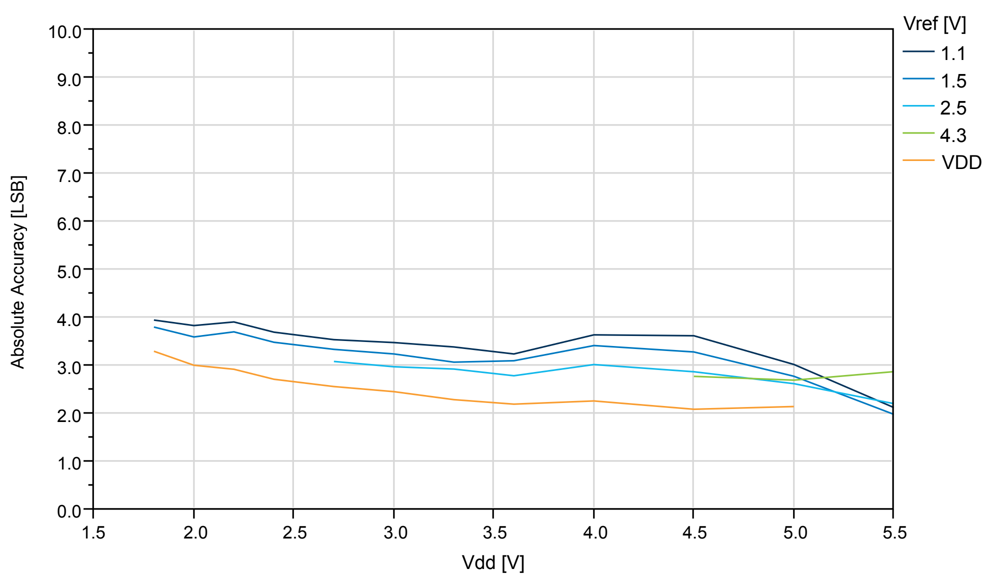


Figure 6-47. Gain Error vs. V_{ref} (V_{DD}=5.0V, f_{ADC}=115 ksps), REFSEL = Internal Reference

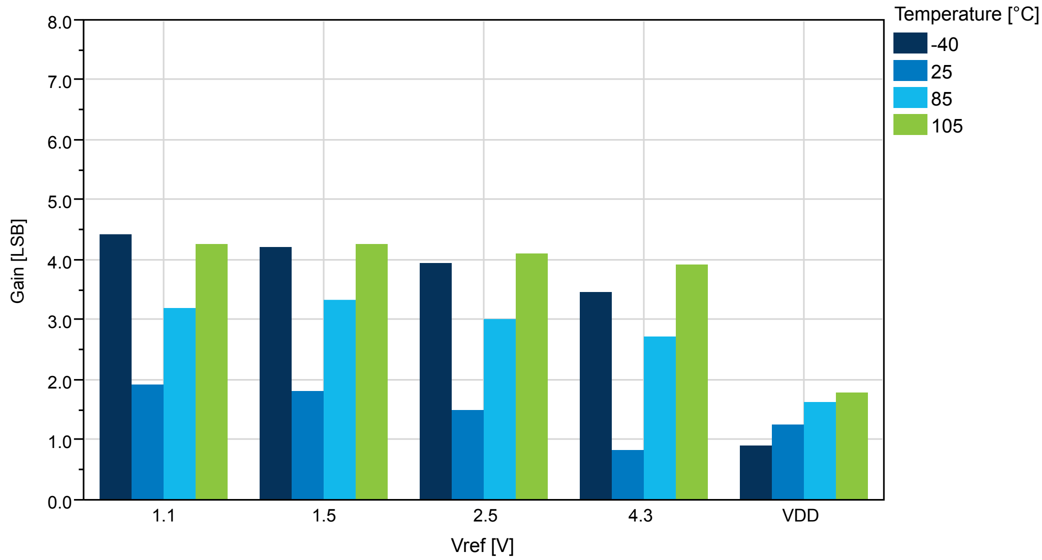


Figure 6-48. INL vs. V_{DD} (f_{ADC}=115 ksps) at T=25°C, REFSEL = Internal Reference

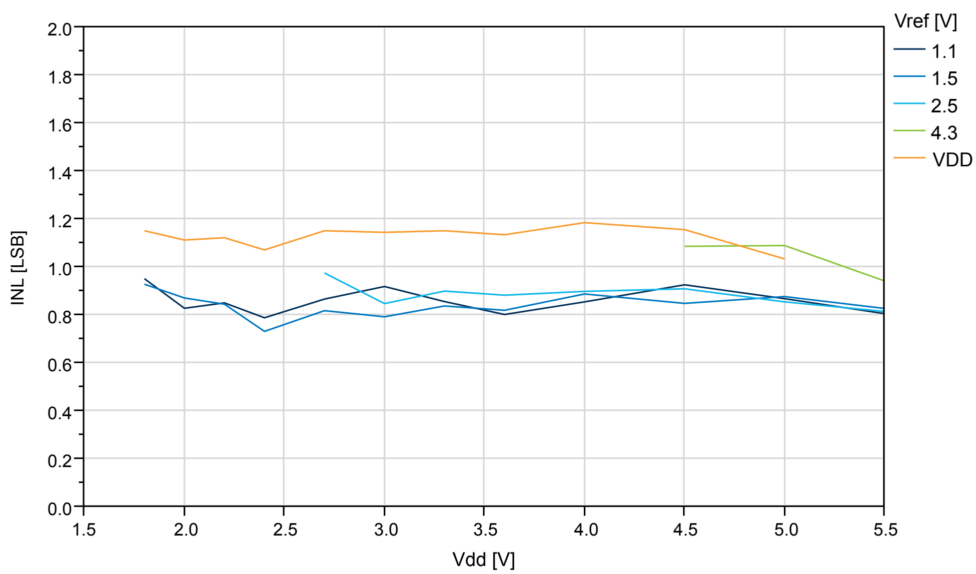


Figure 6-49. INL vs. V_{ref} (V_{DD}=5.0V, f_{ADC}=115 ksps), REFSEL = Internal Reference

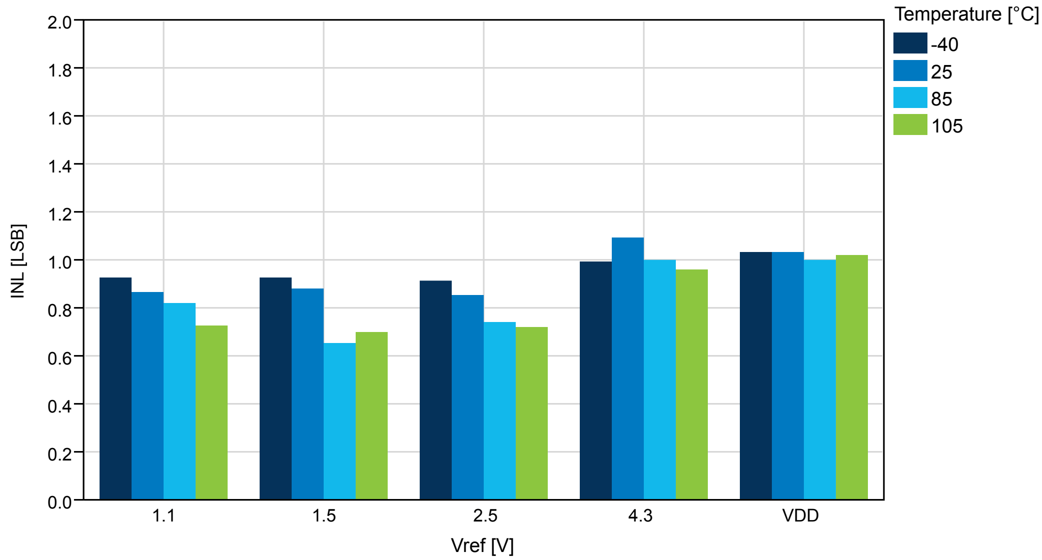


Figure 6-50. Offset Error vs. V_{DD} (f_{ADC}=115 ksps) at T=25°C, REFSEL = Internal Reference

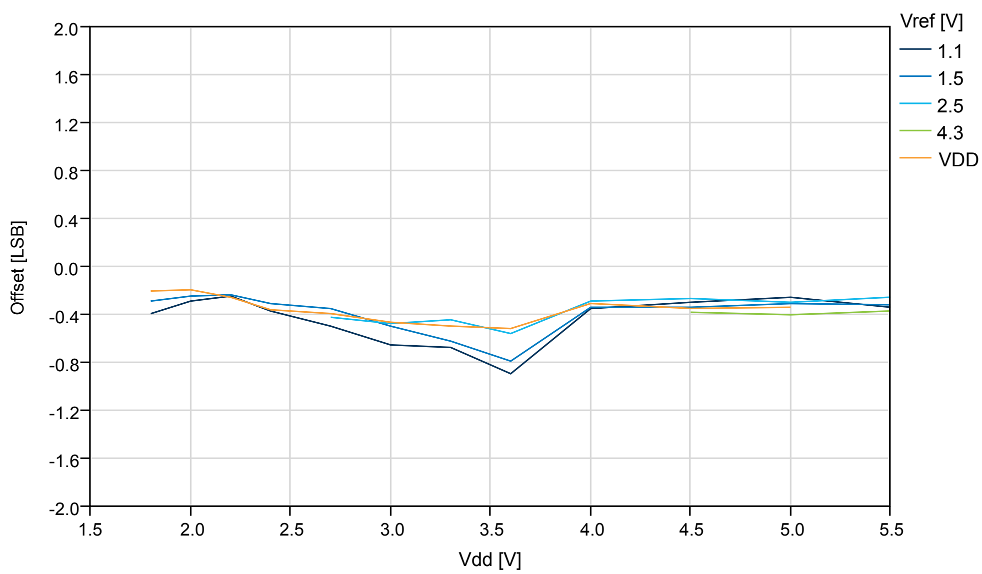


Figure 6-55. DNL vs. V_{REF} (V_{DD}=5.0V, f_{ADC}=115 ksps, REFSEL = External Reference)

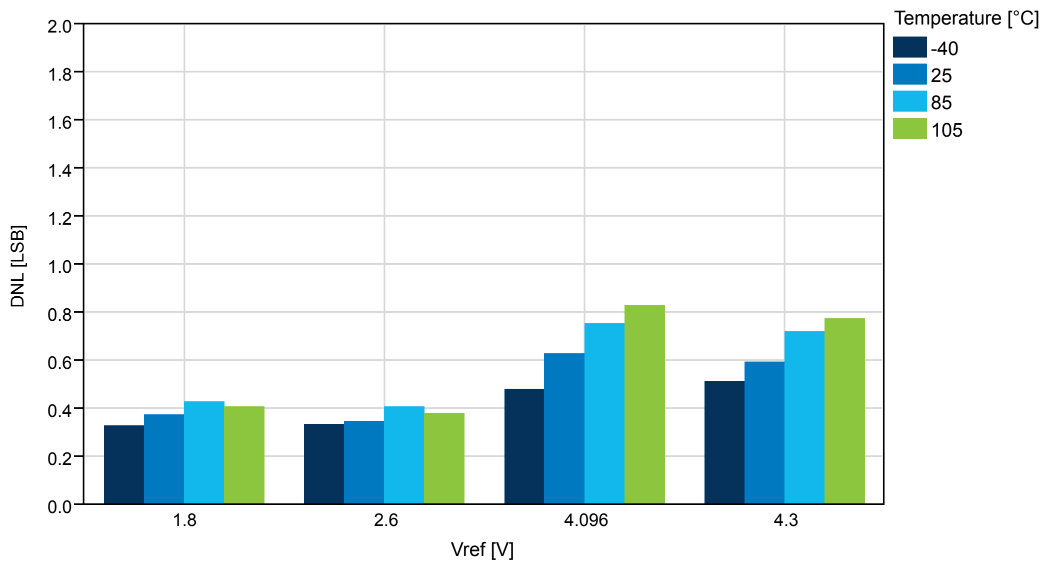


Figure 6-56. Gain vs. V_{DD} (f_{ADC}=115 ksps, T=25°C, REFSEL = External Reference)

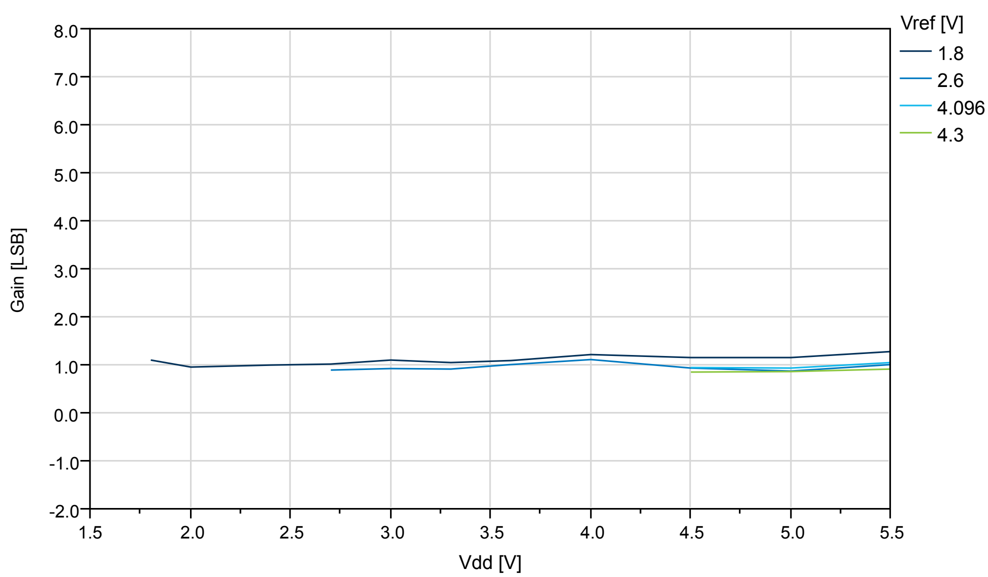
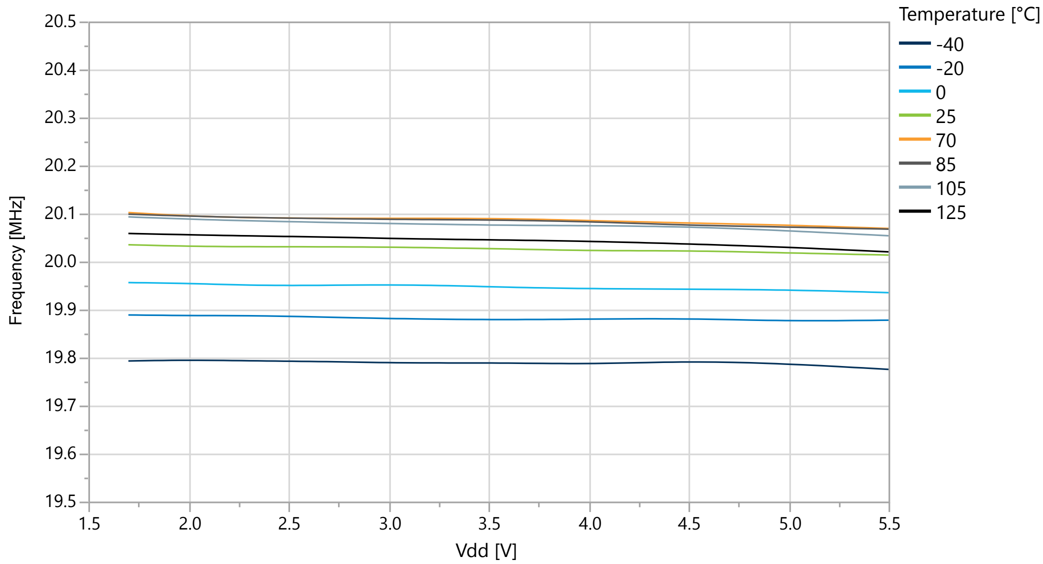
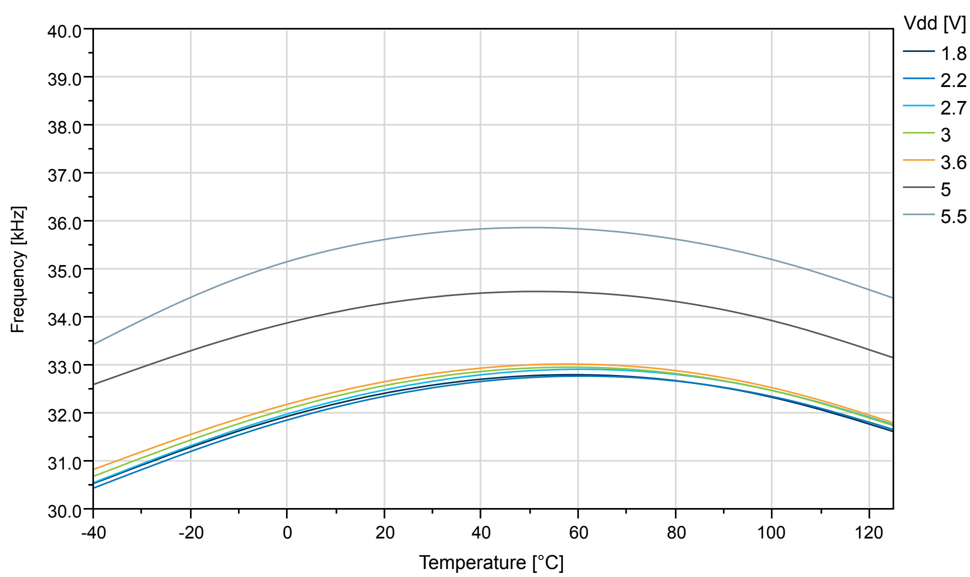


Figure 6-69. OSC20M Internal Oscillator: Frequency vs. V_{DD}



6.8 OSCULP32K Characteristics

Figure 6-70. OSCULP32K Internal Oscillator Frequency vs. Temperature



8. Conventions

8.1 Memory Size and Type

Table 8-1. Memory Size and Bit Rate

Symbol	Description
KB	kilobyte (2^{10} = 1024)
MB	megabyte (2^{20} = 1024*1024)
GB	gigabyte (2^{30} = 1024*1024*1024)
b	bit (binary '0' or '1')
B	byte (8 bits)
1 kbit/s	1,000 bit/s rate (not 1,024 bit/s)
1 Mbit/s	1,000,000 bit/s rate
1 Gbit/s	1,000,000,000 bit/s rate
word	16-bit

8.2 Frequency and Time

Table 8-2. Frequency and Time

Symbol	Description
kHz	1 kHz = 10^3 Hz = 1,000 Hz
KHz	1 KHz = 1,024 Hz, 32 KHz = 32,768 Hz
MHz	1 MHz = 10^6 Hz = 1,000,000 Hz
GHz	1 GHz = 10^9 Hz = 1,000,000,000 Hz
s	second
ms	millisecond
µs	microsecond
ns	nanosecond