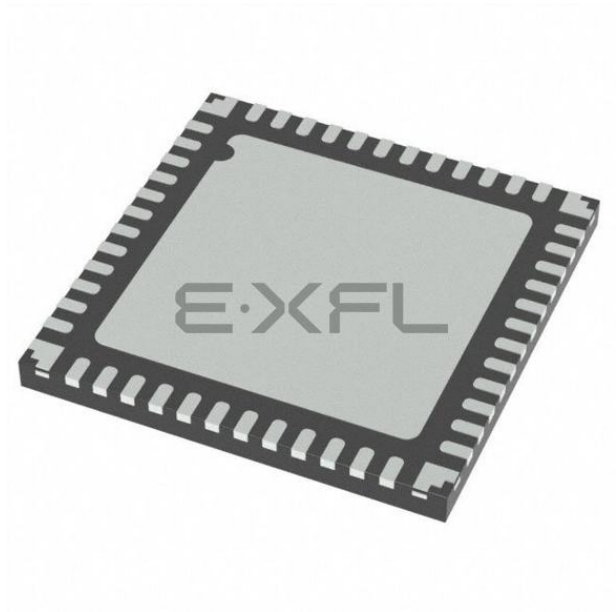

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Applications of "Embedded - Microcontrollers"

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	41
Program Memory Size	32KB (16K x 16)
Program Memory Type	FLASH
EEPROM Size	256 x 8
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 16x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	48-UFQFN Exposed Pad
Supplier Device Package	48-UQFN (6x6)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atmega3209-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)
    - Four 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
    - Four 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:
    - 41 programmable I/O lines
    - 48-pin UQFN 6x6 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

Table of Contents

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

Table 5-14. 32.768 kHz External Crystal Oscillator (XOSC32K) Characteristics

Symbol	Description	Condition	Min.	Typ.	Max.	Unit
f_{out}	Frequency		-	32.768	-	kHz
$t_{startup}$	Startup time	C_L=7.5 pF	-	300	-	ms
		C_L=12.5 pF	-	TBD	-	
C_L	Crystal load capacitance		7.5	-	12.5	pF
C_{TOSC1}	Parasitic capacitor load		-	5.5	-	pF
C_{TOSC2}			-	5.5	-	pF
ESR	Equivalent Series Resistance - Safety Factor=3	C_L=7.5 pF	-	-	80	kΩ
		C_L=12.5 pF	-	-	40	

Figure 5-2. External Clock Waveform Characteristics

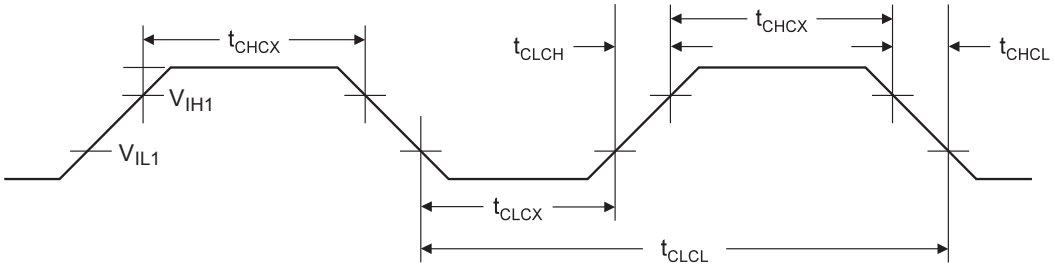


Table 5-15. External Clock Characteristics

Symbol	Description	Condition	V_{DD}=[1.8, 5.5]V		V_{DD}=[2.7, 5.5]V	V_{DD}=[4.5, 5.5]V	Unit		
			Min.	Max.	Min.	Max.		Min.	Max.
f_{CLCL}	Frequency		0	5.0	0.0	10.0	0.0	20.0	MHz
t_{CLCL}	Clock Period		200	-	100	-	50	-	ns
t_{CHCX}	High Time		80	-	40	-	20	-	ns
t_{CLCX}	Low Time		80	-	40	-	20	-	ns
t_{CLCH}	Rise Time (for maximum frequency)		-	40	-	20	-	10	ns
t_{CHCL}	Fall Time (for maximum frequency)		-	40	-	20	-	10	ns
Δt_{CLCL}	Change in period from one clock cycle to the next		-	20	-	20	-	20	%

Symbol(2)	Description	Condition	Min.	Typ.	Max.	Unit
INT15V INT25V						
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 AC0REFSEL bit field in the VREF.CTRLA register.

5.11 ADC

5.11.1 Internal 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 10 pF for 0.55V reference, while it is set to 5 pF for V_{REF}≥1.1V
- Applies for all allowed combinations of V_{REF} selections and Sample Rates unless otherwise noted

Table 5-20. Power Supply, Reference, and Input Range

Symbol	Description	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Supply voltage	CLK_{ADC} ≤ 1.5 MHz	1.8	-	5.5	V
		CLK_{ADC} > 1.5 MHz	2.7	-	5.5	
V_{REF}	Reference voltage	REFSEL = Internal reference	0.55	-	V_{DD}-0.5	V
		REFSEL = External reference	1.1		V_{DD}	
		REFSEL = V_{DD}	1.8	-	5.5	
C_{IN}	Input capacitance	SAMPCAP=5 pF	-	5	-	pF
		SAMPCAP=10 pF	-	10	-	
V_{IN}	Input voltage range		0	-	V_{REF}	V
I_{BAND}	Input bandwidth	1.1V≤V_{REF}	-	-	57.5	kHz

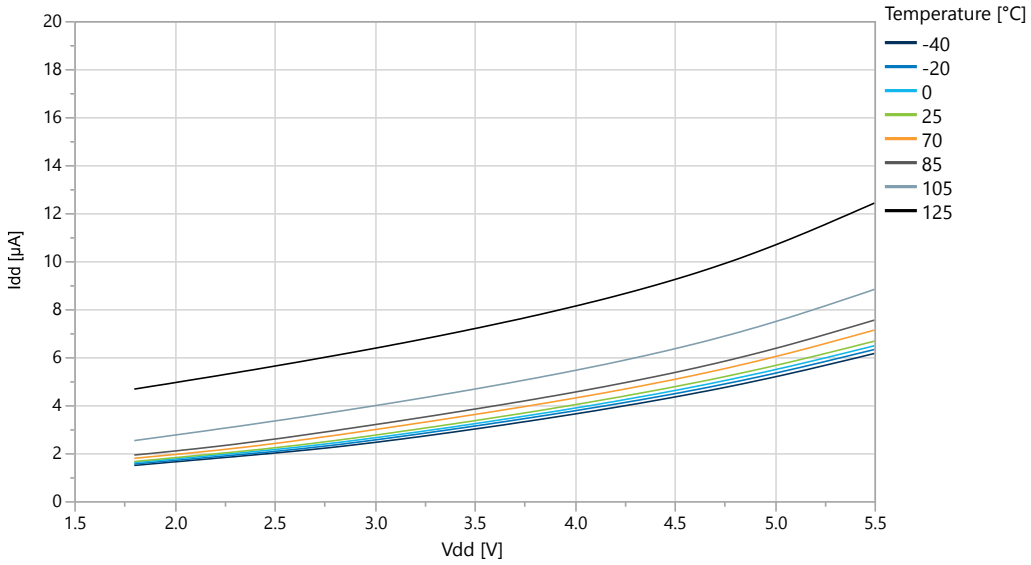
Table 5-21. Clock and Timing Characteristics

Symbol	Description	Conditions	Min.	Typ.	Max.	Unit
f_{ADC}	Sample rate	1.1V≤V_{REF}	15	-	115	ksps
		1.1V≤V_{REF} (8-bit resolution)	15	-	150	
		V_{REF}=0.55V (10 bits)	7.5	-	20	
CLK_{ADC}	Clock frequency	V_{REF}=0.55V (10 bits)	100	-	260	kHz
		1.1V≤V_{REF} (10 bits)	200	-	1500	
		1.1V≤V_{REF} (8-bit resolution)	200	-	2000	
Ts	Sampling time		2	2	33	CLK_{ADC} cycles
T_{CONV}	Conversion time (latency)	Sampling time = 2 CLK_{ADC}	8.7	-	50	µs
T_{START}	Start-up time	Internal V_{REF}	-	22	-	µs

Table 5-22. Accuracy Characteristics Internal Reference(2)

Symbol	Description	Conditions		Min.	Typ.	Max.	Unit
Res	Resolution			-	10	-	bit
INL	Integral Non-linearity	REFSEL = INTERNAL V_{REF}=0.55V	f_{ADC}=7.7 ksps	-	1.0	-	LSB
		REFSEL = INTERNAL or VDD	f_{ADC}=15 ksps	-	1.0	-	
		REFSEL = INTERNAL or VDD 1.1V≤V_{REF}	f_{ADC}=77 ksps	-	1.0	-	
			f_{ADC}=115 ksps	-	1.2	-	
DNL(1)	Differential Non-linearity	REFSEL = INTERNAL V_{REF} = 0.55V	f_{ADC}=7.7 ksps	-	0.6	-	LSB
		REFSEL = INTERNAL V_{REF} = 1.1V	f_{ADC}=15 ksps	-	0.4	-	
		REFSEL = INTERNAL or VDD 1.5V≤V_{REF}	f_{ADC}=15 ksps	-	0.4	-	
		REFSEL = INTERNAL or VDD 1.1V≤V_{REF}	f_{ADC}=77 ksps	-	0.4	-	

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)

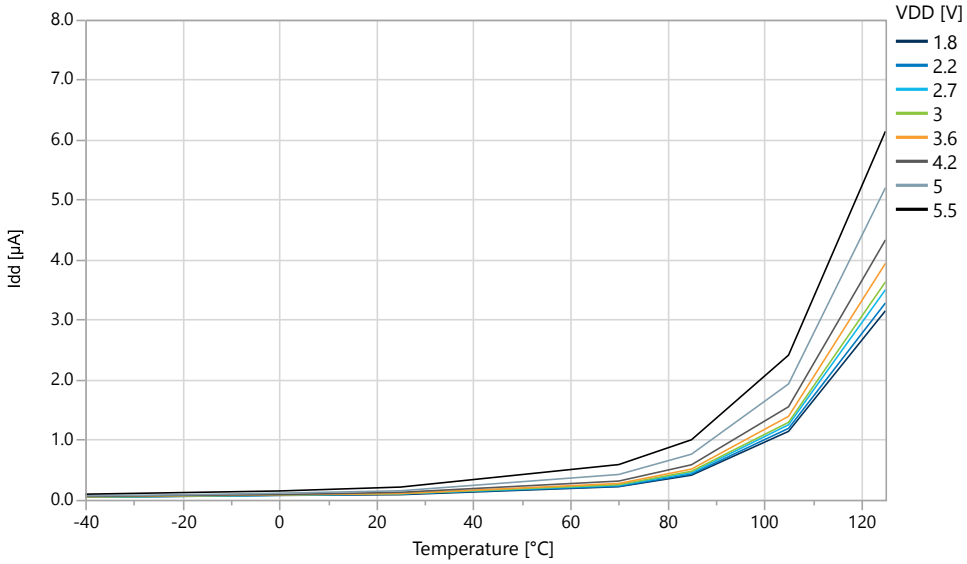
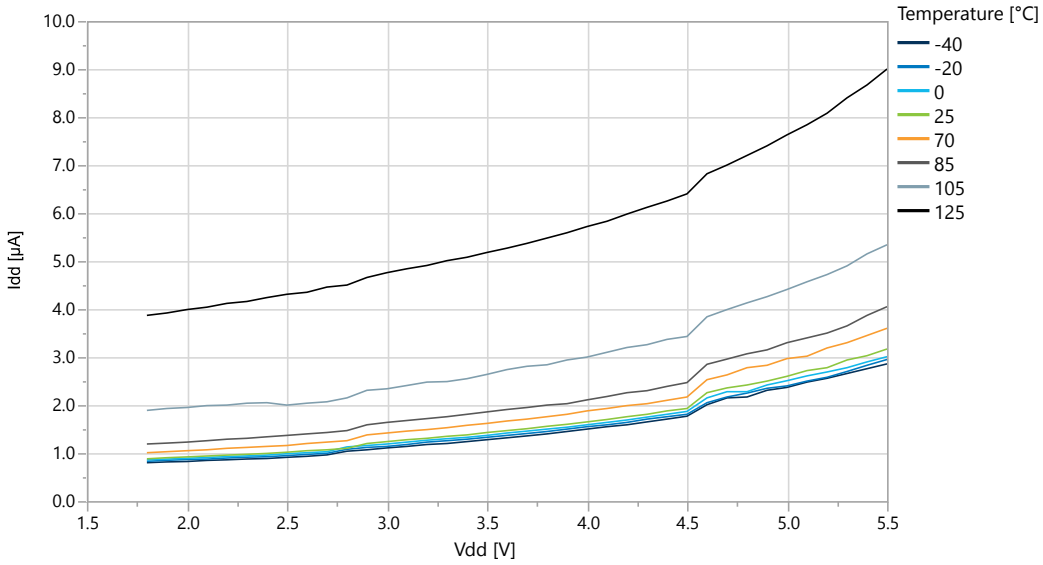
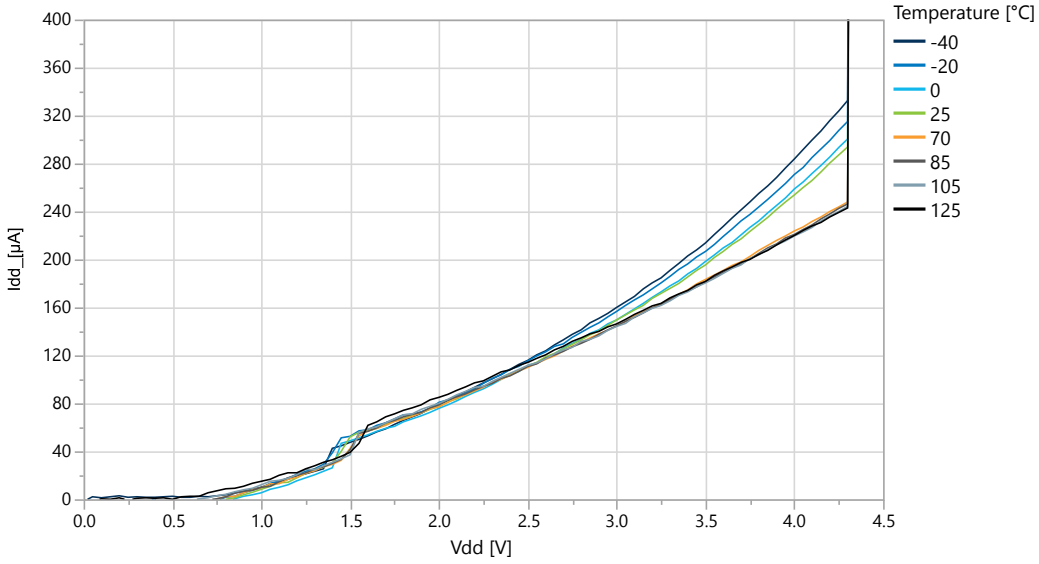


Figure 6-15. Standby Mode Supply Current vs. V_{DD} (Sampled BOD running at 1 kHz)



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}

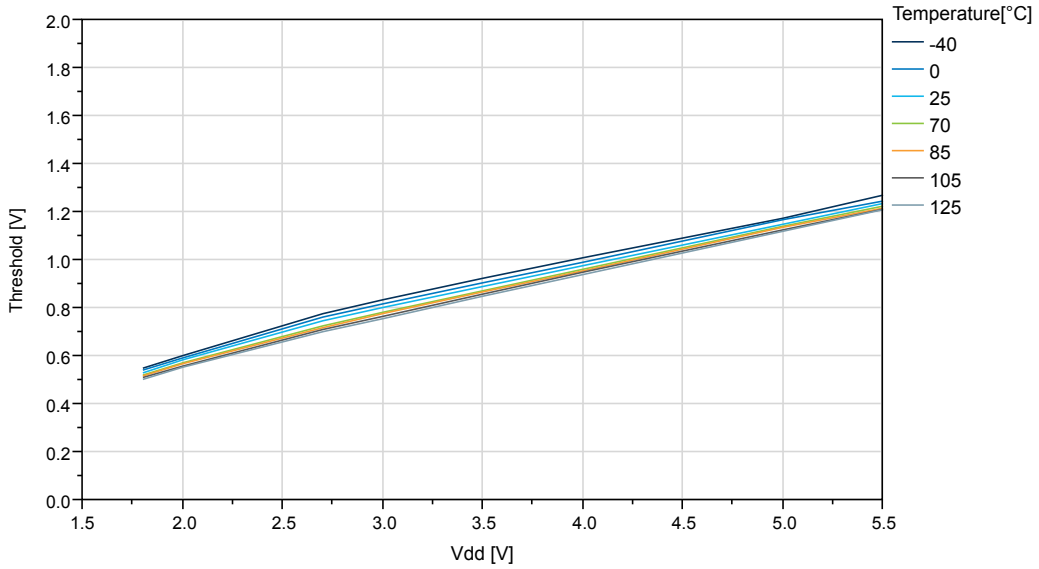


Figure 6-18. I/O Pin Input Threshold Voltage vs. V_{DD} (T=25°C)

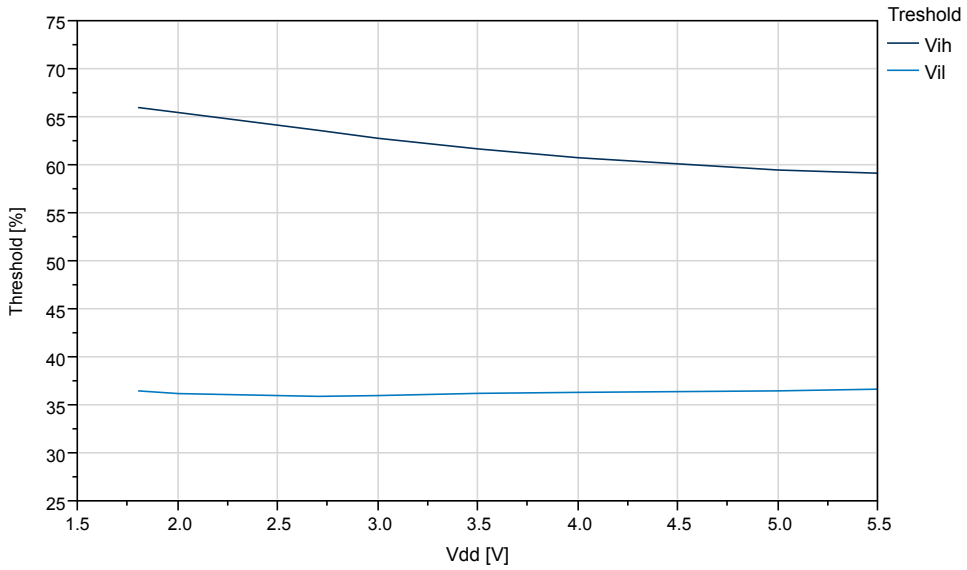


Figure 6-23. I/O Pin Output Voltage vs. Sink Current (V_{DD}=5.0V)

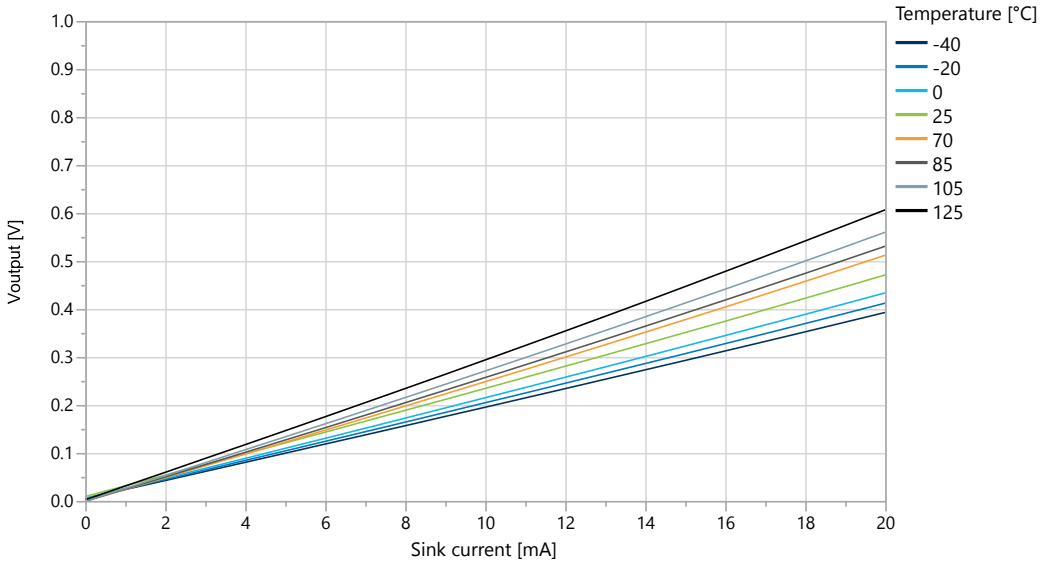


Figure 6-24. I/O Pin Output Voltage vs. Sink Current (T=25°C)

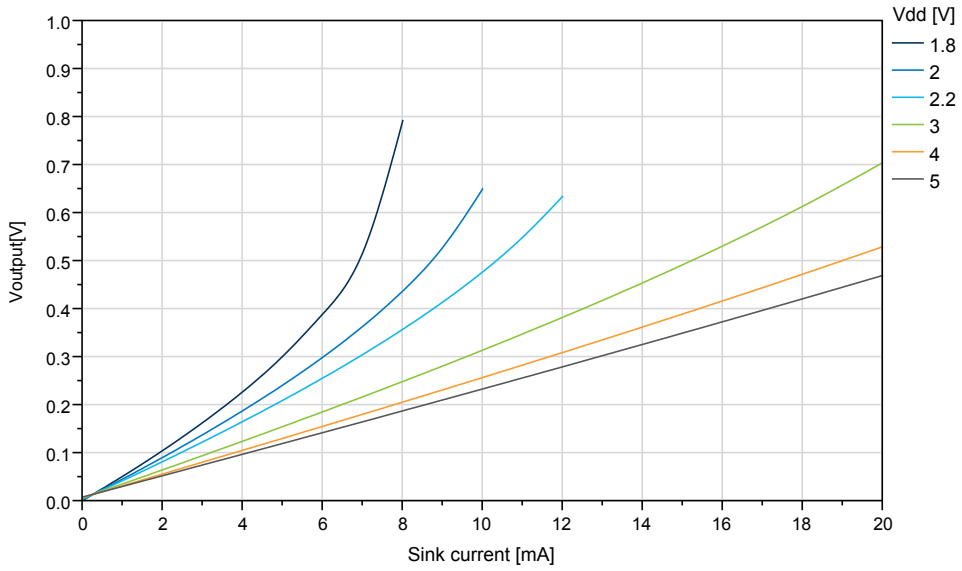


Figure 6-25. I/O Pin Output Voltage vs. Source Current (V_{DD}=1.8V)

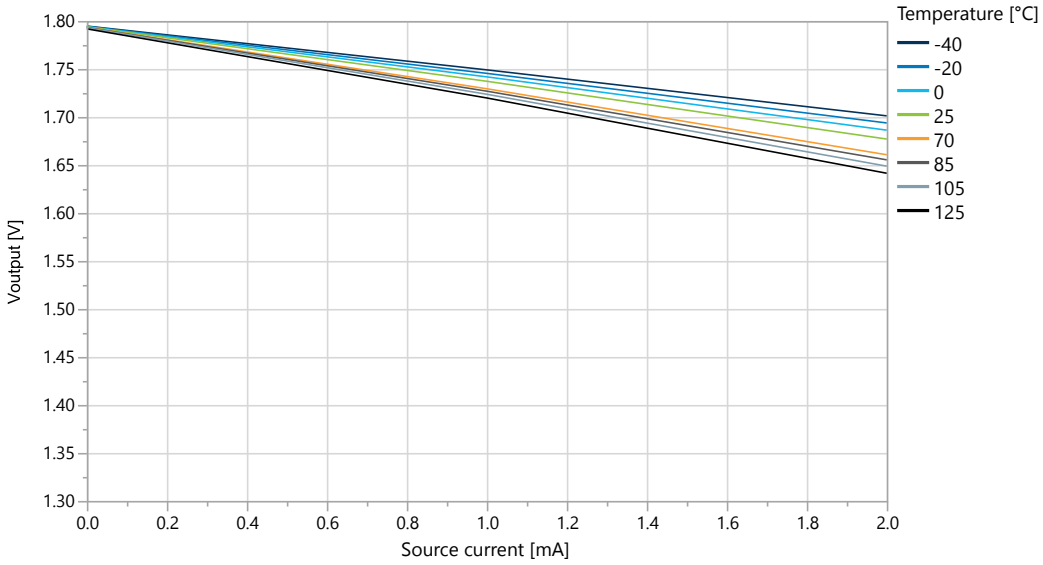


Figure 6-26. I/O Pin Output Voltage vs. Source Current (V_{DD}=3.0V)

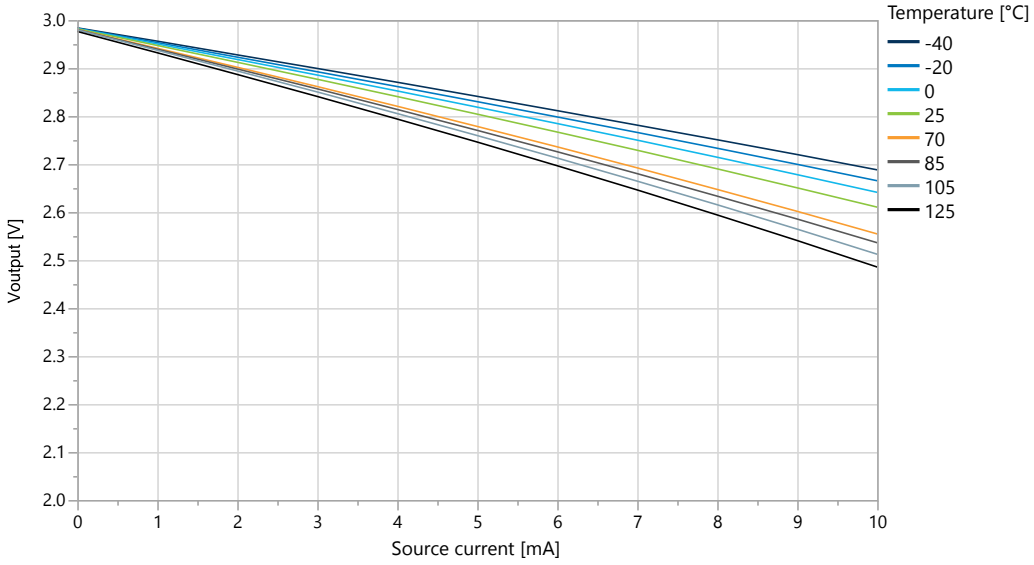


Figure 6-27. I/O Pin Output Voltage vs. Source Current (V_{DD}=5.0V)

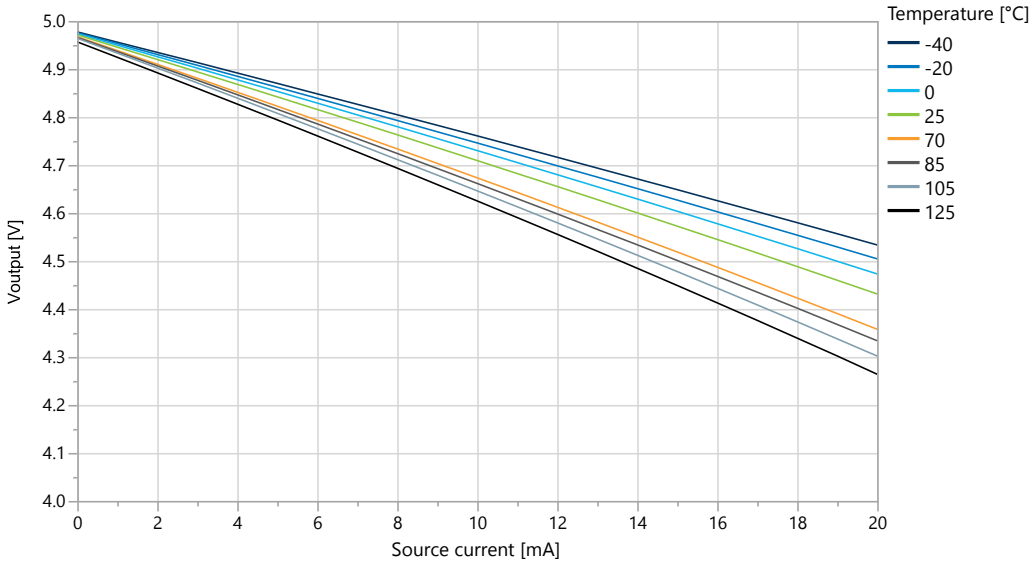


Figure 6-28. I/O Pin Output Voltage vs. Source Current (T=25°C)

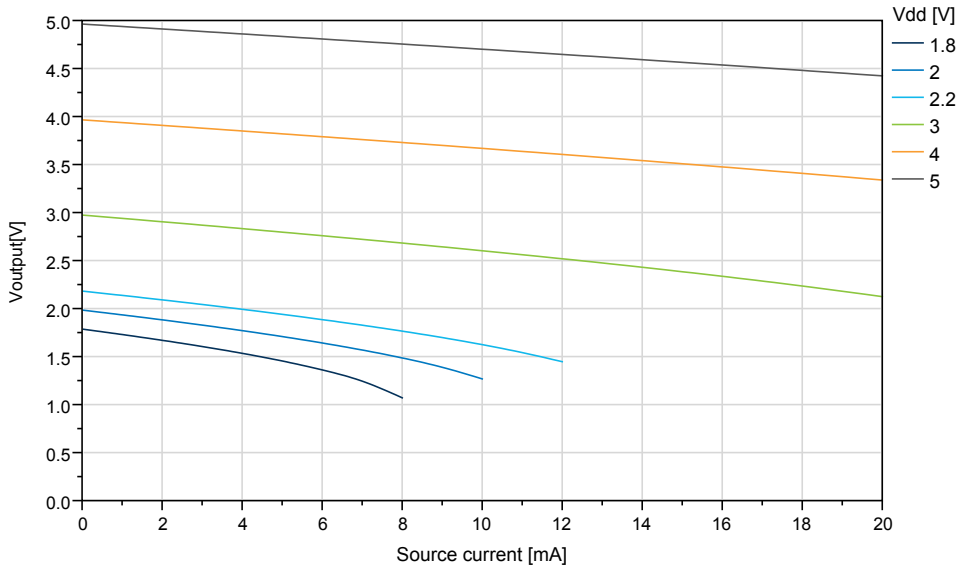


Figure 6-45. DNL vs. V_{ref} (V_{DD}=5.0V, f_{ADC}=115 ksps), REFSEL = Internal Reference

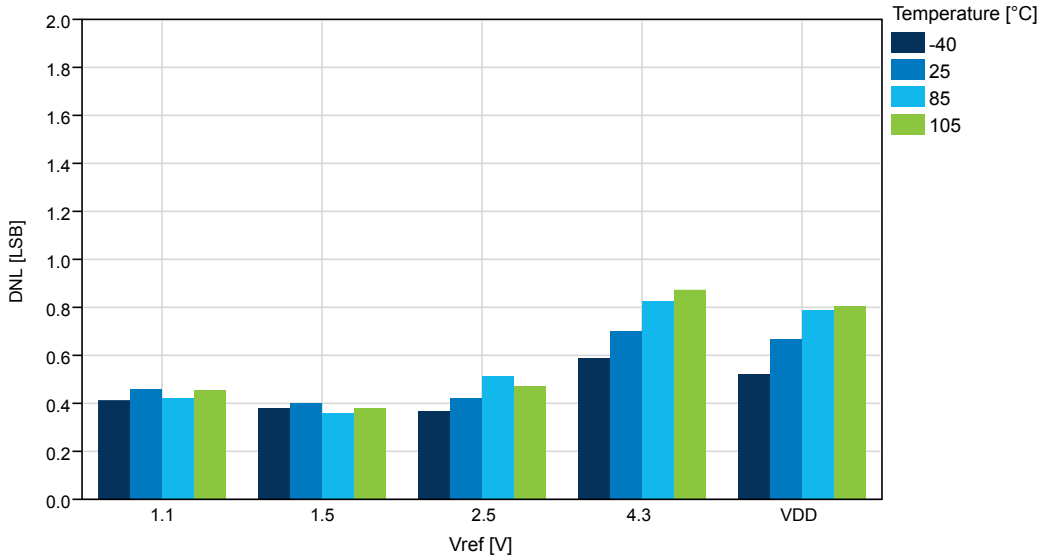


Figure 6-46. Gain Error vs. V_{DD} (f_{ADC}=115 ksps) at T=25°C, REFSEL = Internal Reference

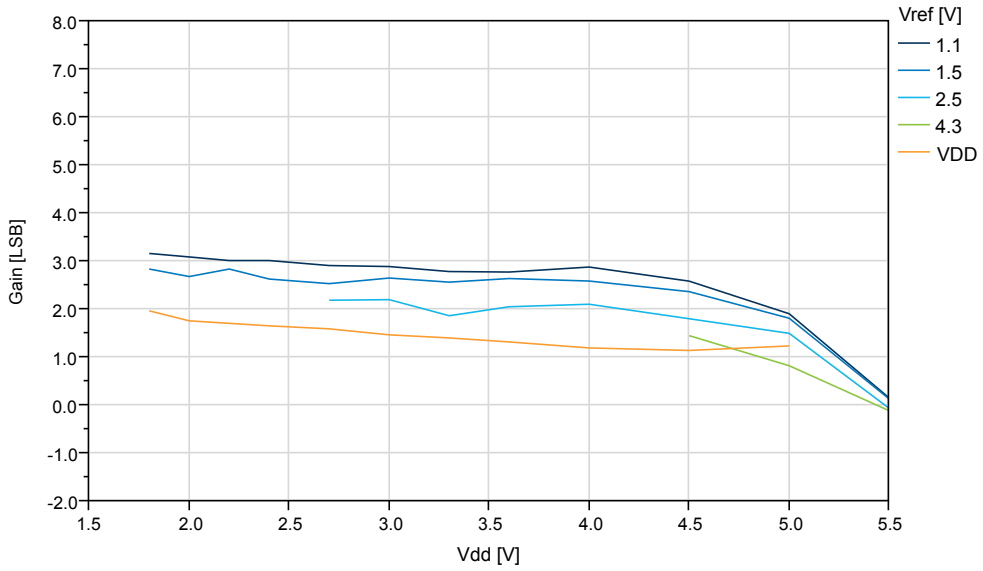


Figure 6-47. Gain Error vs. V_{ref} (V_{DD}=5.0V, f_{ADC}=115 ksps), REFSEL = Internal Reference

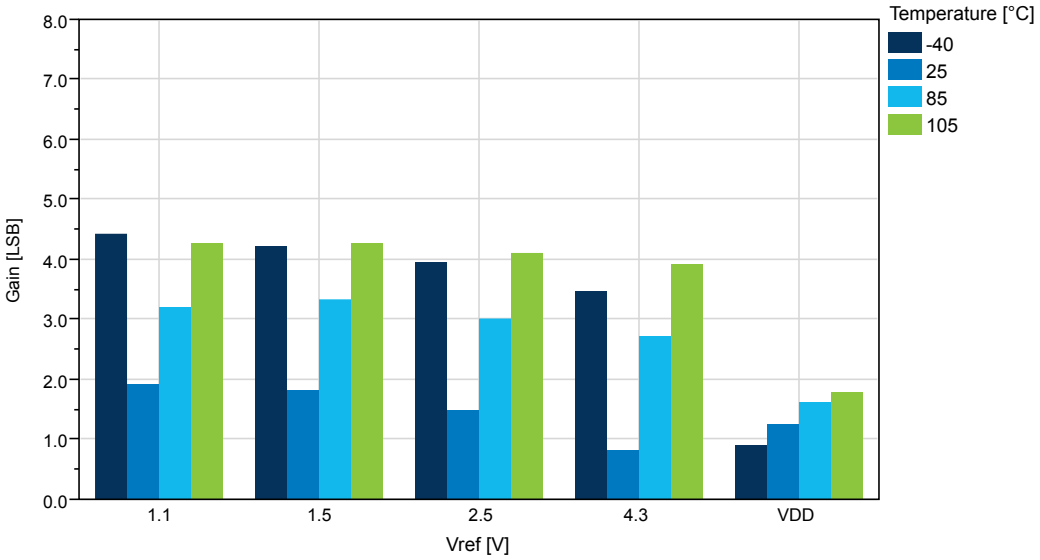


Figure 6-48. INL vs. V_{DD} (f_{ADC}=115 ksps) at T=25°C, REFSEL = Internal Reference

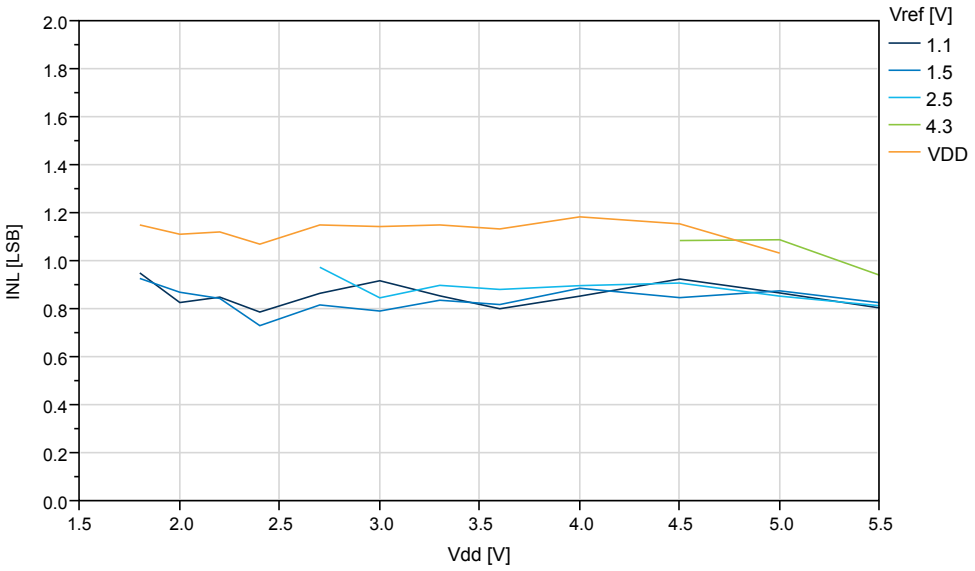


Figure 6-55. DNL vs. V_{REF} (V_{DD}=5.0V, f_{ADC}=115 ksps, REFSEL = External Reference)

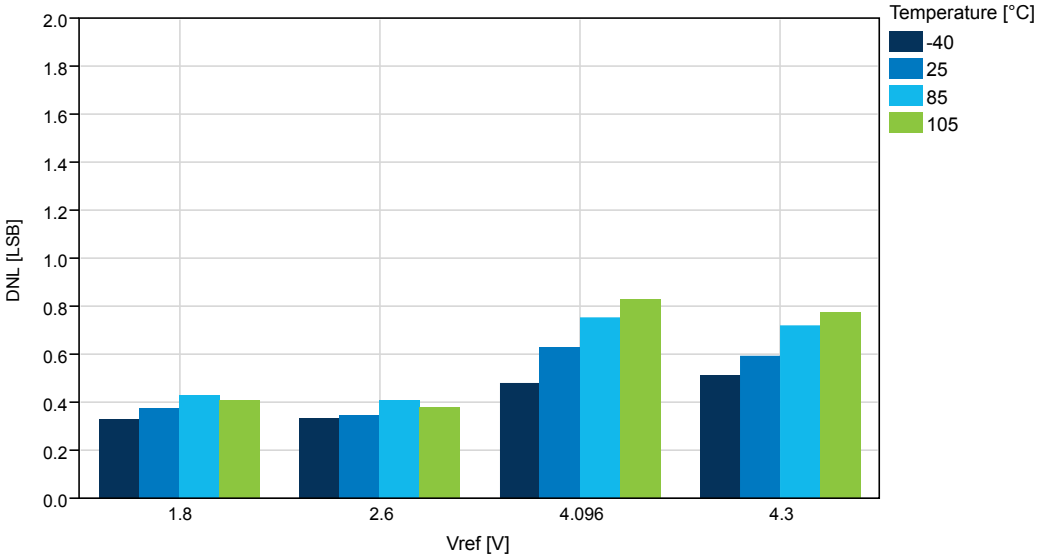


Figure 6-56. Gain vs. V_{DD} (f_{ADC}=115 ksps, T=25°C, REFSEL = External Reference)

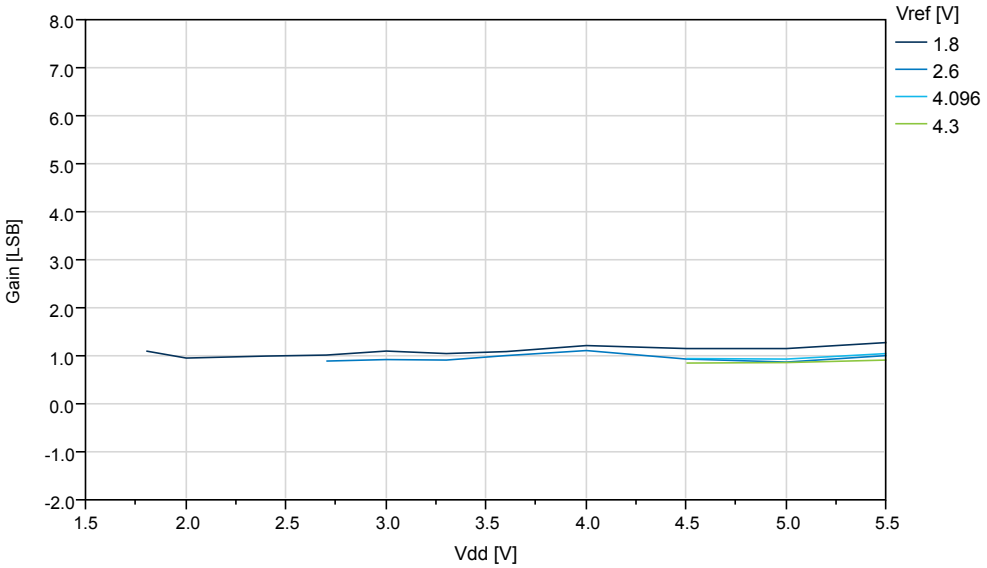
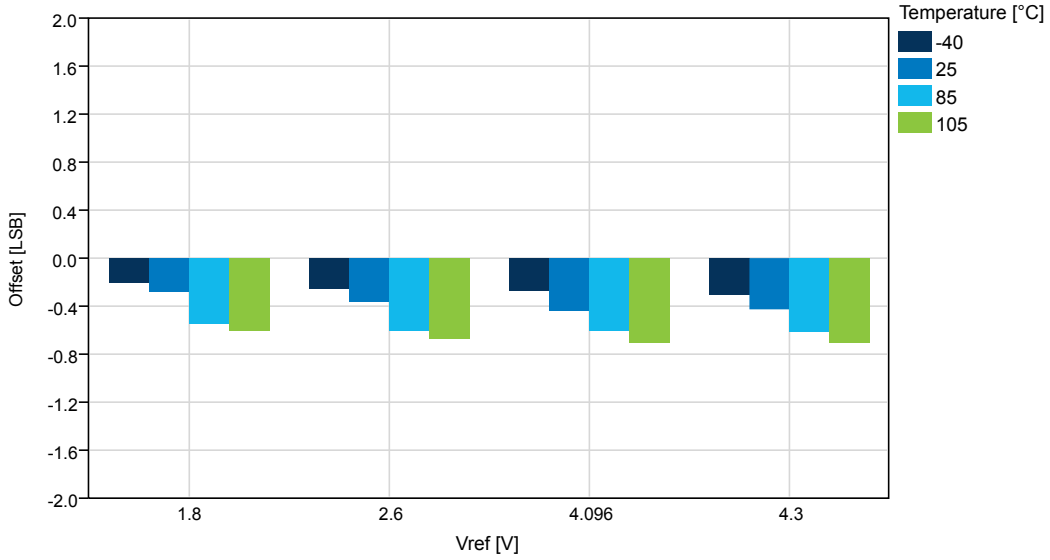


Figure 6-61. Offset vs. V_{REF} (V_{DD}=5.0V, f_{ADC}=115 ksps, REFSEL = External Reference)



6.6 AC Characteristics

Figure 6-62. Hysteresis vs. V_{CM} - 10 mV (V_{DD}=5V)

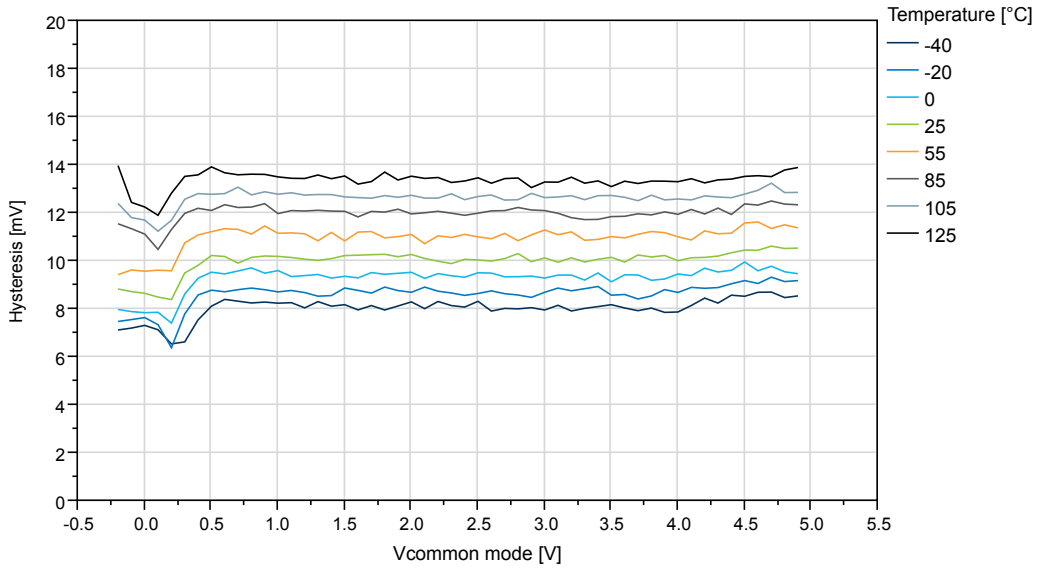


Figure 6-63. Hysteresis vs. V_{CM} - 10 mV to 50 mV (V_{DD}=5V, T=25°C)

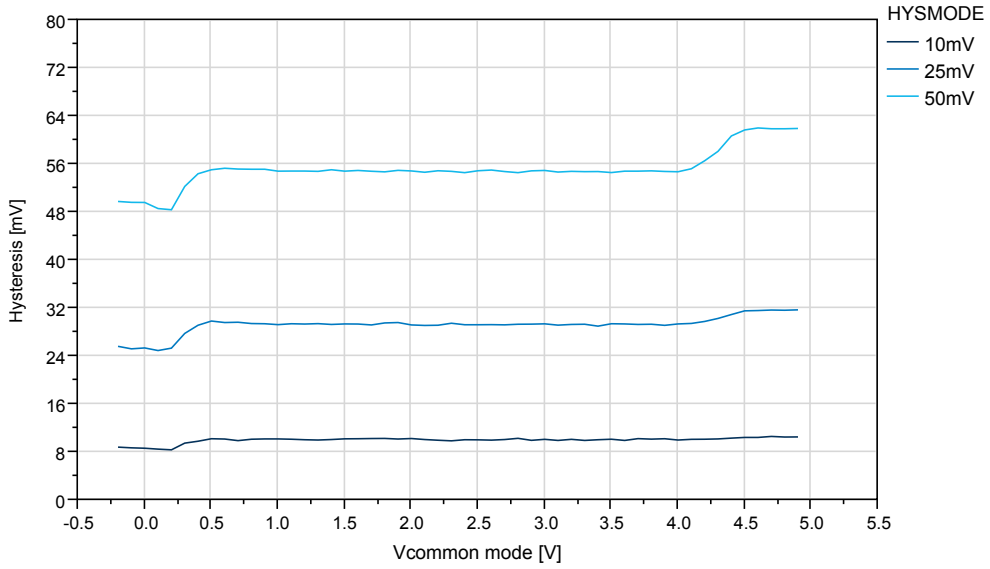


Figure 6-64. Offset vs. V_{CM} - 10 mV (V_{DD}=5V)

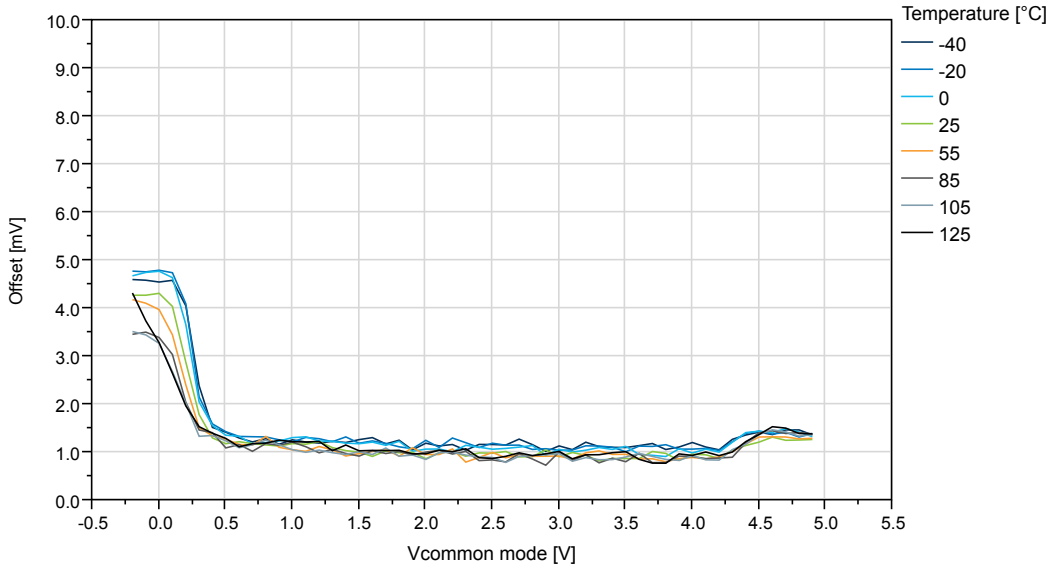
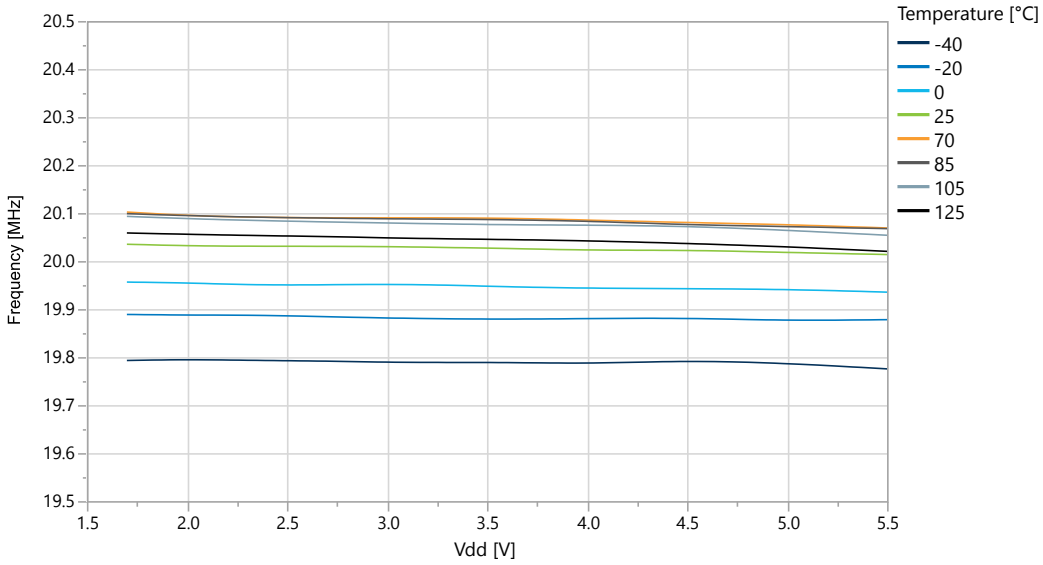
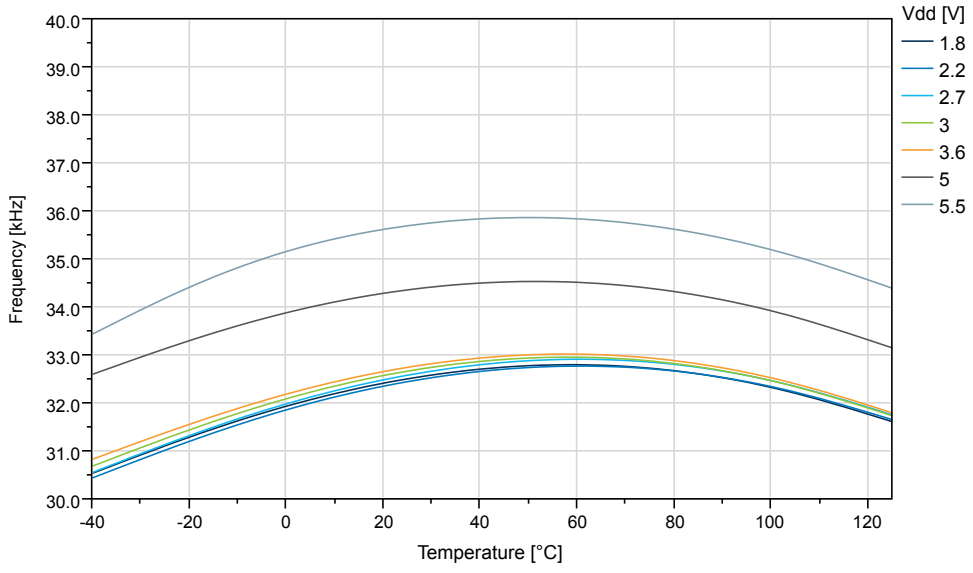


Figure 6-69. OSC20M Internal Oscillator: Frequency vs. V_{DD}



6.8 OSCULP32K Characteristics

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



7. Package Drawings

7.1 48 pin TQFP

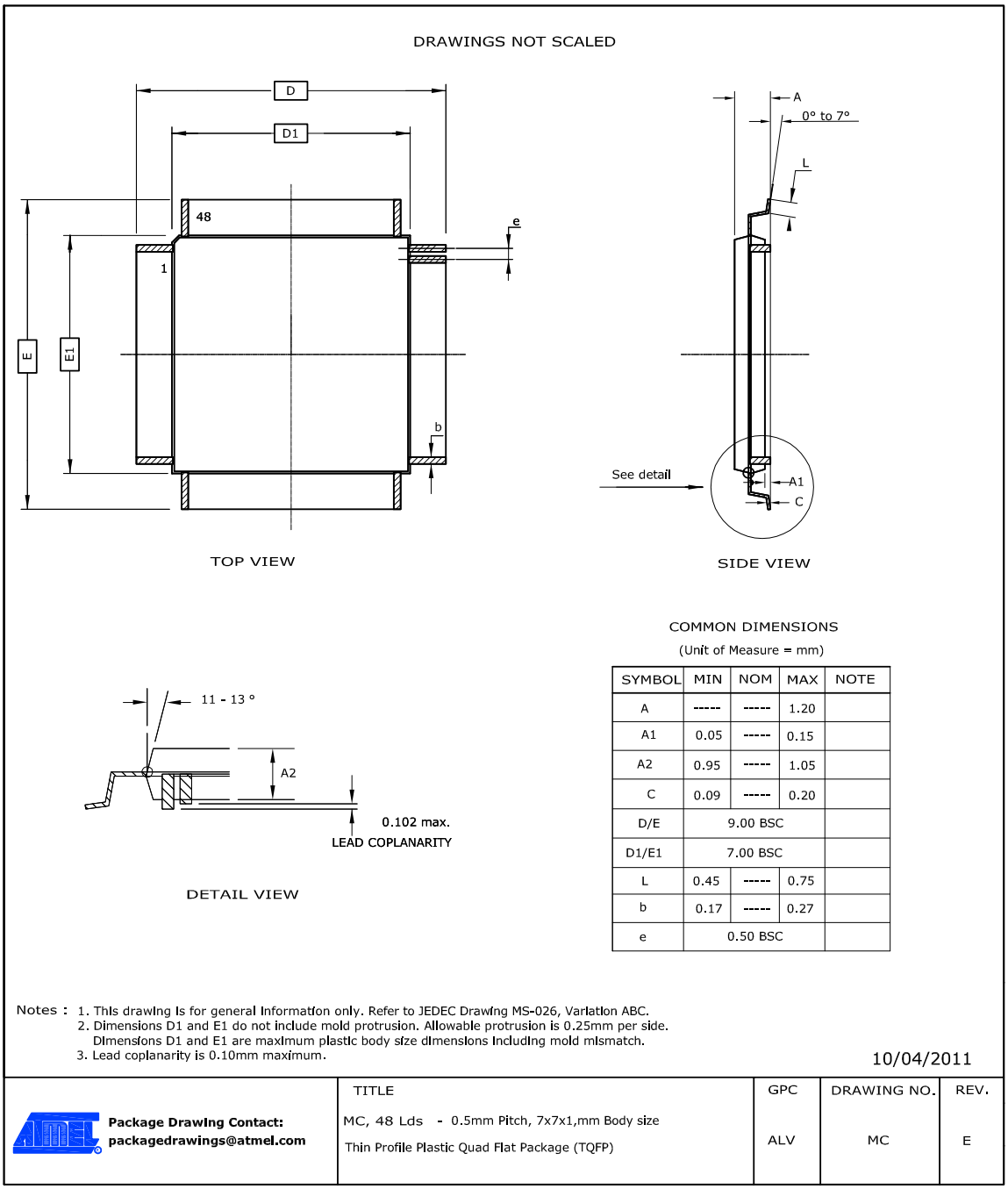


Table 7-1. Device and Package Maximum Weight

140	mg

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