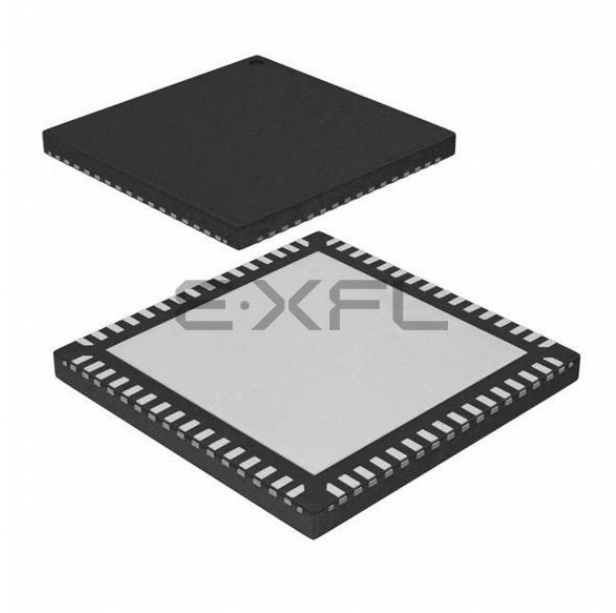

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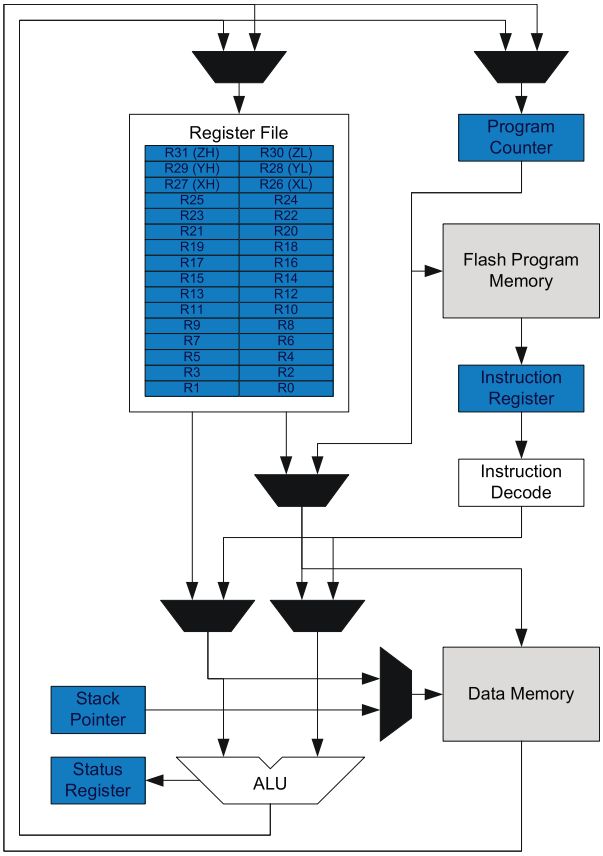
Applications of "Embedded - Microcontrollers"

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-VFQFN Exposed Pad
Supplier Device Package	64-QFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atxmega384d3-mhr

Figure 6-1. Block Diagram of the AVR CPU Architecture



The arithmetic logic unit (ALU) supports arithmetic and logic operations between registers or between a constant and a register. Single-register operations can also be executed in the ALU. After an arithmetic operation, the status register is updated to reflect information about the result of the operation.

The ALU is directly connected to the fast-access register file. The 32 * 8-bit general purpose working registers all have single clock cycle access time allowing single-cycle arithmetic logic unit (ALU) operation between registers or between a register and an immediate. Six of the 32 registers can be used as three 16-bit address pointers for program and data space addressing, enabling efficient address calculations.

The memory spaces are linear. The data memory space and the program memory space are two different memory spaces.

The data memory space is divided into I/O registers, SRAM, and external RAM. In addition, the EEPROM can be memory mapped in the data memory.

All I/O status and control registers reside in the lowest 4KB addresses of the data memory. This is referred to as the I/O memory space. The lowest 64 addresses can be accessed directly, or as the data space locations from 0x00 to 0x3F. The rest is the extended I/O memory space, ranging from 0x0040 to 0x0FFF. I/O registers here must be accessed as data space locations using load (LD/LDS/LDD) and store (ST/STS/STD) instructions.

The SRAM holds data. Code execution from SRAM is not supported. It can easily be accessed through the five different addressing modes supported in the AVR architecture. The first SRAM address is 0x2000.

Data addresses 0x1000 to 0x1FFF are reserved for memory mapping of EEPROM.

The program memory is divided in two sections, the application program section and the boot program section. Both sections have dedicated lock bits for write and read/write protection. The SPM instruction that is used for self-programming of the application flash memory must reside in the boot program section. The application section contains an application table section with separate lock bits for write and read/write protection. The application table section can be used for safe storing of nonvolatile data in the program memory.

Figure 7-2. Data Memory Map (hexadecimal address)

Byte address	ATxmega32D3
0	I/O registers (4K)
FFF	
1000	EEPROM (1K)
17FF	
	RESERVED
2000	Internal SRAM (4K)
2FFF	

Byte address	ATxmega64D3
0	I/O registers (4K)
FFF	
1000	EEPROM (2K)
17FF	
	RESERVED
2000	Internal SRAM (4K)
2FFF	

Byte address	ATxmega128D3
0	I/O registers (4K)
FFF	
1000	EEPROM (2K)
17FF	
	RESERVED
2000	Internal SRAM (8K)
3FFF	

Byte address	ATxmega192D3
0	I/O registers (4K)
FFF	
1000	EEPROM (2K)
17FF	
	RESERVED
2000	Internal SRAM (16K)
5FFF	

Byte address	ATxmega256D3
0	I/O registers (4K)
FFF	
1000	EEPROM (4K)
1FFF	
2000	Internal SRAM (16K)
5FFF	

Byte address	ATxmega384D3
0	I/O registers (4K)
FFF	
1000	EEPROM (4K)
1FFF	
2000	Internal SRAM (32K)
9FFF	

7.6 EEPROM

All devices have EEPROM for nonvolatile data storage. It is either addressable in a separate data space (default) or memory mapped and accessed in normal data space. The EEPROM supports both byte and page access. Memory mapped EEPROM allows highly efficient EEPROM reading and EEPROM buffer loading. When doing this, EEPROM is accessible using load and store instructions. Memory mapped EEPROM will always start at hexadecimal address 0x1000.

10.3.3 Power-save Mode

Power-save mode is identical to power down, with one exception. If the real-time counter (RTC) is enabled, it will keep running during sleep, and the device can also wake up from either an RTC overflow or compare match interrupt.

10.3.4 Standby Mode

Standby mode is identical to power down, with the exception that the enabled system clock sources are kept running while the CPU, peripheral, and RTC clocks are stopped. This reduces the wake-up time.

10.3.5 Extended Standby Mode

Extended standby mode is identical to power-save mode, with the exception that the enabled system clock sources are kept running while the CPU and peripheral clocks are stopped. This reduces the wake-up time.

12. WDT – Watchdog Timer

12.1 Features

- Issues a device reset if the timer is not reset before its timeout period
- Asynchronous operation from dedicated oscillator
- 1kHz output of the 32kHz ultra low power oscillator
- 11 selectable timeout periods, from 8ms to 8s
- Two operation modes:
  - Normal mode
  - Window mode
- Configuration lock to prevent unwanted changes

12.2 Overview

The watchdog timer (WDT) is a system function for monitoring correct program operation. It makes it possible to recover from error situations such as runaway or deadlocked code. The WDT is a timer, configured to a predefined timeout period, and is constantly running when enabled. If the WDT is not reset within the timeout period, it will issue a microcontroller reset. The WDT is reset by executing the WDR (watchdog timer reset) instruction from the application code.

The window mode makes it possible to define a time slot or window inside the total timeout period during which WDT must be reset. If the WDT is reset outside this window, either too early or too late, a system reset will be issued. Compared to the normal mode, this can also catch situations where a code error causes constant WDR execution.

The WDT will run in active mode and all sleep modes, if enabled. It is asynchronous, runs from a CPU-independent clock source, and will continue to operate to issue a system reset even if the main clocks fail.

The configuration change protection mechanism ensures that the WDT settings cannot be changed by accident. For increased safety, a fuse for locking the WDT settings is also available.

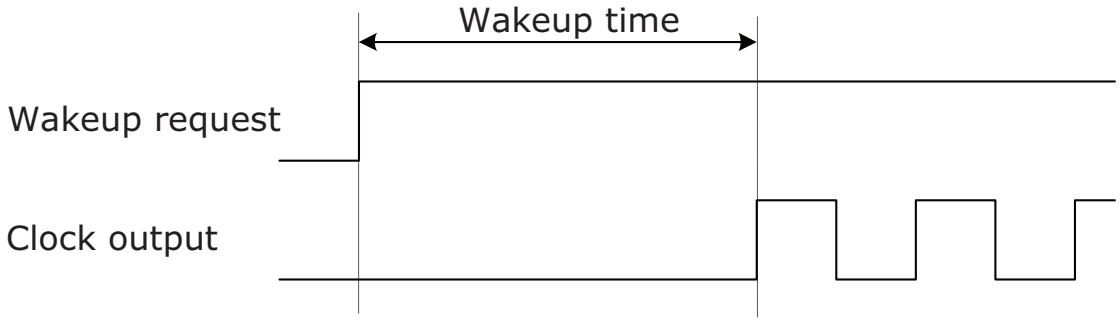
32.2.4 Wake-up Time from Sleep Modes

Table 32-35. Device Wake-up Time from Sleep Modes with Various System Clock Sources

Symbol	Parameter	Condition	Min.	Typ. (1)	Max.	Units
t_{wakeup}	Wake-up time from idle, standby, and extended standby mode	External 2MHz clock		2.0		µs
		32.768kHz internal oscillator		125		
		2MHz internal oscillator		2.0		
		32MHz internal oscillator		0.2		
	Wake-up time from power-save and power-down mode	External 2MHz clock		4.6		
		32.768kHz internal oscillator		330		
		2MHz internal oscillator		9.5		
		32MHz internal oscillator		5.6		

Note: 1. The wake-up time is the time from the wake-up request is given until the peripheral clock is available on pin, see Figure 32-9. All peripherals and modules start execution from the first clock cycle, expect the CPU that is halted for four clock cycles before program execution starts.

Figure 32-9. Wake-up Time Definition



32.2.5 I/O Pin Characteristics

The I/O pins complies with the JEDEC LVTTL and LVCMOS specification and the high- and low level input and output voltage limits reflect or exceed this specification.

Table 32-36. I/O Pin Characteristics

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
I_{OH} (1)/ I_{OL} (2)	I/O pin source/sink current			-15		15	mA
V_{IH}	High level input voltage	V_{CC} = 2.4 - 3.6V		0.7 * V_{CC}		V_{CC} + 0.5	V
		V_{CC} = 1.6 - 2.4V		0.8 * V_{CC}		V_{CC} + 0.5	
V_{IL}	Low level input voltage	V_{CC} = 2.4 - 3.6V		-0.5		0.3 * V_{CC}	
		V_{CC} = 1.6 - 2.4V		-0.5		0.2 * V_{CC}	
V_{OH}	High level output voltage	V_{CC} = 3.3V	I_{OH} = -4mA	2.6	2.9		
		V_{CC} = 3.0V	I_{OH} = -3mA	2.1	2.6		
		V_{CC} = 1.8V	I_{OH} = -1mA	1.4	1.6		
V_{OL}	Low level output voltage	V_{CC} = 3.3V	I_{OL} = 8mA		0.4	0.76	
		V_{CC} = 3.0V	I_{OL} = 5mA		0.3	0.64	
		V_{CC} = 1.8V	I_{OL} = 3mA		0.2	0.46	
I_{IN}	Input leakage current I/O pin	T = 25°C			<0.01	1	µA
R_P	Pull/buss keeper resistor				25		kΩ

Notes:
1. The sum of all I_{OH} for PORTA and PORTB must not exceed 100mA.
   The sum of all I_{OH} for PORTC, PORTD, and PORTE must for each port not exceed 200mA.
   The sum of all I_{OH} for pins PF[0-5] on PORTF must not exceed 200mA.
   The sum of all I_{OL} for pins PF[6-7] on PORTF, PORTR, and PDI must not exceed 100mA.
2. The sum of all I_{OL} for PORTA and PORTB must not exceed 100mA.
   The sum of all I_{OL} for PORTC, PORTD, and PORTE must for each port not exceed 200mA.
   The sum of all I_{OL} for pins PF[0-5] on PORTF must not exceed 200mA.
   The sum of all I_{OL} for pins PF[6-7] on PORTF, PORTR, and PDI must not exceed 100mA.

32.2.13.5 Internal Phase Locked Loop (PLL) Characteristics

Table 32-52. 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.

32.2.13.6 External Clock Characteristics

Figure 32-10.External Clock Drive Waveform

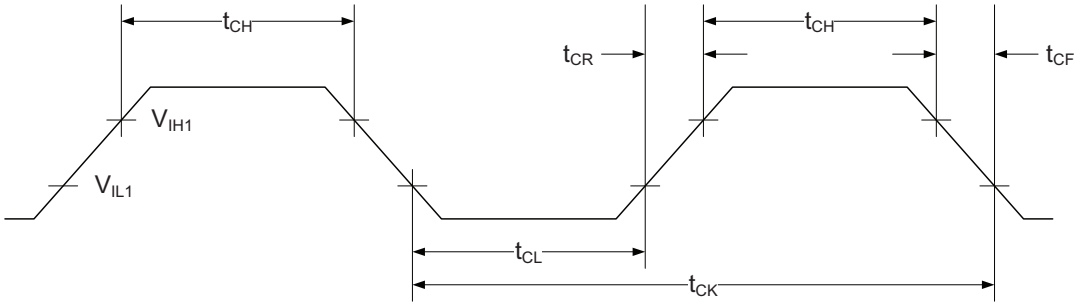
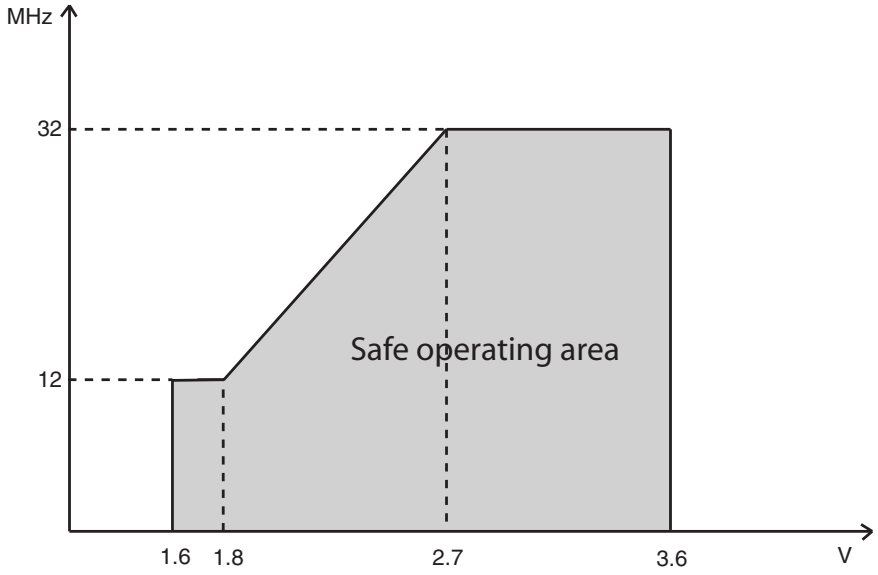


Table 32-53. External Clock used as System Clock without Prescaling

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$1/t_{CK}$	Clock Frequency (1)	V_{CC} = 1.6 - 1.8V	0		12	MHz
		V_{CC} = 2.7 - 3.6V	0		32	
t_{CK}	Clock Period	V_{CC} = 1.6 - 1.8V	83.3			ns
		V_{CC} = 2.7 - 3.6V	31.5			
t_{CH}	Clock High Time	V_{CC} = 1.6 - 1.8V	30.0			
		V_{CC} = 2.7 - 3.6V	12.5			
t_{CL}	Clock Low Time	V_{CC} = 1.6 - 1.8V	30.0			
		V_{CC} = 2.7 - 3.6V	12.5			
t_{CR}	Rise Time (for maximum frequency)	V_{CC} = 1.6 - 1.8V			10	
		V_{CC} = 2.7 - 3.6V			3	
t_{CF}	Fall Time (for maximum frequency)	V_{CC} = 1.6 - 1.8V			10	
		V_{CC} = 2.7 - 3.6V			3	
Δt_{CK}	Change in period from one clock cycle to the next				10	%

Note: 1. 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.

Figure 32-29. Maximum Frequency vs. V_{CC}



32.5.13 Clock and Oscillator Characteristics

32.5.13.1 Calibrated 32.768kHz Internal Oscillator Characteristics

Table 32-135. 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	

32.5.13.2 Calibrated 2MHz RC Internal Oscillator Characteristics

Table 32-136. 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	2.0	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		

32.5.13.3 Calibrated 32MHz Internal Oscillator Characteristics

Table 32-137. 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		

32.5.13.4 32kHz Internal ULP Oscillator Characteristics

Table 32-138. 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	%

32.6.4 Wake-up Time from Sleep Modes

Table 32-151. Device Wake-up Time from Sleep Modes with Various System Clock Sources

Symbol	Parameter	Condition	Min.	Typ. (1)	Max.	Units
t_{wakeup}	Wake-up time from idle, standby, and extended standby mode	External 2MHz clock		2.0		µs
		32.768kHz internal oscillator		130		
		2MHz internal oscillator		2.0		
		32MHz internal oscillator		0.2		
	Wake-up time from power-save and power-down mode	External 2MHz clock		4.5		
		32.768kHz internal oscillator		320		
		2MHz internal oscillator		9.0		
		32MHz internal oscillator		5.0		

Note: 1. The wake-up time is the time from the wake-up request is given until the peripheral clock is available on pin, see Figure 32-37. All peripherals and modules start execution from the first clock cycle, expect the CPU that is halted for four clock cycles before program execution starts.

Figure 32-37. Wake-up Time Definition

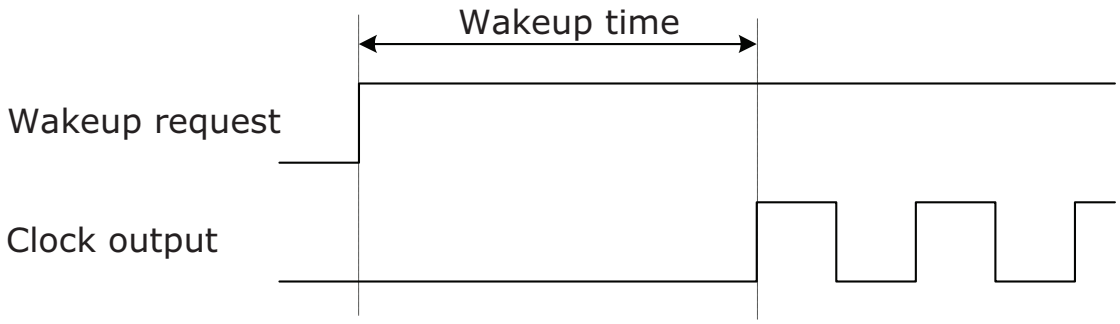
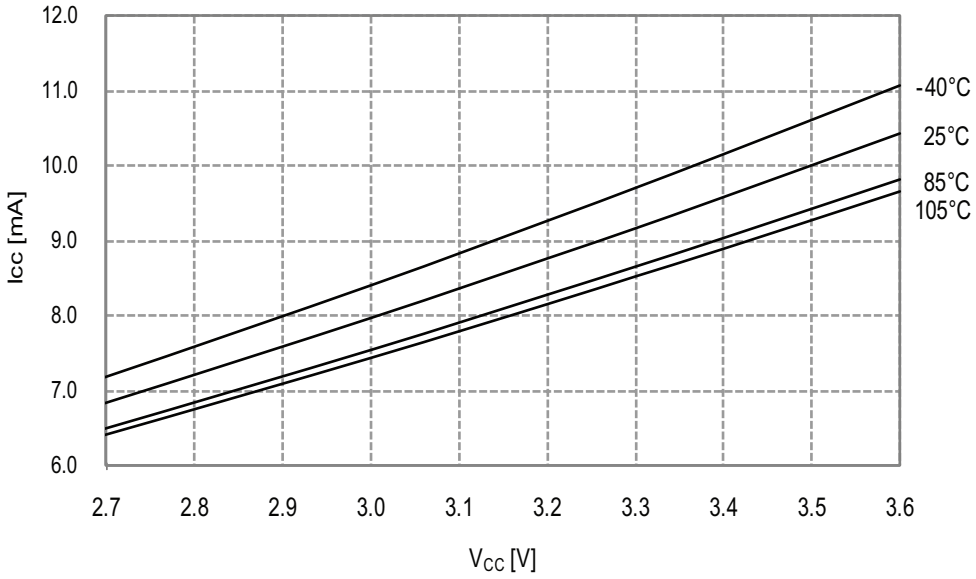


Figure 33-7. Active Mode Supply Current vs. V_{CC}

f_{SYS} = 32MHz internal oscillator



33.1.1.2 Idle Mode Supply Current

Figure 33-8. Idle Mode Supply Current vs. Frequency

f_{SYS} = 0 - 1MHz external clock, T = 25°C

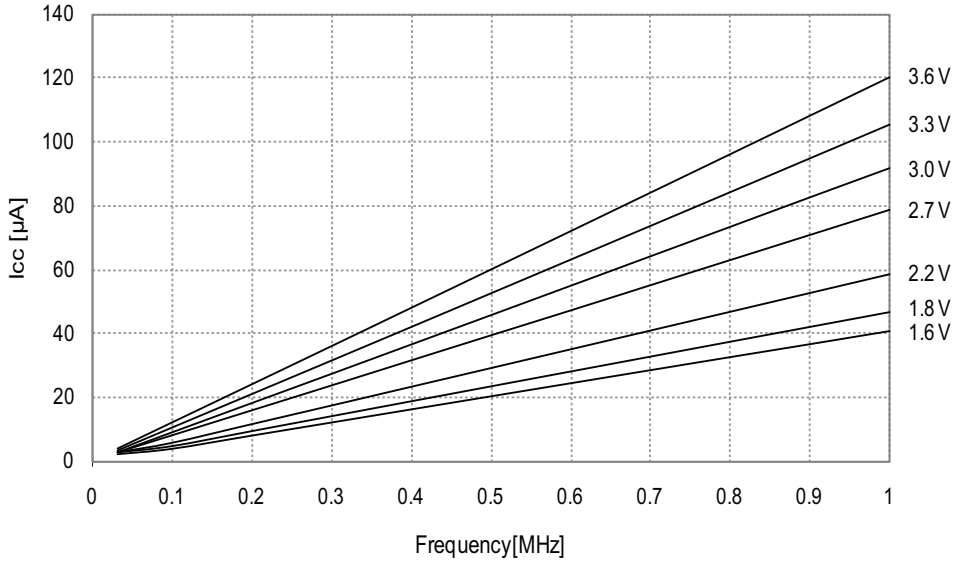


Figure 33-9. Idle Mode Supply Current vs. Frequency

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

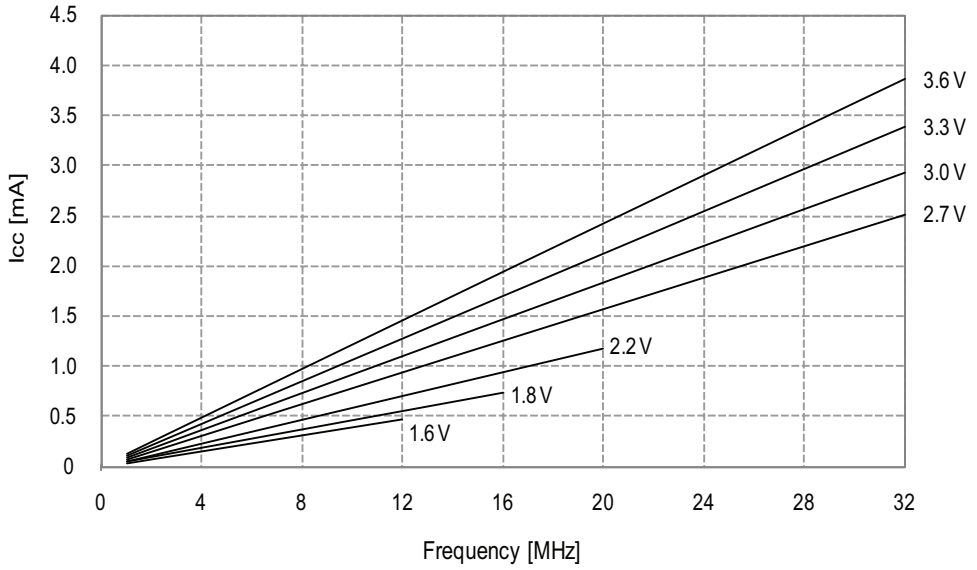


Figure 33-10. Idle Mode Supply Current vs. V_{CC}

f_{SYS} = 32.768kHz internal oscillator

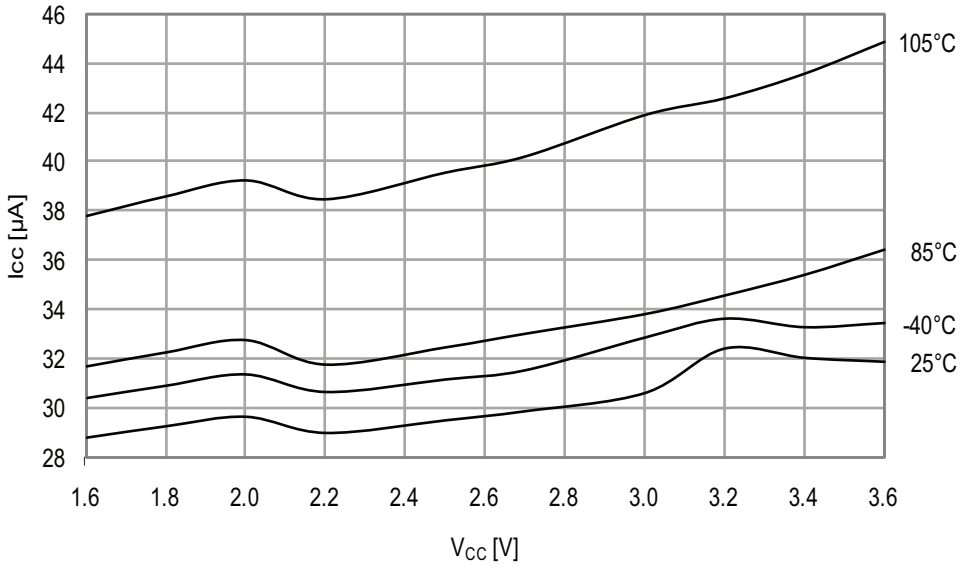


Figure 33-23. I/O Pin Output Voltage vs. Source Current

V_{CC} = 3.0V

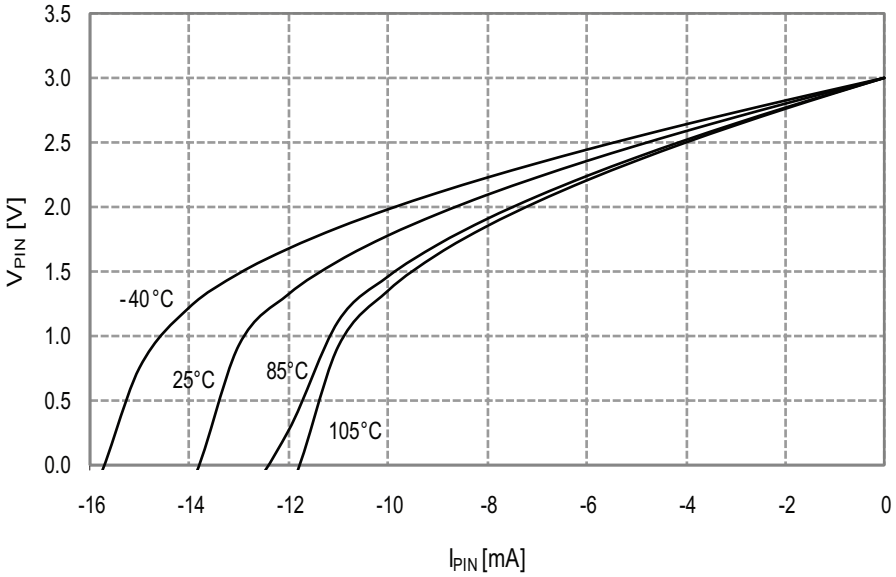


Figure 33-24. I/O Pin Output Voltage vs. Source Current

V_{CC} = 3.3V

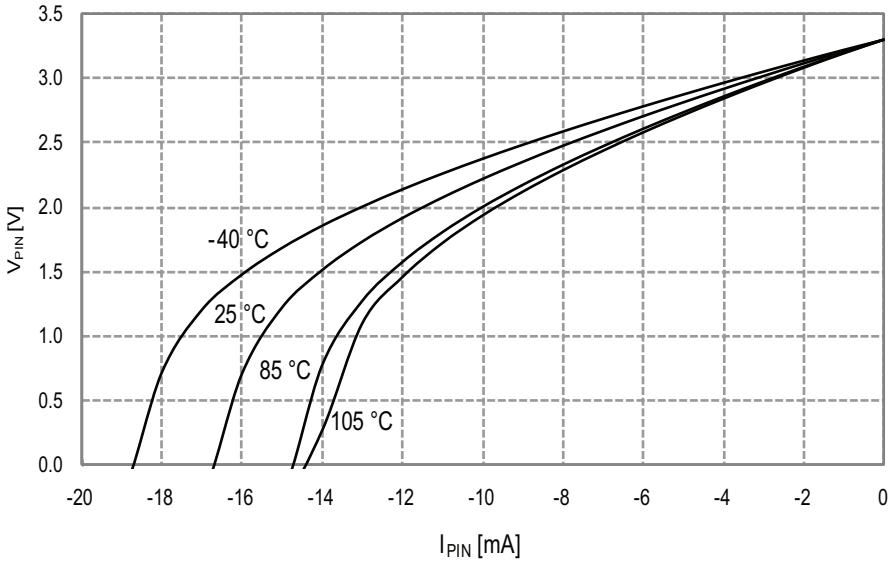
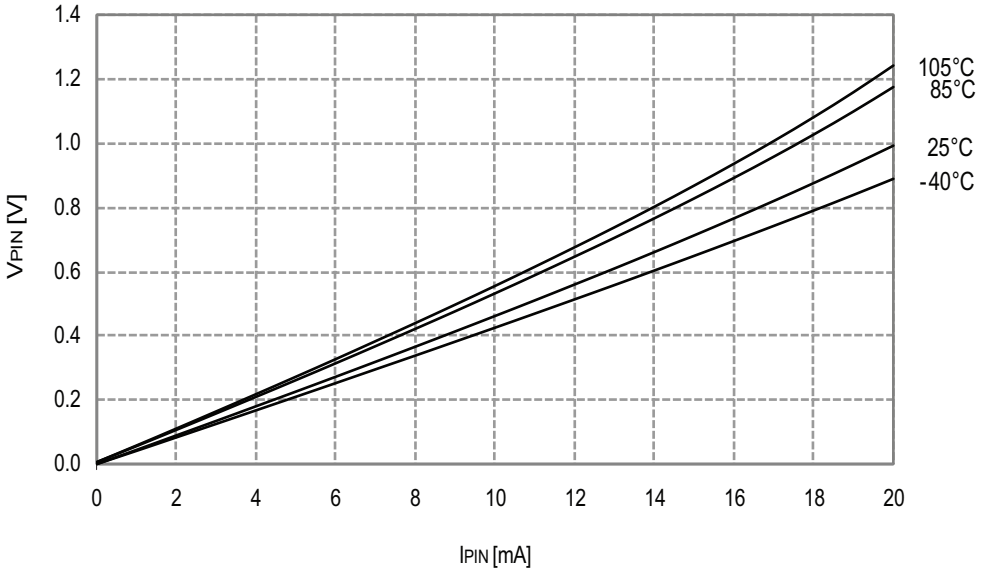


Figure 33-27. I/O Pin Output Voltage vs. Sink Current

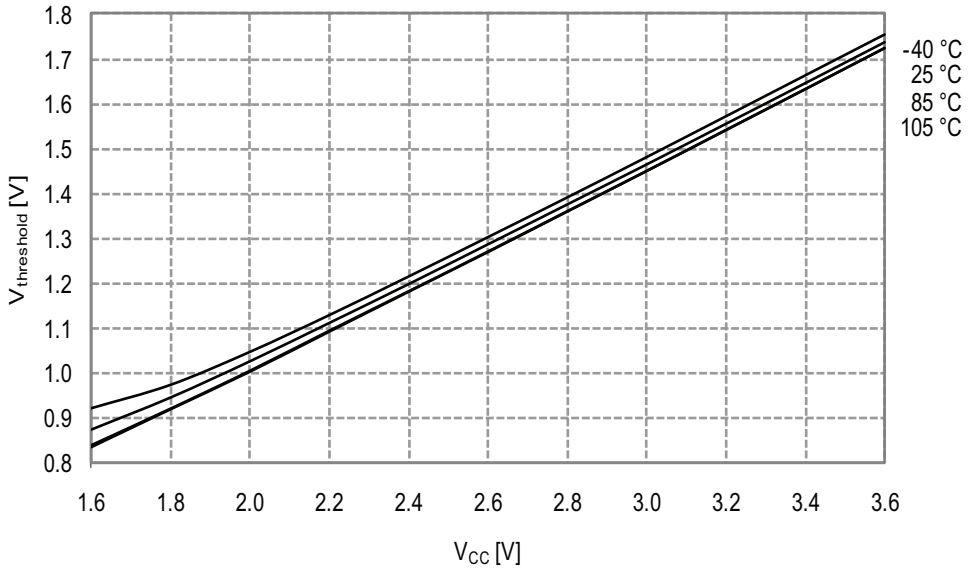
V_{CC} = 3.3V



33.1.2.3 Thresholds and Hysteresis

Figure 33-28. I/O Pin Input Threshold Voltage vs. V_{CC}

V_{IH} I/O pin read as "1"



33.2.7 External Reset Characteristics

Figure 33-120. Minimum Reset Pin Pulse Width vs. V_{CC}

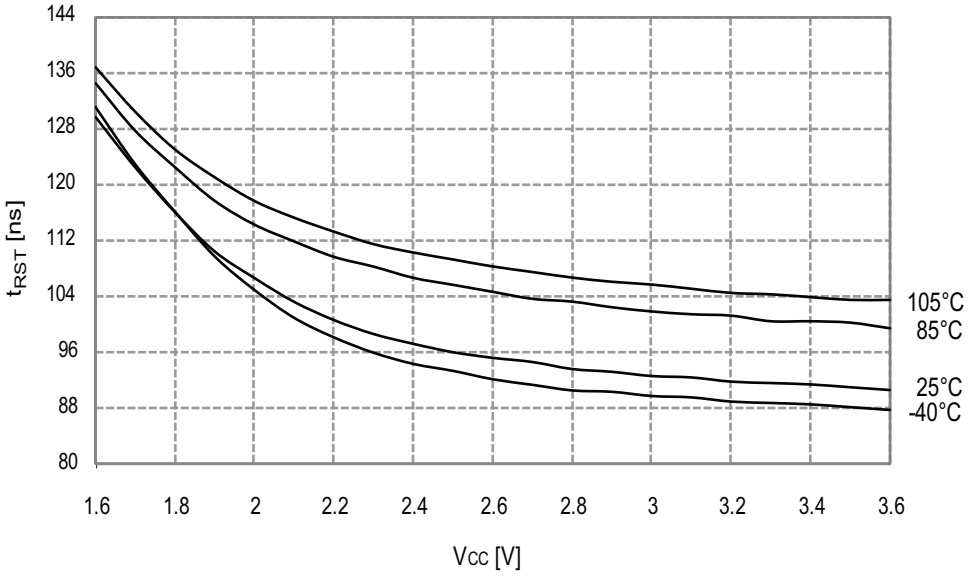


Figure 33-121. Reset Pin Pull-up Resistor Current vs. Reset Pin Voltage

V_{CC} = 1.8V

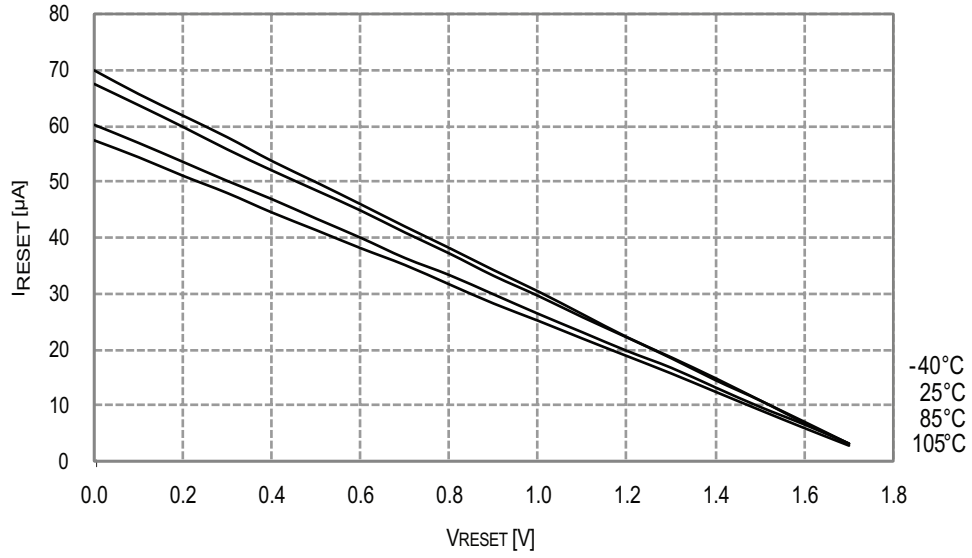


Figure 33-301.I/O Pin Pull-up Resistor Current vs. Input Voltage

V_{CC} = 3.0V

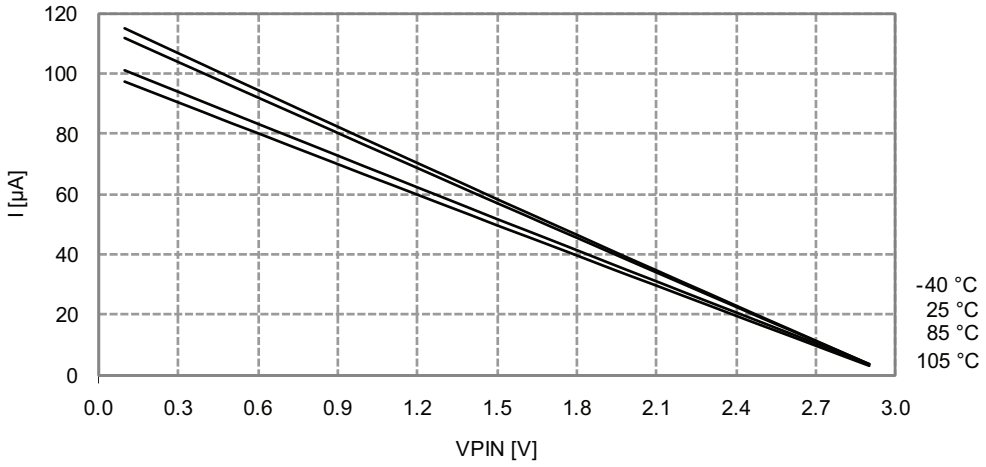
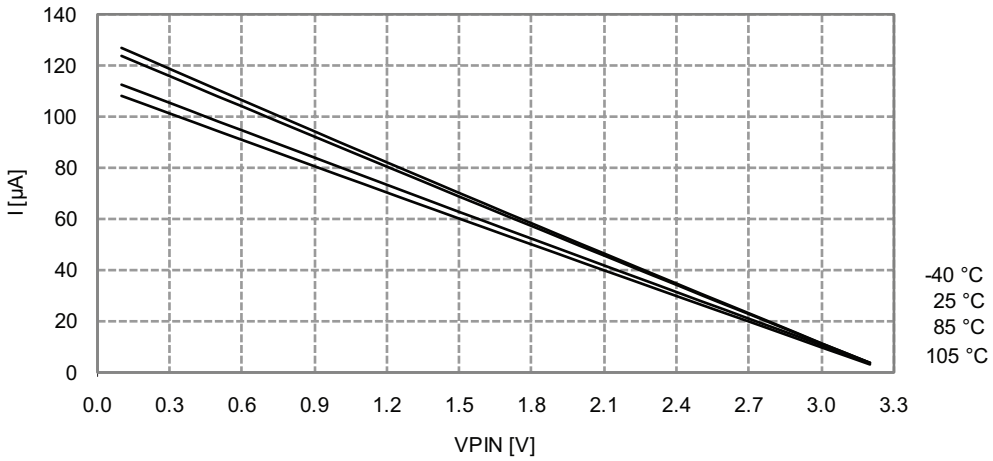


Figure 33-302.I/O Pin Pull-up Resistor Current vs. Input Voltage

V_{CC} = 3.3V



- 1× gain: 2.4 V
- 2× gain: 1.2 V
- 4× gain: 0.6 V
- 8× gain: 300 mV
- 16× gain: 150 mV
- 32× gain: 75 mV
- 64× gain: 38 mV

Problem fix/workaround

Keep the amplified voltage output from the ADC gain stage below 2.4V in order to get a correct result, or keep ADC voltage reference below 2.4V.

6. ADC Event on compare match non-functional

ADC signalling event will be given at every conversion complete even if Interrupt mode (INTMODE) is set to BELOW or ABOVE.

Problem fix/workaround

Enable and use interrupt on compare match when using the compare function.

7. ADC propagation delay is not correct when 8× – 64× gain is used

The propagation delay will increase by only one ADC clock cycle for all gain settings.

Problem fix/workaround

None.

8. Bandgap measurement with the ADC is non-functional when V_{CC} is below 2.7V

The ADC can not be used to do bandgap measurements when V_{CC} is below 2.7V.

Problem fix/workaround

None.

9. Accuracy lost on first three samples after switching input to ADC gain stage

Due to memory effect in the ADC gain stage, the first three samples after changing input channel must be disregarded to achieve 12-bit accuracy.

Problem fix/workaround

Run three ADC conversions and discard these results after changing input channels to ADC gain stage.

10. Configuration of PGM and CWCM not as described in XMEGA D Manual

Enabling Common Waveform Channel Mode will enable Pattern generation mode (PGM), but not Common Waveform Channel Mode.

Enabling Pattern Generation Mode (PGM) and not Common Waveform Channel Mode (CWCM) will enable both Pattern Generation Mode and Common Waveform Channel Mode.

Problem fix/workaround

Table 34-4. Configure PWM and CWCM According to this Table:

PGM	CWCM	Description
0	0	PGM and CWCM disabled
0	1	PGM enabled
1	0	PGM and CWCM enabled
1	1	PGM enabled

11. PWM is not restarted properly after a fault in cycle-by-cycle mode

When the AWeX fault restore mode is set to cycle-by-cycle, the waveform output will not return to normal operation at first update after fault condition is no longer present.

Problem fix/workaround

Do a write to any AWeX I/O register to re-enable the output.

12. BOD will be enabled after any reset

If any reset source goes active, the BOD will be enabled and keep the device in reset if the V_{CC} voltage is below the programmed BOD level. During Power-On Reset, reset will not be released until V_{CC} is above the programmed BOD level even if the BOD is disabled.

Problem fix/workaround

Do not set the BOD level higher than V_{CC} even if the BOD is not used.

13. EEPROM page buffer always written when NVM DATA0 is written

If the EEPROM is memory mapped, writing to NVM DATA0 will corrupt data in the EEPROM page buffer.

Problem fix/workaround

Before writing to NVM DATA0, for example when doing software CRC or flash page buffer write, check if EEPROM page buffer active loading flag (EELOAD) is set. Do not write NVM DATA0 when EELOAD is set.

14. Pending full asynchronous pin change interrupts will not wake the device

Any full asynchronous pin-change Interrupt from pin 2, on any port, that is pending when the sleep instruction is executed, will be ignored until the device is woken from another source or the source triggers again. This applies when entering all sleep modes where the System Clock is stopped.

Problem fix/workaround

None.

15. Pin configuration does not affect Analog Comparator output

The Output/Pull and inverted pin configuration does not affect the Analog Comparator output.

Problem fix/workaround

None for Output/Pull configuration.

For inverted I/O, configure the Analog Comparator to give an inverted result (that is, connect positive input to the negative AC input and vice versa), or use and external inverter to change polarity of Analog Comparator output.

Problem fix/workaround

Table 34-6. Configure PWM and CWCM According to this Table:

PGM	CWCM	Description
0	0	PGM and CWCM disabled
0	1	PGM enabled
1	0	PGM and CWCM enabled
1	1	PGM enabled

11. PWM is not restarted properly after a fault in cycle-by-cycle mode

When the AWeX fault restore mode is set to cycle-by-cycle, the waveform output will not return to normal operation at first update after fault condition is no longer present.

Problem fix/workaround

Do a write to any AWeX I/O register to re-enable the output.

12. BOD will be enabled after any reset

If any reset source goes active, the BOD will be enabled and keep the device in reset if the V_{CC} voltage is below the programmed BOD level. During Power-On Reset, reset will not be released until V_{CC} is above the programmed BOD level even if the BOD is disabled.

Problem fix/workaround

Do not set the BOD level higher than V_{CC} even if the BOD is not used.

13. EEPROM page buffer always written when NVM DATA0 is written

If the EEPROM is memory mapped, writing to NVM DATA0 will corrupt data in the EEPROM page buffer.

Problem fix/workaround

Before writing to NVM DATA0, for example when doing software CRC or flash page buffer write, check if EEPROM page buffer active loading flag (EELOAD) is set. Do not write NVM DATA0 when EELOAD is set.

14. Pending full asynchronous pin change interrupts will not wake the device

Any full asynchronous pin-change Interrupt from pin 2, on any port, that is pending when the sleep instruction is executed, will be ignored until the device is woken from another source or the source triggers again. This applies when entering all sleep modes where the System Clock is stopped.

Problem fix/workaround

None.

15. Pin configuration does not affect Analog Comparator output

The Output/Pull and inverted pin configuration does not affect the Analog Comparator output.

Problem fix/workaround

None for Output/Pull configuration.

For inverted I/O, configure the Analog Comparator to give an inverted result (that is, connect positive input to the negative AC input and vice versa), or use and external inverter to change polarity of Analog Comparator output.

- 1× gain: 2.4 V
- 2× gain: 1.2 V
- 4× gain: 0.6 V
- 8× gain: 300 mV
- 16× gain: 150 mV
- 32× gain: 75 mV
- 64× gain: 38 mV

Problem fix/workaround

Keep the amplified voltage output from the ADC gain stage below 2.4V in order to get a correct result, or keep ADC voltage reference below 2.4V.

6. ADC Event on compare match non-functional

ADC signalling event will be given at every conversion complete even if Interrupt mode (INTMODE) is set to BELOW or ABOVE.

Problem fix/workaround

Enable and use interrupt on compare match when using the compare function.

7. ADC propagation delay is not correct when 8× – 64× gain is used

The propagation delay will increase by only one ADC clock cycle for all gain settings.

Problem fix/workaround

None.

8. Bandgap measurement with the ADC is non-functional when V_{CC} is below 2.7V

The ADC can not be used to do bandgap measurements when V_{CC} is below 2.7V.

Problem fix/workaround

None.

9. Accuracy lost on first three samples after switching input to ADC gain stage

Due to memory effect in the ADC gain stage, the first three samples after changing input channel must be disregarded to achieve 12-bit accuracy.

Problem fix/workaround

Run three ADC conversions and discard these results after changing input channels to ADC gain stage.

10. Configuration of PGM and CWCM not as described in XMEGA D Manual

Enabling Common Waveform Channel Mode will enable Pattern Generation Mode (PGM), but not Common Waveform Channel Mode.

Enabling Pattern Generation Mode (PGM) and not Common Waveform Channel Mode (CWCM) will enable both Pattern Generation Mode and Common Waveform Channel Mode.