



Product Change Notification - SYST-06PUAR399

Date:

07 Feb 2019

Product Category:

32-bit Microcontrollers

Affected CPNs:**Notification subject:**

ERRATA - SAM D5x/E5x Family Errata and Data Sheet Clarification

Notification text:

SYST-06PUAR399

Microchip has released a new DeviceDoc for the SAM D5x/E5x Family Errata and Data Sheet Clarification of devices. If you are using one of these devices please read the document located at [SAM D5x/E5x Family Errata and Data Sheet Clarification](#).

Notification Status: Final

Description of Change:

The following Silicon Issues were updated:

a. FDPLL: 2.13.1 Low-Frequency Input Clock on FDPLLn Reference:CHIP003-4

The following Data Sheet Clarifications were added:

a. Update to Initialization, Enabling, Disabling, and Resetting

b. Update to Loop Divider Ratio Updates

Impacts to Data Sheet: None

Reason for Change: To Improve Productivity

Change Implementation Status: Complete

Date Document Changes Effective: 07 February 2019

NOTE: Please be advised that this is a change to the document only the product has not been changed.

Markings to Distinguish Revised from Unrevised Devices: N/A

Attachment(s):

[SAM D5x/E5x Family Errata and Data Sheet Clarification](#)

Please contact your local [Microchip sales office](#) with questions or concerns regarding this notification.

Terms and Conditions:

If you wish to receive Microchip PCNs via email please register for our PCN email service at our [PCN home page](#) select register then fill in the required fields. You will find instructions about registering for Microchips PCN email service in the [PCN FAQ](#) section.

If you wish to change your PCN profile, including opt out, please go to the [PCN home page](#) select login and sign into your myMicrochip account. Select a profile option from the left navigation bar and make the applicable selections.

Affected Catalog Part Numbers (CPN)

ATSAMD51G18A-MF
ATSAMD51G18A-MFT
ATSAMD51G18A-MU
ATSAMD51G18A-MUT
ATSAMD51G19A-MF
ATSAMD51G19A-MFT
ATSAMD51G19A-MU
ATSAMD51G19A-MUT
ATSAMD51J18A-AF
ATSAMD51J18A-AFT
ATSAMD51J18A-AU
ATSAMD51J18A-AUT
ATSAMD51J18A-MF
ATSAMD51J18A-MFT
ATSAMD51J18A-MU
ATSAMD51J18A-MUT
ATSAMD51J19A-AF
ATSAMD51J19A-AFT
ATSAMD51J19A-AU
ATSAMD51J19A-AUT
ATSAMD51J19A-MF
ATSAMD51J19A-MFT
ATSAMD51J19A-MU
ATSAMD51J19A-MUT
ATSAMD51J19A-UNT
ATSAMD51J19A-UUT
ATSAMD51J19B-AUN01
ATSAMD51J19B-AUTN01
ATSAMD51J20A-AF
ATSAMD51J20A-AFT
ATSAMD51J20A-AU
ATSAMD51J20A-AUT
ATSAMD51J20A-MF
ATSAMD51J20A-MFT
ATSAMD51J20A-MU
ATSAMD51J20A-MUT
ATSAMD51J20A-UNT
ATSAMD51J20A-UUT
ATSAMD51N19A-AF
ATSAMD51N19A-AFT
ATSAMD51N19A-AU
ATSAMD51N19A-AUT
ATSAMD51N20A-AF
ATSAMD51N20A-AFT
ATSAMD51N20A-AU
ATSAMD51N20A-AUT

ATSAMD51P19A-AF
ATSAMD51P19A-AFT
ATSAMD51P19A-AU
ATSAMD51P19A-AUT
ATSAMD51P19A-CTFT
ATSAMD51P19A-CTUT
ATSAMD51P20A-AF
ATSAMD51P20A-AFT
ATSAMD51P20A-AU
ATSAMD51P20A-AUT
ATSAMD51P20A-CTFT
ATSAMD51P20A-CTUT
ATSAME51J18A-AF
ATSAME51J18A-AFT
ATSAME51J18A-AU
ATSAME51J18A-AUT
ATSAME51J18A-MF
ATSAME51J18A-MFT
ATSAME51J18A-MU
ATSAME51J18A-MUT
ATSAME51J19A-AF
ATSAME51J19A-AFT
ATSAME51J19A-AU
ATSAME51J19A-AUT
ATSAME51J19A-MF
ATSAME51J19A-MFT
ATSAME51J19A-MU
ATSAME51J19A-MUT
ATSAME51J20A-AF
ATSAME51J20A-AFT
ATSAME51J20A-AU
ATSAME51J20A-AUT
ATSAME51J20A-MU
ATSAME51J20A-MUT
ATSAME51N19A-AF
ATSAME51N19A-AFT
ATSAME51N19A-AU
ATSAME51N19A-AUT
ATSAME51N20A-AF
ATSAME51N20A-AFT
ATSAME51N20A-AU
ATSAME51N20A-AUT
ATSAME53J18A-AF
ATSAME53J18A-AFT
ATSAME53J18A-AU
ATSAME53J18A-AUT
ATSAME53J18A-MF
ATSAME53J18A-MFT
ATSAME53J18A-MU

ATSAME53J18A-MUT
ATSAME53J19A-AF
ATSAME53J19A-AFT
ATSAME53J19A-AU
ATSAME53J19A-AUT
ATSAME53J19A-MF
ATSAME53J19A-MFT
ATSAME53J19A-MU
ATSAME53J19A-MUT
ATSAME53J20A-AF
ATSAME53J20A-AFT
ATSAME53J20A-AU
ATSAME53J20A-AUT
ATSAME53J20A-MF
ATSAME53J20A-MFT
ATSAME53J20A-MU
ATSAME53J20A-MUT
ATSAME53N19A-AF
ATSAME53N19A-AFT
ATSAME53N19A-AU
ATSAME53N19A-AUT
ATSAME53N20A-AF
ATSAME53N20A-AFT
ATSAME53N20A-AU
ATSAME53N20A-AUT
ATSAME54N19A-AF
ATSAME54N19A-AFT
ATSAME54N19A-AU
ATSAME54N19A-AUT
ATSAME54N20A-AF
ATSAME54N20A-AFT
ATSAME54N20A-AU
ATSAME54N20A-AUT
ATSAME54P19A-AF
ATSAME54P19A-AFT
ATSAME54P19A-AU
ATSAME54P19A-AUT
ATSAME54P19A-CTFT
ATSAME54P19A-CTUT
ATSAME54P20A-AF
ATSAME54P20A-AFT
ATSAME54P20A-AU
ATSAME54P20A-AUT
ATSAME54P20A-CTFT
ATSAME54P20A-CTUT



SAM D5x/E5x Family

SAM D5x/E5x Family Silicon Errata and Data Sheet Clarification

SAM D5x/E5x Family Errata

The SAM D5x/E5x family of devices that you have received conform functionally to the current Device Data Sheet (DS60001507C), except for the anomalies described in this document.

The silicon issues discussed in the following pages are for silicon revisions with the Device and Revision IDs listed in Table 1. SAM D5x/E5x Family Silicon Device Identification. The silicon issues are summarized in the Table of Contents following this section.

The errata described in this document will be addressed in future revisions of the SAM D5x/E5x family silicon.

Note: This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current.

Table 1. SAM D5x/E5x Family Silicon Device Identification

Part Number	Device Identification (DID[31:0])	Revision ID (DID.REVISION[3:0])
		A
ATSAME54P19A	0x6184xx01	0x0
ATSAME54P20A	0x6184xx00	
ATSAME54N19A	0x6184xx03	
ATSAME54N20A	0x6184xx02	
ATSAME53N20A	0x6183xx02	
ATSAME53N19A	0x6183xx03	
ATSAME53J18A	0x6183xx06	
ATSAME53J19A	0x6183xx05	
ATSAME53J20A	0x6183xx04	
ATSAME51N19A	0x6181xx01	
ATSAME51N20A	0x6181xx00	
ATSAME51J18A	0x6181xx03	
ATSAME51J19A	0x6181xx02	
ATSAME51J20A	0x6181xx04	
ATSAMD51P20A	0x6006xx00	
ATSAMD51P19A	0x6006xx01	
ATSAMD51N19A	0x6006xx03	
ATSAMD51N20A	0x6006xx02	
ATSAMD51J18A	0x6006xx06	
ATSAMD51J19A	0x6006xx05	
ATSAMD51J20A	0x6006xx04	
ATSAMD51G18A	0x6006xx08	
ATSAMD51G19A	0x6006xx07	

Data Sheet clarifications and corrections (if applicable) are located in the section [Data Sheet Clarifications](#), following the discussion of silicon issues.

Note: Refer to the “**Device Service Unit**” chapter in the current device data sheet (DS60001507B) for a detailed information on Device Identification and Revision IDs for your specific device.

Table of Contents

SAM D5x/E5x Family Errata.....	1
1. Silicon Errata Summary.....	5
2. Silicon Errata Issues.....	15
2.1. Analog-to-Digital Converter (ADC).....	15
2.2. Analog Comparator (AC).....	16
2.3. Configurable Custom Logic (CCL).....	16
2.4. Controller Area Network (CAN).....	16
2.5. Clock Failure Detector (CFD).....	23
2.6. Device.....	24
2.7. Device Service Unit (DSU).....	25
2.8. 48 MHz Digital Frequency-Locked Loop (DFLL48M).....	26
2.9. Digital-to-Analog Converter (DAC).....	27
2.10. Direct Memory Access Controller (DMAC).....	28
2.11. Ethernet MAC (GMAC).....	29
2.12. External Interrupt Controller (EIC).....	29
2.13. Fractional Digital Phase-Locked Loop (FDPLL).....	30
2.14. Non-Volatile Memory Controller (NVMCTRL).....	31
2.15. Peripheral Access Controller (PAC).....	31
2.16. I/O Pin Controller (PORT).....	31
2.17. Real-Time Counter (RTC).....	32
2.18. Serial Communication Interface (SERCOM).....	34
2.19. Supply Controller (SUPC).....	39
2.20. Timer/Counter (TC).....	39
2.21. Timer/Counter for Control Applications (TCC).....	39
2.22. Position Decoder (PDEC).....	41
3. Data Sheet Clarifications.....	42
3.1. Update to Initialization, Enabling, Disabling, and Resetting	42
3.2. Update to Loop Divider Ratio Updates.....	42
3.3. Flash Timing Characteristics.....	42
3.4. BOD12 Register Information.....	42
4. Appendix A: Revision History.....	43
The Microchip Web Site.....	46
Customer Change Notification Service.....	46
Customer Support.....	46
Microchip Devices Code Protection Feature.....	46
Legal Notice.....	47

Trademarks..... 47

Quality Management System Certified by DNV.....48

Worldwide Sales and Service.....49

1. Silicon Errata Summary

Table 1-1. Errata Summary

Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Analog -to-Digital Converter(ADC)	ADC SYNCBUSY.SWTRIG	2.1.1	The ADC SYNCBUSY.SWTRIG gets stuck to '1' after wake-up from Standby Sleep mode.	X
Analog -to-Digital Converter(ADC)	ADC TUE/INL/DNL	2.1.2	The ADC TUE/INL/DNL performance is not guaranteed in the following scenarios: <ul style="list-style-type: none"> Sampling frequency is above 500 ksp/s ADC VREF is different from VDDANA 	X
Analog -to-Digital Converter(ADC)	Reference Buffer Offset Compensation	2.1.3	ADC converted data could be erroneous when using the Reference Buffer (REFCTRL.REFSEL = INTREF, INTVCC0, INTVCC1, VREFA or VREB) and when Reference Buffer Offset Compensation is enabled (REFCTRL.REFCOMP = 1).	X
Analog Comparator (AC)	AC Hysteresis	2.2.1	Enabling Hysteresis (COMPCTRLn.HYSTEN = 0x1) changes the threshold voltage (VTH-), which could result in unexpected behavior of the Analog Comparator.	X
Configurable Custom Logic (CCL)	Enable Protected Registers	2.3.1	The SEQCTRLx and LUTCTRLx registers are enable-protected by the CTRL.ENABLE bit, whereas they should be enable-protected by the LUTCTRLx.ENABLE bits.	X
Configurable Custom Logic (CCL)	Sequential Logic	2.3.2	LUT output is corrupted after enabling CCL when sequential logic is used.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Controller Area Network (CAN)	CAN Edge Filtering	2.4.1	When edge filtering is activated (CCCR.EFBI = 1) and when the end of the integration phase coincides with a falling edge at the Rx input pin, it may occur that the CAN synchronizes itself incorrectly and does not correctly receive the first bit of the frame. In this case, the CRC will detect the first bit that was received incorrectly, it will rate the received FD frame as faulty, and an error frame will be send.	X
Controller Area Network (CAN)	Dominant Bit of Intermission	2.4.2	When NBTP.NTSEG2 is configured to zero (Phase_Seg2(N) = 1), and when there is a pending transmission request, a dominant third bit of Intermission may cause the CAN to wrongly transmit the first identifier bit dominant instead of recessive, even if this bit was configured as '1' in the Tx Buffer Element of the CAN module.	X
Controller Area Network (CAN)	INTFLAG Status	2.4.3	Message transmitted with wrong arbitration and control fields.	X
Controller Area Network (CAN)	DAR Mode	2.4.4	Retransmission in DAR mode due to lost arbitration.	X
Controller Area Network (CAN)	High Priority Message (HPM) interrupt	2.4.5	Unexpected High Priority Message (HPM) interrupt	X
Controller Area Network (CAN)	TxFIFO	2.4.6	Tx FIFO message sequence inversion	X
Clock Failure Detector (CFD)	CFD with XOSC/ XOSC32K Oscillator	2.5.1	When the CFD is enabled for the XOSC/XOSC32K oscillator and the oscillator input signal is stuck at 1, the clock failure detection works correctly but the switch to the safe clock will fail.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Device	Reverse Current in VDDIOB Domain	2.6.1	For the device with 100-pin, 120-pin, and 128-pin counts, when VDDIOB is supplied with the voltage less than VDDIO - 0.7V, reverse current in VDDIOB cluster is observed.	X
Device	Internal Pull-up on the RESET Pin	2.6.2	The internal pull-up of the RESET pin is not functional.	X
Device	Detection of a Debugger Probe	2.6.3	The detection of a debugger probe could fail if the "BOD33 Disable" fuse is cleared (i.e., BOD33 is enabled).	X
Device	VBAT Mode	2.6.4	VBAT mode is not functional.	X
Device	Internal Reference	2.6.5	When the internal reference is used with the DAC and ADC, their outputs become non-linear when the operating temperature is less than 0°C.	X
Device	Device Operation for Temperature < -20°C	2.6.6	If the operating temperature is less than -20°C, the device does not start.	X
Device Service Unit	CRC32	2.7.1	DSU CRC32 will not complete when targeting NVM memory space while the NVM cache is disabled.	X
48 MHz Digital Frequency-Locked Loop (DFLL48M)	COARSE or FINE Calibration Values During the Locking Sequence	2.8.1	If the DFLL48M reaches the maximum or minimum COARSE or FINE calibration values during the locking sequence, an out of bounds interrupt will be generated.	X
48 MHz Digital Frequency-Locked Loop (DFLL48M)	STATUS.DFLLRDY Bit in Close Loop Mode	2.8.2	In Close Loop mode, the STATUS.DFLLRDY bit does not rise before lock fine occurs. Therefore, the information about DFLL ready to start Close Loop mode is not available.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
48 MHz Digital Frequency-Locked Loop (DFLL48M)	DFLLVAL.FINE Value When DFLL48M Re-enabled	2.8.3	If the DFLL is disabled and then re-enabled, the DFLLVAL.FINE value is ignored by the DFLL module, which will then start its lock fine process at another frequency.	X
Digital-to-Analog Converter (DAC)	Differential Mode the Smoothing of the Output Signal	2.9.1	In Differential mode the smoothing of the output signal is not fully functional.	X
Digital-to-Analog Converter (DAC)	VDDANA as the DAC Reference	2.9.2	The selection of VDDANA as the DAC reference in DAC.CTRLB.REFSEL is non-functional.	X
Digital-to-Analog Converter (DAC)	DAC on Negative Input AIN3	2.9.3	No analog compare will be done on Comparator 1 (AC1) when using the DAC on negative input AIN3.	X
Digital-to-Analog Converter (DAC)	Interpolation Mode	2.9.4	If the Interpolation mode is enabled (with filter integrated to the DAC), the last data from the filter is missing, hence the DAC final output value does not correspond to the DAC input value.	X
Direct Memory Access Controller (DMAC)	Linked Descriptors	2.10.1	When at least one channel using linked descriptors is already active, a channel Fetch Error (FERR) could occur on enabling a channel with no linked descriptor or the second descriptor (index 1) of the channel being enabled could be fetched by one of the already active channels using linked descriptors.	X
Direct Memory Access Controller (DMAC)	Channel Priority	2.10.2	When using channels with different priority levels, the highest priority channel could stall at the end of its current block.	X
Direct Memory Access Controller (DMAC)	DMAC in Debug Mode	2.10.3	In debug mode, DMAC does not restart after a debug halt when DBGCTRL.DBGRUN=0.	X
Ethernet MAC (GMAC)	Ethernet Functionality in 64-pin Packages	2.11.1	Ethernet functionality in 64-pin packages is not available.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
External Interrupt Controller (EIC)	Edge Detection	2.12.1	When enabling EIC, SYNCBUSY.ENABLE is released before EIC is fully enabled. Edge detection can be done only after three cycles of the selected GCLK (GCLK_EIC or CLK_ULP32K).	X
External Interrupt Controller (EIC)	Asynchronous Edge Detection	2.12.2	When the asynchronous edge detection is enabled and the system is in Standby mode, only the first edge will be detected. The following edges are ignored until the system wakes up.	X
Fractional Digital Phase-Locked Loop (FDPLL)	Low-Frequency Input Clock on FDPLLn	2.13.1	When using a low frequency input clock (≤ 400 kHz) for input to FDPLLn, several FDPLL false unlock status indications may occur while the FDPLL output frequency is actually stable.	X
Fractional Digital Phase-Locked Loop (FDPLL)	FDPLL Ratio in DPLLnRATIO	2.13.2	When changing the FDPLL ratio in DPLLnRATIO register on-the-fly, STATUS.DPLLnLDRTO will not be set when the ratio update will be completed.	X
Non-Volatile Memory Controller (NVMCTRL)	NVM Read Corruption	2.14.1	NVM reads could be corrupted when mixing NVM reads with Page Buffer writes.	X
Peripheral Access Controller (PAC)	PAC Protection Error in FREQM	2.15.1	FREQM reads on the Control B register (FREQM.CTRLB) generate a PAC protection error.	X
	PAC Protection Error in CCL	2.15.2	Writing the Software Reset bit in the Control A register (CTRLASWRST) will trigger a PAC protection error.	X
I/O Pin Controller (PORT)	PORT Read/Write Attempts on Non-Implemented Registers	2.16.1	PORT read/write attempts on non-implemented registers, including addresses beyond the last implemented register group (PA, PB,...), do not generate a PAC protection error.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
I/O Pin Controller (PORT)	PORT Pull-Up/Pull-Down Resistor	2.16.2	The pull-down on PA24/PA25 are activated during power-up and when Sleep mode is OFF. On all other pins, except those in the VSWOUT cluster, the pull-up is activated during power-up and when Sleep mode is OFF.	X
Real-Time Counter (RTC)	Write Corruption	2.17.1	<p>A 8-bit or 16-bit write access for a 32-bit register, or 8-bit write access for a 16-bit register can fail for the following registers:</p> <ul style="list-style-type: none"> • The COUNT register in COUNT32 mode • The COUNT register in COUNT16 mode • The CLOCK register in CLOCK mode 	X
Real-Time Counter (RTC)	COUNTSYNC	2.17.2	When COUNTSYNC is enabled, the first COUNT value is not correctly synchronized and therefore it is a wrong value.	X
Real-Time Counter (RTC)	Tamper Input Filter	2.17.3	Majority debouncing, as part of RTC tamper detection, does not work, when enabled by setting Debouncer Majority Enable bit CTRLB.DEBMAJ.	X
Real-Time Counter (RTC)	Tamper Detection	2.17.4	Upon enabling the RTC, a false tamper detection could be reported by the RTC.	X
Real-Time Counter (RTC)	Tamper Detection Timestamp	2.17.5	If an external reset occurs during a tamper detection, the TIMESTAMP register will not be updated when next tamper detection is triggered.	X
Serial Communication Interface (SERCOM)	SERCOM-USART: USART Auto-Baud Mode	2.18.1	In USART Auto-Baud mode, missing stop bits are not recognized as inconsistent sync (ISF) or framing (FERR) errors.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Serial Communication Interface (SERCOM)	SERCOM-USART: Collision Detection	2.18.2	In USART operating mode with Collision Detection enabled (CTRLB.COLDEN=1), the SERCOM will not abort the current transfer as expected if a collision is detected and if the SERCOM APB Clock is lower than the SERCOM Generic Clock.	X
Serial Communication Interface (SERCOM)	SERCOM-USART: Debug Mode	2.18.3	In USART operating mode, if DBGCTRL.DBGSTOP=1, data transmission is not halted after entering Debug mode.	X
Serial Communication Interface (SERCOM)	SERCOM-USART: 32-bit Extension Mode	2.18.4	When 32-bit Extension mode is enabled and data to be sent is not in multiples of 4 bytes (which means the length counter must be enabled), additional bytes will be sent over the line.	X
Serial Communication Interface (SERCOM)	SERCOM-UART: TXINV and RXINV Bits	2.18.5	The TXINV and RXINV bits in the CTRLA register have inverted functionality.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: SDAHOLD Timing	2.18.6	SDAHOLD timing of the SERCOM-I ² C does not match the value shown in the current device data sheet.	X
Serial Communication Interface (SERCOM)	Repeated Start in High-Speed Master Write Operation	2.18.7	For High-Speed Master Write operations, writing CTRLB.CMD = 0x1 issues a STOP command instead of a Repeated Start making repeated start not possible in that mode.	X
Serial Communication Interface (SERCOM)	Repeated Start in High-Speed Master Read Operation	2.18.8	For High-Speed Master Read operations, sending a NACK (CTRLB.CMD = 0x2) forces a STOP to be issued making repeated start not possible in that mode.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Serial Communication Interface (SERCOM)	STATUS.CLKHOLD Bit in Master and Slave Modes	2.18.9	The STATUS.CLKHOLD bit in master and slave modes can be written whereas it is a read-only status bit.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: I ² C in Slave Mode	2.18.10	In I ² C mode, LENERR, SEXTOUT, LOWTOUT, COLL and BUSERR bits are not cleared when INTFLAG.AMATCH is cleared.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: Slave Mode with DMA	2.18.11	In I ² C Slave Transmitter mode, at the reception of a NACK, if there is still data to be sent in the DMA buffer, the DMA will push a data to the DATA register.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: I ² C Slave in DATA32B Mode	2.18.12	When SERCOM is configured as an I ² C slave in 32-bit Data Mode (DATA32B=1) and the I ² C master reads from the I ² C slave (slave transmitter) and outputs its NACK (indicating no more data is needed), the I ² C slave still receives a DRDY interrupt.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: 10-bit Addressing Mode	2.18.13	10-bit addressing in I ² C Slave mode is not functional.	X
Serial Communication Interface (SERCOM)	SERCOM-I ² C: Repeated Start	2.18.14	When the Quick command is enabled (CTRLB.QCEN=1), software can issue a repeated Start by writing either CTRLB.CMD or ADDR.ADDR bit fields.	X
Serial Communication Interface (SERCOM)	SERCOM-SPI: Data Preload	2.18.15	In SPI Slave mode and with Slave Data Preload Enabled (CTRLB.PLOADEN=1), the first data sent from the slave will be a dummy byte if the master cannot keep the Slave Select (SS) line low until the end of transmission.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
Serial Communication Interface (SERCOM)	Repeated Start	2.18.16	For Master Write operations (excluding High-Speed mode), in 10-bit addressing mode, writing CTRLB.CMD = 0x1 does not issue correctly a Repeated Start command.	X
Supply Controller (SUPC)	Buck Converter Mode	2.19.1	Digital Phase-Locked Loop (FDPLL200Mx2) and Digital Frequency-Locked Loop (DFLL48M) PLL's cannot be used with main voltage regulator in Buck converter mode.	X
Supply Controller (SUPC)	BOD33 Hysteresis	2.19.2	The hysteresis feature of the 3.3V BOD is not functional while the device is in STANDBY sleep mode.	X
Timer/Counter (TC)	PERBUF/CCBUFx Register	2.20.1	When clearing the STATUS.PERBUFV/ STATUS.CCBUFx flag, the SYNCBUSY flag is released before the PERBUF/CCBUFx register is restored to its appropriate value.	X
Timer/Counter for Control Applications (TCC)	TCC with EVSYS in SYNC/RESYNC Mode	2.21.1	TCC peripheral is not compatible with an EVSYS channel in SYNC or RESYNC mode.	X
Timer/Counter for Control Applications (TCC)	Dithering Mode with External Retrigger Events	2.21.2	Using TCC in Dithering mode with external retrigger events can lead to an unexpected stretch of right aligned pulses, or shrink of left-aligned pulses.	X
Timer/Counter for Control Applications (TCC)	ALOCK Feature	2.21.3	ALOCK feature is not functional.	X
Timer/Counter for Control Applications (TCC)	LUPD feature in Down-Counting mode	2.21.4	In down-counting mode, the Lock Update bit (CTRLB.LUPD) does not protect against a PER register update from the PERBUF register.	X

SAM D5x/E5x Family

Silicon Errata Summary

.....continued				
Module	Feature	Item Number	Issue Summary	Affected Revisions
				A
PDEC	X2 Mode	2.22.1	In X2 mode, if index signal generated from the motor sensor is stuck at 0, then position counter does not work correctly.	X

2. Silicon Errata Issues

The following issues apply to the SAM D5x/E5x Family of devices.

2.1 Analog-to-Digital Converter (ADC)

2.1.1 ADC SYNCBUSY.SWTRIG Reference:ADC102-4

The ADC SYNCBUSY.SWTRIG gets stuck to '1' after wake-up from Standby Sleep mode.

Workaround

Ignore the ADC SYNCBUSY.SWTRIG status when waking up from Sleep mode.

Affected Silicon Revisions

A							
X							

2.1.2 ADC TUE/INL/DNL Performance Reference:UANA107-3

The ADC TUE/INL/DNL performance is not guaranteed in the following scenarios:

- Sampling frequency is above 500 ksps AND
- ADC V_{REF} is different from VDDANA

Workaround

None.

Affected Silicon Revisions

A							
X							

2.1.3 Reference Buffer Offset Compensation Reference:CHIP003-247

ADC converted data could be erroneous when using the Reference Buffer (REFCTRL.REFSEL = INTREF, INTVCC0, INTVCC1, VREFA or VREB) and when Reference Buffer Offset Compensation is enabled (REFCTRL.REFCOMP = 1).

Workaround

The first five conversions must be ignored. All further ADC module conversions are accurate.

Affected Silicon Revisions

A							
X							

2.2 Analog Comparator (AC)

2.2.1 AC Hysteresis Reference:CHIP003-185

Enabling Hysteresis (COMPCTRLn.HYSTEN = 0x1) changes the threshold voltage (VTH-), which could result in unexpected behavior of the Analog Comparator.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.3 Configurable Custom Logic (CCL)

2.3.1 Enable Protected Registers Reference:CLA100-33

The SEQCTRLx and LUCTRLx registers are enable-protected by the CTRL.ENABLE bit, whereas they should be enable-protected by the LUTCTRLx.ENABLE bits.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.3.2 Sequential Logic Reference Reference:CLA100-32

LUT Output is corrupted after enabling CCL when sequential logic is used.

Workaround

Write the CTRL register twice when enabling the CCL.

Affected Silicon Revisions

A							
X							

2.4 Controller Area Network (CAN)

2.4.1 CAN Edge Filtering Reference:CAN100-7

When edge filtering is activated (CCCR.EFBI = 1) and when the end of the integration phase coincides with a falling edge at the Rx input pin, it may occur that the CAN synchronizes itself incorrectly and does

not correctly receive the first bit of the frame. In this case, the CRC will detect the first bit that was received incorrectly, it will rate the received FD frame as faulty, and an error frame will be send.

The issue only occurs when there is a falling edge at the Rx input pin (CAN_RX) within the last time quantum (tq) before the end of the integration phase. The last time quantum of the integration phase is at the sample point of the 11th recessive bit of the integration phase. When edge filtering is enabled, the bit timing logic of the CAN sees the Rx input signal delayed by the edge filtering. When the integration phase ends, edge filtering is automatically disabled. This affects the reset of the FD CRC registers at the beginning of the frame. The Classical CRC register is not affected, hence this issue does not affect the reception of Classical frames.

In CAN communication, the CAN module may enter an integrating state (either by resetting the CCCR.INIT or by protocol exception event) while a frame is active on the bus. In this case, the 11 recessive bits are counted between the acknowledge bit and the following start of frame. All nodes have synchronized at the beginning of the dominant acknowledge bit. This means that the edge of the following start of frame bit cannot fall on the sample point, hence the issue does not occur. The issue occurs only when the CAN is by local errors, mis-synchronized with regard to the other nodes.

Glitch filtering as specified in ISO 11898-1:2015 is fully functional.

Edge filtering was introduced for applications where the data bit time is at least 2-tq (of nominal bit time) long. In that case, edge filtering requires at least two consecutive dominant time quanta before the counter counting the 11 recessive bits for idle detection is restarted. This means edge filtering covers the theoretical case of occasional 1-tq long dominant spikes on the CAN bus that would delay idle detection. Repeated dominant spikes on the CAN bus would disturb all CAN communication, so the filtering to speed up idle detection would not help network performance.

When this rare event occurs, the CAN sends an error frame and the sender of the affected frame retransmits the frame. When the retransmitted frame is received, the CAN has left the integration phase and the frame will be received correctly. Edge filtering is only applied during the integration phase and it is never used during normal operation. Because the integration phase is very short with respect to "active communication time", the impact on total error frame rate is negligible. The issue has no impact on data integrity.

The CAN enters the integration phase under the following conditions:

- When CCCR.INIT is set to '0' after start-up
- After a protocol exception event (only when CCCR.PXHD = 0)

Scope:

The erratum is limited to FD frame reception when edge filtering is active (CCCR.EFBI = 1) and when the end of the integration phase coincides with a falling edge at the Rx input pin.

Effects:

The calculated CRC value does not match the CRC value of the received FD frame and the CAN module sends an error frame. After retransmission the frame is received correctly.

Workaround:

Disable edge filtering or wait on retransmission in the event that this rare event occurs.

Affected Silicon Revisions

A							
---	--	--	--	--	--	--	--

X							
---	--	--	--	--	--	--	--

2.4.2 Dominant Bit of Intermission Reference: CAN100-8

When NBTP.NTSEG2 is configured to zero (Phase_Seg2(N) = 1), and when there is a pending transmission request, a dominant third bit of intermission may cause the CAN to wrongly transmit the first identifier bit dominant instead of recessive, even if this bit was configured as '1' in the Tx Buffer Element of the CAN module.

Workaround

A phase buffer segment 2 of length '1' (Phase_Seg2(N) = 1) is not sufficient to switch to the first identifier bit after the sample point in intermission where the dominant bit was detected.

The CAN protocol according to ISO 11898-1 defines that a dominant third bit of intermission causes a pending transmission to be started immediately. The received dominant bit is handled as if the CAN has transmitted a Start-of-Frame (SoF) bit.

The ISO 11898-1 specifies the minimum configuration range for Phase_Seg2(N) to be 2..8 tq. Therefore, excluding a Phase_Seg2(N) of '1' will not affect CAN conformance.

Effects:

If NBTP.NTSEG2 = 0, it may occur that the CAN transmits the first identifier bit dominant instead of recessive.

Update configuration range of NBTP.NTSEG2 from 0..127 tq to 1..127 tq in the CAN documentation.

Affected Silicon Revisions

A							
X							

2.4.3 Message Transmitted with Wrong Arbitration and Control Fields Reference: CAN100-16

Description:

Under the following conditions a message with wrong ID, format, and DLC is transmitted:

- The CAN is in the "Receiver" (PSR.ACT #0b10) state, hence no pending transmission
- A new transmission is requested before the third bit of intermission is reached
- The CAN bus is sampled dominant at the third bit of intermission which is treated as SoF (See ISO11898-1:2015, "Section 10.4.2.2")

Under the conditions above, the following might happen:

- The shift register is not loaded with ID, format, and DLC of the requested message
- The CAN will start arbitration with wrong ID, format, and DLC on the next bit
- If the ID wins arbitration, a CAN message with a valid CRC is transmitted
- If this message is acknowledged, the ID stored in the Tx event FIFO is the ID of the requested Tx message and not the ID of the message transmitted on the CAN bus, hence no error is detected by the transmitting CAN

Scope:

The erratum is limited when CAN is in the "Receiver" (PSR.ACT = 0b10) state with no pending transmission (register TXBRP == 0) and a new transmission is requested before the third bit of intermission is reached and this third bit of intermission is seen dominant.

When a transmission is requested by the CPU by writing to TXBAR, the Tx message handler performs an internal arbitration and loads the pending transmit message with the highest priority into its output buffer and then sets the transmission request for the CAN Protocol Controller. The problem occurs only when the transmission request for the CAN Protocol Controller is activated in the critical time window between the sample points of the second and third bit of intermission and if that third bit of intermission is seen dominant.

This dominant level at the third bit of intermission may result from an external disturbance or may be transmitted by another node with a significantly faster clock.

Effects:

In the described case it may happen that the shift register is not loaded with arbitration and control field of the message to be transmitted. The frame is transmitted with wrong ID, format, and DLC but with the data field of the requested message. The message is transmitted in correct CAN (FD) frame format with a valid CRC.

If the message loses arbitration or is disturbed by an error, it is retransmitted with correct arbitration and control fields.

Workarounds

- **Workaround 1:** Request a new transmission only if another transmission is already pending (that is, register TXBRP ≠ 0) or when the CAN is not in the "Receiver" (when PSR.ACT ≠ 0b10) state. To avoid activating the transmission request in the critical time window between the sample points of the second and third bit of intermission, the application software can evaluate the Rx interrupt flags, such as IR.DRX, IR.RF0N, and IR.RF1N, which are set at the last bit of EoF when a received and accepted message becomes valid. The last bit of EoF is followed by third bits of intermission. Therefore the critical time window has safely terminated three bit times after the Rx interrupt. Now a transmission may be requested by writing to TXBAR. After the interrupt, the application has to take care that the transmission request for the CAN Protocol Controller is activated before the critical window of the following reception is reached.
- **Workaround 2:** If a transmission is to be requested while no other transmission request is already pending and the CAN bus is not idle, set the CCCR.INIT bit (which stops the CAN protocol controller), set the transmission request and clear the CCCR.INIT bit. The message currently being received when the CCCR.INIT bit is set will be lost, but no errors (or error frames) will be generated and the CAN protocol controller will re-integrate into the CAN communication immediately at the 11 recessive bits of the next End-of-Frame including intermission.
- **Workaround 3:** It is also possible to keep the number of pending transmissions always at > 0 by frequently requesting a message, then the condition "no pending transmission" is never met. The frequently requested message may be given a low priority, losing arbitration to all other messages.

Affected Silicon Revisions

A							
X							

2.4.4 DAR Mode Reference: CAN100-13

When the CAN is configured in DAR mode (CCCR.DAR = 1) the automatic retransmission for transmitted messages that have been disturbed by an error or have lost arbitration is disabled. When the transmission attempt is not successful, the Tx Buffer's Transmission Request bit (TXBRP.TRPn) will be cleared and the Tx Buffer's Cancellation Finished bit (TXBCF.CFn) will be set.

When the transmitted message loses arbitration at one of the first two identifier bits, chances are that instead of the bits of the actually transmitted Tx Buffer, the TXBRP.TRPn and TXBCF.CFn bits of the previously started Tx Buffer (or Tx Buffer 0 if there is no previous transmission attempt) are written (TXBRP.TRPn = 0, TXBCF.CFn = 1).

If in this case the TXBRP.TRPn bit of the Tx Buffer that lost arbitration at the first two identifier bits are not cleared, retransmission is attempted. When the CAN loses arbitration again at the immediately following retransmission, then actually and previously transmitted Tx Buffer are the same and this Tx Buffer's TXBRP.TRPn bit is cleared and its TXBCF.CFn bit is set.

Scope:

The erratum is limited to the case when the CAN loses arbitration at one of the first two transmitted identifier bits while in DAR mode. The problem does not occur when the transmitted message is disturbed by an error.

Effects:

In this case, it might happen that the TXBRP.TRPn bit is cleared after the second transmission attempt instead of the first. Additionally it may happen that the TXBRP.TRPn bit of the previously started Tx Buffer is cleared, if it has been set again. As in this case the previously started Tx Buffer has lost CAN internal arbitration against the active Tx Buffer, its message has a lower identifier priority. It would also have lost arbitration on the CAN bus at the same position.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.4.5 High-Priority Message (HPM) interrupt Reference: CAN100-15

There are two configurations where the issue occurs:

Configuration A:

- At least one Standard Message ID Filter Element is configured with priority flag set (S0.SFEC = 0b100/0b101/0b110)
- No Extended Message ID Filter Element configured
- Non-matching extended frames are accepted (GFC.ANFE = 0b00/0b01)

The HPM interrupt flag IR.HPM is set erroneously on reception of a non-high-priority extended message under the following conditions:

1. A standard HPM frame is received and accepted by a filter with priority flag set (that is, Interrupt flag IR.HPM is set as expected).

2. An extended frame is received and accepted because of the GFC.ANFE configuration (that is, Interrupt flag IR.HPM is set erroneously).

Configuration B:

- At least one Extended Message ID filter element is configured with priority flag set (F0.EFEC = 0b100/0b101/0b110)
- No Standard Message ID filter element is configured
- Non matching standard frames are accepted (GFC.ANFS = 0b00/0b01)

The HPM interrupt flag IR.HPM is set erroneously on reception of a non high-priority standard message under the following conditions:

1. An extended HPM frame is received and accepted by a filter with priority flag set (that is, Interrupt flag IR.HPM is set as expected).
2. A standard frame is received and accepted because of the GFC.ANFS configuration (that is, Interrupt flag IR.HPM is set erroneously).

Scope:

The erratum is limited to the following configurations:

Configuration A:

No Extended Message ID filter element is configured and non matching extended frames are accepted due to Global Filter Configuration (GFC.ANFE = 0b00/0b01).

Configuration B:

No Standard Message ID Filter Element configured and non-matching standard frames are accepted due to Global Filter Configuration (GFC.ANFS = 0b00/0b01).

Effects:

Interrupt flag IR.HPM is set erroneously at the reception of a frame with:

- Configuration A: Extended Message ID
- Configuration B: Standard Message ID

Workaround

Configuration A:

Setup an Extended Message ID filter element with the following configuration:

- F0.EFEC = 001/010: Select Rx FIFO for storage of extended frames
- F0.EFID1 = any value: The value is not relevant as all ID bits are masked out by F1.EFID2
- F1.EFT = 10: Classic filter, F0.EFID1 = filter, F1.EFID2 = mask
- F1.EFID2 = 0: All bits of the received extended ID are masked out

Now all extended frames are stored in Rx FIFO '0' or Rx FIFO '1' depending on the configuration of F0.EFEC.

Configuration B:

Setup an Standard Message ID filter element with the following configuration:

- S0.SFEC = 001/010: Select Rx FIFO for storage of standard frames
- S0.SFID1 = any value: The value is not relevant as all ID bits are masked out by S0.SFID2

- S0.SFT = 10: Classic filter, S0.SFID1 = filter, S0.SFID2 = mask
- S0.SFID2 = 0: All bits of the received standard ID are masked out

Now all standard frames are stored in Rx FIFO '0' or Rx FIFO '1' depending on the configuration of S0.SFEC.

Affected Silicon Revisions

A							
X							

2.4.6 Tx FIFO message sequence inversion Reference: CAN100-14

Assuming that there are two Tx FIFO messages in the output pipeline of the Tx Message Handler. Transmission of Tx FIFO message 1 is started:

Position 1: Tx FIFO message 1 (transmission ongoing)

Position 2: Tx FIFO message 2

Position 3: Free FIFO bugger

During the transmission of Tx FIFO message 1, a non Tx FIFO message with a higher CAN priority is requested. Due to its priority it will be inserted into the output pipeline. The TxMH performs "message scans" to keep the output pipeline up to date with the highest priority messages from the message RAM.

After the following two message scans, the output pipeline has the following content:

Position 1: Tx FIFO message 1 (transmission ongoing)

Position 2: non Tx FIFO message with higher CAN priority

Position 3: Tx FIFO message 2

If the transmission of Tx FIFO message 1 is not successful (lost arbitration or CAN bus error) it is pushed from the output pipeline by the non Tx FIFO message with higher CAN priority. The following scan again inserts Tx FIFO message 1 into the output pipeline at position 3:

Position 1: non Tx FIFO message with higher CAN priority (transmission ongoing)

Position 2: Tx FIFO message 2

Position 3: Tx FIFO message 1

This results in Tx FIFO message 2 being in the output pipeline in front of Tx FIFO message 1 and they are transmitted in that order, resulting in a message sequence inversion.

Scope:

The erratum describes the case when the CAN uses both, dedicated Tx Buffers and a Tx FIFO (TXBC.TFQM = 0) and the messages in the Tx FIFO do not have the highest internal CAN priority. The described sequence inversion may also happen between two non Tx FIFO messages (Tx Queue or dedicated Tx Buffers) that have the same CAN identifier and that should be transmitted in the order of their buffer numbers (not the intended use).

Effects:

In the described case it may happen that two consecutive messages from the Tx FIFO exchange their positions in the transmit sequence.

Workarounds

When transmitting messages from a dedicated Tx Buffer with higher priority than the messages in the Tx FIFO, choose one of the following workarounds:

Workaround 1

Use two dedicated Tx Buffers, for example, use Tx Buffers 4 and 5 instead of the Tx FIFO.

The Transmit Loop below replaces the function that fills the Tx FIFO.

Write the message to Tx Buffer 4

Transmit Loop:

- Request Tx Buffer 4 - write TXBAR.A4
- Write message to Tx Buffer 5
- Wait until transmission of Tx Buffer 4 completed - IR.TC, read TXBTO.TO4
- Request Tx Buffer 5 - write TXBAR.A5
- Write message to Tx Buffer 4
- Wait until transmission of Tx Buffer 5 completed - IR.TC, read TXBTO.TO5

Workaround 2

Ensure that only one Tx FIFO element is pending for transmission at any time.

The Tx FIFO elements may be filled at any time with messages to be transmitted, but their transmission requests are handled separately. Each time a Tx FIFO transmission has completed and the Tx FIFO becomes empty (IR.TFE = 1), the next Tx FIFO element is requested.

Workaround 3

Use only a Tx FIFO. Send the message with the higher priority also from Tx FIFO.

Drawback: The higher priority message has to wait until the preceding messages in the Tx FIFO are sent.

Affected Silicon Revisions

A							
X							

2.5 Clock Failure Detector (CFD)

2.5.1 CFD with XOSC/XOSC32K Oscillator Reference:CLK100-5

When the CFD is enabled for the XOSC/XOSC32K oscillator and the oscillator input signal is stuck at 1, the clock failure detection works correctly but the switch to the safe clock will fail.

Workaround

Two possible workarounds are as follows:

1. If the main clock source comes from the XOSC/XOSC32K oscillator, the only workaround is indirect (i.e., using the WDT in firmware and switch to safe clock source in firmware at WDT reset).
2. Because the clock failure detection is functional, once the STATUS.CLKFAIL is set, and if the STATUS.CLKSW is not set, manually switch to safe clock from firmware by changing the

configurations of the Generic Clock Generators that use the XOSC/XOSC32K oscillator as a clock source to use another source clock instead.

Affected Silicon Revisions

A							
X							

2.6 Device

2.6.1 Reverse Current in VDDIOB Domain Reference:CHIP003-304

For the device with 100-pin, 120-pin, and 128-pin counts, when VDDIOB is supplied with the voltage less than VDDIO - 0.7V, reverse current in VDDIOB cluster is observed.

Workaround

None. Pin PB13 must be tied to ground.

Affected Silicon Revisions

A							
X							

2.6.2 Internal Pull-up on the RESET Pin Reference:CHIP003-159

The internal pull-up of the RESET pin is not functional.

Workaround

An external 100K pull-up must be added on the RESET pin.

Affected Silicon Revisions

A							
X							

2.6.3 Detection of a Debugger Probe Reference: PWR101-6

The detection of a debugger probe could fail if the "BOD33 Disable" fuse is cleared (i.e., BOD33 is enabled).

Workaround

To secure the detection of debugger probes, enable BOD33 using the SUPC.BOD33 register instead of the "BOD33 Disable" fuse. The "BOD33 Disable" fuse must be kept set.

Affected Silicon Revisions

A							
X							

2.6.4 VBAT Mode Reference:CHIP003-168

V_{BAT} mode is not functional.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.6.5 Internal Reference Reference:CHIP003-8

When the internal reference is used with the DAC and ADC, their outputs become non-linear when the operating temperature is less than 0°C.

Workaround

The internal reference must be used only for positive temperatures (i.e., above 0°C).

Affected Silicon Revisions

A							
X							

2.6.6 Device Operation for Temperature < -20°C Reference:CHIP003-184

If the operating temperature is less than -20°C, the device does not start.

Workaround

Apply an external reset pulse at power-up when V_{DD} is higher than 2V, or keep reset line low until V_{DD} is lower than 2V.

A							
X							

2.7 Device Service Unit (DSU)

2.7.1 CRC32 Reference:CHIP003-171

DSU CRC32 will not complete when targeting NVM memory space while the NVM cache is disabled.

Workaround

Be sure to always enable the NVM cache when performing a DSU CRC32 request targeting the NVM memory space.

Affected Silicon Revisions

A							
---	--	--	--	--	--	--	--

X							
---	--	--	--	--	--	--	--

2.8 48 MHz Digital Frequency-Locked Loop (DFLL48M)

2.8.1 COARSE or FINE Calibration Values During the Locking Sequence Reference: DLL101-1

If the DFLL48M reaches the maximum or minimum COARSE or FINE calibration values during the locking sequence, an out of bounds interrupt will be generated. These interrupts will be generated even if the final calibration values at DFLL48M lock are not at maximum or minimum, and might therefore be false out of bounds interrupts.

Workaround

Check that lockbits, DFLLCKC and DFLLCKF, in the OSCCTRL Interrupt Flag Status and Clear register (INTFLAG) are both set before enabling the DFLL00B interrupt.

Affected Silicon Revisions

A							
X							

2.8.2 STATUS.DFLLRDY Bit in Close Loop Mode Reference: DLL101-4

In Close Loop mode, the STATUS.DFLLRDY bit does not rise before lock fine occurs. Therefore, the information about DFLL ready to start Close Loop mode is not available.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.8.3 DFLLVAL.FINE Value When DFLL48M Re-enabled Reference: UANA139-3

If the DFLL is disabled and then re-enabled, the DFLLVAL.FINE value is ignored by the DFLL module, which will then start its lock fine process at another frequency.

Workaround

Before writing the final configuration in the DFLLCTRLB register, the DFLL module must be re-enabled in Open Loop mode to read and rewrite the DFLLVAL register.

1. OSCCTRL->DFLLMUL.reg = X; // Write new DFLLMULL configuration
2. OSCCTRL.DFLLCTRLB.reg = 0; // Select Open loop configuration
3. OSCCTRL.DFLLCTRLA.bit.ENABLE = 1; // Enable DFLL
4. OSCCTRL.DFLLVAL.reg = OSCCTRL->DFLLVAL.reg; // Reload DFLLVAL register
5. OSCCTRL.DFLLCTRLB.reg = X; // Write final DFLL configuration

Affected Silicon Revisions

A							
X							

2.9 Digital-to-Analog Converter (DAC)

2.9.1 Smoothing of the Output Signal in differential Mode Reference: DAC102-2

In Differential mode the smoothing of the output signal is not fully functional. Smoothing works normally in Differential mode as long as the value of two consecutive data are both positive or negative. The behavior is incorrect when the data changes from positive to negative or vice versa.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.9.2 VDDANA as the DAC Reference Reference: CHIP003-161

The selection of VDDANA as the DAC reference in DAC.CTRLB.REFSEL is non-functional.

Workaround

The VDDANA must be connected externally to a V_{REF} pin and DAC.CTRLB.VREFAU must be selected.

Affected Silicon Revisions

A							
X							

2.9.3 DAC on Negative Input AIN3 Reference: CHIP003-174

No analog compare will be done on Comparator 1 (AC1) when using the DAC on negative input AIN3.

Workaround

Use the internal VDD scaler.

Affected Silicon Revisions

A							
X							

2.9.4 Interpolation Mode Reference: DAC102-4

If the Interpolation mode is enabled (with filter integrated to the DAC), the last data from the filter is missing, and therefore, the DAC final output value does not correspond to the DAC input value.

Although interrupt events are generated at the end of conversion (EOC), the EOC occurs before the final value from the filter and is of no use in the application.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.10 Direct Memory Access Controller (DMAC)

2.10.1 Linked Descriptors Reference:DMA101-6

When at least one channel using linked descriptors is already active, a channel Fetch Error (FERR) could occur on enabling a channel with no linked descriptor or the second descriptor (index 1) of the channel being enabled could be fetched by one of the already active channels using linked descriptors. These errors can occur when a channel is being enabled during the link request of another channel and if the channel number of the channel being enabled is lower than the channel already active.

Workaround

When enabling a channel while other channels using linked descriptors are already active, the channel number of the new channel to enable must be greater than the other channel numbers.

Affected Silicon Revisions

A							
X							

2.10.2 Channel Priority Reference:DMA101-8

When using channels with different priority levels, the highest priority channel could stall at the end of its current block.

When this occurs, the channel is seen as active with BTCNT = 0 in the ACTIVE register with Busy and Pending flag set in the CHSTATUSn register. This condition also prevents the other channels from executing.

Workaround

Use a single priority level for all channels by setting all the CHPRILVLn registers to the same value.

Affected Silicon Revisions

A							
X							

2.10.3 DMAC in Debug Mode Reference:DMA101-9

In Debug mode, DMAC does not restart after a debug halt when DBGCTRL.DBGRUN = 0.

Workaround

Set DBGCTRL.DBGRUN to 1 so that the DMAC continues normal operation when the CPU is halted by an external debugger.

Affected Silicon Revisions

A							
X							

2.11 Ethernet MAC (GMAC)

2.11.1 Ethernet Functionality in 64-pin Packages Reference:CHIP003-262

Ethernet functionality in 64-pin packages is not available.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.12 External Interrupt Controller (EIC)

2.12.1 Edge Detection Reference:INT102-9

When enabling EIC, SYNCBUSY.ENABLE is released before EIC is fully enabled. Edge detection can be done only after three cycles of the selected GCLK (GCLK_EIC or CLK_ULP32K).

Workaround

None.

Affected Silicon Revisions

A							
X							

2.12.2 Asynchronous Edge Detection Reference:INT102-11

When the asynchronous edge detection is enabled and the system is in Standby mode, only the first edge will be detected. The following edges are ignored until the system wakes up.

Workaround

Use the asynchronous edge detection with debouncer enabled. It is recommended to set the DPRESALER.PRESCALER and DPRESALER.TICKON to have the lowest frequency possible. To reduce the power consumption, set the EIC GCLK frequency as low as possible or select the ULP32K clock (EIC CTRLA.CKSEL set).

Affected Silicon Revisions

A							
X							

2.13 Fractional Digital Phase-Locked Loop (FDPLL)

2.13.1 Low-Frequency Input Clock on FDPLLn Reference:CHIP003-4

When using a low frequency input clock (≤ 400 kHz) for input to FDPLLn, several FDPLL false unlock status indications may occur while the FDPLL output frequency is actually stable.

Workaround

When using a low frequency input clock (≤ 400 kHz) on FDPLLn, enable the lock bypass (OSCCTRL.DPLLCTRLB.LBYPASS = 1) and wake up fast (OSCCTRL.DPLLCTRLB.WUF = 1) to avoid losing FDPLL clock output during a false unlock status. The workaround does not avoid false unlock indications but it disables the gating of the FDPLL clock output by the lock status; therefore, the clock is issued even if the FDPLL status shows unlocked. The Clock Ready bit (OSCCTRL.DPLLSTATUS.CLKRDY) can be monitored by the application to ensure activity is present on the FDPLLn output, but clock ready does not provide any indication of FDPLLn Lock or frequency. A 10 ms delay is also suggested after the clock ready bit is set to allow the DPLL to achieve the target frequency.

Pseudo Code

Set OSCCTRL.DPLLCTRLB.WUF = 1 and OSCCTRL.DPLLCTRLB.LBYPASS = 1

Set DPLLCTRLA.ENABLE = 1

Wait (OSCCTRL.DPLLSTATUS.CLKRDY==1)

Delay (10ms)

Set Source for GCLK with DPLL

Affected Silicon Revisions

A							
X							

2.13.2 FDPLL Ratio in DPLLnRATIO Reference:PLL101-4

When changing the FDPLL ratio in DPLLnRATIO register on-the-fly, STATUS.DPLLnLDRTO will not be set when the ratio update will be completed.

Workaround

Wait for the interruption flag INTFLAG.DPLLnLDRTO instead.

Affected Silicon Revisions

A							
X							

2.14 Non-Volatile Memory Controller (NVMCTRL)

2.14.1 NVM Read Corruption Reference:NVM101-7

NVM reads could be corrupted when mixing NVM reads with Page Buffer writes.

Workaround

Disable cache lines before writing to the Page Buffer when executing from NVM or reading data from NVM while writing to the Page Buffer. Cache lines are disabled by writing a one to CTRLA.CACHEDIS0 and CTRLA.CACHEDIS1.

Affected Silicon Revisions

A							
X							

2.15 Peripheral Access Controller (PAC)

2.15.1 PAC Protection Error in FREQM Reference:CLK101-9

FREQM reads on the Control B register (FREQM.CTRLB) generate a PAC protection error.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.15.2 PAC Protection Error in CCL Reference:CLA100-6

Writing the Software Reset bit in the Control A register (CTRLASWRST) will trigger a PAC protection error.

Workaround

Clear the CCL PAC error each time a CCL software reset is executed.

Affected Silicon Revisions

A							
X							

2.16 I/O Pin Controller (PORT)

2.16.1 PORT Read/Write Attempts on Non-Implemented Registers Reference:GPIO100-14

PORT read/write attempts on non-implemented registers, including addresses beyond the last implemented register group (PA, PB,...), do not generate a PAC protection error.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.16.2 PORT Pull-Up/Pull-Down Resistor Reference:CHIP003-158

The pull-down on PA24/PA25 are activated during power-up and when Sleep mode is OFF. On all other pins, except those in the VSWOUT cluster, the pull-up is activated during power-up and when Sleep mode is OFF.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.17 Real-Time Counter (RTC)

2.17.1 Write Corruption Reference:TMR102-46

A 8-bit or 16-bit write access for a 32-bit register, or 8-bit write access for a 16-bit register can fail for the following registers:

- COUNT register in COUNT32 mode
- COUNT register in COUNT16 mode
- CLOCK register in CLOCK mode

Workaround

Write the registers with:

- A 32-bit write access for COUNT register in COUNT32 mode, CLOCK register in CLOCK mode
- A 16-bit write access for the COUNT register in COUNT16 mode

Affected Silicon Revisions

A							
X							

2.17.2 COUNTSYNC Reference:TMR102-19

When COUNTSYNC is enabled, the first COUNT value is not correctly synchronized and thus it is a wrong value.

Workaround

After enabling COUNTSYNC, read the COUNT register until its value is changed when compared to its first value read. After this, all consequent value read from the COUNT register is valid.

Affected Silicon Revisions

A							
X							

2.17.3 Tamper Input Filter Reference:TMR102-16

Majority debouncing, as part of RTC tamper detection, does not work when enabled by setting the Debouncer Majority Enable bit, CTRLB.DEBMAJ.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.17.4 Tamper Detection Reference:TMR102-17

Upon enabling the RTC tamper detection feature, a false tamper detection can be reported by the RTC.

Workarounds

Use any one of the following workarounds:

- **Workaround 1:** Configure TAMPER detection as ONLY falling edge.
- **Workaround 2:** If the user software has to use TAMPER detection as rising edge, it must ignore the first tamper interrupt generated immediately after enabling the RTC tamper detection.

Affected Silicon Revisions

A							
X							

2.17.5 Tamper Detection Timestamp Reference:TMR102-48

If an external reset occurs during a tamper detection, the TIMESTAMP register will not be updated when next tamper detection is triggered.

Workarounds

Enable RTC tamper interrupt and copy the timestamp from the RTC CLOCK register to one of the following destinations::

- SRAM
- GPx register in RTC
- BKUPx register in RTC

Affected Silicon Revisions

A							
X							

2.18 Serial Communication Interface (SERCOM)

2.18.1 SERCOM-USART: Auto-Baud Mode Reference:COM100-38

In USART Auto-Baud mode, missing stop bits are not recognized as inconsistent sync (ISF) or framing (FERR) errors.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.2 SERCOM-USART: Collision Detection Reference:COM100-75

In USART operating mode with Collision Detection enabled (CTRLB.COLDEN = 1), the SERCOM will not abort the current transfer as expected if a collision is detected and if the SERCOM APB Clock is lower than the SERCOM Generic Clock.

Workaround

The SERCOM APB clock must always be higher than the SERCOM Generic Clock to support collision detection. .

Affected Silicon Revisions

A							
X							

2.18.3 SERCOM-USART: Debug Mode Reference:COM100-80

In USART operating mode, if DBGCTRL.DBGSTOP = 1, data transmission is not halted after entering Debug mode.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.4 SERCOM-USART: 32-bit Extension Mode Reference:COM100-54

When 32-bit Extension mode is enabled and data to be sent is not in multiples of 4 bytes, which means the length counter must be enabled, and additional bytes will be sent over the line.

Workarounds

Use any one of the following workarounds:

1. Write the Inter-Character Spacing bits (CTRLC.ICSPACE) to a non-zero-value.
2. Do not use length counter in firmware by keeping the data to be sent is in multiples of 4 bytes.

Affected Silicon Revisions

A							
X							

2.18.5 SERCOM-UART: TXINV and RXINV Bits Reference:COM100-61

The TXINV and RXINV bits in the CTRLA register have inverted functionality.

Workaround

In software interpret the TXINV bit as a functionality of RXINV, and conversely, interpret the RXINV bit as a functionality of TXINV.

Affected Silicon Revisions

A							
X							

2.18.6 SERCOM-I²C: SDAHOLD Timing Reference:CHIP003-167

SDAHOLD timing of the SERCOM-I²C does not match the value shown in the current device data sheet. The following table shows the specified and real values of SDA Hold timing.

Table 2-1. SDA Hold Timing

SDA Hold Time Value	Specified SDA Hold Time	Real SDA Hold Time
0x0	Disabled	Disabled
0x1	50 ns to 100 ns	20 ns to 40 ns
0x2	300 ns to 600 ns	100 ns to 250 ns
0x3	400 ns to 800 ns	150 ns to 350 ns

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.7 Repeated Start in High-Speed Master Write Operation Reference:COM100-122

For High-Speed Master Write operations, writing CTRLB.CMD = 0x1 issues a STOP command instead of a Repeated Start making repeated start not possible in that mode.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.8 Repeated Start in High-Speed Master Read Operation Reference:COM100-123

For High-Speed Master Read operations, sending a NACK (CTRLB.CMD = 0x2) forces a STOP to be issued making repeated start not possible in that mode.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.9 STATUS.CLKHOLD Bit in Master and Slave Modes Reference:COM100-114

The STATUS.CLKHOLD bit in master and slave modes can be written whereas it is a read-only status bit.

Workaround

Do not clear STATUS.CLKHOLD bit to preserve the current clock hold state.

Affected Silicon Revisions

A							
X							

2.18.10 SERCOM-I²C: I²C in Slave Mode Reference:COM100-102

In I²C mode, LENERR, SEXTOUT, LOWTOUT, COLL and BUSERR bits are not cleared when INTFLAG.AMATCH is cleared.

Workaround

Manually clear status bits LENERR, SEXTOUT, LOWTOUT, COLL and BUSERR by writing these bits to 1 when set.

Affected Silicon Revisions

A							
---	--	--	--	--	--	--	--

X							
---	--	--	--	--	--	--	--

2.18.11 SERCOM-I²C: Slave Mode with DMA Reference:COM100-94

In I²C Slave Transmitter mode, at the reception of a NACK, if there is still data to be sent in the DMA buffer, the DMA will push a data to the DATA register. Because a NACK was received, the transfer on the I²C bus will not occur causing the loss of this data.

Workaround

Configure the DMA transfer size to the number of data to be received by the I²C master. DMA cannot be used if the number of data to be received by the master is not known..

Affected Silicon Revisions

A							
X							

2.18.12 SERCOM-I²C: I²C Slave in DATA32B Mode Reference:COM100-88

When SERCOM is configured as an I²C slave in 32-bit Data Mode (DATA32B = 1) and the I²C master reads from the I²C slave (slave transmitter) and outputs its NACK (indicating no more data is needed), the I²C slave still receives a DRDY interrupt.

If the CPU does not write a new data to the I²C slave DATA register, I²C slave will pull SDA line, which will result in stalling the bus permanently.

Workarounds

1. Write a dummy data to data register when a NACK is received from the master.
2. Use command #2 (SERCOMx->I2CS.CTRLB.bit.CMD = 2) when a NACK is received from the master.



Important: Because STATUS.RXNACK always indicates the last received ACK, to determine when a NACK is received from the I²C master, the I²C slave software needs to consider I2CS.STATUS.RXNACK only on the second DRDY interrupt after receiving the AMATCH interrupt.

Affected Silicon Revisions

A							
X							

2.18.13 SERCOM-I²C: 10-bit Addressing Mode Reference:COM100-101

10-bit addressing in I²C Slave mode is not functional.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.18.14 SERCOM-I²C: Repeated Start Reference:COM100-84

When the Quick command is enabled (CTRLB.QCEN = 1), software can issue a repeated Start by writing either CTRLB.CMD or ADDR.ADDR bit fields. If in these conditions, SCL Stretch Mode is CTRLA.SCLSM = 1, a bus error will be generated.

Workaround

Use Quick Command mode (CTRLB.QCEN = 1) only if SCL Stretch Mode is CTRLA.SCLSM = 0.

Affected Silicon Revisions

A							
X							

2.18.15 SERCOM-SPI: Data Preload Reference:COM100-83

In SPI Slave mode and with Slave Data Preload Enabled (CTRLB.PLOADEN = 1), the first data sent from the slave will be a dummy byte if the master cannot keep the Slave Select (SS) line low until the end of transmission.

Workarounds

In SPI Slave mode, the Slave Select pin (SS) must be kept low by the master until the end of the transmission if the Slave Data Preload feature is used (CTRLB.PLOADEN = 1).

Affected Silicon Revisions

A							
X							

2.18.16 SERCOM I²C: Repeated Start Reference:COM100-128

For Master Write operations (excluding High-Speed mode), in 10-bit addressing mode, writing CTRLB.CMD = 0x1 does not issue a Repeated Start command correctly.

Workarounds

Write the same 10-bit address with the same direction bit to the ADDR.ADDR register to generate properly a Repeated Start.

Affected Silicon Revisions

A							
X							

2.19 Supply Controller (SUPC)

2.19.1 Buck Converter Mode Reference:CHIP003-303

Buck Converter mode is not supported when using PLLs. As a result, the information given in Table 54-9 “Active Current Consumption - Active Mode” data for Buck converter mode with FDPLL and DFLL configurations is not valid and must be disregarded.

Workaround

Use the LDO Regulator mode when using FDPLL and DFLL configurations.

Affected Silicon Revisions

A							
X							

2.19.2 BOD33 Hysteresis Reference:PWR101-4

The hysteresis feature of the 3.3V BOD is not functional while the device is in STANDBY sleep mode.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.20 Timer/Counter (TC)

2.20.1 PERBUF/CCBUFx Register Reference:TMR100-12

When clearing the STATUS.PERBUFV/STATUS.CCBUFx flag, the SYNCBUSY flag is released before the PERBUF/CCBUFx register is restored to its appropriate value.

Workaround

Clear successively twice the STATUS.PERBUFV/STATUS.CCBUFx flag to ensure that the PERBUF/CCBUFx register value is restored before updating it.

Affected Silicon Revisions

A							
X							

2.21 Timer/Counter for Control Applications (TCC)

2.21.1 TCC with EVSYS in SYNC/RESYNC Mode Reference:TMR101-87

TCC peripheral is not compatible with an EVSYS channel in SYNC or RESYNC mode.

Workaround

Use TCC with an EVSYS channel in ASYNC mode.

Affected Silicon Revisions

A							
X							

2.21.2 Dithering Mode with External Retrigger Events Reference:TMR101-59

Using TCC in Dithering mode with external retrigger events can lead to an unexpected stretch of right-aligned pulses, or shrink of left-aligned pulses.

Workaround

Do not use retrigger events or actions when the TCC module is configured in Dithering mode.

Affected Silicon Revisions

A							
X							

2.21.3 ALOCK Feature Reference:TMR101-89

ALOCK feature is not functional.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.21.4 LUPD feature in Down-Counting Mode Reference:TMR101-86

In down-counting mode, the Lock Update bit (CTRLB.LUPD) does not protect against a PER register update from the PERBUF register.

Workaround

None.

Affected Silicon Revisions

A							
X							

2.22

Position Decoder (PDEC)

2.22.1

X2 Mode Reference:QE1100-29

In X2 mode, if the index signal generated from the motor sensor is stuck at 0, then the position counter increments by 512 counts instead of 1 on every positive edge of the Count signal, that is, the PDEC peripheral counter presents incorrect counts when used with position sensor with faulty (stuck at 0) index signal.

Workaround
None.

Affected Silicon Revisions

A							
X							

3. Data Sheet Clarifications

The following typographic corrections and clarifications are to be noted for the device data sheet (DS60001507C):

3.1 Update to Initialization, Enabling, Disabling, and Resetting

The following text was added to page 790 of the device Data Sheet:

When the source clock to DPLL_n is less than or equal to 400 kHz, it is necessary to set the Lock Bypass and Wake Up Fast bits. The initial start-up of DPLL_n also requires a 10 ms delay for the module to achieve the target frequency if the DPLL_n source clock is less than or equal to 400 kHz.

3.2 Update to Loop Divider Ratio Updates

The following text was added to page 793 of the device Data Sheet:

On-the-fly updates of the DPLL_nRATIO are not allowed if the source clock to DPLL_n is less than or equal to 400 kHz.

3.3 Flash Timing Characteristics

- Table 54-35 Flash Timing Characteristics is updated for the parameter tCE (Chip Erase) . The updated values are shown in BOLD text.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
tFPW	Program Cycle Time	Write Page	-	1.5	3 ⁽¹⁾	ms
tCE		Chip Erase	-	6.4	25 ⁽¹⁾	s
tFEB		Erase Block	-	50	200 ⁽¹⁾	ms

Note:

- These are based on simulation. They are not covered by production test limits or characterization.

3.4 BOD12 Register Information

The BOD12 register information, found in section 19.8.6, is erroneously present in the device data sheet. The BOD12 is required for a reliable operation of the device. The BOD12 configuration is factory programmed to ensure the reliable operation of the device. User configurations are not available for BOD12.

4. Appendix A: Revision History

Rev F. (2/2019)

The following Silicon Issues were updated:

- [FDPLL: 2.13.1 Low-Frequency Input Clock on FDPLLn Reference:CHIP003-4](#)

The following Data Sheet Clarifications were added:

- Update to Initialization, Enabling, Disabling, and Resetting
- Update to Loop Divider Ratio Updates

Rev. E (11/2018)

The following silicon issues were added:

- SERCOM I²C
 - [2.18.16 SERCOM I2C: Repeated Start Reference:COM100-128](#)
- CAN-FD
 - [2.4.3 Message Transmitted with Wrong Arbitration and Control Fields Reference:CAN100-16](#)
 - [2.4.4 DAR Mode Reference:CAN100-13](#)
 - [2.4.5 High-Priority Message \(HPM\) interrupt Reference:CAN100-15](#)
 - [2.4.6 Tx FIFO message sequence inversion Reference:CAN100-14](#)
- PDEC
 - [2.22.1 X2 Mode Reference:QEI100-29](#)
- DMAC
 - [2.10.2 Channel Priority Reference:DMA101-8](#)
 - [2.10.3 DMAC in Debug Mode Reference:DMA101-9](#)
- RTC
 - [2.17.2 COUNTSYNC Reference:TMR102-19](#)
 - [2.17.3 Tamper Input Filter Reference:TMR102-16](#)
 - [2.17.4 Tamper Detection Reference:TMR102-17](#)
 - [2.17.5 Tamper Detection Timestamp Reference:TMR102-48](#)
- SUPC
 - [2.19.2 BOD33 Hysteresis Reference:PWR101-4](#)
- TCC
 - [2.21.3 ALOCK Feature Reference:TMR101-89](#)
 - [2.21.4 LUPD feature in Down-Counting Mode Reference:TMR101-86](#)

The following [Data Sheet Clarifications](#) were added:

- Table 54-35 Flash Timing Characteristics was updated.
- BOD12 Register Information was updated.

Rev. D (08/2018)

The current device data sheet revision letter was updated.

The following silicon issues were added:

- Configurable Custom Logic (CCL):
 - Enable Protected Registers
 - Sequential Logic Reference
- Device:
 - Reverse Current in VDDIOB Domain
- SERCOM:
 - Repeated Start in High-Speed Master Write Operation
 - Repeated Start in High-Speed Master Read Operation
 - STATUS.CLKHOLD Bit in Master and Slave Modes
- Supply Controller (SUPC):
 - Buck Converter Mode
- TCC:
 - TCC with EVSYS in SYNC/RESYNC Mode

Rev. C (04/2018)

The current device data sheet revision letter was updated.

The following silicon issues were added:

- Analog-to-Digital Converter (ADC):
 - Reference Buffer Offset Compensation
- Peripheral Access Controller (PAC):
 - PAC Protection
 - PAC Protection
- Real-Time Counter (RTC):
 - Write Corruption
- SERCOM-I2C:
 - Slave Mode with DMA
 - I²C Slave in DATA32B Mode
 - I²C Slave Mode in 10-bit Address
 - Repeated Start
- SERCOM-SPI
 - Data Preload
- SERCOM-UART:
 - Collision Detection

All Data Sheet Clarifications were removed.

Rev. B (10/2017)

This revision includes the following additions:

Silicon Issues

- Ethernet Functionality in 64-pin Packages

Data Sheet Clarifications

- ADC Operating Conditions
- GMAC IEEE 802.3AZ Energy Efficient Support

- SERCOM Baud Rate Equations
- SERCOM in SPI Mode Timing
- TQFP 64-pin Package
- DAC Operating Conditions

Rev. A (7/2017)

Initial release of this document.

The Microchip Web Site

Microchip provides online support via our web site at <http://www.microchip.com/>. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Customer Change Notification Service

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at <http://www.microchip.com/>. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://www.microchip.com/support>

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.

- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Legal Notice

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BeaconThings, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KeeLoq, KeeLoq logo, Kleer, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, RightTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KleerNet, KleerNet logo, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PureSilicon, QMatrix, RightTouch logo, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2018, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-4122-9

Quality Management System Certified by DNV

ISO/TS 16949

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: http://www.microchip.com/support Web Address: www.microchip.com	Australia - Sydney Tel: 61-2-9868-6733 China - Beijing Tel: 86-10-8569-7000 China - Chengdu Tel: 86-28-8665-5511 China - Chongqing Tel: 86-23-8980-9588 China - Dongguan Tel: 86-769-8702-9880 China - Guangzhou Tel: 86-20-8755-8029 China - Hangzhou Tel: 86-571-8792-8115 China - Hong Kong SAR Tel: 852-2943-5100 China - Nanjing Tel: 86-25-8473-2460 China - Qingdao Tel: 86-532-8502-7355 China - Shanghai Tel: 86-21-3326-8000 China - Shenyang Tel: 86-24-2334-2829 China - Shenzhen Tel: 86-755-8864-2200 China - Suzhou Tel: 86-186-6233-1526 China - Wuhan Tel: 86-27-5980-5300 China - Xian Tel: 86-29-8833-7252 China - Xiamen Tel: 86-592-2388138 China - Zhuhai Tel: 86-756-3210040	India - Bangalore Tel: 91-80-3090-4444 India - New Delhi Tel: 91-11-4160-8631 India - Pune Tel: 91-20-4121-0141 Japan - Osaka Tel: 81-6-6152-7160 Japan - Tokyo Tel: 81-3-6880-3770 Korea - Daegu Tel: 82-53-744-4301 Korea - Seoul Tel: 82-2-554-7200 Malaysia - Kuala Lumpur Tel: 60-3-7651-7906 Malaysia - Penang Tel: 60-4-227-8870 Philippines - Manila Tel: 63-2-634-9065 Singapore Tel: 65-6334-8870 Taiwan - Hsin Chu Tel: 886-3-577-8366 Taiwan - Kaohsiung Tel: 886-7-213-7830 Taiwan - Taipei Tel: 886-2-2508-8600 Thailand - Bangkok Tel: 66-2-694-1351 Vietnam - Ho Chi Minh Tel: 84-28-5448-2100	Austria - Wels Tel: 43-7242-2244-39 Fax: 43-7242-2244-393 Denmark - Copenhagen Tel: 45-4450-2828 Fax: 45-4485-2829 Finland - Espoo Tel: 358-9-4520-820 France - Paris Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79 Germany - Garching Tel: 49-8931-9700 Germany - Haan Tel: 49-2129-3766400 Germany - Heilbronn Tel: 49-7131-67-3636 Germany - Karlsruhe Tel: 49-721-625370 Germany - Munich Tel: 49-89-627-144-0 Fax: 49-89-627-144-44 Germany - Rosenheim Tel: 49-8031-354-560 Israel - Ra'anana Tel: 972-9-744-7705 Italy - Milan Tel: 39-0331-742611 Fax: 39-0331-466781 Italy - Padova Tel: 39-049-7625286 Netherlands - Drunen Tel: 31-416-690399 Fax: 31-416-690340 Norway - Trondheim Tel: 47-7289-7561 Poland - Warsaw Tel: 48-22-3325737 Romania - Bucharest Tel: 40-21-407-87-50 Spain - Madrid Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 Sweden - Gothenberg Tel: 46-31-704-60-40 Sweden - Stockholm Tel: 46-8-5090-4654 UK - Wokingham Tel: 44-118-921-5800 Fax: 44-118-921-5820