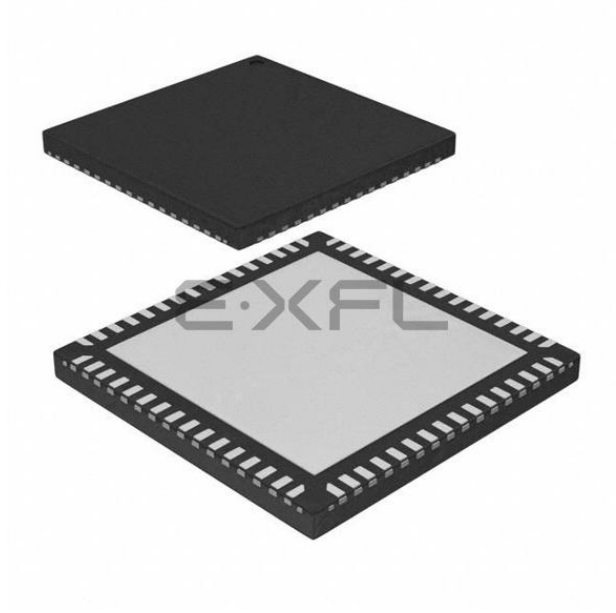

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M4
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART, USB
Peripherals	Brown-out Detect/Reset, DMA, I²S, LCD, POR, PWM, WDT
Number of I/O	43
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	64K x 8
Voltage - Supply (Vcc/Vdd)	1.68V ~ 3.6V
Data Converters	A/D 7x12b; D/A 1x10b
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/atsam4lc8ba-mu

events, even in sleep modes where the module clock is stopped. Power monitoring is supported by on-chip Power-on Reset (POR18, POR33), Brown-out Detectors (BOD18, BOD33). The device features several oscillators, such as Phase Locked Loop (PLL), Digital Frequency Locked Loop (DFLL), Oscillator 0 (OSC0), Internal RC 4,8,12MHz oscillator (RCFAST), system RC oscillator (RCSYS), Internal RC 80MHz, Internal 32kHz RC and 32kHz Crystal Oscillator. Either of these oscillators can be used as source for the system clock. The DFLL is a programmable internal oscillator from 40 to 150MHz. It can be tuned to a high accuracy if an accurate reference clock is running, e.g. the 32kHz crystal oscillator.

The Watchdog Timer (WDT) will reset the device unless it is periodically serviced by the software. This allows the device to recover from a condition that has caused the system to be unstable.

The Asynchronous Timer (AST) combined with the 32kHz crystal oscillator supports powerful real-time clock capabilities, with a maximum timeout of up to 136 years. The AST can operate in counter or calendar mode.

The Frequency Meter (FREQM) allows accurate measuring of a clock frequency by comparing it to a known reference clock.

The Full-speed USB 2.0 device and embedded host interface (USBC) supports several USB classes at the same time utilizing the rich end-point configuration.

The device includes six identical 16-bit Timer/Counter (TC) channels. Each channel can be independently programmed to perform frequency measurement, event counting, interval measurement, pulse generation, delay timing, and pulse width modulation.

The ATSAM4L8/L4/L2 also features many communication interfaces, like USART, SPI, or TWI, for communication intensive applications. The USART supports different communication modes, like SPI Mode and LIN Mode.

A general purpose 16-channel ADC is provided, as well as four analog comparators (ACIFC). The ADC can operate in 12-bit mode at full speed. The analog comparators can be paired to detect when the sensing voltage is within or outside the defined reference window.

Atmel offers the QTouch Library for embedding capacitive touch buttons, sliders, and wheels functionality. The patented charge-transfer signal acquisition offers robust sensing and includes fully debounced reporting of touch keys as well as Adjacent Key Suppression® (AKS®) technology for unambiguous detection of key events. The easy-to-use QTouch Suite toolchain allows you to explore, develop, and debug your own touch applications.

The Audio Bitstream DAC (ABDACB) converts a 16-bit sample value to a digital bitstream with an average value proportional to the sample value. Two channels are supported, making the ABDAC particularly suitable for stereo audio.

The Inter-IC Sound Controller (IISC) provides a 5-bit wide, bidirectional, synchronous, digital audio link with external audio devices. The controller is compliant with the Inter-IC Sound (I2S) bus specification.

Figure 3-2. ATSAM4LC VFBGA100 Pinout

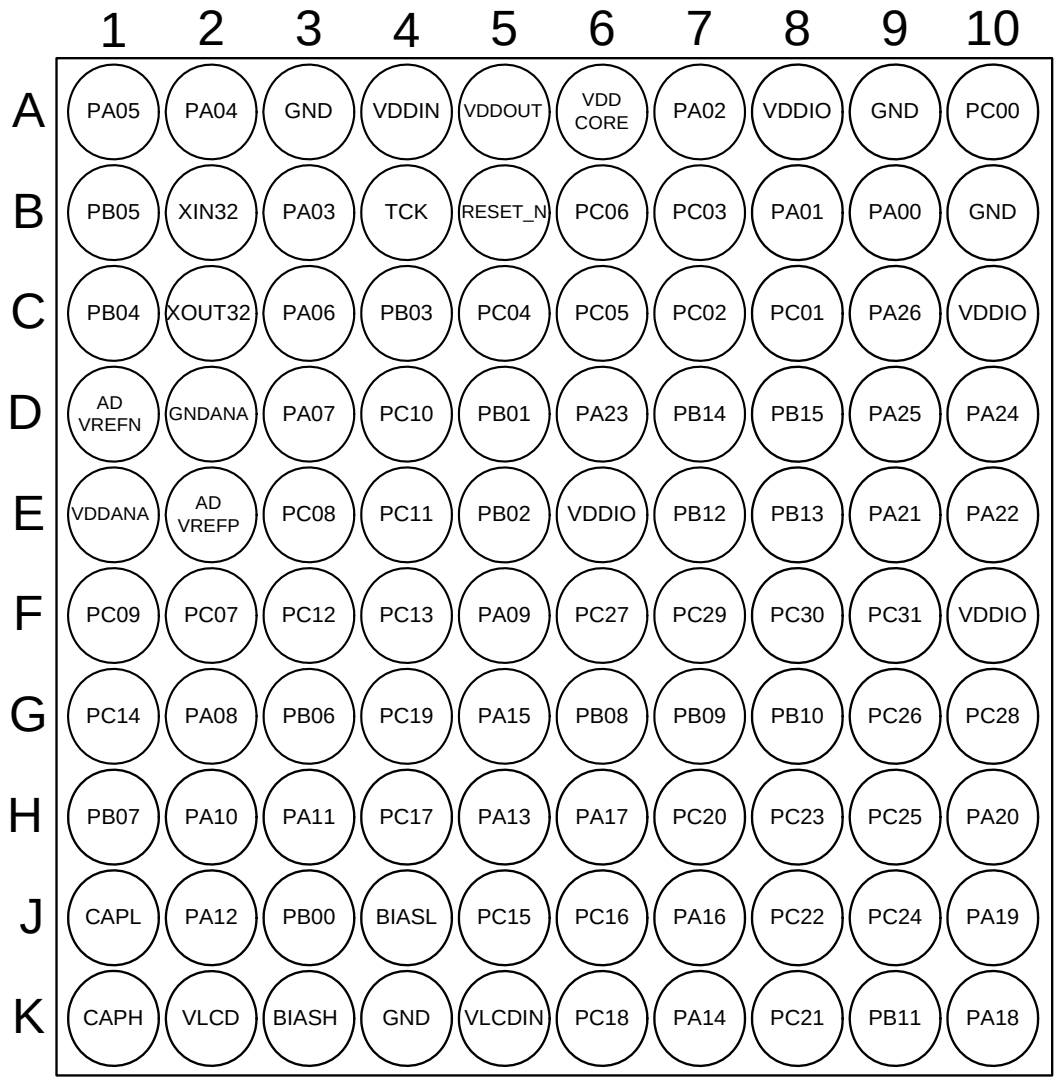


Figure 3-3. ATSAM4LC WLCSP64 Pinout

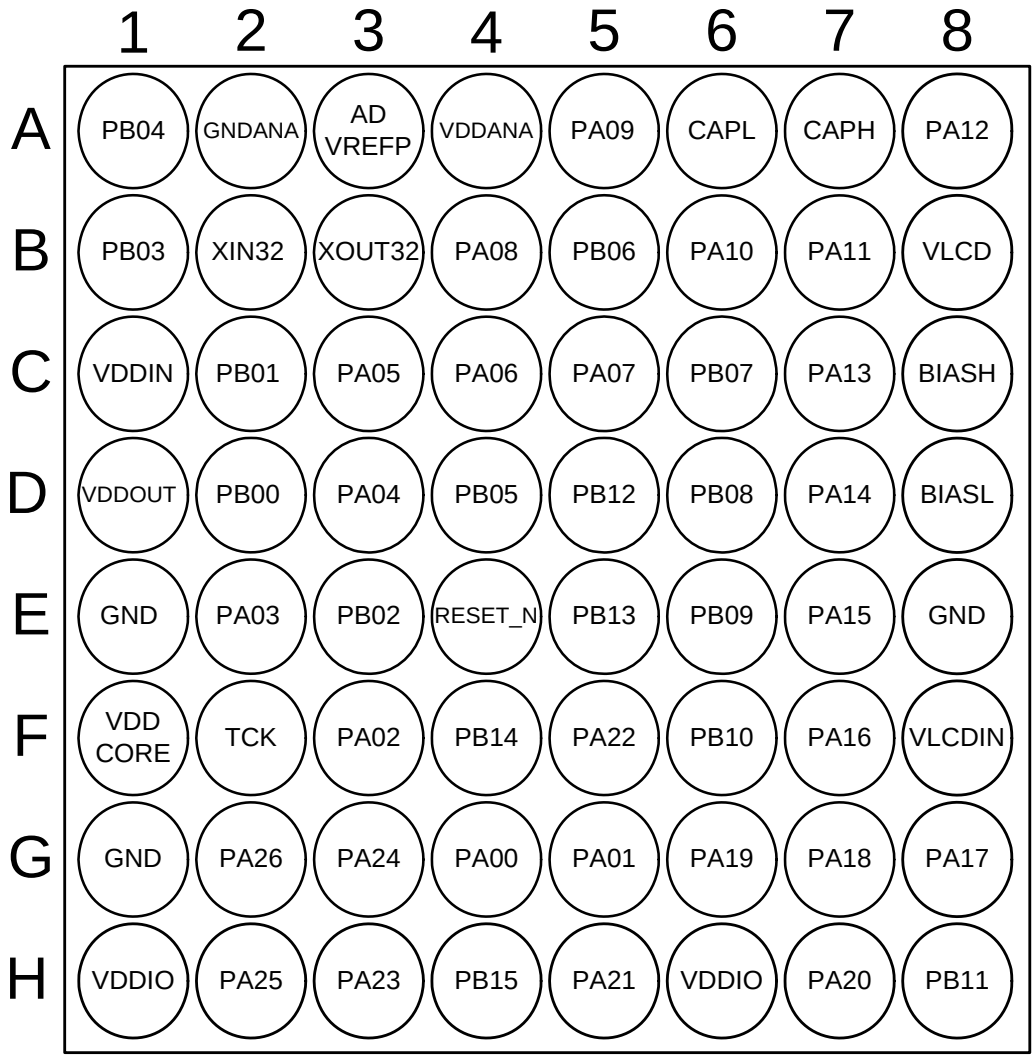


Table 3-2. 64-pin GPIO Controller Function Multiplexing (Sheet 3 of 3)

ATSAM4LC	ATSAM4LS	Pin	GPIO	Supply	GPIO Functions						
QFP QFN	QFP QFN				A	B	C	D	E	F	G
	33	PA27	27	LCDA	SPI MISO	IISC ISCK	ABDACB DAC0	GLOC IN4	USART3 RTS		CATB SENSE0
	34	PA28	28	LCDA	SPI MOSI	IISC ISDI	ABDACB DACN0	GLOC IN5	USART3 CTS		CATB SENSE1
	35	PA29	29	LCDA	SPI SCK	IISC IWS	ABDACB DAC1	GLOC IN6	USART3 CLK		CATB SENSE2
	38	PA30	30	LCDA	SPI NPCS0	IISC ISDO	ABDACB DACN1	GLOC IN7	USART3 RXD		CATB SENSE3
	39	PA31	31	LCDA	SPI NPCS1	IISC IMCK	ABDACB CLK	GLOC OUT1	USART3 TXD		CATB DIS
11	11	PB00	32	VDDIN	TWIMS1 TWD	USART0 RXD					CATB SENSE21
12	12	PB01	33	VDDIN	TWIMS1 TWCK	USART0 TXD	EIC EXTINT0				CATB SENSE22
13	13	PB02	34	VDDANA	ADCIFE AD3	USART1 RTS	ABDACB DAC0	IISC ISCK	ACIFC ACBN0		CATB SENSE23
14	14	PB03	35	VDDANA	ADCIFE AD4	USART1 CLK	ABDACB DACN0	IISC ISDI	ACIFC ACBP0		CATB DIS
19	19	PB04	36	VDDANA	ADCIFE AD5	USART1 RXD	ABDACB DAC1	IISC ISDO	DACC EXT TRIG0		CATB SENSE24
20	20	PB05	37	VDDANA	ADCIFE AD6	USART1 TXD	ABDACB DACN1	IISC IMCK			CATB SENSE25
27	27	PB06	38	LCDA	USART3 RTS		GLOC IN4	IISC IWS		LCDCA SEG22	CATB SENSE26
28	28	PB07	39	LCDA	USART3 CTS		GLOC IN5	TC0 A0		LCDCA SEG21	CATB SENSE27
45	45	PB08	40	LCDA	USART3 CLK		GLOC IN6	TC0 B0		LCDCA SEG14	CATB SENSE28
46	46	PB09	41	LCDA	USART3 RXD	PEVC PAD EVT2	GLOC IN7	TC0 A1		LCDCA SEG15	CATB SENSE29
47	47	PB10	42	LCDA	USART3 TXD	PEVC PAD EVT3	GLOC OUT1	TC0 B1	SCIF GCLK0	LCDCA SEG16	CATB SENSE30
48	48	PB11	43	LCDA	USART0 CTS	SPI NPCS2		TC0 A2	SCIF GCLK1	LCDCA SEG17	CATB SENSE31
53	53	PB12	44	LCDC	USART0 RTS	SPI NPCS3	PEVC PAD EVT0	TC0 B2	SCIF GCLK2	LCDCA SEG32	CATB DIS
54	54	PB13	45	LCDC	USART0 CLK	SPI NPCS1	PEVC PAD EVT1	TC0 CLK0	SCIF GCLK3	LCDCA SEG33	CATB SENSE0
57	57	PB14	46	LCDC	USART0 RXD	SPI MISO	TWIM3 TWD	TC0 CLK1	SCIF GCLK IN0	LCDCA SEG36	CATB SENSE1
58	58	PB15	47	LCDC	USART0 TXD	SPI MOSI	TWIM3 TWCK	TC0 CLK2	SCIF GCLK IN1	LCDCA SEG37	CATB SENSE2

Table 3-4. 48-pin GPIO Controller Function Multiplexing (Sheet 1 of 2)

ATSAM4LC	ATSAM4LS	Pin	GPIO	Supply	GPIO Functions						
					A	B	C	D	E	F	G
1	1	PA00	0	VDDIO							
2	2	PA01	1	VDDIO							
3	3	PA02	2	VDDIN	SCIF GCLK0	SPI NPCS0					CATB DIS
10	10	PA03	3	VDDIN		SPI MISO					
11	11	PA04	4	VDDANA	ADCIFE AD0	USART0 CLK	EIC EXTINT2	GLOC IN1			CATB SENSE0
12	12	PA05	5	VDDANA	ADCIFE AD1	USART0 RXD	EIC EXTINT3	GLOC IN2	ADCIFE TRIGGER		CATB SENSE1
15	15	PA06	6	VDDANA	DACC VOUT	USART0 RTS	EIC EXTINT1	GLOC IN0	ACIFC ACAN0		CATB SENSE2
16	16	PA07	7	VDDANA	ADCIFE AD2	USART0 TXD	EIC EXTINT4	GLOC IN3	ACIFC ACAP0		CATB SENSE3
20	20	PA08	8	LCDA	USART0 RTS	TC0 A0	PEVC PAD EVT0	GLOC OUT0		LCDCA SEG23	CATB SENSE4
21	21	PA09	9	LCDA	USART0 CTS	TC0 B0	PEVC PAD EVT1	PARC PCDATA0		LCDCA COM3	CATB SENSE5
22	22	PA10	10	LCDA	USART0 CLK	TC0 A1	PEVC PAD EVT2	PARC PCDATA1		LCDCA COM2	CATB SENSE6
23	23	PA11	11	LCDA	USART0 RXD	TC0 B1	PEVC PAD EVT3	PARC PCDATA2		LCDCA COM1	CATB SENSE7
24	24	PA12	12	LCDA	USART0 TXD	TC0 A2		PARC PCDATA3		LCDCA COM0	CATB DIS
32	32	PA13	13	LCDA	USART1 RTS	TC0 B2	SPI NPCS1	PARC PCDATA4		LCDCA SEG5	CATB SENSE8
33	33	PA14	14	LCDA	USART1 CLK	TC0 CLK0	SPI NPCS2	PARC PCDATA5		LCDCA SEG6	CATB SENSE9
34	34	PA15	15	LCDA	USART1 RXD	TC0 CLK1	SPI NPCS3	PARC PCDATA6		LCDCA SEG7	CATB SENSE10
35	35	PA16	16	LCDA	USART1 TXD	TC0 CLK2	EIC EXTINT1	PARC PCDATA7		LCDCA SEG8	CATB SENSE11
36	36	PA17	17	LCDA	USART2 RTS	ABDACB DAC0	EIC EXTINT2	PARC PCCK		LCDCA SEG9	CATB SENSE12
37	37	PA18	18	LCDA	USART2 CLK	ABDACB DACN0	EIC EXTINT3	PARC PCEN1		LCDCA SEG18	CATB SENSE13
38	38	PA19	19	LCDA	USART2 RXD	ABDACB DAC1	EIC EXTINT4	PARC PCEN2	SCIF GCLK0	LCDCA SEG19	CATB SENSE14
39	39	PA20	20	LCDA	USART2 TXD	ABDACB DACN1	EIC EXTINT5	GLOC IN0	SCIF GCLK1	LCDCA SEG20	CATB SENSE15
41	41	PA21	21	LCDC	SPI MISO	USART1 CTS	EIC EXTINT6	GLOC IN1	TWIM2 TWD	LCDCA SEG34	CATB SENSE16
42	42	PA22	22	LCDC	SPI MOSI	USART2 CTS	EIC EXTINT7	GLOC IN2	TWIM2 TWCK	LCDCA SEG35	CATB SENSE17
43	43	PA23	23	LCDC	SPI SCK	TWIMS0 TWD	EIC EXTINT8	GLOC IN3	SCIF GCLK IN0	LCDCA SEG38	CATB DIS

Table 3-4. 48-pin GPIO Controller Function Multiplexing (Sheet 2 of 2)

ATSAM4LC	ATSAM4LS	Pin	GPIO	Supply	GPIO Functions						
					A	B	C	D	E	F	G
44	44	PA24	24	LCDC	SPI NPCS0	TWIMS0 TWCK		GLOC OUT0	SCIF GCLK IN1	LCDCA SEG39	CATB SENSE18
46	46	PA25	25	VDDIO	USBC DM	USART2 RXD					CATB SENSE19
47	47	PA26	26	VDDIO	USBC DP	USART2 TXD					CATB SENSE20
	25	PA27	27	LCDA	SPI MISO	IISC ISCK	ABDACB DAC0	GLOC IN4	USART3 RTS		CATB SENSE0
	26	PA28	28	LCDA	SPI MOSI	IISC ISDI	ABDACB DACN0	GLOC IN5	USART3 CTS		CATB SENSE1
	27	PA29	29	LCDA	SPI SCK	IISC IWS	ABDACB DAC1	GLOC IN6	USART3 CLK		CATB SENSE2
	30	PA30	30	LCDA	SPI NPCS0	IISC ISDO	ABDACB DACN1	GLOC IN7	USART3 RXD		CATB SENSE3
	31	PA31	31	LCDA	SPI NPCS1	IISC IMCK	ABDACB CLK	GLOC OUT1	USART3 TXD		CATB DIS

3.2.2 Peripheral Functions

Each GPIO line can be assigned to one of several peripheral functions. The following table describes how the various peripheral functions are selected. The last listed function has priority in case multiple functions are enabled on the same pin.

Table 3-5. Peripheral Functions

Function	Description
GPIO Controller Function multiplexing	GPIO and GPIO peripheral selection A to H
JTAG port connections	JTAG debug port
Oscillators	OSC0

3.2.3 JTAG Port Connections

If the JTAG is enabled, the JTAG will take control over a number of pins, irrespectively of the I/O Controller configuration.

Table 3-6. JTAG Pinout

48-pin Packages	64-pin QFP/QFN	64-pin WLSCP	100-pin QFN	100-ball VFBGA	Pin Name	JTAG Pin
10	10	E2	19	B3	PA03	TMS
43	59	H3	95	D6	PA23	TDO
44	60	G3	96	D10	PA24	TDI
9	9	F2	18	B4	TCK	TCK

3.2.4 ITM Trace Connections

If the ITM trace is enabled, the ITM will take control over the pin PA23, irrespectively of the I/O Controller configuration. The Serial Wire Trace signal is available on pin PA23

3.2.5 Oscillator Pinout

The oscillators are not mapped to the normal GPIO functions and their muxings are controlled by registers in the System Control Interface (SCIF) or Backup System Control Interface (BSCIF). Refer to the Section 15. ”System Control Interface (SCIF)” on page 308 and Section 15. ”Backup System Control Interface (BSCIF)” on page 308 for more information about this.

Table 3-7. Oscillator Pinout

48-pin Packages	64-pin QFN/QFP	64-pin WLCSP	100-pin Packages	100-ball VFBGA	Pin Name	Oscillator Pin
1	1	G4	5	B9	PA00	XIN0
13	17	B2	26	B2	XIN32	XIN32
2	2	G5	6	B8	PA01	XOUT0
14	18	B3	27	C2	XOUT32	XOUT32

8.5 Product dependencies

8.5.1 I/O Lines

Refer to Section 1.1.5.1 ”I/O Lines” on page 5.

8.5.2 Power management

Refer to Section 1.1.5.2 ”Power Management” on page 5.

8.5.3 Clocks

Refer to Section 1.1.5.3 ”Clocks” on page 5.

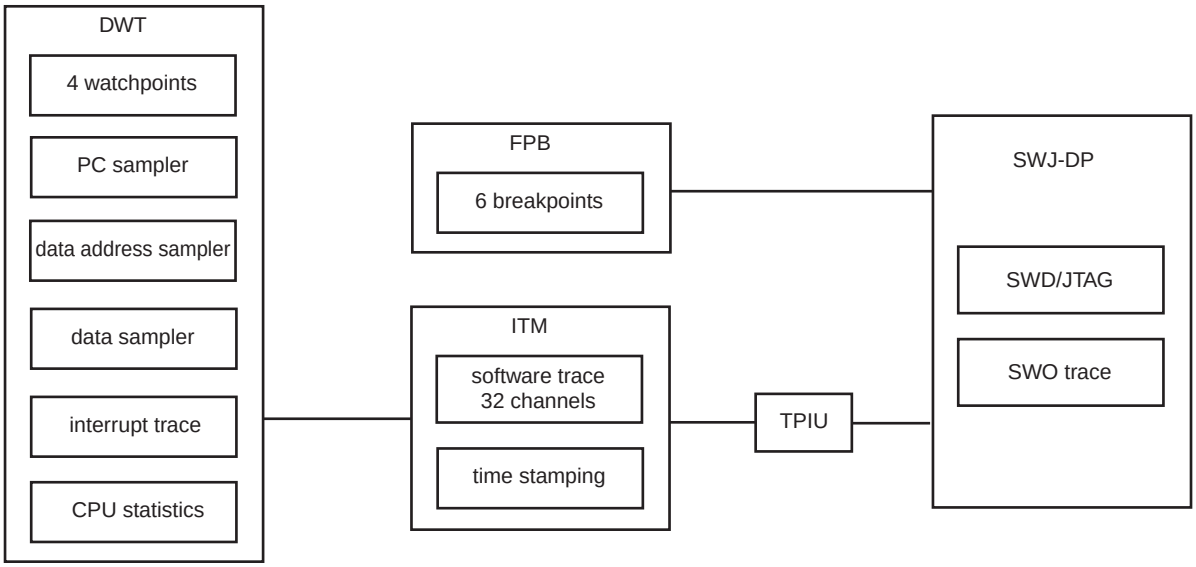
8.6 Core debug

Figure 8-2 shows the Debug Architecture used in the SAM4L. The Cortex-M4 embeds four functional units for debug:

- FPB (Flash Patch Breakpoint)
- DWT (Data Watchpoint and Trace)
- ITM (Instrumentation Trace Macrocell)
- TPIU (Trace Port Interface Unit)

The debug architecture information that follows is mainly dedicated to developers of SWJ-DP Emulators/Probes and debugging tool vendors for Cortex-M4 based microcontrollers. For further details on SWJ-DP see the Cortex-M4 technical reference manual.

Figure 8-2. Debug Architecture



8.6.1 FPB (Flash Patch Breakpoint)

The FPB:

- Implements hardware breakpoints
- Patches (on the fly) code and data being fetched by the Cortex-M4 core from code space with data in the system space. Definition of code and system spaces can be found in the System Address Map section of the ARMv7-M Architecture Reference Manual.

8.7.12 JTAG Instructions Summary

The implemented JTAG instructions are shown in the table below.

Table 8-2. Implemented JTAG instructions list

IR instruction value	Instruction	Description	availability when protected	Component
b0000	EXTEST	Select boundary-scan chain as data register for testing circuitry external to the device.	yes	BSCAN-TAP
b0001	SAMPLE_PRELOAD	Take a snapshot of external pin values without affecting system operation.	yes	
b0100	INTEST	Select boundary-scan chain for internal testing of the device.	yes	
b0101	CLAMP	Bypass device through Bypass register, while driving outputs from boundary-scan register.	yes	
b1000	ABORT	ARM JTAG-DP Instruction	yes	SWJ-DP (in JTAG mode)
b1010	DPACC	ARM JTAG-DP Instruction	yes	
b1011	APACC	ARM JTAG-DP Instruction	yes	
b1100	-	Reserved	yes	
b1101	-	Reserved	yes	
b1110	IDCODE	ARM JTAG-DP Instruction	yes	
b1111	BYPASS	Bypass this device through the bypass register.	yes	

8.7.13 Security Restrictions

The SAM4L provide a security restrictions mechanism to lock access to the device. The device in the protected state when the Flash Security Bit is set. Refer to section Flash Controller for more details.

When the device is in the protected state the AHB-AP is locked. Full access to the AHB-AP is re-enabled when the protected state is released by issuing a Chip Erase command. Note that the protected state will read as programmed only after the system has been reseted.

8.7.13.1 Notation

Table 8-4 on page 73 shows bit patterns to be shifted in a format like "**p01**". Each character corresponds to one bit, and eight bits are grouped together for readability. The least significant bit is always shifted first, and the most significant bit shifted last. The symbols used are shown in Table 8-3.

Table 8-3. Symbol Description

Symbol	Description
0	Constant low value - always reads as zero.
1	Constant high value - always reads as one.
p	The chip protected state.
x	A don't care bit. Any value can be shifted in, and output data should be ignored.
e	An error bit. Read as one if an error occurred, or zero if not.
b	A busy bit. Read as one if the SMAP was busy, or zero if it was not.
s	Startup done bit. Read as one if the system has started-up correctly.

In many cases, it is not required to shift all bits through the data register. Bit patterns are shown using the full width of the shift register, but the suggested or required bits are emphasized using **bold** text. I.e. given the pattern "**01010101** xxxxxxxx xxxxxxxx xxxxxxxx", the shift register is 32 bits, but the test or debug unit may choose to shift only 8 bits "**01010101**".

The following describes how to interpret the fields in the instruction description tables:

Table 8-4. Instruction Description

Instruction	Description
IR input value	Shows the bit pattern to shift into IR in the Shift-IR state in order to select this instruction. The pattern is show both in binary and in hexadecimal form for convenience. Example: **1000** (0x8)
IR output value	Shows the bit pattern shifted out of IR in the Shift-IR state when this instruction is active. Example: p00s

8.7.14.4 CLAMP

This instruction selects the Bypass register as Data Register. The device output pins are driven from the boundary-scan chain.

Starting in Run-Test/Idle, the CLAMP instruction is accessed the following way:

1. Select the IR Scan path.
2. In Capture-IR: The IR output value is latched into the shift register.
3. In Shift-IR: The instruction register is shifted by the TCK input.
4. In Update-IR: The data from the boundary-scan chain is applied to the output pins.
5. Return to Run-Test/Idle.
6. Select the DR Scan path.
7. In Capture-DR: A logic ‘0’ is loaded into the Bypass Register.
8. In Shift-DR: Data is scanned from TDI to TDO through the Bypass register.
9. Return to Run-Test/Idle.

Table 8-8. CLAMP Details

Instructions	Details
IR input value	**0101** (0x5)
IR output value	p00s
DR Size	1
DR input value	x
DR output value	x

8.8 AHB-AP Access Port

The AHB-AP is a Memory Access Port (MEM-AP) as defined in the ARM Debug Interface v5 Architecture Specification. The AHB-AP provides access to all memory and registers in the system, including processor registers through the System Control Space (SCS). System access is independent of the processor status. Either SW-DP or SWJ-DP is used to access the AHB-AP. The AHB-AP is a master into the Bus Matrix. Transactions are made using the AHB-AP programmers model (please refer to the ARM Cortex-M4 Technical Reference Manual), which generates AHB-Lite transactions into the Bus Matrix. The AHB-AP does not perform back-to-back transactions on the bus, so all transactions are non-sequential. The AHB-AP can perform unaligned and bit-band transactions. The Bus Matrix handles these. The AHB-AP transactions are not subject to MPU lookups. AHB-AP transactions bypass the FPB, and so the FPB cannot remap AHB-AP transactions. AHB-AP transactions are little-endian.

Note that while an external reset is applied, AHB-AP accesses are not possible. In addition, access is denied when the protected state is set. In order to discard the protected state, a chip erase operation is necessary.

8.9.11.7 Module Version

Name: VERSION

Access Type: Read-Only

Offset: 0x28

Reset Value: -

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	-

23	22	21	20	19	18	17	16
-	-	-	-	VARIANT			

15	14	13	12	11	10	9	8
-	-	-	-	VERSION			

7	6	5	4	3	2	1	0
VERSION							

- **VARIANT: Variant number**
  Reserved. No functionality associated.
- **VERSION: Version number**
  Version number of the module. No functionality associated.

Table 9-10. Typical Power Consumption running CoreMark on CPU clock sources [1]

RCSYS (MCSEL = 0)	Power scaling mode 1	Switching Mode	0.115	978	µA/MHz
OSC0 (MCSEL = 1)	Power scaling mode 1		0.5	354	
			12	114	
	Power scaling mode 0		12	228	
			30	219	
OSC0 (MCSEL = 1) External Clock (MODE=0)	Power scaling mode 1		0.6	292	
			12	111	
	Power scaling mode 0		12	193	
	Power scaling mode 2		50	194	
PLL (MCSEL = 2)	Power scaling mode 2 Input Freq = 4MHz from OSC0		40	188	
			50	185	
DFLL (MCSEL = 3)	Power scaling mode 0 Input Freq = 32kHz from OSC32K		20	214	
	Power scaling mode 2 Input Freq = 32kHz from OSC32K		50	195	
RC1M (MCSEL = 4)	Power scaling mode 1		1	267	
RCFAST (MCSEL = 5)	Power scaling mode 1 RCFAST frequency is configurable from 4 to 12MHz		4	153	
			12	114	
RC80M (MCSEL = 6)	Power scaling mode 2 f_{CPU} = RC80M / 2 = 40MHz		40	211	

1. These values are based on characterization. These values are not covered by test limits in production.

Table 9-11. Typical Current Consumption by Peripheral in Power Scaling Mode 0 and 2 (1)

Peripheral	Typ Consumption Active	Unit
IISC	1.0	µA/MHz
SPI	1.9	
TC	6.3	
TWIM	1.5	
TWIS	1.2	
USART	8.5	
ADCIFE(2)	3.1	
DACC	1.3	
ACIFC (2)	3.1	
GLOC	0.4	
ABDACB	0.7	
TRNG	0.9	
PARC	0.7	
CATB	3.0	
LCDCA	4.4	
PDCA	1.0	
CRCCU	0.3	
USBC	1.5	
PEVC	5.6	
CHIPID	0.1	
SCIF	6.4	
FREQM	0.5	
GPIO	7.1	
BPM	0.9	
BSCIF	4.6	
AST	1.5	
WDT	1.4	
EIC	0.6	
PICOUART	0.3	

1. These numbers are valid for the measured condition only and must not be extrapolated to other frequencies
2. Includes the current consumption on VDDANA and ADVREFP.

9.5.4 .Peripheral Power Consumption in Power Scaling mode 1

The values in Table 9-13 are measured values of power consumption under the following conditions:

Table 9-48. Unipolar mode, gain=1

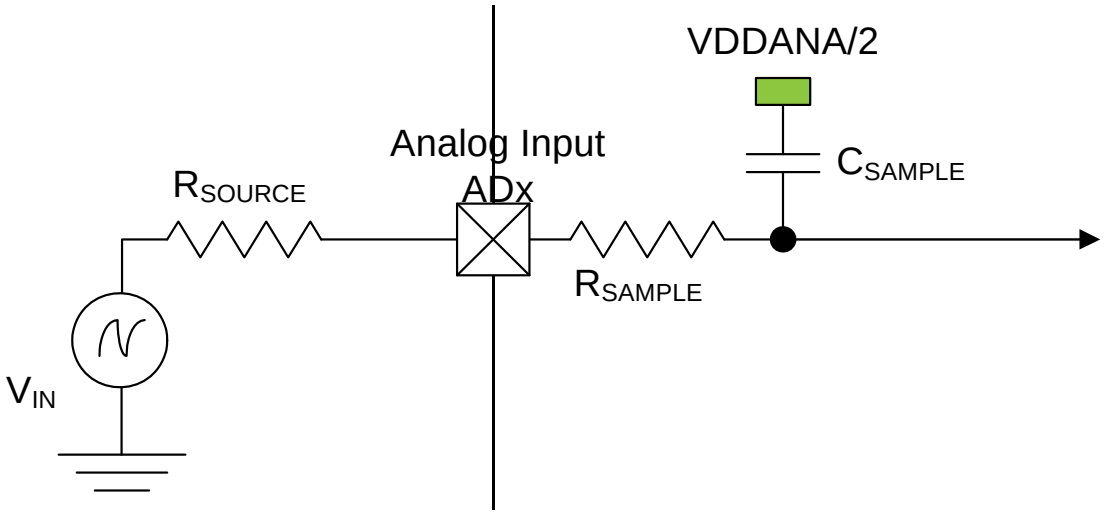
	PSRR[1]	fVdd=100kHz, VDDIO=3.6V		62		dB
		fVdd=1MHz, VDDIO=3.6V		49		
	DC supply current[1]	VDDANA=3.6V		1	2	mA
		VDDANA=1.6V, ADVREFP=1.0V		1	1.3	

1. These values are based on simulation. These values are not covered by test limits in production or characterization.
2. These values are based on characterization and not tested in production, and valid for an input voltage between 10% to 90% of reference voltage.

9.9.4.1 *Inputs and Sample and Hold Acquisition Times*

The analog voltage source must be able to charge the sample and hold (S/H) capacitor in the ADC in order to achieve maximum accuracy. Seen externally the ADC input consists of a resistor (R_{SAMPLE}) and a capacitor (C_{SAMPLE}). In addition, the source resistance (R_{SOURCE}) must be taken into account when calculating the required sample and hold time. Figure 9-6 shows the ADC input channel equivalent circuit.

Figure 9-6. ADC Input



To achieve *n* bits of accuracy, the C_{SAMPLE} capacitor must be charged at least to a voltage of

$$V_{CSAMPLE} \geq V_{IN} \times (1 - 2^{-(n+1)})$$

The minimum sampling time $t_{SAMPLEHOLD}$ for a given R_{SOURCE} can be found using this formula:

$$t_{SAMPLEHOLD} \geq (R_{SAMPLE} + R_{SOURCE}) \times (C_{SAMPLE}) \times (n+1) \times \ln(2)$$

for a 12 bits accuracy : $t_{SAMPLEHOLD} \geq (R_{SAMPLE} + R_{SOURCE}) \times (C_{SAMPLE}) \times 9,02$

where

$$t_{SAMPLEHOLD} = \frac{1}{2 \times fADC}$$

Where $SPIn$ is the MISO delay, SPI6 or SPI9 depending on CPOL and NCPHA. t_{SETUP} is the SPI master setup time. refer to the SPI master datasheet for t_{SETUP} . f_{PINMAX} is the maximum frequency of the SPI pins. refer to the I/O Pin Characteristics section for the maximum frequency of the pins.

9.10.4 TWIM/TWIS Timing

Figure 9-64 shows the TWI-bus timing requirements and the compliance of the device with them. Some of these requirements (t_r and t_f) are met by the device without requiring user intervention. Compliance with the other requirements (t_{HD-STA}, t_{SU-STA}, t_{SU-STO}, t_{HD-DAT}, $t_{SU-DAT-TWI}$, $t_{LOW-TWI}$, t_{HIGH}, and f_{TWCK}) requires user intervention through appropriate programming of the relevant TWIM and TWIS user interface registers. refer to the TWIM and TWIS sections for more information.

Table 9-64. TWI-Bus Timing Requirements

Symbol	Parameter	Mode	Minimum		Maximum		Unit
			Requirement	Device	Requirement	Device	
t_r	TWCK and TWD rise time	Standard(1)	-		1000		ns
		Fast(1)	$20 + 0.1C_b$		300		
t_f	TWCK and TWD fall time	Standard	-		300		ns
		Fast	$20 + 0.1C_b$		300		
t_{HD-STA}	(Repeated) START hold time	Standard	4	t_{clkpb}	-		µs
		Fast	0.6				
t_{SU-STA}	(Repeated) START set-up time	Standard	4.7	t_{clkpb}	-		µs
		Fast	0.6				
t_{SU-STO}	STOP set-up time	Standard	4.0	$4t_{clkpb}$	-		µs
		Fast	0.6				
t_{HD-DAT}	Data hold time	Standard	0.3(2)	$2t_{clkpb}$	3.45()	$15t_{prescaled} + t_{clkpb}$	µs
		Fast			0.9()		
$t_{SU-DAT-TWI}$	Data set-up time	Standard	250	$2t_{clkpb}$	-		ns
		Fast	100				
t_{SU-DAT}		-	-	t_{clkpb}	-		-
$t_{LOW-TWI}$	TWCK LOW period	Standard	4.7	$4t_{clkpb}$	-		µs
		Fast	1.3				
t_{LOW}		-	-	t_{clkpb}	-		-
t_{HIGH}	TWCK HIGH period	Standard	4.0	$8t_{clkpb}$	-		µs
		Fast	0.6				
f_{TWCK}	TWCK frequency	Standard	-		100	$\frac{1}{12t_{clkpb}}$	kHz
		Fast			400		

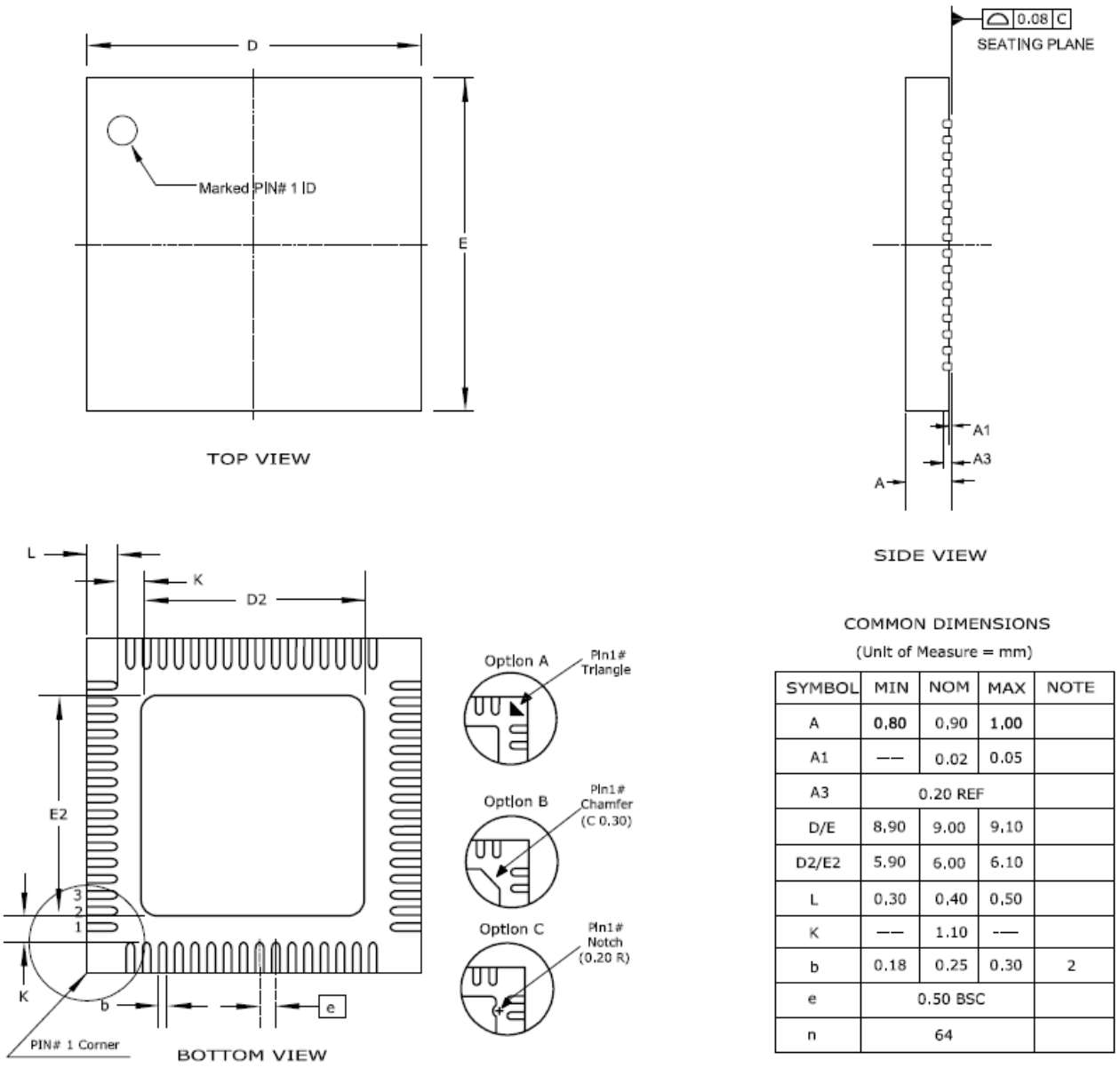
Notes: 1. Standard mode: $f_{TWCK} \leq 100$ kHz ; fast mode: $f_{TWCK} > 100$ kHz .

Table 9-66. SWD Timings[1]

Symbol	Parameter	Conditions	Min	Max	Units
Thigh	SWDCLK High period	V_{VDDIO} from 3.0 V to 3.6 V, maximum external capacitor = 40 pF	10	500 000	ns
Tlow	SWDCLK Low period		10	500 000	
Tos	SWDIO output skew to falling edge SWDCLK		-5	5	
Tis	Input Setup time required between SWDIO		4	-	
Tih	Input Hold time required between SWDIO and rising edge SWDCLK		1	-	

Note: 1. These values are based on simulation. These values are not covered by test limits in production or characterization.

Figure 10-8. QFN-64 Package Drawing



COMMON DIMENSIONS

(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	—	0.02	0.05	
A3		0.20 REF		
D/E	8.90	9.00	9.10	
D2/E2	5.90	6.00	6.10	
L	0.30	0.40	0.50	
K	—	1.10	—	
b	0.18	0.25	0.30	2
e		0.50 BSC		
n		64		

Note: The exposed pad is not connected to anything internally, but should be soldered to ground to increase board level reliability.

Table 10-23. Device and Package Maximum Weight

200	mg

Table 10-24. Package Characteristics

Moisture Sensitivity Level	MSL3

Table 10-25. Package Reference

JEDEC Drawing Reference	MO-220
JESD97 Classification	E3

12. Errata

12.1 ATSAM4L4 /2 Rev. B & ATSAM4L8 Rev. A

12.1.1 General

PS2 mode is not supported by Engineering Samples
PS2 mode support is supported only by parts with calibration version higher than 0.
Fix/Workaround
The calibration version can be checked by reading a 32-bit word at address 0x0080020C. The calibration version bitfield is 4-bit wide and located from bit 4 to bit 7 in this word. Any value higher than 0 ensures that the part supports the PS2 mode

12.1.2 SCIF

PLLCOUNT value larger than zero can cause PLLEN glitch
Initializing the PLLCOUNT with a value greater than zero creates a glitch on the PLLEN signal during asynchronous wake up.
Fix/Workaround
The lock-masking mechanism for the PLL should not be used.
The PLLCOUNT field of the PLL Control Register should always be written to zero.

12.1.3 WDT

WDT Control Register does not have synchronization feedback
When writing to the Timeout Prescale Select (PSEL), Time Ban Prescale Select (TBAN), Enable (EN), or WDT Mode (MODE) fieldss of the WDT Control Register (CTRL), a synchronizer is started to propagate the values to the WDT clcok domain. This synchronization takes a finite amount of time, but only the status of the synchronization of the EN bit is reflected back to the user. Writing to the synchronized fields during synchronization can lead to undefined behavior.
Fix/Workaround
-When writing to the affected fields, the user must ensure a wait corresponding to 2 clock cycles of both the WDT peripheral bus clock and the selected WDT clock source.
-When doing writes that changes the EN bit, the EN bit can be read back until it reflects the written value.

12.1.4 SPI

SPI data transfer hangs with CSR0.CSAAT==1 and MR.MODFDIS==0
When CSR0.CSAAT==1 and mode fault detection is enabled (MR.MODFDIS==0), the SPI module will not start a data transfer.
Fix/Workaround
Disable mode fault detection by writing a one to MR.MODFDIS.

SPI disable does not work in SLAVE mode
SPI disable does not work in SLAVE mode.