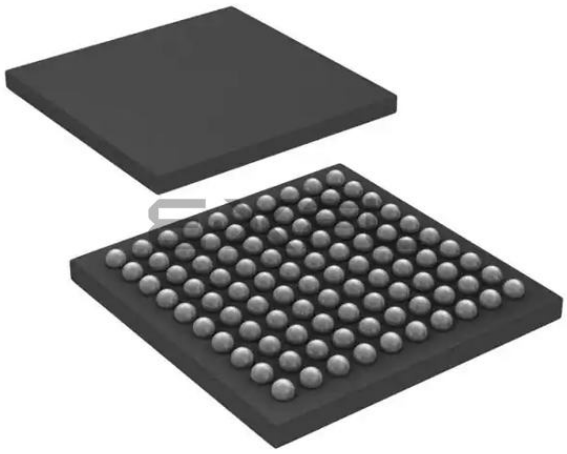

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Applications of "Embedded - Microcontrollers"

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	75
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 15x12b; D/A 1x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-VFBGA
Supplier Device Package	100-VFBGA (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atsam4lc8ca-cfur

Table 2-3. ATSAM4LS Configuration Summary

Feature	ATSAM4LS8/4/2C	ATSAM4LS8/4/2B	ATSAM4LS8/4/2A
Timer/Counter Channels	6	3	
Parallel Capture Inputs	8		
Frequency Meter	1		
Watchdog Timer	1		
Power Manager	1		
Glue Logic LUT	2		1
Oscillators	Digital Frequency Locked Loop 20-150 MHz (DFLL) Phase Locked Loop 48-240 MHz (PLL) Crystal Oscillator 0.6-30 MHz (OSC0) Crystal Oscillator 32 kHz (OSC32K) RC Oscillator 80 MHz (RC80M) RC Oscillator 4,8,12 MHz (RCFAST) RC Oscillator 115 kHz (RCSYS) RC Oscillator 32 kHz (RC32K)		
ADC	15-channel	7-channel	3-channel
DAC	1-channel		
Analog Comparators	4	2	1
CATB Sensors	32	32	26
USB	1		
Audio Bitstream DAC	1		
IIS Controller	1		
Packages	TQFP/VFBGA	TQFP/QFN/ WLCSP	TQFP/QFN

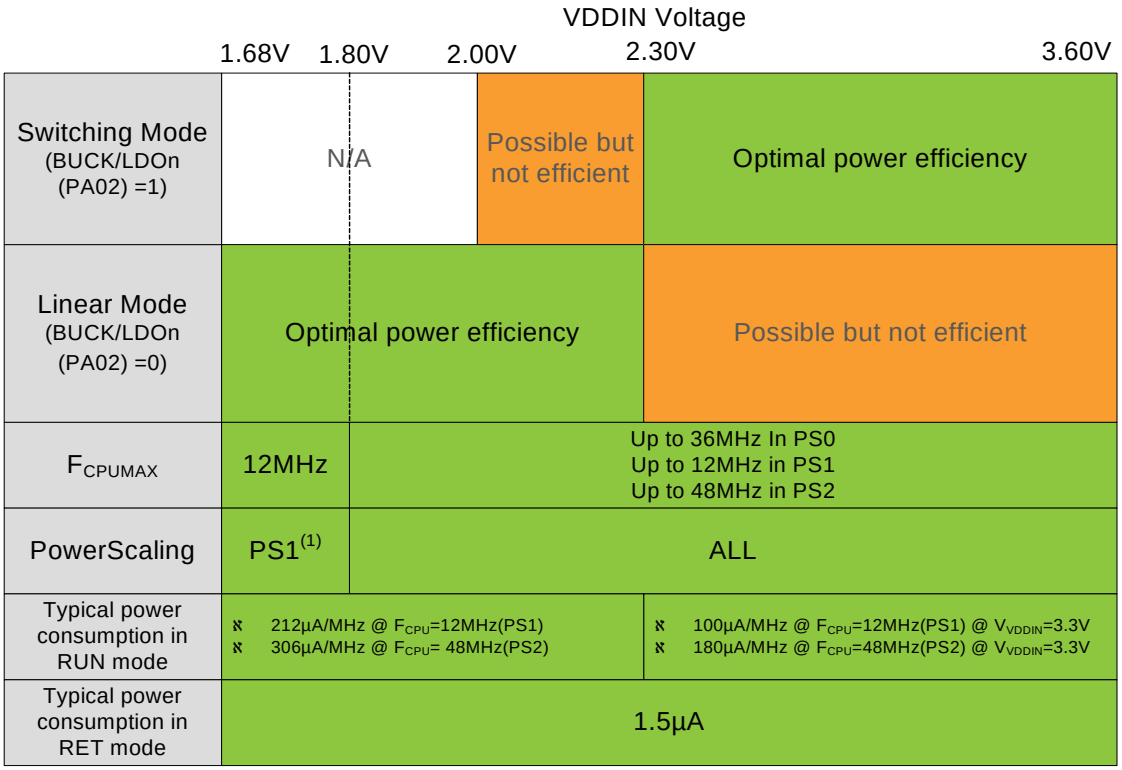
Table 3-2. 64-pin GPIO Controller Function Multiplexing (Sheet 3 of 3)

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

6.2.2 Typical Powering Schematics

The ATSAM4L8/L4/L2 supports the Single supply mode from 1.68V to 3.6V. Depending on the input voltage range and on the final application frequency, it is recommended to use the following table in order to choose the most efficient power strategy

Figure 6-3. Efficient power strategy:



Note 1. The SAM4L boots in PS0 on RCSYS(115kHz), then the application must switch to PS1 before running on higher frequency (<12MHz)

At power-up or after a reset, the ATSAM4L8/L4/L2 is in the RUN0 mode. Only the necessary clocks are enabled allowing software execution. The Power Manager (PM) can be used to adjust the clock frequencies and to enable and disable the peripheral clocks.

When the CPU is entering a Power Save Mode, the CPU stops executing code. The user can choose between four Power Save Modes to optimize power consumption:

- SLEEP mode: the Cortex-M4 core is stopped, optionally some clocks are stopped, peripherals are kept running if enabled by the user.
- WAIT mode: all clock sources are stopped, the core and all the peripherals are stopped except the modules running with the 32kHz clock if enabled. This is the lowest power configuration where SleepWalking is supported.
- RETENTION mode: similar to the WAIT mode in terms of clock activity. This is the lowest power configuration where the logic is retained.
- BACKUP mode: the Core domain is powered off, the Backup domain is kept powered.

A wake up source exits the system to the RUN mode from which the Power Save Mode was entered.

A reset source always exits the system from the Power Save Mode to the RUN0 mode.

The configuration of the I/O lines are maintained in all Power Save Modes. Refer to Section 9. ”Backup Power Manager (BPM)” on page 677.

7.1.1 SLEEP mode

The SLEEP mode allows power optimization with the fastest wake up time.

The CPU is stopped. To further reduce power consumption, the user can switch off modules-clocks and synchronous clock sources through the BPM.PMCON.SLEEP field (See Table 7-1). The required modules will be halted regardless of the bit settings of the mask registers in the Power Manager (PM.AHBMASK, PM.APBxMASK).

Table 7-1. SLEEP mode Configuration

BPM.PSAVE.SLEEP	CPU clock	AHB clocks	APB clocks GCLK	Clock sources: OSC, RCFAST, RC80M, PLL, DFLL	RCSYS	OSC32K RC32K(2)	Wake up Sources
0	Stop	Run	Run	Run	Run	Run	Any interrupt
1	Stop	Stop	Run	Run	Run	Run	Any interrupt(1)
2	Stop	Stop	Stop	Run	Run	Run	Any interrupt(1)
3	Stop	Stop	Stop	Stop	Run	Run	Any interrupt(1)

Notes: 1. from modules with clock running.
2. OSC32K and RC32K will only remain operational if pre-enabled.

7.1.1.1 Entering SLEEP mode

The SLEEP mode is entered by executing the WFI instruction.

Additionally, if the SLEEPONEXIT bit in the Cortex-M4 System Control Register (SCR) is set, the SLEEP mode will also be entered when the Cortex-M4 exits the lowest priority ISR. This

8.7.5 Product Dependencies

8.7.5.1 I/O Lines

The TCK pin is dedicated to the EDP. The other debug port pins default after reset to their GPIO functionality and are automatically reassigned to the JTAG functionalities on detection of a debugger. In serial wire mode, TDI and TDO can be used as GPIO functions. Note that in serial wire mode TDO can be used as a single pin trace output.

8.7.5.2 Power Management

When a debugger is present, the connection is kept alive allowing debug operations. As a side effect, the power is never turned off. The hot plugging functionality is always available except when the system is in BACKUP Power Save Mode.

8.7.5.3 Clocks

The SWJ-DP uses the external TCK pin as its clock source. This clock must be provided by the external JTAG master device.

Some of the JTAG Instructions are used to access an Access Port (SMAP or AHB-AP). These instructions require the CPU clock to be running.

If the CPU clock is not present because the CPU is in a Power Save Mode where this clock is not provided, the Power Manager(PM) will automatically restore the CPU clock on detection of a debug access.

The RCSYS clock is used as CPU clock when the external reset is applied to ensure correct Access Port operations.

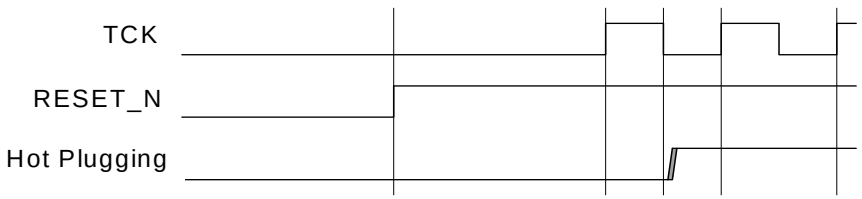
8.7.6 Module Initialization

This module is enabled as soon as a TCK falling edge is detected when RESET_N is not asserted (refer to Section 8.7.7 below). Moreover, the module is synchronously reseted as long as the TAP machine is in the TEST_LOGIC_RESET (TLR) state. It is advised asserting TMS at least 5 TCK clock periods after the debugger has been detected to ensure the module is in the TLR state prior to any operation. This module also has the ability to maintain the Cortex-M4 under reset (refer to the Section 8.7.8 ”SMAP Core Reset Request Source” on page 70).

8.7.7 Debugger Hot Plugging

The TCK pin is dedicated to the EDP. After reset has been released, the EDP detects that a debugger has been attached when a TCK falling edge arises.

Figure 8-4. Debugger Hot Plugging Detection Timings Diagram



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

0: No bus error has been detected sincle last clear of this bit

- **HCR: Hold Core reset**
  1: The Cortex-M4 core is held under reset
  0: The Cortex-M4 core is not held under reset
- **DONE: Operation done**
  1: At least one operation has terminated since last clear of this field
  0: No operation has terminated since last clear of this field

8.9.11.8 Chip Identification Register

Name: CIDR

Access Type: Read-Only

Offset: 0xF0

Reset Value: -

31	30	29	28	27	26	25	24
EXT	NVPTYP			ARCH			

23	22	21	20	19	18	17	16
ARCH				SRAMSIZ			

15	14	13	12	11	10	9	8
NVPSIZ2				NVPSIZ			

7	6	5	4	3	2	1	0
EPROC				VERSION			

Note: Refer to section CHIPID for more information on this register.

instruction for the first time. SAMPLE/PRELOAD can also be used for taking a snapshot of the external pins during normal operation of the part.

When using the JTAG interface for Boundary-Scan, the JTAG TCK clock is independent of the internal chip clock, which is not required to run.

NOTE: For pins connected to 5V lines care should be taken to not drive the pins to a logic one using boundary scan, as this will create a current flowing from the 3,3V driver to the 5V pullup on the line. Optionally a series resistor can be added between the line and the pin to reduce the current.

8.11.7 Flash Programming typical procedure

Flash programming is performed by operating Flash controller commands. The Flash controller is connected to the system bus matrix and is then controllable from the AHP-AP. The AHB-AP cannot write the FLASH page buffer while the core_hold_reset is asserted. The AHB-AP cannot be accessed when the device is in protected state. It is important to ensure that the CPU is halted prior to operating any flash programming operation to prevent it from corrupting the system configuration. The recommended sequence is shown below:

1. At power up, RESET_N is driven low by a debugger. The on-chip regulator holds the system in a POR state until the input supply is above the POR threshold. The system continues to be held in this static state until the internally regulated supplies have reached a safe operating.
2. PM starts, clocks are switched to the slow clock (Core Clock, System Clock, Flash Clock, and any Bus Clocks that do not have clock gate control). Internal resets are maintained due to the external reset.
   – The Debug Port (DP) and Access Ports (AP) receives a clock and leave the reset state,
3. The debugger maintains a low level on TCK and release RESET_N.
   – The SMAP asserts the core_hold_reset signal
4. The Cortex-M4 core remains in reset state, meanwhile the rest of the system is released.
5. The debugger then configures the NVIC to catch the Cortex-M4 core reset vector fetch. For more information on how to program the NVIC, refer to the ARMv7-M Architecture Reference Manual.
6. The debugger writes a one in the SMAP SCR.HCR to release the Cortex-M4 core reset to make the system bus matrix accessible from the AHB-AP.
7. The Cortex-M4 core initializes the SP, then read the exception vector and stalls
8. Programming is available through the AHB-AP
9. After operation is completed, the chip can be restarted either by asserting RESET_N or switching power off/on or clearing SCR.HCR. Make sure that the TCK pin is high when releasing RESET_N not to halt the core.

Table 9-3. Supply Rise Rates and Order [1]

VDDIO, VDDIN and VDDANA must be connected together and as a consequence, rise synchronously

Symbol	Parameter	Rise Rate			
		Min	Max	Unit	Comment
V_{VDDIO}	DC supply peripheral I/Os	0.0001	2.5	V/µs	
V_{VDDIN}	DC supply peripheral I/Os and internal regulator	0.0001	2.5	V/µs	
V_{VDDANA}	Analog supply voltage	0.0001	2.5	V/µs	

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

Table 9-6. ATSAM4L4/2 Current consumption and Wakeup time for power scaling mode 0 and 2

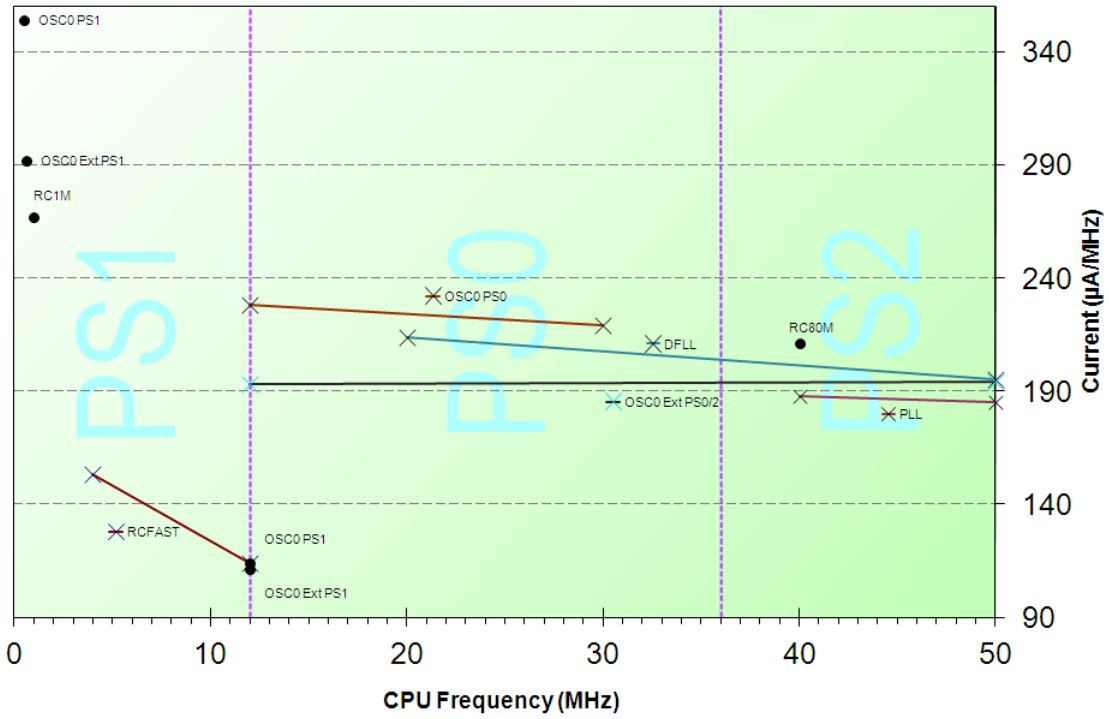
Mode	Conditions	T_A	Typical Wakeup Time	Typ	Max (1)	Unit
SLEEP0	Switching mode	25°C	9 * Main clock cycles	3817	4033	µA
		85°C		3934	4174	
SLEEP1	Switching mode	25°C	9 * Main clock cycles + 500ns	2341	2477	
		85°C		2437	2585	
SLEEP2	Switching mode	25°C	9 * Main clock cycles + 500ns	1758	1862	
		85°C		1847	1971	
SLEEP3	Linear mode	25°C		51	60	
WAIT	OSC32K and AST running Fast wake-up enable		1.5µs	5.9	8.7	
	OSC32K and AST stopped Fast wake-up enable			4.7	7.6	
RETENTION	OSC32K running AST running at 1kHz		1.5µs	3.1	5.1	
	AST and OSC32K stopped			2.2	4.2	
BACKUP	OSC32K running AST running at 1kHz			1.5	3.1	
	AST and OSC32K stopped			0.9	1.7	

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

Table 9-7. ATSAM4L8 Current consumption and Wakeup time for power scaling mode 0 and 2

Mode	Conditions	T_A	Typical Wakeup Time	Typ	Max (1)	Unit
RUN	CPU running a Fibonacci algorithm Linear mode	25°C	N/A	319	343	µA/MHz
		85°C		326	350	
	CPU running a CoreMark algorithm Linear mode	25°C	N/A	343	387	
		85°C		351	416	
	CPU running a Fibonacci algorithm Switching mode	25°C	N/A	181	198	
		85°C		186	203	
	CPU running a CoreMark algorithm Switching mode	25°C	N/A	192	232	
		85°C		202	239	

Figure 9-1. Typical Power Consumption running Coremark (from above table)



Note: For variable frequency oscillators, linear interpolation between high and low settings

Figure 9-2. Measurement Schematic, Switching Mode

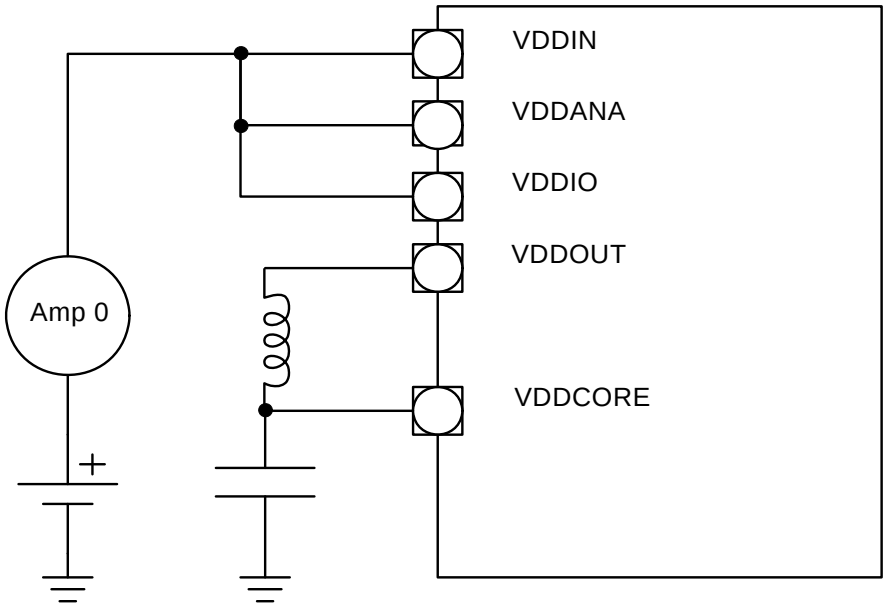


Table 9-47. Differential mode, gain=1

	Offset error drift vs temperature[1]				0.04	mV/°K
	Conversion range [2]	Vin-Vip	-Vref		Vref	V
	ICMR[1]			see Figure 9-5		
	PSRR[1]	fvdd=1Hz, ext ADVREFP=3.0V V_{VDD}=3.6V		100		dB
		fvdd=2MHz, ext ADVREFP=3.0V V_{VDD}=3.6		50		
	DC supply current [2]	VDDANA=3.6V, ADVREFP=3.0V		1.2		mA
		VDDANA=1.6V, ADVREFP=1.0V		0.6		

1. These values are based on simulation only. 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.

Table 9-48. Unipolar mode, gain=1

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Accuracy without compensation [1]			7		ENOB
	Accuracy after compensation[1]				11	ENOB
INL	Integral Non Linearity [2]	After calibration Dynamic tests No gain compensation			±3	LSBs
		After calibration Dynamic tests Gain compensation			±3	
DNL	Differential Non Linearity[2]	After calibration			±2.8	LSBs
	Gain error[2]	External reference	-15		15	mV
		VDDANA/1.6	-50		50	
		VDDANA/2.0	-30		30	
		Bandgap After calibration	-10		10	
	Gain error drift vs voltage[1]	External reference	-8		8	mV/V
	Gain error drift temperature[1]	+ bandgap drift If using bandgap			0.08	mV/°K
	Offset error[2]	External reference	-15		15	mV
		VDDANA/1.6	-15		15	
		VDDANA/2.0	-15		15	
		Bandgap After calibration	-10		10	
	Offset error drift[1]		-4		4	mV/V
	Offset error drift temperature[1]			0	0.04	mV/°K
	Conversion range[1]	Vin-Vip	-Vref		Vref	V
	ICMR[1]			see Figure 9-5		

9.9.5 Digital to Analog Converter Characteristics

Table 9-49. Operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Analog Supply Voltage (1)	on VDDANA	2.4	3	3.6	V
	Digital Supply Voltage(1)	on VDDCORE	1.62	1.8	1.98	V
	Resolution (2)			10		bits
	Clock frequency(1)	Cload = 50pF ; Rload = 5kΩ			500	kHz
	Load(1)	CLoad			50	pF
		RLoad	5			kΩ
INL	Integral Non Linearity (1)	Best fit-line method			±2	LSBs
DNL	Differential Non Linearity (1)	Best fit-line method	-0.9		+1	LSBs
	Zero Error (offset) (1)	CDR[9:0] = 0		1	5	mV
	Gain Error (1)	CDR[9:0] = 1023		5	10	mV
	Total Harmonic Distortion(1)	80% of VDDANA @ fin = 70kHz	-56		7	dB
	Delay to vout (1)	CDR[9:0] = 512/ Cload = 50 pF / Rload = 5 kΩ	2			µs
	Startup time(1)	CDR[9:0] = 512	5		9	µs
	Output Voltage Range	(ADVREFP < VDDANA – 100mV) is mandatory	0		ADVREFP	V
	ADVREFP Voltage Range(1)	(ADVREFP < VDDANA – 100mV) is mandatory	2.3		3.5	V
	ADVREFN Voltage Range(1)	ADVREFP = GND		0		V
	Standby Current(1)	On VDDANA			500	nA
		On VDDCORE			100	
	DC Current consumption(1)	On VDDANA (no Rload)		485	660	µA
		On ADVREFP (CDR[9:0] = 512)		250	295	

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. These values are not covered by test limits in production

9.9.6 Analog Comparator Characteristics

Table 9-50. Analog Comparator Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Positive input voltage range		0.1		VDDIO-0.1	V
	Negative input voltage range		0.1		VDDIO-0.1	
	Offset (1)	V_{ACREFN} =0.1V to VDDIO-0.1V, hysteresis = 0 (2) Fast mode	-12		13	mV
		V_{ACREFN} =0.1V to VDDIO-0.1V, hysteresis = 0(2) Low power mode	-11		12	mV

Maximum SPI Frequency, Master Output

The maximum SPI master output frequency is given by the following formula:

$$f_{SPCKMAX} = MIN(f_{PINMAX}, \frac{1}{SPIn}, \frac{f_{CLKSPI} \times 2}{9})$$

Where $SPIn$ is the MOSI delay, USPI2 or USPI5 depending on CPOL and NCPHA. 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. f_{CLKSPI} is the maximum frequency of the CLK_SPI. Refer to the SPI chapter for a description of this clock.

Maximum SPI Frequency, Master Input

The maximum SPI master input frequency is given by the following formula:

$$f_{SPCKMAX} = MIN(\frac{1}{SPIn + t_{VALID}}, \frac{f_{CLKSPI} \times 2}{9})$$

Where $SPIn$ is the MISO setup and hold time, USPI0 + USPI1 or USPI3 + USPI4 depending on CPOL and NCPHA. T_{VALID} is the SPI slave response time. refer to the SPI slave datasheet for $T_{VALID} \cdot f_{CLKSPI}$ is the maximum frequency of the CLK_SPI. Refer to the SPI chapter for a description of this clock.

9.10.2.2 Slave mode

Figure 9-9. USART in SPI Slave Mode with (CPOL= 0 and CPHA= 1) or (CPOL= 1 and CPHA= 0)

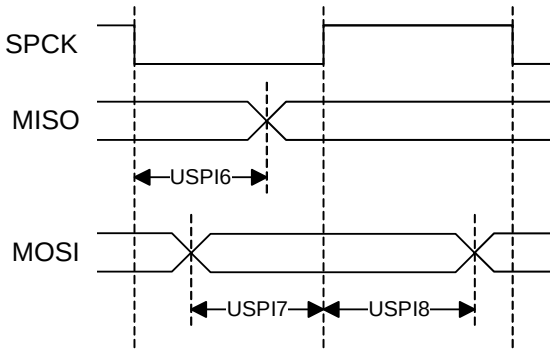


Figure 9-16. SPI Slave Mode, NPCS Timing

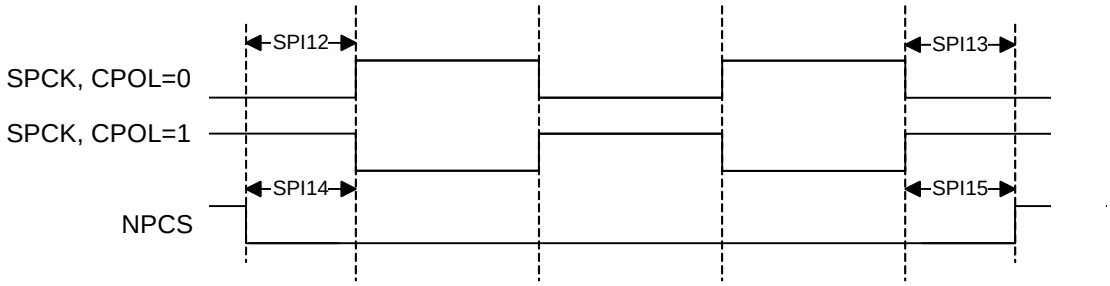


Table 9-63. SPI Timing, Slave Mode[1]

Symbol	Parameter	Conditions	Min	Max	Units
SPI6	SPCK falling to MISO delay	V_{VDDIO} from 2.85V to 3.6V, maximum external capacitor = 40pF	19	47	ns
SPI7	MOSI setup time before SPCK rises		0		
SPI8	MOSI hold time after SPCK rises		5.4		
SPI9	SPCK rising to MISO delay		19	46	
SPI10	MOSI setup time before SPCK falls		0		
SPI11	MOSI hold time after SPCK falls		5.3		
SPI12	NPCS setup time before SPCK rises		4		
SPI13	NPCS hold time after SPCK falls		2.5		
SPI14	NPCS setup time before SPCK falls		6		
SPI15	NPCS hold time after SPCK rises		1.1		

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

Maximum SPI Frequency, Slave Input Mode

The maximum SPI slave input frequency is given by the following formula:

$$f_{SPCKMAX} = MIN(f_{CLKSPI}, \frac{1}{SPIn})$$

Where $SPIn$ is the MOSI setup and hold time, SPI7 + SPI8 or SPI10 + SPI11 depending on CPOL and NCPHA. f_{CLKSPI} is the maximum frequency of the CLK_SPI. Refer to the SPI chapter for a description of this clock.

Maximum SPI Frequency, Slave Output Mode

The maximum SPI slave output frequency is given by the following formula:

$$f_{SPCKMAX} = MIN(f_{PINMAX}, \frac{1}{SPIn + t_{SETUP}})$$

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 .

10.3 Soldering Profile

Table 10-35 gives the recommended soldering profile from J-STD-20.

Table 10-35. Soldering Profile

Profile Feature	Green Package
Average Ramp-up Rate (217°C to Peak)	3°C/s max
Preheat Temperature 175°C ±25°C	150-200°C
Time Maintained Above 217°C	60-150 s
Time within 5·C of Actual Peak Temperature	30 s
Peak Temperature Range	260°C
Ramp-down Rate	6°C/s max
Time 25·C to Peak Temperature	8 minutes max

A maximum of three reflow passes is allowed per component.

11. Ordering Information

Table 11-1. ATSAM4LC8 Sub Serie Ordering Information

Ordering Code	Flash (Kbytes)	RAM (Kbytes)	Package	Conditioning	Package Type	Temperature Operating Range
ATSAM4LC8CA-AU	512	64	TQFP100	Tray	Green	Industrial -40°C to 85°C
ATSAM4LC8CA-AUR				Reel		
ATSAM4LC8CA-CFU			VFBGA100	Tray		
ATSAM4LC8CA-CFUR				Reel		
ATSAM4LC8BA-AU			TQFP64	Tray		
ATSAM4LC8BA-AUR				Reel		
ATSAM4LC8BA-MU			QFN64	Tray		
ATSAM4LC8BA-MUR				Reel		
ATSAM4LC8BA-UUR			WLCSP64	Reel		
ATSAM4LC8AA-MU			QFN48	Tray		
ATSAM4LC8AA-MUR				Reel		

Table 11-2. ATSAM4LC4 Sub Serie Ordering Information

Ordering Code	Flash (Kbytes)	RAM (Kbytes)	Package	Conditioning	Package Type	Temperature Operating Range
ATSAM4LC4CA-AU-ES	256	32	TQFP100	ES	Green	N/A
ATSAM4LC4CA-AU				Tray		Industrial -40°C to 85°C
ATSAM4LC4CA-AUR				Reel		
ATSAM4LC4CA-CFU			VFBGA100	Tray		Industrial -40°C to 85°C
ATSAM4LC4CA-CFUR				Reel		
ATSAM4LC4BA-AU-ES			TQFP64	ES		N/A
ATSAM4LC4BA-AU				Tray		Industrial -40°C to 85°C
ATSAM4LC4BA-AUR				Reel		
ATSAM4LC4BA-MU-ES			QFN64	ES		N/A
ATSAM4LC4BA-MU				Tray		Industrial -40°C to 85°C
ATSAM4LC4BA-MUR				Reel		
ATSAM4LC4BA-UUR			WLCSP64	Reel		Industrial -40°C to 85°C
ATSAM4LC4AA-AU-ES			TQFP48	ES		N/A
ATSAM4LC4AA-AU				Tray		Industrial -40°C to 85°C
ATSAM4LC4AA-AUR				Reel		
ATSAM4LC4AA-MU-ES			QFN48	ES		N/A
ATSAM4LC4AA-MU				Tray		Industrial -40°C to 85°C
ATSAM4LC4AA-MUR				Reel		

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