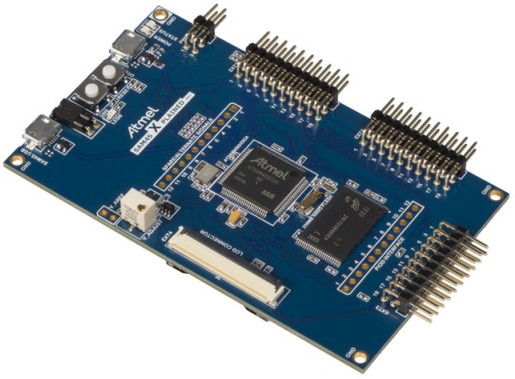
USER GUIDE

Atmel SAM4S Xplained Pro



Preface

The Atmel® SAM4S Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAM4SD32C microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAM4SD32C and explains how to integrate the device in a custom design.

The Xplained Pro MCU series evaluation kits include an on-board Embedded Debugger, and no external tools are necessary to program or debug the ATSAM4SD32C.

The Xplained Pro extension series evaluation kits offers additional peripherals to extend the features of the board and ease the development of custom designs.

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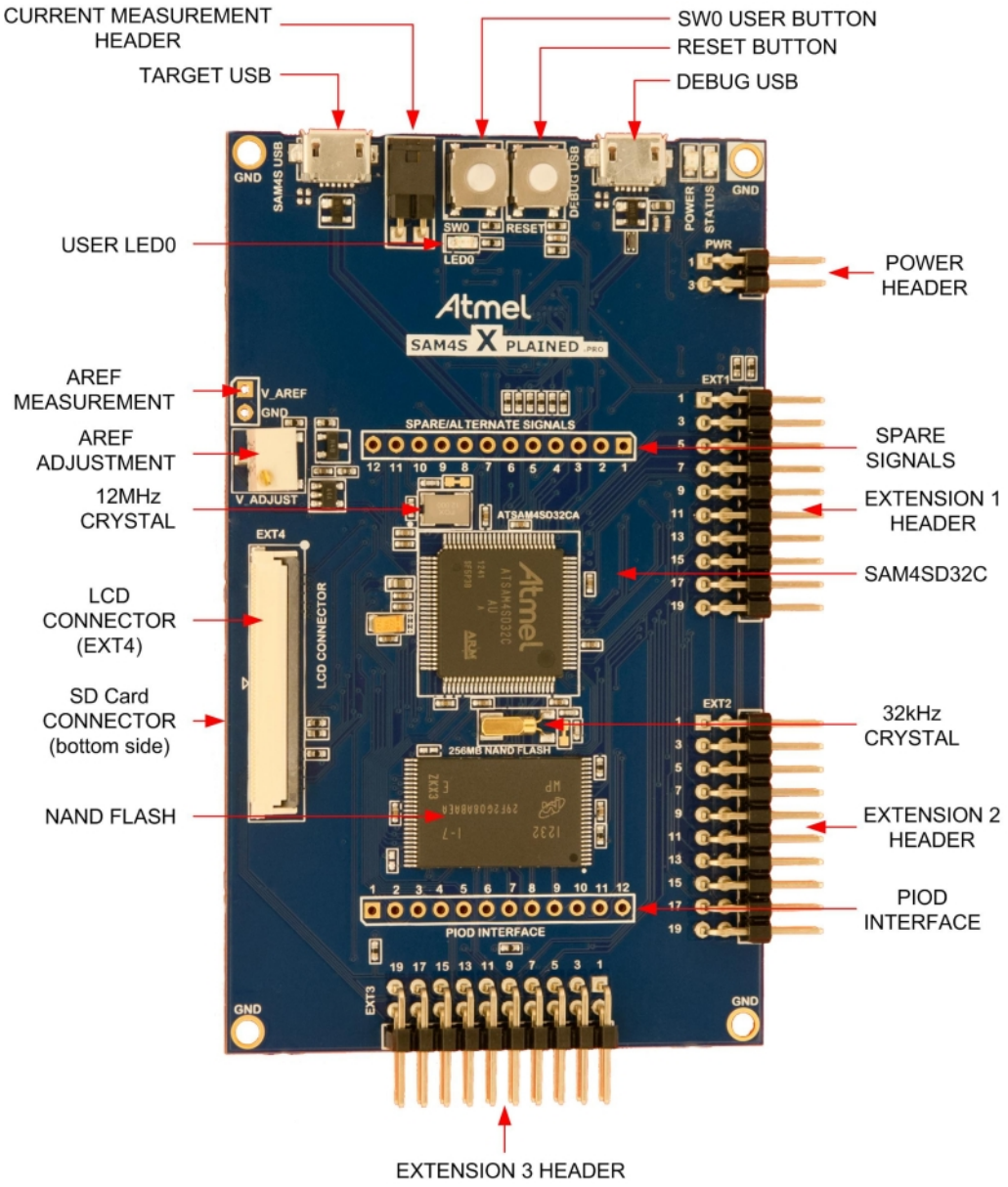
1.2 Kit overview

The Atmel SAM4S Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAM4SD32C.

The kit offers a set of features that enables the ATSAM4SD32C user to get started using the ATSAM4SD32C peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1.1. SAM4S Xplained Pro evaluation kit overview



2. Getting started

2.1 Quick-start

3 Steps to start exploring the Atmel Xplained Pro Platform

- Download and install **Atmel Studio**[1].
- Launch Atmel Studio.
- Connect an USB cable to the DEBUG USB port.

2.2 Connecting the kit

When connecting Atmel SAM4S Xplained Pro to your computer for the first time, the operating system will do a driver software installation. The driver file supports both 32-bit and 64-bit versions of Microsoft® Windows® XP and Windows 7.

Once connected the green power LED will be lit and Atmel Studio will autodetect which Xplained Pro evaluation- and extension kit(s) that's connected. You'll be presented with relevant information like datasheets and kit documentation. You also have the option to launch Atmel Software Framework (ASF) example applications. The target device is programmed and debugged by the on-board Embedded Debugger and no external programmer or debugger tool is needed. Please refer to the Atmel Studio user guide[2] for information regarding how to compile and program the kit.

2.3 Design documentation and related links

The following list contains links to the most relevant documents and software for SAM4S Xplained Pro.

1. **Xplained Pro products** [3] - Atmel Xplained Pro is a series of small-sized and easy-to-use evaluation kits for 8- and 32-bit Atmel microcontrollers. It consists of a series of low cost MCU boards for evaluation and demonstration of features and capabilities of different MCU families.
2. **SAM4S Xplained Pro User Guide** [4] - PDF version of this User Guide.
3. **SAM4S Xplained Pro Design Documentation** [5] - Package containing schematics, BOM, assembly drawings, 3D plots, layer plots etc.
4. **Atmel Studio** [6] - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.
5. **IAR Embedded Workbench® for ARM®.** [7] This is a commercial C/C++ compiler that is available for ARM. There is a 30 day evaluation version as well as a code size limited kick-start version available from their website. The code size limit is 16K for devices with M0, M0+ and M1 cores and 32K for devices with other cores.
6. **Atmel sample store** [8] - Atmel sample store where you can order samples of devices.

[1] http://www.atmel.com/atmelstudio
[2] http://www.atmel.com/atmelstudio
[3] http://www.atmel.com/XplainedPro
[4] http://www.atmel.com/Images/Atmel-42075-SAM4S-Xplained-Pro_User-Guide.pdf
[5] http://www.atmel.com/Images/Atmel-42075-SAM4S-Xplained-Pro_User-Guide.zip
[6] http://www.atmel.com/atmelstudio
[7] http://www.iar.com/en/Products/IAR-Embedded-Workbench/ARM/
[8] http://www.atmel.com/system/samplesstore

3. Xplained Pro

Xplained Pro is an evaluation platform that provides the full Atmel microcontroller experience. The platform consists of a series of Microcontroller (MCU) boards and extension boards that are integrated with Atmel Studio, have Atmel Software Framework (ASF) drivers and demo code, support data streaming and more. Xplained Pro MCU boards support a wide range of Xplained Pro extension boards that are connected through a set of standardized headers and connectors. Each extension board has an identification (ID) chip to uniquely identify which boards are mounted on a Xplained Pro MCU board. This information is used to present relevant user guides, application notes, datasheets and example code through Atmel Studio. Available Xplained Pro MCU and extension boards can be purchased in the Atmel Web Store[1].

3.1 Embedded Debugger

The SAM4S Xplained Pro contains the Atmel® Embedded Debugger (EDBG) for on-board debugging. The EDBG is a composite USB device of 3 interfaces; a debugger, Virtual COM Port and Data Gateway Interface (DGI).

In conjunction with Atmel Studio, the EDBG debugger interface can program and debug the ATSAM4SD32C. On the SAM4S Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM4SD32C.

The Virtual COM Port is connected to a UART port on the ATSAM4SD32C (see section "Embedded Debugger implementation" on page 16 for pinout), and provides an easy way to communicate with the target application through a simple terminal software. It offers variable baud rate, parity and stop bit settings. Note that the settings on the target device UART must match the settings given in the terminal software.

The DGI consists of several physical data interfaces for communication with the host computer. Please, see section "Embedded Debugger implementation" on page 16 for available interfaces and pinout. Communication over the interfaces are bidirectional. It can be used to send events and values from the ATSAM4SD32C, or as a generic printf-style data channel. Traffic over the interfaces can be timestamped on the EDBG for more accurate tracing of events. Note that timestamping imposes an overhead that reduces maximal throughput. The DGI uses a proprietary protocol, and is thus only compatible with Atmel Studio.

The EDBG controls two LEDs on SAM4S Xplained Pro, a power LED and a status LED. Table 3.1, "EDBG LED control" shows how the LEDs are controlled in different operation modes.

Table 3.1. EDBG LED control

Operation mode	Power LED	Status LED
Normal operation	Power LED is lit when power is applied to the board.	Activity indicator, LED flashes every time something happens on the EDBG.
Bootloader mode (idle)	The power LED and the status LED blinks simultaneously.	
Bootloader mode (firmware upgrade)	The power LED and the status LED blinks in an alternating pattern.	

For further documentation on the EDBG, see the EDBG User Guide.

3.2 Hardware identification system

All Xplained Pro compatible extension boards have an Atmel ATSHA204 crypto authentication chip mounted. This chip contains information that identifies the extension with its name and some extra data. When an Xplained Pro extension board is connected to an Xplained Pro MCU board the information is read and sent to Atmel Studio. The Atmel Kits extension, installed with Atmel Studio, will give relevant information, code examples and links to relevant documents. Table 3.2, "Xplained Pro ID chip content" shows the data fields stored in the ID chip with example content.

Table 3.2. Xplained Pro ID chip content

Data Field	Data Type	Example Content
Manufacturer	ASCII string	Atmel'\0'
Product Name	ASCII string	Segment LCD1 Xplained Pro'\0'
Product Revision	ASCII string	02'\0'
Product Serial Number	ASCII string	1774020200000010'\0'
Minimum Voltage [mV]	uint16_t	3000

[1] http://store.atmel.com/CBC.aspx?q=c:100113

Data Field	Data Type	Example Content
Maximum Voltage [mV]	uint16_t	3600
Maximum Current [mA]	uint16_t	30

3.3 Power supply

The SAM4S Xplained Pro kit can be powered either by USB or by an external power source through the 4-pin power header, marked PWR. This connector is described in "Power header" on page 10. The available power sources and specifications are listed in Table 3.3, "Power sources for SAM4S Xplained Pro".

Table 3.3. Power sources for SAM4S Xplained Pro

Power input	Voltage requirements	Current requirements	Connector marking
External power	5 V +/- 2 % (+/- 100 mV) for USB host operation. 4.3 V to 5.5 V if USB host operation is not required	Recommended minimum is 1A to be able to provide enough current for connected USB devices and the board itself. Recommended maximum is 2A due to the input protection maximum current specification.	PWR
Embedded debugger USB	4.4V to 5.25V (according to USB spec)	500 mA (according to USB spec)	DEBUG USB
Target USB	4.4V to 5.25V (according to USB spec)	500 mA (according to USB spec)	TARGET USB

The kit will automatically detect which power sources are available and choose which one to use according to the following priority:

1. External power
2. Embedded debugger USB
3. Target USB

Note External power is required when the 500mA through the USB connector is not enough to power a connected USB device in a USB host application.

3.3.1 Measuring SAM4S power consumption

As part of an evaluation of the SAM4S it can be of interest to measure its power consumption. Because the device has a separate power plane (VCC_MCU_P3V3) on this board it is possible to measure the current consumption by measuring the current that is flowing into this plane. The VCC_MCU_P3V3 plane is connected via a jumper to the main power plane (VCC_TARGET_P3V3) and by replacing the jumper with an ampere meter it is possible to determine the current consumption. To locate the current measurement header, please refer to Figure 1.1, "SAM4S Xplained Pro evaluation kit overview".

Warning Do not power the board without having the jumper or an ampere meter mounted. This can cause the SAM4S to be powered through its I/O pins and cause undefined operation of the device.

3.4 Standard headers and connectors

3.4.1 Xplained Pro extension header

All Xplained Pro kits have one or more dual row, 20 pin, 100mil extension headers. Xplained Pro MCU boards have male headers while Xplained Pro extensions have their female counterparts. Note that all pins are not always connected. However, all the connected pins follow the defined pin-out described in Table 3.4, "Xplained Pro extension header". The extension headers can be used to connect a wide variety of Xplained Pro

extensions to Xplained Pro MCU boards and to access the pins of the target MCU on Xplained Pro MCU board directly.

Table 3.4. Xplained Pro extension header

Pin number	Name	Description
1	ID	Communication line to the ID chip on extension board.
2	GND	Ground
3	ADC(+)	Analog to digital converter , alternatively positive part of differential ADC
4	ADC(-)	Analog to digital converter , alternatively negative part of differential ADC
5	GPIO1	General purpose IO
6	GPIO2	General purpose IO
7	PWM(+)	Pulse width modulation , alternatively positive part of differential PWM
8	PWM(-)	Pulse width modulation , alternatively positive part of differential PWM
9	IRQ/GPIO	Interrupt request line and/or general purpose IO.
10	SPI_SS_B/GPIO	Slave select for SPI and/or general purpose IO.
11	TWI_SDA	Data line for two wire interface. Always implemented, bus type.
12	TWI_SCL	Clock line for two wire interface. Always implemented, bus type.
13	USART_RX	Receiver line of Universal Synchronous and Asynchronous serial Receiver and Transmitter
14	USART_TX	Transmitter line of Universal Synchronous and Asynchronous serial Receiver and Transmitter
15	SPI_SS_A	Slave select for SPI. Should be unique if possible.
16	SPI_MOSI	Master out slave in line of Serial peripheral interface. Always implemented, bus type
17	SPI_MISO	Master in slave out line of Serial peripheral interface. Always implemented, bus type
18	SPI_SCK	Clock for Serial peripheral interface. Always implemented, bus type
19	GND	Ground
20	VCC	Power for extension board

3.4.2 Xplained Pro LCD connector

The LCD connector provides the ability to connect to display extensions that have a parallel interface. The connector implements signals for a MCU parallel bus interface and a LCD controller interface as well as signals for a touchcontroller. The connector pin-out definition is shown in Table 3.5, “Xplained Pro LCD connector”. Note that usually only one display interface is implemented, either LCD controller or the MCU bus interface.

A FPC/FFC connector with 50 pins and 0.5mm pitch is used for the LCD connector. The connector (XF2M-5015-1A) from Omron is used on several designs and can be used as a reference.

Table 3.5. Xplained Pro LCD connector

Pin number	Name	RGB interface description	MCU interface description
1	ID	Communication line to ID chip on extension board.	
2	GND	Ground	
3	D0	Data line	
4	D1	Data line	
5	D2	Data line	
6	D3	Data line	

Pin number	Name	RGB interface description	MCU interface description
7	GND	Ground	
8	D4	Data line	
9	D5	Data line	
10	D6	Data line	
11	D7	Data line	
12	GND	Ground	
13	D8	Data line	
14	D9	Data line	
15	D10	Data line	
16	D11	Data line	
17	GND	Ground	
18	D12	Data line	
19	D12	Data line	
20	D14	Data line	
21	D15	Data line	
22	GND	Ground	
23	D16	Data line	
24	D17	Data line	
25	D18	Data line	
26	D19	Data line	
27	GND	Ground	
28	D20	Data line	
29	D21	Data line	
30	D22	Data line	
31	D23	Data line	
32	GND	Ground	
33	PCLK / CMD_DATA_SEL	Pixel clock	Command and data select. One address line of the MCU for displays where it is possible to select either the register or the data interface.
34	VSYNC / CS	Vertical synchronization	Chip select
35	HSYNC / WE	Horizontal synchronization	Write enable signal
36	DATA ENABLE / RE	Data enable signal	Read enable signal
37	SPI SCK	Clock for Serial peripheral interface	
38	SPI MOSI	Master out slave in line of Serial peripheral interface	
39	SPI MISO	Master in slave out line of Serial peripheral interface	
40	SPI SS	Slave select for SPI. Should be unique if possible	
41	ENABLE	Display enable signal	
42	TWI SDA	I2C data line (maxTouch)	
43	TWI SCL	I2C clock line (maxTouch)	
44	IRQ1	maxTouch interrupt line	

Pin number	Name	RGB interface description	MCU interface description
45	IRQ2	Interrupt line for other I2C devices	
46	PWM	Backlight control	
47	RESET	Reset for both display and maxTouch	
48	VCC	3.3V power supply for extension board	
49	VCC	3.3V power supply for extension board	
50	GND	Ground	

3.4.3 Power header

The power header can be used to connect external power to the SAM4S Xplained Pro kit. The kit will automatically detect and switch to the external power if supplied. The power header can also be used as supply for external peripherals or extension boards. Care must be taken not to exceed the total current limitation of the on-board regulator for the 3.3V regulated output. To locate the current measurement header, please refer to Figure 1.1, “SAM4S Xplained Pro evaluation kit overview”

Table 3.6. Power header PWR

Pin number PWR header	Pin name	Description
1	VEXT_P5V0	External 5V input
2	GND	Ground
3	VCC_P5V0	Unregulated 5V (output, derived from one of the input sources)
4	VCC_P3V3	Regulated 3.3V (output, used as main power for the kit)

Note If the board is powered from a battery source it is recommended to use the PWR header. If there is a power source connected to EDBG USB, the EDBG is activated and it will consume more power.

4. Hardware user guide

4.1 Connectors

This chapter describes the implementation of the relevant connectors and headers on SAM4S Xplained Pro and their connection to the ATSAM4SD32C. The tables of connections in this chapter also describes which signals are shared between the headers and on-board functionality.

4.1.1 I/O extension headers

The SAM4S Xplained Pro headers EXT1, EXT2 and EXT3 offers access to the I/O of the microcontroller in order to expand the board e.g. by connecting extensions to the board. These headers all comply with the standard extension header specified in Xplained Pro Standard Extension Header. All headers have a pitch of 2.54 mm.

Table 4.1. Extension header EXT1

Pin on EXT1	SAM4S pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA17	AD[0]	
4	PA18	AD[1]	
5	PA24	GPIO	PIOD Interface Header
6	PA25	GPIO	PIOD Interface Header
7	PA23	PWMH0	PIOD Interface Header
8	PA19	PWML0	
9	PA1	WKUP1/GPIO	
10	PA6	GPIO	DGI_GPIO0 on EDBG
11	PA3	TWD0	EXT2 and EDBG
12	PA4	TWCK0	EXT2 and EDBG
13	PA21	USART1/RXD1	EXT2
14	PA22	USART1/TXD1	EXT2
15	PA11	SPI/NPCS[0]	
16	PA13	SPI/MOSI	EXT2, EXT3, LCD connector (EXT4) and EDBG
17	PA12	SPI/MISO	EXT2, EXT3, LCD connector (EXT4) and EDBG
18	PA14	SPI/SPCK	EXT2, EXT3, LCD connector (EXT4) and EDBG
19	-	-	GND
20	-	-	VCC

Table 4.2. Extension header EXT2

Pin on EXT2	SAM4S pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PB0	AD[4]	
4	PB1	AD[5]	
5	PC24	GPIO	DGI_GPIO2 on EDBG
6	PC25	GPIO	DGI_GPIO3 on EDBG
7	PC19	PWMH1	

Pin on EXT2	SAM4S pin	Function	Shared functionality
8	PA20	PWML1	
9	PC26	GPIO	
10	PC27	GPIO	
11	PA3	TWD0	EXT1 and EDBG
12	PA4	TWCK0	EXT1 and EDBG
13	PA21	USART1/RXD1	EXT1
14	PA22	USART1/TXD1	EXT1
15	PA9	SPI/NPCS[1]	LCD connector (EXT4)
16	PA13	SPI/MOSI	EXT1, EXT3, LCD connector (EXT4) and EDBG
17	PA12	SPI/MISO	EXT1, EXT3, LCD connector (EXT4) and EDBG
18	PA14	SPI/SPCK	EXT1, EXT3, LCD connector (EXT4) and EDBG
19	-	-	GND
20	-	-	VCC

Table 4.3. Extension header EXT3

Pin on EXT3	SAM4S pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PC29	AD[13]	
4	PC30	AD[14]	
5	PC21	GPIO	
6	PC22	GPIO	DGI_GPIO1 on EDBG
7	PC20	PWMH2	
8	PA16	PWML2	PIOD Header
9	PA0	WKUP0/GPIO	LCD connector (EXT4)
10	PC31	GPIO	
11	PB4	TWD1	LCD connector (EXT4)
12	PB5	TWCK1	LCD connector (EXT4)
13	PB2	USART1/RXD1	CDC UART
14	PB3	USART1/TXD1	CDC UART
15	PA10	SPI/NPCS[2]	LCD connector (EXT4)
16	PA13	SPI/MOSI	EXT1, EXT2, LCD connector (EXT4) and EDBG
17	PA12	SPI/MISO	EXT1, EXT2, LCD connector (EXT4) and EDBG
18	PA14	SPI/SPCK	EXT1, EXT2, LCD connector (EXT4) and EDBG
19	-	-	GND
20	-	-	VCC

4.1.2 LCD extension connector

Extension connector EXT4 is a special connector for LCD displays. The physical connector is an Omron Electronics XF2M-5015-1A FPC connector.

Table 4.4. LCD display connector EXT4

Pin on EXT4	SAM4S pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PC0	D0	NAND Flash
4	PC1	D1	NAND Flash
5	PC2	D2	NAND Flash
6	PC3	D3	NAND Flash
7	-	-	GND
8	PC4	D4	NAND Flash
9	PC5	D5	NAND Flash
10	PC6	D6	NAND Flash
11	PC7	D7	NAND Flash
12	-	-	GND
13	-	-	
14	-	-	
15	-	-	
16	-	-	
17	-	-	GND
18	-	-	
19	-	-	
20	-	-	
21	-	-	
22	-	-	GND
23	-	-	
24	-	-	
25	-	-	
26	-	-	
27	-	-	GND
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	-	-	GND
33	PC18	A0	
34	PC15	NPCS[1]	
35	PC8	NWE	
36	PC11	NRD	
37			
38			
39			
40			
41	PB14	GPIO	
42	PB4	TWD1/SDA	EXT3

Pin on EXT4	SAM4S pin	Function	Shared functionality
43	PB5	TWCK1/SCL	EXT3
44	PA0	WKUP0	EXT3
45	-	-	
46	PA15	PWML3	PIOD Interface header
47	PC28	GPIO	
48	-	VCC_P3V3	
49	-	VCC_P3V3	EXT2
50	-	GND	

4.1.3 Other headers

In addition to the "I/O extension headers" on page 11, SAM4S Xplained Pro has two additional headers with spare signals that offers access to the I/O of the microcontroller which are otherwise not easily available elsewhere or might be favourable to have collected toghether. All headers have a pitch of 2.54mm.

Table 4.5. SPARE SIGNALS header

Pin on header	SAM4S pin	Function	Shared functionality
1	PA2	DATRG	User button, SW0
2	PA9	PWMF10	EXT2
3	PA26	TI0A2	SD Card and PIOD Interface header
4	PA27	TI0B2	SD Card and PIOD Interface header
5	PA28	TCLK1	SD Card and PIOD Interface header
6	PA29	TCLK2	SD Card and PIOD Interface header
7	PA31	PCK2	SD Card and PIOD Interface header
8	PB0	RTCOUT0	EXT2
9	PB1	RTCOUT1	EXT2
10	PB13	DAC0	
11	PB14	DAC1	
12	-	-	GND

Table 4.6. PIOD INTERFACE header

Pin on header	SAM4S pin	Function	Shared functionality
1	PA15	PIODCEN1	LCD connector
2	PA16	PIODCEN2	EXT3
3	PA23	PIODCCLK	EXT1
4	PA24	PIODC0	EXT1
5	PA25	PIODC1	EXT1
6	PA26	PIODC2	SD Card and SPARE Signals header
7	PA27	PIODC3	SD Card and SPARE Signals header
8	PA28	PIODC4	SD Card and SPARE Signals header
9	PA29	PIODC5	SD Card and SPARE Signals header
10	PA30	PIODC6	SD Card
11	PA31	PIODC7	SD Card and SPARE Signals header
12	-	-	GND

4.2 Peripherals

4.2.1 NAND Flash

The SAM4S Xplained Pro kit has one 2Gb NAND Flash connected to the external bus interface of the SAM4S.

Table 4.7. NAND Flash connections

SAM4S pin	Function	NAND Flash function	Shared functionality
PC0	D0	IO0	LCD connector
PC1	D1	IO1	LCD connector
PC2	D2	IO2	LCD connector
PC3	D3	IO3	LCD connector
PC4	D4	IO4	LCD connector
PC5	D5	IO5	LCD connector
PC6	D6	IO6	LCD connector
PC7	D7	IO7	LCD connector
PC9	NANDOE	RE (active low)	
PC10	NANDWE	WE (active low)	
PC13	GPIO	R (active high)/ B (active low)	
PC14	NCS[0]	CE (active low)	
PC16	NANDALE	ALE (active low)	
PC17	NANDCLE	CLE	

4.2.2 SD Card connector

The SAM4S Xplained Pro kit has one SD card connector which is connected to High Speed Multimedia Card Interface (HSMCI) of the SAM4S

Table 4.8. SD Card connections

SAM4S pin	Function	SD Card function	Shared functionality
PA26	MCDA2	DAT2	SPARE Signal and PIOD Interface headers
PA27	MCDA3	DAT3	SPARE Signal and PIOD Interface headers
PA28	MCCDA	CMD	SPARE Signal and PIOD Interface headers
PA29	MCCK	CLK	SPARE Signal and PIOD Interface headers
PA30	MCDA0	DAT0	PIOD Interface header
PA31	MCDA1	DAT1	SPARE Signal and PIOD Interface headers
PC12	GPIO	Card Detect	

4.2.3 Crystals

The SAM4S Xplained Pro kit contains two crystals that can be used as clock sources for the SAM4S device. Each crystal has a cut-strap next to it that can be used to measure the oscillator safety factor. This is done by cutting the strap and adding a resistor across the strap. More information about oscillator allowance and safety factor can be found in appnote AVR4100[1].

Table 4.9. External 32.768kHz crystals

Pin on SAM4S	Function
PA49	XIN32
PA48	XOUT32

[1] http://www.atmel.com/images/doc8333.pdf

Table 4.10. External 12MHz crystals

Pin on SAM4S	Function
PB9	XIN0
PB8	XOUT0

4.2.4 Mechanical buttons

SAM4S Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM4S reset line and the other is a generic user configurable button. When a button is pressed it will drive the I/O line to GND.

Table 4.11. Mechanical buttons

Pin on SAM4S	Silkscreen text
NRST	RESET
PC24	SW0

4.2.5 LED

There is one yellow LED available on the SAM4S Xplained Pro board that can be turned on and off. The LED can be activated by driving the connected I/O line to GND.

Table 4.12. LED connections

Pin on SAM4S	LED
PC23	Yellow LED0

4.2.6 Analog reference

An adjustable voltage reference is implemented on the kit to have a reference for the ADC or DAC. The reference can be adjusted with the on-board multiturn trimmer potentiometer. Next to the potentiometer, a 2-pin header is available to measure the reference voltage for the AREF pin of the SAM4S. The voltage output range for the reference is 0V - 3.36V.

4.3 Embedded Debugger implementation

SAM4S Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAM4SD32C using Serial Wire Debug (SWD). The Embedded Debugger also include a Virtual Com port interface over UART, an Atmel Data Gateway Interface over SPI and TWI and it monitors four of the SAM4S GPIOs. Atmel Studio can be used as a front end for the Embedded Debugger.

4.3.1 Serial Wire Debug

The Serial Wire Debug (SWD) use two pins to communicate with the target. For further information on how to use the programming and debugging capabilities of the EDBG, see “Embedded Debugger” on page 6.

Table 4.13. SWD connections

Pin on SAM4S	Function
PB7	SWD clock
PB6	SWD data
PB5	SWD trace output
PB12	Erase

4.3.2 Virtual COM port

The Embedded Debugger act as a Virtual Com Port gateway by using one of the ATSAM4SD32C UARTs. For further information on how to use the Virtual COM port see “Embedded Debugger” on page 6.

Table 4.14. Virtual COM port connections

Pin on SAM4S	Function
PB3	UART TXD (SAM4S TX line)

Pin on SAM4S	Function
PB2	UART RXD (SAM4S RX line)

4.3.3 Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either a SPI or TWI port. The DGI can be used to send a variety of data from the SAM4S to the host PC. For further information on how to use the DGI interface see “Embedded Debugger” on page 6.

Table 4.15. DGI interface connections when using SPI

Pin on SAM4S	Function
PA5	Slave select (SAM4S is Master)
PA12	SPI MISO (Master In, Slave Out)
PA13	SPI MOSI (Master Out, Slave in)
PA14	SPI SCK (Clock Out)

Table 4.16. DGI interface connections when using TWI

Pin on SAM4S	Function
PA3	SDA (Data line)
PA4	SCL (Clock line)

Four GPIO lines are connected to the Embedded Debugger. The EDBG can monitor these lines and time stamp pin value changes. This makes it possible to accurately time stamp events in the SAM4S application code. For further information on how to configure and use the GPIO monitoring features see “Embedded Debugger” on page 6.

Table 4.17. GPIO lines connected to the EDBG

Pin on SAM4S	Function
PA6	GPIO0
PA22	GPIO1
PA24	GPIO2
PA25	GPIO3

5. Hardware revision history and known issues

5.1 Identifying product ID and revision

The revision and product identifier of Xplained Pro boards can be found in two ways, through Atmel Studio or by looking at the sticker on the bottom side of the PCB.

By connecting a Xplained Pro MCU board to a computer with Atmel Studio running, an information window will pop up. The first 6 digits of the serial number, which is listed under kit details, contain the product identifier and revision. Information about connected Xplained Pro extension boards will also appear in the Atmel Kits window.

The same information can be found on the sticker on the bottom side of the PCB. Most kits will print the identifier and revision in plain text as *A09-nnnn\rr* where *nnnn* is the identifier and *rr* is the revision. Boards with limited space have a sticker with only a QR-code which contains a serial number string.

The serial number string has the following format:

```
"nnnnrrssssssssss"
n = product identifier
r = revision
s = serial number
```

The kit identifier for SAM4S Xplained Pro is 1803.

5.2 Revision 5

On this revision, the SPI clock net is improved to reduce any issues that might be caused by reflections. The SPI has been removed from the LCD (EXT4 connector) to reduce load on the clock net. The remaining clock lines have been divided into four terminated nets for each SPI source (EXT1, EXT2, EXT3, and EDBG) and routed in a star like layout. A series terminator resistor of 43ohm is placed on each clock net, close to the SPI clock pin. This reduces any issues that might be caused by reflections comming back from unterminated/ unused clock lines. It also reduces the rise/fall time of the clock edges and that will also help to reduce any reflection issues.

5.3 Revision 4

Known issues

- SAM4S has an on-die series termination of the SPI CLK which makes this signal not usable for a multi drop clock distribution because all devices along the line will see a fraction of VCC until the signal is reflected from the end of the transmission line. On the SAM4S Xplained Pro revision 4 this signal is routed to each extension connector with EXT1 at the end of the line. That means extensions that are connected along the transission line e.g. EXT3 header is likely to fail due to a non-monotinic edge caused by relections and the fraction of VCC that is present for a short time until the reflection comes back from the end of the line.
  Workaround:
  - By slowing down the clock rise time with a capacitor, and thus effectively increasing the line length at which point it becomes a transmission line, it is possible to remove the clock issue. A 56pF capacitor has been mounted on the bottom side of the board between the SPI clock and GND. This however reduces the maximum SPI clock speed and it is recommended to not run this faster than 30MHz (this also depends on how much additional capacitance is added by connected extensions and needs to be checked case by case). The capacitor was added on revision 4 on the bottom side of the EXT3 header.

6. Document revision history

Doc. Rev.	Date	Comment
B	15/03/2013	Added information about changes done on rev 5
A	11/02/2013	First release

7. Evaluation board/kit important notice

This evaluation board/kit is intended for use for **FURTHER ENGINEERING, DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY.** It is not a finished product and may not (yet) comply with some or any technical or legal requirements that are applicable to finished products, including, without limitation, directives regarding electromagnetic compatibility, recycling (WEEE), FCC, CE or UL (except as may be otherwise noted on the board/kit). Atmel supplied this board/kit "AS IS," without any warranties, with all faults, at the buyer's and further users' sole risk. The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies Atmel from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge and any other technical or legal concerns.

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