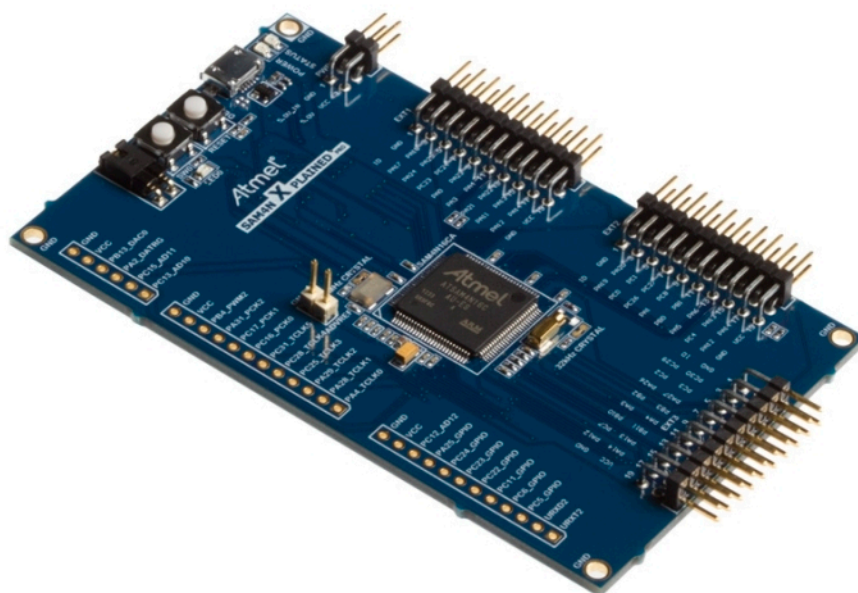# Atmel SAM4N Xplained Pro

Preface

The Atmel® SAM4N Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAM4N16C microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAM4N16C 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 ATSAM4N16C.

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

Table of Contents

1. Introduction

1.1 Features

- Atmel ATSAM4N16C microcontroller
- Embedded debugger (EDBG)
  - USB interface
  - Programming and debugging (target) through Serial Wire Debug (SWD)
  - Virtual COM-port interface to target via UART
  - Atmel Data Gateway Interface (DGI) to target via synchronous USART or TWI
  - Four GPIOs connected to target for code instrumentation
- Digital I/O
  - Two mechanical buttons (user and reset button)
  - One user LED
  - Three extension headers
  - Three spare signal headers
- Two possible power sources
  - External power
  - Embedded debugger USB
- 12MHz crystal
- 32kHz crystal

1.2 Kit overview

The Atmel SAM4N Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAM4N16C.

The kit offers a set of features that enables the ATSAM4N16C user to get started using the ATSAM4N16C peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM4N Xplained Pro evaluation kit overview
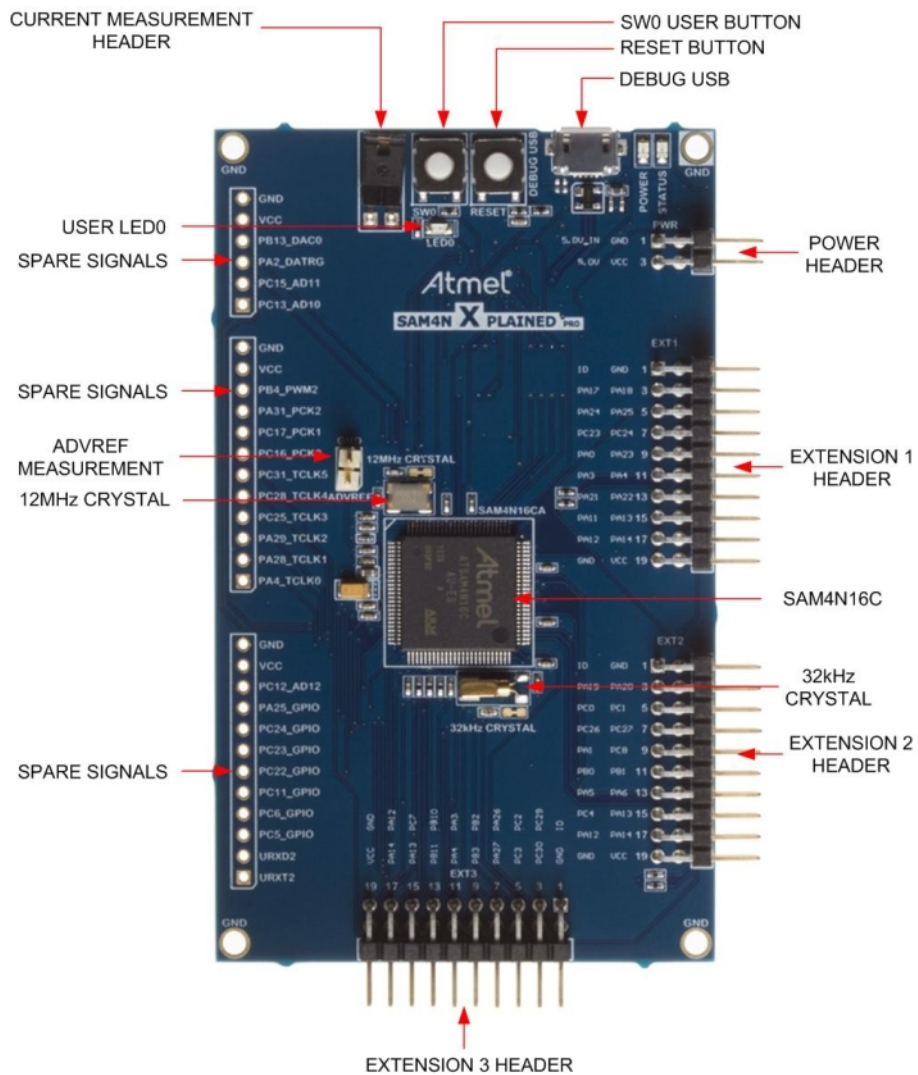
2. Getting started

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 SAM4N 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 SAM4N 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. **SAM4N Xplained Pro User Guide** [4] - PDF version of this User Guide.

3. **SAM4N 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**® [7] **for ARM®.** 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.

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[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-42104-SAM4N-Xplained-Pro_User-Guide.pdf
[5] http://www.atmel.com/Images/Atmel-42104-SAM4N-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 SAM4N 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 ATSAM4N16C. On the SAM4N Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM4N16C.

The Virtual COM Port is connected to a UART port on the ATSAM4N16C (see section "Embedded Debugger implementation" on page 12 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 12 for available interfaces and pinout. Communication over the interfaces are bidirectional. It can be used to send events and values from the ATSAM4N16C, 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 SAM4N 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[2].

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'

Data Field	Data Type	Example Content
Minimum Voltage [mV]	uint16_t	3000
Maximum Voltage [mV]	uint16_t	3600
Maximum Current [mA]	uint16_t	30

3.3 Power supply

The SAM4N 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 "Xplained Pro power header" on page 8. The available power sources and specifications are listed in Table 3-3, "Power sources for SAM4N Xplained Pro".

Table 3-3. Power sources for SAM4N Xplained Pro

Power input	Voltage requirements	Current requirements	Connector marking
External power	4.3V to 5.5V	Recommended minimum is 500mA to be able to provide enough current for extentions 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

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

3.3.1 Measuring SAM4N power consumption

As part of an evaluation of the SAM4N 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, "SAM4N Xplained Pro evaluation kit overview".

Warning   Do not power the board without having the jumper or an ampere meter mounted. This can cause the SAM4N 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.

Pin number	Name	Description
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 power header

The power header can be used to connect external power to the SAM4N 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, "SAM4N Xplained Pro evaluation kit overview"

Table 3-5. 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 SAM4N Xplained Pro and their connection to the ATSAM4N16C. 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 SAM4N 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	SAM4N pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA17	AD0	
4	PA18	AD1	
5	PA24	GPIO	
6	PA25	GPIO	SPARE HEADER2
7	PC23	TIOA3	SPARE HEADER2
8	PC24	TIOB3	SPARE HEADER2
9	PA0	WKUP0	
10	PA23	GPIO	
11	PA3	TWD0	EXT3
12	PA4	TWCK0	EXT3, SPARE HEADER1
13	PA21	RXD1	
14	PA22	TXD1	
15	PA11	NPCS0	
16	PA13	SPI_MOSI	EXT2, EXT3
17	PA12	SPI_MISO	EXT2, EXT3
18	PA14	SPI_SCK	EXT2, EXT3
19	-	-	GND
20	-	-	VCC

Table 4-2. Extension header EXT2

Pin on EXT2	SAM4N pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA19	AD2	
4	PA20	AD3	
5	PC0	GPIO	
6	PC1	GPIO	
7	PC26	TIOA4	
8	PC27	TIOB4	
9	PA1	WKUP1	

Pin on EXT2	SAM4N pin	Function	Shared functionality
10	PC8	GPIO	
11	PB0	TWD2	EDBG
12	PB1	TWCK2	EDBG
13	PA5	RXD0	
14	PA6	TXD0	
15	PC4	NPCS1	
16	PA13	SPI_MOSI	EXT1, EXT3
17	PA12	SPI_MISO	EXT1, EXT3
18	PA14	SPI_SCK	EXT1, EXT3
19	-	-	GND
20	-	-	VCC

Table 4-3. Extension header EXT3

Pin on EXT3	SAM4N pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PC29	AD13	
4	PC30	AD14	
5	PC2	GPIO	
6	PC3	GPIO	
7	PA26	TIOA2	
8	PA27	TIOB2	
9	PB2	WKUP12	
10	PB3	GPIO	
11	PA3	TWD0	EXT1
12	PA4	TWCK0	EXT1, SPARE HEADER1
13	PB10	URXD3	
14	PB11	UTXD3	
15	PC7	NPCS2	
16	PA13	SPI_MOSI	EXT1, EXT2
17	PA12	SPI_MISO	EXT1, EXT2
18	PA14	SPI_SCK	EXT1, EXT2
19	-	-	GND
20	-	-	VCC

4.1.2 Other headers

In addition to the "I/O extension headers" on page 9, SAM4N 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 4-4. SPARE SIGNALS header 1

Pin on header	SAM4N pin	Function	Shared functionality
1	PA4	TWCK0	EXT1, EXT3
2	PA28	TCLK1	
3	PA29	TCLK2	

Pin on header	SAM4N pin	Function	Shared functionality
4	PC25	TCLK3	
5	PC28	TCLK4	
6	PC31	TCLK5	
7	PC16	PCK0	
8	PC17	PCK1	
9	PA31	PCK2	
10	PB4	PWM2	
11	-	-	VCC
12	-	-	GND

Table 4-5. SPARE SIGNALS header 2

Pin on header	SAM4N pin	Function	Shared functionality
1	PA15	UTXD2	
2	PA16	URXD2	
3	PC5	GPIO	
4	PC6	GPIO	
5	PC11	GPIO	
6	PC22	GPIO	
7	PC23	TIOA3	EXT1
8	PC24	TIOB3	EXT1
9	PA25	GPIO	EXT1
10	PC12	AD12	
11	-	-	VCC
12	-	-	GND

Table 4-6. SPARE SIGNALS header 3

Pin on header	SAM4N pin	Function	Shared functionality
1	PC13	AD10	
2	PC15	AD11	
3	PA2	DATRG	
4	PB13	DAC0	
5	-	-	VCC
6	-	-	GND

4.2 Peripherals

4.2.1 Crystals

The SAM4N Xplained Pro kit contains two crystals that can be used as clock sources for the SAM4N 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]. Calculations for the selected crystal can be found in the schematics documentation[2] of the board.

Table 4-7. External 32.768kHz crystals

Pin on SAM4N	Function
PA7	XIN32

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[1] http://www.atmel.com/images/doc8333.pdf
[2] http://www.atmel.com/Images/Atmel-42104-SAM4N-Xplained-Pro_User-Guide.zip

Pin on SAM4N	Function
PA8	XOUT32

Table 4-8. External 12MHz crystals

Pin on SAM4N	Function
PB9	XIN
PB8	XOUT

4.2.2 Mechanical buttons

SAM4N Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM4N 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 4-9. Mechanical buttons

Pin on SAM4N	Silkscreen text
NRST	RESET
PA30	SW0

4.2.3 LED

There is one yellow LED available on the SAM4N 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 4-10. LED connections

Pin on SAM4N	LED
PB14	Yellow LED0

4.2.4 Analog reference

The ADVREF is available on a 2-pin header to measure the analog reference voltage of the SAM4N device.

Note   The ADREF pin can only be used for measuring and must not be used as an input for an external voltage reference.

4.3 Embedded Debugger implementation

SAM4N Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAM4N16C 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 SAM4N 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 .

Table 4-11. SWD connections

Pin on SAM4N	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 ATSAM4N16C UARTs. For further information on how to use the Virtual COM port see .

Table 4-12. Virtual COM port connections

Pin on SAM4N	Function
PA10	UART TXD (SAM4N TX line)
PA9	UART RXD (SAM4N RX line)

4.3.3   Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either a USART or TWI port. The DGI can be used to send a variety of data from the SAM4N to the host PC. For further information on how to use the DGI interface see "Embedded Debugger" on page 6.

Table 4-13. DGI interface connections when using USART

Pin on SAM4N	Function
PC10	USART TXD (SAM4N TX line)
PC9	USART RXD (SAM4N RX line)
PC14	USART CLK

Table 4-14. DGI interface connections when using TWI

Pin on SAM4N	Function
PB0	SDA (Data line)
PB1	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 SAM4N application code. For further information on how to configure and use the GPIO monitoring features see "Embedded Debugger" on page 6.

Table 4-15. GPIO lines connected to the EDBG

Pin on SAM4N	Function
PC21	GPIO0
PC20	GPIO1
PC19	GPIO2
PC18	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 SAM4N Xplained Pro is 1967.

5.2 Revision 2

Revision 2 of SAM4N Xplained Pro is the initial released version.

Known issues:

● In backup mode, the ERASE pin will only work with a power toggle of the SAM4N. This however can't be done by the embedded debugger because there is no switch to control the power to the target. So in cases where e.g. an application is in backup mode and the user needs access in order to program/debug it is necessary to do a manual erase procedure.

Workaround:

● Please connect ERASE test point on the bottom side of the board to VCC (3.3V) e.g. pin 4 on the PWR header. Remove power from the board and reconnect again. The device should be erased by this procedure and it is possible to program/debug via the embedded debugger.

6. Document revision history

Doc. Rev.	Date	Comment
A	07/2013	First release

7.   Evaluation board/kit important notice

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