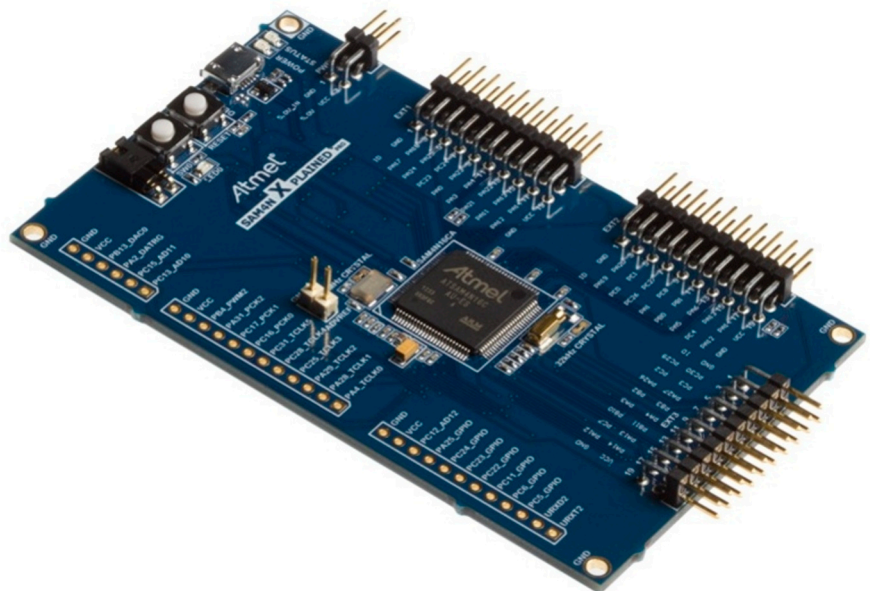# SAM4N Xplained Pro

USER GUIDE

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.

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- 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
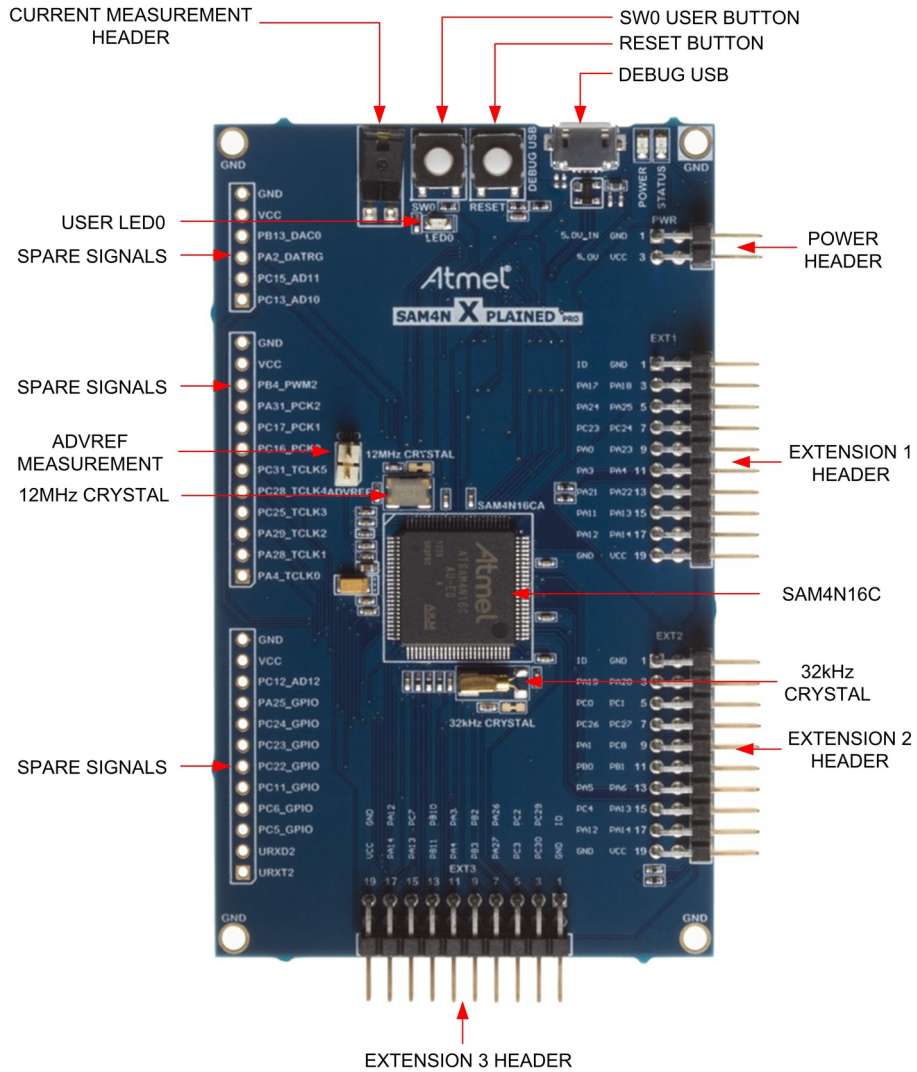
2. Getting Started

2.1. Xplained Pro Quick Start

Steps to start exploring the Atmel Xplained Pro platform:

1. Download Atmel Studio.
2. Launch Atmel Studio.
3. Connect a USB cable (Standard-A to Micro-B or Micro-AB) between the PC and the DEBUG USB port on the kit.

When the Xplained Pro MCU kit is connected to your computer for the first time, the operating system will perform a driver software installation. The driver file supports both 32- and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, Windows 8, Windows 10, and Windows Server 2012.

Once the Xplained Pro MCU board is powered the green power LED will be lit and Atmel Studio will auto detect which Xplained Pro MCU- and extension board(s) are connected. Atmel Studio will present relevant information like datasheets and kit documentation. The kit landing page in Atmel Studio also has the option to launch Atmel Software Framework (ASF) example applications for the kit. The SAM4N device is programmed and debugged by the on-board Embedded Debugger and therefore no external programmer or debugger tool is needed.

2.2. Design Documentation and Relevant Links

The following list contains links to the most relevant documents and software for the SAM4N Xplained Pro.

- **Xplained products** - Atmel Xplained evaluation kits are a series of easy-to-use evaluation kits for Atmel microcontrollers and other Atmel products. For low pin-count devices the Xplained Nano series provides a minimalistic solution with access to all I/O pins of the target microcontroller. Xplained Mini kits are for medium pin-count devices and adds Arduino Uno compatible header footprint and a prototyping area. Xplained Pro kits are for medium to high pin-count devices, they features advanced debugging and standardized extensions for peripheral functions. All these kits have on board programmers/debuggers which creates a set of low-cost boards for evaluation and demonstration of features and capabilities of different Atmel products.
- **Atmel Studio** - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.
- **Atmel sample store** - Atmel sample store where you can order samples of devices.
- **EDBG User Guide** - User guide containing more information about the on-board Embedded Debugger.
- **IAR Embedded Workbench® 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 16KB for devices with M0, M0+, and M1 cores and 32KB for devices with other cores.
- **Atmel Data Visualizer** - Atmel Data Visualizer is a program used for processing and visualizing data. Data Visualizer can receive data from various sources such as the Embedded Debugger Data Gateway Interface found on Xplained Pro boards and COM ports.
- **Hardware Users Guide in PDF format** - PDF version of this User Guide.
- **Design Documentation** - Package containing CAD source, schematics, BOM, assembly drawings, 3D plots, layer plots etc.

- **SAM4N Xplained Pro on the Atmel website** - Atmel website link.

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, which 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, which are connected through a set of standardized headers and connectors. Each extension board has an identification (ID) chip to uniquely identify which boards are connected to an Xplained Pro MCU board. This information is used to present relevant user guides, application notes, datasheets, and example code through Atmel Studio.

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 three interfaces; a debugger, Virtual COM Port, and a Data Gateway Interface (DGI).

Together with Atmel Studio, the EDBG debugger interface can program and debug the ATSAM4N16C. On SAM4N Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM4N16C.

The Virtual COM Port is connected to a UART on the ATSAM4N16C and provides an easy way to communicate with the target application through terminal software. It offers variable baud rate, parity, and stop bit settings. Note that the settings on the ATSAM4N16C must match the settings given in the terminal software.

> **Info:** The virtual COM port in the EDBG requires the terminal software to set the data terminal ready (DTR) signal to enable the UART pins connected to the ATSAM4N16C. If the DTR signal is not enabled the UART pins on the EDBG is kept in high-z (tristate) rendering the COM port unusable. The DTR signal is set automatically by some terminal software, but it may have to be manually enabled in your terminal.

The DGI consists of several physical interfaces for communication with the host computer. Communication over the interfaces is 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. Atmel Data Visualizer is used to send and receive data through DGI.

The EDBG controls two LEDs on SAM4N Xplained Pro; a power LED and a status LED. The table below 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 when any communication happens to 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 CryptoAuthentication™ chip mounted. This chip contains information that identifies the extension with its name and some extra data. When an Xplained Pro extension 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. The table below 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
Maximum Voltage [mV]	uint16_t	3600
Maximum Current [mA]	uint16_t	30

3.3. Power Sources

The SAM4N Xplained Pro kit can be powered by several power sources as listed in the table below.

Table 3-3. Power Sources for SAM4N Xplained Pro

Power input	Voltage requirements	Current requirements	Connector marking
External power	5V ±2% (±100mV) for USB host operation. 4.3V to 5.5V 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.)	500mA (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.

> **Info:** External power is required when 500mA from a USB connector is not enough to power the board with possible extension boards.

3.4. Xplained Pro Headers and Connectors

3.4.1. Xplained Pro Standard Extension Header

All Xplained Pro kits have one or more dual row, 20-pin, 100mil extension header. Xplained Pro MCU boards have male headers, while Xplained Pro extensions have their female counterparts. Note that all pins are not always connected. All connected pins follow the defined pin-out description in the table below.

The extension headers can be used to connect a variety of Xplained Pro extensions to Xplained Pro MCU boards or to access the pins of the target MCU on Xplained Pro MCU boards directly.

Table 3-4. Xplained Pro Standard Extension Header

Pin number	Name	Description
1	ID	Communication line to the ID chip on an 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 I/O
6	GPIO2	General purpose I/O
7	PWM(+)	Pulse width modulation, alternatively positive part of differential PWM
8	PWM(-)	Pulse width modulation, alternatively negative part of differential PWM
9	IRQ/GPIO	Interrupt request line and/or general purpose I/O
10	SPI_SS_B/ GPIO	Slave select for SPI and/or general purpose I/O
11	I^{2}C_SDA	Data line for I^{2}C interface. Always implemented, bus type.
12	I^{2}C_SCL	Clock line for I^{2}C interface. Always implemented, bus type.
13	UART_RX	Receiver line of target device UART
14	UART_TX	Transmitter line of target device UART
15	SPI_SS_A	Slave select for SPI. Should preferably be unique.

Pin number	Name	Description
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 any 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 when using the 3.3V pin.

Table 3-5. Xplained Pro Power Header

Pin number	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 supply for the kit)

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. Xplained Pro Standard 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 Xplained Pro standard extension header. All headers have a pitch of 2.54mm.

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	
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	

Pin on EXT3	SAM4N pin	Function	Shared functionality
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 Xplained Pro standard extension headers, SAM4N Xplained Pro has three additional headers with spare signals that offers access to the I/O of the microcontroller that are otherwise not easily available elsewhere or might be favorable to have collected together. 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	
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

4.1.3.   Current Measurement Header

An angled 1x2, 100mil pin-header marked with MCU current measurement is located at the upper edge of the SAM4N Xplained Pro. All power to the ATSAM4N16C is routed through this header. To measure the power consumption of the device remove the jumper and replace it with an ammeter.

> **Caution:**   Removing the jumper from the pin-header while the kit is powered may cause the ATSAM4N16C to be powered through its I/O pins. This may cause permanent damage to the device.

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 applicaton note AVR4100. Calculations for the selected crystal can be found in the schematics documentation of the board.

Table 4-7. External 32.768kHz Crystal

Pin on SAM4N	Function
PA7	XIN32
PA8	XOUT32

Table 4-8. External 12MHz Crystal

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.

> **Info:**   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) interface use two pins to communicate with the target. For further information on how to use the programming and debugging capabilities of the EDBG, see the EDBG user guide.

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 the EDBG user guide.

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 the EDBG user guide.

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 the EDBG user guide.

Table 4-15. GPIO Lines Connected To the EDBG

Pin on SAM4N	Function
PC21	GPIO0
PC20	GPIO1
PC19	GPIO2
PC18	GPIO3

5. Appendix

5.1. Getting Started with IAR

IAR Embedded Workbench® for ARM® is a proprietary high efficiency compiler not based on GCC. Programming and debugging of Xplained Pro kits are supported in IAR™ Embedded Workbench for ARM using the common CMSIS-DAP interface. Some initial settings have to be set up in the project to get the programming and debugging to work.

The following steps will explain how to get your project ready for programming and debugging:

1. Make sure you have opened the project you want to configure. Open the **OPTIONS** dialog for the project.
2. In the category **General Options**, select the **Target** tab. Select the device for the project or, if not listed, the core of the device.
3. In the category **Debugger**, select the **Setup** tab. Select **CMSIS DAP** as the driver.
4. In the category **Debugger**, select the **Download** tab. Check the check box for **Use flash loader(s)** option.
5. In the category **Debugger** > **CMSIS DAP**, select the **Setup** tab. Select **System (default)** as the reset method.
6. In the category **Debugger** > **CMSIS DAP**, select the **JTAG/SWD** tab. Select **SWD** as the interface and optionally select the **SWD speed**.

Figure 5-1. Select Target Device
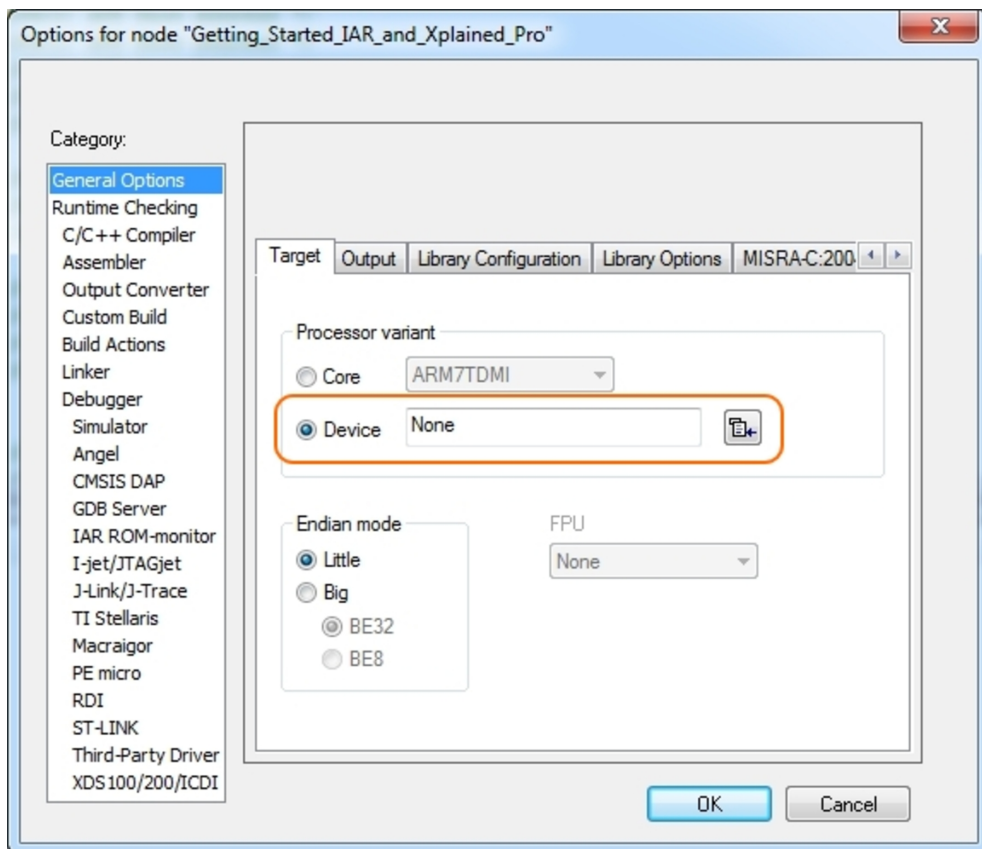
Figure 5-2. Select Debugger
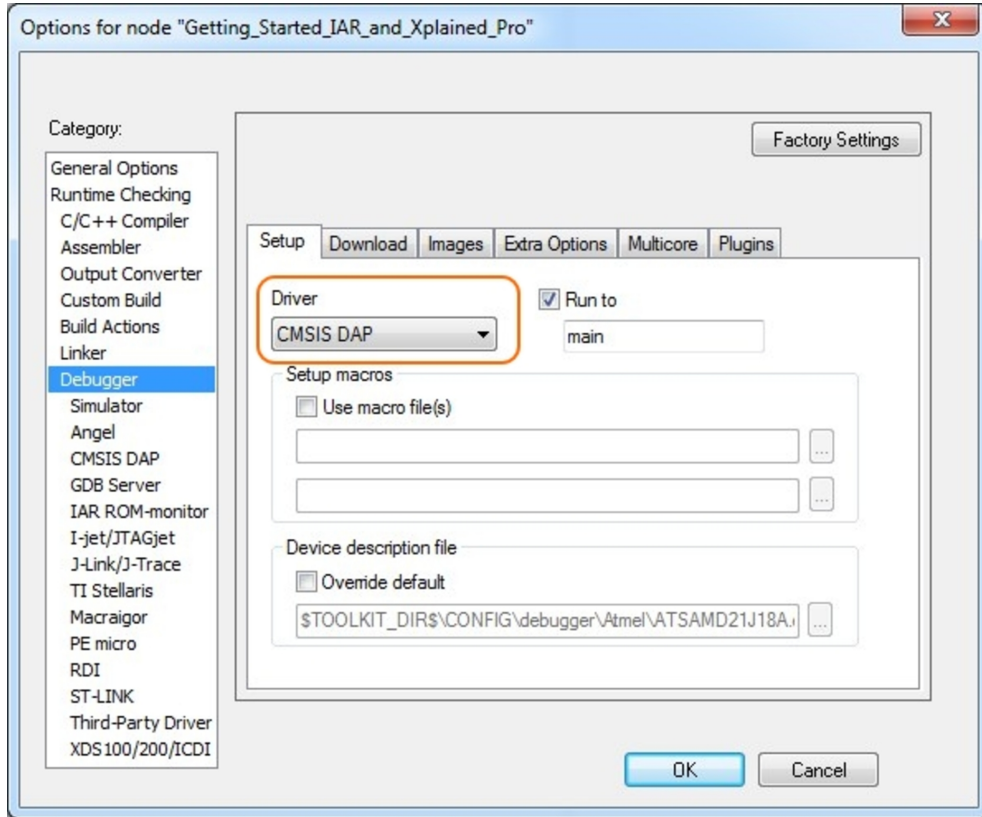
Figure 5-3. Configure Flash Loader
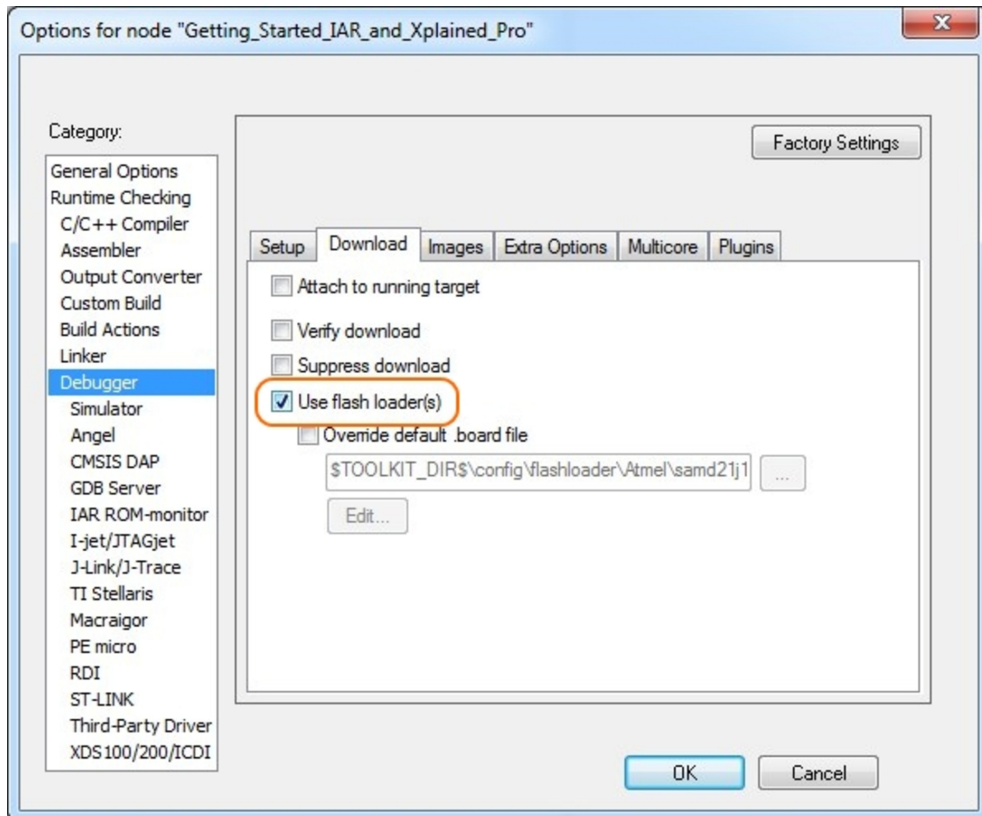
Figure 5-4. Configure Reset
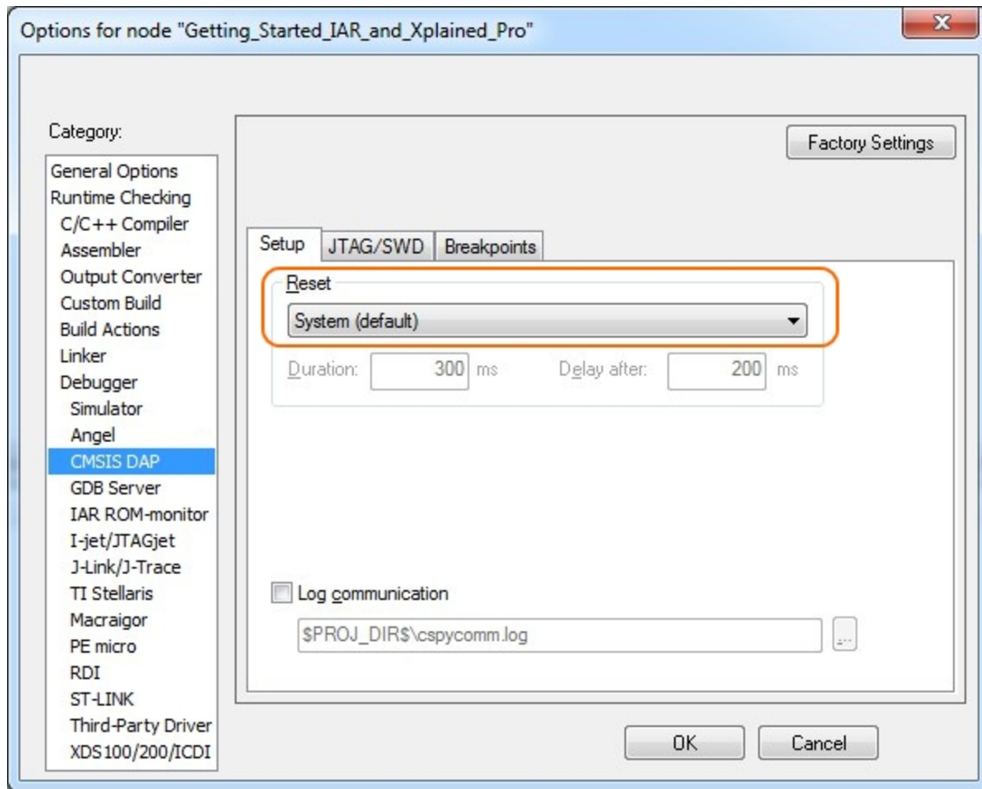
Figure 5-5. Configure Interface
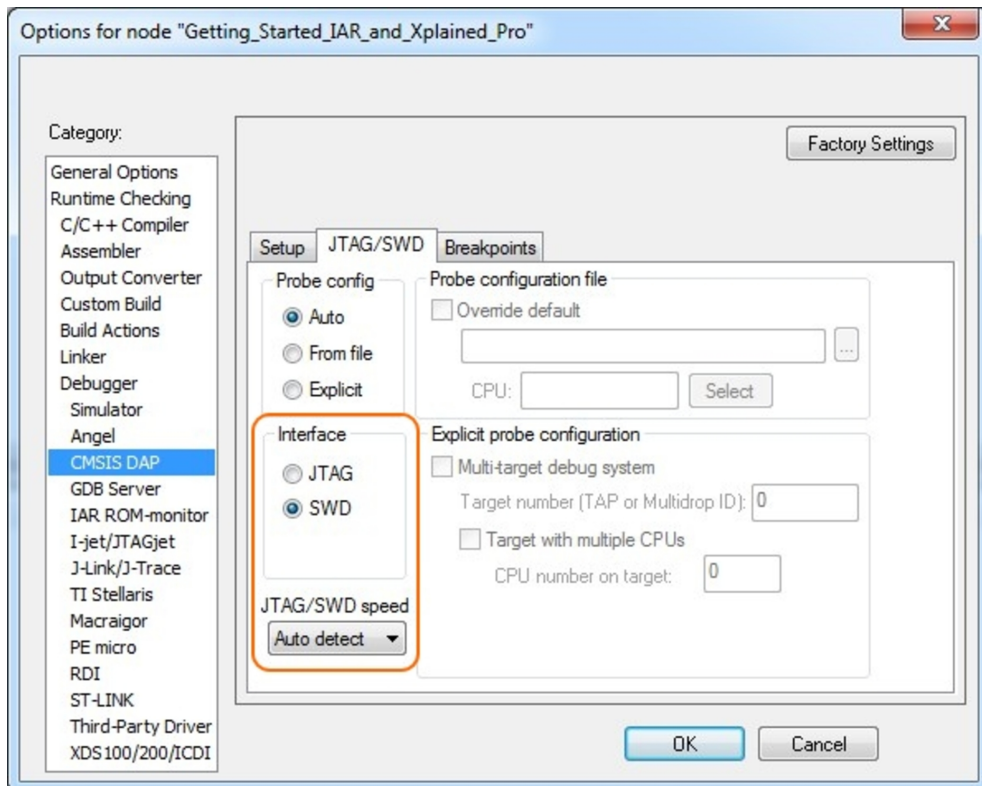
6. Hardware Revision History and Known Issues

6.1. Identifying Product ID and Revision

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

By connecting an Xplained Pro MCU board to a computer with Atmel Studio running, an information window will pop up. The first six 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 Kit's 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 product identifier for SAM4N Xplained Pro is A09-1967.

6.2. 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:

  – 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.

7.   Document Revision History

Doc. rev.	Date	Comment
42104B	04/2016	Added appendix
42104A	07/2013	First release

8. 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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