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1. Introduction

1.1. Features

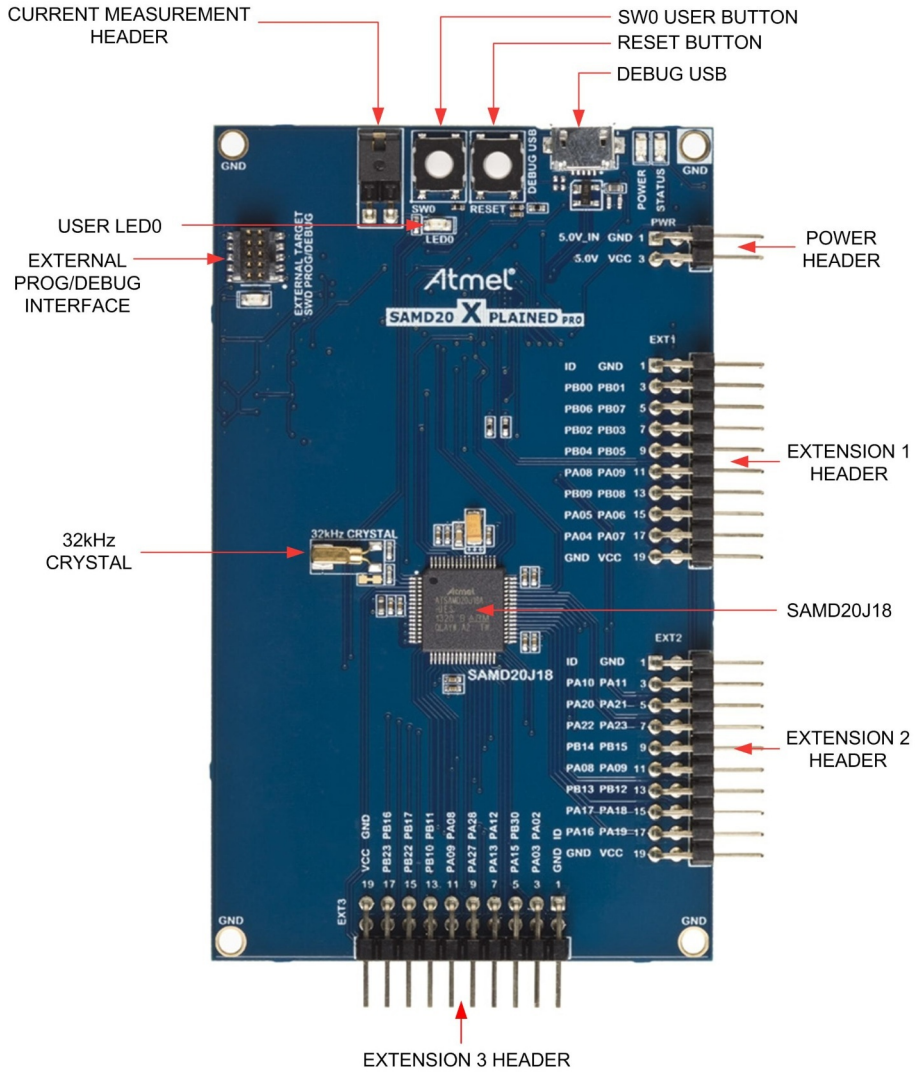
- Atmel ATSAM D20J18A microcontroller
- Embedded debugger (EDBG)
 - USB interface
 - Programming and debugging on board SAM D20 through Serial Wire Debug (SWD)
 - Programming and debugging external targets through Serial Wire Debug (SWD)
 - Virtual COM-port interface to target via UART
 - Atmel Data Gateway Interface (DGI) to target via SPI and 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
- Two possible power sources
 - External power
 - Embedded debugger USB
- 32kHz crystal

1.2. Kit Overview

The Atmel SAM D20 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAM D20J18A.

The kit offers a set of features that enables the ATSAM D20J18A user to get started using the ATSAM D20J18A peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM D20 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 SAM D20 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 SAM D20 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 QTouch® Library PTC](#) - QTouch Library for Atmel AVR® and ARM®-based microcontrollers.
- [Atmel QTouch® Composer](#) - Tool for developing capacitive buttons, sliders, and wheels applications.
- [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.

- [Design Documentation](#) - Package containing CAD source, schematics, BOM, assembly drawings, 3D plots, layer plots etc.
- [Hardware Users Guide in PDF format](#) - PDF version of this User Guide.
- [SAM D20 Xplained Pro on Atmel web page](#) - 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 SAM D20 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 ATSAM20J18A. On SAM D20 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM20J18A.

The Virtual COM Port is connected to a UART on the ATSAM20J18A 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 ATSAM20J18A 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 ATSAM20J18A. 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 ATSAM20J18A 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 SAM D20 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 SAM D20 Xplained Pro kit can be powered by several power sources as listed in the table below.

Table 3-3. Power Sources for SAM D20 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 SAM D20 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 Users Guide

4.1. Connectors

This chapter describes the implementation of the relevant connectors and headers on SAM D20 Xplained Pro and their connection to the ATSAM D20J18A. 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 SAM D20 Xplained Pro headers EXT1, EXT2, and EXT3 offer 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 [Table 3-4 Xplained Pro Standard Extension Header](#). All headers have a pitch of 2.54mm.

Table 4-1. Extension Header EXT1

Pin on EXT1	SAM D20 pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PB00	AIN[8]	
4	PB01	AIN[9]	
5	PB06	GPIO	
6	PB07	GPIO	
7	PB02	TC6/WO[0]	
8	PB03	TC6/WO[1]	
9	PB04	EXTINT[4]	
10	PB05	GPIO	
11	PA08	SERCOM2 PAD[0] I ² C SDA	EXT2, EXT3, and EDBG
12	PA09	SERCOM2 PAD[1] I ² C SCL	EXT2, EXT3, and EDBG
13	PB09	SERCOM4 PAD[1] UART RX ⁽¹⁾	
14	PB08	SERCOM4 PAD[0] UART TX ⁽¹⁾	
15	PA05	SERCOM0 PAD[1] SPI SS	
16	PA06	SERCOM0 PAD[2] SPI MOSI	
17	PA04	SERCOM0 PAD[0] SPI MISO	
18	PA07	SERCOM0 PAD[3] SPI SCK	
19	-	-	GND
20	-	-	VCC

Note:

1. The SERCOM4 module is shared between EXT1, 2, and 3 UART's, but uses different pins.

Table 4-2. Extension Header EXT2

Pin on EXT2	SAM D20 pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA10	AIN[18]	
4	PA11	AIN[19]	
5	PA20	GPIO	
6	PA21	GPIO	
7	PA22	TC4/WO[0]	
8	PA23	TC4/WO[1]	
9	PB14	EXTINT[14]	
10	PB15	GPIO	
11	PA08	SERCOM2 PAD[0] I ² C SDA	EXT1, EXT3, and EDBG
12	PA09	SERCOM2 PAD[1] I ² C SCL	EXT1, EXT3, and EDBG
13	PB13	SERCOM4 PAD[1] UART RX ⁽¹⁾	
14	PB12	SERCOM4 PAD[0] UART TX ⁽¹⁾	
15	PA17	SERCOM1 PAD[1] SPI SS	
16	PA18	SERCOM1 PAD[2] SPI MOSI	
17	PA16	SERCOM1 PAD[0] SPI MISO	
18	PA19	SERCOM1 PAD[3] SPI SCK	
19	-	-	GND
20	-	-	VCC

Note:

1. The SERCOM4 module is shared between EXT1, 2, and 3 UART's, but uses different pins.

Table 4-3. Extension Header EXT3

Pin on EXT3	SAM D20 pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA02	AIN[0]	
4	PA03	AIN[1]	
5	PB30	GPIO	

Pin on EXT3	SAM D20 pin	Function	Shared functionality
6	PA15	GPIO	Onboard SW0
7	PA12	TC2/WO[0]	
8	PA13	TC2/WO[1]	
9	PA28	EXTINT[8]	
10	PA27	GPIO	
11	PA08	SERCOM2 PAD[0] I ² C SDA	EXT1, EXT2, and EDBG
12	PA09	SERCOM2 PAD[1] I ² C SCL	EXT1, EXT2, and EDBG
13	PB11	SERCOM4 PAD[3] UART RX ⁽¹⁾	
14	PB10	SERCOM4 PAD[2] UART TX ⁽¹⁾	
15	PB17	SERCOM5 PAD[1] SPI SS	
16	PB22	SERCOM5 PAD[2] SPI MOSI	EDBG
17	PB16	SERCOM5 PAD[0] SPI MISO	EDBG
18	PB23	SERCOM5 PAD[3] SPI SCK	EDBG
19	-	-	GND
20	-	-	VCC

Note:

1. The SERCOM4 module is shared between EXT1, 2, and 3 UART's, but uses different pins.

4.1.2. Current Measurement Header

An angled 1x2, 100mil pin-header marked with MCU current measurement is located at the upper edge of the SAM D20 Xplained Pro. All power to the ATSAMD20J18A 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 ATSAMD20J18A to be powered through its I/O pins. This may cause permanent damage to the device.

4.2. Peripherals

4.2.1. Crystal

The SAM D20 Xplained Pro kit contains one crystals that can be used as clock source for the SAM D20 device. The 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](#).

Table 4-4. External 32.768kHz Crystal

Pin on SAM D20	Function
PA00	XIN32
PA01	XOUT32

4.2.2. Mechanical Buttons

SAM D20 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM D20 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 4-5. Mechanical Buttons

Pin on SAM D20	Silkscreen text
RESETN	RESET
PA15	SW0

4.2.3. LED

There is one yellow LED available on the SAM D20 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 4-6. LED Connections

Pin on SAM D20	LED
PA14	Yellow LED0

4.3. Embedded Debugger Implementation

SAM D20 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAM D20J18A 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 SAM D20 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](#).

Table 4-7. SWD Connections

Pin on SAM D20	Function
PA30	SWD clock
PA31	SWD data

4.3.2. Virtual COM Port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAM D20J18A UARTs. For further information on how to use the Virtual COM port see [Embedded Debugger](#).

Table 4-8. Virtual COM Port Connections

Pin on SAM D20	Function
PA24	SERCOM3 PAD[2] UART TXD (SAM D20 TX line)
PA25	SERCOM3 PAD[3] UART RXD (SAM D20 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 I²C port. The DGI can be used to send a variety of data from the SAM D20 to the host PC. For further information on how to use the DGI interface see [Embedded Debugger](#).

Table 4-9. DGI Interface Connections When Using SPI

Pin on SAM D20	Function
PB31	SERCOM5 PAD[1] SPI SS (Slave select) (SAM D20 is Master)
PB16	SERCOM5 PAD[0] SPI MISO (Master In, Slave Out)
PB22	SERCOM5 PAD[2] SPI MOSI (Master Out, Slave in)
PB23	SERCOM5 PAD[3] SPI SCK (Clock Out)

Table 4-10. DGI Interface Connections When Using I²C

Pin on SAM D20	Function
PA08	SERCOM2 PAD[0] SDA (Data line)
PA09	SERCOM2 PAD[1] 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 SAM D20 application code. For further information on how to configure and use the GPIO monitoring features see [Embedded Debugger](#).

Table 4-11. GPIO Lines Connected To the EDBG

Pin on SAM D20	Function
PA27	GPIO0
PA28	GPIO1
PA20	GPIO2
PA21	GPIO3

4.3.4. External Programming and Debugging

The SAM D20 Xplained Pro features a Cortex[®] Debug Connector (10-pin) for programming and debugging an external target. The connector is limited to the SWD interface and is intended for in-system programming and debugging of SAM D20 devices in the users final products.

The debug connector is connected to the on-board EDBG through level shifters and switches. When an external target voltage is detected, the EDBG will switch the SWD interface from the on-board target device to the external debug connector and the green LED next to the connector will be lit. The voltage of the external target must be between 1.6V and 5.0V.



Important: This connector can't be used for attaching an external debug unit for programming and debugging the on-board device.

Table 4-12. Cortex Debug Connector

Pin on connector	Specification	Function implemented
1	VCC	VCC
2	SWDIO / TMS	SWDIO
3	GND	GND
4	SWDCLK / TCK	SWDCLK
5	GND	GND
6	SWO / TDO	NC
7	KEY	NC
8	NC / TDI	NC
9	GNDDetect	GND
10	nRESET	nRESET

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

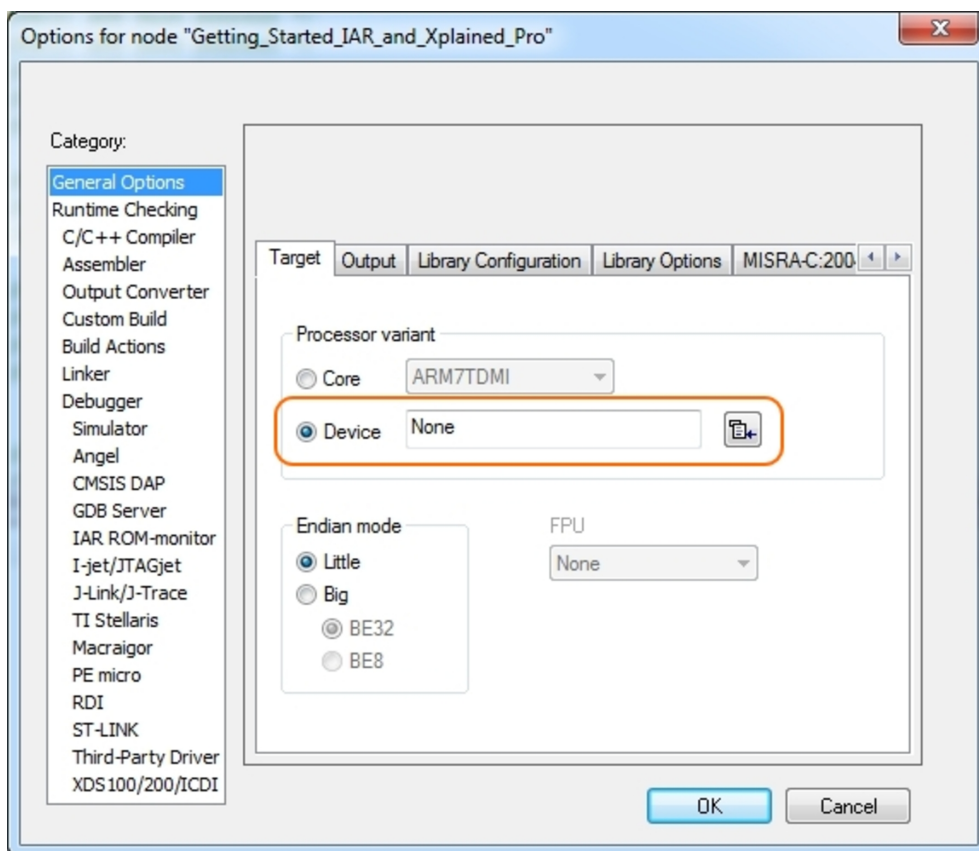


Figure 5-2. Select Debugger

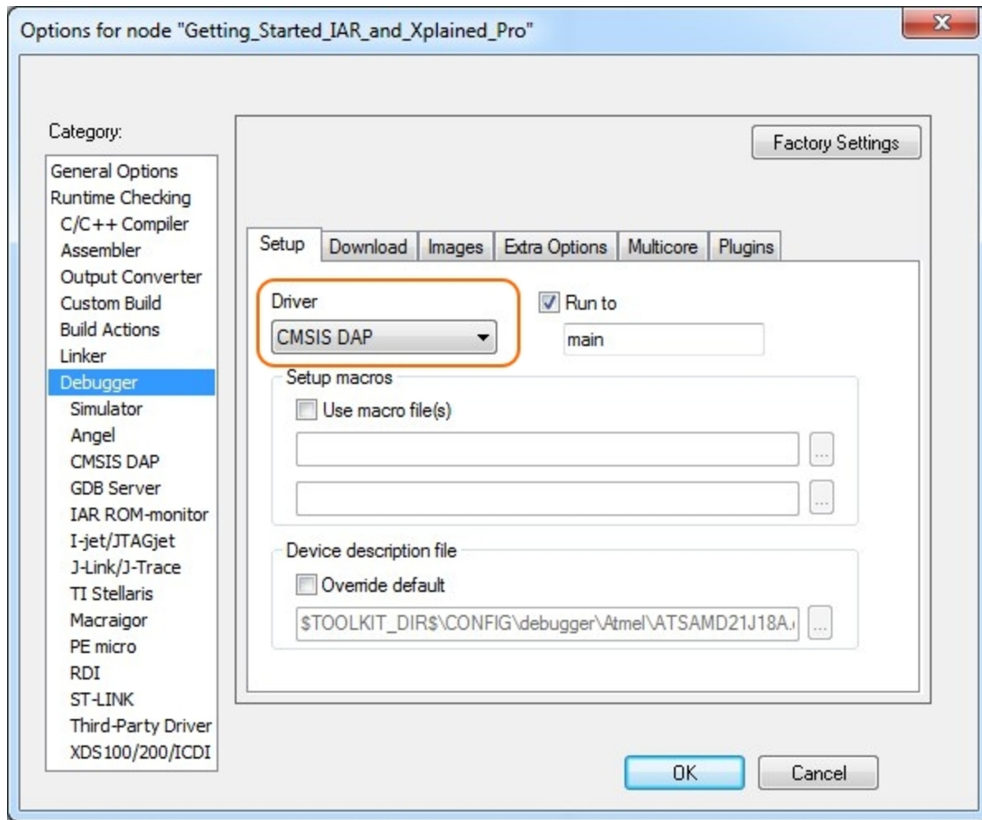


Figure 5-3. Configure Flash Loader

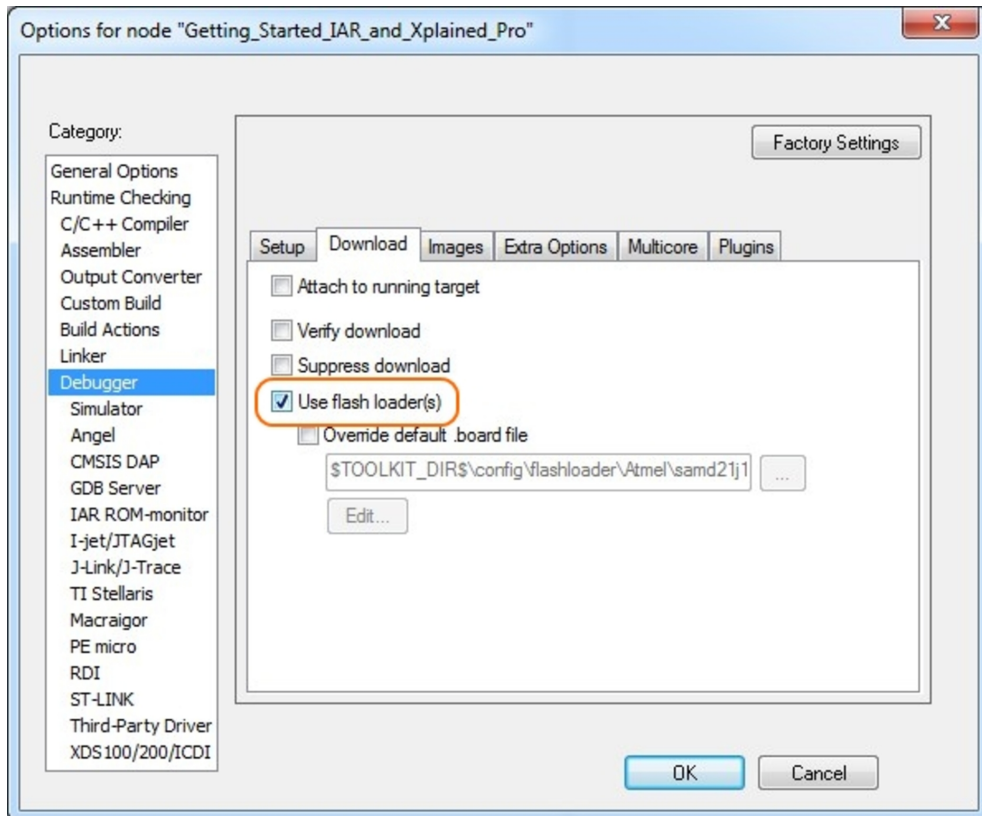


Figure 5-4. Configure Reset

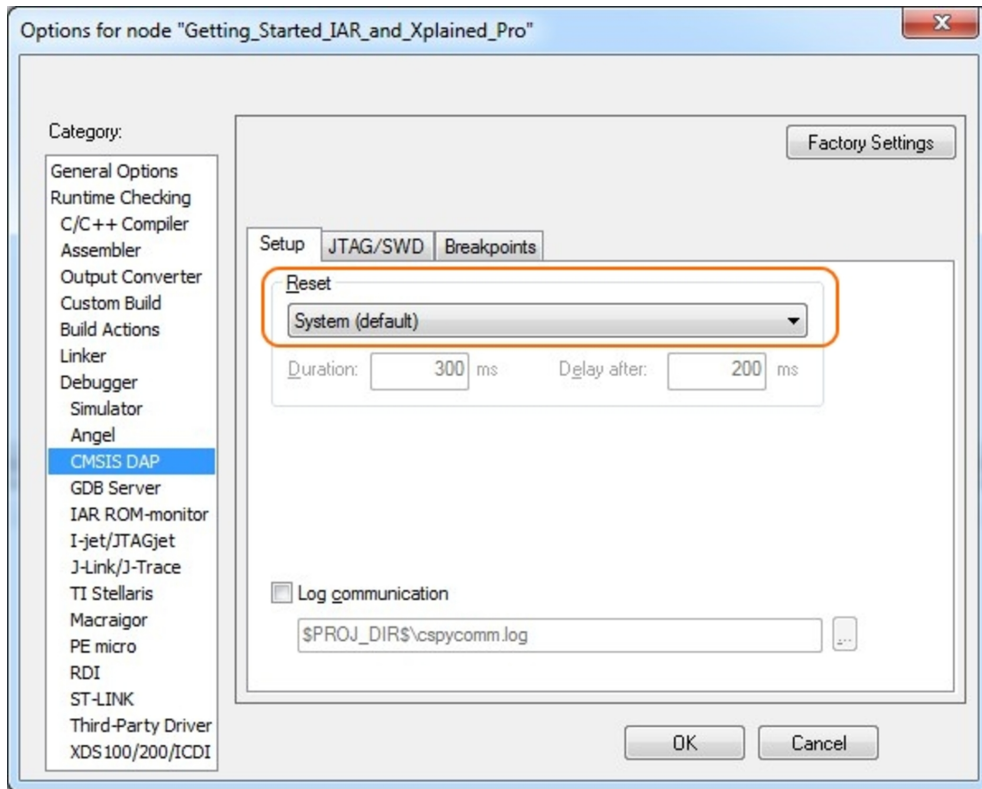
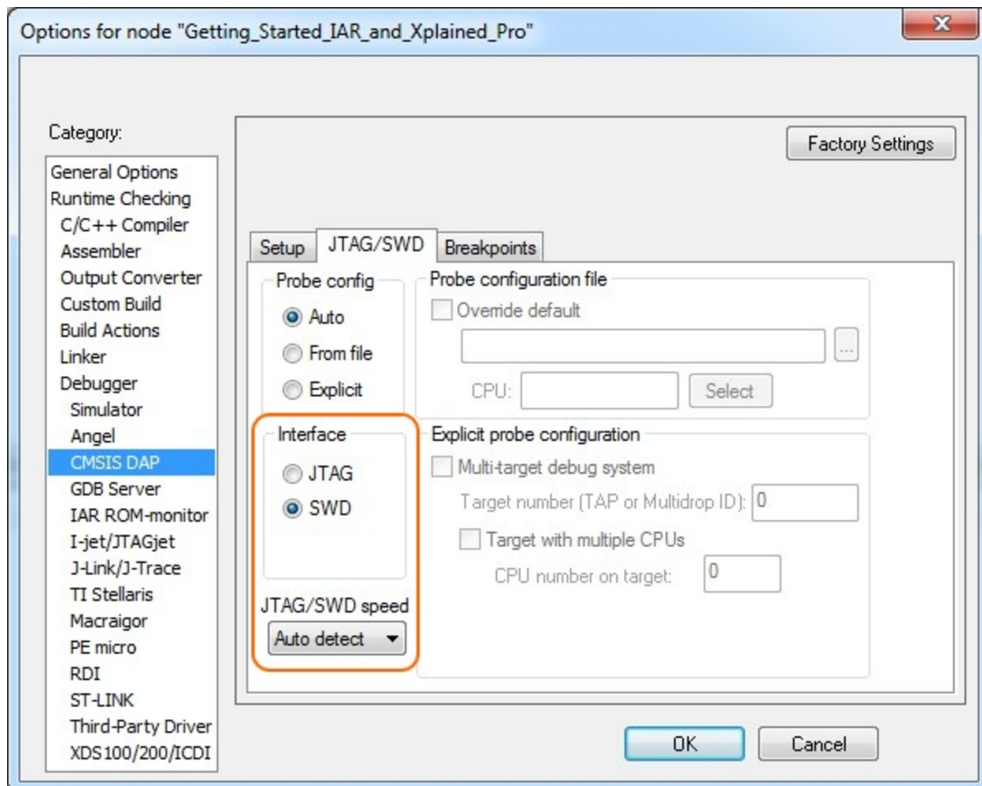


Figure 5-5. Configure Interface



6. Hardware Revision 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 SAM D20 Xplained Pro is A09-1873.

6.2. Revision 5

Revision 5 of SAM D20 Xplained Pro has revision C of the SAMD20J18A device mounted

Known issues

- **VDD_{CORE} decoupling capacitor**

The VDDC_{CORE} output pin on SAMD20J18A has two decoupling capacitors, one 100nF and one 4.7μF. This might lead to a high power consumption when leaving STANDBY sleep mode and the regulator returns to normal operating mode.

Fix/Workaround:

- Change the 4.7μF tantalum capacitor (C315) to 1μF ceramic capacitor.

6.3. Revision 4

Revision 4 of SAM D20 Xplained Pro is the initial released version.

Known issues

- **PTC in self-capacitance mode**

Revision B of the SAM D20 is mounted on this kit. The two lowest gain settings are not selectable and an attempt by the QTouch Library to set enable of these may result in a higher sensitivity than optimal for the sensor. The PTC will not detect all touches. This errata does not affect mutual-capacitance mode which operates as specified.

Fix/Workaround:

- Use SAM D20 revision C or later for self-capacitance capacitive touch sensing. These are mounted on revision 5 or later of the SAM D20 Xplained Pro kit.

- **VDD_{CORE} decoupling capacitor**

The VDD_{CORE} output pin on SAMD20J18A has two decoupling capacitors, one 100nF and one 4.7 μ F. This might lead to a high power consumption when leaving STANDBY sleep mode and the regulator returns to normal operating mode.

Fix/Workaround:

- Change the 4.7 μ F tantalum capacitor (C315) to 1 μ F ceramic capacitor.

7. Document Revision History

Doc. rev.	Date	Comment
42102D	04/2016	Added Getting Started with IAR .
42102C	02/2014	Updated Revision 5 and Table 4-3 Extension Header EXT3 .
42102B	10/2013	Updated Revision 4 .
42102A	06/2013	First release.

8. Evaluation Board/Kit Important Notice

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