SMART ARM-based Microcontrollers

SAM D11 Xplained Pro

USER GUIDE

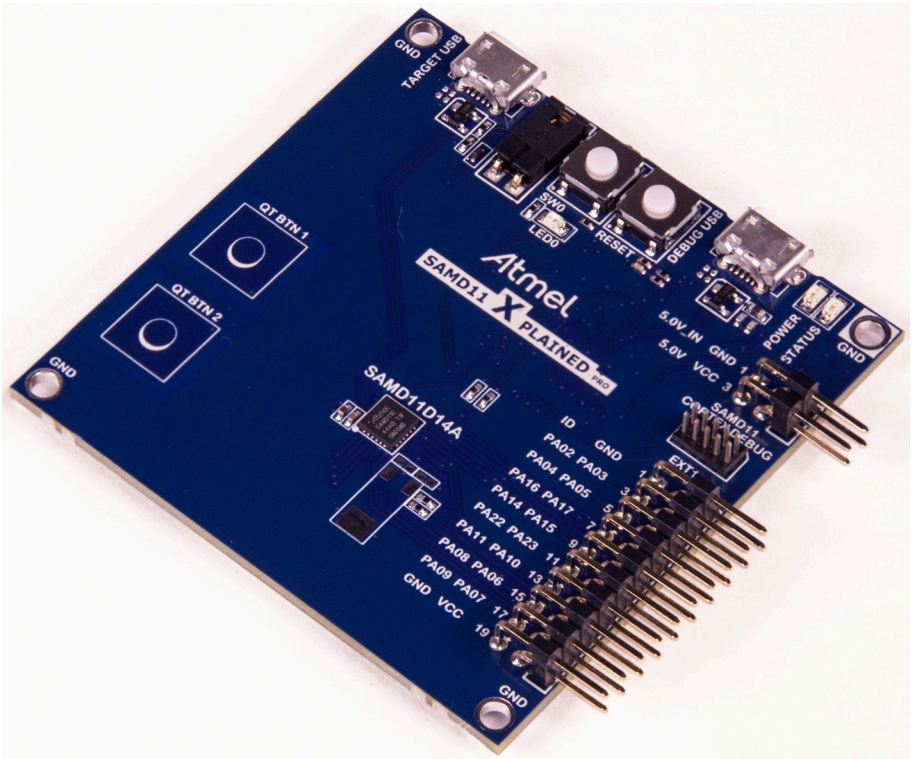
Preface

The Atmel® SAM D11 Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAMD11D14A microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAMD11D14A 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 ATSAMD11D14A.

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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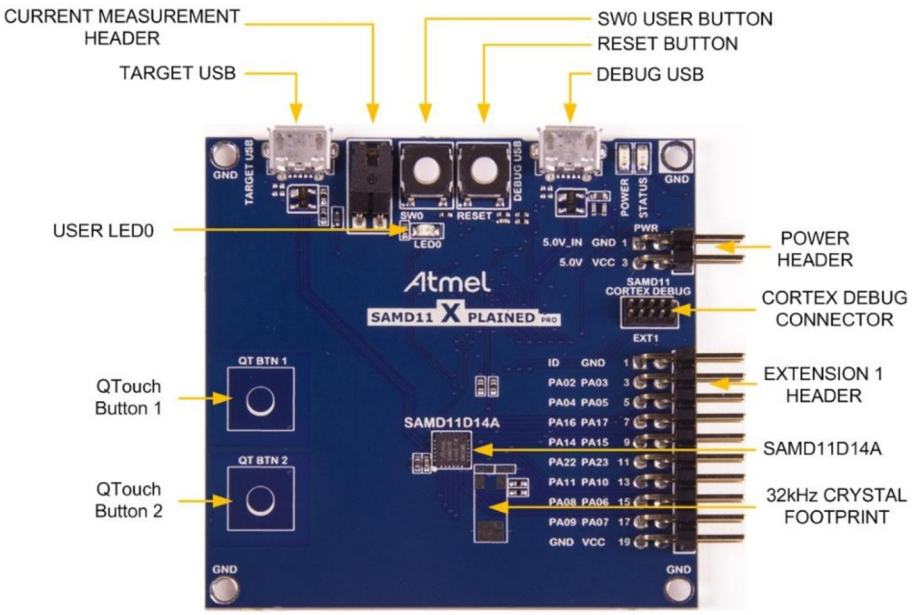
- Two QTouch® buttons

1.2. Kit Overview

The Atmel SAM D11 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAMD11D14A.

The kit offers a set of features that enables the ATSAMD11D14A user to get started using the ATSAMD11D14A peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM D11 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 D11 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 D11 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 D11 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 D11 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 ATSAMD11D14A. On SAM D11 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAMD11D14A.

The Virtual COM Port is connected to a UART on the ATSAMD11D14A 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 ATSAMD11D14A 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 ATSAMD11D14A. 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 ATSAMD11D14A 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 D11 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 D11 Xplained Pro kit can be powered by several power sources as listed in the table below.

Table 3-3. Power Sources for SAM D11 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
Target USB	4.4V to 5.25V (according to USB spec.)	500mA (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.

Info: External power is required when 500mA from a USB connector is not enough to power the board with possible extension boards. A connected USB device in a USB host application might easily exceed this limit.

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^2C_SDA	Data line for I^2C interface. Always implemented, bus type.
12	I^2C_SCL	Clock line for I^2C interface. Always implemented, bus type.
13	UART_RX	Receiver line of target device UART
14	UART_TX	Transmitter line of target device UART

Pin number	Name	Description
15	SPI_SS_A	Slave select for SPI. Should preferably be unique.
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 D11 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 D11 Xplained Pro and their connection to the ATSAMD11D14A. 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 Header

The SAM D11 Xplained Pro header EXT1 offers access to the I/O of the microcontroller in order to expand the board e.g. by connecting extensions to the board. This header is based on the standard extension header specified in Table 3-4 Xplained Pro Standard Extension Header. The header has a pitch of 2.54mm.

Table 4-1. Extension Header EXT1

Pin on EXT1	SAM D11 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to ID chip on extension board.
2 [GND]	-	-	GND
3 [ADC(+)]	PA02	AIN[0]	QTouch Button 1
4 [ADC(-)]	PA03	AIN[1]	QTouch Button 2
5 [GPIO1]	PA04	GPIO	
6 [GPIO2]	PA05	GPIO	
7 [PWM(+)]	PA16	TC1/WO[0]	LED0 and EDBG GPIO
8 [PWM(-)]	PA17	TC1/WO[1]	EDBG GPIO
9 [IRQ/GPIO]	PA14	NMI	SW0 and EDBG GPIO
10 [SPI_SS_B/GPIO]	PA15	GPIO	EDBG GPIO
11 [TWI_SDA]	PA22	SERCOM1 PAD[0] I²C SDA	EDBG I²C
12 [TWI_SCL]	PA23	SERCOM1 PAD[1] I²C SCL	EDBG I²C
13 [USART_RX]	PA11	SERCOM2 PAD[3] UART RX	EDBG CDC
14 [USART_TX]	PA10	SERCOM2 PAD[2] UART TX	EDBG CDC
15 [SPI_SS_A]	PA08	SERCOM0 PAD[2] SPI SS	32kHz Crystal footprint
16 [SPI_MOSI]	PA06	SERCOM0 PAD[0] SPI MOSI	EDBG SPI
17 [SPI_MISO]	PA09	SERCOM0 PAD[3] SPI MISO	32kHz Crystal footprint and EDBG SPI
18 [SPI_SCK]	PA07	SERCOM0 PAD[1] SPI SCK	EDBG SPI
19 [GND]	-	-	GND
20 [VCC]	-	-	VCC

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 D11 Xplained Pro. All power to the ATSAMD11D14A 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 ATSAMD11D14A 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 D11 Xplained Pro kit contain one crystal footprint that can be used for mounting a clock source for the SAM D11 device. The I/O pins for the crystal are shared with the extension header, so two 0Ω resistors (R311 and R312) must be removed before mounting a crystal on the footprint.

Table 4-2. External 32.768kHz Crystal

Pin on SAM D11	Function
PA08	XIN32
PA09	XOUT32

4.2.2. Mechanical Buttons

SAM D11 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM D11 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 4-3. Mechanical Buttons

Pin on SAM D11	Silkscreen text
PA28/RST	RESET
PA14	SW0

4.2.3. LED

There is one yellow LED available on the SAM D11 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 4-4. LED Connections

Pin on SAM D11	LED
PA16	Yellow LED0

4.2.4. Touch Buttons

There are two self capacitance buttons available on the SAM D11 Xplained Pro board that can be used as I/O. These QTouch buttons are intended to be driven by the built-in Peripheral Touch Controller (PTC) of the device.

0Ω resistors are added on the board to easily disconnect either the onboard touch buttons or the connection to the extension header, as the I/O lines are shared between the two. These resistors can be found on the back side of the board, marked "QTBTN1" and "QTBTN2" for disconnecting the touch buttons, and "EXT-3" and "EXT-4" for disconnecting the lines to the extension header.

Table 4-5. QTouch Button Connections

Pin on SAM D11	Silkscreen text
PA02	QT BTN1
PA03	QT BTN2

4.2.5. USB

The SAM D11 Xplained Pro has a Micro-USB connector for use with the SAM D11 USB module. To be able to detect when a target USB cable is connected in self-powered mode, a GPIO is used to detect the VBUS voltage on the connector.

Table 4-6. USB Connections

Pin on SAM D11	USB
PA27	VBUS Detection(1)
PA24	USB D-
PA25	USB D+

Note:

1. PA27 is shared between SPI SS to the EDBG and VBUS detect on target USB. This is implemented so the pin can detect if VBUS is present when configured as input with no internal pull. If VBUS is present, the level on the pin will be high. If VBUS is not present, the line is externally pulled low. It will not be possible to detect this if the EDBG SPI DGI interface is enabled from Atmel Data Visualizer.

4.3. Embedded Debugger Implementation

SAM D11 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAMD11D14A 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 includes four of the SAM D11 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 D11	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 ATSAMD11D14A 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 D11	Function
PA10	SERCOM2 PAD[2] UART TXD (SAM D11 TX line)
PA11	SERCOM2 PAD[3] UART RXD (SAM D11 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 D11 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 D11	Function
PA27	GPIO/SPI SS (Slave select) (SAM D11 is Master)(1)
PA09	SERCOM0 PAD[3] SPI MISO (Master In, Slave Out)
PA06	SERCOM0 PAD[0] SPI MOSI (Master Out, Slave in)
PA07	SERCOM0 PAD[1] SPI SCK (Clock Out)

Note:

1. PA27 is shared between SPI SS to the EDBG and VBUS detect on target USB. This is implemented so the pin can detect if VBUS is present when configured as input with no internal pull. If VBUS is present, the level on the pin will be high. If VBUS is not present, the line is externally pulled low. It will not be possible to detect this if the EDBG SPI DGI interface is enabled from Atmel Data Visualizer.

Table 4-10. DGI Interface Connections When Using I²C

Pin on SAM D11	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 D11 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 D11	Function
PA16	GPIO0
PA17	GPIO1
PA14	GPIO2
PA15	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

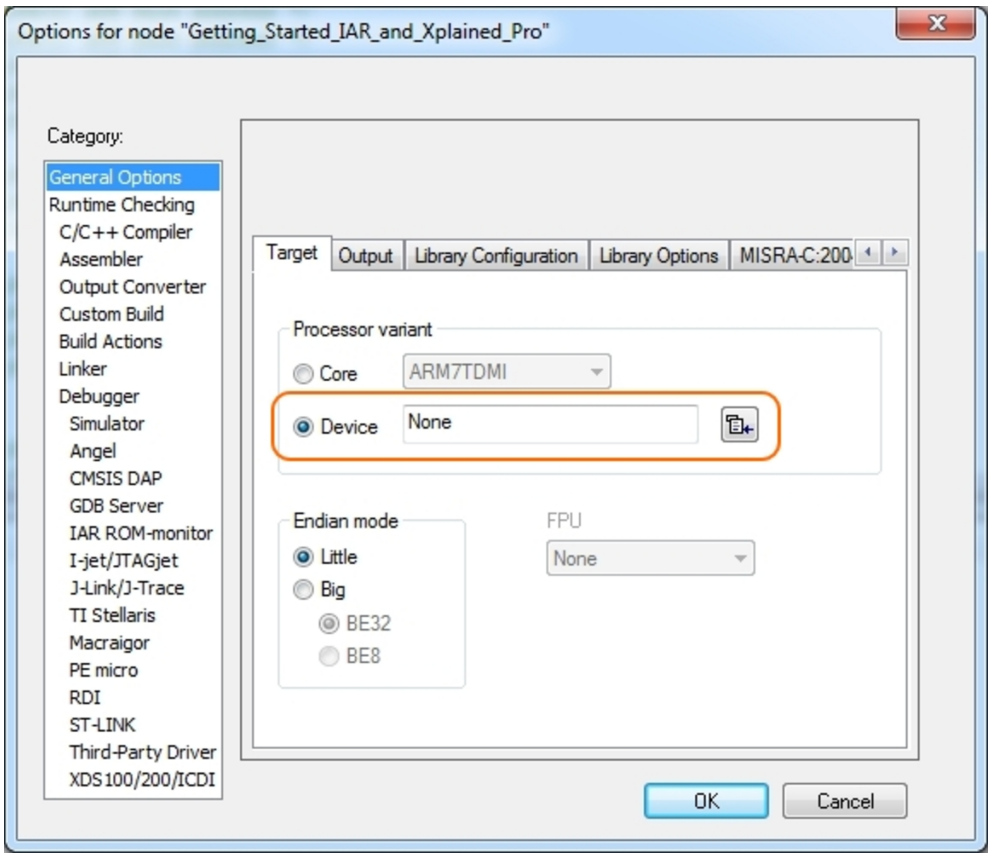


Figure 5-2. Select Debugger

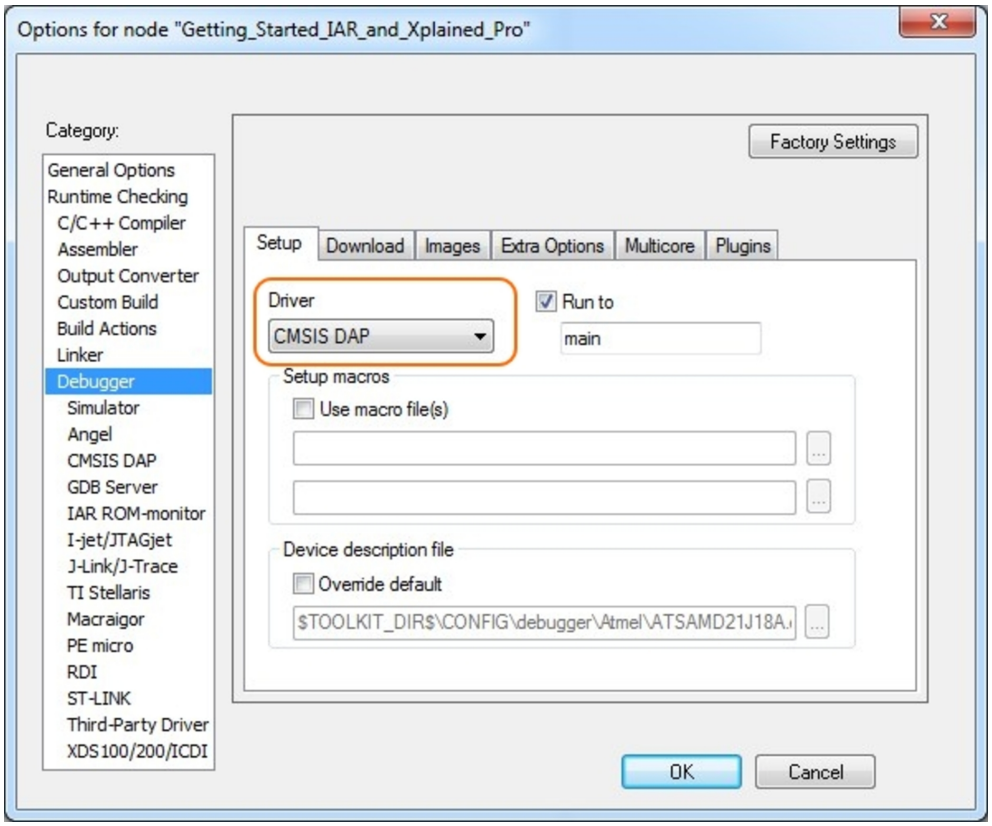


Figure 5-3. Configure Flash Loader

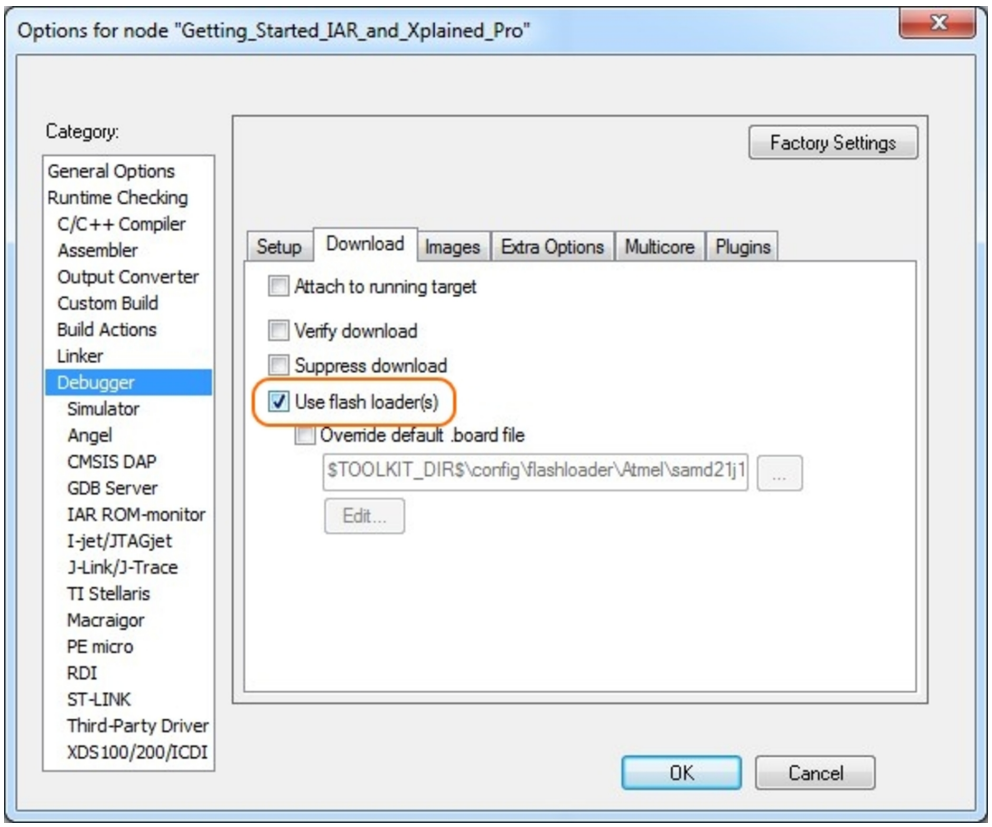


Figure 5-4. Configure Reset

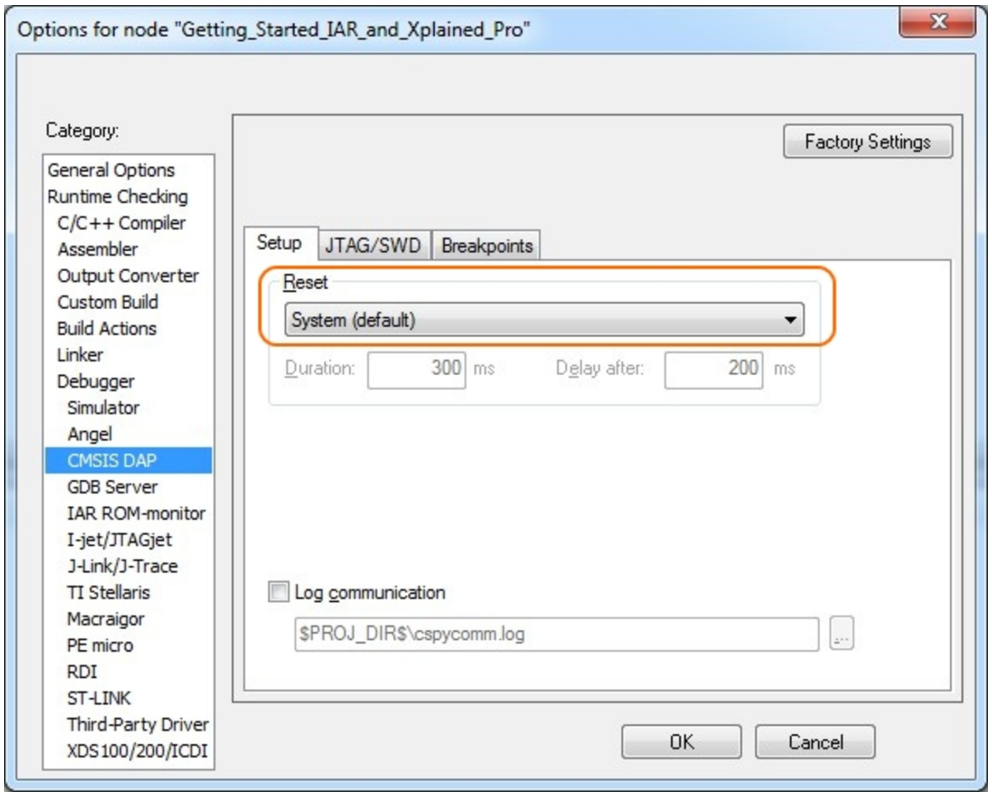
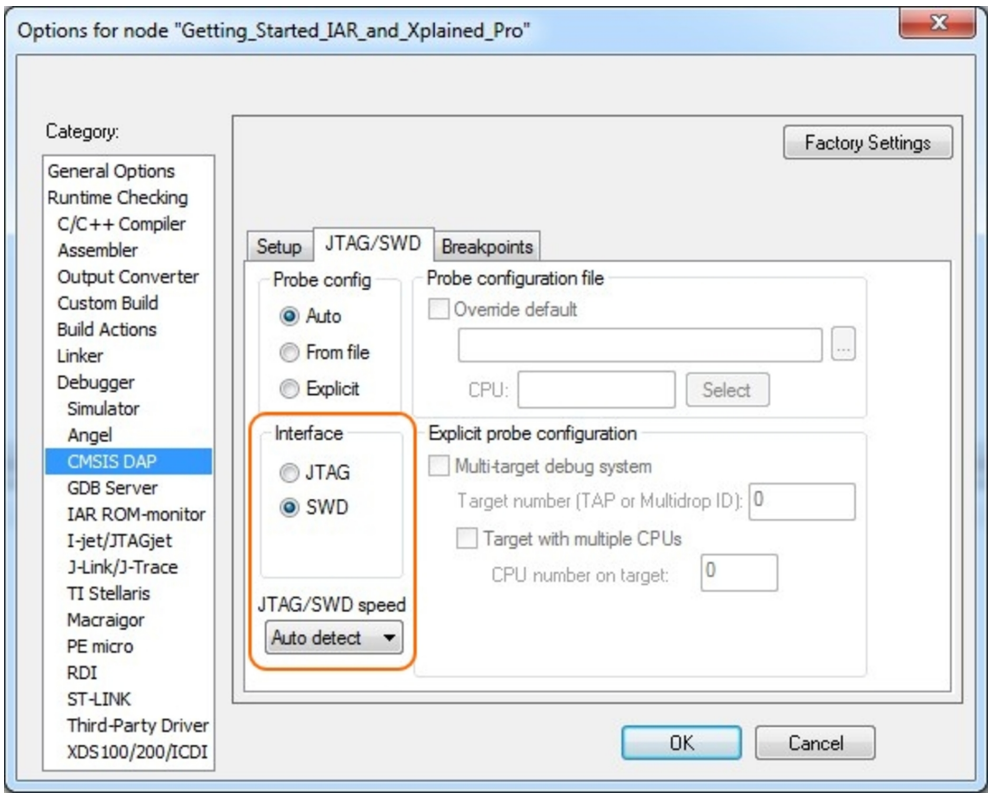


Figure 5-5. Configure Interface



5.2. Connecting a SAM-ICE to an Xplained Pro Board

Xplained Pro kits featuring a 10-pin 50mil debug connector can use external debug tools like SAM-ICE™ or Atmel-ICE instead of the built-in EDBG. Devices using SWD interface on-board will have a connector with the pinout compatible with the Cortex Debug Connector.

You can connect the SAM-ICE to the debug connector on an Xplained Pro using either an Atmel-ICE adapter, SAM-ICE adapter, or a 10-pin 50-mil header to squid cable. When using a squid cable, see the table and figures below for how to connect the SAM-ICE to the Xplained Pro board.

Table 5-1. Squid Cable Connections

Squid Cable pin	SAM-ICE pin
1 (VCC)	1 (VTref)
2 (SWDIO/TMS)	7 (TMS)
3 (GND)	4 (GND)
4 (SWCLK/TCK)	9 (TCK)
5 (GND)	6 (GND)
6 (SWO/TDO)	13 (TDO) (1)
7 (Not used)	
8 (Not used)	
9 (Not used)	
10 (RESET)	15 (RESET)

Note:

1. Optional, if the device has this functionality.

Figure 5-6. SAM-ICE using a Squid Cable

Figure 5-7. SAM-ICE using an Atmel-ICE Adapter

Important:
If contention with the on-board EDBG occur, power the Xplained Pro board from another input like the external power header or from the target USB. Physically removing the connection between the EDBG and the debug header by removing 0Ω resistors, where available, or cutting the tracks to the EDBG can also be done.

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 D11 Xplained Pro is A09-2178.

6.2. Revision 3

Revision 3 of SAM D11 Xplained Pro is the initial released version, there are no known issues.

7. Document Revision History

Doc. rev.	Date	Comment
42349B	04/2016	Added Getting Started with IAR
42349A	01/2015	Initial document 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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