# SAM L21 Xplained Pro

USER GUIDE

Preface

The Atmel® SAM L21 Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAML21J18B microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAML21J18B 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 ATSAML21J18B.

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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1. Introduction

1.1. Features

- ATSAML21J18B microcontroller
- One mechanical reset button
- One mechanical programmable button
- One QTouch® button
- One yellow user LED
- Backup battery
- 32.768kHz crystal
- USB interface, device and reduced host mode
- Three Xplained Pro extension headers
- Embedded Debugger
  - Auto-ID for board identification in Atmel Studio
  - One yellow status LED
  - One green board power LED
  - Symbolic debug of complex data types icluding scope information
  - Programming and debugging, including power measurements
  - Data Gateway Interface: SPI, I²C, four GPIOs
  - Virtual COM port (CDC)
- Embedded current measurement circuitry, with Atmel Data Visualizer support for data visualization
- USB powered
- Supported with application examples in Atmel Software Framework

1.2. Kit Overview

The Atmel SAM L21 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAML21J18B.

The kit offers a set of features that enables the ATSAML21J18B user to get started with the SAM L peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM L21 Xplained Pro Evaluation Kit Overview

CURRENT MEASUREMENT HEADER

SW0 USER BUTTON

RESET BUTTON

TARGET USB

DEBUG USB

USER LED0

POWER HEADER

MCU CURRENT MEASUREMENT SELECT JUMPER

CORTEX DEBUG FOR EXTERNAL DEBUGGER

I/O CURRENT MEASUREMENT SELECT JUMPER

EXTENSION 1 HEADER

32kHz CRYSTAL

PB03/VBAT SELECT JUMPER

SAML21J18A

BACKUP BATTERY

FOOTPRINT FOR EXTERNAL MHz CRYSTAL

VCC_IO POWER INPUT

EXTENSION 2 HEADER

QTOUCH BUTTON

EXTENSION 3 HEADER

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 the DEBUG USB port on the kit to the PC using a USB cable (Standard-A to Micro-B or Micro-AB).

When the Xplained Pro MCU kit is connected to the computer for the first time, operating system will install the software driver. 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.

When the Xplained Pro MCU board is powered, the green power LED will glow and Atmel Studio will auto detect the specific Xplained Pro MCU- and extension board(s) that are connected. Atmel Studio will present relevant information such as datasheets and kit documentation. The kit landing page in Atmel Studio also has an option to launch Atmel Software Framework (ASF) example applications for the kit. The SAM L21 device is programmed and debugged by the on-board Embedded Debugger and therefore no external programmer or debugger tool is required.

2.2. Design Documentation and Relevant Links

The following list contains links to the most relevant documents and software for the SAM L21 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 L21 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 SAM L21 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 ATSAML21J18B. On SAM L21 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAML21J18B.

The Virtual COM Port is connected to a UART on the ATSAML21J18B 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 ATSAML21J18B 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 ATSAML21J18B. 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 ATSAML21J18B 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 L21 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
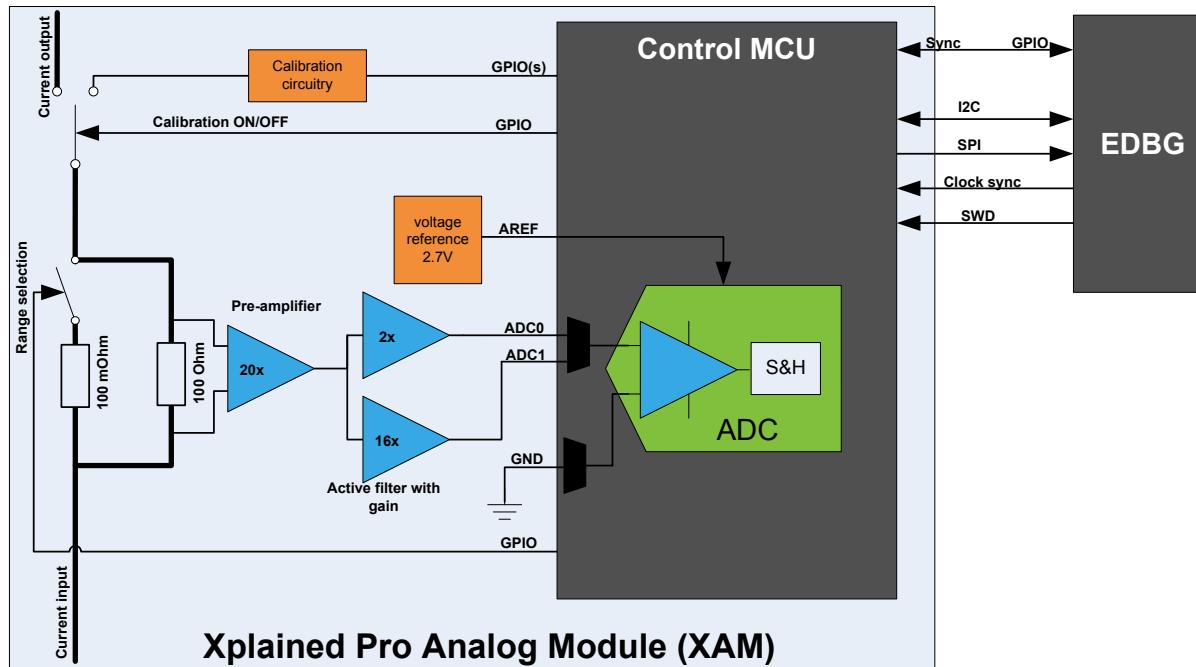
| Operation mode	Power LED	Status LED
Normal operation	Power LED is lit when power is applied to the board.	Activity indicator, LED flashes when any communication happens to the EDBG.
Bootloader mode (idle)	The power LED and the status LED blinks simultaneously.	
Bootloader mode (firmware upgrade)	The power LED and the status LED blinks in an alternating pattern.	

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

3.2. Xplained Pro Analog Module (XAM)

3.2.1. Overview

The Xplained Pro Analog Module (XAM) extends the embedded debugger with high dynamic range current measurement. This enables power profiling of the target system.

The XAM consists of:

- Calibration circuitry
- Voltage reference
- Analog frontend
  - Shunt resistors with a range selection switch
  - Pre-amplifier
  - Two active filters with gain
- Control MCU
  - Analog to digital converter
  - Signal processing
  - Control/communication interface to the EDBG

The current measurement frontend is a high side shunt measurement with a pre-amplifier and a second active filter stage with gain. The wide dynamic range is achieved by four measurement ranges which are defined by two shunts and the two parallel second stage active filters with gain.

3.2.2. EDBG Interface

The Xplained Pro Analog Module (XAM) is connected to the EDBG with the following interfaces:

- I^2C: This is used to control and configure the XAM

- SPI: Current measurement data is streamed to the EDBG via this interface. This is a one-way data transfer channel from the XAM to the EDBG.
- SWD: The MCU in the XAM is programmed via SWD from the EDBG
- GPIO: At least one GPIO that is connected to the EDBG from the target MCU is also connected to the current measurement unit to enable the user to sync current measurements with his application
- Clock sync: Synchronization signal to synchronize ADC measurements with EDBG
- Reference clock: Reference clock for the XAM

3.2.3. Sample Rate

The raw sampling rate of the Xplained Pro analog module (XAM) is up to 250kHz and with the default averaging configuration (average of 16 samples) the actual output of the XAM is 16.67kSPS (note that the XAM output sample rate is not an integer fraction of the raw sampling).

3.2.4. Measurement Ranges and Accuracy

The Xplained Pro analog module has four measurement ranges. These are defined by two shunt resistors and two gain stages.

Measurement range	Hardware	Resolution	Accuracy	Comments
Range 1	Low current shunt and high gain stage	20nA	1 LSB ±1%	Below 1µA the error will increase. Typical error for 300nA is 1 LSB ± 10%
Range 2	Low current shunt and low gain stage	150nA	1 LSB ±1%	
Range 3	High current shunt and high gain stage	10µA	1 LSB ±1%	
Range 4	High current shunt and low gain stage	100µA	1 LSB ±1%	Above 100mA the error will increase to 1 LSB ±5% at 400mA. Maximum current is 400mA

The ranges are switched automatically by the XAM to achieve best measurement results and the currently active range is visualized in the Atmel Data Visualizer frontend tool. The maximum voltage drop over the shunt resistor is 100mV and the XAM will switch the range automatically before this limit is reached.

3.3. 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

3.4. Power Sources

The SAM L21 Xplained Pro kit can be powered by several power sources as listed in the table below.

Table 3-3. Power Sources for SAM L21 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.

3.5. Xplained Pro Headers and Connectors

3.5.1. 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.
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

3.5.2. Xplained Pro Power Header

The power header can be used to connect external power to the SAM L21 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
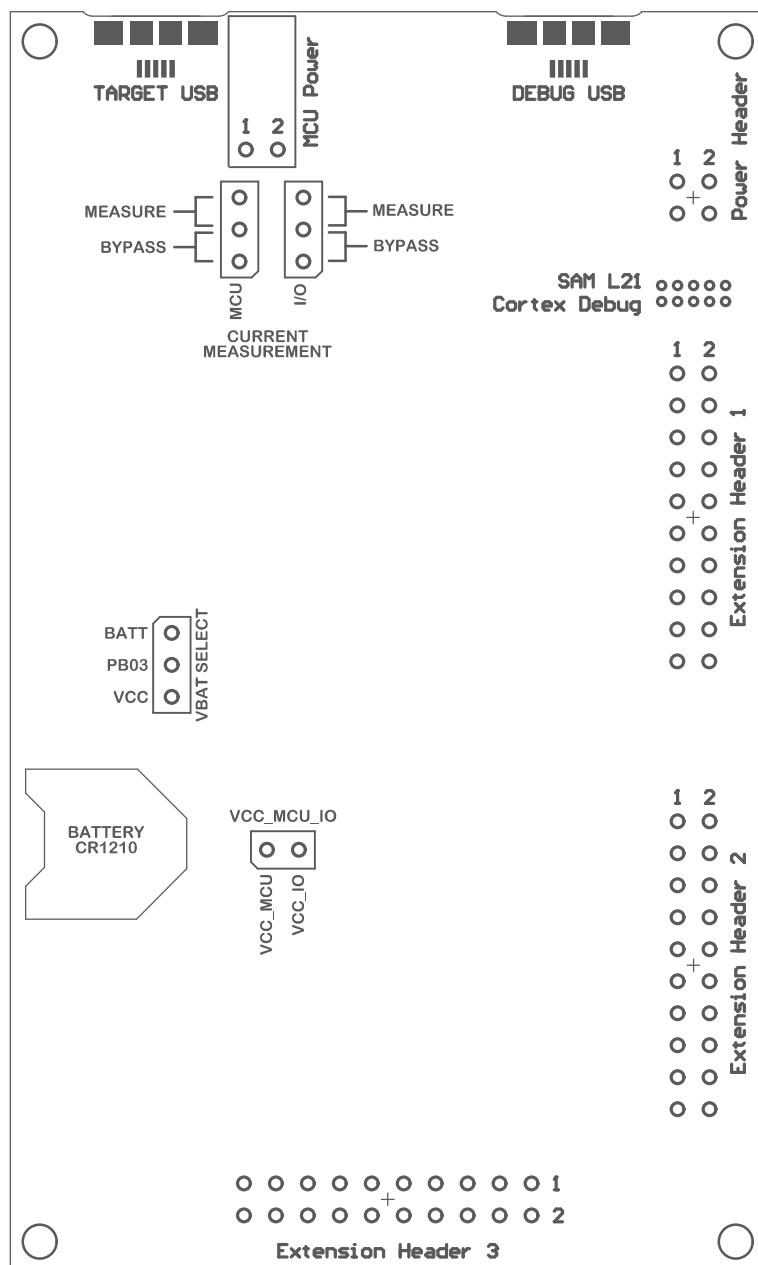
Pin number	Pin name	Description
1	VEXT_P5V0	External 5V input
2	GND	Ground
3	VCC_P5V0	Unregulated 5V (output, derived from one of the input sources)
4	VCC_P3V3	Regulated 3.3V (output, used as main power supply for the kit)

4. Hardware User Guide

4.1. Connectors

The following sections describes the implementation of the relevant connectors and headers on SAM L21 Xplained Pro and their connection to the ATSAML21J18B. The tables of connections in the sections also describes which signals are shared between the headers and on-board functionality. Figure 4-1 shows all available connectors and jumpers on SAM L21 Xplained Pro.

Figure 4-1. SAM L21 Xplained Pro Connector Overview

4.1.1. Xplained Pro Extension Headers

The SAM L21 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 are based on the standard extension header specified in Table 3-4. The headers have a pitch of 2.54mm.

Table 4-1. Extension Header EXT1

EXT1 pin	SAM L21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board
2 [GND]	-	-	Ground
3 [ADC(+)]	PB05	AIN[13]	
4 [ADC(-)]	PA03	AIN[1]	
5 [GPIO1]	PB06	GPIO	
6 [GPIO2]	PB07	GPIO	
7 [PWM(+)]	PA12	TCC2/WO[0]	
8 [PWM(-)]	PA13	TCC2/WO[1]	
9 [IRQ/GPIO]	PB04	IRQ4/GPIO	
10 [SPI_SS_B/GPIO]	PA02	GPIO	SW0
11 [TWI_SDA]	PA08	SERCOM2 PAD[0] I²C SDA	EXT2, EXT3, and EDBG I²C
12 [TWI_SCL]	PA09	SERCOM2 PAD[1] I²C SCL	EXT2, EXT3, and EDBG I²C
13 [USART_RX]	PB09	SERCOM4 PAD[1] UART RX	
14 [USART_TX]	PB08	SERCOM4 PAD[0] UART TX	
15 [SPI_SS_A]	PA05	SERCOM0 PAD[1] SPI SS	
16 [SPI_MOSI]	PA06	SERCOM0 PAD[2] SPI MOSI	
17 [SPI_MISO]	PA04	SERCOM0 PAD[0] SPI MISO	
18 [SPI_SCK]	PA07	SERCOM0 PAD[3] SPI SCK	
19 [GND]	-	-	Ground
20 [VCC]	-	-	Power for extension board

Table 4-2. Extension Header EXT2

EXT2 pin	SAM L21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board
2 [GND]	-	-	Ground
3 [ADC(+)]	PA10	AIN[18] / PTC_Y8	Onboard QTouch Button 1
4 [ADC(-)]	PA11	AIN[19]	

EXT2 pin	SAM L21 pin	Function	Shared functionality
5 [GPIO1]	PA20	GPIO	EDBG GPIO2
6 [GPIO2]	PA21	GPIO	EDBG GPIO3
7 [PWM(+)]	PB12	TC4/WO[0]	
8 [PWM(-)]	PB13	TC4/WO[1]	
9 [IRQ/GPIO]	PB14	IRQ14/GPIO	
10 [SPI_SS_B/GPIO]	PB15	GPIO	
11 [TWI_SDA]	PA08	SERCOM2 PAD[0] I²C SDA	EXT1, EXT3, and EDBG I²C
12 [TWI_SCL]	PA09	SERCOM2 PAD[1] I²C SCL	EXT1, EXT3, and EDBG I²C
13 [USART_RX]	PA19	SERCOM1 PAD[3] UART RX	EXT3 UART
14 [USART_TX]	PA18	SERCOM1 PAD[2] UART TX	EXT3 UART
15 [SPI_SS_A]	PA17	GPIO	
16 [SPI_MOSI]	PB22	SERCOM5 PAD[2] SPI MOSI	EXT3 and EDBG SPI
17 [SPI_MISO]	PB16	SERCOM5 PAD[0] SPI MISO	EXT3 and EDBG SPI
18 [SPI_SCK]	PB23	SERCOM5 PAD[3] SPI SCK	EXT3 and EDBG SPI
19 [GND]	-	-	Ground
20 [VCC]	-	-	Power for extension board

Table 4-3. Extension Header EXT3

EXT3 pin	SAM L21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board
2 [GND]	-	-	Ground
3 [ADC(+)]	PB00	AIN[8]	
4 [ADC(-)]	PB01	AIN[9]	EDBG GPIO0
5 [GPIO1]	PB30	GPIO	
6 [GPIO2]	PA15	GPIO	
7 [PWM(+)]	PB10	TCC0/WO[4]	LED0
8 [PWM(-)]	PB11	TCC0/WO[5]	
9 [IRQ/GPIO]	PA16	IRQ0/GPIO	EDBG GPIO1
10 [SPI_SS_B/GPIO]	PA27	GPIO	
11 [TWI_SDA]	PA08	SERCOM2 PAD[0] I²C SDA	EXT1, EXT2, and EDBG I²C
12 [TWI_SCL]	PA09	SERCOM2 PAD[1] I²C SCL	EXT1, EXT2, and EDBG I²C

EXT3 pin	SAM L21 pin	Function	Shared functionality
13 [USART_RX]	PA19	SERCOM1 PAD[3] UART RX	EXT2 UART
14 [USART_TX]	PA18	SERCOM1 PAD[2] UART TX	EXT2 UART
15 [SPI_SS_A]	PB17	SERCOM5 PAD[1] SPI SS	
16 [SPI_MOSI]	PB22	SERCOM5 PAD[2] SPI MOSI	EXT2 and EDBG SPI
17 [SPI_MISO]	PB16	SERCOM5 PAD[0] SPI MISO	EXT2 and EDBG SPI
18 [SPI_SCK]	PB23	SERCOM5 PAD[3] SPI SCK	EXT2 and EDBG SPI
19 [GND]	-	-	Ground
20 [VCC]	-	-	Power for extension board

4.1.2. VDDIO Header

The SAM L21 Xplained Pro has a 2-pin header connecting the power supply from the VCC_MCU net to VCC_IO net through a jumper. This header can be used to measure the current to the I/O block of the SAM L21 device by removing the jumper and connect an ammeter. SAM L21 has the possibility to run the I/O block at a lower voltage level than the MCU is running and thus support interfacing devices that require lower operating voltages. The header can then be used to power the VCC_IO pin at a different voltage level by removing the jumper and connecting a power supply with the desired voltage. Refer to the datasheet of the device for valid operating voltages.

Table 4-4. VDDIO Header

VDDIO header pin	Function
1	VCC_MCU power supply
2	VCC_IO power input

4.1.3. USB

The SAM L21 Xplained Pro has a Micro-USB connector for use with the SAM L21 USB module labeled as TARGET USB on the kit. 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. In USB host mode VBUS voltage is provided by the kit and can thus not identify a connected device, so another GPIO is used to detect the USB ID of the device.

Table 4-5. USB Connections

SAM L21 pin	USB function	Shared functionality
PA14	VBUS Detection	Crystal footprint
PB02	USB ID	-
PA24	USB D-	-
PA25	USB D+	-

4.1.4. Current Measurement Header

An angled 1x2, 100mil pin-header marked with MCU current measurement is located at the upper edge of the SAM L21 Xplained Pro. All power to the ATSAML21J18B 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 ATSAML21J18B to be powered through its I/O pins. This may cause permanent damage to the device.

4.1.5. Cortex Debug Connector

SAM L21 Xplained Pro has a 10-pin 50-mil Cortex® Debug Connector that can be used to attach external debuggers to the ATSAML21J18B.

Table 4-6. Cortex Debug Connector

Cortex Debug Connector pin	Pin / Net	Function	Shared functionality
1	VCC_TARGET_P3V3	ATSAML21J18B voltage	
2	PA31	SWD data signal	EDBG SWD
3	GND	Ground	
4	PA30	SWD clock signal	EDBG SWD
5	GND	Ground	
6	-	-	
7	-	-	
8	-	-	
9	GND	Ground	
10	RESETN	Target reset signal	

4.2. Peripherals

4.2.1. Crystals

The SAM L21 Xplained Pro kit contains one mounted 32.768kHz crystal and a footprint for higher frequency crystals that can be used as clock sources for the SAM L21. The crystals have cut-straps next to them that can be used to measure the oscillator safety factor. This is done by cutting the strap and adding a resistor across the strap. Information about oscillator allowance and safety factor can be found in application note AVR41001, information about clock calibration and compensation can be found in application note AT03155.

The footprint for the external crystal is based on the Fox FQ5032B series.

Info: Note that PA14 and PA15 are shared with USB VBUS detect and EXT3 pin 5. To disconnect PA14 and PA15 from all functionality except XTAL cut J300 and J302.

Table 4-7. External 32.768kHz Crystal

SAM L21 pin	Function	Shared functionality
PA00	XIN32	-
PA01	XOUT32	-

Table 4-8. External Crystal Footprint

SAM L21 pin	Function	Shared functionality
PA14	XIN	USB VBUS
PA15	XOUT	EXT3

4.2.2. Mechanical Buttons

SAM L21 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM L21 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.

Note: There is no pull-up resistor connected to the generic user button. Remember to enable the internal pull-up in the SAM L21 to use the button.

Table 4-9. Mechanical Buttons

SAM L21 pin	Silkscreen text	Shared functionality
RESET	RESET	-
PA02	SW0	EXT1

4.2.3. LED

There is one yellow LED available on the SAM L21 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 Connection

SAM L21 pin	Function	Shared functionality
PB10	Yellow LED0	EXT3

4.2.4. QTouch Button

There is one self capacitance button available on the SAM L21 Xplained Pro board that can be used as I/O. This QTouch button is intended to be driven by the built-in Peripheral Touch Controller (PTC) of the device. A zero ohm resistor is added on the board to easily disconnect the onboard touch buttons from the extension header, as the I/O lines are shared between the two.

Note: To get started with QTouch refer to Atmel QTouch® Library and Atmel QTouch® Composer.

Table 4-11. QTouch Connection

SAM L21 pin	Silkscreen text	Shared functionality
PA10	QT BTN1	EXT2

4.2.5. Backup Battery

The SAM L21 Xplained Pro has a backup battery for use with the SAM L21 backup module. The battery can be connected to the device by placing a jumper over pin 1-2 on the 3-pin VBAT SELECT header.

By default the jumper is placed over pin 2-3 to select the board power supply. This configuration is selected to avoid draining the battery and can be used during development.

Table 4-12. VBAT SELECT Header

VBAT SELECT pin	Function
1	Power from battery
2	PB03/VBAT pin on SAM L21
3	Power from board supply

4.3.   Embedded Debugger Implementation

SAM L21 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAML21J18B 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 L21 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 4-13. SWD Connections

SAM L21 pin	Function	Shared functionality
PA30	SWD clock	Cortex debug connector
PA31	SWD data	Cortex debug connector

4.3.2.   Virtual COM Port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAML21J18B UARTs. For further information on how to use the Virtual COM port, see Embedded Debugger.

Table 4-14. Virtual COM Port Connections

SAM L21 pin	Function	Shared functionality
PA22	SERCOM3 PAD[0] UART TXD (SAM L21 TX line)	-
PA23	SERCOM3 PAD[1] UART RXD (SAM L21 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. The DGI can be used to send a variety of data from the ATSAML21J18B to the host PC. For further information on how to use the DGI interface, see Atmel Data Visualizer and the EDBG User Guide.

Table 4-15. DGI Interface Connections When Using SPI

SAM L21 pin	Function	Shared functionality
PB31	GPIO/SPI SS (Slave select) (SAM L21 is Master)	-
PB16	SERCOM5 PAD[0] SPI MISO (Master In, Slave Out)	EXT2 and EXT3
PB22	SERCOM5 PAD[2] SPI MOSI (Master Out, Slave in)	EXT2 and EXT3
PB23	SERCOM5 PAD[3] SPI SCK (Clock Out)	EXT2 and EXT3

Table 4-16. DGI Interface Connections When Using I²C

SAM L21 pin	Function	Shared functionality
PA08	SERCOM2 PAD[0] SDA (Data line)	EXT1, EXT2, and EXT3
PA09	SERCOM2 PAD[1] SCL (Clock line)	EXT1, EXT2, and EXT3

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 L21 application code. For further information on how to configure and use the GPIO monitoring features, see Atmel Data Visualizer and the EDBG User Guide.

Table 4-17. GPIO Lines Connected to the EDBG
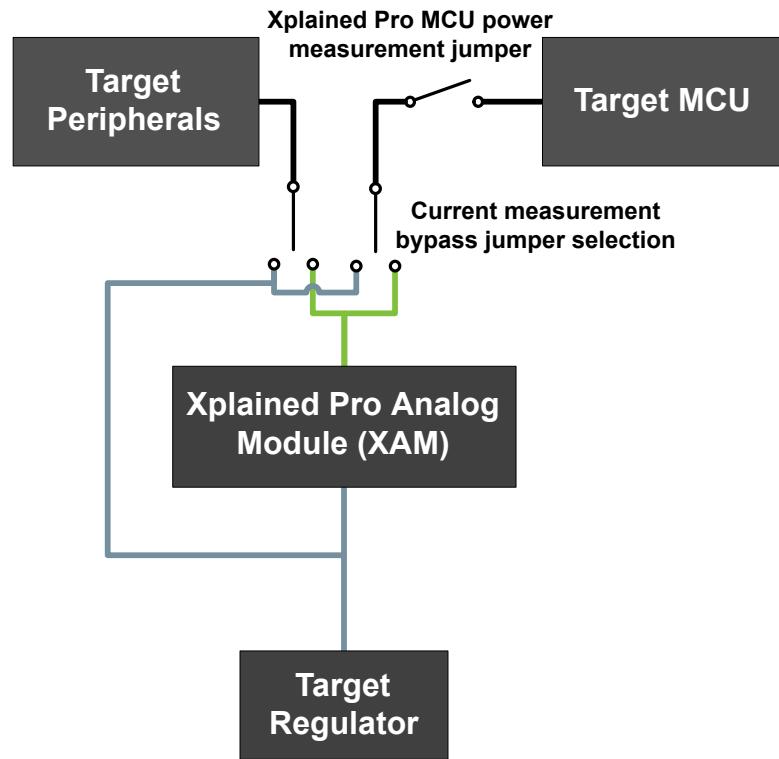
SAM L21 pin	Function	Shared functionality
PB01	GPIO0	EXT3
PA16	GPIO1	EXT3
PA20	GPIO2	EXT2
PA21	GPIO3	EXT2

4.4. SAM L21 Xplained Pro XAM Configuration

On the SAM L21 Xplained Pro the MCU and the MCU peripherals (e.g. extensions) are powered by its own regulator as shown in Figure 4-2. All other parts of the board, mainly embedded debugger and accompanying Xplained Pro Analog Module (XAM), are powered from a separate regulator. The current to the MCU and peripherals can be measured by connecting them to the XAM output through jumper settings.

Figure 4-2. SAM L21 Xplained Pro XAM Implementation Block Diagram

On the SAM L21 Xplained Pro the XAM can be used in four configurations:

1. **No current measurement or external MCU current measurement**: The XAM is bypassed and thus the MCU and peripherals are supplied directly by the regulator. Set both jumpers in the "BYPASS" position. In this configuration it is also possible to connect external measurement tools on the Xplained Pro MCU power measurement header to measure MCU current directly instead of using the XAM.

2. **MCU current measurement**: The XAM measures only the MCU current while the peripherals are supplied directly by the regulator. For this configurations place the jumper for "I/O" (peripherals) into the "BYPASS" position and the "MCU" into the "MEASURE" position.

3. **Peripherals measurement**: The XAM measures only the peripherals current while the MCU is directly supplied by the regulator. For this configuration place the jumper for "MCU" into the "BYPASS" position and the "I/O" jumper into the "MEASURE" position.

4. **MCU and peripherals measurement**: In this configuration both MCU and peripherals are measured by the XAM. Place both jumpers on "I/O" and "MCU" headers in the "MEASURE" position.

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
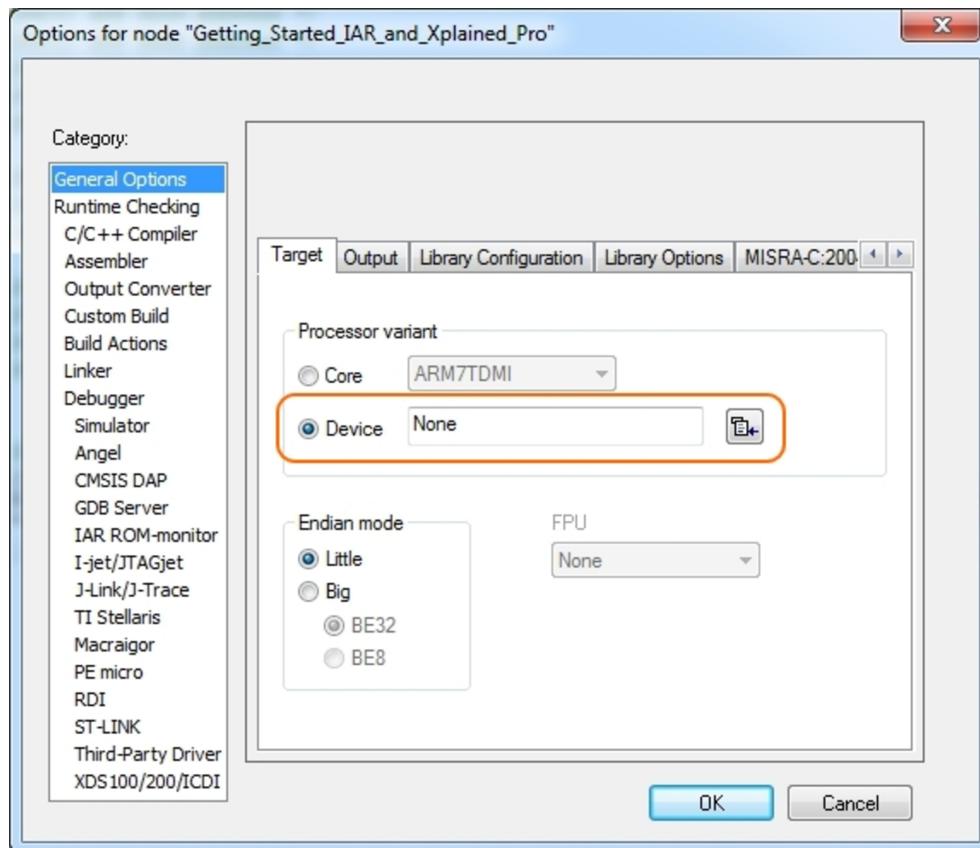
Figure 5-2. Select Debugger
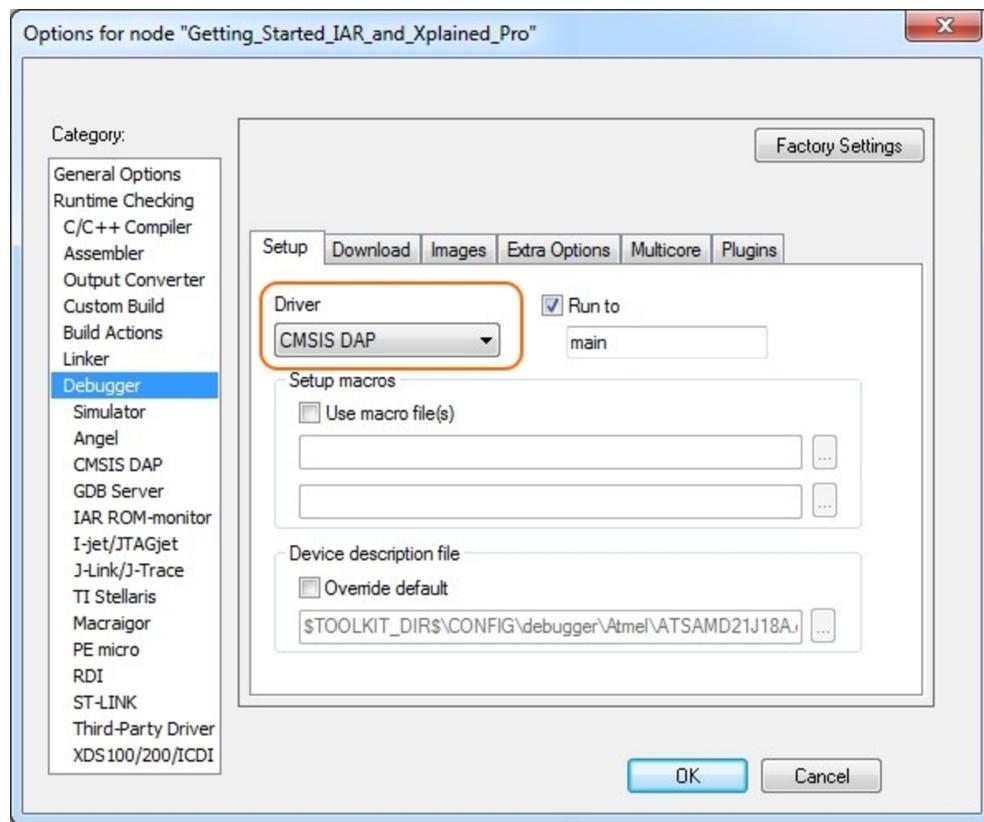
Figure 5-3. Configure Flash Loader
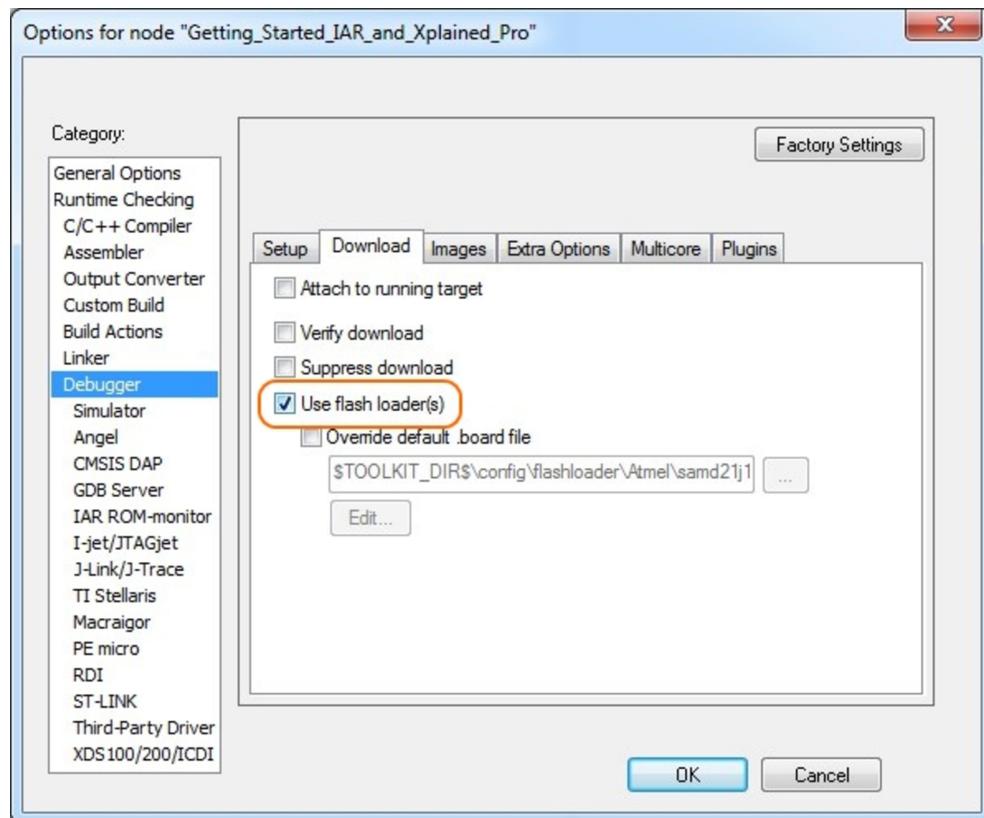
Figure 5-4. Configure Reset
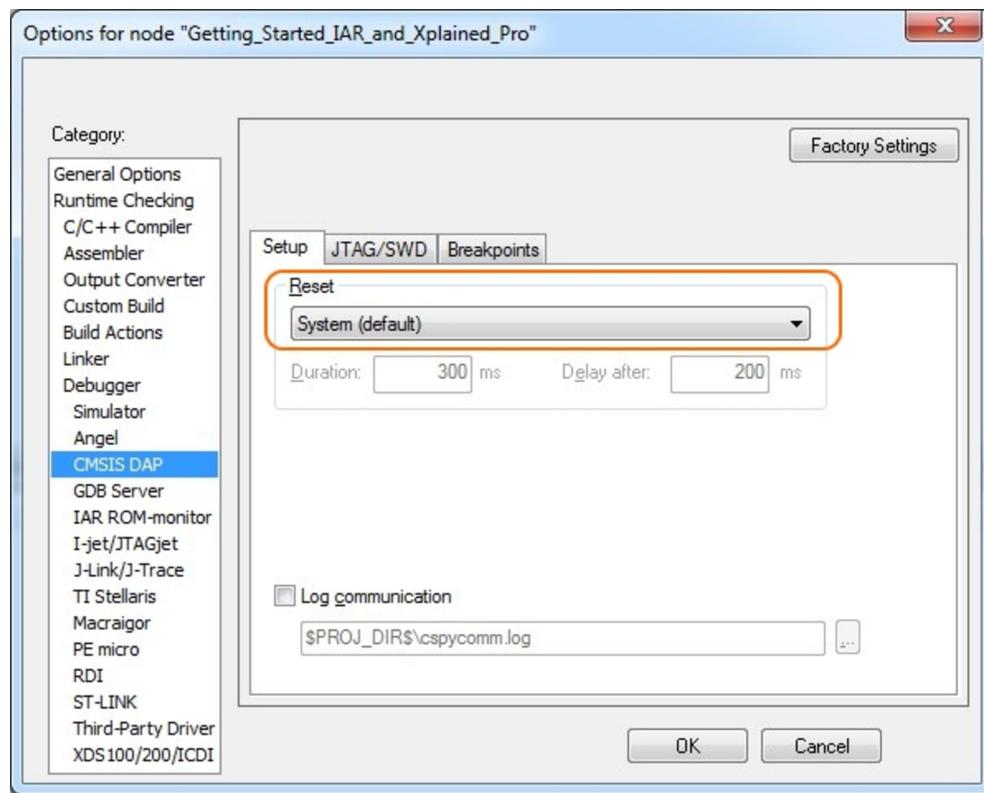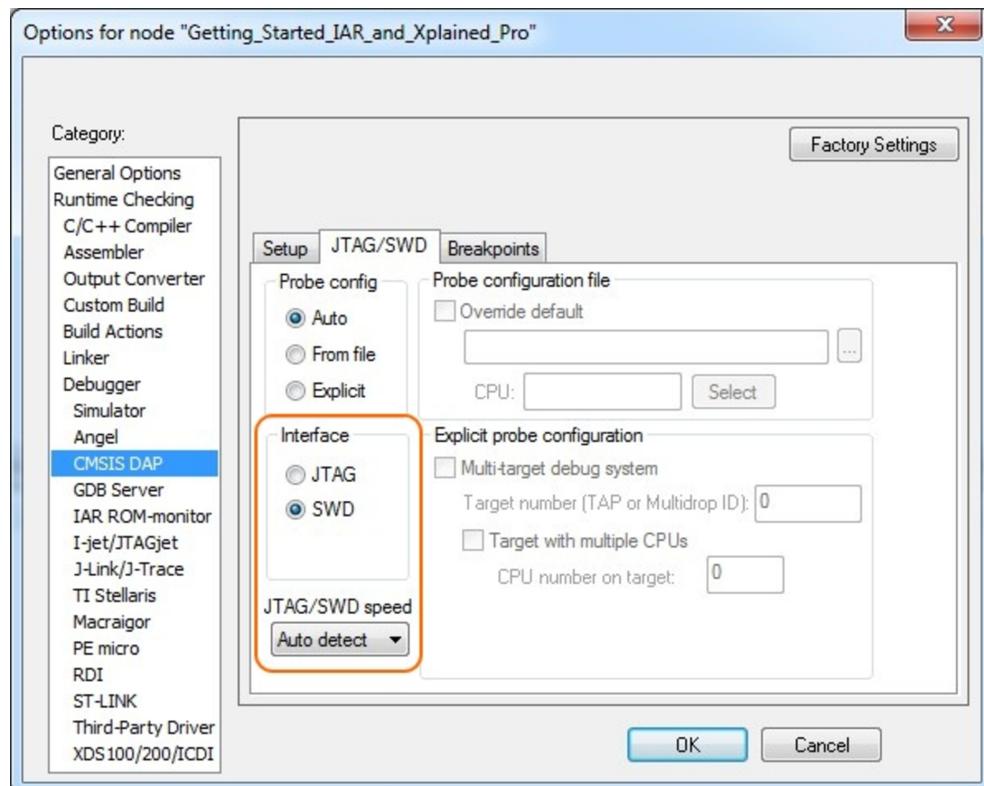
Figure 5-5. Configure Interface

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 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 SAM L21 Xplained Pro is A09-2241.

6.2. Revision 5

The device on revision 5 of the kit has been changed from ATSAML21J18B-AUTES to ATSAML21J18B-AUT revision C or newer.

6.3. Revision 4

The device on revision 4 of the kit has been changed from ATSAML21J18A-AUTES to ATSAML21J18B-AUTES.

The top level order code of the SAM L21 Xplained Pro evaluation kit changed to ATSAML21-XPRO-B for revision 4 and newer. Revision 3 and earlier

6.4. Revision 3
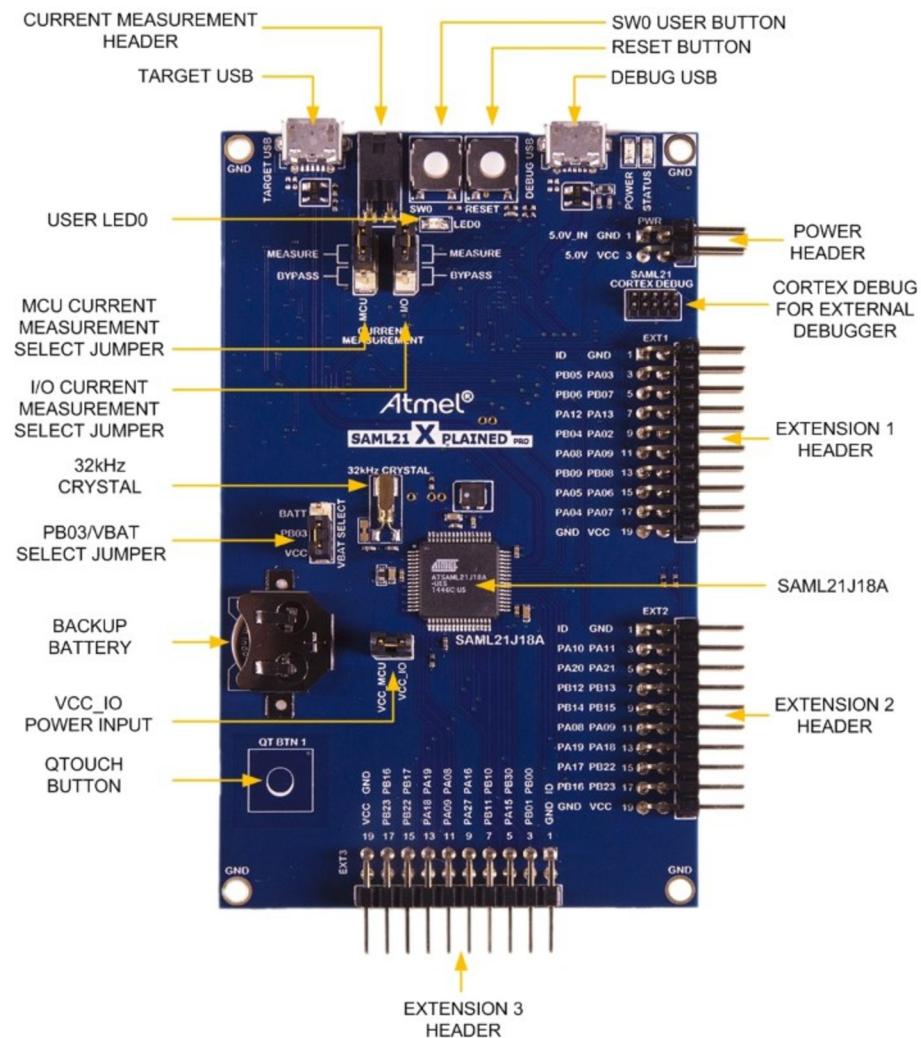
Revision 3 and previous revisions use ATSAML21J18A-AUTES as the main device, revision 3 is the initially released revision.

The top level order code of the SAM L21 Xplained Pro evaluation kit is ATSAML21-XPRO for revision 3.

The extra crystal footprint connected to PA14 and PA15 described in Crystals is not present on this revision.

The overview picture in Figure 1-1 is not applicable for revision 3, see the figure below instead.

Figure 6-1. SAM L21 Xplained Pro Evaluation Kit Overview

7. Document Revision History

Doc. rev.	Date	Comment
42405D	08/2016	Updated power supply chapter with target USB as an input source.
42405C	03/2016	Updated for revision 5 of the kit.
42405B	07/2015	Updated for revision 4 of the kit.
42405A	02/2015	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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