SMART ARM-based Microcontrollers

SAM C21 Xplained Pro

USER GUIDE

Preface

The Atmel® SAM C21 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAMC21J18A microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the ATSAMC21J18A 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 ATSAMC21J18A.

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

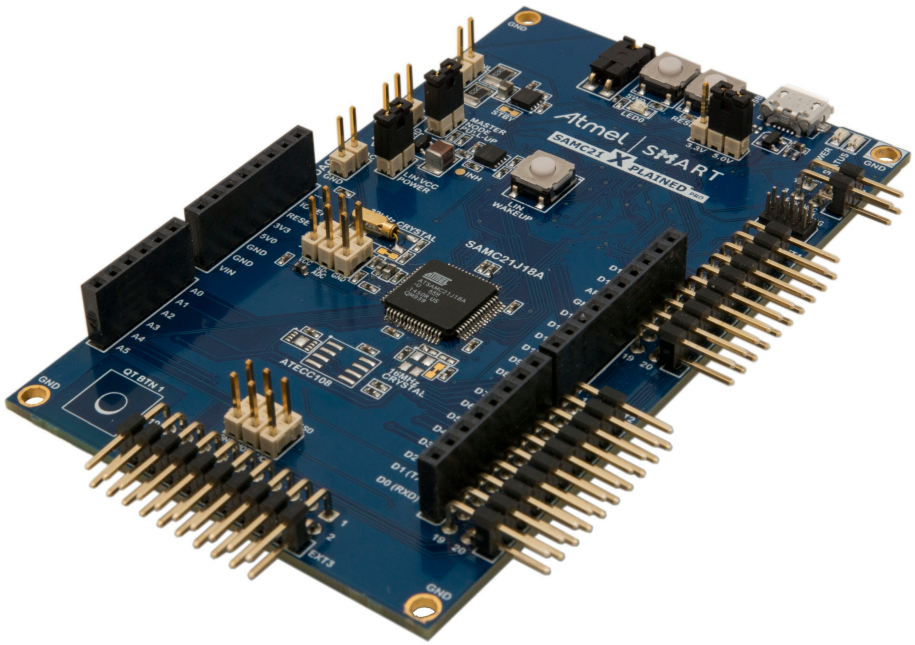


Table of Contents

Preface 1

1. Introduction 4
   - 1.1. Features 4
   - 1.2. Kit Overview 4

2. Getting Started 6
   - 2.1. Xplained Pro Quick Start 6
   - 2.2. Design Documentation and Relevant Links 6

3. Xplained Pro 8
   - 3.1. Embedded Debugger 8
   - 3.2. Hardware Identification System 9
   - 3.3. Power Sources 9
   - 3.4. Xplained Pro Headers and Connectors 10
     - 3.4.1. Xplained Pro Standard Extension Header 10
     - 3.4.2. Xplained Pro Power Header 11

4. Hardware Users Guide 12
   - 4.1. Power Distribution 12
   - 4.2. Connectors 13
     - 4.2.1. Xplained Pro Extension Headers 14
     - 4.2.2. Arduino Connectors 16
     - 4.2.3. VCC Selection Header 18
     - 4.2.4. VREF Header 19
     - 4.2.5. DAC Header 19
     - 4.2.6. Current Measurement Header 19
     - 4.2.7. Cortex Debug Connector 19
   - 4.3. Peripherals 20
     - 4.3.1. LED 20
     - 4.3.2. Mechanical Buttons 20
     - 4.3.3. Crystals 20
     - 4.3.4. CAN 21
     - 4.3.5. LIN 21
     - 4.3.6. QTouch Button 22
     - 4.3.7. Crypto Footprints 22
   - 4.4. Kit Modifications 23
   - 4.5. Embedded Debugger Implementation 30
     - 4.5.1. Serial Wire Debug 31
     - 4.5.2. Virtual COM Port 31
     - 4.5.3. Atmel Data Gateway Interface 31

5. Appendix 33
   - 5.1. Getting Started with IAR 33
   - 5.2. Connecting a SAM-ICE to an Xplained Pro Board 36

6. Hardware Revision History and Known Issues....38
6.1. Identifying Product ID and Revision....38
6.2. Revision 6....38
6.3. Revision 5....38
6.4. Revision 3....43
6.5. Revision 2....43
6.5.1. The QTouch Button PAD is not Connected....43
6.5.2. Kit Does Not Work with 3.3V Target Voltage Selected....43
7. Document Revision History....44
8. Evaluation Board/Kit Important Notice....45

1. Introduction

1.1. Features

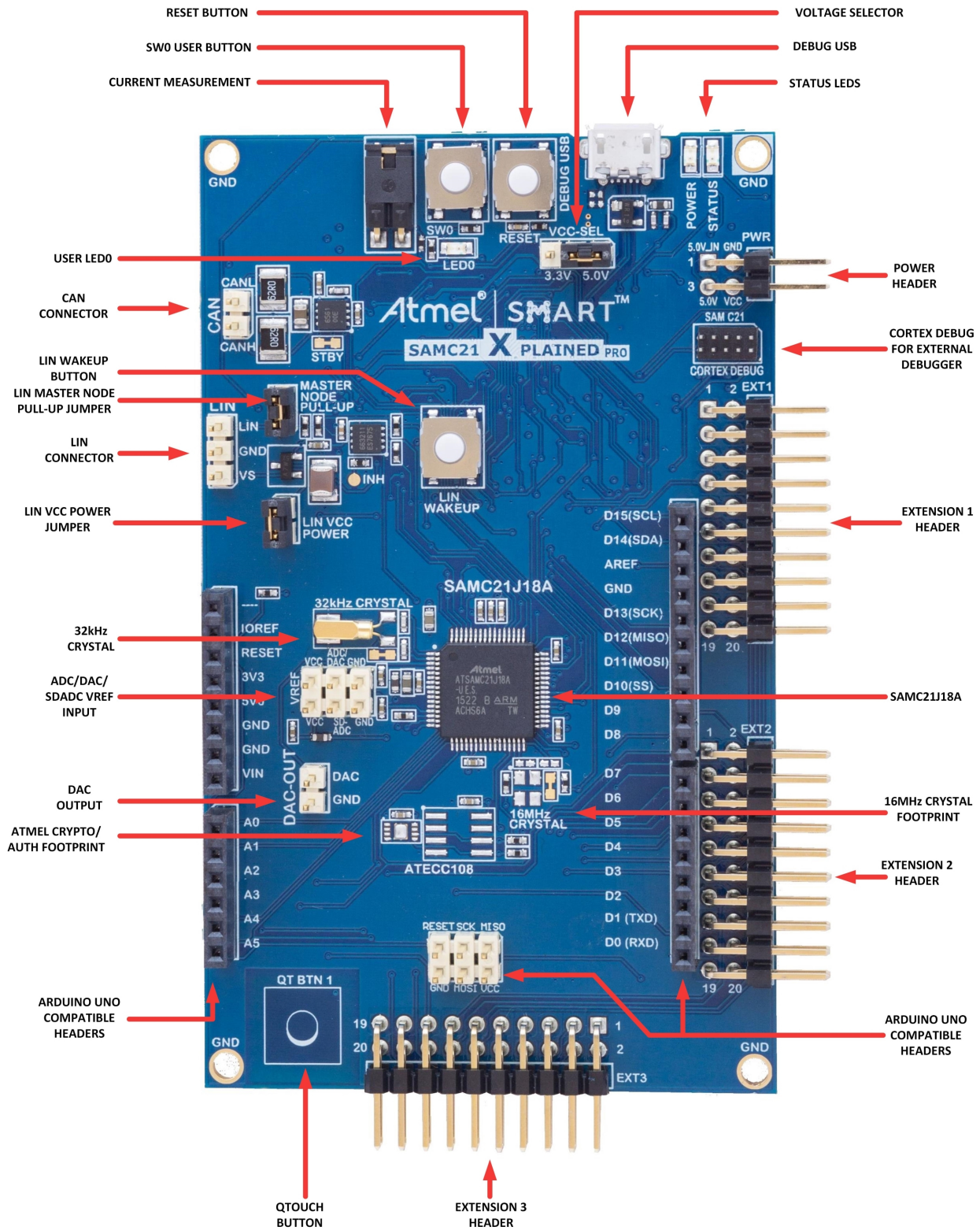
- ATSAMC21J18A microcontroller
- Embedded Debugger
  - USB interface
  - Auto-ID for board identification in Atmel Studio
  - One yellow status LED
  - One green board power LED
  - Symbolic debug of complex data types icluding scope information
  - Programming and debugging of on board SAM C21 through Serial Wire Debug (SWD)
  - Data Gateway Interface: SPI, I^2C, four GPIOs
  - Virtual COM port (CDC)
  - Control of on-board power switch to protect connected extensions against high voltage
- Digital I/O
  - Two mechanical buttons (user and reset button)
  - One QTouch® button
  - One yellow user LED
  - Three Xplained Pro extension headers
- Two selectable target voltages
  - 3.3V
  - 5.0V
- Level converters between target section and EDBG section
- 32.768kHz crystal mounted
- 16MHz crystal footprint (not mounted)
- CAN transceiver
- LIN transceiver
  - Wake-up button
  - Master node pull-up enable
  - Alternate LIN power jumper
- DAC output connector
- Analog voltage reference connector with filtered power supply
  - SDADC VREF
  - ADC/DAC VREF
- Supported with application examples in Atmel Software Framework

1.2. Kit Overview

The Atmel SAM C21 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAMC21J18A.

The kit offers a set of features that enables the ATSAMC21J18A user to get started with the SAM C peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM C21 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 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 C21 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 SAM C21 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 C21 Xplained Pro in the Atmel store** - Atmel Store 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 C21 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 ATSAMC21J18A. On SAM C21 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAMC21J18A.

The Virtual COM Port is connected to a UART on the ATSAMC21J18A 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 ATSAMC21J18A 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 ATSAMC21J18A. 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 ATSAMC21J18A 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 C21 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 C21 Xplained Pro kit can be powered by several power sources as listed in the table below.

Table 3-3. Power Sources for SAM C21 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^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
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 C21 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 or 5.0V 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_P5V0	Regulated 3.3V or 5.0V (output, used as main power supply for the kit)

4. Hardware Users Guide

4.1. Power Distribution

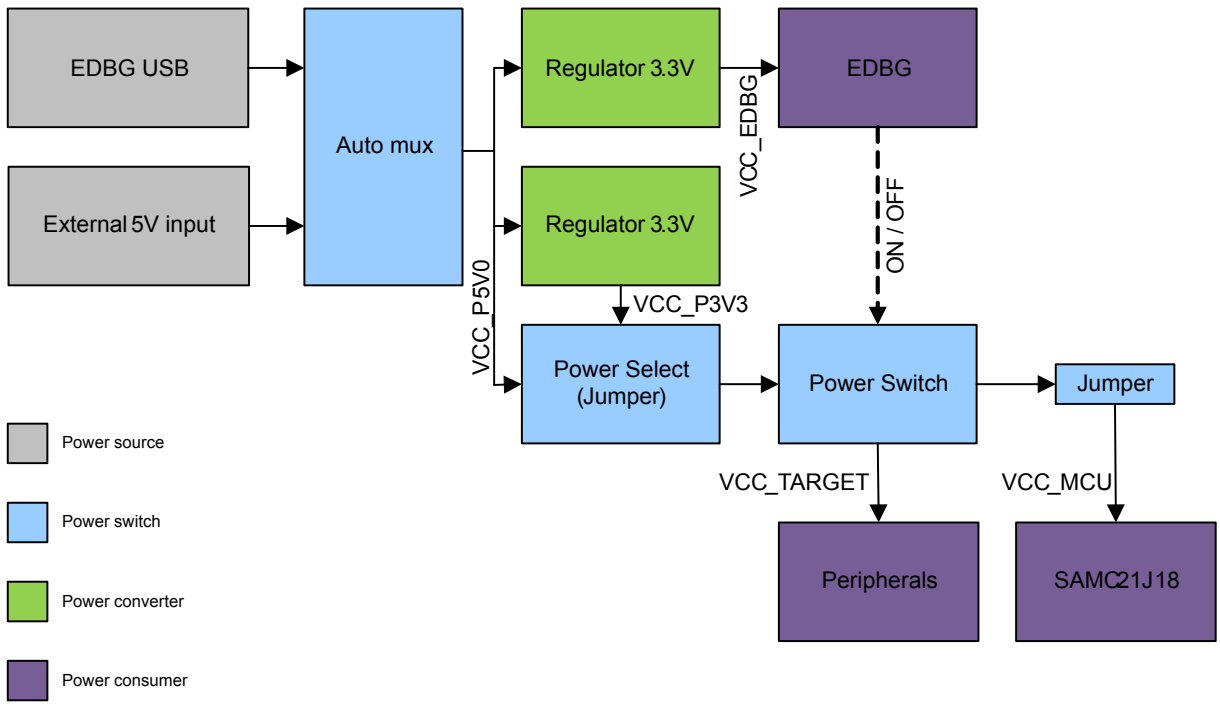
SAM C21 Xplained Pro has two power sources as described in Power Sources. Figure 4-1 shows a block diagram of the power supply circuitry. The kit can be powered from the EDBG USB and an external 5.0V source. The kit will automatically select which source to draw power from.

The EDBG controls an on-board power switch to the ATSAMC21J18A, the on-board peripherals, and extension connectors. When the kit is powered up, the EDBG reads the ID chip information from all connected Xplained Pro extension boards and checks that they are compatible with the voltage selected by the power selection jumper. If the selected voltage is within the connected extensions ranges the switch will open. If not, the EDBG power LED will blink rapidly and the switch will stay closed resulting in no power provided to the ATSAMC21J18A, on-board peripherals, and connectors.

Caution: As the SAM C21 Xplained Pro can be powered by 5.0V care must be taken not to connect any Xplained Pro extensions that does not support this voltage, doing so may result in permanent damage. Check the respective extension kit's user guide to see which voltages are acceptable.

Info: The EDBG only reads the ID information and controls the power switch when the kit is powered up. This mechanism does not check hot-plugging of extension boards.

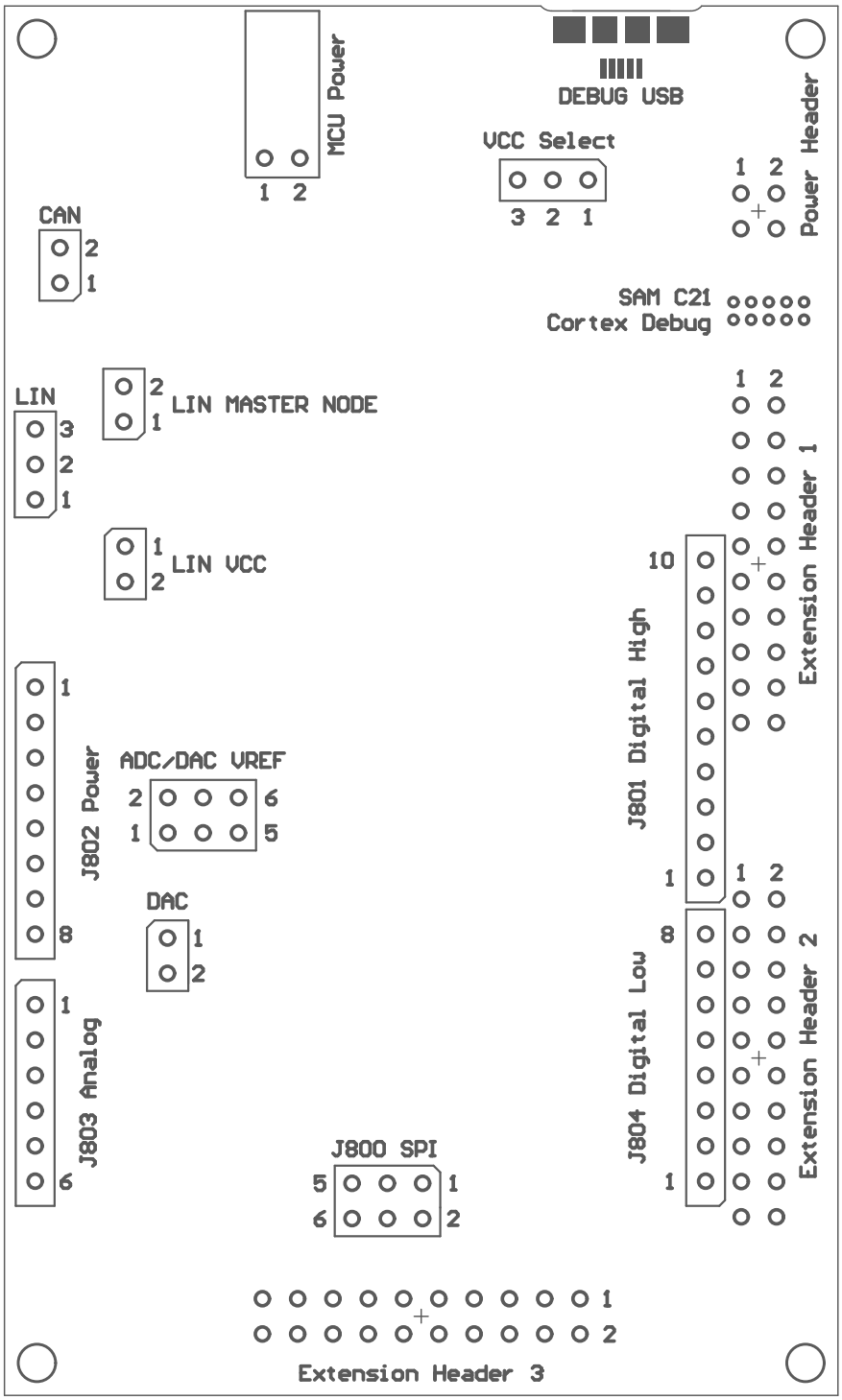
Figure 4-1. Power Supply Block Diagram



4.2. Connectors

The following sections describes the implementation of the relevant connectors and headers on SAM C21 Xplained Pro and their connection to the ATSAMC21J18A. The tables of connections in the sections also describes which signals are shared between the headers and on-board functionality. Figure 4-2 shows all available connectors and jumpers on SAM C21 Xplained Pro.

Figure 4-2. SAM C21 Xplained Pro Connector Overview



4.2.1. Xplained Pro Extension Headers

The SAM C21 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 Xplained Pro Standard Extension Header. The headers have a pitch of 2.54mm.

Table 4-1. Extension Header EXT1

Pin on EXT1	SAM C21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PB09	INP1	Shield
4 [ADC(-)]	PB08	INN1	Shield
5 [GPIO1]	PA20	GPIO	Shield
6 [GPIO2]	PA21	GPIO	Shield
7 [PWM(+)]	PB12	TC0/WO0	Shield and EDBG GPIO0
8 [PWM(-)]	PB13	TC0/WO1	Shield
9 [IRQ/GPIO]	PB14	IRQ14/GPIO	-
10 [SPI_SS_B/GPIO]	PB15	GPIO	-
11 [TWI_SDA]	PA12	SERCOM2 PAD[0] I^2C SDA	EXT2, EXT3, Shield, Crypto Device, and EDBG I^2C
12 [TWI_SCL]	PA13	SERCOM2 PAD[1] I^2C SCL	EXT2, EXT3, Shield, Crypto Device, and EDBG I^2C
13 [USART_RX]	PA23	SERCOM3 PAD[1] UART RX	EXT2, EXT3, and Shield
14 [USART_TX]	PA22	SERCOM3 PAD[0] UART TX	EXT2, EXT3, and Shield
15 [SPI_SS_A]	PA17	SERCOM1 PAD[1] SPI SS	-
16 [SPI_MOSI]	PA18	SERCOM1 PAD[2] SPI MOSI	-
17 [SPI_MISO]	PA16	SERCOM1 PAD[0] SPI MISO	-
18 [SPI_SCK]	PA19	SERCOM1 PAD[3] SPI SCK	-
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

Table 4-2. Extension Header EXT2

Pin on EXT2	SAM C21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PA08	AIN10	Shield
4 [ADC(-)]	PA09	AIN11	Shield
5 [GPIO1]	PA10	GPIO	-
6 [GPIO2]	PA11	GPIO	-
7 [PWM(+)]	PB30	TCC0/WO0	Shield
8 [PWM(-)]	PB31	TCC0/WO1	Shield
9 [IRQ/GPIO]	PB16	IRQ0/GPIO	EDBG GPIO1
10 [SPI_SS_B/GPIO]	PB17	GPIO	EDBG GPIO2
11 [TWI_SDA]	PA12	SERCOM2 PAD[0] I^2C SDA	EXT1, EXT3, Shield, Crypto Device, and EDBG I^2C
12 [TWI_SCL]	PA13	SERCOM2 PAD[1] I^2C SCL	EXT1, EXT3, Shield, Crypto Device, and EDBG I^2C
13 [USART_RX]	PA23	SERCOM3 PAD[1] UART RX	EXT1, EXT3, and Shield
14 [USART_TX]	PA22	SERCOM3 PAD[0] UART TX	EXT1, EXT3, and Shield
15 [SPI_SS_A]	PB03	SERCOM5 PAD[1] SPI SS	
16 [SPI_MOSI]	PB00	SERCOM5 PAD[2] SPI MOSI	EXT3, Shield, Shield(2), and EDBG SPI
17 [SPI_MISO]	PB02	SERCOM5 PAD[0] SPI MISO	EXT3, Shield, Shield(2), and EDBG SPI
18 [SPI_SCK]	PB01	SERCOM5 PAD[3] SPI SCK	EXT3, Shield, Shield(2), and EDBG SPI
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

Table 4-3. Extension Header EXT3

Pin on EXT3	SAM C21 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PB07	AIN9/INP2	Shield
4 [ADC(-)]	PB06	AIN8/INN2	Shield
5 [GPIO1]	PB04	GPIO	Shield
6 [GPIO2]	PB05	GPIO	Shield
7 [PWM(+)]	PA14	TC4/WO0	Crystal footprint
8 [PWM(-)]	PA15	TC4/WO1	User LED and Crystal footprint
9 [IRQ/GPIO]	PA28	IRQ8/GPIO	User Button and EDBG GPIO3
10 [SPI_SS_B/GPIO]	PA27	GPIO	Shield
11 [TWI_SDA]	PA12	SERCOM2 PAD[0] I^2C SDA	EXT1, EXT2, Shield, Crypto Device, and EDBG I^2C
12 [TWI_SCL]	PA13	SERCOM2 PAD[1] I^2C SCL	EXT1, EXT2, Shield, Crypto Device, and EDBG I^2C
13 [USART_RX]	PA23	SERCOM3 PAD[1] UART RX	EXT1, EXT2, and Shield
14 [USART_TX]	PA22	SERCOM3 PAD[0] UART TX	EXT1, EXT2, and Shield
15 [SPI_SS_A]	PA02	GPIO	DAC Header
16 [SPI_MOSI]	PB00	SERCOM5 PAD[2] SPI MOSI	EXT2, Shield, Shield(2), and EDBG SPI
17 [SPI_MISO]	PB02	SERCOM5 PAD[0] SPI MISO	EXT2, Shield, Shield(2), and EDBG SPI
18 [SPI_SCK]	PB01	SERCOM5 PAD[3] SPI SCK	EXT2, Shield, Shield(2), and EDBG SPI
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

4.2.2. Arduino Connectors

SAM C21 Xplained Pro implements Arduino shield connectors based on the Arduino Uno. All references to Arduino pin names are taken from the official Arduino schematics of the Arduino Uno.

Caution: The target section of SAM C21 Xplained Pro can be powered by 3.3V or 5.0V. The maximum voltage the I/O pins can tolerate depends on the supply voltage. Providing higher voltages like 5V to an I/O pin when the ATSAMC21J18A is powered by 3.3V could damage the board.

Info: Note that all pins do not have the exact same functionality as on the Arduino Uno on the shield connectors. Each shield should be checked for compatibility before it is connected.

Table 4-4. J802 - Power

Pin on J802	SAM C21 pin	Arduino pin name	Function	Shared functionality
1	-	RFU	-	-
2	-	IOREF	VCC_TARGET_P3V3_P5V0	-
3	RESETN	RESET	TARGET_RESET	-
4	-	3.3V	VCC_P3V3	-
5	-	5V	VCC_P5V0	-
6	-	GND	GND	-
7	-	GND	GND	-
8	-	VIN	VCC_EXT_P5V0	-

Table 4-5. J803 - Analog

Pin on J803	SAM C21 pin	Arduino pin name	Function	Shared functionality
1	PB09	ADC0	INP1	EXT1
2	PB08	ADC1	INN1	EXT1
3	PA08	ADC2	AIN10	EXT2
4	PA09	ADC3	AIN11	EXT2
5	PB07	ADC4	AIN9 / INP2	EXT3
6	PB06	ADC5	AIN8 / INN2	EXT3

Table 4-6. J804 - Digital Low

Pin on J804	SAM C21 pin	Arduino pin name	Function	Shared functionality
1	PA23	D0 / RX0	SERCOM3 PAD1 UART RX	EXT1, EXT2, and EXT3
2	PA22	D1 / TX0	SERCOM3 PAD0 UART TX	EXT1, EXT2, and EXT3
3	PA20	D2	GPIO	EXT1
4	PB12	D3	TC0_W0	EXT1 and EDBG GPIO
5	PA21	D4	GPIO	EXT1
6	PB13	D5	TC0_W1	EXT1

Pin on J804	SAM C21 pin	Arduino pin name	Function	Shared functionality
7	PB30	D6	TCC0_W0	EXT2
8	PB04	D7	GPIO	EXT3

Table 4-7. J801 - Digital High

Pin on J801	SAM C21 pin	Arduino pin name	Function	Shared functionality
1	PB05	D8	GPIO	EXT3
2	PB31	D9	TCC0_W1	EXT2
3	PA27	D10 / SPI-SS	GPIO	EXT3
4	PB00	D11 / SPI-MOSI	SERCOM5 PAD2	EXT2, EXT3, EDBG SPI, and Shield
5	PB02	D12 / SPI-MISO	SERCOM5 PAD0	EXT2, EXT3, EDBG SPI, and Shield
6	PB01	D13 / SPI-SCK	SERCOM5 PAD3	EXT2, EXT3, EDBG SPI, and Shield
7	-	GND	-	-
8	PA03	AREF	ADC / DAC VREFA	
9	PA12	SDA	SERCOM2 PAD0	EXT1, EXT2, EXT3, Crypto, and EDBG I2C
10	PA13	SCL	SERCOM2 PAD1	EXT1, EXT2, EXT3, Crypto, and EDBG I2C

Table 4-8. J800 - SPI

Pin on J800	SAM C21 pin	Arduino pin name	Function	Shared functionality
1	PB02	MISO	SERCOM5 PAD0	EXT2, EXT3, EDBG SPI, and Shield
2	-	**5V**	VCC_TARGET_P3V3_P5V0	-
3	PB01	SCK	SERCOM5 PAD3	EXT2, EXT3, EDBG SPI, and Shield
4	PB00	MOSI	SERCOM5 PAD2	EXT2, EXT3, EDBG SPI, and Shield
5	RESETN	RESET	TARGET_RESET	-
6	-	GND	GND	-

4.2.3. VCC Selection Header

The SAM C21 Xplained Pro has a 3-pin header labeled VCC_SEL on the board. This header can be used to select between 3.3V and 5.0V as the supply voltage for the ATSAMC21J18A, peripherals, and extension headers by placing a jumper on pin 1-2 or pin 2-3. Selecting 5.0V will supply the kit directly from the USB or an external 5.0V source. Selecting 3.3V will supply the kit from an on-board regulator.

Table 4-9. VCC_SEL Header

VCC_SEL header pin	Function
1	VCC_P5V0
2	VCC_TARGET
3	VCC_P3V3

4.2.4. VREF Header

SAM C21 Xplained Pro has a 6-pin header labeled VREF on the board. This header can be used to select / apply a voltage reference to the ADC, DAC, and SDADC. Jumpers can be used to tie SADC VREF and ADC/DAC VREFT to the kit target voltage from pin 1-3 and 2-4, or external voltages can be applied across pin 3-5 and 4-6.

Table 4-10. VREF Header

VREF header pin	Pin / Net	Function
1	VCC_AREF_P3V3_P5V0	Filtered kit target voltage
2	VCC_AREF_P3V3_P5V0	Filtered kit target voltage
3	PA04	SDADC voltage reference
4	PA03	ADC / DAC voltage reference
5	GND	Ground
6	GND	Ground

4.2.5. DAC Header

SAM C21 Xplained Pro has a 2-pin header labeled DAC-OUT on the board that is connected to the DAC output of the ATSAMC21J18A and ground.

Table 4-11. DAC Header

DAC header pin	Pin / Net	Function	Shared functionality
1	PA02	DAC0 output	EXT3
2	GND	Ground	

4.2.6. Current Measurement Header

An angled 1x2, 100mil pin-header marked with MCU current measurement is located at the upper edge of the SAM C21 Xplained Pro. All power to the ATSAMC21J18A 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 ATSAMC21J18A to be powered through its I/O pins. This may cause permanent damage to the device.

4.2.7. Cortex Debug Connector

SAM C21 Xplained Pro has a 10-pin 50-mil Cortex® Debug Connector that can be used to attach external debuggers to the ATSAMC21J18A.

Table 4-12. Cortex Debug Connector

Cortex Debug Connector pin	Pin / Net	Function
1	VCC_TARGET_P3V3_P5V0	ATSAMC21J18A voltage
2	SWDIO	SWD data signal
3	GND	Ground
4	SWCLK	SWD clock signal
5	GND	Ground
6	-	-
7	-	-
8	-	-
9	GND	Ground
10	RESETN	Target reset signal

4.3. Peripherals

4.3.1. LED

There is one yellow LED available on the SAM C21 Xplained Pro board that can be turned on and off. The LED is activated by driving the connected I/O line to low.

Table 4-13. LED Connection

SAM C21 pin	Function	Shared functionality
PA15	Yellow LED0	Crystal footprint and EXT3

4.3.2. Mechanical Buttons

SAM C21 Xplained Pro contains two mechanical buttons connected to the SAM C21. One button is the RESET button connected to the 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.

Info: There is no pull-up resistor connected to the generic user button. Remember to enable the internal pull-up in the SAM C21 to use the button.

Table 4-14. Mechanical Buttons

SAM C21 pin	Function	Shared functionality
RESETN	RESET	Shield, Shield(2), and EDBG
PA28	SW0	EXT3 and EDBG GPIO3

4.3.3. Crystals

The SAM C21 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 C21. 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 appnote AVR4100. Information about clock calibration and compensation can be found in appnote AT03155.

The footprint for the external crystal is based on the Epson® TSX-3225 series.

Table 4-15. External 32.768kHz Crystal

SAM C21 pin	Function	Shared functionality
PA00	XIN32	-
PA01	XOUT32	-

Table 4-16. External Crystal Footprint

SAM C21 pin	Function	Shared functionality
PA14	XIN	EXT3
PA15	XOUT	EXT3 and User LED

4.3.4. CAN

ATSAMC21J18A has two CAN modules that performs communication according to ISO11898-1 (Bosch CAN specification 2.0 part A,B) and Bosch CAN FD specification V1.0.

CAN0 is connected to an on-board ATA6561 CAN physical-layer transceiver. Table 4-17 shows connections between the ATSAMC21J18A and the ATA6561.

The CAN differential signals are connected to a 1 x 2, 100 mil pin-header labeled CAN.

Table 4-17. ATA6561 Connections

SAM C21pin	Function	ATA6561 function	Shared functionality
PA24	CAN0TX	TXD	-
PA25	CAN0RX	RXD	-

Table 4-18. CAN Header

CAN header pin	Function
1	CANH
2	CANL

4.3.5. LIN

An ATA663211 LIN transceiver is mounted on the kit to convert the LIN signals from the SERCOM module in the SAM C21 device. The LIN compatible signals are available at a 3-pin header.

Table 4-19. LIN Transceiver

SAM C21 pin	Function	ATA663211 function	Shared functionality
PA06	SERCOM0 PAD[2] LIN TX	LIN TXD	-
PA07	SERCOM0 PAD[3] LIN RX	LIN RXD	-
PB22	GPIO	LIN EN	-

Table 4-20. LIN Header

LIN header pin	Function
1	VS
2	GND
3	LIN

Table 4-21. Master Node Pull-up Enable Header

LIN header pin	Function
1	LIN
2	1kΩ pull-up to VS

Table 4-22. LIN VCC Power

LIN header pin	Function
1	VS
2	VCC_TARGET_P3V3_P5V0

4.3.6. QTouch Button

There is one self capacitance button available on the SAM C21 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.

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

Table 4-23. QTouch Connection

SAM C21 pin	Silkscreen text
PA05	QT BTN1

4.3.7. Crypto Footprints

Several of the Atmel security devices, including CryptoAuthentication devices like the ATECC108A, requires only an I^2C interface to work, and they share the same packages and pinouts. SAM C21 Xplained Pro has implemented SOIC8 and UDFN8 footprints for these devices so the user may solder them on themselves. Table 4-24 shows all the connections between the footprints and the ATSAMC21J18A.

Table 4-24. Crypto Footprints

Pin on footprint	SAM C21 pin	Function	Shared functionality
1	-	NC	-
2	-	NC	-
3	-	NC	-
4	-	GND	-
5	PA12 [SDA]	I^2C data line	EXT1, EXT2, EXT3, Shield, and EDBG I^2C
6	PA13 [SCL]	I^2C clock line	EXT1, EXT2, EXT3, Shield, and EDBG I^2C
7	-	NC	-
8	-	VCC_TARGET_P3V3	-
PADDLE	-	GND	-

4.4. Kit Modifications

SAM C21 Xplained Pro has several resistors and jumpers that can be removed/cut to disconnect I/O pins of the ATSAMC21J18A from connectors and on-board ICs and to disconnect/measure power to different sections.

Table 4-25. Resistors

Designator	From	To	Comment
R313	PA14	EXT3 pin 7	Remove when using external crystal
R314	PA15	EXT3 pin 8 and LED	
R609	RESETN	RESET NET	Remove to disconnect the RESETN pin from the reset system

Designator	From	To	Comment
R607	PB11 RX	CDC RX	Remove to disconnect pins from the EDBG level shifters
R610	RESET NET	EDBG RESET	
R611	PA31 SWDIO	EDBG SWDIO	
R612	PA30 SWCLK	EDBG SWCLK	
R614	PB02 MISO	EDBG MISO	
R618	PB12	EDBG GPIO0	
R619	PB16	EDBG GPIO1	
R620	PB17	EDBG GPIO2	
R621	PA28	EDBG GPIO3	
R800	RESETN	Arduino shield RESET	Remove to disconnect the reset system from the Arduino shield connectors

Figure 4-3. Resistors Top

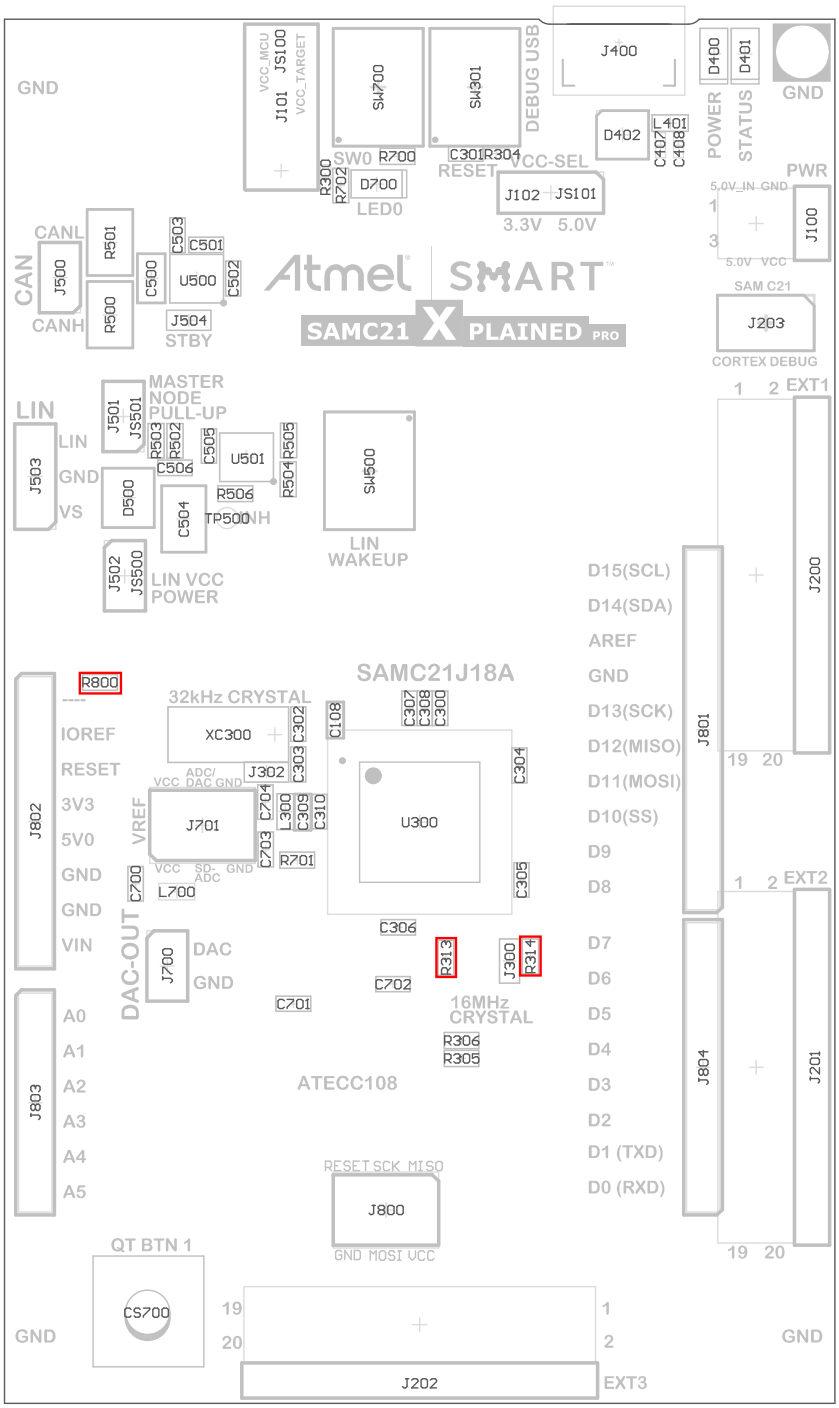


Figure 4-4. Resistors Bottom

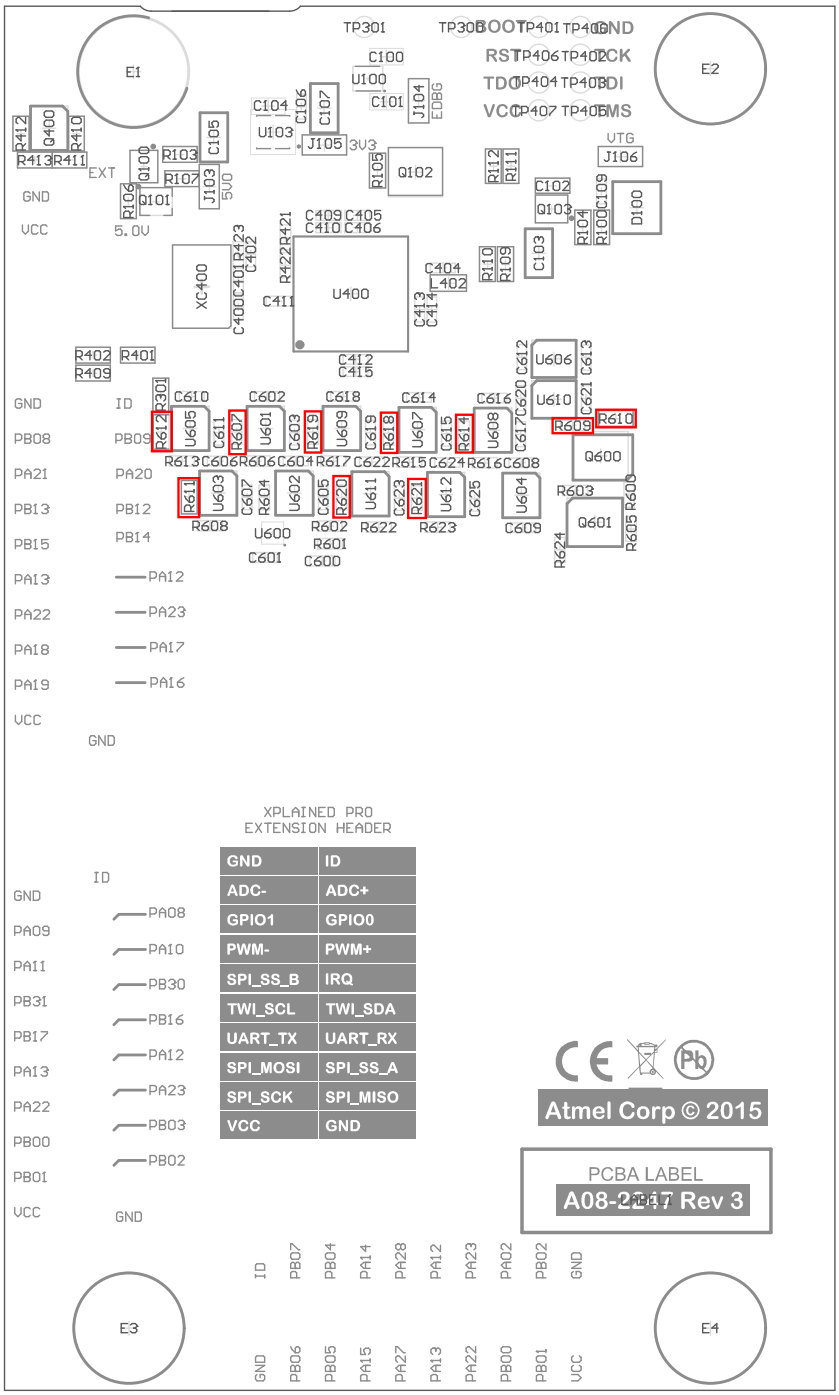


Table 4-26. Jumpers

Designator	From	To	Comment
J101	VCC_TARGET_X_P3V3_P5V0	VCC_TARGET_P3V3_P5V0	Remove this jumper (JS100) to measure current to the MCU section
J102	VCC_IN_P5V0 (pin 1) and VCC_P3V3_TARGET (pin 3)	VCC_TARGET_SWITCH_P3V3_P5V0	Use this jumper (JS101) to select either 5.0V or 3.3V voltage to the Target section. Default setting in production is 5.0V.
J103	VCC_IN_P5V0	VCC_P5V0	Cut this jumper to measure current from the 5.0V input MUX section. The footprint is 0603 sized.
J104	3.3V linear regulator output for EDBG section	VCC_EDBG_P3V3	Cut this jumper to measure current to the EDBG section. The footprint is 0603 sized.
J105	3.3V linear regulator output for Target and MCU sections	VCC_P3V3	Cut this jumper to measure current to the Target and MCU sections. The footprint is 0603 sized.
J106	VCC_TARGET_X_P3V3_P5V0	VCC_TARGET_P3V3_P5V0	Cut this jumper to measure current to the Target section. The footprint is 0603 sized.
J300	PA15_XOUT	16MHz crystal pin	Cut this jumper and mount resistors to find 16MHz crystal oscillator safety factor. The footprint is 0603 sized.
J501	LIN signal	Pull-up resistor to VS voltage	Mount this jumper (JS501) to set the LIN transceiver as Master node. Default setting in production is mounted.

Designator	From	To	Comment
J502	VS_LIN	VCC_TARGET_P3V3_P5V0	Mount this jumper (JS500) to power the LIN transceiver from VCC_TARGET_P3V3_P5V0. Remove this jumper when the LIN transceiver is powered from the LIN bus. Default setting in production is mounted.
J504	CAN device, Standby pin	GND	Cut this jumper to explore the standby functionality of the CAN transceiver (ATA6561). The footprint is 0603 sized.

Figure 4-5. Jumpers Top

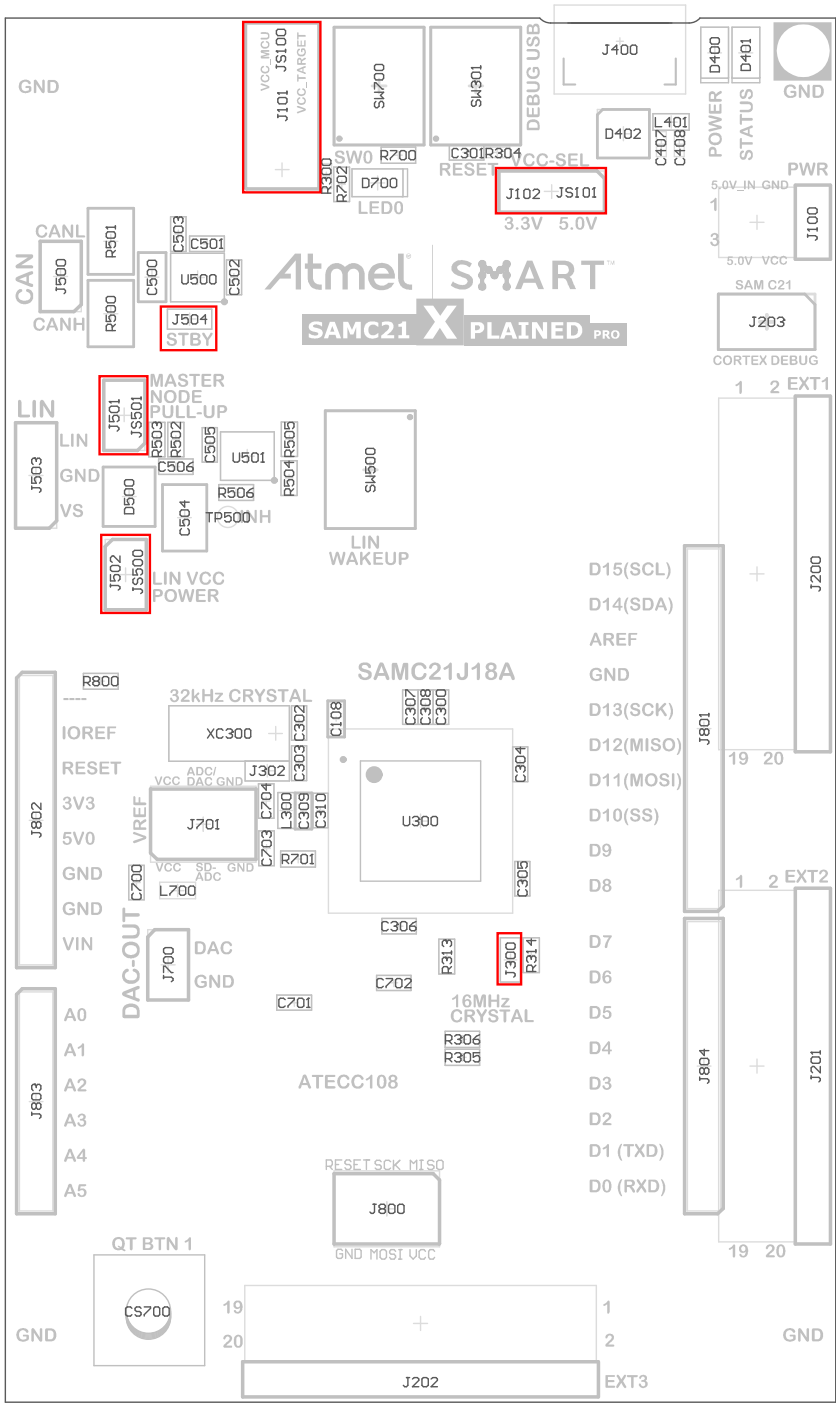
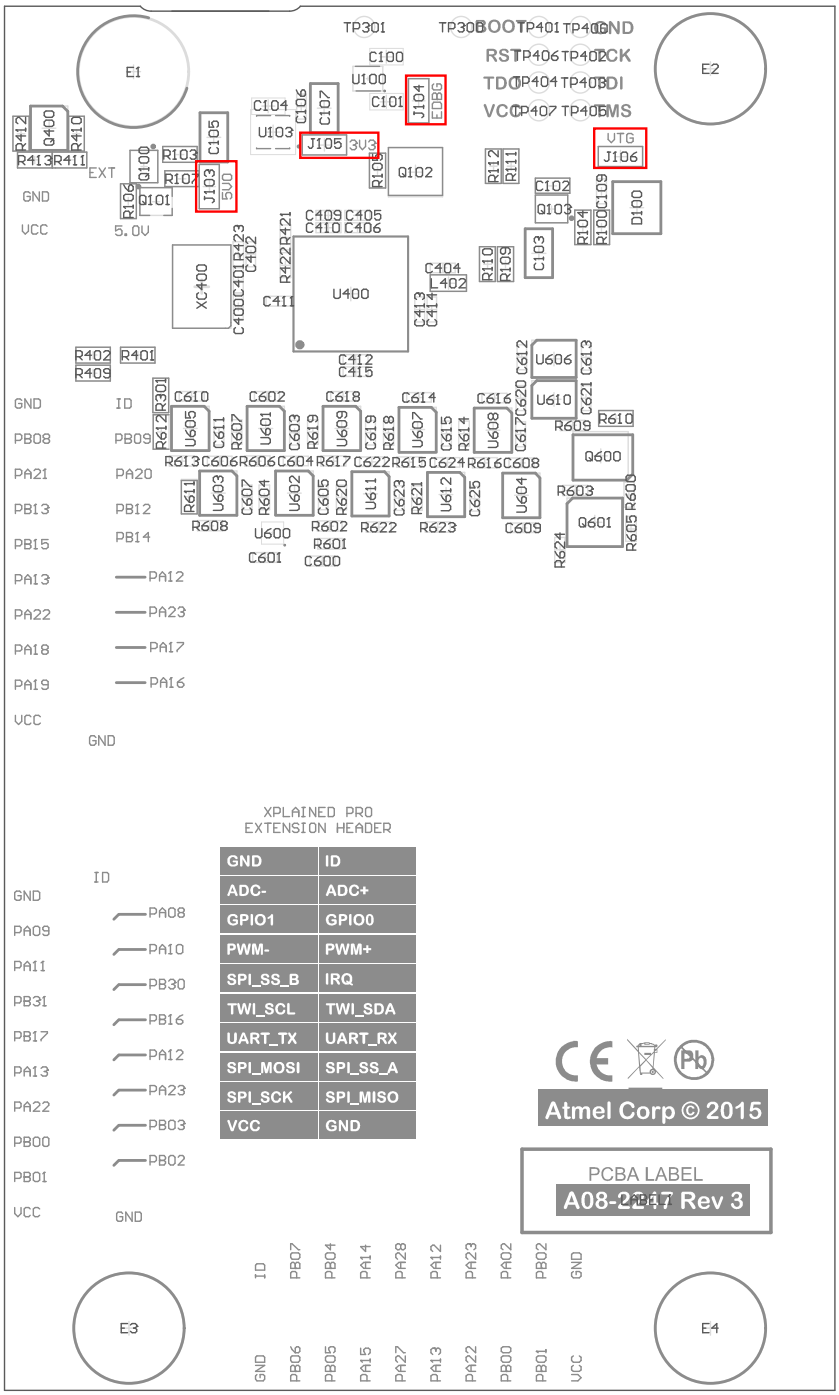


Figure 4-6. Jumpers Bottom



4.5. Embedded Debugger Implementation

SAM C21 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAMC21J18A 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 C21 GPIOs. Atmel Studio can be used as a front end for the Embedded Debugger.

4.5.1. 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 4-27. SWD Connections

SAM C21 pin	Function
PA30	SWD clock
PA31	SWD data

4.5.2. Virtual COM Port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAMC21J18A UARTs. For further information on how to use the Virtual COM port, see Embedded Debugger.

Table 4-28. Virtual COM Port Connections

SAM C21 pin	Function	Shared functionality
PB10	SERCOM4 PAD[2] UART TXD (SAM C21 TX line)	-
PB11	SERCOM4 PAD[3] UART RXD (SAM C21 RX line)	-

4.5.3. Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either an SPI or I²C. The DGI can be used to send a variety of data from the ATSAMC21J18A to the host PC. For further information on how to use the DGI interface, see Atmel Data Visualizer and the EDBG User Guide.

Table 4-29. DGI Interface Connections when using SPI

SAM C21 pin	Function	Shared functionality
PB23	GPIO/SPI SS (Slave select) (SAM C21 is Master)	-
PB02	SERCOM5 PAD[0] SPI MISO (Master In, Slave Out)	EXT2, EXT3, Shield, and Shield(2)
PB00	SERCOM5 PAD[2] SPI MOSI (Master Out, Slave In)	EXT2, EXT3, Shield, and Shield(2)
PB01	SERCOM5 PAD[3] SPI SCK (Clock Out)	EXT2, EXT3, Shield, and Shield(2)

Table 4-30. DGI Interface Connections when using I²C

SAM C21 pin	Function	Shared functionality
PA12	SERCOM2 PAD[0] SDA (Data line)	EXT1, EXT2, EXT3, Shield, and Crypto Footprints
PA13	SERCOM2 PAD[1] SCL (Clock line)	EXT1, EXT2, EXT3, Shield, and Crypto Footprints

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 C21

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 4-31. GPIO Lines Connected to the EDBG

SAM C21 pin	Function	Shared functionality
PB12	GPIO0	Shield and EXT1
PB16	GPIO1	EXT2
PB17	GPIO2	EXT2
PA28	GPIO3	User Button and EXT3

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

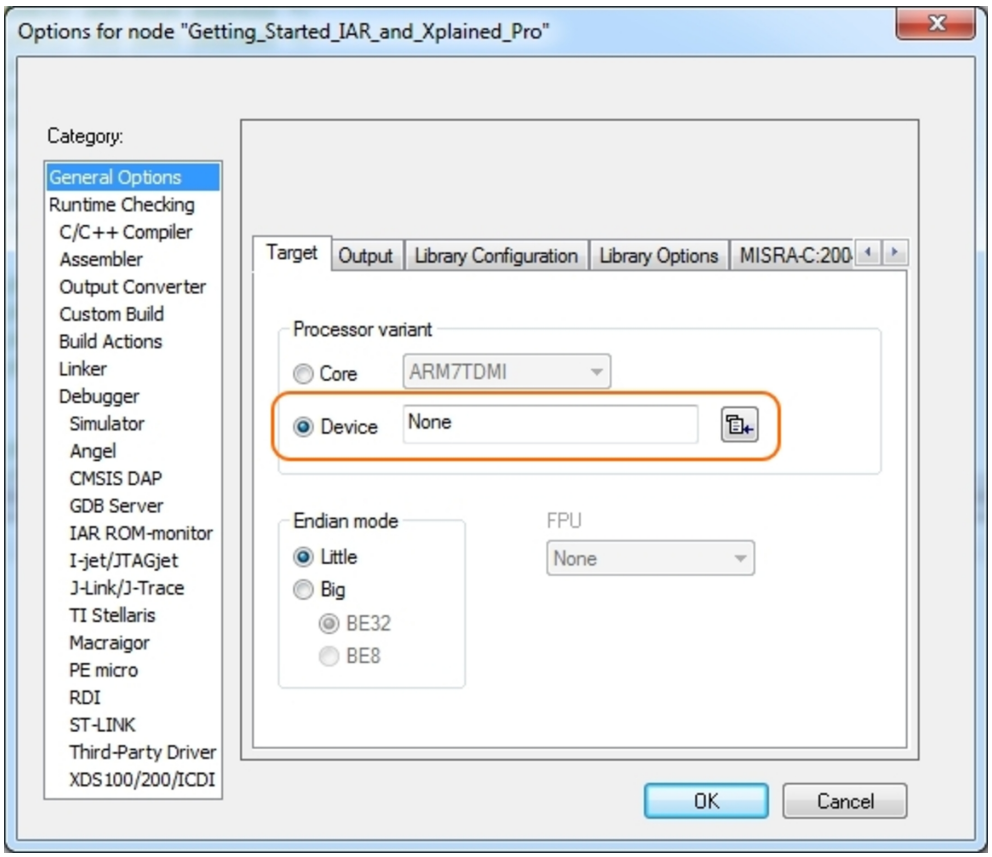


Figure 5-2. Select Debugger

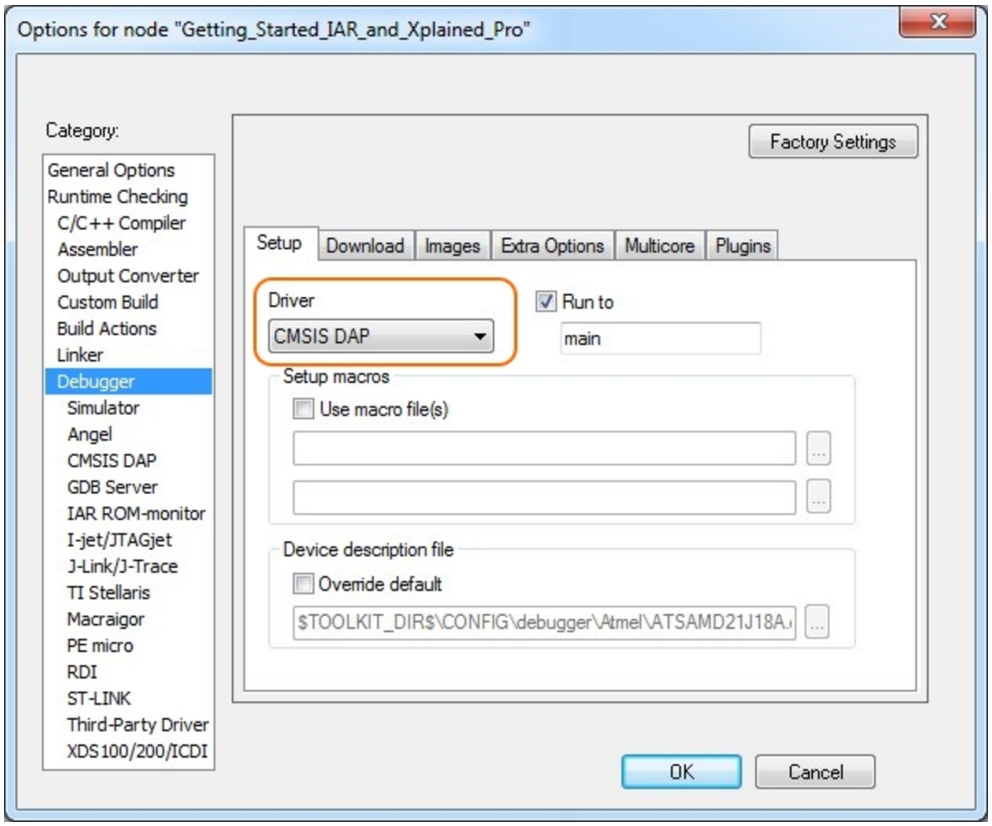


Figure 5-3. Configure Flash Loader

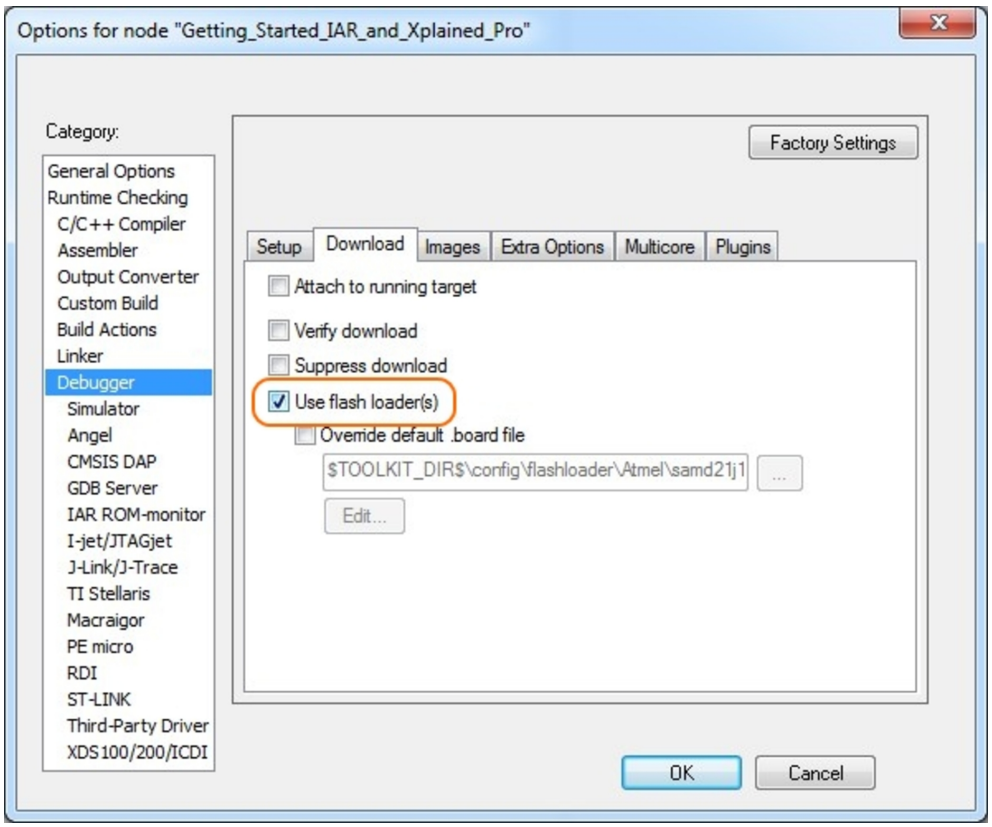


Figure 5-4. Configure Reset

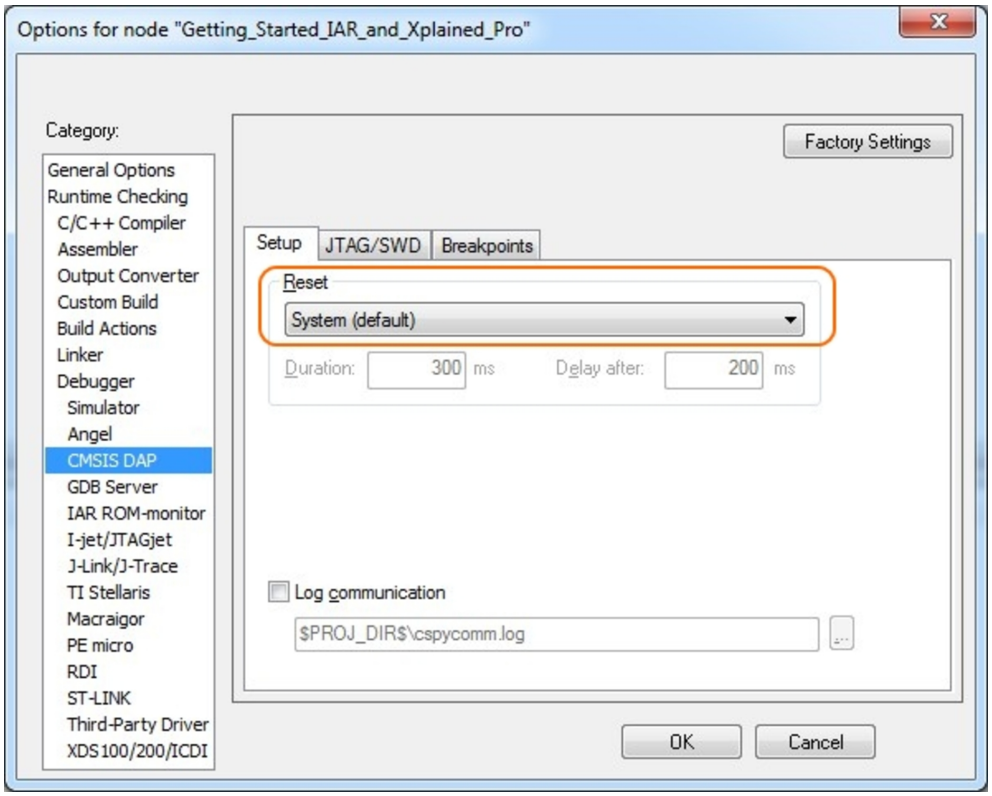
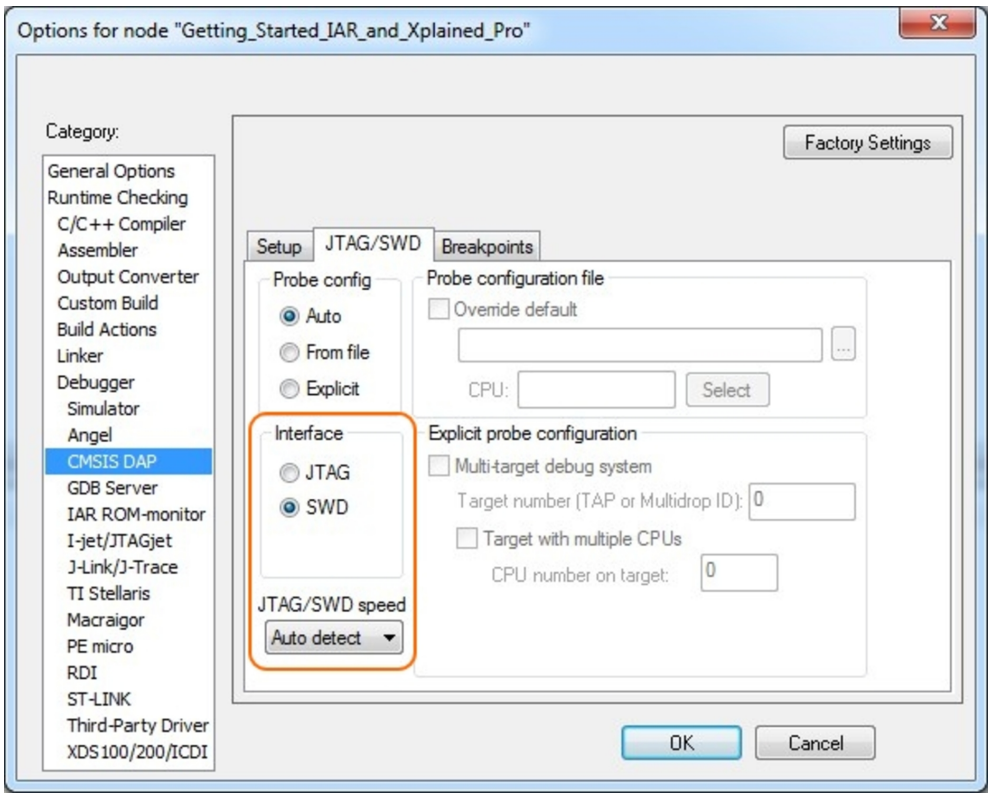


Figure 5-5. Configure Interface



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 C21 Xplained Pro is A09-2419.

6.2. Revision 6

Revision 6 has silicon revision D or newer of the ATSAMC21J18A-AUTES (U300) device mounted, it is otherwise identical to revision 5.

6.3. Revision 5

Revision 5 fixes all known issues outlined on rev. 2-3. The power supply system is divided in two with a separate 3.3V regulator for both EDBG, and for the Target section. The power supply block diagram for revision 2 and 3 is shown below. The power switch has been redesigned to avoid voltage leakage at power on. The DAC, LIN, and CAN connectors have been moved to ease mounting in production. The RESET level-shifter has been redesigned to avoid leakage when target power is switched off.

Figure 6-1. Revision 2 and 3 Power Supply Block Diagram

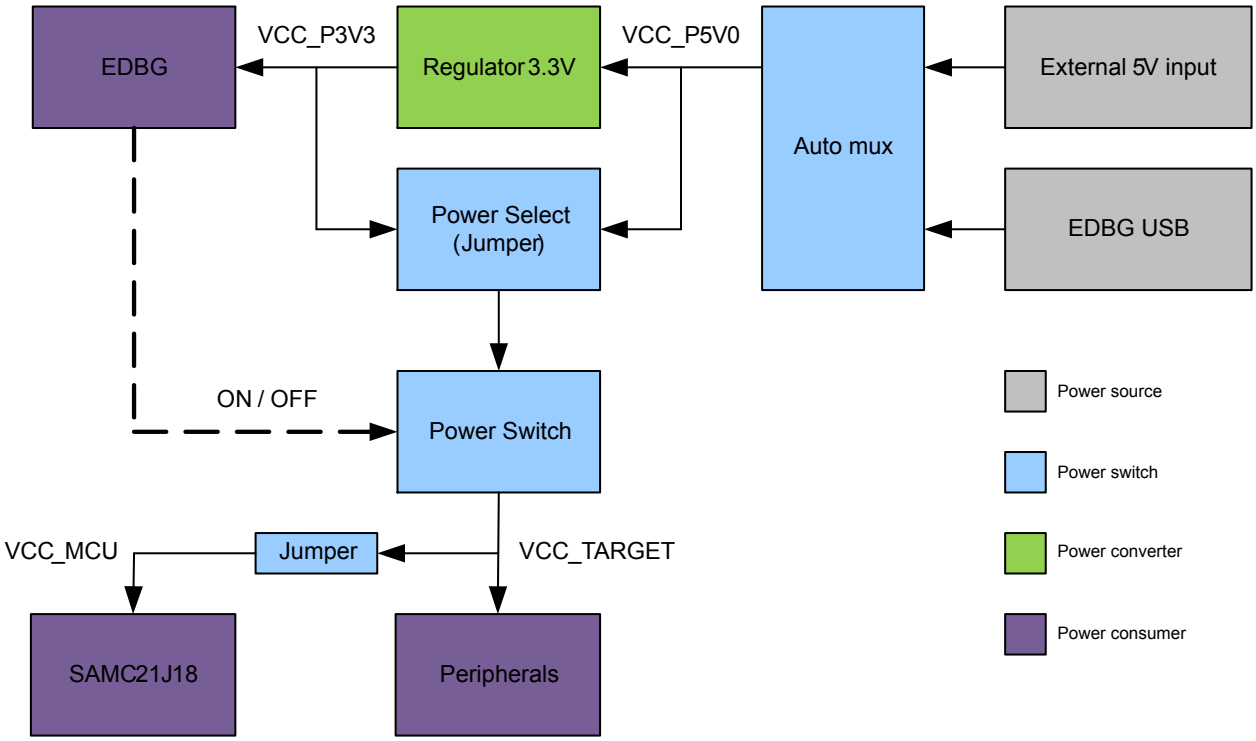


Figure 6-2. Revision 2 and 3 Connector Block Diagram

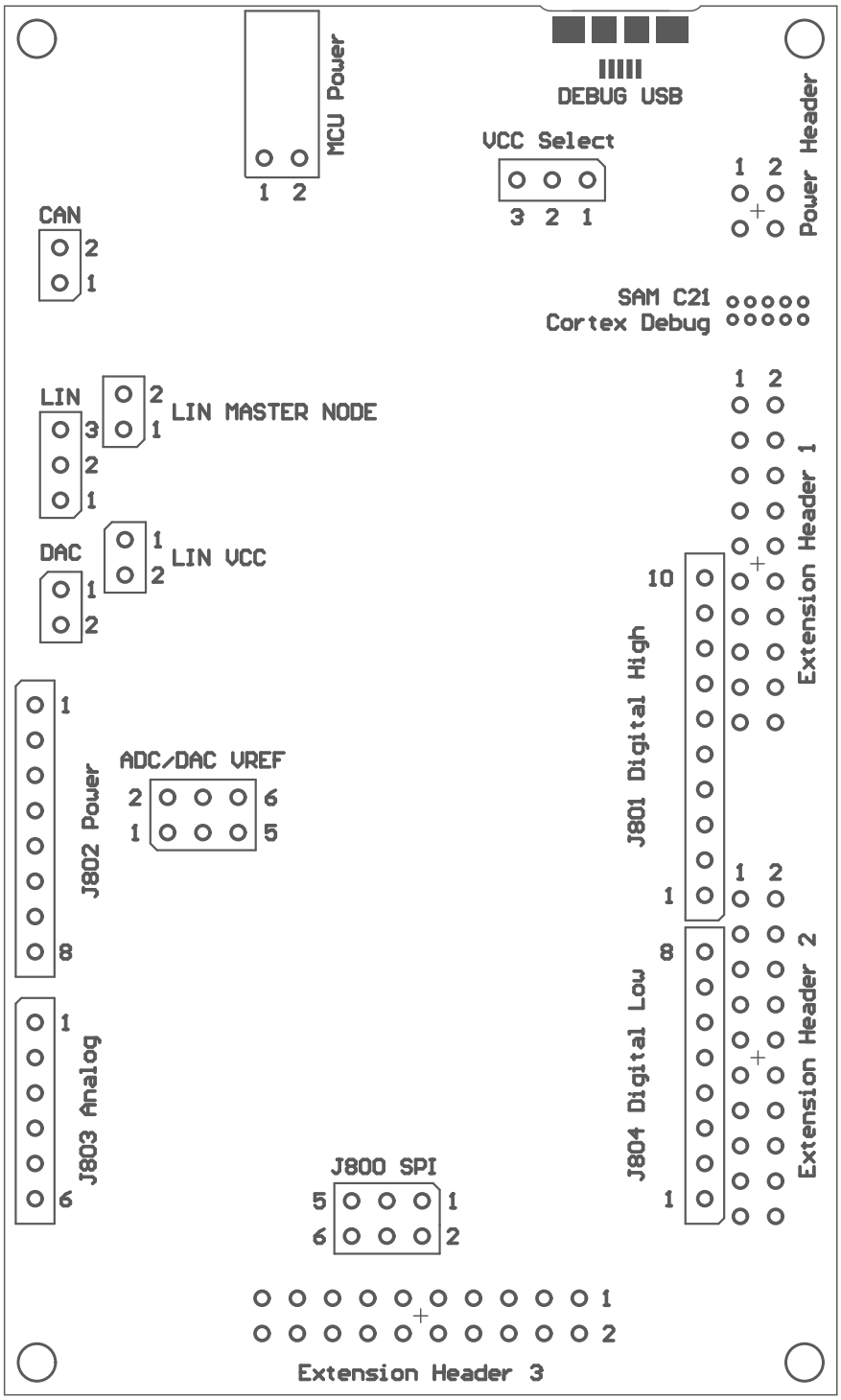


Figure 6-3. Revision 2 and 3 Top Side Resistor Overview

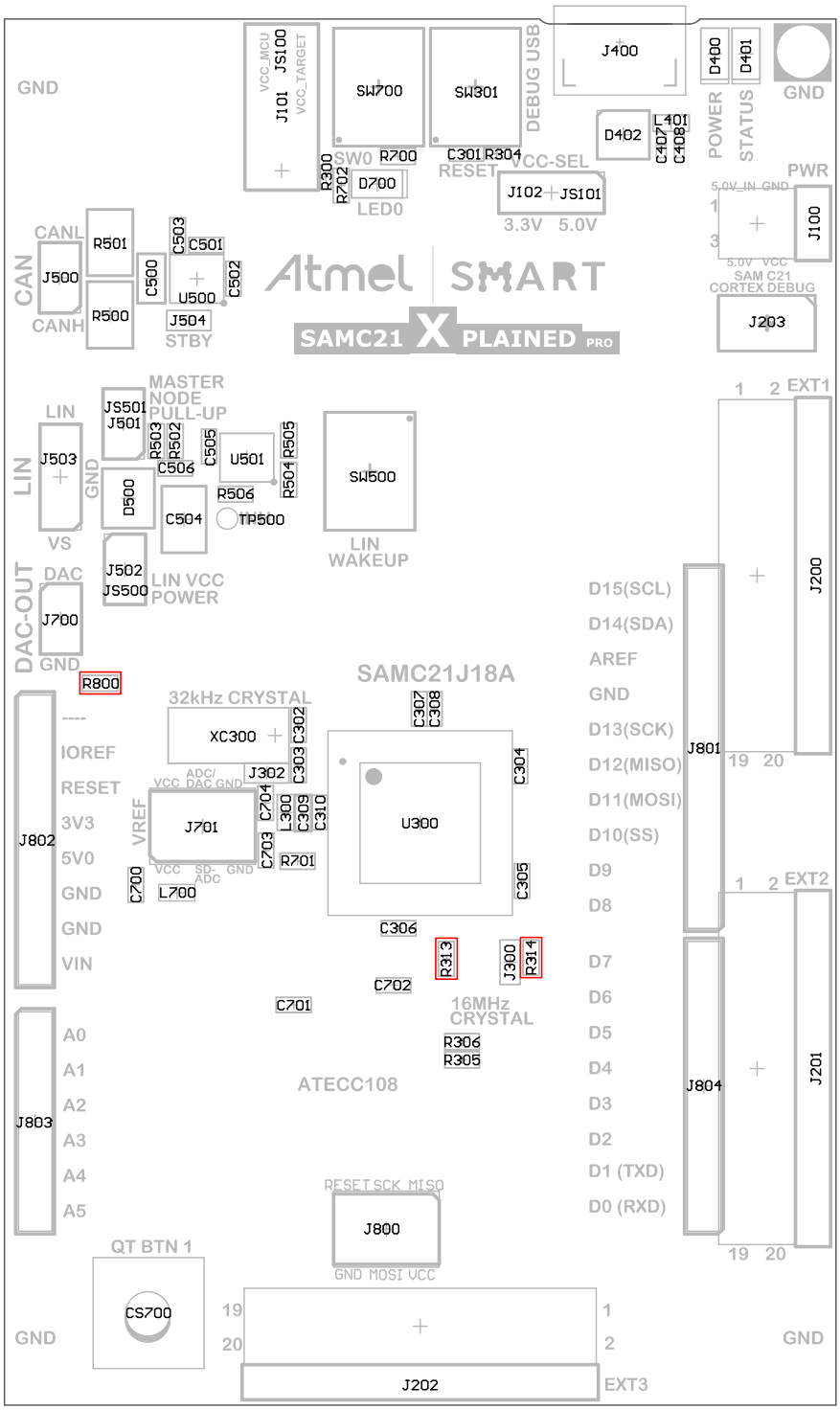
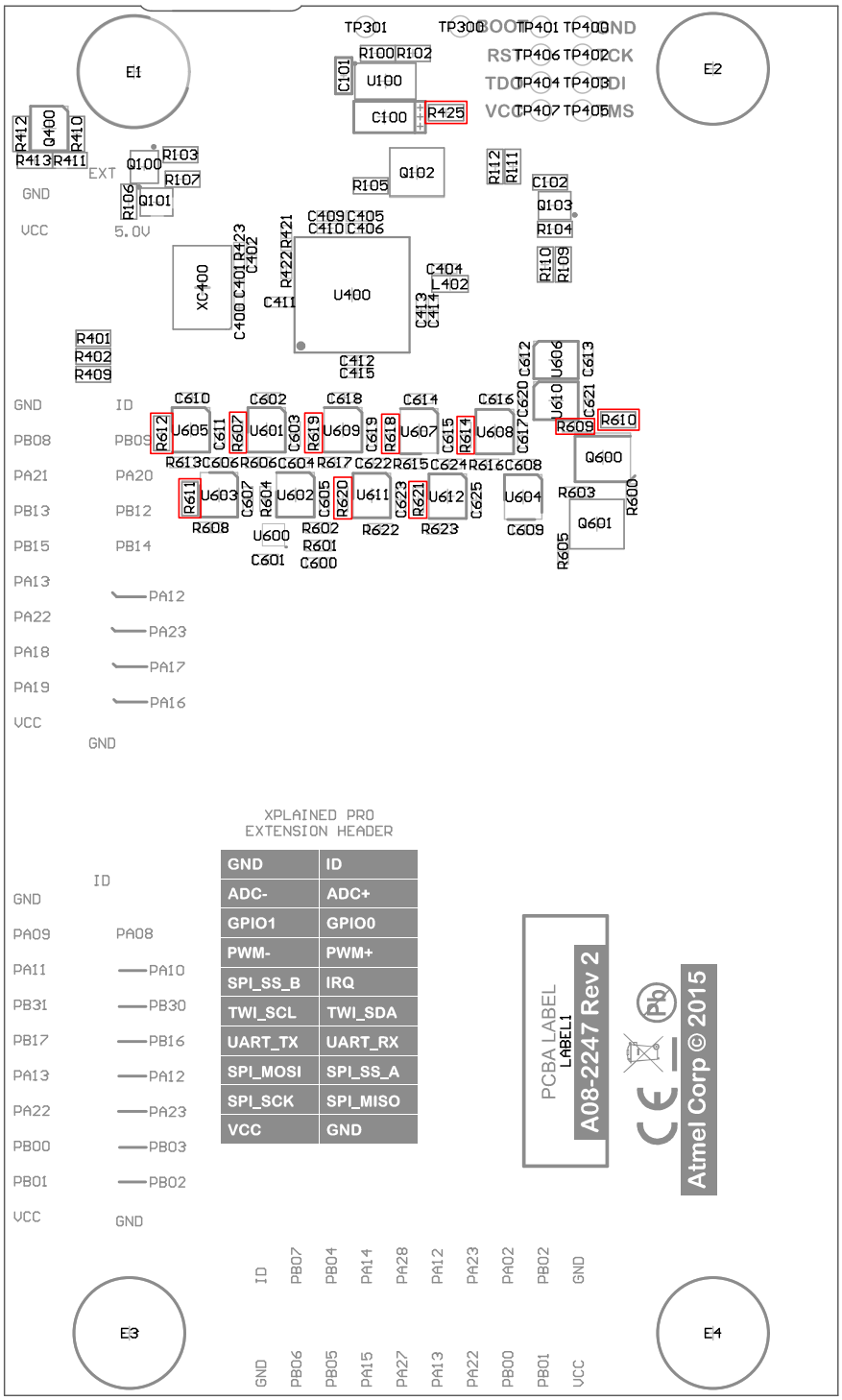


Figure 6-4. Revision 2 and 3 Bottom Side Resistor Overview



Related Links

The QTouch Button PAD is not Connected on page 43

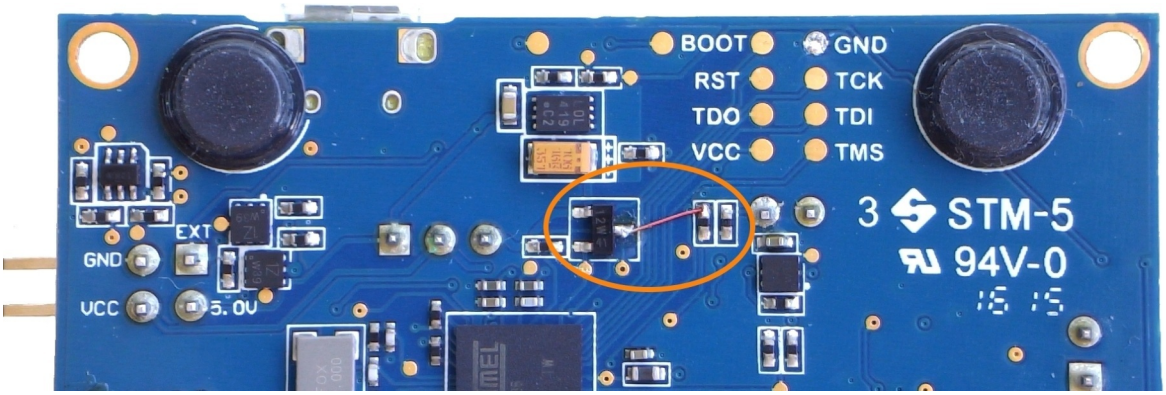
Kit Does Not Work with 3.3V Target Voltage Selected on page 43

Revision 3 on page 43

6.4. Revision 3

Revision 3 is almost identical to revision 2 with an additional quick fix for the 3.3V target supply problem. The fix is implemented by shorting Q102, pin 2 to GND as shown in the figure below. Also the QTouch pad is connected inside the PCB.

Figure 6-5. Strap Fix



Related Links

The QTouch Button PAD is not Connected on page 43

Kit Does Not Work with 3.3V Target Voltage Selected on page 43

6.5. Revision 2

Revision 2 is the initial released revision. This revision has engineering samples mounted with part number ATSAMC21J18A-AUTES.

6.5.1. The QTouch Button PAD is not Connected

On Revision 2 of the kit, the QTouch button PAD is not connected to the track inside the PCB. This will cause the QTouch function to work only on the VIA connection point. There is no workaround for this issue. This will be fixed in next revision of the PCB.

6.5.2. Kit Does Not Work with 3.3V Target Voltage Selected

Revision 2 of the kit has a start-up problem when target voltage is set to 3.3V. When the EDBG opens the target voltage power switch from VCC_TARGET_SWITCH_P3V3_P5V0 to VCC_TARGET_P3V3_P5V0 a power surge is observed. This power surge causes the VCC_P3V3 nets voltage to decrease enough to trigger the EDBGs BOD, resulting in the EDBG entering a locked state where it can not be used.

Fix/Workaround: Use the kit with 5.0V selected as the target voltage.

Force the target voltage switch open by connecting Q102 pin 2 to GND.

Important: Forcing the target voltage switch open will disable any protection for Xplained Pro extension modules connected to EXT1, EXT2, and EXT3. Make sure that connected extensions supports the selected target voltage.

Related Links

Revision 5 on page 38

7. Document Revision History

Doc. rev.	Date	Comment
42460D	08/2016	Updated revision history with information about kit revision 6
42460C	10/2015	Fix broken link and updated with kit revision 5
42460B	07/2015	Updated with kit revision 3
42460A	05/2015	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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