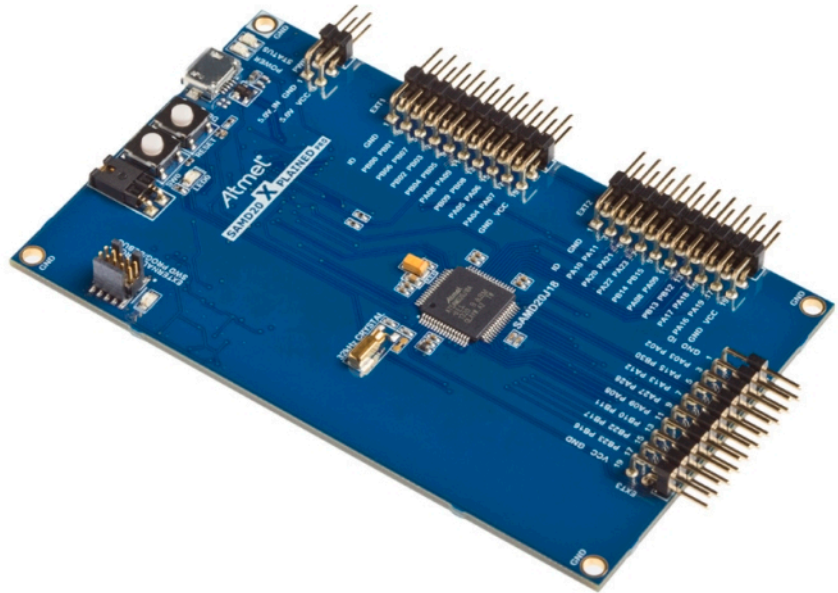


Atmel SAM D20 Xplained Pro



Preface

The Atmel® SAM D20 Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAMD20J18 microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAMD20J18 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 ATSAMD20J18.

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

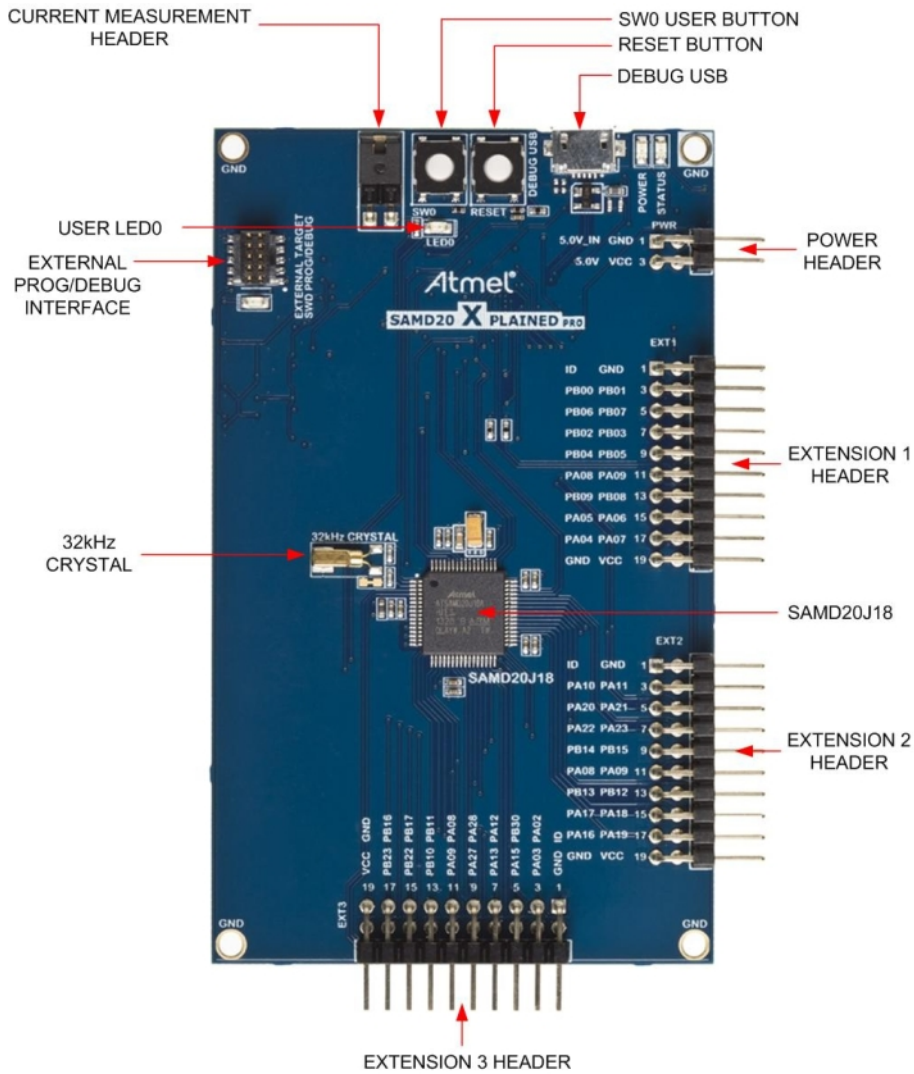
- Atmel ATSAM D20J18 microcontroller
- Embedded debugger (EDBG)
 - USB interface
 - Programming and debugging on board SAM D20 through Serial Wire Debug (SWD)
 - Programming and debugging external targets through Serial Wire Debug (SWD)
 - Virtual COM-port interface to target via UART
 - Atmel Data Gateway Interface (DGI) to target via SPI and TWI
 - Four GPIOs connected to target for code instrumentation
- Digital I/O
 - Two mechanical buttons (user and reset button)
 - One user LED
 - Three extension headers
- Two possible power sources
 - External power
 - Embedded debugger USB
- 32kHz crystal

1.2 Kit overview

The Atmel SAM D20 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAM D20J18.

The kit offers a set of features that enables the ATSAM D20J18 user to get started using the ATSAM D20J18 peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1. SAM D20 Xplained Pro evaluation kit overview



2. Getting started

2.1 Quick-start

3 Steps to start exploring the Atmel Xplained Pro Platform

- Download and install [Atmel Studio](#)¹.
- Launch Atmel Studio.
- Connect an USB cable to the DEBUG USB port.

2.2 Connecting the kit

When connecting Atmel SAM D20 Xplained Pro to your computer for the first time, the operating system will do a driver software installation. The driver file supports both 32-bit and 64-bit versions of Microsoft® Windows® XP and Windows 7.

Once connected the green power LED will be lit and Atmel Studio will autodetect which Xplained Pro evaluation- and extension kit(s) that's connected. You'll be presented with relevant information like datasheets and kit documentation. You also have the option to launch Atmel Software Framework (ASF) example applications. The target device is programmed and debugged by the on-board Embedded Debugger and no external programmer or debugger tool is needed. Please refer to the [Atmel Studio user guide](#)² for information regarding how to compile and program the kit.

2.3 Design documentation and related links

The following list contains links to the most relevant documents and software for SAM D20 Xplained Pro.

1. [Xplained Pro products](#)³ - Atmel Xplained Pro is a series of small-sized and easy-to-use evaluation kits for 8- and 32-bit Atmel microcontrollers. It consists of a series of low cost MCU boards for evaluation and demonstration of features and capabilities of different MCU families.
2. [SAM D20 Xplained Pro User Guide](#)⁴ - PDF version of this User Guide.
3. [SAM D20 Xplained Pro Design Documentation](#)⁵ - Package containing schematics, BOM, assembly drawings, 3D plots, layer plots etc.
4. [EDBG User Guide](#)⁶ - User guide containing more information about the onboard Embedded Debugger.
5. [Atmel Studio](#)⁷ - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.
6. [IAR Embedded Workbench](#)⁸ 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 16K for devices with M0, M0+ and M1 cores and 32K for devices with other cores.
7. [Atmel sample store](#)⁹ - Atmel sample store where you can order samples of devices.

¹ <http://www.atmel.com/atmelstudio>

² <http://www.atmel.com/atmelstudio>

³ <http://www.atmel.com/XplainedPro>

⁴ http://www.atmel.com/Images/Atmel-42102-SAMD20-Xplained-Pro_User-Guide.pdf

⁵ http://www.atmel.com/Images/Atmel-42102-SAMD20-Xplained-Pro_User-Guide.zip

⁶ http://www.atmel.com/Images/Atmel-42096-Microcontrollers-Embedded-Debugger_User-Guide.pdf

⁷ <http://www.atmel.com/atmelstudio>

⁸ <http://www.iar.com/en/Products/IAR-Embedded-Workbench/ARM/>

⁹ <http://www.atmel.com/system/samplesstore>

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 that 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 that are connected through a set of standardized headers and connectors. Each extension board has an identification (ID) chip to uniquely identify which boards are mounted on a Xplained Pro MCU board. This information is used to present relevant user guides, application notes, datasheets and example code through Atmel Studio. Available Xplained Pro MCU and extension boards can be purchased in the [Atmel Web Store](#)¹.

3.1 Embedded Debugger

The SAM D20 Xplained Pro contains the Atmel® Embedded Debugger (EDBG) for on-board debugging. The EDBG is a composite USB device of 3 interfaces; a debugger, Virtual COM Port and Data Gateway Interface (DGI).

In conjunction with Atmel Studio, the EDBG debugger interface can program and debug the ATSAM20J18. On the SAM D20 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM20J18.

The Virtual COM Port is connected to a UART port on the ATSAM20J18 (see section “[Embedded Debugger implementation](#)” on page 11 for pinout), and provides an easy way to communicate with the target application through a simple terminal software. It offers variable baud rate, parity and stop bit settings. Note that the settings on the target device UART must match the settings given in the terminal software.

The DGI consists of several physical data interfaces for communication with the host computer. Please, see section “[Embedded Debugger implementation](#)” on page 11 for available interfaces and pinout.

Communication over the interfaces are bidirectional. It can be used to send events and values from the ATSAM20J18, 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. The DGI uses a proprietary protocol, and is thus only compatible with Atmel Studio.

The EDBG controls two LEDs on SAM D20 Xplained Pro, a power LED and a status LED. [Table 3-1, “EDBG LED control”](#) 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 every time something happens on 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](#)².

3.2 Hardware identification system

All Xplained Pro compatible extension boards have an Atmel ATSHA204 crypto authentication chip mounted. This chip contains information that identifies the extension with its name and some extra data. When an Xplained Pro extension board 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. [Table 3-2, “Xplained Pro ID chip content”](#) 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'

¹ <http://store.atmel.com/CBC.aspx?q=c:100113>

² http://www.atmel.com/Images/Atmel-42096-Microcontrollers-Embedded-Debugger_User-Guide.pdf

Data Field	Data Type	Example Content
Minimum Voltage [mV]	uint16_t	3000
Maximum Voltage [mV]	uint16_t	3600
Maximum Current [mA]	uint16_t	30

3.3 Power supply

The SAM D20 Xplained Pro kit can be powered either by USB or by an external power source through the 4-pin power header, marked PWR. This connector is described in [“Xplained Pro power header” on page 8](#). The available power sources and specifications are listed in [Table 3-3, “Power sources for SAM D20 Xplained Pro”](#).

Table 3-3. Power sources for SAM D20 Xplained Pro

Power input	Voltage requirements	Current requirements	Connector marking
External power	4.3V to 5.5V	Recommended minimum is 500mA to be able to provide enough current for extensions 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)	500 mA (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

3.3.1 Measuring SAM D20 power consumption

As part of an evaluation of the SAM D20 it can be of interest to measure its power consumption. Because the device has a separate power plane (VCC_MCU_P3V3) on this board it is possible to measure the current consumption by measuring the current that is flowing into this plane. The VCC_MCU_P3V3 plane is connected via a jumper to the main power plane (VCC_TARGET_P3V3) and by replacing the jumper with an ampere meter it is possible to determine the current consumption. To locate the current measurement header, please refer to [Figure 1-1, “SAM D20 Xplained Pro evaluation kit overview”](#).

Warning

Do not power the board without having the jumper or an ampere meter mounted. This can cause the SAM D20 to be powered through its I/O pins and cause undefined operation of the device.

3.4 Standard headers and connectors

3.4.1 Xplained Pro extension header

All Xplained Pro kits have one or more dual row, 20 pin, 100mil extension headers. Xplained Pro MCU boards have male headers while Xplained Pro extensions have their female counterparts. Note that all pins are not always connected. However, all the connected pins follow the defined pin-out described in [Table 3-4, “Xplained Pro extension header”](#). The extension headers can be used to connect a wide variety of Xplained Pro extensions to Xplained Pro MCU boards and to access the pins of the target MCU on Xplained Pro MCU board directly.

Table 3-4. Xplained Pro extension header

Pin number	Name	Description
1	ID	Communication line to the ID chip on extension board.

Pin number	Name	Description
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 IO
6	GPIO2	General purpose IO
7	PWM(+)	Pulse width modulation , alternatively positive part of differential PWM
8	PWM(-)	Pulse width modulation , alternatively positive part of differential PWM
9	IRQ/GPIO	Interrupt request line and/or general purpose IO.
10	SPI_SS_B/GPIO	Slave select for SPI and/or general purpose IO.
11	TWI_SDA	Data line for two wire interface. Always implemented, bus type.
12	TWI_SCL	Clock line for two wire interface. Always implemented, bus type.
13	USART_RX	Receiver line of Universal Synchronous and Asynchronous serial Receiver and Transmitter
14	USART_TX	Transmitter line of Universal Synchronous and Asynchronous serial Receiver and Transmitter
15	SPI_SS_A	Slave select for SPI. Should be unique if possible.
16	SPI_MOSI	Master out slave in line of Serial peripheral interface. Always implemented, bus type
17	SPI_MISO	Master in slave out line of Serial peripheral interface. Always implemented, bus type
18	SPI_SCK	Clock for Serial peripheral interface. Always implemented, bus type
19	GND	Ground
20	VCC	Power for extension board

3.4.2 Xplained Pro power header

The power header can be used to connect external power to the SAM D20 Xplained Pro kit. The kit will automatically detect and switch to the 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 for the 3.3V regulated output. To locate the current measurement header, please refer to [Figure 1-1, "SAM D20 Xplained Pro evaluation kit overview"](#)

Table 3-5. Power header PWR

Pin number PWR header	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 for the kit)

Note

If the board is powered from a battery source it is recommended to use the PWR header. If there is a power source connected to EDBG USB, the EDBG is activated and it will consume more power.

4. Hardware user guide

4.1 Connectors

This chapter describes the implementation of the relevant connectors and headers on SAM D20 Xplained Pro and their connection to the ATSAMD20J18. The tables of connections in this chapter also describes which signals are shared between the headers and on-board functionality.

4.1.1 I/O extension headers

The SAM D20 Xplained Pro headers EXT1, EXT2 and EXT3 offer access to the I/O of the microcontroller in order to expand the board e.g. by connecting extensions to the board. These headers all comply with the standard extension header specified in [Xplained Pro Standard Extension Header](#). All headers have a pitch of 2.54 mm.

Table 4-1. Extension header EXT1

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

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

Table 4-2. Extension header EXT2

Pin on EXT2	SAM D20 pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA10	AIN[18]	
4	PA11	AIN[19]	
5	PA20	GPIO	
6	PA21	GPIO	
7	PA22	TC4/WO[0]	
8	PA23	TC4/WO[1]	

Pin on EXT2	SAM D20 pin	Function	Shared functionality
9	PB14	EXTINT[14]	
10	PB15	GPIO	
11	PA08	SERCOM2 PAD[0] I ² C SDA	EXT1, EXT3 and EDBG
12	PA09	SERCOM2 PAD[1] I ² C SCL	EXT1, EXT3 and EDBG
13	PB13	SERCOM4 PAD[1] UART RX ¹	
14	PB12	SERCOM4 PAD[0] UART TX ¹	
15	PA17	SERCOM1 PAD[1] SPI SS	
16	PA18	SERCOM1 PAD[2] SPI MOSI	
17	PA16	SERCOM1 PAD[0] SPI MISO	
18	PA19	SERCOM1 PAD[3] SPI SCK	
19	-	-	GND
20	-	-	VCC

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

Table 4-3. Extension header EXT3

Pin on EXT3	SAM D20 pin	Function	Shared functionality
1	-	-	Communication line to ID chip on extension board.
2	-	-	GND
3	PA02	AIN[0]	
4	PA03	AIN[1]	
5	PB30	GPIO	
6	PA15	GPIO	Onboard SW0
7	PA12	TC2/WO[0]	
8	PA13	TC2/WO[1]	
9	PA28	EXTINT[8]	
10	PA27	GPIO	
11	PA08	SERCOM2 PAD[0] I ² C SDA	EXT1, EXT2 and EDBG
12	PA09	SERCOM2 PAD[1] I ² C SCL	EXT1, EXT2 and EDBG
13	PB11	SERCOM4 PAD[1] UART RX ¹	
14	PB10	SERCOM4 PAD[0] UART TX ¹	
15	PB17	SERCOM5 PAD[1] SPI SS	
16	PB22	SERCOM5 PAD[2] SPI MOSI	EDBG
17	PB16	SERCOM5 PAD[0] SPI MISO	EDBG
18	PB23	SERCOM5 PAD[3] SPI SCK	EDBG
19	-	-	GND
20	-	-	VCC

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

4.2 Peripherals

4.2.1 Crystal

The SAM D20 Xplained Pro kit contains one crystals that can be used as clock source for the SAM D20 device. The crystal has a cut-strap next to it that can be used to measure the oscillator safety factor. This is done by cutting the strap and adding a resistor across the strap. More information about oscillator allowance and safety factor can be found in appnote [AVR4100](#)¹.

¹ <http://www.atmel.com/images/doc8333.pdf>

Table 4-4. External 32.768kHz crystals

Pin on SAM D20	Function
PA00	XIN32
PA01	XOUT32

4.2.2 Mechanical buttons

SAM D20 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM D20 reset line and the other is a generic user configurable button. When a button is pressed it will drive the I/O line to GND.

Table 4-5. Mechanical buttons

Pin on SAM D20	Silkscreen text
RESETN	RESET
PA15	SW0

4.2.3 LED

There is one yellow LED available on the SAM D20 Xplained Pro board that can be turned on and off. The LED can be activated by driving the connected I/O line to GND.

Table 4-6. LED connections

Pin on SAM D20	LED
PA14	Yellow LED0

4.3 Embedded Debugger implementation

SAM D20 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAM D20J18 using Serial Wire Debug (SWD). The Embedded Debugger also include a Virtual Com port interface over UART, an Atmel Data Gateway Interface over SPI and TWI and it monitors four of the SAM D20 GPIOs. Atmel Studio can be used as a front end for the Embedded Debugger.

4.3.1 Serial Wire Debug

The Serial Wire Debug (SWD) use two pins to communicate with the target. For further information on how to use the programming and debugging capabilities of the EDBG, see [“Embedded Debugger” on page 6](#).

Table 4-7. SWD connections

Pin on SAM D20	Function
PA30	SWD clock
PA31	SWD data

4.3.2 Virtual COM port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAM D20J18 UARTs. For further information on how to use the Virtual COM port see [“Embedded Debugger” on page 6](#).

Table 4-8. Virtual COM port connections

Pin on SAM D20	Function
PA24	SERCOM3 PAD[2] UART TXD (SAM D20 TX line)
PA25	SERCOM3 PAD[3] UART RXD (SAM D20 RX line)

4.3.3 Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either a SPI or I²C port. The DGI can be used to send a variety of data from the SAM D20 to the host PC. For further information on how to use the DGI interface see [“Embedded Debugger” on page 6](#).

Table 4-9. DGI interface connections when using SPI

Pin on SAM D20	Function
PB31	SERCOM5 PAD[1] SPI SS (Slave select) (SAM D20 is Master)

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

Table 4-10. DGI interface connections when using I²C

Pin on SAM D20	Function
PA08	SERCOM2 PAD[0] SDA (Data line)
PA09	SERCOM2 PAD[1] SCL (Clock line)

Four GPIO lines are connected to the Embedded Debugger. The EDBG can monitor these lines and time stamp pin value changes. This makes it possible to accurately time stamp events in the SAM D20 application code. For further information on how to configure and use the GPIO monitoring features see [“Embedded Debugger” on page 6](#).

Table 4-11. GPIO lines connected to the EDBG

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

4.3.4 External programming and debugging

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

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

Note

This connector can't be used for attaching an external debug unit for programming and debugging the onboard device.

Table 4-12. Cortex Debug Connector

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

5. Hardware revision history and known issues

5.1 Identifying product ID and revision

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

By connecting a Xplained Pro MCU board to a computer with Atmel Studio running, an information window will pop up. The first 6 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 Kits 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:

```
"nnnnrrssssssss"  
n = product identifier  
r = revision  
s = serial number
```

The kit identifier for SAM D20 Xplained Pro is 1873.

5.2 Revision 4

Revision 4 of SAM D20 Xplained Pro is the initial released version, there are no known issues.

6. Document revision history

Doc. Rev.	Date	Comment
A	06/2013	First release

7. 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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