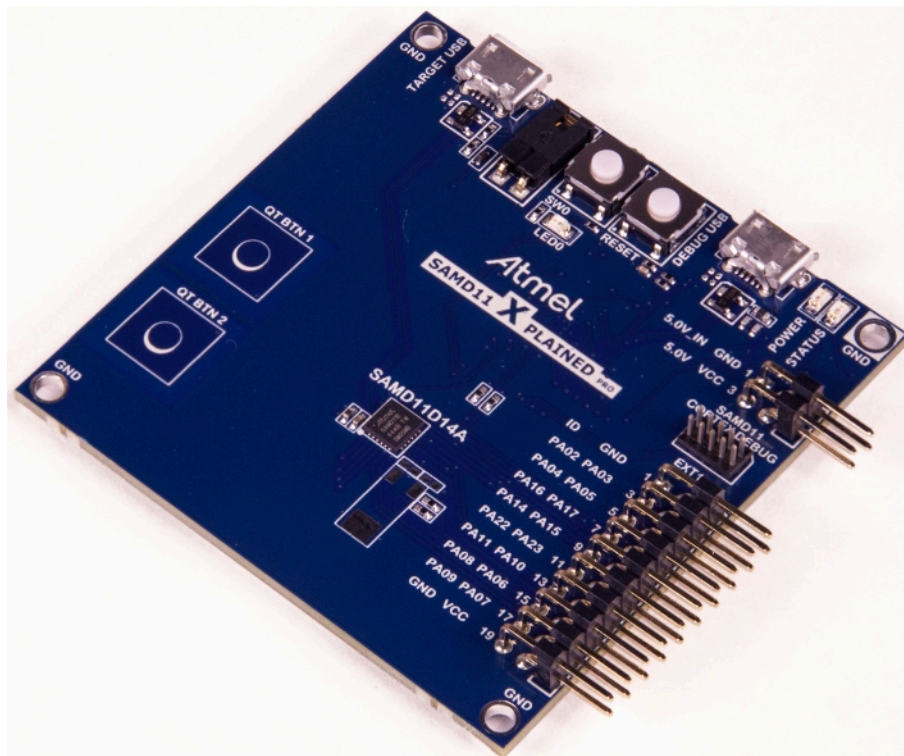


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## Atmel SAM D11 Xplained Pro

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### Preface

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The Atmel® SAM D11 Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAM D11D14A microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAM D11D14A 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 ATSAM D11D14A.

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

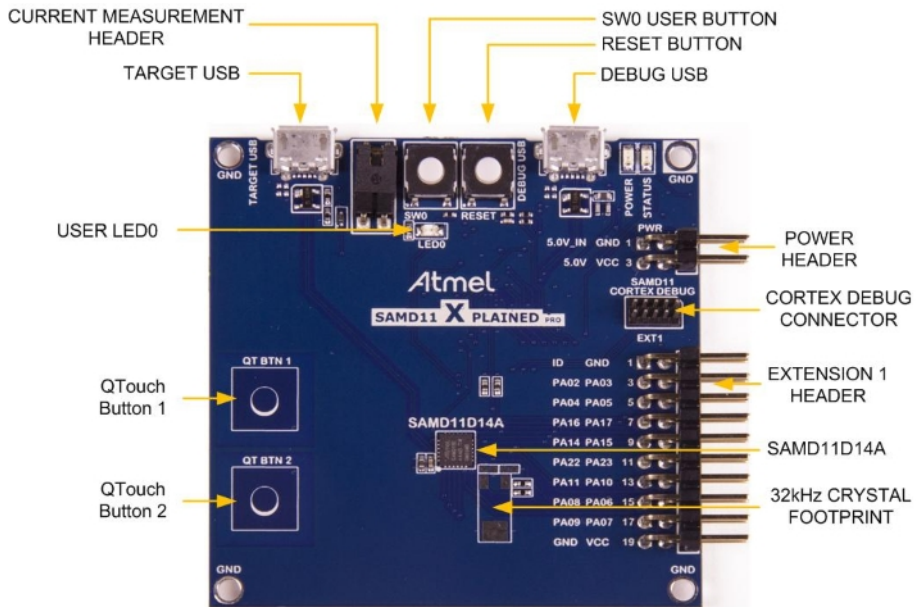
- Atmel ATSAM D11 microcontroller
- Embedded debugger (EDBG)
  - USB interface
  - Programming and debugging on board SAM D11 through Serial Wire Debug (SWD)
  - Virtual COM-port interface to target via UART
  - Atmel Data Gateway Interface (DGI) to target via SPI and TWI
  - Four GPIOs connected to target for code instrumentation
- Digital I/O
  - Two mechanical buttons (user and reset button)
  - One user LED
  - One extension header
- Three possible power sources
  - External power
  - Embedded debugger USB
  - Target USB
- 32kHz crystal footprint
- USB interface, device mode only
- Two QTouch<sup>®</sup> buttons

## 1.2 Kit Overview

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

The kit offers a set of features that enables the ATSAM D11 user to get started using the ATSAM D11 peripherals right away and to get an understanding of how to integrate the device in their own design.

**Figure 1-1. SAM D11 Xplained Pro Evaluation Kit Overview**



## 2. Getting Started

### 2.1 Quick-start

Three steps to start exploring the Atmel Xplained Pro Platform

- Download and install [Atmel Studio](#)<sup>1</sup>
- Launch Atmel Studio
- Connect a Micro-B cable to the DEBUG USB port

### 2.2 Connecting the Kit

When connecting Atmel SAM D11 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. Refer to the [Atmel Studio user guide](#)<sup>2</sup> 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 D11 Xplained Pro.

1. [Xplained Pro products](#)<sup>3</sup> - Atmel Xplained Pro is a series of small-sized and easy-to-use evaluation kits for Atmel AVR® 8- and 32-bit 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 D11 Xplained Pro User Guide](#)<sup>4</sup> - PDF version of this User Guide.
3. [SAM D11 Xplained Pro Design Documentation](#)<sup>5</sup> - Package containing schematics, BOM, assembly drawings, 3D plots, layer plots etc.
4. [EDBG User Guide](#)<sup>6</sup> - User guide containing more information about the onboard Embedded Debugger.
5. [Atmel Studio](#)<sup>7</sup> - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.
6. [Atmel Data Visualizer](#)<sup>8</sup> - Atmel Data Visualizer is a program used for processing and visualizing data.
7. [IAR Embedded Workbench](#)<sup>9</sup> 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.
8. [Atmel sample store](#)<sup>10</sup> - Atmel sample store where you can order samples of devices.

<sup>1</sup> <http://www.atmel.com/atmelstudio>

<sup>2</sup> <http://www.atmel.com/atmelstudio>

<sup>3</sup> <http://www.atmel.com/XplainedPro>

<sup>4</sup> [http://www.atmel.com/Images/Atmel-42349-SAMD11-Xplained-Pro\\_User-Guide.pdf](http://www.atmel.com/Images/Atmel-42349-SAMD11-Xplained-Pro_User-Guide.pdf)

<sup>5</sup> [http://www.atmel.com/Images/Atmel-42349-SAMD11-Xplained-Pro\\_User-Guide.zip](http://www.atmel.com/Images/Atmel-42349-SAMD11-Xplained-Pro_User-Guide.zip)

<sup>6</sup> [http://www.atmel.com/Images/Atmel-42096-Microcontrollers-Embedded-Debugger\\_User-Guide.pdf](http://www.atmel.com/Images/Atmel-42096-Microcontrollers-Embedded-Debugger_User-Guide.pdf)

<sup>7</sup> <http://www.atmel.com/atmelstudio>

<sup>8</sup> <https://gallery.atmel.com/?q=Atmel%20Data%20Visualizer>

<sup>9</sup> <http://www.iar.com/en/Products/IAR-Embedded-Workbench/ARM/>

<sup>10</sup> <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](#)<sup>1</sup>.

### 3.1 Embedded Debugger

The SAM D11 Xplained Pro contains the Atmel Embedded Debugger (EDBG) for on-board debugging. The EDBG is a composite USB device of three interfaces; a debugger, Virtual COM Port, and Data Gateway Interface (DGI).

In conjunction with Atmel Studio, the EDBG debugger interface can program and debug the ATSAM D11D14A. On the SAM D11 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAM D11D14A.

The Virtual COM Port is connected to a UART port on the ATSAM D11D14A (see section “[Embedded Debugger Implementation](#)” on page 11 for pinout), and provides an easy way to communicate with the target application through 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. 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 ATSAM D11D14A, 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 D11 Xplained Pro; a power LED and a status LED. [Table 3-1, “EDBG LED Control”](#) on page 6 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](#)<sup>2</sup>.

### 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 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”](#) on page 6 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'

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

<sup>2</sup> [http://www.atmel.com/Images/Atmel-42096-Microcontrollers-Embedded-Debugger\\_User-Guide.pdf](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 D11 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 D11 Xplained Pro” on page 7.

**Table 3-3. Power Sources for SAM D11 Xplained Pro**

Power input	Voltage Requirements	Current Requirements	Connector Marking
External power	5V $\pm$ 2 % ( $\pm$ 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.

#### Note

External power is required when the 500mA through the USB connector is not enough to power a connected USB device in a USB host application.

#### 3.3.1 Measuring SAM D11 Power Consumption

As part of an evaluation of the SAM D11 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 ammeter it is possible to determine the current consumption. To locate the current measurement header, refer to Figure 1-1, “SAM D11 Xplained Pro Evaluation Kit Overview” on page 4.

#### Warning

Do not power the board without having the jumper or an ammeter mounted. This can cause the SAM D11 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 Standard 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” on page 8](#). 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.
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 positive 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	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 D11 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 power header, refer to [Figure 1-1, “SAM D11 Xplained Pro Evaluation Kit Overview” on page 4](#)

**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)



Pin Number PWR header	Pin Name	Description
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 D11 Xplained Pro and their connection to the ATSAMD11D14A. The tables of connections in this chapter also describes which signals are shared between the headers and on-board functionality.

#### 4.1.1 I/O Extension Headers

The SAM D11 Xplained Pro header EXT1 offers access to the I/O of the microcontroller in order to expand the board e.g. by connecting extensions to the board. This header is based on the standard extension header specified in [Xplained Pro Standard Extension Header on page 7](#). The header has a pitch of 2.54mm.

**Table 4-1. Extension Header EXT1**

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

### 4.2 Peripherals

#### 4.2.1 Crystal

The SAM D11 Xplained Pro kit contain one crystal footprint that can be used for mounting a clock source for the SAM D11 device. The IO pins for the crystal are shared with the extension header, so two zero ohm resistors (R311 and R312) must be removed before mounting a crystal on the footprint.

**Table 4-2. External 32.768kHz Crystal**

Pin on SAM D11	Function
PA08	XIN32
PA09	XOUT32

## 4.2.2 Mechanical Buttons

SAM D11 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM D11 reset line and the other is a generic user configurable button. When a button is pressed it will drive the I/O line to GND.

**Table 4-3. Mechanical Buttons**

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

## 4.2.3 LED

There is one yellow LED available on the SAM D11 Xplained Pro board that can be turned on and off. The LED can be activated by driving the connected I/O line to GND.

**Table 4-4. LED Connections**

Pin on SAM D11	LED
PA16	Yellow LED0

## 4.2.4 Touch Buttons

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

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

**Table 4-5. QTouch Button Connections**

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

## 4.2.5 USB

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

**Table 4-6. USB Connections**

Pin on SAM D11	USB
PA27	VBUS Detection <sup>1</sup>
PA24	USB D-
PA25	USB D+

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

## 4.3 Embedded Debugger Implementation

SAM D11 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAM D11D14A using Serial Wire Debug (SWD). The Embedded Debugger also include a Virtual Com port interface over UART, an Atmel Data Gateway Interface over SPI, and TWI and it includes four of the SAM D11 GPIOs. Atmel Studio can be used as a front end for the Embedded Debugger.

### 4.3.1 Serial Wire Debug

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

**Table 4-7. SWD Connections**

Pin on SAM D11	Function
PA30	SWD clock
PA31	SWD data

### 4.3.2 Virtual COM Port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAM D11D14A 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 D11	Function
PA10	SERCOM2 PAD[2] UART TXD (SAM D11 TX line)
PA11	SERCOM2 PAD[3] UART RXD (SAM D11 RX line)

### 4.3.3 Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either a SPI or I<sup>2</sup>C port. The DGI can be used to send a variety of data from the SAM D11 to the host PC. For further information on how to use the DGI interface see [“Embedded Debugger” on page 6](#).

**Table 4-9. DGI Interface Connections when using SPI**

Pin on SAM D11	Function
PA27	GPIO/SPI SS (Slave select) (SAM D11 is Master) <sup>1</sup>
PA09	SERCOM0 PAD[3] SPI MISO (Master In, Slave Out)
PA06	SERCOM0 PAD[0] SPI MOSI (Master Out, Slave in)
PA07	SERCOM0 PAD[1] SPI SCK (Clock Out)

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

**Table 4-10. DGI Interface Connections when using I<sup>2</sup>C**

Pin on SAM D11	Function
PA08	SERCOM2 PAD[0] SDA (Data line)
PA09	SERCOM2 PAD[1] SCL (Clock line)

Four GPIO lines are connected to the Embedded Debugger. The EDBG can monitor these lines and time stamp pin value changes. This makes it possible to accurately time stamp events in the SAM D11 application code. For further information on how to configure and use the GPIO monitoring features see [“Embedded Debugger” on page 6](#).

**Table 4-11. GPIO Lines Connected to the EDBG**

Pin on SAM D11	Function
PA16	GPIO0
PA17	GPIO1
PA14	GPIO2
PA15	GPIO3

## 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 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 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:

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

The kit identifier for SAM D11 Xplained Pro is 2178.

### 5.2 Revision 3

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

## 6. Document Revision History

Document revision	Date	Comment
42349A	01/2015	Initial document 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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