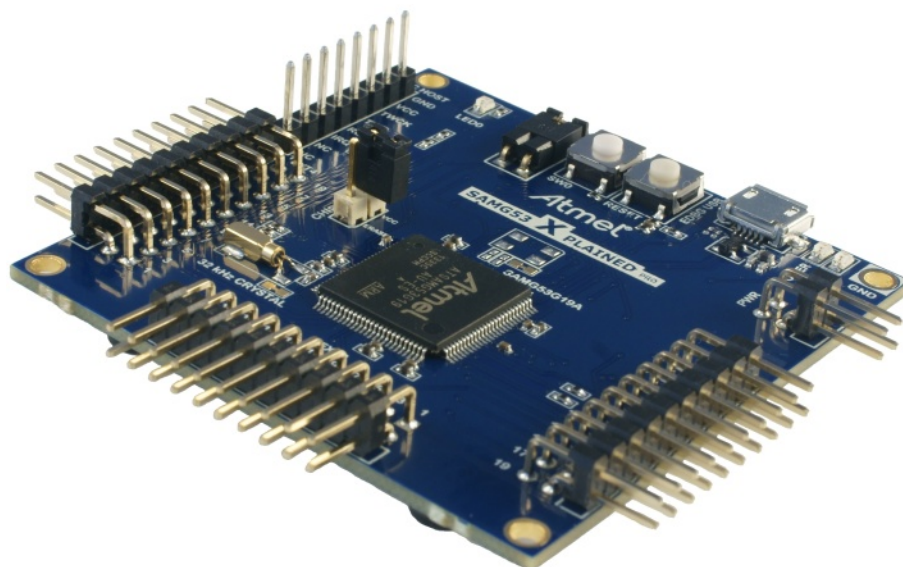# Atmel

Atmel SAM G53 Xplained Pro

Preface

The Atmel® SAM G53 Xplained Pro evaluation kit is hardware platform to evaluate the ATSAMG53N19 microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAMG53N19 and explains how to integrate the device in a customer 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 ATSAMG53N19.

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

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1.   Introduction

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- Atmel ATSAMG53N19 microcontroller

- Embedded debugger (EDBG)

    - USB interface

    - Programming and debugging (target) through Serial Wire Debug (SWD)

    - Virtual COM-port interface to target via UART

    - Atmel Data Gateway interface (DGI) to target via UART or TWI.

    - Four GPIOs connected to target for code instrumentation

- Digital I/O

    - Two mechanical buttons (including one reset button)

    - One user LED

    - Three extension headers

    - I^2C interface for SAM G53 high speed I2C slave

- Two possible power sources

    - External power

    - Embedded debugger USB

- 32kHz crystal

1.2   Kit overview

The Atmel SAM G53 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAMG53N19.

The kit offers a set of features that enables the SAM G53 user to get started using the SAM G53's peripherals right away and to get an understanding of how to integrate the SAM G53 in their own design.

Figure 1-1. SAM G53 Xplained Pro evaluation kit overview
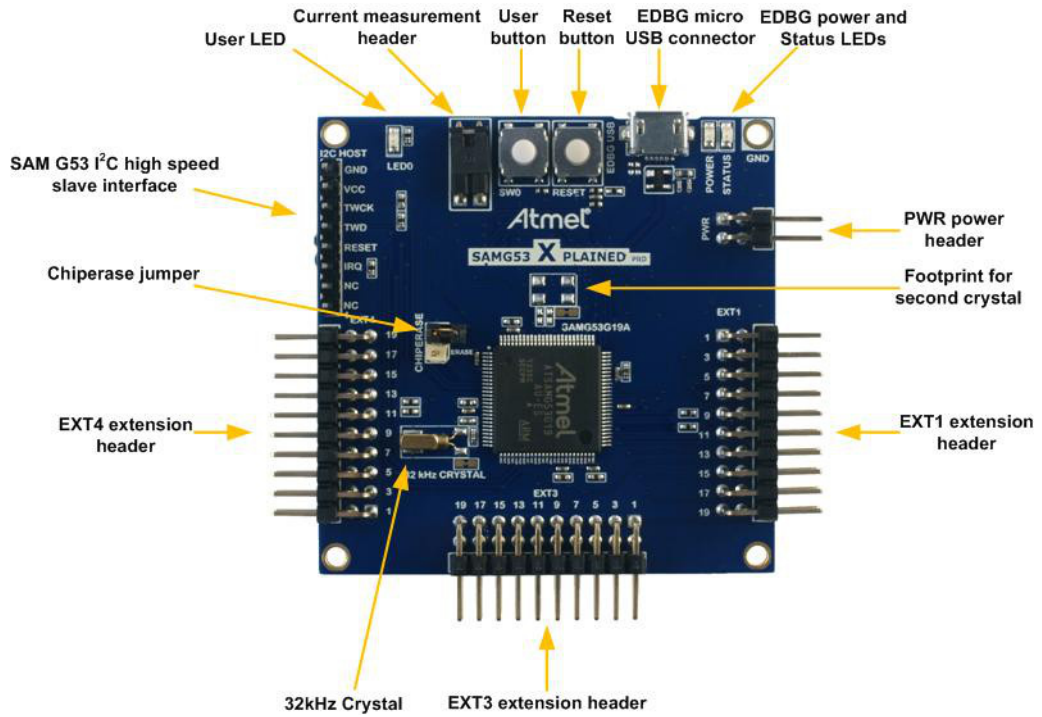
2. Getting Started

2.1 Quick-start

3 Steps to start exploring the Atmel Xplained Pro Platform

- Download and install **Atmel Studio**[1]

- Launch Atmel Studio

- Connect a USB micro B cable to the DEBUG USB port

2.2 Connecting the kit

When connecting Atmel SAM G53 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 the SAM G53 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 G53 Xplained Pro User Guide** [4] - PDF version of this User Guide.

3. **SAM G53 Xplained Pro Design Documentation** [5] - Package containing schematics, BOM, assembly drawings, 3D plots, layer plots etc.

4. **Atmel Studio** [6] - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.

5. **IAR Embedded Workbench® [7] 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.

6. **Atmel sample store** [8] - Atmel sample store where you can order samples of devices.

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[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-42217-SAMG53-Xplained-Pro_User-Guide.pdf
[5] http://www.atmel.com/Images/Atmel-42217-SAMG53-Xplained-Pro_User-Guide.zip
[6] http://www.atmel.com/atmelstudio
[7] http://www.iar.com/en/Products/IAR-Embedded-Workbench/ARM/
[8] 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 G53 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 ATSAMG53N19. On the SAM G53 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAMG53N19.

The Virtual COM Port is connected to a UART port on the ATSAMG53N19 (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. 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 ATSAMG53N19, 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 G53 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[2].

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'

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[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 G53 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 G53 Xplained Pro" on page 7.

Table 3-3. Power sources for SAM G53 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 extentions 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 G53 power consumption

As part of an evaluation of the SAM G53 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 G53 Xplained Pro evaluation kit overview" on page 4.

Warning Do not power the board without having the jumper or an ampere meter mounted. This can cause the SAM G53 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 7. 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 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 G53 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 G53 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)
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 G53 Xplained Pro and their connection to the ATSAMG53N19. 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 G53 Xplained Pro headers EXT1, EXT3 and EXT4 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 on page 7. All headers have a pitch of 2.54mm.

Table 4-1. Extension header EXT1

Pin on EXT1	SAM G53 pin	SAM G53 peripheral function	Shared functionality
1 [ID]	-	-	Communication line to ID chip on extension board.
2 [GND]	-	-	GND
3 [ADC(+)]	PA17	AD0	
4 [ADC(-)]	PA18	AD1	
5 [GPIO1]	PB03	GPIO	EDBG GPIO1
6 [GPIO2]	PB09	GPIO	EDBG GPIO3
7 [PWM(+)]	PA00	TIOA0	
8 [PWM(-)]	PA01	TIOB0	
9 [IRQ/GPIO]	PA24	WKUP11	
10 [SPI_SS_B/GPIO]	PA20	GPIO	EXT3 connector (ADC)
11 [TWI_SDA]	PB00	TWD2	
12 [TWI_SCL]	PB01	TWCK2	
13 [USART_RX]	PA05	USART RXD (URXD0)	EDBG Data Gateway Interface (UART)
14 [USART_TX]	PA06	USART TXD (UTXD0)	EDBG Data Gateway Interface (UART)
15 [SPI_SS_A]	PA11	SPI NPCS0	
16 [SPI_MOSI]	PA13	SPI MOSI	EXT3 connector
17 [SPI_MISO]	PA12	SPI MISO	EXT3 connector
18 [SPI_SCK]	PA14	SPI SCK	EXT3 connector
19 [GND]	-	-	GND
20 [VCC]	-	-	VCC

Table 4-2. Extension header EXT3

Pin on EXT3	SAM G53 pin	SAM G53 peripheral function	Shared functionality
1 [ID]	-	-	Communication line to ID chip on extension board.
2 [GND]	-	-	GND
3 [ADC(+)]	PA19	AD2	
4 [ADC(-)]	PA20	AD3	EXT1 connector (GPIO)
5 [GPIO1]	PB04	GPIO	EDBG GPIO2

Pin on EXT3	SAM G53 pin	SAM G53 peripheral function	Shared functionality
6 [GPIO2]	-	-	
7 [PWM(+)]	PA21	TIOA2	
8 [PWM(-)]	-	-	
9 [IRQ/GPIO]	PA22	WKUP10	
10 [SPI_SS_B/GPIO]	PA15	GPIO	EDBG GPIO0 and EXT4 (GPIO)
11 [TWI_SDA]	PB10	TWD1	EDBG and EXT4 connector (TWI)
12 [TWI_SCL]	PB11	TWCK1	EDBG and EXT4 connector (TWI)
13 [USART_RX]	PA09	USART0 RXD	EDBG (CDC UART)
14 [USART_TX]	PA10	USART0 TXD	EDBG (CDC UART)
15 [SPI_SS_A]	PB02	SPI NPCS1	
16 [SPI_MOSI]	PA13	SPI MOSI	EXT1 connector (SPI MOSI)
17 [SPI_MISO]	PA12	SPI MISO	EXT1 connector (SPI MISO)
18 [SPI_SCK]	PA14	SPI SCK	EXT1 connector (SPI SCK)
19 [GND]	-	-	GND
20 [VCC]	-	-	VCC

Table 4-3. Extension header EXT4

Pin on EXT4	SAM G53 pin	SAM G53 peripheral function	Shared functionality
1 [ID]	-	-	Communication line to ID chip on extension board.
2 [GND]	-	-	GND
3 [ADC(+)]	-	-	
4 [ADC(-)]	-	-	
5 [GPIO1]	PA15	GPIO	EDBG GPIO0 and EXT3 (GPIO)
6 [GPIO2]	-	-	
7 [PWM(+)]	-	-	
8 [PWM(-)]	-	-	
9 [IRQ/GPIO]	PB08	WKUP14	
10 [SPI_SS_B/GPIO]	-	-	
11 [TWI_SDA]	PB10	TWD1	EDBG and EXT3 connector (TWI)
12 [TWI_SCL]	PB11	TWCK1	EDBG and EXT3 connector (TWI)
13 [USART_RX]	-	-	
14 [USART_TX]	-	-	
15 [SPI_SS_A]	-	-	
16 [SPI_MOSI]	-	-	
17 [SPI_MISO]	-	-	
18 [SPI_SCK]	-	-	
19 [GND]	-	-	GND
20 [VCC]	-	-	VCC

4.1.2 High speed TWI interface

The extension connector marked with "Host I^{2}C" targets I^{2}C hosts that want to connect to the SAM G53 high speed I^{2}C slave interface. Besides I^{2}C communication a GPIO and the SAM G53 reset is available. The GPIO can serve as a IRQ to the host and the reset can be used by the host to reset the SAM G53.

Table 4-4. SAM G53 high speed I²C slave interface

Pin on EXT5	SAM G53 pin	SAM G53 peripheral function	Shared functionality
1	-	-	
2	-	-	
3	PA23	GPIO	
4	RESET	Reset	
5	PA03	TWD0	
6	PA04	TWCK0	
7	-	-	VCC
8	-	-	GND

4.2 Peripherals

4.2.1 Crystals

The SAM G53 Xplained Pro kit contains one mounted 32kHz crystal and a footprint for a second crystal. The crystal circuit 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].

Table 4-5. External 32.768kHz crystal

Pin on SAM G53	Function
PA07	XIN32
PA08	XOUT32

Table 4-6. Footprint for additional crystal

Pin on SAM G53	Function
PB09	XIN
PB08	XOUT

4.2.2 Mechanical buttons

The SAM G53 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM G53 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 4-7. Mechanical buttons.

Pin on SAM G53	Silkscreen text
NRST	RESET
PA02	SW0

4.2.3 LED

There is one yellow LED available on the SAM G53 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 4-8. LED connections.

Pin on SAM G53	LED
PA16	Yellow LED0

4.3 Embedded Debugger implementation

The SAM G53 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAMG53N19 using Serial Wire Debug (SWD). The Embedded debugger also provides a Virtual Com

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[1] http://www.atmel.com/images/doc8333.pdf

port interface over UART, an Atmel Data Gateway Interface over UART and TWI, and it monitors four of the SAM G53 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) uses 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 4-9. SWD connections.

Pin on SAM G53	Function
PB07	SWD clock
PB06	SWD data
PB05	SWD trace data

4.3.2 Virtual COM port

The Embedded Debugger act as a Virtual Com Port gateway by using one of the ATSAMG53N19 UARTs. For further information on how to use the Virtual COM port see "Embedded Debugger" on page 6.

Table 4-10. Virtual COM port connections.

Pin on SAM G53	Function
PA10	UART TXD (SAM G53 TX line)
PA09	UART RXD (SAM G53 RX line)

4.3.3 Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either UART or TWI. The DGI can be used to send a variety of data from the SAM G53 to the host PC. For further information on how to use the DGI interface see "Embedded Debugger" on page 6.

Table 4-11. DGI interface connections when using UART.

Pin on SAM G53	Function
PA06	UART TXD (SAM G53 TX line)
PA05	UART RXD (SAM G53 RX line)

Table 4-12. DGI interface connections when using TWI.

Pin on SAM G53	Function
PB10	SDA (Data line)
PB11	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 G53 application code. For further information on how to configure and use the GPIO monitoring features see "Embedded Debugger" on page 6.

Table 4-13. GPIO lines connected to the EDBG.

Pin on SAM G53	Function
PA15	GPIO0
PB03	GPIO1
PB04	GPIO2
PB09	GPIO3

4.4 Jumper description

The SAM G53 Xplained Pro contains two jumpers that can be used to adjust the functionality of the board. You can locate the jumpers in figure Figure 1-1, "SAM G53 Xplained Pro evaluation kit overview" on page 4.

4.4.1   Chiperase jumper

When this jumper is placed on the CHIPERASE header the SAM G53 performes a chiperase after the next power toggle of the board. For normal operation this jumper should be placed e.g. only on one of the pins of the CHIPERASE header so that no contact is made between the two pins.

4.4.2   Target MCU power measurement jumper

This jumper connects the target board VCC power plane (VCC_TARGET_P3V3) to the target MCU power plane (VCC_MCU_P3V3). This jumper can be replaced with an ampere meter to measure the current used by the target device. A user must ensure that a connection between the two power planes is present when the board is powered.

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 G53 Xplained Pro is 2137.

5.2 Revision 1

Revision 1 of SAM G53 Xplained Pro is the initial released version, there are no known issues.

6. Document revision history

Document revision	Date	Comment
42217A	12/2013	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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