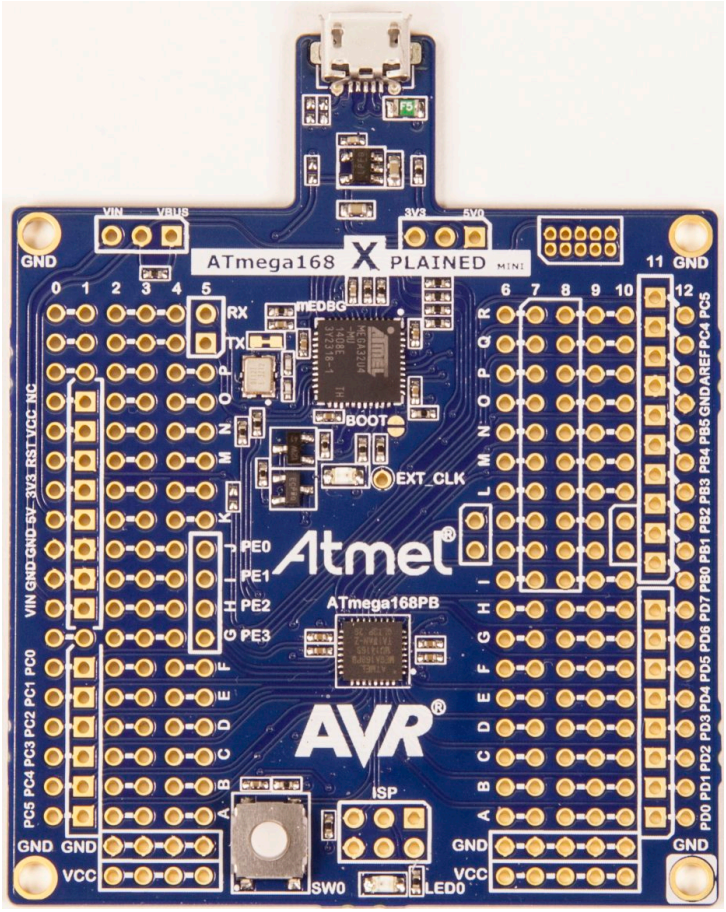
USER GUIDE

ATmega168PB Xplained Mini User Guide



Introduction

This user guide describes how to get started with the Atmel® ATmega168PB Xplained Mini board.

The ATmega168PB Xplained Mini evaluation kit is a hardware platform to evaluate the Atmel ATmega168PB microcontroller. The evaluation kit comes with a fully integrated debugger that provides seamless integration with Atmel Studio 6.2 (and later version). The kit provides access to the features of the ATmega168PB enabling easy integration of the device in a custom design.

Table of Contents

1. Getting Started

1.1 Features

The ATmega168PB Xplained Mini evaluation board provides a development platform for the Atmel ATmega168PB.

1.2 Design Documentation and Related Links

The most relevant documents and software for the evaluation board is available here:

http://www.atmel.com/tools/MEGA168PB-XMINI.aspx

1.3 Board Assembly

The Xplained Mini board is very flexible and can be used in a number of ways. E.g. as your own prototype for SW development and HW verification.

1.3.1 In Customer Development Assembly

The ATmega168PB Xplained Mini board can be wired into the customer prototype assembly by using the on-board connector grid, where the target signals are available.

1.3.2 Connecting an Arduino Shield

By assembling receptacles in the marked positions (J200, J201, J202, and J203) Arduino® shields can be mounted.

1.3.3 Standalone Node

The ATmega168PB Xplained Mini board can be used as a standalone node - use the 4xAAA or 2xAAA battery pack available in Atmel store to provide power.

1.4 Connecting the Kit

How to connect the evaluation board.

1.4.1 Connect the Kit to Atmel Studio

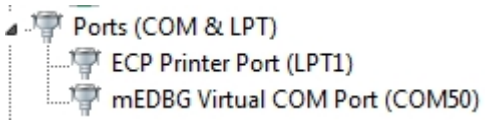
How to connect the ATmega168PB Xplained Mini board to Atmel Studio.

1. Download and install Atmel Studio[1] version 6.2 or later.
2. Launch Atmel Studio.
3. Connect the board to the USB port and it will be visible in Atmel Studio.

1.4.2 Connect the Target UART to the mEBDG COM Port

All Xplained Mini boards have an embedded debugger (mEBDG) with a number of features, among them a CDC/COM port which enables the user to connect the ATmega168PB UART to the PC.

1. Connect the mEDBG USB to the PC.
2. Use the Device Manager to find the COM port number.
3. Default COM port settings are 9600baud N81. The COM port settings can be changed using the Device Manager.



[1] http://www.atmel.com/tools/atmelstudio.aspx

1.5 Programming and Debugging

How to program and debug the Xplained Mini board.

1.5.1 Programming the Target Using mEDBG

Using the Embedded Debugger on the Xplained Mini board to program the ATmega328 via the SPI bus.

1. Connect the mEDBG USB to the PC.
2. Go to Atmel Studio: click Tools, select Device Programming, and select the connected mEDBG as Tool with Device = ATmega168PB and Interface = ISP, click Apply. Note that if ISP programming fails it could be because debugWIRE is enabled. See debugging chapter on how to disable debugWIRE mode: “Debugging the Target Using mEDBG” on page 4.
3. Select "Memories" and locate the source hex or elf file and click Program.
4. If the source contains fuse settings go to "Production file" and upload the elf file and program the fuses.
5. To set fuses manually click Fuses and select the setting.

   Recommended fuse setting:

   BOOTSZ = 1024W_1C00,

   BOOTRST = [ ],

   RSTDISBL = [ ],

   DWEN = [ ],

   SPIEN = [X],

   WDTON = [ ],

   EESAVE = [ ],

   BODLEVEL = DISABLE,

   CKDIV8 = [ ],

   CKOUT = [ ],

   SUT_CKSEL = EXTCLK_6CK_14CK_65MS

Note

If any other cpu clk than the external clk supplied by the mEDBG is used the debugWIRE is not guaranteed to work.

The mEDBG will prevent writing certain fuse combinations in order to protect your kit.

Trying to change CKDIV8 and/or SUT_CKSEL will be prevented and an Error message will be displayed ("One or more registers differs").

To be able to set fuses freely the ATmega32U4 EEPROM has to be programmed to 0x00 from address 0x200 to 0x214.

Note

If not exiting debug mode by selecting "Disable debugWIRE and Close" in the Debug menu, the DWEN fuse will be enabled and the target will still be in debug mode, i.e. it will not be possible to program the target using the SPI.

1.5.2 Debugging the Target Using mEDBG

Using the Embedded Debugger on the Xplained Mini board to debug the ATmega168PB via debugWIRE.

1. Start Atmel Studio.
2. Connect the mEDBG USB to the PC.
3. Open your project.
4. In the Project menu select the project properties page, select the Tools tab and select mEDBG as debugger and debugWIRE as interface.

5. In the Debug menu click Start Debugging and Break.
6. Atmel Studio will display an error message if the DWEN fuse in the ATmega168PB is not enabled, click YES to make Studio set the fuse using the ISP interface.
7. A debug session is started with a break in main, debugging can start.
8. When exiting debug mode select "Disable debugWIRE and Close" in the Debug menu, this will disable the DWEN fuse.

Note If not exiting debug mode by selecting "Disable debugWIRE and Close" in the Debug menu, the DWEN fuse will be enabled and the target will still be in debug mode, i.e. it will not be possible to program the target using the SPI.

Note If any other cpu clk than the external clk supplied by the mEDBG is used the debugWIRE is not guaranteed to work.

Note Applying a signal to J202/RESET (the RESET_SENSE signal) while debugging may result in unexpected behaviour. This signal is NOT available during a debugging session because the RESET line is actively used by the debugWIRE interface.

1.5.3 Programming the Target Using an External Programmer

How to program the target ATmega168PB using the AVR® JTAGICE mkII, JTAGICE3, or other Atmel Programmers.

1. Connect the External Programmer to the PC.
2. Connect the External Programme to the evaluation board ISP connector (J204) (Need the 6-pin 100mil adapter connected to the JTAGICE).
3. Go to Atmel Studio: Tools/Device Programming, and select the External Programmer connected as Tool, Select Device = ATmega168PB, Interface = ISP and click Apply.
4. Select "Memories" and locate the source hex or elf file and click Program.
5. If the source contains fuse settings go to "Production file" and upload the elf file and program the fuses.

   Recommended fuse setting:

   BOOTSZ = 1024W_1C00,

   BOOTRST = [ ],

   RSTDISBL = [ ],

   DWEN = [ ],

   SPIEN = [X],

   WDTON = [ ],

   EESAVE = [ ],

   BODLEVEL = DISABLE,

   CKDIV8 = [ ],

   CKOUT = [ ],

   SUT_CKSEL = EXTCLK_6CK_14CK_65MS

1.5.4 Programming the ATmega32U4 Using an External Programmer

How to program the ATmega32U4 using the AVR® JTAGICE mkII, JTAGICE3, or other Atmel Programmers.

To restore the mEDBG FW use the /tools/mEDBG/mEDBG_fw.zip from the Studio installation.

1. Connect the External Programmer to the PC.
2. Connect the External Programmer to the board connector (J100).
3. Go to Atmel Studio: Tools/Device Programming, and select the External Programmer connected as Tool, select Device = ATmega32U4, Interface = JTAG and click Apply.
4. Select "Memories" and locate the source hex or elf file and click Program.
5. If the source contain fuse settings go to "Production file" and upload the elf file and program the fuses.

   Recommended fuse setting:

   BODLEVEL = DISABLE

   HWBE = [X]

   OCDEN = [ ]

   JTAGEN = [X]

   SPIEN = [X]

   WDTON = [ ]

   EESAVE = [X]

   BOOTSZ = 2048W_3800

   BOOTRST = [ ]

   CKDIV8 = [ ]

   CKOUT = [X]

   SUT_CKSEL = EXTXOSC_8MHZ_XX_258CK_65MS

Note CKOUT must be enabled the provide clock to the target.

1.5.5 Programming the ATmega32U4 Using a Bootloader

This section describes how to use the bootloader to program the ATmega32U4.

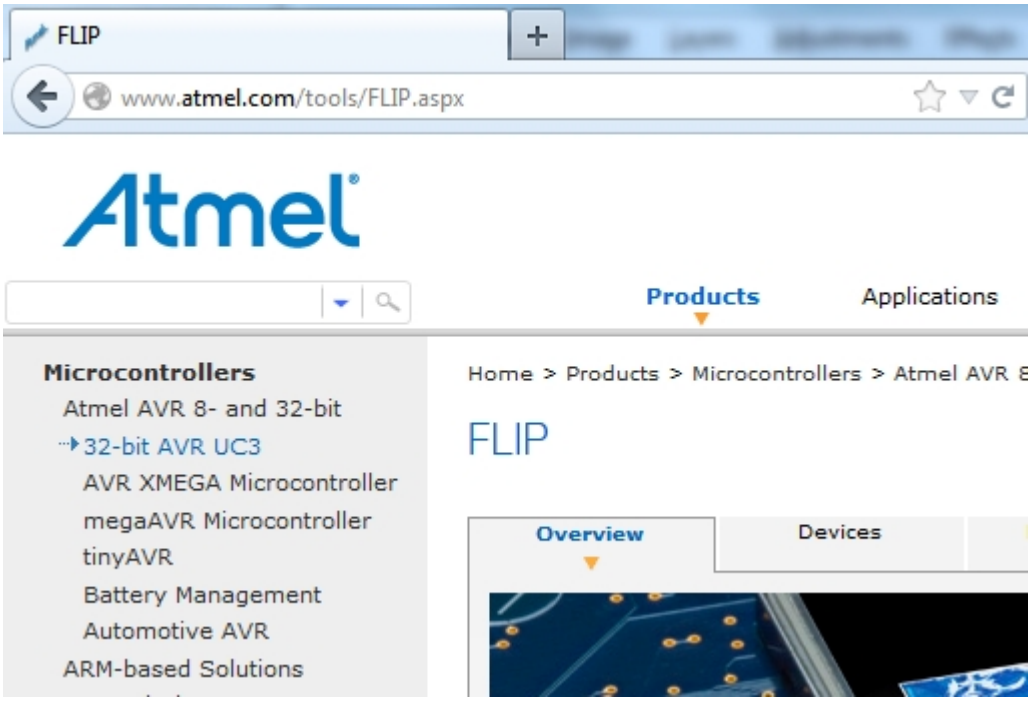
1. Install the Bootloader interface on the PC as described in “How to Install the "Bootloader PC tool"” on page 6.
2. Start the Bootloader PC GUI "FLIP".
3. Short strap J102.
4. Connect the board USB connector to the PC.
5. Select Device = ATmega32U4 (Device - Select).
6. Select USB communication (**Ctrl+U**).
7. Select memory area to program (Use the toggle memory button bellow the Atmel logo).
8. Select Load Hex file (**Ctrl+L**).
9. Select Programming Options.
10. Click "Run", observe status in status field.

1.5.6 How to Install the "Bootloader PC tool"

How to install the Bootloader PC GUI tool.

1. Download the FLIP "in system programming tool" installer from http://www.atmel.com/tools/FLIP.aspx[2].

[2] http://www.atmel.com/tools/FLIP.aspx



2. Run the FLIP Installer.

1.6 Available Example Code

The ATmega168PB is preprogrammed with a demo program, ReMorse. Source code is available in Atmel Spaces[3].

When the CDC COM port is connected to a terminal window, the text you write will be transmitted via the LED in Morse code.

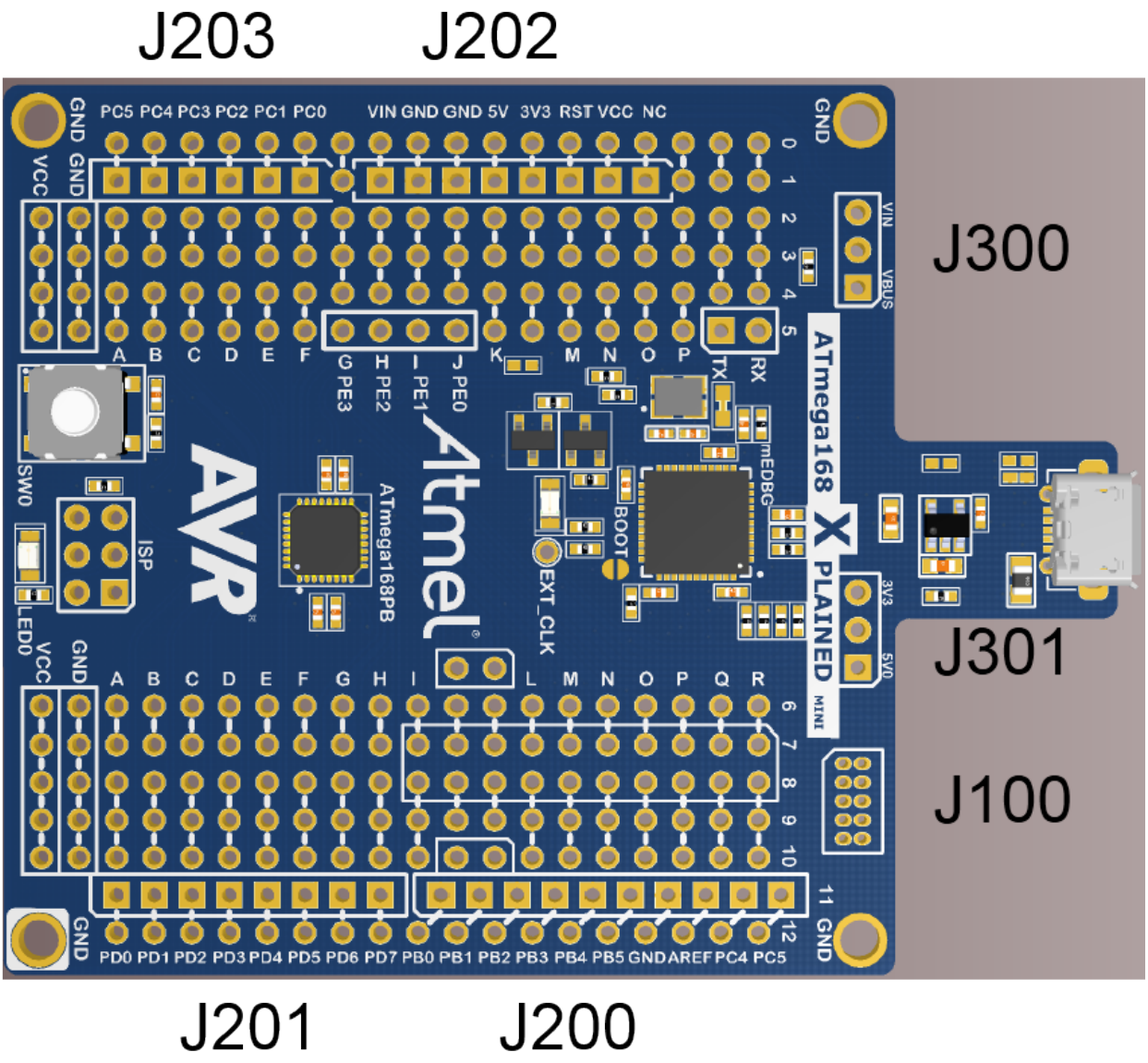
[3] http://spaces.atmel.com/gf/project/avr_xp_mini/

Any Morse code transmitted by using the switch will be displayed as text in the terminal window.

2. Hardware User Guide

2.1 Board Overview

Figure 2-1. ATmega168PB-XMINI Overview



2.2 Clock Distribution

The ATmega32U4 (mEDBG) has an external 16MHz XTAL.

The ATmega32U4 provides an external 16MHz clock to the ATmega168PB (target).

2.3 Headers and Connectors

The board headers and connectors.

2.3.1 JTAG (J100)

J100 is the JTAG programming header typically used by the JTAGICE for programming of the ATmega32U4 (mEDBG).

Table 2-1. J100 JTAG Header

J100 pin	Signal function
1	JTAG_TCK

J100 pin	Signal function
2	GND
3	JTAG_TDO
4	VCC (5V0)
5	JTAG_TMS
6	RESET
7	NC
8	NC
9	JTAG_TDI
10	GND

2.3.2 USB (J101)

J101 is a Micro-B USB connector connected to the embedded debugger (ATmega32U4).

Table 2-2. J101 USB Connector

J101 pin	Function
1	VBUS
2	D-
3	D+
4	NC
5	GND

2.3.3 USART (J104)

The ATmega32U4 USART signals are available on J104 USART header.

The mEDBG CDC COM port is connected to these signals.

Table 2-3. J104 USART Header

J104 pin	ATmega32U4	ATmega168PB	Function
1 - UART TXD	PD3	PD1	TxD from ATmega32U4.
2 - UART RXD	PD2	PD0	RxD to ATmega32U4.

2.3.4 Target Digital I/O (J200 and J201)

The J200 and J201 headers provide access to ATmega168PB digital I/O pins.

Table 2-4. J200 I/O High Header

J200 pin	ATmega168PB pin	Note
J200-1	PB0	
J200-2	PB1	
J200-3	PB2	
J200-4	PB3	
J200-5	PB4	
J200-6	PB5/SCK	Yellow USER LED D200 connected.
J200-7	GND	
J200-8	AREF	
J200-9	PC4/SDA	TWI Serial Data.
J200-10	PC5/SCL	TWI Serial Clock.

Table 2-5. J201 I/O Low Header

J201 pin	ATmega168PB pin	Note
J201-1	PD0/RxD	Target USART Receive Pin.
J201-2	PD1/TxD	Target USART Transmit Pin.
J201-3	PD2	
J201-4	PD3	
J201-5	PD4	
J201-6	PD5	
J201-7	PD6	
J201-8	PD7	

2.3.5 Target Analogue I/O (J203)

The ATmega168PB analogue I/O pins are available in the J203 header.

Table 2-6. J200 Analogue Header

J203 pin	ATmega168PB pin
J203-1	PC0
J203-2	PC1
J203-3	PC2
J203-4	PC3
J203-5	PC4
J203-6	PC5

2.3.6 Power (J202, J300, J301)

The J300 and J301 headers enables selection of power sources and target supply power, the J202 header enables connection to the power system.

Table 2-7. J202 Power Header

J202 pin	Signal	Description
1	NC.	
2	VCC_TARGET	ATmega168PB supply voltage.
3	RESET_SENSE	RESET from external source, monitored by the mEDBG, if pulled low the target RESET line will be pulled low. This functionality is NOT available during a debugging session because the RESET line is actively used by the debugWIRE interface. Applying a signal to RESET_SENSE while debugging may result in unexpected behaviour. It is possible to connect RESET_SENSE directly to the target by assembling R212 and removing R110. Note: DebgWIRE will then be disabled.
4	VCC_P3V3	3.3V from on-board DC/DC converter (U300).
5	VCC_P5V0	Voltage from the selected power source, default VBUS.
6	GND	
7	GND	
8	VCC_VIN	The externally connected power source if any.

2.3.6.1 Power Supply Configuration

The J300 and J301 headers enables Power supply configuration.

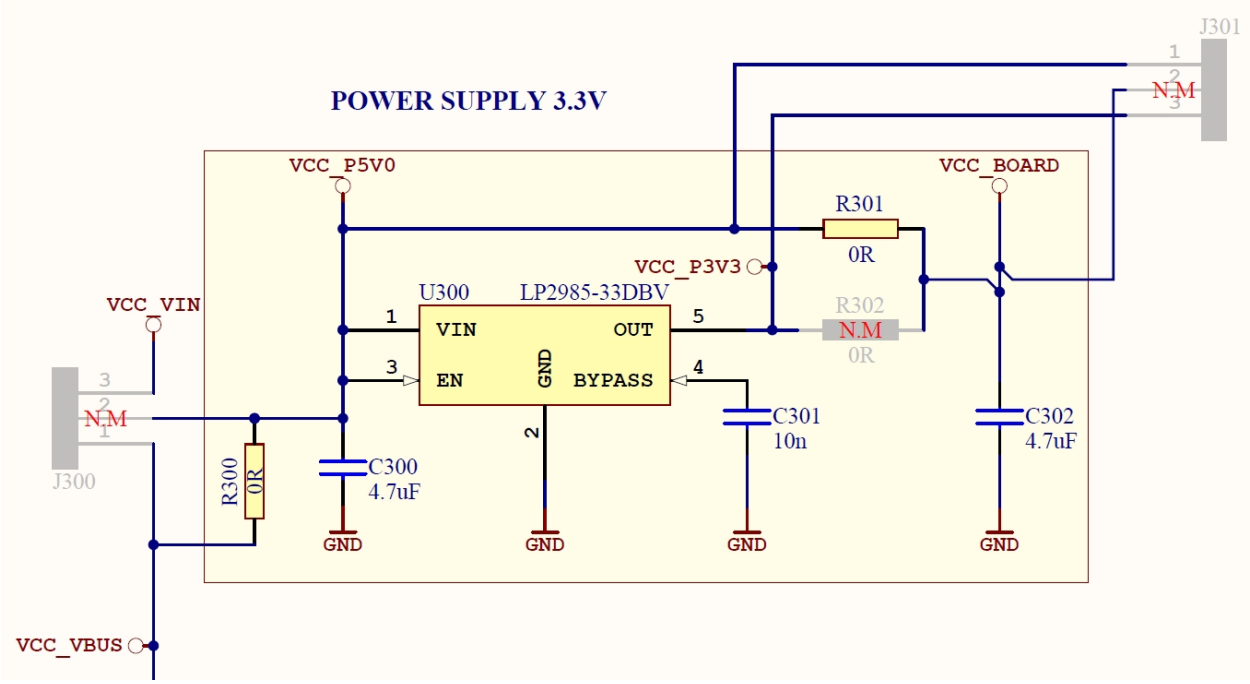


Table 2-8. J300 Board External Power Selection

J300 pin	Signal	Description
1	VCC_VBUS	VBUS Pin of USB Connector via fuse F100, by default connected to VCC_P5V0 via R300.
2	VCC_P5V0	Input voltage (4.3 to 16V) for the fixed-output voltage regulator (U300).
3	VCC_VIN	Alternative power source for the board (4.3 to 16V), study U300 data sheet for detail requirements.

Table 2-9. J301 Board Power Supply Selection

J301 pin	Signal	Description
1	VCC_P5V0	Board external power source as selected by J300, by default connected to VCC_BOARD via R301.
2	VCC_BOARD	Power supply for ATmega32U4 and ATmega168PB.
3	VCC_P3V3	Board 3.3V power supply from U300.

2.3.7 Target SPI (J204)

The J204 header enable direct connection to ISP for programming of the ATmega168PB or to use the SPI bus to connect external equipment.

Table 2-10. J204 SPI Header

J204 pin	Function
1	MISO
2	VCC target (ATmega168PB)
3	SCK
4	MOSI
5	RESET
6	GND

2.3.8 Additional Target Signals

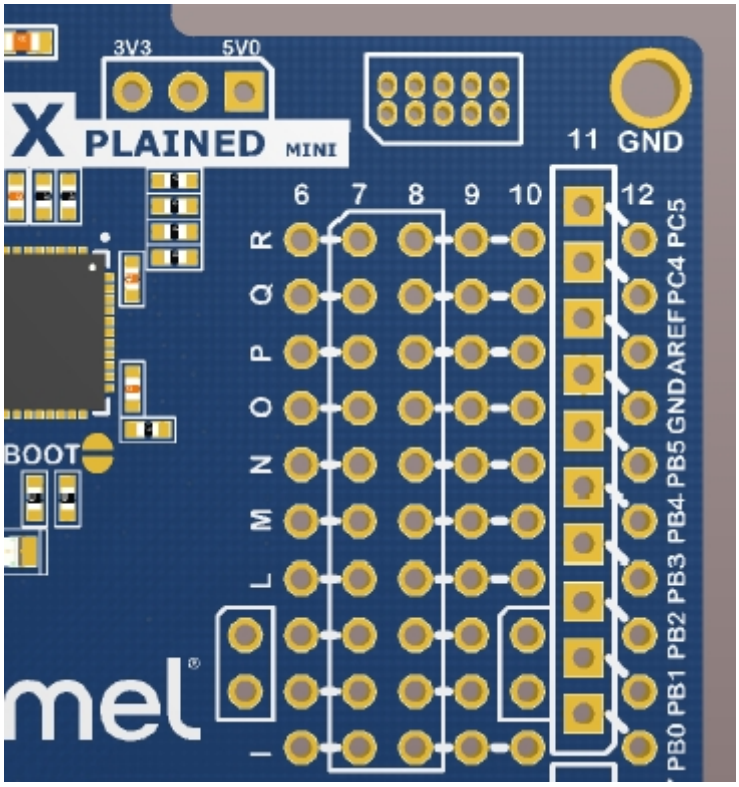
Signals not available in any of the headers or connectors are available in column 5.

Table 2-11. Target µC I/O Signals not connected to any Connector or Header

ATmega168PB pin	Grid position
PE0	J5
PE1	I5
PE2	H5
PE3	G5

2.3.9 Extension Headers

The marked area on the grid I7 to R8 can be used for strapping in a Xplained PRO extension header and a few other headers based on the SPI bus.



The general bus connections for a Xplained PRO Extension board is indicated in the Table 2-12, detailed wiring can be found in the selected Extension board documentation.

Table 2-12. Xplained Pro Extension Header

Pin	Name	Typical µC signal	Typical grid pin	Extension signal description
1	ID	NC		Communication line to the ID chip on extension board.
2	GND			Ground.
3	ADC(+)			Analogue to digital converter, positive part of differential ADC.
4	ADC(-)			Analogue to digital converter, 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. RESET to RF Extension board.
8	PWM(-)			Pulse width modulation, alternatively positive part of differential PWM.
9	IRQ/GPIO			Interrupt request line from extension board.

Pin	Name	Typical µC signal	Typical grid pin	Extension signal description
10	SPI_SS_B/ GPIO			Slave select for SPI and/or general purpose I/O. Wake up interrupt to RF extension (SLP_TR).
11	TWI_SDA	PC4/SDA	M6 to Q12	Data line for two-wire interface.
12	TWI_SCL	PC5/SCL	M9 to R12	Clock line for two-wire interface.
13	USART_RX	PD0/RXD	L6 to A12	USART Input Pin from extension board, remove R107 if used.
14	USART_TX	PD1/TXD	L9 to B12	USART Output Pin to extension board, remove R108 if used.
15	SPI_SS_A	PB2/SS	K6 to K5.5	Slave select for Serial peripheral interface.
16	SPI_MOSI	PB3/MOSI	K9 to K10	Master out slave in line of Serial peripheral interface.
17	SPI_MISO	PB4/MISO	J6 to J5.5	Master in slave out line of Serial peripheral interface.
18	SPI_SCK	PB5/SCK	J9 to J10	Clock for Serial peripheral interface.
19	GND		I6 to GND	Ground.
20	VCC		I9 to VCC	Power for extension board.

A number of Xplained PRO Extensions can be found at http://www.atmel.com/products/microcontrollers/avr/xplainedpro.

Using Pin 11 to 20 enables connection of the 10-pin connector used on the RZ600 wireless modules and the 10-pin Xplained sensor modules.

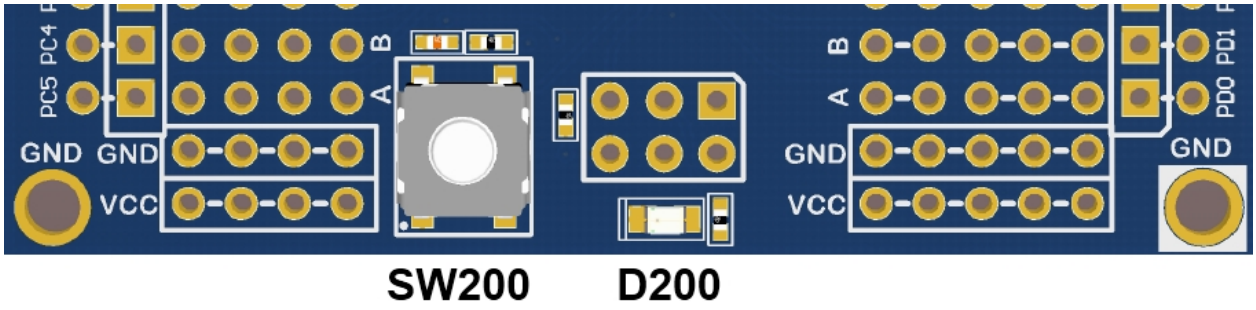
2.4 Board GUI

2.4.1 LEDs

There are One LED available for use by the application SW and one for the mEDBG.

Table 2-13. LEDs

LED	Function
D100 - Green	mEDBG, will light during enumeration.
D200 - Yellow	ATmega168PB pin 17 - PB5, also connected to mEDBG SCK for ISP programming, in 3-state when not used by the ATmega32U4.



2.4.2 Button

A button is available for general use by application SW.

Table 2-14. Button

Button	Function	ATmega168PB pin
SW200	User defined high signal, press to ground (negate).	8 - PB7

2.5 Factory Programmed Data

The ATmega168PB Xplained Mini board comes with a demo program preprogrammed in the ATmega168PB FLASH using the external clock provided by the ATmega32U4.

The ATmega32U4 is preprogrammed with the mEDBG.

3. Document Revision History

Document revision	Date	Comment
42381A	10/2014	Initial document release

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