

AVR Programmer and Multitool

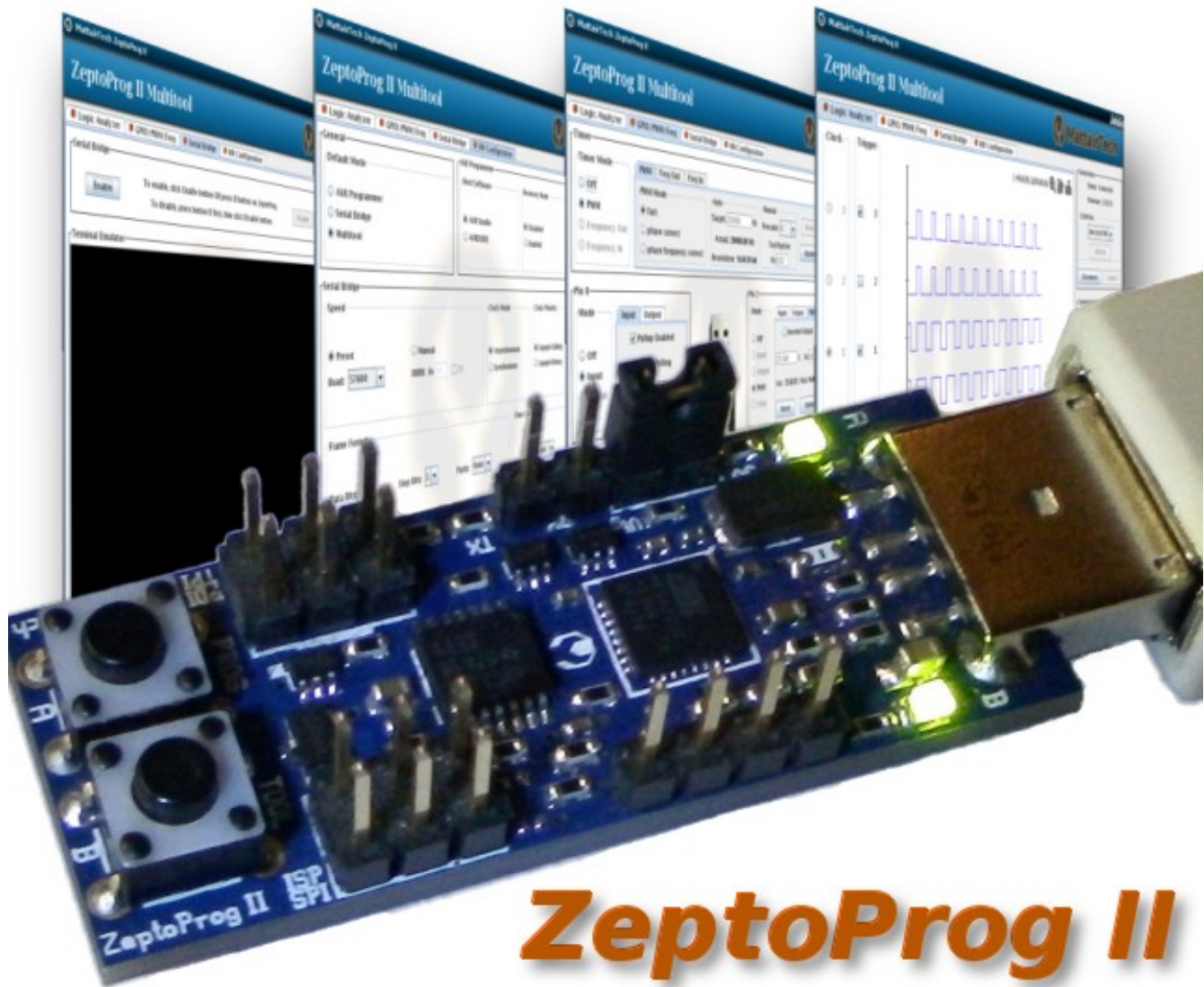
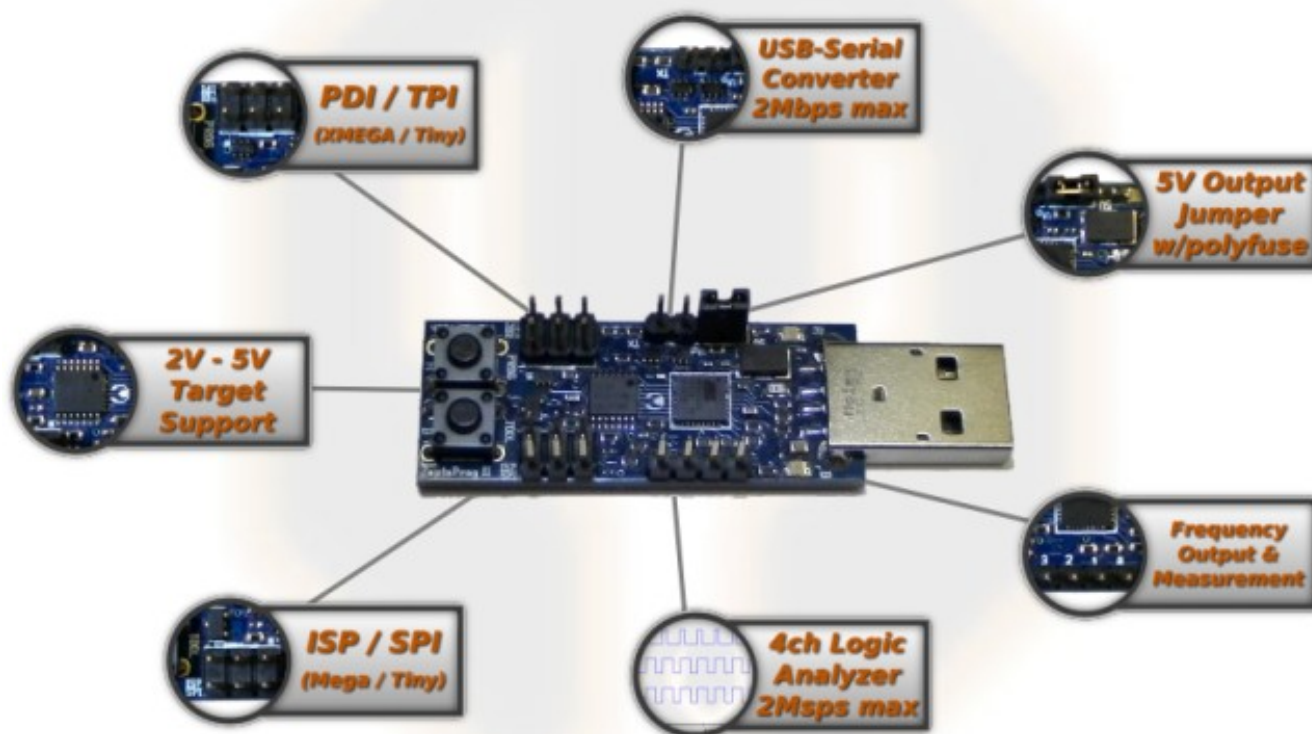


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ZeptoProg II

AVR Programmer and Multitool



Overview

Introduction

The ZeptoProg II™ is an AVRISP mkII compatible USB AVR programmer that supports chips with the ISP, PDI, or TPI programming interfaces, which includes most megaAVR®, tinyAVR®, and XMEGA™ series devices. It supports high-speed in-system programming of the AVR flash, EEPROM, fuses, lock bits, and more using AVR Studio 4 and 5, Atmel Studio 6 and 7, or AVRDUDE. Target boards operating at 2V to 5.5V are supported. A jumper can be installed to provide 5V through a PTC fuse to the target board. Additionally, a multitool mode implements a simple 4-channel logic analyzer, GPIO, PWM, frequency output, frequency measurement, a SPI interface, and configuration, all accessible using the ZeptoProg II Java application or the command line using a terminal emulator. Finally, the USB to serial bridge can be used to connect the target to a computer over USB (virtual COM port) at up to 2Mbps (not recommended for 115.2Kbps or 230.4Kbps).



Java GUI Application

The ZeptoProg II multitool functions can be accessed using a Java GUI application that runs on Windows and Linux (Mac support included, but untested). This includes the logic analyzer, GPIO, PWM, frequency output, frequency measurement, and configuration. Additionally, the serial bridge can be accessed using a very simple terminal emulator. A SPI tab will be added in a future version. The timer configuration, PWM, and frequency output functions allow entering the target frequency or duty cycle percentage directly, with auto-calculation of the prescaler, top value, PWM resolution, and the actual frequency (due to quantization error). The frequency measurement displays quantization error as well. The inputs and frequency measurement can be automatically polled.



Features

- **AVRISPmkII compatible AVR Programmer**
 - Supports all AVR's with ISP, PDI, or TPI programming interface using standard pinouts
 - Includes megaAVR, tinyAVR, XMEGA, and USB, PWM, and CAN AVR's
 - **Optional 5V output** via headers to target board, with standard **jumper and PTC fuse**
 - Up to 8MHz programming speed with optional recovery clock
 - Program flash, EEPROM, fuses, lock bits, and more
 - **Works with AVR Studio 4 and 5, Atmel Studio 6 and 7, AVRDUDE**, Codevision, and BASCOM 2.0.6 (use AVRDUDE mode)
- **Multitool**
 - **Interface using Java GUI application** or command line (via terminal emulator)
 - **Logic Analyzer** (GUI only)
 - 4 channels, trigger on any combination of pins (or immediately)
 - Fast mode: 1024 samples at 2Msps
 - Auto mode: samples on external clock, up to 60Ksps, up to 10K samples
 - Manual mode: configurable sample rate up to 100Ksps, up to 10K samples
 - Pre-trigger buffer (up to 10K samples), post-trigger delay (up to 50K samples)
 - **GPIO / PWM / frequency input & output**
 - 7 TTL inputs, 9 outputs (5 level shifted)
 - 2 PWM outputs with separate duty cycles
 - 1 frequency output
 - 1 frequency measurement input
 - Pattern generator available in alternate firmware
 - **SPI Interface**
 - Up to 8MHz clock, ZeptoProg II is master, Modes 0-3, MSB or LSB
 - 4 chip select outputs (push-pull or open-drain w/ optional pullup)
- **Serial Bridge**
 - Separate serial pins (simultaneous connection of programming cable and serial RX/TX)
 - Up to 2MHz baud rate, synchronous or asynchronous operation
 - Not recommended for 115200 or 230400 baud
 - Optional flow control via `_CTS_` and `_RTS_` pins, 9-bit support
- Upgradeable firmware / USB bus powered
- 2 buttons for control / 2 LEDs for status indication
- **Target board voltage support of 2V to 5.5V** via level-shifted pins on two main headers
- **Reverse polarity protection** on Vtgt and GND pins
- **Over-current protection** on all output pins via series resistors (signal) and PTC fuse (power)
- Measures 5.9cm x 1.8cm x 1.2cm, 1.57mm (0.063") PCB thickness
- Compatible with Windows XP/Vista/7/8/10 (32 and 64 bit) and Linux, with Mac support in progress.
- Uses the AVRISP mkII clone and LUFA library by Dean Camera (<http://www.lufa-lib.org>).

QuickStart

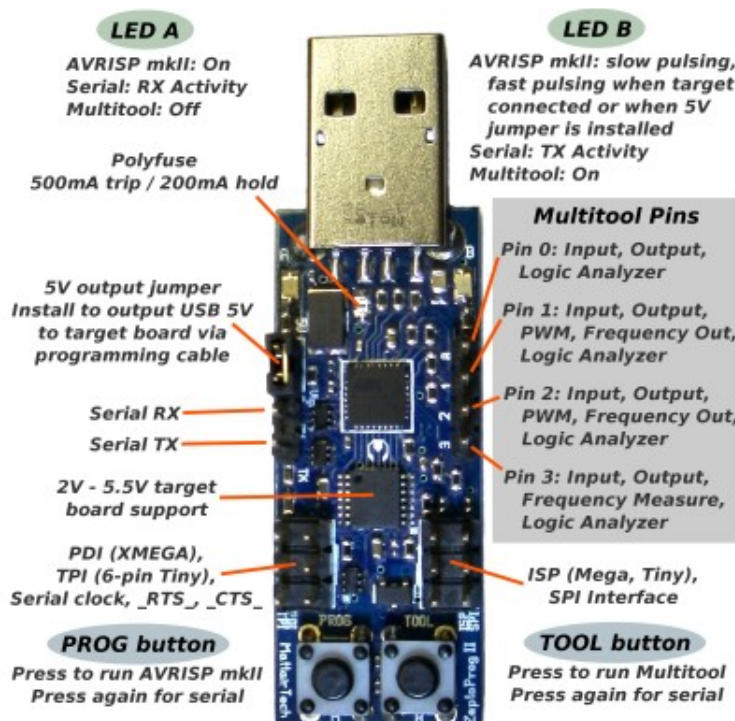
Installation

Before using the ZeptoProg II, you must install at least the AVRISP mkII driver and the MattairTech CDC (virtual COM port) driver. A third DFU driver is available for firmware updates (see Firmware Updates section). If using Atmel Studio 7, the AVRISPMkII driver must now be downloaded separately (see below). Extract the archive to any directory, then plug in the ZeptoProg II. Windows will prompt for drivers, so direct the installer to the new directory. Prior versions of Atmel Studio bundled the AVRISP mkII driver. In these cases, point the installer to "Program Files/Atmel/AVR Jungo USB" and choose the 32 or 64 bit directory. Once the AVRISPMkII driver is installed, press the TOOL button. Point the installer to the directory where you extracted the CDC driver. Remember to rename the file from .txt to .inf if the installer does not see it.

Software	Version	Driver	URL
AVRISPMkII Driver	latest	AVRISPMkII driver	https://www.mattairtech.com/software/MattairTech_AVRISPMkII_Driver_Signed.zip
Tool mode CDC Driver	latest	CDC driver	https://www.mattairtech.com/software/MattairTech_CDC_Driver_Signed.zip
ZeptoProg II Application	latest	N/A	http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II.jar or http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II_64.jar
AVR Studio / Atmel Studio	4.19, 5.x, 6.x, 7.x	Old AVRISPMkII	http://www.atmel.com/tools/atmelstudio.aspx OR http://www.atmel.com/tools/studioarchive.aspx (for AVR Studio)

Multitool

The Multitool currently includes a simple logic analyzer, GPIO, PWM, frequency generation, frequency measurement, a SPI interface, and configuration. The ZeptoProg II Java application or the command line (via terminal emulator) can be used to interface with the multitool. The Java application runs under Windows and Linux (Mac support included but untested) and should be intuitive enough to learn without much documentation. Features include auto-calculation of the prescaler, top value, PWM resolution, and the actual frequency (due to quantization error). The frequency measurement displays quantization error as well. The inputs and frequency measurement can be automatically polled.



AVRISP mkII Compatible Programmer

The AVRISP mkII compatible programmer is compatible with AVR Studio 4.19, 5.x, and Atmel Studio 6.x. AVR Studio 4.19 can be used with older hardware. All versions can be installed simultaneously. AVRDUDE is also supported. To use AVRDUDE, you will need to install libusb-win32 available at <http://sourceforge.net/projects/libusb-win32/files/libusb-win32-releases/>. Choose the latest version, download, and extract. Then, you must switch the programmer to AVRDUDE mode in the configuration tab of the ZeptoProg II application (or command line). Then, with the board in programming mode, run the install-filter-win.exe program included with libusb, which will allow you to install the filter driver.

While in programmer mode, LED B will pulse slowly. Connecting a powered target board to either programming header will cause the LED to pulse quickly. Use this to verify that the target board is powered. A jumper can be placed across the 5V and Vtgt pins to output USB 5V to the target board. This line has a PTC fuse (500mA trip, 200mA hold). Use caution when setting this jumper. DO NOT install the jumper when connecting to an XMEGA or any board that cannot withstand 5V. Also be sure that the target board can be powered in this way (ie: if there is a power supply on the target, can it be powered on the output side?). It is easy to forget that the jumper is installed. If the jumper is installed, the LED will pulse quickly regardless of whether a target board is connected. Always check the state of this LED before connecting a board.

Logic Analyzer

The 4-channel Logic Analyzer has 3 modes. In fast mode, 1024 samples are taken at 2Msps. Manual mode allows user selection of the sampling rate up to 100Ksps, with up to 10K samples. Auto mode makes use of one of the four pins as a sampling clock, either rising or falling edge, at up to 60Ksps and with up to 10K samples. In all modes, any combination of pins can be used as triggers to start the capture. If no triggers are selected, the capture starts immediately. In all modes, a post-trigger delay of up to 50K samples can be enabled. A pre-trigger buffer of up to 10K samples is available in manual and auto modes.

Serial Bridge

The serial bridge is a USB to TTL serial converter that can be used to connect the target board serial pins to a computer over USB, where it will show up as a virtual COM port. The serial bridge is configured in the configuration tab of the application. The bridge can run at up to 2Mbps, and supports asynchronous and synchronous modes, optional flow control via `_RTS_` and `_CTS_` pins, and support for 5-9 data bits. All pins are level-shifted to the Vtgt voltage. While the RX and TX lines are dedicated, the optional clock and flow control lines are shared on the PDI header. Additionally, a ground connection must be made. The ISP cable can provide this ground, or a single jumper wire can be connected to the ground pin on the PDI header (closest pin to TX). Because the outputs are level-shifted, Vtgt must also be provided, which can also be supplied via the programming cable or a single jumper wire.

Windows Installation

Before plugging in the ZeptoProg II for the first time, the latest software and drivers must be downloaded. The ZeptoProg II is supported under Windows XP, Vista (32 and 64 bit), and Windows 7 (32 and 64 bit). There is limited support for Windows 2000. The ZeptoProg II appears as three different devices to the PC depending on which mode is selected by the buttons. These devices are the AVRISP mkII compatible programmer, the DFU bootloader for firmware updates, and the USB CDC device (virtual COM port) which is used for all other modes. Therefore, three drivers are required. The DFU driver is included with software available on the Atmel website. The CDC driver is included with Windows, but requires an .inf file available on the MattairTech website. The following table lists the minimum versions of the required software. If the software provides a driver, it is listed as well. See the Firmware Updates section for installation of the DFU bootloader driver.

Required Downloads

Software	Version	Driver	URL
AVRISPMkII Driver	latest	AVRISPMkII driver	https://www.mattairtech.com/software/MattairTech_AVRISPMkII_Driver_Signed.zip
Tool mode CDC Driver	latest	CDC driver	https://www.mattairtech.com/software/MattairTech_CDC_Driver_Signed.zip
ZeptoProg II Application	latest	N/A	http://www.mattairtech.com/software/ZepetoProg_II/ZepetoProg_II.jar or http://www.mattairtech.com/software/ZepetoProg_II/ZepetoProg_II_64.jar
AVR Studio / Atmel Studio	4.19, 5.x, 6.x, 7.x	Old AVRISPMkII	http://www.atmel.com/tools/atmelstudio.aspx OR http://www.atmel.com/tools/studioarchive.aspx (for AVR Studio)

* 64-bit version of the application is BETA, use the 32-bit version if you have problems

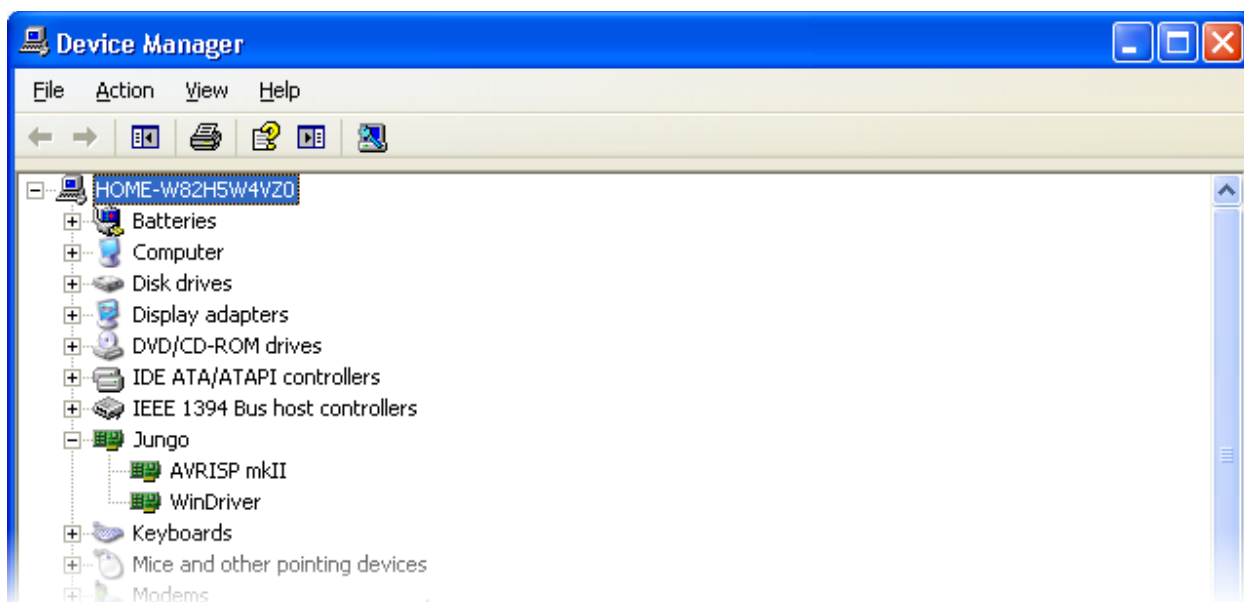
Atmel Studio (AVR Studio) / AVRISP mkII driver

Atmel Studio is a free IDE provided by Atmel that runs on Windows operating systems. It includes an assembler, debugger, simulator, and an AVR chip programming utility. As of April 2016, there are four main versions supported, AVR Studio 4.x and 5.x, and Atmel Studio 6.x and 7.x. The 4.x series is mature and stable, and can run on older hardware, however, it requires the use of the WinAVR gcc toolchain, which is out of date. It also lacks proper support for newer devices, like the XMEGA microcontrollers, but is still a good option for older devices. AVR Studio 4.x is also smaller and less demanding on PC resources. If you choose to use the 4.x series, download version 4.19. You will also need to download and install WinAVR 20100110 prior to installation.

If installing Atmel Studio 7, the AVRISPMkII driver must now be downloaded separately (see above). Extract the archive to any directory, then plug in the ZeptoProg II. The AVRISP mkII compatible AVR programmer will be running. LED A should be lit and LED B should be pulsing on and off. Windows will prompt for drivers, so direct the installer to the new directory. Prior versions of Atmel Studio bundled the AVRISP mkII driver. In these cases, point the installer to "Program

Files/Atmel/AVR Jungo USB” and select the appropriate directory (usb32 or usb64). Do not use the driver in the AVR Tools/usb directory.

If you are having problems communicating with the programmer using Atmel Studio 6.x, please use the procedure at <https://www.olimex.com/forum/index.php?topic=4188.0>



WinAVR

WinAVR contains the GNU GCC compiler for C and C++, compiler tools, and libraries (including AVR Libc). It also includes AVRDUDE for Windows, which is a command line tool for transferring firmware to AVR microcontrollers. A graphical tool is included with AVR Studio. Download WinAVR from <http://sourceforge.net/projects/winavr/files/WinAVR/20100110/> and install it first. To use AVRDUDE, you will need to download and install libusb-win32 available at <http://sourceforge.net/projects/libusb-win32/files/libusb-win32-releases/>. Choose the latest version, download, and extract. Then, you must switch the programmer to AVRDUDE mode in the configuration tab of the ZeptoProg II application (or command line). Then, with the board in programming mode, run the install-filter-win.exe program included with libusb, which will allow you to install the filter driver. Note that WinAVR is outdated. It is not recommended for newer devices like the XMEGA series.

AVRDUDE

AVRDUDE can also be installed by itself, but note that AVRDUDE 6.x does not yet support the ZeptoProg II (it will soon). A working patched version can be found at

http://www.mattairtech.com/software/avrdude_6.0.1_patched_windows.zip.

Thanks to Larry Viesse. For support on Linux 64-bit, download

http://www.mattairtech.com/software/avrdude_6.0.1_patched_Linux_64.zip.

For support on other Linux (especially with xhci (USB 3.0)), replace the usb_libusb.c file from 6.0.1 with http://www.mattairtech.com/software/usb_libusb.c.

To use AVRDUDE, you will need to download and install libusb-win32 available at <http://sourceforge.net/projects/libusb-win32/files/libusb-win32-releases/>. Choose the latest version, download, and extract. Next, you must switch the programmer to AVRDUDE mode in the configuration tab of the ZeptoProg II GUI application. Then, with the board in programming mode (pulsing LED), go to the directory where you installed LibUSB. In the bin directory, you will see three architectures. Click on the folder that matches your architecture. Note that most 64-bit systems will use the amd64 folder, even if it is Intel (IA64 is a server architecture; Itanium). Now, run the install-filter-win.exe program. Click “Install a device filter”, then click “Next”. On the next screen, choose the AVRISP mkII then click “Install”. After installation, close the window with the “X” button (upper-right corner).

BASCOM

BASCOM is supported with the programmer in AVRDUDE mode. Thus, the required setup shown above applies (installation of WinAVR is optional). Details of this process are covered on this BASCOM AVRISP MKII support page: <http://avrhelp.mcselec.com/libusb.htm>. They use AVR Studio 4, but you may install Atmel Studio 5 or higher instead. Follow scenario 1.

ZeptoProg II CDC Driver / Serial Configuration

Next, the ZeptoProg II CDC driver can be installed, which is used by the multitool and serial bridge. This driver allows the board to appear as a COM port. The driver itself is included with Windows, but an .inf file is needed to configure it. Download the .inf file from https://www.mattairtech.com/software/MattairTech_CDC_Driver_Signed.zip. Note that Windows Vista 64-bit, Windows 7 64-bit and Windows 8 require the signed driver. Now, plug in the ZeptoProg II while holding down the TOOL button. This will run the multitool. Only LED B will be lit. Windows will then prompt you for the ZeptoProg II CDC driver. Point the installer to the directory where you downloaded the driver and install. Note that you may need to rename the driver in order for it to show up in the installer. Windows may add the .txt extension to the file after downloading. Rename it so that it ends with .inf. Ignore any warnings given by the installer (ie: unsigned driver). Once the driver is loaded, the device will appear as the ZeptoProg II CDC device using a COM port in the device manager. There is no need to configure serial port parameters. The baud rate, for example, is ignored. The ZeptoProg II will always communicate with the computer at full speed (up to 2Mbps). If you experience any buffering problems, for example, a delayed response to user input, then change both buffer sizes to 1.

Terminal Emulator

Finally, the terminal emulator can be configured. Windows XP includes HyperTerminal, which has been tested with the ZeptoProg II and will be documented here. There are several other terminal emulators available freely on the Internet. If you wish to use any of them, it should be no trouble to adapt the instructions presented here.

Next, start HyperTerminal. Create a new connection. You will refer to this connection again, so give it an appropriate name (after it is configured, you can copy it to your desktop). Select the ZeptoProg II COM port (ie: COM4) and continue. It is not necessary to configure the baud rate or any other serial parameters. Now, click on the connect icon. You should see the ZeptoProg II prompt. If you do not, just press enter. Note that it may not be possible to switch between modes using the buttons until a key is pressed.

It is important to always click the disconnect icon before switching to the AVR Programmer. Then click the connect icon a couple seconds after returning. This is required because changing to the AVRISPmkII driver unloads the CDC driver, then loads the AVRISPmkII driver. In order for the terminal to use the same COM port as before, it must be disconnected when returning to the CDC driver so that it does not assign a new COM port.

Linux Installation

Linux is supported as well. You must download and build the toolchain from the latest script available at AVR Freaks on the AVR GCC Forum (Script for building AVR GCC sticky at <http://www.avrfreaks.net/index.php?name=PNphpBB2&file=viewtopic&t=42631>). All firmware written for the ZeptoProg II is developed under Linux using this toolchain.

Drivers

TODO (drivers should already be installed)

GCC Toolchain

TODO (see opening paragraph)

AVRDUDE

TODO (ie: avrdude -p x128a1 -c avrisp2 -P usb -U flash:w:"myfirmware.hex")

dfu-programmer

TODO (must use version 0.5.2 (currently available via SVN only) or higher)

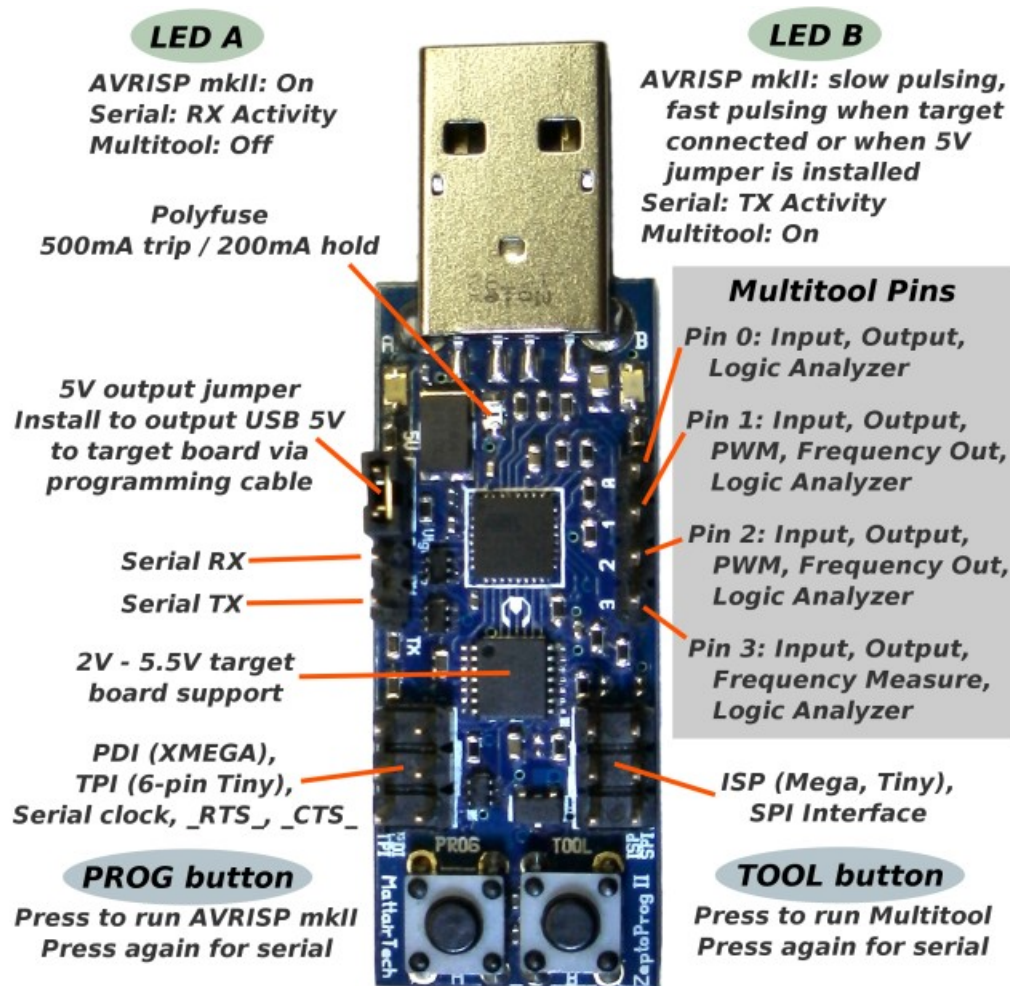
Terminal Emulator

TODO (can use minicom, config port (ie: /dev/tty/ACM0), save config, run with minicom -o)

- If you cannot run the java application, be sure to install the 32-bit version of Java, which can co-exist with the 64-bit version. If running Linux, a 64-bit version is available at http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II_64.jar, but it may not work with your JRE (it should work with 1.6, but this is now pretty old).

ZeptoProg II Hardware

Layout / Header Pins



Header Pinouts (as viewed from above as in diagram, **bold** is multitool numbering)

Header A

6 GND	5 / 11 PCK / RTS / RST / out
4 / 10 CTS / in	3 / 9 TCK / XCK / out
2 Vtgt	1 / 8 data / in

Header B

1 / 4 MISO / in	2 Vtgt
3 / 5 SCLK / out	4 / 6 MOSI / out
5 / 7 RST / out	6 GND

Pin Descriptions

Pin	Description
0	Multitool: TTL input, output (push-pull or open-drain, optional pullup), NOT level shifted SPI: Chip Select 0 (open drain, active low, optional pullup)
1	Multitool: TTL input, output (push-pull or open-drain, optional pullup), PWM (push-pull), frequency output (push-pull), NOT level shifted SPI: Chip Select 1 (open drain, active low, optional pullup)
2	Multitool: TTL input, output (push-pull or open-drain, optional pullup), PWM (push-pull), frequency output (push-pull), NOT level shifted SPI: Chip Select 2 (open drain, active low, optional pullup)
3	Multitool: TTL input, output (push-pull or open-drain, optional pullup), NOT level shifted, frequency input SPI: Chip Select 3 (open drain, active low, optional pullup)
4	Multitool: TTL input SPI: MISO (TTL) AVRISP mkII: MISO (TTL, ISP mode)
5	Multitool: output (push-pull, level shifted) SPI: SCLK (push-pull, level shifted) AVRISP mkII: SCLK (ISP mode, push-pull, level shifted)
6	Multitool: output (push-pull, level shifted) SPI: MOSI (push-pull, level shifted) AVRISP mkII: MOSI (ISP mode, push-pull, level shifted)
7	Multitool: output (open-drain, 47Kohm pullup to Vtgt) SPI: unused (always high, 47Kohm pullup to Vtgt) AVRISP mkII: Reset output (ISP mode, open-drain, 47Kohm pullup to Vtgt)
8	Multitool: TTL input AVRISP mkII: data (PDI/TPI mode, bi-directional, level shifted push-pull or TTL)
9	Multitool: output (push-pull, level shifted) Serial Bridge: XCK (synchronous mode, push-pull, level shifted) AVRISP mkII: TCK (TPI mode clock), recovery clock (ISP mode), push-pull, level shifted
10	Multitool: TTL input Serial Bridge: _CTS_ input (TTL, active low, 20K-50K pullup to 5V, see Serial Bridge section) AVRISP mkII: unused (high impedance)
11	Multitool: output (open-drain, 47Kohm pullup to Vtgt) Serial Bridge: _RTS_ output (active low, open-drain, 47Kohm pullup to Vtgt) AVRISP mkII: PCK (PDI clock), RST (TPI mode reset), open-drain, 47Kohm pullup to Vtgt
TX	Serial Bridge: TX (push-pull, level shifted)
RX	Serial Bridge: RX (TTL, 20K-50K pullup to 5V, see Serial Bridge section)
Vtgt	2V – 5.5V Voltage input from target. Used to set level shifter voltage. Reverse polarity protected when jumper not installed. Outputs 5V when 5V-Vtgt jumper installed. When using the 5V-Vtgt jumper, it is strongly recommended to connect the target board to the header prior to plugging into a USB port. Keep the target board connected when unplugging from the USB port.
5V	5V output from USB Vbus, PTC fuse protected (500mA trip, 200mA hold)
GND	Ground (2 pins)

Buttons / LED's

There are four modes of operation which are selected using the buttons. During powerup, the mode can be selected by holding down the appropriate buttons (if any) when plugging into the USB port. If no button is held down, the default mode will run, which can be configured as the multitool, the AVRISP mkII programmer, or the serial bridge. If both buttons are held down, the DFU bootloader will run. The modes can be changed during runtime as well, except for the DFU Bootloader, which can only be accessed during powerup. Pressing the PROG button (A) runs the programmer. The AVR is always reset via the watchdog before running the programmer. If the programmer is already running, pressing the PROG button will enter the serial bridge. Thus, repeated pressing of the PROG button toggles between the programmer and serial bridge, which is useful for debugging. Pressing the TOOL button (B) runs the multitool. If the multitool is already running, pressing the TOOL button will enter the serial bridge. The following table lists the button functionality.

Button Functionality During Powerup or Runtime

PROG (A)	TOOL (B)	Powerup	Runtime
Pressed	Not Pressed	AVRISP mkII Programmer	AVRISP mkII Programmer Serial bridge if already in programmer
Not Pressed	Pressed	Multitool	Multitool Serial bridge if already in multitool
Not Pressed	Not Pressed	Default Mode programmer, multitool, or serial bridge	N/A
Pressed	Pressed	DFU Bootloader	N/A

There are two green LEDs that are used to indicate the mode of operation, communication activity, and programmer status. The following table lists LED functionality in each mode. When an LED is used to display communication activity, the default state of the LED is shown on the left. For example, during serial bridge RX activity, the LED blinks off for a short time then returns to the default on state.

LED Functionality

Mode	LED A	LED B
AVR Programmer	On / Programmer Activity	PWM pulsing Slow: Target board absent or Vtgt too low Fast: Target board connected or jumper installed
Multitool	Off / Logic Analyzer Data	On / SPI Activity
Serial bridge	On / RX Activity	On / TX Activity
DFU Bootloader	On	Off

AVRISP mkII Compatible Programmer

The ZeptoProg II AVR Programmer is based on the AVRISP mkII compatible programmer written by Dean Camera (<http://www.fourwalledcubicle.com/>). It supports programming of all Atmel AVR microcontrollers with an ISP, PDI, or TPI programming interface. These include the megaAVR series (ISP), the tinyAVR series (ISP, TPI), the XMEGA series (PDI), the USB AVRs (ISP), and the listed CAN and PWM AVRs (see Appendix B for device listing). AVR Studio 4.19 and 5.x, Atmel Studio 6.x and 7.x, and AVRDUDE are supported. The ZeptoProg II uses the standard header pinouts for all protocols. The PDI and TPI modes both use programming header A, while ISP mode uses header B. See hardware section for details on the pinouts.

Programming speeds up to 8MHz are supported in ISP mode. However, current AVRs require a programming speed less than $\frac{1}{4}$ of the target clock speed. For 20MHz AVRs, this is 4MHz. For 16MHz, 2MHz is the limit. It is not recommended to operate at exactly $\frac{1}{4}$ of the target frequency, especially when programming fuses, as this can cause them to become incorrectly set and possibly render the AVR useless (unless parallel programming is available). Note that many AVRs come from the factory with the clock source set to the internal 8MHz oscillator and with the CKDIV8 fuse programmed, resulting in a clock speed of 1MHz. In these cases, the ISP programming speed should be set to 125KHz or less until CKDIV8 is unprogrammed and power cycled.

As of firmware version 140126, PDI and TPI programming speeds are now configurable when using AVRDUDE. By default the PDI/TPI programming speed is 125KHz (250KHz prior to firmware 140126). This speed can be increased up to 250KHz and decreased down to around 17KHz by using the -B option. This option controls the clock period (in ms), so higher numbers mean lower speeds.

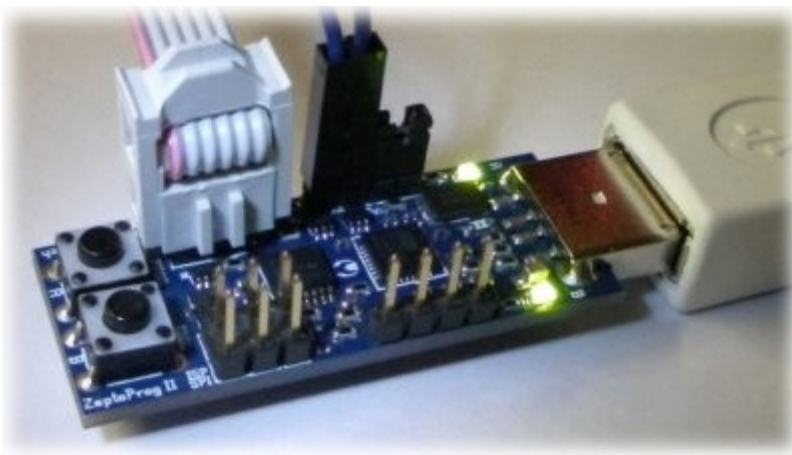
For ISP mode, a 1MHz recovery clock can be enabled on the XCK pin (header A). This clock can be connected to the target clock input. This is useful, for example, to allow resetting of fuses that were mis-configured to use an external clock when intending to use a crystal or internal oscillator. This recovery clock should only be used with an ISP programming speed of 125KHz or less.

The ZeptoProg II supports target devices operating at 2V to 5.5V. Outputs from the ZeptoProg II are level-shifted down to the target voltage. The target device supplies this voltage via the Vtgt input. This input is reverse-polarity protected when the 5V-Vtgt jumper is not installed. LED B will pulse slowly when no target board is connected. It will pulse quickly when a powered target board is connected (~2V or higher). The outputs on the programming headers (A and B) have series resistors that limit current and control overshoot and ringing.

A jumper can be connected across the 5V and Vtgt pins to output USB 5V to the target via the programming headers. Use caution when installing this jumper (see Appendix A). DO NOT install this jumper when connecting to an XMEGA device. LED B will pulse quickly at all times when this jumper is installed, so it can be used as a reminder that the jumper is installed if it is seen pulsing quickly without a target board connected. This 5V output is protected from overcurrent conditions by a PTC fuse. The fuse will trip before reaching 500mA. It will automatically reset when the current drops below about 200mA.

Always ensure that the ZeptoProg II is powered before connecting the target board. If a powered target board is connected to an unpowered ZeptoProg II, it will be detected and will enter a low power state. Note that the orientation of the programming cable connector is marked on the PCB.

Pin 1 is indicated by an asterisk. The connector key points toward the inside of the board. The red wire will be on the side of the asterisk (there is also a key mark, but it may be difficult to see).



Configuration

The AVRISP mkII programmer has two configuration options. The first is the selection of the host application, which can be either AVR Studio or AVRDUDE. This is required because these two modes use a slightly different USB endpoint configuration. If you are using Linux, then this setting will not matter, as they both work with AVRDUDE for Linux (AVR Studio is not available for Linux). Use the **sysconfig host** command to view or change the host configuration.

sysconfig host get

returns: **avrstudio | avrdude | SYNTAX ERROR**

example: **sysconfig host get**
 avrstudio

sysconfig host { avrstudio | avrdude }

returns: **OK | SYNTAX ERROR**

example: **sysconfig host avrdude**
 OK

The second programmer configuration option enables or disables the recovery clock. The recovery clock can be used in ISP programming mode to output a 1MHz clock signal to the target, which is useful if incorrect fuse settings result in an unusable AVR. For example, if the fuses were set to an external clock or to a low frequency crystal, when in fact a high frequency crystal is present, then the AVR will not operate. The only way to recover is to supply a clock signal, for example, to the XTAL1

pin. It is not usually necessary to remove the crystal, if present, as the clock signal will override it. The recovery clock is output on pin 9 (programming header A, marked as TCK/XCK). Be sure that the host is configured for an ISP speed of 125KHz (AVR Studio default) or less. Use the **sysconfig recovery** command to view or change the recovery mode setting.

sysconfig recovery get

returns: disabled | enabled | SYNTAX ERROR

example: sysconfig recovery get
disabled

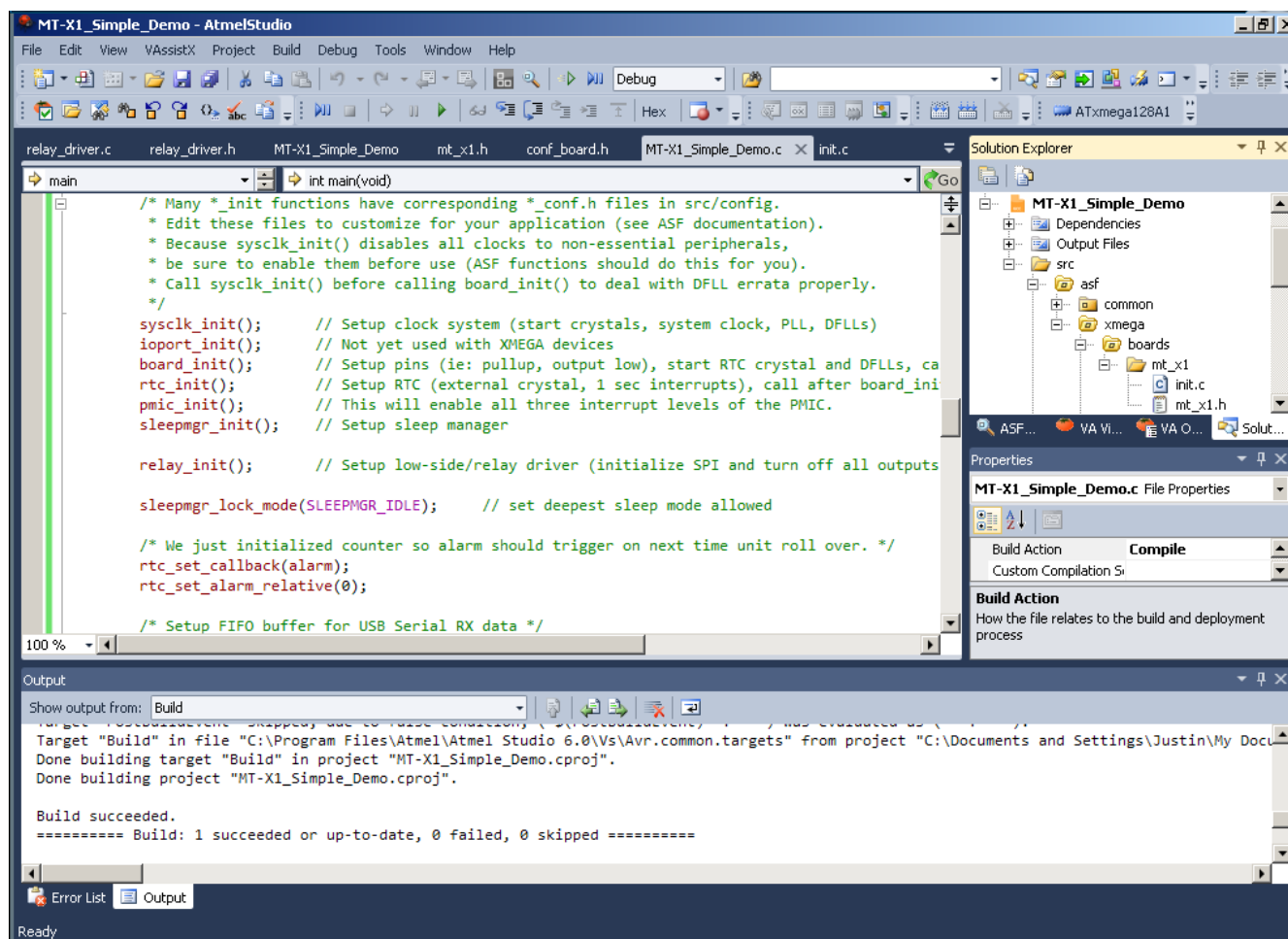
sysconfig recovery { disabled | enabled }

returns: OK | SYNTAX ERROR

example: sysconfig recovery enabled
OK

Using Atmel Studio (AVR Studio)

Start Atmel Studio and open or create a new project. The following screenshots from Atmel Studio 6 show the MT-X1S_Simple_Demo template for the MattairTech MT-X1S ATxmega128A1 development board.



Next, click on the Device Programming button. In the Device Programming window, select the AVRISP mkII as the tool. If no tool appears, be sure that the ZeptoProg II is plugged in and in programming mode (LED B will be pulsing). Select the appropriate device and either ISP, PDI, or TPI as the interface and click Apply. You should now be connected to the AVRISP mkII compatible programmer with serial number 000200012345. Now click Read next to Device signature. It should match the device if all is well. It is recommended to always perform this step first to verify the connection. The target voltage will always read 3.3V, regardless of the actual voltage.

AVRISP mkII (000200012345) - Device Programming

Tool: AVRISP mkII | Device: ATxmega128A1 | Interface: PDI | Apply

Device signature: 0x1E974C | Read | Target Voltage: 3.3 V | Read

Interface settings

Tool information

Device information

Memories

Fuses

Lock bits

Production Signatures

Production file

AVRISP mkII	
Debug host	127.0.0.1
Debug port	1443
Serial number	000200012345
Connection	com.atmel.avrdbg.connection.jungousb
Firmware Version	1.11
Hardware Version	0

External Link: [Tool Information](#)

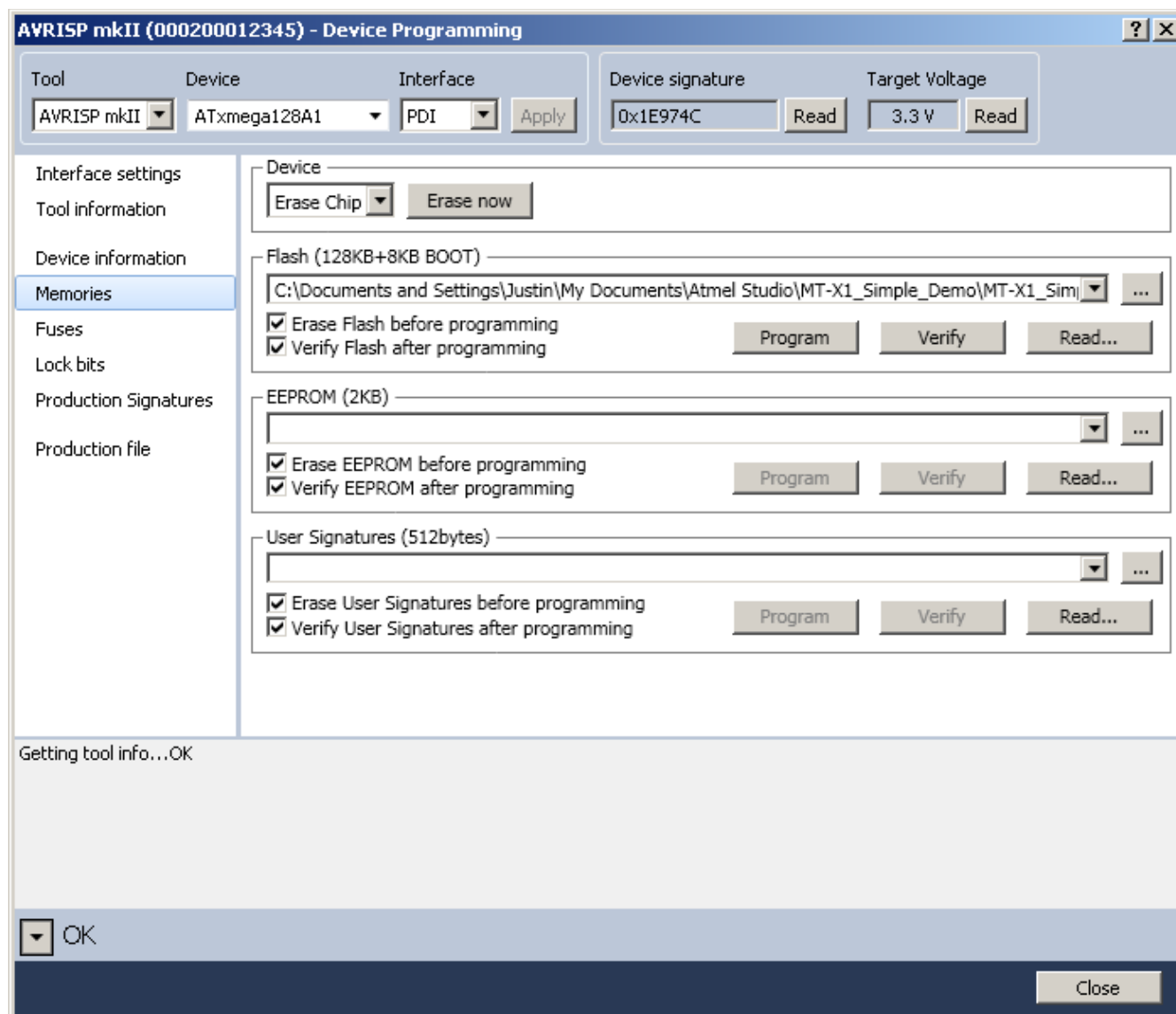
Copy to clipboard

Getting tool info...OK

Getting tool info...OK

Close

Next, select the Memories page. In the Flash section, a hex file can be programmed into the target's flash memory. Load your hex file, then click Program. The hex file is located in the Debug folder. You will need to erase the target first if you do not have "Erase Flash before programming" checked. You should also verify the flash as well.



Next, click on the Fuses tab. It is best to leave the fuse settings alone until you understand what they do. In particular, if using ISP, do not program RSTDISBL or unprogram SPIEN, as this will lock you out of the target chip. Do not set the BOD (Brown-out detection) voltage to a level above the target chip voltage, as this will cause the target to be held perpetually in reset. You must also be careful with the clock settings as well. If you select the wrong clock source, then your target chip will not operate if the configured clock source is not present. However, the ZeptoProg II provides a recovery clock which can be used to recover from this situation (see above).

AVRISP mkII (000200012345) - Device Programming

Tool: AVRISP mkII | Device: ATxmega128A1 | Interface: PDI | Apply

Device signature: 0x1E974C | Read | Target Voltage: 3.3 V | Read

Interface settings | Tool information | Device information | Memories | **Fuses** | Lock bits | Production Signatures | Production file

Fuse Name	Value
✓ JTAGUSERID	0xFF
✓ WDWP	8CLK
✓ WDP	8CLK
✓ DVSDON	<input type="checkbox"/>
✓ BOOTRST	APPLICATION
✓ BODACT	DISABLED
✓ BODPD	DISABLED
✓ RSTDISBL	<input type="checkbox"/>
✓ SUT	0MS
✓ WDLOCK	<input type="checkbox"/>

Fuse Register	Value
FUSEBYTE0	0xFF
FUSEBYTE1	0x00
FUSEBYTE2	0xFF
FUSEBYTE4	0xFF
FUSEBYTE5	0xFF

☒ Auto read
☒ Verify after programming

Copy to clipboard

Program | Verify | Read

Starting operation read registers
Reading register FUSEBYTE0...OK
Reading register FUSEBYTE1...OK
Reading register FUSEBYTE2...OK
Reading register FUSEBYTE4...OK
Reading register FUSEBYTE5...OK
Read registers...OK

Read registers...OK

Close

Now you may wish to look at the other pages. Note that any firmware upgrade feature should not be used. The ZeptoProg II programmer is not an actual AVRISP mkII, it just emulates one, so you should not attempt to update the ZeptoProg II firmware using Atmel Studio. Any firmware updates will be posted to the website and loaded using FLIP or dfu-programmer.

Using AVRDUDE

TODO (ie: avrdude -p x128a1 -c avrisp2 -P usb -U flash:w:"myfirmware.hex")

Changing Programming Speed

TODO

Looks like AVRDUDE does indeed send the -B setting to the programmer during PDI programming. The PDI protocol itself does not specify a speed setting mechanism, so I am reusing the mechanism from ISP programming. With ISP programming over the AVRISP mkII protocol (defined in AVR069), the speed settings are limited to the following:

> 8000000, 4000000, 2000000, 1000000, 500000, 250000, 125000,
> 96386, 89888, 84211, 79208, 74767, 70797, 67227, 64000,
> 61069, 58395, 55945, 51613, 49690, 47905, 46243, 43244,
> 41885, 39409, 38278, 36200, 34335, 32654, 31129, 29740,
> 28470, 27304, 25724, 24768, 23461, 22285, 21221, 20254,
> 19371, 18562, 17583, 16914, 16097, 15356, 14520, 13914,
> 13224, 12599, 12031, 11511, 10944, 10431, 9963, 9468,
> 9081, 8612, 8239, 7851, 7498, 7137, 6809, 6478, 6178,
> 5879, 5607, 5359, 5093, 4870, 4633, 4418, 4209, 4019,
> 3823, 3645, 3474, 3310, 3161, 3011, 2869, 2734, 2611,
> 2484, 2369, 2257, 2152, 2052, 1956, 1866, 1779, 1695,
> 1615, 1539, 1468, 1398, 1333, 1271, 1212, 1155, 1101,
> 1049, 1000, 953, 909, 866, 826, 787, 750, 715, 682,
> 650, 619, 590, 563, 536, 511, 487, 465, 443, 422,
> 402, 384, 366, 349, 332, 317, 302, 288, 274, 261,
> 249, 238, 226, 216, 206, 196, 187, 178, 170, 162,
> 154, 147, 140, 134, 128, 122, 116, 111, 105, 100,
> 95.4, 90.9, 86.6, 82.6, 78.7, 75.0, 71.5, 68.2,
> 65.0, 61.9, 59.0, 56.3, 53.6, 51.1

These are the numbers you may see in the Atmel Studio programming window when using ISP. I don't think that PDI programming has a speed setting in Atmel Studio, but I'm not sure. I have not checked how AVRDUDE translates -B values (in microseconds) to the value required by the AVRISP mkII protocol (an index into the above table; ie: sending a 6 results in a speed of 125KHz).

PDI programming will be limited to the above speeds, but only up to 250KHz. The old fixed speed was 250KHz. The new default speed is 125KHz (same as ISP). I have only been able to get the speed down to around 17KHz (using -B 58). Larger values like -B 100 did not work.

Multitool

The multitool combines a simple logic analyzer, frequency output, PWM output, frequency measurement, GPIO, a SPI interface, and configuration for the serial bridge, SPI interface, and the AVRISP mkII programmer, all accessible through a Java GUI application or the command line using a terminal emulator or scripting language. The multitool is accessed by pressing the TOOL button (button B). This section covers most of the multitool capabilities. While the logic analyzer and SPI interface are a part of the multitool, they are covered in later sections.

Multitool Pin Mode Features / Specifications

Pin Mode	Features / Specifications
Input	0V-0.8V low, 2V-5.5V high, optional pullup (20-50Kohm to 5V)
Output	push-pull or open-drain (w/optional pullup), current limited to ~20mA
PWM	up to 16-bit resolution, up to MHz range PWM frequencies (low res), 2 independent channels, optional phase and frequency correct mode
Frequency Output	<1Hz - 8MHz square wave, two complimentary outputs (same frequency)
Frequency Measurement	0.333Hz - 125KHz, automatic quantization error calculation (GUI only), 1 channel, optional digital filter
Pattern Generator	Pins 0-3

The multitool primarily involves the use of pins 0-3, though the SPI interface uses header B. The 8 signal pins among both programming headers (pin 4 through pin 11) can also be used for GPIO (currently command line only). As inputs, all pins can read voltages as low as 2V as high. However, as outputs, only the pins on the two programming headers are level shifted. Because they are level shifted, the target voltage must be present on at least one of the Vtgt pins (ground must also be present). All pins that can serve as an output have 249 ohm series resistors for overcurrent protection and control of overshoot and ringing. The following table summarizes the pin capabilities

Multitool Main Pin Capabilities

Pin	Capabilities
0	Input, Output, Logic Analyzer, Pattern Generator
1	Input, Output, PWM, Frequency Out, Logic Analyzer, Pattern Generator
2	Input, Output, PWM, Frequency Out, Logic Analyzer, Pattern Generator
3	Input, Output, Frequency In, Logic Analyzer, Pattern Generator

Multitool Programming Headers Pin Capabilities

Pin	Capabilities
4	Input
5	Output
6	Output
7	Output
8	Input
9	Output
10	Input
11	Output

The multitool can operate in two modes, terminal mode enabled (default) and terminal mode disabled. When terminal mode is enabled, the multitool will output a prompt, echo sent characters, and send carriage return and newline characters when the user presses Enter. This mode is used when accessing the multitool from the command line. Note that when first connecting via a terminal emulator, the prompt may not be visible, depending on OS buffering. If this is the case, just press enter. When terminal mode is disabled, no prompt is printed, characters are not echoed, and only newlines are sent. This mode is useful when the multitool is accessed from a program. The Java GUI application uses this mode. Switching between modes is accomplished with the **terminal** command.

terminal on | off

returns: OK | SYNTAX ERROR

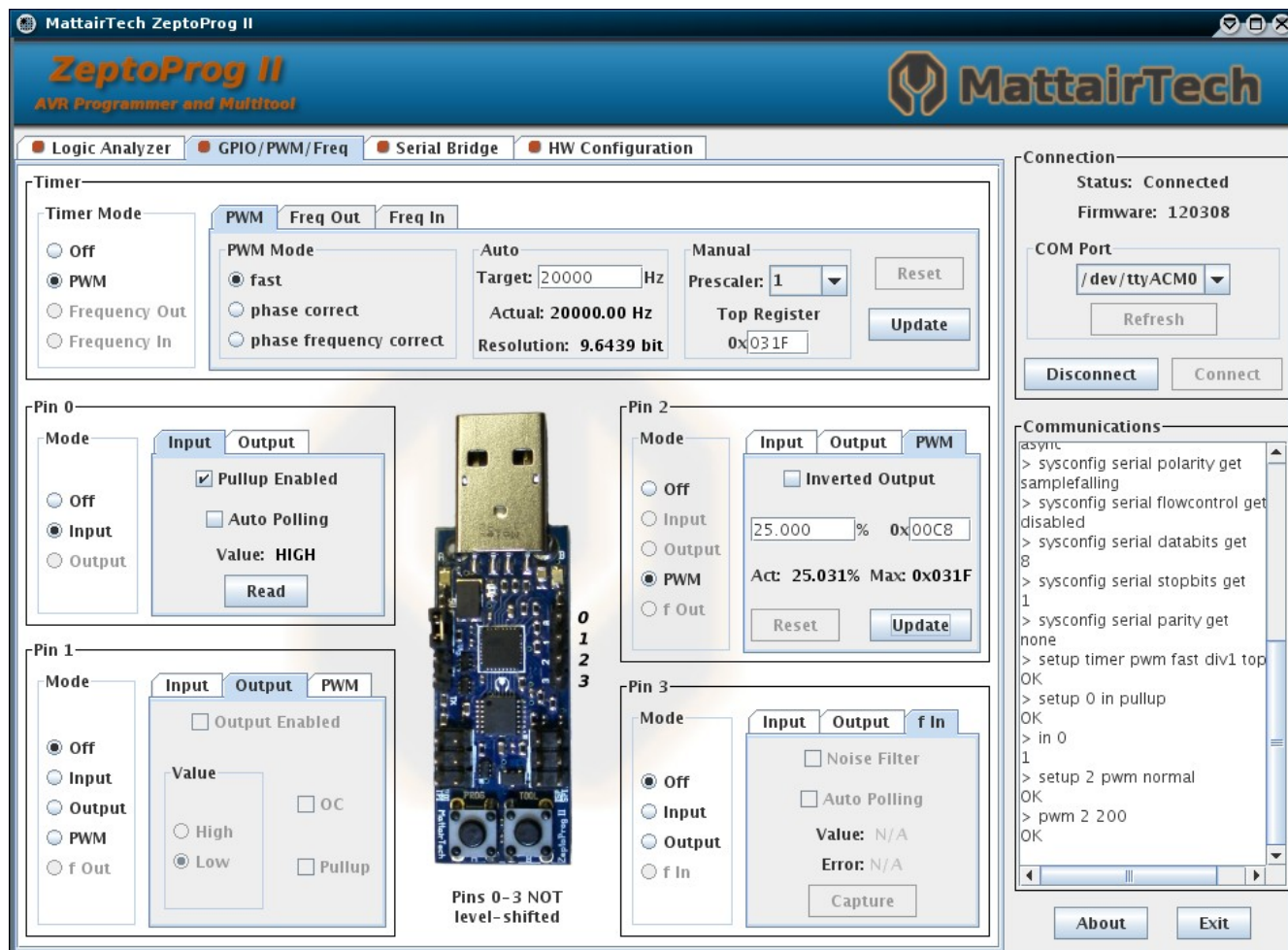
example: terminal off

The current version of the ZeptoProg II firmware is output with the **version** command.

version

returns: {firmware version}

example: version
120308



Configuration

All configuration that is stored in the ZeptoProg II EEPROM is accessed through the multitool using the **sysconfig** command, which includes serial bridge settings, SPI interface settings, AVRISP mkII programmer configuration, and the default mode setting. When reading a configuration option, the **get** argument is used. When writing, the value to be written is used. The general form is:

sysconfig {configuration option} get

returns: {value} | SYNTAX ERROR

example: sysconfig host get
avrstudio

```
sysconfig {configuration option} {value}
```

```
returns:      OK | SYNTAX ERROR | INVALID VALUE
```

```
example:      sysconfig host avrdude  
              OK
```

Default Mode

When plugging the ZeptoProg II into a USB port without holding either button down, the default mode will be entered. This can be the multitool (default), the AVRISP mkII programmer, or the serial bridge. Use the **sysconfig default** command to view or change the default mode.

```
sysconfig default get
```

```
returns:      programmer | bridge | tool | SYNTAX ERROR
```

```
example:      sysconfig default get  
              tool
```

```
sysconfig default { programmer | bridge | tool }
```

```
returns:      OK | SYNTAX ERROR
```

```
example:      sysconfig default bridge  
              OK
```

AVRISP mkII Programmer Configuration

See **AVRISP mkII Compatible Programmer** section for configuration details.

Serial Bridge Configuration

See **Serial Bridge** section for configuration details.

SPI Interface Configuration

See **SPI Interface** section for configuration details.

Timer / Pin Setup

Upon entering the multitool, each pin will be tri-stated (floating), and must be configured before use. In general, the **setup** command is used to associate a pin with a valid function (ie: PWM). In addition to setting the function of a pin, the **setup** command sets configuration for the selected function. For example, a pullup can be enabled for pins setup as an input. Some functions require the timer to be setup first (ie: PWM). In this case, the **setup timer** command is used first, then the pin **setup** command. The pin or timer setup can subsequently be changed as often as necessary. For **setup** arguments that are optional and not specified on the command line, default values are loaded upon initial setup, but not upon any future invocations (until the pin is reset to a floating state). The exception to this is with arguments that have only one option (ie: **pullup** argument of the **setup in** command). In this case, specifying it will enable the feature, while omitting it disables the feature (instead of leaving it unchanged).

setup {pin} in|out|pwm|fi|fo (function-specific arguments)

returns: (varies by function)

example: setup 3 in pullup

{pin}: Required argument indicating the pin number to assign. Can be 0-11.

in|out|pwm|fi|fo: Required argument specifying the function the pin is to be assigned to. **in** stands for input, **out** stands for output, **pwm** stands for pulse width modulation, **fi** stands for frequency input, and **fo** stands for frequency output.

(function-specific arguments): Arguments specific to each function, which may include required arguments, should be placed here. These arguments are covered in later sections.

If a pin must be changed to a different function (ie: from input to output), then it must be disassociated with the current function by using the **reset** command first. Likewise, if the timer is switched to a different function (ie: PWM to frequency output) and a pin is currently associated with the function, then the pin(s) must be **reset** first. The pin is tri-stated when executing this command.

reset {pin}

returns: OK | SYNTAX ERROR | INVALID PIN

example: reset 3

{pin}: Required argument indicating the pin number to unassign. Can be 0-11.

Timer Setup

The timer must be setup for the PWM, frequency output, and frequency input functions. The **setup timer** command configures the timer for the specified function. The prescaler setting (ie: div1) affects all three functions, while the rest of the settings are used only by the PWM function.

setup timer [off|pwm|fo|fi] [div1|div8|div64|div256|div1024] [fast|phase|freq] [top {16bit value}]

returns: OK | SYNTAX ERROR | INVALID VALUE | PIN IN USE

example: setup timer pwm fast top 0x7fff

[off|pwm|fo|fi]: Optional argument that specifies the function the timer will be used for (default off). **fo** stands for frequency output and **fi** for frequency input.

[fast|phase|freq]: Optional argument that specifies what mode the PWM function will run in (default fast). These correspond to the PWM modes of the underlying AVR microcontroller. Please consult the Atmega32U2 datasheet for more information. **phase** stands for phase correct and **freq** stands for phase and frequency correct. This setting is ignored when selecting a non-PWM function.

[div1|div8|div64|div256|div1024]: Optional argument that specifies the timer prescaler setting (default div1). This is the divider of the 16MHz clock frequency. The timer will “tick” at this divided frequency. Please consult the Atmega32U2 datasheet for more information.

[top {value (16b)}]: Optional argument that specifies the 16-bit top value of the timer (default = 0xffff) used in PWM modes. This is the value the timer will count up to before resetting back to 0 (or beginning down-counting in certain PWM modes). This setting combined with the prescaler setting above sets the PWM frequency. Top cannot be below the PWM duty cycle.

Input / Output

The **setup in** command configures the pin to be used as a TTL compatible input. A pullup resistor (20K-50Kohm to 5V) can optionally be enabled. The **in** command can then be used to read the value of the input (0 or 1). Voltages as low as 2V will register as a high.

setup {pin} in [pullup]

returns: OK | SYNTAX ERROR | PIN IN USE | INVALID PIN | OUT OF MEMORY

example: setup 1 in pullup

{pin}: Required argument indicating the pin number to assign.

[pullup]: Optional argument that enables the pullup resistor (default disabled).

in {pin}**returns:** 0 | 1 | INVALID PIN**example:** in 1
1

{pin}: Required argument indicating the pin number to read.

The **setup out** command configures the pin to serve as an output. The output can be setup as push-pull (drive high or low) or as open-drain (drive low, float high). An optional pullup can be enabled in open-drain mode. The initial state (0 or 1) can optionally be specified. The **out** command can then be used to control the output.

setup {pin} out [od] [pullup] [0 | 1]**returns:** OK | SYNTAX ERROR | PIN IN USE | INVALID PIN | OUT OF MEMORY**example:** setup 3 out

{pin}: Required argument indicating the pin number to assign.

od: Optional argument to configure output as open-drain.

pullup: Optional argument to enable pullup in open-drain mode.

[0 | 1]: Optional argument specifying the initial state (default high).

out {pin} 0 | 1**returns:** OK | SYNTAX ERROR | INVALID PIN**example:** out 3 1

{pin}: Required argument indicating the pin number to control.

0 | 1: Required argument specifying the output state.

PWM

The **setup pwm** command configures the specified pin to output a PWM signal. The effect (**normal** or **invert**) of the duty cycle argument can optionally be specified. When normal, the default output is low, with the high pulse time corresponding to the duty cycle. When inverted, the default output is high, with the low pulse time corresponding to the duty cycle. Once configured, the **pwm** command can be used to change the duty cycle. Pin 1 and pin 2 can be used for PWM simultaneously, with different duty cycles, but they must share the same PWM frequency.

The PWM frequency is configured during timer setup. Additionally, the mode of operation (fast PWM, phase correct PWM, and phase and frequency correct PWM) is specified during timer setup (see above). The following equations can be used to determine the PWM frequency:

$$F_{PWM} = \frac{16\text{MHz}}{\text{prescaler} * (1 + TOP)} \quad (\text{fast PWM})$$

$$F_{PWM} = \frac{16\text{MHz}}{2 * \text{prescaler} * TOP} \quad (\text{phase/freq PWM})$$

The resolution in bits can be found with:

$$R_{FPWM} = \frac{\log(TOP + 1)}{\log(2)}$$

setup {pin} pwm [normal|invert]

returns: OK | SYNTAX ERROR | PIN IN USE | INVALID PIN |
INVALID TIMER CONFIG | OUT OF MEMORY

example: setup 2 pwm

{pin}: Required argument indicating the pin number to assign.

[normal|invert]: When normal, the default output is low, with the high pulse time corresponding to the duty cycle. When inverted, the default output is high, with the low pulse time corresponding to the duty cycle.

pwm {pin} {duty cycle (0-top)}

returns: OK | SYNTAX ERROR | INVALID PIN | INVALID VALUE

example: pwm 2 3000

{pin}: Required argument indicating the pin number to control.

{duty cycle (0-top)}: Required argument indicating the duty cycle. The duty cycle as a percent is

$$\text{Duty Cycle \%} = \frac{\text{duty cycle}}{TOP} * 100\%$$

PWM Frequency Ranges

Prescaler	Frequency Range (16b - 2b resolution)
div1	244Hz – 4.00MHz
div8	30.5Hz - 500KHz
div64	3.81Hz - 62.5KHz
div256	0.954Hz - 15.6KHz
div1024	0.238Hz - 3.91KHz

Frequency Output

The **setup fo** command configures the specified pin to output a square wave. Pin 1 and pin 2 can be configured for frequency output, however, they must share the same frequency (but pin 2 is inverted from pin 1). The **fo** command can then be used to set the frequency. The higher the frequency, the lower the resolution in setting the frequency. The frequency can be found using:

$$F_{fo} = \frac{16\text{MHz}}{2 * \text{prescaler} * (\text{TOP} + 1)}$$

setup {pin} fo

returns: OK | SYNTAX ERROR | PIN IN USE | INVALID PIN |
INVALID TIMER CONFIG | OUT OF MEMORY

example: setup 2 fo

{pin}: Required argument indicating the pin number to assign.

fo {pin} {TOP value (16b)}

returns: OK | SYNTAX ERROR | INVALID PIN | INVALID VALUE

example: fo 2 0x17ff

{pin}: Required argument indicating the pin number to control.

{TOP value (16b)}: Required argument used to produce the output frequency.

Frequency Output Ranges

Prescaler Setting	Frequency Range (TOP 65535 - 0)
div1	122Hz – 8.00MHz
div8	15.3Hz – 1.00MHz
div64	1.91Hz – 125KHz
div256	0.477Hz – 31.3KHz
div1024	0.119Hz – 7.81KHz

Frequency Measurement

The **setup fi** command is used to configure the specified pin (3 only) as an input to measure frequencies. Optionally, a simple digital filter may be enabled. See ATmega32U2 datasheet for details. The **fi** command can then be used to measure the frequency. The frequency will be calculated and displayed in Hertz. If no signal is present when the command is executed, the command will timeout with a TIMEOUT error message after a few seconds. If the frequency is too high, a CAPTURE TOO FAST error occurs. The next higher frequency range can then be selected, if available. Note that if the frequency of interest exists within multiple ranges, use the highest range in order to maximize resolution. If the frequency is too low, then a CAPTURE OVERFLOW error occurs.

setup {pin} fi [filter]

returns: OK | SYNTAX ERROR | PIN IN USE | INVALID PIN |
INVALID TIMER CONFIG | OUT OF MEMORY

example: setup 3 fi

{pin}: Required argument indicating the pin number to assign.

[filter]: See ATmega32U2 datasheet for details.

fi {pin}

returns: {frequency (16b)}Hz
or SYNTAX ERROR | INVALID PIN | TIMEOUT | CAPTURE OVERFLOW |
CAPTURE TOO FAST

example: fi 3
7426.284Hz

{pin}: Required argument indicating the pin number to use.

Frequency Input Ranges

<i>Prescaler Setting</i>	<i>Frequency Range</i>
div1	244Hz - 125KHz
div8	30.5Hz - 15.6KHz
div64	3.81Hz - 1.95KHz
div256	0.954Hz - 488Hz
div1024	0.238Hz - 122Hz

Pattern Generator

The pattern generator can be used to output arbitrary digital patterns on any combination of pins 0-3. These patterns are stored in EEPROM. The pattern generator is a new feature and it does not currently fit into the firmware due to limited FLASH space. To use it, you will have to install different firmware available at

http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II_PG.hex. In order to make room for the pattern generator, the SPI commands in the multitool are not present. The pattern generator currently can only be accessed from the command-line. It is implemented with 4 commands (2 new commands and 2 modifications to existing commands):

setup pattern

This command is used to read/write patterns from/to EEPROM. One pin at a time can be read/written.

setup pattern {pin} [get] (you can omit get)

returns the pattern, for example:

```
ZeptoProg II> setup pattern 0
8 steps
repeat 255
H 10 L 8 H 6 L 4 H 2 L 4 H 6 L 8
```

or

```
pattern disabled
```

setup pattern {pin} [set] off (you can omit set)

clears the pattern

setup pattern {pin} [set] repeat {0-255} (h|l {1-65535})+ (you can omit set)

returns OK|SYNTAX ERROR|INVALID VALUE|PIN IN USE|INVALID PIN|OUT OF MEMORY

Repeat specifies how many times the pattern repeats after the initial run. The special value of 255 means repeat forever. Repeat must be specified and it must be positioned as above. The actual pattern follows the repeat value. Each step in the pattern is specified with an action-delay pair. The action can be either l or h. The delay must be at least 1 and up to 65535. The delay specifies the number of timebase ticks. More action-delay pairs can be added, separated with a space. Each of the 4 pins is configured one at a time. Each of the 4 patterns can be up to 83 steps. Note that the terminal buffer size of 512 bytes may limit using all 83 steps. If you cannot type any more characters, the buffer is full. Each pattern is written into EEPROM, so they will be saved even after power is removed.

To setup a pattern as shown in the above example:

```
setup pattern 0 repeat 255 h 10 l 8 h 6 l 4 h 2 l 4 h 6 l 8
```

If the pattern generator timebase (setup timer command) is set to 1ms, then the above pattern will set the pin high for 10ms, low for 8ms, etc.

setup timer

**setup timer [off|pwm|fo|fi|pattern] [fast|phase|freq] [div1|div8|div64|div256|div1024]
[top {value (16b)}]**

returns OK|SYNTAX ERROR|INVALID VALUE|PIN IN USE

The timer is used to set the timebase, so the existing setup timer command is used. All delays used in the pattern are a multiple of this timebase. The timebase can be as low as 100us and as high as 4.19s. Using combinations of clock divider and top value that result in a timebase of less than 100us will return an error. I have more optimization work left, so avoid using a timebase under 250us for now. To set the timebase to 1ms:

```
setup timer pattern div1 top 16000
```

This must be setup prior to using the pattern generator. This can be changed at any time, even while a pattern is running.

setup pin

setup {pin} pattern [1|0](initial state)

returns OK|SYNTAX ERROR|PIN IN USE|INVALID PIN|INVALID TIMER CONFIG|OUT OF MEMORY

This associates a pin with the pattern generator. The timer must be setup for pattern generation first. The initial state will be output immediately.

pattern

pattern on|off (0|1|2|3 [repeat {0-255}])+

returns OK|SYNTAX ERROR|INVALID PIN|INVALID VALUE|PIN IN USE
repeat=0 is no repeat, repeat=255 is indefinite repeat

Start or stop pattern generation. Do after associating pins with the pattern generator. Multiple pins can be specified. The repeat value can be used optionally to override the value stored in EEPROM. When specifying multiple pins, they will be started/stopped simultaneously. When starting, the pattern will begin on the next timebase tick. For example, if the timebase is 1ms, the start of the pattern(s) will be delayed by up to 1ms. If the pattern has a repeat value (from EEPROM or the override value), the pattern will repeat the specified number of times. When a pattern stops, either manually with this command or by reaching the end of the pattern, the pin will be left at its current state (ie: last pattern state). Example:

```
pattern on 0 1 repeat 24 4
```

This starts patterns 0 and 4 using EEPROM repeat values and starts pattern 1 with repeat value of 24.

Logic Analyzer

TODO: This section is not yet documented. It should be fairly intuitive. Unorganized notes follow.

If you cannot run the java application, be sure to install the 32-bit version of Java (or download the 64-bit version of the GUI).

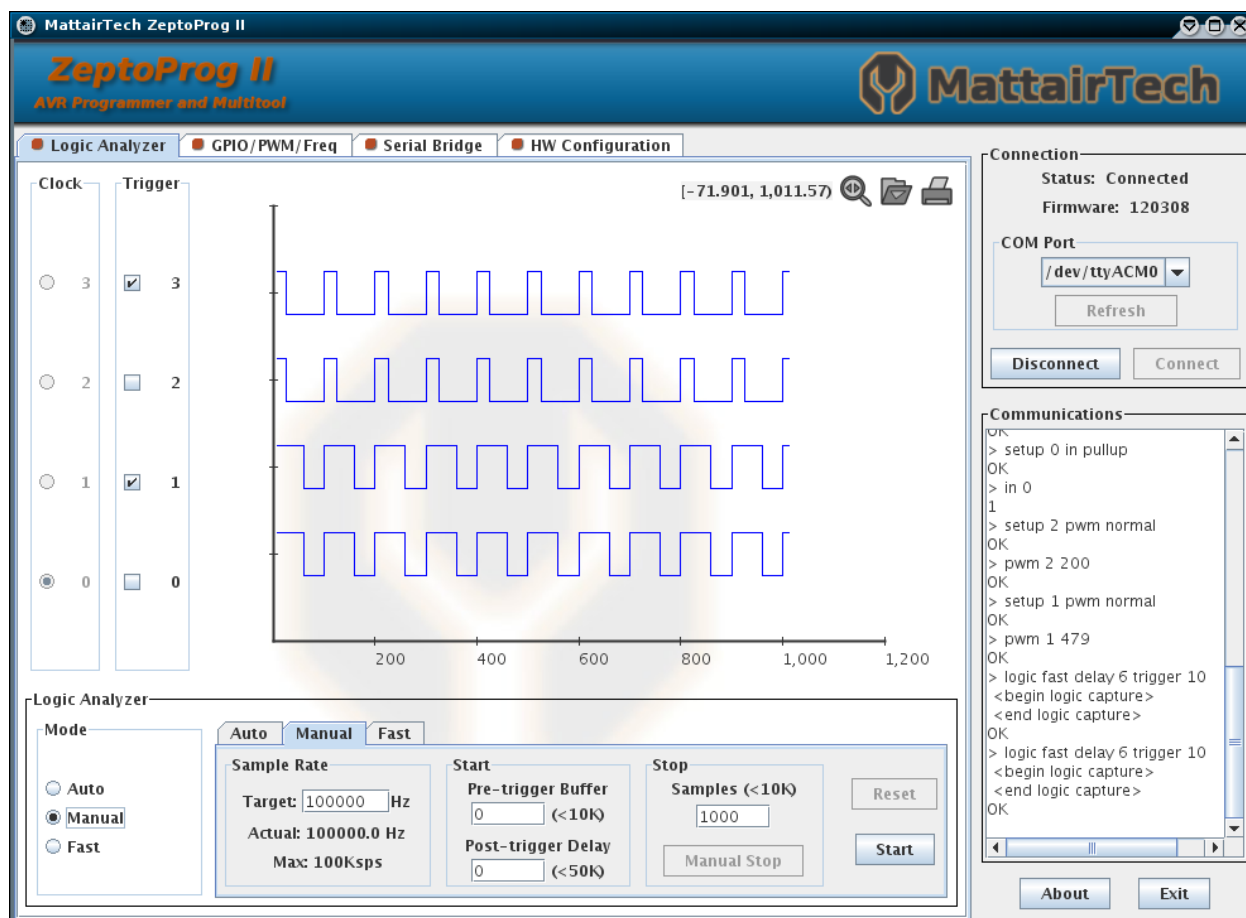
When using auto mode, you must select what channel the sampling clock is on.

In rare cases, especially when using the pre-trigger buffer, you may receive a buffer overflow error. If this happens, try again. Fast mode can never have a buffer overflow, but is limited to 1024 samples.

You may simultaneously use functions from the GPIO/PWM/Freq tab and the logic analyzer (see screenshot, which shows PWM generated from the ZeptoProg II). It does not matter if the pins are inputs or outputs, the logic analyzer can always read them. Note that Manual mode requires use of the timer.

There is a zoom tool. Click and drag the section you want to see closer. Click the magnifying glass icon to return to unzoomed. You can save the capture as an image or print it.

Pre-trigger buffer data (if used) is displayed on the negative side of the X-axis.



SPI Interface

The SPI interface is useful for testing SPI devices or for controlling SPI devices via PC software. With terminal mode enabled, data to be sent is placed on the command line in either ASCII or hex. With Terminal Mode disabled, data is transferred in binary. The ZeptoProg II should be powered before the target board. Gnd and Vtgt must be connected to the target board. There are up to 4 chip select outputs on pins 0-3. These are open-drain and active-low. An optional pullup (20K-50Kohm to 5V) can be enabled by configuring the pin as an input with pullup, or by configuring the pin as an open-drain output with pullup (see Multitool section above).

SPI Configuration

There are several SPI configuration options, which are stored in EEPROM. These options are accessed using the **sysconfig spi** command. The speed can be set from 125KHz up to 8MHz. Note that while the maximum speed over the ZeptoProg II USB connection is 2Mbps, a higher SPI speed may be selected, which can improve performance due to overhead. The SPI mode (0-3) and data order (MSB, LSB) must be set to match the SPI slave device. The optional dummy byte can be used to mask data sent from the slave. Since SPI devices always send and receive data in both directions simultaneously, this can be useful for ignoring return data from the slave (MISO) when it has no significance. Any byte from the slave that matches the dummy byte value will not be sent over USB.

SPI Configuration Options

Configuration Option	Possible Values
Speed	8MHz, 4MHz, 2MHz, 1MHz, 500KHz, 250KHz, 125KHz
SPI Mode	0, 1, 2, 3
Data Order	MSB, LSB
Dummy Byte	Disabled, Enabled
Dummy Byte Value	0x00 - 0xFF

Speed

sysconfig spi speed get

returns: 8000000 | 4000000 | 2000000 | 1000000 | 500000 | 250000 | 125000 |
SYNTAX ERROR

example: sysconfig spi speed get
2000000

sysconfig spi speed { 8000000 | 4000000 | 2000000 | 1000000 | 500000 | 250000 | 125000 }

returns: OK | SYNTAX ERROR | INVALID VALUE

**example: sysconfig spi speed 4000000
OK**

Mode

sysconfig spi mode get

returns: 0 | 1 | 2 | 3 | SYNTAX ERROR

**example: sysconfig spi mode get
0**

sysconfig spi mode { 0 | 1 | 2 | 3 }

returns: OK | SYNTAX ERROR | INVALID VALUE

**example: sysconfig spi mode 3
OK**

Dataorder

sysconfig spi dataorder get

returns: msb | lsb | SYNTAX ERROR

**example: sysconfig spi dataorder get
msb**

sysconfig spi dataorder { msb | lsb }

returns: OK | SYNTAX ERROR | INVALID VALUE

**example: sysconfig spi dataorder lsb
OK**

Dummy Byte

sysconfig spi dummy get

returns: disabled | enabled | SYNTAX ERROR

**example: sysconfig spi dummy get
disabled**

sysconfig spi dummy { disabled | enabled }**returns:** OK | SYNTAX ERROR**example:** sysconfig spi dummy enabled
OK

Dummy Byte Value

sysconfig spi dummyvalue get**returns:** { 0x00 - 0xFF } | SYNTAX ERROR**example:** sysconfig spi dummyvalue get
0xff**sysconfig spi dummyvalue { 0x00 - 0xFF }****returns:** OK | SYNTAX ERROR | INVALID VALUE**example:** sysconfig spi dummyvalue 0x00
OK

SPI Commands

There are 3 commands. They are t (transfer), w (write), and r (read). There are 2 versions of each command. The version used depends on whether Terminal Mode is enabled or not. If enabled, an additional argument is available (**hex**) and data to be sent is entered directly on the command line. If not enabled, **hex** is not available, and the length of data must be specified. Any data to write is sent only after the command is entered (newline) and only if the return value is OK. If OK, the ZeptoProg II will then read **length** bytes from USB.

The chip select line to use (0-3) is a required argument. Normally, the ZeptoProg II holds the specified chip select low only for the duration of the command. The optional argument **hold** keeps the chip select line low between commands until either **hold** is omitted, another chip select line is specified, or multitool mode is exited. This can be useful in terminal mode if the length of data to send exceeds the remaining command line buffer space, or if you wish to mix hexadecimal and ASCII.

The optional **hex** argument is useful to enter binary data when in Terminal Mode. If specified, separate values can then be listed separated by whitespace. Values starting with "0x" are interpreted as hexadecimal, but values can be entered in decimal as well. When **hex** is not specified, all characters are interpreted as ASCII.

example: w 0 Hello World!**example:** t hex 0 0xc1 0x00 0x03 4 5

SPI Transfer

Terminal Mode On:

t [hold] [hex] 0|1|2|3 <TX data (up to remaining line buffer size)>

returns: OK | SYNTAX ERROR | INVALID PIN | INVALID HEX

action: If OK, TX data from the command line is sent over SPI. The length of data is determined automatically from the command line. For each TX byte, an RX byte is read from SPI and sent over USB. If the dummy byte is used, all bytes from SPI that match the dummy byte value will be discarded.

Terminal Mode Off:

t [hold] 0|1|2|3 {length(16b)}

returns: OK | SYNTAX ERROR | INVALID PIN

action: If OK, **length** bytes of TX data are read from USB and sent over SPI. For each TX byte, an RX byte is read from SPI and sent over USB. If the dummy byte is used, all bytes from SPI that match the dummy byte value will be discarded.

SPI Write

Terminal Mode On:

w [hold] [hex] 0|1|2|3 <tx data (up to remaining line buffer size)>

returns: OK | SYNTAX ERROR | INVALID PIN | INVALID HEX

action: If OK, TX data from the command line is sent over SPI. The length of data is determined automatically from the command line.

Terminal Mode Off:

w [hold] 0|1|2|3 {length(16b)}

returns: OK | SYNTAX ERROR | INVALID PIN

action: If OK, **length** bytes of TX data are read from USB and sent over SPI.

SPI Read

Terminal Mode On:

r [hold] [hex] 0|1|2|3 {length(16b)}

returns: OK | SYNTAX ERROR | INVALID PIN

action: If OK, **length** bytes of RX data are read from SPI and sent over USB. If the dummy byte is used, all bytes from SPI that match the dummy byte value will be discarded.

Terminal Mode Off:

r [hold] 0|1|2|3 {length(16b)}

returns: OK | SYNTAX ERROR | INVALID PIN

action: If OK, **length** bytes of RX data are read from SPI and sent over USB. If the dummy byte is used, all bytes from SPI that match the dummy byte value will be discarded.

Example Session

This example demonstrates communication with a SPI SRAM chip (Microchip 23K256) in Terminal Mode using chip select 0 with an 8MHz clock. The hold feature is used to mix commands in hexadecimal (and decimal) with data in ASCII.

SPI > t hex 0 5 0

OK

FF 00

SPI > t hex 0 1 0x41

OK

07 FF

SPI > t hex 0 5 0

OK

FF 41

SPI > w hold hex 0 2 0 0

OK

SPI > w 0 Hello World!

OK

SPI > w hold hex 0 3 0 0

OK

SPI > r 0 12

OK

Hello World!

Serial Bridge

The serial bridge can connect the target MCU (or other device) to a host application (ie: terminal emulator) over USB. On the host side, the ZeptoProg II will appear as a virtual COM port. Unlike the multitool, there is no terminal mode or commands. The ZeptoProg II simply relays bytes between the host and target. Speeds up to 2Mbps* are supported on separate RX and TX pins. The optional synchronous mode clock and flow control pins can be taken from programming header A.

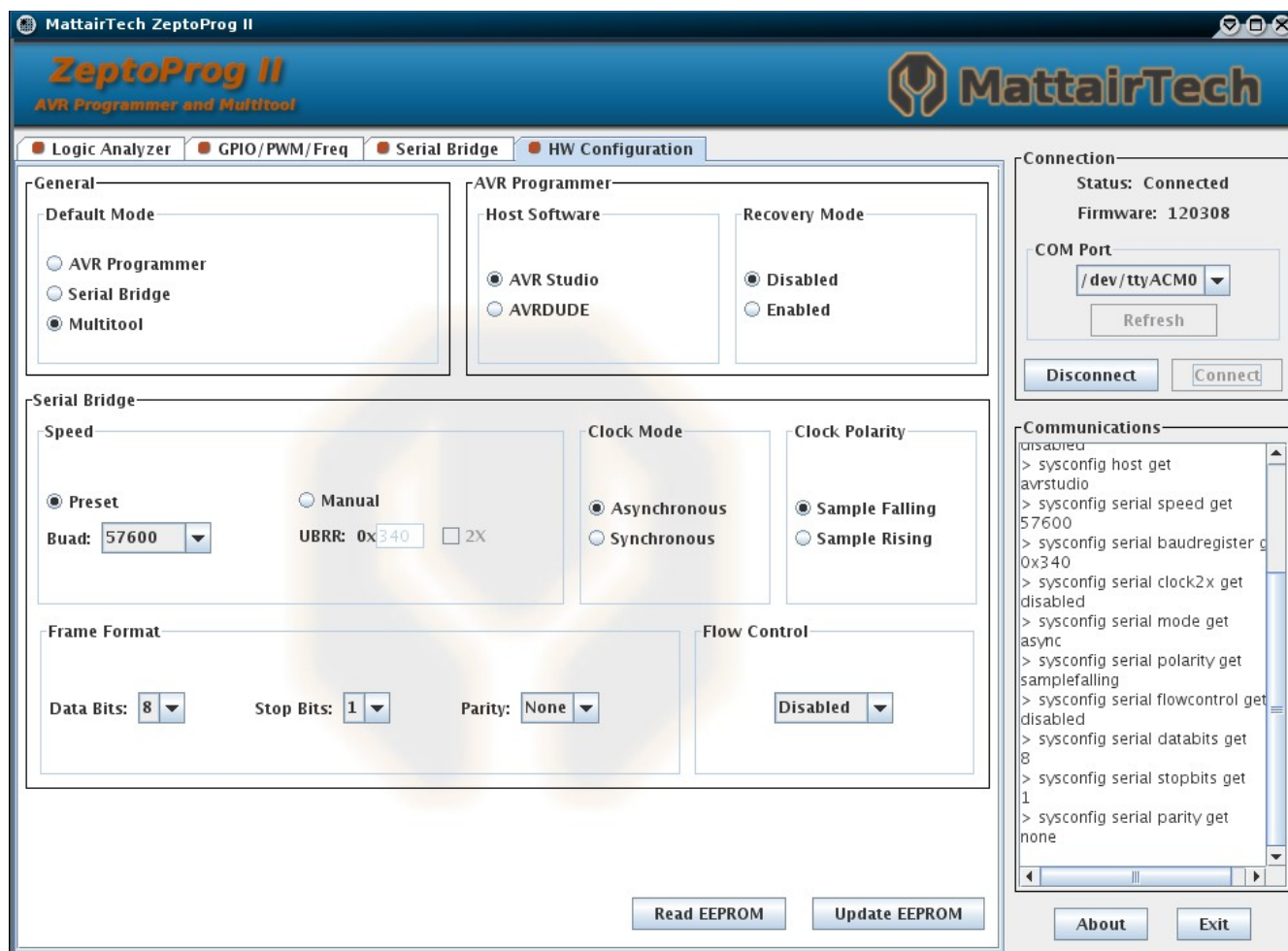
* Not recommended for 115.2Kbps or 230.4Kbps. At these speeds and higher, choose a baud rate that the 8MHz cpu clock can be divided down to (ie: 125Kbps).

Configuration

Before using the serial bridge, it must be configured to be compatible with the target. This configuration is stored in EEPROM. There is no need to duplicate the settings on the host side, as communication between the host and ZeptoProg II will always be the maximum supported USB speed, and the other parameters are ignored by the host. Only the connection between the ZeptoProg II and target use these settings. The serial bridge is configured using the **sysconfig serial** command.

Serial Bridge Configuration Options

Configuration Option	Possible Values
Speed	2M, 1M, 500K, 250K, 125K, 76.8K, 57.6K, 38.4K, 19.2K, 9600, 2400, manual
Baud Rate Register	0x0000 - 0x0FFF (if manual selected as speed)
Clock 2X	1X, 2X
Clock Mode	async, sync
Polarity	samplefalling, samplerising
Flow Control	disabled, enabled
Data Bits	5, 6, 7, 8, 9
Stop Bits	1, 2
Parity	none, even, odd



Speed

sysconfig serial speed get

returns: 2400 | 9600 | 19200 | 38400 | 57600 | 76800 | 125000 | 250000 | 500000 | 1000000 | 2000000 | manual | SYNTAX ERROR

example: sysconfig serial speed get
57600

sysconfig serial speed { 2400 | 9600 | 19200 | 38400 | 57600 | 76800 | 125000 | 250000 | 500000 | 1000000 | 2000000 | manual }

returns: OK | SYNTAX ERROR | INVALID VALUE

example: sysconfig serial speed manual
OK

Baud Rate Register (manual speed setting)

sysconfig serial baudregister get

returns: { 0x0000 – 0x0FFF } | SYNTAX ERROR

example: sysconfig serial baudregister get
0x340

sysconfig serial baudregister { 0x0000 – 0x0FFF | 0 – 4095 }

returns: OK | SYNTAX ERROR | INVALID VALUE

example: sysconfig serial baudregister 832
OK

2X Clock mode (manual speed, asynchronous mode only)

sysconfig serial clock2x get

returns: disabled | enabled | SYNTAX ERROR

example: sysconfig serial clock2x get
disabled

sysconfig serial clock2x { disabled | enabled }

returns: OK | SYNTAX ERROR

example: sysconfig serial clock2x enabled
OK

Serial Mode

sysconfig serial mode get

returns: async | sync | SYNTAX ERROR

example: sysconfig serial mode get
async

sysconfig serial mode { async | sync }

returns: OK | SYNTAX ERROR
example: sysconfig serial mode sync
OK

Polarity

sysconfig serial polarity get

returns: samplefalling | samplerising | SYNTAX ERROR
example: sysconfig serial polarity get
samplefalling

sysconfig serial polarity { samplefalling | samplerising }

returns: OK | SYNTAX ERROR
example: sysconfig serial polarity samplerising
OK

Flow Control (hardware, CTS/RTS)

sysconfig serial flowcontrol get

returns: disabled | enabled | SYNTAX ERROR
example: sysconfig serial flowcontrol get
disabled

sysconfig serial flowcontrol { disabled | enabled }

returns: OK | SYNTAX ERROR
example: sysconfig serial flowcontrol enabled
OK

Parity

sysconfig serial parity get

returns: none | even | odd | SYNTAX ERROR
example: sysconfig serial parity get
none

sysconfig serial parity { none | even | odd }

returns: OK | SYNTAX ERROR
example: sysconfig serial parity even
OK

Data Bits

sysconfig serial databits get

returns: { 5 – 9 } | SYNTAX ERROR
example: sysconfig serial databits get
8

sysconfig serial databits { 5 – 9 }

returns: OK | SYNTAX ERROR | INVALID VALUE
example: sysconfig serial databits 9
OK

Stop Bits

sysconfig serial stopbits get

returns: 1 | 2 | SYNTAX ERROR
example: sysconfig serial stopbits get
1

sysconfig serial stopbits { 1 | 2 }

returns: OK | SYNTAX ERROR | INVALID VALUE
example: sysconfig serial stopbits 2
OK

Serial Connections

The ZeptoProg II should be powered before the target board. In addition to RX and TX, Gnd and Vtgt must be connected to the target board, which can be connected through the ISP cable. Alternatively, two single pin cables can be connected to the programming header Vtgt and Gnd pins. On header A, Gnd is the closest pin to TX. Vtgt can also be taken from the Vtgt pin next to RX. Vtgt is required because the TX line is level shifted to the target voltage. If the 5V-Vtgt jumper is installed, then connecting Vtgt is not required (target board must also be at 5V).

When in synchronous mode, the ZeptoProg II is the master, so the XCK pin is enabled as an output. The target board must enable its clock pin as an input and be configured as a slave. If flow control is used, when CTS is low, TX activity from the ZeptoProg II to the target occurs normally. When CTS is brought high, TX pauses. This prevents buffer overflows on the target if it becomes busy. The RTS line will likewise be brought low by the ZeptoProg II when it cannot keep up with RX data (ie: if there is upstream USB congestion).

When using 9-bit data frames, two bytes are sent or received for every frame. The first byte simply contains the 9th bit, thus the first byte will always be 0 or 1. The second byte contains the rest of the 8 bits.

Baud Rate Register Value (Manual Speed)

Async 1X	Async 2X	Synchronous
$UBRR = \frac{f_{osc}}{16 * BAUD} - 1$	$UBRR = \frac{f_{osc}}{8 * BAUD} - 1$	$UBRR = \frac{f_{osc}}{2 * BAUD} - 1$
$BAUD = \frac{f_{osc}}{16 * (UBRR + 1)}$	$BAUD = \frac{f_{osc}}{8 * (UBRR + 1)}$	$BAUD = \frac{f_{osc}}{2 * (UBRR + 1)}$

where $f_{osc} = 16000000$

CAUTION

Note that the RX line has a 20K-50Kohm pullup resistor enabled that pulls RX to 5V. This is true regardless of the target voltage. AVR's and most other chips have clamp diodes that keep the voltage within 0.5V of the target Vcc. AVR clamp diodes are designed to allow 1mA to flow indefinitely. Since the pullup will limit current to under 150uA in all cases, the 5V pullup will not present a problem. A future firmware version will add the ability to turn off this pullup. In this case, the target must have a pullup enabled/installed. The CTS pin, if enabled, also has this 5V pullup enabled, so the same applies to it.

Firmware Updates

The ZeptoProg II firmware will be updated periodically to add new features and fix bugs. These updates will be available on the MattairTech website. The updates may include just a hex file (for programming flash), or both a hex file and eep file (for programming both flash and EEPROM). FLIP is a graphical utility for Windows used to load firmware updates onto the ZeptoProg II. FLIP includes the DFU bootloader driver. Download FLIP 3.4.2 or higher from <http://www.atmel.com/tools/FLIP.aspx> and install.

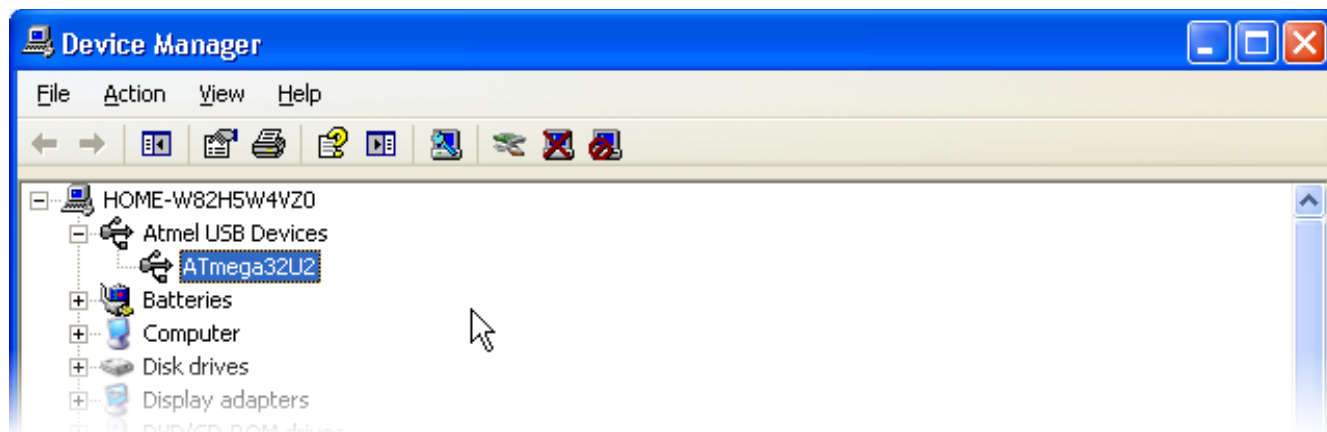
Downloads required for Firmware Updates

Software	Version	Driver	URL
ZeptoProg II Firmware*	latest	N/A	http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II.hex OR http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II_PG.hex
FLIP	3.4.2 +	DFU driver	http://www.atmel.com/tools/FLIP.aspx
Signed DFU Driver*	latest	DFU driver	http://www.avrfreaks.net/index.php?module=Freaks%20Academy&func=viewItem&item_type=project&item_id=2196

* The ZeptoProg_II_PG.hex firmware contains the pattern generator, but not the SPI commands.

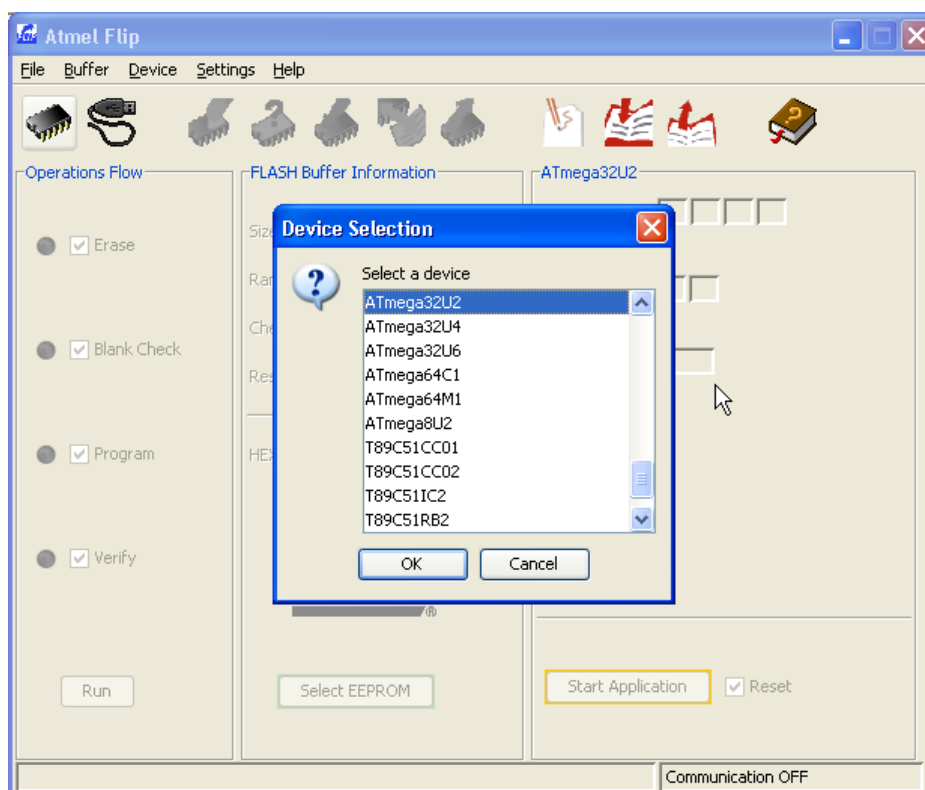
* Newer versions of FLIP include a signed driver. In this case, do not use the driver from avrfreaks.

Once FLIP is installed, the DFU bootloader driver can be loaded. Press and hold both buttons while plugging in the ZeptoProg II to run the DFU bootloader. LED A should be on and LED B should be off. Windows will then prompt you for the ATmega32U2 driver. By default, this is located in the Program Files/Atmel/Flip 3.4.2/usb directory. Point the installer to this location (do not use Windows update, then click 'Install from a list or specific location'). If Windows does not find the driver, try the "don't search/have disk → show incompatible hardware" method. If Windows does not prompt you for drivers, open device manager and look for Unknown Devices → ZeptoProg II Bootloader. Right-click this and select Update driver, then continue as above. If using an older version of FLIP, you may need to download the signed driver from avrfreaks (see table above). Once the driver is loaded, device manager will show an ATmega32U2 device under Atmel USB Devices.

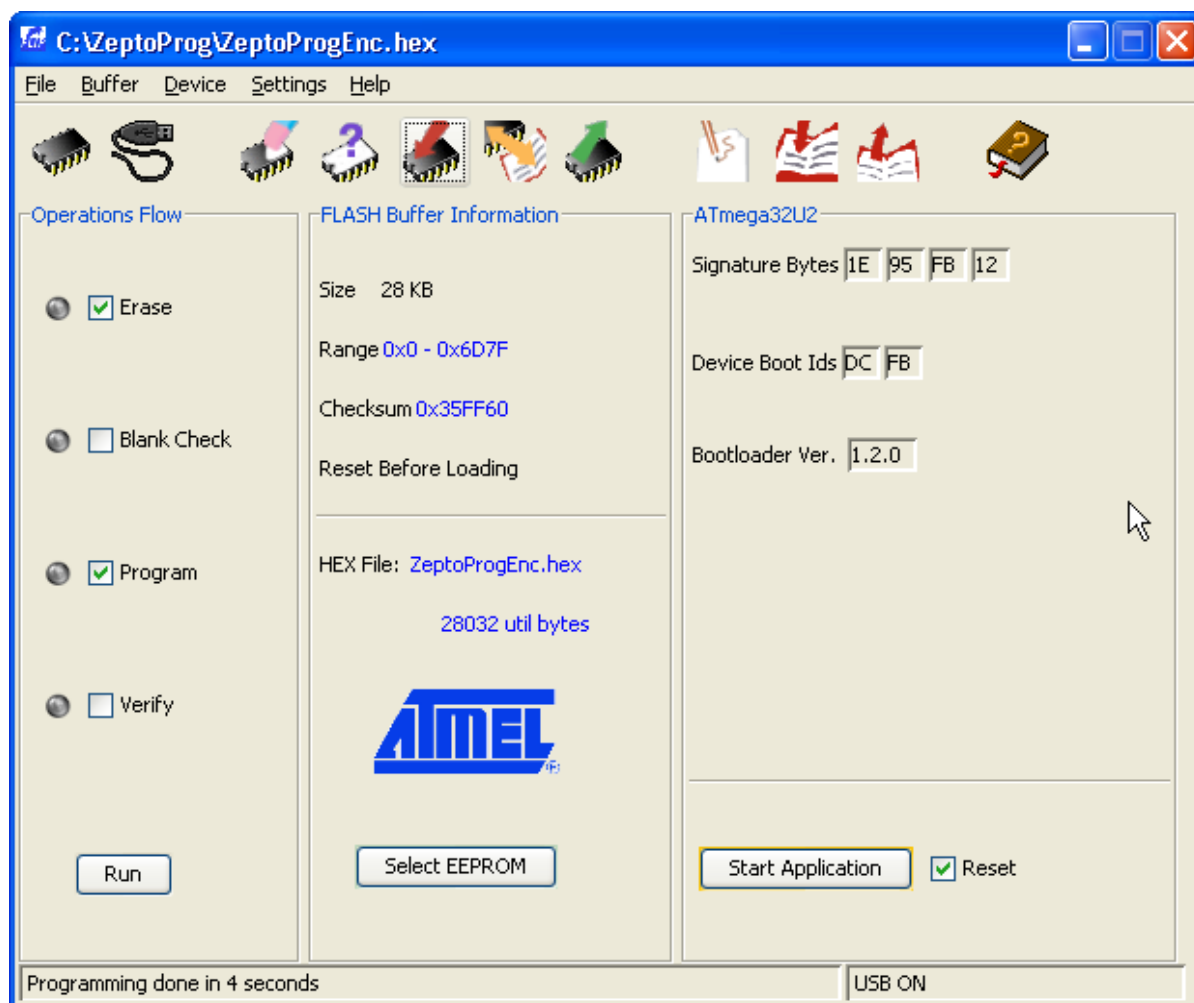


FLIP

Plug in the ZeptoProg II while holding down both buttons to run the DFU bootloader. LED A should be on and LED B should be off. Now launch the FLIP utility. When it has loaded, click on the chip icon and select the Atmega32U2.



Next, click on the USB icon, select USB, then connect. The screen should now show information about the ATmega32U2. Click on the File menu, and open the appropriate hex file. More information will appear about the program. Be sure that erase is checked. The ZeptoProg II firmware cannot be loaded unless the flash is erased first. Uncheck Blank Check, as it is not supported. Program must be checked. Verify must be unchecked. Reading of the flash is not allowed, so verification is not possible. Verification is less useful when programming over USB anyway, as USB provides error detection and correction. Now click on the Run button in the lower-left of the screen, and the firmware will be quickly loaded onto the ZeptoProg II. If you encounter problems, then you will need to unplug the ZeptoProg II, disconnect FLIP, and start over making certain that the above settings are observed.



You may also need to program the EEPROM. If so, click on Select EEPROM at the bottom. Then, click on the File menu and open the appropriate eep file. You will have to change the file filter to allow you to see the eep file. Note that eep files are just hex files but with the eep extension instead of hex. More information will appear about the file when selected. Both Program and Verify should be checked. Click run to program the EEPROM.

dfu-programmer (Linux)

A chip erase must be performed first. The flash cannot be read.

```
dfu-programmer atmega32u2 erase
```

```
dfu-programmer atmega32u2 flash-EEPROM ZeptoProg_II_120306.eep (if applicable)
```

```
dfu-programmer atmega32u2 flash --suppress-validation ZeptoProg_II_120306.hex
```

Troubleshooting / FAQ

- If Atmel Studio wants you to upgrade the firmware, first check that you are not in AVRDUDE programming mode, which can trigger this warning. If you are in AVR/Atmel Studio mode and still get the message, please check the website for firmware updates or email support@mattairtech.com if you are already using the latest version.
- If you cannot run the java application, be sure to install the 32-bit version of Java, which can co-exist with the 64-bit version. A beta 64-bit version is available at http://www.mattairtech.com/software/ZeptoProg_II/ZeptoProg_II_64.jar.
- Updating the firmware with recent versions of FLIP (ie: 3.4.7) may fail. If so, try using the batchisp command line tool included with FLIP:
`C:\Program Files\Atmel\Flip 3.4.7\bin>batchisp -device ATMEGA32U2 -hardware USB -operation erase F loadbuffer "C:\ZeptoProg_II.hex" program start reset 0`
- If BASCOM or AVRDUDE do not work, be sure to put the programmer into AVRDUDE mode.
- Prior to releasing the signed driver on January 28, 2015, Windows 8 users needed to disable driver signing to use Tool mode (terminal emulator or Java app.).
- Atmel Studio (AVR Studio) reports 3.3V when the board in fact is operating at 5V. Ignore this. The ZeptoProg II cannot measure the voltage of the target (but it can detect the presence of a voltage on Vtgt as low as 2V). Voltage reporting is informational only, it does not affect programming.
- AVRDUDE 6.x does not yet support the ZeptoProg II. A working patched version can be found at http://www.mattairtech.com/software/avrdude_6.0.1_patched_windows.zip. Thanks to Larry Viesse. For support on Linux 64-bit, download http://www.mattairtech.com/software/avrdude_6.0.1_patched_Linux_64.zip. For support on other Linux (especially with xhci (USB 3.0)), replace the usb_libusb.c file from 6.0.1 with http://www.mattairtech.com/software/usb_libusb.c.
- If you are having problems communicating with the programmer using Atmel Studio 6.x, download the Zadig USB driver manager at <http://zadig.akeo.ie/>. Under options, List All Devices. The AVRISP mkII should show up in the list. Replace the current driver with libusb-win32 (v1.2.6.0), which comes embedded with Zadig. Alternatively, please use the procedure at <https://www.olimex.com/forum/index.php?topic=4188.0>
- Prior to firmware version 150815, if the PDI/TPI connection to the target board was bad, then Atmel Studio would experience connection issues to the programmer itself for some time after the initial failure. Restarting AS would not immediately restore communications (however, after several attempts / time waited, it will come back). Firmware 150815 solves this by lowering the programmer<->target timeout (AS ignored the timeout response after a certain period of time).

- If you are having problems communicating with the programmer using Atmel Studio 7.x, please ensure that you are using the new AVRISPMkII driver, which now must be downloaded separately (see installation). Prior versions of Atmel Studio included this driver.
- If you are having problems writing the FLASH of the Tiny4/5/9/10 (timeout using Atmel Studio), please update the firmware to at least 160808.

Support Information

Please check the MattairTech website (<http://www.MattairTech.com/>) for firmware and software updates. Email me if you have any feature requests, suggestions, or if you have found a bug. If you need support, please contact me (email is best). You can also find support information at the MattairTech website. A support forum is planned. Support for AVRr in general can be found at AVRfreaks (<http://www.avrfreaks.net/>). There, I monitor the forums section as the user physicist.

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Thanks to Dean Camera (<http://www.fourwalledcubicle.com/>) for his excellent LUFA library, AVRISPMkII clone, and DFU bootloader, all of which are used in the ZeptoProg II firmware. Thanks to the members of AVRfreaks (<http://www.avrfreaks.net/>) for their support. Finally, thanks to Atmel for creating a great product, the AVR microcontroller.

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LUFA USB Library

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QN Plot

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RXTX Serial Library

RXTX License v 2.1 - LGPL v 2.1 + Linking Over Controlled Interface.

RXTX is a native interface to serial ports in java.

Copyright 1997-2007 by Trent Jarvi tjarvi@qbang.org and others who actually wrote it.

See individual source files for more information.

A copy of the LGPL v 2.1 may be found at

<http://www.gnu.org/licenses/old-licenses/lgpl-2.1.html>

64-bit RXTX binary builds provided as a courtesy of Mfizz Inc. (<http://mfizz.com/>).

Please see <http://mfizz.com/oss/rxtx-for-java> for more information.

Appendix A: Precautions

WARNING

Care must be taken if using the 5V-Vtgt jumper to output 5V to the target board. Reverse polarity protection is not active in this configuration, but there is a PTC fuse for overload protection. Be sure that the target board can operate safely when powered from the ISP connector. For example, if the target board has a linear regulator or switched mode power supply, be certain that it can sustain a higher voltage on its output than its input. Do not connect XMEGA devices with the jumper installed. Do not connect a powered target board if the jumper is installed.

When using the 5V-Vtgt jumper, it is strongly recommended to connect the target board to the header prior to plugging into a USB port. Keep the target board connected when unplugging from the USB port.

CAUTION

The ZeptoProg II should be powered first before connecting to a powered target board (in this case, the 5V-Vtgt jumper should be removed). If a powered target board is connected to an unpowered ZeptoProg II, then the target will supply power to the ZeptoProg II, regardless of the state of the 5V-Vtgt jumper. This condition is detected, and it will enter a low power state.

When using the 5V-Vtgt jumper, it is strongly recommended to connect the target board to the header prior to plugging into a USB port. Keep the target board connected when unplugging from the USB port.

CAUTION

The ZeptoProg II contains static sensitive components. Use the usual ESD procedures when handling. For example, touch a grounded metal object prior to handling.

Appendix B: AVR Programmer Supported Devices

The ZeptoProg II supports all Atmel AVR microcontrollers with an ISP, PDI, or TPI programming interface. These include the megaAVR series (ISP), the tinyAVR series (ISP, TPI), the XMEGA series (PDI), the USB AVR (ISP), and the listed CAN and PWM AVR. The following lists most of the supported models. Add to these the different voltage and speed grade variants. **New chips are usually automatically supported with updates to the host software (ie: Atmel Studio or AVRDUDE).**

ZeptoProg II™ AVR Programmer megaAVR® Series Device Support

ATmega128, ATmega1280, ATmega1281, ATmega1284, ATmega1284P, ATmega128A, ATmega16, ATmega162, ATmega164A, ATmega164P, ATmega164PA, ATmega165, ATmega165A, ATmega165P, ATmega168, ATmega168A, ATmega168P, ATmega168PA, ATmega169, ATmega169A, ATmega169P, ATmega169PA, ATmega16A, ATmega16HVB, ATmega2560, ATmega2560, ATmega2561, ATmega32, ATmega324A, ATmega324P, ATmega324PA, ATmega325, ATmega3250, ATmega3250A, ATmega3250P, ATmega325A, ATmega325P, ATmega328, ATmega328P, ATmega329, ATmega3290, ATmega3290A, ATmega3290P, ATmega329A, ATmega329P, ATmega329PA, ATmega32A, ATmega32C1, ATmega32HVB, ATmega32M1, ATmega48, ATmega48A, ATmega48P, ATmega48PA, ATmega64, ATmega640, ATmega644, ATmega644A, ATmega644P, ATmega644PA, ATmega645, ATmega6450, ATmega6450A, ATmega6450P, ATmega645A, ATmega645P, ATmega649, ATmega6490, ATmega6490A, ATmega6490P, ATmega649A, ATmega649P, ATmega64A, ATmega64HVE, ATmega8, ATmega8515, ATmega8535, ATmega88, ATmega88A, ATmega88P, ATmega88PA, ATmega8A, ATmega8HVD

ZeptoProg II™ AVR Programmer tinyAVR® Series Device Support

ATtiny10, ATtiny12, ATtiny13, ATtiny13A, ATtiny15, ATtiny1634, ATtiny167, ATtiny20, ATtiny2313, ATtiny2313A, ATtiny24, ATtiny24A, ATtiny25, ATtiny26, ATtiny261, ATtiny261A, ATtiny4, ATtiny40, ATtiny4313, ATtiny43U, ATtiny44, ATtiny441, ATtiny44A, ATtiny45, ATtiny461, ATtiny461A, ATtiny48, ATtiny5, ATtiny84, ATtiny841, ATtiny85, ATtiny861, ATtiny861A, ATtiny88, ATtiny9

ZeptoProg II™ AVR Programmer XMEGA™ Series Device Support

ATxmega16A4U, ATxmega32A4U, ATxmega64A3U, ATxmega128A3U, ATxmega192A3U, ATxmega256A3U, ATxmega256A3BU, ATxmega64B3, ATxmega128B3, ATxmega64B1, ATxmega128B1, ATxmega16A4, ATxmega32A4, ATxmega64A4U, ATxmega128A4U, ATxmega64A3, ATxmega128A3, ATxmega192A3, ATxmega256A3, ATxmega256A3B, ATxmega64A1, ATxmega128A1, ATxmega16D4, ATxmega32D4, ATxmega64D4, ATxmega128D4, ATxmega64D3, ATxmega128D3, ATxmega192D3, ATxmega256D3, ATxmega128A1U, ATxmega128A4, ATxmega192A1, ATxmega256A1, ATxmega384A1, ATxmega64A4, ATxmega8e5, ATxmega16e5, ATxmega32e5, XMEGA B series, XMEGA C series

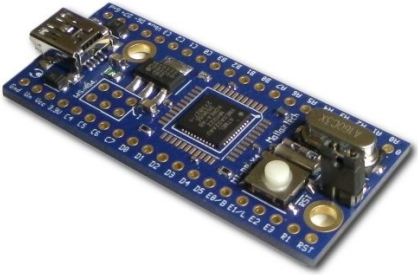
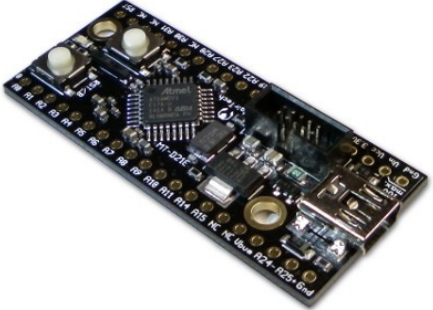
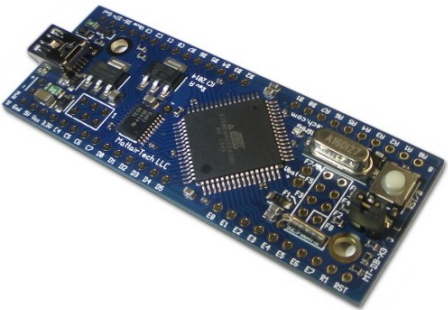
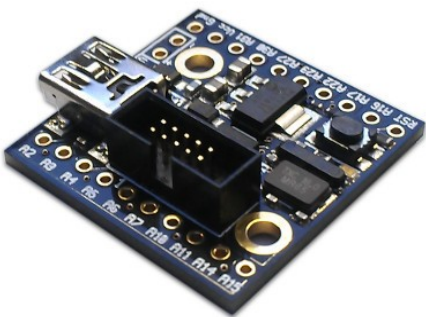
ZeptoProg II™ AVR Programmer USB AVR Device Support

AT90USB1286, AT90USB1287, AT90USB162, AT90USB646, AT90USB647, AT90USB82, ATmega16U2, ATmega16U4, ATmega32U2, ATmega32U4, ATmega8U2

ZeptoProg II™ AVR Programmer CAN AVR and PWM AVR Device Support

AT90CAN128, AT90CAN32, AT90CAN64, AT90PWM2, AT90PWM216, AT90PWM2B, AT90PWM3, AT90PWM316, AT90PWM3B

Appendix C: Other MattairTech Products

	<p>MT-DB-X4 USB AVR XMEGA board</p> <ul style="list-style-type: none"> ● ATxmega128A4U USB XMEGA AVR ● 128KB FLASH, 8KB SRAM, 2KB EEPROM ● 3.3V LDO regulator (low quiescent current) ● 16MHz and 32.768KHz crystals ● LED, boot jumper, PDI header ● Reset button, mounting holes ● USB DFU bootloader preinstalled
	<p>MT-D21E USB ARM Cortex M0+ board</p> <ul style="list-style-type: none"> ● ATSAM21E17A or ATSAM21E18A (32-pin) ● 128KB/256KB FLASH, 16KB/32KB SRAM ● Onboard 3.3V, 250mA LDO regulator (2uA quiescent) ● 16MHz and 32.768KHz crystals ● USB connector (power by USB or external up to 16V) ● Blue LED, 10-pin Cortex header, 2 buttons, I2C pullups ● USB CDC or MSD Bootloader (no programmer required) ● Arduino 1.6.5+ support (core and bootloader)
	<p>MT-DB-X3 USB AVR XMEGA board</p> <ul style="list-style-type: none"> ● XMEGA A3U, A3BU, C3, and D3 (64-pin) ● 32KB - 384KB FLASH, 4KB – 32KB SRAM ● 3.3V 250mA regulator (2uA quiescent current) ● Optional 5V 500mA regulator (23uA quiescent current) ● Optional auto-direction sensing level shifter ● 16MHz and 32.768KHz crystals, optional coin cell holder ● LED, boot jumper, PDI header, button, TWI pullups ● USB DFU bootloader preinstalled (except D variant)
	<p>MT-D11 USB ARM Cortex M0+ board</p> <ul style="list-style-type: none"> ● ATSAM11D14AM (24-pin) ● 16KB FLASH, 4KB SRAM ● Onboard 3.3V, 250mA LDO regulator (2uA quiescent) ● 16MHz and 32.768KHz crystals ● USB connector (power by USB or external up to 16V) ● Blue LED, 10-pin Cortex header, button, I2C pullups ● USB CDC Bootloader (no programmer required) ● Arduino 1.6.5+ support (core and bootloader)