Heron Circuits

Summary

Proboard PB systems (blue in color) are Arduino[1] compatible circuit boards based on the Microchip ATmega328PB microcontroller.

Proboard 328Ps (green in color) are similar, but use the older ATmega328P microcontroller. All information in this datasheet is for the Proboard PB.

Green Proboards are useful where quick setup and total Arduino compatibility are needed. The blue Proboard PBs can also be programmed by using the Arduino Integrated Development Environment, but support ATmega328PB specific functions not available in standard Arduino compatible systems.

Either variant, 328P or PB, can be plugged into an optional Heron Circuits Timeport® accessory board for management of lithium polymer battery charging, voltage boost conversion, interfacing with Sideboard ™ modules, or for access to automatic timed shutdown functions.

Features of the Proboard PB:

- ATmega328PB microcontroller
- Preinstalled OPTIBOOT bootloader
- Compatible with the Arduino Integrated Development Environment (IDE)
- Polarized TTL connector for interfacing with a Heron Circuits Polaron® FTDI USB to TTL converter
- Compatibility with generic USB to TTL converters
- Onboard In Circuit Serial Programming (ICSP) port for burning alternative bootloaders and fuses
- 26 digital I/O pins, 7 analog inputs, 6 PWM outputs
- 16MHz quartz crystal, ±10 parts per million accuracy
- Onboard voltage regulator +5.0 volts direct current (VDC), 150mA, accepts +6VDC to16VDC input
- 32KB flash memory - 0.5K used for bootloader
- Dimensions: 41.9mm x 12.2mm (1.65in x 0.48in)
- Weight: 4.3g

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Note #1: The name "Arduino" is a trademark of the Arduino Company. Heron Circuits, LLC is not affiliated with the Arduino Company. "Proboard" is a trademark of Heron Circuits, LLC. Proboards are not made by the Arduino Company, but are compatible with the Arduino Integrated Development Environment (IDE).

Note #2: Heron Circuits, LLC is not affiliated with Adafruit, OSEPP or SparkFun, but we recommend their products.

1. Pinouts

Figures 1-3 are pinout diagrams for P1 (male 32 pin header plug), J1 (TTL jack) and J2 (ICSP jack).

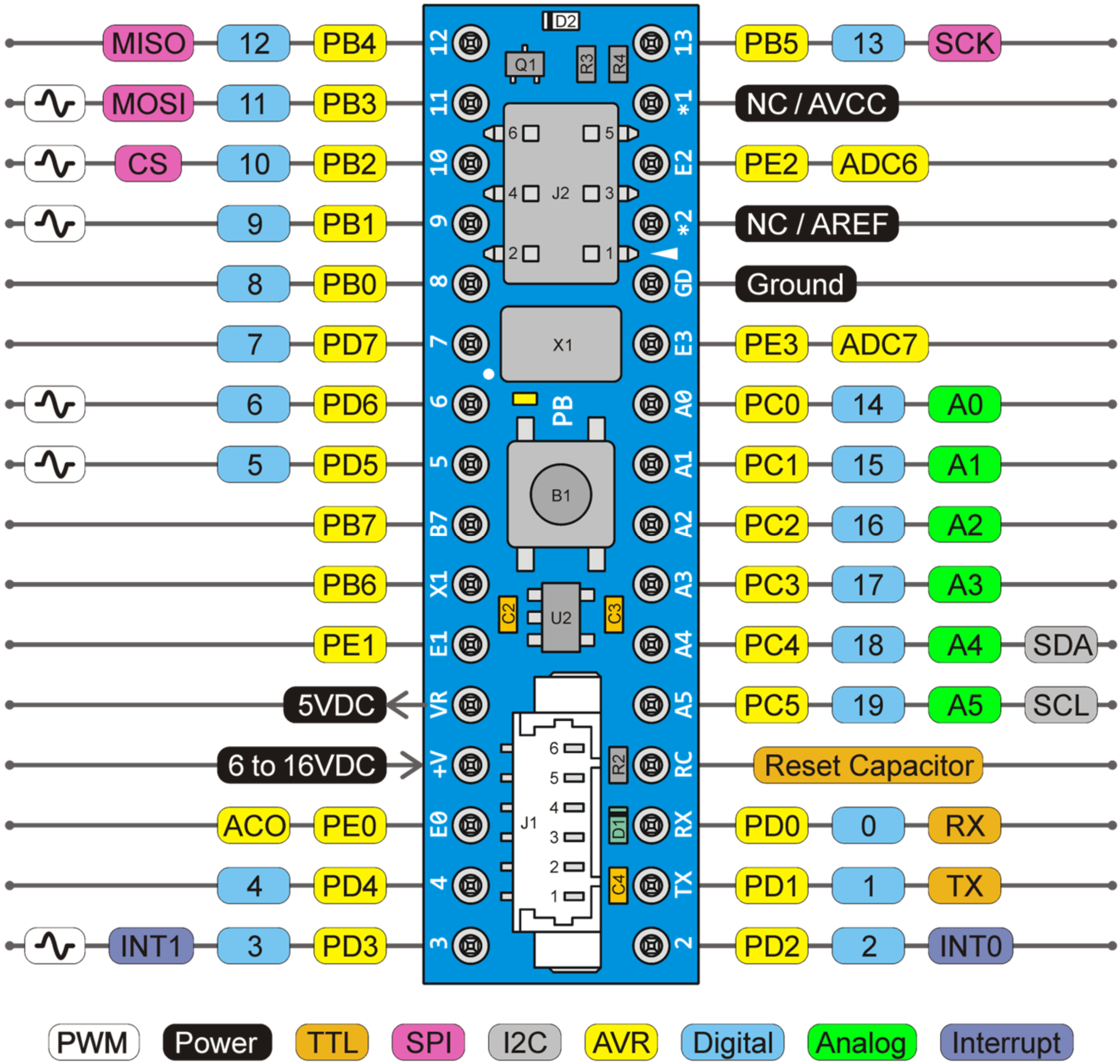

Figure 1 Header Pins

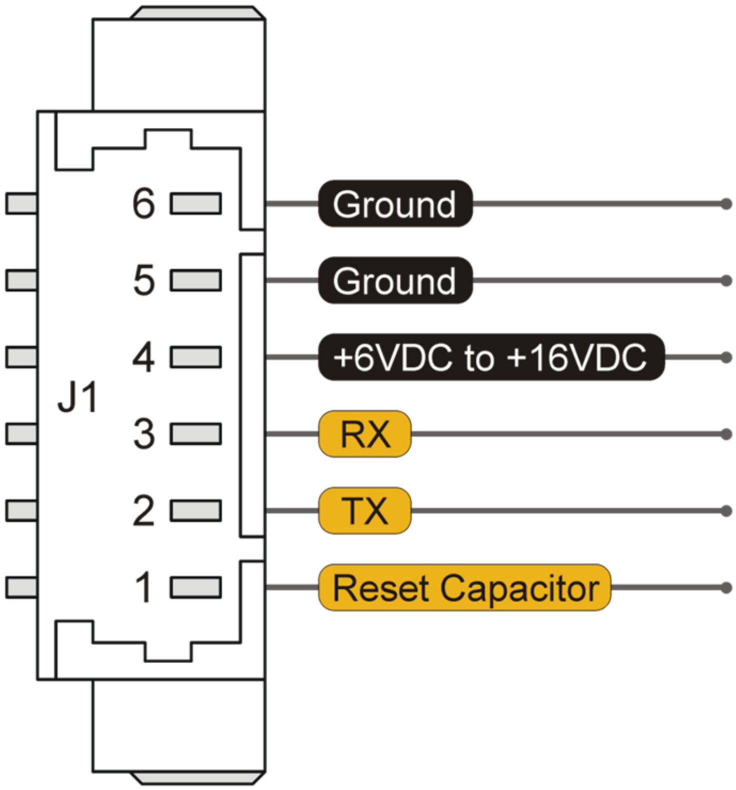

Figure 2 TTL Connections for J1

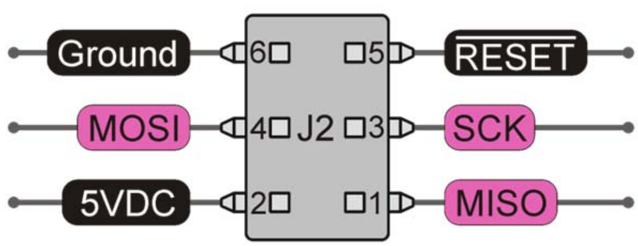

Figure 3 CISP Connections for J2

2. Schematic

The schematic below and all notes in this datasheet are for the blue Proboard PB systems which use the ATmega328PB microcontroller. See the “Programming” section for details on how to set up the Arduino IDE to support programming of Proboard PBs.

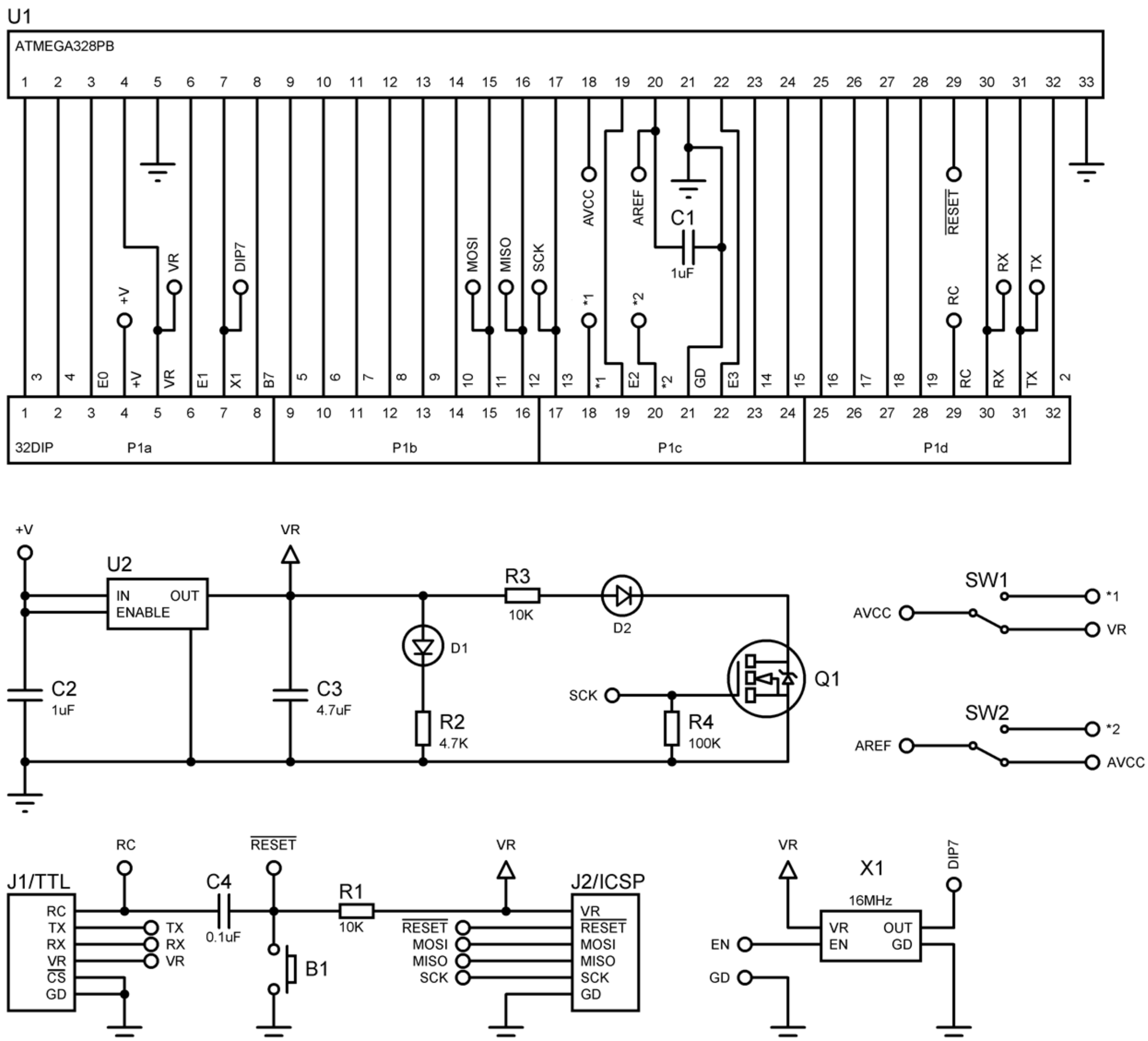

Figure 4 Proboard PB (Blue Board) Schematic

3. Configuration

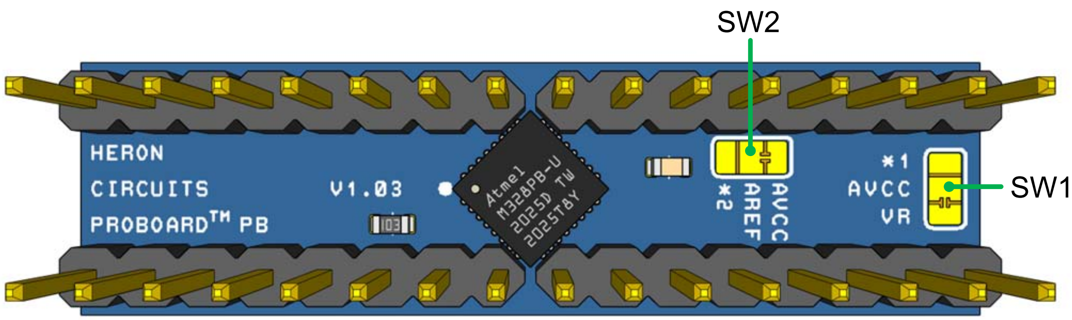

Figure 5 Configuration Switches

Proboard PBs have two solder switches, SW1 and SW2 as shown in Figure 5, plus two extra disconnected pins marked *1 and *2. To find the extra pins, see the P1 pinout in Figure 1.

The default switch configuration has a thin trace in SW1 connecting the processor's AVCC input to the output of the Proboard PB's onboard voltage regulator, VR. Solder switch SW1 can be used to connect the processor's AVCC input to an alternate external voltage on pin *1. By default, SW2 connects the processor's analog reference, AREF, to whatever voltage a user has selected for AVCC by using switch SW1. SW2 can be used to disconnect AREF from AVCC, and connect AREF to the *2 pin.

As shown in the figure, by default, the AVCC and AREF connections are both wired to VR which also powers the processor's digital circuitry. This setup matches all standard Arduino compatible microcontroller boards, and for most applications there is no need to change it. The switches are provided to allow advanced users the freedom to solve absolutely any problem by using any needed processor configuration, but you should understand that making modifications involving cutting of traces will void the warranty.

Proboard PBs are designed to be powered by DC +6V, +9V, or +12V fed into the pin marked "+V" in Figure 1. Each Proboard is warranted to be free from manufacturing defects at the time of manufacture, but connecting the +V pin to any voltage outside the range of 0V to +16VDC or connecting any of the other pins to voltages outside the range of 0V to +5.0VDC will also void the warranty, and probably release magic smoke, so don't.

The user assumes all risk associated with cutting traces by using sharp tools, and soldering using hot tools. Using all necessary cautions, an experienced hobbyist can cut the prewired traces by using the tip of a fresh hobby knife blade. Then, add a small blob of solder to connect the center pad to the opposite setting. Put the Proboard into a circuit board vise while being careful to avoid bending pins. Use a head-mounted magnifier, and good lighting

4. Signal Descriptions

Table 1 Header Pins

Pin Name	Description
RX	Receive serial data
TX	Transmit serial data
2 to 13	Digital Input / Output (I/O) pins
A0 to A5	Combination analog or digital I/O pins, also known as digital pins 14 to 19
E0	Digital I/O pin, or alternately the Analog Comparator Output (ACO)
E1	Digital I/O pin. Note that port E is not available in the ATmega328P processor.
E2	Digital I/O pin, or input to Analog to Digital Converter 6 (ADC6)
E3	Digital I/O pin, or input to ADC7
+V	Input into the onboard voltage regulator, +6VDC to+16VDC
VR	Regulated +5.0VDC output from the onboard voltage regulator
X1	Crystal oscillator clock pulse output terminal
B7	Digital I/O pin
*1	Floating pin, an alternate connection for AVCC
*2	Floating pin, an alternate connection for AREF
GD	Ground pin
RC	Reset Capacitor conducts RTS or DTR signal to reset the microcontroller

5. Powering Proboard PB

Users have multiple options for supplying power.

- Connect the positive terminal of a +6VDC to +16VDC power supply to the pin marked +V, and connect the negative terminal of the power supply to the GD connection.
- Although not recommended for full speed 16MHz operation, the ATmega328PB processor can run on voltages as low as 3.0 volts and still function. For best timing accuracy, use +5.0VDC.
- A reduced input voltage below +5.0VDC can be applied directly to the VR terminal. It is always safest to supply power to the +V input terminal instead, and allow the onboard voltage regulator to protect the system.
- If a reduced voltage is applied directly to the VR terminal, the output of the onboard voltage regulator is protected by an internal blocking diode, so the reduced input voltage on VR will not feed current back into the unused onboard voltage regulator in such low power applications.
- Any standard TTL to USB converter can be used to supply regulated +5VDC power to the Proboard PB.
- A regulated +5.0VDC supply can be connected to pin 2 of the ICSP programming port (J2).
- Install a Proboard PB into a Timeport accessory panel. Timeport accessory boards allow connecting jumper wires to Proboard PB connections from either the top or bottom surfaces, and can connect to optional Sideboard modules. Timeport boards are able to smart charge lithium polymer cells, and can boost a lithium cell's voltage up to a regulated +5.0VDC at 2.0 amps for powering portable projects. They also provide timed power shutdown functions that can be controlled by commands sent from a Proboard 328P or a Proboard PB.

6. Connecting

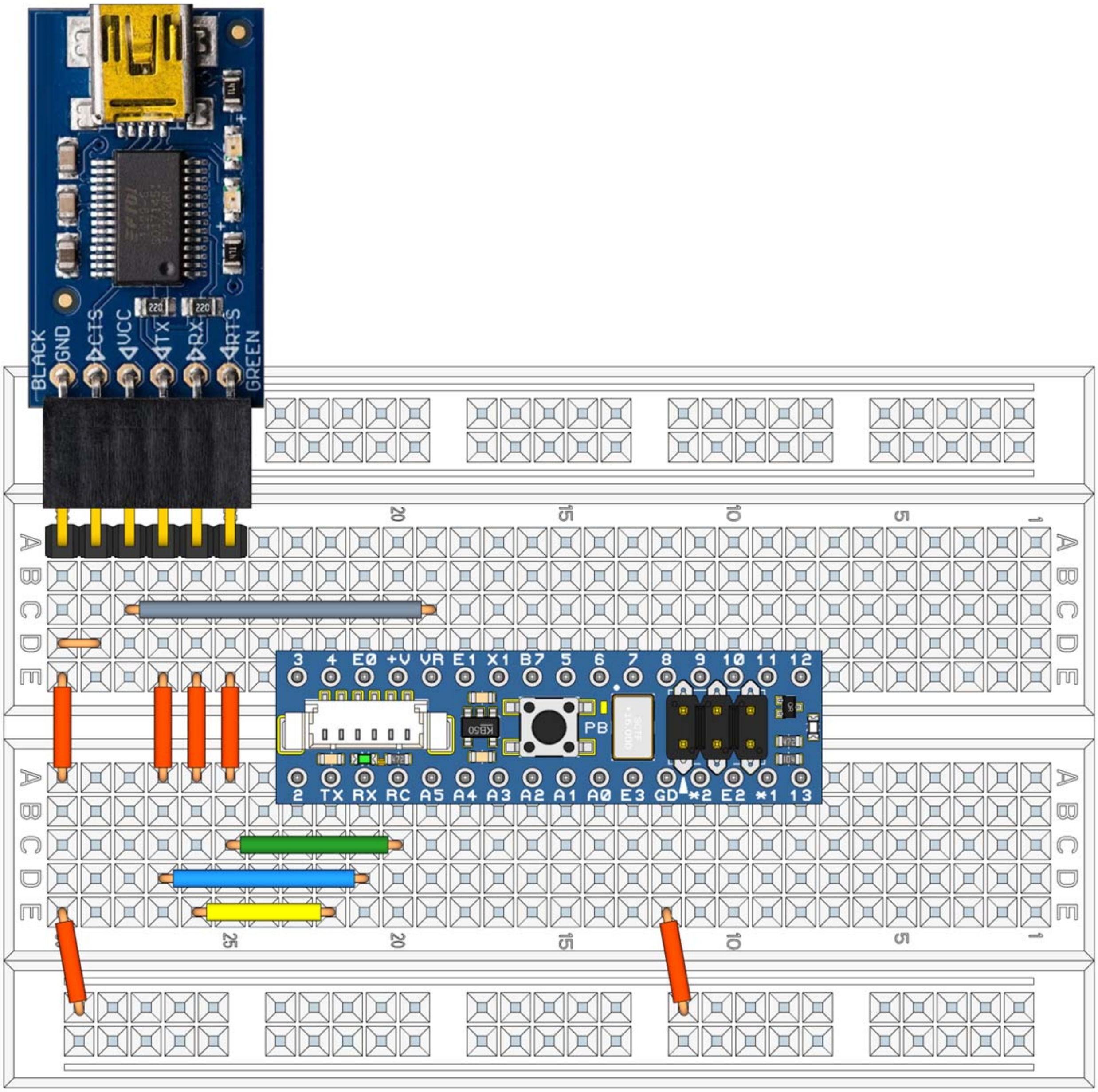

Figure 6 Using a Generic USB to TTL Converter

Figure 6 shows how to use a generic USB to TTL converter for transferring sketches into a Proboard PB. The six-pin device shown is produced by Adafruit[2], but similar devices are available from different manufacturers. Some have the pins arranged in a different order, but devices from Sparkfun and OSEPP have pinouts identical to the unit shown above. We recommend using a USB to TTL converter that contains a genuine Future Technology Devices International (FTDI) chip, although other USB to TTL chips also work.

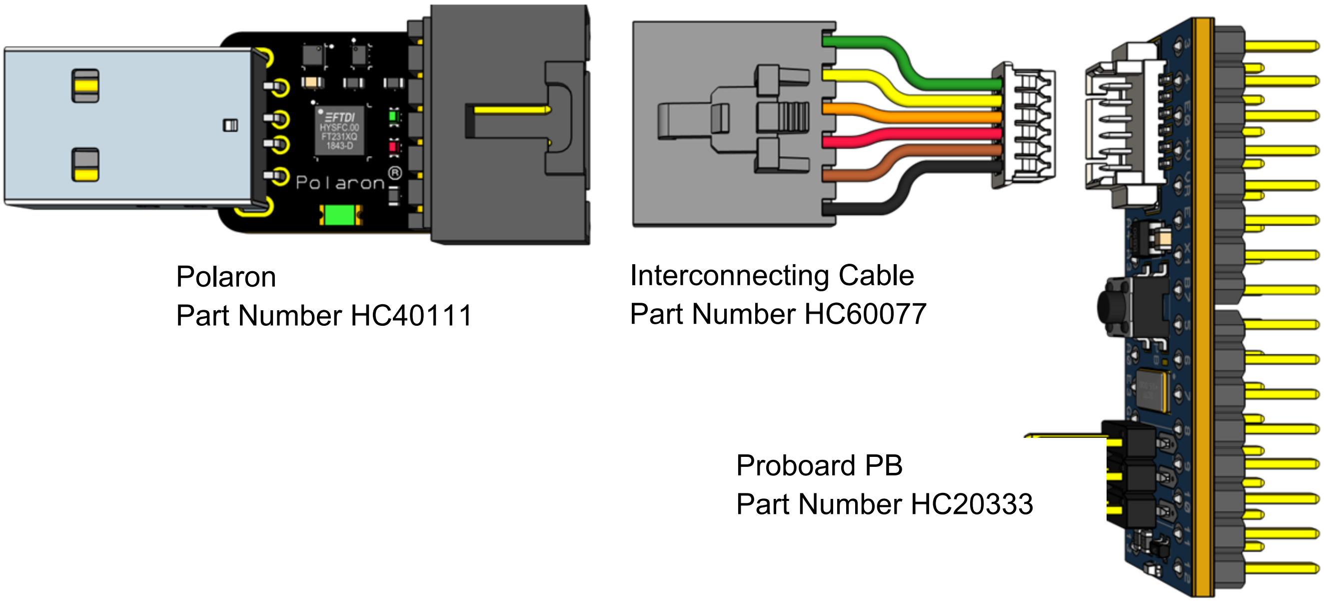

Figure 7 Connecting a Polaron to a Proboard PB

Figure 7 shows how to connect a Polaron to a Proboard PB. The interconnecting cable is pictured with wires shortened for illustration. The actual cable length is about 30 centimeters. The white plug on the right side of the cable plugs into J1, which is a wire to board connector with 1.25mm pin spacing. Compatible plugs that fit J1 are available from manufacturers such as Japan Solderless Terminals (JST) and Molex.

It is not necessary to use the interconnecting cable, and many users will prefer to use a more generic USB to TTL converter as shown in Figure 6, but the hookup shown in Figure 7 has advantages.

If a Polaron is plugged into a laptop, and a Proboard PB is plugged into a breadboard, the combination allows a user to place a laptop and a breadboard together on a table with simplified wiring. Connections at both ends of the interconnecting cable are polarized, so setup can be accomplished without risk of accidentally orienting the TTL connections backwards. Users are free to concentrate on learning how to control any components that are connected to the microcontroller on the breadboard.

A Polaron can provide 200mA, which is enough oomph for most breadboard projects. The device also includes a self-resettable fuse that limits the current that can be pulled from a computer's USB port. Damage is unlikely to happen, but when connecting any equipment to a computer the user assumes all risk. Heron Circuits will not be liable for any damage done when connecting equipment to computers, but the built-in fuse and the polarized connectors effectively reduce risk. See the Polaron data sheet for more information.

7. Programming

Navigate to https://www.arduino.cc/en/main/software where you can download the Arduino IDE to your computer. It will also be necessary to make a few modifications to the Arduino IDE configuration so it can support an ATmega328PB microcontroller. The setup is as follows:

First, install Arduino IDE version 1.8.12 or later on an Internet connected computer.

The Arduino IDE application software will need a Heron Circuits link added to its configuration. In the IDE, select "**File>Preferences**." In the text box marked "**Additional Boards Manager URLs**" add this text:

https://files.heroncircuits.com/proboard-index/package_heroncircuits_index.json

If other installed .json files are listed in the same text box, separate each URL with a comma.

Select "**OK**."

Select "**Tools>Board:>Boards Manager…**" In the "Type" drop-down menu, select "**All**."

Feed "Heron Circuits" into the search box, and press "**Enter**."

Hover over "**Heron Circuits AVR Boards**." Click "**Install**" and then "**Close**."

Choose "**Tools>Board:>Heron Circuits Proboard PB>Proboard PB <- Crystal Oscillator**."

The clock speed will default to 16 MHz.

With your USB to TTL converter connected to your computer, choose "**Tools>Port**" and tell the Arduino IDE which serial port your connection has been assigned to, such as COM5, etc. On a Mac it will look like this:

/dev/tty.usbserial-A6006hSc

Finally, upload a sketch into the Proboard PB by choosing "**Sketch>Upload**." You will see the LEDs flash on the USB to TTL converter followed by a message in the IDE status bar: "**Done Uploading**."

Try an upload using the "**File>Examples>01.Basics>Blink**" sketch.

8. Typical Applications

- An educational tool for learning how to use sensors and actuators with microcontrollers
- Development of basic coding skills for programming microcontrollers.
- A controller for battery powered portable equipment.

9. Low Power Applications

ATmega328PB microcontrollers have capabilities beyond ATmega328P devices, but the PB chip designers removed an important item when designing the new chip. The previous microcontroller included a more robust high-amplitude crystal oscillator drive circuit. The newer ATmega328PB chip only has a low-amplitude crystal oscillator drive circuit.

We ran differently packaged versions of the PB chips through variations of supply voltages, operating temperatures, lead length inductances and capacitances. We tried various surface mount board layouts connected to breadboards, and not. We tested combinations using different types of crystals and resonators. In the final analysis, we were unable to give the low amplitude crystal oscillator circuit in the ATmega328PB processor passing marks. In too many instances the ATmega328PB chips did not ring crystals reliably when running at a full 16 MHz clock speed.

We solved the problem by installing an independent oscillator module. In a Proboard PB, the component marked “X1” is not simply a quartz crystal. It is an integrated circuit which provides high-amplitude (5V) clock pulses on the X1 pin with an accuracy of ±10 parts per million. This provision is necessary for reliable and accurate instrumentation applications.

Instructions in this section show how to configure a Proboard PB in an ultra-low-power configuration – one that does not supply power to the independent oscillator chip. A Proboard PB only uses a few milliamps in total when powering the independent on-board oscillator at 16 MHz. It works fine for almost any battery-powered application, but for operating with the absolute lowest possible power consumption, an advanced user can optionally cut power to the oscillator. Do this:

1. Set the fuses of the ATmega328PB to use the microcontroller’s internal RC clock oscillator.
2. Connect the floating “Enable” contact of the Proboard PB’s X1 oscillator to ground. This cuts the chips power.
3. Disable the Proboard PB’s green power-on indicator LED.

The next pages show how to accomplish the three steps. The instructions assume a user is familiar with burning fuses with an In System Programmer (ISP). If not, then do not follow these instructions without help from a Guru who knows how to burn fuses. Burning fuses incorrectly can brick a system. Bricking a chip by setting fuses incorrectly is not covered under warranty, but if bricking happens as a result of fuse scrambling, it is possible to unbrick the chip by temporarily connecting the 16 MHz clock pulse output of a second Proboard PB to the afflicted system’s X1 pin.

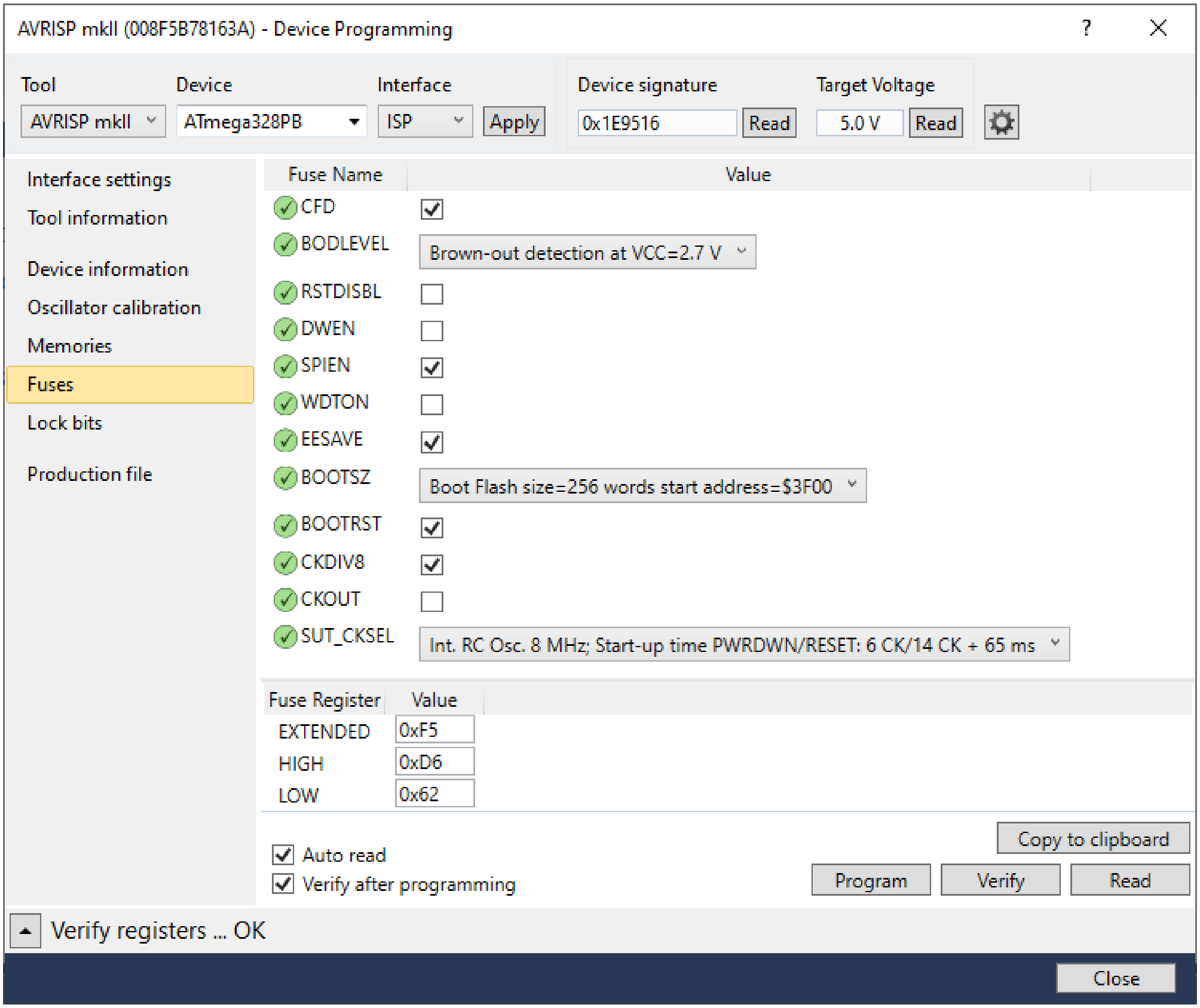

Figure 8 Low Power Fuse Settings

Figure 8 shows how to complete step #1. This is the dialog box for configuring the low-power fuse settings for a Proboard PB when using Atmel (Microchip) Studio software and an Atmel AVR ISP MKII device programmer. Setting the fuses in this way will result in the ATmega328PB running at 1 MHz instead of the normal 16 MHz operation. Reducing the clock speed is a part of what reduces the power consumption to bare minimum.

Fuse settings can be restored to the original 16 MHz configuration by using the Arduino IDE to burn a bootloader specific to a 16 MHz ATmega328PB using an external clock, not the ATmega328P.

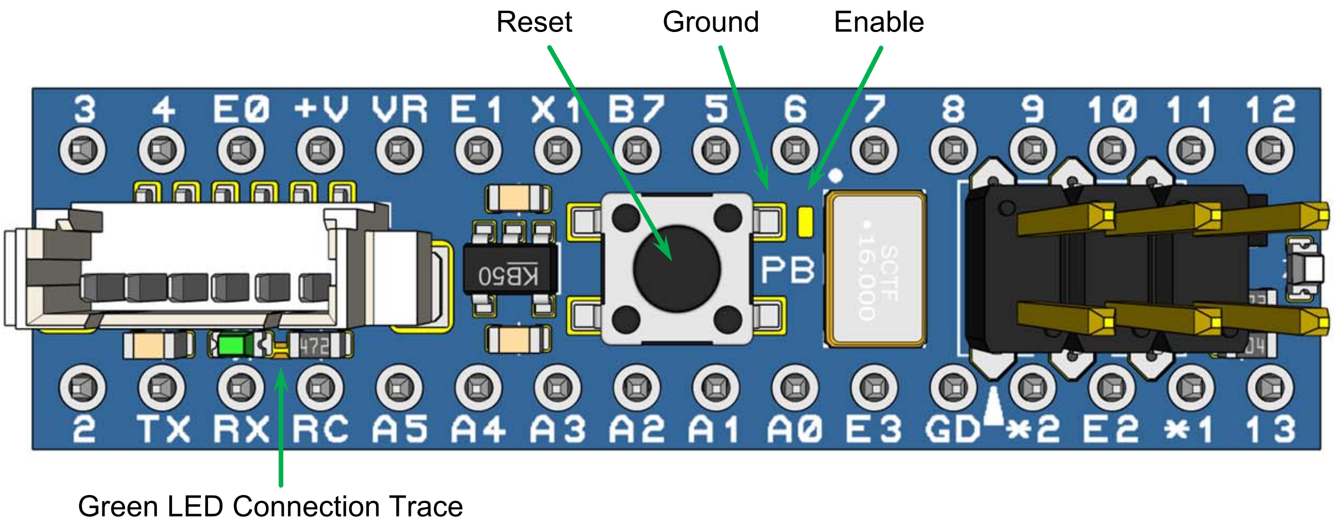

Figure 9 Top Surface Configuration Options

In step #2, the goal is to disable the 16 MHz crystal oscillator. Using the fine tip of a temperature controlled soldering iron, add a solder blob connecting the gold Enable pad shown in Figure 9 to the nearby Ground connection. The nearest ground point is the nearest leg of the Reset pushbutton. Be careful not to form a shunt to pin 6, and avoid overheating the Reset pushbutton. When the X1 chip is disabled it uses no power, and the X1 output becomes an open circuit, high impedance, so the X1 pin becomes a general purpose digital I/O pin.

In step #3, the goal is to stop current from flowing through the green power-on indicator LED. You can cut the exposed gold trace located between the LED and the nearby resistor. If you decide to reactivate the LED, place a solder blob to reconnect the green LED to the resistor. When soldering, be careful not to overheat the LED or the resistor, and avoid shunting the RX or RC pins.

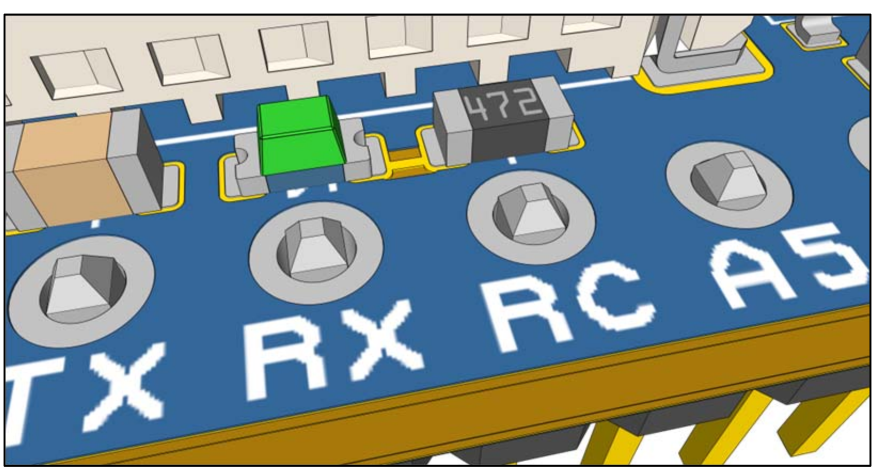

Figure 10 Detail on the LED Connection Trace

10. Notice

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