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Clever Tricks with ATmega328 **Pro Mini** Boards

Robert Sontheimer

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Foreword

I remember it like it was yesterday. I paged through the electronics catalog that had just arrived, and saw a new "home computer," which fascinated me immediately. Not yet available, but announced, it would retail for the equivalent of over 600 euro – the Commodore 64. I knew immediately: One day, I would buy one!

As you can guess, I'm not the youngest anymore. It must have been around 1982, and I was still in school. Two years later, that time came, and I could finally afford the C64. Back then, we programmed in the BASIC programming language, or directly in assembler. I controlled everything I could with the C64, because it had a "User Port" offering 8 data lines, all of which could be used as digital inputs and outputs.

Today, for not much more than a couple of euro, you can get small microcontroller boards, which are much faster, and in some areas can do much more than the home computers of back then. The small Pro Mini board with an ATmega328P microcontroller has no keyboard or video output, of course. But, otherwise, it's a fully-fledged, freely-programmable small computer with numerous input and output pins, which you can use to measure, control, and switch things as you please. That's exactly what this book is about: Simple, inexpensive solutions for every purpose.

Robert Sontheimer

Acknowledgments

I'd like to thank Timo Missel for numerous small jobs on this book, Matthias Abele for his tips and corrections, and, last but not least, Mr. Denis Meyer from Elektor Publishing, who was at my side in word and deed throughout the book project.

For this English-language edition, my special thanks also go to the translator, Mr. Brian Tristam Williams, for his good work and cooperation.

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Chapter 1 • ATmega boards

The ATmega328P from Atmel is one of the most popular Microcontrollers for all applications that don't require a lot of computing power. RAM, ROM (i.e. EEPROM), as well as processor and I/O connections are integrated in a little chip, making up a standalone computer that can be programmed using a USB cable or adapter connected to a PC.

Fig. 1a: ATmega328P

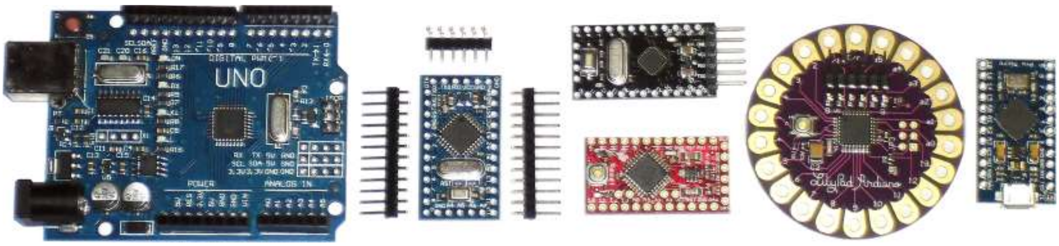

Fig. 1b: An Uno board, 3 different Pro Mini boards, a LilyPad and a Nano

The picture shows different boards using the ATmega328P. Each has a quartz crystal for generating its clock signal. Most have a voltage regulator to supply their chips with a clean, regulated power source (5 V or 3.3 V). The Arduino Uno and Arduino Nano boards also have an integrated USB interface, while the Pro Mini and LilyPad boards require separate USB adapters.

1.1 The Pro Mini form factor

The Pro Mini board is our choice for most of the projects in this book, as it's available from different manufacturers with only minor differences, and it's very affordable. It's very small and has everything that such a board requires.

It doesn't have a USB interface. Because you use that port only to upload your completed programs to the board, it's wasteful to have it on every board only to be sitting there unused in the completed project. Instead, we use a separate USB adapter as the necessary interface, which we can reuse for any of our other boards. The software can be modified and updated at any time simply by plugging in the adapter and connecting it to our PC.

A computer for a few euro

With its small form factor and omission of the USB interface, the Pro Mini board is astonishingly cheap. Nevertheless it's everything built-in, that you need, from processor to EEPROM – a full-featured computer ready to be programmed for measurement and control. Directly from China, you could get them a few years ago for under 2 euro. Since then, the prices have risen occasionally.

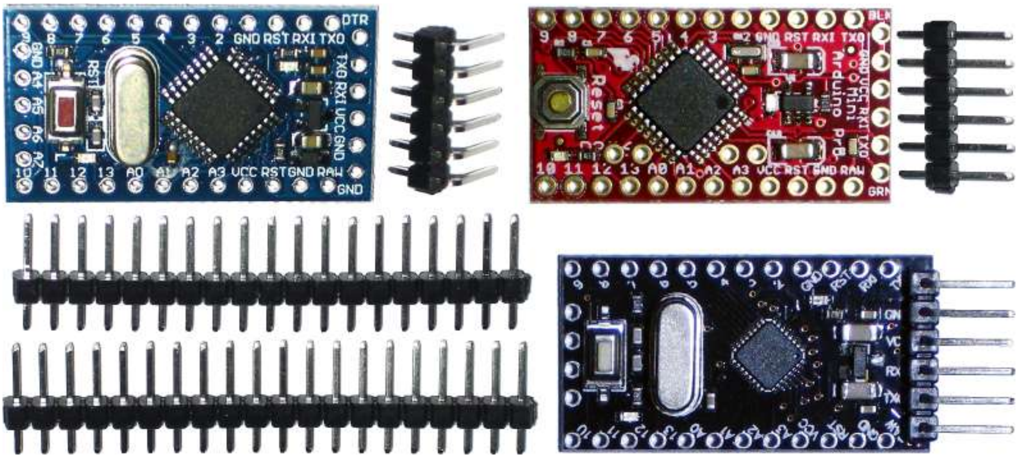

Fig. 1.1a: Different Pro Mini boards

Figure 1.1a shows different Pro Mini boards available directly from China. They usually come with the necessary pin headers. There are generally 2×2 (i.e. 4) different versions, as can be seen in the following table:

	ATmega328P 32 kB Program memory 2 kB RAM 1 kB EEPROM	**ATmega168PA** 16 kB Program memory 1 kB RAM 512 B EEPROM
5 volts 16 MHz	Standard version for projects with mains power	Version for simple projects with mains power
3,3 volts 8 MHz	Suitable for battery-operated projects	Suitable for simple battery-operated projects

5 V / 16 MHz and 3.3 V / 8 MHz versions

The standard version has an ATmega328P microcontroller running on 5 volts at a 16 MHz clock frequency. If you only have a minimal source of power, you can opt for the 3.3-volt version, which is only clocked at 8 MHz and thus runs half as fast. The reason is that the microcontroller needs at least 4 volts to run at 16 MHz, and can even run at up to 20 MHz on a 5 V supply. The microcontroller's direct supply voltage is normally labeled VCC.

Accordingly, the 16 MHz versions have a 5 V regulator on board, while the 8 MHz versions are 3.3 V. The RAW input voltage to the regulator may be as high as 12 V. To keep the regulation as efficient as possible, it's best to have a voltage that's marginally higher (ideally a maximum margin of 3 V) than the regulated output voltage (the 5 V or 3.3 V). That means, for example, a 6 V supply for the 5-volt version, and a 5 V supply for the 3.3-volt version.

ATmega328P and ATmega168PA

Each voltage version also has two microcontroller versions – the ATmega328P and the ATmega168PA. They're identical, apart from the fact that the 168 has half as much RAM, half as much program memory, and half as much EEPROM storage. For less ambitious applications, this is more than adequate, and allows one to save a few cents by using the ATmega168PA for most projects. Generally, however, we could also just use the ATmega328P.

For the sake of simplicity, I'll dispense with the suffixes ("P" and "PA") from here on – "ATmega328" and "ATmega168" are clear enough.

Connections

The following abbreviations are used to identify the individual connections:

RAW: The input to the voltage regulator, which can be as high as 12 V. From this, the microcontroller's actual operating voltage, VCC, is created.

GND: Supply voltage negative, i.e. ground.

RST: Reset pin. This is tied to VCC via a resistor. The Reset button connects this input to ground and causes the chip to reset.

VCC: The microcontroller's operating voltage – usually 3.3 or 5 volts.

0 – 13: The digital inputs and outputs. 0 and 1 also serve as serial TX and RX.

A0 – A7: Analog inputs. A0 to A5 can also be used as digital pins.

Pin layouts

Another difference between Pro Mini boards is in the positions and layout of the connection pins. Fortunately, the variations are limited. Here are a couple of popular examples:

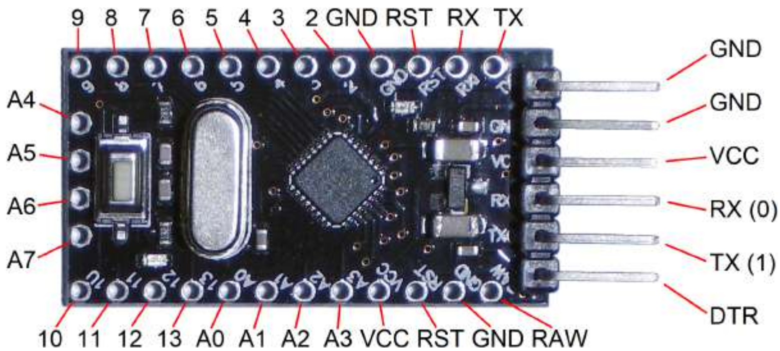

Fig. 1.1b

The pin layout for the upper and lower rows is identical for all Pro Mini boards. On the right side, the connections (seen here with a pin header attached) are for the serial-to-USB adapter. The analog inputs, A4 to A7, are on the left side of this board.

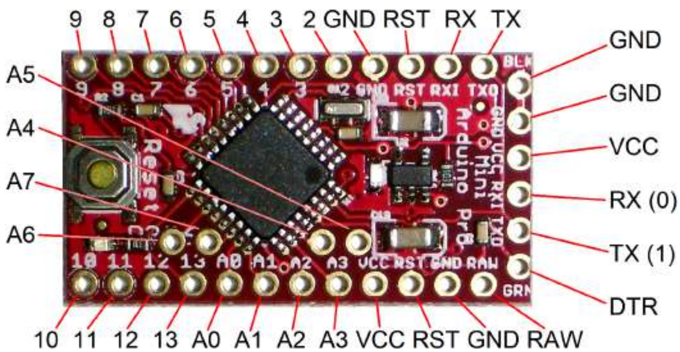

Fig. 1.1c

Here, pins A4 to A7 are located on the inner part of the board. The rest of the pinout is identical.

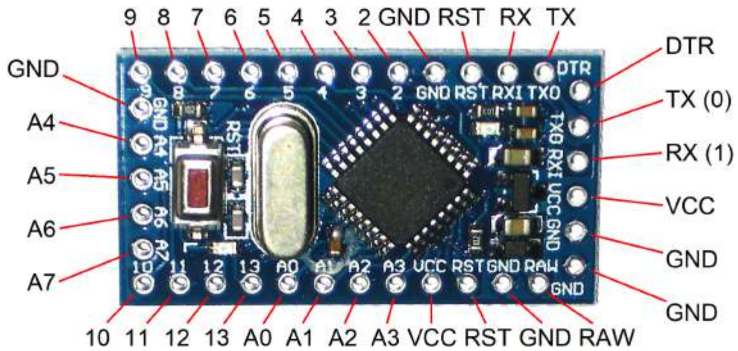

Fig. 1.1d

Here, note that the pins for the serial port (right) are reversed. The adapter must thus be connected the other way around.

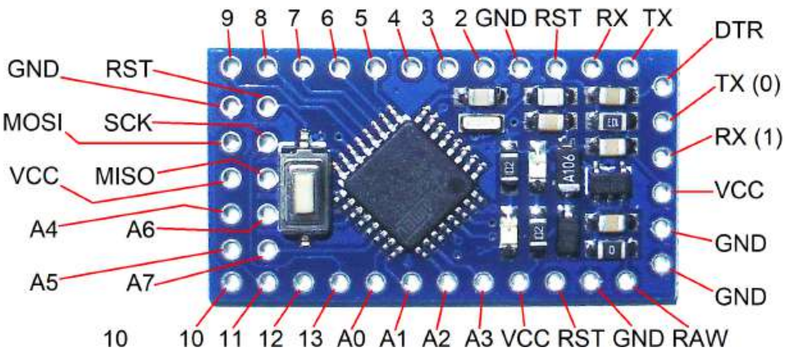

Fig. 1.1e

In this example, the serial port pins are also reversed. On the left, adjacent to pins A4 to A7 are a few more pins, but these are already available on the bottom row. MOSI, MISO, and SCK (identical to Pins 11, 12, and 13) can serve as an SPI bus if required. (This is a different kind of serial port, which we'll discuss on page 256.)

1.2 Uno versions

For the ATmega328P, there are also larger boards. The best-known is the Uno, and there are many variations of it, such as the original Arduino Uno Rev3 and a plethora of other Uno-compatible boards. Elektor even has its own Uno board, the UNO R4, that, with its ATmega328PB variant of the chip, has additional timers and other features.

Fig. 1.2: Different Uno boards

Instead of male pin headers, the Uno boards have female header sockets for the individual pins. This is very practical for adding various peripheral expansion “shields” that are available for the Uno series. For us, however, these headers are sometimes a disadvantage.

In any event, all of these boards may be used for the projects in this book, as long as you have access to at least 5 volts. For battery-powered applications, running at 8 MHz on 3.3 V is more appropriate.

1.3 LilyPads and similar

These boards are optimized for low-power, battery-operated devices, especially those with lithium-ion batteries. These boards save power, not only through their 8 MHz clock frequency, but also because they dispense with the on-board voltage regulator completely. Even a power LED, which serves no purpose but to indicate that the circuit is powered (while itself consuming power), is notably absent.

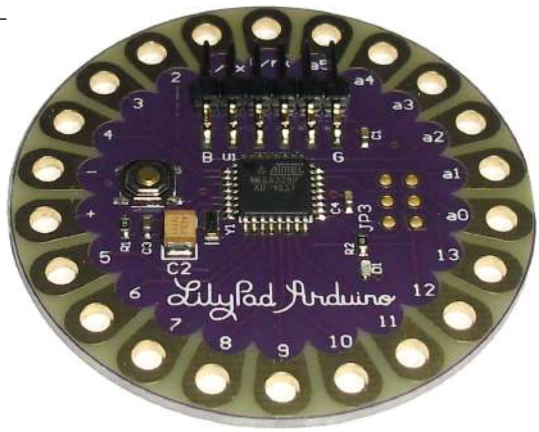

Fig. 1.3: The LilyPad

Running at 8 MHz with no voltage regulator, the ATmega328 can operate on between 2.7 V and 5.5 V. This is ideal for lithium-ion batteries, which deliver around 4.2 volts when fully charged, and about 2.8 V when empty. They should not be drained any further than that.

A degree of battery protection can be achieved by using the ATmega's standby mode when the battery is almost empty. Then, only a few µA are used (i.e. practically nothing). A more in-depth explanation is given in Chapter 13.3, on Page 271.

Even the inexperienced solderer will get familiar with the LilyPad quickly. The clearly-laid-out, large connections invite one to practice. LilyPads can be obtained directly from China for around 3 euro.

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16 MHz LilyPads

Officially, LilyPads operate at 8 MHz, but that doesn't bother some Chinese manufacturers, who now prefer to offer 16 MHz LilyPads. For applications that need high speeds, this may be optimal, but usually the higher clock frequency is a drawback. The current consumption is higher, and thus, according to the datasheet, the microcontroller needs at least 4 volts to work at 16 MHz. We might be able to get by with about half a volt less, so these versions can also be run on batteries, but with restrictions.

When we upload our programs, we have to ensure that the Arduino IDE is aware of LilyPads. For this, we must select a Pro Mini board and then specify a clock frequency of 8 MHz. This is important, otherwise serial ports and delay functions, for example, will run at double speed.

1.4 The Nano board

The Nano is similarly compact to the Pro Mini, but has an integrated USB interface. A CH340 chip is found underneath the board, enabling an interface between the serial port (RS-232) and the USB connector.

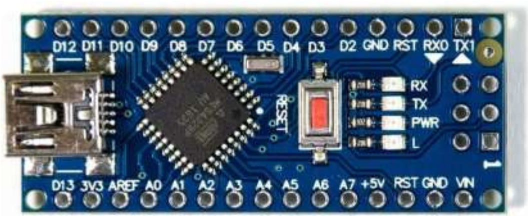


Fig. 1.4: Nano board

The Nano offers one advantage over the Pro Mini: The ATmega328's analog reference input is available at the pinout, labeled "AREF." The Uno also has this pin, while the Pro Mini and LilyPad boards lack it.

The USB interface described in the next chapter is already integrated in the Nano board.

Chapter 2 • USB adapter with serial interface

In contrast with the Uno and Nano boards, the Pro Mini and LilyPad boards have no USB connectors, so we need an appropriate adapter, which is only plugged in when we need to upload our software.

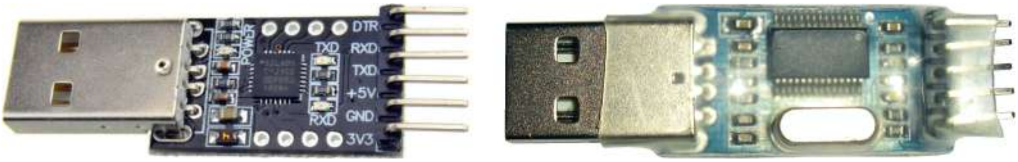


Fig. 2: Two different USB-to-serial adapters

While the program is running, it's also possible for the board to send serial data, which can then be monitored in a window on the PC (using the so-called "Serial Monitor"). This is often useful for debugging purposes. The program still runs without the serial connection, but the data is simply sent into the void.

Additionally, such an adapter can also be used to supply power to the board, but a regular USB cable (without the serial interface) can serve the same purpose if the power is to be supplied via USB.

All of these adapters (or converters, as it should be) have a special IC that enables the conversion between USB and traditional serial protocol. This is like the standard RS-232 interface, but at logic levels of either 5 V or 3.3 V. These are often called UARTs. The most commonly-used ICs for the purpose are the CH340, the PL2303, and the CP2102.

2.1 USB adapters based on the CP2102

I would recommend the converter based on the CP2102. It costs a few cents more, but experience has shown that it works reliably, without driver issues. It also works on any PC USB port. (Other converters sometimes require changes to the port settings when you plug them into another port.) The CP1202 is identifiable by its square shape. Most of the other commonly-used chips are more rectangular.

Fig. 2.1a: CP2102

Another advantage offered by this adapter is the DTR connection, which we can make good use of. One should pay attention to this when purchasing – the most versatile converter will have the following 6 connections:

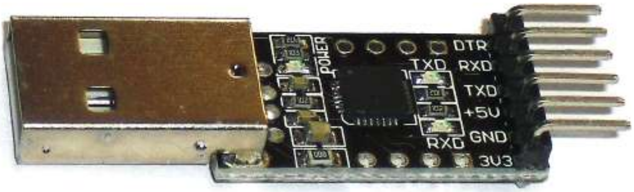


Fig. 2.1b: Serial adapter based on the CP2102

- DTR
- RX (or RXD)
- TX (or TXD)
- +5 V
- GND (minus or ground)
- +3,3 V

Direct from China, these adapters often cost less than one euro. There are versions with large standard USB connectors, which one can plug directly into a desktop or laptop USB port. Others have a Micro USB port, which require the use of a Micro USB cable. These are suitable for permanently connecting an adapter to the Pro Mini. The USB cable then serves as an interface you can plug into the PC. If the adapter is only needed for uploading programs to the board, then I prefer to get rid of the unnecessary additional connectors (via the USB cable) and instead opt for the adapter with the larger standard USB-A connector, which can easily be used as a pluggable adapter cable, as in the project that follows.

2.1.1 Project: Universal serial adapter cable

Before we can begin with Arduino projects, we need a USB adapter. Important criteria: A large, standard USB-A connector, CP2102 chip, 3.3 V and 5 V connection as well as another connection pin, which is usually labeled "DTR." (Of course we also need the GND, TX, and RX pins). With some wires and a few small components, we can create an optimal universal adapter cable.

Construction

Fig. 2.1.1a: The necessary parts

We need:

- 1 USB-to-serial adapter (CP2102 chip)
- 2 meters black wire (appr. 0.14 mm^2)
- 2 m red wire (appr. 0.14 mm^2)
- 2 m yellow wire (appr. 0.14 mm^2)
- 2 m green wire (appr. 0.14 mm^2)
- 2 m blue wire (appr. 0.14 mm^2)
- 1 pin header, 6-way (e.g. BL 1 6 G)
- 2 jumper cables (each 1-pin, female)
- 1 heat shrink tubing (2.4 / 1.2 mm)

The red and black wires are important. Instead of yellow, green, and blue, one may opt for other colors; all that matters is that all 5 colors are clearly distinguishable from each other. The wire lengths are also up to you – I would use at least 1 meter. The signal still comes through clearly at lengths of up to 3 meters. In order to bundle them into one, neat cable, braiding is a good method, but the complete cable will then end up being a bit shorter than the individual wires.

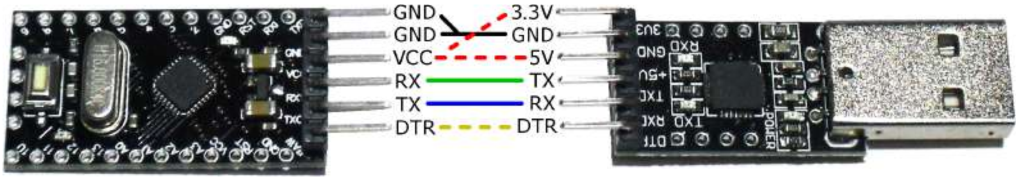


Fig. 2.1.1b: Adapter connections and wiring

Figure 2.2.1b shows the adapters' wiring. The dashed lines have no fixed, soldered connections, but can rather be plugged into the USB adapters later. For example, one could switch the VCC wire between 3.3 V and 5 V.

Once the 5 wires have been cut to the same length, it's best to start on the side of the board with the 6-pin socket that will later be plugged into the Pro Mini's pins. For this, a BL 1 6 Z connector is suitable, but the higher-quality BL 1 6 G is even better, as it has gold-plated contacts. Since such connectors tend to melt or warp during soldering, moving the contacts, I highly recommend connecting each female socket to its male pin counterpart before soldering (the male connector may even be significantly longer with more contacts) to keep everything in place.

Now, the wires' ends are stripped to about 2 mm (not longer than the socket's solder connections), and then soldered into place.

Tip: Neat soldering

After stripping, the threads should be twisted gently by finger, so that no strands are sticking out. Then, the wires can be tinned with the soldering iron and a small drop of fresh solder. Important: Always put the soldering iron at the soldering joint first. Only then do you touch the solder to the soldering joint (or on the border between soldering iron tip and solder joint), rather than to the soldering tip alone, as the solder is supposed to melt and spread out at the solder joint rather than just spreading all over the soldering tip. It's completely wrong to first touch the solder to the soldering iron and then introduce both to the area you wish to solder. Similarly, contacts, pins or solder lugs are always tinned with a little fresh solder at first, because only the flux within the solder causes it to spread along and adhere to the metal surface. However, the flux evaporates quickly, so you need to use fresh solder for each application, regardless of whether there's solder hanging from the tip. Rather tap or wipe the tip off occasionally. Most soldering stations have steel wool or a sponge for the purpose – the latter should be moistened for the purpose.

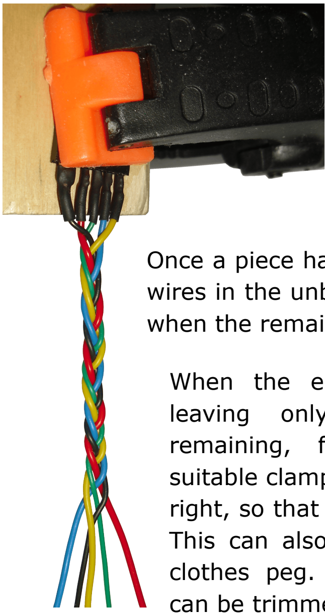
Once the wires and sockets are tinned, the connectors should be fixed in place somehow (e.g. using a weight or a clamp), so that the soldering area is easily accessible. Before that comes a small piece of heat shrink tubing (somewhat longer than the pins to be soldered).

Fig. 2.1.1c: Soldered; loose heat shrink

Now, we have 6 contacts, but only 5 wires. This is because the black ground wire (GND) is connected to the first two pins. The best way to handle this is to hold the wire between the two pins and apply enough solder to create a large solder joint between the two Pins.

Fig. 2.1.1d: Heat shrink shrunk

Ensure that the heat shrink tubing is far enough away when soldering, so that it doesn't shrink right already. The rest of the wires can be soldered to the corre-sponding connector pins. The wire after the black is the red, which is soldered to the "plus" connection, and then the remaining three colors. When all the wires are soldered, the heat shrink sleeving is slid down over the soldered connections, and shrunk firmly into place. For this, one may hold each side of the connector assembly briefly over a cigarette lighter flame.



Now, we can braid the wires. To do this, the connector must be fixed, preferably on a table edge, so that you can tug gently on the wires. With 5 wires, there are several ways of proceeding: I always grab the outer-left and outer-right wire alternately and place them over the two wires immediately adjacent to each of them, toward the middle.

Once a piece has been braided, use your fingers to separate the rest of the wires in the unbraided cable remaining. This is, unfortunately, a bit tedious when the remaining cable is still quite long.

When the entire cable is braided, leaving only a few centimeters remaining, fix the braid with a suitable clamp, as in the image on the right, so that nothing can come loose. This can also work with an ordinary clothes peg. Individual longer wires can be trimmed a little at this point.

Fig. 2.1.1e

Fig. 2.1.1f: Clamp

Now, the individual wires are soldered to the USB adapter. Note: Don't tin all of the pins, as the red "plus" wire and the DTR wire are only connected when in use, not soldered. The RX and TX cables must be crossed over; that is, the wire that goes to RX on the other end of the cable must go to TX on the adapter side, and vice-versa. (There may be another letter after the RX and TX abbreviations, but we can ignore these.) For the black ground wire, there's only a single pin on the adapter side. Note: Don't forget to put the heat shrink tubing on the wires before soldering!

Fig. 2.1.1g: Soldered onto the header pins

Now, only the "plus" wire and the DTR wire remain. These we will make connectable. For this, we'll solder the ends of single-pin header sockets from jumper wires. Best to use jumper wires with the same colors (so, red, and the color you used for the DTR wire). We cut the jumper wires about 3 cm from the connector. Then, we strip about 3 mm of each wire, making sure that we add heat shrink tubing to each wire (about 5 mm long), tin the wires and solder them to each other – i.e. each of the remaining two wires gets a socket.

Usage

Fig. 2.1.1h: Adapter cable, fully soldered

Depending on the board in use and the required operating voltage, the red "plus" wire must be connected either to the 3.3 V pin or the 5 V pin. Should the board be supplied with some other source of power, the red wire is not connected at all.

The DTR wire is needed so that the board can be reset automatically when required. When uploading a program, the board must be reset at the correct point at the beginning of the upload. One can also do this manually, by holding the Reset switch and letting it go at the right point in time, but it's much simpler to let the DTR wire handle this automatically.

Should you need to use the USB in the application, e.g. to send data from the board to the PC (once the board has been programmed with your application), it's best to disconnect the DTR wire. In this way, accidental reset can be avoided. The power supplied by the red wire is only needed if the board is not otherwise supplied with power (e.g. via the board's RAW input).

2.1.2 Serial Micro USB adapter

This USB adapter is useful for when the USB interface needs to be connected to the Pro Mini board for long periods of time, for example in applications that work with the PC and data is output, or if the board must be supplied with power using the USB connector. Connection to the PC will then be done using an ordinary Micro USB cable.

Fig. 2.1.2 PC2102-based Micro USB adapter

One may also make use of the Nano version, which has such a converter built in (although it makes use of the CH340 chip).

Chapter 3 • Buying tips

For microcontrollers and other components that we'll need here, there are, unfortunately no stores just around the corner that you can pop in to. Here, almost everything is done via mail order. With online ordering, the world is open to us, with enormous possibilities and opportunities, but also with some traps and pitfalls that we'll discuss here.

In this chapter, I'd like to offer some tips and suggestions for optimal component purchases in order to save money and avoid problems. I'm independent, so I don't get anything in return from any of the companies mentioned below. In today's digital world, however, many things can change at any time. Therefore, please understand that, as an author, I can't guarantee all information, but I do want to pass on my extensive experience in this area.

Prices also can change at any time. In 2017, for example, I actually bought some ATmega328-based Pro Mini boards directly from China for 1.03 euro. Since then, the prices have spiked again, for now. Therefore, the information on prices in this book can only serve as a rough guide.

3.1 Local suppliers and domestic mail order companies

In many countries, mail order companies were known to sell to their own country, predominantly. Some of them are older than the internet. In the past, they sent out catalogs of various thicknesses regularly, and people ordered by phone, or even by postcard. That's how it was done in the last century. Today, of course, all of the major mail order companies have online stores.

In big cities, there are usually electronic stores that offer ranges of electronics with varying levels of comprehensiveness.

All these offerings are naturally different in every country. Nevertheless, I would like to discuss some of them, especially those that have also established an international trade, and are known beyond the country's borders.

3.1.1 Conrad Electronic

Conrad is a German company that has been around for a hundred years. It's a very large supplier of electronic components with the widest range of products in Germany and meanwhile also internationally known. However, this diversity comes with a cost – literally. Also, despite the large selection, some of the lower-priced components are harder to find, while you can find others but at several times the price offered by other retailers. Therefore, I cannot recommend Conrad Electronic, unfortunately.

3.1.2 Reichelt Elektronik

Reichelt is also a German supplier, which today also sells internationally. In the offer are many standard electronic components, stranded wires, consumables, etc. The range of products is nowhere near as large as at Conrad, but the prices are usually quite reasonable. There's although no Pro Mini board to find at all. Some of the other components that we need for the projects in the book can be found there.

3.1.3 Other online suppliers

There are several other suppliers in some countries, which I do not want to discuss in detail here. Most of them also sell internationally, many also to private customers. The prices often could be better, but it's also worth just browsing these sites. Therefore I want to mention them briefly here:

Arrow Electronics	a US electronics distributor
TME	an electronics supplier based in Poland
Rutronik	another supplier from Germany
Pollin Electronic	only German & Austrian websites, but lot of cheap remaining stock
Lextronc	another supplier from France
Cotubex	a supplier from Belgium (side languages EN, FR and NL)

3.2 Big International online stores

With the spread of the internet, more and more online platforms have opened up that enable you to place orders worldwide. Some serve exclusively as a platform for external sellers, while others, such as Amazon, also offer a huge range of products themselves.

3.2.2 Ebay

Ebay does not sell items itself, but is merely a platform for many dealers and private sellers. They're located around the world, especially in China, and offer their products from there – that's where we find the cheap Pro Mini boards and the other components we'll need for our projects. Since the shipping is mostly from China, the delivery time may often be over a month, depending on your destination address. Most of the items can also be found at local dealers, but often at higher prices.

Search settings

If you type in a search on ebay.com, numerous settings appear above and to the left of the search results. These enable you to limit search results. Under “Item Location,” for example, you can often limit the search to items that are shipped from your own country or region, depending on your location. (Don’t confuse the location settings on ebay.com with the regional Ebay sites, such as ebay.de, ebay.co.uk, or ebay.com.au – these local sites show only items that are available for sale on them.) If you select “Worldwide,” items from other country sites will also appear, sometimes even in other currencies. You may also opt to use the local country sites as well.

Also you can sort items by using the options right above the search results. The setting “Lowest price incl. shipping” makes sense if you’re ordering only one item. If you need to have 3 or 5 Pro Mini boards in stock, it’s best to sort by lowest price (without shipping). Then, take the resulting shipping costs into account when comparing.

There are countless other search settings, which I won’t go into individually here, except to say: You can also click on “Advanced” to the right of the “Search” button, and get many additional search options.

Security on Ebay

Since you don’t know the sellers on Ebay, having comprehensive buyer protection is important. However, you only get this on Ebay if you pay using PayPal. This payment service acts as a trustee. If the goods don’t arrive, are defective, or don’t match their descriptions, you can file a “Case” and claim Buyer Protection.

3.2.3 Amazon

In contrast to Ebay, Amazon is not merely a platform for other sellers. Amazon also sells a lot of products itself. Many items available there can be purchased directly from Amazon, as well as from other sellers. A lot of the sellers store their products at Amazon warehouses, make use of Amazon’s logistics, and Amazon takes care of the shipping. As with Ebay, there are also many Chinese sellers who ship their goods directly from China. Once again, for the microcontroller boards and other components we need, these dealers usually offer the lowest prices. The downside is the lengthy shipping times you can expect from China.

There are also black sheep among Amazon’s sellers, but, as a customer, you are still on the safe side, as Amazon acts as a trustee (much like PayPal). Valid complaints are almost always dealt with without a hitch.

3.2.4 AliExpress

AliExpress belongs to the Chinese Alibaba group, and is a gigantic platform for international trade – it's like a Chinese version of Ebay. Here, we can find microcontroller boards, sensors, and other components in huge quantities and at the lowest prices you'll find. I order almost everything from AliExpress, even though the goods often take over a month to arrive.

On the site, you can select different languages, but the site works best in English. Communication with the sellers (if it's at all necessary) is in English as well.

Searches on AliExpress can be a bit tricky. Most of the time, hundreds or thousands of items will come up, most of which will disappear again when you sort by price. Sometimes it helps to use different search terms. However, you have to select your sort criteria after each search. Often, narrowing the search by using additional terms does not result in fewer search results, as one would expect, but many more. If you click on an offer that you found, it's worthwhile to check right at the bottom of that product's page, at the "Seller Recommendations" and "More To Love" sections. Often, the item you're searching for can be found even cheaper there.

AliExpress shipping costs

Years ago, you could order many electronics parts from China on AliExpress for less than one euro including shipping. That's incredible when you consider that domestic shipping alone (not including the value of the goods) often costs significantly more in most countries. However, those times are over. While small, light goods still benefit from moderate shipping costs, heavier goods (for example, speakers) are usually not worth it.

Buyer Protection on AliExpress

As with the other online stores, AliExpress offers buyer protection to customers. A few years ago, this was merely a bad joke. Even with clearly valid complaints, you'd be required to provide photos, videos, etc., several times as evidence. As a buyer, you often spent an hour of your time just to get 2 euro refunded.

This has changed significantly. With today's buyer protection, the bad joke is now an insane joke. By this, I mean that, even if you read in the tracking that your package never left China, AliExpress decides in favor of the seller, with the terse remark that the goods have been delivered, and even if a seller cheats and sells a completely useless product, at best, you'll get the right to send the goods back to China at your own expense, which, from most countries, usually costs more than the goods did.