Chapter 3 – Arduino Components and Where To Find Them

January, 2020
David Ackmann – Gateway Division NMRA

We know we can bring more action and life to our model railroad with Arduino microprocessors. But where can we buy them, and the components that make them useful in model railroading? That is what this document is all about.

Where did Arduinos come from? The Arduino was invented in the early 2000s in Italy as an inexpensive way to teach young people how to write computer programs. It is "open source", meaning that the hardware design is not patented, and many companies can and do make Arduino clones and components. Many manufacturers sell them on AMAZON. So visit http://www.amazon.com and do a search for "Arduino".

Well, maybe that was not the kindest way for you to start; sorting through over 3,000 hits might be more options than you need to start, so let's narrow things down a bit. This time, search for "Arduino Uno board". Use the selection criteria on the left and constrain the search to items rated 4 stars or more. That's still a lot of options, so further restrict the list to vendors that I know have worked for me, so click on "Sunfounder", "HiLetGo" and "Elegoo" (I'm sure there are other good vendors, but I have used these, they work, and I like the price). You can buy just the board or a more extensive kit: your choice, but make sure it comes with its own USB cable, most of them do. Pick one and order it.
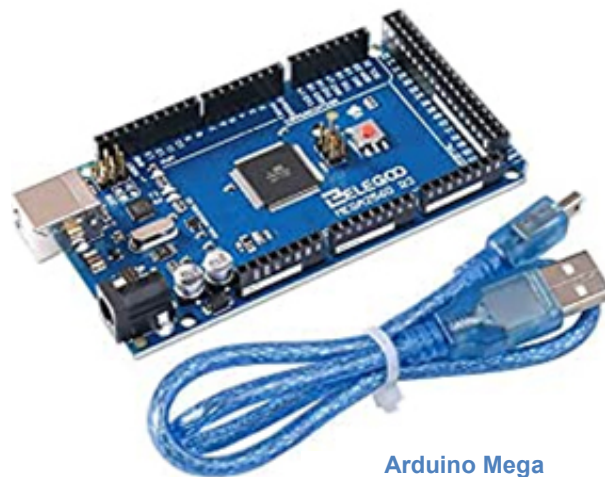

Arduino Uno

Just a quick aside on Arduino board form factors. The Uno is a good starting point, but there are other form factors for less money that do just about the same thing, and others that will do more for a slight increase in price. Respectively, these include the Arduino "Nano" and the Arduino "Mega". I started on the Uno, but now use the Nano almost exclusively. If I want to make a really large project, possibly one that controls three dozen LED lights, all independent of each other, then I would go to the Arduino Mega. There are even more Arduino form factors, but these are all for which I have seen much applicability within model railroading. But for starters, go with the Uno.
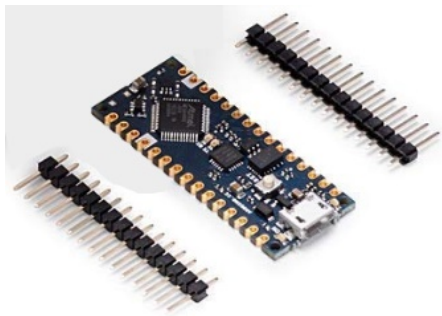
Arduino Nano Without Soldered Headers

Arduino Mega

While I do encourage you to start with the Arduino Uno, in most cases I prefer a combination of the Arduino Nano with pre-soldered headers and an expansion board from AMAZON. I am not good at soldering headers (the pins) into the Nano, so I am willing to pay a manufacturer to do it for me. Take a look at the "Upgraded Nano V3" from Elegoo (ASIN: B0713XK923; an ASIN is a unique AMAZON's Serial Identification Number, and since I am so specific on this item, I encourage you to search for it using the ASIN); these are 3 for $13. Alternately, the units from LAVFIN also work well (ASIN: B07G99NNXL). But why am I so adamant about liking the Nano? Because I can get an expansion board which lets me attach jumpers more securely through screw terminal blocks instead of jumper pins in sockets! There are several Nano expansion boards, some I like and others I do not, but the one with the ASIN of B07MGVC18K is my favorite (5 for $12). And they are versatile too. I have sliced and diced them to make expansion boards for other circuits, specifically MP3 players and amplifiers.

Arduino Nano With Headers
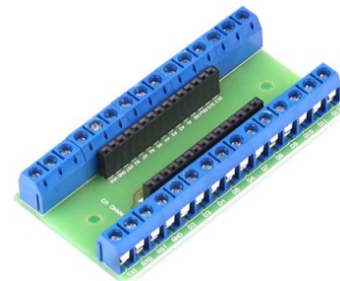
Nano Expansion Board

Now you have a choice. The rest of this document covers different components that can be connected to an Arduino, and how to find them. Other chapters in this series will cover how to connect components to an Arduino. Still other chapters cover how to create specific Arduino projects. So, if you want to learn more about the components I use, keep going.

6/12/2020 5:08 PM

For almost all my Arduino projects, I use an alphanumeric display. For some projects, like the speedometer, it provides operational information. For other projects, like the Carousel, the display provides diagnostic information. Again, visit AMAZON and search for "Sunfounder I2C 2004" and find this display for about $13 (ASIN: B01GPUMP9C). It has 4 lines of text, each 20 characters long. There are less expensive versions of this display that are not "I2C" and you don't want them. There are also versions that display only 2 lines of 16 characters, and you probably don't want them either. You might be tempted to buy from a different manufacturer, but I buy from Sunfounder because I know they work and I know how to use them.

For some projects I use light dependent resistors (aka: LDR, photo resistor, photo cell) to detect when a train is over a specific spot on the layout. Visit AMAZON and search for "photo resistor". You can get 30 of these manufactured by eBoot for less than $5 (ASIN: B01N7V536K).

Photo Resistors

Jumper Wires

AMAZON also sells fixed-resistance resistors and I like to keep values between 200Ω and 500Ω on hand to control the brightness of LEDs. The MP3 player projects need a 330Ω resistor and switches need a 10K resistor. Once purchased, I separate my resistors into small, labeled envelopes; I am color blind and can't reliably read the color codes. You will also need jumper wires in various gender combinations and lengths (ASIN: B01EV70C78). If you don't have plain resistors or jumper wires, search for them on AMAZON.

And speaking of switches, I like to use toggle switches (SPST) to turn my Arduino animations on and off. My most recent purchase was a 6-pack for under $8 (ASIN B07MFQ4TNK); you can save a few bucks by buying the version without the waterproof boot. I also use momentary push button switches where appropriate (ASIN: B01FKXRYVE). Similar items may be purchased at many hardware stores.

I am addicted to applying sound to model railroad animations, and for that I use MP3 players, amplifiers and speakers. Again, AMAZON is my source. I like the DFPlayer Mini from Anmbest (ASIN: B07JGWMPTF); you can get 5 of them for $13. They play sound files stored on a MicroSD card, and a 4G card is plenty big. The
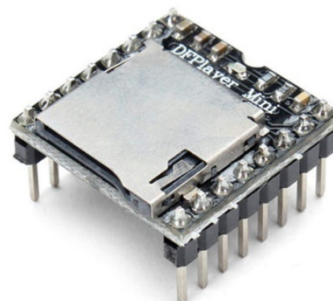
DFPlayer Mini can drive speakers directly, but I prefer to drive through an amplifier and let the amplifier drive the speakers. Why? Because the amplifier I like, the PAM8403 from Chenbo (ASIN: B01MYTZGYM, 2 for $8), has a potentiometer to control the volume. I get sound files for a variety of sources, so see the chapter in this series on audio for details.

For speakers, any 5W, 8Ω speaker will do, but I have been successful with ones from CQRobot; you might want to consider the size of these speaker, as these are a bit large These speakers are under $8 for a pair (ASIN: B0822YL2L2), 5W and 8Ω, have a good sound and are easy to connect.

Arduinos output pins are limited to 40 milliamps (and 200milliamps for the entire board), and while this is enough for LEDs and some small motors, it is not enough for larger devices, and in such cases you will need relays. I bought mine on AMAZON from Youngneer (ASIM: 8 for $12) and they do the job.
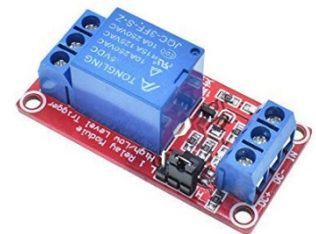
Then there are LEDs. Again, search for them on AMAZON. I recommend you search for "Colored LEDs 3mm" and buy a pack of 500 of the 3mm size (be careful before you add these to your cart because AMAZON will probably show you larger and smaller sizes, even though you searched for only the 3mm size). I have been successful with LEDs from "Dicuno" (ASIN: B07NMFCDX6). If you are really particular with your color requirements, buy white LEDs and paint them with Tamiya paints.

There is also a type of LED that comes in a strip, rather than as discrete components. A single LED or several can be torn from the strip, connected to power and set aglow. I have purchased a roll of 5V LEDs from a company called HWELL, and like what I see (ASIN: B07SZMBPFT). I spent $13 for 120 LEDs. These will be really useful for interior illumination, and the fact that they run on 5VDC (20ma) means I don't need a resistor to make them shine.

Eventually, you will want to use Arduino projects away from the development environment on your personal computer, and for that you will need an external power supply (aka: a "wall wart"). On AMAZON, search for "12V power supply". Make sure the item you choose has a 2.1mm connector and the center is a positive voltage (the ground will be around the exterior of the connector). Different power supplies can deliver different amounts of power, but since they are all about the same price I go with ones that deliver 12VDC and 2 amps. Power Supplies with connectors can also work with an Arduino Nano if you cut off the connector and connect the wires properly to the GND ("Ground") and VIN ("Voltage Input") pins. Make absolutely sure the power supply you order delivers 12V and 2 amps, because AMAZON's search algorithm is notorious for delivering "false positives" when searching for the criteria you supply, and they just might suggest the wrong voltage and different amperage.

Most Arduinos can accept an input voltage between 7 and 12VDC. But some components, such as the DFPlayer Mini MP3 player, would be destroyed at a voltage above 5 volts. In these cases we need a voltage regulator. I like to use a "Buck Converter" for this job, it runs cooler than a simple voltage regulator and is more flexible. DROK makes one with a voltage display and a nice plastic case for $14 (ASIN: B07JZ2GQJF). Zixtec makes a 10-pack without a display for $16 (ASIN: B07VVXF7YX; if you buy the model without the display you must dial in your desired output voltage using a volt meter). Finally, there is one from SainSmart which has a display but no plastic case for $8 each (ASIN: B01299MVD8). These from SainSmart are the ones that I use, and I am sure there are others as well. Your choice.

With Display. with Case

Basic, No Display, No Case
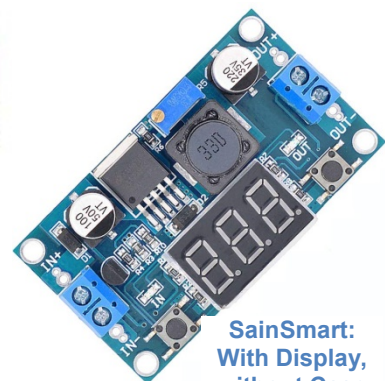
SainSmart: With Display, without Case

I also use stepper motors (Unipolar) to rotate small things. I bought a 5-pack from Elegoo (AMAZON ASIN: B01CP18J4A) for $14, and they have done the job. They come with both a motor and controller board; the motor has a 5mm shaft. But remember that the Arduino has a limit of 40 milliamps per output pin, so if you need something more powerful, power it through a relay.

6/12/2020 5:08 PM

Stepper motors are inexpensive and useful if you need full rotation, but the ones above are fragile and have plastic gears. You may want to consider a different motor type, a servo. These usually are limited to 180° of rotation, sometimes only 90°, but also provide accurate position and may be more rugged. I bought these servos (plastic gears, AMAZON ASIN: B07MLR1498, 4 for $11) but have not tried them yet. I also bought these Maxmoral (AMAZON ASIN: B07NV476P7) metal geared servos (2 for $10). They work, but finding the arms (aka: horns) in the aftermarket has been a problem. I like servos, but need to find a manufacturer who uses a more standard shaft size; BTW, a company called "DuBro" makes aftermarket arms.

If you would like a book which explains Arduino programming, take a look at :Programming Arduino" by Simon Monk, available from Amazon (ISBN: 1259641635). Programming in C can be a bit overwhelming if you have never programmed before, so perhaps a course at a Community College or a school district night course might be useful as well. The big thing for me was that "CaSe MaTtErS", that most lines (except braces, which are paired) end in a semi colon, and that checks for equality in conditional statements always use two "equals signs ("==")". Otherwise things are pretty straight-forward.

That's enough for things you might need to order specifically for many model railroad projects. But I am going to assume that you have some basic model railroading tools, including 20-24 gauge wire (if you need some, pick up some red and black 24 gauge stranded wire from Bryne on AMAZON, ASIN: B07Q14WR9D; they have other colors too), wire cutters, a 40 watt soldering iron with a pencil point tip (not a larger soldering iron or soldering gun for soldering plumbing), some rosin core 60/40 solder and shrink wrap and a heat gun. If not, visit your local hardware store, or visit AMAZON and search for "Weller SP40NUS"; it's a good iron for about $21 (ASIN: B00B3SG6UQ). Also search for "Weller ST7" to get a conical tip for model railroading work; you can get a single one for about $7 from Weller (ASIN: B0002BSQRQ) or five of them from a generic manufacturer for about $14 (AMAZON ASIN: B07P1D3RJG). You will need solder, so search for "Miniatronics 60/40" and get 4 ounces for a bit over $11 (ASIN: B0006O933K). Get a stand for your soldering iron: search for "soldering iron holder" and pick one for under $10 (I use the one from "WEmake/Elenco", ASIN: B00L2KNHW0). Get barrier strips from AMAZON by searching for "Molex screw terminal strips (ASIN: B0084LH4ZG) and cut them to length as needed, or order ASIN: B06W57X4MP and get a 10-pack of 2 position connectors and forget about cutting big

connectors into little ones. I am sure there are other good sources for similar products, but these work for me. Oh, and also have a reliable volt meter and some breadboards for prototyping your projects.

This concludes the third chapter on "Amazing Arduino Animations". When completed (July, 2020), there will be about a dozen more follow-on chapters, including how to download and use the Arduino Interactive Development Environment, and how to interface different types of components with an Arduino. There will also be several "project" documents where I describe how to use multiple components to build something useful for the railroad; there are projects to build a loop speedometer, a MP3 player for a Carousel, sparkling lights and sound effects for a water effect, lights cycling randomly inside a building, a lumberjack chopping a tree, and more are planned.

The fun is just beginning.