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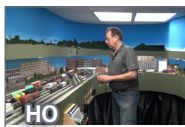
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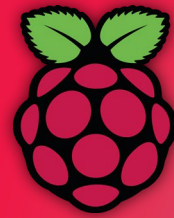
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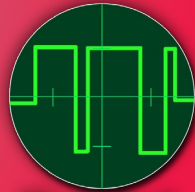
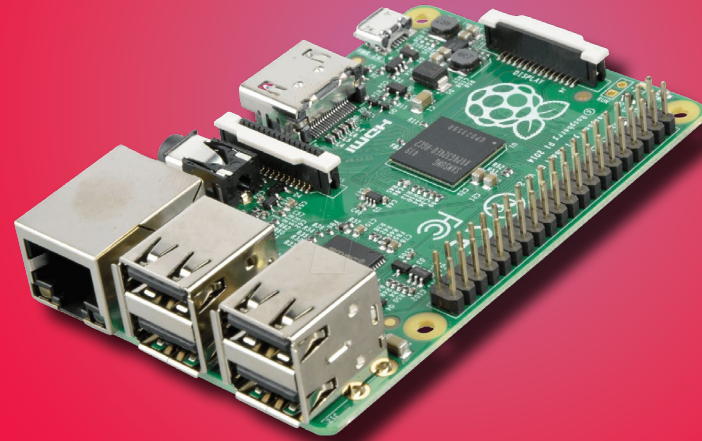
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Raspberry Pi

for model railroaders



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Model Railroad Hobbyist | March 2019 | #109

DR. GEOFF BUNZA shows how to put this new highly affordable tiny computer to good use on your layout ...

MODEL RAILROADERS USE COMPUTERS MORE AND MORE in their hobby to research topics, view magazines, program their DCC decoders, schedule operations, and control their layouts. Often modelers may use an older, hand-me-down PC or laptop for such activities.

A new, low-cost, tiny computer that's starting to gain ground as an attractive option is the "Raspberry Pi" or "RPi" for short.

Just a bit larger than a credit card, the RPi consumes little power, and often exceeds the capabilities of personal computers from several years back. The RPi also offers some additional capabilities which open new possibilities for modelers.

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There are several things a Raspberry Pi offers modelers that make it a winner:

- It can run the full JMRI configuration including its DCC command station interfaces
- It can power up managing its own, independent, WiFi network supporting wireless throttles
- It is low-cost (\$39), small-sized (3.35"x2.2"), and uses little power
- It can run with or *without* a monitor, keyboard, and mouse
- You don't need to program it!

Unlike the small Arduino controllers I have discussed before (MRH December 2016 and MRH March 2017), the RPi offers much more capability. Like your laptop, it runs an operating system (OS). Its



1. Arduino Uno (left) and Raspberry Pi 3B (right).



G. Bunza

LEARNING MORE ABOUT JMRI

The Java Model Railroad Interface (JMRI) is free, widely used, and growing in support. JMRI has free software applications that run on Windows, Linux, or a Mac that can perform a multitude of useful model railroading functions.

JMRI makes programming complex DCC decoders much easier. It can also be used for dispatching, signaling, switching, route control, train control, and more.

If you need more info about JMRI, just visit the web link below.

WEB: jmri.sourceforge.net/help/en/webtoc.shtml

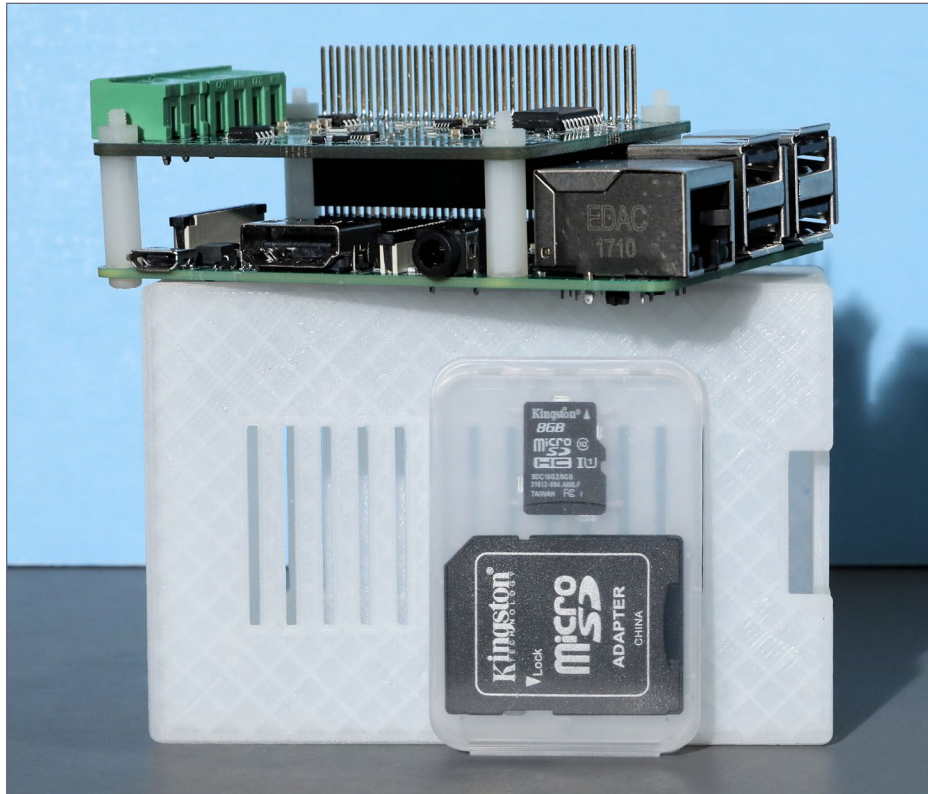
OS, called "Linux," supports displays, keyboards, mice, USB interfaces, SD memory cards, and best of all: the Java Model Railroad Interface (JMRI).

I will assume the reader has a basic acquaintance with JMRI. If not, see my side note on where to learn more about JMRI.

This article is not focused on the technical intricacies of the RPi or JMRI. Instead it provides a step-by-step process for a modeler to set up an RPi and get it going nearly instantly. I provide some different variations, including one with its own WiFi network for wireless throttles.

Later, I'll suggest some additional customization modelers might like to consider.

RASPBERRY PI FOR MODELERS | 4



2. Pi-SPROG components.

From off-the-shelf to do-it-yourself solutions

A year or two ago, I saw a demonstration at our local NMRA divisional meet of a new product called the Pi-SPROG given by Bill Chown of the BBM Group (sprog@bbmgroup.com). I was impressed with its compact size and performance.

When I later needed a compact solution for a JMRI operating demo, Bill was incredibly helpful answering questions, and I quickly got up and running. The Pi-SPROG is a complete, commercial package consisting of an RPi Model B, a special SPROG



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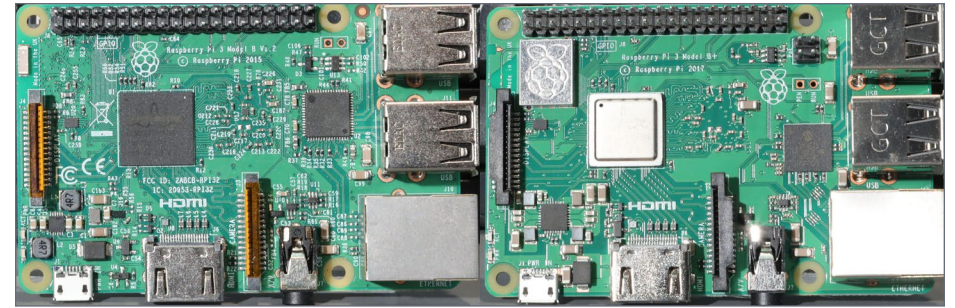
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4. Raspberry Pi 3B (left) and Raspberry Pi 3B+ (right).

plug-in board, a pre-configured and pre-loaded micro SD memory card (like the ones used in some cameras), a power supply, and a small enclosure for the boards.

The micro SD card acts as the hard disk drive found in your laptop or personal computer. I think it took me longer to read the documentation than it did for me to connect everything and get a train running for my demo!

Later, I will step through creating your own RPi setup from scratch.

The Pi-SPROG memory card comes pre-loaded with the correct version of Linux and JMRI, and default configuration setup for the Pi-SPROG DCC board to form a complete DCC command station.

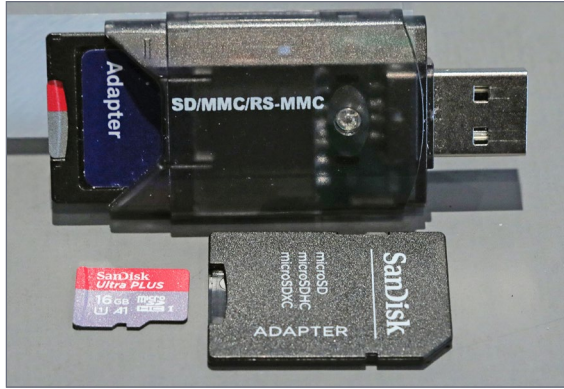
The SPROG board that easily plugs into the RPi is the equivalent of a separate SPROG DCC interface with which you may already be familiar. The RPi runs JMRI, just as it would run on your PC or laptop.

The very best part is that the Model 3 B (and 3 B+) of RPi can also act as a self-contained WiFi network. The RPi has the WiFi hardware, and JMRI provides the wireless throttle protocol. So after a quick setup of my cell phone and its WiThrottle (or Engine Driver) app, I was running a loco via wireless control.

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5. R5V Power Adapter with micro USB plug.



6. Micro SD memory card [top] plugged into an adapter that goes into a USB socket on the computer. Below is a 16 GB MicroSD memory card adapter that plugs into a larger SD card socket.

If you want an off-the-shelf solution for using an RPi, the Pi-SPROG is a solid solution.

WiFi throttles need locos defined in JMRI with their respective decoders before use. Once I added a USB keyboard, a USB mouse,



7. USB Keyboard and USB Mouse.

RASPBERRY PI FOR MODELERS | 7

and a small computer display with an HDMI interface to the RPi, I could use JMRI directly to add the appropriate roster information in JMRI.

These devices can be left disconnected once everything is setup. I also have an alternative to adding these, which I will cover later.



8. Displays with HDMI Interface (24-Inch & two 7-inch).



9. VGA to HDMI Adapter & HDMI Cable.

More slices of Raspberry Pi – Variations on a great application

As an electronics-centric modeler, once I realized the capabilities of the RPi-SPROG, I now wanted build an RPi setup from the ground up.

The component parts can be obtained from a multitude of sources worldwide including: adafruit.com, amazon.com, frys.com, and sparkfun.com.

Unlike many of my other projects, I am not recommending the cheapest or smallest components. Instead, go for quality parts.

Since the RPi is so powerful, these may well become the backbone of your DCC system.

The essential components include:

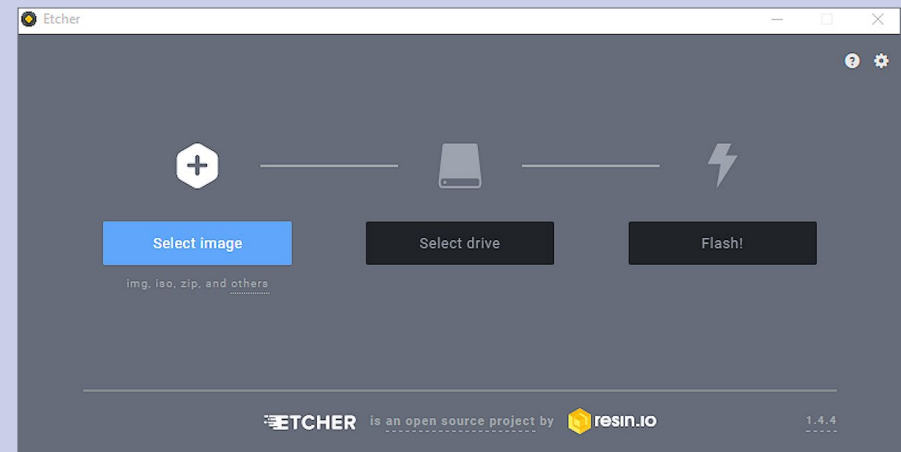
1. A Raspberry pi 3B or Raspberry Pi 3B+ module (stick to these, they are the newer and more capable models)
2. Wall adapter power supply 5.0 volts DC, 2 amps (with USB Micro-B connector)
3. An 8 GB (8 GB-32GB will work) micro SD memory card (I recommend the faster “HC” versions)
4. And (temporarily, which means you do not have to dedicate these to your RPi system after setup is completed):
 - USB keyboard
 - USB mouse
 - Display (HDMI or VGA display with VGA-to-HDMI adapter)

STEP 1: ALL THE SOFTWARE YOU WILL NEED

Next I wanted to see if I could build a new RPi SD card image with multiple configurations and applications. There is some early documentation showing difficulties creating the SD image for the RPi.

Indeed, I did have some difficulties at first, but I have put everything you need to easily build a working SD card image in the additional materials accompanying this article [[bonus download link](#)].

You can download the entire disk image and put it on your own SD card, which is the main “disk” for the RPi. I recommend a 16 GB Micro HC Memory card, but an 8 GB card and/or slower speed card will do if necessary.



10. The Etcher program loads your micro SD card.

CONTINUED ... STEP 1: ALL THE SOFTWARE ...

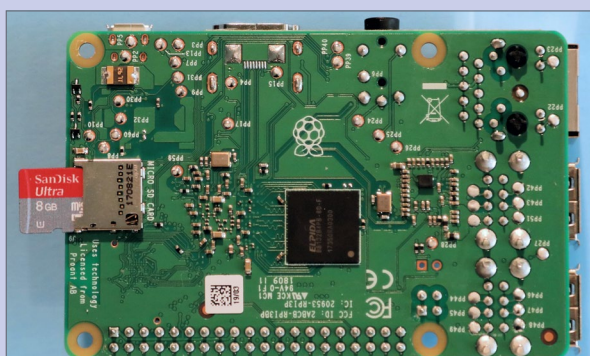
Insert the micro SD memory card into your SD-USB adapter [6]. Download and extract **Etcher-Portable-1.4.4-x86.exe** and **rpisdcad.img** files from this article's bonus materials.

When you run **Etcher**, the window in [10] should appear. Select the **rpisdcad.img** file and your micro SD card, and hit Flash. This will take a while.

Once complete, your SD card will have the most current software, updated at the time of this writing, including JMRI, Java, and the current Arduino software too. This disk image is a derivative version I compiled based on the fine work of Steve Todd.

NOTE: If you're interested, Steve Todd offers his own RPi image and excellent information about customizing it for your needs: mstevetodd.com/jmri-raspberrypi-access-point – I highly recommend it for further reading.

Once the load is done, place the micro SD card into the socket on the back of your Raspberry Pi Board [11].



11. Micro SD memory card inserted into RPi socket.

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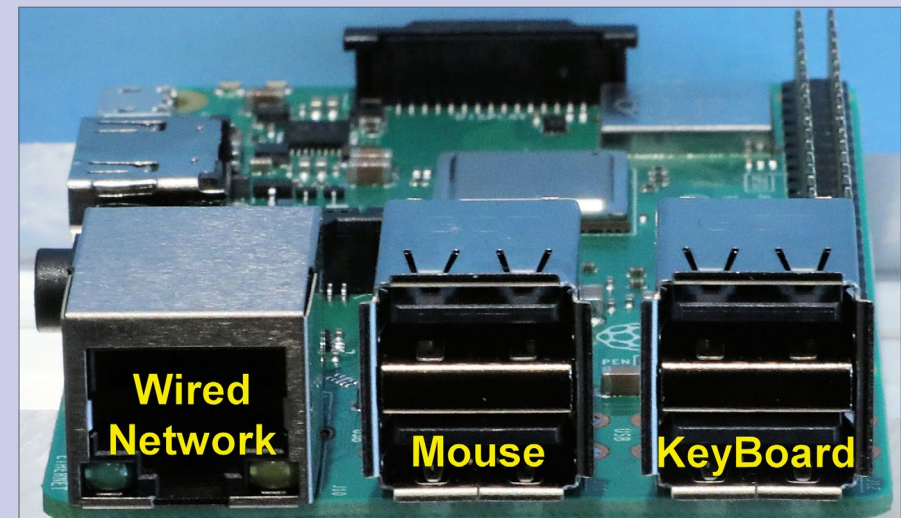
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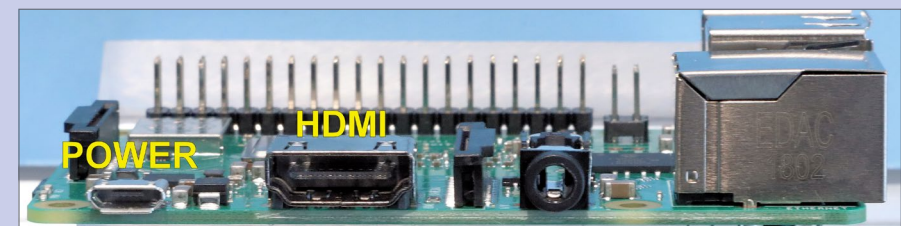
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STEP 2: ASSEMBLE THE COMPONENTS



12. USB sockets and Wired Network (LAN) connectors.



13. Raspberry Pi power and HDMI connectors.

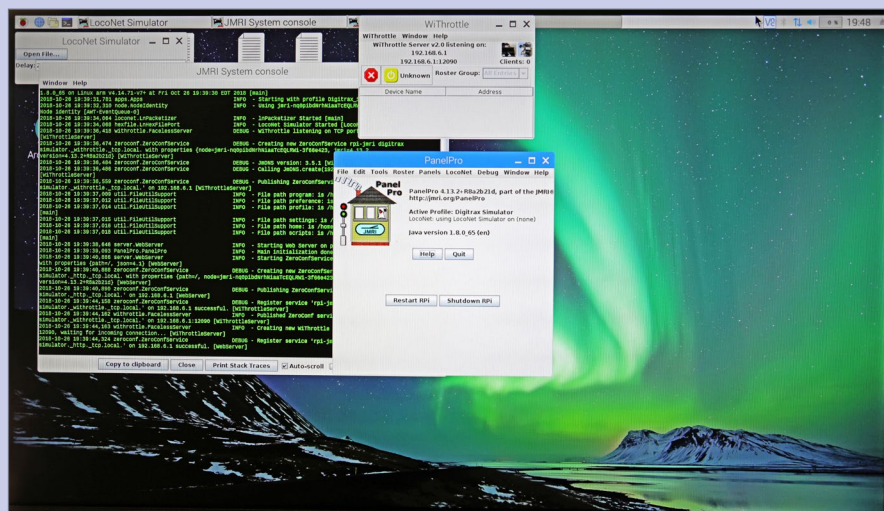
Plug your USB mouse and keyboard [7] into any two of the USB sockets on the end of the RPi card [12]. Leave the wired network connection alone for now.

Now, set up your display. Connect the display's HDMI cable to the connector on the side of the Raspberry Pi card [13]. Turn on the display.

STEP 3: POWER ON

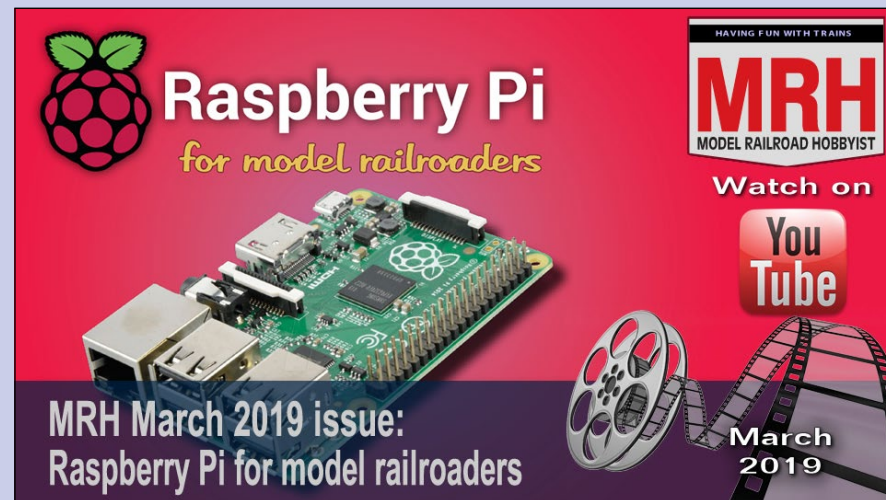
Lastly, connect your 5V power adapter's micro USB plug to the power connector on the side of the RPi [13]. Plug the power adapter into an AC socket. If it has a power switch in the cable, turn it on.

After a short time, your RPi should power up, and automatically run JMRI. Thanks to Steve Todd's work, if you plug in a computer interface to your DCC command station and it is one of the preconfigured interfaces Steve has set up, JMRI will recognize it, and automatically pre-configure itself for operations. The list of preconfigured interfaces is in Step 4. For now, let it power up and display the startup screen [14].



14. RPi Power-on screen.

CONTINUED ... STEP 3: POWER ON ...



Video: The Raspberry Pi start up sequence video.

You can follow the power-on sequence in [Video], and familiarize yourself with the screen layout. This will give you a good orientation in the remaining steps.

Since we have not connected the DCC command station interface, JMRI is set to power up to the Digtrax Locomot Simulator configuration, which we can use for testing later.



STEP 4: CONNECT DCC COMMAND STATION

Once you get to the screen in [14], you are almost done. Again, thanks to Steve Todd's work, the boot-up includes an auto-configure mechanism that's included in the disk image. It accounts for the following configurations:

DCC++ to an Arduino using the FTDI USB interface

DCC++ to an Arduino using the CH340G USB interface (newly added to this disk)

Digitrax Simulator

EasyDCC Serial

LENZ Simulator

LENZ USB

Locobuffer-USB to Digitrax

MERG USB

NCE Serial

NCE USB

PR3 to Digitrax

Pi-SPROG Nano

Pi-SPROG One

RPi

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CONTINUED ... STEP 4: CONNECT DCC ...

If your desired JMRI DCC command station configuration is not listed, don't worry. Simply open JMRI and set up the configuration for your command station, then re-start JMRI. You might contact Steve to ask if he can add it to the auto-configuration list.

Connect your DCC command station USB interface to one of the available ports and re-start the RPi. Once JMRI fully comes up, you should be able to select from the top Panel Pro menu Tools-> Power Control.

From the small window that opens, you should be able to turn your layout DCC power on and off.

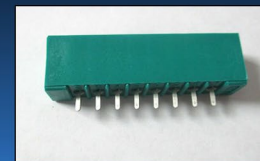
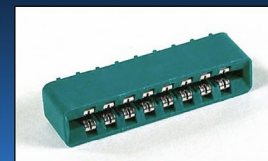
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STEP 5: ARDUINO AND DCC++ (OPTIONAL)

For those modelers using DCC++/Arduino USB connections, note that RPi does not use COM port designations. Instead, serial ports usually are designated by "tty. ." (e.g., tty01, tty05) (teletype). In my installation, the Arduino Uno USB port shows up as "ttyUSB0."

In the disk image you loaded, and on the RPi window that opens up when you start the RPi, you will find the Arduino IDE already loaded for your RPi.

If your Arduino or DCC++ command station is plugged into your RPi, you can open the IDE by double-clicking the icon. Go to the Tools menu, then pick the Port. On a Raspberry Pi 3B+ you should see a port list like: /dev/ttyAMA0, /dev/ttyS0, and /dev/ttyUSB0.

If you unplug your Arduino USB cable, you will see the /dev/ttyUSB0 disappear. But note well: if you plug it back in, the RPi will likely assign a new designation like: /dev/ttyUSB1, which may well mess up previous settings, so be careful. Plug and unplug your USB cables before powering up.

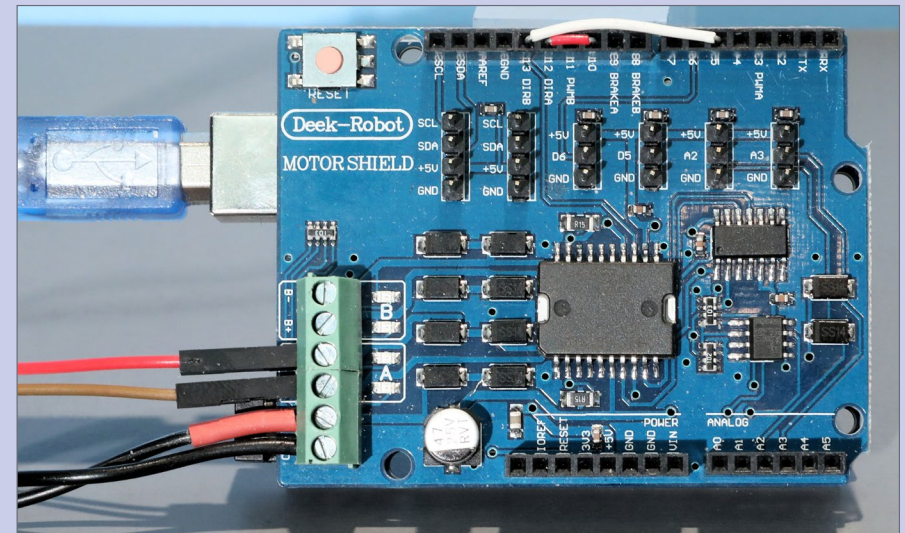
There has been some confusion using the RPi with DCC++ configurations, in part because vendors of Arduino Uno's and Mega2560's have substituted a cheaper USB interface chip, the CH340. I have added a DCC++ configuration using this interface to facilitate using this variation. The appropriate driver is included and is recognized by the Raspian version 9 operating system on your disk.

CONTINUED ... STEP 5: ARDUINO & DCC++ ...

I've written several times before about installing and loading Arduino software in MRH December 2016, "A modeler's introduction to the Arduino" [mrhpub.com/2016-12-dec/online] and in MRH March 2017, "DCC projects using the Arduino" ... [mrhpub.com/2017-03-mar/online/html5].

While we are discussing the Arduino setup, if you start the Arduino IDE and select **File->Open...** from the menu and select **Arduino** at the top-left of the open window, you will see all the Arduino sketches from my MRH Arduino articles.

This is everything from my December 2015 and March 2016 MRH articles, including the DCC++ and DCC decoders sketches. Yes, you can program your Arduino from your RPi!



15. Basic DCC++ setup – The USB cable connects directly to the RPi.

STEP 6: TURN CELL PHONE INTO DCC THROTTLE

I mentioned before that one of the great benefits of using the RPi with JMRI is the WiFi capability built into the RPi module. When Panel Pro opens on your RPi, you should also see a window at the top of your screen labeled “**WiThrottle**.” It should also show “**192.168.6.1:12090**”

This is the IP address (**192.168.6.1**) and port number (**12090**) for your RPi, running its own wireless network, identified (SSID) as “**model-rr**” with an access password of “**model-rr**” that I will show you how to change later. You will need this information.

The easiest way to access and use the WiThrottle interface to run your layout is to load a free application (App) onto your cell phone or tablet that is WiFi-capable. On an iPhone the App is called “**WiThrottle**” – pretty clever, eh?

On an Android WiFi device it is called “**Engine Driver**.” These are free on the Apple App Store and the Google Play Store respectively. First go to settings and set your phone or tablet to access the WiFi for SSID: **model-rr**, and the password: **model-rr**.

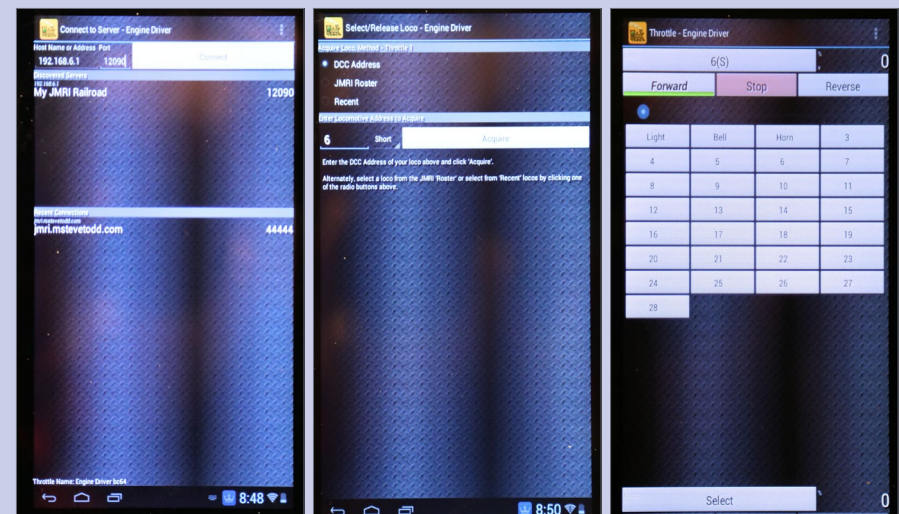
You will need to provide the IP address **192.168.6.1** and port: **12090** when you first set the server for your WiThrottle or Engine Driver App.



CONTINUED ... STEP 6: CELL PHONE THROTTLE ...



16-19. WiThrottle setup: server setup, enter loco address, set loco address, change to throttle and run!



20-22. Engine Driver Setup: server setup, set loco address, change to throttle and run!

CONTINUED ... STEP 6

Once you connect to the RPi's WiFi network, you can try controlling a loco. But first, let's test the connection:

Step A: On the Panel Pro Window on the RPi, select **Tools->Throttles->New Throttle** and in the **Address Panel** in the **Throttle** Window type an arbitrary address, like 6.

Hit **Set**, and see if you can toggle the Off (red) / On (green) power button at the top right of the Throttle window. If not, something is not set up correctly.

Step B: Assuming you got this far, go to your WiFi handheld throttle (your cell phone or tablet), and enter the same loco address (6) and hit **Set**.

Step C: Now go change the speed setting for this imaginary loco (6) on your handheld throttle and watch the throttle speed indicator move on your RPi! You are now capable of running your trains on your own private network.

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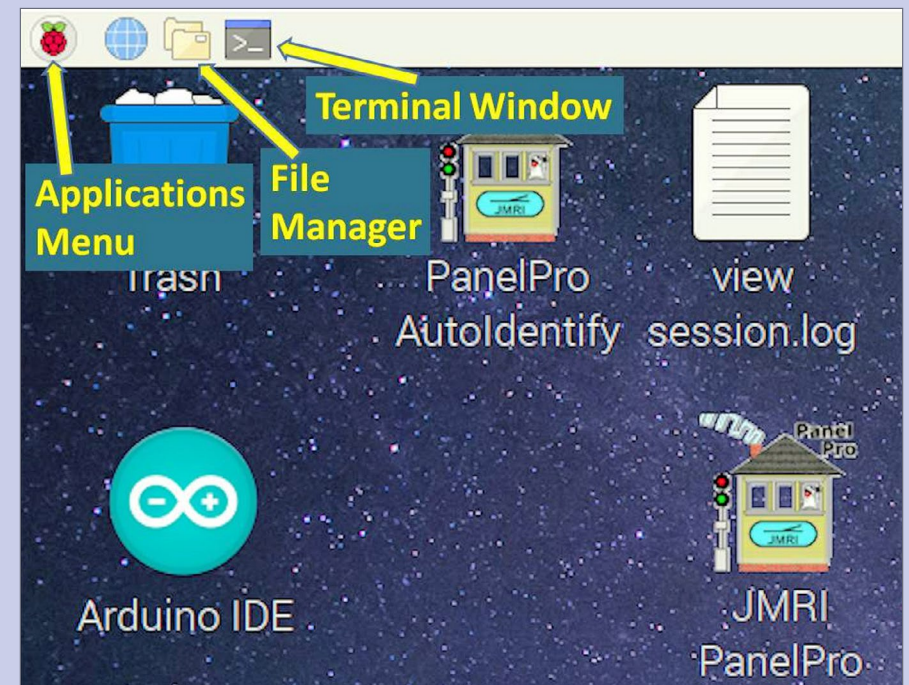
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STEP 6: CUSTOMIZING YOUR RPi (OPTIONAL)

There may be some things you would like to change on your RPi. You will find a wealth of information on the web, including Steve Todd's website: : mstevetodd.com/jmri-raspberrypi-access-point.

Let me add some quick notes which may be of help if you would like to make some changes. Most of these need to be typed in a "terminal window" which you can open by clicking on the black terminal window icon in the upper left menu bar [23].



23. RPi Main menu bar icons (top-left).

CONTINUED ... STEP 6: CUSTOMIZING ...

Here are some additional useful notes for modelers:

1. If you already have a JMRI loco roster entered on another computer, you can open the JMRI on your other computer and from the top menu bar click **Roster->Export Complete Roster...**, enter a file name, and save it to a USB drive which you can insert into your RPi and then from the JMRI top menu bar click **Roster->Import Exported Roster...**, enter a file name, and save the entries you want in the RPi JMRI installation.

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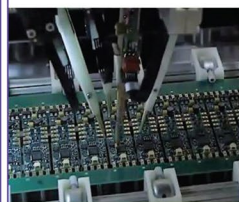
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CONTINUED ... STEP 6: CUSTOMIZING ...

2. In the terminal window, type **lsblk** to see which devices are currently connected to your machine. You will likely find **mmcblk0** as the main RPi disk, and if you inserted a separate USB drive, it may be listed as **sda** or **sda1**.
3. When you insert a USB drive into a running RPi, it will ask you if you want to look at the new drive with the File Manager (also accessible on the main RPi menu bar, the top-left). This tool is very similar to the MS Windows file explorer and will let you move, copy, and delete files and folders.
4. To change your WiFi SSID and password, click File Manager from the top menu bar, and instead of /home/pi in the entry bar, type /etc/hostapd and hit enter. Right click hostapd.conf, and select **Open With... -> +Accessories -> Text Editor**, then OK. Then edit the lines **SSID=model-rr** and **wpa_passphrase=model-rr** to whatever you want to name your network and its associated password, like: **SSID=my_WiFi** and **wpa_passphrase=supersecret**. Then save and quit the editor. Re-booting your RPi should follow.
5. To safely unload and eject a USB drive that you plugged into your RPi (for file transfers), click the up arrow on the far upper-right of the main menu bar. A list of devices should appear. Select the one you want to eject, and a message should appear saying that it is now safe to remove the device.

CONTINUED ... STEP 6: CUSTOMIZING ...

6. To change the screen resolution on your display, click the **raspberry icon** (the Applications menu icon labeled in [23]), then **Preferences -> Raspberry Pi Configuration** and the Raspberry Pi Configuration window should open. Next click **Set Resolution...** -> then **down arrow**, and select the new screen resolution you want.
7. To shut down your RPi in an orderly fashion, click the **raspberry icon** (the Applications menu icon labeled in [23]), then **Shutdown...** and in the new small window that opens click **Shutdown** again. Wait for the small indicator light on your RPi to stop blinking, then turn off the power. *Caution here – see our note below.*
8. There is another alternative to equipping your RPi with its own mouse, keyboard, and display – VNC Viewer. If you have a WiFi-equipped laptop or PC, you can load, run, and configure VNC Viewer to open a window on your PC that will behave as if it were the display on the RPi. The mouse and keyboard on your laptop will act as if they were



M. Dodd

RPi POWERING DOWN BEST PRACTICES

The web is full of warnings to never power down an RPi by just killing the power. Always do the orderly shutdown recommended by Geoff in #7, above. If you have a “headless” RPi, you can add an orderly shutdown power button using one of these aftermarket kits: mausberrycircuits.com. Or if you’re more adventurous, here is a do-it-yourself video: youtu.be/W5YTm0xkCb8

CONTINUED ... STEP 6: CUSTOMIZING ...

directly connected to the RPi as well. Sometimes called a “virtual or remote desktop,” it will give you full access to set up and configure your RPi and its applications, like JMRI. You can find the documentation and the software here: www.realvnc.com/en/products/viewerplus/

Download a copy for free, personal use. VNC will need to be configured on both your laptop or PC and on your RPi. It is already installed on your RPi, with a general access password of “model-rr” which can be changed to suit your needs.

9. You can plug your RPi into your home network (your LAN) via an Ethernet cable to the “Wired Network” jack in [12]. If your home router is set to automatically assign IP addresses (via DHCP), the RPi will auto-connect and give your RPi the same capabilities as if you connected your laptop to your net, including web access if it has it. Click the blue globe icon on the upper left main menu bar on the RPi screen to open a web browser.
10. When using VNC, remember to shut down the RPi as instructed per #7 in this list.

There are many more things that a modeler can do with an RPi. This article should get you started on a whole series of new adventures in model railroading, quickly, and for relatively low cost! Have fun! ☑

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DR. GEOFF BUNZA



Geoff Bunza started as a model railroader when he received a Mantua train set for Christmas, at age 6. He fed his interests through college, becoming a member of the Tech Model Railroad Club (TMRC) at MIT while getting his doctorate and three other degrees in electrical engineering. He has collected Lionel HO trains for many years, which spawned his interest in realistic model animation and control. Primarily, he models the New York Central Railroad.

Geoff is a member of the New York Central System Historical Society, a life member of the NMRA, and holds an Extra Class amateur radio license. ■

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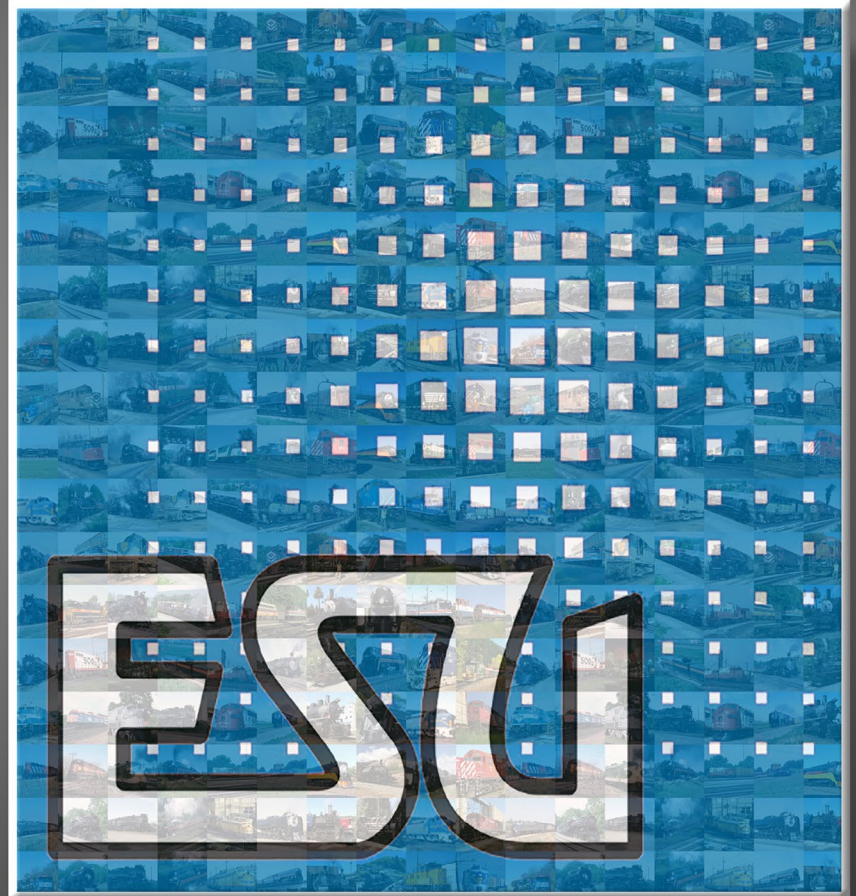


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