

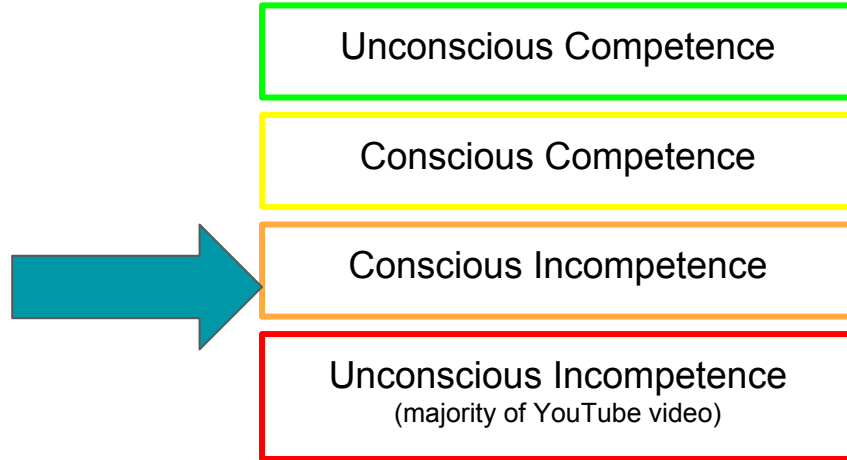
Do-It-Yourself DCC Command Station and JMRI/Computer

For the Western Heritage Division

October 6, 2018

A few notes added 10/8/2018

Fair Warning - Competence Disclaimer



Notes added 10/8/2018

When using JMRI with DCC++, make sure you read the specific hardware notes on the JMRI website. At the time of writing, this is a good link.

<http://jmri.org/help/en/html/hardware/dccpp/index.shtml>

JMRI is updated at least once a year. Steve Todd also updates his pre-built image. So make sure to read any release notes.

This overview is just that. It is not step-by-step instructions. It's only meant to point you in the direction of getting started with DCC++ and JMRI. You will need to follow up with reference materials to make sure things work for you, the way you want them to work.

Thanks, gs

Review - How does DCC communicate?

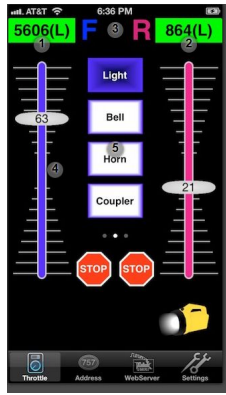


Proprietary
Cab
Bus

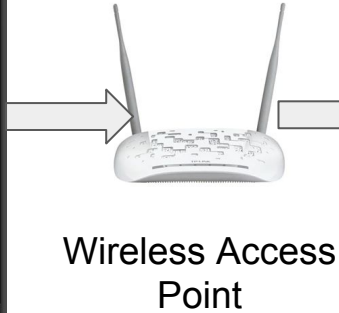
NMRA
Standard
Track
Bus

Your Trains

Adding JMRI - flexibility, function



WiThrottle,
Engine Driver,
Or
Other Throttle



JMRI Computer

Cable, PR4, LIUSB,
System dependent

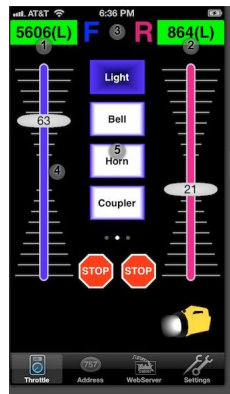


DCC Command Station

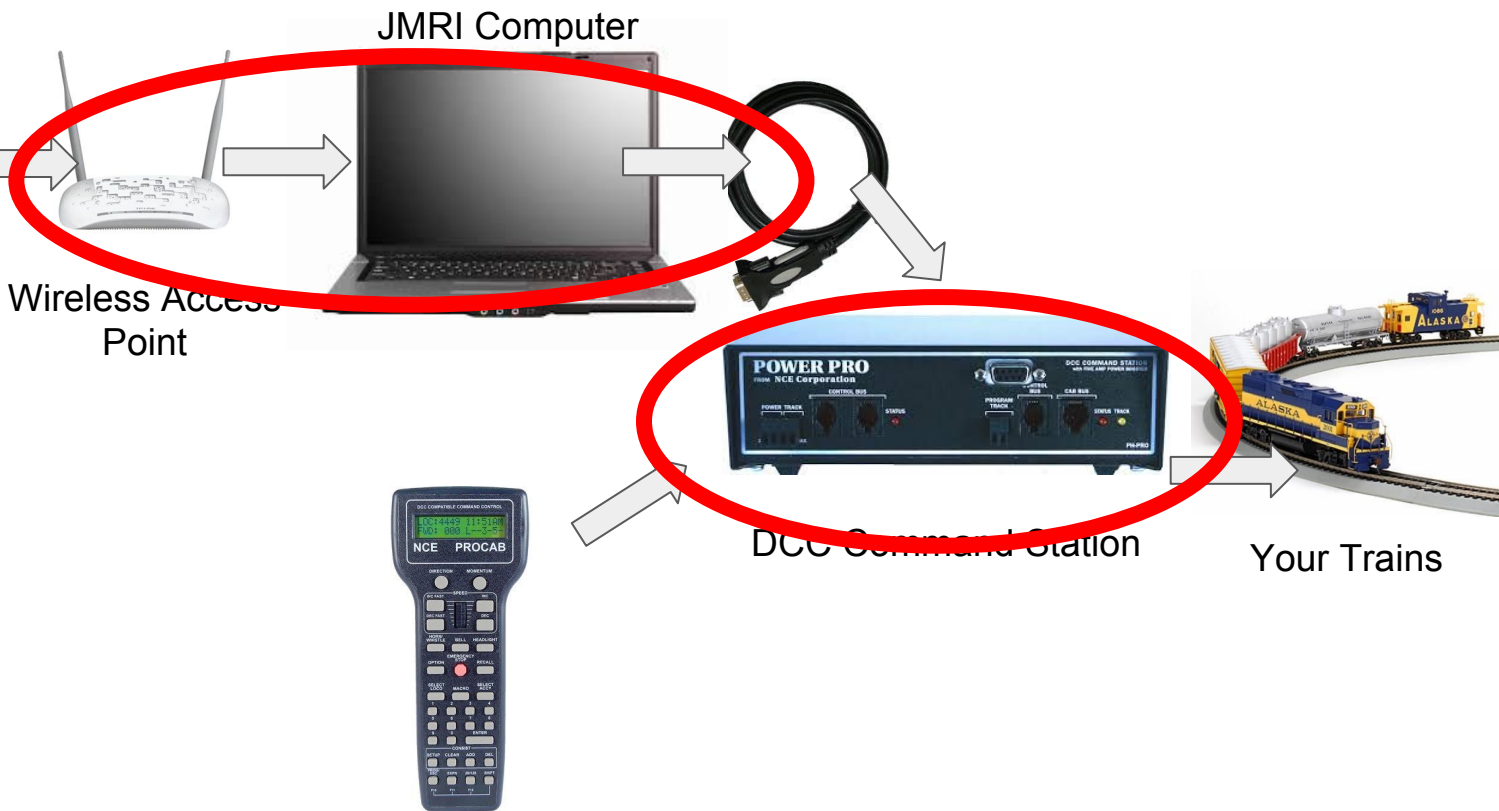
Your Trains



Replace Command Station, Computer, Both? Why?



WiThrottle,
Engine Driver,
Or
Other Throttle



Why would I use a DCC++ Command Station

Relatively low cost starter system.

A small project layout.

A secondary command station for an isolated program track?

A learning experience.

You like playing with electronics and get satisfaction for making things work.

Why would I use a Raspberry Pi for JMRI

Stability (no automatic updates, nothing changes until you change it)

Reliability (that old computer you're using is just waiting to die)

Simplicity (JAVA and all necessary drivers are included in operating system)

Security (built-in wireless access, not connected to Internet or home network)

A learning experience.

Low-cost - *some examples for comparison*

New Laptop - \$200+

Digitrax - LNWI at \$60, only four throttles, no layout control

MRC - WiFi adaptor at \$80, eight throttles

Some Additional Comparisons

1. Digitrax Zephyr (\$180) + PR4 (\$70) + RPi-JMRI (\$67) = **\$317**
2. NCE PowerCab (\$145) + USB Card (\$35) + Rpi-JMRI (\$67) = **\$247**
3. PiSprog One - Full System = **\$170** (phone/tablet throttle)
4. **3 amp DCC++ and RPi-JMRI = \$140 (phone/tablet throttle)**

Note: The NCE PowerCab is self-contained. Add a PCP panel and wall wart to a layout and you can just plug in the PowerCAB - (\$30-50) based on your shopping skills)

Why would I not do this?

Raspbian (the OS) similar to Mac and Windows, but may not be familiar.

Layout requires a bit more sophistication.

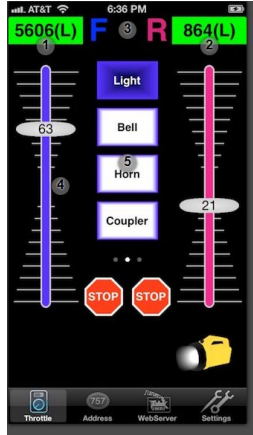
Just don't want to deal with the DIY aspect.

Not a commercial product - no warranties, all volunteer support

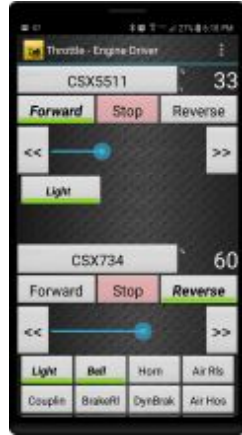
Prefer the commercial throttles from NCE, Digitrax, Lenz, etc.

In the grand scheme of things - the savings may not be that significant.

Some Throttle Options -



For iPhone
WiThrottle Lite (Free)
WiThrottle (\$10)



For Android
Engine Driver (Free)

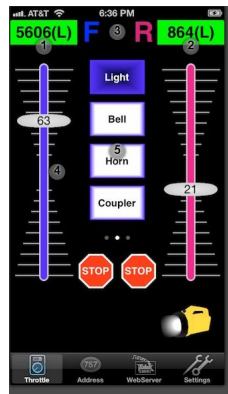


Engine Driver
On
ESU MCII (\$240)

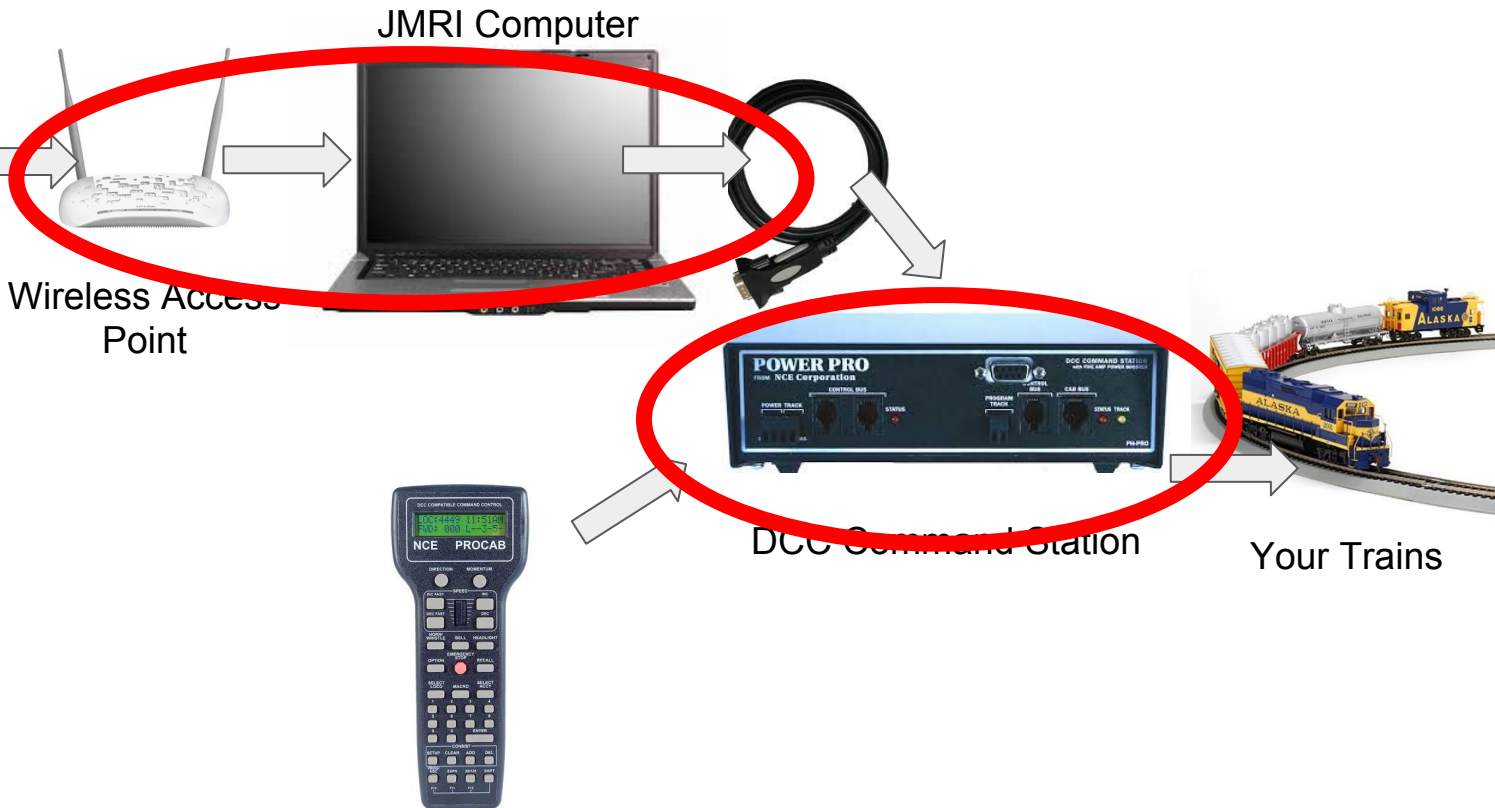


ISE ProtoThrottle
\$580
(Currently Sold Out)

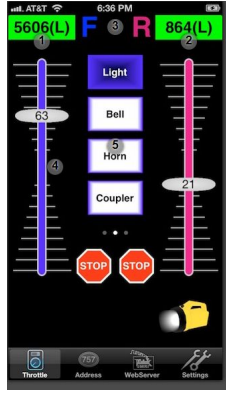
Replace Command Station, Computer, Both? Why?



WiThrottle,
Engine Driver,
Or
Other Throttle



Step 1 - Replace the Commercial DCC Command Station



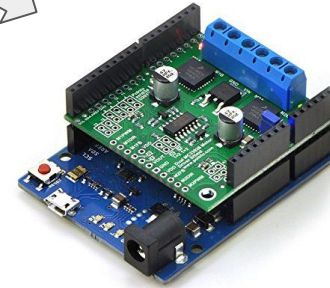
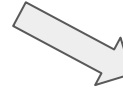
WiThrottle,
Engine Driver,
Or
Other Throttle



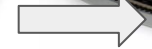
Wireless Access
Point



JMRI Computer



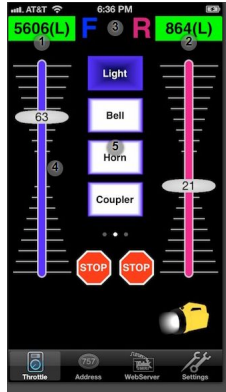
DCC++ Command Station
(\$50)



Your Trains



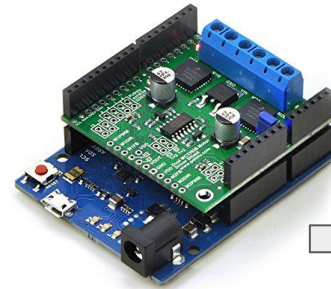
Step 2 - Replace WAP and Computer



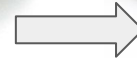
WiThrottle,
Engine Driver,
Or
Other Throttle



Wireless Access Point
&
JMRI Computer
(\$50)



DCC++ Command Station
(\$50)



Your Trains

Things you need to know...

- 1) Download and Install Software
- 2) Edit 1 digit in a configuration file (maybe)
- 3) Solder a few connections (maybe)

A note on prices...

- 1) I've quoted prices from well known sources
- 2) You may save about \$20-30 using other sources.
- 3) When I start a new project, without a deeper understanding, I buy the exact parts specified to reduce problems. In this case, the motor shield.



The DCC++ Command Station -

Specs - not bad. Covers the fundamentals, commercial products are more fully featured.

- Simultaneous control of multiple locomotives
- 128 step speed control (*only 128 - older decoders may not work.*)
- Control of all cab functions F0-F28
- Programming on the Main or Programming Track
- Accessory address range 0-2048 (*but turnout control is very fussy*)

All of the needed links are at the

JMRI DCC++ page - <http://jmri.org/help/en/html/hardware/dccpp/index.shtml>

Remember, Command station only, No Throttle

The DCC++ Command Station - The Arduino

1) Parts List -

- a) **Arduino Uno** - \$21 (\$5-15)
- b) Motor Shield
- c) Power Supply (for track power)
- d) USB cable, Jumper Wires

The Arduino is “the brains” of the command station.

But, it cannot supply enough power to run the trains.

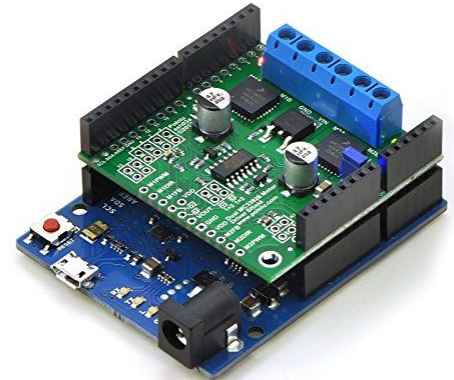
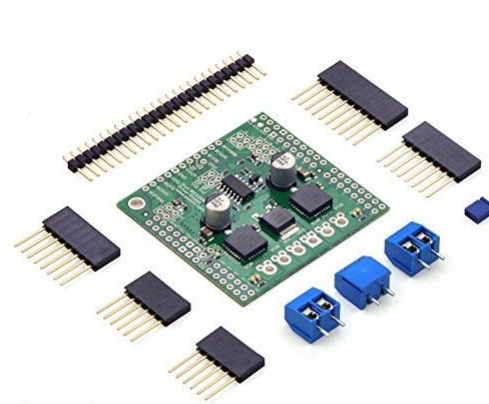
<https://store.arduino.cc/usa/arduino-uno-smd-rev3>



The Motor Shield

Official Arduino Rev 3 - 2A or Pololu MC33926 - 3A

(out of stock or extremely overpriced, perhaps discontinued)



The DCC Command Station - The Motor Shield

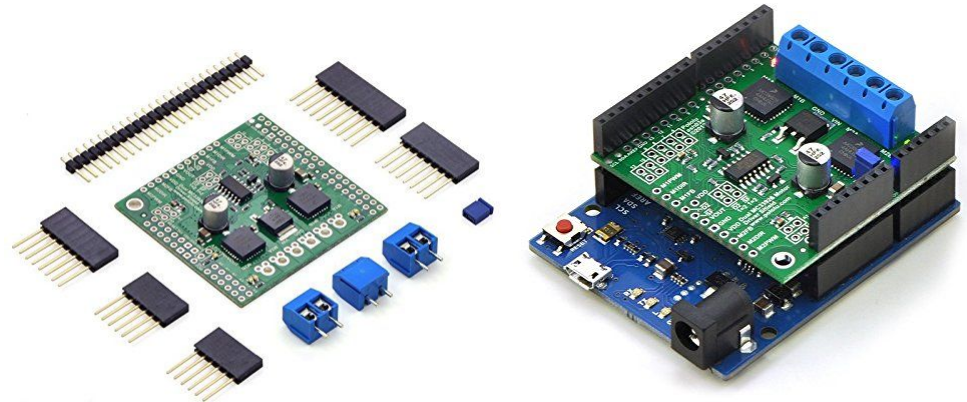
Parts List -

- a) Arduino Uno - \$21
- b) **Motor Shield - \$30**
- c) Power Supply (for track power)
- d) USB cable, Jumper wires

The motor shield will boost the commands from the Arduino to the higher power level needed to run the trains.

“Some assembly required.”

Pololu MC33926 Dual Motor Driver Shield



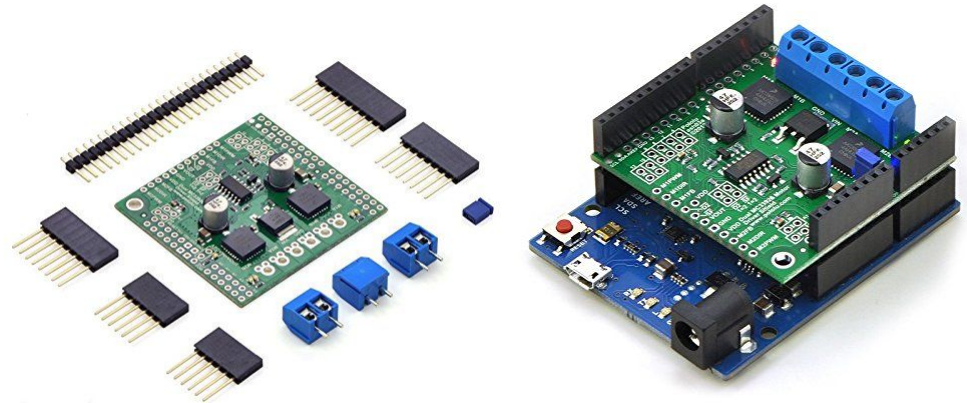
The DCC Command Station - The Motor Shield

Parts List -

- a) Arduino Uno - \$21
- b) **Motor Shield - \$30**
- c) Power Supply (for track power)
- d) USB cable, Jumper wires

- 1) *Solder the black and blue connectors to the shield.*
- 2) *Solder one end of the orange and yellow wires as shown on next page.*
- 3) *Connect jumpers as shown on next page.*

Pololu MC33926 Dual Motor Driver Shield



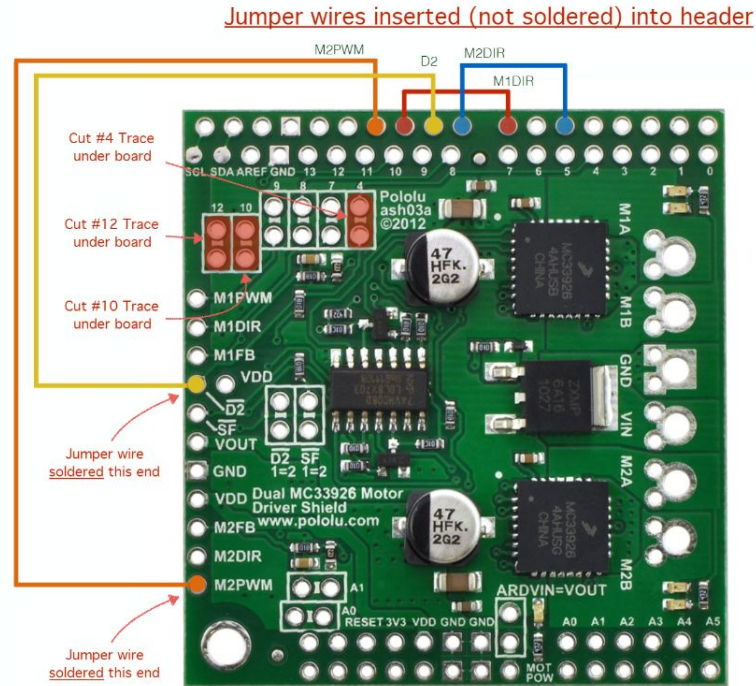
The DCC Command Station - The Motor Shield

Cut Traces 4, 10 and 12

Install 4 Jumpers

[Click here for PDF User's Guide](#)

[Click here for PDF of pin maps for both motor shields and both Arduinos](#)



DCC++ Base Station Signal Name	Pololu Motor Shield
SIGNAL_ENABLE_PIN_MAIN	9
SIGNAL_ENABLE_PIN_PROG	11
CURRENT_MONITOR_PIN_MAIN	A0
CURRENT_MONITOR_PIN_PROG	A1
DCC_SIGNAL_PIN_MAIN	10
DCC_SIGNAL_PIN_PROG	5
DIRECTION_MOTOR_CHANNEL_PIN_A	7
DIRECTION_MOTOR_CHANNEL_PIN_B	8

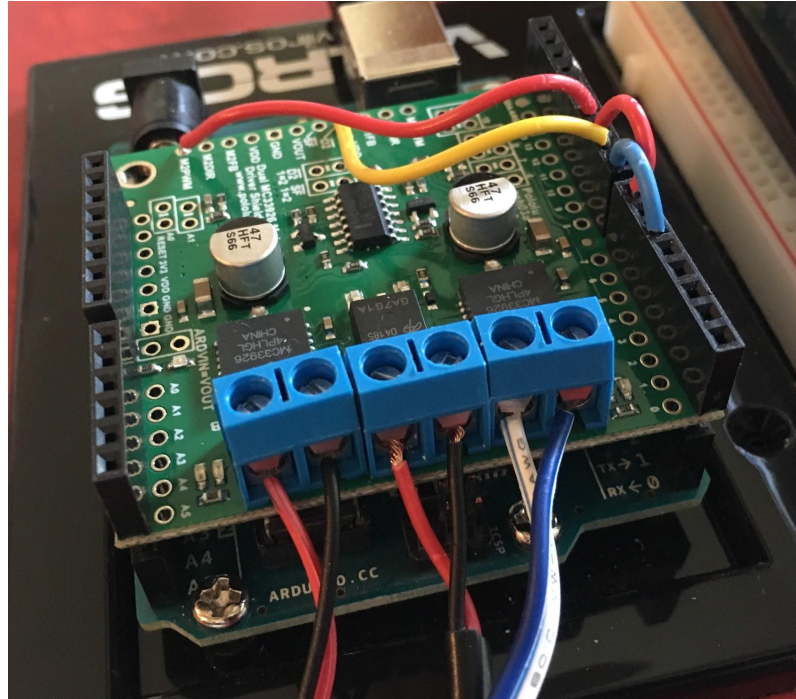
➔ Main Ops Track

➔ DC Power Supply

➔ Programming Track

**Pin Mappings for
Arduino UNO
with
Pololu MC33926
Motor Shield**

The DCC Command Station - The Motor Shield



The DCC Command Station - The Power Supply

Parts List -

- a) Arduino Uno - \$21
- b) Motor Shield - \$30
- c) **Power Supply - \$12**
- d) USB cable, Jumper wires

- 1) *Remove the barrel connector*
- 2) *Strip the wires.*
- 3) *Insert the wires in the center terminal block, mind the polarity.*

14V-3A Adapter/Charger



THIS PRODUCT COMES WITH A UPBRIGHT®

LIMITED WARRANTY CERTIFICATE
+ UPBRIGHT® LIMITED WARRANTY



The DCC Command Station - Total Hardware Cost

1) Parts List -

- a) Arduino Uno - \$21
- b) Motor Shield - \$30
- c) Power Supply - \$12
- d) USB cable , Jumper wires - \$5

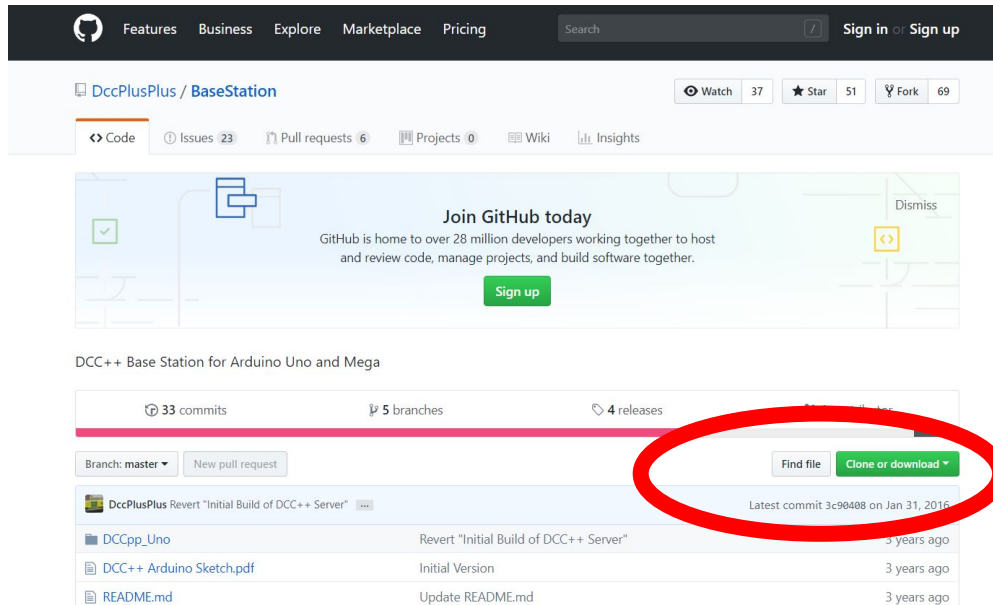
Total Command Station Hardware Cost - approx. \$70 or less

For Comparison - Most Commercial DCC systems will require \$30-\$150 of additional accessories to connect to your JMRI computer.

The DCC Command Station - Software

Download the software from <https://github.com/DccPlusPlus/BaseStation>

Unzip the DCCppUno folder, keep it intact



The screenshot shows the GitHub repository page for `DccPlusPlus/BaseStation`. The repository has 37 watchers, 51 stars, and 69 forks. The navigation tabs include Code, Issues (23), Pull requests (6), Projects (0), Wiki, and Insights. A banner for joining GitHub today is visible. Below the banner, the repository name is followed by statistics: 33 commits, 5 branches, and 4 releases. The file list includes `DCCpp_Uno`, `DCC++ Arduino Sketch.pdf`, and `README.md`. A red circle highlights the `Clone or download` button.

File	Description	Commit	Time
<code>DCCpp_Uno</code>	Revert "Initial Build of DCC++ Server"	3c90408	3 years ago
<code>DCC++ Arduino Sketch.pdf</code>	Initial Version		3 years ago
<code>README.md</code>	Update README.md		3 years ago

The DCC Command Station - Software

1) Parts List -

- a) Arduino Uno - \$21
- b) Motor Shield - \$30
- c) Power Supply - \$12
- d) **USB cable** , Jumper wires - \$5



<https://www.adafruit.com/product/62>

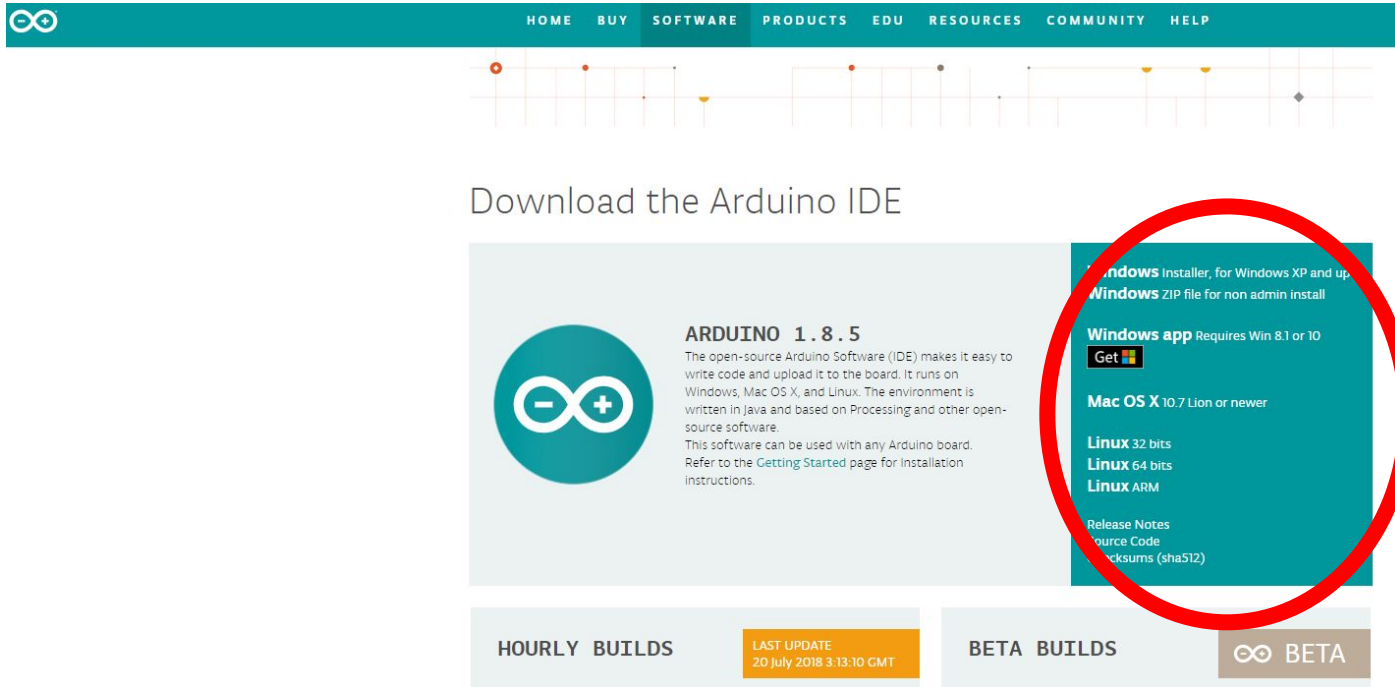
Connect the Arduino to your computer -

The Last Step -

Using the Arduino IDE software to configure, compile and load the DCC system software.

The Arduino IDE

Download and install the IDE from <https://www.arduino.cc/en/Main/Software>



HOME BUY SOFTWARE PRODUCTS EDU RESOURCES COMMUNITY HELP

Download the Arduino IDE

ARDUINO 1.8.5
The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
This software can be used with any Arduino board. Refer to the [Getting Started](#) page for installation instructions.

Windows Installer, for Windows XP and up
Windows ZIP file for non admin install

Windows app Requires Win 8.1 or 10
Get

Mac OS X 10.7 Lion or newer

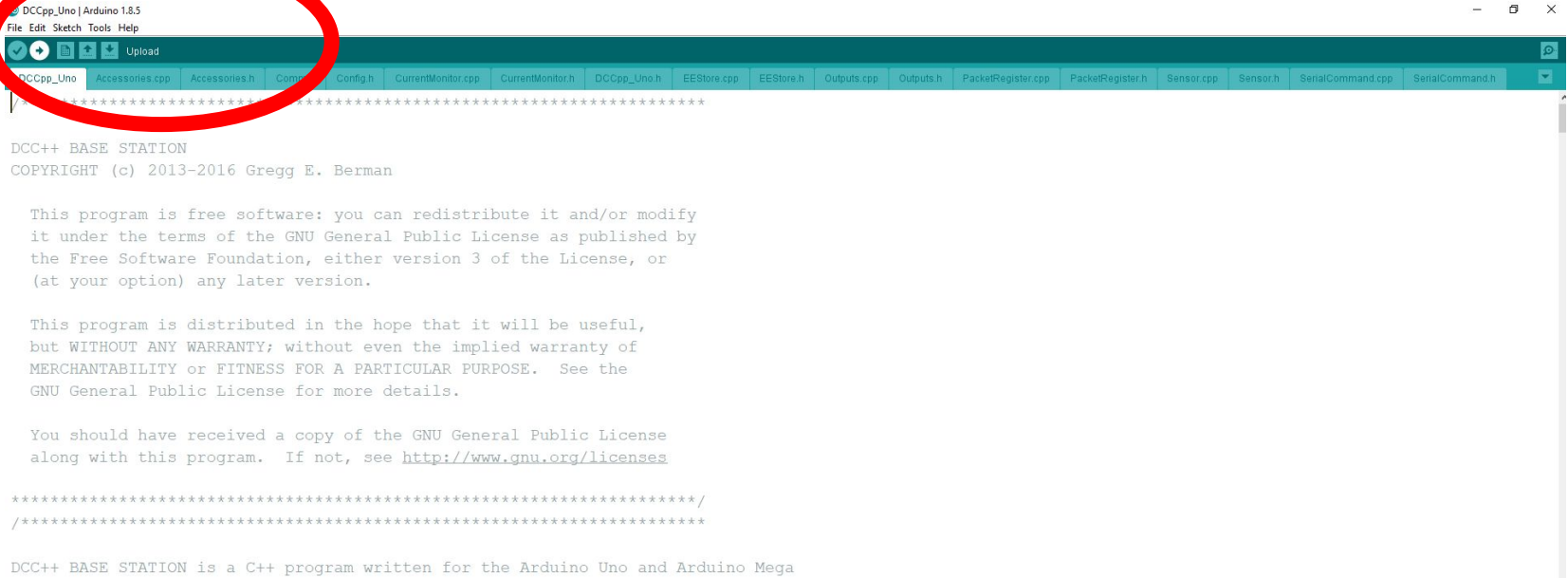
Linux 32 bits
Linux 64 bits
Linux ARM

[Release Notes](#)
[Source Code](#)
[Checksums \(sha512\)](#)

HOURLY BUILDS **LAST UPDATE** 20 July 2018 3:13:10 GMT **BETA BUILDS** **BETA**

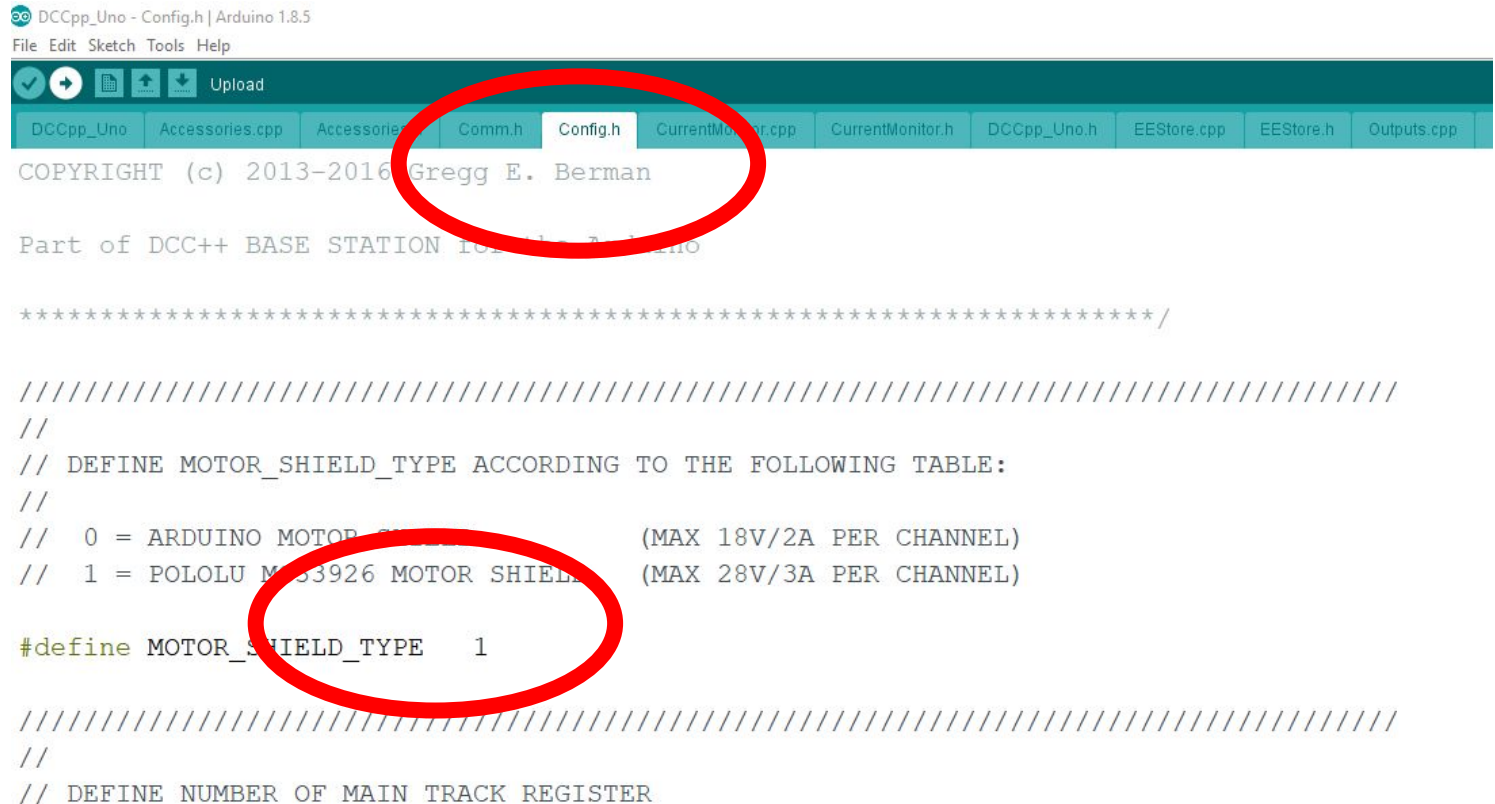
The Arduino IDE

Start the IDE - under Tools - configure your board and port - Under File - load the DCCpp_Uno folder you saved earlier.



The Arduino IDE

Edit and save the board type in the Config.h file



```
DCCpp_Uno - Config.h | Arduino 1.8.5
File Edit Sketch Tools Help
Upload
DCCpp_Uno Accessories.cpp Accessories.h Comm.h Config.h CurrentMonitor.cpp CurrentMonitor.h DCCpp_Uno.h EESore.cpp EESore.h Outputs.cpp
COPYRIGHT (c) 2013-2016 Gregg E. Berman

Part of DCC++ BASE STATION for the Arduino

*****/

////////////////////////////////////
//
// DEFINE MOTOR_SHIELD_TYPE ACCORDING TO THE FOLLOWING TABLE:
//
// 0 = ARDUINO MOTOR SHIELD (MAX 18V/2A PER CHANNEL)
// 1 = POLOLU M53926 MOTOR SHIELD (MAX 28V/3A PER CHANNEL)

#define MOTOR_SHIELD_TYPE 1

////////////////////////////////////
//
// DEFINE NUMBER OF MAIN TRACK REGISTER
```

The Arduino IDE

Compile and load the sketch to the arduino -

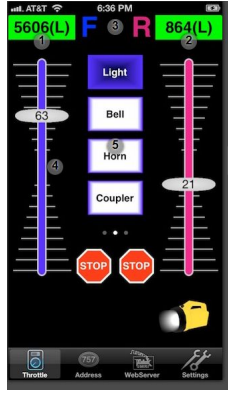


DCC++ BASE STATION

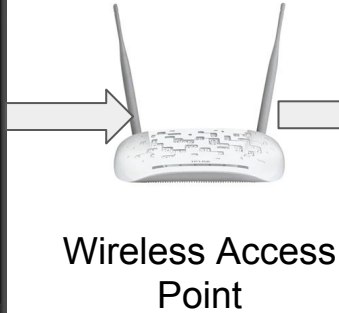
COPYRIGHT (c) 2013-2016 Gregg E. Berman

This program is free software: you can redistribute it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License or (at your option) any later version.

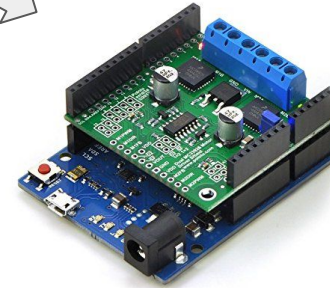
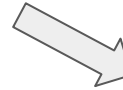
Step 1 - Replace the Commercial DCC Command Station



WiThrottle,
Engine Driver,
Or
Other Throttle



JMRI Computer



DCC++ Command Station
(\$50)



Your Trains



Ready to go - but we need a throttle from JMRI

Option 1 -

At this point you can use the DCC++ command station. Use JMRI on your computer.
(We'll talk about loading JMRI in a few minutes.)

Option 2 -

You can build a dedicated Raspberry Pi computer for JMRI.

Why?

Stability

Reliability

Pre-loaded Drivers and Java

Low-cost - *some examples for comparison*

New Laptop - \$200+

Digitrax - LNWI at \$60, four throttles

MRC - WiFi adaptor at \$80, eight throttles

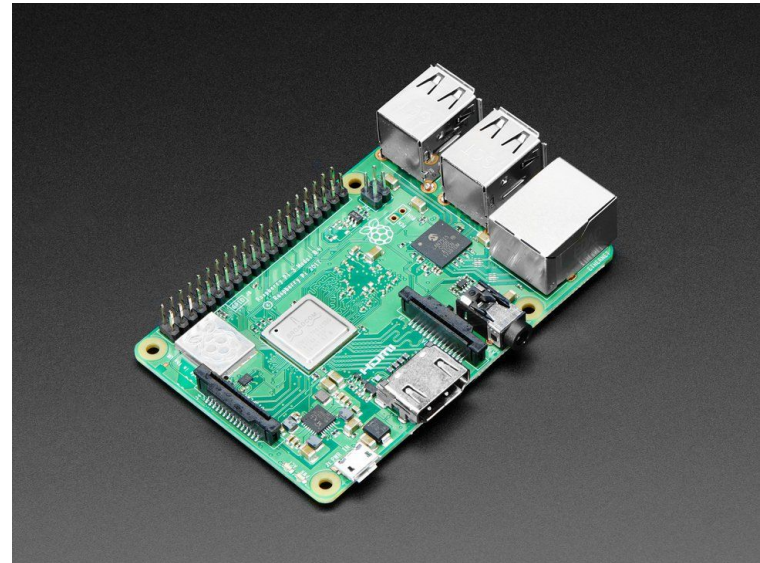
On to the Raspberry Pi

The Computer

1) Parts List -

- a) **Raspberry Pi - \$35** (\$10-\$15)
- b) Heat Sink -
- c) Case -
- d) MicroSD memory card -
- e) Power Supply -
- f) Monitor -
- g) Keyboard -

<https://www.adafruit.com/product/3775>

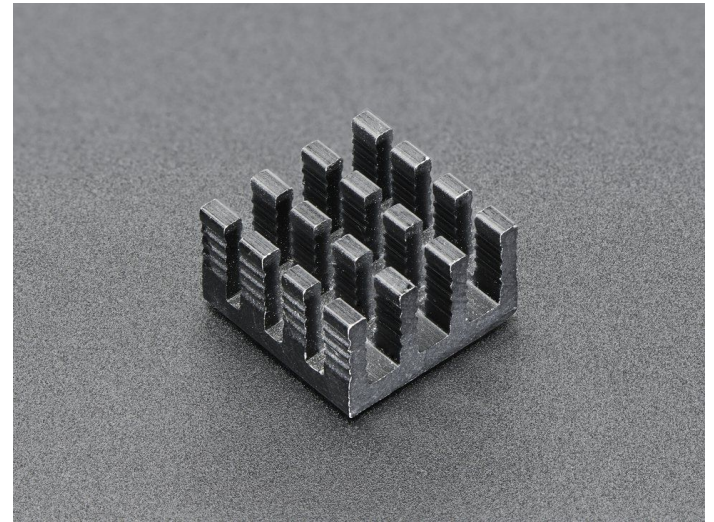


The Computer

1) Parts List -

- a) Raspberry Pi
- b) *Heat Sink - \$1.50 (optional)***
- c) Case -
- d) MicroSD memory card -
- e) Power Supply -
- f) Monitor -
- g) Keyboard -

<https://www.adafruit.com/product/3083>



The Computer

1) Parts List -

- a) Raspberry Pi
- b) Heat Sink -
- c) **Case - \$8** (*optional*)
- d) MicroSD memory card -
- e) Power Supply -
- f) Monitor -
- g) Keyboard -

<https://www.adafruit.com/product/2258>



The Software - JMRI

- 1) Download the Raspian Operating system (or use NOOBS)
 - a) <https://www.raspberrypi.org/downloads/>
- 2) Download, JMRI from JMRI.org
- 3) Install and and Configure JMRI for your computer and DCC interface
- 4) Use your home WiFi or a dedicated WAP

OR

Use Steve Todd's image <https://mstevetodd.com/rpi>

- **Possible Issue:** As delivered, bluetooth disabled. Instructions for re-enable on Advanced page.

Only for:

*Digitrax Locobuffer-USB or PR3/4, Sprog, Lenz-USB,
NCE-Serial, NCE-USB, **DCC++**, EasyDCC-Serial, MERG-USB, or MRC Prodigy*

Steve Todd's Raspbian & JMRI image

Download from <https://mstevetodd.com/rpi> then unzip it

most recent version September 27, 2018

JMRI RaspberryPi as Access Point



Many model railroaders would benefit from using smartphones as Throttles, but most are not computer experts, and may be intimidated by the setup required. To lower this bar, I've preconfigured everything needed to get started, and provide the software free of charge.

First, start with the tiny [RaspberryPi](#) computer (\$35). Download my free, preconfigured image to your SD card. Then simply turn on main power, and the RPI will start up and load JMRI, scanning for your layout hardware connection. It will also start up a dedicated wireless network from the RPI. Within 30 seconds, you can connect your phone(s) or pad(s) to the RPI's Wifi and start running trains! The RPI needs no screen, keyboard or mouse, so it can stay nicely out of the way under the layout, or in your electronics box.

Below are the details of how to get your own JMRI RaspberryPi access point for [EngineDriver](#) and [WiThrottle](#) devices:

Hardware

Item	Purchase
RaspberryPi Model 3	Newark
5V 2.5A Power Supply w/ MicroUSB Cable	NewEgg
8Gb MicroSD memory card	NewEgg
RPI Case with Lid (<i>**optional</i>)	Newark

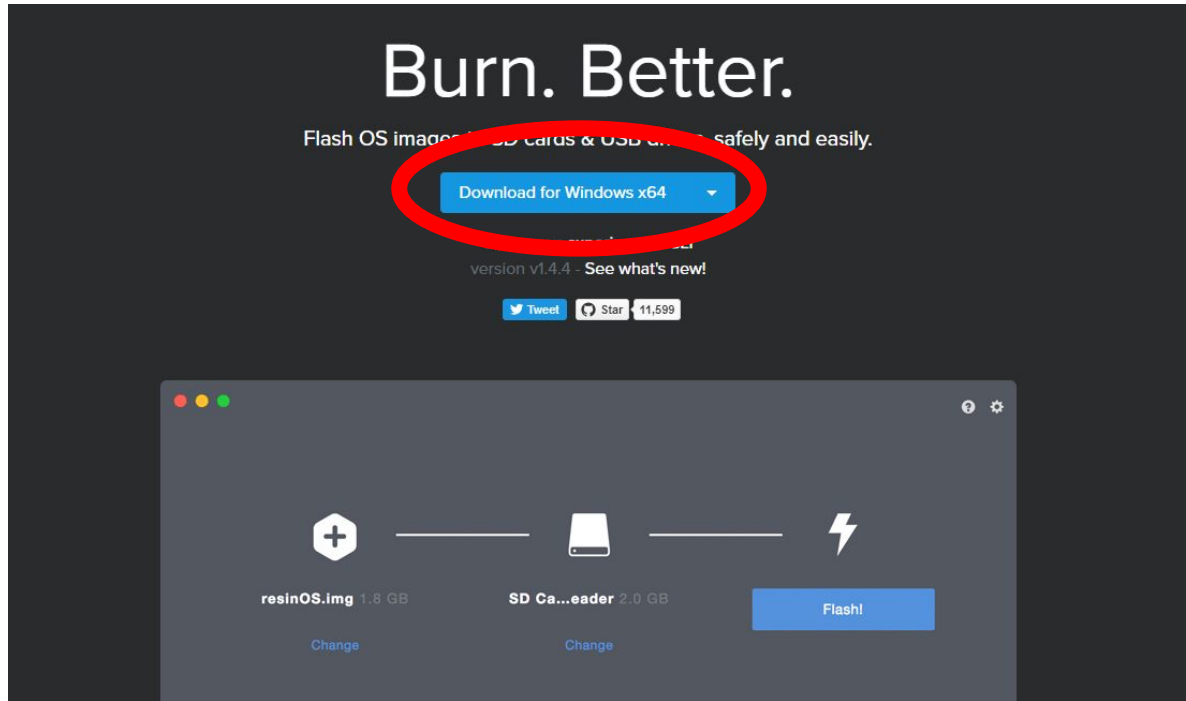
Software Image

I have created an image file which contains all software and config needed to autostart JMRI PanelPro on the RPI, as an access point, with WiThrottle Server, Web Server and LocalNetOverTCP (or JMRI Simple) server included. Also included is remote access to the RPI via ssh (command line) and to the RPI "desktop" via VNCServer (at port ::5900). Download the [zipped image file \[here\]](#) (1.3Gb, updated July 18, 2018), or an earlier [zipped image file \[here\]](#) (1.3Gb, updated April 25, 2018). The image features:

- Autoidentify of attached hardware (Locobuffer-USB, PR3, SPROG, LENZ USB, Digital NCE USB, DCC, etc) (via RS-485 or Serial)
- Autostart of PanelPro with WiThrottle and Web Server.
- Creates network access point for device connection, or can be plugged into existing network
- You can upload roster files and icons via the JMRI web server.
- Access to GUI desktop via attached monitor or remotely via VNC client

Download and Install Etcher

Download from etcher.io for your computer



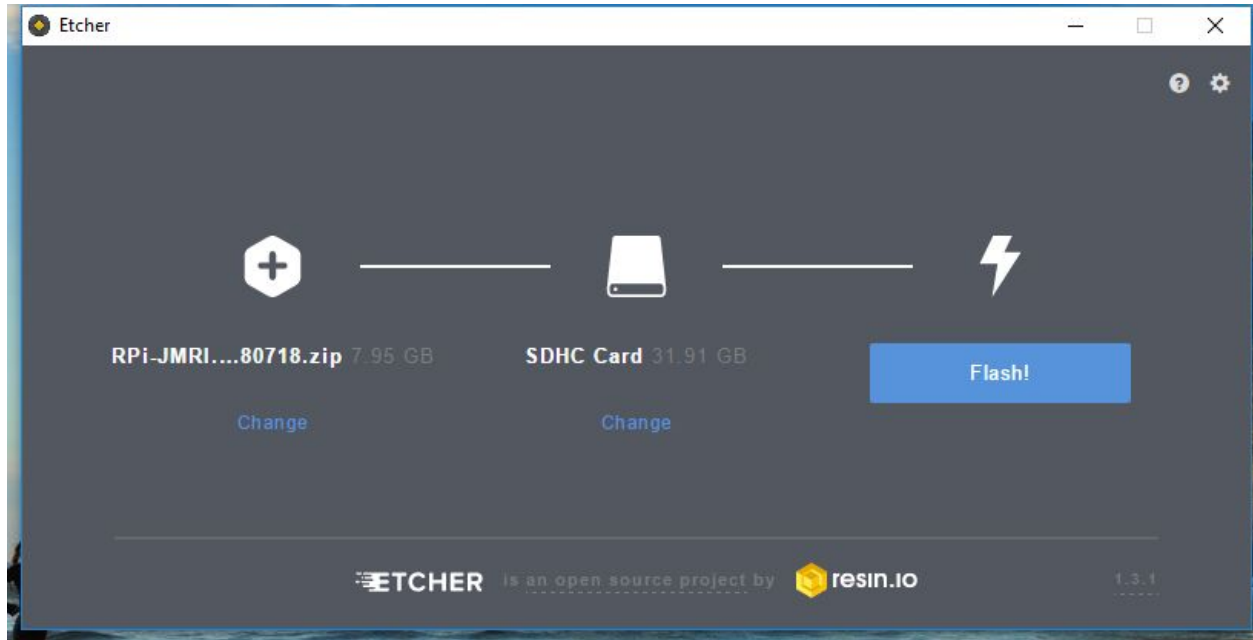
The Computer - The Memory Card

1) Parts List -

- a) Raspberry Pi
- b) Heat Sink
- c) Case -
- d) 8 Gb+ MicroSD memory card - \$8-\$10**
- e) Power Supply -
- f) Monitor -
- g) Keyboard -



1. User Etcher to Burn the Image to your SD card
2. Remove the Card from your computer
3. Put the microSD card into RPi



The Computer - The Power Supply

1) Parts List -

- a) Raspberry Pi
- b) Heat Sink
- c) Case
- d) MicroSD memory card
- e) **Power Supply (for the computer) - \$7.50**
- f) Monitor -
- g) Keyboard -

5V, **2.4A** Switching Power Supply

<https://www.adafruit.com/product/1995>



The Computer - Total Hardware Cost

1) Parts List -

- a) Raspberry Pi - \$35
- b) Heat Sink - \$1.50
- c) Case - \$8
- d) MicroSD memory card - \$10
- e) Power Supply - \$7.50
- f) *Monitor - Any HDMI monitor (or cheap TV) - no more than \$100 (optional)*
- g) *Keyboard, Mouse, HDMI cable - no more than \$20 (optional)*

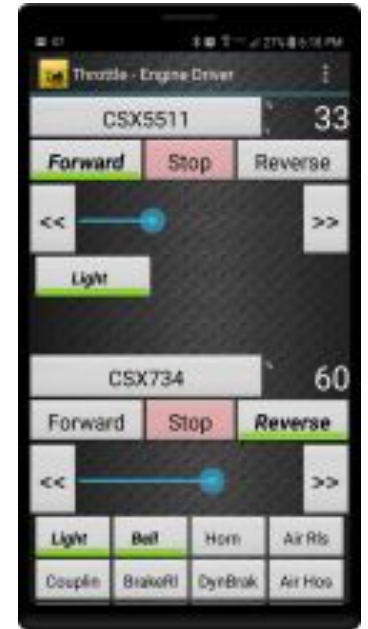
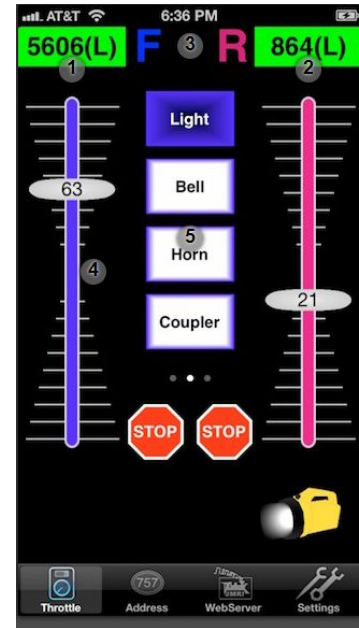
Total Computer Cost (less monitor and keyboard) - \$67 or less.

Total Cost \$67 + \$70 = \$137

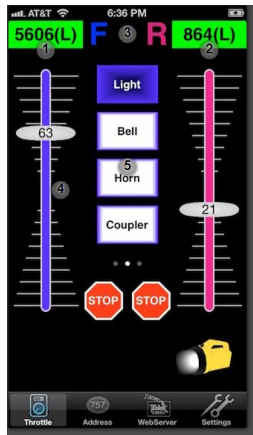


The Cell Phone Apps

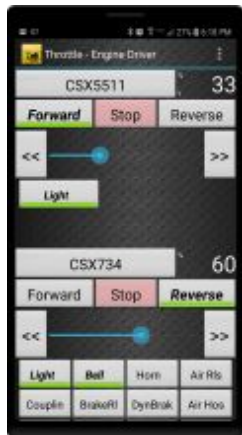
- 1) Withrottle (From Apple's App Store)
 - a) Throttle only - Free
 - b) Throttle and Layout Control - \$10
- 2) Engine Driver (From Google's Play Store)
 - a) Throttle and Layout Control - Free



Some Throttle Options -



For iPhone
WiThrottle Lite (Free)
WiThrottle (\$10)



For Android
Engine Driver (Free)

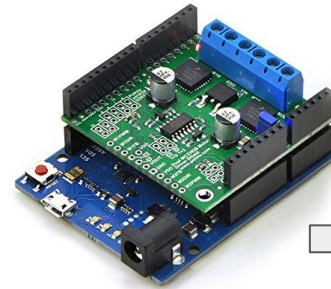
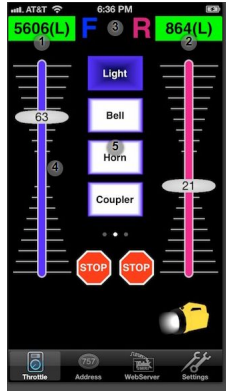


Engine Driver
On
ESU MCII (\$240)



ISE ProtoThrottle
\$580
(Currently Sold Out)

Ready to Test



WiThrottle,
Engine Driver,
Or
Other Throttle

Wireless Access Point
&
JMRI Computer
(\$50)

DCC++ Command Station
(\$50)

Your Trains

If you're happy running trains, you can stop here.

If you'd like to use JMRI for programming locomotives, controlling layout accessories, making control panels and more:

Add a monitor, keyboard and mouse.

Or

Use VNC to remotely Log into your RPi with your computer.

The VNC Viewer

- 1) So you don't need a monitor and keyboard.
- 2) Download from <https://www.realvnc.com/en/connect/download/viewer/>

Download VNC Viewer to the device to control from

Make sure you've downloaded [VNC Connect](#) to the computer you want to control.



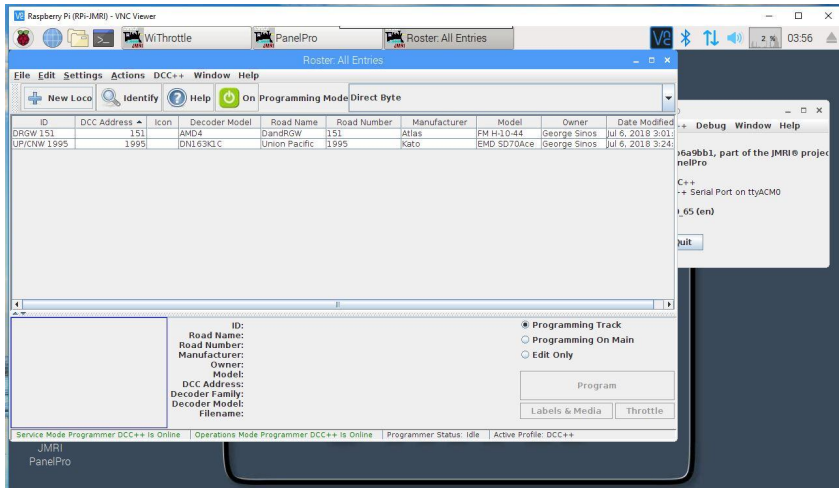
DOWNLOAD VNC VIEWER

SHA-256: 644d325026dc2cbaa2701ac726d6abaa434e9754d37508d634d440dc2a37670d

EXE x86/x64

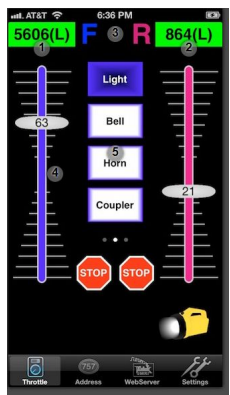
The VNC Viewer

- 1) Connect your computer to the RPi-JMRI network
- 2) Start the VNC viewer
- 3) Connect to RPi-JMRI.local::5900
- 4) Operate JMRI remotely from your computer, phone or tablet



Unused Extras

The JMRI Computer and DCC++ Command Station



WiThrottle,
Engine Driver,
Or
Other Throttle



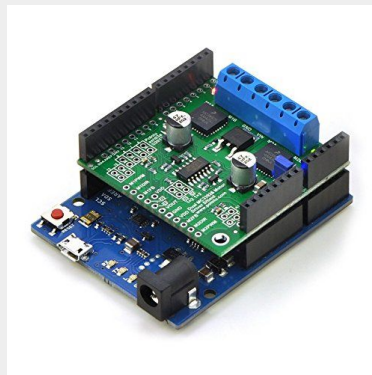
Or



JMRI Computer



Or



DCC Command Station



Your Trains

Test - *(no monitor or keyboard needed)*

1. Connect the Track Power Supply to the Motor Shield, Track, and AC outlet.
2. Connect the USB cable to the Arduino and Raspberry Pi
3. Connect the RPi power supply to the RPi and AC Outlet.
4. Wait a minute or so
5. Go to the settings on your phone - Select the RPi-JMRI network
 - a. Password is rpl-jmri (third letter is capitol eye)
 - b. *(Didn't I tell you - it acts as its own private network, no router needed.)*
6. Wait for network to connect
7. Start your app
8. Enter your engine's DCC address.
9. Run.