

# Do It Yourself DCC++

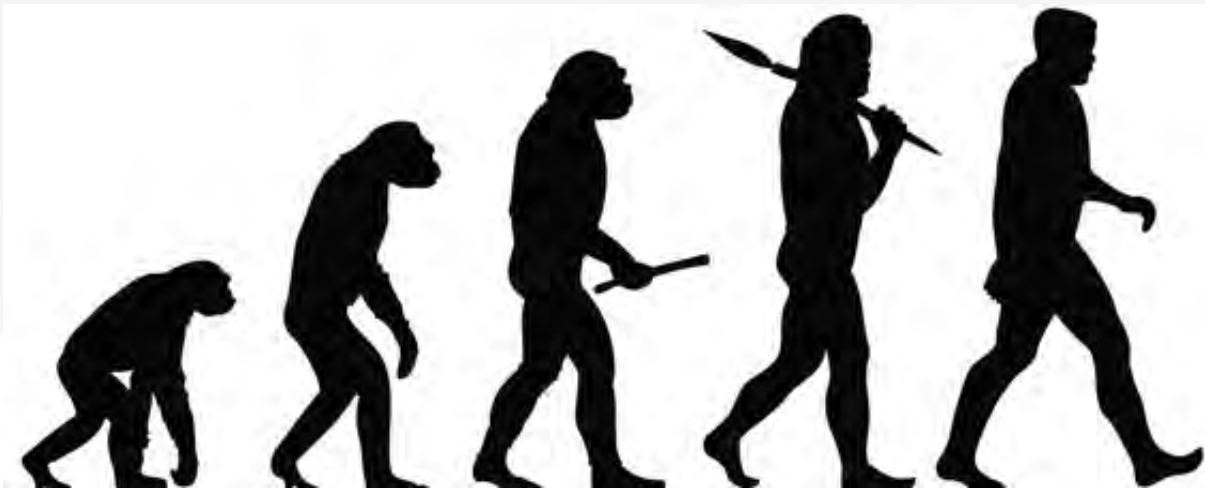
A full-featured DCC system using an Arduino an Arduino Motor Shield and connecting it to a model railroad for less than \$100.



Presented by David Ramos  
dramos\_1701@yahoo.com

# Do It Yourself DCC++

## Evolution



Our first  
trainset

DC Block  
control

DC  
Tethered  
Throttles

Early  
Analogue  
Command  
Control

DCC – Digital  
Command  
Control

## Do It Yourself DCC++

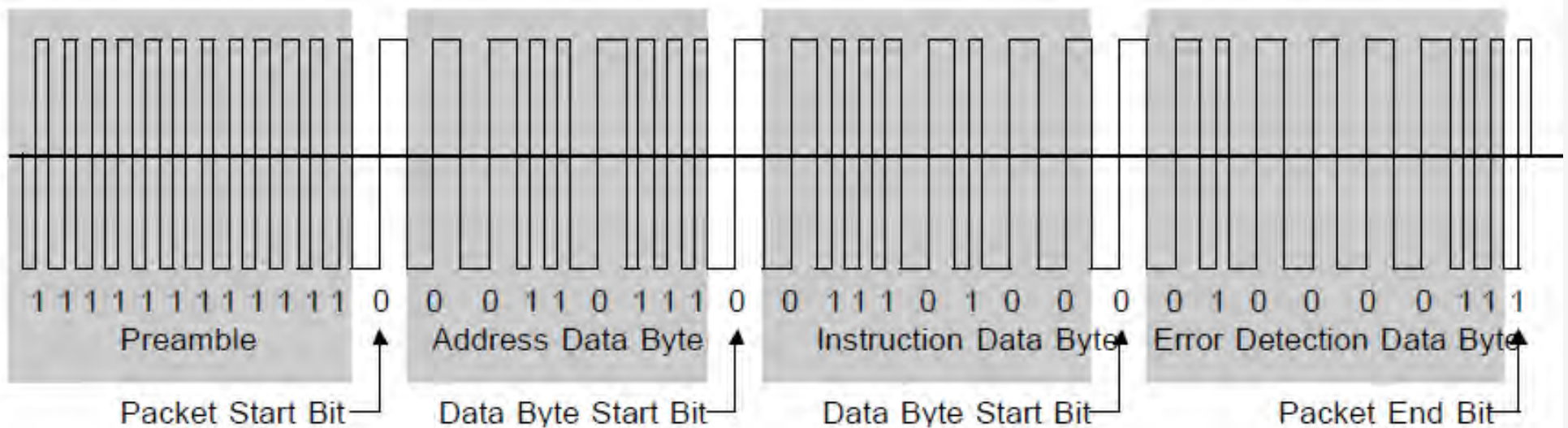


Image from: <http://trains4africa.co.za/?p=1451>

## Do It Yourself DCC++

Traditional DCC Suppliers



Yes there are many others!

# Do It Yourself DCC++

Let's go shopping!

Parts List:

Arduino Uno R3



The image shows an Elegoo EL-CB-001 UNO R3 Board. It is a black PCB with a USB Type-A connector on the left, a DC power jack, and a 5-pin header. The board features an ATmega328P microcontroller and an ATMEGA16U2 chip. Various components like resistors, capacitors, and integrated circuits are visible. Labels point to specific features: ICSP for UIC interface, USB to Computer, Serial interface chip (FT232RL), 5V to 12V DC input, ICSP for ATmega328P, VCC, GND, 5V, and GND headers, and a 16U2 chip (ATMEGA16U2).

Elegoo EL-CB-001 UNO R3 Board ATmega328P ATMEGA16U2 with USB Cable for Arduino  
by **ELEGOO**  
★★★★★ 420 customer reviews | 79 answered questions  
**Amazon's Choice** for "arduino uno"

Price: **\$11.86** ✓prime

Get a \$125 Amazon.com Gift Card upon approval for the Amazon Business Prime Card. Terms apply.

- New improvement: clearly printed on the female header connector, more precise and easier to use the wire
- The Uno now uses an ATmega16U2 instead of the ATmega8U2 chip. Faster transfer rates and more memory
- Control using ATMEL ATMEGA328P chip
- 100 percent compatible with the official version, for Arduino Uno R3
- We have always cared about the customer experience and improve the product function details

Roll over image to zoom in

Build Price:  
**\$11.86**




# Do It Yourself DCC++

Let's go shopping!

Parts List:

R3 Power Shield



Alice1101983

### L298P Shield R3 DC Motor Driver Module 2A H-Bridge 2 way For Arduino UNO 2560

★★★★★ 18 product ratings

Condition: **New**

Quantity:  More than 10 available  
**2,341 sold** / [See feedback](#)

Price: **US \$5.97**

[Buy It Now](#)

[Add to cart](#)

[Add to watch list](#)

**100% buyer satisfaction**    2,341 sold    More than 97% sold

Shipping: **\$2.99** Standard SpeedPAK from China/Hong Kong/Taiwan | [See details](#)  
See details about international shipping here. ⓘ  
Item location: Shenzhen, China  
Ships to: Worldwide [See exclusions](#)

Delivery: **Estimated between Thu. Jun. 6 and Mon. Jun. 17** ⓘ  
Please note the delivery estimate is **greater than 8 business days**.

Build Price:  
\$20.82

# Do It Yourself DCC++

Let's go shopping!

Parts List:

Micro SD Card



SanDisk 16GB Ultra  
microSDXC UHS-I Memory  
Card with Adapter - 98MB/s,  
C10, U1, Full HD, A1, Micro  
SD Card - SDSQUAR-016G-  
GN6MA

by SanDisk

★★★★☆ 16,298 customer reviews  
| 1000+ answered questions

Amazon's Choice for "16 gb micro sd card"

List Price: ~~\$10.98~~

Price: **\$5.79** ✓prime

You Save: **\$5.19 (47%)**

Get a \$125 Amazon.com Gift Card upon  
approval for the Amazon Business Prime Card.  
Terms apply.

**Note:** Available at a lower price from other  
sellers, potentially without free Prime shipping.

**Save \$10 wit...** 1 Applicable Promotion

Capacity: **16GB**

Build Price:  
**\$26.61**

# Do It Yourself DCC++

Let's go shopping!

Parts List:

Power Supply 14 Volt 5 Amps



SHNITPWR 5V Power Supply 5 Volt 10A 50W AC 100V ~ 240V to DC Power Adapter Converter Transformer 5.5x2.5mm Plug for WS2812B WS2811 LED Pixel Strip Light Controller Raspberry Pi Webcam Router USB-HUB

by SHNITPWR

[Be the first to review this item](#)

With Deal: **\$14.31** ✓prime

- Input: AC 100 - 240V, 50 / 60Hz ; Output: DC 5V, Max 10A/10000mA, 50W ; It means that it can supply with all amperage less than 10A. ---such as 500mA, 800mA, 1A, 2.5A, 4A, 6A, 8A, 10A, all is available. For example, if your device draws 5A then 5A will be supplied. If draws more than 10A, only 10A will be supplied and power supply will be damaged soon. NEVER OVERLOAD!
- Output DC adaptor jack size is 5.5mm x 2.5mm. In order to meet your more requirements, we give away a female DC connector. You can screw wires onto it easily, no soldering required.
- Certified by FCC CE ROHS. We focus on producing high quality power adapters. No noise, low temperature operation, no spontaneous combustion, no explosion, no fire hazard, stable output. Automatic overload cut-off, over voltage cut-off, automatic thermal cut-off, short circuit protection.
- Compatible: WS2812B WS2811 WS2801 APA102 SK6812 WS2813 LED Strip Pixel light/ USB-HUB / Graco Swing / Mobile phone/ Home Phone System / VoIP Phone Router / Serato DJ Controller / Nextbook / Webcam Router / Toy / Recorder / Bluetooth Speaker / Scanner / DVR / Hard Disk Box and more 5v devices.
- If you don't like our product or don't want it, please feel free to contact us. We will happily accept the return and give you refund, we have 30 days money back guarantee, 24 months exchange.

[Compare with similar items](#)

New (1) from **\$14.31** ✓prime

☐ [Report incorrect product information.](#)

Build Price:  
**\$40.95**



# Do It Yourself DCC++

Let's go shopping!

Parts List:

Jumper Wire for Arduino



COMEap 120pcs 10CM 40pin Male to Female, 40pin Male to Male, 40pin Female to Female Breadboard Jumper Wire Ribbon Dupont Cables Kit

by COMEap

★★★★☆ 13 customer reviews

Price: \$7.99 ✓prime

Get a \$125 Amazon.com Gift Card upon approval for the Amazon Business Prime Card. Terms apply.

- Including: 1x 40-pin male to female jumper wires, 1x 40-pin male to male jumper wires, 1x 40-pin female to female jumper wires=120pcs in total;
- Made of high-quality copper soft wire material, cable length: 3.93-inch/10cm;
- The male end is used to insert into standard 0.1"inch (2.54mm) female sockets;
- The female end is used to insert into standard 0.1"inch (2.54mm) male headers;
- The cables are available to be separated to form an assembly containing the number of wires you requested for your connection and to support non-standard odd-spaced headers;

New (1) from \$7.99 ✓prime

☐ Report incorrect product information.

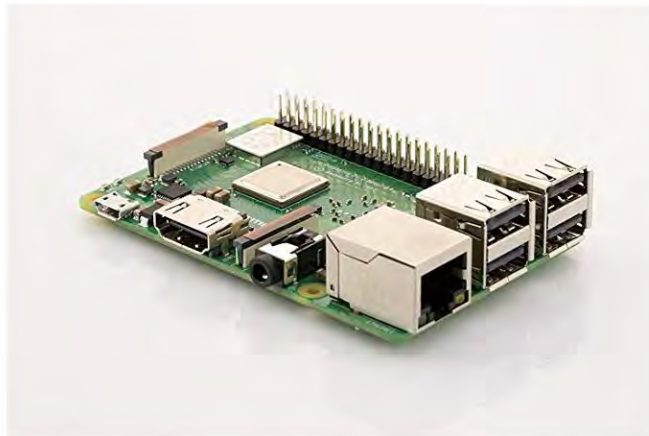
Build Price:  
\$48.94

# Do It Yourself DCC++

Let's go shopping!

Parts List:

Raspberry Pi 3 B+



## Element14 Raspberry Pi 3 B+ Motherboard

by Element

★★★★☆ 481 customer reviews | 108 answered questions

Amazon's Choice for "Raspberry Pi"

Price: **\$37.81** ✓prime

Get a \$125 Amazon.com Gift Card upon approval for the Amazon Business Prime Card. Terms apply.

Free Amazon tech support included

- 1.4GHz 64-bit quad-core ARMv8 CPU, 1 GB RAM
- 802.11n Wireless LAN, 10/100Mbps Lan Speed
- Bluetooth 4.2, Bluetooth Low Energy
- 4 USB ports, 40 GPIO pins, Full HDMI port, Combined 3.5mm audio jack and composite video
- Camera interface (CSI), Display interface (DSI), Micro SD card slot (now push-pull rather than push-push), VideoCore IV 3D graphics core

See more product details

Used & new (20) from \$35.16 ✓prime

Report incorrect product information.

Build Price:  
\$86.75

# Do It Yourself DCC++

Let's go shopping!

Parts List:

## Raspberry Pi 3 B+ Power Supply



### CanaKit 5V 2.5A Raspberry Pi 3 B+ Power Supply / Adapter (UL Listed)

by CanaKit

★★★★★ 1,151 customer reviews | 47 answered questions

Amazon's Choice for "raspberry pi power supply"

List Price: \$14.95

Price: **\$9.99** ✓prime

You Save: **\$4.96** (33%)

Get a \$125 Amazon.com Gift Card upon approval for the Amazon Business Prime Card. Terms apply.

Service: **Get professional installation** Details

Without expert installation

Include installation  
+\$78.42 per unit

✓ See more

- Tested with all versions of the Raspberry Pi including the Pi 2 and Pi 3
- UL Listed
- 5 Feet cord length
- Micro USB plug
- Output 5V DC 2.5A Regulated Input 100V to 240V AC

New (3) from **\$9.99** ✓prime

Report incorrect product information.

Build Price:  
**\$96.74**

# Do It Yourself DCC++

Let's go shopping!

## Parts List:

Amazon	Arduino Uno R3	\$11.86
EBay	R3 Power Shield	\$5.97
EBay	Shipping	\$2.99
Amazon	Micro SD Card	\$5.71
Amazon	Power Supply 14 Volt 5 Amps	\$14.31
Amazon	Jumper Wire for Arduino	\$7.99
Amazon	Raspberry Pi 3 B+	\$37.81
Amazon	Raspberry Pi 3 B+ Power Supply	\$9.99

Build Price: \$96.74

# Do It Yourself DCC++

Free Software and stuff to make it work

## **Arduino Programing Software**

<https://www.arduino.cc/en/Main/Software>

## **GitHub – Repository of the DCC ++ Firmware for the Arduino**

<https://github.com/DccPlusPlus/BaseStation>

## **JMRI – Repository for the Raspberry Pi JMRI Software**

<https://mstevetodd.com/jmri-raspberrypi-access-point>

## **Windows Disk Imager – Needed to Program the Raspberry Pi**

<https://sourceforge.net/projects/win32diskimager/>

## **Apple Disk Imager: ApplePi v2**

<https://www.tweaking4all.com/hardware/raspberry-pi/applepi-baker-v2/>

## **NOOBS for Raspberry Pi**

<https://www.raspberrypi.org/downloads/noobs/>



# Do It Yourself DCC++

Free Software and stuff to make it work

Arduino Programing Software

<https://www.arduino.cc/en/Main/Software>

## Download the Arduino IDE



### ARDUINO 1.8.9

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



**Mac OS X** 10.8 Mountain Lion or newer

**Linux** 32 bits

**Linux** 64 bits

**Linux** ARM 32 bits

**Linux** ARM 64 bits

[Release Notes](#)

[Source Code](#)

[Checksums \(sha512\)](#)

# Do It Yourself DCC++


Free Software and stuff to make it work


GitHub – Repository of the DCC ++ Firmware for the Arduino


<https://github.com/DccPlusPlus/BaseStation>


<https://github.com/DccPlusPlus/BaseStation/wiki/What-is-DCC--Plus-Plus>

DCC++ Base Station for Arduino Uno and Mega

 33 commits

 5 branches

 4 releases

 1 contributor

Branch: **master** ▾ [New pull request](#) [Find File](#) [Clone or download ▾](#)

# Do It Yourself DCC++

Free Software and stuff to make it work

JMRI – Repository for the Raspberry Pi JMRI Software  
<https://mstevetodd.com/jmri-raspberrypi-access-point>



and click "Download".

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 [\[photo\]](#).

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

## Hardware

### Item

RaspberryPi 3 Model B+  
5V 2.5A Power Supply w/ MicroUSB Cable  
8Gb MicroSD memory card  
RPi Case with Lid (\*\*optional )

### Purchase

[Newark](#)  
[NewEgg](#)  
[NewEgg](#)  
[Newark](#)

## Software Image

I have built 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 LoconetOverTCP (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 \[here\]](#) (1.4Gb, updated April 21, 2019), or the previous version [\[here\]](#) (1.3Gb, updated January 3, 2019). *NOTE: Ignore the "too large" warnings*

# Do It Yourself DCC++

Free Software and stuff to make it work

Windows Disk Imager – Needed to Program the Raspberry Pi  
<https://sourceforge.net/projects/win32diskimager/>

[Home](#) / [Browse](#) / [System Administration](#) / [Storage](#) / Win32 Disk Imager



## Win32 Disk Imager

A Windows tool for writing images to USB sticks or SD/CF cards  
Brought to you by: [gruemaster](#), [tuxinator2009](#)

★★★★☆ 102 Reviews Downloads: 56,216 This Week

 **Download**  Get Updates  Share This

Windows

# Do It Yourself DCC++

Free Software and stuff to make it work

Apple Disk Imager: ApplePi v2

<https://www.tweaking4all.com/hardware/raspberry-pi/applepi-baker-v2/>

## ApplePi-Baker v2 – Backup & Restore SD cards, USB drives, etc.

12 MAY 2019



Applications  
MacOS X  
Raspberry Pi

ApplePi-Baker has become well known amongst Raspberry Pi users, with a Mac running macOS, to backup and restore SD-cards. Users do not just use ApplePi-Baker for this purpose anymore – I have seen users use it for backup and restore of pretty much anything not Raspberry Pi related.

Late 2013, I created ApplePi-Baker for my own use – I just got tired of looking up the proper command-line statements. This way, ApplePi-Baker became my personal frontend for command-line tools like "dd", "diskutil", "mount" etc.

Over time, the use of command-line tools came with some problems; thanks Apple for changing command-line tool output with every new version of macOS. Besides that, having to enter your "sudo" password each time was a pain as well, and came with the occasional problems for a small group of users, so that had to go as well.

About 2 years ago I decided to rebuild ApplePi-Baker from scratch, no longer using any of the command-line tools. This came with quite a few challenges, especially since Apple increased security for macOS, not allowing me to do certain things straight from my program (see also SMJobBless: Elevated Privileges in Lazarus Pascal). I'm not even mentioning the drama when it comes to supporting the different compression formats, signing applications, and 64-bit requirements.

Almost 2 years later, I proudly present **ApplePi-Baker v2** 🥳 – special thanks to Jeff and Mark for testing!



- 1 | **Start Download & Install** (Recommended) Update All Drivers - Fast and Free: Start My Update, Drivers Update >
- 2 | **Start Download** Microsoft 64/32 Bit Driver Download Driver Support Free Scan download.driversupport.com >
- 3 | **Start Zip Download** Get Zip Cruncher! Zip Cruncher >



# Do It Yourself DCC++

Free Software and stuff to make it work

NOOBS for Raspberry Pi


<https://www.raspberrypi.org/downloads/noobs/>

## NOOBS


Beginners should start with NOOBS – New Out Of the Box Software. You can purchase a pre-installed NOOBS SD card from many retailers, such as [Pimoroni](#), [Adafruit](#) and [The Pi Hut](#), or download NOOBS below and follow the [software setup guide](#) and [NOOBS setup guide video](#) in our help pages.

**NOOBS** is an easy operating system installer which contains [Raspbian](#) and [LibreELEC](#). It also provides a selection of alternative operating systems which are then downloaded from the internet and installed.

**NOOBS Lite** contains the same operating system installer without Raspbian pre-loaded. It provides the same operating system selection menu allowing Raspbian and other images to be downloaded and installed.



<b>NOOBS</b>
Offline and network install
Version: 3.0.1
Release date: 2019-04-09
<a href="#">Download Torrent</a> <a href="#">Download ZIP</a>



<b>NOOBS Lite</b>
Network install only
Version: 3.0
Release date: 2018-11-16
<a href="#">Download Torrent</a> <a href="#">Download ZIP</a>

SHA-256: 551d8d9352dc02a6feef010dec217aefee11f08c44b391b7c428043 17b318db4

SHA-256: 7c23568142c1af017be8fa6b27737c11aff61009d9d6d53e87e013c36355422f

# Do It Yourself DCC++

## How to Videos on YouTube

Excellent Beginners how to guide by: Steve Todd

<https://www.youtube.com/watch?v=l1pgvCKT410>

More detailed four part series.

<https://www.youtube.com/watch?v=-nsVdpMhiTU>

# Do It Yourself DCC++

## Starting the Build

Step 1: Install Arduino IDE on your laptop or desktop.

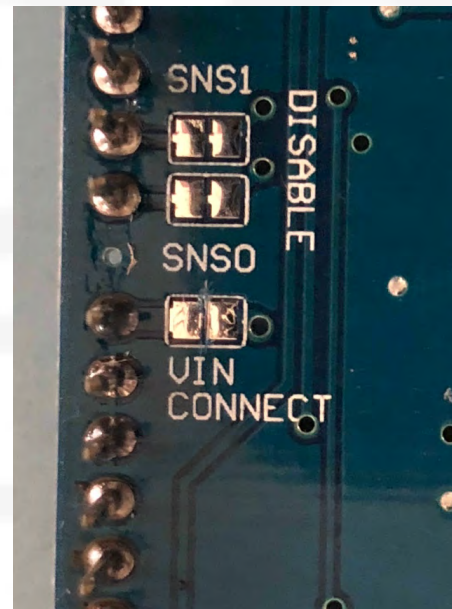
Step 2: Download from GitHub the DCC++ firmware for the Arduino.

Step 3: Connect the Arduino to your computer.

Step 4: Using the Arduino IDE, push the code to the Arduino

Step 5: Cut the trace on the back of the Power Shield

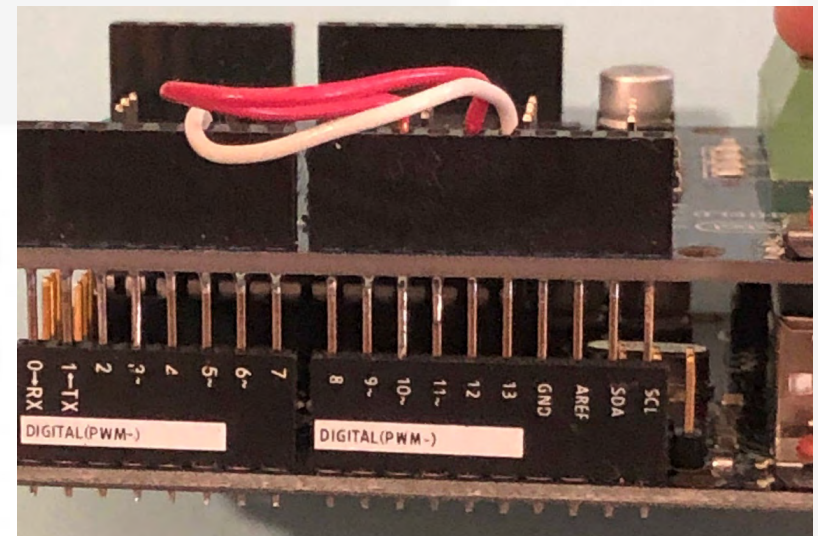
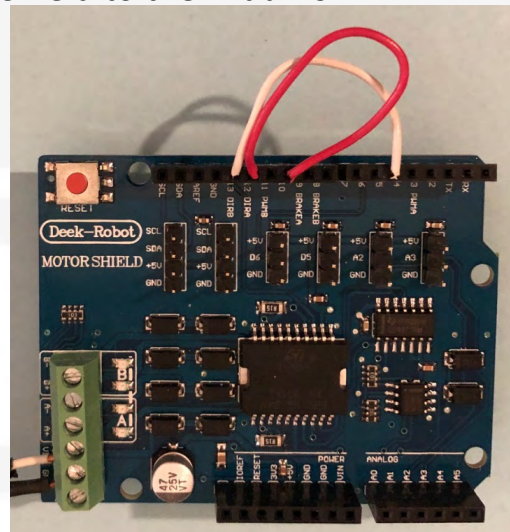
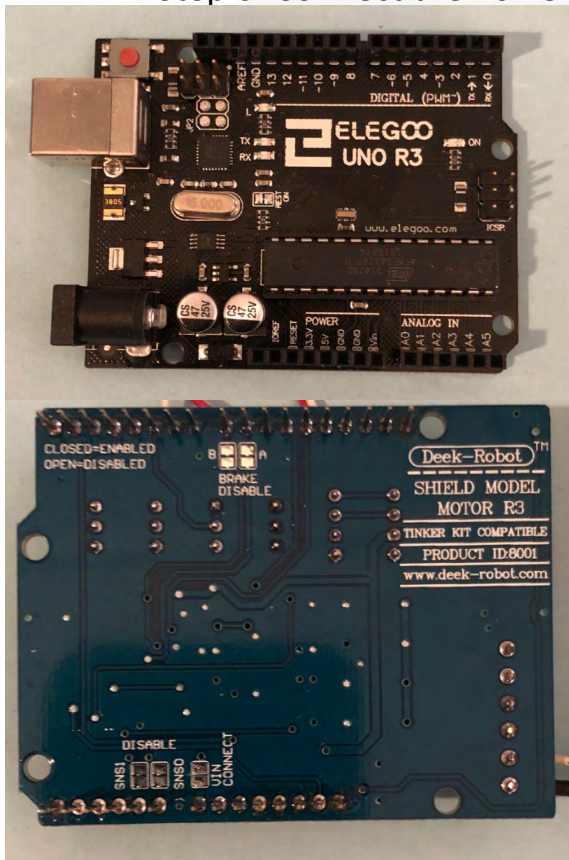
This is done to protect the CPU on the Arduino since it is designed to handle 12 Volts and this project requires 14 Volts!



# Do It Yourself DCC++

## Starting the Build

### Step 6: Connect the Power Shield to the Arduino



Place the pins in the socket and gently and with even pressure connect the two sections together.

This procedure can be undone to mount the device.



# Do It Yourself DCC++

## Starting the Build

There are two jumper that you will need to put in.

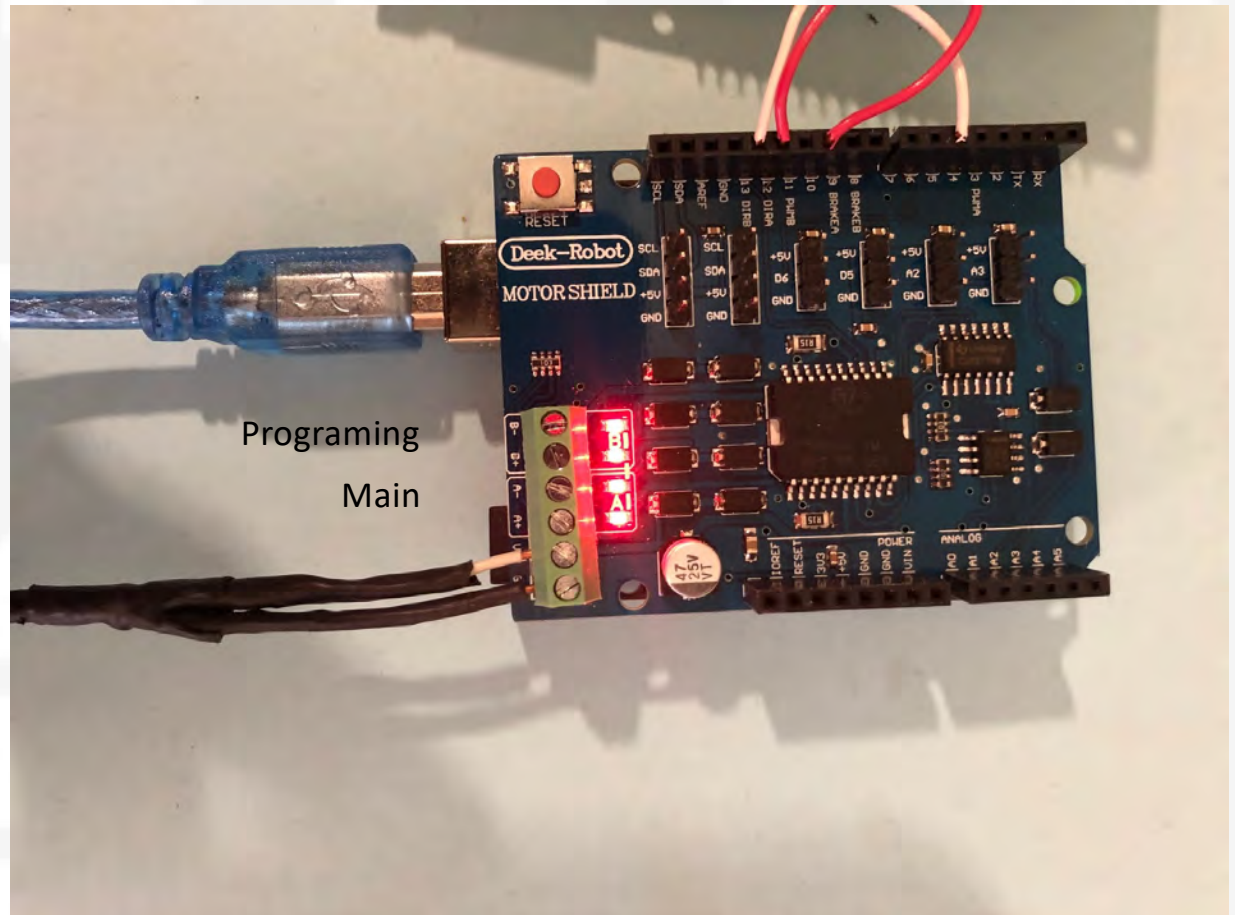
Jumper #1 Pin 10 and 12

This provides the DCC Logic to be transmitted to the Mail Track Power.

Jumper #2 Pin 5 and Pin 13

This provides the DCC Logic to be transmitted to the Programming track.

The Blue USB connector needs to go to either a Computer, Laptop or a Raspberry Pi Running JMRI.





# Do It Yourself DCC++

## Starting the Build

There are two jumper that you will need to put in.

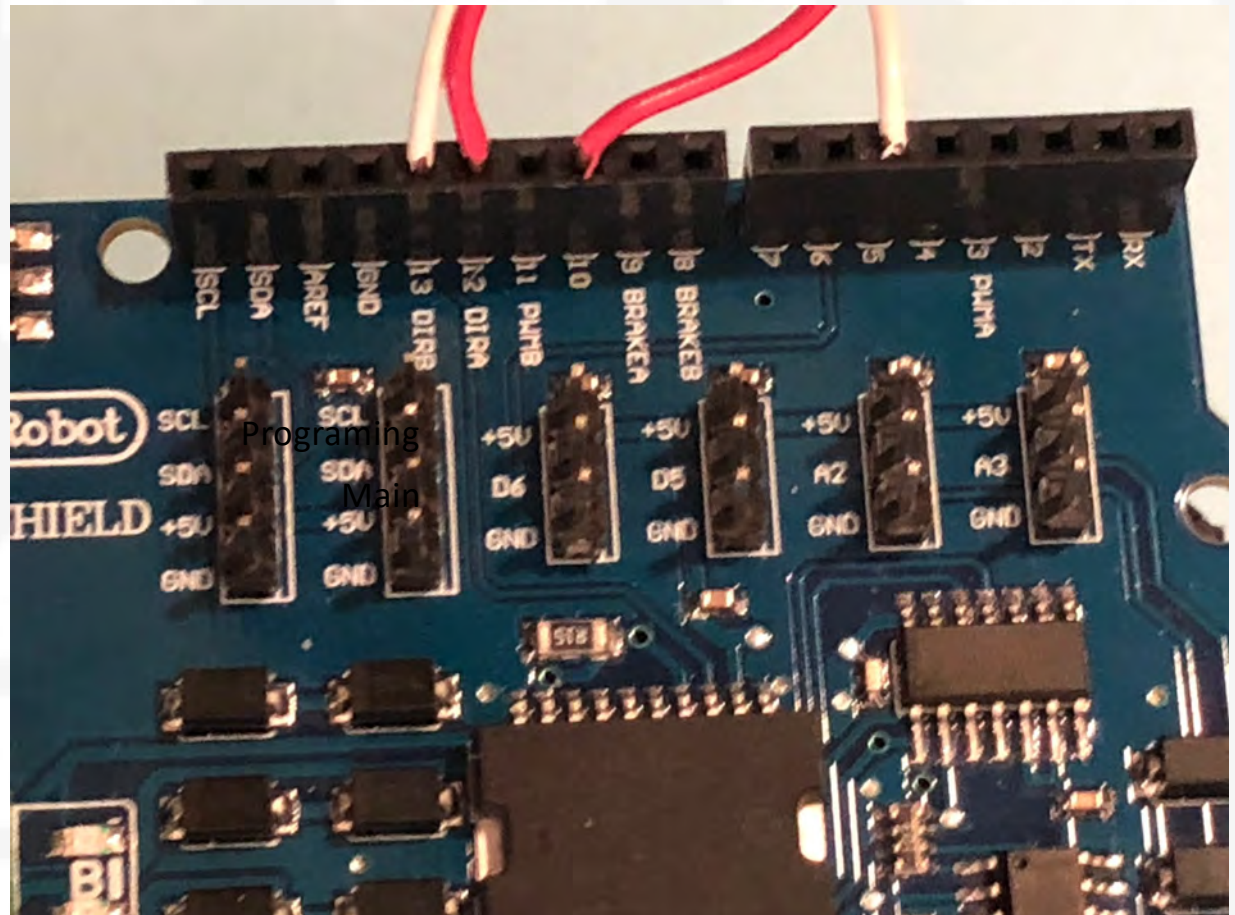
Jumper #1 Pin 10 and 12

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This provides the DCC Logic to be transmitted to the Programing track.

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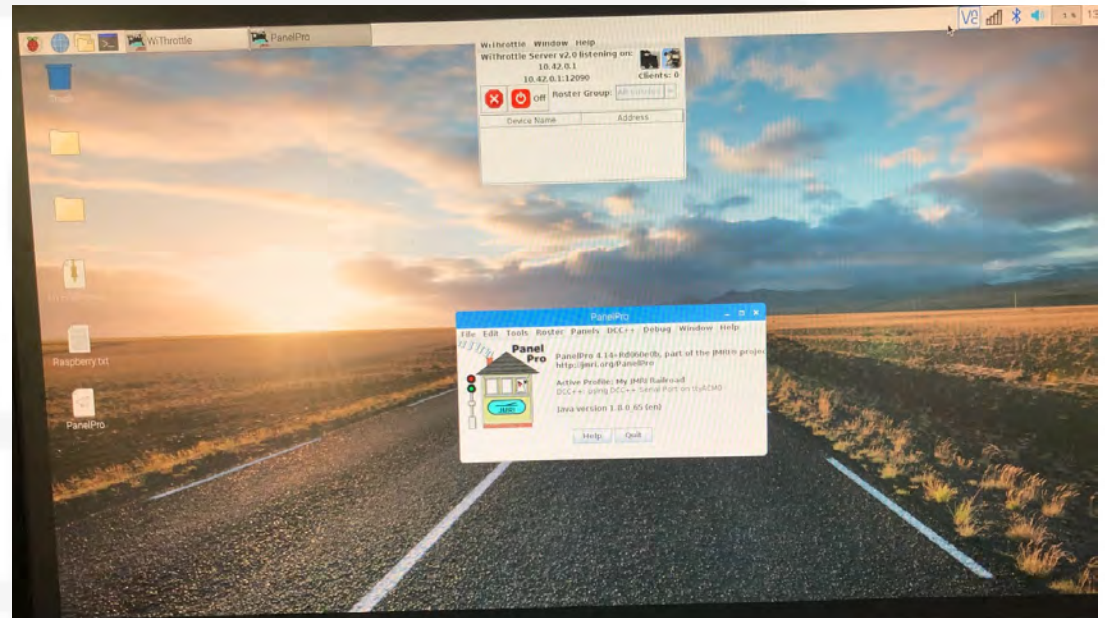
# Do It Yourself DCC++

## JMRI

There are a few paths you can take at this point.

You can use an existing Laptop or computer to connect to the DCC++ or you can program a Raspberry Pi to do the job. Here is what goes next.

With the Laptop or desktop you will need either a router or software to turn then computer in to a wireless access point. You will need to install JMRI and set it up to talk to the DCC++ over a USB cable.



# Do It Yourself DCC++

## JMRI

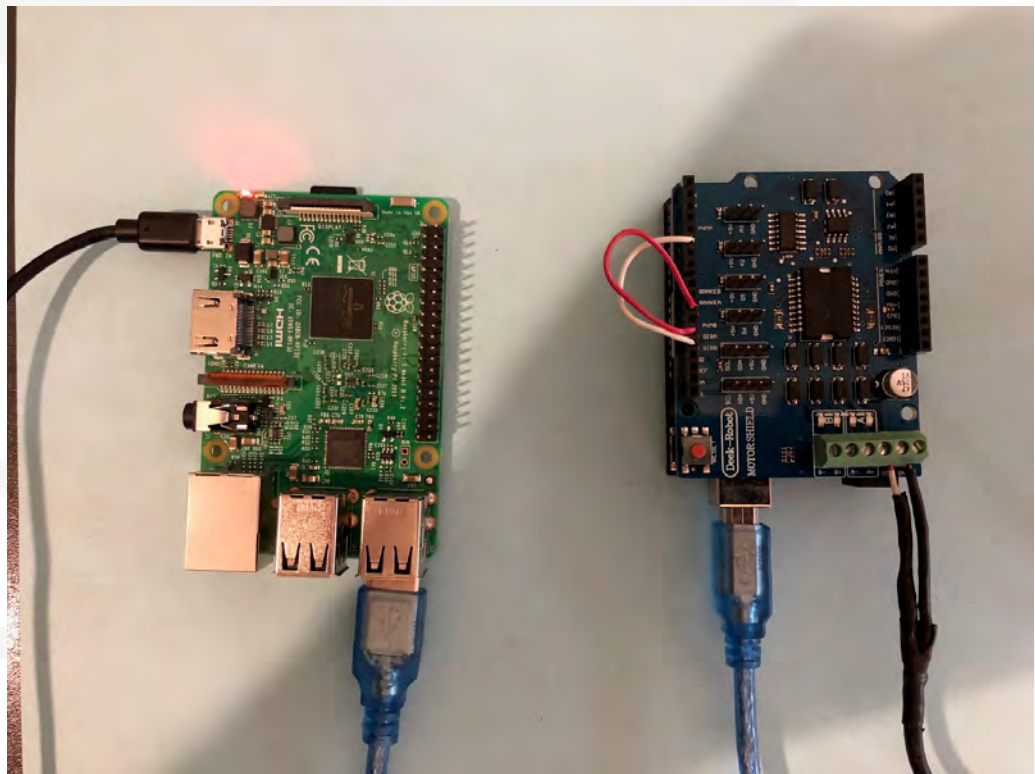
There are a few paths you can take at this point.

With the Raspberry Pi there will be some configuring task and software that you will need to do.

For this task you will need an install image to setup the Raspberry Pi. Not to worry a complete solution is available at the JMRI website. You will need the image file and a software to configure the Micro SD card.

Windows based PC should use Windows 32 Disk Imager and Mac OS users will need to use ApplePi-Baker V2.

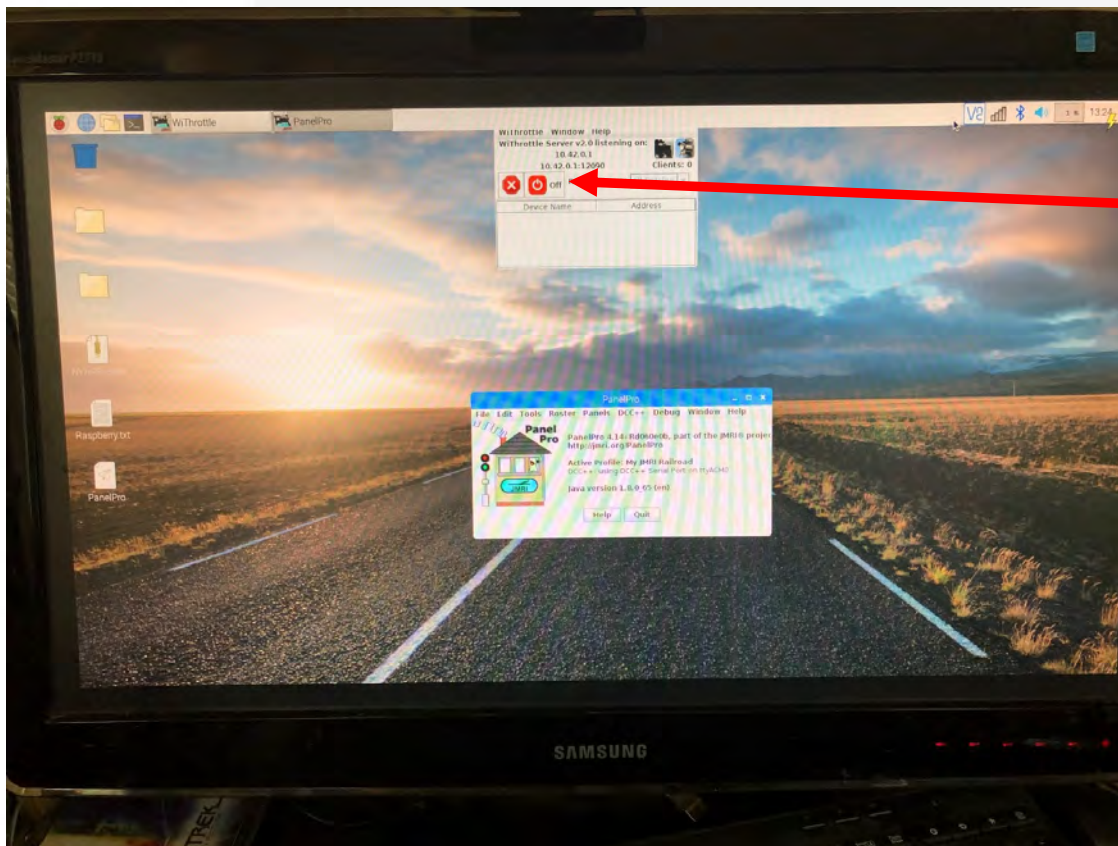
Both of these programs take the file and convert it to a bootable file that will program the Raspberry Pi!



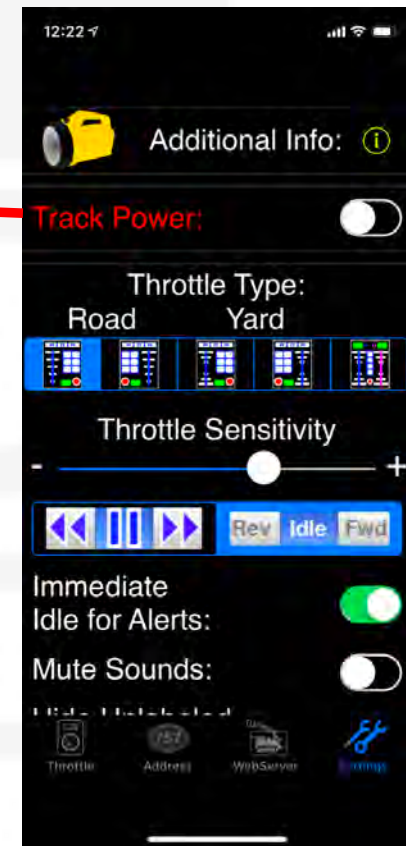


# Do It Yourself DCC++

Ready For Testing

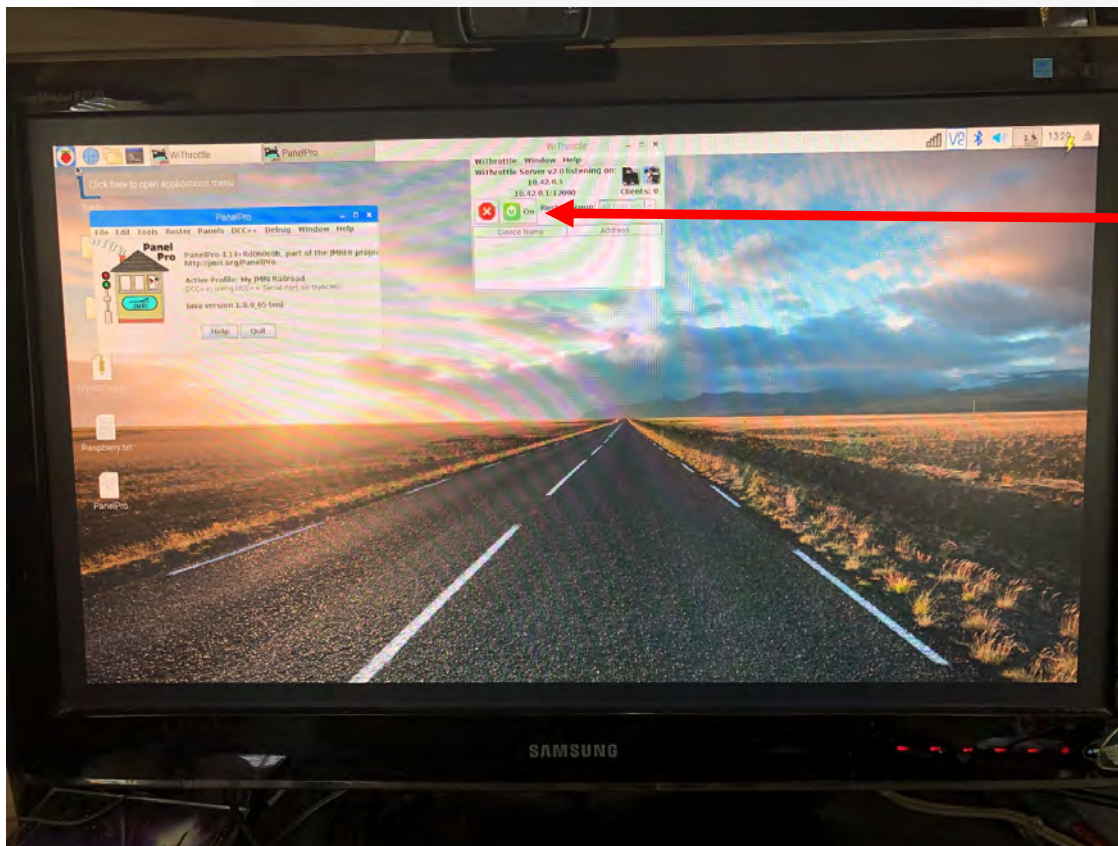


The Wi-Fi SSID: JMRI-LVRR  
Password: LVRR1925

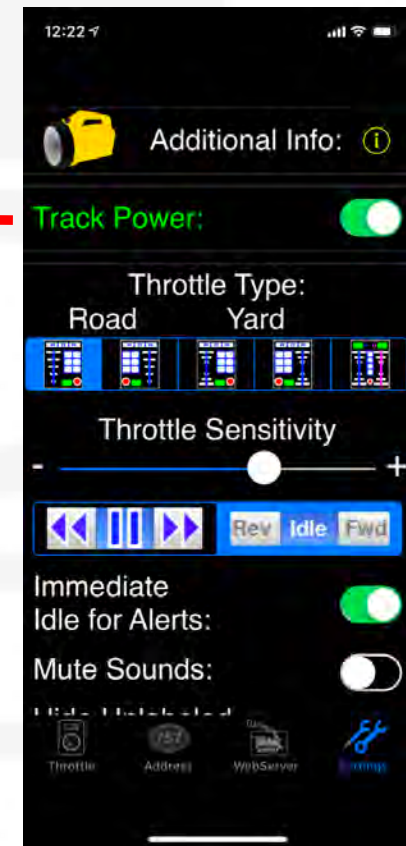


# Do It Yourself DCC++

Ready For Testing



The Wi-Fi SSID: JMRI-LVRR  
Password: LVRR1925





# Do It Yourself DCC++

## What If?

If you have a DCC system like an NCE system already you can use the Raspberry Pi to add Wi-Fi throttles to your layout.

You will need a USB to Com Port male cable.



Sabrent USB 2.0 to Serial (9-Pin) Db-9 RS-232 Converter Cable, Prolific Chipset, Hexnuts, [Windows 10/8.1/8/7/Vista/XP, Mac OS X 10.6 and Above] 2.5 Feet (CB-DB9P)

by Sabrent

★★★★★

928 customer reviews | 83 answered questions

Amazon's Choice for "usb to com port cable"

Price: **\$8.99** ✓prime

Thank you for being a Prime member. Get \$70 off instantly: Pay **\$0.00** upon approval for the Amazon Prime Rewards Visa Card. No annual fee.

Free Amazon tech support included

- Provides the connection between USB and the traditional RS-232 serial port
- Supported OS: Windows 2000/ME/98SE, Windows XP (32/64-bit), Windows Vista (32/64-bit), Windows 7 (32/64-bit), Windows 8/8.1 (32/64-bit), Windows 10 and higher (32/64-bit), Mac OS X 10.6 and Above, Linux 2.4 or above
- Easy to setup: Plug & Play - Simply plug your device into the adapter and the adapter into your PC or Mac.
- COM ports and Baud rates can be modified to desired set up.
- This product comes with LIFETIME manufacturer warranty.

Compare with similar items

**New** (3) from **\$8.99** ✓prime

Report incorrect product information.

# Do It Yourself DCC++

## Additional Boosters?

Tam Valley Depot makes an excellent Stand alone DCC booster system that will let you expand the scope of your railroad.

Booster Cost: \$54.95

Power Supply: \$16.95

### DCC Booster for Accessories and Track Power Districts

This DCC Booster was designed to solve two issues that putting a lot of DCC accessory decoders on your layout brings up. 1) They are a drain on your precious loco amps and 2) When a loco causes a short all the accessories lose power. To solve this problem we have made a DCC booster that can be used for accessories on any brand of DCC system. It can provide about 5 Amps of power to run the DCC accessories independent of the track power from your command station. During a short on the layout, when the DCC signal dies, the booster continues to deliver full power. This is a so-called "dumb" booster in that it does not need a cab bus - it connects directly to the track output of your existing command station.

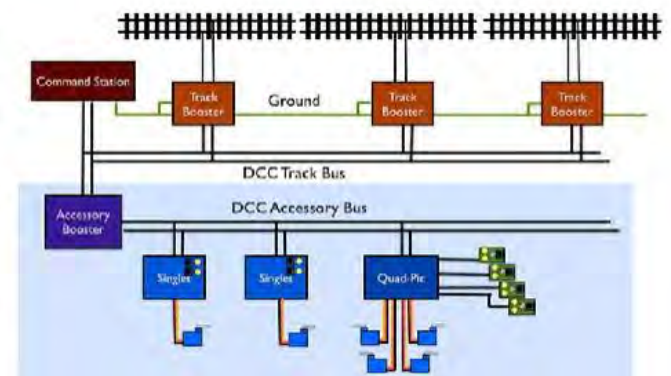
You can also use the booster as a "powered circuit breaker". It fills all the functions of a circuit breaker but provides its own power. Each of your power districts puts no load on the command station as it is fully buffered. I use several of these with 16 V power supply which gives about 14.5 Volts on the track to power my own layout with just a single NCE PowerCab.

Auto- shutdown - the unit shuts down after 5 minutes of no DCC signal (accessory mode) or immediately (power district mode). When the DCC signal returns it wakes up immediately. Just plug the booster in and forget about it.

The booster has protection against shorts and overheating. The input is optically isolated.

Efficient - this booster uses the latest in efficient power electronics and as such it does not get hot in normal operation - the power supply is a highly efficient switching power supply that also stays nice and cool. A heatsink is provided although in normal use it never becomes warm unless the track is continuously shorted.

To use the booster with Loconet you can connect it to the railsync lines (the outer pair in the loconet cable) or to the rail outputs of your command station. The Loconet method has the advantage that the signal can be sent farther without significant degradation in quality.



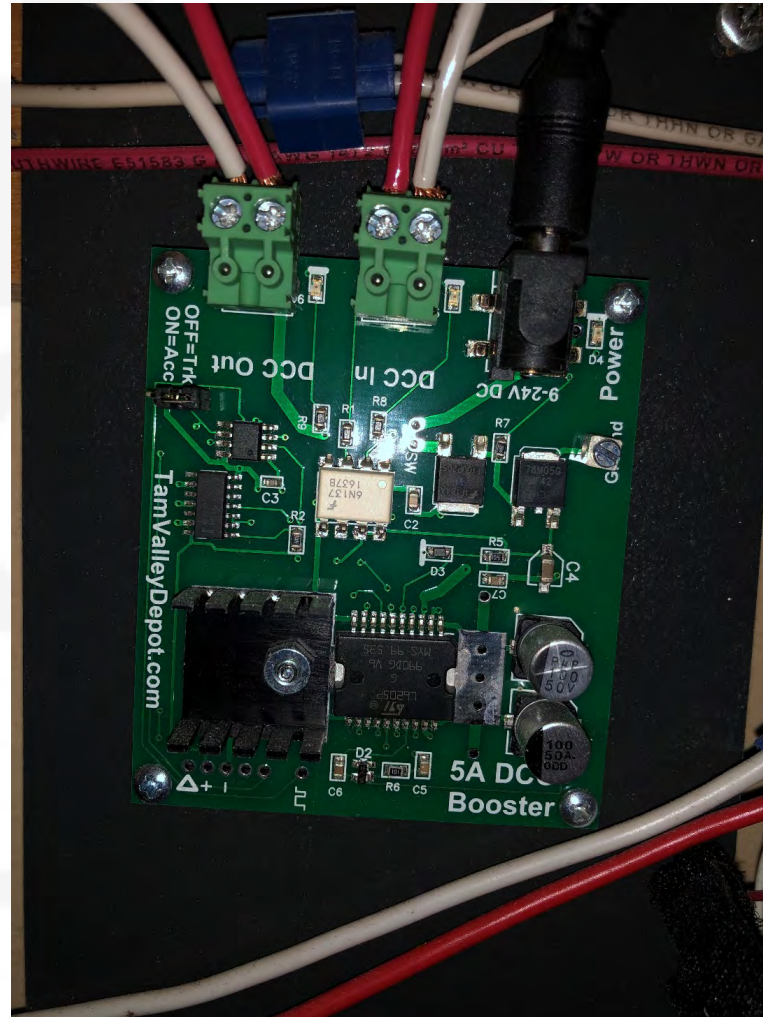
# Do It Yourself DCC++

## Additional Boosters?

Here is a photo of the Tam Valley Depot Booster as installed on the New York Harbor.

This 5 amp Booster handles all of staging on the layout.

This booster can also be used to power accessories that are DCC controlled. Off loading there power requirements from the main DCC system.



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Questions?

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Go out and build one!