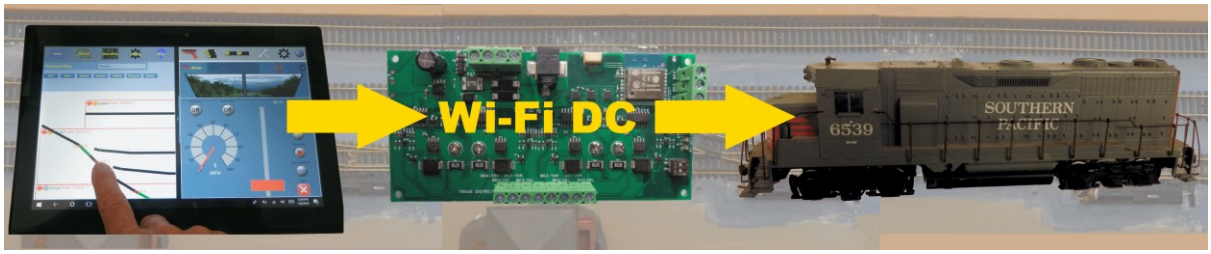


Wi-Fi DC: Drive DC Locomotives over your Home Wi-Fi Network

Back to Web Site

The WifiTrax concept will allow you to connect your entire model railroad to your home Wi-Fi network giving you a flexible and versatile method of control from almost any hand-held device or computer on your network. In our earlier WifiTrax Vision Documents we described our Wi-Fi Cab Control of locomotives and Wi-Fi control of other layout features such as Switches (points or turnouts), Signals, Lights and Power. These products are now in production and can be purchased from our website.

Read the first WifiTrax Vision Document here…

Read the Wi-Fi Layout Vision Document here…

Introducing Wi-Fi DC

Many railroad modellers do not want to take their locomotives apart to install decoder or controller modules within them and many N scale locomotives are not large enough for our modules. There are a lot of modellers with DC layouts already divided into blocks and controlled with manual control panels. For these reasons, we think that our Wi-Fi DC concept is a good idea.

Wi-Fi DC uses the same Wi-Fi technology as our locomotive controllers and the same locomotive control circuitry, using back e.m.f. from the locomotive's motor to provide speed input to the controller, allowing precise control, and to provide speedometer readout to our Loco Operator app running on an Android or Windows 10 tablet, phone or computer.

A Word about Power Blocks or Districts

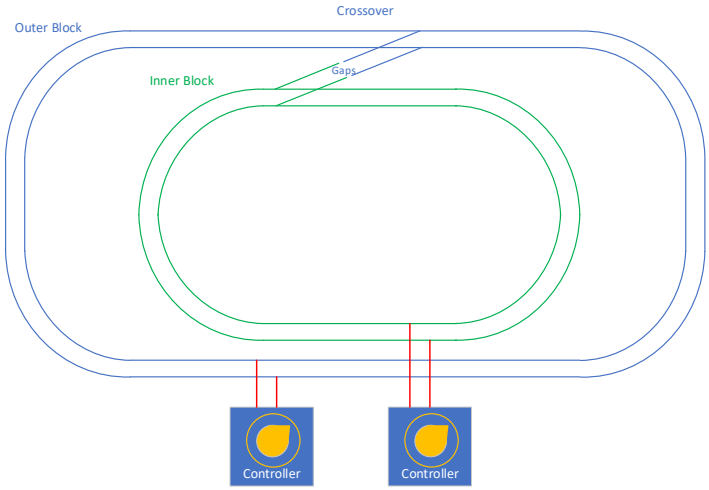


Figure 1 Simplest Block Concept for a Model Railroad

Model railroaders have always known that to operate more than one DC locomotive on a layout required that the layout be divided into blocks with a separate DC controller connected to each block. The simplest manifestation of this concept is the simple train-set with two elliptical tracks connected by two turnouts in a crossover configuration, shown in Figure 1. There are two controllers, one connected to the outer track and one to the inner. Two separate trains can be operated, one on the inner track, one on the outer, each controlled by a separate controller. To run a train from the inner to the outer track, both controllers must be turned on and as the train traverses the crossover, it moves between obtaining power from one controller to the other. For a short period of time the power from both controllers are connected. Therefore, care must be taken to ensure that they are both connected the same way around to the track and both are operating in the same direction to avoid a short.

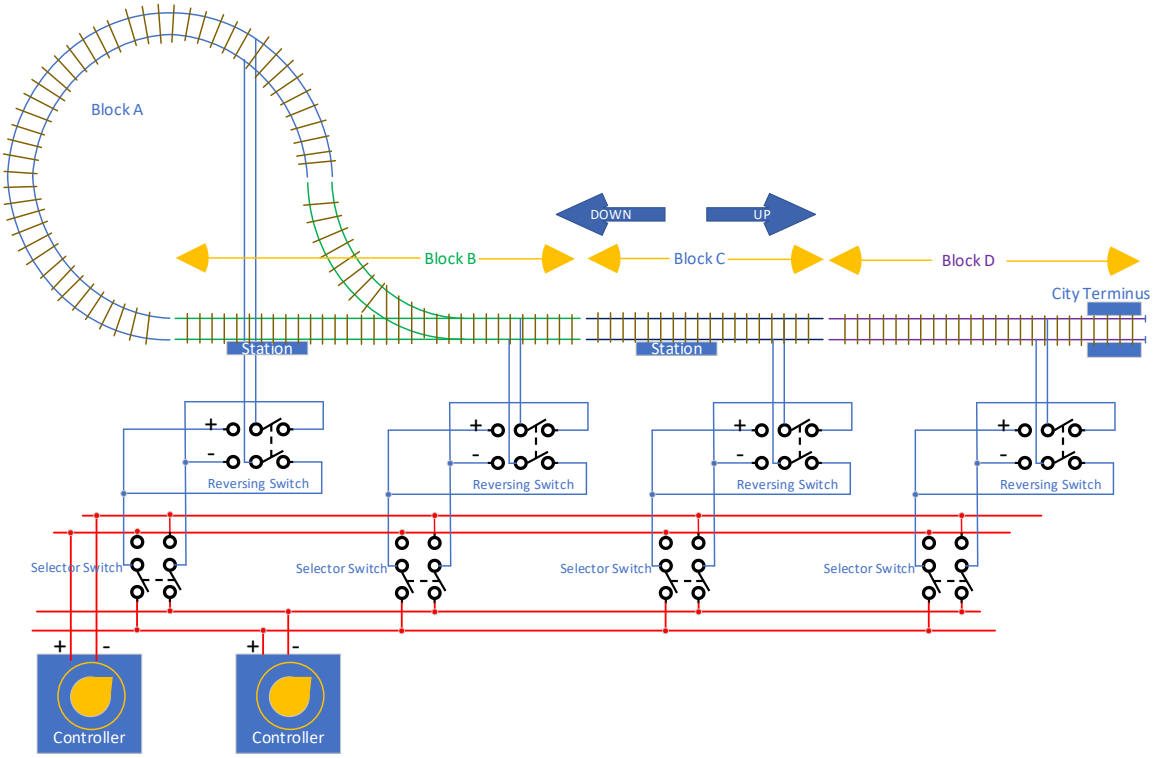


Figure 2 A Part of a Model Railroad with a more Complicated Block System

Figure 2 shows part of a model railroad with a more complicated block wiring system. Sidings and freight yards etc. are omitted. This is what is needed to provide proper versatility for running more than one train. There are four blocks shown, one of which forms part of a reversing loop. There are two controllers each wired to a bus shown in red that can supply controlled DC power to each block via a selector switch and a reversing switch.

The selector switches allow each block to be connected to one or other of the controllers. The reversing switches allow the DC power to each block to be applied in either direction. Let's call those directions UP and DOWN and assume that the main city terminus is to the right of block D.

Let's suppose that we want to run a train from the city terminus, left, though Block D, Block C, Block B, round the loop of Block A and then back through Blocks B, C and D. First, we set all the blocks to DOWN, run our train down and into Block A. At that point we must reverse Block B, C and D to the UP direction, so that when the train re-enters Block B a short will be avoided.

If our blocks are long enough, we can run a second train down and up though blocks B, C and D while the first train is in Block A, by selecting the second controller for those blocks.

This is the classic approach for model railroads before cab control became available.

Along came Cab Control

Cab Control, of course is a system of controlling a locomotive in which the power on the track remains at a constant voltage (with coded signals in DCC) and each locomotive is controlled independently so that its speed and direction can be determined from a control station. This is a great idea because now locomotives can be driven close together on the same block or coupled together in multi-unit consists – in fact you don't need blocks at all!

The current popular system for cab control is called DCC (Digital Cab Control) supported by many manufacturers, according to a specification maintained by the National Model Railroad Association (NMRA). WifiTrax (www.wifitrax.com), and some other vendors, have developed a system of direct cab control based on Wi-Fi, using a normal domestic router. We think this is an improvement on DCC. Both systems provide all the advantages of Cab Control, but they do require a quite complicated decoder or controller module to be installed in each locomotive.

Now WifiTrax offers Wi-Fi DC and if you convert your DC layout to use this technology, it does not prevent you from using DCC or moving to WifiTrax Wi-Fi Direct Cab Control. The modules sold by WifiTrax, currently the WUFP-40 allow you to select any of these options for each block on your layout.

The need for Blocks or Power Districts

The use of blocks for DC layouts has been described earlier and, of course, using DCC or WifiTrax Wi-Fi Direct Cab Control, you do not need blocks, With DCC you can simply connect your DCC Cab Controller or Booster direct to all of your layout. With WifiTrax you can simply connect 12-18 V DC to your entire layout – there's no track signals, or boosters needed.

There are two disadvantages with doing away with blocks. The first is that it is nice to separate your layout into sections, normally called Power Districts, to better distribute power between boosters and to better indicate and protect from shorts on the track.

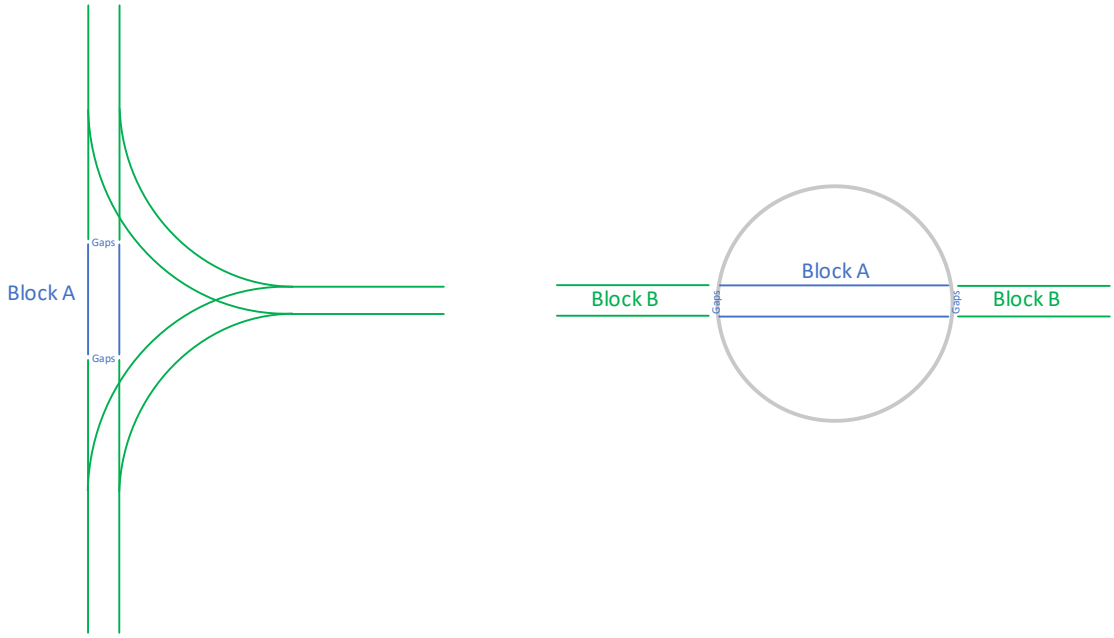


Figure 3 The Wye and Turntable Track Configurations

The second is that blocks are essential if you include any features on your track plan that result in shorts as a locomotive traverses them. There are three well-known examples: reversing loops, wyes and turntables. Figure 2 shows an example of a reversing loop with the necessary gaps included. If the gaps were not present, the effect of the loop would be to connect each rail going into the loop to the opposite rail coming out, thus immediately shorting the DC power to the track.

Similarly, the wye shown in Figure 3 will have the same problem if no gaps are provided. It is clear that without gaps, and assuming the switches do not isolate power, each track entering the wye will be connected to the opposite track coming out of the wye,

Why are TWO double rail, gaps necessary? If you simply break both rails at just one point, there will no longer be a permanent short circuit in either the wye or the reversing loop. The problem is that as the locomotive crosses the gap, it will connect the rails across both gaps, restoring the short circuit for as long as it stays in that position. Typically, the locomotive (whether DC, DCC or WifiTrax) will stop and the power supply detect a short and go into overload protect mode.

Moreover, it is not sufficient JUST to have two gaps in both tracks, you must have a means of reversing one of the blocks. If you do this manually, you would reverse Block B while the locomotive is in Block A, for both the Wye and the reversing loop configurations.

For the turntable shown also in Figure 3 gaps are always present at both ends just because of the design. Therefore, you must connect power to the track on the turntable itself. Let's suppose you connect power to the turntable track so that each end of each track has the same polarity as the fixed rail next to it. Then the locomotive will run onto and off the turntable without causing a short. However, when you rotate the turntable though 180 degrees, with the same power connections, the locomotive will now connect each rail to its opposite rail if it tries to exit. So ,you must change the polarity of the turntable track (Block A) when you rotate the turntable by 180 degrees.

So, whether you call them blocks or power districts, they are a good idea and absolutely necessary when any of the three features described are included.

Converting your Existing (or Planned) DC Layout to Wi-Fi DC

One of the features of Wi-Fi DC is that you can convert your existing HO or N scale DC layout to Wi-Fi DC without much effort. If you are building a new layout in HO or N scale and you want to run DC locomotives, you are saved the labor, complexity and expense of building a physical control panel with all of its wiring and switches.

Wi-Fi DC allows you to use the Tower Operator app which enables you to build a schematic control panel (in the form of a map) just like a CTC (Centralised Train Control) system *and carry it around with you*, and copy it to whatever computer you want to use. Moreover, if you start with a very simple system with only a few switches, you can list them, name them and control them in a simple way from Loco Operator, the driving app from WifiTrax.

Remember also that, if you do are prepared to install WifiTrax controllers or DCC decoders in some of your locomotives, you can run those as well (though of course, not on the same block at the same time as a DC locomotive).

Let's look at how the layout shown in Figure 2 can be converted to Wi-Fi DC.

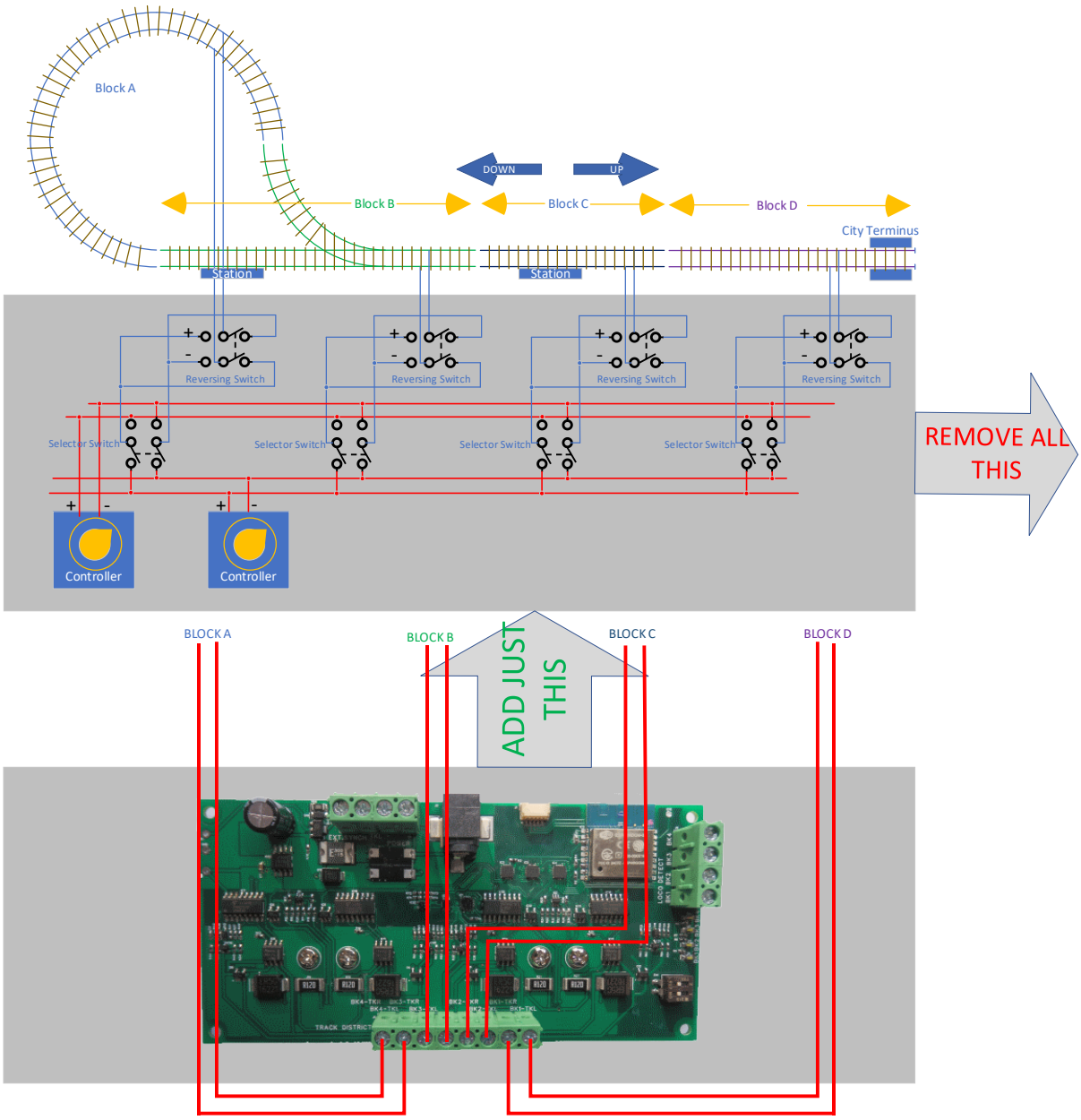


Figure 4 Converting a DC Layout to Wi-Fi DC with one WUFP-40 Module

Figure 4 shows how you can convert your DC layout to Wi-Fi DC simply by disconnecting the blocks from your physical control panel with all its switches and connecting each of those blocks to an output of a WUFP-40 module. This module provides all the features of the switch-based control panel and more.

(1) It enables direction switching of each block,
(2) It connects each block to one of two controllers,
(3) It contains two controllers

That's covered everything the switch-based system did in Figure 4 – what else do you get?

(4) The controllers in the WUFP-40 provide precise speed control using back e.m.f.,
(5) You get speedometer display, MPH or KPH, scale speed for HO or N scale as you select,
(6) There is current monitoring with readout and overload protection,

(7) You can select constant DC for any block to use WifiTrax equipped locomotives,
(8) You can select external DCC input to any block for DCC equipped locomotives,
(9) You get occupancy detection of a locomotive in a block, whether DC, WifiTrax or DCC,
(10) You get automatic reversing of a block when used in a reversing loop, wye or turntable.
(11) Last – and most important – everything is under Wi-Fi control from your computer or walk-around tablet running Windows 10 or Android and you get the benefit of the free Tower Operator (map-based) CTC control panel.

So, whether you already have a DC layout or are building a DC layout whether HO scale or N scale, you can benefit from the use of WifiTrax Wi-Fi DC technology.

Some questions:

What if my layout has more than four blocks? You can use more than one WUFP-40 – any number can be managed by Tower Operator

How can I run more than two trains? Each WUFP-40 provides two controller channels so if you have two WUFP-40 installed, you can run four trains altogether at the same time. You can run two on the first four blocks and two on the second. Any set of the four blocks on each module can be connected to either of the two controllers on the same module.

Getting into the Details – Installing the Hardware

Power Block Control

Each WUFP-40 unit is shipped with a Getting Started guide that shows you how to connect it in several situations. It's available online here.

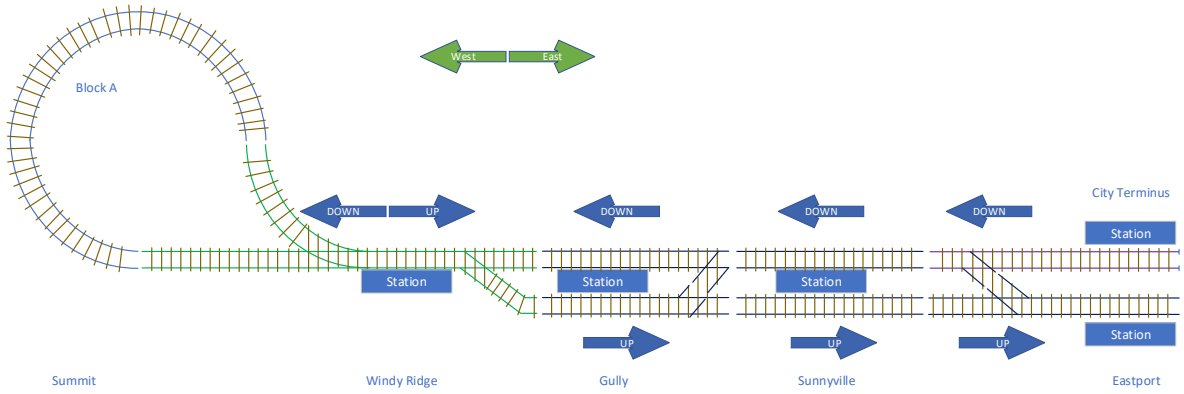


Figure 5 Example DC Layout – Sunny Valley Railroad

In this guide, however, we'll consider an example DC layout shown in Figure 5 and go through the detail of connecting up the necessary hardware, then installing and configuring Tower Operator, and finally operating the layout.

The example, Sunny Valley Railroad, is a point to point layout with terminal station called Eastport at one end, three stations: Sunnyville, Gully and Windy Ridge leading to a reversing loop at the other. Part of the layout has double track so that a train can be run on the up line with another on the down line. No freight yard or industrial sidings are included for simplicity, but these could easily be added. There are crossovers included on the double track section and the country, single track section also includes a station.

The track is divided into eight power blocks and can be powered using two WUFP-40 modules. The next figure, Figure 6, shows how these will be wired. The blocks, from left to right are Summit, Windy Ridge, Gully Down, Gully Up, Sunnyville Down, Sunnyville Up, Eastport Down, Eastport Up. In accordance with convention, the Up direction is the one leading to the main station and in the double sections, the trains drive on the right.

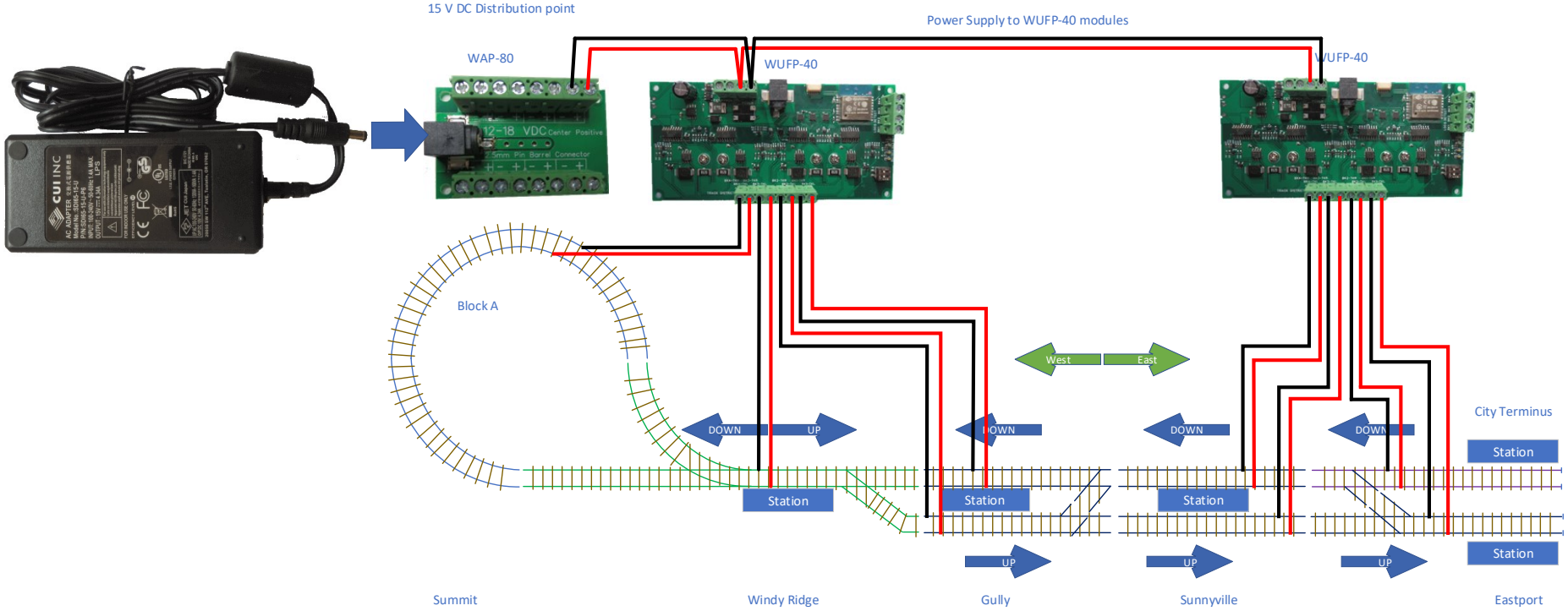


Figure 6 Power Wiring of the Sunny Valley DC Layout

Since there are eight blocks, two WUFP-40 modules are required. Figure 6 shows how these are wired to the eight blocks, four from the track outputs of each module. Each of the WUFP-40 modules require 12-15 VDC input. This can be provided from a Power Adapter such as the PA15-43-1 unit that WifiTrax sells. You need a mains power cord to suit your country's mains plug style. It is convenient to use our small WAP-80 unit to allow the 15V plus and minus leads to be connected to the WUFP-40 modules. The WAP-80 provides eight outputs so you can either loop along from one WUFP-40 to the next as shown in Figure 6 or separately connect them to two pairs of WAP-80 outlets. The WUFP-40 modules do not need to be close to each other, so you can place them on your layout near to the tracks that they supply. It is better to make the power supply leads longer than the track outputs – it uses less wire and will give better performance. It is always good to keep the track outputs as short as possible.

Switch Machine Control

There are only six switches included in the layout. As mentioned earlier, this is probably a simplification, but we'll base the design on this. Two pairs of switch machines form crossovers from one side to the other of the double track portion of the layout. They can therefore be operated together and connected to the same controller and only four switch machines control channels are required, making the WFS-46 a suitable choice.

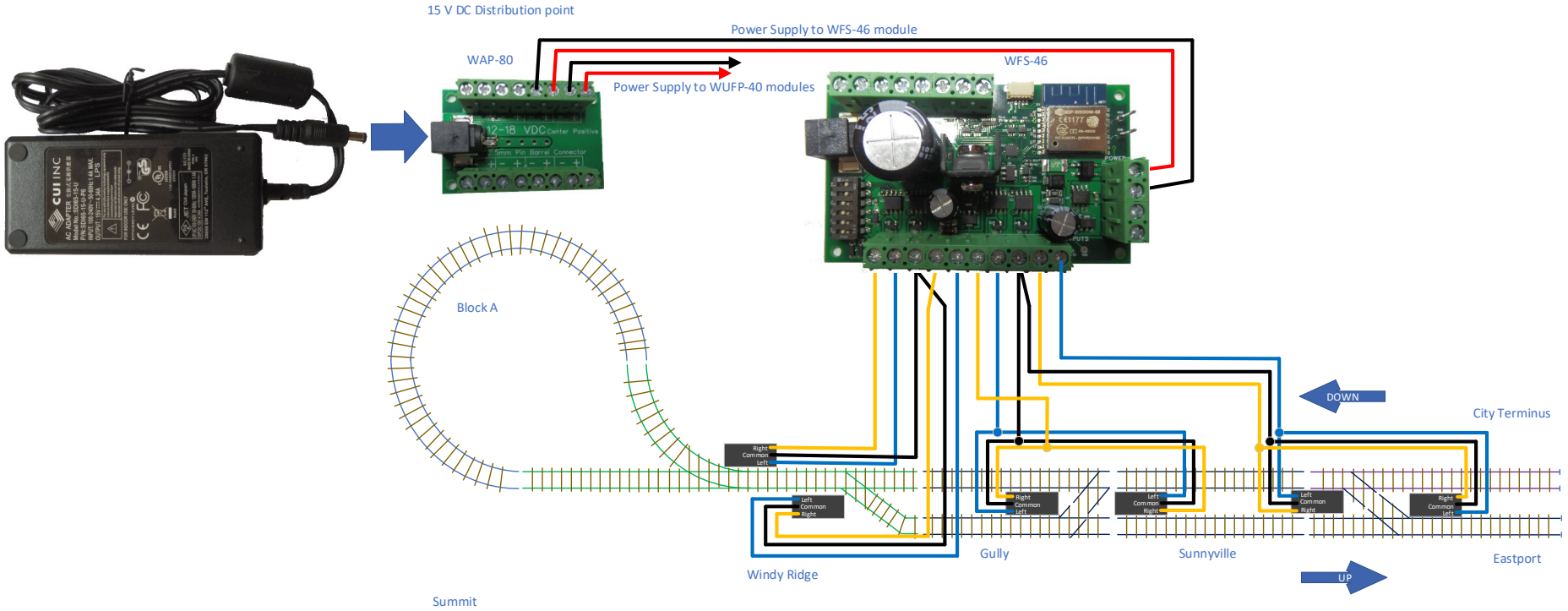


Figure 7 Switch Machine Wiring using the WFS-46

Figure 7 shows the switch machine wiring. The assumption is that all switch machines are of the twin coil, three wire type. If you are using Kato twin coil, two wire, or stall-motor such as Tortoise, you should consult the wiring diagrams supplied with the WFS-46 or WFS-86, available here and here. You also need to consult these documents to set the DIP Switches correctly on the WFS-46 for your type of switch machines.

Configuring Tower Operator for your Layout

There are actually two ways of operating the WUFP-40, using the Tower Operator app and the Loco Operator app. Loco Operator is intended for driving locomotives and the features that allow control of switches and power are rather primitive, so in this section we will concentrate on setting up the WUFP-40 units and the WFS-46 switch machine controllers using Tower Operator.

First Steps – Installing the Tower Operator App

Having wired our WUFP-40 modules and connected power, we first want to make sure they operate correctly using Tower Operator app. Tower Operator is available from the Windows App Store, for Windows 10, or the Google Play Store, for Android.

Windows 10 Installation

(1) On your Windows 10 Machine click on the URL below which should go straight to the Microsoft Store for Tower Operator:
https://www.microsoft.com/en-us/store/p/tower-operator/9np2zh4gp1j5

(2) Alternatively, on your Windows 10 computer click on the Start Button and click on Microsoft Store

Figure 8 Microsoft Store

(3) The store allows you to search for Tower Operator – once you have found its picture in the search results, click on it and it should show the same screen as below

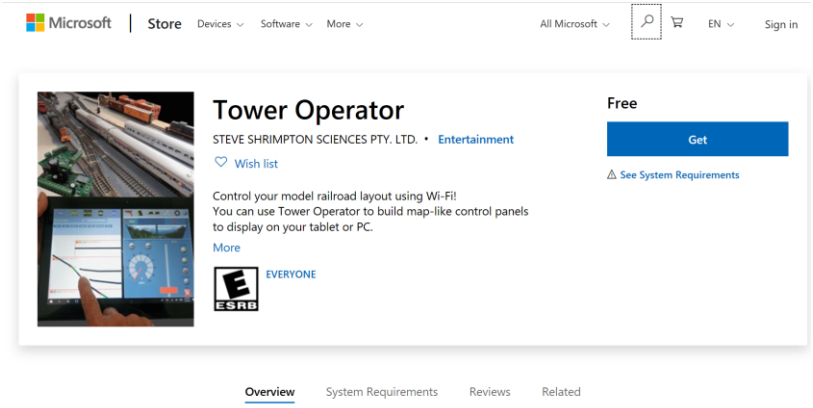


Figure 9 Tower Operator in the Microsoft Store - the Google Play Store is similar

(4) To install the app, click on the Get button or Install button as displayed. The app will then download and install on your machine, giving you an option to Launch it, which you accept. The splash screen should display as below, followed by the screen requesting that you scan for Wi-Fi networks.

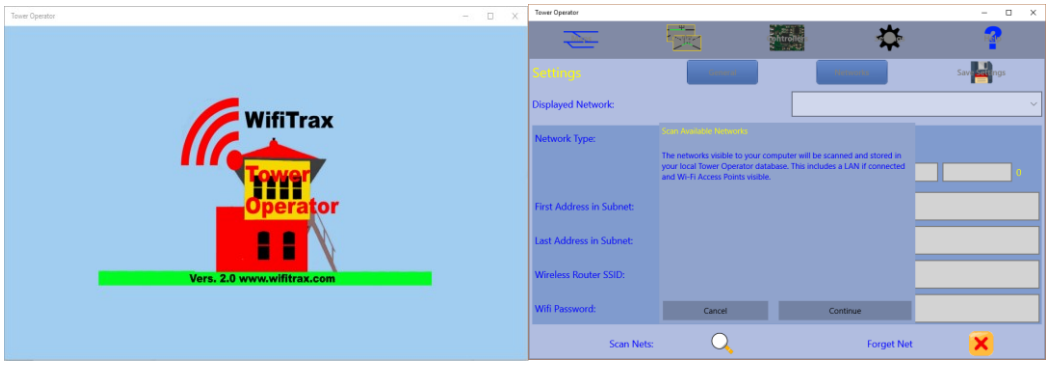


Figure 10 Tower Operator Start-up

(5) Click on Continue. This will scan the networks that are accessible to your computer including any nearby Wi-Fi access points, and perhaps a LAN or Bluetooth connection.

(6) The result should be something like the screen below. This is the Networks page of the Settings screen. In this case our lab Wi-Fi infrastructure network is showing which happens to be called SSSWireless. You can find general help for Tower Operator from the Help Pages on our website: http://www.wifitrax.com/help/towerOperator/help.html but for now, you might want to continue with these instructions.

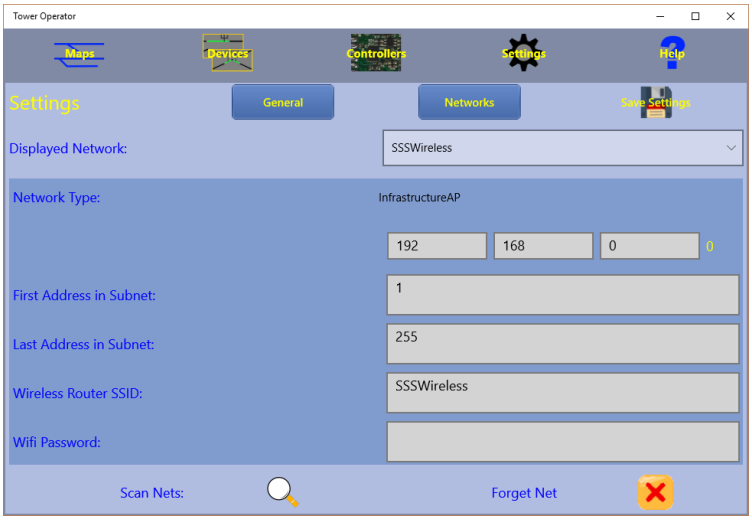
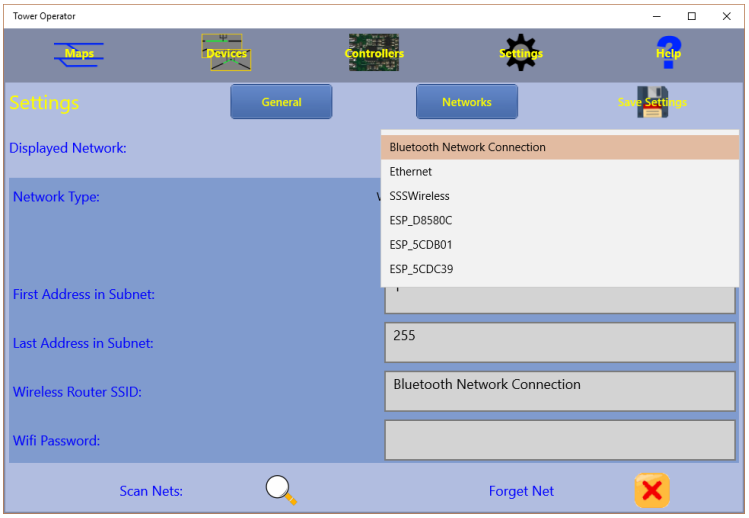


Figure 11 Network Scan Completed

(7) You can see all of the networks that were found by clicking on the "Displayed Network" drop-down list:



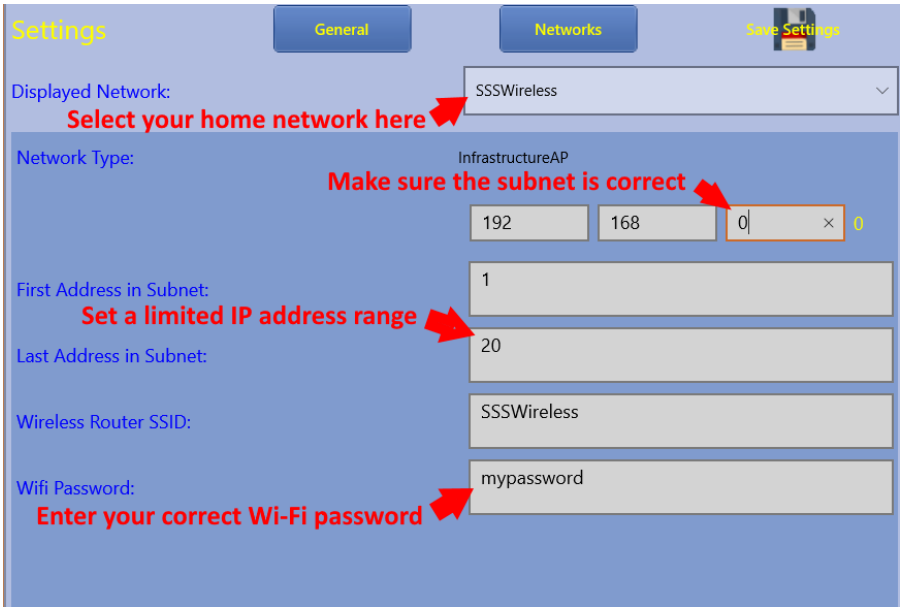
By selecting one of these, you can see and modify its details on this screen. These networks include a Bluetooth connection which is not relevant, an Ethernet connection, SSSWireless – the local infrastructure network – for you it will be your home Wi-Fi – and also a lot of networks beginning with "ESP_". These are the controller networks for your installed WifiTrax controllers. In this example there are three, two WUFP-40 modules and one WFS-46 module. They are Wi-Fi access point that your computer can connect to.

Setting up your Home Network in Tower Operator

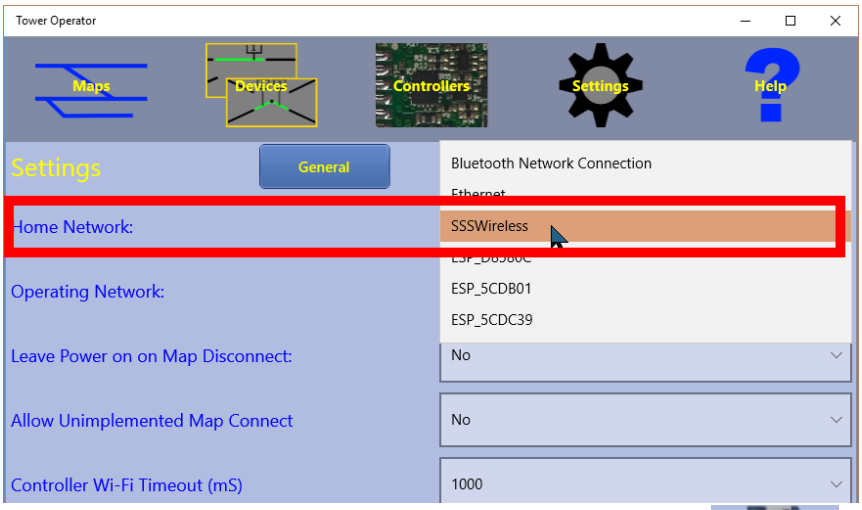
(8) The first thing you need to do is select the network that represents your home Wi-Fi (in this case SSSWireless) and set the values on the screen correctly, so that when all your modules join your home network they will communicate properly.

a. First select your home network in the Displayed Network drop-down list,
b. Then check the subnet. Most routers are set up with the subnet as shown, but yours might be different. It will be the first three numbers of your computer's IP address.
c. Set a limited IP address range for your model railroad network. Most homes do not have as many as 20 devices so 1 to 20 is usually enough.

d. Enter your Wi-Fi password. This is the one you need to enter when connecting a new device like a phone to your home Wi-Fi network. If you don't know it, it's probably somewhere on the router supplied by your telco.



(9) Click on the General button to go to the General Settings page. Select your home Wi-Fi network in the Home Network drop-down list. This is the network that will be sent to each controller when you configure them to attach to your home infrastructure network.



When you have done all this, click the Save Settings button 

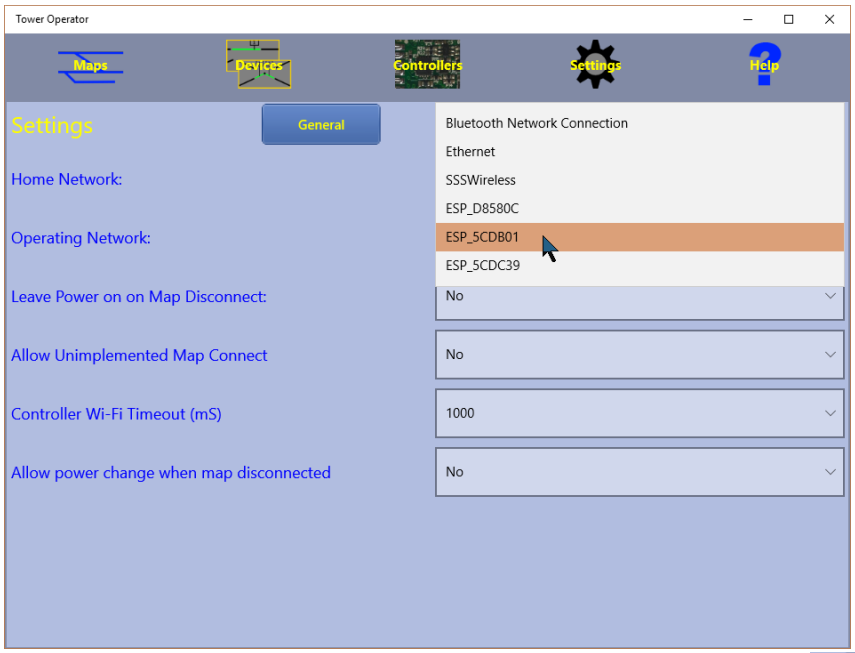
, accept the privacy statement about your password, and OK on the popup response. You have set up your networks, now you need to set up your first controller.

Configuring the First Controller onto your Home Network

(10) **Direct Mode and Infrastructure Mode**: There are two ways that Tower Operator can communicate with a WifiTrax controller: Direct Mode and Infrastructure mode. In Direct mode, you join your computer to the controller's own Wi-Fi access point. This means you can't communicate over Wi-Fi with anything else, but you have to do this at first so that you can tell your new WifiTrax controller how to join your home Wi-Fi infrastructure network. Once you've done that, you can operate in Infrastructure mode, which means your WifiTrax controllers all connect to your home network and your computer can talk to all of your controllers – in this case three – and other things like your printer and the internet. In these

instructions, we will only stay in direct mode long enough to tell the controllers your home Wi-Fi information.

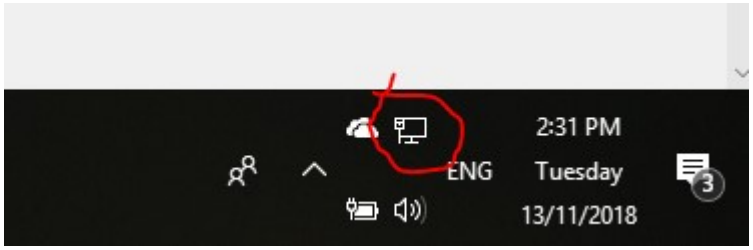
(11)So, to get started in Direct mode, you need to go to the General page of the Settings screen and, in the Operating Network drop-down list, select the access point of the Controller that you want to work with first. You can identify the right network from the AP MAC that is printed on the bag label of your WUFP-40 module. It will be something like 5C-CF-7F-5C-DB-01. The last six characters will match the last six characters of the network – in this case ESP_5CDB01.



Once you have selected the network, click the Save Settings button 

and OK at the popup response.

(12)Now you must connect your computer to the same Network. **This is done outside of the Tower Operator app, using your computer's network settings**. In Windows 10 the best way is to click the Networks icon in the system tray at the bottom right of the Windows screen:



This brings up the list of networks visible to the computer which should include, in this case, ESP_5CDB01. Click on this and then check the Connect Automatically option, then click Connect. It's also a good idea to temporarily disable Connect Automatically for your other Wi-Fi networks. This stops your computer from going back to its old network if you should cycle power on your WifiTrax module. You'll need to go back and recheck this for your normal network when you are done with working in direct mode. Figure 12 shows this.

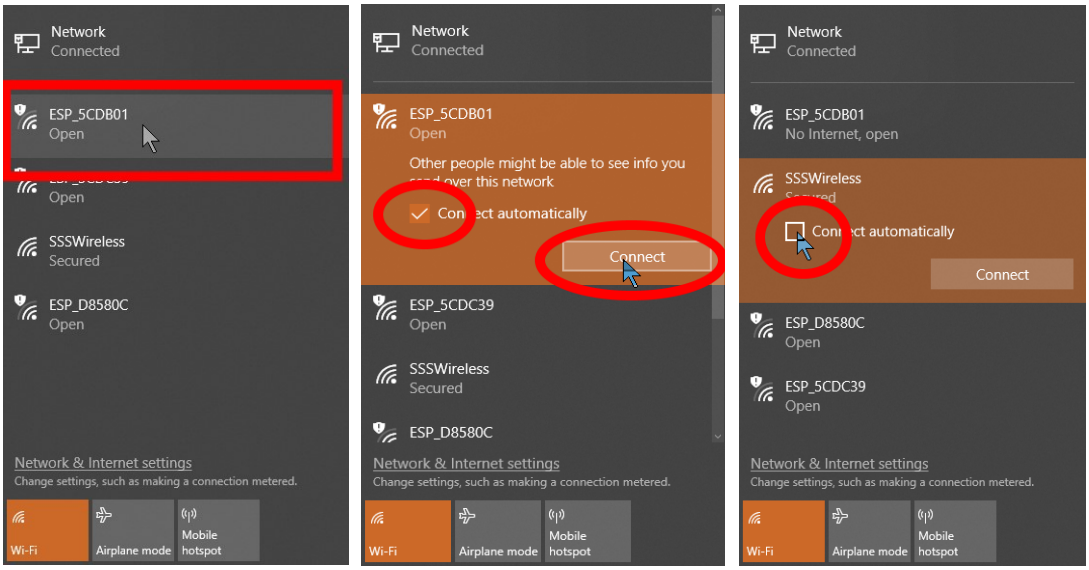
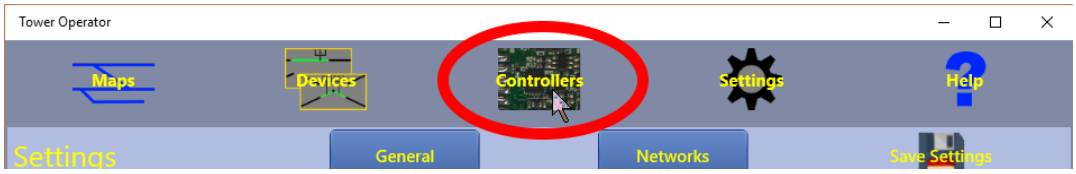


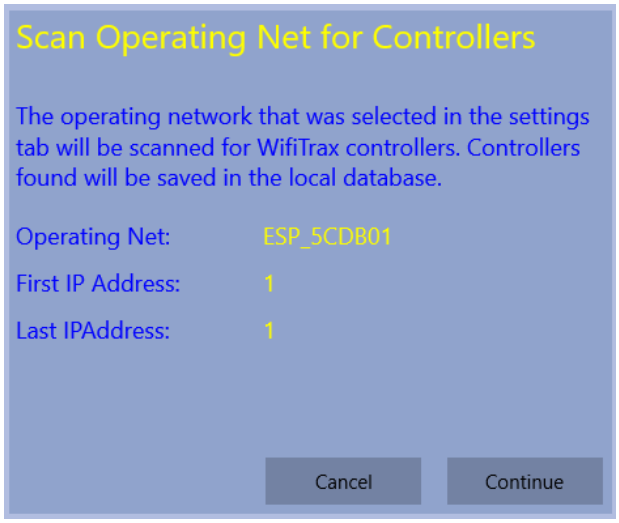
Figure 12 Connecting your Windows 10 Computer to the Controller Network ESP_5CDB01

(13)Once this is done, go back to the Tower Operator app and select the Controllers screen



The Controllers screen allows you to scan the operating network for WifiTrax controllers. Since you have set the operating network to the WUFP-40's own private network, there will only be one IP address to scan and one controller visible. Click the Scan button 

, then Continue on the popup:



Your Controllers screen should now show just one controller, as in Figure 13, the WUFP-40, whose network you joined.

Figure 13The WUFP-40 Controller Present on its own ESP_5CDB01 Network. Transfer the Home Network Information to this Controller.

The important thing to do now is click on the Set Home Net button. This will tell the controller two things: the name of the infrastructure network to join, in this case SSSWireless, and the password needed to connect to that network, in this case "mypassword". Of course, your values will be different! When you've done this, those values should look like below:

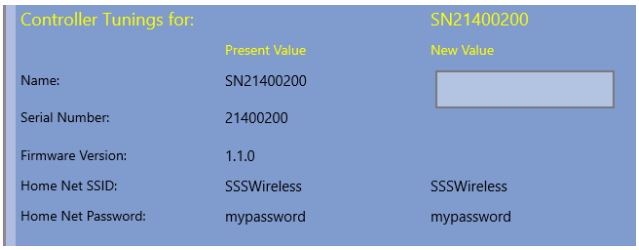


Figure 14 The Home Network Information has been Successfully Transferred to the Controller

(14)If you only had one WUFP-40 and were happy to always connect your tablet just to its Wi-Fi network and nothing else, you could continue in direct mode. You can also use Loco Operator in direct mode and operate a simple train set for as long as you like. However, for the example described in this document, there are three WifiTrax modules and your tablet with Tower Operator installed need to deal with all of them, therefore you need to go back to the General page of the Settings screen and select your home Wi-Fi network as the operating network.

(15)Next go back to the Network Settings of your computer as you did in (12) and connect back to your home network.

(16) Now go to the Controllers screen and do a scan on your home network. You should see the controller, similar to Figure 13, but now operating as a station on your home infrastructure network.

Configuring the remaining Two Controllers onto your Home Network

Our example layout, Sunny Valley Railroad, has three WifiTrax controllers: two WUFP-40 and one WFS-46 to control its eight power blocks and six switches. Therefore, we must go through the procedure described above twice more, so that two more controllers are added to your home network.

Remember in each case to select the controller's network – as shown on its bag – as the operating network, and also to temporarily connect your computer to the same network before you scan for, and configure, each controller.

Viewing and Naming the Sunny Valley Railroad Controllers

Once this is done, ensure your home network is the selected as the operating network and that your computer is connected to your home network – remember my home network is SSSWireless.

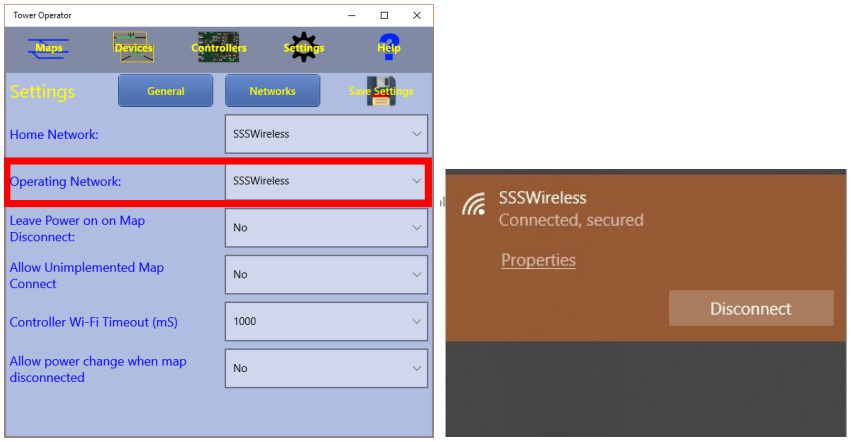


Figure 15 Returning to Operate on the Home Network

Then select the Controllers Screen and perform a scan to make sure all controllers are accessible.

You should see a list of three controllers in the top part of the Controllers screen as below:

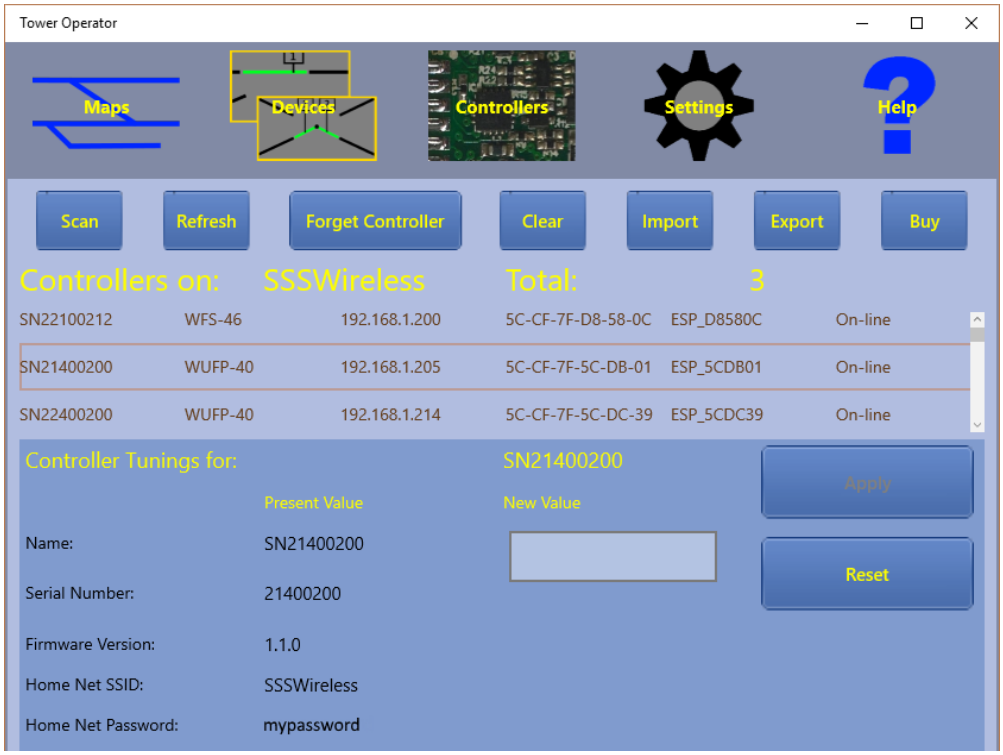


Figure 16 All of the Sunny Valley Railroad Controllers on the Home Network

As expected, there are three, two WUFP-40 and one WFS46. Their names are defaulted to their serial numbers. Details of the selected controller are shown in the Controller Tunings section below the Controllers List. There is only one controller tuning (or setting) that can be changed here, its Name. Let's change those to values that are more useful. Select a controller in the list, type a new name and click the Apply button as below:

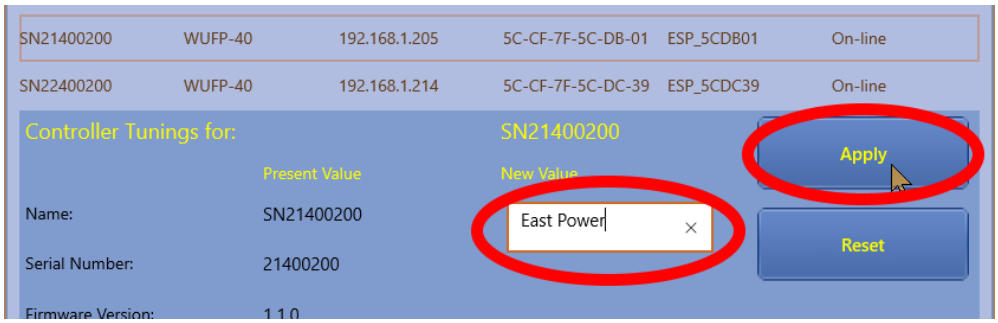


Figure 17 Changing the Name of a Controller

Repeating that for all the controllers, they now have meaningful names as below:

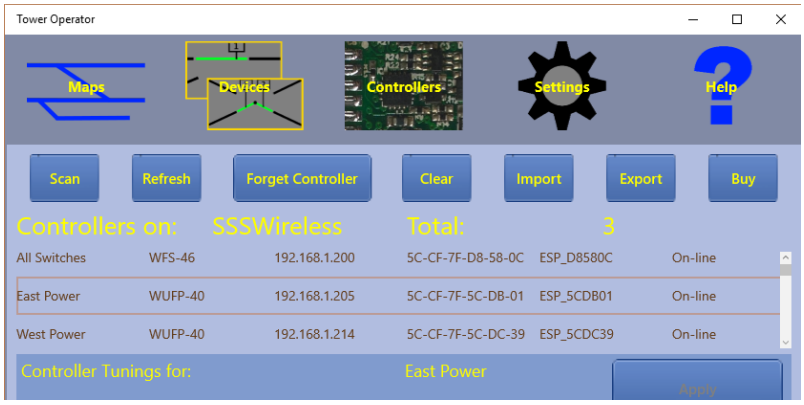


Figure 18 All of the Controllers have been Renamed

Now let's look at the remainder of the Controllers screen. We've already mentioned the Controller Tunings section. Below that is the Controller Capabilities list. Each WifiTrax controller has a set of *Capabilities*. These are things that it is capable of doing, such as control a switch, control a power block, light a lamp or drive a locomotive. Below, the Capabilities List is shown for the selected WUFP-40 controller named East Power:

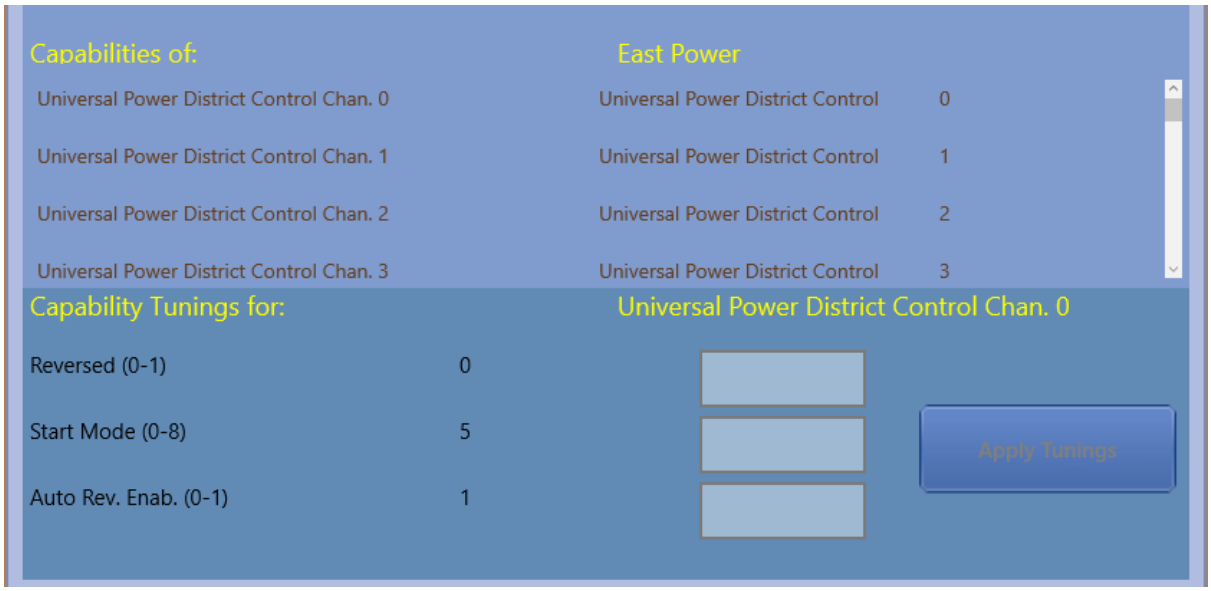


Figure 19 The First Four Capabilities of the East Power Controller

The Capabilities List has a scroll bar and only the first four are visible in Figure 19. These are the Universal Power Districts that the controller can provide, channels 0 to 3. When one of these is selected, it has tunings that can be set, shown in the Capability Tunings section below. There are quite a lot of these and only three are visible. We don't need to worry about these just now, we can come back to them later.

Scrolling down the Capabilities List, we can see the two Locomotive Control Channels as below. Each of these represent the capability to drive a Locomotive on one or more of the power blocks:

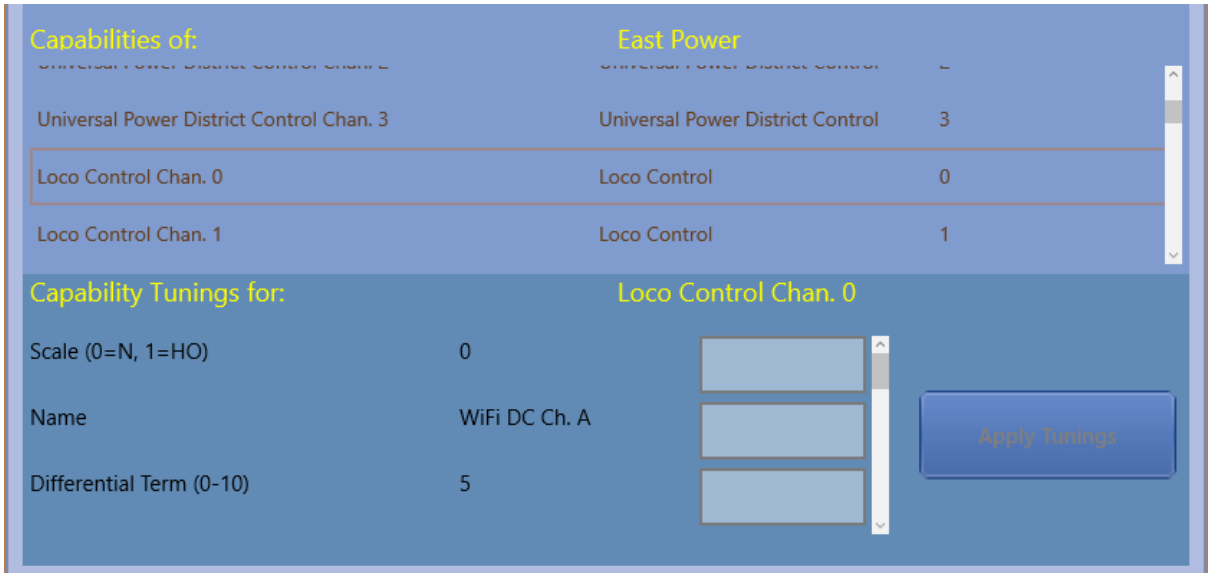


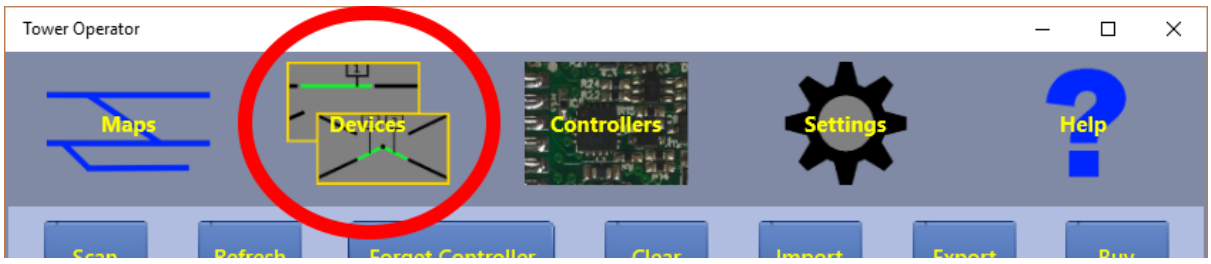
Figure 20 The two Locomotive Control Capabilities

The first two capability tunings are worth a mention. The first is the scale, N or HO. You will need to change this according to the scale of your layout. It is important to have this correct so that the speedometer will show correctly in scale miles per hour. The second is the name which can be changed if you wish. If you change any tunings, you need to click the Apply Tunings button to send the new values to the controller.

Creating the Logical Devices for the Sunny Valley Railroad

Each switch or power block on the model railroad is represented by a logical device that can be placed on a control panel map and provide control. Before we can build a map for our control panel, we first need to create the logical devices – one for each switch and one for each power block.

Click on the Devices Tab at the top of the Tower Operator screen to display the Devices screen:



There are quite a lot of device types that can be created and they are divided into categories.

Creating the Switch Logical Devices

The first Right-Hand Switch

Let's create the switches first. In the Device Category drop-down list, we select the Switches category, then click the New Device button. Looking back at the Sunny Valley track plan we see that we need four right-hand switches and two left-hand switches. There is no distinction between switches of different radius – they appear the same on the control panel maps. There is a special Y switch though and also the more complex double slip switch and three way switch.

So, after clicking the New Device button, the New Logical Device dialog appears. We need to type a name for the device, and the type. Here is the new switch for Windy Ridge Junction, the switch that leads into the reversing loop at the West end of the layout. We've selected RH Switch in the Type drop-down list, given it the name "Wy Rg Jc" and then we click Create.

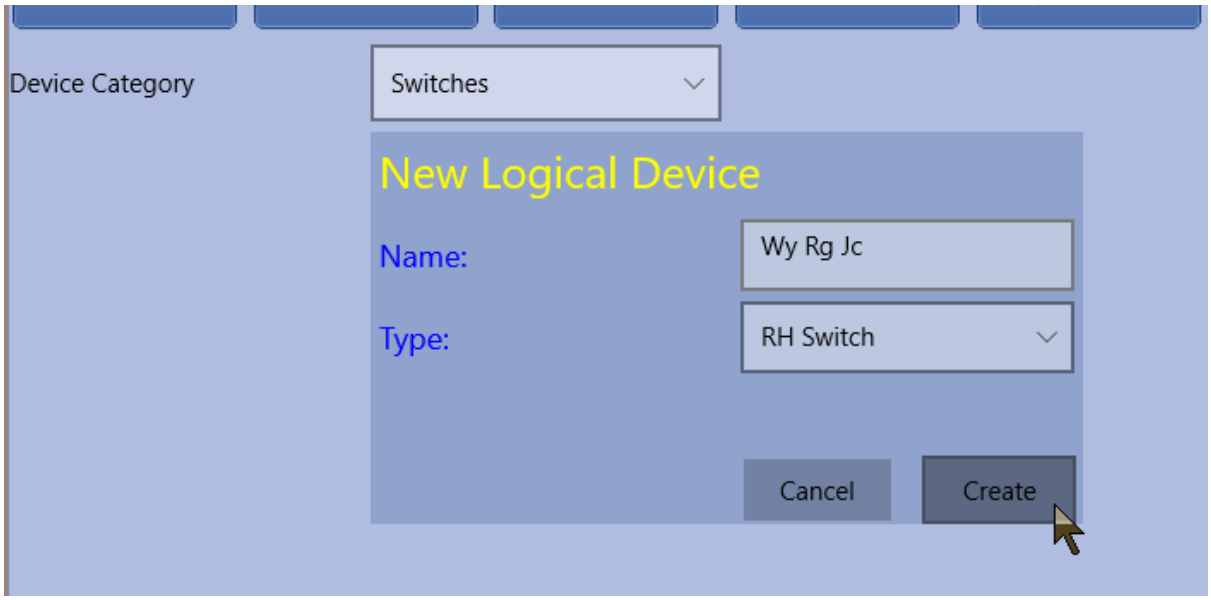


Figure 21 Creating a new Device

The Devices screen now appears as below:

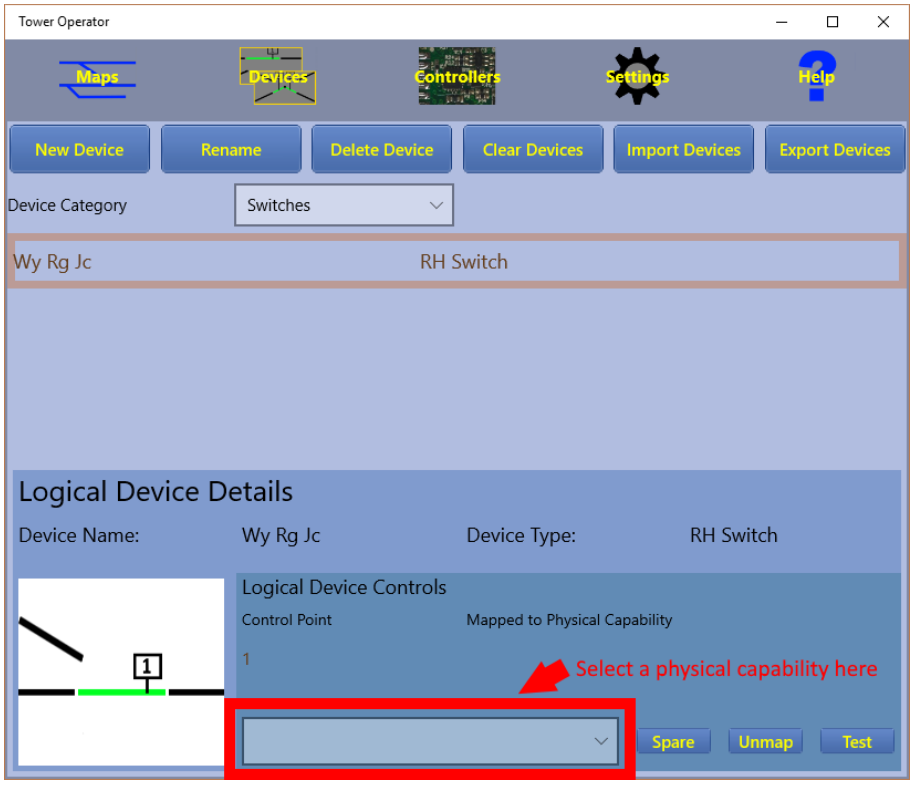


Figure 22 The Devices Screen Showing our First Switch

We've created our right-hand switch and we could now place it on a map for a schematic control panel. But it would not be able to do anything! To make the logical device symbol actually operate a

real physical switch on our layout, we have to assign a *Physical Controller Capability* to the control points on the logical device. Looking at Figure 22, the Logical Device Details section shows the details of the device that is selected in the list of logical devices in the upper part of the screen. At the bottom left of the Logical Device Details section is a schematic image of the device. On this image any *control points* that exist on the logical device are indicated with a number. These control point numbers correspond to a row in the Logical Device Controls List to the right of the image. In Figure 22 we can see that the Mapped Physical Capability column is empty, which means that there is no WifiTrax controller capability allocated to the single control point on the right-hand switch. The control point labelled "1" is of course the tie bar. More complex switches such as double slip, will have two tie bars and hence two control points.

To assign a physical capability to the switch's control point, we simply select a control in the Logical Device Controls list and then select a capability in the drop-down list below the controls.

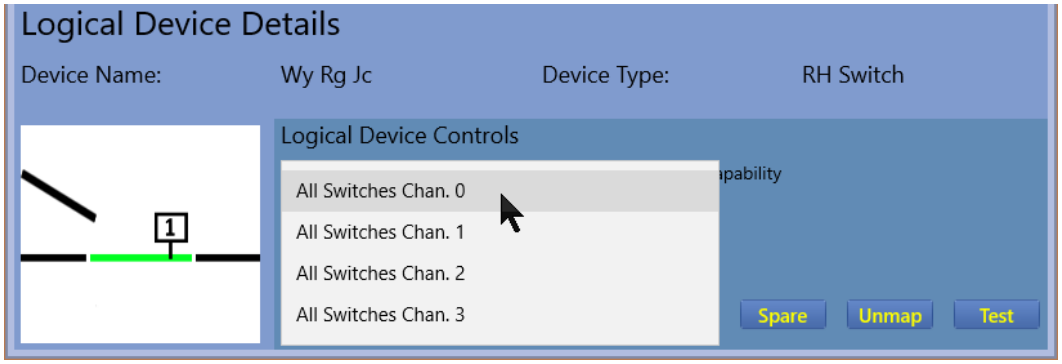


Figure 23 Selecting the Physical Controller Capability for a Logical Device

When we do this, we do need to remember which channel of the installed WFS-46 module is wired to which switch. Here I know that I have connected SW1 output of the WFS-46 to the Windy Ridge Junction switch on the railroad. On the modules the outputs are labelled SW1, SW2, SW3, SW4, but the channels are numbered 0 – 3, so Channel 0 is SW1 etc. Sorry for that confusion! Once you've assigned a physical capability to the logical device, you can test it by clicking the Test button. The switch should operate if the power to the WFS-46 is on and Tower Operator has access to your home Wi-Fi network.

The First Crossover

Let's next create the logical devices for the crossover at Gully Station. Here there are two left-hand switches that can be wired to the same controller switch machine capability as shown in the wiring diagram of Figure 7. We'll call these switches "Gy X Up" and "Gy X Dn". So, on the Devices screen we click on New Device and create, this time, a LH Switch with the name "Gy X Up", then create another with the name "Gy X Dn".

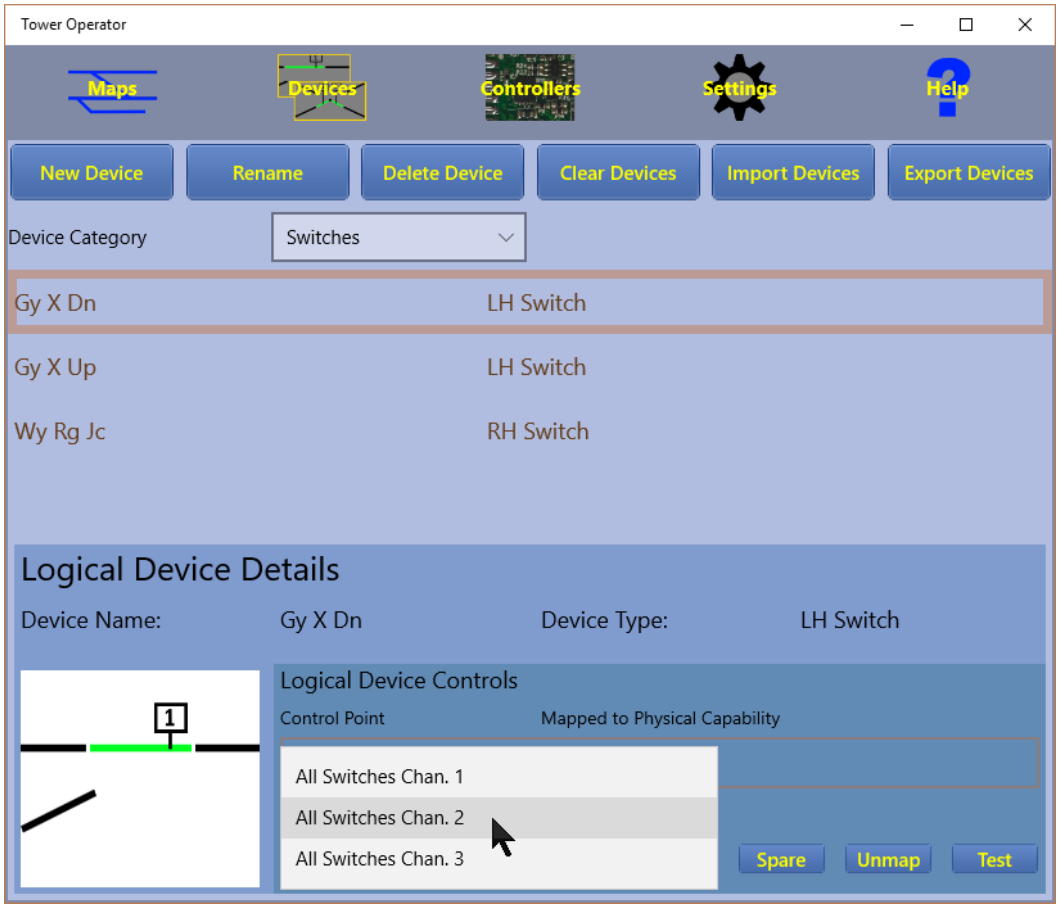


Figure 24 Assigning the Controller Capability for the LH Switch "Gy X Dn"

Figure 24 shows the Devices screen, and this time, we only have three switch machine capabilities to choose from. From the wiring diagram in Figure 7, we know that we wired both the switch machines here to SW-3 on the WFS-46, that is Channel 2, so we select Chan. 2 in Figure 24.

Now we do Gy X Up, and we see only Channel 1 and Channel 3 available as in Figure 25, but we want to assign Channel 2 to this switch also so the two crossover switches operate together. To allow us on this occasion to assign the Channel 2 capability twice, we click on the Spare button in Figure 25 this will toggle to All and all of the switch machine capabilities will be shown – not just the spare ones.

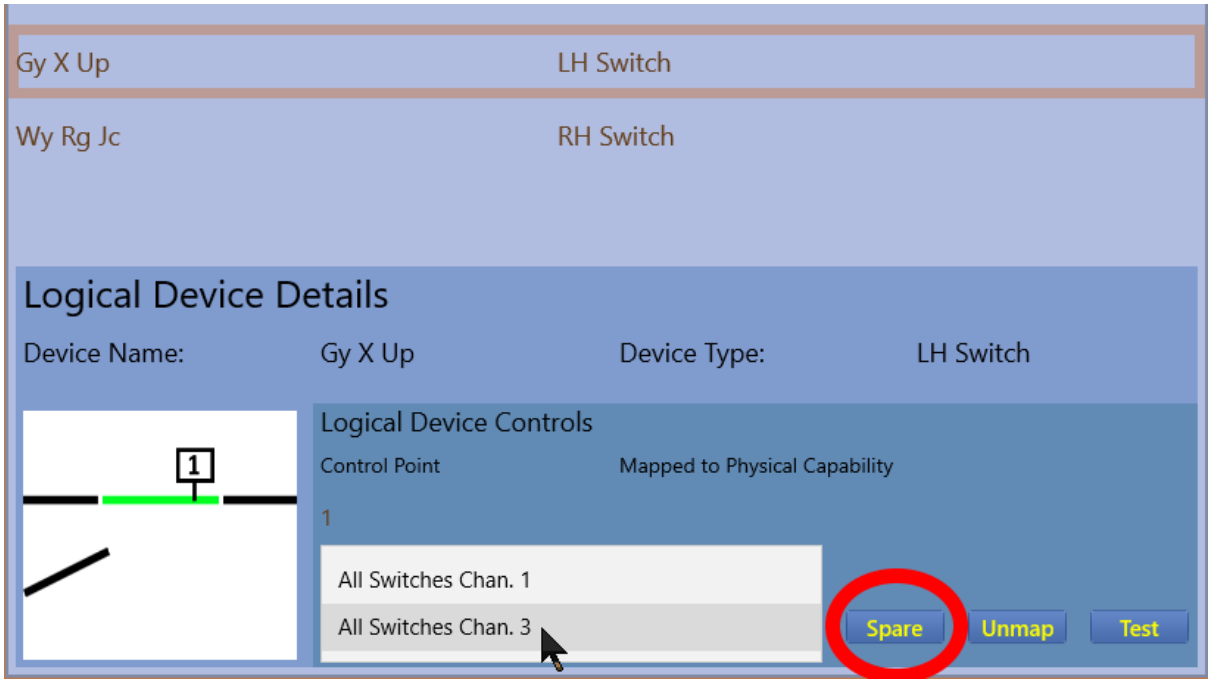


Figure 25 Normally you can only Assign a Capability Once

Once you have done this you can select Channel 2 again as in Figure 26.

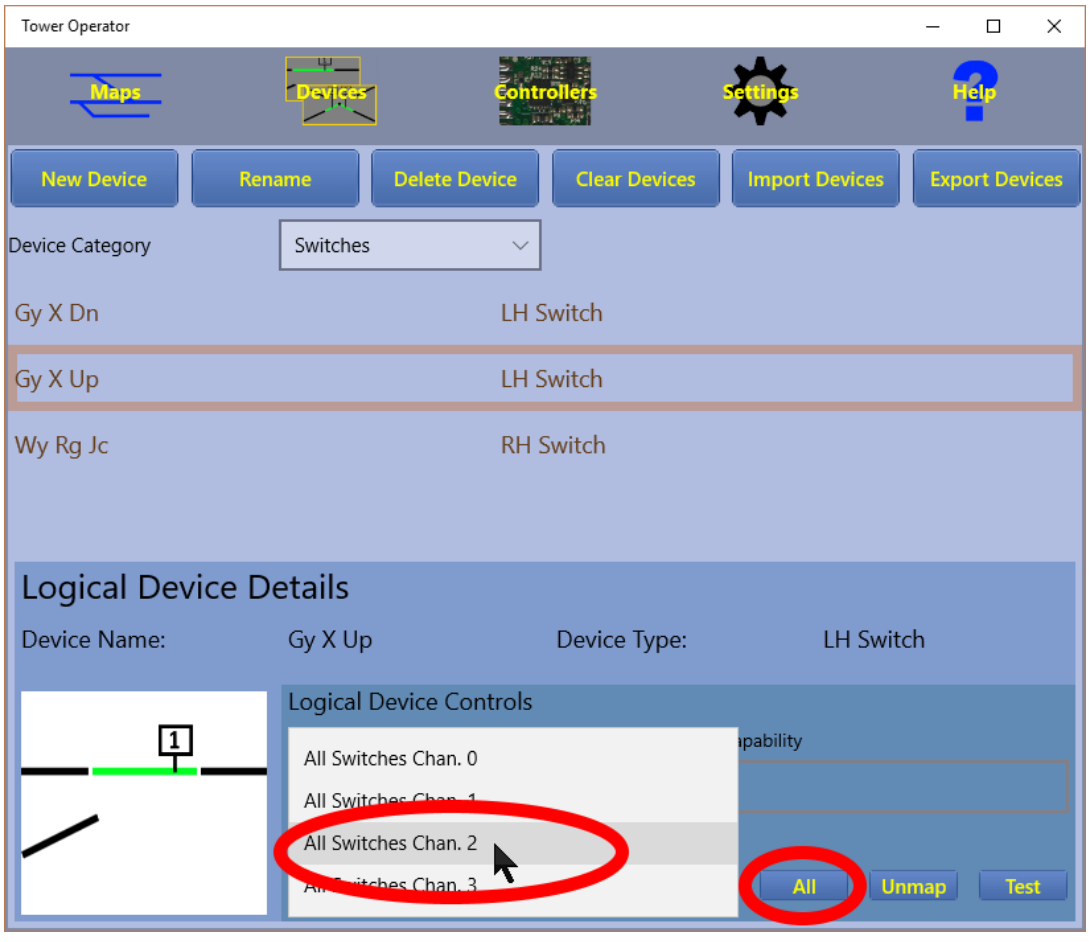


Figure 26 All Button Allows Assignment of the same Capability to Multiple Devices

Now we can go ahead and create the rest of the devices: RH Switch called “Gy W” where the west-bound double track becomes single and the two RH switches at the Eastport crossover, “Ep X Up” and “Ep X Dn”. Gy W is assigned to Channel 1 with Ep X Up and Ep X Dn both assigned to Channel 3.

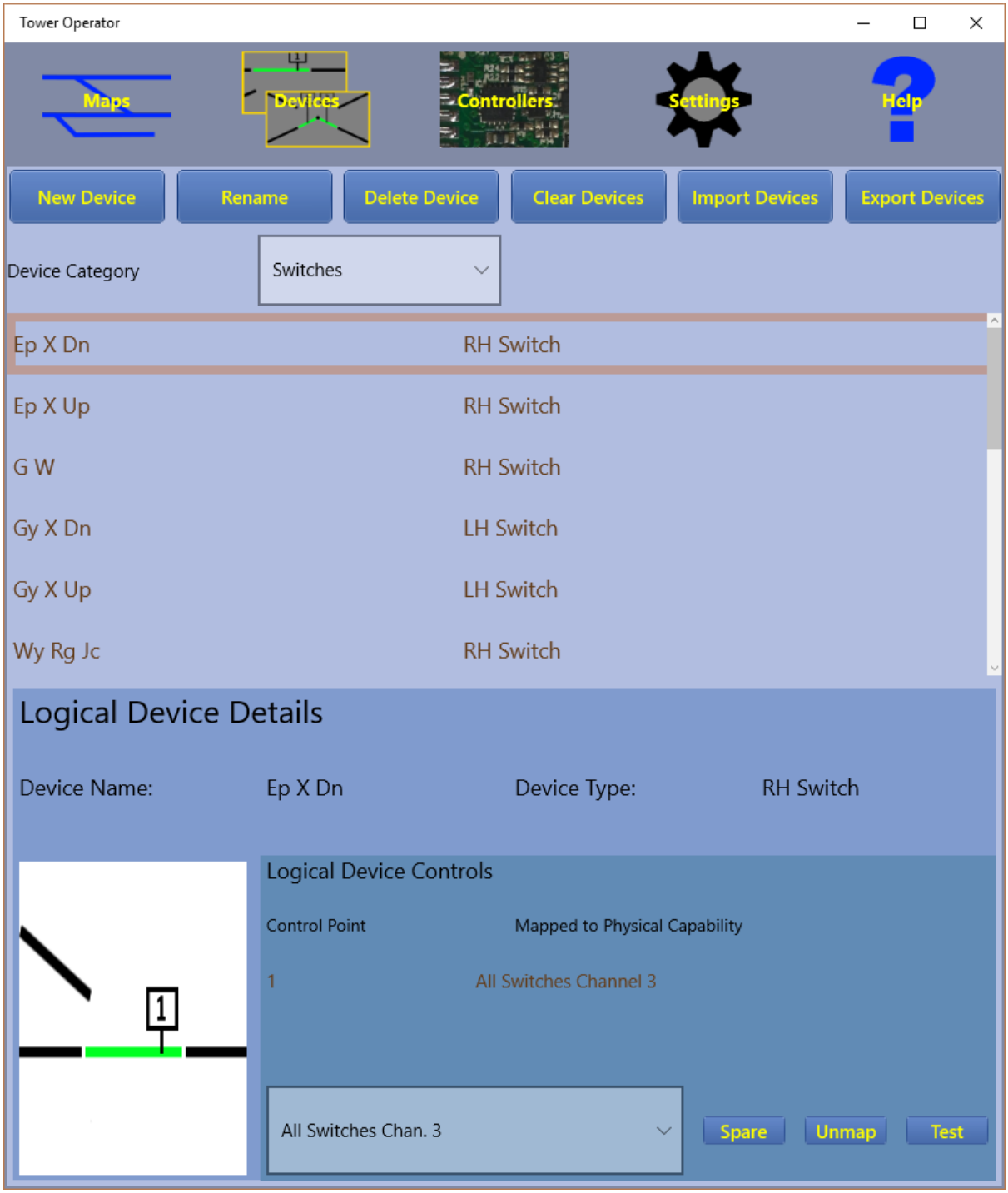


Figure 27 All the Switch Devices have been Created

The resulting list of switch logical devices appears as in Figure 27.

Creating the Power Block Logical Devices

The Sunny Valley Railroad has eight power blocks connected to channels of two WUFP-40 modules. Therefore, we need to create logical devices that we can place on the maps that form schematic control panels. These logical devices will provide control of these blocks and display their status.

To create these, we go to the Devices page and select the Power device category, then click New Device to get the dialog in Figure 28. This will be the westernmost power block which we will call Summit. We select a Universal Power District, since that is the type that expects a channel of a WUFP-40 as its assigned capability.

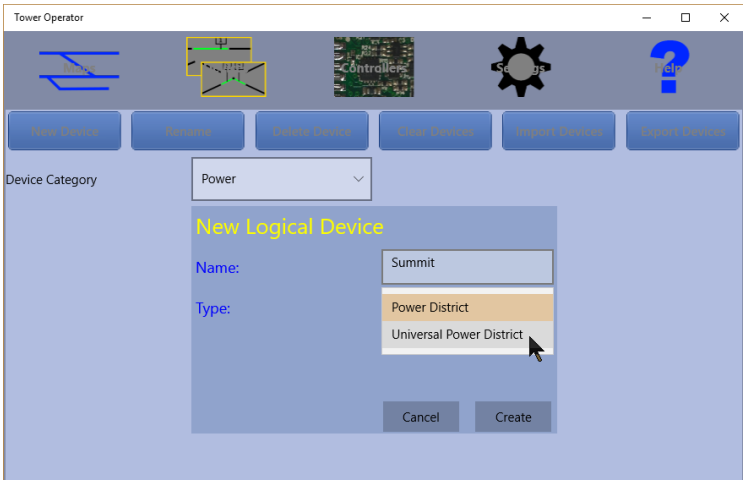


Figure 28 Creating a new Universal Power Block (or District)

Clicking Create, makes the new power block appear in the Logical Devices List. It has one control point and we can assign it to any of the spare channels provided by the two WUFP-40 modules. We choose West Power Chan. 0, as in Figure 29 since the wiring diagram connects the westernmost block to Block 1 of the WUFP-40 named West Power.

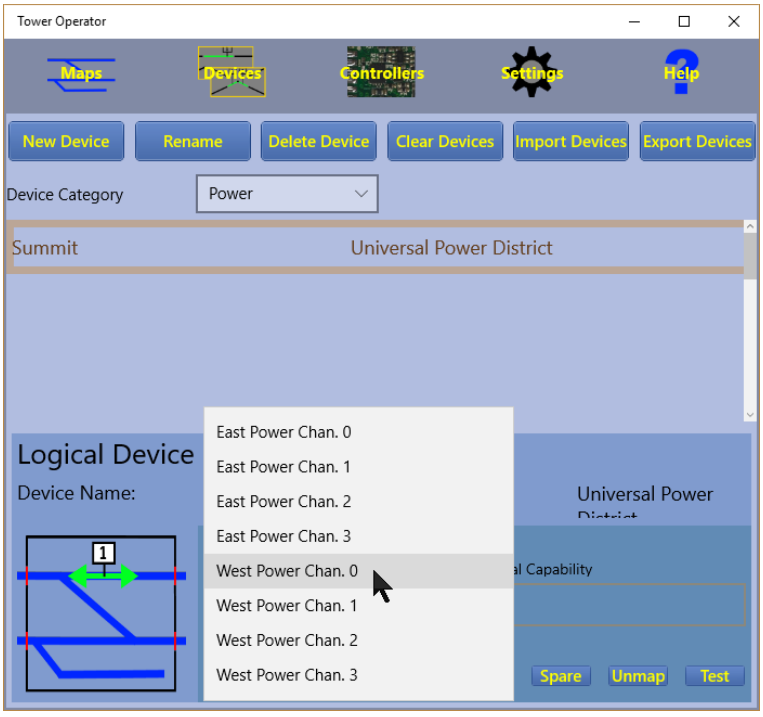


Figure 29 Select the Correct Physical Capability for the Summit Block

We can continue creating seven more similar power blocks with the names Wy Rdg, Gully Up, Gully D, Sunny Up, Sunny Dn, Ep Up, Ep Dn. We try to keep the names short to avoid cluttering the control panel maps. The result will look like Figure 30 although not all the power blocks are visible.

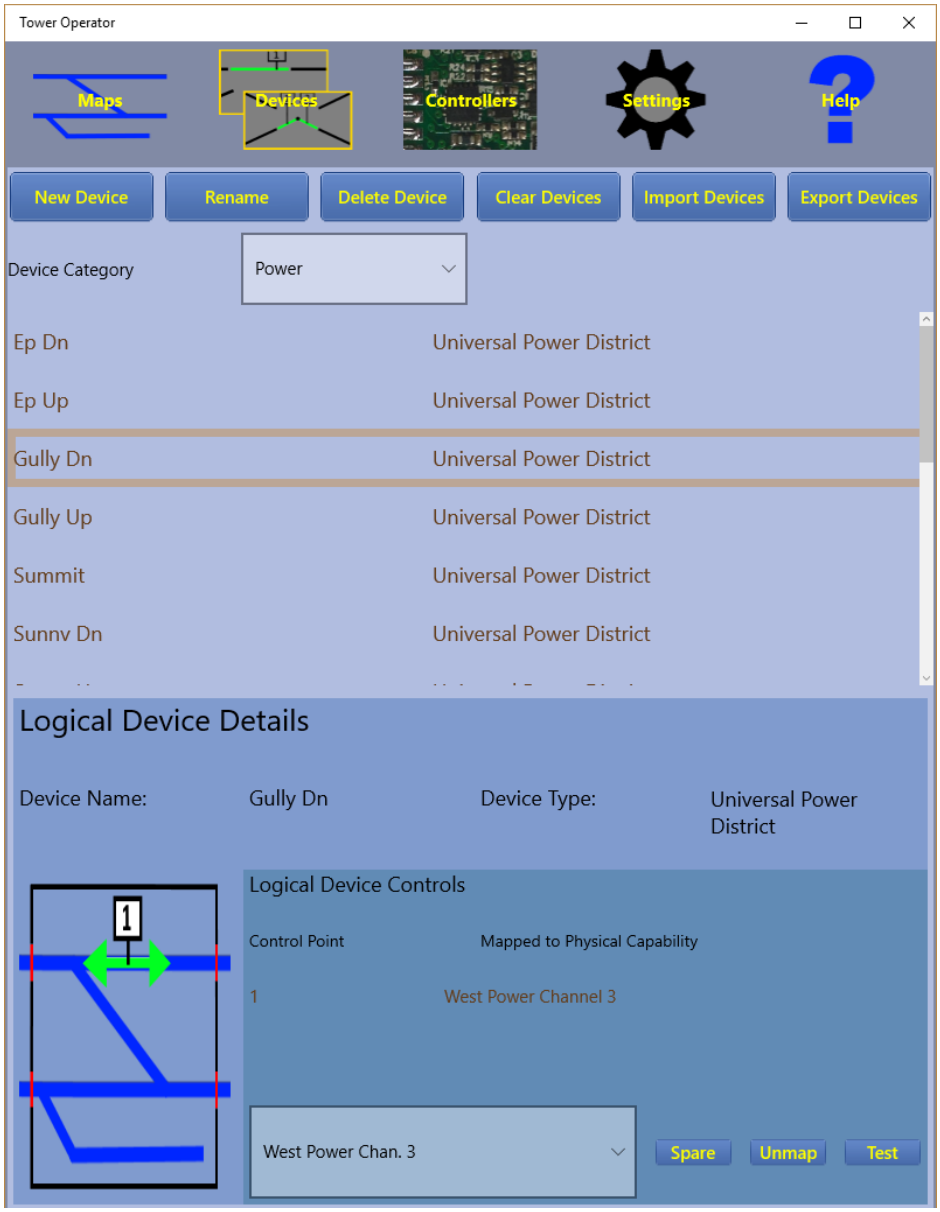
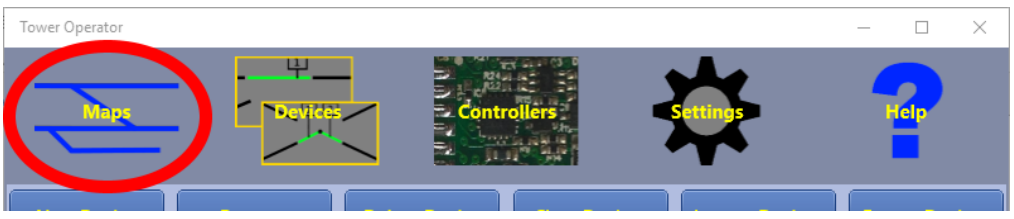


Figure 30 Complete set of Power District Logical Devices

Building the Schematic Control Panel Map

We can use the logical devices we have created in any set of schematic control panels we choose to create. We can have one control panel for the entire layout, or several representing different parts of the layout. For simplicity we will create one. First, we select the Maps screen:



Next, we click the New button and, on the dialog, give it the name we require and click Continue.

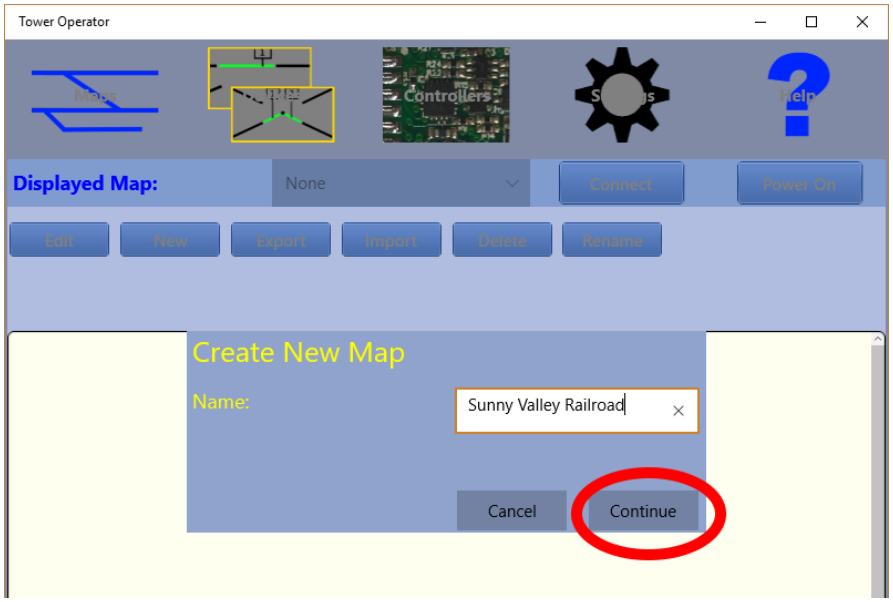


Figure 31 Creating a New Map

When the new empty map is displayed, we need to click the Edit button and start adding logical devices to it together with other static features such as track and buildings.

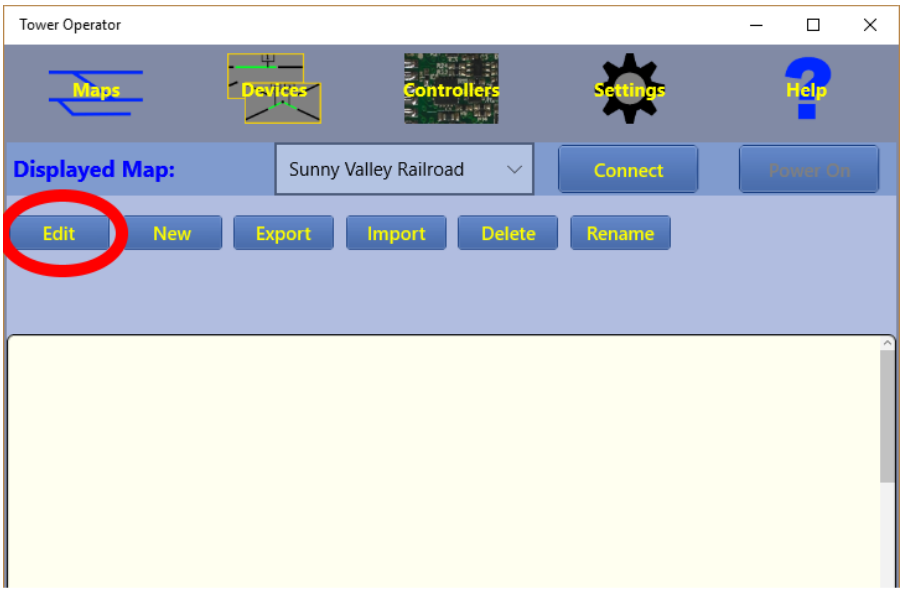


Figure 32 A New, Empty Map

Once we have begun editing the map, the Edit Toolbar appears as in Figure 33. Also, there are two toolboxes at the left, the Static Features toolbox at the top left and the Logical Devices toolbox at the bottom left. You can add items from these toolboxes by first clicking on them and then clicking on the map. You can only add a logical device once to any given map, but you can add static features as many times as you like.

The full details of the map editing capabilities are explained in the Tower Operator Help Pages:

http://www.wifitrax.com/help/towerOperator/help.html#maps

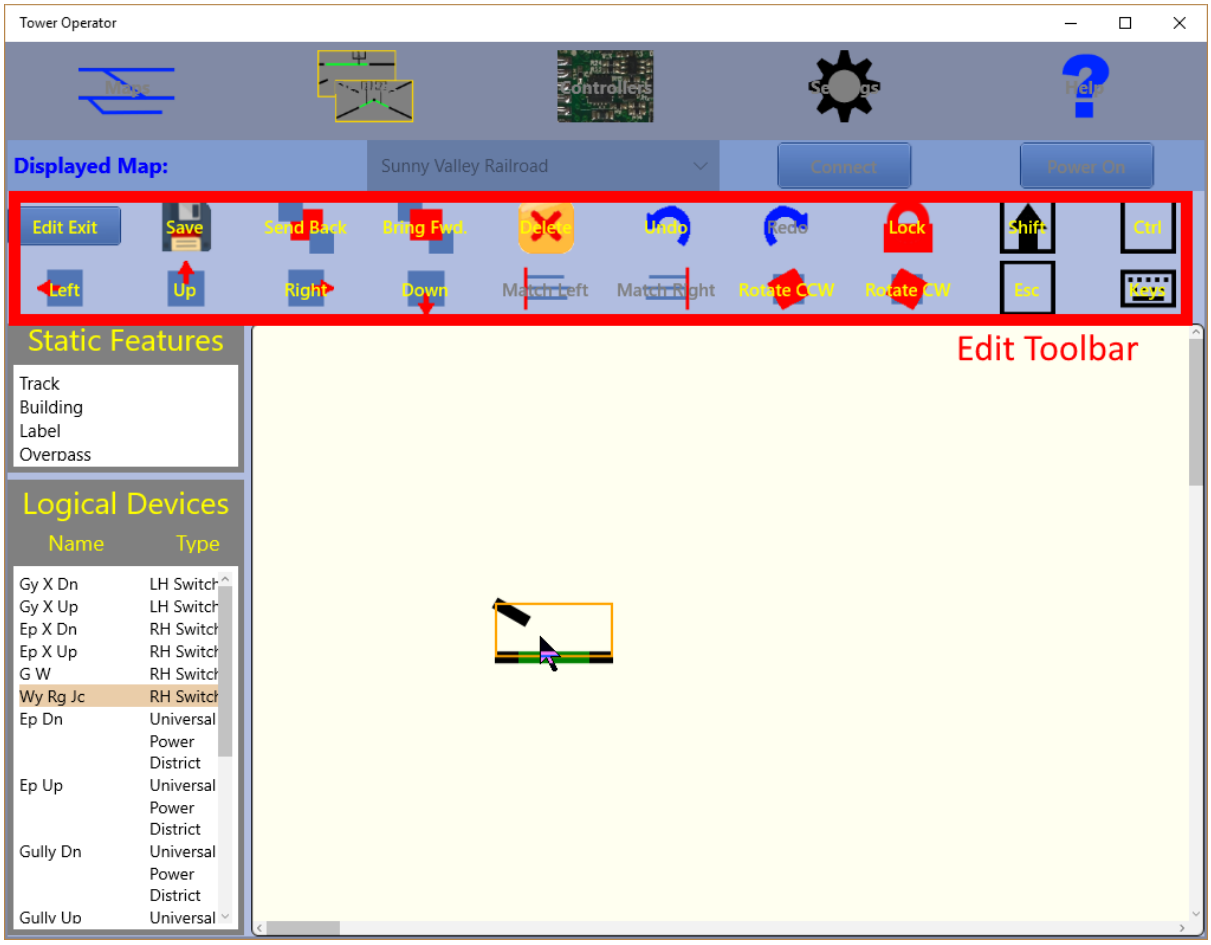


Figure 33 Adding the Windy Ridge Junction Switch to the new Map

Once an item has been placed on a map, you can drag it around and join it to other devices or track. When entry or exit points of switches are brought close to similar points on other switches or to the ends of tracks, they will snap together. Check the Help pages for details.

Continue adding the switch logical devices to the map to represent the railroad. You can rotate switches by 90 degrees by selecting the switch on the map and clicking the Rotate CW or Rotate CCW buttons. You can rotate by a smaller angle by clicking the Shift button or holding down the shift key before clicking a rotate button. As a tip, you can make sure switches line up by snapping them together then using the left or right arrow keys on your keyboard. The nudge buttons Left, Up, Right and Down will also move by a fixed amount. Holding down shift key or clicking Shift will make the nudge amount smaller. Figure 34 shows the map with all the switches in place. Click the Save button. Now we can place the track.

Track is a static feature but you need it to make your schematic clear and it also serves to define routes that can be discovered by the software.

Add a track by clicking on the “Track” line in the Static Features toolbox, then clicking on the map to place it. Once a track is on the map, you can drag its ends to snap to an entry or exit point on a switch.

When you have added all of the tracks as in Figure 35. Click the save button.

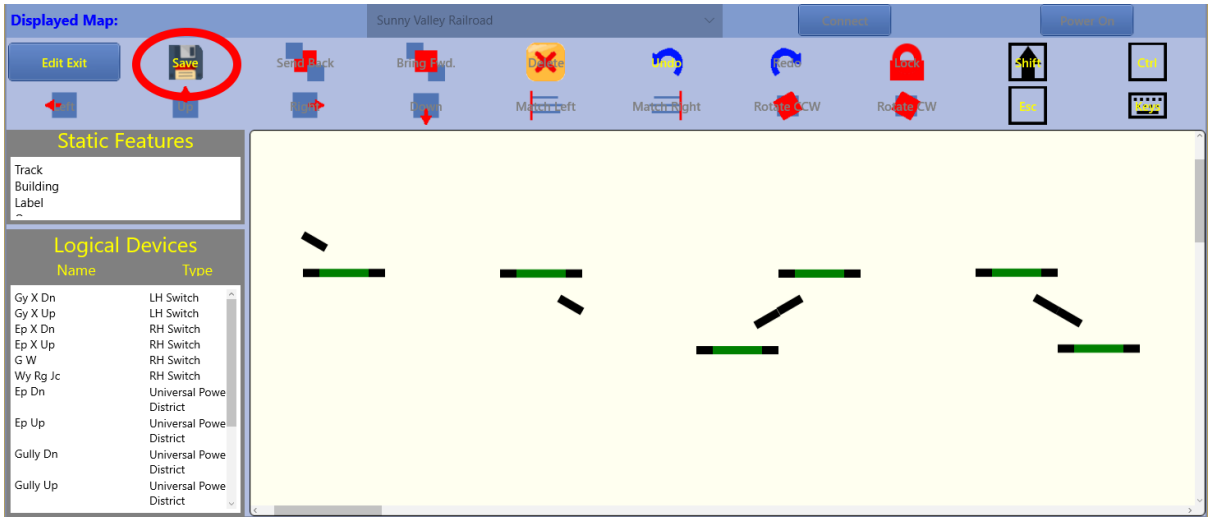


Figure 34 Now the Switches are all Approximately in Place.

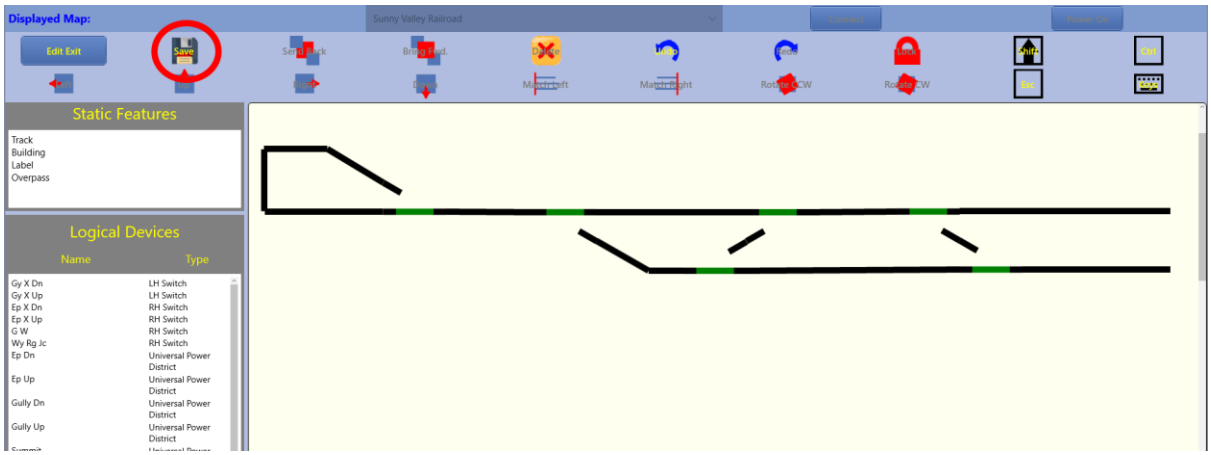


Figure 35 Now the Tracks have been Added to Join the Switches

Next, we can add the power blocks (or districts), again by selecting them in the Logical Devices toolbox and placing them on the map. Once placed, they can be moved by dragging or resized by dragging any of the grab points. It's best to try to arrange the power blocks so that the buttons and numeric displays at the top are well above any track or switches in the diagram to avoid obscuring the track.

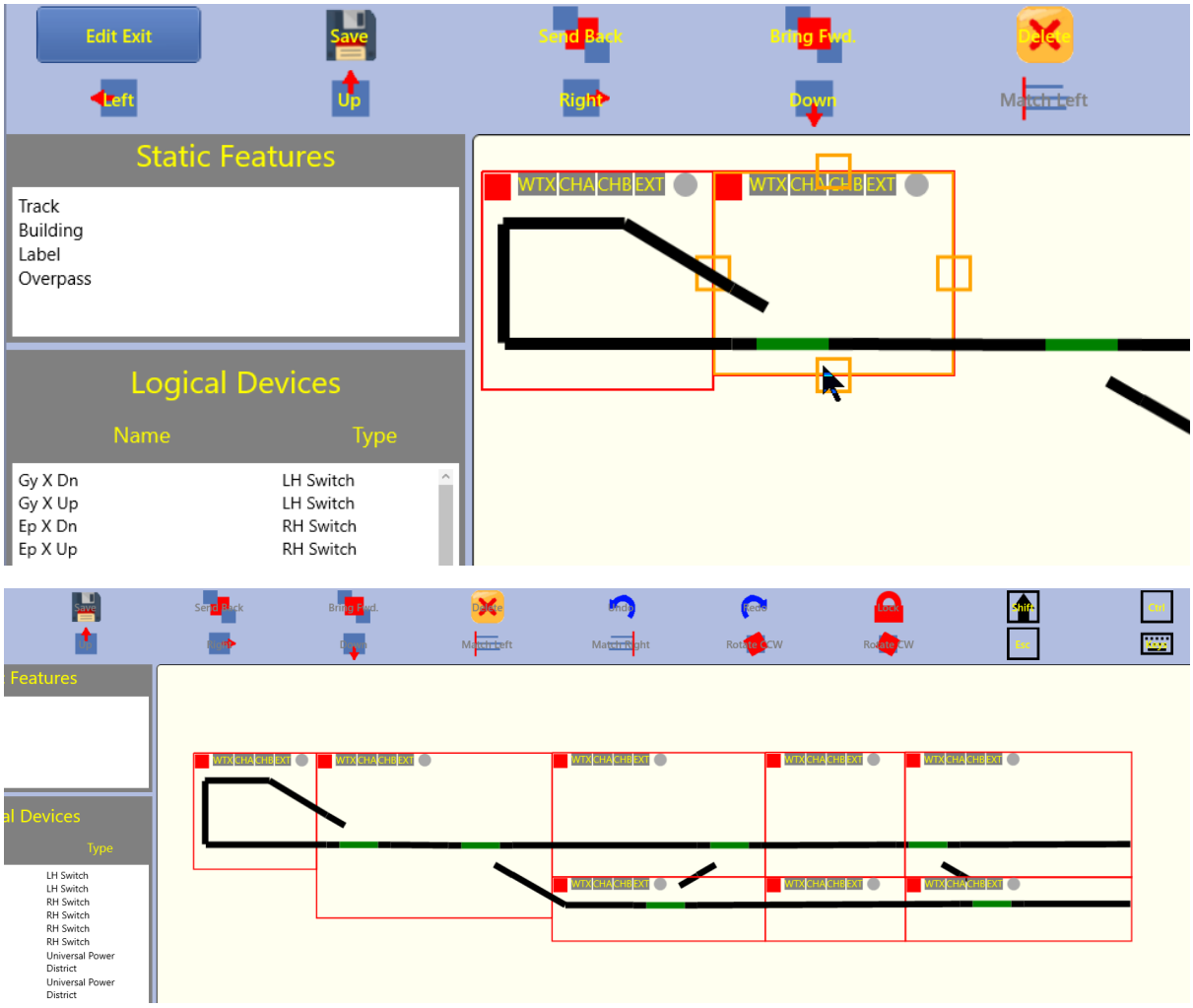


Figure 36 All the Switches, Track and Power Blocks are Complete

Figure 36 shows the map with all the Switches, Track and Power Blocks. Finally, we add some buildings to represent the stations and also some labels. When you have finished click Save and Edit Exit. The map then loads in run mode as in Figure 37.

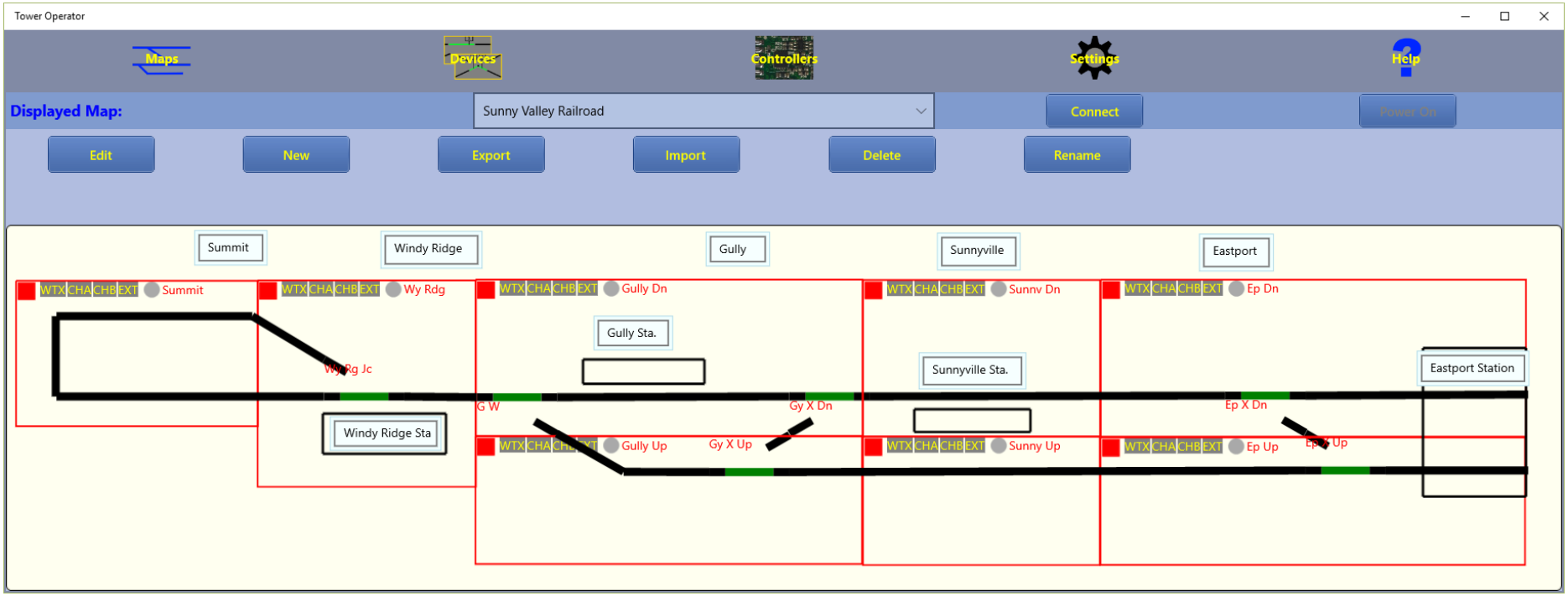


Figure 37 Completed Control Panel Map in Run Mode

Running the Wi-Fi DC Model Railroad

Connecting to the Layout

To connect the Schematic Control Panel in Figure 37 to your physical layout, click the Connect button above the map itself. To do this, you need to have power to all of the controllers and have all of the devices on the map assigned to controller capabilities. When you click the Connect button, a brief message will display “Contacting all of the controllers in the map” then the Connect button will show green and clicking it again will result in disconnection.

Connection Problems?

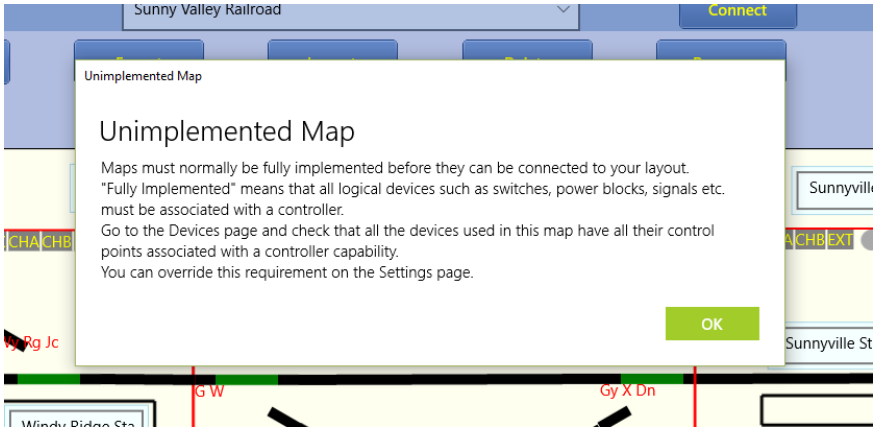


Figure 38 The Unimplemented Map Warning Displays if one or more Logical Devices on the Map do not have a Controller Capability Assigned to them

If you see the message in Figure 38, it means that you have forgotten to assign a physical controller capability to one or more of the logical devices on the map. For example, you may have forgotten to assign a channel of the WFS-46 to one of your switches. Go back to the Devices screen and check by clicking on each device that it is assigned to a controller capability. In Figure 39, a RH Switch has not been assigned to a controller capability. There is an option on the Settings screen, General page to allow you to override this requirement if, for example, you want to test part of your control panel before the layout wiring is complete.

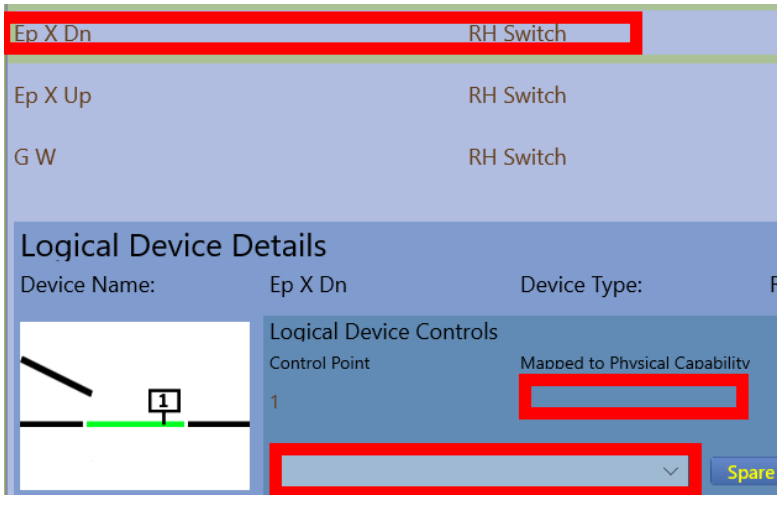


Figure 39 Here a Switch “Ep X Dn” has not been Assigned a Physical Capability on a Controller

Another reason the map may not connect is because a controller such as WUFP-40 or WFS-46 is not reachable on the Operating Network Wi-Fi. This may be due to several causes:

(1) You have the controller powered down,
(2) It has not joined your home Wi-Fi network because its Home Net SSID or Password are incorrect (Check this on the Controllers screen),
(3) It has joined your Home Wi-Fi network but has been given a different IP address to the one it had at first (you can fix this by going to the Controllers screen and doing a new Scan),
(4) You may have disconnected your computer from your Home Wi-Fi network,
(5) Your Wi-Fi router may need to be restarted (try cycling power) – they do seem to need this sometimes! If you do this, it's best to wait a minute, then also cycle power on the layout.

In any of these cases you will see the warning message in Figure 40.

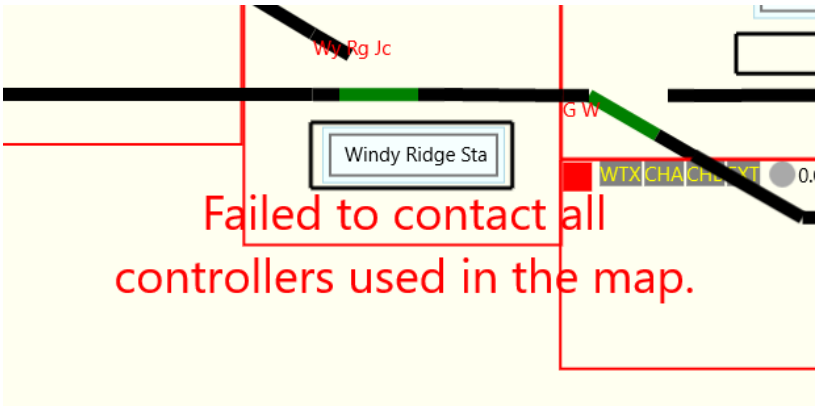


Figure 40 Warning Message when one of the Controllers Cannot be Reached

Checking the Switches

When your Control Panel Map is connected, you can click on each switch in turn to make sure it operates correctly. You need to check that clicking on a switch on the map causes the correct switch to operate on your layout. You also need to verify that the switch position (straight or thrown) on the map matches the physical position of the switch. This will only be true if the map is connected.

If the wrong switch operates when tapping a switch symbol on the map, you have likely selected the wrong controller capability for that switch on the Devices screen. Go back and correct it. You must disconnect the map before you can access the Devices screen.

If the switch is actually thrown when the map shows straight – WHEN THE MAP IS CONNECTED, you have two choices:

(1) Go to your layout, power everything down and reverse the connections to the two coils of the switch machine – leave the common one untouched (for a stall-motor or two-wire machine, just reverse the two wires),
(2) If this is not easy, there is another option. Disconnect the map, go to the Controllers screen, select the controller being used for the switch (the WFS-46), and the capability assigned to the offending switch, then change the "Reversed" Capability Tuning from 0 to 1. Click the Apply Tunings button. The switch will then be reversed and the settings maintained in Flash memory in the controller. See Figure 41.

Figure 41 Changing the "Reversed" Tuning Value for an Incorrectly Wired Switch

Turning on the Track Power

When power is applied to the layout, switches and power blocks will each take a default setting. For the WUFP-40, this is a configurable tuning but it is shipped so that its default power up setting is DC CHA. This means that you can start driving a DC locomotive with Loco Operator, in a simple layout, without even using Tower Operator. You can change the power-on block configuration for a WFP-40 using the Start Mode (0-8) Capability Tuning on the Controllers screen (See Table 1 for a definition of these nine values).

When you connect your Map to the layout, the logical devices on the screen will show the current configuration of all the logical devices. So, the switch symbols on the screen will flip to their correct position according to their assigned WFS-46 modules, and the power blocks will show their current settings obtained from the WUFP-40 modules on the layout.

Block Mode Number	Block Mode	Mode Buttons	Description
0	Off	WTX CHA CHB EXT	Power to block is off.
1	WFX UP	WTX CHA CHB EXT	Continuous DC is supplied in the Up direction for WifiTrax Equipped Locos.
2	WFX DOWN	WTX CHA CHB EXT	Continuous DC is supplied in the Down direction for WifiTrax Equipped Locos.
3	EXT UP	WTX CHA CHB EXT	NMRA DCC from the EXT. input is supplied in the Up direction.
4	EXT DOWN	WTX CHA CHB EXT	NMRA DCC from the EXT. input is supplied in the Down direction.
5	CHA UP	WTX CHA CHB EXT	Wi-Fi DC is supplied from on-board controller A in the Up direction.
6	CHA DOWN	WTX CHA CHB EXT	Wi-Fi DC is supplied from on-board controller A in the Down direction.
7	CHB UP	WTX CHA CHB EXT	Wi-Fi DC is supplied from on-board controller B in the Up direction.
8	CHB DOWN	WTX CHA CHB EXT	Wi-Fi DC is supplied from on-board controller B in the Down direction.

Table 1 WUFP-40 Block Power Modes

The modes in which each block can operate is shown in Table 1 and you can set the Start Mode (0-8) Capability Tuning of each of the four block capabilities of the WUFP-40 modules via the Controllers screen.

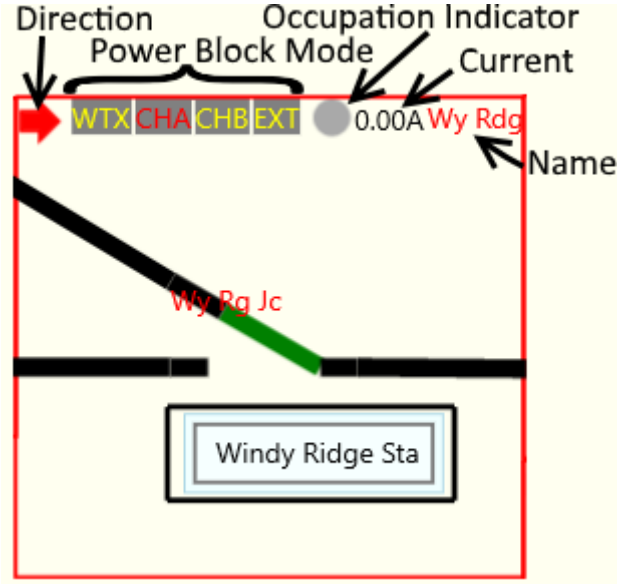


Figure 42 Appearance of a Power Block on a Map

Figure 42 shows the appearance of a power block. At the top left is the direction indicator. You click on this to toggle between Up, Down and Off (Up is to the right). To the right of this are four buttons on which you can click to select the Power Mode. These are explained in Table 1. Turning the block off and on will not change its power mode.

To the right of the power mode buttons is the Occupation Indicator which will show yellow when a locomotive is present in the block, but only when power is on at the block, in any mode. When in Wi-

Fi DC modes (CHA or CHB), a short pulse is sent to the track at intervals, to determine occupancy when the locomotive is not running, which results in brief flashes of the lights and a very faint click. You can change the interval or tun it off if you do not like it, but then you will not see occupancy indication for stationary DC locomotives.

To the right of this again is the Current Indicator that shows approximately the current drawn in amps.

Finally, on the extreme right is the name of the block. When you are designing your map in edit mode, you need to try to leave plenty of horizontal space so that this display does not overlap another block and also make the block tall enough so that these buttons and text do not obstruct track or switches etc. within the block.

The Power On/Off button at the top right of the Map screen turns all the power on or off. When you turn the power off and then on again, the blocks power up in the same Power Mode, but in version 2.0 of Tower Operator, they all revert to the Up direction (left to right). (This may be changed in the next release.)

Please be careful not to switch a block to WTX mode when a DC locomotive is present on it. This will cause the locomotive to immediately run at full speed and may cause a collision!

Before we start using Loco Operator, it is a good idea to rename the Loco Control Channels on the two WUFP-40, so that they can be distinguished. You can do this by going to the Controllers screen in Tower Operator, selecting the East Power controller and its Loco Control Chan. 0 capability. Find the “Name” capability tuning and set it to “East Chan. A” and click Apply Tunings. Set the name of Loco Control Channel 1 to “East Channel B”, and also “West Chan. A” and “West Chan. B” on the second WUFP-40.

Figure 43 Set the Name of the Loco Control Channels

Downloading and Installing Loco Operator

Tower Operator is essentially a CTC system and you cannot use it to drive trains. You must download and install the free app Loco Operator. This is available for Windows 10 at the Microsoft Store:

https://www.microsoft.com/en-us/store/p/loco-operator/9mtb0rbz405f?rtc=1

or you can go to the Microsoft Store in the same way as for Tower Operator and this time search for "Loco Operator".

On your Android device tap on the Play Store icon and search for "Loco Operator", then install – be sure to get at least version 2.2.

(1) Make sure your computer or tablet is connected to your home network.

(2) Start the Loco Operator App on your computer, tablet or phone  ,

(3) On the App, select the Settings Tab  , then the Networks Page  , and Click or Tap the Scan Nets button  . If this is the first time you have run Loco Operator, this will happen automatically – just click Continue on the pop-up. The networks available for your computer will be scanned. Make sure that the settings for your home Wi-Fi network are the same as you made them for Tower Operator in the "Setting up your Home Network in Tower Operator of this document.

(4) Go to the General Page  of the Settings tab,

(5) Click or tap the Home Network drop-down and select your home Wi-Fi network.

(6) Click or tap the Operating Network drop-down and select your home Wi-Fi network.

(7) Click or tap the Save button  and OK on the pop-up.

(8) Select the Locomotives Tab.  Check the network is shown as accessible, then click the Scan button  and Continue on the pop-up.

(9) You should see four "Locomotives" as in Figure 44. They are not really locomotives, but represent four Wi-Fi DC Locomotive Control Channels, two on each of the WUFP-40 modules – the modules were called Wet and East and we named the Locomotive Control Channels East Chan. A, East Chan. B etc.

(10) Go to the Drive Tab  . You should be able to select any of the four Locomotive Control Channels in the Drive drop-down list.

(11) Notice also that Loco Operator Version 2.2 and above has a Layout flyout on the Drive screen. This allows a simple control of switches and power from Loco Operator. If you click on the Layout button, the flyout shows all of the capabilities on the Sunny Valley layout. They are not logical devices as on Tower Operator maps, but the raw capabilities themselves. However, you can name them to remind you what they are so you can quickly flip a switch while you are walking around driving a train. Do this by clicking the Edit button in the flyout, typing new names, then click Done when complete.

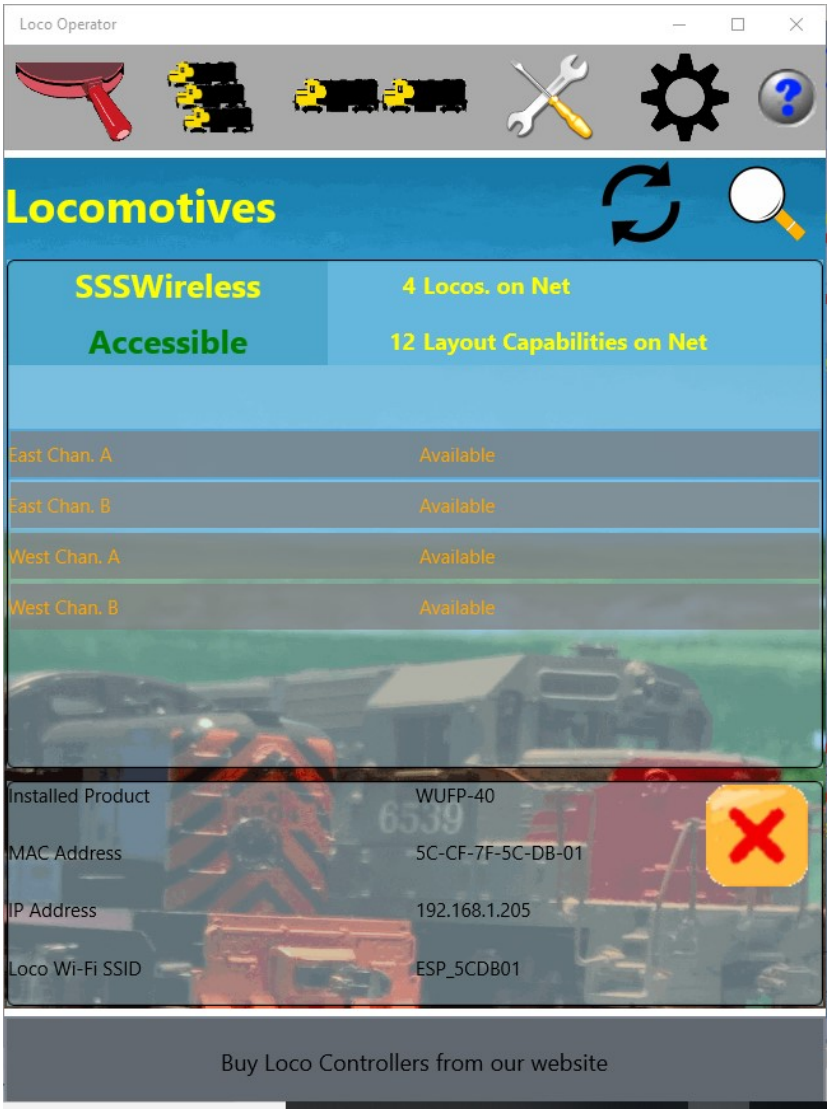


Figure 44 Loco Operator has Found Four "Locomotives" - Really Loco Control Channels on the two WUFP-40 Modules

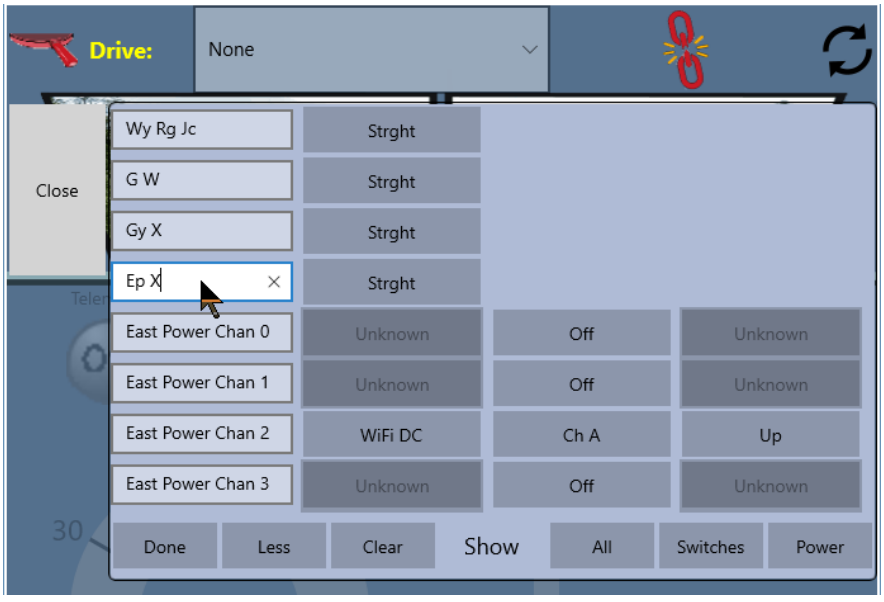


Figure 45 Naming the Capabilities in the Loco Operator Layout Flyout

Running your first Train

Let's begin by seeing how you would run a train from Eastport Station along the Down track as far as Gully, then onto the single-track section to Windy Ridge, round the Summit loop and back to Eastport on the Up track.

First, we set up the first part of the route on tower operator, Figure 46, authorizing the train to travel from Eastport Station on the Down track. The train is present in Eastport Station as marked on Figure 46 (Tower operator does not currently show positions of trains, only block occupancy). The Ep Dn block and the Sunny Dn block are both set to CHA DOWN which means we can drive them using Loco Operator by selecting East Chan. A as in Figure 47. Here we have selected East Chan. A, Main Line driving mode and moved the throttle control upwards. The speed shows on the Speedometer as we get going. Now it's up to the engineer to drive the train visually only as far as Sunnyville Station.

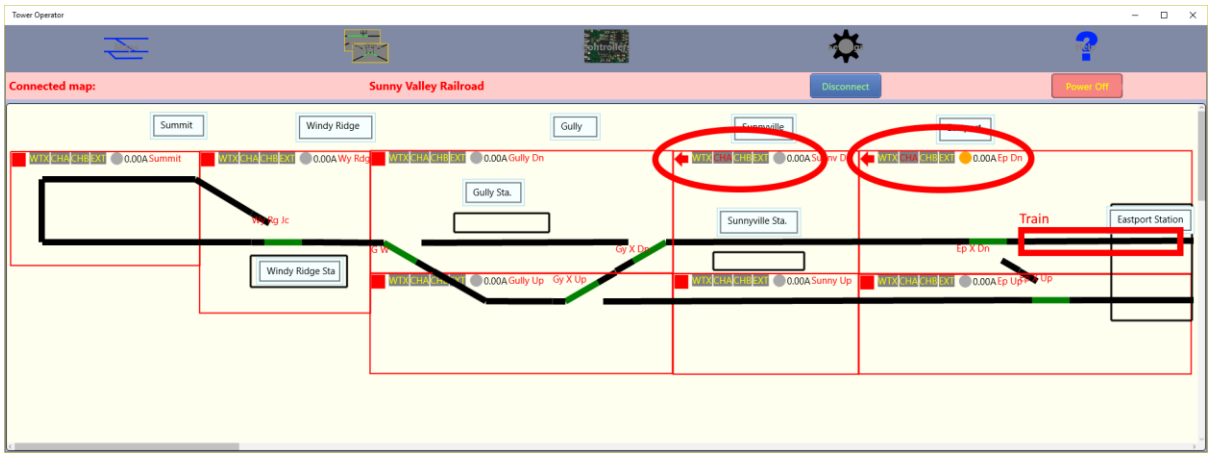


Figure 46 Train in Eastport Station, authorized to Proceed to Sunnyville Station

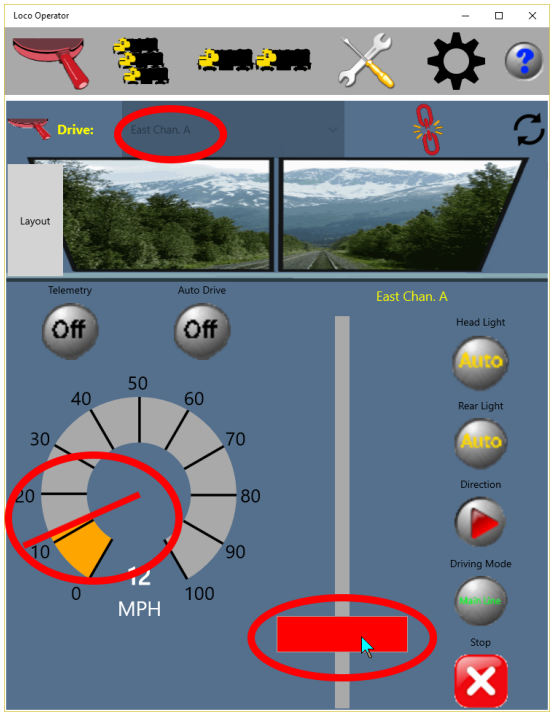


Figure 47 Driving the Train from Eastport to Sunnyville

Tower Operator currently supports manual colored light signals, so you could install signals at the beginning and end of Sunny Dn block. We expect in future versions to augment the dispatching capability of Tower Operator with automatic control of signals.

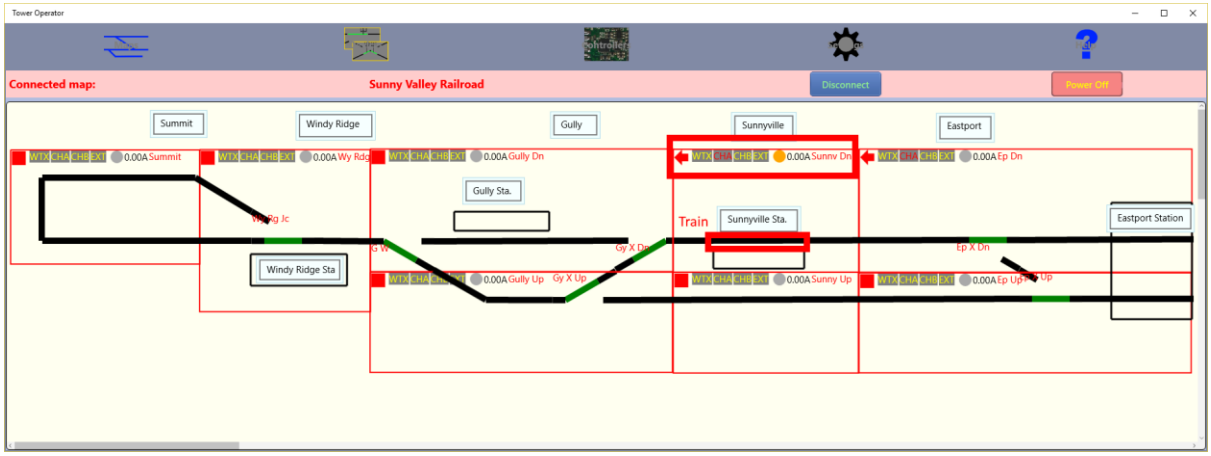


Figure 48 The Train has Arrived at Sunnyville

Figure 48 shows Tower Operator when the train has arrived at Sunnyville. Now we plan to authorize the train as far as Summit. We need to change some switches to keep it on the Down track and also set Gully Dn and Wy Rdg blocks to CHA DN.

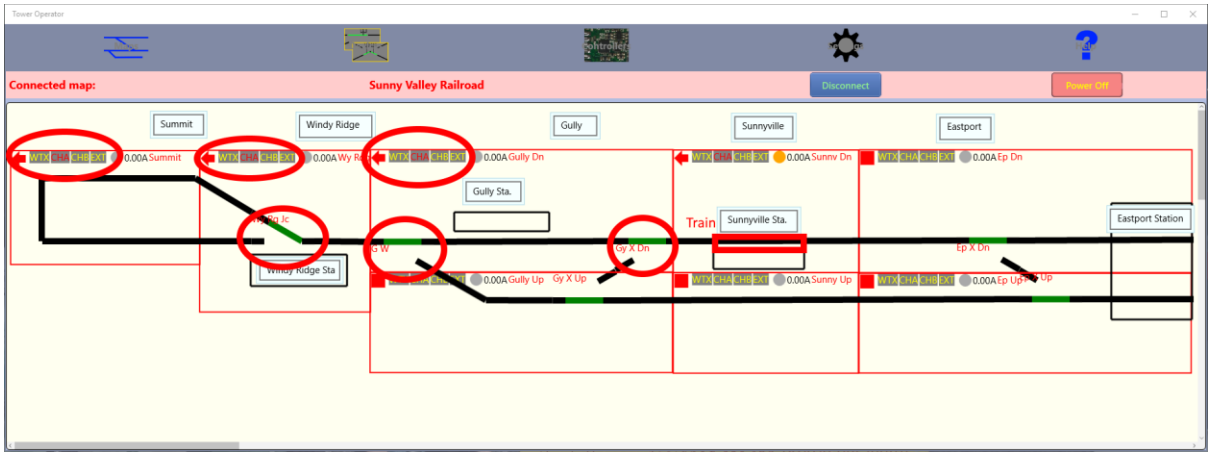


Figure 49 Train is now Authorized all the way to Summit

The changes we have made as despatcher are all circled in Figure 49 and the train may now drive all the way to summit.

But wait a minute! Loco Operator has selected East Chan. A which is OK to drive it through the Sunny Dn block, but how do we enter Gully Dn block. We need to select West Chan. A to drive in all of the western blocks because they are controlled by the other WUFP-40.

Well we could go as far as we can, just off of the western end of Sunny Dn, the loco will then stop and we can select East Chan. A to continue. This makes driving a bit clumsy in this situation when we have more than one WUFP-40 unit on our layout.

However, there is a better way – and in fact we will be improving this on the next versions of Tower Operator and Loco Operator. For version 2, the way is to set up a *consist*. If you've read the Loco

Operator help pages, consists are for multiple locos with WifiTrax modules installed to drive together as a multi-unit consist. You can't do that with Wi-Fi DC, but you can use consists for something else – to join Locomotive Control Channels in the WUFT-40 units together!

So, in Loco Operator, go to the Consists page, create a new Consist, call it "Chan A Train" and click the Save button as in Figure 50.

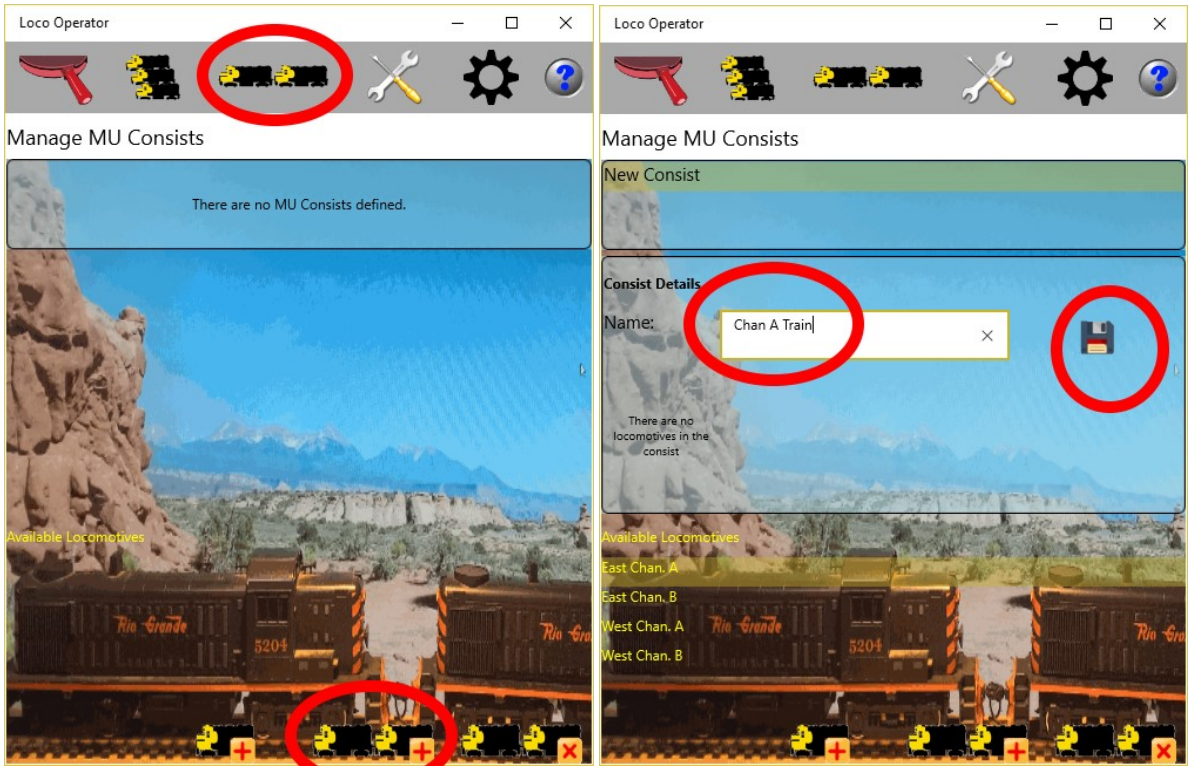


Figure 50 Creating and Naming the Chan A Train

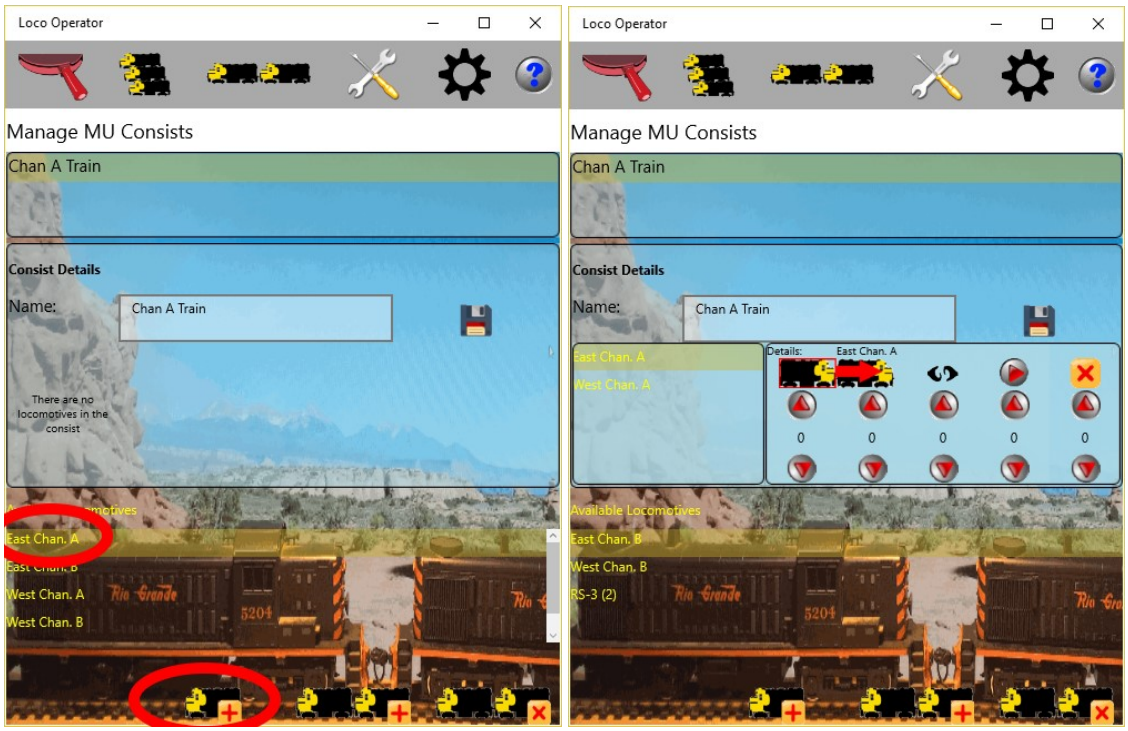


Figure 51 Adding the Loco Control Channels to the Chan A Train

Then select East Chan A, which is the East WUFP-40 Loco Control Channel, and click the Add Loco button. Repeat for West Chan. A, so that the (dummy) consist appears as in the right-hand side of Figure 51.

Now you can go back to the Driving screen and in the Drive drop-down list, you can select Chan. A Train. This means that you drive Loco Control Channel A of BOTH the East and West WUFP-40 Universal Power Controllers. This means that the train can run without stopping across the boundaries. You could, and normally would, do this right from the start. It is only necessary to set up the Chan. A Train consist once on the device in which Loco Operator is installed. To drive a second train on the layout, you need to set up a Chan. B Train consist in a similar manner.

Now you can drive the train all the way through to Summit, stopping at the stations on the way as required.

While the train is on the Summit loop, we will certainly need to change the switch at Windy Ridge and the switch west of Gully to direct the train onto the UP track.

We will also need to change the direction of the Wy Rdg block and the Gully Dn block so that the power is in the correct direction for the Eastbound train to pass through on its way to the UP track in the Gully, Sunny and Eastport blocks. Once this is done, the settings are as in Figure 53 and the train is authorized all the way up to Eastport Station.

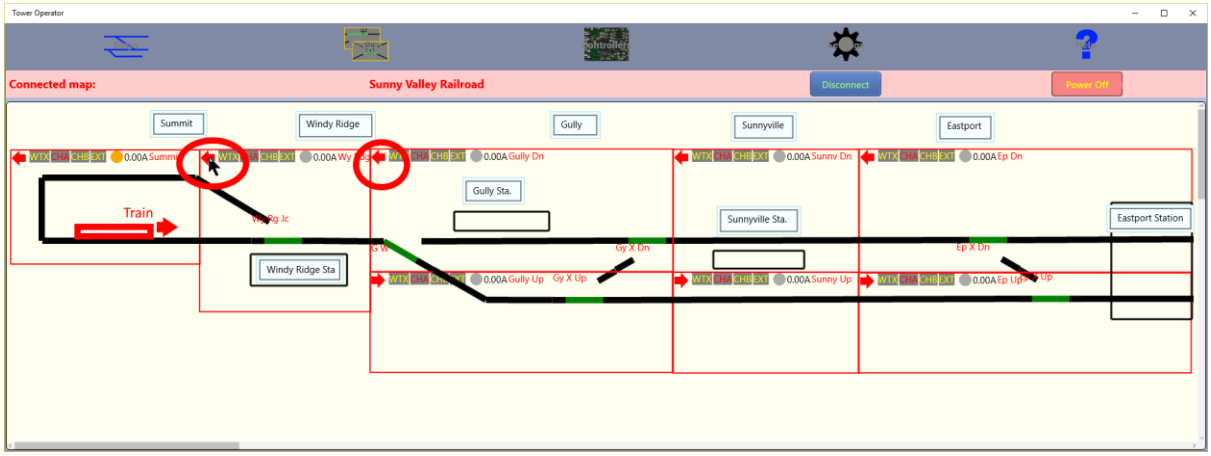


Figure 52 Correct the Switch Settings and Reverse the Windy Ridge and Gully Dn Blocks

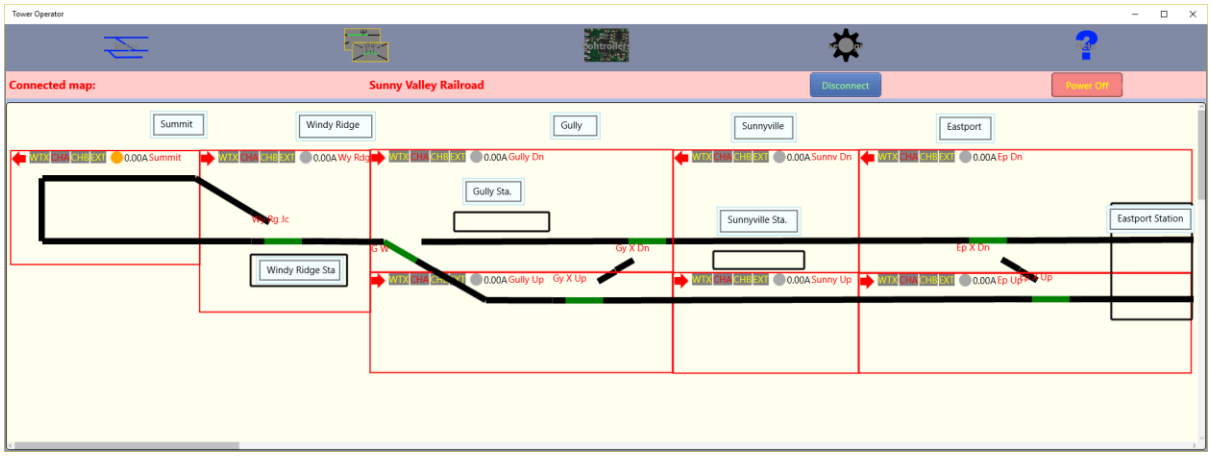


Figure 53 Train Authorized up to Eastport

Remember you can use the same approach for WifiTrax equipped or DCC locomotives on this layout except that you would set the blocks to WFX or EXT respectively before the train is authorized to enter. You also do not need to set the direction as these will auto-reverse as needed as the locomotive goes over the gaps.

Summary

This document has explained the advantages of Wi-Fi DC and shown how a WUFP-40 module can replace a whole lot of control panel switches and wiring. We have seen how a representative DC layout with switches and power blocks can be designed and implemented with Wi-Fi DC devices and software. We've seen how to build a schematic control panel for the layout and connect it to a physical layout and how to control switches and power. Finally we've shown the procedure for dispatching and driving a train through the entire layout.