

## Wi-Fi DCC and DCCIP: Drive DCC Locomotives over your Home Wi-Fi Network

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This document describes **Wi-Fi/DCC**, a new WifiTrax technology that allows you to operate locomotives with DCC Decoders via your home Wi-Fi Network using Smart-Phones, Tablets or Computers. It also introduces **DCC over IP** which allows the opposite – you can also use DCC Throttles or Command Stations to control locomotives via the Wi-Fi network. Compatibility is maintained with locomotives directly Wi-Fi controlled using Wi-Fi Loco technology.

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### Introduction – WifiTrax Model Railroad Technologies

WifiTrax technologies allow you to connect your entire model railroad to your home Wi-Fi network giving you a flexible and versatile method of control from many hand-held devices or computers on your home network.

In our earlier WifiTrax Vision Documents we described our Wi-Fi Direct Cab Control of locomotives, called Wi-Fi Loco, and control of other layout features such as Switches (points or turnouts), Signals, Lights and Power, called Wi-Fi Layout. Products supporting these are now in production and can be purchased from our website and operated using our two Apps: Loco Operator and Tower Operator. Recently another Wi-Fi Model Railroad Technology was announced, Wi-Fi DC which allows DC locomotives also be operated from these same Apps using a block-oriented layout.

**Now we add Wi-Fi/DCC providing complete inter-operability with existing DCC technology as well as the exciting idea of Dead Rail.**

[Read more about WifiTrax Model Railroad Technologies](#)

[Read the first WifiTrax Vision Document here...](#)

[Read the Wi-Fi Layout Vision Document here...](#)

[Read about Wi-Fi DC here...](#)

### DCC, Sound and Dead Rail

DCC has been around since the early 90's and many companies have invested a great deal of effort in manufacturing good quality locomotive and accessory decoders. Particularly popular are sound loco decoders which come with a good range of authentic sound recordings carefully edited and processed to provide realistic locomotive sound effects linked to the motion of the locomotive.

Many railroad modellers have installed locomotives with these decoders or have them available for installation. Also, many new locomotives come with DCC already installed complete with excellent sound.

**WifiTrax now integrates these products into the concept of Wi-Fi Control.**

There is also the N Scale and large-scale community. DCC decoders are available that will fit in N scale and others are sold that are powerful enough for large scales. WifiTrax Wi-Fi Loco technology does not support N Scale since our WMH-20 and WMR-10 are too large and currently supports N-Scale only using Wi-Fi DC – that is N Scale Layouts can be run with Wi-Fi controlled DC blocks.

**WifiTrax wants to make Wi-Fi Cab Control available to N-Scale and Large-Scale modellers.**

Yet another area of our interest is the growth of the Dead Rail idea where railroaders seek to avoid problems of poor electrical wheel contact due to dirty track, dead frogs etc. by providing batteries in their locomotives. No more cleaning track! Dead Rail also eliminates power problems with return loops, wyes and turntables. The development of LiPo batteries supports this aim, and DC-DC Converter and Battery Managers such as the BPS-v4 from Stanton Associates (<http://www.s-cab.com>) are available allowing a single 4.2 V LiPo battery to generate 12V for the locomotive motor and electronics.

However Dead Rail locomotives requires some kind of radio control, since obviously DCC cannot be used on the track if there is no power on the track.

So, you can't use DCC then? Well actually – yes you can!

**Wi-Fi/DCC neatly provides the solution.**

## Introducing Wi-Fi/DCC and DCCIP

To achieve these goals, WifiTrax now introduces a new technology which we call Wi-Fi/DCC and has developed products that make use of existing DCC controllers' capability but allow control to take place over the Wi-Fi network. The remainder of this document describes Wi-Fi/DCC, its various configurations and our products in support of it.

As with our original Wi-Fi Loco, control can be from our apps on smart-phone, tablet or computer. However, Wi-Fi/DCC now provides the ability to also *use an existing DCC Throttle*, via a part of Wi-Fi/DCC called *DCC over IP* or DCCIP. Such a DCC throttle can even control our existing Wi-Fi Loco products!

DCCIP (call it "Deesip" if you like) actually provides a kind of tunnel for DCC signals through the Wi-Fi IP network – or in other words the network *carries* the DCC signals – so its "DCC over IP".

Here are some advantages of our new Wi-Fi/DCC technology:

- (1) You can make use of your existing investment in DCC Decoders and Throttles,
- (2) You can get the benefit of the sound built into your favorite DCC decoder,
- (3) If you do not already own DCC Boosters, you can avoid their cost,
- (4) You can avoid track power altogether with dead-rail and still use DCC,
- (5) You can use your smartphone, tablet or computer to control all your DCC decoders, including locos, switch machines etc.,

- (6) You can make use of your existing walk-around DCC Throttles if you prefer those to smart-phone throttle apps. Some people prefer using physical control handles and these throttles are usually more robust!
- (7) You can make use of the high bandwidth of Wi-Fi to return more data from your locomotives as our products evolve (our Wi-Fi Loco products currently return scale speed and telemetry),
- (8) Wi-Fi is an industry standard and will evolve and improve. It is far bigger than model railroading!

## What actually is Wi-Fi DCC and DCCIP?

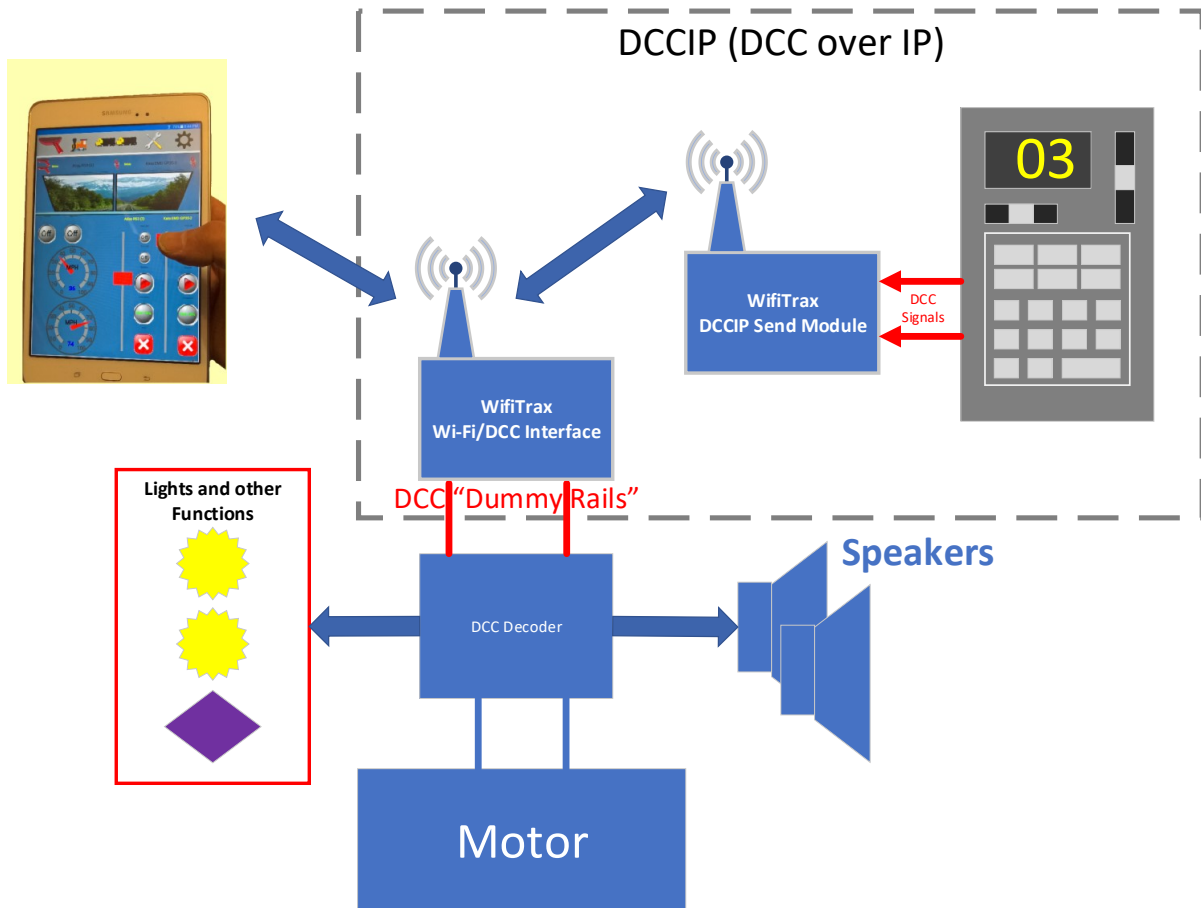


Figure 1 Conceptual view of Wi-Fi DCC. DCCIP is a subset in which DCC is carried over the Wi-Fi IP network.

The concept of Wi-Fi DCC is shown in Figure 1. The crucial component is the Wi-Fi/DCC interface which generates ordinary DCC signals on the power supplied to the DCC Decoder via the "Dummy Rails" which may be just wires connecting the interface module to the DCC Decoder. These signals are fully compatible with the NMRA DCC specification so that any manufacturer's DCC decoder may be used as long as it is compliant with the NMRA standard; you may therefore choose your own favorite DCC Decoder with the features you like: sound, extra functions, smoke - whatever.

The connections from the DCC Decoder to your locomotive are made in the way the manufacturer specifies and these may include motor, lights and other functions as well as speaker connections if your decoder provides sound. All that is required to use Wi-Fi DCC is that instead of connecting the DCC Decoder's track connections to the locomotive's track pick-ups, you connect them to the Bipolar DCC output of the Wi-Fi/DCC interface module.

The interface module itself requires power which may be obtained from the track, from a battery (possibly via a DC-DC converter) or, in the case of stationary Wi-Fi/DCC interfaces, from a mains adapter.

That's right, not all Wi-Fi/DCC interface modules are intended to fit in locomotives, some are for accessories and some are intended to act as DCC Boosters feeding the track. We'll look more at these details later.

Once the Wi-Fi/DCC interface module is installed, all the behavior of the DCC Decoder can be controlled over your home Wi-Fi Network; this includes not just the motor of a locomotive but also its DCC functions (Lights, Sound etc.) and the programming of its DCC Configuration Variables.

This control can be achieved in two ways. Firstly, you can use our WifiTrax Loco Operator App that you would use to control a locomotive fitted with a Wi-Fi Loco module such as WMH-20 or WMR-10.

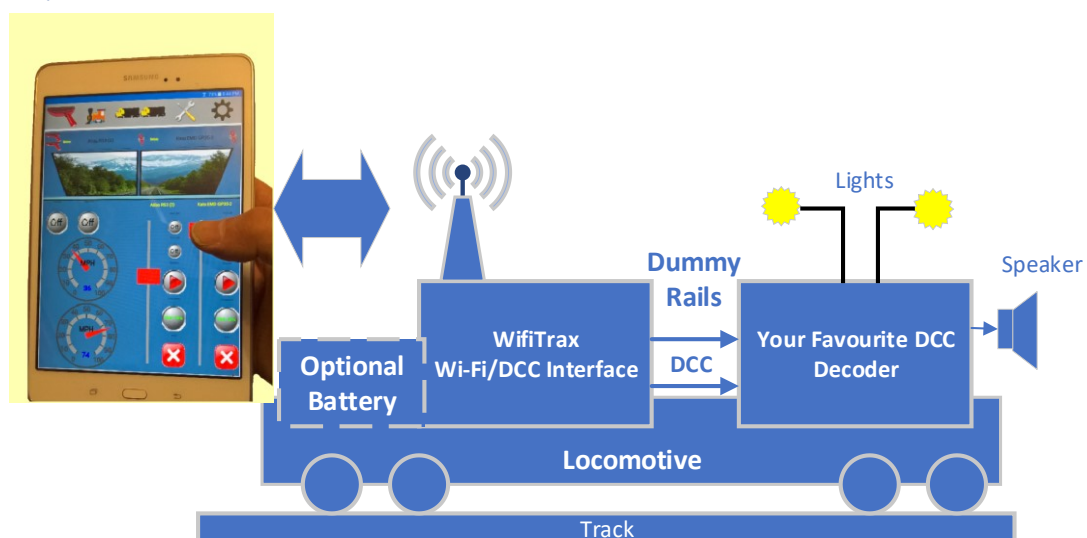
When you use this app, to scan for locomotives, it will detect those that are behind Wi-Fi/DCC interface modules and record those as DCC locomotives. When you select one of these locomotives to drive, the app will show a display that allows DCC functions to be used, just like the DCC Command Station you may be used to.

Secondly, if you want to use a more tactile and robust controller rather than a smart phone or tablet, you can use any existing DCC Command station that provides a bipolar or logic-level output and connect it to our other Wi-Fi/DCC module called a DCCIPS (DCC over IP – SEND). This will decode the output of your existing DCC Command Station, convert it to a protocol that can be sent over the Wi-Fi network and send the commands to the selected Wi-Fi/DCC interface module. This option is the DCCIP (DCC over IP) that was mentioned earlier. Wi-Fi is of course an example of an IP (Internet Protocol) network, the same concept used by all computers, tablets and phones to communicate over a network. This DCCIP option is shown within the dotted box in Figure 1.

So for DCCIP, the Wi-Fi/DCC Interface Module and DCCIP Send Module form a pair – one at each end of the tunnel through the Wi-Fi network.

Now that the concepts of Wi-Fi/DCC have been described, let's look at some examples of how it can be used with specific module manufactured by WifiTrax.

## Wi-Fi/DCC in a Locomotive

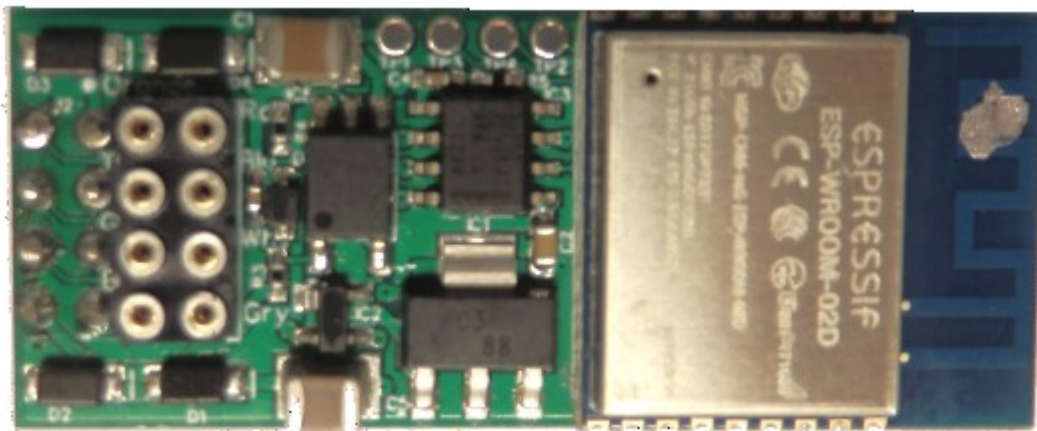


*Figure 2 A Wi-Fi/DCC Interface module installed in a locomotive with a DCC Decoder.*

Figure 2 shows a block diagram of Wi-Fi/DCC used within a locomotive. In this case your chosen DCC Decoder is installed and connected to the lights and speaker as well as to the locomotive. The decoder connections that would normally go to the track pick-ups become the “Dummy Rails” output by the Interface Module. The interface module can obtain its power either directly from the track or from a battery (shown as “Optional Battery” in Figure 2). A DC-DC converter can be placed between the battery and the interface module to boost up the battery voltage. In large scales, a 12-Volt battery can be connected directly and the DC-DC booster is unnecessary.

Control can, of course be either from an installation of Loco Operator (shown in Figure 2) or using DCCIP from an existing DCC Command Station as in Figure 1. WifiTrax manufactures several products that support Wi-Fi/DCC in a locomotive which we now review.

### WDMI-34 Wi-Fi/DCC Locomotive Interface Module



*Figure 3 WDMI-34 Wi-Fi/DCC Locomotive Interface Module*

The WDMI-34 is an interface module designed to plug into a DCC-Ready locomotive that has an NMRA 8-Pin socket intended to take a DCC decoder with a harness ending in an NMRA 8-pin plug. To install this module, simply plug the module into the 8-Pin socket of your locomotive, then plug your decoder harness in the 8-pin socket on the top of the interface module. The motor and light connections will go through the DCC-Ready socket on the existing locomotive circuit board. If your decoder has speaker outputs or other function outputs, you will need to connect them separately. Figure 4 shows an example of an installation with a Lenz Digital plus Lokdecoder installed in an Atlas TRAIN MAN series HO locomotive. Incidentally, the WDMI-34 will respond to traditional DCC signals on the track as well as Wi-Fi/DCC control from a smart-phone or from a DCC Throttle via DCCIP.

You can read more about this module on our web site at:

<http://www.wifitrax.com/products/product-WDMI-34-detail.html>



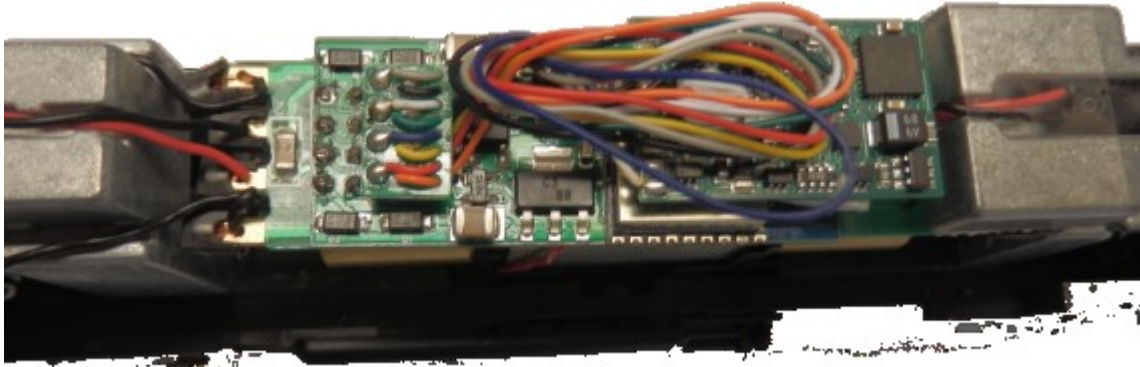


Figure 4 WDMI-34 Installed in an Atlas Locomotive together with a Lenz Decoder

## WDMI-52 and WDMI-53 Locomotive Motherboards



Figure 5 WDMI-52 Locomotive Motherboard - Top View



Figure 6 WDMI-52 Locomotive Motherboard Bottom View

WifiTrax makes two *Locomotive Motherboards* aimed particularly at Dead-Rail installations. These motherboards are intended to work with Stanton Associates ( [www.s-cab.com](http://www.s-cab.com) ) BPS-v4 and BPS-420 LiPo Batteries and space and connections are provided for them. A space is also provided for an NMRA compliant DCC decoder and it is possible to fit a speaker in as well. For example, a SoundTraxx Eco-100 Decoder works well. Figure 7 shows an installation in a Kato GP-35, but the motherboards should be able to be installed in other locomotives as well.

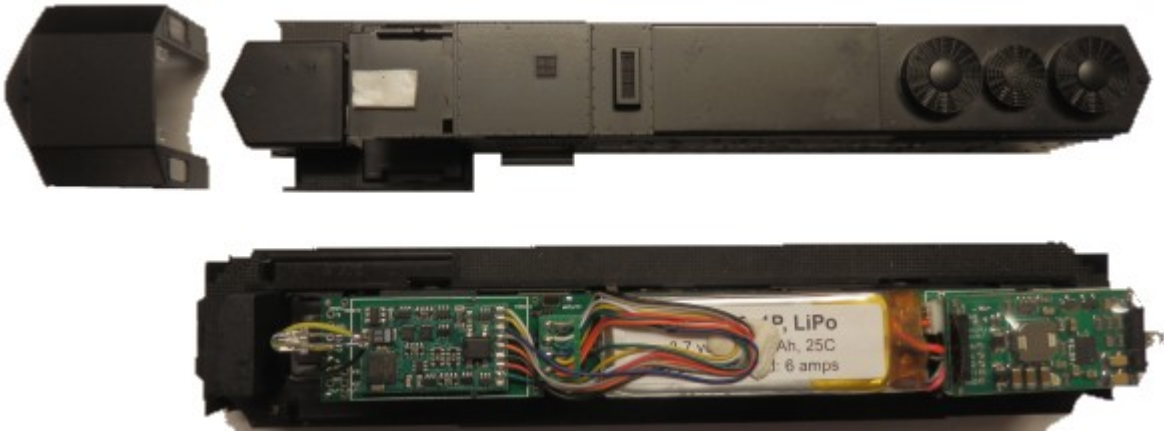


Figure 7 WDMI-52 Installed in a Kato GP-35 Locomotive together with Stanton BPS-v4, BPS-420 Battery and a Lenz Decoder.

Another motherboard, the WDMI-53 is made to fit the larger Kato SD-90 and offers the same features. WifiTrax plans to offer several more motherboards in different shapes and sizes. No track power is required, except for a short section powered at 12V for recharge. The BPS will automatically recharge the battery when driven onto that section, which can also be powered with a DCC signal without any effect.

Again, these locomotives can be controlled from Loco Operator on a Smart Phone, Tablet or Computer or, using a DCCIPS module, from a traditional DCC Command Station as described earlier.

Please go to our web site to obtain more information:

<http://www.wifitrax.com/products/product-WDMI-52-detail.html>

#### WDMI-24 Large Scale Battery Wi-Fi/DCC Interface Module

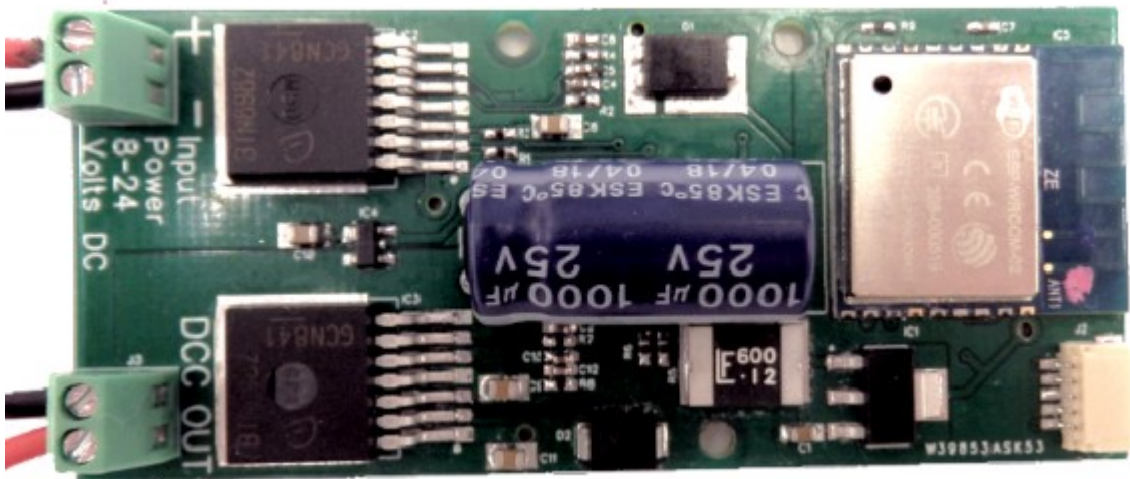


Figure 8 WDMI-24 Large Scale Wi-Fi/DCC Interface Module.

For large scales, WifiTrax manufactures the WDMI-24 shown in Figure 8. This is powerful enough to drive Bipolar DCC (that's DCC signals on power) to a decoder such as TCS G8 or similar which will drive a large-scale O or G Scale locomotive. The WDMI-24 is intended to be connected to a 12-Volt rechargeable battery via the screw terminals provided, and the DCC output is to be connected to the

Track Inputs of the DCC Decoder. All the other connections from the decoder, such as motor and lights, speaker etc., need to be connected as usual directly to the locomotive.

Another version of this unit intended for track power rather than battery operation is also expected to be made available.

Please go to our web site to obtain more information:

<http://www.wifitrax.com/products/product-WDMI-24-detail.html>

## Wi-Fi/DCC Trackside

### **Can Wi-Fi/DCC support N-Scale?**

**Suppose I don't want to take apart my DCC-Installed locomotives to add interface modules or there's no room?**

**What about new locos with DCC and sound already installed?**

These questions are addressed by installing Wi-Fi/DCC Trackside!

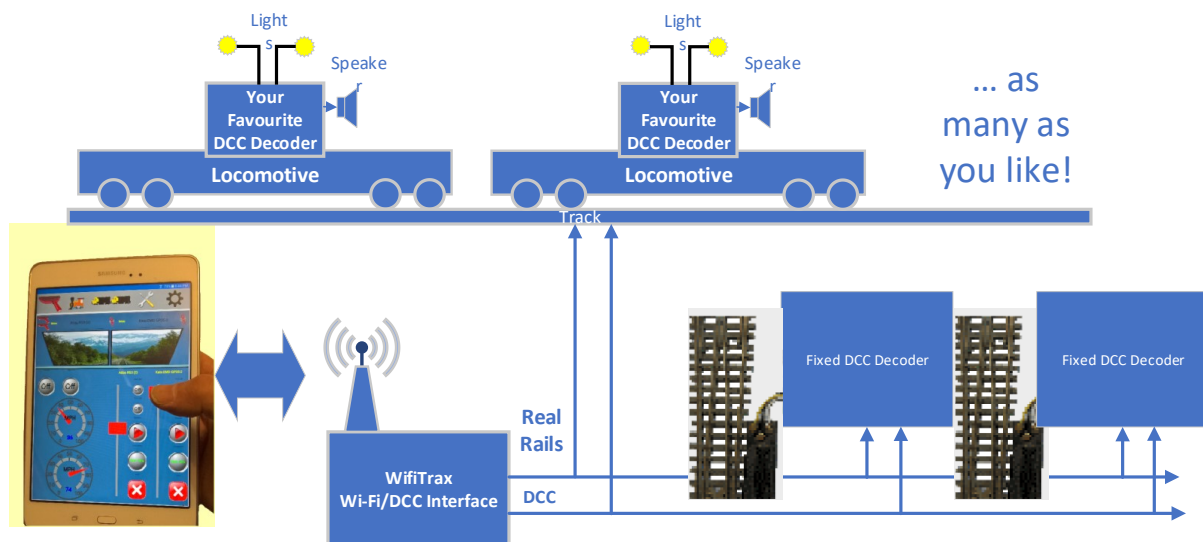


Figure 9 Wi-Fi/DCC Trackside concept used to provide DCC to the track and to several fixed DCC Decoders controlling switch machines.

The concept of Wi-Fi/DCC Trackside is shown in Figure 9. In this case, the Wi-Fi/DCC interface module is installed on the layout somewhere and connected to the track. This time the “Dummy Rails” become “Real Rails” and the interface model performs the function of a DCC booster. Of course, the interface module now needs to be more powerful, delivering enough power for several locomotives running simultaneously and possible fixed DCC decoders as well.

With this, you don't need to open your locomotives, just place them on the track and add their DCC addresses to the roster held in the interface module and you can control them all independently from an installation of Loco Operator app or from a traditional DCC Command/Controller using DCCIP.

By the way, unless you've already got DCC controlled switch machines, there's no reason to go out and buy them, you can use our 4-Way or 8-Way Universal Switch Machine Controllers which are



operated directly over Wi-Fi from Loco Operator, Tower Operator or even from your traditional DCC Control Station or throttle.

<http://wifitrax.com/products/switchControllers.html>

Now to the specific products for Wi-Fi/DCC Trackside ...

WFD-25 Wi-Fi/DCC Interface Booster for Track DCC

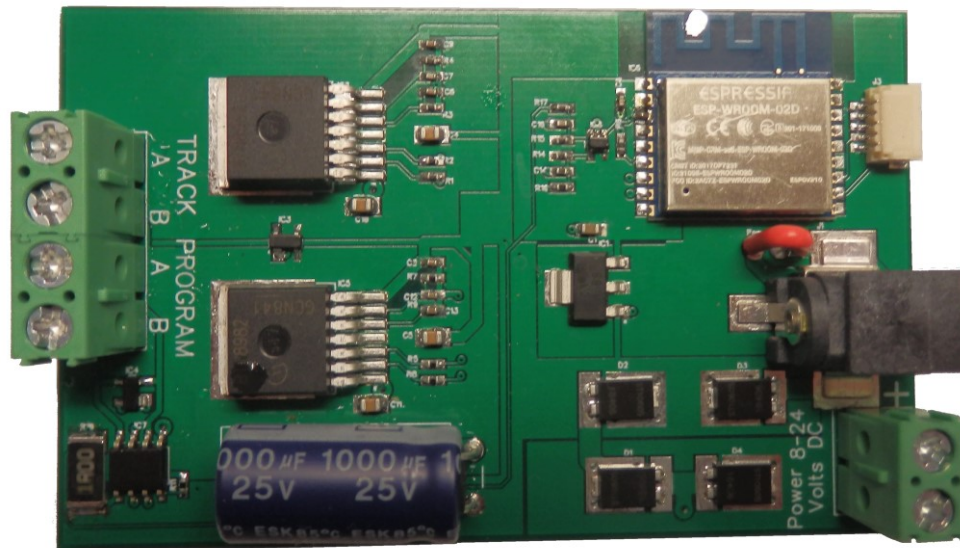


Figure 10 WFD-25 Wi-Fi/DCC Interface Booster for Track DCC

The WFD-25 shown in Figure 10 is a Wi-Fi/DCC interface module in trackside form for mounting on your baseboard. This makes it comparable to a Wi-Fi controlled DCC booster. It implements all of the features of Wi-Fi/DCC Trackside as described in the previous section and can control a set of locomotives running on the same track using NMRA compatible DCC. It can also control fixed DCC decoders such as are used for switch machines.

All DCC locomotives and fixed decoders can be operated independently using the Loco Operator or Tower Operator apps (as appropriate) on smart-phones, tablets or computers as well as using one or more traditional DCC Command/Controllers via DCCIP. Control methods may be mixed on a layout, but any individual locomotive can naturally only have one operator at a time.

WFD-25 is compatible with locomotives fitted with Wi-Fi Loco controllers such as (WHM-20 and WMR-10) but not DC locomotives – these locos will just ignore the DCC.

The unit is suitable to run groups of N Scale, HO Scale or larger locomotives on a layout provided they are each fitted with either DCC decoders or Wi-Fi Loco controllers.

Please go to our web site to obtain more information:

<http://wifitrax.com/products/product-WFD-25-detail.html>

## More about DCCIP Modules

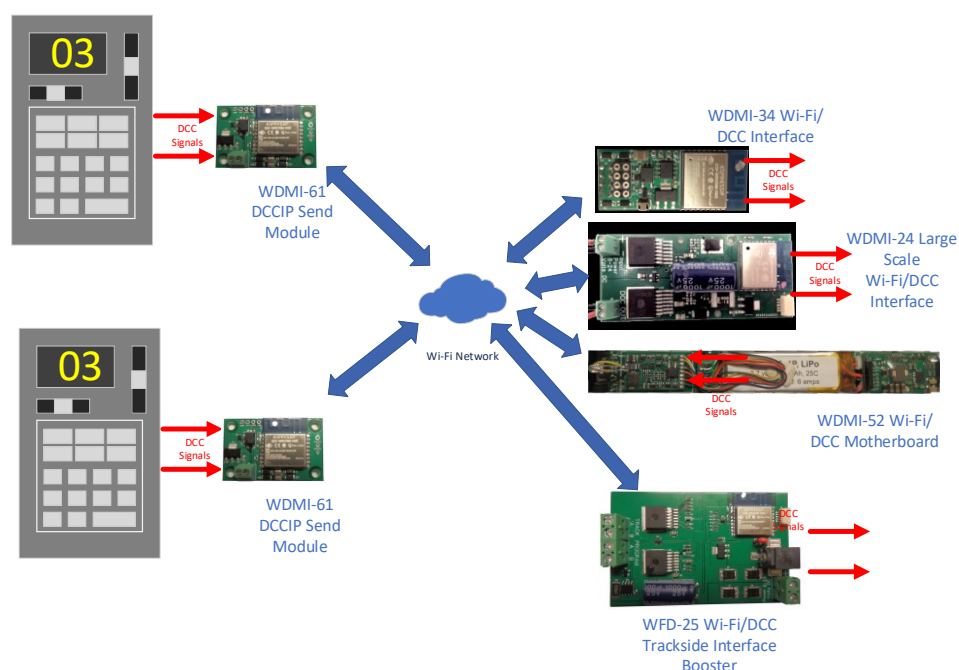


Figure 11 Modules involved in a DCCIP Configuration

Let's understand more clearly what is meant by DCCIP. Wi-Fi and Ethernet connections that connect computers, tablets and phones together are examples of IP Networks. IP stands for Internet Protocol and it's all about breaking messages up into packets and making sure they get to their destination.

We don't need to worry about all that, but DCCIP simply stands for DCC over IP, which means that the DCC protocol from a Command/Controller for sending data over model track is decoded, formed into messages, sent over the network then recoded again and sent to the model train decoders. As far as the decoders in the locomotives are concerned, the messages came directly from the Command Controller. The networking process is invisible – the DCC signals are being *carried* by the network IP protocol – hence the name *DCC over IP*.

Now we introduce the WDMI-61 DCCIP Send module.

In Figure 11 all the Wi-Fi/DCC modules currently available are shown participating in DCCIP. On the left-hand side, there are two DCC Command/Controllers each connected to a WDMI-61 DCCIP Send module. When powered on, these modules scan the network to determine the DCC decoders that are present and their DCC Addresses as well as IP Addresses. They also detect Wi-fi-Loco and Wi-Fi Layout controllers and give them a dummy DCC address too.

On the right-hand side there are examples of Wi-Fi/DCC modules that all act as DCCIP Receive units. Each of these units responds to scanning from the units on the left-hand side. In the top three units, there is only one DCC decoder attached, so they respond with the DCC Address of their attached decoder. The WFD-25 Wi-Fi/DCC Interface Booster at the bottom responds with all the locomotives that it knows may be on the track to which its DCC output is connected.

So, after scanning, each DCCIP Send module knows where to send the message containing DCC bytes when it receives a command from the controller connected to it. It knows because it looks up the DCC address in the table it built during its scan.

We could also show any number of Smart-Phones, Tablets or Computers on the left-hand side of Figure 11, but they would communicate directly with the units on the right, since they are connected directly to the Wi-Fi network.

On the right-hand side, we could show any number of locomotives fitted with Wi-Fi Loco Controllers or Switch Machines fitted with Wi-Fi Layout controllers but they would not need DCCIP Receive units since they would be connected directly to the Wi-Fi Network.

Both the DCC controllers on the left and any Smart-Phones, tablets etc. that were added on the left could also select and control those units directly connected to Wi-Fi.

## Summary

The aim of this document was to describe our new Wi-Fi DCC technology.

This provides control “by” and “of” DCC devices over a Wi-Fi network alongside those with directly connected Wi-Fi Controllers.

It described DCCIP (DCC over IP) as a subset in which the controlling device is a DCC device and the DCC is “carried” over the Wi-Fi IP network.

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