User's Manual for the ProMini Air Transmitter

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1 Introduction

Before understanding how to use the ProMini Air transmitter, we will introduce some terminology that may be new. The National Model Railroad Association (NMRA) set forth a standard [1] for communicating with decoders onboard locomotives and other model railroad devices called Digital Command Control (DCC). DCC-compliant throttles control and configure these devices by sending coded, digital voltage waveforms over wires or tracks (usually) to these devices, which sift out those addressed to them. These coded waveforms contain digital messages or "packets" that specify an action along with an "Address" that determines the recipient device. Most DCC packets are addressed to a specific recipient, although a few kinds of messages are for *all* listening recipients.

Any DCC output (say from Digitraxx, NCE, or other DCC throttle) can be wirelessly transmitted by Radio Frequency (RF) using the ProMini Air transmitter over the Airwire Frequencies in the 902–928 MHz "ISM Band" band (the Airwire channel and output power level is adjustable as described below) to a variety of RF receivers that in turn convert the RF transmissions back to DCC that any DCC decoder can "understand." The connection between the DCC throttle and the ProMini Air requires an additional, small interface board (details in Section 4) that receives high-voltage, bipolar DCC output on wires connected to the throttle and converts it to +5V, ground, and unipolar, 5V logic-level DCC for power and signal input to the ProMini Air.

2 Required Hardware

The easy-to-assemble Blueridge ProMini Air kit provides all of the hardware components necessary for assembly and gives the user access (in the software) to the DCC signal from the throttle so that the user can manipulate it if desired. Of course, the pre-loaded software is operational without any further modifications by the user.

The following information is provided in case the transmitter board or the controller fail.

The ProMini Air transmitter is based on a Texas Instruments CC1101 transceiver chip on a small Printed Circuit Board (PCB) with supporting electronics (available at Amazon for $9.95, and a 16MHz Arduino Pro Mini from Sparkfun for $9.95+shipping or from Amazon for $12.95 that uses open-source software available at the "AirMiniTransmitter" GitHub site. The *ten*-pin version of the CC1101 PCB is required so that it will mount correctly to the current version of the ProMini Air PCB. Other versions of the CC1101 PCB are available on Amazon, but they will all cost you about $9.00 to $10.00. Knock-offs of the Pro Mini are also available on Amazon at considerably less cost than the Sparkfun original, but I have occasionally had trouble with these knock-offs. Your mileage may vary, and the cost of the knock-offs is about one-third the Sparkfun version.

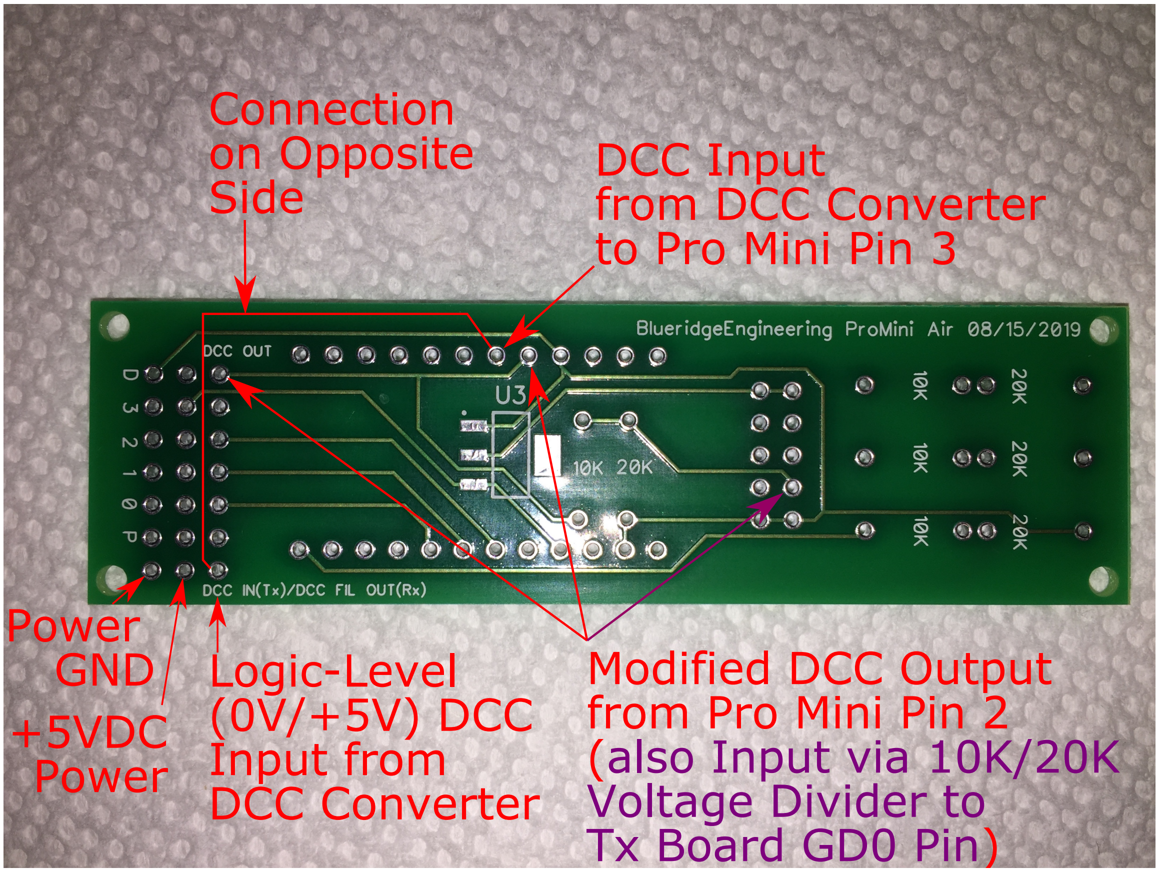

Figure 1: Input/output connections to the ProMini Air transmitter from the DCC Converter and to the transmitter

3 Hardware Assembly

The ProMini Air transmitter software tightly integrates with the Blueridge Engineering hardware. See here for instructions on assembling the ProMini Air transmitter. The Pro-Mini Air can be used as either an RF receiver or transmitter. Which mode is determined by software load and which inputs the ProMini Air uses. As a transmitter, the 5V logic-level DCC input from the DCC Converter is connected to the ProMini Air at the input indicated in Figure 1. The DCC output generated by the ProMini Air software that is input to the RF transmitter chip is also provided as a diagnostic output, as indicated in the Figure.

4 Hardware Power and DCC Interfacing

The ProMini Air requires +5VDC power, power ground, and a 5V logic-level "unipolar" DCC input that can be provided by the very simple circuit shown in Figure 2. Figures 3 and 4 show the simple DCC converter circuit connected to a combined rectifier/filter and power supply available here for $9.59.

The parts list for the power-supply/DCC converter shown in Figure 2 is

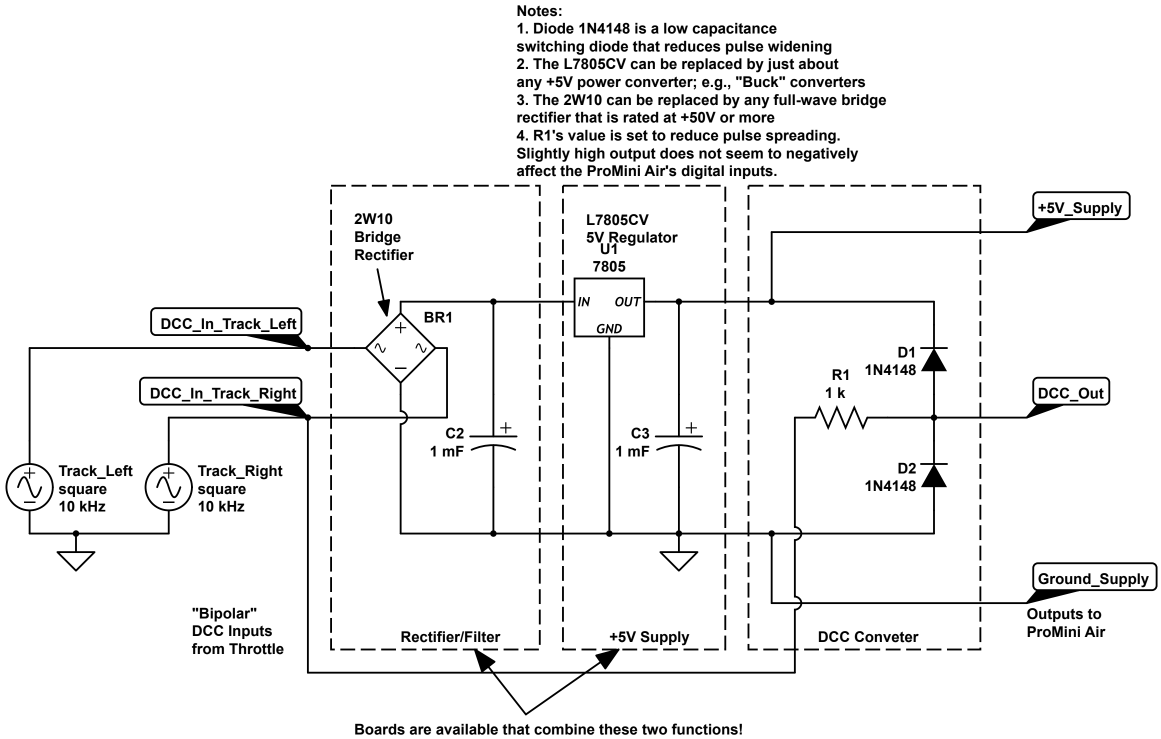

Figure 2: Power and signal generation schematic for the ProMini Air. The DCC throttle provides “bipolar” DCC, and the the circuits convert these inputs to +5V, ground, and 5V logic level DCC for the ProMini Air.

- 2W10 Bridge Rectifier: Almost any full-wave bridge rectifier that can handle at least 50VAC will do. This one is available here for about $0.32 each.
- L8705CV Voltage Regulator: This is an inexpensive, commonly-available 5VDC voltage regulator, which is available here for about $0.47 each. This device may need a heat sink to keep it from overheating during long-term use.
- 1N4148 Diode (2): This is a commodity, low-capacitance switching diode that can be found at numerous locations, including here.
- 1K 1/4 W resistor: This is a commodity electronic component.
- 4.7uF capacitor: This is a commodity electronic component.

You can replace the L8705CV with a “Buck” voltage converter (costs are less than $2.00, for example, here) and eliminate the requirements for cooling. In this case, both the input and output V- of the voltage converter are connected to the ground (the “-” output of the bridge rectifier) in the circuit diagram shown in Figure 2.

The 1K resistor between the DCC input and the DCC output was chosen to reduce the pulse spreading. While this slightly increases the output amplitude compared to using larger resistors, the increased amplitude does not appear to have a negative impact on the ProMini Air’s Pro Mini digital inputs.

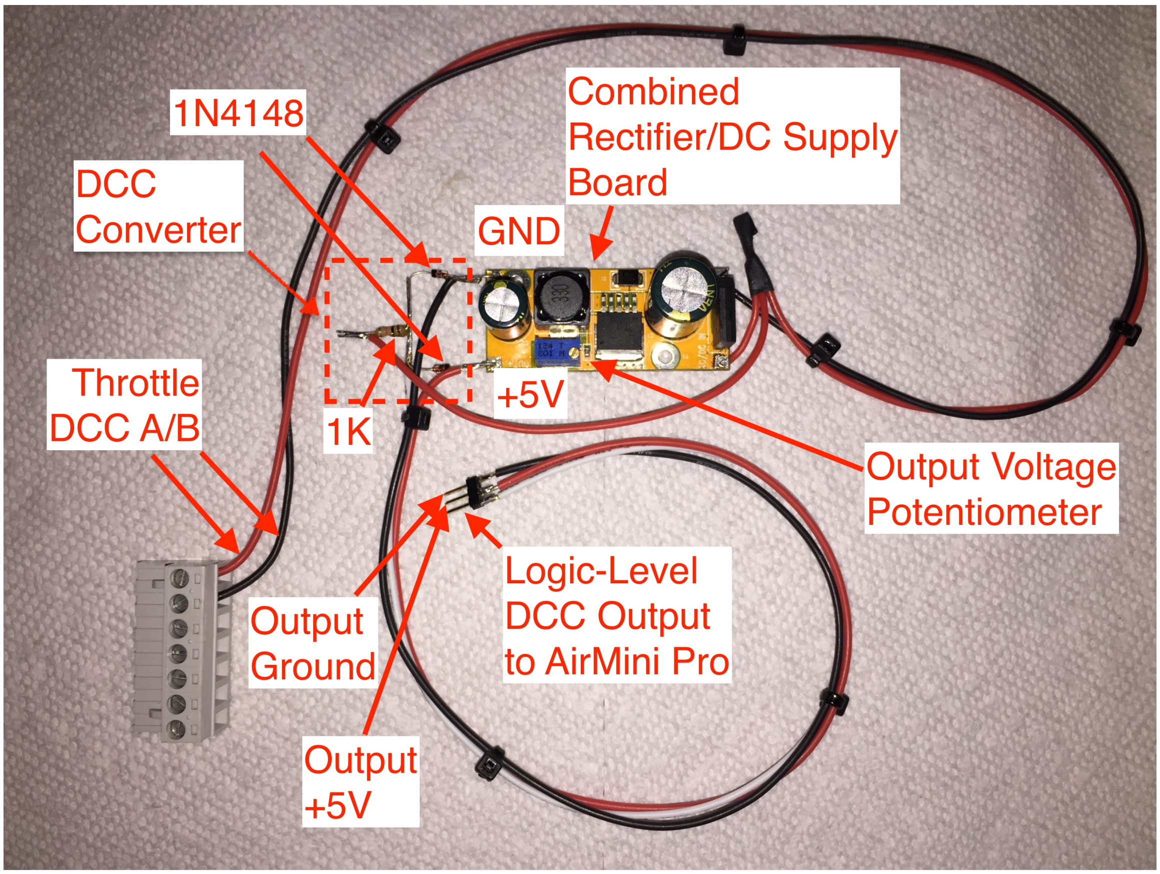

Figure 3: 5V power supply/DCC converter circuit for the ProMini Air. The combined rectifier/power supply board is available here.

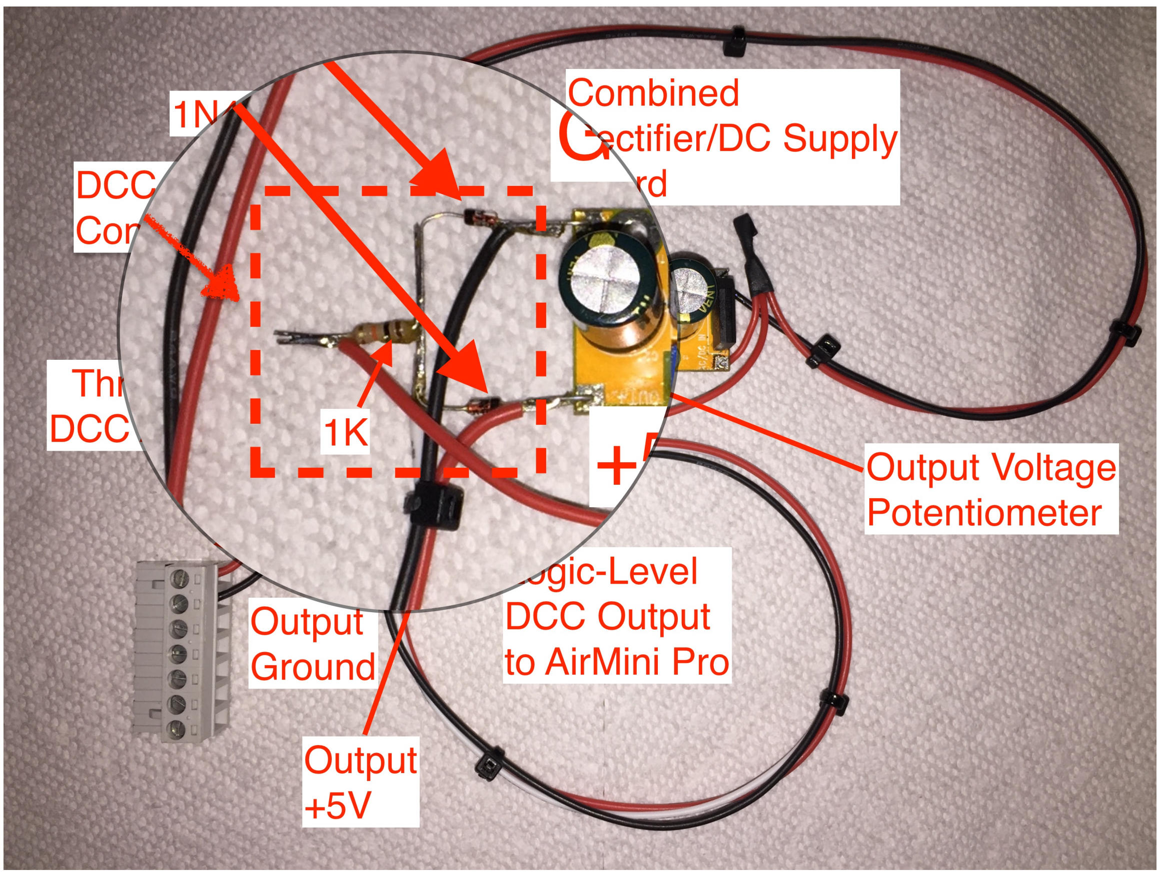

Figure 4: Close-up showing the DCC converter circuit

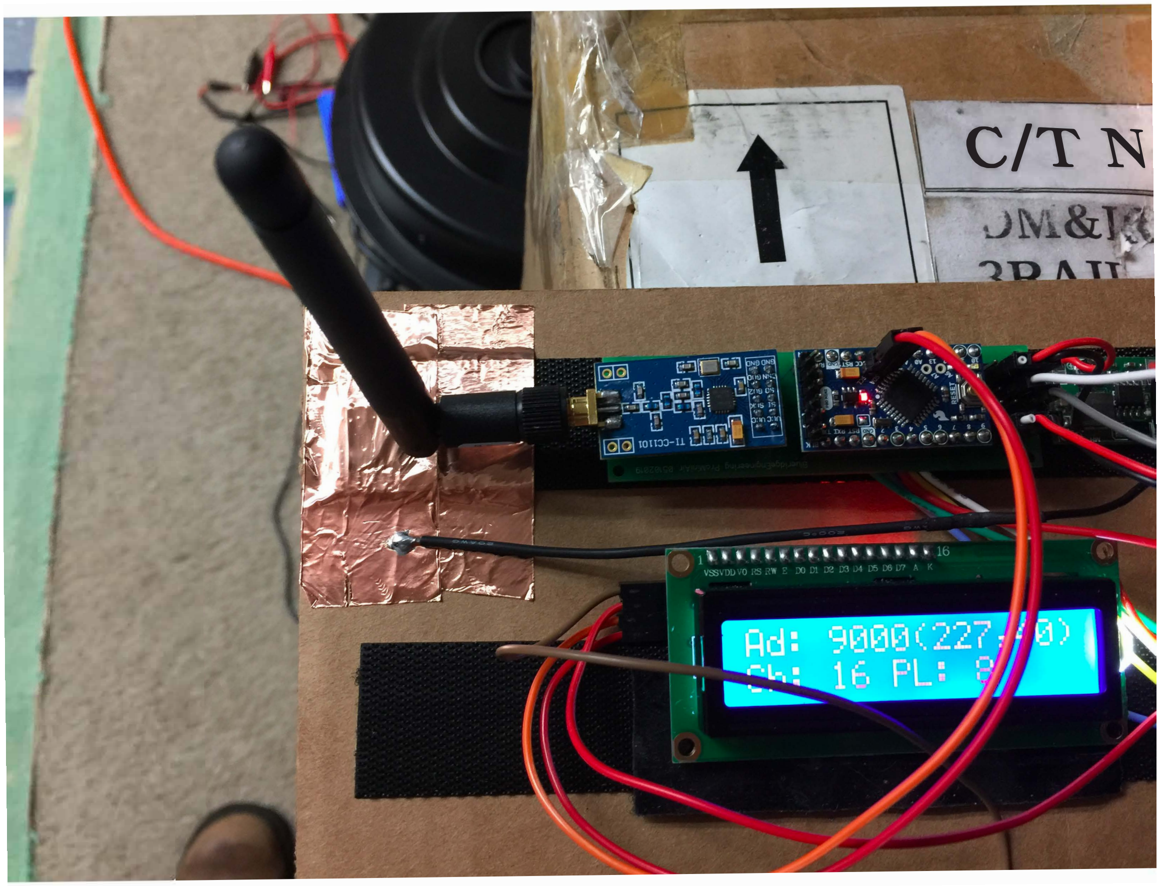

Figure 5: Quarter wave antenna usage. Note the additional pieces of grounded copper foil just below the antenna is an attempt to improve transmission efficiency. The foil has conductive tape on its back to provide electrical continuity between the pieces, and a power ground is soldered to the copper foil.

The user can purchase these electronics, pre-assembled and tested, from Blueridge Engineering.

5 Antenna Topics

The antenna that usually comes with the transmitter modem PCB (see the Blueridge Engineering website for information regarding this transmitter modem PCB) is far too small for efficient transmission. The user is strongly urged to purchase a longer, quarter- or half-wave antenna and optionally place a metallic "ground plane" beneath the antenna as a "counterpoise" [4] to improve transmission efficiency. See Figure 5 showing the copper tape applied beneath the base of the antenna with a soldered connection to power ground. We have not, however, *quantitatively* verified that the metal counterpoise improves range performance. If the antenna has an internal counterpoise, the external ground plane will not improve range performance.

These antennas can be purchased on-line from many sites, and we suggest the reputable

Figure 6: Linx half-wave antennas. The ANT-916-OC-LG-SMA has better gain than the ANT-916-CW-HWR-SMA at the expense of being 42% longer.

Linx products such as their SMA one-half wave antennas with an internal counterpoise. You can find these antennas at Digi-Key, e.g., ANT-916-OC-LG-SMA ($10.55) and ANT-916-CW-HWR-SMA ($12.85). The former antenna has a slightly better gain (2.2dBi versus 1.2dBi) but is somewhat longer (6.76” versus 4.75”). See Figure 6.

6 Software and Firmware Loading

You can follow these instructions should you want to update the firmware loaded into the ProMini Air. The ProMini Air uses open-source software that is available at the AirMini-Transmitter Github site. Once you download the software into a directory that the Arduino development environment can find, it’s a snap to compile and down-load updated firmware via USB to the ProMini Air hardware with the Arduino Integrated Development Environment (IDE).

Since the Pro Mini board in the ProMini Air doesn’t have it’s own USB plug and port to provide a connection to a PC, one end of a 5V SparkFun FTDI Basic Breakout USB connector attaches to the six-pin connector on the Pro Mini board, and the FTDI’s mini USB plug connects to the PC. Be sure to orient the FTDI plug to the Pro Mini pins correctly by matching up the labeling on the USB connector with the pins on the Pro Mini board on the ProMini Air. See Figures 7 and 8.

7 ProMini Air Settings/Configuration

The ProMini Air has a number of default configuration settings that should make it useful “out of the box,” and “OPS Mode” (sometimes called “Programming on the Main” or “PoM”) re-configuration by the DCC throttle described below can change these settings, perhaps the most important of which is the Airwire RF channel to transmit on. But first, we

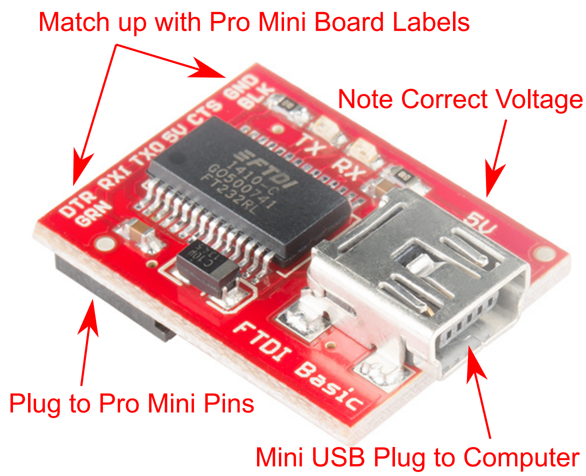

Figure 7: 5V Sparkfun FTDI Basic Breakout USB connector

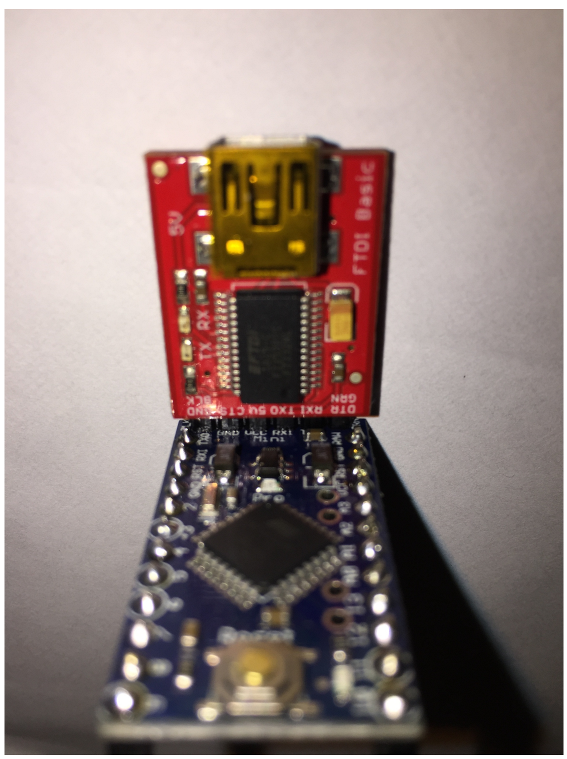

Figure 8: Correct connection of FTDI board to Pro Mini board

need to explain how to make the ProMini Air "listen" to the DCC throttle's re-configuration commands explicitly meant for the ProMini Air.

While DCC throttles are mostly concerned with commanding the speed, direction, and other behavior of locomotives, they can be used to reconfigure the "decoders" that are busy interpreting the DCC commands sent by the DCC throttle. Usually, reconfiguration involves changing lighting effects and other behavior of devices on a locomotive *at a specific address*, and "OPS mode" is very convenient for doing so. Each DCC throttle manufacturer has a slightly different method for putting the throttle into "OPS mode" so that it can communicate with a decoder at a specific address, but once in this mode, the DCC throttles all send the same NMRA-compliant, DCC packets to reconfigure the recipient decoder by means of changing the *value* of a *Configuration Variable* (CV).

This last point is the source of a lot of confusion. A *Configuration Variable* (CV) is the *fixed address number with a set purpose* where we will deliver a *change in its value held at this address*. We usually refer the *fixed address with a set purpose* as "CV#", where # is some number. For instance, CV1 holds the value of a device's "short address" (whose *value* can be between 1 and 127). The *value* stored at this address can be changed, so we often refer to the *value* held at the CV address # as "CV#=*value*".

The ProMini Air "listens" to DCC commands from the throttle, and if the address of a command matches the ProMini Air's address, which is 9000 by default, while the throttle is in "OPS mode", the ProMini Air can be re-configured.

Table 1 provides CVs that can be changed to re-configure the ProMini Air. To change these values, the throttle that the ProMini Air connects to must first select the current address of the ProMini Air, which is 9000 by default. Then according to the instructions for the particular throttle, set the throttle in "OPS mode" or "programming-on-the-main" of Configuration Variables (CVs).

Table 1 also provides valid values for the CVs, so if the user attempts to set an invalid value for a CV, the entry will be ignored and will NOT take effect! All changes to CV values made in "OPS mode" are persistent after power-down except for CV254 (RF power level), which will reset to the original default value of 8 upon power-up. This feature prevents the ProMini Air from producing unexpected high-power RF output upon turn-on.

In general, it should not be necessary to change the ProMini Air's address. But, if the user needs to change the address, the following information will help. It's a little complicated. If the user is not changing from a short to a long address or vice versa, no change in CV29 is needed. The fifth bit of CV29 specifies whether to use a "long" (bit 5=1) or "short" (bit 5=0) address. For the ProMini Air, no other bits of CV29 are relevant, so either set CV29=0 to use the "short" address specified in CV1 or set CV29=32 to use the "long" address specified by CV17 and CV18.

When resetting the "long address" for the ProMini Air, the user *must* set CV17 *before* setting CV18! Once the user programs the value of CV18, the ProMini Air's address will change to the new address, whose value is set by the funny formula:

$$\text{Address} = (\text{CV17value} - 192) * 256 + \text{CV18value},$$

so for the default values for CV17 and CV18 in Table 1: (227-192)*256 + 40 = 9000. Changing the address by first setting CV17 and then CV18 means that the ProMini Air

Table 1: ProMini Air Settings and Configuration

Feature	CVAddress	Valid CV Values	Default	Comments
RF Channel	CV255	0–16	0	Airwire channels
RF Power*	CV254	0–10	8	Experimentation is required
Long addr high byte	CV17	192–231	227	Program CV17 *before* CV18!
Long addr low byte	CV18	0–255	40	Default CV17 & CV18 make Address = 9000
Configuration	CV29	0–255	32	CV29=32 to use long address
Short addr	CV1	1–127	3	CV29=0 to use short address

*Resets to default on power-up

will no longer accept "OPS mode" changes at the *old* address and the user must change the throttle's address to the *new* address before going back into "OPS mode" for any further configuration changes to the ProMini Air. Similarly, if the user changes the value of CV29, then the address for the ProMini Air may have changed from long-to-short or short-to-long address, so the user must change the address on the throttle to communicate with the ProMini Air in "OPS mode" at the *new* address.

A small LCD display can be attached to the ProMini Air, which provides the user with useful information. The LCD shown in Figure 9 displays the ProMini Air's address, Airwire channel number, and power level. The display is a FICBOX IIC/I2C 1602 Serial 5V Blue Backlight LCD Display for Arduino 2560 UNO AVR (which can be purchased here). There are many of these kinds of displays available that use an "I2C" interface, and will probably work. The display requires 5V power and ground, and the display's SCA (Serial DAta) and SCL (Serial CLock) pins connect to the Pro Mini's A4 and A5 pins, respectively. It is crucial to make a contrast adjustment of the LCD using a small screwdriver to adjust the contrast potentiometer on the back of the display. Many users believe the display is defective simply because the contrast setting is wrong. See Figure 9.

A standard Arduino LiquidCrystal_I2C library by Frank de Brabander is included at the GitHub site for the ProMini Air to implement the display functions.

Some final points about the reconfiguration of the ProMini Air:

- While many DCC throttles have alternative methods for re-configuring decoders, such as "Service Mode" and "Quick Decoder Setup", the only method that the ProMini Air will respond to is the very simple "OPS Mode" or "programming-on-the-main mode" that allows specific CVs to be *directly* set.

- Technically the ProMini Air is not a "multi-function" decoder, but we have chosen the addressing and reconfiguration of the ProMini Air as if it were one because the user usually becomes quite adept at quickly:

Figure 9: ProMini Air with an LCD display and DCC Converter/+5V Power Supply

1. changing the decoder address to the ProMini Air's,
2. putting the throttle in "OPS mode",
3. making CV changes to re-configure the ProMini Air,
4. exiting "OPS mode", and finally
5. changing the DCC throttle address back to whatever locomotive the user is trying to control.

8 RF Receiver Compatibility

We have successfully tested the ProMini Air with several wireless, RF receivers, operating in the 902–928 MHz Industrial, Scientific, and Medical (ISM) band, that are designed to interface with onboard DCC decoders: Airwire CONVRTR series; QSI Solutions Gwire; Tam Valley Depot DRS1, MkIII and MkIV; and the Blueridge Engineering ProMini Air receiver.

Table 2: RF Receiver Summary

Name	Channels	Antenna	RF Loss Output	CV27 Relevant?
CONVRTR	0-16	Int or U.FL	DC	Yes
Gwire	0-7	Wire or U.FL	Pulses	No
DRS1, MkIII	16	Wire	Pulses	No
DRS1, MkIV	0-16	Int	Pulses	No
ProMini Air	0-16	SMA or U.FL	Pulses/DC*	No/Yes*

Int=Internal, *software configurable

8.1 Airwire CONVRTR Series

The company CVP manufactures and supports its Airwire series of products that include hand-held wireless DCC-compliant throttles (such as the T5000 and T1300) and receivers, such as the CONVRTR series that seamlessly connects to DCC decoders onboard the locomotive. As a general comment, CVP provides excellent, detailed installation and operation documentation, and that's in part why they are dominant in some segments of wireless model railroad control. The CONVRTR receiver has some sophisticated features, such as setting its Airwire RF channel purely in software, as described in its User Guide.

However, the CONVRTR interacts with the Airwire wireless throttles in ways that make it challenging to transmit "garden variety" DCC wirelessly to the CONVRTR for proper operation. The Airwire throttles transmit numerous DCC "Idle" packets as a "keep-alive" message for the CONVRTR. A red LED on the CONVRTR board indicates received signal quality and flickers least when receiving a large number of DCC Idle packets. The *brightness* of the LED is an indication of received RF power. Typical DCC throttles are not designed with these concerns in mind, and do not output DCC Idle packets often enough to keep the CONVRTR "happy."

To combat this problem, the ProMini Air software intercepts “garden variety” DCC from the throttle and interleaves a sufficient number of DCC Idle packets to communicate successfully with the CONVRTR. The Airwire CONVRTR’s “keep-alive” requirement for numerous “Idle” packets is challenging, so sometimes a reset of the DCC throttle or the ProMini Air is required to initially send enough DCC Idle packets to initiate communication with the CONVRTR.

Like the Gwire receiver below, the Airwire CONVRTR has a U.FL connector for connecting a shielded antenna cable from the receiver to an externally-mounted antenna. An internal antenna option is available as well for CONVRTR mountings that are not surrounded by metal.

8.2 QSI Solutions Gwire

The Gwire receiver operates on Airwire RF channels 0-7, which must be selected from a dial on the device itself and is a suitable wireless DCC receiver for the ProMini Air. A nice feature of this receiver is an onboard U.FL connector (see Figure 10) that allows the user to connect a shielded antenna cable between the receiver and an externally-mounted antenna. The U.FL connector is useful when the antenna must be mounted on the exterior of a metal locomotive or tender shell. See Blueridge Engineering’s website for details on how to interface the Gwire to any onboard DCC decoder. The Gwire presents no difficulties for the ProMini Air transmitter, and you can find it on eBay at reasonably low prices.

8.3 Tam Valley Depot DRS1, MkIII

The DRS1, MkIII receiver operates only on Airwire RF channel 16 (actually 916.49 MHz, which is close enough to Airwire channel 16 at 916.37 MHz) and makes a suitable wireless DCC receiver. This receiver has a long, single-wire antenna that provides efficient RF reception (see Figure 11). However, the user should place this wire outside any metal shell, which may be inconvenient in some mounting applications. The DRS1, MkIII, presents no difficulties for the ProMini Air transmitter. The DRS1, MKIV, described in the next section, supersedes this receiver.

8.4 Tam Valley Depot DRS1, MkIV

The DRS1, MkIV, receiver is a complete departure from the DRS1, MkIII, and operates at the original Tam Valley 916.49 MHz frequency and Airwire Channels 0-16. The DRS1, MkIV, comes with either an internal antenna or a U.FL plug for connecting to an external antenna. The DRS1, MkIV presents no difficulties for the ProMini Air transmitter. This receiver is an interesting choice because it changes channels automatically until it finds sufficient RF signal carrying DCC packets. See Figures 12 and 13.

8.5 Blueridge Engineering ProMini Air Receiver

The inexpensive ProMini Air receiver kit presents no issues when used with the ProMini Air transmitter. This receiver operates on Airwire RF channels 0–16 and requires a separate

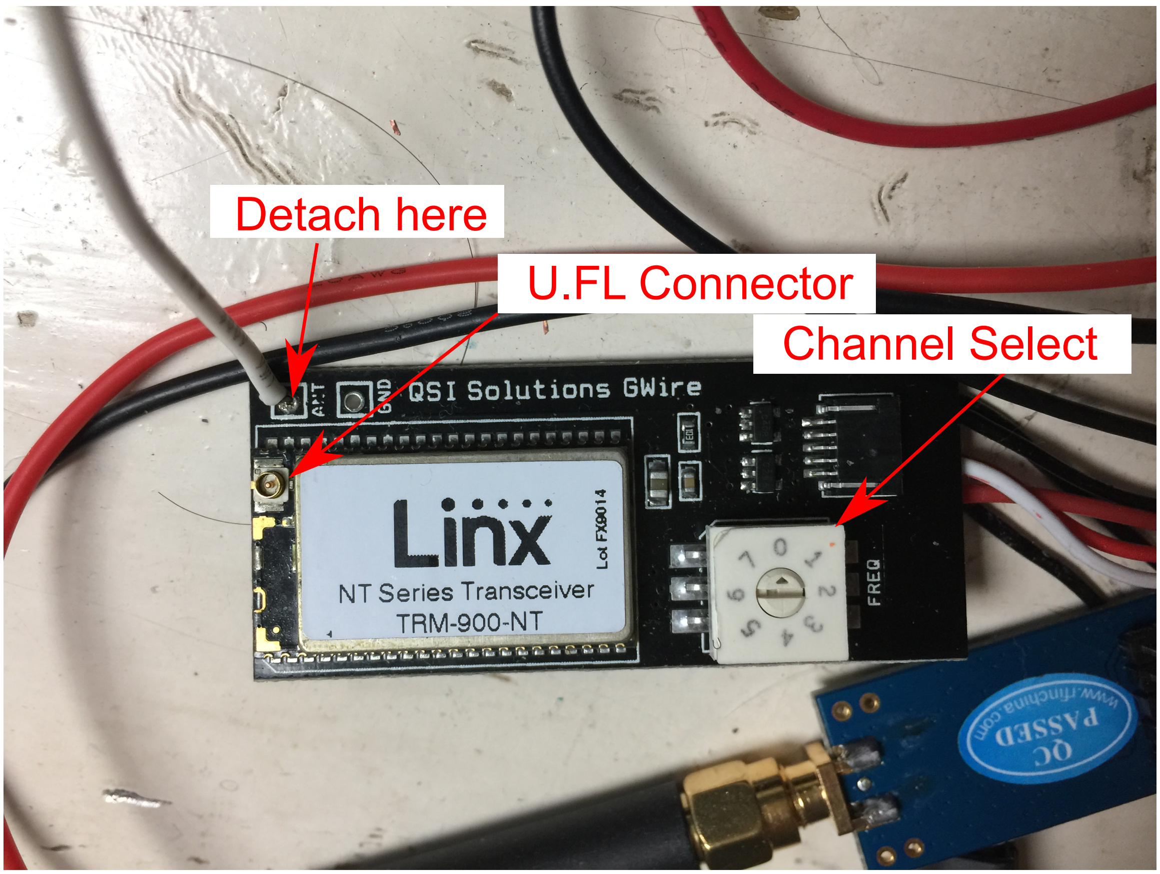

Figure 10: Gwire U.FL connector. If using the U.FL connector, detach the wire antenna.

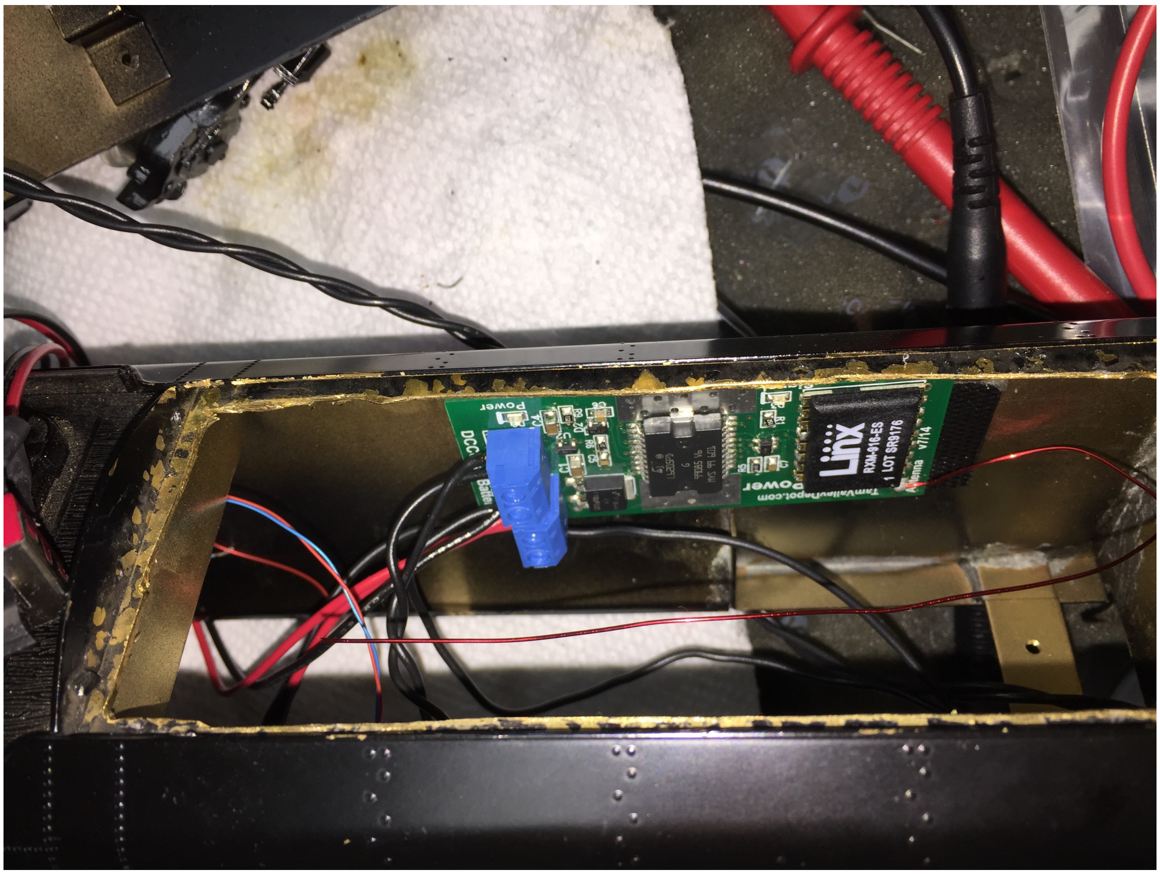

Figure 11: Tam Valley Depot DRS1, MKIII in an open-cavity install. Note the built-in long wire antenna.

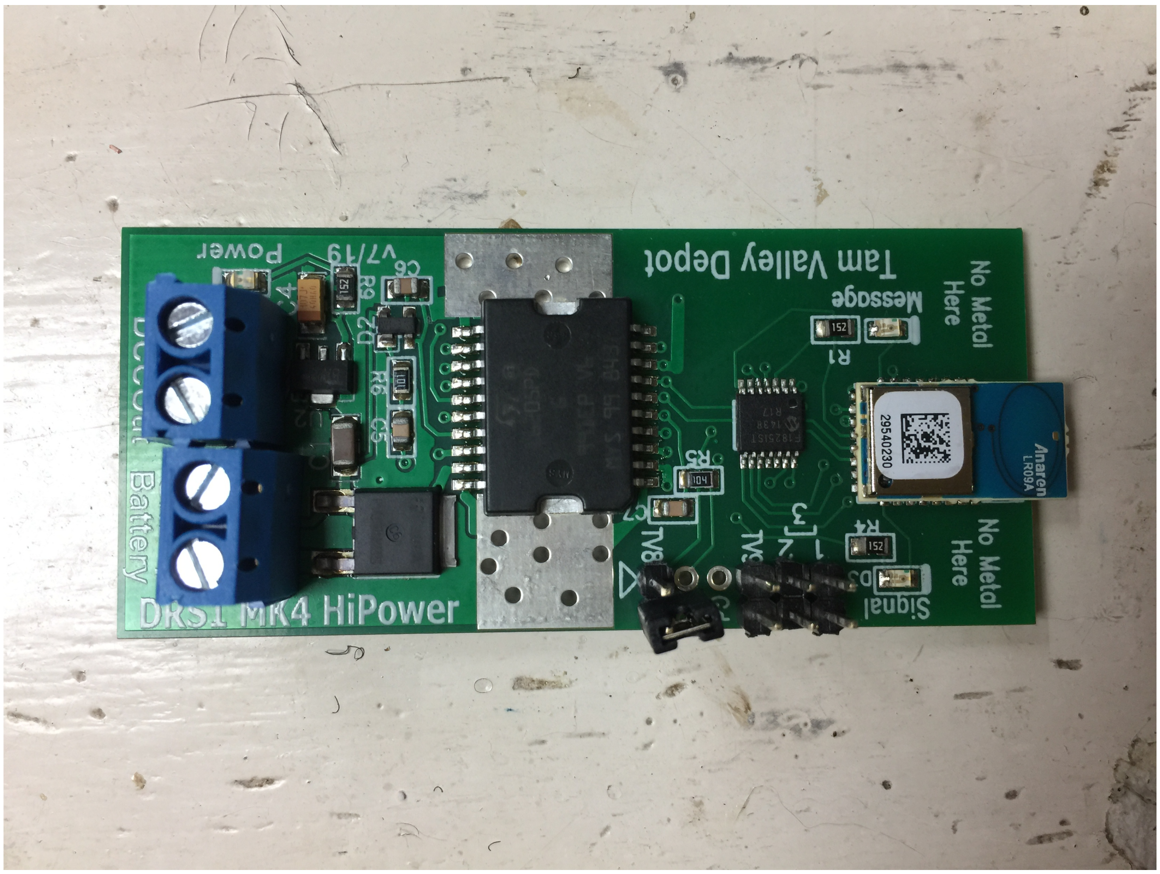

Figure 12: The recently-released Tam Valley Depot DRS1, MkIV receiver. Note the internal antenna on the right side of the board.

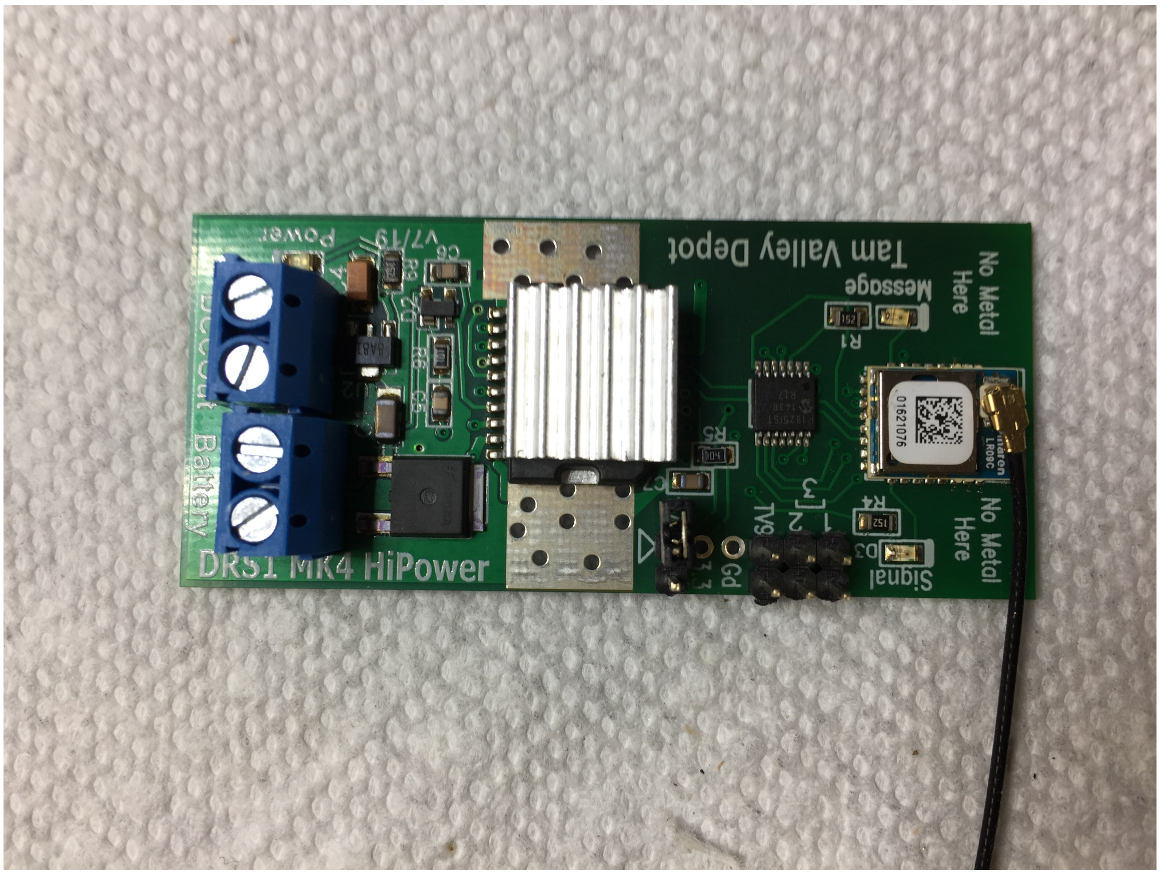

Figure 13: The recently-released Tam Valley Depot DRS1, MkIV receiver with a U.FL plug for connecting to an external antenna.

amplifier to convert the ProMini Air's unipolar 5V DCC to bipolar DCC that provides sufficient power to the decoder. See the Blueridge Engineering web page for details on how to build the kit and connect the ProMini Air to the amplifier that is in turn connected to the onboard DCC decoder.

8.6 Behavior with Loss of RF

The designers of various DCC-compatible RF receivers have a couple of strategies for what output to provide to the onboard DCC decoders when a valid RF signal is lost:

1. Output the random pulses that the RF receiver naturally outputs when a valid RF signal is lost. This option will cause most DCC decoders to maintain direction and speed while the DCC decoder "sifts" the random pulses searching for valid DCC packets.

2. Output a fixed, positive Direct Current (DC) voltage to one of the DCC decoder's "Track" inputs and a zero voltage DC the other "Track" input when either a) valid RF signal is lost or b) for some RF receivers such as the Airwire CONVRTR, it does not receive "keep-alive" DCC packets often enough from the RF transmitter. How the DCC decoder responds to these DC "Track" inputs depends upon DCC decoder configuration and, unfortunately, DCC decoder manufacturer discretion.

There are several NMRA-specified *Configuration Variables* (CVs) that affect how decoders handle the loss of valid DCC packets, which is important to understand when using the ProMini Air transmitter because the RF receivers may lose or receive corrupted RF signal from the ProMini Air transmitter.

The NMRA standard S-9.2.4, Section C "Occurrence of Error Conditions" [3] describes "Multi-Function Digital Decoder shall have a Packet Update time-out value." Further down on line 60, the standard states, "A value of 0 disables the time-out (i.e., the user has chosen not to have a time-out)". This part of the NMRA standard is *not* universally-implemented by manufacturers, and it affects how decoders will respond to the loss of RF transmission of DCC packets. To implement this requirement, the NMRA standard NMRA standard S-9.2.2 [2] has defined the "recommended", but *not* "mandatory", CV11, Packet Time-Out Value. A value of CV11=0 is defined to turn off the time-out, but CV11 is frequently *not* implemented.

However, another CV that *is* often implemented addresses some aspects of the loss of DCC. The "optional" CV27, Decoder Automatic Stopping Configuration, is under re-evaluation by NMRA, but the NMRA has taken no definite action for some time. Here is what the NMRA standard [2] currently (as of 2019) states about CV27:

> Configuration Variable 27 Decoder Automatic Stopping Configuration
> Used to configure which actions will cause the decoder to stop automatically.
>
> Bit 0 = Enable/Disable Auto Stop in the presence of an asymmetrical DCC signal which is more positive on the right rail.
> "0" = Disabled "1" = Enabled

Bit 1 = Enable/Disable Auto Stop in the presence of an asymmetrical DCC signal which is more positive on the left rail.
"0" = Disabled "1" = Enabled

Bit 2 = Enable/Disable Auto Stop in the presence of an Signal Controlled Influence cutout signal.
"0" = Disabled "1" = Enabled

Bit 3 = Reserved for Future Use.

Bit 4 = Enable/Disable Auto Stop in the presence of reverse polarity DC.
"0" = Disabled "1" = Enabled

Bit 5 = Enable/Disable Auto Stop in the presence forward polarity DC.
"0" = Disabled "1" = Enabled

Bits 6-7 = Reserved for future use.

Since DCC decoder manufacturers frequently *do* implement CV27, what electrical output the DCC-compatible RF receiver provides to the DCC decoder upon loss of a valid RF signal will influence how the DCC decoder responds. We will break this down for various brands of DCC-compatible RF receivers *in the 902-928 MHz ISM band* in the following subsections.

Note that some DCC decoders will *not* honor CV27=0; i.e., all auto-stopping features *disabled*. For example, with CV27 set to 0, the Zimo MX-696, and probably other Zimo DCC decoders as well, will continue speed and *forward* direction if *positive* DC level is input to the *"Right Track" DCC input*, and a zero DC level is input to the *"Left Track" DCC input*. Under these "track voltage" conditions, the locomotive will *stop* if originally moving *backward*. Some (but not all) DCC-compatible RF receivers, such as the Airwire CONVRTR, provide these DC inputs, if a valid RF signal is lost, but only if connected correctly.

The "correct" connection relates to how the user connects the DCC output from the RF receiver to the "Track Right" and "Track Left" inputs of the DCC decoder. Under normal circumstances, when there is a valid RF signal, which way the DCC decoder connects to the RF receiver does *not* matter. Under the exceptional case of DC-only output by the RF receiver, if it loses a valid RF signal, which way the DCC decoder connects to the RF transmitter *does* matter. The user will likely want the locomotive to continue *forward* with the loss of a valid RF signal, so some experimentation is required to determine which of the RF transmitter DCC outputs should connect to which of the DCC decoder's "Track" inputs to achieve the desired behavior.

As a further complication, we recommend that the user *turn off* the decoder's "analog" mode of operation by setting Bit 2 of CV29 to 0 to force the decoder to use "NMRA Digital Only" control of "Power Source Conversion" (see [2]). If Bit 2 of CV29 *is* set to 1, and again we emphasize the user should probably *not* activate this feature, then "Power Source Conversion Enabled" and then CV12 determines the power source; the most common of which is CV12=1, “Analog Power Conversion.”

8.6.1 Airwire CONVRTR Series

When the CONVRTR loses a valid RF signal or receives insufficiently-frequent DCC Idle packets, it detects these conditions and sends a fixed DC voltage to the decoder. Consequently, the user *should* set CV27 according to the description above.

While it seems that you would want the locomotive to stop if its RF receiver loses a valid RF signal, consider what might happen in tunnels or remote locations. Getting stuck under these circumstances if a valid RF signal is lost is probably not what the user wants, so we strongly suggest that the user set CV27=0.

The user is cautioned, however, that some DCC decoders, such as the new ESU LokSound 5 L DCC, do *not* honor the CV27=0 setting unless the decoder’s ”Track Right/Left” is connected ”correctly” to the CONVRTR’s ”A/B” output. Experimentation may be required to determine the correct connection, but my experience is the following: CONVRTR A <–> Decoder Track Right & CONVRTR B <–> Decoder Track Left.

8.6.2 QSI Solutions Gwire and Tam Valley Depot DRS1 Series

The QSI Solutions Gwire and Tam Valley Depot DRS1, MkIII and MkIV DCC-compatible RF receivers will output random pulses to the onboard DCC decoder when a valid RF signal is lost, so setting CV27 is probably of no use. On the “plus” side, most DCC decoders will maintain locomotive direction and speed in the presence of these random pulses since the DCC decoder is actively sorting through these pulses for valid DCC packets, which is usually the behavior the user wants.

This Blueridge Engineering webpage describes how to easily modify the GWire for use as an RF receiver for any onboard DCC decoder.

8.6.3 Blueridge Engineering ProMini Air Receiver

The Blueridge Engineering ProMini Air receiver has a default long address of 9001. Like the ProMini Air transmitter, the ProMini Air’s receiver’s channel can be reset in “OPS Mode” by setting CV255 to a value in the range of 0—16. The ProMini Air receiver has the following options when a valid RF signal is lost:

- Output random pulses to the onboard DCC decoder: The user can set the ProMini Air receiver to output the random pulses when it loses a valid RF signal by setting CV246 to 0 in “OPS mode” at the ProMini Air’s address. In this case, setting CV27 for the onboard DCC decoder is not relevant, because the random pulses from the ProMini Air receiver will cause the on-board DCC decoder to maintain speed and direction of the locomotive while it is “sifting” through the random pulses for valid DCC packets.

- Output either fixed positive or negative voltage DC to the onboard DCC decoder: In this case, setting CV27 for the onboard DCC decoder at *its* address *is* relevant. The user can set the ProMini Air receiver to output fixed DC voltage when it loses a

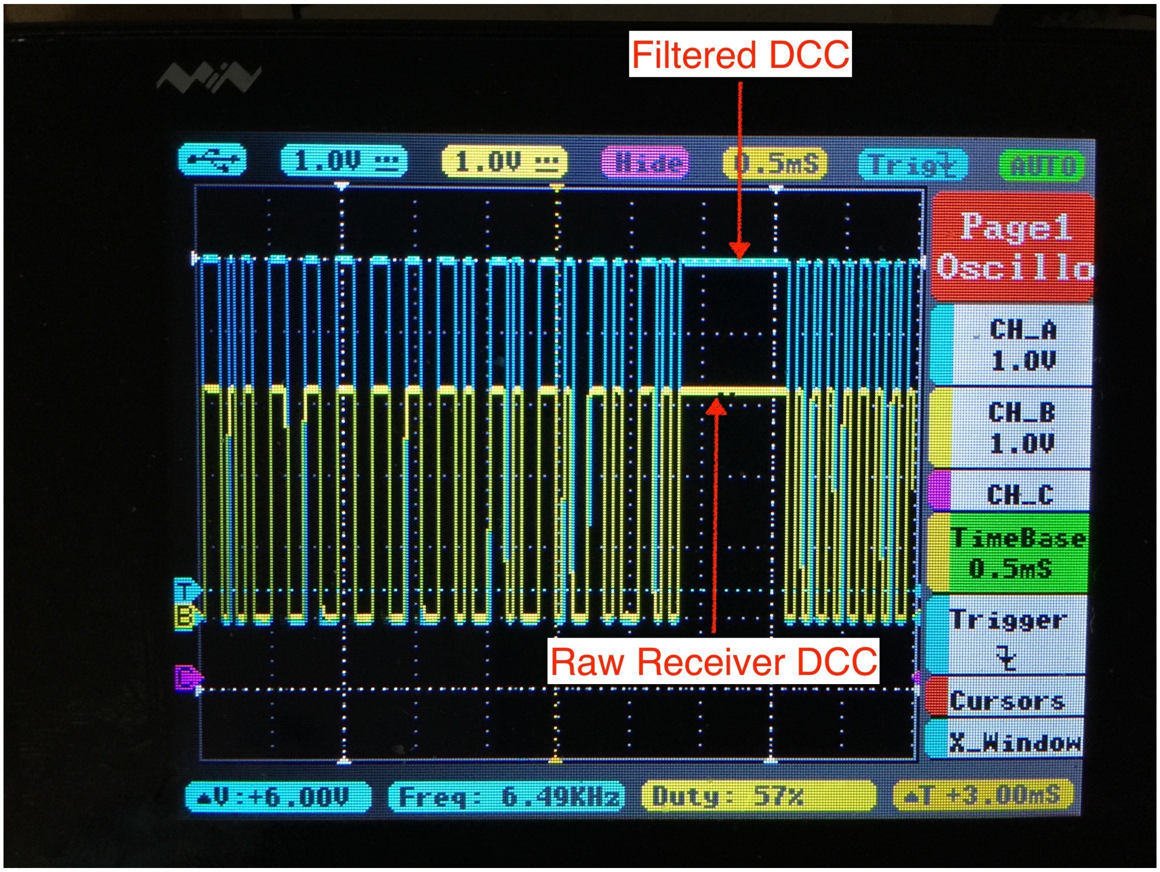

Figure 14: ProMini Air's raw transceiver and filtered DCC outputs with valid RF DCC signal

> valid RF signal by setting CV246 to 1 in "OPS mode" at the ProMini Air's address. A positive DC voltage is output by setting the ProMini Air receiver's CV248 to 1 in "OPS mode" at the ProMini Air's address, or a negative DC voltage is output by setting CV248 to 0. If the user does not want the locomotive to stop with the loss of a valid RF signal, then set CV27=0 for the onboard DCC decoder at *its* address. Of course, setting CV27 to other values (see above) in the DCC decoder will determine how the DCC decoder responds to the fixed DC voltage that the ProMini Air outputs to the onboard DCC decoder upon loss of a valid RF signal.

See Figures 14, 15, and 16 for how the ProMini Air can be configured.

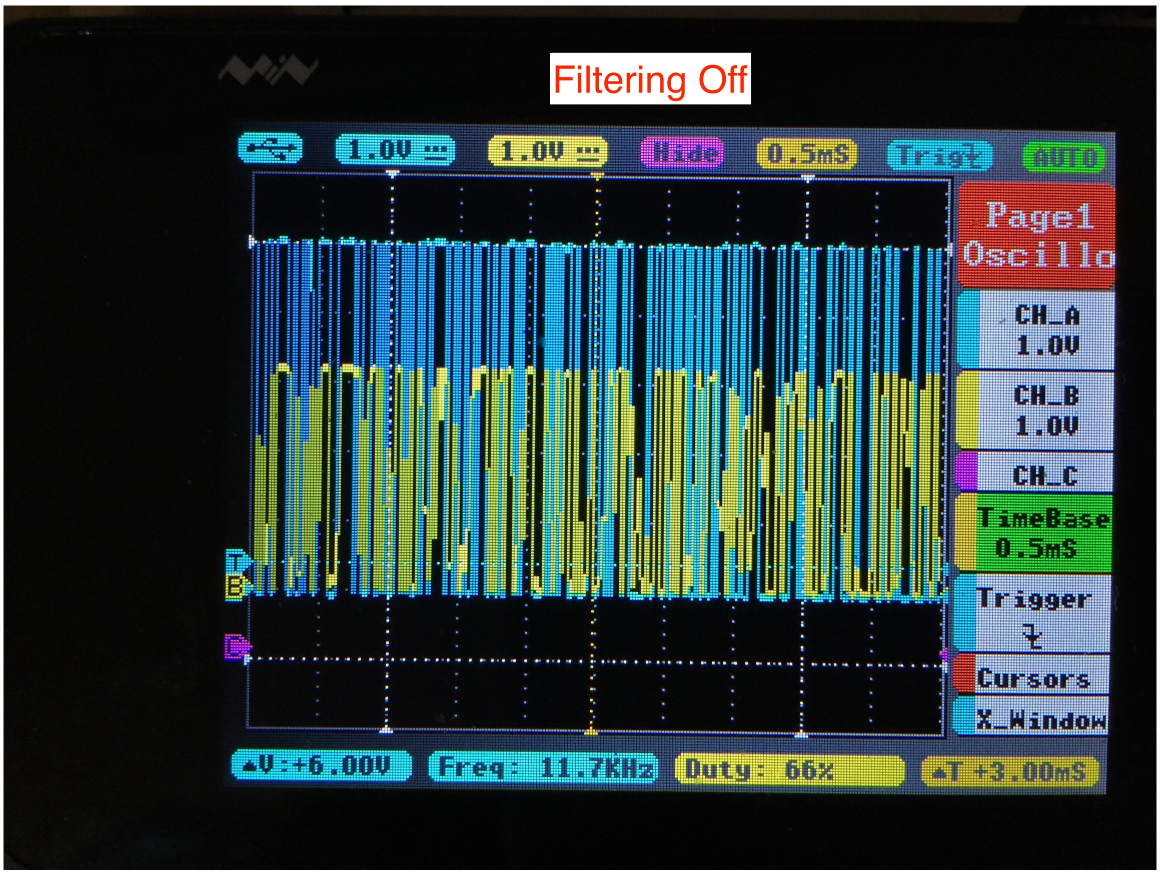

Figure 15: ProMini Air's raw transceiver and filtered DCC outputs with no valid RF DCC signal and filtering off (CV246=0). This is the output produced by the Gwire and Tam Valley Depot receivers.

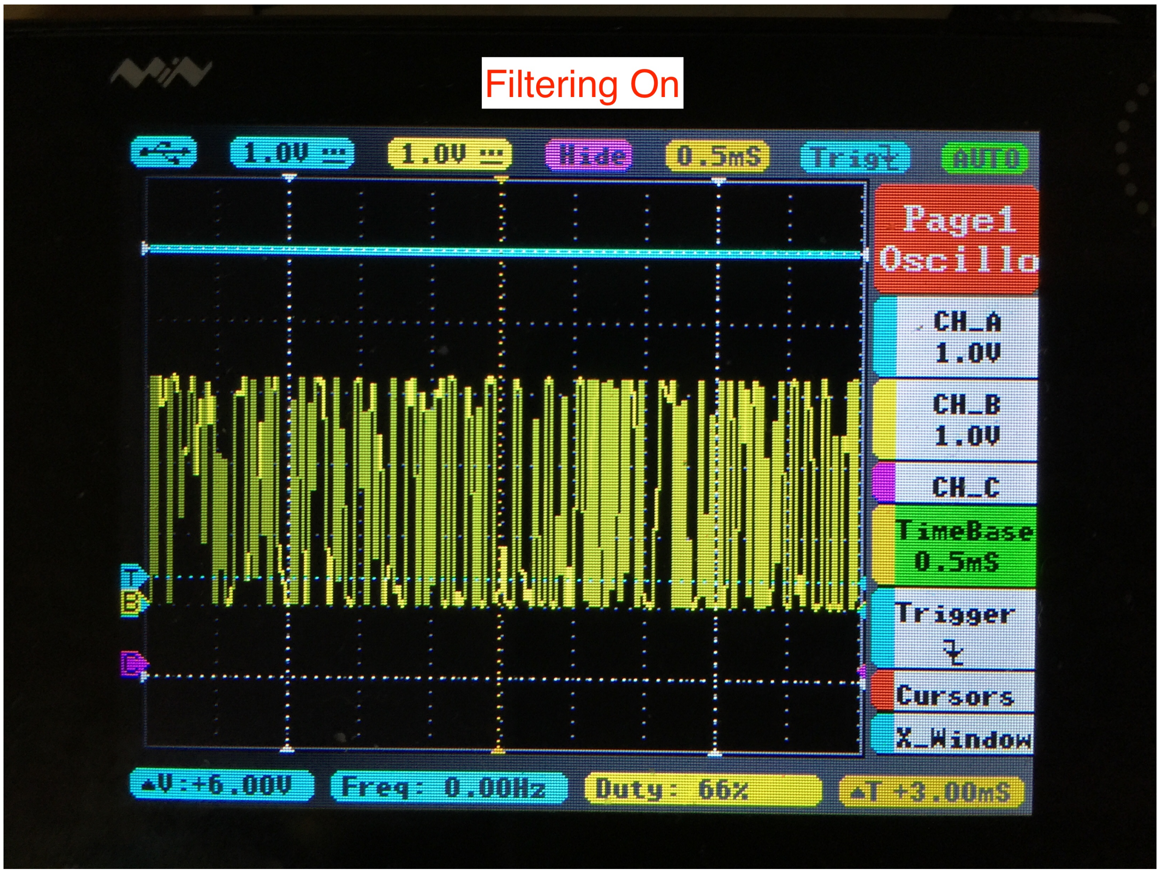

Figure 16: ProMini Air's raw transceiver and filtered DCC outputs with no valid RF DCC signal and filtering on (CV246=1, CV248=1). This is the output produced by the Airwire CONVRTR as well.

References

[1] Anonymous. Communications Standards For Digital Command Control, All Scales. NMRA Standard S9.2, National Model Railroad Association, Inc., National Model Railroad Association, Inc., P.O. Box 1328, Soddy Daisy, TN 37384-1328, July 2004. https://www.nmra.org/sites/default/files/s-92-2004-07.pdf.

[2] Anonymous. Configuration Variables For Digital Command Control, All Scales. NMRA Standard S9.2.2, National Model Railroad Association, Inc., National Model Railroad Association, Inc., P.O. Box 1328, Soddy Daisy, TN 37384-1328, July 2012. https://www.nmra.org/sites/default/files/standards/sandrp/pdf/s-9.2.2_decoder_cvs_2012.07.pdf.

[3] Anonymous. Fail-Safe Operating Characteristics For Digital Command Control, All Scales. NMRA Standard S9.2.4, National Model Railroad Association, Inc., National Model Railroad Association, Inc., P.O. Box 1328, Soddy Daisy, TN 37384-1328, July 2012. https://www.nmra.org/sites/default/files/s-9.2.4_2012_07.pdf.

[4] Anonymous. Understanding Antenna Specifications and Operation. Application Note AN-00501, Linx Technologies, 159 Ort Lane, Merlin, OR, US 97532, 2012. https://www.linxtechnologies.com/wp/wp-content/uploads/an-00501.pdf.

Abbreviations/Acronyms

DCC Digital Command Control

ISM Industrial, Scientific, and Medical

LCD Liquid Crystal Display

NMRA National Model Railroad Association

PCB Printed Circuit Board

RF Radio Frequency

Glossary

I2C Inter-Integrated Circuit, sometimes abbreviated "IIC." A synchronous, multi-master, multi-slave, packet switched, single-ended, serial computer bus invented in 1982 by Philips Semiconductor (now NXP Semiconductors).

ISM Band For the purposes of this document and for the US only, the 902–928 MHz RF band reserved for: "Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications." Other ISM bands exist as well, both in the US and internationally.

OPS Mode "Operations Mode" or "Programming-On-the-Main" (PoM). The mode of a DCC throttle that can change the configuration variables for a DCC decoder at a specific address while the locomotive or device is operating.