Grandpa's Railroad Control Panel User's Manual

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1 Introduction

Grandpa's Railroad is an integrated hardware and software system designed to provide **computerized control** for model trains. It caters to a wide range of model train enthusiasts, from beginners to seasoned club members. Our primary objective, which we successfully achieved, was to develop a user-friendly system requiring no programming expertise and minimal hardware setup. The system offers highly realistic automation, including signals, gates, flashers, locomotive sounds, speed control, and more—all at an affordable price.

Grandpa's Railroad Control Panel offers a sophisticated computerized interface for model train operations, enabling control of turnouts, sensors, signals, and even locomotives based on their positions on the layout, when paired with **Grandpa's Railroad DCC Throttle**. The system is centralized, with all data routed to a single Windows 11 Mini PC, which handles all computational tasks for the control panel. This ***centralized*** design allows for the use of advanced algorithms to process data seamlessly, without the user needing to be aware of the complexities involved. For example, IR proximity locators—typically affected by varying lighting conditions—can be continuously recalibrated, effectively eliminating these issues. Additionally, in a centralized system, each component can operate independently, meaning they aren't restricted to a specific function. This flexibility allows devices like proximity locators to serve multiple purposes, such as activating crossing flashers, managing train traffic signals, supporting collision avoidance, and even enabling animation, all within one integrated system.

1.1 Trading Wires for WIFI

Centralized systems often face challenges due to the extensive wiring needed to transmit data to a central processing unit and the significant space required for boards that digitize and manage this data. The abundance of wiring makes centralized control in modular layouts nearly unfeasible. Grandpa's Railroad addresses these issues by digitizing and processing data locally—near its source—and then transmitting it to and from the centralized system via Wi-Fi. Depending on the router used, data can be reliably transmitted over several hundred feet, accommodating even very large layouts. Currently, Grandpa's Railroad software supports up to 32 Wi-Fi modules, which come in two types: Digital/Proximity

modules and RFID/Analog modules. The Digital/Proximity Wi-Fi module can handle up to 16 digital I/O elements and 16 proximity locators. Since a turnout requires only one digital I/O connection, this setup allows for up to 512 turnouts and 512 proximity locators on a single control panel if only this type of module is used. The RFID/Analog module can manage two RFID readers and two analog inputs.

1.2 Dedicated Processor and Router for Reliable Operation

Grandpa's Railroad software comes pre-installed on a Windows 11 Mini PC to eliminate installation issues. Anyone who has used a Windows PC has likely encountered a newly installed software package requesting system changes. These changes can sometimes modify dynamic link libraries or drivers, which may not be compatible with our software—games, in particular, are known for this. Rather than troubleshooting installation problems on older computers or handling potential claims that our software "doesn't work," we provide customers with a pre-installed, pre-tested system.

This does not mean you cannot install additional reliable software, such as Microsoft Office, later. The Mini PC we provide is more than capable of handling such applications. While we do not guarantee a specific brand, we ensure that the PC includes two 4K display ports. This allows you to use multiple displays for your layout and provides room for future model train control enhancements without requiring you to purchase a new Mini PC.

Most homes have a Wi-Fi router, typically used for streaming, gaming, and other bandwidth-intensive applications. These activities can quickly consume a router's capacity. Since small routers are inexpensive, we strongly recommend using a dedicated router for Grandpa's Railroad. While you can use your existing home router, be mindful of potential bandwidth limitations. To simplify setup, we've included a pre-installed software application to program our Wi-Fi modules for your router.

1.3 Ease of Use

From its inception, Grandpa's Railroad was designed with simplicity in mind. Our goal was to create a system that anyone could use, provided they possess basic skills such as counting, adding, using a screwdriver, handling pliers, and operating a Windows PC. We are confident we have achieved this goal.

No programming knowledge is required to operate the system. The setup process is straightforward, utilizing conventional dialog boxes—many of which include illustrations to guide users through data entry. Additionally, the software features robust error-checking mechanisms to detect potential issues or missing inputs.

Despite its ease of use, the system does not compromise on flexibility or sophistication. Behind the scenes, advanced algorithms power its various features, but users are not required to interact with or understand these complexities.

1.4 Educational Benefits

One of the key goals of Grandpa's Railroad is to inspire young people's interest in science and engineering. We believe that many young individuals are naturally drawn to both model trains and computers, so we have combined the two. Scientific and engineering creativity can be just as fulfilling as art or music, and we aim to encourage that exploration.

To support this, we are developing a video course on electricity designed for absolute beginners—those with no prior knowledge of the subject. While the course is not specifically for children, it serves as a resource for parents, grandparents, group leaders, and mentors who want to help younger learners grasp the fundamentals. Typically, introductory courses are labeled as "101" (e.g., Cooking 101, Sewing 101). However, our course is called *Electricity 99* because it starts at an even more basic level, beginning with the atom and building from there.

Since hands-on learning is crucial to understanding, we encourage viewers to replicate the experiments demonstrated in the videos. These videos are available on our website, **GrandpasRR.com**, and our YouTube channel, **Grandpa's Railroad**.

Additionally, Grandpa's Railroad software includes various features that provide visual insights into its data. For example, users can view plots of data captured by IR proximity locators (see **Section 3.6.4** for details).

We also encourage our users to share the creative animations and unique implementations they have developed using Grandpa's Railroad.

1.5 User Manual Outline

Grandpa's Railroad Control Panel Software operates in three modes:

1. **Layout Setup**
2. **Control Panel Setup**
3. **Control Panel**

The first mode, **Layout Setup**, involves defining the layout of your model railroad, including the placement of tracks, turnouts, and other elements.

The second mode, **Control Panel Setup**, focuses on configuring how the layout elements interact with the hardware, ensuring proper connections and functionality.

The third mode, **Control Panel**, is where you operate the control panel to manage your model railroad. The first two steps typically need to be completed only once unless you make modifications or expansions to your layout. Since the control panel is software-based, expanding your layout is straightforward.

Overview of the Manual

- **Chapter 2** covers the initial steps in building a control panel, including defining the layout size, selecting a layout type, and customizing turnouts if needed.
- **Chapter 3** provides a comprehensive guide to each layout element, addressing both hardware and software setup, along with practical examples.

- **Chapter 4** explores software tools that assist in control panel development, such as axes, grids, connection viewing and printing, problem-checking features, and customization options.
- **Chapter 5** delves into advanced topics, offering insights, best practices, and detailed instructions for integrating specific features into your layout.

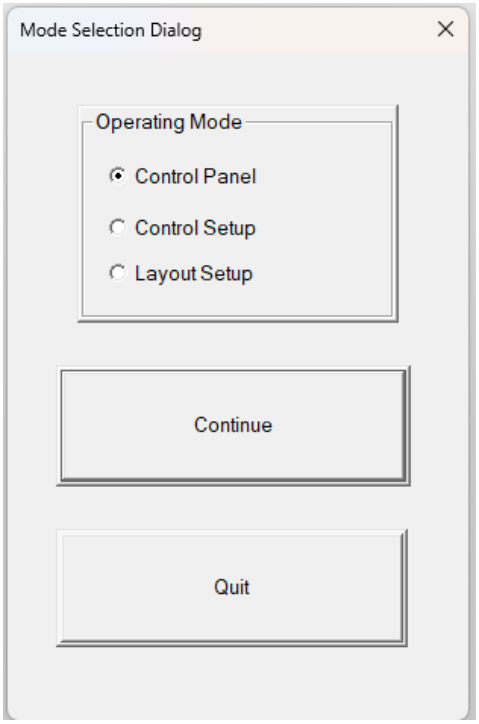
This structured approach ensures a clear and efficient process for setting up and managing your Grandpa's Railroad control panel.

2 Layout Basics

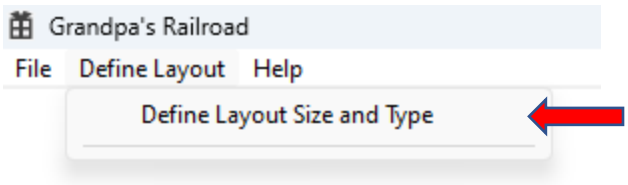
The first step in defining a layout is determining its size and type. Additionally, this chapter covers the process of defining custom turnouts, which may be necessary before beginning layout construction, especially if you have hand-built turnouts or ones not included in our list. If you are using an RFID reader to identify locomotives, RFID tag data is required. This data enables the transmission of DCC commands to **Grandpa's Railroad DCC Throttle** Software, allowing it to activate various functions for specific locomotives.

2.1 Defining the Layout Size and Type

When you first start the software, a dialog box will appear, prompting you to select the basic mode. To begin, choose **Layout Setup**.

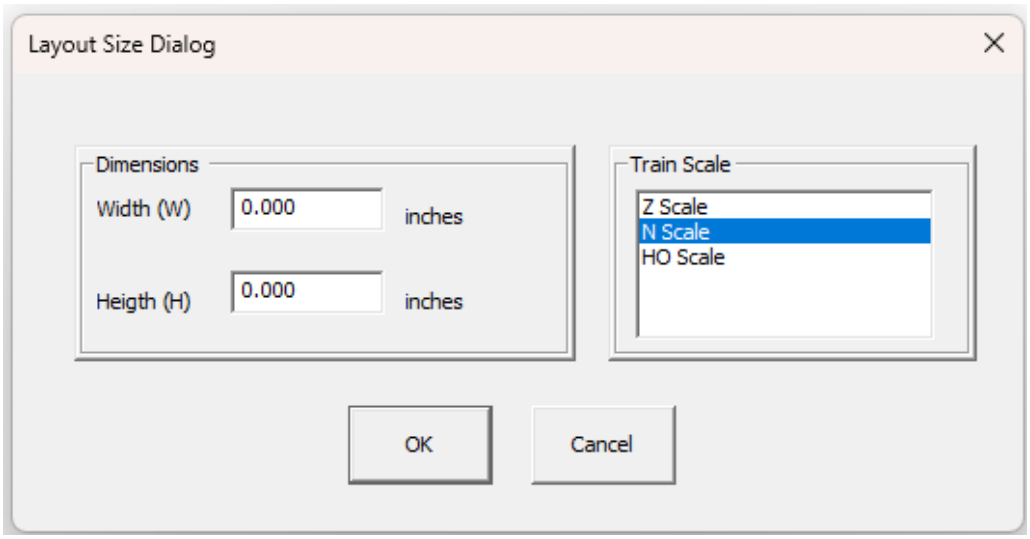


After that, from the main menu at the top of the screen, navigate to **Define Layout** and select **Define Layout Size and Type**.



Define Layout/Define Layout Size and Type

This will bring up the layout definition dialog box.



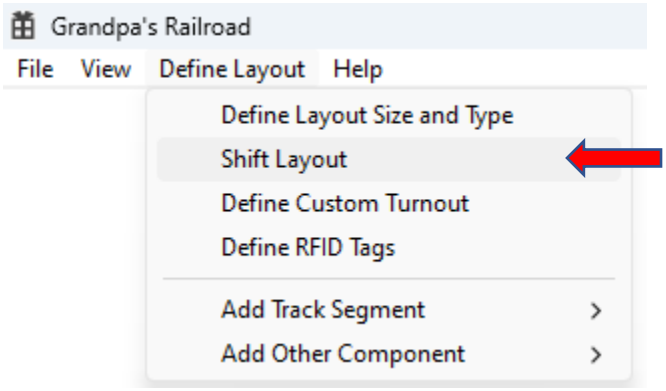
In this dialog, you'll be asked to enter the dimensions of the smallest rectangle that can completely enclose your entire layout, even if the layout itself is not rectangular in shape. The dimensions should always be entered in inches. This step is essential as it helps define the overall space for your layout, ensuring the software knows the maximum boundaries of your setup.

Before exiting the dialog, be sure to select the appropriate train scale for your layout. Currently, only **N** and **HO** scales are supported. Although **Z** scale is listed as an option in the dialog, it is not yet supported in this version of the software, so be sure to select one of the available options.

Once you've defined the size and type of your layout, you will notice additional menu options appear. These new options will allow you to further define and add various elements to your layout, such as track segments, borders, buildings, buttons, proximity locators, and more. This enables you to continue building your layout with the specific components that fit your needs.

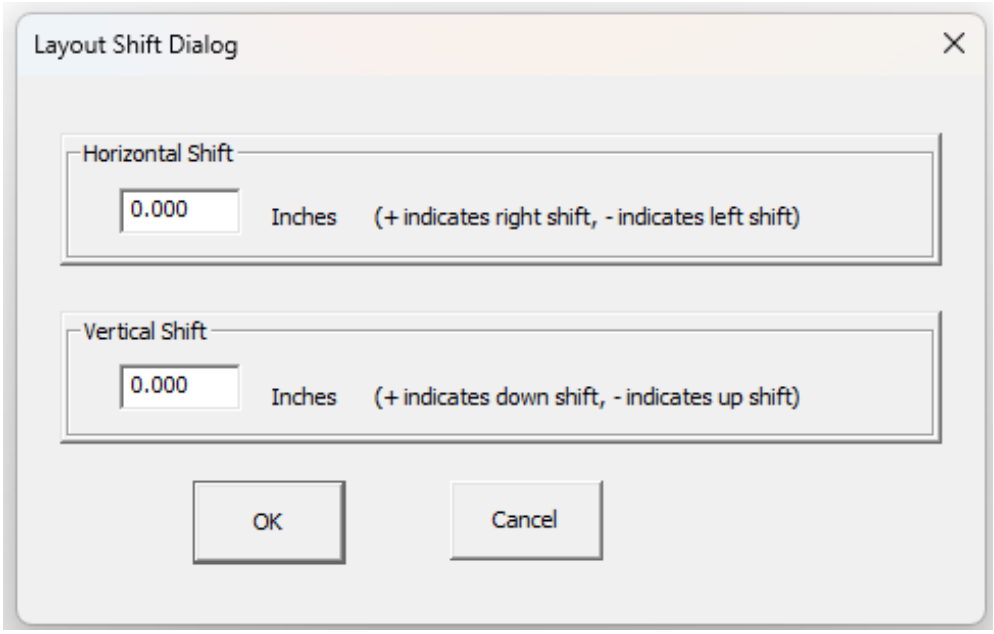
2.2 Shifting the Layout

If you want to expand your layout or create additional space on your control panel to add buttons along the edges, this can be easily done by accessing the "Define Layout Size and Type" option in the Layout Setup mode. When the dialog appears, simply increase the height or width to your preferred size. The extra space will be added to the right and/or bottom of the layout. To add the space to the left or top of the layout instead, shift the layout by selecting the following option:



Define Layout/Shift Layout

Upon selecting this menu item, the following dialog will appear.

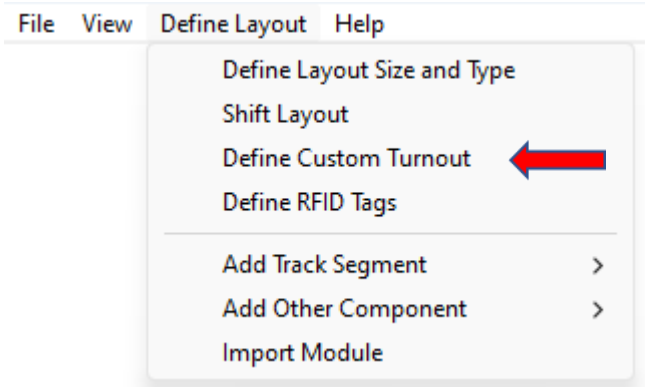


You can now enter the desired left or right shift for your layout.

2.3 Defining Custom Turnout

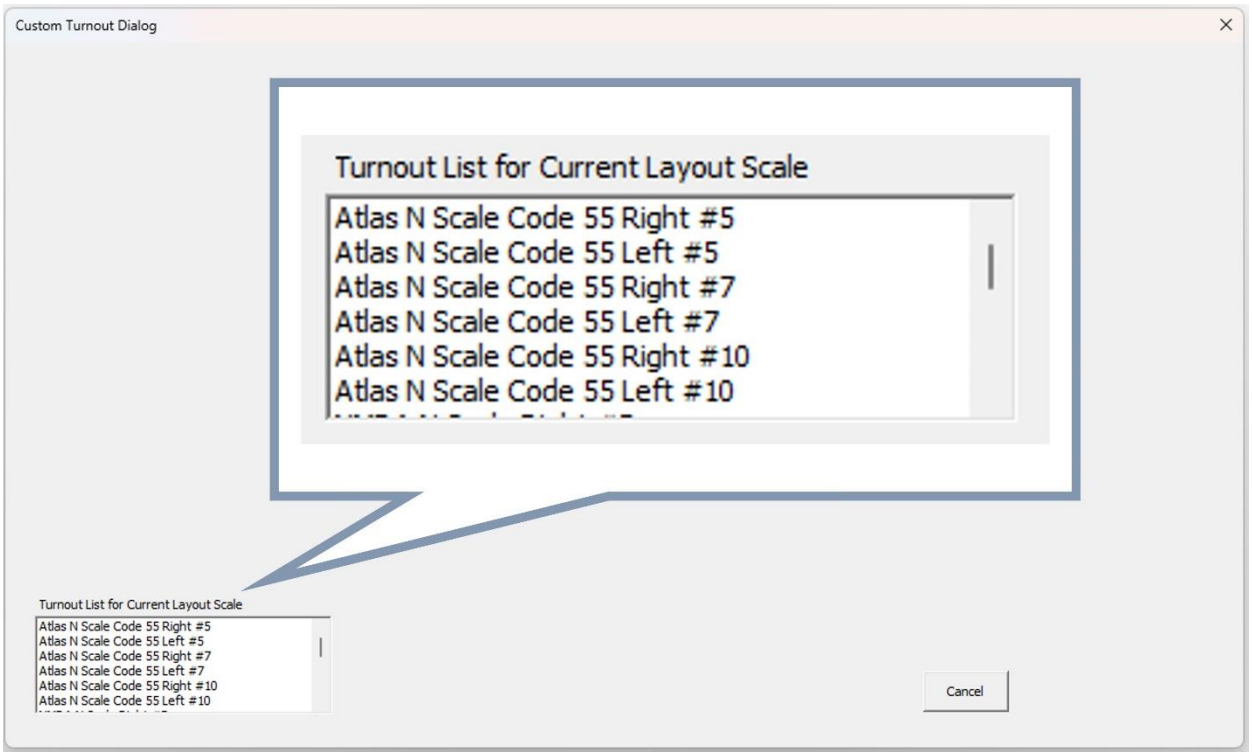
If you have turnouts from a manufacturer not listed or custom-made ones, you can add them to the turnout list by using the "**Define Custom Turnout**" option. This will appear once the train scale is set.

To add a custom turnout, select:



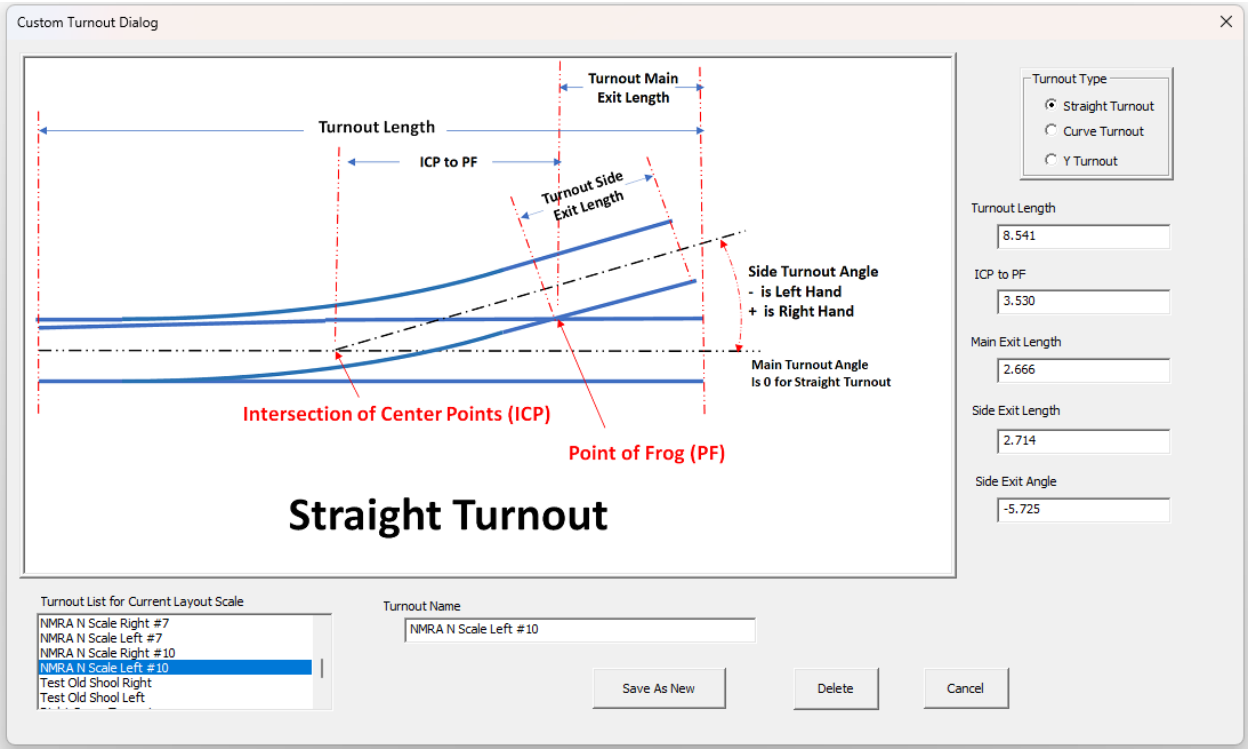
Define Layout/Define Custom Turnout

When you select this option, a dialog box will open.



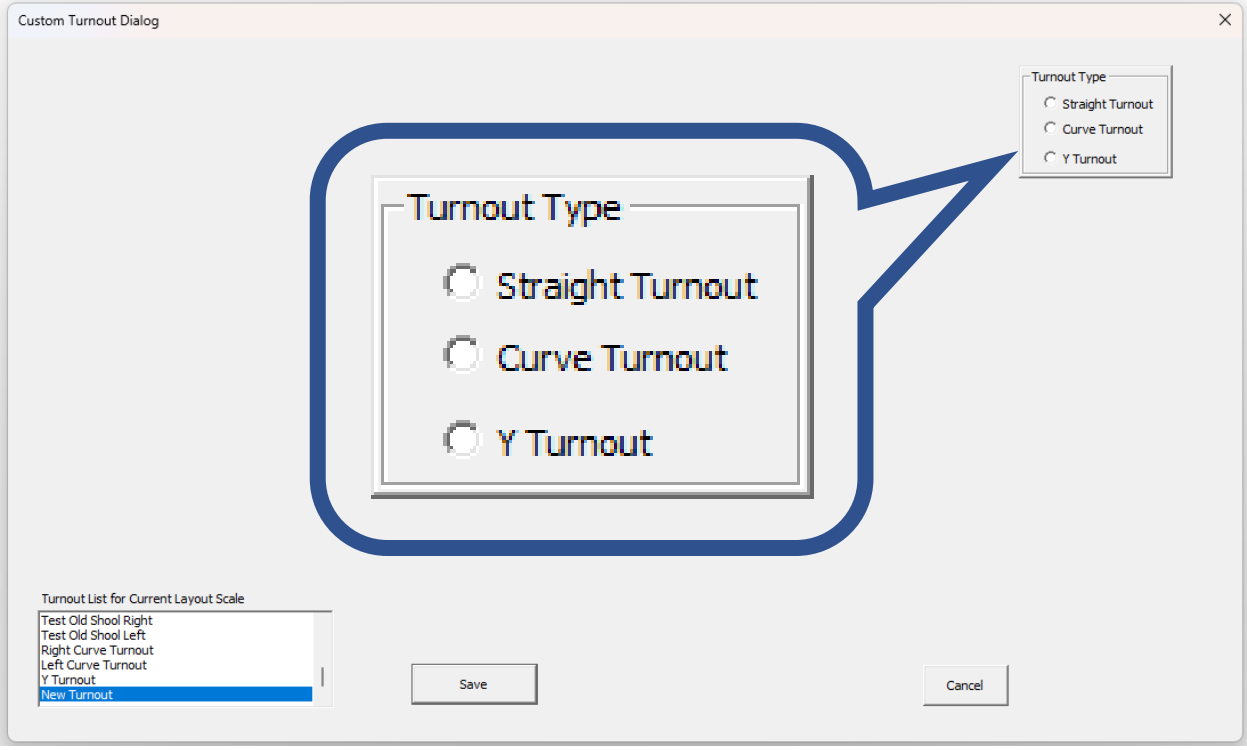
In the bottom corner, you'll see a list of turnouts currently defined for the selected layout scale. You can either select an existing turnout to modify or create a new one by choosing "New Turnout" at the bottom of the list.

If you select an existing turnout, the dialog will populate with its parameters and display an image to visually illustrate these settings.

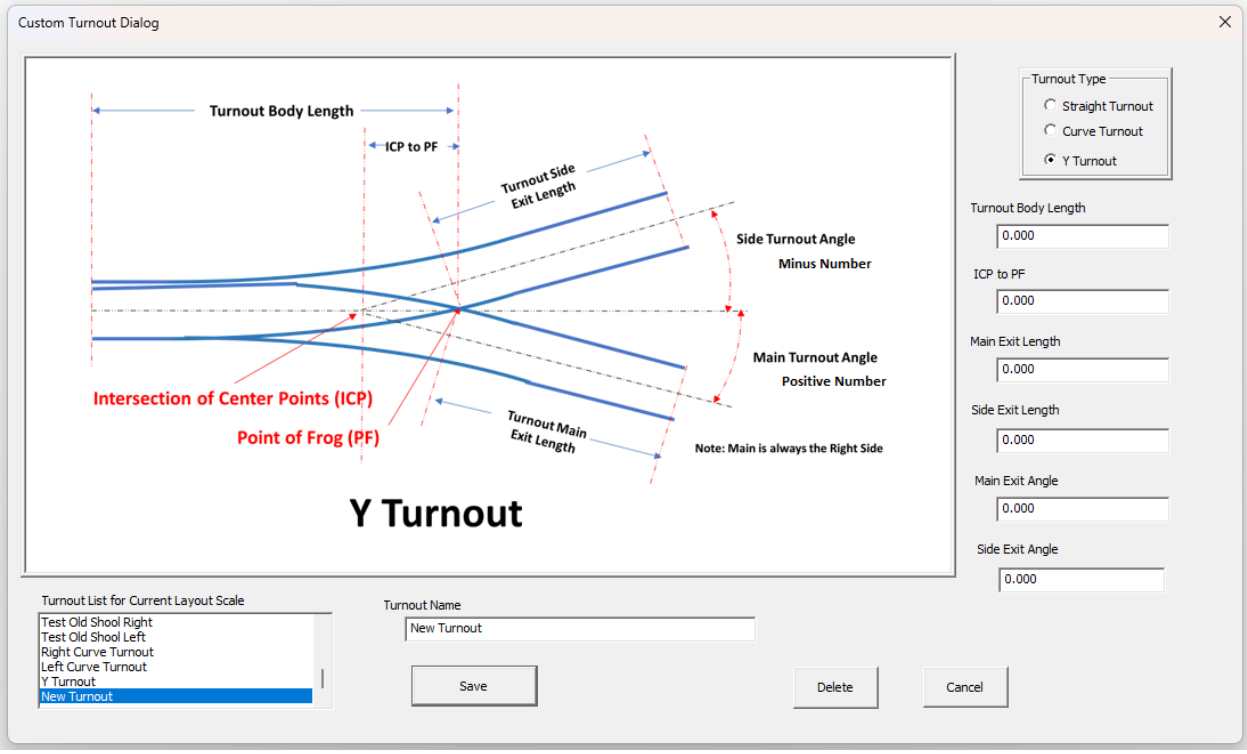


You can then edit the parameters and either save the changes or save them under a new name.

If you select "**New Turnout**," the dialog will update, allowing you to choose the type of turnout.



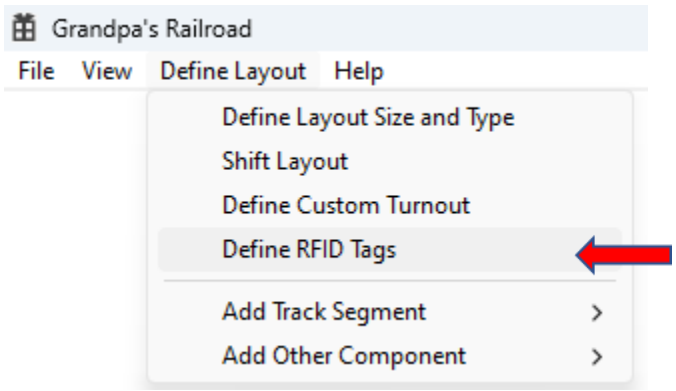
Once you select a type, the relevant parameters and an image to illustrate them will appear. For example, a Y-turnout will display the corresponding parameters.



After entering the necessary data, click "**Save**" to store the definition under the chosen **Turnout Name**. If the data is incorrect, an error message will appear, detailing what needs to be corrected.

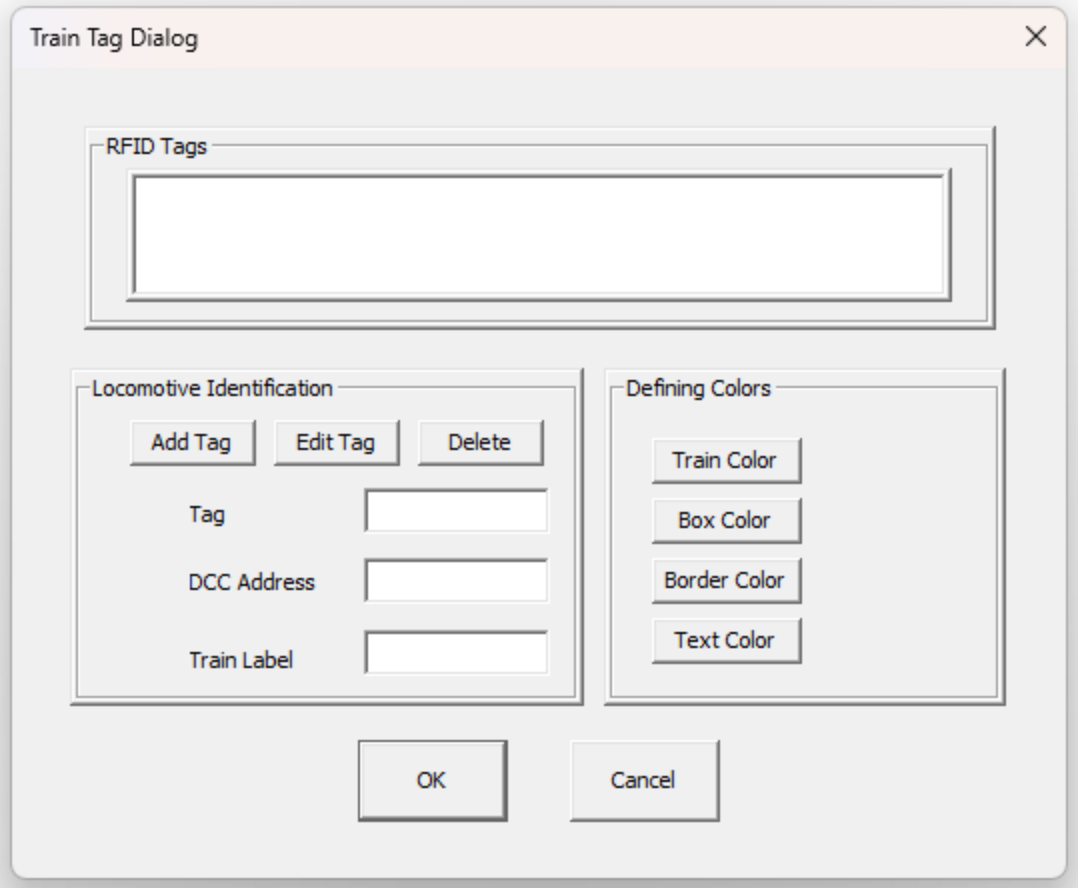
2.4 Defining RFID Tags

RFID Tag data is required if you're using an RFID reader to identify locomotives. This data enables the sending of DCC commands to **Grandpa's Railroad DCC Throttle Software**, activating various locomotive functions. To input this data, select the following menu option:



Define Layout/Define RFID Tags

Upon selecting this menu item, a dialog box will appear.



Once you have installed an RFID Tag on a locomotive the first thing is to determine the identifier or Tag number. This is done by running the locomotive over an RFID reader that you have installed on your layout and read the identifier from the display. (If you have not entered tag data for the tag yet, the identifier will be displayed.)

After you obtain the tag number you can enter it in the tag box above along with the locomotive DCC address and the label you wish to be displayed as the train passes over the reader. Also, by pressing the buttons in the Defining Colors group a dialog will appear allowing you to choose a color for each category. The categories are:

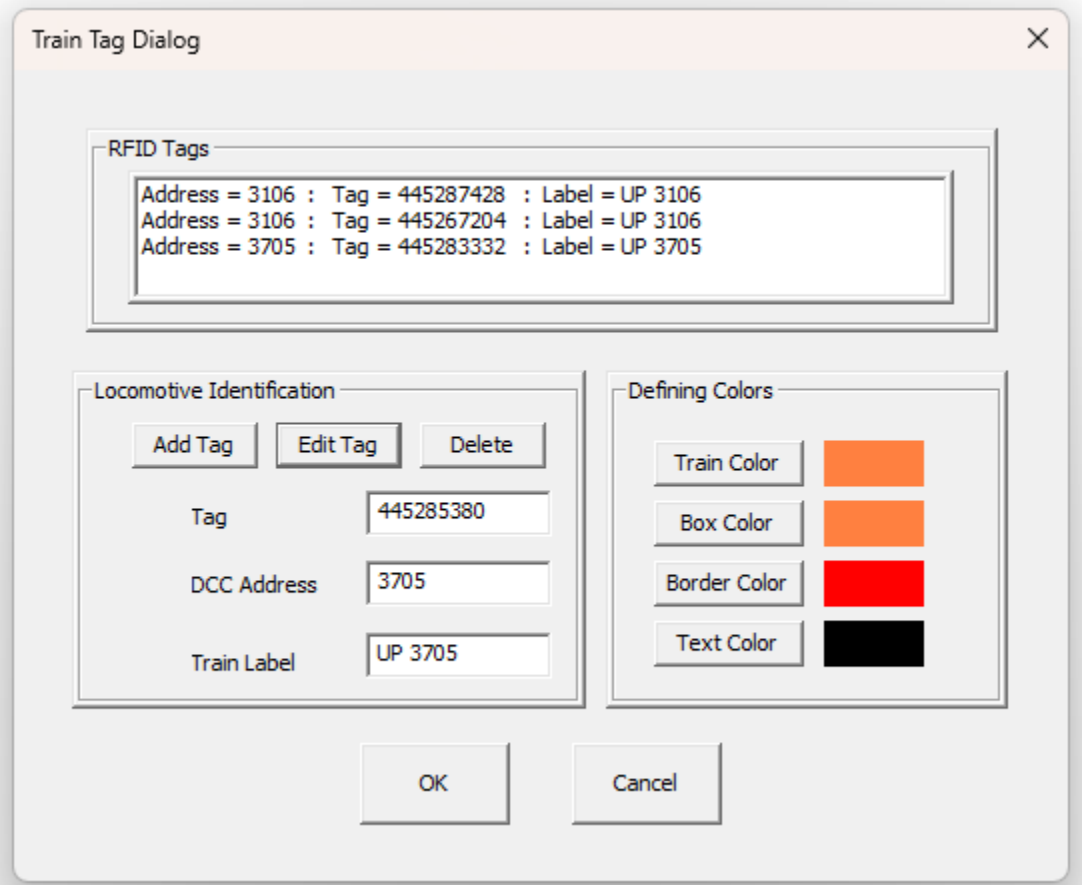
- **Train Color** Color the proximity locator will change when the train activates it.
- **Box Color** Color the RFID reader display background will change when the tag is read.

- **Border Color** Color the RFID reader display border will change when the tag is read.
- **Text Color** Color the RFID reader display text will change when the tag is read.

After adding all the data, you can left click with your mouse on the *Add Tag* button to add the data to the list.

You can edit or delete a code by highlighting it in the list box (clicking it with the left mouse button) and then pressing the *Edit Tag* or *Delete* button.

An example of the dialog with tag data is shown below:



If you look closely, you'll notice that more than one tag can be defined with the same locomotive address. It's possible to use multiple tags on a single locomotive. Our tags and readers have been tested at 100 scale miles per hour with over a

95% success rate in tag reading. (Success depends on tag placement, reader installation, distance between the tag and reader, and the time the tag spends crossing the reader.) If you have a high-speed train running at scale speed, adding a second tag can increase the likelihood of identification. The second tag should be placed at the opposite end of the locomotive, not next to the first.

3 Adding an Element to Your Layout

Each element in a layout may have unique hardware requirements and functions to be executed in each software mode. The process of adding an element to your layout will be thoroughly explained, covering the following areas (if applicable):

1. Hardware Requirements
2. Adding to the Layout
3. Control Panel Setup
4. Control Panel Operation
5. Special Considerations
6. Practical Example

The table below outlines each element and includes quick links to their respective sections.

Element	Section
Adding Straight Track	3.1
Adding Curved Track	3.2
Adding Turnout	3.3
Adding Border Line	3.4
Adding Button	3.5
Adding Proximity Locator	3.6
Adding Gate, Signal, or Animation	3.7
Adding Collision Avoidance	3.8
Adding DCC Event or Sequence	3.9
Adding Digital Input for Control Panel	3.10
Adding Digital Input for DCC Panel	3.11
Adding Analog (Speed) Input for DCC Panel	3.12
Adding RFID Reader	3.13
Adding WIFI Module	3.14
Adding Legend	3.15

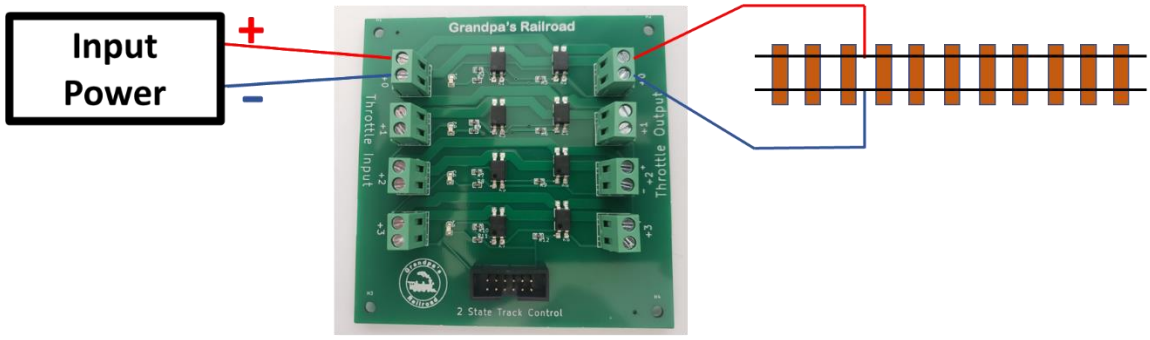
3.1 Adding Straight Track

A straight track section isn't defined by a specific length; rather, it can refer to a continuous straight section made up of multiple individual pieces.

3.1.1 Hardware Required

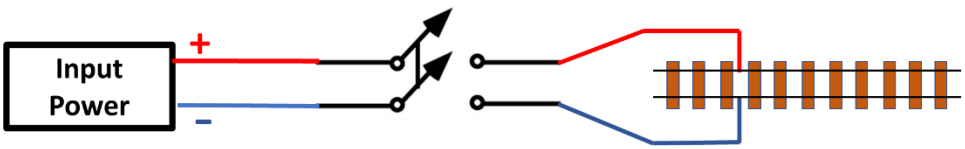
Hardware is only necessary if you're configuring this section to control the power for the entire block. A block encompasses all track elements that are electrically connected, meaning all elements between track insulators. Defining blocks within a layout is crucial for isolating segments, preventing collisions, and in non-DCC layouts, allowing locomotives to park on sidings. A 2-state Track Control card can either power off a block or connect it to a single power source, such as a Cab (Throttle Power Pack) or another track section. In DCC systems, there's only one power source, so this card will simply toggle the power on or off.

The 2-state Track Control card functions similarly to a solid-state double-pole, single-throw switch. The wiring setup is as follows:



Note: Input power could be a DC Controller, power currently being supplied to another block, or in the case of DCC a DCC power supply.

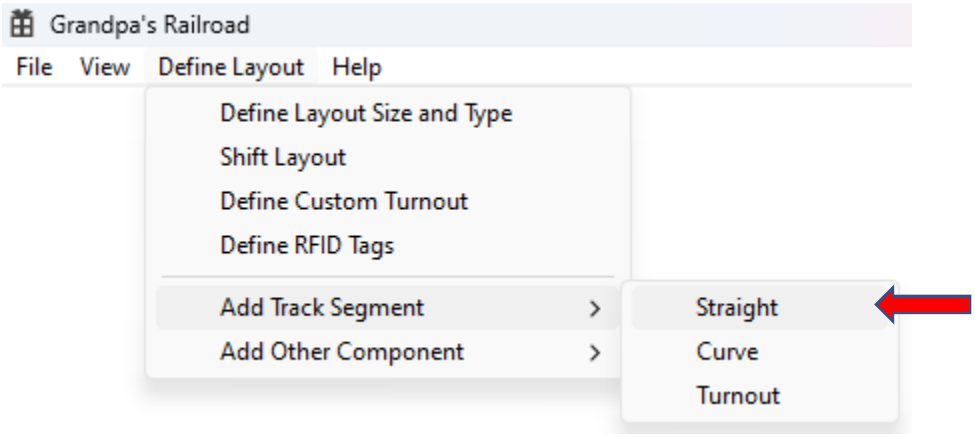
A simplified diagram for this configuration is:



Note: Input power could be a DC Controller, power currently being supplied to another block, or in the case of DCC a DCC power supply.

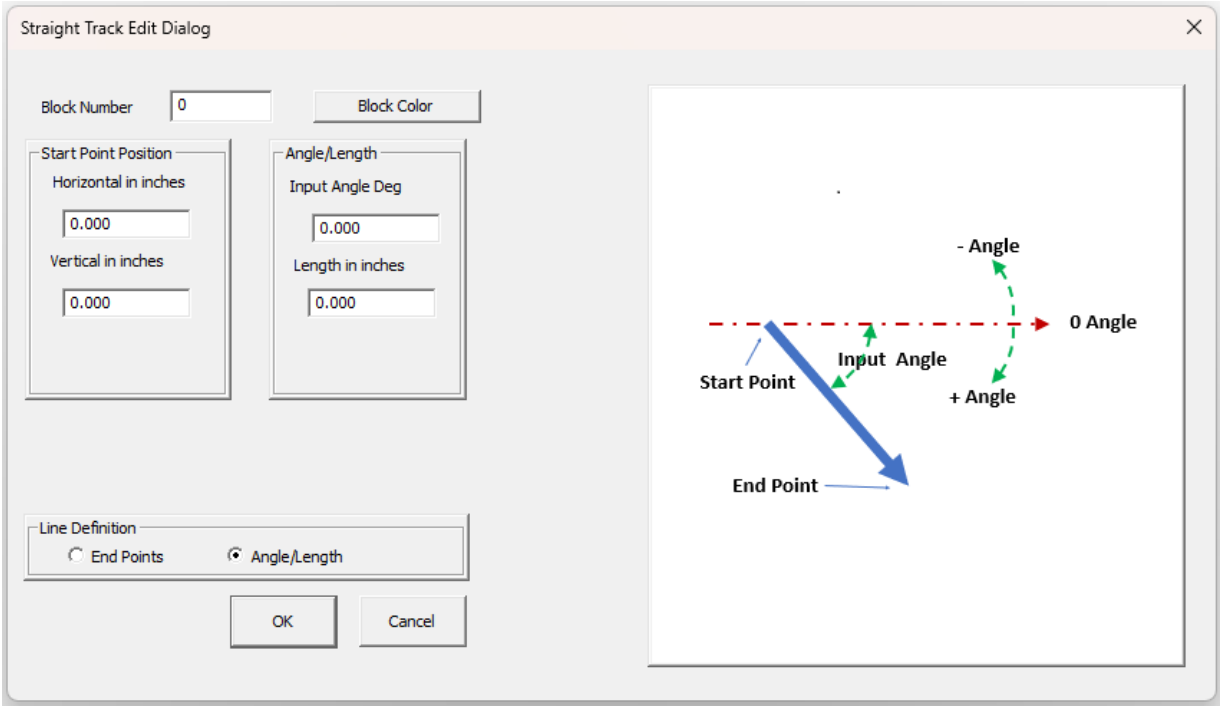
3.1.2 Adding a Straight Track Section to Your Layout

From the main menu select

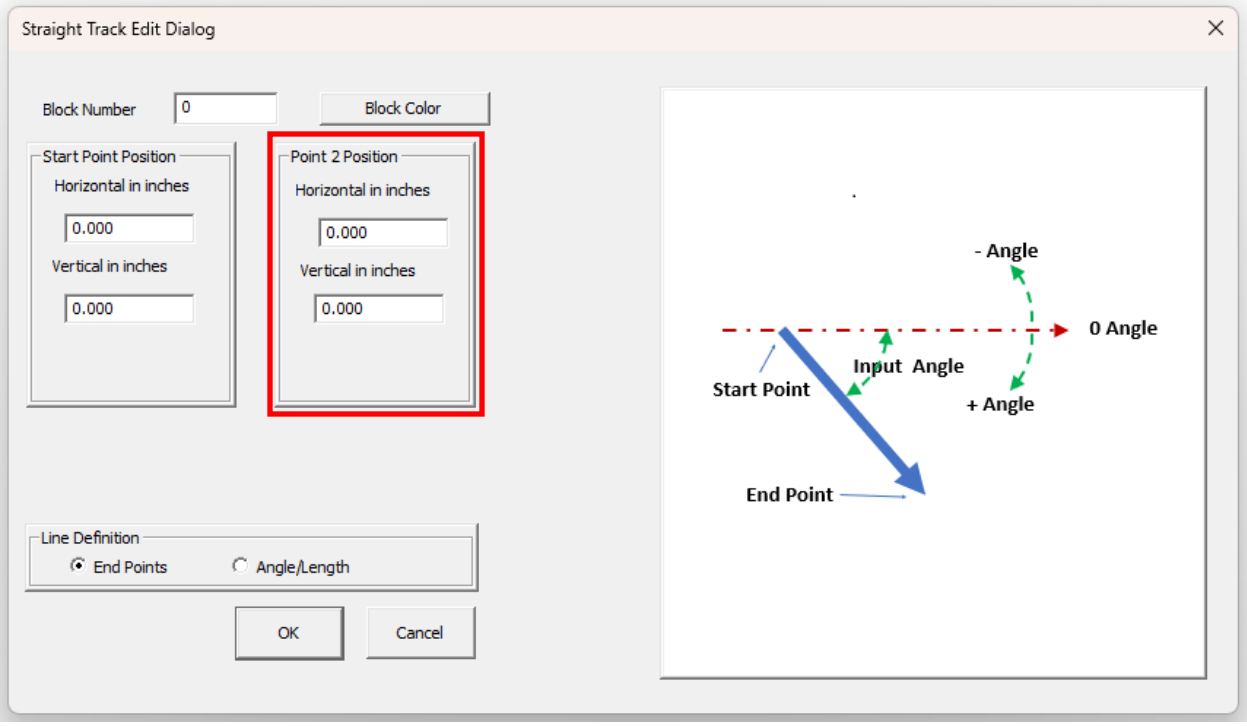


Define Layout/Add Track Segment/Straight

After selecting this menu item, the following dialog box will appear.

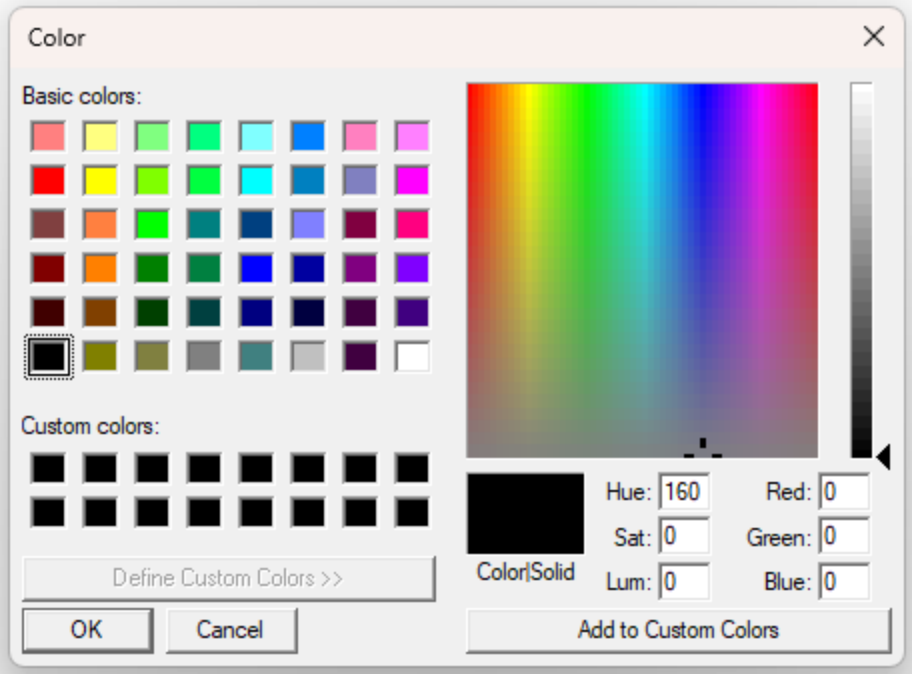


In this form, you can enter the starting point, angle, and length for the straight track segment. If you prefer to define the two endpoints for the line, select the **Line Definition/End Points**" option, which will change the dialog as follows:



In addition to defining the segment, you must also input the Block Number, which must be a value between 1 and 100. A Block Number represents all track elements that are electrically connected, i.e., all elements located between track insulators. Defining blocks in a layout is crucial for isolating segments to avoid collisions, and in non-DCC layouts, it allows for parking locomotives on sidings.

After entering the Block Number, if it has already been used for another segment, its associated color will be displayed. If it has not been previously used, you will be prompted to define a color by clicking the "Block Color" button, which will bring up the following dialog:



If the color has been previously defined and you select the **Block Color** button, the color you select from the dialog that appears will be applied to all track segments with that **Block Number**.

Once you select "**OK**" from the Straight Track Editing dialog, and if all required data has been entered correctly, the track segment will be added to the layout. If there are any errors in the data, a detailed error message will appear, explaining what needs to be corrected.

To edit an existing track segment, simply left-click on the track segment's Edit Location. This will reopen the dialog (See Show Edit Locations).

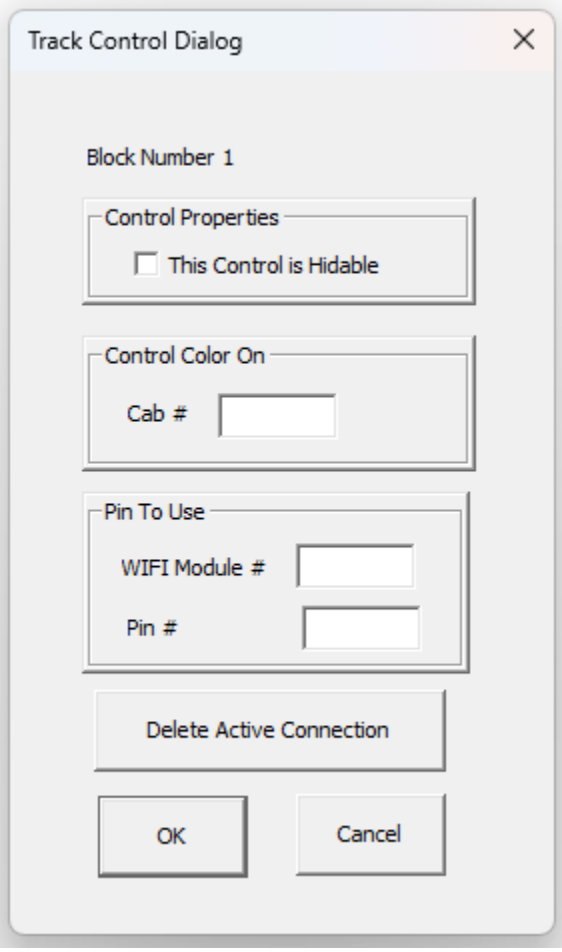
3.1.3 Setting Up a Straight Track Section as a Block Control

Note: This section is only applicable if you are setting up a Block Control on this track section. A section can only be used as Block Control if it is long enough to display the control image.

When you set up a Block Control on a track segment, the image (a single round button) will appear as shown below.

As the name implies, a 2-State Block Control allows you to either cut power to the block or connect to one power source. For DCC operation this would be DCC power and for DC operation this could be either a throttle cab or another track block.

To set up a straight track section for your layout as a Block Control you must be in the **Control Setup** mode. Using the *Left Mouse Button*, click the **Control Box** (See **Show Control Boxes**) for the section on the layout and the following dialog will appear.



Using this dialog, the Block Control can be customized.

This Control is Hidable: When operating in control panel mode, several options are available to simplify the display. One of these options allows active Block Control Points to be hidden. However, they can only be hidden if the control has been designated as hidable by checking this box.

Control Color On: This group allows you to specify the color of the track control when it is ON. The OFF color is always dark gray. The color is determined by specifying the Cab # you are connected to (see **Section 4.6**).

- **For DC operation:** If you have multiple Power Packs, you can assign each a different color. This helps easily identify which Power Pack is controlling the track.
- **For DCC operation:** Since there is only one power source, you can choose a Cab # and assign it a color of your preference.

Pin to Use: You must enter the Digital/Proximity WIFI Module number that the Throttle Control card is connected to. This number corresponds to the actual number programmed into the WIFI Module.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

Use the WIFI Module Programmer software to assign this number. The Pin # is calculated by adding the number of the connector on the WIFI Module (where the ribbon cable is connected) and the Input Pin number on the card used.

Delete Active Connection: This option removes the track control from the current block.

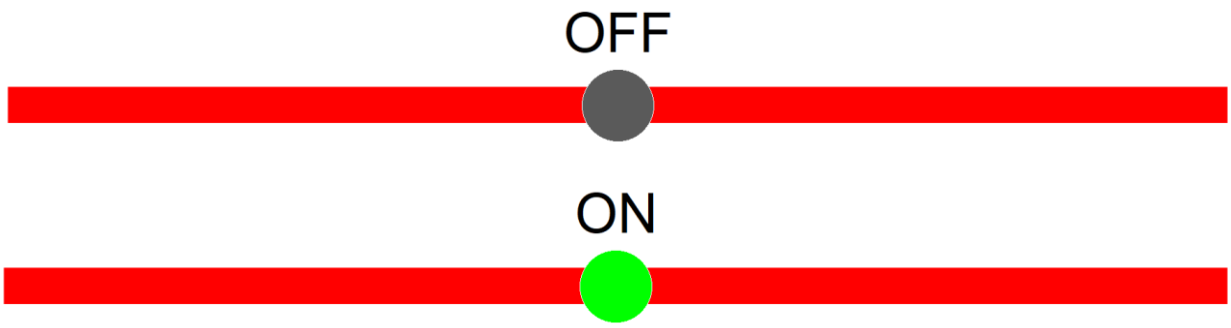
3.1.4 Control Panel Operation of a Block Control

On the control panel, the circle on the Block Control indicates the power source to which the block is connected.

For DCC operation, there is only one power source. In this case, the Block Control simply shows whether the block is on or off.

For DC operation, the circles on the Block Control indicate the power source—either a Cab or a connection to another block's power source.

To illustrate, consider the layout shown below.

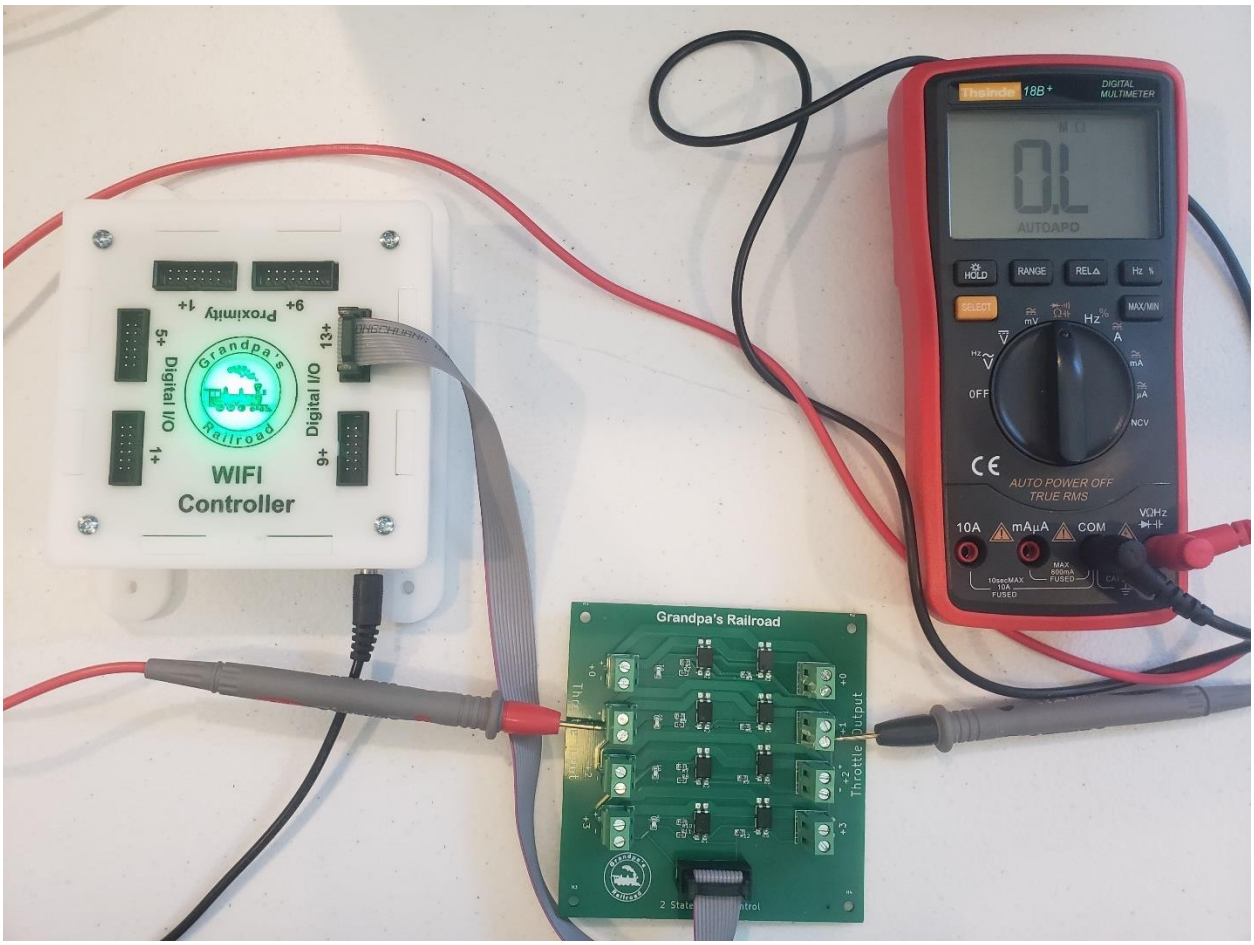


In this example, both the OFF and ON conditions are displayed. Note that the titles do not appear on the layout.

3.1.5 Practical Example 2 State Block Control

A simple example of a 2-state Active Block Control is illustrated below. In this example, we will use a multimeter to demonstrate the power source connection. High resistance indicates that the input is not connected to the output, while low resistance shows that the power source is connected, and power will be available at the output connector.

Step 1: Connect a 2-State Track Control Card to the WIFI module. In the photo below, the card is connected to the +13 connection, and the multimeter is connected to the +1 connection on the card.

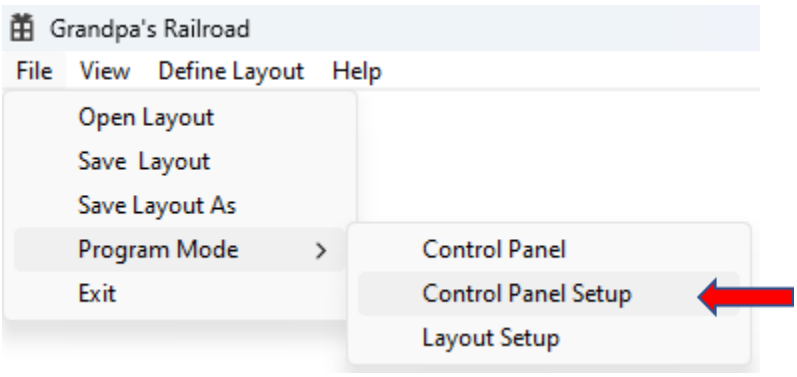


Step 2: Launch the Grandpa's Railroad Application, select the **Layout Setup** mode, and create a 30-inch by 30-inch layout in any scale.

Step 3: Add a Digital/Proximity WIFI Module to your layout as described in the section "Adding a WIFI Module." The module number should be the one assigned to the module you are using. If you're unsure of the module number, use the WIFI Module Programmer software to determine it.

Step 4: Add a straight track section at location x = 0, y = 15, length = 30, and angle = 0.

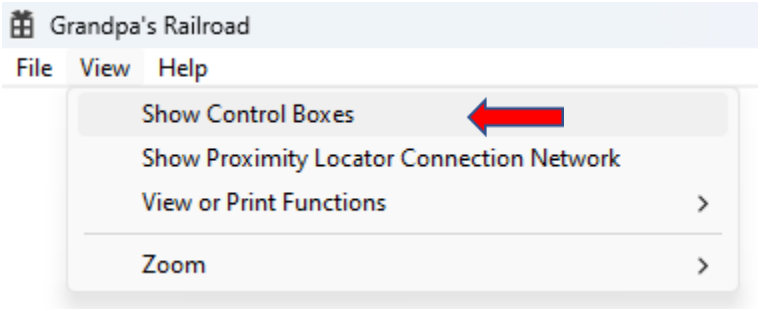
Step 5: From the File menu, select:



File/Program Mode/Control Panel Setup

This will switch to the Control Panel Setup mode.

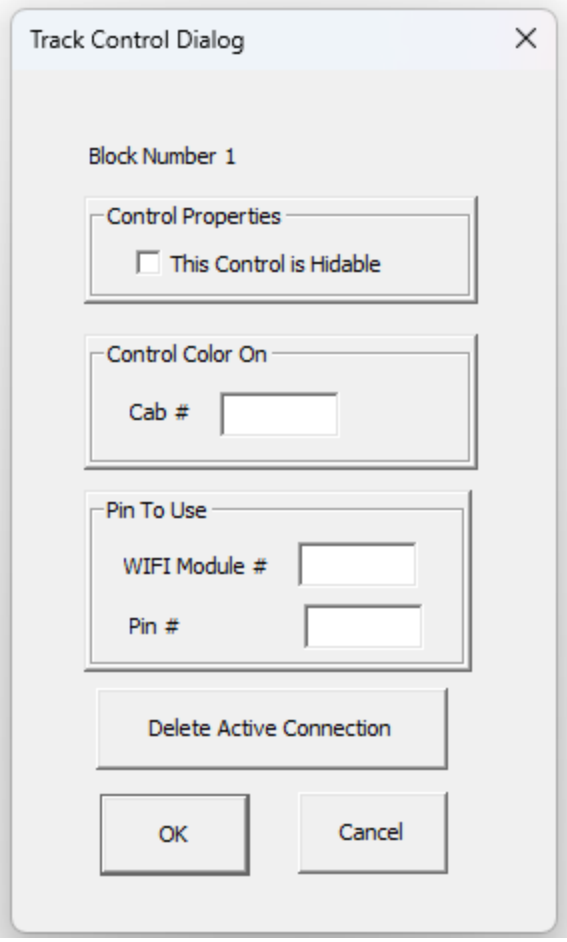
Step 6: From the View Menu item select:



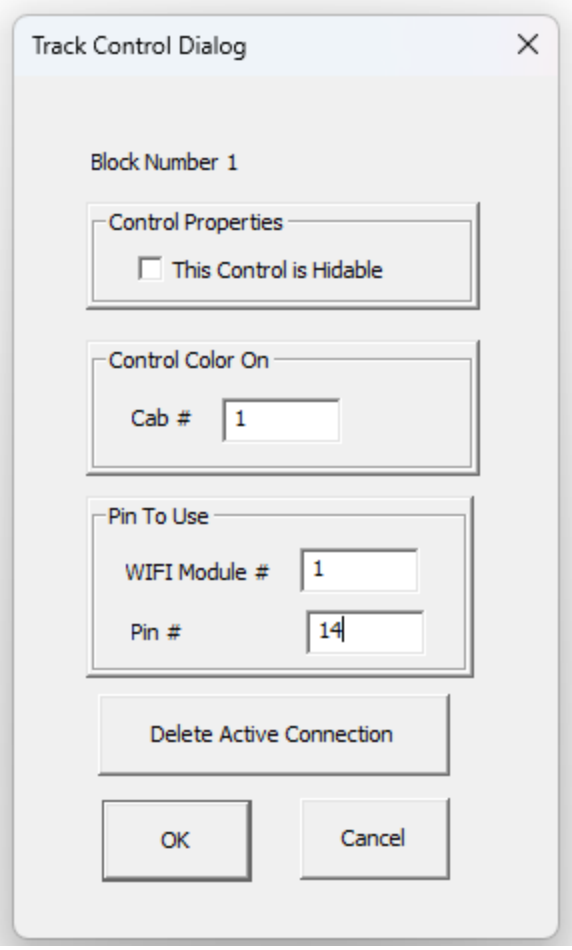
View/Show Control Boxes

This will display a circle at the center of the straight track segment.

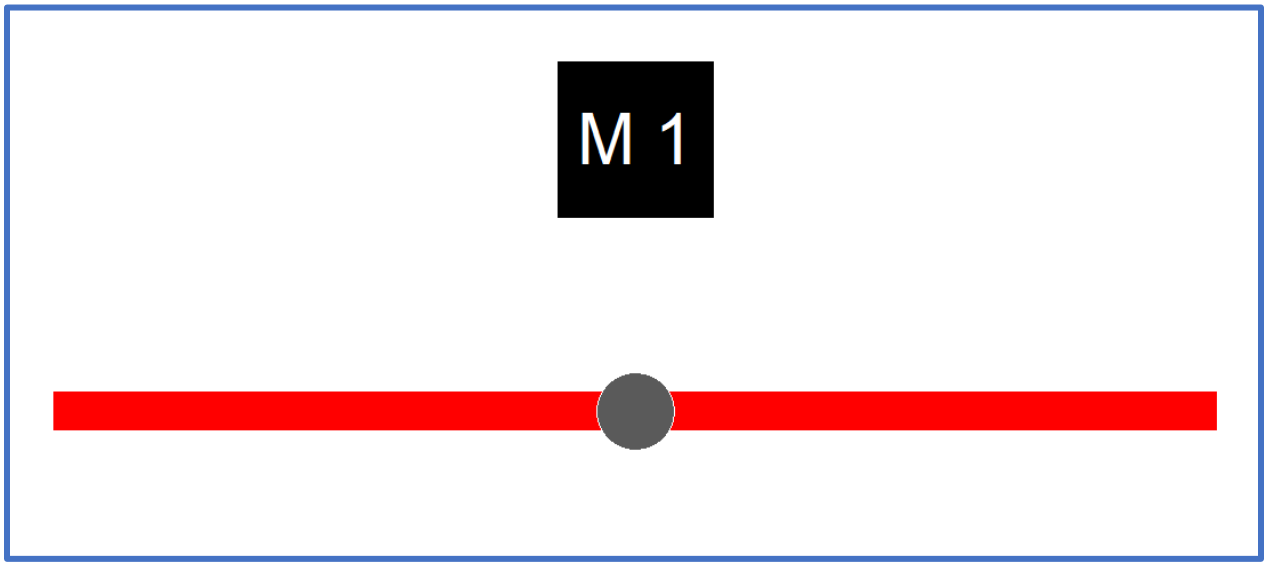
Step 7: Using the *left mouse button*, click the circle on the straight track segment, and the following dialog will appear.



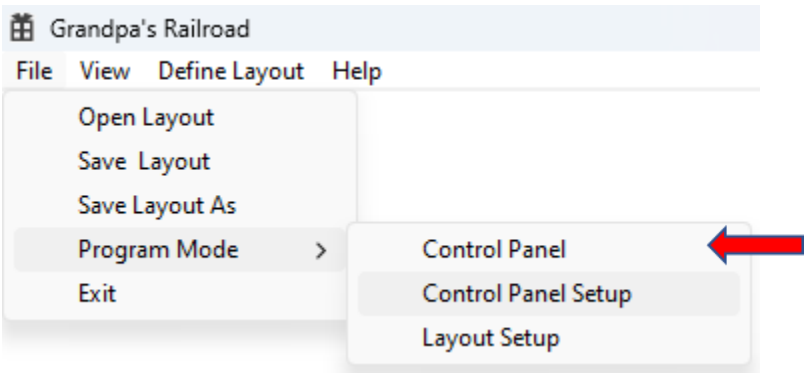
Set this as an Active Control Point and enter the Digital/Proximity WIFI Module # and Pin #. Since we used the +13 connector on the Digital/Proximity WIFI module and the +1 connection on the card, the pin # will be 14 in this example. The dialog box should now look as follows:



Press OK, and your layout should appear as shown.



Step 8: Ensure that the Digital/Proximity WIFI Module is powered on. From the File menu, select:



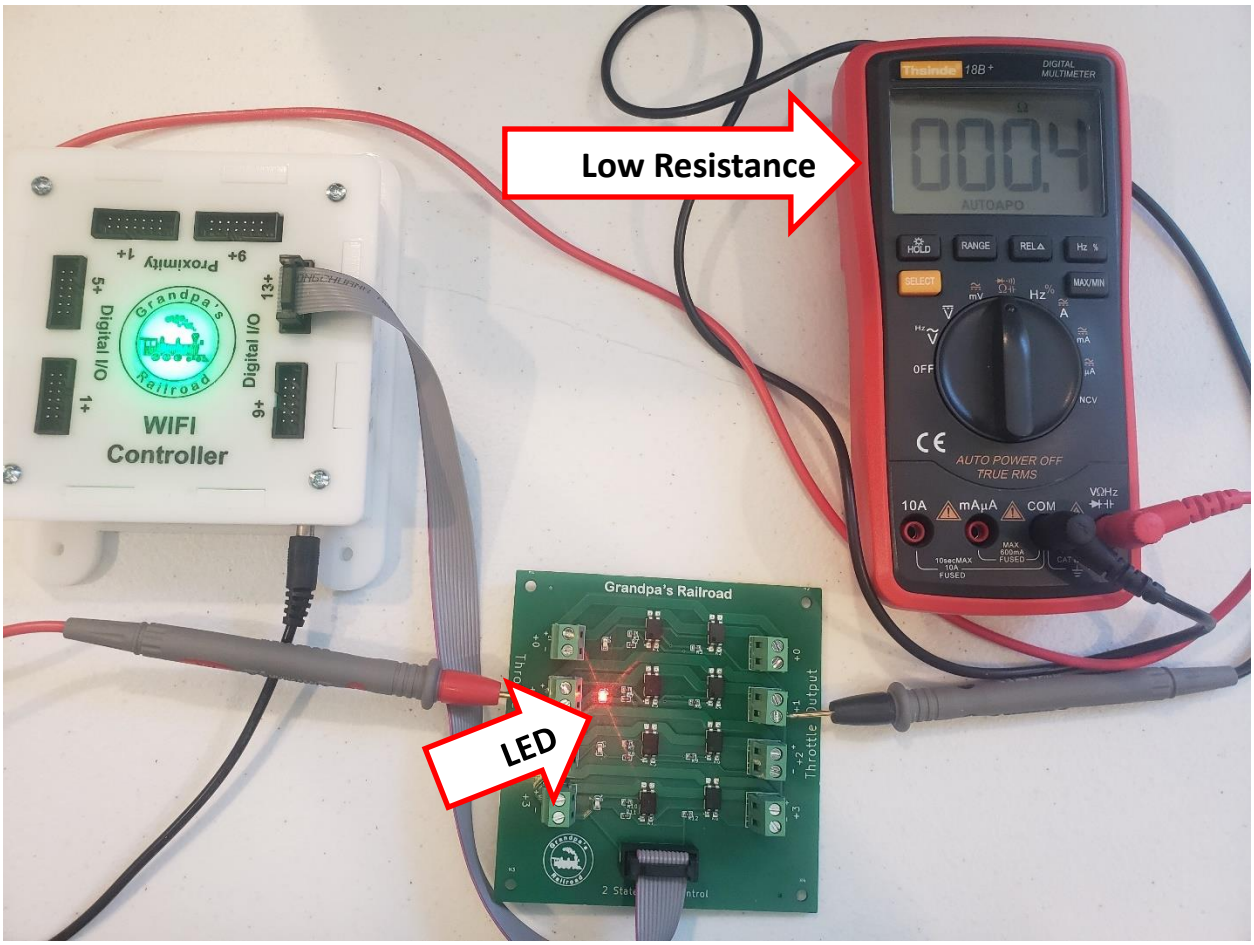
File/Program Mode/Control Panel

This will switch to the Control Panel mode.

Step 9: The Digital/Proximity WIFI Module should now connect to the network and change to the connected color. The Control Point should indicate the OFF

condition, and the multimeter should read high resistance. Pressing the gray dot will connect the input throttle connection to the output. The layout should now look like this:

The multimeter should show very low resistance, and a red LED will light next to the +1 connection on the card. This indicates that the throttle is now connected to the output.



Note: When ON, the Throttle Input to Throttle Output + to + and – to – connections will show low resistance, but the – to + and + to – terminals will always show high resistance.

3.2 Adding Curved Track

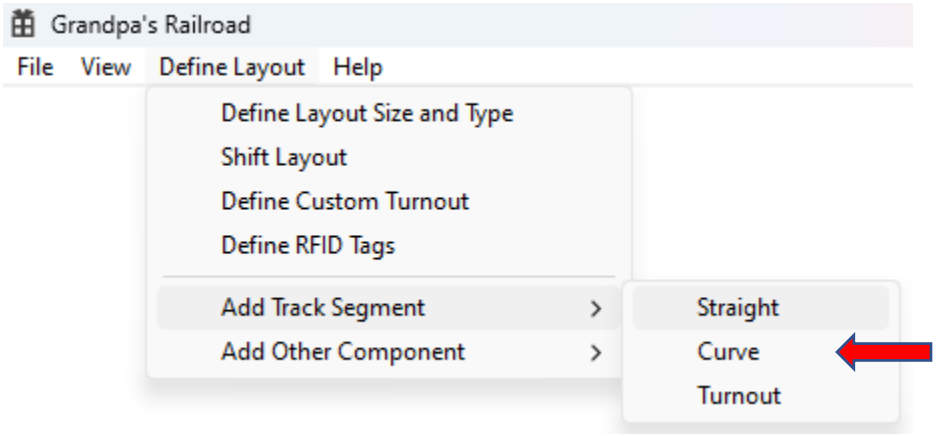
A curved track section is not limited to a specific length of track; instead, it can encompass an entire curved segment composed of multiple individual pieces. The only requirement is that all sections of the curve share the same radius.

3.2.1 Hardware Required

Hardware is only necessary if you intend to control power for the entire block using this section. If so, refer to **3.1.1 Adding Hardware for Straight Track**, as the process is identical.

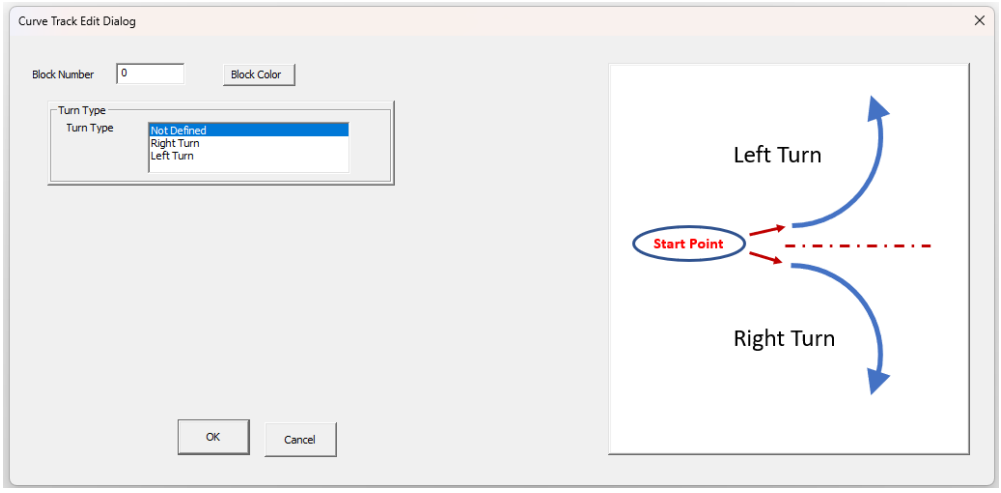
3.2.2 Adding a Curved Track Section to Your Layout

From the main menu, select:

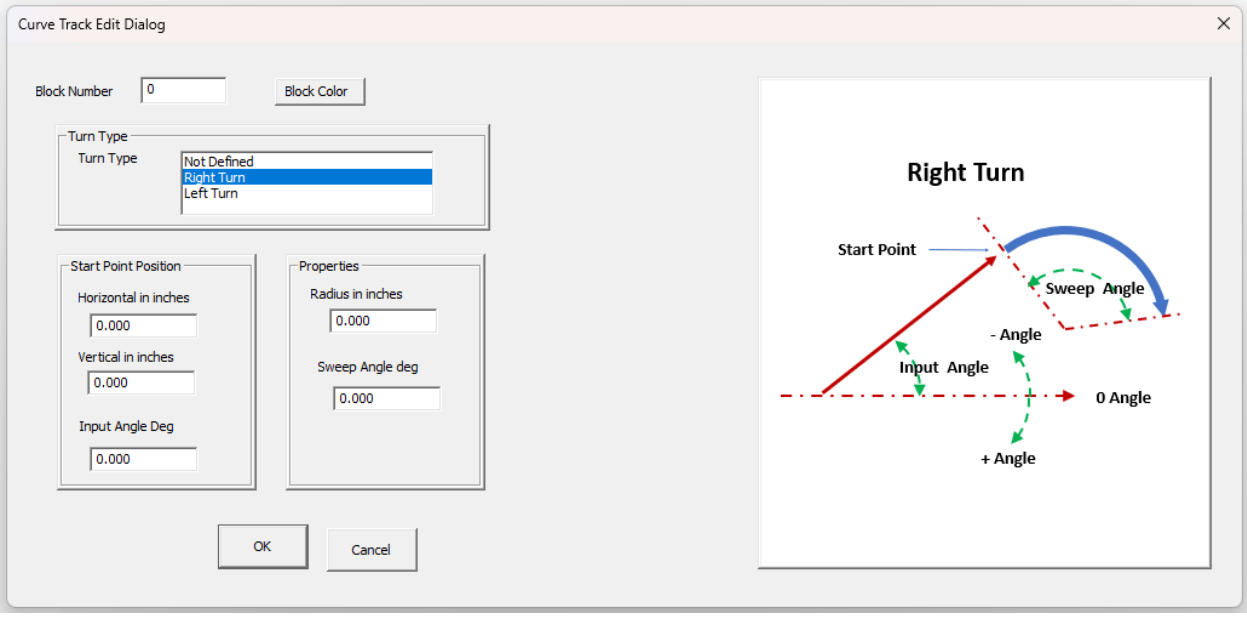


Define Layout/Add Track Segment/Curve

Upon selecting this menu item, the following dialog will appear.



Once you specify whether the turn is to the right or left, the dialog will update accordingly for a right turn.



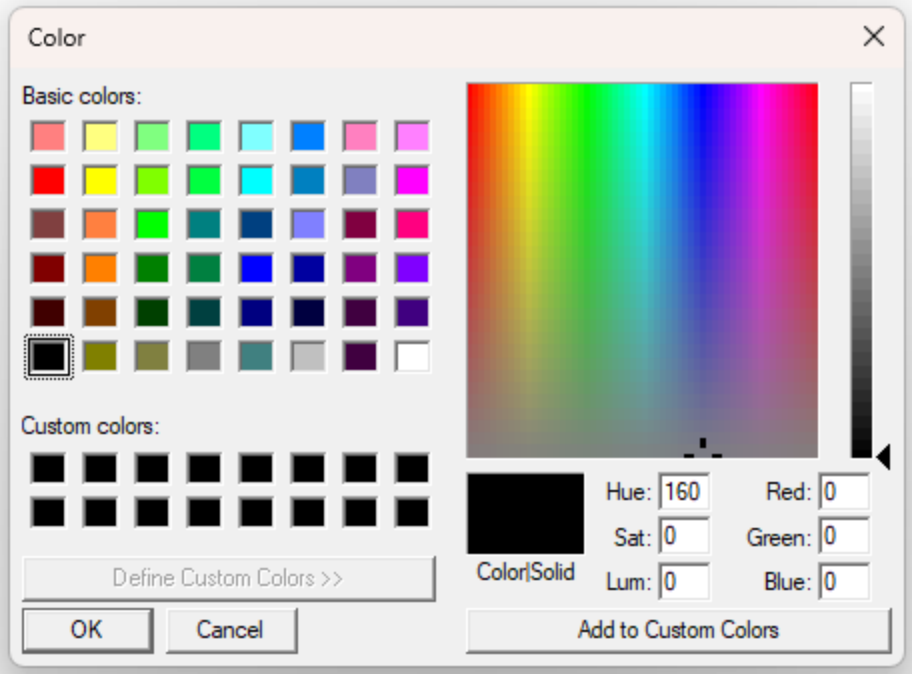
This allows you to define the turn based on the following parameters:

- **Start point:** Horizontal and vertical position
- **Input angle:** Angle at the start point
- **Radius:** Radius of the turn
- **Swept angle:** Total angle covered by the turn

These parameters are visually represented in the accompanying diagram within the dialog.

Additionally, you must enter a **Block Number**, which can range from 1 to 100. A Block Number represents all track elements that are electrically connected—i.e., all segments between track insulators. Defining Blocks in a layout is essential for collision avoidance and, in non-DCC layouts, for parking locomotives on sidings.

If the block number has been used previously, the selected color for that Block Number will be displayed. If it is a new Block Number, you must assign a color using the **Block Color** button, which will open the corresponding color selection dialog.



If a Block Color has already been defined and you select the **Block Color** button again, the newly selected color will be applied to all track segments with that Block Number.

Once you select **OK** in the Curved Track Editing dialog and all required data has been entered correctly, the track segment will be placed on the layout. If any data is incorrect, a detailed error message will indicate the issue.

To edit a track segment, left-click on the track segment's **Edit Location**, and the dialog will reappear. (See Show Edit Locations.)

3.2.3 Setting Up a Curved Track Section as a Block Control

Note: This section is only applicable if you are setting up a Block Control on this track section. A section can only be used as Block Control if it is long enough to display the control image.

Setting up a curved section as a block control follows the same process as a straight track section. Refer to 3.1.3 Setting Up a Straight Track Section as a Block Control for details.

3.2.4 Control Panel Operation of a Block Control

The control panel operation for a curved section is identical to that of a straight section. Refer to **3.1.4 Control Panel Operation of a Block Control** for more information.

3.2.5 Practical Example

Refer to the examples provided for straight track sections.

3.3 Adding A Turnout

A turnout can be added to the layout from a predefined list. You can also expand this list using the **Define Custom Turnout** feature. Available options include right or left, straight or curved turnouts, as well as Y turnouts.

3.3.1 Hardware Required

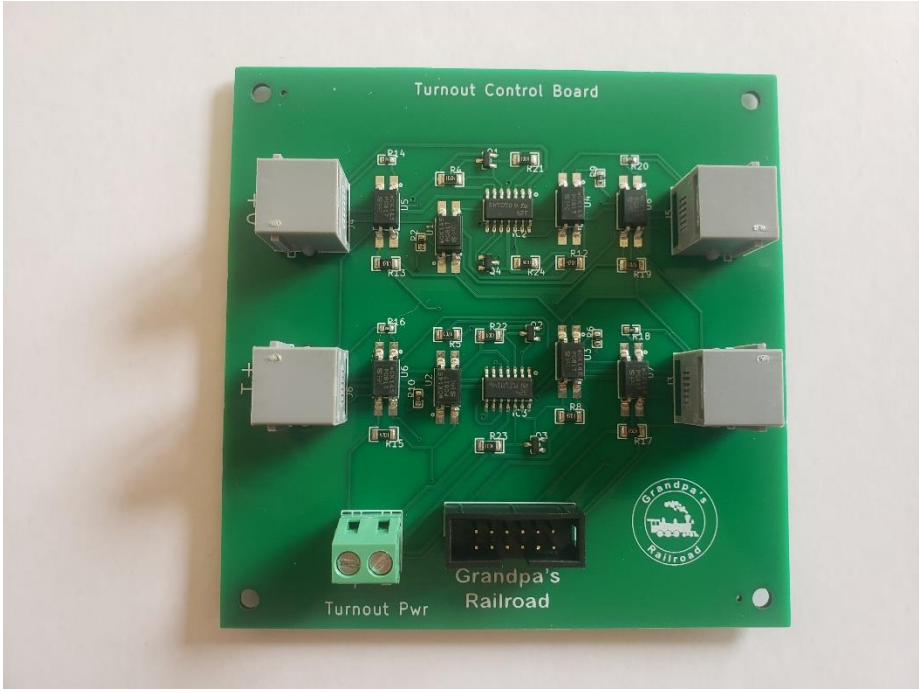
Note: Currently only servo type turnout machines like the Tortoise Slow Motion Switch Machine are supported. Use of a relay type machine with the currently available cards will cause them to fail.

There are three types of cards used to connect servo-type turnout machines:

- The **Turnout & I/O Board** has two screw connections for turnout machines.

- The **Turnout Control Board** has four screw connections for turnout machines.

- A similar board to the above uses RJ11 connectors.



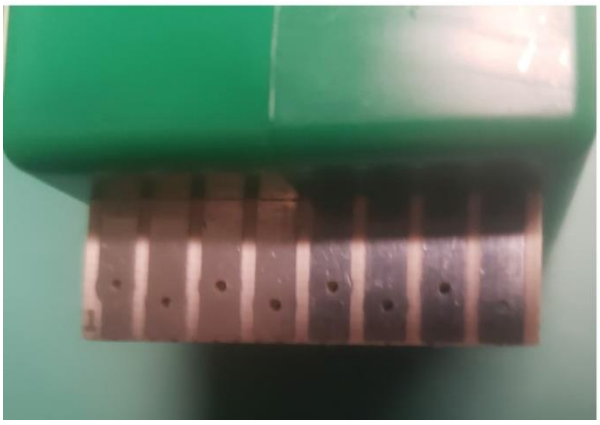
One advantage of using Grandpa's Railroad Control Panel software is that turnouts are wired consistently, regardless of the turnout machine or connector mounting. This is because the switch machine direction can be adjusted in the setup dialog box.

Note: Turnout machines must be wired in the same manner, or the software will not work correctly.

3.3.1.1 Connection to a Tortoise Switch Machine

The Tortoise Switch Machine has two versions, old and new, which differ primarily in their connectors.

Old Design



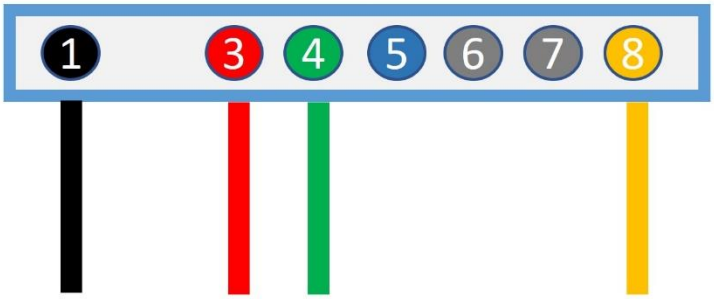
New Design

The new boards feature an industry-standard edge connector, whereas the old boards have undersized connectors and should not be used with our optional edge connector. Instead, they should be connected by soldering.

At Grandpa's Railroad, we use 26 AWG telephone cable (solid or stranded) for wiring turnouts. This cable is advantageous because of its color-coded wires and easy availability.

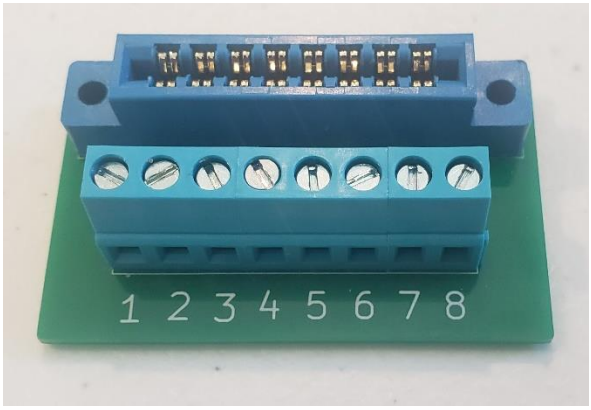
The Tortoise Switch Machine wires should always be connected as follows:

Tortoise Turnout Machine Connector



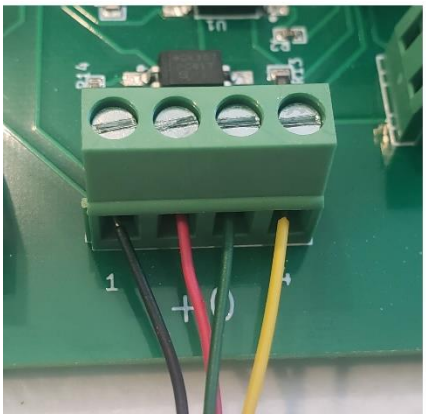
Turnout Control Board Connector

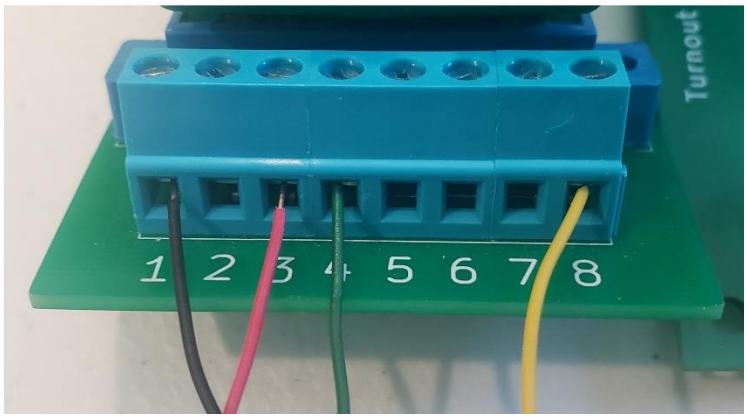
While soldering to the switch machine connector is fine, you could also use this optional Grandpa's Railroad connector that slips over the switch machine connector.



The final wiring setup should resemble the image below:

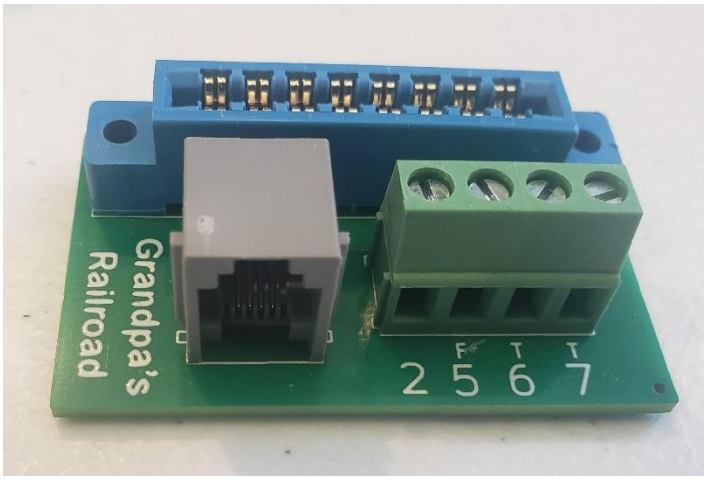
Turnout Card **Switch Machine**





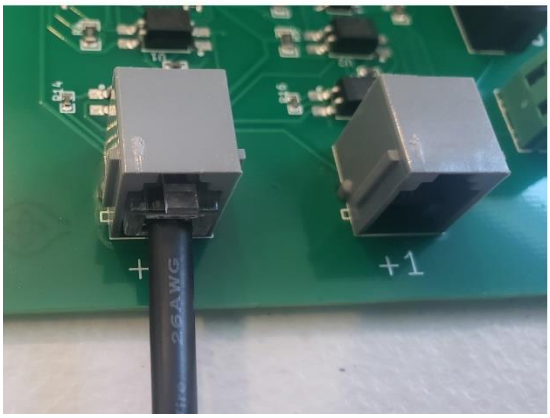
A second method of wiring a turnout involves using the Turnout Control Board with RJ11 connectors. This method simplifies connections, allowing for premade cables of various lengths—useful when working under a layout. However, this method requires additional tools for making cables, such as a crimp tool as shown below:

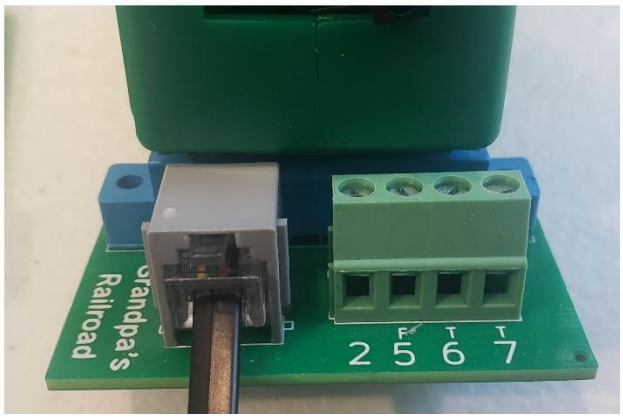
To do this you must use a Grandpa's Railroad RJ11 connector.



If you properly make a RJ11 telephone cable, the connections are as follows:

Turnout Card **Switch Machine**

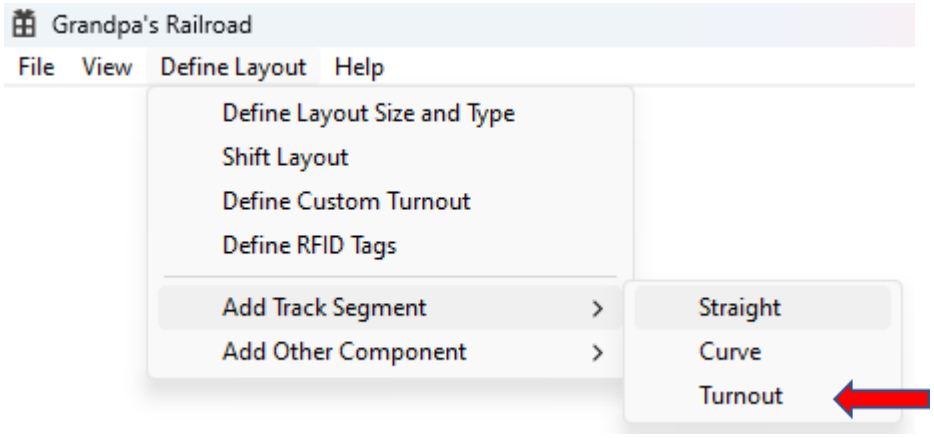




These connections are simple, clean, and easy to install or change. Also note that the unused connections on the switch machine are still available through a screw connector for turnout frog wiring or signals.

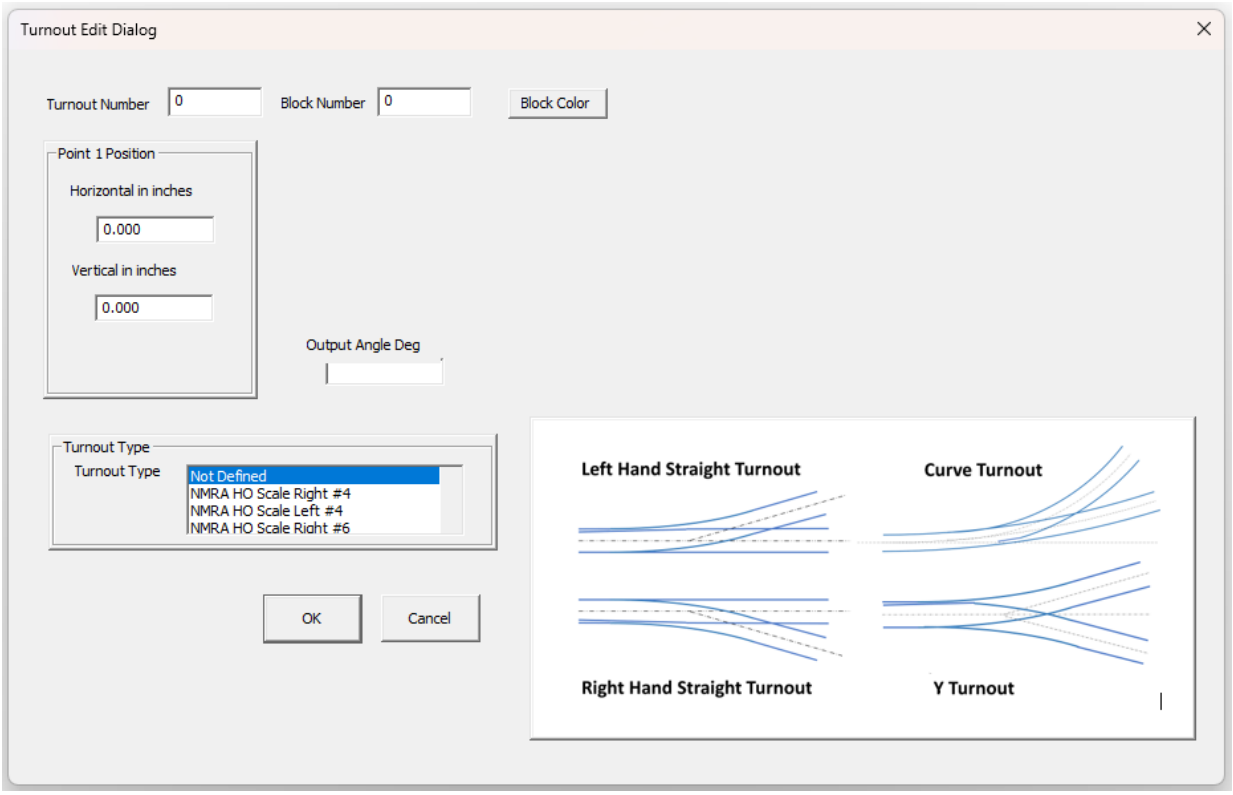
3.3.2 Adding a Turnout to your Layout

From the main menu select



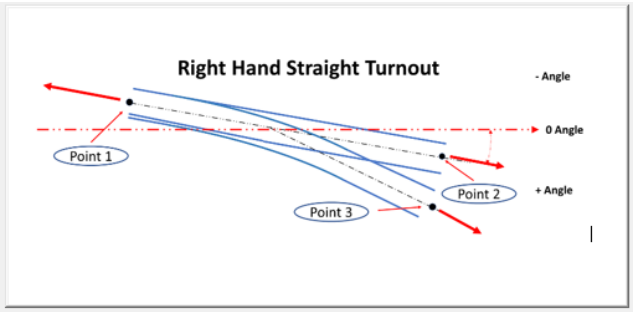
Define Layout/Add Track Segment/Turnout

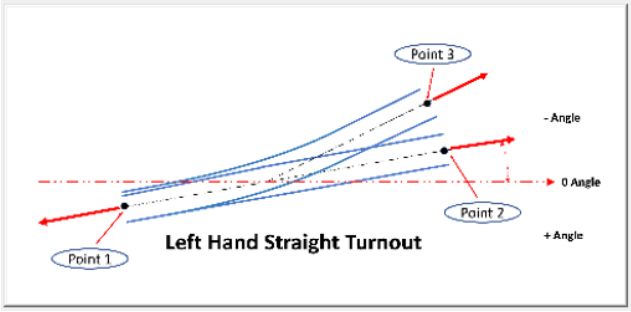
Upon selecting this option, a dialog box will appear.

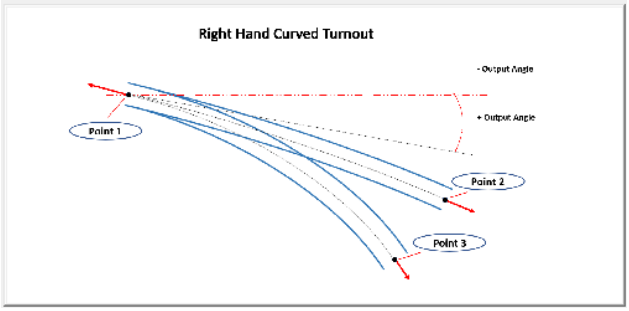


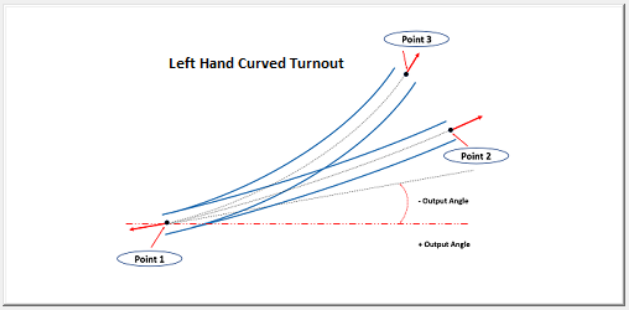
From the **Turnout Type** list, select the type of turnout you want to add. If the turnout you want is currently not in the list, you can exit the dialog using the cancel button and then define a custom turnout and add it to the list. (see **Defining a Custom Turnout**).

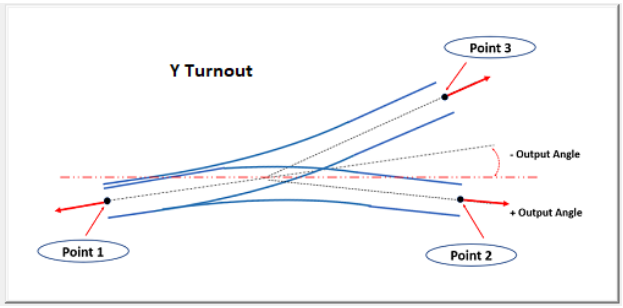
After selecting a turnout Type the image in the dialog will change depending on the type as follows:





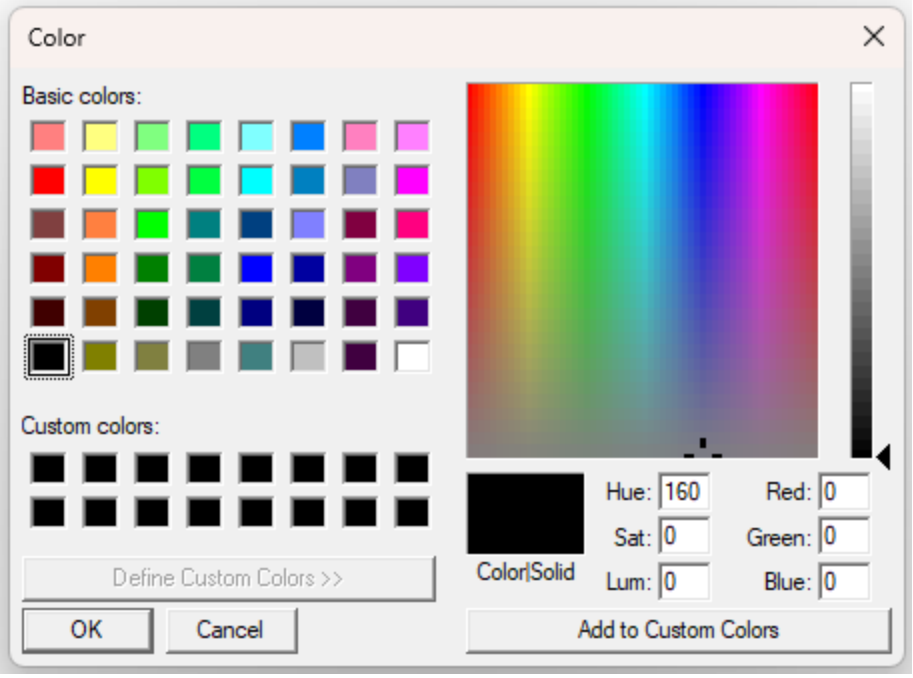






These images visually define the parameters that must be entered in the dialog, including the Point 1 position and the Output Angle. Additionally, you must enter the Block Number, a value between 1 and 100. A Block Number represents all track elements that are electrically connected, i.e., all elements situated between track insulators. Defining Blocks in a layout is crucial for isolating segments to prevent collisions and, in non-DCC layouts, to park locomotives on sidings.

After inputting the Block Number, if it has been previously assigned to another segment, the selected color for that Block Number will be displayed. If it hasn't been used before, you'll need to define a color using the Block Color button, which will prompt the following dialog to appear.

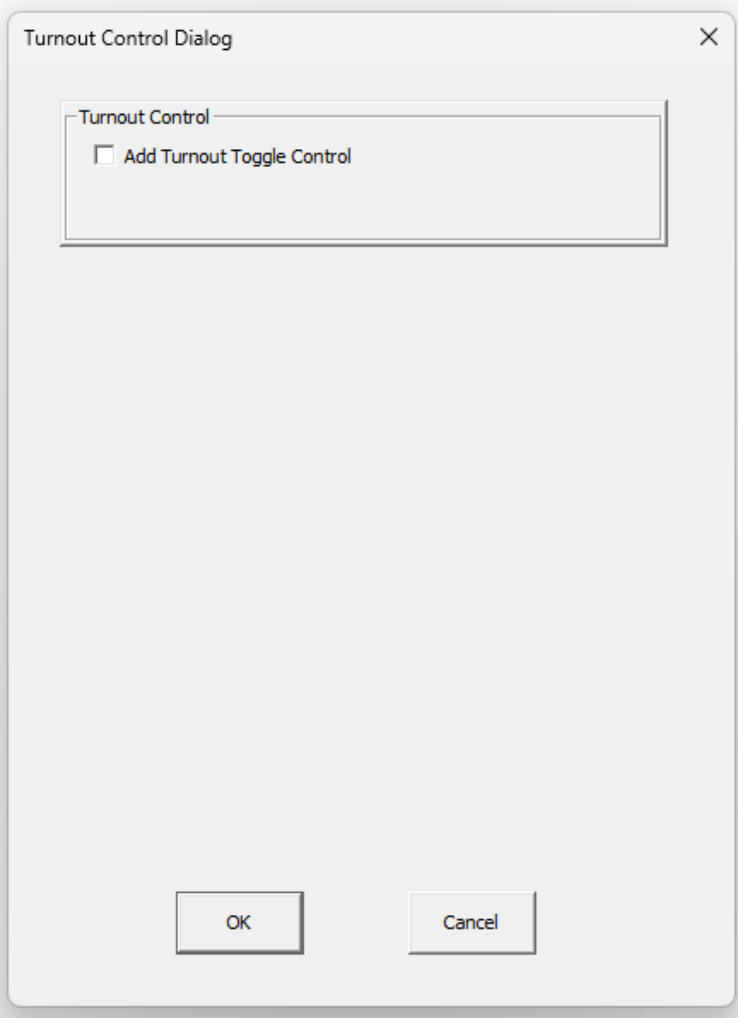


If the color has been previously defined and you select the Block Color button, the color you choose from the ensuing dialog will be applied to all track segments with that Block Number. Once you select OK in the Turnout Edit dialog and have entered all required data, the turnout segment will be placed on the layout. If the data is incorrect, a detailed error message will explain the issue.

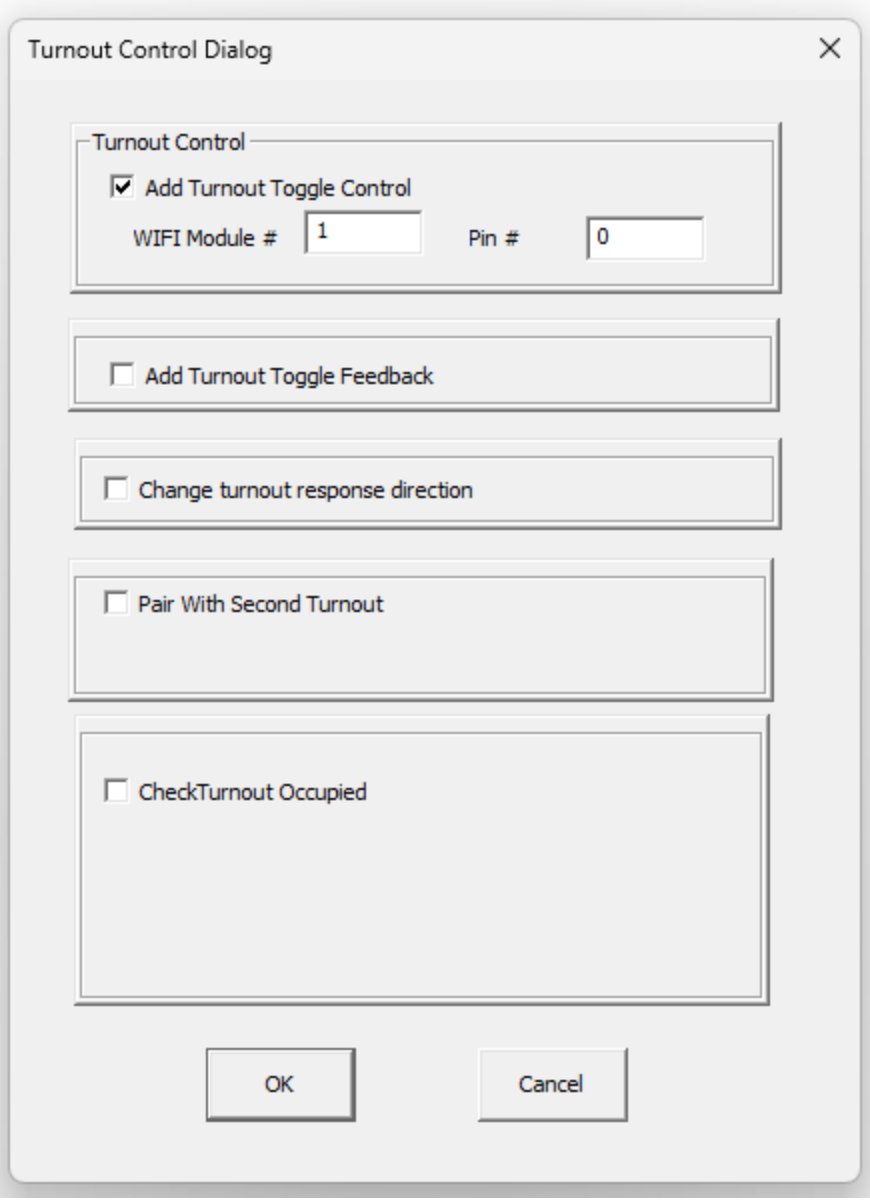
To edit a turnout, left-click on the turnout element's Edit Location, and this dialog will reappear. (See Show Edit Locations)

3.3.3 Control Panel Setup for a Turnout

To set up a turnout, you must be in Control Setup mode. Using the left mouse button, click the Control Box (see Show Control Boxes) near the center of the turnout, and the following dialog will appear:



If you check the box "Add Turnout Toggle Control," additional setup options will be displayed.



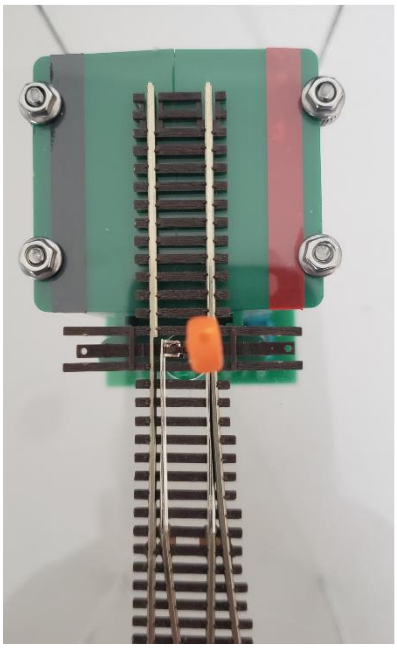
You must enter the Digital/Proximity WIFI Module number to which the Turnout Control card is connected. This number corresponds to the one programmed into the WIFI Module using the WIFI Module Programmer software.

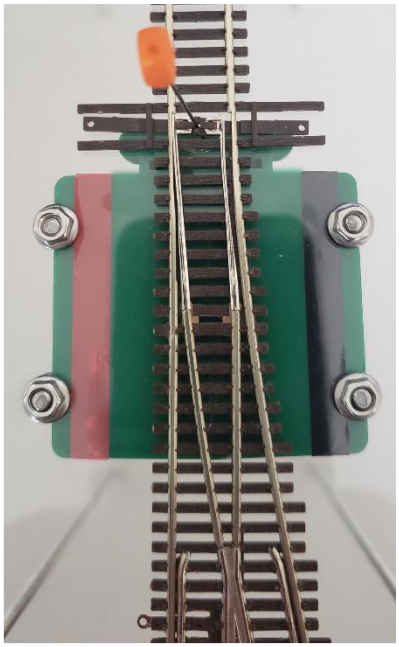
Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

The Pin number is calculated by adding the connector number on the Digital/Proximity WIFI Module where the ribbon cable is connected to the Input Pin number on the card used.

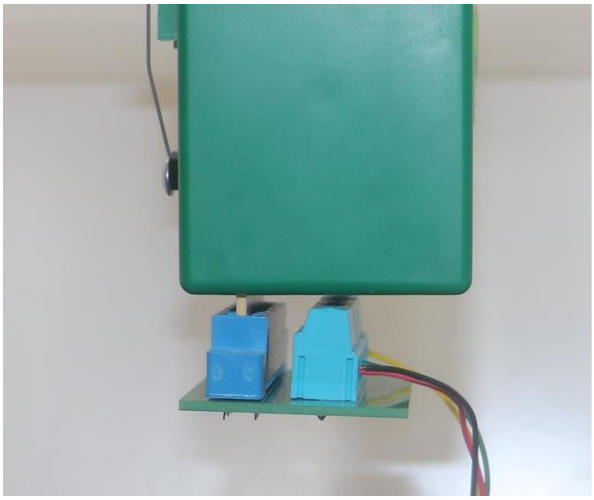
"Add Turnout Toggle Feedback" can be enabled if there's a return signal from the turnout connection indicating the actual turnout position. This feature, implemented with the Tortoise switch machine connection shown earlier, will cause an indicator on the display to change when the turnout reaches the desired position. This will be described in the control panel mode.

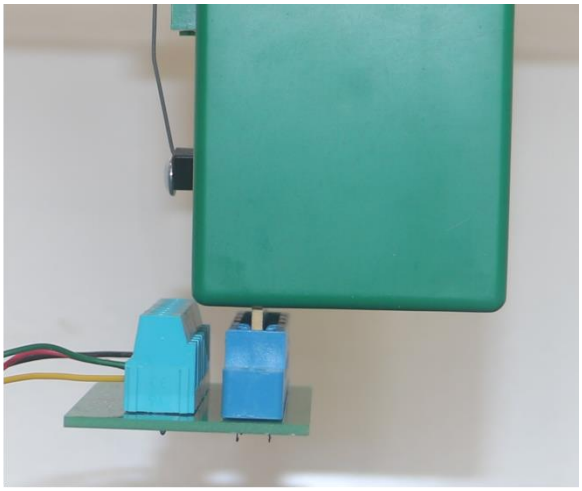
"Change Turnout Response Direction" allows you to connect the switch machine motor and connector in any orientation. The image below shows a switch machine mounted on a clear surface below a turnout. Red and black tape has been placed





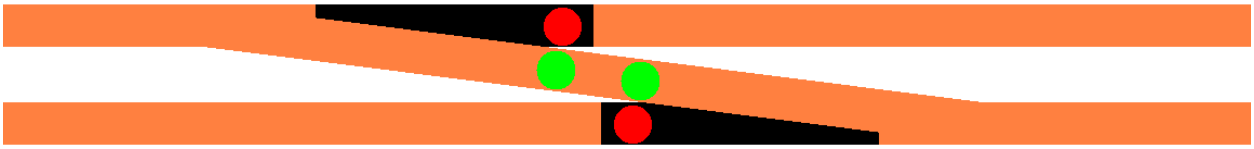
on top of the turnout. Note that when the turnout machine is oriented toward the red tape, the turnout changes from straight to siding, depending on the mounting. Similarly, changing the orientation of the connector on the switch machine, as shown below, will alter the motor's direction.



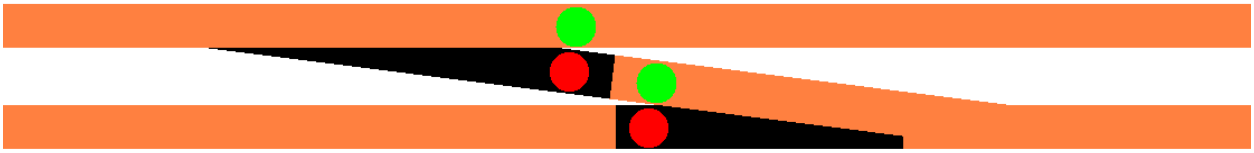


By checking the **"Change Turnout Response Direction"** box, the switch machine's output direction will change. *The easiest way to determine the correct setting for this box is to complete all hardware and software setup and then test it. If the indicator on the control panel doesn't match the turnout direction, checking this box will correct it.* Therefore, you don't need to worry about orientation when mounting your switch machines.

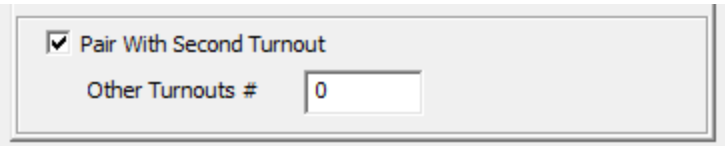
In some cases, two turnouts on a layout should always operate together. For example:



It would be illogical to allow the following configuration:

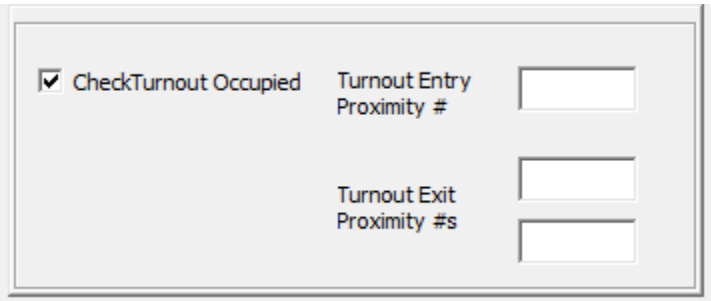


To enable the turnouts to operate together, you can pair them. By checking the **"Pair with Second Turnout"** box, the dialog will change, allowing you to enter the number of the turnout you wish to pair with.

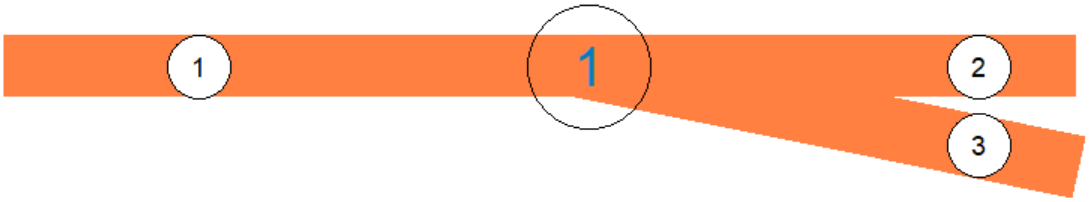


Note: The second turnout must also have the pairing option activated with the appropriate turnout number.

Selecting **'Check Turnout Occupied'** will trigger a warning if a train is detected over the turnout when you attempt to toggle it. By checking this box, the dialog



will update to allow you to enter the proximity numbers for the locators at the entry (1) and the two exit points (2 and 3) of the turnout.



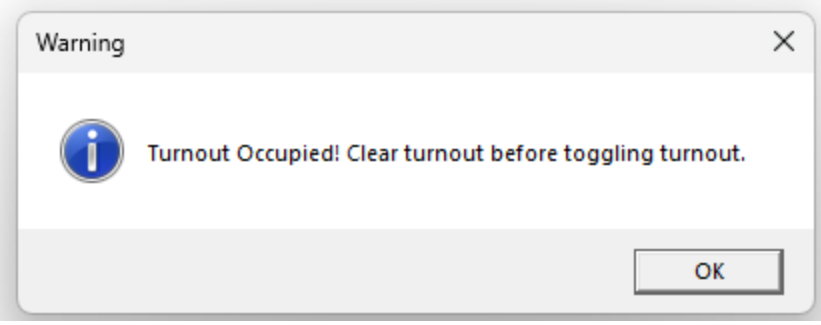
For this feature to work effectively, the proximity locators should be placed near the turnout.

3.3.4 Control Panel Operation for a Turnout

To change the direction of a turnout in control panel mode, place the mouse cursor over the circle indicating the desired turnout direction and press the left mouse button. If you're not using **Turnout Toggle Feedback**, the circle will be black and white. Clicking the black circle will toggle its colors, as well as the active

turnout direction's color. These changes occur immediately. When using **Turnout Toggle Feedback**, the colors will be green for the current direction and red for the other direction. Clicking the red circle will immediately change the active track direction's color. However, the red and green circles won't change colors until feedback from the turnout connection confirms the turnout has changed direction. This positive feedback ensures the turnout direction corresponds to the actual direction.

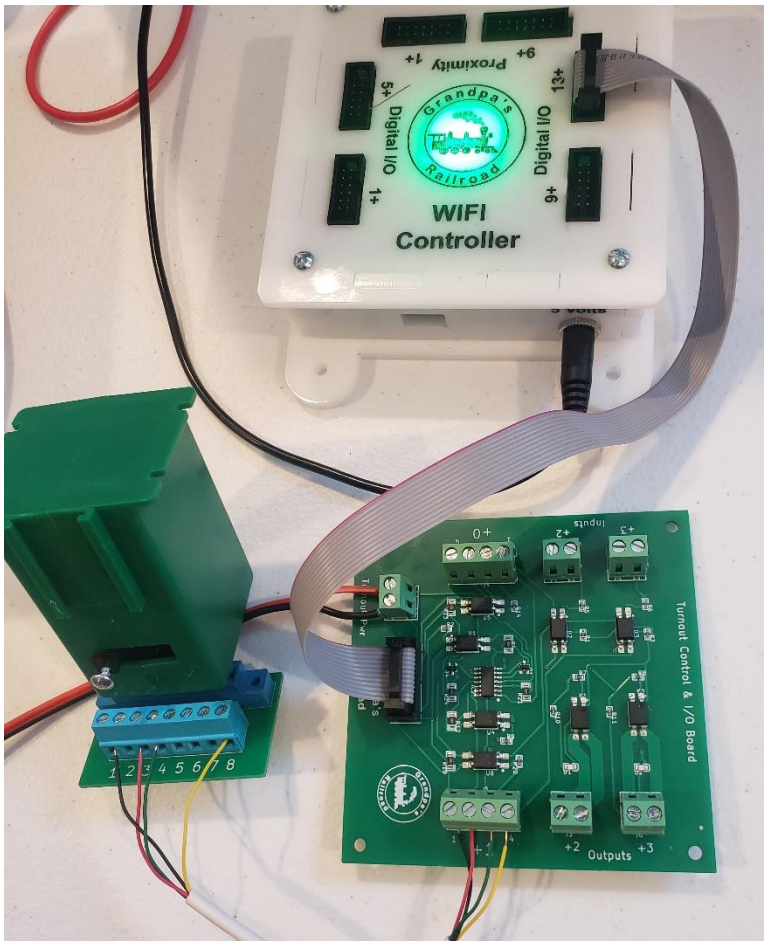
If the **'Check Turnout Occupied'** feature is enabled and a train is detected over the turnout or its paired partner (indicated by the entry and at least one exit proximity locator being ON), a warning message will appear for 5 seconds, and the turnout will not toggle.



3.3.5 Practical Example

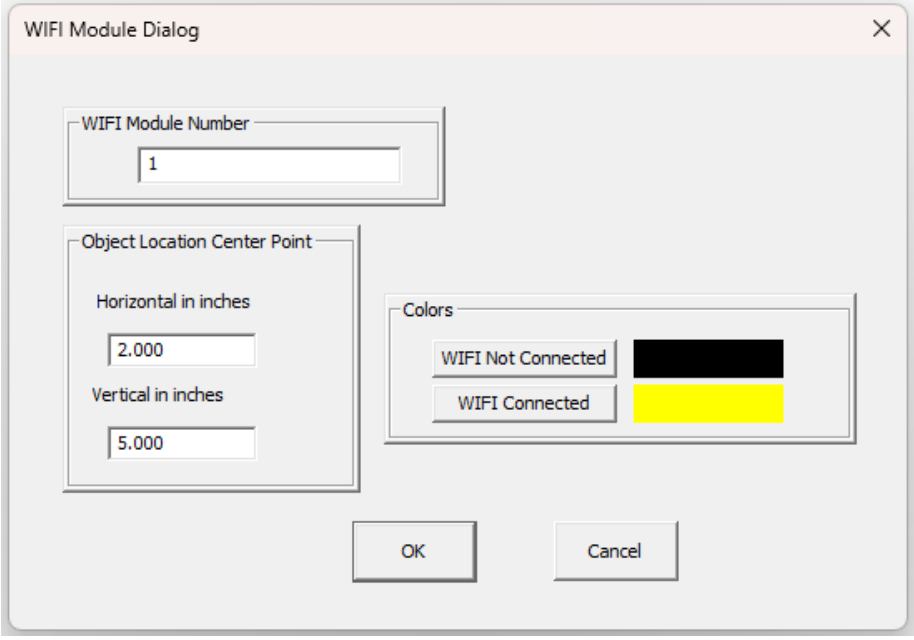
A simple example of adding a turnout is illustrated below. In this example, we'll demonstrate how toggling the turnout changes the direction of the Tortoise servo motor.

Step 1: Connect a Turnout Control and I/O Card to the WIFI module. In the photo below, the card is connected to the +13 connection, and the turnout is connected to the +1 connection on the card. Additionally, 12 volts DC should be connected to the *Turnout PWR* connector of the card. Ensure the polarity of the 12V is correct.

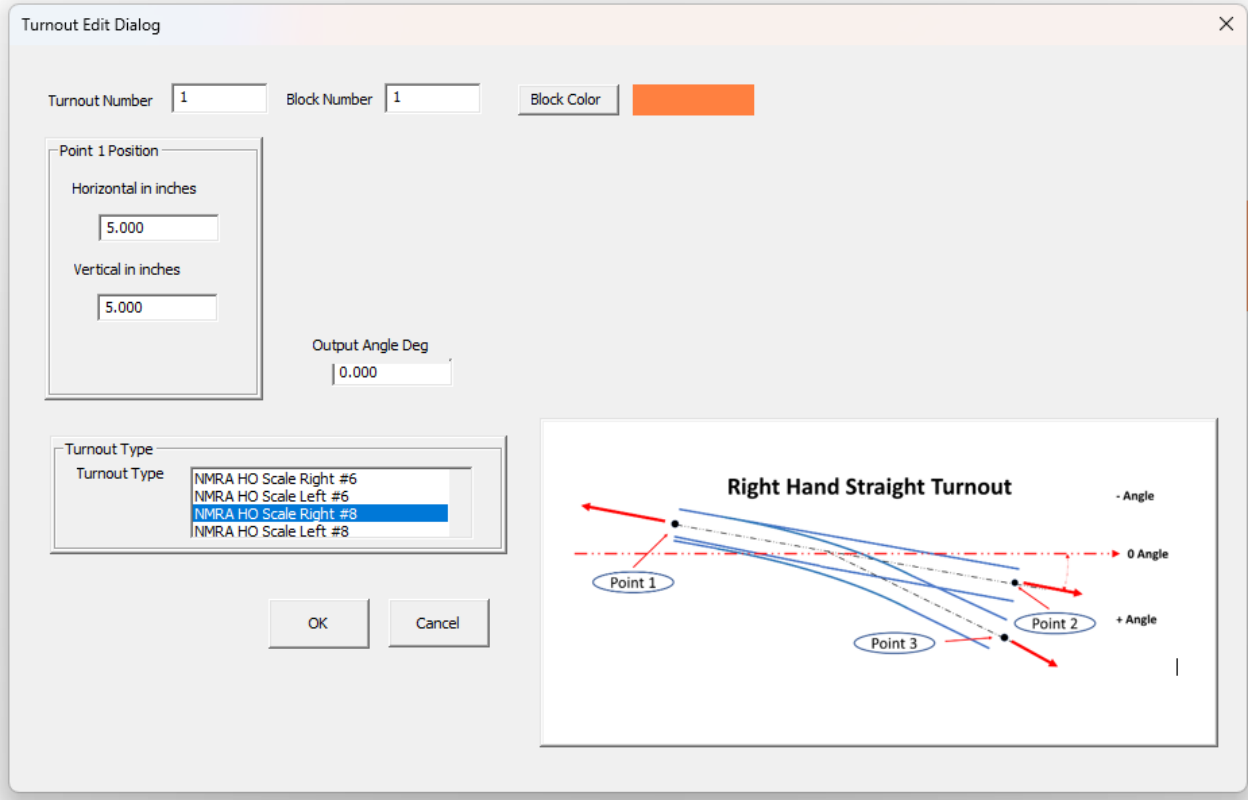


Step 2: Launch the Grandpa's Railroad Application, select Layout Setup mode, and create a 20-inch by 20-inch layout in HO scale. (Note: A layout doesn't need to be complete. In this example, we're only adding a turnout.)

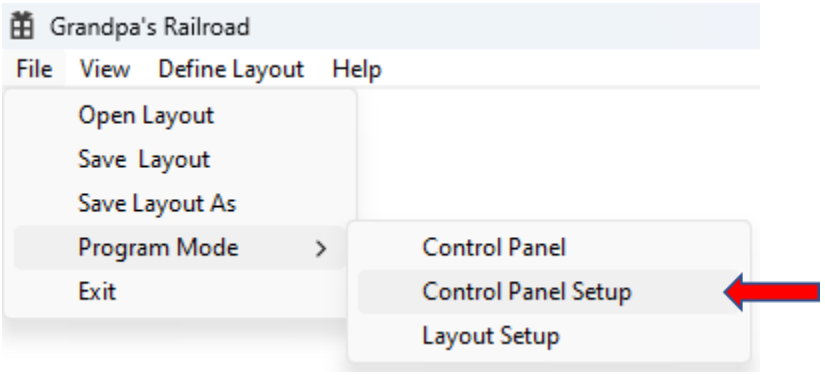
Step 3: Add a Digital/Proximity WIFI module to the layout at 2 inches horizontal and 5 inches vertical, with the desired Connected and Not Connected colors.



Step 4: Add a turnout to the layout. Place an NMRA HO Scale Right #8 at 5 inches horizontal and vertical with a zero-output angle.



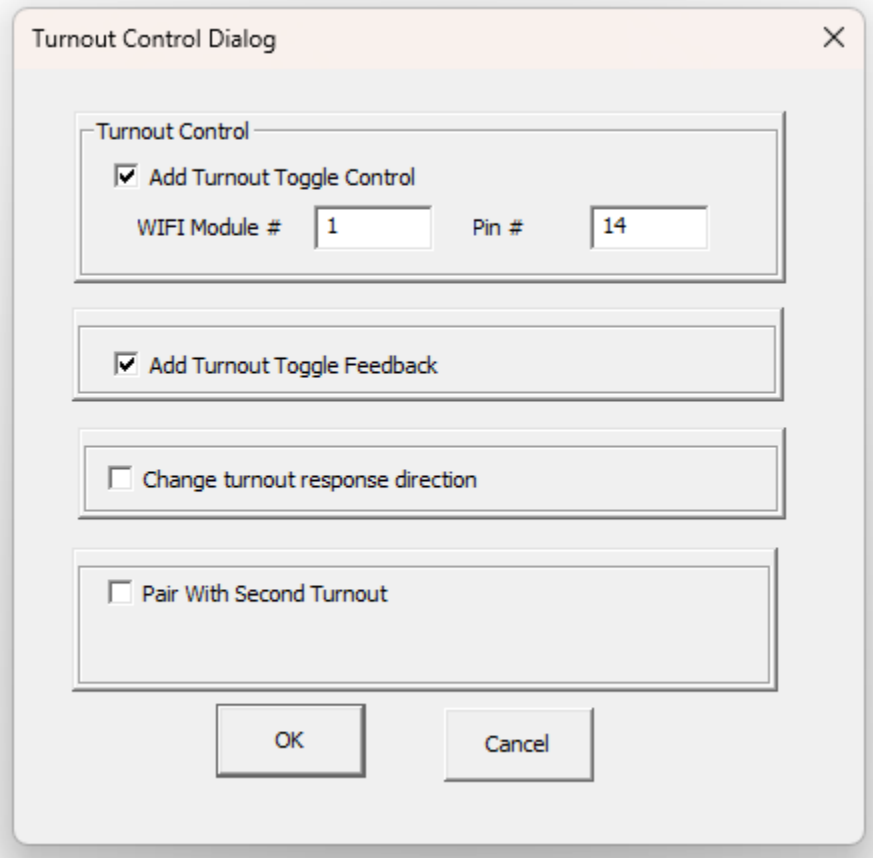
Step 5: From the File Menu item select:



File/Program Mode/Control Panel Setup

This will switch to the Control Panel Setup mode.

Step 6: Left click on the turnout element's **Control Box** and the following dialog will appear. (See **Show Control Boxes**)



Enter the Digital/Proximity WIFI module number and Pin number. Select Turnout Toggle Feedback. At this point, your layout should look as follows:

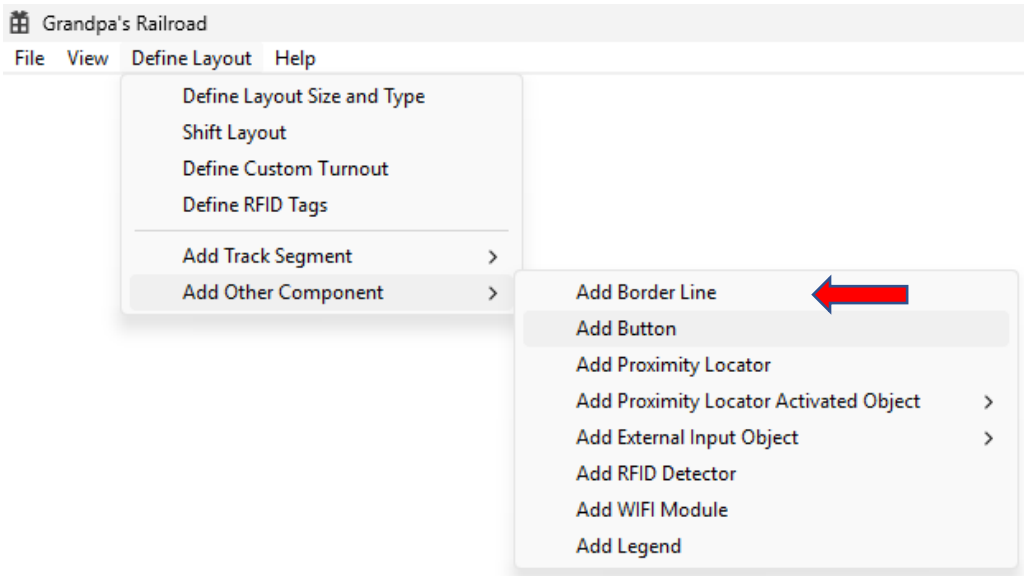
Step 7: Switch to the Control Panel mode. As you toggle the turnout by clicking on the red circle with the left mouse button, the motor should move from one side to the other.

If there's an issue, first verify the wiring is correct. Then, ensure the wires are properly fitted and secured into the connectors.

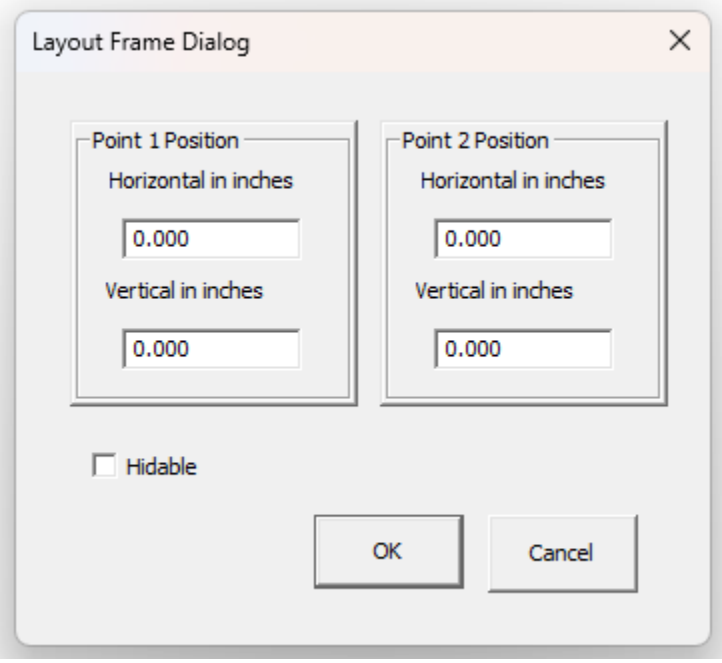
3.4 Adding Border Line

A borderline is a visible boundary in your layout that you want to display, such as the outline of a table.
To add a borderline, select the appropriate option from the main menu

Define Layout/Add Other Component/Add Border Line



Upon selecting this menu item, the following dialog will appear.



This dialog allows you to enter the two endpoints of a border line. You can also make the line hidable in Control Panel mode, which is useful for defining internal or side borders of a physical module and later hiding them once the final layout is complete.

After selecting **OK**, if all required data has been entered correctly, the border line will be placed on the layout. Otherwise, a detailed error message will appear, explaining any issues.

To edit a border element, left-click on the border element's **Edit Location**, and this dialog will reappear. (See **Show Edit Locations** for more details.)

3.5 Adding Button

A button is a switch used to turn a digital pin on or off, allowing it to control anything connected to that pin.

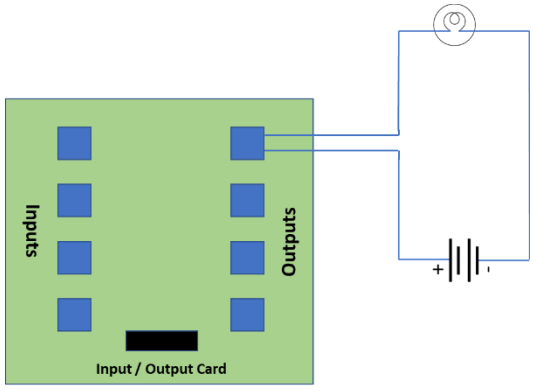
3.5.1 Hardware Required

The most basic use of a button is to control a light or another external electrical device. To achieve this, you need at least one Output Pin on an Input/Output Card

or a Turnout Control & I/O Board. The output pins on these boards function as switches for AC or DC current.

Note: Refer to the card specifications for voltage and amperage limits.

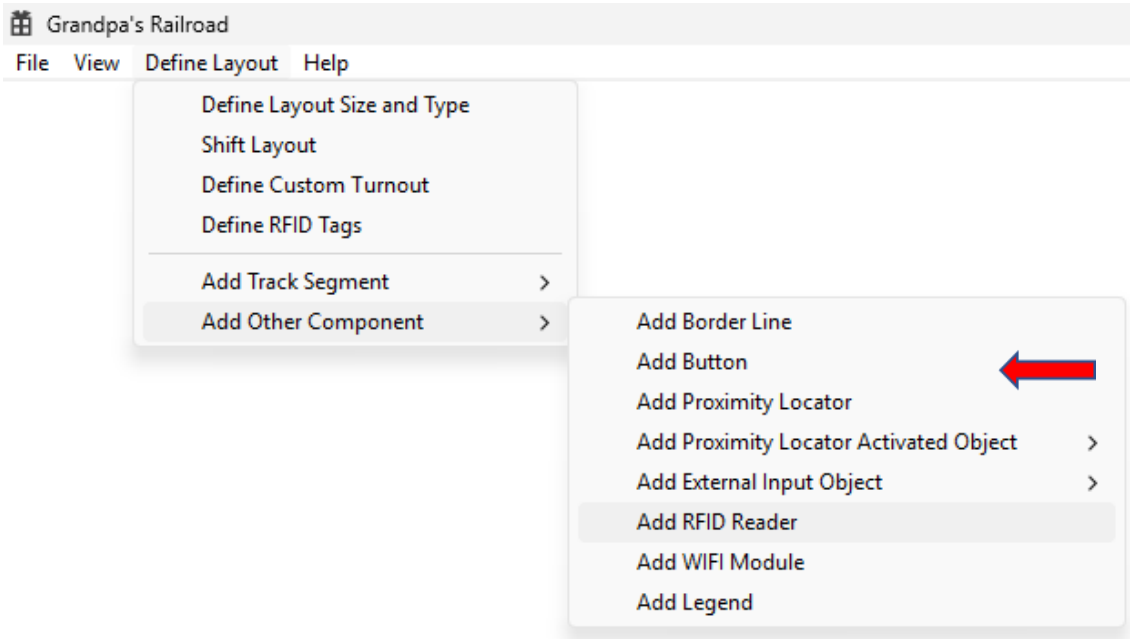
A simple schematic illustrating how to connect a light to the Output Pin is shown below:



To learn more about electricity, voltage, and current, watch the educational tutorial *"Electricity 99."*

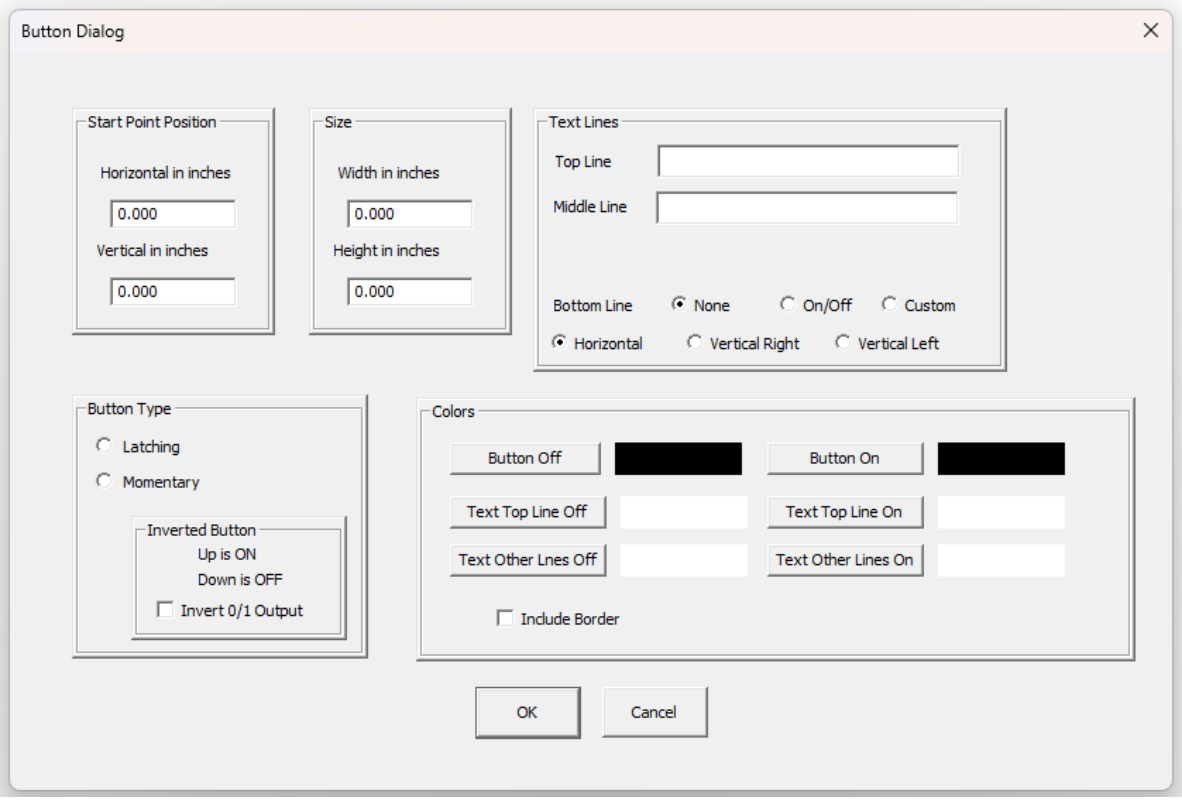
3.5.2 Adding a Button to your Layout

To add a button to your layout, you must be in **Layout Setup mode**. From the main menu, select:



Define Layout/Add Other Component/Add Button

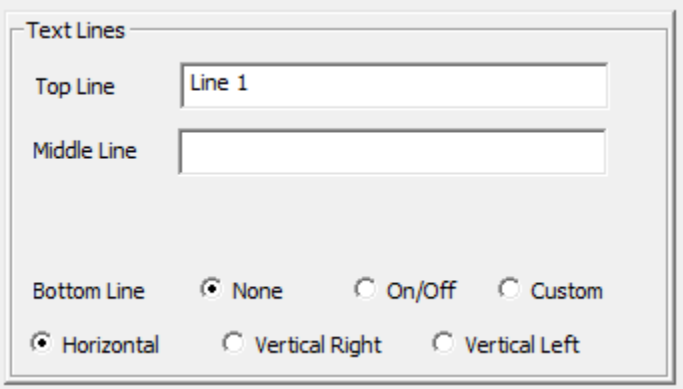
Upon selecting this menu item, the following dialog will appear, allowing you to

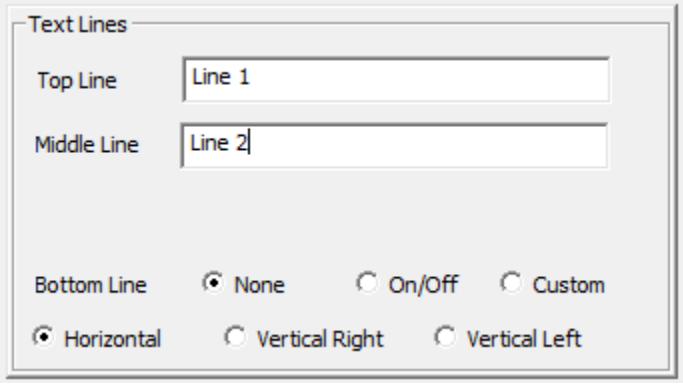


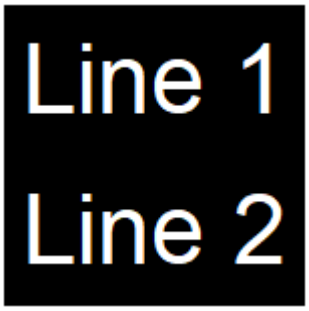
customize each button by adjusting its size, color, text, and other properties. You must enter the following parameters.

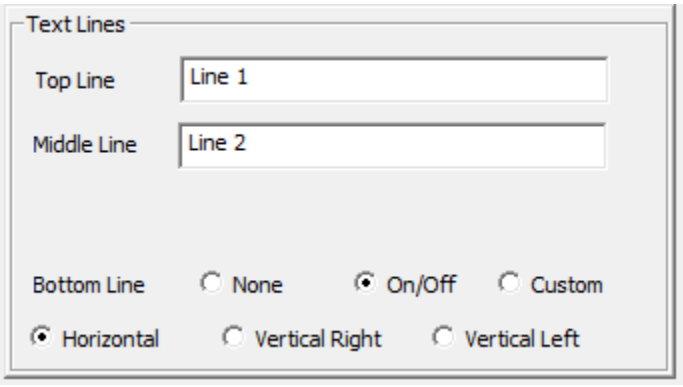
- **Start Point Position**: Defines the location of the upper-left corner of the button. If the button is associated with a specific item on your layout (e.g., a building), it is beneficial to place it near that item.
- **Size**: Determines the dimensions of the button. If linked to an item, it is recommended to match the button's size to that of the item.
- **Button Type**: Specifies whether the button is **Latched** or **Momentary**:
    - A **Latched** button turns **On** with the first left mouse click and **Off** with the second.
    - A **Momentary** button remains **On** only while the left mouse button is held down.

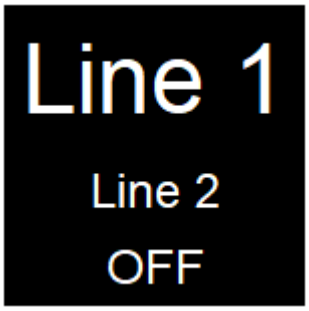
- **Invert I/O Output**: Reverses the button's state. A momentary button will normally be **On** and turn **Off** while the left mouse button is held down.
- **Text Lines**: Allows you to add up to three lines of text to the button.





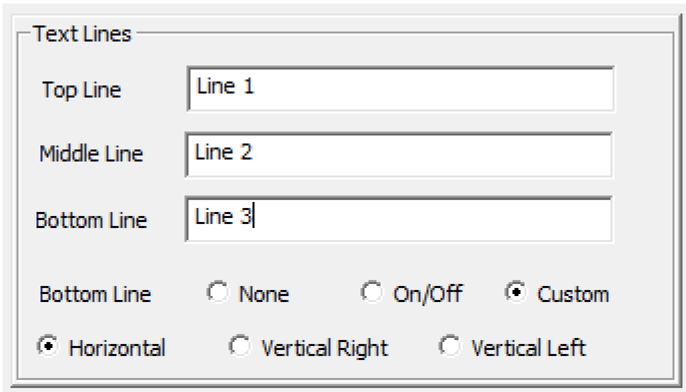


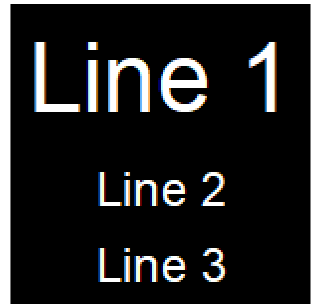


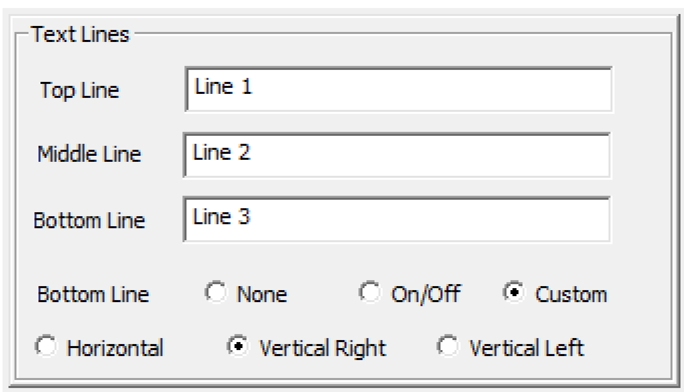


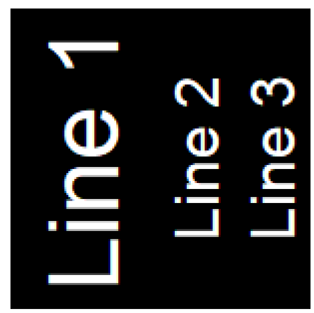
Selecting **Bottom Line On/Off** will display **Off** when the button is off and **On** when it is on.

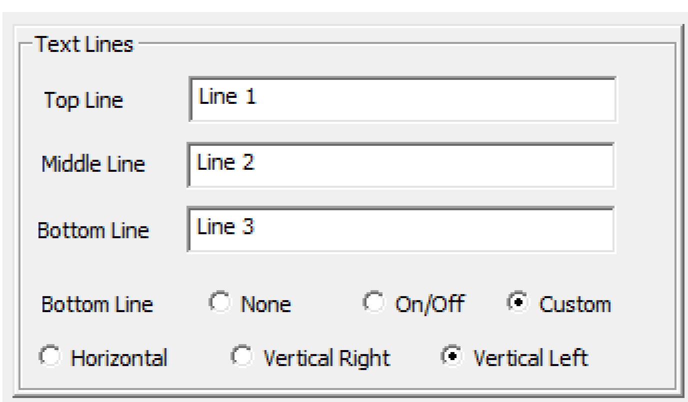
Options like **Horizontal, Vertical Right, or Vertical Left** adjust the text orientation accordingly.

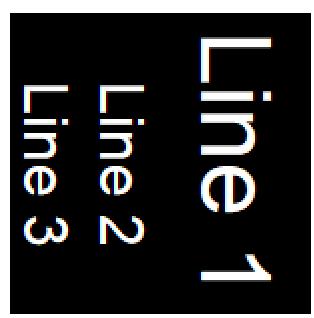




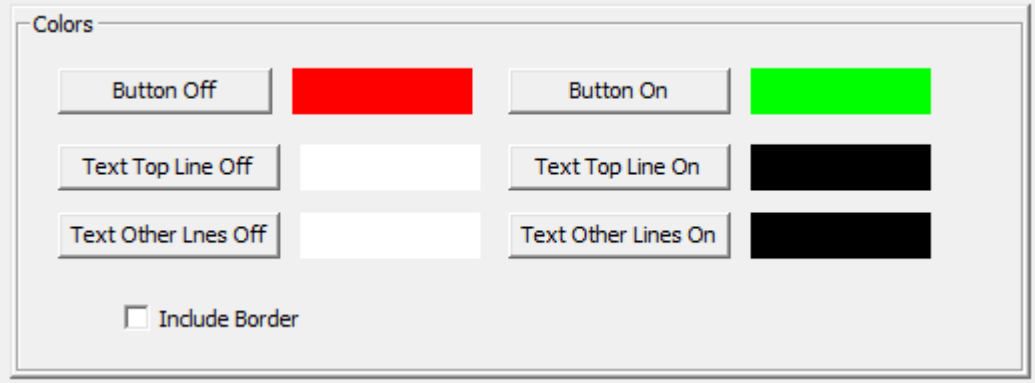


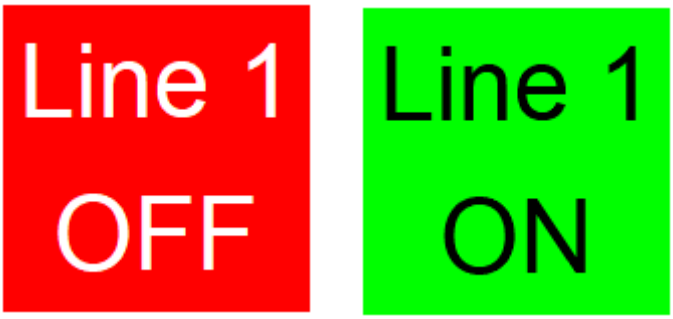




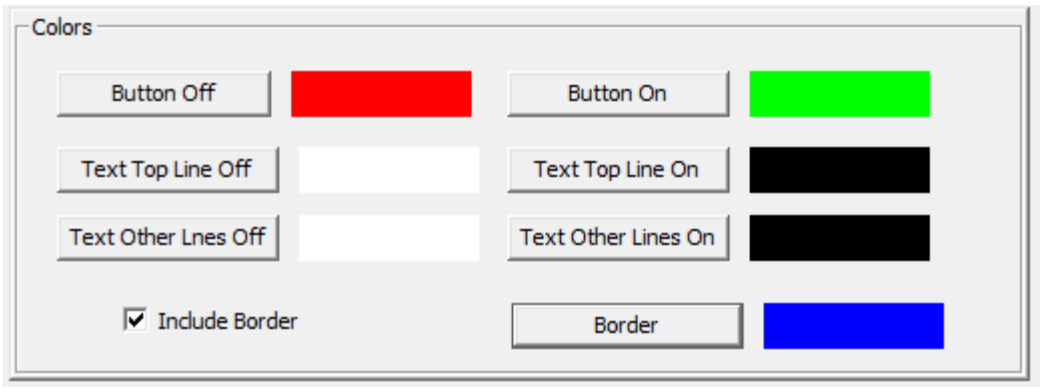


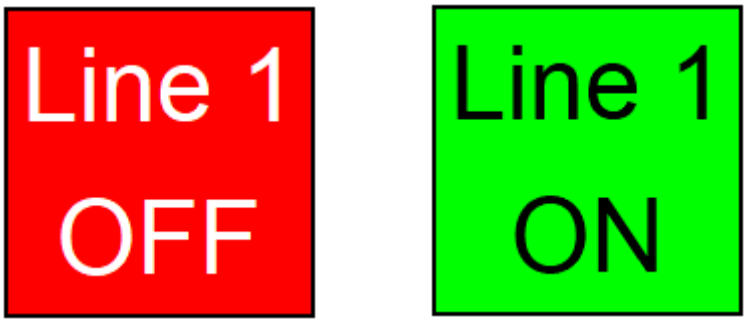
- **Colors:** Enables customization of the button's On and Off colors, including text color.





- **Include Border:** Allows you to select a border color for the button.



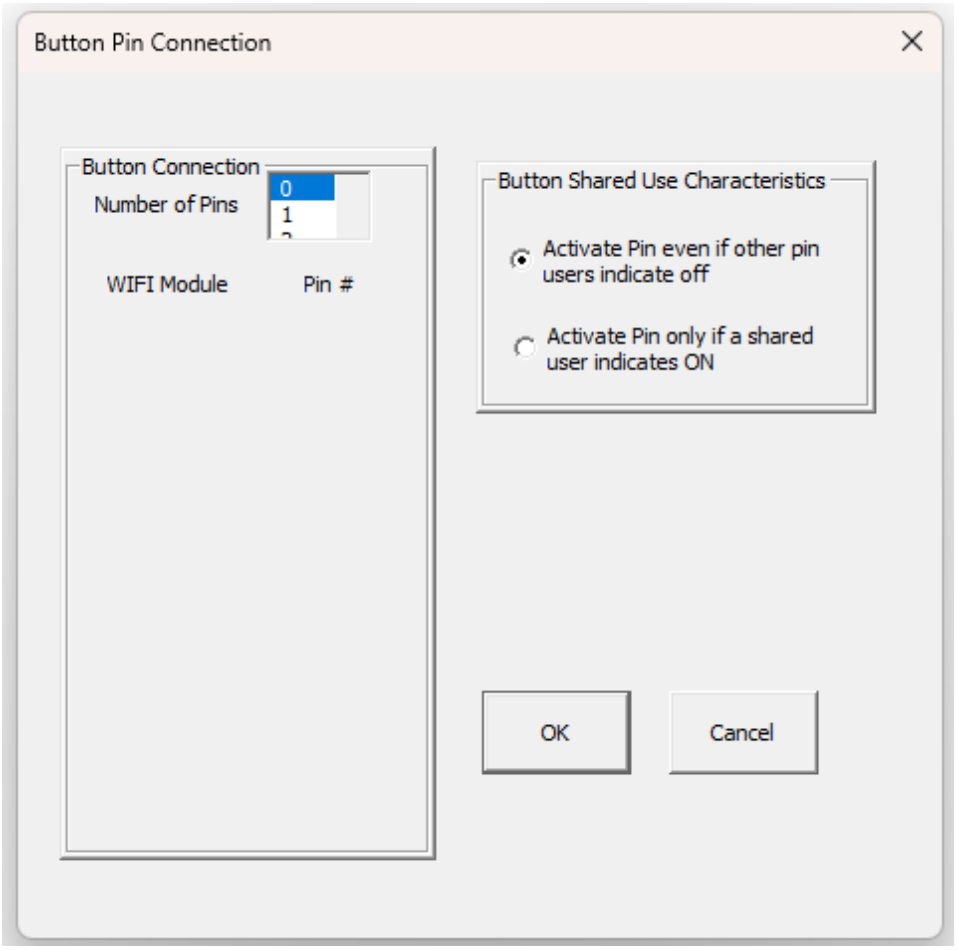


Additionally, a button can function as a **non-active layout element** or a **line of text** by *not* associating it with an output pin in **Control Panel Setup mode**. For a text-only button, set its color to white.

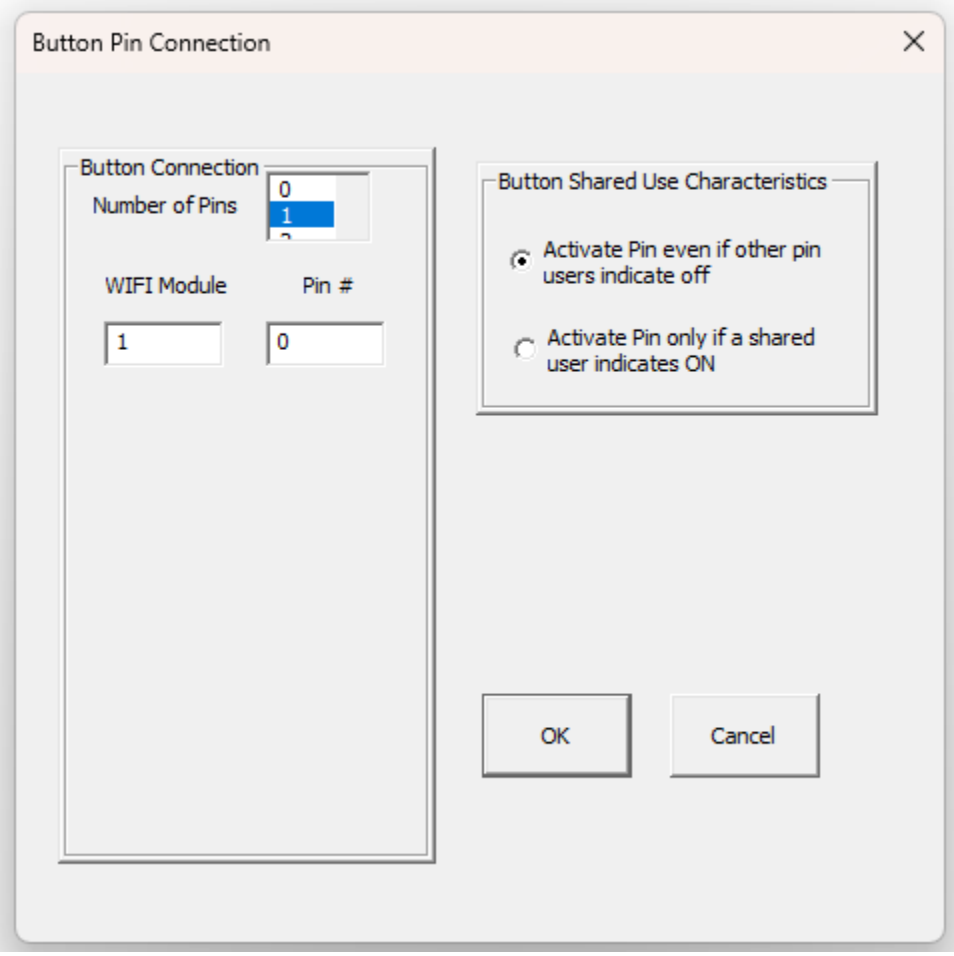
Text Line 1

3.5.3 Setting Up a Button for your Control Panel

To set up a button for your layout, you must be in Control Setup mode. Using the left mouse button, click the button image on the layout, and the following dialog will appear.



Next, you must select the number of output pins that this button will activate. Selecting zero is a special case where the button is used as a line of text. You can activate up to 8 pins with one button. If a non-zero value is selected, the dialog will update to allow you to enter the output pin to be controlled. For example, selecting "1" will result in the following change.

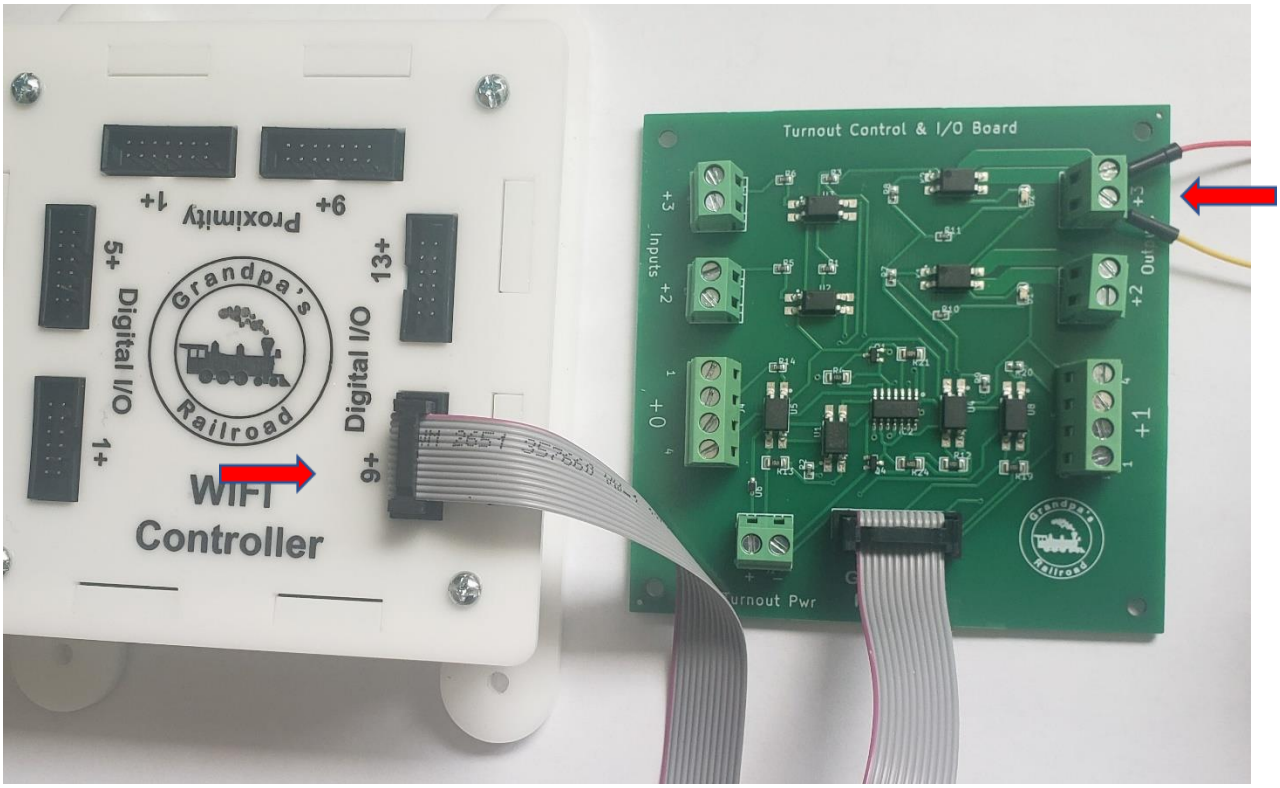


For each output pin that is activated, you need to enter the Digital/Proximity Wi-Fi module number that the I/O card is connected to. This number is the actual number programmed into the Wi-Fi module.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

Use the WIFI Module Programmer software to assign that number.

The pin number is calculated by adding the connector number on the Digital/Proximity Wi-Fi module (where the ribbon cable is connected) to the output connector number on the card used.

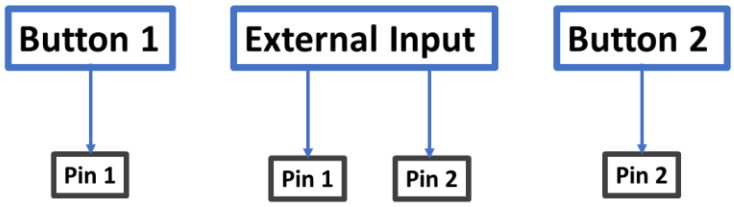


For example, using the image above, we calculate the pin number by adding 9 from the Digital/Proximity Wi-Fi module and 3 from the board, for a total of 12. Therefore, you would enter 12 for the pin number.

The final setting to specify is whether the button is shared. Sharing means the button can be paired with a second button, an external input, or some proximity objects. This feature allows you to easily turn off or switch to an alternate pin via external inputs. For instance, if your layout includes an external button for visitors to control an animation, sharing the external input with a button lets you turn off the external input. Button sharing has two types:

1. The button activates the designated pin, even if other pin users indicate Off.
2. The button only activates the designated pin if other pin users indicate On, and this button itself indicates On.

To illustrate the above, let's assume we have an external input that controls two pins, and it is set to Type 2 sharing as described. Additionally, let's assume there is a button of Type 2 associated with each pin.



In this case, Pin 1 and the animation associated with it will only be On if both Button 1 and the external input are On. Similarly, Pin 2 and its associated animation will only be On if both Button 2 and the external input are On. Therefore, by simply manipulating Buttons 1 and 2, you can control what the external input affects in real time, without changing the Control Panel setup.

3.5.4 Button Control Panel Operation

To activate a button in control panel mode, hover the mouse cursor over it and press the Left Mouse Button. If the button is of the **Momentary** type, it will remain active only while the Left Mouse Button is held down. If the button is of the **Latched** type, it will stay On until the Left Mouse Button is pressed again while the cursor is over it**.**

3.5.5 Practical Example

A basic example of using a button is illustrated below. In this demonstration, we use a multimeter to show that the output connection functions as a switch. In the Off state, the switch is open, resulting in an immeasurably high resistance. In the On state, the switch is closed, and the resistance becomes very low. Additionally, we will connect a simple LED circuit to illuminate an LED.

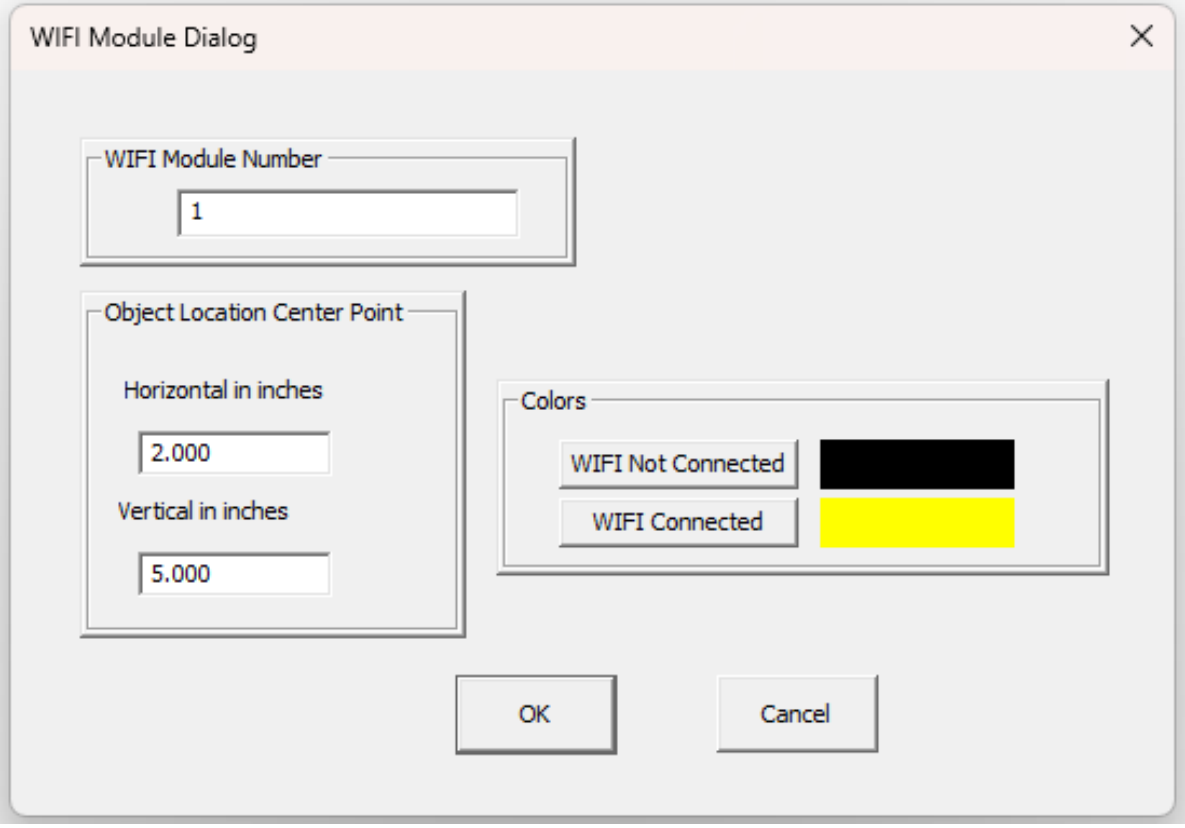
Step 1: Create a Layout

1. Launch the **Grandpa's Railroad Control Panel** application.
2. Select **Layout Setup** mode.

3. Create a **10-inch by 10-inch** layout in any scale.
    - (*Note: A layout does not need to contain track. In this example, we are only adding a button.*)

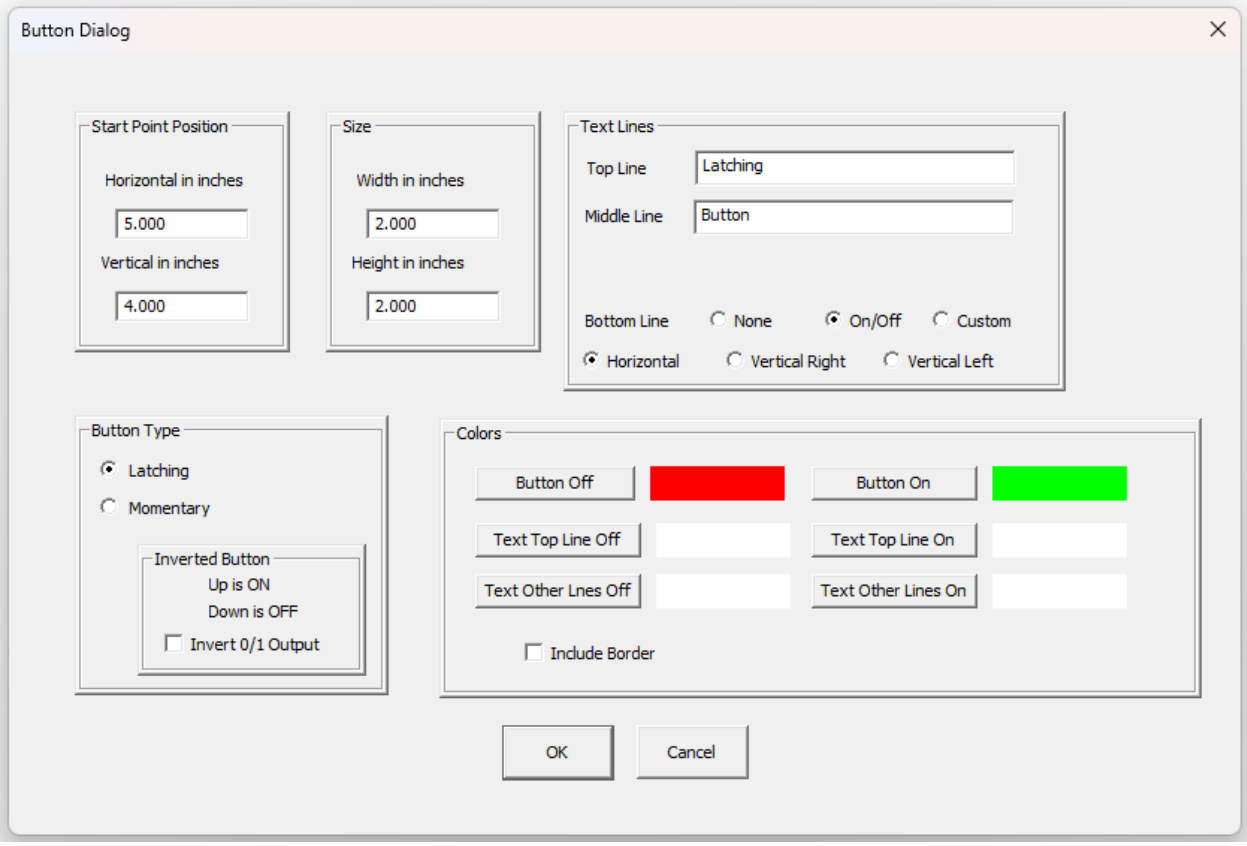
Step 2: Add a Digital/Proximity WiFi Module

1. Add a **Digital/Proximity WiFi module** to the layout.
2. Position it at **2 inches Horizontal** and **5 inches Vertical** coordinates.
3. Set the desired **Connected** and **Not Connected** colors.



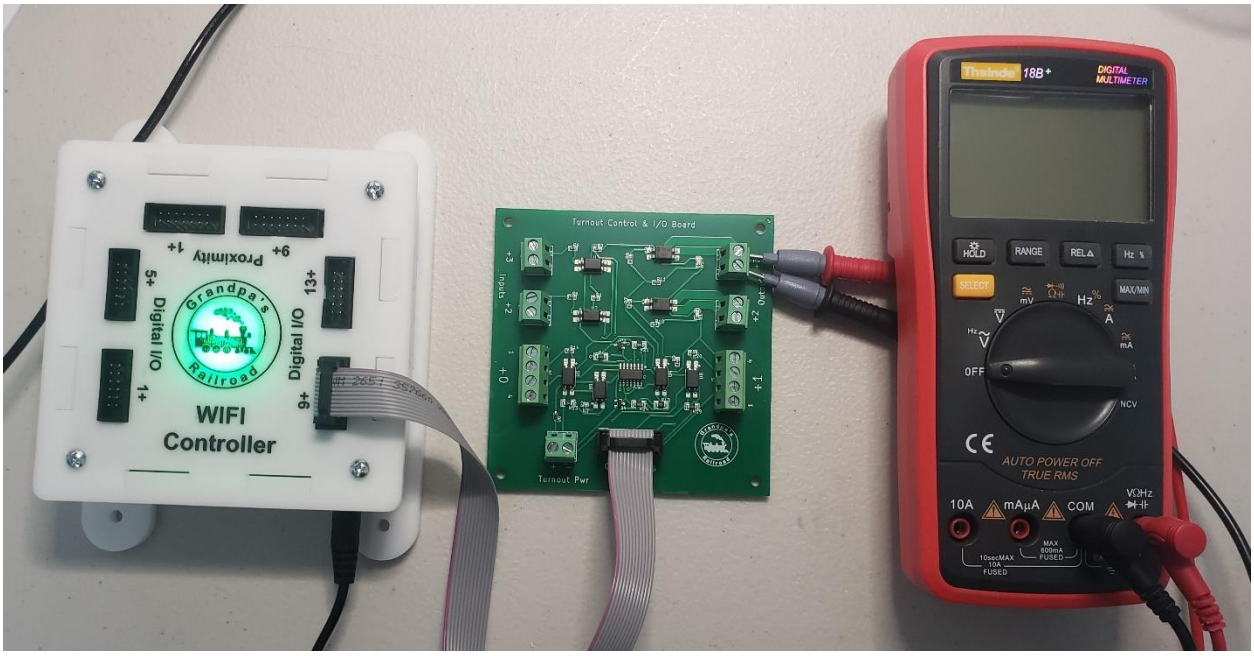
Step 3: Add a Latching Button

1. Add a **Latching Button** to the layout.
2. Position it at **5 inches Horizontal** and **4 inches Vertical** coordinates.
3. Set the **width and height** to **2 inches**.
4. Add text to the button. In this example, we use **On/Off** as the label.
5. Select colors for the **On** and **Off** states.



Step 4: Connect the Hardware

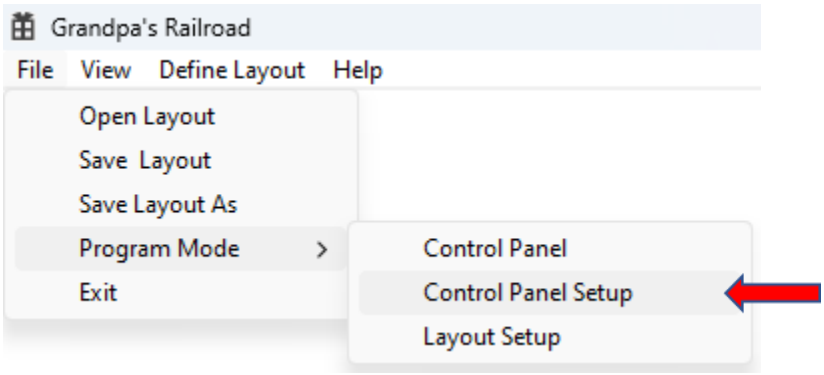
1. Connect **power** to the **WiFi Module**.
2. Connect the **card** to the **9+ port** on the **WiFi Module**.
3. Connect a **multimeter** to the **+3 connector** on the card.
    - These connections provide a **Pin #12** for the multimeter.
    - The card used in this example is the **Turnout Control & I/O Board**.



○

Step 5: Switch to Control Panel Setup Mode

1. From the **File Menu**, navigate to:



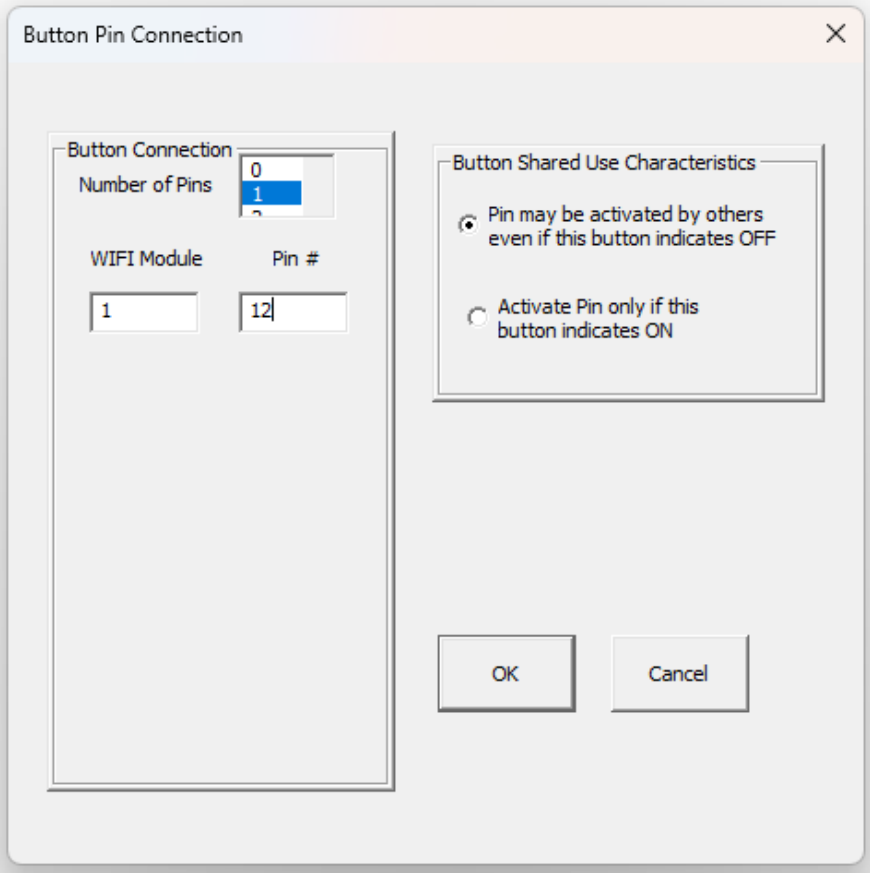
File/Program Mode/Control Panel Setup

2. This will switch to **Control Panel Setup** mode.

Step 6: Configure the Button

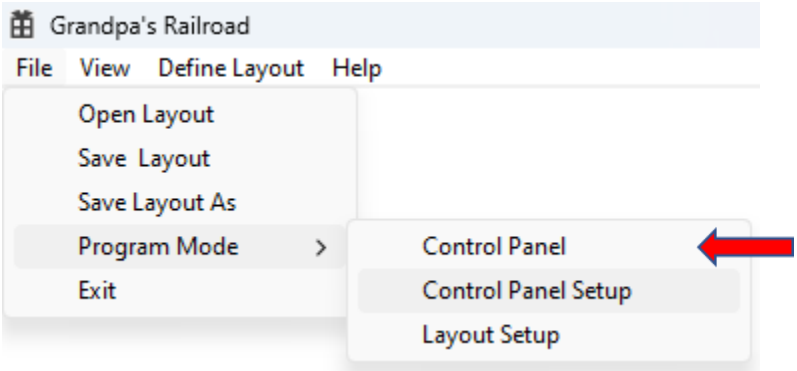
1. Place the mouse cursor over the button and press the **Left Mouse Button**.
2. A dialog box will appear.

- Based on the connections from **Step 4**, the **Module # is 1** and the **Pin # is 12**.
- Since only one button is defined, the **sharing type** is not relevant.



Step 7: Switch to Control Panel Mode

1. From the **File Menu**, navigate to:

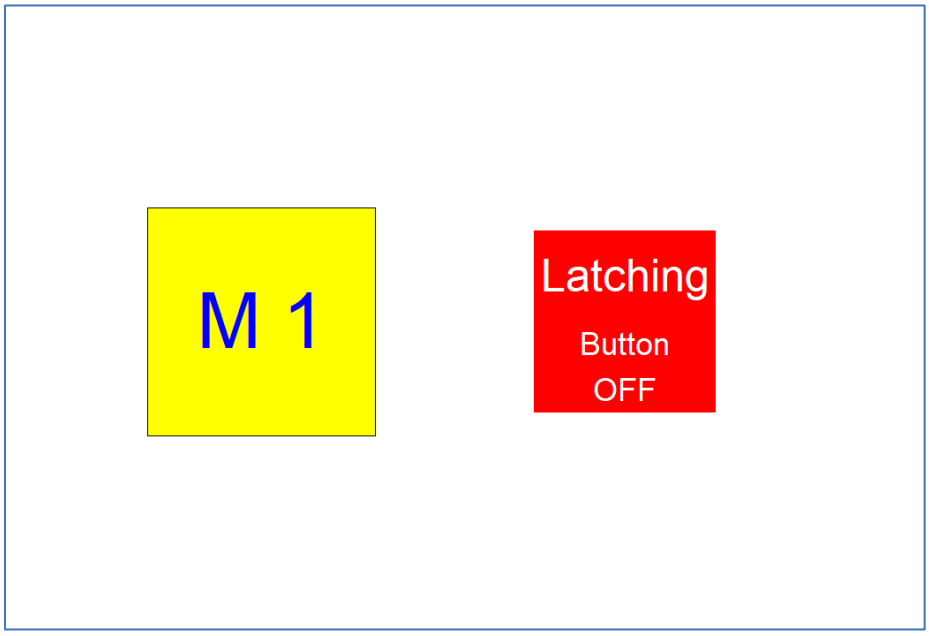


File/Program Mode/Control Panel

2. This will switch to **Control Panel** mode.

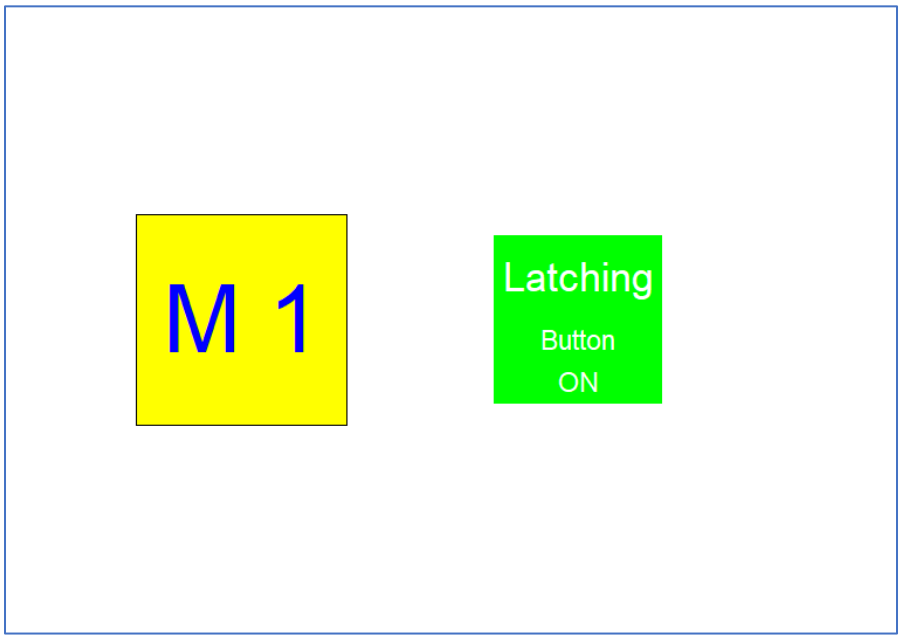
Step 8: Testing the Button

1. Once the **Digital/Proximity WiFi Module** connects, the screen should resemble the following layout (if using the provided setup parameters and colors).

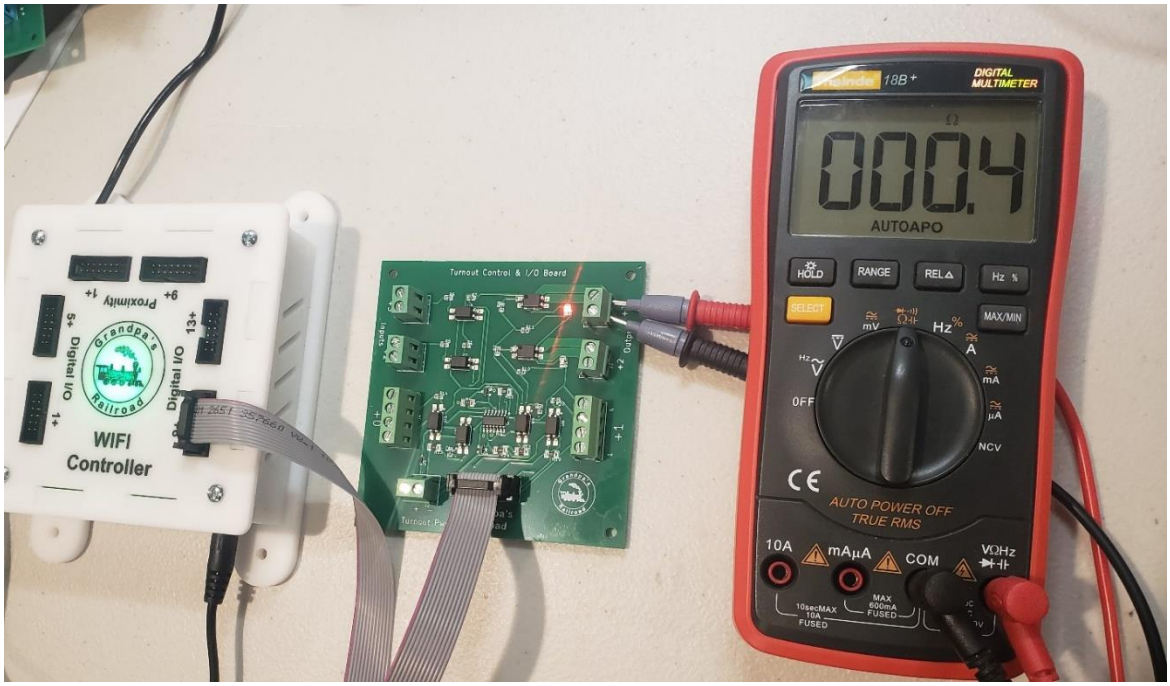


2. The multimeter should display **0.L**, indicating an open circuit (no connection).

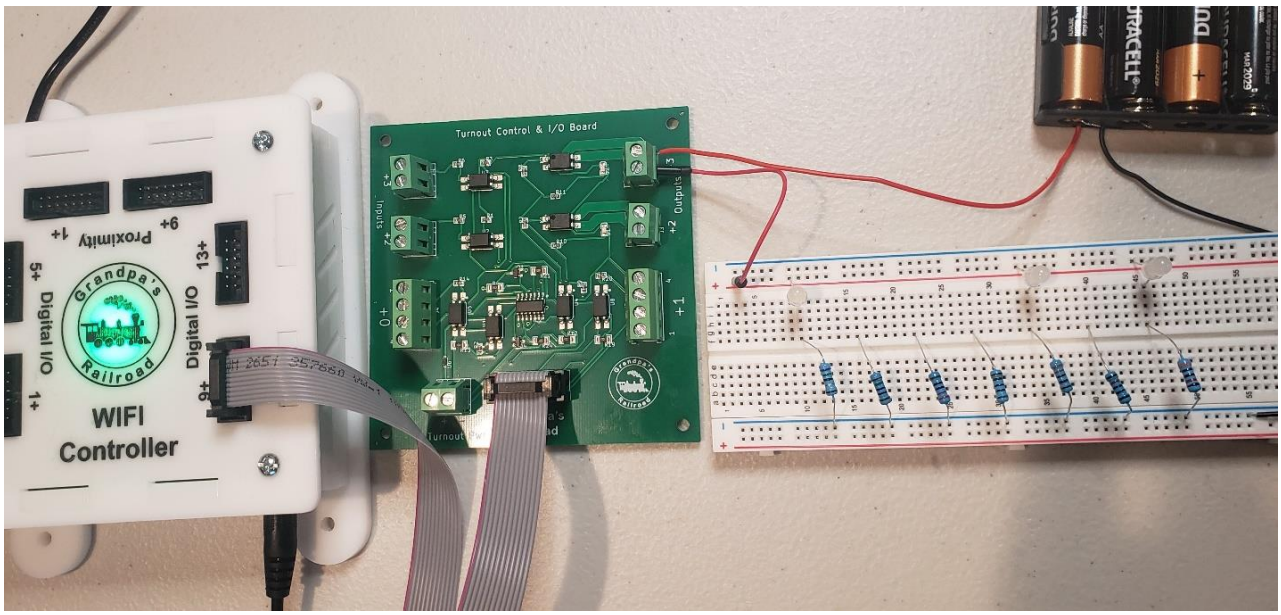
3. Press the **Left Mouse Button** over the button symbol.

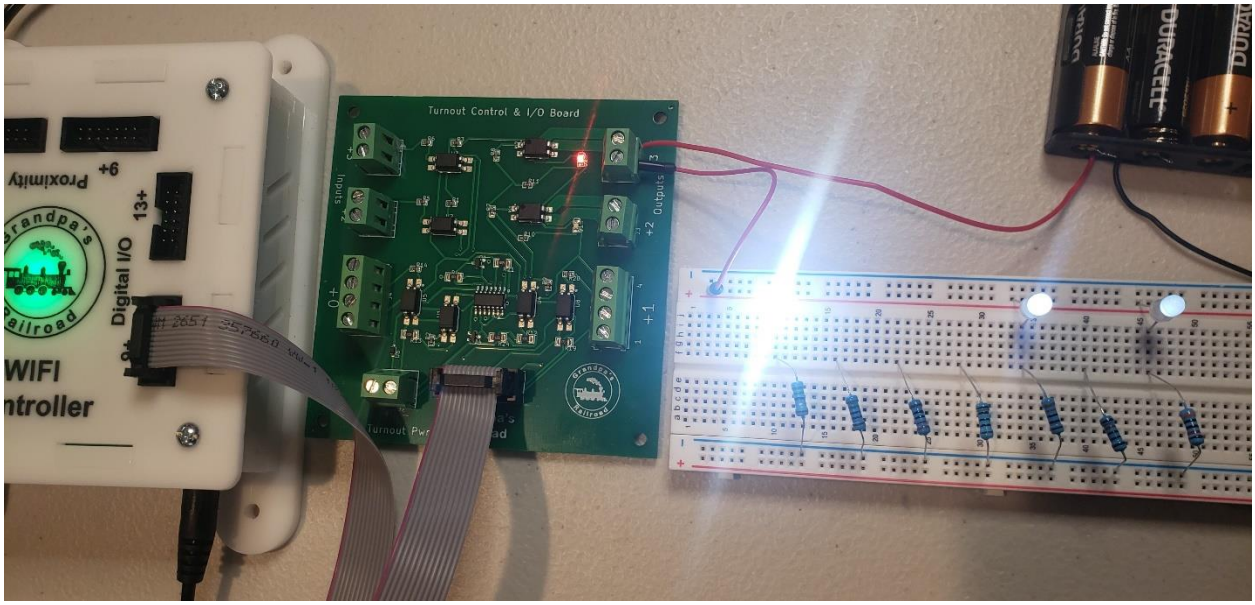


4. The screen will update, and the multimeter will now read **0.4 ohms**, which is typical for a closed switch.
5. Additionally, a **red LED** next to the connector will light up, indicating that the switch is **On**.



If you have been following our **Educational Tutorials: "Electricity 99"**, a more practical application for model trains would be to use the button to **control lighting**. By connecting a circuit from those tutorials, we can see how a button can be used to turn **lights on and off** within the layout. Of course, in a real setup, the **battery pack** would be replaced with the **accessory power source**.





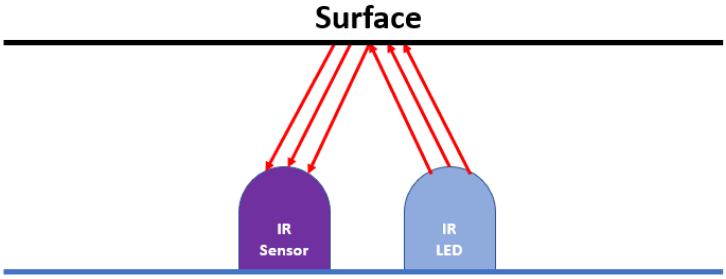
3.6 Adding a Proximity Locator

A proximity locator on Grandpa's Railroad is an infrared (IR) device used to determine a train's position or detect nearby objects. An IR device emits and senses light within a wavelength range of approximately 800 nanometers to 1 millimeter. This light is invisible to the human eye and is generally emitted by heated objects. The primary sources of IR radiation include the sun, heat lamps, and conventional light bulbs, which can sometimes cause IR devices on model railroads to function inconsistently.

Since Grandpa's Railroad operates as a centralized system, sophisticated algorithms continuously calibrate these devices, ensuring their stability and ease of use.

There are two primary methods for utilizing these devices:

1. **Reflective Mode** – Typically used for devices placed within the train tracks. An IR LED transmits light, which reflects off a nearby object and is detected by an IR sensor. The presence of reflected IR light at the sensor indicates an object's presence.



Reflective Proximity Sensor

2. **Direct Mode** – In this setup, the IR LED transmits light directly to an IR sensor. When an object interrupts the beam, it signals the presence of an obstruction.

Direct Proximity Sensor

On a model railroad, the direct method can be used on opposite sides of a track to detect trains.

3.6.1 Hardware Required

The hardware required to use proximity locators includes a **Digital/Proximity WiFi Module** and one of the following options:

1. **Screw-Type IR Proximity Locator Card**
    - IR Proximity Locator (included with the card)

- Shrink tubing (included with the card)
- 4-wire telephone cable (solid wire)
- Wire strippers
- Soldering iron and solder or butt connectors
- Hair dryer or heat gun
- Screwdriver

or

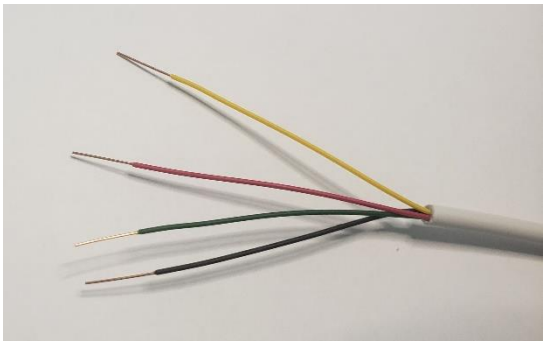
2. **RJ11-Type IR Proximity Locator Card**
    - IR Proximity Locator (included with the card)
    - Shrink tubing (included with the card)
    - 4-wire flat stranded 26 AWG telephone cord
    - RJ11 6P4C male connector (ensure it is 6P4C)
    - Wire strippers
    - Soldering iron and solder or butt connectors
    - Hair dryer or heat gun
    - RJ11 crimp tool

The first step in preparing the hardware is attaching the wire to the IR LED and sensor. The following steps outline the wiring process and methods we use. You may find other methods easier, but it's important to ensure that the chosen approach does not apply excessive heat to the IR LED or sensor. Additionally, the final units should have a small enough diameter to fit into a 9/64-inch hole (see *Installing the Proximity Locator* under *Special Considerations*).

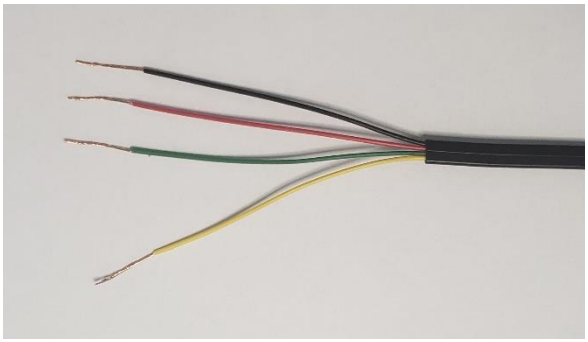
3.6.1.1 Soldering Method of Wiring IR LED and Sensor

Step 1: Cut the appropriate cord to a length that reaches from the proximity locator's position on your layout to the designated pin on the IR Proximity Locator card. It's best to cut the cord slightly longer than needed to allow for some slack.

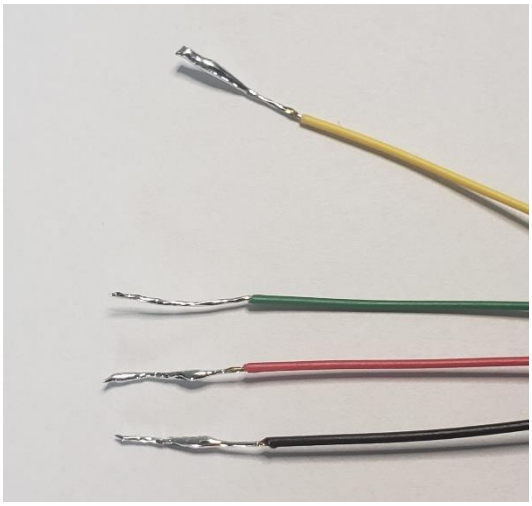
<u>Step 2</u>: Strip **2.5 inches** of the cable jacket from the cord. Then, strip **½ inch** of insulation from each wire. Twist the ends of each stranded wire to keep the strands together.



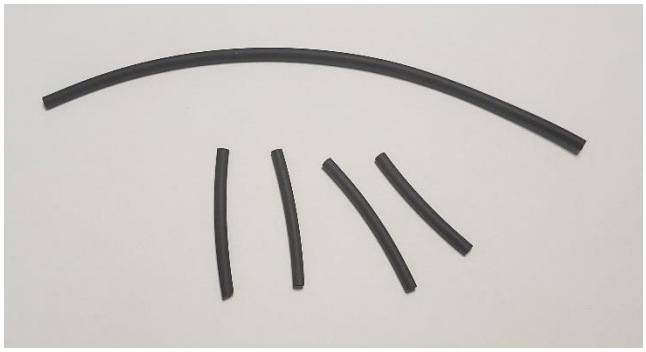
or



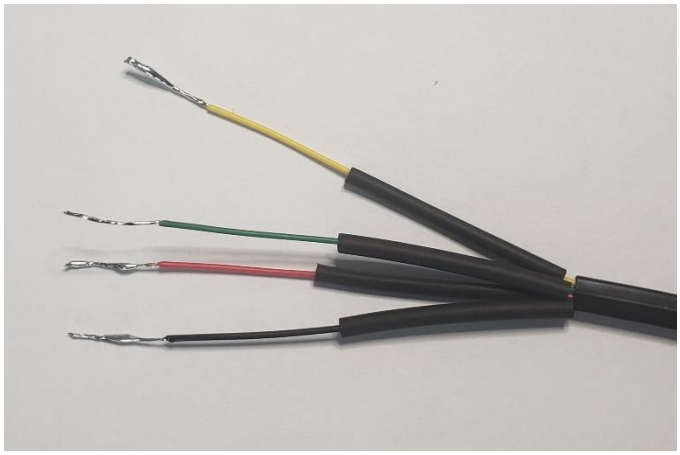
<u>Step 3</u>: Tin each exposed wire end with solder. Apply a generous amount, even to solid wires.



Step 4: Cut a **5-inch** piece of shrink tube into **four equal pieces**.

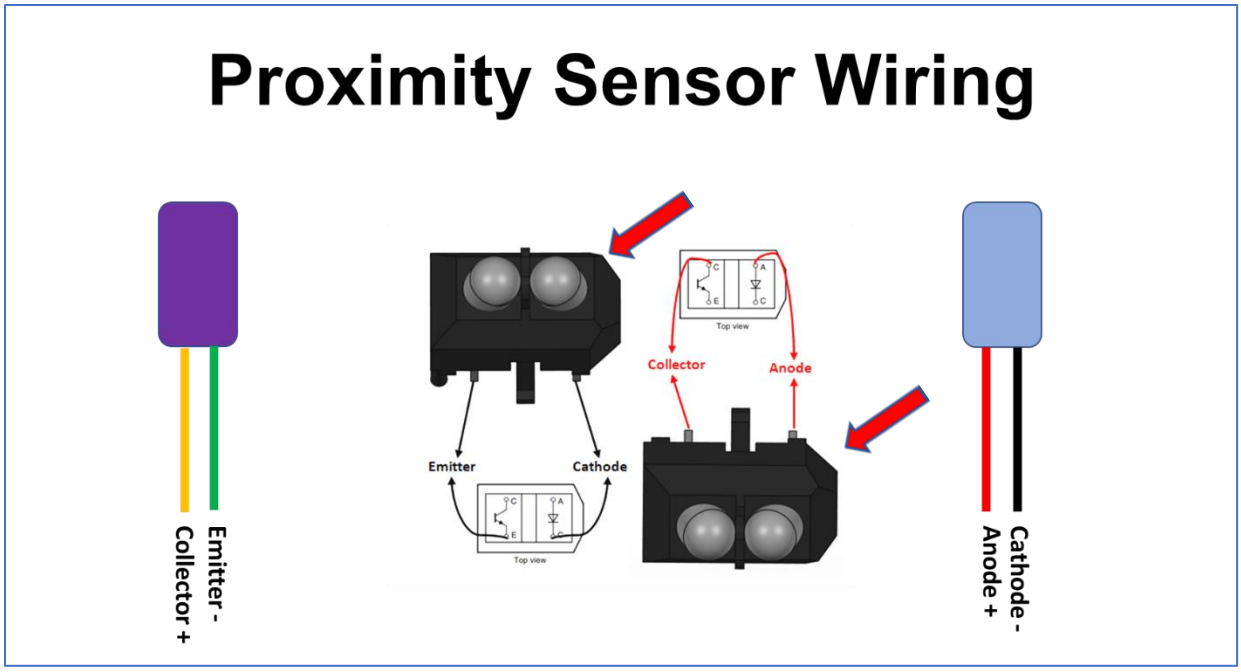


Step 5: Once the solder has cooled, slide the shrink tube over each wire, positioning it all the way to the cable jacket. Ensure the shrink tube remains away from the soldering area during further steps.



Step 6: Using the diagram below, solder the correctly colored wire to the IR device. Normally, you would heat the leg of the device before attaching the wire, but in this case, apply minimal heat to the leg while heating the wire and solder simultaneously. Keep the shrink tube away from the soldering area.

Do not remove the LED or sensor from the plastic case before soldering. Doing so may cause you to lose track of how the colored wires are to be connected. If you do lose track of the leads, see determining IR leads under Special Considerations.

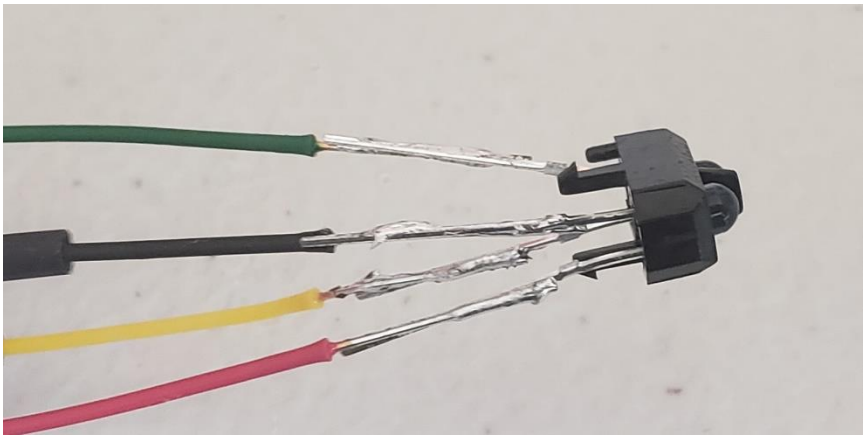


The 45-degree corners on the case indicate the LED side of the case which we will call the front. Therefore, when looking from the back to the front, the wiring is as follows:

1) Front left – LED Anode (Red wire)
2) Front right – LED Cathode (Black wire)
3) Back left – Sensor Collector (Yellow wire)
4) Back right – Sensor Emitter (Green wire)

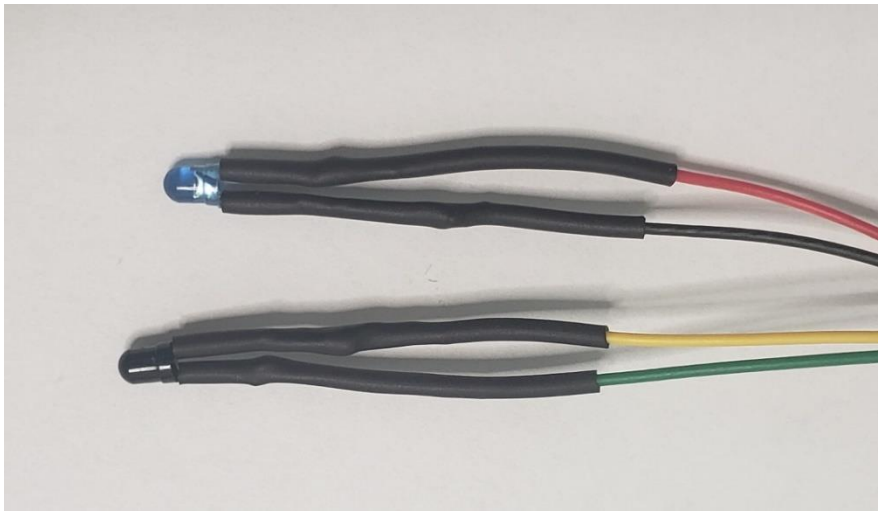
To solder, slightly bend the legs outward. If available, use a stand for support.

The final assembly should resemble the following:



Step 7: Once the solder has cooled, carefully remove the LED and sensor from the case. Slide the shrink tubing all the way up (keep the case for later testing). To remove the LED and sensor, hold the case and press the top with a soft plastic or padded item to avoid scratching the lens.

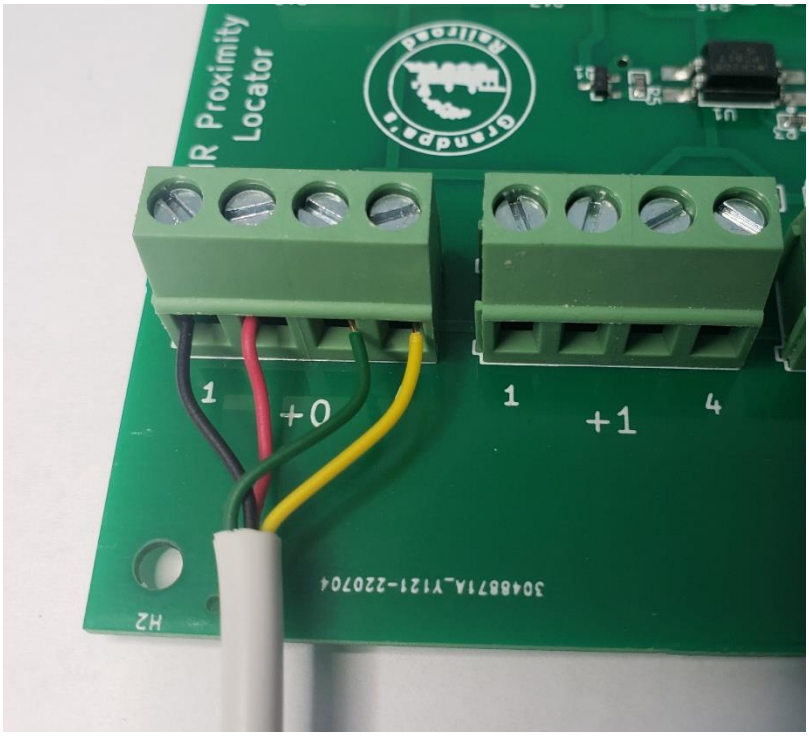
Use a **hair dryer or heat gun** to shrink the tubing, ensuring it extends fully to the top. A hair dryer takes longer but reduces the risk of damaging the LED or sensor. A heat gun may melt the plastic case if not used carefully.



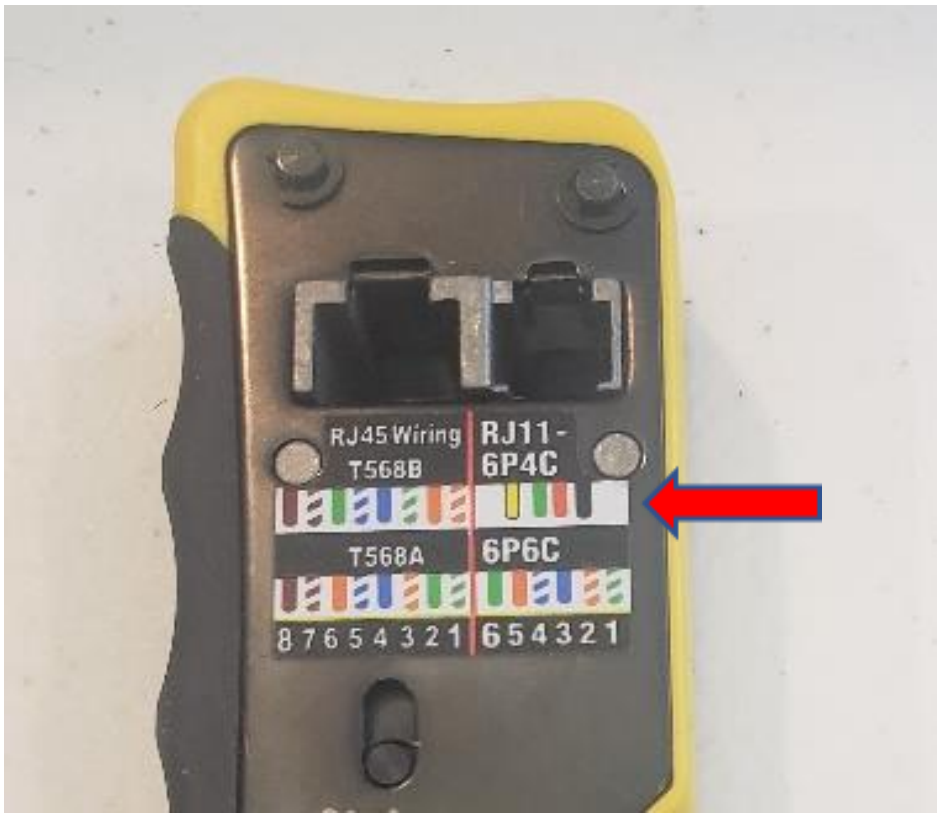
Step 8: Connecting the IR Proximity Locator to the card depends on the card type:

- **Screw Terminal Connection:**
    - Strip **1 inch** of the cable jacket from the **4-wire telephone cable (solid wire)**.
    - Strip **¼ inch** of insulation from each wire.
    - The connection to the card is as follows: the colors indicate the wire colors, while the numbers represent the connection points. On the card, positions 1 and 4 are marked to indicate the two endpoints.

- Ensure the wire is not trapped under the connector. Fully open the connector, insert the wire, tighten the connector, and check for a secure connection. This prevents connection failures or intermittent issues.



- **RJ11 Connection:**
  - Strip **¼ inch** of the cable jacket.
  - Use a **crimping tool** to attach an **RJ11 6P4C connector** to the wires. The tool ensures proper wire orientation.
  - Insert the connector into the appropriate slot on the card.



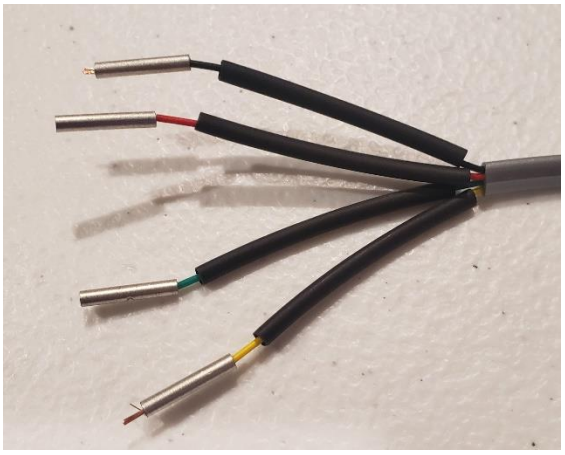
Step 9: Reinstall the plastic case for the IR LED and sensor. Next, test the setup using the example provided in a later section.

Best Practice: Keep a known working setup for testing components like cables before installation. This approach helps identify issues early and saves significant time and effort.

3.6.1.2 Butt Connector Method of Wiring IR LED and Sensor

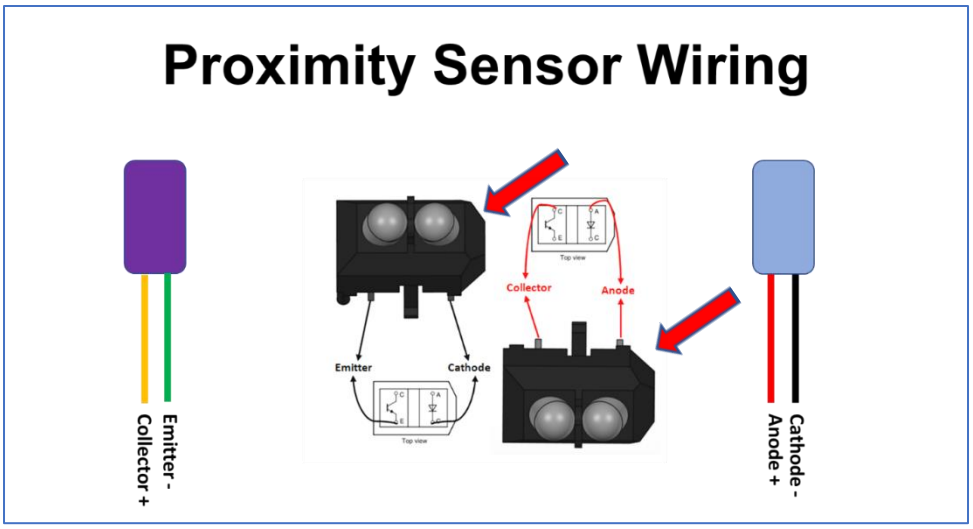
Follow Steps 1 through 4 as outlined in the soldering method.

Step 5: Slide a shrink tube over each wire, ensuring it reaches the cable jacket. Then, slide a BN0.5 butt connector onto the end of each wire.



Do not remove the LED or sensor from the plastic case before crimping. Doing so may cause you to lose track of how the colored wires are to be connected. If you do lose track of the leads, see determining IR leads under Special Considerations.

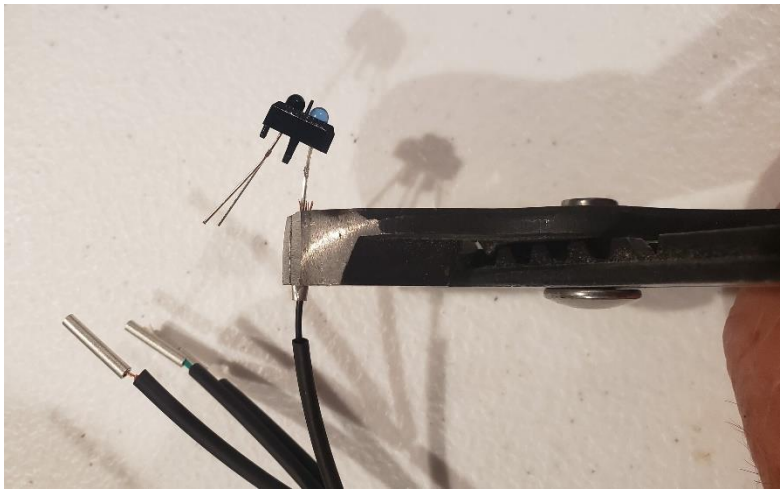
Step 6: Refer to the diagram below and crimp the correctly colored wire to the corresponding IR device terminal. The case features 45-degree corners, which



indicate the LED side—this will be referred to as the front. Therefore, when looking from the back to the front, the wiring is as follows:

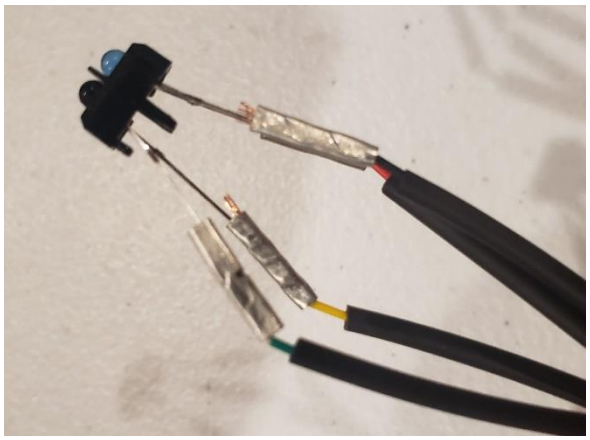
1) Front left – LED Anode (Red wire)
2) Front right – LED Cathode (Black wire)
3) Back left – Sensor Collector (Yellow wire)
4) Back right – Sensor Emitter (Green wire)

To crimp, slightly bend out the legs.



Use a large set of pliers to apply high force when crimping the legs to the wire. Additionally, flatten the butt connector so that the flat side is perpendicular to the wire axis of the LED or IR sensor. This ensures that when the connector wires are inserted through the hole under the track, their flat sides will face each other.

The final assembly should resemble the following:

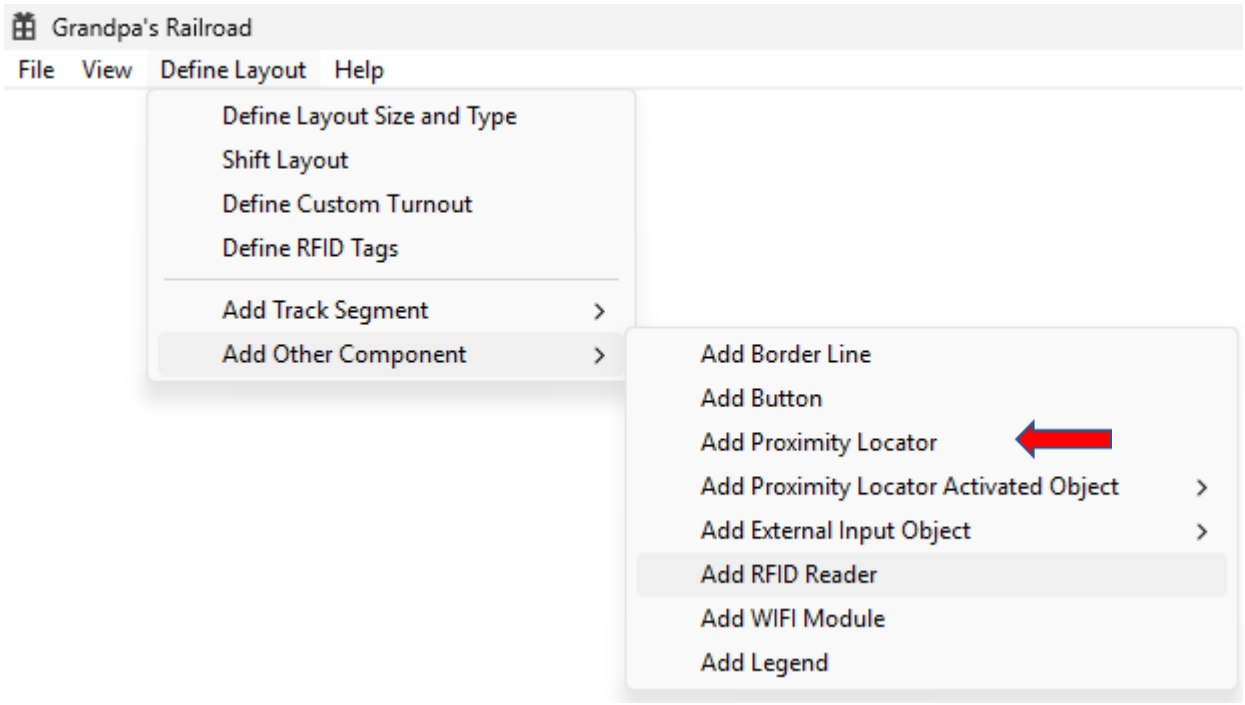


Follow steps 7 through 9 as defined above for the soldering method.

Best Practice: Keep a known working setup for testing components like cables before installation. This approach helps identify issues early and saves significant time and effort.

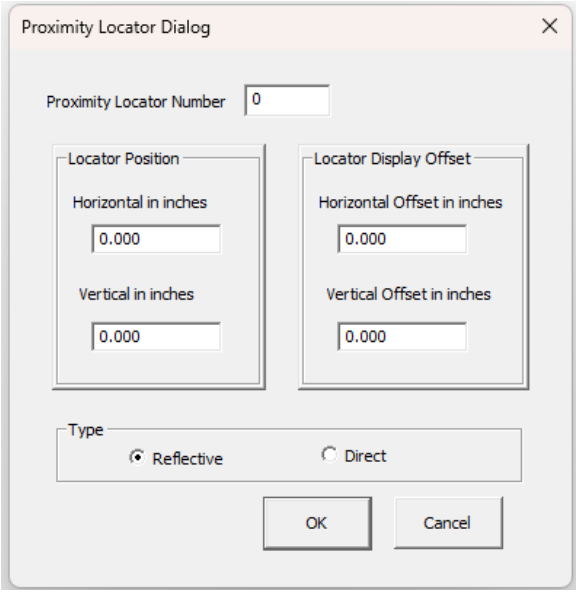
3.6.2 Adding a Proximity Locator to your Layout

From the main menu, select



Define Layout/Add Other Component/Add Proximity Locator

Upon selecting this menu option, the following dialog will appear.



In this dialog, you must enter the following data:

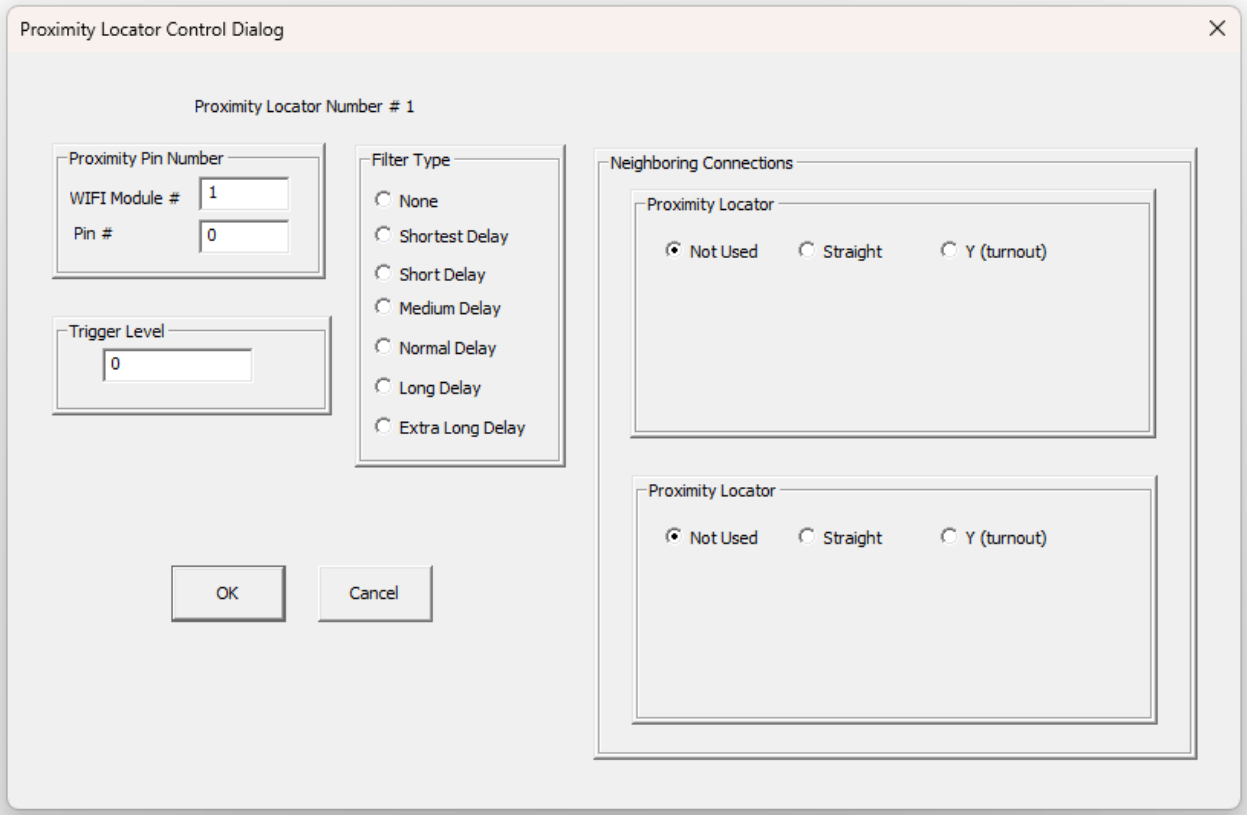
- **Proximity Locator Number** – A unique number between 1 and 999 assigned to this device. This number is used to identify the device for interaction with Proximity Objects.
- **Locator Position** – The point on your layout where the locator is installed. This serves as the trigger point for the device.
- **Locator Display Offset** – An adjustment to the locator's displayed position on the screen. In rare cases, the actual device location may overlap with another layout display element, so this offset allows you to move its on-screen representation without affecting its real position.
- **Type** – The implementation method of the device:
    - **Reflective** – Typically used for devices placed inside train tracks.
    - **Direct** – Used when an IR LED transmits directly to an IR sensor, with beam interruption indicating an object. On a model railroad, this setup may be placed on opposite sides of a track to detect trains.

Once you select **OK** in the Proximity Locator dialog and have entered all required data correctly, a circle will be placed on the layout. If the data is incorrect, a detailed error message will explain the issue.

To edit a proximity locator, left-click on the proximity locator element, select **Edit Location**, and the dialog will reappear. (See **Show Edit Locations** for more details.)

3.6.3 Setting Up a Proximity Locator for your Control Panel

To set up a Proximity Locator for your layout, you must be in **Control Setup** mode. Using the **Left Mouse Button**, click on the **Proximity Locator** image in the layout, and the following dialog will appear.



Entering the Digital/Proximity WiFi Module Number

You must enter the **Digital/Proximity WiFi Module** number to which the **Proximity Locator** card is connected. This number corresponds to the actual

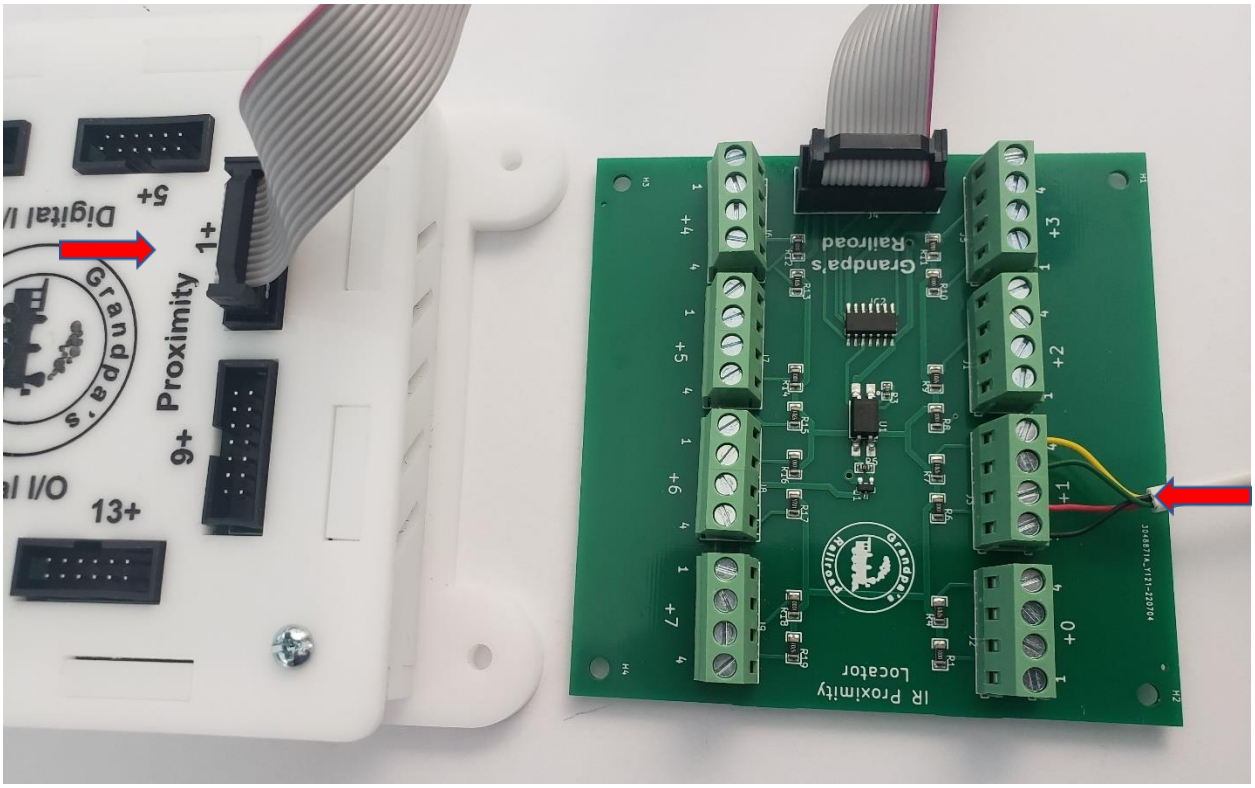
number programmed into the **WiFi Module**. Use the **WiFi Module Programmer** software to assign this number.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

Calculating the Pin Number

The **Pin #** is determined by adding:

- The connector number on the **Digital/Proximity WiFi Module** where the ribbon cable is attached.
- The **Proximity Locator** connector number on the card being used.



For example, using the image above, we calculate the **Pin #** as follows:

- **1** (from the **Digital/Proximity WiFi Module**)
- **+1** (from the board)
- **Total = 2**

Thus, we would enter **2** for the **Pin #**.

Setting the Trigger Level

The **Trigger Level** defines the threshold at which the **Proximity Locator** detects an object (e.g., a train). Since each locator and installation vary, you should set this value based on observed results and adjust accordingly. (See **3.6.4 Proximity Control Panel Operation** for data plotting.)

A typical starting value is **10**.

Filter Type Selection

The **Filter Type** allows you to apply predefined filters instead of using a direct calibrated value to determine when an object is detected. Filters smooth out transitions between "On" and "Off" states.

For instance, gaps between train cars might momentarily register as "Off." Using a filter prevents this, ensuring a smoother result. The **delay length** represents how much smoothing occurs. The ideal filter depends on installation factors such as **scale, car type, speed,** etc.

To determine the best filter, experiment visually in **Control Panel mode** by viewing the plotted data with different filters applied versus the **Trigger Level**.

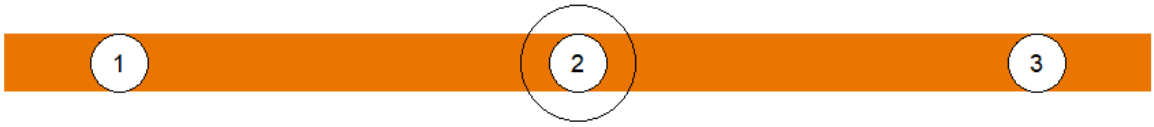
Neighboring Connections Group Box

The **Neighboring Connections Group Box** defines the closest **Proximity Locators** on either side of the current locator, helping to establish a connectivity network.

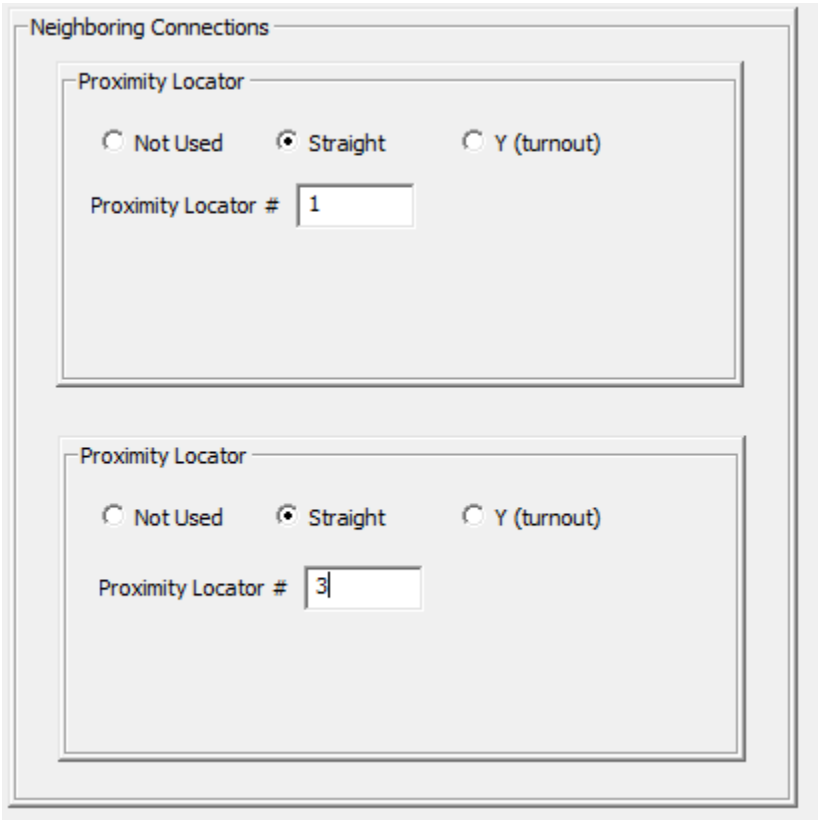
If an **RFID reader** is used to identify a locomotive, this network allows tracking as the locomotive moves across the layout. While this data is optional, it is required when using **RFID readers**.

There are two types of network connections:

1. **Straight Connection**
    - In the diagram below, **Proximity Locator #2** has two straight connections: one to **#1** and one to **#3**.

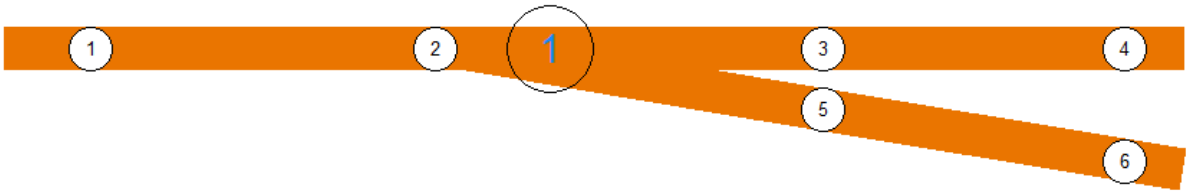


    - This would be entered in the dialog as follows:

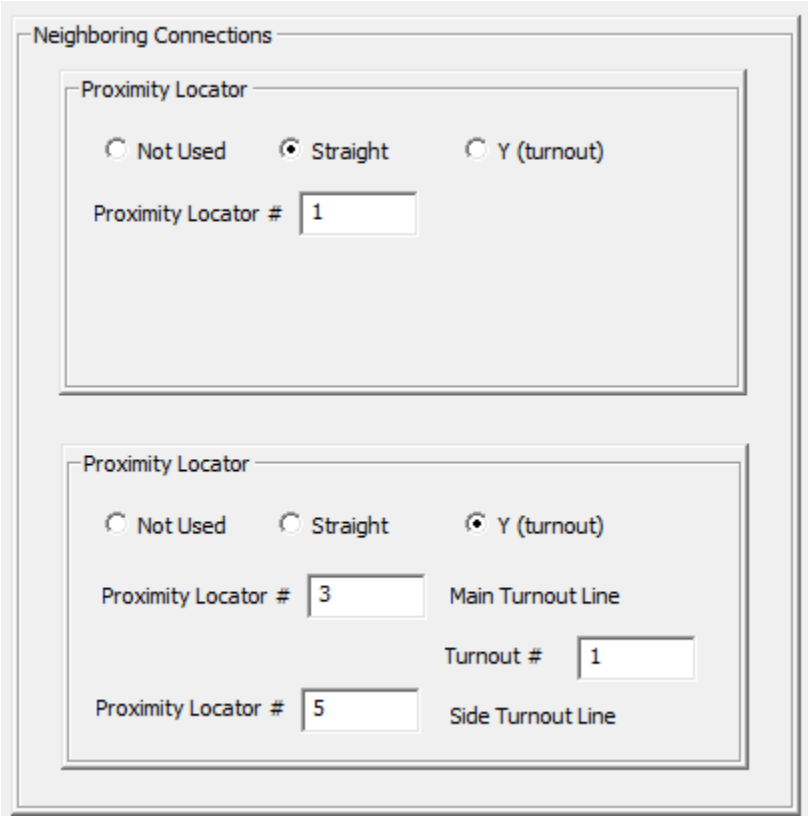


2. **Y (Turnout) Connection**
    - In the second diagram, **Proximity Locator #2** has:
        1. A **straight connection** to **#1**.

2. A **Y (Turnout) connection** to **#3** and **#5** via **Turnout #1**, as a locomotive could travel either down the mainline (**#3**) or the sideline (**#5**).



- This would be entered in the dialog as follows:



If we further look at this example, **Proximity Locator #5** has a straight connection to both **#2** and **#6**. Even though a locomotive crosses a turnout at an angle, it is

still considered a **straight connection** because there is only one possible next **Proximity Locator** without changing direction.

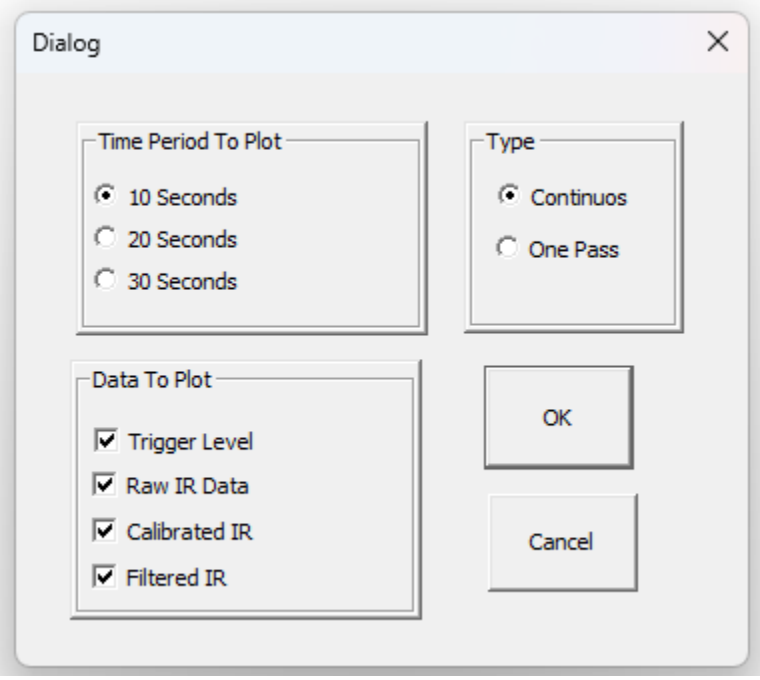
Note: You can think of a straight connection as one that only has one choice for its next proximity locator to pass over and a Y connection having two choices.

If you install **Proximity Locators** on only part of your layout, and a locator is the last one before a large gap, label one of the connections as **"Not Used."**

3.6.4 Proximity Locator Control Panel Operation

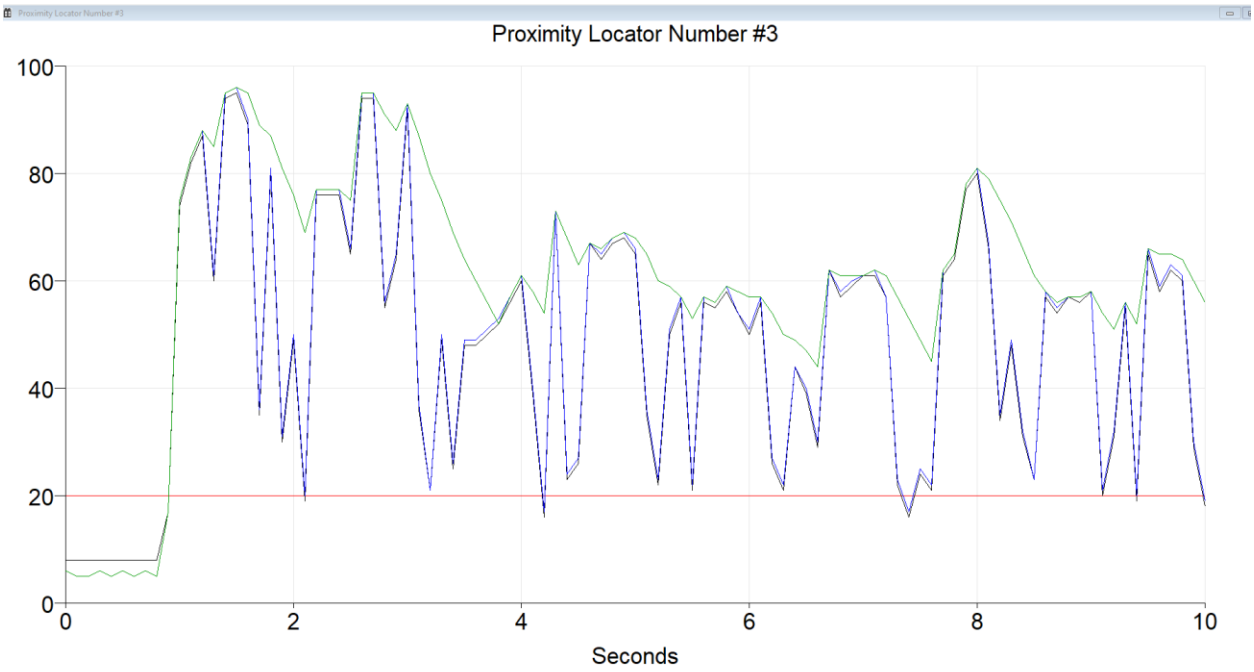
The proximity locator will turn on or off depending on the calibrated (or filtered) value of the trigger level. By default, the locator appears white but will change to black (or a preselected color if an RFID reader is used to track a locomotive) when an object is detected.

For a deeper understanding of its operation, click the **Proximity Locator** image using the **Left Mouse Button** to open a dialog that allows you to plot the sensor's data.

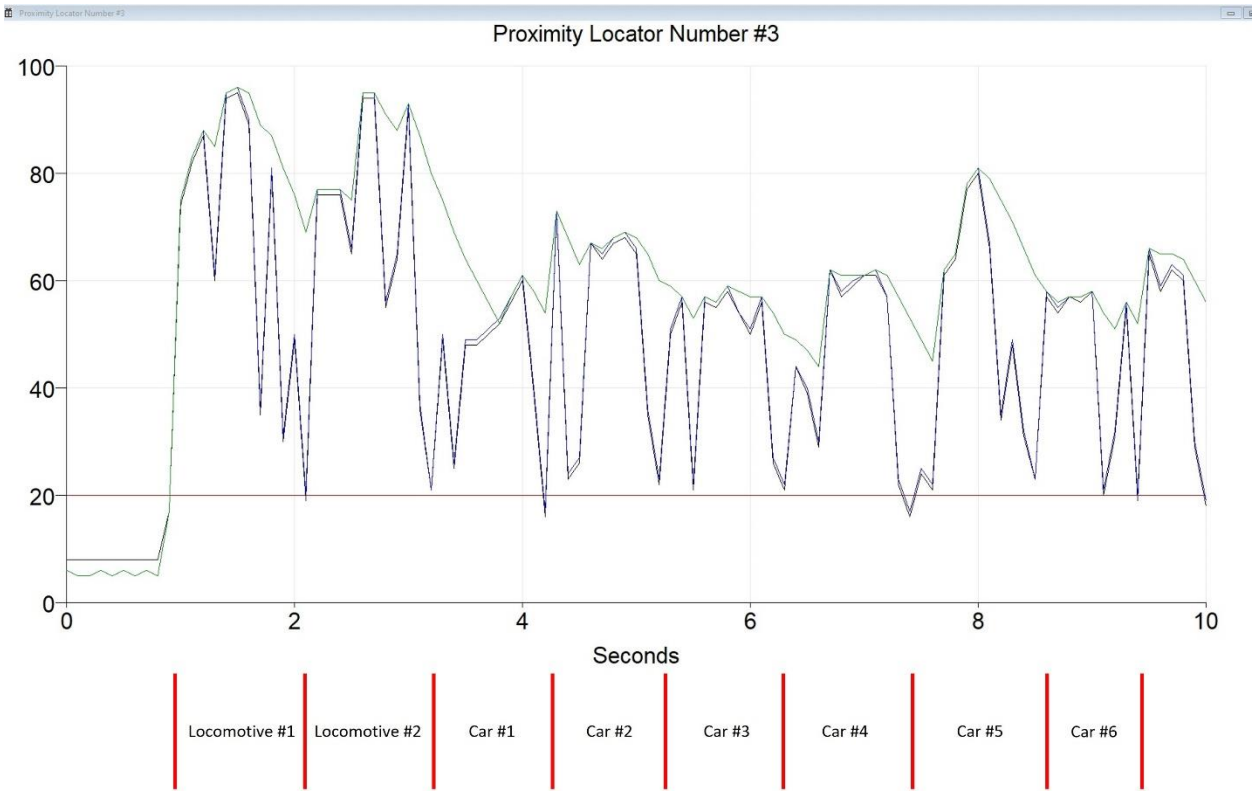


- **Time Period to Plot** adjusts the time axis of the plot.
- **Type** determines whether the plot scrolls continuously or displays a single time-segment pass that stops upon completion.
- **Data to Plot** enables the visualization of various data sets:
    - **Raw IR data** recorded by the sensor (black)
    - **Calibrated version** of the data (blue)
    - **Filtered version** of the data (green), based on the selected filter in **Control Setup mode**
    - **Object presence trigger level** (red)

Below is a sample plot showing a train passing over a proximity locator.



Since the proximity locator system digitally samples data, each train pass results in different sampling points along the bottom of the train cars, leading to variations in plots. The reflectivity of each car differs based on its color, shape, and height, causing variations in detected patterns from car to car. To illustrate this, an annotated version of the plot is provided.



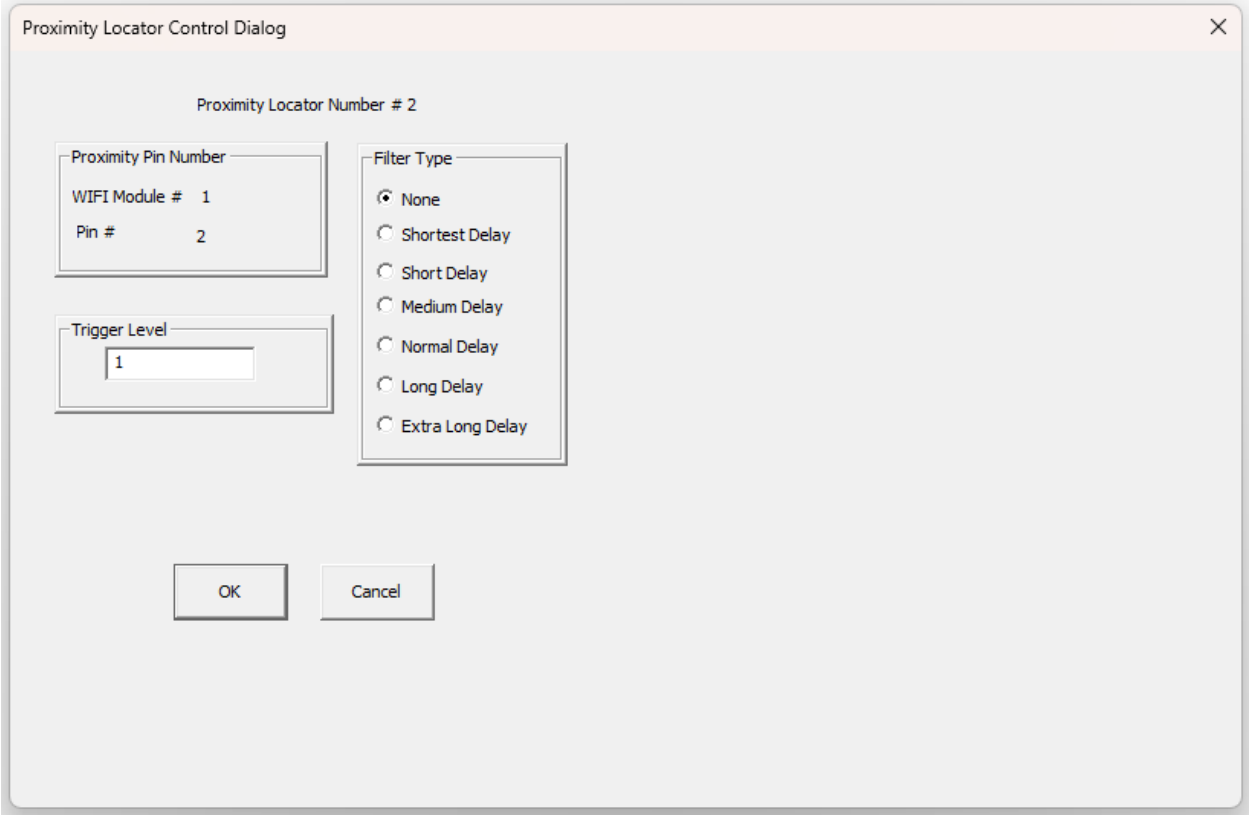
You can observe the spaces between train cars. In some instances, the calibrated reflectivity signal from the coupler drops below the trigger level. Without a filter, the proximity locator would flicker between **On** and **Off**, which could affect both the display and any proximity-based objects relying on it. However, in these cases, the **green line** (filtered value) remains above the trigger level, preventing unwanted flickering.

The filter delay setting determines the responsiveness of the filtered value:

- A **shorter delay** causes the green line to drop more quickly.
- A **longer delay** slows the drop, allowing for customized adjustments.

While understanding the precise workings of the filtering algorithms is not necessary, experimenting with different filters and observing reflectivity across various train cars can provide valuable insights into IR sensor behavior.

If you wish to adjust the trigger level or filter type during operation, click the **Proximity Locator** image using the **Right Mouse Button** to open a dialog where you can modify these settings.



3.6.5 Special Considerations

3.6.5.1 Mounting IR Proximity Locator in Your Track When mounting your locator, it is essential to ensure that a barrier is placed between the IR LED and the sensor. The plastic holder that comes with the unit includes a small barrier between the two components to prevent direct IR transmission from the LED to the sensor, which could result in false readings.

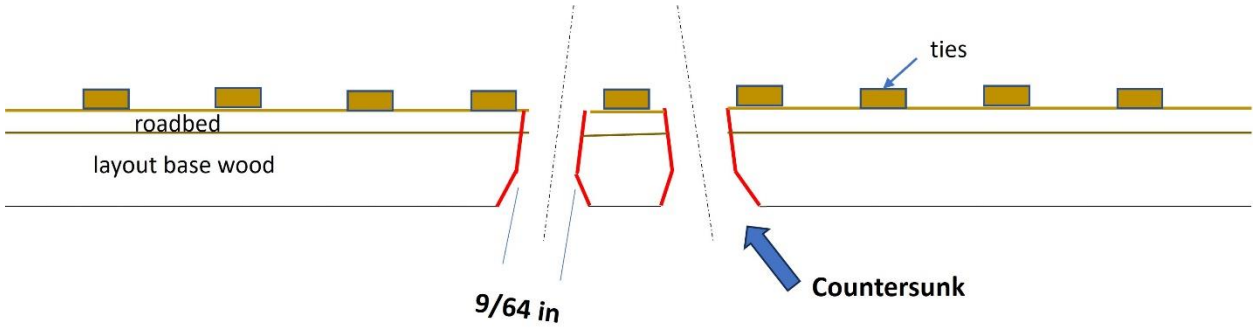
For **N scale tracks**, the units must be mounted parallel to the rails due to width constraints. It is best to use a railroad tie as the barrier in this setup.

For **HO scale tracks**, the unit can be mounted either parallel or perpendicular to the track. Mounting it parallel allows the use of a railroad tie as

the barrier, while mounting it perpendicular requires ballast to serve as the barrier. In all cases, ensure sufficient spacing between the rails and units, as well as between individual units.

To install the units:

1. Use a **9/64-inch drill bit** to drill two holes at slight angles, as illustrated below.



2. The exact angle of the holes is not critical, but they should intersect approximately **½ to ¾ inch up**, depending on the scale. The underside of the holes may be **countersunk** for easier installation.
3. For **N scale**, you may need to remove part of a railroad tie to drill the holes.
4. Run the drill up and down several times to clean out the hole, allowing the units to slide in snugly.

After installation, test each unit and adjust the LED and sensor height for optimal performance. Once satisfied, secure them with **a small amount of hot glue** underneath.

To practice and experiment, we recommend building a **short section of track and roadbed on a test board** before final installation.

3.6.5.2 Determining the leads of the IR LED and Sensor

If the LED, sensor, or both become loose from the case before wiring, follow these steps to determine the correct wiring:

For the LED (light blue element):

1. Set your multimeter to the **diode setting**.  (For the multimeter shown in our "Electricity 99" series, turn the dial to the **Ω** position and press the **Select** button until the diode symbol  appears.)
2. Connect the two leads to the LED.
    - If the multimeter displays **.0L**, switch the leads.
    - In one of the two lead connections, you should get a reading slightly over **1 volt**.
3. In this position, the **red lead** of the multimeter is connected to the **LED anode**, and the **black lead** is connected to the **cathode**.
4. Wire these leads **exactly the same way.**

Wiring Instructions:

- Connect the **black phone cord wire** to the **Cathode**.
- Connect the **red phone cord wire** to the **Anode**.

For the Sensor (dark purple element):

1. Set your multimeter to the **Ω (ohms) setting**.
2. Connect the leads to the sensor.
    - If the reading is **erratic** or fluctuates, or if it shows **.0L** when you place your finger over the sensor, switch the leads.

- In one of the two lead connections, you should observe the following readings:
    - **Approximately 150 kΩ** with your finger over the sensor
    - **Approximately 15 kΩ** in normal room light
    - **Between 250Ω and 1 kΩ** in direct sunlight

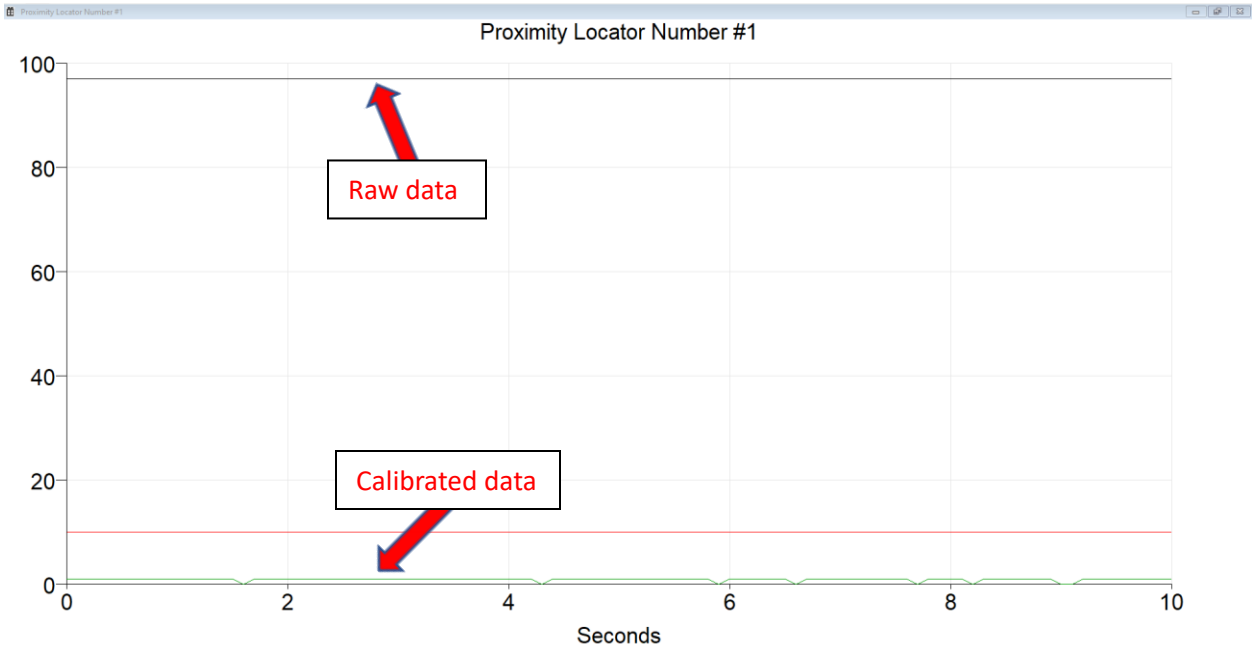
When these readings are obtained:

- The **red lead** of the multimeter is connected to the **sensor collector**.
- The **black lead** of the multimeter is connected to the **sensor emitter**.

Wiring Instructions:

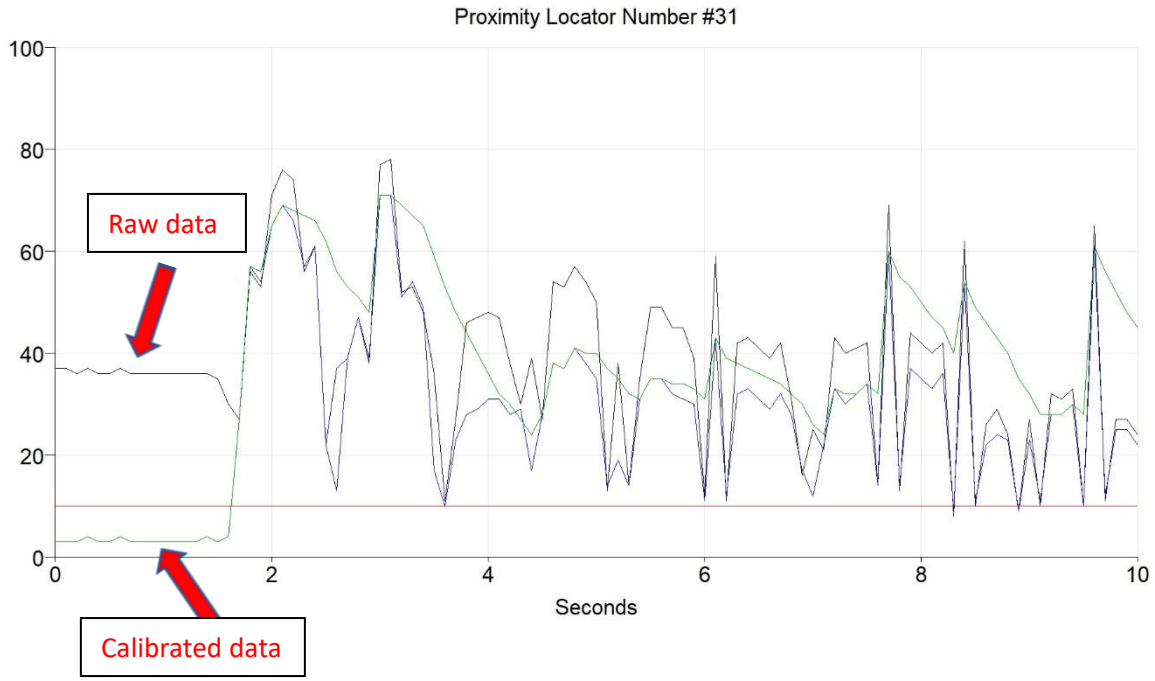
- Connect the **green phone cord wire** to the **emitter**.
- Connect the **yellow phone cord wire** to the **collector**.

3.6.5.3 Effect of sun on IR Proximity Locator The sun is a significant source of infrared (IR) light and, as expected, has a considerable impact on the readings from a proximity locator. When we analyze the performance of the IR Proximity Locator under direct sunlight, we observe the following:



Notably, the raw data line remains around 98, well above the trigger line. However, the calibrated data is approximately 2, which is well below the trigger threshold. This raw data behavior highlights why many people are hesitant to use IR sensors. **By centralizing our processing in a main computer, we can apply algorithms to calibrate the sensors effectively.**

The plot below illustrates data from an N-scale layout, where part of the layout was exposed to sunlight while a train passed by.



Without calibration, the raw data would have continuously triggered the reflective locator. However, the calibrated and filtered data demonstrate flawless operation, accurately detecting the train as it moves through the layout.

3.6.6 Practical Example

The following example demonstrates the use of an IR Proximity Locator. In this example, we add only a Digital/Proximity WiFi Module and a single Proximity Locator.

Step 1: Prepare the Hardware

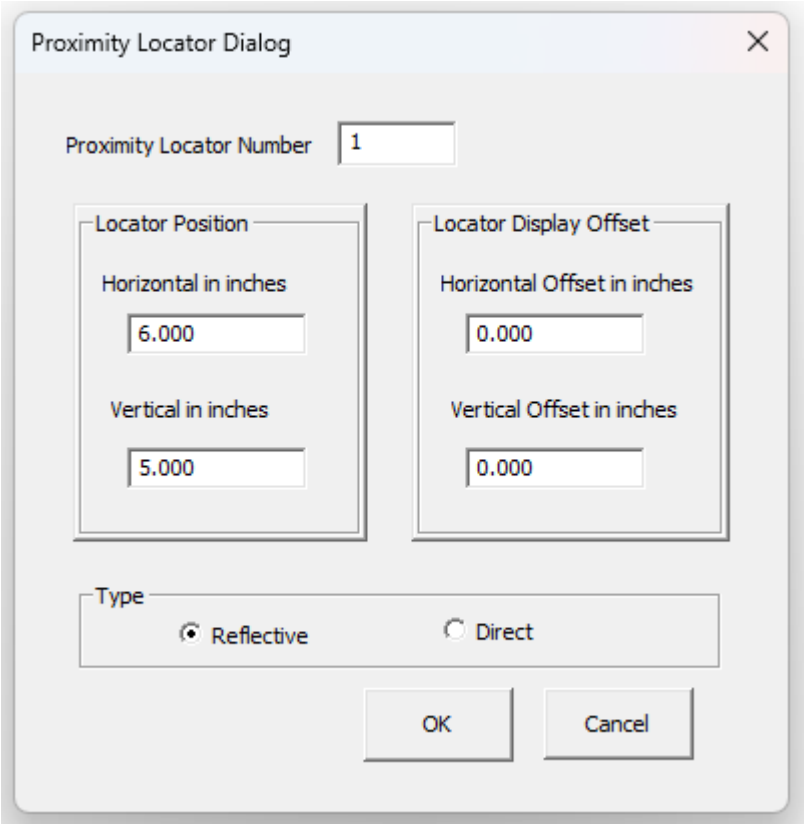
Set up the hardware as outlined in the **Hardware Required** section above. Ensure the plastic case is properly reinstalled.

Step 2: Add a Digital/Proximity WiFi Module

Integrate a **Digital/Proximity WiFi Module** into your layout, following the instructions in the **Adding a Digital/Proximity WiFi Module - Practical Example** section.

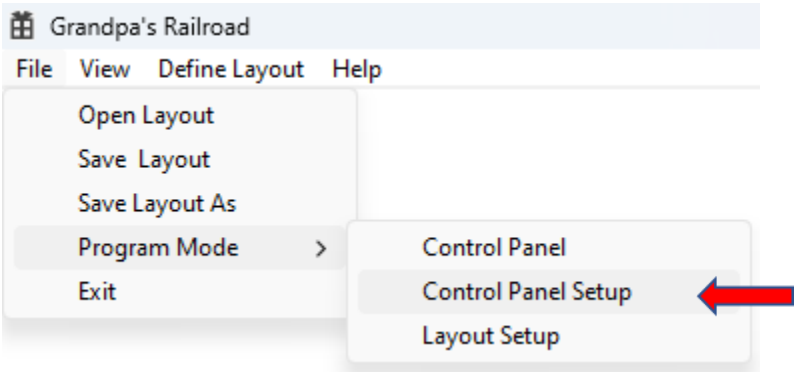
Step 3: Add a Proximity Locator

Position the **Proximity Locator** at **6 inches horizontally** and **5 inches vertically** on the layout. Set the **Type** to **Reflective**.



Step 4: Enter Control Panel Setup Mode

From the File menu, select:

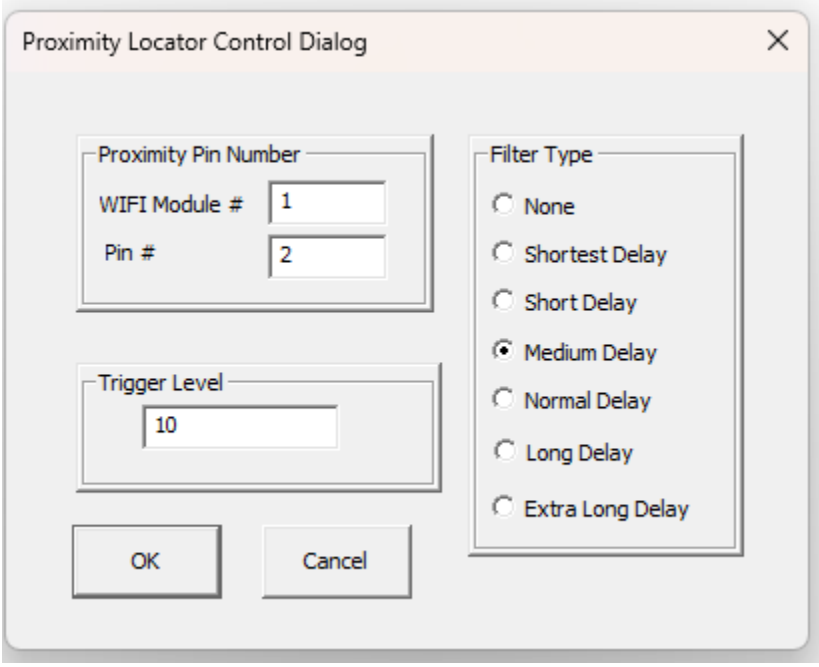


File/Program Mode/Control Panel Setup

This will switch the system to **Control Panel Setup Mode**.

Step 5: Configure the Proximity Locator

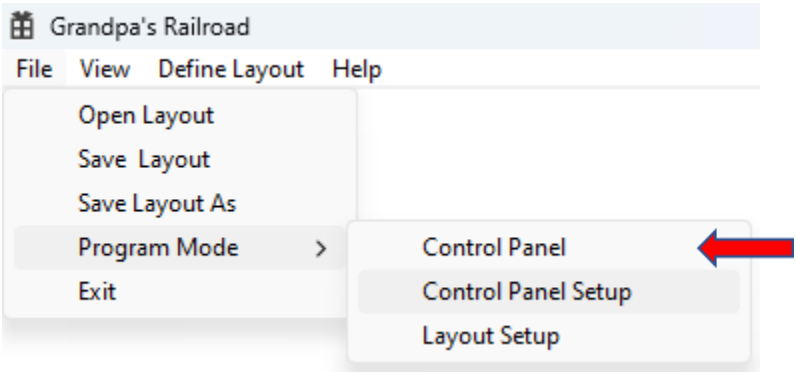
- Using the **left mouse button,** click on the **Proximity** Locator image in the layout. A dialog box will appear.
- Enter the required data in the dialog.



-

Step 6: Switch to Control Panel Mode

From the File menu, select:

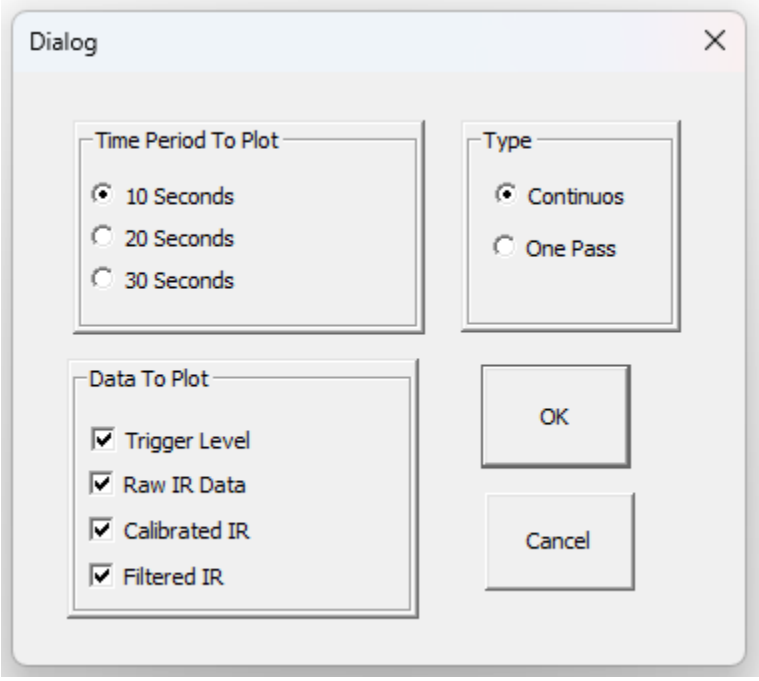


File/Program Mode/Control Panel

This will switch the system to **Control Panel Mode**, and the **Digital/Proximity WiFi Module** should establish a connection.

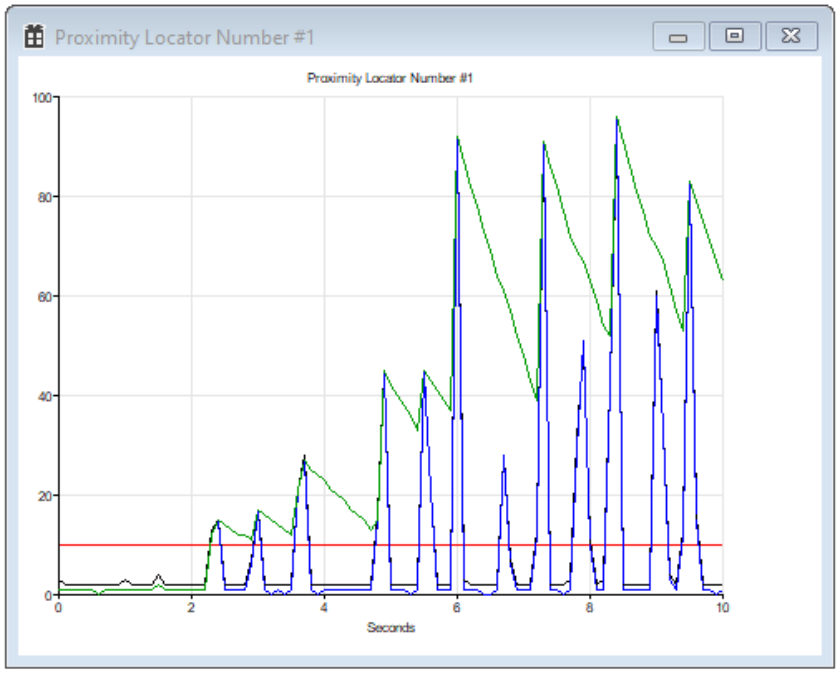
Step 7: Define the Proximity Locator Plot

- Click on the **Proximity Locator image** in the layout using the **left mouse button**.
- A dialog box will appear, allowing you to define the **Proximity Locator Plot**.
- Enter the required data and click **OK**.



Step 8: Test the Sensor

- Wave your hand **approximately 1 inch** in front of the sensor. The screen should update accordingly.
- Experiment with different **filters, lighting conditions**, and other parameters to observe changes in detection performance.



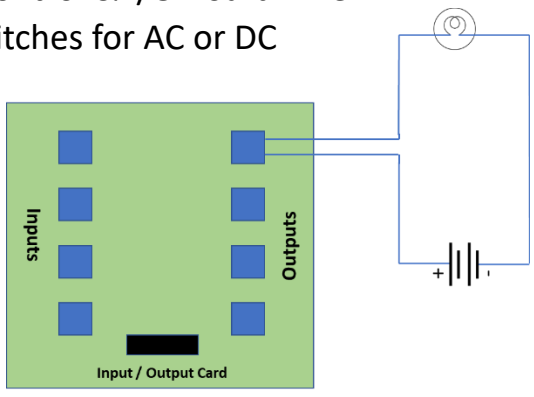
3.7 Adding Gate, Signal, or Animation

Adding a gate, signal, or animation to Grandpa's Railroad follows a straightforward process. We provide the necessary tools to configure the ON or OFF conditions for lights, gates, or any other animations triggered by proximity locators. The following sections will guide you through using these tools effectively.

3.7.1 Hardware Required

The simplest form of animation control involves operating a light or another external electrical device. To achieve this, you will need at least one output pin on either an Input/Output Card or a Turnout Control & I/O Board. The output pins on these boards function as switches for AC or DC current.

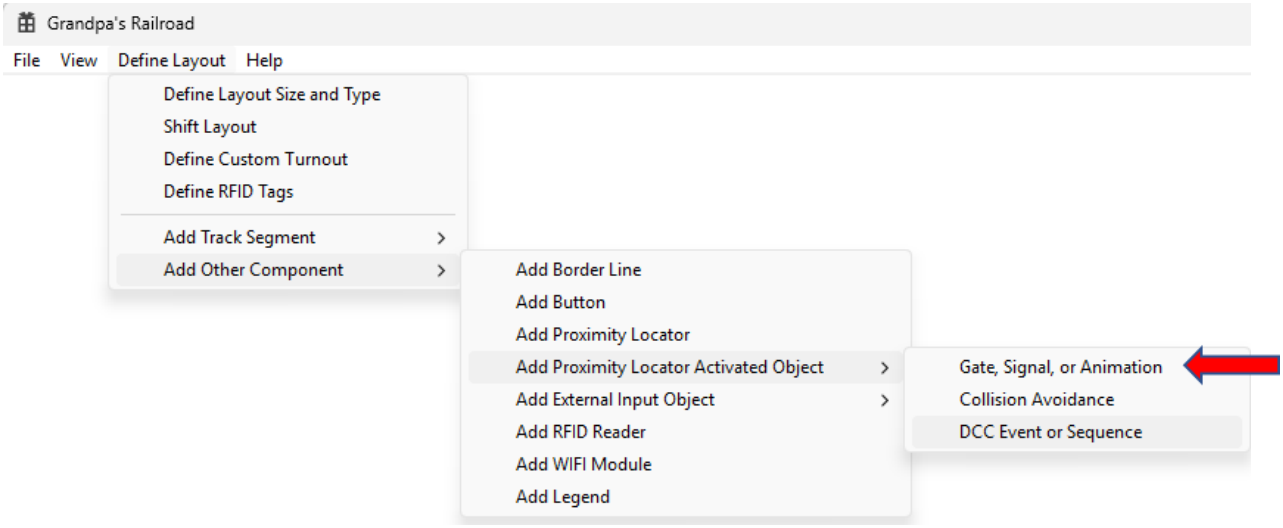
Below is a basic schematic demonstrating how to connect a light to an output pin:



For a deeper understanding of electricity, voltage, and current, refer to the educational tutorial *"Electricity 99."*

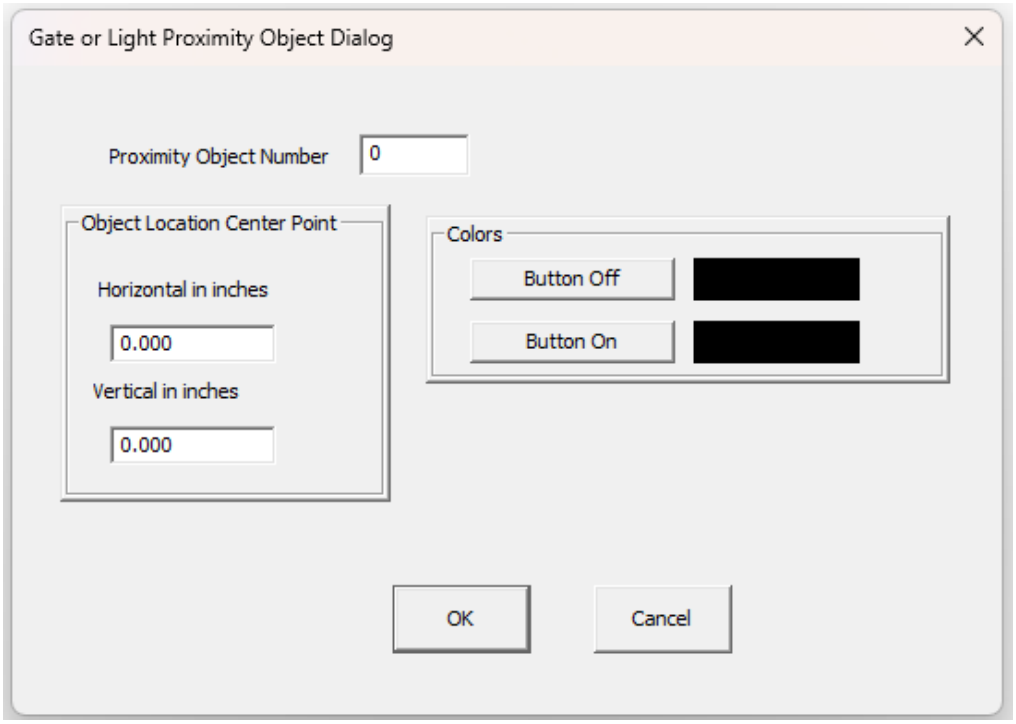
3.7.2 Adding a Gate, Signal, or Animation to your Layout

To add an animation to your layout, you must enter *Layout Setup* mode. From the main menu, navigate to:



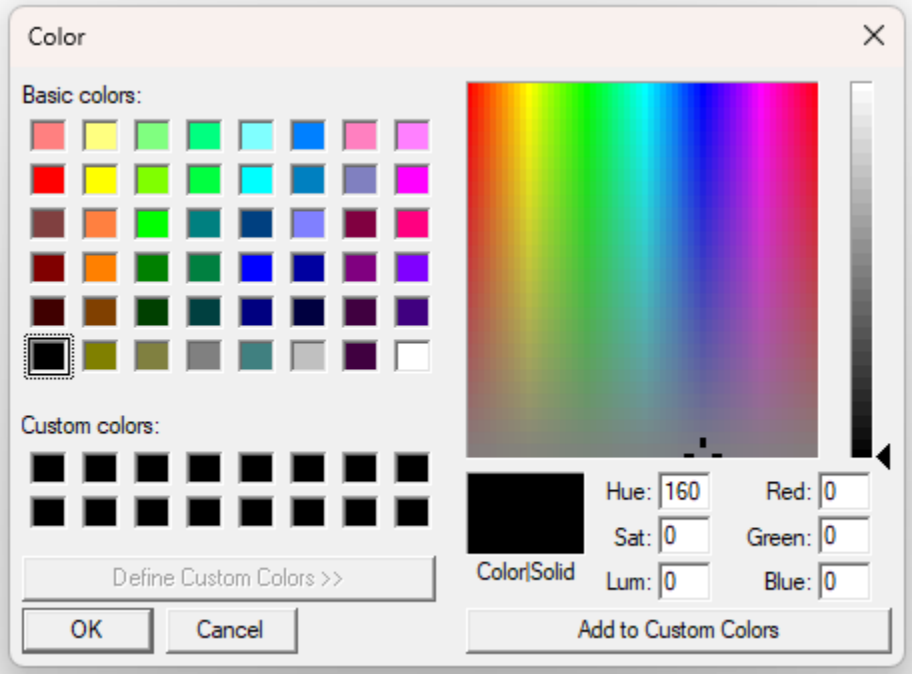
Define Layout/Add Other Component/Add Proximity Locator Activated Object/Gate, Signal, or Animation

Upon selecting this menu option, the following dialog box will appear:



This dialog allows you to configure the Proximity Object number, position, and ON/OFF colors.

- **Proximity Object Number:** A unique number between 1 and 999 assigned to this object.
- **Object Location Position:** The center point where the circular indicator will be placed on the layout.
- **Colors:** This section lets you customize the ON and OFF colors of the button. Clicking either color button opens a selection dialog.



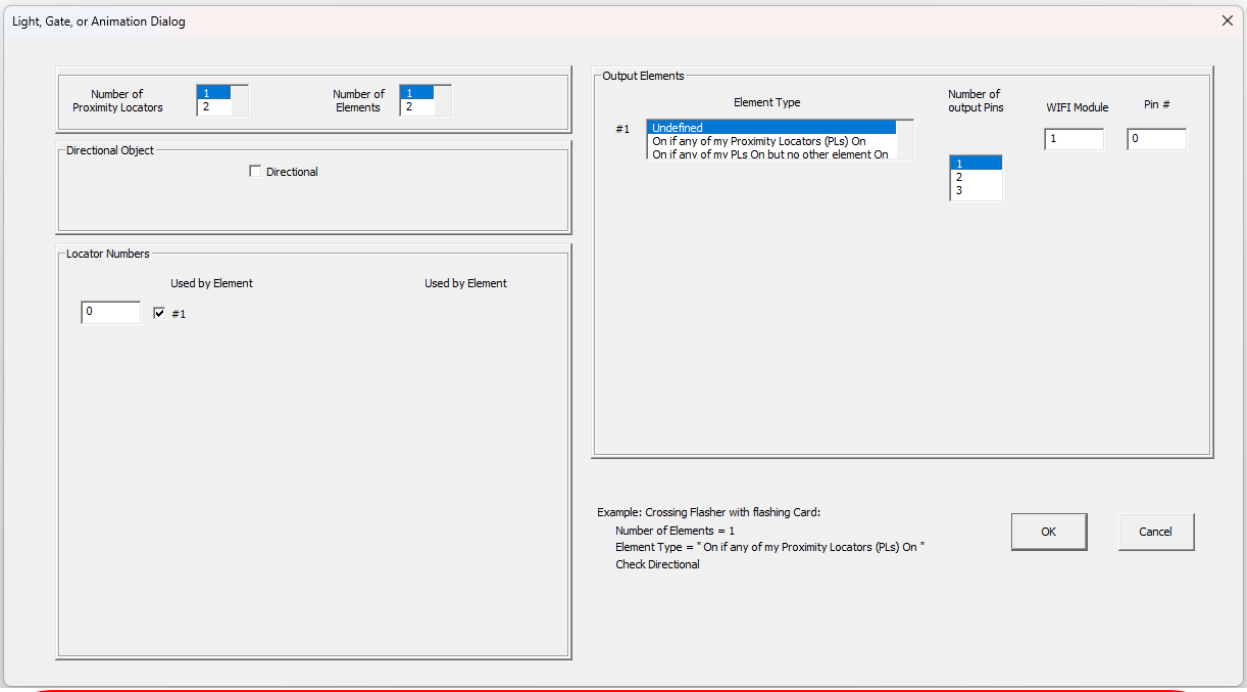
After configuring these settings, click **OK** in the Gate or Light Proximity Object dialog. If all required data has been entered correctly, a circle representing the object will appear on the layout. If there are errors, a detailed message will explain what needs correction.

To edit a gate, signal, or animation object, simply left-click on it, and the dialog will reopen, allowing you to make modifications.

3.7.3 Setting Up a Gate, Signal, Animation Object

To configure a **Gate, Signal, or Animation Object** in your layout, you must first enter **Control Setup mode**. Once in this mode, click on the **Gate, Signal, or Animation** image using the **Left Mouse Button**. This action will open a

configuration dialog, allowing you to customize how the object interacts with the system.



Note: This dialog has been designed so that many different features can be controlled by it. For this reason, we realize that its use can be difficult to understand. Therefore, we will provide two detailed examples at the end of this section, one adding a crossing flasher which has a flasher card and two adding a green, yellow, red train traffic signal. After reading this section, refer to those examples for a better understanding of some of these elements.

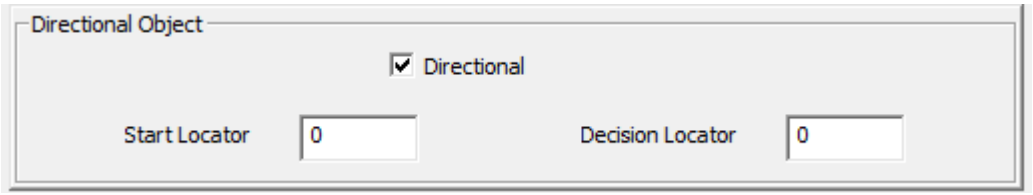
Configuring Proximity Sensors and Output Elements

In the **top-left section** of the dialog, you will find fields to define the number of **proximity sensors** that will control this object, as well as the number of **output elements** the object will manage. The number of output elements depends on the type of device being controlled.

For example, if you are controlling a **crossing flasher** with a flasher card, the number of output elements should be set to **1**, as it functions as a simple **on/off** device. However, if the object being controlled is a **train traffic signal** that features **green, yellow, and red lights**, then typically **3 output elements** would be required—one for each color. Some train traffic signals are designed so that when neither the red nor yellow lights are active, the green light is automatically illuminated. In such cases, only **2 elements** are necessary instead of 3.

Directional Control Option

Below this section, there is an option to enable **directional control**, which allows the object to activate only when a train moves in a specific direction. If this option is selected, the dialog will update to include fields for two proximity locators. The

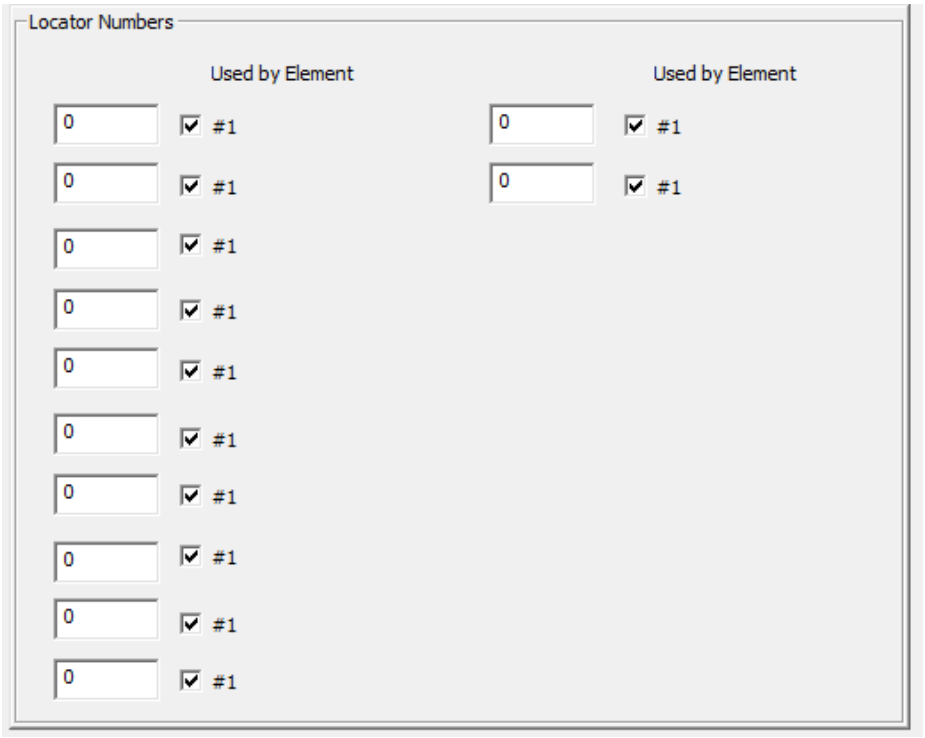


system determines the direction of the train by the order in which these locators are triggered. If the **start locator** is activated before the **decision locator**, the object will respond accordingly. However, if the order is reversed, the object will not activate.

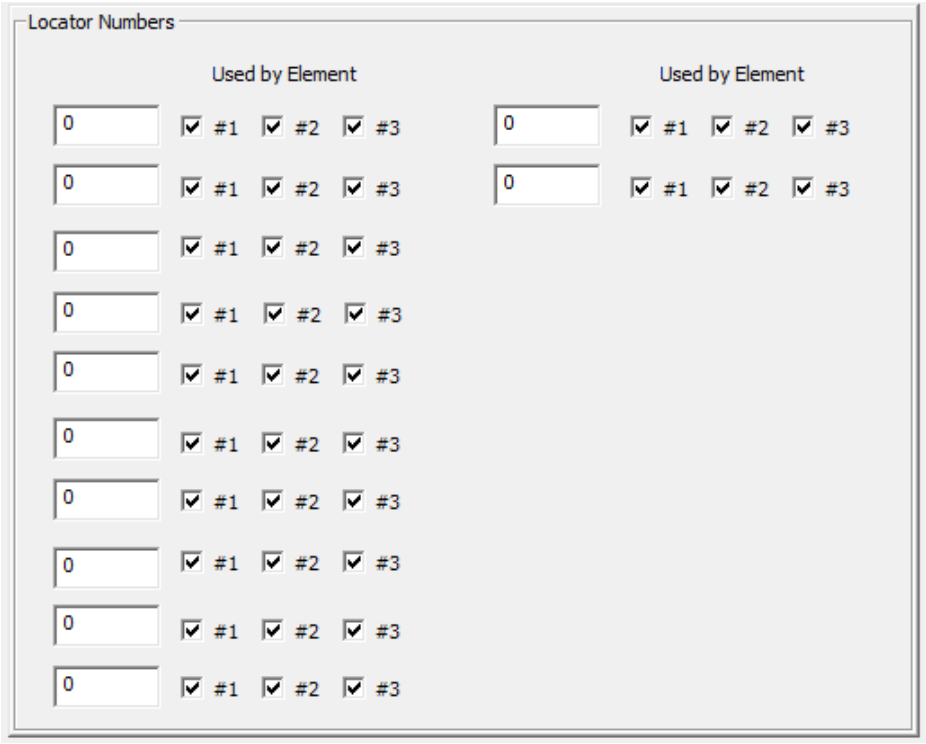
Although most model train **crossing flashers** currently available operate in a **non-directional** manner, using directional control can significantly improve realism. We will provide examples demonstrating how this setting enhances accuracy without requiring additional hardware.

Example Configurations

- The dialog interface will change depending on the number of proximity locators and output elements selected. If, for example, you choose **12 proximity locators** and **1 output element**, the configuration will display



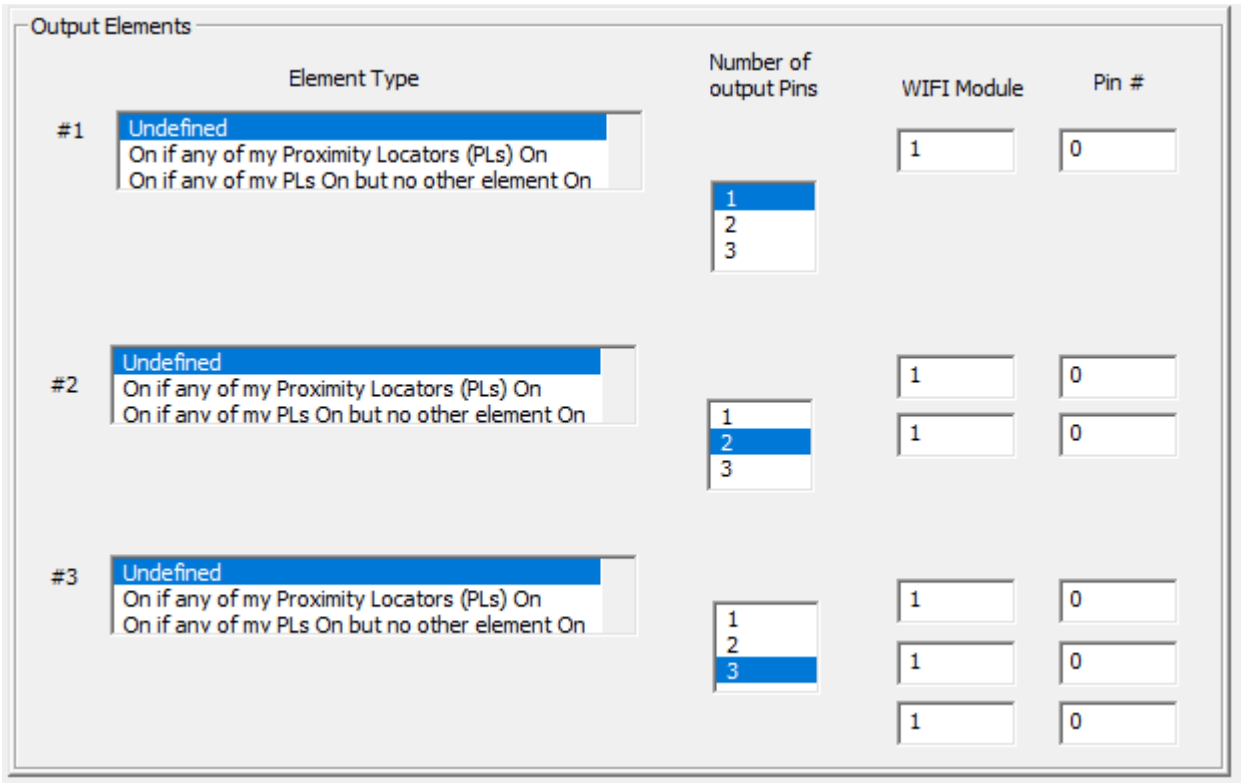
differently compared to a selection of **12 proximity locators** and **3 output elements**.



When configuring **1 output element**, all proximity locators will typically be selected by default. If certain locators are unnecessary, they can be removed from the list to streamline functionality. In the case of **3 output elements**, the dialog will initially check all locators for all elements. However, not all locators need to control every element, and adjustments should be made depending on the application. For further insight, refer to **Section 3.7.5.3: Three-Color Train Traffic Signal**, which provides a practical example of how these settings are applied.

Configuring Output Elements

The final section of the dialog is where you define the **output element type** and configure its **connection settings**. If you have **3 output elements**, the dialog will display three corresponding rows, each representing a separate output. If there are only **2 output elements**, the dialog will show only the top two rows, and if there is just **1 output element**, only a single row will be visible.



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Understanding Output Element Types

There are **seven different element types**, each defining specific conditions that determine when an output element will be activated. These types allow for greater control over how signals, gates, and animation objects behave in response to train movements.

Type	Meaning
Undefined	Not a valid type indicating not defined yet. You will not be able to leave the dialog without defining it.
On if any of my Proximity Locators (PLs) On	This is the most common type and indicates that the element will be on if any of the proximity locators assigned to it are on.
On if any of my PLs On but no other element On	For this option the element will only be on if one of the proximity locators assigned to it is On but none of the other elements for this object is On.
On if no other element On	This is a unique case that causes the element to be On if no other element is On. This is useful for lighting the green light on train traffic signals.
Flash Element every 0.5 sec if any of my PLs On	This causes an element to flash at a 0.5 sec rate if any of its assigned proximity locators is On. It is useful for creating a crossing flasher when you don't have a flasher card.
Flash Element every 1.0 sec if any of my PLs On	This causes an element to flash at a 1.0 sec rate if any of its assigned proximity locators is On. It is useful for creating a crossing flasher when you don't have a flasher card.
Flash Element every 1.5 sec if any of my PLs On	This causes an element to flash at a 1.5 sec rate if any of its assigned proximity locators is On. It is useful for creating a crossing flasher when you don't have a flasher card.

More details about these output element types can be found in **Section 3.7.5: Practical Examples**, where practical implementations are discussed.

Completing the Setup Process

Once you have entered all the required settings, click **OK** to finalize the configuration. If any information is missing or incorrectly entered, an error message will appear, providing details about what needs to be corrected before proceeding.

By following these steps, you can successfully configure gates, signals, and animation objects to enhance your layout, ensuring accurate and realistic responses to train movements.

3.7.4 Gate, Signal, Light Object Control Panel Operation

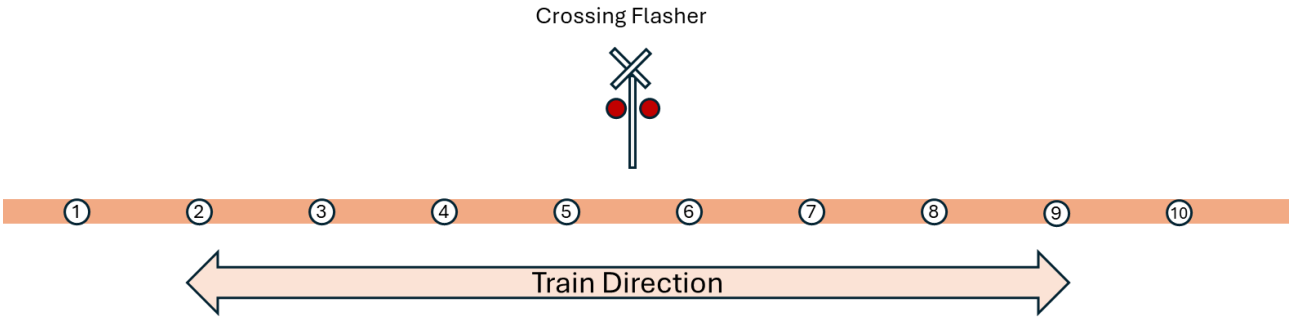
The Gate, Signal, and Light Object is activated by one of its proximity sensors. The control panel color will shift from the ***OFF*** state to the ***ON*** state. Additionally, the object elements will function according to the specified setup.

3.7.5 Practical Examples

To illustrate and clarify the use and setup of this object, we have selected three examples. The first is a crossing flasher, which uses a flasher card to control its flashing. The second example is similar to the first, but without a flasher card. The third example is a three-color (red, yellow, green) train traffic signal.

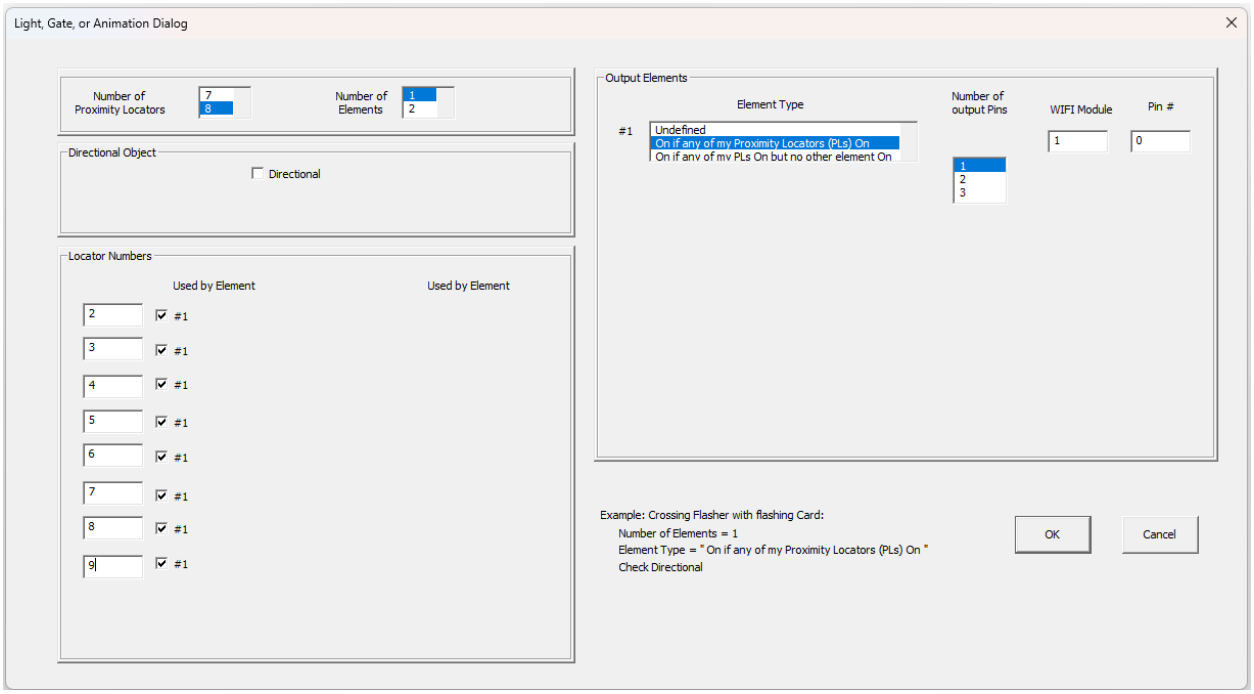
3.7.5.1 Crossing Flasher with Flasher *Card*

Suppose we want to create a crossing flasher for a road crossing over a single train track, as illustrated below.



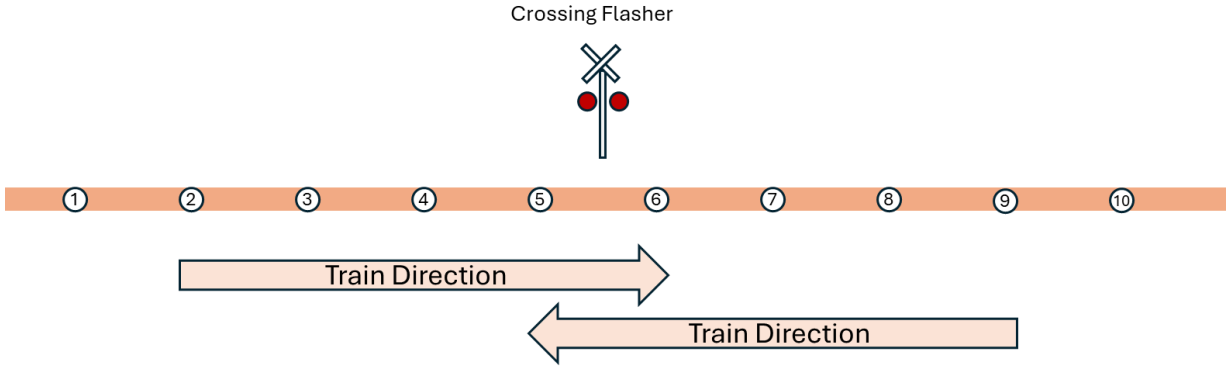
One method to achieve this is by defining a non-directional Gate, Light, and Animation object. In this approach, we would use locators 2 through 9, and the element type (On if any of my Proximity Locators (PLs) are **ON**). To set up this

method, the control panel setup dialog would appear as follows:

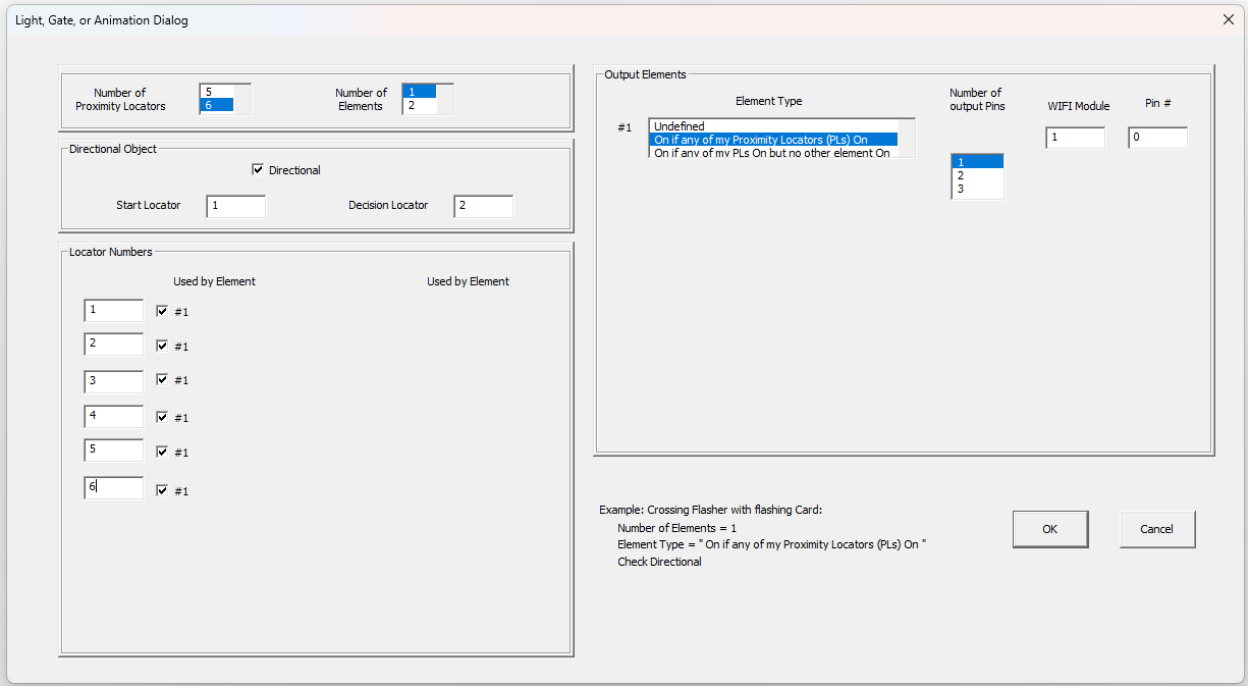


The disadvantage of this method is that while the flasher turns on a sufficient distance from the crossing, it will not turn off until long after the train has passed. This behavior mirrors how hardware implementations for crossings operate.

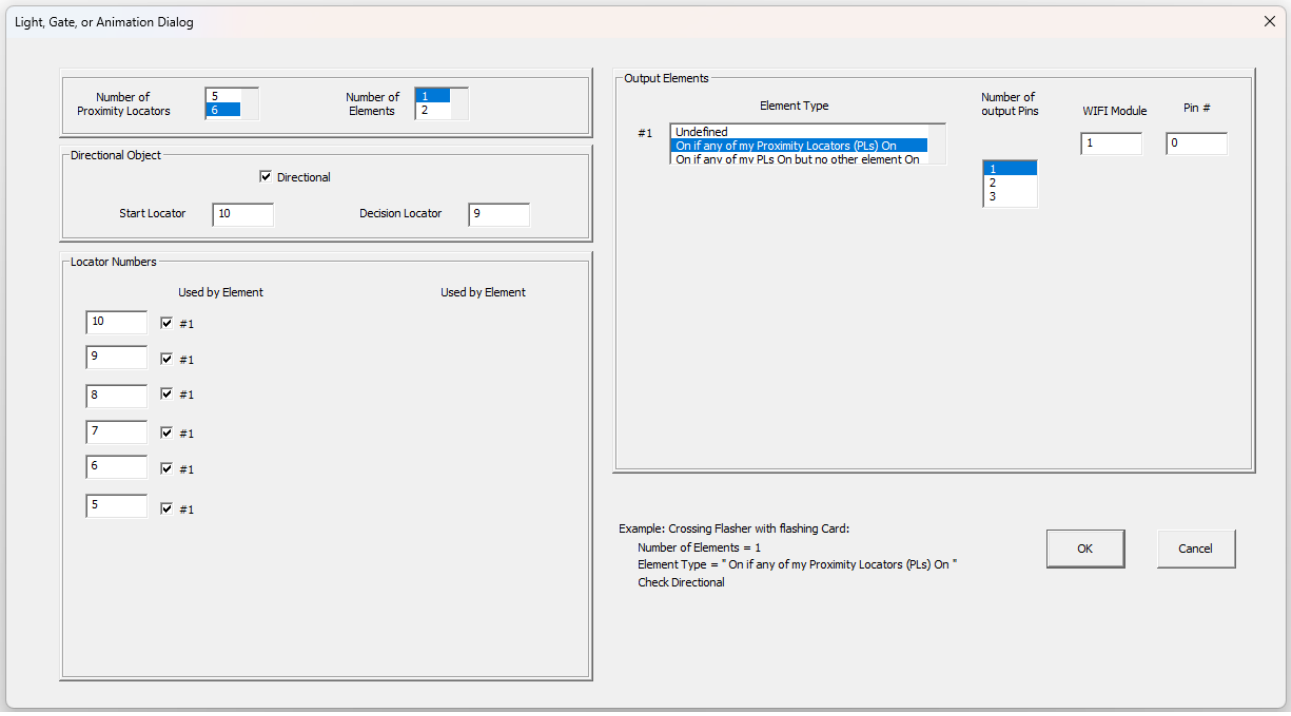
A more realistic approach would be to create two directional Gate, Light, and Animation objects. Both objects would control the same output pin to turn the flasher on and off, requiring only two additional proximity locators (#1 and #10). This results in a more realistic behavior.



Based on the layout above, the dialog for the object controlling a train moving from left to right would be:



The dialog for the object controlling a train moving from right to left would be:

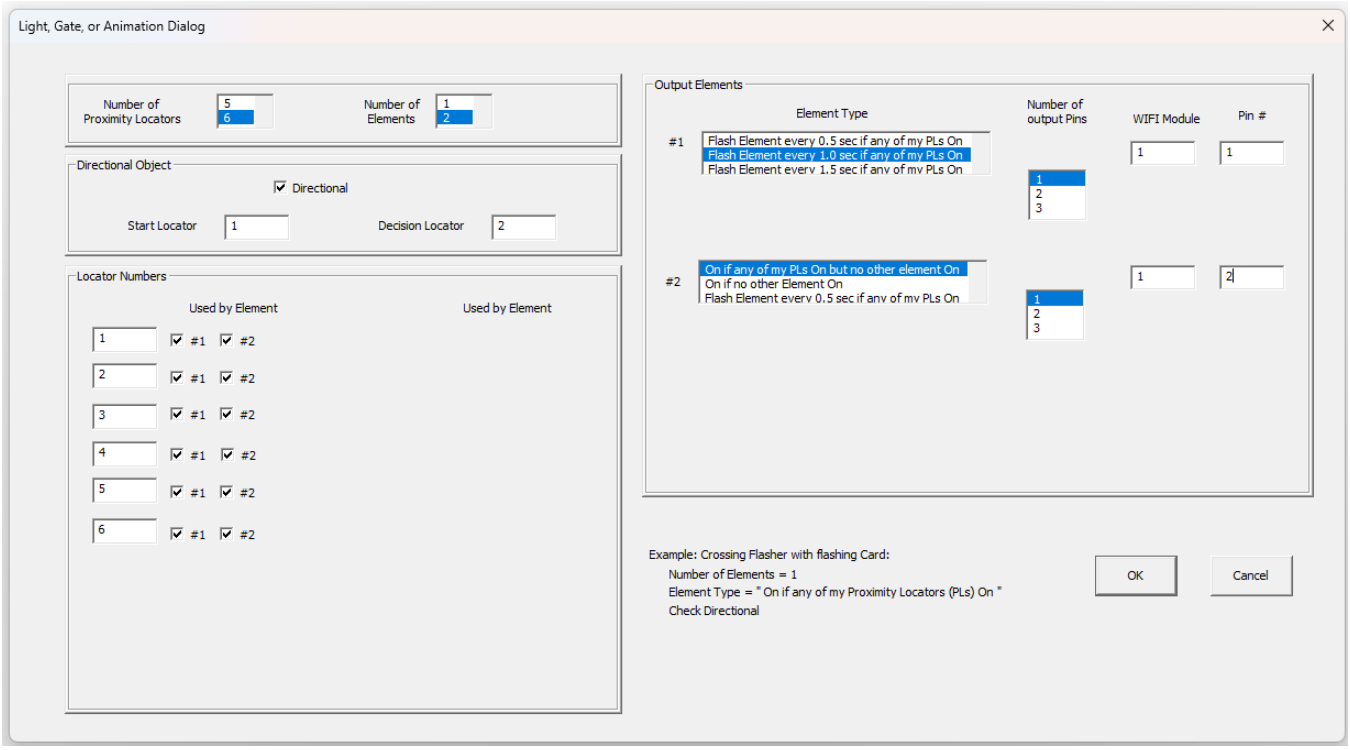


Note: Since proximity locators are independent of any specific function, they can be used multiple times servicing many functions. A single locator could be used for signals, collision avoidance, DDC events, etc.

For a crossing flasher with two parallel tracks, we could define two additional directional Gate, Light, and Animation objects. These would control the same pin and use the proximity locators from the second track.

3.7.5.2 Crossing Flasher without Flasher Card

Assume we have the same layout as above for a crossing flasher over a single train track, but without a flasher card. In this scenario, we must control each light of the flasher independently, which requires two output elements—one for each light. The dialog for setting up the object for a train moving from left to right would be as follows:



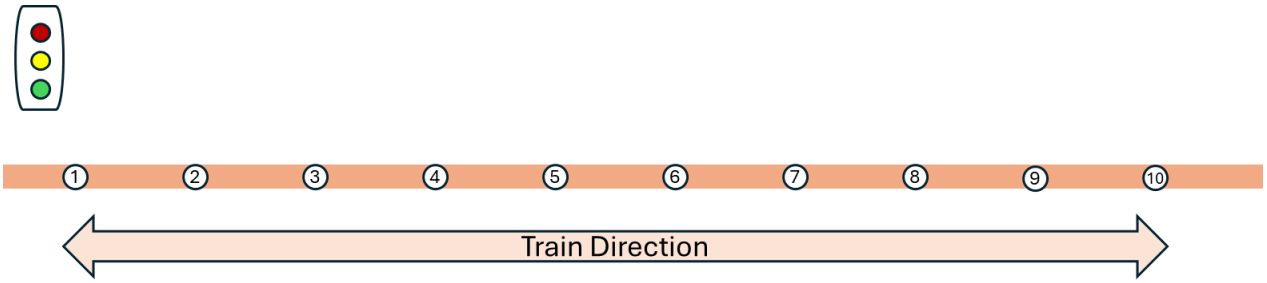
Key points to note in the dialog above:

1. Set the number of elements to 2.
2. Select all proximity locators to be used by both elements.
3. Set the element type for the first element to: ***Flash Element every 1.0 sec if any of my PLs are On*** (0.5 or 1.5 seconds could also be used).
4. Set the Pin # for the first element to 1 (representing the hypothetical pin connected to the first flasher light).
5. Set the element type for the second element to: ***On if any of my PLs are On, but no other element is On***.
6. Set the Pin # for the second element to 2 (representing the hypothetical pin connected to the second flasher light).

Setting up the object in this manner will cause the first light to flash on and off at 1-second intervals, while the second light will turn on only when the first light is off.

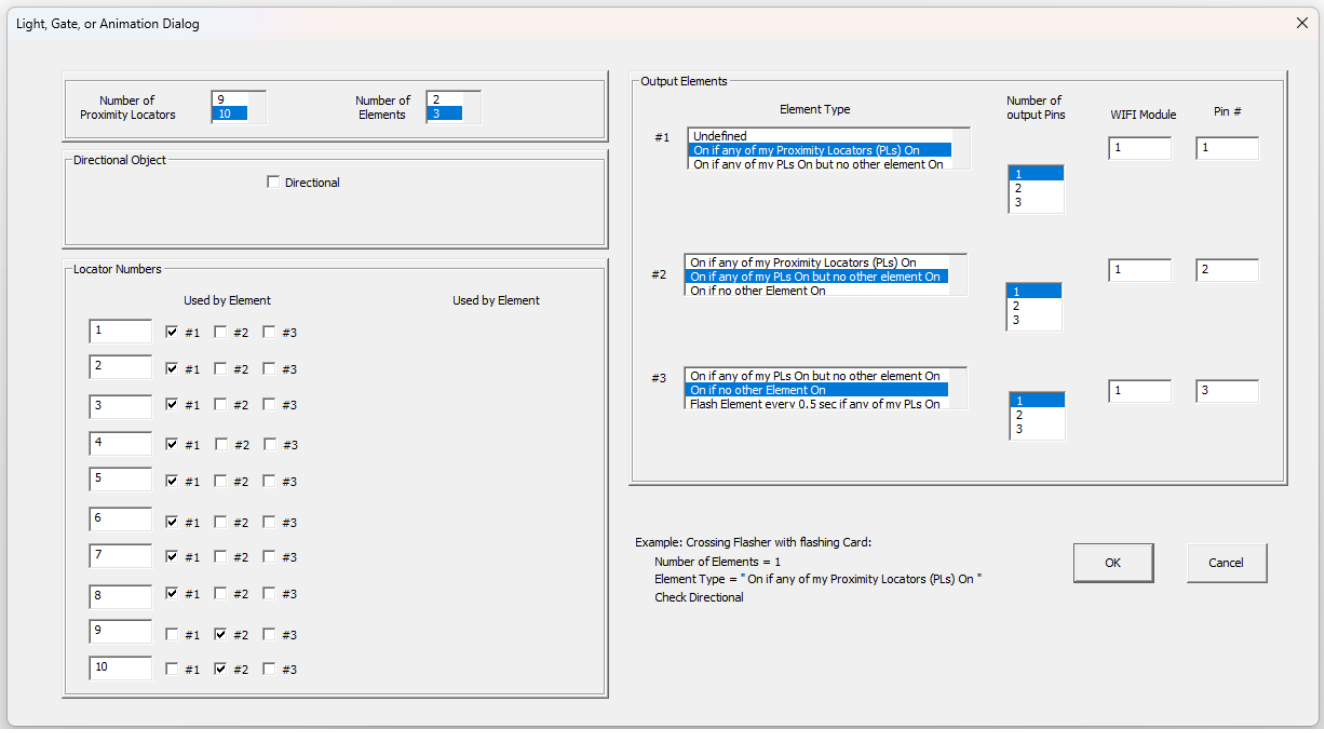
3.7.5.3 Three Color Train Traffic Signal

Assume we want to add a red, yellow, and green train traffic signal to a track, as illustrated below:



Additionally, we want the signal to indicate red when the train is near proximity locators 1 through 8, and yellow when the train is near proximity locators 9 or 10.

The setup dialog for a Gate, Signal, or Animation Object to achieve this is shown below:



If we connect element 1 to red, element 2 to yellow and element 3 to green, the items to note in the above dialog is that we have:

1. Set the number of elements to 3.
2. Check proximity locators 1 through 8 in the first column (red).
3. Set the element type for #1 to: "**On if any of my Proximity Locators (PLs) are On.**"
4. Set the WIFI and Pin # to which the red element is connected.
5. Check proximity locators 9 and 10 in the second column (yellow).
6. To ensure the yellow light does not activate when the train is still occupying locators 1 through 8, set the element type for #2 to: "**On if any of my PLs are On, but no other element is On.**"
7. Set the WIFI and Pin # to which the yellow element is connected.
8. Ensure no proximity locators are checked in the third column (green).
9. Set the element type for #3 to: "**On if no other element is On**."
10. Set the WIFI and Pin # to which the green element is connected.

By configuring the object in this manner, the green light will turn on when none of the 10 proximity locators are activated, the red light will turn on when any of locators 1 through 8 are activated, and the yellow light will turn on when locators 9 or 10 are activated, provided locators 1 through 8 are not activated.

3.8 Adding Collision Avoidance

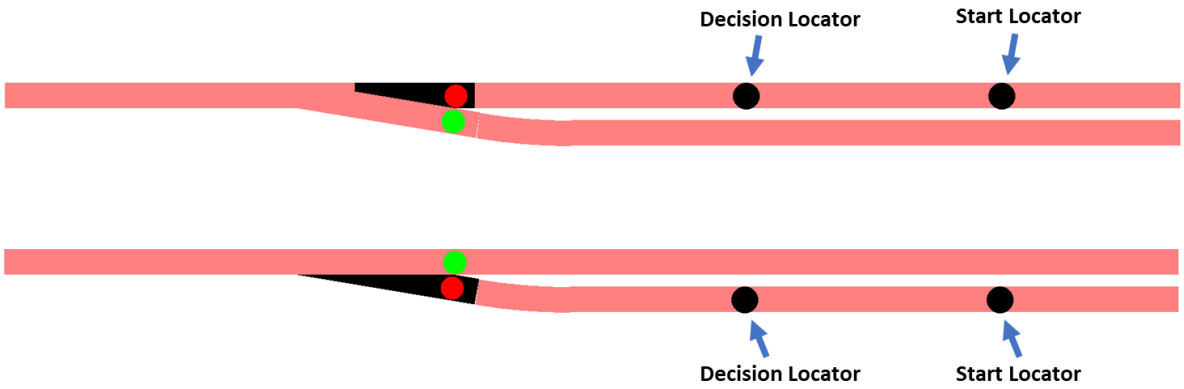
Collision Avoidance on Grandpa's Railroad is designed to prevent trains from colliding with obstacles on the tracks or derailing when entering a switch set in the wrong direction. In both cases, the system works by automatically cutting power to the track section (Block) that the train is currently occupying. (Refer to **Section 3.1.1** for a discussion of **Blocks**.)

3.8.1 Hardware Required

To implement collision avoidance, the track must be connected to a block control card. The installation and configuration of this card are discussed in **Section 3.1**. Additionally, two proximity locators are required for each leg of a turnout to enable turnout collision avoidance, and three or more locators are needed for each track segment for track-occupied collision avoidance. Before moving forward with setting up these features, the relationship between the proximity locators and the track will be explained.

3.8.1.1 Turnout Collision Avoidance Hardware Location Three scenarios for positioning proximity locators relative to turnouts will be discussed.

The first scenario involves a simple turnout, as shown below:

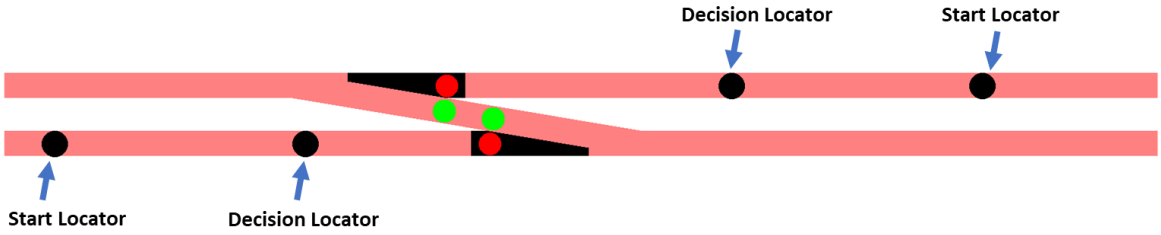


To fully cover this situation, two collision avoidance proximity objects need to be defined, one for each leg of the turnout. Each object must have a start locator and a decision locator. The decision locator should always be positioned closer to the turnout to help determine both the direction of travel and motion. If the train is moving away from the turnout, power should not be cut to the track. Likewise, if the train is stationary, power should not be cut.

It's crucial to place the decision locator far enough from the switch so that the train can coast to a stop before reaching the switch when power is cut. The distance required may vary depending on the type of track, such as a high-speed mainline versus a siding. If multiple control blocks are involved, as depicted below,

the decision locator should be placed far enough from the end of the block so that the train does not coast into the next powered block. In this case, the decision locator should be placed far enough from the end of the green control block to ensure the train stops before reaching the powered red block.

The second scenario involves paired turnouts. In this example, although two turnouts are used, there are only two potential derailment situations because the



turnouts are paired. The turnouts will change together to ensure the crossover situation remains correct. Two collision avoidance proximity objects would still need to be defined, covering the two legs, with locators positioned according to the same rules as in the first scenario.

The third scenario occurs when a turnout is positioned directly in front of another turnout, as shown below. In this case, if the turnouts are aligned as shown in the

first image, a derailment situation would occur, and power should be cut. However, if the turnouts are aligned as shown in the second image, no derailment would occur, and power should not be cut. To address this, the use of a second turnout during control panel setup can be considered, which will be discussed later.

3.8.1.2 Track Occupied Collision Avoidance Hardware Location Two scenarios for positioning proximity locators relative to track block positioning will be discussed.

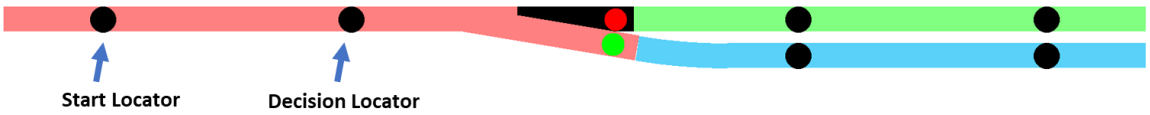
The first scenario is the simple case of moving from one track block to another, as shown below. As with turnout collision avoidance, both the direction of travel and

the motion of the train are important. Power should not be cut if the train is traveling away from the green block or is stationary on the red block. However, if the green block is occupied, the train should stop. One or more proximity locators can be placed on the green block to detect occupancy. The higher the sensor

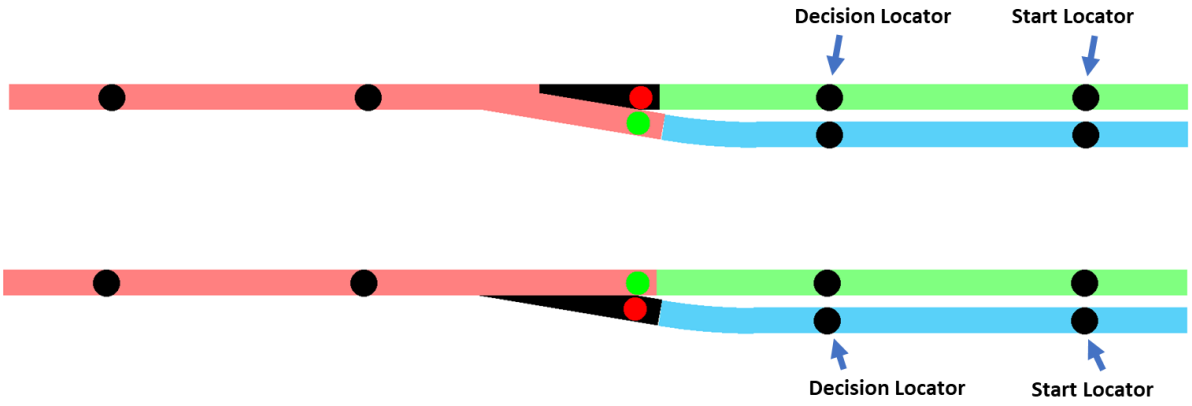
density, the smaller the obstruction that can be detected. For example, if you're trying to determine whether a long train is occupying the segment or just a single car, the sensor density should be adjusted accordingly. As with turnout collision avoidance, the decision locator should be placed closer to the end of the block than the start locator, but far enough away to give the train enough distance to coast to a stop before reaching the powered green block. The diagram above shows protection for occupancy only on the green block. If protection is needed for the opposite direction (for a train traveling from the green block to the red block), a second track-occupied collision object must be defined. This may not require additional resources or wiring, as Grandpa's Railroad proximity locators are not dedicated to a specific function. The same locators used for occupancy detection on the green block can also serve as the start and decision locators for the opposite direction.

The second scenario occurs when a turnout is positioned before the occupied block, as shown below. In this scenario, occupancy detection should focus on the

green block only if the turnout is in the mainline position. However, if the turnout is switched, blue block occupancy should be considered instead. If the switch position changes, green block occupancy should be prioritized. During control



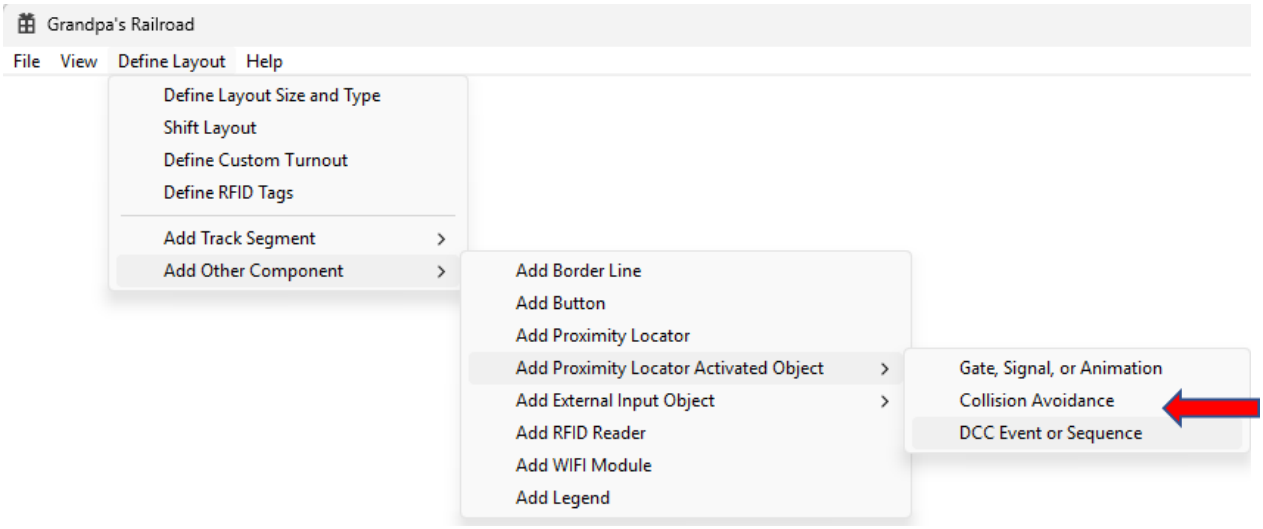
panel setup, the turnout direction can be specified to handle this situation. To



cover the two possible switch positions, two track-occupied proximity objects must be defined, as the locators will differ based on the switch configuration. If track occupancy collision avoidance is required in the opposite direction, two additional track-occupied collision avoidance objects must be defined for the scenarios below. As with previous examples, no extra resources or wiring may be necessary, as Grandpa's Railroad proximity locators are not dedicated to a specific function.

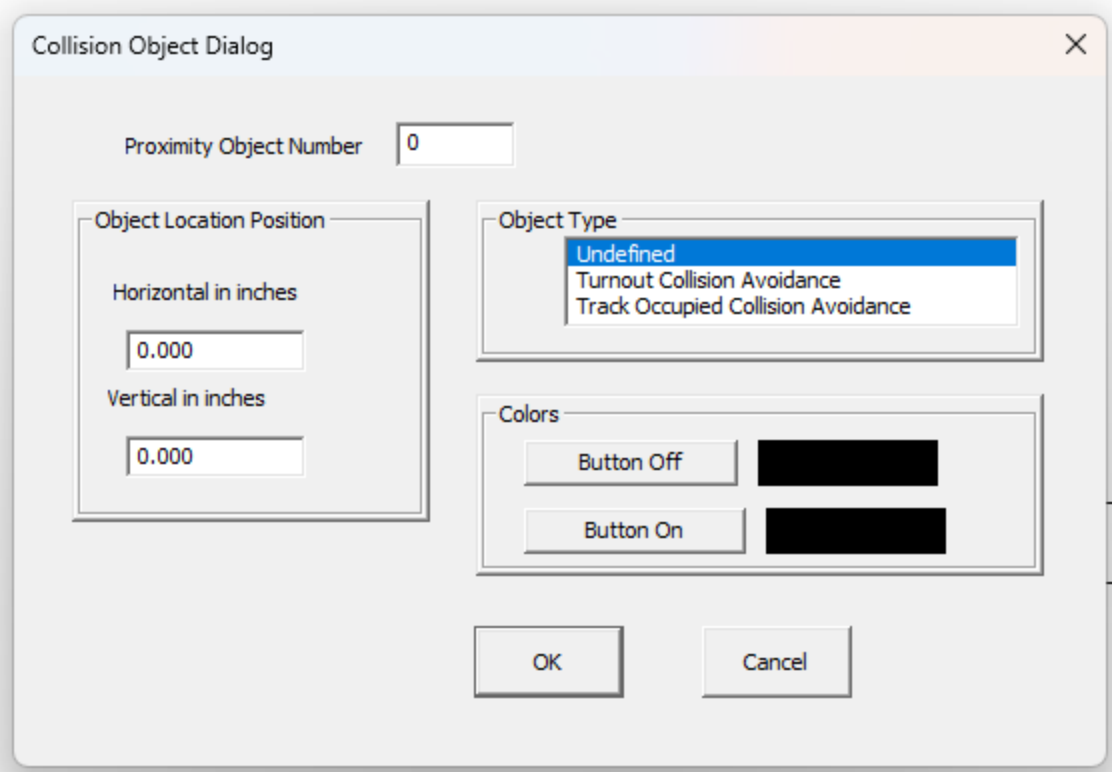
3.8.2 Adding a Collision Avoidance Object to your Layout

From the main menu select



Define Layout/Add Other Component/Add Proximity Locator Activated Object/Collision Avoidance

Upon selecting this menu item, the following dialog will appear.

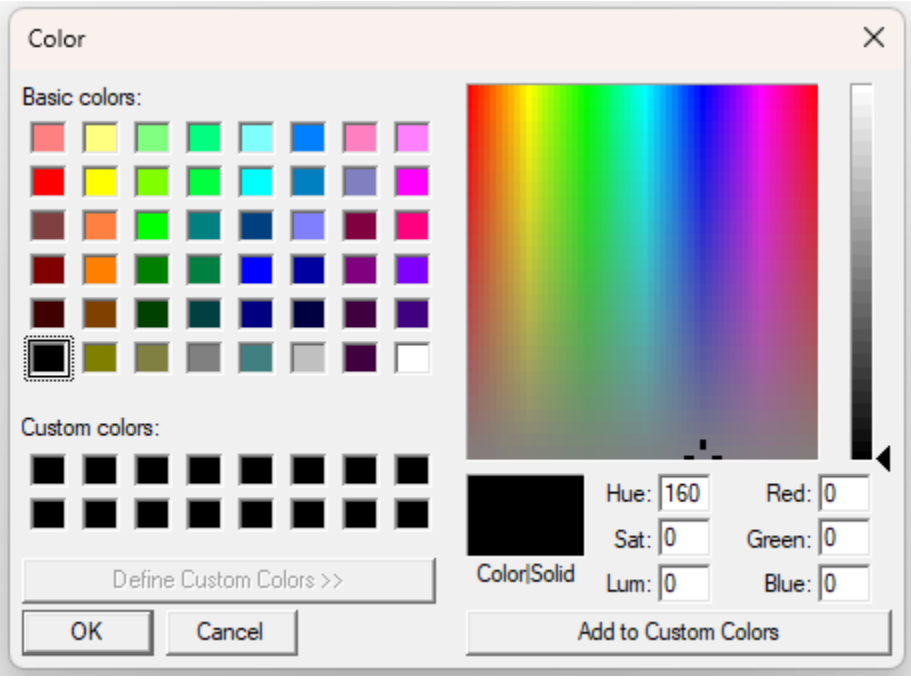


Input Data Requirements

Using this dialog, you must enter the following information:

- **Proximity Object Number**: A unique identifier between 1 and 999 for this object.
- **Object Location Position**: The placement of the object symbol (a square) on your layout. It is recommended to position the symbol near the location where avoidance is utilized. For instance, if it is a turnout collision avoidance object, place it next to the turnout it affects. This ensures that in case of an avoidance event, the flashing symbol will indicate the problem's location.
- **Object Type**: Choose between "Turnout Collision Avoidance" or "Track Occupied Collision Avoidance."
- **Colors**: Customize the "On" and "Off" colors of the collision avoidance signal. If collision avoidance is manually disabled, the "Off" color is displayed; otherwise, the "On" color appears. Different colors can be set for

each type to help distinguish them. Clicking either button will open a color selection dialog.



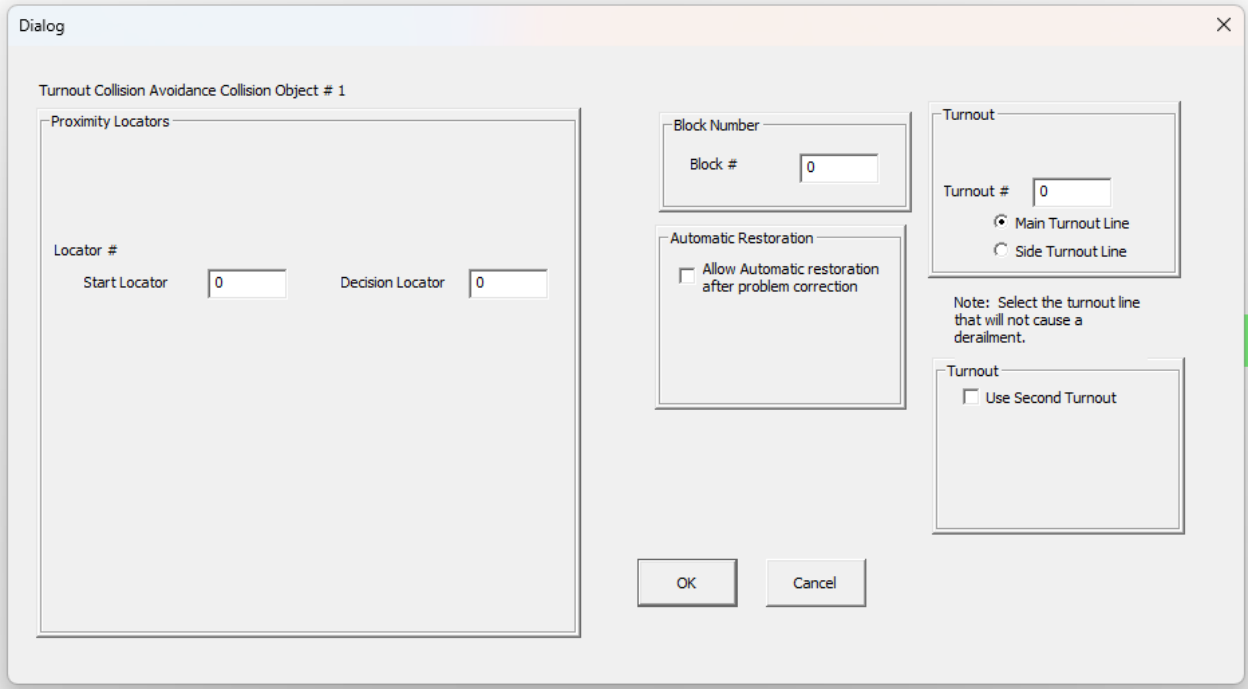
Once you click **OK** in the Collision Object dialog, and if all required data is correctly entered, a square will be placed on the layout. If there are errors, a message will appear explaining the issue.

To edit a Collision Avoidance Object, left-click on it to reopen the dialog.

3.8.3 Setting Up a Collision Avoidance Object for your Control Panel

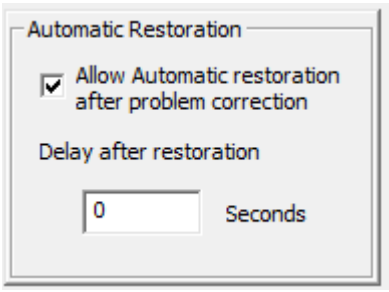
To configure a Collision Avoidance Object for your layout, enter **Control Setup Mode**. Left-click on the Collision Avoidance Object image on the layout. The dialog that appears depends on the avoidance type and is discussed below.

3.8.3.1 Turnout Collision Avoidance Control Panel Setup The dialog that appears for Turnout Collision Avoidance is as follows:



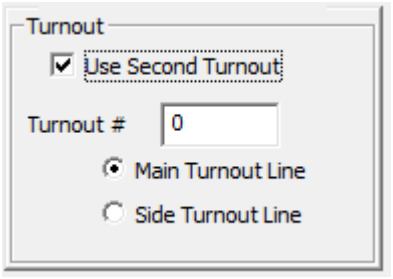
The dialog for Turnout Collision Avoidance requires the following inputs:

- **Start Proximity Locator Number**: The first locator encountered when approaching the turnout. It initiates the train direction testing sequence.
- **Decision Proximity Locator Number**: The locator nearest the turnout, acting as the decision point for determining turnout position to prevent derailments.
- **Block Number**: The control block number where power will be cut if a derailment is detected.
- **Turnout #**: The turnout being tested. You must specify whether it should be in the "mainline" or "siding" position to avoid derailment.
- **Automatic Restoration**: Enabling this option allows power to be restored after a set delay (typically 4-6 seconds), accounting for the turnout switch

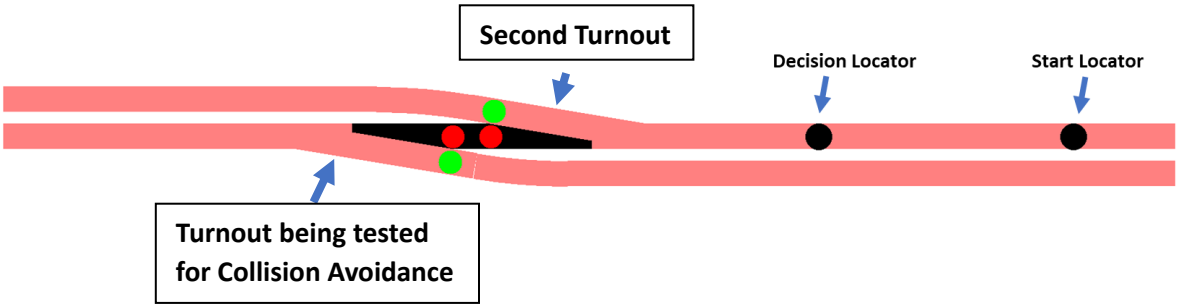


time. The delay must be an integer (in seconds). Even with automatic restoration enabled, manual control can be taken after the train has stopped.

- **Use Second Turnout**: If you the Use Second Turnout box, the dialog changes as follows:



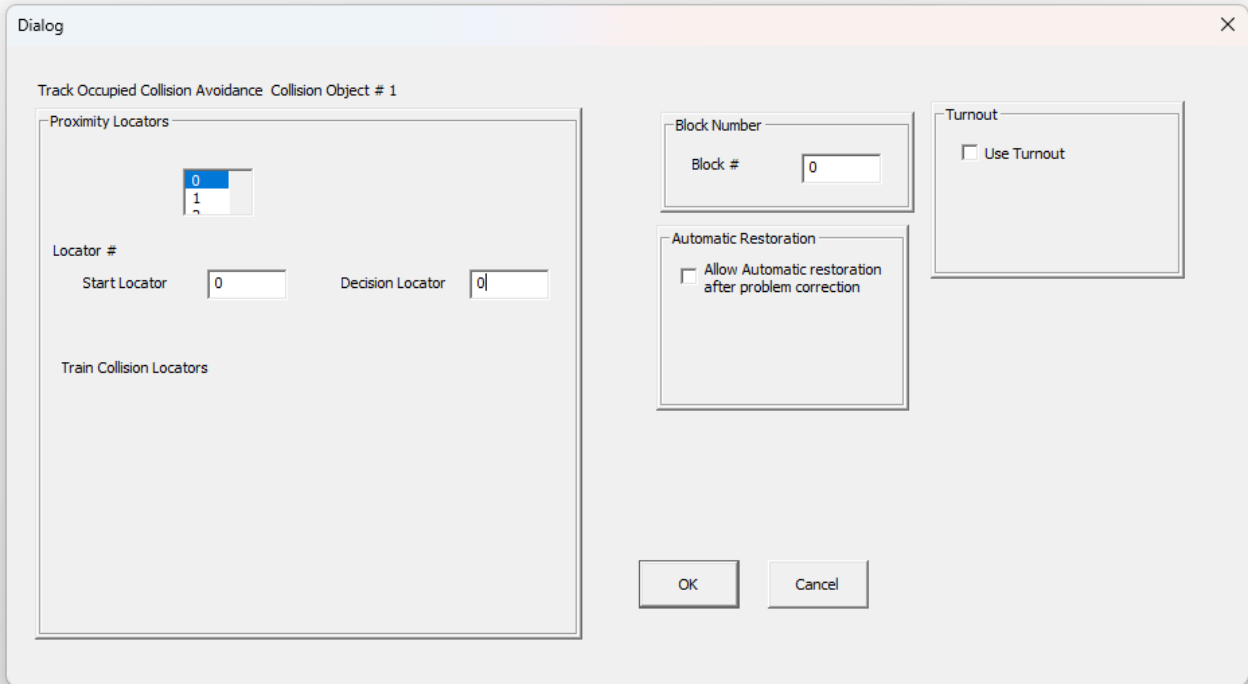
This feature allows you to address the third scenario described in section 3.8.1.1 where a turnout is directly in front of a second turnout as pictured below.



Using this dialog, enter the turnout number of the second turnout and the direction that **will not reach** the turnout being tested for collision avoidance.

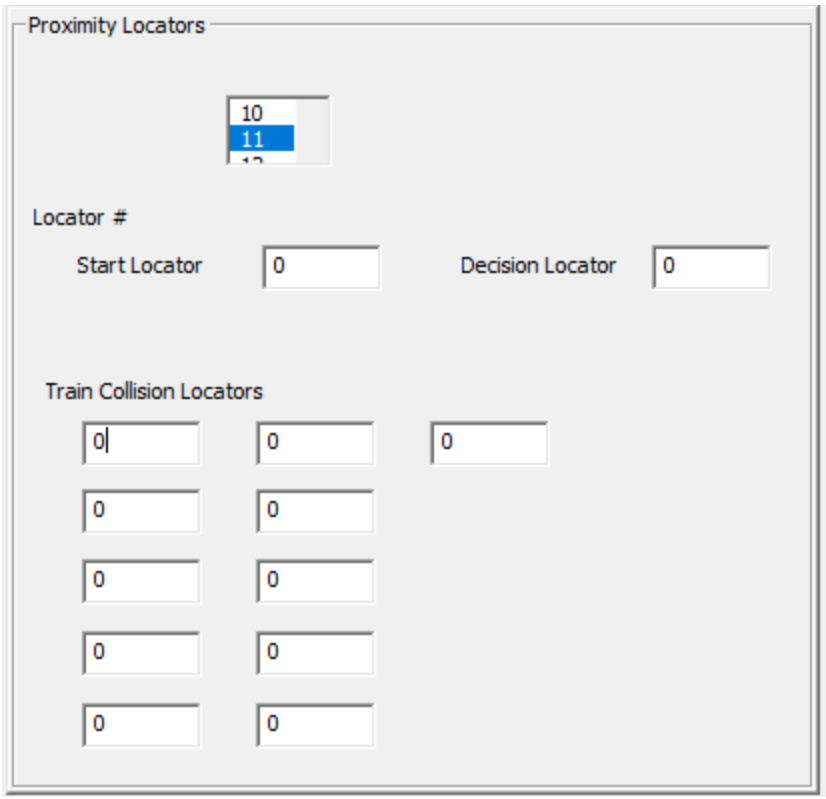
After entering all required data, click **OK**. If data is incorrect, an error message will explain the issue.

3.8.3.2 Track Occupied Collision Avoidance Control Panel Setup The dialog that appears for Track Occupied Collision Avoidance is as follows:



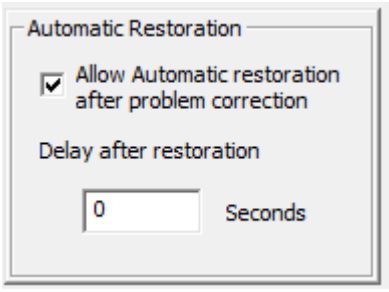
For Track Occupied Collision Avoidance, enter the following:

- **Start Proximity Locator Number**: The locator encountered first when approaching an occupied block. It initiates train direction testing.
- **Decision Proximity Locator Number**: The locator closest to the potentially occupied block. It determines train direction and when to check proximity locators defined as Train Collision Locators.
- **Number of Proximity Locators**: Set the number of locators to be tested (1-20). These do not include the start and decision locators. When a number is selected the dialog box changes allowing the entry of those numbers as shown below:



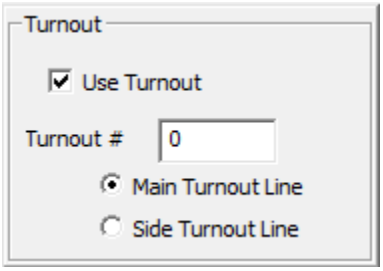
These are the locators that will be tested to determine occupancy.

- **Block Number**: The control block number where power will be cut if a collision is detected.
- **Automatic Restoration**: Enabling this option allows power to be restored after a set delay (typically 4-6 seconds), accounting for the turnout switch

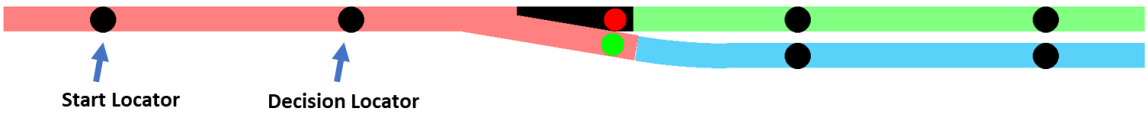


time. The delay must be an integer (in seconds). Even with automatic restoration enabled, manual control can be taken after the train has stopped.

- **Turnout**: If selected, the dialog changes as follows:



This feature allows you to address the second scenario described in section 3.8.1.2 where a turnout is directly in front of a track block to be tested for track occupancy as pictured below:



In this scenario the turnout position will determine whether the green or blue block is important for occupancy. You should select either the main or side turnout line. To provide a test for both the green and blue blocks you would need to define 2 track occupied collision objects one for each track. We will clarify this using the example above. The train occupied collision avoidance object testing the green line should have the main turnout line set. When the train reached the decision point since the turnout is pointed to the side turnout track, even if the green or mainline is occupied, the power would not be cut.

Once all required data is entered, click **OK**. If errors exist, an error message will provide details.

3.8.4 Control Panel Operation for a Turnout

Before using the collision avoidance feature, ensure individual objects are **turned on** by clicking their symbols with the left mouse button. The color settings help differentiate between active and inactive states.

When a collision avoidance event occurs:

Power is cut to the designated block.

The block symbol starts flashing.

If **automatic restoration** is enabled, operation resumes once the issue is cleared. Otherwise, use **manual restoration**:

1. Correct the cause (e.g., adjust turnout position, reverse train direction, etc.).
2. Close the collision avoidance warning window by right-clicking on the "X."
3. Restore power via the **Block Control** feature (refer to section 3.1.4).

If the issue is not resolved, the collision avoidance event will recur.

Multiple collision avoidance events can happen simultaneously. Since power is cut only to one block at a time, the rest of the layout remains operational.

3.8.5 Practical Example

Due to the complexity of the collision avoidance feature, no simple test example is provided. It is recommended that you familiarize yourself with **Proximity Locators** and **Track Block Controls** before implementing this feature in your layout.

3.9 Adding DCC Event or Sequence

A DCC Event or Sequence is an object that triggers one or more functions when a locomotive passes over it. These functions could include sounding the horn, executing a horn sequence (e.g., when approaching a crossing), changing speed, stopping, and more.

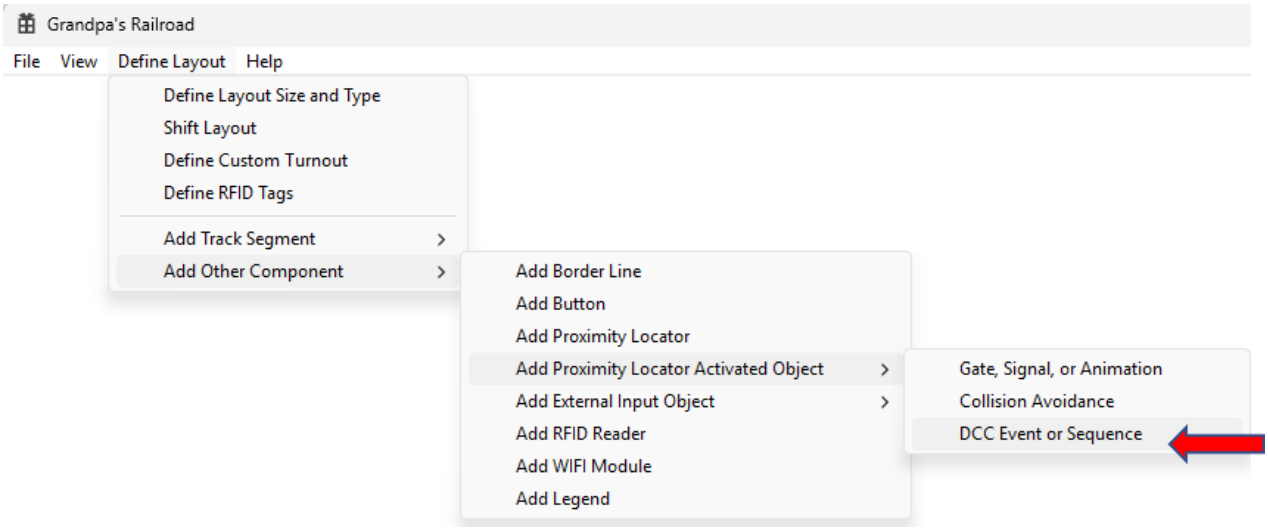
To use this feature, both Grandpa's Railroad Control Panel and Grandpa's Railroad DCC Throttle must be running.

3.9.1 Hardware Required

The layout must contain an RFID reader (see **Section 3.13**) and one or two proximity locator's setup as a connectivity network (see **Section 3.6**).

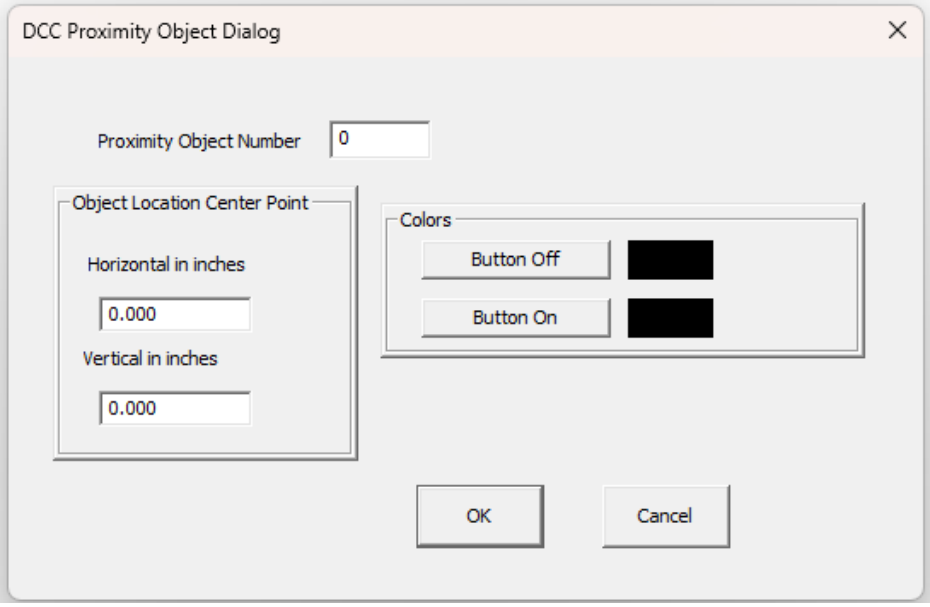
3.9.2 Adding a DCC Event or Sequence Object to your Layout

From the main menu select



Define Layout/Add Other Component/Add Proximity Locator Activated Object/DCC Event or Sequence

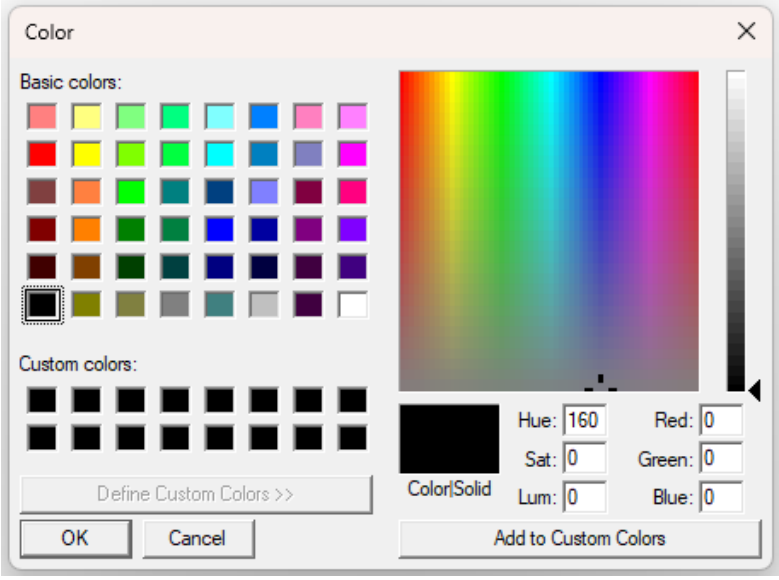
Upon selecting this menu item, the following dialog will appear.



This dialog allows you to enter the Proximity Object number, position, and ***ON/OFF*** colors of the object. **Proximity Object Number**: A unique number (between 1 and 999) assigned to this object.

- **Object Location Position**: Defines the center of the circular indicator that will appear on the layout.
- **ON/OFF Colors**: Customize the appearance of the button when activated or deactivated.

  Clicking either **ON** or **OFF** will open a color selection dialog.



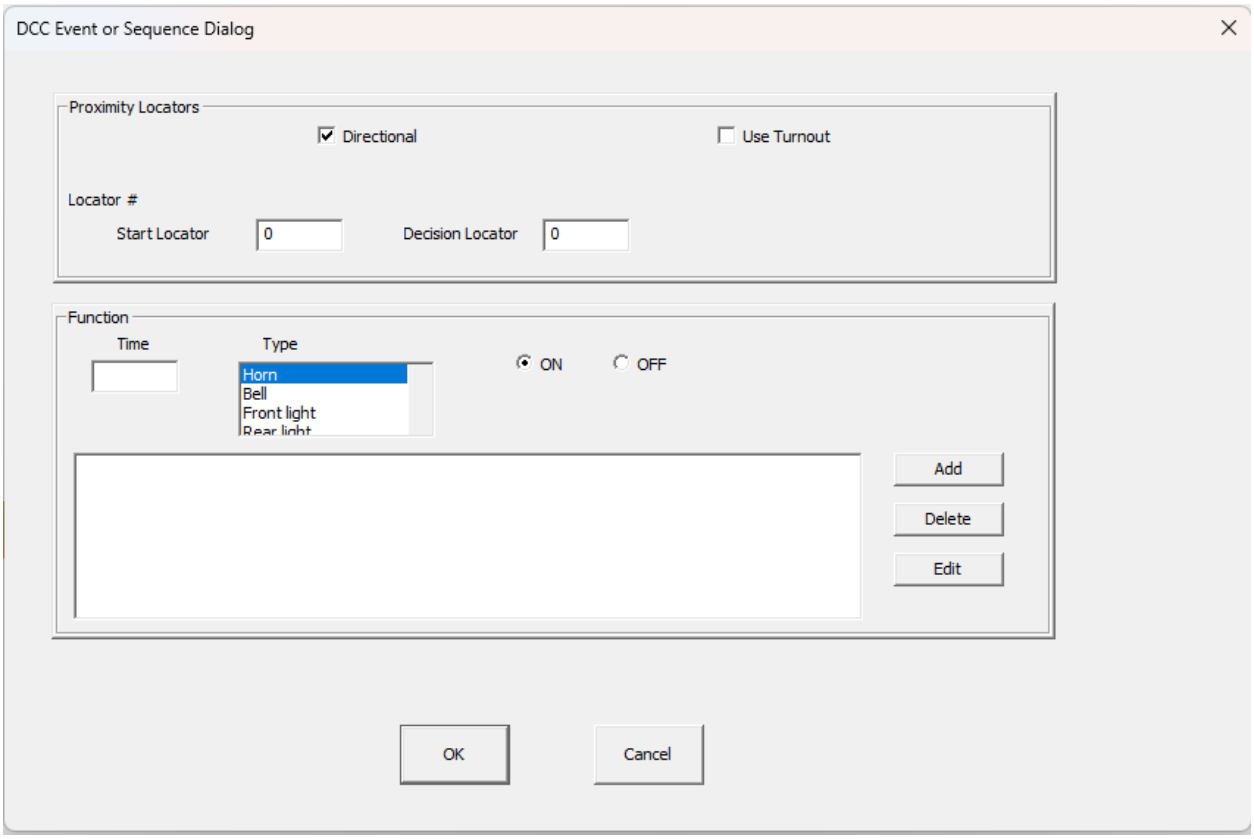
Using this dialog, you can select the color of the object.

Once you click **OK** and all required data is entered correctly, a circle will appear on the layout. If there are errors, a message will detail what needs to be corrected.

To edit a DCC Event or Sequence Object, left-click on the object to reopen the dialog.

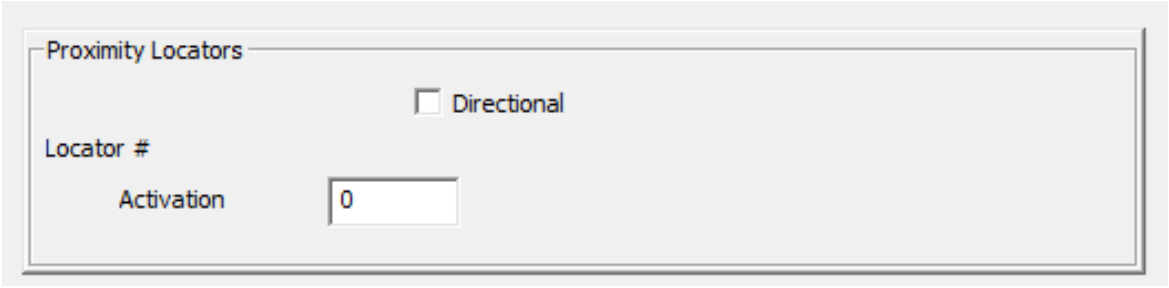
3.9.3 Setting Up a DCC Event or Sequence Object

To configure a DCC Event or Sequence Object for your layout you must be in **Control Setup** mode. Using the *Left Mouse Button*, click the **DCC Event or Sequence Object** image on the layout and the following dialog will appear.

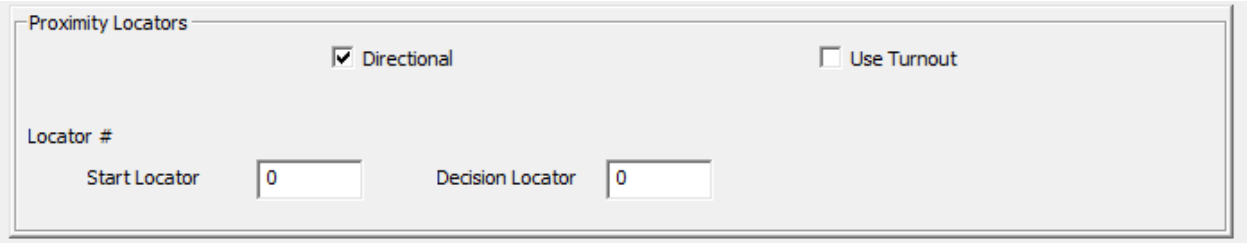


Configuring Activation Conditions

The first step in configuring an event is determining how it will be triggered. If the event should activate regardless of the train's direction, only a **Proximity Locator Number** needs to be entered. However, if the event should only activate when a



train is traveling in a specific direction, the **Directional** checkbox must be selected. Enabling this option adds a second locator field, requiring activation in a



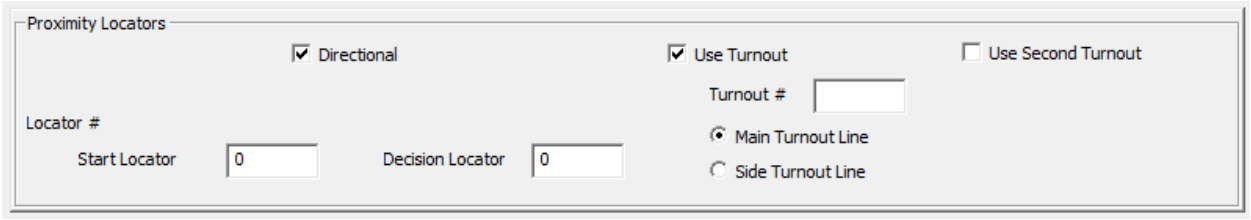
predefined order: the **Start Locator** must be triggered before the **Decision Locator** for the event to occur.

Both proximity locators must be integrated into a **connectivity network** that is linked to an RFID reader. This ensures that the event is only triggered when a specific, identified locomotive passes over the designated area.

Using Turnouts to Refine Activation

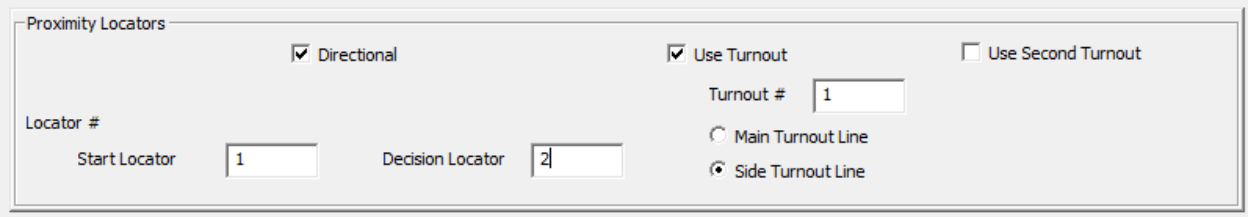
For more precise control, a turnout can be included in the activation conditions. If the event should only occur when a train turns onto a siding, the **Use Turnout**

option should be selected. In this case, the system will only trigger the event if the turnout is set to direct the train onto the designated track.



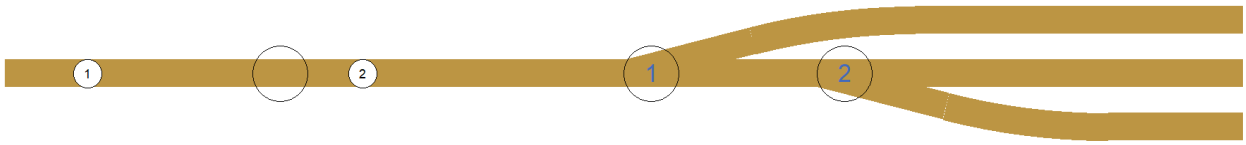
For more complex routing scenarios, such as requiring the train to pass multiple turnouts before activation, the **Use Second Turnout** option can also be enabled. This ensures that the event does not activate if the train diverts onto an earlier track.

For the example above we would enter the data as shown below for the event or sequence to only work when the train was entering the siding.

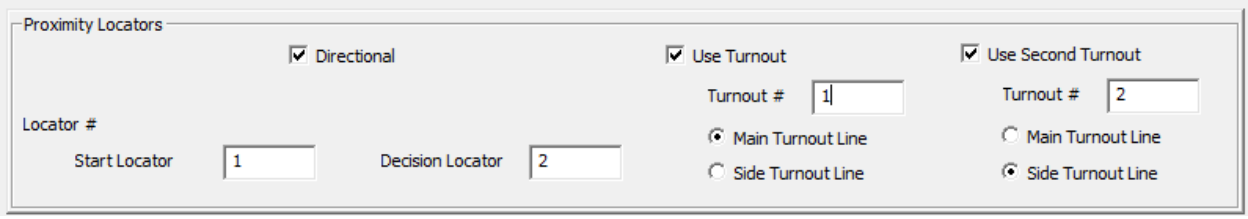


In some cases, you may want the event to occur before two turnouts are reached.

If we have the case illustrated below and we only want to do the DCC event or sequence when we are turning onto the second siding, then we would select *Use Turnout* and *Use Second Turnout*.



For this example, we would not want the event or sequence to occur if we turned on to the first siding. We would enter the data as shown below for the event or sequence to only work when the train was entering the second siding.



Assigning Actions and Sequences

Once activation conditions have been set, the next step is defining the actions to be performed when the event is triggered. The setup dialog provides a list where users can assign specific functions to the event. Each action must include the following parameters:

- **Time Delay**: The delay (in seconds) after activation before the action occurs. This value must be between **0 and 300 seconds**.
- **Action Type**: The specific function to be executed, selected from a predefined list.
- **ON/OFF Status**: Determines whether the action should turn the function ON or OFF (for applicable actions).

Clicking **Add** will store the action in the sequence, allowing multiple actions to be defined for a single event. A maximum of **30 actions** can be assigned to a single DCC sequence.

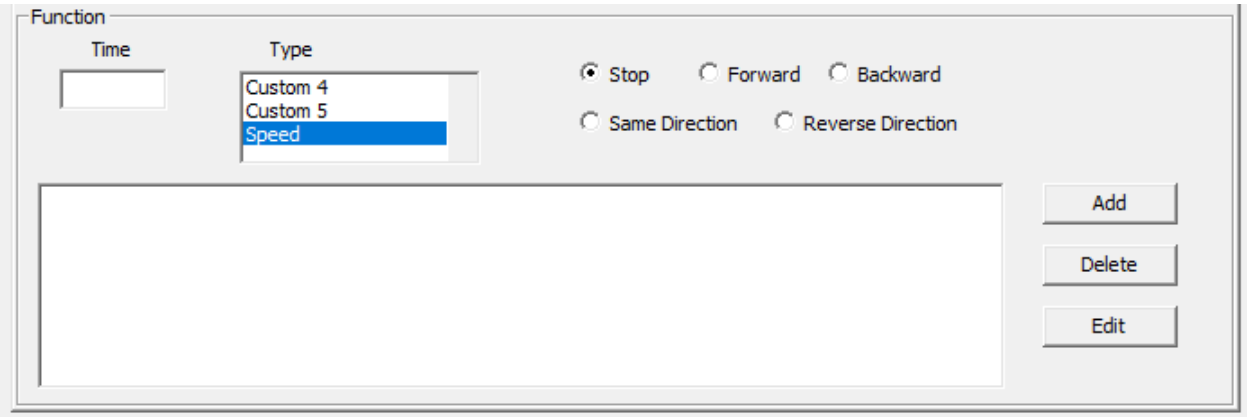
The available actions include standard locomotive controls, as well as customizable options:

- **Horn**
- **Bell**
- **Front Light**
- **Rear Light**
- **Cab Light**
- **Ditch Light**
- **Speed**
- **Custom 1-5** (user-defined functions based on DCC F Codes)

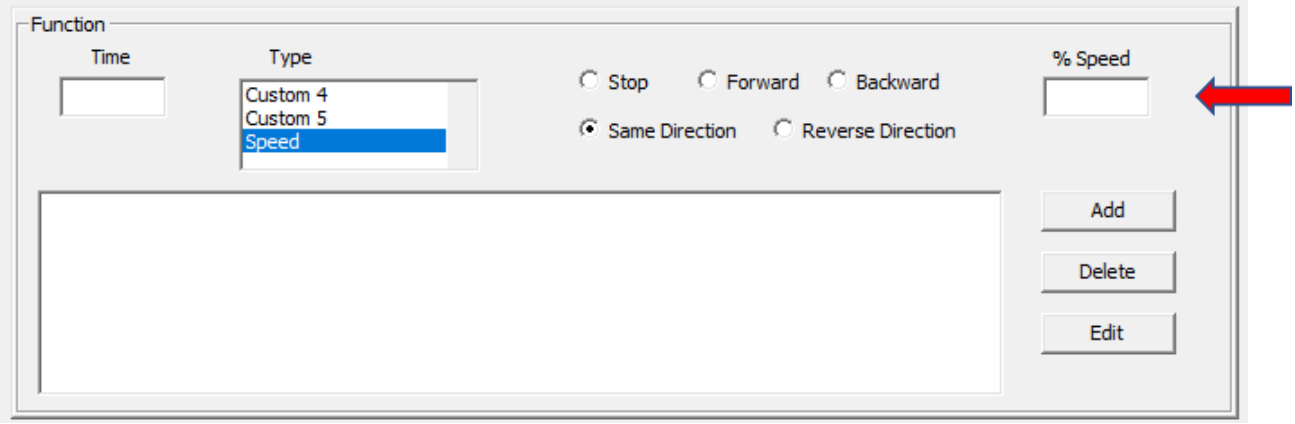
The Custom values depend on the DCC F Code that you associate with them in the DCC Throttle application.

Note: You must setup the F Codes for the above functions in the DCC Throttle. (see Section 3.1.2 of the DCC Throttle User's Manual)

In the above list **Speed** is a special function not requiring an ON/OFF entry. Instead, if you select Speed, the following options appear.



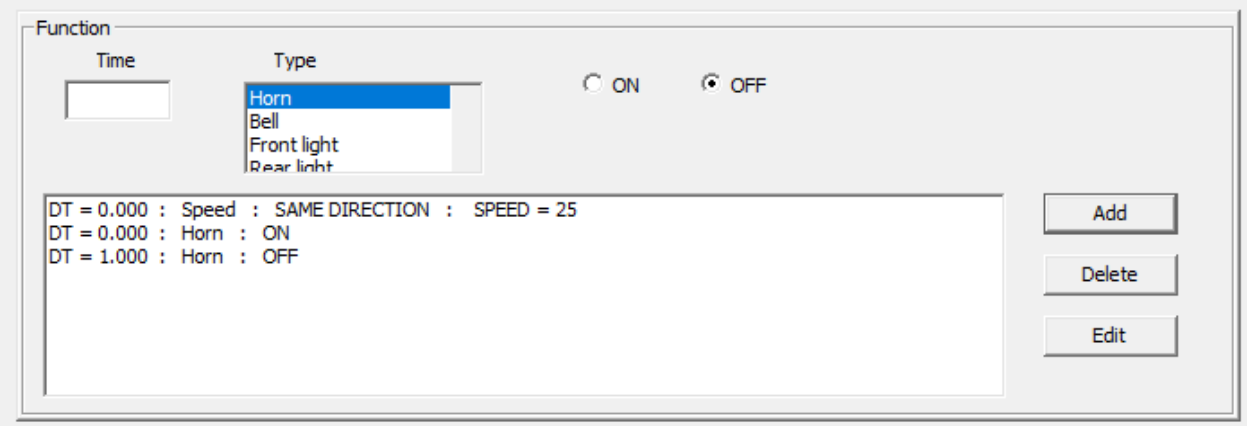
If you then select any speed option other than *Stop* a box will appear allowing you to enter a % of full throttle or speed that you wish to change to.



We have chosen to work with % of full throttle or speed as our approach so that we can work with all makes of locomotives and decoders which achieving approximately the same speed. (See the discussion of **Throttle Limit** in section 3.2.2 DCC Panel Setup of the DCC Throttle User's Manual.)

You can edit or delete a code by highlighting it in the list box (clicking it with the left mouse button) and then pressing the ***Edit*** or ***Delete*** button.

A sample of how this dialog would appear if we wished to have the speed change to 25% full throttle and a 1 sec horn blow at the same time follows:



The actual rate of speed change depends on the momentum profile of your decoder or whether you have Grandpa's Railroad momentum activated.

3.9.4 DCC Event or Sequence Operation

Once configured, a **DCC Event or Sequence** is activated when a properly identified locomotive passes over the designated **proximity locator(s)**. A locomotive is considered **identified** when it has been recognized by an **RFID reader**, which then communicates the locomotive's information through the connectivity network.

Upon activation, the corresponding control panel button will visually change from its OFF color to its ON color, signaling that the event has been triggered. At the same time, the programmed DCC functions will execute automatically, performing the assigned actions in the specified order and timing.

This feature allows for a highly automated and dynamic model railroad experience, enabling locomotives to respond to layout conditions in a realistic and controlled manner.

Make sure the DCC Throttle is operating, a DCC Panel has been defined for the decoder address, and that you have defined the F code for the function you are activating.

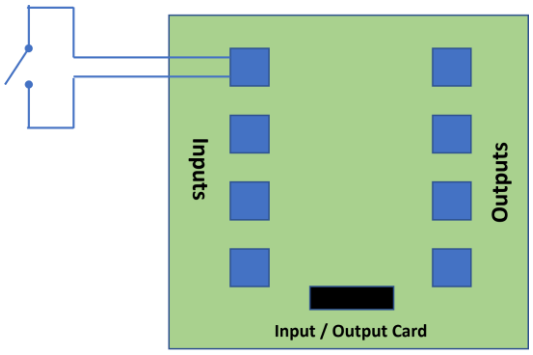
.

3.10 Adding Digital Input for Control Panel

The **External Input Object: Digital Input for Control Panel** allows a physical external switch or button to interact with Grandpa's Railroad Control Panel. One of its primary uses is enabling an observer (such as a grandchild) to trigger a feature or animation.

3.10.1 Hardware Required

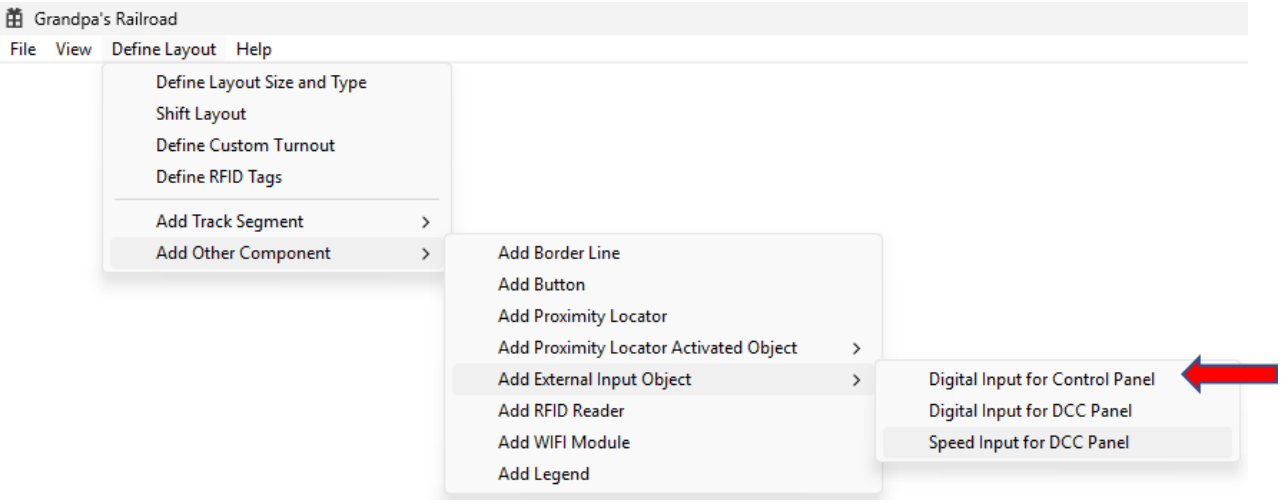
To use a digital input, you will need at least one input connection on an **Input/Output Card** or a **Turnout Control & I/O Board**.
A simple schematic illustrating how to connect a switch to the input connector is shown below:



For more information on electricity, voltage, and current, watch the Educational Tutorials "Electricity 99".

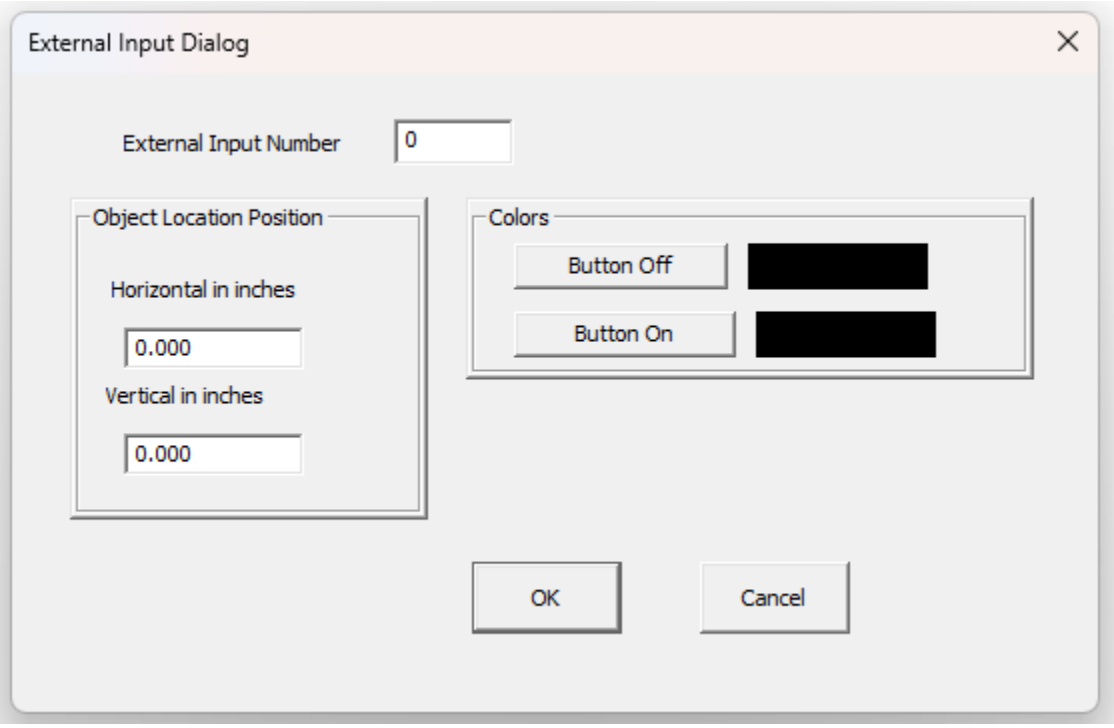
3.10.2 Adding a Digital Input for Control Panel to your Layout

To add a digital input to your layout, you must be in **Layout Setup Mode**. From the main menu, navigate to:



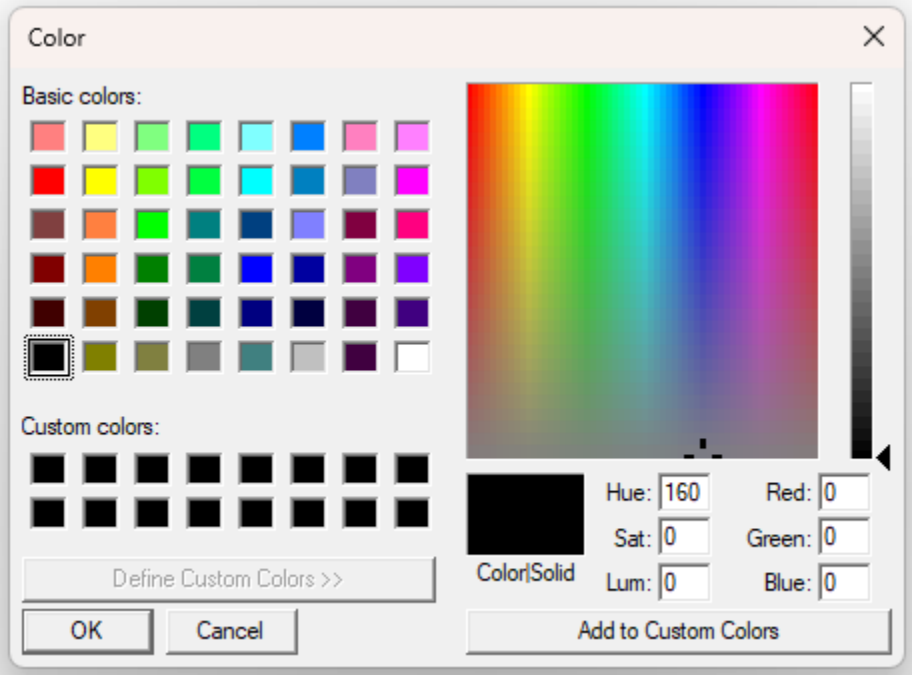
Define Layout/Add Other Component/Add External Input Object/Digital Input for Control Panel

Upon selecting this option, the following dialog box will appear:



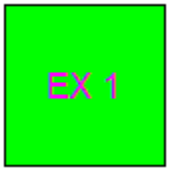
This dialog allows you to configure the **External Object Number, Position, and ON/OFF colors** of the object:

- **External Object Number**: A unique number between 1 and 999 assigned to this object.
- **Object Location Position**: Specifies the center of the square indicator on the layout.
- **Colors**: Customizes the ON and OFF colors of the button. Clicking either button opens a color selection dialog:



Using this dialog, you can select the color of the object.

After entering all the required data, selecting **OK** will place a square indicator on the layout, labeled **"EX"** followed by the object number.

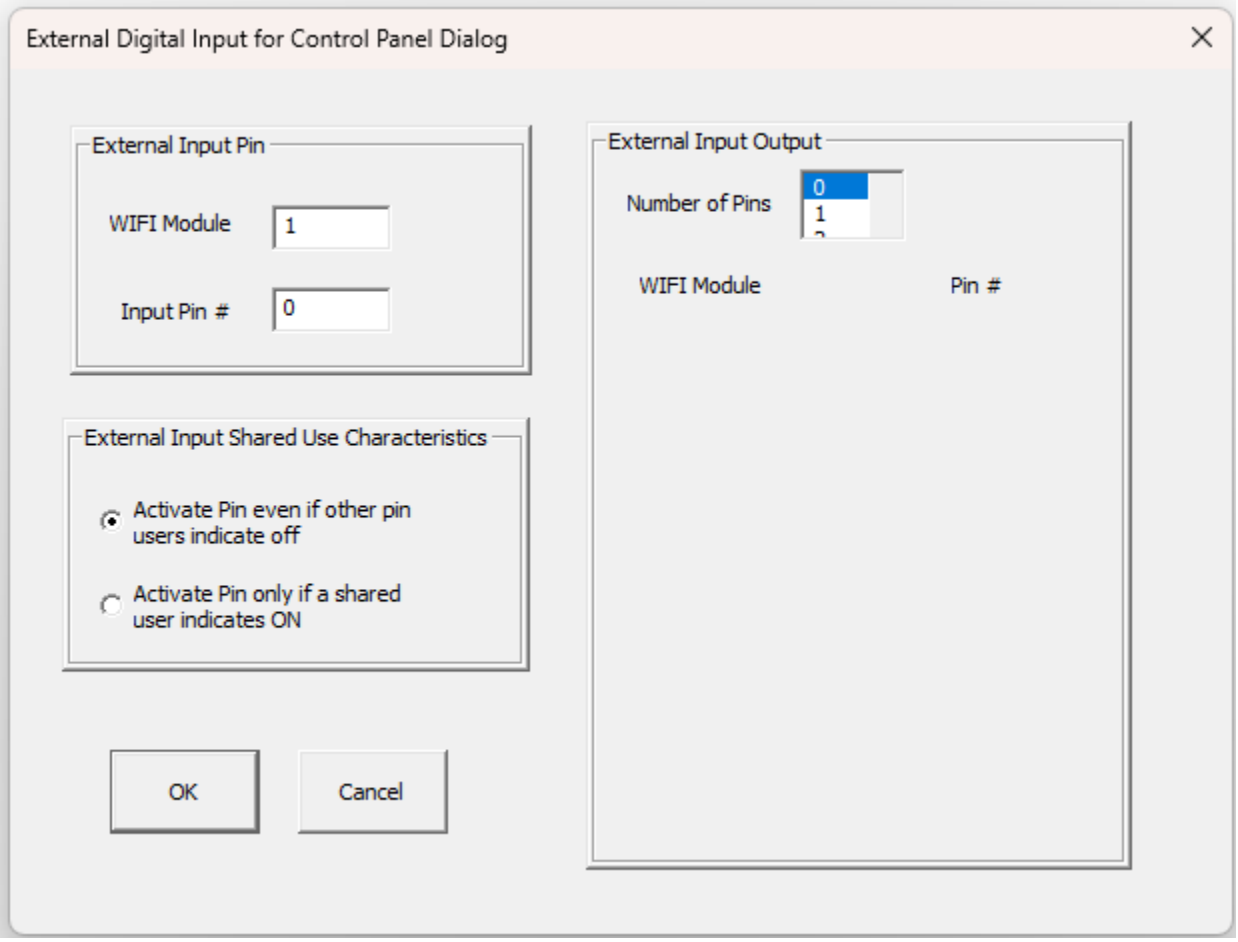


If any required information is missing or incorrect, an error message will appear explaining the issue.

To edit an **External Input Object**, simply left-click on it, and the configuration dialog will reappear.

3.10.3 Setting Up a Digital Input for your Control Panel

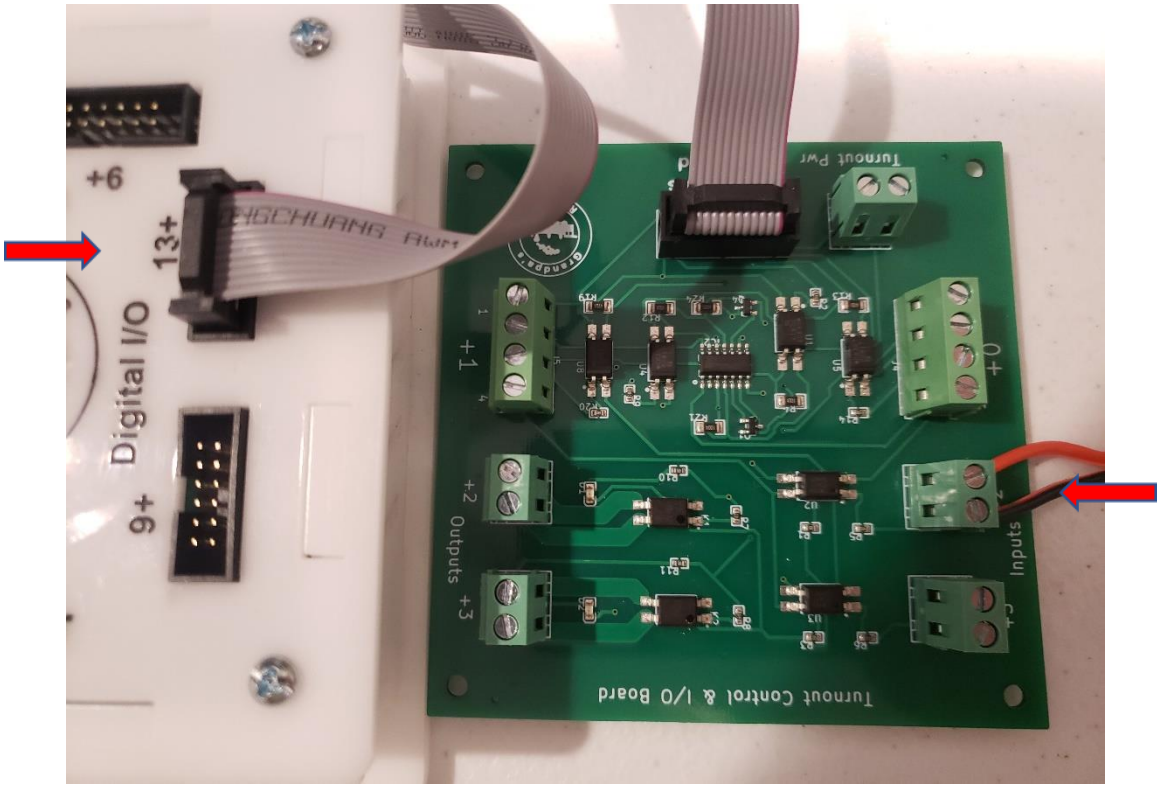
To configure a Digital Input for your layout, you must first enter **Control Setup Mode**. Begin by clicking on the **Digital Input for Control Panel** image in the layout using the **left mouse button**. This action will bring up a configuration dialog where you can define the necessary settings for the input.



In this dialog, enter the **Digital/Proximity WiFi Module number** that corresponds to the **Input/Output Card** or **Turnout Control & I/O Board** to which the input is connected. This number is the actual value programmed into the WiFi Module.

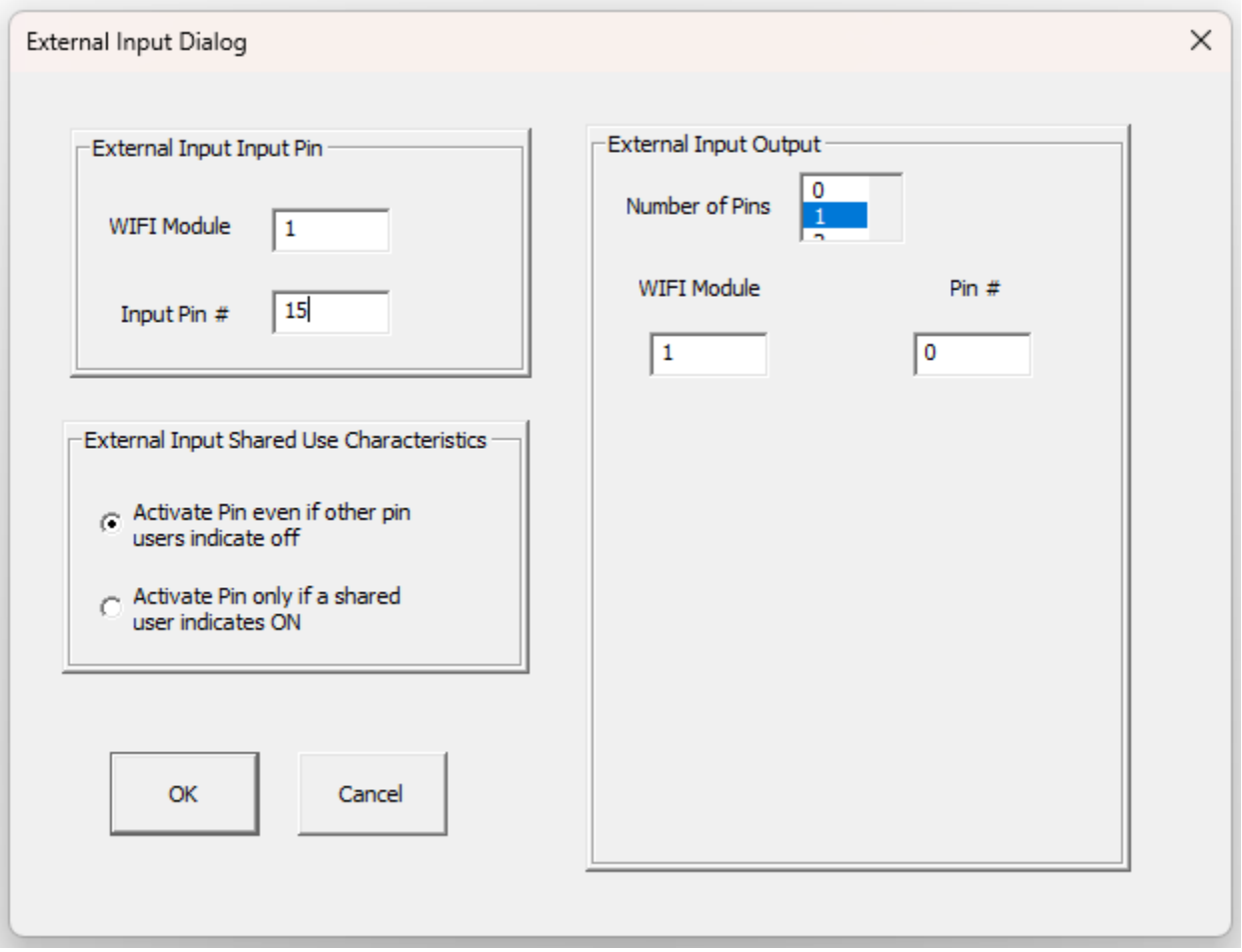
Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

The **Pin #** is calculated based on the connector where the ribbon cable is attached to the **WiFi Module** and the connector number on the **Input/Output Card** or **Turnout Control & I/O Board**. For example, if the WiFi Module contributes **13** and the board contributes **2**, the total Pin # is **15**, which should be entered in the field.



Once the Pin # has been set, determine how many **Output Pins** this external input will activate. A value of **zero** means the external input is disconnected, while up to

eight pins can be activated with a single button. If a non-zero value is selected, the dialog updates, allowing you to specify the **Output Pin** to be controlled.



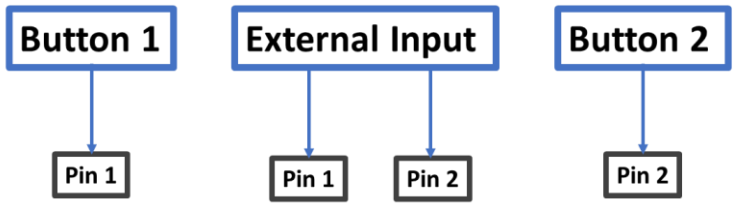
For each Output Pin activated, you must enter the **Digital/Proximity WiFi Module number** connected to the **I/O card**. This value must match the programmed module number.

The final setting to configure is whether the **external input is shared**. Sharing allows the external input to be paired with a **button** or **Proximity Objects**, providing flexibility in how the input interacts with the control panel. For example, if an external input enables visitors to control an animation, sharing it with a button lets you **disable or redirect** it to another pin.

There are two types of **button sharing**:

1. The button **always activates the designated pin**, even if other users have set it to Off.
2. The button **only activates the designated pin if both the external input and other users have set it to On**.

For example, if an external input is set to **type 2 sharing** and controls two different pins, each with an associated button, **Pin 1 and its animation will only turn On if**



both Button 1 and the external input are On. The same applies to **Pin 2**, which will activate only if both Button 2 and the external input are On. This setup allows real-time control of the external input's effects without modifying the **Control Panel Setup**.

3.10.4 Digital Input for Control Panel Operation

The **Digital Input for Control Panel** is activated by pressing an external button or switch. When activated, the control panel color changes from the **OFF color** to the **ON color**, providing a clear visual indication of activation. Additionally, the associated pins are triggered, allowing the connected devices or animations to respond accordingly.

3.10.5 Practical Example

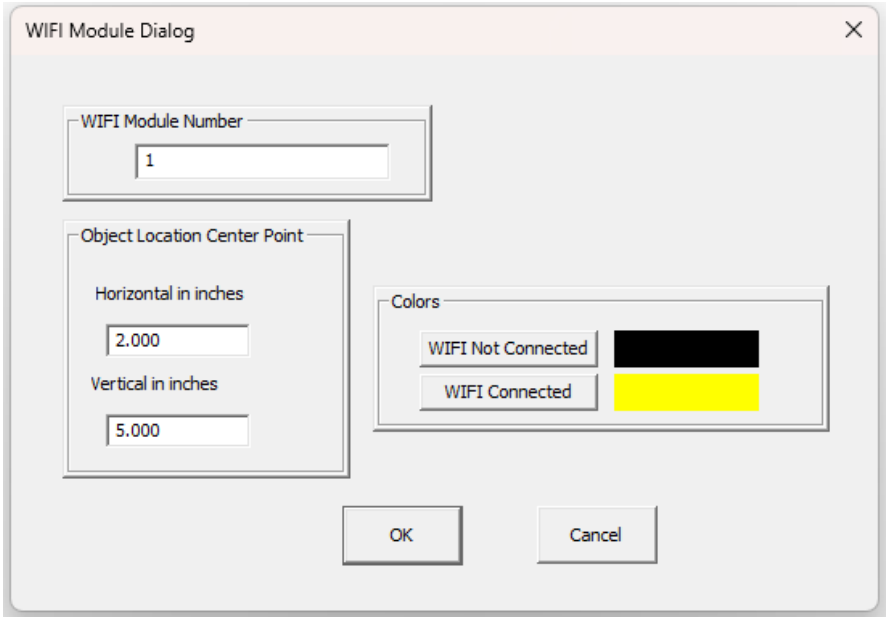
To demonstrate how a Digital Input works, we will use a **multimeter** to observe how the output connection changes when the external button is pressed. When the button is **Off**, the switch remains open, meaning resistance is **unmeasurably high**. When the button is pressed, the switch closes, and the resistance drops to a **very low value**. We will also connect a simple **LED circuit** to confirm the activation by lighting up an LED.

Step 1:

Start the **Grandpa's Railroad Application**, select **Layout Setup Mode**, and create a **10-inch by 10-inch layout** in any scale. *(Note: A layout does not need to contain track. In this example, we are only adding a button.)*

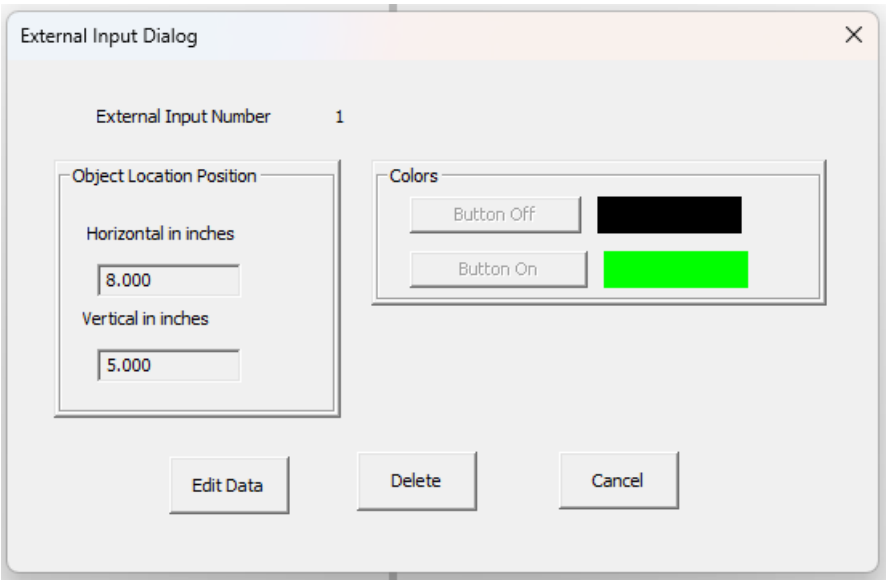
Step 2:

Add a **WiFi Module** to the layout at **2 inches Horizontal** and **5 inches Vertical**, configuring the **Connected** and **Not Connected** colors.



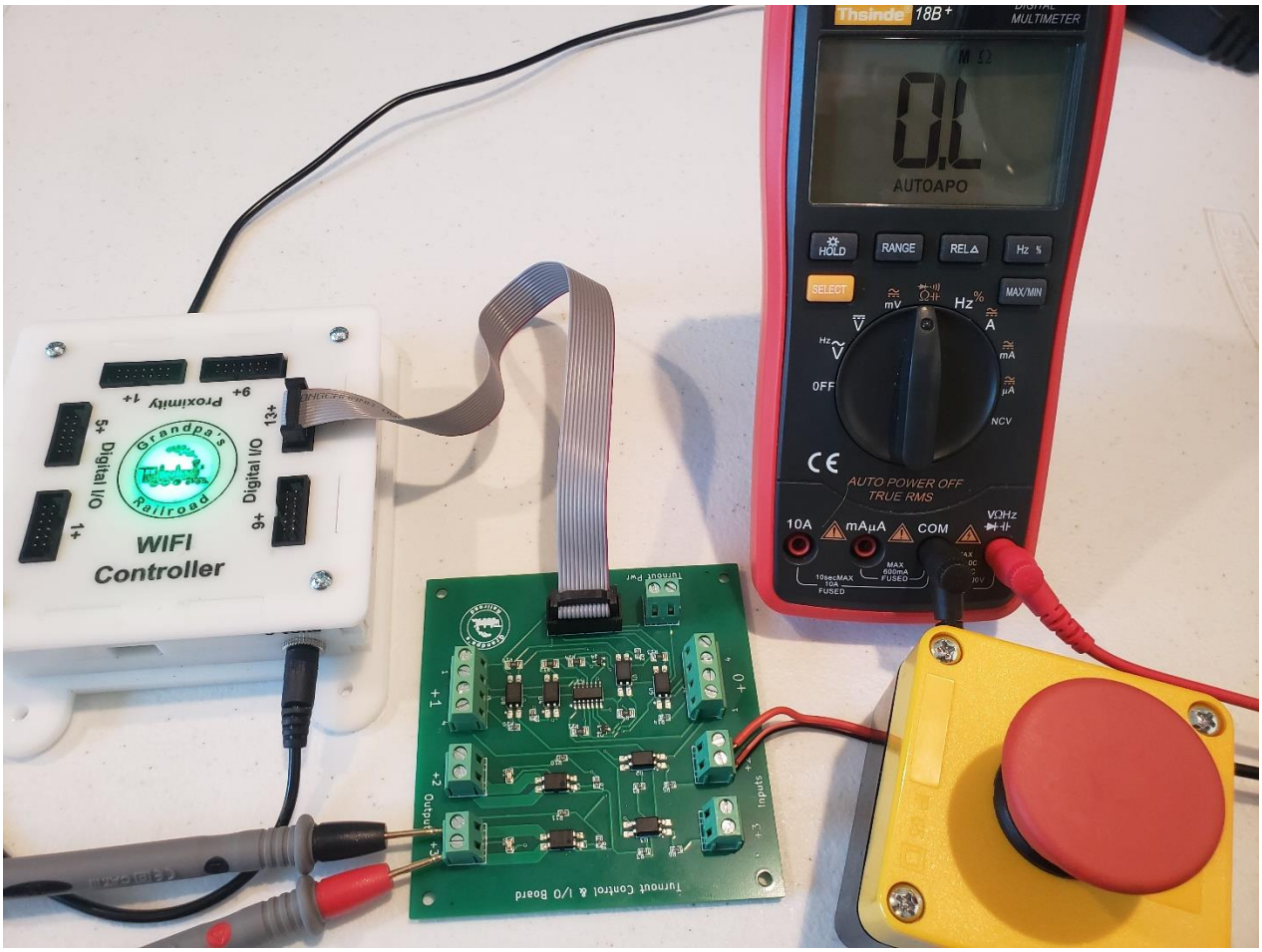
Step 3:

Add an External Input to the layout at 8 inches Horizontal and 5 inches Vertical.



Step 4:

Connect the hardware as shown below:

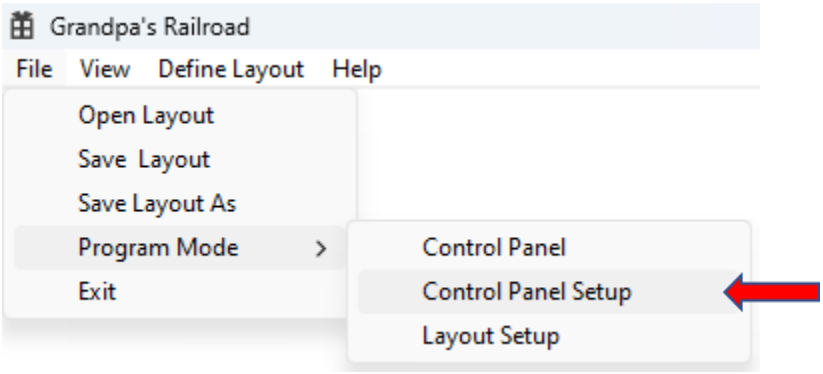


- **Power the WiFi Module.**
- **Connect the Input/Output Card** to the **13+ port** on the WiFi Module.
- **Wire the external switch** to the **+2 connector** on the input side of the board.
- **Attach a multimeter** to the **+3 connector** on the output side.

These connections assign **Pin #15** to the switch and **Pin #16** to the multimeter. The **Turnout Control & I/O Board** from the basic system is used for this setup.

Step 5:

From the File Menu, navigate to:



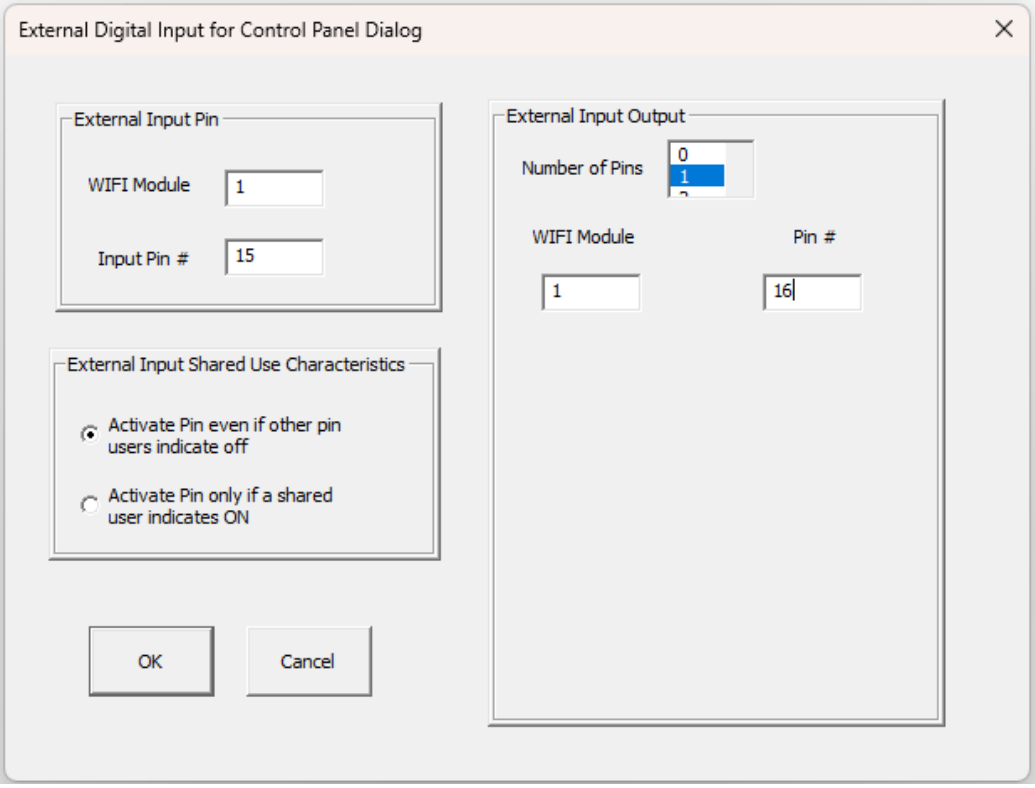
File/Program Mode/Control Panel Setup

This switches the system to **Control Panel Setup Mode**.

Step 6:

Move the cursor over the **External Input** and click the **left mouse button** to open the configuration dialog.

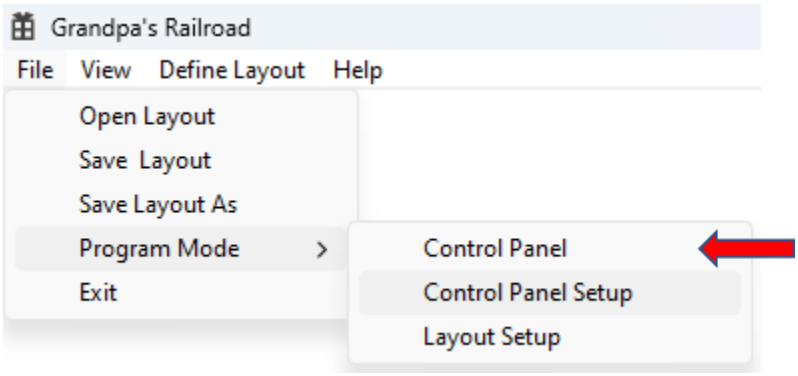
- Based on our connections, enter **1** as the **Module #.**
- Enter **15** as the **Pin #** for the **input switch.**
- Enter **16** as the **Pin #** for the **output connection.**
- Since there are no other defined external inputs or buttons, the sharing type is not applicable here.



-

Step 7:

Go to the **Control Panel Mode** by selecting:

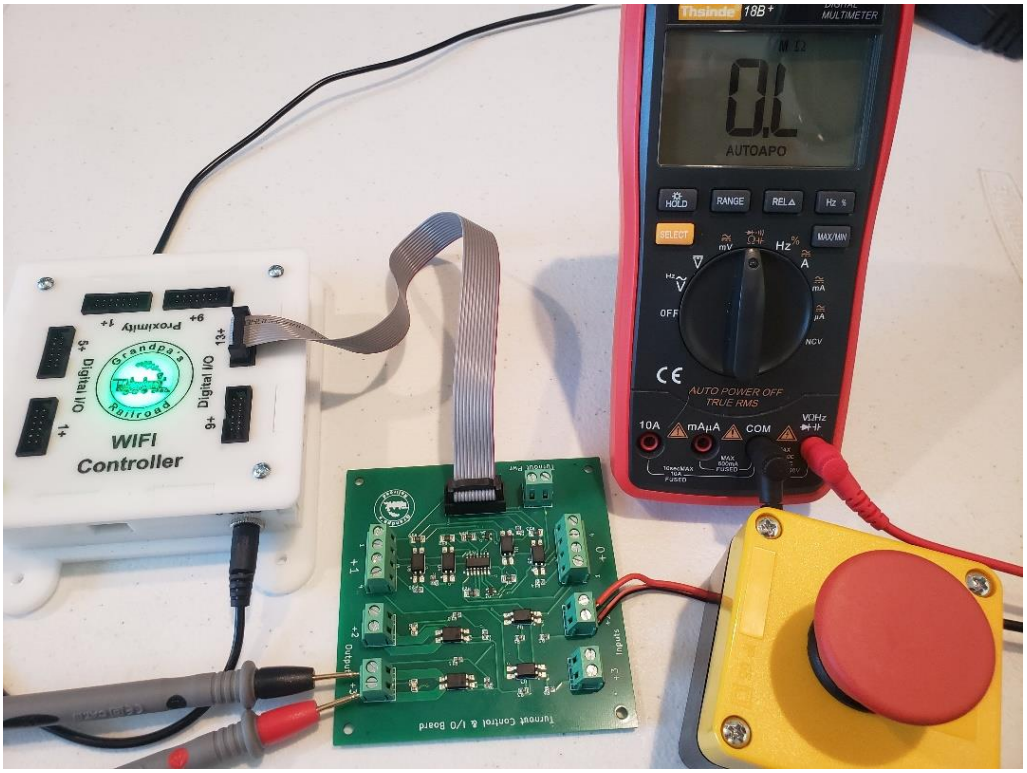


File/Program Mode/Control Panel

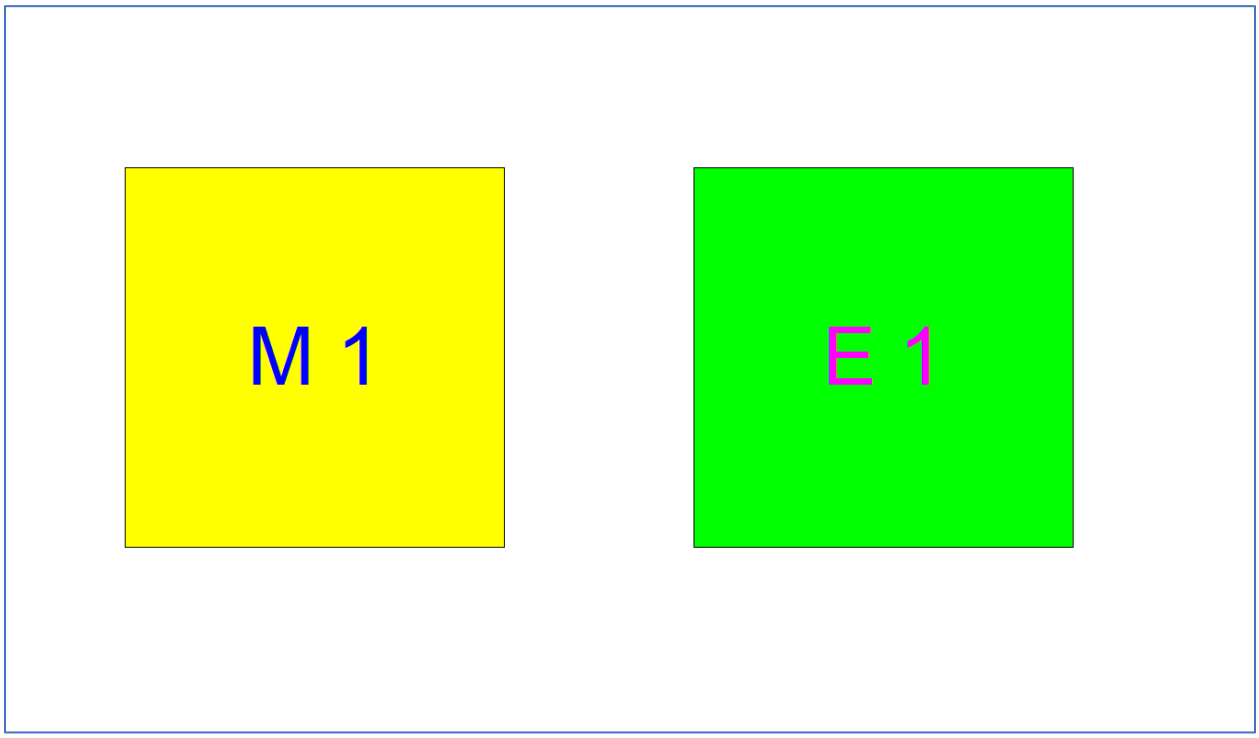
Step 8:

Once the **Digital/Proximity WiFi Module** is connected, the screen should reflect the setup.

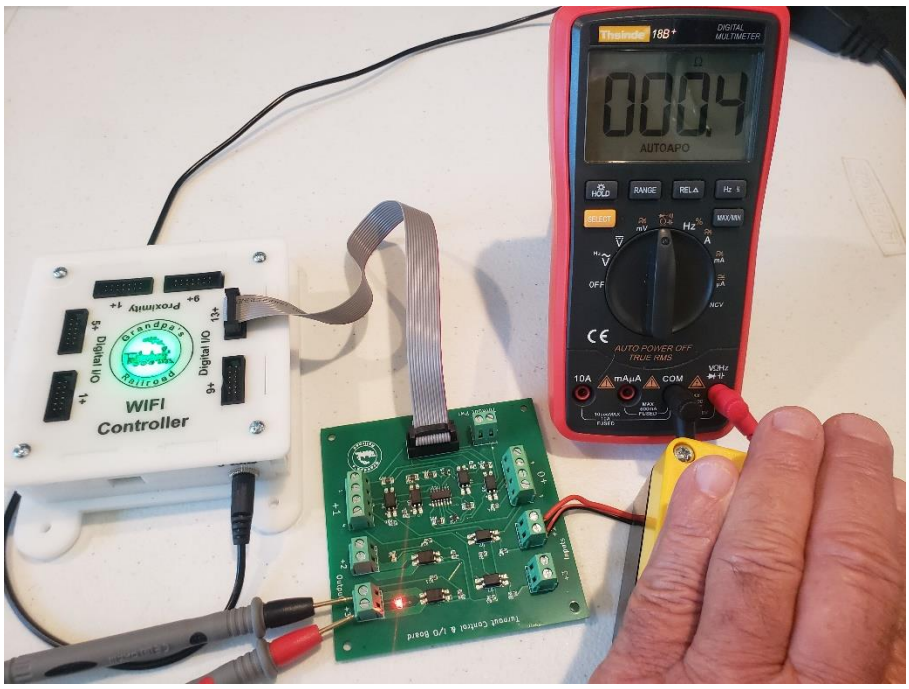
At this point, the multimeter should display **0.L**, indicating an open circuit (no connection).



When you press the **External Input switch**, the screen updates, and the



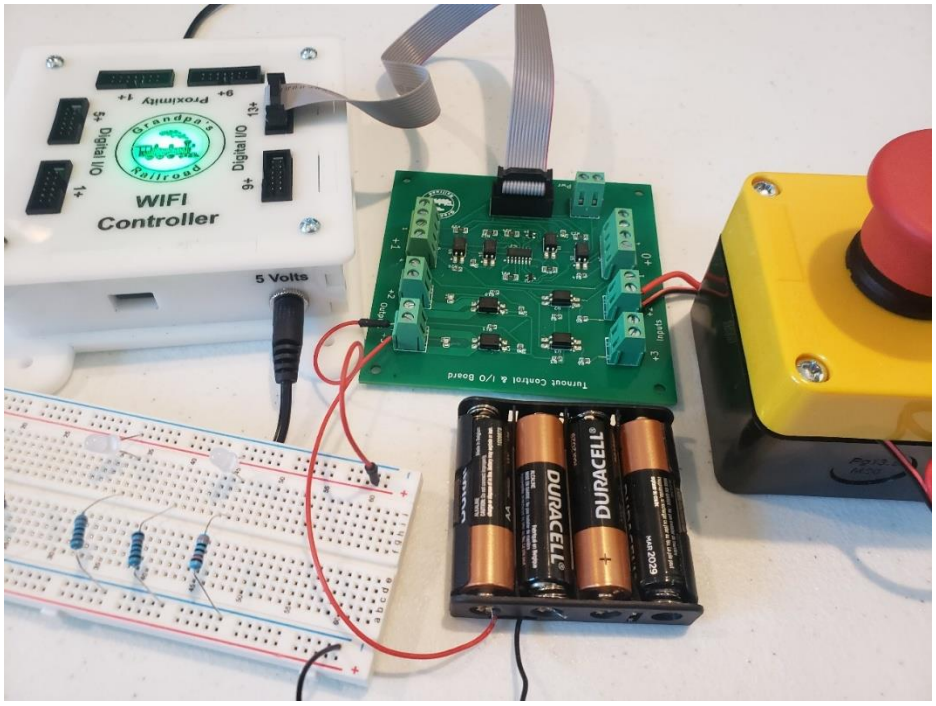
multimeter reading changes to 0.4 ohms, signifying a closed circuit. Additionally, a **red LED** near the connector lights up, confirming the switch is active.

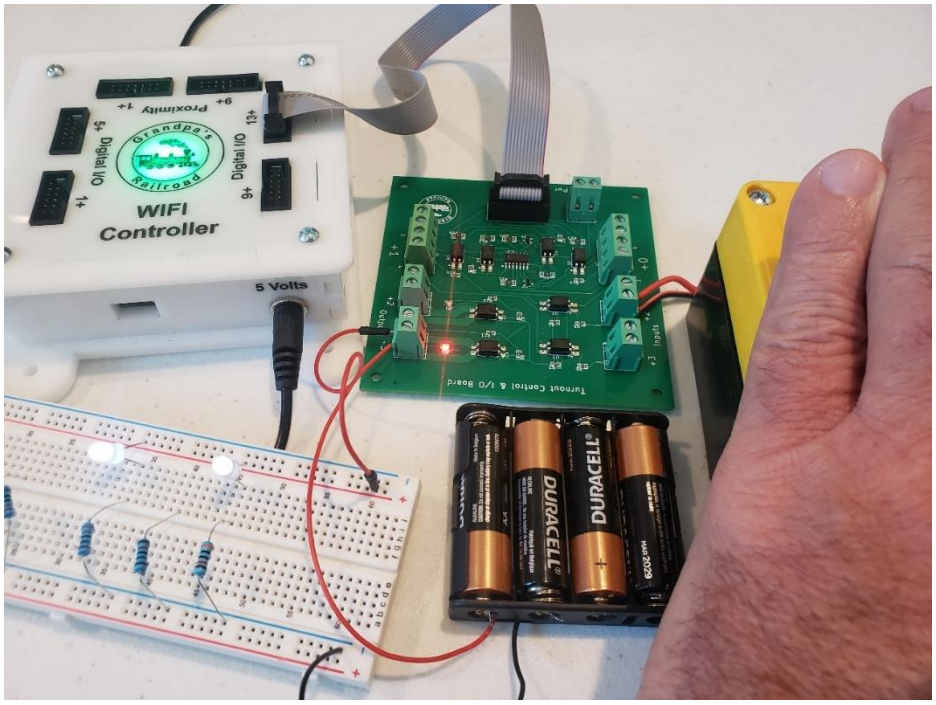


For those following the **"Electricity 99" Educational Tutorials**, this setup can be expanded for practical model train applications. Instead of a multimeter, a **Digital Input for Control Panel** can be used to control layout lighting or trigger

animations. In a real-world setup, the battery pack used in this example would be replaced with a **dedicated accessory power source** for consistent operation.

This example highlights how a **Digital Input for Control Panel** can be used for interactive model train layouts, allowing users to automate animations, lighting, and other electrical components with ease.





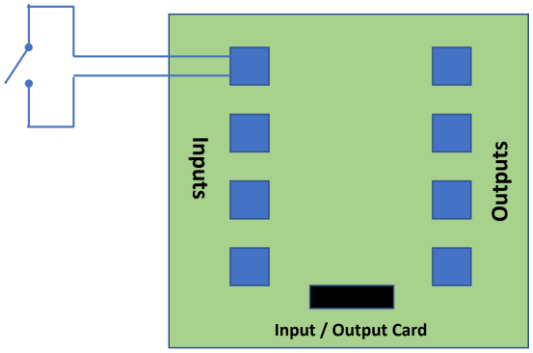
3.11 Adding Digital Input for DCC Panel

If you are using Grandpa's Railroad Control Panel along with Grandpa's Railroad DCC Throttle, you can control certain locomotive functions using an external input. For example, visitors can blow a locomotive horn or ring a bell using a physical switch or button.

3.11.1 Hardware Required

To set up a digital input, you will need at least one input connection on either an Input/Output (I/O) Card or a Turnout Control & I/O Board.

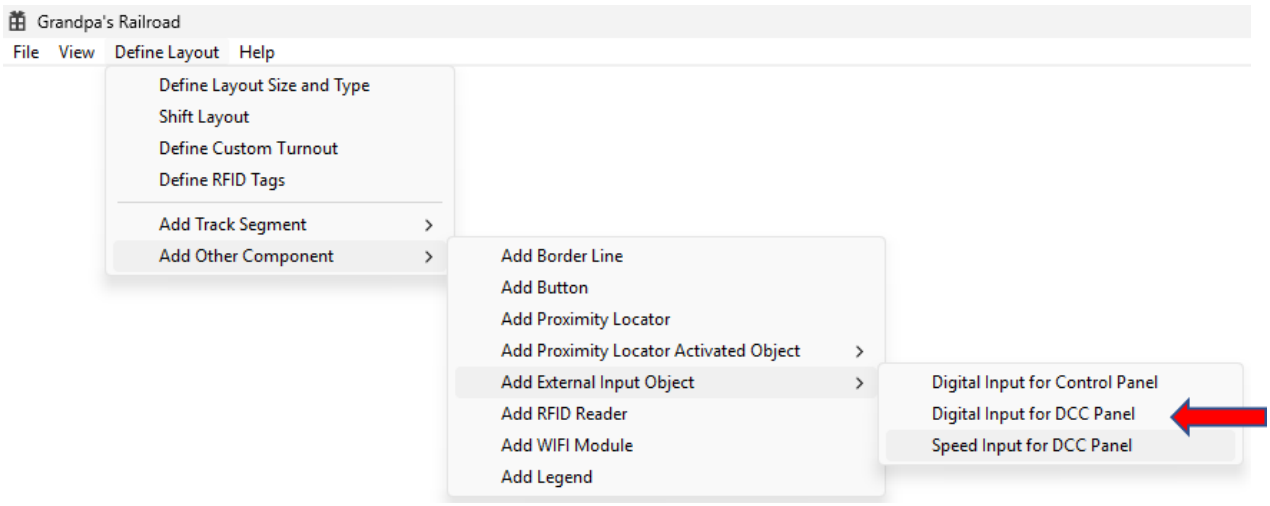
A simple schematic showing how to connect a switch to the input connector is provided below:



For a deeper understanding of electricity, voltage, and current, refer to the educational tutorial **"Electricity 99."**

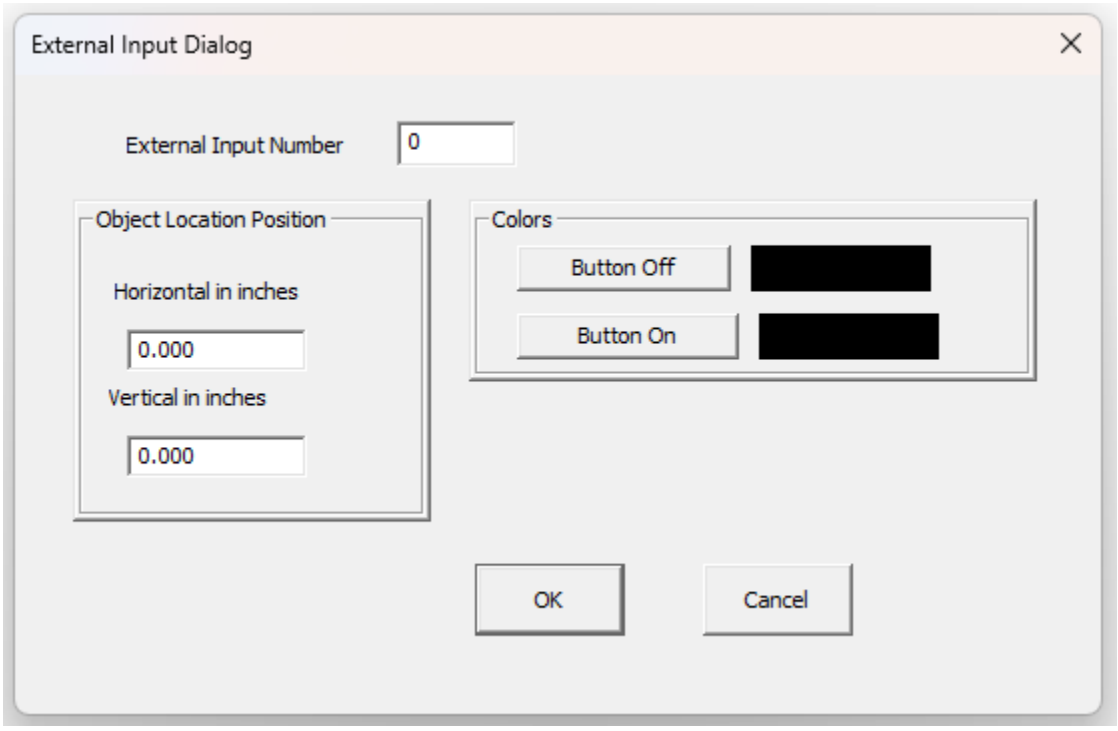
3.11.2 Adding a Digital Input for DCC Panel to your Layout

To add a Digital Input for DCC Panel to your layout you must be in the **Layout Setup** mode. From the main menu select



Define Layout/Add Other Component/Add External Input Object/Digital Input for DCC Panel

Upon selecting this menu item, the following dialog will appear.

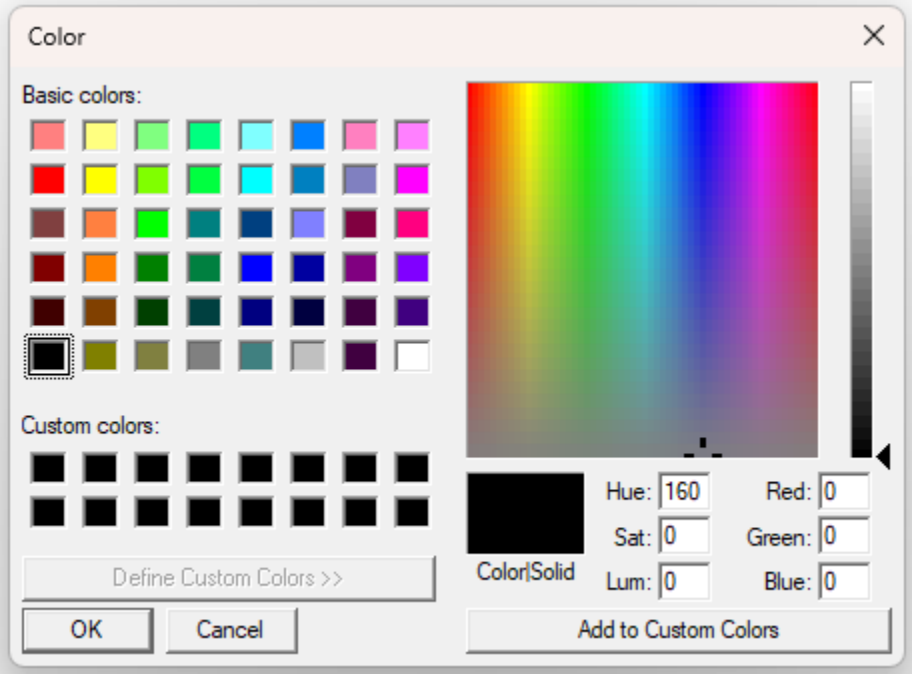


In this dialog, you can enter:

- **External Object Number** (a unique number between 1 and 999).

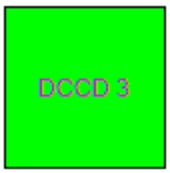
- **Object Location Position** (the center position of the square indicator on the layout).
- **ON/OFF Colors** (to customize the button's appearance).

Selecting a color will open another dialog where you can choose the desired color for the object.



Using this dialog, you can select the color of the object.

Once all required information is entered and confirmed, a square labeled **"DCCD" + object number** will appear on the layout.

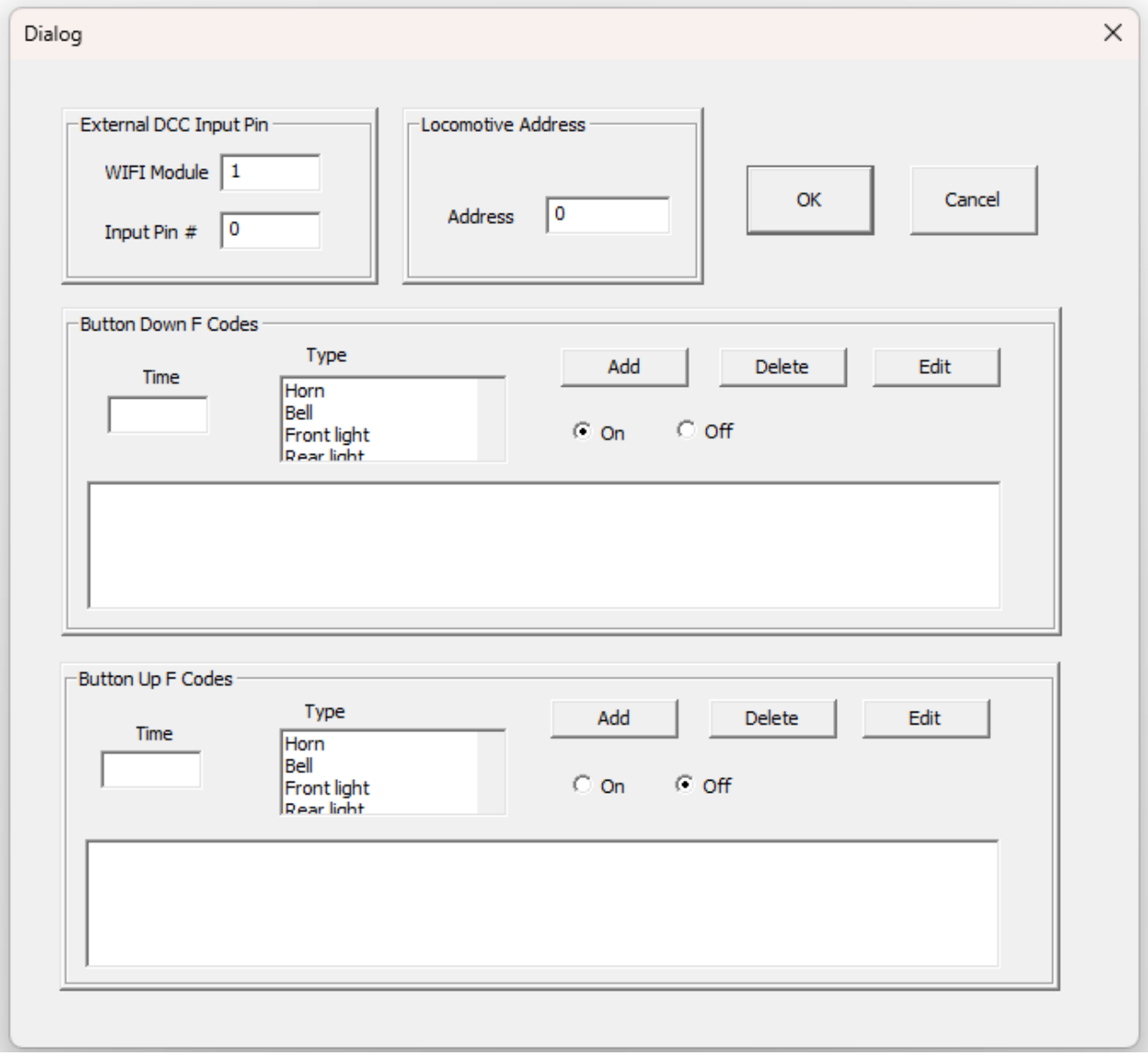


If there are any errors, a detailed message will explain what needs to be corrected.

To edit an External Input, left-click the object in the layout, and the configuration dialog will reappear.

3.11.3 Setting Up a Digital Input for your DCC Panel

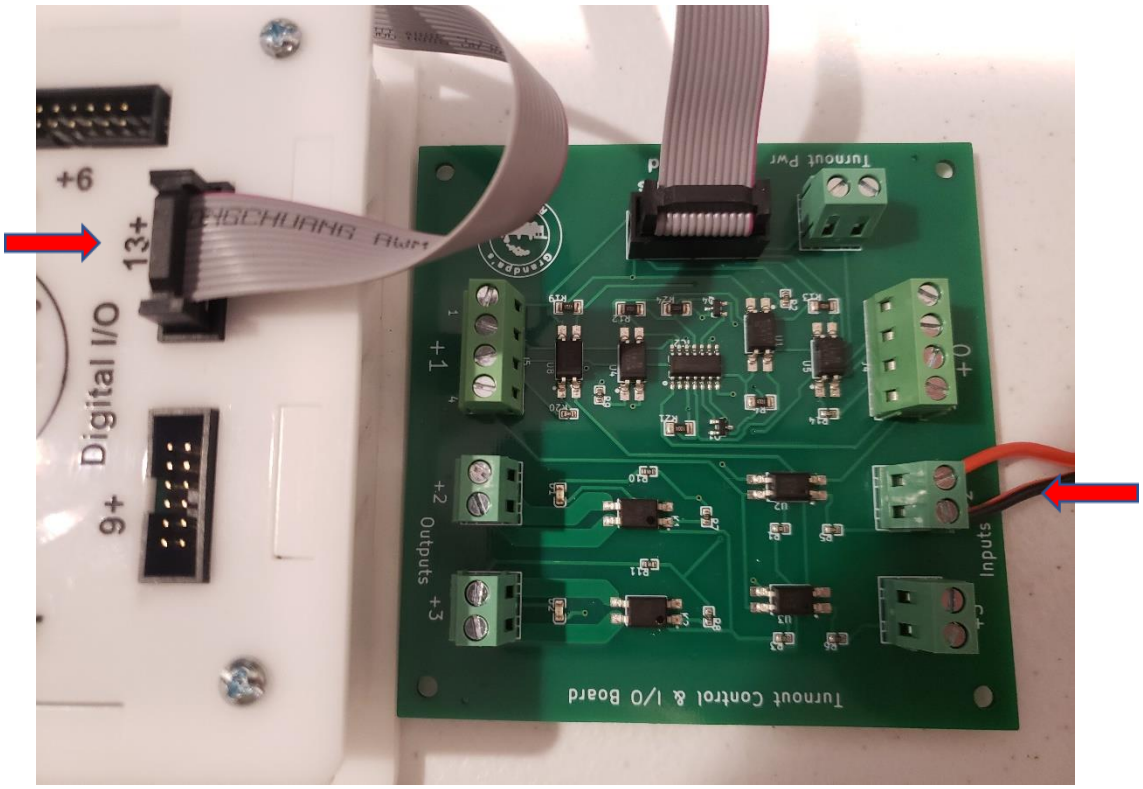
Once a digital input has been added to the layout, it must be configured to function properly within the control system. To do this, you need to enter **Control Setup Mode** and click on the **Digital Input for DCC** image within the layout using the left mouse button. This action will open a configuration dialog where you can enter the relevant settings.



The first required setting is the **Digital/Proximity WiFi Module Number**, which corresponds to the WiFi module that is physically connected to the Input/Output Card or Turnout Control & I/O Board. This number must match the one programmed into the module.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

Next, you need to determine the **Pin Number** for the connection. The pin number is calculated by adding two values: the number of the connector on the Digital/Proximity WiFi Module where the ribbon cable is attached and the connector number on the Input/Output Card or Turnout Control & I/O Board. For example, if the module's connector is numbered **13** and the board's connector is



numbered **2**, then the total pin number will be **15**. This value must be entered correctly to ensure the input device functions as expected.

The **Locomotive Address** field allows you to specify the DCC address of the locomotive that will be controlled by this external input. Before assigning an address, make sure that a locomotive panel has already been set up in the DCC Throttle application for the corresponding locomotive. This ensures that the input is properly linked to the intended train.

The dialog also includes a section for defining what actions will occur when the button is either pressed or released. Two list boxes on the left side of the dialog allow you to create a sequence of events based on input activation. To configure an action, you must enter a **time delay** (in seconds) that determines when the event should take place after the button is pressed or released. The time delay must be between **0 and 300 seconds**. After entering the time, you can select an **action type** from a predefined list of commands. These include the following functions:

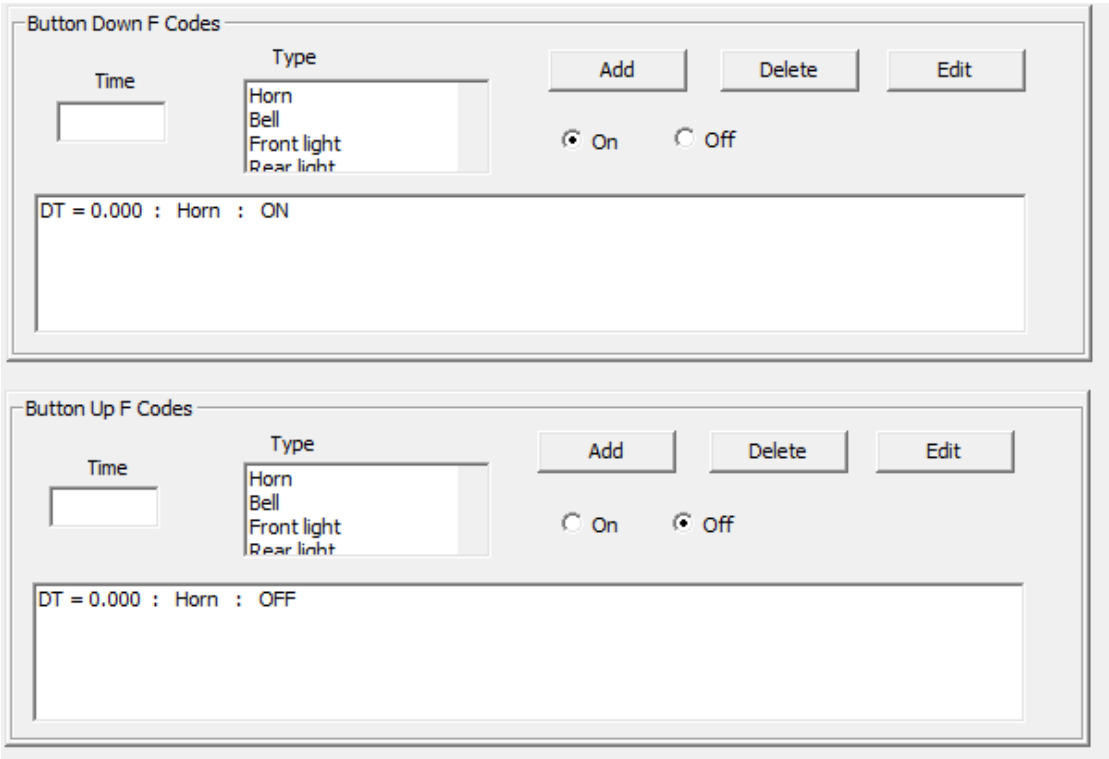
- Horn
- Bell
- Front Light
- Rear Light
- Cab Light
- Ditch Light
- Custom 1 – Custom 5 (Configurable via DCC Throttle F Codes)

The Custom values allow users to associate unique DCC F Codes with the external input. These codes can be configured in the DCC Throttle application to perform specialized functions.

Note: You must setup the F Codes for the above functions in the DCC Throttle. (see Section 3.1.2 of the DCC Throttle User's Manual)

Once an action has been defined, you must specify whether it should be triggered when the button is in the **ON** or **OFF** state. After making a selection, press the **Add** button to store the action. Each button sequence can accommodate up to **30**

different actions. If you need to modify or remove an existing action, simply click on the item in the list and press the **Edit** or **Delete** button.
For example, if you want the external button to activate the locomotive's horn while it is being pressed, you would select the **Horn** action and assign it to the **ON** state. This means that as long as the button is held down, the horn will sound, and it will stop when the button is released.



3.11.4 Digital Input for DCC Panel Operation

Once the digital input has been configured, it becomes fully functional within the system. When an external button or switch is pressed, the input is activated, causing the corresponding color on the control panel to change from the OFF color to the ON color. This visual feedback helps operators verify that the input has been successfully triggered. At the same time, the assigned DCC function—such as sounding the horn, ringing the bell, or turning on a specific light—will be executed by the locomotive.

This functionality adds a dynamic, interactive element to your model railroad, allowing visitors or operators to engage with the system in a tactile way. Whether it's for demonstrations, automation, or simply enhancing the realism of your layout, digital inputs provide a powerful way to extend the capabilities of Grandpa's Railroad Control Panel.

Make sure the DCC Throttle is operating, a DCC Panel has been defined for the decoder address, and that you have defined the F code for the function you are activating.

3.12 Adding Analog (Speed) Input for DCC Panel

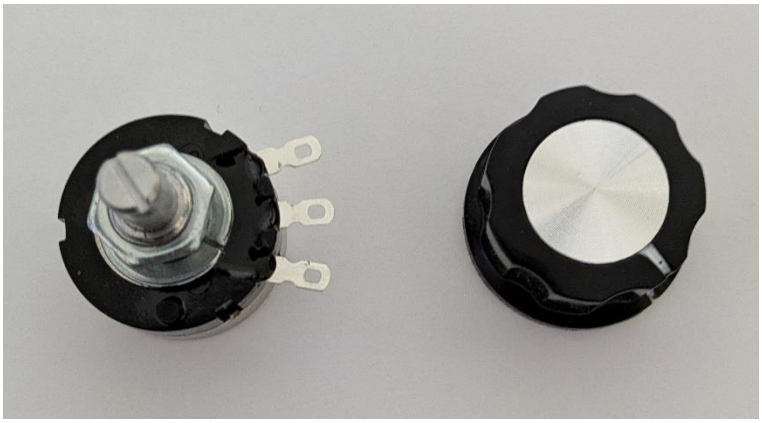
If you are using Grandpa's Railroad Control Panel in conjunction with Grandpa's Railroad DCC Throttle, you can control the speed of a locomotive externally using the **Analog (Speed) Input for the DCC Panel** object. This feature is particularly useful for installing an external throttle, allowing children to control a train safely. Since Grandpa's Railroad enables maximum throttle position control and collision avoidance, it ensures a secure experience even for younger users.

Additionally, external control of a locomotive's horn, bell, and/or lights can be managed using the **Digital Input for the DCC Panel**, making it possible to set up a complete external control panel for a locomotive.

3.12.1 Hardware Required

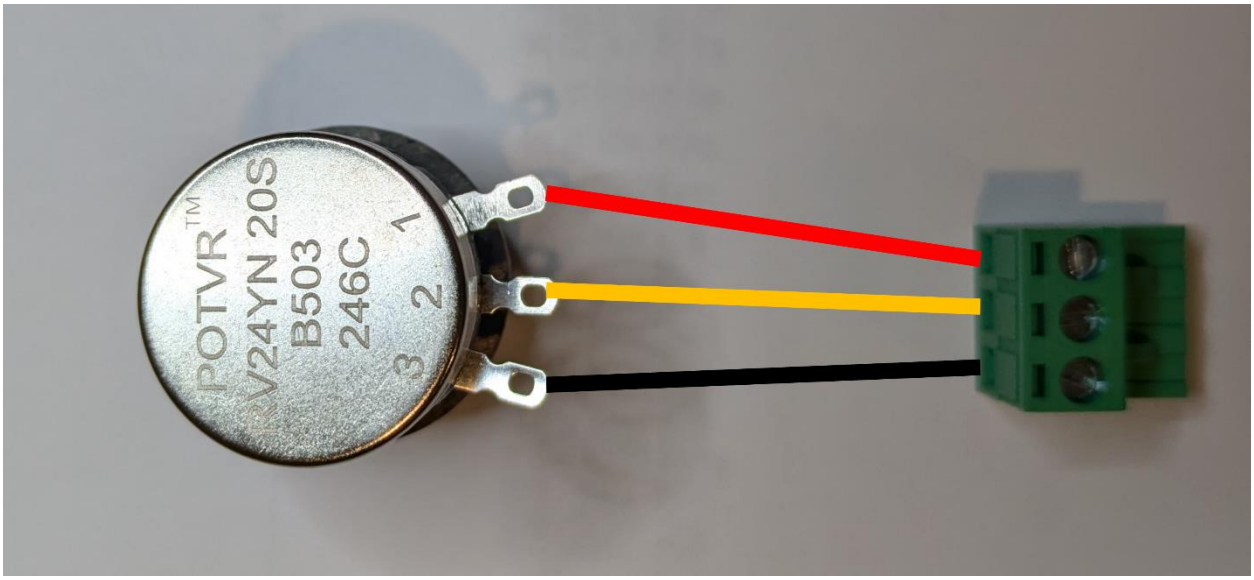
The following hardware components are needed:

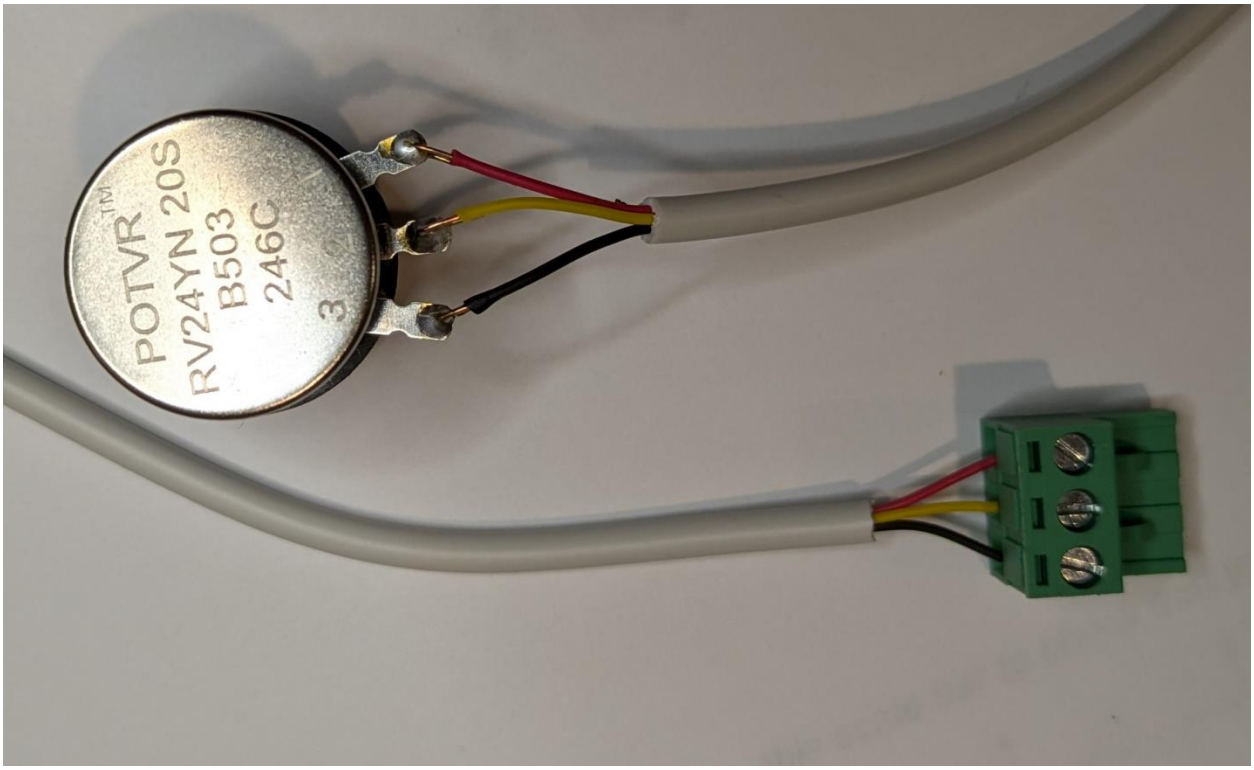
50K ohm Potentiometer:



RFID WIFI Module:

The potentiometer should be wired to the connector provided with your RFID module as shown below. We recommend using solid-wire phone cord and cutting the green wire.

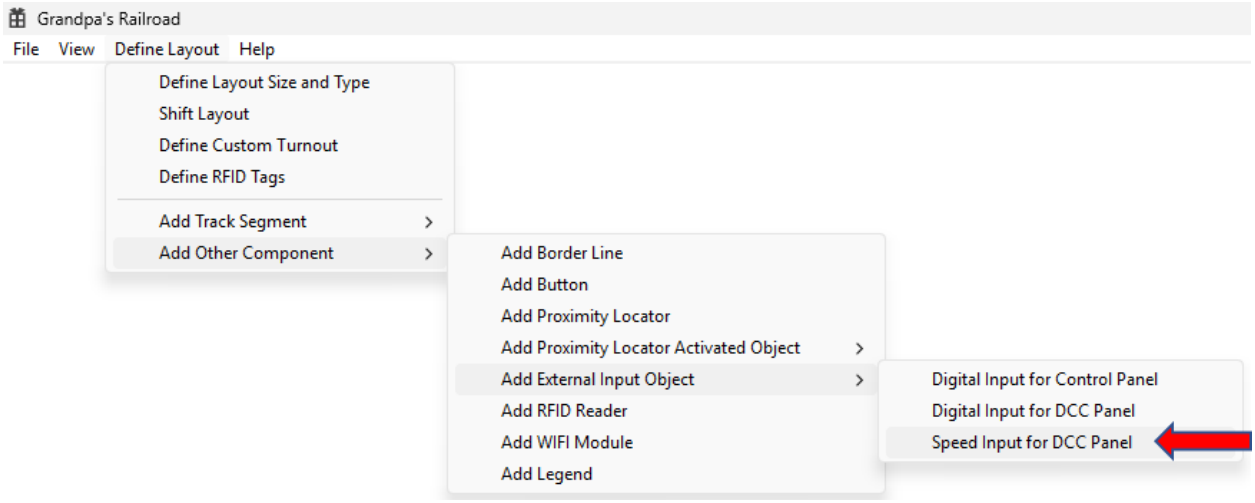




The center wire should always be connected to the center terminal of the connector and potentiometer. If you wish to change the direction of rotation that increases speed swap the red and black wire on the connector.

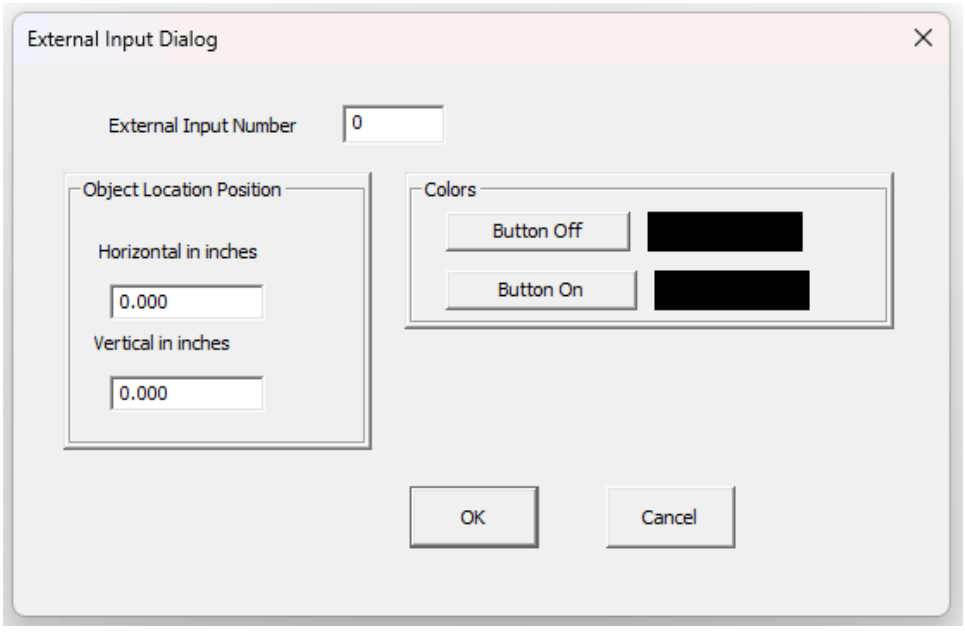
3.11.2 Adding a Analog (Speed) Input for DCC Panel to your Layout

To add a Analog (Speed) Input for DCC Panel to your layout you must be in the **Layout Setup** mode. From the main menu select



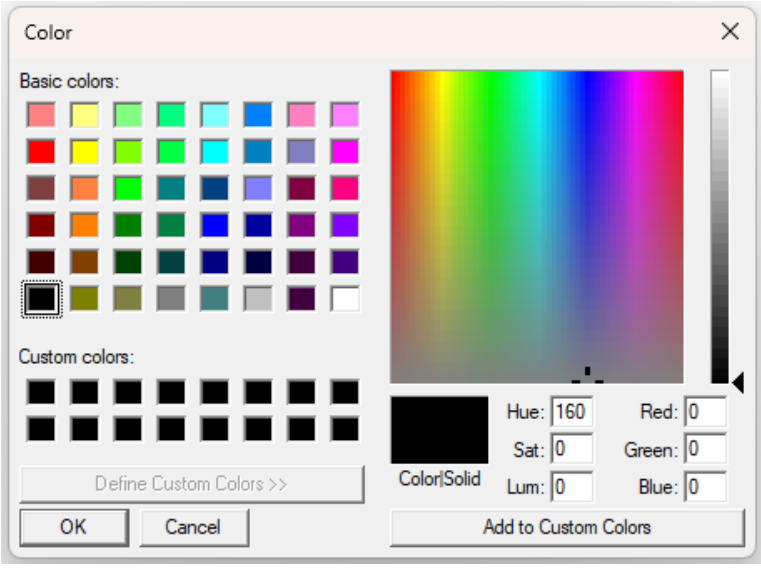
Define Layout/Add Other Component/Add External Input Object/Speed Input for DCC Panel

Upon selecting this menu item, the following dialog will appear.



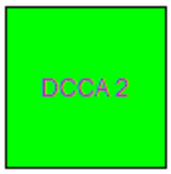
This dialog allows you to configure the **External Object Number, Position, and ON/OFF colors** of the object:

- **External Object Number:** A unique number between 1 and 999 assigned to this object.
- **Object Location Position:** The center location of the square indicator that will be placed on the layout.
- **Colors Group:** Used to customize the **ON** and **OFF** colors of the object. Clicking either button opens a color selection dialog.



Using this dialog, you can select the color of the object.

Once you select **OK** from the External Input dialog and if you have entered all required data, a square will be placed on the layout. The Label will be DCCA plus the object number.

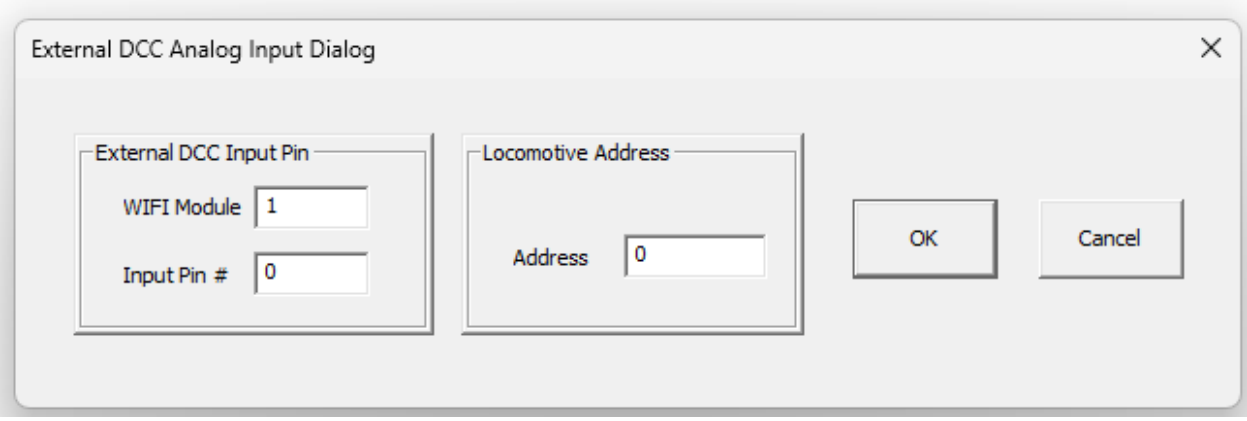


If the data has not been added correctly, a detailed error message will appear explaining what is incorrect.

If you need to edit an External Input, you can left click with your mouse on the External Input Object and this dialog will reappear.

3.12.3 Setting Up a Analog (Speed) Input for your DCC Panel

To set up a Analog (Speed) Input for your layout you must be in **Control Setup** mode. Using the *Left Mouse Button*, click the **Analog (Speed)** Input image on the layout and the following dialog will appear.



You must enter the RFID **WIFI Module** number that the *Potentiometer connector* is connected to. That number is the actual number that is programmed into the **WIFI Module**.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into each module.

The Input Pin # is the number on the RFID **WIFI Module** next to the connector that you plug the potentiometer into.

The Locomotive Address is the DCC address for the locomotive you wish to have the Analog (Speed) Input control. A locomotive panel for this address must be setup in the **DCC Throttle** application.

3.12.4 Analog (Speed) Input for DCC Panel Operation

The Analog (Speed) Input is activated by rotating the potentiometer knob. The input follows all the same rules as the thumb button on the throttle of a locomotive panel. If the potentiometer appears to not be working, check if the thumb knob is working. If not make the corrections (direction selected, locomotive power on, etc.) to make it work and then try the potentiometer again.

Make sure the DCC Throttle is operating, a DCC Panel has been defined for the decoder address, a direction has been selected and if the throttle has been setup to only operate when locomotive power is on, that power is on.

Note: The analog (Speed) Input follows all the same rules as the thumb button on the throttle of a locomotive panel.

3.13 Adding RFID Reader

RFID is an acronym the stands for "Radio Frequency Identification". It is a wireless method of identifying an object and in some cases transmitting data.

While the idea of using RFID on a model railroad may sound intimidating to some, Grandpa's Railroad has reduced the process to simply sticking a tag on a locomotive and mounting a reader under the track. The following explanation is for educational purposes.

The RFID system is be composed of two parts. A two-way radio transmitter/receiver called an *Interrogator* or *Reader*, and a transponder called a *Tag*. There are two types of tags, active and passive. Active tags have their own

power source while passive tags get their power from the reader. At Grandpa's Railroad we only use the passive tags since they are cheaper and simpler to install.

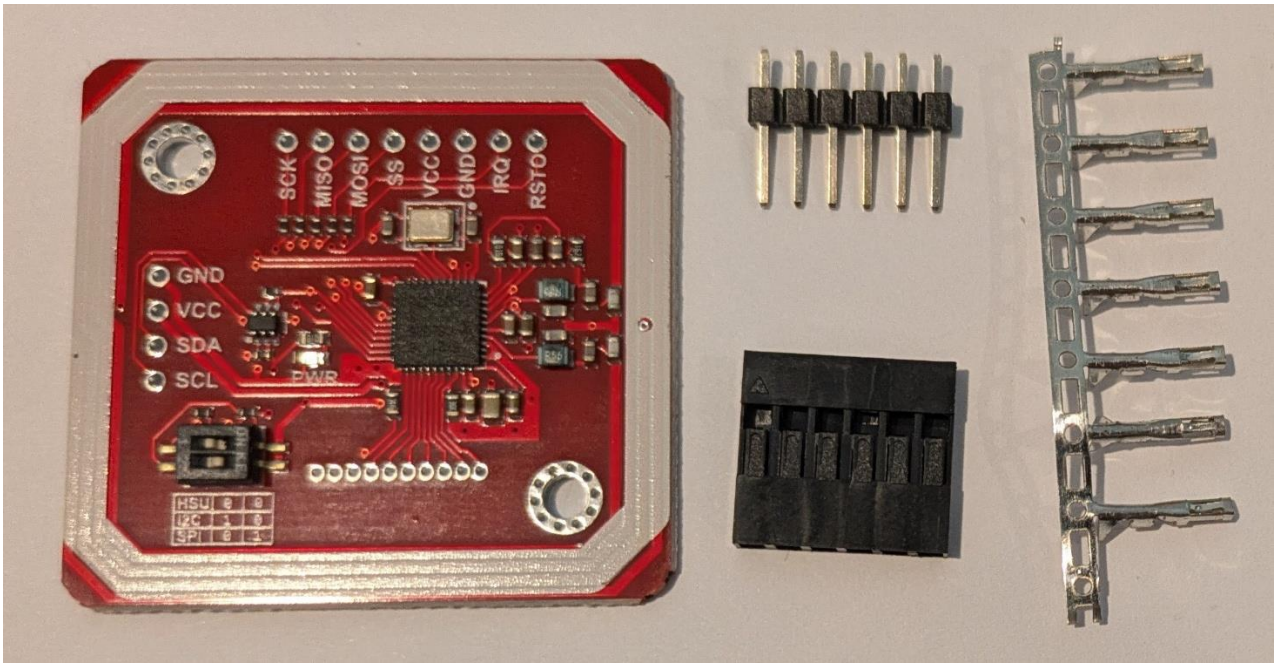
The RFID Tag consists of a micro-chip and a coil antenna. For a passive tag, a coil antenna at the Reader produces a magnetic field which when the tag coil antenna is in the vicinity produces an electrical current to power the micro-chip of the tag. The antennas are also used for data transmission and reception. This method of powering the tag is like the way wireless cell phone charging works.

When the reader interrogates a tag, it readers a unique identifier and in some cases data from the non-volatile memory of the chip. Currently we read only the identifier since we are storing no data on the tag.

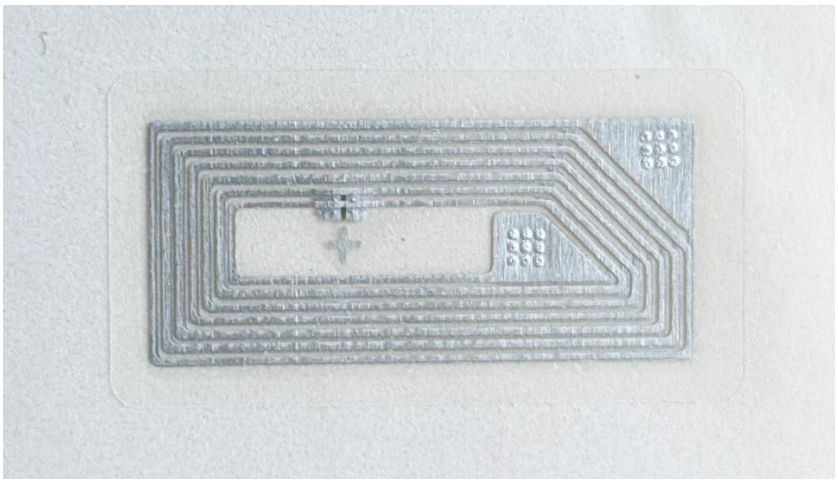
3.13.1 Hardware Required

The following hardware is used:

RFID Reader:



RFID Tag:



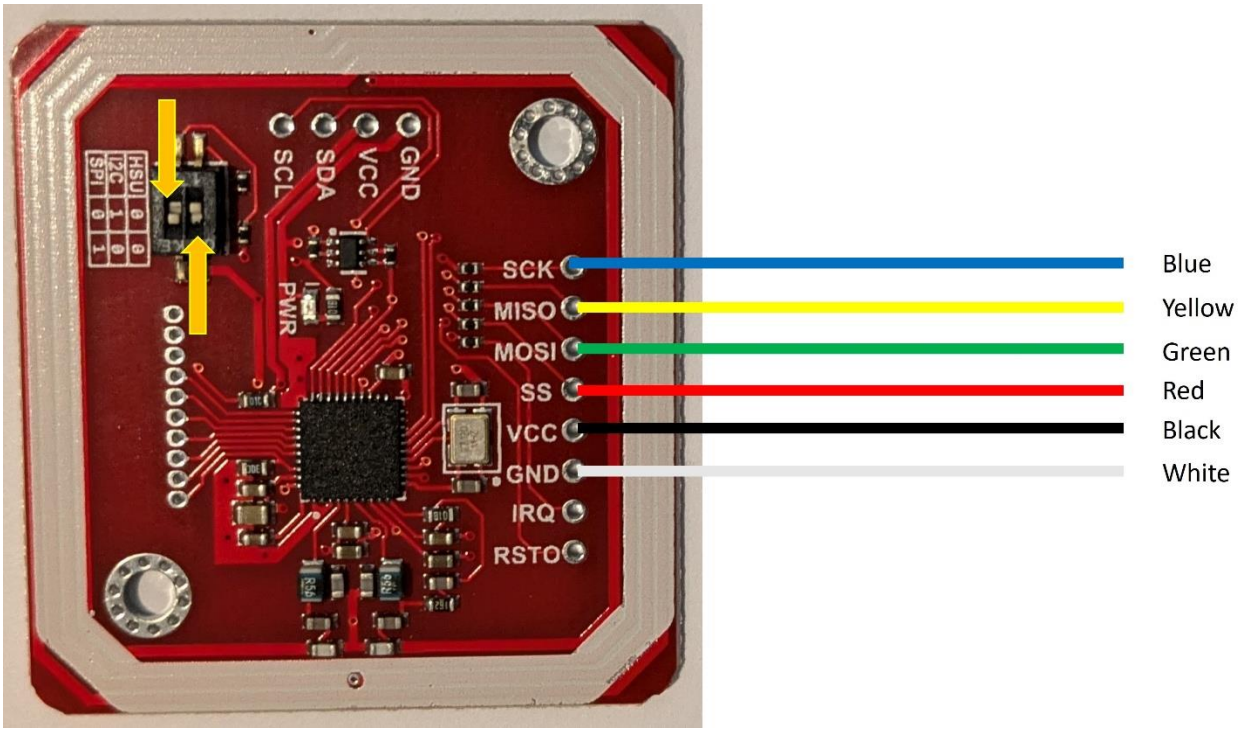
RFID WIFI Module:

3.13.1.1 Wiring the RFID Reader

The connector for the RFID reader on the RFID WIFI Module is a RJ12 type, **6-position, 6-conductor (6P6C).** Therefore, we use an RJ12 cable to wire it. The simplest way to get this cable is to buy a RJ12 cable with a connector on each end and cut off the connector with the length of wire you need. If you have a crimp tool like the one shown you can make additional connectors from any excess cable.

The maximum length of a RFID cable is 3 to 4 feet. Longer than this may cause erratic behavior.

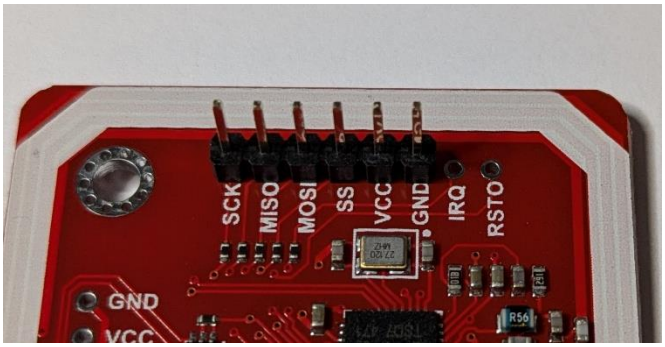
To connect the cable to the RFID Reader you can solder it directly to the card or use the 6 pin connector provided with the card. We prefer this method since we feel it provides a stronger connection which is easier to mount. Whichever method you choose the card should be wired and the switches positioned as follows:



Note: The two switches in the upper left corner of this image must be positioned as shown. *The card does not come pre-configured in this arrangement.* The switch on the left should be placed toward the center of the card, while the switch on the right should be positioned toward the outer edge.

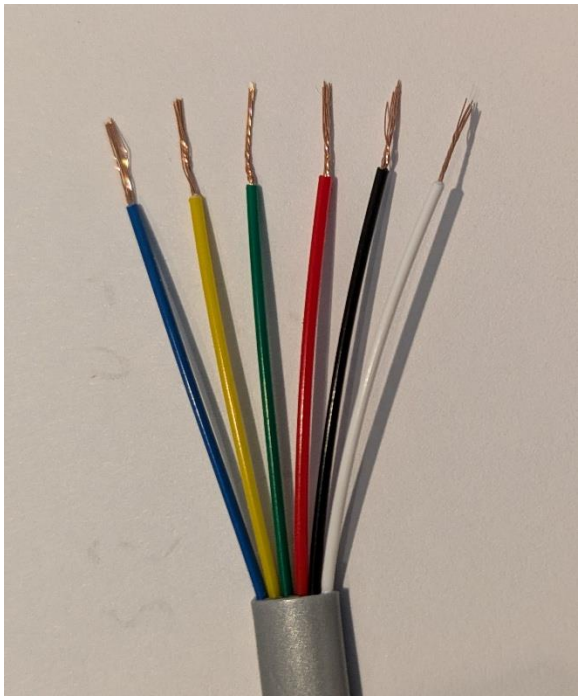
If you choose to use the connector do the following:

Step 1: Solder the six-pin header to the topside of the RFID reader from the SCK to GND positions. We put the header on the top side so that when mounted, the



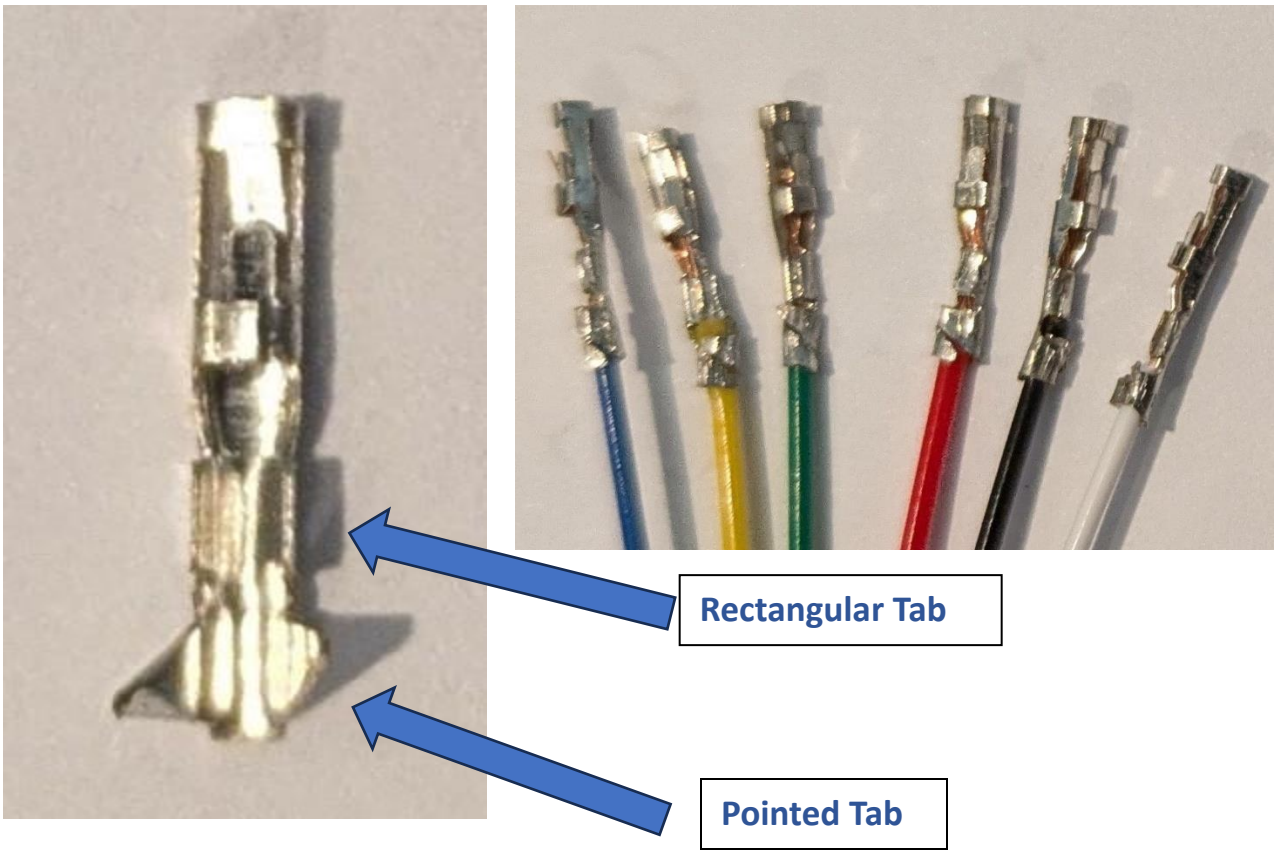
RFID reader will be upside down. Therefore, ballast will not be placed directly on the card components.

Step 2: Cut the desired length of RJ12 cable. Strip about 1 ½ inches of the cable shield. Strip about 3/8 inch of insulator from each colored wire and twist the copper strands to form a single wire.



Step 3: Using fine point pliers crimp a female pin connector to each wire.

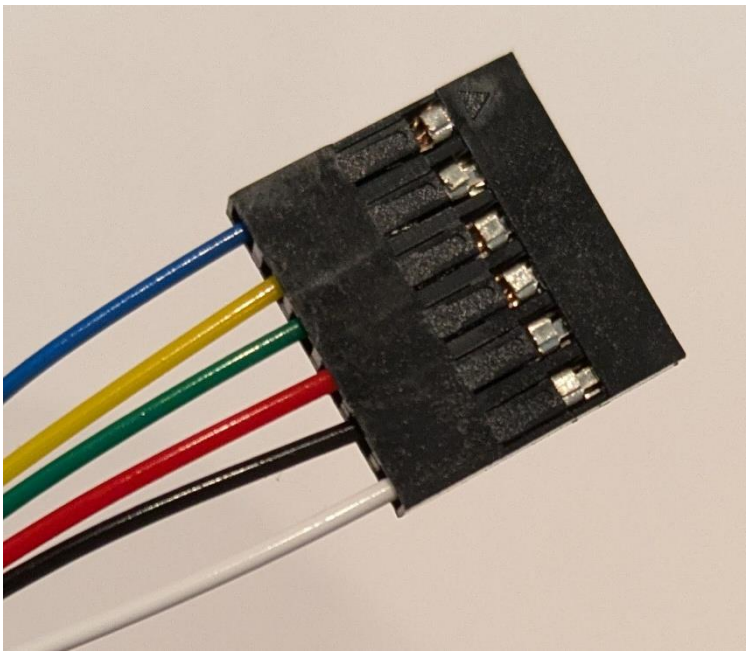
- The pointed tabs should be used over the insulated part of the wire.
- The rectangular tabs should be used over the bare wire.
- Crimp each wire hard so that the wire will not slide out.
- Make sure you have kept each crimp as small as possible
- Give each wire a small tug to make sure it is secure.
- Keep the pins as straight as possible since you will need to slide them inside of the plastic housing.



Step 4: Slide the female pin connectors inside the plastic housing. The small bump at the top of the pin should face the hole in the housing and will snap into it when properly seated.

Warning: Make sure you slide the wires into the connector in proper order. They should be in the order of the cable with no wires crossing.

The finished connector should look like this.



Step 4: Slide the connector on the six pin header on the RFID Reader making sure the blue wire is on the SCK pin and white on the GND pin.

3.13.1.2 Mounting the RFID Reader

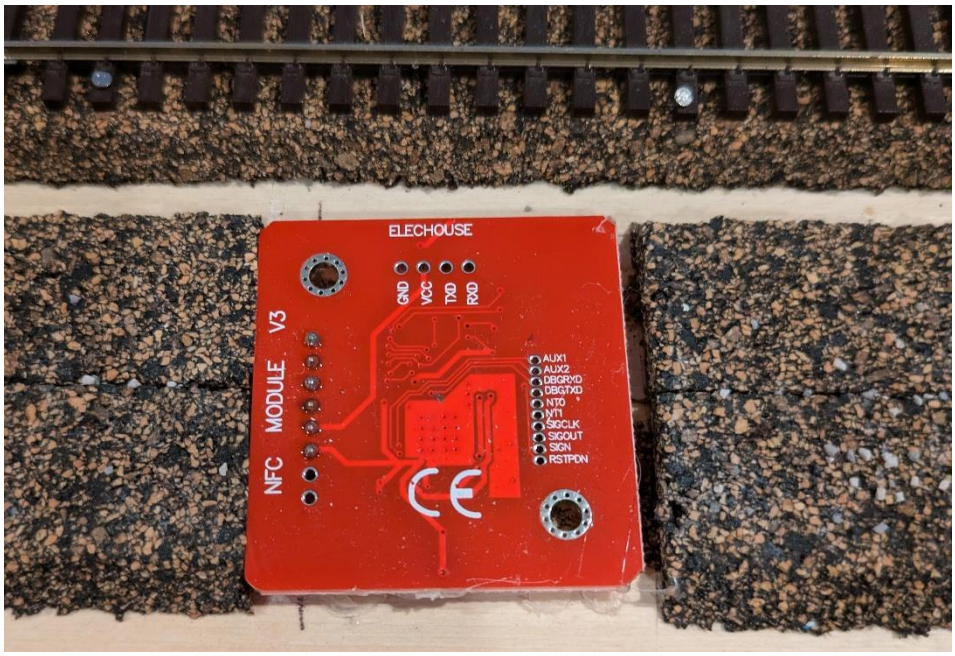
The RFID Reader must be centered under the track as close as possible to the track. On Grandpa's Railroad we use cork roadbed on ½ inch plywood as the base for the track. For this setup it is easy to mount the RFID reader card.

Important: Since this item is not easy to replace it should be tested often during installation. This can be done similar to the method shown under a 3.13.5 Practical Example.

Step 1: Cut out a section of cork roadbed the size of the reader.

Step 2: Cut a slot in the plywood at the location of the connector. If you have soldered the cable to the reader, you can drill a hole that the RJ12 connector can pass through. (Note the orientation of the reader is not important.)

Step 3: Pass the connector through the slot and slide it onto the pin header making sure that the white wire is connected to GND. It is best at this point to test the reader to make sure it is wired properly and working.



Step 4: If the reader is working, glue it in place using a hot glue gun.

Step 5: Place the track over the reader and test it again.

Important: Since this item is not easy to replace it should be tested often during installation. This can be done similar to the method shown under a 3.13.5 Practical Example.

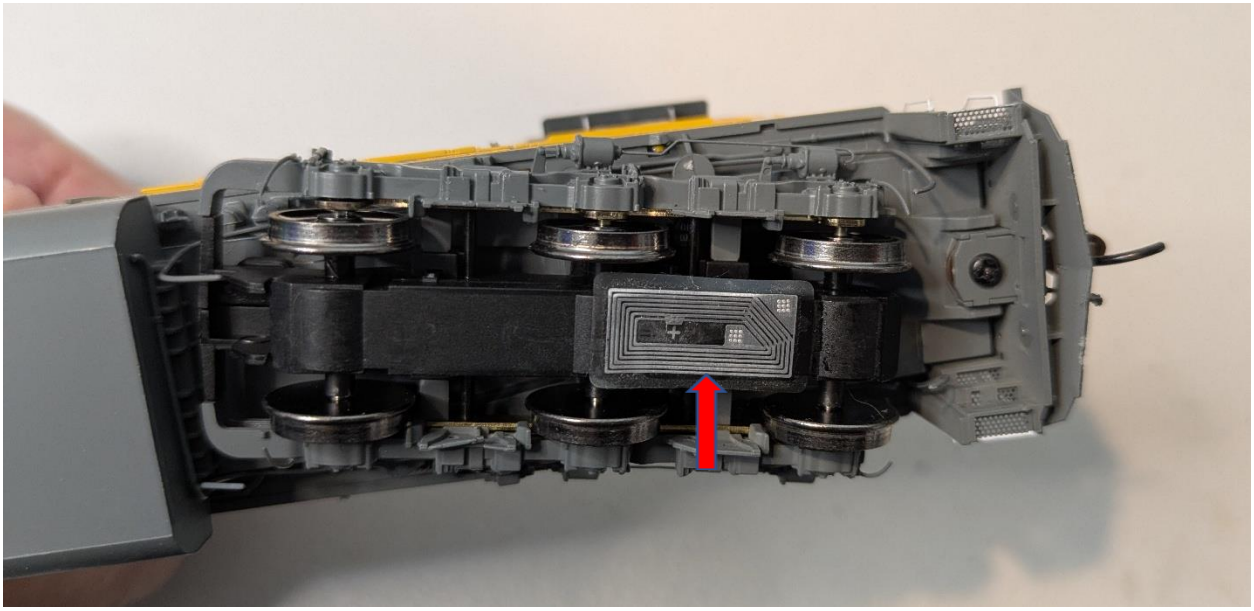
Step 6: You can ballast over the card and track as you normally as long as there is no metal in the ballast. (Make sure the ballast is totally dry before powering up the reader.)

3.13.1.3 Placing the RFID Tag on the Locomotive

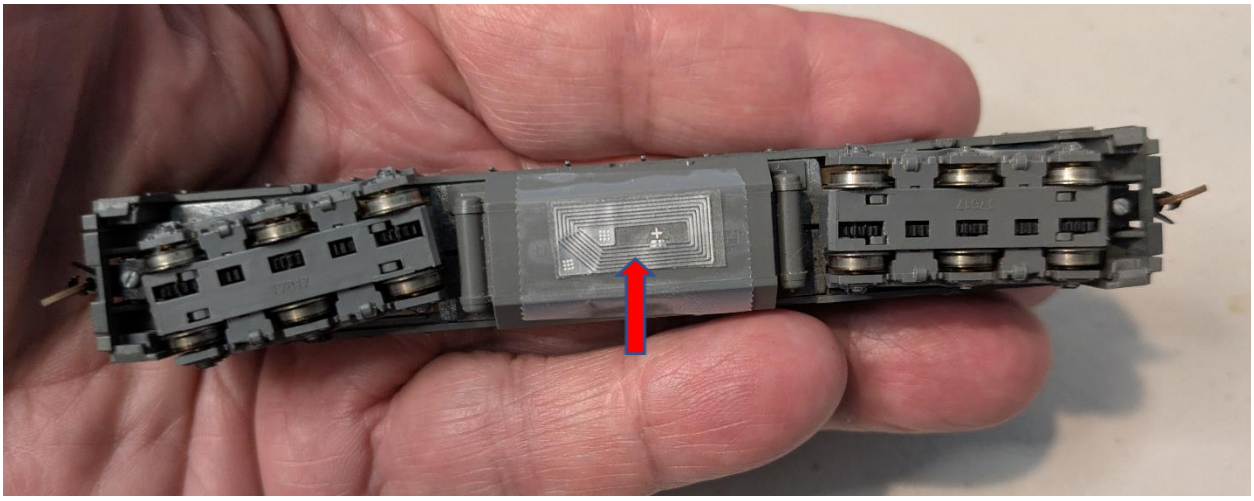
The tags supplied with your RFID reader are self-stick. They should be applied:

- So, they travel between the tracks.
- So, they travel as close to the reader as possible.
- *Do not* apply to a metal surface.
- *Do not* place near the motor since the motor generates electrical waves that can interfere with the Tag.

We have found that on most HO scale locomotives the best place for the tag is under the front trucks.



N scale locomotives do not have enough space for placement in this location. On most of our locomotives, trimming the tag and mounting it on the fuel tank has been successful,

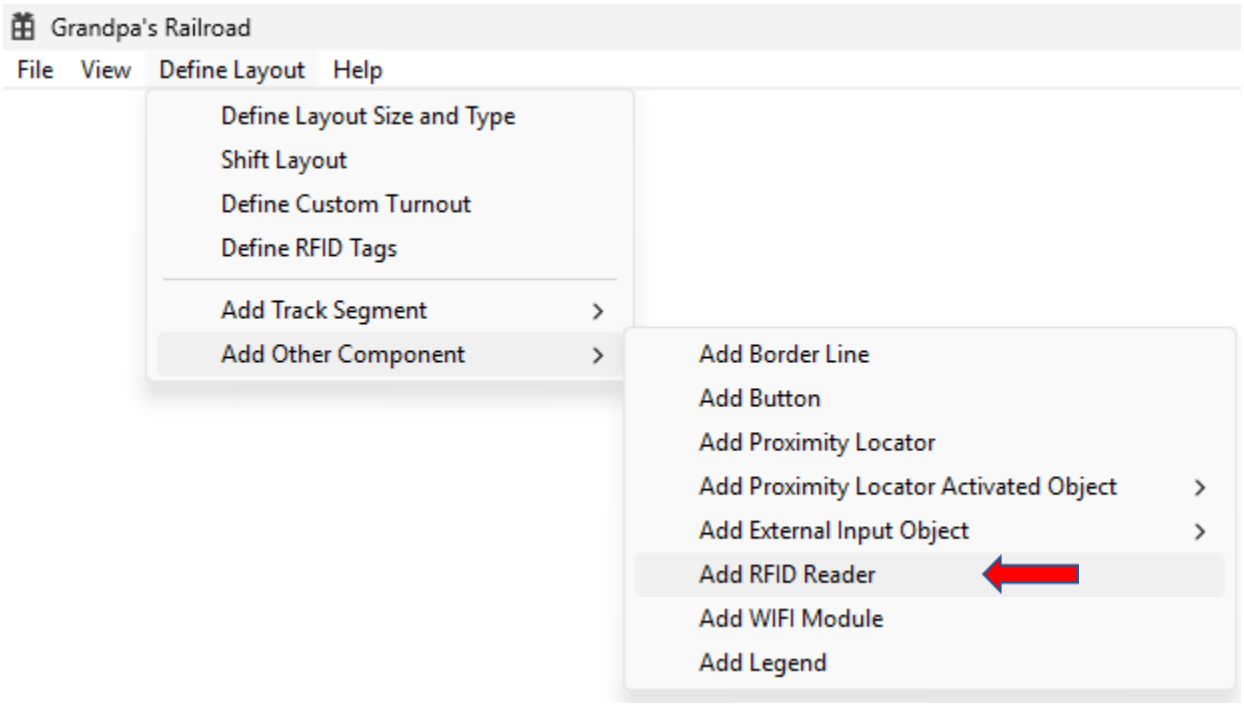


even though it is near the motor. Placement is a trial-and-error process—position the tag and test it by running the locomotive over an RFID reader to check functionality.

If no suitable location is found on your locomotive, you can always mount the tag on the first car following the locomotive.

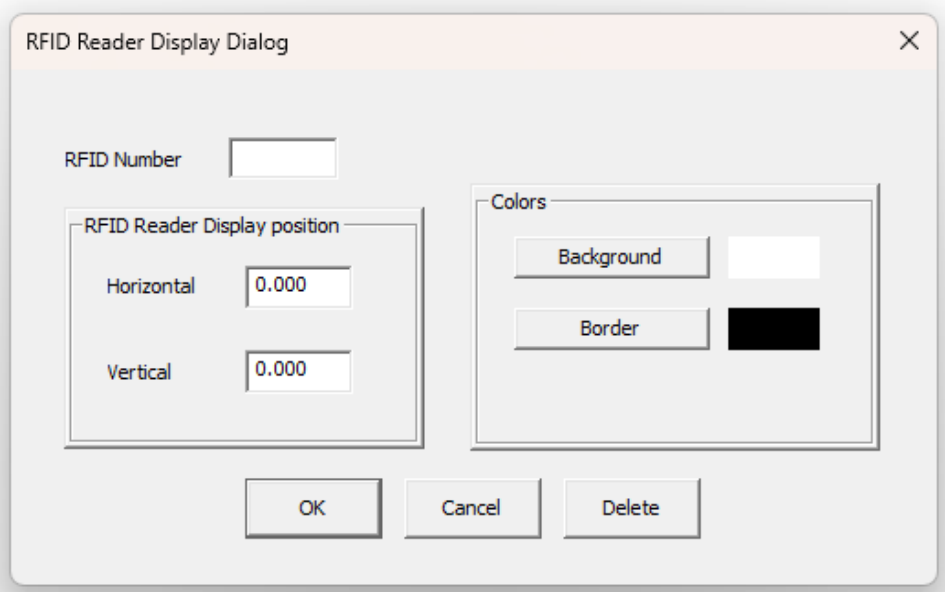
3.13.2 Adding a Reader to your Layout

To add a RFID Reader to your layout you must be in the **Layout Setup** mode. From the main menu select



Define Layout/Add Other Component/Add RFID Detector

Upon selecting this menu item, the following dialog will appear.

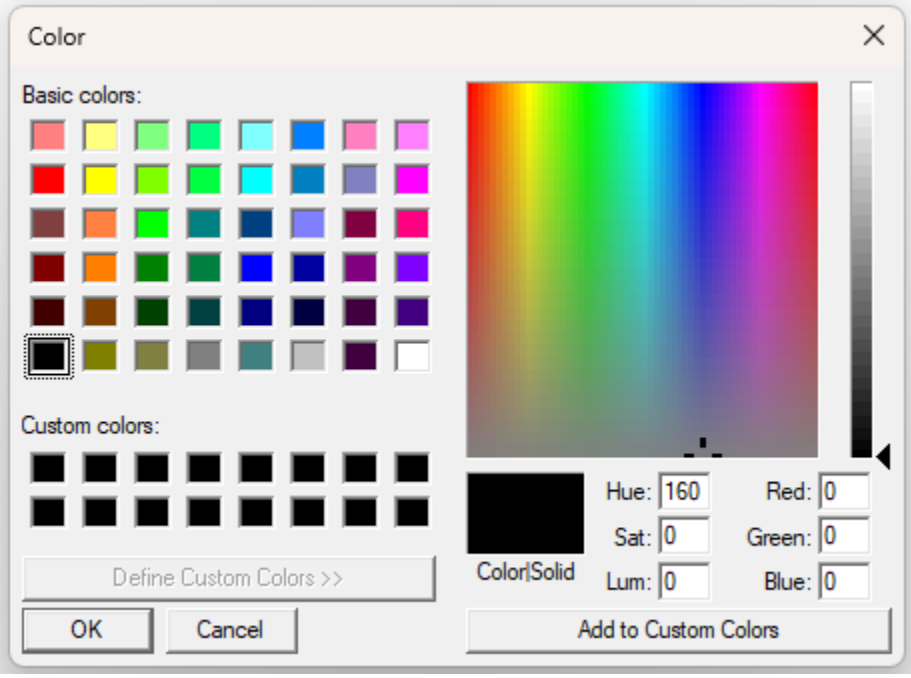


This dialog allows you to enter the RFID number, display position, and background and border colors of the object display.

RFID Number is a number between 1 and 999 that you assign to this object. This number must be unique for the object.

Reader Display Location Position is the location of the center of the rectangle RFID display that will be placed on layout. We find it convenient to locate the display near the actual reader so that we can associate the data with the reader.

The **Colors** group is used to customize the background and border color for the RFID diaplay. Pushing either button will cause the following dialog to appear.



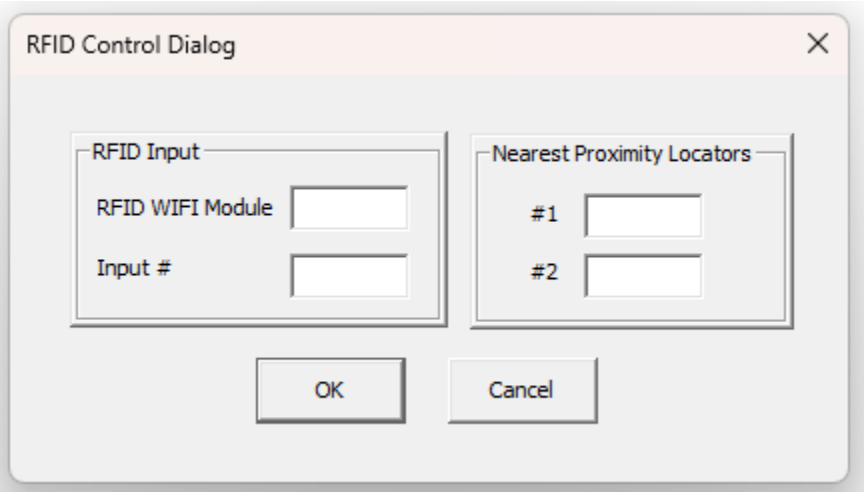
Using this dialog, you can select the color of the object.

Once you select **OK** from the RFID Reader Display dialog and if you have entered all required data, a rectangle will be placed on the layout. If the data has not been added correctly, a detailed error message will appear explaining what is incorrect.

If you need to edit an RFID Reader Input, you can left click with your mouse on the RFID Reader Display and this dialog will reappear.

3.13.3 Setting Up a RFID Reader for your Control Panel

To set up a RFID Reader for your layout you must be in **Control Setup** mode. Using the *Left Mouse Button*, click the **RFID Reader Display** image on the layout and the following dialog will appear.



You must enter the **RFID WIFI Module** number and the input connector number that the RFID reader is connected to.

The *Nearest Proximity Locators* group allows you to enter the number of the nearest proximity locator on each side of the RFID Reader. This data is not required and may be left blank. If it is left blank, then the reader will only show the locomotive identification in the display box. While this doesn't serve much purpose it will indicate the reader is working. If you do enter these locators and have done similarly with the proximity locators, the reader will be linked to a connectivity network. This network will allow the train to be tracked as it passes over other locators. Also, DCC Event or Sequence Objects can be defined and tied to this network.

3.13.4 RFID Reader Control Panel Operation

During operation the RFID Reader display will display the Tag identifier or the locomotive identifier for all locomotives that have an RFID Tag installed*. If you have just installed a tag on a locomotive, you will not know it's tag value. Therefore, run the locomotive across an RDFI detector so that you can read the tag. You can now assign a locomotive to that tag value. (See Section 2.4)*

If you have defined a proximity locator that is a nearest neighbor, a connectivity network will be started for that locomotive, so that its train color can be displayed on the proximity locators and DCC Event or Sequence objects activated.

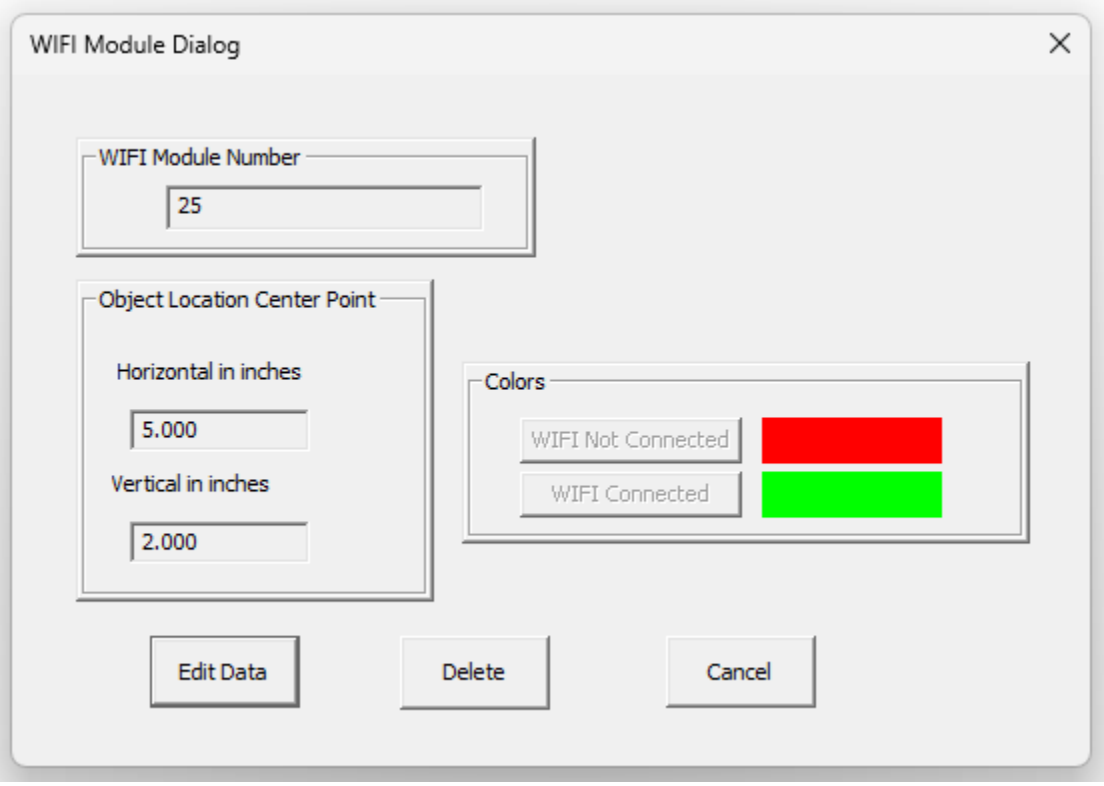
3.13.5 Practical Example

As you build and install you RFID reader it is best to test it at various steps to verify operability since replacement is difficult. The flowing steps can be used to test it.

Step 1: Wire the reader as specified in Section 3.13.1.1 Wiring the RFID Reader.

Step 2: Start the Grandpa's Railroad Application, select the **Layout Setup** mode, and create a 10-inch by 6-inch layout in any scale. (Note: A layout does not need to contain track. In this example we are only adding a button.)

Step 3: Add a WIFI module to the layout at 5 inches Horizontal and 2 inches Vertical with the desired Connected and Not Connected colors

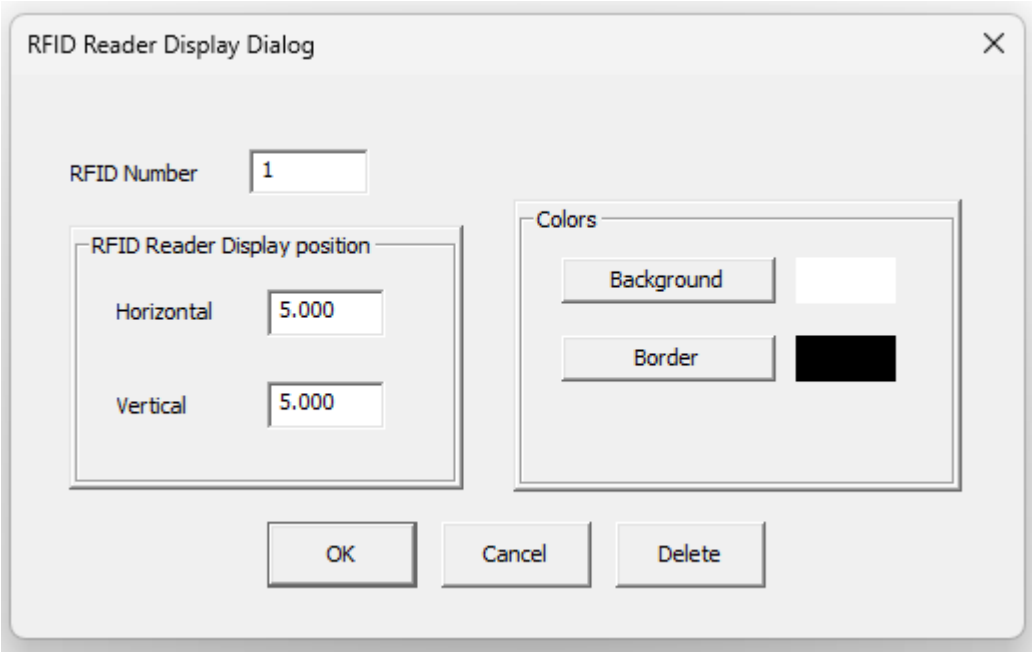


The WIFI module we are using is number 25. This number corresponds to the actual number programmed into our WIFI Module. You should use the number

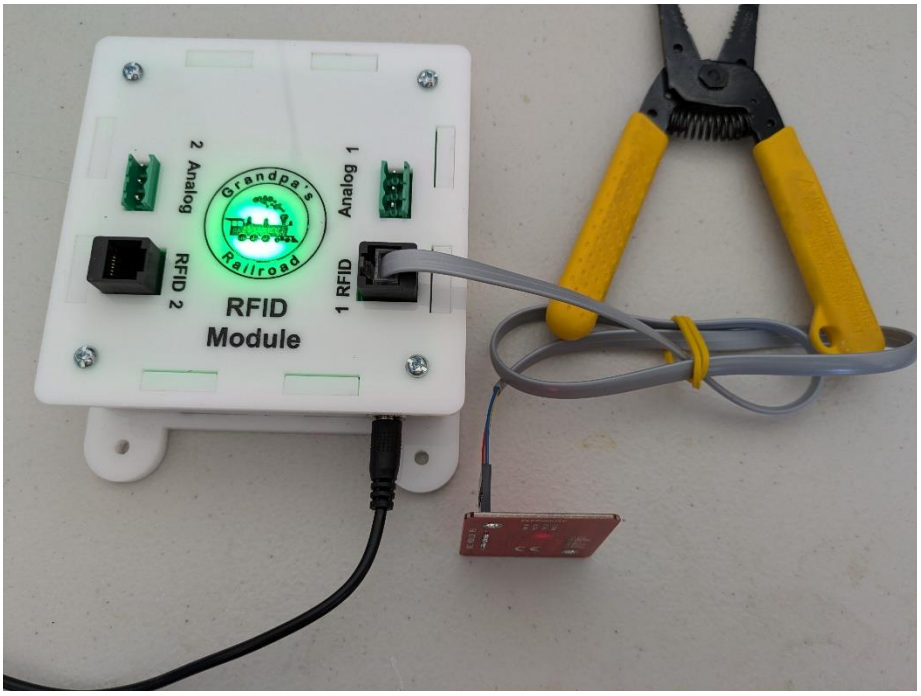
you programmed into your WIFI module with the WIFI Module Programmer software.

Note: You must use the WIFI Module Programmer software to program that number and your router name and password into the module.

Step 4: Add an **RFID Detector** to the layout at 5 inches Horizontal and 5 inches Vertical.

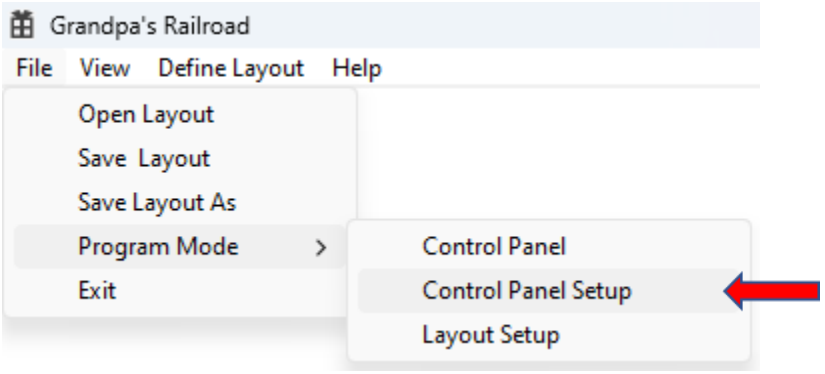


Step 5: Connect the hardware as pictured below:



We have connected power to the WIFI Module and the RFID detector to the RFID #1 on the WIFI Module.

Step 6: From the File Menu item select:

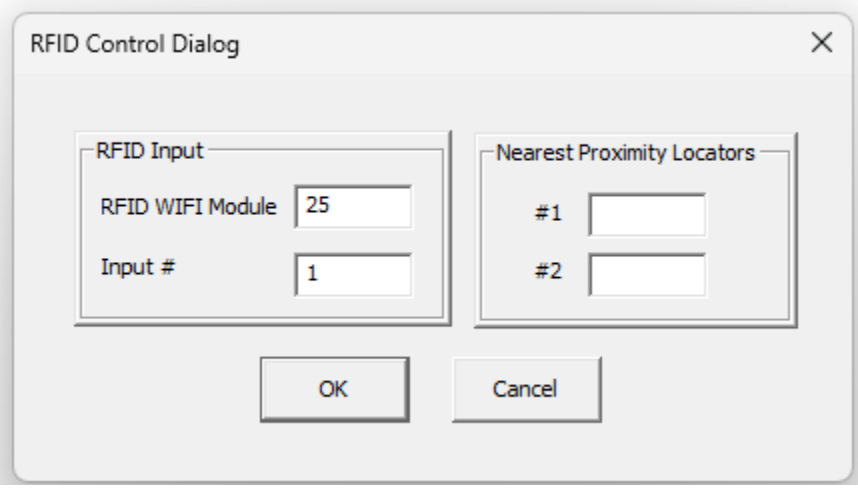


File/Program Mode/Control Panel Setup

This will change to the Control Panel Setup mode.

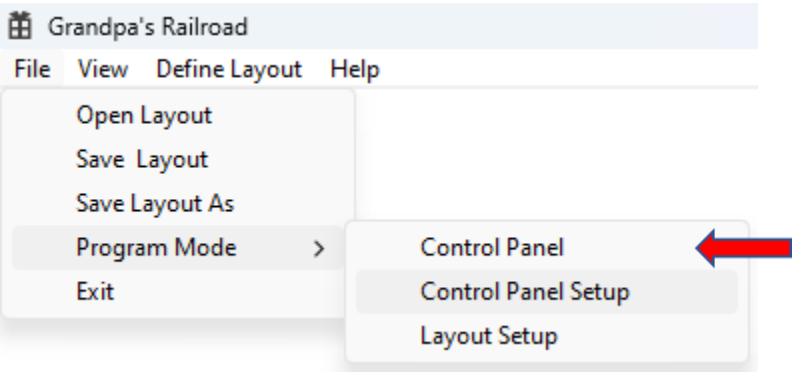
Step 7: Place the mouse cursor over the RFID reader and press the left mouse button.

The following dialog will appear.



Based on the connections we made in step 5, the RFID module # is 25 and the Input # is 1.

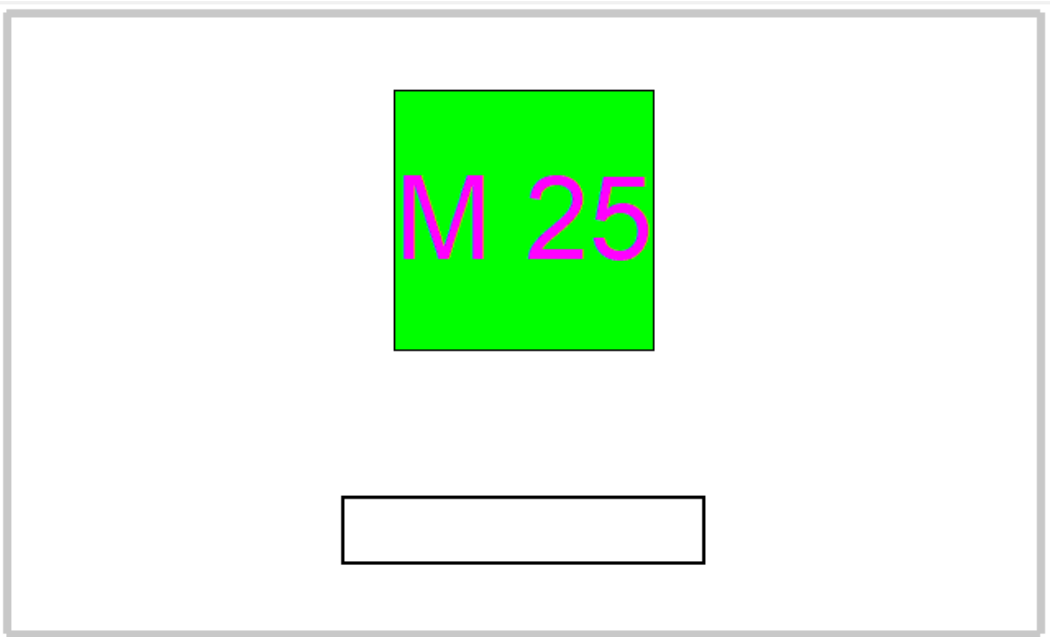
Step 8: From the File Menu item select:



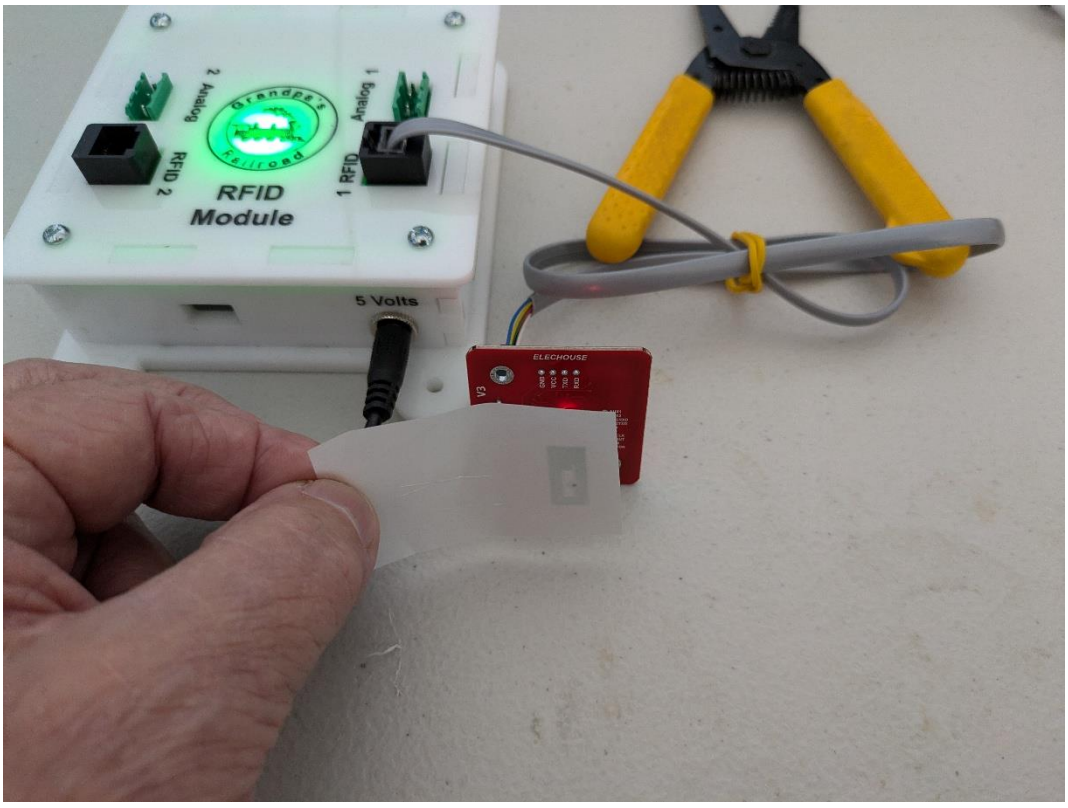
File/Program Mode/Control Panel

This will change to the Control Panel mode.

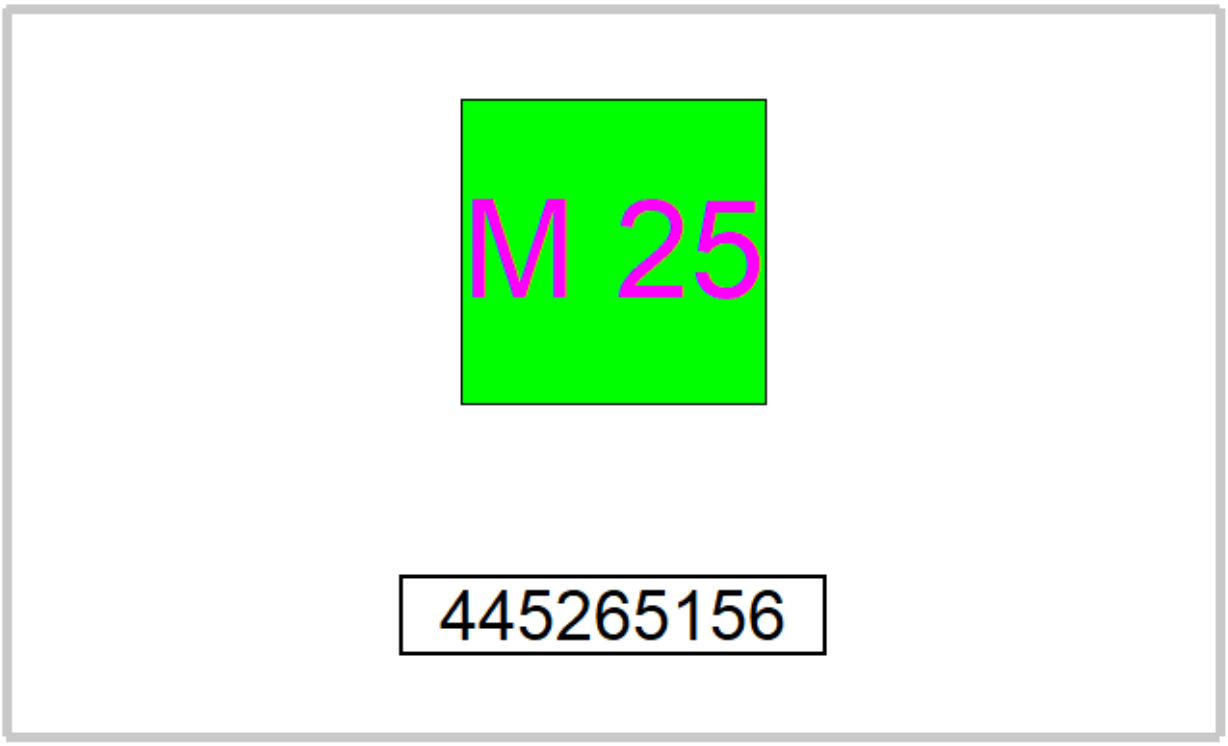
Step 9: If you have used our setup parameters and colors, after the WIFI Module connects, the screen should resemble the following.



Now hold an RFID tag in front of the RFID reader. (This is the bottom side of the card.)



The screen should now display the RFID tag number.



If you have previously associated the tag you are using with a locomotive as defined in *section 2.4 Defining RFID Tags*, then the train label and the colors associated with it will appear.

3.14 Adding WIFI Module

The WIFI Module is the basic controller for Grandpa's Railroad Control Panel. All other cards are connected to this controller. Up to 32 controllers can be used on one layout.

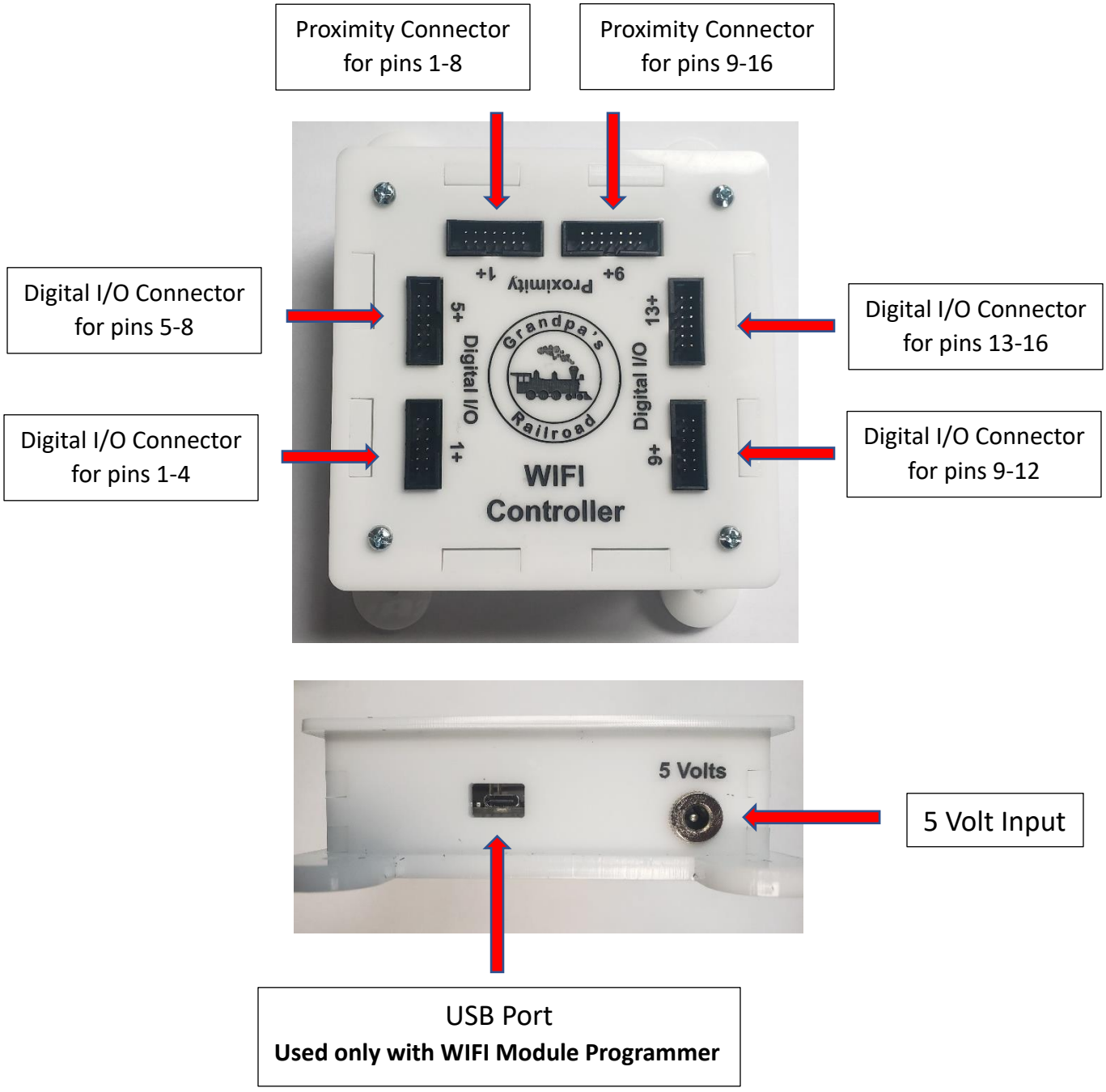
There are two types of modules Digital/Proximity module and RFID/Analog module. The first Digital/Proximity WIFI module can process up to 16 digital I/O elements and 16 proximity locators. Since a turnout only requires one digital I/O connection, this means that up to 512 turnouts and 512 proximity locators could

be used on one control panel if only this type of module were used. The second RFID/Analog module can process two RFID readers and two analog inputs. The controllers pass information to the main centralized computer via WIFI for processing. Each WIFI controller that is added must have a unique number from 1 to 32. Controllers must first be programmed to set the number, WIFI name, and WIFI password for your system. This is easily accomplished by using the WIFI Module Programmer App preloaded on the Windows PC. (See the WIFI Module Programmer User's Manual.)

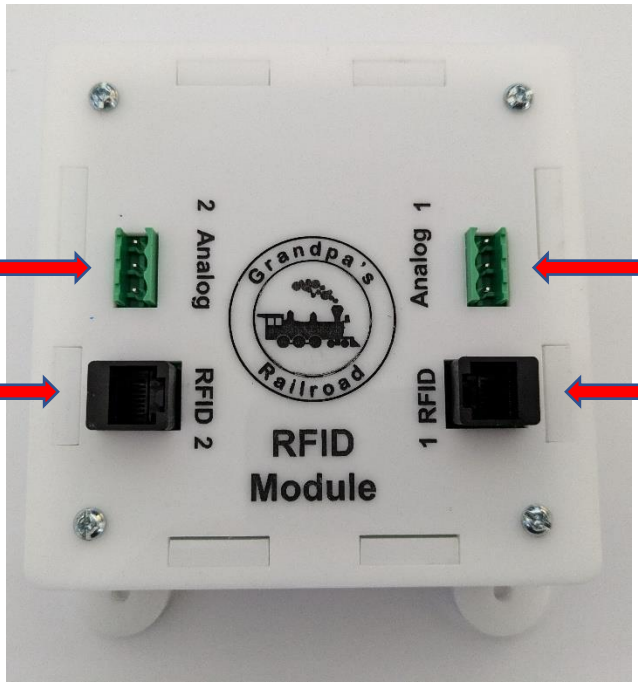
3.14.1 Hardware Required

The following hardware is used:

Digital/Proximity WIFI Module



RFID WIFI Module

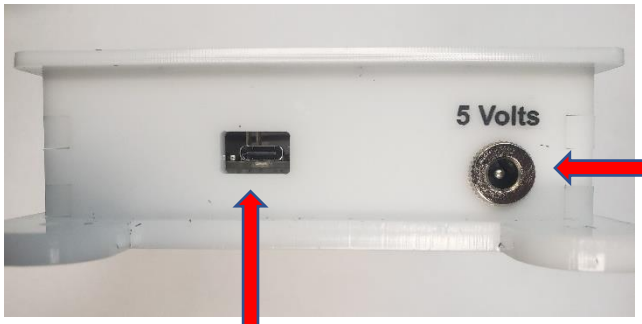


Analog Input 2

Analog Input 1

RFID Reader 2

RFID Reader 1

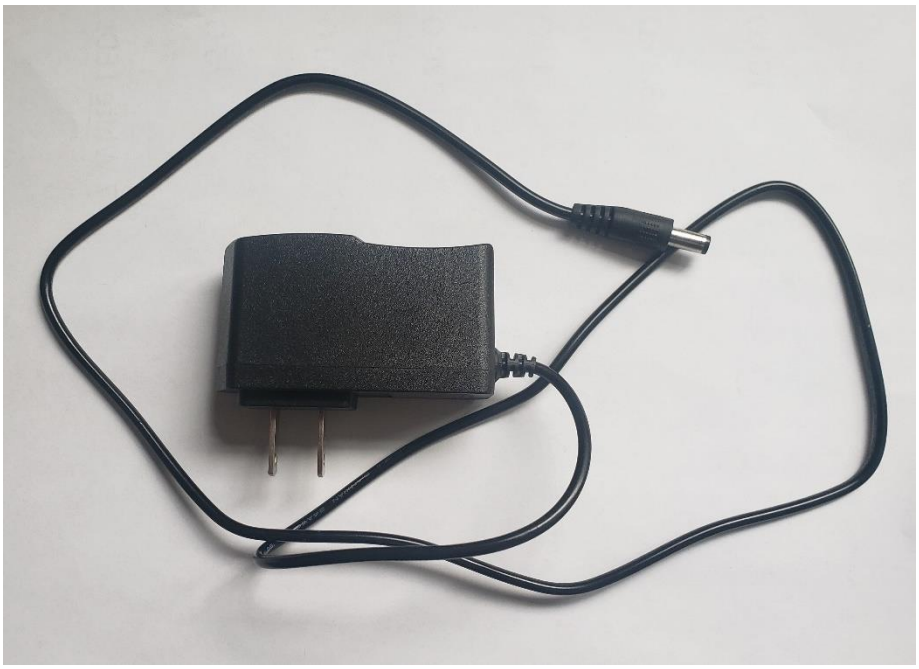


5 Volt Input

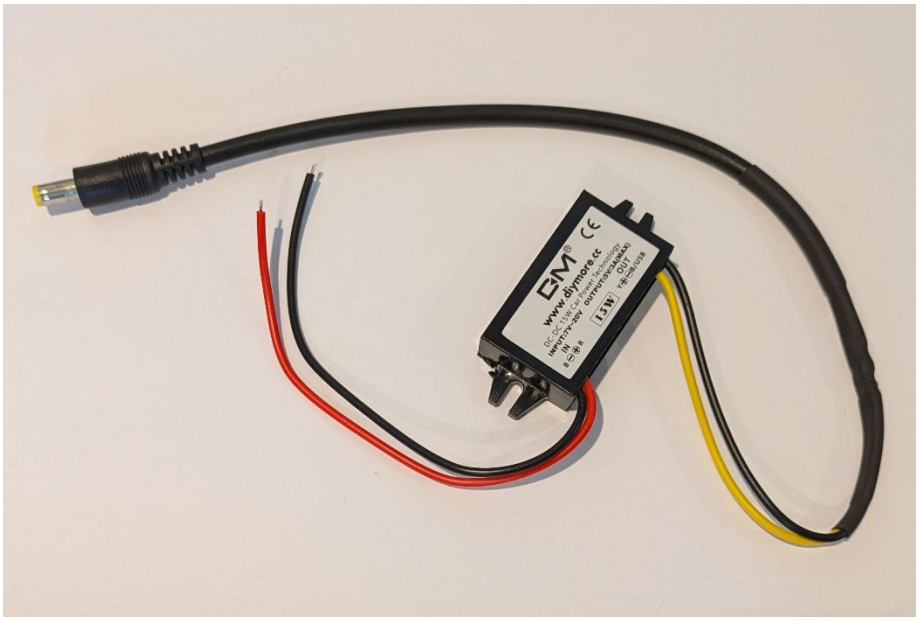
USB Port

Used only with WIFI Module Programmer

<u>5 Volt Power Supply or Buck Converter</u> A 5-volt power supply or



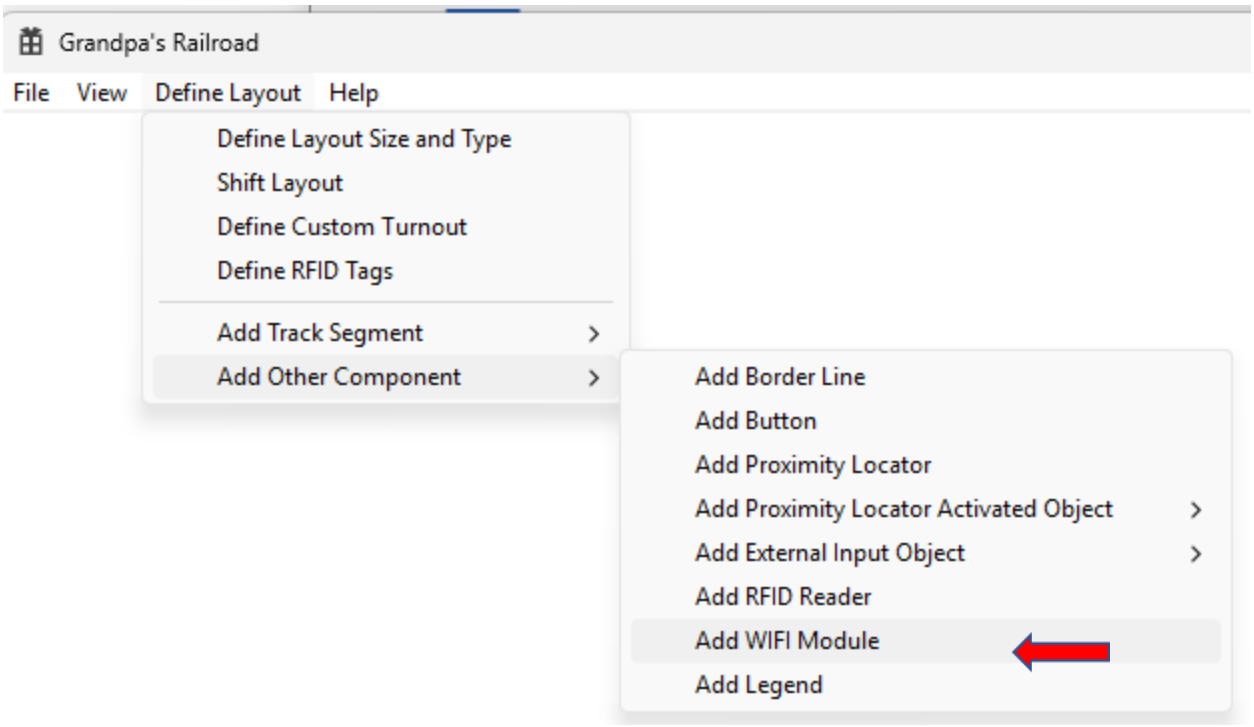
buck converter



is needed for the WIFI module. Both are capable of powering 2 WIFI Modules. The buck converter would also need a 7-to-20-volt DC power supply. We have presented this latter option since on our layouts we only use one 12-volt power supply to power everything, DCC command station, WIFI modules, lighting, sound, etc. *<u>This simplifies power distribution and eliminates multiple power supplies reducing costs.</u>*

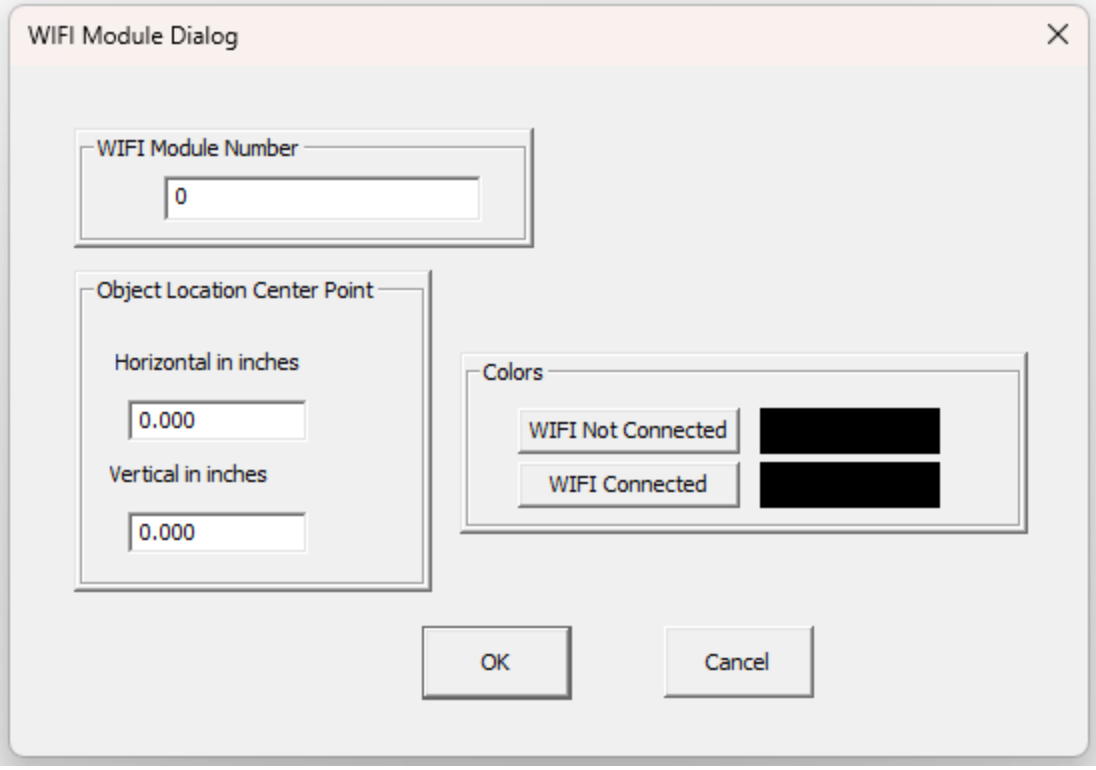
3.14.2 Adding a WIFI Module to your Layout

A WIFI Module is the remote data collector and controller of the Grandpa's Railroad system. You must add each module you use to identify it for identifying connections in the **Control Panel Setup** mode. To add a WIFI Module of either type to your layout, you must be in the **Layout Setup** mode. From the main menu select



Define Layout/Add Other Component/Add WIFI Module

Upon selecting this menu item, the following dialog will appear.



WIFI Module Number is the number from 1 to 32 that has been programmed into the module. There must be only one module per layout using this number. If you reprogram the module with a different number, you must edit this value.

Object Location Center Point is the point on your layout that the Module is displayed. Typically, this should be at the location of the module or in the near vicinity so it can be easily associated with the module. Its location is for display only so you can place it anywhere.

Colors allow you to enter a unique color for the connected and not connected so that problems connecting can be analyzed if they occur.

Once you select **OK** from the dialog and you have entered all required data, a Rectangle will be placed on the layout with the appropriate color and the text M# where # is the module number. If the data has not been added correctly, a detailed error message will appear explaining what is incorrect.

If you need to edit the Module data, you can left click with your mouse on the Module element while in Layout Setup Mode and this dialog will reappear.

3.14.3 Setting Up a WIFI Module for your Control Panel

No setup is needed in Control Panel Setup. The Module number was specified in the Layout Setup mode.

3.14.4 WIFI Module Control Panel Operation

When power is applied to a WIFI Module the top will light with a green, red combination.

This indicates that the module has not yet connected to the WIFI network. In less than 10 seconds the module light should turn totally green indicating a connection.

If the Module does not connect, it could possibly be for one of the following reasons:

1) The WIFI router network name is incorrect in the module.
2) The WIFI router network password is incorrect in the module.
3) The WIFI router is not On.
4) The WIFI router is too far from the module, therefore its signal is too weak.

The power should be applied to the WIFI Modules in a layout at least 10 sec before opening a file in the Control Panel Mode. This allows time for the modules to connect to the network before the Grandpa's Railroad software tries to connect to them.

After the Modules are connected, and when you open a layout file in the Control Panel mode, the Grandpa's Railroad software will connect to the modules. If you have selected different colors for the Connected and Not Connected states for the modules, the color of the modules should change. After several seconds if all modules in your layout file have not been connected, an error message will appear. Possible reasons connection does not occur are:

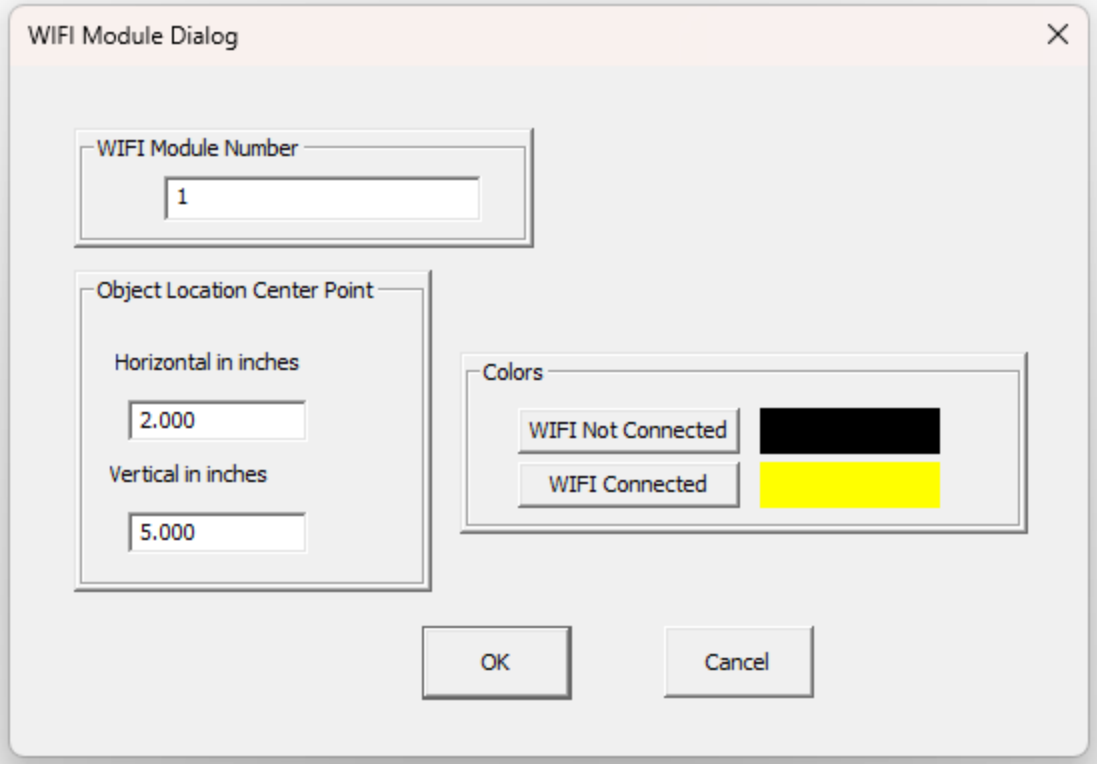
1) The Grandpa's Railroad Mini PC is not connected to the network.
2) The Mini PC and modules are connected to different networks. This can occur if you have used your Mini PC on your home network and have not changed it back to the Grandpa's Railroad router network.

3.14.5 Practical Example

A simple example using a **Digital/Proximity WIFI Module** is to create a layout that only contains the module.

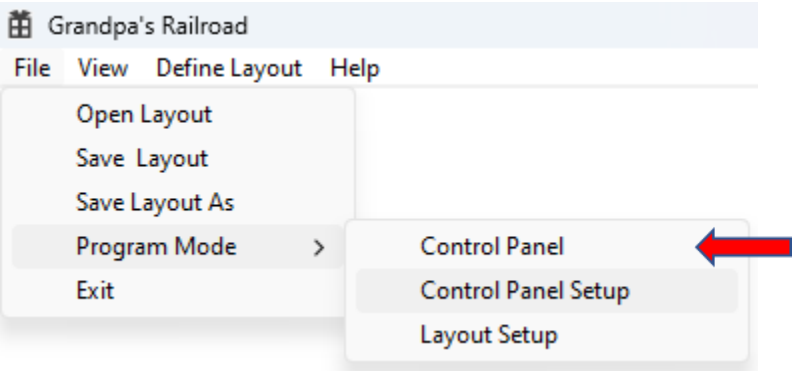
Step 1: Start the Grandpa's Railroad Application, select the **Layout Setup** mode, and create a 10-inch by 10-inch layout in any scale. (Note: A layout does not need to contain track. In this example we are only adding a WIFI Module.)

Step 2: Add a WIFI moule to the layout at 2 inches Horizontal and 5 inches Vertical with the desired Connected and Not Connected colors.



Step 3: Connect power to the WIFI Module and make sure the module light turns fully green indicating it has connected to the network.

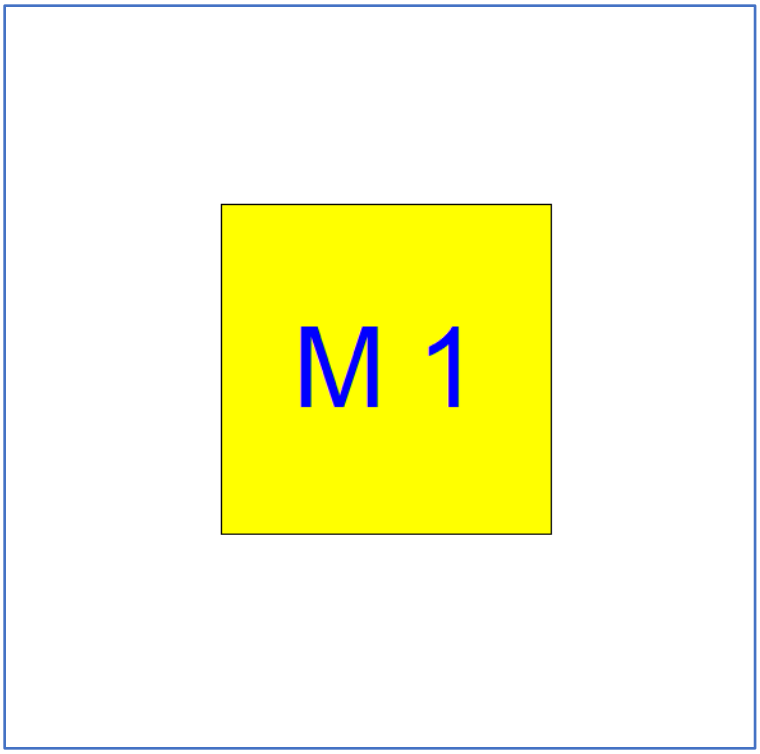
Step 4: From the File Menu item select:



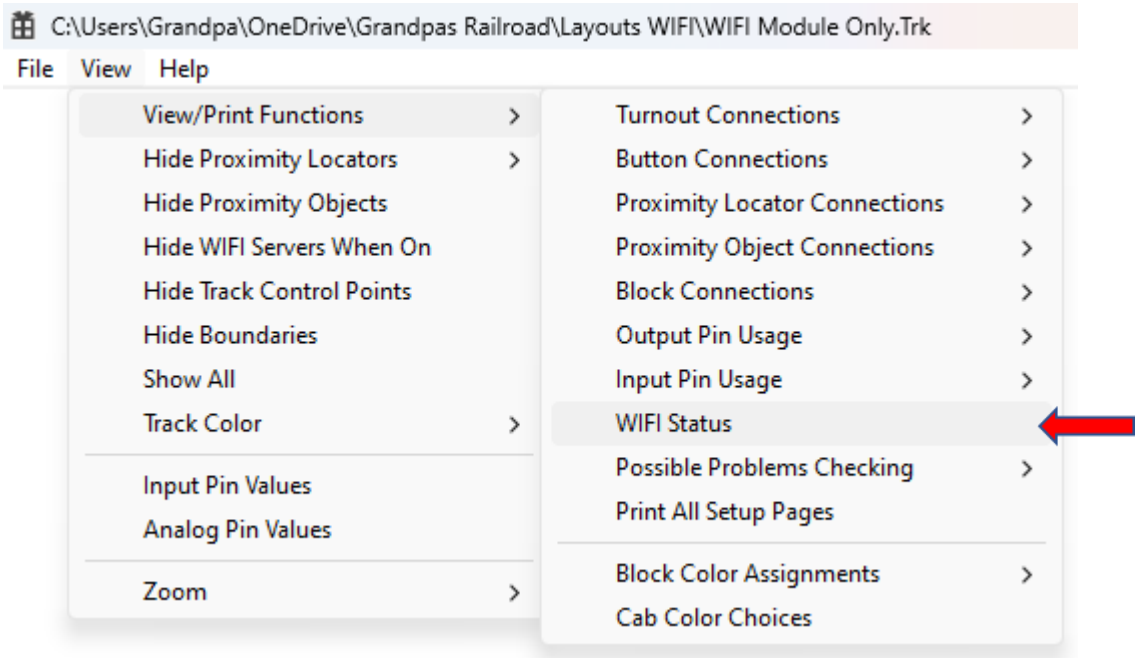
File/Program Mode/Control Panel

This will change to the Control Panel mode.

Step 5: If you have used our setup parameters and colors, after the WIFI Module connects, the screen should resemble the following.

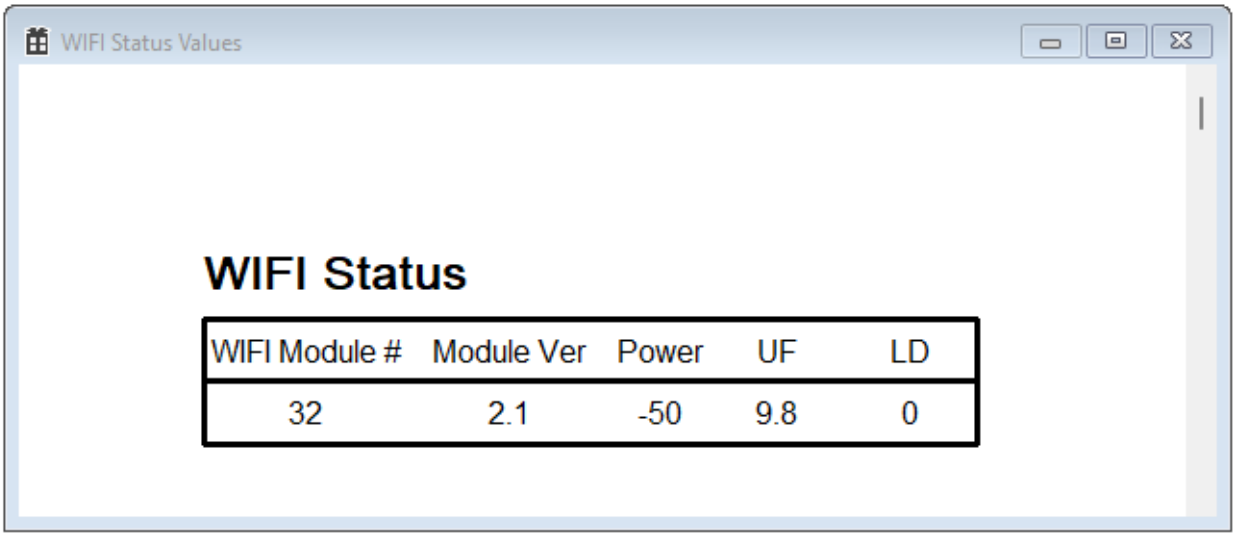


Step 6: To determine the strength of the connection, from the View Menu item select:



View / View/Print Functions / WIFI Status

This will provide a window containing the status of all WIFI modules in the layout.

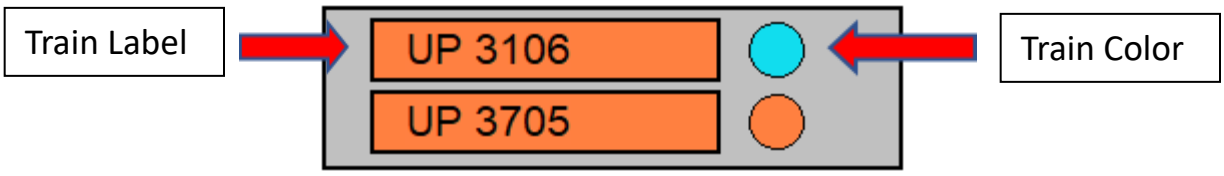


The most important number for users in this window is the Power number. This number has units of dbm or decibel milliwatts. Basically, the smaller the number the worse the signal strength. To make this perfectly clear since there can be some confusion as to what smaller means with negative numbers, a strength of -40 dbm is stronger than -60 dbm. In general, we would like to see strengths of -70 dbm or greater. These numbers may bounce around since they are single samples, but it is the mean value over time that is important. Re-locating your WIFI router may improve signal strength. If your layout is too large you may have to use a more powerful router.

3.15 Adding Legend

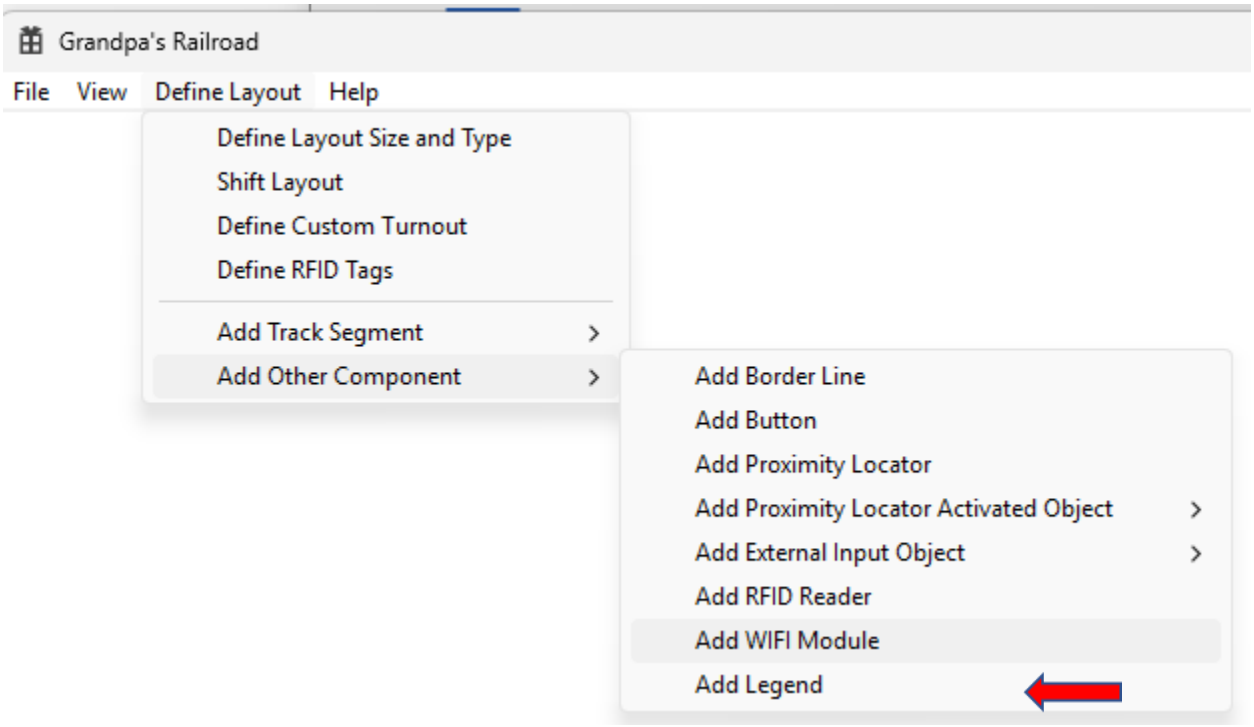
A legend is a static element that displays train labels and colors on the layout, making it easier to identify individual trains. The train colors are shown by the proximity locators, which are activated as a train passes over them.

An example of a legend is shown below:



The legend includes all train labels and colors that have been predefined for RFID tags, as outlined in Section 2.4 Defining RFID Tags. Each label is displayed in a separate row.

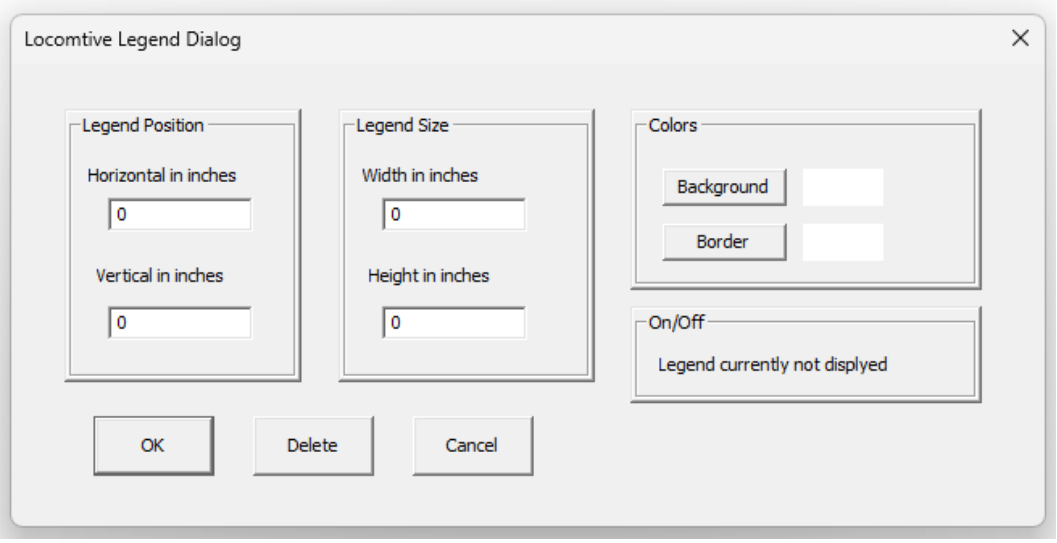
To add a legend, you must be in the **Layout Setup** mode. From the main menu select



Define Layout/Add Other Component/Add Legend

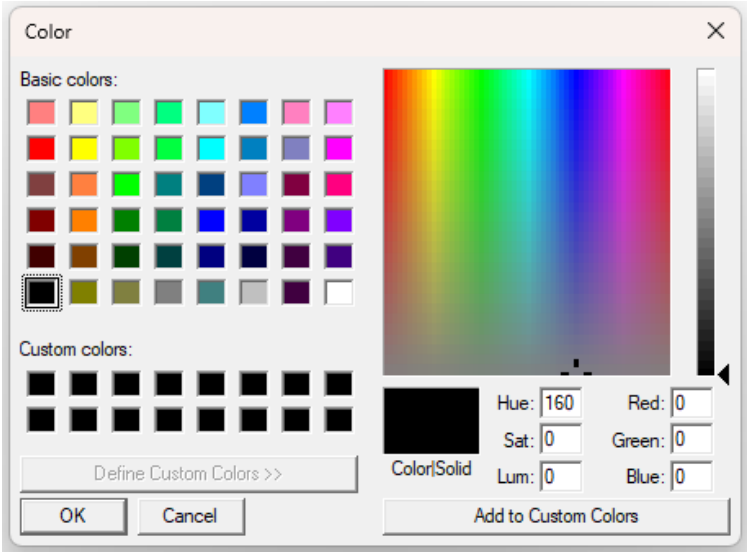
Note: Only one legend is allowed on a layout. Once a legend has been added, the "Add Legend" menu item will be disabled (grayed out).

Upon selecting this menu item, the following dialog will appear, allowing you to



customize the legend properties. You must enter the following parameters.

- **Legend Position**: Specifies the location of the legend's upper-left corner.
- **Legend Size**: Determines the legend's dimensions. The height controls the size of the train label box and font. All defined labels must fit within this space, so the height should be sufficient to accommodate them. Once the height is set, the width should be adjusted to ensure enough space for displaying the labels. It is best to fine-tune the dimensions through trial and error.
- **Colors:** Allows customization of the legend's background and border colors. Pressing either button in this group opens the following dialog.



After selecting **OK**, if all required data has been entered correctly, the legend will be placed on the layout. Otherwise, a detailed error message will appear, explaining any issues.

To edit a legend, left-click on the any spot on the legend while in the layout mode, and this dialog will reappear.

4 Aids for Building, Troubleshooting, and Documenting a Control Panel

This chapter introduces software features designed to assist in building a control panel. These include tools such as axes, grids, connection viewing and printing, problem detection, and various other useful features for development and documentation. Some features allow you to customize the appearance of your control panel to match your preferences. However, not all features are available in every operational mode.

All these features can be found under the **View** menu in all modes. The table below outlines the available features and the corresponding modes in which they apply.

Feature	Applicable Mode			Section
	Layout	Setup	Panel	
Show Edit Location	√	NA	NA	4.1
Show Axis Scales	√	NA	NA	4.2
Show Grid Lines	√	NA	NA	4.3
Show Layout Boundary	√	NA	NA	4.4
Block Color Assignments (View or Print)	√	√	√	4.5
Cab Color Choices	√	√	√	4.6
Zoom	√	√	√	4.7
Mouse Thumbwheel Zoom	√	√	√	4.8
Dragging a Zoomed Layout to Change Position	√	√	√	4.9
Using the Mouse to Get Precise Coordinates	√	NA	NA	4.10
Show Control Boxes	NA	√	NA	4.11
Turnout Connections (View or Print)	NA	√	√	4.12
Button Connections (View or Print)	NA	√	√	4.13
Proximity Locator Connections (View or Print)	NA	√	√	4.14
Proximity Object Connections (View or Print)	NA	√	√	4.15
Proximity DCC Object Connections (View or Print)	NA	√	√	4.16
RFID Reader Connections (View or Print)	NA	√	√	4.17
Block Connections (View or Print)	NA	√	√	4.18
Output Pin Usage (View or Print)	NA	√	√	4.19
Input Pin Usage (View or Print)	NA	√	√	4.20
Possible Problem Checking (View or Print)	NA	√	√	4.21
Print All Setup Pages	NA	√	√	4.22
Hide Proximity Locators	NA	NA	√	4.23
Hide Proximity Objects	NA	NA	√	4.24
Hide WIFI Modules When Connected	NA	NA	√	4.25
Hide Track Block Controls	NA	NA	√	4.26
Hide Border Lines	NA	NA	√	4.27
Show All	NA	NA	√	4.28
Track Color	NA	NA	√	4.29
Show Proximity Locator Connection Network	NA	√	NA	4.30
WIFI Status	NA	NA	√	4.31

4.1 Show Edit Locations

To activate this feature, navigate to:

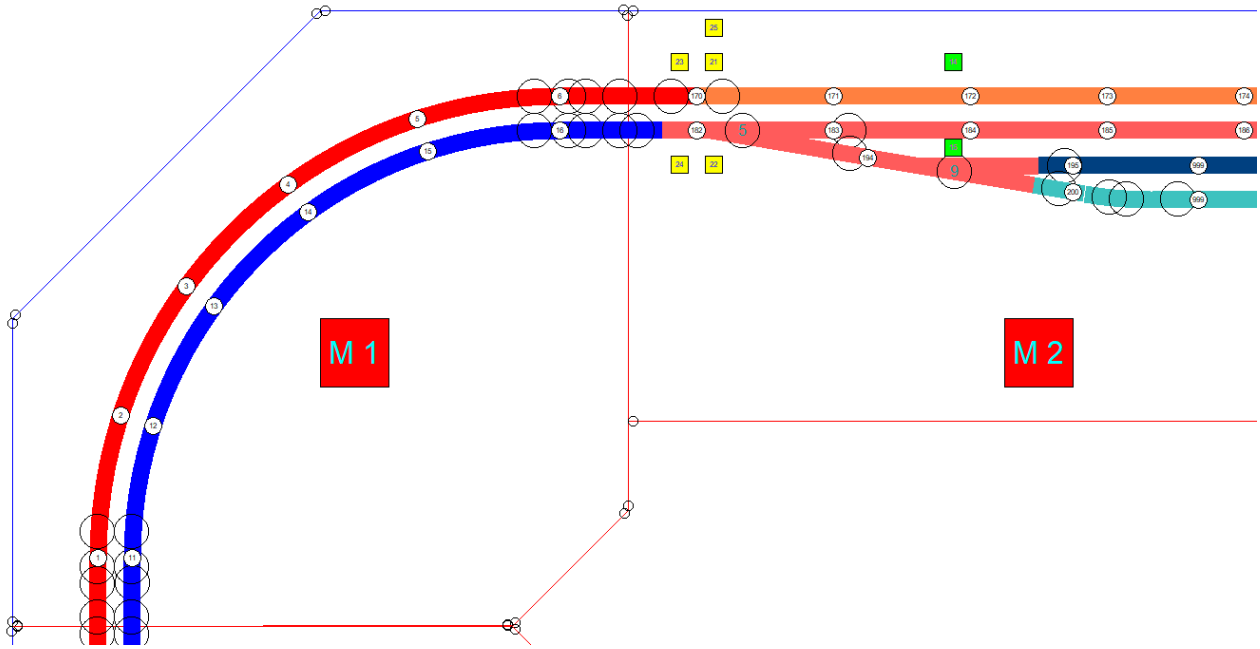
View/Show Edit Locations

When enabled, the layout diagram will be annotated as follows:

- Circles at the ends of straight and curved track sections
- A circle at the center of turnouts displaying the turnout number
- Small circles at the ends of border lines
- The **Proximity Locator Number** on proximity locators
- The **Proximity Object Number** on proximity objects
- Buttons and Wi-Fi objects remain unannotated (as they represent the edit points)

These points indicate edit locations. Clicking on them with the left mouse button will open the original dialog box used to define the object, allowing you to edit its parameters.

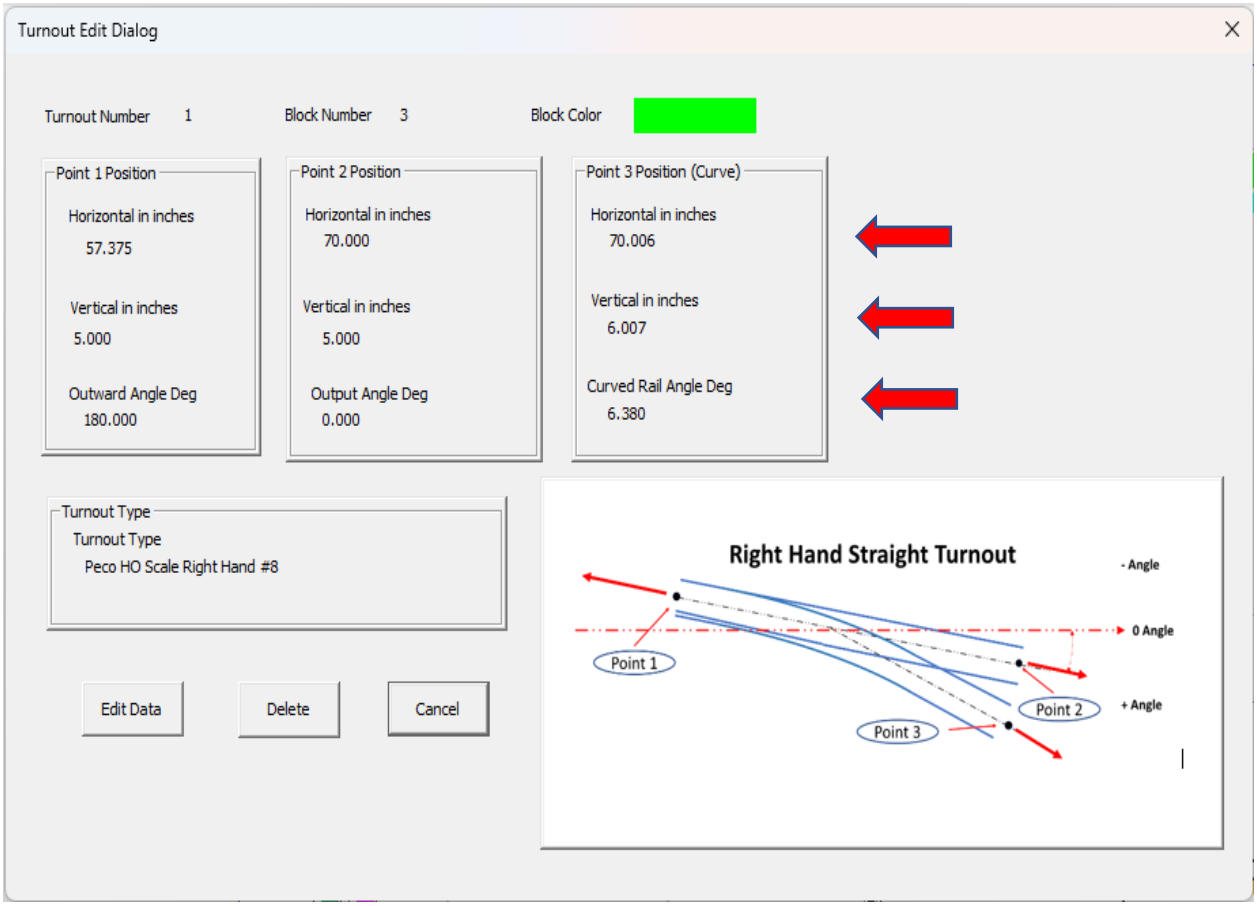
An example of an annotated layout is shown below:



If multiple edit locations overlap, their respective dialog boxes will appear sequentially. You can close any dialogs for objects you do not wish to modify.

Note: This is a very useful way of determining the end points and angles of track sections and turnouts when building your layout to get track sections that butt to each other with smooth connections.

For example, to view the endpoints of a turnout, simply open its edit dialog.

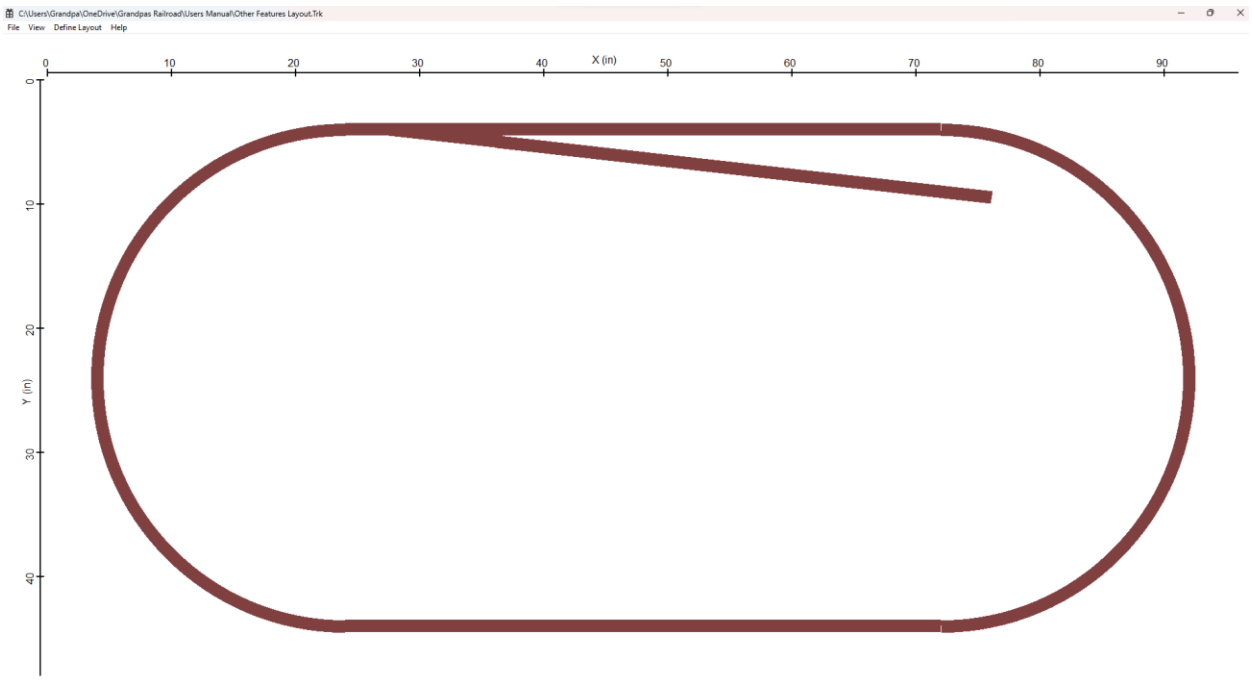


4.2 Show Axis Scales

To enable axis scales, navigate to:

View/Show Axis Scales

An **X** and **Y** scale will appear on the diagram, helping you accurately position components within your layout. The scales reflect the dimensions of your defined layout. For example, in a **4x8 foot layout (48x96 inches),** the scale numbers represent inches.

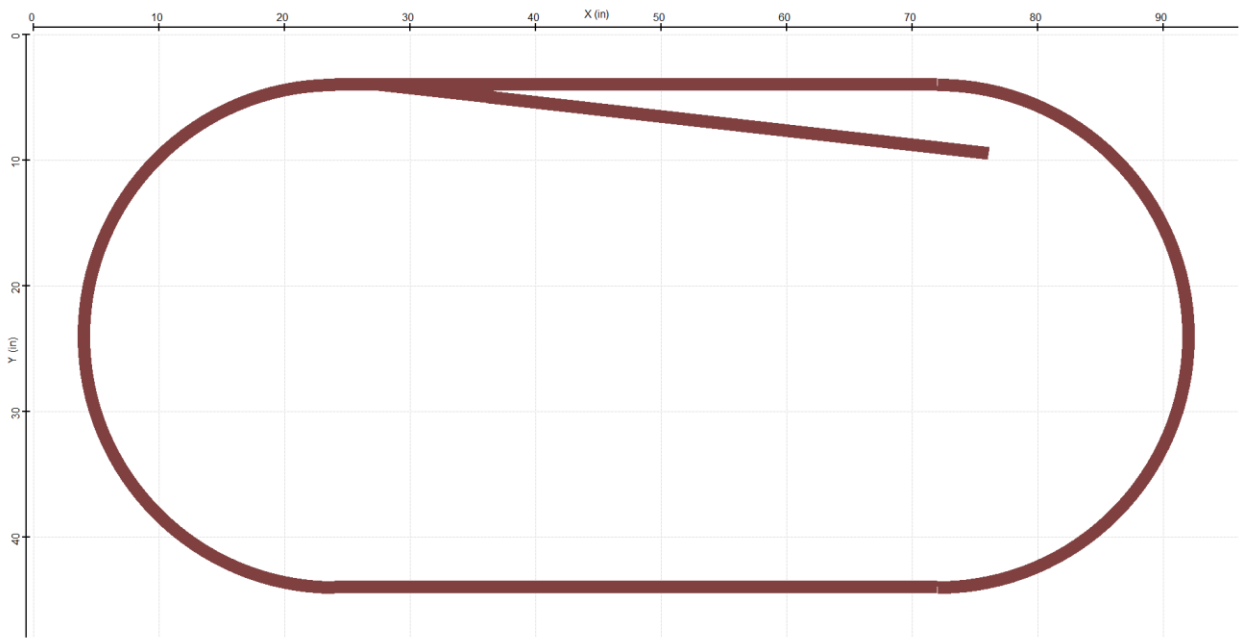


4.3 Show Grid Lines

To display grid lines, navigate to:

View/Show Grid Lines

Equally spaced **X** and **Y** grid lines will appear on the diagram, aiding in the precise placement of layout components. These grid lines are especially useful when used alongside the **Axis Scales**.



Note: In some illustrations, grid lines may appear faint. **Zooming in on the image** can improve visibility.

4.4 Show Layout Boundary

To highlight the layout boundary, navigate to:

View/Show Layout Boundary

A **light gray frame** will appear, marking the defined boundaries of the layout.

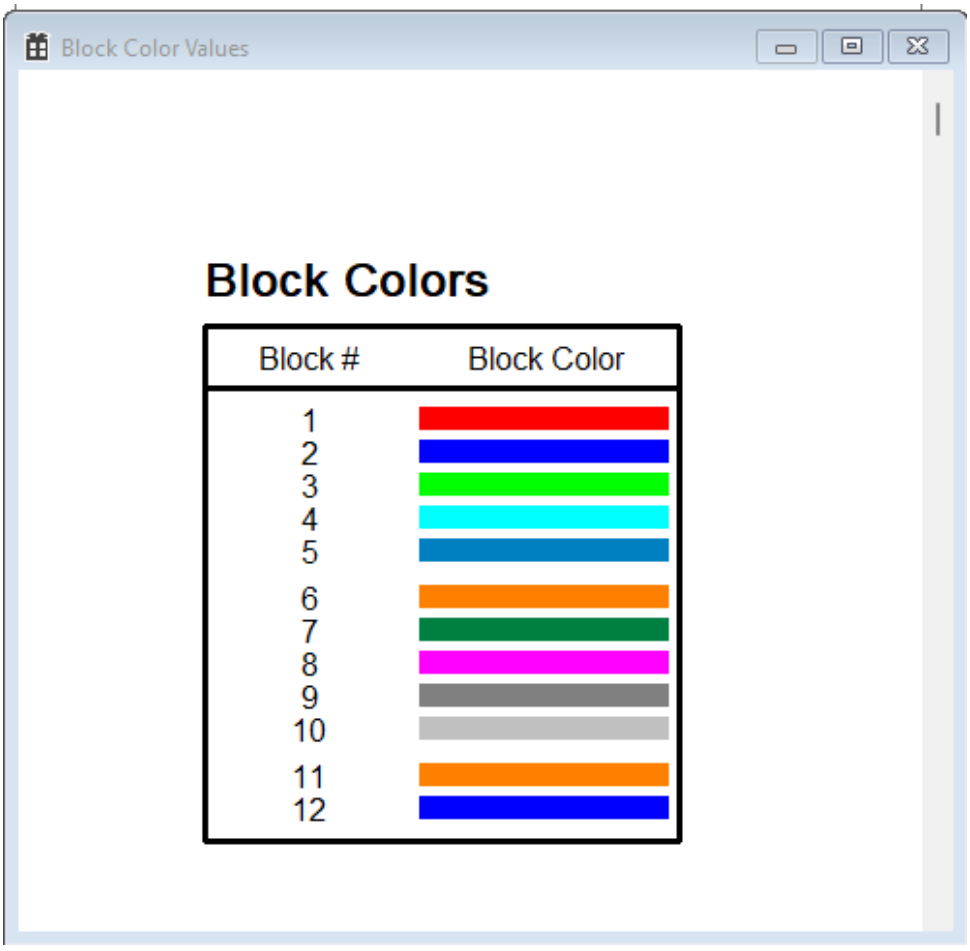
4.5 Block Color Assignments (View or Print)

To access this feature, navigate to:

View/View or Print Functions/Block Color Assignments

electing this option opens a window displaying the assigned colors for all blocks within the layout.

For example, if 12 blocks are defined, their assigned colors will be shown. To change the color of a block, select any track segment within that block and edit its color. The new color will automatically apply to all connected segments in that block.



4.6 Cab Color Choices

To access Cab Color Choices, go to the **View** menu and select:

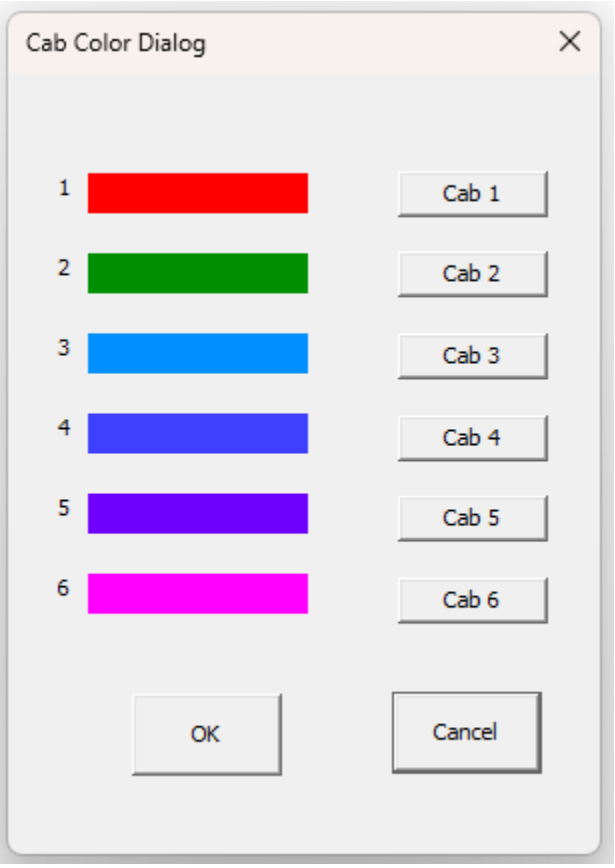
View/Cab Color Choices

In a DC system, a cab serves as a throttle control. *Grandpa's Railroad* software supports up to six cabs for DC operation. In contrast, a DCC system has a single power source for the entire layout, requiring only one cab.

A window will open, displaying the current color assignments for each cab. Clicking the **Cab #** button allows you to change the color for a specific cab. These colors are used in two ways during operation:

- To represent a cab power source in **Active Block Control**
- As the track color if **Power Source Color** is selected

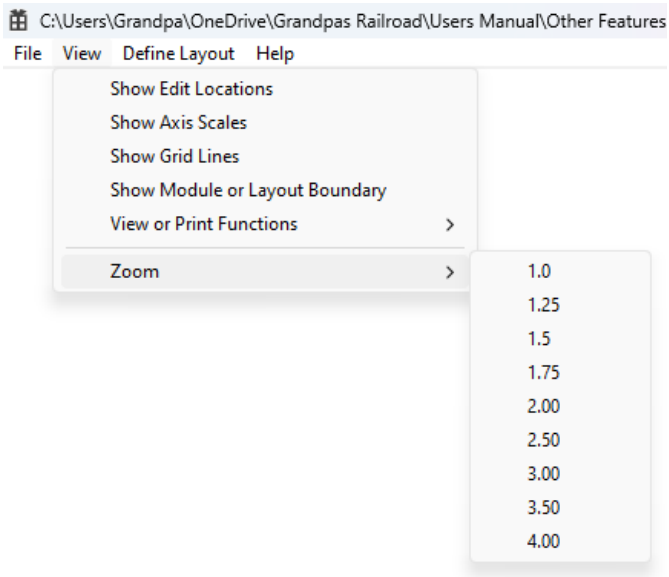
For more details, see Section 4.29: Track Color for Control Panel Additional Features.



4.7 Zoom

To zoom in on the control panel, go to the **View** menu and select:

View/Zoom



A menu will appear, allowing you to magnify the Control Panel Display from 1× to 4×. At 1× magnification, the entire control panel fits within the display. At higher magnifications, the view expands relative to the base window size, making the full panel no longer visible in a single view. In such cases, horizontal (bottom) and vertical (right) scrollbars will appear, allowing you to navigate the display.

For more details on repositioning the zoomed view, see **Section 4.9 Dragging a Zoomed Layout to Change Position**.

4.8 Mouse Thumbwheel Zoom

Another way to zoom is by using the mouse wheel. The zoom effect centers around the mouse cursor when scrolling begins:

- Rolling the wheel **upward** increases magnification.
- Rolling the wheel **downward** decreases magnification.

The zoom range is from 1× to 4×. This method is particularly useful for large layouts, allowing you to focus on specific areas for easier interaction, such as clicking on turnouts.

4.9 Dragging a Zoomed Layout to Change Position

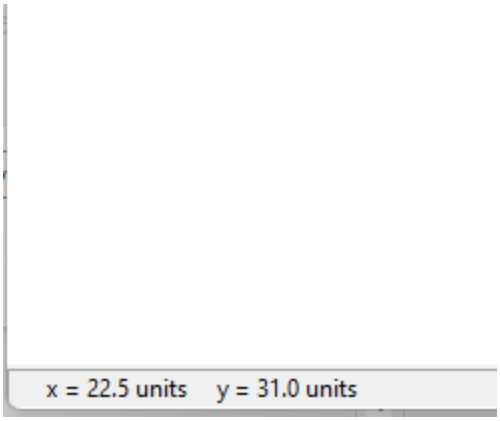
To reposition a zoomed display, place the mouse cursor over the display, **hold down the right mouse button**, and drag the view **left, right, up, or down**.

4.10 Using the Mouse to Get Precise Coordinates

If you need to place a component at an exact location, an easy way to determine its coordinates (*in the layout mode only*) is as follows:

1. Move the cursor to the desired point.
2. **Hold down the right mouse button.**
3. The **x** and **y** coordinates (in inches) will appear in the lower-left corner of the window.

This method also works when the display is zoomed in.



4.11 Show Control Boxes

To display control boxes, navigate to the **View** menu and select:

View/Show Control Boxes

The layout diagram will be annotated as follows:

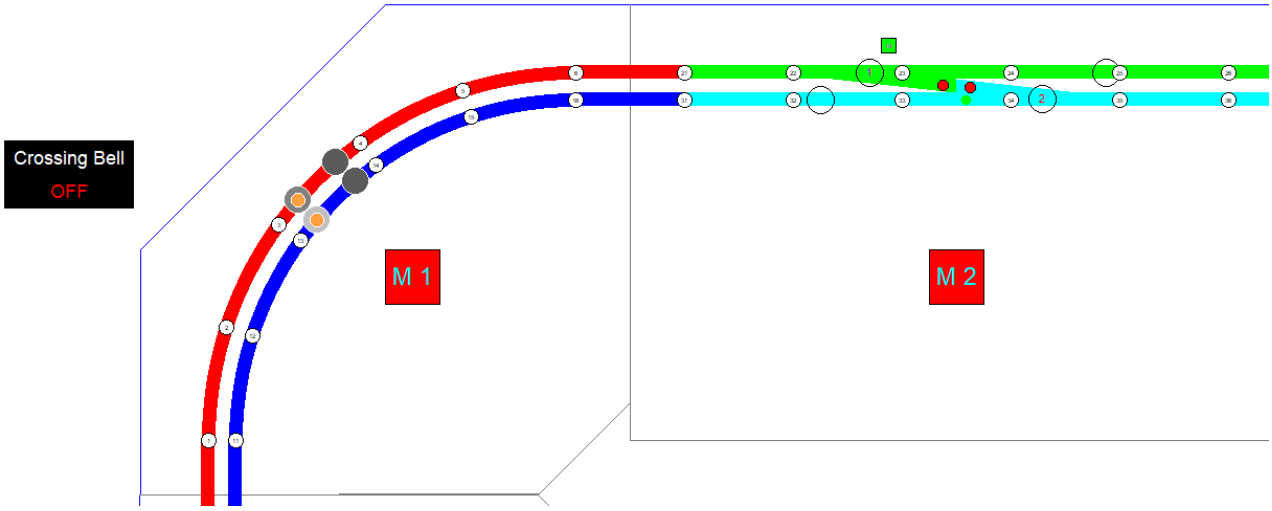
- Circles at the center of straight and curved track sections if no block control exists.
- A circle at the center of turnouts, displaying the turnout number.

- The **Proximity Locator Number** on proximity locators.
- The **Proximity Object Number** on proximity objects.
- Buttons and Wi-Fi objects remain unannotated, as they serve as control points.

These annotations indicate the locations of Control Boxes. By clicking the left mouse button on any of these points, a dialog box will appear, allowing you to define or edit the control parameters for the object.

For more details on these dialogs, refer to the sections on adding specific components to the layout in **Chapter 3**.

An example of an annotated layout is shown below:



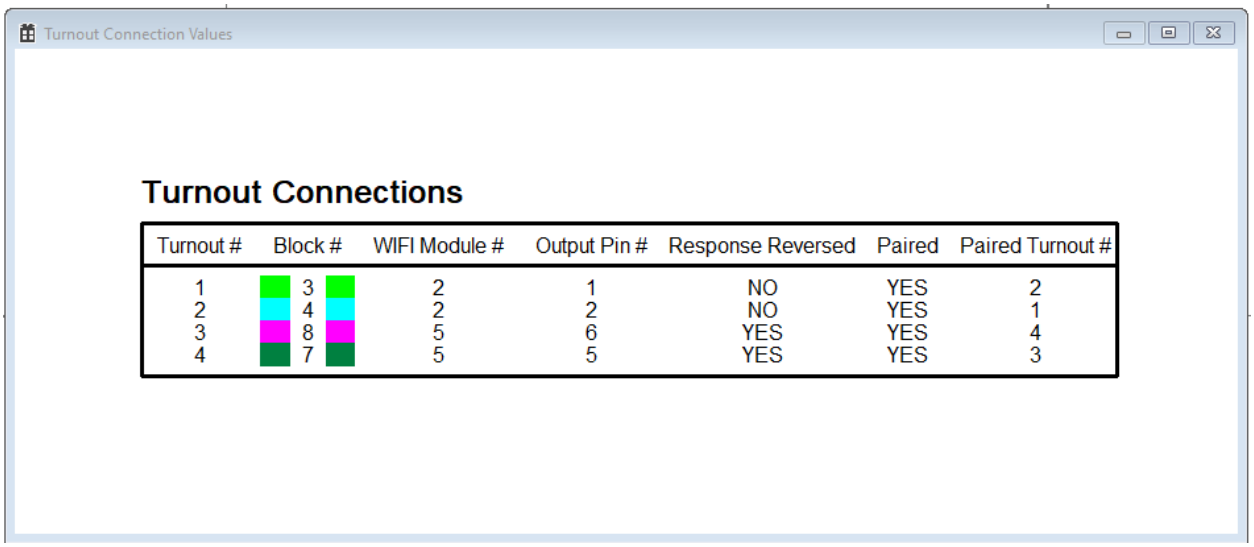
4.12 Turnout Connections (View or Print)

From the main menu select:

View/View or Print Functions/Turnout Connections

Selecting the "View" option opens a window that displays the parameters for all turnout connections. This is useful not only for documenting your configuration but also for verifying that all parameters are properly defined. A sample window is

shown below:



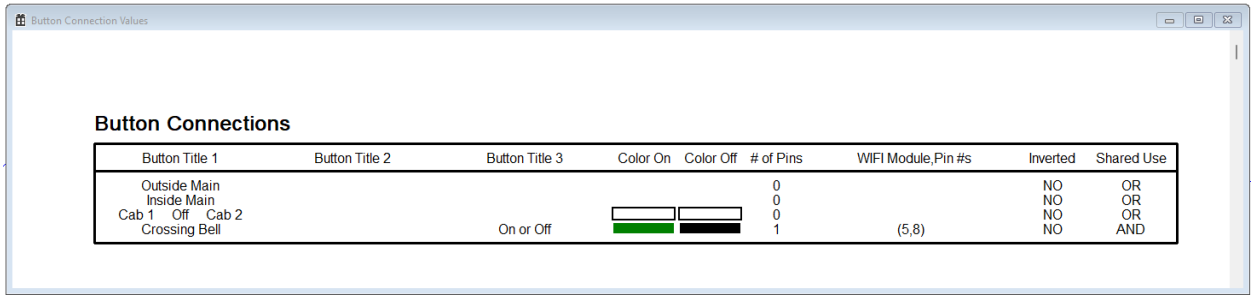
Selecting the "Print" option generates a similar table.

4.13 Button Connections (View or Print)

From the main menu select:

View/View or Print Functions/Button Connections

Selecting the "View" option opens a window that displays the parameters for all button connections. This is helpful for documenting your configuration and ensuring all parameters are defined correctly. A sample window is shown below:



Selecting the "Print" option generates a similar table.

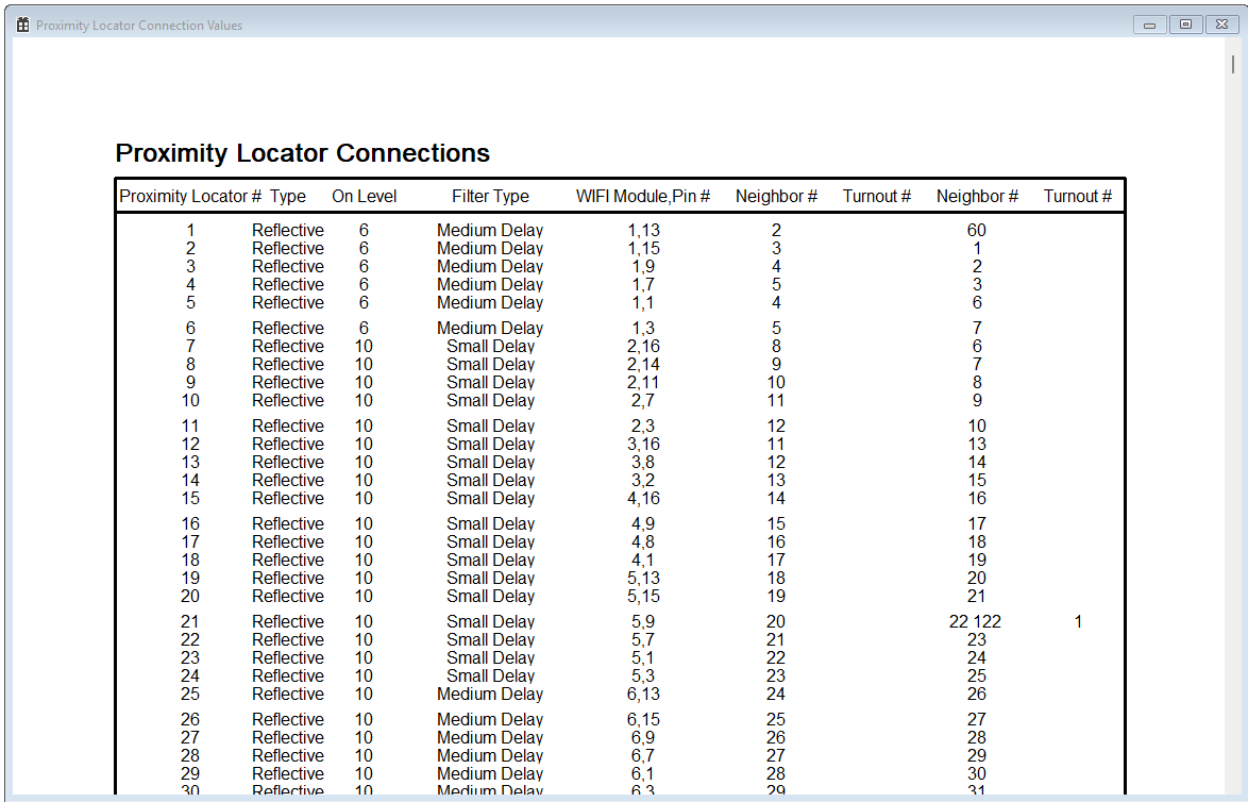
In this example, buttons without Wi-Fi connections are used as labels rather than functioning buttons. For a definition of the parameters, refer to **Section 3.5 Adding a Button.**

4.14 Proximity Locator Connections (View or Print)

From the main menu select:

View/View or Print Functions/Proximity Locator Connections

Selecting the "View" option opens a window displaying the parameters for all proximity locator connections. This is useful for documenting your configuration and verifying that all parameters are defined. A sample window follows:



Proximity Locator #	Type	On Level	Filter Type	WIFI Module,Pin #	Neighbor #	Turnout #	Neighbor #	Turnout #
1	Reflective	6	Medium Delay	1,13	2		60	
2	Reflective	6	Medium Delay	1,15	3		1	
3	Reflective	6	Medium Delay	1,9	4		2	
4	Reflective	6	Medium Delay	1,7	5		3	
5	Reflective	6	Medium Delay	1,1	4		6	
6	Reflective	6	Medium Delay	1,3	5		7	
7	Reflective	10	Small Delay	2,16	8		6	
8	Reflective	10	Small Delay	2,14	9		7	
9	Reflective	10	Small Delay	2,11	10		8	
10	Reflective	10	Small Delay	2,7	11		9	
11	Reflective	10	Small Delay	2,3	12		10	
12	Reflective	10	Small Delay	3,16	11		13	
13	Reflective	10	Small Delay	3,8	12		14	
14	Reflective	10	Small Delay	3,2	13		15	
15	Reflective	10	Small Delay	4,16	14		16	
16	Reflective	10	Small Delay	4,9	15		17	
17	Reflective	10	Small Delay	4,8	16		18	
18	Reflective	10	Small Delay	4,1	17		19	
19	Reflective	10	Small Delay	5,13	18		20	
20	Reflective	10	Small Delay	5,15	19		21	
21	Reflective	10	Small Delay	5,9	20		22 122	1
22	Reflective	10	Small Delay	5,7	21		23	
23	Reflective	10	Small Delay	5,1	22		24	
24	Reflective	10	Small Delay	5,3	23		25	
25	Reflective	10	Medium Delay	6,13	24		26	
26	Reflective	10	Medium Delay	6,15	25		27	
27	Reflective	10	Medium Delay	6,9	26		28	
28	Reflective	10	Medium Delay	6,7	27		29	
29	Reflective	10	Medium Delay	6,1	28		30	
30	Reflective	10	Medium Delay	6,3	29		31	

Selecting the "Print" option generates a similar table. For a definition of the parameters, refer to "Adding a Proximity Locator.".

4.15 Proximity Object Connections (View or Print)

From the main menu select:

View/View or Print Functions/Proximity Object Connections

Selecting the "View" option opens a window displaying the parameters for all proximity object connections. This is useful for documenting your configuration and verifying that all parameters are defined. A sample window follows:

Proximity Objects

Object,Element #	Object Type	Directional	Color On	Color Off	# of Proximity Locators	Proximity Locator #s	# of Output Pins	Output Module,Pin #s
51,1	On if any of my Proximity Locators (PLs) On	NO			8	106 1 2 3 4 5 6 21	1	(6,6)
51,2	On if any of my PLs On but no other element On	NO			2	22 23	1	(6,5)
51,3	On if no other Element On	NO			0		1	(6,4)
52,1	On if any of my Proximity Locators (PLs) On	NO			8	116 11 12 13 14 15 16 31	1	(6,3)
52,2	On if any of my PLs On but no other element On	NO			2	32 33	1	(6,2)
52,3	On if no other Element On	NO			0		1	(6,1)
53,1	On if any of my Proximity Locators (PLs) On	YES			10	111 96 95 94 93 92 91 76 75 112	2	(4,5) (4,6)
54,1	On if any of my Proximity Locators (PLs) On	YES			8	102 101 86 85 92 91 76 75	2	(4,5) (4,6)
55,1	On if any of my Proximity Locators (PLs) On	YES			10	53 54 55 56 71 72 73 74 75 76	2	(4,5) (4,6)
56,1	On if any of my Proximity Locators (PLs) On	YES			10	102 101 86 85 84 83 82 81 66 65	2	(4,5) (4,6)
57,1	On if any of my Proximity Locators (PLs) On	YES			10	43 44 45 46 61 62 63 64 65 66	2	(4,5) (4,6)
1	Train Collision	YES			9	84 83 66 65 64 63 62 61 46		
2	Train Collision	YES			9	94 93 76 75 74 73 72 71 56		
3	Train Collision	YES			14	64 65 81 82 83 84 85 86 101 102 103 104 105 106		

Selecting the "Print" option generates a similar table.
For a definition of the parameters, refer to **Section 3.7 "Adding Gate, Signal, or Animation"** and **Section 3.8 "Adding Collision Avoidance."**

4.16 Proximity DCC Object Connections (View or Print)

From the main menu select:

View/View or Print Functions/Proximity DCC Object Connections

Selecting the "View" option opens a window displaying the parameters for all proximity DCC object connections. This is useful for documenting your configuration and verifying that all parameters are defined. A sample window follows:

Proximity DCC Objects

Object #	Color On	Color Off	Directional	Proximity Locator #s	DCC Event Sequence
1			YES	2 3	DT = 0.000 Same Direction Speed = 25% DT = 0.000 Horn Turn ON DT = 1.000 Horn Turn OFF

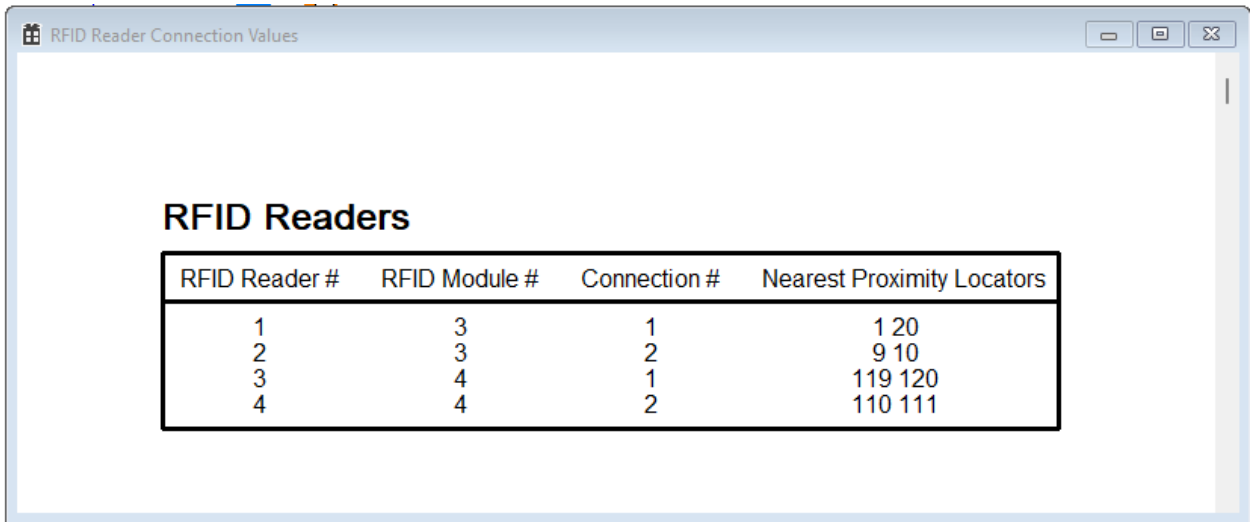
Selecting the "Print" option generates a similar table.
For a definition of the parameters, refer to **Section 3.9 Adding DCC Event or Sequence.**

4.17 RFID Reader Connections (View or Print)

From the main menu select:

View/View or Print Functions/RFID Reader Connections

Selecting the "View" option opens a window displaying the parameters for all RFID Reader connections. This is useful for documenting your configuration and verifying that all parameters are defined. A sample window follows:



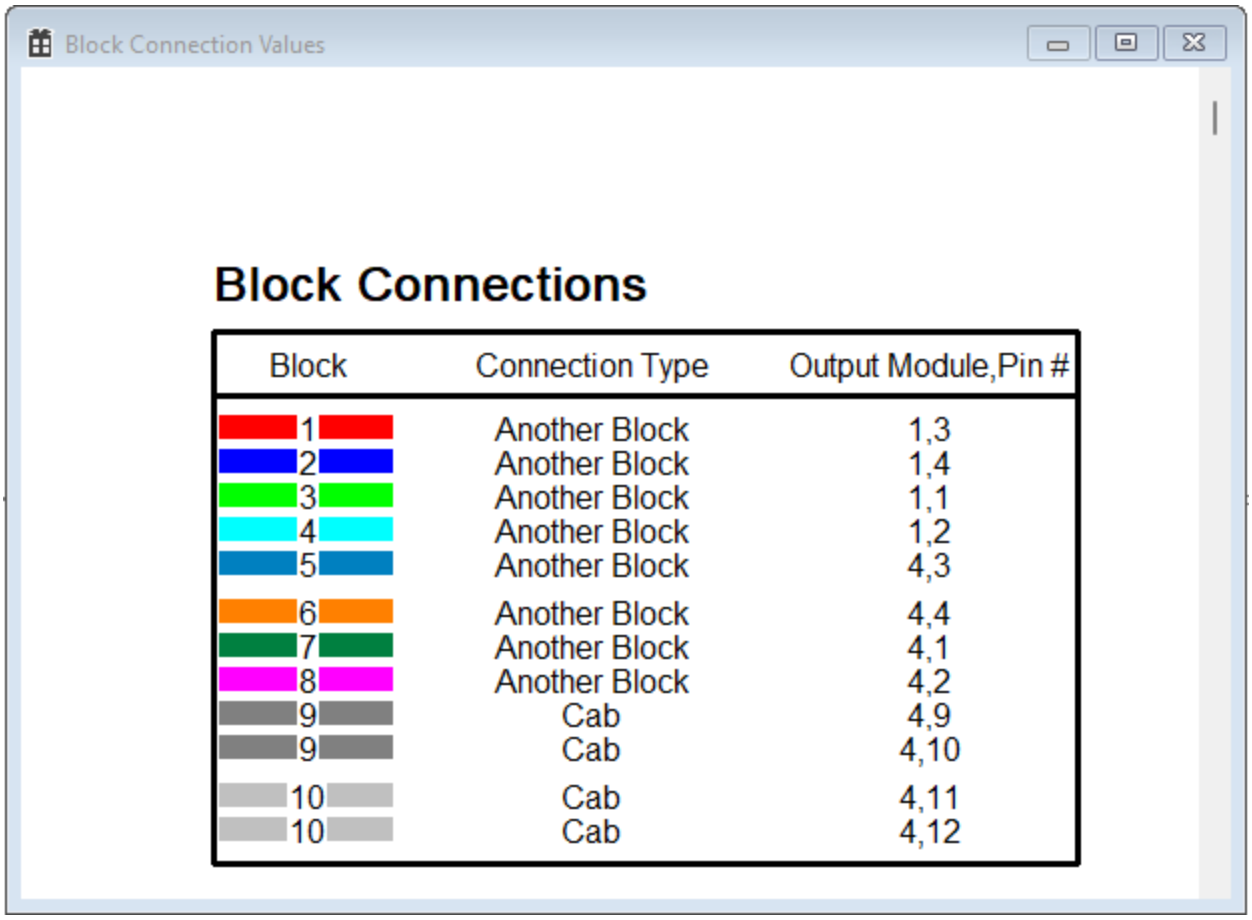
Selecting the "Print" option generates a similar table.
For a definition of the parameters, refer to **Section 3.13 Adding a RFID Reader.**

4.18 Block Connections (View or Print)

From the main menu select:

View/View or Print Functions/Block Connections

Selecting the "View" option opens a window displaying the parameters for all block connections. This is useful for documenting your configuration and verifying that all parameters are defined. A sample window follows:



Selecting the "Print" option generates a similar table.

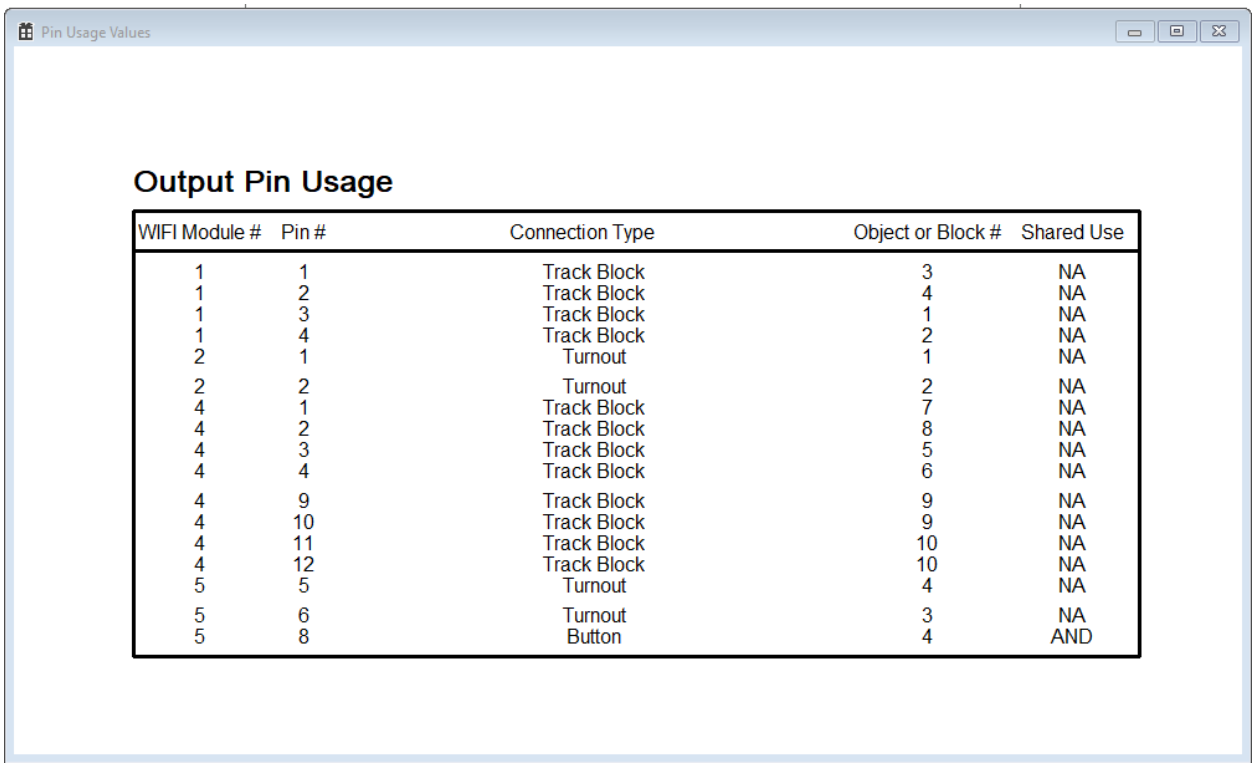
For a definition of the parameters, refer to **Section 3.1 Adding a Straight Track Section**.

4.19 Output Pin Usage (View or Print)

From the main menu select:

View/View or Print Functions/Output Pin Usage

Selecting the "View" option opens a window displaying the usage of all connected output pins. This is helpful for documenting your configuration and verifying that all parameters are defined and the connections are correct. A sample window follows:



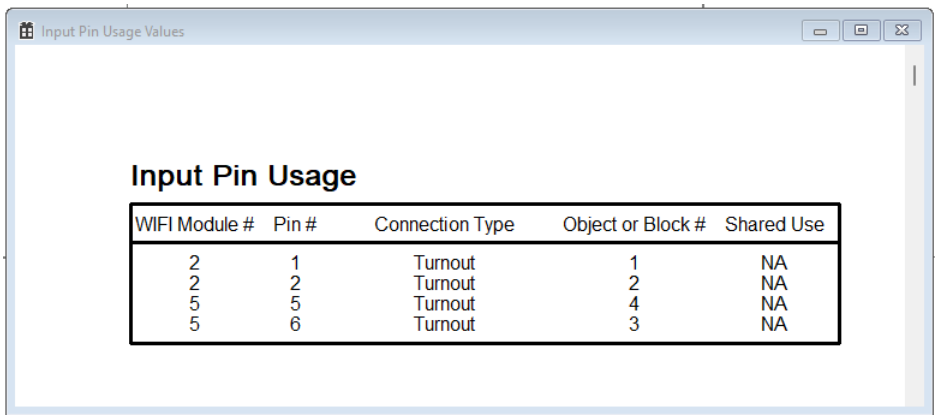
Selecting the "Print" option generates a similar table.

4.20 Input Pin Usage (View or Print)

From the main menu select:

View/View or Print Functions/Input Pin Usage

Selecting the "View" option opens a window displaying the usage of all connected input pins. This is helpful for documenting your configuration and verifying that all parameters are defined and the connections are correct. A sample window follows:



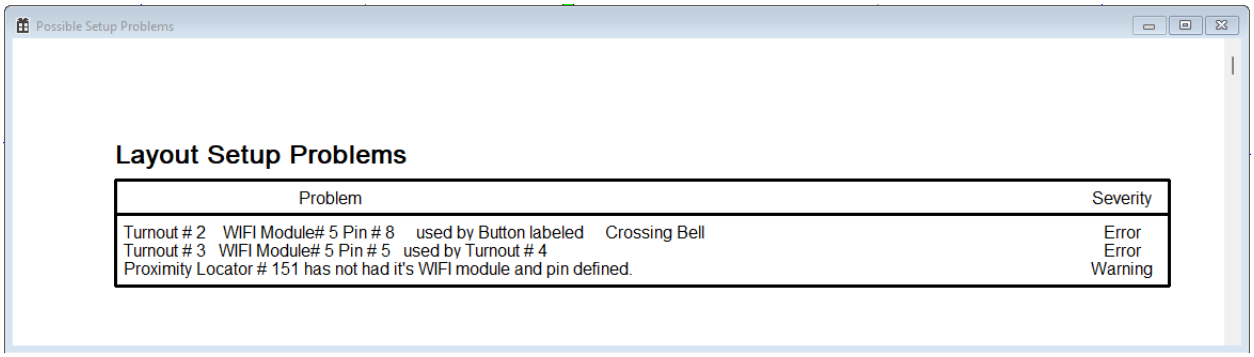
Selecting the "Print" option generates a similar table.

4.21 Possible Problem Checking (View or Print)

From the main menu select:

View/View or Print Functions/Possible Problem Checking

Selecting the "View" option opens a window displaying potential issues with the control panel setup. These are divided into errors and warnings. Errors must be resolved for proper operation, as unresolved errors could lead to erratic behavior. Warnings are less critical and may result from testing before the layout is fully complete. A sample window showing errors intentionally created follows:



Selecting the "Print" option generates a similar table.

4.22 Print All Setup Pages

From the main menu select:

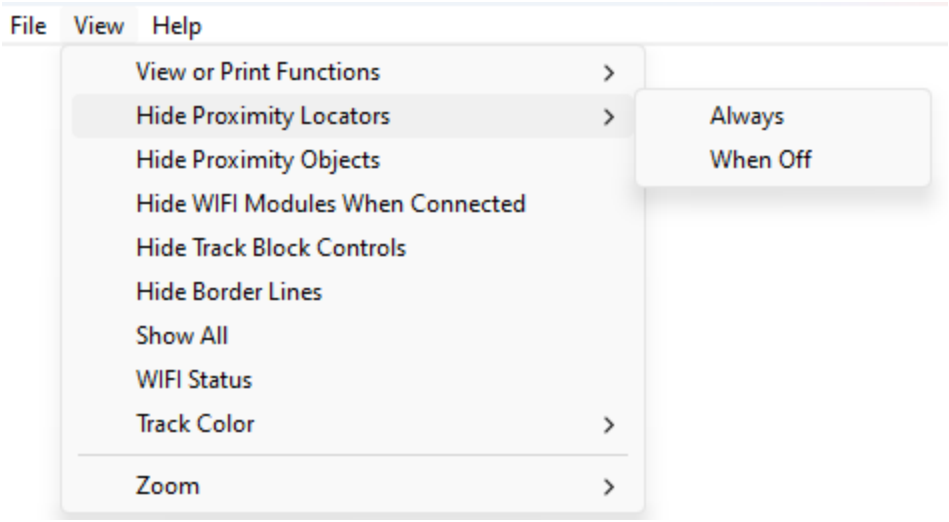
View/View or Print Functions/Print All Setup Pages

Selecting this option prints a document containing all the information from sections 4.12 – 4.21, offering a detailed description of the control panel setup.

4.23 Hide Proximity Locators

From the main menu select:

View/Hide Proximity Locators



This option allows you to customize your control panel during operation. Selecting this item presents options to hide proximity locators either always or only when they are off. If you previously selected one of these options, it will be checked when you return to the menu. Simply click again to deactivate the option.

4.24 Hide Proximity Objects

From the main menu select:

View/Hide Proximity Objects

This option allows you to customize your control panel during operation. Selecting this item hides all proximity objects that are off, while active objects remain visible. Activating this option can simplify your display. If you previously selected this option, it will be checked when you return to the menu. Click again to deactivate it.

4.25 Hide WIFI Modules When Connected

From the main menu select:

View/ Hide WIFI Modules When Connected

This option allows you to customize your control panel during operation. Selecting this item hides all WIFI modules when they are properly connected. If a module loses connection to the router, it will reappear. Activating this option can simplify

your display. If you previously selected it, it will be checked when you return to the menu. Click again to deactivate the option.

4.26 Hide Track Block Controls

From the main menu select:

View/ Hide Track Block Controls

his option allows you to customize your control panel during operation. When Active Block Controls are added to a track segment, you can choose to make them hideable (see **Section 3.1 "Adding Straight Track"**). Selecting this item hides all Active Block Controls marked as hideable. If you previously selected this option, it will be checked when you return to the menu. Click again to deactivate the option.

4.27 Hide Border Lines

From the main menu select:

View/ Hide Boundaries

This option allows you to customize your control panel during operation. When Border Lines are added to the layout, you can choose to make them hideable (see **Section 3.4 Adding Border Lines"**). Selecting this item hides all Border Lines marked as hideable. If you previously selected this option, it will be checked when you return to the menu. Click again to deactivate the option.

4.28 Show All

From the main menu select:

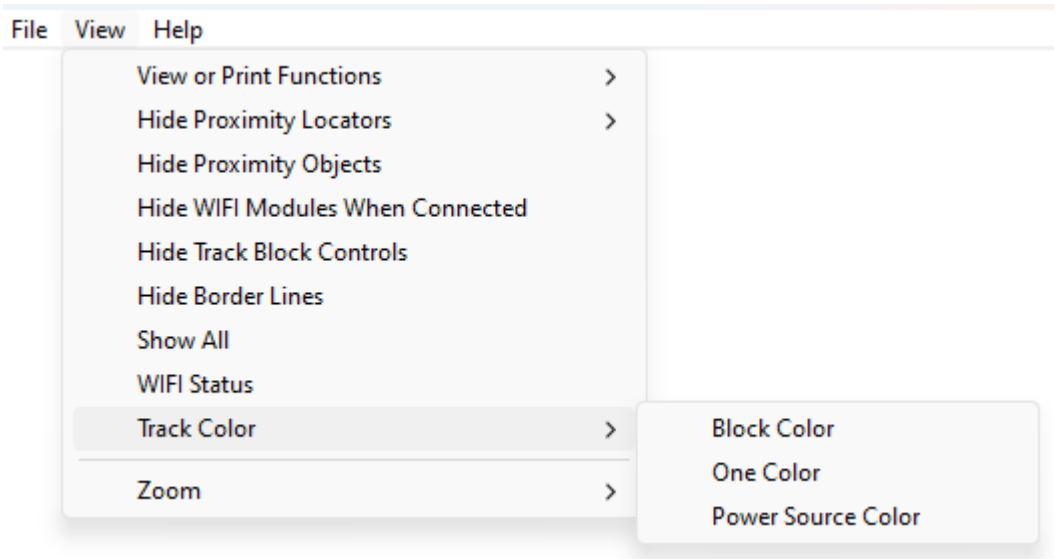
View/ Show All

Selecting this option reveals all control panel elements that were previously hidden.

4.29 Track Color

From the main menu select:

View/ Track Color



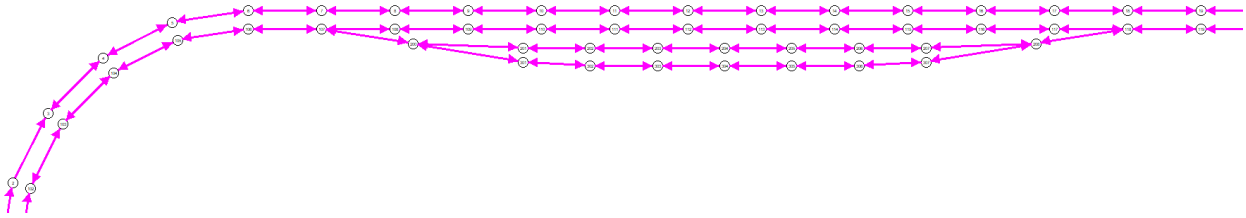
This option allows you to customize how the track is displayed on the layout. The first option, Block Color, shows the track in the color previously assigned to its block when the layout was defined. The second option, One Color, allows you to assign a single color to all track elements. The final option, Power Source Color, is useful for DC operation. It colors each track block according to the cab (throttle) it is connected to. If the block is off, the color will be black.

4.30 Show Proximity Locator Connection Network

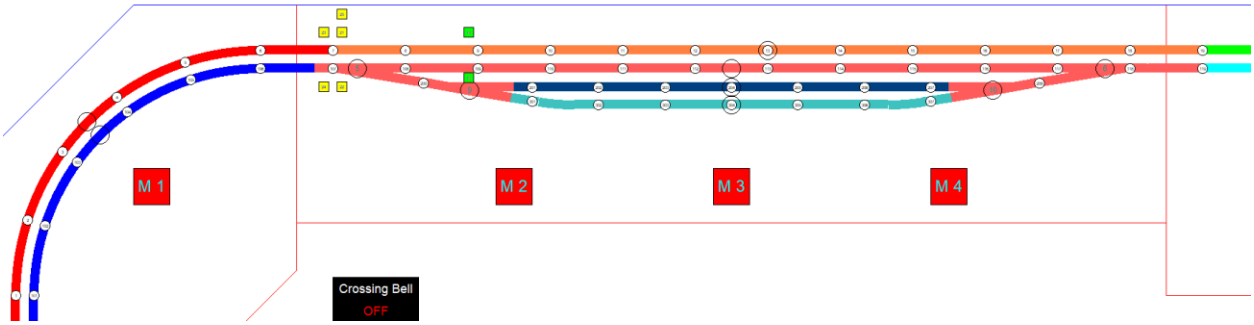
Sometimes, a graphical representation is the best way to check for errors. While the Proximity Locations Table (see Section 4.14) can help review proximity neighbors, it doesn't visually show the connections or data flow. To see these connections physically, from the main menu, select:

View/Show Proximity Locator Connection Network

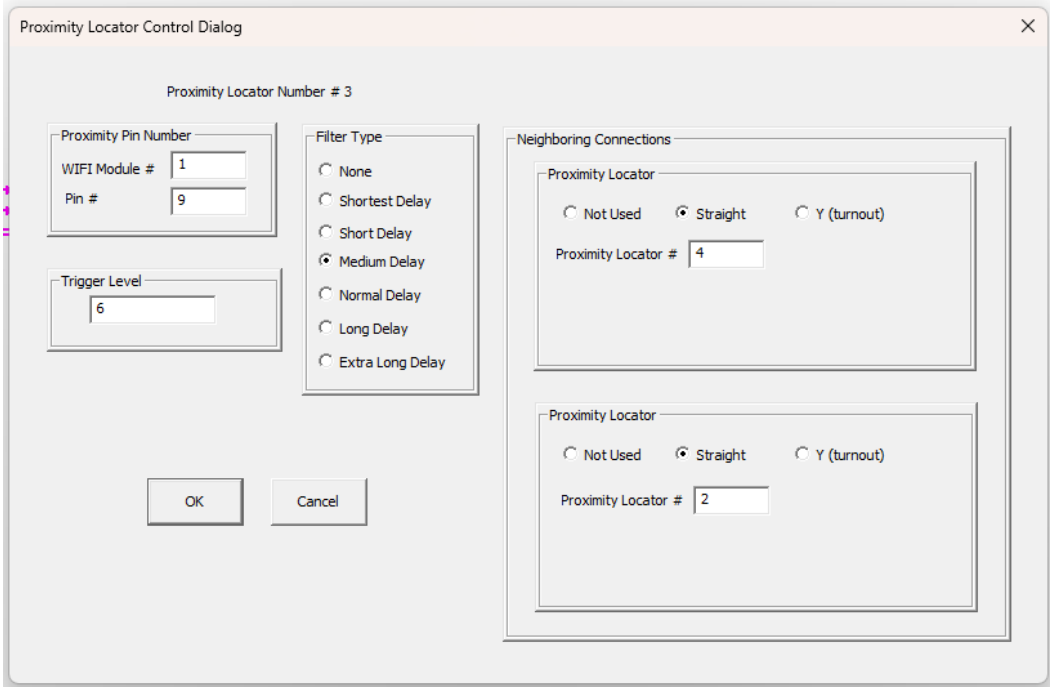
An image of the connections will appear. An example is provided below:



This image was obtained from a portion of the following layout.



In this example, train data flows in the direction of the arrows from one locator to the next. (Proximity locator numbers can be displayed on the connectivity diagram by using "Show Control Boxes.") A closer look at the outer track on the far left reveals that there is no arrow for data flowing from locator 3 to locator 2. This is an error that may not have been detected by reviewing the table. You can edit the data in the diagram by clicking the proximity locator with the left mouse button. The Proximity Locator Dialog will open, allowing you to edit the neighbors.

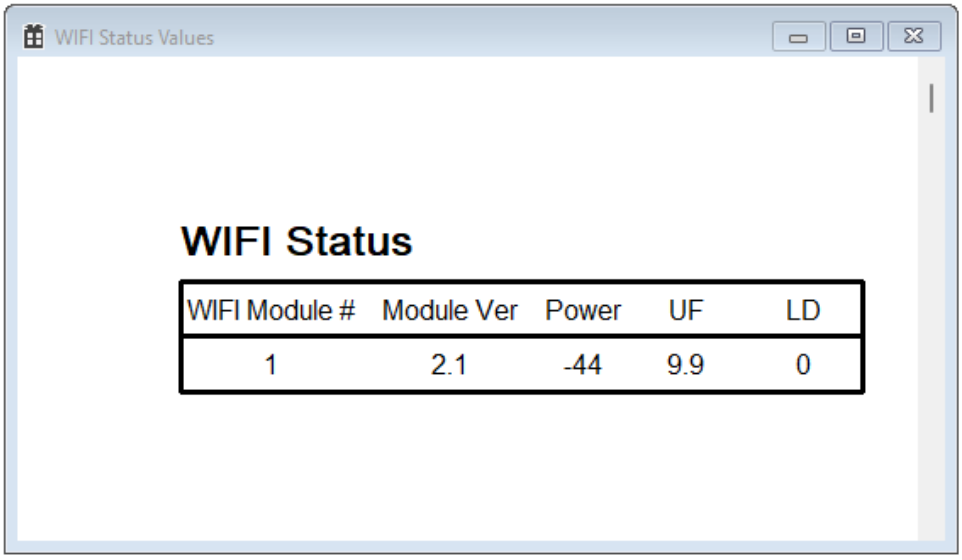


4.31 WIFI Status

From the main menu, select:

View/WIFI Status

Selecting this item opens a window displaying the current power settings of each WIFI module. This is useful for locating your router relative to the modules. It also provides the firmware version number for each module and other related data.



The most important number in this window is the Power value, measured in dbm (decibel milliwatts). A smaller number indicates weaker signal strength. To clarify, -40 dbm is a stronger signal than -60 dbm. Generally, a signal strength of -70 dbm or greater is desirable. While signal strengths can fluctuate due to single samples, the mean value over time is most important. Relocating your WIFI router may improve signal strength, and if your layout is large, you may need a more powerful router.

5 Special Topics for Grandpa's Railroad Construction

This chapter covers special topics and insights we've gained, along with specific details on how to connect certain features to your layout. While we don't claim these methods are the only possible solutions, they represent the way we approach things. We encourage our users to share their suggestions so we can learn and pass along their insights to the community.

5.1 Selecting the Right Wire Gauge

Selecting the right wire gauge for your model railroad and accessories can lead to hours of uninterrupted operation. Selecting the wrong gauge could lead to unnecessary expense, poor operation, or even wires overheating. For your understanding we are going to go into further detail as to why this occurs and how to choose the proper wire gauge. You do not have to understand everything we will present because we also present an easy way to calculate your wire size with some examples.

5.1.1 Background and Theory

In Episode 2 of our "Electricity 99" video tutorial series, Grandpa shows an analogy between current flow and water flow. Let's use that analogy to demonstrate our point. If firemen arrived at a house fire with only garden hoses, I'm sure the house would burn down before they could put the fire out. That is because the garden hose can't deliver the amount of water needed. Likewise, I'm sure you could water your garden with a fire hose but since you don't need the volume of water it could deliver you would just be wasting money on purchasing such a hose. The same holds true for electrical wire. Why purchase an oversized wire if a smaller one would suffice. It would be a waste of money and space under your layout. The converse of this is even more important. If you use too small a wire for an application, two very important things happen, voltage drop, and the wire will heat. In extreme cases the heat could cause the insulation to melt or even catch fire. Let's look a little closer as to why these two things happen.

We learned from “Electricity 99”, that electricity is electrons in motion and current is a measure of the movement of electrons in a wire over time. Wire has a resistance based on its material and diameter. This resistance results in a voltage drop in the wire and causes heating of the wire. If we have too large of a voltage drop your model train may run at different speeds depending on where you are on your layout. The voltage drop may also cause accessories to function slowly or improperly.

For model railroading there are only three types of wire we will consider:

1. Copper
2. Aluminum
3. Copper clad aluminum

The last type, copper clad aluminum, for simplicity we will consider as having the same conductivity as the aluminum wire. This wire is basically aluminum with a copper coating to aid in making connections.

A materials resistivity (ρ) is a measure of that materials ability to conduct electricity and is given by its resistance (R) times it’s cross-sectional area (A) divided by a unit length (L).

$$\rho = \frac{RA}{L}$$

The resistivity of copper is 1.72x10-8 Ωm or 5.6429x10-8 Ωft.

For aluminum wire the resistivity is 2.82e-8 Ωm or 9.2519x10-8 Ωft.

Rearranging the above equation, we can solve for the resistance (R) of a single strand of wire.

$$R = \frac{\rho L}{A}$$

The area of a round wire is $A = \pi r^2$ where r the radius is the wire diameter divided by 2.

For a particular wire gauge **n** AWG, the diameter can be calculated as

$$\mathbf{d_n = 0.005 \text{ inches} \times 92^{(36-n)/39}}$$

For example, if we consider a single strand of gauge 22 AWG wire, the diameter in inches is

$$\mathbf{d_{22} = 0.005 \text{ inches x } 92^{(36-22)/39} = 0.005 \text{ inches x } 92^{(14)/39} = 0.0253 \text{ inches}}$$

Therefore, the area A is

$$A = \pi\,(0.0253/2)^2 = 0.0005027 \text{ in}^2 = 0.0005027 \text{ in}^2$$

Converting to ft^2 by dividing by 144 in^2 / ft^2

$$A = 3.4911x10^{-6} \text{ ft}^2$$

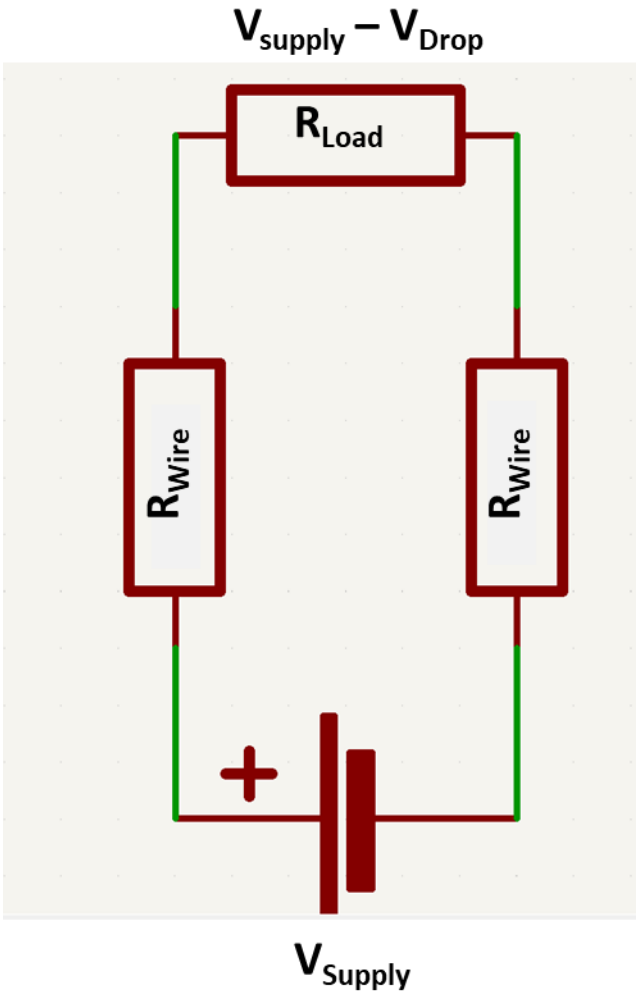
The resistance for a 10 ft length of 22 AWG copper wire would be

$$R = 5.6429x10\text{-}8\ \Omega ft \text{ X } 10 \text{ ft} / 3.4911x10^{-6} \text{ ft}^2 = 0.1616\ \Omega$$

Episode 3 of our “Electricity 99” video tutorial series, presented Ohm’s Law which shows the relationship between current voltage and resistance in a circuit.

$$\mathbf{V_{(Volts)} = I_{(Amps)} * R_{(Ohms)}}$$

Now consider a simple circuit where the wires in the circuit have resistance as follows:



Assume the two wires are of equal length with a resistance of R_{Wire}. Since there is only one path in this circuit, the current (I) flows through the entire circuit. Applying Ohms Law

$$V_{Supply} - V_{Drop} = I \times R_{Load}$$

$$R_{Load} = V_{Supply} - V_{Drop} / I$$

$$V_{Supply} = I \times R_{Wire} + V_{Supply} - V_{Drop} + I \times R_{Wire;}$$

$$V_{Drop} = 2 \times I \times R_{Wire;}$$

$$\textbf{Voltage Drop \%} = 2 \times I \times R_{Wire;} / V_{Supply} \times 100$$

Using the 10 ft 22 AWG wire we calculated above, for a 12 V supply and a 0.25 amp load current, the voltage drop is

$$\mathbf{V_{Drop} = 2 \times 0.25\ amp \times 0.1616\ \Omega = 0.0808\ volts}$$

Voltage Drop % = 0.0808 volts / 12 volts x 100 = 0.6733%

The above discussion is the way the voltage loss is calculated. Doing this for every wire would be more complex than necessary. The following section shows a much easier way.

5.1.2 Solid vs Stranded Wire

Stranded wire is more flexible than solid wire and if this is a consideration it should be used. However, stranded wire of the same gauge (AWG) has a higher DC resistance than solid wire since the wire has air gaps between strands. This can be 20% to 50%. This should be taken into consideration if you choose to use stranded wire in the following discussion of wire size. On Grandpa's Railroad we use solid wire in all cases except if we use RJ11 or RJ45 connectors or for very low amperage application such as IR sensors.

5.1.3 Calculating Wire Size with Examples (The Easy Way)

There are many Voltage Drop Calculators online. One that we use is:

https://www.rapidtables.com/calc/wire/voltage-drop-calculator.html

For the low voltages used in model trains, a voltage drop of 2% to 3% is fine. These low levels cause no temperature problems and even on track power wires show no slowing of trains. Likewise, accessories do not seem to be affected. These voltage drop levels also do not seem to place an undue burden on wire size. On Grandpa's Railroad we use telephone wire for many applications. This type of wire is cheap, easy to get, and easy to work with.

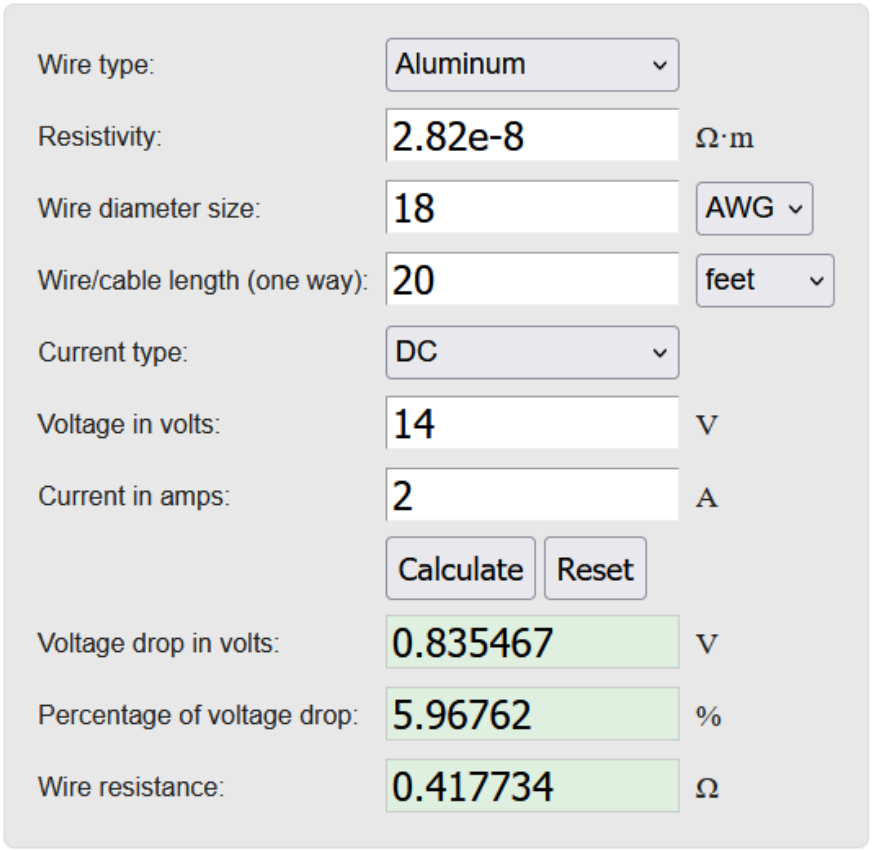
5.1.3.1 Calculating Wire Size for Track Power There are many opinions on power requirements for N or HO scale engines since these vary based on manufacture and age of equipment. To calculate wire size, we don't need to know specific

values only a general idea of the requirements. For planning purposes, I use 12V 0.25 amp for N scale and 14V 0.5 amp for HO scale.

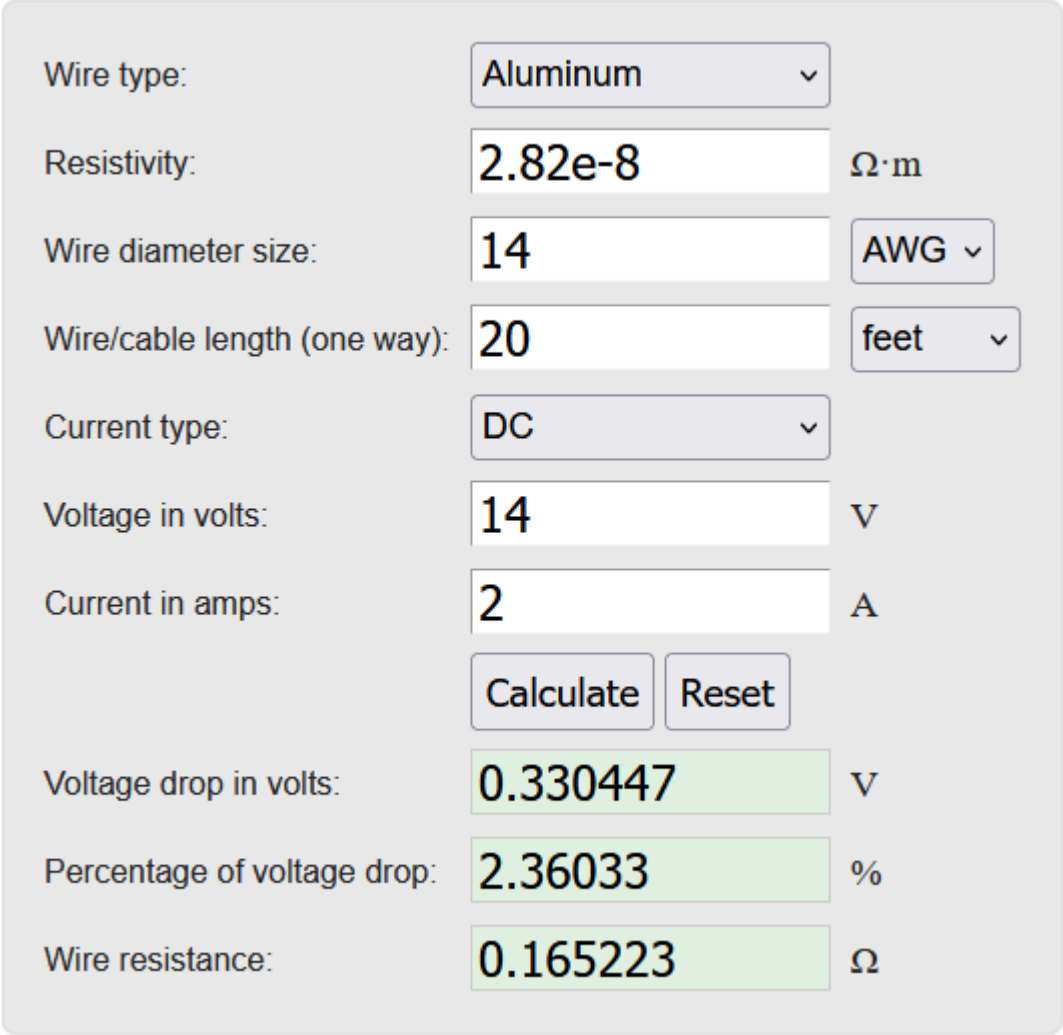
Assume we have a block in our layout that we wish to wire that will run up to 4 HO locomotives. This would need wiring to support 14V at 2 amps. Also assume the supply line (main bus) will need to be 20 ft long to travel from the transformer to the block.

To calculate wire size, we must first choose a preferred wire type. I find that 18- and 14-gauge copper clad aluminum wire is cheap and comes in many colors since it is commonly used in cars. It has many connector types that can be used with it and most of these can be used on both gauges requiring the need for stocking fewer types. (Connectors will be covered in Section 5.3)

Using the calculator given above and these values we see that an 18-gauge produces a voltage drop of 5.97% which is well above our desired 3%.

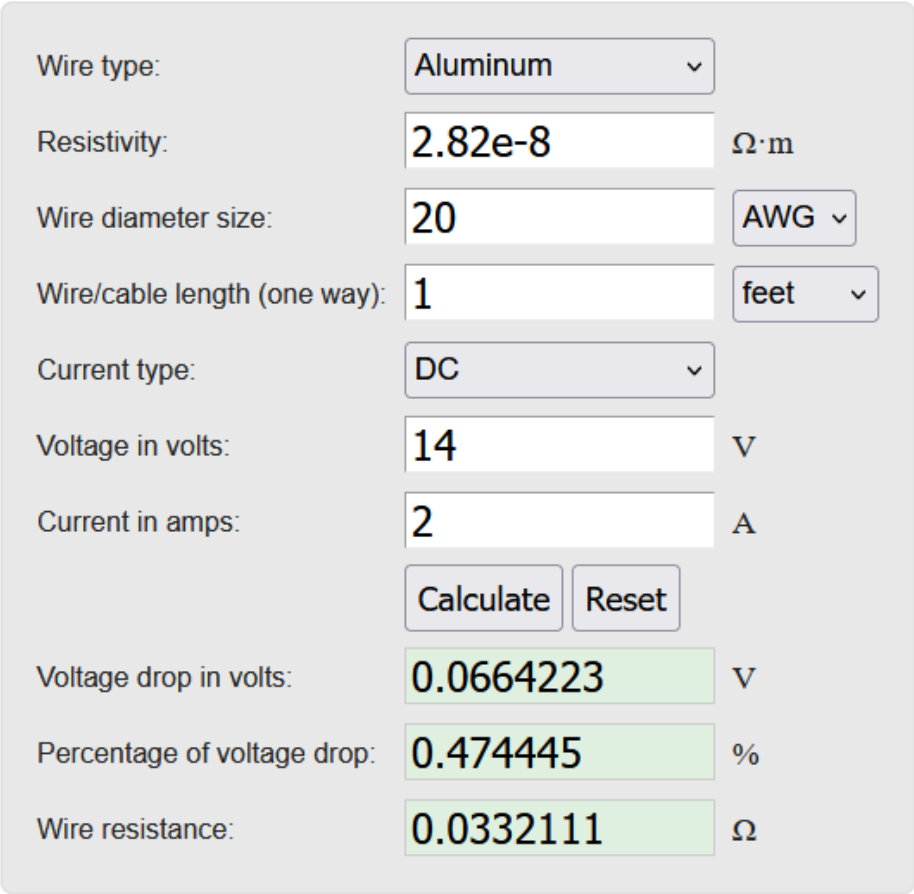


Using a 14-gauge wire the results produce a 2.36% drop which is not only



acceptable but also provides some room for loss from feeder wires to the track.

Let's assume we use a 1 ft 20-gauge feeder wire from the main bus 14-gauge wire to the track. The voltage drop is 0.47% which when added to the 2.36% main bus



the loss is still below 3%. Although model train track is conductive, it is still a good idea to connect from the main bus wire to the track in multiple places. Let's assume 3 for this example. From the above figure, we see that one wire has a resistance of about 0.033 Ω. We are now effectively connecting three wires with a 0.033 Ω resistance in parallel. In Episode 5 of our "Electricity 99" video tutorial series, we saw that resisters in parallel have an equivalent resistance of

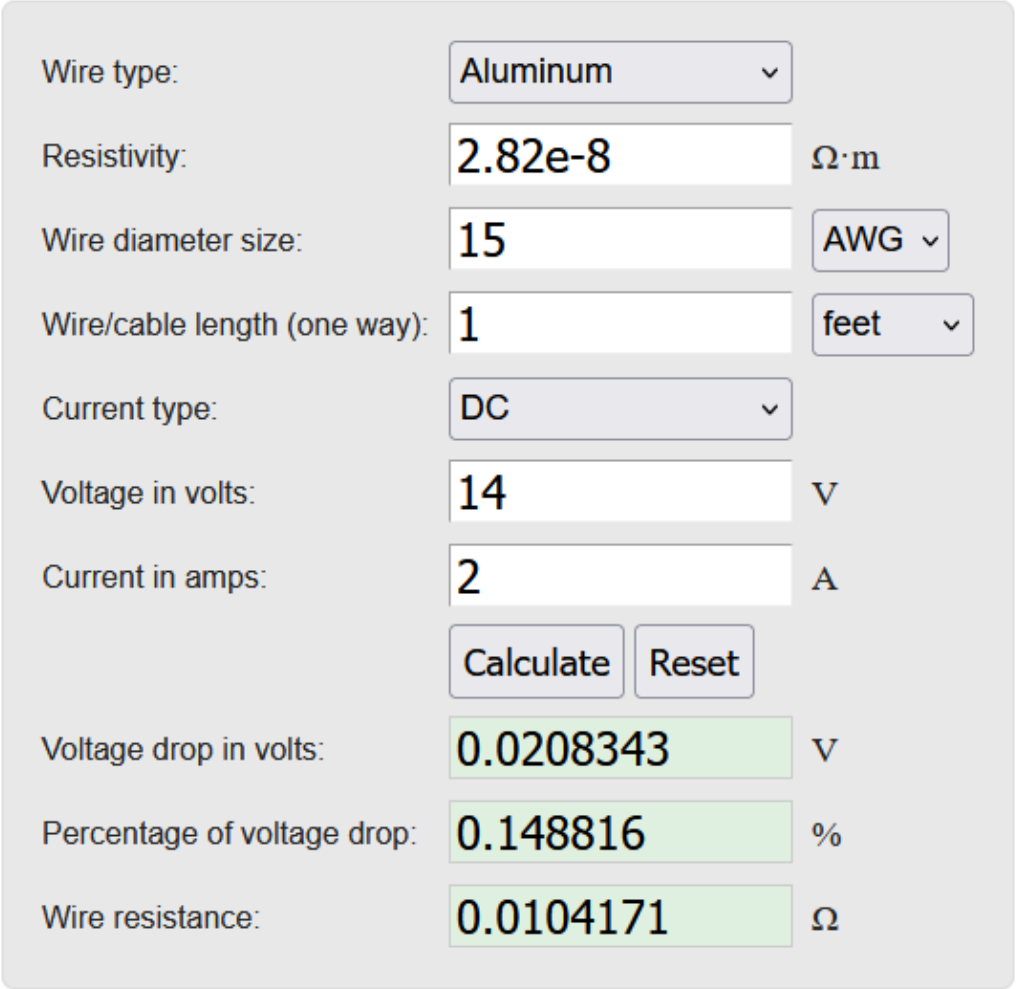
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Therefore, the three wires are equivalent to

$$\frac{1}{R_T} = \frac{1}{0.033} + \frac{1}{0.033} + \frac{1}{0.033}$$

or $R_T = 0.011\ \Omega$.

Using the calculator to determine a near equivalent wire gauge, we find that a



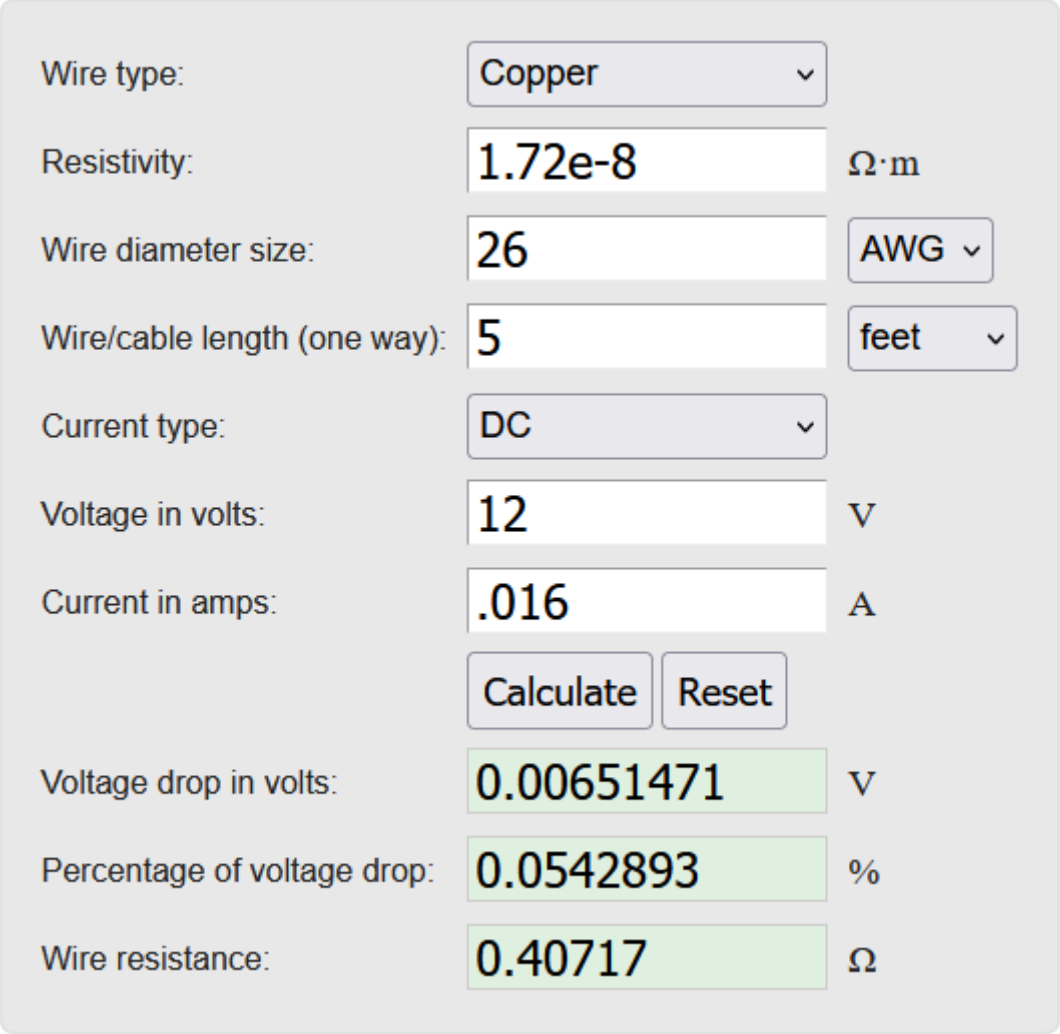
gauge of 15 provides a nearly equivalent resistance. The percentage of voltage drop is only 0.149%. Thus, multiple connections will not only cause less dependency on the track as a conductor, but also reduces the voltage drop for the equivalent feeder wire.

For this example, we can use a use a 20 ft 14-gauge aluminum main supply wire and three 1 ft aluminum feeder wires to the track and achieve a 2.51% voltage drop.

5.1.3.2 Calculating Wire Size for Accessories On Grandpa's Railroad we chose to use 12 V as our main accessory power supply. We convert this to 5 V when necessary to power WIFI modules, servos, etc. Since most accessories are near

their controller (WIFI card) very short wire lengths can be used. This results in small gauge wires being possible with low voltage drops. Where possible we use telephone wire in these situations because it is cheap with various connector options. Typically, these wires are copper which has lower resistance.

A Tortoise Switch Machine is said to use only 16 milliamps. If we drive it at 12 volts, (using the above voltage drop calculator) we see that a 26-gauge copper wire has a voltage drop of only 0.05% over 5 ft and 0.22% over 20 ft. Therefore



26-gauge telephone wire is totally acceptable for this application.

LED lights typically draw 20 ma. If we use a 12-volt supply (with resistor) and 25 LEDs connected for a small scene, this would be 0.4 amps. Using the calculator this is a 2.71% drop over 10 ft. (Note: In the case of LEDs lowering the voltage

drop would be of no significance. We showed in Episode 6 of our “Electricity 99” video tutorial series that LED lights required a large voltage drop before becoming noticeably dimmer. Again, it is a good place to use 26-gauge phone wire.

Small servo motors can draw 0.25 amps during operation typically at 5 volts. If we apply these parameters to the calculator, we see a 2.04% drop at 5 ft. Since accessories are typically close to their controller (WIFI card) 26-gauge phone wire is appropriate.

Note: In some cases (where WIFI has not been used to replace long wire runs), larger gauge wire may need to be used for accessories.

5.2 Making your own Cables

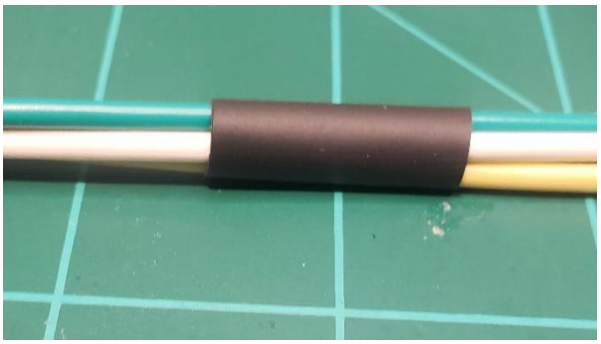
Often, when working on a model railroad, you may want to use a cable containing multiple wires to keep the wiring neat and organized. For instance, on Grandpa’s Railroad traveling layout, we’ve wired it to run on two DC throttles for the two parallel main lines. This setup requires two sets of wires to supply track power to the mainlines. While running a four-wire cable seems like a good idea, it has several disadvantages. Four-wire, 14-gauge cables can be expensive, and it’s difficult to access and separate the wires when you need to add feeder wires for powering the track. It’s much easier and more cost-effective to make your own cable (wire bundle) using heat shrink tubing.

Individual wire strands come in a variety of colors, which makes identifying each wire in the bundle simple. (It’s a good practice to reserve specific colors for certain functions on your layout. For example, we use red for our positive 12-volt DC accessory supply wire and black for ground.)

The following table shows the heat shrink tubing we use:

Wire Type		Heat Shrink Tube
Gauge	Number of wires	
14	4	1/4 inch (6mm) 2:1 shrink ratio
14	2	3/16 inch (5mm) 2:1 shrink ratio
18	4	3/16 inch (5mm) 2:1 shrink ratio
18	2	1/8 inch (3mm) 2:1 shrink ratio

Before shrinking, the wire is held in place, and it's easy to slide the tubing on. After shrinking, the wire is tightly secured together. We typically use 1-inch pieces of tubing spaced 6 to 8 inches apart, leaving enough room for adding connectors between the tubing. Below are images of a cable before and after shrinking.



For more detailed instructions on creating your own cables, check out our video on Grandpa's Railroad YouTube Channel.

5.3 Wire Connectors Coming Soon

5.4 Adding Sound Coming Soon

6 Glossary

Connectivity Network A group of proximity locators each knowing its nearest neighbors so that information can be passed among them.