This controller can automate a single track 'back-and-forth' model train layout -- or, one train can travel continuously around a loop, making stops at predetermined locations.

Requirements:

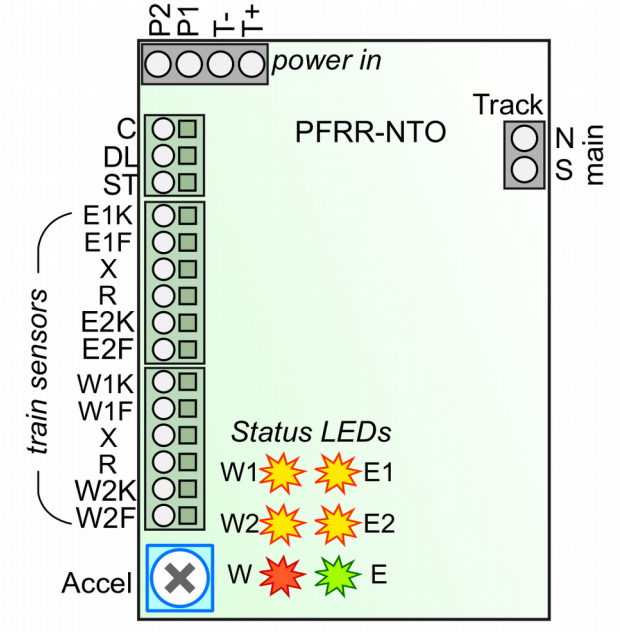
Trains must be DC powered, not DCC or AC, because train direction is controlled by the polarity of the track power.

Maximum track current: 2 amps (2.5 amps for acceleration).

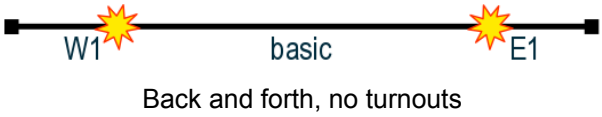
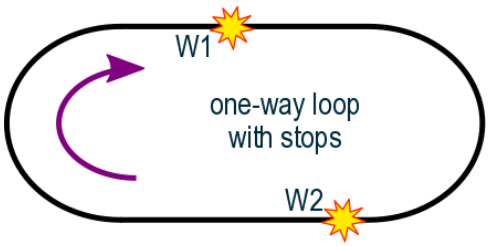
An accessory power supply, 12 to 17 volts AC or DC is required to run the PFRR circuit. This is separate from the track power.

Train sensors:

One train sensor must be installed at each track location where a train is to stop. One sensor is needed at each track end point. Additional sensors or external detectors may be added for station stops where a train will momentarily stop, then continue in the same direction.



The PFRR controller has connections for up to two train sensors. They are numbered W1, W2, E1 and E2. **The operating mode of the PFRR is determined by the combination of sensors that are connected.** So be careful to connect your sensors to the correct terminals on the PFRR controller. The wrong combination will result in unexpected operation.

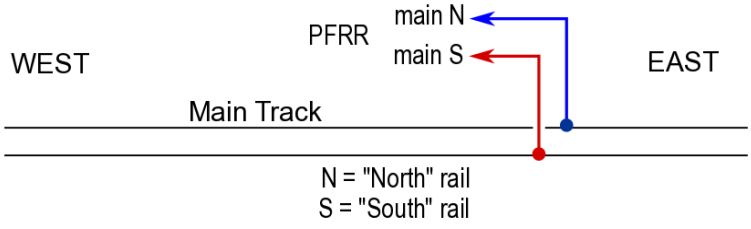
 Back and forth, no turnouts	Connect sensors: ***Do not connect W2*** W1 at west end E1 at east end *E2 may be used as a station stop between W1 & E1.* *External detectors may also be used for station stops.*	see page 1 below
	Connect sensors: ***Do not connect E1*** ***Do not connect E2*** W1 at first station stop W2 at second station stop, if desired *External detectors may also be used for station stops.*	see page 2

Back-and-forth operation

Must connect sensors W1 and E1
Sensors W2 and E2 are optional

Step 1 - Track wiring

Connect the main line rails to terminals 'main N' and 'main S' on the PFRR circuit board.



Step 2 - Install the Sensors

Install a train sensor at each location where a train will stop. Leave space between the sensor and the end of the track so the train will be able to slow down and stop before reaching the end of the track. The rate of deceleration and acceleration is varied by turning the ACCEL adjustment.

Sensors W1 and E1 must always be used for back-and-forth operation.

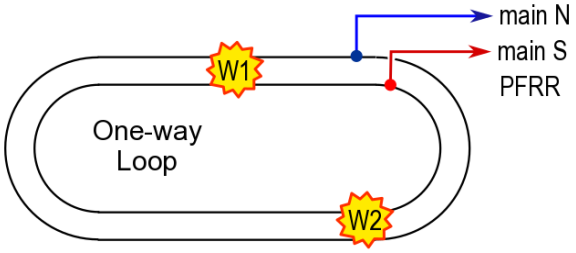
Sensor E2 may be installed for an intermediate station stop between sensors W1 & E1.
Other station stops can be created with external train detectors connected to terminals 'ST' and 'C.'
Go to page 4 for sensor installation details.

One-way loop operation

Connect sensors W1 and/or W2
Do not connect sensor E1 and do not connect sensor E2

Step 1 - Track wiring and rail gaps

Connect one loop track rail to 'main N' on the PFRR circuit board. Connect the other rail to 'main S'. To run the train in the opposite direction, swap these two wires.



Step 2 - Install the sensors for station stops

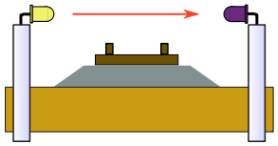
Install train sensor W1 where the train will stop momentarily, then continue in the same direction. If a second stop location is desired, install sensor W2.
Additional station stops can be created with external train detectors connected to terminals 'ST' and 'C.'

The rate of deceleration and acceleration is varied by turning the ACCEL adjustment.

Installing the Sensors

An IR (infrared) LED paired with an IR receiver may be used at each sensor location, or a mechanical switch such as a magnetic reed switch may be used. When using a mechanical switch, a resistor must be wired in parallel with it (see pg. 5). Use a resistor of 200 to 1000 ohms.

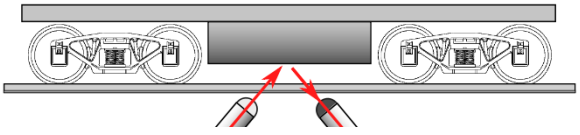
Each IR sensor pair may be installed in one of two different ways - 'Across the Track' or 'Reflective.'



Across the Track sensing: The IR LED is positioned horizontally on one side of the track, and its IR receiver is placed on the opposite side. A train is detected when it blocks the light path between the IR LED and its receiver. The distance between the IR LED and receiver can be up to 18 in. (46cm), or more with careful alignment. Place the sensors at an angle across the track to prevent the sensors being fooled by the gap between cars.

Tip #1 - If mounting the sensors vertically as shown here, slide the plastic tube away from the sensor then carefully bend the leads to a right angle. The leads are somewhat brittle, bending them more than two or three times may cause a break.

Tip #2 - Locate the IR receiver so it faces away from bright lights or sunny windows. Use scenery or structures to conceal the sensors.



Reflective sensing: Trains are detected when light from the IR LED is reflected off a train and sensed by the IR receiver. Typically the sensors are mounted in two #12 (3/16 inch, 4.8mm) holes drilled in the roadbed as shown above. Vertical installation works for S, O and larger scales as long as there is no structure above the track such as a bridge.

Angling the IR LED and its receiver toward each other is best for N and HO scale where the trains are close to the rail head, and in places where an object above the track might cause false detections. Angle the IR LED and receiver so their

centerlines intersect at the height of the bottom of your rolling stock.

Tip #3 - Track can be ballasted after sensors are installed. Cover sensors with transparent tape. Apply ballast. When the glue has dried remove ballast from the sensors with a dental pick or similar tool. An opening of just 1 or 2 mm is required.

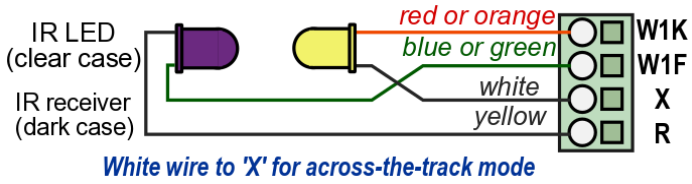
Connecting wires to the terminal blocks: The PFRR has 'spring cage' terminal blocks for the IR sensors. Connections are made as follows:

- ♣ Strip 3/8 inch (1 cm) of insulation off the end of the wire.
- ♣ Use a small screwdriver to push down (push, do not turn) the terminal's button. Push firmly.
- ♣ While the button is pushed in, hold the wire at a 45 degree angle to the terminal block and push it in. About 3/8 inch of wire should go into the terminal block.
- ♣ Release the button. Tug on the wire to make sure it is secure.

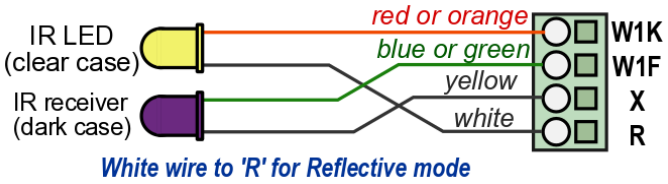
Note - not all track configurations require installation of all four sensor pairs.

Connecting a sensor pair: This example shows the W1 sensor pair. All IR sensors connect to the PFRR in a similar way.
Connect the **orange (or red)** wire from the IR LED to the **K** terminal (W1K in this case).
Connect the **green (or blue)** wire from the IR receiver to the F terminal (W1F in this case).

Now, how you connect the white and yellow wires to the PFRR will determine whether this sensor pair operates in 'Across the Track' or 'Reflective' mode. See the diagrams below.



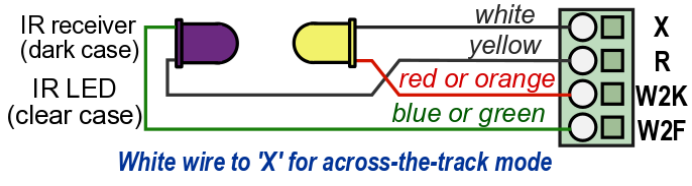
White wire to 'X' for across-the-track mode



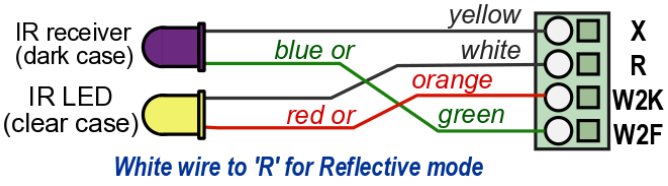
White wire to 'R' for Reflective mode

Add connections for the next sensor pair: This example uses sensor pair W2, your installation may not use sensor pair W2. Connect the orange (or red) wire from the IR LED to terminal W2K. Connect the green (or blue) wire from the IR receiver to terminal W2F. As with sensor pair W1, how you connect the two white and yellow wires will determine whether sensor pair W2 operates in 'Across the Track' or 'Reflective' mode.

Sensor pair W2 can operate in the same mode as W1, or in a different mode. When both sensor pairs are wired to the PFRR, there will be two white or yellow wires in 'X' and two white or yellow wires in 'R.' For best reliability, twist the ends of these wires together.



White wire to 'X' for across-the-track mode



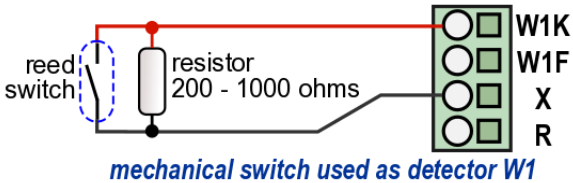
White wire to 'R' for Reflective mode

Additional wire may be spliced to the sensor leads if needed. Use similar twisted pair wire up to 26 ft (8m).

Connect any remaining sensors. The E1 sensor, if used, connects to terminals E1K, E1F, X and R similar to sensor W1. The E2 sensor, if used, connects to terminals E2K, E2F, X and R similar to sensor W2.

➽ **Pairing is important!** The IR LED that is connected to W1K must be paired on the layout with the IR receiver that is connected to W1F. Likewise the IR LED that is connected to E1K must be paired on the layout with the IR receiver that is connected to E1F. This is true for all sensor pairs.

Mechanical switches: Reed switches, limit switches or relays (such as Azatrax MRD1 detectors) may be used in place of the IR sensor pairs. Connect the two leads of the normally open switch or relay contact to



mechanical switch used as detector W1

the X and K terminals for the appropriate sensor. A resistor must be connected in parallel with the detector switch. Use 200 to 1000 ohms.

Test the sensors:
Connect an accessory power supply, 12 - 17 volts AC or DC, to terminals **P1** and **P2**. If one side of the power supply is connected to a layout 'common' or 'ground,' connect it to terminal **P2**. Connect the 'hot' side to **P1**.

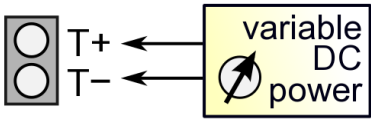
When power is first turned on, the red & green Direction LEDs will flash back and forth (except for the Continuous Loop mode, only the red W LED will flash because the train only goes in the 'west' direction).
During this time the yellow Detector LEDs will light to show which detector inputs actually have IR sensors or switches/resistors connected.

Verify that all the detectors you intend to use show a lighted LED.

Now check each detector individually by placing a rail car or other solid object on the track at each detector location. The yellow LED for each detector on the PFRR circuit should light when an object is at the detector, and should go out or blink when the object is removed.

Always turn off power before making or changing connections !

Step 4 - Connect the Train Power Supply to terminals T+ and T-.



Begin with the 'ACCEL' adjustment turned counter-clockwise for quick acceleration and braking.

Place a train on the track. Set the speed knob to a slow setting, then turn on the train power. The train will not move until the PFRR controller has been turned on (power applied to P1 & P2).

Increase the speed control until the train moves. If the train will not move, change the polarity of the power pack by changing the direction control switch or swapping the wires at '**T+**' and '**T-**.'

Make sure the train moves East or West as the PFRR direction LEDs indicate. If the train is moving in the wrong direction, swap the track power wires.

Tip #5 - Once the train is moving in the proper direction, *mark the power pack's direction switch.*

ACCEL adjustment - Turn the 'ACCEL' adjustment clockwise for longer train acceleration and braking times. Turn it counter-clockwise for quicker starts and stops. *It is OK to let the train coast past the train detectors.* The PFRR will remember that a train passed the detector, and will assume the train remains on that end track until the train trips the detector again when going in the opposite direction.

Memory Effect - The PFRR remembers when a train enters an end siding (see 'ACCEL adjustment' above), even if the train passes the detector before it stops.

Why is the yellow LED blinking? When a train enters an end track, it starts decelerating when it is detected by that track's sensor. If the train coasts past the sensor before coming to a stop, the PFRR circuit remembers that a train is on that track. A blinking yellow LED tells you the PFRR believes there is a train on that end track, but the sensor is not detecting the train. This is a "hidden" train.

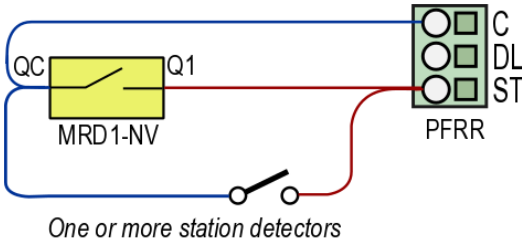
When the PFRR wants to bring that "hidden" train back to the main line, it applies power to the track and waits for that end sensor to be tripped, indicating that the train is coming out of the end track.

When adding a new train to the layout, make sure all trains are on end detectors before turning the PFRR on again. The PFRR will take a few extra seconds to reconcile train locations before starting operation.

When removing a train from the layout, it is best to let the train run to an end detector before removing it.

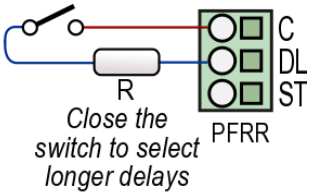
If a train is removed from the main line, allow the PFRR several extra seconds to adjust to the new situation. If it is not able to start correct operation then the PFRR memory must be cleared.

Station Stops - Additional train detectors may be added to create intermediate stopping points. When a train reaches one of these detectors, the PFRR will stop the train for several seconds, then the train will continue in the same direction. The east or west direction LED on the PFRR module will flash while the train is stopped.
These detectors may be separate circuits or switches. The example here shows two station stops. One is implemented with an Azatrax MRD1-NV detector circuit, the other with a reed switch.



Connect each station stop detector to PFRR terminals **ST** and **C**. Unlike mechanical switches used at the endpoints (E1, E2, W1 and W2), the switches used as station detectors do not need a resistor connected to them.

Longer Delays - The default pause time is six seconds. This can be changed to 12 seconds by connecting a wire from terminal **DL** to **C**.



For other delay times connect a resistor or a 10k potentiometer to terminals **DL** and **C**.
A 10k resistor results in the maximum pause time of 45 seconds.
1k ➞ 4 sec, 3k ➞ 8 sec, 6k ➞ 20 sec, 10k ➞ 45 sec. (Times are approximate.)

On the first pass after the PFRR has been turned on, the train will only stop for one second at each station stop. This lets you check all stops without having to wait for the full delay at each stop.

Troubleshooting - If the train is not moving, check the PFRR LEDs. If either the east or west direction LED is on steadily, this indicates that power from the power pack is being routed to the rails. Check that the power pack is turned on and the speed control is turned up. Check the power pack's direction switch.
Check for dirty track or a wiring problem between the power pack and PFRR or between the PFRR and the track.

If one of the direction LEDs is flashing and the other is off, the PFRR has sensed a train at a station stop detector. The PFRR will pause the train and flash the direction LED, then will resume. When the train pauses at the west or east end, both east and west direction LEDs will be off until the train starts in the reverse direction.

If the train is not moving and both direction LEDs are flashing simultaneously, it is because the PFRR senses too many occupied detectors and there is no open destination for the train. Check sensor adjustments. The PFRR's memory may need to be cleared if it is unable to resume normal operation (see above).