This system automates a switchback model train layout. Switchbacks are typically used by mountain railroads to enable a train to climb a steep mountain to reach a mine or logging location.

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

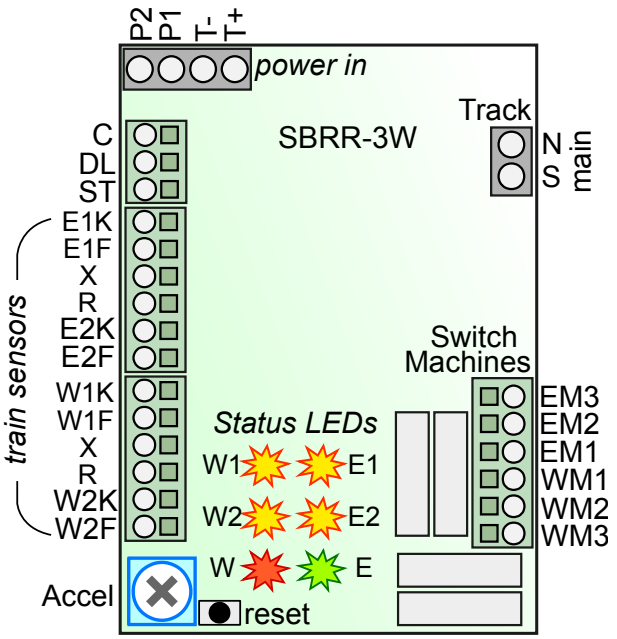
Maximum track current: 2 amps (2.5 amps for acceleration).

The SBRR-3W is designed for use with s**witch machines that have three-wire control cables**. These are twin-coil 'snap' switch machines such as Atlas, Bachmann and Peco.

If your switch machines have two control wires, use an SBRR-2W.

Additional required components:

- A DC train power pack ('throttle' or 'cab').
- Accessory power supply, 12 to 17 volts AC or DC, to power the SBRR circuit and switch machines - not a capacitor discharge unit.



How does the SwitchBack controller work?

Power from the train power pack (throttle) enters the controller's 'T+' and 'T-' terminals. It is routed through an acceleration / braking control circuit and a reversing relay, then goes to the track rails via terminals 'main N' and 'main S.' The on-board processor monitors the train detector inputs, and sets the relays and track switches to control train movement.

Step 1 - Track wiring

Connect the 'upper' rail ('north' rail) to the controller's '**main N**' terminal. Connect the 'lower' rail ('south' rail) to the controller's '**main S**' terminal.

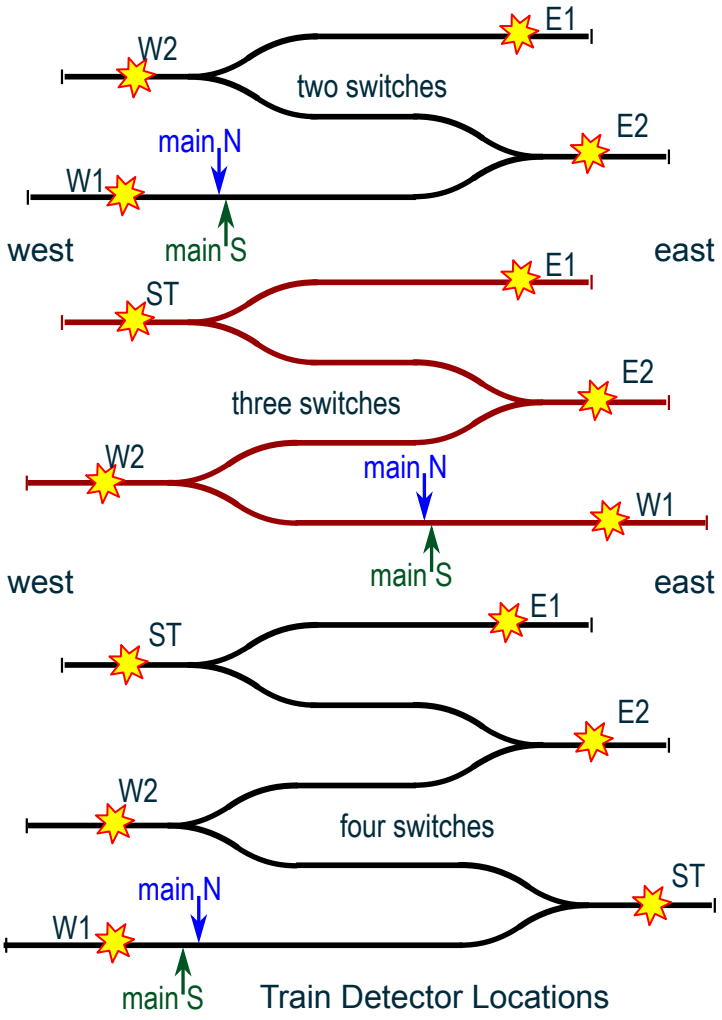
Step 2 - Install the detectors

Three possible track plans are shown at right. Train sensors are placed at each end track and connected to the controller inputs as indicated:

E1 - 'top' terminal track, top terminal is always on the 'east' side.

W1 - **bottom** terminal track, either west or east side.
E2 - any **east** side track that has **two** departure directions.
W2 - any **west** side track that has **two** departure directions.
The E1, W1, E2 and W2 detectors are built in to the SBRR circuit board. Infrared sensors are placed at the track locations and connected directly to the SBRR circuit board. See the wiring diagrams on pg 3.

The **ST** detectors are external train detectors. These can be Azatrax MRD1-NV infrared detectors, or reed switches activated by a magnet on the train. The **ST** detectors can be used at any midpoint track that has **two** departure



directions. **ST** detectors cannot be used at the top or bottom terminal tracks (E1 or W1).
When an approaching train trips a detector, the train will begin to slow down then stop. Locate each detector to allow enough stopping distance between the detector and the end of the track.

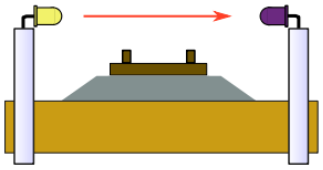
Note that after the train has been running 10 - 20 minutes, it will get warm and the grease will thin. It will run faster and require a longer stopping distance than when it first started. Leave enough distance from the detector to the end of the track to allow for varying stopping distance. Stopping distance is adjustable with the 'Accel' control, see below.

Step 3 - Connect IR Sensors E1, W1, E2 and W2 to the Controller

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.

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

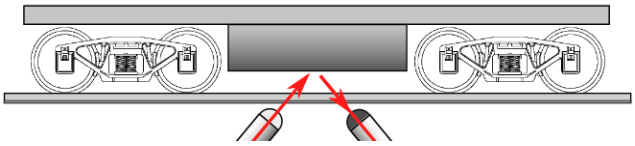
Across the Track sensing: The IR LED is positioned horizontally on one side of the track, and its IR receiver is placed on the opposite side. A train is detected when it blocks the light path between the IR LED and its receiver. The distance between the IR LED and receiver can be up to 18 in. (46cm).



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.

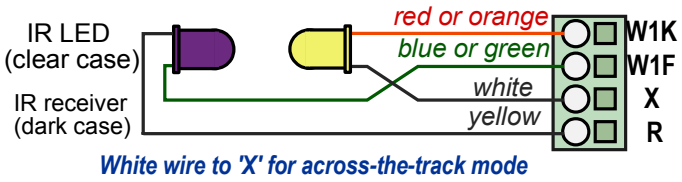
Tip #3 - Track can be ballasted after sensors are installed. Cover sensors with transparent tape. Apply ballast. When the glue has dried remove ballast from the sensors with a dental pick or similar tool. An opening of just 1 or 2 mm is required.

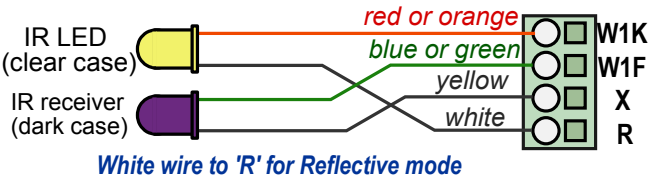
Connecting wires to the terminal blocks: The SBRR has 'spring cage' terminal blocks for the IR sensors. Connections are made as follows:

♦ 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.

Connecting a sensor pair: The following example shows the W1 sensor pair wring. All IR sensors connect to the SBRR 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).

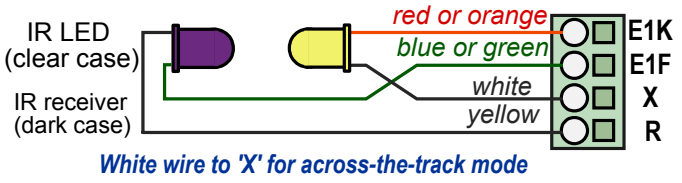
How you connect the white and yellow wires to the SBRR will determine whether this sensor pair operates in 'Across the Track' or 'Reflective' mode. See the diagrams below.

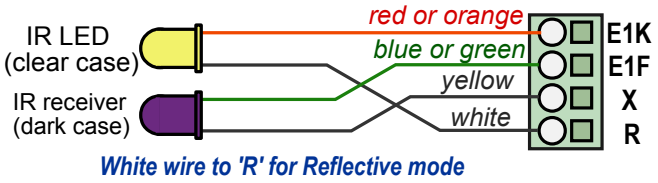




Add connections for the next sensor pair: The next example shows sensor pair E1. Connect the orange (or red) wire from the IR LED to terminal E1K. Connect the green (or blue) wire from the IR receiver to terminal E1F. As with sensor pair W1, how you connect the two white and yellow wires will determine whether sensor pair E1 operates in 'Across the Track' or 'Reflective' mode.

Sensor pair E1 can operate in the same mode as W1, or in a different mode. When both E1 & E2 sensor pairs, or W1 & W2 sensor pairs are wired to the SBRR, 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.



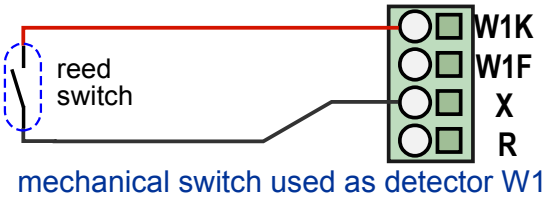


Additional wire may be spliced to the sensor leads if needed. Use similar twisted pair wire up to 26 ft (8m).

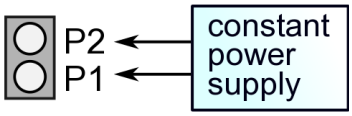
Connect the W2 sensor to terminals W2K, W2F, X and R similar to sensor W1.
The E2 sensor connects to terminals E2K, E2F, X and R similar to sensor W2.

➽ **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 to the X and K terminals for the appropriate sensor.



ST detectors: Will be covered soon, but first,
Test sensors W1, E1, W2 and E2 as follows:
Connect an accessory power supply, 12 - 17 volts AC or DC, to terminals **P1** and **P2**. It must be able to activate all west side or all east side switch machines at the same time.



Four yellow LEDs marked W1, E1, W2 & E2 are on the SBRR circuit.
These correspond to the built-in detector circuits.
There is a red LED marked West and a green LED marked East to indicate train direction.

Power-on check:
When power is applied to the SBRR, the green and red LEDs will flash for a few seconds. While they are flashing, the yellow LEDs will show which IR sensors are connected to the SBRR. If you connected an IR LED to an SBRR sensor input and its yellow LED is not on during this power-on check, turn off power and check the wiring to that IR LED.

After the green and red LEDs have stopped flashing, the **yellow LEDs will light steadily** when a train is being sensed by the IR sensors. **A blinking yellow LED** means the SBRR sensed a train going in to an end track, but the train coasted past the IR sensor before stopping. The SBRR believes the train is on the end track even though it is not being sensed.

A yellow LED that is off means no train is being sensed and the SBRR believes that end track is empty.

If no train is on a sensor but its yellow LED is steady 'on', this is a **"false sensing" condition**.

To fix false sensing for *Across-the-Track* mode:
1. Verify that the sensor pair is wired correctly.
2. Make sure the IR LED and photo receiver are pointed at each other, and nothing is between them.
3. Shade the photo receiver from bright lights, and point it away from windows or other strong light sources.
4. Change the nearby room light from incandescent to a fluorescent or LED bulb if possible.

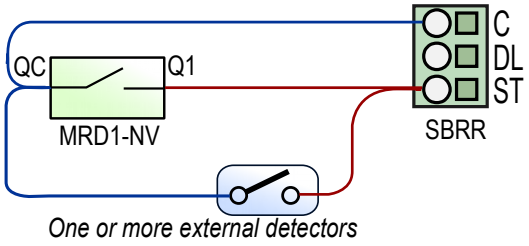
To fix false sensing for *Reflective* mode:
1. Verify that the sensor pair is wired correctly.
2. Pull the IR LED and photo receiver a bit deeper into the roadbed.
3. Infrared light may be 'leaking' through the roadbed material from the IR LED to the photo receiver. Push a metal shim, such as the tip of a hobby knife blade, vertically into the roadbed between the IR LED and photo receiver.
4. Is there an object above the sensor, such as a bridge, or an upper layout level? Mount the IR LED and photo receiver at a shallower angle, or paint the object flat black. Or use across-the-track sensing.

If a train is on a sensor but its yellow LED is not steady 'on', this is a **"false clear" condition**.

To fix a false clear indication for *Across-the-track* mode:
1. Verify that the sensor pair is wired correctly.
2. Adjust the sensor height so the train is fully blocking the light path from the IR LED to the photo receiver.

To fix a false clear indication for *Reflective* mode:
1. Verify that the sensor pair is wired correctly.
2. Adjust the sensors higher or lower in the roadbed.
3. A bright light source above and to the side of the track may be saturating the IR photo receiver. Try pulling it deeper into the roadbed or create shade with scenery or a structure. Change the nearby light from incandescent to a fluorescent bulb.

Test with several types of rolling stock and adjust the sensors as needed.
Sensors must be working correctly before continuing the installation.

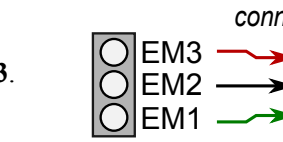


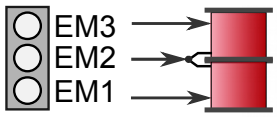
ST detectors
External detector circuits such as Azatrax MRD1-NV IR detectors or magnetic reed switches can be used at any west or east side end track that has **two** departure directions. They can be used anywhere except the top terminal point (E1) or the bottom terminal point (W1).

External detectors should close a switch or relay when a train is detected (they should be 'normally open'). One side of each detector switch connects to SBRR terminal '**ST**' and the other side of the detector switch connects to terminal '**C**'.

Step 4 - Connect the Switch Machines
Connect all west side switch machines to terminals **WM1, WM2 & WM3**.
Connect all east side switch machines to terminals **EM1, EM2 & EM3**.

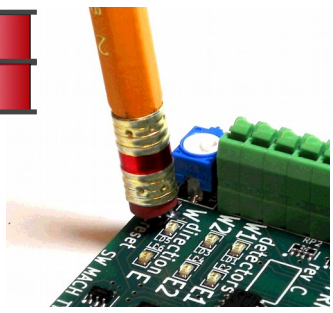
Do not connect to other buttons or circuits.
Do not connect 'EM2' or 'WM2' to a layout 'common' or 'ground.'



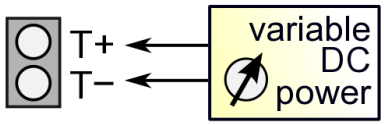


Test the switch machines by resetting the SBRR circuit.

Reset the SBRR circuit
Turn on the accessory power. Press the **Reset** button with a non-conductive tool such as the eraser end of a pencil.
The green and red direction LEDs will flash.
All turnouts will line for their 'downhill' branch -- that is, if a train moves from the points toward the frog, it will take the downhill track.
If a turnout lines the wrong way, swap the two outer wires (EM1-EM3 or WM1-WM3) at the switch machine.

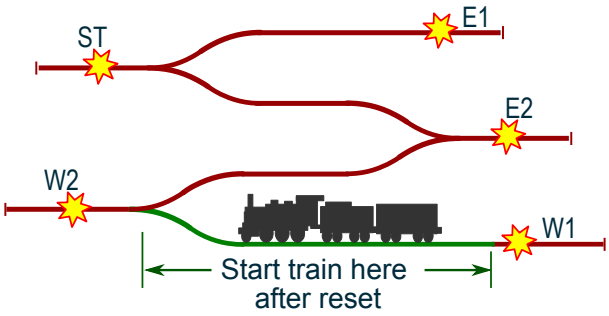


Step 5 - Connect the DC Train Power Pack to terminals T+ and T-.
Set the speed control to zero before placing a train on the track.



Step 6 - Put a train on the track
Add a train to the lower terminal track.
Place the train between sensor W1 and the turnout.
Make sure the train is clear of sensor W1.

After a reset, the train should move to the west.
Make sure the **red direction LED** is lit on the SBRR circuit.
Gradually increase the speed control until the train begins to move.



If it does not move at all, change the direction switch on the power pack and try again.
If the train moves in the wrong direction, swap the track power wires at terminals main N and main S.

When the train is moving in the correct direction, mark or tape the direction switch on the power pack.
It will only work in this position. Changing the direction switch will **not** change the train's direction.

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

As the train moves west it eventually trips the first west detector. The train should stop and turnouts will change their points.

After a few seconds the train will move east until it trips an east detector. It will stop and all turnouts will change position. This process continues until the train encounters the top detector (**E1**), then the train will work its way back down.

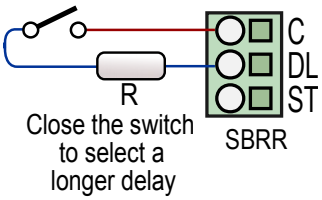
ACCEL adjustment - Turn the 'ACCEL' adjustment clockwise for longer train acceleration and braking times. Turn it counter-clockwise for quicker starts and stops. It is OK to let the train coast past the train detectors. The controller will remember that a train passed the detector.

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

If a train has been removed from the layout, a yellow LED may be flashing for an end track that is actually empty. **When replacing a train on the layout,** reset the SBRR circuit and place the new train on the bottom track as described above.

Longer Delays - The default pause time is six seconds. This can be doubled 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.)



Troubleshooting - If the train is not moving, check the SBRR 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 SBRR or between the SBRR and the track.
Check the power pack's direction switch.
If both direction LEDs are flashing simultaneously, it is because the SBRR senses too many occupied detectors. Check sensor adjustments. The SBRR may need to be reset if it is unable to resume normal operation (see above).
The accessory power supply must have enough current capacity (amps) to activate half of the turnouts simultaneously. It should not be a 'capacitive discharge' (CD) unit.