

What it is: The MRD2 'exhibit' edition is a two-channel model train detector. It can detect two model trains at two sidings on an oval track, and alternately run the trains in opposite directions around the loop. Or, the MRD2 can be used as a direction sensing train detector, activating one circuit when a train moves in one direction on a track, and activating a different circuit when a train moves in the opposite direction on that track..

Kit contents:

- ★ Circuit board
- ★ Two infrared light-emitting diodes (IR LEDs) with orange & white (2 ft length) or red & white (6 ft length) wire leads
- ★ Two infrared phototransistors (IR receivers) with green & yellow (2 ft length) or blue & yellow (6 ft length) wire leads
- ★ Four plastic mounting tubes. The tubes are for protection of the sensor leads and to provide mounting support. They are not essential for detector operation and may be shortened or removed entirely to best fit your situation. Just use caution not to damage the leads.
- ★ Diodes for exhibit layouts that have DC-powered trains (DC power to the rails)
- ★ Connector for making a cable for slow motion switch machines
- ★ Mounting screws

How it works: Trains are detected by infrared (IR) light, invisible to the human eye. There are two sensing elements at each track location - an IR LED light source paired with an IR phototransistor (the receiver). The output relay contacts are electrically isolated from the detector electronics. Green and red LEDs on the MRD2 show the status of the detectors. The action of the relays and LEDs in response to train detection depends on the operating mode selected by the user. The available operating modes are:

- ◆ Set up (LEDs show detector status, but relays are disabled)
- ◆ Direction sensitive train detector
- ◆ Loop exhibit with either 2-second or 6-second delay.

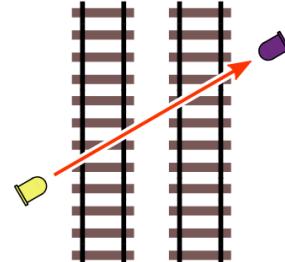
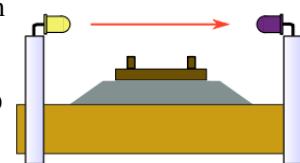
Details are covered below under 'Operating Modes.'

Installation

The five installation steps are: Sensor installation, Power connection, Sensor adjustment, Mode selection and Layout wiring.

First, install the sensors: Each sensor pair may be installed in one of two different ways - 'Across the Track' or 'Reflective.' Choose locations according to how you will use the detector -- see 'Operating Modes'.

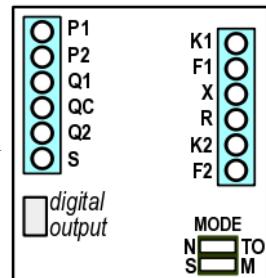
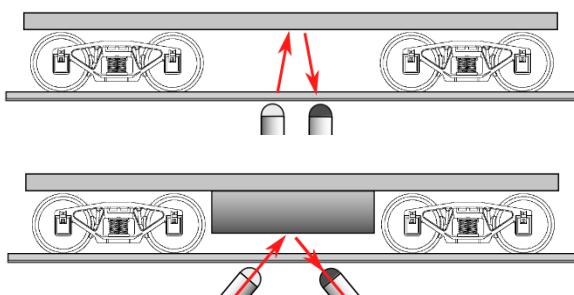
Across the Track sensing: The IR LED is positioned horizontally on one side of the track(s), and the IR phototransistor is placed on the opposite side. A train is detected when it blocks the light path between the LED and phototransistor. The distance between the LED and phototransistor can be up to 18 in. (46cm), or more with careful alignment. Placing the sensors at an angle across the track(s) creates a longer detection zone and avoids possible detector flickering caused by the gaps between cars.



Tip #1 - If mounting the sensors vertically as shown here, slide the plastic tubes 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.

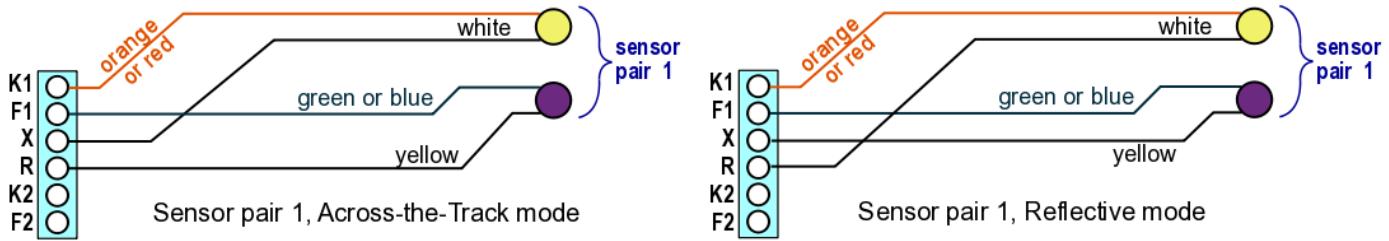
Tip #2 - Locate the phototransistor (receiver) so it faces away from bright lights or sunny windows. Use scenery or structures to conceal the sensors and shade them from room lighting.

Reflective sensing: Trains are detected when light from the IR LED is reflected off a train and sensed by the IR phototransistor. Typically the sensors are mounted in two 3/16-inch (4.8mm) holes drilled in the roadbed as shown here. Vertical installation works for HO and larger scales as long as there is no structure above the track such as a bridge. Angling the IR LED and phototransistor toward each other is best for N scale where the trains are close to the rail head, and in places where an object above the track might otherwise cause false detections. Angle the IR LED and phototransistor so their centerlines intersect at the height of the bottom of your rolling stock.



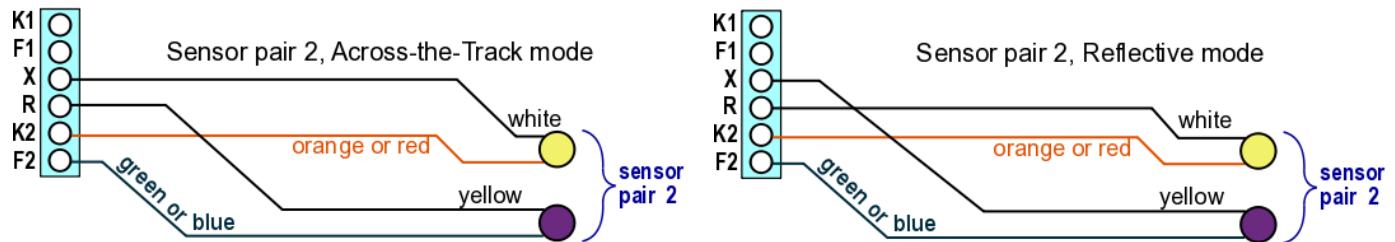
Tip #3 - You can ballast your track after sensors are installed. Cover each sensor with a bit of transparent tape. Apply ballast. When the glue has dried, use a dental pick or similar tool to remove ballast from the sensors. An opening of only 1 or 2 mm is required.

Connect sensor pair 1: How you connect the IR LED and phototransistor to the MRD2 module determines whether Detector 1 will operate in 'Across the Track' or 'Reflective' mode.



Add connections for sensor pair 2: Detector 2 can operate in the same mode as Detector 1, or in a different mode.

Note: when both sensor pairs are connected, there will be two white/yellow wires in 'X' and two white/yellow wires in 'R.'



Additional wire may be spliced to the sensor leads if needed. Use similar twisted pair wire for total length up to 25 ft (7.5m).

Connect power to the MRD2 module: Connect an accessory power supply of 9 to 15 volts AC or DC to terminals P1 and P2. Do not connect the relay outputs Q1 and Q2 until after the sensors have been adjusted.

Adjust the sensors: Set the Mode switches to 'N' and 'S' and apply power to the MRD2. We use this mode because the on-board LEDs indicate detector status with no delays. Both relay contacts will remain open.

With no trains in either detection zone, the green and red LEDs on the MRD2 module should be off. If either LED is on, correct the 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 phototransistor are pointed at each other, and nothing is between them.
3. Shade the phototransistor 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 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 phototransistor a bit deeper into the roadbed.
3. Infrared light may be 'leaking' through the roadbed material from the IR LED to the phototransistor. Push a metal shim, such as the tip of a hobby knife blade, vertically into the roadbed between the IR LED and phototransistor.
4. Is there an object above the sensor, such as a bridge, or an upper layout level? Mount the IR LED and phototransistor at a shallower angle, or paint the object flat black. Or use across-the-track sensing.

Both detectors now off? Now **test for train detection**. Place a locomotive or car in the detection zone of Detector 1. The MRD2's green LED should light. If the red LED also lights, re-adjust sensor pair 2 for false detection (see above). If the green LED does not light, correct sensor pair 1 for 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 phototransistor.

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 phototransistor. 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.

Remove the train from Detector 1's detection zone, make sure the green LED goes out.

Place a train in Detector 2's detection zone. The MRD2's red LED should light. If the green LED also turns on, adjust sensor pair 1 for false detection (see above). If the red LED does not light, adjust sensor pair 2 for a false clear condition (same as above for sensor pair 1).

Operating Modes - Selection and Wiring

Set the Mode switches on the MRD2 module according to the desired operating mode. Do not connect relay outputs Q1 and Q2 until after setting the Mode switches.

MODE Set up. Set the Mode switches to 'N' and 'S'. The green on-board LED will light when a train is being sensed by sensor pair 1, and the green LED will be off when sensor pair 1 is not sensing a train. Similarly, the red on-board LED shows the status of sensor pair 2. Both relay contacts are always open.

MODE Direction sensing train detector. Set the Mode switches to 'N' and 'M'. Two separate circuits can be activated depending on the direction that the train is moving. Place sensor pairs 1 and 2 on the same track. The **minimum** distance between them is the distance that your **fastest** train will travel in 1/2 second. The **maximum** distance between the two sensor pairs is the distance that your **slowest** train will travel in 10 seconds **plus** the length of your **shortest** train.

When a train first encounters sensor pair 1, the MRD2 relay 1 will close and the green LED will turn on. Relay 1 and the green LED will stay on as long as a train is on sensor pair 1. Once the train clears sensor pair 1 the green LED will flash and Relay 1 will stay closed for 10 seconds. If the train reaches sensor pair 2 before the 10 seconds expire, the green LED will remain flashing and Relay 1 will remain closed until the train clears sensor pair 2.

If a train is moving in the opposite direction and encounters sensor pair 2 first, similar operation occurs with the red on-board LED and relay 2.

MODE Exhibit loop operation. Set the Mode switches to 'TO' and 'S' for a two-second delay between trains, or to 'TO' and 'M' for a six-second delay between trains.

An exhibit loop layout consists of an oval of track with two passing sidings. Typically the passing sidings are hidden behind a backdrop. At one end of the layout is a model of a producer industry such as a coal mine, and at the other end is a consumer

industry such as a power plant or steel mill. Two trains operate on the layout, one with loaded open cars such as hopper cars filled with coal, the other with identical empty cars. The loaded train travels from its hidden siding, around the producer site (coal mine) to the consumer site (steel mill) and then into the hidden area and its siding. The loaded train stops, then a few seconds later the empty train travels in the opposite direction from its siding, around the consumer site to the producer site, then behind the backdrop to its siding. After another pause the cycle repeats. If space permits, another loop can show another pair of trains taking goods from the consumer site (steel mill) to another industry such as a stamping plant.

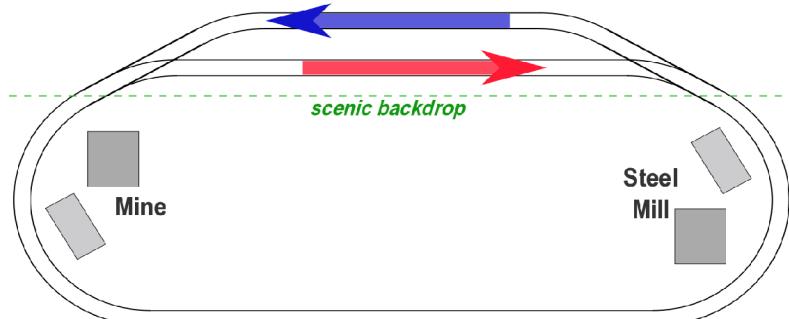
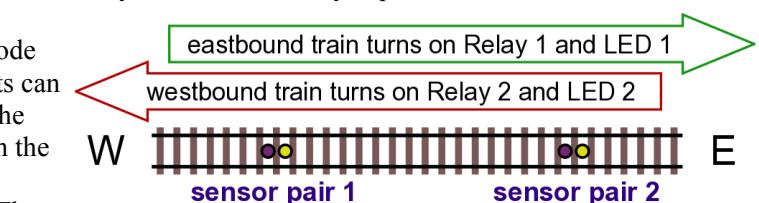


Exhibit layout wiring for AC or DCC powered trains

The MRD2 Exhibit Controller alternately powers the two sidings in response to the trains triggering the two sensor pairs. Make sure your trains will always start in the forward direction when power is restored to their track (lock the 'e-unit' on AC powered trains). The MRD2 can switch loads up to 3 amps, sufficient for N and HO scale and for single S and O scale locos with modern can motors. For heavier loads, wire the MRD2's outputs to two power relays, and use the relays to switch the power to the sidings. The diagram below shows connections for an exhibit layout with AC or DCC track power.

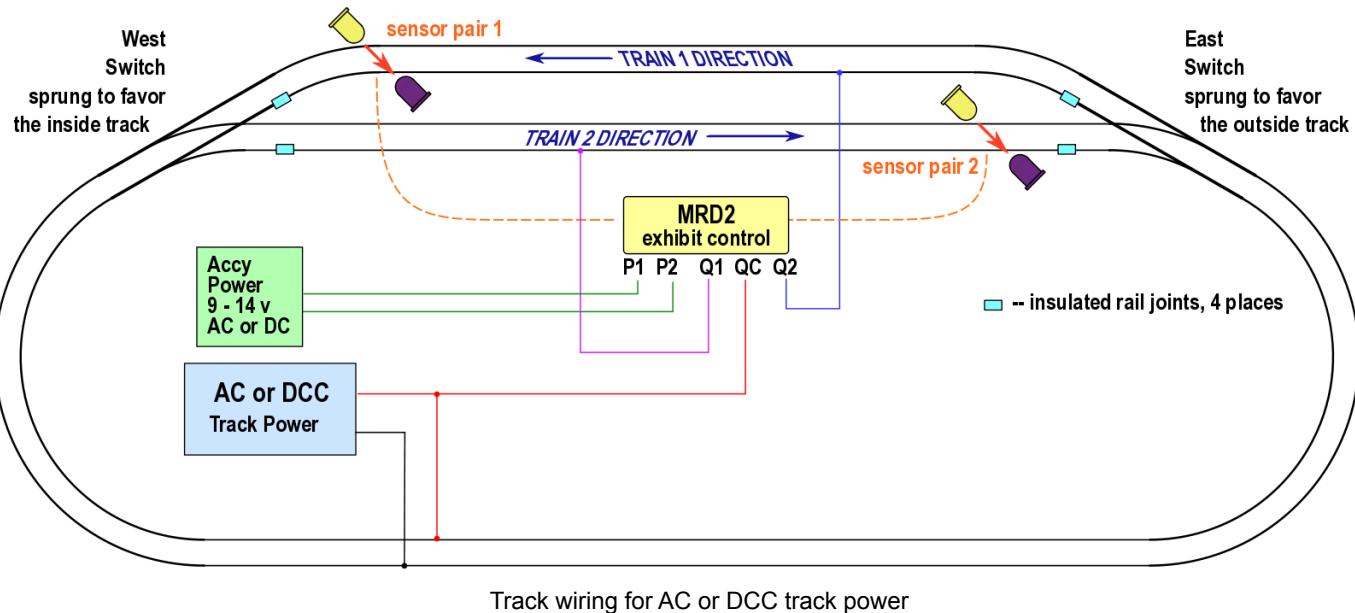
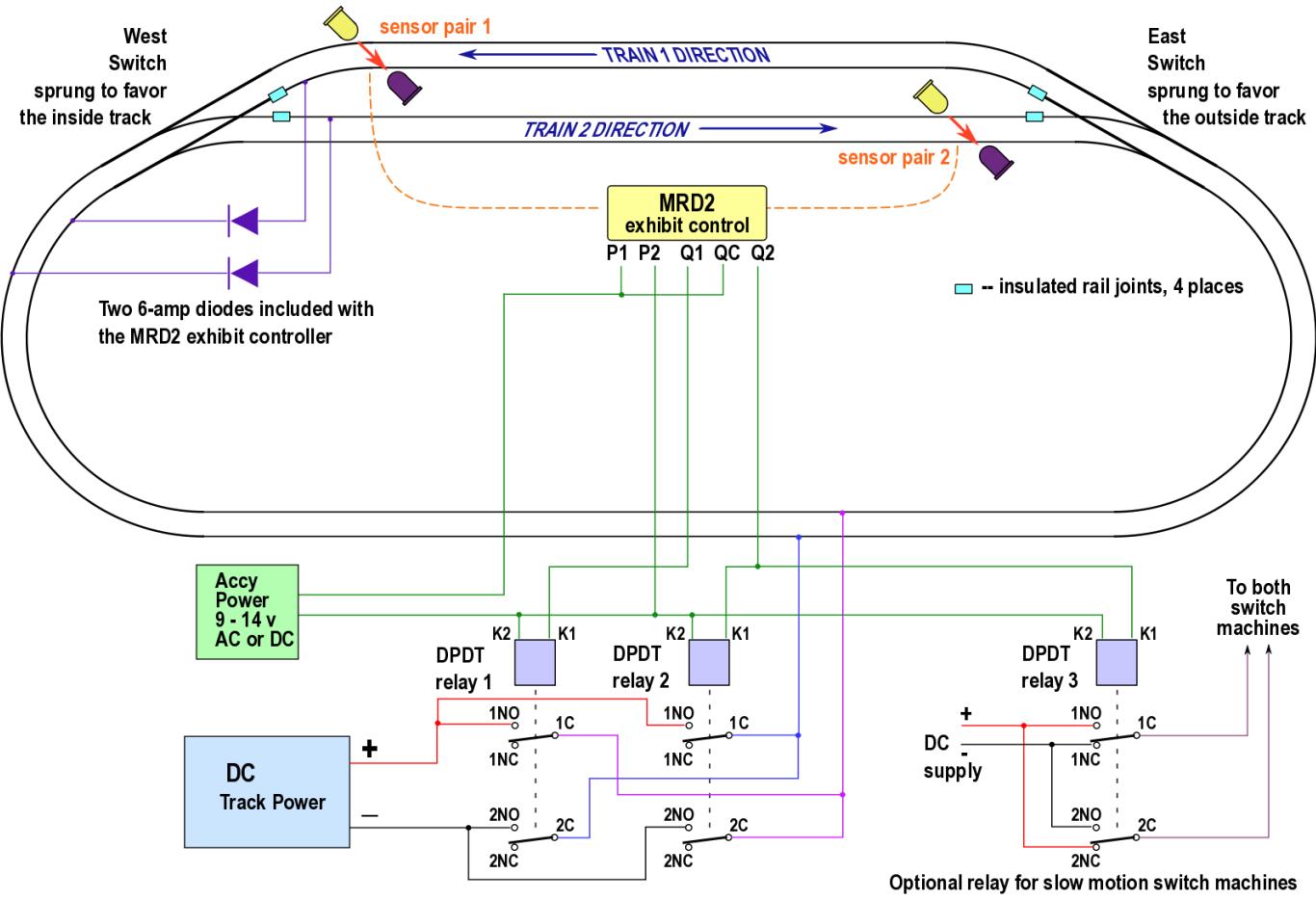


Exhibit layout wiring for DC powered trains

The direction of trains that use DC track power is determined by the +/- polarity of the track power. As shown in the diagram below, the MRD2 controls two relays, K1 and K2, to change the track power polarity. The two diodes allow trains to move in only one direction on the passing sidings.



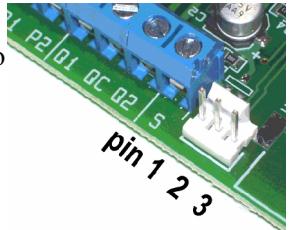
Track wiring for DC track power

Track switches

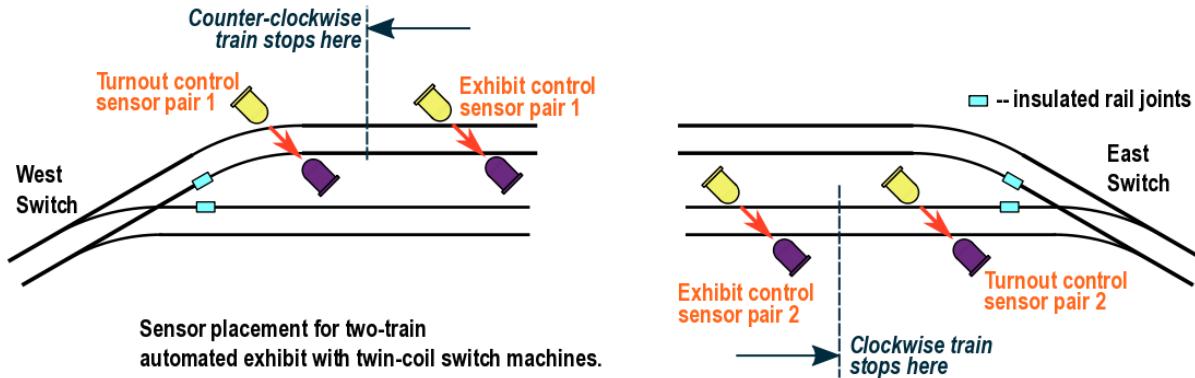
Sprung track switches do not have switch machines. They have a light spring that holds the points in one position, so trains always take the same siding every time they enter the switch. The spring is light enough that a train can exit either siding without derailing.

If powered switches are used, they may have slow-motion switch machines or twin-solenoid 'snap' switch machines. Two **slow-motion switch machines** (SwitchMaster® or Tortoise®) can be wired in parallel to pins 1 & 3 of the white 3-pin connector on the MRD2. Cobalt® switch machines run too slowly on the 5-volt output from the MRD2.

Use the 3-wire connector included with the MRD2 exhibit controller and AWG #24 (0.22 mm²) stranded wire to make connections to the slow motion switch machines. If you wish to use a different connector, choose one that mates with the **AMP 640456-3** on the board.



Twin-coil or single-coil ('snap') switch machines require a separate MRD2 in turnout control configuration. Place the sensors for the turnout controller as shown in the drawing below. The trains should stop when they trigger the exhibit controller sensors. Place the turnout controller sensors past the point where the trains come to a stop, so the turnouts will be thrown only after the train starts moving again.



Tortoise® is a trademark of Circuitron, Inc., Romeoville, IL. SwitchMaster® is a trademark of Builders In Scale, Mukilteo, WA.