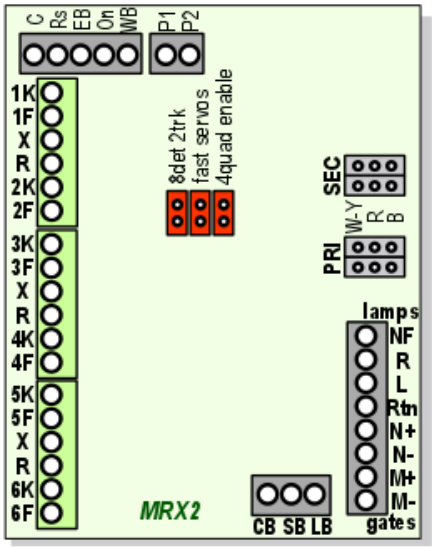


What it is: The MRX2 is a sophisticated controller that realistically operates model railroad / highway crossing signals. The MRX2 includes six infrared train detectors.

Kit contents:

★ Circuit board and mounting screws

If this controller was purchased with infrared train sensors, the kit also includes:

★ Infrared light-emitting diodes (IR LEDs) with orange & white (2 ft length) or red & white (6 ft length) wire leads

★ Infrared photo receivers with green & yellow (2 ft length) or blue & yellow (6 ft length) wire leads

★ 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 to avoid damaging the leads.

How it works: Trains are detected by infrared (IR) light, invisible to human eyes. There are two sensing elements at each track location - an IR LED light source paired with an IR photo receiver. Yellow LEDs on the MRX2 show the status of the detectors -- 'on' if the circuit is detecting an object, 'off' if no object is detected.

External train detectors, such as current sensing block detectors may also be used with the MRX2. See page 6.

The processor on the MRX2 watches all the train detectors and decides when the crossing signals should be turned on or off. Signals can have left/right flashing lamps, non-flashing lamps and operating crossing gates in either 2-quadrant or 4-quadrant configuration. The MRX2 also has connections for triggering an external sound module or other accessories.

Installation

There are four installation steps: Sensor installation, Power connection, Sensor adjustment, and Output connection.

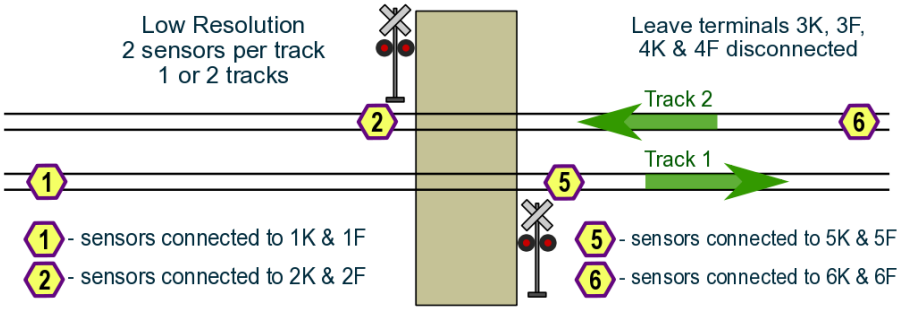
First, choose sensor locations: Choose locations according to the number of tracks and the type of train movements that are expected at the crossing. There are three levels of train detection resolution. The higher the resolution, the more realistic the operation:

◊ **Low Resolution** -- Two detectors per track, one on each side of the crossing

◊ **Standard Resolution** -- Four detectors per track, two on each side of the crossing

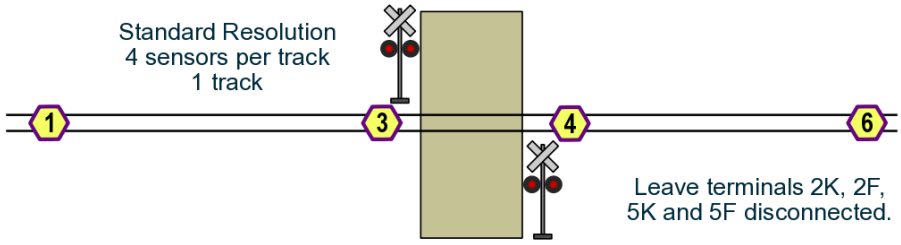
◊ **High Resolution** -- Six detectors per track, three on each side of the crossing.

2 sensors per track, 1 or 2 tracks:



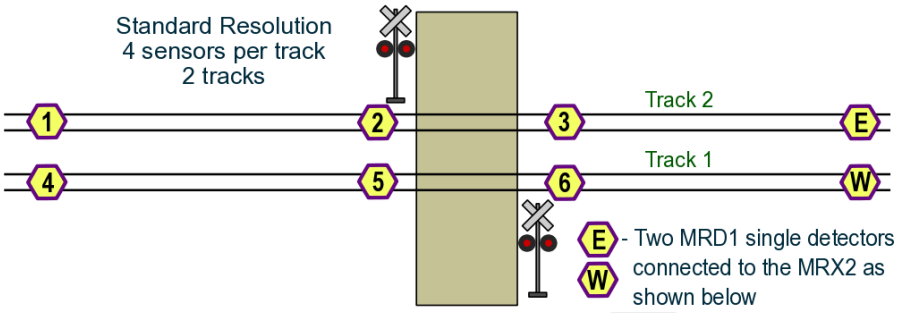
Signal turns on when a train on track 1 moves from left to right and triggers sensor 1. Signal stays on as long as the train is on either sensor 1 or sensor 5. If a short train leaves sensor 1 before reaching sensor 5 the signals will stay on for up to 30 seconds. Once the train clears sensor 5, the signals will turn off. Similar operation happens if the train on track 1 moves from right to left, encountering sensor 5 first. If trains travel in both directions on a track, place the two sensors equal distances from the crossing. Sensors 2 and 6 on track 2 operate in the same way as the sensors on track 1.

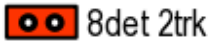
4 sensors, single track:



Signal turns on when a train moving left to right is detected by sensor 1. If the train does not reach sensor 3 within 30 seconds, whether it is still on sensor 1 or not, the signal tuns off. When the train does reach sensor 3, the signal remains on as long as the train is on either sensor 3 or 4. When the train clears both sensor 3 and sensor 4 the signal will turn off. Similar operation occurs when a train travels from right to left.

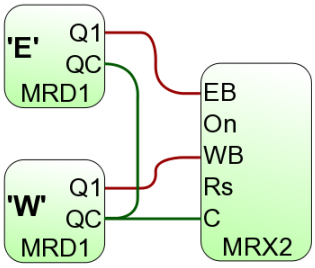
4 sensors per track, 2 tracks:
Use two external detectors (Azatrax MRD1) in addition to the six detectors on the MRX2 to provide standard resolution detection for a double track crossing. Install the two single detectors according to their instructions, and connect them to MRX2 terminals 'EB' and 'WB' as shown at right. Each track is independently monitored in the same fashion as described above for '4 sensors single track.'



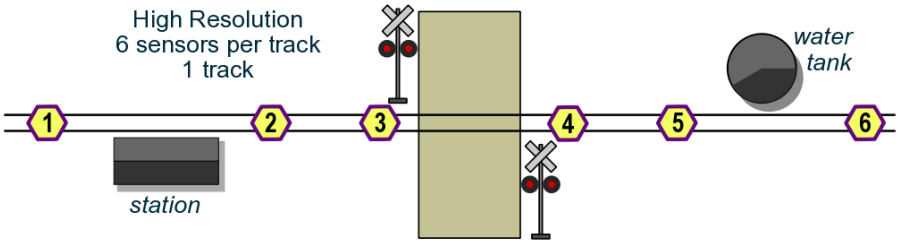


Install a connecting jumper across the two pins on the MRX2 labeled '8det 2trk' ('8 detectors, 2 tracks').

Remove the jumper (or place it on just one pin) for single track operation:

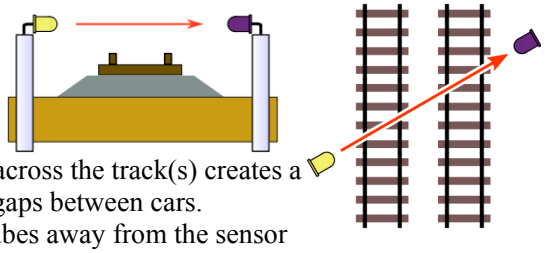


5 or 6 sensors, 1 track: Use five or six sensors per track when trains might stop or change direction within the crossing warning zone, or when trains of vastly different speeds use the same track. Signal turns on when a train moving left to right is detected by sensor 1. The train has 30 seconds to reach sensor 2 to keep the signal on. If the train stops before it reaches sensor 2, the signal will turn off even if the train remains on sensor 1. When the train starts again and resumes its motion toward the crossing, it trips sensor 2 turning the signal on again.
The train has another 30 seconds to reach sensor 3, or else the signal will turn off. While the train is on either sensor 3 or sensor 4 the signal will stay on. Once the train clears sensors 3 and 4 the signal turns off. If the train is moving away from the crossing and it clears sensor 5, but then stops and changes direction (now moving right to left), the signal will turn on again when the train re-triggers sensor 5. Use if switching moves occur near the crossing. To use just five sensors, leave either sensor 2 or sensor 5 disconnected.



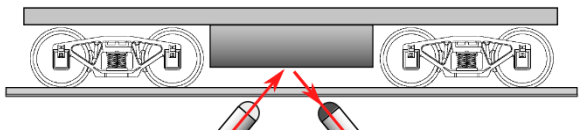
Choose mounting style: Each sensor pair may be installed in one of two different ways - 'Across the Track' or 'Reflective.'

Across the Track sensing: The IR LED is positioned horizontally on one side of the track(s), and the IR photo receiver is placed on the opposite side. A train is detected when it blocks the light path between the LED and photo receiver. The distance between the LED and photo receiver 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 photo 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.
Tip #3 - The detection zone of each detector can be expanded by adding a second IR LED/ photo receiver pair. Additional sensor pairs may be purchased from Azatrax, see the website www.azatrax.com for details.

Reflective sensing: Trains are detected when light from the IR LED is reflected off a train and sensed by the IR photo receiver. Typically the sensors are mounted in two 3/16-inch (4.8mm) holes drilled in the roadbed as shown above. Vertical installation works for S and larger scales as long as there is no structure above the track such as a bridge. Angling the IR LED and photo 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 photo receiver so their centerlines intersect at the height of the bottom of your rolling stock.



Tip #4 - Track can be ballasted after sensors are installed. Cover sensors with transparent tape. Apply ballast. When the

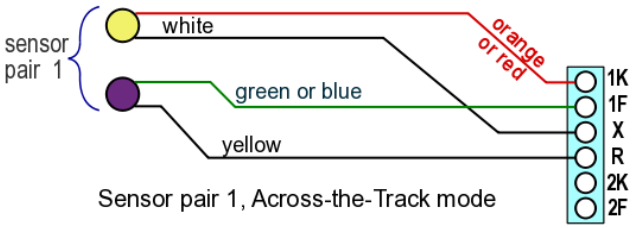
glue has dried remove ballast from the sensors with a dental pick or similar tool. An opening of just 1 or 2 mm is required.

Connecting wires to the terminal blocks: The MRX2 has 'spring cage' terminal blocks for the IR sensors. Connections are made as follows:

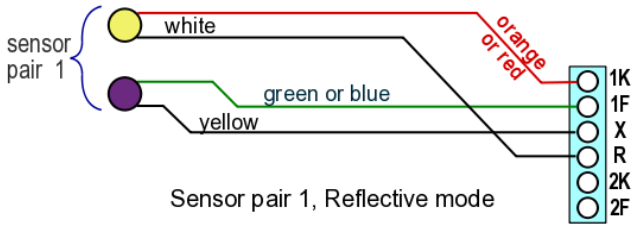
- ♣ Strip 3/8 inch (1 cm) of insulation off the end of the wire. You can measure with the strip gauge printed near the edge of the circuit board.
- ♣ Use a small screwdriver to push down (push, do not turn) the terminal's button. Push firmly.
- ♣ While the button is pushed in, hold the wire at a 45 degree 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 that not all crossing signal systems will require installation of all six sensor pairs.

Connect sensor pair 1: Connect the orange (or red) wire from the IR LED to terminal 1K. Connect the green (or blue) wire from the IR photo receiver to terminal 1F. Now, how you connect the two white and yellow wires to the MRX2 will determine whether Detector 1 will operate in 'Across the Track' or 'Reflective' mode. See the diagrams below.

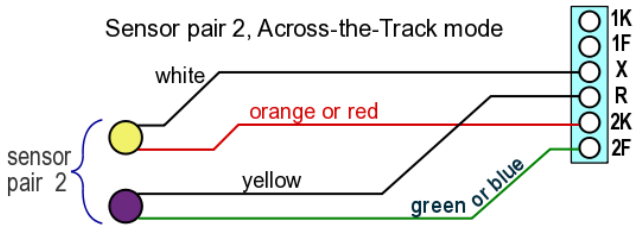


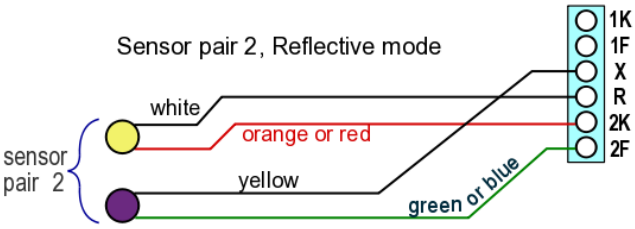
Sensor pair 1, Across-the-Track mode



Sensor pair 1, Reflective mode

Add connections for the next sensor pair: (This example uses sensor pair 2, your installation may not use sensor pair 2). Connect the orange (or red) wire from the IR LED to terminal 2K. Connect the green (or blue) wire from the IR photo receiver to terminal 2F. As with sensor pair 1, how you connect the two white and yellow wires will determine whether Detector 2 will operate in 'Across the Track' or 'Reflective' mode. Detector 2 can operate in the same mode as Detector 1, or in a different mode. Note that when both sensor pairs are wired to the MRX2, there will be two white or yellow wires in 'X' and two white or 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 26 ft (8m).

➽ **Pairing is important!** The IR LED that is connected to 1K must be paired on the layout with the IR photo receiver that is connected to 1F. And the IR LED that is connected to 2K must be paired on the layout with the IR photo receiver that is connected to 2F. This is true for all sensor pairs.

Connect power to the MRX2: Connect an accessory power supply to terminals P1 & P2. The LEDs will briefly flash to show that power is on and the circuit is working.

Choosing a power supply -- Installations without crossing gates, or that use low current DC stall motors to operate the gates (slow motion switch machines such as Tortoise®), may use an AC or DC power supply of 9 to 15 volts.

Installations with R/C servo motors should use a ***regulated*** 9 or 12 volt DC power supply that is rated for at least 600 milliamps (0.6 amp) output current.

R/C servos draw high current in short bursts, so a regulated DC supply works best.

Adjust the sensors:

Test and adjust sensor pairs 1 & 2 as follows before connecting the rest of the sensors:

With no trains in any of the detection zones, all of the yellow LEDs on the MRX2 module should be off. If any yellow 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 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 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.

Are all detectors now off? Now **test for train detection**. Place a locomotive or car in the detection zone of Detector 1. Yellow LED#1 should light. If yellow LED#2 also lights, re-adjust sensor pair 2 for false detection (see above). If LED#1 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 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.
Remove the train from Detector 1's detection zone, make sure LED#1 goes out.
Place a train in Detector 2's detection zone. The yellow LED#2 should light. If LED#1 also turns on, adjust sensor pair 1 for false detection (see above). If LED#2 does not light, adjust sensor pair 2 for a false clear condition (same process as above for sensor pair 1).

Connect sensor pair 3 (if used): Turn off the power. Move on to the next input terminal block. Connect the orange (or red) wire from the IR LED to terminal 3K. Connect the green (or blue) wire from the IR photo receiver to terminal 3F. Again, how you connect the two white and yellow wires to the MRX2 will determine whether Detector 3 will operate in 'Across the Track' or 'Reflective' mode.

Connect sensor pair 4 (if used): Connect the orange (or red) wire from the IR LED to terminal 4K. Connect the green (or blue) wire from the IR photo receiver to terminal 4F. As with the previous sensor pairs, how you connect the white and yellow) wires will determine whether Detector 4 will operate in 'Across the Track' or 'Reflective' mode. Detector 4 can operate in the same mode as Detector 3, or in a different mode.

When both sensor pairs are connected, there will be two white (or yellow) wires in 'X' and two white (or yellow) wires in 'R.'
Turn on power to test and adjust sensor pairs 3 & 4 the same way you tested sensor pairs 1 & 2 (see pg. 2).
Once sensor pairs 1 - 4 are working properly, connect the remaining sensors in the same way.

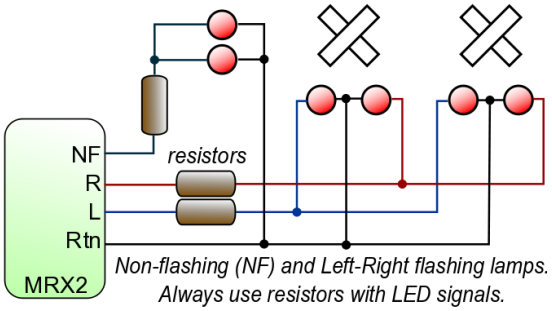
Sensor pair 5 (if used):

IR LED orange (or red) wire to 5K. IR LED white wire to X (for across-the-track) or R (for reflective mode).
IR receiver green (or blue) wire to 5F. IR receiver yellow wire to R (across-the-track) or X (reflective).

Sensor pair 6 (if used):

IR LED orange (or red) wire to 6K. IR LED white wire to X (for across-the-track) or R (for reflective mode).

IR receiver green (or blue) wire to 6F. IR receiver yellow wire to R (across-the-track) or X (reflective).
Turn on power. Test and adjust sensor pairs 5 & 6. All sensors should now be connected and working.

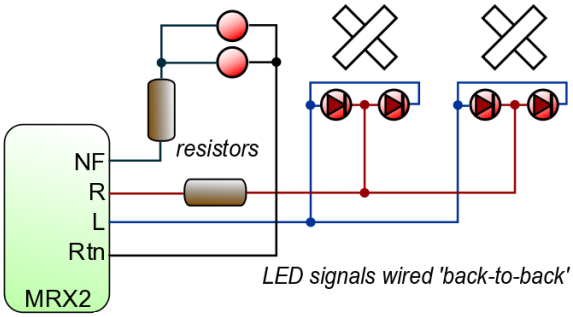


Non-flashing (NF) and Left-Right flashing lamps. Always use resistors with LED signals.

Connect signal lights to these four terminals only:
NF - non-flashing lamps **R -** right side flashing lamps
L - left side flashing lamps **Rtn -** common return for all lamps
Connect signal lamps only to the above four terminals. Do not connect any

signal to 'C' or to any other layout 'common' or 'ground' point. **Turn off power when changing connections.**

LED signals must always have resistors to limit current in the LEDs. If signals are pre-assembled with resistors, use them. Otherwise include resistors in the signal circuits as shown above. Start with 1/4 watt, 500 to 1000 ohm resistors. If the lamps seem too bright, use higher resistance (higher ohms). If the lamps are too dim, try lower resistance. If the resistors get hot, use higher resistance, use higher wattage, or a separate resistor in series with each signal.



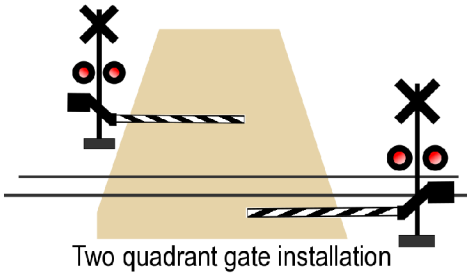
LED signals wired 'back-to-back'

It does not matter if your signals are wired as common anode (common positive) LEDs, common cathode (common negative) LEDs, back-to-back LEDs, or incandescent bulbs. However, **each signal must be of the same wiring configuration as all the other signals.**

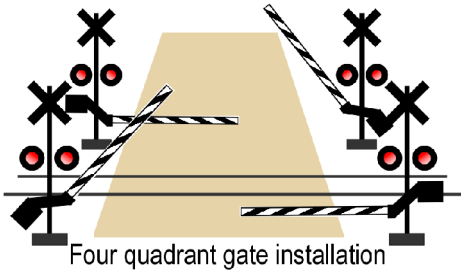
If scratch building or assembling signals from kits, consider wiring the LEDs 'back to back' (left / right LEDs in parallel, anode to cathode). This method requires running only two wires to each signal and simplifies system wiring.

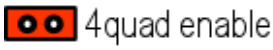
Connecting Crossing Gate Motors

4-quadrant vs. 2-quadrant: Historically, most North American railroad crossing gate installations have been the '2 quadrant' type. The gates block road traffic that is approaching the tracks, but the side where road traffic normally moves away from the tracks is left unprotected.


Two quadrant gate installation

Four quadrant gates operate in sequence. The primary ('entrance') gates start down a few seconds after the lights start flashing. After a few more seconds the secondary ('exit') gates start moving down. The extra delay allows vehicles on the track to exit the crossing so as not to be trapped on the track. This picture shows entrance gates down, exit gates partially down (right hand auto traffic).
The MRX2 will properly operate both 2-quadrant and 4-quadrant gate installations.


Four quadrant gate installation

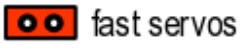


To enable 4-quadrant gate sequencing, place a connecting jumper on both pins labeled **'4quad enable'**. If the jumper is off, all gates operate simultaneously.

Tortoise® motors: Low current DC stall motors (such as Tortoise® switch machines) can be used to operate crossing gates. Each motor can be mounted to drive a gate directly, or Circuitron's Remote Signal Actuator Add-on Actuator & Cable kits (Circuitron 800-8100 & 800-8101) can mounted under the layout base to operate two gates with one Tortoise® motor. The MRX2 applies 4.5 volts DC to the motors, which results in a 7 second operation time for the gates (10 sec. for 4-quadrant). Connect one or two Tortoise® motors for the primary (entrance) gates to the 'M+' and 'M-' terminals of the MRX2. If a 4-quadrant system is being installed, connect one or two Tortoise® motors for the secondary (exit) gates to the 'N+' and 'N-' terminals. The M+ and N+ terminals will be positive to put the gates down. The M- and N- will be positive to put the gates up. If your gates operate in the wrong direction, swap the two motor wires.

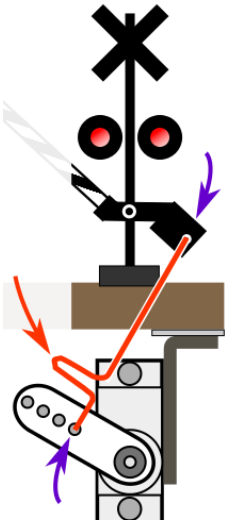
R/C servo motors: Servo motors are small actuators used in radio controlled ('R/C') models. Servos can be used with the MRX2 to operate model crossing gates. Servos have three-wire cables attached, about six inches long (15cm). Extension cables are available. The MRX2 has two connectors for primary gate servos and two connectors for secondary gate servos. Connect servo cables with the **black** (or **brown**) wire aligned with **'B'** and the **white** (or **yellow**) wire aligned with **'W-Y'**. For smoothest operation choose 'analog' servos, and avoid 'high speed' or 'high torque' servos. Examples of servos shown to work well with the MRX2 are HiTec HS-55, Futaba S3111 and HobbyKing HK-15178.

Only change connections to the MRX2 while power is off. When power is turned back on, the MRX2 will check how many gate motors are connected and will adjust its operation accordingly.
Servo connectors can be tight. Always support the circuit board with your fingers when removing a servo cable.



For faster gate operation when using servos, place a connecting jumper across both pins labeled **'fast servos'**. The crossing gates will close in 2 seconds. *This only changes the speed of servo motors, it will not change the speed of DC motors connected to M+/- and N+/- (Tortoise® motors).*

Gate Installation **Crossing gate actuating wires** are often placed too close to the pivot by the manufacturer. It looks good, but is not good for smooth operation. It's best to remove the factory wire, then drill a small hole in the gate or counterweight as far as practical from the pivot point. Drill a hole in the layout base at a 30 deg. angle and use 0.015 or 0.020 in. (0.5mm dia.) steel wire, or the factory wire. Making a hairpin bend in the wire as shown will enable small adjustments.

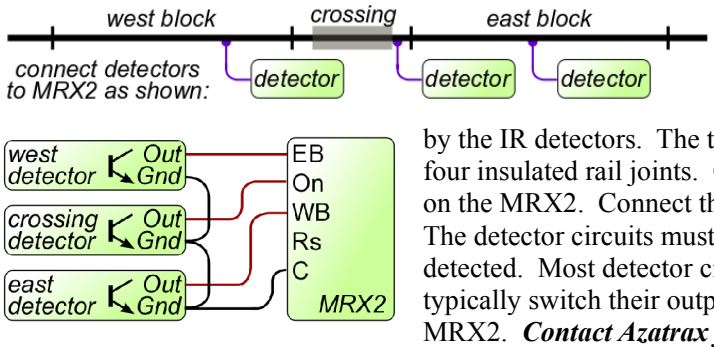


Determine which direction your servo operates. This is important because servo direction cannot be changed by swapping the wires! Temporarily install an actuator arm ('horn') on the motor shaft. Connect the servo to the MRX2, then turn on power. Connect terminal 'Rs' to 'C.' The motor will move to the gates-up position. Disconnect 'Rs' and connect terminal 'On' to 'C.' The motor will rotate about 45 degrees to the gates-down position.

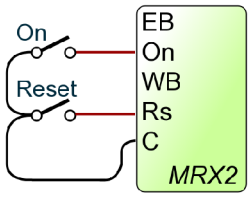
When mounting the servo under the layout, it is best to start with the servo at the half-way position. Turn off power to the MRX2. Connect terminal 'Rs' to 'C'. Turn on power. The servo will move to its center position until the connection to 'Rs' is removed.
With the servo in its center position, place the servo under the layout and secure the actuating arm so that the arm makes a 90º angle to the gate actuator wire. Prop the gate in the half-way position, then bend the gate actuating wire and insert in the actuator arm hole closest to the motor shaft. Remove the prop.

Put the gate in the **up** position by briefly disconnecting the 'Rs' terminal then re-connecting 'Rs' to 'C.' If the gate does not go up far enough, move the actuator wire to the next hole away from the motor shaft.

Put the gate in the **down** position by disconnecting the 'Rs' terminal then connecting 'On' to 'C.' If the gate does not go down far enough, move the actuator wire to the next hole away from the motor shaft. Repeat the process as necessary.

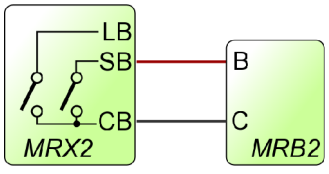


Block Detectors may be used with the MRX2, either to protect one track instead of using the IR detectors, or to protect a parallel track in addition to the track(s) protected by the IR detectors. The track near the crossing is divided into three blocks by creating four insulated rail joints. Connect the 'ground' point of each detector to the 'C' terminal on the MRX2. Connect the detector outputs to terminals 'EB', 'On' and 'WB' as shown. The detector circuits must switch their output lines to 'ground' (0 volts) when a train is detected. Most detector circuits are designed this way. However, Digitrax detectors typically switch their outputs to +5 volts when active. This will not work with the MRX2. ***Contact Azatrax for assistance with Digitrax block detectors.***



Manual Override of the automatic operation is done with toggle switches.
Connecting terminal 'On' to 'C' will activate the signals. Connecting 'Rs' to 'C' will reset the controller and keep the signals off.
If 'Rs' is connected to 'C' while power to the MRX2 is first turned on, the servo motors will move to their center positions. This is useful for adjusting crossing gate linkages (see above).

More Parallel Tracks at the crossing can be protected by one or more Azatrax MRD6X HexDetex™ circuits. Connect the 'C' terminal each MRD6X to 'C' on the MRX2. Connect the 'B' output of each MRD6X to 'On' of the MRX2. See the MRD6X installation instructions.



Sound Modules or other accessories can be switched by the 'Bell' outputs of the MRX2. Two relay contacts provide electrical isolation and allow the MRX2 to control circuits that require either 'high side' or 'low side' switching. 'LB' is Long Bell, 'SB' is Short Bell, 'CB' is the bell common. Relay contacts are rated for 0.2 amp max current, up to 28 volts AC or DC. The example shows a connection to an Azatrax MRB2 bell/strobe circuit.
If no gate motors are connected: SB connects to CB only until the head end of the train crosses the road. This can be used to control a locomotive bell or whistle sound. LB connects to CB for the entire time that the signal lights are flashing.
If gate motors are connected: LB connects to CB until the gates start to open. SB connects to CB only until the gates are fully closed. For more info, see the Azatrax website, `www.azatrax.com`