

# TDP/NJI ServoMaster

## Grade crossing/Semaphore signal controller

You have purchased the TDP ServoMaster which is capable of operating two crossing gates complete with their flashing lights, two semaphore signals, two turnout motors or many other motion devices. The installation is not difficult but does require some planning. The ServoMaster will work with all scales.

### Contents of the Kit

- \*Two servos including servo linkage hardware. (not included in SM kit)
- \*One Servo Controller Board (PC card)
- \*Two programming jumpers.
- \*One ten wire cable (2 1/2 feet long) with a plug on one end only (Output Cable)
- \*One ten wire cable (10 feet long) with a plug and 4 sensors. (Input Cable)

### Power Requirements

A power supply of 9V to 12V AC or DC is required. It may be a simple “wall wart” battery replacement unit, a simple transformer or an old train set controller. The power needed by the system is about ½ amp (500ma).

### Materials and Tools

Wire cutters, misc. screwdrivers, a drill with assorted bits, (optionally) a soldering iron w/ rosin core solder and flux will get you through the installation.

If you do solder, we caution you NOT to use any flux other than ROSIN based. The solder paste used by plumbers and most “No Corrode” solders / fluxes will create corrosion and do NOT belong any where near the railroad.

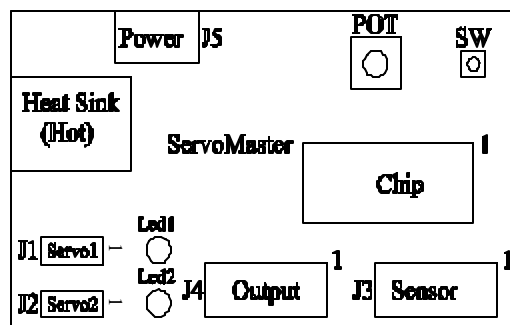
Also, have a supply of heat shrink tube on hand. It is easier to use than tape and will do a vastly better insulating job.

If you prefer not to solder, we suggest that you visit a Radio Shack and get some “wire nuts” of a size suitable for 26 to 18 gauge wire. Radio shack part number 64-3057 (Assorted Screw-On Wire Connectors) or number 64-3068 (One Size Wire Connector) will do the job.

Some 26 to 18-gauge wire may be needed.

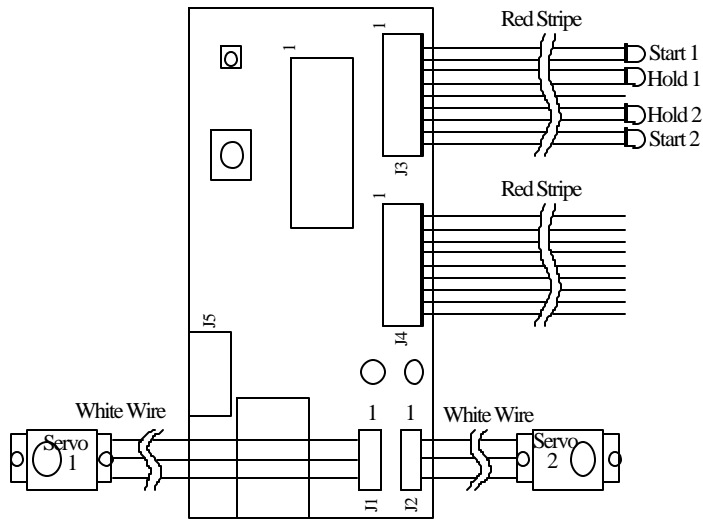
### Connections

There are five sets of connections to the ServoMaster (don't make the connections yet). J5 is the power connector. This connector is not polarized.



J1 is the connector for servo 1 and J2 is the connector for servo 2. On most servos there will be a white wire in the cable. This wire should be installed toward the '1' printed on the board near the connectors (the end of the connector toward the LEDs has the '1'). If you connect a servo wire 'backwards', don't panic as damage will not usually occur from this.

The last two connections are ten lead flat cables. The input connector is J3 (closest to the IC with the red dot). The long cable with the optical sensors on it is connected to this connector. There is a red stripe on the cable. This indicates pin 1, and the cable should be installed with the red stripe toward the '1' nearest J3. The short flat cable is the output cable. It is connected to J4, again with the red stripe toward the '1' nearest J4.



## Handling and Safety

As with all electronic items, the ServoMaster is static sensitive, so care should be taken when handling it. However, in the model railroad environment what is called ‘electrical over-stress’ is much more likely to damage the ServoMaster. **Never place the board on a conductive surface while it is powered up.** The most readily available conductive surface around your layout is the rails! **Never place the board on the rails (even if it is not powered up)** as the voltages that can be found on the rails can very easily damage the circuitry.

When setting the servo positions it is very advisable to secure the board to the layout, even if it is in a temporary position. It will be much easier to adjust the POT and press the button if the board is securely attached to something. If you must hold the board during the programming of the servos you should hold it by the edges only. If you place your fingers near the crystal (silver oval located between the push button and the microprocessor) the board may not function properly (no permanent damage will occur), and could make the programming very frustrating!

## Operating Modes

The current software supports four operating modes:

- (1) Crossing gate control using supplied sensors. This is the Factory default mode of operation.
- (2) Crossing gate control using owner’s detection system.
- (3) Control of two servos to operate turnouts.
- (4) The selection of up to four different positions for each of the two servos to operate devices such as semaphore signals.

The board is programmed at the factory for mode 1 and positive logic. If you are going to use the ServoMaster in this mode you do not need to set the mode.

If you wish to select another Operating Mode you will need to connect the power to the board. This mode programming consists of two steps, and both must be performed. To start the operating mode programming sequence you must hold the push button down (labeled ‘SW’, see PC Board picture on Page 2) as you apply power to the unit. Hold the button for 3 to 4 seconds after power is applied and then release it.

To set the mode turn the “Pot” (see PC Board picture on Page 2) with a small screwdriver. Turn the pot until the LEDs match the desired mode from the table below.

Mode	LED D3	LED D2
1 - Stand alone grade crossing (w/supplied sensors)	On	On
2 - Simple grade crossing (owners detectors)	Off	On
3 - Turnout Operator	On	Off
4 - Four position	Off	Off

Once the LED’s are lit as desired, press & hold the button for about 3-4 seconds (The old one-thousand-one, one-thousand-two ... works here).

If you have entered the operating mode programming mode, you **MUST** complete the sequence (setting the mode **AND** the logic polarity) even if you are not planning on changing anything or the board may not work as desired.

The second step in setting the operating mode sets the ‘logic polarity’ of the inputs. If you turn the pot now both LEDs will either be on or off depending upon the position of the pot. Both LEDs off (unlit) indicates positive logic (this is the mode that works with the supplied optical sensors and is the factory default). Both LEDs on (lit) is negative logic which may be needed for other types of sensors (and the optional expansion kit). When the polarity is set, press and hold the button for 3-4 seconds again to lock the logic polarity into the board’s memory. The ServoMaster will now reset and begin normal operation.

## Servo Initialization

Before starting the installation you should center the servos to prevent sudden long movement when you first power up the board with the servos connected. So, connect the servos to the board and then apply power. The unit will reset by moving the servos to position 2, pause for a few seconds and then servos will move slowly to position 1. Right after this, if no other connections are made, and you are in mode 1 (standalone grade crossing), a grade crossing sequence will begin, moving the servos back to position 2 (this may happen so quickly that you won’t see the servos move to position 1). The unit comes preset with four slightly different positions near the center of the servo’s range of motion which are good places to begin the installation. After the servos finish moving you can remove the power and proceed with the installation. One note here, sometimes upon powering up one or both of the servos may buzz. The cause for this is usually because the servos do not move far enough during the reset sequence (like if the servos start from position 2 when power is applied). The servos will sync up properly as soon as the servos are moved by changing one of the inputs (like starting a grade crossing sequence).

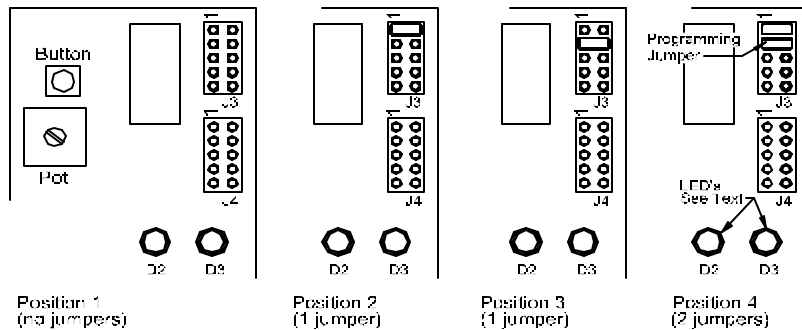
## Servo Position & Speed Programming

When you mount the PC board where desired you must allow access to permit programming. You will need screwdriver access to the component side of the board for adjustment of the pot and access to the push button to set the positions and speed of the servos. You may want to purchase servo extension cables to allow you to mount the board in a convenient location to allow easy programming. Once the board has the servo positions and speeds set the extensions can be removed and the board can be mounted near the servos.

Any time you apply power to the PC board wait for about 10 seconds for all to settle down. If the system is already powered up you may enter the programming mode at will. Once the board is powered up and the servos stop moving you can tighten the screws in the servo links to lock the wire in place. Occasionally the locking screws will need to be filed down a bit (make them a bit ‘pointy’) if they do not lock the rod in place (usually because the rods are too thin).

There is a sketch on the next page to show the jumper positions for the programming of servo position and speed.

Press and hold the pushbutton. LED D3 will light. It will go out in 3 to 4 seconds. Release the button. You may now set the first position of servo 1.



Servo Position Programming Detail

Table 2

Position	Input 1	Input 2	Notes
1	Open	Open	‘Gates up’ in the grade crossing mode, position 1 of turnout mode
2	Jumpered	Open	‘Gates down’ in the grade crossing mode, position 2 of turnout mode
3	Open	Jumpered	Position 3 (Not used in grade crossing or turnout modes )
4	Jumpered	Jumpered	Position 4 (Not used in grade crossing or turnout modes )

(1) Remove all the jumpers (if any are installed) and you are in programming mode for position 1 of servo 1, “Gates Up”. Set the position of the gate by turning the pot with a small screwdriver. The servo will not move until you ‘pass’ the current position of the servo. This will prevent the servo

from jumping to an undesired position upon entering the programming mode. Adjust the pot until the gate is in the desired position. You now must lock this position into memory by pressing and immediately releasing the button. That position is now stored (locked) in memory.

(2) To set the ‘down’ position, set the jumpers as shown in the diagrams. Move the pot until the gate is in the proper position and lock this position into memory by pressing and immediately releasing the button.

(3) If you are using the ServoMaster for something that requires more positions you can program those positions in the

- same manor as the 'up' and 'down' positions, setting the jumpers as needed.
- (4) When all the needed positions are set (you only need to set the needed positions, not all four) press & hold the button until LED D3 goes out. You are now in speed programming mode for servo 1.
  - (5) You may now set the speed of servo 1 by turning the pot. Note that the servo (gate) is oscillating between up and down. Adjust the speed as desired (counterclockwise will make the movement faster). Too fast and the gate will be unrealistic and too slow and the servo might move in a jerking movement. Now press and release the button as before to lock in the speed setting into memory.
  - (6) Press and hold the button for 3 to 4 seconds. This time LED D2 will light and when it goes out release the button. Follow steps 1 through 3 for servo 2.
  - (7) If you are using the ServoMaster for something other then crossing gates set the speed of servo 2 as in step 4 & 5. In the grade crossing modes both servos will move at the speed set for servo 1. When completed, press & hold the button until the LED goes out. The ServoMaster will reset and begin 'normal' operation. However, you may need to cycle the gates once to get then into 'sync' with each other. Reconnect the input cable at this time.

Note that you may skip any of these setting steps by pressing and holding the button until the LED goes out. So, for example, if you need to readjust the down position of servo 2, press & hold the button once to get into programming mode, press & hold again to go to speed mode for servo 1, then press & hold the button for a third time to get to position mode for servo 2. None of the servo 1 settings will be disturbed this way.

## Grade Crossing Installations

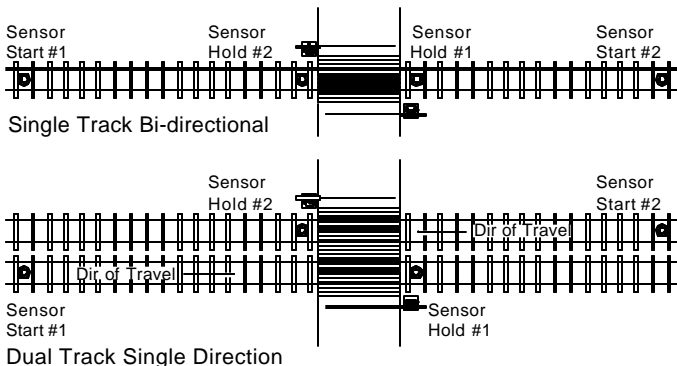
Note that these instructions are given as guidelines, and that they generally refer to HO scale. The ServoMaster will work with all scales.

Start by trying to determine where the sensors need to be placed. There are four sensors on the input cable. The two 'outer' sensors (nearest the edges of the cable) are the 'start' sensors, while the two in the center are the 'hold' sensors:

(Red stripe) Start #1    Hold #1    Hold #2    Start #2

The flat cable can be separated into individual wire pairs for the sensors by gently splitting the wire along the 'groove' and 'tearing' the wires apart such that the distant sensors can be run out to their needed locations in opposite directions along the track. This distance will vary depending upon your scale and the speeds your trains will typically run and getting the spacing right may take some trial and error.

### Preliminary Sensor Installation



**Figure 2**

Now is the time to plan for the mounting of the controller card and to determine if the supplied cables are of sufficient length. Should a preliminary layout of the cable on top of the layout prove that it is not long enough; you will be well advised to lengthen them now.

Just cut the cable, separate, strip about 1/8" of insulation and add suitable wire extensions. Use any wire available of at least 30 gauge. Solder and insulate with heat shrink or wire nut as desired.

**BE VERY CAREFUL TO KEEP THE SAME WIRES CONNECTED AS SHIPPED.**

The sensors have a polarity and if reversed will not work. Use a magic marker to trace one conductor before you cut to keep from mixing up the wires.

Prepare the Servos for Installation by installing the servo arms and linkages (see 'Servo Linkages' in the General Notes section.

Note that the servo leads are rather short. They are about 6" long. If it is not practical to locate the controller near the crossing

gates you may wish to extend the servo leads.

You can purchase servo extension wires which are available from TDP or any RC hobby store (take a servo with you to match the connectors as different brand servos have different connectors), or you can just cut the leads, separate, strip about 1/8" of insulation and add suitable wire extensions. Use any wire available of at least 30 gauge. Solder and insulate with heat shrink or wire nut as desired. **BE SURE TO CONNECT THE SAME COLOR LEADS TO EACH OTHER.**

**Warning: The servos should NOT be installed on the layout yet. Do NOT attach your crossing gate operating linkages to the servos this time as you may damage the crossing gate.**

## Sensor Installation

Drill a 3/16 inch hole through the layout in the location you determine depending on the sketch selected in figure 2. There is about a three second delay from when the start sensor is tripped until the gates will start moving. Add this to the time it takes the gates to drop completely (you will be setting this after the gates are installed) to determine how far away the start sensors need to be from the crossing. Do not permanently install the sensors until you are sure about this spacing!

Carefully separate the sensors as wire pairs to permit insertion through the 3/16 inch holes. Position the sensor from below and use a piece of masking tape to hold it in place or a toothpick to wedge it snugly in the hole. The sensor should have its domed surface about even with the top of a tie (don't exceed the rail height as you will destroy the sensor the first time you use an abrasive track cleaner over it!).

We advise against gluing the sensors in place. If you feel compelled to glue the sensors in place, be careful NOT to cover the top (domed) surface (push the sensor all the way through the hole, place the glue on the back side of the sensor and then press it back into the hole from the top). Elmer's will do fine. Avoid any solvent-based glue.

Do not pug the sensor cable onto the PC board at this time.

## Install the Gates and Electronics

We recommend that the crossing gate assemblies be mounted on a small square piece of styrene with a length of 1/4" diameter tube cemented to the bottom. This tube is to be of sufficient length to pass through the layout construction.

Pass all wiring and the gate operating rod/wire through the tube. Now is the time to lengthen these as necessary. If the operating rod is to be lengthened, lay a piece of spring wire (about ten thousands) beside, overlapping 1", cleaning both well, and solder or "magic glue" together. There should be enough slack wire from the lamps to permit easy connection to the Output Cable. Don't wait till you are on your back in the dark under the layout to lengthen the wires.

Install the servos using small wood screws. See the Servo Mounting Sketch. The Servos should be mounted on a piece of wood, which may then be glued or screwed to the layout construction in a location below the gate operating wire/rod. You will need to access the top of the servo with a small screwdriver to lock the control rod into the servo linkage. The servo arm can be removed by taking out the center screw and pulling the arm off the servo (it uses a splined fitting allowing course position adjustment of the arm's position). The servo linkage should be installed in one of the inner-most holes on the arm. This will provide for the slowest possible movement of the gates. **Do not tighten the locking screw onto the control rod yet** (don't do this until you have powered up the board and are ready to set the position as you could damage the crossing gate when you power up the board before the positions are set properly).

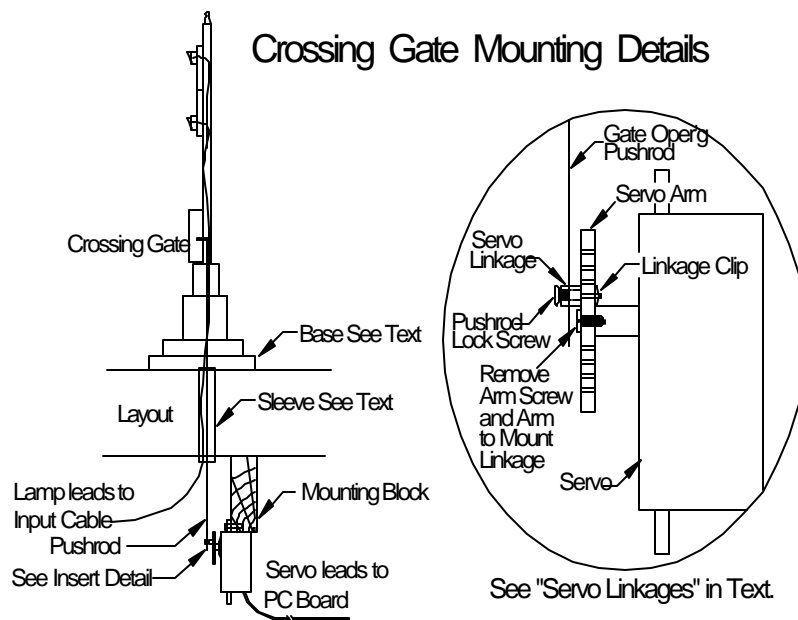


Figure 3

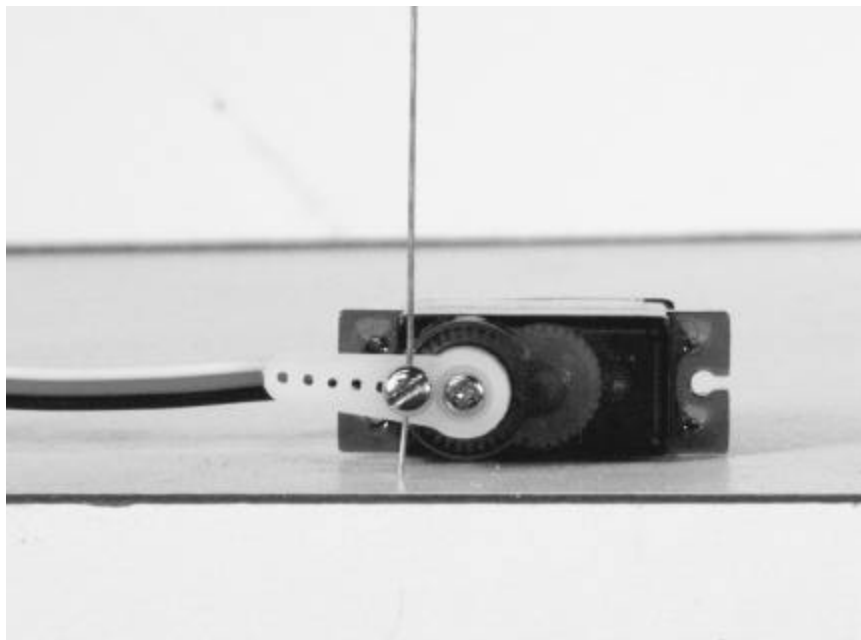
When the servo is mounted you can slide the operating rod into the hole in the linkage (see photo), then mount the servo arm on the servo. Do not tighten the locking screw in the linkage yet!

Connect the lights of the gates up to the output cable. Each gate assembly should have three wires coming from it. One is a 'common'. The gates should have their LED's wired in 'common anode' mode to work properly (most gates including NJI's are wired this way). Two of the wires will have resistors in them, while the third 'common' wire will be just a wire. Connect the common wires from each gate to wire 2 of the output connector (wires are counted from the red stripe). The wires with the resistors should be wired to wires 7 and 9 (one wire from each gate to 7 and the other two to wire 9). Solder and insulate with heat shrink or wire nuts.

## Semaphore signals

Most semaphore signals come with the actuating rod already installed. Depending upon the thickness of your roadbed and sub-roadbed (and anything else that may be in the way), extend the wires for the lamp(s) and the actuating rod(s) now, before installing the signal on your layout. Drill a hole that is large enough to allow the lamp wires and actuating rod to pass through and install the signal on your layout. Be sure to secure it firmly to the roadbed and/or the sub-roadbed structure.

Once the signal is installed on the layout you can install the servo. This can be done in several ways. Prepare the servo arm by cutting off any arms that won't be used, and install the linkage in the inner-most hole on the one remaining arm (you can trim this arm shorter too).



Example of servo linkage installation. Note that the unused portion of the servo 'arm' can be trimmed off for clearance.

Mount the servo directly beneath the signal with brackets, wooden blocks or industrial grade double sided foam tape. Be sure to feed the actuating rod through the linkage as you position the servo. Do not tighten the clamping screw yet! If you are mounting a double headed semaphore you can stack the servos on top of each other. You may need to put a bend into one of the actuator rods to clear the first servo.

You should program the servo positions now. You will need to program all four positions as detailed in the section titled: "Servo Position & Speed Programming". Even though a semaphore signal has only three positions you will need to set all four positions (the 'stop' position will need to be programmed in two places). Connect the servos and power to the board, and power up the board (make sure that the clamping screw on the linkage is NOT tightened yet!) Once the servos move to their home positions you can tighten the clamp screws. If the servo arm is not close to horizontal you can pull the servo arm off the servo and rotate it until it is horizontal before tightening the clamp screw. Following the steps outlined in: "Servo Position & Speed Programming", program the 'red' (stop) position into position 3 and position 4 as given by the jumper setting in Table 2. 'Green' (clear) should be programmed into position 1, and 'yellow' (approach) should be programmed into position 2. Program the speed as desired.

You will need some kind of detection to make the semaphore work prototypically. You can use the supplied optical detectors that are included to be used for grade crossings but they will have some drawbacks. If your train will not span the distance between the two sensors (one placed right after the signal to make it 'drop' as the train passes, and one at the junction of the next track block) the signal will clear up while the next block is really occupied. Also, the signal will transition to 'yellow' as soon as the end of the train clears the sensor located right after the signal. It would be much better to use a fully functional block occupancy detector for this, either a current sensing block detector or a 'latching' optical sensor. For servo #1 the 'red' sensor (the one installed right after the signal) should be connected to pin 4 of the input cable and the 'yellow' sensor should be connected to pin 2. For servo #2 the 'red' sensor is connected to pin 9 and the yellow sensor should be connected to pin 7. If you are using the supplied sensor cable the sensors are identified like this on the cable:

You can use this cable to connect to third party detectors, just cut off the optical sensors. Each pair of wires will have a ground and input. The ground is located closest to the red stripe. You will need to connect the ground to the third party detector's ground for the circuit to work.

If you are using third party sensors (such as a current occupancy detector) you may need to switch the polarity of the sensors. For example, if you use a Digitrax BDL162 for detection the ServoMaster will need to be programmed for 'positive' polarity (see the section titled: "Description of the Operating Modes"), while if you are using NCE BD10 detectors you will need to use negative polarity. If you're not sure of the polarity needed, don't worry. If the ServoMaster doesn't behave correctly (if it looks like it is responding 'backwards') go into the mode programming mode as described in the "Description of the Operating Modes" section and choose the opposite polarity. This should fix the problem.

You can use the ServoMaster to power the lamps on the signals if you want to. The voltages available are +5V and 'Vin (DC)'. 'Vin (DC)' is the voltage that you have supplied the ServoMaster with, rectified to DC (if the power provided was AC). Be very careful to add an appropriate series resistor when connecting the lamps up as it is very easy to burn out the bulbs (and very hard to replace them!). It is best to start with a high valued resistor (1000 ohms) and work down to an acceptable brightness (don't count on a resistor supplied by the signal manufacturer as I have found these to be too small at times and the lamp burns out in a few minutes). Do not use the pins labeled 'lamp1' or 'lamp2' as these are for the crossing gates and will not be lit all the time like a semaphore's lamp should be.

## Detailed Description of Operation

### Mode 1 (Standalone grade crossing)

Use one servo per gate. Care should be taken to use a 'long' arm on the gate and a 'short' arm on the servo. This means that the connection to the servo arm should be close to the center (pivot point) and the connection to the gate should be as far as possible from the pivot point. This will allow the slowest movement of the gates. The optional sensor cable has four phototransistors installed on it. There is a single red wire on the cable. This corresponds to pin #1. There are two kinds of sensors, 'start' sensors and 'hold' sensors. There is two of each sensor in the cable. This allows you to have a single-track bi-directional grade crossing or a dual track single directional (on each track) grade crossing. To have more than these options an additional expansion module will be needed along with additional sensor cables. Counting the sensors on the cable from the pin 1 (red) end of the cable, the sensors functions are given here:

Start #1 Hold #1 Hold #2 Start #2

The start sensors are placed in the track where you want the grade crossing sequence to begin. The hold sensor is placed right after the grade crossing. The hold sensor will keep the gates down and the lights on until the end of the train passes it. See figure 2 for the placement of the sensors.

There are limitations in the double track setup. If two trains arrive at exactly the right times (well, really the wrong times) the gates will go up after the first train clears the hold sensor if the second train has not yet reached the hold sensor on its track. The gates will go down again as soon as the second train reaches the hold sensor. There is a delay from when the train clears the hold sensor and when the gates will go up, so it is possible to place the hold sensor just before the road to help this limitation. As the likelihood of this happening is small you will most likely experience it the first time you run two trains!

The sequence is typical though slightly compressed; when the start sensor is covered the lights will come on, and after about a 2 second delay the gates will lower. The gates will stay down until the train covers and then uncovers the hold sensor. After the train clears the hold sensor there will be about a 2 second delay then the gates will go up. Once the gates go up the lights will go out. The full sequence will not re-trigger until all of the sensors show 'no train' at the same time. There is a timeout feature that will cause the gates to go back up if the sequence is not completed properly after several minutes. So if an inadvertent finger or mouse wandering around the layout trips the gates they will correct themselves in a little while. In single track mode only one hold sensor is really needed. If you choose not to install the second hold sensor you will need to cut the sensor off and strip the two wires and twist them together so the gates will operate correctly. As an extension to this, these wires could be hooked up to an SPST (single pole single throw) switch mounted near the grade crossing to allow manual operation of the gates in the case where a train crew is doing some switching in the area of the crossing.

### Mode 2 (Simple grade crossing)

Use one servo per gate. Care should be taken to use a 'long' arm on the gate and a 'short' arm on the servo. This means that the connection to the servo arm should be close to the center (pivot point) and the connection to the gate should be as far as possible from the pivot point. This will allow the slowest movement of the gates. Input 1 of servo 1 will control the lights, while Input 2 of servo 1 will control the gates. Shorting these inputs to GND will put the gates up and/or turn the lights off. Leaving the inputs open will drop the gates and/or turn on the lights. If the polarity was programmed to 'negative' (see the 'Operating Modes' section) leaving the inputs open will cause the lights to come on and the gates to come down. The lights should be LEDs only. Incandescent lights need to be buffered somehow. Connect the lights 'common anode' (NJI's gates are wired this way). Wire the two gates' lights in parallel. Be sure to use a resistor in series to limit the current (again NJI's gates come with the resistors already installed). The resistor should be at least 560 ohms. Connect the common lead of the lights to the +5V line of the output connector. Connect the 'light 1' line to one light of each gate and connect 'light 2' to the other light of each gate. Normally the lights will come on for a few seconds before the gates

come down, and will stay on until the gates are all the way back up. If your controlling circuit does not accommodate this you can connect In1 and In2 together to make the lights come on at the same time that the gates come down.

### **Mode 3 (Turnout mode)**

The servo controller can control two turnouts. Only position 0 and position 1 are used, so only Input 1 for each servo is used. Input 2 can be used to light a LED to show the position of the turnout. Be sure to use at least a 750 ohm resistor on the LED to limit the current. If point wiring is used, this can be controlled two ways. You can use a lever switch (sometimes called a micro switch) to switch the power on the points. I've glued the lever switch to the back of the servo and the arm of the servo trips the switch. You can also use a 5V PCB style relay to switch the point power. This relay would connect to the output connector. Use the 'light 1' output for the turnout connected to servo 1, and 'light 2' for servo 2. The other side of the relay coils should be connected to +5V.

### **Mode 4 (Four position)**

This mode allows selection of up to four different positions, as shown in table 4. You can set the inputs by either leaving the Input pin open, or shorting it to GND. The flat ribbon cable will have the Input pin and a GND pin on adjacent wires. If you are using a switch or relay to control the servo, you will only need to connect these two wires to the switch. See the 'Pin Assignments' section at the end of this manual for how to hook up the inputs.

## **General Notes**

NJ International makes crossing gates and semaphore signals that the servo controller is ideal for controlling. In the case of the semaphores setting up for three positions is much easier than with slow motion switch machines as there is no complicated linkage needed. All you need to do is connect the signal push rod to the servo arm and program the position of the arm in the three needed positions precisely. You can also easily program the speed of the arm's movement. In the case of the double-headed semaphores, you can stack two servos on top of each other easily and compactly.

The NJI HO and larger crossing gates have completely hidden linkage. But, because it is hidden the 'arm' (distance the linkage connection point is from the pivot point) is extremely short. That means that the servo must move only a very short distance to make the gate go through its entire movement. What you will see here is that if you slow the servo movement down enough to make the gate movement time close to what the prototype gate takes to move you will begin to see the 'steps' that the servo makes as it moves. To correct this you must make the arm on the gate longer. The only way to do this is to add your own push rod to the gate. You will need to drill a small hole on the gate itself about ¼ inch from the pivot point, and insert a brass wire pushrod in the hole. If you do this very smooth and slow gate movement will result.

N gauge crossing gates do not have a built-in control rod, so you will need to drill a small hole in the arm and install your own rod (I use .010 brass wire). Drill the hole in the counterweight, in the top right hand corner (as viewed from the front, with the gate down, see cover picture).

One thing that can be a bit hard is programming the position of the servos with everything installed on the layout, as you are required to see the gate or signal as you adjust the position with the POT. A trip to your local RC store can make this much easier. Purchase two servo extension cables (take a servo with you!). Use these cable to allow you to temporarily mount the ServoMaster board where you can easily reach it while adjusting the positions. You do not need either the input or output cable connected for position programming. After programming the positions you can remove the extensions and mount the board back near the servos.

### **Servo linkages**

The most useful linkage we have found is the Dubro mini easy link (supplied in the kit). This linkage snaps onto the servo arm and has a hole for your push rod to pass through. A small screw on top of the connector is tightened to lock the pushrod in place making the setting of the pushrod length quite simple. Note that you may need to trim the locking nut slightly to allow the linkage to rotate freely when using the innermost hole on the arm. You will need to enlarge the hole in the servo arm slightly. The link MUST rotate freely (but not loosely) if the gates or signals are to move smoothly. There are many other kinds of linkages available at your local RC store. Or, you can bend a 'Z' into the rod and slide the end into the servo arm.

### **Tips**

It may be worthwhile to purchase servo extension cables even if you do not need them for the final installation. The extension cables will allow you to position the ServoMaster board in a convenient location during servo position programming. Once the programming is done you can remove the extensions and mount the board in its final location and save the extensions for future installations. Extensions can be purchased directly from TDP or from any RC hobby shop. The extensions needed for servos supplied by TDP should be 'Futaba J' compatible extensions.

### **Troubleshooting**

When you have installed everything the and power up the ServoMaster the unit will reset itself by going through one cycle. With the crossing gates, the gates should go down and then slowly return to the up position if there is nothing on the tracks to block the light to the photo sensors. If the unit fails to finish the reset there may not be enough light on the photo sensors. You can try moving the

sensors up to be just *below* the rail tops where they will receive more light. Another thing to try is to add more light in the area of the sensors.

When testing an installation it is very hard to tell if the sensors are getting enough light. In a grade crossing installation, if any sensor does not get enough light it will cause the gates to go down. You can shine extra light on the sensors to test for this. However, if the cause was not enough light on a start sensor you will need to shine the light on the start sensor, but then trip the hold sensor with a finger (block the light from one of the hold sensors for a couple of seconds). The gates will then go up if this is the problem. If the problem is the hold sensors not getting enough light, just shining the light on them will cause the gates to go up. Remember that if you are using only one of the hold sensors you must short out the unused sensor by cutting the sensor off, stripping the wires and twisting them together.

If you cannot get the system to go 'gates up', you can try shorting the leads of all four of the sensors temporarily with four pieces of bare wire. Wrap the wire around the base of the sensors to short them out, and then power up the board. This should make it look like all the sensors have light, which should make the system end up with the gates up after the unit initializes. You can then debug the system one sensor at a time. So, power down the board, un-short one sensor and install it in its hole. Power the ServoMaster up again. If the gates end up 'up' after the unit finishes initializing that sensor is working. Move on to the next sensor....

It is easy to incorrectly install the sensor cable. Be sure that the red stripe is installed on the end of the connector on the controller board that is marked with a '1'. Also, make sure that the connector covers both rows of pins. An uninstalled or incorrectly installed input cable will cause the gates to go down and stay down all the time.

If the black heat sink gets very hot there is a short circuit somewhere. Note that the heat sink in this case will get hot enough to burn you! However, no permanent damage will occur to the ServoMaster (however it may damage the power supply you are using if you do not use a fuse). If this happens disconnect the power and check all of your wiring (especially if you had to extend any of the cables).

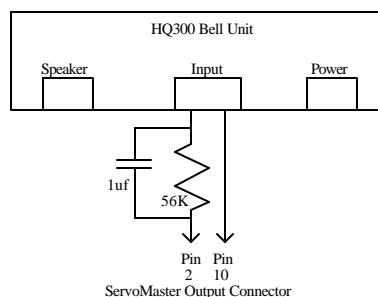
If things are just not working as you expect, try going through the Operating Mode programming section. Set the operating mode and polarity as desired or needed for your application. If you are using the standard optical sensors for a grade crossing (**not** the expanded sensors) you want the operating mode set to 'both LEDs on' and the polarity to 'both LEDs off'. This is the factory default setting. If you are using the optional optical grade crossing expansion kit you need to set the mode to 'both LEDs on' and the polarity to 'both LEDs on'. To start the mode setup you need to **hold the pushbutton down while the power is turned on** (see the operating mode section).

## Optional Accessories

### Bell Unit

An optional bell unit can be connected to the ServoMaster. A suitable bell unit can be purchased from Greenway Products (724) 238-6268 ([www.greenwayproducts.com](http://www.greenwayproducts.com)). The order number for the unit is HQ300. To connect the bell unit you will need a 56K ohm resistor and a 1 uf capacitor. If you hook it up as shown below you will get a grade crossing bell for about 13 seconds as the lights come on. After this time the bell will be silent just like it is usually done on prototype grade crossings. Note that pin 2 of the output cable is also used as the common lead for the crossing gate lights.

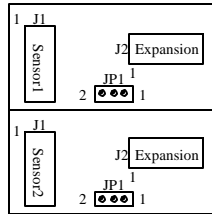
**The bell unit will need to be powered from a separate AC power supply.** Connect the units as shown below.



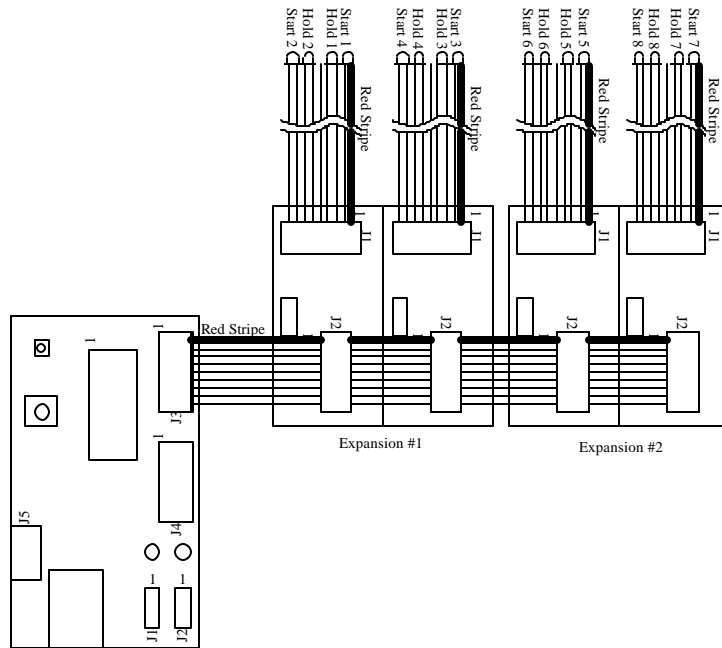
### Expansion to more tracks

TDP offers sensor expansion kits for the ServoMaster to allow the operation of a grade crossing on up to four bi-directional tracks. The expansion kit will add one additional sensor cable giving you two additional pairs of start and hold sensors. This gives the system four sensor pairs for use on four tracks in one direction or two tracks in both directions (or any other combination of the four sensor pairs such as a center bi-directional track with the outer tracks being single directional on a three track railroad). Adding a second expansion kit will add an additional sensor cable giving you six pairs of sensors. To fully expand the system to eight pairs of sensors you need to add one additional sensor cable.

The expansion board is actually two identical boards in one as shown below.



The both jumpers (JP1) on the expansion board should be in position 1 for optical sensors and in position 2 for IR sensors. The interconnections for the expansion are shown below.



To set up two tracks with bi-directional detection you will get the best results by using Sensor cable #1 in the ‘East’ direction and sensor cable #2 in the ‘west’ direction. In other words, one sensor cable should cover one side of the grade crossing and the other cable should cover the other side of the grade crossing. Use sensor pair #1 (start #1 and hold #1) on track #1 on the ‘east’ side, sensor pair #2 on track #2 on the ‘east’ side, sensor pair #3 on track 2 on the ‘west’ side, and sensor pair #4 on track #1 on the ‘west’ side of the crossing. Follow this pattern when expanding beyond two bidirectional tracks.

You will need to change the polarity setting (see the Operating Mode section). You will want to set the operating mode to ‘both LEDs on’ and the polarity to ‘both LEDs on’. Note that it may be difficult to debug the full expanded system. You can install the sensors and try each cable out one at a time by leaving the ServoMaster in factory default mode (operating mode set to ‘both LEDs on’ and the polarity to ‘both LEDs off’) and plugging the cable under test into J3 of the ServoMaster board. In other words, treat each cable as a ‘standard’ unexpanded ServoMaster installation until you are sure that the sensors are properly installed. Once all cables work properly power down the system, connect the expansion board and cables as shown above, and change the operating mode to invert the polarity (operating mode set to ‘both LEDs on’ and the polarity to ‘both LEDs on’). Your grade crossing should then work properly.

# Pin Assignment for Provided Cables

The following tables represent the Standard Grade Crossing Gate configuration.

## Input cable (connect to J3)

Pin	Use
1	GND
2	Start Sensor 1 (Servo 1 input 1 in other operating modes)
3	GND
4	Hold Sensor 1 (Servo 1 Input 2 in other operating modes)
5	+5V
6	GND
7	Hold Sensor 2 (Servo 2 Input 1 in other operating modes)
8	GND
9	Start Sensor 2 (Servo 2 Input 2 in other operating modes)
10	+5V

## Output cable (connect to J4)

Pin	Use
1	GND
2	Lamp common (pos)
3	No Connection
4	+5V
5	Vin (DC)
6	Vin (DC)
7	Lamp1 (neg)
8	+5V
9	Lamp 2 (neg)
10	+5V

The input cable is a ten wire flat ribbon cable which is about ten feet long and has a connector on one end. The other end has four detectors attached. Wire one is identified with a red trace.

The output cable is a ten wire flat ribbon cable of about two feet long and has a connector on one end. The other end has none.  
Notes:

- (1) At any time power is removed from the unit and restored, the unit will be in the operating mode. If you become confused in the programming steps, turn off the unit, wait 10 seconds and restart it. You may then go back to Step 1 on page 5 (Servo Position & Speed Programming) and begin again.
- (2) We will update the installation manuals and make them available on our web site. [WWW.trainspeed.com](http://WWW.trainspeed.com). You may also email us at [support@trainspeed.com](mailto:support@trainspeed.com).

## WARRANTY INFORMATION

TDP & Associates guarantees the ServoMaster to be free of component and manufacturing defects for a period of one year after date of purchase. If a defect occurs return the product to TDP & Associates for service. TDP & Associates will repair or replace the ServoMaster at its discretion at no charge during the warranty period. This warranty excludes damage due to abuse, such as but not limited to failure to properly install the unit, applying excessive input voltage to the unit or failure to provide protection against input over current with a fuse or circuit breaker.

TDP & Associates will make non-warranty repairs to the ServoMaster at reasonable and fair rates.

All warranties on this product are limited to refund of purchase price or repair or replacement of this product at the sole discretion of TDP & Associates.

In the event that this product is not installed or used in accordance with the manufacturer's specifications any and all warranties either expressed or implied are void. Except for what is expressly stated in this section there are no warranties, express or implied, including but not limited to any warranties of merchantability or fitness for a particular application.

TDP & Associates, Inc. reserves the right to make changes to this product's design or specifications, and/or to make improvements to this product, at any time, without obligating TDP & Associates to install these changes, additions or improvements on previously manufactured products.

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