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 9100 kit)
*One Serve 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)
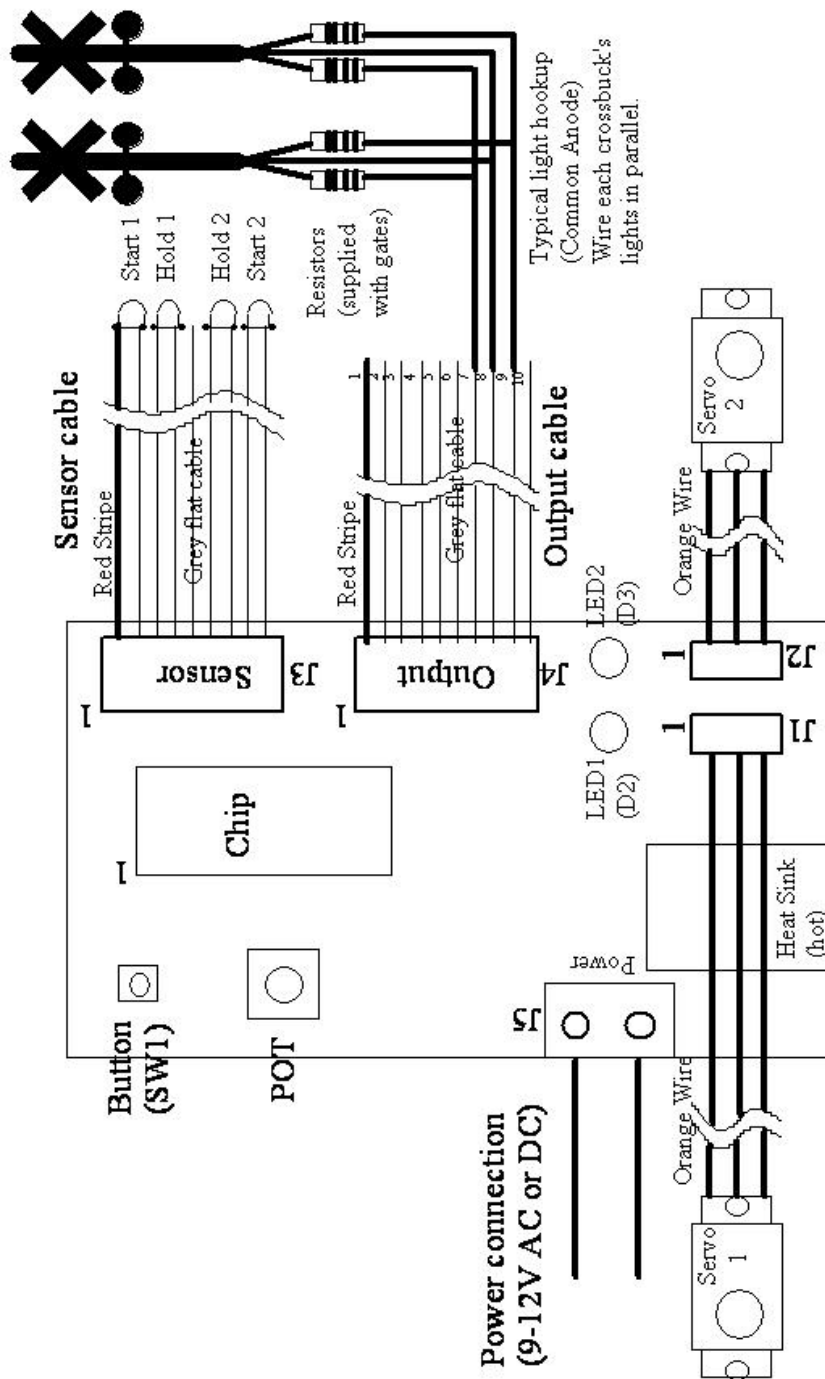
Power Requirements

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).

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. A power supply of 9V to 12V AC or DC should be connected to this terminal.

J1 is the connector for servo 1 and J2 is the connector for servo 2. On most servos there will be a white or orange 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. The diagram shows the sensor assignments for the sensor cable connected to J3 and a typical crossing light connection to the output cable connected to J4. The output cable (connected to J4) can also be used to control an optional bell unit

Typical light hookup (Common Anode)
Wire each crossbuck's lights in parallel.

Resistors (supplied with gates)

Start 1
Hold 1
Hold 2
Start 2

Sensor cable
Red Stripe
Grey flat cable

Red Stripe
Grey flat cable
Output cable

1
2
3
4
5
6
7
8
9
10

Sensor J3
Output J4
LED2 (D3)
LED1 (D2)

Chip

Button (SW1)
POT

Power J5

Orange Wire
Servo 2
J2
J1

Heat Sink (hot)

Power connection (9-12V AC or DC)

Orange Wire
Servo 1

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 you 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!

System Initialization

Before starting the installation you should set the desired operating mode and center the servos. Centering the servos prevents sudden long movement when you first power up the board with the servos connected. This is best done before you install the board

on your layout. Connect the servos to J1 & J2 on the circuit board with the orange wire going toward the '1' on the board above the connectors, as shown on the previous page. Connect the power supply to J5 but do not turn the power on yet.

Determine what operating mode you would like to use from this table:

Operating Modes	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

The four operating modes are:
   (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 servos to operate devices such as semaphore signals.

More detailed descriptions of the operating modes can be found in a later section of the manual.

The board is programmed at the factory for mode 1 and positive logic which is used for the full featured grade crossing controller and the optical sensors. This mode is the one used for a full feature grade crossing using the optical sensors included with the GCS kit. If you are going to use the ServoMaster in this mode you do not need to set the operating mode. If this is the case you should power up the board and allow the servos to initialize. This will take ten to fifteen seconds. After the servos take their initial positions you can power down the board and proceed with the rest of the installation.

If you wish to select another Operating Mode you will need to follow the step by step mode programming procedure given in appendix 1. The basic procedure has two phases, programming the mode and then programming the input polarity. The 'polarity' is simply whether the system will respond to an input that is 'high' (this is 'positive: greater then 1.5V but less then 5.0V) or a 'low' (this is 'negative: Less then 1.5V). The optical sensors require positive polarity while the IR sensors and any 'expanded' system (more then one bi-directional track, details later in the manual) require negative polarity. A step-by-step procedure for programming the operating mode is given in Appendix 1.

******Important note*******

One thing that seems to cause great confusion is what happens when you power up the ServoMaster. If the unit is in the factory default mode, and no input cable is connected, or the input cable is connected but doesn't have enough light on the sensors, when you power up the board a grade crossing event will start. This will be indicated by LED1 (marked 'D2' on the board) lighting while LED 2 (marked 'D3' on the board) will flash. The servos will assume position 2 (the 'down' position). This is normal. If your unit does this after everything is installed you may not have enough light on the sensors.

One other thing that seems to cause confusion is when you are programming the operating mode, when you power the unit up with the switch pressed the unit will NOT display the current operating mode. Some people have expected this to occur and thought the unit was not accepting the operating mode that they have programmed.

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:

<div align="center">(Red stripe) Start #1   Hold #1   Hold #2   Start #2</div>

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.
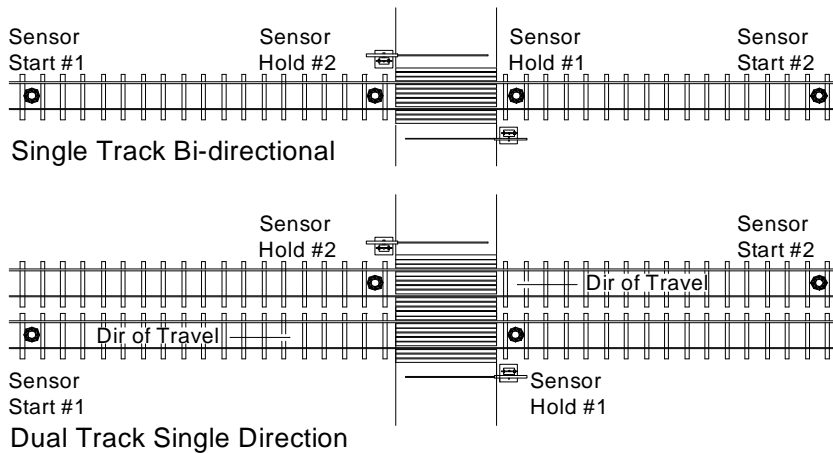
Preliminary Sensor Installation

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 and figure 4).

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 #20 hole through the layout (5/32" is close but slightly small) 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 snuggly 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 side of the sensor and then press it back into the hole from the top). Do not get glue on the lens or between the leads on the bottom of the sensors! Do not use CA glue (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

The gates and servos can be installed in several ways. Some people like to build up the gate installation on the bench and cut a hole big enough in the layout to drop the whole thing in from the top. This may be a very viable alternative for installations in areas of the layout where you cannot easily get to the underside of the layout where the gates are to be installed. You will need to leave the wires long enough in this kind of installation to allow you to get to them in that remote location under the layout.

In areas where the underside of the layout is more accessible I prefer to mount the gate solidly to the layout being sure that the proper holes are drilled for the wires and control pushrod (more on pushrods later). Build up a proper base for the crossing gate (most are mounted on concrete pads in real life) and secure it and the gate to the layout. Mount the servo arm with the servo linkage installed on the servo. I then look at where the pushrod comes through the underside of the layout and slide the rod through the hole

on the servo linkage and secure the servo to the underside of the layout with double sided tape (I use the indoor/outdoor industrial strength tape). If there isn't a flat space available to mount the servo with tape a mounting bracket can be fashioned and screws can be used to mount the servo.

The pushrod used to make the gates move is critical to a smooth running crossing. Some gates come with the pushrods built in to the base of the signal. However, these types of installations result in a very short movement of the pushrod to make the gate move, and can 'stick' at the top or bottom of the run. We strongly suggest that you do not use this method. If your gates do not have an external pushrod it is much better to install an external pushrod by drilling a small hole on the back side counterweight at least 1/8 of an inch away from the pivot point (longer is better, however you can go too long if you are not careful). With the pushrod mounted in this way you will be able to attain a smooth, full length movement of the gates. We have also found that having this pushrod go through the layout at an angle about 30 degrees from vertical works the best. If you go through the layout vertically you may have trouble getting the gate to move over its full range of movement. The angle allows full, smooth movement.
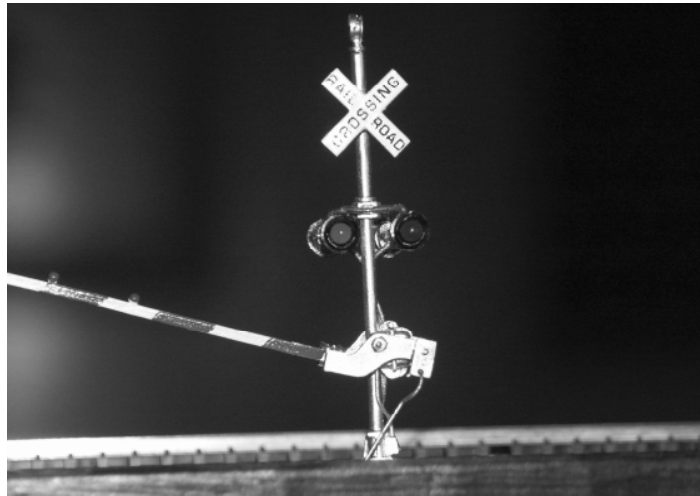
Figure 3
Note the pushrod angle

The connection of the lights is fairly simple. You first need to know if the LEDs in the crossbucks are common anode (positive lead is common to both) or if they are common cathode (negative lead is common to both). NJ International signals are wired common anode, and come with the needed dropping resistors already installed on the wires leading from the crossbuck. If your flasher lights are wired differently see appendix 3 for hookup details. In this case you need to only connect the common wire from both crossbucks to wire #8 on the output cable, one wire with resistor from each crossbuck to wire #7 on the output cable, and the other wire with resistor from each crossbuck to wire #9 on the output cable. Note too that you can hook up extra crossbucks in the same manor. For instance, if you want to add an overhead highway crossing signal to your gate installation you can hook those flashers up to wires 7, 8 and 9 of the output cable too. The ServoMaster can handle at least 6 sets of parallel wired flashers. More can be used if the resistors associated with the flashers are made larger (1K ohm and above). Be sure to use individual resistors with each flasher light.

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 one of the inner-most holes on the one remaining arm (you can trim this arm shorter too).

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:

(Red stripe) Yellow #1   Red #1   Yellow #2   Red #2

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.

   The TDP ABSMaster signal controller can be used to provide proper prototypical operation of up to four semaphore block signals.

   You can use the ServoMaster to power the lamps on the signals if you want to. The voltage available is +5V. 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. Use the wires labeled +5V and GND (see appendix 4 for output cable wiring assignments).

Servo Position & Speed Programming

   Once you have the servos mounted you can program the positions and speeds. Mount the PC board where desired being sure that you will have access to the top of the board 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 it to reset and for the servos to stop moving. If a servo is buzzing it means that it did not move far enough to allow proper initialization. You can stop the buzzing by manually moving the servo arm until it locks into position, or you can ignore it until you move the servo's position during position programming. Once the system is 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 (it will be best if you hold the gate halfway between up and down when you lock the screw down). 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 (this is usually because the rods are too thin).

   This sketch shows the jumper positions for the programming of servo position and speed.
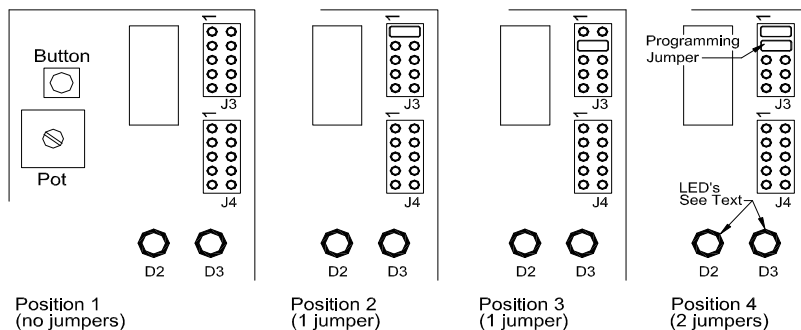
Servo Position Programming Detail

Table 2

Servo 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)

A step by step procedure for position programming is given in Appendix 2A & 2B. The following is a description of what is happening during the position/speed programming operation.

The position/speed programming procedure consists of four main steps:

1 - Positions of servo 1
2 - speed of servo 1
3 - positions of servo 2
4 - speed of servo 2

You enter position/speed programming by pressing and holding the button for about five seconds (D3 will light when the button is pressed and go out when programming mode is entered). This puts you in step 1. Whenever you are in a position programming step the servo will 'follow' the position of the POT. In other word as you turn the POT the servo will turn. However, to get the servo to start following the POT you must turn the POT slowly (perhaps several times) through its full rotation until it 'picks up' the servo's current position. This is done to prevent the servo from jumping to an undesired and potentially damaging position when you enter position programming mode. Once you have the servo following the POT turn the POT until the servo is in the desired position. In the case of a grade crossing this first position will be the 'gates up' position. You now press and release the button to store this position in the ServoMaster's memory. Led D3 will flash on and go out as you release the button. If Led D3 does not turn on you did not hold the button long enough. However, be careful to release the button as soon as you see the led turn on. If you hold the button in too long you will advance to the next step (which is indicated by the led turning off while you are still holding the button in). Now move the servo to the second desired position (in grade crossing mode this would be 'gates down'). Install one of the supplied jumpers across pins 1 & 2 of J3 (see diagrams on page 10). Press and release the button again to store the second position in memory. It is the jumper positions from the diagram that tells the ServoMaster which position is being programmed. For non-grade crossing applications you can program up to two additional positions as detailed in appendix 2B.

Now you need to advance to step 2 by pressing and holding the button – Led D3 will turn on and then go out. Once the led goes out release the button. You are now in speed programming mode for servo 1. Speed programming is done in a similar manor, but no jumpers are involved. The servo will begin to move between positions 1 & 2 (there can be a slight delay before the servo begins to move). Adjust the POT until the desired speed is achieved. Note that if the pot has been left in a very 'slow' position you may not notice that the servo is moving until you turn the POT to a faster setting. Once the desired speed is achieved press & release the button to store that speed in memory in the same way you did for position programming.

Servo 2 is programmed in the same way as servo 1, but the LEDs will be different, as detailed in appendix 2A. Note that in grade crossing applications setting servo 2's speed will have no effect. It has been found that getting the two gates to operate at the same speed with two independent speed setting was difficult so the software was written to use only servo 1's speed for both servos in grade crossing mode.

A step can be skipped by holding the button in until the LED goes out (then release the button). If you did not do a 'press and release' of the button as detailed above for setting positions or speeds nothing will be stored in memory. To give you a practical example here, if you need to change gate #2's down position you **do not need to reset gate 1's positions and speed too**. To do this you would enter position/speed programming mode by pressing and holding the button for five seconds (putting you in step 1); pressing and holding the button until D3 goes out (advancing you to step 2 without changing anything in step 1); pressing and holding the button until D3 goes out (advancing you to step 3, servo 2 position programming); install the jumper on pins 1 & 2; and then adjusting the POT to set the new down position for gate #2. Now you would press & release the button to store only this new position in memory. Two more 'press & holds' of the button will move you out of the programming mode.

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 optical 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 (one direction each track) grade crossing. To have more then 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:

<div align="center">Start #1   Hold #1   Hold #2   Start #2</div>

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' (NJ International'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 NJ International'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 then with slow motion switch machines as there is no complicated linkage or mechanical stops 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.

Some of the NJ International 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 or steel wire pushrod in the hole. If you do this very smooth and slow gate movement will result.

Some N gage 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).

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. Servo extension cables can make this much easier. TDP offers servo extension cables, or they can be purchased from any RC hobby store. 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. See figure 4 below for linkage installation details.
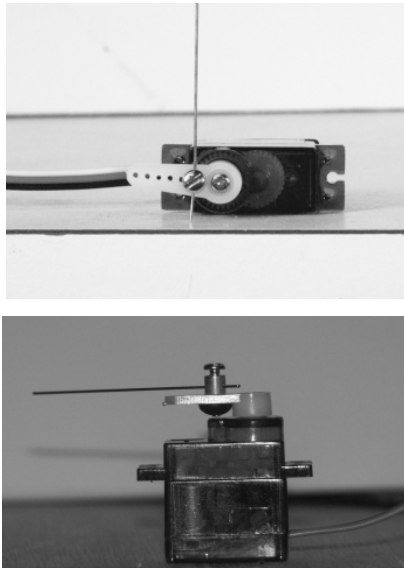
Figure 4
Example of servo linkage installation.

Note that the unused portion of the servo 'arm' can be trimmed off for clearance. Also, you should choose an appropriate hole in the servo arm that will allow enough linear motion to activate your gates (or whatever you are controlling). The closer the hole chosen is to the center of the arm will translate into a shorter motion of the control rod.

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 (take a servo with you!).

Troubleshooting

When you have installed everything 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….

A word about the sensor sensitivity is in order. The sensors detect light in the IR end of the light spectrum. Most fluorescent lights produce a 'cold' light that does not have very much IR content. This can cause sensor sensitivity problems. If you cannot seem to get enough light on the sensors and you are using fluorescent lights try temporarily adding some incandescent light (bring an old lamp into the area or use a flashlight). If the sensors start working then the fluorescent lights are the problem. You can either mount an incandescent light in the area or switch to a warmer fluorescent light (sometimes called a 'daylight' tube).

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.
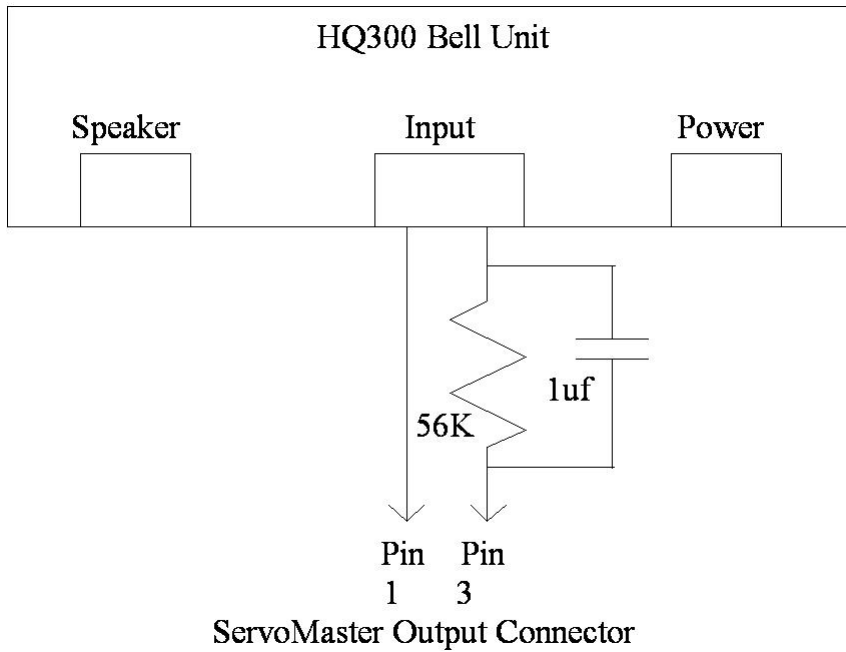
If the black heat sink gets very hot there is a short circuit somewhere. Note that the heat sink in this case will get hot enough to burn you! However, no permanent damage will occur to the ServoMaster (however it may damage the power supply you are using if you do not use a fuse). If this happens disconnect 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 system) 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).
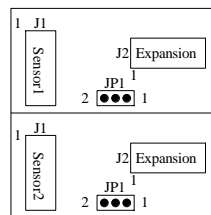
Optional Accessories

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). The order number for the unit is HQ300. To connect the bell unit you will need a 56K ohm resistor and a 1 uf non-polarized 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. **The bell unit will need to be powered from a separate AC power supply.** Connect the units as shown below. Note that these connections are for rev 4 boards and above. For rev three boards use wire #2 in place of wire #1 and wire 10 in place of wire 3.

HQ300 Bell Unit

Speaker   Input   Power

1uf

56K

Pin   Pin
1   3

ServoMaster Output Connector

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 (Stock # 8001 for optical sensors).   The expansion kit will add a printed circuit board and 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 (stock #8002 for optical sensors).

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

1 J1   J2 Expansion
Sensor1   1
                    JP1 1
                  2 ●●● 1

1 J1   J2 Expansion
Sensor2   1
                    JP1 1
                  2 ●●● 1

    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.
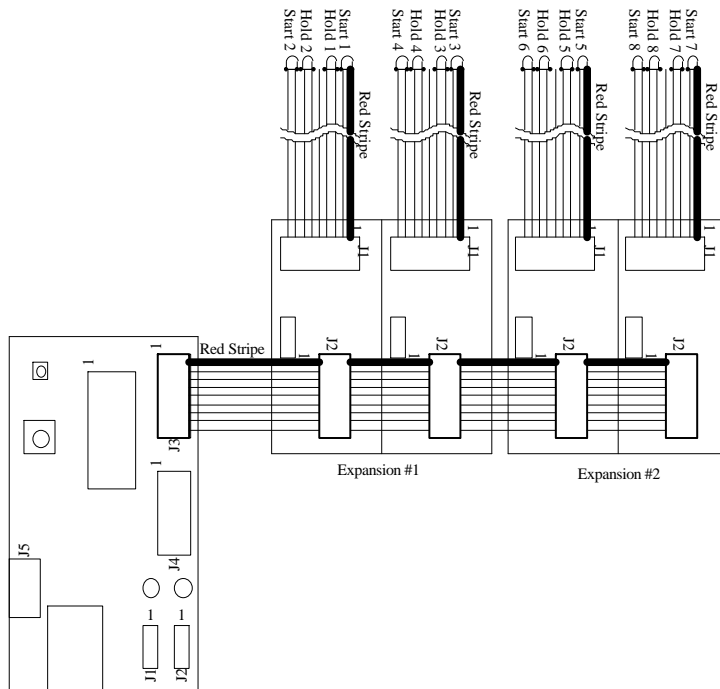
To set up two tracks with bi-directional detection you will get the best results by using Sensor cable #1 in the 'East' direction and sensor cable #2 in the 'west' direction. In other words, one sensor cable should cover one side of the grade crossing and the other cable should cover the other side of 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.

Appendix 1 – Mode Programming,
Step by Step

Operating mode programming (Should be done prior to installation on the layout)

1 – Connect only Power to the board at J5, do not power up yet!
2 – Press and hold the button (SW1)
3 – Apply power while holding the button down
4 – Release button after 2 seconds
5 – Rotate the POT (R2) with a screwdriver until the LEDs match the mode desired

D2	D3	Mode	Description
Off	Off	1	Four position mode (Semaphore signals etc.)
Off	On	2	Turnout control mode
On	Off	3	Grade crossing mode without detection
On	On	4	Grade crossing mode with detection (this is the factory default)

6 – Press and release the button (SW1)
7 – Set the input polarity by rotating the POT (R2) until the LED's match the polarity desired:

D2	D3	Polarity
Off	Off	Positive, use for non-expanded optical grade crossings and Modes 2, 3 & 4.
On	On	Negative, use for IR crossings and all expanded grade crossings

8 – Press and release the button (SW1), the unit will now reset

Appendix 2A – Position/Speed Programming for grade crossings, Step by Step

Servo Position Programming

1 – Connect power to the board at J5, do not power up yet!
2 – Connect the servos to J1 and J2
3 – Do not tighten the screws that lock the actuating pushrods to the servos yet!
4 – Apply power; wait about ten seconds for the unit to reset.
5 – Press and hold the button (SW1) for about 5 seconds (D3 will light when the button is pressed and go out when programming mode is entered. D2 will still be lit. You are now ready to set servo 1's positions.
      6 – Turn the pot slowly until servo #1 begins to 'follow' the movement of the POT
      7 – Tighten the locking screw on servo #1
      8 – Turn the pot until the gate is in the up position.
      9 – Press and release the button. D3 should turn on for a short time.
      10 – Install a jumper across pins 1 & 2 of J3 (see manual page 10)
      11 – Turn the pot until the gate is in the down position.
      12 – Press and release the button. D3 should turn on for a short time.
      13 – Remove all jumpers.
14 – Press and hold the button, D3 should light, when D3 goes out release the Button (about five seconds). You are now ready to set servo 1's speed.
      15 – Servo 1 should now begin moving between positions 1 & 2. Turn the POT until the servo moves at the desired speed (turning the pot counter clockwise makes the movement faster).
      16 – Press and release the button. D3 should turn on for a short time.
17 – Press and hold the button, D3 should light, when D3 goes out release the Button (about five seconds), D2 should now go out and D3 will light.   You are now ready to set servo 2's positions.
      18 – Turn the pot slowly until servo #2 begins to 'follow' the movement of the POT
      19 – Tighten the locking screw on servo #2
      20 – Turn the pot until the gate is in the up position.
      21 – Press and release the button. D2 should turn on for a short time. D3 will go out.
      22 – Install a jumper across pins 1 & 2 of J3 (see manual page 10)
      23 – Turn the pot until the gate is in the down position.
      24 – Press and release the button. D2 should turn on for a short time.
      25 – Remove all jumpers.
26 – Press and hold the button, D2 should light, when D2 goes out release the Button (about five seconds).
27 – Press and hold the button for about five seconds. The unit should now reset.
28 – Remove power and install the sensor cable and the output cable.

The above procedure is a step by step description of how to program everything. However, for example, if you only need to 'correct' the down position of gate #2, you do not have to reprogram everything. You do not need to unlock the locking screws on either servo. To adjust just gate 2's down position you only need to do the following steps: 1, 2, 4, 5, 14, 17, 22, 23, 24, 25, 26, 27 & 28. The position programming sequence has for major segments:
1) position of servo 1 (begins at step 5)
2) speed of servo 1 (begins at step 20)
3) position of servo 2 (begins at step 23)
4) speed of servo 2. (begins at step 37

Step 27 exits the position programming mode. Note too that shutting down the power at any step will exit the programming mode. So, if you only need to modify the up position of servo 1 you can 'pull the plug' after step 9 without the need to go through any additional steps. Positions of the servos are only saved to memory by the button presses in steps 9, 12, 16, 21 and 24. Speed is stored in step 21. If the short button presses in these steps are skipped then no changes of servo positions or speeds will be made. Note too that if the LED mentioned in the step does not light when the button is pressed in the above steps then the button was not held down long enough (about a half second) and the new position will not be remembered!

Appendix 2B – Position/Speed Programming for Semaphores and multi-position applications,
Step by Step

Servo Position Programming

1 – Connect power to the board at J5, do not power up yet!

2 – Connect the servos to J1 and J2

3 – Do not tighten the screws that lock the actuating pushrods to the servos yet!

4 – Apply power; wait about ten seconds for the unit to reset.

5 – Press and hold the button (SW1) for about 5 seconds (D3 will light when the button is pressed and go out when programming mode is entered. D2 will still be lit. You are now ready to set servo 1's positions.

      6 – Turn the pot slowly until servo #1 begins to 'follow' the movement of the POT

      7 – Tighten the locking screw on servo #1

      8 – Turn the pot until the servo is in the first desired position.

      9 – Press and release the button. D3 should turn on for a short time.

      10 – Install a jumper across pins 1 & 2 of J3 (see manual page 10)

      11 – Turn the pot until the servo is in the second desired position.

      12 – Press and release the button. D3 should turn on for a short time.

      13 –Move the jumper from pins 1& 2 to pins 3 & 4 (see page 10).

      14 – Turn the pot until the servo is in the third desired position.

      15 - Press and release the button. D3 should turn on for a short time.

      16 – Install a second jumper on pins 1 & 2 of J3 (see page 10)

      17 – Turn the pot until the servo is in the fourth desired position.

      18 – Press and release the button. D3 should turn on for a short time.

      19 – Remove all jumpers.

20 – Press and hold the button, D3 should light, when D3 goes out release the Button (about five seconds). You are now ready to set servo 1's speed.

      21 – Servo 1 should now begin moving between positions 1 & 2. Turn the POT until the servo moves at the desired speed (turning the pot counter clockwise makes the movement faster).

      22 – Press and release the button. D3 should turn on for a short time.

23 – Press and hold the button, D3 should light, when D3 goes out release the Button (about five seconds), D2 should now go out and D3 will light. You are now ready to set servo 2's positions.

      24 – Turn the pot slowly until servo #2 begins to 'follow' the movement of the POT

      25 – Tighten the locking screw on servo #2

      26 – Turn the pot until the servo is in the first desired position.

      27 – Press and release the button. D2 should turn on for a short time. D3 will go out.

      28 – Install a jumper across pins 1 & 2 of J3 (see manual page 10)

      29 – Turn the pot until the servo is in the second desired position.

      30 – Press and release the button. D2 should turn on for a short time.

      31 – For non grade crossing applications move the jumper from pins 1& 2 to pins 3 & 4 (see page 10). Grade crossing applications should jump to step 37.

      31 – Turn Turn the pot until the servo is in the third desired position.

      32 – Press and release the button. D2 should turn on for a short time.

      33 – Install a second jumper on pins 1 & 2 of J3 (see page 10)

      34 – Turn the pot until the servo is in the fourth desired position.

      35 – Press and release the button. D2 should turn on for a short time.

      36 – Remove all jumpers.

37 – Press and hold the button, D2 should light, when D2 goes out release the Button (about five seconds). You are now ready to set servo 2's speed.

      38 – Servo 2 should now begin moving between positions 1 & 2. Turn the POT until the servo moves at the desired speed (turning the pot counter clockwise makes the movement faster).

      39 – Press and release the button. D3 should turn on for a short time.

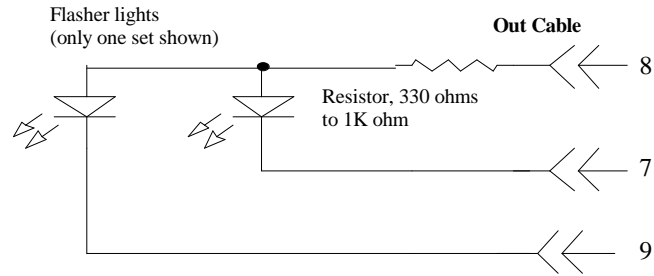40 – Press and hold the button for about five seconds. The unit should now reset.

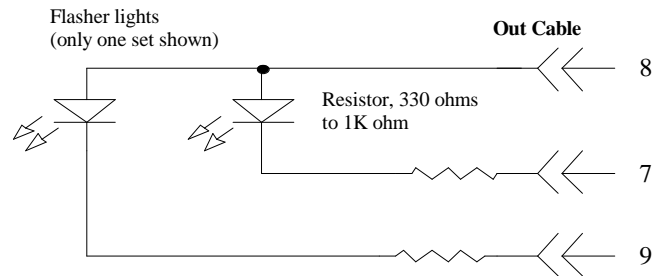41 – Remove power and install the sensor cable and output cable.
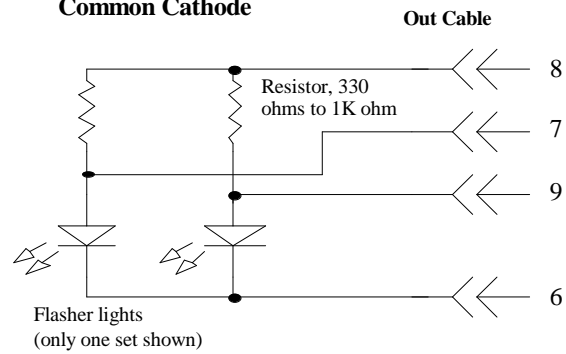
Appendix 3

Light wiring options

Common Anode w/common external resistor

Flasher lights
(only one set shown)

Out Cable

Resistor, 330 ohms to 1K ohm

8

7

9

Common Anode w/individual external resistors

Flasher lights
(only one set shown)

Out Cable

Resistor, 330 ohms to 1K ohm

8

7

9

Common Cathode

Out Cable

Resistor, 330 ohms to 1K ohm

8

7

9

6

Flasher lights
(only one set shown)

If you do not know how your flashers are wired up (common anode or common cathode) try hooking them up as common anode first as this is the most likely way that they are wired. If this doesn't work try the common cathode wiring.

Appendix 4

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 (Rev 4 and above boards)	Use (Rev 3 board)
1	GND	GND
2	Bell high	Lamp Common (pos)
3	Bell low	No Connection
4	+5V	+5V
5	Vin (DC)	Vin (DC)
6	GND	Vin (DC)
7	Lamp1 (neg)	Lamp1 (neg)
8	Common anode	+5V
9	Lamp 2 (neg)	Lamp2 (neg)
10	Common cathode	+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 stripe.

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. You may also email us at 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.

CONTACT INFORMATION

TDP & Associates, Inc.

4 Jones Drive
Garnet Valley, Pa. 19060
(610) 358-0460
www.trainspeed.com
Email:
sales@trainspeed.com

©2006, TDP & Associates, Inc.
Ver. 3.4