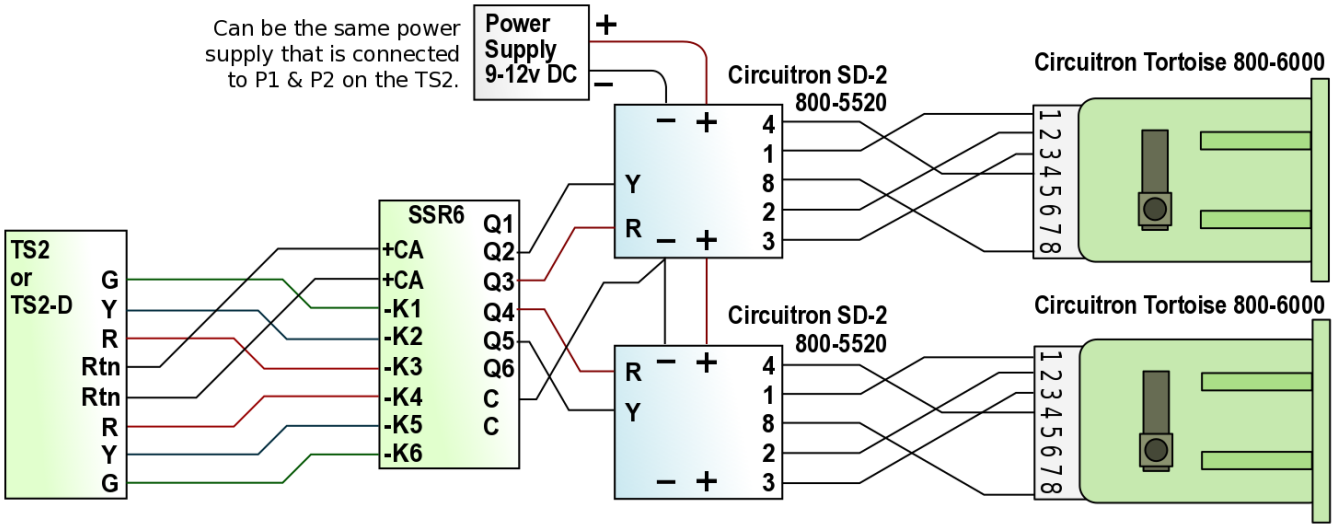
Azatrax block signal control circuits TS2 and TS2-D can be used to control two model railroad semaphore signals when used with:

- one Azatrax SSR6 solid state relay module,
- two Circuitron SD-2 (800-5520) adapter circuits, and
- two Tortoise® slow motion motors.

Use of two Circuitron Remote Signal Activator kits (800-8100) is recommended, but is optional.

The SSR6 has six solid state relays on board. Only four of the relay outputs are connected to the SD-2 adapters, but all six green/yellow/red TS2 or TS2-D outputs must be connected to a load. This lets the TS2 or TS2-D know that all three signal indications are being used.



On the following pages are Circuitron's instructions for the SD-2 (800-5520) adapter circuit and for the Remote Signal Activator kit (800-8100).

The SD-2 instructions explain modifications to be made to the Tortoise motor.
However, if the Remote Signal Activator kit is also used in the semaphore installation, then no modifications to the Tortoise are needed.

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Electronics for Model Railroads
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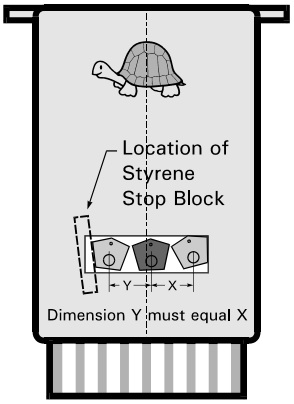
SD-2

SEMAPHORE DRIVER- 3 POSITION

GENERAL DESCRIPTION: The CIRCUITRON **SD-2** is designed to drive a CIRCUITRON Tortoise Switch Machine to all three signaling positions when used in conjunction with a Semaphore signal. Linkage and mounting hardware will need to be fabricated for each particular application and brand/scale of signal. The **SD-2** requires a 10-18 volt DC power source for proper operation. With no connection to the **[Y]** or **[R]** pins on the circuit board, the **SD-2** will move the Tortoise to the "Green (Clear)" position. Connecting either **[Y]** or **[R]** to GROUND or **[-]** will move the Tortoise to the "Yellow (Approach)" or "Red (Stop)" positions. These connections can be made through a multi-pole switch or automatically with CIRCUITRON Block Detection Circuits.

MODIFYING THE TORTOISE: Refer to Figure 1. When the Tortoise is connected to the **SD-2**, you will note that the center stopping position (for the "yellow" approach signal) is slightly off of center. This is due to the internal switch configuration of the Tortoise and is unavoidable. The **SD-2** will, however, consistently stop the Tortoise in approximately the same center position going in either direction. It is recommended that a styrene "stop" be glued to the Tortoise case across the arm opening to equalize the throw on either side of "center". You will need to connect the **SD-2** and Tortoise on the bench following the wiring instructions below. With power applied to the **SD-2**, connect a temporary jumper wire from the **[-]** power supply terminal to the terminal marked **[Y]**. The Tortoise should move to the center position and stop. Mark the centerline stopping position of the moving arm on the case with a marker. Move the jumper wire to the **[R]** terminal. The Tortoise should move to the "Stop" (Red) position. Again mark the centerline position on the case. Quickly move the jumper wire from the **[R]** terminal to the **[Y]** terminal. The Tortoise should again stop in the center position. If this position is slightly different than the previously marked one, mark a new 'center' in between the two positions noted. Measure the distance between the center stop mark and the "Red" stop mark (X distance). Measure the same distance on the other side of the center mark (Y distance) and mark the case for the "Green (Clear)" stopping position. Remove power from the **SD-2** and carefully apply pressure to the arm to slowly move it to align with the "Green (Clear)" stopping position. This will be a short distance in from the normal stop in the case opening. Glue a block of styrene square tube or angle across the opening in the case to provide a new stop for the arm in the "Green (Clear)" position. Make sure the glue is dry before proceeding.

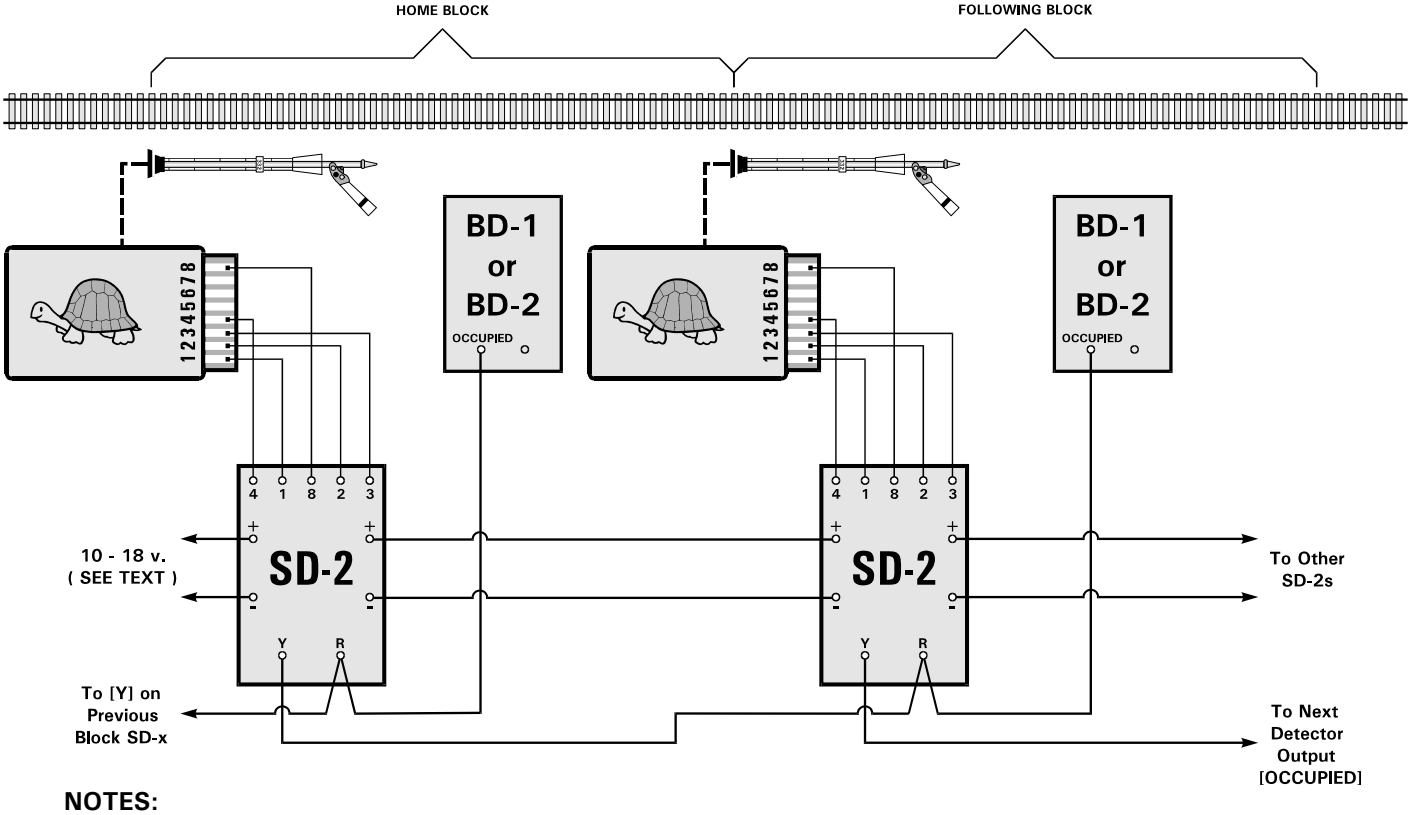
Figure 1



MOUNTING THE TORTOISE: The Tortoise will need to be mounted horizontally under the layout. A wood block or a pair of small steel angles may be used to attach the machine to the underside of the layout. Linkage will have to be fabricated depending on the amount of throw required. The Tomar semaphore only has about 1/8" total throw. Since it is likely that the Tortoise will be mounted some inches away (for clearance), a new fulcrum will likely have to be fabricated also. One system that we have found effective is to use a small steel angle bracket for the fulcrum and temporarily mount it just beyond the control wire for the semaphore. Open up one of the pre-formed holes in the bracket with a 1/4" bit. Flatten a 12" piece of 1/4" brass tube at one end and drill a clearance hole for the retaining screw on the Tortoise arm. Attach the tube to the arm with the screw. Do not over-tighten. Place the end of the tube through the hole in the bracket and keep the assembly just to the side of the semaphore control wire. Holding the Tortoise in place, *gently* move the arm up and down through its complete motion. Note how much the tube moves at the point where it crosses the control wire. Adjust the Tortoise position until you achieve about 1/8" throw at the wire. Mark the wire location on the tube with a marker. Remove the Tortoise and tube and drill a small hole through the tube for the wire to pass through. Mount the Tortoise after passing the wire through the hole in the tube and re-inserting the tube in the bracket. Wire the Tortoise to the **SD-2**, apply power to the board and set the driver to the "approach" aspect by connecting a jumper between **[Y]** and **[-]**. Manually adjust your semaphore to the 45 degree approach position. Wedge a tiny sliver of wood or plastic into the hole in the tube so that the control wire is held firmly. Using the **SD-2** to power the Tortoise, run the semaphore to all 3 positions. If it wants to overrun the horizontal and vertical positions, move the fulcrum bracket closer to the Tortoise a bit. You may need to re-adjust the 45 degree position with each move. After you are satisfied with the throw, firmly attach the fulcrum to the layout and glue the wire into the hole with ACC.

WIRING: The **SD-2** can be connected with .110" x .032" solderless connectors (available from CIRCUITRON) or by soldering leads directly to the terminals on the printed circuit board. If soldering, use a small pencil-type iron and electronics-grade rosin core 60/40 solder (available from Radio Shack). Use only as much heat as

necessary to obtain a good joint and do not wiggle the terminal until the solder has cooled completely. A section of CIRCUITRON'S **PCMT** can be used for simple, snap-in mounting of the circuit board or you may drill holes in the mounting pads in the corners of the board and mount the **SD-2** with screws and standoffs.



NOTES:

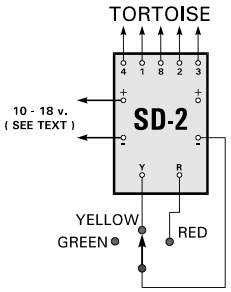
1. BD-1/BD-2 power supply and BD-1 Opto-Sensor connections are not shown.
2. Block Detectors and SD-2 board(s) must share a common power source.
3. Single direction mainline shown. Bi-directional travel requires additional signals & SD-2s for opposite direction.

1) Connect 5 light gauge (22-24 ga.) wires from the numbered terminals on the top of the **SD-2** to the corresponding connection points on the Tortoise as shown above.

2) Connect the [+] and [-] terminals on the **SD-2** to a 10 - 18 volt DC source. Leave your power source OFF during these connections. AC may be used to power the **SD-2**, but if the **SD-2** will be connected to Detection Circuits for automatic operation, then *DC MUST BE USED!* You will notice that the supply terminals, [+] and [-] are bussed across the board so that multiple **SD-2** installations are easily wired. Merely connect [+] to [+] and [-] to [-] for daisy-chained installations.

3) For automatic operation, connect a wire from the **[R]** terminal on the **SD-2** to the output from a CIRCUITRON detection circuit installed for the *SAME* block that the signal is supposed to protect. This terminal is labelled **[OCCUPIED]** in the case of the **BD-1** or **BD-2**. With this connection, the **SD-2** will now display 2 aspect signals (red and green). This block is designated the ***HOME*** block and will be referred to as such in the diagrams. *NOTE: The detection circuits and the **SD-2** must have the same power source for proper operation.*

Figure 3



MANUAL CONTROL

4) Connect a wire from the **[Y]** terminal on the **SD-2** to the output from a CIRCUITRON detection circuit installed for the block following the ***HOME*** block above. This block is designated the ***FOLLOWING*** block.

5) This completes the installation. Apply power to the board and run a train through the blocks and note that the signal properly displays all three aspects.

WARRANTY

CIRCUITRON warrants this device against defects in materials and workmanship for a period of one year from the date of purchase. This warranty covers all defects incurred in normal use of the device and does not apply in the following cases:

a) damage to the device resulting from abuse, mishandling, accident or failure to follow operating instructions.
b) if the device has been serviced or modified by other than the CIRCUITRON factory.

EXCEPT AS MENTIONED ABOVE, NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED INCLUDING MERCHANTABILITY, ON THE PART OF THE UNDERSIGNED OR ANY OTHER PERSON, FIRM OR CORPORATION, APPLIES TO THIS DEVICE.

CIRCUITRON, INC.

Remote Signal Activator

[GATE / SEMAPHORE ACTUATOR]

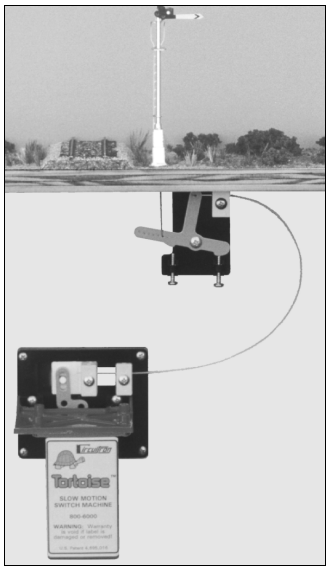
800-8100

CONGRATULATIONS!

Your new Remote Signal Activator (RSA) will now allow you to use the TORTOISE™ to drive any scale crossing gate or semaphore-style signal that has a vertical actuating wire extending through the layout base. The actuator features positive, screw-adjusted stops at both the vertical and horizontal positions. Stops at the mid-position for 3-color semaphore arms can be easily accomplished by utilizing a CIRCUITRON **SD-2** (800-5520) Semaphore Driver Circuit. By purchasing an extra RSA Cable and Actuator (part no. 800-8101), one TORTOISE™ can simultaneously drive two gates at one crossing.

HOW IT WORKS

The TORTOISE™ mounts to the drive mechanism and can be located up to 18" from the signal. A drive arm with multiple pivot holes (for adjusting the total throw) moves a slide back and forth as the TORTOISE™ runs (crawls?). A fine stainless steel wire is clamped to the slide and moves inside a small teflon™ tube, much like a sub-miniature choke cable. At the other end of the wire and tube, an actuator bellcrank is swung by the moving wire. Multiple holes are provided in the bellcrank to accomodate virtually any vertically actuated signal wire.



Fully adjustable screw stops are provided to set the range of motion precisely. The drive mechanism assembly with the TORTOISE™ mounted on it can be located in any position above or below the layout surface. It may even be possible to locate the mechanism inside of larger structures if that would be an advantage.

CONTENTS

Please check your kit carefully and refer to the drawings to identify all parts. You should have:

- (1) Drive Mechanism Base Plate
- (1) TORTOISE™ Mounting Plate
- (1) Drive Mechanism Arm
- (1) Slide
- (1) Slide Clamp Plate (4 Shallow Grooves)
- (1) Base Clamp Plate (4 Deep Grooves)
- (1) Bellcrank Mounting Plate
- (1) Actuator Clamp Plate (2 Deep Grooves)
- (1) Bellcrank
- (14) #4 x 3/8" Phillips Truss (large) Head Screws
- (6) #4 x 5/8" Phillips Pan Head Screws
- (2) #4 x 1/2" Phillips Shoulder Screw
- (1) 18" Length Stainless Steel Wire
- (1) 18" Length Teflon Tube

CAUTION: Handle the Stainless Steel Wire and Teflon Tube carefully to avoid kinking either of them. Kinks will degrade performance and may render the mechanism unusable. Replacement Wire/Tube sets are available from Circuitron for $3.00 postpaid.

TOOLS REQUIRED

#1 Phillips Screwdriver
Diagonal Wire Cutters (Hardened or Heavy Duty)
Flush Cutting Nippers
Needle Files
Square Jawed Needle Nose Pliers
Abrasive Cutoff Disc in Motor Tool
Drill with 3/32" drill bit.
Hobby Knife with new (sharp) #11 Blade
ACC Adhesive (Thin)

PREPARING THE PARTS

Remove all parts from their sprues, if necessary, and trim the gate vestiges with flush cutters. File the trimmed surface smooth on the Slide.

GETTING STARTED

1) Determine the total travel of the signal you want to actuate by holding a caliper, ruler or scale next to the wire under the layout and moving it between both extremes. Refer to the chart in the next column and make a note of the recommended pivot hole and Bellcrank hole to use for your application.

NOTE: The numbers in the chart are just suggestions and should provide a small amount of desirable over-travel for most applications. However, the length of cable and friction of the actuated device may affect the operation and you may need to choose a hole combination that provides somewhat more total travel.

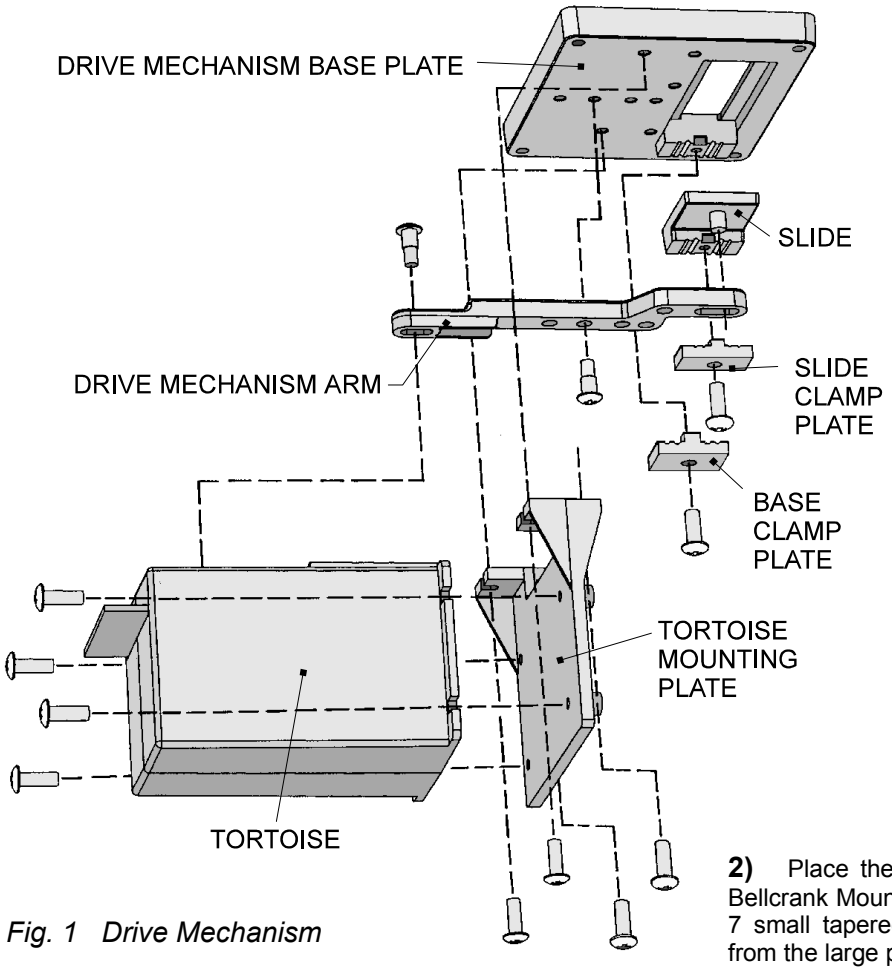


Fig. 1 Drive Mechanism

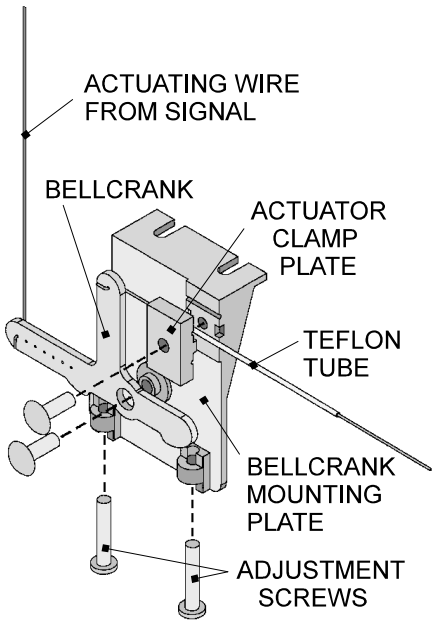


Fig. 2 Actuator

Total Signal Actuator Wire Travel in Inches	Drive Mechanism Pivot Number	Bellcrank Hole Number
.035 - .049	1	1
.050 - .069	1	3
.070 - .089	2	2
.090 - .109	2	4
.110 - .129	3	1
.130 -.150	3	2
.155 - .175	3	3
.180 - .200	3	4
.205 - .230	3	5
.235 - .265	4	1
.270 - .300	4	2
.305 - .340	4	3
.345 - .385	4	4
.390 - .440	4	5
.445 - .495	4	6
.500 - .540	5	4
.545 - .610	5	5
.615 - .680	5	6
.685 - .750	5	7

2) Place the Bellcrank over the molded boss on the Bellcrank Mounting Plate as shown above. Note that the 7 small tapered holes (Numbered 1 - 7 counting *OUT* from the large pivot hole) have their larger opening facing *toward* the Mounting Plate. Insert a # 4 x 3/8" Phillips Truss Head Screw into the hole in the boss and tighten until just snug. The Bellcrank should still move freely.

3) Place the Bellcrank and mounting plate next to the signal actuating wire with the mounting flange against the underside of the layout. Adjust the Bellcrank so that the lower arm with all the holes in it is horizontal. Position the assembly so that the wire passes directly over the Bellcrank hole number determined in step 1.

EXAMPLE: The 2nd hole (in combination with Drive Mechanism Pivot Number 3) is usually ideal for use with signals that have a little over 1/8" (.135") total travel such as Tomar's HO Scale semaphores and NJ International's HO Scale gates. If your signal's travel is different, it will be necessary to use a different hole combination.

4) Using a fine tip marker, make a mark on the signal wire directly over the hole in the Bellcrank. Also mark the two mounting locations on the underside of the layout. Remove the Bellcrank from the Mounting Plate.

5) Holding the wire with pliers, bend it to 90 degrees at the mark.

6) Drill two 3/32" pilot holes at the locations you marked in Step 4 and *temporarily* mount the Bellcrank Mounting Plate with two # 4 x 3/8" Phillips Truss Head Screws.

7) Drill out the selected hole in the Bellcrank with a drill-bit in a pin vice sized to match the diameter of the signal actuating wire.

8) Prepare the stainless steel wire by cutting 1/4" off of one end. *CAUTION: This wire is quite hard and will destroy delicate cutters. Use good quality hardened cutters or use the abrasive cutoff wheel.* Run the cut end through your fingers and make sure there are no burrs or hooks on the end.

HANG IN THERE!

IT'S GOING TO TAKE YOU FAR LESS TIME TO DO THE INSTALL THAN TO READ ALL THE INSTRUCTIONS.

LOCATING THE DRIVE MECHANISM

It is desirable to locate the Drive Mechanism with the TORTOISE™ attached as physically close to the Actuator as possible. Shorter cable lengths result in smoother action and more positive throws. Although the cable can be up to 18" long, you should shorten it if space permits. Select a location for the Drive Mechanism Base Plate near the actuator and temporarily tape or screw it in place. Tape one end of the Teflon tube in the Actuator Clamp groove and then place the tube in the Base Plate Clamp groove. The goal is to find a location for the Drive mechanism where the Teflon tube will have a minimum of bends and also the shortest overall length (short and as straight as possible is what we're after here). No bend should have less than a 2" radius (4" minimum preferred).

9) After finding the best location, make a mark on the Teflon Tube with a permanent felt tip marker at the center of the Base Plate Clamp groove. ***CAUTION: HANDLE THE TEFLON TUBE WITH CARE. DO NOT KINK!*** Also mark the locations of the four corner mounting holes. Loosen the two mounting screws slightly and remove the Bellcrank Mounting Plate.

COMPLETING THE ACTUATOR

10) Using the sharp hobby knife or a single edge razor blade, cut the Teflon Tube to a length 2" *LONGER* than the mark on the tube you made above.

11) Carefully thread the previously cut end of the stainless steel wire into one end of the cut Teflon Tube. Thread it through until it extends a few inches out the other end.

12) Make a 90 degree bend in the stainless steel wire about 3/8" in from the trimmed end.

13) Locate the small single hole near the end of the Bellcrank vertical arm and note that the hole is tapered. Feed the wire through the arm from the larger side so that it exits the tiny opening on the other side. (If it doesn't want to go through, it may be necessary to enlarge the hole slightly with a #75 - 80 drill bit in a pin vise.) Bend the end of the wire over into a "Z" shape, capturing it in the Bellcrank arm.

14) Place the Bellcrank back in position on the Mounting Plate and re-insert the Truss Head Screw. Lay the Teflon Tube in the Mounting Plate clamp block groove so that the end of the tube is flush with the inside edge of the clamp block. Place the Clamp Plate on top and *making sure that the tube is fully seated in the groove*, press it down in place. Use a # 4 x 3/8" Phillips Truss Head Screw to clamp the plate tightly to the block.

15) Position the Actuator Mounting Plate / Bellcrank assembly back in position under the screwheads and tighten in place. Insert the signal actuating wire into the proper hole in the Bellcrank and then bend the signal wire into a 'Z' shape to capture it in the Bellcrank. Hold the Teflon Tube in one hand and move the stainless wire in and out with the other. The signal should move smoothly and without binds to the extremes of its motion.

16) Carefully thread 2 Adjustment Screws (# 4 x 5/8" Phillips Pan Head) into the molded openings at the bottom of the Bellcrank Mounting Plate until the end of the screw is flush with the edge of the raised area.

ASSEMBLING THE DRIVE MECHANISM

The Drive Mechanism can be set for 5 different total travel lengths. The pivot holes are numbered 1 through 5 with number 1 being closest to the Slide.

1st Pivot Hole	.125" Total Travel
2nd Pivot Hole	.150" Total Travel
3rd Pivot Hole	.275" Total Travel
4th Pivot Hole	.490" Total Travel
5th Pivot Hole	.675" Total Travel

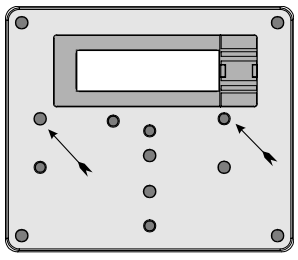
Refer to the chart in the third column to determine the recommended Pivot Hole for your application.

17) Drill 4 pilot holes 1/2" deep at the locations you marked in Step 9. Use a 3/32" drill bit.

18) Place the Slide in the recessed area of the Base Plate so that the raised Clamp Block on the Slide is next to the raised Clamp Block on the Base Plate.

19) Place the end of the Drive Mechanism Arm with the longest slot over the molded pin on the Slide so that the 5 Pivot Holes in the Arm line up with the molded holes in the Base Plate.

20) Place a # 4 Shoulder Screw in the correct Pivot Hole and screw it into the base. Tighten gently, then back out 1/8 turn. The Arm (and Slide) should move easily back & forth.



21) Partially thread 2 Truss Head Screws into the

holes indicated.

22) Slip the mounting flanges on the TORTOISE™ Mounting Plate under the two screw heads. The smooth side of the Plate faces *AWAY* from the Slide.

23) Screw 2 more Truss Head Screws through the remaining two slots in the Mounting Plate into the Base and tighten all four screws securely.

24) Attach the TORTOISE™ to the smooth side of the Mounting Plate with 4 additional Truss Head Screws.

25) Align the Drive Mechanism Arm with the TORTOISE™ arm projecting through the case. Insert the final # 4 Shoulder Screw into the molded hole in the TORTOISE™ arm. *Do Not Over-Tighten!*

26) Test the operation by applying power (9-12 vDC) to the #1 and #8 terminals on the TORTOISE™ circuit board. Then reverse your connections to make the TORTOISE™ run the other way. There should be no binds and the Slide should move smoothly back and forth. Remove power.

CONNECTING THE CABLE

27) Set your signal or gate to the mid-point of its motion.

28) Examine the Slide Clamp Plate and the Base Clamp Plate. Notice that the Slide Clamp Plate has very fine grooves in its bottom surface whereas the Base Clamp Plates grooves are much deeper.

CAUTION: *These two parts are* ***not*** *interchangeable and are keyed to fit only the proper location. FORCING the parts in the wrong location will likely damage them and may prevent proper operation.*

29) GENTLY move the TORTOISE™ arm to the very center of its travel. *Be careful!* Applying too much force too fast may damage the gears.

30) Lay the Teflon Tube in one of the two slots in the raised Base Clamp Block closest to the center screw hole. The Stainless Steel Wire should be laying across the corresponding slot in the Slide and extending out over the Drive Mechanism Arm.

31) Place the Base Clamp Plate over the Teflon Tube and being very careful to keep the tube straight in the slots, press the Clamp Plate down. Insert a Truss Head Screw through the Clamp Plate and into the Base. The end of the tube should be *barely* visible projecting toward the Slide. Tighten the screw.

32) Follow the same procedure with the Wire in the Slide, making certain that it is aligned with the proper fine groove before tightening the screw. Re-check that *BOTH* the Tortoise and the signal remain at their mid-positions. Tighten the screw securely.

33) Cut off the excess wire projecting past the Slide Clamp with your diagonal cutters or cutoff wheel.

34) Test the operation under power and check that the signal is at the mid-point of its throw when the TORTOISE™ is at the mid-point of its throw. If the throw appears off-center, you can adjust it by loosening the Base Clamp Plate slightly and moving the Teflon Tube one way or the other a small amount. Mount the assembly with four # 4 x 5/8 Phillips Pan Head Screws.

35) Watch the operation of your signal under power. If it tends to over-run either the horizontal or vertical position, you can adjust one or both Adjustment Screws to contact the Bellcrank and limit the motion.

36) **[OPTIONAL]** Once you are satisfied with the operation, you can place a *TINY* drop of ACC adhesive where the Teflon Tube enters the Base Clamp. Do the same for the Actuator Clamp. *DO NOT GET ANY GLUE NEAR THE ENDS OF THE TEFLON TUBE.* The adhesive will wick into the clamp and prevent the tube from ever moving, but can be removed by disassembling.

TO POWER 2 CROSSING GATES OR SIGNALS FROM ONE TORTOISE™

The Remote Signal Activator can accomodate a second Cable and Actuator (Part Number 800-8101). All instructions are the same but use the second set of slots closest to the screw hole on the Base and Slide Clamps.

DO NOT USE ANY LUBRICANTS ON THIS MECHANISM

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