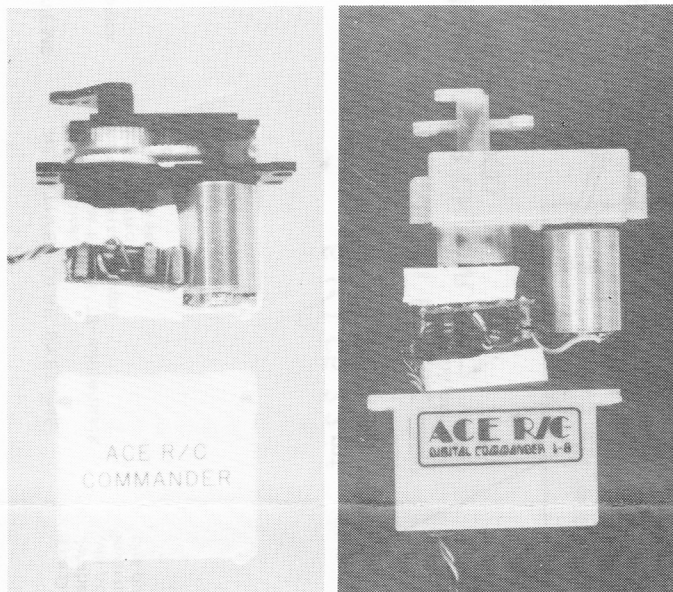




DIGITAL COMMANDER

BY FRED M. MARKS

SERVO



SERVO DESIGN

The servo amplifier is based on the application of the Signetics NE543K integrated circuit. Figure 4 represents the schematic for the servo amplifier. It is a bridge amplifier requiring 17 transistors. Most of the action is in the chip so it would do little good to describe the circuit with a couple of exceptions. Diode D1 prevents burn out of the IC when reverse polarity is applied accidentally which would normally pop the chip immediately. If reverse polarity exists for over a few seconds, D1 will short and need to be replaced, but the IC will remain protected. Better to replace a 25¢ diode than a \$5.00 IC.

The circuit also requires only two wires to the feedback pot which reduces the probability of failure; no arc suppression components need be mounted on the motor for a clean installation.

The servo will operate satisfactorily on 3.6 volts; however, it will not tolerate the added drop of a diode so that the use of a bypass diode on a failed battery will not guard against battery failure. This servo does offer the potential for use with a 3.6 volt system with slightly reduced power and speed.

Resolution with all servo mechanisms is outstanding; about .25 degrees which is quite capable of measuring stick slop. Transit time is quick, varying between .5 and .6 seconds depending on the mechanics.

If you have the Bantam mechanics, a High Power conversion kit is available if you desire more thrust. It increases the thrust from 2.75 to 3.6 lbs. with a subsequent increase in transit time of about .1 second. No. 14K89---\$1.00.

DIGITAL COMMANDER SERVO PACKAGE

Items in brackets are for Retract Servo only.

INTEGRATED CIRCUIT

- () 1 NE543K or WE3141

CAPACITORS

- () 1 .22 mfd Erie Bluecap Disc Capacitor
- () 1 .56 mfd Components, Inc. Tantalum Capacitor
- () 1 2.2 mfd Components, Inc. Tantalum Capacitor
- () 3 4.7 mfd Components, Inc. Tantalum Capacitors

RESISTORS

- () 2 33 ohm (orange, orange, black) 1/4 w 5%
- [() 1 1.2K (brown, red, red, silver) 1/4 w 10% resistor]
- () 1 3.3K (orange, orange, red, silver) 1/4 w 10% resistor
- [() 1 10K (brown, black, orange, silver) 1/4 w 10% resistor]
- () 1 22K (red, red, orange, silver) 1/4 w 10% resistor
- () 2 33K (orange, orange, orange) 1/4 w 5%
- () 1 10K (brown, black, orange, silver) 1/4w 10% resistor
- () 1 100K (brown, black, yellow, silver) 1/4 w 10% resistor
- () 1 100K (brown, black, yellow, silver) 1/8w 10% resistor

MISCELLANEOUS

- () 1 Servo Mechanics
- () 1 11 ohm Furuichi or Mitsumi 16 mm motor
- () 1 1N4446 Diode
- () 1 5K Servo Pot Element
- () 1 Printed Circuit Board
- () Wire:

9"	red (+4.8 volt)
10½"	black (0 volt & motor ground)
12"	blue (signal & pot wires)
1"	white (motor)
1"	orange (motor red terminal)
- () 18" Micro solder
- () 2 Pieces of foam insulation
- () 2" Insulation Sleeving

PLEASE NOTE: As supplied your pot element has been coated with a special lubricant. Please do NOT remove under any circumstances.

POSITIVE PULSE SYSTEMS:

Ace Digital Commander
Blue Max
EK ('73 and Later--red/black
polarized connectors)
Heath
Kraft
Micro Avionics
MRC
Orbit
Royal
W. E. Midget

NEGATIVE PULSE SYSTEMS:

Contolaire
EK (Super Pro to '73--white/black
non-polarized plugs)
EK Logictrol II
EK MM3 servos
F & M
M.A.N.
O.S.
Pro-Line

The Digital Commander system will not work with Bonner Digimite, Jerobee, or Kraft KP2B (early two channel). Digital Commander servos will not work with Hobby Lobby 5 (amps are in decoder). A pulse inverter is available for using the Digital Commander servos with negative pulse systems: 14G19--Servo Pulse Inverter \$1.00.

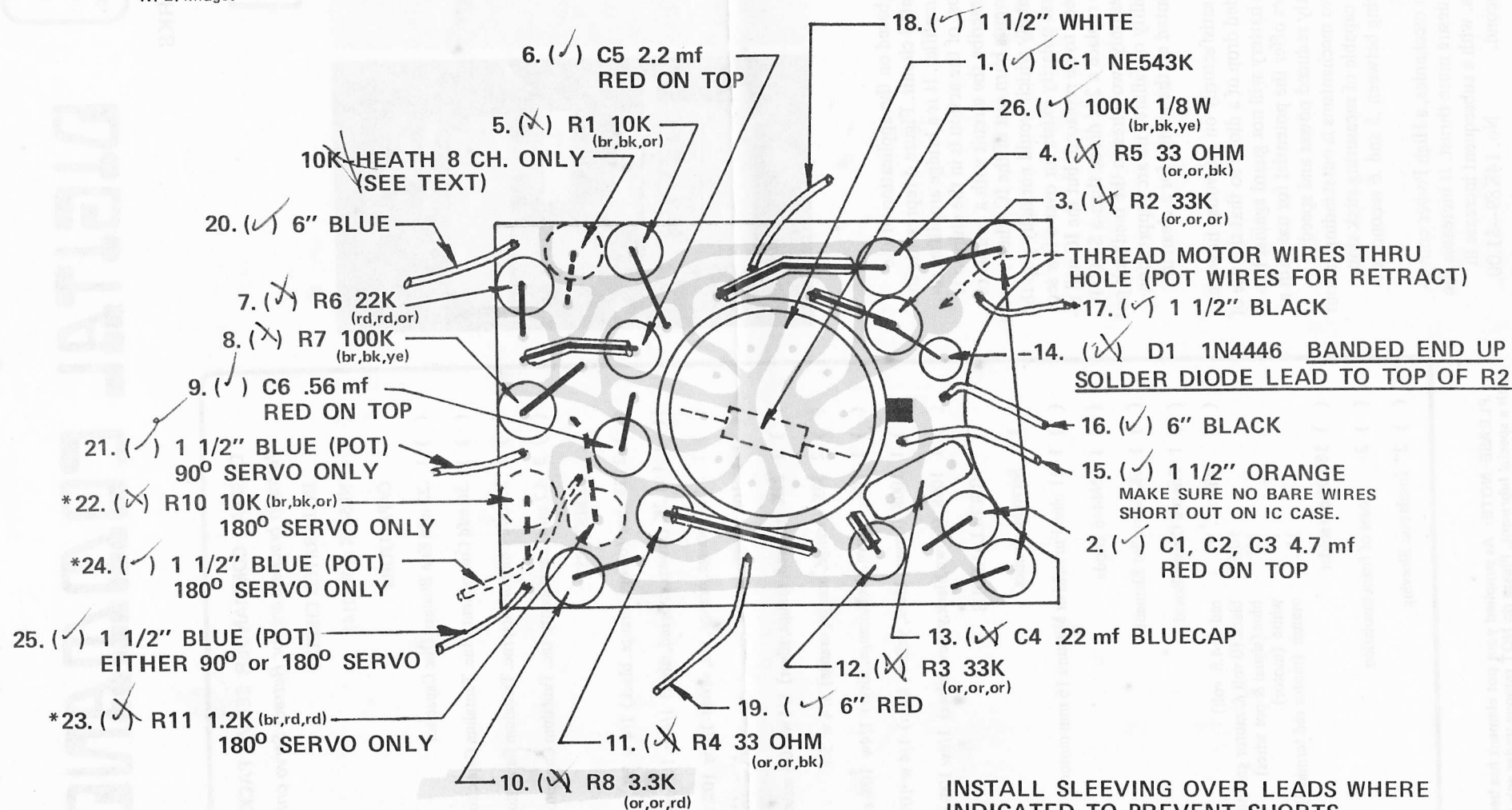


FIGURE 1
SERVO OVERLAY

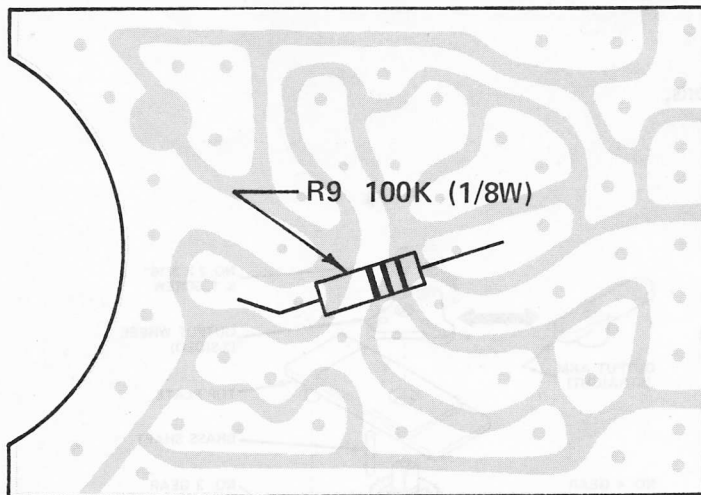
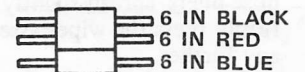
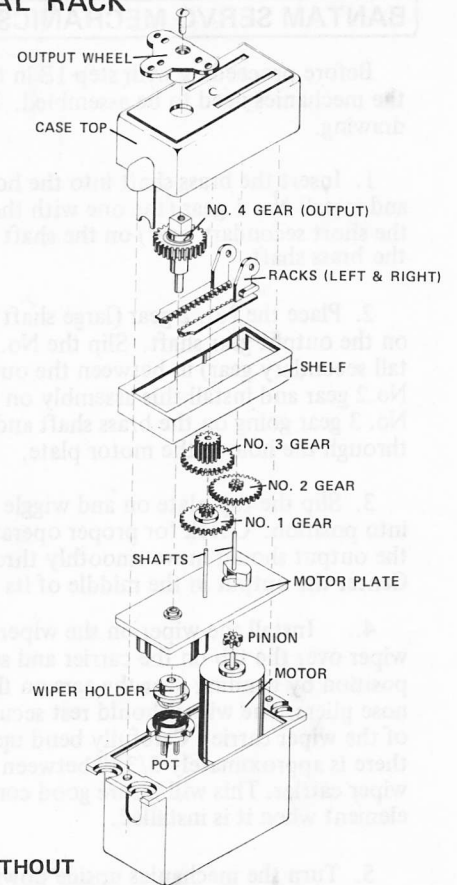


FIGURE 2

DUAL RACK



DEANS 3-PIN CONNECTOR
MALE HALF

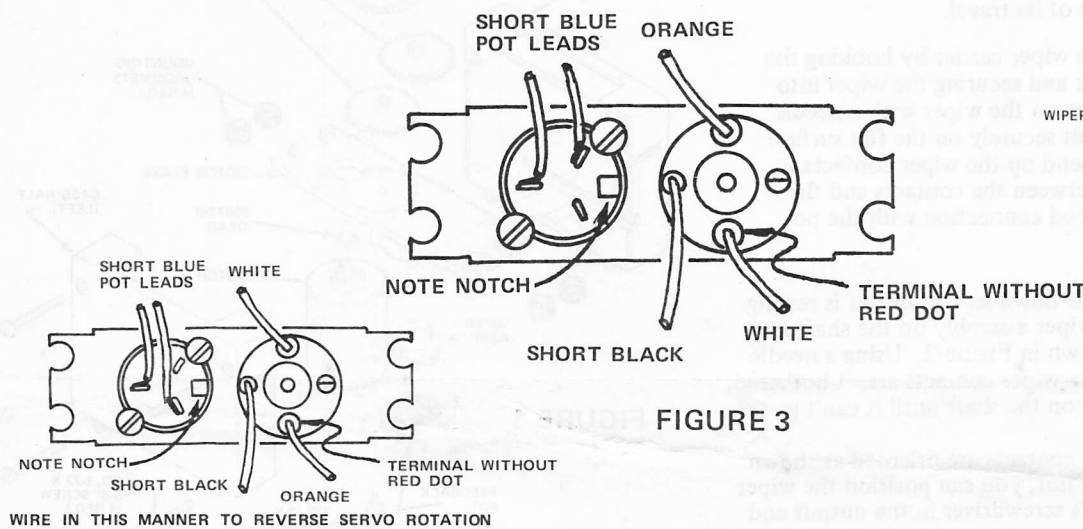


FIGURE 3

SERVO SCHEMATIC

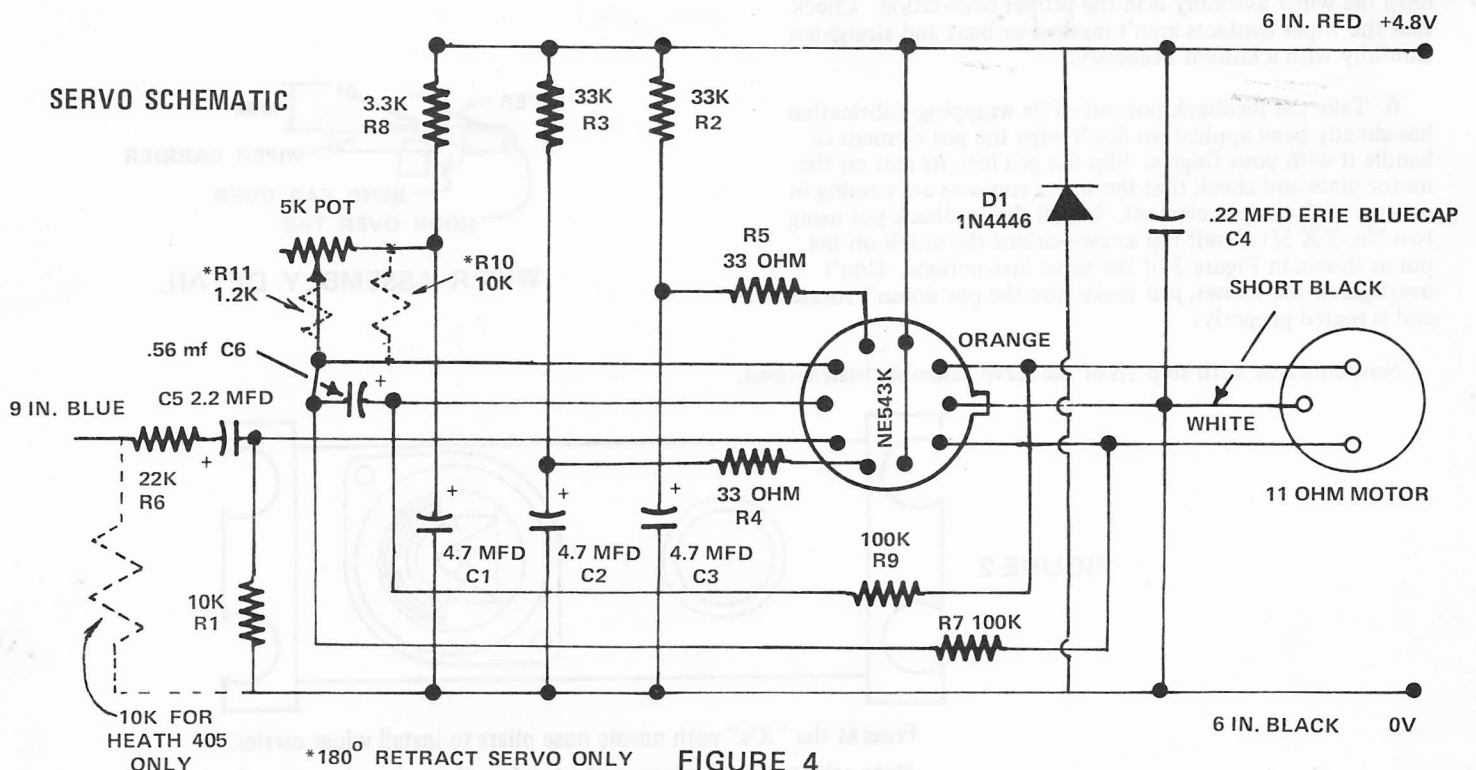


FIGURE 4

BANTAM SERVO MECHANICS ASSEMBLY

Before proceeding with step 18 in the servo assembly instructions, the mechanics need to be assembled. Refer to the exploded drawing.

1. Insert the brass shaft into the hole in the motor plate and install No. 1 gear (the one with the small shaft hole and the short secondary gear) on the shaft. Put a drop of oil on the brass shaft.
2. Place the No. 2 gear (large shaft hole, short secondary gear) on the output gear shaft. Slip the No. 3 gear (small shaft hole, tall secondary gear) in between the output gear (No. 4) and the No. 2 gear and install this assembly on the motor plate with the No. 3 gear going on the brass shaft and the output shaft going through the hole in the motor plate.

3. Slip the top plate on and wiggle it around until it snaps into position. Check for proper operation of the gear train--the output should move smoothly through approximately 120°. Center the output in the middle of its travel.

4. Install the wiper on the wiper carrier by hooking the wiper over the tab on the carrier and securing the wiper into position by bending over the ears on the wiper with a needle nose pliers. The wiper should rest securely on the flat surface of the wiper carrier. Carefully bend up the wiper contacts so there is approximately 3/32" between the contacts and the wiper carrier. This will insure good connection with the pot element when it is installed.

5. Turn the mechanics upside down so the output is resting on the work surface. Lay the wiper assembly on the shaft and orient the wiper contacts as shown in Figure 2. Using a needle nose pliers spread slightly so the wiper contacts aren't bothered, firmly press the wiper assembly on the shaft until it can't go on any further.

Double check that the wiper contacts are oriented as shown when the output is centered. If not, you can position the wiper assembly by inserting a jeweler's screwdriver in the output and while keeping the gear train from turning, rotate the screwdriver until the wiper assembly is in the proper orientation. Check that the wiper contacts aren't mashed or bent and straighten carefully with a knife if necessary.

6. Take the feedback pot out of its wrapping--lubrication has already been applied, so don't wipe the pot element or handle it with your fingers. Slip the pot into its seat on the motor plate and check that the wiper contacts are coming in contact with the pot element. Install the feedback pot using two No. 2 X 3/16" self tap screws--orient the notch on the pot as shown in Figure 3 of the servo instructions. Don't overtighten the screws, just make sure the pot doesn't rotate and is seated properly.

Now continue with step 18 of the servo assembly instructions.

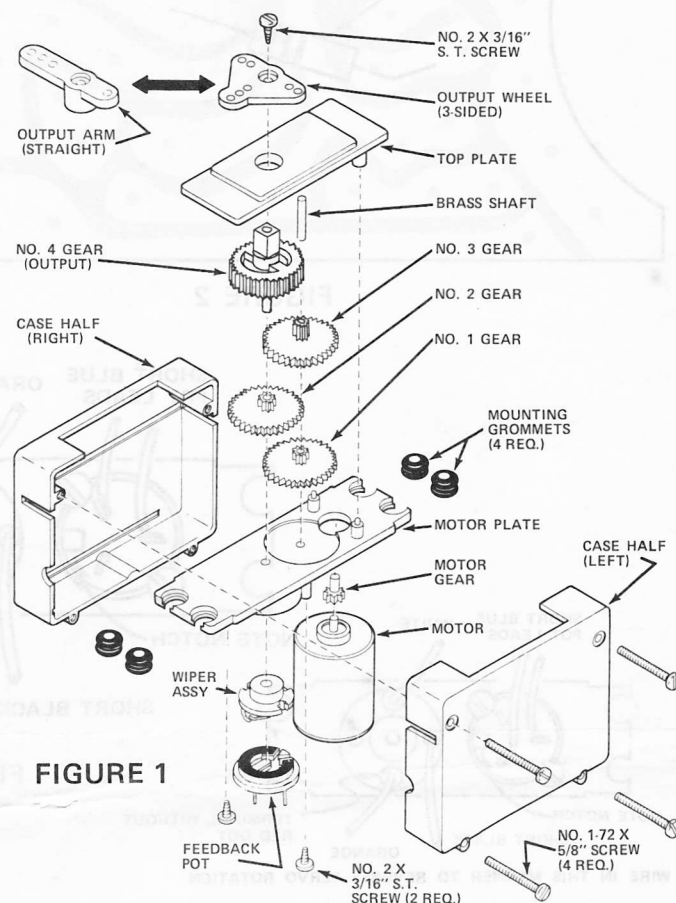
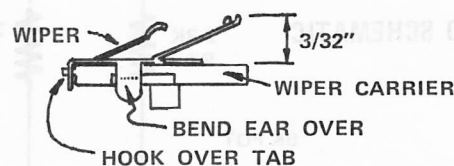
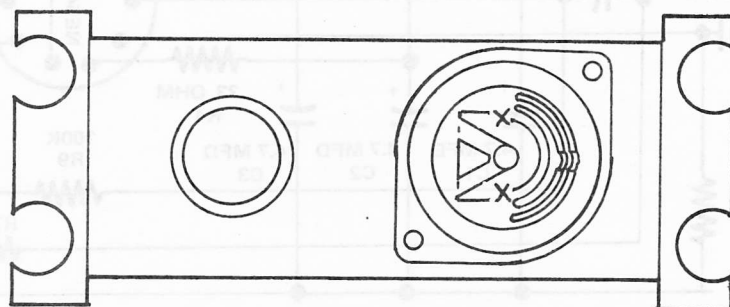


FIGURE 1



WIPER ASSEMBLY DETAIL

FIGURE 2



Press at the "X's" with needle nose pliers to install wiper carrier.
Note orientation of wiper contacts when the output is centered.

SERVO ASSEMBLY INSTRUCTIONS

The stock Digital Commander servo will work only with positive pulse IC decoder systems. A pulse inverter is available for using the servos with negative pulse systems: 14G19—Servo Pulse Inverter \$1.00.

1. () Check the parts against the components list.
2. () Study the overlay drawing carefully before starting construction. The numbers refer to the order in which to assemble the PC board.
3. () Observe the following construction notes as the steps on the overlay are completed.
 - a. When installing IC-1, clip each of the leads about 1/16 inch shorter than the preceding lead, proceeding from one through eight. The shortest lead must be at least 1/4 inch long. Leave the lead located at the tab full length. This permits easier positioning and insertion of the Leads. **INSTALL IC-1 WITH THE TAB AS SHOWN IN THE OVERLAY.**
 - b. Observe the polarity of the tantalum (cylindrical) capacitors carefully. The + end is red. **NOTE:** All are inserted with the red end up. In Step 2 all three 4.7 μ f capacitors are installed.
 - c. Notice that steps 22-24 show installations of R10 and R11 which are for the 180° Retract Servo version only and that for the Retract Servo one of the short blue pot wires is installed in step 24, not step 21. Disregard steps 22 through 24 if you're building the standard amplifier.
 - d. Install the components in the order shown in Figure 1. Work slowly and carefully, check continually for possible solder bridges. Notice that some components require sleeving over the bare leads to prevent shorts.
Caution: Don't forget the 1/8 watt. 100K resistor which goes on the bottom of the board. Figure 2 is provided to show exactly where it goes.
 - e. If this servo is to be used with the Heath Eight Channel (405 Series), an additional 10K resistor (not furnished) is to be added to the position indicated on the parts overlay drawing.
4. () From the 12" of blue wire, cut two 1 1/2" lengths and from the 10 1/2" of black wire, cut one 1 1/2" length. Strip 1/8" of insulation from one end of each wire, twist the strands together, and tin (i.e., melt a little solder on the wire and flip off the excess).
5. () Install the wires.
6. () Use alcohol and scrub all the resin from the PC board. Check the finished PC board against Figure 2 for possible solder bridges. Use the nail clippers or small diagonal cutters to trim all leads 1/16 inch from the bottom of the board. Complete the servo wiring as follows:
7. () Twist the 6 inch blue, red, and black leads tightly and clip to the same length.
8. () Slip a rubber grommet over the wires. If you are building the Retract Servo, thread the wires through the hole in the bottom of the case before installing the connector.
NOTE: Steps 9 through 15 apply specifically to the Deans connectors used in the Digital Commander Flite Packs and Systems. For other connectors the same general principle applies.
9. () Slip a 1/2 inch piece of 1/8 ID heat shrink tubing over these three wires.
10. () Slip one of the pieces of sleeving provided with connectors you are using over each wire after first untwisting one inch of the twisted cable.
11. () Strip 1/8 inch of the ends of the three wires and tin.
12. () Tin three of the pins of the male half of the connector. Refer to the introduction if you are using Deans connectors.
13. () Touch the wires and the soldering iron to their respective pins. The tinned joint will form quickly. Avoid excessive heat which may damage the plug. Perform this operation with the plug halves mated for a good heat sink.
14. () Slip the sleeving up over the pins and wires.
15. () Retwist the wires up to the sleeving and slide the heat shrink tubing up against them. Heat this tubing with the soldering iron to shrink evenly.

16. () If the servo is to be used with another system besides the Digital Commander, determine the proper wiring between the receiver and the servo. If the system is a three wire system (non-center tapped battery), simply determine polarity and wire together accordingly, using plugs. Do the same for a four wire system (center tapped battery) but ignore the lead which delivers current from the battery center tap.

The 5 wire MRC systems have two +4.8V leads (red and green) going to the servo connection. Ignore the green wire when wiring this servo to the MRC decoder.

17. () Strip 1/8 inch from the ends of the short blue, white, black and orange wires and tin.

IF YOU ARE BUILDING THE RETRACT SERVO, disregard the remaining steps and refer to the additional sheet furnished with your kit on assembling the mechanics and final wiring.

IF YOU ARE BUILDING THE BANTAM SERVO, assemble the mechanics according to the enclosed sheet before proceeding with step 18.

18. () The pot element is already lubricated and installed in approximately the right position. When adjusting the pot element be careful not to overtighten the screws and chip the ceramic.

The following steps refer to Figure 3 which shows the motor installed. Do not install until Step 23.

19. () Prepare the potentiometer element by clipping the lugs to 1/16 inch length and bend flat as shown in Figure 3.

20. () Thread the three motor leads through to hole in the PC board and solder the short wires to the correct pot terminals and motor terminals EXACTLY as shown in Figure 3.

21. () Recheck all preceding steps. If there is a solder bridge, misplaced component, or reverse polarity when voltage is applied, the IC will probably burn out immediately, so make sure you've made no mistake.

22. () Install the nylon or brass pinion gear on the motor. Make sure there's no rub between the gear and the motor case.

23. () Do not place the motor in position yet. Plug in the servo, turn on the transmitter and receiver. Slowly rotate the servo output until the motor halts, reverses direction, or pulses back and forth slightly. If the servo is being used with an existing transmitter, and the output is not centered at this point, loosen the pot retention screws and rotate the element slightly until the output is centered. Retighten the screws and place the motor in position. The output should be centered and travel should be smooth with a swing of $\pm 45^\circ$. Your servo mechanics also has a pot wiper arm adjustment accessible through the servo output shaft so you can center the servo without disassembly. For the Bantams, linears, and Three Servo Blocks, insert a small jeweler's screwdriver in the hole in the output shaft and rotate. For the Dual Rack or Retract servo use a 1/16" Allen wrench.

If the amount of servo travel is too great or too little, the value of resistor R8 can be changed in small increments. Lower R8 to increase travel and increase R8 the decrease amount of travel.

If interference is caused by excessive servo motor noise, this can be eliminated by installing a 1 mf capacitor across the motor terminals (orange and white wires).

24. () Sandwich the amplifier in the foam provided and install in the case as shown in the photo.

For the Three Servo Block, insulate the pot terminals by sticking a 1/2" sq. piece of foam tape over the terminals. Cushion the amplifiers by trimming and placing the furnished piece of thin foam in the bottom of the case . . . if desired, cut out circles to clear the three motors. Disregard the two small squares of foam furnished in the electronics packages.

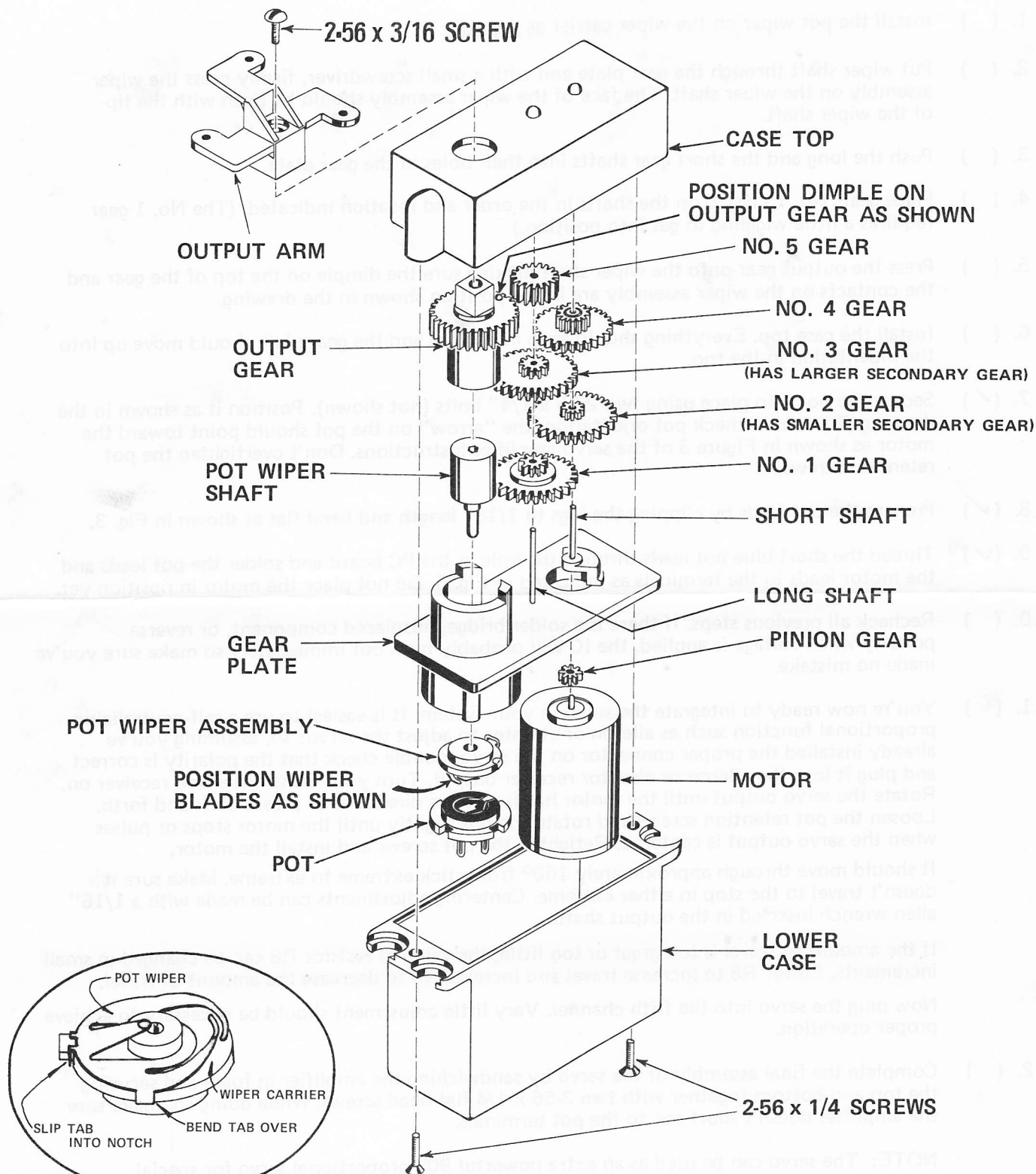
RETRACT SERVO MECHANICS ASSEMBLY AND FINAL WIRING

Referring to the assembly drawings, put the mechanics together in the following sequence:

1. () Install the pot wiper on the wiper carrier as shown.
2. () Put wiper shaft through the gear plate and with a small screwdriver, firmly press the wiper assembly on the wiper shaft. The face of the wiper assembly should be flush with the tip of the wiper shaft.
3. () Push the long and the short gear shafts into their holes in the gear plate.
4. () Place gears No. 1 - No. 5 on the shafts in the order and location indicated. (The No. 1 gear requires a little wiggling to get into position.)
5. () Press the output gear onto the wiper shaft making sure the dimple on the top of the gear and the contacts on the wiper assembly are in the position shown in the drawing.
6. () Install the case top. Everything should snap into place and the gear plate should move up into the indentation in the top.
7. (✓) Secure the pot into place using two 2-56 x 1/4" bolts (not shown). Position it as shown in the drawing. To double check pot orientation, the "arrow" on the pot should point toward the motor as shown in Figure 3 of the servo amplifier instructions. Don't overtighten the pot retention screws.
8. (✓) Prepare the pot leads by clipping the lugs to 1/16" length and bend flat as shown in Fig. 3.
9. (✓) Thread the short blue pot leads through the hole in the PC board and solder the pot leads and the motor leads to the terminals as indicated in Fig. 3. Do not place the motor in position yet.
10. () Recheck all previous steps. If there is a solder bridge, misplaced component, or reverse polarity when voltage is applied, the IC will probably burn out immediately so make sure you've made no mistake.
11. () You're now ready to integrate the servo in your system. It is easiest to use a self-neutralizing, proportional function such as aileron or elevator to adjust the servo; so, assuming you've already installed the proper connector on the servo, double check that the polarity is correct and plug it into the aileron or elevator receiver output. Turn your transmitter and receiver on. Rotate the servo output until the motor halts, reverses direction, or pulses back and forth. Loosen the pot retention screws and rotate the pot slightly until the motor stops or pulses when the servo output is centered. Retighten the pot screws and install the motor.
It should move through approximately 160° from stick extreme to extreme. Make sure it doesn't travel to the stop in either extreme. Centering adjustments can be made with a 1/16" allen wrench inserted in the output shaft.
If the amount of travel is too great or too little, the value of resistor R8 can be changed in small increments. Lower R8 to increase travel and increase R8 to decrease the amount of travel.
Now plug the servo into the fifth channel. Very little adjustment should be necessary to achieve proper operation.
12. () Complete the final assembly of the servo by sandwiching the amplifier in foam and securing the top and bottom together with two 2-56 x 1/4 flat head screws. While doing so, make sure the amplifier doesn't short out to the pot terminals.

NOTE: The servo can be used as an extra powerful 90° proportional servo for special applications. Simply wire the amplifier as shown for the 90° version.

NOTE: If while in operation, the servo slowly creeps into the end positions when activated, remove R7 (100K) and R9 (the 1/8 W resistor on the bottom of the board) from the circuit. This decreases damping.



WIPER ASSEMBLY DETAIL