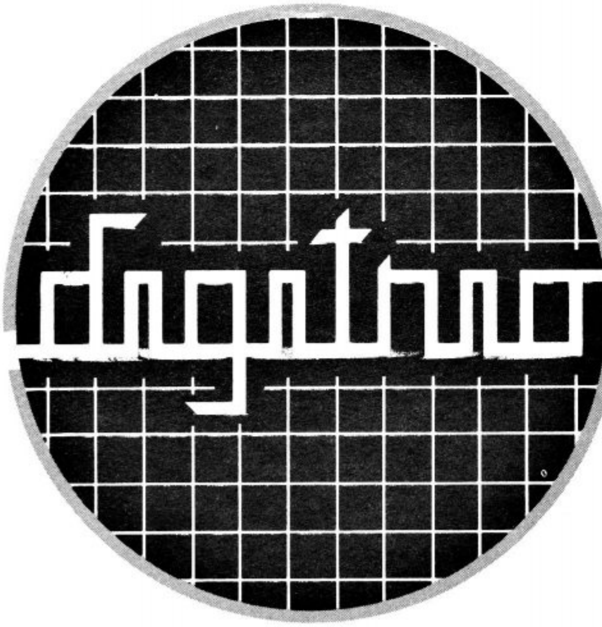


CONSTRUCTING THE DIGITRIO SERVOS

BY ED THOMPSON

Contributing Technical Editor

THE Digitrio is still going strong. It survived two crashes this month due to a dead battery in the receiver pack. My test pilot ignored short range and erratic motor control on repeated flights until the inevitable happened. That's right, I said two crashes – the second exactly as the first – a result of incomplete testing, ignoring instructions and hoping for the best!

Don't let this happen to you! Above all, follow instructions and don't fly until your system is operating perfectly. If you are going to use your old reed battery pack, check it under load first. You can have defective cells that may not show up with your reed system but will cause you grief with the Digitrio. Both of the crashes this month followed the same pattern. After the surface charge dissipated one cell completely discharged. This allowed a couple of satisfactory flights followed by a "prang." During the satisfactory flights, however, the motor control was erratic due to insufficient range, and if this warning had been heeded trouble could have been averted.

I checked one reed pack after experiencing excessive noise in the system to find all the cells bad except one which the owner had just replaced. This same pack had previously been used with a reed system and according to the owner performed satisfactorily.

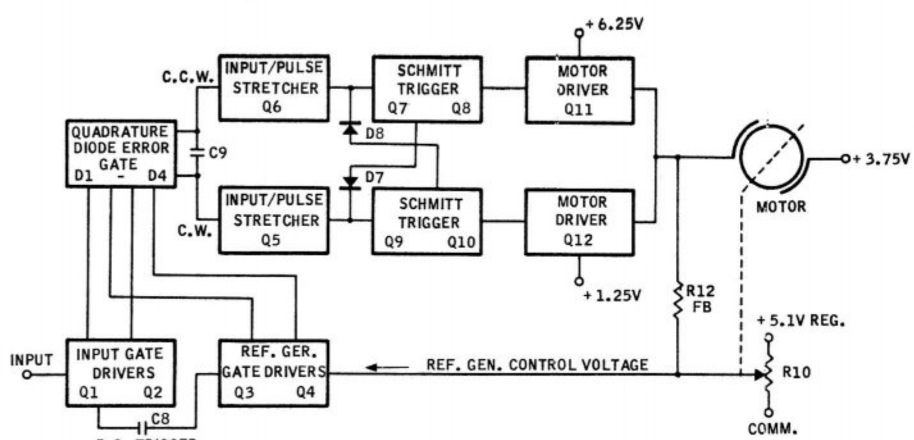
In all fairness to my nicads I must admit that they have been subjected to severe discharge rates and occasional overcharges while testing the system, so, the nicads were not to blame. The point is this: if the system is not operating perfectly or changes characteristics (especially after prolonged consistent operation) don't be lulled into a false sense of security, keep it on the ground until it is right.

In testing some transmitters with more than average power output I found some RF feedback. The shield described at the end of this month's article will prevent this condition. Install it whether you are having this trouble or not. If you don't install it send me your broken crankcases – I collect them!

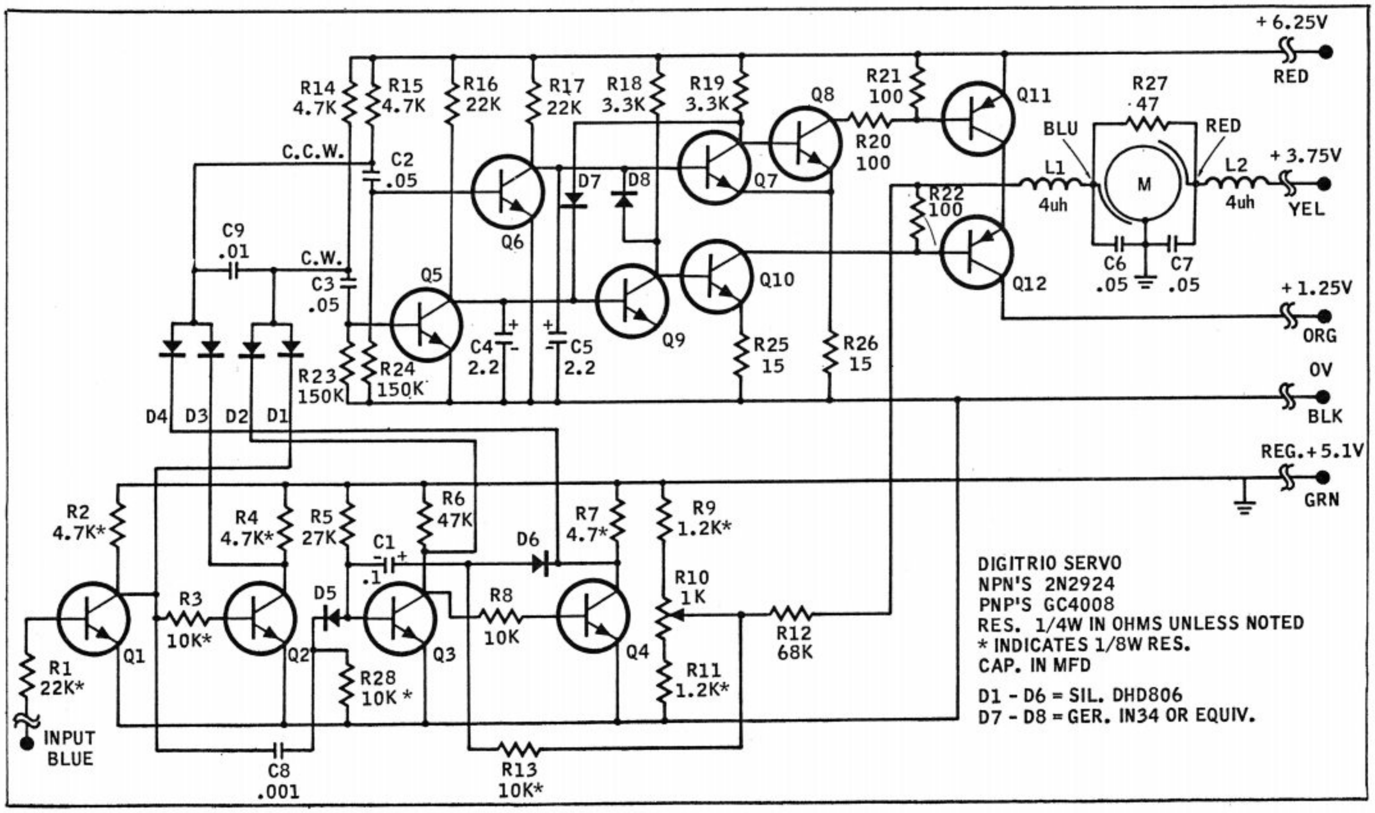
Rusty Fried flew the Digitrio to fourth place in Class II at the Annual Arizona Invitational Meet sponsored by the ARCS of Phoenix. Not bad, considering that all the Phoenix and Tuscon pros showed up. He used a Tauri with a Supertigre 23. Those boys from Tuscon are tough to beat, "especially to the hamburgers!"

THEORY OF SERVO

For want of a starting place let's consider the action of D1. D1's anode is connected to R14. D1's cathode is connected to Q1's collector. One side of C3 is connected to the D1-R14 junction and the other side to the base of Q5. Assume that Q1 is conducting. This forward-biases D1 and the voltage at the junction of R14-C3 is at ground. If we now cause Q1 to cutoff,



DIGITRIO SERVO BLOCK DIAGRAM



the voltage at the R14-C3 junction will rise to the positive voltage applied to the top end of R14 (in this case +6.25 V). This positive voltage will be transferred across C3 forward-biasing Q5 which will conduct. The base to emitter resistance of Q5 and R23 will discharge this positive voltage and a pulse will result. Q5 will conduct for the duration of this pulse. When Q1 conducts initially a negative pulse will result but Q5 will ignore it. Therefore each time we cause Q1 to alternately conduct and cutoff a positive pulse will appear at Q5's base causing it to conduct.

D2 is connected to the R14-C3 junction also and operates in the same manner except the positive pulse to Q5 is controlled by Q3. It is important to note here that if either diode is forward biased (either Q1 **or** Q3 conducting) the voltage at the R14-C3 junction cannot rise positive.

Q1/D1 and Q3/D2 work in conjunction with each other to control the positive pulse to Q5's base. Since Q5 is the input stage to the CW half of the servo amplifier the action of Q1 and Q3 controls the servo motor rotation in that direction.

The action of D3 and D4 is identical except they are controlled by Q2 and Q4 respectively. The resulting pulse in their case is delivered to Q6 (CCW half of the servo amplifier). R15, C2 and R24 form these pulses. So we can supply an input pulse to either half of the servo amplifier by controlling the operation of Q1 through Q4 which in turn controls the diode error gate (diodes D1 thru D4). Assume that the servo is in the neutral position and no input pulses are being applied to R1.

In this quiescent state Q2 and Q3 are conducting – Q1 and Q4 are cutoff. Q2 and Q3 in conjunction with D3 and D2 respectively will place a ground at the R15-C2 and R14-C3 junctions. R10 is mechanically coupled to the output arm and will be centered – this will give a nominal pulse width of 1 MS when we trigger the reference generator (one shot formed by Q3 and Q4). If we now apply a 1 MS positive pulse to R1 we will cause Q1 to conduct and Q2 to cutoff. The leading edge of this pulse also triggers the reference generator (via C8 and D5) and Q3 cuts off while Q4 conducts. This action happens simultaneously and now we hold the pulse producing resistor/capacitor junctions at ground with Q1 and Q4. Since the changeover was instantaneous (we merely swapped diodes) no positive pulse appeared at either Q5 or Q6. At the end of 1 MS the reference generator will return to its quiescent state – Q3 conducting and Q4 cutoff. Since our input pulse is also 1 MS Q1 will cutoff and Q2 will conduct at the same time the reference generator changes state. So we again merely swapped diodes and no servo input pulses were produced. This action is the same regardless of the servo position as long as the input pulse to R1 matches the reference generator pulse. In other words the diode gate is balanced and no error pulses are produced. Let's assume that the reference generator will produce a 1 MS pulse and our incoming pulse is .5 MS wide. We will again trigger the reference generator at the leading edge of the pulse, cause Q1 to conduct and Q2 to cutoff, and swap diodes. The incoming pulse will cause Q1 to cutoff and Q2 to conduct at the end of .5 MS. Since Q3 is still cutoff (reference generator still has .5 MS to go before returning to its quiescent state) Q1 cutting off will allow the R14-C3 junction to rise positive producing a positive error pulse at Q5's base. Q2 and Q4 are now both holding the R15-C2 junction at ground so no pulse is produced here. When the reference generator returns to its quiescent state Q3 will return the R14-C3 junction to ground and the circuit is ready for another incoming pulse to compare. We will produce a negative pulse at Q5's base when the R14-C3 junction is grounded but Q5 will ignore it. Under these conditions Q5 will receive a positive error pulse each time the incoming pulse is sampled. This will cause the motor to turn in a CW direction. As the output arm moves it changes the position of the wiper on R10 to shorten the pulse width of the reference generator. The servo will continue to move until the output arm has positioned R10's wiper to cause the reference pulse and incoming pulse to be identical in width (in this case .5 MS). No error pulses are produced now and the servo will stop.

Assume now that the reference generator will produce a .5 MS pulse and we apply a 1 MS pulse to R1. Again we trigger the reference generator, cause Q1 to conduct, Q2 to cutoff and swap diodes. The reference generator returns to its quiescent state at the end of .5 MS (Q3 conducting and Q4 cutoff). Q2 is still cutoff (the incoming pulse has .5 MS to go) and Q4 cutting off allows the R15-C2 junction to rise positive placing a positive error pulse on Q6's base. The servo motor will now run in a CCW direction until R10 is positioned to cause a 1 MS reference generator pulse. Again no error pulses are produced and the servo will stop.

I have used only three examples of pulse comparison but the action of the servo is infinite. It will respond any time the incoming and reference pulses are not identical, regardless of where the servo is positioned or where the stick is moved up to the limits of its travel.

The servo amplifiers consist of an input/pulse stretcher stage, Schmidt trigger and motor driver. Let's consider the CCW half first. Q6 is normally cutoff and R17 holds Q7 in conduction. Since R26 is common to both Q7 and Q8's emitter the base to emitter voltage of Q8 is essentially O V and Q8 is cutoff. The voltage drop across R26 is now dependent upon Q7's conduction. This places Q11's base at the same voltage as its emitter and it is cutoff.

If we apply a positive pulse to Q6's base its collector will go toward ground and remove forward bias from Q7. This allows Q7's collector to go positive forward biasing Q8. The voltage drop across R26 is now dependent upon Q8's conduction and the positive voltage at Q7's emitter is regenerative to Q7 tending to cut it off even further. Actually there is a discreet level at which the regenerative action takes place giving a threshold voltage for Q6 to work against. This gives a defined on and off voltage for Q11's base. When Q8 conducts the junction of R20 and R21 goes toward ground (negative as far as Q11's base-emitter junction is concerned). This forward biases Q11 which conducts. Q11's collector goes to +6.25 V which places 2.5 V across the motor (the other side of the motor is at +3.75 V). This 2.5 V is positive at the Q11/Q12 junction with respect to the battery side (yellow lead). We must convert the short input pulses into a smooth DC voltage to run the motor. C5 is charged to +6.25 V by R17. When Q6 conducts it discharges C5 rapidly due to the low resistance across Q6. It charges much more slowly through R17 when Q6 is cutoff so it holds the collector voltage below Q7's forward-bias point between pulses. This "stretches" the pulses into a smooth DC voltage for the motor. The action of the Schmidt trigger provides Q11 with either a full on or off voltage with a discreet operating point.

The CW half of the servo amplifier is identical up to Q12. When Q12 conducts the Q11/Q12 junction goes to +1.25 V. Since the battery side is at +3.75 V we have a 2.5 V voltage across the motor of opposite polarity than before. Therefore the motor turns in the opposite direction.

D7 and D8 are used to prevent Q11 and Q12 conducting simultaneously (if they do, a short, through Q11 and Q12, would practically exist between the red and orange leads). This, incidently, could play havoc with the decoder by falsely triggering the different stages. At first glance this "double conduction" may look unlikely, however, since the servo "resolution" is so high it is susceptible to minute variations of pulse width caused by noise, etc. Since we are "stretching" the pulses this could cause both sides to conduct simultaneously. If Q6 is conducting first it will forward bias D8 removing the positive voltage at Q9's collector so that Q10 cannot conduct even if Q9 loses forward bias. If Q5 conducts first it forward biases D7 and the same thing happens to Q7/Q8. Due to other circuit considerations perfect protection is not possible, but it is more than adequate.

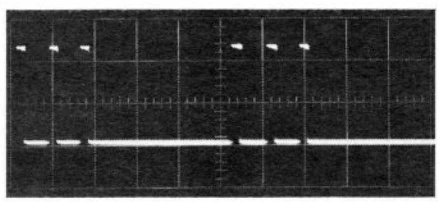
L1, L2, C6, C7 and R27 are used to minimize motor noise and are quite effective. C9 is used to prevent "trash signals" caused by differing rise and fall times of the components from producing false error pulses to the servo amplifiers. R9 and R11 limit the servo travel electrically. The values can be adjusted for use with control sticks having different throw measurements than "Digitrio." Increasing their value will cause more travel and vice-versa. Resistance values of 1.5K work well with the "Bonner Stick Assembly."

R12 is used for voltage feedback to prevent output arm "overshoot." It feeds back voltage to R10's wiper that opposes the voltage change necessary for correcting its position. The closer the wiper is to the correct position the more pronounced its effect. It causes the output arm to "dampen" into its corrected postion. If voltage is applied to an electric motor and then removed, the shaft will continue to rotate for a while due to inertia. This would cause the servo to coast past the corrected position and in turn be driven back whereupon it would again coast and the arm would "oscillate" trying to find the precise stopping point but not being able to. This would go on unless some mechanical damping was present or the dead band was sufficient to allow it to coast to a stop. Electrical feedback is used here to allow a minimum deadband and nondependence on mechanical damping. The reference generator is voltage regulated to prevent trim drift. The component values have all been carefully worked out and what may appear as an innocent change could lead to decreased performance.

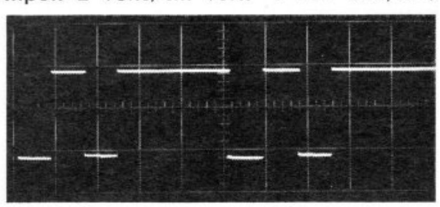
PREPARING P.C. BOARDS

( ) Make the composite P.C. board

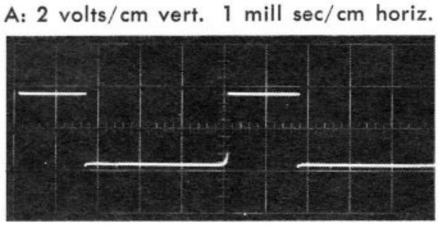
Dave Holmes submitted the following scope traces from his decoder. Dave's Digitrio on 6 meters.



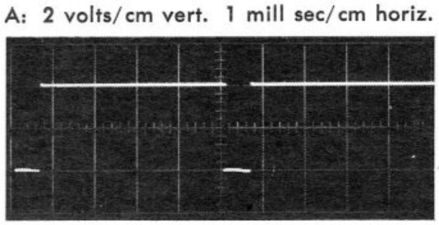
Input: 2 volts/cm vert. 1 mill sec./cm.



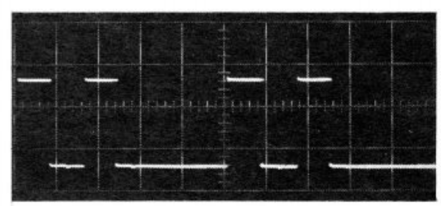
A: 2 volts/cm vert. 1 mill sec/cm horiz.



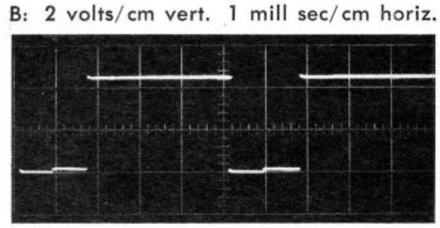
A: 2 volts/cm vert. 1 mill sec/cm horiz.



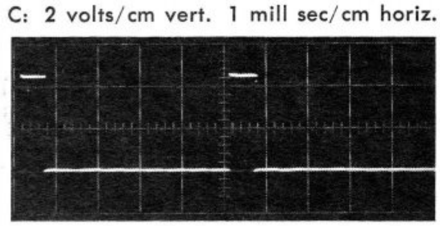
B: 2 volts/cm vert. 1 mill sec/cm horiz.



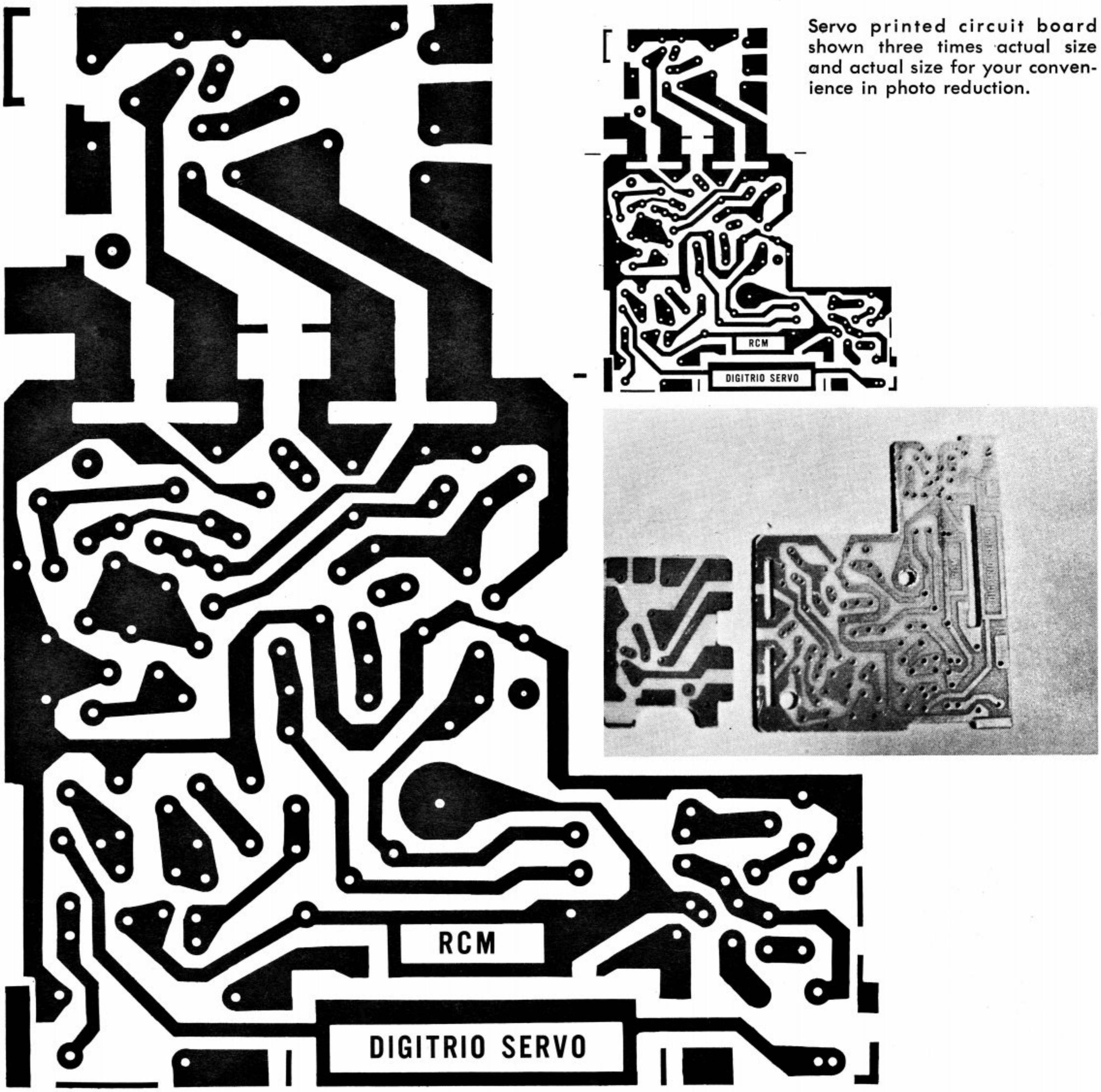
B: 2 volts/cm vert. 1 mill sec/cm horiz.



C: 2 volts/cm vert. 1 mill sec/cm horiz.



2 volts/cm vert. 1 mill sec/cm horiz. Outputs all same.



Servo printed circuit board shown three times actual size and actual size for your convenience in photo reduction.

with 3⁄64″ stock and clean thoroughly.

( ) Drill all holes with a #65 drill. Enlarge mounting hole and hole B in the main board with a #42 drill. There may be an extra die hole in the board if purchased from World Engines but it will not be used. It will be in the upper right-hand corner of the main board (copper side down).

( ) Drill hole A in the auxiliary board with a #31 drill.

( ) Remove all burrs around holes in copper lands.

( ) Saw two thin slots as shown for insertion of brass wiper later on — use a thin Xacto saw.

( ) Make cutout for R10. See construction overlay for exact position (fit but do not install R10 at this time).

( ) Cut the two boards apart where shown with a fine Xacto saw.

( ) Place main board on C frame and position it so that the board fits into the notches at the front of the frame and with downward pressure at rear of the board it presses into place. Front edge of the board should be flush with front of the C frame. File the board to fit.

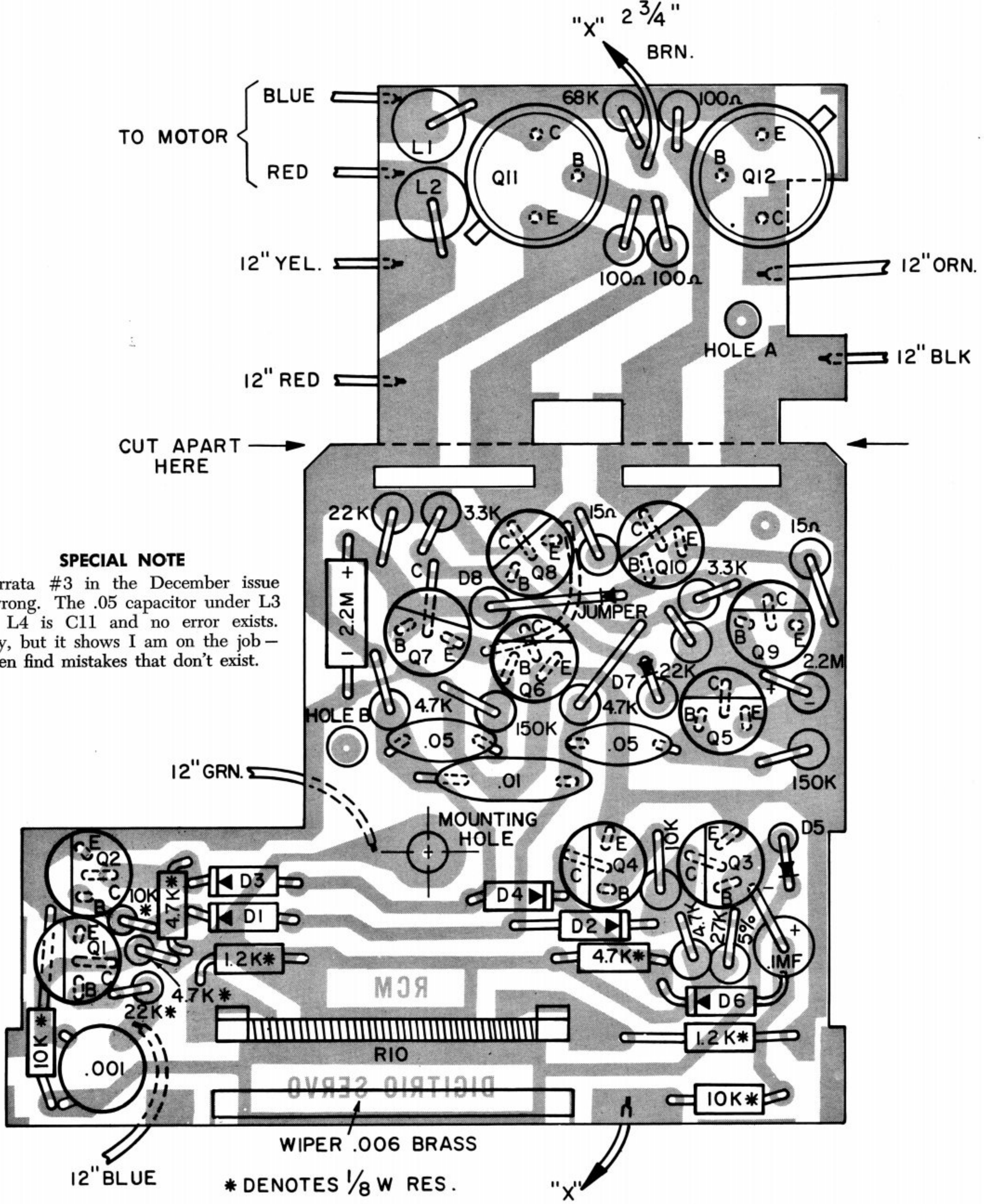
( ) Fit auxiliary board into place filing as necessary so that the notches in the board fit firmly and the auxiliary board goes all the way down against the main board.

PREPARING SERVO MECHANISM

( ) Refer to figure 1 and insure that the red dot is at the bottom of the motor as shown. If not remove motor mounting screws and rotate motor. Tighten motor screws in either case.

( ) Scrape paint from heads of screws in back of motor.

( ) Cut leads to ½″ and solder .05 disc capacitors as shown—be sure "hot" capacitor leads don't short to motor frame. Heat-shrink tubing can be used on the "hot" capacitor leads for insurance. The easiest way is to solder leads while they are straight and then bend the capacitor down along the side of the motor.



SPECIAL NOTE

Errata #3 in the December issue is wrong. The .05 capacitor under L3 and L4 is C11 and no error exists. Sorry, but it shows I am on the job – I even find mistakes that don't exist.

( ) Solder 47 ohm resistor as shown.

( ) Solder 1" red and blue wires to motor as shown. Do not solder the other ends to the auxiliary board yet.

NOTE: Make sure that no component, wire or solder mound is equal to or exceeds the height of the plastic cap on the motor or a direct "short" will exist when the cover is installed.

( ) Refer to the servo instruction sheet supplied with the mechanism for checking gears, etc.

WIRING THE MAIN P.C. BOARD

( ) Install all quarter-watt resistors flush with board and straight up and down.

( ) Mount the two germanium diodes D7 (bar down) and D8 (bar down) observe polarity – make sure D7's lead doesn't short to the 4.7K lead adjacent.

( ) Mount 2.2 MFD electrolytics, observe polarity.

( ) Mount .1 tantalum, observe polarity. Be sure your tantalum has an insulated cover or it may short to "C' frame.

( ) Mount two each disc .05's.

( ) Mount the .01 disc. Center the body midway between the two .05's as shown on overlay.

( ) Mount the .001 disc capacitor. It must be mounted close to the board and bent over flush and parallel with the board.

( ) Mount all silicon diodes observing polarity. The ones laying down must be flush against the board. These silicon diodes must be DHD 806's due to physical size requirements – normal size diodes will

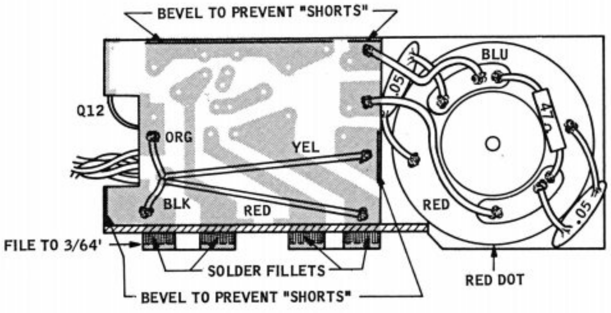


FIGURE 1 REAR VIEW

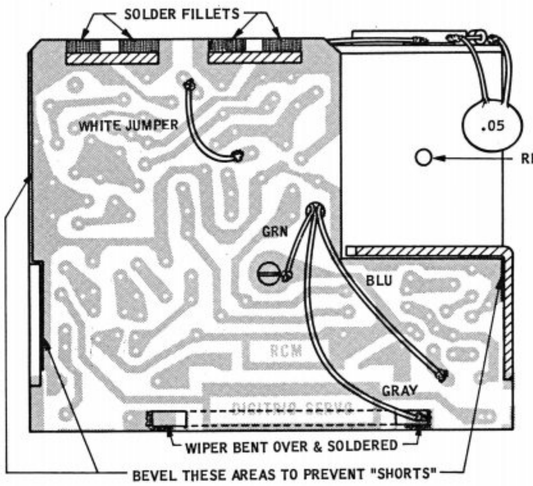
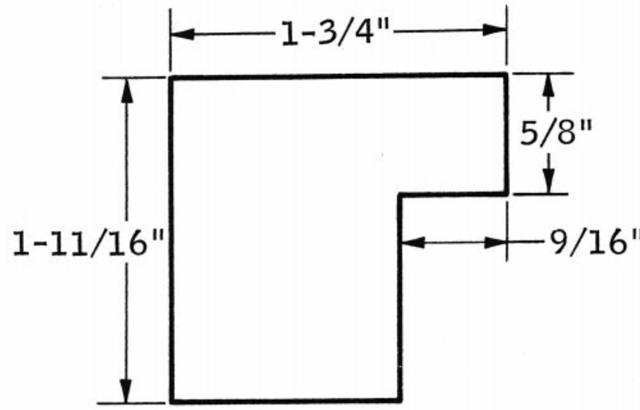
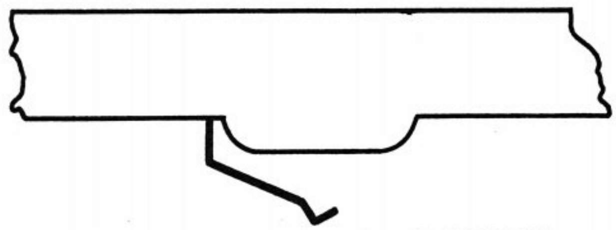


FIGURE 2 BOTTOM VIEW



1/64" SHEET

FIGURE 4 INSULATING SHEET



BEND ALL WIPERS AS SHOWN

FIGURE 3 WIPER ARM

not fit.

( ) Mount all ⅛-watt resistors. These are shown by an asterisk* on the overlay and schematic. The ones laying down must be flush with the board.

( ) Mount all 2N2924's. Note all collector leads must be bent out (refer to overlay for correct installation). Mount all transistors so they are approximately the same height or slightly higher than the ¼-watt resistors overall including leads.

( ) Fit the main board onto the C frame and check for correct alignment (front edge of P.C. board should be flush with front edge of C frame). Insert and tighten mounting screw. (If Q3 and/or Q4 will not permit correct alignment, loosen the mounting screw and reheat their solder joints allowing them to shift slightly while applying corrective pressure to front edge of board.) NOTE: The emitter leads of Q3 and Q4 are close to the C frame. If sufficient clearance cannot be obtained file notches in C frame for insurance against shorting.

( ) Make sure the motor body or C frame does not come into contact with any component lead. Bend any leads that are close to touching to provide adequate clearance. Insure that no lands come in contact with the C frame. Inspect carefully the areas pointed out in the photos and drawings as potential "shorts." Use an Xacto knife or file to bevel the board in these areas removing enough copper to insure against accidental shorting. NOTE: The C frame and motor are grounded to 5.1 V and any contact in the areas mentioned will be a direct short to the battery supply.

( ) Remove the board and with a fine file flat the solder mounds so that they are 1/32″ to 3/64″ high.

( ) Clean the board of all solder resin and foreign material with acetone or dope thinner.

( ) Install white insulated jumper routed as shown on overlay by dotted lines.

( ) Mount the resistance element so that only about one quarter of the element is above the surface of the P.C. board by bending the tabs over at the bottom and soldering them. Be careful from now on so you don't damage this element.

( ) Install the wiper in the slots at the front edge of the board. Take care here so that the wiper lays perfectly flat against the board. Bend the wiper over on the copper side and solder the ends to the lands provided. The proper position of this wiper is slightly rearward of the front edge of the board approximately 1/128″ — don't mount it flush as it may short to the top of the servo cover. Be careful you don't scratch, dent, etc., this wiper during installation.

( ) Do not install gears or operating arm at this time (we will do this later during final assembly and wiring of servo).

WIRING AUXILIARY BOARD

( ) Mount Q11 and Q12 flush against board. Enlarge lead holes slightly if they won't go all the way against board.

( ) Mount the ¼-watt resistors making sure that their leads don't contact transistor cases.

( ) Mount L1 and L2 making sure leads don't come into contact with transistor cases. Enlarge the holes where the choke body fits so they will mount close to the board.

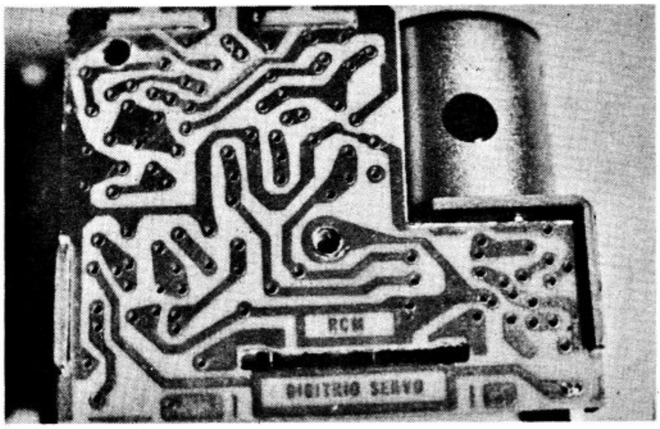
( ) Fit the auxiliary board into main board and check for clearance. If necessary some of the components on main board may have to be mounted lower on the board.

( ) Remove the auxiliary board and flat the solder mounds 1/32″ to 3/64″ high with a fine file.

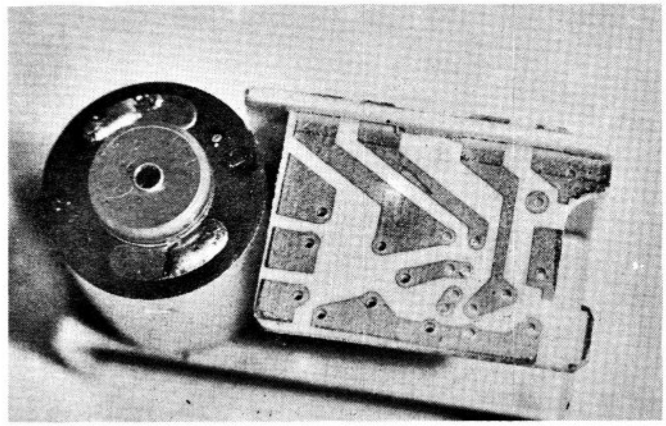
( ) Clean the board with acetone or dope thinner.

CONNECTING THE TWO P.C. BOARDS

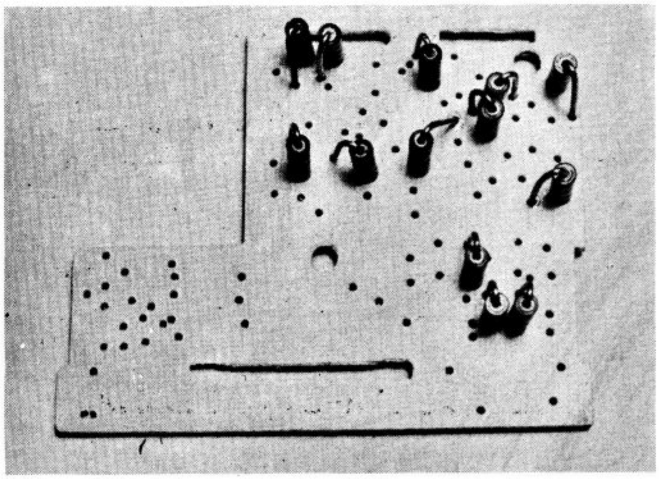
( ) Insert auxiliary board into main board and solder in place. Make solder fillets at the four soldering



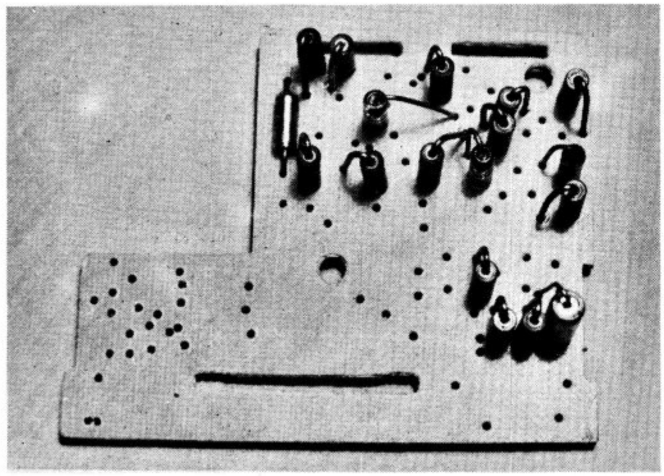
Main PC board fitted to "C" frame.



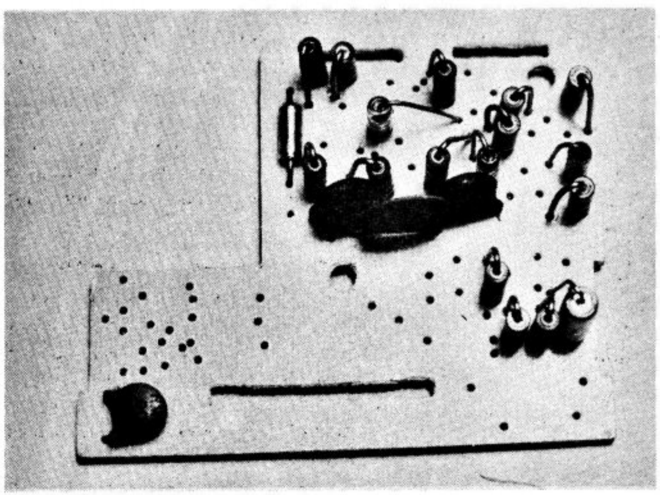
Interlocking auxiliary PC board in place.



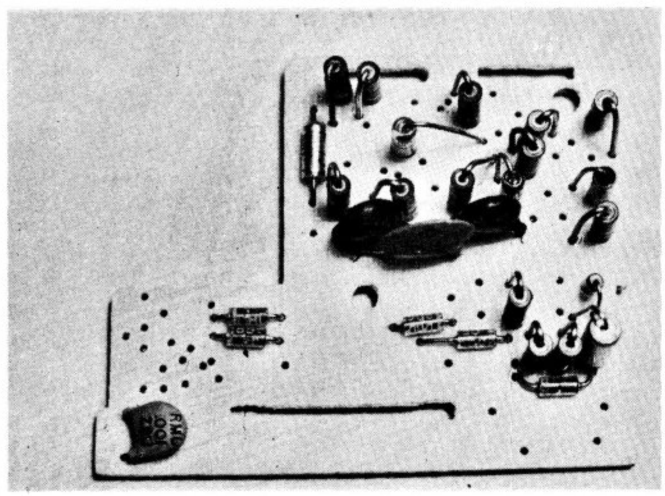
Main PC board with ¼ watt resistors installed.



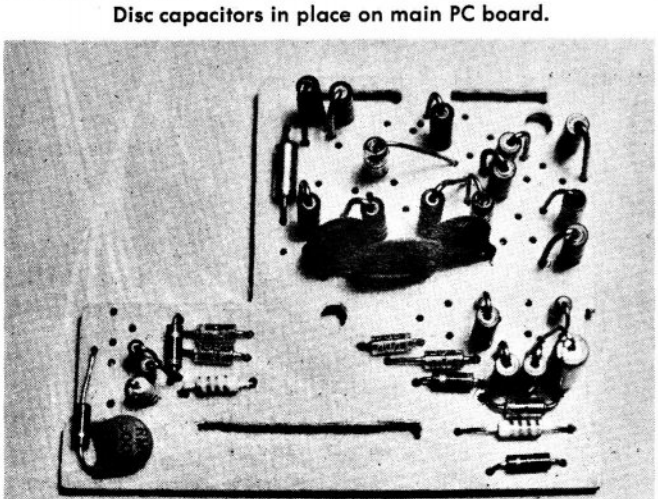
Main PC board with electrolytics added.

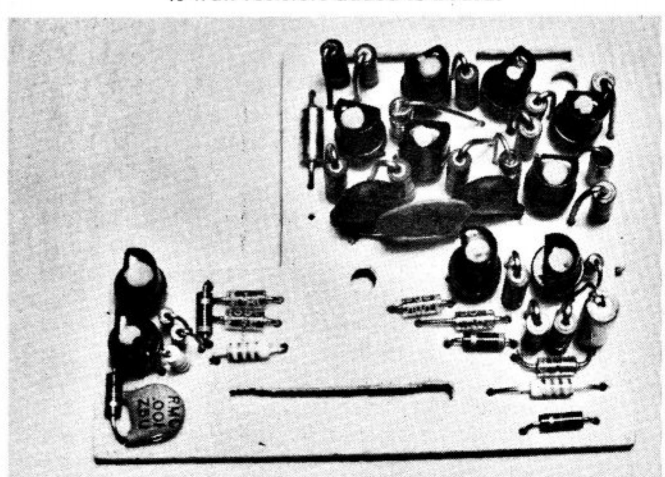


Disc capacitors in place on main PC board.

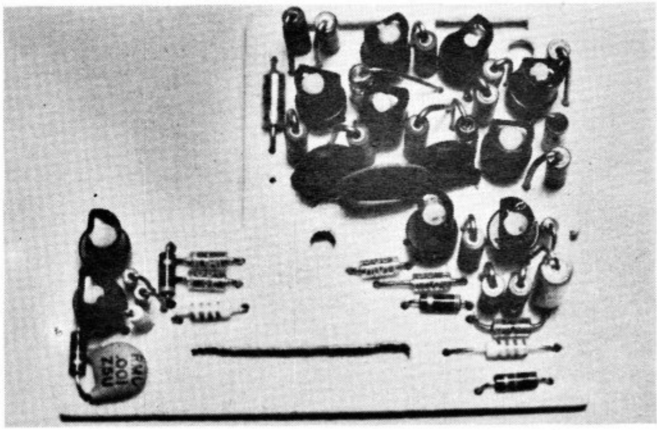


⅛ watt resistors added to board.

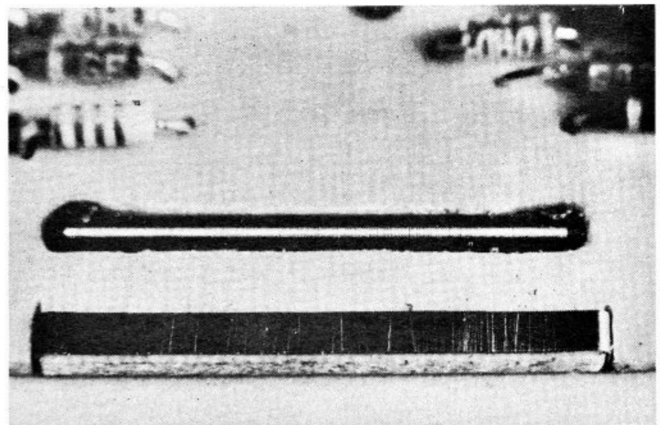




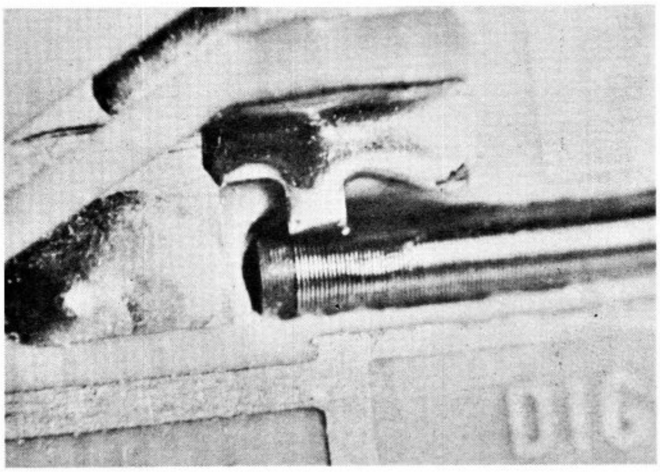
Transistors added in place on main board.



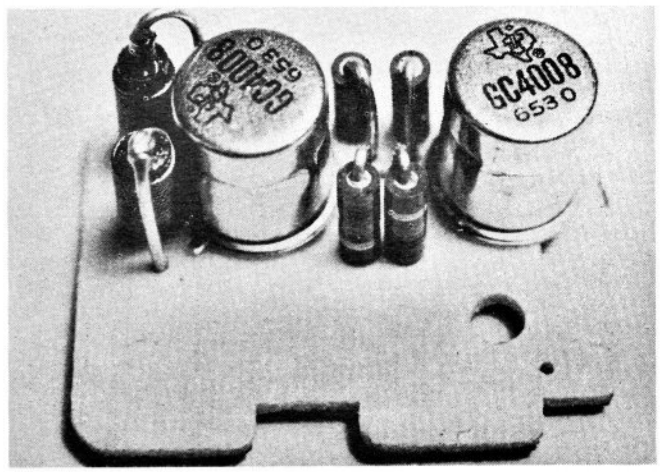
Main board now completed except for wiper and pot.



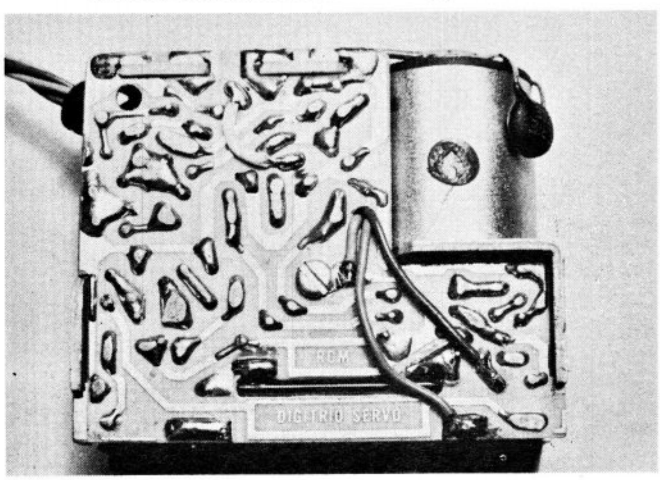
Wiper and pot installed. Follow text carefully when installing.



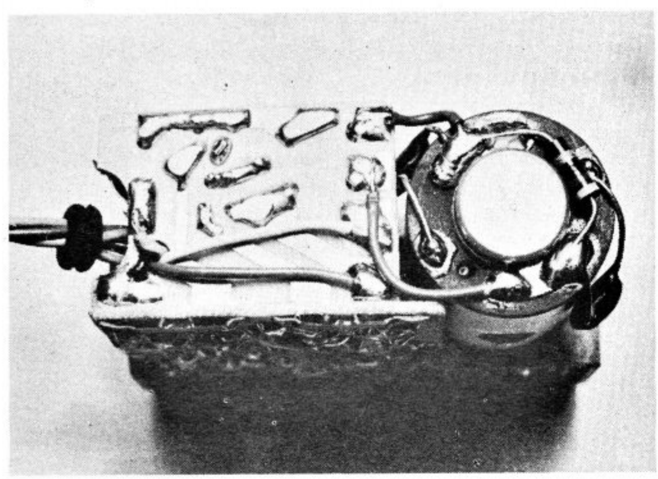
Closeup of pot tab soldered to copper PC land.



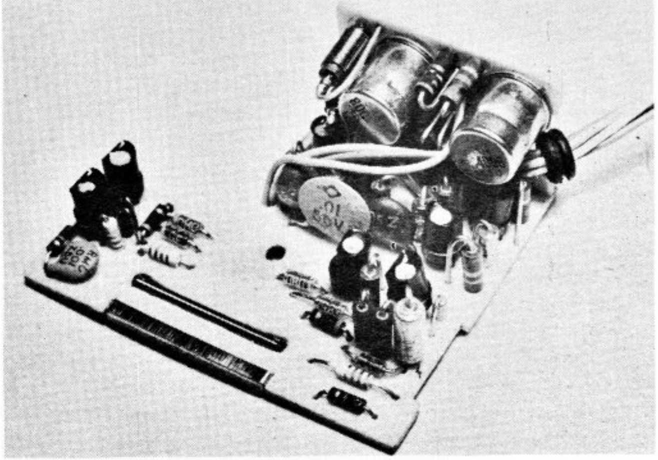
Auxiliary board with transistors, resistors and chokes installed.



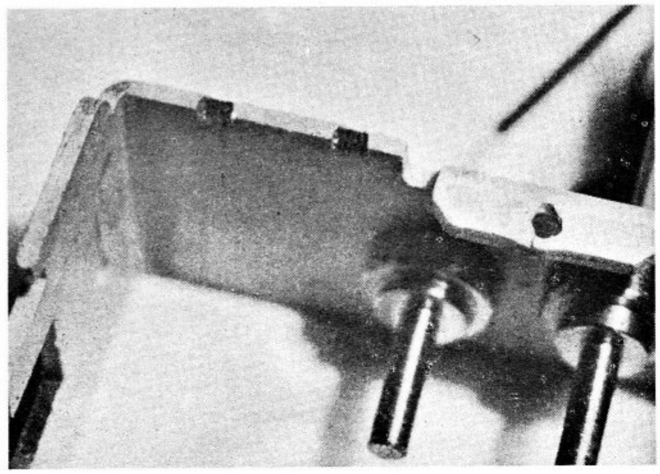
View of base of main board showing routing of wires between lands.



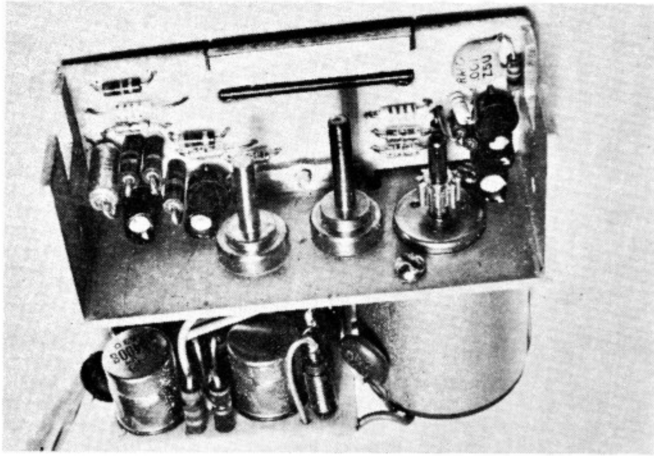
View of base of auxiliary board illustrating motor components and servo wire routing.



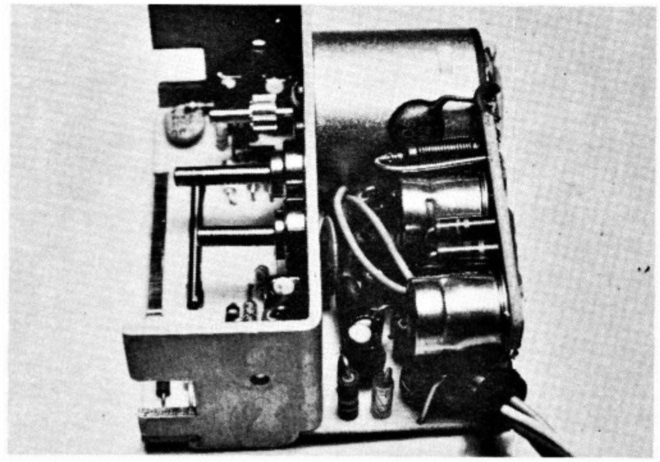
Completed servo amplifier.



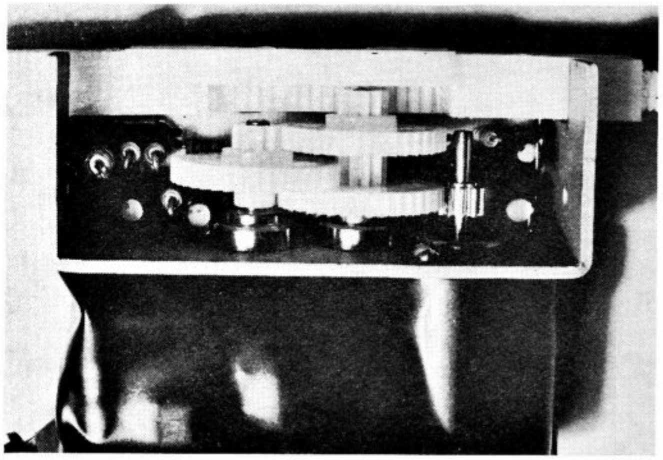
If necessary, notch C frame with file for transistor clearance.



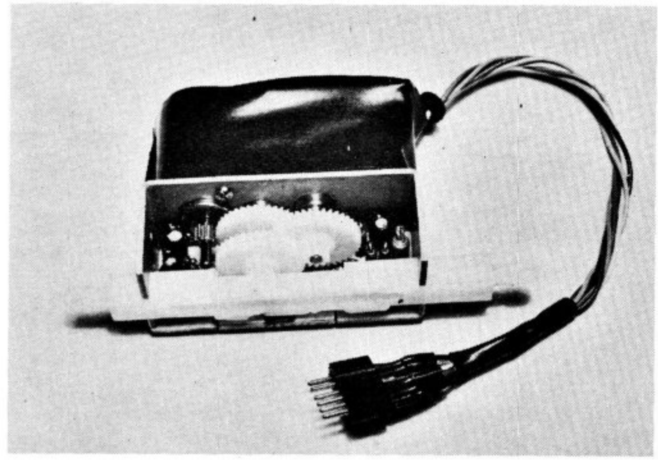
Amplifier installed on "C" frame. Gears and output arm removed in this photo.



Another view of servo assembly showing auxiliary board and servo motor.



Gears and output arm installed. Note plastic electrical tape around base of frame.



Completed servo less case halves.

points. (Make sure auxiliary board is pushed down flush on main board and at a right angle to it.)

( ) Cut 12″ pieces of black, orange, red and yellow hook-up wire.

( ) Solder them as shown in figure 1 and insert them through hole A in the auxiliary board.

( ) Cut 12″ pieces of blue and green and a 2¾″ piece of brown hook-up wire.

( ) Solder them as shown in figure 2 and insert them through hole B in the main board.

( ) Route the blue and green wires over the top of main board components so they come out at the cutout in the auxiliary board along with the four leads from the auxiliary board.

( ) Insert and solder the other end of the brown wire into the vacant hole between Q11 and Q12 (68K ohm lead).

( ) Slip a ¼″ grommet over the servo lead wires to hold them in place and out of the way.

NOTE: All wires should be routed between solder mounds. If any wire is routed over a solder mound it will be pressed down by the cover and may cause a "short."

FINAL WIRING OF SERVO

( ) With completed amplifier on the C frame make a check for last minute clearances, wiring, etc.

( ) Secure the amplifier with the mounting screw and again check for clearances, etc. Make sure the inside .05 motor capacitor doesn't short against any lands on the auxiliary board (see figure 1). Bevel the board if necessary.

( ) Solder the blue and red motor leads as shown in figure 1. Leave some "slack" in the wires to prevent breakage by vibration.

( ) Bend the wiper arms as shown in figure 3.

( ) Put the gears and push/pull arm in place one by one and work the servo by hand (use the second idler gear when fully assembled). Insure that the gears and/or arm do not rub or hit any component. If necessary trim the "knob" slightly on the bottom of the output arm to clear the .001 capacitor.

NOTE: When inserting or removing the output arm be careful the wipers or R10 are not damaged. Jack Port recommends using a thin piece of insulating sheet as a "shoe horn."

( ) Check alignment of wiper arms on R10 and brass strip making minor adjustments if necessary. The middle arm is not used and should "ride" between the brass strip and R10. Tension of wipers will be correct if they extend to bottom edge of P.C. board with output arm in line with C frame slots.

( ) Twist the servo leads together and slip a 1″ piece of large heat-shrink tubing over them.

( ) Cut your leads to desired length (6″ is about average).

( ) Unravel the end of the leads for about 1″.

( ) Tin each lead and slip a ½″ piece of small heat-shrink tubing over each wire.

( ) Clean and tin each pin of the connector where you are going to solder.

( ) Solder all wires as shown in previous wiring diagram.

( ) Slip the heat-shrink tubing in place and heat with a match or by rubbing your soldering iron over it. A match works better but may discolor the wires.

FINAL ASSEMBLY OF SERVO

( ) Remove output arm and gears.

( ) Check overhang on Q12 as per figure 1. It should not extend beyond edge of P.C. board.

( ) Bevel areas of P.C. board shown in figures 1 and 2 to provide clearance between copper lands and cover.

( ) Wrap a ¾" wide piece of black electrical tape around motor and P.C. board as shown in photo. This will give additional protection against accidental contact between case and components, especially Q12's case which is internally connected to its collector lead.

( ) Place top cover (with output arm cutouts) in position and adjust until top edge is flush with top edge of C frame. If holes in case and C frame don't line up "carve" away aluminum with an Xacto knife inserted in the cover holes.

( ) Tighten the cover in place with two each #2 x ⅜" screws.

( ) Insert gears and output arm — check final tension and alignment at this time.

( ) Center and cement insulating sheet, provided with servo, to bottom cover with contact glue.

( ) Slip on bottom cover and tighten securely with four #2 x ⅜" screws.

( ) Check output arm for binding. There should be a slight amount of "play" in all directions when worked by hand. If not adjust the cover. Do not attempt to operate the servo mechanically or gears may be damaged.

( ) Save mounting kit for installation.

PRELIMINARY CHECKOUT

( ) Measure the resistance between the black and green wire (black to black meter lead and green to red meter lead). You should read approximately 1.2K ohms. If you read a "short," check for shorts in the areas pointed out in the article.

( ) If the above reading is normal, and with the meter still connected, squeeze the servo case all over while observing the meter for shorts. If any show up during this check, correct the trouble before proceeding.

( ) Make the same check with the red lead connected to the red meter lead and black to black meter lead. You should read approximately 1.5K ohms and not show a short while squeezing; correct the trouble here also before proceeding.

( ) Run the same check between the black and orange lead. The normal reading is approximately 1.7K ohms.

( ) Run the same check between the black and yellow lead. The normal reading is approximately 1.6K ohms.

NOTE: While the above tests are not very scientific they may prevent "pranging" an airplane later on.

( ) If you have a good understanding of the circuitry you can check

SERVO PARTS LIST

REFERENCE NUMBER	DESCRIPTION	MANUFACTURER OR SOURCE	MANUFACTURER'S NUMBER
C1	.1 MFD Tantalum	T.I.	SCM104FPO35D2
C2	.05 Disc	Erie	Z5E
C3	"	"	"
C4	2.2 MFD (axial leads)	W.E.	CT 225
C5	"	"	"
C6	.05 Disc	Erie	Z5E
C7	"	"	"
C8	.001 Disc	RMC	SM .001 MF
C9	.01 Disc	CRL	CK 103
D1	Silicon Diode	W.E.	DHD 806
D2	"	"	"
D3	"	"	"
D4	"	"	"
D5	"	"	"
D6	"	"	"
D7	Germanium Diode	Ohmite	1N34 or equiv.
D8	"	"	"
L1	4 uh RFC	W.E.	4 uh RFC
L2	"	"	"
Q1	2N2924	G.E.	2N2924
Q2	"	"	"
Q3	"	"	"
Q4	"	"	"
Q5	"	"	"
Q6	"	"	"
Q7	"	"	"
Q8	"	"	"
Q9	"	"	"
Q10	"	"	"
Q11	GC 4008	T.I.	GC 4008
Q12	"	"	"
R1	22K ⅛ W	Ohmite	LIDVS
R2	4.7K "	"	"
R3	10K "	"	"
R4	4.7K "	"	"
R5	27K ¼ W 5%	"	LIDED
R6	4.7K ¼ W	"	LIDSM
R7	4.7K ⅛ W	"	LIDVS
R8	10K ¼ W	"	LIDSM
R9	1.2K ⅛ W	"	LIDVS
R10	1K Wirewound (Linear)	W.E.	1K SPL
R11	1.2K ⅛ W	Ohmite	LIDVS
R12	68K ¼ W	"	LIDSM
R13	10K ⅛ W	"	LIDVS
R14	4.7K ¼ W	"	LIDSM
R15	4.7K ¼ W	"	"
R16	22K "	"	"
R17	" "	"	"
R18	3.3K "	"	"
R19	" "	"	"
R20	100 "	"	"
R21	" "	"	"
R22	" "	"	"
R23	150K "	"	"
R24	" "	"	"
R25	15 "	"	"
R26	" "	"	"
R27	47 "	"	"
R28	10K ⅛ W	"	LIDVS

MISCELLANEOUS — ALL ITEMS AVAILABLE FROM WORLD ENGINES

Servo Mechanism with Cover, Insulating Sheet, Screws and ¼" Grommet
Male Six-Pin Servo Plug
Servo Mounting Kit
Package Hook-up Wire
No. 2 x ¼" Screw
Set P.C. Boards
1" Large Heat-Shrink Tubing
4" Small Heat-Shrink Tubing
Wiper —5/64" x 1¼" .006 Brass Stock

For Complete Set of Miscellaneous Items Plus R10 Order DTSM-1.

For Complete Servo Including Electronics Order DTSC-1.

NOTE: Again physical size will limit substitutions. Before you purchase substitute items make sure they will fit; don't buy them on an assumption.

your complete system now. If not (and no local Einsteins are available), spend the rest of the month getting your plane ready.

Next month I'll explain final tuning and testing as well as trouble shooting and preventive maintenance.

NOTE: If you don't know exactly what you're doing or the system is not operating perfectly – wait – don't fly it – you were warned! While waiting you can also recheck all construction for errors, replace all components you substituted hoping they might work (chances are they won't), straighten out all shortcuts you took, etc.; in other words make sure your system is according to the articles. If it is not, please don't tell anyone it's a Digitrio.

Give it another name like "Mickey-Mouse-itrio."

ADDING COPPER SHIELD TO TRANSMITTER

Some Digitrio transmitters have exhibited RF instability with the antenna retracted or removed. This is due to RF radiation from L5 entering the base circuit of the final amplifiers Q2 and Q3. With the antenna fully extended (assuming resonance) the impedance at the base of the antenna is relatively low and radiated RF voltage of L5 is minimum.

When the antenna is retracted (non-resonant) or removed the impedance rises as does the radiated RF voltage of L5. This can cause regeneration. The solution of course is to reduce the effect of L5's radiation when the antenna is non-resonant or removed. The copper shield described below will accomplish this and is easy to install. I recommend its use even if you are not having this trouble.

( ) If your Digitrio is already built remove L5.

( ) Cut the shield as shown and clean it thoroughly.

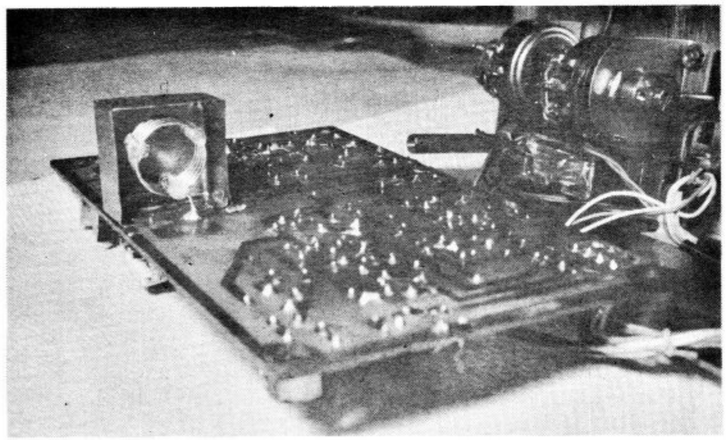
( ) Bend it to shape and check for fit.

( ) Pre-tin all surfaces to be soldered and solder top joints.

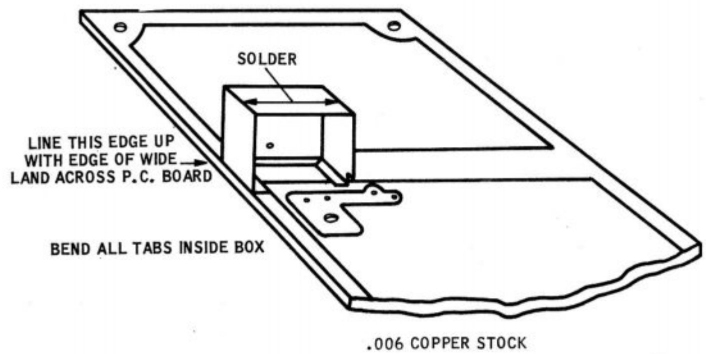
( ) Place it in position and solder it to the P.C. board. Use enough heat to allow "wet" solder flow insuring a tight "RF" bond.

( ) Drill a 1/16" hole for L5's lead and install L5. Use a piece of small heat shrink tubing over the lead sticking through the shield to prevent shorting.

NOTE: Center L5 in the shield compartment and insure that it does not contact the shield at any point. L5 will have to be moved over slightly toward the antenna mount and a short extension of L5's opposite lead may be necessary if L5 was previously installed. As a further precaution C4 and C5 should be mounted close to and bent over flat against the board to minimize stray RF pickup by their plates.

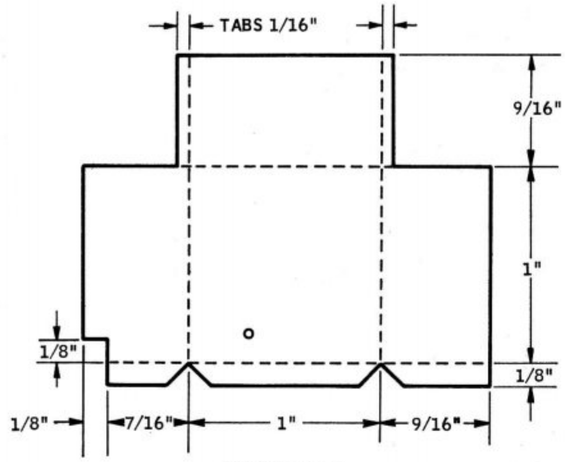


RF shield added to transmitter P.C. board. Below: Pictorial for adding shield.



DIGITRIO TRANSMITTER SHIELD

Full size pattern for thin copper RF shield. Below: Ed Thompson's Tauri with Digitrio.



PATTERN 1 = 1