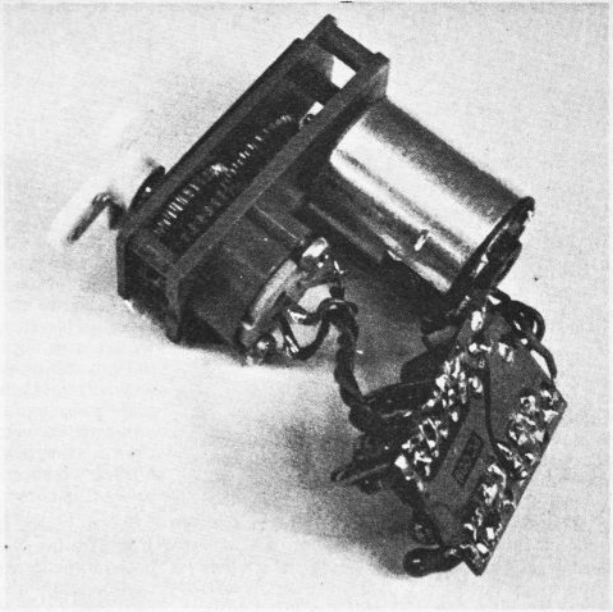
OCTOBER 1979

RCM&E FM



DIGITAL SYSTEM PART 5

TERRY PLATT DESCRIBES SERVO SETTING UP AND MATCHING TO THE SYSTEM

IN the fourth part of this series it was stated, without going into great detail, that almost any positive pulse driven servo would work satisfactorily with the receiver. The aim of this article is to clarify this statement with more detail about various commercially available servos and indicate any minor modifications which may be needed to use these with the system — I do not intend to give details of a servo design of my own as there are so many excellent units on the market at a wide range or prices that no significant advantage would be gained by "rolling one's own."

In assessing the suitability of any servo for matching to the system several points need to be taken into consideration as follows:

(1) Is the servo designed to work with positive going input pulses?

(2) Is it a three or four wire input type?

(3) Is the mechanical/electronic centre point at 1.5ms pulse width?

Other less important criteria are:

(4) Is the input directly or capacitively coupled?

(5) Is the direction of rotation with stick movement suitable for the installation in the model?

I will first discuss points 4 and 5 as these are readily dealt with as follows:

Point (4) is mentioned mainly because several persons have commented on it as a possible source of trouble while in practise it is not, as now shown: the problem which can arise with a directly coupled servo amplifier input is that if the input is driven positive by a voltage in excess of the trigger level the servo will regard this as an extremely long signal pulse and drive itself against its end stop, thus stalling the motor and possibly damaging the gears or servo amplifier. In some decoders this can happen if the signal is lost and one decoder output remains high, however in the *RCM&E* receiver this cannot happen as, if the signal disappears for some reason, the noise output of the receiver clocks the shift register (IC2) and empties it almost instantly whilst not producing any further sync. pulses to enter any "ones." All eight outputs thus fall to zero volts very rapidly on the loss of signal and any directly coupled servos remain in the position last set when the signal was present. This "self-clearing" ability is a useful attribute of the "4015" shift register and the main reason for its use in the receiver in preference to the more common "4017" counter type decoder.

Point (5) can arise if the servo linkages in a model can be fitted only in such a way that the servo being employed operates in the wrong direction. The simplest solution is to reverse the transmitter stick potentiometer so that the pulse width varies in the opposite direction (remember of course to re-centre the pot for the correct output pulse width after reversing the wires).

If you are in the position of having two models with servos, one of which works correctly and the other in reverse, the alternative action is to

Fig. 1

SERVO REVERSAL AT THE TRANSMITTER

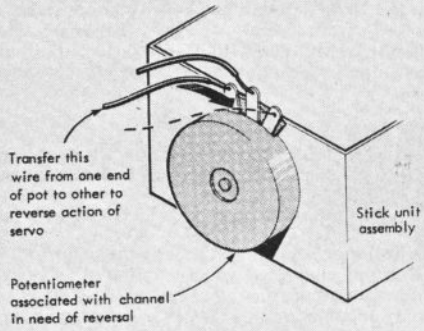


Fig. 2 SINGLE

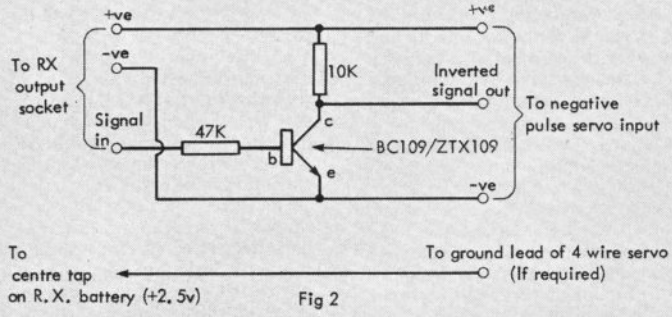
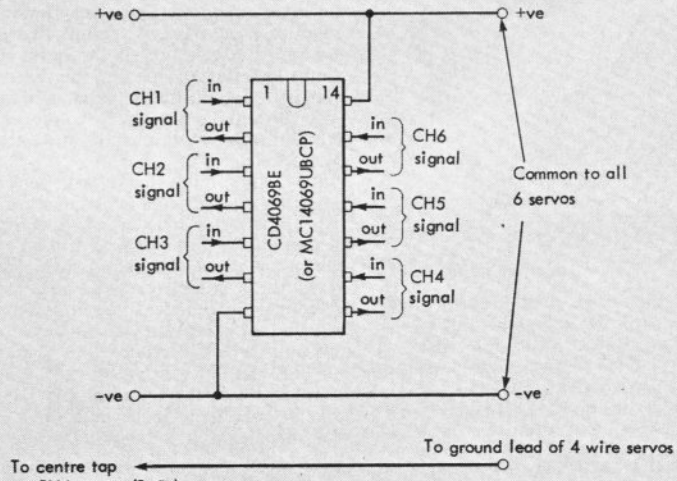


Fig 2

Fig. 3 MULTI WAY INVERTER



reverse the servo itself and this is dealt with in the last part of this article.

I shall now return to the first three important points.

With respect to point (1) the great majority of servos, if not all those manufactured in the last few years, are intended to work with positive pulse input signals. This system became almost universal with the introduction of integrated circuits for servo amplifiers which caused the electronics of servos to become largely standardised on the positive pulse system. It can thus be stated without likely exception that any servo manufactured from, say, 1975 onward is almost certainly a positive pulse design — a further confirmation may be obtained by cautiously unscrewing the casing of the unit and examining the servo circuit board for the presence of IC's (often labelled NE543, NE544 or SRC419 although some "oriental" servos use other unique codes!) Most negative pulse servos also fall into category — (2) having four input wires for use with centre-tapped receiver batteries and this can serve to identify at least some of them. If it is desired to use such a servo with the receiver this may be done by the inclusion of an inverter stage between the servo and the decoder output. Such an inverter is easily constructed from a single transistor and a few resistors as shown below in Fig. 2 or in the case of several such inverters being required — from a Cmos Hex inverter such as CD4069BE or MC14069UBCP. These devices will invert up to six outputs with no other external components being necessary as shown in Fig. 3 but remember to connect any unused *inputs* to the —ve supply as a floating input can cause strange things to happen!

Point (2) is effectively covered in the preceding discussion as four wire servos simply need a centre tap on the receiver battery for their "ground" lead as shown in Figs. 2 and 3 and so we are now left with Point (3) — the "centre" pulse width of the servo. The great majority of servos reach their mechanical centre position at some pulse width between 1.3 and 1.8ms., and although there may be some subtle reason for the variation in centres, it appears to be largely arbitrary from manufacture to manufacturer as to what is chosen within this range.

As a reasonable average value I selected 1.5mS for my system which corresponds to stick potentiometer value of about 40K when set to mid-position however, the constructor is not restricted to precisely this value for stick centre and setting to 35K gives about 1.3mS or setting to 48K gives 1.8mS. This allows any servos within this range of centres to be used without adjustment to the servo feedback potentiometers but if this is the method used beware of very narrow pulses at one extreme of the stick range being rejected by the receiver detector time constant. This can happen if centres around 1,3mS are selected (i.e. for use with *Futaba* servos at about 1.35mS) and leads to a sudden loss of control on all channels when extreme stick deflection (one way) is selected. Control is recovered immediately on re-centring the stick concerned but the situation is obviously undesirable (!!) and can be cured simply by reducing the time constant of the components R7 and C14. If R7 is changed from 2.2K to 1K this should be more than adequate and the only sacrifice is a small drop in interference rejection.

The only servos which are both commonly available and operate at centres less than 1.5mS seem to be the above mentioned *Futaba* series and if you intend to use these without re-adjustment the modification to R7 is advisable, most other servos should work correctly without change to the receiver.

Servos which I have used successfully during development include *Fleet FPS3, Sprengbrook, World Engines, DJ&D Modelgear, OS, MacGregor, Kraft, Futaba* and more recently the *Viking Mini* servo. This last mentiond also has the useful facility of an adjustable "centre" without dismantling by insertion of a small jeweller's screwdriver through the centre hole of the output shaft into the slotted end of the feedback pot shaft which is a concentric friction fit in the gear sleeve. Most other servos require dismantling to effect a change of centring and for this please refer to the following section under the heading of "matching." Also see below for reversing of servos to suit models without changing the transmitter wiring.

DIGITAL SYSTEM SERVO MATCHING

MANY readers are unwilling to delve into the vitals of their R/C equipment armed with a soldering iron and suffer agonies of frustration when for example the only possible combination of servos for an installation leaves one servo with the incorrect direction of rotation. The experts will no doubt scoff at these difficulties 'what problem?' — 'Reverse the servo', they say. All well and good if you have the confidence and knowledge, but when the result of a mistake is at the very least a damaged servo and at worst a wrecked model, having that confidence is not easy.

When I was first confronted with the servo reversing problem I had much the same reservations about tackling the problems as most proud owners of new R/C gear feel, and was loth to risk damaging anything, but, after consultation with the club expert I proceeded to successfully reverse my first servo. The feeling of wonder and satisfaction experienced then still persists after many many 'servo reversals' which I now treat as a matter of course.

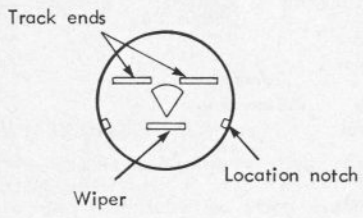


Fig. 1

Principles and practice

To reverse a servo, reverse the motor connections and the feedback potentiometer connections; simple isn't it? etc. etc. Follow the procedure outlined below and all will be well — I haven't damaged a servo yet!

(1) You will need a 15 watt soldering iron with a fine pointed, well tinned bit; a pair of fine 'snipe' nosed pliers, a small *Posidrive* or *Philips* screwdriver, a jewellers screwdriver and possibly some de-soldering braid, (braided 'screen' from T.V. aerial co-axial cable will do) a pencil and paper.

(2) Remove the servo output arm after centring the servo with Tx or Rx switched on with the Tx trim set at neutral. Make a mark with a soft pencil on the output shaft and case, to indicate where neutral should be. It may help to stick a scrap of adhesive tape onto each item.

(3) Dismantle the case carefully using the correct size and type of screwdriver in the screws. Try to keep the gear train in one piece on its frame. Now carefully slide the amplifier — that is the little printed circuit board, and motor out of the case being careful not to strain any soldered lead connections. Examine the amplifier and you will notice that there are normally three distinct groups of leads connected to it. They are — (a) the input leads — on modern servos there will be three; positive, negative and signal. There are numerous colour codes used but most commonly Red +ve, Black — ve and a contrasting colour for the signal. If in doubt examine the rest of the receiver wiring harness to establish the colours used for +ve and —ve throughout the system to prevent damage should the battery be plugged into a servo socket by mistake.

(b) Three more leads will run from the amplifier to the feedback potentiometer. The case for this is usually moulded into the lower gear frame and the element will be retained in the case with two small locking screws. If your servo has a completely unitised feedback pot, you may encounter some difficulties on re-centring the servo and you will have to decide at this point whether to burn your boats and carry on or retire gracefully! (c) Finally the connections to the servo motor. The amplifier may be soldered directly onto the motor — do not dispair, if it was soldered on it can be unsoldered!

(4) Identify the leads which connect to the *ends* of the feedback pot track. Many are identified on the pot element see Fig. 1. If not take out the two remaining screws and examine the tracks. The horseshoe shaped track will have terminals to. Disconnect the two track end wires contact the wiper. Draw a small diagram of the pot connections noting the colour of the wires and some salient feature to relate the three terminals to. Discount the two track end wires from their tags and re-solder in reverse positions. Should the telephone ring half-way through this operation check with your drawing before completing it when you return to the workbench.

Fig. 2

(5) Now to the motor — once again Sketch the existing situation before attempting to change anything. If the motor is soldered direct to the circuit board it will normally be necessary to de-solder the joints with braid. A little *Fluxite* or other resin flux on the braid helps. It may be necessary to re-position an earthing tag on the motor if one is fitted. Do not omit the earth to the motor case when turning the motor round.

If the motor is connected to the amplifier with fly-leads simply reverse the +ve and —ve; these may be marked on the motor case.

(6) Re-assemble the feed-back pot element. If you are really keen, clean and lubricate before re-assembly.

(7) With the feedback pot re-assembled but the motor free of the gear box switch-on. The motor is almost certain to run and by rotating the output shaft of the gearbox (and thus the feedback pot wiper) you should be able to find a position where the motor stops and by further rotation starts to run in the opposite direction. If so all is well.

(8) Re-set the output shaft so that the marks made at the start of the operation coincide, at which point the motor should start to buzz

happily. Now by rotating the feedback pot *element* in its housing you should find the neutral point once again, with the servo output arm still in its' correct position.

(9) With the servo now reversed and neutralised switch off and re-assemble all the mechanics, amplifier case etc.

(10) Switch on and re-check.

Not too difficult was it? There are one or two variations that may occur — firstly the previously mentioned unit feedback pot. This is usually retained with a nut on top of the lower gear frame which may be coated with locking compound. Additionally the case of the pot will probably be located with a tag into a hole in the case. Servos using this type of pot frequently employ a hexagon or D section output shaft onto which the output gear and servo arm location are fitted. This means that the arm can only be fitted in one position, which is fine if the neutral happens to be correct when the servo is reversed. If not then first check the amplifier to see if a skeleton pre-set pot is fitted, see Fig. 2. If it is then reverse the servo and then adjust the neutral with the pre-set. If there is no pre-set then I usually remove the unit pot from the gear frame, bend down the locating tag thus enabling me to rotate the whole unit to re-centre the servo. A tiny drop of cyanoacrylate will lock everything in place when the job is completed.

There are one or two servos available which feature external neutral adjustments — once again reverse the servo then use the facility provided to adjust the neutral. Never leave the output arm just where it finishes up after reversal — it may be that the feedback pot wiper is dangerously near the end of the track and a glitch could cause it to ride off the track and either stop the servo completely or jam up the control linkages. This is particularly tempting with splined output servos, but don't do it, re-centralise that servo!

New leads for old

It may be that you wish to change the leads to the amplifier, or fit leads of a different type to the servo in order to use it with a different make of R/C equipment. If so proceed with caution. It will firstly be necessary to very positively identify the pin arrangement of the plugs i.e. positive, negative and signal. Now slip the amplifier out of the case and note where the various leads go to on the P.C. board. Draw a sketch of the amplifier circuit board and note on it carefully which lead goes where.

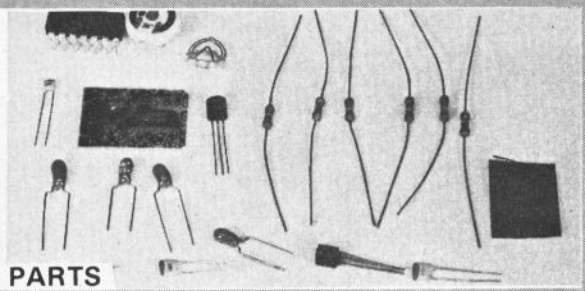
Trim about 2mm of insulation from the ends of the new lead, twist together the strands and tin. Un-solder the leads and remove from the amplifier. Check that the holes in the P.C. board are clear, if not de-solder with braid and possibly use a plated steel dress-making pin in the moulten solder to clear the hole.

If there is a grommet on the old lead place it on the replacement, insert the tinned ends into the board, solder and trim off excess lead.

None of the above is difficult to perform, good eyesight, care and patience are the bywords for success. Do not be tempted to omit the sketching before starting, you can be distracted and on returning to the job you will have forgotten which wire is which. Happy reversing!

SERVO KIT ASSEMBLY STEP BY STEP

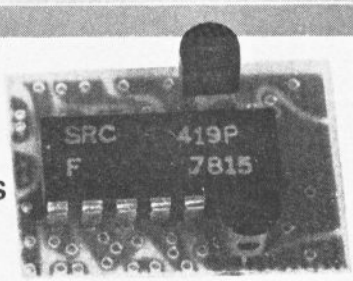
1



KIT PARTS

2

ASSEMBLE THE I.C. AND TRANSISTORS ONTO THE PCB FIRST THEN THE REST OF THE COMPONENTS



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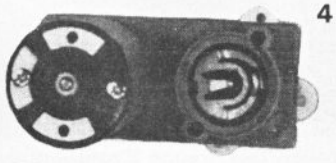


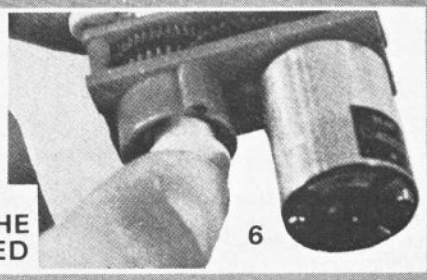
FIT THE POT WIPER

4

PLACE THE WIPER IN POSITION

5

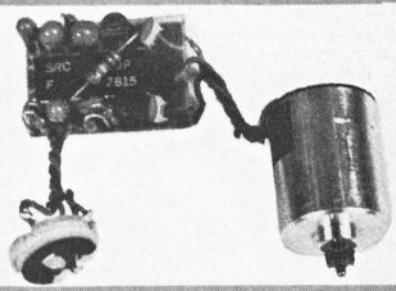
PRESS INTO PLACE WITH THE TOOL PROVIDED



6

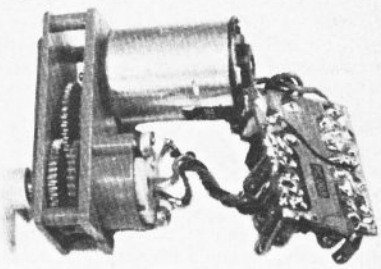
7

MAKE THE CONNECTIONS BETWEEN MOTOR, AMP & POT TRACK



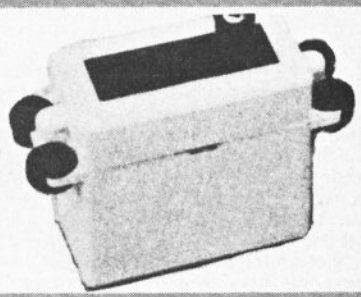
8

ASSEMBLE THE MOTOR AMP., AND POT TRACK ONTO THE GEAR FRAME



9

FIT THE COMPLETED UNIT INTO THE CASE



SERVO KIT SUPPLIERS

DJ&D Modelgear, 5 Springfield Place, Garforth, Leeds LS25 1LT. Tel: 0532 864355. Teleradio, 35 Fore Street, Edmonton N9 OPE. Tel: 01-807 3719. Micron, Hayworth Road, Sandiacre, Nottingham NG10 5LR. Trio Instruments Limited, Dept. RCM&E, Dartford Road, Farmingham, Kent DA4 ODZ. Tel: Farmingham 862082. Microtrol, 4 Winston Crescent, Sunderland, Tyne & Wear SR4 8RH. Tel: Sunderland 284978. Fleet Control Systems, 47 Fleet Road, Fleet, Hants. Tel: Fleet 5011.