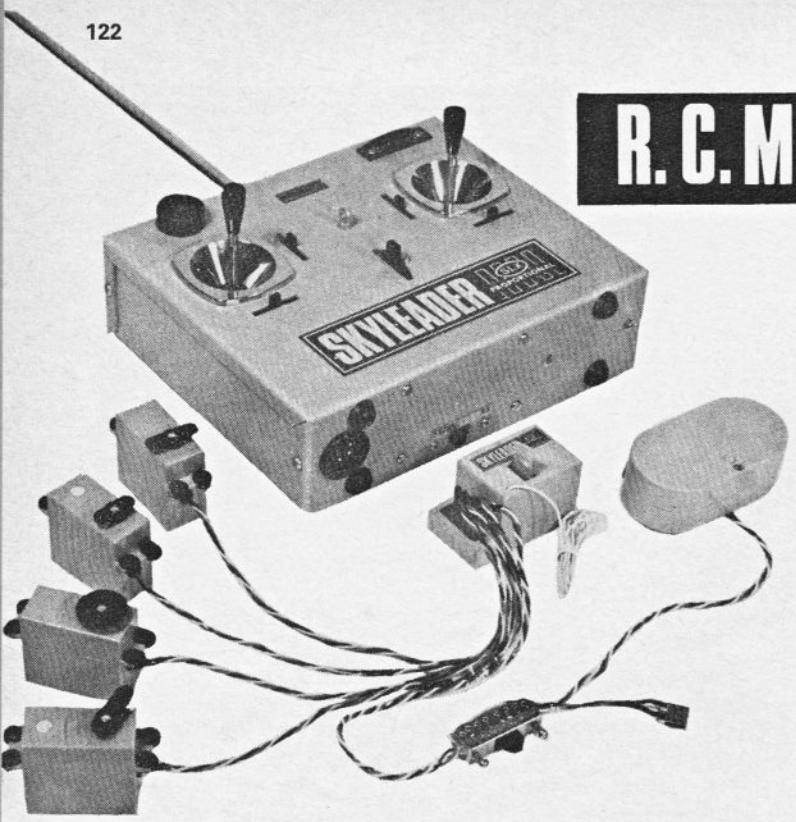
R.C.M. & E. Test Report



SKYLEADER SLX 6

OUR last test analysis of a Skyleader R/C system appeared in January, 1970, *R.C.M. & E.*, when we examined the then-new Skyleader S.L. system.

Equipment by this British R/C manufacturer is very much a part of the R/C scene at weekend club flying fields and contests throughout the country. Contest success is, in fact, something on which this particular manufacturer lays considerable emphasis, and there is no denying the considerable number of competition successes achieved using Skyleader equipment in recent years.

Skyleader's line progressed a stage further some months ago, with the introduction of their SLX system, incorporating some changes and innovations which more than justify a test analysis. For this we have obtained a standard SLX 6 system, which offers six independent fully proportional systems using the generally accepted 'digital' signal information techniques.

Transmitter

The SLX transmitter can be described as a completely orthodox general layout, with two-piece vinyl-clad folded metal case and using two dual-axis stick units.

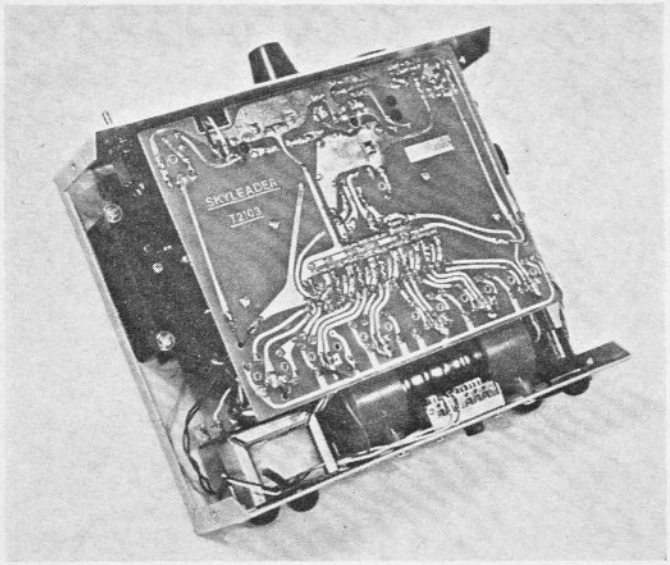
Case layout includes an output meter at top centre of the front case, neatly flush mounted with the case face, and flanked on the right by an on/off switch, and on the left by a buddy-box change-over button. The button has a protective surround which prevents accidental depression of the button, thereby turning off the output signal – a disaster if accidentally depressed during operation of a model!

The buddy-box connection is a wander lead which plugs into the charging socket in the bottom of the case, which doubles duty for the purpose.

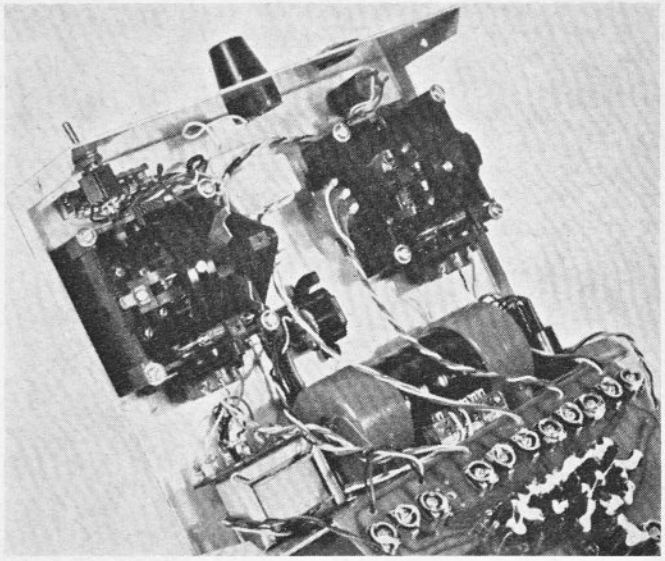
An auxiliary lever for the fifth control function is centrally placed below the two main control columns, and on the case top there is a two-position toggle switch intended for a retracting undercarriage function. The switch can be positioned at either left- or right-hand corner for convenient operation, depending on stick mode desired – normally for *mode 1* (aileron/throttle, right) the switch is placed on the right, and vice-versa for *mode 2*.

Also on the case top, adjacent to the aerial socket, is a removable cap, covering the plug-in crystal, which is easily accessible in its socket.

The two dual-axis stick units used were tooled specially for Skyleader and have stylish chromed front bezels which produce a very elegant effect. 'Feel' of the control column is extremely light, probably the lightest we have yet encountered on any R/C system, but for individuals who require a stronger centring force, stronger replacement springs are available. Stick lengths are adjustable to suit individual preference – you just move the tight-fitting plastic top caps up and down to suit. Trim action on the Skyleader stick units is good – smooth, with no tendency to local binding.



Transmitter case rear cover removed to reveal p.c. board, mounted component side inwards. Switch in bottom of case controls dual rate charger.



Component p.c. board removed from mounts to reveal mechanical arrangement. Note the retract switch top left and the charger transformer bottom left.

Interchanging of stick modes is simply achieved by the removal and repositioning of a centring spring and a throttle ratchet catch, necessitating the removal of the P.C. board from its mounts – in all, a ten-minute job at the most.

The transmitter carries an integral transformer isolated charger designed to serve both transmitter and receiver power packs. Use of a very tiny transformer permits incorporation of the charger without drastically increasing the weight of the transmitter unit, which is comfortably light. A ready-wired charging harness is provided with the system, designed to provide mains input to the transmitter via the socket in the case base. The charging lead also connects up to the airborne power pack via a socket in the switch harness. A two-position change-over slide switch mounted in the case base allows simultaneous charging of both Tx and Rx power packs or separate charge for the airborne pack as desired. In both cases the output meter on the case front doubles duty to monitor the charge. We also found that when the transmitter is switched on, the charger is switched out of circuit to prevent accidentally overloading the transmitter circuit.

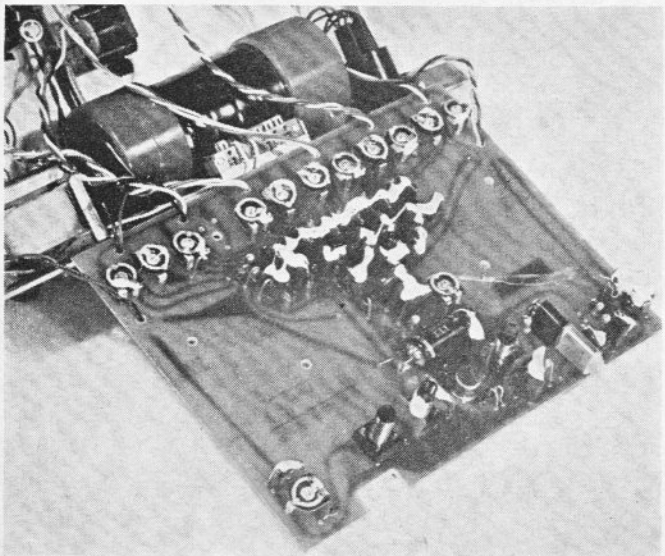
The internal layout of the SLX is the epitome of the 'standard' arrangement, with large, neatly soldered glass epoxy p.c. board sparsely spread with components. Components are supported in place with silicone rubber sealant, which is also sensibly applied to all the encoder half shot adjustment pots.

Receiver

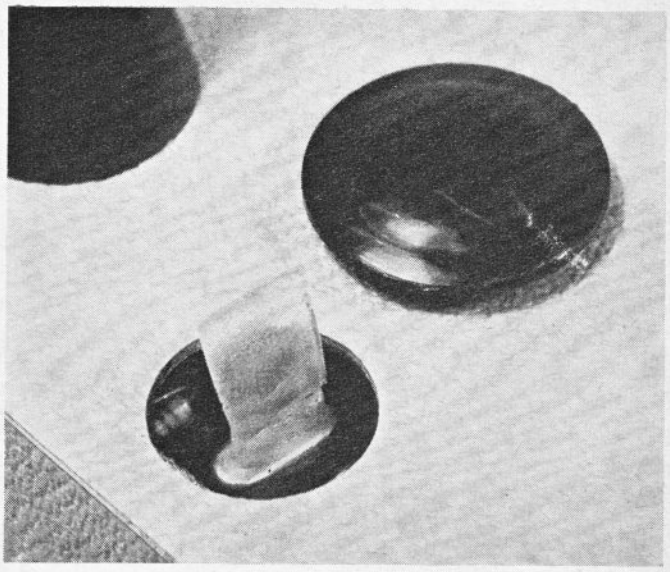
Two types of receiver are now available with the SLX system, using common electronics but with differing packaging, to suit individual preference.

These involve a standard 'boot' of 'L'-shaped receiver case or an alternative normal oblong-shaped type. The 'Boot' case features an SLM connector block in one end – hence the unusual shape. The conventional oblong cased unit has fly-leads and line connectors with which to connect up to the servos and power pack, and offers a slightly more compact shape.

The 'Boot' type receiver unit was a major physical feature of the SLX system when originally introduced, but Skyleader find a surprising demand for the 'conventional' shape Rx. Both units, however, are very compact and both offer the facility of plug-in interchangeable crystals. Outputs on the connector block receiver (which we will consider the 'Standard' arrangement for the purposes of this test) are not identified, and fig. 1 should be useful in identifying and matching operational functions to output points for both mode 1 and mode 2 control arrangements.



Detail of the p.c. component layout of the transmitter, showing liberal use of supporting silicone rubber compound, to components and to seal pre-set pots in encoder network.



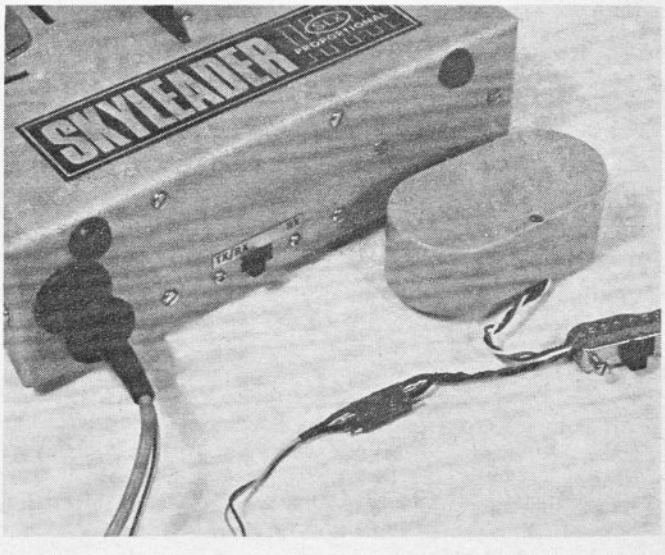
Close-up detail of plug-in crystal in transmitter, accessible through hole punched in case top adjacent to aerial socket. Plastic cap covers crystal and holds it in place.

The internal layout of the receiver involves two separate p.c. boards for the R.F. circuit and decoder. In such a compact package (both types represent one of the smallest receivers of the type available anywhere), it is no surprise to find a very tight component fit on the R.F. p.c. board, although on the decoder board there is a surprising amount of 'air' space, due to the use of an I.C. chip in the circuit. Soldering work on both boards was extremely good.

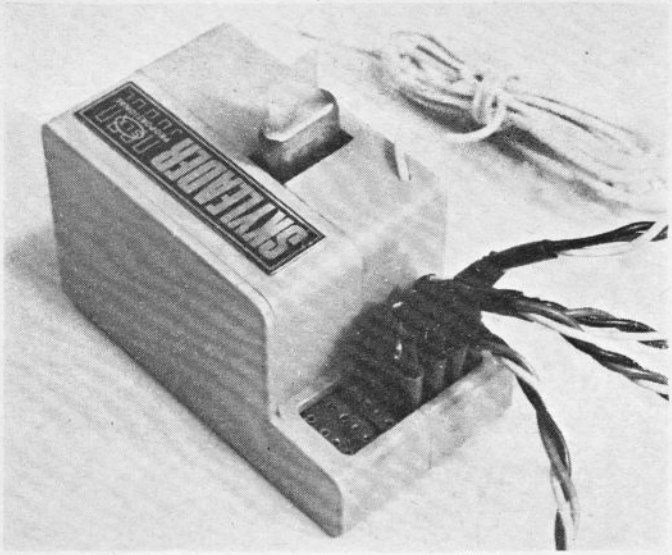
Servos

Heart of the Skyleader SLX system is the tiny Kraft KPS-12 mechanics and Kraft bridge amplifier I.C. chip, which is the major feature of the entire system. This results in a servo amplifier circuit which requires only three wires to each servo, eliminating the normal 'centre tap'. Major advantage here is that if a single cell in the power pack fails during flight, the system will still be flyable, although with reduced servo speed, whereas with the centre tap type circuit, the result would be uncontrollable servo drift towards one end of the servo throw, with obvious results.

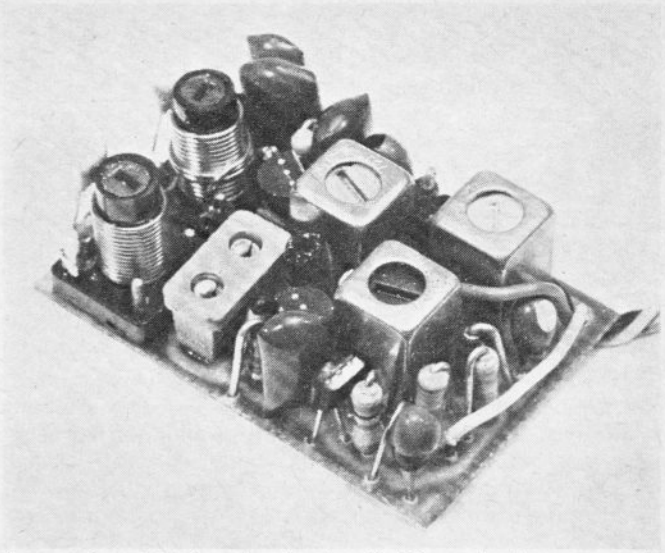
Actually, the SLX power pack still has the centre tap wire in the harness and wired into circuit, and while the Kraft/SLX servo unit ignores this, the inclusion does permit the use



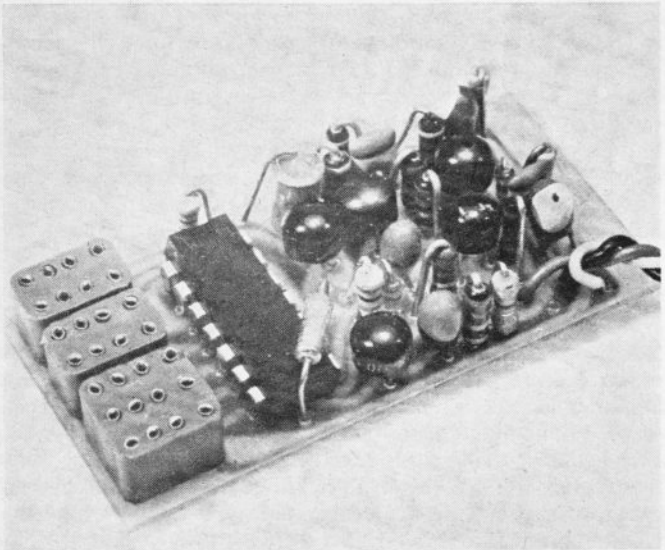
The charging harness, showing mains input to socket in left of case base, two-position charge-rate switch and SLM line connector to airborne power pack.



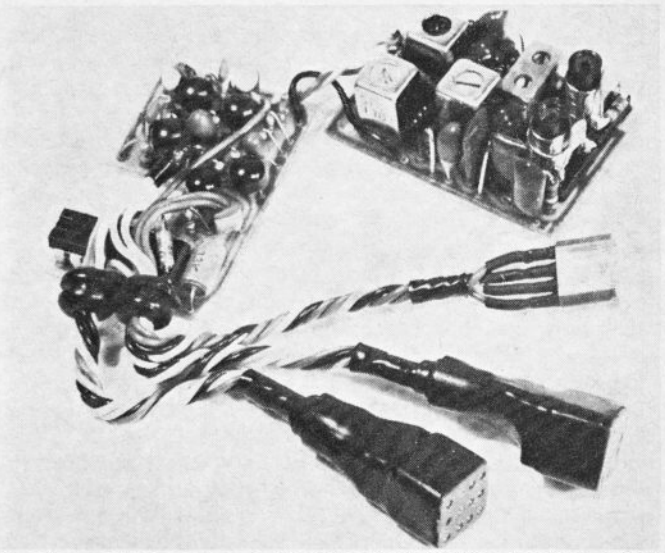
The 'boot' type receiver with connector block in one end of case. SLM line connections insert into block. Note plug-in crystal.



The receiver R.F. board, showing tightly packed components. Crystal removed from holder for clarity.



The decoder board as used in the 'boot' type standard receiver shown above. Note relatively wide spacing of components and I.C. 'chip'.



Receiver and decoder p.c. boards of alternative receiver, which offers operator servo and power pack connectors on fly leads, using SLM plugs and connector blocks.

of normal four-wire type Skyleader servos if occasionally desired.

The Kraft I.C. chip used in the SLX servo amplifier provides the capability of extremely tight centring and servo accuracy. This in turn must be justified at the transmitter end by the use of high quality stick units with very accurate control potentiometers to take advantage of the servo amplifier performance, and this is the basic reason for Skyleader's specially tooled stick unit.

Servo action is indeed extremely fast (a feature of bridge amplifier circuits, with their relatively high resistance motor armatures) and very sensitive to minute stick movements. It is not possible to detect any improvement in servo resolution with the naked eye, but positive and solid reaction to most minute stick movements is apparent.

One very practical feature of the Skyleader system, which we have always commended, are the 'opposite acting servos'. That is to say, for a given input signal (say, left aileron) two of the four servos drive one way, and two in the opposite direction – a very useful and practical feature when it comes to installing the equipment. The opposite acting servo units are identified by small white dots on the case tops.

Servos use SLM 4-pin connectors and four types of output levers and wheels are provided for each servo, to achieve various amounts and variations of throw.

Power Pack

A 500 mAH 'flattie' power pack is provided with the SLX system, supplied in a protective mounting case. The pack is wired in harness with an on/off slide switch, and charging socket. The slide switch has no moulded rear cover, the wires to the switch solder tags being simply supported with a coating of contact cement. On expressing our feelings towards this practice, which certainly does not compliment the neatness of the rest of the system, the manufacturer countered that with a switch cover in place, the switch would not mount on the Kraft servo tray provided with the system, thereby denying the operator a useful little installation feature deliberately provided.

Touche!

Accessories and services

The Skyleader SLX comes complete with extra servo drive arms and discs, servo installation tray and aileron servo bracket, together with mounting hardware. Also provided is a jumper lead for the aileron servo and an adjustable neck strap.

Plug-in crystals are available for any of the established spot frequencies and additional matched crystal pairs are obtainable. An interesting little item available to go with the set is

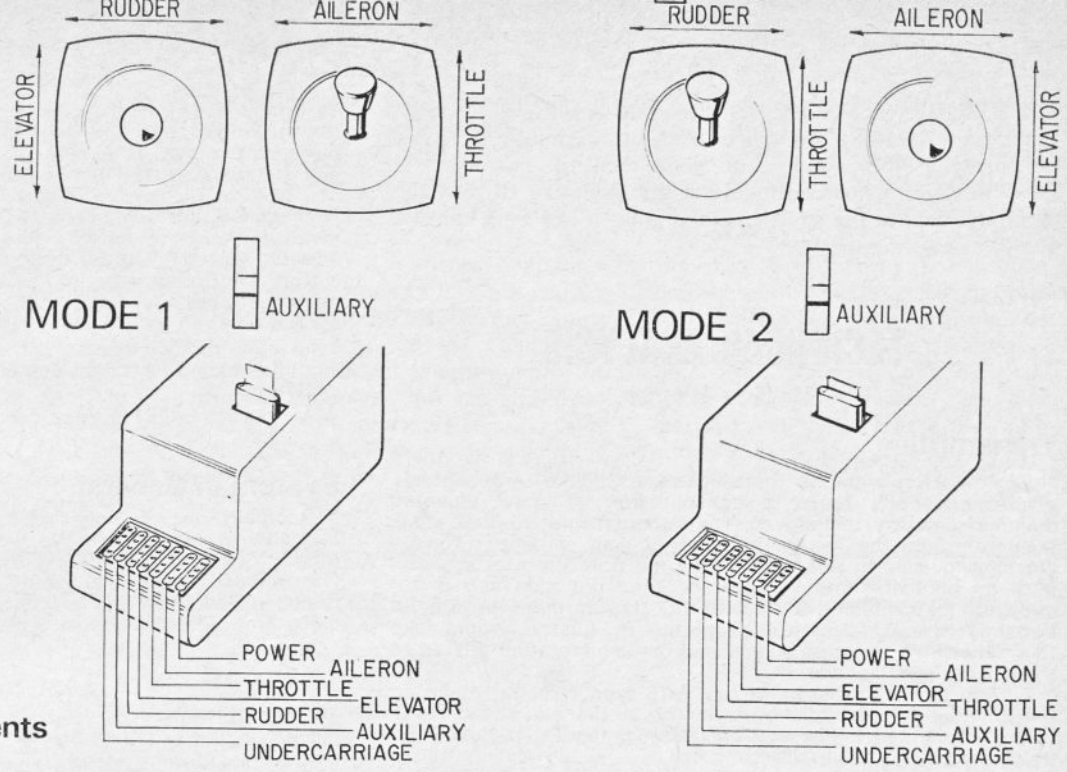


Fig. 1: Outputs from SLL receiver identified for mode 1 & mode 2 transmitter arrangements

a 'Y' lead which accommodates two servos from a single decoder output line, to couple two servos on one function for such operations as throttle control for twin engine models, and for coupled aileron/rudder or even coupled elevators and flaps.

During the past year Skyleader have also made available a retract servo amplifier on a custom-made-to-order basis, for operation with the RMK retract servo unit. We have personally used this unit over nearly two years, with excellent results. The retract amplifier is particularly good because it can be inserted into circuit like an ordinary servo without the need for any extra power pack, thereby providing retract capability for a minimum weight penalty.

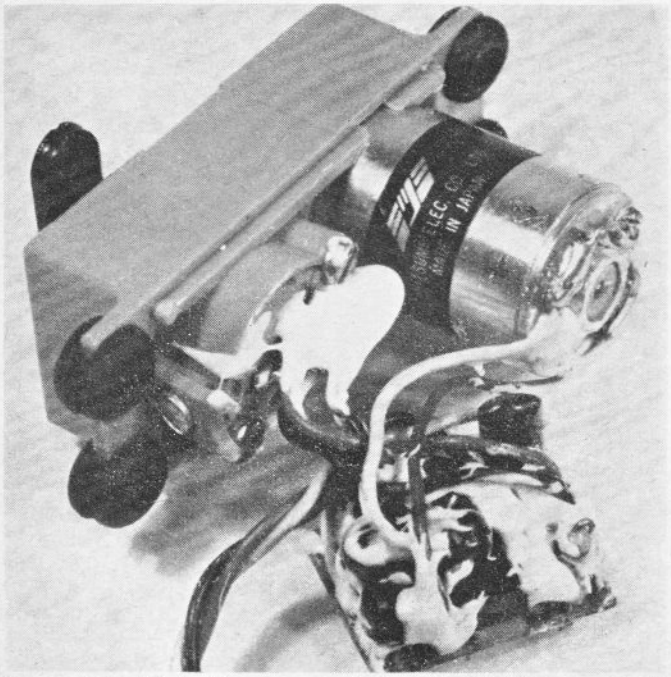
Skyleader now plan to make this amplifier, together with retract servo, generally available. It will come in two versions, for operation from either the main airborne power pack or from a separate, auxiliary pack for heavy duty work.

Flying and conclusions

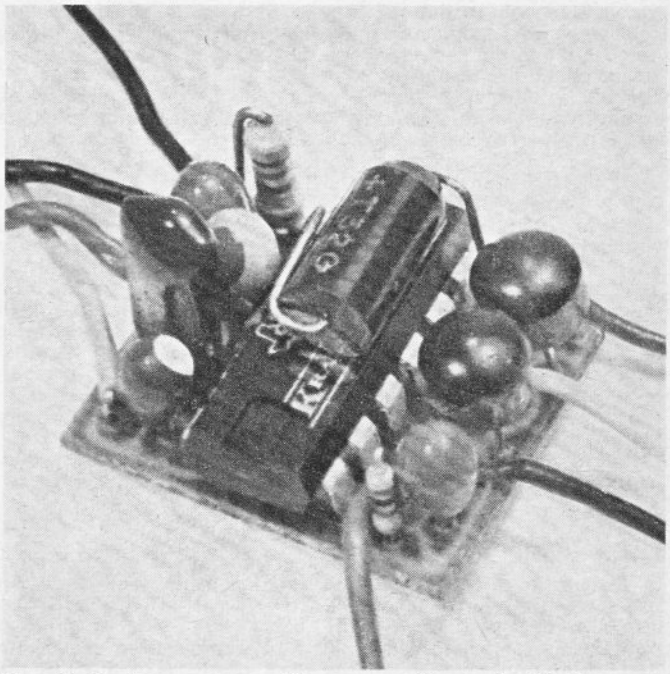
We do not always have the opportunity to test fly systems subjected to test analysis, but in the case of the SLX, the equipment was installed in the editor's Mace R-2 Shark Formula 1 pylon racer, which is a useful test, since the very high speed and high vibration levels of these little racers certainly amplify any unsatisfactory aspects of control response.

Radio installation proved particularly easy, thanks to the servo tray provided and the very compact nature of the equipment which sunk into the fuselage with bags of room to spare. The equipment is very light and the model was initially underweight.

Control and handling was certainly improved by the installation of the SLX system. Anyone who goes the round of the pylon race meetings will confirm that the editor's Shark, with H.P. 40 and K&B Speed Fuel has been no slouch during the latter part of the past racing season and the fact that the



A complete Skyleader servo unit showing Kraft servo mechanics and tiny p.c. board liberally coated with silicone rubber compound to protect components. Servo centre position is adjustable externally.



The Skyleader servo amplifier, sans silicone 'potting', reveals special Kraft I.C. chip made by Texas Instruments, plus arrangement of discrete components.

model won its racing even first time out with the SLX system must say something for the equipment. Certainly there was no denying the quick and solid control response, all of which leads us to conclude that the Skyleader SLX system certainly justifies the excellent reputation it has built up over the past few months.

TECHNICAL ANALYSIS

By Rex Boyer

Transmitter

Commencing with the transmitter we find no unusual technical innovations rather a consolidation of now accepted standard circuitry techniques. The common multivibrator clock generator fires the inevitable string of half shots to produce the logic pulses. In this section, we did note the use of preset pots on all half shots in both the time out side and in the collector load, making a total of 11. Use of these pots must certainly ease initial setting up of the Tx, but we would take this opportunity to warn against the great temptation offered to those with itchy fingers!

A total of 11 transistors of the To18 type (plastic) make up the encoder and modulation circuitry of the Tx. The modulation is applied to the crystal oscillator of the Tx, the oscillator transistor being a Silec TIS 46.

The R.F. output uses a 2N2218 transistor and follows the conventional single π (pi) circuit tuning of which is effected by a slug in the aerial loading coil.

On the SLX 6, one auxiliary function is controlled from a two-position switch in place of the usual semi-rotary control, the effect being to give an output pulse of two distinct fixed widths. The application of this switch is, of course, intended for any command function that requires just two preset positions, i.e. retract undercarriage, dummy bomb drop, etc.

Charging facilities are included in the transmitter and an additional switch on the bottom of the case permits charging of the transmitter and receiver packs or just the receiver pack, very handy when you have two or more airborne systems.

One small detail of the system we were not happy with concerned the marking of the plug-in XTALS. Identification is merely a small colour spot on one side of the XTAL with a handwritten 'T' or 'R' on it. A more permanent and positive stamped identification is certainly desirable.

Receiver

The receiver is available packaged two ways as indicated in the foregoing general description and circuitry in each appears to be identical. In the R.F. (radio frequency) end of the receiver, the now familiar double-tuned front end is apparent. We noted a diode connected across the first (aerial) coil, a feature not so common these days.

The output of the second coil feeds into the mixer stage which in turn is followed by two stages of I.F. (intermediate frequency) amplification. A separate crystal oscillator stage is used and A.G.C. appears to be applied to both I.F. stages.

Of the five transistors on the receiver board, two are Silec types, Siemens BF 254 and three, unmarked Pihers.

The outgoing signal from the R.F. board is fed via flexible connections to the logic decoder board, which contains five To18 plastic transistors of the style used in the transmitter. The circuitry associated with these transistors shapes and modifies the incoming signals in such a way as to make them presentable to the I.C. 16 lead decoder chip which, reference to our T.T.L. I/C Handbook indicates is an eight bit shift register (two outputs not used), of the series-input-to-parallel-output type. The receiver standing current of 32mA (39mA with transmitter on – no servos) leads one to the conclusion that the I.C. is of the *normal* type.

Pulses from the decoder to the servo are, as one would expect, positive going with a magnitude of some 3.5 volts.

Servo

Here we see the biggest technical innovations in the system in the use of KRAFT KPS-12 servo mechanics and the Kraft I.C. servo amplifier chip. This is a TEXAS INSTRUMENTS chip specially designed for KRAFT using a 12-lead Dual-in-line plastic packaging which contains all the transistors apart from the PNP outputs which, in the case of the SKYLEADER are ME 0404-2 plastic To18 types.

The chip works on the two wire system, i.e. employing no centre tap-in on the battery, the reverse current to the motor being achieved by a transistor equivalent of a double pole change-over switched in the form of a 'bridge circuit' – hence the technical term for the circuit – 'Bridge Amplifier'. This dictates the use of a relatively high resistance servo motor and the SKYLEADER servo uses an 11 ohm 16 mm Mitsumi. The idea of the two wire bridge output is not new, and was first seen in the commercial R/C field in the *Logictrol* system some years ago in an all discrete component form. It is beneficial in that the battery cells are discharged equally and the motor and output transistors have an easier time due to the lower currents they have to handle – particularly the starting currents.

In addition to the I.C., the SKYLEADER/KRAFT/TEXAS amplifier uses 13 external components to complete its working circuit.

Average standing current for the servo itself is 22mA.

System in General

Generally, we certainly find the SKYLEADER up to the latest in technical innovations. We would, as we are sure will many others, question the holding together of the servo mechanics with adhesive tape. We would add though, that it is not just ordinary Sellotape but special vinyl and would warn against using any old tape if replacement becomes necessary.

Test Results

Frame rate: 18 m/s, i.e. 55 frames/sec.
Pulse Lengths:

Channel	Short	Neutral	Long	Function	Comments
1	1m/s	1.4	1.8	Ailerons	
2	1	—	1.8	Engine	(Trim Movement
3	1	1.4	1.75	Elevator	.15m/s)
4	1	1.45	1.84	Rudder	(approx. 8%)
5	0.9	—	1.9	Rotary	Aux
6	0.9	—	1.88	Switch	(U/C)

Servo performance (All loads are taken at $\frac{3}{8}$ in. radius)
Servo movement is $\pm 40°$

Load in oz.	Time against load	With load
NO LOAD	0.400 sec.	0.43 sec.
5.3 oz.	0.495 sec.	0.43 sec.
10.5 oz.	0.510 sec.	0.43 sec.
16.0 oz.	0.580 sec.	0.43 sec.
21.0 oz.	0.545 sec.*	0.42 sec.
26.5 oz.	0.590 sec.*	0.41 sec.
32.0 oz.	1.030 sec.*	0.40 sec.

Just stalled at 56 oz. ($3\frac{1}{2}$ lb.)

Loaded in excess of 18 oz., the servo response was such that the travel came within 97% of the correct position, then slowed before reaching the 100% position. The times taken in the last three load results are to the 97% position.

Servo linearity over the range was good when travelling fast, while on slow movements had 3% overshoot in one direction and very slight undershoot in the other.

The stop to stop times of this servo are the fastest we have seen, and centring accuracy was extremely good.

Test figures

Receiver
Battery voltage: 4.8v normal, 5.1v measured.
STANDING CURRENTS (Tx ON):

Receiver only	: 38mA
Receiver + 1 servo	: 59mA
Receiver + 2 servos	: 82mA
Receiver + 3 servos	: 105mA
Receiver + 4 servos	: 125mA
Average running current	200-250mA
1 servo stalled	510mA dropping to 450mA

Tx Battery 9.6v Nominal, 9.9v measured.
Tx Current : 82mA No aerial
85mA Aerial extended

Physical Data

Transmitter
Case size: 7 x $5\frac{3}{4}$ x 2 in.
Weight: $2\frac{1}{2}$ lb.
Receiver (Standard)
Case size: $2\frac{1}{8}$ x $1\frac{1}{8}$ x $1\frac{1}{4}$ in.
Servo (Kraft KPS-12)
Case size: $1\frac{1}{2}$ x $1\frac{7}{8}$ (inc. lugs) x 1 11/32 x 23/32 in.
Total Airborne installation weight (500 mAH pack): $11\frac{1}{4}$ oz.