



TRANSROC

OWNER'S MANUAL



CHANNEL SELECT

1

2

3

POWER

OWNER'S MANUAL "B" CONFIGURATION

R&D-348-71

IMPORTANT RECEIVER CONSIDERATIONS

An essential accessory for use with the TRANSROC is a portable receiver capable of operation in the 27 Mhz citizens band. A communications receiver, such as those used for amateur radio or a citizens band receiver (either fixed or mobile), works well except for rocket finding or other applications where portability is required.

Walkie-talkies are mass produced in Japan at low cost. Some of them are ideal for use as receivers for the TRANSROC. If you buy two or more of them, you can also have the added enjoyment and utility of two-way communication with your friends. Be careful when buying a walkie-talkie though. While some work very well with the TRANSROC, others can be worse than useless and may even cause you to lose your rocket.

There are two types of receivers commonly used in walkie-talkies. One (the super-regenerative) has the advantage of low cost, and the other (the superheterodyne) has the advantage of far superior performance.

Superheterodyne receivers when used with the TRANSROC provide from five to more-than-ten times the operating range that can be expected from the use of super-regenerative receivers. Because of this vast difference in performance, we at ESTES INDUSTRIES sell only walkie-talkies that employ superheterodyne receivers.

If you presently own one or more super-regen walkie-talkies we recommend that you purchase your TRANSROC and a superheterodyne walkie-talkie with crystals for use

on the same citizens band channel as your super-regen walkie-talkie/s.

Your super-regen walkie-talkie/s will probably be able to receive the TRANSROC during part of its rocket flight and can serve in conjunction with the superheterodyne walkie-talkie to provide communication between two or more points for launch/recording coordination, etc.

The following information will help you to determine what type receiver is employed in your present walkie-talkie or one that you may be considering purchasing:

- (1) Superheterodyne walkie-talkies cost considerably more (usually at least twice as much as super-regens).
- (2) Superheterodynes have two crystals per operating channel while super-regens have only one (since super-regen receivers are not crystal controlled).
- (3) Superheterodynes usually have six or more transistors while super-regens usually have five or less.
- (4) The sensitivity and selectivity of a superheterodyne are far superior to the sensitivity and selectivity of a super-regen.
- (5) A super-regen usually emits a louder hiss when not receiving a signal than does a superheterodyne.

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SECTION A. General.

This manual is supplied with the TRANSROC Model Rocket Transmitter for use as an aid in the assembly, installation, operation, and troubleshooting of the unit. It should be kept in a safe place for future reference even after construction of the unit has been completed.

The TRANSROC is a miniature, multi-purpose transmitter sold in kit and preassembled form by ESTES INDUSTRIES for use with model rockets.

Note that some changes were made in the design of the TRANSROC after the first 1,000 units had been manufactured. The changes which generated the "B" configuration made an improvement in ease of construction and made the PC board less subject to being damaged by excessive soldering heat. These changes also made it unnecessary for a resistor to be selected by the owner when installing his first TM kit. Although these circuit changes were minor, considerable change to the PC board layout was required in order to accommodate them.

The "A" and "B" configurations are identical in operating characteristics and specifications. This updated Owner's Manual accompanies the modified TRANSROC Model TX-1B.

A.1 Specifications:

Weight including battery:	1.3 ounces
Length including battery:	4.2 inches
Length of trailing wire antenna:	30 inches

CHAPTER I.

Description Of The Transroc:

Diameter - TRANSROC/battery assembly: .937 inches

Temp. and Spin-rate TM modes: 10 hours

The TRANSROC/battery assembly fits into a BT-50 (paper) or PST-50FJ (clear plastic) body tube.

Microphone mode: 1 hour

Transmit frequency: Any one of 23 channels in the 27 Mhz citizens band which you specify.

A.2 Licensing:

The TRANSROC may be operated legally without obtaining an FCC license since it complies with part 15 of the FCC regulations as follows:

- a. The power input to the final RF amplifier does not exceed 100 milliwatts.
- b. The antenna does not exceed five feet in length.
- c. The transmitter frequency is confined within the limits of the 27 Mhz citizens band (26.97-27.27 Mhz), and any radiation outside these limits is at least 20 decibels below the power level of the RF carrier.

Fortunately, these requirements imposed by the FCC for unlicensed operation of a transmitter do not cause much of a problem to the field of model rocketry. The range of the TRANSROC (up to five miles or more) is adequate for model rocketry applications.

A.3 Reversed Battery Connections:

The TRANSROC design includes protection against reversed voltage. If you accidentally insert the battery backward (polarity reversed), your TRANSROC will not transmit, but neither the transmitter nor the battery will

Circuitry - all silicon: 5 transistors, including one uni-junction plus 5 diodes

Transmitter power input: 100 milliwatts

Transmitter frequency tolerance: $\pm .005\%$

Battery: Miniature 15 volt (Eveready Type 504, Ray-O-Vac #220, Burgess Type Y10, etc.) -- not included
Operating voltage range:

Rocket-finder mode: 6 to 15 volts

Temp. and Spin-rate TM modes: 9 to 15 volts

Microphone mode: 12 to 15 volts

Current drain (average):

Rocket-finder mode: 3 milliamps

Temp. and Spin-rate TM modes: 3 to 4 milliamps

Microphone mode: 11 milliamps

Approximate total useful battery life, intermittent usage:

Rocket-finder mode: 24 hours

be damaged.

A.4 Operating Frequencies:

It is essential that your TRANSROC and your receiver be capable of operating on the same frequency. ESTES catalogs which list TRANSROCS and walkie-talkies give detailed information about crystals and frequency compatibility.

SECTION B. Modes Of Operation:

The TRANSROC has three basic modes of operation one of which, TM (telemetry), can be further broken down and expanded into several subdivisions. This versatility offers the ESTES rocketeer many hours of educational enjoyment and a wide field of new horizons in model rocketry.

B.1 Rocket-Finder Mode:

The most basic mode of operation for the TRANSROC is as a rocket finder. The basic kit is supplied complete with all components needed for operation in this mode. The only accessory needed for rocket finding is a good receiver.

(See receiver recommendations inside front cover.)

In the rocket-finder mode, the transmitter is pulsed on approximately once per second for approximately one-fifth second and is off during the remainder of the cycle. This provides a beacon signal similar to the ones used in space capsules and survival equipment for locating astronauts and fliers after they lower by parachute into the ocean. This "cw" (continuous wave) type signal provides excellent penetration in the presence of severe

interference. The rocket-finder signal from the TRANSROC mixes with any other signals which are being received to produce an easily distinguishable audio beat note in the receiver's speaker.

Depending upon the level of interference present and the sensitivity of the receiver used, it is possible to receive the TRANSROC in the rocket-finder mode at distances to five miles or more during flight and up to a few hundred yards after the rocket has landed. Field tests have shown battery life up to 24 hours or more.

B.2 Telemetry:

The telemetry modes are similar to the rocket-finding mode in that the transmitter is turned on and off in sequence to convey information. The cycle is much shorter for TM, however. The time during which the transmitter is off during each cycle is controlled by the appropriate transducer such as a photocell, thermistor, etc.

Current consumption is only about one-third greater in the telemetry modes than for rocket finding, but useful battery life is shortened more than this. The shorter usable battery life is mostly due to the fact that a much stronger signal is needed for receiving good TM than is needed for rocket finding.

B.3 Microphone Transmitter:

The microphone transmitter mode is significantly different than the rocket-finder or telemetry modes in that, instead of the transmitter output being turned on and off intermittently, its amplitude (strength) is varied in pro-

portion to the sound striking the microphone. It thus transmits in the same manner as a standard AM (amplitude modulated) radio station or a walkie-talkie. This signal can be tape recorded as it comes from the receiver. The tape recording thus obtained will include your voice during countdown, engine burning noises, and a variety of sounds caused by the wind rushing by, the ejection charge, and the rubbing between the rocket body and the parachute shroud lines, etc., after ejection.

Battery life is shortest in the microphone mode due to higher current drain and a higher minimum usable battery voltage. A new battery is adequate for six to ten flights if recovered and turned off after a few minutes each time. The battery can then be used for several TM flights followed by several rocket-finder flights.

SECTION C. Accessories:

The following is a brief description of the accessories which were made available at or about the time that the TRANSROC was first introduced. It is planned that additional telemetering accessories will be made available at future dates.

C.1 Microphone Accessory Kit:

The microphone accessory kit consists of a miniature microphone, two resistors, two capacitors, one transistor, and an instruction manual. When this kit is added to the TRANSROC, all the parts except the microphone install on the printed circuit board in spaces provided for them but not used in the rocket-finder configuration. The microphone is then located at one end of the TRANSROC and attached to it electrically. When you wish to return your

TRANSROC to one of the other modes, it is not necessary to remove the transistor, etc., from the circuit board.

With the microphone accessory kit added, you can listen to and/or tape record sounds from your model rocket flights. Some of the things which you can do with the TRANSROC/microphone combination are:

- a. Record in sequence the sounds and exact timing of countdown, engine thrusting, coasting, parachute ejection, rubbing between rocket parts during recovery, and landing.
- b. Make a sound movie from your model rocket by flying a TRANSROC and a CINEROC in the same rocket. This will require some high-powered ingenuity to provide adequate acoustic insulation of the microphone from the sounds generated by the CINEROC. It could prove to be a severe challenge.

C2. Spin-rate Telemetering Accessory Kit:

The spin-rate telemetering accessory kit consists of a specially masked photocell, a capacitor, a short length of insulated tubing, and an instruction manual. These components install on the TRANSROC printed circuit board. A transparent payload section (required for this mode and optional for others) allows sunlight to strike the masked photocell. As the rocket spins during flight, more and less sunlight alternately strike the photocell. This causes the TRANSROC to transmit a tone that increases in frequency with increasing light intensity and decreases with decreasing light intensity. The data is normally recorded on a tape recorder during flight and played back later for

analysis of rocket spin characteristics. Full data analysis is possible if you first transfer the data to an analog recording.

C.3 Temperature TM Accessory Kits:

Each of the temperature telemetering accessory kits consists of a fast-response thermistor with special thermal isolated mounting, two capacitors, a JT-50C stage coupler, a 1 inch body tube, (BT-50AE) and an instruction manual. The capacitors attach to the TRANSROC printed circuit board, and the thermistor mounts in a special outrigger assembly (to provide proper thermal contact with the airstream).

Both temperature TM kits are identical except for the resistance of their respective thermistors. These kits are for the 60 to 100 degree Fahrenheit and the 20 to 70 degree Fahrenheit temperature ranges.

As the TRANSROC with temperature TM kit is flown, a series of pips which change in spacing as a function of temperature are transmitted from the TRANSROC, received on a walkie-talkie, and recorded on a tape recorder. For information on calibration and data reduction, see Chapter V.

CHAPTER II.

Assembly Instructions:

The TRANSROC is a complicated device, and the soldering which must be accomplished during its construction is very intricate. Since there are a variety of ways in which one can goof in the construction of the TRANSROC we suggest that you read the construction portion of the "Electronic Kit-Builders Handbook" very carefully at least twice. If you have trouble mastering the techniques, read it a third or fourth time. When you are familiar with the construction techniques, you are ready to proceed.

Note that the basic TRANSROC kit includes only enough parts to operate the transmitter in the "rocket-finder" mode. When you have completed construction of your basic kit, there will be several unused holes and spaces on the circuit board. These are reserved for installing additional parts which are used in the microphone and telemetering modes. Eyelets are provided in the board at points where parts must be removed and/or installed when changing modes of operation.

SECTION A. Parts Inventory And Inspection:

Check carefully to verify that no parts are missing or broken. This will also help you to become familiar with the parts used in your TRANSROC.

PARTS LIST

Basic Transmitter (Rocket - Finder Mode)

Quantity	Stock#	Description of Component	Price Each
() 1	TXR-8	A 1/4 watt resistor (R6), green marking This resistor is a selected value chosen for compatibility with Q4 and D2. It can be replaced without replacing Q4 or D2, however, Specify the resistance value or color code from your old resistor when ordering a replacement.	.20 each
() 1	TXS-2A	2N5138 PNP silicon transistor (Q4), green top (**)	.65 each
() 1	TXS-4A	DZ805 silicon diode (D2), G.E. or equiv., green lead (**) (**) The three components identified with a green marking are a matched set. If Q4 (TXS-2A) or D2 (TXS-4A) need replacement, the entire set of three components consisting of R6, Q4, and D2 should be replaced. If you replace Q4 or D2 without replacing the rest of the set, you run the risk that your TRANSROC may not work properly.	.30 each
	TXQ-1	A set of matched components consisting of one TXS-2A, one TXS-4A, and one TXR-8.	1.00 set
() 1	TXPC-2	Printed circuit board with two prewound coils.	4.00 each
() 1	TXTS-1	Powdered iron slug for oscillator coil, 3/16" dia. x 5/16" L.	.35 each

() 1	TXTS-2	Powered iron slug for antenna-matching coil, ¼" dia. X ½" L.	.35 each
() 1	TXX	Crystal, (Specify the proper CB channel)	2.95 each
		Crystals for channels 11 and 14 normally supplied from stock. Crystals for other CB channels supplied from stock when available; otherwise, they are supplied via a prepaid certificate which you mail to the crystal manufacturer for redemption.	
() 1	TXS-1	2N6027 programmable unijunction transistor, G.E. or equivalent, red top.	1.00 each
() 2	TXS-3	2N5172 NPN silicon transistor, G.E. or equiv.	.60 each
() 1	TXS-3A	2N5172 NPN silicon transistor, G.E. or equiv., blue top	.60 each
() 4	TXS-4	DZ805 miniature silicon diodes, G.E. or equiv.	.30 each
() 1	TXC-1	3.3 microfarad tantalum capacitor, marked 3.3 M	1.00 each
() 2	TXC-2	0.01 microfarad ceramic capacitor	.25 each
() 4	TXC-3	500 picofarad ceramic capacitor, marked 500K	.25 each
() 1	TXC-14	33 picofarad ceramic capacitor, marked 33J	.25 each
() 3	TXR-1	270K ohm \pm 10% 1/4 watt resistor (red, violet, yellow, silver)	.20 each
() 1	TXR-2	100K ohm \pm 10%, 1/4 watt resistor (brown, black, yellow, silver)	.20 each
() 1	TXR-3	33K ohm \pm 10%, 1/4 watt resistor (orange, orange, orange, silver)	.20 each
() 2	TXR-5	10K ohm \pm 5%, 1/4 watt resistor (brown, black, orange, silver)	.30 each
() 1	TXR-13	56 ohm \pm 5%, 1/4 watt resistor (green, blue, black gold)	.30 each

() 1	TXR-7	180 ohm \pm 10%, 1/2 watt resistor (brown, gray, brown, silver)	.20 each
() 1	TXW-1	1 3/8 inch length, red wire	.10 each
() 1	TXW-2	2 1/4 inch length, black wire	.10 each
() 1	TXW-3	30 inch length, white wire	.20 each
() 1	TXM-1	Top transmitter mount, plastic (one slot and one odd-shaped hole)	.50 each
() 1	TXM-2	Bottom transmitter mount, plastic (one slot and two holes)	.50 each
() 1	TXM-3	Thumb transmitter mount, plastic (one rectangular hole)	.50 each
() 1	TXM-4	Battery cup, plastic (one long slot)	.50 each
() 1	TXM-5	Tuning tool, plastic	.50 each
() 2	TXH-1	Battery contacts, brass	.25 each
() 1	RS-1	Coil of solder	.25 each

*The prices listed are current as of this printing (June, 1971) and are subject to change without notice.

SECTION B.

Attaching Components To The Circuit Board:

Read carefully the soldering instructions in the separate "Electronic Kit Builder's Handbook" included with the TRANSROC kit.

Refer to Figures 1 and 2 as you complete the following steps. Note that each identifier line in Figure 1 ends at a dot which is located on the body of the respective component. Place a check mark in the () provided as you complete each step. In each case, when the instruction calls for the installation of a component, several additional instructions are implied:

- (a) The component must be installed in the position shown in Figures 1 and 2 on the side of the board opposite the copper foil lands.
- (b) If a two-lead component such as a resistor or diode is to be installed in an upright position, the upper lead must be bent nearly 180 degrees to allow insertion of both leads into the printed circuit (PC) board. The bend should be near the top of the component. (See D1 in the upper left corner of Figure 2.)
- (c) The component must be oriented as shown in Figure 1. In cases where the illustration is insufficient to identify polarity, etc., the instruction will include the additional information. Be careful to insert transistors with the flat surface oriented as shown in Figures 1 and 2.

(d) Solder all leads of the component to the appropriate lands on the bottom of the board. Withdraw the soldering tip by "running" it up the lead. This important final step in the soldering process will remove excess solder from the joint.

(e) Clip off the excess lead length using a pair of small, side-cutting pliers.

LAST WARNING: Do not use acid core solder. It will ruin your kit.

ASSEMBLING THE BATTERY CUP:

Upon completion of the parts inventory, you are ready to assemble the battery cup. This should be completed before the parts are soldered to the PC board so that the plastic cement used in the assembly of the battery cup can be allowed to set and harden. Refer to Figure 4 as you perform the following steps. Check off each step as it is completed.

1. () Strip 1/8 inch of the insulation from one end of the red and the black wires.
2. () Tin the exposed copper strands by heating and applying solder.
3. () Tin both the brass battery contacts in the area where the wires will be attached. See Figure 4. Use a liberal amount of solder (an extra drop or two).
4. () Clamp one of the brass battery contacts in a

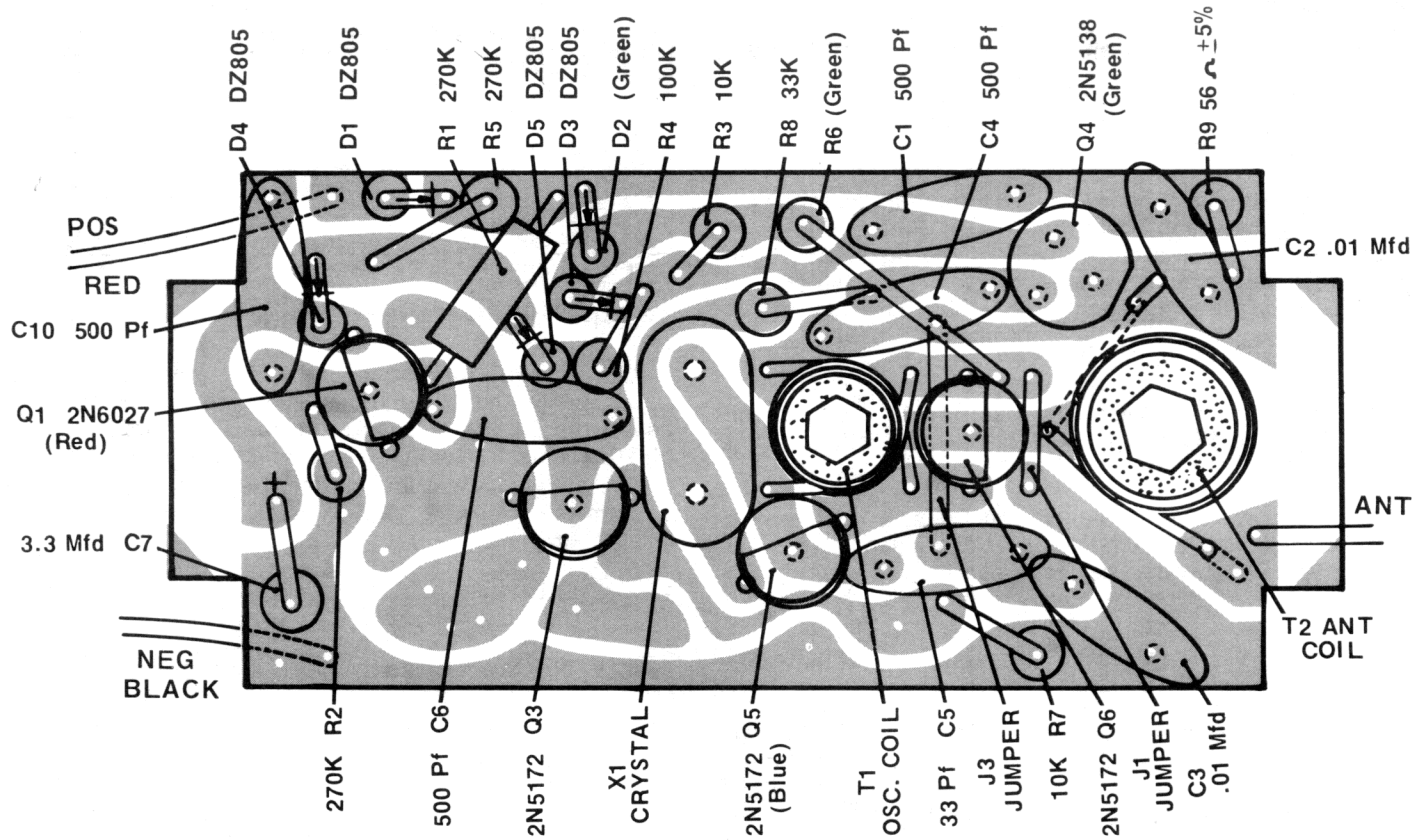


FIG. 1 PC BOARD (ROCKET-FINDER MODE), COMPONENT SIDE

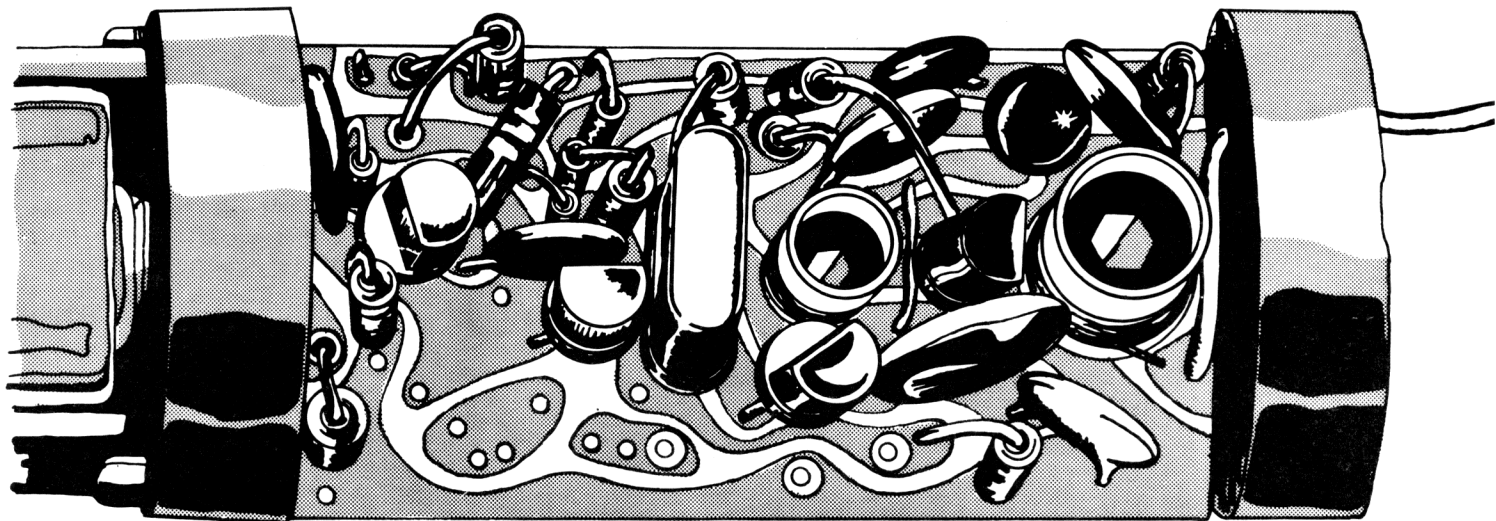


FIG. 2 TOP VIEW, TRANSROC (RKT-F MODE)

vise or wedge it into a crack to hold it while you solder one of the wires to it.

5. () Holding the black wire in one hand and the soldering iron in the other, join the wire to the brass contact by simultaneously heating the pre-tinning solder on both, causing it to flow together. Note from Figure 4 the direction in which the black wire leads away from the brass contact.
6. () Clamp the other brass battery contact in a vise or wedge it into a crack as was done in Step 4.
7. () Hold the red wire in one hand and the soldering iron in the other. Complete the soldering of the wire to the brass contact by simultaneously heating the previously applied solder on both, causing it to flow together. Note from Figure 4 that the red wire leads away from its brass contact in a different direction than does the black wire.
8. () Place the contact with the black wire in the thumb mount, apply a sparing amount of plastic cement (Cat. #711-PC-1 or equivalent) to the battery holder end marked negative (-), and insert the tap into the brass contact and thumb mount. Hold until the cement has taken a set.
9. () Place the contact with the red wire into the top mount, apply plastic cement to the positive (+) end of the battery holder, and insert the battery holder tab into the brass contact and top mount. Hold these together until the cement has taken a set. Lay the assembly aside to dry for at least an hour.

ATTACHING COMPONENTS TO THE PC BOARD:

1. () Install the crystal (X1). This device looks like an oval shaped tin can.
2. () Install D5 (a DZ805 diode). Orient as shown in Figures 1 and 2 with the banded (cathode) end toward the PC board.
3. () Install R4 (a 100K resistor - brown, black, yellow silver). Leave the top lead unsoldered until D3 has been inserted.
4. () Install D3 (a DZ805 diode). Orient as shown in Figures 1 and 2 with the banded (cathode) end away from the PC board. Be sure to solder both brass eyelets securely to the copper lands. Solder the top lead of R4 and the top lead of D3 simultaneously.
5. () Install D2 (a DZ805 diode with green marking on the (anode) lead). Orient as shown in Figures 1 and 2 with the banded (cathode) end toward the PC board. Leave the top lead unsoldered until R1 has been inserted.
6. () Install R1 (a 270K resistor - red, violet, yellow, silver). Note that this resistor mounts flat on the PC board. Solder the top lead of D2 and one lead of R1 simultaneously.
7. () Install R5 (a 270K resistor - red, violet, yellow, silver). Be sure to solder both brass eyelets securely to the copper lands.

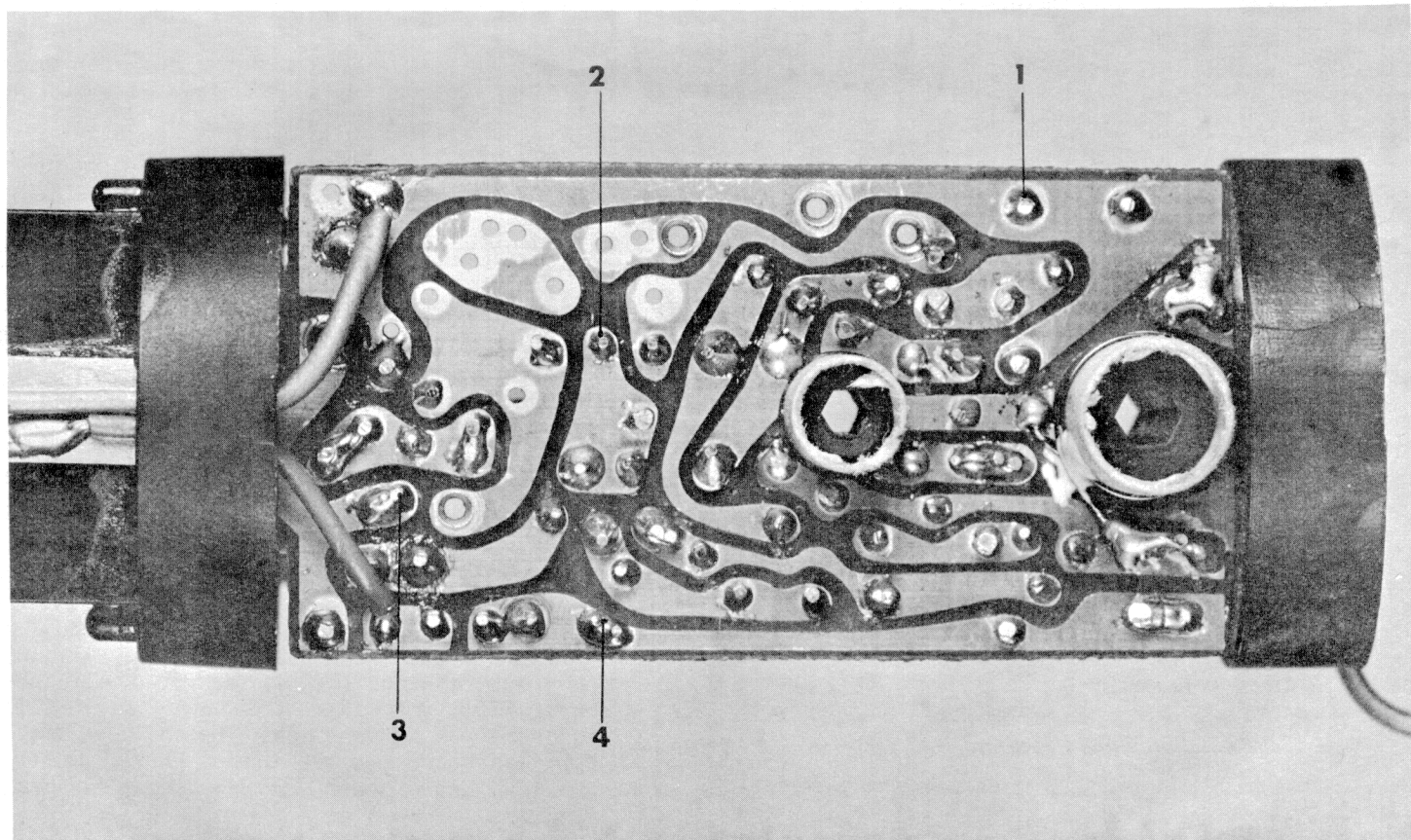


FIG. 3 BOTTOM VIEW, TRANSROC (RKT-F MODE)

8. () Install D1 (a DZ805 diode). Orient as shown in Figures 1 and 2 with the banded (cathode) end away from the PC board.
9. () Install D4 (a DZ805 diode). Orient as shown in Figures 1 and 2 with the banded (cathode) end toward the PC board.
10. () Install C10 (a 500 picofarad ceramic capacitor - marked 500K).
11. () Install C6 (a 500 picofarad ceramic capacitor - marked 500K).
12. () Install Q1 (a 2N6027 programmable unijunction transistor identified by a red top).
13. () Install Q3 (a 2N5172 transistor).
14. () Install R2 (a 270K resistor - red, violet, yellow, silver).
15. () Install C7 (a 3.3 mfd tantalum capacitor). This device, which resembles a miniature tin can, has a lead on each end and is marked 3.3 M. Orient as shown in Figures 1 and 2 with the positive end (marked with red or a + sign) away from the PC board. Be sure to solder both brass eyelets securely to the copper lands.
16. () Install Q5 (the 2N5172 transistor with blue top).
17. () Install R9, a 56 ohm resistor (green, blue, black, gold).
18. () Install C2 (a 0.01 mfd ceramic capacitor).
19. () Install Q4 (a 2N5138 transistor with green top). Be sure to orient the flat surface as shown in Figure 1.
20. () Install C1 (a 500 picofarad ceramic capacitor - marked 500K).
21. () Install R8 (a 33K resistor - orange, orange, orange, silver).
22. () Install R3 (a 10K resistor - brown, black, orange, gold).
23. () Install C4 (a 500 picofarad ceramic capacitor - marked 500K).
24. () Install J3 (a jumper made from the thin wire clipped off one of the DZ805 diodes). Bend the wire 90 degrees in two places spaced 3/8 inch apart. This will allow the jumper to lie flat against the PC board.
25. () Install J1 (a jumper made from the thin wire clipped off one of the DZ805 diodes). Bend the wire 90 degrees in two places spaced 3/16 inch apart. This will allow the jumper to lie flat against the PC board. Leave the end next to the top lead of R6 and the emitter lead of Q6 unsoldered until these components have been installed.

26. () Install R6 (a resistor identified with a green mark). The resistance value of R6 is selected to be compatible with Q4 and D2. The top lead of R6 arches over C4. Leave the top lead of R6 unsoldered until Q6 has been installed.
27. () Install Q6 (a 2N5172 transistor). Solder the remaining lead of J1, the top lead of R6, and the emitter lead of Q6 simultaneously.
28. () Install C5 (a 33 picofarad ceramic capacitor - marked 33J).
29. () Install C3 (a .01 mfd ceramic capacitor).
30. () Install R7 (a 10K resistor - brown, black, orange, gold).
31. () Install the two powdered iron slugs into their respective coils using the plastic tuning tool provided. The initial setting for bench testing the TRANSROC is with slugs "buried" in the windings of the two coils. This means that you insert the slugs until they are recessed approximately the same amount at each end of the coil form.
- Scrape the tuning tool lightly if necessary to make it fit the slugs. Be careful not to round off the corners on the tuning tool. "Burying" the slugs in the coils is an important preliminary to later tuning procedures.
32. () Connect the 30-inch piece of antenna wire to the point marked "ANT" in Figure 1. First, strip the

insulation from approximately 1/8 inch of the wire; then, insert the wire from the top of the board and solder to the land on the bottom of the board.

33. () Clean the bottom of the PC board thoroughly, using a solvent and small, moderately stiff brush. The solvent can be isopropyl alcohol, denatured alcohol, rubbing alcohol, etc. These solvents are inflammable, so be careful. The brush can be a small water-color or paint brush which has had the bristles cut off short. Be sure to brush parallel with the lands with the objective or removing thoroughly any flux or contamination from between them.
34. () Inspect the top of the PC board thoroughly, comparing it with Figure 2. All the transistors and components should be located and oriented as shown in the illustration.
35. () Inspect the bottom of the PC board (preferably with a magnifying glass), comparing it with Figure 3. Pay particular attention to the solder joints to see that the solder has flowed smoothly onto both the land and the wire lead. Inspect carefully to see that all of the eyelets which are in use are securely and smoothly soldered to their appropriate lands. Eyelets which are not soldered to the land will not make a reliable electrical connection. Over 90 per cent of TRANSROC problems could be eliminated if Steps 35 and 36 were carried out properly.
36. () Inspect to see that all of the spaces between adjacent lands are clear of solder or foreign

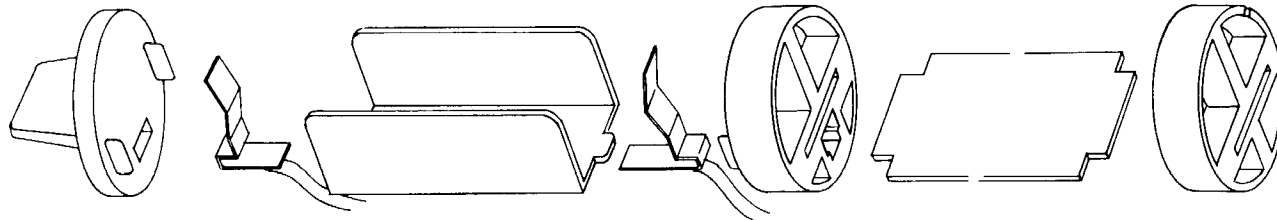
THUMB MOUNT

BATTERY HOLDER

TOP MOUNT

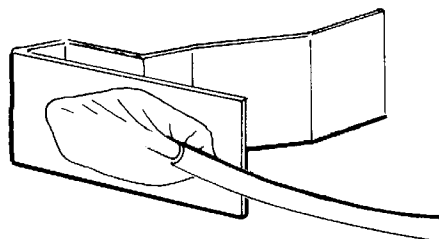
CIRCUIT BOARD

BOTTOM MOUNT

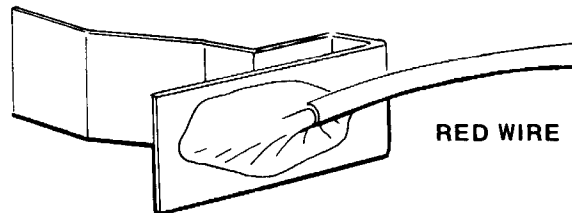


CONTACT WITH BLACK WIRE

CONTACT WITH RED WIRE



BLACK WIRE



RED WIRE

FIG. 4 ASSEMBLY OF TRANSROC BATTERY HOLDER

material. A solder bridge or foreign material between adjacent lands may form a short. Such a short may be practically invisible to the naked eye.

37. () If you have done any more soldering or resoldering in the above steps, again clean the bottom of the PC board with a solvent.
38. () Attach the bottom mount to the PC board. The PC board and the plastic slot were designed to provide a very tight friction fit, so it may take some force to push them together. If the fit is too tight, scrape the end of the PC board. If for any reason these parts are somewhat loose, remove the board and squeeze a very small amount of plastic cement into the slot and replace the board. Leave this combination to set up for several hours. Note that the larger hole in the bottom mount should be directly over the antenna hole in the PC board.
39. () Press the battery holder assembly onto the opposite end of the PC board so that the small opening is on the circuit side. If this fit is too tight, scrape this end of the PC board. If this fit is loose, repeat the cementing process as explained before.
40. () Pass the red and black leads through the rectangular opening provided in the top mount as shown in Figure 3.
41. () Strip the insulation from the ends of the red and black wires to a length about 1/16 inch short of the holes marked "RED-POS" and "BLACK-NEG", respectively, in Figure 1.
42. () Insert the stripped portion of the black wire into its respective hole from the bottom of the PC board. Note that this wire passes through the PC board in a direction opposite that of the component leads. Leave about 1/16 inch of stripped wire on the bottom of the PC board for soldering.
43. () Solder this wire to its copper land, and trim the excess length of wire from the top of the board.
44. () Pass the antenna wire between the large coil and the bottom mount and out through the small hole in the bottom mount. This completes the assembly of the PC board.
45. () Temporarily solder the stripped end of the red wire to one end of the 180 ohm, 1/2 watt resistor (brown, gray, brown, silver).
46. () Temporarily solder the opposite end of the 180 ohm resistor to the point where the red wire normally connects to the PC board. This resistor will limit the current to a safe level in the event that you might have a short in your TRANSROC at initial turn-on. This current-limiting will usually prevent damage to your battery and transistors.
47. () Collapse the whip antenna on your walkie-talkie and turn it to maximum volume or until it produces a barely audible hiss. Place the walkie-talkie about two or three feet from the TRANSROC, and turn on the TRANSROC by inserting the battery. You should now receive the TRANSROC on your

walkie-talkie. It should pulse "on" approximately 1/6 second and be in an "off" state during the remainder of the modulation cycle. Nominal modulation cycle is 150 milliseconds on and 600 milliseconds off.

If your TRANSROC fails to transmit at this point in the procedure, remove the battery to prevent damage (in case your TRANSROC might be shorted) and refer to Section IV for troubleshooting.

In addition to the RF power "on" level, you should detect a weak signal (hiss) from your TRANSROC during the "off" periods.

48. () When your TRANSROC is transmitting and has the proper modulation cycle as described in the previous step, you are ready to remove the 180 ohm current-limiting resistor. Solder the red wire permanently to the appropriate land on the PC board.
49. () Again, collapse the whip antenna on your walkie-talkie, turn it to maximum volume or until it produces a soft, but audible, hiss, and place it about two or three feet from the TRANSROC. Insert the battery into the TRANSROC battery cup. It should again transmit with the modulation cycle described above and is ready to be tuned.
50. () The oscillator can be tuned with the TRANSROC lying on your workbench. It is permissible to touch the TRANSROC during oscillator tuning but not

during antenna coil tuning (a later procedure). Insert the plastic tuning tool into the bottom end (circuit foil side) of the small oscillator coil (T1). Rotate the slug CCW (counter-clockwise) to the "critical" position which can be determined as follows:

As you rotate the slug CCW, a position will be reached where the modulation duty cycle will begin to diminish to less than its normal 1/6 second "on" period and then break up into clicks. Turning the slug slightly further CCW will cause the TRANSROC to stop transmitting completely. The "critical" point is the most CCW slug position which produces a full (undiminished) modulation cycle. The "idle hiss" produced by your TRANSROC during the "off" periods will have maximum amplitude at the "critical" slug position.

When you have located the "critical" point, complete the oscillator tuning procedure by turning the slug one and one-half turns CW. The oscillator should require no further adjustment at any time unless the slug position has been disturbed. The "idle hiss" will have slightly less amplitude at this final slug setting than at the "critical" point. The oscillator will have plenty of reserve power, however, to drive the RF output amplifier to the 100 milliwatt limit under all conditions, and it will have maximum stability.

When properly tuned, the bottom of the slug in T1 will be approximately 1/8 to 3/16 inch inside the bottom (circuit foil side) of the coil form.

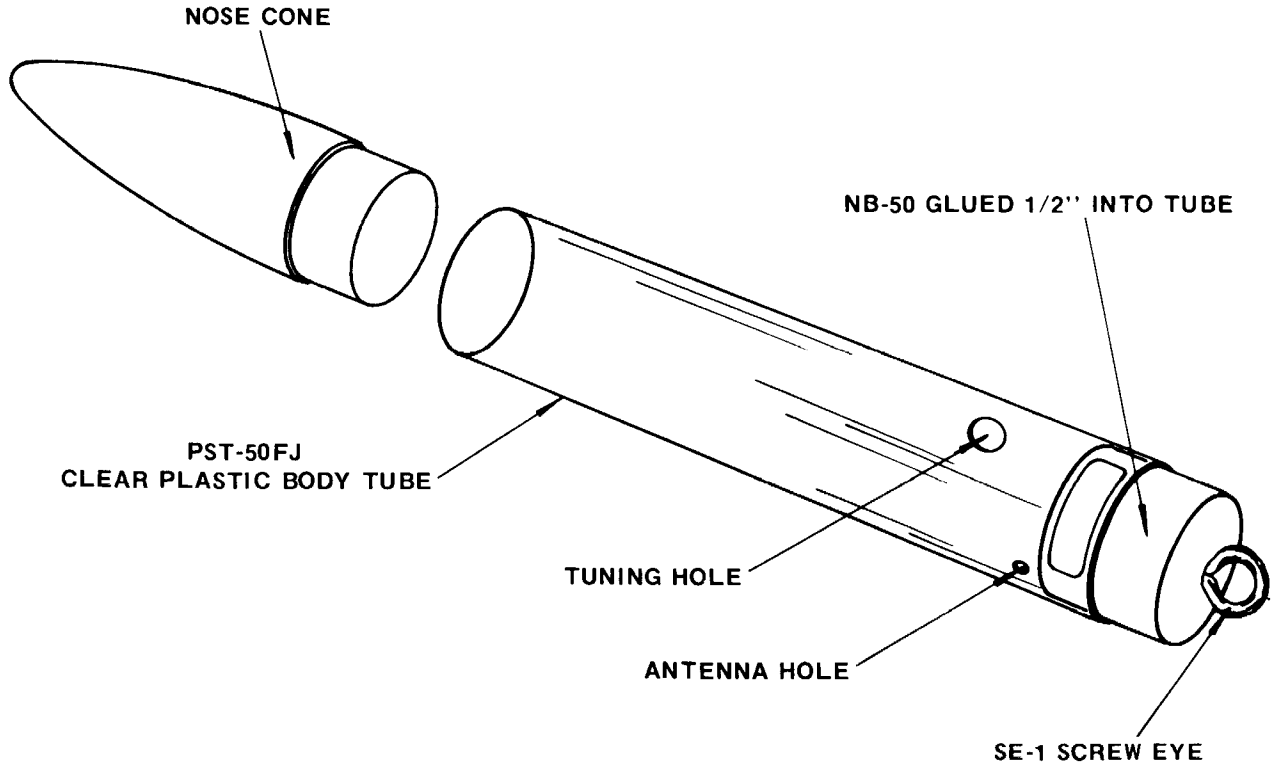


FIG. 5 PAYLOAD SECTION

51. () You are now ready to pretune the antenna-matching coil (T2). The final tuning of the antenna system must be performed after the TRANSROC has been installed in the rocket, since the proximity of the rocket will slightly affect the antenna tuning. This pretuning operation will serve to verify that your TRANSROC is capable of being tuned properly and will help you to become adept at tuning it.

Suspend the TRANSROC by the tip of its antenna using a piece of string, at least a foot long, as an insulating support. Be careful not to let any portion of the TRANSROC or its antenna hang near (within a few inches of) a conductor such as your body or a piece of metal. Do not turn on the TRANSROC yet.

Collapse the antenna on your walkie-talkie, and turn the volume control completely up or until it produces a soft, but audible, hiss. Wrap the antenna stub with paper or cloth (for insulation), and then wrap the entire walkie-talkie in a generous piece of aluminum foil (to shield most of the TRANSROC signal from it). At this point, you should barely be able to hear the hiss from your walkie-talkie with the TRANSROC turned off. If this condition is not being met, adjust the setting of the volume control accordingly. Place the foil-wrapped walkie-talkie approximately three feet from the suspended TRANSROC.

Now, turn on the TRANSROC. If your walkie-talkie is wrapped adequately, it will not be able to receive the TRANSROC. Add more aluminum

foil wrapping if necessary. Now unwrap your walkie-talkie slightly until it barely begins to receive the TRANSROC.

Slip a piece of body tube (BT-50, PST-50FJ, etc.) over the battery compartment of your TRANSROC, keeping your hand a minimum of several inches from it, by using the section of body tube as a handle. With your other hand, insert the plastic tuning tool into the bottom end (copper foil side) of the slug of T2 (the large antenna-matching coil). Be careful also to keep your "tuning" hand as far as possible from the TRANSROC, since the presence of a conductor near the TRANSROC during this tuning operation will affect the tuning. (See Figure 7.)

Adjust the slug in T2 to the most CCW position that produces a maximum level of hiss in your walkie-talkie. If the hiss level increases significantly as you tune, you will need to increase the aluminum foil wrapping on your walkie-talkie slightly so that it will be receiving a weak (unsaturated) signal. Rock the adjustment about the point of maximum indication until you develop a good "feel" for the proper slug position. This is similar to rocking the dial of a radio to both sides of a station to gain a "feel" for the proper setting. You will need to rock the slug in T2 somewhat more slowly than you would the dial of a radio, since the rate of information transmitted from the TRANSROC is only one bit per second.

Note that these procedures are written on the assumption that a walkie-talkie with superheter-

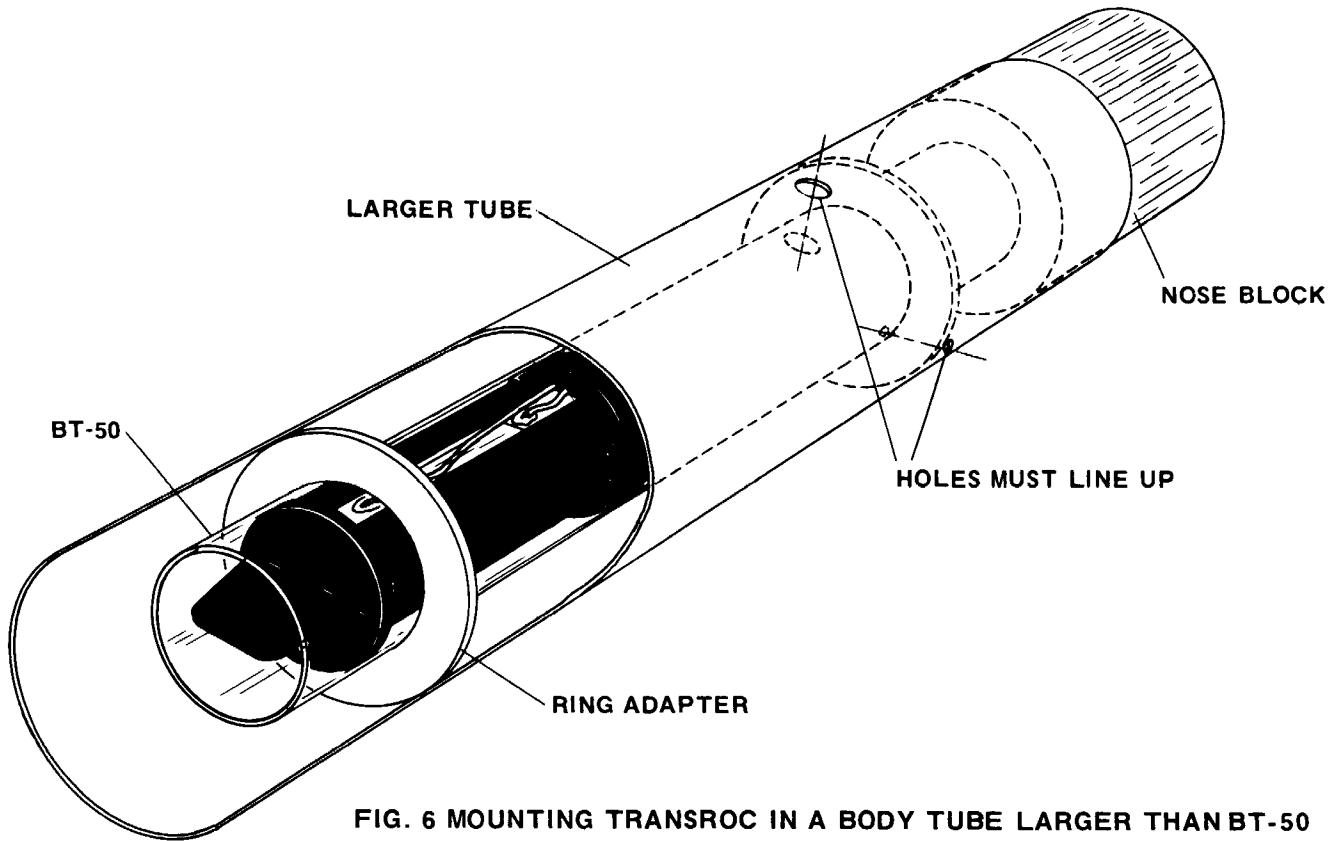


FIG. 6 MOUNTING TRANSROC IN A BODY TUBE LARGER THAN BT-50

odyne receiver will be used. (See inside front cover for a discussion of the characteristics of the two types of receivers commonly used in walkie-talkies.) If you attempt to tune the TRANSROC using a super-regenerative receiver, you will find that an indication of maximum signal strength will be minimum volume (maximum quieting) and will be difficult to detect.

The normal position for the slug of T2 when properly adjusted is approximately 1/8 to 3/16 inch inside the bottom end (circuit foil side) of the coil form.

- 52. () Check to see that you can receive the TRANSROC at a considerable distance (a block or more) with your walkie-talkie.
- 53. () Design and fabricate the payload section:

The TRANSROC can be installed in any rocket capable of carrying its small (1.3 oz.) weight and having a payload section BT-50 or larger. The basic requirement of a payload section is that it have a tuning hole suitable for inserting the plastic tuning tool into the bottom of the antenna-matching (large) coil and a second (smaller) hole for the antenna wire to thread through.

The TRANSROC package has been designed to eliminate the payload installation problems associated with transmitters of the "strung-out" variety. Padding is not required with the TRANSROC, except for special applications.

A quick and easy payload section has been illustrated for your convenience and is all that is required with the basic rocket-finder mode. (See Figure 5.) If desired, a section of BT-50 (paper) body tube may be used instead of the illustrated PST-50FJ clear plastic body tube. When flying the TRANSROC in the microphone mode, a longer payload section will have to be used. This can be accomplished by using the full (uncut) length of PST-50FJ plastic body tube. Don't forget the tuning and antenna holes. Make these holes no larger than is absolutely necessary. The antenna wire will have to be threaded through its hole from the inside like a needle. Bend a small crook in the end of the antenna to aid in locating the hole. Note that the bottom mount has a small notch. This is to allow strain relief for the antenna and provide a good solid seat of the TRANSROC in the bottom of the payload section. Always rotate the TRANSROC slightly when installing to insure that the antenna has popped into the notch.

It may be necessary to sandpaper the cylindrical surfaces of the TRANSROC plastic parts in order to keep them from fitting too snugly inside the PST-50FJ plastic body tube.

It is best to suspend the payload section from the parachute with a length of shock cord. This will aid in damping out an unusually hard chute opening.

The TRANSROC may be mounted in a BT-55, 60 or larger payload section, using ring adapters as illustrated in Figure 6.

54. () Insert the battery in the battery cup when you wish to turn on the TRANSROC. The positive and negative markings on the battery should match the corresponding positive and negative markings on the battery holder. The TRANSROC circuitry is protected against damage by accidental reversed battery insertion, but it will not transmit under these conditions.

Removing the battery causes the TRANSROC to turn off. This is most easily done by inserting a probe through the slot in the rear of the battery out. Don't use your plastic tuning tool for this purpose or you may break it.

55. () Final tuning:

When the design and installation of the payload section has been completed, you are ready to perform the final antenna-tuning procedure. This procedure is essentially the same as Step 51. Prepare your rocket by inserting the TRANSROC (turned off) and suspending it, nose down, by the tip of the TRANSROC antenna using a piece of string at least a foot long (for insulation). The antenna should also be secured to a rocket fin using another piece of string or a rubber band. (See Figure 7.) The rocket should be suspended in a position where it and the antenna will be clear of conducting objects such as your body or pieces

of metal. Do not turn on the TRANSROC yet.

Collapse the antenna on your walkie-talkie, and turn the volume control completely up or until it produces a soft, but audible, hiss. Wrap the antenna stub with paper or cloth (for insulation), and then wrap the entire walkie-talkie in a generous piece of aluminum foil (to shield most of the TRANSROC signal from it). At this point, you should barely be able to hear the hiss from your walkie-talkie. If this condition is not being met, adjust the setting of the volume control accordingly.

Place the foil-wrapped walkie-talkie approximately three feet from the suspended TRANSROC. Now, turn on the TRANSROC and re-insert it in your rocket. If your walkie-talkie is wrapped adequately, it will not be able to receive the TRANSROC. Add more aluminum foil wrapping if necessary. Now, unwrap your walkie-talkie slightly until it barely begins to receive the TRANSROC.

Insert the plastic tuning tool into the bottom end (circuit foil side) of T2 (the antenna-matching coil). Be careful to hold the tuning tool as the rocketeer is doing in Figure 7, so that your hand is several inches from the TRANSROC. The presence of a portion of your body too near the TRANSROC during this tuning operation will affect the tuning, causing you to mistune the coil.

Adjust the slug in T2 to the most CCW position which produces a maximum level of hiss in your walkie-talkie. If the hiss level increases signifi-

cantly as you tune, you will need to increase the aluminum foil wrapping on your walkie-talkie slightly so that it will be receiving a weak (undistorted) signal. Rock the adjustment about the point of maximum indication until you develop a good "feel" for the proper slug position. This is similar to rocking the dial of a radio to both sides of a station to gain a "feel" for the proper setting. You will need to rock the slug in T2 somewhat more slowly than you would the dial of a radio, since the rate of information transmitted from the TRANSROC is only one bit per second (approximately).

The normal position for the slug of T2 when properly adjusted is approximately 1/8 to 3/16 inch inside the bottom end (circuit foil side) of the coil form.



FIG. 7 FINAL TUNING OF TRANSROC

CHAPTER III.

Theory Of Operation:

The TRANSROC is a relatively complicated device for its size. However, its theory of operation can be mastered easily by persons with a background in electronics, and the average model rocketeer will be able to gain a reasonable knowledge of what goes on inside by studying this section.

SECTION A. Basic Elements

Figure 8 is a highly simplified block diagram of the basic elements contained in the TRANSROC. The element on the left is the input transducer. This element does not exist in the rocket-finder configuration, since there is no information such as temperature, spin rate, heart beat, sound, etc., to be transmitted. In the mode which telemeters temperature, this transducer (sensor) is a thermistor which changes electrical resistance as a function of its temperature. This changing resistance is then used as an input to the modulator.

In a like manner, a photocell changes resistance as the amount of light striking it changes. This characteristic of the photocell makes it a useful transducer for supplying the modulator with usable information about rocket spin rate.

A microphone is still another type of transducer which converts sound vibrations into minute electrical currents (equivalent to the sound). These electrical "vibrations" are then amplified by the multi-purpose modulator and passed on to the RF (radio frequency) section in a format which will cause it to transmit these via the antenna back to earth superimposed on an RF carrier.

Other types of transducers or other applications of the same types are possible and can be used to extend the telemetering applications of the TRANSROC.

In the rocket-finder mode, the modulator is set up (arranged) so that the RF section turns on and off intermittently. This modulation is usually referred to as "cw" (continuous wave), which means that, when the transmitter carrier is on, it is on at a fixed ("continuous") amplitude.

In the telemetering mode, the basic format of the modulation is the same as for rocket finding, except that the modulation frequency is greater and is varied (controlled) by the resistance of the transducer being used.

In the microphone mode, the carrier is always on, but its amplitude (strength) is made to vary in step with the sound vibrations being picked up by the microphone. In this mode, the TRANSROC is an AM (amplitude modulated) transmitter essentially like your local AM broadcast station.

SECTION B. Modulator In TM Mode:

The brief discussion above tells something about what the modulator does. This section will be devoted to a study of how it works. Figure 9 is a simplified diagram of

the TRANSROC modulator when it is operating in either the rocket-finder or telemetering modes. These modes are similar except for two differences which will be discussed later. This circuit is a special type of asymmetrical multivibrator. This means that it oscillates and has an on-off type output that is not symmetrical. (It is off longer during each cycle than it is on.)

In order to study the action of a multivibrator or other free-running oscillator, it is convenient to examine the circuit, starting at any point, and assume a set of initial conditions. The analysis is then a matter of studying cause and effect and tracing the action around the loop, returning to the starting point and conditions at the end of the first cycle. If the reader is not familiar with electronic components, refer to the "Electronic Kit Builder's Handbook".

For our analysis of this oscillator, we will start at the collector of Q3 and assume that this transistor is turned off (not conducting). With this set of initial conditions existing, the gate (D4 and D5) will be turned on by the voltage being supplied to it through D2, R3, and R4. At

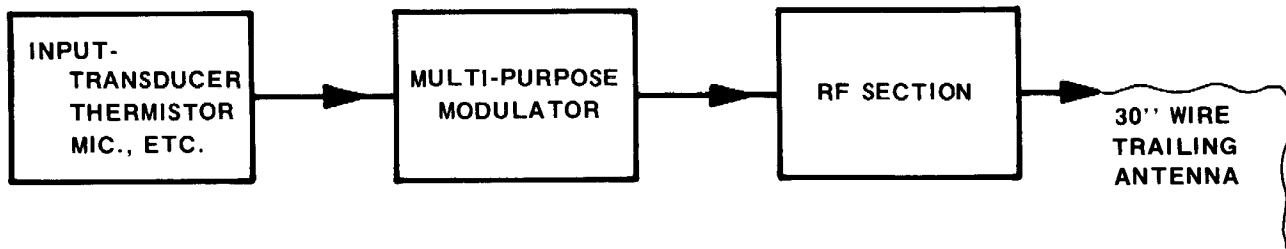


FIG. 8 SIMPLIFIED BLOCK DIAGRAM, TRANSROC

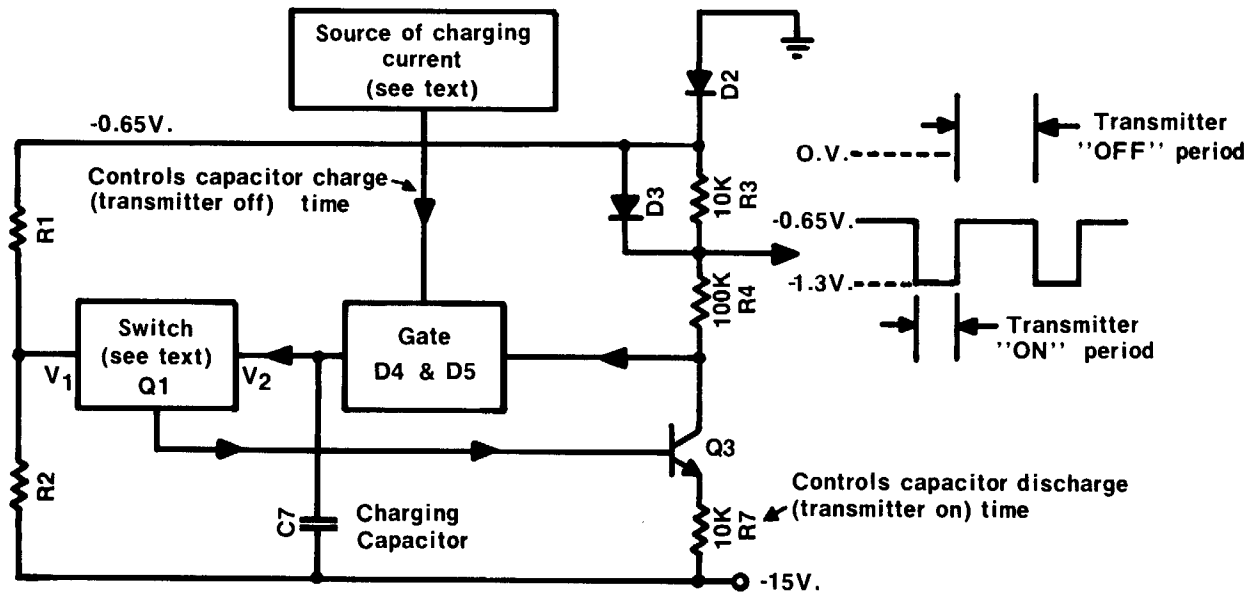


FIG. 9 SIMPLIFIED DIAGRAM OF TRANSROC MODULATOR RKT, FNDR. & TM MODES

the top of the gate is a source of charging current which is allowed to pass through the gate and build up an increasing level of voltage on the charging capacitor (C7). This voltage level (V2) is supplied to the switch (Q1) as one of its inputs. The other input to Q1 is the fixed voltage (V1) which is used as a reference. When V2 has risen to a level approximately equal to V1, Q1 will switch to its conducting state; and the charge which had been accumulated on C7 will begin to discharge through Q1, the base/emitter junction of Q3, and the current-limiting resistor (R7). This flow of current through the base/emitter junction of Q3 will cause its collector circuit to conduct. The resulting drop in the voltage on the collector of Q3 will turn off the gate (D4 and D5) so that no more charging current is delivered to C7. After a time period approximately one-third as long as was required to charge C7 to firing potential, it will have discharged through R7 to such a low level that Q1 will reset to its non-conducting state. This will allow Q3 to turn off, which will again turn on the gate (D4 and D5), allowing current to again charge C7. Note that we have now traced through the completion of an entire cycle and just started another. Of course, this cycle will repeat over-and-over (oscillate) for as long as power is applied.

We will now examine the output portion of the modulator circuit to see how it produces the desired waveform. The voltage drop across the diode at the top of the drawing (D2) is approximately -0.65 volts, meaning that this voltage level could be measured at the cathode of D2. As we will study later, this is also the voltage level that will just barely cause the RF section of TRANSROC to start producing an output. With Q3 not conducting, the voltage level at the modulator output will be at the same -0.65 volt level as the cathode of D2, since no current will be

flowing through R3 and R4. When Q3 conducts, current will flow through R4 and the parallel combination of R3 and D3. The output voltage under this condition will be -1.3 volts (the total drop across two diodes in series). This -1.3 volt level will cause the transmitter RF section to turn on at a level of 100 mw power input.

The block shown on the diagram as SOURCE OF CHARGING CURRENT is actually any one of several. In the rocket-finder mode, this is a fixed source of current as provided by a voltage across a 270K resistor. In the telemetering modes, a transducer which changes resistance as a function of light, heat, acceleration, etc., is substituted for the fixed resistor. Since more bits of data per second are needed for telemetering a changing function such as spin rate than are needed for locating a rocket, the modulation frequency is increased appropriately by substituting a smaller capacitor for C7.

SECTION C. Modulator In Microphone Mode:

Figure 10 is a simplified schematic diagram of the modulator when it is in the microphone mode. If you compare Figure 10 with Figure 13 (the complete schematic), you will note that several components which are present in all modes of modulator operation have been omitted from this simplified schematic. These other components are omitted because they serve no function in the microphone mode, even though they are still present.

The microphone produces a minute audio current (the electrical equivalent of the sound striking the microphone). This is amplified first by Q2 and then by Q3. Q2 and Q3 are thus an audio amplifier with two cascaded stages. C8 is a bypass capacitor across R7, which removes the audio frequency components of voltage from the emitter of Q3

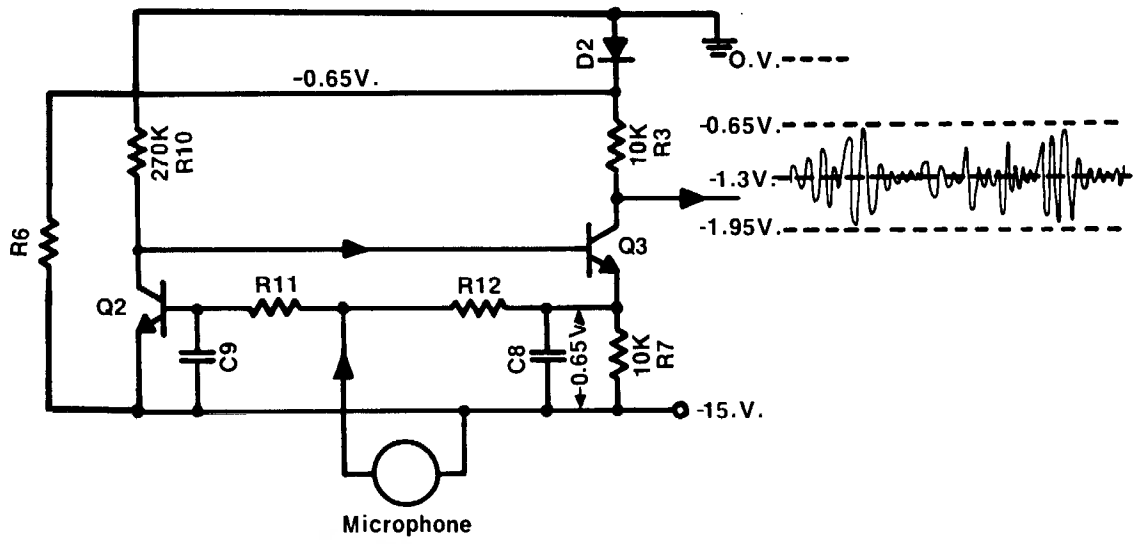


FIG. 10 SIMPLIFIED SCHEMATIC, TRANSROC MODULATOR, MIC. MODE

(increasing its gain by preventing degeneration). The voltage across C8 also serves two other purposes. One of these is to provide an operating-point bias for both Q2 and Q3 with automatic stabilization. The bias thus established on C8 is equal to, and results from, the emitter/base threshold potential of Q2; and this is an accurately known 0.65 volts for any silicon junction. It can be seen from this that a very stable current flows in R7 and that, by Ohm's Law, it will be $E/R = 0.65 \text{ volts}/10,000 \text{ ohms} = 65 \text{ microamps}$. Further inspection will reveal that current flowing in R3 is the summation of this 65 microamps DC plus or minus the instantaneous audio voltage. Since the output voltage (to the RF section) is the sum of the voltage across D2 and the voltage across R3, it is equal to $-0.65 \pm (-0.65 \pm \text{the audio voltage}) = -1.3 \pm \text{audio voltage}$.

SECTION D. The RF Section:

Figure 11 is a simplified block diagram of the RF (radio frequency) section. The purpose of the RF section is to produce a radio frequency (27 Mhz) output to the antenna that is proportional in power to the command received from the modulator.

Transistor Q4 is used as a voltage comparator and amplifier. The voltage supplied to its base is the voltage input from the modulator, which is a command to the RF section to produce a particular level of power. The input to the emitter of this transistor is the voltage across R9 (the output current sensing resistor). This voltage is a function of output power and is a feedback to Q4, telling it how much power is actually being produced by the RF section. If Q4, in comparing these two voltages, detects the condition that less power is being produced than is being commanded by the modulator, it increases the base

circuit drive to Q5 (a crystal-controlled oscillator), causing it in turn to drive Q6 harder and, thereby, increase the output power and current to the required level. If Q4 senses that slightly too much power is being produced, the opposite reaction results; and the drive to Q5 and thence to Q6 is reduced, restoring equilibrium. The fact that an emitter/base threshold voltage of -0.65 volts is required to make Q4 operate is taken into account in the design of the modulator which, as was seen previously, produces a threshold voltage of -0.65 volts (the voltage drop across D2).

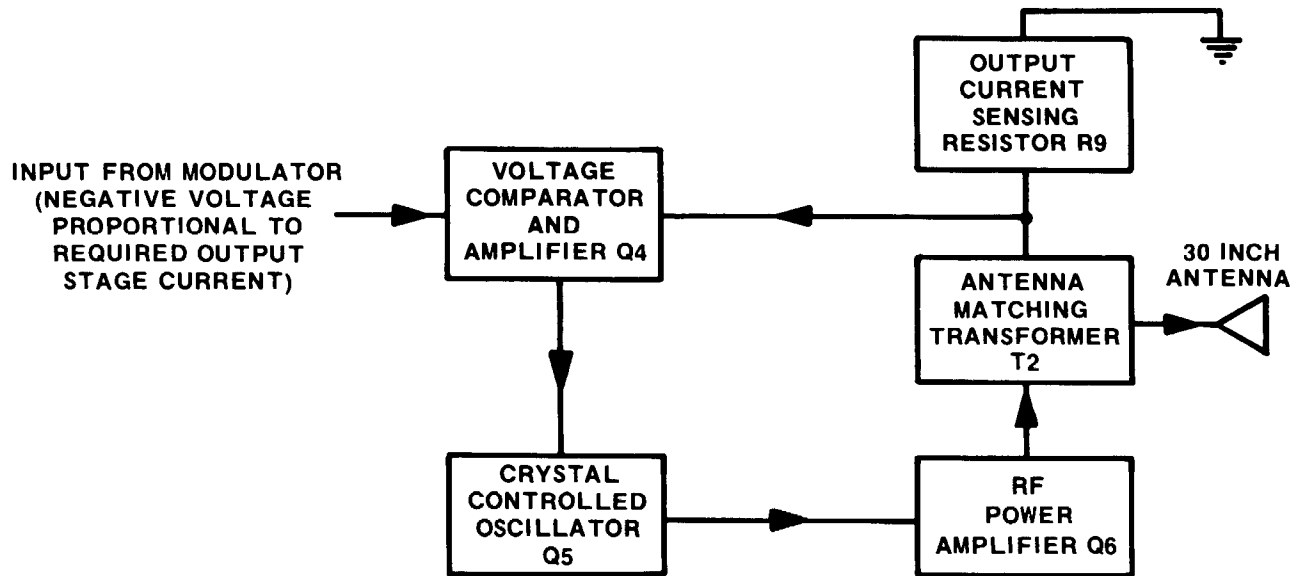


FIG. 11 BLOCK DIAGRAM, TRANSROC RF SECTION

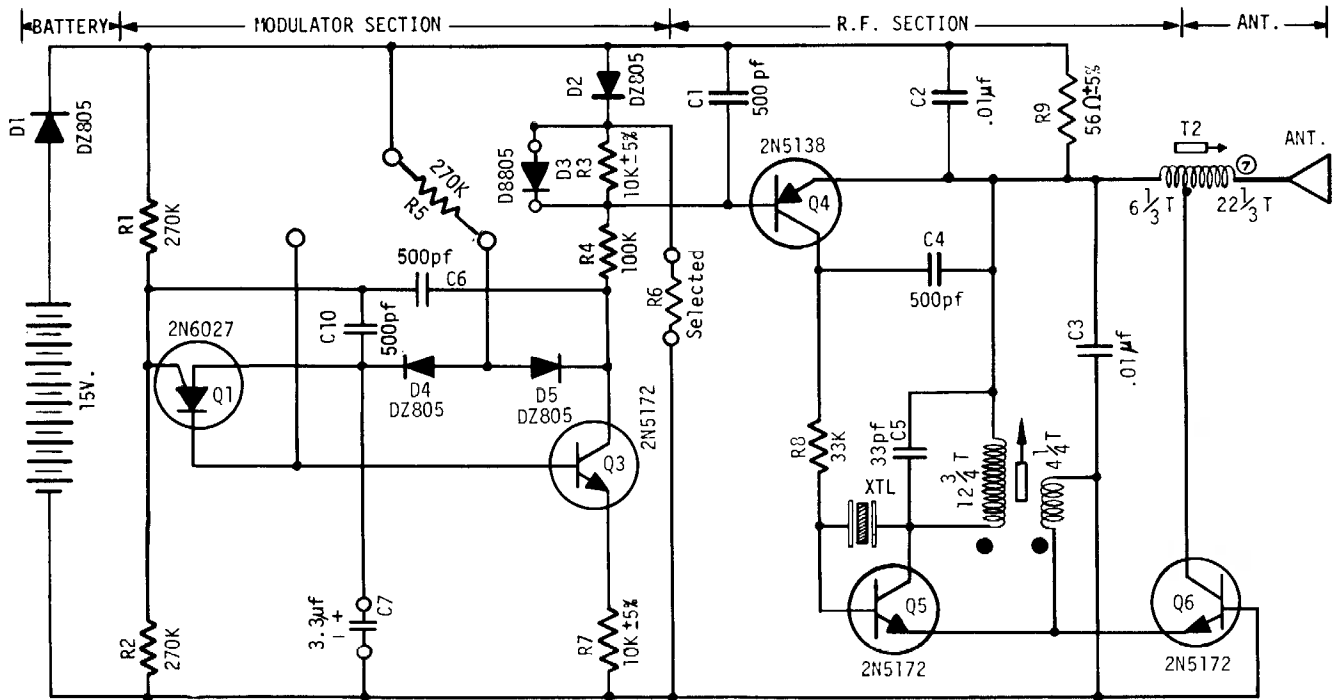


FIG. 12 SCHEMATIC DIAGRAM, TRANSROC (ROCKET-FINDER MODE)

CHAPTER IV.

Troubleshooting Guide:

In the event that your TRANSROC fails to operate properly when you first turn it on, the following list of suggestions may help you in locating and fixing the trouble.

SECTION A. Proper Soldering:

Improper soldering causes more problems in the construction of electronic kits than all other causes combined. With miniature devices such as TRANSROC, this problem is even more severe than with larger devices. Inspect your TRANSROC very carefully for faulty solder joints and for "bridging" of solder between adjacent conductors. We suggest the use of a magnifying glass for your final inspection. Make sure that all eyelets which are in use are soldered to the copper lands.

SECTION B. Placement Of Parts:

Check very carefully, comparing your TRANSROC with the one in the picture. You may have one of the transistors reversed in its 3-lead mount, or you may have the 2N6027 interchanged with one of the 2N5172 transistors. Check to see that the proper color coding is on each resistor and that the proper capacitors are in each position. It is easy to get one resistor or capacitor in the wrong position or a diode or a tantalum capacitor with polarity reversed.

SECTION C. Receiver Operation

If noise or other signals can be heard in the speaker or earphones of your receiver with the volume turned all the way up, it is probably working okay.

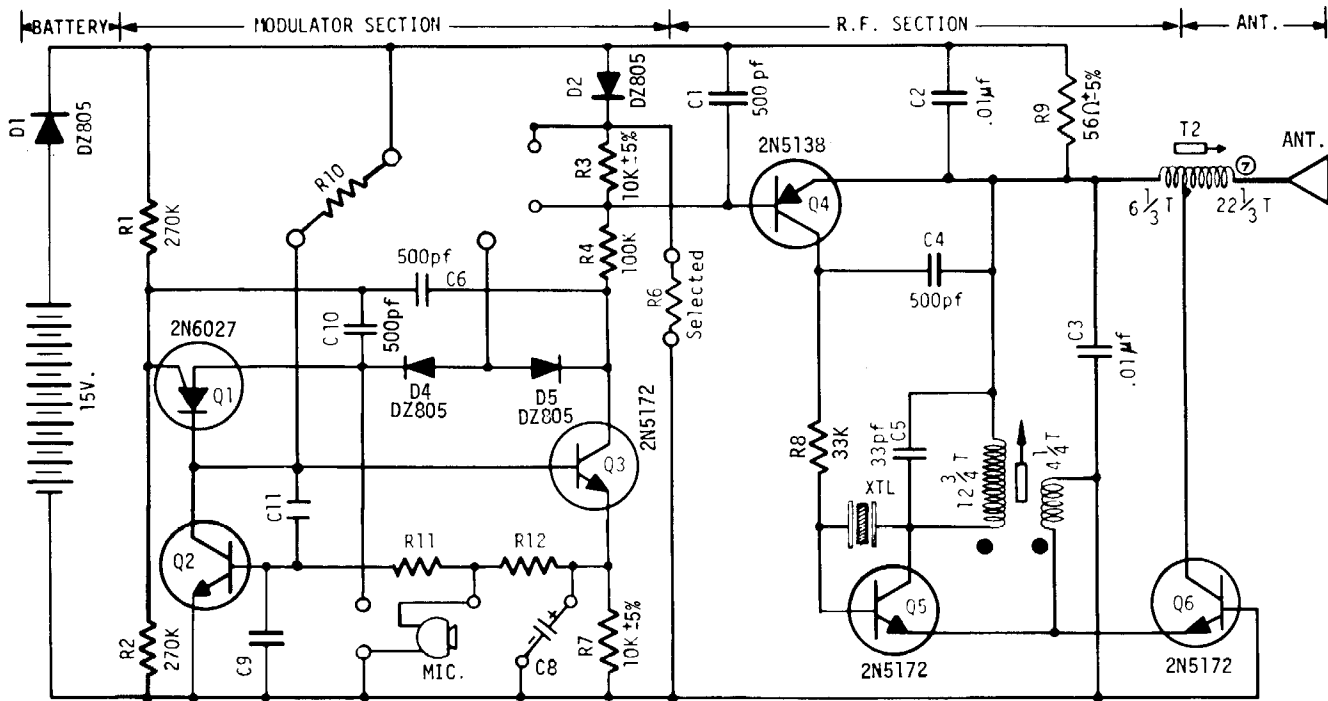


FIG. 13 SCHEMATIC DIAGRAM, TRANSROC (MICROPHONE MODE)

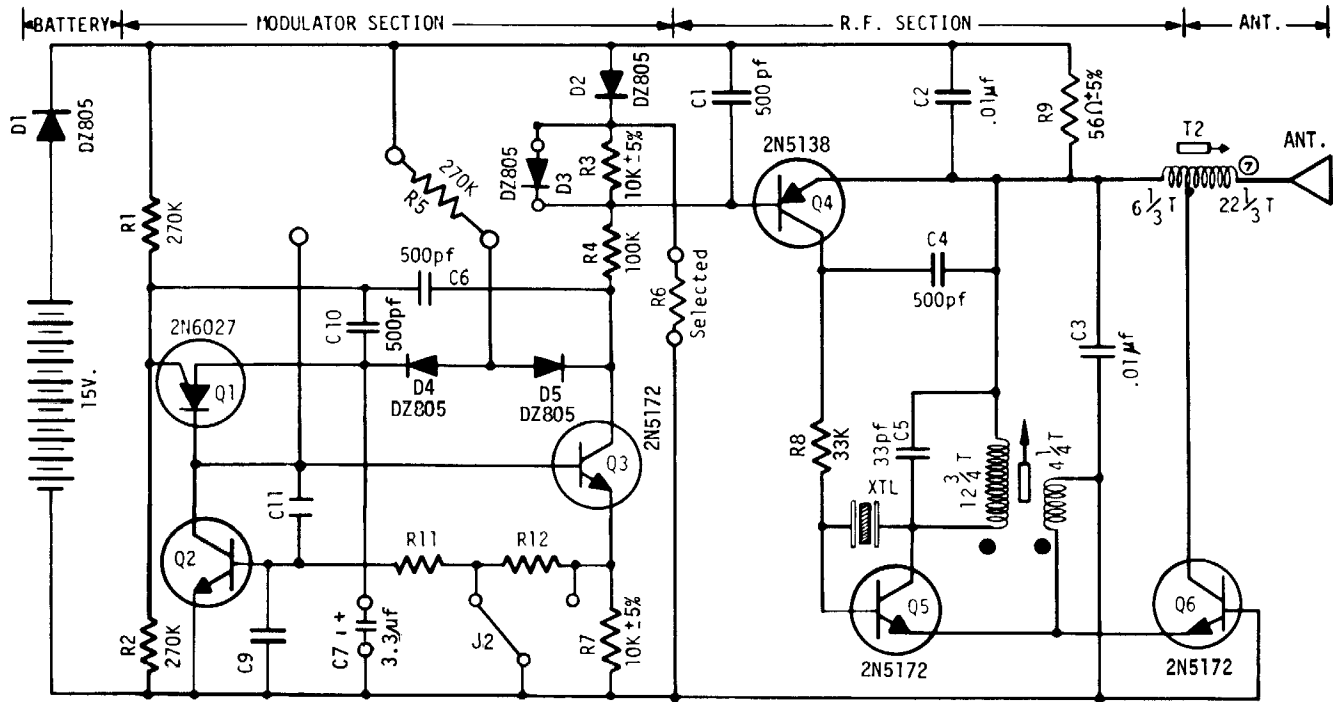


FIG. 14 SCHEMATIC DIAGRAM TRANSROC (ROCKET FINDER MODE), MIC. KIT INSTALLED

SECTION D. Frequency Compatability:

When you purchase your receiver and TRANSROC from ESTES INDUSTRIES at the same time, we supply units capable of compatible operation on the same frequency unless you specify otherwise. If you already have a receiver or plan to use one from another source, check to verify that the TRANSROC crystal is for the same channel as your receiver. This should be specified at the time of ordering the TRANSROC. If possible, check to verify that your receiver will receive a signal from another walkie-talkie or other transmitter that operates on the same frequency as your TRANSROC. It should be able to receive at a distance of several blocks minimum.

SECTION E. No Output:

Check for a dead battery or reversed battery connections.

With your receiver known to be operating and on the proper frequency, try tuning the oscillator (small coil) of your TRANSROC. If no signal is detected by the receiver, temporarily tack solder a short piece of wire from point (1) to point (2) (see Figure 3) and again try tuning the oscillator. If no signal is received, the trouble is probably in the oscillator. If a signal is received after tack soldering the jumper and tuning the oscillator, the trouble is probably in the modulator section. Check very carefully the affected portion of the circuit for soldering or construction errors.

SECTION F. Low Power Output:

Check for a weak battery.

Retune the antenna coil following directions carefully.

SECTION G. Factory Service.

Should you be unable to solve the problem by using this guide, you may wish to send your TRANSROC to ESTES INDUSTRIES for factory service. Only unmodified kits, fully assembled per these directions, will be serviced by our technicians. Service will also be refused on any kit which has been assembled using acid core solder.

1. Minimum service charge for inspecting a returned kit is \$3.00.
2. The Rocketronics Service Center will replace, at no charge, all components which were defective at the time of shipment. Our Service Center technicians reserve the right to determine whether or not a component was defective at the time it was shipped. This determination will be based upon visual inspection and electrical tests.
3. Components found to have been damaged by the kit builder will be replaced at current prices. The parts list gives prices in effect at the time of this printing.
4. Be sure to enclose the following:
 - a. A note describing the trouble (symptoms, etc.) and your complete return address.
 - b. Remittance for \$3.00.
5. Be sure to pack your TRANSROC adequately with plenty of packing on all sides. Send it to the following address:

Rocketronics Service Center
Estes Industries, Inc.
Penrose, Colorado 81240

CHAPTER V.

Tips On The Use Of The TRANSROC

The TRANSROC is a basic working tool for the serious model rocketeer. It, no doubt, has applications that have not yet been thought of. No set of instructions for such a device can serve as a substitute for imagination, ingenuity, and forethought. We believe, however, that the following hints can serve as a supplement and basis for such resourcefulness.

SECTION A. Combating Interference:

It is an unfortunate fact that the FCC has allocated only a very small portion of the radio frequency spectrum for use by private citizens. As a result of this problem, the citizens and amateur bands are very badly overcrowded, and the overcrowding is rapidly getting worse. This does not mean, however, that you cannot hope to make good use of your TRANSROC. It means, instead, that you may have to carefully choose the time and location for some of your shots, adjust the length of your receiving antenna, etc.

Some increase in transmitter performance can be obtained by lengthening the TRANSROC antenna to about 45 inches. Of course, this will cause an increase in drag. Use of an antenna longer than 45 inches requires modification of the antenna-matching coil, or transmitter performance will be reduced and use of an antenna longer than 60 inches would be illegal.

A1. Rocket-Finder Mode:

The TRANSROC is least affected by interference when used in the rocket-finder mode because of the type modulation ("cw") employed. Low levels of interference, usually present in many places, actually improve the range of the system by serving the purpose of a beat frequency oscillator. This means that the signal received from the

TRANSROC mixes in the receiver with any other signal being received and produces an easily identifiable "beat" note. Severe levels of interference degrade the TRANSROC/receiver performance, but never so bad in tests that we couldn't find our rocket. When searching for your rocket, try collapsing the antenna on your receiver until you are barely receiving the TRANSROC. This will make the interference seem less severe.

A2. Microphone Mode:

Virtually all citizens-band transmitters, whether installed in homes, autos, trucks, or hand-held (walkie-talkies), use AM (amplitude modulation). For the same good reasons that AM is used in these other citizens-band transmitters and receivers, it is also used in the TRANSROC when the microphone mode is employed. This means that there is no difference between the characteristics of your signal and the signals generated by the interfering transmitter/s; and it follows from this that the interference problem is the most severe in the microphone mode, since it is not practical to discriminate against the interfering signal by using a different "type" of signal. It, therefore, becomes necessary to overcome the interference by taking measures to ensure that the signal arriving at the receiver from the TRANSROC is stronger than the interfering signal/s.

a. Choosing the right time:

Due to changes in the ionosphere (a layer of ionized air above the surface of the earth), the interference level changes drastically with the seasons and with the hour of the day. During the middle of the day in the winter months (from about 8:00 a.m. to about 4:00 p.m.) interference is the worst. During the early morning and late

evening hours and during the summer, however, there is usually little or no interference. You can see from this how you can beat the interference in most areas by choosing the right time for your critical microphone and TM mode flights.

b. Choosing the right place:

It is likely that the interference in or near many large cities may be severe at times when there is no problem in more-or-less remote areas. Consider the possibility of taking along your TRANSROC, receiver, and tape recorder when you go on vacation during the summer and getting off a few shots out away from it all. Another possibility is to make your launches with the receiver and tape recorder located down in a depression. You could, for instance, launch the rocket from the rim of a dry lake bed, gravel pit, etc., with the receiver and tape recorder located at the bottom. When you do this, the interfering signals will pass right over your head, moving mostly horizontally, while the signal from the TRANSROC will descend from the rocket in a straight line to your receiver.

c. Antenna orientation:

Usually the level of interference can be reduced more than the level of the signal by holding the antenna of your walkie-talkie near the ground (about one foot high) and parallel with the ground. This gains a little of the same advantage that can be gained by locating the receiver at the bottom of a depression. You might try combining the advantages of locating your receiver in a small depression (a few feet deep) plus holding the antenna horizontal near the ground. Don't lay the receiver right on the ground, however, since this would detune the antenna and might cause a large reduction in the receiver's sensitivity.

A3. Telemetering Mode:

The effect of interference upon the telemetering mode, regardless of what function is being telemetered, is moderate, being much more severe than the effect upon the rocket-finder mode but not as severe as the effect upon the microphone mode. This is because the modulation in the telemetering mode (like that of the rocket-finder mode) is different from the modulation of the interfering transmitters; however, good TM requires a cleaner signal than good rocket finding. The techniques for combating the interference are the same as for the microphone mode.

SECTION B. Locating Your Rocket.

Your TRANSROC can be used as a rocket finder whether it is in the "rocket-finder" mode or one of the other modes. Its range is greatest and battery consumption is lowest in the rocket-finder mode, however; and, as mentioned before, it is less susceptible to interference. The techniques used for locating it are the same, however.

After your rocket lands, its antenna is detuned by the fact that it is lying on the ground. It is also likely that there will not be a direct line of sight from the TRANSROC to your receiver. For these reasons, its range will be much less than during flight, and you may or may not be receiving it from the launch site (particularly if it is in the microphone mode and there is a lot of interference).

B1. Grid Technique for Rocket Finding:

If you had the rocket in sight as it descended, naturally, you would start walking in that direction; if not, you should walk downwind. Keep your receiving antenna fully extended until you are close enough to your rocket to begin receiving it, then collapse your antenna until

you can barely receive the TRANSROC. Walk in a straight line in a direction that you think is most likely to take you near the rocket. As you approach the rocket, the signal will get louder, and you should keep pulling in the antenna to keep the signal barely audible. When you pass the point in your straight walk that is nearest your rocket, the signal will begin to slowly get weaker. When this happens, you have gone too far. Return to the point at which the signal was the strongest, and start walking a second path at right angles to your original path. You will soon discover that the signal will get stronger or weaker. If it gets weaker, reverse your direction. If it gets stronger again, start collapsing your antenna and keep walking in a straight line until the signal starts to diminish. Now, return to the point along your second path at which the signal was strongest, and start walking in a direction at right angles of this path. You will now be walking a third path in a direction parallel to your first path. Repeat this procedure as many times as necessary. When you can receive the TRANSROC with the antenna completely collapsed and when walking only a few feet on any new path you take causes a rapid reduction in signal strength, then look around very carefully and you should find the rocket within a few feet of you. In poor light, be careful to not step on the rocket and crush it. See Figure 15 for an illustration of this grid pattern.

B2. Directional Antenna Method:

An alternate possibility for locating your rocket is the loop antenna. It is possible to build a simple loop antenna and attach it to your walkie-talkie. A loop antenna is directional and can be used to lead you in the direction of your TRANSROC.

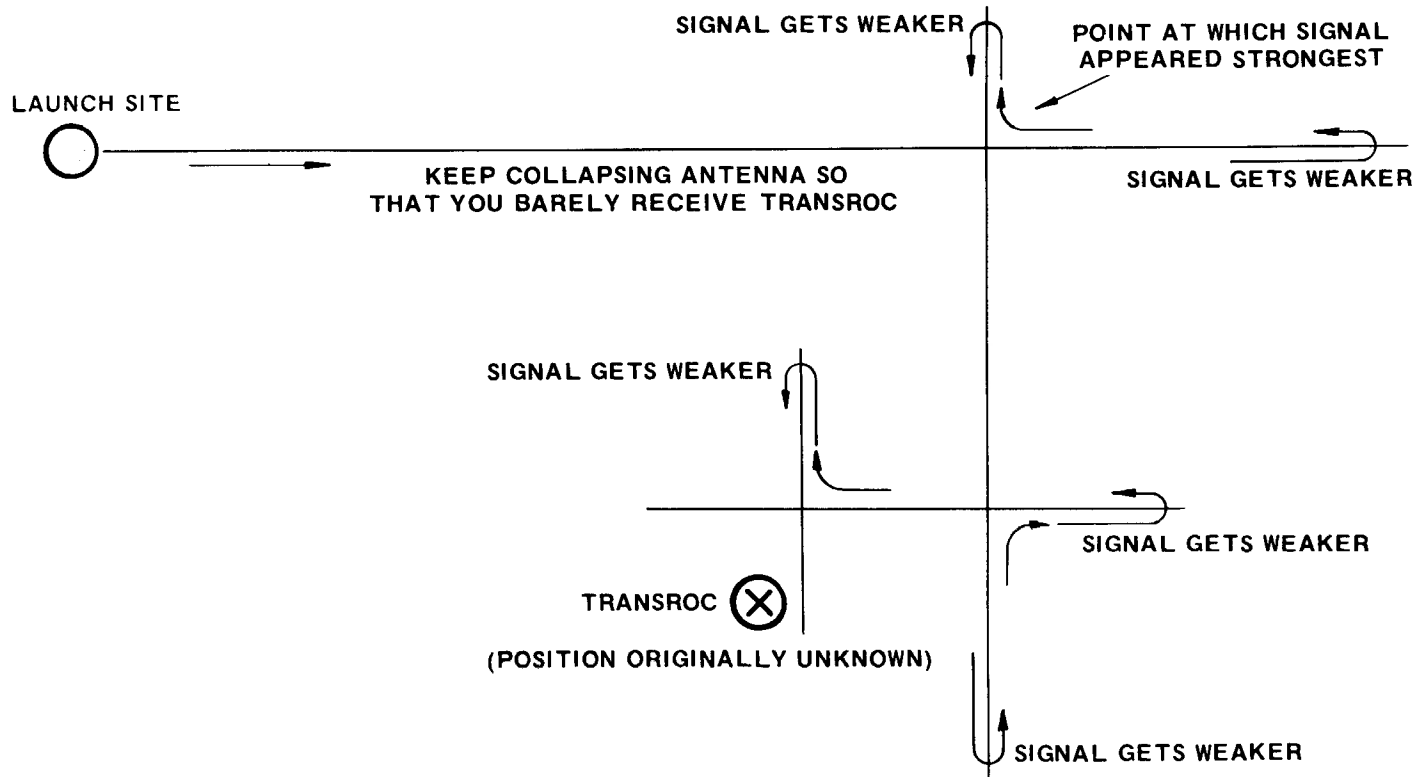


FIG. 15 GRID TECHNIQUE FOR ROCKET FINDING

Completely collapse the whip antenna on your receiver so that it is not used. Fashion a hoop of wire about two feet in diameter by taping it to the ends of a pair of plastic rods or other non-conducting framework. Connect one end of the hoop to your collapsed whip antenna using a 500 ohm carbon potentiometer as shown in Figure 16. Connect the other end of the hoop to a metallic ground point on the walkie-talkie, such as the earphone jack. The hoop can be made of piano or similar wire.

A loop antenna has the strongest response when the radio wave it is receiving strikes the edge of the loop, and its weakest response occurs when the radio wave strikes the plane of the loop (on axis). The loop you build by the simple procedure outlined above will be imperfect, however, and you will need some practice in order to learn how to use it effectively.

When you are a distance from the TRANSROC, you will need to turn the gain control (carbon potentiometer) most or all of the way up. Set the gain so that you receive the signal weakly. As you rotate the antenna, you will observe a weakening of the signal when the axis of the antenna is pointing toward the TRANSROC. This will only tell you, however, that it is in one of two opposite directions. Observations such as wind direction, etc., will usually tell you which of these directions is true and which is false.

As you approach the TRANSROC, keep turning down the antenna gain control so that you are just barely receiving the TRANSROC. This will improve the direction determining capability of your antenna/receiver combination. When you are quite near the TRANSROC (especially with walkie-talkies that have plastic cases), you will not get a very

good null in the signal strength. Try some extra practice in-close to a TRANSROC of known location until you are fully familiar with the required procedure. Try listening for a slight hiss or for a change in the signal-to-interference ratio.

If you want to get sophisticated, you can build your loop antenna and gain control into a metal box, which will act as a shield when the walkie-talkie is inserted and connected to a potentiometer terminal. Leave some holes in the box so the sound from the walkie-talkie can get out. This outfit should work effectively to within a few feet of the TRANSROC; but, of course, it is more bulky and more complicated to build.

Another approach, which is more simple and is usually adequate, is to wrap the plastic cased walkie-talkie in aluminum foil. The foil wrapping acts as a shield which mostly eliminates the problem of the TRANSROC signal entering the receiver without first going through the loop antenna.

SECTION C. Antenna Angles:

The trailing wire antenna on the TRANSROC transmits best in a direction perpendicular to the axis of the rocket and antenna and transmits only weakly in a direction on axis. If you examine the geometry of a normal rocket flight, you will see that, as the rocket rises above the launch site, a receiver at the launch site will be at the worst possible angle with respect to the TRANSROC antenna. In most cases, a receiver at the launch site will experience loss of signal as the rocket approaches apogee, while a receiver located a mile away will be receiving a strong signal. We recommend, therefore, that you sep-

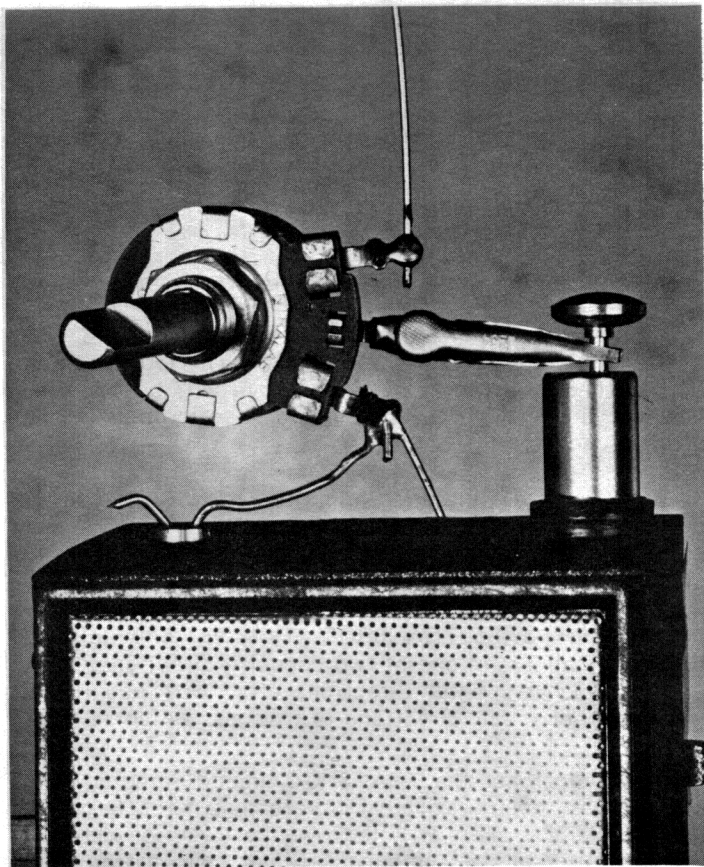
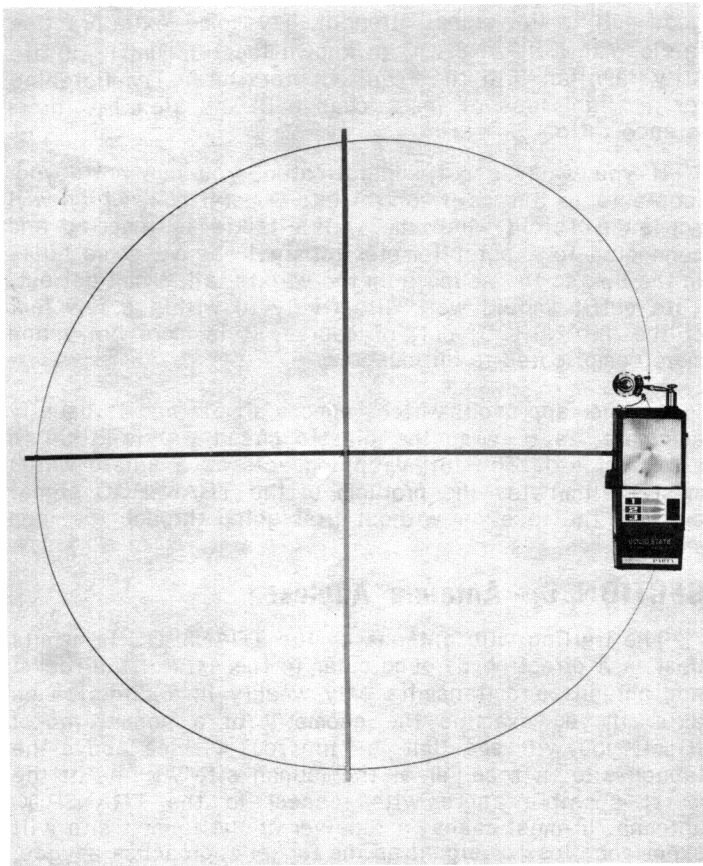


FIG. 16 LOOP ANTENNA

arate the launch site and your receiver by approximately 1000 to 2000 feet for microphone and telemetering flights, where it is important that you do not experience a temporary loss of signal.

This will cause a problem with communication between launch site and receiving/recording site. Which can be overcome in two ways:

1. Use a second walkie-talkie at the launch site for communication with the receiving/recording site.
2. Synchronize your watches to be used at each station; then, if recording the signal, start the tape recorder running about 1 minute before the scheduled launch time.

SECTION D.

Transmitting a Good Pre-Launch Signal:

When you separate the launch site from the receiving/recording station, as in (c) above, it may be difficult to receive the TRANSROC before launch. This problem can usually be overcome by placing the launch pad on top of a wooden post or other insulated structure which is elevated a few feet or more above the ground.

It might also be possible to fashion a non-metallic launch system which would not detune the antenna, but we have not found this to be necessary.

SECTION E. Beat Frequency Oscillator

When the "cw" signal from your TRANSROC is received by a walkie-talkie under various conditions, it produces different effects as follows:

1. If the signal being received from the TRANSROC is weak and little or no interference is being received, the signal will beat with the noise (hiss) generated in your receiver to cause an easily audible increase in this noise level. This is okay for rocket finding, since you can control the strength of the received signal by adjusting the length of your walkie-talkie antenna.
2. If a TRANSROC signal is being received in the presence of interference from one or more other CB transmitters, the TRANSROC signal will beat with the interference to generate a distinct tone which is easily recorded. Of course, the level of TRANSROC signal and the interference must be within reasonable proportions of each other, but this will usually be approximately the case. Under these conditions, the interference can actually work to your advantage and improve the recordability of your telemetry signal. This condition is not optimum, however, since the interference will contain amplitude modulation and there will usually be more than one interfering station causing one or more beat notes. Also, you will have only limited control over the the signal level of the interference. (See Chapter V, Section A.)
3. If the TRANSROC TM signal is strong and little or no interference is being received, it will sound okay to your ear but will actually consist of pairs of clicks spaced according to the TM format. If these spikes are recorded on an analog recorder with a mixture of receiver noise, power line interference, etc., they will be difficult to interpret. A BFO (beat

frequency oscillator) can be used to greatly improve the quality and fidelity of your TM recordings. A BFO signal gains you the advantages of interference without the disadvantages, since it is pure "cw" (not modulated) and can be controlled to any desired level.

PROVIDING A BFO:

Most communications receivers used for amateur radio, etc., have a BFO built in; but we know of no portable receiver, such as a walkie-talkie, that has this feature. You can simulate this feature, however, by the use of a second walkie-talkie with its transmitter keyed "on" continuously during your TM flight. With the antenna collapsed, place this second walkie-talkie (BFO) a few feet from your TM receiver walkie-talkie and tape down the "talk" button in the "on" position. Wrap the BFO walkie-talkie in a towel, or otherwise deaden its microphone, so that it will not pick up and add to the recording any local sounds, such as the wind. Adjust the separation between your BFO walkie-talkie and your TM receiver walkie-talkie so that you are receiving and recording a prelaunch TM signal that has the strongest and clearest tone possible.

Note that, although a super-regenerative walkie-talkie is unsuitable for use as a TM receiver, it is just as good as a superheterodyne for use as a BFO. If you have a super-regen. that will transmit on the same CB channel as your TRANSROC, this is a good way to use it.

SECTION F. TM Calibration:

Any metering device for measuring a physical parameter such as temperature, speed, altitude, etc., must be calibrated before its output readings will be very useful. A telemetry system, likewise, requires calibration. It is merely a metering system which uses radio waves to transmit data to a receiving and readout station.

Calibration of a metering system (telemetry or other) is merely a process of subjecting the system to be calibrated to several known inputs (temperatures for instance) and taking corresponding readings of the resulting outputs. You then plot a calibration curve which relates the outputs (in whatever form they may occur) to the known inputs (in degrees F for instance). The more points at which you take and record readings, the more accurate your curve will be. You will usually find, however, that four readings are sufficient. These readings should be spaced approximately evenly over the range of temperature, acceleration, etc. which you expect your rocket to encounter during flight.

SECTION G.

Tape Recording The Output Of The Transroc:

It will frequently be desirable, for microphone and telemetry flights, to tape record the output of your receiver as you fly your TRANSROC. The following hints may be helpful in doing this:

G1. Speaker-to-Microphone Coupling:

The simplest method for tape recording the output of

(a walkie-talkie is to merely place the tape recorder microphone in front of the walkie-talkie speaker.) This method is satisfactory for some applications, but it has the following disadvantages:

- a. The fidelity is poor compared to what can be achieved by using a direct hook-up. This means that a microphone flight would not sound as realistic as with a direct

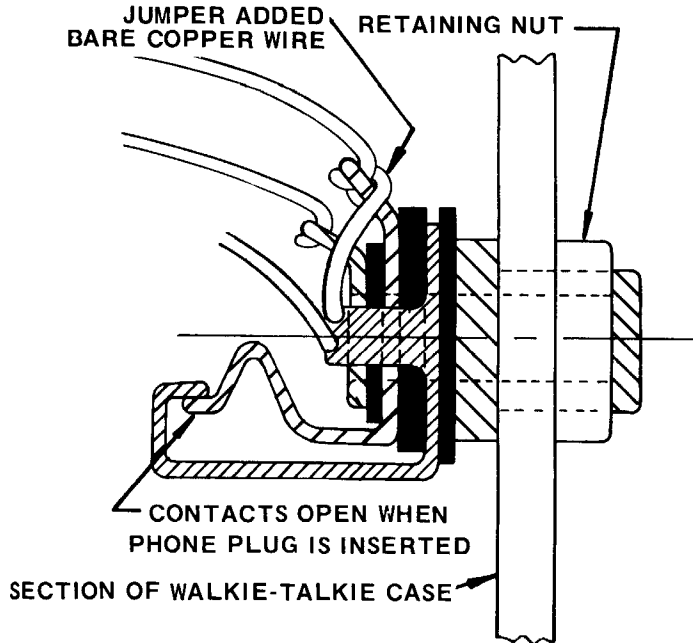


FIG. 17
SHORTING THE SWITCH ON THE OUTPUT JACK

hook-up and that, in a telemetering flight, some data could be lost that would otherwise have been reducible.

- b. If you are using the walkie-talkie and tape recorder outdoors, the wind may blow on the microphone and cause a low-frequency roar or waterfall sound to be recorded with your data. Naturally, this would degrade the quality of the data.

G2. Direct Coupling:

Direct coupling has the advantage of overcoming the above objections, but it is a little more difficult to use. The following hints may be helpful:

- a. Modify the earphone jack:

The earphone jack on most, if not all, walkie-talkies is designed so that, when an earphone is plugged into the jack, the jack automatically disconnects the speaker. This raises the impedance level of the circuit (which may cause distortion) and leaves you without a speaker for monitoring the flight as you operate the tape recorder. The solution is to make a temporary modification to the jack.

Begin by gaining access to the jack. This may require removing the jack from its mounting hole, or it may only require removing the back from the walkie-talkie. In any event, it should not be necessary to disconnect any of the wires from the jack terminals. Inspect the jack, and you will see that two of the three terminals form a pair of switch contacts which open when the earphone plug is inserted. The objective of the modification is to place a temporary short across these two terminals so that opening the switch (by inserting the plug) does not turn off the speaker. This is done by soldering a short piece of bare wire across these two terminals as shown in Figure 17.

We recommend that you not remove this short from across the jack unless you are sure that you will not want to make any more TM recordings. The only detriment that this modification causes to the walkie-talkie is a slight reduction in earphone volume and the fact that the speaker continues to operate when you use the earphone.

b. Make a connector cable:

Make a connector cable as shown in Figure 18. The input plug (the one on the left of the illustration) is a miniature earphone plug which mates with the earphone jack on your walkie-talkie. The plug on the right is just like the one used on the microphone for your tape recorder. The wires from the resistors to the tape recorder should

be kept short (perhaps six inches) while the wires on the left may be any length up to several feet. It may be possible to install the resistors inside the tape recorder plug which would give a neat appearance and reduce the wire length to zero. The parts can be obtained inexpensively at your local electronic parts distributor. These resistors may not be required for some tape recorders.

c. Alternate method:

It is possible by the use of an external speaker (from an old radio, etc.) to avoid modifying the earphone jack. Figure 18 shows where this external monitor speaker would connect to your patch cord assembly.

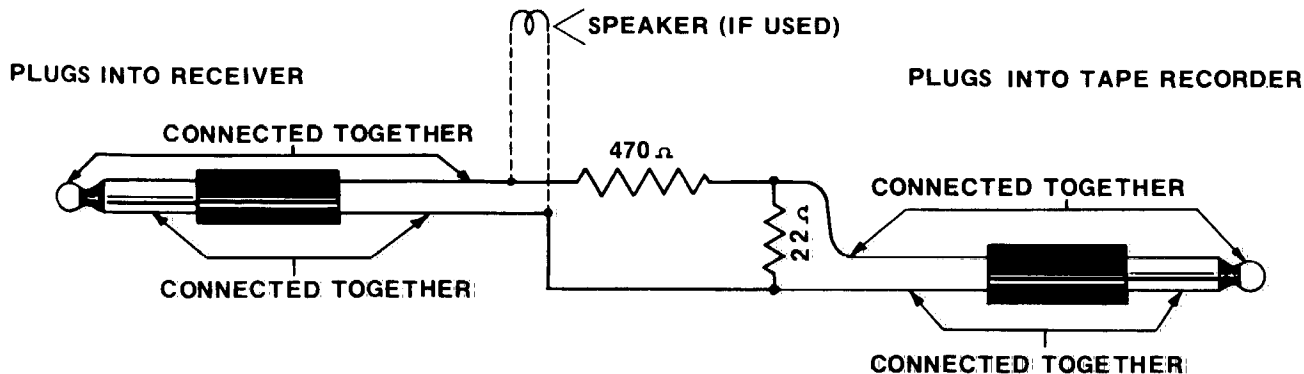


FIG. 18 CONNECTOR, RECEIVER TO TAPE RECORDER.

SECTION H. Chart (Analog) Recording:

If you wish to fully reduce your telemetry data and plot the respective function (rocket spin, temperature, etc.) on a graph, you will need to first make a chart recording of the telemetry signal. This requires that you record your data using an analog recorder. Most rocketeers will not be able to purchase an analog recorder. You will need to either borrow one and record the TM data on it during flight or you may record the data on a tape recorder during flight and then take the tape recorder to an analog recorder for transferring the data. Many high school and college physics laboratories have analog recorders, and some professors would be willing to help you transfer your data. (See Figure 24.)

The connection from tape recorder or walkie-talkie to the analog recorder should be made using a germanium

diode and capacitor as shown in Figure 19. The diode can be a 1N34, 1N277, etc. The value of the capacitor may need to be changed (either increased or decreased) to suit the particular analog recorder and type of telemetry.

Run the analog recorder at a high speed (100 to 200 millimeters per second) so that the data pips will be spaced far enough apart that you can measure the spacing between them.

SECTION I. Data Plotting:

When your TM data has been transferred to a chart recording, it will look approximately like the sample recording in Figure 20 and may be as much as ten feet long. You will need to measure the distance between cycles at every point where you wish to take a reading. It is usually convenient to make these measurements in centimeters or

PLUGS INTO RECEIVER OR TAPE RECORDER

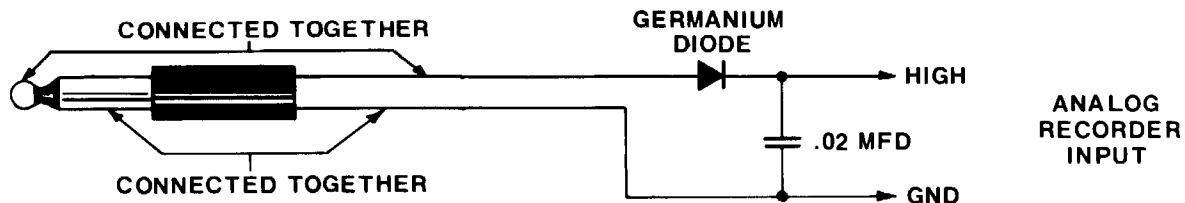


FIG. 19 CONNECTOR, RECEIVER OR TAPE RECORDER TO ANALOG RECORDER

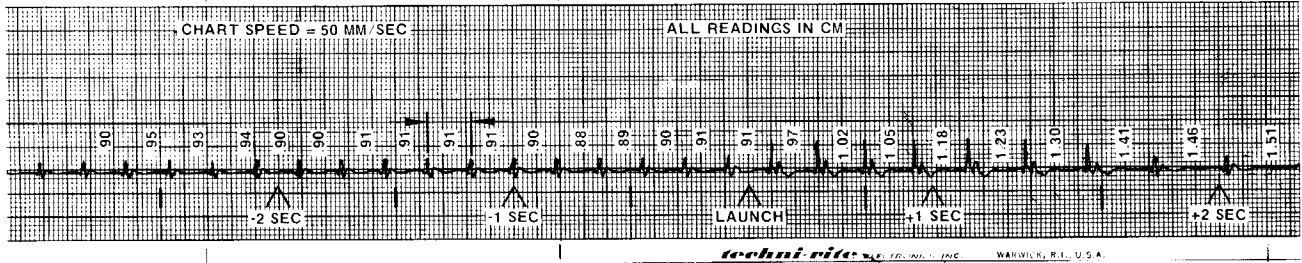


FIG. 20 SAMPLE CHART RECORDING (MARKED UP)

millimeters. Knowing the speed at which the recording chart was run, you can also mark off time intervals as shown in the example. Of course, launch is the logical choice for "zero" seconds.

The first graph you will need to plot will be a calibration curve which will relate pulse-spacing in milliseconds to a physical function such as temperature. You will probably want to choose pulse spacing as the horizontal axis on your graph and the physical function as the vertical axis. Plot all of your calibration data points on this graph and draw a smooth curve through them. This graph will then serve to correlate the spacing of the pulses during your rocket flight to the real temperature; etc., that these pulse spacings represent.

Figure 21 is a typical example of a calibration curve (actually two curves on one graph). With the aid of your

calibration graph, you will be able to plot a second graph which will be the true profile of your telemetered function versus flight time. See Figure 22 for a typical example.

CHAPTER VI.

Returning Your Transroc To The Rocket-Finder Mode:

When you purchase and install and/or attach accessory kits in order to convert your TRANSROC to another mode (microphone or telemetering), the accessory kit will contain instructions for converting to the mode corresponding to the respective kit. After you have finished using the TRANSROC in the other mode, you will likely want to convert it back to the rocket-finder mode. The procedure for doing this will also be included in the instructions for each of the accessory kits. Ten eyelets have been swaged into the TRANSROC PC board to make removal and

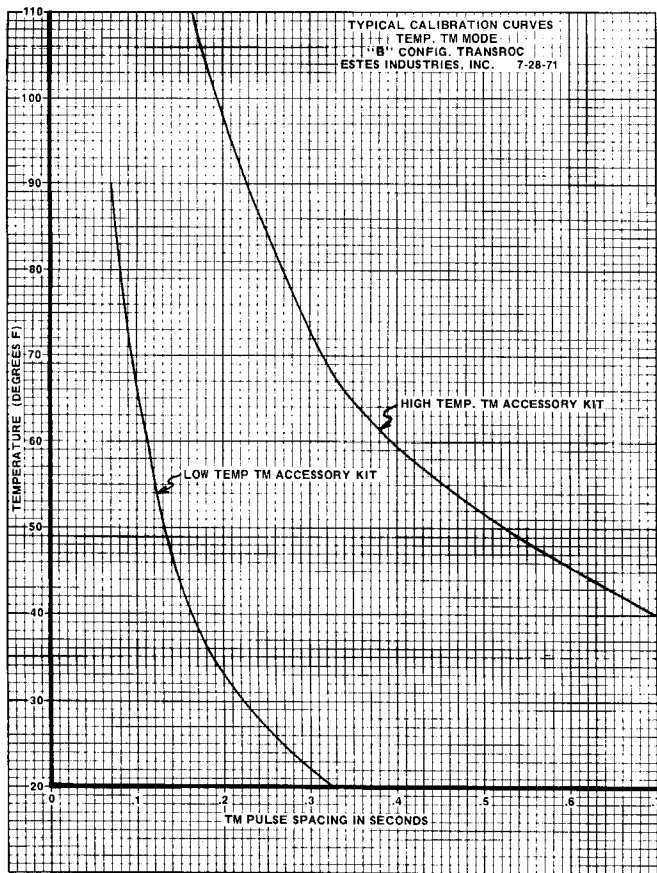


FIG. 21 TYPICAL TEMP. CALIBRATION CURVES

insertion of components (for mode changes) as easy as possible and to reduce the possibility of damage to the circuit board by repeated application of soldering heat. This is still an exacting process, however, and extreme care must be exercised in following directions. See the sections in the "Electronic Kit Builders' Handbook" on desoldering and removal of components. Caution: Allow plenty of time for the PC board to cool thoroughly between the soldering of each connection; otherwise, the heat will be conducted through the PC board and deform the plastic parts at one or both ends of the TRANSROC.

It will not be necessary to remove Q2, C9, C11, R11, or R12 once they have been installed for initial use in the microphone mode. Figure 23 shows the PC board in the rocket-finder mode after installation of the microphone accessory kit. As in Figure 1, the dot on the end of the identifier lines are shown on the body of the respective component.

R5, D3, R10, C7, C8, and J2 are optional components which are selected in various combinations to set up the TRANSROC for rocket-finding, microphone, or telemetry operation. The optional components used in the rocket-finder mode are as follows:

R5 - 270K; red, violet, yellow, silver

D3 - DZ805 diode (see Figure 23 for polarity orientation).
 end of the diode is on top
 (away from the PC board).

C7 - 3.3 Mfd (see Figure 23 for polarity orientation).
 The positive terminal of the capacitor (marked by red or a + sign) is on top.

J2 - Install a shorting jumper (J2) as shown in Figure 23.
 (Not needed if the microphone accessory kit has not been installed.)

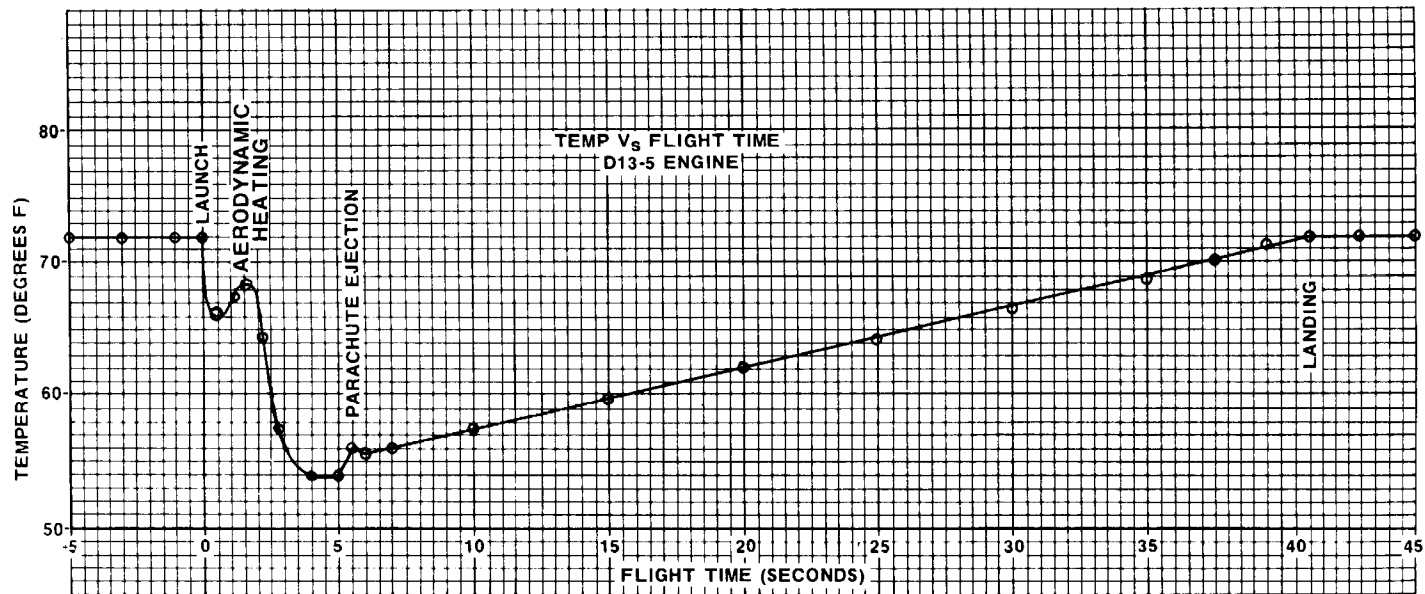


FIG. 22 PLOT OF TELEMETERED FUNCTION

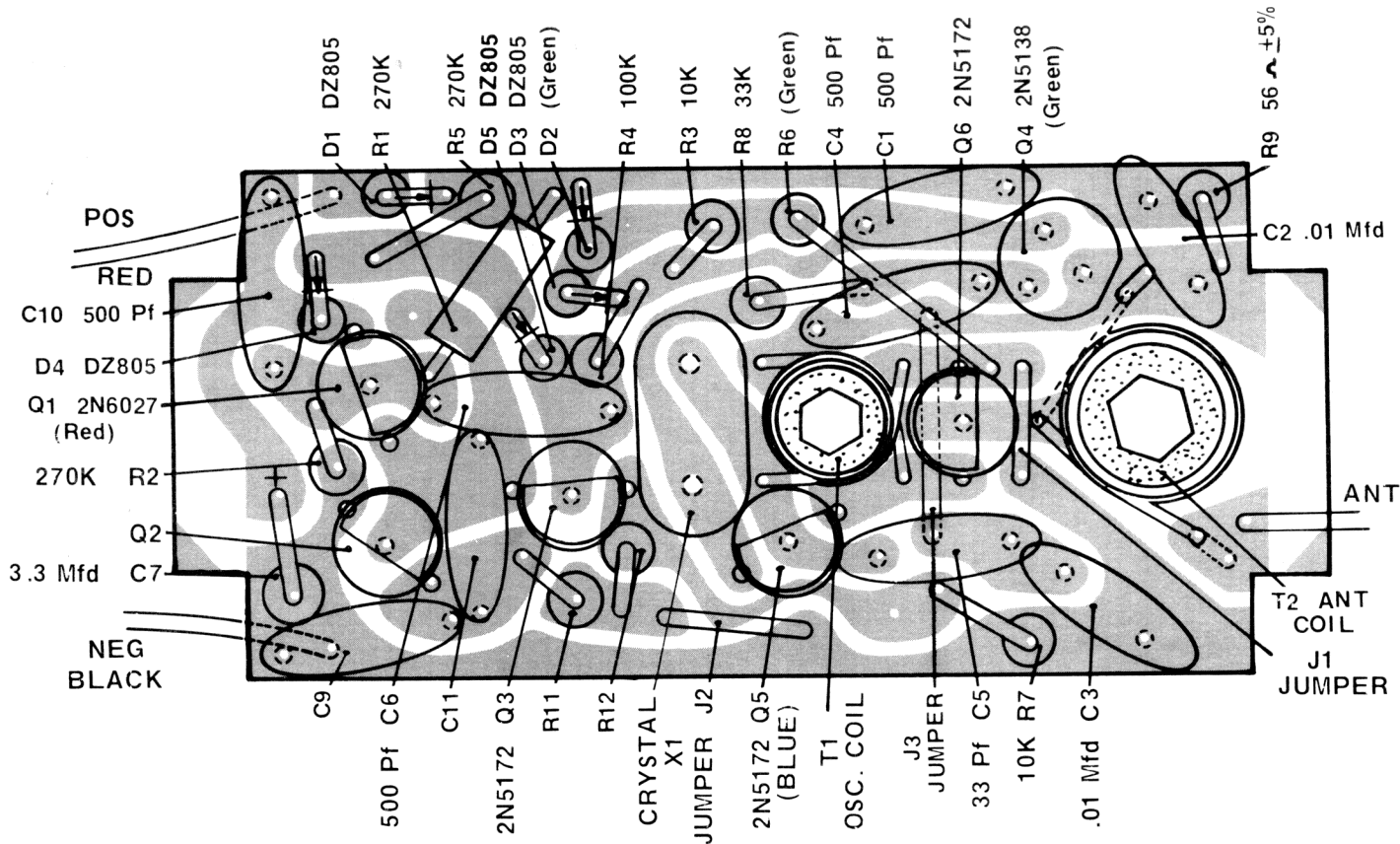


FIG. 23 PC BOARD (ROCKET-FINDER MODE), MIC. KIT INSTALLED



FIG. 24 TRANSFERRING DATA TO AN ANALOG RECORDING



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