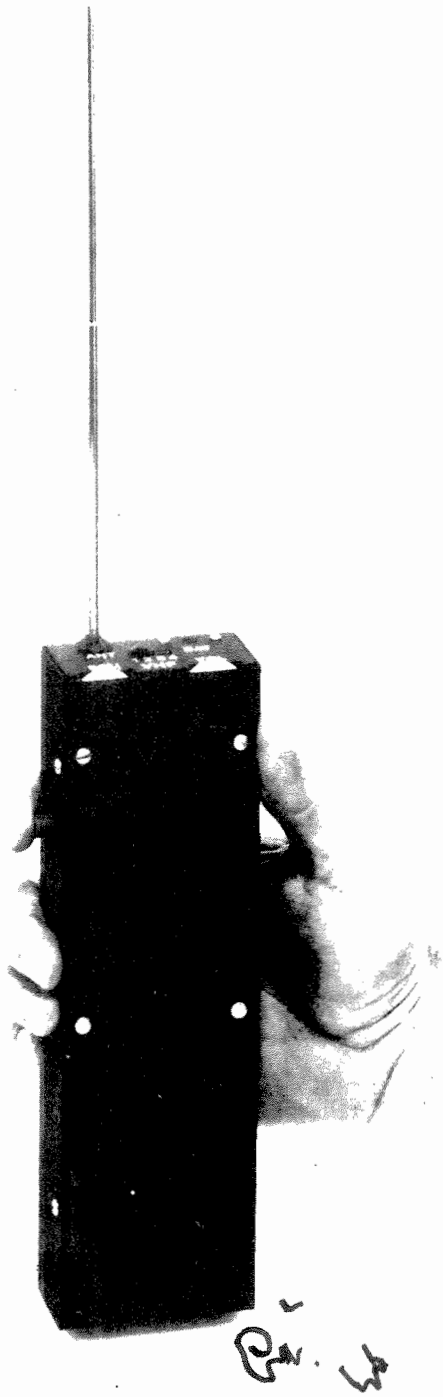
PRICE $2.00

# HT 144B

# HAND HELD TRANSCEIVER MANUAL

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hf engineering

DIVISION OF BROWNIAN ELECTRONICS CORP.

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HT-144B TRANSMITTER SPECIFICATIONS: OUTPUT 2 watts minimum. 3 db. BANDWIDTH 2 MHz typical. STABILITY .002 typical ( depends on crystal ). SPURIOUS outputs down 30db.or better. MODULATION true FM with varactor in crystal circuit. NETTING seperate trimmers for each channel. DEVIATION adjustable to 5 KHz. AUDIO limiter and active low pass filter. MICROPHONE speaker type. CRYSTAL 18 MHz parallel at 20pf. MULTIPLICATION FACTOR frequency times 8. CURRENT DRAIN 500 ma typical.

HT-144B RECEIVER SPECIFICATIONS: SENSITIVITY better than .35uV for 20db. quieting. SQUELCH THRESHOLD better than .3uV. STABILITY .002 typical (depends on crystal). ADJACENT CHANNEL REJECTION 60db. SPURIOUS RESPONSES down 70db. FIRST IF 10.7 Mhz. SECOND IF 455 KHz. FILTER 4 pole monolithic 10.7 MHz crystal. DISCRIMINATOR pretuned ceramic 455 KHz BANDWIDTH 15 KHz at 3db.points. CRYSTAL 45 MHz parallel at 20pf. CRYSTAL FORMULA receive frequency minus 10.7 divided by 3. AUDIO OUTPUT .5W typical. CURRENT DRAIN 15 ma squelched, 100 ma on voice peaks.

ACCESSORIES:

* 'Rubber Duckie' Antenna (BNC Connectors)
* Nicad Battery Charger
* Sealed 12 V Nicad Battery Pack

WARRANTY

All parts carry the original manufacturer's warranty. Defective parts must be returned for credit.

The unit may be returned to the factory for repair and alignment for a charge of $15.00 plus parts and shipping. It must be accompanied by a note describing the difficulty and the date of purchase. Units which have been modified or obviously misused will not be covered under this warranty.

# HT144B ERRATA SHEET

PAGE 3, STEP 5

Add - Be sure to push crystal pins flush with top of board (switch side is top).

PAGE 4, STEP 5

First sentence should read - Mount all capacitors except C26, C40, and C84 which will be installed later.

PAGE 6, STEP 16

Add the following sentence: Solder C84 directly across the foil between pins 1 and 4 of IC2.

PAGE 7, STEP 18C

Change Q15 to Q13

PAGE 16, VOLTAGE CHART

IC2 Pin 1 - .6VDC

PAGE 17 PARTS LIST

| | |
|---|---|
| C7 | 1pf $\pm$ .25 |
| C34 | .1 at 16V |
| C40 | 100pf mounted across R31 |
| C77 | .001 |
| C84 | .001 mounted under board |
| R11 | 1K |
| R40 | 2.2K strike word across R31 |

PAGE 18, PARTS LIST

| | |
|---|---|
| R46 | 100K |
| R48 | 2.2K |
| FL3 | Add - OR 5-438 |

PAGE 19

Remove C84 from Pictorial

If you experience trouble netting the crystals, add a 10pf ceramic NPO across the varactor on the foil side of the board.

# HT 144B ADDEMDUM SHEET II

Please turn in your manual to page 17 - the parts list.

Correct C1 to read 12pf (10pf or 15pf will work but 12pf works best).

Correct C77 to read .001. (Your transmit audio will be appreciably better.)

When putting the speaker in, use electrical tape, etc. to make a plastic "doughnut" around the speaker's magnet. This will insulate the speaker's metal frame and solder terminals from the PC board.

In many cases, where the IF system seems unstable or "touchy", terminating the output of FL2 with a 3.3K ohm ¼ watt resistor will work wonders.

Also, decoupling the + battery lead at the on-off-switch is suggested. This may be accomplished with a 100MFD capacitor to ground paralleled with a .005 ceramic disc capacitor.

Be sure to follow the instructions on placing C84 under the board as directly as possible between pins #1 and #4; the capacitor leads must in this case be very short.

Thank you for purchasing this VHF Engineering kit. We hope you will get as much pleasure and satisfaction out of building and using this unit as we have from designing it for you. Please read all of the enclosed material carefully. Unlike kits which are produced for the general public, this kit was designed for the ham who has some home-brew experience and technical knowledge. If you encounter problems in alignment or testing, don't hesitate to obtain assistance from a competent fellow ham near you or here at VHF Engineering.

Bob Brown Wil Kupfrian Marvin Druskoff

| Bob Brown | Will Kupfrian | Marvin Druskoff |
|---|---|---|
| W2EDN | W2BVA | K2VIV |

The construction techniques and procedures in this manual are very important to the proper and easy building of VHF Engineering kits. If your previous experience has been with unminiaturized equipment the following information should prove invaluable. To build miniaturized equipment using P.C. boards requires extra patience and care, normal dexterity, and the proper tools for the job.

## GENERAL NOTES

A. A good soldering job is essential to the satisfactory performance of this unit. Soldering to etched circuit boards is easier than conventional point to point wiring when it is done correctly.

Use rosin core solder only (1/16'' or smaller is easiest to work with). Acid core solder or paste fluxes will cause corrosion and void all warranties. Use a clean, freshly tinned soldering iron of about 30-35 watts. (A controlled temperature type is preferred). A small tip will greatly reduce bridging and similar problems.

When soldering a part to the P.C. board, the solder must completely surround the wire lead where it comes through the board. Do not apply excessive solder, but do not hesitate to apply sufficient heat to assure a smooth flow of solder all around the lead and onto the board. Do not worry about overheating semiconductors. It is likely that P.C. board lands will be lifted long before a semiconductor device is damaged.

B. Leads on resistors, capacitors, transistors etc. are often longer than required. These leads should be trimmed as short as possible unless specific directions to the contrary are given in the instructions.

As a general rule all parts should be mounted as close to the board as possible. In the case of capacitors it may be necessary to scrape the body coating off of the leads to allow the bottom of the capacitor to rest on the board.

C. Inspect your work after each step and check off the steps as they are completed. You will find it helpful to check off capacitors, resistors, etc. on the parts list as they are installed. This will save you time and mistakes.

D. Check and double check the direction in which polarized components should be installed. In particular, take great care when inserting transistors, I.C.'s, electrolytic and tantalum capacitors etc. Remember the old carpenters rule ''Measure twice and cut once''.

# PARTS IDENTIFICATION

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. For example; 4.7 MFD for 5 MFD; .022 MFD for .02 MFD. Such substitutions are carefully checked before they are approved and the parts supplied will function satisfactorily. These changes are usually self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Each manufacturer seems to have his own method of marking for similar parts. In order to eliminate confusion about reading values marked on components, the following examples are presented.

DISC CERAMIC CAPACITORS - value and a tolerance letter printed on body. For example: 2.2C=2.2PF ± 1/4pf; 5D=5pf ± 1/2pf; 12J=12pf ± 5%; 680K=680pf ± 10%; 1000p=.001 Mfd; 104p=10000pf= .1 Mfd. Please note that the letters on capacitors do NOT denote a multiplier, they indicate tolerance only.

SILVER MICA (SM) CAPACITORS - value and tolerance are coded on the body of the device. For example: 220J03=22pf ± 5%; 330J03=33pf ± 5%; 221J03=220pf±5%; 331J03=330pf ±5%. Actual value may also be printed on the body. This should be self-evident.

ELECTROLYTIC AND TANTALUM CAPACITORS - the value is printed on the body of the device. There are several shapes and sizes the only odd one which we use is a tantalum which is shaped like a drop of water. BE SURE THAT YOU OBSERVE POLARITY MARKINGS.

RESISTORS - are color coded. Be very careful, when reading codes, not to confuse red and orange, brown and orange, violet and grey etc. When in doubt, check values with an ohmeter.

R. F. CHOKES - read color code as follows:

1. Start reading from wide silver band.
2. The next group of bands indicate significant figures.
3. When a gold band appears in the significant figure grouping it should be read as a decimal point.
4. Last band indicates tolerance: gold=5% silver=10% None=20%

Examples:
wide silver/ gold/ orange/ orange = .33 uhy20%
wide silver/ brown/ black/ black/ gold = 10 uhy 5%
wide silver/ blue/ grey/ brown/ gold = 680 uhy 5%
wide silver/ yellow/ gold/ purple/ silver = 4.7 uhy 10%

COIL WINDING: Follow our coil data exactly as given in the main part of this manual. When counting turns, be very careful to start with the first complete turn and not the second. For example: when a 3 1/2 turn coil is completed if you look at one side of the coil you will count 3 turns and looking at the other side you will count 4. Be very careful to wind all coils in the same direction.

## CRYSTAL DECK INSTALLATION

1.) Insert the 16 crystal socket pins into the crystal deck from the bare side and press down firmly. It may be helpful to ream the holes slightly in order to make pin insertion easier. When the pins are in place they should protrude from the foil side of the board. Solder the sockets in place. Be very careful not to lift lands or damage the board with excess heat.

2.) Cut 6 one inch pieces of #20 silver plated wire.

3.) Orient the small P.C. board so that the foil side is facing you and the largest ground plane is to your right.

4.) Put one of the 6 precut wires into each of the 6 lower holes in the crystal deck. About 1/16 inch should protrude from the bare side of the board. Bend each wire tightly down against both sides of the board. Refer to fig. 2 for proper final configuration. These wires serve as both circuit connections and mounting studs for the crystal deck.

5.) Mount the channel selector switch on the bare side of the board and solder all 14 points. It can be mounted in only one way.

6.) Insert the 6 mounting wires into the main board and press the crystal deck assembly down firmly. Shift the deck until both edges line up with the main board. Solder the 6 mounting wires to the main board and cut off excess wire.

7.) Solder all 6 mounting wires on the crystal deck. Check carefully for solder bridges.

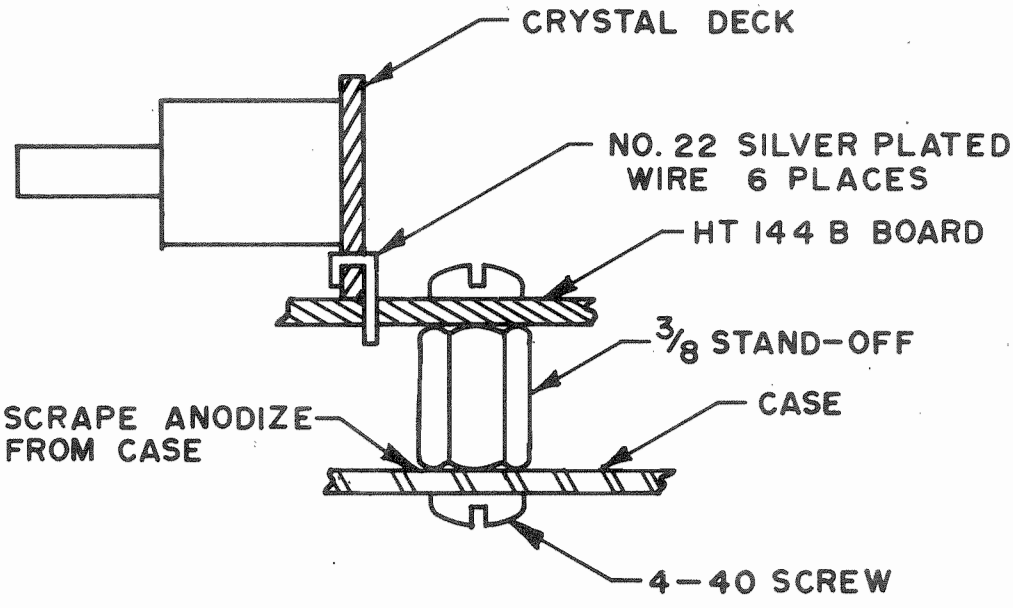



Fig. 2

## MAIN BOARD PARTS MOUNTING

IMPORTANT NOTE: The latest additions and engineering changes are shown on the printed parts layout (fig. 1). In all cases where the silk screen layout on the P.C. board and the printed layout disagree - the printed layout is correct.

The parts are packaged in groups of like components as shown on the parts list to help sorting and identification. There are many important points given in the step by step proceedure which are NOT shown on the parts layout etc. Read through each step before starting and check off each step when completed. This will save time and help you avoid mistakes.

As a general rule component lead lengths should be as short as possible. It may be necessary to remove excess coating from some of the capacitor leads. All components which must be polarized are marked both on the component and on the printed parts layout (fig. 1).

1.) Mount the push to talk switch as shown in fig. 1. Press down firmly into the board and solder all 6 lugs to the foil side of the board.

2.) Cut off all of the solder lugs on top of the switch except for the center lug on the side closest to L2 on the boards. This will be the antenna connection point.

3.) a.) Mount the 4 plastic trimmer capacitors ( C51, C52, C53, C54 ).
b.) Mount the 2 ceramic trimmers ( C72, C73 ). There are several possible styles furnished. They will all fit the board with a small amount of preparation.

4.) a.) Mount the white ( L1, L2, L3, L4, L8, and L9 ) and the blue ( L6, L7 ) pre-wound coils. These coils must be polarized as shown on the printed parts layout. The dot indicates the start of the winding ( see detail on fig. 1 ). Cut off the small plastic tab on the side of each coil form before mounting.
b.) Mount the 11.155 crystal ( Y1 ) and the filters ( 2 metal crystal can types and one plastic covered type. )
c.) Mount the 10.7 MHz I. F. transformers, 455 KHz I. F. transformer

5.) a.) Mount all capacitors except C26, C40 and C84 which will be installed later. C65 and C70 are polarized. The polarity is marked on the body. Check off each capacitor on the parts list and you install it. Refer to "parts indentification" for help if you have difficulty in locating some of the capacitors.
b.) Mount C84 a .001 capacitor, on the foil side of the board between pin 1 and pin 4 of IC1. The leads should be as short and direct as possible.

6.) Prepare RFC4 by winding four turns of #30 wire through a ferrite bead. Scrape and tin the leads and mount as shown on fig. 1. The other bead will be used later.

7.) The three final output stage coils ( L10, L11, L12 ) should be close wound. Use #22 enamel coated wire on the shank of a 1/8" drill bit. Scrape and tin the leads and mount the coils flush to the board. Being sure to wind all 3 coils in the same direction.

8.) Prepare and mount Q15 (final output transistor) as follows:
   a.) Place a mark on the main body of the device indicating the position of the collector lead (angle cut).
   b.) Cut off all leads to approxomately 1/16 inch.
   c.) Mount by soldering the leads to the foil side of the board. (The mounting lug projects on the component side of the board). Be absolutely certain that the collector lead which was previously marked is connected to the junction of L10 and L11.

9.) Slip a ferrite bead over the gate 1 lead of transistor Q1 and insert as shown on the parts layout. The bead location is indicated on the parts layout.

10.) Mount the remaining transistors. Orient exactly as shown on fig. 1.

11.) Mount IC1 and IC2 as shown on fig. 1.

12.) a.) Mount diodes D1 through D6 vertically on the board. The body MUST be placed on the circle with the top lead oriented as shown. The color band (indicating the cathode lead) MUST be down.
   b.) Mount D7. Refer to fig. 1 for proper orientation. The silk-screen layout is NOT correct.

13.) Mount RFC1, RFC2 and L5.

14.) Twist one of the leads of C26 and one of the leads of RFC6 together. Solder the two leads and trim off the excess wire. Insert the remaining two leads into the holes provided for C26 in the board. (See fig. 1 inset).

15.) The resistors are mounted as follows:
   a.) R31 should be prepared by soldering C40 across the resistor leads. Use the resistor leads to mount this sub-assembly.
   b.) R13 and R43 should be prepared with a small loop in the top lead to facilitate their use as test points during tuneup.
   c.) All the remaining resistors which are on the main board are oriented as shown on the silk-screened layout. Be sure that the body is placed on the circle and the top lead is oriented as shown on the layout.
   d.) Mount C84, a .001 capacitor, on the foil side of the board between pin 1 and pin 4 of IC2. The leads should be as short as possible and go directly to the point where the IC leads connect.
   e.) Mount C85 a 10pf disc, on the foil side of the board - across varactor D7. The leads should be as short and direct as possible.

16.) R39, RFC3 and RFC5 are mounted on the foil side of the board as shown in fig. 3. Use tubing on the leads to prevent shorts.

NOTE: The wire furnished for jumpers is Teflon covered. Be careful when stripping not to damage the wire itself. A good pair of wire strippers (not cutters or pliers) is needed. You may find Teflon somewhat difficult to install but it will not melt from heat and will make later servicing easier.

17.) a.) Bend the lugs on the volume and squelch controls up away from P.C. board. See detail on fig. 3 for the proper final configuration of this bend.

b.) Install the jumper wires on the foil side of the board as shown in fig. 3. Install the speaker wires but do not connect the speaker at this time. DO NOT orient these wires in such a way as to block the speaker mounting hole. Be very careful when soldering to the volume and squelch controls. They can be permanently damaged by excess heat.

c.) Install the battery connector by passing the black and red leads through both of the strain relief holes adjacent to C29 (see fig. 3). Solder the red lead to the B+ feed point. Pull any access wire back through the strain relief leaving some slack in the red wire. Cut the black lead 3/4 inch from the strain relief and solder to the ground plane.

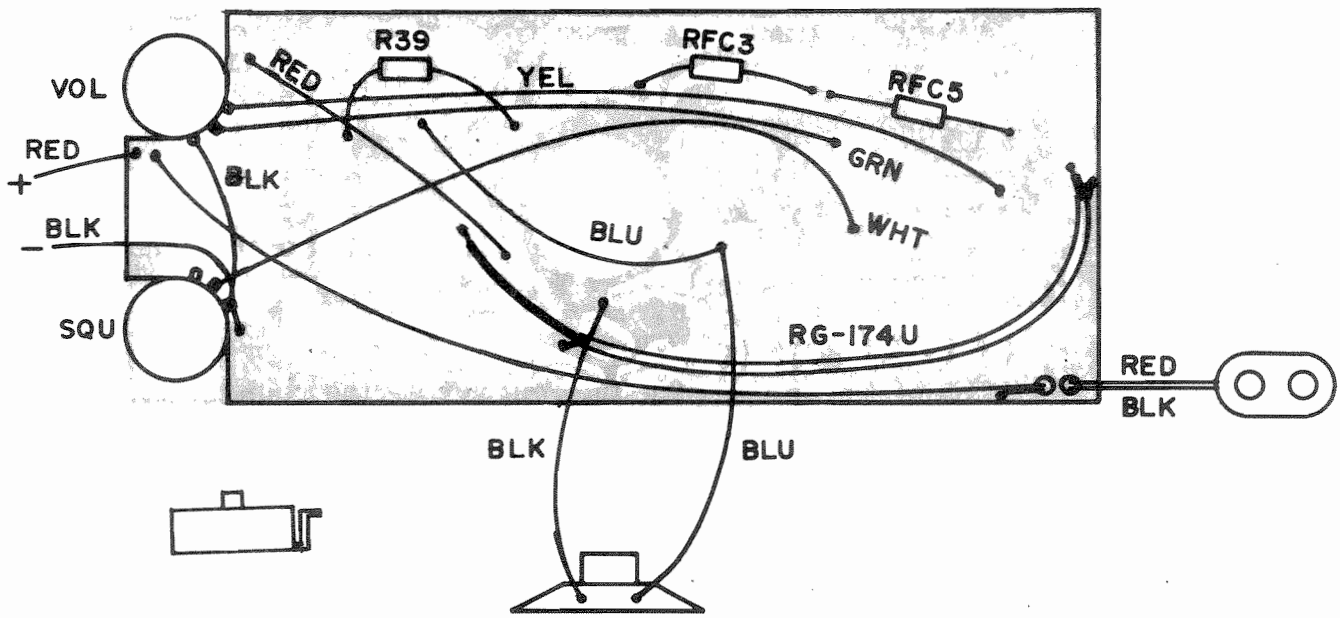



fig. 3 Bottom view of board

18.) Using Teflon wire, install three jumper wires on the component side of the board as follows:

a.) Red wire from the junction of R38 and R45 (near S1) to the junction of C69 and C70 (near Q15).

b.) White wire from the hole between D5 and R8 (near S1) to the hole between C34 and R31.

c.) Yellow wire from the hole near C55 and R40 (base connection of Q15) to the top center pin of the crystal switch.

Be sure none of the above jumpers blocks the speaker cutout. They need not be tight but only as short and direct as possible.

CHECK ALL JUMPER WIRES TO BE SURE THAT THEY ARE PROPERLY INSTALLED. This is also a good time to check for cold solder joints, bridges etc.

19.) Install crystals following the switch and trimmer layout in fig. 4. It is possible to jumper receive crystal positions if two positions will be used on the same frequency. For example: 34-94 and 94-94 can use the same crystal in the receive side of the deck. Use fine wire (Teflon insulation is best) and avoid solder bridges.

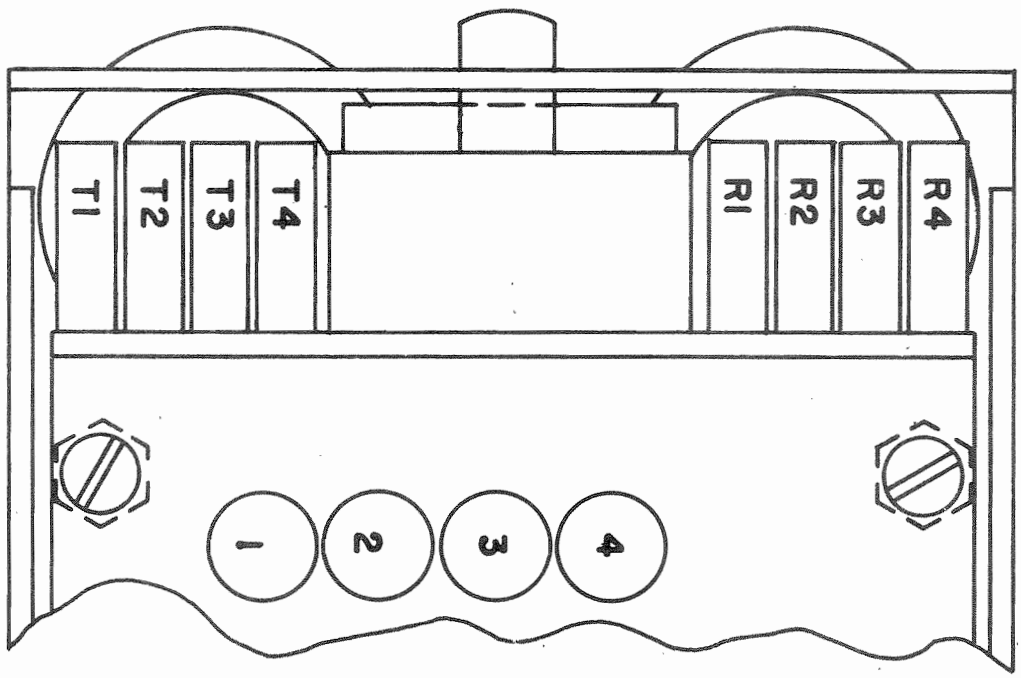



fig. 4 Crystal Location

## BOARD INSTALLATION AND FINAL HOOKUP

1.) Check the circuit board very carefully for solder bridges and cold solder connections.

2.) Scrape the black anodize from the areas inside the case around the four P.C board mounting holes. Install the 3/8'' stand offs in the case. Use the 4/40 × 3/4'' screw in the lower right position (viewed from the back of the case). The other three stand offs are mounted using 4/40 × 1/4'' machine screws. See fig. 2.

3.) a.) Cover the back of the speaker with black electrical tape to eliminate possible shorts after it has been installed. This also raises the resonant frequency of the speaker to improve transmit audio.
b.) Cut the black and blue speaker leads to about 2 1/2 inches. Solder the leads to the speaker.
c.) Carefully press the rear of the speaker through the mounting hole. Be sure that no leads are shorted when installing the speaker.

4.) Install the knobs on the squelch and volume controls using the two screws provided.

5.) Affix a piece of grill cloth over the speaker slots inside the cover.

6.) The board is installed in the case by sliding the controls into their slots and then dropping the back end of the board onto the spacers. Be sure that the two power connecting leads are pulled up and will be accessible after installation. Care must be taken to avoid pinching jumper wires between the P.C. board and the stand offs.

7.) Secure the board into the case. Use 4/40 × 1/4'' machine screws in three positions and the 3/4 inch stand off in the fourth position where the long machine screw was previously installed. This will be used for mounting the antenna which will be installed in a later step.

8.) Cut off the two side lugs on the female Nicad charging plug. Do not cut off the center pin solder lug. Mount the jack using 2 - #2 × 1/4'' self-tapping screws.

9.) Solder the red B plus lead from the main board to the charger plug center lug.

10.) Solder the black (ground) lead from the main board to the side of the charging plug. Note that there is no lug. This wire must be soldered directly to the plug ground strap. Be sure to scrape and tin the strap before soldering.

## TUNING PROCEEDURE

The unit may be tuned before installing the antenna.

RECEIVER TUNING:

1.) Connect a signal generator to the antenna lug on the push to talk switch.

2.) Turn squelch control full C.C.W. (off).

3.) Connect battery.

4.) Turn unit on and set volume at one half. Background noise should be heard at this point. If it is not turn the unit off and check again for proper construction (cold joints, solder bridges etc.).

5.) Set the generator to the frequency which has been selected with the channel switch.

6.) Advance generator attenuator to give 50 % quieting signal from the speaker. Rock the generator through the receiver bandpass to be certain that it is centered on the frequency selected.

7.) Adjust all coils and transformers in receiver for maximum quieting. Be sure to compensate for increased gain by reducing the signal generator level to keep the signal well into the noise.

NOTE: Use a non-metallic tool for ALL tuning adjustments.

8.) Repeat steps 6 and 7 until no further improvement is possible.

9.) If a scope is available the following may give a small improvement in performance: Connect the scope probe to the base of Q6 (This is easily accessible at the top lead of R13). Increase the output of the signal generator until about a .1 volt peak to peak signal is seen on the scope. Adjust all coils and transformers for maximum signal.

10.) T1 and T2 may be adjusted for maximum fidelity using an on the air signal. Adjust for best clarity while listening to the audio quality. One half turn in either direction should be sufficient.

11.) If a sweep generator and scope are available connect the scope to the base of Q6 (top of R13) and the generator to the antenna input. Tune the generator to the channel selected and sweep 20KHz or more. Align T1 and T2 for a flat response curve.

12.) If no alignment equipment is available, reasonable good results can be obtained by using an on the air signal for alignment. Use the weakest possible signal and align all coils and transformers for maximum.

## TRANSMITTER TUNING

1.) Connect a 50 OHM dummy load and watt meter to the antenna lug of the push to talk switch. A #47 bulb can be substituted if a dummy load and watt meter are not available.

2.) Connect a D.C. volt meter between the emitter of Q14 (at the top lead of R43) and ground.

3.) Depress PTT button. Using a non-metalic alignment tool align L6 and L7 for maximum reading on the volt meter. This should be .5 volts or more.

4.) Tune L8 and L9 for maximum output on watt meter.

5.) Adjust C72 and C73 for maximum output on watt meter.

6.) Repeat steps 3, 4 and 5 until no further improvement is possible.

7.) The transmit frequencies maybe adjusted using the four trimmer capacitors adjacent to the small crystal deck board (see fig. 4 for the sequence of these trimmers). A non-metalic alignment tool MUST be used for these adjustments.
   a.) The preferred method is to use an accurately calibrated frequency meter.
   b.) An alternate method is an on-the-air check with a friend who has a receiver equipped with a discriminator meter. He can talk you into desired frequency.

8.) If a deviation meter is available adjust R53 for 5 KHz peak deviation. If no meter is available adjust for normal audio level on the air.

## ANTENNA INSTALLATION

1.) Insert the rubber grommet into the 3/8" hole in the case.

2.) Push the lower end of the antenna through the cable clamp furnished. Put the antenna through the grommet and secure the cable clamp to the 3/4 inch spacer previously installed. Use a 4/40 × 1/4" machine screw.

3.) Connect the antenna to the antenna lug on the push to talk switch using as short a lead as possible. This connection should be made directly adjacent to the switch, not to the end of the antenna. Prepare the antenna for soldering by filing off the chrome coating at the point of connection.

## COVER INSTALLATION

1.) Remove the backing paper from the foam pad. Place the pad inside the cover at the lower end. This serves to hold the battery pack firmly when the cover is installed.

2.) Carefully but firmly remove the button from the push to talk switch. A pair of pliers may be helpful. BE SURE TO PULL STRAIGHT OUT. Set aside the button. It will be installed after the cover is installed. Using a pair of wire cutters snip off the end of the switch plunger at the first notch. This will leave one notch remaining.

3.) Place the battery pack into the bottom of the case. Be sure that it is oriented in such a way that shorting of any of the battery leads and studs to the case is impossible.

4.) Place the cover over the case with the switch hole aligned with the switch. Depress the PTT switch and move the cover down over the case until the mounting holes are lined up. Secure the case and cover using 4 - 4/40 × 1/4 inch screws.

5.) Install the button on the PTT switch by pressing it through the hole provided. Press carefully but firmly until it "clicks" onto the switch plunger.

6.) If is necessary to remove the cover for adjustment simply reverse the above procedure

# THEORY OF OPERATION

## GENERAL

The HT-144 B "HAND TRANSCEIVER" is a complete 2-meter, 4-channel, crystal-controlled, battery-operated transceiver. The main circuit board and the four-channel crystal deck are both G-10 epoxy. Extremely low standby current is achieved by operating several stages in D. C. series.

## RECEIVER

The receiver is a dual conversion superheterodyne with a 1st I. F. of 10. 7 MHz and 2nd I. F. of 455 KHz. Q1 is a diode protected dual-gate MOS-FET which provides about 20 db. of gain with good cross modulation characteristics. The output of the R F amplifier is capacitively coupled to the first mixer (Q3). The local oscillator (Q2) is a modified Colpitts with the collector tuned to the third harmonic of the crystal frequency. The mixer and local oscillator are connected in D. C. series. The oscillator injection voltage is fed to the mixer via the mutual coupling between L3 and L4.

The 10. 7 MHz output of the first mixer is passed through the two-section four-pole monolithic crystal filter, and coupled to the base of the second mixer. The second mixer and oscillator are connected in D. C. series.

T3 couples the 455KHz difference signal to the base of the first 455 KHz I. F. amplifier (Q6). Q6, Q7, Q8, and Q9 are RC. coupled and connected in D. C. series. These four cascaded stages provide over 100 db of gain. As a result of this high gain the last stage is always saturated. This insures excellent AM. rejection.

The 455 KHz discriminator uses a high Q ceramic resonator which requires no tuning. The design center of the resonator is placed adjacent to the I. F. band pass. The resultant output voltage of the detector diodes resembles the familiar discriminator "S" curve.

The output of the discriminator is coupled to the audio I. C. through the volume control. The squelch amplifiers are coupled with relatively small capacitors, therefore amplifying only the high-frequency noise present when no signal is being received. The noise signal is rectified by a voltage doubler (D3 and D4) and applied to the squelch switch Q10. Q10 is saturated by the detected noise signal which effectively grounds pin 2 of the audio I. C., removing its operation bias. This causes the receiver to mute when no signal is present. A 455 KHz trap (L5 and C47) in the emitter of the first noise amplifier prevents strong signal feed through from squelching the receiver.

The audio output I. C. is capable of approximately . 5 watt output into an 8 ohm load.

TRANSMITTER

IC2 is a 3 stage cascaded audio amplifier. It is biased to assure that cut-off and saturation occur at the same point. This design parameter was chosen to produce symmetricalclipping. Q16 is an active low-pass filter which attenuates audio frequencies above 3 KHz.

Deviation control R53 establishes the level of audio applied to a variable capacitance diode (Varicap D-7). This diode is in series with the crystal in a modified Colpitts oscillator circuit. (Q13 and related components). The variable trimmers in series with each crystal allow fine adjustment of the oscillator frequency (netting). Operating bias applied to the oscillator and Varicap is regulated by Zener diode D6.

The collector of the oscillator is tuned to the fourth harmonic of the 18 MHz crystal frequency. Doubler-driver Q14 delivers over 150 MW at the final output frequency. Q15 operates as a straight through class C amplifier with over two watts output.

## BATTERY INFORMATION

Several types of batteries can be used in the HT-144B.

1.) 8 - AA size standard batteries
2.) 8 - AA size rechargeable alkaline
When using 8 standard or 8 alkaline batteries 2 sections of the battery holder must be jumpered in order to provide proper voltage to the HT-144B.
3.) 10 - AA size rechargeable Nicads
4.) Our model BP - 12 Nicad pack

Normal Nicad charging rate is 40 - 50 Ma. Any 14 - 26 volt power supply can be used for charging Nicads if a limiting resistor is used. The current must be limited to 40 - 50 Ma. A 25 V supply with a 500 ohm series resistor would be ideal. The batteries may be charged when the receiver is turned on. However the charging rate will be reduced by approxomately 25 %.

# RECEIVER TROUBLESHOOTING

## SET CONTROLS AS FOLLOWS:

Volume - Rotate 1/2 way  Squelch - Fully ccw. until switch clicks

## I. NO AUDIO, RECEIVER COMPLETELY INOPERATIVE

A. Inject a signal into the audio amplifier by touching the top of R28 or R32 with a metal object held in your hand (screw driver blade etc.). If a loud buzz is heard in the speaker, the amplifier is functioning properly, - go directly to step I. - C.

B. If no buzz is heard, check the voltage at pins 2 and 3 of IC - 1. This should be approximately 1.2 volts. The voltage at pin 6 should equal about 1/2 of the supply voltage (be sure the squelch is off). If this voltage is not present, check for shorts, misplaced components or a shorted Q10. If these checks do not show any trouble then the I.C. must be defective.

C. Check the D.C. voltage at the junction of R22 and D1. A voltage of over .6V. D.C. indicates a bad or improperly installed diode. A positive voltage of .6 Volts D.C. indicates that the diodes are conducting normally and that the 455 KHz amplifier is not functioning properly. A negative voltage indicates that the 455 KHz I. F. circuit is working normally and the trouble is in the volume control circuitry.

D. The four 455 KHz I. F. amplifiers are connected in D.C. series. If one stage opens, all stages will be inoperative. Each stage operates on about 3 volts D.C. Therefore, the voltage on Q7 emitter will be 3 volts, Q8 emitter will be 6 volts, Q9 emitter will be 9 volts. If these voltages are not present, check each transistor and it's associated circuitry.

## II. AUDIO NOISE PRESENT, NO SIGNALS RECEIVED

A. The overall gain of the four 455 KHz I. F. stages is approximately 100 db. Touching the base of Q6 (test point at top of R13) with a screw driver blade will usually bring in strong local A.M. radio stations. This indicates that the stages are operating normally.

B. Inject a 10.7 MHz unmodulated signal at the junction of FL1 and T1. A 20 micro volt signal should give approximately 20 db.of quieting. If the 10.7 MHz signal produces quieting proceed to step II. - D.

If the 10.7 signal fails to effect quieting check the 10.7 filters, second crystal oscillator and mixer circuits.

C. The voltage measured at the emitter of Q4 should be 6 volts. If this voltage is correct, C19, C20 or the 11.155 crystal may be defective. If this voltage is absent or too high, check Q4, Q5 and associated circuitry.

D. Check the voltage on the emitter of Q3. 5 to 6 volts indicates that Q2 and Q3 are operating properly and that the problem is likely to be in the first oscillator circuit. If the voltage is absent or too high, check Q2, Q3 and associated circuitry.

E. Check the DC voltage at the hot side of the crystal in use. A reading of .6 volts is normal. No voltage indicates a short or open in the wiring, crystal switch or circuit board. The crystal oscillator circuit may be checked with a voltmeter and R. F. voltmeter. Reading should be as follows:

| | | | |
|---|---|---|---|
| 1. | Q2-base | .6 VDC | .2 VRF |
| 2. | Q2-emitter | 0 VDC | 3 VRF |
| 3. | Q2-collector | 6 VDC | .2 VRF |

Correct DC voltage reading but lack of any R. F. voltages indicates a bad crystal.

III. AUDIO OK, SIGNALS RECEIVED, BUT POOR SENSITIVITY

A. Connect a signal generator to the top of L3. A 3 uv signal (at the channel frequency) should give 20 db.of quieting. If more than 3 uv is required, check the filters (FL1 and FL2), associated circuitry and alignment. If these all check o.k. go back to step II - B.

B. If 3 uv or less produces quieting, the problem should be found in the RF stage.

C. Check the voltages on Q1 as follows:

| | | |
|---|---|---|
| 1. | drain (junction of C5) | 12 volts |
| 2. | source (junction of C4) | .5 volts |
| 3. | gate 2 (junction of R1) | 2 volts |
| 4. | gate 1 (junction of L1) | 0 volts |

If the above voltages are not correct, check the associated circuitry. If they are correct, replace Q1.

IV. AUDIO OK, SIGNALS RECEIVED, SENSITIVITY OK, SQUELCH INOPERATIVE

A. The voltage at the junction of D3 and C41 should vary from 0 to .6 volts as the squelch control is advanced from off to full-on position.

B. If this voltage swings properly, check for open Q10 and associated circuitry.

C. If no voltage is present, check the diodes for open, shorts or improper polarity.

D. If the diodes check - o.k., measure the voltage at the emitter of Q11. This voltage should read 6 volts. If a voltage significantly less or greater than 6 volts is found, check the noise amplifiers Q11, Q12 and associated circuitry.

# TRANSMITTER TROUBLE SHOOTING

## I. NO R. F. OUTPUT

Check the D.C. voltage from the top of R43 to ground. A reading of .5 volts or more indicates that the oscillator (Q13) and base of the doubler (Q14) are functioning properly. The trouble will be found in the collector circuit of Q14 or in the output stage. A low or zero reading indicates that the trouble is in the oscillator or Q14 base circuitry.

The following voltage chart will assist you in locating the problem.

| | Q15 | Q14 | Q13 |
|---|---|---|---|
| Collector | 12 VDC - 5 VRF | 12 VDC - 5 VRF | 12 VDC - 4 VRF |
| Base | .7 VDC - .6 VRF | 0 VDC - 1.5 VRF | 4 VDC - 1.8 VRF |
| Emitter | None - | 7 VDC - 0 VRF | 2 VDC - 1.2 VRF |

## II. NO MODULATION

Check the audio signal at the emitter of Q16 with an oscilloscope. If a signal of about 6 volts peak-to-peak is present when talking directly into the speaker, check the Varicap diode (D7) and associated circuitry. If no signal is present, connect the scope probe to the output (pin 3) of I.C. 2. If a peak to peak signal of about 6 volts is present, check Q16 and associated circuitry. If no signal is present, check I.C. 2 and associated circuitry.

VOLTAGE CHART - I.C. 2

Pin 1 - .6 VDC
Pin 2 - 11.5 VDC
Pin 3 - 5.8 VDC
Pin 4 - 0 VDC

# HT-144B PARTS LIST

| | | | | | |
|---|---|---|---|---|---|
| C1 | 15 pf | C42 | .022 | R1 | 22 k |
| C2 | 47 pf | *C43 | 5-16 V | R2 | 330 |
| C3 | .001 | C44 | .001 | R3 | 100 k |
| C4 | .001 | C45 | .001 | R4 | 100 |
| C5 | 10 pf | C46 | 220 pf | R5 | 470 k |
| C6 | .001 | C47 | 220 pf | R6 | 100 |
| C7 | 1 pf | C48 | .001 | R7 | 470 k |
| C8 | 27 pf | C49 | .001 | R8 | 100 |
| C9 | 10 pf | C50 | .022 | R9 | 470 k |
| C10 | 33 pf | C51 | 20 pf VAR | R10 | 470 k |
| C11 | 22 pf | C52 | 20 pf VAR | R11 | 1 k |
| C12 | 15 pf | C53 | 20 pf VAR | R12 | 100 |
| C13 | .001 | C54 | 20 pf VAR | R13 | 56 k |
| C14 | .001 | C55 | 220 pf SM | R14 | 2.2 k |
| C15 | .022 | C56 | 220 pf SM | R15 | 56 k |
| C16 | 3.3 pf | C57 | 27 pf | R16 | 2.2 k |
| C17 | 33 pf | C58 | .022 | R17 | 56 k |
| C18 | 5 pf | C59 | 2.2 pf | R18 | 2.2 k |
| C19 | 100 pf | C60 | 33 pf | R19 | 56 k |
| C20 | 33 pf | C61 | 150 pf | R20 | 1 k |
| C21 | .1 | C62 | .001 | R21 | 2.2 k |
| C22 | .022 | C63 | 5 pf | R22 | 220 k |
| C23 | .001 | C64 | .001 | R23 | 100 |
| C24 | .001 | *C65 | 1-16 V | R24 | 6.8 k |
| C25 | .022 | C66 | 3.3 pf | R25 | 6.8 k |
| C26 | 220 pf in series | C67 | 10 pf | R26 | 680 k |
| C27 | .022 with RFC6 | C68 | 120 pf | R27 | 100 k |
| C28 | .001 | C69 | .001 | R28 | 10 k |
| C29 | .022 | *C70 | 1-16 V | R29 | 10 k pot |
| C30 | .001 | *C71 | 47-16 V | R30 | 2.2 k |
| *C31 | 1-16 V | C72 | 40 pf VAR | R31 | 1.5 m across C40 |
| C32 | .022 | C73 | 40 pf VAR | R32 | 510 k |
| *C33 | 22-16 V | C74 | 22 pf SM | R33 | 100 |
| C34 | .1 | *C75 | 5-16 V | R34 | 470 k |
| *C35 | 100-16 V | C76 | .01 | R35 | 2.2 k |
| C36 | .1 | C77 | .005 | R36 | 470 k |
| C37 | 220 pf | C78 | .1 | R37 | 10 k pot |
| C38 | 220 pf | C79 | 30 pf | R38 | 330 |
| C39 | .022 | C80 | 30 pf | R39 | 47 k under board |
| C40 | 100 pf across R31 | C81 | 30 pf | R40 | 2.2 k |
| *C41 | 5-16 V | C82 | 30 pf | R41 | 4.7 k |
| | | C83 | .001 | | |
| | | C84 | .001 under board | | |
| | | C85 | 10 pf | | |

All capacitors values are in mfd unless otherwise noted.

* OBSERVE POLARITY on the following capacitors: C31, C33, C35, C41, C43, C65, C70, C71, C75.

| | |
|---|---|
| R42 | 120 |
| R43 | 10 |
| R44 | 10 |
| R45 | 100 |
| R46 | 100 k |
| R47 | 15 k |
| R48 | 2.2 k |
| R49 | 4.7 k |
| R50 | 15 k |
| R51 | 15 k |
| R52 | 2.2 k |
| R53 | 5 k pot |
| | |
| Q1 | 3N204 |
| Q2 | 2N5222 or MPS6539* |
| Q3 | 2N5222 or MPS6539* |
| Q4 | 2N5222 or MPS6539* |
| Q5 | 2N5222 or MPS6539* |
| Q6 | MPS6513 |
| Q7 | MPS6513 |
| Q8 | MPS6513 |
| Q9 | MPS6513 |
| Q10 | MPS5172 |
| Q11 | MPS5172 |
| Q12 | MPS5172 |
| Q13 | 2N3866 |
| Q14 | 2N3866 |
| Q15 | 2N5589 |
| Q16 | MPS5172 |
| | |
| IC1 | MFC6070 |
| IC2 | TAA-263 |

* Matched Hfe to ± 10 %

| | |
|---|---|
| D1 | 1N34 |
| D2 | 1N34 |
| D3 | 1N34 |
| D4 | 1N34 |
| D5 | 15 V. Zener 1N4744 |
| D6 | 5.6 V. Zener 1N4734 |
| D7 | Varicap MV 2209 |
| | |
| T1 | 10.7 IF. transformer pink |
| T2 | 10.7 IF. transformer pink |
| T3 | 455 KHz IF. transformer yellow |
| | |
| L1 | 3 1/2 T white coil |
| L2 | 3 1/2 T white coil |
| L3 | 3 1/2 T white coil |
| L4 | 3 1/2 T white coil |
| L5 | 680 UH choke |
| L6 | 6 1/2 T blue |
| L7 | 6 1/2 T blue |
| L8 | 3 1/2 T white |
| L9 | 3 1/2 T white |
| L10 | 5 T #22 1/8'' I.D. close wound |
| L11 | 6 T #22 1/8'' I.D. close wound |
| L12 | 6 T #22 1/8'' I.C. close wound |
| | |
| FL1 | 10.7 MHz IF. filter 4410 or 2195 |
| FL2 | same FL1 |
| FL3 | ceramic filter TF-02 or BFB-455 |
| | |
| Y1 | 10.245 or 11.155 crystal |
| | |
| RFC1 | 4.7 UH choke |
| RFC2 | 100 UH choke |
| RFC3 | 100 UH choke (under board) |
| RFC4 | 4 T #30 looped through a FB |
| RFC5 | 100 UH choke (under board) |
| RFC6 | 680 UH choke in series with C26 |
| S1 | DPPT push to talk switch |
| S2 | DP4T channel switch |

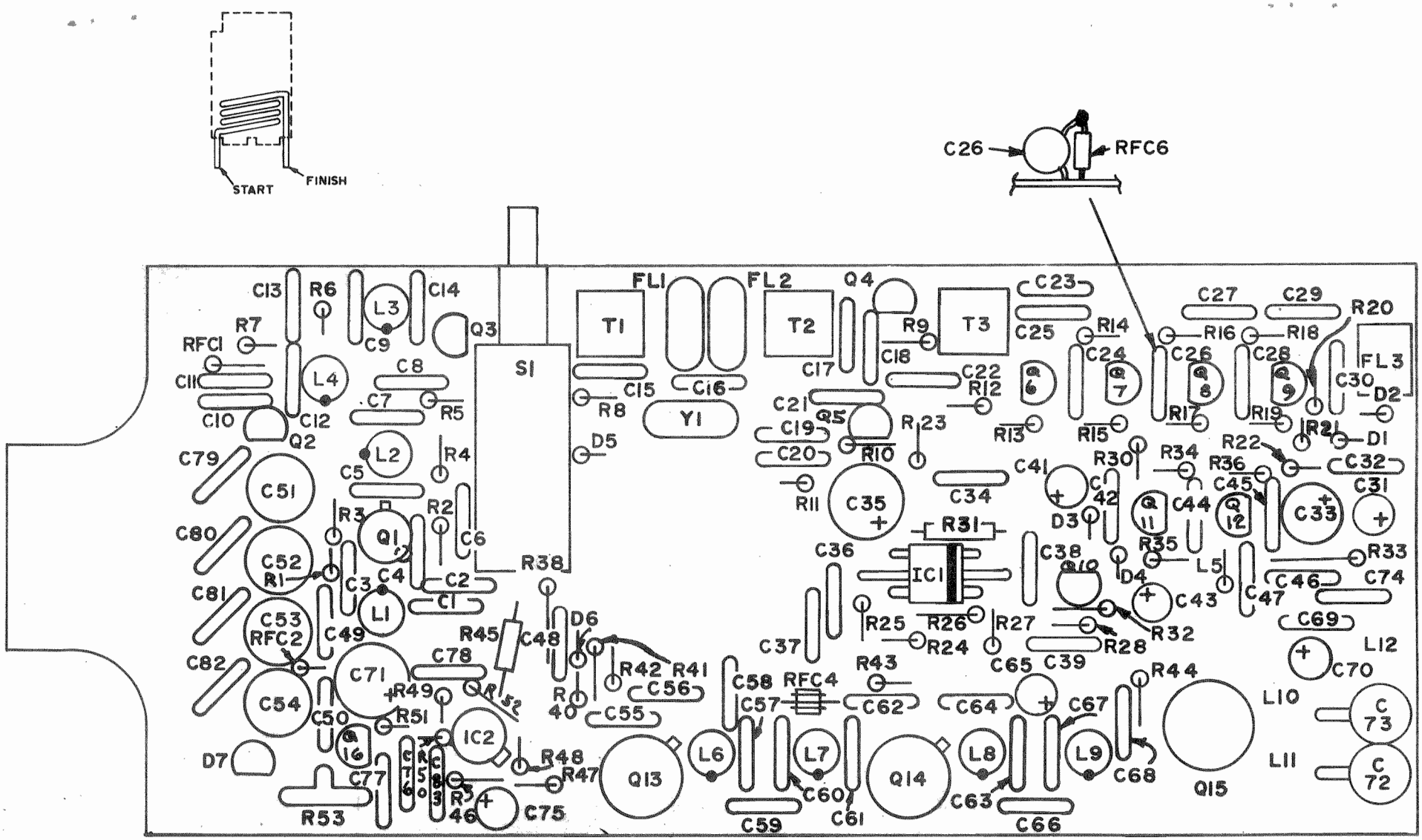
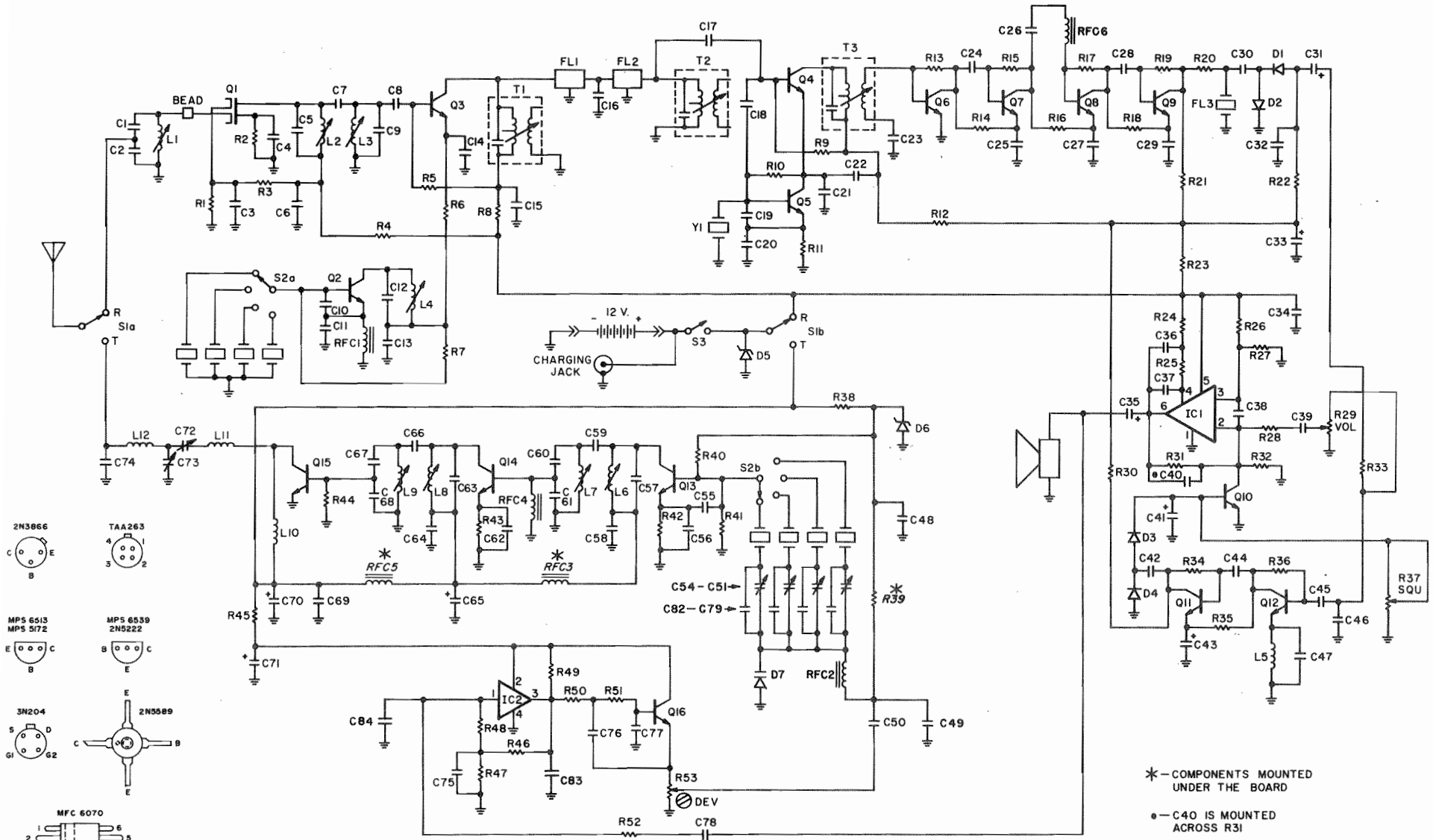

START
FINISH
C26
RFC6
C13
R6
L3
C14
R7
RFC1
Q3
T1
FL1
FL2
T2
Q4
T3
C23
C27
C29
R20
C11
L4
C8
S1
C25
R14
C24
R16
R18
C28
FL3
C10
C12
C7
R5
C15
C16
Y1
C17
C18
R9
C22
R12
C30
D2
Q2
C21
Q5
R23
C19
R10
R13
R15
R17
R19
R21
D1
C79
L2
C5
R4
D5
C20
R11
C35
C41
C34
C42
R30
R34
R36
R22
C32
C45
C31
C51
R3
R2
Q1
C6
R38
C36
R31
IC1
C38
D3
D4
R35
L5
C33
C80
C52
R1
C3
C4
C2
C1
C37
R25
R26
R27
R24
C65
C39
C43
C44
C46
C74
R33
C81
C53
RFC2
L1
C49
R45
C48
D6
R32
R28
C69
C82
C71
C78
R42
R41
C56
C58
RFC4
R43
C70
L12
C54
R49
R52
R40
C57
C62
C64
C67
R44
L10
C50
R51
IC2
C55
C73
D7
C77
R48
R47
Q13
L6
L7
Q14
L8
L9
C68
Q15
L11
C72
R53
R46
C75
C59
C60
C61
C63
C66

Fig. 1

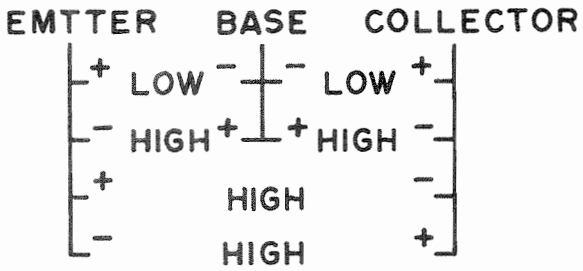



HT 144 B SCHEMATIC

# TRANSISTOR TESTING PROCEEDURE

Use a VOM set on the lowest ohms scale. Connect the test leads as shown in the chart below. If any readings are not as shown the device is defective.

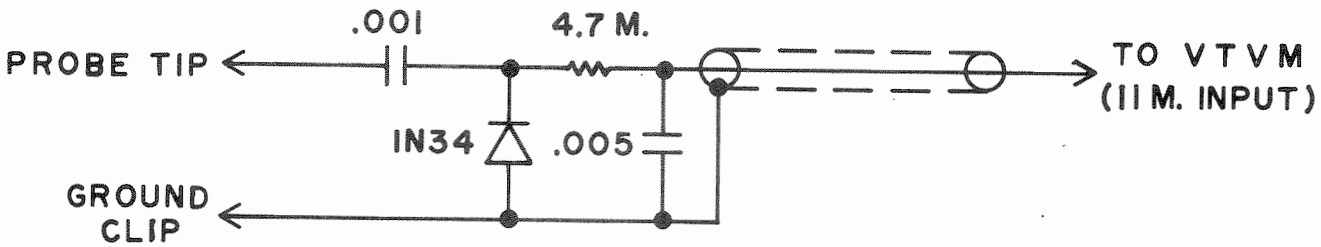
## NPN TRANSISTOR



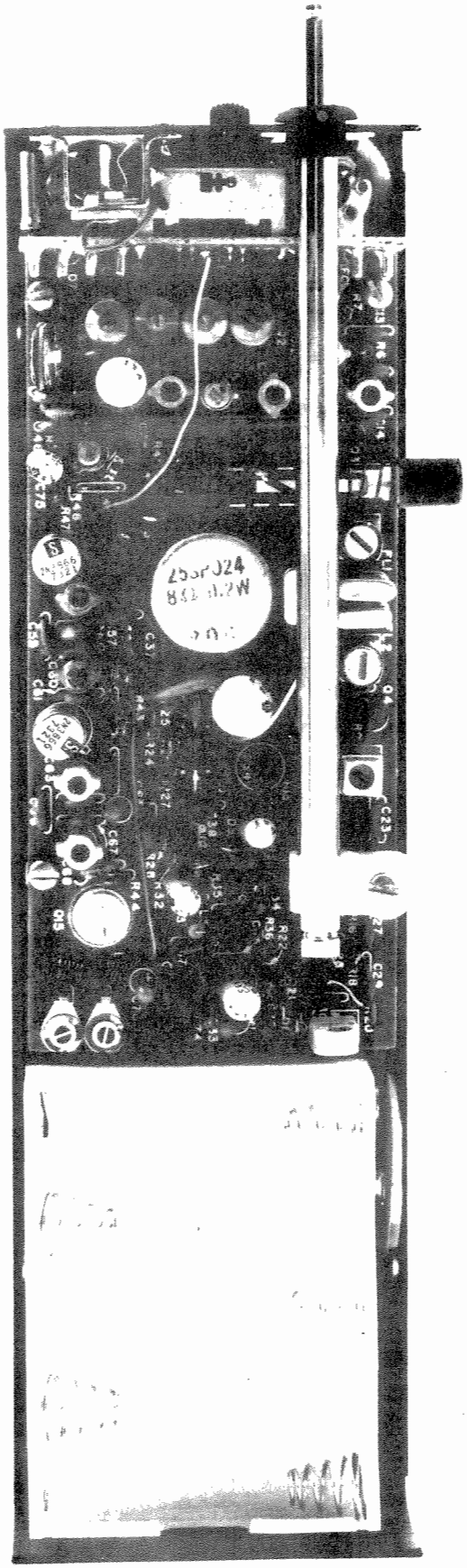

"Low" and "High" are relative resistance indications.
Low is usually less than 50 ohms and High is usually more than 500 ohms

Signs indicate test lead connections
+is red lead - is black lead

Reverse the above signs for PNP devices




## RF TEST PROBE



# Vhf engineering

## THE WORLD'S MOST COMPLETE LINE OF VHF-FM KITS AND EQUIPMENT

### RECEIVERS

| | | |
|---|---|---|
| RX28C | 28-35 MHz FM receiver with 2 pole 10.7 MHz crystal filter | $ 59.95 |
| RX28C W/T | same as above–wired & tested | 104.95 |
| RX50C Kit | 30-60 MHz rcvr w/2 pole 10.7 MHz crystal filter | 59.95 |
| RX50C W/T | same as above - wired & tested | 104.95 |
| RX144C Kit | 140-170 MHz rcvr w/2 pole 10.7 MHz crystal filter | 69.95 |
| RX144C W/T | same as above–wired & tested | 114.95 |
| RX220C Kit | 210-240 MHz rcvr w/2 pole 10.7 MHz crystal filter | 69.95 |
| RX220C W/T | same as above - wired & tested | 114.95 |
| RX432C Kit | 432 MHz rcvr w/2 pole 10.7 MHz crystal filter | 79.95 |
| RX432C W/T | same as above - wired & tested | 124.95 |

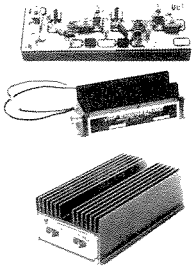
| | | |
|---|---|---|
| RXCF | accessory filter for above receiver kits gives 70 dB adjacent channel rejection | 8.50 |
| RF28 Kit | 10 mtr RF front end 10.7 MHz out | 12.50 |
| RF50 Kit | 6 mtr RF front end 10.7 MHz out | 12.50 |
| RF144D Kit | 2 mtr RF front end 10.7 MHz out | 17.50 |
| RF220D Kit | 220 MHz RF front end 10.7 MHz out | 17.50 |
| RF432 Kit | 432 MHz RF front end 10.7 MHz out | 27.50 |
| IF 10.7F Kit | 10.7 MHz IF module includes 2 pole crystal filter | 27.50 |
| FM455 Kit | 455 KHz IF stage plus FM detector | 17.50 |
| AS2 Kit | audio and squelch board | 15.00 |

### TRANSMITTERS

| | | |
|---|---|---|
| TX50 | transmitter exciter, 1 watt, 6 mtr. | 39.95 |
| TX50 W/T | same as above–wired & tested | 59.95 |
| TX144B Kit | transmitter exciter–1 watt–2 mtrs | 29.95 |
| TX144B W/T | same as above–wired & tested. | 49.95 |
| TX220B Kit | transmitter exciter–1watt–220 MHz | 29.95 |

| | | |
|---|---|---|
| TX220B W/T | same as above–wired & tested | 49.95 |
| TX432B Kit | transmitter exciter 432 MHz | 39.95 |
| TX432B W/T | same as above–wired & tested | 59.95 |
| TX150 Kit | 300 milliwatt, 2 mtr transmitter | 19.95 |
| TX150 W/T | same as above–wired & tested | 29.95 |

### POWER AMPLIFIERS

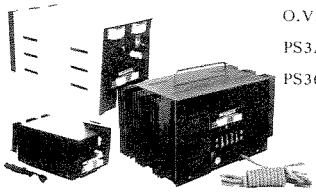


| | | |
|---|---|---|
| PA2501H Kit | 2 mtr power amp–kit 1w in–25w out with solid state switching, case, connectors | 59.95 |
| PA2501H W/T. | same as above–wired & tested | 74.95 |
| PA4010H Kit | 2 mtr power amp–10w in–40w out–relay switching | 59.95 |
| PA4010H W/T. | same as above–wired & tested | 74.95 |
| PA50/25 Kit | 6 mtr power amp, 1w in, 25w out, less case, connectors & switching | 49.95 |
| PA50/25 W/T | same as above, wired & tested. | 69.95 |
| PA144/15 Kit | 2 mtr power amp–1w in–15w out–less case, connectors and switching | 39.95 |
| PA144/25 Kit | same as PA144/15 kit but 25w | 49.95 |
| PA220/15 Kit | similar to PA144/15 for 220 MHz | 39.95 |
| PA432/10 Kit | power amp–similar to PA144/15 except 10w and 432 MHz | 49.95 |
| PA140/10 W/T | 10w in–140w out–2 mtr amp | 179.95 |
| PA140/30 W/T | 30w in–140w out–2 mtr amp | 159.95 |

Blue Line . . . RF power amp, wired & tested, emission–CW-FM-SSB/AM

| Model | Frequency | Power Input | Power Output | |
|---|---|---|---|---|
| BLB 3/150 | 45- 55MHz | 3W | 150W | TBA |
| BLC 10/70 | 140-160MHz | 10W | 70W | 139.95 |
| BLC 2/70 | 140-160MHz | 2W | 70W | 159.95 |
| BLC 10/150 | 140-160MHz | 10W | 150W | 259.95 |
| BLC 30/150 | 140-160MHz | 30W | 150W | 239.95 |
| BLD 2/60 | 220-230MHz | 2W | 60W | 159.95 |
| BLD 10/60 | 220-230MHz | 10W | 60W | 139.95 |
| BLD 10/120 | 220-230MHz | 10W | 120W | 259.95 |
| BLE 10/40 | 420-470MHz | 10W | 40W | 139.95 |
| BLE 2/40 | 420-470MHz | 2W | 40W | 159.95 |
| BLE 30/80 | 420-470MHz | 30W | 80W | 259.95 |
| BLE 10/80 | 420-470MHz | 10W | 80W | 289.95 |

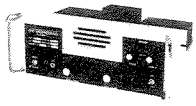
### POWER SUPPLIES



| | | |
|---|---|---|
| PS15C Kit | 15 amp–12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection | 79.95 |
| PS15C W/T | same as above–wired & tested | 94.95 |
| PS25C Kit | 25 amp–12 volt regulated power supply w/case, w/fold-back current limiting and ovp | 129.95 |
| PS25C W/T | same as above–wired & tested | 149.95 |
| PS25M Kit | same as PS25C with meters | 149.95 |
| PS25M W/T | same as above–wired & tested | 169.95 |

| | | |
|---|---|---|
| O.V.P. | adds over voltage protection to your power supplies, 15 VDC max. | 9.95 |
| PS3A Kit | 12 volt–power supply regulator card with fold-back current limiting | 8.95 |
| PS3012 W/T | new commercial duty 30 amp 12 VDC regulated power supply w/case, w/fold-back current limiting and overvoltage protection | 239.95 |

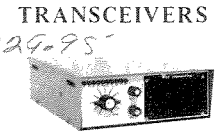
### REPEATERS



| | | |
|---|---|---|
| RPT50 Kit | repeater–6 meter | 465.95 |
| RPT50 | repeater–6 meter, wired & tested | 695.95 |
| RPT144 Kit | repeater–2 mtr–15w–complete (less crystals) | 465.95 |
| RPT220 Kit | repeater–220 MHz–15w–complete (less crystals) | 465.95 |
| RPT432 Kit | repeater–10 watt–432 MHz (less crystals) | 515.95 |
| RPT144 W/T | repeater–15 watt–2 mtr | 695.95 |
| RPT220 W/T | repeater–15 watt–220 MHz. | 695.95 |
| RPT432 W/T | repeater–10 watt–432 MHz. | 749.95 |
| DPLA50 | 6 mtr close spaced duplexer | 575.00 |

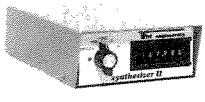
| | | |
|---|---|---|
| DPLA144 | 2 mtr, 600 KHz spaced duplexer, wired and tuned to frequency | 379.95 |
| DPLA220 | 220 MHz duplexer, wired and tuned to frequency | 379.95 |
| DPLA432 | rack mount duplexer | 319.95 |
| DSC-U | double shielded duplexer cables with PL259 connectors (pr.) | 25.00 |
| DSC-N | same as above with type N connectors (pr.) | 25.00 |

### TRANSCEIVERS



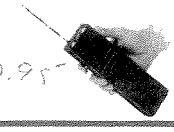
| | | |
|---|---|---|
| TRX50 Kit | Complete 6 mtr FM transceiver kit, 20w out, 10 channel scan with case (less mike and crystals) | ~~249.95~~ 229.95 |
| TRX144 Kit | same as above, but 2 mtr & 15w out | 219.95 |
| TRX220 Kit | same as above except for 220 MHz | 219.95 |
| TRX432 Kit | same as above except 10 watt and 432MHz | 254.95 |
| TRC-1 | transceiver case only | 19.95 |
| TRC-2 | transceiver case and accessories | 39.95 |

### SYNTHESIZERS



| | | |
|---|---|---|
| SYN II Kit | 2 mtr synthesizer, transmitt offsets programmable from 100 KHz–10 MHz, (Mars offsets with optional adapters) | 169.95 |
| SYN II W/T | same as above–wired & tested | 239.95 |
| MO-1 Kit | Mars/cap offset optional | 2.50 |
| TO-1 Kit | 18 MHz optional tripler | 2.50 |

### WALKIE-TALKIES



| | | |
|---|---|---|
| HT 144B Kit | 2 mtr, 2w, 4 channel, hand held receiver with crystals for 146.52 simplex | 129.95 |
| NICAD | battery pack, 12 VDC, ½ amp. | 29.95 |
| BC12 | battery charger for above | 5.95 |
| Rubber Duck | 2 mtr, with male BNC connector | ~~8.95~~ 12.95 |

### OTHER PRODUCTS BY VHF ENGINEERING

| | | |
|---|---|---|
| CD1 Kit | 10 channel receive xtal deck w/diode switching. | $ 6.95 |
| CD2 Kit | 10 channel xmit deck w/switch and trimmers | 14.95 |
| CD3 Kit | UHF version of CD1 deck, needed for 432 multi-channel operation. | 12.95 |
| COR2 Kit | carrier operated relay. | 19.95 |
| SC3 Kit | 10 channel auto-scan adapter for RX with priority | 19.95 |
| Crystals | we stock most repeater and simplex pairs from 146.0-147.0 (each). | 5.00 |
| CWID Kit | 159 bit, field programmable, code identifier with built-in squelch tail and ID timers | 39.95 |
| CWID | wired and tested, not programmed | 54.95 |
| CWID | wired and tested, programmed | 59.95 |
| MIC I | 2,000 ohm dynamic mike with P.T.T. and coil cord | 12.95 |
| TS1 W/T | tone squelch decoder | 59.95 |
| TS1 W/T | installed in repeater, including interface accessories | 89.95 |
| TD3 Kit | 2 tone decoder | 29.95 |
| TD3 W/T | same as above - wired & tested | 39.95 |
| HL144 W/T | 4 pole helical resonator, wired & tested, swept tuned to 144 MHz ban | 24.95 |
| HL220 W/T | same as above tuned to 220 MHz ban | 24.95 |
| HL432 W/T | same as above tuned to 432 MHz ban | 24.95 |


**VHF ENGINEERING**

*DIVISION OF BROWNIAN ELECTRONICS CORP.*

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