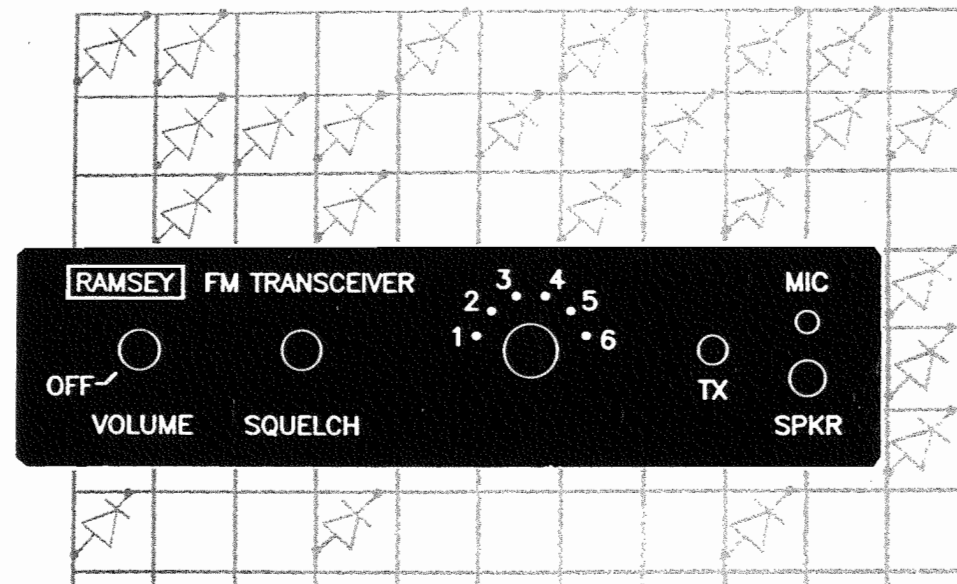


2 METER AMATEUR PLL SYNTHESIZED FM TRANSCEIVER



- Reference Information
- Step-by-Step Kit Assembly Instructions
- PLL Synthesizer Programming Data
- Alignment and Operation

RAMSEY

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**KIT ASSEMBLY
AND INSTRUCTION MANUAL FOR:**

**2 METER
AMATEUR
PLL SYNTHESIZED
FM TRANSCEIVER**

Model FTR-146

Second Edition
Revised: May 1991

RAMSEY

RAMSEY ELECTRONICS, INC.
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FTR-146 Transceiver Assembly & Instruction Manual GUIDE TO CONTENTS:

This spiral-bound publication is designed to be kept updated as easily as possible by the Publisher, by Ramsey Electronics and by FTR users who request any revision pages available. It is organized in the following four general sections:

I. General Reference Information

FTR-146 Specifications
Essential information for building this kit
Master Component Index
Kit Parts List and information on the FTR-C enclosure kit
Information for Ham Radio newcomers

II. Kit Assembly Stages

Each Assembly Stage is clearly designated by a letter code, keyed to the Schematic Diagram. See page 9 in Reference Section I.

III. PLL Programming Information

These pages cover assembly of the diode matrix, programming suggestions, an introduction to PLL programming for newcomers, including 8 worksheet pages and sample frequency log pages.

IV. Alignment and Operation

This section includes alignment procedures, troubleshooting suggestions, and information on understanding the FTR circuit.. See this section for Ramsey **KIT WARRANTY** information, Packet operation and continued product support.

This Guide to Contents is itself designed to be updated periodically. A large schematic diagram and multi-color parts-placement guide are part of this documentation package. Replacement copies of these folded sheets may be ordered separately from the complete manual.

AUTHOR'S DEDICATION (to First Edition) and Book Production Note

When a book develops to the size of this one, even if its purpose is technical instructions to customers, and there's a Somebody whose extra-diligent work made possible both the book and a true breakthrough in home-built ham gear, a dedication indeed is called for.

So, this one is for **TOM, WA2YTM**, whose patient labwork on the fine points of the "FTR" design and competent mastery of CAD techniques now makes it possible for hams worldwide to become once again PROUD of their skills when enjoying their popular VHF FM bands. That's right: bands! Watch for FTR-223 & FTR446.

This first edition of the FTR-146 instruction manual was prepared for printing on a tight timeline geared for Dayton 1991. Instead of our normal computer-interfaced phototypesetting, my friendly old CP/M Wordstar 3.3 and manual graphic pasteup procedures, I put my faith in the speed of a new 386SX with Canon ink-jet printer and PFS: First Publisher (3.0) to permit giving first attention to consistent accuracy in the hundreds of details to be observed in doing justice to Tom's patient labors, revision after revision. If there's a goof anywhere (there ALWAYS is!), this publication is designed with enough cross-references to keep you on track to completion.

Don't get bogged down in the dots of the ink-jet matrix: take command of that versatile PLL Synthesizer Matrix which puts YOU in control of your homebuilt FM rig!

73,

Dan F. Onley, K4ZRA

RAMSEY FTR-146 2-METER AMATEUR RADIO FM TRANSCEIVER

Specifications:

Frequency Range: Tuning:	143.000 to 148.110 MHz. Diode-programmable PLL synthesis Six panel-selected frequency pairs easily expandable by switches, microprocessors, etc.
PLL Programming: Transmit Offset: Mode:	Choice of 5 KHz. or 10 KHz. steps Programmable on matrix: Simplex, +600, -600 NBFM
Packet Operation: Power Requirement:	5-pin DIN jack for TNC cable 13.8V DC +/-10% (Negative grounding)
Power Consumption:	1.0 A Transmit (for 5.5 watts RF output) 200 ma. (Receive, no signal)
Antenna Impedance: Microphone Impedance: T-R switching: PTT circuit:	50 ohms High impedance, crystal or electret PIN diodes Solid State (for standard ICOM-type mic connection)
Semiconductors:	4 IC's, 26 transistors, 25 diodes (plus programming diodes)
Transmitter: Final Power Output Final Output Stage: Modulation: Maximum frequency deviation: Modulation distortion:	4-6 watts MRF237 or equivalent VCO +/- 25 KHz., +/- 5KHz. NBFM Less than 5%
Receiver: Circuitry:	Double-conversion superhet First IF: 10.7 MHz. Second IF: 455 KHz.
Sensitivity: Selectivity:	12 db. SINAD less than 0.35 uv. +/- 7 KHz. (-6db.) +/- 15 KHz. (-60db.) 4-pole crystal filter at 10.7 MHz.
Squelch sensitivity: Audio output:	Less than 0.25 uv. More than 2.0 watts

**VERY IMPORTANT
PC-BOARD ASSEMBLY
INFORMATION FOR A-L-L OUR BUILDERS!**

1. Your FTR transceiver PC-board is double-clad with plated-through holes. What this means in practice is that it is VERY important to select and install correct part values the FIRST time around. This type of board makes "desoldering" much more difficult and risky because the solder adheres inside the hole and flows to the component side of the board as well. It is VERY tricky to remove a part without damaging it. If too much de-soldering heat or component "pulling" is used, there is also the serious risk of damaging small PC-board traces. Be careful and methodical in assembly!!!

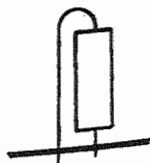
2. Do not, under any circumstances, install L11, R29 or R8 until instructed to do so in Assembly Stage "P." This applies even if you are following your own assembly sequences. This procedure will prevent damage to Q9 and Q10 during the initial test and alignment procedure.

3. Do not attempt to "re-engineer" our transistor orientation illustrations. Simply point flat sides or tabs as illustrated.

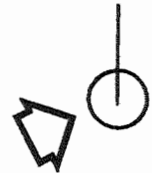
4. After installing all parts, you will see a few empty holes in the circuit traces on the top or component side of the board. These plated-through holes are placed intentionally to connect with traces on the solder side. The hole IS the connection! However, if these holes nag at you, simply fill them in with a touch of solder -- AFTER verifying that all parts have been placed and installed correctly.

5. Please regard No. 1 above very seriously.

6. Many resistors are mounted in vertical or upright position. You can see that the wire leads for resistors come in several styles. If a resistor's pre-trimmed lead is ever too short for upright installation, simply use a scrap wire nipped from another resistor to extend its length.



6b. Many of the miniature inductors used in this circuit also require upright or vertical installation. It is important to follow the orientation illustrated for vertically-installed parts. Always put the body of the part in the hole with the circle!



7. Whenever you have a choice, install parts with stamped markings so that you can still see the markings later. This will help greatly with any possible troubleshooting needed.

8. PARTS SORTING: In a kit of this size and complexity, there is no single best way to sort and organize the 300+ individual components used. We at the factory have tried to help by grouping similar or related parts in individual sealed bags. Sorting organizers popular among kit builders include empty egg cartons, muffin tins, small box tops, or the "holy" edges of corrugated cartons.

Since the assembly of this kit is presented in distinct stages, some builders may prefer to group their parts by stage before beginning assembly.

9. HELPFUL HINT: Many of the parts are supplied on tape strips cut from bulk reels. Leave them taped, which keeps them nicely sorted for you. It is NOT necessary to pull the entire lengths of both leads from the tape. Simply nip the leads right at the edge of the tape, and you'll have plenty of length to work with.

10a. .01 disc capacitors may be marked in any of the following ways:

.01
103
10n
(nanofarads)

10b. Similarly, .001 ufd. discs:

.001
102
1n

10c. Picofarad values are clearly stamped on capacitor bodies. The several .1 ufd. units required should be clearly recognizable and often will have a rectangular rather than disc shape.

11. We tried to make it clear in both lists and assembly steps that some components can have a RANGE of acceptable values, even though a single value is indicated on the schematic; the control document for this project. A rule of thumb is that a value within 10% of the stated value will work fine: 2 or 2.2 pf, 4.7 or 5 pf, 8 or 8.2 and so forth. 10 ufd. electrolytics may be 4.7 to 10 ufd. Remember that there's a reason for the "tolerance" codes for all parts. Unless we scream in bold print that something must be exact down to the last microhenry, ohm or partial picofarad, PLEASE assume the 10% rule in sorting through your kit parts!

12. Manufacturer stamping patterns can vary, and we sometimes need to use simple logic and deduction to identify parts, particularly the extremely common ones.

For example: if your kit includes 15 identical transistors with no apparent body marking at all, you may presume them to be the 15 NPN transistors described as 2N3904 or equivalent.

13. Check your manual or kit package for any insert page advising that a part identification or physical description has changed. We cannot control how manufacturers may vary their product codes or colors of plastic.

14. Observe correct POLARITY when installing all diodes and electrolytic capacitors!

15. Please review No. 1 above!

16. Use the extra spaces provided throughout this manual to write down the details of any changes or revisions noted on additional sheets that may be supplied with your kit.

FTR-146 MASTER COMPONENT INDEX

The following information was prepared to serve these purposes:

1. A general cross-reference for circuit study and servicing;
2. Additional help for parts sorting and identification;
3. An accommodation for experienced builders who prefer to work out their own assembly sequences. (If you have ANY questions or doubt about a part, refer to the specified assembly steps.)

Key to Component Index format:

- A. Part designator number (e.g., C1, Q16, Y4, etc.)
- B. [] [] (Experienced builders always double-check!)
- C. Part value or manufacturer identification
- D. Assembly step number (which also identifies general circuit stage per the schematic.)
- E. Component function note (or space for your own note.)

Key to assembly step letter-number codes:

The letter code indicates the circuit stage(s) in the step-by-step assembly instructions. The numeral designates the specific step. If you have any question whatsoever about a particular part, please consult its assembly step.

A:	DC Power input
B:	Receiver audio amplifier
CF:	Receiver FM detector and squelch
DF:	Receiver 10.7 MHz. IF and 4-pole Crystal Filter
E:	Microphone amplifier, solid-state PTT, Packet connections
F:	PLL Frequency Synthesizer
G:	PLL Mixer and Oscillator Buffer-Tripler
H:	VCO (Voltage Controlled Oscillator)
I:	Receiver Mixer and RF Preamp
JO:	Receiver Oscillator
K:	Receiver RF Input, Antenna Coupling, PIN diode T-R
LO:	Transmit Oscillator (Simplex)
M:	Transmit Oscillator (-600 KHz. Offset)
N:	Transmit Oscillator (+600 KHz. Offset)
O:	Transmit Coil and RF Choke Preparation
P:	Transmit Buffer, Driver and RF Final
PL:	PLL Programming and Alignment

Stages CF, DF, JO and LO are so named to prevent confusion with schematic designators for capacitors, diodes, jacks and coils.

PART	VALUE or ID	STEP	NOTE:
C: Capacitors (All Types):			
C1	[] [] 100 pf.	F3	see Y1
C2	[] [] 22 pf.	F2	
C3	[] [] .01 ufd.	G11	
C4	[] [] .01 ufd.	G24	
C5	[] [] .001 ufd.	J18	
C6	[] [] .01 ufd.	F4	
C7	[] [] .01 ufd.	F5	
C8	[] [] 4.7-10 ufd. elec.	F6	
C9	[] [] .01 ufd.	G3	
C10	[] [] 3.9 pf.	G15	
C11	[] [] 2 or 2.2 pf.	G14	
C12	[] [] 4.7 or 5 pf.	JO4	
C13	[] [] 22 pf.	G17	
C14	[] [] 470 pf.	G1	see L3
C15	[] [] 470 pf.	G2	" "
C16	[] [] 10 pf.	JO9	
C17	[] [] 22 pf.	G16	see L5
C18	[] [] 56 pf.	JO3	
C19	[] [] .001 ufd.	JO1	
C20	[] [] .1 ufd.	F11	
C21	[] [] 4.7-10 ufd. elec.	F12	
C22	[] [] .001 ufd.	JO7	
C23	[] [] 4.7-10 ufd. elec.	A7	
C24	[] [] "	A6	
C25	[] [] 39 pf.	K14	
C26	[] [] .001	LO19	
C27	[] [] .01	P5	
C28	[] [] 8.2 pf.	LO4	
C29	[] [] 47 ufd. elec.	H20	
C30	[] [] 56 pf.	G12	
C31	[] [] 10 pf.	LO10	
C32	[] [] 35 pf. trimmer	H5	
C33	[] [] .01	P27	
C34	[] [] 56 pf.	LO3	
C35	[] [] .001	P12	
C36	[] [] 220 ufd.	P2	
C37	[] [] .001	P24	
C38	[] [] .1	P22	
C39	[] [] .001	LO1	
C40	[] [] 15 pf.	H2	
C41	[] [] 33 pf.	H7	
C42	[] [] 3.9 pf.	P16	
C43	[] [] .001	K13	
C44	[] [] .01	K15	
C45	[] [] 15 pf.	P6	
C46	[] [] 33 pf.	H11	
C47	[] [] 35 pf. trimmer	P29	
C48	[] [] 15 pf.	H9	
C49	[] [] 56 pf.	H21	
C50	[] [] 10 pf.	P6b.	

PART	VALUE or ID	STEP	NOTE:
C51	[] [] 10 pf.	P18	
C52	[] [] 35 pf. trimmer	P17	
C53	[] [] 56 pf.	H10	
C54	[] [] .001	E35	
C55	[] [] 3.9 pf.	P15	
C56	[] [] 27 pf.	H19	
C57	[] [] .01	K10	
C58	[] [] 27 pf.	H22	
C59	[] [] 220 pf.	CF28	
C60	[] [] .01	CF22	
C61	[] [] .01	CF24	
C62	[] [] .01	CF30	
C63	[] [] .001	K12	
C64	[] [] .001	M19	
C65	[] [] .01	K11	
C66	[] [] .01	CF23	
C67	[] [] 22 pf.	CF27	
C68	[] [] 39 pf.	K25	
C69	[] [] .01	DF12	
C70	[] [] 8.2 pf.	M4	
C71	[] [] 10 pf.	M10	
C72	[] [] 4.7 or 5 pf.	K7	
C73	[] [] .001	DF3b.	
C74	[] [] 56 pf.	M3	
C75	[] [] 4.7 or 5pf.	K1	
C76	[] [] 2 or 2.2 pf.	K2	
C77	[] [] 330 ufd.	B6	
C78	[] [] 27 pf.	K3	
C79	[] [] 27 pf.	K4	
C80	[] [] .001	M1	
C81	[] [] 100 pf.	CF26	
C82	[] [] 22 pf.	I5	
C83	[] [] .01	B2	
C84	[] [] 470 ufd.	B5	LM380 output
C85	[] [] .01	B7	
C86	[] [] .1	B4	
C87	[] [] .01	CF9	
C88	[] [] .01	B3	
C89	[] [] .001	CF7	
C90	[] [] .001	CF6	
C91	[] [] .01	CF3	
C92	[] [] 4.7 to 10 uf. elec.	CF2	
C93	[] [] "	CF13	
C94	[] [] .01	CF31	
C95	[] [] 18 pf.	P26	
C96	[] [] .001	N19	
C97	[] [] .001	E34	
C98	[] [] 15 pf.	N4	
C99	[] [] 10 pf.	N10	
C100	[] [] 56 pf.	N3	
C101	[] [] .01	E15	
C102	[] [] .001	N1	

PART	VALUE or ID	STEP	NOTE:
C103	[] [] 220 ufd. elec.	E2	
C104	[] []		not used
C105	[] [] .001	E28	
C106	[] [] .001	E12	
C107	[] [] .001	E14	
C108	[] [] .001	A16	
C109	[] [] .001	A13	
C110	[] [] .001	A15	
C111	[] [] .001	A14	
C112	[] [] .001	E27	
C113	[] [] .001	E24	
C114	[] [] 4.7-10 ufd. elec.	E5	
C115	[] [] "	JO22	
C116	[] [] "	LO23	
C117	[] [] "	M23	
C118	[] [] "	N23	
C119	[] [] .01	H12	
C120	[] [] .001	DF5	
C121	[] [] .01	DF4	
C122	[] [] 4.7 or 5pf.	DF6	
C123	[] [] 100 pf. SMT chip	P1	See Q10
D: Diodes (All Types):			
D1	[] [] 1N914 or 1N4148	JO21	
D2	[] [] BB505 varactor	JO13	RX oscillator
D3	[] [] 1N4002-type	A2	+DC input
D4	[] [] 1N914 or 1N4148	LO22	
D5	[] [] 1N914 or 1N4148	H6	
D6	[] [] BB505 varactor	LO14	Simplex oscillator
D7	[] [] BA482 PIN diode	K19	
D8	[] [] BB505 varactor	H3	VCO
D9	[] [] 1N914 or 1N4148	LO7	
D10	[] [] 1N914 or 1N4148	LO8	
D11	[] [] BA389 PIN diode	K18	Antenna T-R
D12	[] [] 1N914 or 1N4148	I2	
D13	[] [] 1N914 or 1N4148	M22	
D14	[] [] BA482 PIN diode	K20	Antenna T-R
D15	[] [] BB505 varactor	M14	-600 KHz. oscillator
D16	[] [] 1N914 or 1N4148	M7	
D17	[] [] 1N914 or 1N4148	M8	
D18	[] [] 1N914 or 1N4148	CF15	
D19	[] [] 1N914 or 1N4148	CF16	
D20	[] [] 1N914 or 1N4148	N22	
D21	[] [] 1N914 or 1N4148	N8	
D22	[] [] BB505 varactor	N14	+600 KHz. oscillator
D23	[] [] 1N914 or 1N4148	E37	
D24	[] [] 1N914 or 1N4148	N7	
D25	[] [] LED	E40	PTT transmit indicator
D26-Dx	[] [] 1N914 or 1N1418	(see text)	Synthesizer programming

PART	VALUE or ID	STEP	NOTE:
FL: Filters:			
FL1	[] [] 455 KHz. ceramic	CF25	Receiver 2nd IF
FL2	[] [] 10.7 MHz. crystal	DF9,10	For 4-pole IF filter
FL3	[] [] 10.7 MHz. crystal	DF9,11	" "
J: Jacks:			
J1	[] [] DC coaxial	A1	13.5 VDC input
J2	[] [] SO-239	K23	Antenna
J3	[] [] 5-pin DIN	A9	Packet TNC connections
J4	[] [] miniature	B15	Speaker
J5	[] [] subminiature	E38	Microphone
L: Inductors (Coils, Transformers, Chokes):			
L1	[] [] .04 uh. (4T 1/8")	G18,19	
L2	[] []		not used
L3	[] [] 2.2 uh. molded	G4	
L4	[] [] "	J14	
L5	[] [] .04 uh. (4T 1/8")	G18,20	
L6	[] [] .33 uh. molded	JO2	
L7	[] [] 1.8 uh. (LQ186)	LO15	
L8	[] [] RF choke (VK200)	P23	See Stage "O"
L9	[] [] .33 uh. molded	LO2	
L10	[] [] .33 uh., axial	P4	
L11	[] [] .04 uh. (4T 1/8")	P13	
L12	[] [] 2.2 uh. molded	K21	
L13	[] [] 1.5T 1/8"	P21	
L14	[] [] 1.5T 3/8"	P25	See Stage "O"
L15	[] [] .04 uh. (4T 1/8")	K24	
L16	[] [] 2.5T 3/8"	P11	See Stage "O"
L17	[] [] " "	P19	" " "
L18	[] [] 50-84885-2,	H4	VCO alignment
L19	[] [] 2.2 uh. molded	K22	
L20	[] [] RF choke (VK200)	P10	See Stage "O"
L21	[] [] .33 uh. axial	P20	
L22	[] [] .04 uh. (4T 1/8")	H23	
L23	[] [] 1.8 uh. (LQ186)	M15	
L24	[] [] 455 KHz. LB53303	CF20	
L25	[] [] .33 uh. molded	M2	
L26	[] [] .04 uh. (4T 1/8")	K5	
L27	[] [] " "	K6	
L28	[] [] 10.7 MHz. TB933	DF7	Receiver 10.7 MHz. IF
L29	[] [] .33 uh. molded	I7	
L30	[] [] 1.8 uh. (LQ186)	N15	
L31	[] [] .33 uh. molded	N2	
L32	[] [] 10.7 MHz. TB933	DF8	Receiver 10.7 MHz. IF

PART	VALUE or ID	STEP	NOTE:
Q: Transistors (All Types):			
Q1	[] [] 2N3904	J15	Receiver oscillator
Q2	[] [] "	F16	PLL buffer
Q3	[] [] 3N204 MOSFET	G5,6	PLL mixer
Q4	[] [] 2SC2570	G21	Osc. buffer
Q5	[] [] 2N3904	J05	Receiver oscillator
Q6	[] [] "	LO16	+600 Osc.
Q7	[] [] "	H17	VCO
Q8	[] [] 2SC2570	H16	VCO
Q9	[] [] 2N3866 NPN RF	P2a	Transmit Driver
Q10	[] [] MRF237 or SD1127	P2b	Transmit Final
Q11	[] [] 2N3904	LO5	TX simplex oscillator
Q12	[] [] 2SC2570	P8	Transmit buffer
Q13	[] [] 2N3904	M16	
Q14	[] [] PNP 2N3906 (228256)	B8	See U3, LM380
Q15	[] [] 2N3904	DF1	
Q16	[] [] 2SC2570	I8	Receiver pre-amp
Q17	[] [] 3N204 MOSFET	I4	Receiver mixer
Q18	[] [] 2N3904	M5	
Q19	[] [] "	N16	
Q20	[] [] "	E30	
Q21	[] [] "	N5	
Q22	[] [] PNP 2N3906 (228256)	E20	PTT switching
Q23	[] [] 7011507	E21	PTT (+12V TX)
Q24	[] [] 2N3904	E6	PTT (+12V RX)
Q25	[] [] "	E9	PTT
Q26	[] [] "	DF2	

R: Resistors (Fixed, Trimmers and Panel-Mounted):

R1	[] [] 100	G23	
R2	[] [] 100	JO17	
R3	[] [] 10K trimmer	JO10	RX osc +5KHz. adjust
R4	[] [] 10K trimmer	JO11	RX osc 0 adjust
R5	[] [] 270	F15	
R6	[] [] 47k	F17	
R7	[] [] 10K	G22	
R8	[] [] 47K	J16	
R9	[] [] 10K	JO12	
R10	[] [] 100	JO8	
R11	[] [] 51	G9	
R12	[] [] 47K	JO20	
R13	[] [] 10K	F10	
R14	[] [] 100	G8	
R15	[] [] 47K	G7	
R16	[] [] 1K	F13	
R17	[] [] 10K	JO6	
R18	[] [] 10K	LO6	
R19	[] [] 100	LO18	
R20	[] [] 10k trimmer	LO11	Simplex osc. +5 adj.

PART	VALUE or ID	STEP	NOTE:
R21	[] [] 10K trimmer	LO12	Simplex osc. 0 adj.
R22	[] [] 1K	H18	
R23	[] [] 47K	LO17	
R24	[] [] 1K	H8	
R25	[] [] 10K (also 1-amp F1)	A5,A6	(See A5 re. fusing)
R26	[] [] 10K	LO13	
R27	[] [] 100	P3	
R28	[] [] 100	LO9	
R29	[] [] 82 (1/2W)	P14	
R30	[] [] 47K	LO21	
R31	[] [] 10K	H1	
R32	[] [] 270	H14	
R33	[] [] 10K	H13	
R34	[] [] 33K	P7	
R35	[] [] 47K	E36	
R36	[] [] 51	P9	
R37	[] [] 51	H15	
R38	[] [] 82 (1/2W)	P28	
R39	[] [] 470	K8	
R40	[] [] 200-240 (1/2W)	K16	
R41	[] [] 100K	DF3b.	sqelch circuit
R42	[] [] 100	M18	
R43	[] [] 10K trimmer	M11	-600 osc. +5 adj.
R44	[] [] 10K trimmer	M12	-600 osc. 0 adj.
R45	[] [] 100K	DF3a.	
R46	[] [] 47K	M17	
R47	[] [] 1K	B9	
R48	[] [] 470	C18	
R49	[] [] 470	K9	
R50	[] [] 10K	M13	
R51	[] [] 100K	CF17	
R52	[] [] 100	M9	
R53	[] [] 33K	CF21	
R54	[] [] 270	I6	
R55	[] [] 51	I1	
R56	[] [] 47K	M21	
R57	[] [] 100K	I9	
R58	[] [] 10K panel pot	DF14	Squelch control
R59	[] [] 10K	M6	
R60	[] [] 47K	I3	
R61	[] [] 470K	CF8	
R62	[] [] 100K	CF32	
R63	[] [] 100K	CF10	
R64	[] [] 10K	CF4	
R65	[] [] 18K	CF5	
R66	[] [] 1K	CF12	
R67	[] [] 47K	CF11	
R68	[] [] 100	N18	
R69	[] [] 10K pot with S2	A12,B12	Volume control
R70	[] [] 10K trimmer	N11	+600 osc +5 adj.
R71	[] [] 10K trimmer	N12	+600 osc 0 adj.
R72	[] [] 10K	B10	

PART	VALUE or ID	STEP	NOTE:
R73	[] [] 47K	N17	
R74	[] [] 10K	N13	
R75	[] [] 100	N9	
R76	[] [] 47K	N21	
R77	[] [] 100K	E29	
R78	[] [] 47K	E33	
R79	[] [] 100K	E11	
R80	[] [] 10K trimmer	E31,T22	Modulation level adj.
R81	[] [] 10K	N6	
R82	[] [] 10K	E26	
R83	[] [] 10K	E25	
R84	[] [] 47K	E23	
R85	[] [] 2.2K	E17	
R86	[] [] 2.2K	E16	
R87	[] [] 10K	E8	
R88	[] [] 2.2K	E7	
R89	[] [] 100K	E13	
R90	[] [] 10K	E10	
R91	[] [] 47K	E3	
R92	[] [] 270	E4	
R93	[] [] 10K	E19	
R94	[] [] 1K	E18	
R95	[] [] 1K	G10	
S: Switches T: Test Points			
S1	[] [] 12 position	PL1	Frequency selection
S2	[] [] on R69 (volume)	A12	DC on-off
TP1	[] [] VCO output (spectrum analyzer TP)		
TP2	[] [] Frequency counter test point (L18 adj.)		
TP3	[] [] Adjust for 3.6v on both transmit and receive		
U: Integrated Circuits			
U1	[] [] MC145106	F1	PLL freq. synthesizer
U2	[] [] MC3359	CF1	FM receiver IC
U3	[] [] LM380	B1	Receiver audio amp
U4	[] [] LM358	E1	Microphone amp
V: Voltage Regulator			
VR1	[] [] 7808	A8	+8VDC where needed
Y: Crystals:			
Y1	[] [] 10.240 MHz.	F7	PLL reference oscillator
Y2	[] [] 44.100 MHz.	J19	RX master oscillator
Y3	[] [] 47.6667 MHz.	LO20	TX Simplex oscillator
Y4	[] [] 47.4666 MHz.	M20	TX -600 offset
Y5	[] [] 10.245 MHz.	CF29	RX IF oscillator
Y6	[] [] 47.8667 MHz.	N20	TX +600 offset

INTRODUCTION TO YOUR FTR-146 TWO METER FM TRANSCEIVER

For Ramsey Electronics, Inc.
by Dan F. Onley, K4ZRA

As the manufacturer of the world's most economical professional service equipment for VHF communications, Ramsey Electronics wants the FTR-146 to revolutionize how ham operators use, think about, and maintain equipment for our most popular VHF ham band.

Many of us have watched 2 Meter FM grow from its roots in surplus GE and Motorola car trunk rigs to the current situation of all mobile and handheld equipment being manufactured overseas and generally needing factory service in case of malfunction. USA-made rigs from the 1970's languish in fleamarkets, with their manufacturers either out of business or pursuing other interests. The FTR-146 is designed to change all that -- it's USA-designed by us here at Ramsey, and it's USA-built by USA hams, made-in-Canada by our Canadian neighbors, and made in YOUR country by our many international friends and customers, from the USSR to Africa and the Pacific including eager kit-builders in Japan!

Most hams do appreciate owning at least one full-featured 2 Meter rig, ever more miniaturized, with more and more popular features. However, one VHF transceiver rarely is enough these days, whether from the standpoint of serious operating flexibility, personal convenience, dedicated packet or autopatch requirements, multiple vehicles or fixed locations, emergency preparedness, several hams in the family, and so forth. And we all know that these needs or ideals add up to becoming very, very expensive!

Your new Ramsey FTR-146 is designed to make reliable FM VHF transceiver technology a **hands-on skill** among all interested hams worldwide -- at the most reasonable price possible. The great pricing of this new rig reminds me of my 1973 drive over to Indianapolis from Cincinnati to buy a 10-channel (crystal) Genave rig right at the factory for over \$150 . . . and then adding crystal pairs, one at a time at no small cost . . . and then relocating to Arizona only to find all my new crystals to be of no use to me! (A sad part of that story is that both the Genave GTX and my prized "Drake Twins" were part of the loot burglarized from my home in '77.)

Getting back to the "hands-on" design of the FTR-146 we want you to be able to count on this transceiver over the years. We want you to understand it, to be able to fix it, and to be confident and ever more

knowledgeable about modifying and improving it. That's why YOU get to build it from the start and why we want this instruction manual's detail to match the exciting capabilities of the FTR-146.

The FTR-146 is basic but very state-of-the-art VHF ham radio: 1990's technology at 1950's pricing. We want you to get to know the inner workings of this transceiver like a trusted old friend. Like you, we can imagine tons of additional features _ each of which would start to add to the base price. Our design philosophy has been to give you a practical VHF transceiver with useful I/O connections for which you'll never need to buy a crystal. Our research shows that easy switching of YOUR choice of any 6 of the hundreds of possible 2-Meter frequency pairs responds amply to the real-life needs of most radio amateurs. And nothing stops you from adding dozens or even hundreds of additional frequencies, ingenious switching, readout and tone encoding features.

The FTR-146 design invites and urges customizing. Our philosophy about customizing goes this way: instead of a \$500 rig that covers everybody's needs, how about \$100 or so for a rig that you can put on the air on ANY frequency as soon as you have finished construction, ready for this or that easy custom feature that YOU really want or need to add? How about a radio that YOU can always and easily fix yourself if a part or solder joint goes bad?

You will see FTR-146 mods in ham magazines. Also, as a FTR-146 buyer, you can count on receiving free on request the most current issue of "FtrUN," published by DRRC. If this user network service seems useful to you, you can join in as a subscriber, contributing author, or both.

The FTR-146 has almost-limitless customizing possibilities. For that very reason, this instruction manual will focus on the BASICS of building, adjusting and understanding this transceiver. We KNOW that you can add bells and whistles -- our job is to make sure that this transceiver becomes a FRIEND and not a mystery to you!

We do understand that eager temptation to just stuff all the parts, solder, nip and start tinkering. However, PLEASE follow our step-by-step directions for assembly, alignment and testing. The FTR-146 works very impressively when it's RIGHT from the start.



A MESSAGE TO HAM RADIO BEGINNERS:

If you have just earned your Novice or Technician license, or are studying for either of them right now, we'd like to say a special Thank You for choosing this Ramsey VHF transceiver as part of your ham radio beginnings. We have tried to make this instruction manual as clear as possible. However, there are some VHF radio "basics" covered by the FCC question pools for all ham license study guides that we must presume that you have studied and understood. Here is a simple guide to selected Technician Class questions to help with any review you wish to make:

FCC Subelement 3AA (Selected Rules):
4.2 11-1.1 12.5 15.2

FCC Subelement 3AB (Operating Procedures):
2-1.1 2-1.2 2-1.3 2-1.4 2-1.5
2-2.1 2-2.2 2-3.1 3.2 6-3.1

FCC Subelement 3AC (Propagation):
It's up to you to understand the characteristic differences among HF (shortwave), VHF and UHF communications.

FCC Subelement 3AD (Amateur Radio Practice):
All of this is fundamental know-how for hams.
In working on this project, be especially familiar with:
1-1.1 1-1.2 1-1.3 7.1
9.1 through 9.5 (dummy loads)

FCC Subelement 3AE (Electrical Principles)
3AF (Circuit Components)
Please know ALL of this.

FCC Subelement 3AG (Practical Circuits):
4.21

FCC Subelement 3AH (Signals and Emissions):
1.1 2-1.1 2-4.1 2-6.2 2-7.1 4.1
6-1.2 7-1.1 7-2.1 7-2.2

FCC Subelement 3A1 (Antennas and Transmission Lines):

You will WANT to know all of this, if you don't want to take all your savings from building your own transceiver and spend it on a commercially-built antenna. Very good VHF antennas are easy and inexpensive to build yourself!

Finally, if this is your very first kit project, PLEASE take your time. We'd prefer that you build another, easier kit first, such as one of our inexpensive FM receivers, or something even simpler. Or, just get a little practice by "de-building" and re-building any discarded electronic gizmo that's handy to you. (Don't faint if you also get it working again!)

However, if you follow carefully our Stage-by-Stage procedure, doing no more one or two stages per evening, we think you will do just great! Please make a point of reviewing ALL pages in this book, because they indeed have been included with YOU in mind!

"It's not how fast you build it,
it's how **WELL** you build it!"

We hope you'll enjoy the experience of building AND understanding your own VHF FM ham radio transceiver!

FTR-146 MASTER KIT PARTS LIST:

INTEGRATED CIRCUITS

- 1 [] MC145106 18-pin DIP PLL IC (U1)
- 1 [] MC3359 18-pin DIP FM Receiver IC (U2)
- 1 [] LM380 14-pin DIP Audio Amplifier IC (U3)
- 1 [] LM358 8-pin DIP Dual Op-amp IC (U4)
- 1 [] 7808 voltage regulator [VR1]

TRANSISTORS:

- 15 [] NPN transistor, type 2N3904 or equivalent (Q1, Q2, Q5, Q6, Q7, Q11, Q13, Q15, Q18, Q19, Q20, Q21, Q24, Q25, Q26.)
- 2 [] PNP transistor, 2N3906-type [marked 228256] (Q14, Q22)
- 1 [] NPN type 7011507 or 2N3053 (Q23)
- 4 [] NPN VHF type 2SC2570 (Q12, Q16, Q4, Q8)
- 1 [] RF NPN type 2N3866 (transmit driver, Q9)
- 1 [] RF NPN type MRF237 or SD1127 (transmit final, Q10).
- 2 [] Dual gate MOSFET, type 3N204 (PLL mixer Q3, mixer Q17)

DIODES:

- 1 [] Red LED (D25, transmit indicator)
- 50+ [] 1N914 or 1N4148 switching diode (D1, D10, D12, D13, D16, D17, D18, D19, D20, D21, D23, D24, D4, D5, D9) {plus PLL matrix}
- 5 [] Varactor diode, type BB505 (D2, D6, D8, D15, D22)
- 1 [] PIN diode, type BA389 (D11)
- 2 [] PIN diode, type BA482 (D7, D14) {smallest diodes, 1 red band}
- 1 [] 1N4002 or 1N4003 rectifier diode (D3)

CRYSTALS:

- 1 [] 10.240 MHz. (Y1, PLL reference frequency)
- 1 [] 10.245 MHz. (Y5, receiver IF oscillator)
- 1 [] 44.100 MHz. (Y2, receiver master oscillator)
- 1 [] 47.4666 MHz. (Y4, transmitter -600 Offset oscillator)
- 1 [] 47.6667 MHz. (Y3, transmitter Simplex oscillator)
- 1 [] 47.8667 MHz. (Y6, transmitter +600 Offset oscillator)
- 2 [] 10.7 MHz. crystal filter (FL2, FL3 for 4-pole IF filter)

INDUCTORS:

- 2 [] 10.7 MHz. IF transformers, marked TB933 (L28, L32)
- 1 [] 455 KHz. shielded inductor, marked LB53303 (L24)
- 1 [] Shielded variable coil, marked 50-84885-2 (L18)
- 1 [] .015 uh., 1.5 turns, .125" diameter (L13)
- 7 [] .04 uh., 4 turns, .125" diameter (L1, L5, L11, L15, L22, L26, L27)

- 5 [] .33 uh., upright-style molded mini-inductor: markings include 2 orange stripes (L6,L9,L25,L29,L31)
- 2 [] .33 uh., axial leads, wirewound (L10,L21)
- 3 [] 1.8 uh. molded mini-inductor (L7,L23,L30) {marked LQ186}
- 4 [] 2.2 uh. molded mini-inductors: markings include two red stripes (L3,L4,L12,L19)
- 1 [] 1.5 turns, .375" diameter, hand-wound (L14)
- 2 [] 2.5 turns, .375" diameter, hand-wound (L16,L17)
- 2 [] RF chokes, hand-wound on ferrite cores (L8,L20)

SPECIALIZED COMPONENTS:

- 1 [] Ramsey FTR-series Printed Circuit Board
- 2 [] ferrite cores (for making L8,L20)
- 1 [] 455 KHz. ceramic filter (black cube, FL1)
- 1 [] 100 pf. SMT chip capacitor (C123)

INTERNAL ALIGNMENT COMPONENTS:

- 9 [] 10K trimmer potentiometers (R3,R4,R20,R21,R43,R44,R70,R71,R80)
- 3 [] 35 pf. trimmer capacitors (C32,C47,C52)

FIXED-VALUE CAPACITORS (RF-critical picofarad values):

- 2 [] 2 or 2.2 pf. (C11,C76)
- 3 [] 3.9 pf. (C10,C42,C55)
- 4 [] 4.7 or 5 pf. (C12,C72,C75,C122)
- 2 [] 8 or 8.2 pf. (C28,C70)
- 6 [] 10 pf. (C16,C31,C50,C51,C71,C99)
- 4 [] 15 pf. (C40,C45,C48,C98)
- 1 [] 18 pf. (C95)
- 5 [] 22 pf. (C2,C13,C17,C67,C82)
- 4 [] 27 pf. (C56,C58,C78,C79)
- 2 [] 33 pf. (C41,C46)
- 2 [] 39 pf. (C25,C68)
- 7 [] 56 pf. (C18,C30,C34,C49,C53,C74,C100)
- 2 [] 100 pf. (C1,C81)
- 1 [] 220 pf. (C59)
- 2 [] 470 pf. (C14,C15)

ADDITIONAL CAPACITORS:

- 28 [] .001 ufd. (C5,C19,C22,C26,C35,C37,C39,C43,C54,C63,C64,C73,C80,C89,C90,C96,C97,C102,C105,C106,C107,C108,C109,C110,C111,C112,C113,C120.)
- 24 [] .01 ufd. (C3,C4,C6,C7,C9,C27,C33,C44,C57,C60,C61,C62,C65,C66,C69,C83,C85,C87,C88,C91,C94,C101,C119,C121.)
- 3 [] .1 ufd. (C20,C38,C86).

- 11 [] 4.7 to 10 ufd. electrolytic (called 10 ufd. in text) (C8,C21,C23,C24,C92,C93,C114,C115,C116,C117,C118).
- 1 [] 47 ufd. electrolytic (C29)
- 2 [] 220 ufd. electrolytic (C36,C103)
- 1 [] 330 ufd. electrolytic (C77)
- 1 [] 470 ufd., 6.3 volt electrolytic (C84)

FIXED RESISTORS:

- 4 [] 51 ohm [green-brown-black] (R11,R36,R37,R55)
- 2 [] 82 ohm, 1/2 watt [gray-red-black] (R29,R38)
- 11 [] 100 ohm [brown-black-brown] (R1,R2,R10,R14,R19,R27,R28,R42,R52,R68,R75)
- 1 [] 220 ohm, 1/2 watt [red-red-brown] (R40) {R40 may be 200 to 240 ohms.}
- 4 [] 270 ohm [red-purple-brown] (R5,R32,R54,R92)
- 3 [] 470 ohm [yellow-purple-brown] (R39,R48,R49)
- 7 [] 1K ohms [brown-black-red] (R16,R22,R24,R47,R66,R94,R95)
- 3 [] 2.2K ohms [red-red-red] (R85,R86,R88)
- 20 [] 10K ohms [brown-black-orange] (R7,R9,R13,R17,R18,R25,R26,R31,R33,R50,R59,R64,R72,R74,R81,R82,R83,R87,R90,R93)
- 1 [] 18K ohms [brown-gray-orange] (R65)
- 2 [] 33K ohms [orange-orange-orange] (R34,R53)
- 16 [] 47K ohms [yellow-purple-orange] (R6,R8,R12,R15,R23,R30,R35,R46,R56,R60,R67,R73,R76,R78,R84,R91)
- 9 [] 100K ohms [brown-black-yellow] (R41,R45,R51,R57,R62,R63,R77,R79,R89).
- 1 [] 470K ohms [yellow-purple-yellow] (R61).

Type	1	2	3
2N3904	E	B	C
2N3906	E	B	C
2SC2570	B	E	C (Note well!)

3N204 (Q3, Q17)

- 1 Drain
- 2 Gate 2
- 3 Gate 1
- 4 Source, Case

CONTROLS, HARDWARE AND MISC.

- 1 [] 10K volume control pot with switch (R69,S2)
- 1 [] 10K squelch control pot (R58)
- 1 [] 12-position rotary switch (S1)
- 1 [] 3.5 mm. Jack, miniature (J4, speaker)
- 1 [] 2.5 mm. Jack, subminiature (J5, microphone)
- 1 [] 2.1 mm. DC coaxial power jack (J1)
- 1 [] 2.1 mm. DC coaxial power plug to mate J1
- 1 [] 5-pin DIN PC-mount jack (J3, packet)
- 1 [] SO-239 coaxial RF connector (J2)
- 2 [] sets of: 4-40 screw and nut (to mount J2)
- 1 [] solder lug (to ground J2 and C68)
- 1 [] 27" length of No. 20 bus wire
- 1 [] hookup wire, as needed
- 1 [] 7" length of 3-conductor wire
- 1 [] 10" length of 2-conductor wire
- 1 [] document packet, including this manual

REQUIRED, NOT SUPPLIED WITH KIT:

- [] Thin-diameter rosin-core solder
- [] Correct tools for all phases of assembly (see text)
- [] Microphone and speaker per specifications in text (J4,J5 and PTT circuit are designed for ICOM-type mike)
- [] Fused, 13.5 VDC power supply
- [] 50-ohm dummy load
- [] 50-ohm 2-meter antenna with PL259 or adapter.

OPTIONAL, RECOMMENDED:

- [] Ramsey FTR-C Transceiver Case and Knob Kit

NOTE: For proper RF shielding and secure mounting of controls, connectors, and the PC-board, **immediate** consideration must be given to the transceiver enclosure as **integral** to the assembly process. The FTR-C kit is the quality, custom-designed finishing touch for your transceiver.

ENCLOSURE & HARDWARE CONSIDERATIONS:

The companion FTR-C case and knob kit is sold as an option only as an accommodation to those radio hams who always have their own ideas or resources for the "finishing touches."

However, a proper case for your FTR-146 is much more than a "finishing touch," since the controls and microphone jack are panel-mounted, proper RF-shielding is required, and attention must be given to the L-C circuitry at the antenna jack.

The FTR-C case measures 9"L X 6"W X 1.5"H. The 9"X6" dimensions are minimum for accommodating the PC-board. The height may vary if you wish to include an internal speaker, accessory PC-boards, additional front panel controls or indicators, etc.

If you are new at all this and do not already own a suitable enclosure plus that collection of hardware and knobs that every ham seems to accumulate, here is what you need to know if you are hesitant to purchase the FTR-C case kit:

- A. "Blank" electronics enclosures have become among the most expensive hardware in the industry, especially if you are buying just one unit. This is because they are sold mainly to engineers and designers for prototyping. A blank metal enclosure even slightly comparable to the FTR-C case will run \$30 to \$80 or more. Even a very plain aluminum chassis box with cover will be around \$15.00.
- B. If you think there's any chance you someday may wish to sell or trade your transceiver, you should be aware that units mounted in odd boxes may have even less value than the bare circuit board with documentation alone.
- C. Many industrial electronics parts distributors have a minimum order of \$25.00.
- D. Your best chance for finding an inexpensive alternative case is to have access to a lot of ham friends who tend to "collect stuff," or to browse the catalogs or showrooms of electronic surplus dealers. You just might find a gorgeous new box originally intended for somebody's ingenious Ultra Modem, external disk drive or other gadget from two years ago.

Are we trying to discourage you? No, not really! We know you can see that there are good reasons to consider calling Ramsey Electronics and getting your FTR-C case on its way while you work on the PC-board, Programming and Alignment. However, we do not want you to feel "stuck," so we have worked up a detailed shopping list for getting what you will need to make as attractive a finished unit as possible with a single trip to the neighborhood Radio Shack.

DC POWER SUPPLY CONSIDERATIONS

Your Ramsey FTR FM Transceiver is designed to operate from any stable DC voltage source in the 12 to 15 volt range, from typical car, boat or plane 12V systems to a wide variety of battery packs or AC-powered DC sources. In a pinch, you can get on the air for quite a while with 8 to 10 ordinary "D" batteries! Our lab tests show only a .93 amp current draw for 5.5 watts of RF output.

We have just a few points of advice and caution:

1. Your DC supply should be able to provide a minimum of 1.5 amperes in continuous service.
2. Those convenient adapter cords for auto lighter sockets are fine, but PLEASE be sure that the cord is set up for correct DC polarity. The center pin of J1 is +DC.
3. Use of wall plug power supplies is NOT recommended. Obviously, 12VAC output is not suitable. Most DC output units do not have adequate voltage regulation.
4. Turn your FTR transceiver OFF before re-starting the vehicle in which it has been installed.
5. Some mobile installations may require ignition noise filtering, primarily to prevent such noise from being introduced into the FM modulation. If you hear ignition noise in the receiver, the vehicle has a serious general problem. Check your transmitted signal on another receiver before mobile operation. Radio Shack sells a variety of noise-suppression capacitors and chokes. The ultimate solution, which has been tested, is to run the transceiver from a smaller accessory battery.

If you plan to build a power supply for fixed-station use, there are numerous construction articles in all ham magazines as well as the ARRL Handbook. A convenient new book featuring easy-to-find components is **Building Power Supplies** (Radio Shack 276-5025.)

Kit Builder's Notes:	Date

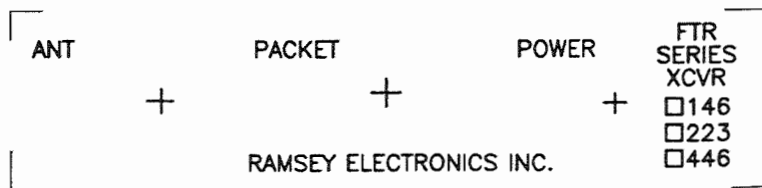
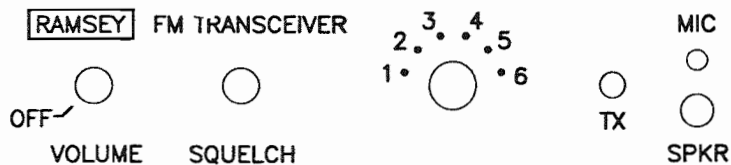
RAMSEY

Quantity	RS Part No.	Description	1991 Price
1	270-272/74	Deluxe Project Enclosure (two heights available)	8.79 or 10.79
1 set	274-section	Pkg. of 3 or 4 knobs	2.00-3.00 (styles vary)
1 set	270-201	Rub-on project labels	2.99
2 sets	276-195	PC-board standoffs/screws	2.38

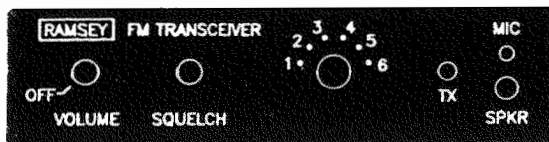
This \$16 to \$18 (plus tax) in basic hardware also presumes availability of all needed drill bits and/or a reamer or punches of sufficient size to make the needed access holes for the rear panel jacks. You'll also want to figure on spray paint as well as a clear finish to protect the panel labels.

In addition, this style of case will have to be utilized upside-down and also length-wise rather than as designed. This means that the top (black) becomes the foundation for mounting the PC-board with the standoffs as well securing the SO-239 antenna connector assembly. You may wish to repaint the white bottom which now becomes the top. And, to use the project labels (black lettering), you'll probably wish to repaint both pieces.

This adaptation of standard Radio Shack hardware is adequate for indoor or occasional use but not recommended for mobile operation. We are happy to provide this suggested alternative to the rugged case, knob and hardware kit custom-designed for the FTR transceivers. The choice is yours!



FTR-C front and rear panel layouts
(not to scale)



THE RAMSEY FTR-C TRANSCEIVER ENCLOSURE KIT

The FTR-C Kit is very obviously a fair value and solid investment for the long-term performance and worth of your transceiver. As we have mentioned, we make it "optional" ONLY because some of our ham customers have specialized applications requiring only the basic PC-board kit. So, we try whenever we can to accommodate that important do-it-yourself spirit of ham radio.

ENCLOSURE KIT PARTS LIST

- 1 [] Steel bottom shell with 5 threaded PC-board standoff shafts
- 1 [] Steel top shell
- 1 [] Front control panel
- 1 [] Rear panel with access holes to PC-mounted jacks
- 2 [] Steel side rails with holes threaded for screws and mobile mounting bracket (mobile bracket not supplied)
- 5 [] PC-board standoff spacers
- 5 [] #4 nuts to secure PC-board on standoffs
- 8 [] #4 screws to mount front and rear panels
- 8 [] #6 screws for securing top and bottom to side rails
- 1 [] large knob for Channel Selection Switch
- 2 [] smaller knobs for Volume and Squelch controls
- 4 [] self-adhesive rubber feet

FTR -C CASE ASSEMBLY SUGGESTIONS:

The purpose of these hardware parts is largely self-evident. We offer the following suggestions for your convenience and to minimize wear and tear on your factory-fresh FTR enclosure.

- [] 1. Since the bottom shell will be needed for several "test fittings" during transceiver assembly, install the rubber feet right away to protect its finish.
- [] 2. Obviously, the PC-board cannot be secured permanently to the bottom section until after installation of L11, R29 and L8 AFTER Alignment and before Transmitter tuneup.

FTR-C Transceiver Case Kit Assembly Suggestions

- [] 3. Since the top shell will not be needed until you're ready to go on the air, keep it wrapped in protective material until you're really ready to use it.
- [] 4. When advised to do so in Assembly Stage K, a temporary loose fitting of the rear panel with the SO-239 RF connector will be needed.
- [] 5. The side rails may be installed to the bottom section at any time. To prevent loss of the screws for the top, keep them loosely-threaded in the side rails.
- [] 6. There is no point in securing the front-panel controls and jacks to the panel permanently until AFTER wiring the Channel Selection switch.
- [] 7. Whenever you find it necessary to remove the top shell, "store" the screws back into their holes in the side rails.

Kit Builder's Notes:	Date

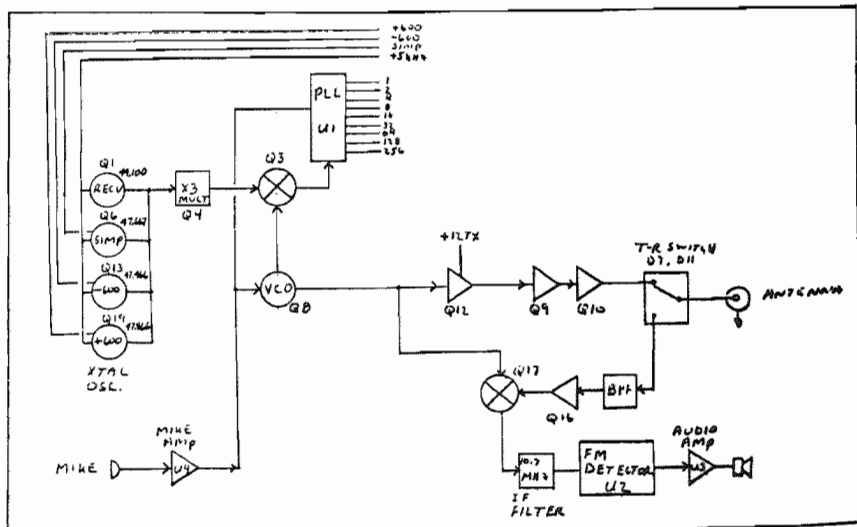
RAMSEY

FTR-146 THEORY OF OPERATION

Understanding how your transceiver works is important both for maximum enjoyment of its capabilities and for maintaining it with no factory service expense. The author has been developing a comprehensive, illustrated guide to the inner workings of the FTR transceiver which may be included in this edition of the instruction manual, as pages bound into the book, or as a pamphlet insert. The goal is a plain-language tour through the circuit that is technically accurate, easy to understand, and based on questions and observations we are receiving from FTR builders who have been using their new rigs since the FTR-146's introduction at the 1991 Dayton Hamvention. If this information is not included in your own copy of this book, you are most welcome to send a business-size or 6X9" SASE directly to the author for the final version to be printed. Your request also will register you automatically for the first issue of *FtrUN*, the newsletter for FTR builders and users.

Send SASE to:
K4ZRA c/o DRRC
642 North Grandview
Daytona Beach, FL 32118

In the meantime, here's a wallet-size reproduction of the Ramsey engineering sketch that started it all!



IMPORTANT MICROPHONE & SPEAKER INFORMATION

If your immediate goal for your new FTR-146 is dedicated Packet Radio operation, the following information will not be of immediate concern to you. (See note on page 11 in the Alignment & Operation section regarding packet hookup.)

The FTR transceiver with hardware supplied is designed to accept standard ICOM or ICOM-compatible microphones or speaker-mikes such as MFJ-284.

Be aware that the receiver audio amplifier is capable of supplying a husky 2 watts or more of audio power.

The PTT switching circuit (see PNP Q22) can be activated simply by introducing a resistance (e.g. 10K) from the microphone input to ground. This resistance is enough to trigger the PTT circuit without interfering with the microphone audio input to U4 through C106 and C107.

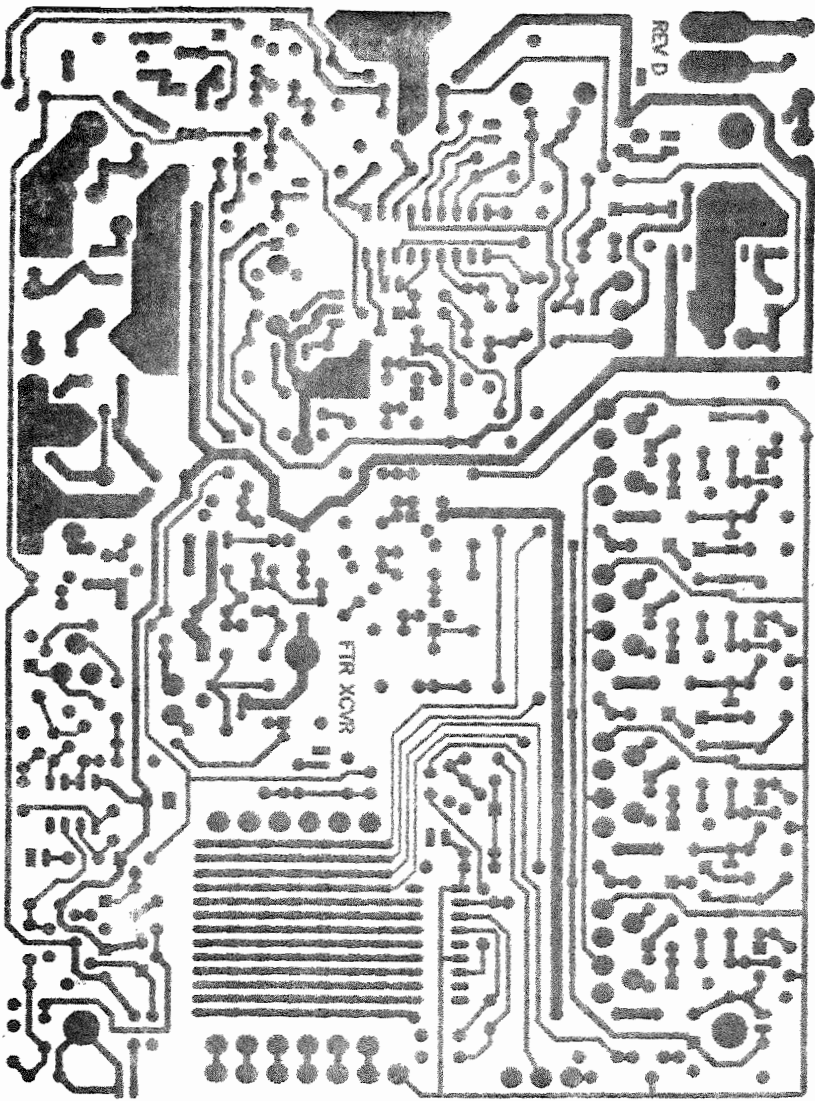
Consider these factors carefully in selecting microphone, speaker and/or speaker-mike for FM voice operation.

Kit Builder's Notes:	Date

RAMSEY

CHECKING FOR SOLDER BRIDGES

It's one thing to be warned repeatedly not to cause "solder bridges" (unwanted flowing of solder from one point to another, particularly around IC pins and other tight spots.) However, even after a good assembly job, the process of checking our work can make us wonder if this or that pair of pads have been bridged OR are intentionally connected by PC-traces. This "right-reading" depiction of your FTR PC-board solder-side should help. Simply keep it near your board, positioned in the same direction, as you go over your work.



FTR PC-board Copyright 1991 Ramsey Electronics, Inc.
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IMPORTANT FOR ALL FTR KIT-BUILDERS:

First Assembly Step:

[] [] Examine your FTR circuit board. Notice that one side is covered almost completely by tinned copper or "foil." This is called a groundplane. This side is the Top or COMPONENT SIDE of the board. All parts (except SMT C123) will be mounted on this side. The other side has most of the printed circuit traces and is called the Bottom or CIRCUIT SIDE.

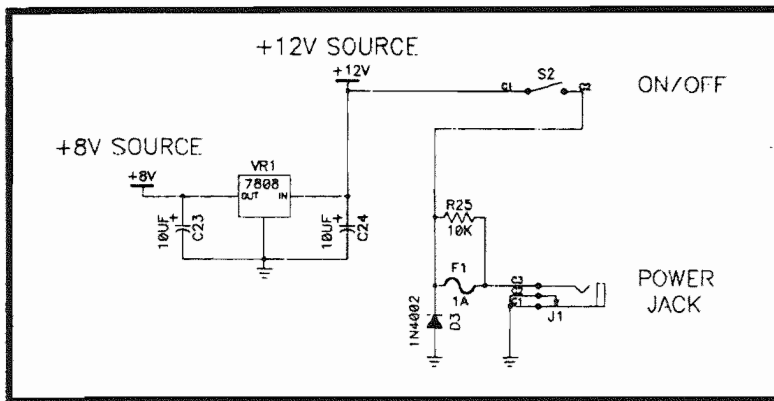
The following step-by-step directions were prepared with newcomers and beginners in mind. Experienced amateurs may prefer other approaches to preparing the PC-board. **However**, the step-by-step assembly stages occasionally contain component information that is essential to proper operation of your FM transceiver.

We remind you once again that de-soldering incorrectly-installed components is neither easy nor pleasant.

Do not install L11, R29 or L8 until instructed to do so after initial alignments.

Take your time
and ENJOY your FM Transceiver project!

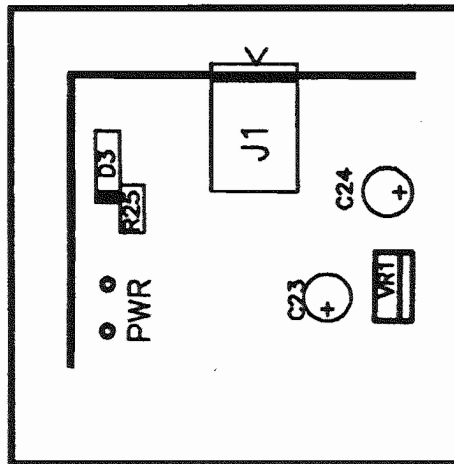
Stage A: DC Power Supply



PLEASE NOTE:

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If you have questions, ALWAYS review the complete schematic, the full PC-board illustration and the Master Component Index.



Stage A: DC Power Supply

These first steps will supply correct voltages throughout the circuit board and permit periodic, safe testing of completed receiver and transmitter stages as you go along.

- [] [] A1. Install J1, the coaxial DC power jack in this manner: first, gently bend the side tab to a right angle so that it may be soldered to the top side of the board. After making sure the jack seats squarely, solder all three connections.
- [] [] A2. Install D3, the 1N4002 diode, taking care to orient the banded (cathode) end as shown. [D3 is the largest diode used in your kit, generally black in color.]
- [] [] A3. Prepare a DC power cord using a plug which mates J1. IMPORTANT: notice that the barrel is negative and the tip is positive! Be attentive to this fact especially if you want to use a pre-assembled cable set, many of which use the opposite polarity.

NOTE: Depending on bulk-quantity availability, a pre-assembled power cord MAY be provided in your kit, at the sole discretion of Ramsey Electronics, Inc.

- [] [] A4. Fuse F1 consists of a single strand of bare #30 wire soldered across 10K resistor R25 (brown-black-orange). Simply remove one 1" strand from any of the multi-strand hookup or speaker wire supplied with your kit. Do NOT "cheat" by using heavier wire, or your transceiver circuitry will not be properly protected.

- [] [] A5. Install R25 with fuse wire as explained in 4A.

NOTE: If you use a cable with an inline fuseholder, be sure to use only 1A to 2A fast-acting fuses. The same is also true if you install your own panel-mount fuse holder.

- [] [] A6. Install C24, a 4.7 or 10 ufd. electrolytic, making sure to observe correct POLARITY on this and all other electrolytic capacitors in your kit.

- [] [] A7. Similarly, install 4.7 or 10 ufd. electrolytic C23.

- [] [] A8. Install VR1, the 7808 Voltage Regulator. The metal heat sink tab MUST be oriented as shown (away from C23, C24 and J1 already installed.) Press VR1 firmly into its three holes, as far as it will reasonably go, and solder all three points.

A: DC POWER INPUT (and Packet Connection Jack), A10-A16

- [] [] A9. This step is out of our stage-by-stage sequence but will relieve stress on other parts when the board is lying on its component side. Install J3, the 5-pin DIN Packet connection jack. Make sure the base of J3 is flush and square on the board before soldering. Solder all 5 points.
- [] [] A10. Cut two 8-1/2" lengths of the hookup wire supplied in your kit. Strip about 1/8" from all four ends. Very lightly tin all four ends with solder to keep the strands from straying.
- [] [] A11. Solder one end of each wire to the two points designated "Power" on the board.
- [] [] A12. Solder the two wires of the other end to the two switch terminals on R69, the Volume Control. Consult the main PC-board illustration as needed.

NOTE: We know that there are MANY parts to be installed in this transceiver project. As more parts are installed, and as you grow more familiar with assembly routines, these printed instructions will simply list groups of parts to be installed with minimal commentary.

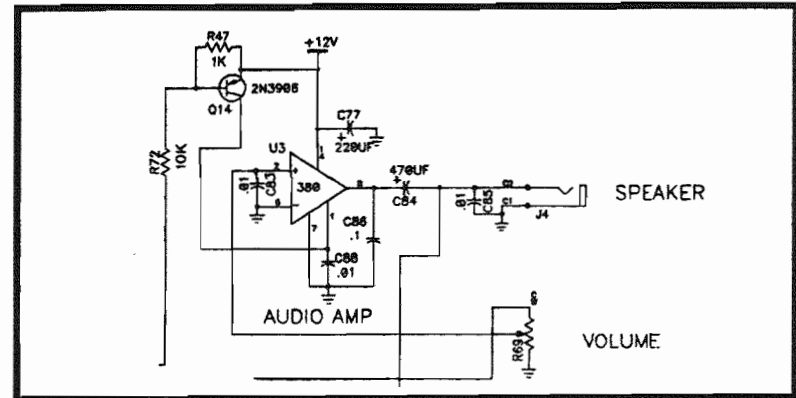
For a sample, let's go back to that PC-board area around the Packet connector (J3) that you soldered in Step A9. Install the following parts:

- A13. [] [] C109, .001 ufd.
 A14. [] [] C111, .001 ufd.
 A15. [] [] C110, .001 ufd.
 A16. [] [] C108, .001 ufd.

Kit Builder's Notes:	Date

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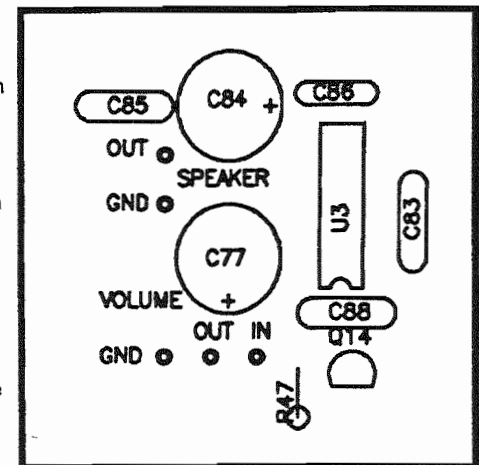
Stage B: Receiver Audio Amplifier



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⊕ Watch POLARITY on ALL electrolytics! 10 ufd. may be 4.7 to 10 ufd.

Stage B: Receiver Audio Amplifier

Some of the preceding steps required more detailed explanation than simply inserting and soldering parts. As we move along, there will be more and more short "one liners"! The following steps will complete a working audio amplifier ready to power up and test.

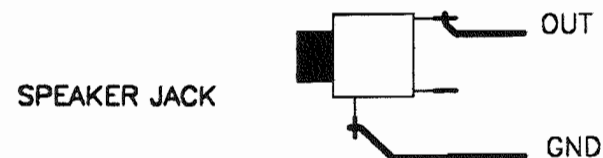
- [] [] B1. Install U3, the LM380 IC. Be sure to orient the dotted or banded end as illustrated. (The use of a DIP socket for U3 is NOT recommended, even if you use sockets for the other IC's. Notice that most of U4's pins are soldered to a ground plane to provide proper heat dissipation.)
- [] [] B2. Install C83, .01 ufd.
 [] [] B3. Install C88, .01 ufd.
 [] [] B4. Install C86, .1 ufd.
- [] [] B5. Install C84, 470 ufd. electrolytic. Watch for correct polarity.
 [] [] B6. Install C77, 330 ufd. electrolytic.
- [] [] B7. Install C85, .01 ufd.
- [] [] B8. Install PNP transistor Q14. Be sure to have identified it correctly as one of the two PNP transistors used in your kit, and be sure to orient the flat side as illustrated.
 {Marked 228256}
- [] [] B9. Install R47, 1K (brown-black-red). Notice that this is the first of numerous VERTICAL installations of resistors. The body of such resistors should be snug against the board at the designated hole, with the other wire neatly looped into the other hole without needless excess.
- [] [] B10. Install R72, 10K (brown-black-orange).
- [] [] B11. Cut a 8-1/2" length of the 3-conductor wire to connect the volume control to the three points near C77. Strip and tin all six ends, referring back to Step [A10] if necessary.
- [] [] B12. Referring to the main PC-board drawing, correctly interconnect the Volume Control's three terminals to the 3 connecting points on the PC-board.
- [] [] B13. Use the 12" of 2-conductor wire in your kit to prepare the Speaker Cable. Neatly strip and tin all 4 ends as in [A10] and [B11].
- [] [] B14. Solder both wires of one end of the Speaker Cable to the two marked points between C84 and C77.

AUDIO AMPLIFIER: Steps B15-16

- [] [] B15. The other two ends of the speaker cable may be connected in any of the following ways:
 [] to J4, the Speaker Jack supplied.
 [] to a test speaker, temporarily.
 [] to a speaker intended for regular use in or with your FTR FM Transceiver.
- [] [] B16. Solder the speaker cable to your choice of speaker. Give attention to the polarity marks on most bare speakers as well as enclosed units.

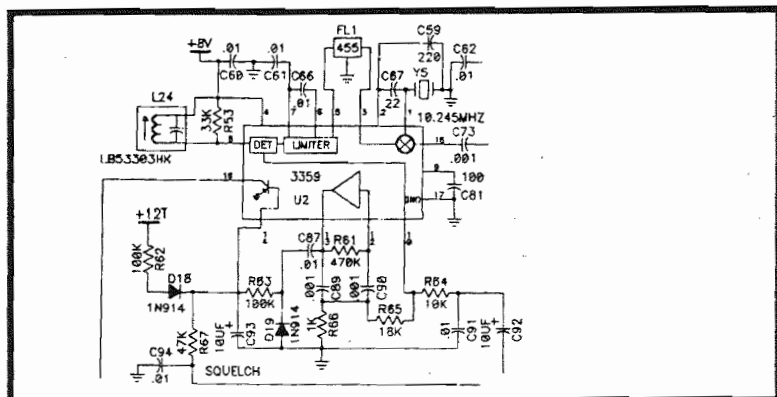
AUDIO AMPLIFIER TEST:

1. Connect DC power to J1.
2. Turn on power switch S2. All you should hear is a gentle pop in the speaker. There should be no hiss or whistle. Touch the center terminal of the volume control, and you should hear a moderate AC hum. If you wish, connect a test oscillator or line-level audio source to the input line to the control. You should hear plenty of good quality sound.
3. Disconnect power before proceeding with assembly.



Kit Builder's Notes:	Date
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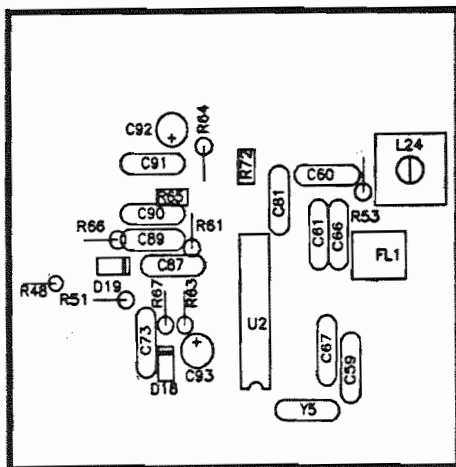
Stage CF: Receiver FM Detector and Squelch Circuits



PLEASE NOTE:

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Stage CF: Receiver FM Detector and Squelch Circuits

{This step is named "CF" so that the assembly step numbers do not resemble designator numbers for capacitors}.

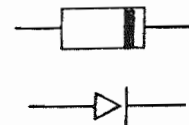
The heart of this stage is the MC3359 FM Receiver IC (U2), which has been at the center of best-selling Ramsey VHF FM receivers for popular VHF ham radio bands. This transceiver's implementation of this proven circuit gives you synthesized frequency control, 4-pole IF filter plus receiver pre-amp.

- [] [] CF1. Install U2, the MC3359 18-pin DIP FM Receiver IC. It's OK but not necessary to use your own 18-pin DIP socket in lieu of direct soldering of U2. The same care in soldering and pin insertion MUST be given to either method of installation! Be sure to install U2 with the banded or dot end oriented as illustrated.
- [] [] CF2. Install C92, 10 ufd., using correct polarity.
- [] [] CF3. Install C91, .01 ufd.
- [] [] CF4. Install R64, 10K, (brown-black-orange). Upright installation required: review Step [B9].
- [] [] CF5. Install R65, 18K (brown-gray-orange).
- [] [] CF6. Install C90, .001 ufd.
- [] [] CF7. Install C89, .001 ufd.
- [] [] CF8. Install R61, 470K (yellow-purple-yellow), upright.
- [] [] CF9. Install C87, .01 ufd.

Install the following in upright position:

- [] [] CF10. R63, 100K (brown-black-yellow).
- [] [] CF11. R67, 47K (yellow-purple-orange).
- [] [] CF12. R66, 1K (brown-black-red).
- [] [] CF13. Install C93, 10 ufd. electrolytic.
- [] [] CF14. Identify the batch of 60 type 1N914 or 1N4148 common switching diodes supplied with your kit. For convenience, they will be referred to as 1N914 in all parts of this book, including the schematic. The same type of diode is used for programming the PLL frequency synthesizer. Keep them handy for routine installation throughout the circuit, and carefully set aside the 5 varactor diodes and 3 PIN diodes.

IMPORTANT:
Because your transceiver uses dozens of diodes, we will not be giving constant reminders to observe correct anode-cathode polarity.



CF: FM RECEIVER IC: Steps CF15-CF31

- [] [] CF15. Install 1N914 diode D18.
- [] [] CF16. Install 1N914 diode D19.
- [] [] CF17. Install R51, 100K (brown-black-yellow), upright.
- [] [] CF18. Install R48, 470 ohms (yellow-purple-brown).
- [] [] CF19.
- [] [] CF20. Install L24, the shielded coil marked LB53-303. It fits in only one way. Make sure it is square and flush on the board before soldering.
- [] [] CF21. Install R53, 33K (orange-orange-orange).
- [] [] CF22. Install C60, .01 ufd. (Notice that C60 also brings the +8V output of the 7808 voltage regulator to the solder side of the PC board.)
- [] [] CF23. Install C66, .01 ufd.
- [] [] CF24. Install C61, .01 ufd.
- [] [] CF25. Select and install FL1, the rectangular plastic block with 3 thin pins. It fits only one way. This is the 455 KHz. IF filter.

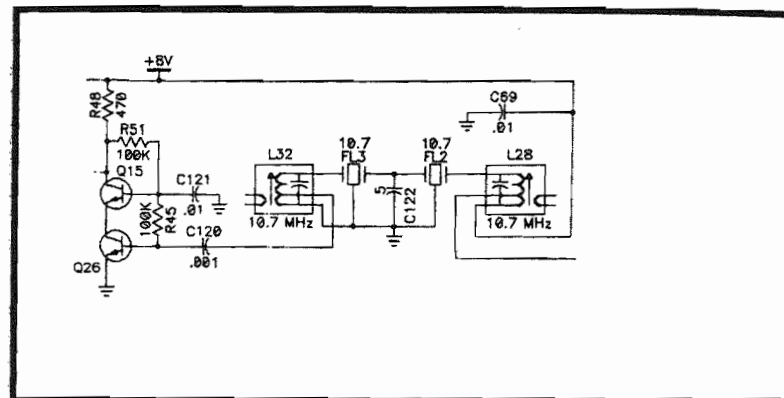
So far, most disc capacitors installed have been from your endless supply of .01 and .001 capacitors. If you have not done so already, now would be a good time to sort and organize all your "picofarad" capacitors, ranging in value from 2 to 100 pf. Correct selection of these values will be ESSENTIAL throughout the RF stages of your transceiver.

- [] [] CF26. Install C81, 100 pf. (marked 100 or 101).
- [] [] CF27. Install C67, 22 pf.
- [] [] CF28. Install C59, 220 pfd. (marked 220 or 221).
- [] [] CF29. Select and install Y5, the 10.245 MHz. crystal. It must be snug on the board before soldering. [Be sure not to confuse Y5 with Y1, the 10.240 MHz. crystal which will set the Reference Frequency for the PLL Synthesizer.]

Install the following parts now, so that they will not get left out:

- CF30. [] [] C62, .01 ufd.
- CF31. [] [] C94, .01 ufd.
- CF32. [] [] R62, 100K ohms (brown-black-yellow).

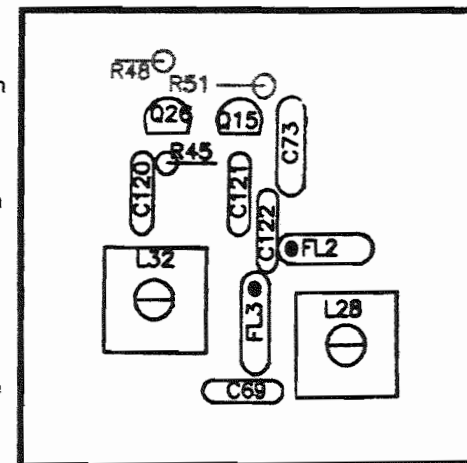
Stage DF: 10.7 MHz. Receiver IF and 4-pole Crystal Filter



PLEASE NOTE:

These sections or stages from the complete schematic and PC-board layout are printed as a help in understanding the circuit. The assembly steps MAY require installation of parts not illustrated on this page because they are depicted elsewhere on the schematic or placed in some other area of the PC-board.

If you have questions, ALWAYS review the complete schematic, the full PC-board illustration and the Master Component Index.



Any components which are printed in a tint (gray shade) were installed in a previous stage. See main drawing for X-Ray view of traces.

Stage DF:

10.7 MHz. Receiver IF and 4-pole Crystal Filter

We got into this part of the circuit already by installing the resistors and capacitors associated with Q15 and Q26.

Again, these steps have the prefix "DF" rather than "D" so that there will be no confusion with the many diodes required in this project.

- [] [] DF1. Install transistor Q15, NPN type 2N3904, taking care to orient its flat side as illustrated.
- [] [] DF2. Similarly, install Q26, also 2N3904.
- [] [] DF3a. Install R45, 100K, upright (brown-black-yellow).
- [] [] DF3b. Install C73, .001 ufd.
- [] [] DF4. Install C121, .01 ufd.
- [] [] DF5. Install C120, .001 ufd.
- [] [] DF6. Install C122, 4.7 or 5 pf.
- [] [] DF7. Install 10.7 MHz. transformer L28. (marked TB933)
- [] [] DF8. Install 10.7 MHz. transformer L32. (marked TB933)
- [] [] DF9. Select and examine the two crystal filters, which are in standard crystal cases but with three wires. Notice the orientation dot on the top of each filter. These dots MUST be positioned as illustrated.
- [] [] DF10. Install crystal filter FL2.
- [] [] DF11. Install crystal filter FL3.
- [] [] DF12. Install C69, .01 ufd.

Squelch control installation:

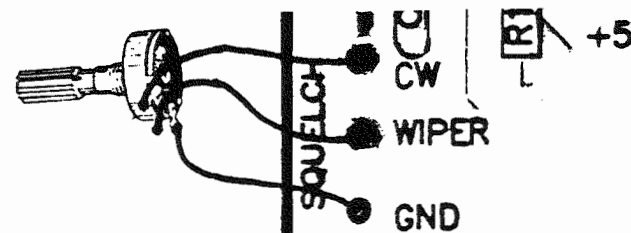
- DF13. [] [] Examine the main PC-board illustration and install R41, 100K (brown-black-yellow) near the front edge of the PC-board.
- DF14. [] [] Using 2" or so of the remaining 3-wire cable, make the 6 solder connections required to install R58, the 10K Squelch Control. As long as the wire from the "wiper" point on the PC-board goes to the middle terminal of R58, the worst we can do is get a backwards-working squelch! (If you need to change after testing, do it at the control rather than the PC-board connections.)

STAGE DF: PROGRESS TEST

The purpose of this test is enjoy the results of the progress made so far AND to catch any basic error BEFORE starting on the more demanding RF circuitry. (For example: the author missed soldering a single pin on U2. Since he knew in theory what the receiver circuit should do at this point, the error was much easier to find before the board got further filled with parts.)

TEST PROCEDURE:

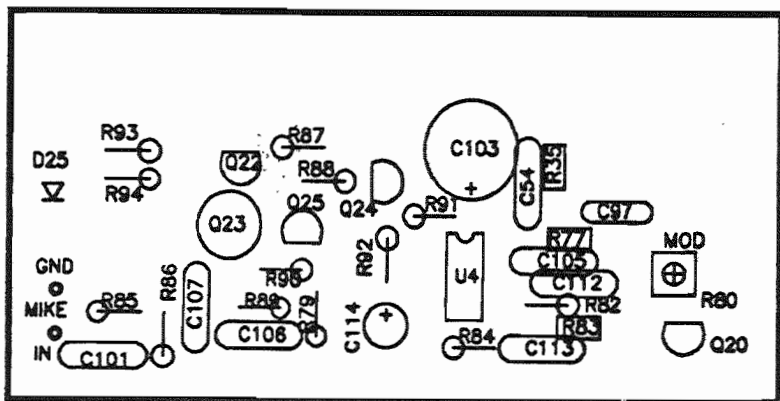
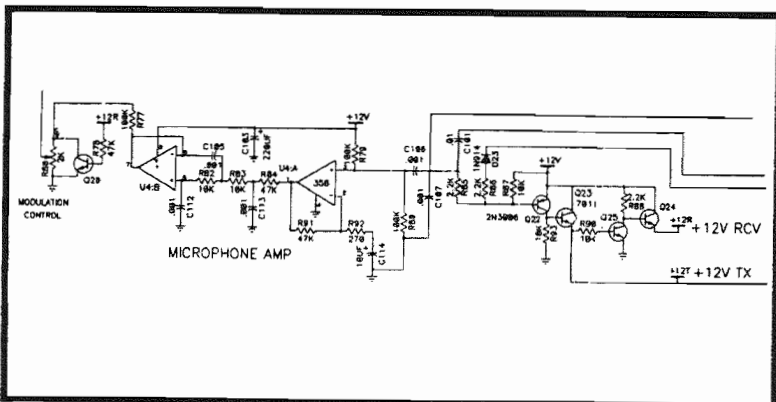
1. Re-connect DC power and speaker.
2. Set both squelch and volume controls fully to the left.
3. Turn on the power switch and advance the volume slightly. You should hear the loud, distinctive "hiss" of a VHF receiver or scanner with no signal, no squelch.
4. Check the squelch control for proper operation. It should cut the hiss completely at some point in its rotation.
5. Tune a shortwave receiver in CW mode to 10.245 and bring a short wire from its antenna input to within a few inches or even feet from your transceiver project. You should hear the 10.245 MHz. IF oscillator controlled by crystal Y5.
6. If you do not get these test results, review your work before proceeding.
7. Disconnect DC power before further assembly.



Kit Builder's Notes:	Date
RAMSEY	

+
 Watch POLARITY
 on ALL electrolytics!
 10 ufd. may be 4.7 to 10 ufd.

Stage E: Microphone Amplifier, PTT (Push to Talk) & Packet Circuits



Stage E: Microphone Amplifier, PTT (Push to Talk) & Packet Circuits

This phase continues our gameplan of building and testing as many of the peripheral functions of the transceiver as possible, so that quality attention can be given to all details of frequency control and RF circuitry. This phase will also give you an experience loved by many builders -- a chance to just "stuff the board" with a lot of parts, without so much reading. Go for it, but don't get careless!

- [] [] E1. Review Step CF1 above and then install the LM358 8-pin DIP integrated circuit, U4, which is a dual "op-amp" (operational amplifier).

Install the following, with care for electrolytic, diode and transistor orientation as well as upright installation of many of the resistors:

- [] [] E2. C103, 220 ufd. electrolytic.
 - [] [] E3. R91, 47K (yellow-purple-orange).
 - [] [] E4. R92, 270 ohm (red-purple-brown).
 - [] [] E5. C114, 10 ufd. electrolytic.
 - [] [] E6. Q24, 2N3904 NPN transistor.
 - [] [] E7. R88, 2.2K (red-red-red).
 - [] [] E8. R87, 10K (brown-black-orange).
 - [] [] E9. Q25, 2N3904 NPN transistor.
 - [] [] E10. R90, 10K (brown-black-orange).
 - [] [] E11. R79, 100K (brown-black-yellow).
 - [] [] E12. C106, .001 ufd.
 - [] [] E13. R89, 100K (brown-black-yellow).
 - [] [] E14. C107, .001 ufd.
 - [] [] E15. C101, .01 ufd.
 - [] [] E16. R86, 2.2K (red-red-red).
 - [] [] E17. R85, also 2.2K.
 - [] [] E18. R94, 1K (brown-black-red).
 - [] [] E19. R93, 10K (brown-black-orange).
 - [] [] E20. Select and install Q22, the other of the two PNP (2N3906 or similar) transistors used.
 - [] [] E21. Q23 is the round, black NPN transistor marked 7011507. While this unit is generally manufactured with a very small flat spot on the side, which should point toward R94, it is easiest to simply match the actual pin pattern of Q23 to the drilling pattern of the board. Its leads may stand 1/8" above the board, or just press Q23 snug before soldering.
 - [] [] E22. Install Q23 per E21 above.
- Install these additional parts for the microphone circuit:
- [] [] E23. R84, 47K (yellow-purple-orange).
 - [] [] E24. C113, .001 ufd.
 - [] [] E25. R83, 10K (brown-black-orange).
 - [] [] E26. R82, 10K (brown-black-orange).

- [] [] E27. C112, .001 ufd.
- [] [] E28. C105, .001 ufd.
- [] [] E29. R77, 100K (brown-black-yellow).
- [] [] E30. Q20, NPN transistor type 2N3904.

- [] [] E31. Select one of the 9 trimmer potentiometers for installation as R80, the FM modulation level control. Be sure to distinguish these trimmer pots from the 3 trimmer capacitors to be used, which have only two connection pins.

- [] [] E32. Install trimmer pot R80 per E31 above.
- [] [] E33. Install R78, 47K (yellow-purple-orange.)

- [] [] E34. Install ONE lead of C97, .001 ufd., the lead closest to R80. Let the other lead stand straight up for an optional test of the microphone amplifier. The other lead will be soldered in place after the testing is done. If you do not wish to conduct that test, simply install C97 in the normal manner.

The following two parts are more directly associated with the FM modulation of the VCO but are quite convenient to install now:

- [] [] E35. Install C54, .001 ufd.
- [] [] E36. Install R35, 47K (yellow-purple-orange).

Diode D23 is part of this circuit stage but is installed near the Packet jack (J3).

- [] [] E37. Install D23, type 1N914.

MICROPHONE CONNECTION:

- [] [] E38. The following instructions assume your use of the Ramsey FTR-C enclosure or a case of virtually identical size and shape. If you are doing something radically different, we must assume you know what you are doing and that you will use shielded miniature audio cable as required.

NOTE: The subminiature jack supplied with your kit may be either open-circuit (2 connections) or closed circuit (3 connections). If the latter is true, you still should install it as a simple open-circuit jack, since no useful purpose would be served by keying the transmitter when the mike is unplugged.

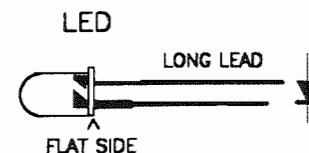
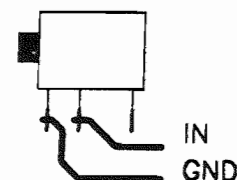
- [] E39A. Prepare 2 short pieces of hookup wire, 1.25" long.
- [] E39B. Solder one end of each wire to the "MIKE" and "GND" holes on the board.

NOTE: They say a picture is worth a thousand words, but your VOM set up for continuity testing is even better when it comes to identifying connections on small jacks. Use your meter to identify positively the tip and "barrel" (ground) connections. For closed circuit jacks, do your test with a plug inserted!

- [] E39C. The "Mike" wire must be soldered to the TIP connection of the microphone jack.
- [] E39D. Solder the "GND" wire to the ground connection of the jack.

- [] [] E40. Install D25 transmit LED, using full lead length so that the bulb can be fitted into its front panel hole.

MICROPHONE JACK



PROGRESS TEST:

Ideally, this test requires temporary connection of a suitable microphone compatible with the solid-state PTT circuit of your transceiver. We can test both the PTT circuit and the microphone amplifier. Your transceiver is designed to accept the ICOM "speaker mike" sold as an accessory for ICOM handheld transceiver. Other microphones may be used, provided that their PTT function presents sufficient resistance from ground to the base of PNP switching transistor Q22. (See "Microphone Considerations.")

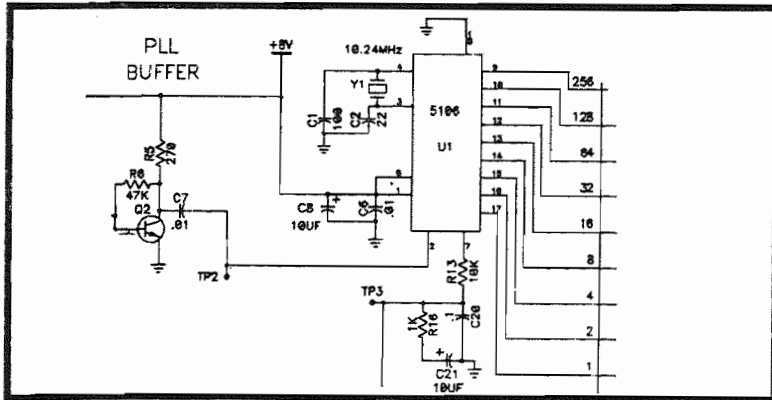
An example of a suitable microphone is MFJ No. MFJ-284. If a microphone is not yet ready or available, the PTT circuit may still be tested by momentarily shorting the microphone leads.

1. Connect microphone.
2. Apply DC power and adjust volume and squelch for moderate receiver background noise.
3. Press the mike's PTT switch several times. The Transmit LED should light only when the switch is pressed.
4. Pressing the PTT should also mute the receiver noise.
5. Any point on the schematic marked "+12T" should show 12-14 VDC from that point to the ground plane ONLY when the PTT is keyed.
6. If the PTT circuit does not function as described, re-check all work and components associated with Q22 before proceeding.

OPTIONAL TEST:

If desired, the operation of the microphone amplifier can be checked by sampling its output at C97 with a test amp or audio signal tracer. This test is not essential. Finish installation of C97 before proceeding.

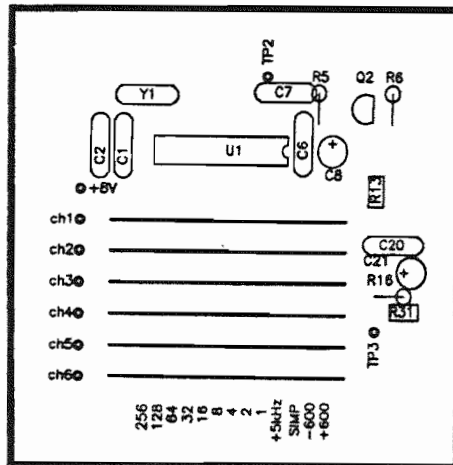
Stage F: The PLL Frequency Synthesizer



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Stage F: The PLL Frequency Synthesizer

Before we get into coils, mixers and more crystals, let's build a computer! Receiver as well as transmitter frequency control depends on the operation of -- and your understanding of -- the "brains" of your transceiver, the MC145106 PLL IC, programmed by the channel selection matrix. Let's get started!

- [] [] F1. Referring back to Step [3A] if needed, install CAREFULLY the 18-pin DIP IC, U1, type MC145106.
- [] [] F2. Install C2, 22 pf.
- [] [] F3. Install C1, 100 pf.
- [] [] F4. Install C6, .01 ufd.
- [] [] F5. Install C7, .01 ufd.
- [] [] F6. Install C8, 4.7 or 10 ufd. electrolytic.
Just a reminder on all electrolytics: WATCH POLARITY!
- [] [] F7. Install Y1, the 10.240 MHz. crystal. Make sure the crystal case is squarely on the PC-board before soldering. CHECK FREQUENCY MARKING CAREFULLY!
- [] [] F8. Next to C7, at TP2, solder a 1/4" length of scrap wire standing upright. This same procedure will be used at other Test Points to permit easy connections for final alignment. (TP2 is intended for connection of a frequency counter for precise alignment of this PLL stage while also observing voltage readings from TP3 to be installed in step F14a.) ALL TEST POINTS MAY BE MADE FROM EXCESS RESISTOR WIRE LEADS.
- [] [] F9. Use another piece of scrap wire bent in a "U" shape to make a temporary jumper between the "+8V" point near C2 and the nearby hole marked "CH1." This will permit initial tests on Channel 1 before final wiring and installation of the channel switch.
- [] [] F10. Install R13, 10K (brown-black-orange).
- [] [] F11. Install C20, .1 ufd.
- [] [] F12. Install C21, 4.7 or 10 ufd. electrolytic.
- [] [] F13. Install R16, 1K (brown-black-red), upright.
- [] [] F14a. Referring to Step F8, install TP3.
- [] [] F14b. OPTIONAL STEP: Refer to section PLL of this book and construct one diode matrix for 146.52 MHz. SIMPLEX, established as the reference standard for aligning your transceiver.

It is necessary to study and understand Section PLL before testing the receiver stages and doing basic transceiver alignment.

The preceding steps completed the circuit of the PLL synthesizer itself, except for testing and programming. The following several steps will set up the Q2 PLL Buffer stage:

- [] [] F15. Install R5, 270 ohms (red-purple-brown).
- [] [] F16. Install Q2, NPN type 2N3904.
- [] [] F17. Install R6, 47K (yellow-purple-orange).

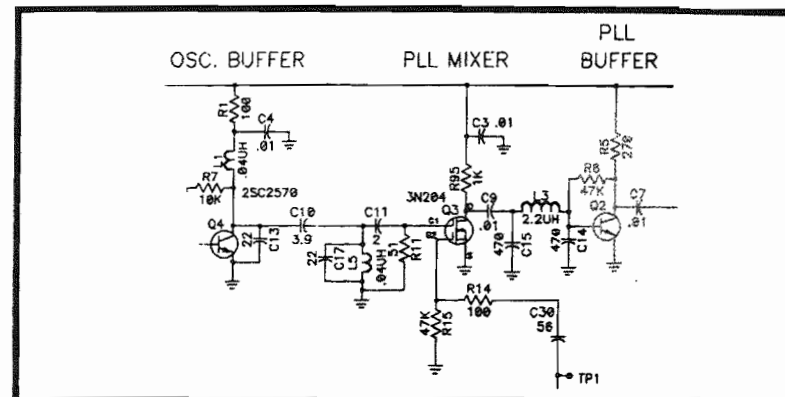
PROGRESS TEST (Optional):

If you wish, you can use your HF communications receiver or frequency counter to check for an additional oscillator signal at 10.240 MHz. as well as the 10.245 MHz. signal already verified.

DO NOT conduct any further tests or "demonstrations" for friends during assembly steps unless you are at a point where a test is explicitly suggested or required. This caution is for maximum protection of the 3N204 MOSFET transistors and other components.

If your earlier progress tests went well, and you are ready for further careful parts installation, proceed with confidence!

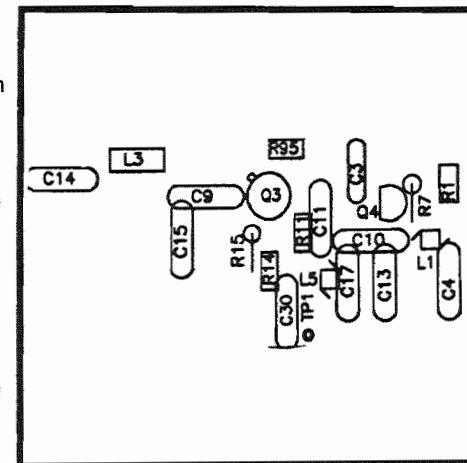
Stage G: PLL Mixer and Oscillator Buffer-Tripler



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Kit Builder's Notes:	Date

RAMSEY

Stage G:

PLL Mixer and Oscillator Buffer-Tripler

You may have noticed that only 4 components created the "PLL Buffer" section already completed. Notice that there is a buffer stage on each side of the PLL Mixer. The purpose of buffer stages in RF design is to provide a degree of isolation, so that the interconnecting stages do not mess each other up. Without the "buffering" provided by Q2 and Q4, the frequency stability of the PLL can be compromised by the crystal oscillators, and vice versa. In addition, Q2 operates as a frequency tripler, bringing the 44-47 MHz. crystal oscillators up to the desired range for VHF synthesis.

- [] [] G1. Install C14, 470 pf. (Marked 470 or 471).
- [] [] G2. Install C15, also 470 pf.
- [] [] G3. Install C9, .01 ufd.

- [] [] G4. For L3, select one of the four 2.2 uh. molded inductors used in this circuit. Note that its color coding includes two red bands. Install L3.

- [] [] G5. Select Q3, one of the two 3N204 dual gate MOSFET transistors. Study its orientation on the PC-board, noting the direction of the small tab. (IF there is a thin wire around the 4 leads, leave it on until after installation, but gently remove it before forgetting about it and applying power.)

- [] [] G6. Install Q3 per Step G5.

Install the following additional components, keeping all component leads as short as possible:

- [] [] G7. R15, 47K (yellow-purple-orange), upright.
- [] [] G8. R14, 100 ohms (brown-black-brown).
- [] [] G9. R11, 51 ohms (green-brown-black).
- [] [] G10. R95, 1K (brown-black-red).
- [] [] G11. C3, .01 ufd.
- [] [] G12. C30, 56 pf.
- [] [] G13. Wire for Test Point 1 (Review Step F8).
- [] [] G14. C11, 2 or 2.2 pf.
- [] [] G15. C10, 3.9 pf.
- [] [] G16. C17, 22 pf.
- [] [] G17. C13, also 22 pf.

- [] [] G18. Select two of the seven .04 uh., 1/8" 4-turn coils supplied. This type of coil is installed by slipping it into its designated holes and soldering, as for other small components. It is not necessary to "straighten" these coils after soldering.

G19-G24

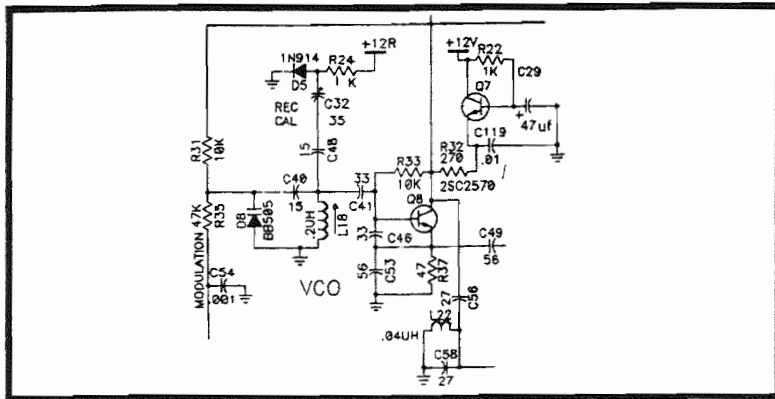
- [] [] G19. Install coil L1, per step G18.
- [] [] G20. Install coil L5, per step G18.

- [] [] G21. Install Q4, VHF NPN transistor 2SC2570.
- [] [] G22. Install R7, 10K (brown-black-orange).
- [] [] G23. Install R1, 100 ohms (brown-black-brown).
- [] [] G24. Install C4, .01 ufd.

The only test necessary at this point is to review the accuracy of your assembly work.

Kit Builder's Notes:	Date
RAMSEY	

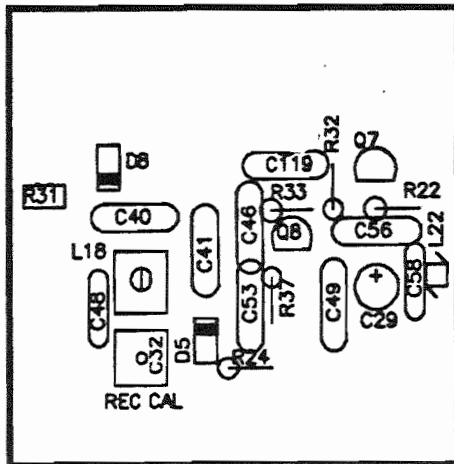
Stage H: VCO (Voltage Controlled Oscillator)



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Stage H: VCO (Voltage Controlled Oscillator)

If we take a good look at this small circuit in the bigger picture of the whole schematic, we see that it is the crossroads for many of the basic functions of both receiver and transmitter. Do your work in this stage VERY carefully.

- [] [] H1. Install R31, 10K (brown-black-orange).
- [] [] H2. Install C40, 15 pf.
- [] [] H3. Install varactor diode D8, type BB505.
Be sure you have identified it correctly.
- [] [] H4. Install L18, the small, remaining shielded coil.
It fits the board two different ways: either is OK.
- [] [] H5. Install C32, one of the 3 trimmer capacitors.
Again, be sure to distinguish these trimmers from the remaining 8 trimmer potentiometers.
- [] [] H6. Install diode D5, type 1N914.
- [] [] H7. Install C41, 33 pf.
- [] [] H8. Install R24, 1K (brown-black-red).
- [] [] H9. Install C48, 15 pf.
- [] [] H10. Install C53, 56 pf.
- [] [] H11. Install C46, 33 pf.
- [] [] H12. Install C119, .01 ufd.
- [] [] H13. Install R33, 10K (brown-black-orange).
- [] [] H14. Install R32, 270 ohms (red-purple-brown).
- [] [] H15. Install R37, 51 ohms (green-brown-black).
- [] [] H16. Select and install Q8, VHF NPN type 2SC2570.
- [] [] H17. Install Q7, NPN type 2N3904.
- [] [] H18. Install R22, 1K (brown-black-red).
- [] [] H19. Install C56, 27 pf.
- [] [] H20. Install C29, 47 ufd. electrolytic.
- [] [] H21. Install C49, 56 pf.
- [] [] H22. Install C58, 27 pf.
- [] [] H23. Refer to Step G18 and install L22, .04 uh.

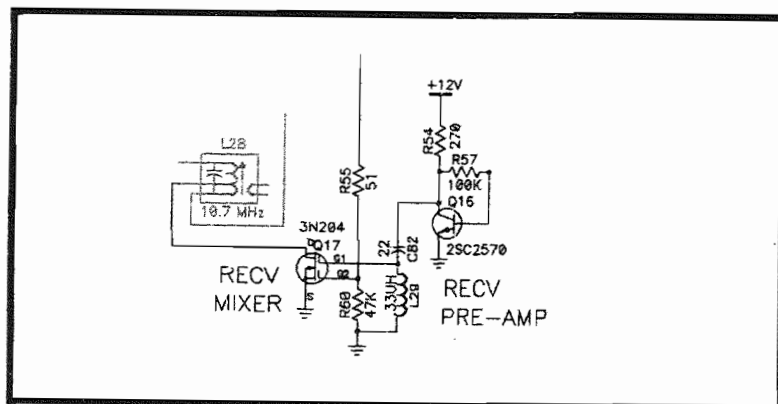


Please review your work for this stage.
No testing is needed or recommended at this point.

Kit Builder's Notes:	Date

RAMSEY

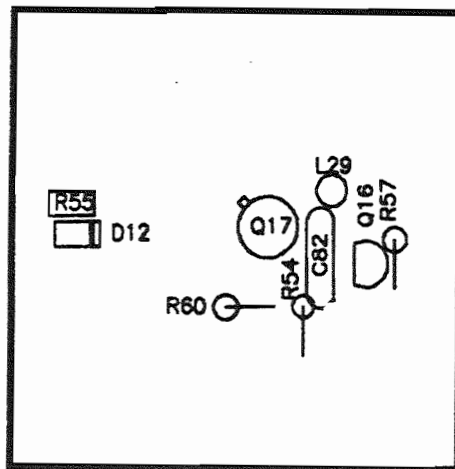
Stage I: Receiver Mixer and RF Pre amp



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Stage I: Receiver Mixer and RF Preamp

We have reached a point where it can be a tossup whether to build the receiver Oscillator or this Mixer-Preamp section. Both are needed for a working receiver, our most immediate goal at this point. We'll do the Receiver Oscillator a little later, so that the repetitive pattern of building the three Transmit oscillators can remain fresher in your memory!

- [] [] 11. Install R55, 51 ohms (green-brown-black).
- [] [] 12. Install D12, diode type 1N914.

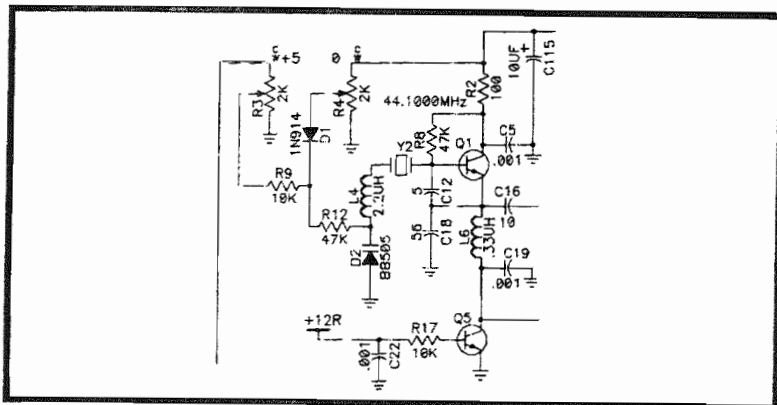
For above steps, refer to the main PC-board drawing, if needed. R55 brings the VCO signal to the Receiver Mixer. D12 is part of the solid-state T-R switching circuit.

- [] [] 13. Install R60, 47K (yellow-purple-orange).
- [] [] 14. Referring to Step [G5] as needed, use care in installing Q17, the other 4-pin MOSFET transistor, type 3N204. Pay close attention to tab position.
- [] [] 15. Install C82, 22 pf.
- [] [] 16. Install R54, 270 ohms (red-purple-brown).
- [] [] 17. Install L29, .33 uh. (upright style: see note).

NOTE: This transceiver uses seven .33 uh. inductors. 5 are molded in upright or vertical style for compact installation, with markings that include two orange stripes. The other two are heavier-duty axial-lead types with visible coil windings.

- [] [] 18. Install Q16, VHF NPN type 2SC2570.
- [] [] 19. Install R57, 100K (brown-black-yellow).

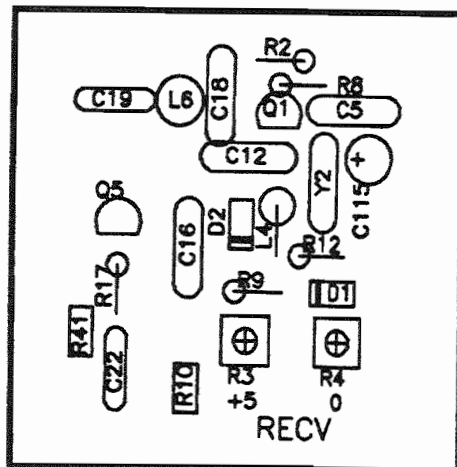
Stage JO: The Receiver Oscillator Section



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Stage JO: The Receiver Oscillator Section

This is the first of four nearly-identical crystal oscillator sections that you will build. The testing and alignment possible after building this stage will verify correct operation of MANY stages of your new FM Transceiver.

Our previous work on this transceiver project should give you the hands-on confidence to build this crystal oscillator (and three more just like it) with minimal commentary. Including the obvious and essential recognition of correct crystal frequency markings, you have already worked with ALL of these component-types in preceding stages.

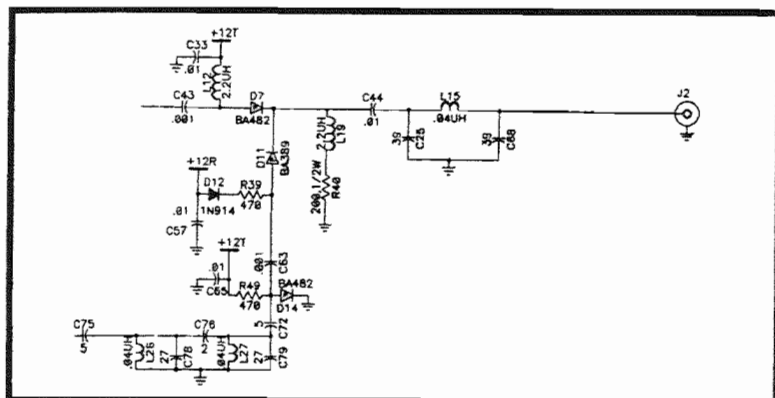
INSTALL these following parts, reviewing previous assembly steps if you have any question:

- | | | | | |
|-------|-----|-----|-----|---|
| JO1. | [] | [] | [] | C19, .001 ufd. |
| JO2. | [] | [] | [] | L6, .33 uh., upright style. |
| JO3. | [] | [] | [] | C18, 56 pf. |
| JO4. | [] | [] | [] | C12, 4.7 or 5 pf. |
| JO5. | [] | [] | [] | Q5, NPN transistor, type 2N3904. |
| JO6. | [] | [] | [] | R17, 10K (brown-black-orange). |
| JO7. | [] | [] | [] | C22, .001 ufd. |
| JO8. | [] | [] | [] | R10, 100 ohms (brown-black-brown). |
| JO9. | [] | [] | [] | C16, 10 pf. |
| JO10. | [] | [] | [] | R3, trimmer potentiometer. |
| JO11. | [] | [] | [] | R4, trimmer potentiometer. |
| JO12. | [] | [] | [] | R9, 10K (brown-black-orange). |
| JO13. | [] | [] | [] | D2, BB505 varactor diode. |
| JO14. | [] | [] | [] | L4, 2.2 uh. (molded, red bands).
Install upright, just like resistors. BE SURE to orient the body of L4 as illustrated on the PC-board and explained on page 7 of the Reference section. |
| JO15. | [] | [] | [] | Q1, NPN transistor, type 2N3904. |
| JO16. | [] | [] | [] | R8, 47K (yellow-purple-orange). |
| JO17. | [] | [] | [] | R2, 100 ohms (brown-black-brown). |
| JO18. | [] | [] | [] | C5, .001 ufd. |
| JO19. | [] | [] | [] | Y2, 44.100 MHz. crystal.
(Be sure to select CORRECT crystal!) |
| JO20. | [] | [] | [] | R12, 47K (yellow-purple-orange). |
| JO21. | [] | [] | [] | D1, diode type 1N914. |
| JO22. | [] | [] | [] | C115, 4.7 or 10 ufd. electrolytic. |

PLEASE DOUBLE-CHECK:

- [] [] Orientation of diodes, transistors, and C115.

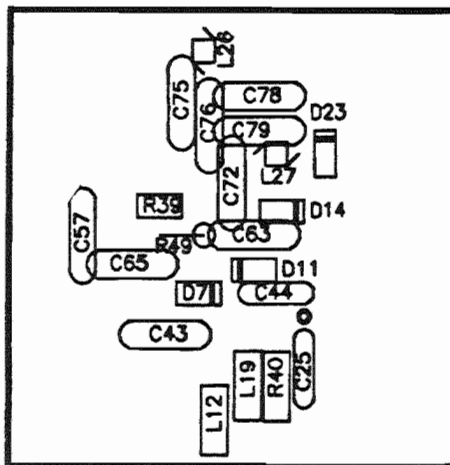
Stage K: Receiver RF Input, Antenna Coupling and PIN Diode T-R Circuits



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Stage K: Receiver RF Input, Antenna Coupling and PIN Diode T-R Circuits

Completion of this phase will make the receiver fully functional and finishes all work common to transmit and receive functions.

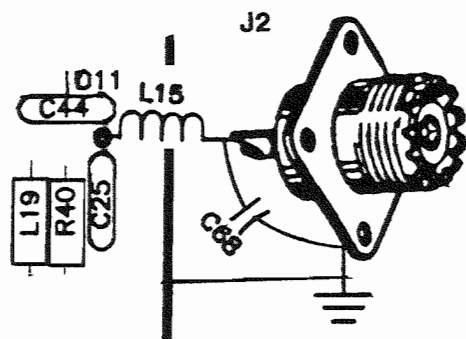
First, install the following parts:

- K1. [] [] C75, 4.7 or 5 pf.
 - K2. [] [] C76, 2 or 2.2 pf.
 - K3. [] [] C78, 27 pf.
 - K4. [] [] C79, 27 pf.
 - K5. [] [] L26, .04 uh. (4 turn coil as in Stage G)
 - K6. [] [] L27, also .04 uh.
 - K7. [] [] C72, 4.7 or 5 pf.
 - K8. [] [] R39, 470 ohms (yellow-purple-brown).
 - K9. [] [] R49, also 470 ohms, installed upright.
 - K10. [] [] C57, .01 ufd.
 - K11. [] [] C65, .01 ufd.
 - K12. [] [] C63, .001 ufd.
 - K13. [] [] C43, .001 ufd.
 - K14. [] [] C25, 39 pf.
 - K15. [] [] C44, .01 ufd.
- [] [] K16. Resistor R40 is one of the three larger resistors used, rated at .5 watt or more. It may be 200 ohms (red-black-brown) or 220 (red-red-brown), or 240 ohms (red-yellow-brown). Install R40.
- [] [] K17. Select the three PIN diodes set aside earlier. Verify the imprinted markings. Be sure to orient the banded ends as illustrated. Type BA482 are the smallest: look for a single red stripe.
- [] [] K18. Install D11, PIN diode type BA389.
- [] [] K19. Install D7, PIN diode type BA482.
- [] [] K20. Install D14, also PIN type BA482.
- [] [] K21. Install L12, 2.2 uh. (molded, markings include two red stripes.)
- [] [] K22. Install L19, also 2.2 uh.

Installation of C68, L15 and SO-239 RF Antenna Connector:

L15, C25 and C68 form pi-network filter which must be constructed with mechanical rigidity. C25 is already installed on the board in the normal manner. The same construction principles apply whether you are using the custom Ramsey FTR transceiver case or your own enclosure: the antenna connector must be secured to the PC-board using the hardware provided.

- [] [] K23-25. Following is a suggested order for assembling the antenna jack with L15 and C68. Plan to use full soldering heat when soldering the solder lug to the top groundplane of the board. These steps assume your use of the Ramsey FTR-C transceiver case.
- [] A. Using the 5 spacers, set the PC-board into the bottom shell of the case.
- [] B. Bend the solder lug at a right angle so it will rest on the top groundplane of the board after step C.
- [] C. With all screws only "finger tight," mount the SO-239 and the bent solder lug to the rear panel, and mount the panel to the case shell. The lug should be in the SO-239 mounting hole closest to the edge of the board.
- [] D. After making sure there is a good fit of jack, panel and case, solder the lug to the groundplane. If the rear panel is absorbing too much heat for a clean connection, remove it after soldering just enough to hold the lug in place. Then, finish soldering the lug.
- [] E. Solder one end of both L15 (small 4-turn coil) and C68 (39 pf.) to the SO-239 center terminal.
- [] F. Solder the other end of C68 to the solder lug.
- [] G. Gently coax the other end of L15 into the PC-board hole next to C25 and solder this connection.
- [] H. Whether the rear panel remains attached during the rest of the assembly work is up to you. However, the screws holding the antenna connector should be sufficiently tight for a good RF ground connection.



GENERAL PROGRESS NOTE:

If we add up and trace the circuit stages that have been completed, we can see that we have done all the work needed to complete the RECEIVER sections of your transceiver.

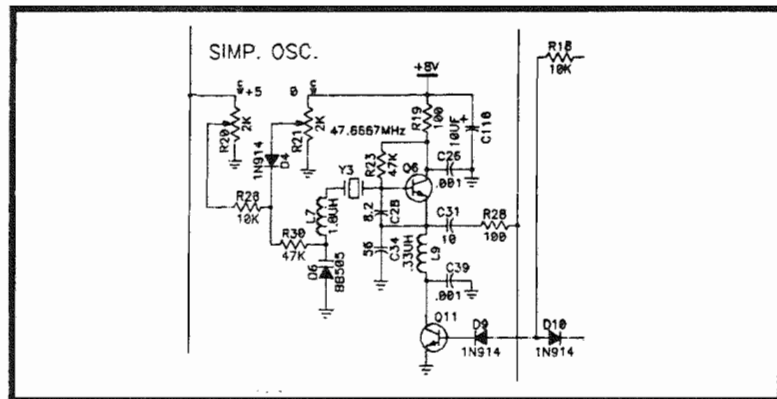
If you are still awaiting your ham license, or if you think it will be a while before you have time to finish the transmitter portion, you could go ahead with PLL Programming and Receiver alignment (only). The receiver should then be fully functional for all frequencies that you have programmed correctly.

If using the receiver portion only, do not have a microphone or other PTT line connected.

Bear in mind that the PLL will have to be re-aligned for proper locking when you are ready to do the transmitter.

There is a lot of repetition in the transmitter oscillator circuits coming up so please work carefully!

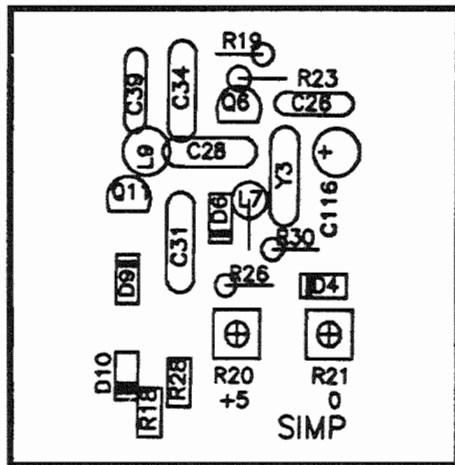
Stage LO: The Simplex Transmitter Oscillator



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Stage LO: The Simplex Transmitter Oscillator

The work of building this and the next two oscillator sections will be familiar and repetitive. It's an opportunity to make swift progress, but no time to get careless!

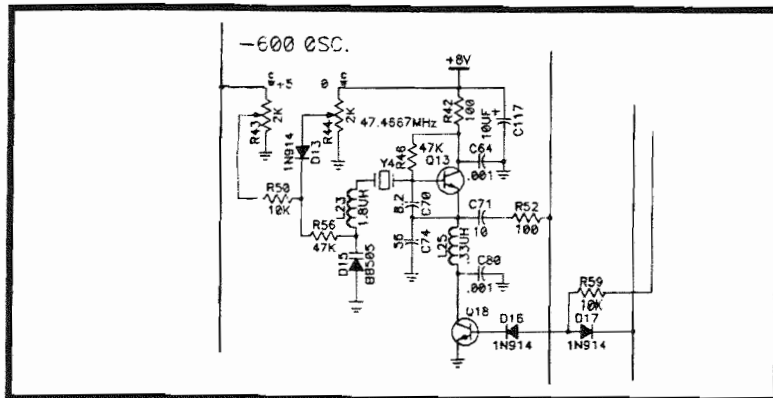
INSTALL these following parts, reviewing previous assembly steps if you have questions.

- | | | | |
|-------|-----|-----|---|
| LO1. | [] | [] | C39, .001 ufd. |
| LO2. | [] | [] | L9, .33 uh., upright style. |
| LO3. | [] | [] | C34, 56 pf. |
| LO4. | [] | [] | C28, 8.2 pf. |
| LO5. | [] | [] | Q11, NPN transistor, type 2N3904. |
| LO6. | [] | [] | R18, 10K (brown-black-orange). |
| LO7. | [] | [] | D9, diode type 1N914. |
| LO8. | [] | [] | D10, diode type 1N914. |
| LO9. | [] | [] | R28, 100 ohms (brown-black-brown). |
| LO10. | [] | [] | C31, 10 pf. |
| LO11. | [] | [] | R20, trimmer potentiometer. |
| LO12. | [] | [] | R21, trimmer potentiometer. |
| LO13. | [] | [] | R26, 10K (brown-black-orange). |
| LO14. | [] | [] | D6, BB505 varactor diode. |
| LO15. | [] | [] | L7, 1.8 uh. (molded, marked LQ186).
Install upright, just like resistors.
BE SURE TO ORIENT L7 BODY AS ILLUSTRAT. |
| LO16. | [] | [] | Q6, NPN transistor, type 2N3904. |
| LO17. | [] | [] | R23, 47K (yellow-purple-orange). |
| LO18. | [] | [] | R19, 100 ohms (brown-black-brown). |
| LO19. | [] | [] | C26, .001 ufd. |
| LO20. | [] | [] | Y3, 47.6667 MHz. crystal.
(Be sure to select correct crystal!) |
| LO21. | [] | [] | R30, 47K (yellow-purple-orange). |
| LO22. | [] | [] | D4, diode type 1N914. |
| LO23. | [] | [] | C116, 4.7 or 10 ufd. electrolytic. |

DOUBLE CHECK:

- [] [] Orientation of diodes, L7, transistors, and C116.

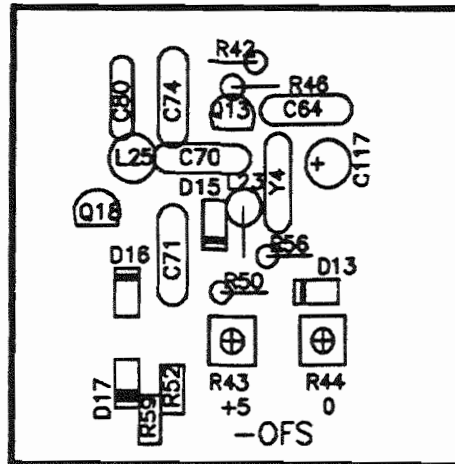
Stage M: Transmitter Oscillator (- 60) KHz. Offset



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Stage M: Transmitter Oscillator (- 600 KHz. Offset)

INSTALL these following parts, reviewing previous assembly steps if you have questions.

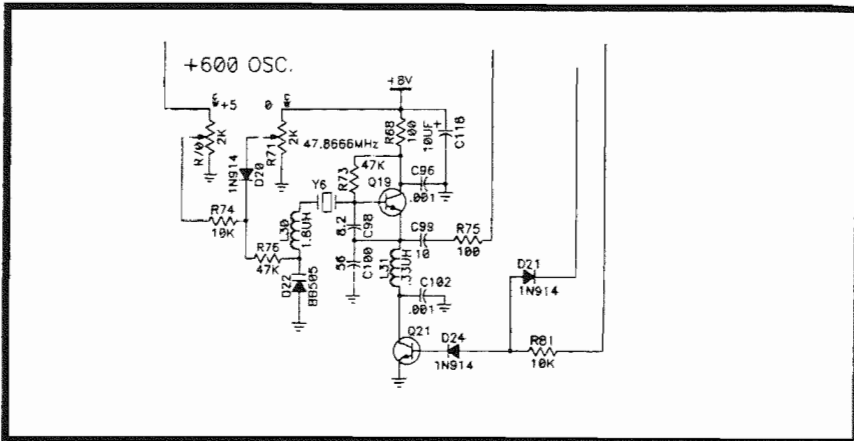
- | | | | |
|------|-----|-----|---|
| M1. | [] | [] | C80, .001 ufd. |
| M2. | [] | [] | L25, .33 uh., upright style. |
| M3. | [] | [] | C74, 56 pf. |
| M4. | [] | [] | C70, 8.2 pf. |
| M5. | [] | [] | Q18, NPN transistor, type 2N3904. |
| M6. | [] | [] | R59, 10K (brown-black-orange). |
| M7. | [] | [] | D16, diode type 1N914. |
| M8. | [] | [] | D17, diode type 1N914. |
| M9. | [] | [] | R52, 100 ohms (brown-black-brown). |
| M10. | [] | [] | C71, 10 pf. |
| M11. | [] | [] | R43, trimmer potentiometer. |
| M12. | [] | [] | R44, trimmer potentiometer. |
| M13. | [] | [] | R50, 10K (brown-black-orange). |
| M14. | [] | [] | D15, BB505 varactor diode. |
| M15. | [] | [] | L23, 1.8 uh. (molded, marked LQ186).
Install upright, just like resistors.
BE SURE TO ORIENT BODY OF L23 AS ILLUSTRATED |
| M16. | [] | [] | Q13, NPN transistor, type 2N3904. |
| M17. | [] | [] | R46, 47K (yellow-purple-orange). |
| M18. | [] | [] | R42, 100 ohms (brown-black-brown). |
| M19. | [] | [] | C64, .001 ufd. |
| M20. | [] | [] | Y4, 47.4666 MHz. crystal.
(Be sure to select correct crystal!) |
| M21. | [] | [] | R56, 47K (yellow-purple-orange). |
| M22. | [] | [] | D13, diode type 1N914. |
| M23. | [] | [] | C117, 4.7 or 10 ufd. electrolytic. |

DOUBLE CHECK:

- [] [] Orientation of diodes, L23, transistors, and C116.

Stage N:

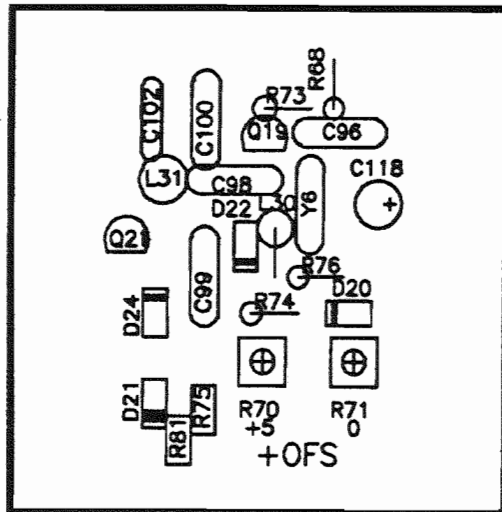
Transmitter Oscillator (+ 600 KHz. Offset)



PLEASE NOTE:

These sections or stages from the complete schematic and PC-board layout are printed as a help in understanding the circuit. The assembly steps MAY require installation of parts not illustrated on this page because they are depicted elsewhere on the schematic or placed in some other area of the PC-board.

If you have questions, ALWAYS review the complete schematic, the full PC-board illustration and the Master Component Index.



Stage N:

Transmitter Oscillator (+ 600 KHz. Offset)

INSTALL these following parts, reviewing previous assembly steps if you have questions.

- | | | | |
|------|-----|-----|--|
| N1. | [] | [] | C102, 001. ufd. |
| N2. | [] | [] | L31, .33 uh., upright style. |
| N3. | [] | [] | C100, 56 pf. |
| N4. | [] | [] | C98, 15 pf. |
| N5. | [] | [] | Q21, NPN transistor, type 2N3904. |
| N6. | [] | [] | R81, 10K (brown-black-orange). |
| N7. | [] | [] | D24, diode type 1N914. |
| N8. | [] | [] | D21, diode type 1N914. |
| N9. | [] | [] | R75, 100 ohms (brown-black-brown). |
| N10. | [] | [] | C99, 10 pf. |
| N11. | [] | [] | R70, trimmer potentiometer. |
| N12. | [] | [] | R71, trimmer potentiometer. |
| N13. | [] | [] | R74, 10K (brown-black-orange). |
| N14. | [] | [] | D22, BB505 varactor diode. |
| N15. | [] | [] | L30, 1.8 uh. (molded, marked LQ186).
Install upright, just like resistors.
BE SURE TO ORIENT BODY OF L30 AS ILLUSTRATED. |
| N16. | [] | [] | Q19, NPN transistor, type 2N3904. |
| N17. | [] | [] | R73, 47K (yellow-purple-orange). |
| N18. | [] | [] | R68, 100 ohms (brown-black-brown). |
| N19. | [] | [] | C96, .001 ufd. |
| N20. | [] | [] | Y6, 47.8667 MHz. crystal.
(Be sure to select correct crystal!) |
| N21. | [] | [] | R76, 47K (yellow-purple-orange). |
| N22. | [] | [] | D20, diode type 1N914. |
| N23. | [] | [] | C118, 10 ufd. electrolytic. |

DOUBLE CHECK:

[] [] Orientation of diodes, L30, transistors, and C116.

Assembly Phase O: Coil & RF Choke Preparation

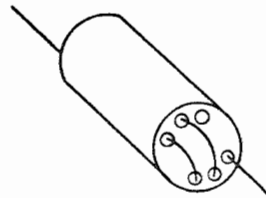
Five parts need handmade preparation before installation in the transmitter RF stages of your transceiver. We recommend that you get them ready for installation before wiring the Driver and Final stages. If you prefer to proceed with those stages, winding coils as you go, that's fine, too, as long as you realize that all coil-making details are provided in this section.

The wire used for the following work is the tinned "bus" wire supplied with your kit.

[] O1. RF CHOKES (two identical units required for L8 and L20):

Examine the two cylindrical ferrite cores provided in the kit. Notice that there are six holes at either end of these cylinder-shaped units, arranged in two groups of three.

Cut 6" of bus wire, study this sketch, and thread the wire, pulling each turn "gently tight." Your finished RF chokes should look like this sketch when viewed from either end.



NOTE: Depending on availability, L8 and L20 may be supplied, in which case you can proceed with installation. HOWEVER, remember that L8 is installed AFTER alignment.

[] O2. WINDING L16 and L17:

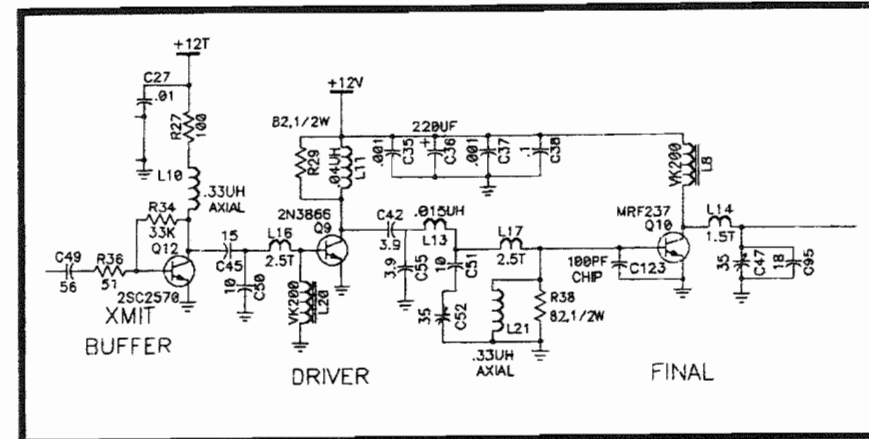
Winding these two coils on a 3/8"x18 bolt permits perfect forming and spacing of the turns. An adequate job can be done using any 3/8" O.D. object such as an Xacto knife handle, screwdriver shaft, etc. Viewed from the top or sides, these coils should appear to have 3 turns, but a careful count of complete circles will reveal the required 2.5 turns. Studying the mounting holes for these coils on the PC-board will also help you visualize.

[] O3. WINDING L14:

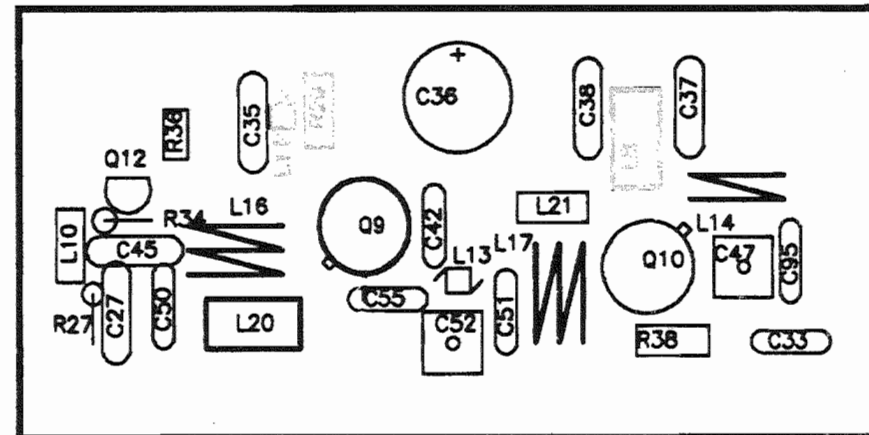
Review O2, examine the PC-board hole spacing, and wind a 1.5 turn coil for L14. It will appear to be 2 turns from the top.

The legs or leads for inserting L16, L14 and L17 should be 1/4" long.

Stage P: Transmitter Buffer, Driver and Final



L11, R29 and L8 are installed as part of the Alignment Process. DO NOT install them until instructed to do so.



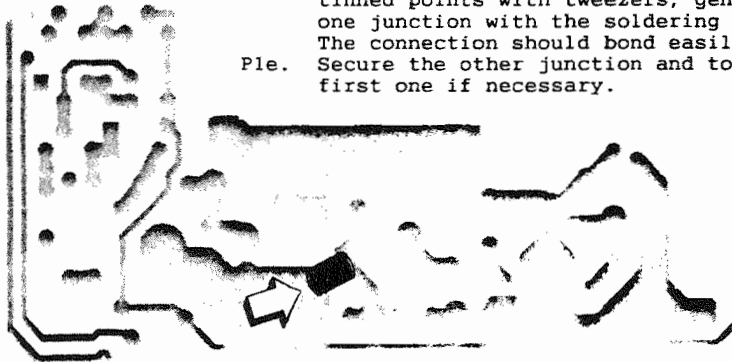
Stage P: Transmitter Buffer, Driver and Final

Install the components in the order recommended and DO NOT under any circumstances connect DC power to the unit unless instructed to do so at a particular point. The following assembly steps presume that Stage "O" (RF coil and choke preparation) was done. Refer to "O" if you have any question on these parts.

C123 is a SMT (surface-mount-technology) "chip" capacitor and is the only part installed on the SOLDER SIDE (bottom) of the board.

NOTE: The existence of several deleted steps plus alphanumeric series for some step numbers is the result of a revision of this section for easier assembly.

- P1a. Prepare the following tools for installing SMT chip capacitor C123:
 - Tweezers
 - Magnifier
 - Low wattage, clean soldering tip.
- P1b. Unpack and study the design of the chip, noting both ends are metallic.
- P1c. Lightly pre-tin both PC-board points.
- P1d. Holding C123 in place across the two tinned points with tweezers, gently touch one junction with the soldering tip. The connection should bond easily.
- P1e. Secure the other junction and touch up the first one if necessary.



All further components will be mounted on the top side.

- P2a. Install Q9, RF NPN type 2N3866. Let it rest flush on the square bare area of the board. The holes match the pins, so the tab will point exactly as illustrated.
- P2b. READ CAREFULLY:
RF Final transistor Q10 (MRF237 or SD1127) is ALSO installed completely flush on the board, with the tab oriented toward L14. The case of Q10 is common to the emitter. Be sure the case remains flush on the top ground plane when soldering the 3 points.

Now, using only your low-wattage soldering pen and NOT a soldering "gun," solder the rim of Q10 directly to the top ground plane, starting at the tap. Use just enough solder for a fine bead.

The above procedure lets the top groundplane serve as the heatsink for the RF final output transistor.

Identify and install the following components:

- P2c. Electrolytic, 220 ufd. Watch polarity.
- P3. 100 ohms (brown-black-brown).
- P4. Axial-lead, .33 uh.
- P5. .01 ufd.
- P6a. 15 pf.
- P6b. 10 pf.
- P7. 33K (orange-orange-orange).
- P8. Install Q12, the Transmit Buffer transistor. Make sure it is type 2SC2570 and not a leftover of some other type. All small transistors should now be installed.
- P9. Install R36, 51 ohms (green-brown-black).
- P10. In installing RF choke L20 (prepared in Stage O), notice that the holes are diagonal from each other. If the choke was wound correctly, L20 will line up straight as illustrated.
- P11. Coil L16 was also prepared in Stage O. Insertion will stretch the windings very slightly. Gently press L16 in as close to the top of the board as possible, leaving about 1/8" clearance. The coil windings must not, of course, touch the solder plane.
- P12. Install C35, .001 ufd.
- P13. (Deleted: go to P15)
- P14. (Deleted: go to P15)
- P15. Install C55, 3.9 pf.
- P16. Install C42, also 3.9 pf.
- P17. Install C52, one of the two remaining trimmer capacitors.
- P18. Install C51, 10 pf.
- P19. Referring to step P11 and Stage O as needed, install L17, the other 2.5T coil.

[] [] P20. Install L21, the other .33 uh. inductor with axial leads.

[] [] P21. Install L13, the one 1/8" 1.5 turn coil.

We're getting close: install these components, making sure that you get them right the first time!

[] [] P22. Install C38, the last .1 ufd. capacitor.

[] [] P23. (Deleted: go to P24)

[] [] P24. .001 ufd.

[] [] P25. 1.5 turns, 3/8". Review "O" and P10.

[] [] P26. 18 pf.

[] [] P27. .01 ufd.

[] [] P28. 82 ohm, 1/2-watt resistor.
(gray-red-black, large size.)

[] [] P29. 35 pf. trimmer.

At this point, every single PC-board component has been installed except for L11, R29 and L8, which apply power to the RF output transistors (driver Q9, final Q10). DO NOT INSTALL these parts until instructed to do so during the Alignment procedure.

FINAL PROGRESS TEST:

[] PF1. Double check component selection for Steps P1-P29.

[] PF2. Use bright light and magnifier to go over entire board to check for missed connections or solder bridges. If you suspect a solder bridge, simple review the X-ray illustrations to see whether the points in question are indeed to be tied together.

[] PF3. Carefully check entire board for:

[] Loose bits of wire lodged among connections or components on either side of board.

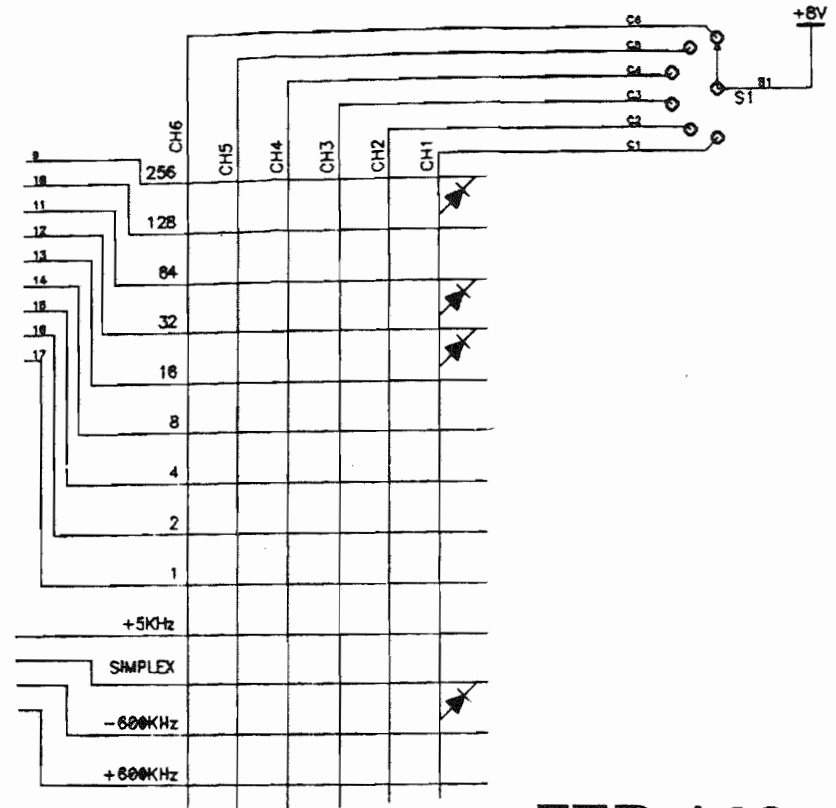
[] Excess wire lengths which may not have been nipped and are now bent flat, probably against another connection.

[] PF4. Go to the PLL Programming Section.

Kit Builder's Notes:

Date

RAMSEY



FTR-146 PLL Frequency Synthesizer Programming

FREQUENCY SYNTHESIS: Some Basics

If you are experienced with PLL and VHF design, feel free to skip this section. The rest of us are going to try to get a handle on some concepts fundamental to the FTR-146 and other modern multi-channel radio equipment.

The best incentive for understanding the beauty of modern frequency synthesis is . . . MONEY! Had we taken the easier way out, charged a lower price for your kit, and left it up to you to order the crystals of your choice for 6 frequency pairs, you would pay about \$72.00 for the 12 crystals required, or over \$100 for "expedited service" if you wanted to get your rig on the air within the next two weeks. To change or add frequencies, you would spend still more money and waiting time.

Most radio hams have some basic understanding of VFO's, crystal oscillators and even TV channel tuners. As these basic building blocks of radio have given way to digital readouts in our ham gear as well as TV's and stereo receivers, we really love the convenience but feel a little uncomfortable if we really don't understand much how all this works.

(Let's keep it clear that a "digital readout" is the function of frequency counter circuitry driving a LED or LCD display and that it is not Frequency Synthesis in itself. A digital frequency display can be added to any receiver or transceiver of any vintage -- and it is not uncommon for modern frequency-synthesized equipment to rely on simple switch markings to indicate a channel or actual operating frequency. For example: the small thumbwheel switches on some handheld transceivers.)

Understanding Frequency Synthesis is a useful exercise in reviewing some basics of digital circuitry that is at the heart of all computer design and most modern electronics. This understanding shows you how your FTR-146 gives you ready access to all 800 2-meter channels (\$4000 worth of crystals?!).

For example, most of us know by now that "1K" or one kilobyte of computer memory or diskette space is actually 1024 bytes. Therefore, it is not arbitrary that the Reference Oscillator for the MC145106 PLL IC is controlled by a precision 10.240 MHz. crystal. In fact, let's review that simple family of numbers important to this PLL circuit and all computers:

1	
2	
4	
8	Notice that we begin with 1,
16	and simply double it
32	only 10 times before
64	reaching 1024.
128	
256	More precisely, $1024 = 2^{10}$
512	
1024	

Notice on the schematic diagram and your PC-board that the 5106 IC has 9 pins labeled 1,2,4 through 256. These are the programming inputs for the Frequency Divider section of the 5106. These pins can be connected to additional IC circuitry to program the divider to any number between 100 and 500 -- OR, we can program the divider ourselves using the diode matrix and switch that are part of your basic FTR-146 kit. The bigger the matrix and the more switch positions you have, the more frequency pairs you can program.

In fact, if you can "think binary" and also keep track of a reference chart of some kind, you could have full front panel control of 800 possible FM channels and transmitter offsets using only 13 simple SPST switches (which is why microprocessor circuits are very nice!)

Now let's try to imagine more clearly what happens in the circuit when you program and select a particular frequency. Honestly, there is no substitute for understanding the formula which is the heart of this frequency synthesizer:

$$\text{Synthesized Output Frequency} = \text{Crystal Oscillator Frequency} + (N \times 10 \text{ KHz.})$$

N is the number between 100 and 500 programmed on your diode matrix for the desired frequency.

The 10 KHz. is the precision reference frequency obtained by dividing the output of the 10.240 MHz. oscillator by 1024.

Notice that control lines for the 3 Transmit crystal oscillators cross into the diode matrix, letting you choose which of the oscillators are needed for each frequency pair. In addition, the +5KHz. line permits 5 KHz. channel spacing to be programmed for both receive and transmit.

It is important to understand that N is a DECIMAL representation of the BINARY number required by the PLL IC. While computer languages readily convert hexadecimal or octal numbers to or from decimal numbers, they do not magically hand us the decimary-to-binary information needed to program the synthesizer, even though the computer itself operates in the binary world.

This edition of this book could have included a sample program written in BASIC which would take the tedium out of doing a decimal-to-binary conversion for the 400 possible numbers between 100 and 500. The program actually requires more "If N > x then . . ." lines than one might first imagine. However, there is no substitute for UNDERSTANDING how to make these conversions yourself. With that understanding, you could write your own conversion program in the computer language of your choice or prepare charts for any or all frequencies of interest to you.

The best way to grasp how to program your diode matrix is by considering some practical examples, remembering that we are interested only in numbers between 100 and 500:

- If N = 128, only one diode is needed -- at 128.
- If N = 129, use 2 diodes -- at 128 and at 1.
- If N = 127, diodes would be required at 64,32,16,8,4,2 and 1!

RULE OF THUMB:

Any N number between 100 and 400 is the sum of some combination of the programming codes between 256 and 1, using each code **ONLY ONCE!**

Even though conversion programs and charts are possible, you may find it easiest to work it out in your head and jot the codes on the log pages printed in this book. To establish the **HIGHEST** programming code required, use 128, 256, and 384 {256+128} as starting points to work down from.

FTR-146 PLL Synthesizer Programming Log

RX Freq.	N =	256	128	64	32	16	8	4	2	1	+5KHz?	TX Offset?

To find N, subtract 143.00 from Receiver Frequency and multiply the result by 100.

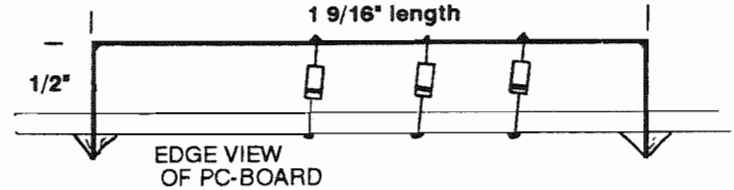
EXAMPLE:

$$\begin{array}{r}
 146.52 \text{ MHz.} \\
 - 143.00 \\
 \hline
 = 3.52 \\
 \times 100 \\
 \hline
 352 = N!
 \end{array}$$

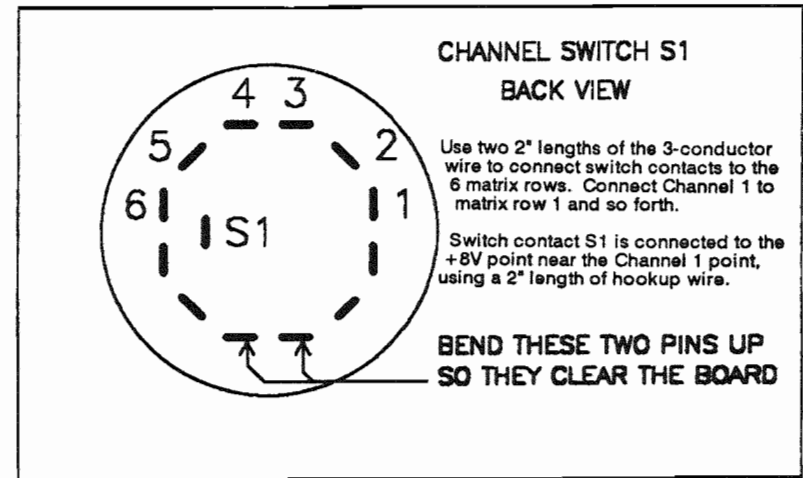
SETTING UP THE DIODE MATRIX

Before constructing the diode matrix switch lines explained below, you might like to preview the section "Diode-Programming Flexibility," especially if you just are not sure which channels are of most interest to you.

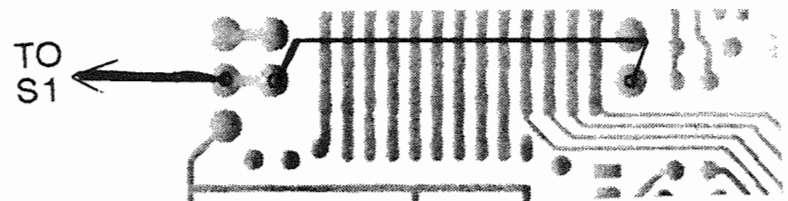
The matrix is constructed with lengths of the bus wire supplied in your kit. Consult the following illustrations:



Do not solder ANY diodes until you have studied the programming information!



The extra 6 switch positions may be used to give front-panel control of 6 additional channels (using an additional matrix area designed by you!)



DIODE PROGRAMMING FLEXIBILITY

Remembering that "desoldering" is never lots of fun, there can be some perfectly good reason why you are not ready to program all six of the channels with the matrix system provided. You may not be at all sure yet what frequencies you want to select from the front panel. If so, then build up only the matrix lines you are sure about. If you want to be able to "shop around" for various frequencies of interest to you, here is one suggestion that will NOT disqualify your transceiver from factory warranty service, if that ever becomes necessary. (Please DO be aware that modification generally does disqualify kits from factory service.)

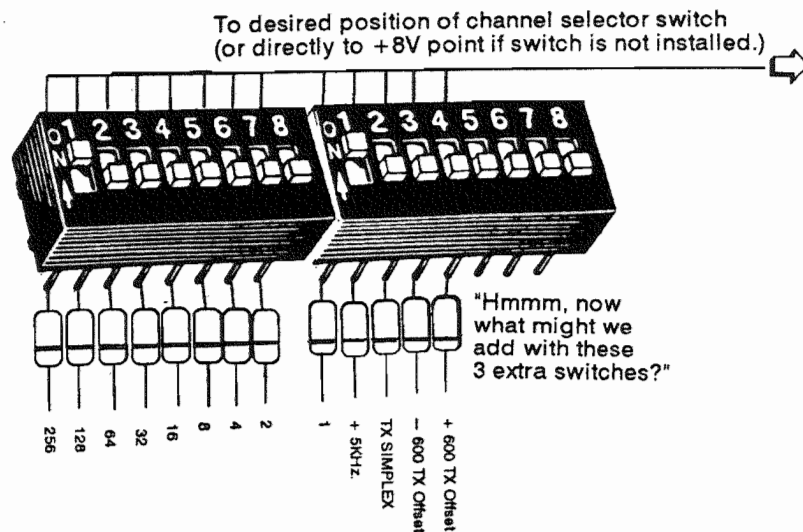
- [] 1. Use a 13 or 14 position DIP switch, or obtain two 8-position DIP switches (Radio Shack 275-1301).
- [] 2. Prepare a small section of perfboard (.1" holes) approximately the same size as the matrix area on the transceiver board.
- [] 3. The diodes may be mounted either on the board or running from beneath the board into the corresponding holes of the matrix.
- [] 4. Make all connections per the drawing below, using the Channel row of your choice.
- [] 5. The row of diodes will give some rigidity to the switch platform. Use a couple short lengths of scrap resistor wire soldered from empty holes on the perfboard to the PC-board groundplane for additional rigidity.

When your channel switch is turned to the row used for the DIP switch assembly, you can program THAT channel position for ANY 2- meter frequency of your choice by turning ON the diodes of your choice. The experience of doing this should also give you a wealth of bright ideas on how to use very simple logic IC's or other switching schemes to make your transceiver ever more versatile.

Kit Builder's Notes:	Date

RAMSEY

When you get your own great ideas for harnessing the practical programming possibilities of the FTR-146 diode matrix, pass them on to your friends, or write them up for 73 Amateur Radio Today, or QST, CQ, RadioScan or the new Radio Fun Magazine. We'll enjoy hearing about them too!



Install diodes to desired channel switch row or to extra row of holes provided in matrix area.

To find N,
subtract 143.00
from Receiver Frequency
and multiply the
result by 100.

EXAMPLE:

$$\begin{array}{r}
 146.52 \text{ MHz.} \\
 - 143.00 \\
 \hline
 = 3.52 \\
 \times 100 \\
 \hline
 352 = N!
 \end{array}$$


Following are some blank worksheets to help you program ANY 2M frequency pair easily and perfectly on the first try. Study the following sample then pick a frequency of interest to you and see how easy it is!

DIODE PROGRAMMING EXAMPLE . . .

To convert N from decimal to binary, simply TRY to subtract EACH of the 9 binary values from N, always in descending order, always starting with 256 and always ending with 1. This process will always yield nine YES or NO answers, which will give you exact diode installation instructions. Four more clear YES or NO decisions complete the programming for this channel pair selection.

$$N = \boxed{146.880} - 143.00 = \boxed{3.88} \times 100 = \boxed{388}$$

Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?	$\begin{array}{r} 388 \\ - 256 \\ \hline 132 \\ - 128 \\ \hline 4 \\ - 4 \\ \hline \emptyset \end{array}$ 		X	256
2. Can you subtract 128?			X	128
3. Can you subtract 64?				64
4. Can you subtract 32?		X		32
5. Can you subtract 16?		X		16
6. Can you subtract 8?		X		8
7. Can you subtract 4?			X	4
8. Can you subtract 2?		X		2
9. Can you subtract 1?		X		1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)		X		+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)			X	SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)		X		- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)			X	+ 600

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$$N = \boxed{} - 143.00 = \boxed{} \times 100 = \boxed{}$$

Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
You can program ANY standard 2M Channel Pair!

Install (or switch on) diodes in "YES" positions ONLY!
For 146.52 MHz., we install only at 256, 126, 4 and Simplex.

Kit Builder's Notes:	Date

RAMSEY

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{[]} - 143.00 = \text{[]} \times 100 = \text{[]}$
 Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
 You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date

RAMSEY

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{[]} - 143.00 = \text{[]} \times 100 = \text{[]}$
 Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
 You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date

RAMSEY

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{} - 143.00 = \text{} \times 100 = \text{}$
 Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
 You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date

RAMSEY

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{} - 143.00 = \text{} \times 100 = \text{}$
 Receiving Frequency (Repeater OUTPUT)

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
 You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date

RAMSEY

FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{Receiving Frequency (Repeater OUTPUT)} - 143.00 = \text{ } \times 100 = \text{ }$

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date



FTR Diode Matrix Programming Worksheet No.

Use these pages to get acquainted with how to program the first few channels you wish to use. Please REVIEW our handwritten example and feel free to make more copies of this page for your personal use.

$N = \text{Receiving Frequency (Repeater OUTPUT)} - 143.00 = \text{ } \times 100 = \text{ }$

Subtracting from N:	Doodle space	NO	YES	Matrix point
1. Can you subtract 256?				256
2. Can you subtract 128?				128
3. Can you subtract 64?				64
4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+ 5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
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Kit Builder's Notes:	Date



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Subtracting from N:	Doodle space	NO	YES	Matrix point
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4. Can you subtract 32?				32
5. Can you subtract 16?				16
6. Can you subtract 8?				8
7. Can you subtract 4?				4
8. Can you subtract 2?				2
9. Can you subtract 1?				1
10. Does this frequency require 5 KHz. channel spacing? (e.g. 147.125 MHz.)				+5 KHz.
11. Will this be a Simplex channel? (Transmit & Receive on same frequency.)				SIMPLEX
12. Will Transmit be 600 KHz. LOWER than Receive? (This answer must be NO if either 11 or 13 are YES.)				- 600
13. Will Transmit be 600 KHz. HIGHER than Receive? (This answer must be NO if either 11 or 12 are YES.)				+ 600

Install (or switch on) diodes in "YES" positions ONLY!
You can program ANY standard 2M Channel Pair!

Kit Builder's Notes:	Date

RAMSEY

FTR-146 PLL Synthesizer Programming Log

RX Freq.	N =	256	128	64	32	16	8	4	2	1	+5KHz?	TX Offset?

Kit Builder's Notes:	Date

RAMSEY

FTR-146 PLL Synthesizer Programming Log

RX Freq.	N =	256	128	64	32	16	8	4	2	1	+5KHz?	TX Offset?

Kit Builder's Notes:	Date
RAMSEY	

FTR-146
2-Meter FM Transceiver

ALIGNMENT

Operation

Troubleshooting Guide

Revisions
and Updates

FTR-146 TRANSCEIVER ALIGNMENT

Complete alignment of your new FM VHF transceiver requires the availability of the following:

- [] Digital or QUALITY analog voltmeter/VOM/VTVM
 - [] Reliable test clips (small size)
 - [] Non-metallic RF alignment tool(s)
 - [] 50-ohm dummy load
 - [] Frequency Counter accurate to at least 200 MHz.
- OR: digitally-accurate HF-VHF receivers with BFO.

We hope you won't be sore at us because of the frequency counter requirement together with the fact that Ramsey Electronics, Inc., has been the proud USA manufacturer of universally-respected frequency counters for many years.

Alignment procedures like this one are exactly WHY frequency counters exist. Ham radio is a sociable hobby, so we are confident that you can get together with a local ham friend with a counter in case you haven't decided which Ramsey Frequency Counter is your best choice. In addition, experienced ham radio experimenters have the option of using properly-calibrated HF and VHF communications receivers (BFO on, RIT off) to make the required measurements. Ramsey Electronics, Inc. stands behind the tolerances and accuracy of our frequency counters. It is between you and other manufacturers to verify the reliability of frequency measurements made with other counters or receivers.

Here's a brief summary of the specs and features of the Ramsey frequency counter line. All of these models are factory-built with a one-year guarantee:



ALL COUNTERS ARE FULLY WIRED & TESTED					
MODEL	FREQ. RANGE	SENSITIVITY	DIGITS	RESOLUTION	PRICE
CT-50	20 Hz-600 MHz	< 25 mV to 500 MHz	8	1 Hz, 10 Hz	\$189.95
CT-70	20 Hz-550 MHz	< 50 mV to 150 MHz	7	1 Hz, 10 Hz, 100 Hz	\$139.95
CT-90	10 Hz-600 MHz	< 10 mV to 150 MHz < 150 mV to 600 MHz	9	0.1 Hz, 10 Hz, 100 Hz	\$169.95
CT-125	10 Hz-1.25 GHz	< 25mV to 50 MHz < 15 mV to 500 MHz < 100 mV to 1 GHz	9	0.1 Hz, 1 Hz, 10 Hz	\$189.95
CT-250	10 Hz-2.5 GHz typically 3.0 GHz	< 25 mV to 50 MHz < 10 mV to 1 GHz < 50 mV to 2.5 GHz	9	0.1 Hz, 1 Hz, 10 Hz	\$239.95
PS10B Prescaler	10 MHz-1.5 GHz, divide by 1000	< 50 mV	Convert your existing counter to 1.5 GHz		\$89.95

Other makes of frequency counters might well do the job. We are sure that you understand that the real issue at hand is the correct performance of your FTR transceiver rather than the serviceability of measuring devices made by our competitors.

Be certain that you understand how your frequency counter works and what "frequency counting" actually IS before you jump to hasty conclusions about your test and alignment results. In particular, please study your counter documentation regarding gate timing and probe impedances. Be sure you understand what we mean when a desired frequency count should be accurate +/- .0005 Mhz., which is +/- 500 Hz.

We recommend that one of your FTR146 channels be programmed to 146.52 MHz., the national simplex frequency. This programming is clearly illustrated on the schematic as well as elsewhere in this book. 146.52 will be our discussion/demonstration channel throughout these alignment directions. If you choose to align using a different frequency or frequency pairs, it is up to you to understand and keep track of what you are doing.

PROGRAMMING FOR 146.52 MHz. SIMPLEX:

While the theory and practice of PLL programming is covered in the previous section, our demonstration frequency of 146.52 is so important for clarity in the alignment procedure that we repeat at least the basics now for correct programming of 146.52 Mhz. Simplex:

- [] $146.52 - 143.00 = 3.52$
 $3.52 \times 100 = 352 = N$
 N converted to Binary = $256 + 64 + 32$.
- [] Install 4 diodes in the channel row of your choice at matrix positions **256, 64, 32** and **Simplex**.
- [] The cathode (banded) ends of the diodes are soldered to the indicated PC-board positions, with the anodes all soldered to the bus wire as illustrated on page 5 of the PLL programming section.

The clearest way we can emphasize the importance of programming 146.52 Mhz. into the capabilities of your FTR-146 is to tell you that it is a prior condition for both phone/fax/letter (free) consultation and ANY level of factory service in accord with the standard Ramsey Electronics kit warranty. We can't talk about it or touch it unless both you and our staff are flying the same basic flight plan. (And we're supposed to use simplex instead of repeaters whenever we can anyway!)

PROCEDURE

Please check and double-check these performance requirements and adjustments:

- T1a. [] [] VR1 output: 8.0 volts
 - T1b. [] [] Diode anode bus wire at 146.52 position of PLL matrix: 8.0 volts.
 - T2. [] [] D12 anode: 12 volts
 - T3. [] [] L12: 0 volts on either side
 - T4. [] [] Press mike PTT switch and measure 0.0 volts at D12 anode.
 - T5. [] [] Press mike PTT switch and confirm 12V on L12
 - T6. [] [] Connect frequency counter to TP2.
 - T7. [] [] Connect voltmeter (+) to TP3, and voltmeter (-) to the groundplane.
 - T8. [] [] Press mike PTT switch, or otherwise key the unit, and adjust **L18** (VCO section) for **3.520 MHz.** at TP2 when voltage at TP3 is 3.6 volts (+/- 0.1 volt).
 - T9. [] [] With the rig **NOT** keyed, adjust **C32** for **3.6V** at TP3.
- T10. [] [] **Repeat** T8 and T9 until you note 3.6V (TP3) and 3.520 MHz. (TP2) consistently in **both** transmit and receive. This is your indication that the PLL is properly locking.
- T11. [] [] Connect the counter to TP1.
 - [RECEIVE] Adjust **R4** at Receive Oscillator for: **135.820 MHz.** +/- .0005 MHz. (+/- 500 Hz.) (135.820 = 146.52 - 10.7 MHz.)
 - T12. [] [] The counter remains connected to TP1.
 - [TRANSMIT] With the transmitter keyed, adjust **R21** (Simplex Oscillator) for **146.520 MHz.** +/- .0005 MHz. (+/- 500 Hz.)

FTR-146 TEST & ALIGNMENT PROCEDURE

The following steps assume that your transceiver has been fully assembled with the exception of installing L11, R29 and L8. These are factory-specified performance criteria which take precedence over the optional progress tests described by the author in the step-by-step assembly stages of this book. Our goal is to verify important voltage readings and essential frequency readings and to guarantee a fully-functional receiver section and accurate transmitter oscillators before finishing and tuning the transmitter output.

TEST CONDITIONS:

- [] DC power connected (12-15VDC, referred to as 12V)
- [] Speaker and microphone connected
- [] 146.52 MHz. Simplex programmed and selected
- [] S2 (DC power) turned on
- [] 2M Antenna connected (not a dummy load just yet.)
- [] L11, R29 and L8 NOT INSTALLED

Kit Builder's Notes:	Date

RAMSEY

RECEIVER ALIGNMENT

The preceding steps ensure that the transceiver is ready to operate on 146.520 MHz. Simplex. If you need to tune other frequencies for receiver adjustment, such as a busy local repeater that is familiar to you, it is necessary to have programmed the diode matrix for any such frequencies before doing the following receiver adjustments.

- T13. [] [] With the receiver on and antenna connected, set squelch control fully counter-clockwise. Using a proper alignment tool, adjust L24, L28 and L32 for the highest noise level you can get with NO signal.
- T14. [] [] Find or generate a WEAK signal and re-adjust L24, L28 and L32 for the best-sounding signal.
- T15. [] [] If you're satisfied, then that's it. Receiver sensitivity can sometimes be boosted a bit by slightly spreading the small 4-turn coils at the RF preamplifier input (L26,L27).

Kit Builder's Notes:	Date
RAMSEY	

TRANSMITTER OFFSET ALIGNMENT

Our demonstration frequency pairs for aligning the +600 and -600 transmitter oscillators are:

-600 KHz: 146.94/34 (Receive on 146.94, Transmit on 146.34 MHz.)
+600 KHz: 146.22/82 (Receive on 146.22, Transmit on 146.82 MHz.)

If you wish to align using other frequency pairs, be sure that you know the principles of what you are doing before proceeding.

T16. [] [] With the transmitter keyed and the frequency counter connected to TP1, adjust **R44** for a frequency of **146.340** +/- .0005 MHz. (+/-500 Hz.)

T17. [] [] With the transmitter keyed and the counter connected to TP1, adjust **R71** for **146.820** +/- .0005 MHz. (+/- 500 Hz.)

ALIGNMENT FOR 5 KHz. CHANNEL SPACING

You may do the following steps either now or after your FTR-146 is finished and on the air. It depends on how soon you need to use 2 meter channels with 5 KHz. spacing.

The most common repeater frequency pairs employ 10 KHz. channel separation, and steps T11 through T17 provide the full alignment procedure needed for operation with standard 10 KHz. channel spacing. The following procedure can be done whenever you find a need for 5 KHz. capability, even after the transmitter is completed. Of course, a dummy load is required for this process if the transmitter has been completed.

The following procedure assumes that the FTR-146 is programmed for 146.52 Simplex just as for the basic alignment already completed. You will be aligning all four oscillators for 5 KHz. spacing using 146.52 as the reference standard. When the +5KHz. line is switched on by the diode matrix, each crystal oscillator frequency is raised by 1.66667 KHz., resulting in a 5 KHz. increase in the Q4 Buffer-Tripler output. {1.6667 X 3 = 5.00 KHz.}

Procedure:

- TA1. [] [] Connect a dummy load if the transmitter is already operational.
- TA2. [] [] Install or switch on a diode at the +5KHz. position of the programming matrix.
- TA3. [] [] Connect a frequency counter to TP-1.
- TA4. [] [] In **Receive** mode, adjust **R3** (Stage JO) for **135.825 MHz.** +/- .0005 MHz. (+/- 500 Hz.)
- TA5. [] [] Key the transmitter and adjust **R20** (Stage LO) for **146.525 MHz.** +/- .0005 MHz. (+/- 500 Hz.).
- TA6. [] [] Install or switch on a diode at the - 600 KHz. position of the programming matrix.
- TA7. [] [] Key the transmitter and adjust **R43** (Stage M) for **145.925 MHz.** +/- .0005 MHz. (+/- 500 Hz.).
(145.925 = 146.520 - .600 + .005)
- TA8. [] [] Remove or switch off the - 600 KHz. diode.
- TA9. [] [] Install or switch on a diode at the +600 KHz. position of the matrix.
- TA10. [] [] Key the transmitter and adjust **R70** (Stage N) for **147.125 MHz.** +/- .0005 MHz. (+/- 500 Hz.).
(147.125 = 146.520 + .600 + .005)
- TA11. [] [] Remove or switch off the +600 and +5KHz. diodes.

If the above alignment was done accurately, the +5KHz. feature will work properly in Receive and all three transmitter oscillators whenever it is switched on by a diode in its matrix position.

TRANSMITTER COMPLETION AND TUNEUP

Do not proceed with the following until the preceding steps have been completed successfully. Again, however, you may choose to do the +5 KHz. alignment at a later time.

- TX1. [] [] [] Disconnect DC power and antenna.
- TX2. [] [] [] Install L11, a small 4-turn coil.
- TX3. [] [] [] Install R29, one of the 1/2-watt 82 ohm resistors. (Larger body: gray-red-black).
- TX4. [] [] [] Install RF choke L8, reviewing Section "O" and Step P10, if necessary.
- TX5. [] [] [] Connect the following to your transceiver:
[] 50-ohm dummy load
[] VHF RF wattmeter
[] DC power
- TX6. [] [] [] Press (key) the transmit button and alternately adjust C52 and C47 with a non-metallic alignment tool for maximum RF output indicated on the meter. Keep these key-down tests as brief as possible.
- TX7. [] [] [] If you are observing at least 4 watts of output, transmitter tuneup is completed. Slightly spreading L17 and/or L14 might maximize RF output.
- TX8. [] [] [] Adjust Modulation control R80 by listening on another receiver or scanner and simply adjust for best-sounding audio.

Remember that indicated RF output also depends on the accuracy of the wattmeter and correct DC supply voltage. Our test lab (Bird wattmeter) measurements consistently show 5 watts or better. If your application demands significantly more RF output, your FTR-146 transceiver will drive the Ramsey PA-1 (kit) or PA-10 (factory assembled with receiver pre-amp) to their maximum rated outputs in the 30-40 watt range.

- TX9. [] [] [] Replace the dummy load with a well-designed 2-Meter antenna and enjoy the FM transceiver that you built yourself!

TROUBLESHOOTING GUIDE (Version 1.2: May 1991)

A detailed guide to servicing your new transceiver cannot be developed until after the ham community has been using this newly-released kit-built equipment for a while. For now, we need to regard any malfunction to be caused by:

- incorrect part selection
- incorrect part orientation (diode or capacitor polarity, transistors, etc.)
- soldering error (missing connection, solder bridge)
- part damaged during assembly
- part defective in manufacturing
- part damaged by incorrect installation of other part(s)
- part breakdown after extended operation

The above possibilities may seem vague, but they cover what can go wrong in any multi-stage electronic device. For this reason, it is important for you to learn the FTR circuit design in as much detail as possible, which is why both the schematic and assembly instructions are presented stage by stage.

Trouble-shooting is a process that considers EVERYTHING possible, especially including the following:

- power supply
- ALL cables and connectors
- microphone
- speaker
- antenna
- again, ALL cables and connectors!

Based on general experience and the FTR's theory of operation, here is our view of the most probable trouble zones. Mentioning a transistor or IC means check all parts associated with them:

- PLL and Receiver Mixers: Q3 and Q17
(A mixer is a crossroads for THREE stages!)
- Any use of 2N3904 where 2SC2570 is required
- Use of NPN where PNP is required: Q22, Q14
- Incorrect crystal selection
- Mistaken use of .01 or .001 disc capacitors where a small picofarad value is specified.

If tracing and repairing complex circuits is new to you, we urge you to retrace your assembly steps thoroughly and then give us a call, with your unit, schematic and PC-board illustration right in front of you. If you prefer to write or fax, please format your information and questions so that our technicians can jot short marginal notes. Study the terms of your Ramsey kit Warranty before considering factory service.

If you ask a more experienced ham friend to look at your unit, it is up to you to be able to recognize whether this person has the know-how and proper equipment and tools to be of real help to you. Most hams really want to be helpful, but good intentions are no substitute for competence. (If your friend drags out the trusty soldering gun and big, rusty alligator clips, suggest a fishing trip or antenna-fixing party instead.)

The best favor any friend can do for your kit project is to use the other set of the double check brackets [] [] provided throughout this book to review the correctness of part choices.

SERVICE LAB NOTE FTR.001 (May 1991)

Occasionally, any one of the four crystal oscillators has actual measured frequency output slightly higher than required by alignment standards. This is caused by slight variations in component value tolerances. The remedy is to add a small-value "padding" capacitor in PARALLEL with the base-to-emitter capacitor of that oscillator. We have provided an extra quantity of 4.7 or 5.0 pf. capacitors in case you need them for this purpose. "Tack-solder" one of these capacitors across the SOLDER-SIDE (bottom) of the PC-board. [NEWCOMER NOTE: "tack-soldering" means adding a part "on the surface" -- very secure but easily removeable. Keep the leads as short as possible and review Steps Pla-etc. for SMT C123 for good hints on this bottom-of-the-board technique.]

Receiver Oscillator	Stage J0	C12	5 pf.
Simplex Oscillator	Stage L0	C28	8.2 pf.
- 600 TX Oscillator	Stage M	C70	8.2 pf.
+ 600 TX Oscillator	Stage N	C98	15 pf.

SERVICE LAB NOTE FTR.002 (May 1991)

If you encounter any distortion of your TRANSMITTED signal in mobile operation such as a "motorboating" sound in pace with engine acceleration, please review "Power Supply Considerations" in Section I. A simple "hash filter" conveniently available from Radio Shack, or independent DC supply, may be needed.

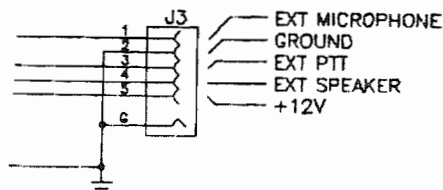
FTR-146 PACKET OPERATION

Your FM transceiver was planned and designed to accommodate easy and reliable VHF packet radio operation.

Your first step is to prepare a reliable 5-conductor cable with a 5-pin DIN plug (RS 274-003) at one end, and the correct connector needed by your packet TNC at the other end. If you salvage a "ready made" 5-pin DIN cable from something like a discarded computer joystick, be sure that there are indeed 5 wires, or at least the ones that are required by your TNC!

Consult your packet TNC documentation for ALL details on hookup and operation. Pin 4 of J3 offers a choice of amplified (speaker level) audio output, or low-level (discriminator) output. This choice is set up by the jumper wire positions clearly visible on the PC board.

Use this space to diagram your cable hookup pin numbers:



Packet Audio Jumper: Some TNC's require low-level audio from the discriminator output of the FM detector, while others will accept speaker output. Either is available in the FTR transceivers. Simply install a jumper in the appropriate location near VR1, to connect "EXT AUDIO" to either "SPKR" for speaker audio or "DISC" for discriminator audio. Use scrap resistor wire to make the jumper. You also can choose to wire these three points to a miniature SPDT switch which you can mount on the rear panel near the packet connector. OR, use a PC-mount switch in the jumper area itself..

Kit Builder's Notes:	Date

RAMSEY

An Important Notice regarding your Standard Ramsey Kit Warranty as Applicable to this FM Transceiver Kit:

We at Ramsey Electronics have been happy over the years to produce the industry's widest variety of inexpensive kits for hobbyists, students and radio hams. Many of these kits are quite simple, with tens of thousands of them successfully assembled from single-page instruction sheets. Even so, we devoted 1990 to producing new, detailed instruction manuals for every kit in our line. This process required refinements and fixes for some of the circuits or the PC-boards as well as progressive revisions of even the new instruction manuals.

Your FTR-146 FM Transceiver is being called by critics and experts the most important new Kit product in recent ham radio history. It requires a reasonable but very significant investment of money and time on your part. We KNEW that fact as this project began to take shape, so we understood clearly that you would expect much more than the good-natured fun of a \$5.00 oscillator-timer kit or a youngster's first shortwave set. So, we committed the team at Ramsey Electronics, Inc. to a very major investment as well.

The performance of the FTR-146 has been reviewed, critiqued and fine-tuned by a half-dozen different fellow hams with solid VHF experience. The PC-board went through more revisions than we want to think about, even with the new advantage of CAD auto-routing. This instruction manual is keyed to every detail of the CAD-generated schematic, with extensive cross-checking to prevent serious error. When the computer was finished, the VHF hams among us kept working on toward the best possible performance, picofarad by picofarad.

We tell you these facts for these reasons:

1. We KNOW that this transceiver WORKS as specified.
2. We want YOUR transceiver to work as specified.
3. We believe that it WILL work as specified for all builders who carefully follow our published instructions.

We believe you will succeed, and we'll give you all the support that our small profit-margin on this "Let's Bring Ham Radio Back Home" crusade can possibly permit. However, we are really counting on YOUR determination that we hams indeed can build, understand and service our own VHF FM radios!

Sure, we can service your transceiver for a flat fee of \$49.95, or at the \$36/hour rate required for our professional test equipment, but that would defeat the whole idea of you getting a true FM ham transceiver that you can build and service yourself. If you run into a problem, we're always ready to answer a few quick phone, fax or written questions -- the more well-prepared and cheerful, the better. Even though this is an advanced kit that cost you (and us) some

hard dollars, there's no need for hostility if a difficulty turns up. We still believe in the old saying that the customer is always "right," but we who believe in keeping the electronics kit business going just have no control over what can happen when our good customers join our assembly line!

You'll see this advice elsewhere in this book, but please at least promise yourself and us that you'll be attentive to these very basic concerns:

**** Use thin-diameter rosin-core solder ONLY.**

**** Mount all parts with as little excess lead-length as possible.**

**** If you have any doubts, cross-check all the following:**

- Schematic Diagram
- Part numbers imprinted on your PC-board
- Published PC-board illustration
- Kit Assembly Steps
- Master Component Index
- Kit Parts List

**** Follow all alignment directions, using 146.52 Simplex as your reference standard.**

Your FTR VHF transceiver is a serious piece of ham radio equipment. It's worth devoting several days to a patient process of LEARNING about it while building and aligning it, even though one of our genius technicians managed to build one and get it fully operational in a such a small number of hours that we'll never tell you!

PLEASE let the details in this publication be your guide and "bible" in enjoying the satisfaction of building, understanding and maintaining your FM VHF transceiver! THANKS for your interest and confidence in this truly new adventure in serious ham radio kits for the 1990's!

RAMSEY

THE **RAMSEY** KIT WARRANTY

Please read carefully BEFORE assembling your kit. Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that a team of knowledgeable people have field-tested several "copies" of this kit straight from Ramsey inventory. If you need help, write, call or send a fax for technical assistance.

1. DEFECTIVE PARTS: All kit parts carry the Ramsey Electronics Warranty that they are free from defect for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send **only** the defective part(s), NOT the entire kit. The part(s) **MUST** be returned to us in suitable condition for testing.

2. MISSING PARTS: Ramsey Electronics project kits are packed with pride in the U.S.A. If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual as supplied with the basic kit by Ramsey, please write or call us with information on the part you need and proof of kit purchase. Before assuming a part value is incorrect, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a range of values is suitable (such as "100 to 500 ufd.")

3. FACTORY REPAIR OF ASSEMBLED KITS:

To qualify for Ramsey Electronics factory repair, kits **MUST**:

1. **Not** be assembled with acid core solder or flux.
2. **Not** be modified in any manner.
3. **Be** returned in fully-assembled form, not partial.
4. **Be** accompanied by payment of proper repair fee. No repair will be undertaken until we have received the minimum one-hour fee (\$18.00), or authorization to charge it to your credit card account.
5. **Include** a description of the problem and legible return address. **Do not send a separate letter; include all correspondence with unit.** Please do not include your own hardware such as non-Ramsey cabinets, knobs, cables, external battery packs, and the like.

Ramsey Electronics, Inc., reserves the right to refuse repair on ANY item in which we find excessive problems or damage due to construction methods. To assist customers in such situations, Ramsey Electronics, Inc., reserves the right to solve their needs on a case by case basis.

Please understand that our technicians are not volunteers and that set-up, testing, diagnosis, repair, repacking and paperwork can take nearly an hour of paid employee time on even a simple kit. Of course, if we find that a part was defective in manufacture, there will be no charge to repair your kit (But please realize that our technicians know the difference between a defective part and parts burned out or damaged through improper use or assembly.)


4. MODIFIED AMATEUR RADIO (only) KITS: Ramsey may elect to supply you with information on a knowledgeable service center willing to assist you with an amateur radio (only) kit that you have modified in accord with good ham radio experimental practice. Ramsey Electronics, Inc., can in no way warrant any service provided or its cost. Send us **ONLY** the following: Proof of purchase, description of modifications, and description of your problem, your name and complete return address.

5. REFUNDS: You are given ten (10) days to examine our products. If you are not satisfied, you may return your **unassembled** kit with all parts and instructions and proof of purchase to the factory for a full refund. The return package should be packed securely. Insurance is recommended. Do not cause needless delays. Please read all information carefully.

RAMSEY ELECTRONICS, INC. • 793 Canning Parkway • Victor, New York 14564
Telephone (716) 924-4560 • Fax (716) 924-4555

The Standard Repair Fee for the FTR-series Transceiver is \$49.95 provided that the kit is assembled per the published instructions.

COLOR CODE:

 Solder-side traces and pads

 Component-side etched areas

Note:
PCB holes are plated-through



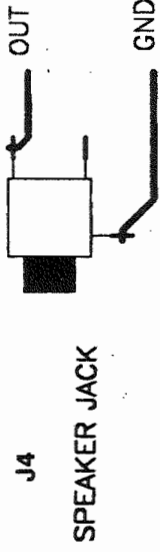
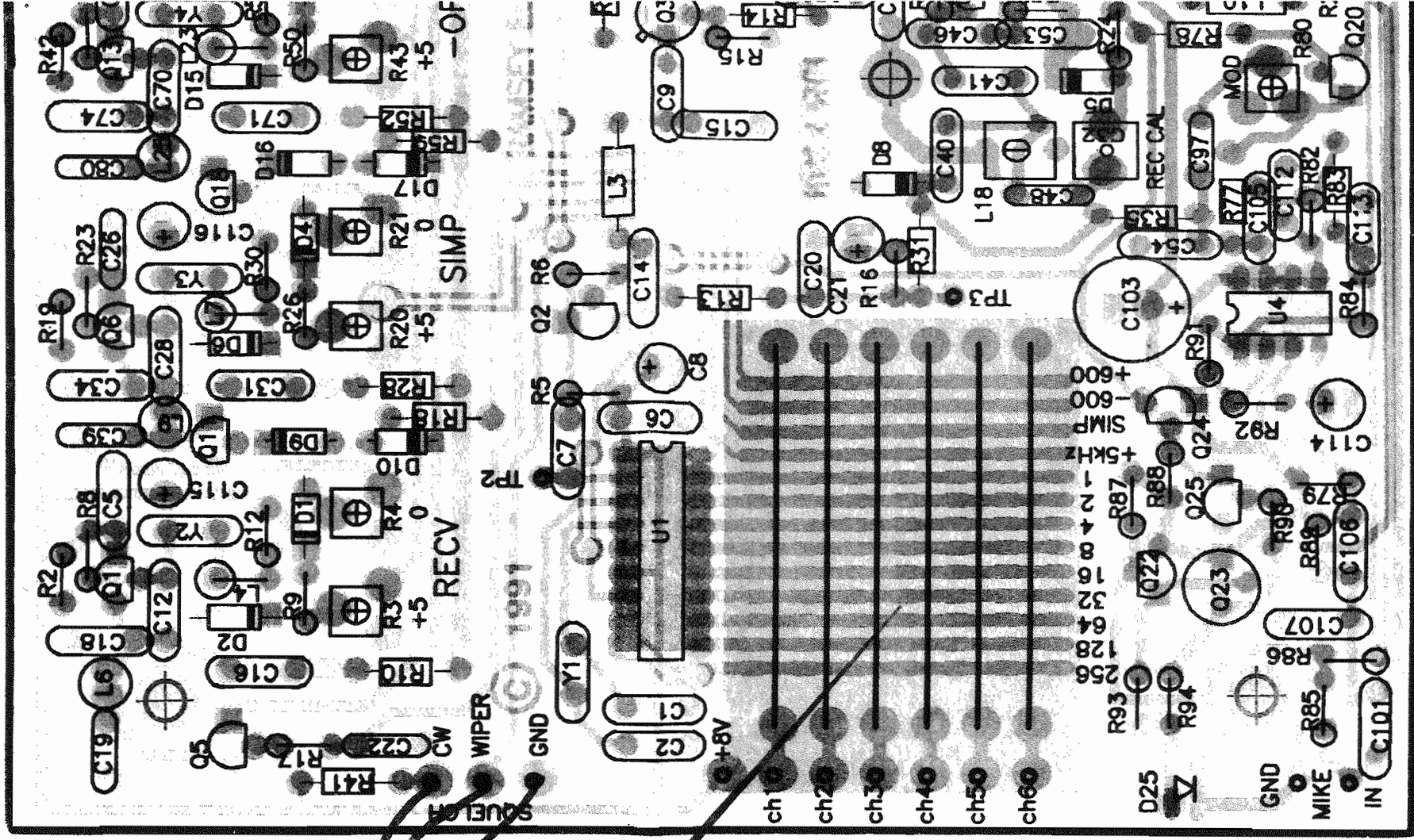
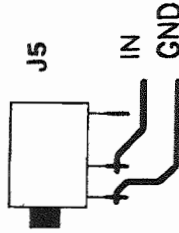
Completion and Binary Programming of diode Matrix is explained in Stage PL.

FTR-146 2-METER FM AMATEUR TRANSCIVER

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793 Canning Parkway
Victor, NY 14564
(716) 924-4560



MICROPHONE JACK



See instruction manual regarding this Packet audio jumper wire option.

PACKET

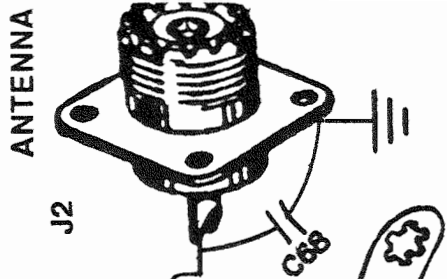
R69/S2
Volume
DC On-Off

#30 strand of wire installed on R25 for fuse F1. SEE TEXT.

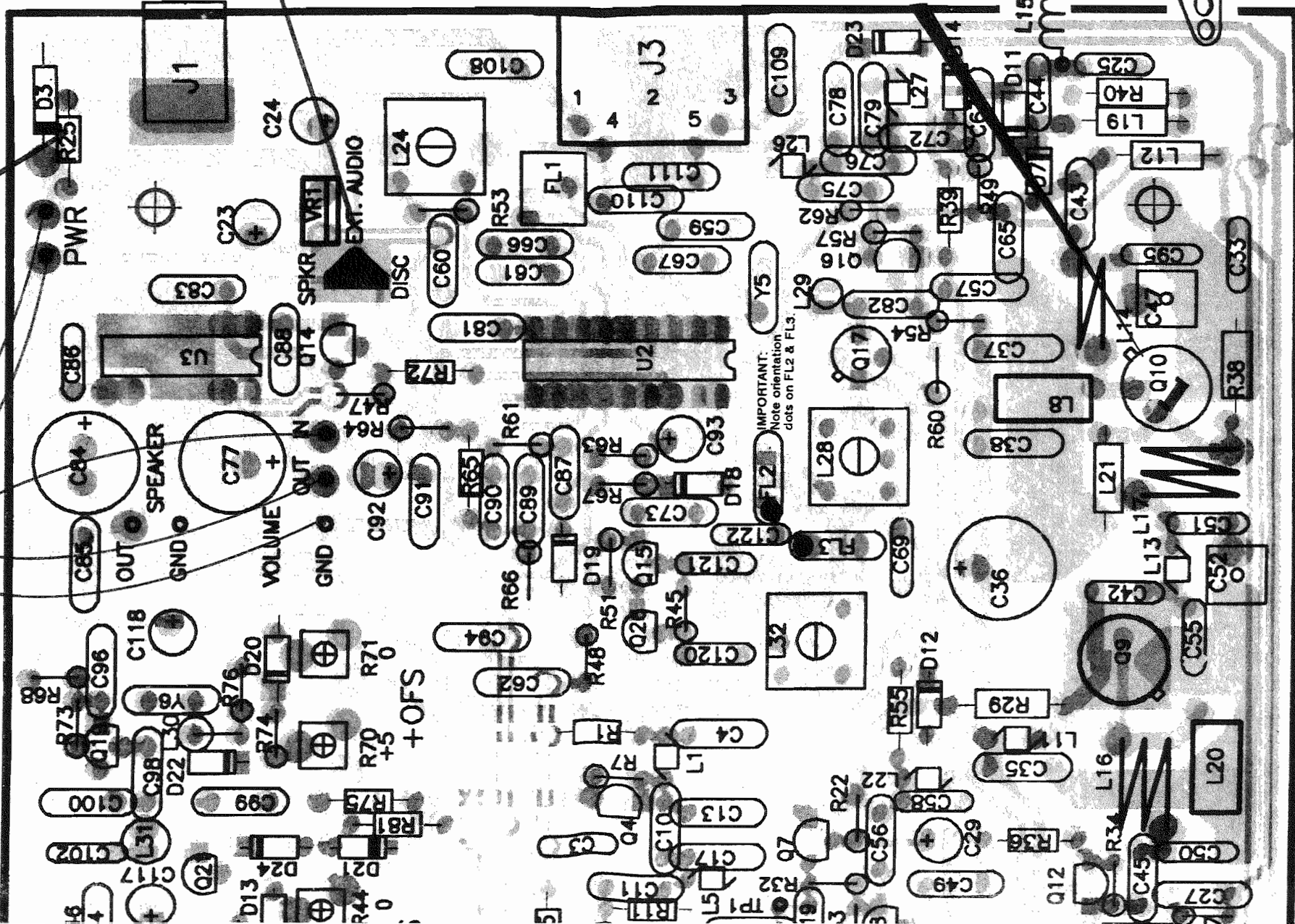
+ 13.8 VDC

1. EXT MIC
2. GROUND
3. EXT PTT
4. EXT SPEAKER
5. + 12 VOLTS D

C123 SMT 100 pf. *chi installed on solder side See Step P1.

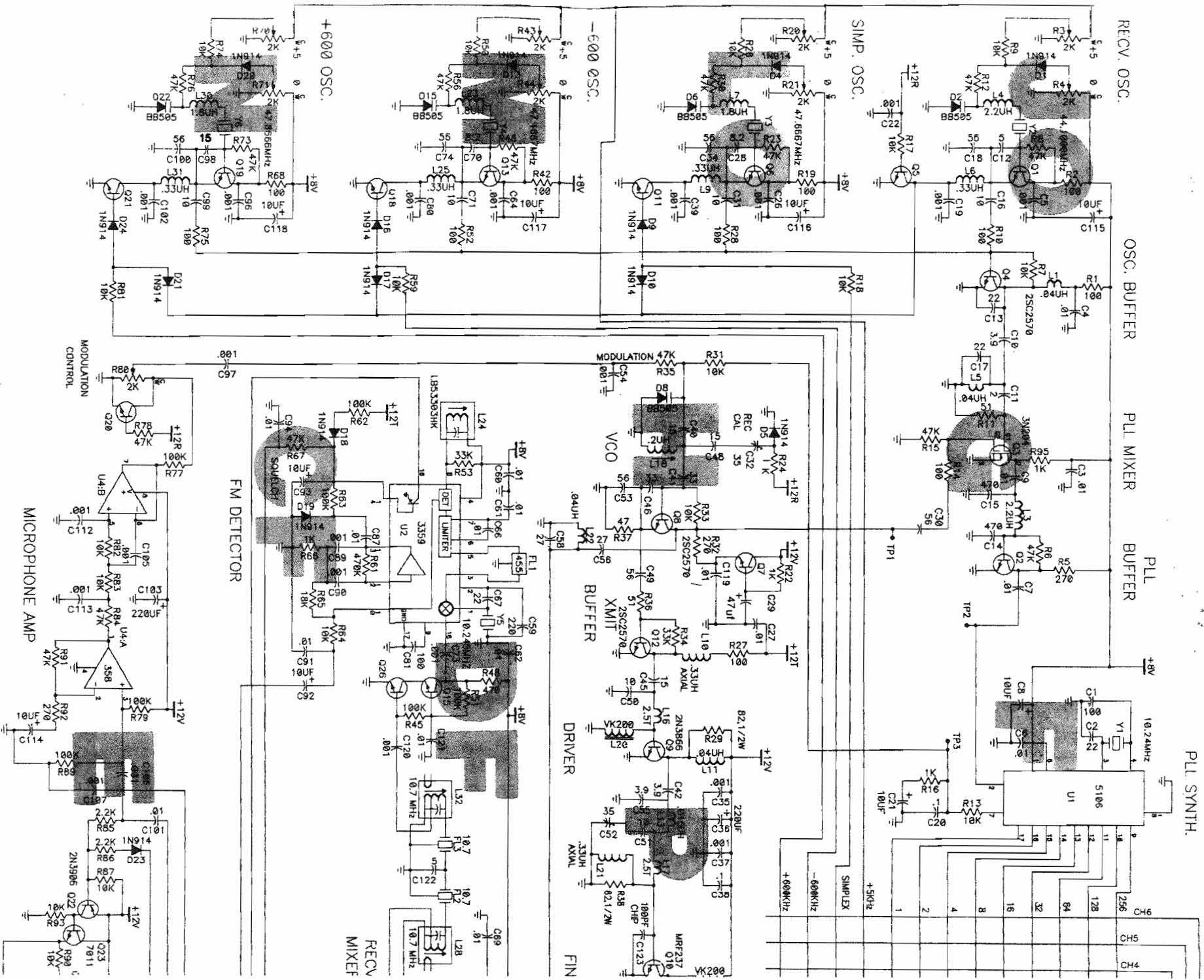


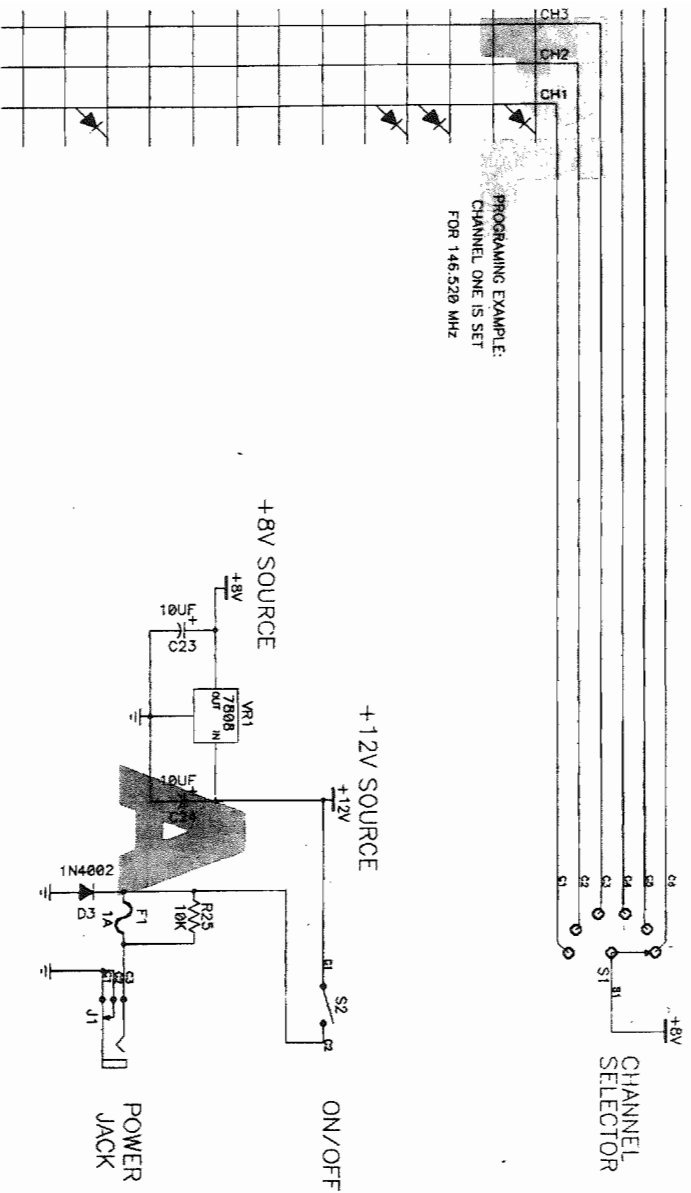
CONNECT SOLDER LUG HERE



IMPORTANT:
Note orientation dots on FL2 & FL3.

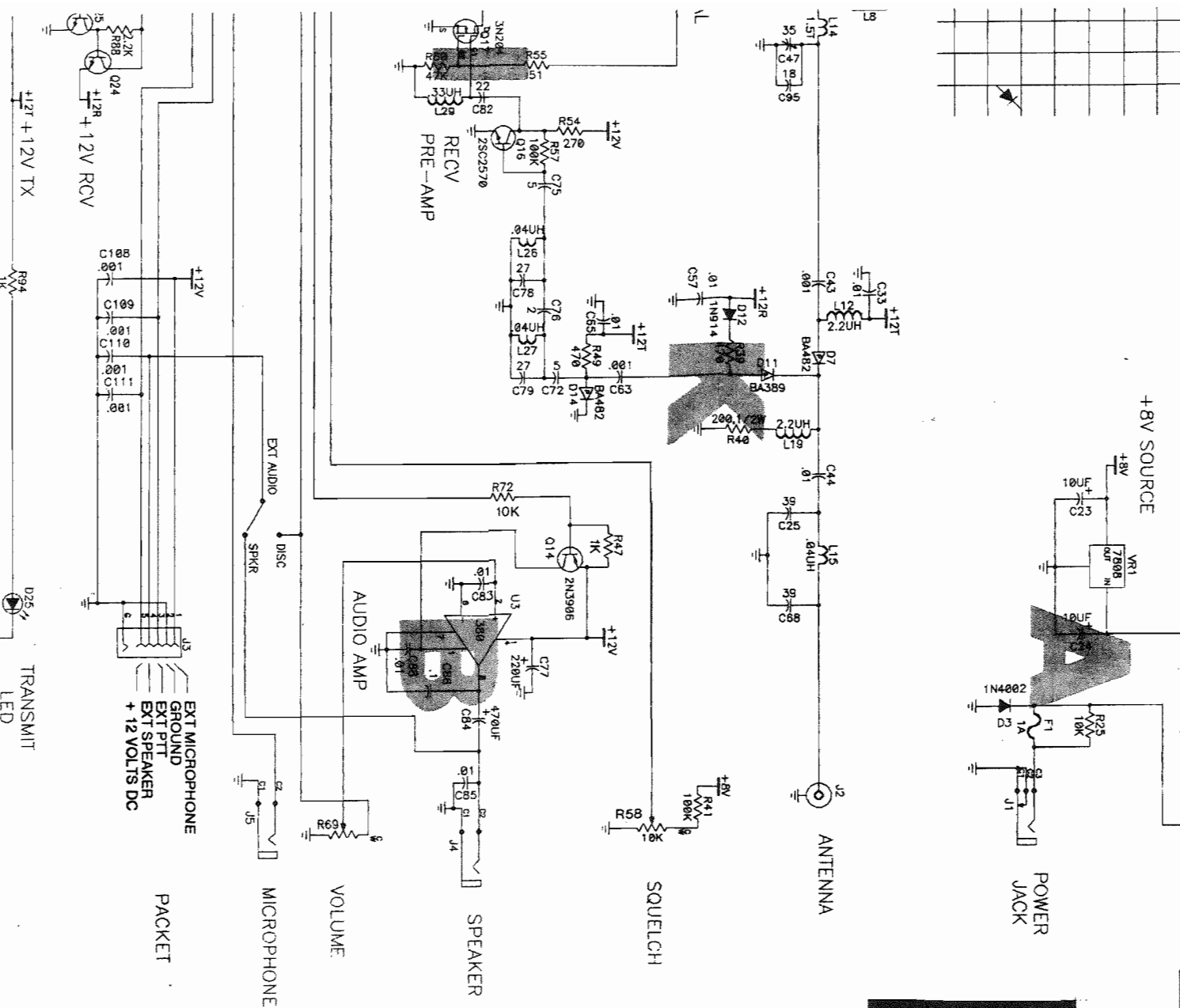
DO NOT INSTALL L11, R29 or L8 until AFTER Alignment!





NOTICE:
 Non-critical values or specifications of some components may vary. Consult the Transceiver Assembly & Operating Manual. Examples: 5 pf may be 4.7 or 5.0 2 pf may be 2.0 or 2.2 1N914 may be 1N4148 10 ufd. may be 4.7-10 ufd.

RAMSEY ELECTRONICS, INC 199
 FTR146 Revision F



FTR-146 Amateur Radio 2 Meter PLL Synthesized Transceiver
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FTR-146 PLL Synthesizer Programming Log

RX Freq.	N =	256	128	64	32	16	8	4	2	1	+5KHz?	TX Offset?

Ramsey Publication No. M146FTR
ASSEMBLY AND INSTRUCTION MANUAL
for
Model No. FTR-146
Amateur 2M PLL-Synthesized FM Transceiver



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