

No. 1209

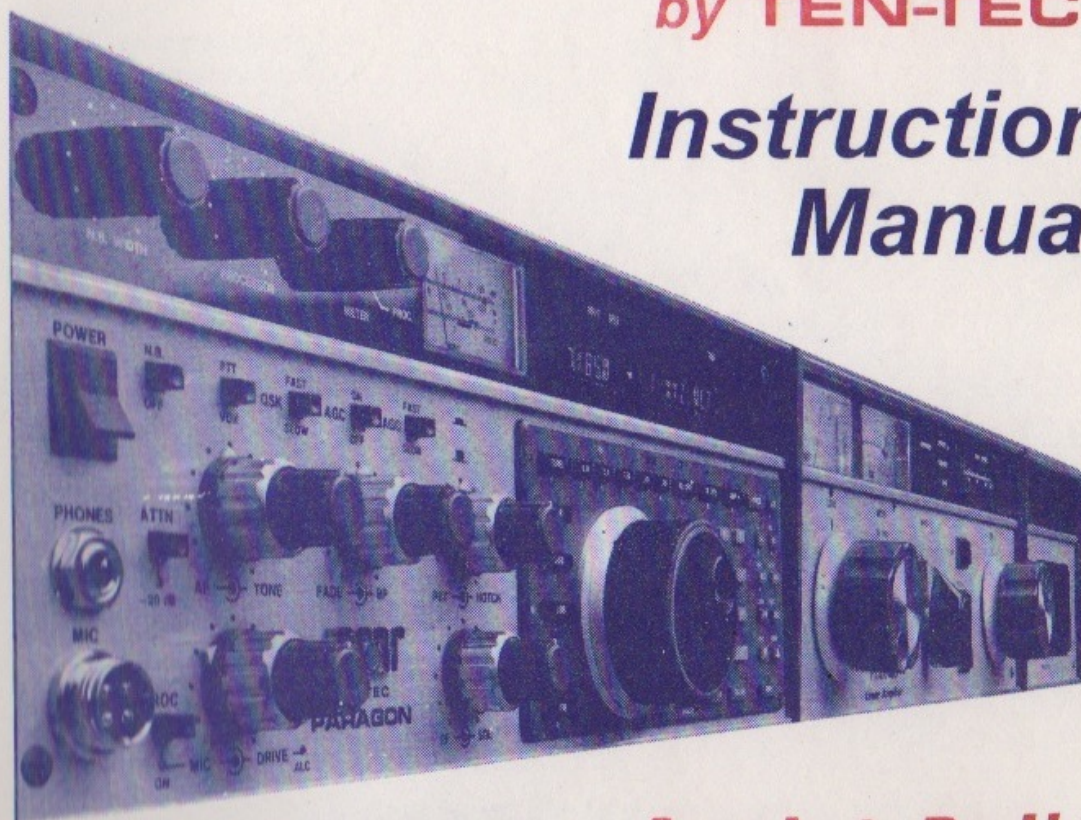
◆ Complete T-KIT with Enclosure, Hardware ◆

6 Meter Transverter

8 watt output, any mode, for use with
2 Meter handheld or mobile transceivers

T-KIT
by TEN-TEC

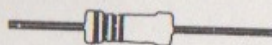
Instruction Manual



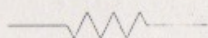
America's Best!

T-KIT Electronic Parts Identification Guide with Schematic Symbols

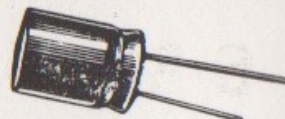
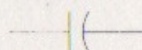
*If your kit also includes parts not illustrated below,
consult this manual for detailed description or illustration.*



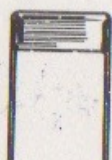
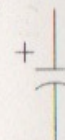
Resistor



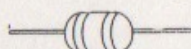
**Ceramic disc
capacitor**



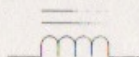
**Electrolytic
capacitor**



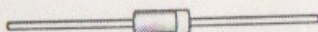
**Mylar film
capacitor**



Molded inductor



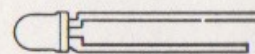
**Trimmer
potentiometer**



Diode



Varactor diode



LED



**Transistors
(TO-92 case)**

NPN



PNP



FET



**Transistor
or Voltage Regulator
(TO-220 case)**



Other parts and symbols are illustrated in
electronics catalogs and handbooks.

T-KIT Manual No. 74335

Price: \$8.00

Kit Assembly and Instruction Manual
for T-KIT Model No. 1209

6 Meter Transverter
for 2 Meter Transceivers

***IMPORTANT: Please read Warranty Terms
BEFORE starting kit assembly.***

... A quality electronics kit project from
T-KIT

a Division of TEN-TEC, Inc.
1185 Dolly Parton Parkway
Sevierville, Tennessee 37862
(423) 453-7172
Fax (423) 428-4483

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Manual text and design by Dan F. Onley, K4ZRA.

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T-KIT Model 1209
6 Meter Transverter
Kit Instruction Manual

Section 1

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Introduction

The T-KIT No. 1209 Transverter permits operation on 6 Meters (50-54 MHz) with any amateur radio transceiver capable of 5 watts RF output on 2 meters (144-148 MHz.) We designed its ultra-simple operation, compact size, and budget price to stimulate interest in 6 meter operation, a fascinating band for which most U.S. hams, including newly-licensed Technicians, have operating privileges but no equipment. With a tip of the TEN-TEC cap to experienced VHFer's, this instruction manual is addressed primarily to ham newcomers inspired to take on a serious kit-building project with openness to and enthusiasm about the adventures and surprises of 6 meter operating.

This instruction manual includes some additional explanation of the operating characteristics of the 6 meter band. However, you'll want to look again at monthly VHF columns in your ham magazines, talk with experienced 6 meter operators, and also do a lot of listening on the band itself.

While we expect the transverter to be used primarily with 2 meter FM handhelds, you may use any 2 meter transceiver, correctly adjusted to 5 watts RF output, to transmit and receive FM, SSB, CW and other modes on 6 meters through the 1209 Transverter. In this case, the Transverter itself is your transmitter (8 watts RF output), and the 2 meter transceiver is the source of frequency control and modulation.

Converters, Transverters: the Basic Idea

In brief, the transverter converts incoming 50 MHz signals to be received at 144 MHz, and it converts your 144 MHz transmit signal to 50 MHz RF output.

A **converter**, or the process of conversion, means MIXING two different RF signal frequencies to produce a third signal frequency. Converting can be done in both the receiving and transmit processes. A very common example of conversion is found in both your 2 meter HT transceiver and in ordinary FM broadcast radios. The incoming VHF signal (such as 90.7 MHz or 144.52 MHz) is mixed with an oscillator signal to produce an "intermediate frequency" (IF) of 10.7 MHz, which is processed or converted further to provide intelligible audio. A cable TV converter changes the incoming cable signal to your choice of TV channels 3 or 4. (The process of transmit conversion is similar in theory.)

Mixing is a process of either **adding or subtracting** the antenna input frequency and the "local oscillator" frequency to produce the desired conversion, a third frequency. Whether the first two frequencies are added or subtracted depends on the tuned L-C (inductor-capacitor) circuits used.

Since our focus is on the 6 meter ham band, a practical example of receiver-only conversion is our economical T-KIT No. 1061, which mixes incoming 50-54 MHz signals with a 22 MHz crystal oscillator signal, adding 22 MHz to the input of a 10 meter (28-29.6 MHz) receiver or transceiver. If the receiver is tuned to 28.110 MHz, it will detect 50.110 MHz signals, and so forth.

If the 22 MHz oscillator in the 1061 T-KIT converter were to be replaced with a 94 MHz crystal oscillator, with corresponding changes in tuned L-C circuits, the mixer output would be 50 MHz plus 94 MHz, or 144 MHz. Stated in another way, $144 \text{ MHz} - 94 \text{ MHz} = 50 \text{ MHz}$, which is the working principle of the T-KIT Model 1209 Transverter.

A "transverter" is a converter-with-a-difference, a "converter-PLUS." A transverter is an efficient working combination of ALL circuitry needed to carry out BOTH receive and transmit VHF conversion. Just as huge transmitter/receiver "hamshacks" gave way to compact transceivers, the jobs of separate receive and transmit VHF-to-HF converters, and the T-R switching needed between them, are handled best today by the "transverter." The T-KIT 1209 uses today's PIN-diode switching and RF mixer technologies to combine a sensitive 50 MHz receiving converter and 144 MHz transmit converter to bring TEN-TEC's legendary QSK T-R performance to economical 6 meter operation.

Why "Conversion" at All?

Why isn't 6 Meters INCLUDED on my Transceiver?

A very fair question, since 6 meters was included routinely in HF transmitters of 30 years ago! A few modern HF transceivers DO include 6 meters, and so do a few VHF rigs . . . and they are priced accordingly. 6 meters is not included routinely on today's HF equipment because solid-state RF devices (such as those expensive "finals" in your transceiver) have rigid frequency cutoff characteristics. A power transistor designed for 1-30 MHz becomes useless at 50 MHz. HF and VHF are two different worlds in RF design, and 6 Meters sits between them.

There's another, less technical reason: 50-54 MHz ham operation is or was restricted or prohibited in many corners of the world

because this spectrum belongs to that "missing channel" on your TV or VCR tuner — for many people, 6 meters is TV Channel 1! Since so much ham equipment is manufactured overseas for a global ham/commercial/paramilitary/diplomatic market, 6 meters gets little consideration except for a few costly accessory transverters or expanded-coverage rigs.

6 Meters is FOUR MEGAHERTZ of valuable VHF spectrum with many HF DX characteristics, four MHz available to virtually all U.S. hams as well as hams in an ever-growing number of other countries. The T-KIT 1209 Transverter gives you access to that band very conveniently and affordably.

Circuit Description

The T-KIT 1209 Transverter uses a 94 MHz crystal controlled oscillator, quad diode mixer, PIN diode signal switching and other supporting circuitry to transmit and receive in the 50-54 MHz amateur band using a 2 meter transceiver capable of 5 watts output. Please use the block diagram on page 9 and the following descriptions to build up an understanding of the Model 1209 schematic diagram. The schematic diagram is also reproduced in sections corresponding to the kit assembly phases. Learning the circuit, even if done very gradually, is the key to building, using and maintaining the transverter with full confidence in it and in yourself.

Transmit/Receive Control Voltages: The transverter uses a carrier detect circuit C6, D1 and D2 to monitor the input from the 2 meter transceiver. When the transceiver is keyed the two diodes rectify a small sample of the input signal and develop a control voltage that switches transistors Q1 through Q4. These transistors provide a pair of TRANSMIT and RECEIVE bias voltages that power the other stages in the transverter. This circuit operates automatically and is silent and almost instantaneous.

Input Attenuator: Most 2 meter mobile transceivers will have a low power setting that results in an output of about 5 watts. Handheld transceivers usually will also have an output of about 5 watts. For convenience the model 1209 is set to accept this input level. Resistors R1-R4 provide the necessary 50 ohm load for the transceiver. R5 and R6 are selected to provide a small amount of input signal to the diode mixer stage.

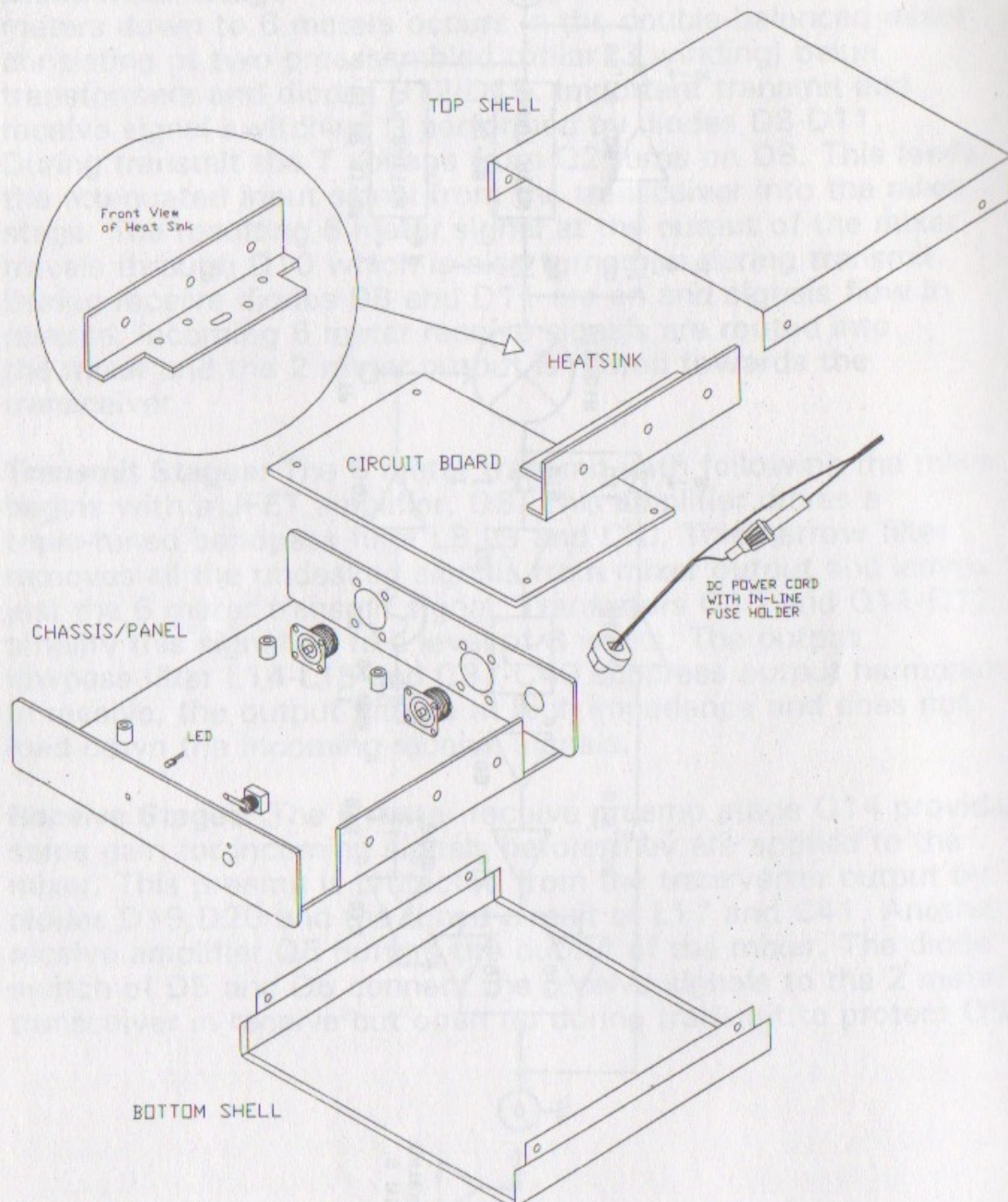
Crystal Oscillator: Transistor Q6 and crystal Y1 form a fifth overtone oscillator. The 94 MHz signal is fed by buffer-amplifier Q7 to the diode mixer. Adjustable coil L23 permits a precise adjustment of the oscillator frequency at the LO TP test point using a frequency counter.

Diode Mixer Stage: The actual frequency translation from 2 meters down to 6 meters occurs in the double-balanced mixer consisting of two preassembled trifilar (3 winding) balun transformers and diodes D12-D15. Important transmit and receive signal switching is performed by diodes D8-D11. During transmit the T voltage from Q2 turns on D8. This feeds the attenuated input signal from the transceiver into the mixer stage. The resulting 6 meter signal at the output of the mixer travels through D10 which is also turned on during transmit. During receive diodes D9 and D11 are on and signals flow in reverse. Incoming 6 meter receive signals are routed into the mixer and the 2 meter output is routed towards the transceiver.

Transmit Stages: The 6 meter transmit path following the mixer begins with a JFET amplifier, Q8. This amplifier drives a triple-tuned bandpass filter L8,L9 and L10. This narrow filter removes all the undesired signals from mixer output and leaves just the 6 meter transmit signal. Transistors Q10 and Q11-Q12 amplify this signal up to a level of 8 watts. The output lowpass filter L14-L16 and C37-C40 suppress output harmonics. In receive, the output filter is at high impedance and does not load down the incoming receive signals.

Receive Stages: The 6 meter receive preamp stage Q14 provides some gain for incoming signals before they are applied to the mixer. This preamp is protected from the transverter output by diodes D19,D20 and the tuned circuit of L17 and C41. Another receive amplifier Q5 buffers the output of the mixer. The diode switch of D5 and D6 connect the receive signals to the 2 meter transceiver in receive but open up during transmit to protect Q5.

T-KIT Model 1209 Six Meter Transverter Overview of Mechanical Assembly:



IMPORTANT NOTICE

The Model 1209 Transverter is designed to convert a **5 watt 2 meter transmit signal** to 6 meters, 8 watts RF output. Therefore, it is well-suited for use with the T-KIT Model 1220 2 Meter Transceiver.

The unit also should work well with virtually any handheld 2 meter transceiver, depending on the quality of receiver design and T-R circuit in any given transceiver.

It is YOUR responsibility to determine whether your mobile transceiver or other VHF transceiver's output can be switched or adjusted reliably to 5 watts or less. Study your transceiver manual carefully and use a quality RF wattmeter with dummy load to verify that 5 watt operation is possible. Up to 10 watts of RF may be applied provided that resistor R5 is changed per directions in this manual.

TEN-TEC, Inc. is not responsible for damage to the 1209 Transverter or to other equipment of any kind from attempts to circumvent the 1209 Transverter's 5 watt RF transmit input requirement.

NOTE to Customers who have built the Model 1208 Transverter (20 Meters to 6 Meters): While there are many similarities between Models 1208 and 1209, please follow THIS manual carefully, because there are numerous circuit differences.

Useful Terminology For this Kit Project:

The following plain-English words are used throughout the construction steps with the following specific meanings:

BOARD ◇ our short name for the "printed circuit board"

BOTTOM ◇ "solder side" of the board. All parts are inserted or installed through the TOP side of the board with most (but not all) soldering done on this bottom side.

GROUNDPLANE ◇ any large area (or trace) of copper foil on either side of the board which is common to DC or RF ground.

HT ◇ abbreviation for "handi-talkie," hand-held transceiver.

HEATSINK ◇ any metal surface fastened to a solid-state device to dissipate heat. This kit uses a preformed aluminum angle mounted to the chassis as the heatsink required to absorb and distribute the heat generated by Q11, Q12 and Q13.

INSTALL ◇ unless explained otherwise, this always means to insert a part into its holes on the top of the board (component side), solder both or all points on the bottom side and cut (nip) away excess wire lengths.

JUMPER ◇ a wire of any length, bare or insulated, which bridges or "jumps" two points on the board. For your convenience, this kit used "zero ohm" resistors for the four jumpers required.

TEST POINT ◇ any kind of hardware which provides easy access to a circuit for testing or adjusting.

TIN ◇ to "tin" a wire or an area of a circuit board is to heat it with the soldering iron so that solder flows freely to form a thin, shiny coating.

TOP ◇ "component side" of board, clearly recognizable by the silkscreened imprints of component outlines.

TRIMMER ◇ a small variable capacitor or potentiometer used for initial circuit adjustments.

VIA ◇ A hole in the board intended to join a bottom pad to a top pad or groundplane either by plating-through during board manufacture or by soldering a short bare wire to both points.

T-KIT 1209 6-Meter Transverter KIT PARTS LIST

1. Check and organize all parts before starting construction.
2. See T-KIT Warranty if you suspect any parts are missing.
3. If "****" appears in the "Schematic" column for a common part value, please refer to the Component Reference Index (pages 17-22) to see all uses of that value.

Quantity	Description and Value	Schematic	Part No.
----------	-----------------------	-----------	----------

Fixed Resistors

The 3 color bands denote resistance value. The 4th band (gold) denotes 5% tolerance.

All resistors are 1/4-watt unless specified otherwise.

3	□ "zero ohm" jumper (single black band)	JMP1-3	30353
3	□ 10 ohm (brown-black-black)	R33,R39,R40	30115
1	□ 33 ohm (orange-orange-black)	R32	30120
2	□ 47 ohm (yellow-violet-black)	R6,22	30122
10	□ 100 ohm (brown-black-brown)	***	30126
1	□ 150 ohm (brown-green-brown)	R52	30128
4	□ 150 ohm (brown-green-brown), 3/4 watt	R44-R47	30059
1	□ 220 ohm (red-red-brown), 1/4 watt	R54	30130
4	□ 220 ohm (red-red-brown), 2 watt	R1,R2,R3,R4	30423
6	□ 470 ohm (yellow-violet-brown)	***	30134
2	□ 680 ohm (blue-gray-brown)	R30,R35	30136
10	□ 1K (brown-black-red)	***	30138
1	□ 2.2K (red-red-red)	R14	30142
1	□ 3.3K (orange-orange-red)	R5	30144
4	□ 4.7K (yellow-violet-red)	***	30146
11	□ 10K (brown-black-orange)	***	30150
2	□ 47K (yellow-violet-orange)	R8,R50	30157

Fixed Capacitors

All capacitors are ceramic disc unless specified otherwise.

3	□ 2 pF	C6,C18,C20	23301
1	□ 3 pF	C55	23248
1	□ 5 pF	C4	23249
1	□ 10 pF	C53	23251
1	□ 33 pF 50V, no other marking	C54	23246
5	□ 33 pF, 1KV (marked 33K)	***	23376
5	□ 47 pF	***	23378
1	□ 62 pF	C37	23380

Capacitors, cont.

5	□	100 pF (marked 101)	***	23385
2	□	120 pF (marked 121)	C38,C39	23386
1	□	220 pF (marked 151)	C5	23396
6	□	.001 μ F (marked 102)	***	23245
25	□	.01 μ F (marked 103)	***	23260
1	□	1 μ F electrolytic	C8	23264
1	□	10 μ F electrolytic	C36	23266
1	□	470 μ F electrolytic	C61	23228

Inductors, Coil-Making Supplies:

1	□	Shielded .05 μ H slug-tuned coil	L2	21182
1	□	Unshielded .12 μ H slug-tuned coil	L23	21180
1	□	Shield can for above coil		38131
5	□	Unshielded .25 μ H slug-tuned coil	L8-10,L19-20	21059
5	□	Shield cans for above #21059 coils		38226
1	□	Molded 0.15 μ H inductor (brown-green-silver-gold)	L25	21102
1	□	Molded 0.47 μ H inductor (yellow-violet-silver-gold)	L22	21108
5	□	Molded 2.2 μ H inductor (red-red-gold-gold)	L1,3,4,5,24	21116
5	□	Molded 4.7 μ H inductor (yellow-violet-gold-gold)	L6,7,11,18,21	21120
1	□	Balun transformer, bifilar	T3	21152
2	□	Balun transformer, trifilar	T1,T2	21153
2	□	Ferrite wideband choke, 6 hole balun	L12,L13	21179
1	□	Ferrite "Cero" bead	FB1/Q6	21027
3	□	Ferrite bead (.120X.060X.085)	FB2,3,4	21090
1	□	Wire, #18 solid, silver-plated, 2.7'	L17,L14-16	46076
2	□	RF transformer core assembly	T4,T5	85412
1	□	#22 Wire, teflon insulated, Red, 1.25'	(for T4-T5)	46071
1	□	#22 Wire, teflon insulated, Black, 8"	(for T4-T5)	46072

Semiconductor Devices: Transistors, Diodes

4	□	NPN transistor type 2N4124	Q1,3,7,9	25258
2	□	Transistor, type 2N5087	Q4,Q15	25001
1	□	Transistor, type MPSW01A	Q13	25053
1	□	Transistor, type MPSW51A	Q2	25371
1	□	Transistor, type MPS5179	Q6	25135
2	□	Transistor, FET type J310	Q5,Q8	25115
1	□	Transistor, dual-gate MOSFET type 3SK122	Q14	25119
2	□	Transistor, RF power type 2SC1971	Q11,12	25337
1	□	Transistor, RF power type 2SC1970	Q10	25338
10	□	1N4148/914 silicon diode	D1-6,D12-15	28001
5	□	PIN diode, type 1SS135	D8-11,20	28056
4	□	1N4007 silicon rectifier diode	D16-19	28043
1	□	9.1 volt zener diode	D7	28012
1	□	LED diode	LED1	28024

Other Components, Connectors:

1	☐	Trimmer capacitor, 10-60 pF	C41	23268
1	☐	Trimmer potentiometer	R43	30618
1	☐	Crystal, 94.000 MHz	Y1	48204
1	☐	Fuse MDL 5 amp (SEE NOTE BELOW)		27052
1	☐	DPDT toggle switch	S1	32110
2	☐	2-pin PC-mount terminal	TP1,TP2	35065
1	☐	2-position socket to mate TP1, TP2	Test plug	35075
2	☐	SO239 coax jack	J1,J2	35007

Model 1209 Hardware and Miscellaneous

**See Page 40 of the Assembly Section
for illustration of mechanical assembly.**

1	☐	Circuit Board for Model 1209	93244-3A
1	☐	Chassis/panel assembly for Model 1209	93245-DP2A
1	☐	Steel bottom shell	93104-DP
1	☐	Steel top shell	93105-DP
1	☐	Heatsink for 1209	93107
1	☐	#4X nylon shoulder washer (to insulate Q10)	38058
1	☐	Insulating pad (for Q10)	38176
8	☐	#4 lock washer	51002
11	☐	#4-40 3/8" screws	60003
11	☐	#4-40 hex nuts	54002
3	☐	#4-40 3/8" screws with captive lock washer	60069
4	☐	#6 sheet metal screw (black)	65003
1	☐	6" #24 black hookup wire	46010
1	☐	12" #24 red hookup wire	46012
3	☐	#4 solder lug	41039
1	☐	DC power cord with fuseholder (SEE NOTE BELOW)	46162
1	☐	Power cord strain relief grommet	42047
4	☐	Rubber bumper feet (self-adhesive)	42001
1	☐	Model 1209 instruction manual	74335

NOTE ON FUSE & POWER CORD: The power cord's in-line fuseholder is supplied with a different fuse (12A) pre-installed. Remove this fuse NOW and replace it with the 5A fuse supplied in your kit. Replacement 5A fuses are a stock item at hardware/electronic stores.

REQUIRED, NOT SUPPLIED:

- ☐ Regulated, well-filtered 12-15 Volts DC supply (4 amp minimum)
- ☐ 50-ohm coax jumper (dual PL-259, or PL-259 to BNC)
- ☐ Antenna for 6 meter band with 50-ohm coax feedline
- ☐ 2 Meter (144 MHz) transceiver with 2-5 watt RF output
- ☐ drop of clear glue or electrical tape (to secure LED1)
- ☐ thin-diameter rosin core solder

MINIMUM TOOLS FOR KIT ASSEMBLY:

- ☐ 15 to 35 watt soldering iron
- ☐ diagonal cutters or wire "nippers"
- ☐ needle-nose pliers
- ☐ X-Acto knife handle (.313" OD) or 3/8" machine bolt for winding coils
- ☐ #4-40 miniature socket wrench (or other wrench, utility pliers)
- ☐ adjustable wire stripping tool
- ☐ Hex alignment tool
- ☐ Medium phillips screwdriver

MINIMUM TEST EQUIPMENT:

- ☐ VOM for 12VDC measurements and 1000 mA range for bias adjustment
(If 1000 mA or higher range not available, we explain how bias may be adjusted by measuring a small voltage increase across resistance in series with DC power cord.)
- ☐ VHF RF Wattmeter to verify 5W output of 144 MHz transceiver and to obtain reading of 50 MHz transverter output during alignment.

RECOMMENDED (OPTIONAL) TEST EQUIPMENT:

- ☐ Frequency Counter to set 94 MHz crystal oscillator (L23)
- ☐ RF Wattmeter with 50 MHz range or element
- ☐ RF signal generator with 50 MHz range
- ☐ 50-ohm dummy load such as T-KIT 1203

About the Component Reference Index

The preceding Parts List shows the quantity of each type of part supplied in your kit. The following Index, keyed to the schematic diagram identifies the assembly step for each part as well as descriptive information about selected parts. Add your own notes as you grow familiar with the circuit. The Index is your assurance (and ours!) that every component is accounted for in the Assembly Steps, cross-checked to the schematic diagram.

T-KIT Model 1209 6-Meter Transverter

COMPONENT REFERENCE INDEX

(See Kit Parts List for TEN-TEC part numbers not repeated below.)

■ CAPACITORS

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
C1	.01 μ F	2-22		
C2	.01 μ F	1-41		
C3	.01 μ F	1-42		
C4	5 pF	3-13		
C5	220 pF	3-12		
C6	2 pF	2-23		
C7	.001 μ F	2-33		
C8	1 μ F elec.	2-24		sets T-R changeover speed
C9	100 pF	3-22		
C10	33 pF	3-21		
C11	.01 μ F	3-20a		
C12	.01 μ F	3-20b		
C13	.01 μ F	1-20		couples oscillator to mixer
C14	.01 μ F	1-45		
C15	.01 μ F	4-1		
C16	.01 μ F	4-15		
C17	33 pF	4-18		
C18	2 pF	4-16		
C19	33 pF	4-19		
C20	2 pF	4-17		
C21	47 pF	4-21		
C22	100 pF	4-20		
C23	.01 μ F	4-24		
C24	.01 μ F	4-23		
C25	.01 μ F	4-25		couples exciter output to Q10 driver
C26	.01 μ F	4-22		
C27	.01 μ F	5-41		
C28	.01 μ F	5-42		
C29	.01 μ F	5-44		
C30	.01 μ F	5-45		
C31	.01 μ F	5-46		
C32	.01 μ F	5-47		
C33	100 pF	5-49		
C34	.01 μ F	5-48		
C35	.01 μ F	5-43		
C36	10 μ F el.	5-40		
C37	62 pF	5-59		7-pole transmit low pass filter
C38	120 pF	5-60		" " " "
C39	120 pF	5-61		" " " "
C40	47 pF	5-62		" " " "
C41	10-60 pF		23268	trimmer, tunes 50 MHz $\frac{1}{4}$ -wave section

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
C42	.01 μ F	3-26a		
C43	47 pF	3-27		
C44	.001 μ F	3-26b		
C45	47 pF	3-28		
C46	100 pF	3-29		
C47	.001 μ F	3-48		requires ferrite bead (FB3)
C48	.01 μ F	3-44		
C49	.01 μ F	3-45		
C50	100 pF	3-46		
C51	47 pF	3-47		
C52	.001 μ F	1-9		
C53	10 pF	1-7		
C54	33 pF	1-8		
C55	3 pF	1-14		
C56	.001 μ F	1-19		
C57	33 pF	1-15		94 MHz oscillator low pass filter
C58	33 pF	1-18		" "
C59	.001 μ F	1-10		
C60	.01 μ F	3-11		
C61	470 μ F elec.	1-52		+12V input filtering

■ DIODES

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
D1	1N4148	2-1		RF voltage rectifier/doubler with D2
D2	1N4148	2-2		RF voltage rectifier/doubler with D1
D3	1N4148	3-3		RF voltage rectifier/doubler with D4
D4	1N4148	3-4		RF voltage rectifier/doubler with D3
D5	1N4148	3-5		
D6	1N4148	3-6		
D7	1N757A	1-13	28012	9.1 volt zener regulation of oscillator
D8	1SS135	1-47	28056	PIN diode
D9	"	1-48	"	"
D10	"	1-49	"	"
D11	"	1-50	"	"
D12	1N4148	1-29		diode mixer with T1,T2
D13	"	1-30		" "
D14	"	1-31		" "
D15	"	1-32		" "
D16	1N4007	5-13	28043	temperature compensate bias for Q11
D17	1N4007	5-16	"	temperature " " for Q12,13
D18	1N4007	5-15	"	" " " "
D19	1N4007	3-32	28043	isolates receive input during transmit
D20	BA482	3-51	28056	"
LED1	mini LED	7-18	28024	DC voltage indicator

■ INDUCTORS

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
L1	2.2 μ H	3-14a	21116	
L2	.05 μ H	3-17	21182	
L3	2.2 μ H	3-23	21116	
L4	2.2 μ H	3-14b	"	
L5	2.2 μ H	1-37	"	
L6	4.7 μ H	4-6	21120	
L7	4.7 μ H	1-51	"	
L8	.25 μ H	4-8	21059	50 MHz post-mixer transmit filter
L9	.25 μ H	4-9	"	" " "
L10	.25 μ H	4-10	"	" " "
L11	4.7 μ H	5-36	21120	
L12	ferrite choke	5-34	21179	wideband 6-hole balun
L13	ferrite choke	5-35	21179	wideband 6-hole balun
L14	5 turns #18	5-64	46076	transmit low pass filter
L15	"	5-65	"	" "
L16	"	5-66	"	" "
L17	6 turns #18	3-33,35	46076	forms $\frac{1}{4}$ -wave section with C43
L18	4.7 μ H	3-36a	21120	
L19	.25 μ H	3-37	21059	
L20	.25 μ H	3-39	"	
L21	4.7 μ H	3-36b	21120	
L22	.47 μ H	1-11	21108	
L23	.12 μ H	1-12	21180	94 MHz oscillator adjust
L24	2.2 μ H	1-23	21116	
L25	.15 μ H	1-24	21102	
FB1	ferrite bead		21027	on base of Q6 oscillator
FB2	ferrite bead		21090	on gate of Q5 FET
FB3	ferrite bead		"	on ground side of C47
FB4	ferrite bead		"	on gate of Q8 FET
T1	Trifilar balun	1-33,34	21153	diode mixer with D12-D15
T2	Trifilar balun	1-33,35	21153	" " "
T3	Bifilar balun	4-33	21152	
T4	RF transformer	5-17	85412	Steps 5-17 — 5-29
T5	RF transformer	5-17	"	Steps 5-17, 5-30 — 5-33

YOUR CIRCUIT NOTES

■ TRANSISTORS

Ref.	Description	Step No.	Part No.	Circuit Notes, if any:
Q1	2N4124	2-7	25258	Switch, T-R control voltages
Q2	MPSW51A	2-25	25371	PNP Switch for "T" voltage
Q3	2N4124	2-9	25258	switch for Q4 base
Q4	2N5087	2-26	25001	PNP Switch for "R" voltage
Q5	J310	3-15	25115	144 MHz receive post amplifier
Q6	MPS5179	1-11	25135	94 MHz crystal oscillator
Q7	2N4124	1-26	25258	Oscillator buffer-amplifier
Q8	J310	4-14	25115	Low-level 50 MHz transmit RF
Q9	2N4124	4-32	25258	Transmit buffer-amplifier
Q10	2SC1970	5-10	25338	Transmit driver stage
Q11	2SC1971	5-11	25337	Transmit RF power amplifier
Q12	2SC1971	5-12	25337	Transmit RF power amplifier
Q13	MPSW01A	5-37	25053	Bias for Q11,Q12, adjust by R61
Q14	3SK122	3-49	25119	50 MHz receive preamp
Q15	2N5087	3-1	25107	PNP switch to control D6

YOUR CIRCUIT NOTES

■ RESISTORS

All resistors are 1/4-watt, 5% tolerance unless specified otherwise

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
R1	220, 2W	2-27	30423	50Ω 8W RF input attenuator
R2	"	2-28	"	" "
R3	"	2-29	"	" "
R4	"	2-30	"	" "
R5	3.3K	2-31		attenuator output (may be changed)
R6	47	2-32		" "
R7	10K	1-38		
R8	47K	3-10a		
R9	1K	3-8		
R10	10K	3-9		
R11	10K	3-7		
R12	10K	2-11		
R13	10K	2-10		
R14	2.2K	2-19		
R15	10K	2-20		
R16	1K	2-14		
R17	10K	2-12		
R18	1K	2-18		
R19	4.7K	2-21		
R20	1K	2-16		
R21	1K	2-17		
R22	47	3-10b		
R23	100	3-18		
R24	100	3-19		
R25	1K	1-39		
R26	100	4-2		
R27	4.7K	4-3		
R28	100	4-28		
R29	4.7K	4-29		
R30	680	4-30		
R31	1K	4-26		
R32	33	4-28		
R33	10	4-27		
R34	100	4-5		
R35	680	4-31		
R36	100	5-51		
R37	100	5-50		
R38	470	5-53		
R39	10	5-67a		
R40	10	5-67b		
R41	100	5-52		
R42	470	5-54a		
R43	1K trimmer	5-38	30618	bias adjustment, steps 6-7 to 6-12
R44	150 ½w	5-55		
R45	150 ½w	5-56		
R46	150 ½w	5-57		

All resistors are 1/4-watt, 5% tolerance unless specified otherwise

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
R47	150 $\frac{1}{2}$ w	5-58		
R48	470	3-31a		
R49	470	3-31b		
R50	47K	3-43		
R51	10K	3-42		
R52	150 $\frac{1}{4}$ w	3-41		don't mix up with R44-R48 (150, $\frac{1}{4}$ W)
R53	100	3-30		
R54	220 $\frac{1}{4}$ w	1-4		don't mix up with R1-R4
R55	10K	1-6		
R56	10K	1-5		
R57	4.7K	1-21		
R58	10K	1-16		
R59	470	1-17		
R60	100	1-22		
R61	470	5-54b		
R62	1K	1-40		current limiting for LED
R63	1K	2-16		
R-TP	1K	1-L		mounted on test plug for TP1,TP2
JMP1	"zero- Ω "	2-3		circuit board jumper (not on schematic)*
JMP2	"	2-4		" " "
JMP3	"	2-5		" " "

*may be replaced with *insulated* wire

■ OTHER COMPONENTS

Reference	Description	Step No.	Part No.	Circuit Notes, if any:
Y1	94 MHz Crystal	1-3	48204	5rd overtone 94.000 MHz oscillator
J1	SO-239	7-6	35007	transceiver input on rear chassis
J2	SO-239	7-5	"	6 meter antenna input on chassis
S1	DPDT toggle	7-12	32110	DC on-off
TP1	2-pin PC-mount	1-J	35065	L8-L10 alignment aid
TP2	2-pin PC-mount	1-K	"	Transmit bias adjustment
TP3	1/2" #22 wire	1-G		"T" voltage test point
TP4	1/2" #22 wire	1-H		"R" voltage test point
TP5	1/2" #22 wire	1-I		94 MHz frequency counter output

YOUR CIRCUIT NOTES

Antennas for the 6 Meter Band

With antenna dimension requirements being very modest, 6 Meters is an ideal band for do-it-yourself antenna projects. The ARRL *Antenna Handbook* and *Antenna Compendium* as well as CQ publications provide numerous designs. Based on your operating interests or advice received from experienced VHF operators, you probably will try several antenna projects for this band. A useful and economical first step would be a self-supporting vertical groundplane. For 50.1 MHz, this will consist of a 56" vertical radiator and four 57" radials. Or, make a simple vertical dipole with two 56" elements made of either wire or tubing. While the majority of 6 Meter enthusiasts seem to use yagi beams of 5 elements or more, the omni-directional characteristics of verticals is useful for casual operators on a budget. **And never underestimate the effectiveness of the simple horizontal dipole placed as high and in the clear as possible!**

Discovering the 6 Meter Band

The Model 1209 was designed primarily to increase the usefulness of your basic 2 meter FM equipment. If you happen to have a multi-mode 2 meter transceiver, be sure to explore the low end of the 6 meter band. Most of the interesting 6 meter CW-SSB action is found below 50.2 MHz.

When first trying out your new 6 Meter setup, assume that the band is "dead", unless you happen to live in a large metropolitan area known for regular, local 6 Meter activity. If your 2 meter HT has extra memories not needed for that band, program as many as possible for regional or even distant 6 meter repeaters.

For the casual user of 6 Meters, this band has two basic conditions: it's completely dead, or it's alive as 20 meters with your 8 watts and simple antenna sounding like a kilowatt — perhaps causing the seasoned VHF expert to wonder briefly about all reasoning that led to the tower, beam and RF power amplifier! Yes, when the band is "wide open" in a given direction, your 1209 transverter and very basic antenna will provide plenty of fast satisfaction and fun.

2M-6M FREQUENCY CONVERSION GUIDE:

144.000	=	50.000 MHz
145.000	=	51.000 MHz
146.000	=	52.000 MHz
147.000	=	53.000 MHz
148.000	=	54.000 MHz

6 Meter Repeater Offset Programming Example:

- 6 Meter Repeater Output: 53.15 MHz. Input: 52.15 MHz.
- Tune 2M rig to 147.15 to listen for repeater at 53.15 MHz.
- Select the "-" TX offset for your 2M transceiver.
- Follow your transceiver's instructions to program a nonstandard offset (i.e. not 600 KHz) of 1 MHz.

If 6 Meters is new to you, and you have a multi-mode 2 meter transceiver, and you are satisfied that your 1209 Transverter works properly, we suggest that you monitor 50.125 MHz persistently. Described by the ARRL *Repeater Directory* as the "top" of a "window" for finding SSB (and CW) DX, 50.125 MHz is the accepted gathering place for 6 Meter enthusiasts checking for band activity. If contact is established on 50.125 MHz, both stations should be prepared to QSY to continue communication, to clear the calling frequency for other users.

If you hear some 50.125 MHz activity, it becomes useful to tune down to ± 50.07 MHz to check out the numerous low-power CW propagation beacons (which also are listed in the ARRL *Repeater Directory*). If you hear a good 1W or 3W beacon signal from 500 or 2000 miles away, simple logic says that stations in that region will hear your 8W signal just fine! Don't wait — QSY to 50.130 (SSB) or 50.095 (CW) and call some crisp CQ's as if you own the place. Or, reply to the CQ's of your choice.

If your Technician license status makes you nervous about CW, don't hesitate to try out 6 Meters. Send your CQ's as slow as you wish, and you can expect replies at the speed you set. While SSB and CW "ragchewing" can become as intense on 6 Meters as on the lower bands, a simple exchange of Grid Squares, with perhaps RST and name, is very typical, since band openings can fade swiftly.

Even if your 2 meter transceiver limits you to FM operation, keep in mind that 6 meter propagation is such that simplex DX QSO's indeed happen. Monitor or call CQ on 52.525 MHz, the national FM simplex frequency.

The Bottom Line: the sound of YOUR signal will be genuinely appreciated on 6 Meters, rarely taken-for-granted or ignored as might happen on the HF bands or on 2 Meters. And if you happen to live in or operate from a "rare" grid square, you can expect to be very popular and receive many QSL cards!

6 METER BAND GUIDE	
50.000 - 50.100	CW and Propagation Beacons
50.060 - 50.080	Greatest concentration of USA Beacons
50.070	Most-used USA beacon frequency
50.100 - 50.600	SSB and AM
50.125	Best SSB/CW Monitoring/Calling Frequency (USA and DX)
50.200	National (USA) SSB Calling Frequency
50.400	AM Calling Frequency
50.600 - 51.000	Experimental modes
50.700	RTTY Calling Frequency
50.800 - 50.980	R/C channels
51.000 - 54.000	FM Simplex and Repeaters
51.700	National Packet Simplex
52.525	National FM Simplex

GENERAL NOTE on 6 Meter FM Repeater Operation:

The ARRL Repeater Directory and similar reference publications are invaluable for understanding 6 Meter Repeater systems. The most common Input/Output offset is 1 MHz, but offsets of 500 KHz and 600 KHz are found in densely populated areas. Non-standard splits such as 1.1 or 1.7 MHz are also used. Some repeaters have a 6 meter output but with a 2 meter or 1.25 meter input. Regional repeater coordinators may have certain operating protocols (do's and don'ts!) which you should learn. **Remember that splits or offsets are a function of your 2 meter transceiver, not the Model 1209 transverter.**

Troubleshooting Guide

This transverter is designed to work as specified if the right parts are selected and installed correctly and all connections are made as explained in this manual. A number of units were test-built by different people and used extensively on the air before the kit was released for sale. The #1 cause of problems in most kit projects is exactly what we tend to take for granted: *a mistake or broken wire in the connection of external items to the circuit board*, such as DC power, antenna, switch and so forth. After that comes a mistake on the board itself, such as:

- ☐ Incorrect part value
- ☐ Reversed orientation of diode or transistor
- ☐ Bad solder connection (cold joint or bridge)

Model 1209 Service Tips:

If there is a very sudden loss of transmit power, be sure to check the output from the 2 meter transceiver.

If erratic or unusual phenomena occur, such as unusual out-of-band frequency counter readings, sudden new RFI/TVI, or other indications of spurious oscillation, an easy and important first test is to recheck the T and R voltages at test points TP3 and TP4. If there is "R" voltage present at TP4 during transmit, spurious emissions could result. Similarly, the presence of "T" voltage at TP3 while in receive mode could result in deteriorated receive performance.

To be candid with you, the only problems we noticed in the test-built prototypes were minor construction mistakes with major consequences. For example: missing any of the "via" connections from the top ground plane, or failure to follow the explicit directions for insulating Q10 from the heatsink .

T-KIT Model 1209

Service Notes

Date **Detail:**

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Operating & Design Considerations

The guiding purpose in designing the 1209 transverter was to help the broadest possible group of radio amateurs add 6 Meter FM capability to today's commonplace 2 meter transceivers — *AFFORDABLY, and in compliance with FCC Technical standards.* This design meets our goals, but we truly understand that there still are situations where it will not "plug 'n play" in the way you might hope.

While it was feasible to include internal 6M-HF antenna switching in the Model 1208 transverter, any such switching between 2 meters and 6 meter Model 1209 operation should be done externally, either with VHF-grade coax switches or by simply connecting a PL259-to-BNC 50-ohm jumper cable from the Model 1209 to the BNC antenna connector of your HT.

The value of resistor R5 (3300 ohms) can be changed to permit some flexibility in the 144 MHz RF level required at the transverter input. Following is a general guide using standard resistor values:

Power (watts)	Value of R5 (ohms)
0.25	820
0.5	1200
1.0	1500
2.5	2700
5.0	3300
8.0	3900
10*	4700 *

* 10 watts input with R5 changed to 4700 is acceptable for short CW or SSB transmissions but is not recommended for prolonged key-down situations such as FM operation. Some experimenting with resistance values may be needed: excess RF to the mixer will cause nonlinearity (SSB distortion).

Conclusion

TEN-TEC is known best for our high-performance Omni VI and Paragon II HF transceivers, along with the budget-friendly go-anywhere "Scout" series. However your T-KIT Model 1209 6 meter Transverter design is backed by our solid history in VHF products. Recently, we designed and manufactured a complete amateur Satellite Station, with a 435 MHz CW-SSB transmitter plus 145 MHz to 29 MHz receiver conversion. Long before founding TEN-TEC in 1969, our Chairman (Al Kahn, K4FW) had merged the entire line of those classic, smooth-tuning RME VHF products into his Electro-Voice corporation. Throughout the 1980's, our USA-made full-feature 2 meter HT was a solid favorite until we bowed out of the costly competition with imported handhelds. And, you'll be very impressed with the T-KIT Model 1220 microprocessor-controlled 2 Meter Transceiver, as well as the Model 1260 for 6 Meters.

You get the T-KIT 1209 Transverter at a great price because, well, our gang here happens to LIKE 6 Meters — and we hope to meet you on the air soon!

To try the excitement of 6 Meter SSB-CW economically with your HF transceiver, consider building the T-KIT Model 1208 Transverter (20 meters to 6 meters).

THANKS for your interest in T-KIT by TEN-TEC!

T-KIT

T-KIT Model 1209 Transverter Specifications and Operating Requirements

Transmit RF input: 5 watts* nominal, 144 to 148 MHz,
for 50 to 52 MHz output.

* may be varied from .25 to 10 watts by changing value of R5.

Internal Attenuator: up to 8 watts continuous, 10 watts light duty.

Transmit RF output: 8 watts typical, 50-54 MHz.

144 MHz Input/Output Impedance: 50 ohms

50 MHz Input/Output Impedance: 50 ohms

Local Oscillator: 94.000 MHz, crystal-controlled

Mixer: double-balanced diode bridge

Receiving Range: 50 to 54 MHz converted to 144 to 148 MHz.

Receiving Sensitivity: .15 μ v typical
(over-all sensitivity depends on transceiver.)

144 MHz Feedthrough: > -75 dB.

Image Rejection: ($\approx$ 238MHz) -60 dB typical.

T-R Switching: RF-sensing, solid-state

Power supply requirement: 11-14 volts DC, 4 amps

DC current drain (receive): 170 mA

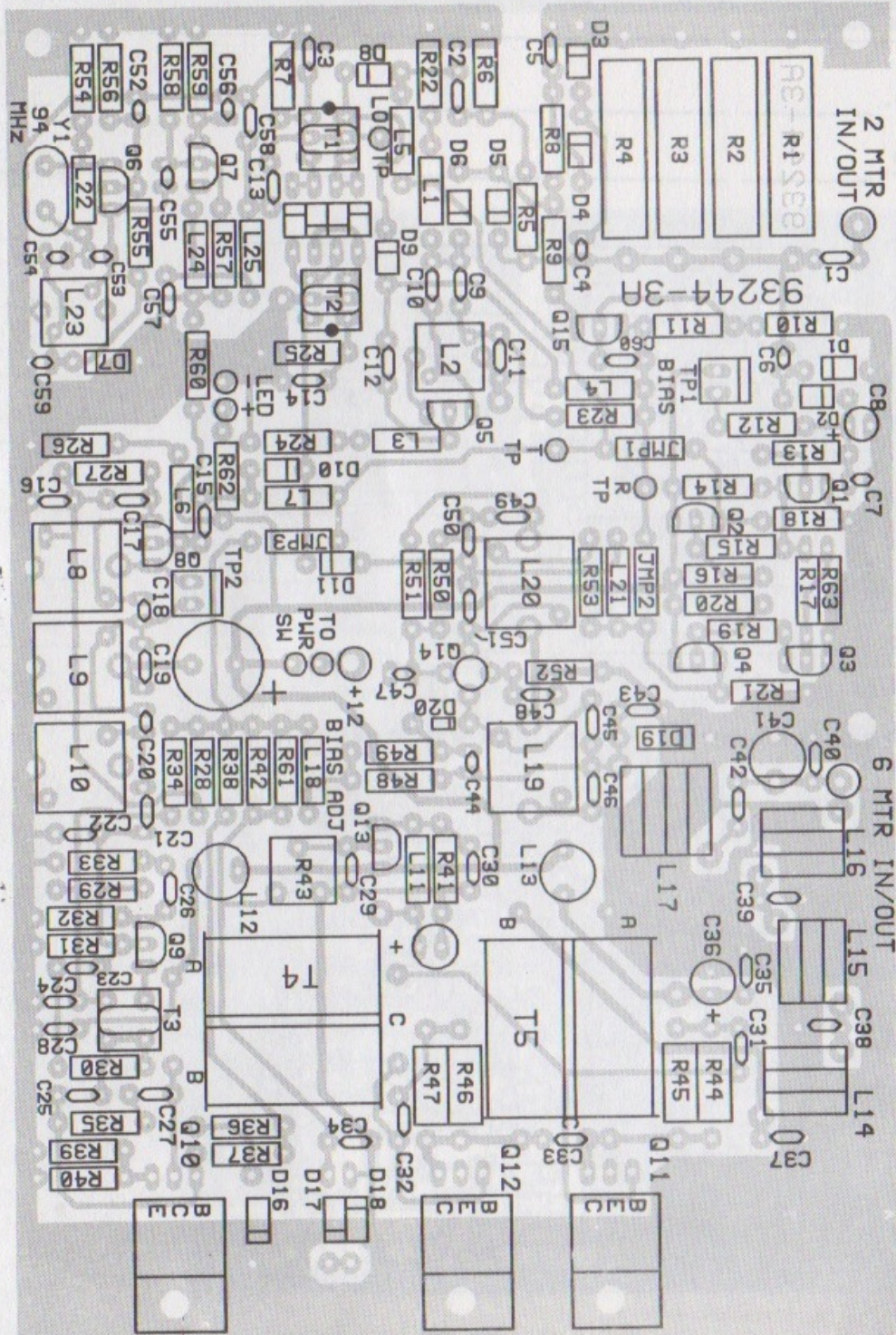
DC current requirement (transmit): 3.8 amps

Cabinet dimensions: 1-5/16"H X 7.25"W X 6-1/8"D

Weight: 2.5 pounds

X-RAY VIEW OF SOLDER-SIDE TRACES

This depiction of the 1209 circuit board shows the solder-side traces in relationship to the parts legend silkscreened on the board, but without the top groundplane. An enlarged 2-color X-Ray View including the groundplane is printed separately.



T-KIT Model 1209 6 Meter Transverter 6 Meter to 2 Meter Conversion Log

6M Output (Repeater or Simplex)	6M Input (TX offset)	TX Offset in $\pm$ MHz	2M Main Freq (Repeater output or Simplex)	2M TX Offset Frequency
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
5. _____	_____	_____	_____	_____
6. _____	_____	_____	_____	_____
7. _____	_____	_____	_____	_____
8. _____	_____	_____	_____	_____
9. _____	_____	_____	_____	_____

Your 6 Meter/2 Meter Conversion Notes:

T-KIT

T-KIT Model 1209 6 Meter Transverter

Circuit Board X-Ray View

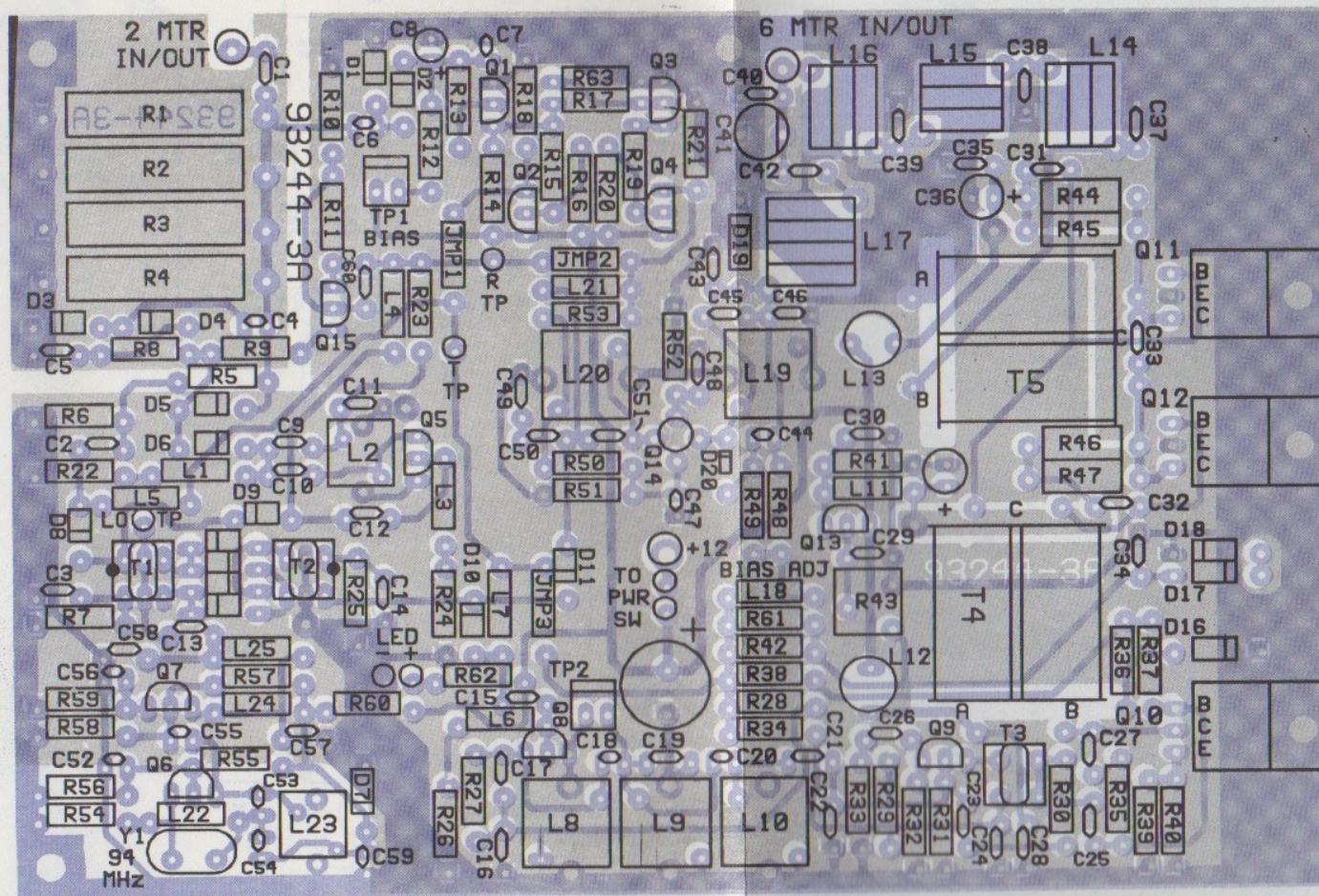
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Solder-side traces and pads



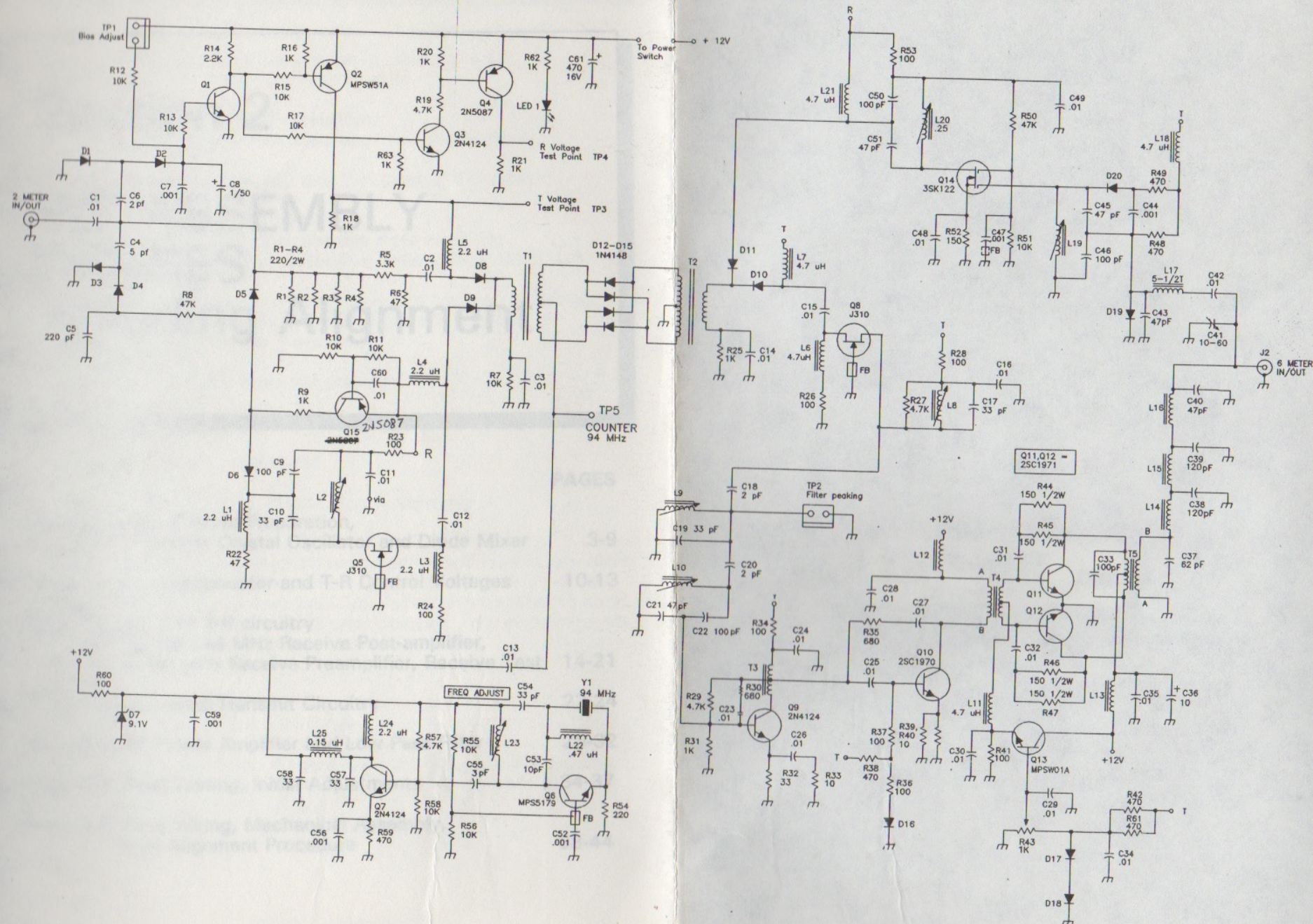
Component side groundplane



TOKIT

Schematic Diagram T-KIT Model 1209 6 Meter Transverter

TOKIT



T-KIT Model 1209
6 Meter Transverter
Kit Instruction Manual

Section 2

KIT ASSEMBLY PHASES including Alignment

	PAGES
Phase 1.0. Circuit Board Preparation, 94 MHz Crystal Oscillator and Diode Mixer	3-9
Phase 2.0. Input Attenuator and T-R Control Voltages	10-13
Phase 3.0. A. Q16 T-R circuitry B. Q6 144 MHz Receive Post-amplifier, C. 50 MHz Receive Preamplifier, Receive Test	14-21
Phase 4.0. Low-level Transmit Circuitry	22-24
Phase 5.0. RF Power Amplifier and Low Pass Filter	25-32
Phase 6.0 Final Testing, Initial Adjustments	34-37
Phase 7.0 Final Wiring, Mechanical Assembly, Final Alignment Procedure	38-44

KIT CONSTRUCTION SEQUENCE

The T-KIT Model 1209 Transverter is constructed and progressively tested in these Phases:

**Phase 1.0. Circuit Board Preparation,
94 MHz Crystal Oscillator and Diode Mixer**

Phase 2.0. Input Attenuator and T-R Control Voltages

**Phase 3.0. A. Q15 T-R circuitry
B. Q5 144 MHz Receive Post-amplifier
C. Q14 50 MHz Receive Preamplifier, Receive Test**

At this point, the receiving function of the transverter works perfectly, letting you tune 6 meters with any receiver or transceiver which covers 2 meters.

Phase 4.0. Low-level Transmit Circuitry

Phase 5.0. RF Power Amplifier and Low Pass Filter

Phase 6.0 Testing, Alignment

Phase 7.0 Final Wiring, Mechanical Assembly

While the parts within each Phase could be soldered in any order convenient to you, the instruction steps provide many helpful details. Be sure to double-check your work after soldering each Phase, using the second set of check blocks. We encourage you to follow the assembly directions as published.

When we say to **"INSTALL"** a part, we mean:

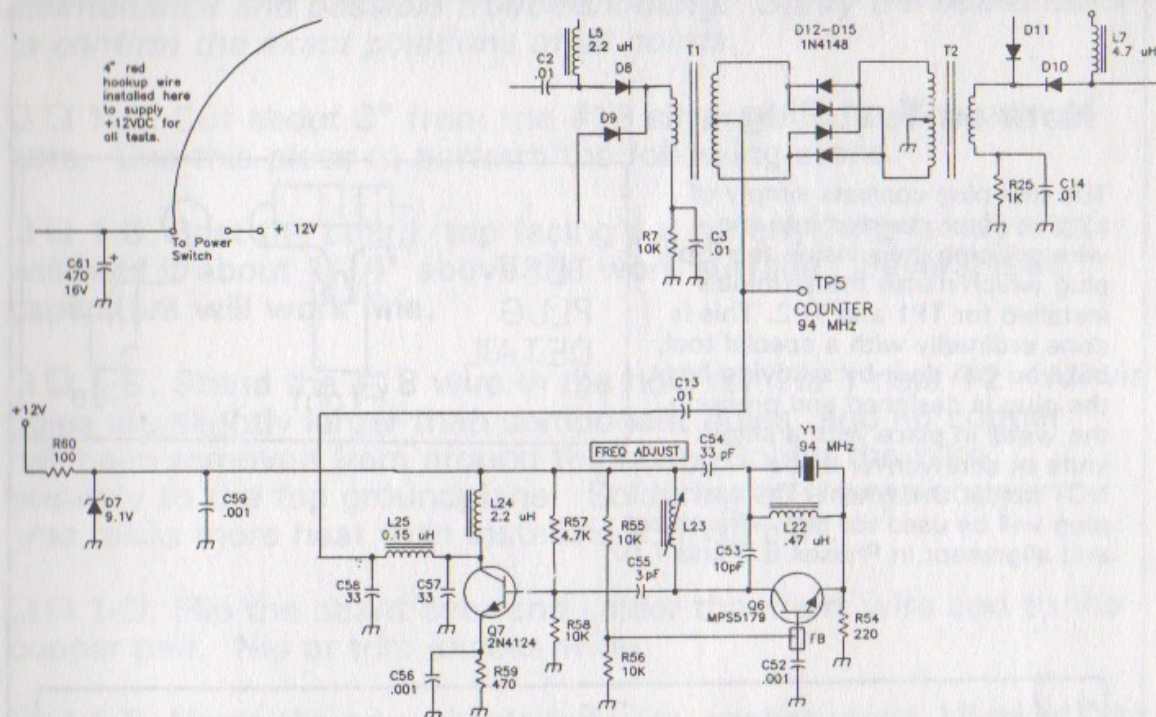
- ☐ Choose correct part value
- ☐ Insert in correct PC Board location
- ☐ Insert *correctly*, if there is a right way and wrong way such as for diodes, electrolytic capacitors, transistors etc.
- ☐ Solder all wires or pins
- ☐ Trim or "nip" excess wire lengths

A Few Do's and Don'ts:

1. If you prefer not to keep track of the three smaller ferrite beads until Phase 3.0, DO install them now with Q5, C47 and Q8, following Steps 3-15, 3-48 and 4-14.
2. If you're feeling sharp and wish to tackle the most demanding of all the assembly steps, RF transformers T4 and T5 may be installed and wound at any time per Steps 5-17 through 5-33.
3. If you wish to perform our suggested Progress Tests, DO follow our Phase by Phase assembly directions exactly.
4. After installing RF transistors Q10,Q11,Q12,
DO NOT connect DC voltage until instructed to do so.
5. Specifically, DO NOT attempt to experiment with the board in transmit mode until the heatsink has been attached to the chassis assembly.
6. DO replace the stock fuse in the DC power cord fuseholder with the 5A fuse supplied in this kit.
7. DO install all groundplane Vias and test points as explained on page 5.
8. DO use a VOM to verify resistor values if you have any doubt, or to confirm whether a color-coded part is a resistor or a molded inductor (which has negligible resistance).
9. Please DO a general reading of this manual before you begin soldering.
10. DO check the REV (revision) marked on the circuit board itself. If it is "B" or higher, be alert to any special notices which may be bound into this manual or included in your kit package.

USE ROSIN-CORE SOLDER ONLY,
of a type intended for electronic PC-board assembly.
(Available at electronics distributors or Radio Shack stores.)
DO NOT use hardware store solder, paste or flux.
Solder contains LEAD: wash hands before eating!

PHASE 1.0 Circuit Board Preparation94 MHz Crystal Oscillator and Diode Mixer

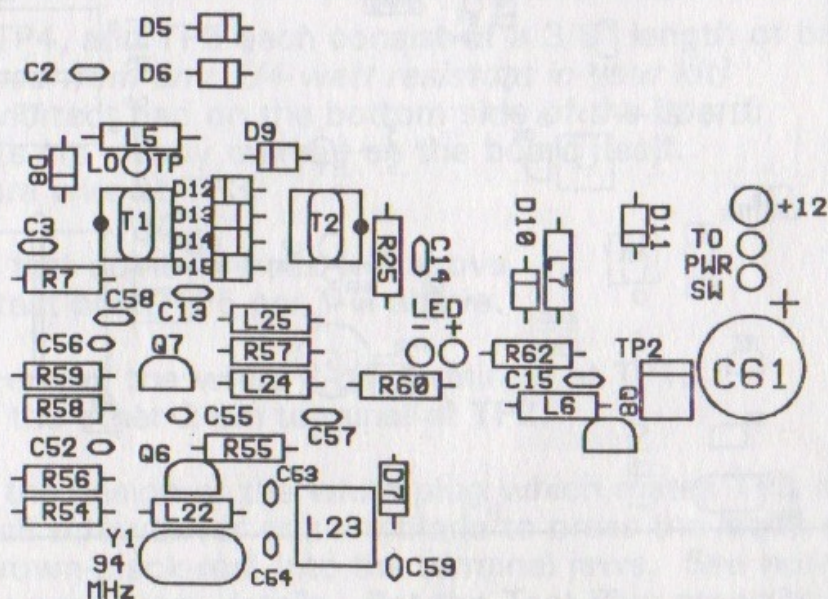


*This page presents sections from both the schematic and board layout as a help in understanding the circuit. Assembly steps in this Phase **may** call for installing some parts impractical to illustrate here because they appear in some other area of the schematic or are positioned elsewhere on the board.*

If you have Questions . . .

Please always review the complete schematic, the complete PC-board illustration, soldering steps for this Phase

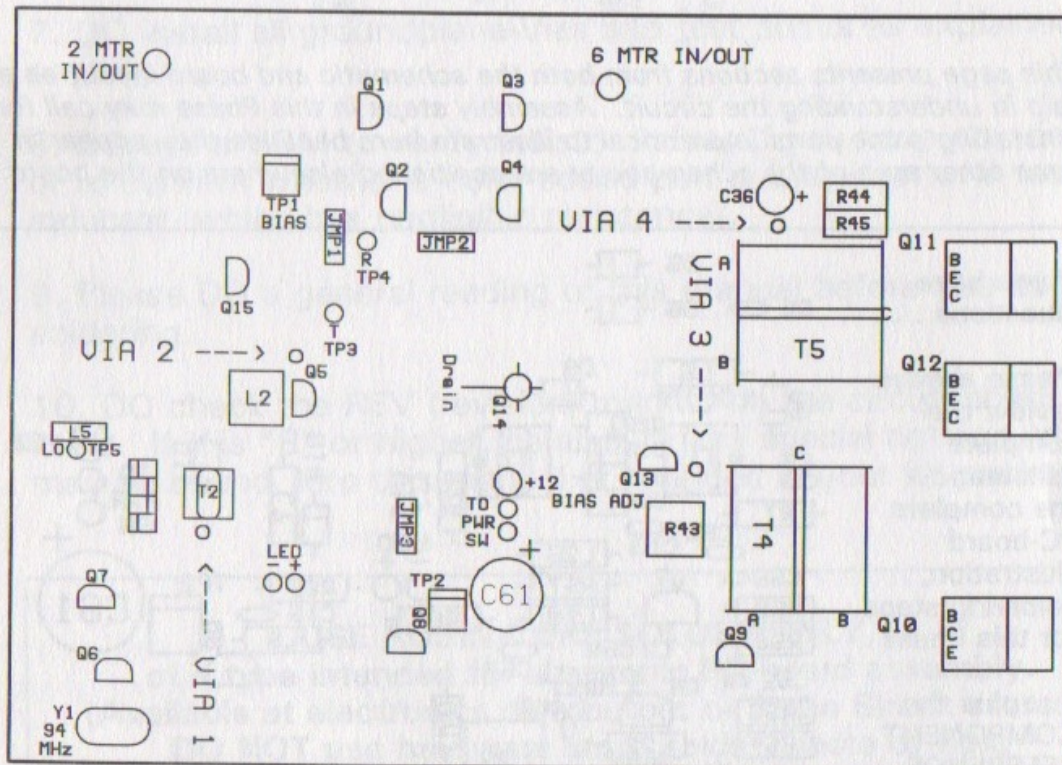
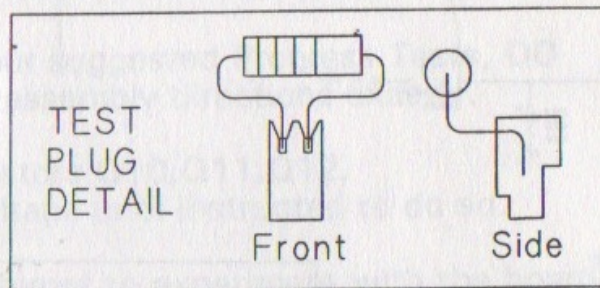
. . . plus the COMPONENT REFERENCE INDEX!



Circuit Board Preparation: Groundplane Vias and Test Points

Note on Test Plug

The test plug consists simply of a 1K resistor inserted into the wire gripping jaws inside the 2-pin plug which mates the terminals installed for TP1 and TP2. This is done ordinarily with a special tool, but you can do it by studying how the plug is designed and pressing the wires in place with a small knife or screwdriver blade — DO NOT solder the wires! The test plug will be used for bias adjustment and alignment in Phases 6.0 and 7.0.



Circuit Board Preparation Steps

The illustration on the facing page shows the approximate positions for 4 "via" holes (to connect bottom points to the top groundplane or islands) and 5 test points helpful for alignment, maintenance and possible troubleshooting. Study the board itself to confirm the exact positions of all points.

- ☐ ☐ 1-A. Cut about 3" from the #18 silver-plated coil-winding wire. Use this piece to perform the following steps.
- ☐ ☐ 1-B. Rest the board, top facing up, on anything handy that will hold it about 1/16" above the work surface. Several disc capacitors will work fine.
- ☐ ☐ 1-C. Stand the #18 wire in the hole for Via 1 near T2. All via holes are slightly larger than component holes, and no copper has been removed from around the hole. Solder the wire securely to the top groundplane. Soldering to a large copper area takes more heat than installing a small part.
- ☐ ☐ 1-D. Flip the board over and solder the short wire end to the copper pad. Nip or trim excess wire.
- ☐ ☐ 1-E. Using the now-shortened wire, repeat steps 1B, 1C, 1D to make the Via 2 connection.
- ☐ ☐ 1-F. Install Vias 3 and 4 per the preceding steps:
 - ☐ ☐ Via 3 ☐ ☐ Via 4
- ☐ ☐ 1-G. TP3, TP4, and TP5 each consist of a 3/8" length of bare #22 wire *[trimmed from any 1/4-watt resistors in your kit]* soldered to the correct pad on the bottom side of the board. These test points are clearly marked on the board itself. Install a 1/2" bare wire at TP3.
- ☐ ☐ 1-H. Install test point TP4 per 1-G above.
- ☐ ☐ 1-I. Install test point TP5 per 1-G above.
- ☐ ☐ 1-J. Install one of the white 2-pin terminals at TP1.
- ☐ ☐ 1-K. Install the other 2-pin terminal at TP2.
- ☐ ☐ 1-L. Study the design of the white plug which mates TP1 and TP2. Use a small screwdriver or knife blade to press the leads of a 1K resistor (brown-black-red) into the terminal jaws. See note on page 4 if you need more details. Set the Test Plug assembly aside for use in Phases 6.0 and 7.0.

Phase 1

94 MHz Crystal Oscillator and Diode Mixer

☐ ☐ 1-1. **Read first:** Installing transistor Q6 and ferrite bead FB1: before soldering, make sure you have correctly selected type MPS5179, that its flat side is aligned as outlined on the board, and that it is pressed in as far as it reasonably will go with the largest of the four ferrite beads on the middle (base) lead of Q6.

☐ ☐ 1-2. Install Q6 and FB1 per step 1-1.

☐ ☐ 1-3. Insert and solder Y1, the 94.000 MHz oscillator crystal. Before soldering, press the crystal casing as close to the top of the board as it can go.

Select and install the following parts:

- REV. 220A*
- ☐ ☐ 1-4. Resistor R54, 470 Ω (yellow-violet-brown).
 - ☐ ☐ 1-5. Resistor R56, 10K Ω (brown-black-orange).
 - ☐ ☐ 1-6. Resistor R55, also 10K
 - ☐ ☐ 1-7. Capacitor C53, 10 pF
 - ☐ ☐ 1-8. Capacitor C54, 33 pF (**Note:** C54 has narrower lead spacing than the other five 33 pF 1KV capacitors marked 33K.)
 - ☐ ☐ 1-9. Capacitor C52, .001 μ F (marked 102)
 - ☐ ☐ 1-10. Capacitor C59, also .001 μ F
 - ☐ ☐ 1-11. Inductor L22, .47 μ H (yellow-violet-silver-gold).

☐ ☐ 1-12a. Identify shielded coil L23. It is one of the two smaller shielded coils and has a light purple plastic body, supplied with a separate shield can (L2 has a red body and is preassembled).

☐ ☐ 1-12b. Install L23 and its shield can per step 1-12a.

☐ ☐ 1-13. Install zener diode D7 (marked 1N757A), being sure to orient its banded cathode end toward C59 per board outline. Also, solder the anode side to the top groundplane as well as to the bottom pad.

Select and install the following parts:

- ☐ ☐ 1-14. Capacitor C55, 3 pF.
- ☐ ☐ 1-15. Capacitor C57, 33 pF.
- ☐ ☐ 1-16. Resistor R58, 10K (brown-black-orange).
- ☐ ☐ 1-17. Resistor R59, 470 Ω (yellow-violet-brown).
- ☐ ☐ 1-18. Capacitor C58, 33 pF
- ☐ ☐ 1-19. Capacitor C56, .001 μ F (marked 102).
- ☐ ☐ 1-20. Capacitor C13, .01 μ F. (marked 103).

- ☐ ☐ 1-21. Resistor R57, 4.7K (yellow-violet-red).
- ☐ ☐ 1-22. Resistor R60, 100 Ω (brown-black-brown).
- ☐ ☐ 1-23. Inductor L24, 2.2 μ H (red-red-gold-gold).
- ☐ ☐ 1-24. Inductor L25, .15 μ H (brown-green-silver-gold).

☐ ☐ 1-25. Referring to Step 1-1 as needed, install transistor Q7, type 2N4124.

☐ ☐ 1-26. *reserved*

☐ ☐ 1-27. *reserved*

The preceding steps have completed the 94 MHz crystal oscillator and buffer stages. While the oscillator could be tested right now, we'll proceed with installing the parts for the diode mixer and the T-R circuitry for the mixer.

☐ ☐ 1-28. Carefully separate the 5 1SS135 PIN diodes from the 10 1N4148 switching diodes. Both types have glass bodies. The PIN diodes are smaller and have a gray cathode band, while the 1N4148 diodes have a black cathode band.

Install mixer diodes D12-D15, type 1N4148, making sure to align the black cathode bands exactly as outlined on the board:

☐ ☐ 1-29. Diode D12, type 1N4148.

☐ ☐ 1-30. Diode D13, type 1N4148.

☐ ☐ 1-31. Diode D14, type 1N4148.

☐ ☐ 1-32. Diode D15, type 1N4148.

☐ ☐ 1-33. Select T1 and T2, the pre-assembled trifilar balun transformers, noting that they have SIX pins. Notice carefully which end of the plastic base has the two yellow/gold primary wires coming from the ferrite core over the base to two pins. The transformers must be installed with these primary ends furthest from D12-D15. (In other words, the ends nearest the diodes have NO wires!)

☐ ☐ 1-34. Install balun transformer T1 per 1-33.

☐ ☐ 1-35. Install balun transformer T2 per 1-33.

☐ ☐ 1-36. *reserved*

☐ ☐ 1-37. Install inductor L5, 2.2 μ H (red-red-gold-gold).

Select and install the following parts:

- REV. → 1K Ω
- ☐ ☐ 1-38. Resistor R7, 10K (brown-black-orange).
 - ☐ ☐ 1-39. Resistor R25, 1K (brown-black-red).
 - ☐ ☐ 1-40. Resistor R62, also 1K
 - ☐ ☐ 1-41. Capacitor C2, .01 μ F (marked 103).
 - ☐ ☐ 1-42. Capacitor C3, also .01 μ F.
 - ☐ ☐ 1-43. " C11, also .01 μ F.
 - ☐ ☐ 1-44. " C12, also .01 μ F.
 - ☐ ☐ 1-45. " C14, also .01 μ F.
 - ☐ ☐ 1-46. *reserved*

Referring to Step 1-28 as needed, install the following four PIN diodes, type 1SS135, being sure to orient the gray cathode bands as outlined on the board:

- ☐ ☐ 1-47. PIN diode D8, type 1SS135.
- ☐ ☐ 1-48. PIN diode D9, type 1SS135.
- ☐ ☐ 1-49. PIN diode D10, type 1SS135.
- ☐ ☐ 1-50. PIN diode D11, type 1SS135.
- ☐ ☐ 1-51. Install inductor L7, 4.7 μ H (yellow-violet-gold-gold).
- ☐ ☐ 1-52. Install C61, the large 470 μ F electrolytic capacitor with correct polarity as marked on the board. (If C61 is not specified on your board, look for its position on page 4).
- ☐ ☐ 1-53. Cut 4" lengths of red and black *stranded hookup wire, not to be confused with the solid teflon-covered red and black wires used to make T4 and T5*. (Both teflon wires are longer than the hookup wires.) Strip about 1/4" insulation from all four ends of the 4" red and black wires. These wires will serve as DC voltage entry for the several progress tests to be conducted during assembly. The red (+) wire will be connected to the DC on-off toggle switch during final assembly. The black wire (ground) will be connected to the front panel LED.
- ☐ ☐ 1-54. Solder one end of the red 4" wire to the "TO PWR SWITCH" pad nearest the large electrolytic capacitor C61.
- ☐ ☐ 1-55. Solder one end of the black 4" wire to LED (-).
- ☐ ☐ 1-56. DOUBLE CHECK your work in steps 1-1 to 1-55.

Phase 1.0

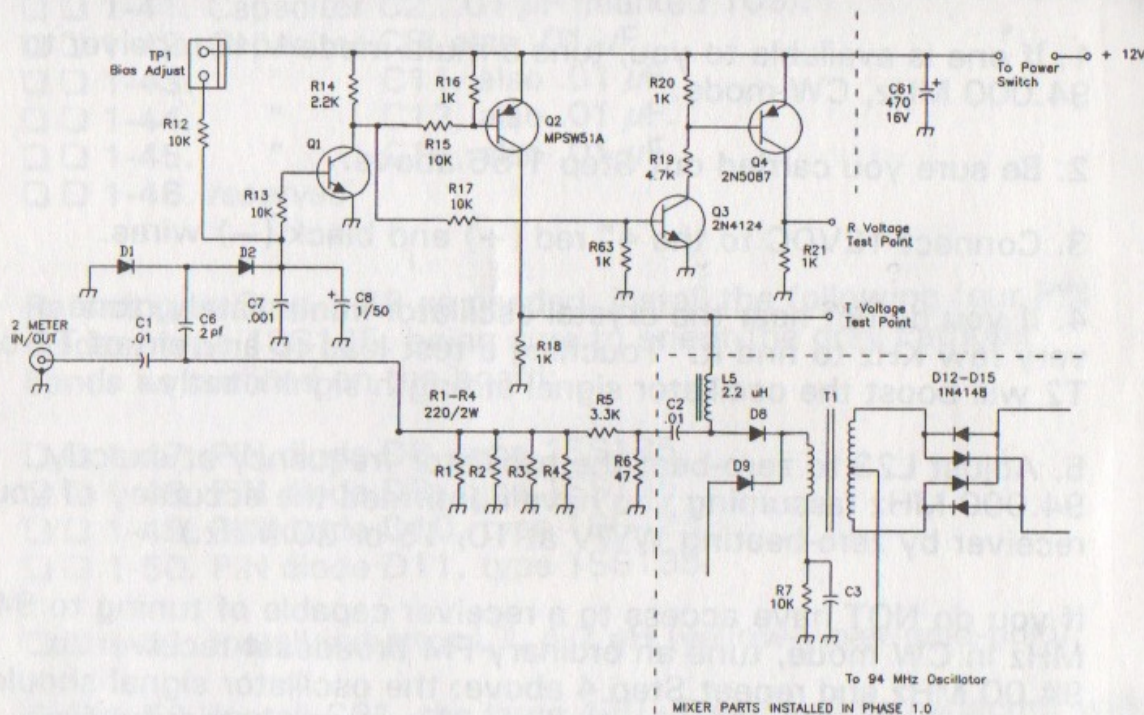
Progress Test

This test is optional but worthwhile, especially if this is your first major kit project.

1. If one is available to you, tune a multi-mode VHF receiver to 94.000 MHz, CW mode.
2. Be sure you carried out Step 1-56 above.
3. Connect 12VDC to the 4" red (+) and black (—) wires.
4. If you do not hear the crystal oscillator immediately, tune a very few KHz to find it. Touching a test lead to any pin of T1 or T2 will boost the oscillator signal strength significantly.
5. Adjust L23 to zero-beat the oscillator frequency at exactly 94.000 MHz (assuming you have confirmed the accuracy of your receiver by zero-beating WWV at 10, 15 or 20 MHz.)

If you do NOT have access to a receiver capable of tuning to 94 MHz in CW mode, tune an ordinary FM broadcast receiver to 94.00 MHz and repeat Step 4 above: the oscillator signal should cause "full quieting," as in the case of a strong carrier with no modulation. *However, adjustment of L23 will have no useful effect when checking the oscillator signal in FM mode.*

NOTE: Q6, Q7 and Y1 form a fifth overtone crystal oscillator specifically engineered to operate at 94 MHz with high attenuation of possible sub-harmonics. No meaningful signal will be found below 94 MHz. If you do hear the oscillator on a general coverage HF receiver, it is likely to be a phantom product of 94 MHz mixed with a local oscillator frequency in your radio and will be comparatively weak.

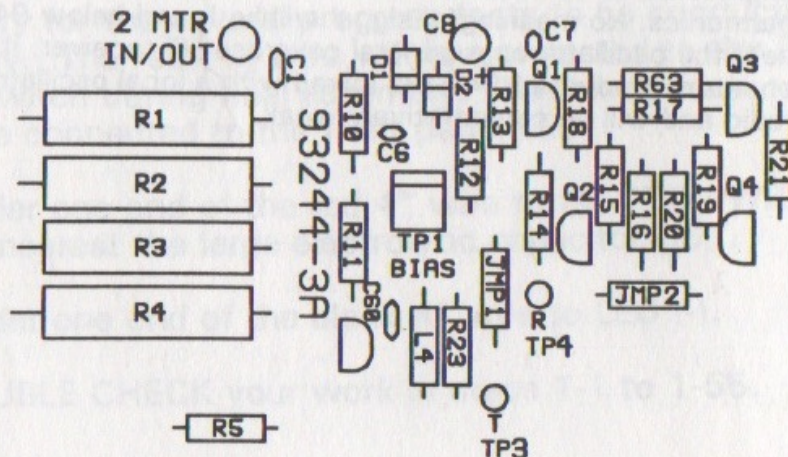


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**If you have
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**Please always
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illustration,
soldering steps
for this Phase**

**... plus the
COMPONENT
REFERENCE
INDEX!**



Phase 2.0

T-R Voltage Control, RF Input Attenuator

☐ ☐ 2-1. Referring to step 1-28 if needed, install diode D1, type 1N4148, orienting the banded cathode end per board outline.

☐ ☐ 2-2. Install D2, also type 1N4148, per step 2-1.

☐ ☐ 2-3. Install JMP1, a zero-ohm jumper (one black band on resistor-style body.) NOTE: jumpers JMP1-JMP3 are outlined on the board but do not appear on the schematic.

☐ ☐ 2-4. Install JMP2 per step 2-3.

☐ ☐ 2-5. Install JMP3 per step 2-3.

☐ ☐ 2-6. reserved

☐ ☐ 2-7. Install Q1, NPN transistor type 2N4124. Make sure the flat side is oriented as outlined on the board.

☐ ☐ 2-8. reserved

☐ ☐ 2-9. Install Q3, also type 2N4124, per step 2-7.

Select and install the following parts:

☐ ☐ 2-10. Resistor R13, 10K (brown-black-orange).

☐ ☐ 2-11. " R12, also 10K.

☐ ☐ 2-12. " R17, also 10K.

☐ ☐ 2-13. reserved

☐ ☐ 2-14. Resistor R16, 1K (brown-black-red).

☐ ☐ 2-15. " R20, also 1K.

☐ ☐ 2-16. " R63, also 1K.

☐ ☐ 2-17. " R21, also 1K.

☐ ☐ 2-18. " R18, also 1K.

☐ ☐ 2-19. Resistor R14, 2.2K (red-red-red).

☐ ☐ 2-20. " R15, 10K (brown-black-orange). *REPL. 6.8K Ω*

☐ ☐ 2-21. " R19, 4.7K (yellow-violet-red)..

☐ ☐ 2-22. Capacitor C1, .01 μ F (marked 103).

☐ ☐ 2-23. " C6, 2 pF.

☐ ☐ 2-24. Install C8, 1 μ F electrolytic, being sure its (+) side is oriented as outlined on the board. The negative side is marked by the dark band on the capacitor itself.

□ □ 2-25. Install PNP transistor Q2, type MPSW51A, with its flat side oriented as outlined on the board.

□ □ 2-26. Install PNP transistor Q4, type 2N5087, with its flat side oriented as outlined on the board.

To make the RF attenuator circuit, install these six resistors:

□ □ 2-27. Resistor R1, 220Ω, 2 watts (red-red-brown).

□ □ 2-28. " R2, also 220Ω, 2 watts.

□ □ 2-29. " R3, also 220Ω, 2 watts.

□ □ 2-30. " R4, also 220Ω, 2 watts.

□ □ 2-31. " R5, 3.3K (orange-orange-red).

□ □ 2-32. " R6, 47Ω (yellow-violet-black).

□ □ 2-33. Install C7, .001 μF (marked 102).

□ □ 2-34. Solder the ground ends of R1-R4 to the top groundplane.

□ □ 2-35. Solder a 1" length of the #18 silver-plated wire to the pad marked "2 MTR IN/OUT."

□ □ 2-36a. Examine both sides of the board corner where you installed R1-R4, C1, D4 and other components. Notice that the top groundplane and the bottom ground traces are completely isolated from other grounds on both sides of the board. To eliminate spurious emissions, the proper grounding of this 144 MHz input area will be accomplished in the final assembly phase when a 1/2" wire is soldered from a solder lug in the input coax connector to the top groundplane, and the board is mounted to the chassis. However a simple electrical ground is required for your Model 1209 Progress Tests. To do this, simply solder a scrap of bare wire as a temporary jumper from the isolated input groundplane to the main top groundplane. This may be done near C1 or near C5.

□ □ 2-36b. Install a temporary grounding jumper from the 144 MHz input area groundplane to the main top groundplane as explained in 2-36a.

Phase 2.0 Progress Test

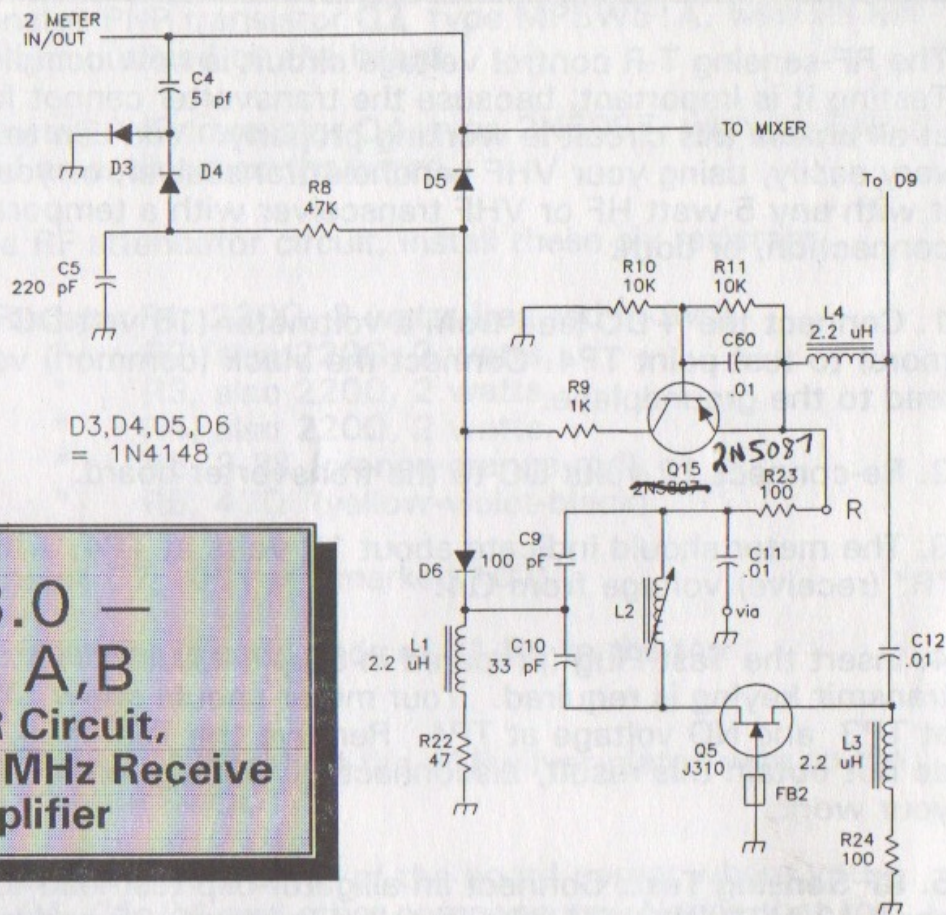
The RF-sensing T-R control voltage circuit is now complete. Testing it is important, because the transverter cannot function at all unless this circuit is working properly. You can test it now very easily, using your VHF handheld transceiver, or you can test it with any 5-watt HF or VHF transceiver with a temporary coax connection, or both.

1. Connect the +DC lead from a voltmeter (15 volt DC scale, or more) to test point TP4. Connect the black (common) voltmeter lead to the groundplane.
2. Re-connect 12 volts DC to the transverter board.
3. The meter should indicate about 12 volts at TP4, which is the "R" (receive) voltage from Q4.
4. Insert the Test Plug (prepared in Step 1-L) onto TP1. NO transmit keying is required. Your meter should show "T" voltage at TP3 and NO voltage at TP4. Remove the Test Plug. (If you do not obtain this result, disconnect DC voltage and re-check your work.
5. **RF Sensing Test:** Connect an alligator-clip test lead to the short "2 MTR IN/OUT" wire installed in step 2-35 and loop at least 10-12 turns of the wire around the antenna of your HT.
6. Using an unoccupied frequency, press your HT transmit button — the R voltage should drop to 0. Use proper procedure to identify your call sign.
7. Move the voltmeter +DC lead to TP3, the "T" (transmit) voltage from Q2. There should be no voltage indicated unless you transmit with your HT.

If you do not achieve these results, you can try other ways of coupling 3-5 watts of RF to the transverter's 2 meter input. Otherwise, the test should be repeated after making a direct RF connection from your transceiver output to the transverter input. There is little point to adding more parts to the board until you can confirm that the T-R control voltages are operating properly.

The RF-sensing T-R control circuit does not care what frequency is applied to the transverter input, as long as it does not exceed 5-6 watts. So, with proper connectors or adapters, you can directly feed the output of your HT to the transverter input, or use any HF QRP rig you wish.

**PHASE 3.0 —
Parts A,B
Q15 T-R Circuit,
Q5 144 MHz Receive
Post-amplifier**

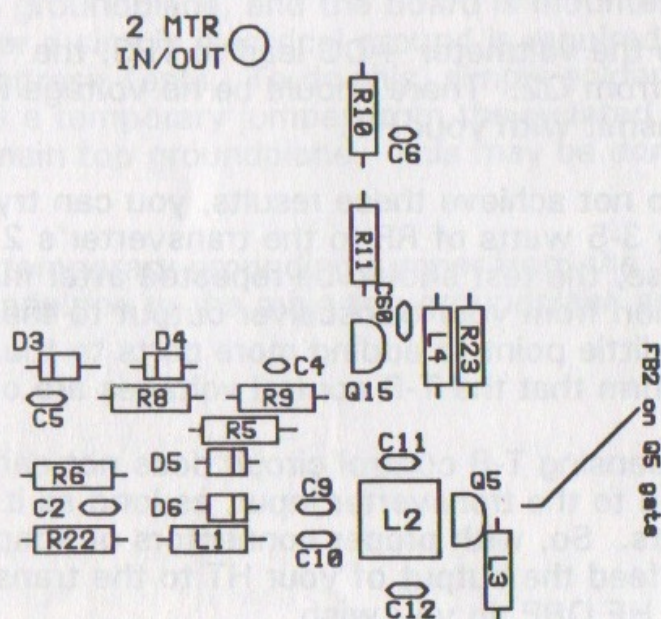


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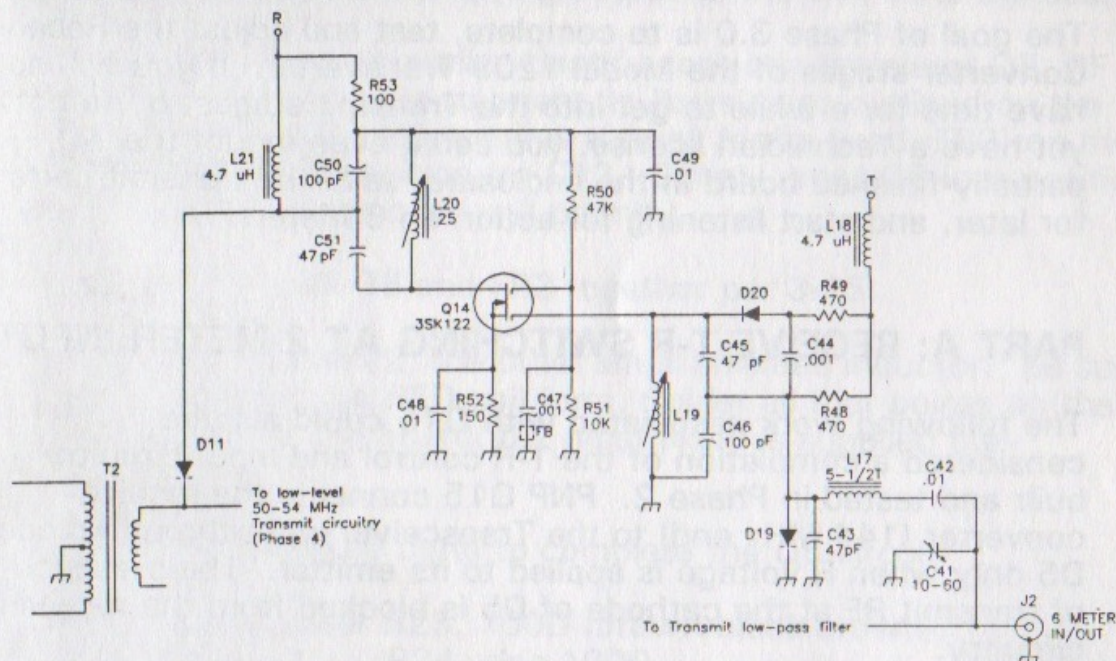
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PHASE 3.0 — Part C 50 MHz Receive RF Preamplifier

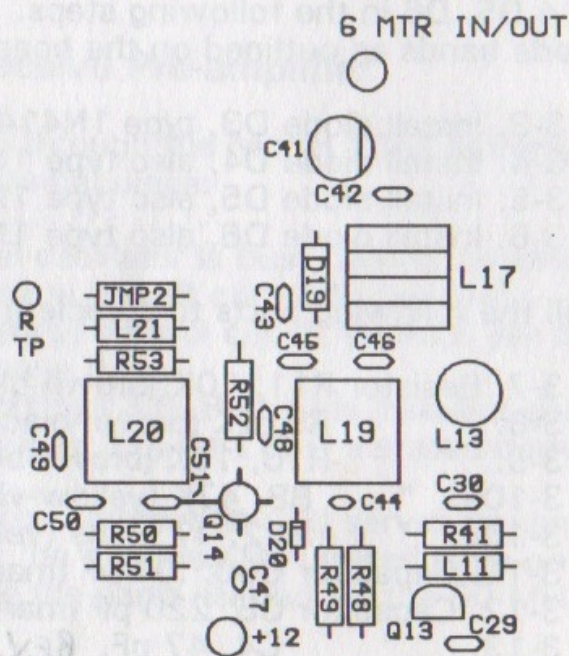


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Phase 3.0

50 MHz and 144 MHz Receiving Amplifiers

The goal of Phase 3.0 is to complete, test and adjust the Receive Converter stages of the Model 1209 Transverter. If you will not have time for a while to get into the Transmit stages, or do not yet have a Technician license, you could even mount the partially-finished board in the enclosure, save the transmit parts for later, and start listening for action on 6 Meters.

PART A: RECEIVE T-R SWITCHING AT 2-METER INPUT:

The following work associated with Q15 could also be considered a completion of the T-R control and input circuitry built and tested in Phase 2. PNP Q15 connects the receive converter (144 MHz end) to the Transceiver input through diode D5 only when R voltage is applied to its emitter. The presence of transmit RF at the cathode of D5 is blocked from the receiving circuitry.

REV. 2N5087

☐ ☐ 3-1. Correctly identify and install Q15, PNP transistor type ~~2N5807~~. Before soldering, be sure its flat side is oriented as outlined on the board.

☐ ☐ 3-2. Review step 1-28, if necessary, before installing diodes D3, D4, D5, D6 in the following steps. Be sure to align the cathode bands as outlined on the board.

☐ ☐ 3-3. Install diode D3, type 1N4148.

☐ ☐ 3-4. Install diode D4, also type 1N4148.

☐ ☐ 3-5. Install diode D5, also type 1N4148.

☐ ☐ 3-6. Install diode D6, also type 1N4148.

Install the following parts to complete the Q15 circuit:

☐ ☐ 3-7. Resistor R11, 10K (brown-black-orange).

☐ ☐ 3-8. " R9, 1K (brown-black-red).

☐ ☐ 3-9. " R10, 10K (brown-black-orange).

☐ ☐ 3-10a. " R8, 47K (yellow-violet-orange).

☐ ☐ 3-10b. " R22, 47 ohms (yellow-violet-black).

☐ ☐ 3-11. Capacitor C60, .01 μ F (marked 103).

☐ ☐ 3-12. Capacitor C5, 220 pF (marked 221).

☐ ☐ 3-13. " C4, 47 pF. REV. 5 pF.

☐ ☐ 3-14a. RF choke L1, 2.2 μ H (red-red-gold-gold).

☐ ☐ 3-14b. RF choke L4, 2.2 μ H (red-red-gold-gold).

PART B: 144 MHz Post-Amplifier

With the Q15 T-R switching circuit completed, only a few components are needed to build the Q5 amplifier stage between T1 of the mixer and receiving output to the 144 MHz transceiver.

☐ ☐ 3-15. **Read carefully:** Identify correctly transistor Q5, RF FET type J310, being sure to orient its flat side as outlined on the board. Important: Q5 requires a small ferrite bead (FB2) on the lead nearest the position for C12. Simply press Q5 into position as far down as the bead will permit.

☐ ☐ 3-16. Install Q5 and FB2 together per 3-15.

☐ ☐ 3-17. Install L2, the other small shielded inductor. Be sure it is the one with the RED coil form. Solder all four points on the bottom side of the board. (L2 most likely is supplied pre-assembled.)

Install the following parts to complete the Q5 circuit:

☐ ☐ 3-18. Resistor R23, 100 Ω (brown-black-brown).

☐ ☐ 3-19. " R24, also 100 Ω

☐ ☐ 3-20a. Capacitor C11, .01 μ F (marked 103).

☐ ☐ 3-20b. Capacitor C12, .01 μ F

☐ ☐ 3-21. Capacitor C10, 33 pF

☐ ☐ 3-22. " C9, 100 pF (marked 101).

☐ ☐ 3-23. Inductor L3, 2.2 μ H (red-red-gold-gold).

REV. DONE
AT STEP 1-43/44

PART C: 50 MHz Receive Pre-amplifier

We are moving forward through the Model 1209 schematic diagram with these understandings:

☐ ☐ The 94 MHz crystal oscillator is built, tested, working.

☐ ☐ The T1-T2 mixer stage is built correctly, isn't it!

☐ ☐ The Q1-Q4 T-R voltage control circuit WORKS per the Progress Test for Phase 2.0.

☐ ☐ The Q15 circuitry (Phase 3.0, Part A) is installed correctly.

☐ ☐ The Q5 circuitry (Phase 3.0, Part B) is installed correctly.

Since the 6 meter antenna connection (J2) serves transmit as well as receive circuitry, be prepared for unfilled gaps on the board as you install only the parts needed for the 50 MHz received signal.

☐ ☐ 3-24. *reserved*

☐ ☐ 3-25. Install C41, the 10-60 pF variable trimmer, orienting its flat side as outlined on the board.

Install these parts:

☐ ☐ 3-26a. Capacitor C42, .01 μ F (marked 103).

☐ ☐ 3-26b. Capacitor C44, .001 μ F (marked 102).

☐ ☐ 3-27. " C43, 47 pF.

☐ ☐ 3-28. " C45, 47 pF.

☐ ☐ 3-29. " C46, 100 pF (marked 101).

☐ ☐ 3-30. Resistor R53, 100 Ω (brown-black-brown).

☐ ☐ 3-31a. " R48, 470 Ω (yellow-violet-brown).

☐ ☐ 3-31b. " R49, also 470 Ω

☐ ☐ 3-32. Diode D19, 1N4007, with correct cathode polarity.

☐ ☐ 3-33. **PLEASE READ:** Coil L17 in the receive circuit is similar to coils L14, L15, and L16 coming up in the transmit low pass filter. L17 looks like 6 complete turns, while L14-16 look like 5 turns of the #18 silver-plated wire supplied in your kit, wound on the handle of a standard X-acto hobby knife handle (.313" dia.) or 3/8" machine bolt. If winding coils is new to you, the threads on the 3/8" bolt will help considerably with the even spacing desirable in the coils. Wind the turns **TIGHTLY** on the bolt so that it is necessary to "unscrew" the coil from the bolt as if it were a nut.

[Technically, L17 is 5.5 turns and the other coils are 4.5 turns.]

L17 is wound correctly if you count 6 turns when viewing the top or sides, and 5 turns between the two mounting legs. For ease of installation, allow at least 1/2" for each leg. If necessary, make a practice coil with scrap to make sure that the legs align correctly with the holes in the board, because there is a right and a wrong winding direction.

At this point, you have a choice of winding and installing L17 only, or preparing all four coils. You will be referred back to this section when it is time to install the transmit coils.

☐ ☐ 3-34. Wind L17, SIX TURNS, per 3-33.

☐ ☐ 3-35. Install L17 in its marked position per step 3-33.

- ☐ ☐ 3-36a. Install L18, 4.7 μ H (yellow-violet-gold-gold).
- ☐ ☐ 3-36b. Install L21, also 4.7 μ H.

☐ ☐ 3-37. Install L19, one of the 5 adjustable .25 μ H coils for which shield cans are supplied separately. Make sure the coil base is seated squarely on the board before soldering.

☐ ☐ 3-38. Install a shield can over L19. Solder both tabs on the bottom side of the board.

☐ ☐ 3-39. Install coil L20, .25 μ H, per step 3-37.

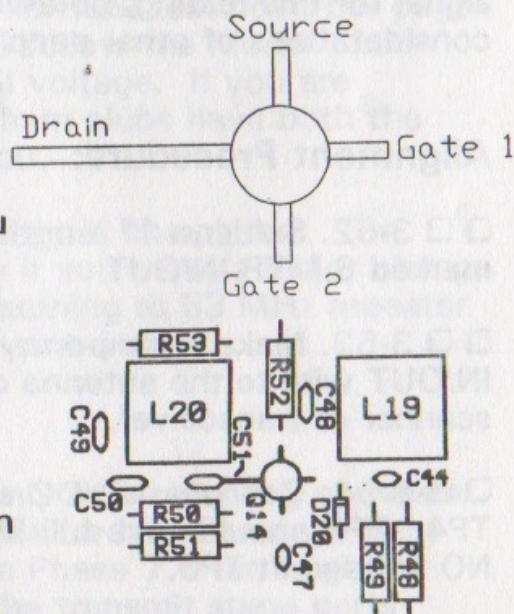
☐ ☐ 3-40. Install the shield can for L20 per step 3-38.

Install the following parts:

- ☐ ☐ 3-41. Resistor R52, 150 Ω (brown-green-brown). [$\frac{1}{4}$ -watt]
- ☐ ☐ 3-42. " R51, 10K (brown-black-orange).
- ☐ ☐ 3-43. " R50, 47K (yellow-violet-orange).
- ☐ ☐ 3-44. Capacitor C48, .01 μ F (marked 103).
- ☐ ☐ 3-45. " C49, also .01 μ F
- ☐ ☐ 3-46. " C50, 100 pF (marked 101).
- ☐ ☐ 3-47. " C51, 47 pF.

☐ ☐ 3-48. Ferrite Bead and C47: Slip the remaining small ferrite bead (FB3) over one lead of C47, .001 μ F (marked ~~103~~ ^{REV.} (102)) and install C47 with the bead nearest Q14. (The bead is between the capacitor body and the top of the board and is required to prevent possible self-oscillation of the Q14 dual gate FET.)

☐ ☐ 3-49. Examine Q15, type 3SK122, supplied on a protective backing strip. **Notice that one lead (the drain) is longer than the other three and that this drain lead is clearly outlined in Figure 3.1.** If you live in an exceptionally cold, dry climate, use MOSFET precautions in handling and installing Q15: discharge static electricity from yourself and the soldering iron. Remove Q15 from the adhesive strip and gently bend all 4 leads down to right angles for insertion in the 4 board holes. Tweezers may be helpful in the insertion process.



- ☐ ☐ 3-50. Per step 3-49 and Figure 3.1, install Q15, type 3SK122, with the longer drain lead aligned as shown.

- ☐ ☐ 3-51. Install D20, PIN diode type 1SS135 with the cathode band aligned as outlined on the board.

PHASE 3.0 PROGRESS TEST

The receiving converter is now complete and ready for testing. Basic alignment can be accomplished even without a 6 meter signal by peaking L2, C41, L19, and L20 for maximum background noise in the 144 MHz receiver (this works in CW-SSB mode *only*). However, a test signal, ideally a real 6 meter signal, makes the procedure more satisfying and convincing and is essential for proper alignment in FM mode. A good alignment frequency is mid-band at 52 MHz, or your intended main operating frequency.

Sources for a test signal include: actual 6 meter signals, RF signal generator, or a harmonic of an HF rig operated QRP into a dummy load. For example:

$$\begin{aligned} 7 \times 7.25 \text{ MHz} &= 50.750 \text{ MHz} \\ 5 \times 10.150 \text{ MHz} &= 50.750 \text{ MHz.} \end{aligned}$$

If your transceiver includes extended VHF coverage, you also can tune for 49 MHz walkie-talkie or cordless phone signals by tuning down slightly from 144.000 MHz. If using a cordless phone signal for this testing, be aware of the ethical and legal considerations of other people's right to privacy.

Alignment Procedure:

- ☐ ☐ 3-52. Solder a 1" length of the silver-plated wire to the pad marked 6 MTR IN/OUT.
- ☐ ☐ 3-53. Make a temporary coax connection between the 2 MTR IN/OUT wire to the antenna connector of your 2 Meter receiver, scanner or transceiver.
- ☐ ☐ 3-54. Connect 12VDC and use your VOM to recheck TP3 and TP4. TP4 should have full "R" DC voltage, and there should be NO voltage at TP3.
- ☐ ☐ 3-55. Tune receiver to the frequency where you expect to hear the test signal (e.g. 144.750 to hear 50.750) — or adjust the test signal frequency until you hear it in the receiver.

PROCEDURE:

☐ ☐ 3-56. Peak for maximum signal strength or quieting in this order (varying C41 has a very small effect):

☐ L2

☐ C41

☐ L19

☐ L20

If your transceiver has a signal strength indicator, peak for maximum.

Adjustment of C41 will have only a small effect on receiving, and it will be readjusted during transmit alignment.

☐ ☐ 3-57. Reduce the test signal strength to make it as weak as possible but still audible (by reducing either the output of the signal source or the receiver RF gain, or both.)

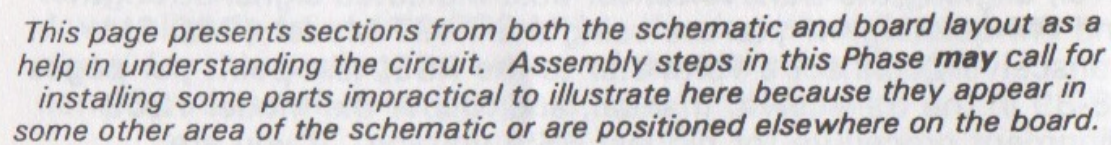
☐ ☐ 3-58. Repeat the peaking sequence done in step 3-59.

General Note on Aligning in FM Mode: The ideal test signal is a weak to moderate one (i.e. S3 to S7) over which you have full control of the signal output level. If your test signal is too strong, you will experience "full quieting" of the background noise without alignment at all. While service bench signal generators do the job well, we found hobby-type RF oscillators to be difficult to use; we had better results aligning to the 5th harmonic of 10.150 MHz from a TEN-TEC HF transceiver keyed into a dummy load, adjusting the RF Power control to a useful level, aligning the transverter for best indicated signal strength and FM quieting. If you are using the T-KIT Model 1220 2M transceiver, connect a voltmeter to the RSSI test point per pages 38-39 in the transceiver manual, and follow the Model 1209 alignment procedure for highest RSSI voltage. If you are inexperienced with alignment, most ham clubs have both the people and test equipment to help you.

The receiving function of the transverter is completed. The above adjustments are repeated only if you make a major change in band usage, such as going from listening to 53 MHz repeater outputs to 50.1 MHz CW or SSB, or vice-versa.

If you prefer to use the transverter only as a receiving converter for a while, saving the transmit phases for later, proceed to Steps 5-68 through 5-73 and then to Phase 7.0 for Final Assembly details. Be sure to store the transmit stage parts carefully.

PHASE 4.0
Low-level
50 MHz
Transmit
Circuitry

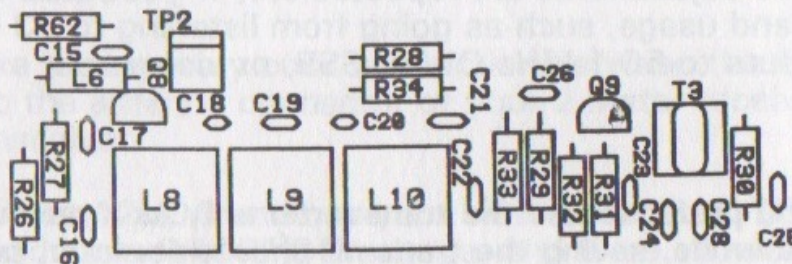


**Please always
review the
complete
schematic,
the complete
PC-board
illustration,
soldering steps
for this Phase**

If you have
Questions . . .

Please always
review the
complete
schematic,
the complete
PC-board
illustration,
soldering steps
for this Phase

. . . **plus the
COMPONENT
REFERENCE
INDEX!**



Phase 4.0

Low-level 50 MHz Transmit Circuitry

The work in this phase will take the transmit output from T2 of the mixer, amplify it and filter it (L8-L10) to remove unwanted signal products. Without this stage and proper adjustment of it, the final RF amplifier would get a confusing mess of competing signals, such as: 50 MHz (144-94), 238 MHz (144 + 94), 194 MHz (2X144-94), and other possible combinations.

Install the following parts:

- ☐ ☐ 4-1. Capacitor C15, .01 μ F (marked 103).
- ☐ ☐ 4-2. Resistor R26, 100 Ω (brown-black-brown).
- ☐ ☐ 4-3. " R27, 4.7K (yellow-violet-red).
- ☐ ☐ 4-4. " R28, 100 Ω (brown-black-brown).
- ☐ ☐ 4-5. " R34, also 100 Ω .
- ☐ ☐ 4-6. Inductor L6, 4.7 μ H (yellow-violet-gold-gold).

- ☐ ☐ 4-7. Review steps 3-37 and 3-38 before installing L8, L9, L10 and their shield cans in the following steps.

- ☐ ☐ 4-8. Install .25 μ H coil L8 per step 4-7.
- ☐ ☐ 4-9. Install .25 μ H coil L9 per step 4-7.
- ☐ ☐ 4-10. Install .25 μ H coil L10 per step 4-7.
- ☐ ☐ 4-11. Install a shield can for L8 per step 4-7.
- ☐ ☐ 4-12. Install a shield can for L9 per step 4-7.
- ☐ ☐ 4-13. Install a shield can for L10 per step 4-7.

- ☐ ☐ 4-14a. **Read First:** FET Q8, type J310, is installed with its flat side oriented as outlined on the board and with ferrite bead FB4 on the lead nearest C18's position.

- ☐ ☐ 4-14b. Install Q8 and FB4 per 4-14a.

Install the following parts:

- ☐ ☐ 4-15. Capacitor C16, .01 μ F (marked 103).
- ☐ ☐ 4-16. " C18, 2 pF.
- ☐ ☐ 4-17. " C20, 2 pF.
- ☐ ☐ 4-18. " C17, 33 pF.
- ☐ ☐ 4-19. " C19, 33 pF.
- ☐ ☐ 4-20. " C22, 100 pF (marked 101).
- ☐ ☐ 4-21. " C21, 47 pF.
- ☐ ☐ 4-22. " C26, .01 μ F (marked 103).
- ☐ ☐ 4-23. " C24, also .01 μ F.
- ☐ ☐ 4-24. " C23, also .01 μ F.
- ☐ ☐ 4-25. " C25, also .01 μ F.

- ☐ ☐ 4-26. Resistor R31, 1K (brown-black-red) [See also 4-35].
- ☐ ☐ 4-27. " R33, 10 Ω (brown-black-black).
- ☐ ☐ 4-28. " R32, 33 Ω (orange-orange-black) [See 4-35].
- ☐ ☐ 4-29. " R29, 4.7K (yellow-violet-red).
- ☐ ☐ 4-30. " R30, 680 Ω (blue-gray-brown).
- ☐ ☐ 4-31. " R35, also 680 Ω .

- ☐ ☐ 4-32. Install transistor Q9, type 2N4124, orienting its flat side as outlined on the board.

- REV. Bd. IS RIGHT*
- ☐ ☐ 4-33. Examine T3, the bifilar balun transformer similar to T1 and T2 installed in the mixer stage. Notice that two sides are identical (wide side of balun core, wires visible on plastic base), which we can call the "wire sides." The opposing sides also are identical (rounded end of balun, no wires on base). The balun may be installed with either "wire" side facing Q9.

- ☐ ☐ 4-34. Install T3 with "wire" side facing Q9, per step 4-33.

- ☐ ☐ 4-35. Notice that the ground sides of both R31 and R32 pass through holes in the top groundplane with no insulating circle removed from the copper. Solder these ends of ~~R31~~ and ~~R32~~ to the top groundplane to create additional "via" connections between top and bottom paths.

- REV. (DONE/STEP 1-51)*
- ☐ ☐ 4-36. Install L7, 4.7 μ H (yellow-violet-gold-gold).

- ☐ ☐ 4-37. Double-check all your work in Phase 4.0.

OPTIONAL Phase 4.0 PROGRESS TEST:

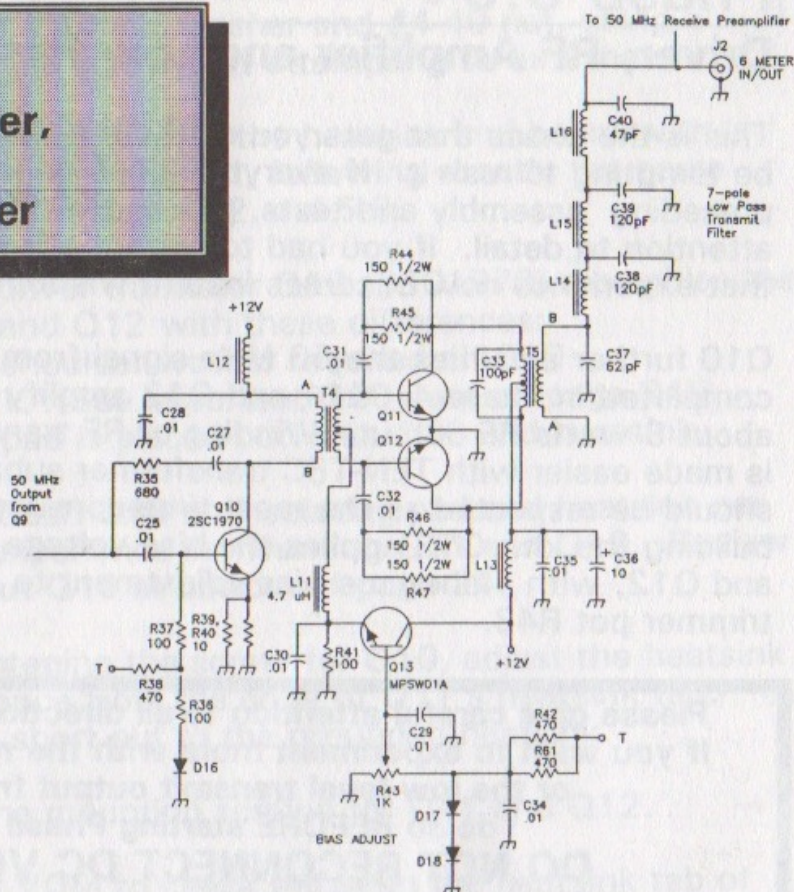
The 50 MHz "exciter" stage of the transmit section is now completed and may be tested if you have the equipment to do so conveniently, such as a receiver or scanner which covers 6 meters. It is capable of transmitting a few milliwatts of 50 MHz signal from C25. However, remember that alignment of L8, L9 and L10 are important for maximum 50 MHz output and minimum spurious emission.

A LOOK AHEAD: Important Note on Q10, Steps 5-1 to 5-10
RF driver transistor Q10, type 2SC1970, MUST be installed properly to prevent overheating damage. Study steps 5-1 through 5-10 carefully. In particular, the nylon shoulder washer MUST pass through Q10's metal tab into the heatsink hole without becoming deformed or crushed, causing poor heat dissipation from Q10 through its insulating pad to the heatsink. Q10 MUST be mounted tight against the heatsink!

PHASE 5.0

Transmit Driver, RF Amplifier, Low Pass Filter

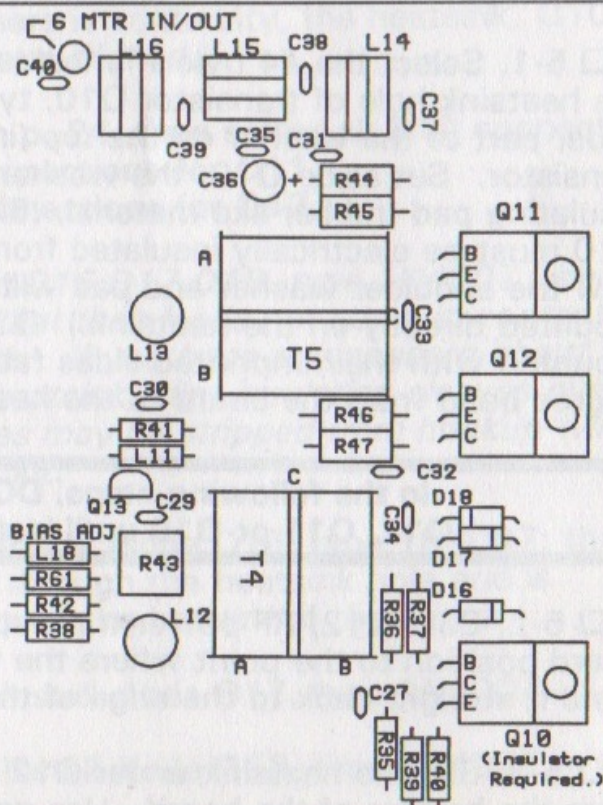
This page presents sections from both the schematic and board layout as a help in understanding the circuit. Assembly steps in this Phase may call for installing some parts impractical to illustrate here because they appear in some other area of the schematic or are positioned elsewhere on the board.



If you have
Questions . . .

Please always
review the
complete
schematic,
the complete
PC-board
illustration,
soldering steps
for this Phase

. . . plus the
COMPONENT
REFERENCE
INDEX!



Phase 5.0

Driver, RF Amplifier and Low Pass Filter

This is the phase that gets you ready to go on the air, so it can be tempting to rush it. If everything has gone smoothly in the preceding assembly and tests, proceed with the same care and attention to detail. If you had to correct a few goofs already, that experience now becomes instant wisdom.

Q10 further amplifies the 50 MHz signal from the exciter stages completed in Phase 4. Q11 and Q12 amplify Q10's output to about 8 watts RF output. Winding of RF transformers T4 and T5 is made easier with TEN-TEC transformer subassemblies but should be respected as the most time-consuming single task in building the kit. Q13 applies the bias voltage required by Q11 and Q12, with a one-time bias adjustment to be made with trimmer pot R43.

Please give careful attention to all directions in Phase 5.0. If you wish to experiment more with the receive capability or the low-level transmit output from Q10, do so BEFORE starting Phase 5.0.

DO NOT RECONNECT DC VOLTAGE
until specifically instructed to do so.

□ □ 5-1. Select the #4 nylon "shoulder washer" and place it in the heatsink hole of transistor Q10, type 2SC1970, with the wider part of the washer on the top (imprinted) side of the transistor. Set aside Q10, the washer, and also its small insulating pad (rubber-like material, .5X.75", with one hole.) Q10 must be electrically insulated from the heatsink; visualize how the shoulder washer and pad will do this. (Q11 and Q12 are mounted directly on the heatsink.) Q10, Q11 and Q12 are all mounted with their imprinted sides facing up, requiring a 90-degree bend from the board to the heatsink.

In the following steps, DO NOT SOLDER
Q12, Q11 or Q10 until instructed to do so.

□ □ 5-2. Seat Q12, RF power transistor type 2SC1971, into its board position to the point where the three leads become wider. Bend it straight back to the edge of the board.

□ □ 5-3. Slip the heatsink under Q12 and insert a #4-40 screw from the bottom of the board. Use gentle manipulation of Q12,

screw and heatsink to bring the screw through Q13's heatsink tab. Loosely attach a #4 lockwasher and #4-40 nut, using a screwdriver to turn the screw, not attempting to turn the nut.

☐ ☐ 5-4. Loosely attach Q11 to the heatsink and board with #4-40 screw, lockwasher and nut, following exactly the same procedure as for Q12 in steps 5-2 and 5-3.

☐ ☐ 5-5. Installing driver transistor Q10 (2SC1970) resembles the procedure for Q11 and Q12 with these differences:

- ☐ Insulating shoulder washer required on Q10 per Step 5-1. (**See important Q10 note on page 24!**)
- ☐ Insulating pad is placed between Q10 and heatsink.

☐ ☐ 5-6. Loosely attach Q10 on insulating pad and heatsink per step 5-5 and your experience in mounting Q11 and Q12. **Review important note about Q10 at bottom of page 24.**

☐ ☐ 5-7. While tightening the screw for Q10, adjust the heatsink for maximum clearance from the edge of Q11's heatsink tab. This tab must NOT short out to the grounded heatsink.

☐ ☐ 5-8. Tighten the mounting screws for Q11 and Q12.

☐ ☐ 5-9. Use your VOM to check between the heatsink tab of Q10 and the heatsink itself: there must be NO continuity or indicated resistance. (If there is continuity, the heatsink, Q10 and the #4-40 nut must be re-aligned.)

☐ ☐ 5-10. **Review Note on p. 24**, then solder all Q10 connections.

☐ ☐ 5-11. Solder the 3 connections for Q11.

☐ ☐ 5-12. Solder the 3 connections for Q12.

☐ ☐ 5-13. *Installing diodes D16,D17,D18, type 1N4007, requires (except for D18 cathode) that their leads not come in contact with the grounded heatsink. If you have any concern about these wires touching the heatsink, slip insulating sleeves over the bare leads. The sleeves may be stripped from hookup wire or the wire supplied in the kit.*

☐ ☐ 5-14. Per step 5-13, Install diode D16, type 1N4007: the banded cathode end goes through the heatsink hole and is soldered in the normal way on the bottom of the board.

☐ ☐ 5-15. Per step 5-13, Install diode D17, type 1N4007.

☐ ☐ 5-16. Per step 5-13, Install diode D18, type 1N4007.

✓ **IMPORTANT:**

DO NOT jump ahead and install more miscellaneous small parts before installing T4 and T5 — they will get in the way of the work required on the two RF transformers.

☐ ☐ **Detail 5-17:**

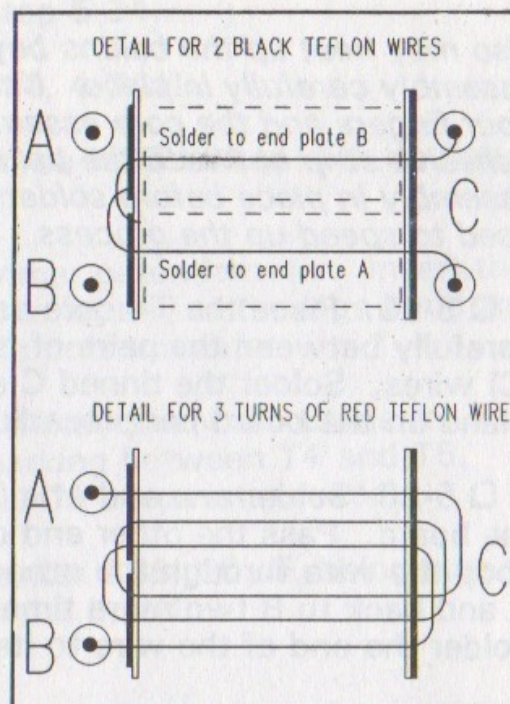
RF Transformers T4 and T5

Please study these details and Figure 5A until you have a clear idea how to assemble T4 and T5. Both transformers are constructed and installed in the same way using the red and black teflon wire.

- ☐ ☐ Examine the pre-assembled transformer core, noticing the difference in the two copperclad end plates. One has two squares around the holes, which we call "A" and "B", while the other end is copper all the way across, which we call "C."
- ☐ ☐ The A-B and C ends of T4 and T5 are outlined on the board. Both ends of the red winding exit to the board through A and B.
- ☐ ☐ The C end of each transformer is soldered to the copper island isolated from the rest of the ground plane (using the same style of solder bonds as you did for the coil shield cans.) Notice also that the A-B end of each transformer rests on the large area with all copper removed.
- ☐ ☐ Notice that the teflon insulation on the black and red wires is quite tough and that the wire is solid, not stranded. Therefore, be careful in stripping the insulation.
- ☐ ☐ The RED winding is three complete turns through both cores: the coil is correct if you see 3 turns at the C end, and 2 turns plus the wire ends at A and B.
- ☐ ☐ The BLACK winding is done in two parts. One end of a 1.75" black wire is soldered to copper pad A and passed through core hole B: the other end is soldered to its board position on the C end. Similarly, one end of another 1.75" black wire is soldered to copper pad B and passed through core hole A for soldering to the board at the C end.
- ☐ ☐ Finally, make sure that VIA ^{REV.} ~~4~~ ³ and VIA ~~5~~ ⁴ in the copper islands for the C ends of T4 and T5 have been completed per Step 1-F.

While you can carry out these T4-T5 assembly details in whatever order seems easiest to you, we believe you will find it best to solder the "C" end plate of each transformer to its copper island before doing the red wire windings (which may get in the way of making a good solder bond from the end plate to the copper island).

Figure 5A



Suggested procedure for installing T4 and T5 per Detail 5-17 and Figure 5A.

- ☐ ☐ 5-18. Cut two lengths of the red teflon wire exactly 7.75" long. Strip 1/8" insulation from each end.
- ☐ ☐ 5-19. Cut four 1.75" lengths of black teflon wire. Strip 1/8" insulation from each end.
- ☐ ☐ 5-20. Solder the circular brass flanges to the adjoining copper on both ends of one transformer cores.
- ☐ ☐ 5-21. Solder the flanges of the other core per Step 5-20.
- ☐ ☐ 5-22. Tin each end of the copper island for the "C" end of T4. Use sufficient soldering heat to flow a shiny coat of solder. (If you tin the full island area, be sure not to lose the wire soldered at Via 4.)
- ☐ ☐ 5-23. Tin the "C" island area for T5 per step 5-22.
- ☐ ☐ 5-24. Tin each edge of the C side of T4 (which should be mounted first). Remember that the "C" side is a copperclad strip with no break in the copper.

NOTE: *soldering the C side of the core assemblies to their tinned island areas on the board requires generous solder heat — which*

also may heat up the baluns beyond your tolerance to hold the assembly carefully in place. Use several layers of cloth between your fingers and the core assembly: OR, use a double-sided foam adhesive strip between the balun cores and the board to lock the assembly in place before soldering. Also, a soldering gun may be used to speed up the process.

□ □ 5-25. Place the T4 core assembly in position; align it carefully between the pairs of holes for the red (A-B) and black (C) wires. Solder the tinned C end plate edge to the tinned C island on the board per preceding explanations.

□ □ 5-26. Solder one end of a 7.75" RED wire to the A point on the board. Pass the other end completely through the A core. Loop the wire through the other core back to B. Loop it through A and back to B two more times to form the 3-turn winding. Solder the end of the wire to its board pad at B.

□ □ 5-27. Solder one end of a 1.75" black wire to a board pad at the C end and pass it completely through the core hole immediately above it. Solder the other end to the OPPOSITE square copper pad. I.e., solder the wire through core A to the B pad, and vice-versa.

□ □ 5-28. Install the other 1.75" black wire for T4 per step 5-27.

□ □ 5-29. Examine the now-completed T4 assembly. As outlined in Figure 5A, you should see 3 turns of red wire at the C end, with the red ends soldered to the board at A and B. One black wire from the board at the C end comes through the A core and is soldered to the B side of the end plate. The black wire soldered to the A side of the end plate passes through core B to its board pad at the C end.

□ □ 5-30. Solder the C end plate of the T5 core assembly in place per steps 5-24 and 5-25.

□ □ 5-31. Install the red winding for T5 per step 5-26.

□ □ 5-32. Install the two black wires for T5 per 5-27, 5-28.

□ □ 5-33. The completed T5 assembly should appear as described in step 5-29. *Congratulations* on correct assembly of T4 and T5: modern kit-building rarely is more complex than the procedures you have just completed.

□ □ 5-34. Install L12, one of the two wideband chokes pre-wound with tinned wire on a 6-hole ferrite core.

☐ ☐ 5-35. Install choke L13 per step 5-34.

☐ ☐ 5-36. Install molded choke L11, 4.7 μ H.

☐ ☐ 5-37. Install transistor Q13, type MPSW01A, with its flat side oriented as outlined on the board.

☐ ☐ 5-38. Install R43, the 1K trimmer potentiometer. Insert the device gently: be very careful not to let any of the legs bend and short against the metal base of the potentiometer.

☐ ☐ 5-39. NOTE: The circuit board *may* show an outline for an electrolytic capacitor with "+" marking between T4 and T5. This capacitor is not used in the 1209 transverter model.

☐ ☐ 5-40. Install electrolytic capacitor C36, 10 μ F, being sure to orient its (+) side as indicated on the board.

Install the following small parts; while most of the more difficult work is now finished, please select these components with care. Also, tweezers may be helpful when inserting parts in the areas crowded by RF transformers T4 and T5.

☐ ☐ 5-41. Capacitor C27, .01 μ F (marked 103).

☐ ☐ 5-42. " C28, .01 μ F.

☐ ☐ 5-43. " C35, .01 μ F.

☐ ☐ 5-44. " C29, .01 μ F.

☐ ☐ 5-45. " C30, .01 μ F.

☐ ☐ 5-46. " C31, .01 μ F.

☐ ☐ 5-47. " C32, .01 μ F.

☐ ☐ 5-48. " C34, .01 μ F.

☐ ☐ 5-49. " C33, 100 pF (marked 101).

☐ ☐ 5-50. Resistor R37, 100 Ω (brown-black-brown).

☐ ☐ 5-51. " R36, 100 Ω

☐ ☐ 5-52. " R41, 100 Ω

☐ ☐ 5-53. " R38, 470 Ω (yellow-violet-brown).

☐ ☐ 5-54a. " R42, also 470 Ω

☐ ☐ 5-54b. " R61, also 470 Ω

☐ ☐ 5-55. Resistor R44, 150 Ω , 3/4 watt (brown-green-brown).

☐ ☐ 5-56. Resistor R45, 150 Ω , 3/4 watt

☐ ☐ 5-57. Resistor R46, 150 Ω , 3/4 watt

☐ ☐ 5-58. Resistor R47, 150 Ω , 3/4 watt

Install the capacitors for the transmit low pass filter:

- ☐ ☐ 5-59. Capacitor C37, 62 pF.
- ☐ ☐ 5-60. " C38, 120 pF.
- ☐ ☐ 5-61. " C39, also 120 pF.
- ☐ ☐ 5-62. " C40 47 pF.

☐ ☐ 5-63. Refer back to step 3-33 and the preparation of L17 in the quarter wave section before the receive preamplifier. If you did not do so at that time, wind L14, L15, and L16 in exactly the same way, using 5 turns (NOT the 6 turns required only for L17) of the #18 silver-plated wire wound on an X-acto knife handle or very tightly in the grooves of a 3/8" machine bolt. Again, remember that there is a right and wrong direction for winding these coils so their "legs" match the board. If in doubt, make a practice coil with scrap wire.

- ☐ ☐ 5-64. Install 5-turn coil L14.
- ☐ ☐ 5-65. Install 5-turn coil L15.
- ☐ ☐ 5-66. Install 5-turn coil L16.

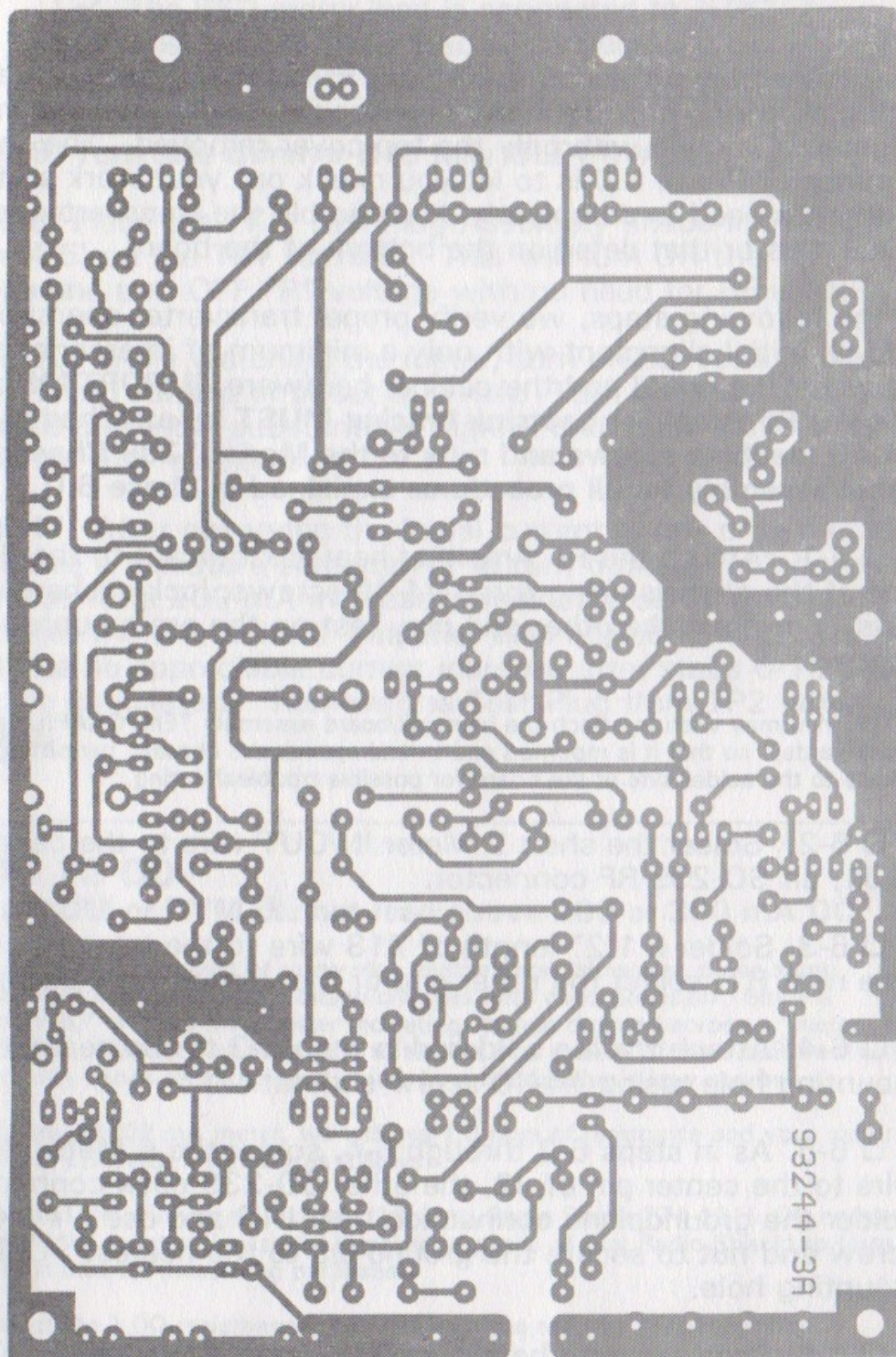
- ☐ ☐ 5-67a. Install resistor R39, 10 Ω (brown-black-black)
- ☐ ☐ 5-67b. Install resistor R40, also 10 Ω .

Important Final PC-board Assembly Steps:

- ☐ ☐ 5-68. Inspect board for possible solder bridges per bottom traces reproduced on page 33. Orient the page and the bottom of the board identically.
- ☐ ☐ 5-69. Check for wire scraps or untrimmed wires that may be lodged between solder connections.
- ☐ ☐ 5-70. Double-check all work done in Phase 5.0.
- ☐ ☐ 5-71. Prepare 3" lengths of RED and BLACK hookup wire, stripping 1/8" of insulation from one end of each.
- ☐ ☐ 5-72. Solder the RED wire to LED (+) and solder the BLACK wire to LED (-). Connection to the LED itself will be done in Phase 7.0. If you wish, twist these wires together neatly.
- ☐ ☐ 5-73. DO NOT connect 12VDC until instructed to do so.

Model 1209: CHECKING FOR SOLDER BRIDGES

The purpose of this mirror view or direct bottom view of the traces and pads is to help you confirm quickly whether any given points are intentionally joined, in which case a flow of solder between them is OK. Circuit board layout Copyright 1995 by TEN-TEC, Inc. All Rights Reserved.



PHASE 6.0

Final Tests and Initial Adjustments

You indeed have the option of going straight to Phase 7.0 and doing all wiring and mounting "for keeps," because all normal alignment is done with only the top cover removed. The sole purpose of Phase 6.0 is to let you check out your work so far without a need to completely disassemble the transverter to re-check this or that detail on the bottom of the board.

In the following steps, we verify proper transverter operation and do initial alignment with only a minimum of interconnections between the board and the cabinet hardware. **IMPORTANT: the board's RF Amplifier heatsink bracket MUST be attached by #4-40 machine screws and nuts to the Model 1209 Chassis/ Panel assembly for all procedures explained in Phase 6.0.**

☐ ☐ 6-1. Attach the RF Amplifier heatsink bracket to the drilled end of the chassis using three #4-40 screws, lockwashers and nuts. For now, the other end may rest on the pre-mounted spacers.

NOTE: You may wish to attach the heatsink/board assembly TEMPORARILY and "backwards," so that it is mounted end-to-end against the chassis, permitting easy access to the solder side of the board for possible troubleshooting.

☐ ☐ 6-2. Solder the short 2 Meter IN/OUT wire to the center pin of J1, an SO-239 RF connector.

☐ ☐ 6-3. Solder a 1/2" length of #18 wire to the top groundplane area near R1; solder the other end of the wire to a #4 solder lug.

☐ ☐ 6-4. Attach the lug soldered in Step 6-3 to the nearest J1 mounting hole, using #4-40 screw and nut.

☐ ☐ 6-5. As in steps 6-2 through 6-4, solder the 6 Meter IN/OUT wire to the center pin of J2, the other SO-239 coax connector. Solder the groundplane connection near L16 and use a #4-40 screw and nut to secure the ground lug to the nearest SO-239 mounting hole.

☐ ☐ 6-6. Organize your bench, cables, yourself and your DC power supply to be able to connect 12-15VDC to the 1209 board easily — **and SHUT IT OFF quickly if needed.**

□ 6-7. Connect a DC milliammeter (the DC MA range of a multimeter) in series with the DC power cord; the meter range should be at least 1000 mA (1 amp). (Since many VOM's have maximum ranges of 200 or 300 mA, you may need to borrow a meter — or use the Ohm's law procedure explained below.)

- ✓ The RED meter lead is connected to + DC
- ✓ The BLACK meter lead is connected to the Red wire of the DC power cord.

□ □ 6-8. Turn bias trimmer R43 fully CLOCKWISE.

□ □ 6-9. Place the 1K Ω Test Plug Assembly (made in Phase 1, pages 4-5) on the TP1 terminal. This will turn ON the "T" voltage and turn OFF "R" voltage with no need for RF input.

□ □ 6-10. While watching the meter, turn on DC voltage briefly to see an idling current of about 600 mA. Turn voltage OFF if the indicated current is substantially higher, and again make sure R43 is set fully clockwise.

□ □ 6-11. After observing the initial current in mA drawn in idling mode, use a miniature screwdriver to turn trimmer R43 *counter-clockwise* for a 200 mA increase in indicated current. Doing so completes the one-time RF amplifier Bias adjustment. There should be no appreciable current increase after steps 6-10 and 6-11 are completed. Remove the Test Plug from TP2 when finished.

WHAT TO DO

if your VOM or DVM cannot read above 200 or 300 mA DC

200 mA is a common limit of many nice multimeters. However, those same instruments can display small voltage changes with good precision. Since a "milliammeter" is really a voltmeter indicating voltage dropped across a "meter shunt" resistance, our one-time need to set the bias current of the 1209 transverter offers a nifty hands-on experience of just how handy Ohm's Law can be.

To simulate a 1000 mA meter, we will use 1.0 ohm of resistance and your meter set to read DC VOLTAGE (not mA) as follows:

1. Use one 1.0 Ω wirewound resistor (10 watt, Radio Shack 271-131). Or, connect ten 10 Ω 1/4W resistors in parallel (stocked in packs of 5 at Radio Shack) to form a 1.0 Ω resistance for measuring purposes.
2. Connect the 1.0 Ω resistance in SERIES with the red (+) DC power line.
3. Set your VOM to read DC voltage in its lowest range above 1 volt. Connect the (+) probe to the resistance end nearest to the DC voltage source. Connect the (-) probe to the resistance end nearest the transverter.

WHAT TO DO, cont.

4. Consider this result from Ohm's Law: since $1000 \text{ mA} = 1 \text{ A}$, and $R = 1.0\Omega$ and $E = IR$, then $E \text{ (voltage)} = 1 \text{ A} \times 1\Omega = 1.0 \text{ V}$. In other words, a 1000 mA current flow through the 1 ohm resistance will indicate a voltage use of 1 volt. Therefore, we can produce the following handy chart:

Current (mA)	Voltage across 1.0Ω
1000	1.0
800	0.8
600	0.6
400	0.4
200	0.2

AND: a 200 mA increase to set 1209 Transverter Bias requires simply a 0.2 VDC increase over first meter reading!

5. With the voltmeter/resistance setup connected as explained above, perform Step 6-9 to place T-R voltage control in "T." Observe the VOM voltage reading with R61 fully clockwise, and then turn R61 for an indicated increase of 0.2 VDC. This completes the bias adjustment! **As in Step 6-10, turn voltage OFF if you get an excessive initial voltage reading (above 1.0 volts) across the 1.0 ohm resistance.**

☐ ☐ 6-12. Remove the meter from the DC supply line, or change it to its 5, 10 or 20 AMP range! Also, remove the test plug.

INITIAL RF OUTPUT TEST:

☐ ☐ 6-13. Use a coax jumper cable to connect the coax jack set up in 6-5 to the 144 MHz 5-watt transceiver.

☐ ☐ 6-14. Connect an antenna suitable for 6 Meters, or a 50 ohm dummy load, through an RF wattmeter to J4.

NOTE: unless you use a wattmeter/SWR bridge which specifically includes 50 MHz in its specifications, the meter readings must be considered approximate and relative. Most any wattmeter, SWR meter or antenna tuner (with built-in bridge) for HF (1.8 - 30 MHz) will provide an adequate indication for peaking the transverter's RF output. To confirm this, we noted the following readings for a similar transverter (Model 1208) on the following devices:

TEN-TEC Lab (Bird 43, element 10W)	8.2W
MFJ 816	6W
Welz 10SPX HF-VHF meter	10W
Heathkit HM-9 QRP Wattmeter	8W
TEN-TEC 254 (20W range)	6W
TEN-TEC 254 (200W range)	8W

☐ ☐ 6-15. Move the Test Plug Assembly from TP1 to TP2. This will have the effect of making easier adjustment of L8 and L10 in the triple filter circuit between Q8 and Q10.

□ □ 6-16. Connect your VOM red lead (DC volts scale) to TP3 as you did in the first tests of the T-R control voltage circuit. (Of course, the black/common VOM lead is connected to ground.)

□ □ 6-17. Reconnect DC voltage: there should be NO significant voltage indication at TP3.

□ □ 6-18. Key your 2 Meter rig briefly: your VOM should show about 12VDC at TP3.

□ □ 6-19. Move the VOM red probe or clip to TP4 (to check "R" voltage). With DC voltage connected but no RF keyed from the transceiver, you should get the expected 12-14 VDC reading.

□ □ 6-20. Again, key the transceiver briefly: the "R" voltage being monitored at TP4 **MUST** (absolutely!) drop to 0 or under .5 VDC. (If this does not happen, you have a problem that **MUST** be straightened out before any further adjustments are useful or meaningful. Voltage applied to "R" points on the schematic during "T" mode will result in spurious emissions and/or self-oscillation of the transmit circuitry. Refer to the "Trouble-Shooting" section of this manual.)

□ □ 6-21. Assuming that step 6-20 was done successfully, key the transceiver as needed to observe the RF wattmeter. If you are using an antenna rather than a dummy load, use correct procedure to identify your callsign and purpose of transmission. Adjust L8 and L10 for maximum indicated RF output. Adjust trimmer C34, realizing that RF output changes will be very small.

□ □ 6-22. If you are seeing "respectable" RF output at this point, it's time to move to Phase 7.0 and finish building the T-KIT 1209 Transverter. Our definition of "respectable" is at least 4-5W on a lab-grade meter designed for 50 MHz, and anything from 3 to 15 watts on meters intended for HF (up to 30 MHz) applications.

□ □ 6-23. Disconnect DC voltage.

□ □ 6-24. Immediately touch and feel all transistors. Some will be quite warm, but none should be too hot to touch. Give special attention to driver Q10, reviewing the note on p. 24 if needed.

□ □ 6-25. **Some steps in Phase 7.0 will refer you back to Phase 6.0 or ask if you have done the work described in Phase 6.0.**

□ □ 6-26. **REMOVE** the temporary grounding jumper installed per Steps 2-36a and 2-36b. **DO NOT** attempt further operation of the transverter until all Phase 7.0 steps are completed.

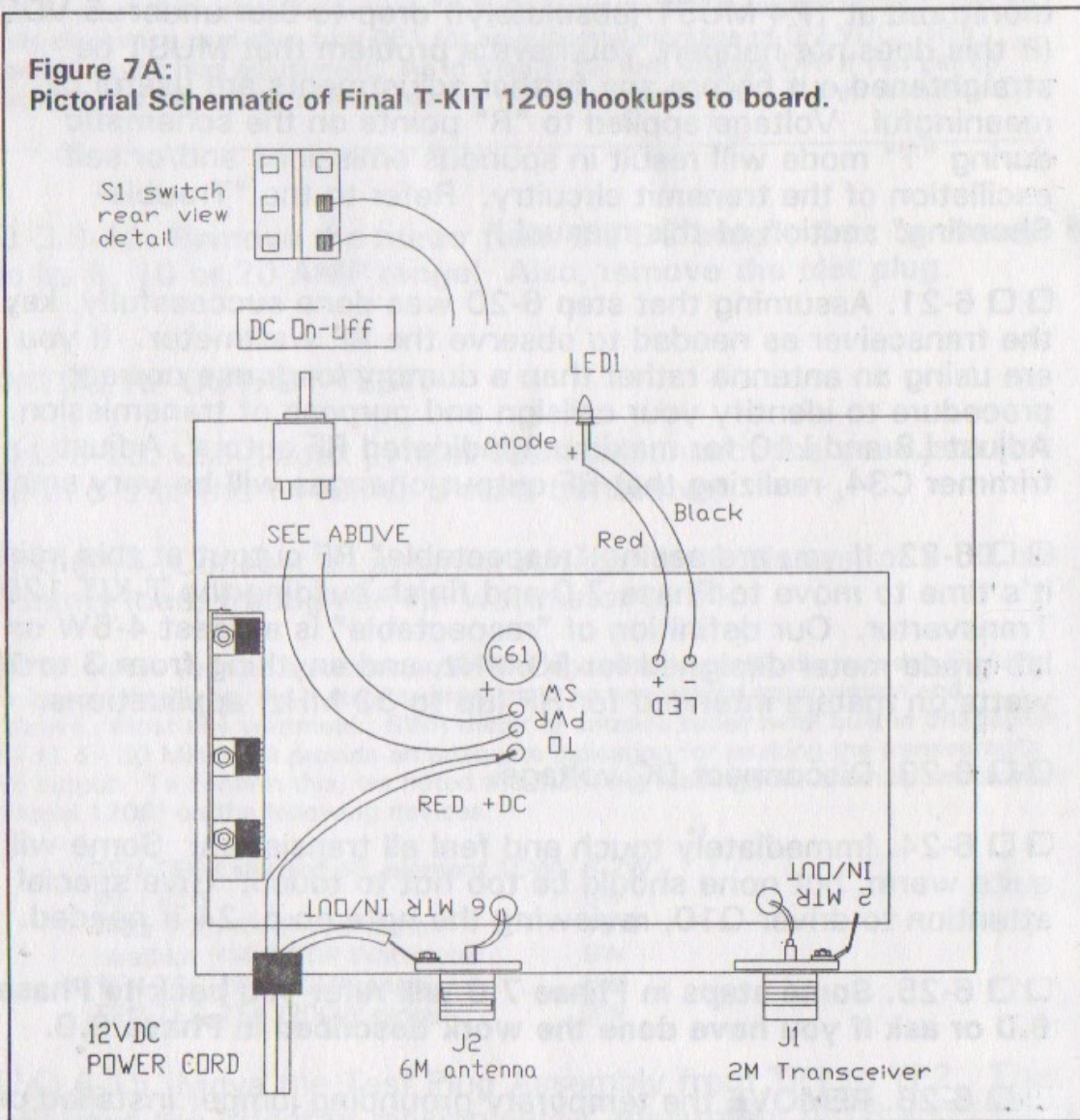
PHASE 7.0

Final Assembly and Adjustments

THIS IS IT: time to blend all PC board work with hardware to make a finished T-KIT Model 1209 Six Meter Transverter!

The step-by-step directions in Phase 7.0 presume that you have performed successfully ALL previous steps. Also, these steps will refer you routinely to drawings or diagrams more frequently than in preceding stages.

Figure 7A:
Pictorial Schematic of Final T-KIT 1209 hookups to board.



General Note on Final Assembly:

The order of the following steps is not rigid, and you may find it more convenient to mount the switch and connectors without the board in place.

□ □ 7-1. Study Figure 7A.

□ □ 7-2. Mount DPDT Switch S1, using washer and nut supplied. Note the small hole in the panel which mates the locking tab on the washer.

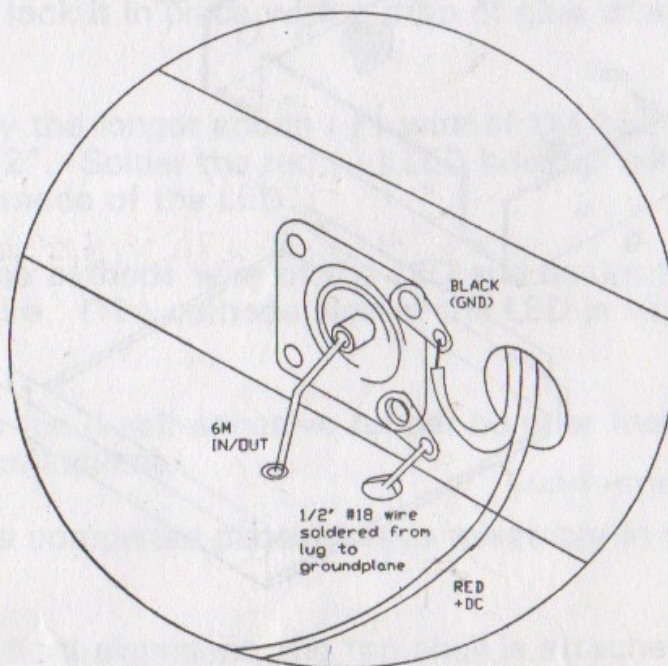
□ □ 7-3. Using two #4-40 screws and nuts, mount SO239 coax connector J1 (2 Meters) and its solder lug in their correct position. Orient the solder lug as illustrated.

□ □ 7-4. Using three #4-40 screws and nuts, mount coax connector J2 and its solder lug in their correct position. Orient the solder lug as illustrated. Include an additional #4 solder lug for the DC power cord ground connection.

□ □ 7-5. Pass the DC power cord through its rear panel hole, but *do not install* the restraint grommet until the cable has been soldered and routed correctly.

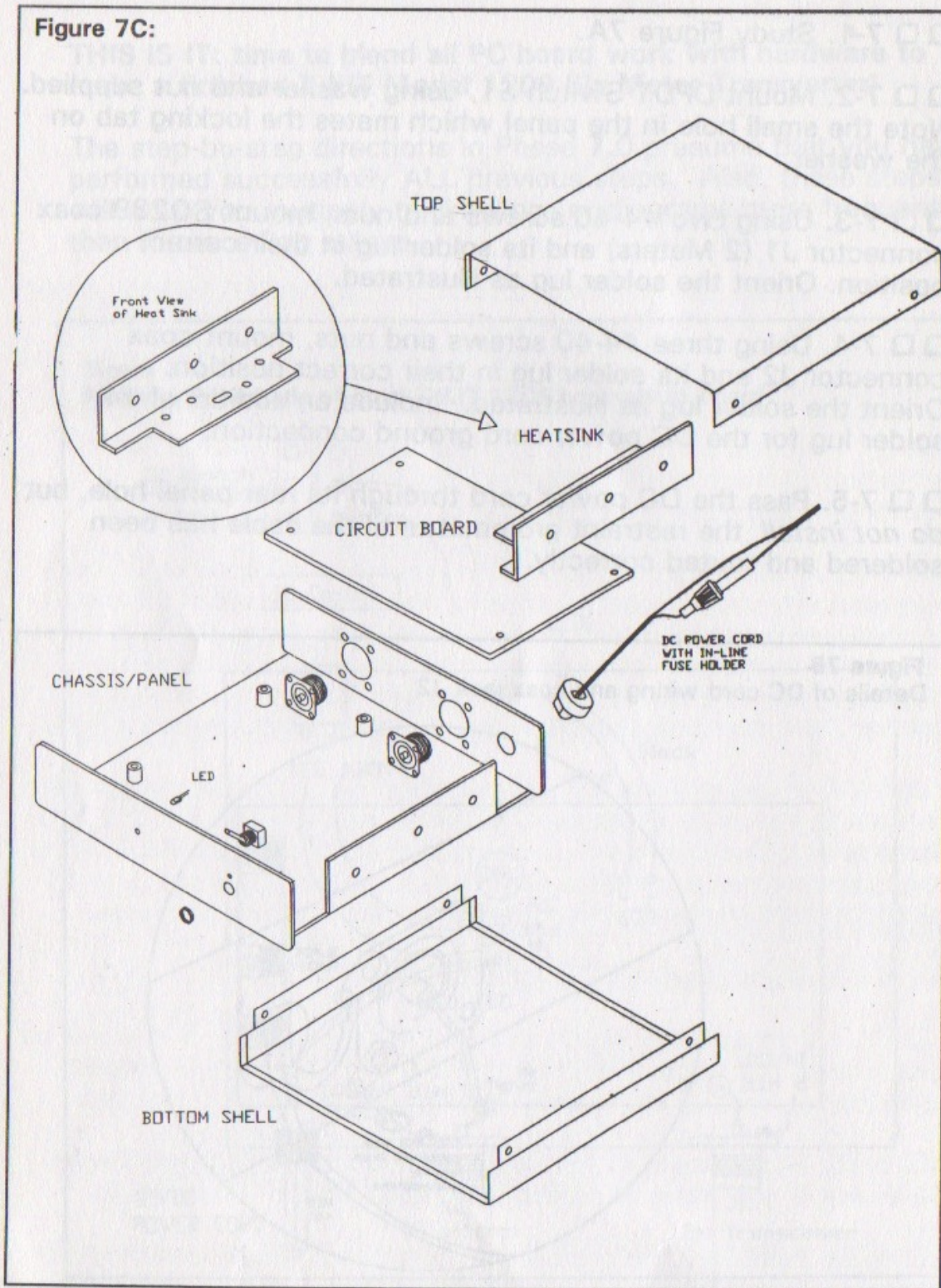
Figure 7B

Details of DC cord wiring and coax jack J2



T-KIT Model 1209 6 Meter Transverter Overview of Mechanical Assembly

Figure 7C:



- □ 7-6. Prepare and solder a 4" red hookup wire to the other "TO POWER SW" pad.
- □ 7-7. Pass the power cable through its panel hole and solder the red wire of the power cable to the "+12" pad near the red hookup wires for the power switch.
- □ 7-8. Solder the 4" red wires to switch S1 as illustrated. Either or both poles of the switch may be used.
- □ 7-9. Re-mount the board to the chassis/panel assembly, using the three #4-40 screws with "captive" lockwashers.
- □ 7-10. Neatly loop the red power cable wire so that there is about 7" of wire between the board connection and the panel hole.
- □ 7-11. As soon as you have the DC cord routed as explained, lock it into place with the strain relief grommet. Study the design of the grommet; it is easiest to insert if its two sections are firmly clamped around the cable with pliers.
- □ 7-12. Cut and strip the black wire of the DC cord to form the shortest possible path between the strain relief and the solder lug on the 6M SO-239 connector. Solder the black wire to the lug.
- □ 7-13. The LED fits snugly in its panel hole, but you will probably want to lock it in place with a drop of glue or a strip of electrical tape.
- □ 7-14. Identify the longer anode (+) wire of the LED and cut it down to about 1/2". Solder the red (+) LED hookup wire from the board to the anode of the LED.
- □ 7-15. Trim the cathode wire of the LED and solder the black (-) LED hookup wire. (The cathode side of the LED is slightly flattened.)
- □ 7-16. Attach the 4 self-adhesive rubber bumper feet to the bottom shell of the cabinet.
- □ 7-17. Set the completed panel/chassis assembly in the bottom shell.
- □ 7-18 AFTER final alignment, the top shell is attached using the four #6 sheet metal screws.

FINAL ALIGNMENT PROCEDURE

1. Receiver alignment is detailed in Steps 3-52 to 3-59.
 2. Transmit bias adjustment is explained in Phase 6.
 3. The following touchup steps presume that you observed a reasonable RF output level during Phase 6 testing and that there are no problems on the circuit board or in the switch and connector wiring just completed.
- ☐ ☐ 7-20. With S1 turned OFF, connect DC power. Connect a 5 watt 144 MHz transceiver to J1.
 - ☐ ☐ 7-21. Connect a 50 ohm dummy load or 6 meter antenna and RF wattmeter to J2. (See note about HF SWR/wattmeters on page 36, step 6-14.)
 - ☐ ☐ 7-22. Turn on the transCEIVER only. Tune to 146 MHz and adjust for comfortable listening volume: the background noise level should be quite low in CW/SSB mode. If using an FM rig, turn the squelch down so you can hear the noise.
 - ☐ ☐ 7-23. Turn on S1. There should be a good increase in CW/SSB receiver noise but negligible change in FM noise, and the LED should glow.
 - ☐ ☐ 7-24. Adjust FM volume and squelch as desired.
 - ☐ ☐ 7-25. With the Test Plug at TP2, key the transceiver and adjust L8 and L10 for maximum indicated RF output.
 - ☐ ☐ 7-26. Remove the Test Plug, key the transceiver and adjust L9 for maximum output.
 - ☐ ☐ 7-27. Adjust trimmer C42 for maximum RF output. (Watch the meter closely and do not expect a dramatic change).
 - ☐ ☐ 7-28. Optional: Compressing or stretching coil L14 slightly may have a small effect on maximum RF output. Use a non-metallic alignment tool, not your fingers, to do this!
 - ☐ ☐ 7-29. Oscillator Calibration. Connect a frequency counter to test point TP5. Adjust coil L23 for a reading of 94.000 MHz per the maximum resolution offered by your counter.

T-KIT Model 1209 6 Meter Transverter Kit Assembly and Alignment Notes

T-KIT Model 1209 6 Meter Transverter 6 Meter to 2 Meter Conversion Log

6M Output (Repeater or Simplex)	6M Input (TX offset)	TX Offset in $\pm$ MHz	2M Main Freq (Repeater output or Simplex)	2M TX Offset Frequency
---------------------------------------	-------------------------	---------------------------	---	---------------------------

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

Your 6 Meter/2 Meter Conversion Notes:

- Q Q 7-24. Adjust FM volume and search as desired.
- Q Q 7-25. With the Test Plug at TP2, key the transceiver and adjust L8 and L10 for maximum indicated RF output.
- Q Q 7-26. Remove the Test Plug, key the transceiver and adjust L9 for maximum output.
- Q Q 7-27. Adjust trimmer C42 for maximum RF output. Watch the meter closely and do not expect a dramatic change!
- Q Q 7-28. Optional: Compressing or stretching coil L4 slightly may have a slight effect on maximum RF output. Use a non-metallic alignment tool, not your fingers, to do this!
- Q Q 7-29. Oscillator Calibration. Connect a frequency counter to test point TP3. Adjust coil L23 for a reading of 94,000 Mhz for the maximum readings affected by your counter.

T-KIT Limited WARRANTY

Please read carefully BEFORE building your kit.

This Limited Warranty applies solely to KITS sold by TEN-TEC, Inc. under the trade name "T-KIT." The terms of this Warranty do not apply to other products of any kind manufactured by TEN-TEC, Inc., nor shall any other warranties published by TEN-TEC, Inc., or any TEN-TEC customer service policies for its manufactured products, be construed as applicable to T-KIT products.

1. All components and hardware supplied as parts of a kit are warranted to be free from manufacturing defect for one year from date of purchase.
2. The original purchaser has the option of examining the kit and manual for 30 days. If you choose within this period not to construct the kit, you may return the entire unassembled kit at your own expense for full credit toward any other TEN-TEC product, or a refund, less original shipping/handling charges.
3. This warranty is voided if acid-core solder is used in construction. **USE ROSIN-CORE SOLDER ONLY**, of a grade designed for electronic PC-board assembly. **WARNING:** solder contain LEAD, which is known to cause birth defects or other reproductive harm. Avoid breathing solder fumes, which may cause pulmonary irritation or damage. After handling any solder, wash hands with soap and water before eating.
4. TEN-TEC, Inc. warrants this device to function as described in its documentation provided that it is assembled and used correctly in accord with all printed directions. It is your responsibility to follow all directions in the instruction manual, to identify components correctly and to use good workmanship and proper tools in constructing this kit.
5. We do not accept the return of partially-assembled kits for repair or refund.
6. If you believe a kit part is missing, do a thorough sorting of all parts, checking each off on the parts list in the manual. Check all bags, envelopes or boxes carefully. Simply call, fax, or write, and we will promptly replace any missing part. Even if you find an exact replacement part locally, please notify us so we may assist other customers.
7. If your kit does not work after final assembly, please follow these three steps in order:
 - A. Double-check EVERY step in the assembly manual and any troubleshooting tips provided.
 - B. Ask an experienced ham or hobbyist friend to review your work. A fresh set of eyes can catch a detail which you may have overlooked.
 - C. If necessary, you are welcome to ask for T-KIT Technical Assistance at 423-453-7172.
(Technical Assistance for T-KITs is available ONLY through THIS number.)
8. **Factory Inspection or Service.** If you wish to return a kit for professional inspection or repair, there is a minimum charge of \$20.00, payable by cash, check, money order or credit card charge authorization. There is no need to call or write for authorization; simply send your kit with a note explaining the problem, and provide authorization to make repairs at prevailing hourly shop rates. To minimize extra cost to you we reserve the right simply to send you replacement parts with notes on how to solve your problem. If we find that a part was defective in manufacture, there will be NO CHARGE to repair your kit unit. Our technicians will make the determination whether a part was defective in manufacture or was damaged during installation.
9. TEN-TEC, Inc. reserves the right to revise this Limited Warranty, to change or discontinue any kit product or revise its instruction manual with no liability to previous purchasers. However, if you complete any Kit Registration form which may be supplied with a kit, you will receive periodic technical news from us, including tips, special offers on upgrades. Individual kit manuals may contain Warranty extensions or limitations for that specific kit product.
10. TEN-TEC, Inc., is not liable for any consequences from use or abuse of any T-KIT or part contained therein.

T-KIT BY TEN-TEC

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RESISTOR Ω REFRESHER

Multiply both digits of first 2 bands by 3rd Band:

black	0	0	X 1
brown	1	1	X 10
red	2	2	X 100
orange	3	3	X 1000
yellow	4	4	X 10,000
green	5	5	X 100,000
blue	6	6	X 1,000,000
violet	7	7	
gray	8	8	
white	9	9	
gold	--	--	X 0.1

✓ Examples . . .

red-red-gold = 2.2 Ω
 red-red-black = 22 Ω
 red-red-brown = 220 Ω
 red-red-red = 2200 Ω (2.2K)
 red-red-orange = 22K
 4th Band = mfr's tolerance.
 Gold = 5% Silver = 10%

MOLDED μ H INDUCTORS

look very much like resistors, but don't "resist" much -- just check them out on your meter to read less than 1-2 Ω , much lower than resistors in your kit. Values are in μ H (microhenries), to 1000 μ H per resistor code, with 3rd silver band = X .01.

✓ Examples:

red:red-silver (22X.01) = 0.22 μ H
 red:red-gold (X 0.1) = 2.2 μ H
 red:red-black (X 1) = 22 μ H
 red:red-brown (X 10) = 220 μ H
 brown-black-red = 1000 μ H

ALL ABOUT THOSE Disc Cap Numbers!

101 = 100 pF
 102 = .001 μ F
 103 = .01 μ F
 104 = .1 μ F

✓ Want more?

221 = 220 pF
 222 = .0022 μ F
 223 = .022 μ F
 331 = 330 pF
 332 = .0033 μ F
 471 = 470 pF
 472 = .0047 μ F
 473 = .047 μ F
 474 = ?

Got the idea ?!?

FOR SURE!

We ALL know this . . .

E volts = I amps X R ohms

R = E / I

I = E / R

P watts = E X I

Some Ham Band Highlights ☆

✓ WARC Bands

10.100 - 10.150
 18.068 - 18.168
 24.890 - 24.990

✓ National Calling Frequencies (Simplex):

29.600 FM
 50.110 SSB DX
 50.200 USA SSB
 51.700 Packet
 52.525 FM
 144.20 SSB
 146.52 FM
 222.10 CW-SSB
 223.50 FM
 432.10 CW
 446.00 FM

✓ Easy QRP CW

7.040
 10.106
 14.060

✓ Easy Space to Earth

29.357 RS-10 Series
 Satellite CW beacon
 145.55 FM SAREX & MIR
 space-earth downlinks

MAKE your Antennas!

1/4 Wavelength (in FEET)
 = $234 \div \text{FREQ in MHz}$

*use 238 for radials

* FOR VHF, you can use 2808
 to get 1/4 λ in INCHES !!!

They used to make BULLETS

by dropping melted lead way down into cold water. That's how some folks make excellent cold solder joints . . . by melting solder with the iron so it blobs onto the board, looking like deformed buckshot.

PLEASE . . .

heat the connection itself so IT does all the melting, forming a shiny cone, not a dirty blob!

A super SOLDER BRIDGE

is built with that extra solder clinging to the iron's tip that we didn't need anyway. Just jiggle the soldering iron, and we can build nifty bridges across 2, 3, 4 or more PC-board soldering points, especially DIP IC's or sockets. **Don't try it: you'll hate it !**

70KIT

A Division of TEN-TEC, Inc.

1185 Dolly Parton Parkway • Sevierville, TN 37862-3710

Information • 1-423-453-7172

Fax • 1-423-428-4483

Orders • 1-800-833-7373 (credit card orders only)

Read BEFORE Starting Kit Assembly!

T-KIT Technical Bulletin No. 1209-0596-2

✓ **VERY IMPORTANT:** *The following details clarify, supplement or replace information in your instruction Manual. Read this Bulletin, the "Kit Building Tips" card AND the entire manual before soldering any parts.*

◆ T-KIT No. 1209 • 6 Meter Transverter

- ☐ ☐ In the parts list on page Reference-13 the list of resistors has changed to include 11 pieces of the 1K (30138), 1 piece of a 6.8K (30148) and 9 pieces of the 10K (30150). These substitutions effect resistor R7 which we have changed from a 10K to a 1.0K and resistor R15 which has been changed from 10K to 6.8K. Please make these corrections on page Reference-21 and on the fold-out schematic page. R7 is installed in step 1-38 and R15 in step 2-20 so correct these steps also.
- ☐ ☐ On page Reference-17, capacitors C11 and C12 are installed in steps 1-43 and 1-44.
- ☐ ☐ On page Reference-30 the Transmit RF Input specification should read: 5 watts* nominal, 144 to 148 MHz, for 50 to 54 MHz output.
- ☐ ☐ On page Assembly-6 in step 1-4 resistor R54 should be 220 ohm (red-red-brown) not 470 ohm.
- ☐ ☐ On page Assembly-16, step 3-13 should call for a 5 pF capacitor (23249), not 47 pF.
- ☐ ☐ Also on page Assembly-16 in step 3-1, the transistor is a type 2N5087.
- ☐ ☐ On page Assembly-17 steps 3-20a and 3-20b should be ignored. These parts were already installed in steps 1-43 and 1-44.

- ☐ ☐ On page Assembly-19 in step 3-48 the .001 μ F capacitor is marked "102".
- ☐ ☐ We wish to make a correction concerning transformer T3. The text description in step 4-33 does not agree with the outline shown on the board layout. The orientation outline shown on the printed circuit board and in the layouts in the manual is correct. Our description of the transformer in Step 4-33 is incorrect. Simply install the transformer as it is outlined on the board and the circuit will be wired correctly.
- ☐ ☐ On page Assembly-24 step 4-35 the instructions incorrectly refer to R45 and R46. This step only involves R31 and R32.
- ☐ ☐ On page Assembly-24 step 4-36 should be ignored. This coil was installed in step 1-51.
- ☐ ☐ On page Assembly-28 the last step dealing with T4 and T5 should refer to VIA's 3 and 4.
- ☐ ☐ On the fold-out schematic page, transistor Q15 should be labeled 2N5087.

Thank you for your confidence in T-Kit by Ten-Tec.

T-KIT, a division of TEN-TEC, Inc.

Part No. 74335-1

1185 Dolly Parton Parkway • Sevierville, TN 37862

PLEASE read Warranty and Troubleshooting Guide in manual
before calling Technical Assistance at 1-(423) 453-7172