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T Wireless System

SERVICE MANUAL CHANGE NOTICE

T4 DIVERSITY RECEIVER

Changes and corrections have been made to the Service Manual for the T4 Receiver. To update your Service Manual, remove the pages identified in the tables below and replace them with the pages attached to this Change Notice. Note that there are no changes to pages not specifically identified in the tables below.

T4 RECEIVER SERVICE MANUAL REVISION HISTORY

Release	Part Number	Date Code	Color
Original	25A1020	QG	White
Revision 1	25B1020	SB	Pink
Revision 2	25C1020	SI	White
Revision 3	25C1020	TF	White
Revision 4	25C1020	CC	White
Revision 5	25C1020	EA	Red

CHANGES EFFECTIVE JANUARY 13, 2005

REMOVE these pages from the T4 Service Manual	INSERT these new Revision pages into the T4 Service Manual
21 & 22	21 & 22

25–1020–1 (EA)
Printed in U.S.A.

Service Manual

25C1020 (EA)

T4 Diversity Receiver

Characteristics

General

This manual tells how to service and align the Shure T4 Diversity Receiver (Figure 1). This single-channel, crystal-controlled unit operates within the 169 MHz to 238 MHz VHF-FM band.

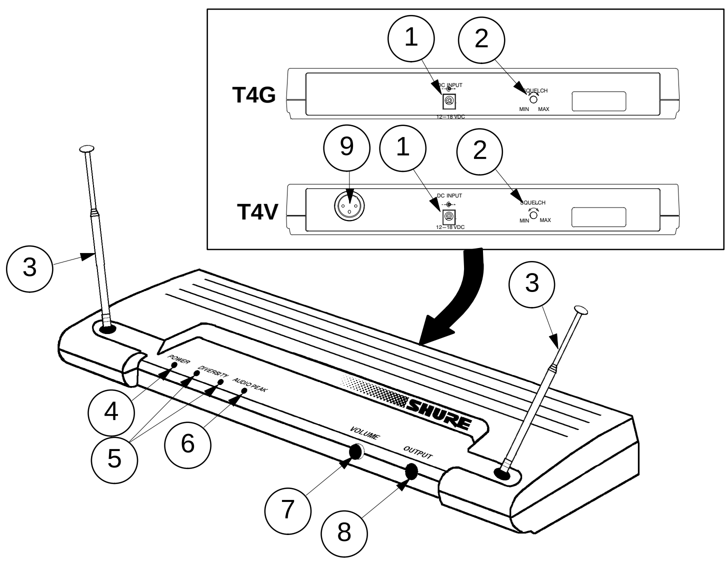


Figure 1. Controls and Connectors

1. "DC Input" jack
2. *Squelch* control
3. Antennas
4. "Power" LED
5. "Diversity" LEDs
6. "Audio Peak" LED
7. *Volume* control
8. Audio "Output" ($^1/_4$″ phone jack)
9. "Balanced Low Z" audio output (XLR)

Service Note: Shure recommends that all service procedures be performed by a factory-authorized service center or that the product be returned directly to Shure Brothers Inc.

Circuit Description

The Shure Model T4 is a single-conversion superheterodyne diversity FM receiver operating in the 169–238 MHz band. It is intended for use with the matching Shure T Series wireless transmitters.

RF Stages

Two complete, independent RF sections provide diversity reception. Signals enter via the single-element, quarter-wave antennas.

Channel A: The signals pass through a double-tuned filter (L3 and L4) before entering MOSFET amplifier Q1. The output of this stage is double-tuned by L5 and L6, which also provide impedance-matching to Gate 2 of GaAs MESFET (gallium arsenide metal semiconductor field effect transistor) mixer Q3. Gate 1 receives the local oscillator signal from transistor Q5. A third-overtone quartz crystal in the 50–70 MHz range provides frequency control. The collector circuit of the oscillator is tuned by L8 to the third harmonic of the crystal (160–230 MHz) to provide the proper injection frequency for a 10.7 MHz intermediate frequency (IF).

Channel B: This channel is identical in design to channel A. The signals from the antenna pass through a double-tuned filter (L12 and L13) before entering MOSFET amplifier Q6. The output of this stage is double-tuned by L14 and L15 and fed to Gate 2 of GaAs MESFET mixer Q8. Gate 1 receives the local oscillator injection from buffer transistor Q4, which is tuned by L7. The buffer stage helps isolate the diversity channels from one another by preventing crosstalk through the common local oscillator section.

IF and Audio-Detection Stages

Channel A: L2 tunes the output of mixer Q3 to 10.7 MHz before the signal enters ceramic filter FL3. Transistor Q2 provides IF amplification to make up for the losses in the filters. After passing through a second IF filter, FL2, the signal enters amplifier/detector U1. The detected audio from pin 6 is amplified by U105C.

Channel B: L11 tunes the output of mixer Q8 to 10.7 MHz before the signal enters ceramic filter FL6. Transistor Q7 provides IF amplification before the signal passes through the second ceramic filter, FL5, and enters amplifier/detector U2. The detected audio from pin 6 is amplified by U108B.

Noise-Operated Squelch

A noise-operated squelch system provides both diversity-channel selection and muting. Noise signals are obtained from the additional detector outputs at pin 7 of U1 and U2.

Noise Signals

Channel A: The squelch level control (R16) adjusts the noise signal from U1 before it is amplified by U105A. Active high-pass filter UI05D removes audio components that could cause false triggering. The noise is then rectified by D101 and smoothed by C111 to provide a dc voltage that varies with the amount of noise present on the detected signal.

Channel B: This follows an identical scheme: noise signals from U2 are adjusted by squelch level control R41 before being amplified by U108C, filtered by U108A, rectified by D107, and smoothed by C140.

Comparator Circuits

U106C and U106D compare the dc noise signals from the two channels. When these signals are comparable, U106C and U106D direct analog switches U103C (Channel A) and U103B (Channel B) to allow both channels to pass through. The signals from each channel are correlated while the noise is uncorrelated, which makes possible a theoretical signal-to-noise improvement of 3 dB. When the dc noise signals are not comparable, the channel with less noise is chosen.

U106A imposes an additional criterion on Channel A, and U106B does the same for Channel B. Each channel's dc noise voltage is compared to a threshold set by user-adjustable R112 (*Squelch*). A channel whose noise exceeds this threshold is squelched. If both channels exceed their thresholds, the audio output of the receiver is squelched. Squelching is accomplished by tying together the outputs of U106A and U106C (Channel A) or U106B and U106D (Channel B). These outputs also control the yellow "Diversity" status indicators. Comparator U102 provides additional attenuation in the squelched state by shutting off compandor U3.

Audio Output

The audio signals from the two channels pass through analog switches U103C and U103D, are buffered by U109A, and enter U3, which provides a 2:1 logarithmic expansion. An additional IC amplifier (U109D) operates in conjunction with U3 to provide a lower noise floor. The output of this stage passes through the *Volume* control (R126) to the "Output" connector (J101). A bridging amplifier formed by U109B and U109C provides the "Balanced Low Z" output.

"Peak" LED

This red indicator warns the user when the transmitter deviation is approaching the limit of 15 kHz. This function is implemented by a window comparator (U102C and U102D) and a pulse stretcher (U102B) that makes short transients more visually apparent.

Power

The green "Power" LED indicates when the external power converter (or a battery pack) is supplying power to the receiver. The circuitry operates normally with an input of 12–18 Vdc. D10 provides reverse polarity protection, and U101 supplies voltage regulation. The "Dc Input," audio "Output," and "Balanced Low Z" output connectors are filtered to prevent local oscillator radiation from the cables.

Notes

Preliminary Tests

Listening Tests

Before disassembling the unit, operate it to determine whether it is functioning normally. First and most important: Review the customer's complaint (if available) and focus your tests on the problem. If this proves inconclusive or you want somewhat more extensive checks, perform the following functional tests.

Functional Tests

The following tests require partial disassembly of the unit:

RF Test

The following is the best "fast" test of a receiver's RF performance. A receiver that passes this test can be removed from the list of suspects for any "dropout" or "range" problem.

Initial Set-up

1. Set the receiver's *Squelch* control to its middle position and the *Volume* control to its maximum position.
2. Set the RF signal generator to the receiver's frequency.
3. Remove the receiver's antenna (see "Disassembly," page 7). Plug the BNC end of the 50 Ω test cable into the RF signal generator. Tack-solder the cable's center conductor to the receiver's antenna input (TPA1 or TPB1), and the shield to a ground plane as close as possible to the antenna input (TPA2 or TPB2).

Test

1. Connect power to the receiver and turn it on.
2. Verify that the unit unsquelches with RF signals greater than –89 dBm.
3. When the unit unsquelches, verify that the "Diversity" LED glows.

Audio Tests

Initial Set-up

1. Set the RF generator as follows:

   Level: *–60 dBm*
   Deviation: *15 kHz*
   Modulation: *Ext*

2. Set the audio analyzer as follows:

   Amplitude: *1.4* V_{rms}
   Frequency: *1 kHz*

3. Using a 3.3 kΩ load, connect the receiver's unbalanced audio output to the input of the audio analyzer, and engage the 400 Hz and 30 kHz fil-

ters. The receiver's *Volume* control should still be in its maximum position.

Tests

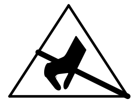
1. Verify the following receiver measurements:
   - Audio level is 400 mV_{rms}, ±90 mV. Record your measurement as a reference level for the next two steps.
   - Thd is <0.75%.
2. Change the audio analyzer's frequency to 100 Hz, and disengage the audio analyzer's 400 Hz filter. Verify that the receiver's unbalanced audio output is within +2 dB, –1 dB of the reference level recorded in step 1.
3. Set the audio analyzer's frequency to 10 kHz. Verify that the receiver's unbalanced audio output is –7.5 dB to –10.5 dB of the reference level recorded in step 1.
4. *Model T4V only:* Place a 150 Ω load across the receiver's balanced output, then connect this output to the audio analyzer. Verify that the output is 65 mV_{rms}, ±15 mV. Remove the 150 Ω load.
5. If you are finished testing the receiver, remove the test cable and reinstall the antenna (see "Reassembly," page 8).

Units that Pass

If the receiver passes these tests, then it is functioning as expected and shouldn't require alignment. If you did not use the customer's microphone transmitter for these tests, check it for proper operation. If it also checks out of it it was not sent in with the receiver, inform the customer that the product has retested within specifications.

Disassembly and Assembly

To access the printed circuit (pc) board, disassemble the receiver.



! CAUTION

Observe precautions when handling this static-sensitive device.

Disassembly

1. Disconnect all power to the receiver.
2. Collapse the antennas and rotate them until they lie flat against the case. Place the receiver upside down. Remove and set aside the four screws securing the bottom of the case (Figure 2).

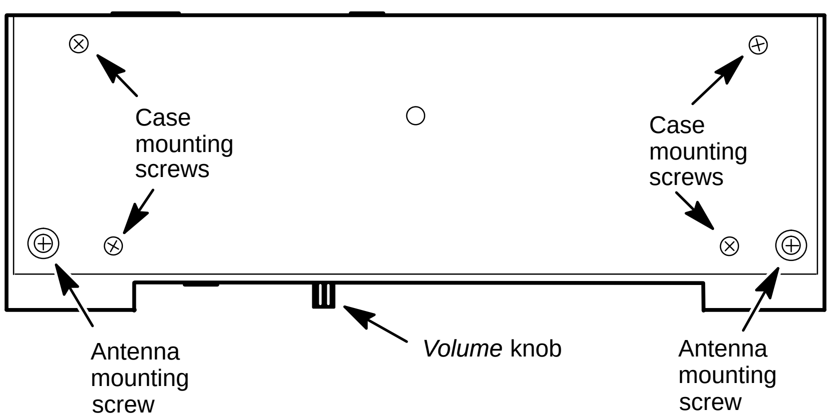


Figure 2. Bottom View of Case

3. Place the receiver in its normal operating position and rotate the antennas to their vertical positions. Note that an adhesive-backed nameplate at the at the rear of the unit holds the upper and bottom parts of the case together. To open the case, carefully separate the upper part from the bottom part at the front of the unit. Carefully swing the bottom part of the case away until the two halves are at a 90° angle, to allow removal of the circuit board and antennas (Figure 3).
4. After the circuit board has been removed, pull off and retain the *Volume* knob.

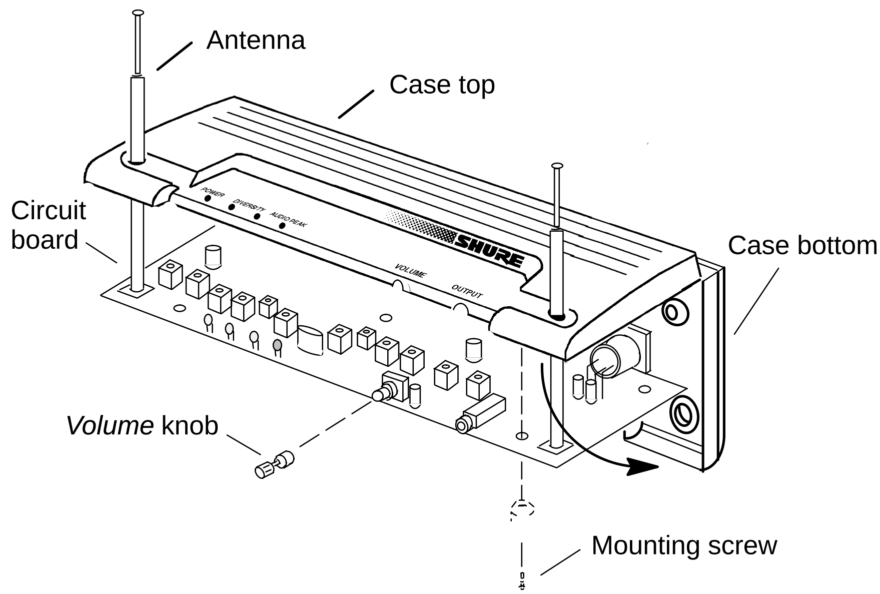


Figure 3.

Reassembly

1. Slide the *Volume* knob back on: note how it is keyed to the flat part of the shaft.
2. Rotate the antennas to their vertical positions. Place the pc board, component-side up, inside the top half of the case: after feeding the antennas through their holes, make sure the notches in the case align with the *Volume* knob, the LEDs align with the holes in the upper half of the case, and that the board is fully seated on the studs.
3. Swing the two halves of the case together until they snap in place.
4. Rotate the antennas until they lie flat against the case. Turn the receiver upside down and secure the assembly with the four screws removed earlier (Figure 2, page 7). Check that the *Volume* knob rotates freely.

Antenna Replacement

The antennas can be replaced without disassembling the case. Rotate the antenna you are replacing to its vertical position, collapse it, and remove the mounting screw through its access hole in the bottom of the case (Figure 2). Insert the new antenna and start the screw from the bottom, leaving it loose enough for you to rotate the entire antenna between your fingers. Rotate the antenna in this way as you lightly press it into the case until you feel the base seat in the slot of the bracket on the pc board. Tighten the screw.

Service Procedures

Reference Material

The Shure *Wireless System T Series User's Guide* provides a description of the unit as well as operating instructions, troubleshooting suggestions, and technical data.

Special Equipment and Tools

In addition to the standard items described in the *Service Equipment* manual, you will need:

- a wireless microphone with the same frequency (usually a T1, T2, or T11) to verify that the receiver is working properly
- an audio amplifier with a high-impedance input ($\geq$10 kΩ) and a monitor speaker, for listening tests

System Operating Frequencies

Each receiver's circuit board has a resistor next to the group letter (A–H, J–L) that identifies the range of frequencies on which the receiver can operate (see Figure 4). Table 1 shows the Group Letter and its associated frequencies. Note that this chart applies only to T4 receivers.

Table 1
Pc Board Groups

Group	Frequency Range
A	169.000–173.975 MHz
B	174.000–179.975 MHz
C	180.000–185.975 MHz
D	186.000–191.975 MHz
E	192.000–197.975 MHz
F	198.000–203.975 MHz
G	204.000–209.975 MHz
H	210.000–215.975 MHz
J	216.000–222.975 MHz
K	223.000–229.975 MHz
L	230.000–237.975 MHz

Tables 2 and 3 provide information for identifying the system frequency. The Crystal Code, together with the appropriate Shure model number, identifies a specific operating frequency for transmitters and receivers. Note that, although a Crystal Code always designates a specific frequency, it may be used with different Group Letters on other products.

Table 2
FCC-Approved Operating Frequencies

Group	Crystal Code	Freq. (MHz)
A	V	169.445
A	W	171.845
B	CA	176.200
B	CC	177.600
C	CE	182.200
C	CF	183.600
D	CG	186.200
E	CL	192.200
F	CQ	202.200
G	CV	208.200

Table 3
ETSI-Approved Operating Frequencies

Group	Crystal Code	Freq. (MHz)
A	AQ	173.800
B	AY	174.100
B	AZ	174.500
B	ZZ	174.500
B	BA	174.800
B	NB	175.000
B	BB	175.000
B	ND	176.600
B	NE	177.600
C	NH	182.000
C	NK	183.600
C	NL	184.600
C	CS	184.800
C	S	184.800
D	NP	189.000
D	NR	190.600
E	NX	197.600
F	NY	198.600
F	NZ	200.350
F	PU	201.650
F	PB	203.000
G	PD	204.600
J	PP	217.000
J	PR	218.600
J	PS	219.600
L	PV	232.825
L	PX	233.125
L	PY	234.625
L	PZ	237.325

Changing the Frequency

The operating frequency of the T4 Receiver may be changed within a specific group by changing the crystal on the pc board (for group information, see the preceding section). Check the receiver for proper operation before attempting to change its operating frequency. After installing the new crystal, perform the alignment procedures. Then run an operational test to ensure the receiver is functioning properly. Finally, update the label to show the new frequency and letter identification code.

Note: To ensure proper operation, obtain the crystal from Shure and verify that it operates within the frequency range of the pc board. Since crystals are marked with the nominal oscillating frequency, not with a letter code, you can use the following equation to determine the frequency at which a receiver will operate with a given crystal:

Carrier Frequency = (3 × nominal crystal freq. in MHz) + 10.71

Alignment

The alignment steps must be done together, as a single, continuous procedure. Before beginning, be sure to do the setup described in the following subsection, “Test Conditions.”

Test Conditions

The following are the standard test conditions for the T4 Receiver:

- With a #1 Phillips screwdriver, remove the antennas.
- Load the the unbalanced, audio output (J101) with a 3.3 kΩ resistor.
- For RF adjustments, connect a 33 kΩ resistor between ground and the following points:

  Channel A: TPA4 (pin 13 of U1)

  Channel B: TPB4 (pin 13 of U2)

- Set the potentiometers as follows:

  Volume (R126): *Fully CW*

  Squelch (R112): *Midrange*

  Audio level (R106 and R168): *Midrange*

  Mute level (R16 and R41): *Midrange*

Test Cable

1. Obtain a 50 Ω coaxial cable for connecting the circuit boards to various test equipment. (To construct this cable, see “50 Ω Test Cable Assembly” in the *Service Equipment* manual.) Refer to Figure 4 for the locations of the test points, controls, and tuning components.
2. Tack-solder the cable to the pc board as follows:

   Channel A: Center conductor to the antenna input (TPA1) and shield to ground (TPA2)

   Channel B: Center conductor to the antenna input (TPB1) and shield to ground (TPB2)

Presettings

Most field units should already be tuned closer to the desired settings than these approximations. However, you may need to preset units when you are changing the frequency or an RF coil, or when an unskilled person has attempted to retune them.

Minimum inductance occurs when the core is level with the top of the can. Turning the core further counterclockwise or even removing it will not appreciably affect the inductance.

Maximum inductance occurs when the core is about two turns less than its full clockwise rotation—about 3.2 mm ($^1/_8$ in.) below the top of the can. Never screw the core against the board.

The manufacturer's setting of the two smaller, IF coils (L2 and L11) is close to their ideal setting, so you generally would not preset them. For coils L3–L8 and L12–L15, refer to Table 2 or 3 (page 10) to determine where the desired frequency lies within the board's group. For frequencies near the bottom of a group, use the maximum-inductance settings; for frequencies near the top of the group, use the minimum-inductance settings.

Display Check

1. Connect an external 12–15 Vdc supply to the dc input (J103). The green "Power" LED should glow.
2. Check for 9 Vdc (±0.35) at TP9 (pin 3 of voltage regulator U101).

Test-Equipment Settings

1. Plug into the RF generator the BNC end of the 50 Ω cable you soldered to the pcb (antenna and ground). Set the generator's controls as follows:
   - –20 dBm on the receiver's operating frequency
   - ±15 kHz FM deviation with 1 kHz modulation
2. Activate the 400 Hz high-pass and 30 kHz low-pass filters on the audio analyzer.

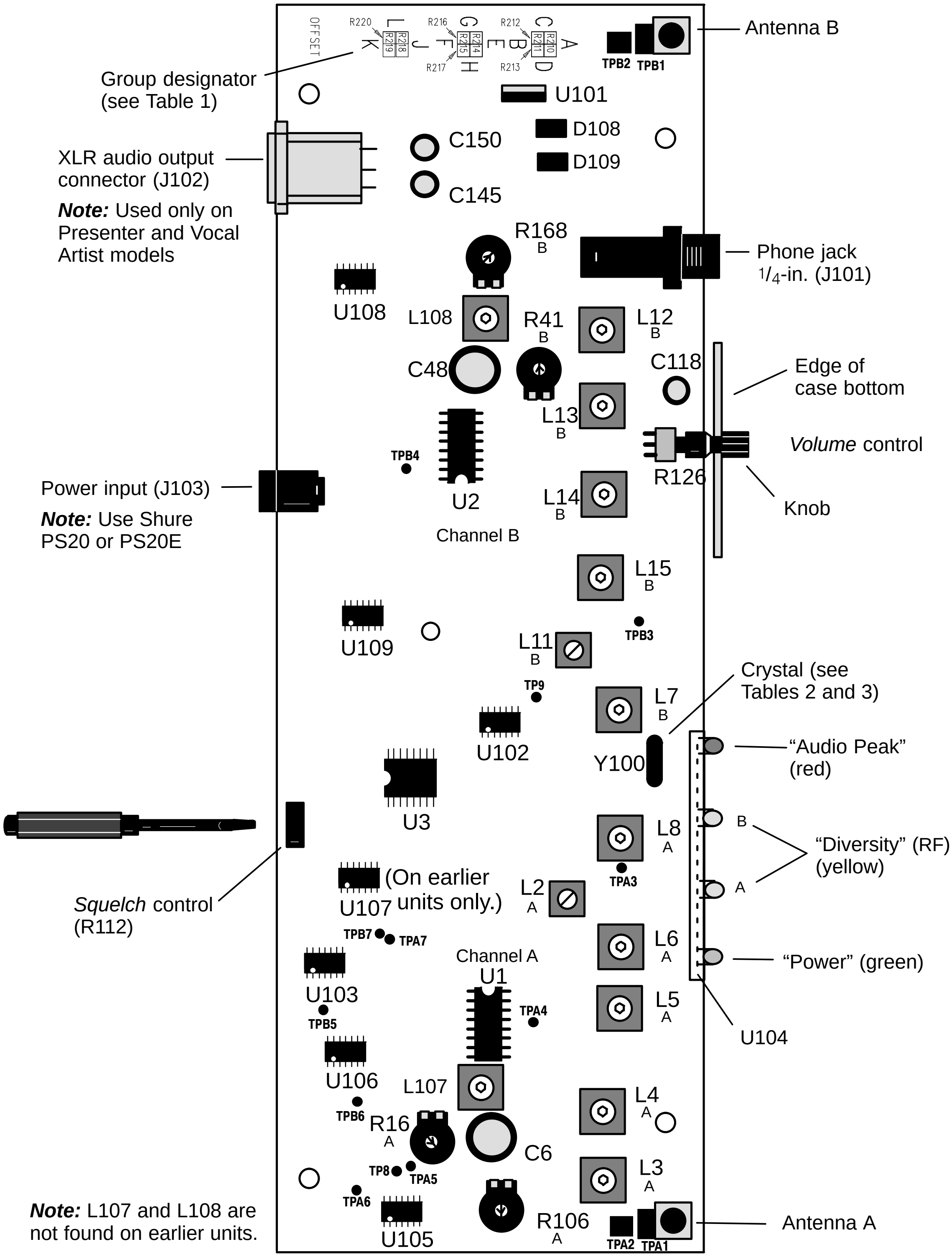


Figure 4. *Major Components*

Coil Adjustments

Each channel has to be adjusted separately.

A: Channel A RF and IF

1. Disconnect the power to the receiver. Mute Channel B by grounding TPB7 (pin 14 of U106). Reconnect the power.
2. Adjust the signal generator's RF output so that you obtain a reading of approximately 2 Vdc at TPA4. If this is unattainable even with the full –20 dBm generator output, adjust IF coil L8 until you obtain a reading above 2 V. If you cannot get more than 1.25 V, return L8 to its preset position and adjust coil L2.
3. Adjust coils L2, L8, L3, L5, L4, and L6 (in that order) for maximum voltage at TPA4. Use a hex tuning wrench for all adjustments except L2, which requires a non-metallic screwdriver (like a Toray driver). Reduce the generator output as required to keep the signal voltage under 3 Vdc. Perform the final adjustments with a generator output of approximately –85 dBm.

   Note: For coils other than L2, the "sharpness" of the tuning depends on the operating frequency within the frequency group. At the upper and lower edges of a group, a distinct peak may be difficult to observe. In this case, adjust the core for maximum indication.

B: Channel A Audio

Note: Before making the following adjustments, power up the circuit board for at least one minute. This allows the FM detector to stabilize.

1. Set the RF signal generator for an output level of –60 dBm, a modulation of 1 kHz, and a deviation of 15 kHz.
2. *Version E and later boards only:* With the probe of an ac voltmeter on TPA5 (pin 8 of U105), adjust L107 for peak output.
3. Adjust R106 for 0 dBu (775 mV), ±0.1 dB, at TPA5 (pin 8 of U105).
4. Reset the signal generator to its minimum output level (or "Off"). Check that both "Diversity" LEDs turn off.
5. Set the signal generator as follows:

   Level: *–50 dBm*
   Ext. Modulation: *50 kHz*
   Deviation: *15 kHz*

   Adjust R16 for 1 Vdc (±0.5 Vdc) at TPA6 (the positive end of C111).
6. Turn off the modulation of the signal generator. Set its output to the minimum level, then gradually increase the level until the "Diversity A" LED turns on. This should occur with an RF input between –102 dBm and –87 dBm (typically –95 dBm).
7. Disconnect power from the receiver. Remove the jumper from TPB7 and the RF input from TPA1 and TPA2.

C: Channel B RF and IF

1. Make sure that the RF generator is connected to the antenna input for Channel B. Mute Channel A by grounding TPA7 (pin 13 of U106).

2. Connect power to the receiver.
3. Adjust the RF output of the signal generator RF output so that you obtain a reading of approximately 2 Vdc at TPB4. If this is unattainable even with the full –20 dBm generator output, adjust IF coil L7 until you obtain a reading above 2 V. If you cannot get more than 1.25 V, return L7 to its preset position and adjust coil L11.
4. Adjust coils L11, L7, L12, L14, L13, and L15 (in that order) for maximum voltage at TPB4. Use a hex tuning wrench for all adjustments except L11, which requires a non-metallic screwdriver (like a Toray driver). Reduce the generator output as required to keep the signal voltage under 3 Vdc. Perform the final adjustments with a generator output of approximately –85 dBm.

   Note: For coils other than L11, the "sharpness" of the tuning depends on the operating frequency within the frequency group. At the upper and lower edges of a group, a distinct peak may be difficult to observe. In this case, adjust the core for maximum indication.

D: Channel B Audio

Note: Before making the following adjustments, power up the circuit board for at least one minute. This allows the FM detector to stabilize.

1. Set the signal generator for an output level of –60 dBm, a modulation of 1 kHz, and a deviation of 15 kHz.
2. *Version E and later boards only:* With the probe of an ac voltmeter on TPB5 (pin 7 of U108), adjust L108 for peak output.
3. Adjust R168 for 0 dBu (775 mV), ±0.1 dB, at TPB5.
4. Reset the signal generator to its minimum output level (or "Off"). Check that both "Diversity" LEDs turn off.

   Level: *–50 dBm*
   Ext. Modulation: *50 kHz*
   Deviation: *15 kHz*
5. Set the RF signal generator as follows:

   Adjust R41 for 1 Vdc (±0.5 Vdc) at TPB6 (the positive end of C140).
6. Turn off the modulation of the signal generator. Set its output to the minimum position, then gradually increase the level until the "Diversity B" LED turns on. This should occur with an RF input between –102 dBm and –87 dBm (typically –95 dBm).
7. Disconnect power from the receiver. Remove the jumper from TPA7 and the RF input from TPB1 and TPB2.

E: Final Steps

1. If you were unable to align the unit, refer to the "Bench Checks" section, which follows immediately.
2. When you have finished working on the unit, reassemble it, as described in the earlier "Reassembly" subsection on page 8.

Bench Checks

Note: In this section, test points for Channel A are given first, and the corresponding test points for Channel B are enclosed in square brackets.

DC Power

- Check for 9 Vdc (±0.35 Vdc) at TP9 (pin 3 of U101):
  - *If the voltage is lower than normal (but not zero):* Check for 15 Vdc at the input of U101 (pin 1), a reversed electrolytic capacitor (C152), or a stage that is drawing excessive current.
  - *If the voltage is zero:* Check for solder bridges or shorted foil traces (defective pcb).
  - *If the voltage is higher than normal or the other tests prove negative:* Replace U101.
- Check for 5 Vdc (±0.25 Vdc) at TP8 (pin 10 of U3).

Tuning

- First check that that the RF signal is being applied to the correct diversity channel and that the other channel is being muted with the jumper.
- If the voltage reading at TPA4 [TPB4] does not vary when the RF coils are adjusted, check the operation of the local oscillator. If everything is working properly, you should obtain a reading of 1–2 Vdc with a –95 dBm RF input signal, depending upon component parameters and receiver frequency. If you do not obtain this reading, try the following:
  - With the RF generator turned off, use a spectrum analyzer to measure the injection level at TPA3 [TPB3] for approximately –15 to –20 dBm.
  - If the preceding level is correct, use a frequency counter to verify that the local oscillator signal is 10.7 MHz (±.015 MHz) below the operating frequency of the receiver.

    Example: To receive 169.445 MHz, the local oscillator frequency should be 158.745 MHz (±.015 MHz). Crystal Y100 operates at a third of this frequency, or 52.915 MHz. The nominal crystal frequency, which is stamped on the part, is 3.333 kHz lower (52.911667 MHz) in this example. This discrepancy arises because the load reactance of the oscillator is not precisely zero.
- If any of the RF coils will not tune properly, check for frequency-dependent capacitors that are missing or have the wrong value. If the IF coil will not tune, check C9 [C52].
- If all the coils tune but the RF signal is low, compare the dc voltages and components at RF amplifier Q1 [Q6] with those of a properly working unit.

Muting

- With TPA7 [TPB7] connected to ground, the selected diversity channel should be squelched and the "A" ["B"] LED should be off, whether or not an RF input signal is present. If you obtain different results, compare the dc voltages at U106, U107 (earlier units only), U103, and U105 [U108] with those of a properly working unit, or replace the pc board.

- If the muting circuit works but has insufficient adjustment range, set the RF generator for a –95 dBm signal and check TPA4 [TPB4] for 1–2 Vdc, as described in the preceding, “Tuning,” subsection. If you get a lower reading, consider the following:
  - Low RF levels at the input of U1 [U2] will cause inadequate noise at the output of U105D [U108A].
  - In order for the noise squelch circuit to function, the detector portion of U1 [U2] must also be functioning properly (see the following, “Audio,” subsection).
  - If necessary, check the component values and dc voltages (versus those of a known working unit) of the following:

    Noise amplifier U105A [U108C]

    High-pass filter U105D [108A]

Audio

- If there is no audio at the output of the receiver:
  - To verify that the receiver is not squelched, defeat the squelch circuit by rotating R16 [R41] fully CCW. There should be 9 Vdc at TPA7 [TPB7], and the yellow “A” [“B”] “Diversity” LED should be on.
  - If the preceding test does not yield the proper results, check for a problem in the squelch circuitry (see the “Muting” subsection, immediately above).
- Next, check pin 6 of U1 [U2] for an audio signal of approximately –15 dBV. If there is no detected audio:
  - Check C1 [C44] and the components connected to pins 7–10 of U1 [U2].
  - *On earlier units only:* Make sure that FL1 [FL4] is an 86A8920 ceramic *discriminator* and not an 86A8910 ceramic filter, which is similar in appearance.
  - Check the dc voltages at U1 [U2] against those of a known working unit. If no other problem is found, replace the IC.
  - If audio is present at pin 6 of U1 [U2] but not at the output of the receiver, trace the signal through signal amplifier U105C (TPA5) [U108B (TPB5)] and expander U3/U109D. When measuring at audio TPA5 [TPB5], use a 1 kΩ resistor in series ***at the test point*** to prevent loading the amplifier.
  - Check the *Volume* control (R126) and the components going to the audio output jack (J101).
  - On vocal models, check for a signal at the Low Z microphone-level output, J102. If no signal is present, check U109B, U109C, and associated components.
  - Check the dc voltages on any stage that is not working properly; then look for wrong or missing components. Replace the ICs in the faulty stage if no other problem is found.

- ✓ If you cannot set the audio level properly with R106 [R168], make sure that the other diversity channel is squelched: only one channel should be activated during this adjustment.
- ✓ If you can set the audio levels properly for each channel while the other is squelched, but these levels change significantly when both channels are activated, check U103.
- ✓ If the audio level is correct but the unit exhibits high total harmonic distortion (thd), vary the RF input frequency 20 kHz above and below the operating frequency. If the thd drops to an acceptable level, check the local oscillator frequency. If it is within specifications, repeak the quadrature coil, L107 [L108], for maximum ac output at TP5 [TP8] (see step 1 of "Channel A Audio," page 14 [step 1 of "Channel B Audio," page 15]). *On earlier units only*, which do not have L107, replace ceramic discriminator FL1 [FL4].
- ✓ If the audio circuitry works properly but the red audio peak LED either fails to light when the standard test signal is applied or remains on when there is no modulation, check the dc voltages at U102B, U102C, and U102D against those in a known working unit. Also check the peak LED itself. Replace any defective components.

Notes:

Replacement Parts and Drawings

On the next page, the parts are listed according to the designations from the pc board (see Figure 5, page 25) and the schematics at the end of this manual. Parts shown on the circuit diagram and not listed below are available through electronic-parts distributors.

On the pages following the parts list are the drawings of the printed circuit boards and the schematics.

Product Changes

This section briefly describes significant changes to the T4.

Op Amps: The older part for U105, U108, and U109 (manufactured by Raytheon) was replaced. No other component changes were involved.

“E” Revisions: These revisions of the pc boards temporarily changed the IF detector, deleted U107, changed a number of resistors and capacitors, made eight coils and a resistor frequency-dependent, and changed Q3 and Q8 from bipolar mixers to GaAs MESFET (gallium arsenide metal semiconductor field-effect transistor) mixers.

FM Detector: A temporary shortage of the Sanyo chip caused the temporary substitution of a Harris FM detector. It used two additional resistors, R174 and R175. Should you replace the Harris detector with the Sanyo unit, be sure to remove those two resistors.

Frequencies: The “G” version of the pc board introduced many new European frequencies, five additional board groups (E–J), and a consequent reassignment of some frequencies to different board groups. The revised board received both some component changes and an altered layout.

Quadrature Coil: The extensive changes on the “G” pc boards, referred to in the preceding paragraph, included the replacement of ceramic discriminators FL1 and FL4 with quadrature coils L107 and L108.

Test Points: On earlier versions of the pc boards, the test points were designated as “TP1A,” “TP1B,” etc.; on newer boards, the designations are “TPA1,” TPB1,” etc.

“J” Frequency Code: Starting in the summer of 1997, T Series transmitters and receivers tuned to 175.000 MHz have been labeled as “BB” rather than “J.” The change was made to avoid confusion with the different meaning of the “J” designation in the LX88 and ELX88 units. It is only a labeling change; the units are physically the same.

“L” Frequencies: The “F” pcb assembly mainly addresses the addition of a new “L” group with new European frequencies. There were also a number of minor changes to capacitors, partly small corrections, mainly adaptations to simplify parts procurement and stocking.

Parts Designations

The following comments apply to the parts list and the schematic:

Resistors: All resistors are surface-mount with $^1/_{10}$ W rating and 1% tolerance.

Capacitors: Unless otherwise noted, non-polarized capacitors are surface-mount NPO dielectric types with a 100 V capacity and a 5% tolerance, and polarized capacitors are tantalum types.

Table 1
T4 Hardware Replacement Parts

Reference Designation	Description	Shure Part No.
A1	Printed Circuit Board Assembly	90_8550F [In the underlined space, insert the proper **Group Code-Letter** from Table 2 or 3, page 10.]
E1	Antenna	95A8320
K1	Case Screws, Antenna Mounts & Antenna Screw Kit	RPW612
	Case Screw	30C1245A
	Antenna Mount Bracket	53A8322
	Antenna Screw	30C1208A
	Hardware Kit	90VY1371
MP1	Case (top)	65B8198
MP2	Case (bottom)	65A8199
MP3	Knob (for *Volume* control)	65B8235
MP4	Screw, Hi–Lo, Pan (for case)	30C1245A
MP5	Nameplate, Polycarbonate, Rear (Euro)	39A8368
MP6	Nameplate, Polycarbonate, Rear (Domestic)	39B8368

Table 2
T4 PCB Replacement Parts

Reference Designation	Description	Shure Part No.
C6, 48	Capacitor, Electrolytic, 470uF, 16V, 20%	86S629
C105,114,144, 149,151,153	Capacitor, Electrolytic, SMD, 10uF, 35V, 20%	151BF106MC
C111,116,127, 132,140,141, 156	Capacitor, Electrolytic, SMD, 1.0uF, 50V, 10%	151BG105KB
C118,145,150	Capacitor, Electrolytic, 47uF, 63V, 20%	86BE629
C129	Capacitor, Electrolytic, SMD, 4.7uF, 35V, 20%	151BF475MB
C152	Capacitor, Electrolytic, SMD, 100uF, 16V, 20%	151BD107MD

D101,107,110, 111,112,113	Diode, Signal, Switching, SOT–23, 100VDC (MMBD7000L)	184A08
D108, 109	Rectifier, Silicon, 140VDC	184A20
FL2, 3, 5, 6	Ceramic Filter, 10.7MHz	86A8910
J101	Phone Jack, Stereo, Right Angle, $^1/_4$-inch	95A8329
J102	XLR connector (Vocal units only)	95A8400
J103	DC Power Jack	95A8328
L1,10,101,102 ,103,104,105, 106	Ferrite Bead, SMD 805, 600 OHM	162A12
L2, L11	If Coil, 4.7uH	82A8005
L7, 8	Tunable, 10 mm, RF Coil, Red, 45nH	82A8003
L9	Inductor, SMD 1008, .22uH (220nH)	162C06
L107, 108	Quadrature Coil, 10.7MHz	82A8004
Q1, 6	MOSFET (metal-oxide-semiconductor field-effect transistor) SOT–143, (3SK131)	183A23
Q2, 4, 5, 7	Transistor, UHF/VHF, RF, SOT–23, NPN, (MMBTH10L)	183A03
Q3, 8	Amplifier, 2 Gate, Hi Gain, Lo Noise, SOT143 (3SK177)	183A12
R16, 41, 106, 168	Potentiometer, Linear Taper 5 kΩ	46C84
R112	Potentiometer, Linear Taper, 100 kΩ (*Squelch*)	46A8008
R126	Potentiometer, Log Taper, 10 kΩ (*Volume*)	46A8046
U1, U2	Integrated Circuit, FM IF, SO–16 (LA1235)	86A8877
U3	Compandor, SOL–16 (SA571D)	188A01
U101	9 V Regulator (MC7809CT)	86A8944
U102, 106	Comparator, Quad, Low Power, SO–14 (LP339M)	188A123
U103	Switch, Multiplexer, Quad, SO–14 (HEF14066)	188A19
U104	LED Bar, Green/Yellow/Yellow/Red	95A8519
U105,108,109	Quad Op Amp, SO–14 (MC33179D)	188A49
Y100	Crystal	40_8003A [In the underlined space, insert the appropriate **Crystal Code** from Tables 2 and 3, p. 10]

Note: The tables on the following pages list frequency-dependent parts.

In the following four-part table, “Grp” is the board’s frequency group, and “Desig” is the number of the resistor that designates the Group Number. The parts are listed across the tables in alphanumeric order. All capacitor tolerances are in picofarads.

Table 3
Frequency-Dependent Parts I

Grp	Desig	C8, C51	C10	C11	C12, C56	C17	C18
A	R210	Not used	1 pF (±0.1)	12 pF	18 pF	15 pF	Not used
B	R211	1 pF (±0.1)	Not used	12 pF	15 pF	12 pF	1.8 pF (±0.1)
C	R212	Not used	1 pF (±0.1)	10 pF	15 pF	12 pF	1 pF (±0.1)
D	R213	1.8 pF (±0.1)	NA	10 pF	12 pF	12 pF	Not used
E	R214	1 pF (±0.1)	1 pF (±0.1)	20 pF	12 pF	10 pF	1 pF (±0.1)
F	R215	Not used	Not used	20 pF	12 pF	10 pF	Not used
G	R216	Not used	Not used	18 pF	10 pF	10 pF	Not used
H	R217	1 pF (±0.1)	1.8 pF (±0.1)	15 pF	8.2 pF	8.2 p F	1 pF (±0.1)
J	R218	1 pF (±0.1)	1.8 pF (±0.1)	15 pF	18 pF	15 pF	1.8 pF (±0.1)
K	R219	Not used	1 pF (±0.1)	15 pF	18 pF	15 pF	1.8 pF (±0.1)
L	R220	1 pF (±0.1)	1.8 pF (±0.1)	12 pF	15 pF	15 pF	Not used

Frequency-Dependent Parts II

Grp	C19, C63	C20	C21	C33, C36	C40	C42	C54
A	56 pF	12 pF	NA	15 pF	20 pF	20 pF	1 pF (±0.1)
B	56 pF	10 pF	1 pF (±0.1)	15 pF	20 pF	20 pF	NA
C	56 pF	10 pF	NA	12 pF	20 pF	20 pF	1 pF (±0.1)
D	56 pF	8.2 pF (±0.25)	1 pF (±0.1)	12 pF	20 pF	20 pF	NA
E	56 pF	8.2 pF (±0.25)	1 pF (±0.1)	10 pF	20 pF	20 pF	1 pF (±0.1)
F	56 pF	8.2 pF (±0.25)	NA	10 pF	20 pF	20 pF	NA
G	47 pF	6.8 pF (±0.25)	NA	8.2 pF (±0.25)	20 pF	20 pF	NA
H	47 pF	5.6 pF (±0.25)	1 pF (±0.1)	10 pF	20 pF	20 pF	NA
J	56 pF	15 pF	1 pF (±0.1)	6.8 pF (±0.25)	10 pF	10 pF	NA
K	56 pF	15 pF	NA	6.8 pF (±0.25)	10 pF	10 pF	1 pF (±0.1)
L	56 pF	12 pF	1.8 pF (±0.1)	5.6 pF (±0.25)	10 pF	27 pF	1 pF (±0.1)

Frequency-Dependent Parts III

Grp	C55	C60	C61	C64	C65	C77, C78
A	12 pF	15 pF	1 pF (±0.1)	12 pF	Not used	3.3 pF (±0.1)
B	12 pF	15 pF	Not used	10 pF	1 pF (±0.1)	3.3 pF (±0.1)
C	10 pF	12 pF	1.8 pF (±0.1)	10 pF	NA	1.8 pF (±0.1)
D	10 pF	12 pF	1 pF (±0.1)	8.2 pF (±0.25)	1 pF (±0.1)	1.8 pF (±0.1)
E	20 pF	12 pF	Not used	8.2 pF (±0.25)	1 pF (±0.1)	1 pF (±0.1)
F	20 pF	10 pF	1 pF (±0.1)	8.2 pF (±0.25)	Not used	1 pF (±0.1)
G	20 pF	10 pF	NA	6.8 pF (±0.25)	Not used	1 pF (±0.1)
H	18 pF	8.2 pF (±0.25)	1 pF (±0.1)	6.8 pF (±0.25)	Not used	1 pF (±0.1)
J	18 pF	18 pF	Not used	15 pF	1.8 pF (±0.1)	3.3 pF (±0.1)
K	15 pF	15 pF	1.8 pF (±0.1)	15 pF	1 pF (±0.1)	3.3 pF (±0.1)
L	12 pF	15 pF	Not used	12 pF	1.8 pF (±0.1)	3.3 pF (±0.1)

Frequency-Dependent Parts IV

Grp	L5, L14	L3, L4, L6, L12, L13, L15	R24	R26
A	82A8003	82A8003	1.82 kΩ	24.9 kΩ
B	82A8003	82A8003	1.82 kΩ	24.9 kΩ
C	82A8003	82A8003	1.82 kΩ	24.9 kΩ
D	82A8003	82A8003	1.82 kΩ	24.9 kΩ
E	82C8003	82A8003	1.82 kΩ	24.9 kΩ
F	82C8003	82A8003	1.82 kΩ	24.9 kΩ
G	82C8003	82A8003	1.82 kΩ	24.9 kΩ
H	82C8003	82A8003	1.82 kΩ	24.9 kΩ
J	82C8003	82C8003	1 kΩ	12.1 kΩ
K	82C8003	82C8003	1 kΩ	12.1 kΩ
L	82C8003	82C8003	1 kΩ	12.1 kΩ

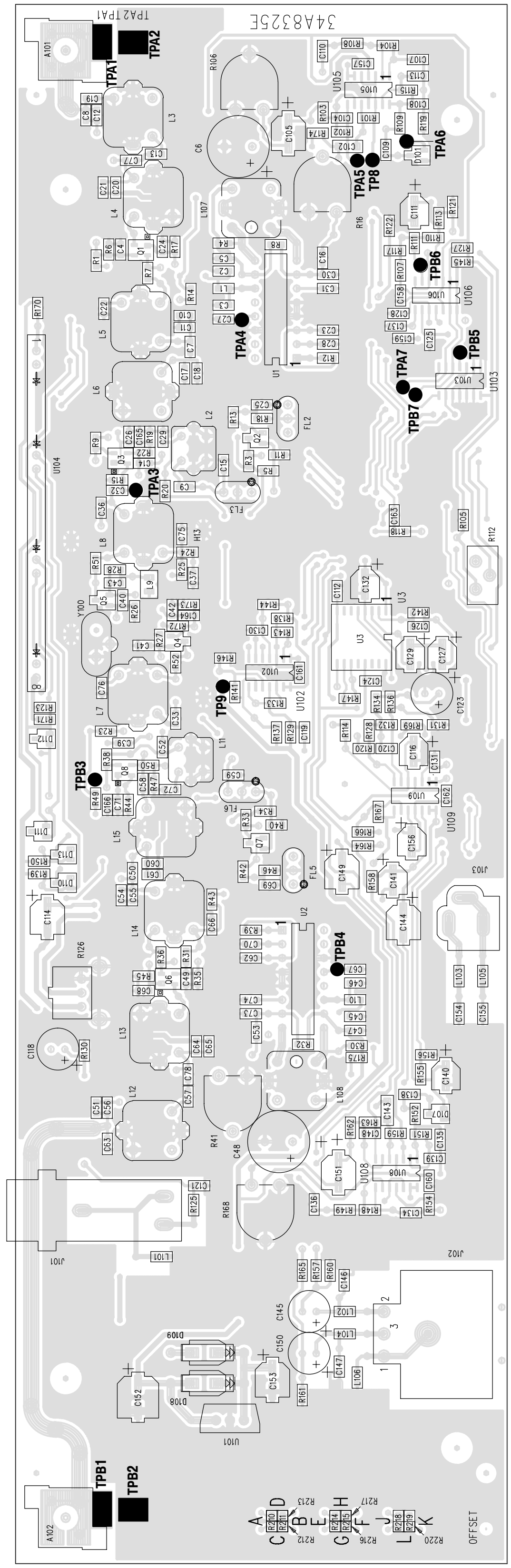


Figure 5. *T4 Receiver Pc Board, Component Side*

TP – Test Points

Channel A

- TP1A 50 Ω Input Cable
- TP2A 50 Ω Input Cable
- TP3A RF Test Point
- TP4A (U1, Pin 13) RF Alignment
- TP5A (U105, Pin 8) Audio
- TP6A (Positive end of C111) 1 Vdc
- TP7A (U106, Pin 13) If 9 Vdc, Channel is "ON"

Channel B

- TP1B 50 Ω Input Cable
- TP2B 50 Ω Input Cable
- TP3B RF Test Point
- TP4B (U2, Pin 13) RF Alignment
- TP5B (U108, Pin 7) Audio
- TP6B (Positive end of C40) 1 Vdc
- TP7B (U106, Pin 14) If 9 Vdc, Channel is "ON"

- TP8 (U3, Pin) 5 Vdc
- TP9 (U101, Pin 3) 9 Vdc

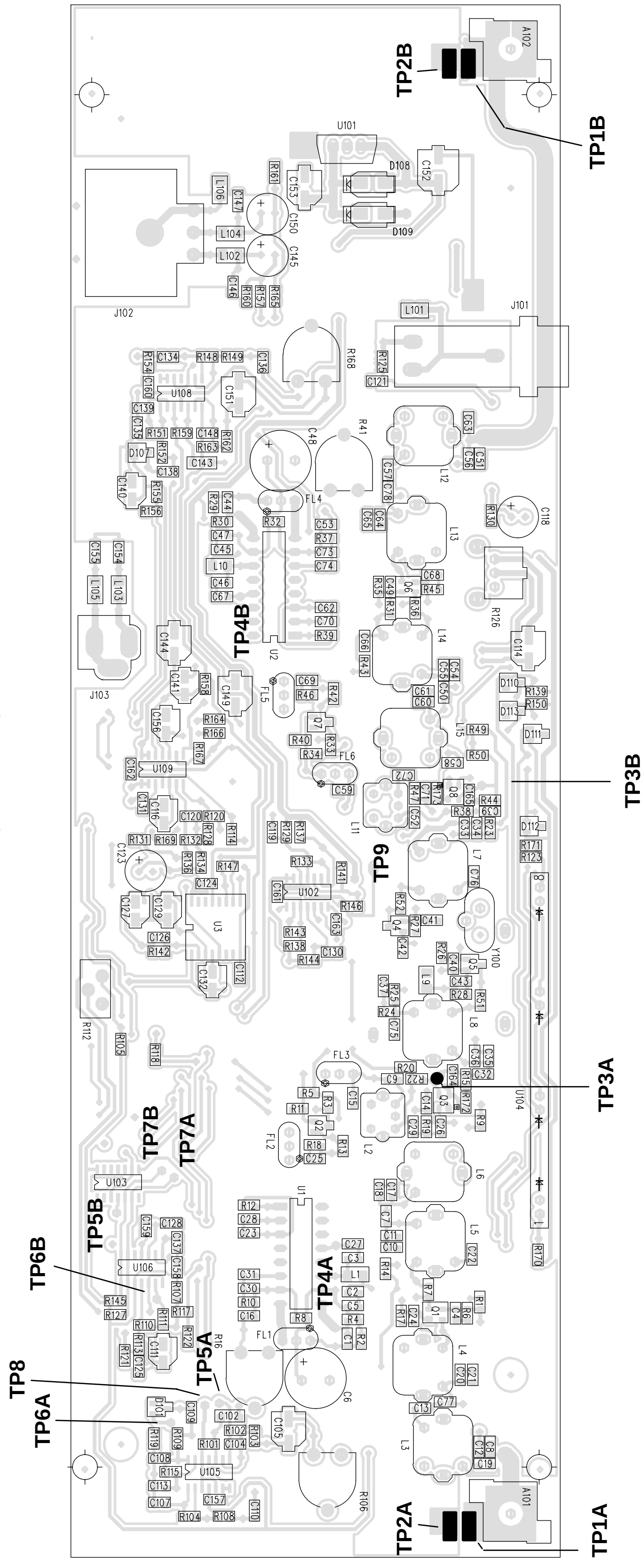
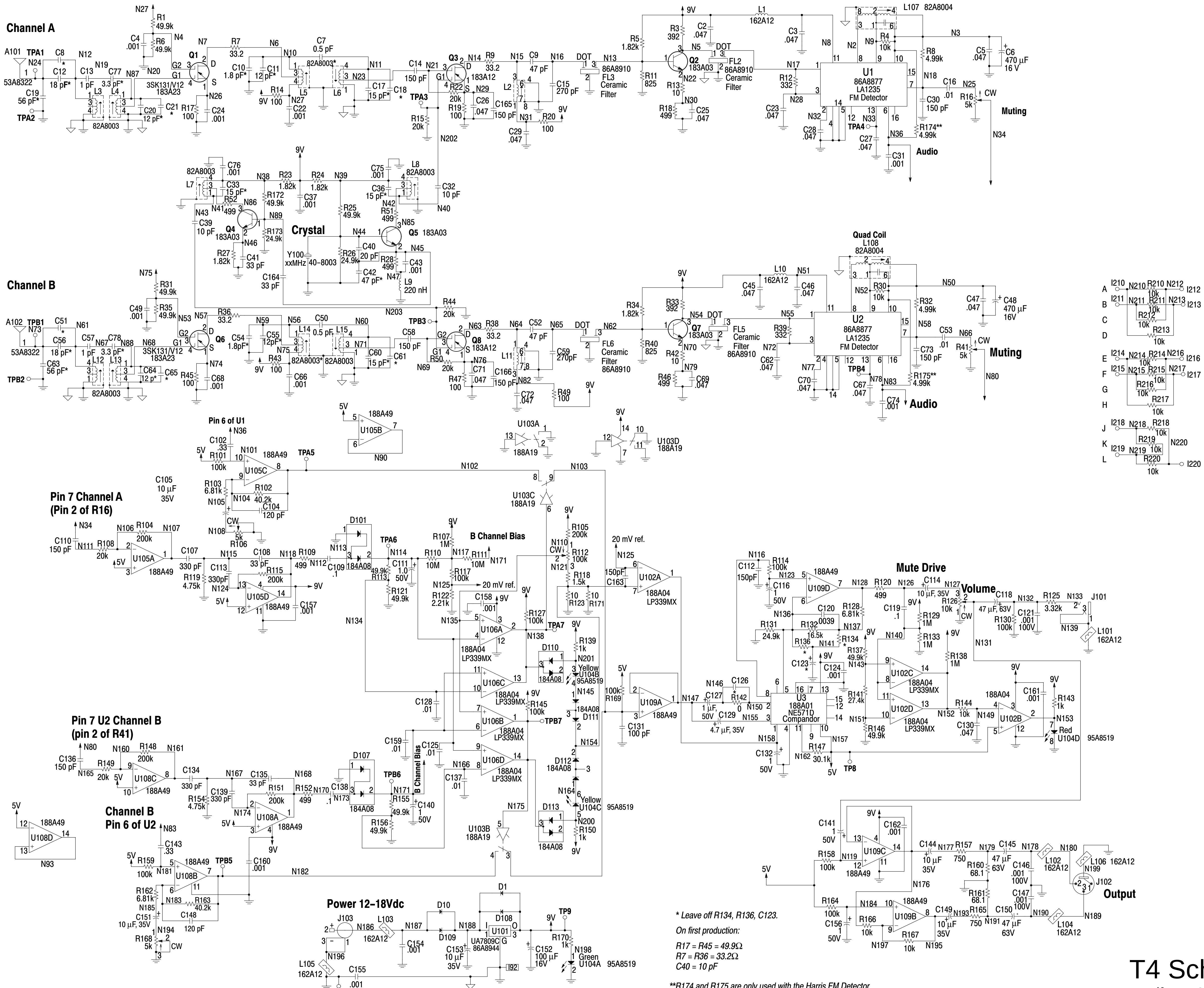
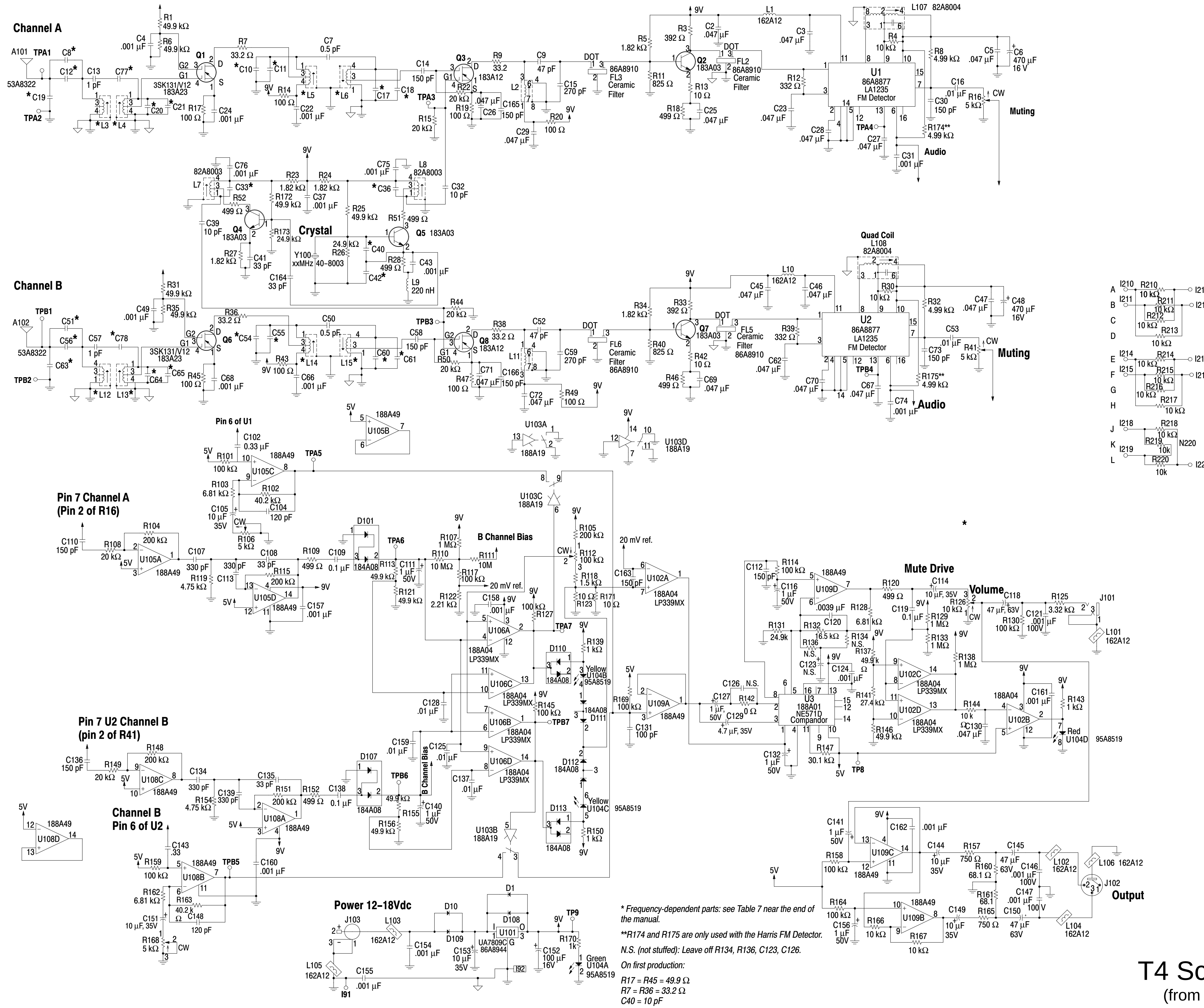


Figure 6. ***Earlier Version*** *of T4 Receiver Pc Board, Side 1*



T4 Schematic
(from 90-8550E-11)



** Frequency-dependent parts: see Table 7 near the end of the manual.*

***R174 and R175 are only used with the Harris FM Detector.*

N.S. (not stuffed): Leave off R134, R136, C123, C126.

On first production:

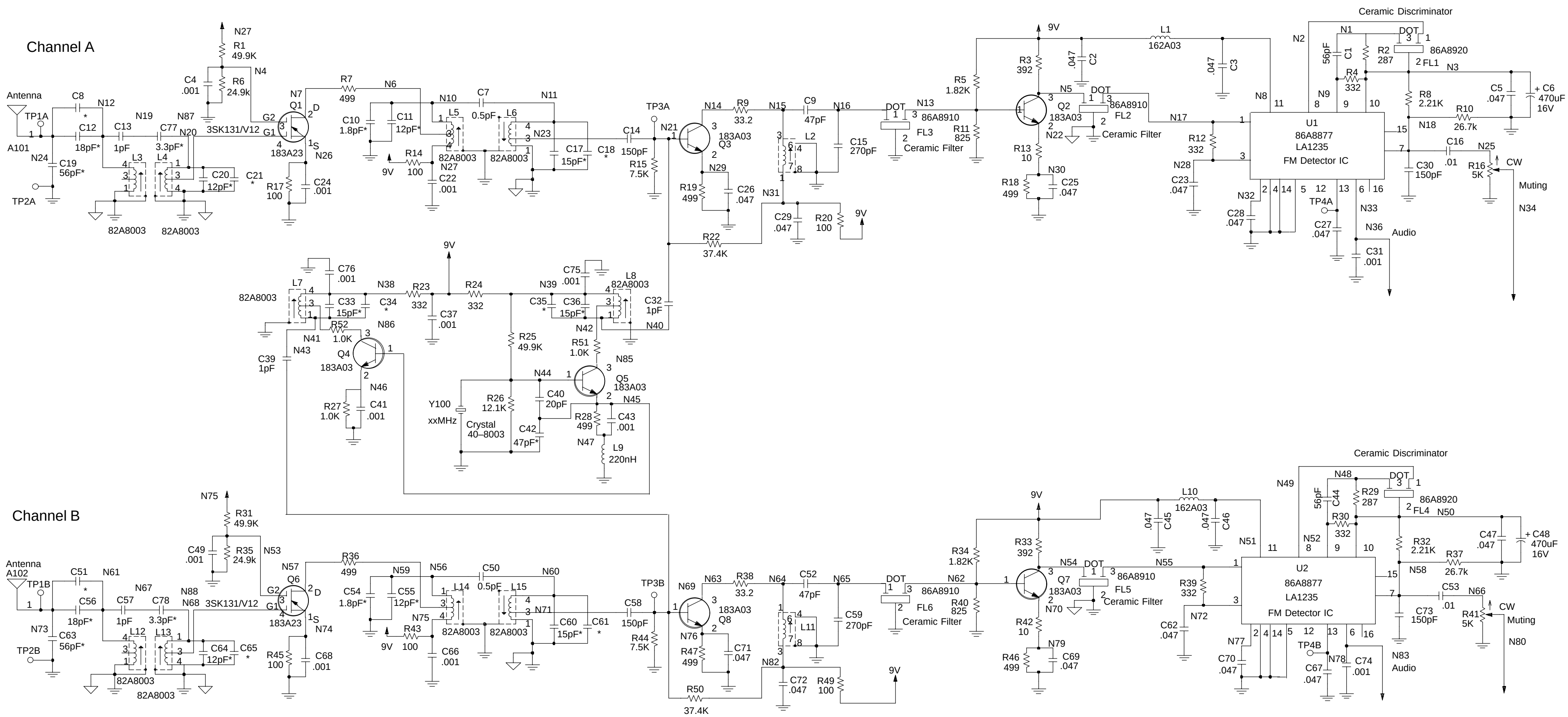
R17 = R45 = 49.9 Ω

R7 = R36 = 33.2 Ω

C40 = 10 pF

T4 Schematic

(from 90-8550F-11)



T4 Earlier Version Schematic

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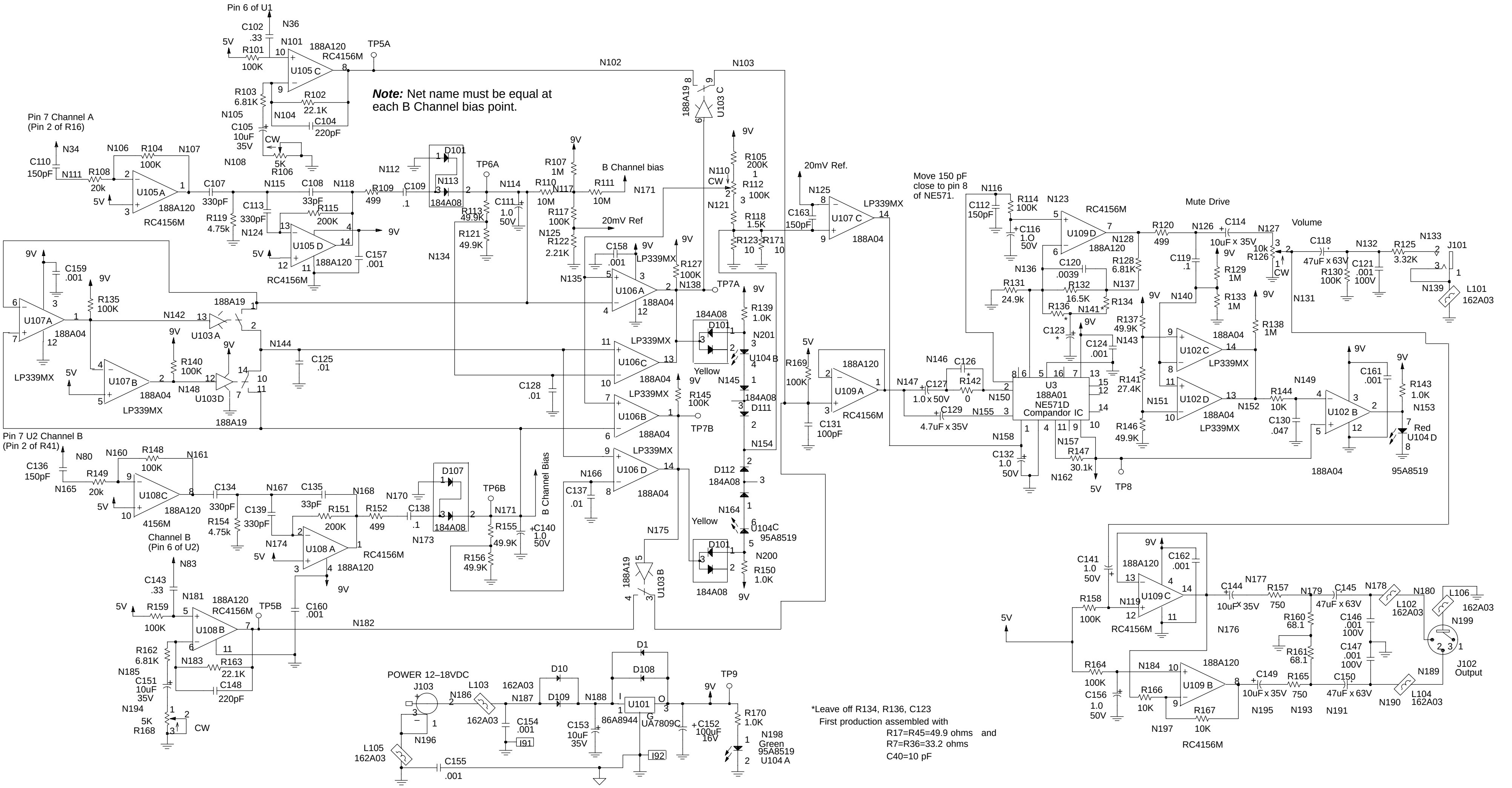
27C1020 (SB)



T4 Earlier Version Schematic

(page 2 of 2)

27C1020 (SB)