Indice del Manuale RTX Kenwood (in lingua inglese)

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CONTENUTO

POWER SUPPLY CIRCUIT (Riparazione dei circuiti di alimentazione)

RECEPTION CIRCUIT

Thursday, December 25, 1997   9:57 PM

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POWER SUPPLY CIRCUIT (Riparazione dei circuiti di alimentazione)

RECEPTION CIRCUIT

Thursday, December 25, 1997   9:57 PM

Thursday, December 25, 1997   9:57 PM

DIGITAL CIRCUIT

Thursday, December 25, 1997   9:57 PM

Thursday, December 25, 1997   10:08 PM

Fine documento

Thursday, December 25, 1997   9:57 PM

POWER SUPPLY CIRCUIT (Troubleshooting the power supply circuit)

1. Power is Not Turned ON
(For models containing an AC power supply)

Setup ; Connect the AC power cord to the set.

1. Turn the power ON and OFF quickly.
   Did the internal speaker buzz?
   > YES : The AC primary line is OK. Go to Item 5.
   > NO : The AC line is defective.
   > Check the fuse at the AC primary side.

2. Open the case and measure the AC voltage at the primary side of the transformer with a tester. (Measure the voltage between A and B with the AC range of the tester.)
   Is the AC voltage present?
   > YES : The power switch is OK. Go to Item 3.
   > NO : The wire from the AC connector to the transformer has broken.
   > The power switch may be defective.

3. Measure the voltage at the secondary side of the AC transformer. (Measure the voltage between C and D and between E and F with the AC range of the tester.)
   Is the voltage present at the AC secondary side?
   > YES : The transformer is OK. Go to Item 4.
   > NO : The wire at the secondary side of the transformer has broken.
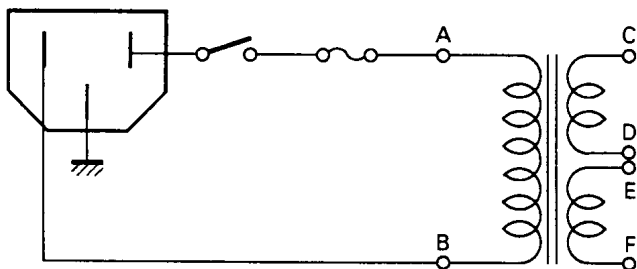
4. Measure the output voltage of the diode bridge. (DC-VM)
   Is the DC voltage present? (G, H)
   > YES : The diode bridge is OK. Go to Item 5.
   > NO : The bridge is defective.
   > If the bridge is shorted, the fuse at the AC primary side blows when the power turns ON.
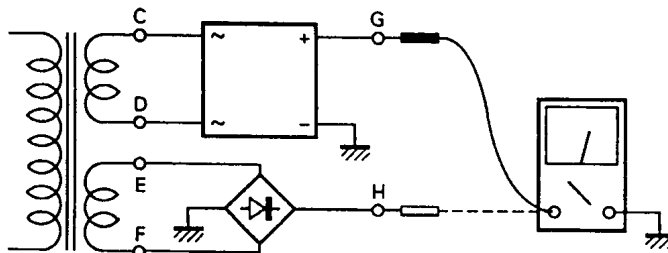
5. Measure the output voltage at the output terminal of the AVR board.
   (Examples: TS-930, TS-940 28F, TS-950 FHV)
   Is the prescribed voltage present?
   > YES : The AVR transistor is OK. Go to Item 6.
   > NO : The AVR transistor is defective or the lead connecting the AVR transistor and the AVR board has poor contact.

6. Measure output voltages, such as 15V, 12V, 8V, and 5V, from the AVR board.
   Are the correct voltages output?
   > YES : The AVR board is OK.
   > (The power is not turned ON due to a problem in another board.)
   > Check 12V and 5V applied to the control board and digital board. (Is the voltage applied to the microcomputer or other ICs?)
   > NO : The AVR board is defective.
   > Check the rear side of the AVR board for soldering defects.
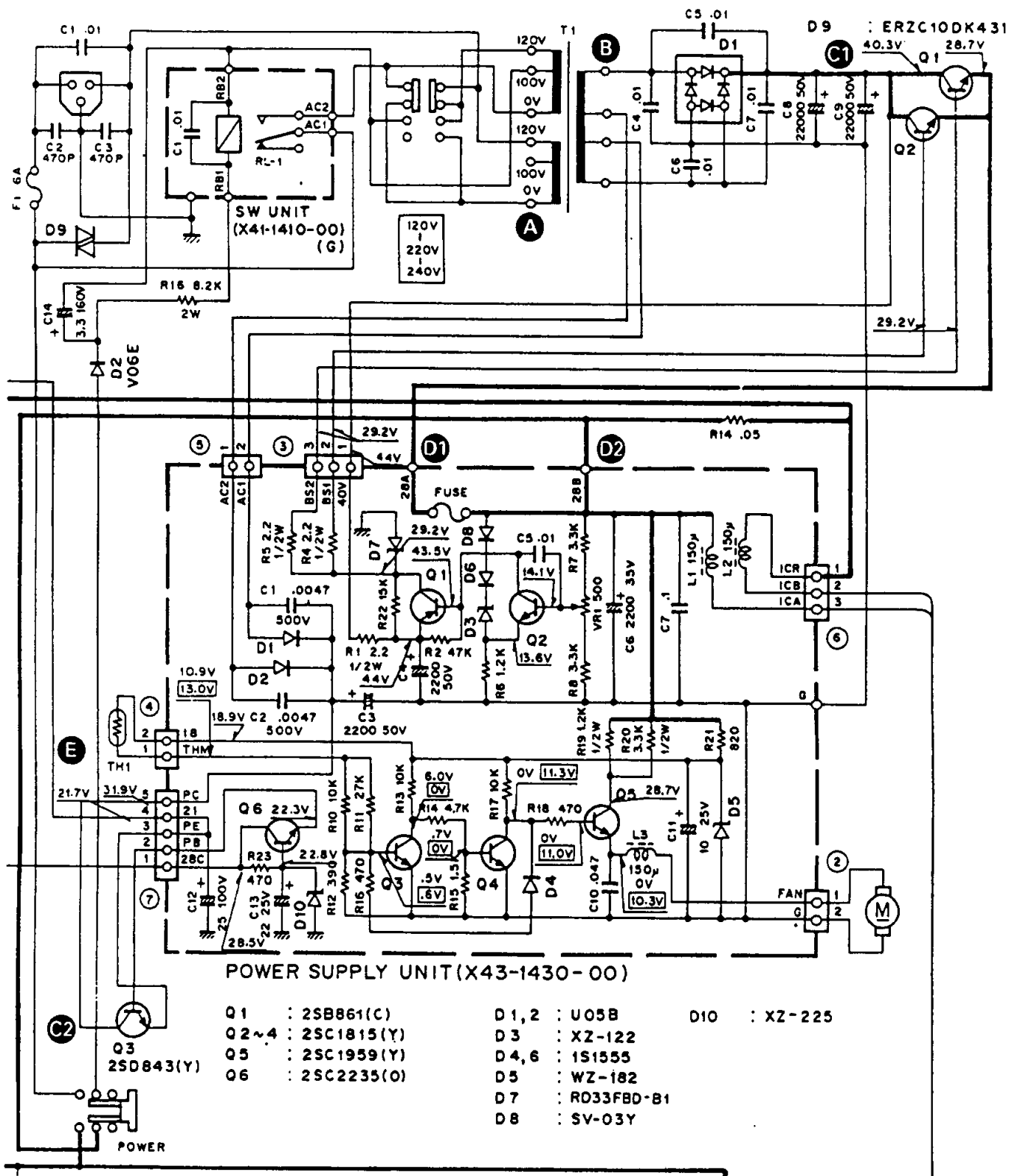
Check points

(A) AC primary voltage T1IN
(B) AC secondary voltage T1OUT
(C1) High B D1OUT
(C2) Common B Q3 collector

(D1) 28A Q1, Q2 emitters
(D2) 28B FUSEOUT
(E) 21C Q3 emitter

TS-930 AVR unit

2. Power is Not Turned ON
(For models with an external power supply)

Connect the external power supply to the set with a DC power cord. (The power supply should have an ammeter and a current-limiting circuit.)
The limit current should be set to 3 to 5A.

1. The pointer of the ammeter on the power supply does not move when the power switch on the set is turned OFF.
   YES : Turn the set ON. Go to Item 2.
   NO : The final transistor, power module, or reverse-connection prevention diode is broken. The power line may be directly grounded (due to wire seizure).

2. Does the ammeter pointer move when the power is turned ON?
   YES : The DC cord fuse is OK. (If the pilot lamp lights, the voltage has been applied to the set.)
   NO : Has the fuse blown?

3. Open the case and measure voltages (SB, CB, 8C, 8R, 5C, etc.).
   Are all the voltages correct?
   YES : The power supply circuit is OK.
   NO : Check the power line.

Check the voltages input to the IF and RF boards. If any of them are incorrect, check the line on the power supply board. If the voltage is still incorrect, the power supply board is defective. If the voltage is correct, there is a problem between the power supply board and the first checkpoint.

4. The power supply circuit is OK, but the power is not turned ON.
   The display circuit is defective and the pilot lamp is broken.
   Check the voltage at both ends of the pilot lamp.
   Check the voltage of the DC-DC converter in the display circuit.
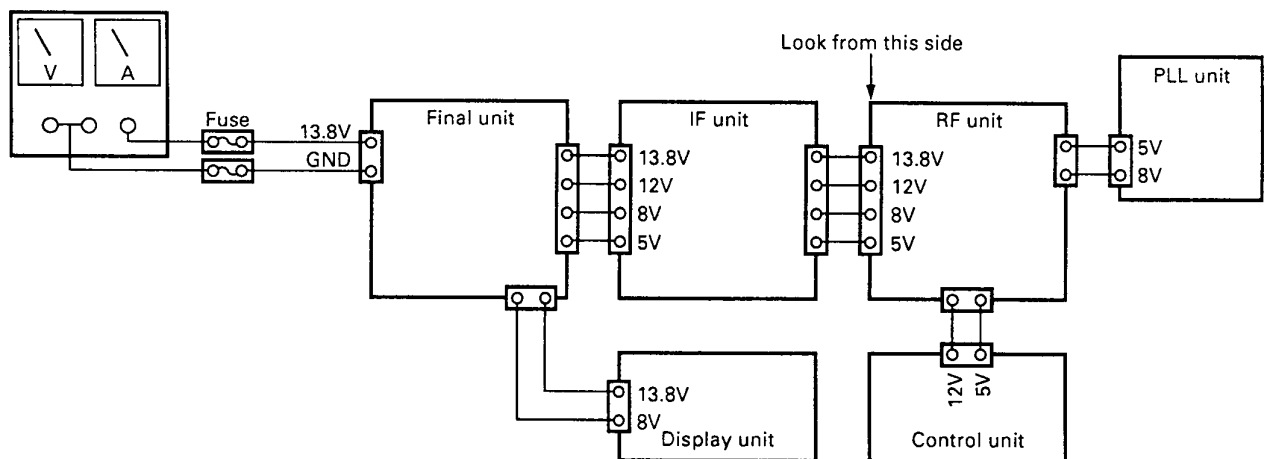
Conceptual diagram of power line

3. Power is Not Turned ON
(For models with a software sense type power switch)

Examples: TH-27, TH-47, TH-77, TH-28, TH-48, TH-78, TM-741, TM-742, TM-732, TS-50 (Receivers containing timers, such as R-5000)

Setup ; Connect the power cord (battery) to the set.

1. Reset
· How to reset HF transceivers, including TS-50
  Hold down the A=B key and turn the power ON. (All reset)
  Hold down the A/B key and turn the power ON. (VFO reset)

· How to reset mobile transceivers, such as TM-742
  Hold down the MR key and turn the power ON. (All reset)
  Hold down the VFO key and turn the power ON. (VFO reset)

· How to reset handy transceivers
  Hold down the M key and turn the power ON. (All reset)

· TH-28, TH-48, and TH-78
  Hold down the F key and turn the power ON. (VFO reset)

· TH-27, TH-47, and TH-77
  Hold down the ENT key and turn the power ON. (VFO reset)

This is a "software resetting" procedure for the microcomputer.

2. Disconnect the power connector (battery), hold down the appropriate reset key and the power switch, and connect the power connector (battery).

For models with software sense type power switch, the microcomputer is active while the power supply is connected. If the power is turned OFF while the microcomputer is malfunctioning, it enters the backup mode and remeins in the abnormal state. Therefore, the microcomputer does not accept any command to turn the power ON.
The check in Item 2 is performed to shut down the power completely, and to stop and reset the microcomputer.

3. Open the case and check whether the voltage is applied to the microcomputer.
   (Measure the voltage between the microcomputer Vcc and GND, using a DC-VM.)
   Is the voltage present?
       YES : The SB line, fuse, and power cord are OK. Go to Item 4.
       NO : Check the SB line, fuse, power cord, and connector.

4. Check the line from the power switch to the microcomputer.
   Does the CPU port go HIGH when the power switch is pressed?
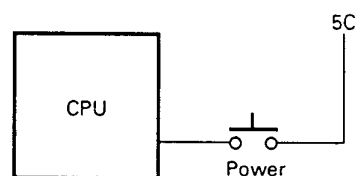
5. Disconnect the lithium battery for microcomputer backup from the board to discharge the backup line and reset the microcomputer. (Hardware reset)

   · Unplug the power cable.
   · Ⓐ Remove the lithium battery. (Unplug the power cable.)
   · Ⓑ This line does not discharge soon. Ground the line by using a lead.
   · Connect the power cable and reset.
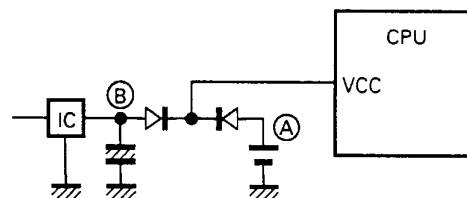
6. Does the microcomputer output clocks?
   (Check the microcomputer clock input waveform with an oscilloscope.)
       YES : The crystal oscillator is OK. Go to Item 7.
       NO : Is a voltage applied to the lead of the crystal oscillator?

If voltage is applied to the lead of the crystal oscillator, but clocks are not generated, the oscillator or microcomputer may be faulty.
If no voltage is applied to the lead, check whether the voltage is applied to the power input pins of the microcomputer. There are two or three power input pins.
If no voltage is present at these pins, replace the microcomputer.

7. Replace the board

As shown in the circuit diagram, the ground pin of the microcomputer is not directly grounded, but is grounded through a 10-ohm resistor. If the resistor is broken, the ground pin is not grounded, so the microcomputer malfunctions. Before replacing the board, check this resistor.
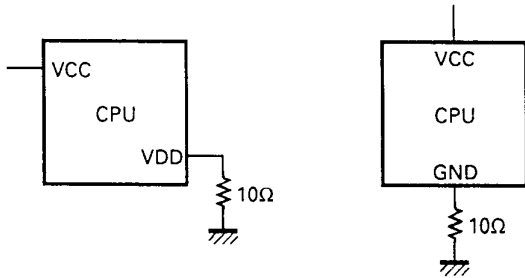
4. The Voltage Cannot be Adjusted

The AVR unit contains a circuit that generates the reference voltage, which can be adjusted by turning a semi-fixed variable resistor (VR).

The AVR circuit of the TS-940 is shown below.

When the voltage-adjusting variable resistor VR1 is turned, the base and collector voltages of Q2 change. The base and collector voltages of Q1 change. The base voltages of Q101 and Q102 change. The emitter voltages of Q101 and Q102 are determined.

TS-940 AVR unit

— 9 —
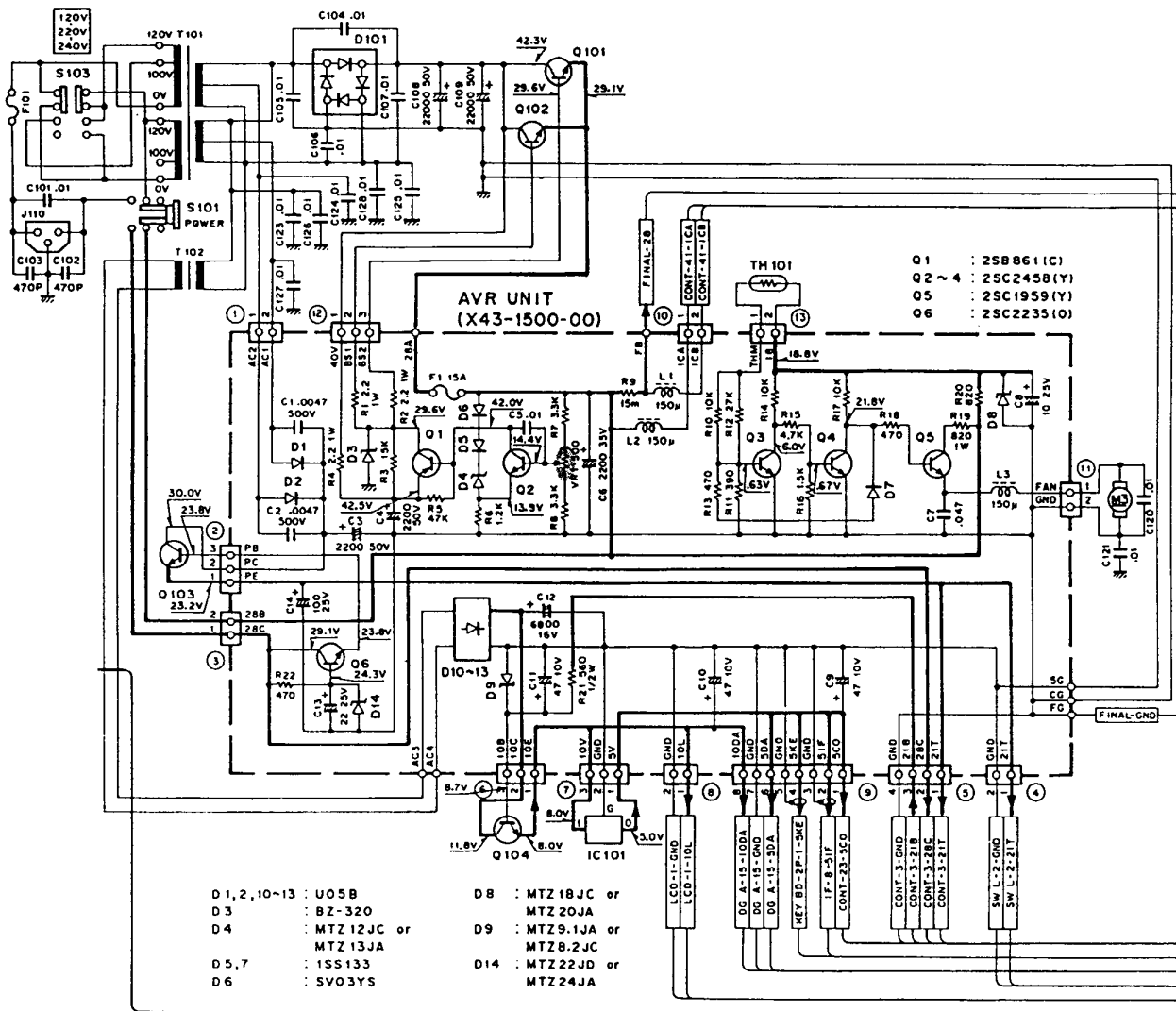
■ The voltage of FB (final B) is high or low

1. Is the Q2 emitter voltage correct?
   YES : D4, D5, and D6 are OK.
   NO : D4, D5, or D6 is shorted or a wire has broken. The R6 wire is broken.

2. Is the Q1 collector voltage correct?
   YES : D3 and Q1 are OK.
   NO : Check D3 and Q1.

3. Are the R1 and R2 resistances correct?
   YES : Q101 or Q102 is defective.
   NO : The R1 or R2 wire has broken. (R1 and R2 are bias resistors for Q101 and Q102.)

The TS-940 is taken as an example in the above description, but it is the same for other models.

Most models can be repaired by checking the bias resistances of the AVR transistor, zener diode for voltage determination, bias determination transistor, and AVR transistor.

■ The voltage of 28B, 10A is high or low

1. Is the zener diode (D14 or D9) for voltage determination shorted?
   If one of the diodes is shorted, the output goes LOW.
   If the diode wire is broken, the output goes HIGH.
   In either case, be sure to check the output transistor because it may be damaged.

■ The output voltage of the three-terminal regulator is high or low

1. Is the input voltage of the three-terminal regulator HIGH (or LOW)?
   Normal : The IC is defective or the load is LOW (or HIGH). Go to Item 2.
   Abnormal : A circuit prior to the IC input is defective.

2. First, replace the IC.
   If the problem persists, the load may be abnormal.

5. Example

See the TS-940 AVR circuit diagram again (Page 9).

■ If the IC101 output is incorrect

Disconnect CN9 (IC101 output).
If the IC output becomes normal, the load is wrong.
Disconnect the 5V output pins of CN9 one at a time.
If the voltage becomes normal when a pin is disconnected, the load on the pin is abnormal.

- **If the voltage is HIGH**
  Measure the voltage at the pin. (DC-VM)
  Normally, the voltage is 0V or less. If it is higher than the IC output, it is the cause of the problem.

- **If the voltage is low**
  Measure the resistance at the pin. (Tester, ohm range)
  It must be lower than the resistances of the other pins.
  This is the cause of the problem.

■ Example 1

1. Disconnect all CN-A connectors.
2. Disconnect all CN-A pins one at a time.
3. CN-A pin 1 is found to be faulty. Reconnect the pins.
4. Disconnect CN-B pin 1. If the voltage becomes normal, this line is defective.
5. Reconnect CN-B pin 1.
6. Disconnect the CN-C.
7. This indicates that the CN-C board is defective.

If the line is grounded, use an ohmmeter.
If the voltage is abnormal, use a DC-VM

Ω meter
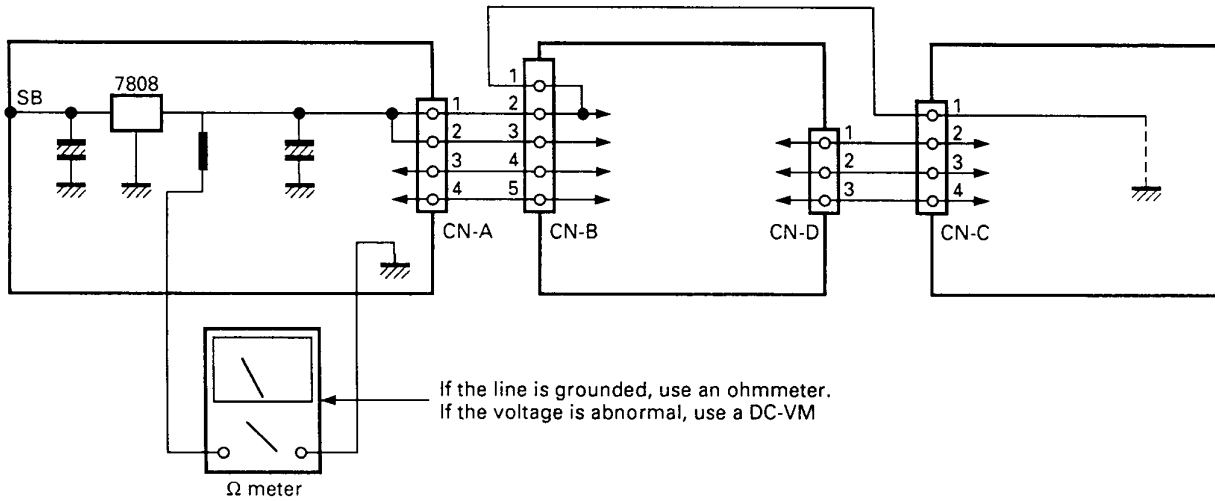
■ Example 2 : TS-940 RF unit

Remove the components on the board one at a time in the same way and check them. (Solder them again after checking.)

Symptom: 18V is lower than the prescribed value.
Cause: D48 is shorted.

1. Remove L85 → No change → Solder it again.
2. Remove L47 → No change → Solder it again.
3. Remove R60 and R150 → No change → Solder them again.
4. Remove R24, D27, VR1, and C77 → No change → Solder them again.
5. Remove L3 and L4 → No change → Solder them again.
6. Remove R143 and R144 → The voltage becomes normal.
7. Solder R143 → The voltage remains normal.
8. Solder R144 → The voltage drops → This line is defective.
9. Remove IC1 pin 16, C178, D48, D25, and R152.
10. Solder the components again one at a time to find the one that reduces the voltage.
11. D48 is found to be shorted.

See the circuit diagram on the next page.

TS-940 RF unit

RF UNIT (X44-1660-00)
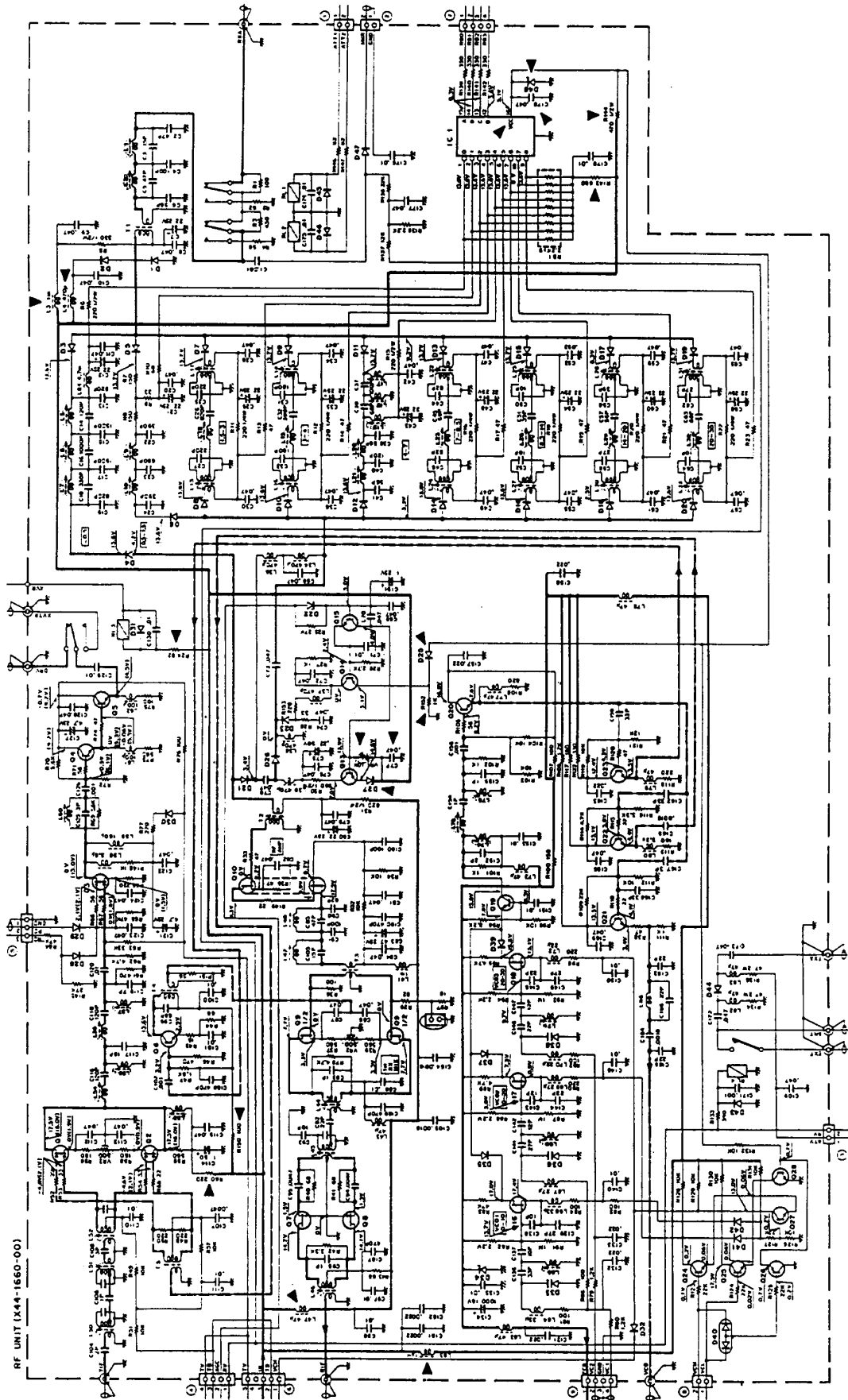
6. Models That Can Use Two-way Power Supplies (TS-711, TS-811, etc.)

These models have the following configuration:
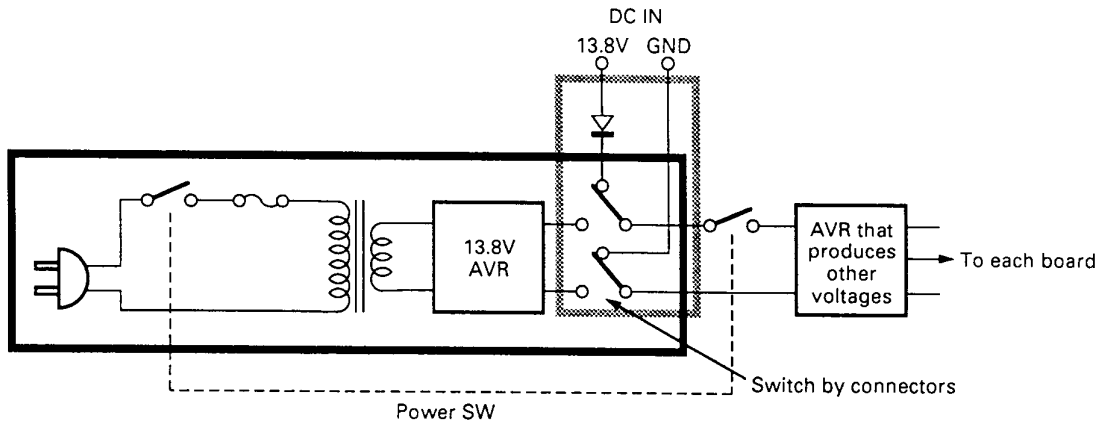
1. The AC power is supplied, but DC power is not supplied
   The parts enclosed by ▒▒▒ seem to be defective.

2. The DC power is supplied, but AC power is not supplied
   The parts enclosed by ▭ may be defective.
   See the "Power is not turned ON" section.

For a two-way power supply, check AC or DC power to isolate the defect.
If neither AC nor DC power is supplied, a circuit following DC-IN is suspected.

■ The AVR gets excessively hot

The AVR transistor normally gets very hot. So it uses a heat sink to dissipate heat, but it may get too hot to touch the heat sink.

- **Check the cooling fan operation (If any)**
  Warm the thermistor (TH) with a dryer or soldering iron.
  If the fan runs, the cooling fan is OK.
  If not, the motor or the temperature detection circuit is defective.

- **How to identify a defective thermistor**
  Warm the thermistor to the temperature at which the fan motor starts running.

There are two types of motor drive circuits
  A type : If the motor ground voltage drops, the detection circuit is OK.
  The motor is considered defective.
  B type : Unplug the connector and measure the voltage at the positive (+) side of the motor. If Vcc is present, the detection circuit is OK. The motor is considered defective.

A type
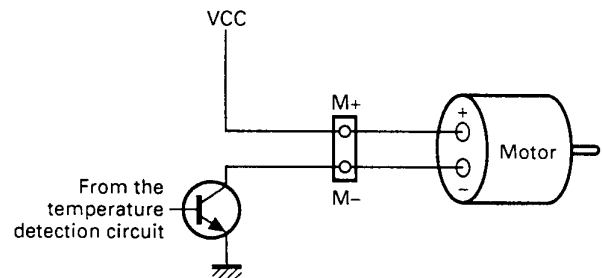
B type
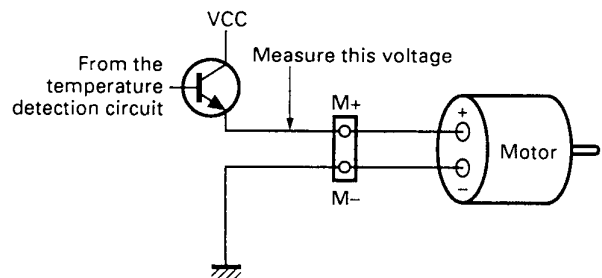
- Touch the transistors or ICs to find the hottest one
  If you find a component that becomes excessively hot, the load on the output from that component is excessive. (Overcurrent) See page 10.

If the AVR circuit or the final circuit is repaired, check the cooling fan. This is an important tip for minimizing redundant repairs.

■ A transistor in the AVR circuit fails

Many engineers probably have experiencing finding a defective transistor and replacing it with a new one, that also failed when the power was turned ON.

1. Measure the resistance between the output pattern of the transistor that failed and the ground (GND). (Tester: ohm x 1 range)
   Is it grounded?
2. Is the zener diode shorted?
3. Check whether the transistor fails due to an abnormal load or a defective AVR circuit.
   Remove the loads. (FB, 28C, 10C, 8C, 5C, etc.)
   If the transistor fails again, the AVR circuit is defective.
   If it does not fail, plug in the connectors again, one at a time. See page 11.
4. If the AVR circuit seems to be defective, desolder and solder the AVR board components again.
   Pull any soldered leads.

- Example
  AVR transistor leads of the TS-940 (The component leads are connected directly to the lead wires.)
    Check the mini-connectors for poor contact.
  TS-940 Q103 three-pin connector
    If a three-pin connector is used to connect transistor leads, remove the connector and solder the leads directly to the pins.
    Replace the AVR transistor.

2SB 861

Remove the connector and solder the leads directry to the pins.
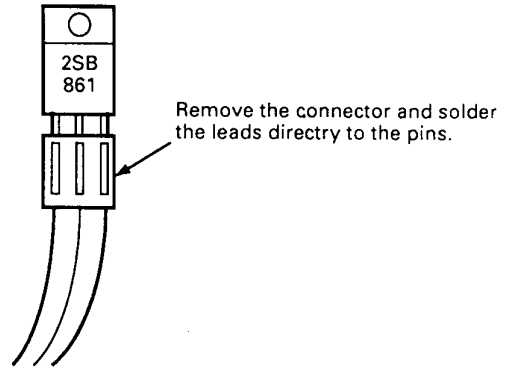
RECEPTION CIRCUIT

Setup ; SQL-VR: MIN, RF GAIN-VR: MAX,
ANT: To SG, AF-VR: 10:00

1. Does the beep sound when the mode is changed?
(For models containing the mode-announce function)
YES : The AF power amplifier is OK.
NO : The AF power amplifier does not work, or a circuit following the AF amplifier is defective.

1. No Reception (No Noise)

1. Apply a large input (60dB) from the SG to check the S- meter.
The meter operates: The receiver circuit is working normally. A circuit following the detection circuit is defective.
The meter does not operate: The receiver circuit is not working normally. See page 19.

■ **Possible causes in circuits after the detection stage**
1. The external phone jack or headphone jack has a poor contact. A speaker wire has broken.
2. The AF amplifier is defective. No bias is applied to the IC.
3. The AF-VR is defective. The connector has a poor contact.
4. The mute circuit or squelch circuit is always working.
5. The mode change circuit or AF notch circuit is defective. (For models containing an AF notch circuit)
6. Broken pattern, poor soldering, or poor connector contact is present in the above circuits.

■ **If the receiver circuit is OK, check as follows:**
(A circuit following the detection stage is defective)
• **Example: TS-440 IF unit (See next page)**
1. Touch J11-SPK. (The AF-VR must be set to about 10:00.)
2. Touch J4-SPO.
3. Touch J2-AF2.
4. Touch J2-AF3.
5. Touch the Q12 base.
6. Touch IC1 pin 1.

Check the above points to find a point where a buzz does not sound.
For example, if a buzz sounds when SPO is touched, and it does not when AF2 is touched, the circuit between these points is defective.

Apply the tester probe to the four points within the ohm range (x1000) to check whether a buzz sounds.
Check the points in the order shown below.
(You can use an oscilloscope to check whether a noise is output.)
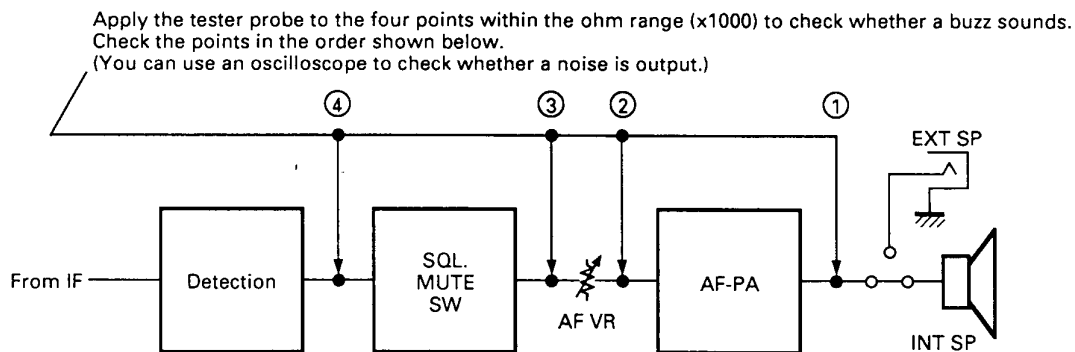
If the receiver circuit is OK, check as follows
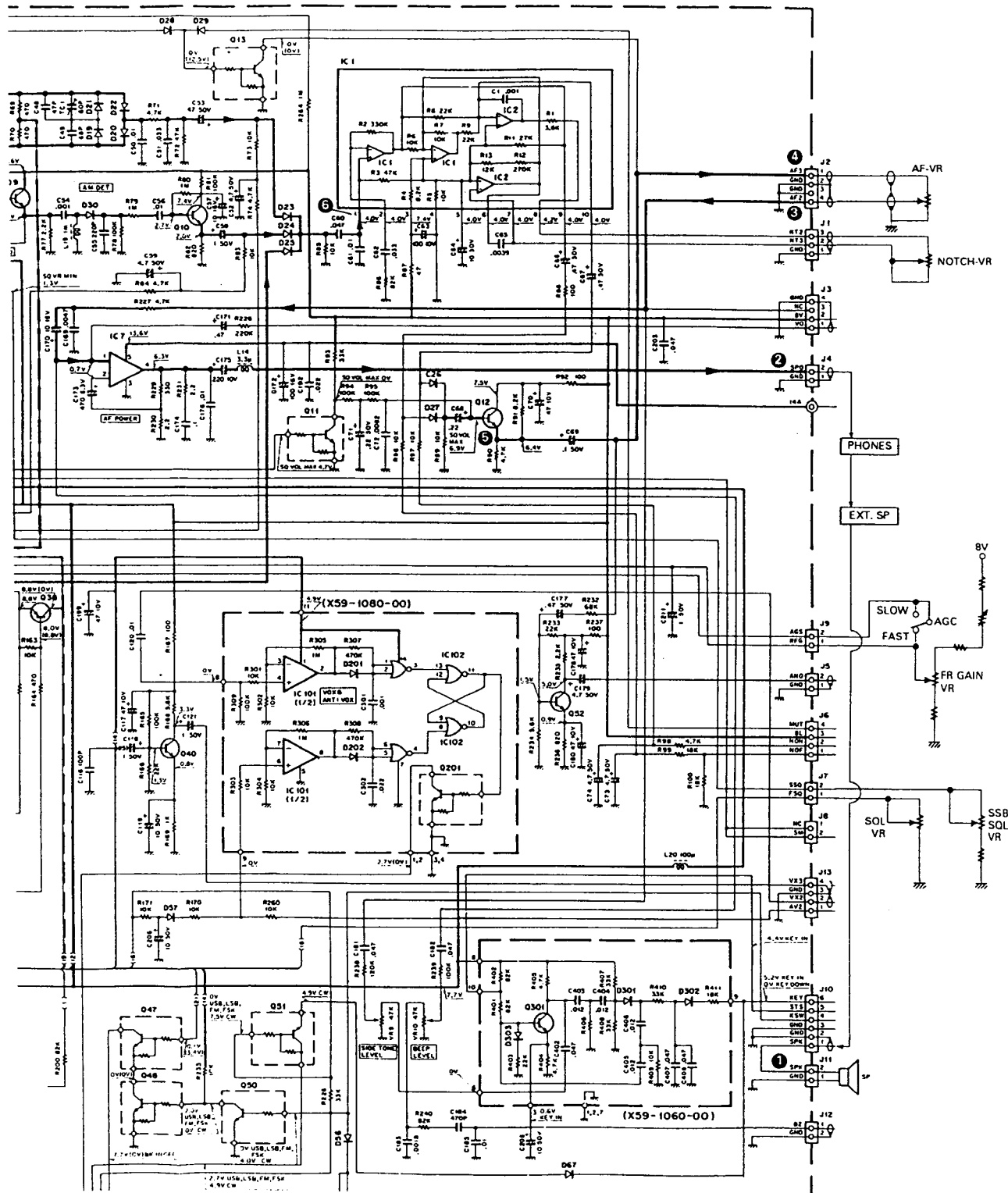
TS-440 IF unit

■ How to check the SQL circuit

1. Check the SQL volume.
   If the SQL-VR is OK, the SQL circuit is defective.

· TS-440, TS-450, TS-690, TS-850, TS-790, TS-50, etc.

SQL MIN
0Ω~500Ω

SQL MAX
10kΩ~100kΩ

· TS-940, TS-950, TS-950SDX

SQL MIN
0Ω

SQL MAX
Several kΩ~
Several dozen kΩ

2. Measure the SSQ line voltage using the DC-VM, and turn the SQL-VR from MIN to MAX.
   Does the voltage change?
   If it does, the line is OK.

3. Measure the base voltage of the transistor that mutes the AF line, and then turn the SQL-VR from MIN to MAX.
   Does the voltage change?
   It is OK if the voltage flowing between the base and emitter of the transistor is 0.6 V or less when the SQL-VR is set to MIN, or if it is higher than the voltage (0.6V) that can turn the transistor ON when the SQL-VR is set to MAX.

0.6V or higher

0.6V
or higher

More accurately, if the voltage changes, the AF mute transistor may be defective.
If it does not change, check the voltage of the preceding circuits by changing the SQL-VR.

■ How to check muting

The mute signal is output to cut off pop noise when one mode is changed to another or also to turn the AF signal OFF during transmission.
The microcomputer outputs it when one mode is changed to another.
The TXB or RL signal is received during transmission.
Check the input to the muting transistor or IC in the AF line before the AF-VR.
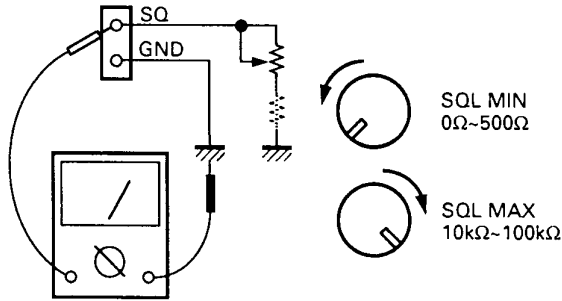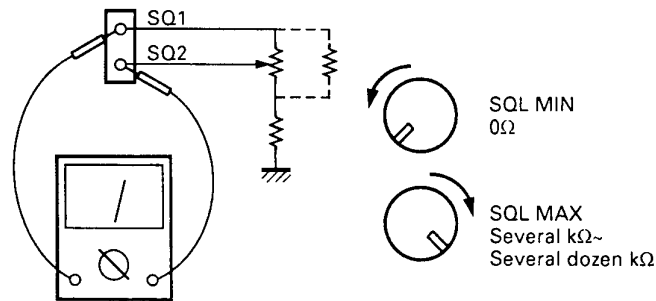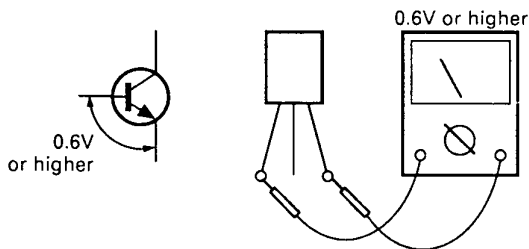
· The AF power amplifier does not work

1. Check the Vcc line voltage with the DC-VM.
2. Replace the IC.
3. Is the resistance of the resistor connected to the output correct? Is the capacitor shorted?
4. Check the resistors and capacitors of the negative return circuit.
5. Check the voltage of the input terminal. If it is abnormal, desolder all the connected parts and solder them again to locate the defective circuit.

■ Mode-change circuit

There are two types of mode-change circuits: one that changes the mode with a diode and another that changes it with an IC switch.

The TS-140 circuit diagram from the detection circuit to SPOUT is shown on the next page.
The TS-140 SQL is effective in FM only, and Q58 is turned ON and OFF by the voltage at IC6 pin 13.
The mute signal makes CN3 pin 9, MUT, HIGH, and passes through D70 to control Q57.
In transmit mode, CN3 pin 14, RB, and Q43 OUT go HIGH to control D112 and Q57. (In SSB mode, TXB and Q55 input go HIGH, the output goes LOW, and IC7 (2/4) turns OFF.)
The mode-change circuit is changed by IC7 in AM (4/4), SSB (2/4), and FM (3/4).

ON   OFF

HI   LOW

AM mode: IC7 pin 12 goes HIGH, and the other pins go LOW.
SSB mode: IC7 pin 5 goes HIGH, and the other pins go LOW.
FM mode: IC7 pin 6 goes HIGH, and the other pins go LOW.

VCC

OFF   HI   OFF

LOW   LOW

VCC

ON   LOW   ON

HI   HI

Circuit are like this.
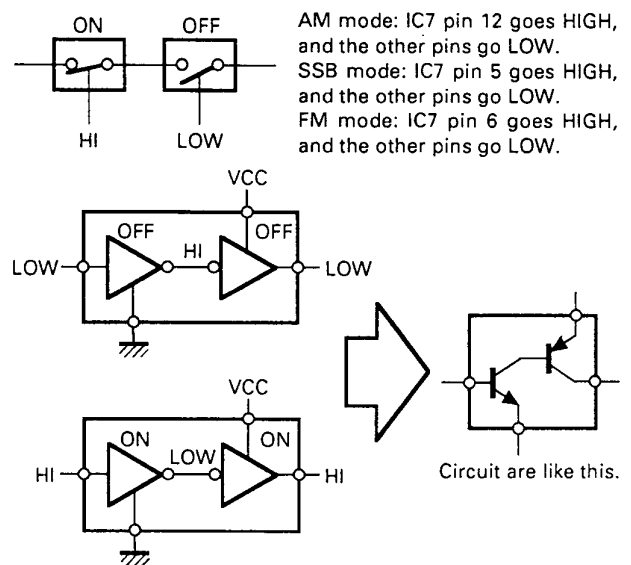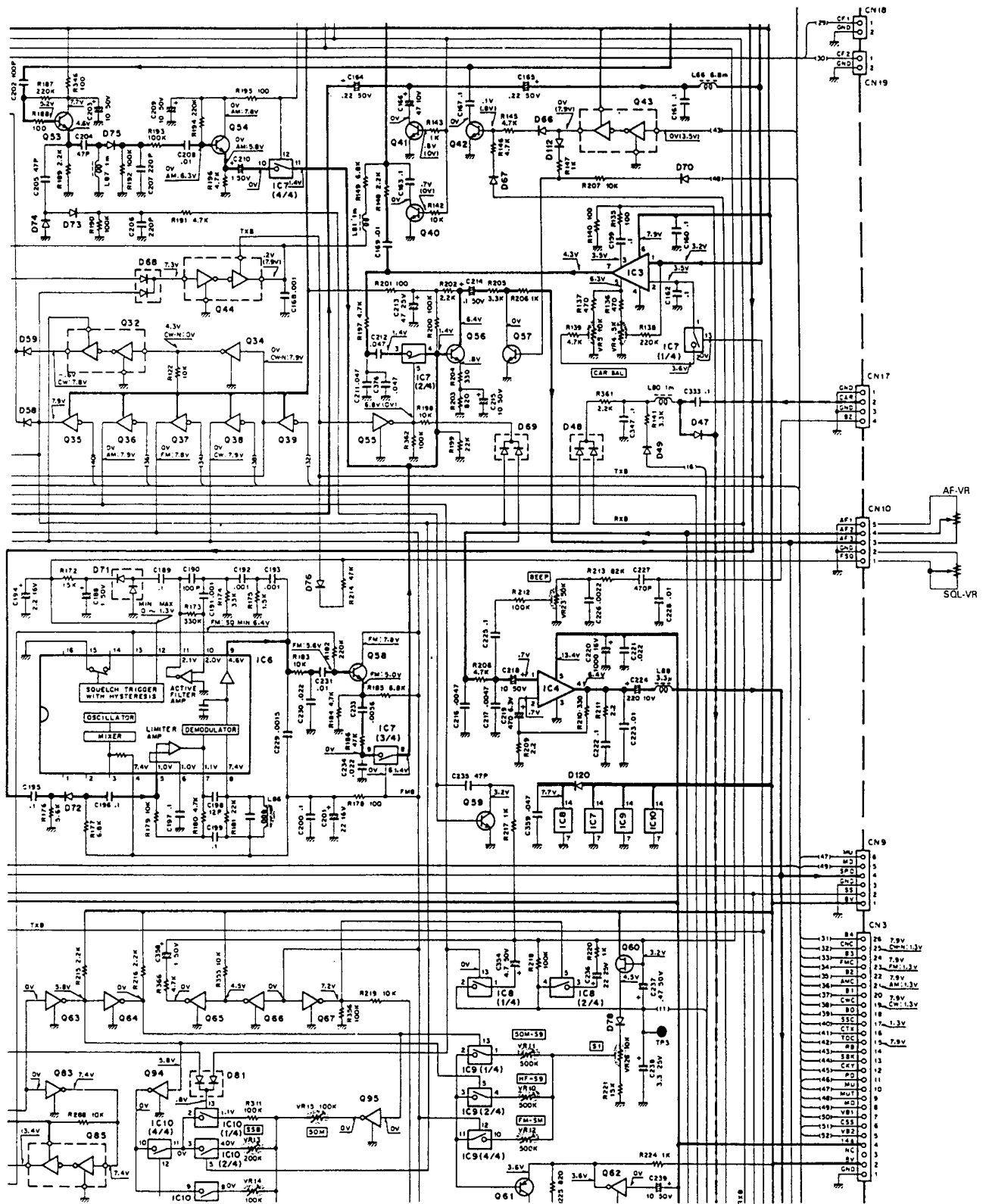
The TS-140 circuit diagram from the detection circuit to SPOUT

■ **If a circuit prior to the detection circuit is defective**
- Examples of typical problems
1. CAR is not input to the detection circuit.
   (No noise is output in SSB only. OK in FM and AM.)
   Use an oscilloscope to check them.
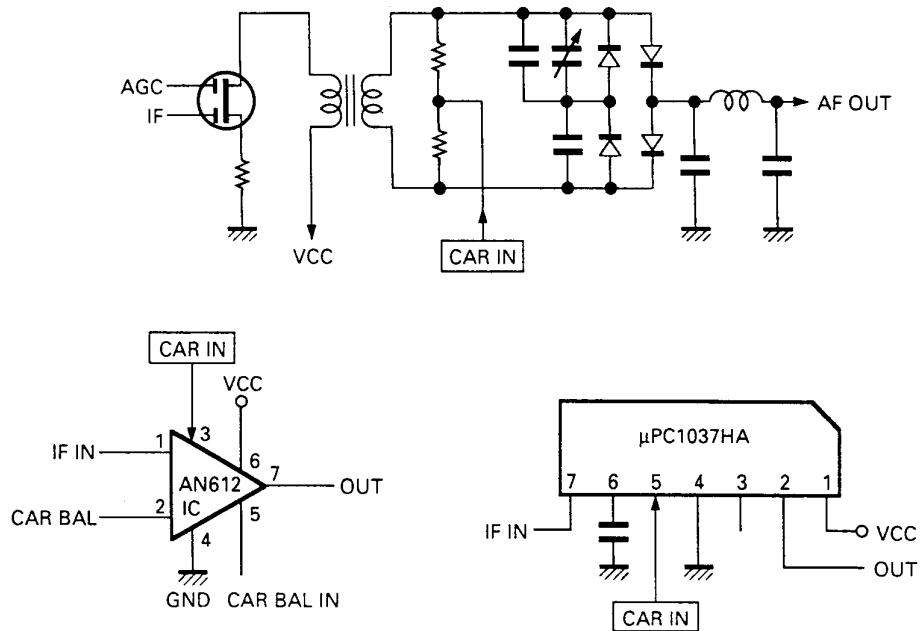
SSB detection circuit

2. RXB is not supplied to the receiver IF stage. (SSB, FM, AM)
   Check the voltage of the receiver circuit FET or transistor.
3. Defective AGC
   Check the voltage of the dual-gate FET to which AGC is applied.

If TXB leaks, it is 8V or 15V during transmission, but it must be zero during reception. If the voltage leaks during reception, the input line of the dual-gate FET in the IF stage becomes zero or lower. If negative voltage is applied to the dual-gate FET, check TXB.
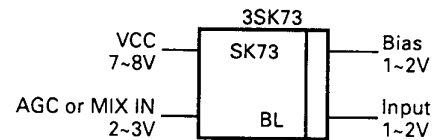
Model with common B of 8V.
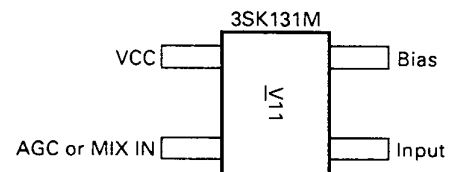
If common B is 15V, VCC becomes 10V or higher.

— **19** —

2. Signals are Not Received (Noise is Output)

Set frequency: 14.100MHz, USB mode
SSG frequency: 14.101MHz

1. Input a 100dBμ signal from the SSG to the antenna. Does the transceiver receive it?

    YES : The signal line is broken or the mixture level is wrong.

    NO : The mixture frequency is incorrect. The PLL frequency is wrong.

BPF

BPF

BPF

RF ATT

RF AMP

1st MIX

1st IF BPF

1st IF AMP

2nd MIX

IF FILTER

IF FILTER

OPTIONAL FILTER

2nd IF AMP NB GATE

3rd MIX

IF FILTER

IF FILTER

OPTIONAL FILTER

Point A   LO1   Point B

Point C   LO2   Point D

Point E   LO3   Point F
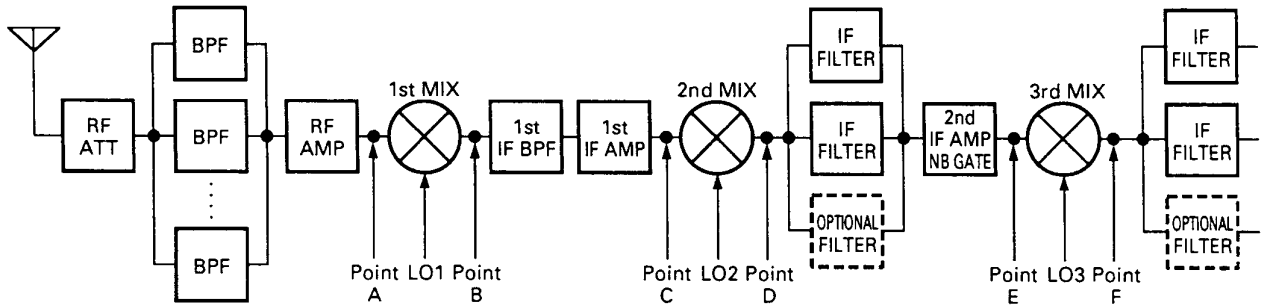
2. Make a jig like this

The capacitor is used for DC cutting. Use a capacitor with high capacitance so that it may be used for HF to UHF.

GND

M type connector

Connect to GND of the set.

Fix here

103

To SSG

0

Capacitor 0.01μF

Lead
Attach the clip to the test point

Set
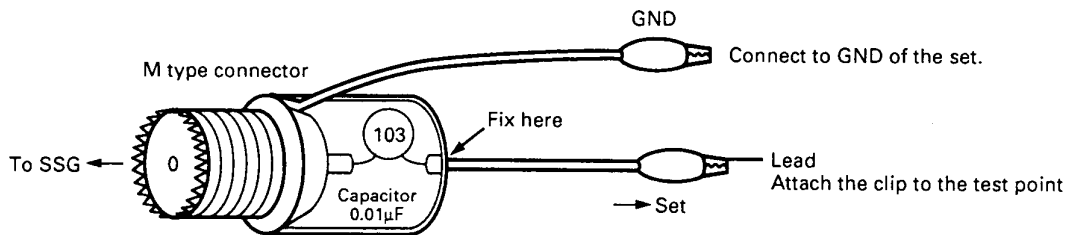
The alligator clip does not provide sufficient grounding. See the figure below to better understand the connection.

Joint the antenna connector to shielding plate, etc.

To SSG

Test point
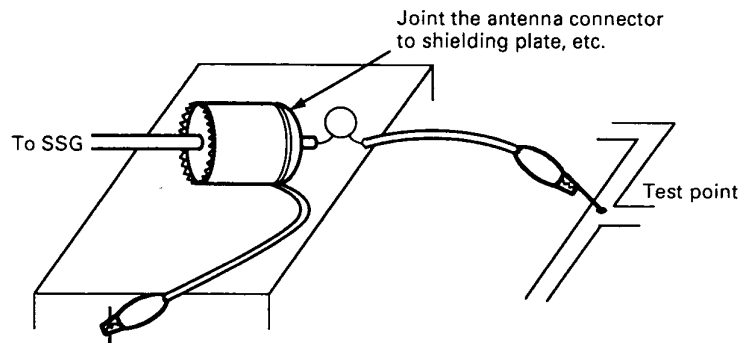
3. Connect the SSG to the jig and input signals to each point. (Fix the set frequency to 14.100MHz.) The set IF frequencies are as follows:
1st: 73.05MHz; 2nd: 8.83MHz; 3rd: 455kHz.

Point A: 14.101MHz (SSG frequency), about 10dB (SSG output)
Is the signal received?
　YES : The RF band-pass filter (BPF) is defective. Check connections from the antenna to point A, RF amplifier power supply, and the BPF switch.
　NO : Other circuits are defective.

Point B: 73.05MHz, about 10dB
Is the signal received?
　YES : The LO-1 frequency is incorrect.
　Is the LO-1 frequency correct?　Is the level sufficient?
　NO : Other circuits are defective.

Point C: 73.05MHz, about 25dB
Is the signal received?
　YES : The first band-pass filter (BPF) is defective or the first IF amplifier does not work.
　There is a problem between points B and C. Locate it with the jig.
　NO : Other circuits are defective.

Point D: 8.83MHz, about 25dB
Is the signal received?
　YES : The LO-2 frequency is incorrect.
　Is the LO-2 frequency correct?　Is the level sufficient?
　NO : Other circuits are defective.

Point E: 8.83MHz, about 40dB
Is the signal received?
　YES : The second IF filter or the second IF amplifier is defective.
　There is a problem between points D and E. Check it with the jig. The NB gate may be closed. If so, check the NB circuit.
　NO : Other circuits are defective.

Point F: 455kHz, 40 to 60dB
Is the signal received?
　YES : The LO-3 frequency is incorrect.
　Is the LO-3 frequency correct?　Is the level sufficient?
　NO : Other circuits are defective.
　Check the IF filter change circuit or the third IF amplifier.

■ **How to calculate LO-1, LO-2, and LO-3 frequencies**
Suppose that the frequencies are as follows:
Set display frequency : 14.10MHz
First IF frequency : 73.05MHz
Second IF frequency : 8.83MHz
Third IF frequency : 455kHz

1. LO-1
　$73.05 - 14.10 = 58.95$MHz
　$73.05 + 14.10 = 87.15$MHz
　LO-1 must be one of the above frequencies.

2. LO-2
　$73.05 - 8.83 = 64.22$MHz
　$73.05 + 8.83 = 81.88$MHz
　LO-2 must be one of the above frequencies.

3. LO-3
　$8.83 - 0.455 = 8.375$MHz
　$8.83 + 0.455 = 9.285$MHz
　LO-3 must be one of the above frequencies.

■ **If the IF frequency is different**
Set display frequency : 14.175 MHz
First IF frequency : 40.055 MHz
Second IF frequency : 10.7 MHz

1. LO-1
　$40.055 - 14.175 = 25.88$MHz
　$40.055 + 14.175 = 54.23$MHz
　LO-1 must be one of the above frequencies.

2. LO-2
　$40.055 - 10.7 = 29.355$MHz
　$40.055 + 10.7 = 50.755$MHz
　LO-2 must be one of the above frequencies.

■ Example: TS-950SDX

Suppose that the AF unit or IC11 is defective and the H642 frequency is incorrect.

1. Input the 100dBμ signal to the antenna. → NG
2. Input the signal from the RX-ANTIN terminal on the rear of the unit. (20dBμ) → NG
3. Input the signal to RF unit TP-3. → NG
4. Input the 73.05MHz, 20dBμ signal to the RF unit CN-7, MIF. → NG
5. Input the signal to IF unit TP-3. → NG
6. Input the 8.83MHz, 50dBu signal to TP-3.
   Reception begins at this time. If the signal is not received before being mixed, but is received after mixing, the signal is not being mixed properly.
7. Check the H642 frequency with a frequency counter.
8. It is found that the H642 frequency is wrong.
9. The VFO2 in the AF unit is defective.
10. See the PLL troubleshooting section.
11. IC11 is found to be defective.

3. Receiver Sensitivity is Low

Use a sensitivity check jig.

Use another set that can be used for comparison, if any, to find a problem.
If the sensitivity is lower than 5dB, it is difficult to find the problem without using a set for comparison.

If such a set is not available, check the sensitivity by referring to the level diagram shown in the Service Manual. (The level diagram should be used for information only. The manual shows the values of the design samples and pre-produced sets. The design and the level diagram may be changed during mass production.)

The level diagram is explained in detail in the "Reading the service manual" section on page 90, taking the TS-850 as an example.

4. The Reception Frequency Fluctuates and The Reception Tone is Wrong

■ The reception tone fluctuates in SSB

There is a possibility of 90% or higher the PLL lock is not stable.
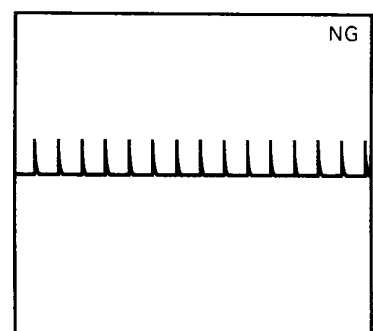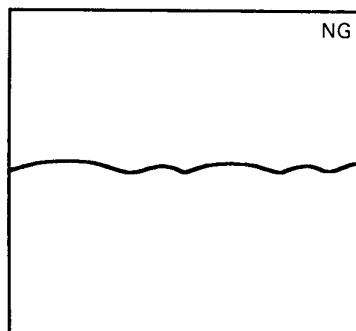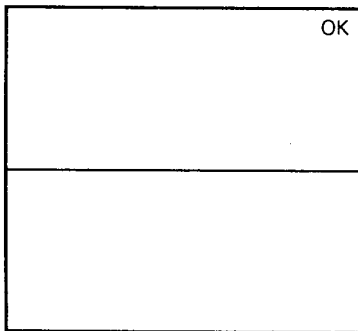
Refer to the PLL unlock section.

■ Technique for finding a problem

Apply the oscilloscope probe to the adjusting points for the PLL lock voltage and observe the waveform.
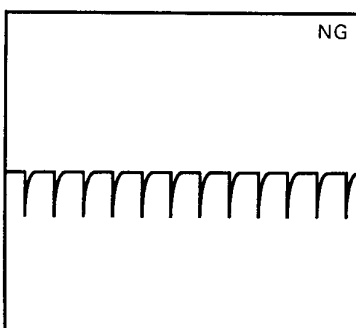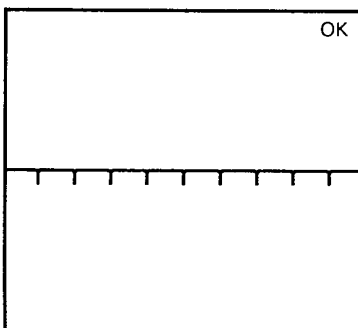
- Oscilloscope setup
  VOLT/DIV: Maximum sensitivity,
  Input: AC, TIME/DIV: About 1ms

1. If all the test points are OK:
   Check the IC UL detection terminal in the same way.

2. If the UL detection terminal is OK:
   The terminal can be checked by using SSGs as follows:

   · If two SSGs are available:
     Connect one to the antenna of the defective set.
     Use the other to supply the local frequency.

· If only one SSG is available:
  Connect a dummy load to the set that can transmit signals.
  Transmit signals at low power.
  Use the SSG to supply the local frequency.
  Connect a simplified antenna to the antenna of the defective set.

SSG2

To ANT

To LO

SSG1

or

Set that can transmit signals
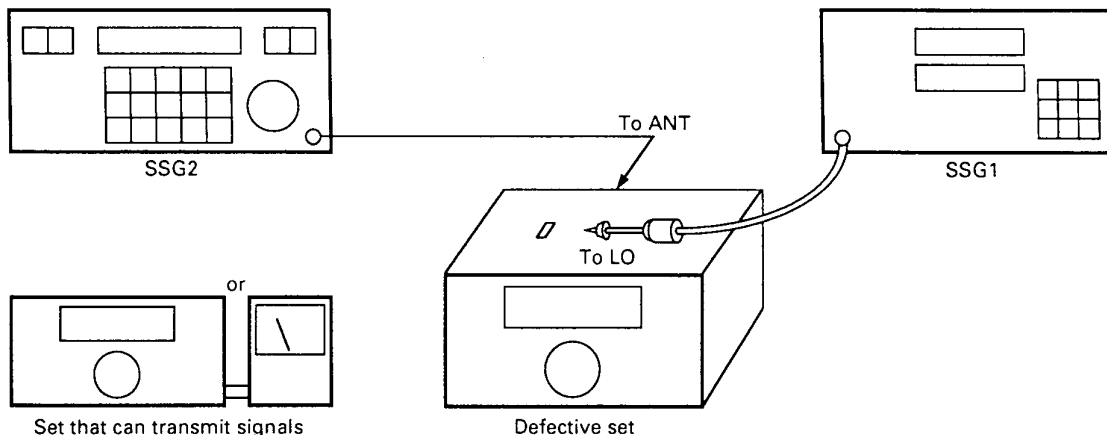
Defective set

■ Let the defective receiver receive signals

1. Remove LO-1 and input the SSG carrier to the first mixer circuit.
   The problem is solved ; LO-1 is wrong. To PLL circuit LO-1
   The problem is not solved ; LO-2 or LO-3 is wrong.
2. Install LO-1, remove LO-2, and input the SSG carrier to the second mixer circuit.
   The problem is solved ; LO-2 is wrong. To PLL circuit LO-2
   The problem is not solved ; LO-3 is wrong. To PLL circuit LO-3

Measure the LO-1, LO-2, and LO-3 frequencies with a frequency counter when the connectors are disconnected. Input the frequencies into the SSG. The SSG output must be at least 80dBμ.

Note : If the circuit is configured as follows, it does not work unless the voltage is applied to the hot side of the shielding wire. (TS-790)

This check can isolate a defective PLL.

8C, 8R

LO OUT   LO IN

OSC

Shielding wire

To SSG   0

103

1.5D 2V   To LO IN

M type connector

4.7μH

1kΩ

To 8V line
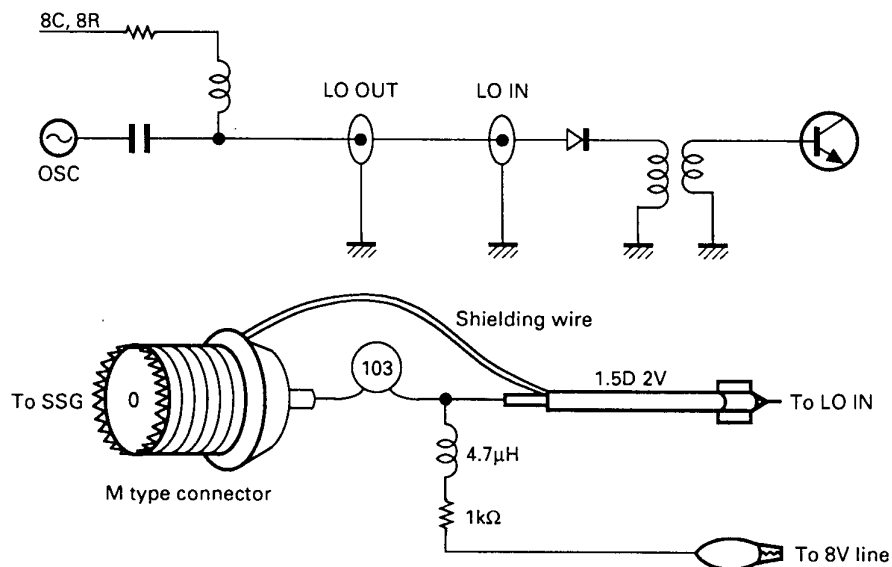
■ If you find a defective PLL
1. Replace the VCO transistor and FET.
2. Replace the varicap diode.
3. If the model is designed to adjust the lock voltage with a trimmer, replace the trimmer.
4. Replace the smoothing capacitor in the PLL LPF circuit.
5. Replace the transistor and IC in the PLL LPF circuit.
6. Replace the PLL IC.

You can solve the problem in this way with a possibility of greater than 80%.
If the VCO is modularized, replace the module.

■ If the problem still persists, do as follows
1. Apply cold spray to each PLL component during reception.
   Cool only one component and observe it until it goes back to the normal temperature.
   Continue this process until you find a component that worsens or improves the symptom.
2. Approach a hot soldering iron to each component, and perform a check in the same way.

5. Frequency Shift

(Both the transmission and reception frequencies must be checked here because it is necessary to determine which has shifted, the transmission or reception frequency.)

■ Check the transmission and reception frequencies for display:
1. Both the transmission and reception frequencies have shifted equally in the same direction.
   The PLL reference frequency has shifted.

2. Only the transmission frequency has shifted.
   One of the local frequencies has shifted.
   Calculate the local frequencies (LO-1, LO-2, and LO-3).

Set display: 14.000 MHz, Mode: CW
IF frequency: First: 73.05MHz; Second: 8.83MHz; Third: 455kHz
```
LO-1   73.05 ± 14.00  = 87.05xxxx
                       = 59.05xxxx
LO-2   73.05 ± 8.83   = 81.99xxxx
                       = 64.22xxxx
LO-3   8.83 ± 0.455   = 9.285xxxx
                       = 8.375xxxx
```

One of the two values is correct.
Check which frequency has shifted by calculating the frequencies in this way.

If the value measured with the frequency counter equals the calculated value within ±2kHz, it is OK. (The local frequencies shift in some modes.)
±3 to 5 kHz shift: Suspected. Check it.
±6 kHz or more: Check the PLL circuit.

See the PLL circuit section.

Note : The old models use crystal oscillators. Readjust each frequency as instructed in the Service Manual.
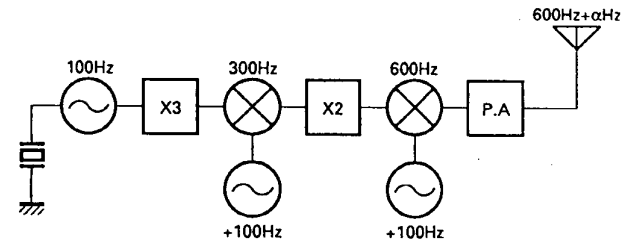
Each oscillator has a slight error as shown above, but if it is added to or doubled, the frequency shift may become significant.

■ The transmission frequency shifts in FM mode only (TS-770, TS- 780, TS-711, TS-811, TS-790, etc.)
The old models use crystal oscillators in HETs for frequency modulation in FM mode.
1. Verify that the transmission frequency does not shift in CW mode.
2. Verify that the transmission frequency shifts in FM mode only.
3. Find the varicap diode for frequency modulation. (It probably is located in the IF unit.)
4. Adjust the frequency of the crystal oscillator connected to the diode.

■ If the frequency is correct in FM mode only
The FM frequency may have been adjusted while the CW (basic) frequency has shifted. Adjust the CW frequency, then the FM frequency.

■ Only the reception frequency has shifted in FM mode
In SSB, if the frequencies are correct, only the reception frequency never shifts.

■ Verify that the transmission frequency is correct
Check the PLL reference frequency.
Check whether each mix frequency is correct.
This shows that the transmit frequency is correct, but the receive frequency has shifted.

■ Check how much the receive frequency has shifted

SSG frequency: 29.5000MHz
SSG MOD frequency: 1kHz; DEV: 3kHz; MOD: ON
Set frequency: 29.5000MHz

1. Shift the SSG frequency in 100Hz units and find the best SINAD point.
   If it is within ±1kHz, it varies within the components. It can be improved to some degree by readjusting the IF.
2. If it cannot be adjusted to within ±1kHz:
   Check each LO frequency shift during reception. (Refer to the transmission section.)
   If each measured frequency equals the theoretical frequency ±2kHz, there is no problem.
   If it is greater, perform troubleshooting as described in the transmission section.
3. Each frequency is correct.
   A common cause is a pass band shift of the MCF filter.
   Because the central frequency of the MCF filter has shifted, it seems to be an IF shift in FM mode.

4. If an IC is used for FM detection:
   Replace the components in the order listed below:
   IC
   455 IF filter → Discrete coil
   IC oscillator (Its frequency may shift by ±2kHz, but it is permissible.)
   IF MCF filter
5. A sensitivity check jig may be useful.
   Example: 14.100MHz, MODE: FM, SSG frequency: 14.100MHz; MOD frequency: 1 kHz; DEV: 3kHz
   In this case, do as follows:
   · Apply the jig to point A, and enter the IF frequency. (455kHz, 60dBμ)
   · Apply the jig to point B, and enter the IF frequency. (455kHz, 60dBμ)
   · Apply the jig to point C, and enter the IF frequency. (40.055MHz, 60dBμ)
   · Apply the jig to point D, and enter the IF frequency. (40.055MHz, 20dBμ)
   · Apply the jig to point E, and enter the IF frequency. (40.055MHz, 20dBμ)
   · Apply the jig to point F, and enter the RF frequency. (14.100MHz, 20dBμ)

   You can find the defective part by checking the point where the frequency begins to shift.
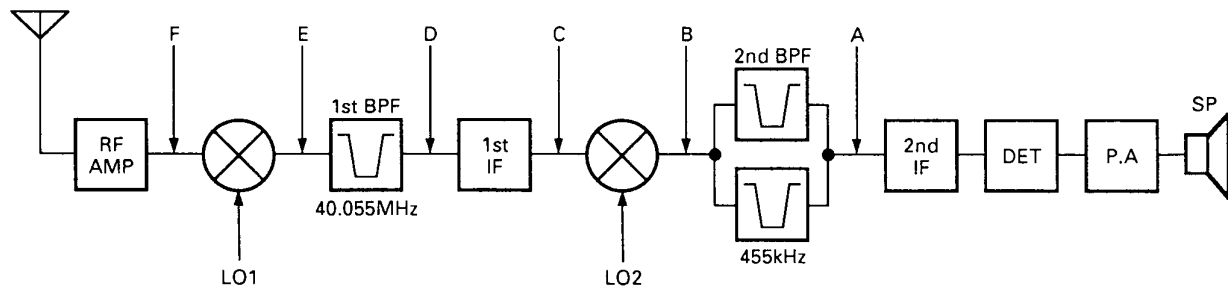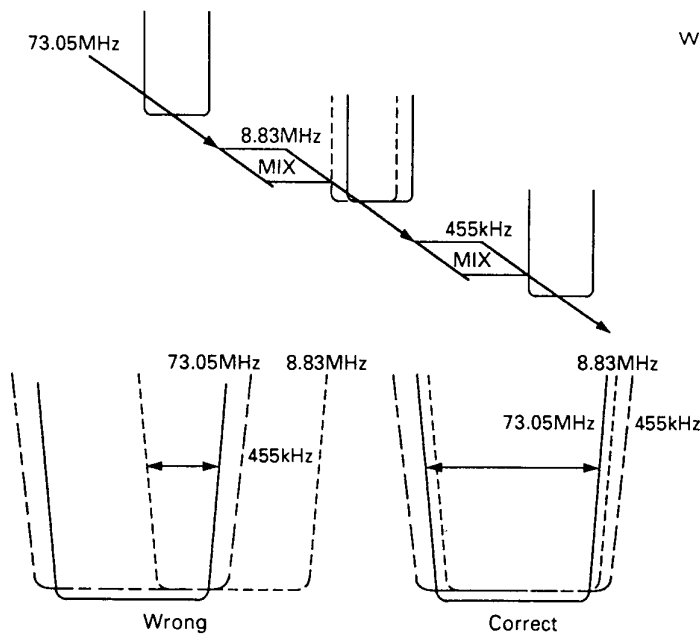
6. The Reception Tone Breaks

1. Subject the set to vibration.
   The reception tone breaks when the set is subjected to vibration. → The components have not been securely soldered to the board, or connectors have poor contact.
2. Connect an external speaker and subject the set to vibration.
   The reception tone breaks when the set is subjected to vibration. → Some circuits before the external speaker may be defective.
3. Subject the set to vibration while observing the S-meter. (Receive signals at about S-9.)
   The S-meter indication changes largely due to vibration. → The AGC or power supply circuit is defective.
4. While subjecting the set to vibration, observe the waveform at each point from point A with an oscilloscope. (Oscilloscope VOLT/DIV: 50mV; Input: AC; Sweep time/div: 2ms)

If there is a problem prior to point D:
   Does the carrier or local signal break due to vibration? (Point E)
   Does the AGC voltage fluctuate? (Point F)
   Does any reception voltage, such as 8R, change?
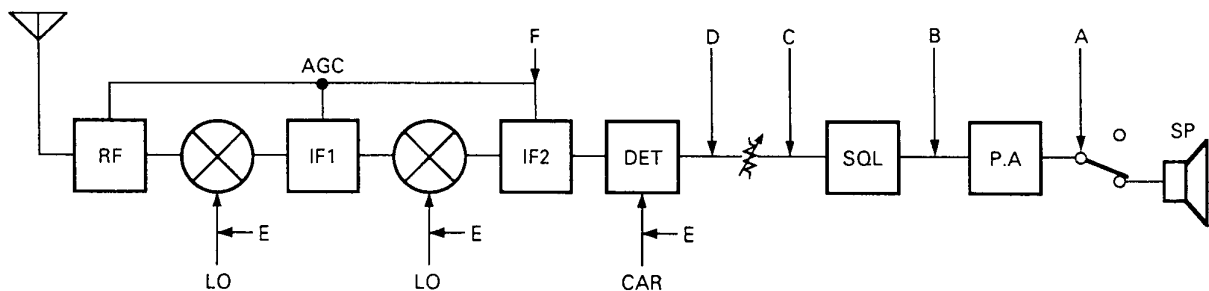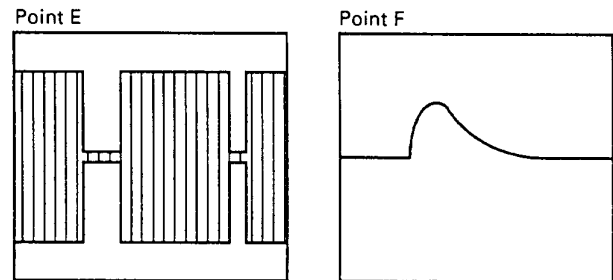
Point E

Point F

7. Receive Tone Distortion

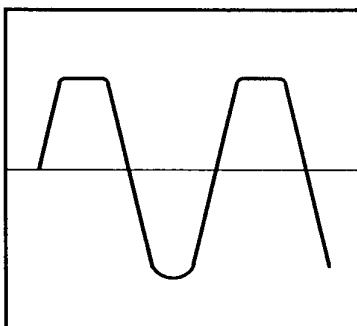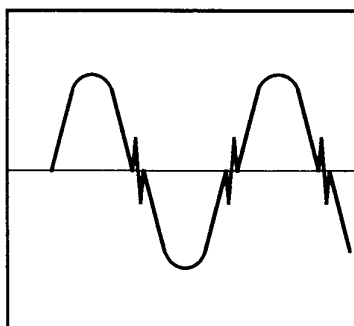Check the points A to D in the same way.
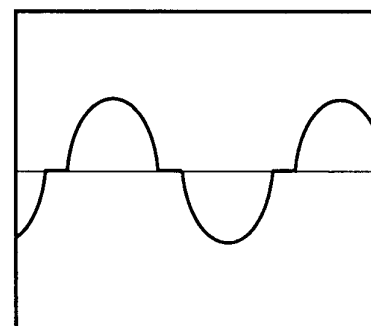
■ Possible defects

1. Poor contact of an external speaker and phone.
2. Defective AF power amplifier or AF-VR.
3. SQL gate, mute gate, or mode change circuit.
4. Defective DET diode or DET IC.
   When checking the diode, remove it from the board and check it in both the forward and reverse directions.


Defective IC

Defective IC

Poor contact

8. The Sound is Low

1. Is the sensitivity low?
   If SSG OUT is –6dBµ and the S/N ratio is 10dB, the sensitivity is OK. If the S/N ratio is not 10dB, go to the "Low sensitivity" section.
2. Check the waveform at the positive side of the internal speaker (INT-SP) and GND with an oscilloscope.
   Does any waveform appear at the positive side?
   Does any waveform appear at the GND?

A waveform appears at the GND when the wire is open.
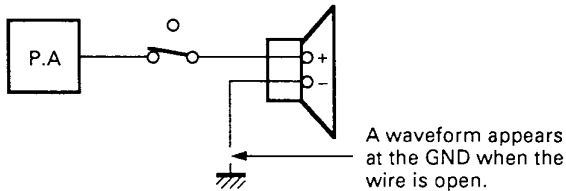
3. Check the AF line prior to the AF-VR with an oscilloscope.
   Receive the SSG OUT 20dBµ signal.
4. If the AF output is 0.1 to 0.2Vp-p, the line is OK.
5. Is the RF-VR set to MAX?
6. Is the AGC line OK?
   Set the AGC line to about 3V when there is no signal. (It depends on the model.) As the reception signal strengthens, the voltage of this line decreases. It is finally reduced to about 1V.
7. Is the CAR or LO signal level correct?
   CAR: 0.5 to 0.8Vp-p
   LO: 0.4 to 1.0Vp-p

9. S-meter

Since the S-meter operates differently in SSB, AM, and FM, the checkpoint depends on the mode. (Except R-5000)
   SSB and AM : The S-meter is operated by the AGC voltage.
   FM : The S-meter operates when the carrier is detected.

■ The S-meter does not operate

Observe how the S-meter pointer moves in SSB and FM modes.

1. The S-meter pointer does not move at all in any mode.
   The meter or the meter-change circuit is defective.
   The connector has a poor contact.
2. Connect the tester as follows:
   Reduce the Ohm range from x1000 to x100 to x10.
   If the S-meter pointer moves, the meter is OK.

Ω RANGE
x1000 → x100
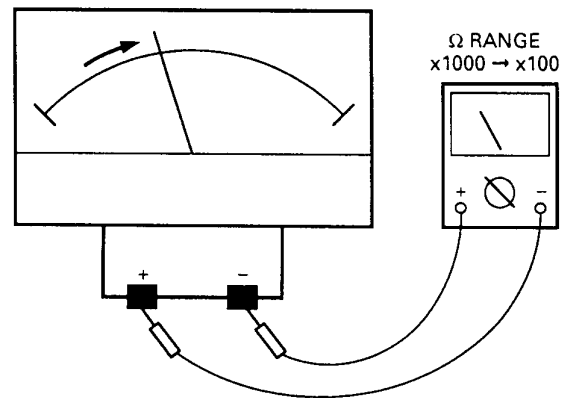
- If the meter pointer does not move:
1. Measure the resistance between the positive (+) side of the meter and the chassis.
   If it is zero, the S-meter line is grounded.
   Replace the meter.

Ω RANGE
x1

SM
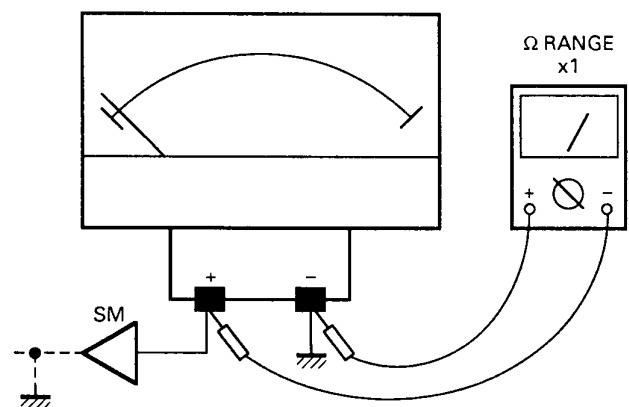
2. With the power ON, apply the tester probe to points 1 to 5 in this order. (Ohm range x1000)
If the S-meter pointer does not move, this point may be defective.

Example: If the pointer moves at point 3, but does not move at point 4, the part between these points is defective.
1) Remove the CNA and apply the tester probe to the meter side of the CNA.
2) Install the CNA, remove the CNB, and apply the tester probe to the board side of the CNB.
3) Install the CNB, remove the CND, and apply the tester probe to the board side of the CND.
4) If the S-meter pointer moves at this time, the PCB3 board is defective.

■ If the meter goes off-scale (Is the RF-GAIN VR set to MAX?)
1. Change to FM.
   Is the meter reading reduced?
   > YES : Defective in SSB only.
   > NO : The entire S meter circuit is defective.
2. The meter is off-scale in SSB only.
   Enter about signals 40dB to the antenna from the SSG.
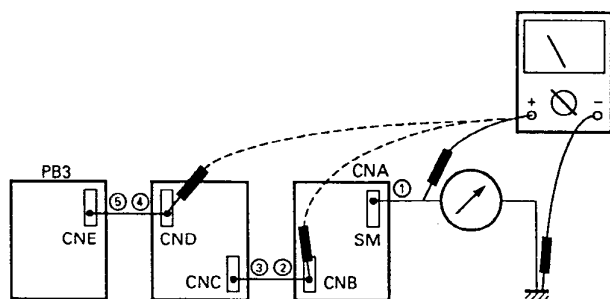   Are the signals received? (SSB)
   > YES : Only the S meter circuit is defective.
   > NO : The AGC or power supply circuit is defective.
   Check the AGC voltage.
   > Most sets balance the positive and negative voltages of the AGC circuits. If either voltage is absent, the meter goes off-scale.
3. The meter goes off-scale in both modes.
   Check the RXB, common power supply voltages (such as 8C), and TXB.
   > If TXB is applied during reception, the ALC, SWR, PROC, or PWR IC meter may turn ON. So check TXB.

The S-meter adjustment in SSB is a little complicated. Adjust the S-meter as instructed in the Service Manual.
If the variable resistor (or coil) used for S-1 adjustment shifts excessively, the AF output or sensitivity may decrease.

10. Cross Modulation
Advise the user to use the ATT or AIP switch.
The BPF-change diode for reception may have failed. Check the diode.
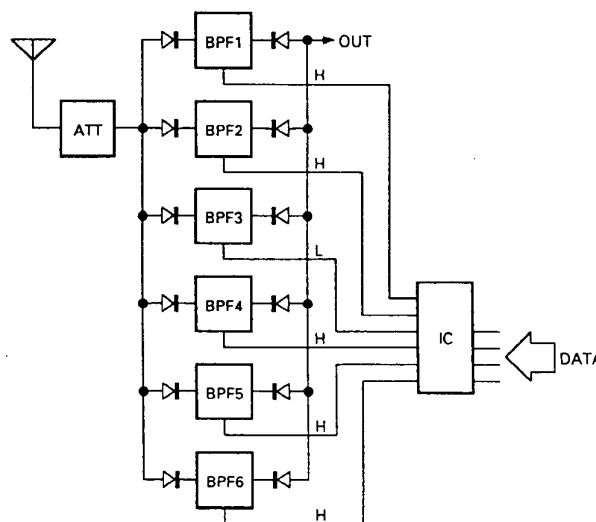
If the BPF3 shown in the above figure is the current band, only the BPF3 diode should turn ON and the others should turn OFF. If the BPF5 diode fails, the signal passes through the BPF3 and BPF5, causing cross modulation.

11. Mobile and Handy Transceivers

■ No sound output (Check with an oscilloscope)

1. Check whether the IF IC DET output contains noise.
2. If the IF unit is modularized, replace the module. (It contains the SQL circuit.)
3. If noise appears in the IC output or IF module RA, check the input and output of the electronic variable resistor (VR).

   If the input is OK, but the output is NG, the electronic variable resistor (VR) IC or the control line is defective. Data is input to the control line. Check the data line while turning the AF-VR. If data is present, the line is OK.
4. Is the PLL unlocked? Check the LD line of the PLL module.
5. The dual-band models contain an IC that switches the AF signals (MAIN and SUB). Does it work correctly?
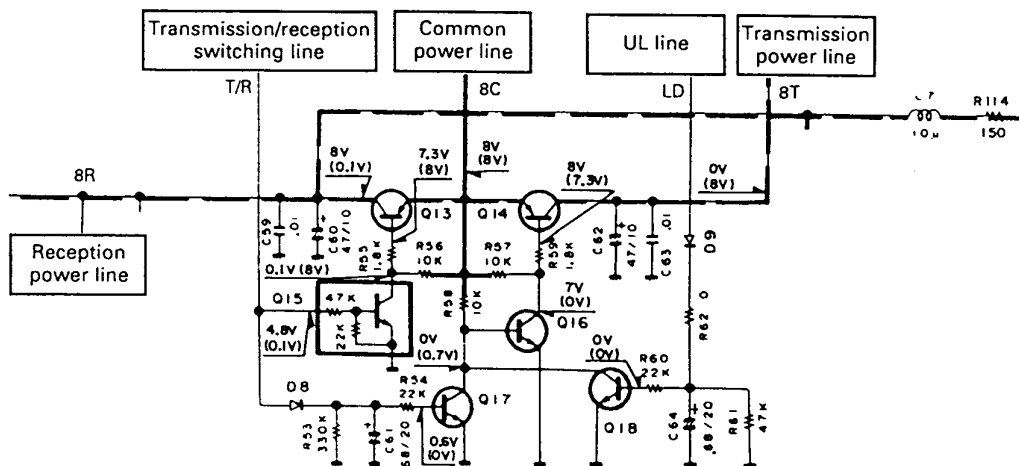6. Is the TXB low?

TM-241 power switching circuit

■ Poor reception (low sensitivity)

Perform troubleshooting with a jig. See page 31.
The RF amplifier at the first stage fails most often. (Poor sensitivity of 10 to 20dB)

- **Reason why the RF amplifier at the first stage often fails**

When a signal is transmitted, forward bias is applied to transmission/reception switching diode D1 to turn it ON. Diode D2 that protects the first reception stage also turns ON. Therefore, the RF signal from the module is grounded by D2 and not applied to RF amplifier Q1.

If no bias is applied to D1 or D2 for some reason or other, D1 or D2 is OFF as shown below (the diode serves as a capacitor), RF power goes to Q1 and destroys it.

If Q1 is damaged, solder R again.
Some ICs in the first stage may fail due to a problem in the transmission circuit, so verify that all the ICs in the first stage work properly by repeatedly checking transmission and reception following repair.
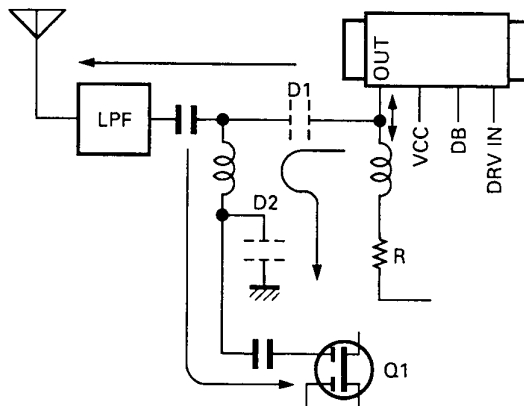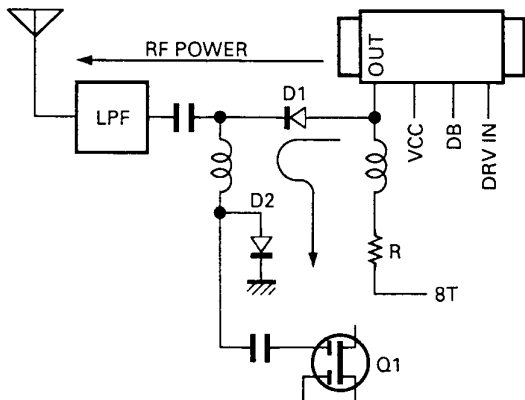
■ Low reception sensitivity
This input should provide SINAD 12dB.
1. Defect is suspected after point D
   IF local oscillator failure. Low oscillator level.
   Defective IF IC. Defective 455 IF filter

2. Defect suspected between points D and C
   Low mix level. Defective MCF.
3. Defect suspected between points C and B
   Defective RF amplifier or helical BPF
4. Defect suspected between points B and A
   Defective LPF or switch (EL, additional band, etc.)
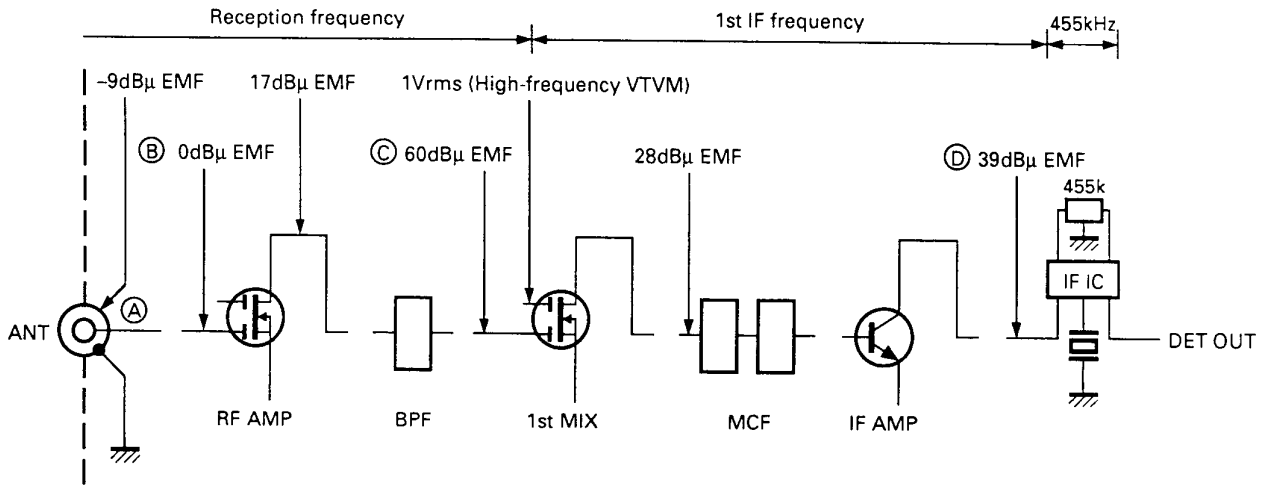
■ Receiver frequency shift
See Page 25.

■ Defective SQL
See Page 17.

■ S-meter

— 31 —
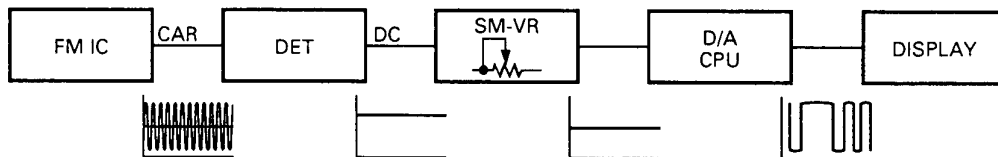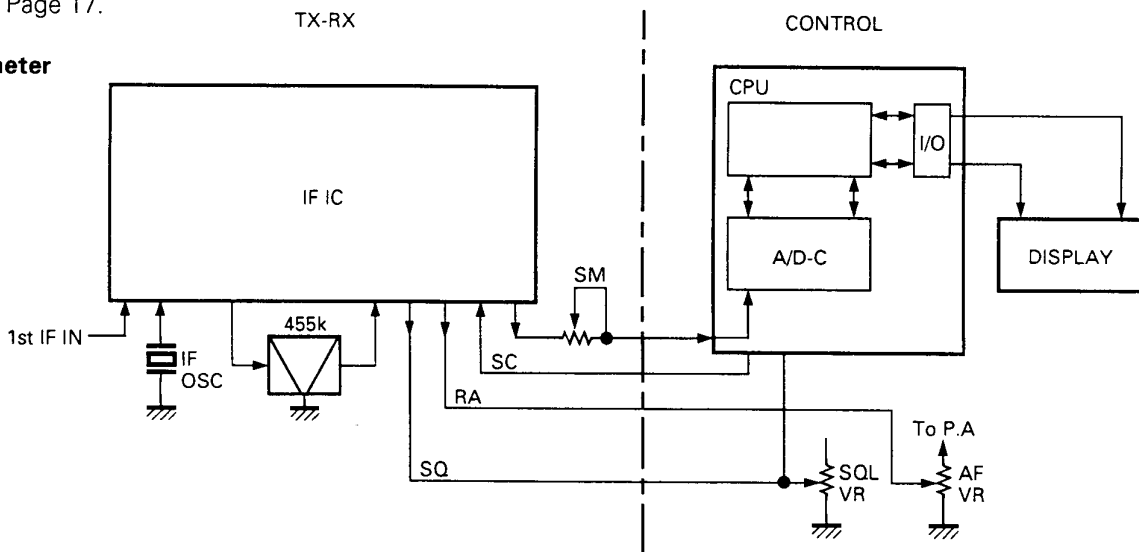
■ Low sensitivity (with an additional band)

Most recent transceivers have additional bands (wide-band receiver circuits). If they fail, the sensitivity deteriorates.

As shown in the below figure, many switching diodes are connected to the receiver line.

1) D208: Transmission/reception switching diode
2) D209 and D210: Receiver stage protection diodes
3) D211: Economical low-power RF switch
4) D214 and D215: Switching between 360MHz and 430MHz bands

If any one of them is shorted or malfunctions, the sensitivity deteriorates.
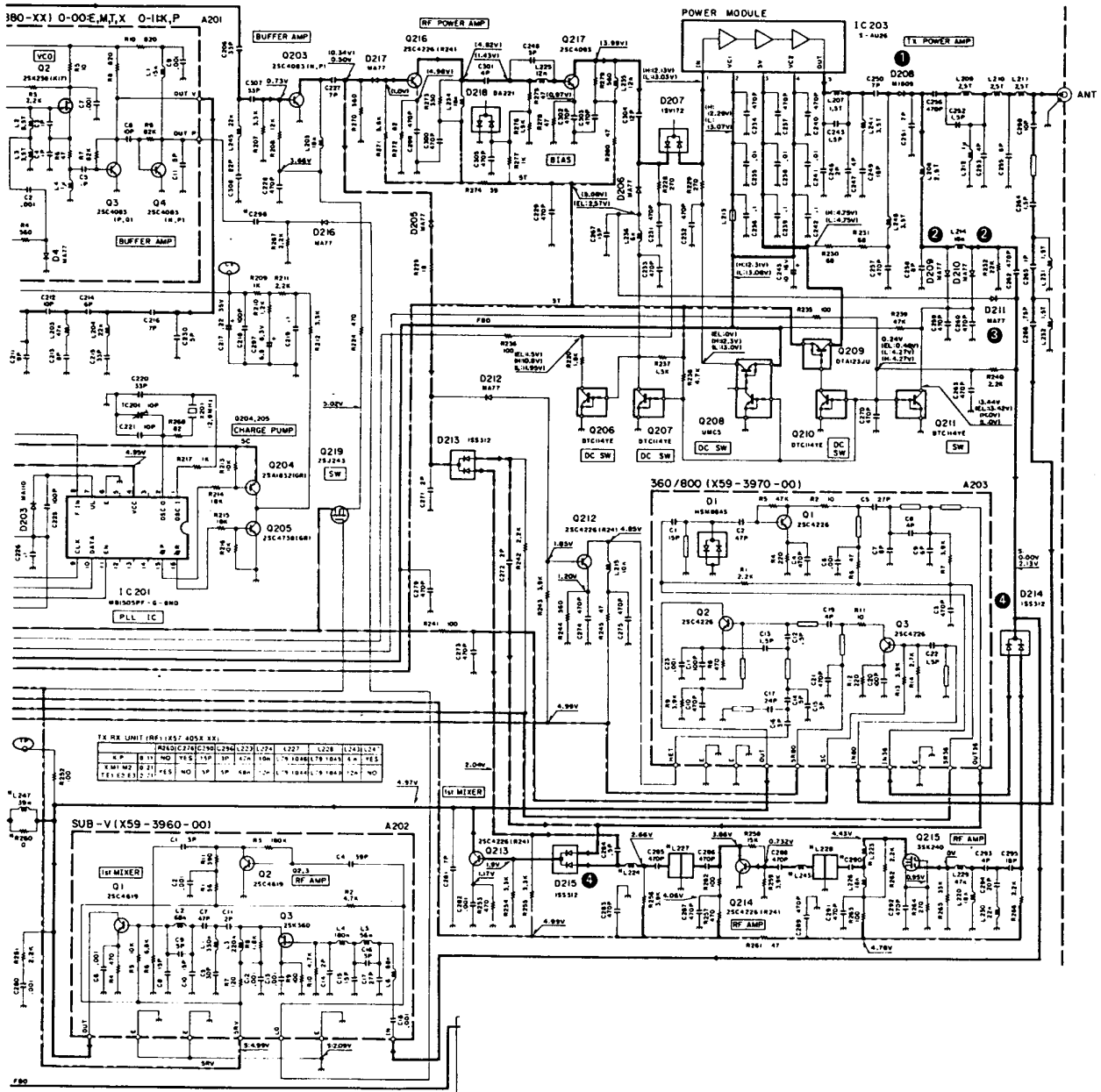
TRANSMISSION CIRCUIT

Setup ; Set an amateur band frequency.
Connect the antenna of the set to a dummy load.

1. Press the SEND or PTT switch.
   Does the SS line go LOW?
      Verify that the SS line becomes 0V at the microcomputer input pin.
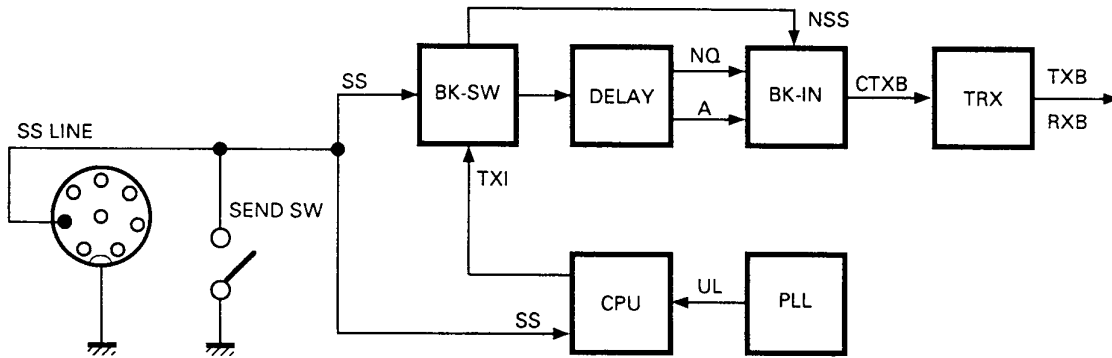
Example of TS-850

2. Is any voltage applied to the TXB on the IF or RF board?
   If no voltage is applied to the TXB:
      Is the transistor that generates TXB defective?

The transistors that produce power supply voltages are of 2SA or 2SB type. They may fail easily if the output is grounded. If a transistor has failed, check whether its output has been grounded before replacing the transistor. If you omit this check, many transistors may fail.

3. Does the transistor that controls the TXB generation work properly?
4. Check the UL detection circuit voltage.

During reception
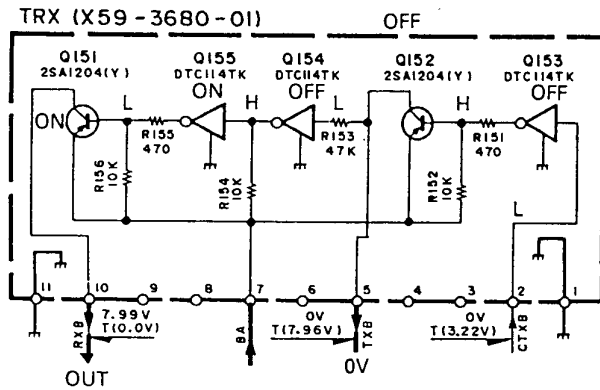
During transmission
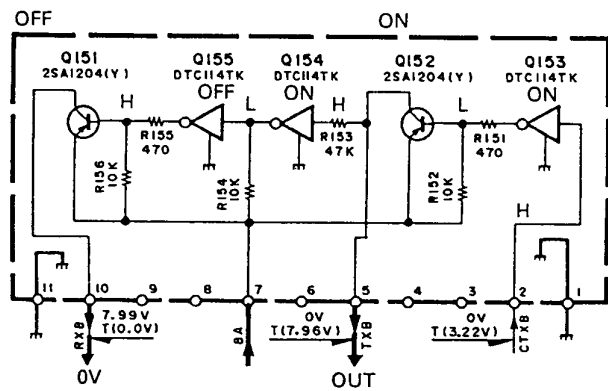
TRX board operation

1. Transmission is Impossible

The RXB and TXB voltages are the same as the common power supply voltage. (TS-950: 15V, TS-850: 8V, TH-28: 5V)
8V is taken here because it is used by many models.)

1. Does the TXB change? RX: 0V TX: 8V
2. Does the SS change? RX: 8V TX: 0V
3. Does the CSS change? RX: 5V TX: 0V
4. Does the transistor that generates TXB work properly?
    NPN transistor: The base goes HIGH.
    PNP transistor: The base goes LOW.
5. Does the transistor that controls the TXB generation work properly?
    If it is modularized, check the CTXB.
6. Does the microcomputer issue a transmission-inhibit request? (TXI)
7. Check all the voltages that change during transmission.

■ Troubleshooting

This repair is difficult unless you have some knowledge on transistor ON/OFF function, NOT and NAND circuits.

A	B	C (AND)	D (NAND)
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

a	b	c (OR)	d (NOR)
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

• Example 1:

TS-850 does not transmit signals. Q49 in the IF unit is defective. (See page 35.)

1. Press the SEND button and check whether 8T is applied to the TXB of the IF board.
2. Press the SEND button and check whether the SS line falls to 0V.
    Check the microcomputer ports of the IF unit and digital unit.
3. Check the CTXB on the TRX board in the IF unit.
    Reception: 0V; Transmission: 5V
4. Check pin 2, RLB, on the BKIN board.
    Does it go HIGH?
5. Is any voltage applied to the D1 terminal on the BKIN board?
    Is 8V present?
6. Check pin 10, NSS, on the BKIN board.
    Is any voltage present?

7. Is any voltage applied to the collector of Q49?
    No.
8. Does the base of Q49 go LOW?
    Yes.
9. Q49 is defective.

IN=HIGH : Switch turns OFF
IN=LOW : Switch turns ON

DTA TYPE

Input voltage → t   Output voltage → t
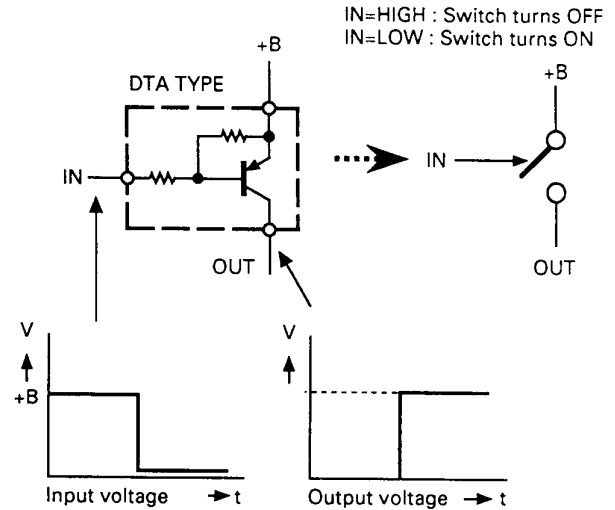
• Example 2:

TS-450 does not transmit. D73 is defective. (See page 36.)

1. Is the TXB present? (IF unit TRX pin 5)
2. Check the SS line. (Q52 base)
3. Is the Q52 collector 8V?
4. Is the CTXB HIGH? (TRX pin 2)
5. Is RLB HIGH? (BKIN pin 3)
6. Is NSS HIGH? (BKIN pin 8)
7. Check IC11 pin 10.
8. Check IC11 pin 12.
9. Check Q49 pin 2.
10. Check Q49 pin 3.
11. Check Q49 pin 4. (Low)
12. Check pin 18, TXI, of IC11 in the digital unit.
13. Check the UL line in the digital unit.
14. Check the CSS line in the digital unit.
15. Check the collector of Q50 in the IF unit.
16. Check the base of Q50.
17. D73 is defective.

DTC TYPE

This switch is OFF   This switch is ON
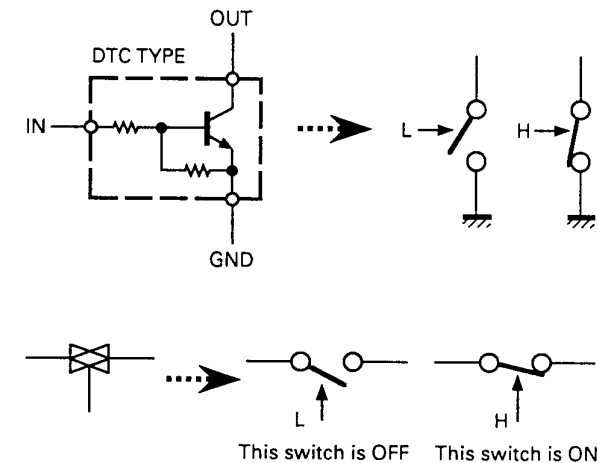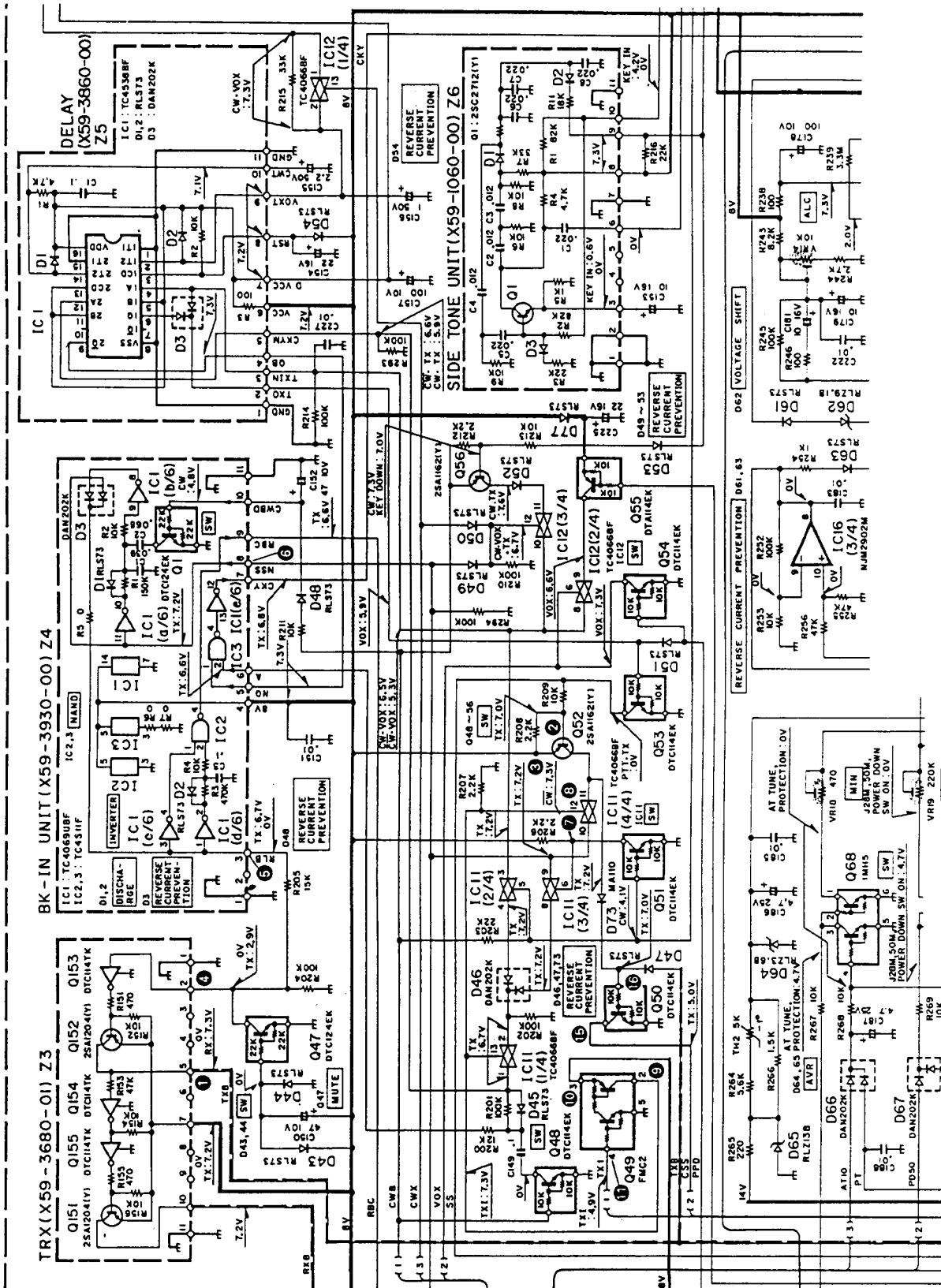
TS-850 IF unit

TS-450 IF unit

2. No Transmission Power is Output (The ON-AIR Indicator Lights)

1. Enter FM or CW mode. CAR-VR: MIN
   In CW mode, set BK-SW to SEMI or FULL.
2. SEND button: ON
3. Slowly increase the CAR-VR from zero.
4. Observe the ammeter on the power supply.
   If the current exceeds 10A, the final unit is considered to be working.
5. Use the SWR meter to measure the SWR.
   If it goes off-scale, a wire between the final unit and the antenna is broken.
6. Set the CAR-VR to about 8:00, and check the level with an oscilloscope.
   Measure ANT, LPF OUT, LPF IN, and FINAL OUT in the order listed. The level increases at some point. Check it carefully.

7. If the current is about 3A: Check the DRV OUT terminal on the RF board with an oscilloscope.
8. It is OK if it is about 2Vp-p when the CAR-VR is set to MAX.
9. If the drive is low, a previous circuit is defective.
10. Is the LO-1 level correct?
11. Is the IF signal level correct?
12. Does the mixer circuit work correctly?
13. Is the LO-2 level correct?
14. Is the TIF signal level correct?
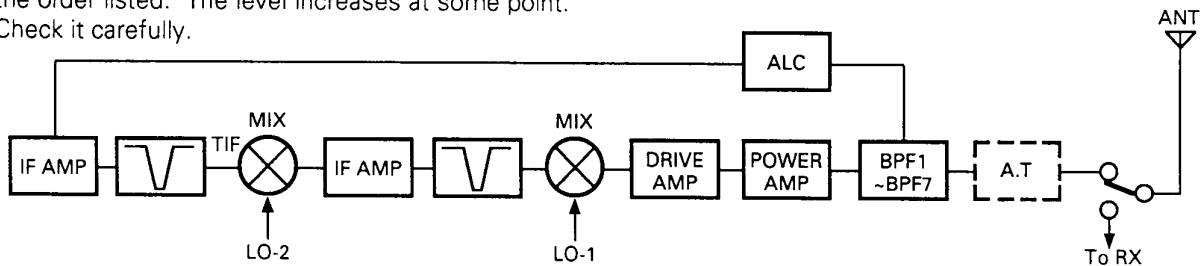15. Does the mixer circuit 2 operate correctly?
16. Is 455kHz CAR output?

3. Low Power

If the power is low, turn the ALC adjusting variable resistor (VR).
CAR VR: MAX, POWER VR: MAX,
ALC adjusting VR: MAX, Frequency: 14.200MHz
180W or higher can be output. Reduce the CAR-VR immediately after confirmation. (See page 41, "Maximum power is low.")

If the power is output, the final unit is OK. A following circuit is suspected. Check the LPF relay and connectors.
Or the final unit or a circuit before the drive is defective.

■ How to check whether the final unit or a circuit before the drive is defective

1. Connect the jig shown below to the DRV terminal on the RF board and measure the output level with an oscilloscope.
   If the level is about 2Vp-p, the circuits before the drive are OK.
2. If the CAR VR is set to MAX, the drive waveform is distorted.
   If it is a clear sine wave, the drive is insufficient. (14 MHz)

■ Check for a defective final unit (See next page)
Use an oscilloscope.
CAR VR: 8:00

Do not increase the variable resistor (VR) excessively. Otherwise, the final transistor may fail due to high-frequency sneaking.

1. See the level of the pre-driver base of the final unit.
2. See the level of the pre-driver collector of the final unit.
   The collector level is about five times higher than the base level.
3. See the level of each base of the drive transistor of the final unit.
4. See the level of each collector of the drive transistor of the final unit.
   The collector level is about four times higher than the base level.
5. See the level of each base of the final transistor.
6. See the level of each collector of the final transistor.
   The collector level is about ten times higher than the base level.
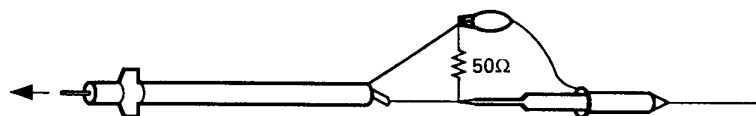
Is there any stage in which the gain is low?
If there is such a stage, check the base bias of the transistor with a DC-VM.
Is it about 0.6V?

    YES : The output load may be too high. Check the output circuit.

    NO : The bias circuit or a transistor in it is defective.

■ Checking for a defective transistor

1. Switch the power OFF.
2. Remove the base of the transistor. (For push-pull type, remove both bases.)
3. Power: ON, Mode: USB, SEND button: ON
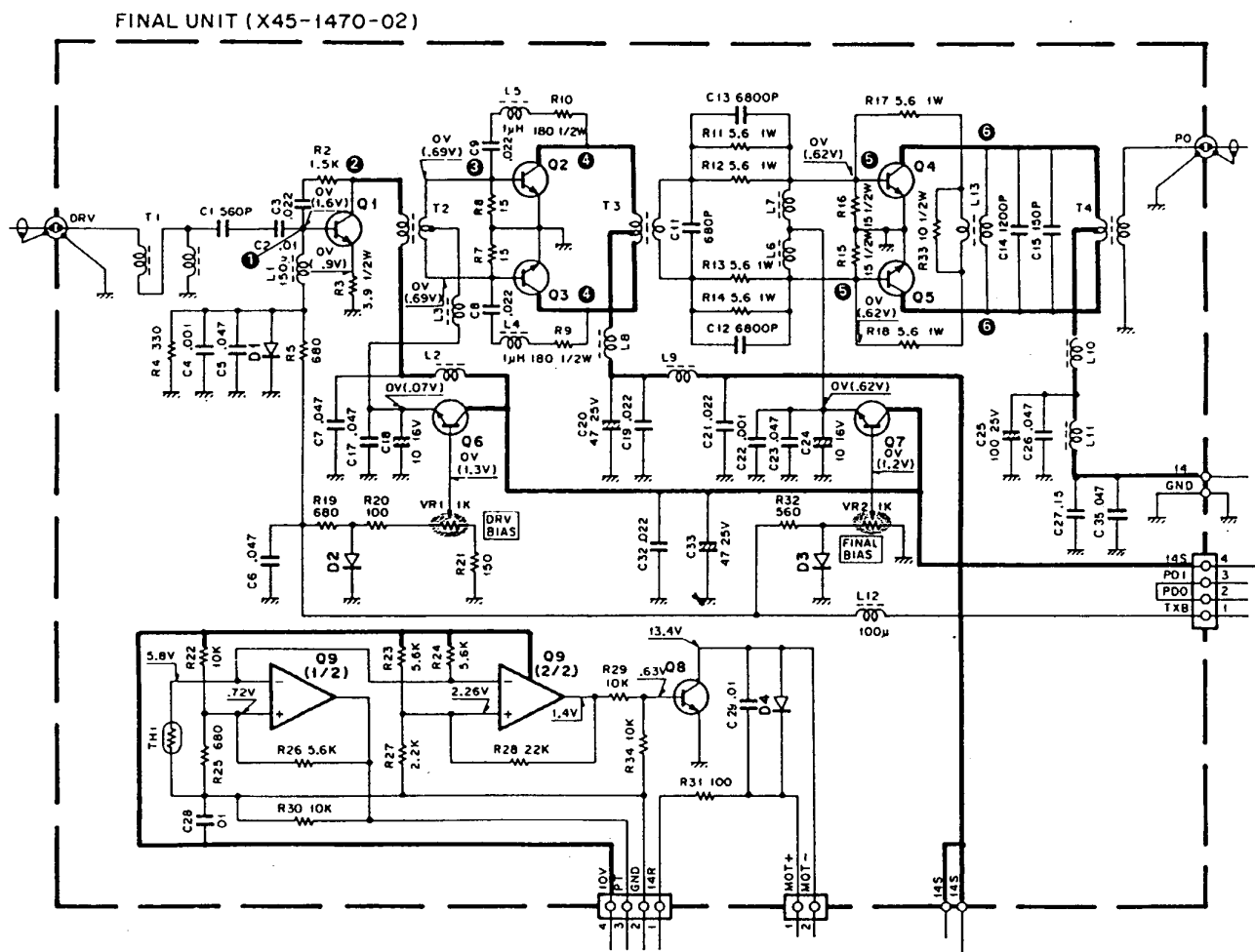
If at least 0.6V is applied to the base pattern, the bias circuit is normal. The transistor is defective.

If at least 0.6V is not applied to the base pattern, the transistor is OK. Check the bias circuit.

(If a bias adjusting variable resistor (VR) is provided, turn it. If it can be adjusted to 0.6V or higher, the bias circuit is OK.)

FINAL UNIT (X45-1470-02)

TS-850 final unit

■ If a circuit before the drive is defective

14.200MHz, Mode: CW, CAR-VR: MAX, BKIN: FULL
Connect a 50-ohm jig to DRV OUT on the RF board,
SEND: ON

1. Is the LO-1 input to the mixer circuit?
   Check the level.
2. Is the IF signal input to the mixer circuit?
   Check the level.
3. Check the level and the frequency of the mixed
   signal.

4. Is the LO-2 input to the mixer circuit?
   Check the level.
5. Is the TIF signal input to the mixer circuit?
   Check the level.
6. Check the level after mixing as well as the
   frequency.

10. Check the bias voltage of the FET that generates
    ALC.
11. Check the CAR level.
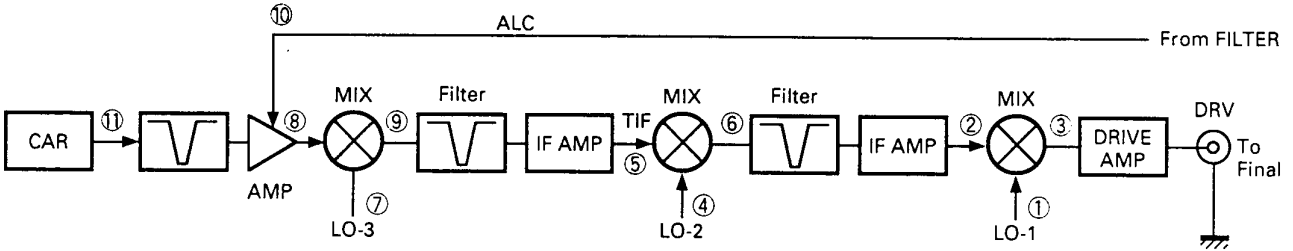
4. Cannot Adjust Power

(The power cannot be adjusted by the ALC adjustment variable resistor (VR).)

In this case, mostly the ALC is defective.
The reference voltage and power of the ALC should be adjusted.
First adjust the reference voltage. If it is incorrect, various problems arise (for example, the ALC meter is always off-scale, the meter pointer does not move at all, or the power is too low or too high).

1. Check the ALC detection diode in the filter unit with a tester (ohm range).
2. Check the VSF line voltage with a DC-VM while turning the CAR VR. As the power increases, the VSF voltage increases.
3. Does the voltage at the middle point of the ALC (VSF) variable resistor (VR) change when it is turned?
4. Is the negative voltage for the ALC applied correctly?
5. Is the ALC voltage correct? If not, adjust it.
6. Is an appropriate voltage applied to the transistor or FET that generates ALC?
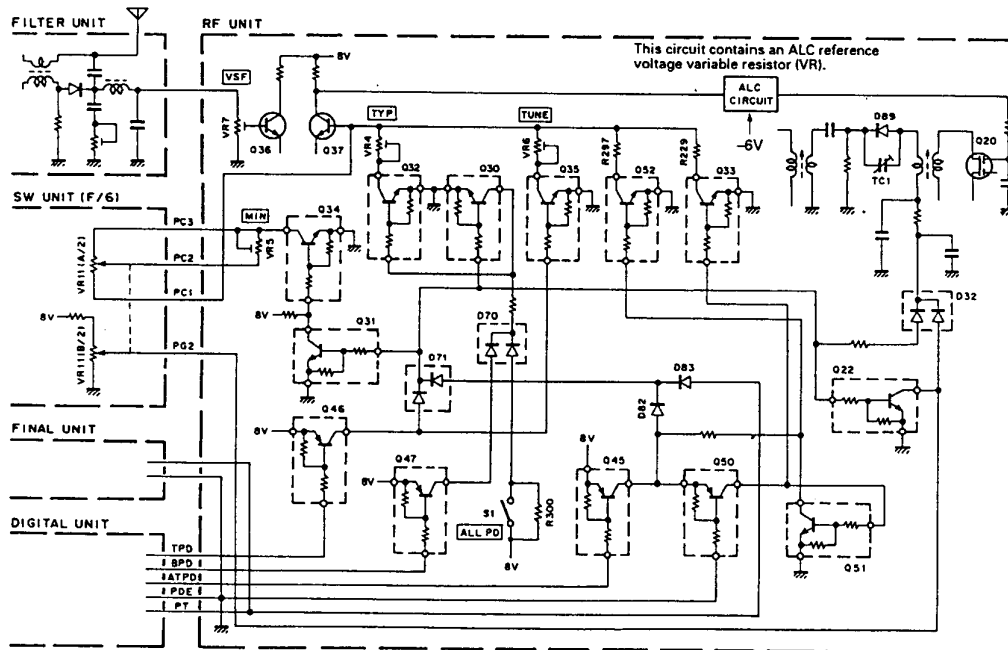
TS-850 power control

5. ALC Meter

The ALC is a type of feedback circuit. The meter pointer indicates the feedback level.

If you adjust the power of the 180W final unit to 100W, the ALC meter reading corresponds to 80W.

If you adjust the power of the 120W final unit to 100W, the ALC meter pointer moves less because its reading corresponds to 20W.

Connect the AG and power meter as shown below.
Set: 14.200MHz, Mode: USB, CAR VR: MAX, PWR VR: MAX, MIC: MIN

1. Adjust the meter to zero. → Internal semi-fixed variable resistor (VR)
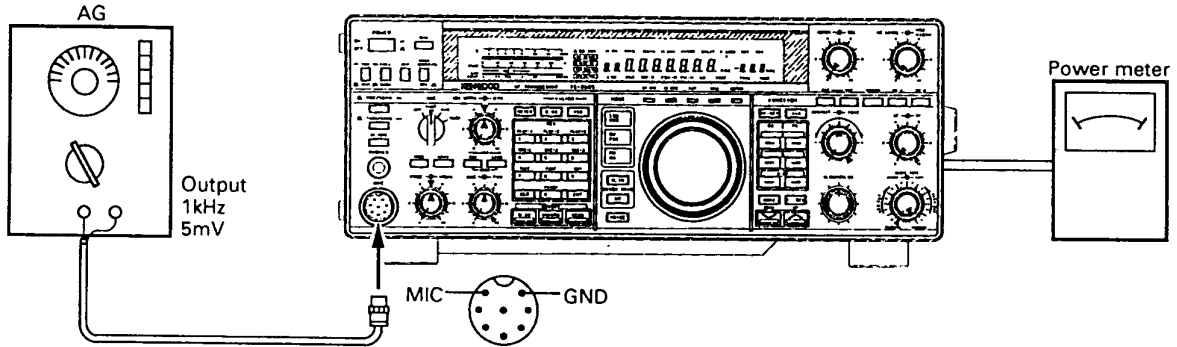2. Adjust the meter start point. → Front panel MIC variable resistor (VR)
3. Adjust the ALC zone MAX. → Internal semi-fixed variable resistor (VR)

34. ALC meter	1) Meter : ALC AG : 1kHz/5mV MODE : USB MIC VR : MIN RF unit VR12 : MAX STBY : SEND	Power meter DC V.M	Rear panel RF	ANT TP6	RF	VR11	Adjust prior to voltage deviation.	0V
	2) AG : 1kHz/5mV STBY : SEND	AG AF V.M Power meter	Front panel	MIC			Adjust so that ALC meter one dot lights with MIC VR.	
	3) AG : 1kHz/10mV STBY : SEND					VR12	Adjust so that ALC meter lights to zone MAX.	ALC

■ Caution

Adjust the ALC to zero at point A. If it is incorrect, the ALC meter does not operate properly, so the ALC may not be adjusted.

For Digital

When the variable resistor (VR) is turned in this direction, the voltage becomes zero at any point. Do not turn it in this direction.

The voltage is applied in this range.

Point A
The voltage becomes zero the first time.
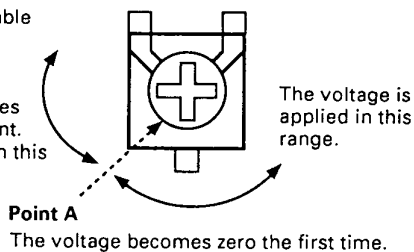
For Analog

ALC zero-point variable resistor (VR)
(Same as for the S-meter)

The meter pointer stops here, but this is not the correct point.

Point A

The meter pointer moves.

When the variable resistor (VR) is turned clockwise a little, the pointer begins moving.
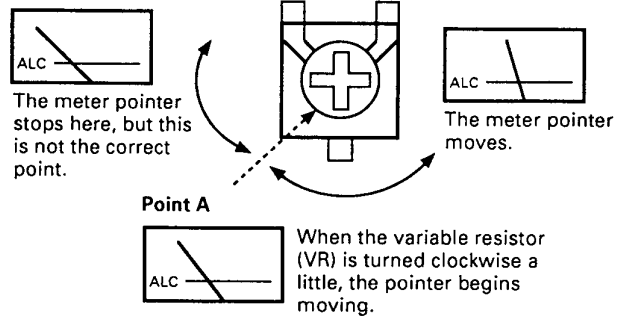
6. The Max Power is Low

Connect the set directly to the power meter from OUT of the final unit.

Increase the CAR VR slowly. If the 100-W model outputs 170 to 180W, it is OK. The TS-950 outputs about 200W.

■ Caution

In this case, ALC and protection do not work.

If the output power is too high, the final transistor fails. Decrease the CAR VR to reduce the power immediately after verifying that the maximum power can be output.

Refer to the "Low Power" on page 37.

Pay attention to the current capacity of the power supply.

If the power supply has a red zone of 22A and the maximum current of 25A, the power can be raised to up to about 140W and current protection is activated.

If you are using such a power supply, you may consider that the final unit is OK if the ammeter goes off-scale and the indicator changes from CV to CC.
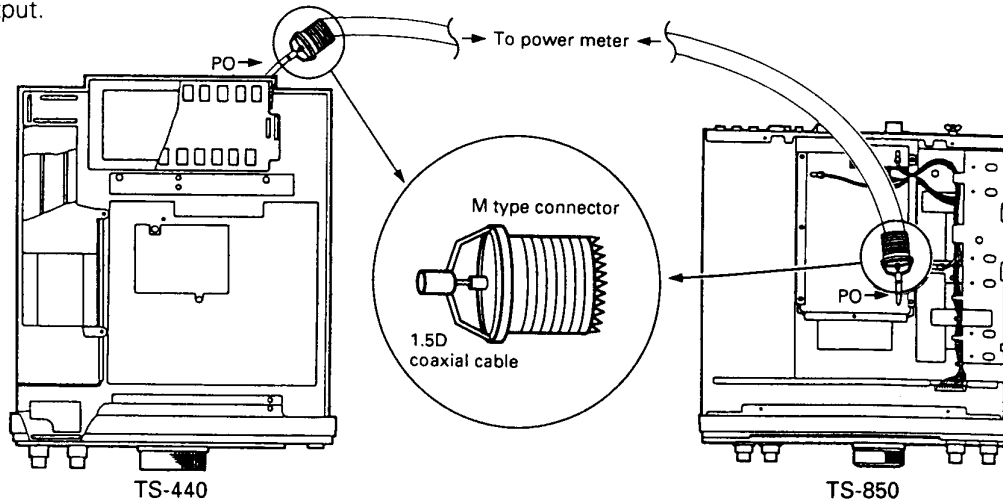

M type connector

1.5D coaxial cable

To power meter

TS-440

TS-850

7. SWR Meter

When the SWR meter fails, the diode in the SWR detection circuit fails in most cases.
The important point for troubleshooting SWR defects is the VSR terminal of the filter unit.

1. As the power increases slowly, the VSR voltage increases gradually.
2. The VSR voltage is adjusted to the minimum with a trimmer and so on when the antenna terminal is terminated with 50 ohms.

3. If the antenna terminal is 55 ohms, not 50 ohms, the VSR voltage increases for an additional 5 ohms when compared with the voltage when the terminal is 50 ohms. This voltage is converted to the SWR meter indication.

You can locate a defective part by checking the VSR voltage.
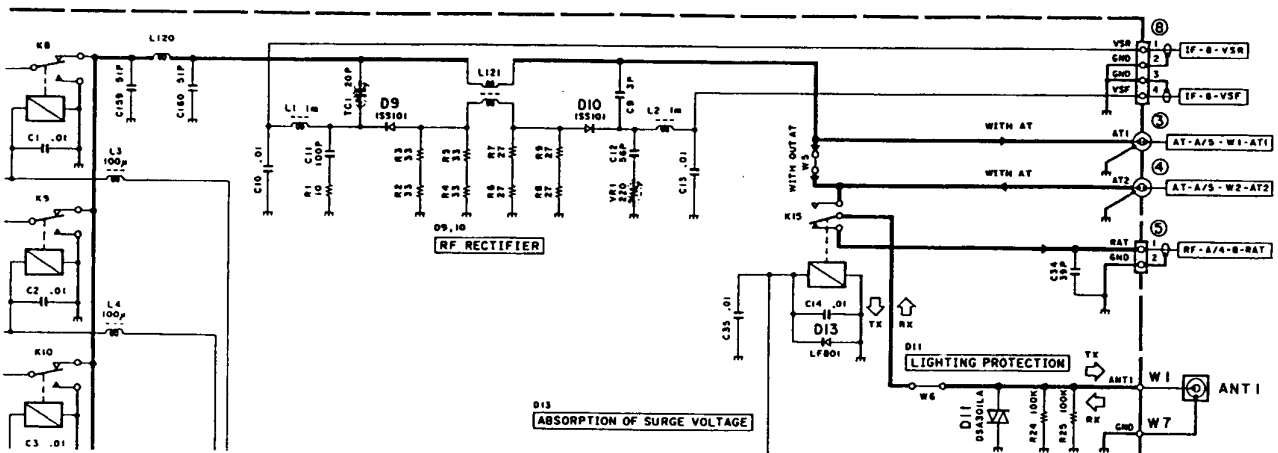
■ VSR voltage adjustment

1. When the antenna terminal is terminated with 50 ohms, power of about 25W is output.
2. Apply the DC-VM probe to the VSR terminal and set the voltage to MIN by TC1.

■ Caution

Some manuals specify that the output power should be 10W, but 25W should be output to precisely adjust the voltage to MIN.

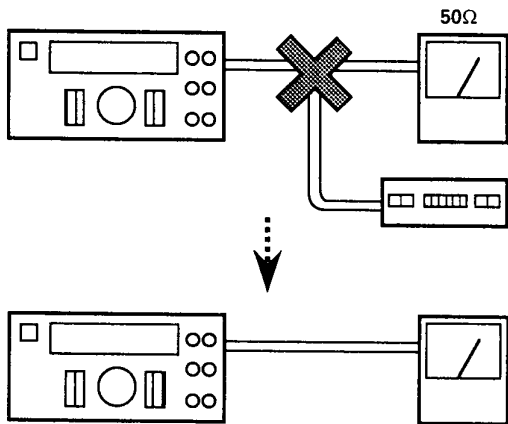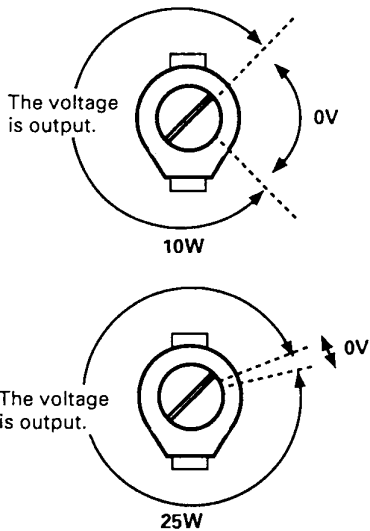Do not put any changer between the antenna and dummy when adjusting the SWR NULL. Otherwise, the minimum voltage point shifts.

The voltage is output. / 0V

10W

The voltage is output. / 0V

25W

50Ω

Do not put any changer between the antenna and dummy when adjusting the SWR NULL. Otherwise, the minimum voltage point shifts.

8. RF Meter and Power Meter

The RF meter detects the transmitter with a diode, converts it to a DC voltage change, amplifies it with an operational amplifier, and operates the meter.
Some recent models share the VSF signals.

## ■ The meter pointer does not move (TS-850 or subsequent models)

1. Receive about a 4dB signal from the SSG, and verify that the S-meter pointer moves.
2. Enter the transmit mode, and check the VSF voltage.
   Does the VSF voltage rise when the power increases slowly?
3. Check the voltage of the variable resistor (VR) used to adjust the power meter.
4. Check the voltage at the power meter input port of the microcomputer.
   The microcomputer port does not accept signals if the input voltage exceeds 5V.
   If it is higher than 5V, it is the cause of this problem.
   (The circuit contains a zener diode for excessive voltage prevention.)

■ The meter is off-scale

Make a check in the same way as above.

MIC / IF / RF / FINAL / FILTER / RFM / VSF / Digital / CPU / DISPLAY
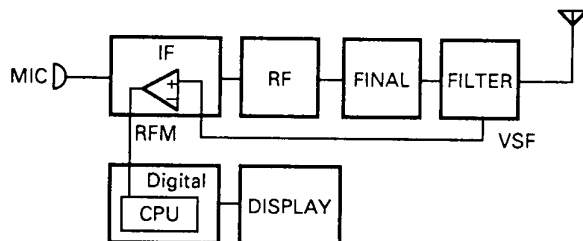
■ If an analog meter is used

1. Is any voltage present at the PWM terminal of the filter unit?
   Meter change switch: POWER, MODE: USB
   MIC VR: MIN, SEND: ON
2. Set the tester to the ohm range and apply the probe to the PWM terminal.
   If the power meter pointer moves, the circuits from the terminal to the meter are normal. Refer to "S-Meter" section.

MIC / IF / RF / FINAL / FILTER / RFM (PWM) / ALC / SWR
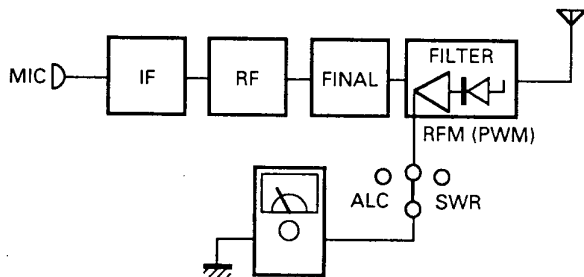
9. Break IN

The TS-850 and subsequent models are modularized. Replace modules.
Replace the modules in the order of BK-SW, BK-IN, and DELAY.

• BK-SW

This board sets transmission conditions. Signals can be transmitted with a key when the CW is FULL, the VOX turns ON or OFF, transmission outside the band is inhibited, or the CW is entered.
• DELAY
Sets the delay time for VOX ON or SEMI BK-IN.
• BK-IN
Controls the CTXB terminal on the TRX board according to the conditions of the BK-SW and DELAY boards.

10. VOX

The TS-440 and subsequent sets are modularized. First, replace the modules.

• VXS

Transmission/reception control line when VOX is ON. This line goes low in the following case:
The microphone signal enters the VX2 (pin 9), but the AF signal does not enter the AV (pin 8).
• AV
ANTI VOX line. The receiver AF signal line is connected to this pin through the ANTI VOX VR. As the AF VR is turned, the AF signal level changes.
• VX2
VOX GAIN line. The AF signal from the microphone is connected to this pin through the VOX GAIN VR.
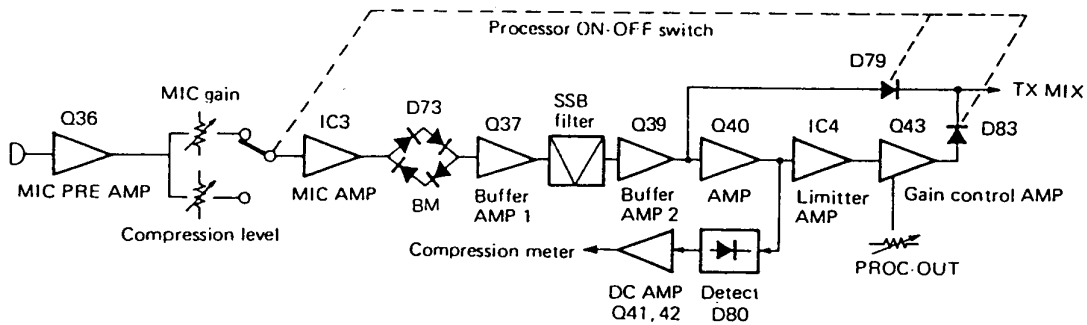

VOX (X59-1080-00) Z5
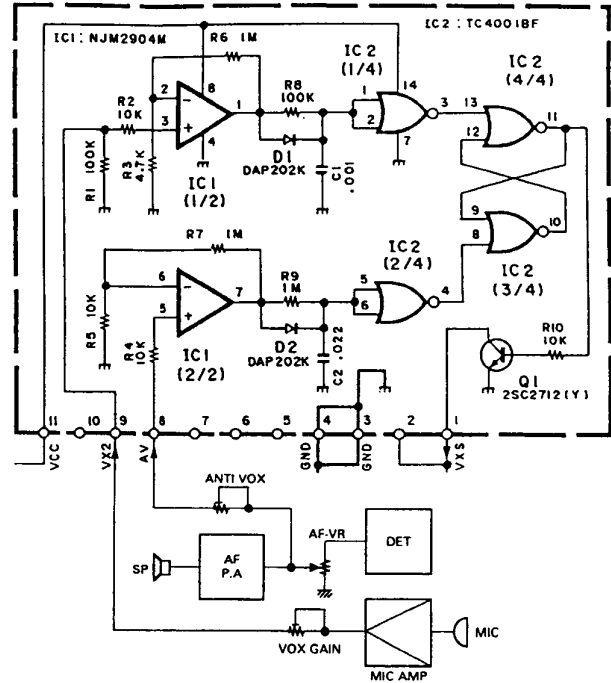
11. PROC (Processor)

There are two types of processors.

■ RF type (TS-950, TS-940, TS-930)

Converts the transmitted AF signal to the IF signal and amplifies it.

The following block diagram shows the TS-940 processor. When the processor is OFF, the IF signal passes through D79. When the processor is ON, the IF signal passes through Q40, IC4, Q43, and D83.

■ AF type or other sets

Increase the microphone amplifier gain.
If the processor is off, Q41 is off, and the gain of IC4 is determined by R1 and R3.

If the processor switch is ON, 8V is applied to the base of Q41, the part between C and E of Q41 is shorted, and the gain of IC4 is determined by R1 and R2 (which are connected in parallel), and R3. In addition, the Q42 ALC circuit starts operation.
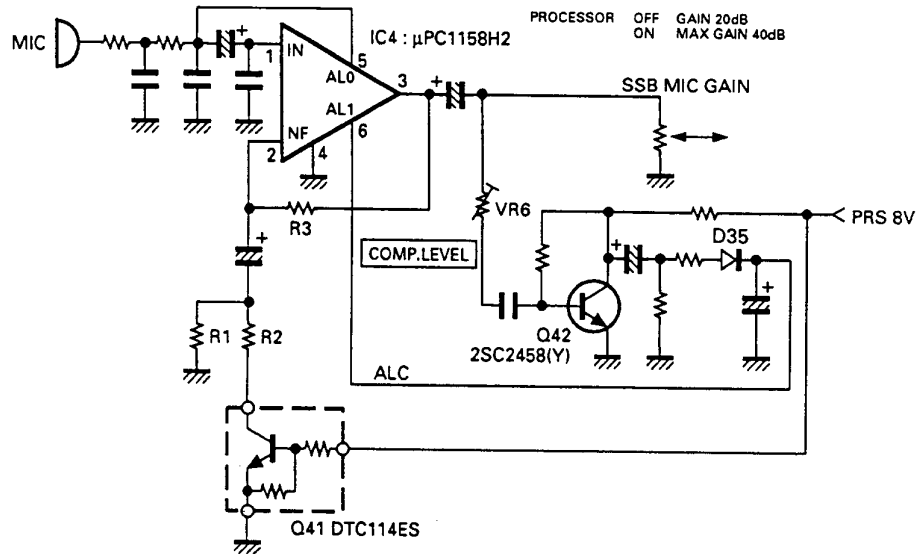
12. Transmission Tone Quality is Poor
■ SSB

1. Check the final bias.
   Mode: USB, CAR VR: MIN, MIC VR: MIN,
   SEND: ON
   Check the base voltage of the driver and power transistor in the final unit.
   If it is 0.6V or higher, the transistor bias is OK.

2. Adjust the transmission frequency characteristics. (Tuning)
   The 2TONE frequency is different from model to model.
   Therefore, the adjustment procedure depends on models. Adjust the transmission frequency characteristics as instructed in the manual.

MIC terminal (view from front panel side)
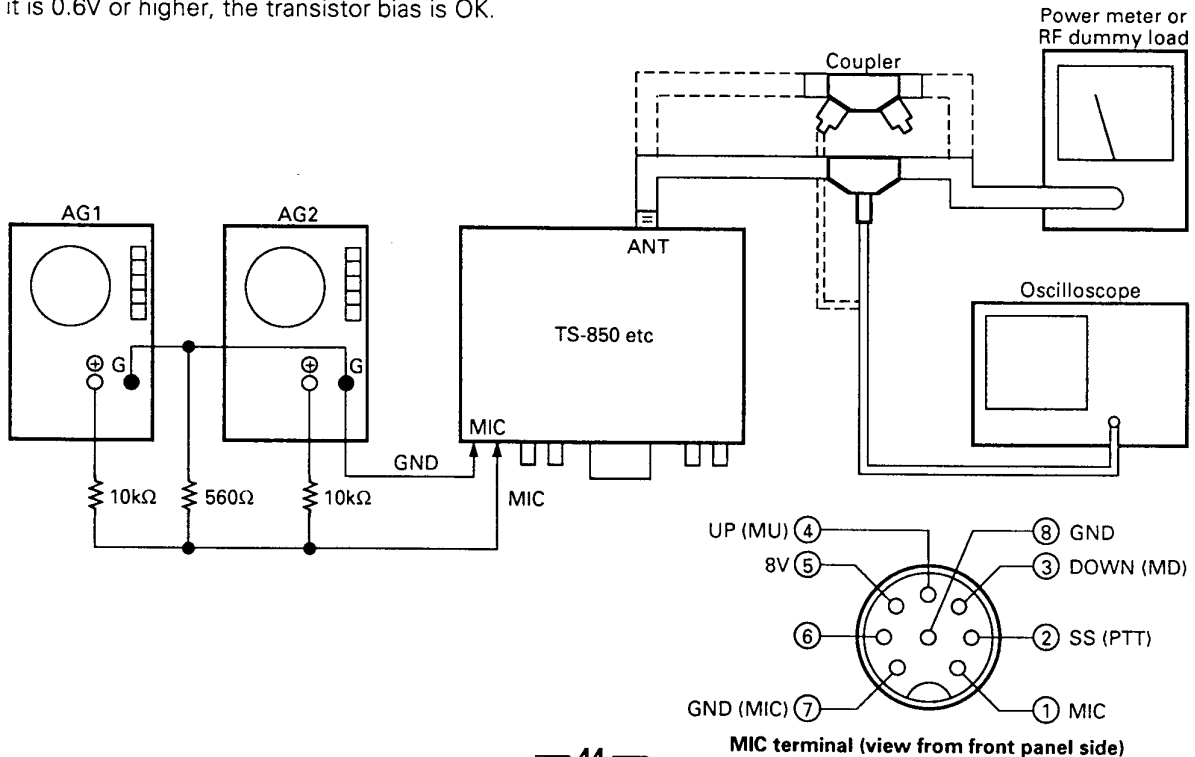
13. Defective PLL

If the modulation tone is not stable, suspect the PLL. Refer to the "PLL" section on page 59.
If the TS-440 reception BPF (RF) diode fails, modulation cannot be executed properly.

14. Power Fluctuation

■ ALC voltage fluctuation

Oscilloscope: VOLT/DIV: 20mV, SWEEP/DIV: 5ms, AC input
Check the AC line.

■ Power supply voltage fluctuation

Oscilloscope: Same as above.
Check the power supplies (TXB, –C, 8C, etc.) that produce ALC.
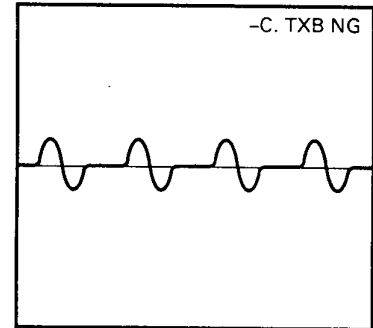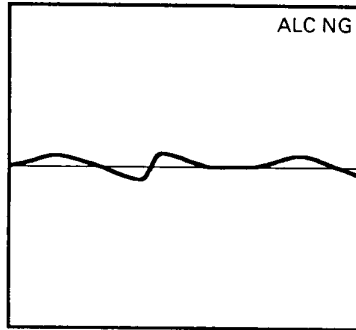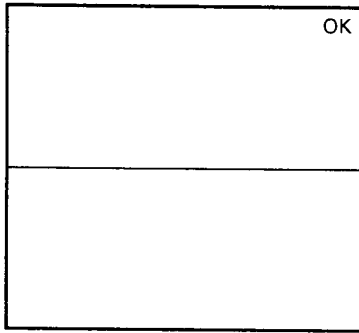
■ Carrier level fluctuation

Oscilloscope: VOLT/DIV: 0.5V
Check the carrier input level and local signal level.
Do they fluctuate?

■ Poor carrier or local-signal connector contact

Check the MIX FET input level with an oscilloscope.
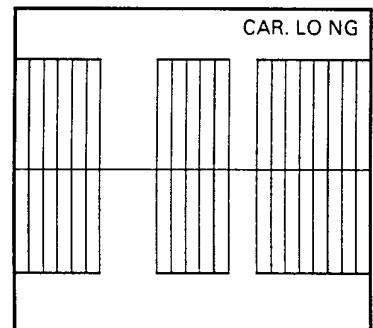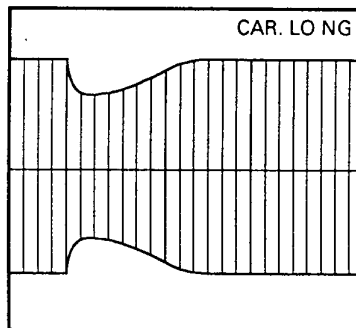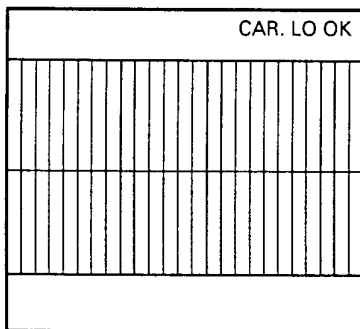
■ Poor final board pattern contact

The TS-930 and TS-940 final boards have a poor contact via holes.
Solder the component and soldered sides of the board again.

■ Poor LPF or TX-RX relay contact

If the transmission LPF relay is defective, change the transmission band and check whether the symptom still persists.
Check the signal line of the band at which the symptom exists.
Lightly tap the TX-RX change relay case with an adjusting rod. If the symptom is confirmed, the relay may be faulty.

15. High Noise

If noise occurs during modulation, perform the check as follows:
While monitoring with another receiver,
1. Ground the microphone input terminal.
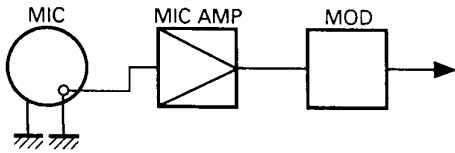
2. Ground or unground the MIC AMP IN terminal.
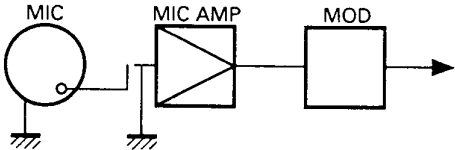
3. Ground or unground the MIC AMP OUT terminal.
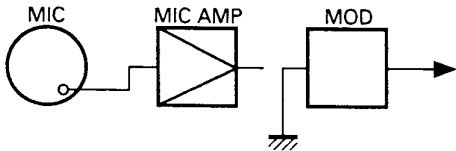
This shows whether the noise occurs when the AF signal is issued or after CAR conversion.
If the noise occurs after CAR conversion: The PLL probably is defective.

■ Large noise from FM models
1. Replace the PLL VCO (FET and transistor)
2. Replace the PLL lock voltage adjusting trimmer.
3. Replace the PLL varicap diode.
4. Replace the PLL LPF transistor and smoothing capacitor.
5. Replace the PLL IC.

At least 80% of the problems may be solved by now.
If the VCO is modularized, replace the module. (If the problem still persists, see page 25, "Defective receiver tone.")

16. Mobile and Handy Transceivers
■ Do not transmit signals
Does the ON-AIR indicator appear on the display when pressing the microphone PTT key?

• Light
The transmission request signal enters the microcomputer.
The transmission request signal is then converted to digital data and is sent to the shift register IC and PLL IC in the TX-RX unit.
These ICs decode the data and reverse the voltage of the transmission/reception switching terminal (T/R).
The T/R line is connected to the transmission power (8T)/reception power (8R) switching circuit. So when the T/R voltage is reversed, the 8T/8R voltage is reversed.

• Check
1. Is 8T present during transmission?
   YES : No transmission power is output. Check the drive output or VCO output. (See page 37.)
   NO : Check the PLL module LD terminal or the shift register T/R terminal.
      LD → 0V when the PLL is locked; High when it is unlocked.
      T/R → 0V in transmission mode; High in reception mode.
2. If the LD is abnormal, check the PLL circuit. (See the description of the PLL circuit on page 59.)
3. If the T/R is abnormal, check whether data is input to the data input pin of the shift register (PLL IC). (See page 61.)

The transmission request data is output from the microcomputer immediately after the PTT key is pressed.

Model or series name;
Transmission/reception switching signal "Terminal name"

TM-201 and TM-211; Microcomputer output port "ST"
TM-221; PLL IC "SW1" "SW2"
TM-231 and TM-241; Shift register IC "T/R"
TM-701 and TM-702; Voltage supply select IC "T1" "T4"
TM-721 and TM-731; PLL module "TR"
TM-741 and TM-742; Shift register IC "T/R"
TM-732; Shift register IC "TX"
TR-751 and TR-851; "ST" line from the microcomputer

- **Does not light**

The transmission request signal does not enter the microcomputer.

1. Replace the microphone.

   Transmit : The microphone is defective.

   Does not transmit : The PTT line is defective.

2. Is any voltage applied to the PTT line?

   YES : If the voltage becomes 0V when the PTT turns ON, the microcomputer is defective.

   If the voltage does not change, check the ground line.

   NO : The pull-up resistor is defective.

   The microcomputer port is defective.

   The capacitor for high-frequency sneaking prevention is shorted.

   Check the ground line.

■ Caution

The MIC connector has two ground lines. One is used for the audio signal ground line, such as microphone shield, and designated as ME or MGND. The other is used for controlling the UP, DWN, and PTT and is designated as E or GND.

These two ground lines are not connected at the MIC side in order to prevent transmission noise.

They are grounded at different locations at the main unit side. (The resistances of the two lines, which are measured with a tester, are zero.)

The connection locations depend on models. (MGND is grounded at a point where the transmission noise is minimized at the design stage.)

When checking the ground, consider the two ground lines sufficiently.
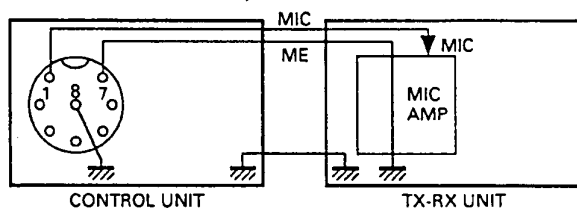
CONTROL UNIT   **TX-RX UNIT**
TM-702
MIC GND is grounded in the TX-RX unit.
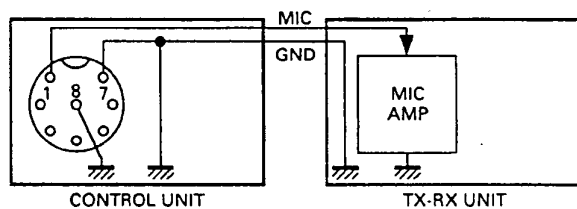
CONTROL UNIT   **TX-RX UNIT**
TM-221
MIC GND is grounded in the control unit.

The external MIC GND of the handy transceiver is supplied from the ground of the external speaker. Since the external microphone jack does not have a ground, the external PTT cannot be operated just by inserting the plug into the microphone connector only. The SP GND must always be connected to the PTT circuit.

■ The transmission power is insufficient

1. Connect a power supply with an ammeter to the transceiver and start transmission.

2. Observe the ammeter on the power supply. If the ammeter indicates the following value, the power module is OK.

   50W model : 6 A

   25W model : 4 A

   10W model : 2.5 A

   5W model : 1 A

A wire between the module OUT and the antenna is broken.

3. Check the module voltage (during transmission).

- INPUT

   The voltage is different from model to model. Refer to the Service Manual.

- TXB, APC (DB)

   8V (5V) during transmission. If this pin is used for APC, refer to the Service Manual.

- VCC

   Power supply voltage is applied to the VCC. This line is directly connected to the power cord. Remove the power cord before sucking solder. (Otherwise, the fuse will blow.)

- OUTPUT

   The 1.6-V (DC) bias is applied to this output terminal. (It depends on models.)

INPUT   DB   VCC   OUTPUT

INPUT   VC1   TXB   VCC   OUTPUT
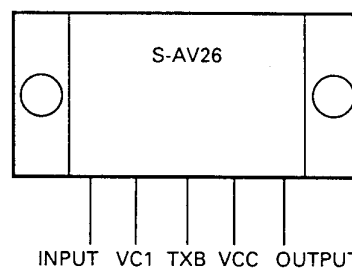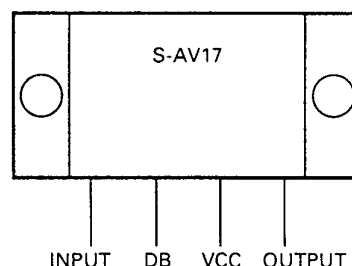
4. See the waveform at drive OUT. (Use an oscilloscope for up to 144MHz, and use an RF VT-VM or spectrum analyzer for 430MHz or higher.)
   If the drive level is OK, the module is defective.
   If the drive level is NG, check the power supply voltage at the drive stage.
5. Check the level of the drive input terminal.
   If the level is sufficient, the drive circuit is defective.
   If the level is low, check the VCO.
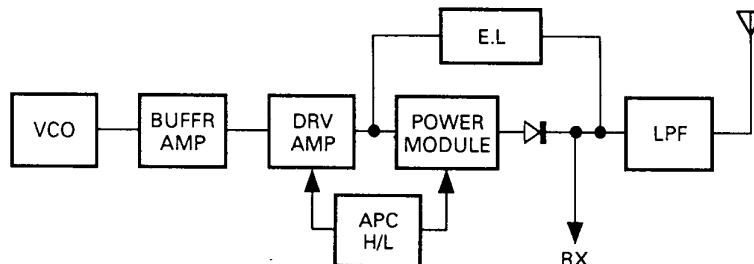
■ If the drive waveform is not seen at the input of the module

See following figure, APC operation. This figure shows that the drive output does not enter the module unless antenna diode D4 turns ON.

Since the anode of D4 is connected to the +B line, it receives the power supply voltage. The cathode of the diode is connected to the output terminal of the operational amplifier. To turn D4 ON, the cathode voltage of D4 must be no fewer than 1.2V lower than the +B voltage due to the output terminal of the operational amplifier.

If the voltage does not decrease, consider why.

• Possible causes
1. Q313 does not turn ON during transmission. (The ground pin of the IC is not grounded.)
2. R303 or R304 is broken.
3. Q315 or Q316 does not turn ON during transmission.
4. The power supply voltage is not applied to the IC.
5. Q311 has failed.

There are so many possible causes like these.
The TH-25G (26) and subsequent handy transceivers have similar circuit configurations. (Models with economical low power)
If the power is not output after the final module is replaced, check the above items.
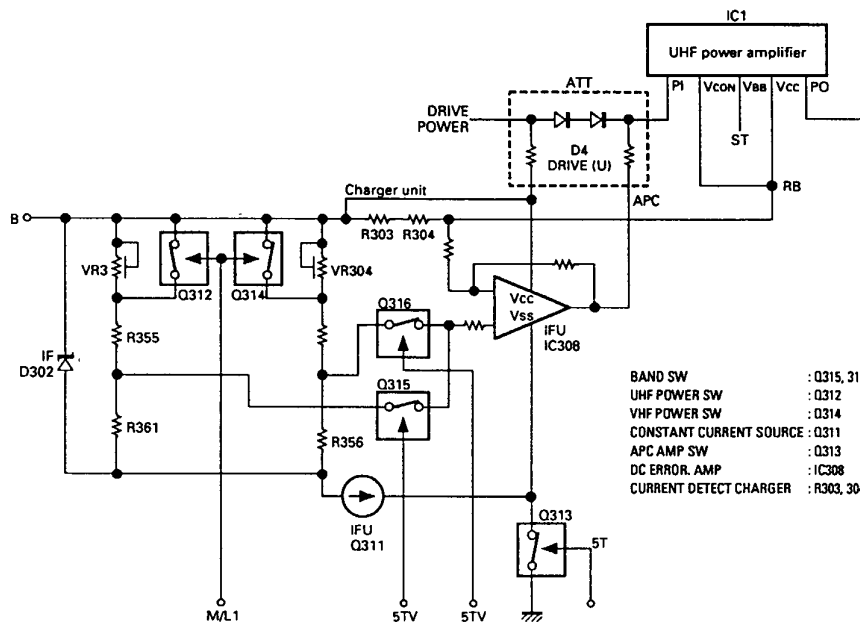
BAND SW	: Q315, 316
UHF POWER SW	: Q312
VHF POWER SW	: Q314
CONSTANT CURRENT SOURCE	: Q311
APC AMP SW	: Q313
DC ERROR. AMP	: IC308
CURRENT DETECT CHARGER	: R303, 304

TH-78 APC circuit

— 48 —

■ **Additional functions**

• **CTCSS**

1. First, replace the CTCSS unit.
   Verify that the unit is not defective.
   Is the tone frequency correct?

2. The SQL does not open during reception.
   Does the AF signal enter the RD terminal?
   Check whether the CTC, CTD, and CTS lines are shorted.
   Is each line connected to the appropriate microcomputer port?
   Is 5C present?

3. The SQL of the other transceiver does not open.
   Check the tone frequency and modulation with a linear detector. (88.5Hz, about 0.4 to 0.8kHz)
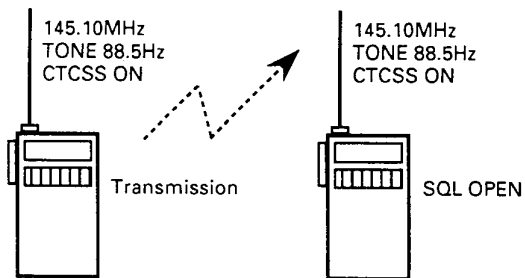
• **DTSS**

1. Verify that the DTSS code is correct.

2. The SQL does not open during reception.
   Does the AF signal enter the input pin of the DTMF decoder IC?
   Does the DTMF decoder oscillator operate?
   Is the appropriate voltage applied to the IC?

3. Characters are incorrect (TH-28, TH-78). → The DTMF decoder IC is defective.

145.10MHz
TONE 88.5Hz
CTCSS ON

Transmission

145.10MHz
TONE 88.5Hz
CTCSS ON

SQL OPEN

144.98MHz
DTSS code 123
DTSS ON

Transmission

144.98MHz
DTSS code 123
DTSS ON

SQL OPEN
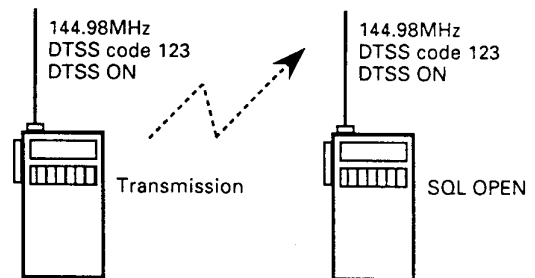
DIGITAL CIRCUIT

1. Display Error

■ First, check as follows
1. Reset
2. Turn up the AF VR and check whether noise occurs.
3. Connect the SSG to the antenna and check whether signals are received. (SSGOUT: 14.001MHz, 60dBµ)

■ If signals are received
1. The reception circuit and PLL circuit are working.
2. The microcomputer PLL data is correct.
3. There is a defective part between the display data output circuit and the display circuit in the digital (control) circuit.

■ Key points
• Models with a display tube

Turn the power ON and OFF several times.

If any segment of the display tube lights, the display tube and DC-DC converter are functioning.

There is a defective part between the micro-computer and the display drive circuit.

• Models with an LCD

Replace the LCD assembly. You can see whether the LCD assembly or the digital circuit is defective.

If the transceiver does not have an LCD:

Check the voltage and waveform of the connectors between the LCD and digital board.

5V, 8V (DC-VM), data line (oscilloscope)

Apply the oscilloscope probe to the data line and turn the encoder. If the data waveform changes, the digital circuit is considered to be functioning properly.

• Models with diodes (LEDs)

Is a voltage present common at the LED?

Is a voltage applied to the drive IC and transistor?

2. How to Check The Microcomputer
1. Is the microcomputer clock output?
2. Is a voltage applied to the microcomputer, I/O, RAM, and ROM?
3. Is a voltage applied to the RESET pin of the microcomputer? → 5 V (Low for some models)

   Turn the power OFF and check the waveform with an oscilloscope.
4. Observe the ROM $\overline{CS}$ and CS2 pins with the oscilloscope. (Pulses are output from the pins.)

5. Observe the data and address lines with the oscilloscope.
6. Check the INT, WR, and RE with the oscilloscope.

The microcomputer can be checked in this way. You should verify how the microcomputer runs and where the program stops to isolate a fault.

■ No display, no reception, no noise

The microcomputer does not work at all. There is a basic problem in the microcomputer operation. (For example, Vcc is not supplied to the microcomputer or IC; No clocks are generated; The microcomputer is not reset; The data line has a break.)

■ No display, but reception is normal

The microcomputer functions properly. The display is defective. (The display tube is defective.)

■ Abnormal display (8.8.8.8.8.8.8)
no reception, no noise

The microcomputer does not work at all. There is a basic problem in the microcomputer operation. (For example, Vcc is not supplied to the microcomputer or IC; No clocks are generated; The microcomputer is not reset; The data line has a break.)

■ Abnormal display (-14.-188 - - :Example), but reception is normal

The microcomputer functions properly. The microcomputer display output data is wrong. The I/O or display drive IC is defective. (The microcomputer, I/O, RAM, or ROM is malfunctioning.)

■ Abnormal display (. . . . . . .), no reception

The microcomputer functions properly. Unlock display. (The microcomputer, I/O, or PLL circuit is malfunctioning.)

■ Display OK, the frequency continues increasing or decreasing

The microcomputer functions properly. The microphone UP or DOWN key is kept pressed. (The microcomputer or I/O circuit is shorted. (MU, MD))

■ Keys are not accepted

The microcomputer functions properly. The key input I/O is defective. (The microcomputer or I/O is malfunctioning.)

3. Nothing is Displayed

1. Turn the power ON and OFF several times.
   Does the display light even once?
   • **YES**
   The DC-DC converter and the display tube are functioning properly.
   The display driver circuit, display data circuit, or dimmer control circuit is defective.
   • **NO**
   Check the input and output voltages of the DC-DC converter.
   • There is no input voltage
   Check the power supply circuit of the DC-DC converter.
   • There is an input voltage
   Has the oscillating transistor of the DC-DC converter failed?
   Remove the transistor from the board and measure its resistance with the ohm range of the tester.

2. Is the oscillating transistor functioning?
   Check the transistor collector with an oscilloscope.
   • **NO**
   Replace the transistor.
   Check the output diode bridge. Remove the four diodes from the board and measure each of them.

   The DC-DC converters of the TS-140 and TS-680 are modularized. If the DC-DC converter is suspected, replace it.

3. Is any voltage applied to the filament of the display tube?
   Is the zener diode connected to the filament shorted? (If the about 5V zener diode fails, 88.888 is displayed.)
   Check the voltage at each terminal of the display tube. (Negative voltages)
   If the same voltage is applied to the terminals, the drive IC is not working.
   Check the drive IC input with an oscilloscope.
   Turn the encoder and check the data line.
   If any data enter the data line, replace the drive IC.

4. If no data enter the line:
   Check the data line with a tester. (From the microcomputer output to the driver IC input)

■ LCD

New models use LCD assemblies. Replace the LCD assembly.
If the model does not have an LCD assembly, check the data line with an oscilloscope.
Check points A and B with an oscilloscope. OK if a digital signal is output when turning the encoder.

If data arrives at the LCD driver input and 5C and 8C are input to the board, the driver IC may be defective.
The LCD assembly is registered as one unit. Replace the entire LCD assembly.
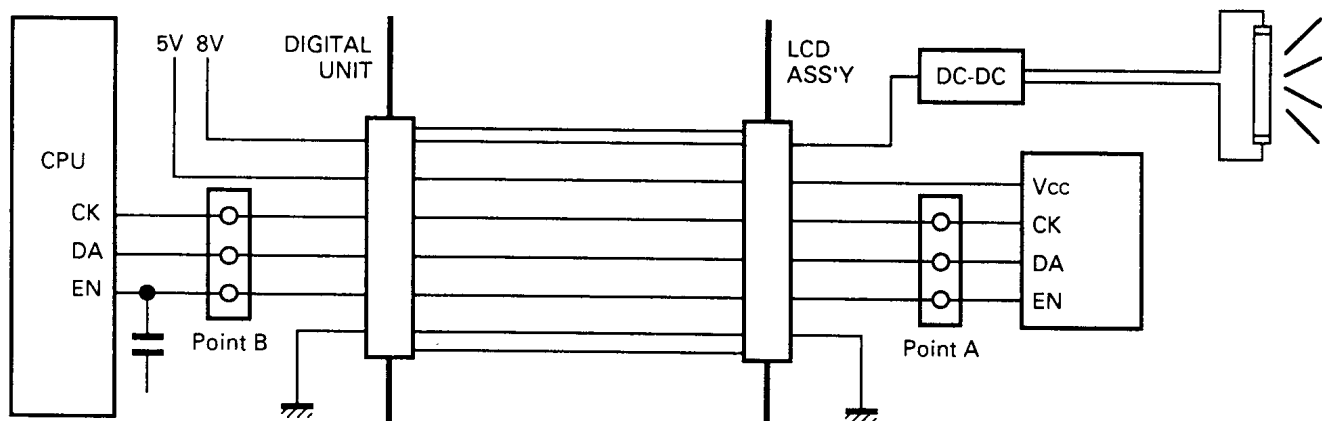
■ Car transceiver

For some car transceivers, the flat cable of the LCD assembly data line is soldered. Check for defective soldering or shorting. (TR-751, TR-851, etc.)

Some reflow-type connectors were not soldered securely, and solder was separated due to shocks. (TM-702, etc.)

■ Handy transceiver

If the display is abnormal, the zebra may be installed incorrectly. Disassemble the display unit, clean the zebra and terminals, and reassemble them. (Especially, TH-25 and TH-26 series)
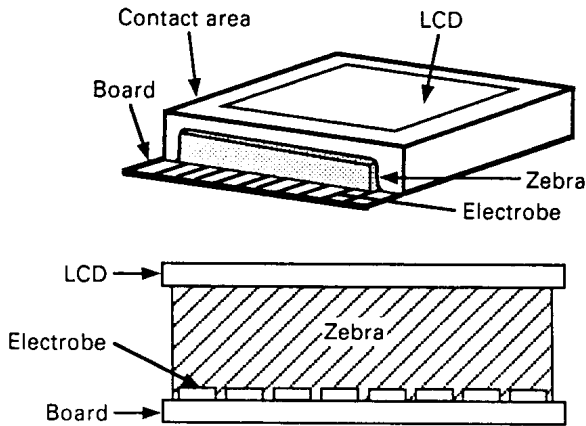
Type attached by heat press (TH-77, TR-50); Both ends of the contact area tend to have poor contact. If the contact becomes poor, the display that should be invisible becomes visible from some angles. (This occurs frequently in the initial lot of the TH-77.)
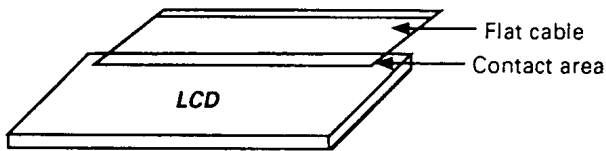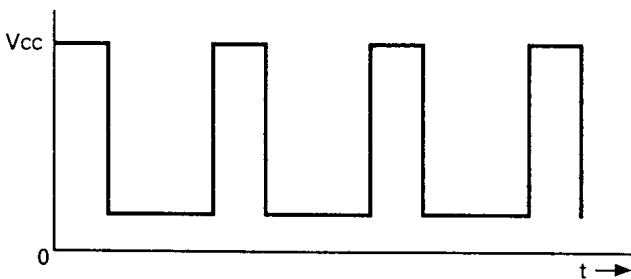

■ Models with diodes (LEDs)

The recent models do not use any diodes (LEDs). (The models before the TM-211 used them.)
When the current flows from the anode to the cathode of the LED, it lights. Check whether the voltage is applied to the anode.
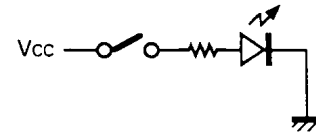The cathode voltage should be negative if the LED lights dynamically. Check it with an oscilloscope.
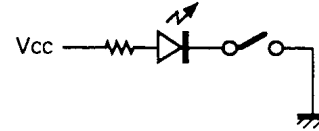

• Notes for checking the LED

There are two methods of lighting the LED.
Turn the LED ON and OFF by controlling the anode voltage. No voltage is applied to either end of the LED when it is OFF.

Turn the LED ON and OFF by grounding the cathode. Vcc is applied to both ends of the LED when it is OFF.

4. The Display is Dark

■ If the display tube is used

Is the dimmer circuit kept ON?
Is the heater voltage low?
The display tube may be defective. (If the vacuum is low, the display darkens.)
If the power supply voltage of the DC-DC converter is low, the display darkens.
If the output voltage of the DC-DC converter is low, the display also darkens.

■ If an LCD is used

The back light is dark. (The DC-DC converter is defective. The fluorescent lamp of the backlight is defective. The power supply voltage is low. 8C, 5C)
An abnormal voltage is applied to the LCD drive IC.
The drive IC is defective.
Is the dimmer circuit kept ON?

■ If an LED is used

An abnormal voltage is applied to the drive IC.
The drive IC is defective.
The diode is defective. (Brightness is uneven.)
The power supply voltage is low.

For any display type, check as follows:
1. Check the power supply. (8C, 5C, heater AC line)
2. Check the display unit voltage.
3. Check the other circuit operations.

5. Meaningless Display or Display Error

Check whether the transceiver can receive signals. Reset the microcomputer. → It reverts to the initial status.

HF : 14.000MHz, USB
VHF : 144.000MHz, CW (145.000MHz, FM)
UHF : 430.000MHz, CW (K 440.000MHz)

To receive these signals, set the SSG frequency as follows:

HF : 14.001MHz, 40dBμ
VHF : 144.000MHz, 40dBμ
    (145.000MHz, 40dBμ, MOD ON)
UHF : 430.000MHz, 40dBμ
    (K 440.000MHz, 40dBμ, MOD ON)

■ If the signals are received

PLL data is normal.
    The display data line is defective.
    The display drive IC is defective.
    The display is defective.

■ If signals are not received

The microcomputer does not work.
    Reset the transceiver. → Refer to the "Power is not turned ON " section on page 8.
    If a ROM socket is used to install the ROM, remove the socket from the board and solder the ROM directly to the board.
    Replace the microcomputer, RAM, and ROM IC in this order.

6. Keys are Not Accepted

Is the F. LOCK switch ON? → Turn the encoder. Reset the transceiver.

■ If the trasceiver is not reset

1. Unplug the power cable with the power switch ON. (Remove the battery.)
2. Hold down the reset key, and plug in the power cable. (Reinstall the battery.)
3. Reset the transceiver.
4. Check the microcomputer or I/O ICs.

If there is a spare board, use it to replace the board . Other boards may be defective.

■ If the transceiver is reset

1. Is any special function indicator shown on the display? (Example: RIT, XIT, MHz, a mode other than USB)
2. If such an indicator is displayed:
    The key corresponding to the indicator may be kept pressed mechanically or electrically. Press it again.
3. If it is not mechanically locked, it is electrically locked.

■ Troubleshooting

The TS-850 keyboard unit is provided as an example on the next page.

• If the transceiver is not reset

1. Unplug the power cable with the power switch ON. (Remove the battery.)
2. Hold down the reset key, and plug in the power cable. (Reinstall the battery.)
3. Reset the transceiver.
4. Check the microcomputer or I/O ICs.
5. If there is a spare board, use it to replace the board. Other boards may be defective.

When the AM/FM key is pressed, K3 and S2 lines are connected through D3.

• Key checking procedure 1 (Tester)
(Turn the power switch on the set OFF.)

1. Connect the tester to K3 and S2. Press the AM key. (Ohm x1 range)
    Does the ohmmeter operate?
    If not, change the polarity of the tester and make a check again. The ohmmeter should operate this time. If not, the diode or switch is defective.
2. If the ohmmeter operates in both cases, remove the flat cable from the digital unit and make a check again. If the ohmmeter still operates in both cases, the keyboard board is defective.
3. If the set becomes normal (the ohmmeter operates only with one polarity) by removing the flat cable (the ohmmeter pointer moves only once), the digital board is defective. Is any I/O IC lead shorted?

Check all the other keys in this way.
Example: If the MHz key is held down: K4 and S4 are connected through D5.

- **Key checking procedure 2 (Oscilloscope)**
1. Turn the set ON, and observe the waveforms of the groups of S0 to S5 lines and K0 to K5 lines.
2. The waveforms of S0 to S5 lines of the S group must be the same when the key switch is OFF.
3. The waveforms of K0 to K5 lines of the K group must be the same when the key switch is OFF.

These are normal states.
Example: When the VOICE switch is pressed, S5 data passes through D6 and goes to K3. The microcomputer reads it and recognizes the data from S5 to K3 as voice.

Suppose that a key is electrically kept pressed. Observe the waveforms of S0 to S5 lines and K0 to K5 lines with an oscilloscope.
The waveform of one line of the S group differs from the waveforms of the other lines, and the waveform of one line of the K group differs from the waveforms of the other lines.
Example: If the waveform of S1 and K5 is abnormal, the TX-A switch is being kept pressed.
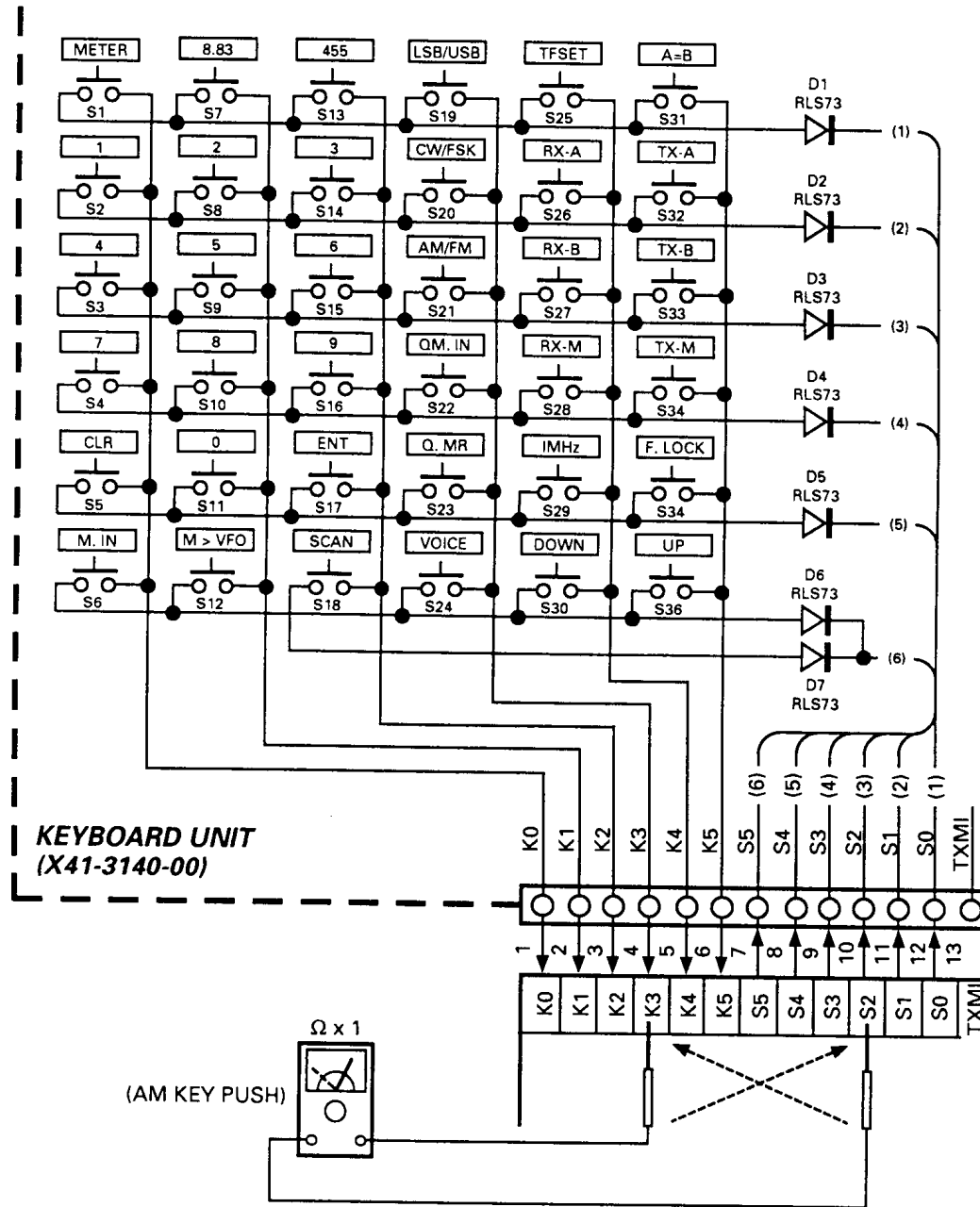
TS-850 key matrix circuit

7. How to Find Missing

(Throughout holes in a board, broken patterns, capacitors or coils connected to the data lines)
Analog tester : x10 or x100 ohm range
Turn the set OFF.

Measure the resistance of the data and address lines in both forward and backward directions.
The data lines must have almost the same resistance.

If the resistance of a line differs from the others, that line is defective. The address lines must have similar resistance.
Example: A0 to A15
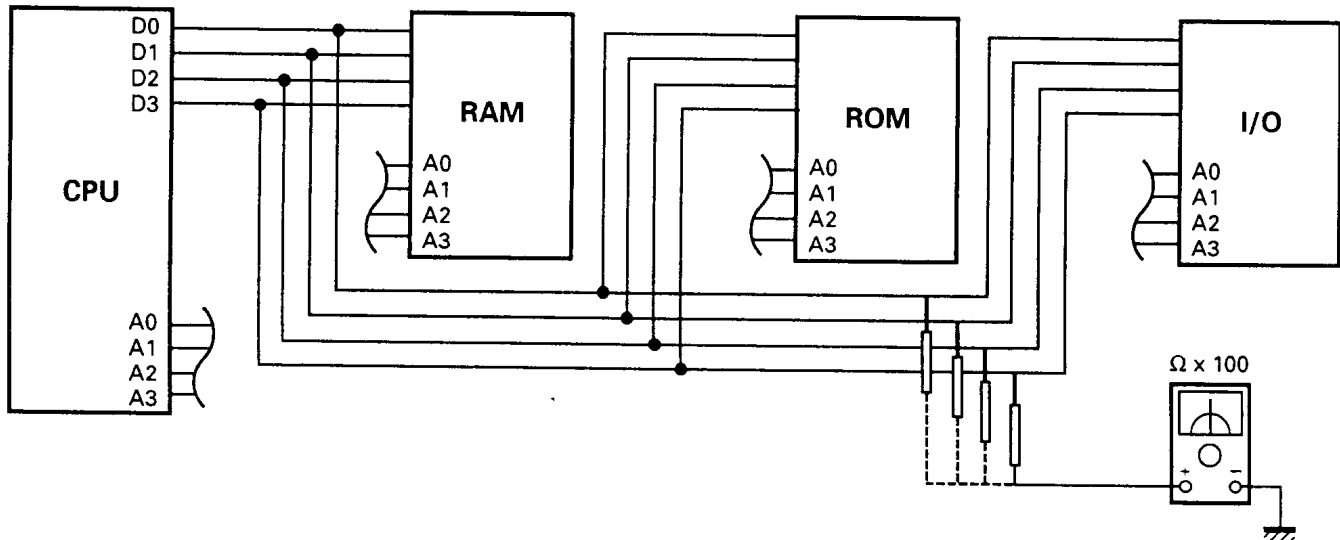
A0 to A7 (The resistances are almost the same.)
↑
Resistance differs slightly
↓
A8 to A15 (The resistances are almost the same.)

You can find defective lines in this way. Then check the cause of the different resistances.

■ One line has a lower resistance than the others
Remove IC leads, resistors, and capacitors connected to the line one at a time. When the line resistance becomes the same as that of the other lines, the component just removed is defective.

■ One line has a higher resistance than the others
A pattern is broken or a component has a poor contact.

■ Conceptual drawing of the digital circuit
The resistance between D0 and GND is determined by the sum of the resistances of the CPU, ROM, RAM, and I/O ports. The resistances between D1 to D7 and GND are determined in the same way.

If the line has a break at point A, the resistance of the I/O port is not added, so the total resistance of the line is different from that of the other lines. You can find a defective line in this way.
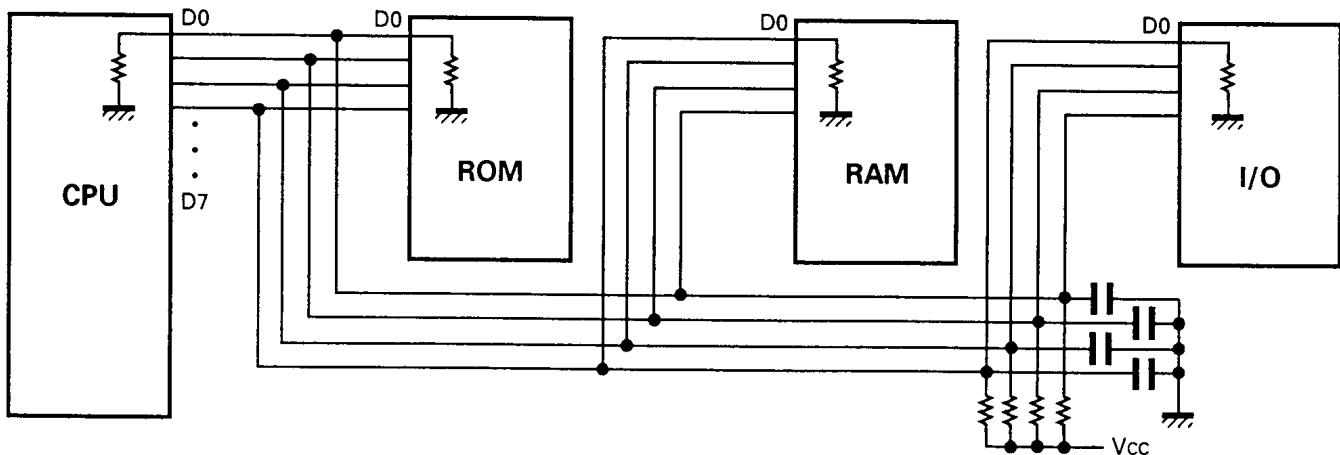
The data lines are mostly pulled up with resistors. Check the leads of the complex resistor with a tester. (It is difficult to check the leads of the flat package IC.)

Common B is applied to pin 1 of the complex resistor. Pins 2 to 9 are connected to the microcomputer data lines. Measure the resistances with respect to the ground.
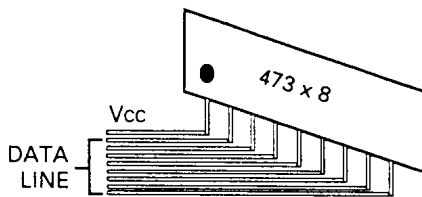
Apply one tester probe to pin 2, and measure the resistance of pin 3, pin 4, pin 5, ..., pin 9.
Apply one tester probe to pin 3, and measure the resistance of pin 4, pin 5, pin 6, ..., pin 9.
Apply one tester probe to pin 4, and measure the resistance of pin 5, pin 6, pin 7, ..., pin 9.

↓

Measure the data line resistances in this way.

Assume that each data line runs from one edge to the other of the digital board. Therefore, D1 may become adjacent to D7 in the pattern. D1 and D7 may be shorted, though it rarely occurs.
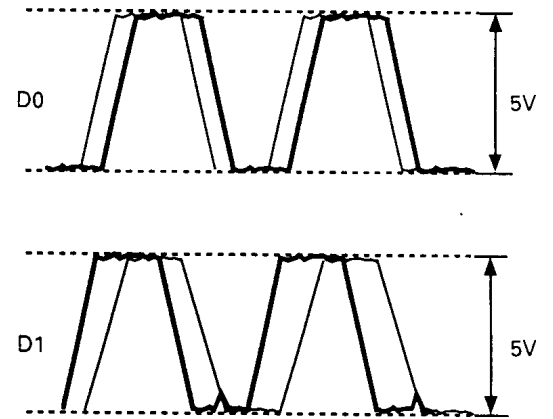*The above procedure checks for this problem.*

8. Checking Waveforms With the Power ON

Waveforms can be checked with the power ON, though it depends on models. It is advised to compare the waveforms with those of another set if available.
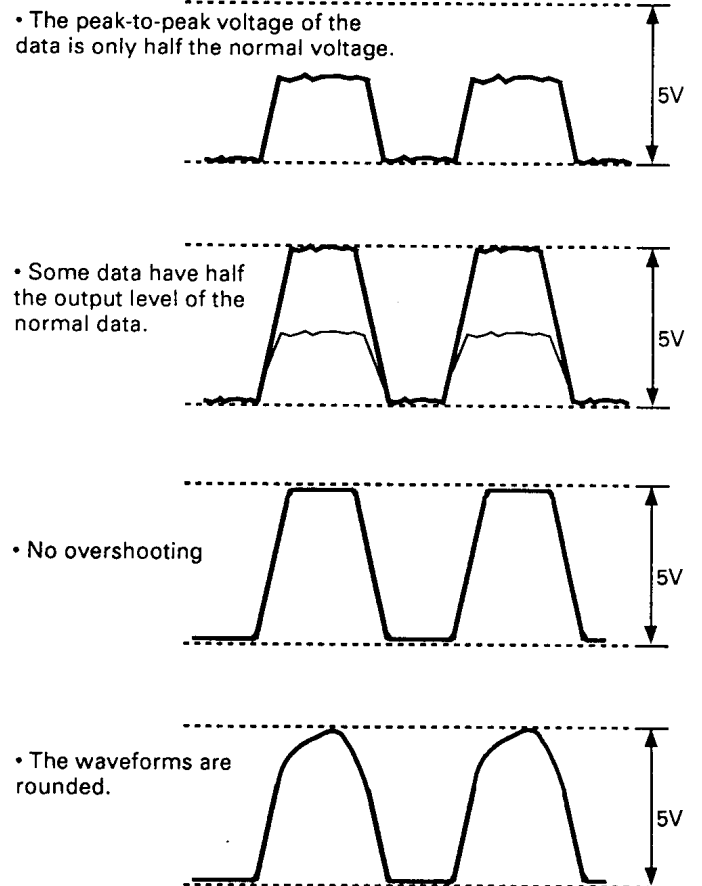Oscilloscope: DIV 5V or 10V, Sweep Trigger point

1. Remove the ROM.
2. While monitoring the microcomputer data line, turn the power ON.
   If no waveform appears on the oscilloscope, turn the power OFF and ON again.
   When the power is turned ON and OFF several times, a waveform is displayed.
3. Observe the waveform height, rising edge, and overshooting of the data and address lines.

Example

Example of the bad waveforms

• The peak-to-peak voltage of the data is only half the normal voltage.

• Some data have half the output level of the normal data.

• No overshooting

• The waveforms are rounded.

4. If terminals are shorted by mistake during the check, the waveform disappears.
   Turn the power OFF and ON again repeatedly until a waveform appears again.
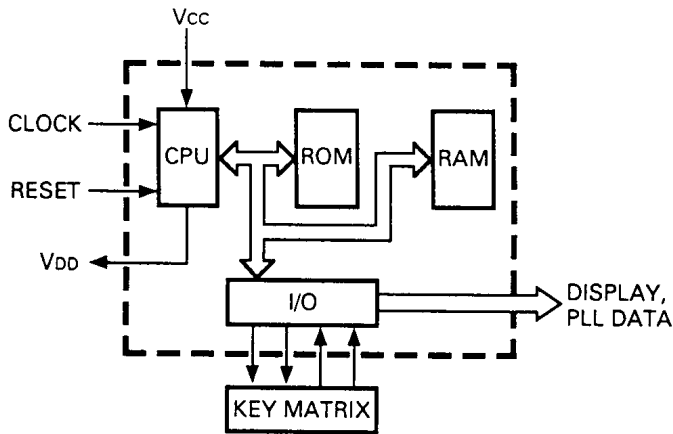5. Locate the defective line in this way.

If an IC lead is lifted during the check by this method, the waveform disappears. The microcomputer stops operating.
This method is useful if the resistance check fails to find the cause of the problem.

9. Mobile and Handy Transceivers

■ Digital circuit

The digital circuit is comprised of a single-chip microcomputer.

The contents of the internal ROM differ from model to model. Pay special attention to this when replacing the microcomputer.

Example:

TM-441   75116GF-728-3BE

TM-702   75116GF-667-3BE

These models contain microcomputers of the same type, but the three digits in the middle of the codes differ, so they are not compatible with each other.

The recent multi-functional handy transceivers and car transceivers with detachable panels have a sub-CPU in addition to the main CPU, which communicate with each other to transfer data.
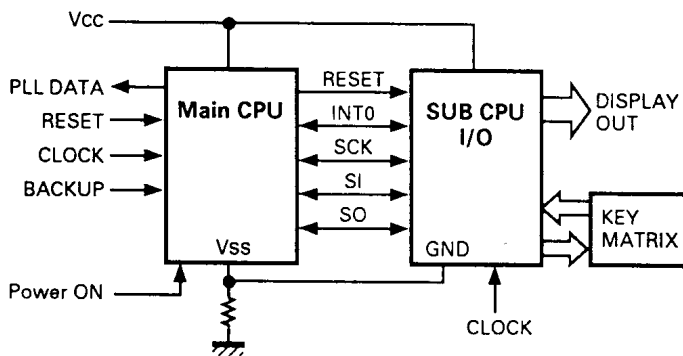
■ How to check

1. Is the power supply voltage applied to each IC?
2. Does the microcomputer output clocks? (Also check the sub-CPU.)
3. Is the reset voltage present?
4. Are the main CPU and sub-CPU grounded with a low-resistance resistor (about 10 ohms)?
5. Reset the transceiver.
6. Check the data line that connects the main CPU and sub-CPU.
7. Check the soldered parts of the microcomputer.
   Before soldering them again, be sure to unplug the power cord of the set.
   Before applying the soldering iron tip to microcomputer leads, apply it to the ground once (to set the potential of the iron tip equal to that of the set).
8. If an LED stays lit:
   Check the waveforms of the key output and key return terminals with an oscilloscope.
9. If the car transceiver has a detachable panel, replace the panel assembly.
   Check the voltage of the connector and the waveform of the data line.
   When it is checked by turning the encoder, AF VR, or SQL VR, digital data definitely is output from SI and SO.
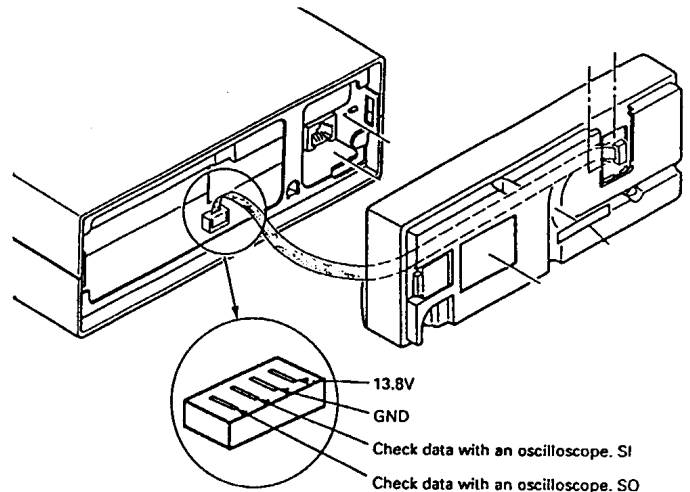
PLL CIRCUIT

1. PLL

The PLL circuit generates the frequencies required for transmission and reception with the transceiver.

■ Operation

1. The reference oscillator produces the reference frequency and sends it to the reference oscillator INPUT of the phase comparator (P. D.).
2. The VCO generates free-run frequencies. (It does so even if it is unlocked.)
3. Part of the VCO output goes to the divider (I/N). Division data from the microcomputer enters the divider and the VCO signal is divided according to the microcomputer data.
4. The phase comparator (P. D.) compares the phases of the reference oscillator and Frequency demultiplier outputs. The difference between the phases of the two frequencies is converted to DC voltage and output to P. Dout. If the phase difference between the two frequencies is zero, proceed to 8.

5. The DC voltage from P. Dout enters the low-pass filter (LPF), through which unwanted ripple components are removed. The resulting signal enters the VCO.
6. Since the VCO uses a variable capacitor diode, the change in the DC voltage from the low-pass filter indicates the change in the capacitance of the varicap diode, and it changes the VCO oscillation frequency.
7. Return to 3.
8. If the phases of the reference oscillator and 1/N VCO frequencies match (the DC voltage is always constant → the VCO frequency is always constant), the PLL is locked.
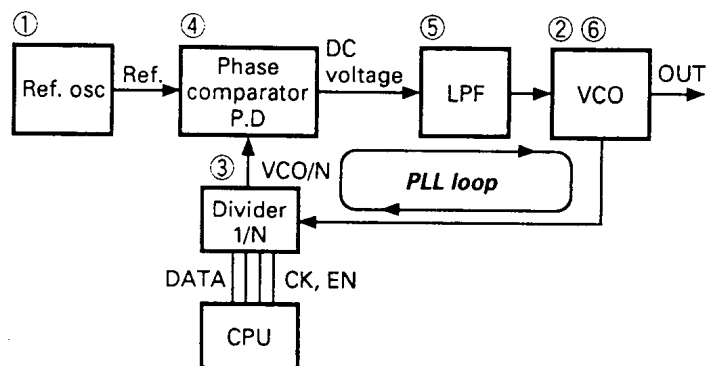
2. Unlock

Check all the bands by setting the BAND switch UP or DOWN.

■ Only particular band frequencies shift

Check which frequencies shift.

• The VCO switching frequency shifts

1. Check the VCO oscillation level of the last PLL loop. Change the band to another and check the oscillation level. Is there any band in which the oscillation level is extremely low? (The output should be 0.5 to 1Vp-p, though it depends on models.)

• YES

The VCO for that band is defective. Check the oscillating transistor voltage and oscillation level.
The VCOs for the other bands must stop oscillating. Verify that they stop oscillating.
The VCO may not oscillate steadily if band data is wrong.

• NO

Does any signal enter the comparison frequency input pin of the PLL IC?
See page 64 and check the comparison frequency input of the PLL IC.

■ A certain range of frequencies is unlocked
(The range is not definite or are all the bands unlocked)

See the PLL block diagram on page 64.

• Example

The D7 voltage is zero. (Lock: 5V; Unlock: 0V)
If IC9 is unlocked, do not check only this loop.
The comparison frequency of the loop is a combination of the frequency produced by Q18, the IC1 PLL output, and the IC4 PLL output.
If the IC1 or IC4 loop is unlocked, the IC9 loop may also be unlocked. If the IC9 loop is unlocked, the last loop is also unlocked.

To repair a PLL of a high-frequency (HF) transceiver or all-mode transceiver, it is a fundamental step to find the highest-level unlocked loop.

The highest-level PLL loop of the TS-440 is the IC1 and IC4 PLL. The last loop is the IC17 loop.
The IC18 loop is an independent loop. If this loop is unlocked, it does not affect the other loops.

■ How to find unlocked loops

The PLL ICs has an unlock detection pins.
Locked: High, Unlocked: Low (Some ICs have a reverse logic.)
Check all the unlock detection pins. (Use a digital voltmeter or oscilloscope.) You can find unlocked loops in this way.

• If all the loops are unlocked

1. Check the common power lines (8C, 5C, and 15C).
2. Check whether the reference oscillator is working and whether the reference frequency is supplied to all the PLL ICs.
3. While turning the encoder check whether digital pulses are input to the data line of the IC.

• If several loops are unlocked

If two or more loops are unlocked, find the highest-level loop.

1. Check whether any signal is input to the reference frequency input pin and comparison frequency input pin of the PLL IC.
2. Check the power supply voltages of the PLL IC, low-pass filter (LPF), and VCO.
3. Check the data line of the UNLOCK IC with an oscilloscope.
4. Adjust the lock voltage as instructed in the Service Manual.
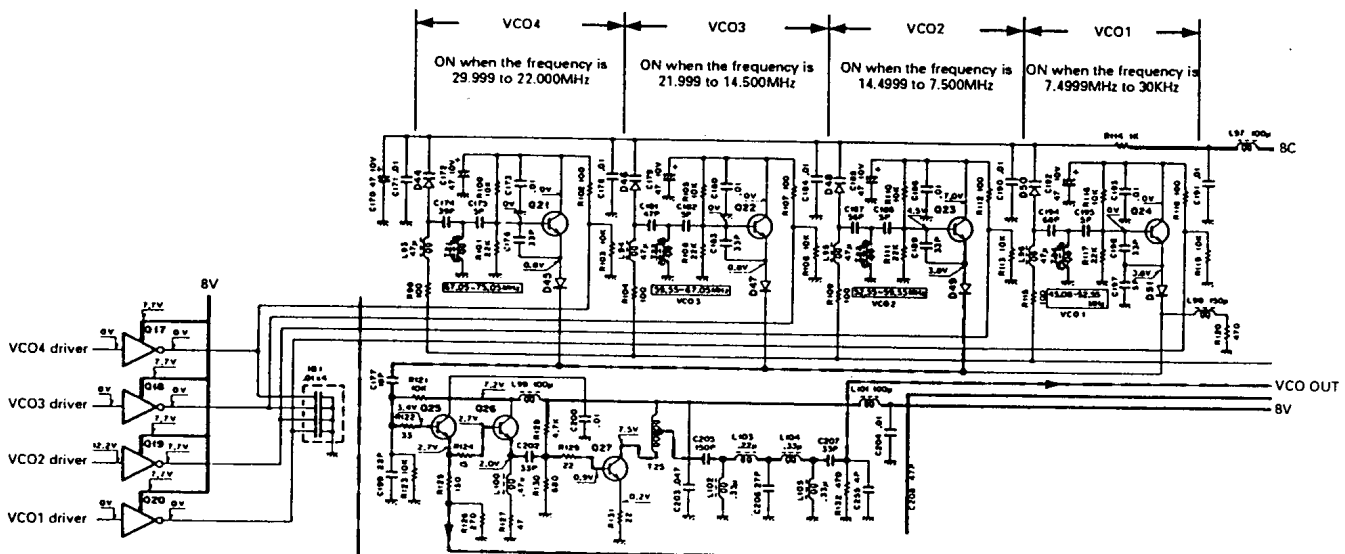
TS-440 RF unit

Apply the oscillator probe to the PLL VCO terminal and check the waveform level.
IF it is 0.5 to 1 Vp-p, the output is OK.

■ If unlocked loops are not detected with the digital voltmeter

Check them with an oscilloscope. (IC UL pin)
VOLT/DIV: 2V   Sweep time/DIV: 5mV to 0.5mV
(Change the SWEEP/DIV in this range. If the incorrect waveform shown below appears, the circuit is unlocked.)

a)   b)   c)

| OK | NG | NG |
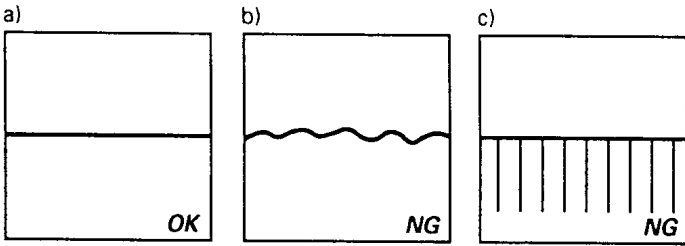
b) The VCO oscillation frequency is unstable.
The low-pass filter does not work properly.
The comparison frequency level is insufficient.

c) The PLL is malfunctions.
The VCO does not work properly.

Set VOLT/DIV to 20mV or 10mV and make a check again.

a)   b)   c)

| OK | NG | NG |
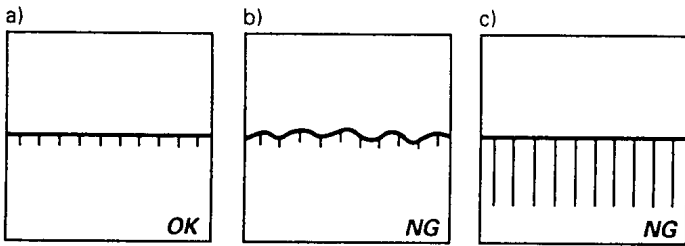
b) The VCO oscillation frequency is fluctuates.
(The VCO transistor makes a loud noise.)
The low-pass filter transistor makes a loud noise.
The smoothing capacitor diode is defective.
The variable capacitor diode is defective.

c) The waveform is influenced by other PLL loops.
Check the high-level PLL loops.

3. How to Check the PLL Data Lines (1)

1. Apply the oscilloscope probe to the data line of the PLL IC and check whether a digital pulse comes from the digital circuit.
   If a digital signal is present, the data line is OK.
2. Check all the CK, DA, LE, SCK, and SO data lines.
3. If no data arrive at a data line, check it again with an oscilloscope.
4. Turn the encoder. If data is found, the line is OK.
5. If not, change the mode. If data is detected at this time, the line is OK.
6. If no data is found, turn the power OFF and ON again several times. If data arrive at the line, it is OK.

If a digital signal enters each PLL data line, the data lines are OK. If no data enter a line, that line is defective.

The data output I/O is defective or a wire between the I/O IC and PLL IC is broken.

4. How to Check the PLL Data Lines (2)

Turn the set OFF.
Each PLL IC has a data line, a clock line, and an enable line.

• **Example: If there are four PLL ICs**

DA0 to DA3, CK0 to CK3, and LE0 to LE3 data lines are connected with the PLL ICs. (CK and DA lines may be shared.) Check the resistance of these groups (positive and negative polarities).

The lines of each group must have almost the same resistance. If the resistance of one line differs from the others, that line is defective.

Check the lines by referring to the digital circuit section on page 55.

5. Tips for Repair (For Repairing PLLs)

1. The levels of input pins 2 and 5 of the mixer IC, SN16913P, must be almost the same. If there is a large difference between pins 2 and 5 (two VOLT/DIV ranges or more), one of the 2 lines is faulty.
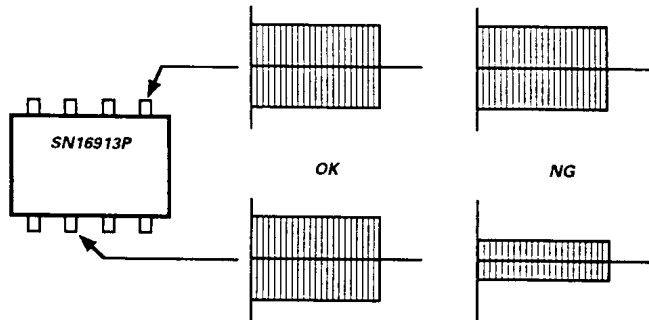
2. Because a PLL is unlocked, does not necessarily mean the PLL unit is defective.

   The TS-940 has two PLL circuits in the CAR unit, four PLL circuits in the PLL unit, and the last PLL VCO in the RF unit. It is therefore necessary to check the CAR, PLL, and RF units for repair.

   The TS-950 has four PLL circuits in the CAR unit, four PLL circuits in the PLL unit, and the two PLL circuits in the AF unit.

   The TS-440 has five PLL circuits in the PLL unit, the last PLL VCO in the RF unit, and a 8.375MHz oscillator circuit in the IF unit.

   Also check the control (digital) unit that is common to all the models and power supply lines when making a repair.

3. When the TS-790, TS-811, and TM-4xx are repaired, a limited number of parts can be checked with an oscilloscope. See the measurement section on page 96.

4. Before adjusting the lock voltage, read the Service Manual carefully.

   If the mode or frequency is set incorrectly during adjustment, another problem may occur as a result.

5. How to check the VCO operation

   If the PLL is unlocked, the VCO keeps oscillating at free-run frequencies.

   Connect the frequency counter to the VCO output, and turn the lock voltage adjustment coil (trimmer) while monitoring the frequency.

   If the frequency changes, the VCO is functioning correctly.

6. You can determine which circuit is defective by checking the PLL lock voltage.

   If it is 0.6V → either the VCO is not functioning properly; the reference frequency is not input correctly; the comparison frequency input is wrong; or the power supply line is defective.

   If it is kept high → either data are incorrect, or the low-pass filter or the PLL IC is defective.

   Use this information as a guide for repair. (There are some exceptions.)

7. The checkpoints of the TS-440 PLL are shown in the block diagram. TS-940, TS-930, and other models with multiple PLL loops basically are checked in the same way.

6. DDS (Direct Digital Synthesizer)

TS-850 and subsequent models use a DDS IC as a carrier oscillator circuit.

The DDS synthesizes sine waves with digital signals and produces signals with little distortion and a high C/ N ratio at low cost compared with conventional PLL oscillators. Since there is no PLL lockup time (time after the frequency changes until the PLL loop returns to normal status), and it responds quickly, it is advantageous for CW full break-in and AMTOR.
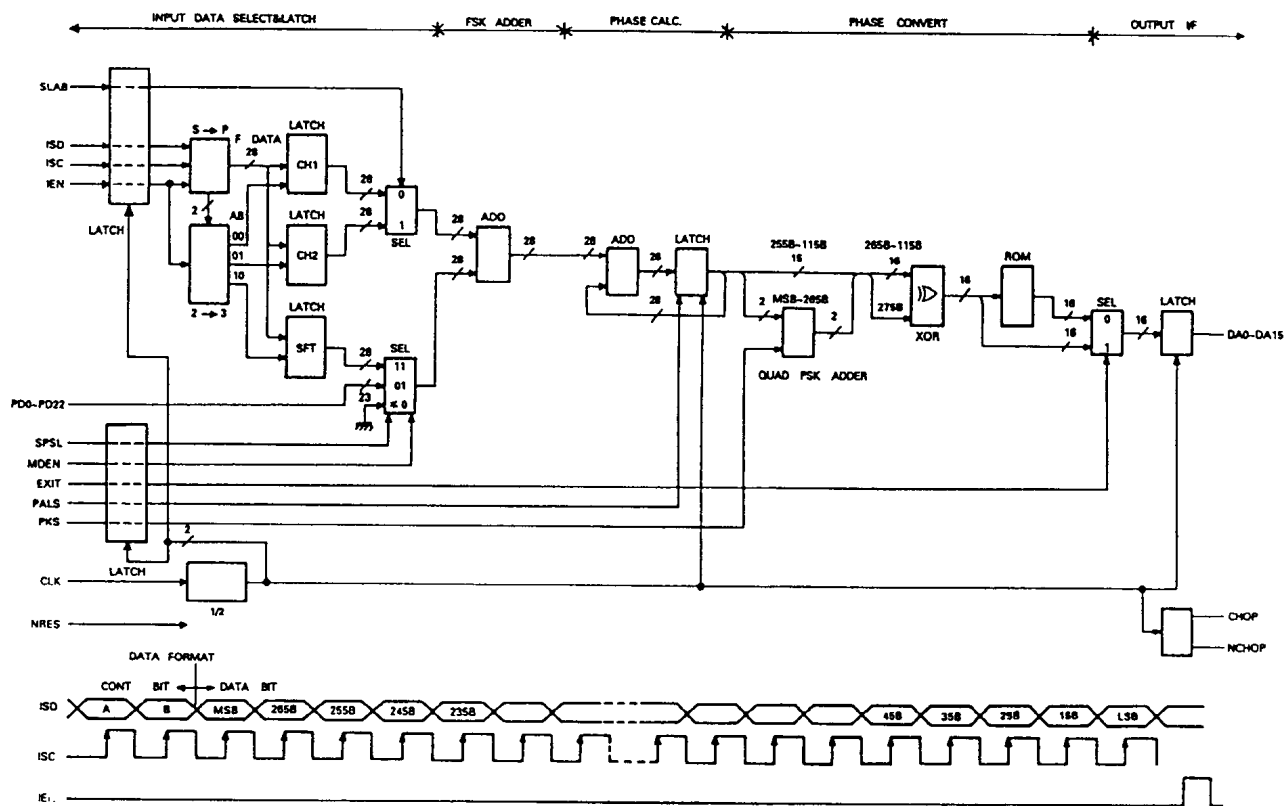
DDS IC : YM6631 block diagram and data format

■ Check procedure

1. Is the power supply voltage present at the power pin of the DDS IC?
2. Is the reference frequency input to the CLK pin of the DDS IC?
3. Are data input from the CPU to the data input pins of the IC?
   (YM6631 → pins 60 to 63; F71022 → pins 1, 42 to 44. See PLL data line checking method 1 on page 61 for details of data checking.)
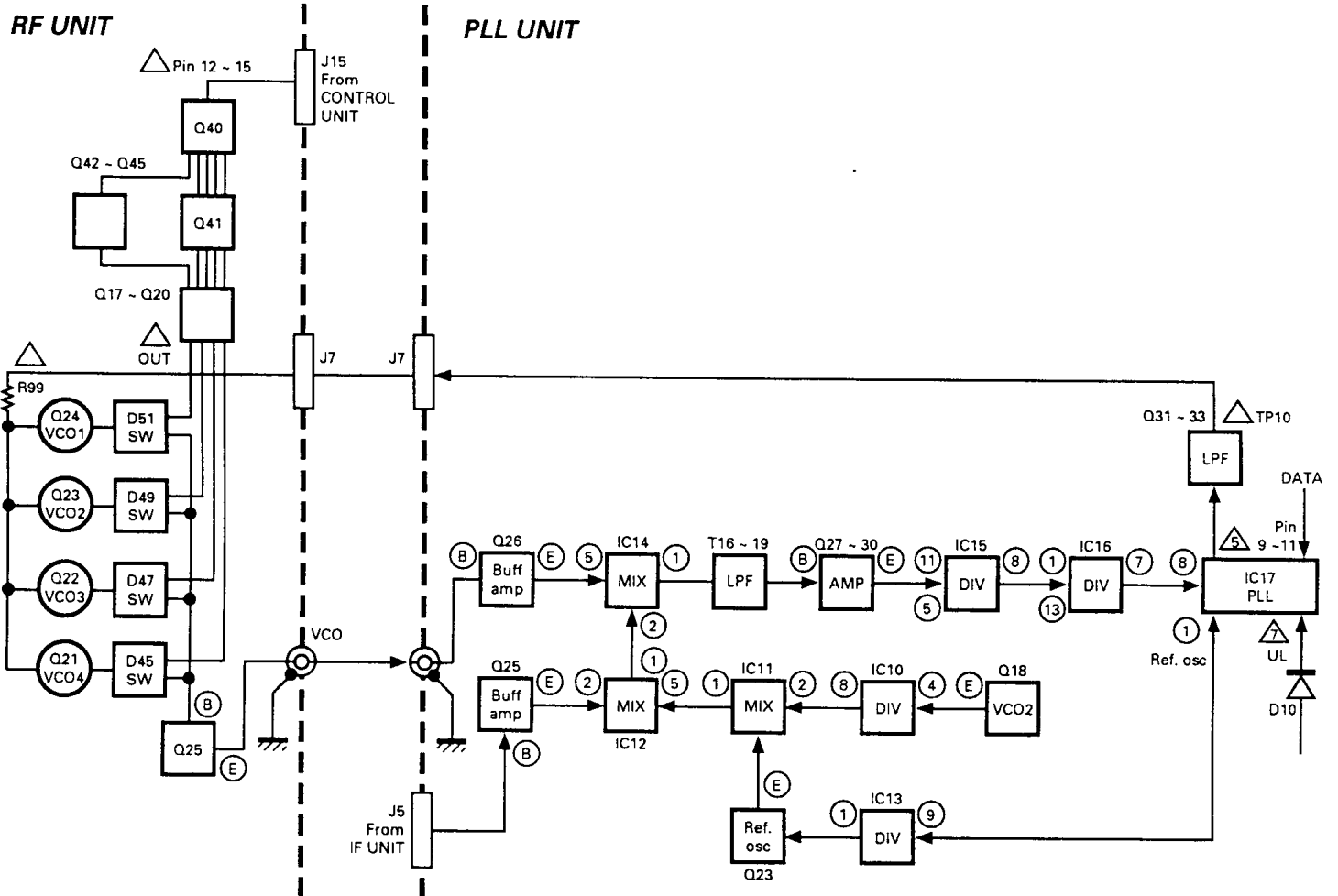4. Replace the DDS IC.
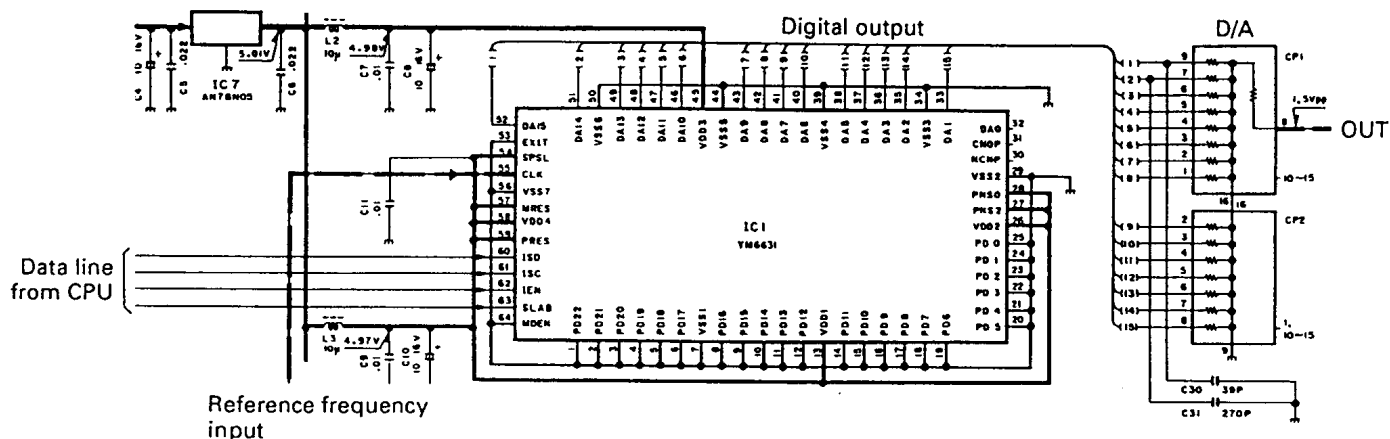
7. TS-440 PLL Checkpoints

○ : Check the level with an oscilloscope.
△ : Check the voltage with a digital voltmeter.
B: Base   E: Emitter   C: Collector
S: Source   Number: Pin number

— 64 —
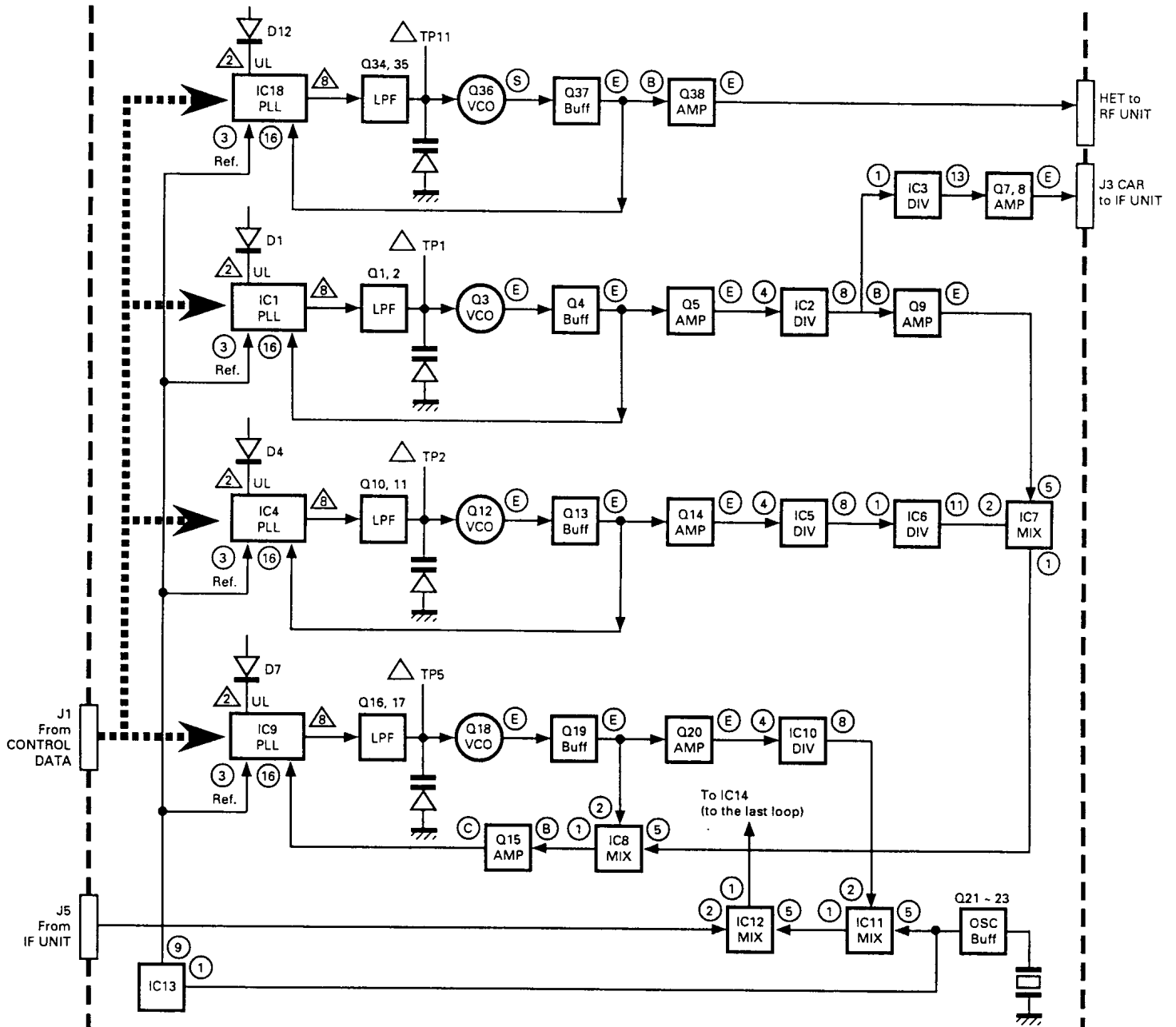
8. TS-440 Last Loop Checkpoint

◯ : Check the level with an oscilloscope.

△ : Check the voltage with a digital voltmeter.

B: Base   E: Emitter   Number: Pin number

9. Quick Chart of PLL IC Input/Output Pins
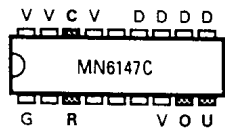
R: Reference frequency input
U: UL detection
G: Ground
D: Data line

C: Comparison frequency input
O: DC OUT
V: Power supply
F.O.: Frequency out

MN6147C
V V C V D D D D
G R V O U
TS-430, TS-440, TS-940

MB87006
D D D
R V O G U C
TW-4100, TS-440, TS-940

M54927P
V R U O G
D D C D G
TS-140, TS-680

CXD1225M
G V C U
D D D R O
TS-450, TS-850, TS-690
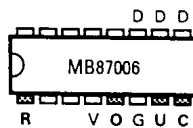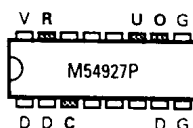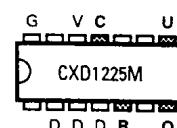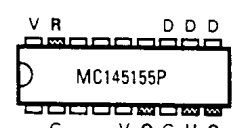
MC145155P
V R D D D
G V O G U C
TS-930, TS-780, TM-201 TS-711, TS-811, TM-211
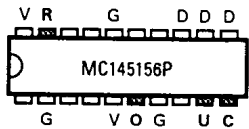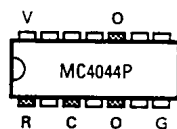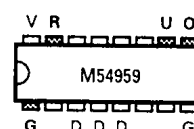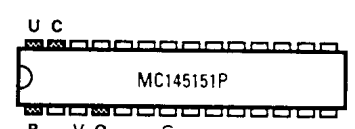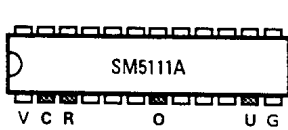
MC145156P
V R G D D D
G V O G U C
TS-930, TS-711, TS-811

MC4044P
V O
R C O G
TS-120, TS-130, TS-530, TS-830

M54959
V R U O
G D D D G
TM-211

MC145151P
U C
R V O G
TM-201, TM-401, TM-2570

SM5111A
D D D
V C R O U G
TR-7600

MB1504
R V O G U C
TH-26

M56760FP
V R U O
D D D C G
TH-27

PLL2001
V O D D D
R G U C
TS-140, TS-680

CX-7925B
G (C) V C U
D D D R O
TS-950SDX, TS-790

TC5081AP
O U V R C G
TR-9000, TR-7850

X58-3080, X58-3230
V U D D D O F.O V MO
TH-25, TH-45

X58-3360
O V MO
U
D
D
D
F.O V
TH-55
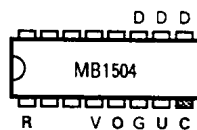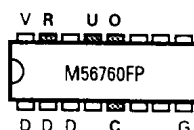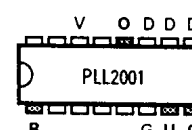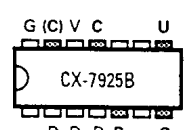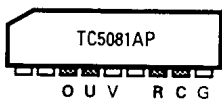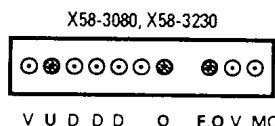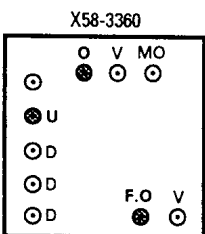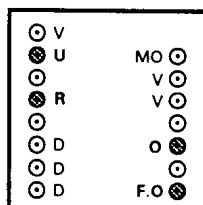
V
U MO
V
R V
D
D O
D F.O
KCH-05, KCH-09, KCH-10 KCH-11, KCH-12, TM-741

X58-3470, X58-3480
V MO
U V
V
R
D
D O
D
F.O
TM-231, TM-431

X58-3490
V MO
U V
V V
R
D O
D
D F.O
TM-721

X58-3330, X58-3340, X58-3450
D D D
F.O O
V
MO R U
V V
TM-721

— 66 —
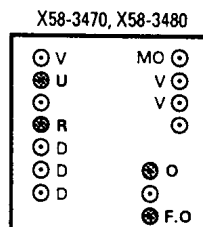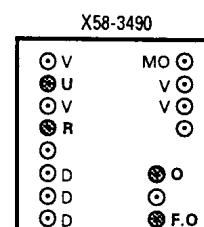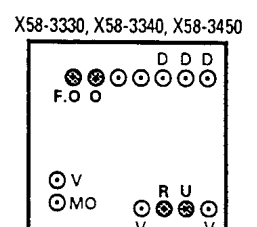
10. PLLs of Mobile and Handy Transceivers

■ Example (TH-26)

A single VCO oscillates transmission and reception frequencies.

Q1 : VCO
Q2 : Buffer amplifier
Q4 : AVR
Q5 : Amplifier
Q24 : RX band-pass filter transistor
IC1 : PLL IC
IC3 : UL detection IC
D2 : FM diode
D1 and D6 : Varicap diodes
D3 : Diode for switching the VCO frequency during transmission
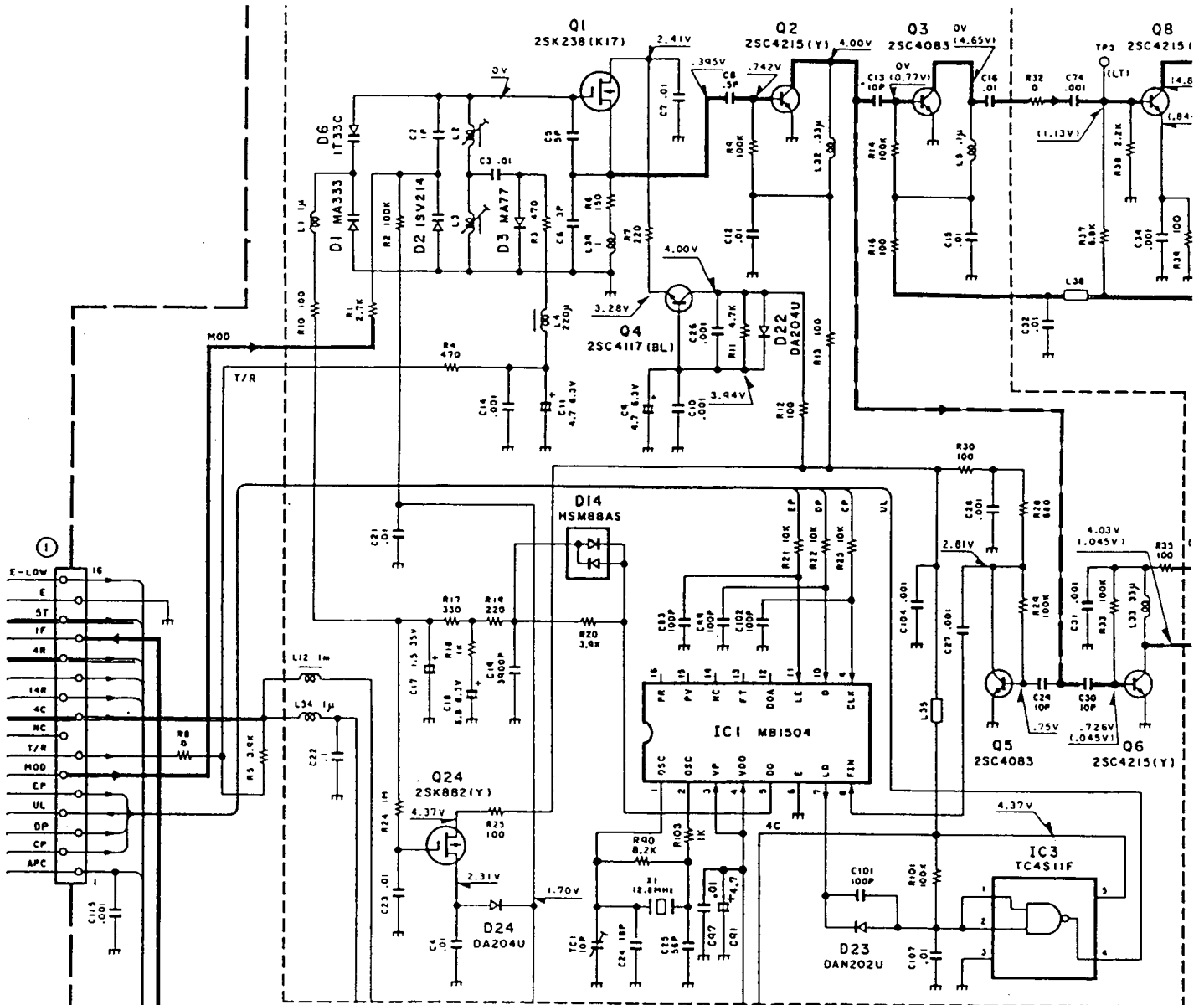
TH-26 TX-RX unit (B/2)

AUXILIARY CIRCUITS

1. Noise Blanker

■ Configuration
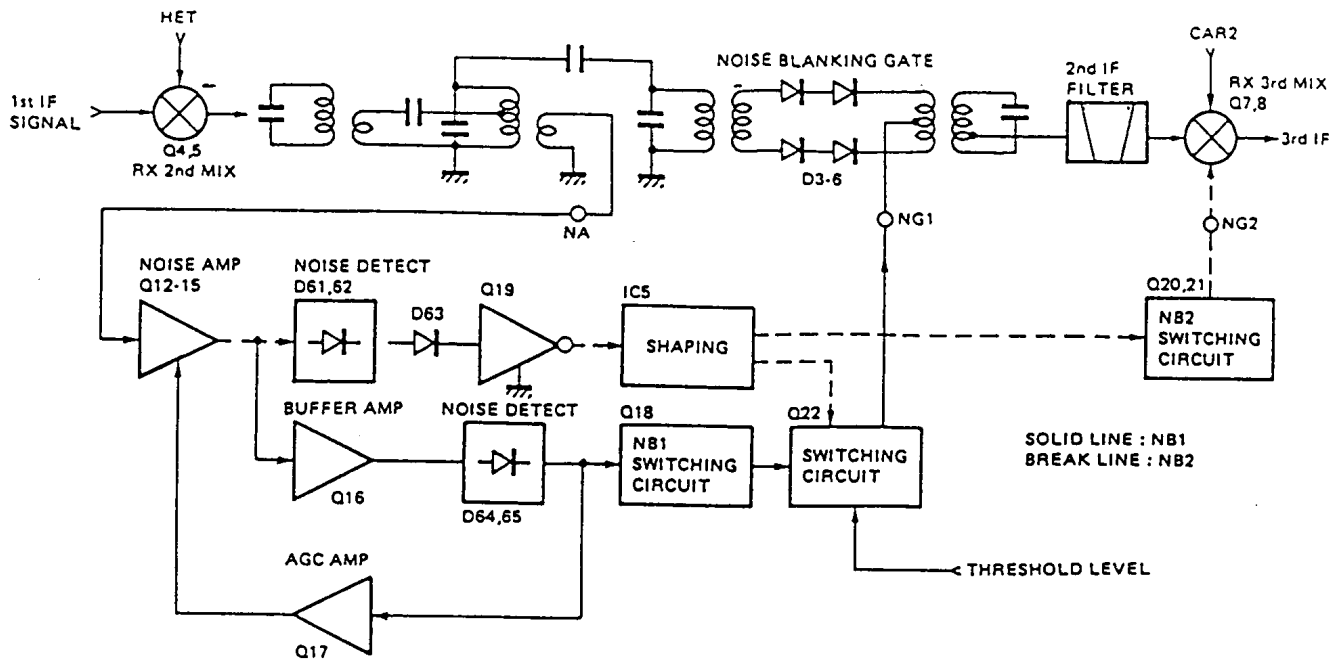
■ **Repair procedure**

A noise generator is required to repair the noise blanker.

Connect the noise generator to the antenna of the set. Vary the noise generator output so that the S-meter of the set indicates about S-9. If the set is normal, pulse noise is eliminated and the S-meter level decreases when the NB (NB1) switch turns ON.

This is because the bias of the noise blanking gate diode is reversed if pulse noise occurs, and the signal line breaks.

1. Connect the noise generator, turn the NB switch ON, and check whether the NB gate diode outputs a pulse waveform with an oscilloscope. (NG1)
2. Observe the waveform of the base of the transistor that controls the NB gate. (Q22-B)
3. Check with an oscilloscope whether the noise detection output changes according to the noise. (Q12-B)
4. Is the AGC amplifier in the NB circuit working properly? (Q17)
5. Is the noise amplifier functioning correctly? (Q12-15)

■ Repair procedure (NB2)

1. Does the NB2 switching circuit output any pulses? (NG2)
2. Does the waveform shaping circuit output any pulses? (IC5)
3. Does the NB2 noise detection circuit output any pulses? (D63)
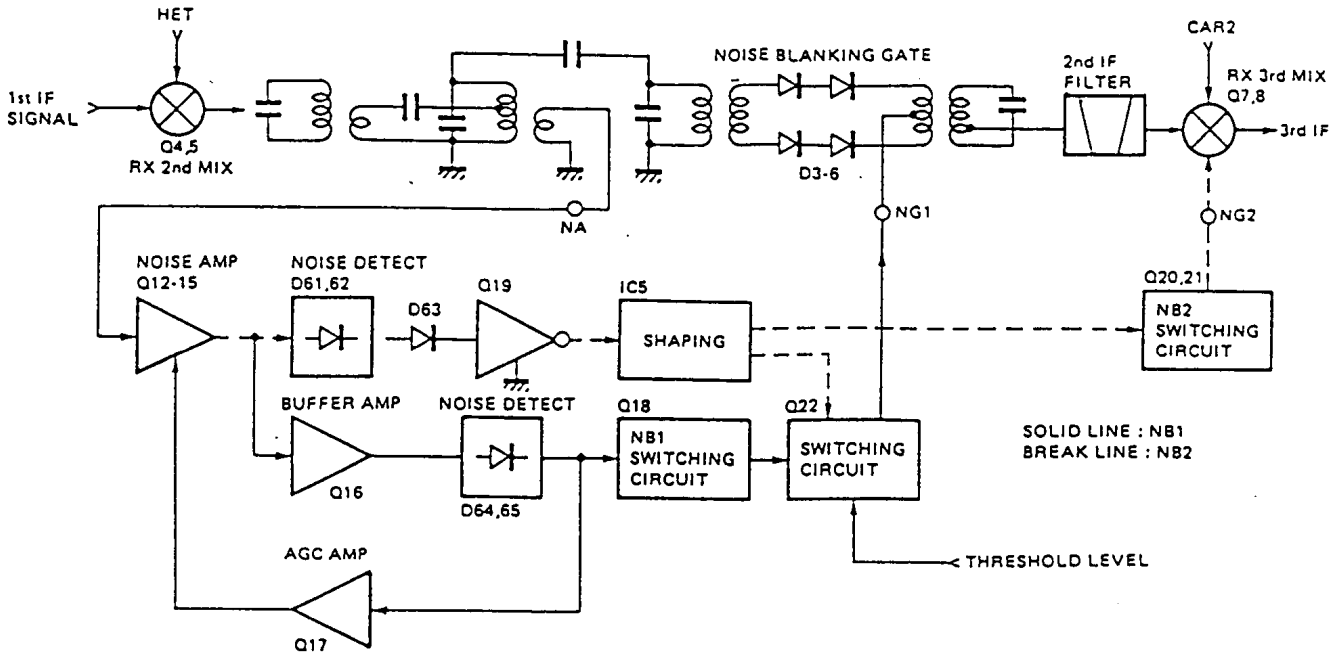
2. Notch Circuit

There are two types of notch circuits: AF notch and RF notch.

■ AF notch

NOTCH (X59-3030-00)
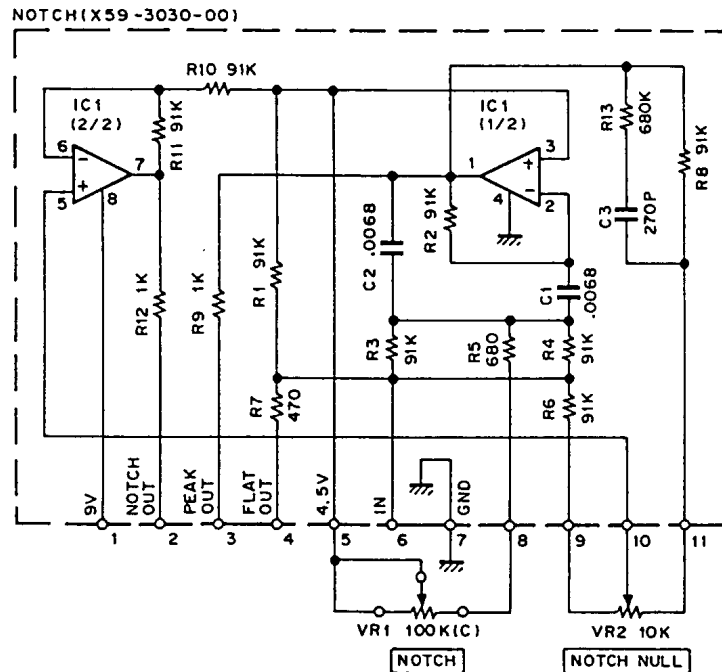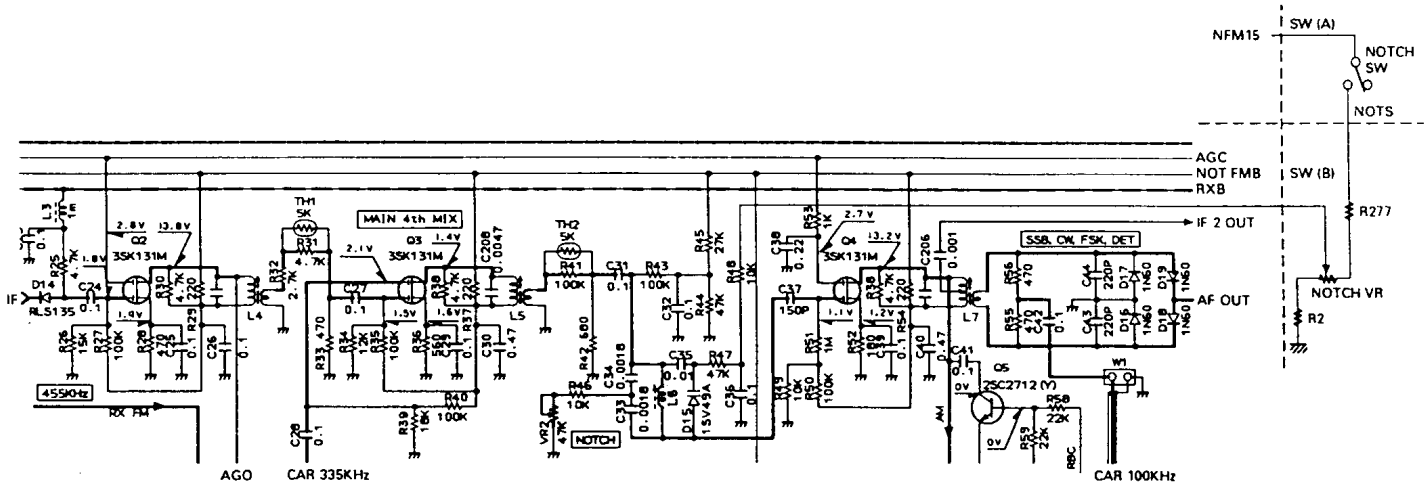
■ RF notch

TS-950 Signal unit

■ To identify the AF notch and RF notch

1. Receive about a 40dB signal from the SSG and observe the S-meter.
2. Turn the notch switch ON, and turn the NOTCH-VR to set the AF to the minimum level.
3. Observe the S meter.

   AF notch: The S-meter pointer does not move (because the notch circuit follows the detection circuit).

   RF notch: The S-meter pointer moves to the left.

   Since the signal passes through the notch circuit in the IF stage, the S-meter pointer changes.

AF notch: It is modularized in most recent models. Replace the module. Check the NOTCH VR. See the reception description on page 17.

RF notch: Turn the NOTCH VR and verify that the voltage of the varicap diode for the notch frequency changes. The diode is in the IF (signal) unit.

3. Encoders

There are various types of encoders: VFO, contact, optical, and magnetic.

* VFO type
  Contains an internal LC oscillator. As the encoder is turned, the capacitance of the variable capacitor and the oscillation frequency change. Contains a mechanical speed-reduction gear. TS-180 or previous models.
* Optical type
  There is a disc with a slit between the LED and light receiver. When the encoder is turned, the light receiver outputs pulses as the LED light is blocked or transmitted. The microcomputer counts the pulses and displays frequencies. TS-770 to TS-140, TS-680.
* Magnetic type
  Produces pulses magnetically. Compact and highly reliable. TS-950 to TS-50, TS-60
* Contact type
  Used for all click-type encoders employed in car transceivers.

The optical, magnetic, and contact-type encoders produce electric pulses and send them to the microcomputer.

■ Troubleshooting

The output terminals of the optical, magnetic, and contact-type encoders are shown below.

ENC

Vcc (5V, 8V)
EN1
EN2
GND
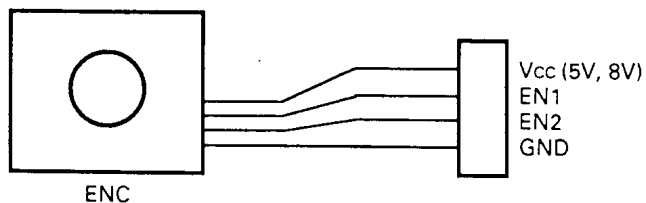
1. The encoder does not work

Is the following pulse output from the EN1 and EN2 output terminals of the encoder when it is turned? If not, the detection circuit may be defective.
If the 5V power is not supplied or the GND is not effective, the pulse is not output.

5V

0V
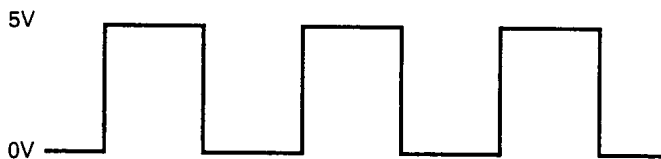
2. Do the EN1 and EN2 duty ratios differ much when turning the encoder?

Example (Optical)

5V
EN1
0V

5V
EN2
0V
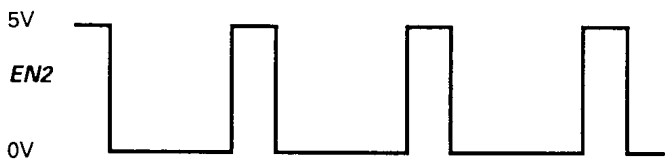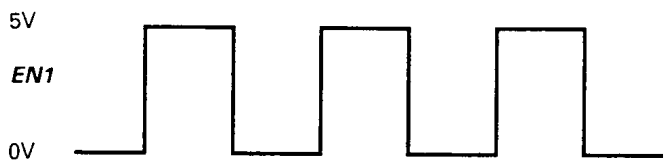
In this case, the EN2 duty ratio is wrong. Adjust it to 50:50. The adjusting variable resistor (VR) usually is in the encoder unit.

If the duty ratio of a magnetic or contact-type encoder is wrong, the encoder must be replaced.

3. Checking procedure

If the optical encoder does not output the following waveform:
The waveform rectification circuit on the encoder board may be defective.

+5
EN1
EN2
G

To oscilloscope

Power supply

Rubber belt

Motor
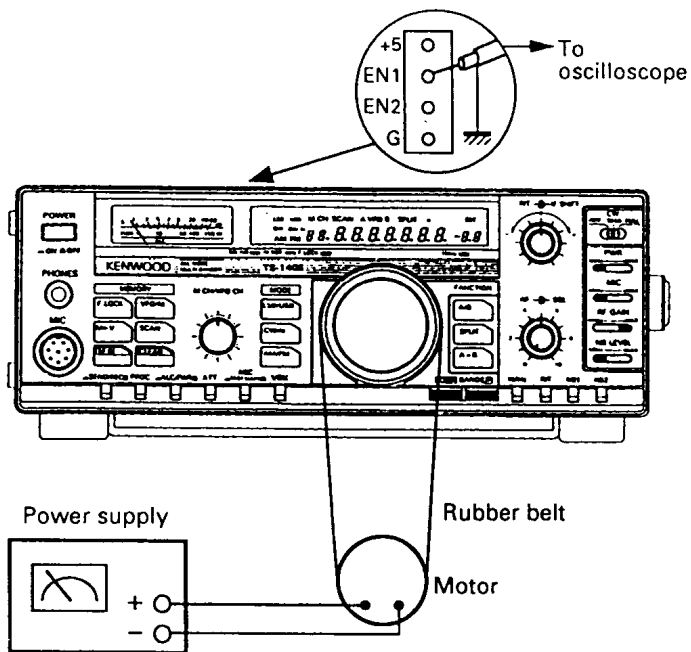
EN1 or EN2
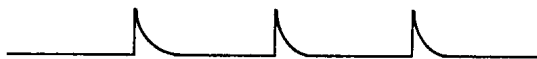
4. Some initial models of optical encoders may not work if the encoder pulse phases do not match exactly.

Examples: TS-770, TS-780: The STR (Service Technical Report) has been issued. Read it before starting adjustment.
TS-770: No. D0-B0-1092, 1081, 1501
TS-780: Market quality improvement request No. SC-4111 (July 27, 1983)

5. If the EN1 and EN2 waveforms are correct:
   The waveform rectification circuit, gate IC, or microcomputer in the control or digital unit may be defective.

TS-440 control unit
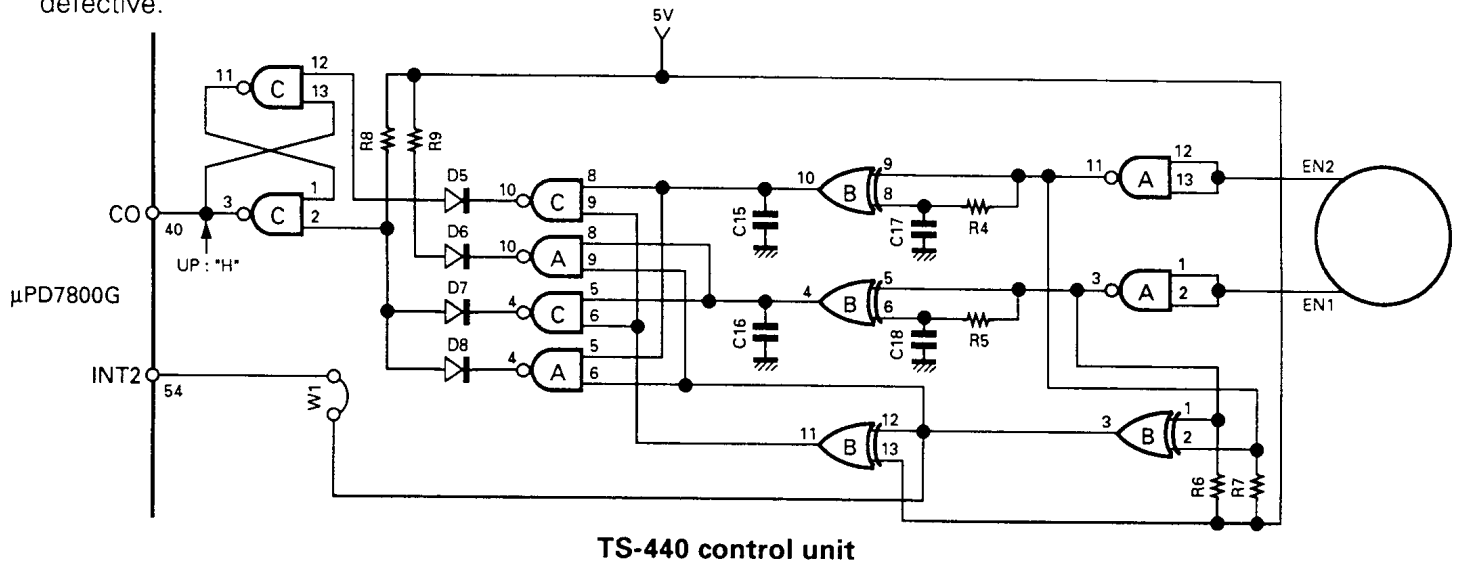
6. If reception or transmission sometimes fails when the VFO encoder is turned:
   The part of the VFO indicated by the arrow has poor contact. Polish it cleanly.
   Since the rotor is not grounded, the capacitance changes and the VCO stops operating.
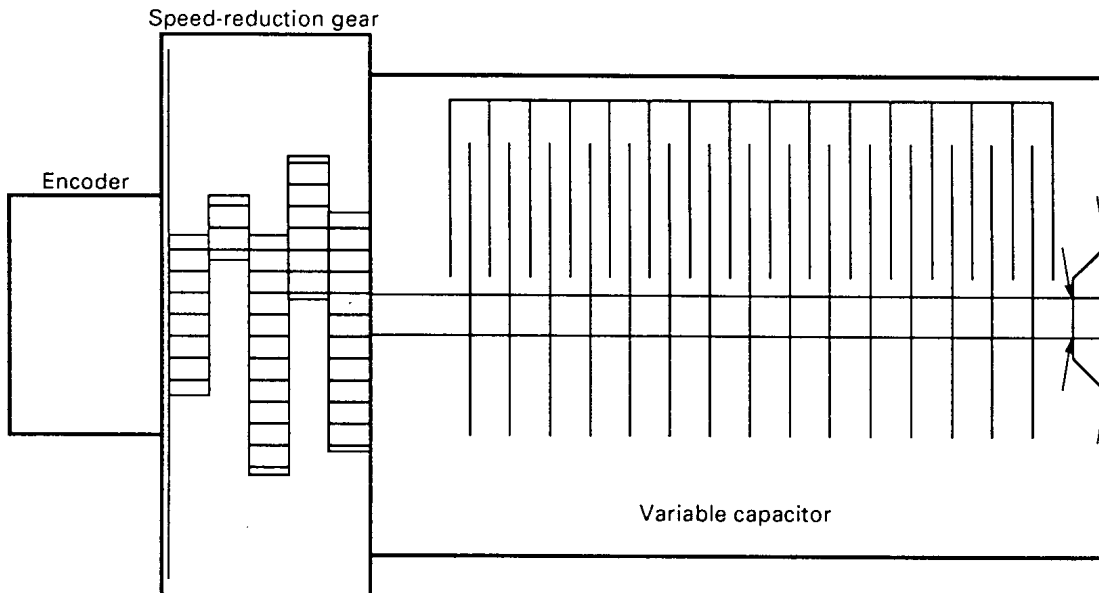
4. RF Attenuator

There are two types of attenuators according to models:

1. When the attenuator is turned ON, a voltage is applied to the relay.
2. When the attenuator is turned ON, the voltage to the relay is cut off.

Check whether the correct voltage is applied to the relay for both types of attenuators.

If the voltage for switching the relay is normal, the relay is defective or the attenuator resistor has a broken wire.
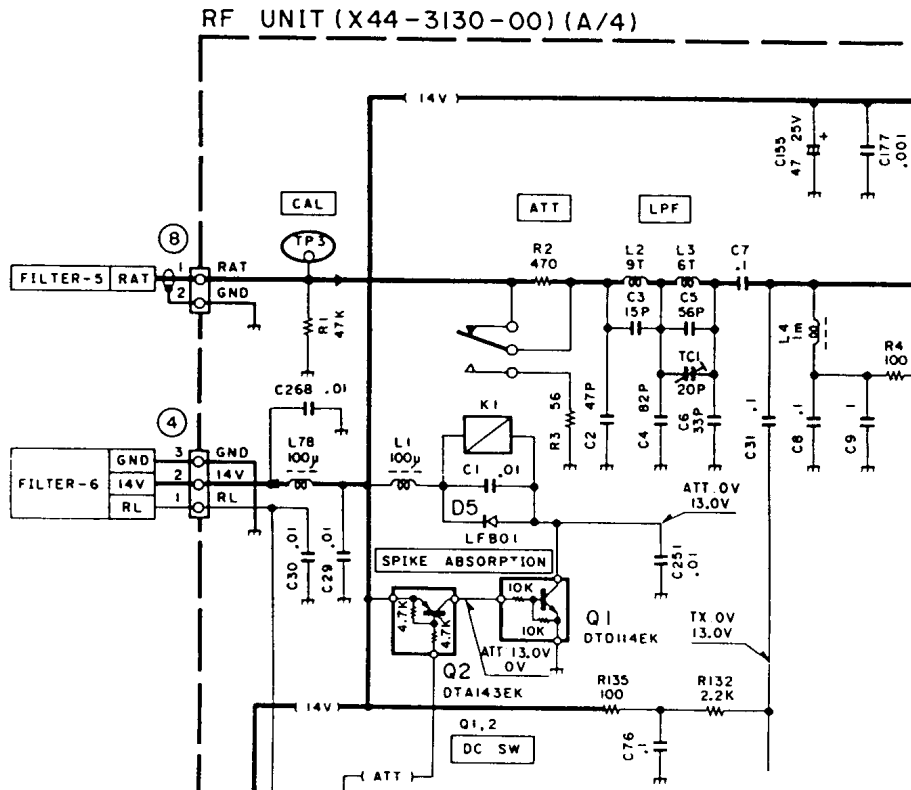
TS-690 RF unit
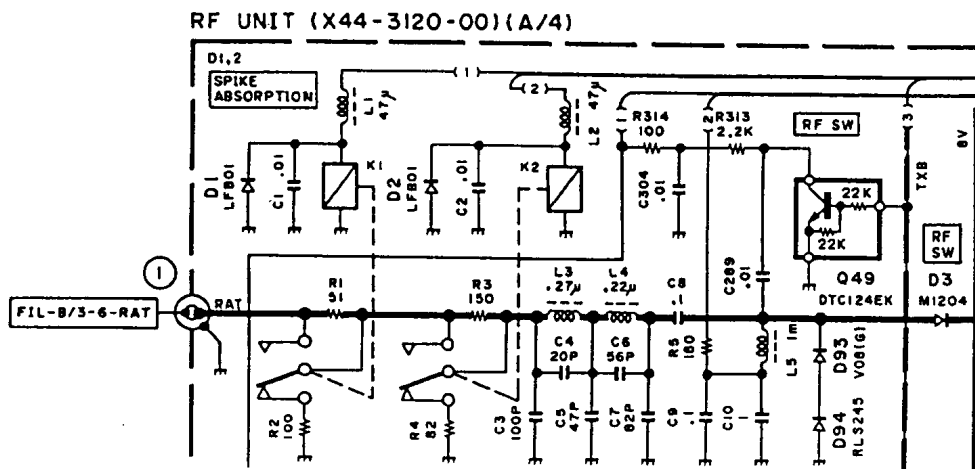
TS-850 RF unit

5. Filter Switching

The TS-450 8.83MHz filter switching is described below.

1. When the filter switch on the panel is pressed, a signal is sent to the microcomputer.
2. The microcomputer transfers it to IC3 in the RF unit (DA, CK, LE) as digital data.
3. IC3 decodes the data and controls the output pin (OFF: High; ON: Low)
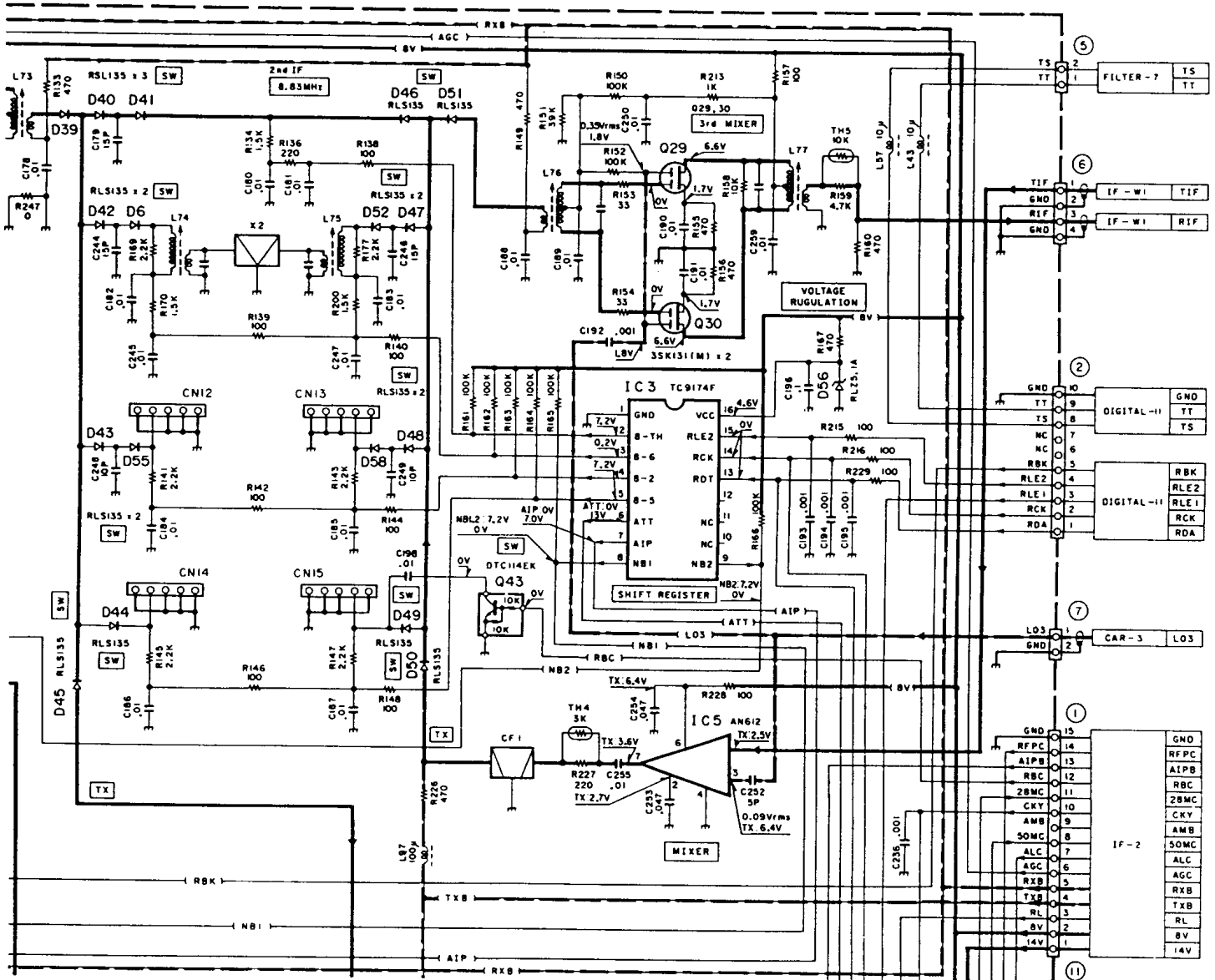
6. Automatic Antenna Tuner (AT)

The automatic antenna tuner is installed between the set with a 50 ohm output impedance and an antenna with an impedance of more than 50 ohms to match their impedances.

The impedance of the antenna matches as viewed from the set.
The impedance of the set also matches as viewed from the antenna.
The antenna tuner is an impedance converter as shown above.
The automatic antenna tuner matches the antenna and set automatically. KENWOOD's automatic antenna tuner guarantees impedances of 20 to 150 ohms.

■ The automatic antenna tuner does not work

1. Check the CAR VR in the set.
   (If sufficient power is not provided, since the SWR cannot be detected, the antenna tuner will not tune or stop tuning.)
2. Set that allows switching between the internal and external antenna tuners.
   Although the internal antenna tuner is optional, the AT switch is set to the internal antenna tuner.
   Although the AT switch is set to the external antenna tuner, the external antenna tuner is not connected. (TS-850, TS-450, AT-300)

50Ω

150Ω   ANT

Mismatching SWR3

50Ω   50Ω

150Ω   ANT

150Ω

AT

SWR1 between the set
and antenna tuner

SWR1 between the AT output
and antenna
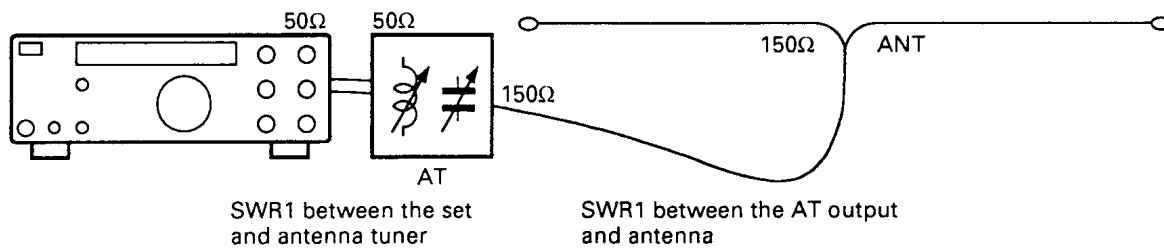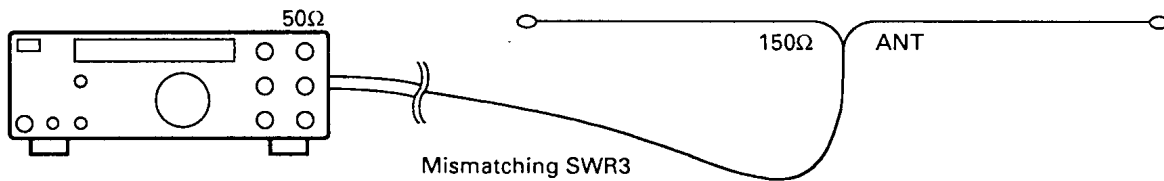
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■ The automatic antenna tuner does not stop (360-degree rotation type)

If the set of blades of the variable capacitor rotate 360 degrees, check the motors.

Do both the X and R motors run?

If either of them does not run at all, check the motor voltage. If the voltage is correct, the motor is defective. If the voltage is incorrect, the motor drive IC or a circuit before it is defective. (Voltages applied to the positive and negative terminals of the motor: 0V: 0V or 14V: 14V.)

■ Troubleshooting the AT board

How to measure the voltages and waveforms of ICs in the antenna tuner; It is difficult to repair the AT board if another AT board is unavailable for comparison.

- **Type of which the variable capacitor has a set of blades that rotate 360 degrees**
1. Set the sets of blades of the variable capacitors of the two antenna tuners to almost the same position and unplug the power line of the motor.
2. Start the antenna tuner of the good set with the open antenna and unplug the power line to the motor at an appropriate time.
3. Set the set of blades of the variable capacitor of the defective set to the same position as that of the good set as follows:
   1) Disconnect the motor connector.
   2) Apply about 10V to the motor to activate it. Stop it if the position of the set of blades of the variable capacitor of the defective set matches that of the good set. (X, R)
4. Start both of the antenna tuners and compare their voltages and waveforms.

- **Presetting type**
1. Reset both the good and defective sets.
2. Set the AUTO/THROUGH switch on the antenna tuner to AUTO.
3. The variable capacitors will be set to the initial positions. Check the positions of the sets of blades of the variable capacitors of the two sets. If they are almost the same, they are OK.
4. Disconnect the power lines of the two antenna tuner motors.
5. Press the AT TUNE switches on both sets and compare their voltages and waveforms.

Note : Connect a dummy to each of the two sets and start antenna-tuning. If a mismatch alert tone sounds, turn the tuner OFF and ON again.

This procedure is useful in detecting incorrect capacitance of capacitors.

- **Example (AT-50)**
The motor power supply has been soldered.
1. Reset the two sets.
2. Desolder the set.
3. The voltages and waveforms can be checked while tuning.

AT UNIT

Motor   Motor

DC POWER SUPPLY
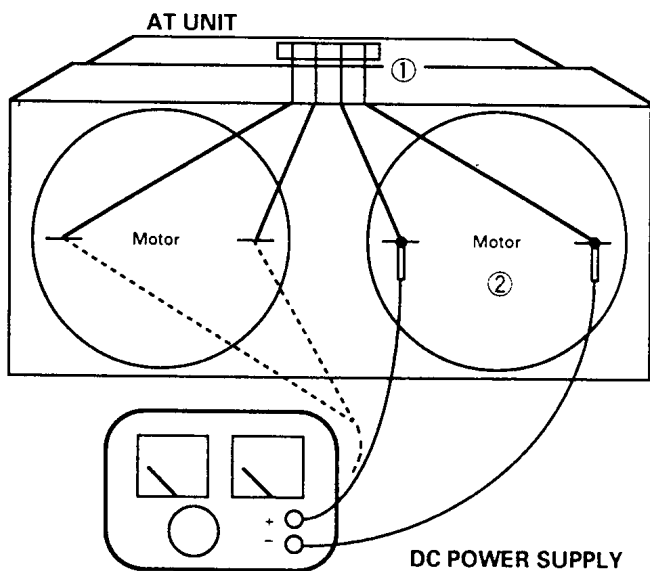
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2. Rules for Parts Lists

■ The general list

The general list shows the parts numbers in ascending alphabetical order (A to Z)

Example: A12-3456-03

↓

W02-1453-05

■ The list of PC boards

The list of PC boards shows the initial letters of reference numbers in ascending alphabetical order (A to Z). Semiconductors are listed at the end of the list.

Example:

Cxx	CK73FBIH102K	Chip C
↓		↓
VRxx	R12-0443-15	Trimming pot
Sxx	S31-3456-05	Switch
Dxx	RLS135	Diode
ICxx	NJM2902M	IC
Qxx	2SC2712(Y)	Transistor
THxx	157-501-53009	Thermistor

■ The initial letters of parts numbers in the general list indicate groups of parts

A Front panel, Case, Chassis, etc.
B Front glass, SP saran, Nameplate, Meter, Lamp, etc., Instruction manual, Service manual, Warranty card/letter
C Capacitor
D Extension shaft
E Connector, Cable, Grounding fitting, etc.
F Fuse, Fitting, etc.
G Spring, Packing, Cushion, etc.
H Packing materials
I
J Feet, Lead holder fitting, Wire harness band, Spacer
K Handle and Knob
L Transformer, Coil, Filter, Crystal ·
M
N Screws and Nuts
O
P
Q
R Resistor
S Switch and Relay
T Speaker, Microphone, Motor
U
V
W Assembly (Encoder, LCD), Backup battery .

The second from the last digit of the parts number indicates the number of minor changes of the parts. Old and new parts are basically compatible with each other, but some parts are not compatible. See the STR for details.

Example: A20-2634-05

A20-2634-15 (RZ-1)

• **Reasons for minor changes**
Improve electrical and mechanical performance, change of parts supplier, etc.

■ The general list shows some components installed on boards

Example: Lithium batteries

The lithium batteries for the TS-790, TS-850, and TS-450 are listed in the list of boards. The lithium batteries for the other models are listed in the general list.

They are differentiated as some are installed on the PC board line and others are installed in the main unit assembly line in the plant.

The parts listed in the general list are installed in the main unit assembly line.

The parts listed in the PC board list are installed in the machine installation line, insertion line, and PC board completion line.

The lithium batteries for most models are installed in the main unit line. They therefore are listed in the general list.

Since the lithium batteries for the TS-850, TS-450, and other models are installed on PC boards in the PC board assembly stage, they are shown in the PC board list.

If a component mounted on a PC board is not shown in the parts list, see the general list. (If a part installed on a PC board is not found in the general list, see the parts list.)

• **Parts that may be shown in either list**
Temperature detection thermistor
Transistors and ICs installed in radiators
Lamps
Encoders

■ Pay attention to split boards

Example: The TH-78 encoder is installed in the TX-RX unit, but is not shown in the parts list of the TX-RX unit. The encoder board is designated as (X53-) as shown in the circuit diagram. See the control board to find the parts number of the encoder.

The encoder board is originally part of the control board, but is separated from it and soldered to the TX-RX board.

There are many such cases. Carefully check on which boards the parts are installed.

3. Adjustment

Before starting adjustment, read the "Preparation" section thoroughly and set up the unit correctly. If it is not set up correctly, adjustment of other items may be affected. (The standard is not conformed to, cannot be adjusted, etc.)

If you are not certain what is wrong, see the voltage adjustment section. It shows the important voltages for operating the set properly.

The parts (such as band-pass filters) with standardized waveforms do not need to be adjusted. A spectrum analyzer is required to adjust them accurately, and if the waveform varies a little, it does not affect the performance. A problem may occur if you try to adjust them (especially the PLL band-pass filter).

Check the mode and frequency when adjusting the lock voltage.

When adjusting the frequency, check the mode, frequency, transmission, reception, WIDE, NARROW, CW pitch, VBT, SLOPE TUNE, and IF shift.

The zero-adjustment procedure of the S meter depends on the model. Some procedures are complicated (especially the TS-950 series), but there are reasons for them as described in the manuals. Perform zero-adjustment as instructed in the manuals.

The transmission voltage adjustment is described before or after reception adjustment. The ALC reference voltage is very important for adjusting transmission. See the reference voltage adjustment section to repair the transmitter.

When adjusting the drive, make the jig shown below and connect it to the DRV terminal. Do not connect the jig to the final OUT. Otherwise, it will fail immediately after the power is boosted.

1.5D coaxial cable
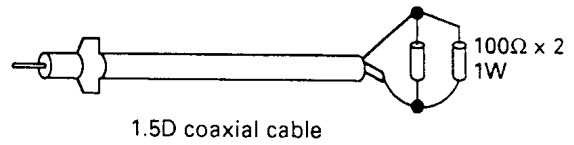
The final bias method directly measures the current by insertion of an ammeter into the power supply line. (Almost all transistor finals)

The current can be checked by measuring the drop of the voltage across a resistor. (TS-950 series, SDX)

Adjust the bias after the components warm up sufficiently. If it is adjusted soon after the power is turned ON, an excessive idling current flows and results in a thermal runaway. If it occurs, the set must be repaired again.

The power adjustment name is not standardized; it is called "power adjustments" in some models or "ALC adjustment" in others.

A 150-ohm dummy is required to adjust the SWR.

It is very important to check the frequency during adjustment.

When the CAR frequency is adjusted, the SSB transmission frequency characteristics (CAR POINT) also must be adjusted.

MIC terminal (view from front panel side)
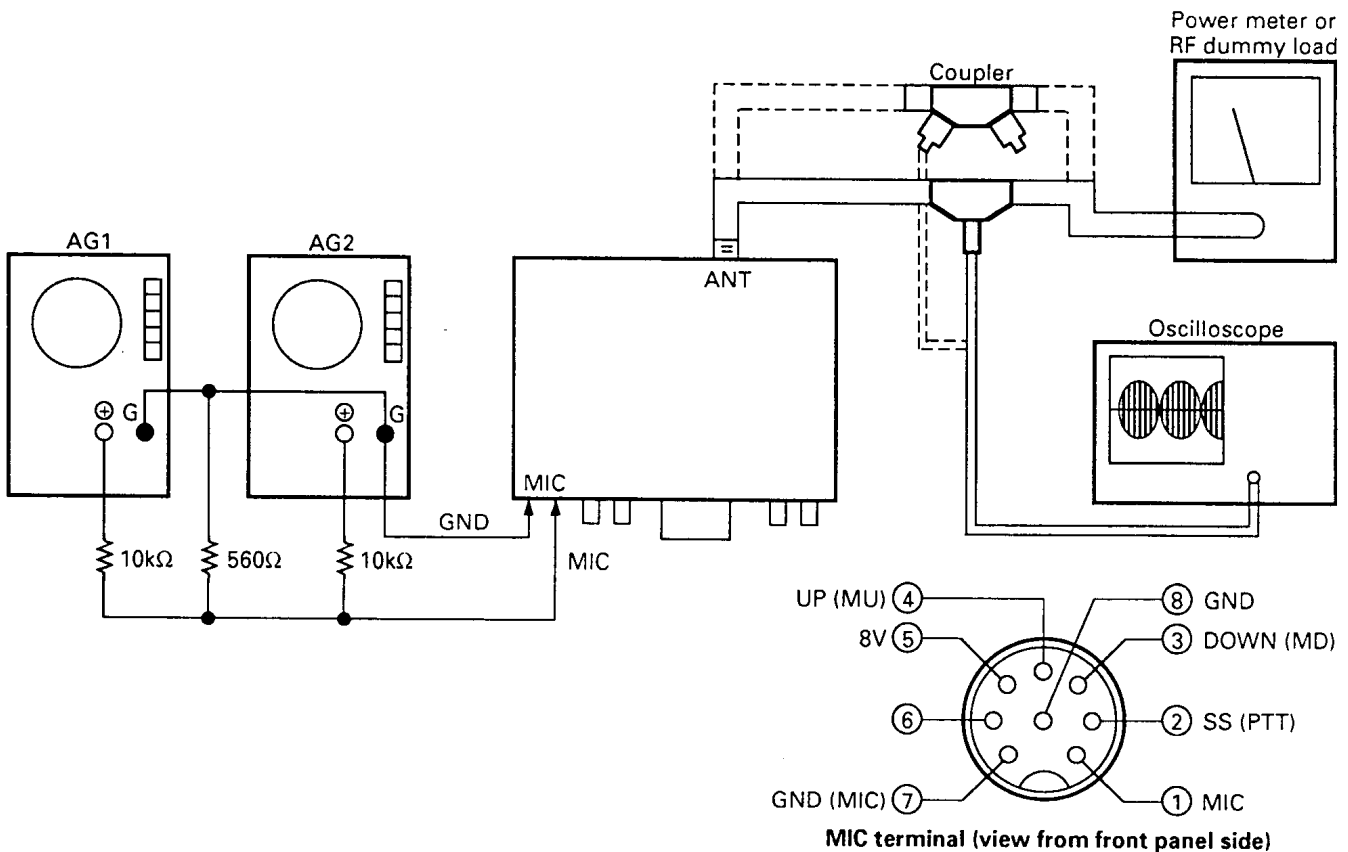
■ ALC meter adjustment

AG output increase 6dB → 5mV increase by 6dB, resulting in 10mV.

■ Adjustment mode

TS-450 and subsequent models send data to the microprocessor and hold it in the EEPROM to cut down on costs and simplify adjustment. The microcomputer calculates and displays meter curves according to the data. Before adjusting the units, read the "Preparation" section carefully.

■ TS-450 and TS-690

• How to enter the adjustment mode

· Hold down the AIP, XIT, and SCAN keys and turn the power switch ON.

· Press the UP key in menu No. 02 once. The adjustment frequency is automatically read into the memory channel.

• How to adjust without clearing the memory contents

1. Check and adjust the frequency and mode for items to be adjusted.
   Example 1: CAR POINT : CH39 (14.200MHz; USB)
   Set the set to VFO A or B to specify 14.200MHz and USB.
   Switch the filter from 8.83 to 6K and from 455 to 2.4K.
   Turn the power switch OFF.
2. Enter the adjustment mode.
   Hold down the AIP, XIT, and SCAN keys and turn the power switch ON.
   Turn the MCH/VFO CH and adjust the items in menus 11 and 12.
3. Write data into the EEPROM.
   Press the UP key in menu 17 once. Data writing is completed.
   Press the CLR key once to terminate the adjustment mode.

   Example 2: S-meter : CH07 (14.100MHz; USB)
   Set frequency: 14.100MHz, Mode: USB
   Filter switching: 8.83 → 6K; 455 → 2.4K
   SSG frequency: 14.101 MHz, MOD: OFF
1. Turn the power OFF.
   Enter the adjustment mode.
   Hold down the AIP, XIT, and SCAN keys and turn the power switch ON.
   Turn the MCH/VFO CH and adjust the S meter in menu 08.
2. Write data into the EEPROM.
   Press the UP key in menu 17 once. Data writing is completed.
   Press the CLR key once to terminate the adjustment mode.

• To adjust the S-meter at 28MHz as well
Example 3: S-meter : CH09 (28.800MHz; USB)
Set frequency: 28.800MHz, Mode: USB
Filter switching: 8.83 → 6K; 455 → 2.4K
SSG frequency: 28.801MHz, MOD: OFF
1. Turn the power OFF.
   Enter the adjustment mode.
   Hold down the AIP, XIT, and SCAN keys and turn the power switch ON.
   Turn the MCH/VFO CH and adjust the S meter in menu 09.
2. Write data into the EEPROM.
   Press the UP key in menu 17 once. Data writing is completed.
   Press the CLR key once to terminate the adjustment mode.

• To adjust the S-meter at 50MHz as well (TS-690)
Adjust it in the same way as for 28MHz (use menu No.10.).

■ TS-950SDX

• To recall the memory for adjustment
1. Hold down the 1 and 7 keys and switch the power ON.
2. TS-950SDX enters the adjustment mode, and the adjustment frequency is written into the memory channel.

• How to adjust without clearing the memory contents
1. Hold down the 3 and 9 keys and switch the power ON. TS-950SDX enters the adjustment mode.
2. To change the frequency, turn the main encoder or press the ENTER key.
   Use the M.CH/VFO CH control to change the menu.
3. Press the CLR key once to write data into the EEPROM.
4. Be sure to press the CLR key after completion of the adjustment.

■ TS-50

The adjustment frequency is not written into memory.
When the adjustment mode is entered and a menu is specified, the adjustment frequency and mode are set forcibly.

### • To enter the adjustment mode:
1. Hold down the NB and MHz keys and switch the power ON.
2. Press the UP or DOWN key in menu No. AD.
   When "good" is displayed, data writing is completed.

The adjustment procedure for new models may be changed. The main advantage of this adjustment mode is that the meter can be easily readjusted from the panel without opening the case.

Press the UP key three times: at S-1, S-9, and S-FULL for the S meter, or ALC0, ALC zone MAX, and ALC FULL for the ALC meter.
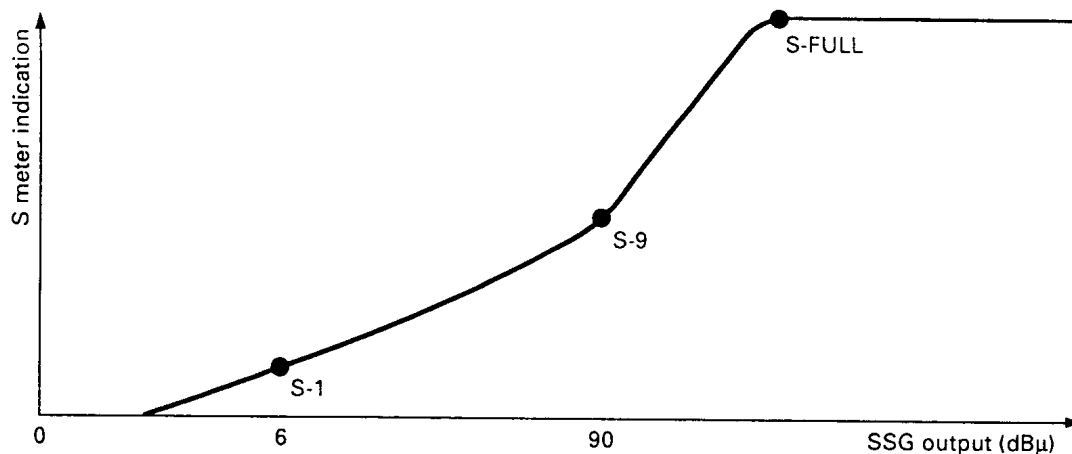
The voltages at the three points are stored in memory by the microcomputer. If the received S-meter voltage becomes one of the three voltages, the microcomputer operates the S-meter to indicate S-1, S-9, or S-FULL. If the voltage is between the stored voltages, the microcomputer calculates and displays an ideal S-meter curve.
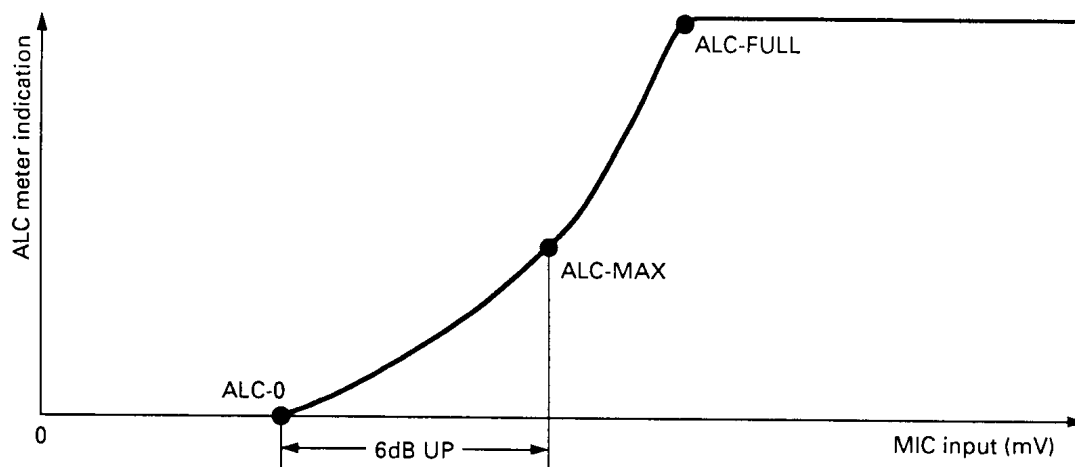
The voltages at the three points are stored in memory by the microcomputer. If the ALC meter voltage becomes one of the three voltages, the microcomputer operates the ALC meter to indicate ALC0, ALC MAX, or ALC-FULL. If the voltage is between the stored voltages, the microcomputer calculates and displays an ideal ALC meter curve.

4. Reading Circuit Diagrams

Power supply line → Red,
Signal line → Black thick line,
Local signal → Black dashed line,
TXB, RXB → Red dashed line

When comparing the voltage of each part with the voltage shown on the circuit diagram:
Check the conditions under which the voltages shown on the circuit diagram were measured.

Example 1: The highest voltage RB of the power amplifier unit, which is shown on the circuit diagram in the TH-78 service manual, is 8.7V, and APC is 7V. These voltages are measured when DC IN is 9V. If DC IN is 13.8V, RB is about 13V and APC is higher than 13.8V. Therefore, the power supply voltage must be reduced to compare the voltages under the same conditions.

Example 2: For all-mode models, the frequency, mode, VOX, BK-IN, etc. must be taken into account.
For HF models, the voltages usually are measured at 14.000MHz USB.

Example 3: The TX power stage, ALC line, VSF, and VSR line differ much depending on whether they are measured with full power or with no power output.

Check whether circuit variables have been changed. The circuit variables shown in the manual should be considered as those determined during pre-production. They may be changed later. See the STR for details.
The voltages shown on the circuit diagrams are very useful, but if the rules are ignored during checking, they become confusing.
If the actual set voltage differs much from the voltage on the circuit diagram, consider the above-mentioned items.

5. Functions of Components

Diode — Used for switching, reverse-flow prevention, voltage setting, and detection.
Transistor — Amplifying and switching element.
FET — Amplifying and constant-current element.
Resistor — Used to divide the voltage or current.
Capacitor — Cut DC current and pass AC current.
As the capacitance increases, low frequencies pass.
As the capacitance decreases, only high frequencies pass.
Coil — Passes DC current, but does not pass AC current easily.
As the capacitance increases, the low-frequency AC current is suppressed.
As the capacitance decreases, only high frequencies are suppressed.

■ How to calculate voltages at points where no voltage is shown

1. What is the voltage at points A and B?
   A = 5V, B = 7.5V
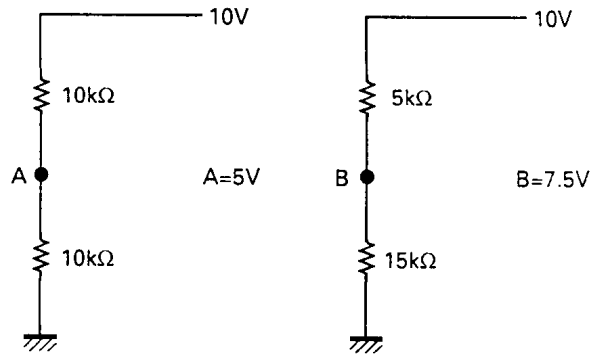
2. If point A is 8 V and point B is 6 V, what is the voltage at point C?
   What are the voltages at points D and E?
   C = 6V, D = 5.3V, E = 0V
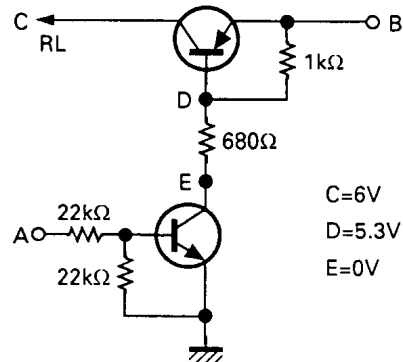
3. What is the voltage at point A?
   The 90K ohm resistor is sufficiently large, and the resistance of the 10K ohm resistor is considered to be about 1/10 that of the 90K ohm resistor. Since 9/10 of the voltage is applied to the 90K ohm resistor, the voltage applied to the 10K ohm resistor is about 1V.
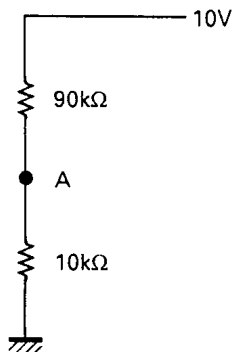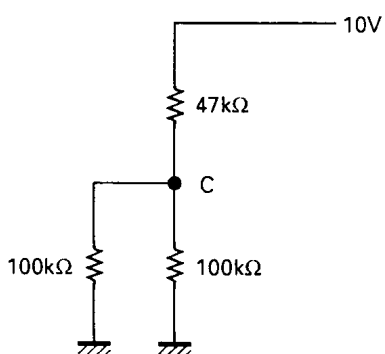

4. What is the voltage at point B?
   The 1K ohm resistor is quite small as compared with the 100K ohm resistor. Thus, most of the voltage is applied to the 100K ohm resistor, totaling about 10V.
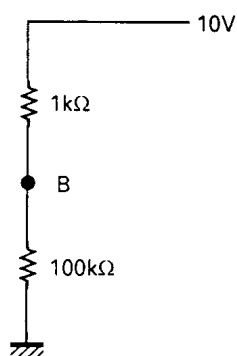

5. What is the voltage at point C?
   The synthesized resistance of the parallel 100K ohm resistors is 50K ohms. The difference between this resistance and 47K ohms is 3K ohms. This difference may be ignored, and the voltage may be considered to be halved.

6. What is the voltage at point A?
   10V is output. DC current is cut by a capacitor. If a capacitor is placed in the circuit, the current does not flow directly. When S turns ON, the voltage at A decreases.
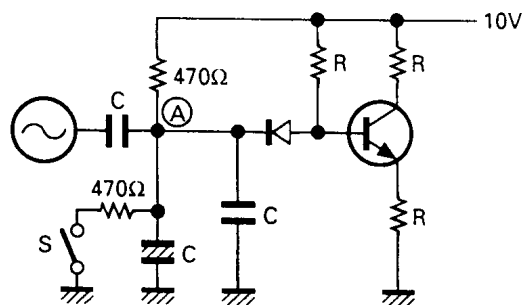
7. Estimate the voltages at points B, C, and E. The 100 ohm resistor is ignored here and the collector voltage is 8V. The base voltage is 4V, half the collector voltage.
   When the NPN transistor is ON, the VBE (voltage between the base and emitter) has a potential difference of 0.6V, and the base voltage increases. The emitter voltage is obtained by subtracting 0.6V from the base voltage. $4V - 0.6V = 3.4V$
   0.3 to 0.5V is subtracted from each voltage in consideration of the voltage drop effected by the 100 ohm resistor, which was ignored at the end.
   Base voltage 3.6V
   Collector voltage 7.6V
   Emitter voltage 3.0 V
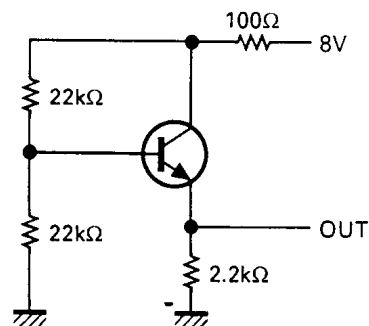
   The voltages were estimated as above. Such rough calculation procedures are sufficiently useful.

■ Transistors

Connect the voltmeter as follows. If there is a potential difference of 0.6V, the transistor is ON.
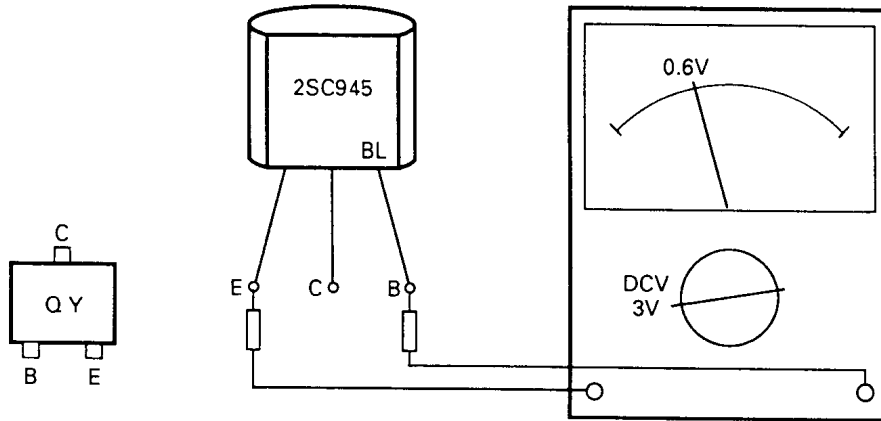

1. Fix the red probe to the base with the x1 range of the tester.
2. Measure the resistance between the base and collector.
3. Measure the resistance between the base and emitter.
4. Apply the red probe to the collector while attaching the black probe to the emitter.
5. Measure the resistance between the collector and emitter.
6. Fix the black probe to the base.
7. Measure the resistance between the base and collector.
8. Measure the resistance between the base and emitter.
9. While attaching the red probe to the emitter, apply the black probe to the collector.
10. Measure the resistance between the collector and emitter.

If the tester pointer moves twice, the transistor is OK. The tester pointer moves twice for transistors of all types of A, B, C, and D (with some exceptions, such as digital transistors).

If the pointer moves only once or three times or more, the transistor is defective. Even if the pointer moves twice, increase the ohm range to about x100 to confirm that the pointer does not move. If it does not move, the transistor is OK. If the pointer moves even slightly, the transistor is defective.

Remove the transistor from the board before measuring. If the transistor is installed on the board, it is affected by the ambient circuits, and the tester pointer moves at several points, resulting in inaccurate measurement.
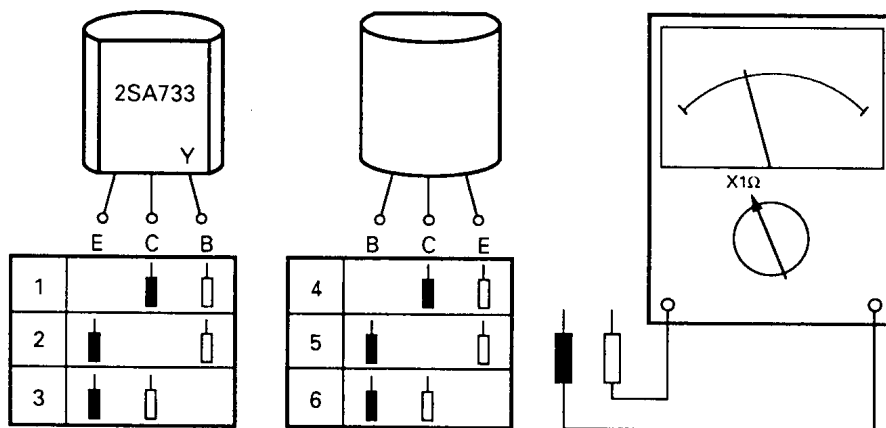
■ Capacitors

The electrolytic capacitors as well as capacitors with high capacitance can be checked with a tester.

1. Set in the 1 ohm to 1K ohm range.
2. Connect the tester probe to the capacitor.
3. The pointer moves briefly and returns to zero. It takes longer time to return to zero if the capacitance is higher. If the pointer does not return to zero, the capacitor is defective.
4. Change the polarity of the tester probe and perform the check again.
5. If the pointer moves and returns to zero, the capacitor is OK.

■ Coils

Shorted coils can be detected with a digital multimeter.

1. Set the multimeter to the ohm range and maximize the sensitivity.
2. Short the multimeter probe and check the reading when the resistance is zero.
3. When the probes are applied to both ends of the coil, the resistance differs from that when the probe is shorted.

- Resistance
  1mH   About 9.0 ohms (102, brown, black, red)
  100μH   About 4.5 ohms (101, brown, black, brown)
  10μH   About 0.5 ohm (100, brown, black, black)
  1μH   About 0.2 ohm (1R0, brown, black, gold)

This type has low internal resistance

This type has high internal resistance

■ Digital transistors

NPN type NOT circuit. Used to ground the output. (DTC type)
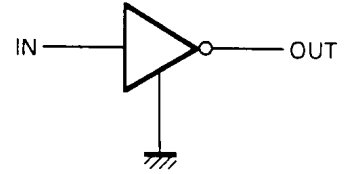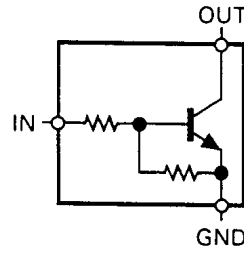
PNP type NOT circuit. Used to apply Vcc to the output. (DTA type)
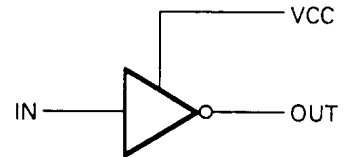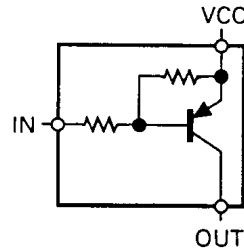
■ FETs

FETs cannot be checked with a tester. The voltages are shown on the circuit diagram.

■ Thermistor

Thermistor for circuit temperature compensation.

■ IFT

Configured as shown at the right. Whether it is open can be checked with a tester.

- To install a six-lead IFT

Align the silk mark on the board with the notch on the IFT case.

■ Handy transceiver microphone connector

1. PTT OFF: 5 V; PTT ON: 0 V
   If this is grounded, the transmission mode is entered.
2. External microphone input. If no external microphone is connected, the two pins conduct.
3. 5V output for power supply to capacitor microphone and so on. If no external microphone is connected, the two pins have conductivity.

■ Handy transceiver speaker terminal (with remote controller)

1. GND
2. Remote terminal. The change in the voltage at this terminal activates the external remote control. If no external speaker is connected, the two pins have conductivity.
3. Speaker terminal. If no external speaker is connected, the two pins have conductivity.

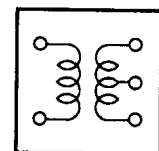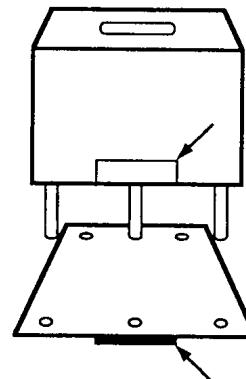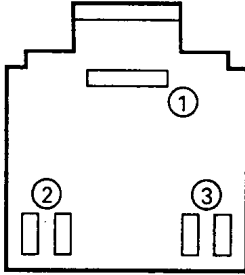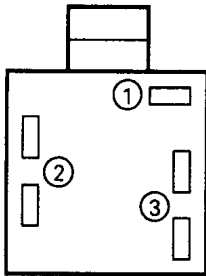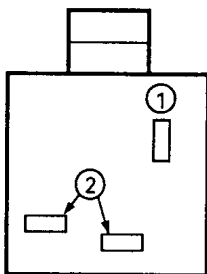## ■ Handy transceiver speaker terminal (without remote controller)

1. GND
2. Speaker terminal. If no external speaker is connected, the two pins have conductivity.

■ Relays

There are various relays of different shapes and pin counts. Check the wiring diagrams in the Service Manual.

Pay attention to application of the voltage when operating the relay.

1. When the relay is OFF, the voltage is applied to the coil.
2. When the relay is ON, Vcc is applied to the coil.
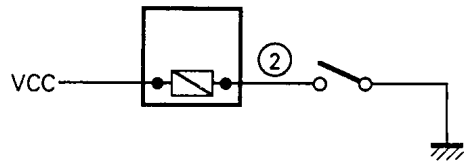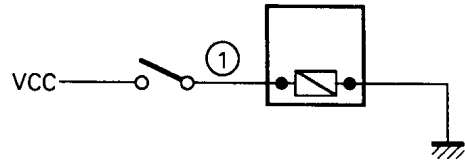
6. Rules for Naming Terminals

The name of each terminal is shown on the circuit diagram. It is helpful for repair to become familiar with the functions of the terminals.

The recent manuals show the functions of all the terminals. Look at them when checking the terminals.

The manuals for old models do not show the functions of terminals, but they are similar to those of the new terminals.

xxB	Power supply lines (SB, FB, TXB, RXB, etc.)
xxV	Power supply lines (15V, 9V, 5V, etc.; The initial numbers indicate voltages.)
xxC	Power supply lines (15C, 8C, 5C, SSBC, CWC, common voltage, control voltage)
SS (ST)	Standby line. When grounded, transmission starts.
Mxx	Microphone lines (MIC, MGND, MI, MO, etc.) Marker lines, or main signal lines for dual-band transceivers
UP/DN	Microphone UP/DOWN signal. Normally high.
CAR	Carrier signal line
TIF	Transmission IF signal
RIF	Reception IF signal
VXx	VOX signal, control line
Kxx	CW KEY control line
SQ	Squelch control (FSQ, SSQ, SC)
SPx	Speaker signals (SPI, SPO)
AFx	AF signals (AF1, AF2, AI, AO)

AGx	AGC signals (AGC, AGS, RFG → RFGAIN VR)
VSx	Voice unit
RA	RX antenna
DRV	Drive OUT (DO)
SM	S-meter (FSM, SSM)
ICM	IC meter
PWM	Power meter
ALM	ALC meter
PROx	Processor line
ATx	Antenna tuner (ATA, ATT, ATS)
RAT	RF attenuator (ATT)
VSF	VSF signal line
VSR	VSWR signal line
VCO	VCO signal line
CV	CW carrier control voltage, VCO control voltage
VCV	VCO control voltage
TOx	TONE control, signal line
NBx	Noise blanker line
HET	Hetero signal (H642, etc.)
LOx	Local signal (LO1, LO2)
DA	PLL data signal
CK	PLL clock signal
EN	PLL enable signal
UL	PLL unlock signal (ULU, ULV)
TXI	Transmission control line
BZ	Buzzer (BP, BEEP)
PRE	Preset signal
NXX	NOTCH signal
DIM	Dimmer control line
MON	Monitor line

7. Reading Level Diagrams

Example: Use the level diagram to solve the problem of low reception sensitivity of the TS-850. See the TS-850 reception level diagram. (Page 92)

■ **Setup**
SSG frequency: 14.201MHz,
Output: Vary from 0dB.
Set frequency: 14.200MHz,
Mode: USB,
F. LOCK: ON
AGC: OFF signal reception.
Set the AF output to 0.63Vrms by turning the AF-VR.

The AF output is used as reference for subsequent measurements. Do not touch the AF-VR after setting.

■ **Attach the sensitivity checking jig to the SSG output and touch the test point**
Example 1: Q2 input terminal
The AF output increases or decreases.

• If the AF output increases:
Reduce the SSG output and set the AF output to 0.63V.
Example 2: Suppose that the AF output increases from 0.63V (ANT input) to 0.75V (Q2 input).
If the SSG is reduced and the AF output returns to 0.63V at –2.5dB, 2.5dB is lost in the circuit from Q2 to ANT.
• If the AF output decreases:
Increase the SSG output and set the AF output to 0.63V.
Example 3: Suppose that the AF output decreases from 0.63V (ANT input) to 0.36V (Q2 input).
If the SSG is increased and the AF output returns to 0.63V at 3.3dB, there is a 3.3dB gain up in the circuit from Q2 to ANT.

Note : There is no amplifying element in the circuit from ANT to Q2, but 2 to 3 dB are gained or lost due to matching of the impedances of the jig and circuit.

■ **Check the difference between the Q2 input and Q3 output gains**
Calculation is carried out with an example 3.

When the SSG signal is input to Q2 input at 3dB, the AF output is 0.63V. Connect the jig to Q3 output. Increase the SSG output so that the AF output becomes 0.63V at 18dB.
The gain is 18 – 3 = 15dB.
The level diagram shows that the gain is 13 – 0 = 13dB. Since the difference is 2dB, this circuit is OK.

■ **Mixingloss of 1st mix**
Connect the jig to the L56 input and adjust the SSG output so that the AF output is 0.63V. Assume that the gain is 14dB.
Set the SSG frequency to 73.05MHz (IF frequency). Connect the jig to the L59 input. Vary the SSG output so that the AF output becomes 0.63V.
If the gain is 21dB: 21dB – 14dB = 7dB

The mixing loss is 18.5 – 12 = 6.5dB according to the level diagram. Therefore, the mixing is OK.

If the SSG frequency is changed to the IF frequency to check the IF stage, the received AF tone may change. However, if the AF frequency is 800Hz to 1.5kHz, continue measurement. If the AF frequency is incorrect, fine-adjust the SSG frequency so that the tone is the same as that before mixing.

■ Q13 gain

$33.2 - 16.5 = 16.7$dB (according to the level diagram)

Measure the actual value with a jig.

If the measured gain is 17dB ± 3dB, it is probably OK.

If there is a large difference between the actual measurement and the gain shown on the level diagram, check the circuit.

FM transceivers: The SSG output with 12dB SINAD is shown on the level diagram.

■ How to convert levels

The LO-1 level corresponds to 0.85Vrms at L85 OUT. It corresponds to the peak value of about 1.2Vp-p on the oscilloscope. It is useful to use the Vp-p units when measuring it with the oscilloscope.

( ) Vrms x 1.41 = ( ) [Vp-p]
Example: If LO-2 is 0.43Vrms:
   $0.43 \times 1.41 = 0.606$Vp-p

- **Simple conversion method of dBm**
1. Read the RF-VTVM.
2. To convert 0dBm to Vrms:
   Read the scale on the range changeover switch.
      → 0.3V, 0dBm range
   Here, suppose that the pointer indicates zero on the 50-ohm 1mW dBm scale.
   Read the upper scale (black). → It is 0.71V and 2.24V.
   Since the range changeover switch is the 0.3V range, read the lower line of the two black lines (full scale 3). (2.24V)
   Since the full scale value is 0.3V in the 0.3V range, 2.24V is 0.24Vrms.

3. To convert +5dBm to Vrms:
   The maximum value of the 0.3V, 0dBm range of the range changeover switch is +3dBm on the dBm scale. Therefore, +5dBm cannot be converted to Vrms.
   Set the range changeover switch to 1V, +10dBm range.
   When the pointer indicates 0dBm, this point is +10dBm (as the range changeover is +10dBm).
   To obtain the value for +5dBm, move the pointer to the negative side by 5dBm from +10dBm.
   Read the black scale above the –5 point on the dBm scale. (0.4 and 1.25)
   Since the range changeover switch is set to 1V, +10dBm, the full scale value is 1V.
   Read the black scale value directly.
      → +5dBm corresponds to 0.4Vrms.

It can be measured with an oscilloscope by using an equation: Vrms x 1.41 = Vp-p.

If you master these methods, you can obtain data required for repair from the level diagrams.

8. Options

The parts numbers and characteristics of filters are given in the circuit description.

The options shown at the end of this manual mainly are those with electrical circuits.

VOLTS
dBm

VOLTS dBm
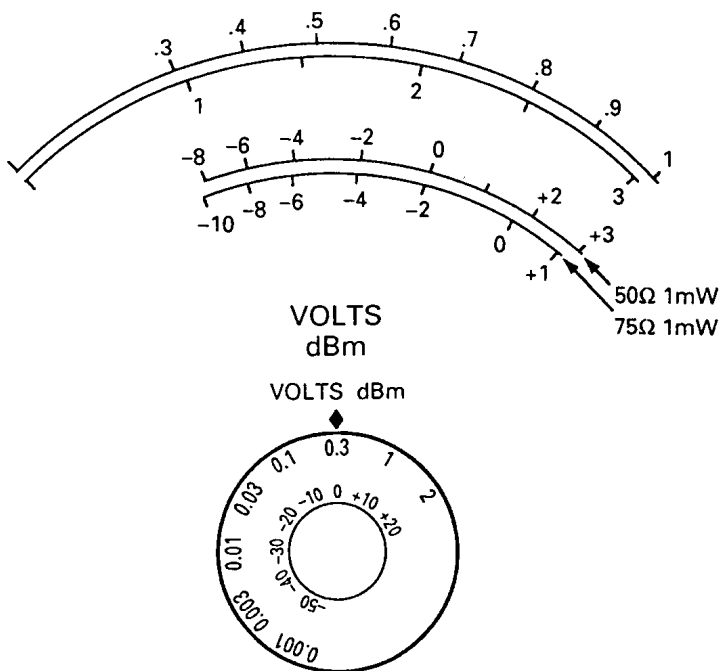
ADDITIONAL INFORMATION 1 (To prevent repeated repaires)

1. TS-930, TS-940

■ The final unit emits smoke and transmission power is not output

1. Replace defective parts
   X45-1400-00
   - Q2, Q3 : MRF485
   - R9, R10 : 22 ohms, 1W
   - D5 : BZ-192 or RD20F(B2)
2. Re-solder the solderd and component sides of the board. (Do so deliberately because the Q1 or Q6 pattern may have poor contact at through holes.)
3. Check Q6, Q7, and D1 with a tester.
4. Take special care not to damage insulating spacers when installing Q1, Q2, Q3, and Q7.
5. After installing all the screws, check the collector and ground of the Q1, Q2, Q3, and Q7 transistors with a tester.
   If it is shorted, the insulating spacer is damaged and the screw and the collector are shorted.
6. Desolder L7, place an ammeter between the Q7 collector and L7 lead, and set as follows:
   - 14.200MHz, Mode: USB,
   - MIC, CAR VR: MIN, Transmission
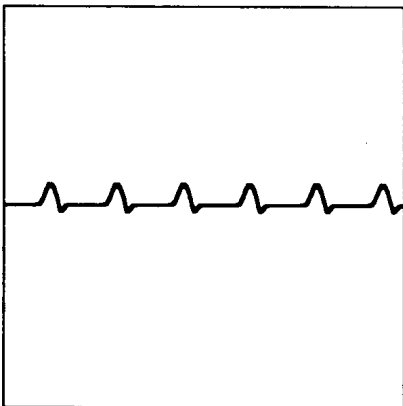   Set the bias current to 50mA with VR and leave it for an hour.
   Check how much the current increases.
   Observe how the ammeter pointer moves.
   Normally, the pointer moves slowly. If it moves quickly at intervals of one or two seconds, IC1 may be defective.
   Check the waveform at the base of Q4 and Q5.
   If the waveform shown at the below appears, replace the IC (MC1723CL).


■ Power supply circuit (TS-930 only)

1. Measure the voltage at CN1 pin 18 with a digital voltmeter.
   If it is 18V or fewer, replace IC8 in the signal unit. If the voltage applied to this IC fluctuates largely, the final unit (UA7818UC) fails.
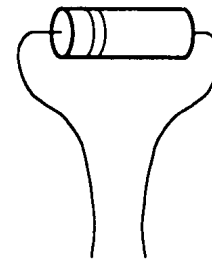
■ Thermally connect D2 and TH1 in the final unit

If D2 is this type of diode, the bias current increases slowly and the maximum current does not exceed 300mA.
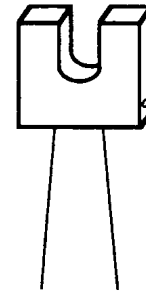
STV-3H (O)

If D2 is this type of diode, the bias current increases rapidly. If the circuit is not modified, the current exceeds 300mA.

SV-03YS

See S.T.R. E51-91-083.

Note: Finally, check the cooling fan.

2. TS-950S/SD Final Transistor Failure

■ Replacing defective parts
Q4 : MRF429MP
Q2, Q3 : 2SC3133
Q8 : 2SC2922LB
The problem usually is solved by replacing these parts.

1. Q6, Q7 : 2SD1406(Y), or Q1 : 2SC1971 may be defective. Check them with a tester.
2. Replace L5 with an output transformer (L39-1238-05) for the SDX.
3. Completely remove the S1 and S2 heat sinks.
   If the switch mold cracks as shown in the figure at the below, replace the thermal switch.

■ Assembly
1. Do not forget to reinstall C23 and C24 in the final transistor.
2. Q1 has an insulating spacer. Install it carefully.
3. Thermally connect D1, D2, and D3 correctly.
4. Do not use an electric or pneumatic screwdriver to install the S1 and S2 screws. Tighten them manually without using any excessive force.
   The screws are special ones that are not attracted by any magnets.
   Do not use screws that are attracted by magnets, or otherwise the thermal switch may fail.
5. After tightening all the screws fixing the final board, remove the filter board and check the rear side of the board. Check whether the coil and capacitor leads are soldered securely to the filter board. Resolder them if desired.
   If the filter board is OK, reinstall it.
6. When wiring is completed, turn the power switch ON.
   14.200MHz, Mode: USB, CAR, MIC, PWR VR: MIN
   Monitor the voltage across R38 with a digital voltmeter and start transmission.

■ Bias current adjustment
1. Set the voltage to about 15mV with VR2. (150mA)
2. Apply the digital voltmeter probe to TP1 and set the voltage to about 160mV with VR1. (1.6A)
3. Leave the set in transmission mode for about 30 minutes. (Check the voltage across R38 frequently. If it exceeds 30mV, reduce it to 20mV.)
4. Final adjustment of the bias current (about 30 minutes later)
   Set the voltage across R38 to 20mV with VR2, and set the voltage across TP1 to 170mV with VR1.

■ Caution
1. Do not output full power with the shielding plate removed.
   There is no problem if the output is about 10W, but the final transistor will fail if full power is output.
2. Before installing the shielding plate, switch the power OFF.
   If any metallic object strikes the DRV IN of the heat sink in transmission mode, the final transistor will fail.
3. Do not crash any wires when installing the shielding plate.

■ Operation confirmation
1. Close the heat sink of the final transistor and connect the DRV IN and OUT terminals on the rear.
   14.200MHz, Mode: CW, CAR VR: MAX
   PWR VR: MIN, VOX, FULL SW: ON, Transmission.
2. About 10W is output. If not, other parts also are defective
3. If power is output, increase the PWR VR gradually. If the ALC has been adjusted correctly, 150W is output and the ALC meter activates.
4. Turn the PWR VR fully clockwise and adjust the power with the CAR VR so that the ALC meter indicates the maximum zone.

■ Checking the cooling fan
1. If the 50°C switch is turned ON, the fan starts.
2. If the 70°C switch is turned ON, the fan noise will increase while transmitting with full power for about 30 minutes. (The SDX fan starts as soon as transmission starts.)

■ Power-check in each transmission band
1. Check the power at each of the 1.8MHz to 29MHz amateur bands.

■ Turn the AT switch ON, perform tuning, and check the power with the antenna tuner
1. Check the power at each of the 1.8MHz to 29MHz amateur bands.

If there is no problem, the repair is completed.
If the transceiver is repaired again, it must be checked thoroughly to avoid repeated repairs.

3. TS-440 Unlock (R-5000)

■ If the TS-440 HET (PLL5) is unlocked:

1. Remove all the bond on the parts.
2. Remove Q34, Q35, and Q36 from the board, and eliminate bond scraps from the leads as shown in the figure at the below.
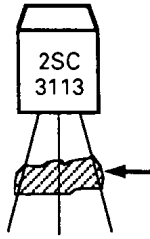
3. After cleanly removing the bond, secure the parts with jet melt (or paraffin).
4. After the jet melt (or paraffin) cools, adjust the lock voltage.
   If the 5V lock voltage is adjusted while the jet melt is warm, the lock voltage will become incorrect when the jet melt cools. (FM deviation also shifts.)
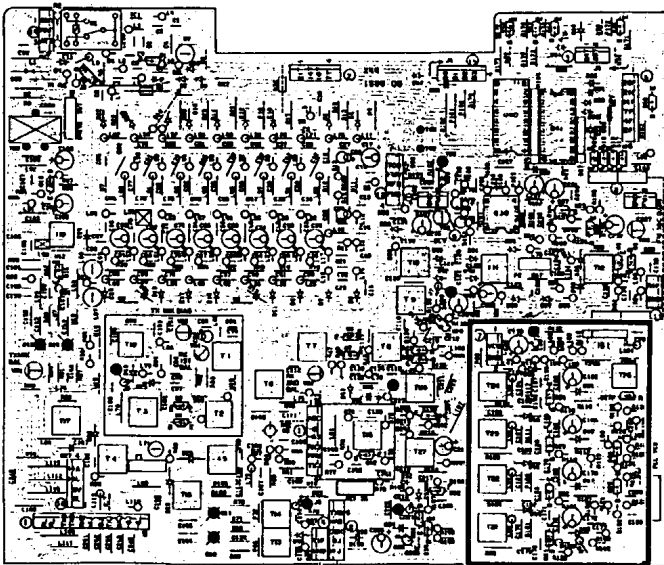
This problem occurs only when hot melt (brown) is filled in. It does not occur when jet melt (white) is used.

■ R-5000 unlock

1. Remove the bond in the shield case containing Q7 and Q8 in the PLL unit.

■ TS-440 unlock

1. Some parts of the VCO shield of the RF unit may be soldered poorly. (Parts near C177)
   Check these parts to repair.
2. Push in the pins of the PLL, RF, and IF circuits.


X44-1680-XX

Re-solder

4. TS-940 Unlock

The TS-940 or TS-440 mini-connectors may have poor contact. If a model is returned for repair to solve an unlock problem, but the symptom is not found: Push in connector pins.

■ Mainly, check the following parts

RF unit	CN7, CN8, CN9
IF unit	CN5, CN9, CN10, CN12, CN13
Control unit	CN1, CN2, CN3, CN8, CN17, CN18, CN20, CN21
Digital A unit	CN4, CN5, CN7, CN13, CN14, CN15, CN16
Keyboard	2P-1, 7P-1, 7P-2
CAR unit	All parts
PLL unit	All parts

Check for poor contact of the ground side of CN8 of the PLL unit.
Symptom; The sensitivity or transmission power is low. → Tighten the part shown in the figure at the below.
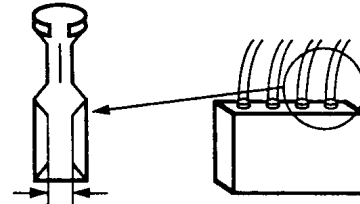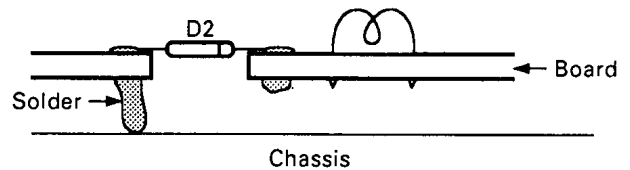

5. TS-790

■ If D2 in the 430MHz final unit fails
Excessive power is output.

1. If the final module and D2 failed, turn the board over, and check the solder on the D2 pattern.
   It may be as follows:

2. Solder D2 and peripheral parts again and reinstall the board.
   Adjust the power to 42W.

ADDITIONAL INFORMATION 2 (Measurement)

The oscilloscope can measure high voltages of the KV order. Apply the high-voltage probe to a digital voltmeter to measure high voltages.

If a high-voltage probe is available, there is no problem in measurement. If no high-voltage probe is available, perform the measurement as follows:

1. Connect a high-resistance resistor to the positive (+) terminal of the digital voltmeter in series. (We connected five 8.2M ohm resistors, which have the highest resistance among the available resistors.)
2. The HV circuit voltage decreases to less than 1000V, and the voltage can be measured.
   If there is another set for comparison, the voltage can be evaluated by comparing the voltages.

1. How to Estimate the Voltage

Find or measure the high voltage that can be measured without attaching any resistors. (Vacuum-tube type final B is appropriate.)

1. Measure the voltage without attaching resistors.
   Example: 850V
2. Measure the voltage again with resistors attached.
   Example: 600V
3. Measure the HV circuit voltage with resistors attached. Example: 950V
4. Assume that the actual HV circuit voltage is X:
   $850 : 600 = X : 950$
   $600X = 950 \times 850$
   $X = 807500 / 600 = 1345.8V$

The approximate voltage of the high-voltage circuit is obtained in this way.
Take special care to avoid electric shocks.

2. How To Measure the Radio Frequency Carrier Level (200MHz or Higher)

Normally use a RF VTVM. The position of the RF VTVM pointer changes according to the grounding method, inclination of the probe during measurement, and application of the probe.

The carrier level can be measured most accurately by setting the measurement point as shown in the figure at the below.

Attach the metallic part of the probe to the chassis directly.
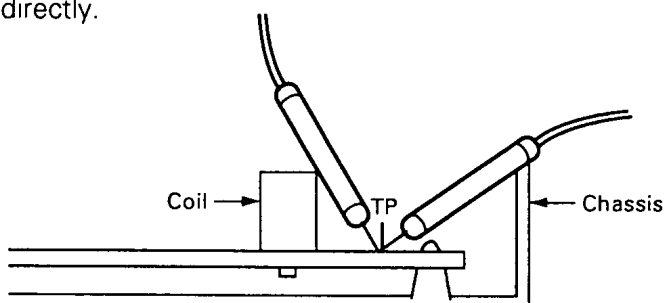
3. How To Measure the Level With a Spectrum Analyzer

This section describes how to use the spectrum analyzer for comparison. (It is used to check whether the level is higher or lower than the correct level and examine the difference of the levels.)

1. Connect the oscilloscope probe to RF INPUT of the spectrum analyzer at a 10:1 ratio.
2. Turn the spectrum analyzer ON and set the frequency to zero.
3. Set the peak of the calibration (CAL) signal to a horizontal scale of the brown tube by using LOG. REF. It may be set to any scale, but it is preferable to set it to a high scale.
4. Find the frequency of the signal to be measured, and set it with the frequency control.
5. Apply the probe to the measuring point and search for the signal with the frequency control knob.
6. Observe the signal level.
   If it is lower than the CAL signal level, continue checking.
   If it is higher than the CAL signal level, reduce it to lower than the CAL signal level by INPUT ATT.

CAL   NG   OK
INPUT LEVEL
OVER
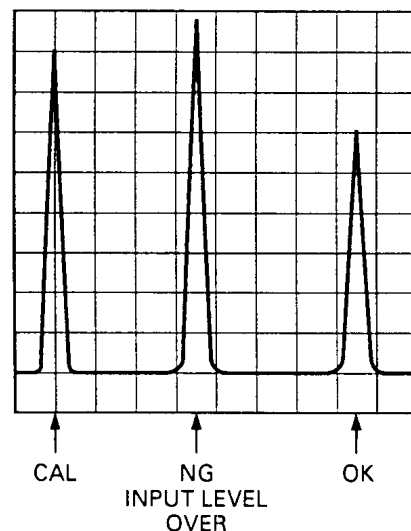
If the input level is higher than the CAL signal level, the input amplifier of the spectrum analyzer causes distortion and signals with incorrect frequencies are produced.

The waveform of the base band is easier to observe if the video filter is turned ON.

The scan time can be set to a desired value, but should be set to the highest value in the range in which the UNCAL LED does not light.

The band width should be about 100KHz.

Set the scan width to a desired value. Set it to about 1MHz to see the carrier signal level. Set it to 10, 50, or 100MHz to observe the harmonic spurious. Set it to 1MHz or less to see the near-by spurious.

Locate the cause by comparing the good set with the bad one.

It is very useful in measuring the 200-MHz and higher levels of the TS-790 430MHz PLL, TS-811 HET board, TR-851, and UT-10.

The peak of the desired signal can be obtained by adjusting the band-pass filter following the mixer circuit.
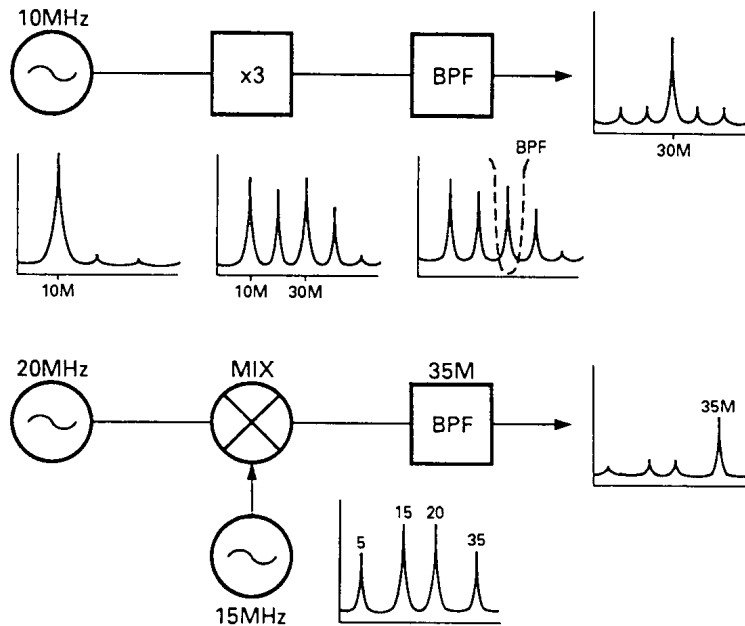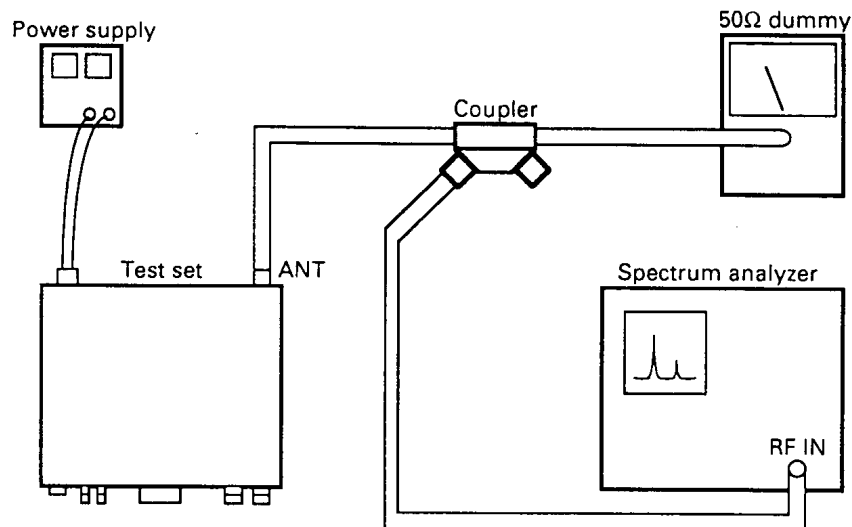

4. Observing the Harmonic Spurious

Scan width: 50 or 100MHz
Input attenuation: 30dB
The spurious can be observed.

Do not supply RF power to the input terminal of the spectrum analyzer. Otherwise, the internal attenuator will fail. Up to the drive stage level can be directly input.

5. Check the Characteristics of the Band-Pass Filter With the Spectrum Analyzer

A tracking generator is required to observe the characteristics of the band-pass filter.

Tracking generator output   BPF   Spectrum analyzer   Spectrum analyzer
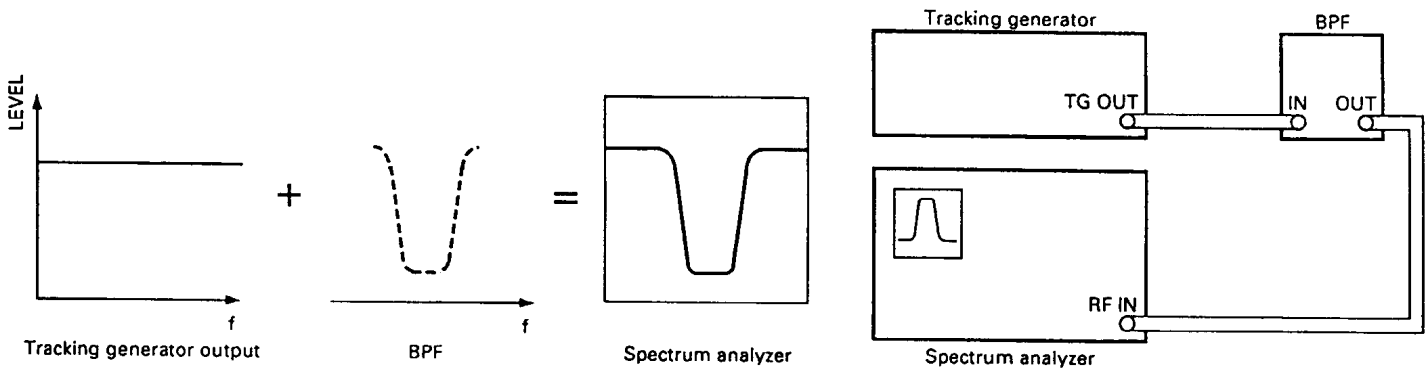
■ If the spectrum analyzer and tracking generator are not available

Measurement can be performed by connecting the SSG, band-pass filter, and oscilloscope as follows.
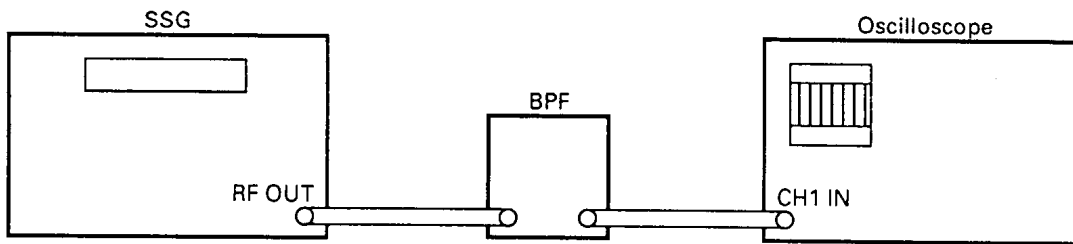
Set the SSG frequency equal to the central frequency of the band-pass filter to be measured.
Set the SSG output to about 100dBμ.
Turn the VOLT/DIV on the oscilloscope so that the level can be observed.

- To check the frequency band of the YK88S-1
  SSG frequency: 8.83MHz, 100dBμ
  Oscilloscope: 0.1V, 2μS

1. Reduce the SSG frequency in 100Hz units and observe the oscilloscope level. (Many peaks will appear on the display.)
2. If the waveform diminishes and the level can no longer be recognized, return the frequency slightly, and read the frequency of the last peak.
3. Record f1.
4. Increase the frequency and check in the same way.
5. Record f2.

This shows the approximate band width.
  Band width = f1 − f2
  Frequency band width: f1 to f2
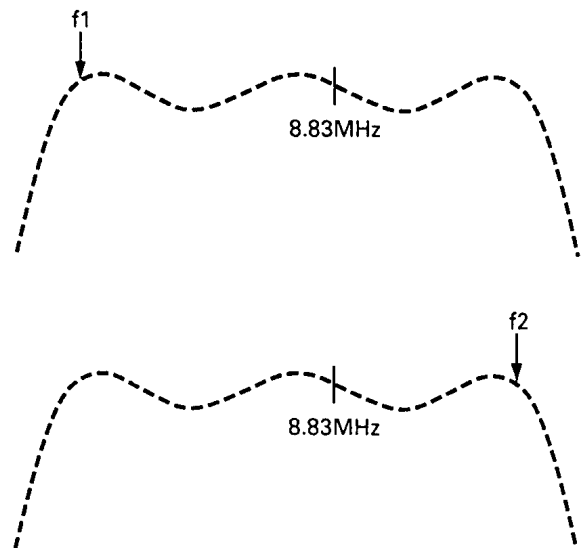
6. How To Measure SSB Sensitivity; 10dB S/N Method

1. Enter the standard sensitivity signal from the SSG.
   (The standard sensitivity is given in the specifications in the manual.)
   Example: 0.25µV
   SSG frequency: 14.100MHz
2. Make the set receive a signal and check the AF peak.
3. Set the AF-VTVM pointer to 0dB on the red scale with the AF-VR on the set. (For a digital meter, set the display to dBm display, and increase the AF output to 0dB.)
4. Turn the encoder (or press the band switch) to detune.
5. Read the AF-VTVM when noise is emitted.
6. The standard is satisfied if the difference between AF outputs during reception and detuning is 10dB or more.