

SERVICE MANUAL

Model TS-660

VOX-4, SP-120, PS-20, MB-100

ALL MODE QUAD BANDER



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SPECIFICATIONS/CIRCUIT DESCRIPTION

[GENERAL]

| | |
|---|--|
| Frequency Range: | 15 meter band 21.0000 ~ 21.4500 MHz * 12 meter band 24.5000 ~ 24.9999 MHz (Receive only) 10 meter band 28.0000 ~ 29.7000 MHz 6 meter band 50.0000 ~ 53.9000 MHz |
| Mode: | FM (F3), SSB (A3j), CW (A1), AM (A3) |
| Frequency Stability: (At room temperature) | Within ± 200 Hz during the first hour after 1 minute of warmup Within ± 30 Hz during any 30 minutes after warmup |
| Antenna Impedance: | 50 Ω |
| Power Requirements: | 12 ~ 16 VDC (13.8 VDC nominal) Transmit (max.) 4 A (SWR: Less than 1.5) Receive 1 A |
| Semiconductor Complement: | ICs 35 FETs 22 Transistors 156 Diodes 217 Display tube 1 |
| Dimensions (projections excluded): | 241 (9-1/2") W \times 94 (3-11/16") H \times 236 (9-5/16") D mm |
| Weight: | 4.9 kg (10.8 lbs) |

[TRANSMITTER SECTION]

| | |
|--|---|
| RF Output Power: | SSB, CW, FM 10 W AM 4 W |
| Carrier Suppression: | Better than 40 dB |
| Sideband Suppression: | Better than 50 dB |
| Spurious Radiation: | 21 ~ 28 MHz band Better than 40 dB 50 MHz band Better than 60 dB |
| Maximum Frequency Deviation (FM): | ± 5 kHz |
| Microphone Impedance: | 500 Ω ~ 50 k Ω |
| Audio Frequency Response: | 400 ~ 2600 Hz (-6 dB) |

[RECEIVER SECTION]

| | |
|----------------------------------|---|
| Sensitivity: | SSB, CW 0.25 μ V for 10 dB S/N AM 1 μ V for 10 dB S/N FM 1 μ V for 30 dB S/N 0.4 μ V for 12 dB SINAD |
| Image Ratio: | Better than 60 dB |
| IF Rejection: | Better than 70 dB |
| Selectivity: | SSB, CW, AM 2.4 kHz (-6 dB), 4.2 kHz (-60 dB) FM 15 kHz (-6 dB), 32 kHz (-60 dB) |
| Optional Filter | |
| AM filter | YK-88A 6 kHz (-6 dB), 11 kHz (-60 dB) |
| CW filter | YK-88C 500 Hz (-6 dB), 1.5 kHz (-60 dB) YK-88CN 270 Hz (-6 dB), 1.1 kHz (-60 dB) |
| Squelch Sensitivity (FM): | 0.32 μ V (at threshold) |
| Audio Output: | 1.5 W |
| Audio Output Impedance: | 8 ~ 16 Ω |

Note: Circuit and ratings may change without notice due to developments in technology.

* Will transmit on the new 12 meter band. A lead wired for preventing accidental transmission before government amateur authorization.

RECEIVER CIRCUIT

There are two antenna terminals on the TS-660 : one for 50 MHz ANT 1 and one for 21-28 MHz ANT2. The 50 MHz antenna terminal can be switched to operate the full 21-50 MHz range by means of a rear-panel changeover switch S2. When ANT 1 is used for All-BAND operation, ANT 2 is automatically grounded.

The receiver system is single conversion with an IF of 8.830kHz. The FM is dual conversion with a 2nd IF of 455 kHz.

At the RF stage, the 50 MHz and 21-28 MHz inputs are independent, but become common from the mixer stage. The 50 MHz antenna signal enters through the transmission LPF (Filter unit, L7-9) and then to the VHF antenna coils. For HF bands (21-28 MHz), the signal enters the RF unit HF antenna coils directly. Changeover between these transmission and reception antenna paths is accomplished by diode switches. However, relays are used for band changeover. Input signals are stepped up by the RF unit antenna coils ; VHF L3, 4 and HF antenna coils (L9-11) and RF amplified by VHF Q1 : 3SK73, or HF Q5 : 3SK73.

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CIRCUIT DESCRIPTION

Either VHF or HF signal then enters the common mixer (Q3, 4 : 3SK74). A 50 MHz signal enters through matching transformer (T12) and helical resonator (L6). Each H.F. BAND has its own BPF (Band Pass Filter) : (21 MHz L17-19, 24.5 MHz L20-22, 28 MHz L23-25).

In this double balanced mixer, the input signal is mixed with the PLL (phase locked loop) VCO (voltage controlled oscillator) output to derive an 8.83 MHz IF (intermediate frequency) signal. Transformers T2, T3, ceramic filter CF-1 (with a bandwidth of about 50 kHz), and T4 couple this IF signal from the mixer output to the first IF amplifier FET (Q7 : 3SK73).

T5 couples this signal into the noise blanker gate (D22- 25) and T6 couples the gate output to the RIF (RX IF), which runs to the IF unit input. The signal to the FM unit is applied from T6 via buffer amplifier (Q7 : 2SC1815). The noise blanker signal is obtained at the output of the 1st IF amplifier (Q7) through FET buffer amplifier (Q10 : 2SK19). This noise signal is amplified by Q11-13 : 2SC460 and detected by D28, 29. Finally the switching driver Q8 : 2SC1815 drives the NB gate to eliminate or reduce pulse-type (ignition) noises.

The signal entering the IF unit from the RF unit is first filtered by the MCF (Monolithic crystal Filter) and then amplified by two IF amplifier stages (Q10, 11 : 3SK73). SSB and CW signals are product detected by D25-28 : 1N60 and fed to the audio preamplifier (Q22 : 2SC2240) via SSB, CW and AM squelch switch transistor (Q43 : 2SC2240).

The AM mode is derived from the output of Q11 through buffer amplifier (Q15 : 2SC1815) and detected by diode (D49 : 1N60). This is amplified by Q25 : 2SC1815 and fed to the squelch switch transistor Q43. SSB and CW or AM mode selection is performed by diode switches (D40, 41). In all cases excluding FM, a squelch signal is taken from the AGC line and amplified by Q39 : 2SC1815 and Q40 : 2SK40. Q41 : 2SA1015 is adjusted by the squelch control. This biases Q42 : 2SC1815 OFF at no signal, and ON when signal is present, to bias Q43 : 2SC2240 on when signal is present.

In the FM mode, the RF unit FMI output is delivered to the FM unit, where the signal is input to Q5 : MC3357, a monolithic IC containing the second conversion oscillator, mixer, limiting amplifier, quadrature discriminator, active filter, squelch, scan control, and mute. Q4 : 2SC2240 buffers the detected output and returns this audio signal (via the FAF line) to the IF unit, D42 switch.

FM signal meter drive (FSM) is derived through amplifiers Q6,7 : 2SC1815 (Y), transformer T3, and rectifiers D5, 6 : 1N60.

Audio signals for each mode are preamplified by Q22, volume controlled, then power amplified by the audio output IC (Q23 : HA1366W).

| Item | Rating |
|----------------------------|---------------------|
| Center frequency (fo) | 8831.5 kHz ± 250 Hz |
| -6 dB bandwidth | 6 kHz |
| Attenuation bandwidth | 11 kHz |
| Guaranteed attenuation | 80 dB or more |
| Ripple | 2 dB or less |
| Loss | 3 dB ± 2 dB |
| Input and output impedance | 600Ω // 15pF |
| Temperature | -10°C ~ +50°C |

**Table 1 AM Crystal filter YK-88A
(L71-0223-05) Option**

| Item | Rating |
|----------------------------|--|
| Center frequency fo | 8830.7kHz |
| Center frequency deviation | fo ± 150Hz at 6dB |
| 6dB bandwidth | ± 250Hz or more |
| 60dB bandwidth | ± 900Hz or less |
| Ripple | 2dB or less |
| Loss | 6dB ± 2dB |
| Guaranteed attenuation | 80dB or more within fo ± 2kHz to ± 1MHz |
| Input and output impedance | 600Ω/15pF |

**Table 2 CW Crystal filter YK-88C
(L71-0211-05) Option**

| Item | Rating |
|----------------------------|--|
| Center frequency fo | 8830.7kHz |
| Center frequency deviation | fo ± 50Hz at 6dB |
| 6dB bandwidth | ± 125Hz or more |
| 60dB bandwidth | ± 600Hz or less |
| Ripple | 2dB or less |
| Loss | 8dB ± 2dB |
| Guaranteed attenuation | 80dB or more within fo ± 2kHz to ± 1MHz |
| Input and output impedance | 600Ω/15pF |

**Table 3 CW Crystal filter YK-88CN
(L71-0221-05) Option**

| Item | Rating |
|-------------------------------|----------------------|
| Nominal center frequency (fo) | 455 kHz |
| 3 dB bandwidth | ± 5 kHz or more |
| 6 dB bandwidth | ± 7.5 kHz or more |
| 60 dB bandwidth | ± 16 kHz or less |
| Guaranteed attenuation | Within 455 ± 100 kHz |
| | 45 dB or more |
| Ripple | Within 0.1 ~ 1.0 MHz |
| | 30 dB or more |
| Ripple | (Within 455 ± 5 kHz) |
| Loss | 3 dB or less |
| Loss | 5 dB or less |
| Input and output impedance | 1.5 kΩ |

Table 4 Ceramic filter CFT455F2

CIRCUIT DESCRIPTION

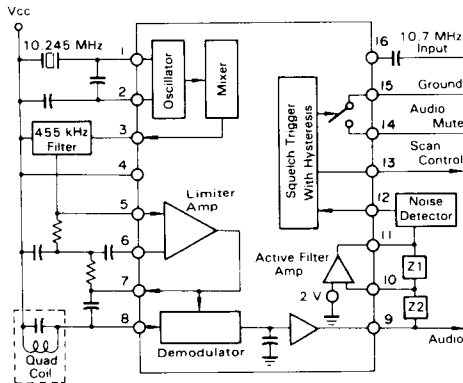


Fig. 1 MC3357P Block diagram

TRANSMITTER CIRCUIT

As in the receiver system, the transmitter is single conversion in the SSB, CW and AM modes and dual conversion in the FM mode.

In SSB and AM modes, the MIC audio signal is amplified in the switch unit by Q1 : 2SC2240, Q2, 3 : 2SC1815, and applied to the balanced modulator (D29-32 : 1N60) on the IF unit, where an 8.83 MHz DSB signal is generated. In SSB mode, this is buffer-amplified by Q17 : 2SK19, and passed through the 8.83 MHz MCF (Monolithic Crystal Filter) exiting as an SSB signal SSB mode. In the AM mode Q17's output is switched through either R91 82Ω or YK-88A AM filter (option) when installed. SSB, CW and AM mode signals are then amplified by the transmitter IF amplifier (Q18 : 3SK73) and are output via the TIF line from the IF to the RF unit.

In the FM mode, the audio signal from the Switch unit microphone amplifier (Q1 : 2SC2240) goes to the FM unit via the FMC line. In the FM-1 unit, the MIC signal is amplified and limited by Q1 : TA7061AP, an OP AMP, and is applied to varicap diode D1 : 1S2208 to modulate crystal X1.

The 8831.5 kHz carrier output generated by oscillator Q2 : 2SC460 and amplified Q3 : 3SK74 is fed via the FMT line to the RF unit (connector 6) and into the transmitter balanced mixers (Q15, 16 : 3SK74).

SSB, CW and AM or FM signal selection is performed by diode switching (D29, 30).

The various mode signals are mixed with the VCO output for each band by the transmitter balanced mixers (Q15, 16) and this output is routed to one of two paths ; one for 50 MHz and the other for 21-28 MHz. Signal path selection is performed by diodes D31, 32. The 50 MHz signal is filtered by helical coils L37 and then amplified by transmitter amplifier Q17 : 3SK73.

This is then further filter by helical coils L38 and amplified

This 50 MHz signal is relay selected (RL1) and is fed to the DRV (DRIVE) terminal and then to the Final unit. 21-28 MHz signals are first Band Pass Filtered, then amplified by wide-band amplifiers Q21 : 2SC1815 and Q22 : 2SC2086. These 50 MHz or 21-28 MHz signals are fed to the Final unit via relay RL1.

The signals input to the Final unit are amplified by a wide band push-pull driver amplifiers (Q1, 2 : 2SC1971), and then amplified by wide band push-pull final amplifiers (Q3, 4 : 2SC1972) to the 10W output level. This RF output is Low Pass Filtered for each band in the Filter unit. ALC detection is provided by Q1, and protection is provided by Q2 (both 2SC1815) before the LPF section.

| Item | Condition | Symbol | Rating | | | Unit |
|--------------------|------------------------------|-----------|--------|------|------|------|
| | | | TYP | MIN | MAX | |
| Output voltage | $V_i = 15V$ $I_o = 350mA$ | V_o | 9.00 | 8.65 | 9.35 | V |
| MAX output current | $V_i = 15V$ | I_o MAX | 750 | - | - | mA |

Table 5 NJM78M09A (V30-1107-16)
Electrical Characteristic

| | VCBO | VEBO | VCEO | IC | PC | Tj | Tstg | Ta |
|------------|------|------|-----------------------|----|--------------|--------|----------------|-----------------------|
| Condition | | | R = $\infty\Omega$ | | Tc = 25°C | | | 25 $\pm 3^\circ C$ |
| MAX rating | 35V | 4V | 17V | 2A | 12.5W | +150°C | -55~ +150°C | |

Table 6 2SC1971 (V03-1971-16) Max Rating

| | VCBO | VEBO | VCEO | IC | PC | Tj | Tstg | Ta |
|------------|------|------|-----------------------|------|--------------|--------|----------------|-----------------------|
| Condition | | | R = $\infty\Omega$ | | Tc = 25°C | | | 25 $\pm 3^\circ C$ |
| MAX rating | 35V | 4V | 17V | 3.5A | 25W | +175°C | -55~ +175°C | |

Table 7 2SC1972 (V03-1972-16) Max Rating

PLL CIRCUIT

The TS-660 uses a system of three Phase-Locked Loops to obtain the final VCO (voltage controlled oscillator) output frequency. A 16 MHz master oscillator is employed, from which all other standard fixed frequencies are derived. Frequency control is achieved by a 10 Hz step digital VFO feeding an 8 bit microcomputer (μ PD8048C), which controls the divide ratio of each PLL circuit.

Fig. 2 shows the PLL circuit block diagram. VCO 1 consists of a PLL circuit operating between 6-4 MHz in 2 kHz steps, using a 2 kHz reference frequency and a divide ratio of $1/N1=1/3000-1/2001$. The divider used is a TC9122P. The divide ratio is set as a 13 bit BCD signal. Next, this 6-4 MHz signal is divided by 1/200 to become a 30-20kHz signal in 10 Hz steps. It is then mixed with the 8 MHz standard frequency by MIX 1 and this becomes a 7.97-7.98 MHz output signal, with a bandwidth of 10 kHz

CIRCUIT DESCRIPTION

This signal enters the VCO 2 PLL circuit through MIX2. **Table 8** shows the frequency relationships within the first PLL.

VCO 2 operates between 6–7 MHz in 10 kHz steps using a 10 kHz reference frequency and a divide ratio 1/N2 of 1/197–1/98. The divider used is an MC14569B and the divide ratio is set as an 8 bit binary input, as shown in **Table 9**.

As previously mentioned, VCO 2 is controlled in 10 kHz steps. While VCO 1 operates in 10 Hz steps. The mix of the VCO 1 signal 7.97–7.98 MHz in 10 Hz steps by MIX 2 yields a VCO 2 operating range of 6–7 MHz in 10 Hz steps by the sum of 1/N1 and 1/N2 divide ratios.

This signal is then mixed with the CAR frequency, filtered, and fed into MIX 4. Here, one of two standard frequencies are mixed. For the 21 and 24 MHz bands, 4 MHz is injected. For the 28 and 50 MHz bands, 32 MHz is injected. Therefore, the output for the 21 and 24 MHz bands becomes 18.83–19.83 MHz and for the 28 and 50 MHz bands 46.83–47.83 MHz. This signal is fed into the final PLL circuit through MIX 5.

PLL-3 actually contains three VCO's. The 21 and 24 MHz bands share VCO 3-1 with a 1 MHz coverage.

The 28 MHz band VCO 3-2 covers a 2 MHz range. The 50 MHz band VCO 3-3 covers a 4 MHz range.

This PLL employs an MC4044P phase comparator and a 1 MHz reference frequency, along with a conventional SN74LS163AN TTL-type divider. **Table 10** shows the frequency relationships within the Final Loop circuit.

The RIT (Receiver Incremental Tuning) function uses an 8 MHz VXO (Variable X-TAL Oscillator) circuit which is switched in place of the 8 MHz standard input signal to MIX 1. During CW transmission, the 800 Hz carrier shift is performed by this VXO.

IF shift is easily accomplished, since the carrier frequency is mixed in the PLL circuit.

When the CAR frequency is VXOed, both the IF input (to the MCF), and Product Detector CAR input shift, moving the IF input signal across the MCF Pass Band width. In the TS-660, there are two carrier crystal oscillator circuits. In CW, SSB, and AM TX, CAR 1 operates at 8.8315 MHz. In the FM and AM RX modes, the carrier frequency into PLL MIX 3 is lowered 100 kHz by CAR 2 : 8.7315 MHz. Simultaneously, the divide ratio 1/N2 is changed to raise the VCO 2 frequency 100 kHz. So the final VCO output remains the same.

| Displayed frequency | VCO2 | 1/N2 | 1/N2(binary) | |
|---------------------|-------|-------|-----------------|-----|
| | | | MSB | LSB |
| 50.000.0 | 6.000 | 1/197 | 1 1 0 0 0 1 0 1 | |
| 50.010.0 | 6.010 | 1/196 | 1 1 0 0 0 1 0 0 | |
| ⋮ | ⋮ | ⋮ | ⋮ | |
| 50.500.0 | 6.500 | 1/147 | 1 0 0 1 0 0 1 1 | |
| ⋮ | ⋮ | ⋮ | ⋮ | |
| 50.980.0 | 6.980 | 1/99 | 0 1 1 0 0 0 1 1 | |
| 50.990.0 | 6.990 | 1/98 | 0 1 1 0 0 0 1 0 | |

Table 9

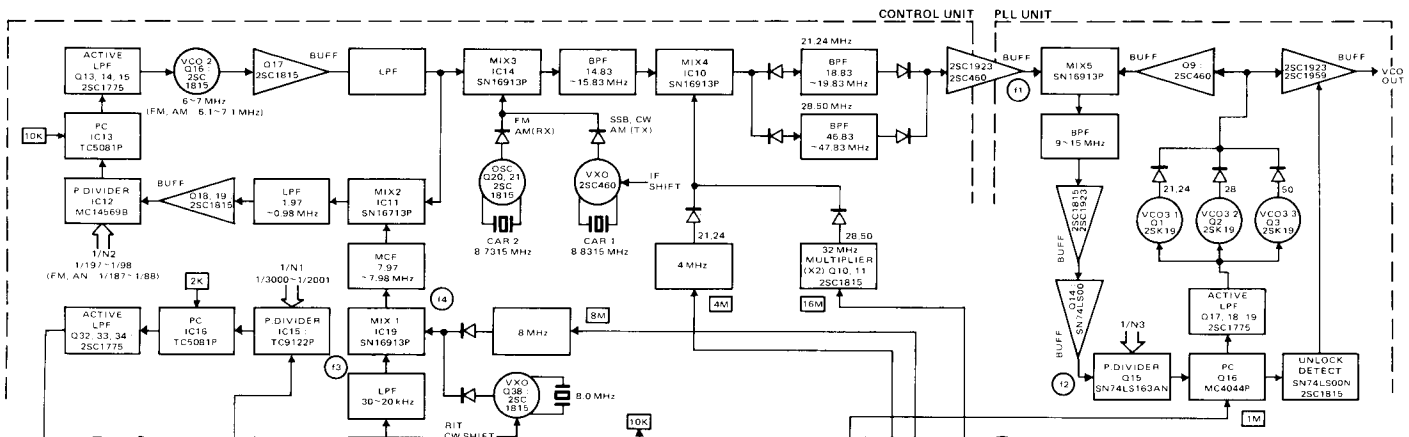
| Display | VCO1(MHz) | 1/N1 | f3(kHz) | f4(MHz) |
|---------|-----------|--------|---------|----------|
| 0.0 0 | 6.000 | 1/3000 | 30.000 | 7.970000 |
| 0.0 1 | 5.998 | 1/2999 | 29.990 | 7.970010 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 5.0 0 | 5.000 | 1/2500 | 25.000 | 7.975000 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 9.9 8 | 4.004 | 1/2020 | 20.020 | 7.979980 |
| 9.9 9 | 4.002 | 1/2001 | 20.010 | 7.979990 |

Not displayed

Table 8

| BAND | f1(MHz) | VCO3(MHz) | f2 | 1/N3 | Divide ratio | | | | |
|------|-------------|-------------|----|------|--------------|---|---|---|--|
| | | | | | D | C | B | A | |
| 21 | 18.83~19.83 | 29.83~30.83 | 11 | 1/11 | 0 | 1 | 0 | 1 | |
| 24 | " | 32.83~33.83 | 14 | 1/14 | 0 | 0 | 1 | 0 | |
| 28 | 46.83~47.83 | 36.83~37.83 | 10 | 1/10 | 0 | 1 | 1 | 0 | |
| 39 | " | 37.83~38.83 | 9 | 1/9 | 0 | 1 | 1 | 1 | |
| 50 | " | 58.83~59.83 | 12 | 1/12 | 0 | 1 | 0 | 0 | |
| 51 | " | 59.83~60.83 | 13 | 1/13 | 0 | 0 | 1 | 1 | |
| 52 | " | 60.83~61.83 | 14 | 1/14 | 0 | 0 | 1 | 0 | |
| 53 | " | 61.83~62.83 | 15 | 1/15 | 0 | 0 | 0 | 1 | |

Table 10



CIRCUIT DESCRIPTION

CONTROL CIRCUIT

● Rotary encoder input circuit

In the encoder unit a 250-slit rotary tuning disk and two photo-interrupters generate two clock signals with a 90° phase difference. This is fed to the Control unit via the EN1, 2 lines. These are waveform shaped by Schmitt trigger gate IC23 (TC4049BP), then multiplied by four through IC21, 22 (TC4011BP) so that a signal of 250 pulses/rotation becomes 1,000 pulses/rotation.

This is input to the microcomputer INT terminal (Pin 6) via one-half of flip-flop IC20-2 (TC4011BP).

The encoder's direction of rotation is identified by phase difference of its two output signals. flip-flop IC20-1 delivers this to microcomputer input T1 (Pin 39). Timing and waveforms are shown in **Fig. 3**.

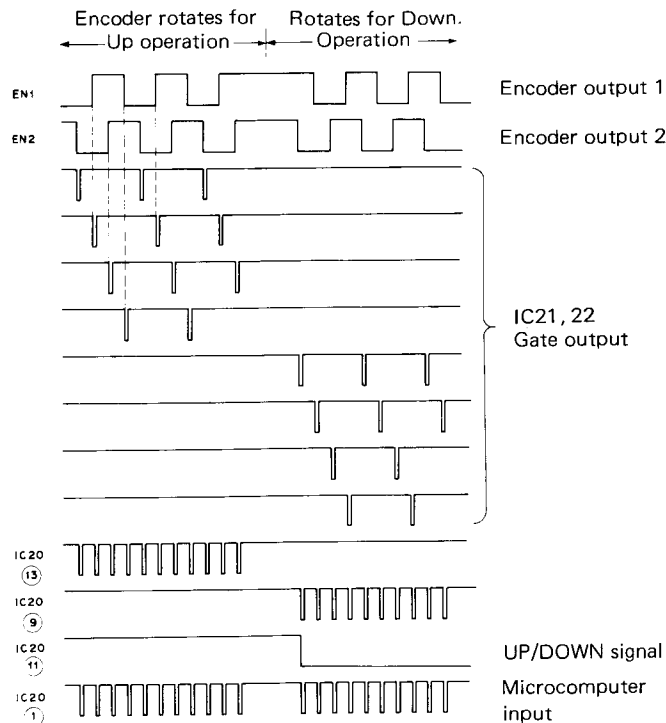


Fig. 3 Encoder output to micro-processor input timing and waveforms

● MIC Frequency shift circuit

The TS-660 permits frequency shift control by microphone-mounted switches. To generate the frequency shift control clock, the TS-660 incorporates a dedicated clock oscillator. The oscillator consists of an astable multivibrator combining two NAND gates (IC24-1 : TC4011BP). Frequency shift is controlled by the interval in which the switch is held down, and is switchable between step-by-step and continuous shifting. Shift speed is determined by CR time constant C149 (0.022 μ F) and R158 (150k Ω) to be approximately 100 Hz to achieve a shift speed of about 1 kHz/sec.

The 1-step shift function involves direct input to the microcomputer to terminal via IC2 (SN74LS151N) and is separate from the Timing circuit.

The interval from the step-by-step to continuous shift is determined by R160 (82k Ω) and C151 (10 μ F).

● Buzzer circuit

In the TS-660, a tone is generated to confirm BAND change, UP/DOWN frequency operation or MEMORY STORE by means of a driver circuit and a ceramic oscillator. When any of these operations occur, a pulse of several μ sec. is output from IC1 terminal P73 (Pin 16). This pulse is multiplied by 10 by a one-shot multiplier circuit IC24-2 (TC4011BP) and RC R6 (83k Ω) and C1 (1 μ F), and a tone is generated by switching on the power supply to the ceramic transducer.

● Switch input circuits

All front-panel switch signals (FUNCTION, MEMORY, CH, M, S HOLD, BAND, etc.) are fed to the control unit and then compiled by diode matrix D7-10, 13-17, 19-22. This information is fed to the microcomputer via two data selector ICs.

IC2 (SN74LS151N) is a 1 bit x 8 ch data selector handling MODE, MIC, BAND UP/DOWN and S HOLD signals. IC3 (TC4019BP) is a 4 bit x 2 ch data selector handling FUNCTION, MEMORY and CH data input.

● Microcomputer power supply circuit

The microcomputer 5V power supply (IC5 : μ PD8048C) has two 5V input terminals : a VCC terminal (No. 40) for microcomputer operation and developed on the Control unit, and a VDD terminal (No. 26) for internal RAM back-up fed from the external main power source. Therefore, the VDD 5V is applied only during back-up to hold the memory.

CIRCUIT DESCRIPTION

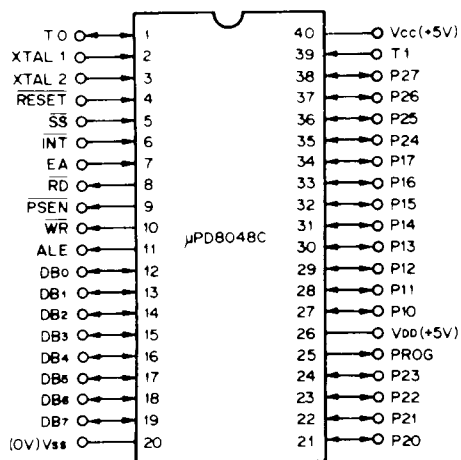


Fig. 4 μPD8048C-292 Terminal name

| Item | Symbol | Rating |
|-----------------------|------------------|---------------|
| Operating voltage | V _{cc} | -0.5 ~ +7.0V |
| | V _{DD} | -0.5 ~ +7.0V |
| Input voltage | V _i | -0.5 ~ +7.0V |
| Output voltage | V _o | -0.5 ~ +7.0V |
| Operating temperature | T _{opt} | 0 ~ +70 °C |
| Storage temperature | T _{stg} | -65 ~ +150 °C |

Table 11 μPD8048C-292 Max Rating

| Terminal No. | Symbol | Explanation | Terminal No. | Symbol | Explanation |
|--------------|--------|--------------------------------------|--------------|--|---|
| 1 | T0 | DATA SELECTOR input | 21 | P20 | I/O EXPANDER control output |
| 2 | X0 | Microcomputer CLOCK(5 MHz) input | 22 | P21 | |
| 3 | X1 | Microcomputer reset input Normally H | 23 | P22 | |
| 4 | RST | | 24 | P23 | |
| 5 | SS | Normally 5V | 25 | PRG | RAM BACK UP 5V power supply |
| 6 | INT | Encoder CLOCK input | 26 | VDD | |
| 7 | EA | Normally GND | 27 | P10 | VCO 2 dividing ratio output (binary) |
| 8 | | Unused, normally open | 28 | P11 | |
| 9 | | | 29 | P12 | |
| 10 | | | 30 | P13 | |
| 11 | | VCO 1 dividing ratio output (BCD) | 31 | P14 | |
| 12 | B0 | | 32 | P15 | |
| 13 | B1 | | 33 | P16 | |
| 14 | B2 | | 34 | P17 | |
| 15 | B3 | | 35 | P24 | I/O EXPANDER SELECT H : EX(0) L : EX(1) |
| 16 | B4 | | 36 | P25 | |
| 17 | B5 | | 37 | P26 | DATA SELECTOR control |
| 18 | B6 | 38 | P27 | Encoder CLOCK latch clear output | |
| 19 | B7 | 39 | T1 | Encoder UP/DOWN input H : UP, L : DOWN | |
| 20 | GND | GND | 40 | Vcc | Microcomputer 5V power supply |

Table 12 μPD8048C-292 Terminal function

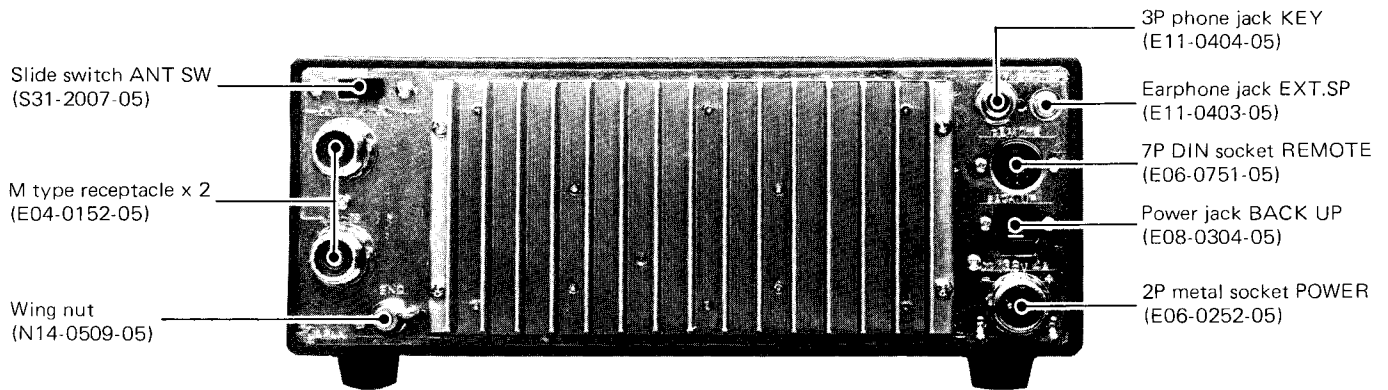
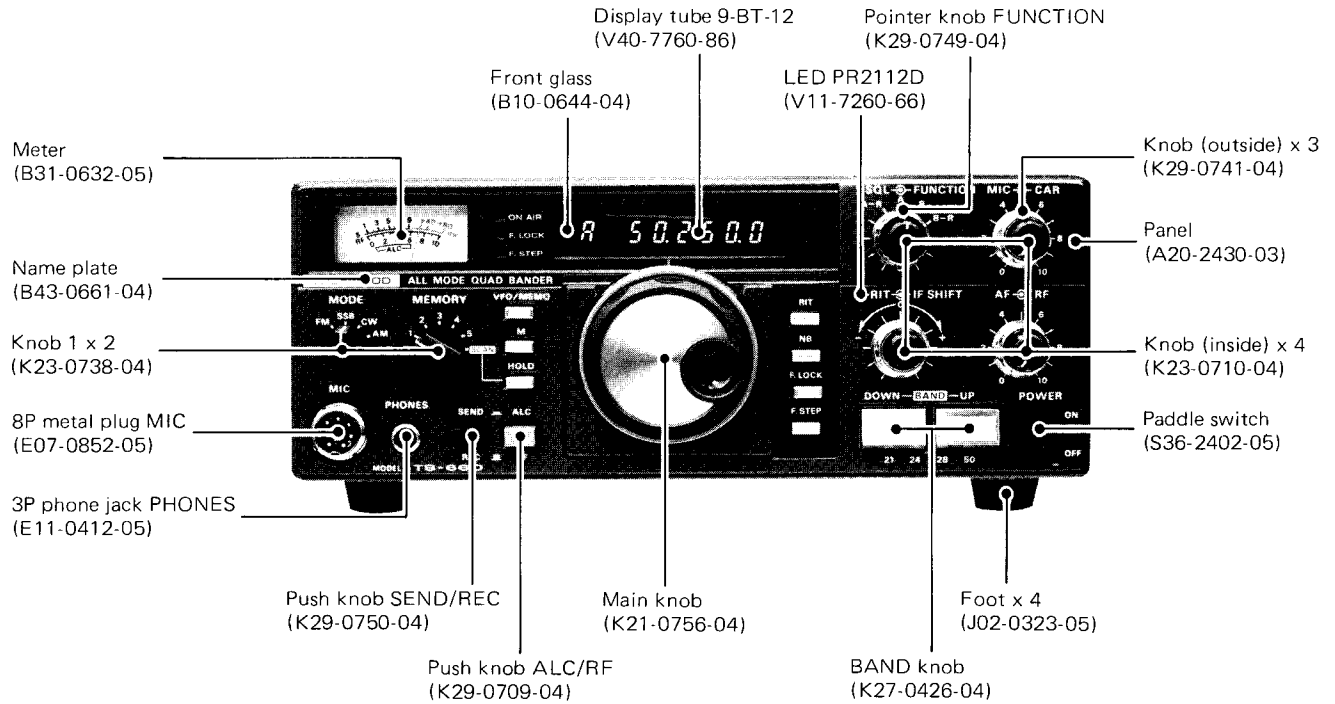
| Terminal No. | Symbol | Explanation |
|--------------|--------|-----------------------------------|
| 2 | P40 | VCO 1 dividing ratio output (BCD) |
| 3 | P41 | |
| 4 | P42 | |
| 5 | P43 | |
| 1 | P50 | VCO 3 dividing ratio output |
| 23 | P51 | |
| 22 | P52 | |
| 21 | P53 | |
| 20 | P60 | 50 MHz BAND data |
| 19 | P61 | 28 MHz BAND data |
| 18 | P62 | 24 MHz BAND data |
| 17 | P63 | 21 MHz BAND data |
| 13 | P70 | DATA SELECTOR input |
| 14 | P71 | |
| 15 | P72 | |
| 16 | P73 | |

| Terminal No. | Symbol | Explanation | |
|--------------|--------|-----------------------------------|--------------------------|
| 2 | P40 | Lit by L | |
| 3 | P41 | | Display SEGMENT output a |
| 4 | P42 | | Display SEGMENT output b |
| 5 | P43 | | Display SEGMENT output c |
| 1 | P50 | | Display SEGMENT output d |
| 23 | P51 | | Display SEGMENT output e |
| 22 | P52 | | Display SEGMENT output f |
| 21 | P53 | Display SEGMENT output g | |
| 20 | P60 | Display DIGIT output 100 Hz digit | L column lit |
| 19 | P61 | Display DIGIT output 1k | |
| 18 | P62 | Display DIGIT output 10k | |
| 17 | P63 | Display DIGIT output 100k | |
| 13 | P70 | Display DIGIT output 1M | |
| 14 | P71 | Display DIGIT output 10M | |
| 15 | P72 | Display DIGIT output CH display | |
| 16 | P73 | Buzzer sound output | |

Table 14 I/O EXPANDER (1) IC1 : μPD8213C

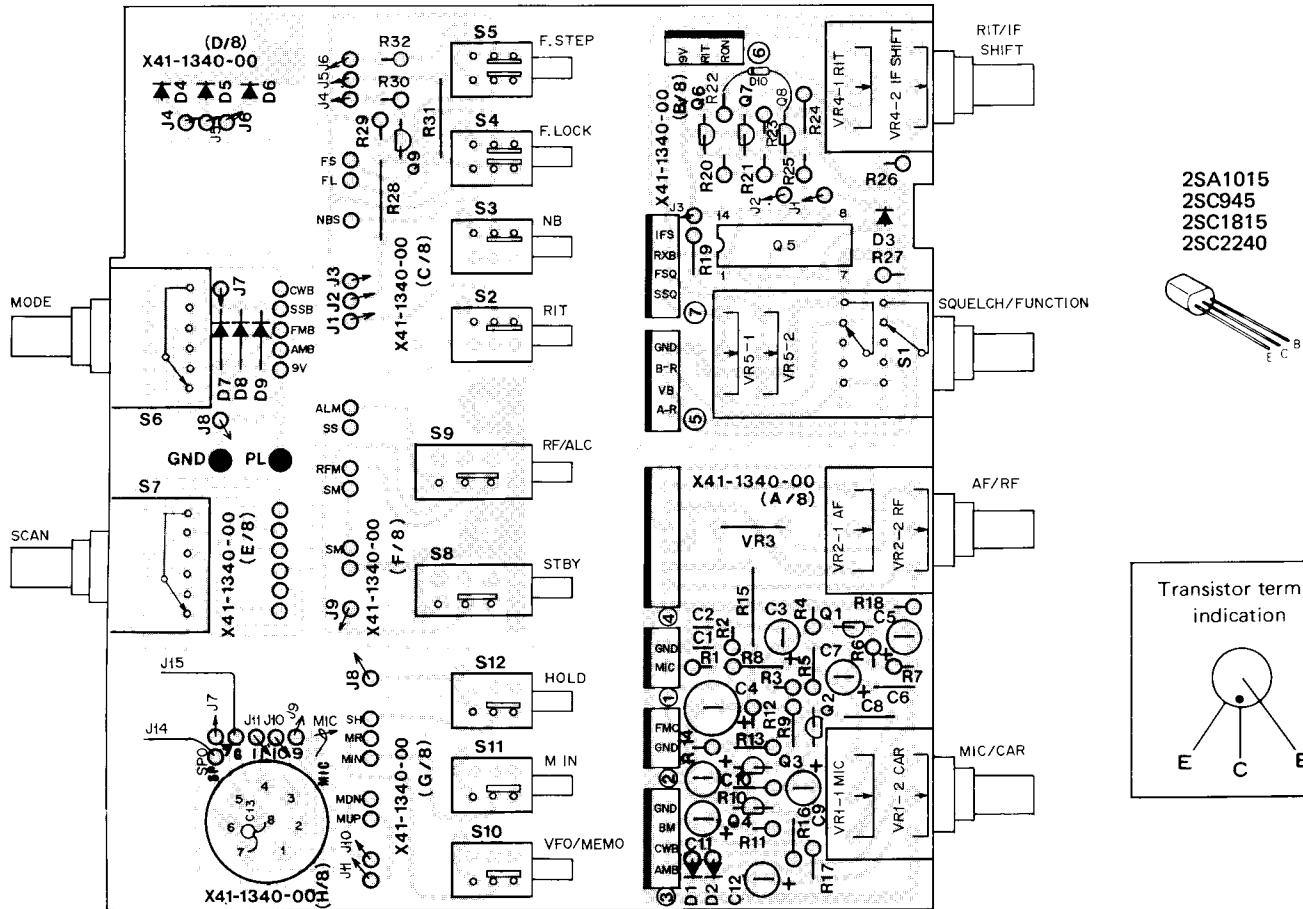
TS-660

OUTSIDE VIEWS



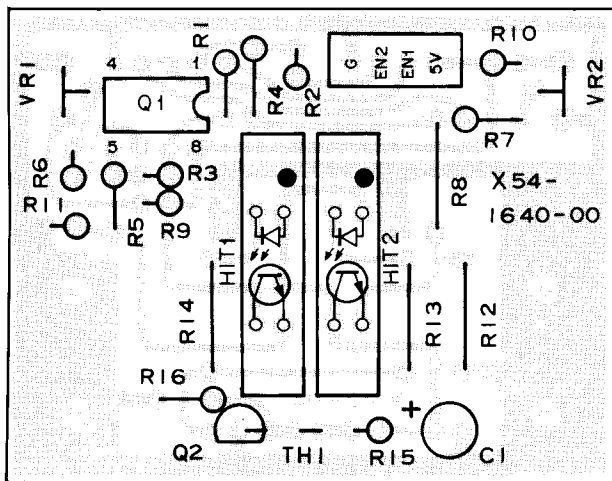
PC BOARD VIEWS TS-660

▼ SWITCH UNIT (X41-1340-00) Components side view



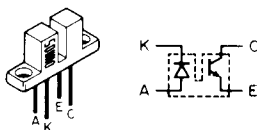
Q1 : 2SC2240(GR) Q2~4 : 2SC1815(Y) Q5 : TC4011BP Q6~9 : 2SC945(R)
 D1, 2, 7~9 : 1S1555 D3 : PR2112D D4 : SR538D D5 : SG238D D6 : SY438D D10 : WZ-071

▼ ENCODER UNIT (X54-1640-00) Components side view



Q1 : LM358P Q2 : 2SA1015(Y) HIT1, 2 : ON1105

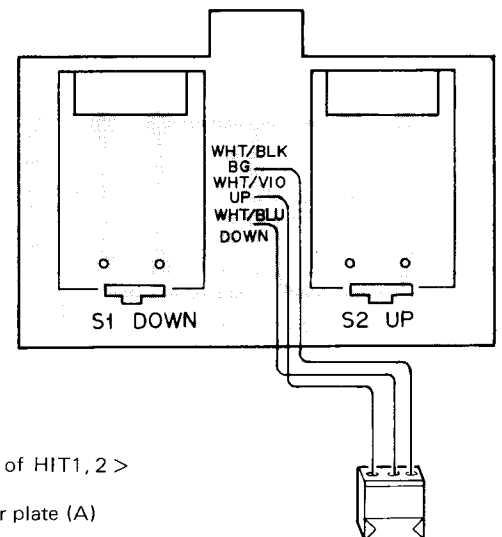
ON1105



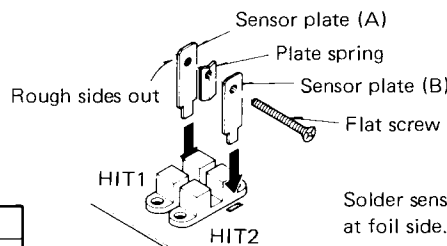
MAX. Rating

| VR | IF | PD | IC | V _{CEO} | V _{ECO} | PC | Top. |
|----|----|----|----|------------------|------------------|----|------|
| | | | | | | | |

▼ BAND SWITCH UNIT (X41-1350-00) Components side view



< Attachment method of HIT1, 2 >

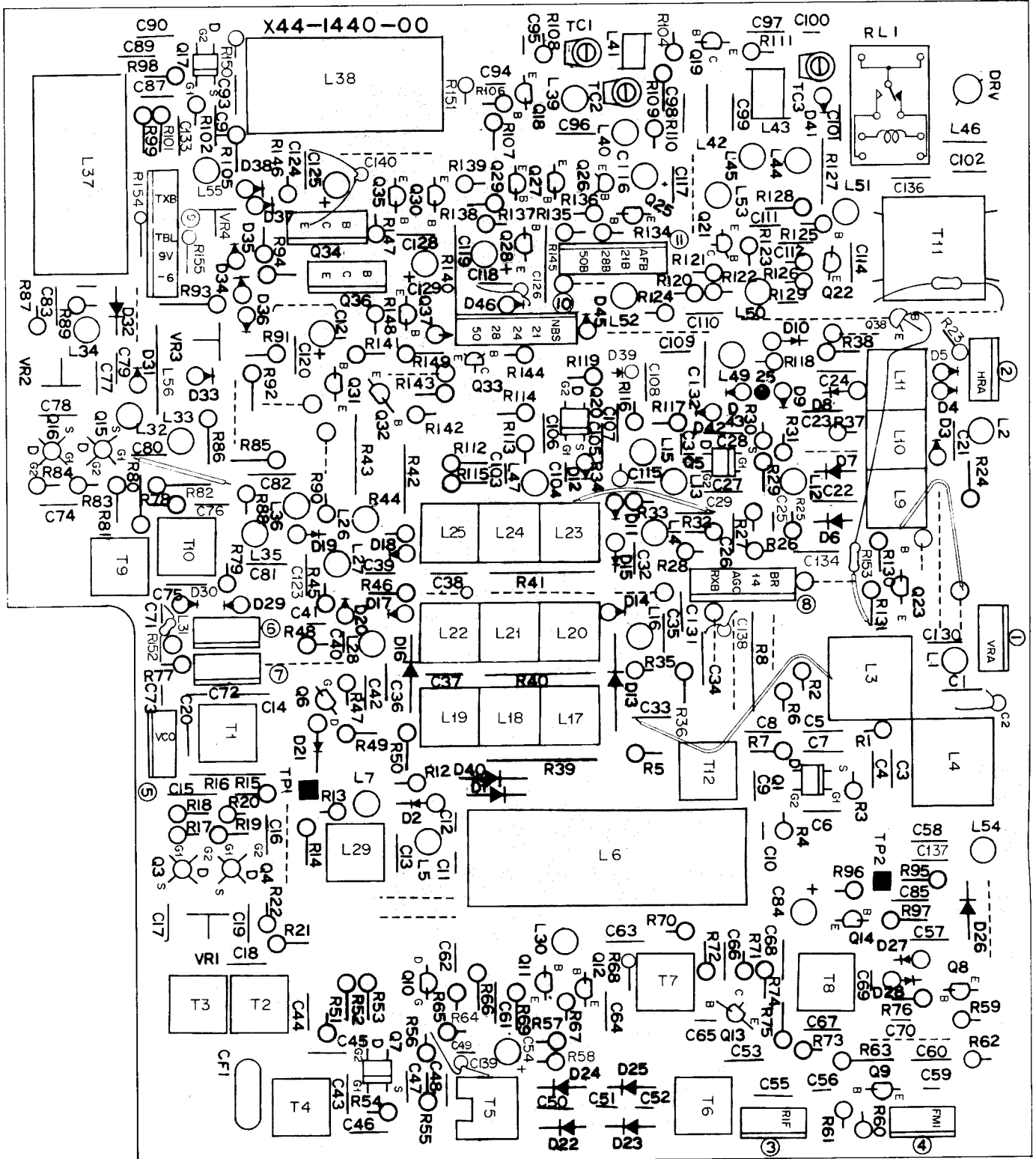


Solder sensor plate (A) and (B)
 at foil side.

TS-660 PC BOARD VIEW

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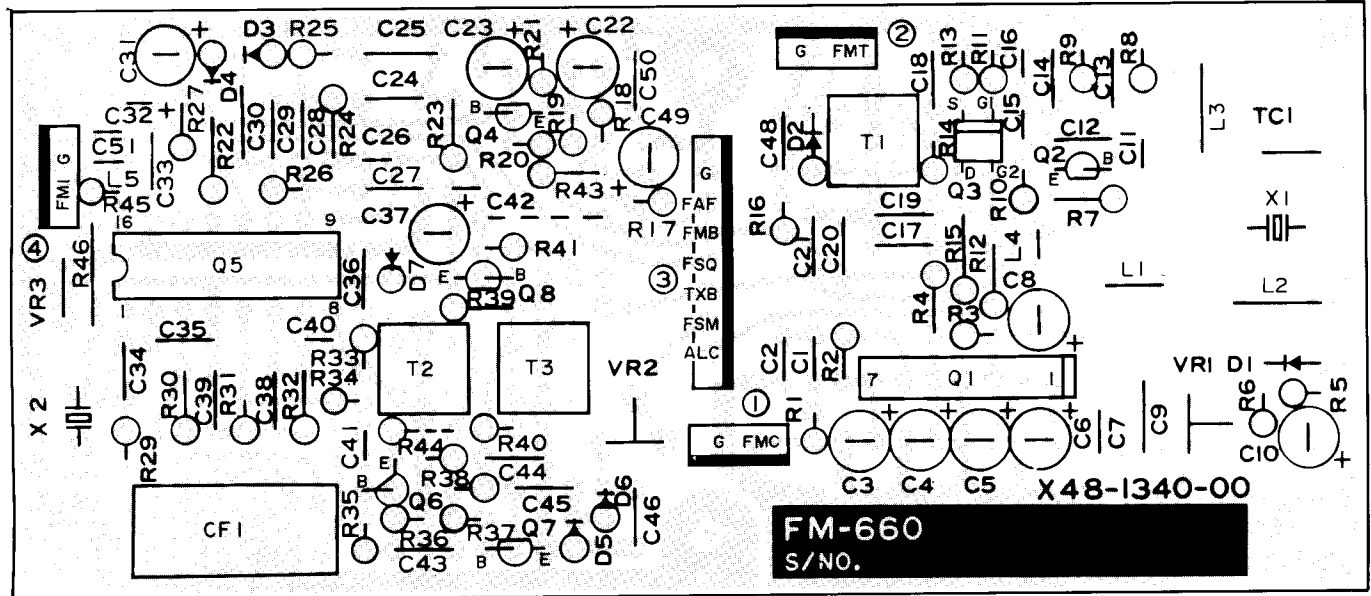
▼ RF UNIT (X44-1440-00) Components side view



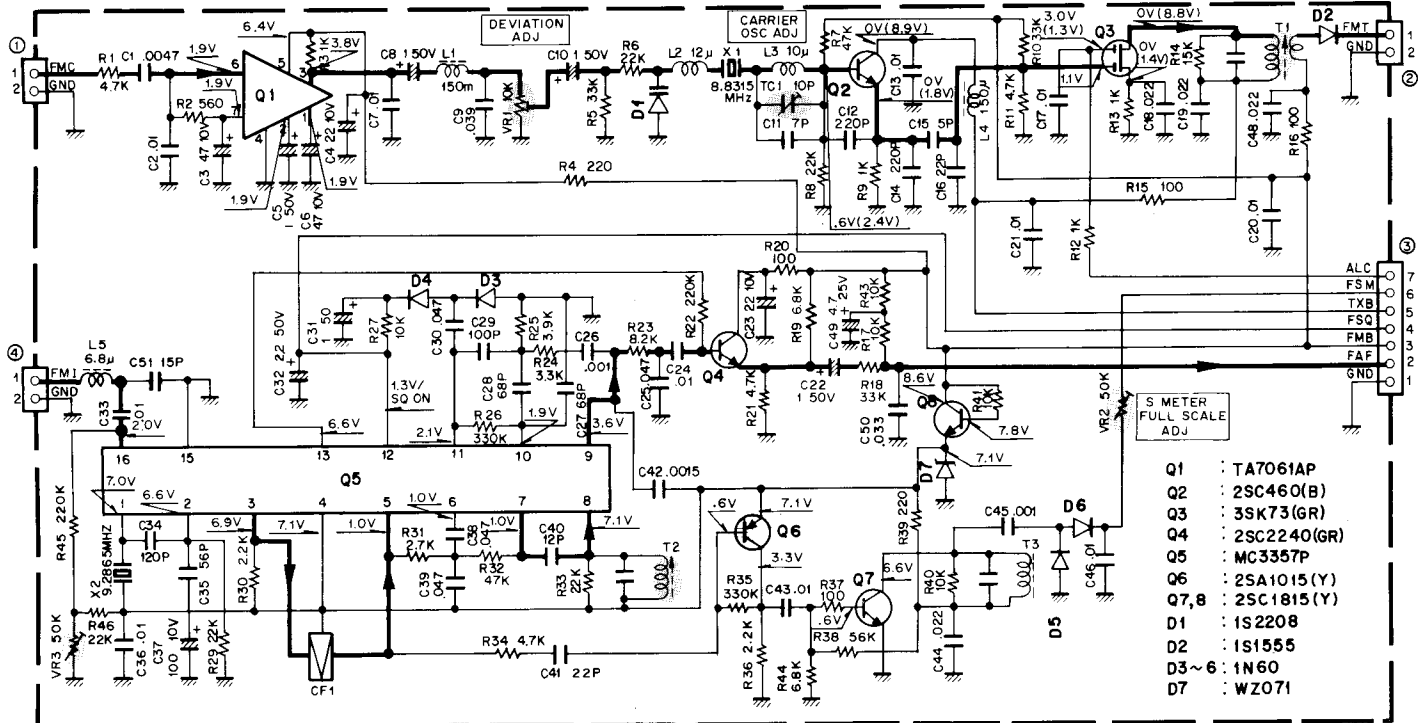
- Q1, 5, 7, 17, 20 : 3SK73(GR) Q3, 4, 15, 16 : 3SK74(L) Q6 : 2SK61(GR) Q8, 9, 14, 21, 26, 27, 29, 30, 32, 33, 35, 37, 38 : 2SC1815(Y)
 Q10 : 2SK19(Y) Q11~13 : 2SC460(B) Q18, 19, 22 : 2SC2086 Q23 : 2SA562(Y) Q25, 28, 31 : 2SC1959(Y) Q34, 36 : 2SD880(Y)
 D1, 5, 9, 10, 29, 30~36, 40~46 : 1S1555 D2~4, 21 : 1S2586 D6~8, 11~20, 22~25 : 1S1587 D26 : MV13 D27, 28 : 1N60

PC BOARD VIEW/CIRCUIT DIAGRAM TS-660

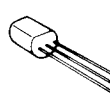
▼ FM UNIT (X48-1340-00) Components side view



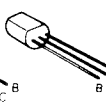
FM UNIT (X48-1340-00)



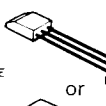
2SC1815
2SC1959
2SC2240



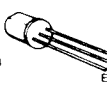
2SC2086



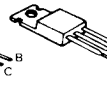
2SC460



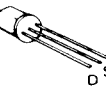
2SA562



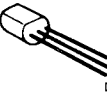
2SD880



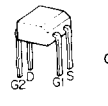
2SK19



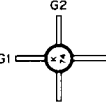
2SK61



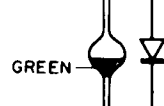
3SK73



3SK74

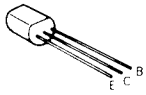


MV-13

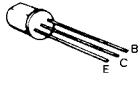


TS-660 PC BOARD VIEW

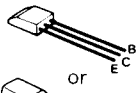
2SA1015
2SC1815
2SC1959
2SC2240



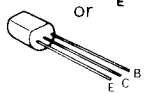
2SA562



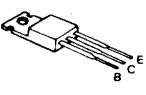
2SC460



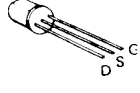
OR



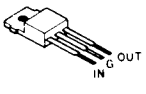
2SD880



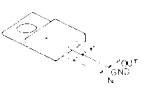
2SK19



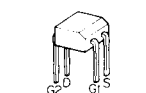
MPC14305H



NJM78M09A

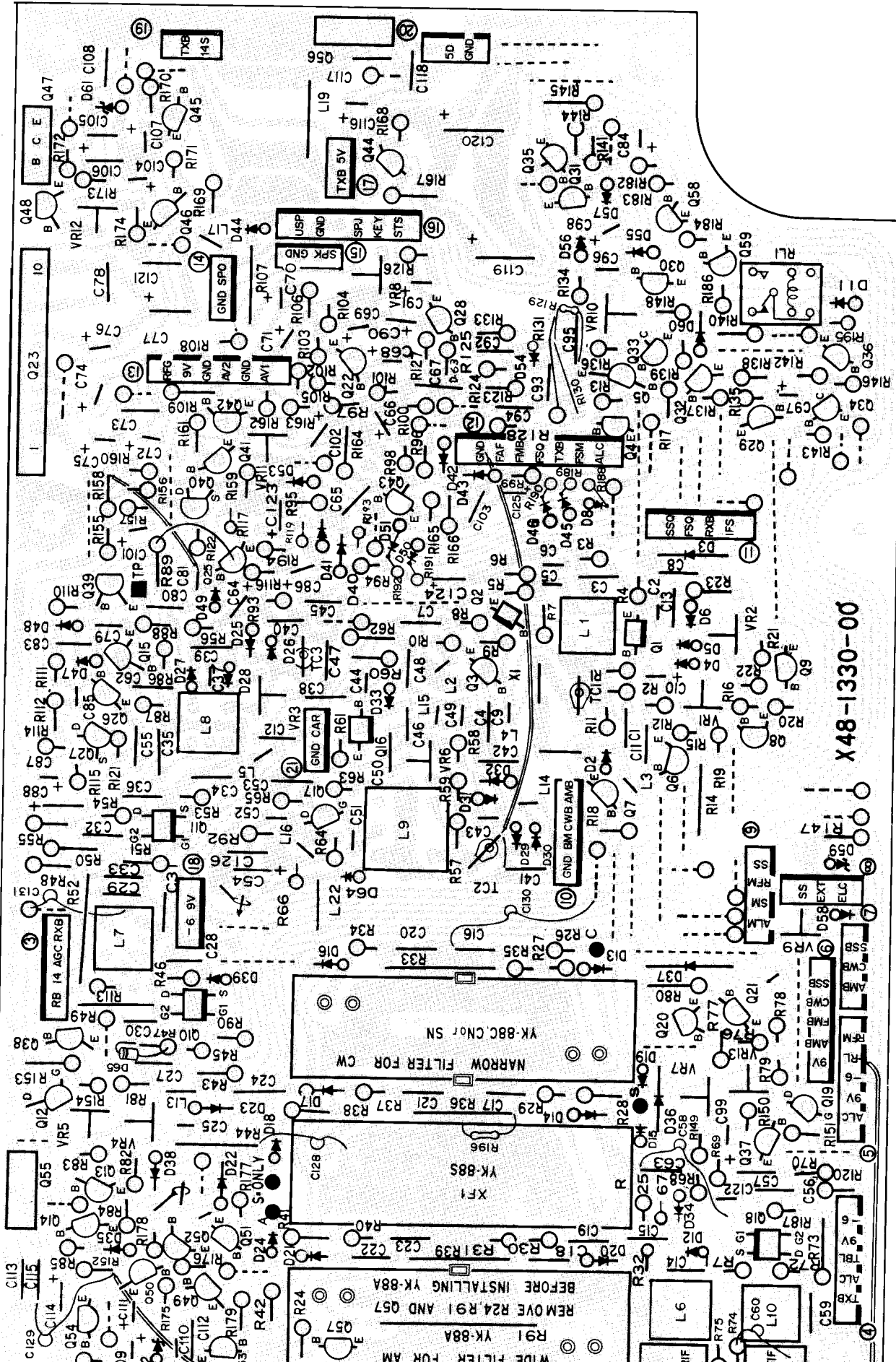


3SK73



HA1366W

IF UNIT (X48-1330-00) Components side view



X48-1330-00

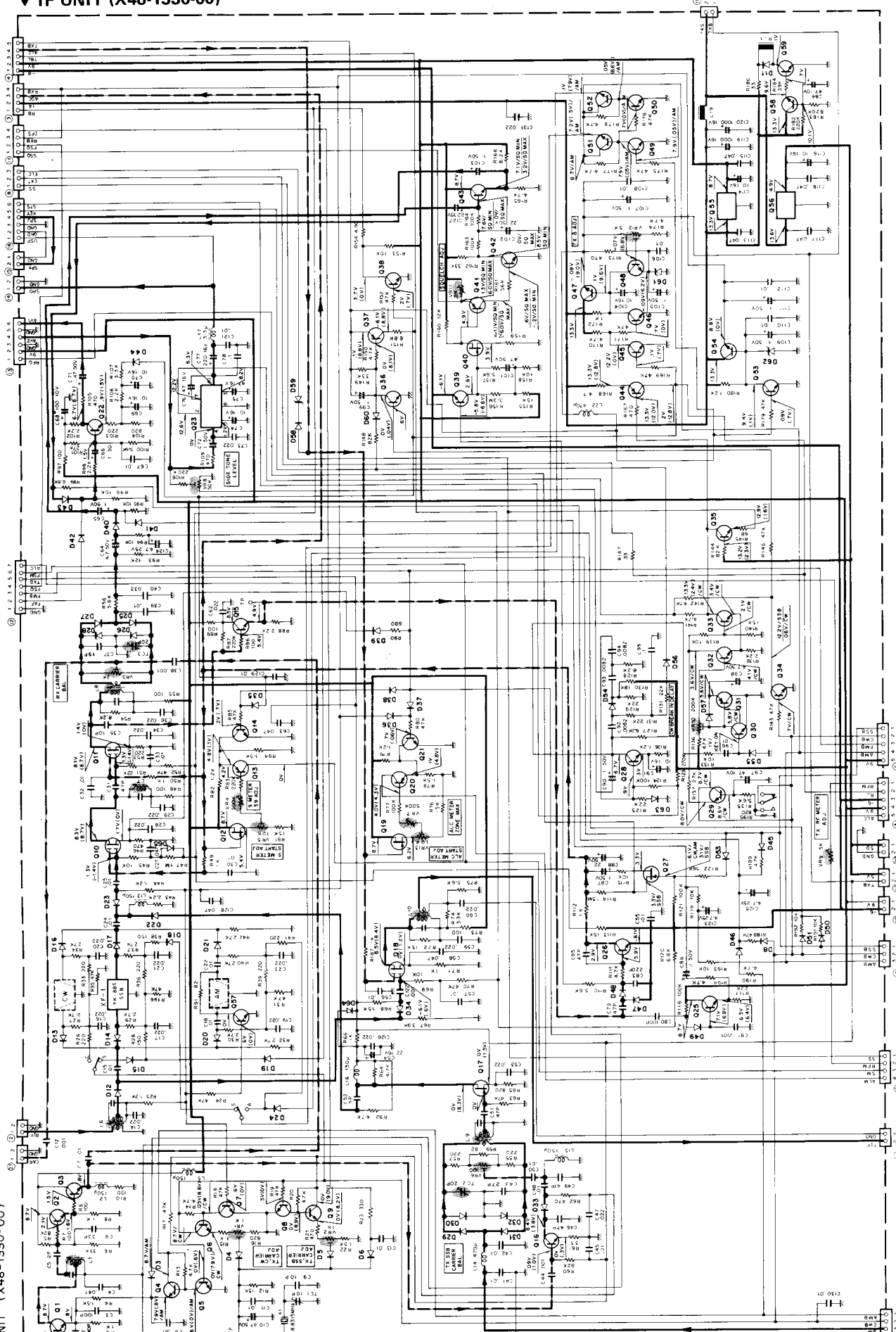
REMOVE R24, R91 AND Q57
BEFORE INSTALLING YK-88A
R91 YK-88A

WIDE FILTER FOR AM
R20 C18 R30 R31 R39 C23 C22
R24

NARROW FILTER FOR CW
YK-88C No. 5N
R28 R29 C17 R36 C21 R37 R38
D1

CIRCUIT DIAGRAM TS-660

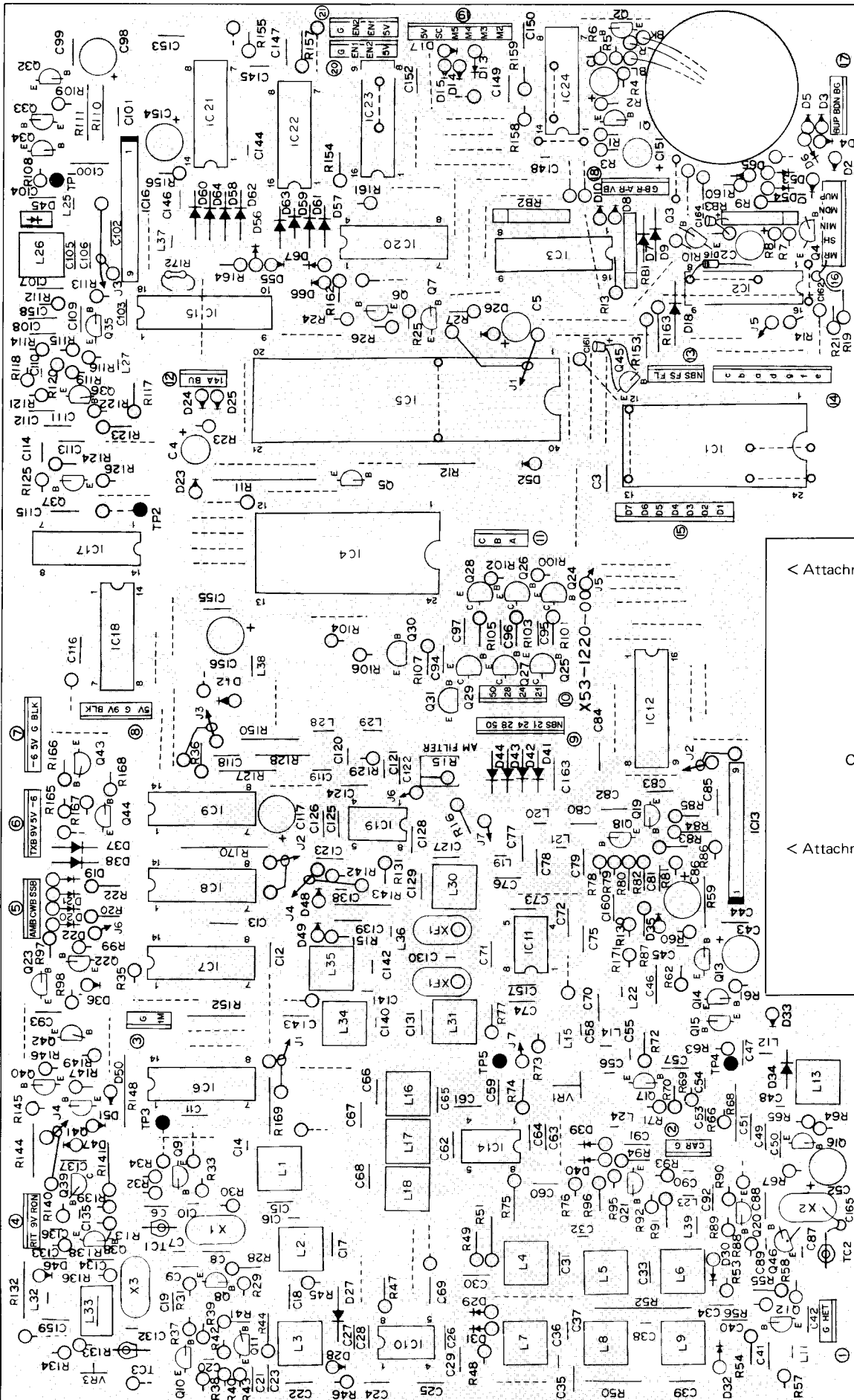
IF UNIT (X48-1330-00)



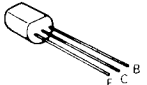
- 010, 11, 18 : 3SK73 (GR)
- 013, 20, 31, 37, 41 : 2SA1015 (Y)
- 022, 43 : 2SC2240 (GR)
- 012, 17, 19 : 2SK19 (GR)
- 020 : 2SC460 (B)
- 021 : 2SC1959 (Y)
- 024, 15, 21, 25, 26, 28-30 : 2SC1815 (Y)
- 025, 38, 39, 42, 45, 46 : 2SC1815 (GR)
- 027 : HA1366 W
- 027, 40 : 2SK30 (O)
- 044 : 2SA652 (Y)
- 047 : 2SD860 (Y)
- 055 : NJM 78M09A
- 056 : JPC19305H
- 059 : 15V83A
- 061 : WZ-061
- 062 : XZ-094
- 063-6, 8, 16, 17, 19, 15, 16, 18, 19 : D2
- 22-24, 33-46, 50, 51, 53-56, 60, 63-65 : D3
- 059 : D4
- 17, 20, 21 : D5
- 059 : D6
- 059 : D7
- 059 : D8
- 059 : D9
- 059 : D10
- 059 : D11
- 059 : D12
- 059 : D13
- 059 : D14
- 059 : D15
- 059 : D16
- 059 : D17
- 059 : D18
- 059 : D19
- 059 : D20
- 059 : D21
- 059 : D22
- 059 : D23
- 059 : D24
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- 059 : D28
- 059 : D29
- 059 : D30
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- 059 : D77
- 059 : D78
- 059 : D79
- 059 : D80
- 059 : D81
- 059 : D82
- 059 : D83
- 059 : D84
- 059 : D85
- 059 : D86
- 059 : D87
- 059 : D88
- 059 : D89
- 059 : D90
- 059 : D91
- 059 : D92
- 059 : D93
- 059 : D94
- 059 : D95
- 059 : D96
- 059 : D97
- 059 : D98
- 059 : D99
- 059 : D100

TS-660 PC BOARD VIEW

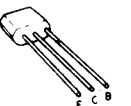
▼ CONTROL UNIT (X53-1220-00) Components side view



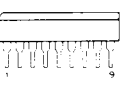
2SA1015
2SC945
2SC1775
2SC1815
2SC1923



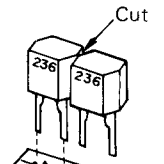
2SC2458



TC5081P



< Attachment direction of D45 >



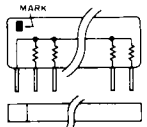
Cut D45 as shown

< Attachment direction of XF1 >

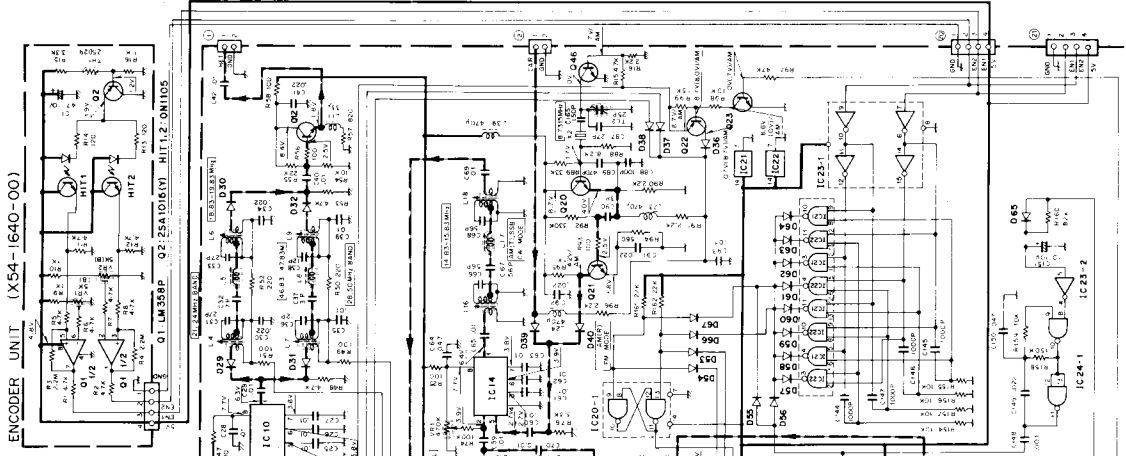


XF1 should be used as a pair.

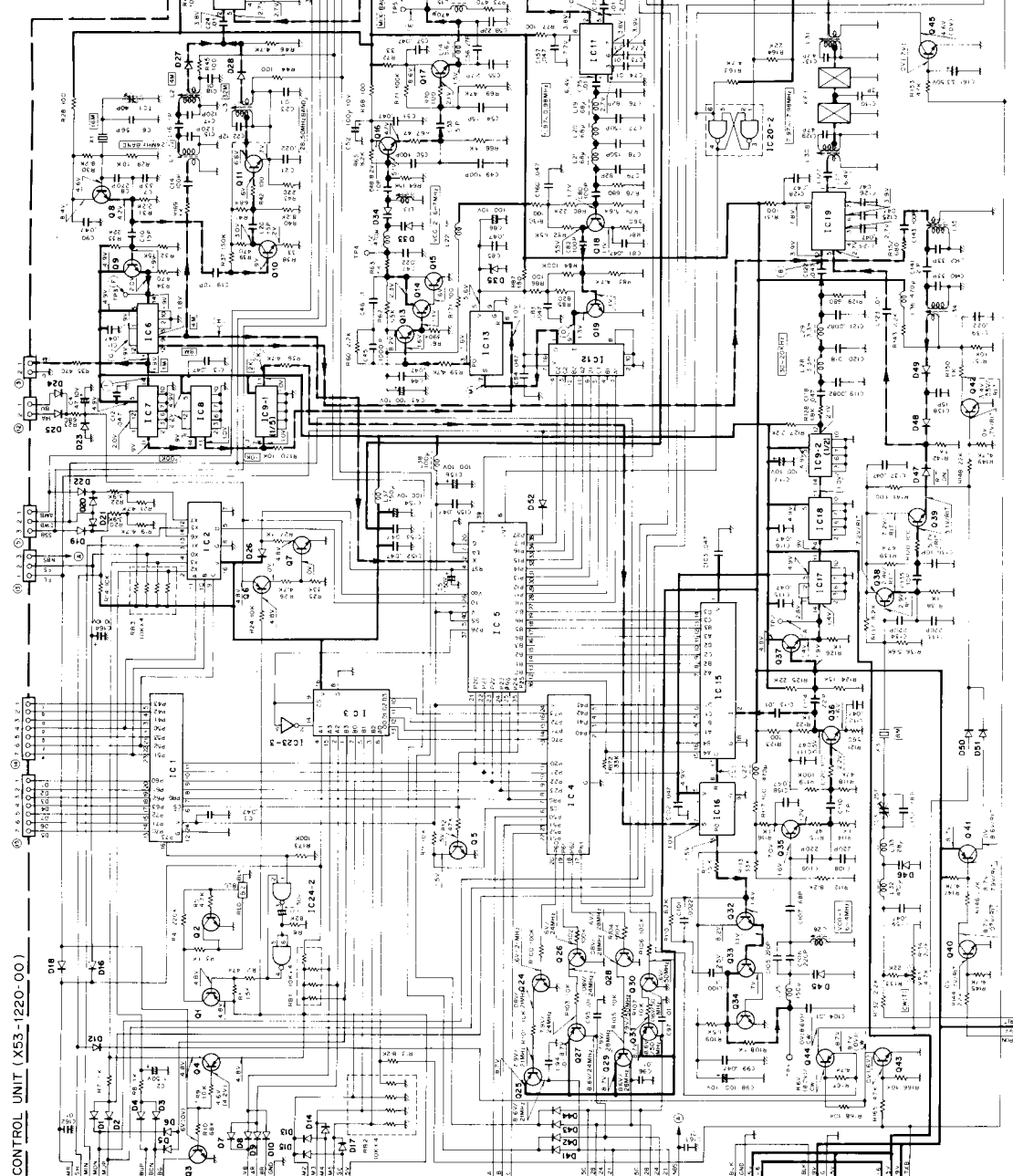
< Attachment direction of resistor block >



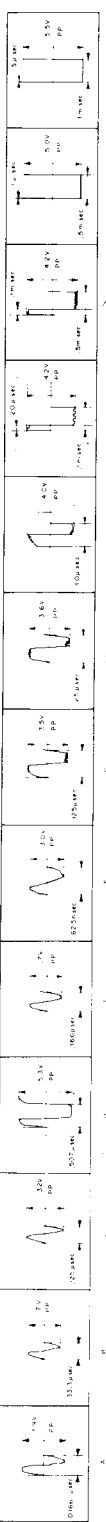
▼ ENCODER UNIT (X54-1640-00)



▼ CONTROL UNIT (X53-1220-00)



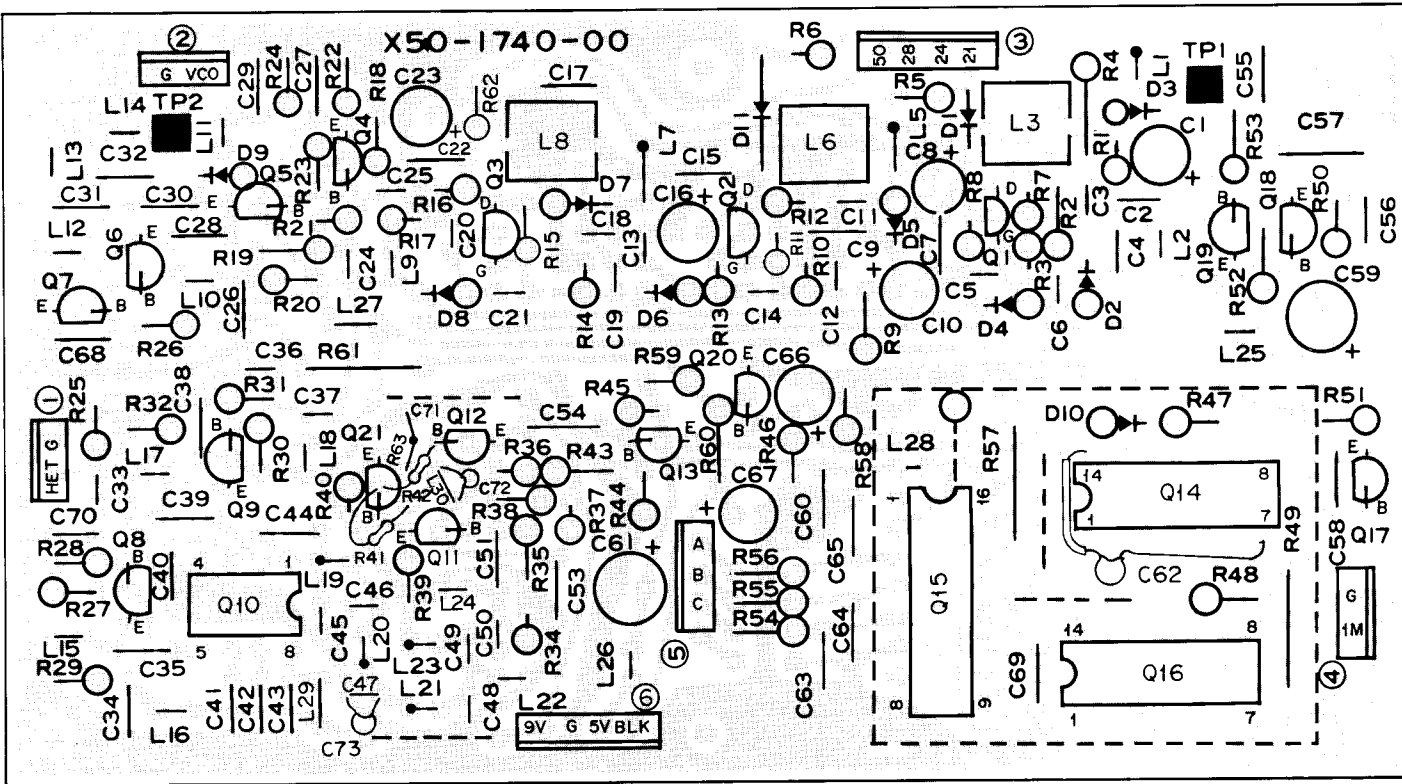
- | | | | | | | | | | | |
|-------|--------------|---------------|-----------|------------|----------|--------------------------------------|--------------------------------------|--------------------|---------|-------------|
| IC1-4 | μP08243C | IC6 | SN74LS93N | IC13,16 | IC5061P | 01,4,6,22,25,27,29,31,41,44 | 25A1015(Y) | D23 | WZ-050 | D1=10,12~22 |
| IC2 | SN74LS93N | IC7-9,17,18 | SN74LS93N | IC15 | TC9122P | 02,8~11,16~21,35~39 | 25C1815(Y) | D27~30,39,40,47~49 | IS1587 | 24~26,36~38 |
| IC3 | SN74LS93N | IC10,11,14,19 | SN74LS93N | IC20~22,24 | TC4018P | 03,5,7,23,24,26,28,30,40,42,43,45,46 | 25C0615(Y) or 25C0495(0), 25C0498(Y) | D33,34,46 | ISV54GC | 41~44,50~57 |
| IC5 | μP08046C-292 | IC12 | MC145595B | IC25 | TC4098BP | 012 | 25C1775(E) 25C0925(0) | D35 | XZ-085 | IS1555 |



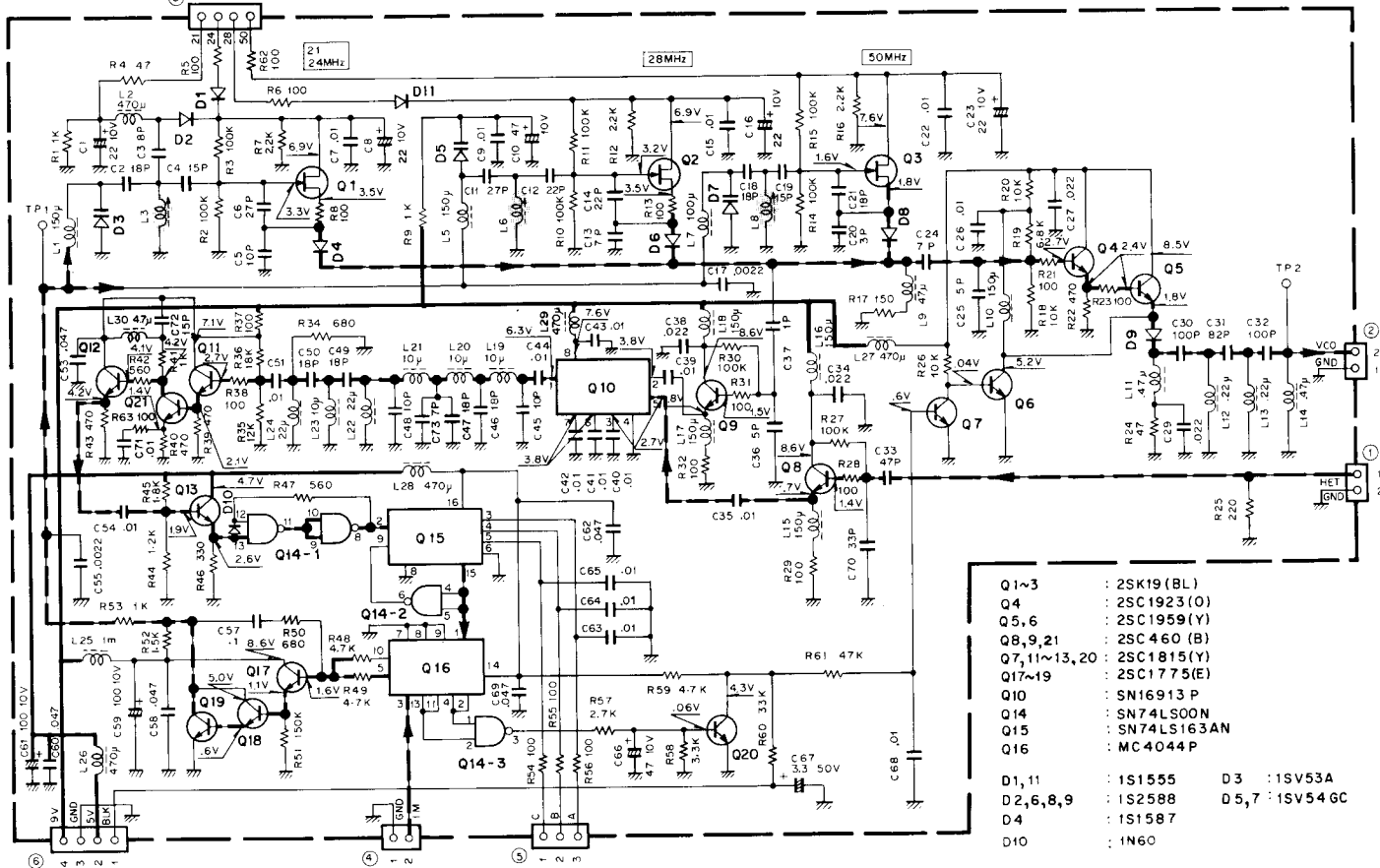
Measurement conditions f = 50,000MHz

TS-660 PC BOARD VIEW/CIRCUIT DIAGRAM

▼ PLL UNIT (X50-1740-00) Components side view



PLL UNIT (X50-1740-00)



| | | | |
|-------------|---------------|----------|----------|
| Q1~3 | : 2SK19 (BL) | D3 | : 15V53A |
| Q4 | : 2SC1923(O) | D2,6,8,9 | : 1S2588 |
| Q5,6 | : 2SC1959(Y) | D4 | : 1S1587 |
| Q8,9,21 | : 2SC460 (B) | D10 | : 1N60 |
| Q7,11~13,20 | : 2SC1815(Y) | | |
| Q17~19 | : 2SC1775(E) | | |
| Q10 | : SN16913 P | | |
| Q14 | : SN74LS00N | | |
| Q15 | : SN74LS163AN | | |
| Q16 | : MC4044P | | |

2SC1815 2SC1923
2SC1775 2SC1959

2SC460

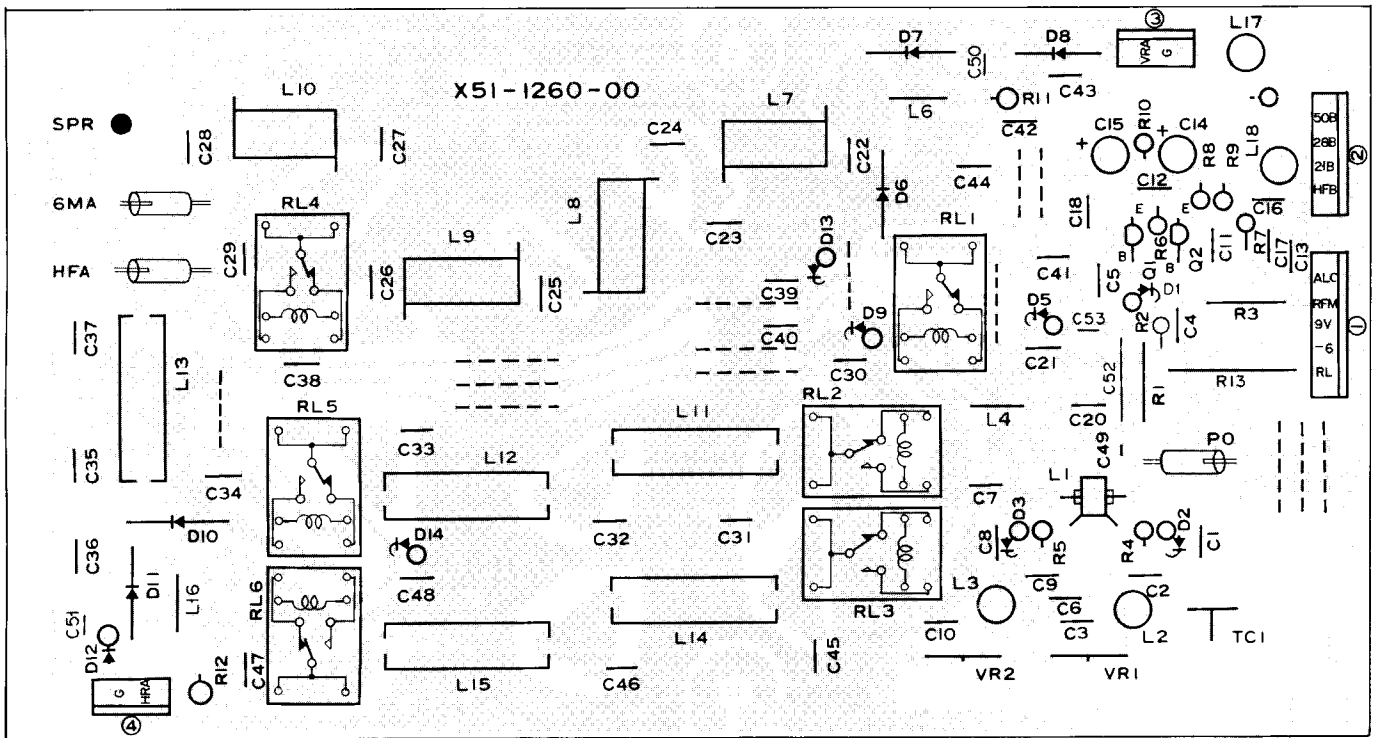
2SC496

2SC1971
2SC1972

2SK19

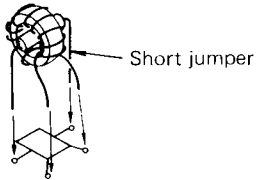
PC BOARD VIEWS TS-660

▼ FILTER UNIT (X51-1260-00) Components side view



< Attachment direction of L1 >

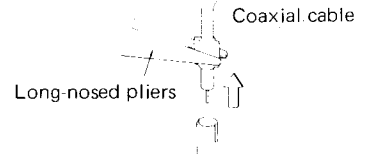
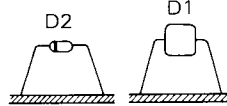
Q1, 2 : 2SC1815(Y) D1~3 : 1N60 D5, 9, 13, 14 : 1S1555
D6, 7, 10, 11 : MI402 D12 : V06B D8 : MI301



Short jumper

< Disconnecting the coaxial cable >

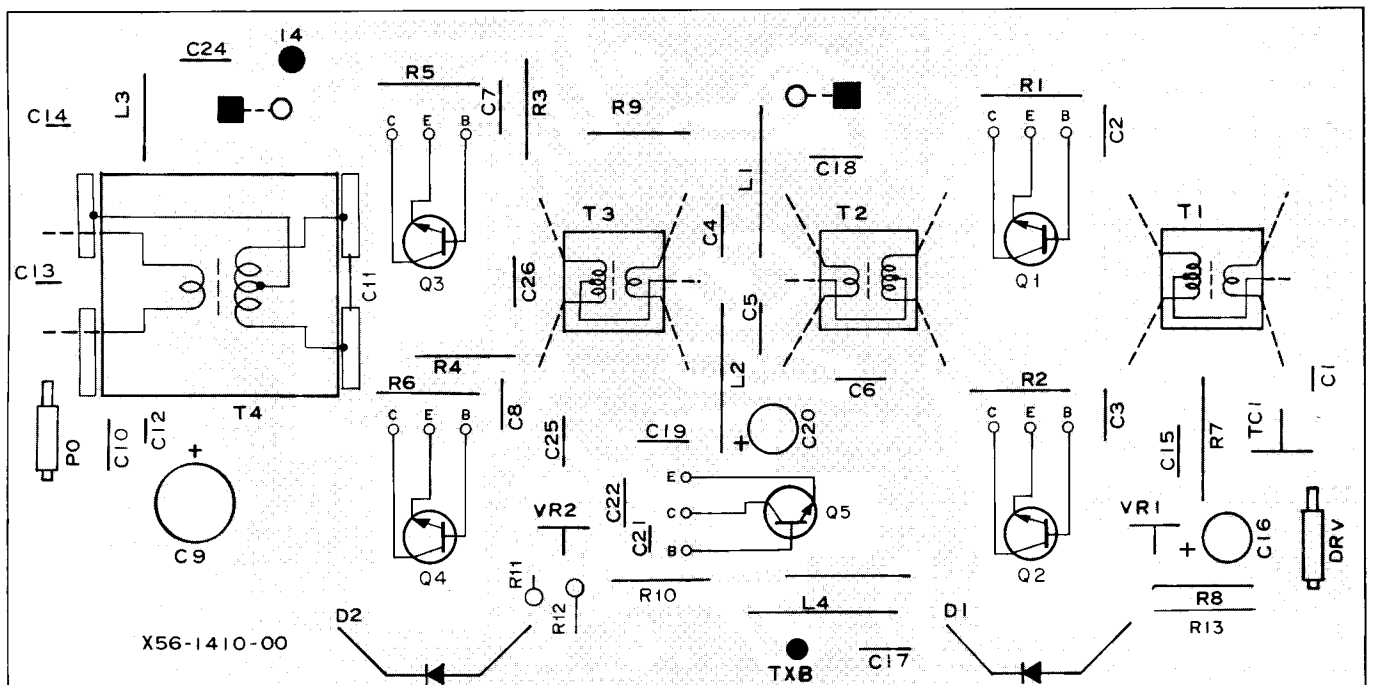
< Attachment direction of D1, 2 >



Long-nosed pliers

Hold the crimped metal sleeve with Pliers and pull up as shown.
Caution : DO NOT pull on the cable.

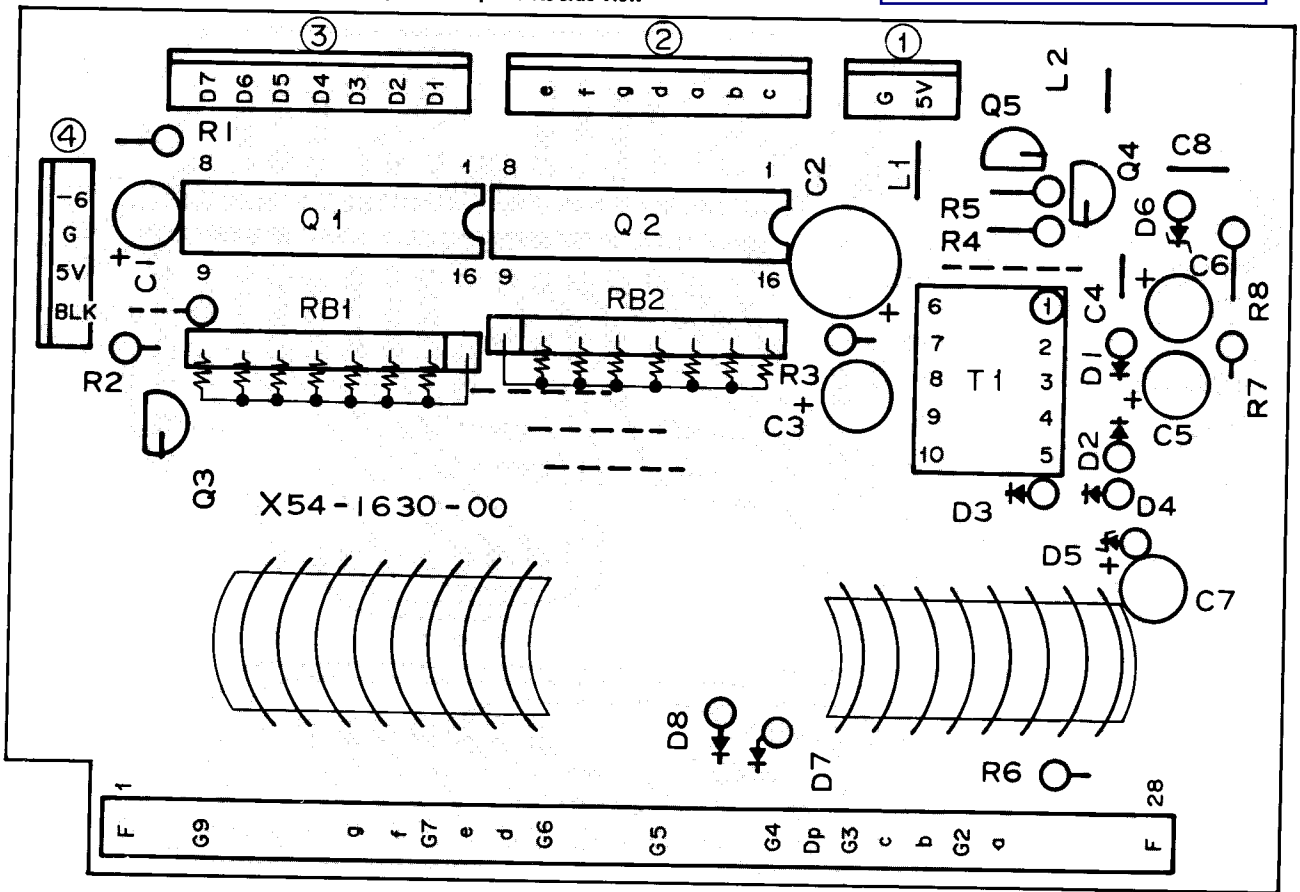
▼ FINAL UNIT (X56-1410-00) Components side view



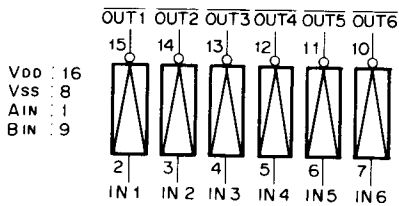
TS-660 PC BOARD VIEW/CIRCUIT DIAGRAM

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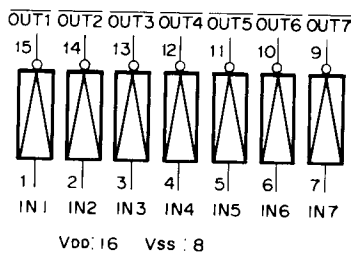
▼ DISPLAY UNIT (X54-1630-00) Components side view



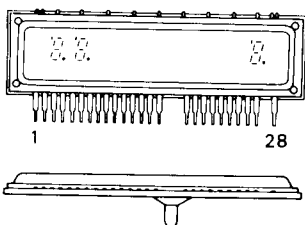
< TC5065BP Blockdiagram >



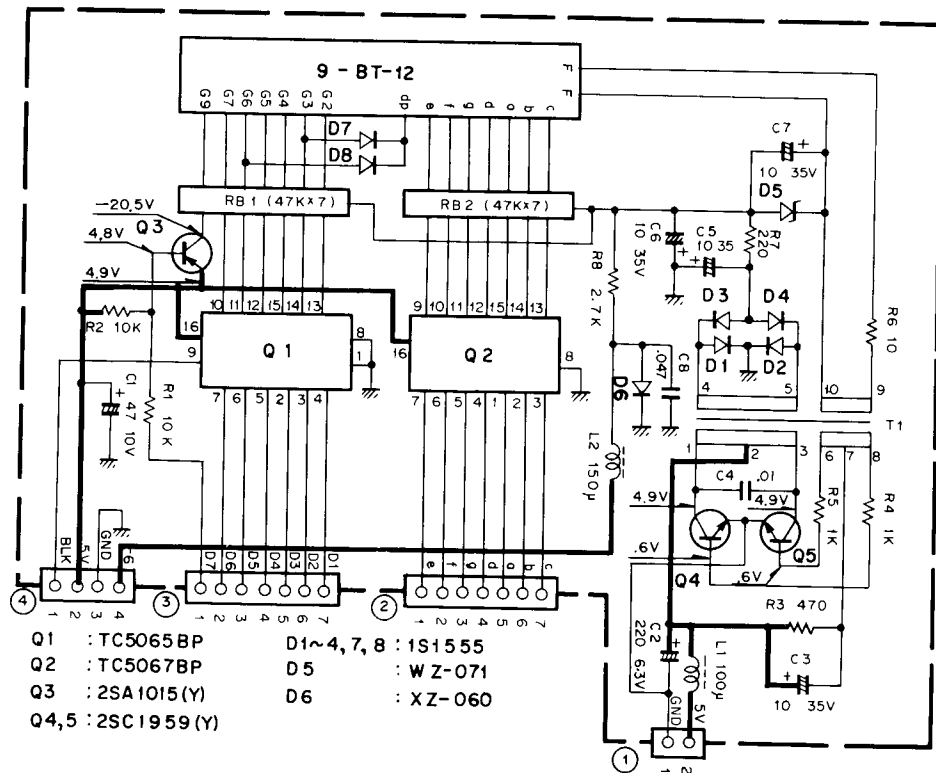
< TC5067BP Blockdiagram >



< Display tube 9-BT-12 >



DISPLAY (X54-1630-00)



- Q1 : TC5065BP D1~4, 7, 8 : 1S1555
- Q2 : TC5067BP D5 : WZ-071
- Q3 : 2SA1015(Y) D6 : XZ-060
- Q4, 5 : 2SC1959(Y)

| PIN NO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----------------|----|----|----------------|----|----|----------------|----|----|----------------|----|----|
| CONNECTION | F | Nc | G _a | Nc | Nc | G ₈ | g | f | G ₇ | e | d | G ₆ | Nc | Nc |
| | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |

2SA1015
2SC1959

PARTS LIST

Note 1:

K. U.S.A. T. Britain W. Europe X. Australia

Note 2:

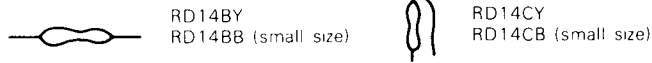
Only special type of resistors (example: cement, metal film, etc.) and capacitors (example: electrolytic, tantalum, mylar, temp. coeff. capacitors) are detailed in the PARTS LIST. For the value of all common type components, refer to the schematic diagram of the P.C. board illustration. Resistors not otherwise detailed are carbon type (1/4W or 1/8W). Order carbon resistors and capacitors according to the following example:

A carbon resistor's part number is RD14BY 2E222J

A ceramic capacitor's number is CK45F1H103Z, CC45TH1H220J

RESISTOR

1. Type of the carbon resistor



2. Wattage

1W → 3A 3W → 3F 5W → 3H
2W → 3D 4W → 3G

3' = CC45 ○ ○ ...

Ceramic capacitor (type I) temperature coeff. capacitor 1' 3'

| 1st word (Color) | C (Black) | L (Red) | P (Orange) | R (Yellow) | S (Green) | T (Blue) | U (Violet) |
|---------------------|--------------|------------|---------------|---------------|--------------|-------------|---------------|
| ppm/°C | 0 | -80 | -150 | -220 | -330 | -470 | -750 |

3 = CK45 ○

Ceramic capacitor (type II) 3

| Cord | B | D | E | F |
|-----------------------------|------------|------------|------------|------------|
| Operating temperature °C | -30 +85 | -30 +85 | -30 +85 | -10 +70 |

6 = Tolerance

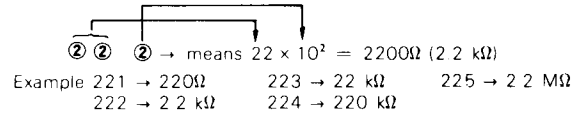
| Cord | C | D | G | J | K | M | X | Z | P | No cord |
|------|-------|------|----|----|-----|-----|------------|------------|------------|---|
| (%) | ±0.25 | ±0.5 | ±2 | ±5 | ±10 | ±20 | +40 -20 | +80 -20 | +100 -0 | More than 10 μF -10 ~ +50 Less than 4.7 μF -10 ~ +75 |

Less than 10 pF

| Cord | B | C | D | F | G |
|------|------|-------|------|----|----|
| (pF) | ±0.1 | ±0.25 | ±0.5 | ±1 | ±2 |

| Abbreviation | | Abbreviation | |
|--------------|--------------|--------------|----------|
| Cap | Capacitor | ML | Mylar |
| C | Ceramic | S | Styren |
| E | Electrolytic | T | Tantalum |
| MC | Mica | | |

3. Resistance value



4. Tolerance

J = ±5% (Gold) K = ±10% (Silver)

CAPACITORS

Type I

CC 45 TH 1H 220 J CK 45 F 1H 103 Z

1' 2 3' 4 5 6 1 2 3 4 5 6

1 = Type ceramic, electrolytic, etc 4 = Voltage rating
2 = Shape round, square, etc 5 = Value
3 = Temp range 6 = Tolerance
3' = Temp coefficient

Type II

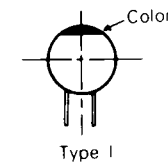
Ex. CC45TH = -470 ±60 ppm/°C

| 2nd Word | G | H | J | K | L |
|----------|-----|-----|------|------|------|
| ppm/°C | ±30 | ±60 | ±120 | ±250 | ±500 |

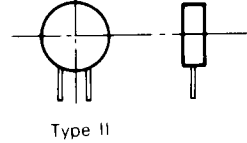
5 = Capacitor value

Example: 010 → 1 pF
100 → 10 pF
101 → 100 pF
102 → 1000 pF = 0.001 μF
103 → 0.01 μF

CC45



CK45



TS-660 SEMICONDUCTOR

N : New parts

| Item | Name | Re- marks | Parts No. |
|----------|--------|--------------|-------------|
| Diode | 1N60 | | V11-0051-05 |
| | 1S1007 | | V11-4160-66 |
| | 1S1555 | | V11-0076-05 |
| | 1S1587 | | V11-0370-05 |
| | 1S2208 | | V11-0317-05 |
| | 1S2588 | | V11-0414-05 |
| | KV1236 | N | V11-3178-76 |
| | MI301 | | V11-0255-05 |
| | MI402 | | V11-5260-16 |
| | U05B | | V11-0270-05 |
| V06B | | V11-0219-05 | |
| Varistor | MV-13 | | V21-0004-05 |
| | SV03 | | V21-0007-05 |
| | SV03 | | V11-1332-22 |

| Item | Name | Re- marks | Parts No. |
|-------------|---------|--------------|-------------|
| Vari-Cap | 1SV53A | | V11-4161-36 |
| | 1SV54GC | | V11-4173-46 |
| Zener diode | WZ-050 | | V11-4102-10 |
| | WZ-061 | | V11-0243-05 |
| | WZ-071 | | V11-4160-86 |
| | WZ-090 | | V11-0240-05 |
| | XZ-055 | | V11-4105-50 |
| LED | XZ-060 | | V11-4101-20 |
| | XZ-094 | | V11-4173-26 |
| | PR2112D | | V11-7260-66 |
| | SG238D | N | V11-1278-16 |
| | SG500D | N | V11-1278-06 |

TS-660

PARTS LIST

| Item | Name | Re- marks | Parts No. |
|--------------------------|-------------|--------------|-------------|
| Thermistor | SY438D | N | V11-1278-26 |
| | 25D29 | | V11-3360-16 |
| Photo interruptor | ON1105 | | V11-1173-76 |
| Display tube | 9-BT-12 | | V40-7760-86 |
| TR | 2SA562(Y) | | V01-0032-05 |
| | 2SA1015(Y) | | V01-1015-06 |
| | 2SC460(B) | | V03-0079-05 |
| | 2SC496(Y) | | V03-0336-05 |
| | 2SC945(Q) | | V03-0945-06 |
| | 2SC945(R) | | V03-0316-05 |
| | 2SC1775(E) | | V03-1775-06 |
| | 2SC1815(GR) | | V03-1815-16 |
| | 2SC1815(Y) | | V03-1815-06 |
| | 2SC1923(O) | | V03-1923-06 |
| | 2SC1959(Y) | | V03-1959-06 |
| | 2SC1971 | N | V03-1971-16 |
| | 2SC1972 | N | V03-1972-16 |
| | 2SC2086 | | V03-2086-06 |
| | 2SC2240(GR) | | V03-2240-06 |
| | 2SC2458(Y) | | V03-2458-06 |
| | 2SD880(Y) | | V04-0880-16 |
| FET | 2SK19(BL) | | V09-0013-05 |
| | 2SK19(GR) | | V09-0012-05 |
| | 2SK19(Y) | | V09-0011-05 |
| | 2SK30A(O) | | V09-0056-05 |
| | 2SK61(GR) | | V09-1014-06 |
| | 3SK73(GR) | | V09-1002-46 |
| | 3SK74(L) | | V09-1002-56 |
| IC | 74LS00N | | V30-1111-06 |
| | 74LS163N | | V30-1037-06 |
| | HA1366W | | V30-1045-06 |
| | HD74LS00P | | V30-1046-06 |
| | HD74LS163P | | V30-1047-06 |
| | LM358P | | V30-1024-56 |
| | MC3357P | | V30-1003-36 |
| | MC4044P | | V30-0173-05 |
| | MC14569B | | V30-1100-06 |
| | NJM78M09A | N | V30-1107-16 |
| | SN74LS00N | | V30-0301-30 |
| | SN74LS90N | | V30-1005-26 |
| | SN74LS93N | | V30-1113-06 |
| | SN74LS151N | | V30-1240-16 |
| | SN74LS163AN | | V30-1154-06 |
| | SN16913P | | V30-1048-06 |
| | TA7061AP | | V30-0039-05 |
| | TC40118P | | V30-0301-70 |
| | TC40198P | | V30-1049-06 |
| TC4049BP | | V30-1009-26 | |
| TC5065BP | N | V30-1056-16 | |
| TC5067BP | N | V30-1057-16 | |
| TC5081P | | V30-1132-06 | |

| Item | Name | Re- marks | Parts No. |
|------|--------------|--------------|-------------|
| | μPC14305H | | V30-1029-36 |
| | μPD8048C-292 | N | V30-1176-36 |
| | μPD8243C | | V30-1177-16 |

| Ref. No. | Parts No. | Re- marks | Description |
|----------|-----------|--------------|-------------|
|----------|-----------|--------------|-------------|

TS-660 GENERAL

| | | | | |
|----|--------------|---|---------------------------|---------------|
| | A01-0901-02 | N | Case (A) upper | |
| | A01-0902-12 | N | Case (B) lower | |
| | A20-2430-03 | N | Panel | |
| | B05-0708-04 | | SP grill cloth | |
| | B05-0713-04 | | Grill cloth Buzzer | |
| | B10-0644-04 | N | Front glass | |
| | B20-0819-04 | N | Dial scale | |
| | B30-0820-05 | N | Pilot lamp 9V, 60mA | |
| | B31-0632-05 | N | Meter | |
| | B39-0407-04 | | Spacer x 2 Assistant foot | |
| | B42-1707-04 | N | Switch plate | |
| | B43-0661-04 | N | Name plate | |
| | B46-0058-10 | | Warranty card | K |
| | B50-3910-00 | N | Instruction manual | |
| C1 | C90-0806-05 | E | 2200μF 16V | |
| C7 | CC45SL2H100D | C | 10pF | |
| | E04-0152-05 | | M type receptacle x 2 | ANT |
| | E06-0252-05 | | 2P metal socket | POWER |
| | E06-0751-05 | | 7P DIN socket | REMOTE |
| | E07-0252-05 | | 2P metal plug | DC cord ass'y |
| | E07-0751-05 | | 7P DIN plug (accessory) | REMOTE |
| | E07-0852-05 | | 8P metal plug | MIC |
| | E08-0304-05 | | Power jack | BACK UP |
| | E11-0403-05 | | Earphone jack | EXT. SP |
| | E11-0404-05 | | 3P phone jack | KEY |
| | E11-0412-05 | N | 3P phone jack | PHONES |
| | E12-0001-05 | | Phone plug (accessory) | EXT. SP |
| | E22-0207-05 | | Lug plate x 2 | |
| | E30-1675-05 | | DC cord ass'y | |
| | E31-0431-05 | | Speaker cord | |
| | F05-4022-05 | | Fuse 4A | |
| | F05-4022-05 | | Fuse 4A (accessory) | |
| | F29-0420-05 | | Insulating bushing | |
| | G01-0804-04 | | Coil spring Dial scale | |
| | G02-0505-05 | | Knob spring x 4 | |
| | G02-0518-04 | | Gnd spring (C) | |
| | G02-0531-04 | | Gnd spring | |
| | G53-0511-04 | | Packing | |
| | H01-2757-04 | N | Carton case (inside) | |
| | H03-2008-04 | N | Carton case (outside) | |
| | H10-2549-02 | N | Packing fixture (F) | |
| | H10-2550-02 | N | Packing fixture (R) | |
| | H12-0482-04 | N | Cushion | |
| | H20-1405-03 | | Protective cover | |
| | H25-0079-04 | | Protective bag MIC | |
| | H25-0112-04 | | Protective bag DC cord | |
| | H25-0116-04 | | Protective bag | |
| | J02-0323-05 | | Foot x 4 | |

PARTS LIST

| Ref. No. | Parts No. | Re- marks | Description | Ref. No. | Parts No. | Re- marks | Description |
|-------------|-----------|--------------|--|---------------------------------------|--------------|--------------|---------------------------------------|
| J02-0407-04 | | | Assistant foot | SWITCH UNIT (X41-1340-00) | | | |
| J21-2573-04 | | | Foot mounting hardware x 2 | C1, 2 | CC45SL1H101J | | C 100pF |
| J31-0141-04 | | | Spacer ring MIC | C3 | CE04W1H010M | | E 1μF 50V |
| J61-0401-05 | | | Nylon band x 4 | C4 | CE04W1A101M | | E 100μF 10V |
| K21-0756-04 | N | | Main knob | C5 | CE04W1E4R7M | | E 4.7μF 25V |
| K23-0710-04 | | | Knob (inside) x 4 SQL, MIC, RIT, AF | C6 | CQ92M1H153K | | ML 0.015μF |
| K23-0738-04 | | | Knob 1 x 2 MEMORY, MODE | C7 | CE04W1H010M | | E 1μF 50V |
| K27-0414-04 | | | Push knob x 5 RIT, NB, F. STEP, M, HOLD | C8 | CQ92M1H473K | | ML 0.047μF |
| K27-0415-04 | | | Push knob x 2 VFO/MEMO, F. LOCK | C9 | CE04W1H010M | | E 1μF 50V |
| K27-0426-04 | N | | BAND knob x 2 | C10 | CE04W1E4R7M | | E 4.7μF 25V |
| K29-0709-04 | | | Push knob ALC/RF | C11 | CE04BW1C3R3M | | E 3.3μF 16V (Non-pole) |
| K29-0741-04 | | | Knob (outside) x 3 CAR, IF SHIFT, RF | C12 | CE04W1H010M | | E 1μF 50V |
| K29-0749-04 | N | | Pointer knob FUNCTION | | E06-0853-05 | | 8P male socket MIC |
| K29-0750-04 | N | | Push knob SEND/REC | | E23-0047-04 | | Square terminal x 2 |
| N09-0256-05 | | | Gnd screw x 4 | | E40-0273-05 | | Mini connect wafer x 2 2P |
| N14-0115-05 | | | Flange nut GND | | E40-0373-05 | | Mini connect wafer 3P |
| N14-0509-05 | | | Wing nut GND | | E40-0473-05 | | Mini connect wafer x 3 4P |
| N15-1040-46 | | | Washer x 2 GND | | E40-0673-05 | | Mini connect wafer 6P |
| N19-0608-04 | | | Washer x 2 Dial scale | VR1-1, 1-2 | R19-3410-05 | N | Pot. MIC/CAR, AF/RF |
| N30-2604-46 | | | Round screw x 15 2.6 x 4 | 2-1, 2-2 | | | |
| N30-3004-46 | | | Round screw x 2 ANT SELECT SW | VR3 | R12-4020-05 | | Trim. pot 50kΩ |
| N30-3008-46 | | | Round screw Panel | VR4-1, 4-2 | R19-3411-05 | N | Pot. RIT/IF SHIFT |
| N30-4016-46 | | | Round screw GND | VR5-1, 5-2 | S03-2401-05 | N | Rotary switch with VR |
| N32-2606-46 | | | Flat screw 2.6 x 6 LED | | R92-0150-05 | | Short jumper |
| N32-3006-46 | | | Flat screw x 2 Display unit | S1 | S03-2401-05 | N | Rotary switch with VR |
| N33-3006-46 | | | Round flat screw x 8 SP, Panel | S2-5 | S40-2419-05 | | Push switch RIT, NB, F. LOCK, F. STEP |
| N35-3006-45 | | | Bind screw x 15 Case A, B | S6 | S01-2431-05 | N | Rotary switch MODE |
| N87-2606-46 | | | Self tapping screw Front glass | S7 | S01-1428-05 | N | Rotary switch MEMORY |
| N87-3006-41 | | | Self tapping screw x 2 Name plate | S8, 9 | S40-2405-05 | | Push switch METER, STBY |
| N87-3006-46 | | | Self tapping screw x 14 | S10 | S40-2419-05 | | Push switch VFO/MEMO |
| N87-3008-46 | | | Self tapping screw x 4 Final unit | S11 | S40-2426-05 | N | Push switch M |
| N87-3012-46 | | | Self tapping screw x 32 | S12 | S40-2419-05 | | Push switch HOLD |
| N88-2606-46 | | | Flat tapping screw x 3 BAND | BAND SWITCH UNIT (X41-1350-00) | | | |
| N88-3006-46 | | | Flat tapping screw x 10 Sub, Rear panel | S1, 2 | S50-1409-05 | N | Tact switch |
| N89-3005-46 | | | Bind tapping screw x 5 Lug plate, Assistant foot | RF UNIT (X44-1440-00) | | | |
| N89-3006-46 | | | Bind tapping screw x 2 IF unit | C1 | CC45RH1H820J | | C 82pF |
| S31-2007-05 | | | Slide switch ANT | C2 | CC45RH1H101J | | C 100pF |
| S36-2402-05 | | | Paddle switch POWER | C3 | CC45RH1H181J | | C 180pF |
| S50-1406-05 | | | Tact switch x 2 | C4 | CC45RH1H560J | | C 56pF |
| T03-0027-15 | | | Speaker | C9 | CC45SL1H101J | | C 100pF |
| T91-0316-15 | | | Microphone | C10 | CC45SL1H100D | | C 10pF |
| X41-1340-00 | N | | Switch unit | C11 | CC45SL1H270J | | C 27pF |
| X41-1350-00 | N | | BAND switch unit | C12 | CC45SL1H101J | | C 100pF |
| X44-1440-00 | N | | RF unit | C20 | CC45SL1H220J | | C 22pF |
| X48-1330-00 | N | | IF unit | C31 | CC45SL1H330J | | C 33pF |
| X48-1340-00 | N | | FM unit | C40 | CC45SL1H180J | | C 18pF |
| X50-1740-00 | N | | PLL unit | C41 | CC45SL1H470J | | C 47pF |
| X51-1260-00 | N | | Filter unit | C48 | CC45SL1H050C | | C 5pF |
| X53-1220-00 | N | | Control unit | C49 | CC45SL1H100D | | C 10pF |
| X54-1630-00 | N | | Display unit | C51, 52 | CC45SL1H470J | | C 47pF |
| X56-1410-00 | N | | Final unit | C54 | CE04W1C100M | | E 10μF 16V |
| X60-1170-00 | N | | Encoder ass'y unit | C56 | CC45SL1H100D | | C 10pF |
| | | | | C65 | CC45SL1H030C | | C 3pF |
| | | | | C71 | CC45SL1H150J | | C 15pF |
| | | | | C72, 73 | CC45SL1H180J | | C 18pF |

PARTS LIST

| Ref. No. | Parts No. | Re- marks | Description | Ref. No. | Parts No. | Re- marks | Description |
|-----------------------------|--------------|--------------|-----------------------------|------------------------------|--------------|--------------|----------------------------|
| C84 | CE04W1H010M | | E 1 μ F 50V | L51 | L40-3392-02 | | Ferri-inductor 3.3 μ H |
| C87 | CC45SL1H560J | | C 56pF | L52-54 | L40-1511-03 | | Ferri-inductor 150 μ H |
| C94 | CC45SL1H820J | | C 82pF | L55 | L40-4701-03 | | Ferri-inductor 47 μ H |
| C100 | CC45SL1H680J | | C 68pF | L56 | L40-1511-03 | | Ferri-inductor 150 μ H |
| C102 | CC45SL1H820J | | C 82pF | T1 | L19-0324-05 | N | Wide bandwidth trans |
| C105 | CC45SL1H330J | | C 33pF | T2 | L30-0506-05 | | IFT |
| C109 | CC45SL1H101J | | C 100pF | T3 | L30-0512-05 | N | IFT 8.83 MHz |
| C116, 119, 121, 125, 129 | CE04W1H010M | | E 1 μ F 50V | T4 | L34-0536-05 | | Tuning coil |
| TC1-3 | C05-0309-05 | | Ceramic trimmer 40pF | T5 | L34-0942-05 | | Tuning coil |
| | E04-0154-05 | | Mini pin jack | T6 | L30-0511-05 | N | IFT 8.83 MHz, NB |
| | E23-0046-04 | | Square terminal x 2 | T7 | L34-0535-05 | | Tuning coil |
| | E23-0512-05 | | Terminal | T8 | L34-0536-05 | | Tuning coil |
| | E29-0413-05 | | 1P connector (female) | T9 | L19-0324-05 | N | Wide bandwidth trans |
| | E40-0273-05 | | Mini connect wafer x 7 2P | T10 | L34-0697-05 | | Tuning coil |
| | E40-0473-05 | | Mini connect wafer x 2 4P | T11 | L19-0328-05 | N | Wide bandwidth trans |
| | E40-0573-05 | | Mini connect wafer x 2 5P | T12 | L34-2026-05 | N | ANT coil 28 MHz |
| | J31-0502-04 | | PC board collar x 4 | CF1 | L72-0324-05 | | Ceramic filter 8.83 MHz |
| | J42-0428-05 | | PC board bushing x 4 | VR1, 2 | R12-0420-05 | N | Trim. pot 500 Ω (B) |
| L1, 2 | L40-1511-03 | | Ferri-inductor 150 μ H | VR3, 4 | R12-1415-05 | | Trim. pot 3k Ω (B) |
| L3, 4 | L34-2027-05 | N | ANT coil 50 MHz | | R92-0150-05 | | Short jumper x 32 |
| L5 | L40-1511-03 | | Ferri-inductor 150 μ H | RL1 | S51-1404-05 | | Relay G2E |
| L6 | L79-0484-05 | N | Coil block A 50 MHz | IF UNIT (X48-1330-00) | | | |
| L7 | L40-1511-03 | | Ferri-inductor 150 μ H | C3 | CC45SL1H101J | | C 100pF |
| L9 | L34-0983-05 | | BPF coil 21C | C5 | CC45SL1H020C | | C 2pF |
| L10, 11 | L34-2025-05 | N | ANT coil 24 MHz | C6 | CC45SL1H330J | | C 33pF |
| L12 | L40-2211-03 | | Ferri-inductor 220 μ H | C9 | CC45UJ1H100D | | C 10pF |
| L13-16 | L40-4711-03 | | Ferri-inductor 470 μ H | C10 | CE04W1HR47M | | E 0.47 μ F 50V |
| L17 | L34-0981-05 | | BPF coil 21A | C27 | C91-0456-05 | | C 0.047 μ F |
| L18 | L34-0982-05 | | BPF coil 21B | C31 | CC45SL1H470J | | C 47pF |
| L19 | L34-0983-05 | | BPF coil 21C | C35 | CC45SL1H100D | | C 10pF |
| L20 | L34-0984-05 | | BPF coil 24A | C37 | CC45SL1H150J | | C 15pF |
| L21 | L34-0985-05 | | BPF coil 24B | C40 | CQ92M1H333K | | ML 0.033 μ F |
| L22 | L34-0986-05 | | BPF coil 24C | C43 | CC45SL1H220J | | C 22pF |
| L23 | L34-0707-05 | | BPF coil 28A | C46, 49, 51 | CC45SL1H470J | | C 47pF |
| L24 | L34-0987-05 | | BPF coil 28B | C52 | CC45SL1H050C | | C 5pF |
| L25 | L34-0984-05 | | BPF coil 28C | C54 | CE04W1C220M | | E 22 μ F 16V |
| L26 | L40-4711-03 | | Ferri-inductor 470 μ H | C58, 63 | C91-0456-05 | | C 0.047 μ F |
| L27 | L40-3311-03 | | Ferri-inductor 330 μ H | C64 | CE04W1H4R7M | | E 4.7 μ F 50V |
| L28 | L40-4711-03 | | Ferri-inductor 470 μ H | C65 | CE04BW1H010M | | E 1 μ F 50V |
| L29 | L34-0966-05 | | Trap coil 8.83 MHz | C66 | CE04W1H010M | | E 1 μ F 50V |
| L30 | L40-1511-03 | | Ferri-inductor 150 μ H | C68 | CE04W1A101M | | E 100 μ F 10V |
| L31 | L40-2282-01 | | Ferri-inductor 0.22 μ H | C69, 70 | CE04W1C100M | | E 10 μ F 16V |
| L32 | L40-1011-03 | | Ferri-inductor 100 μ H | C71 | CE04W1HR47M | | E 0.47 μ F 50V |
| L33 | L40-4711-03 | | Ferri-inductor 470 μ H | C72 | CE04W1H010M | | E 1 μ F 50V |
| L34 | L40-1511-03 | | Ferri-inductor 150 μ H | C73 | CQ92M1H223K | | ML 0.022 μ F |
| L35 | L40-1011-03 | | Ferri-inductor 100 μ H | C74 | CE04W1C100M | | E 10 μ F 16V |
| L36 | L40-3311-03 | | Ferri-inductor 330 μ H | C75, 76 | CE04W1C470M | | E 47 μ F 16V |
| L37 | L79-0485-05 | N | Coil block B 50 MHz | C77 | CE04W1C221M | | E 220 μ F 16V |
| L38 | L79-0486-05 | N | Coil block C 50 MHz | C78 | CQ92M1H104K | | ML 0.1 μ F |
| L39 | L40-3392-02 | | Ferri-inductor 3.3 μ H | C79 | CC45SL1H470J | | C 47pF |
| L40 | L40-1001-03 | | Ferri-inductor 10 μ H | C80 | CC45SL1H101J | | C 100pF |
| L41 | L34-1021-05 | N | Input coil | C84 | CE04W1A470M | | E 47 μ F 10V |
| L42 | L33-0222-05 | | Choke coil | C85 | CC45SL1H470J | | C 47pF |
| L43 | L34-1022-05 | N | Output coil | C86 | CE04W1H0R1M | | E 0.1 μ F 50V |
| L44 | L40-1001-03 | | Ferri-inductor 10 μ H | C87 | CE04W1H010M | | E 1 μ F 50V |
| L45 | L40-4791-02 | | Ferri-inductor 4.7 μ H | C88 | CE04W1HR22H | | E 0.22 μ F 50V |
| L46 | L33-0222-05 | | Choke coil | C90 | CE04W1H010M | | E 1 μ F 50V |
| L47 | L40-2211-03 | | Ferri-inductor 220 μ H | C91 | CE04W1C100M | | E 10 μ F 16V |
| L49 | L40-1511-03 | | Ferri-inductor 150 μ H | | | | |
| L50 | L40-4701-03 | | Ferri-inductor 47 μ H | | | | |

PARTS LIST

| Ref. No. | Parts No. | Re- marks | Description | Ref. No. | Parts No. | Re- marks | Description |
|-----------|--------------|--------------|----------------------------|------------------------------|--------------|--------------|----------------------------|
| C92-94 | CQ92M1H822K | | ML 0.0082 μ F | VR6 | R12-0421-05 | | Trim. pot 100 Ω |
| C95 | CQ92M1H104K | | ML 0.1 μ F | VR7 | R12-7403-05 | N | Trim. pot 500k Ω |
| C96 | CQ92M1H103K | | ML 0.01 μ F 50V | VR8 | R12-4408-05 | N | Trim. pot 50k Ω |
| C97 | CE04W1A470M | | E 47 μ F 10V | VR9 | R12-2409-05 | N | Trim. pot 5k Ω |
| C98 | CE04W1H4R7M | | E 4.7 μ F 50V | VR10 | R12-5408-05 | N | Trim. pot 200k Ω |
| C99 | CE04W1H010M | | E 1 μ F 50V | VR11, 12 | R12-2409-05 | N | Trim. pot 5k Ω |
| C101 | CE04W1HR47M | | E 0.47 μ F 50V | VR13 | R12-3430-05 | | Trim. pot 10k Ω |
| C102 | CE04W1HR22M | | E 0.22 μ F 50V | | R92-0150-05 | | Short jumper x 60 |
| C103 | CE04BW1H010M | | E 1 μ F 50V | RL1 | S51-1410-05 | N | Relay OUC-S-112D |
| C104 | CE04W1C100M | | E 10 μ F 16V | FM UNIT (X48-1340-00) | | | |
| C105 | CE04W1H010M | | E 1 μ F 50V | C1 | CQ92M1H472K | | ML 0.0047 μ F |
| C107 | CE04W1H010M | | E 1 μ F 50V | C2 | CQ92M1H103K | | ML 0.01 μ F |
| C109, 111 | CE04W1H010M | | E 1 μ F 50V | C3 | CE04W1A470M | | E 47 μ F 10V |
| C113, 115 | C91-0456-05 | | C 0.047 μ F | C4 | CE04W1A220M | | E 22 μ F 10V |
| C114, 116 | CE04W1C100M | | E 10 μ F 16V | C5 | CE04W1H010M | | E 1 μ F 50V |
| C119, 120 | C90-0817-05 | | E 1000 μ F | C6 | CE04W1A470M | | E 47 μ F 10V |
| C123-125 | C90-0839-05 | | E 4.7 μ F 25V | C7 | CQ92M1H103K | | ML 0.01 μ F |
| C128 | C91-0456-05 | | C 0.047 μ F | C8 | CE04W1H010M | | E 1 μ F 50V |
| TC1 | C05-0031-15 | | Ceramic trimmer 10pF | C9 | CQ92M1H393K | | ML 0.039 μ F |
| TC2, 3 | C05-0030-15 | | Ceramic trimmer 20pF | C10 | CE04W1H010M | | E 1 μ F 50V |
| | E23-0046-04 | | Square terminal | C11 | CC45UJ1H070D | | C 7pF |
| | E23-0512-05 | | Terminal x 4 | C12, 14 | CC45SL1H221J | | C 220pF |
| | E29-0413-05 | | 1P connector (female) | C15 | CC45SL1H050C | | C 5pF |
| | E40-0273-05 | | Mini connect wafer x 9 2P | C16 | CC45SL1H220J | | C 22pF |
| | E40-0373-05 | | Mini connect wafer x 2 3P | C22 | CQ92M1H473K | | ML 0.047 μ F |
| | E40-0473-05 | | Mini connect wafer x 4 4P | C23 | CE04W1A220M | | E 22 μ F 10V |
| | E40-0573-05 | | Mini connect wafer x 3 5P | C24 | CQ92M1H103K | | ML 0.01 μ F |
| | E40-0673-05 | | Mini connect wafer x 2 6P | C25 | CQ92M1H473K | | ML 0.047 μ F |
| | E40-0773-05 | | Mini connect wafer 7P | C26 | CE04W1A3R3M | | E 3.3 μ F 10V |
| | F20-0516-05 | | Insulating sheet | C29 | CQ92M1H332K | | ML 0.0033 μ F |
| | F29-0014-05 | | Shoulder washer | C30 | CQ92M1H473K | | ML 0.047 μ F |
| | J31-0502-04 | | PC board collar x 6 | C31, 32 | CE04W1H010M | | E 1 μ F 50V |
| | J42-0428-05 | | PC board bushing x 6 | C34 | CC45SL1H121J | | C 120pF |
| L1 | L32-0201-05 | | OSC coil | C35 | CC45SL1H560J | | C 56pF |
| L2 | L40-1511-03 | | Ferri-inductor 150 μ H | C37 | CE04W1A101M | | E 100 μ F 10V |
| L3 | L40-2211-03 | | Ferri-inductor 220 μ H | C40 | CC45SL1H120J | | C 12pF |
| L4 | L33-0636-05 | | Choke coil 28 μ H | C41 | CC45SL1H220J | | C 22pF |
| L5 | L40-1511-03 | | Ferri-inductor 150 μ H | C49 | CE04W1E4R7M | | E 4.7 μ F 25V |
| L6 | L34-0708-05 | | Tuning coil | C50 | CQ92M1H103K | | ML 0.01 μ F |
| L7 | L34-0535-05 | | Tuning coil | C51 | CC45SL1H150J | | C 15pF |
| L8 | L34-0536-05 | | Tuning coil | TC1 | C05-0031-15 | | Ceramic trimmer 10pF |
| L9 | L34-0567-05 | | Tuning coil | | E40-0273-05 | | Mini connect wafer x 3 2P |
| L10 | L34-0535-05 | | Tuning coil | | E40-0773-05 | | Mini connect wafer 7P |
| L13 | L40-1511-03 | | Ferri-inductor 150 μ H | | J31-0502-04 | | PC board collar x 6 |
| L14, 22 | L40-4711-03 | | Ferri-inductor 470 μ H | | J42-0428-05 | | PC board bushing x 6 |
| L15, 16 | L40-1511-03 | | Ferri-inductor 150 μ H | L1 | L40-1541-27 | | Ferri-inductor 150mH |
| L17 | L40-3391-03 | | Ferri-inductor 3.3 μ H | L2 | L33-0640-05 | N | Choke coil 12 μ H |
| L19 | L15-0016-05 | | Choke trans | L3 | L33-0639-05 | N | Choke coil 10 μ H |
| XF1 | L71-0208-05 | | MCF YK-88S | L4 | L40-1511-03 | | Ferri-inductor 150 μ H |
| X1 | L77-0485-05 | | Crystal 8.8315 MHz | L5 | L40-6891-01 | | Ferri-inductor 6.8 μ H |
| | N10-2030-46 | | Nut x 5 | T1 | L34-0535-05 | | Tuning coil |
| | N30-3008-46 | | Round screw x 3 | T2 | L30-0503-05 | | Tuning coil |
| | N30-3010-46 | | Round screw x 2 | T3 | L30-0199-05 | | Tuning coil |
| VR1-3 | R12-1414-05 | N | Trim. pot 1k Ω | CF1 | L72-0309-05 | | Ceramic filter CFT455F2 |
| VR4 | R12-7403-05 | N | Trim. pot 500k Ω | | | | |
| VR5 | R12-3430-05 | N | Trim. pot 10k Ω | | | | |

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| Ref. No. | Parts No. | Re- marks | Description | Ref. No. | Parts No. | Re- marks | Description |
|-------------------------------|--------------|--------------|---------------------------|----------------------------------|--------------|--------------|---------------------------|
| X1 | L77-0940-05 | N | Crystal 8.8315 MHz | L8 | L32-0639-05 | N | OSC coil 50M |
| X2 | L77-0939-05 | N | Crystal 9.2865 MHz | L9 | L40-4701-03 | | Ferri-inductor 47μH |
| VR1 | R12-3430-05 | | Trim. pot 10kΩ (B) | L10 | L40-1511-03 | | Ferri-inductor 150μH |
| VR2 | R12-4408-05 | | Trim. pot 50kΩ (B) | L11 | L40-4782-02 | | Ferri-inductor 0.47μH |
| VR3 | R12-4410-05 | | Trim. pot 50kΩ (B) | L12, 13 | L40-2282-01 | | Ferri-inductor 0.22μH |
| | R92-0150-05 | | Short jumper | L14 | L40-4782-02 | | Ferri-inductor 0.47μH |
| PLL UNIT (X50-1740-00) | | | | L15-18 | L40-1511-03 | | Ferri-inductor 150μH |
| C1 | CE04W1A220M | | E 22μF 10V | L19-21 | L40-1001-03 | | Ferri-inductor 10μH |
| C2 | CC45UJ1H180J | | C 18pF | L22 | L40-2201-03 | | Ferri-inductor 22μH |
| C3 | CC45UJ1H080D | | C 8pF | L23 | L40-1001-03 | | Ferri-inductor 10μH |
| C4 | CC45TH1H150J | | C 15pF | L24 | L40-2201-03 | | Ferri-inductor 22μH |
| C5 | CC45UJ1H100D | | C 10pF | L25 | L40-1021-03 | | Ferri-inductor 1000μH |
| C6 | CC45UJ1H270J | | C 27pF | L26-29 | L40-4711-03 | | Ferri-inductor 470μH |
| C8 | CE04W1A220M | | E 22μF 10V | L30 | L40-4791-02 | | Ferri-inductor 4.7μH |
| C10 | CE04W1A470M | | E 47μF 10V | | R92-0150-05 | | Short jumper x 5 |
| C11 | CC45UJ1H270J | | C 27pF | FILTER UNIT (X51-1260-00) | | | |
| C12 | CC45TH1H220J | | C 22pF | C1 | CC45SL2H150J | | C 15pF 500V |
| C13 | CC45UJ1H070D | | C 7pF | C2 | CC45SL1H331J | | C 330pF |
| C14 | CC45UJ1H220J | | C 22pF | C8 | CC45SL2H070D | | C 7pF 500V |
| C16 | CE04W1A220M | | E 22μF 10V | C9 | CC45SL1H331J | | C 330pF |
| C18 | CC45UJ1H180J | | C 18pF | C14 | CE04W1HR47M | | E 0.47μF 50V |
| C19 | CC45TH1H150J | | C 15pF | C15 | CE04W1C100M | | E 10μF 16V |
| C20 | CC45UJ1H030C | | C 3pF | C22 | CC45SL2H390J | | C 39pF 500V |
| C21 | CC45UJ1H180J | | C 18pF | C23, 25 | CC45SL2H820J | | C 82pF 500V |
| C23 | CE04W1A220M | | E 22μF 10V | C26 | CC45SL2H390J | | C 39pF 500V |
| C24 | CC45CH1H070D | | C 7pF | C27, 28 | CC45SL2H470J | | C 47pF 500V |
| C25 | CC45CH1H050C | | C 5pF | C31 | CC45SL2H560J | | C 56pF 500V |
| C29 | C91-0457-05 | | C 0.022μF | C32 | CC45SL2H151J | | C 150pF 500V |
| C30 | CC45SL1H101J | | C 100pF | C33 | CC45SL2H680J | | C 68pF 500V |
| C31 | CC45SL1H820J | | C 82pF | C35 | CC45SL2H820J | | C 82pF 500V |
| C32 | CC45SL1H101J | | C 100pF | C37 | CC45SL2H680J | | C 68pF 500V |
| C33 | CC45SL1H470J | | C 47pF | C45 | CC45SL2H470J | | C 47pF 500V |
| C36 | CC45CH1H050C | | C 5pF | C46 | CC45SL2H151J | | C 150pF 500V |
| C37 | CC45CH1H010C | | C 1pF | C47 | CC45SL2H121J | | C 120pF 500V |
| C45 | CC45SL1H100D | | C 10pF | C49 | CC45SL1H220J | | C 22pF |
| C46, 47 | CC45SL1H180J | | C 18pF | C50 | CC45SL1H330J | | C 33pF |
| C48 | CC45SL1H100D | | C 10pF | C51 | CC45SL1H101J | | C 100pF |
| C49, 50 | CC45SL1H180J | | C 18pF | C52 | CC45CH1H0R5C | | C 0.5pF |
| C57 | CQ92M1H104K | ML | 0.1μF | C53 | CC45CH1H020C | | C 2pF |
| C59, 61 | CE04W1A101M | E | 100μF 10V | TC1 | C05-0043-05 | | Ceramic trimmer 20pF |
| C66 | CE04W1A470M | E | 47μF 10V | | E04-0157-05 | | Mini pin jack A x 3 |
| C67 | CE04W1H3R3M | E | 3.3μF 50V | | E23-0512-05 | | Terminal |
| C70 | CC45SL1H330J | C | 33pF | | E40-0273-05 | | Mini connect wafer x 2 2P |
| C72 | CC45SL1H150J | C | 15pF | | E40-0473-05 | | Mini connect wafer 4P |
| C73 | CC45SL1H070D | C | 7pF | | E40-0573-05 | | Mini connect wafer 5P |
| | E23-0046-04 | | Square terminal x 2 | | J31-0502-04 | | PC board collar x 6 |
| | E40-0273-05 | | Mini connect wafer x 3 2P | | J42-0428-05 | | PC board bushing x 6 |
| | E40-0373-05 | | Mini connect wafer 3P | | | | |
| | E40-0473-05 | | Mini connect wafer x 2 4P | L1 | L39-0410-15 | N | Detector coil |
| | J31-0502-04 | | PC board collar x 3 | L2, 3 | L40-1511-03 | | Ferri-inductor 150μH |
| | J42-0428-05 | | PC board bushing x 3 | L4 | L33-0641-05 | N | Choke coil 47μH |
| L1 | L40-1511-03 | | Ferri-inductor 150μH | L6 | L33-0641-05 | N | Choke coil 47μH |
| L2 | L40-4711-03 | | Ferri-inductor 470μH | L7 | L34-3002-05 | N | Filter coil |
| L3 | L32-0197-05 | | OSC coil 21M | L8 | L34-3003-05 | N | Filter coil |
| L5 | L40-1511-03 | | Ferri-inductor 150μH | L9 | L34-3004-05 | N | Filter coil |
| L6 | L32-0198-05 | | OSC coil 28M | L10 | L34-3005-05 | N | Filter coil |
| L7 | L40-1011-03 | | Ferri-inductor 100μH | L11 | L34-0830-05 | | Filter coil |
| | | | | L12 | L34-3006-05 | N | Filter coil |
| | | | | L13 | L34-0830-05 | | Filter coil |

PARTS LIST

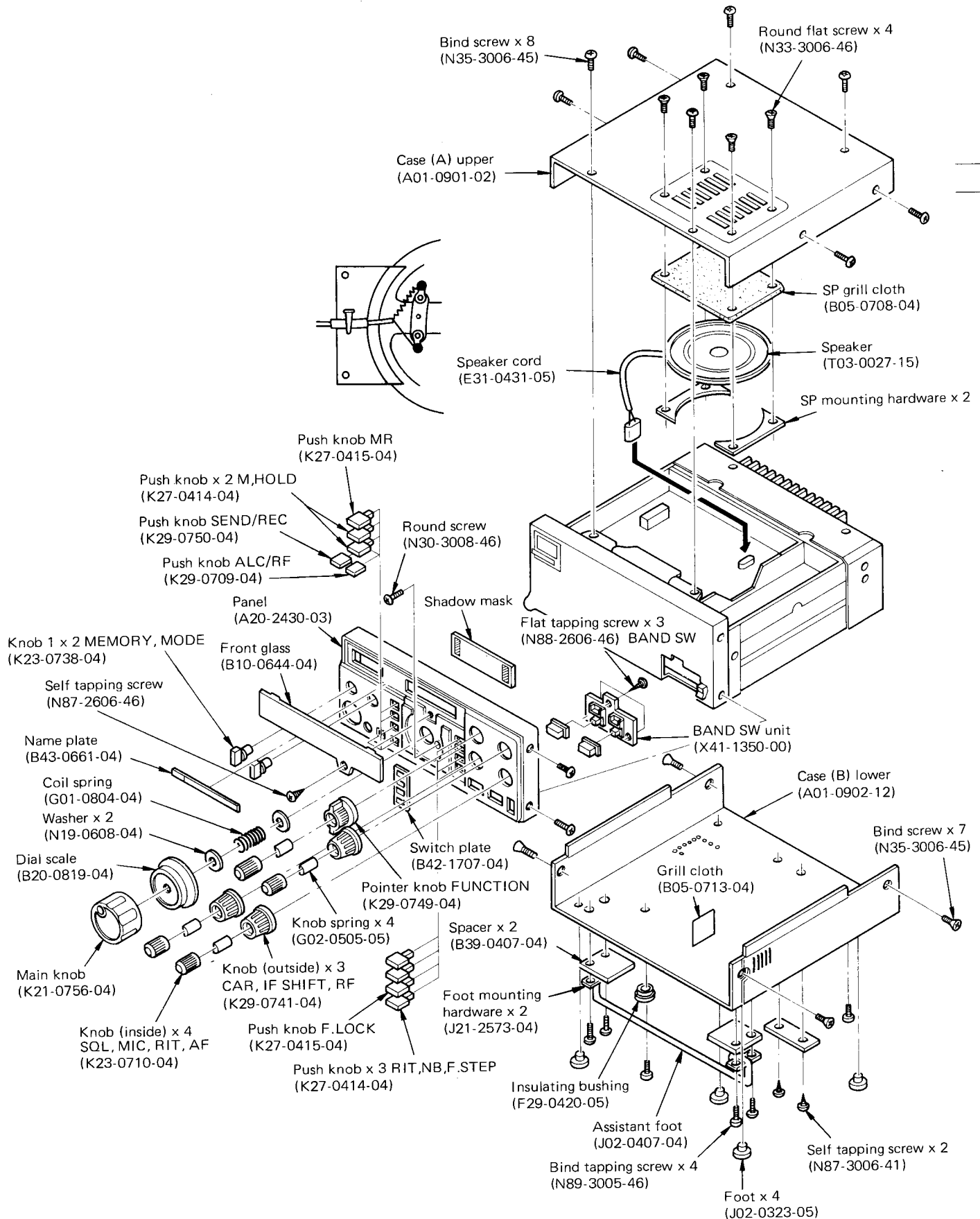
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| L14 | L34-3007-05 | N | Filter coil | C108, 109 | CC45RH1H221J | C | 220pF |
| L15 | L34-3008-05 | N | Filter coil | C110 | CC45CH1H070D | C | 7pF |
| L16 | L33-0641-05 | N | Choke coil 47μH | C112 | C91-0456-05 | C | 0.047μF |
| L17, 18 | L40-1511-03 | | Ferri-inductor 150μH | C114 | CC45CH1H220J | C | 22pF |
| R11, 12 | RS14AB3A181J | | Metal film 180Ω 1W | C117 | CE04W1A101M | E | 100μF 10V |
| R13 | RS14AB3A470J | | Metal film 47Ω 1W | C118 | C91-0456-05 | C | 0.047μF |
| VR1, 2 | R12-4016-05 | | Trim. pot 50kΩ (B) | C119 | CQ92M1H822K | ML | 0.0082μF |
| | R92-0150-05 | | Short jumper x 17 | C120 | CQ92M1H183K | ML | 0.018μF |
| RL1-6 | S51-1409-05 | N | Relay | C121 | CQ92M1H822K | ML | 0.0082μF |
| CONTROL UNIT (X53-1220-00) | | | | C122, 125, 126, 128 | C91-0456-05 | C | 0.047μF |
| C1, 2 | CE04W1H010M | | E 1μF 50V | C129 | CC45RH1H470J | C | 47pF |
| C4 | CE04W1A470M | | E 47μF 10V | C130 | CC45CH1H030C | C | 3pF |
| C5 | CE04W1H010M | | E 1μF 50V | C131 | CC45RH1H470J | C | 47pF |
| C6 | CC45CH1H560J | | C 56pF | C132 | CC45UJ1H180J | C | 18pF |
| C7 | CC45CH1H330J | | C 33pF | C133, 134 | CC45SL1H221J | C | 220pF |
| C8 | CC45SL1H271J | | C 270pF | C135, 136 | CC45CH1H100D | C | 10pF |
| C10 | CC45CH1H150J | | C 15pF | C137 | C91-0456-05 | C | 0.047μF |
| C14 | CC45SL1H101J | | C 100pF | C138 | CC45SL1H150J | C | 15pF |
| C15 | CC45RH1H121J | | C 120pF | C140 | CC45RH1H330J | C | 33pF |
| C16 | CC45CH1H010C | | C 1pF | C141 | CC45CH1H020C | C | 2pF |
| C17 | CC45RH1H121J | | C 120pF | C142 | CC45RH1H330J | C | 33pF |
| C19 | CC45CH1H100D | | C 10pF | C143 | CC45SL1H101J | C | 100pF |
| C20 | CC45CH1H150J | | C 15pF | C149 | C91-0457-05 | C | 0.022μF |
| C22 | CC45RH1H120J | | C 12pF | C151 | CE04W1A100M | E | 10μF 10V |
| C31 | CC45RH1H270J | | C 27pF | C154, 156 | CE04W1A101M | E | 100μF 10V |
| C32 | CC45RH1H070D | | C 7pF | C157-159 | C91-0456-05 | C | 0.047μF |
| C33 | CC45RH1H270J | | C 27pF | C164 | C90-0840-05 | C | 10μF 16V |
| C36 | CC45RH1H120J | | C 12pF | C165 | CC45SL1H151J | C | 150pF |
| C37 | CC45RH1H030C | | C 3pF | TC1 | C05-0309-05 | | Ceramic trimmer 40pF |
| C38 | CC45RH1H120J | | C 12pF | TC2, 3 | C05-0067-05 | | Ceramic trimmer 25pF |
| C41 | C91-0457-05 | | C 0.022μF | | E40-0273-05 | | Mini connect wafer x 4 2P |
| C43 | CE04W1A101M | | E 100μF 10V | | E40-0373-05 | | Mini connect wafer x 5 3P |
| C45 | CQ92M1H102K | ML | 0.001μF | | E40-0473-05 | | Mini connect wafer x 7 4P |
| C46 | CQ92M1H104K | ML | 0.1μF | | E40-0573-05 | | Mini connect wafer x 2 5P |
| C47 | C91-0457-05 | | C 0.022μF | | E40-0673-05 | | Mini connect wafer 6P |
| C48 | CC45TH1H100D | | C 10pF | | E40-0773-05 | | Mini connect wafer x 2 7P |
| C49, 50 | CC45TH1H101J | | C 100pF | | G11-0605-04 | | Cushion |
| C52 | CE04W1A101M | | E 100μF 10V | | J31-0502-04 | | PC board collar x 7 |
| C53 | CC45CH1H050C | | C 5pF | | J42-0428-05 | | PC board bushing x 7 |
| C54 | CC45CH1H150J | | C 15pF | L1, 2 | L34-0996-15 | | Tuning coil 4M |
| C55, 56 | CC45CH1H270J | | C 27pF | L3 | L34-0710-05 | | Tuning coil 32M |
| C58 | CC45CH1H220J | | C 22pF | L4 | L34-2018-05 | N | Tuning coil 19M BPF |
| C66-68 | CC45RH1H560J | | C 56pF | L5 | L34-2019-05 | N | Tuning coil 19M BPF |
| C76 | CC45SL1H820J | | C 82pF | L6 | L34-2018-05 | N | Tuning coil 19M BPF |
| C77, 78 | CC45SL1H151J | | C 150pF | L7 | L34-2020-05 | N | Tuning coil 47M BPF |
| C79 | CC45SL1H820J | | C 82pF | L8 | L34-2023-05 | N | Tuning coil 15M BPF |
| C80, 82 | CC45SL1H101J | | C 100pF | L9 | L34-2020-05 | N | Tuning coil 47M BPF |
| C86 | CE04W1A101M | | E 100μF 10V | L11 | L40-3301-03 | | Ferri-inductor 33μH |
| C87 | CC45CH1H270J | | C 27pF | L12 | L40-4711-07 | | Ferri-inductor 470μH |
| C88 | CC45SL1H101J | | C 100pF | L13 | L32-0636-05 | | OSC coil |
| C90 | CC45CH1H030C | | C 3pF | L14 | L40-5691-02 | | Ferri-inductor 5.6μH |
| C98 | CE04W1A101M | | E 100μF 10V | L15 | L40-4711-03 | | Ferri-inductor 470μH |
| C100 | CQ92M1H104K | ML | 0.1μF | L16 | L34-2022-05 | N | Tuning coil 15M BPF |
| C101 | CQ92M1H222K | ML | 0.0022μF | L17 | L34-2023-05 | N | Tuning coil 15M BPF |
| C101 | CE04W1H3R3M | | E 3.3μF 50V | L18 | L34-2022-05 | N | Tuning coil 15M BPF |
| C104 | C91-0455-05 | | C 0.01μF | L19-21 | L40-6801-03 | | Ferri-inductor 68μH |
| C105, 106 | CC45RH1H221J | | C 220pF | L22 | L40-1021-03 | | Ferri-inductor 1mH |
| C107 | CC45RH1H680J | | C 68pF | L23, 24 | L40-4711-03 | | Ferri-inductor 470μH |

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PARTS LIST

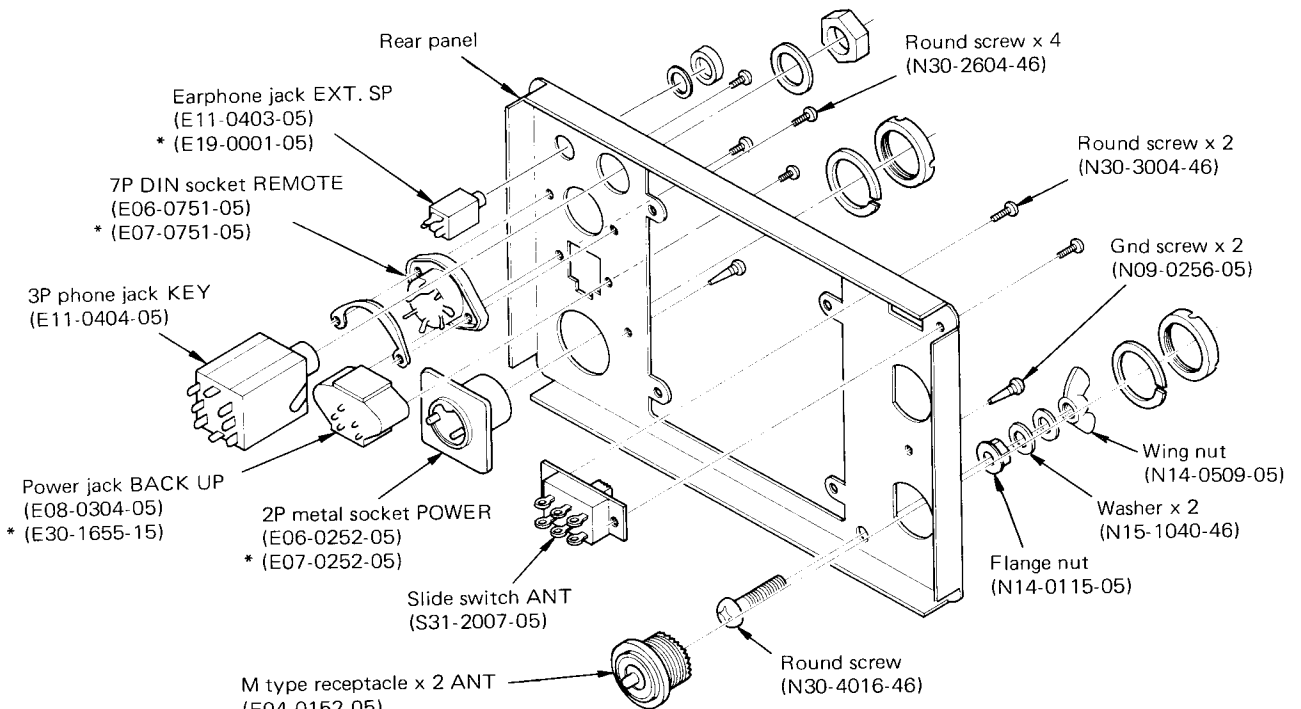
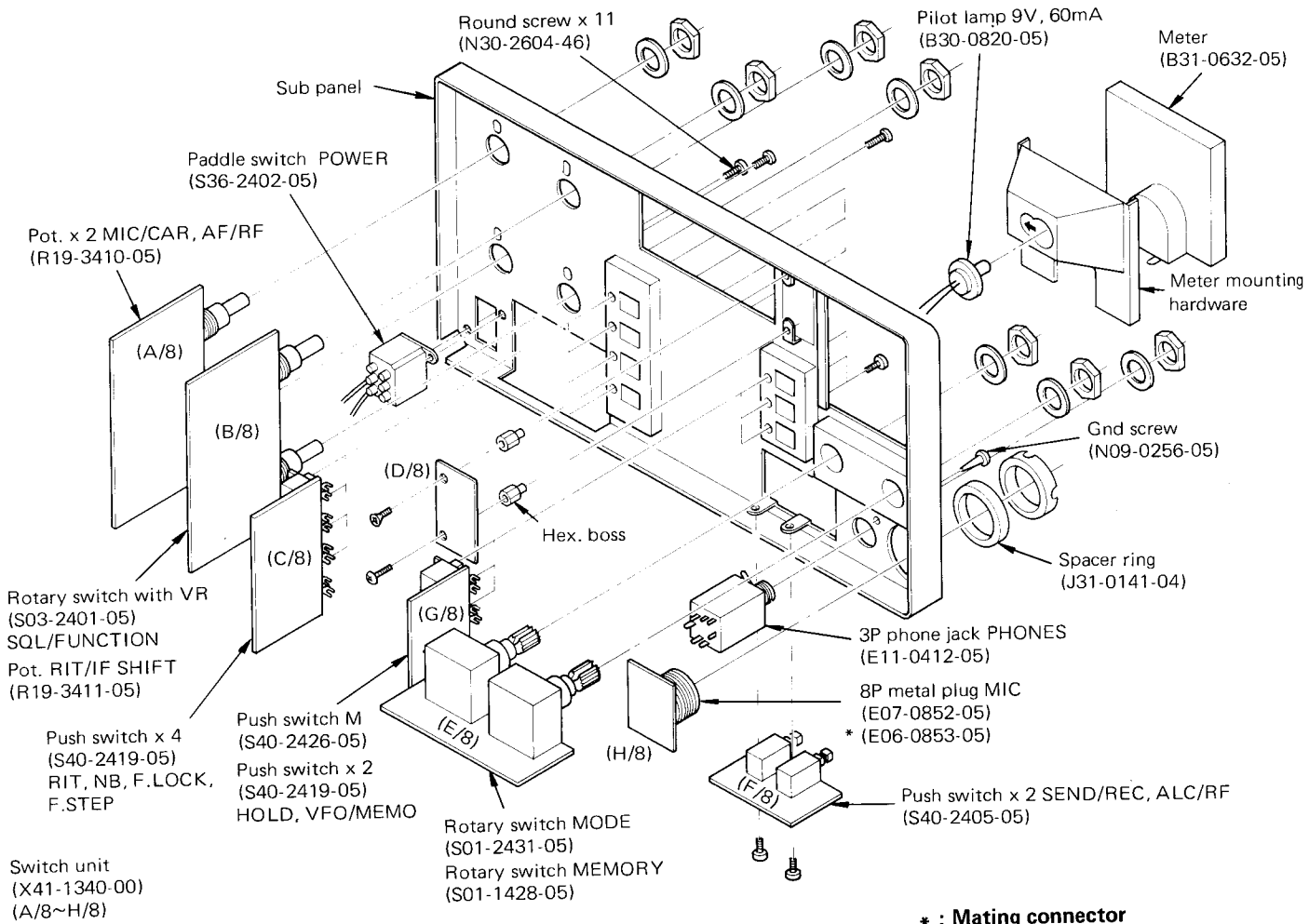
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| L25 | L40-1511-03 | | Ferri-inductor 150 μ H | | E23-0046-04 | | Square terminal x 2 |
| L26 | L32-0640-05 | N | OSC coil | | E23-0401-05 | | Round terminal |
| L27 | L40-4711-03 | | Ferri-inductor 470 μ H | | E23-0512-05 | | Terminal |
| L28, 29 | L40-3325-04 | | Ferri-inductor 3.3mH | | F01-0761-03 | N | Heat sink A |
| L30, 31 | L34-2024-05 | N | Tuning coil 8M | | F20-0078-05 | | Insulating board |
| L32 | L40-4711-03 | | Ferri-inductor 470 μ H | | J31-0505-04 | | Spacer x 6 |
| L33 | L33-0636-05 | | Choke coil 28 μ H | L1, 2 | L33-0025-05 | | RFC 1 μ H |
| L34, 35 | L34-0845-05 | | Tuning coil 8M | L3 | L33-0617-05 | | RFC |
| L36 | L40-4711-03 | | Ferri-inductor 470 μ H | L4 | L33-0025-05 | | RFC 1 μ H |
| L37 | L40-1511-03 | | Ferri-inductor 150 μ H | T1 | L19-0315-25 | | Wide bandwidth trans |
| L38 | L40-1011-04 | | Ferri-inductor 100 μ H | T2 | L19-0325-05 | N | Matching trans (A) |
| L39 | L40-4711-03 | | Ferri-inductor 470 μ H | T3 | L19-0326-05 | N | Matching trans (B) |
| X1 | L77-0941-05 | N | Crystal 16M | T4 | L19-0327-05 | N | Output trans |
| X2 | L77-0942-05 | N | Crystal 8.7315M | | N30-2606-46 | | Round screw |
| X3 | L77-0943-05 | N | Crystal 8M | | N87-3006-46 | | Self tapping screw x 4 |
| XF1 | L71-0213-05 | | MCF 7.975M | | N87-3010-46 | | Self tapping screw x 6 |
| RB1-3 | R90-0515-05 | | Resistor block 10k Ω x 4 | R9 | R92-0601-05 | | Cement resistor 0.22 Ω |
| VR1 | R12-6401-05 | | Trim. pot 470k Ω | VR1 | R12-1422-05 | | Trim. pot 1.5k Ω |
| VR3 | R12-1416-05 | | Trim. pot 4.7k Ω | VR2 | R12-0408-05 | | Trim. pot 100 Ω |
| | R92-0150-05 | | Short jumper x 101 | | R92-0150-05 | | Short jumper x 3 |
| BZ1 | T95-0051-05 | | Buzzer | ENCODER ASS'Y UNIT (X60-1170-00) | | | |
| DISPLAY UNIT (X54-1630-00) | | | | | D09-0304-04 | N | Encoder slit |
| C1 | CE04W1A470M | | E 47 μ F 10V | | D21-0818-05 | N | Shaft ass'y |
| C2 | CE04W0J221M | | E 220 μ F 6.3V | | N30-3006-46 | | Round screw x 4 |
| C3 | CE04W1V100M | | E 10 μ F 35V | | N89-3005-46 | | Bind tap tight screw x 3 |
| C4 | CQ92M1H103K | | ML 0.01 μ F | | X54-1640-00 | N | Encoder unit |
| C5-7 | CE04W1V100M | | E 10 μ F 35V | ENCODER UNIT (X54-1640-00) | | | |
| C8 | C91-0456-05 | | C 0.047 μ F | C1 | CE04W1A470M | | E 47 μ F 10V |
| | E40-0273-05 | | Mini connect wafer 2P | | E40-0474-05 | | Mini connect wafer 4P |
| | E40-0473-05 | | Mini connect wafer 4P | | G02-0519-04 | | Spring plate |
| | E40-0773-05 | | Mini connect wafer x 2 7P | | J19-1342-04 | | Sensor mounting hardware (A) |
| L1 | L40-1011-04 | | Ferri-inductor 100 μ H | | J19-1343-04 | | Sensor mounting hardware (B) |
| L2 | L40-1511-03 | | Ferri-inductor 150 μ H | | N32-3020-46 | | Flat screw |
| T1 | L19-0305-05 | | OSC transformer | VR1, 2 | R12-2410-05 | N | Trim. pot 5k Ω (B) |
| | N30-3006-46 | | Round screw x 6 | Note : Encoder unit (X54-1640-00) is not available. Please order complete Encoder ASS'Y (X60-1170-00). | | | |
| RB1, 2 | R90-0521-05 | | Resistor block 47k Ω x 7 | | | | |
| | R92-0150-05 | | Short jumper x 5 | | | | |
| FINAL UNIT (X56-1410-00) | | | | | | | |
| C1 | CC45SL1H220J | | C 22pF | | | | |
| C6 | CC45SL1H820J | | C 82pF | | | | |
| C9 | CE04W1C221M | | E 220 μ F 16V | | | | |
| C11 | CC45SL2H820J | | C 82pF 500V | | | | |
| C16, 20 | CE04W1C100M | | E 10 μ F 16V | | | | |
| C26 | CC45SL2H101J | | C 100pF 500V | | | | |
| TC1 | C05-0043-05 | | Ceramic trimmer 20pF | | | | |
| | E04-0157-05 | N | Mini pin jack A x 2 | | | | |

DISASSEMBLY



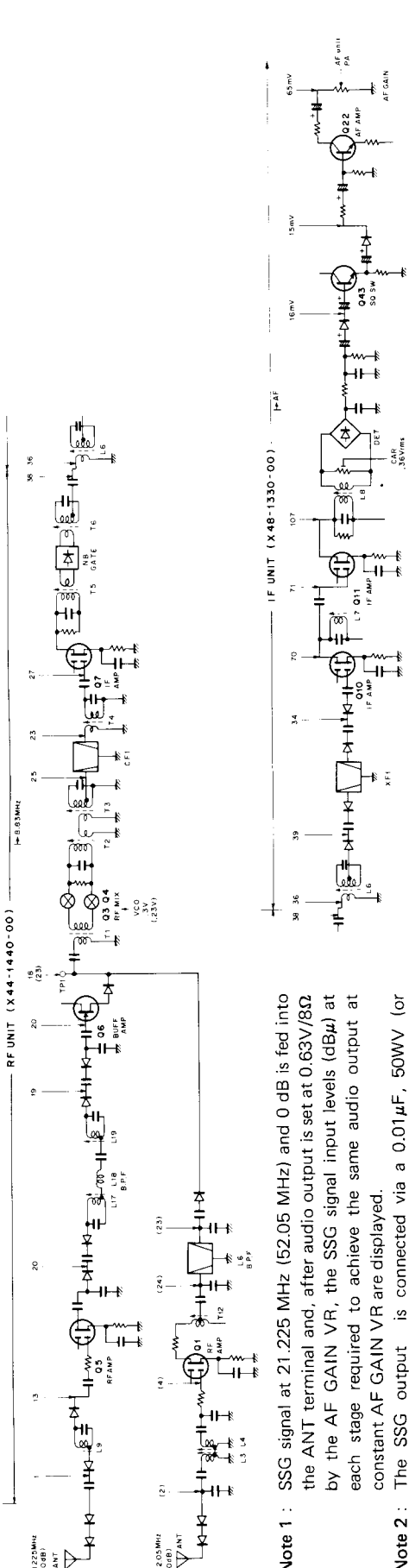
TS-660

DISASSEMBLY



LEVEL DIAGRAM

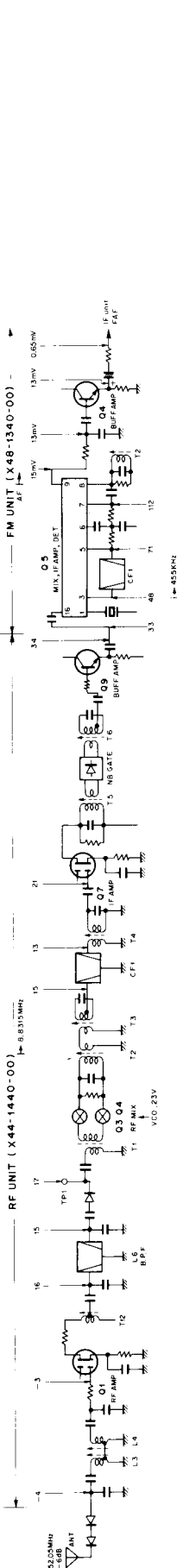
RECEIVER SECTION (21, 50MHz BAND SSB)



Note 1 : SSG signal at 21.225 MHz (52.05 MHz) and 0 dB is fed into the ANT terminal and, after audio output is set at 0.63V/8Ω by the AF GAIN VR, the SSG signal input levels (dBμ) at each stage required to achieve the same audio output at constant AF GAIN VR are displayed.

Note 2 : The SSG output is connected via a 0.01μF, 50WV (or Greater) capacitor.

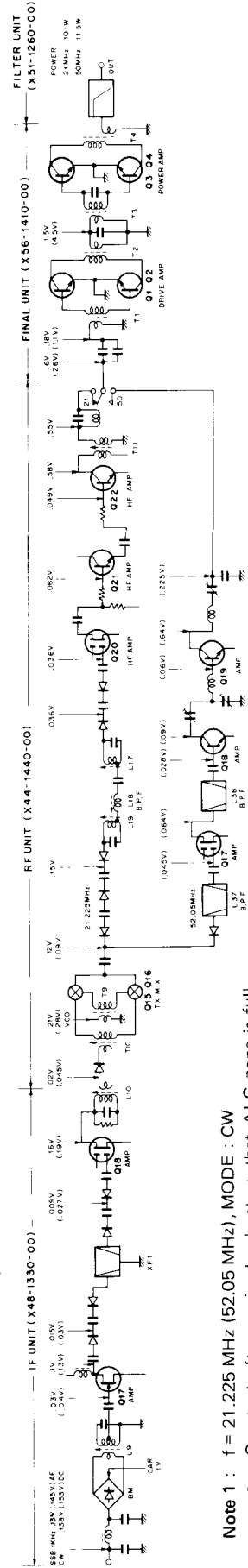
RECEIVER SECTION (50MHz BAND FM)



Note 1 : SSG unmodulated signal at 52.05 MHz and -6 dB is fed to the ANT terminal, and the SSG signal input levels (dBμ) required to achieve 20 dB noise quieting in the FM mode.

Note 2 : The SSG output is connected via a 0.01μF, 50WV (or Greater) capacitor.

TRANSMITTER SECTION (21, 50MHz BAND CW)



Note 1 : f = 21.225 MHz (52.05 MHz), MODE : CW

Note 2 : Constant after carrier level set so that ALC zone is full scale.

Note 3 : Measurement is made by a P type variable volume, a probe with a input capacity of 3pF or less is used and the ground point is near the extreme measuring point.

ADJUSTMENT

REQUIRED TEST EQUIPMENT

1. DC Voltmeter

- 1) Input resistance : More than 1 MΩ
- 2) Voltage range : 1.5 to 1000V AC/DC

NOTE : A high-precision multimeter may be used. However, accurate readings can not be obtained for high-impedance circuits.

2. DC Ammeter

- 1) Current range : 150 mA, 500 mA, 2A, 10A, High-precision ammeter may be used.

3. RF VTVM

- 1) Input impedance : 1MΩ and less than 3pF, min.
- 2) Voltage range : 10 mV to 300V
- 3) Frequency range : 10 kHz~100 MHz or greater

4. AF Voltmeter

- 1) Frequency range : 50 Hz to 10 kHz
- 2) Input resistance : 1MΩ or greater
- 3) Voltage range : 10 mV to 30 V

5. AF Generator (AG)

- 1) Frequency range : 200 Hz to 5 kHz
- 2) Output : 1mV or less ~1V, low distortion

6. AF Dummy Load

- 1) Impedance : 8Ω
- 2) Dissipation : 3W or greater

7. Oscilloscope

Requires high sensitivity, and external synchronization capability.

8. Sweep Generator

- 1) Center frequency : 5 MHz~60 MHz
- 2) Frequency deviation : Maximum±16 MHz
- 3) Output voltage : 0.1 V or greater
- 4) Sweep rate : At least 0.5sec/cm

9. Standard Signal Generator (SSG)

- 1) Frequency range : 8 to 60 MHz
- 2) Output : -20 dB/0.1μV~120 dB/1V
- 3) Output impedance : 50 Ω
- 4) AM and FM modulation can be possible.

NOTE : Generator must be frequency stable.

10. Frequency Counter

- 1) Minimum input voltage : 50 mV
- 2) Frequency range : 60 MHz or greater

11. Noise Generator

Must generate ignition noise containing harmonics beyond 60 MHz.

12. Power Meter

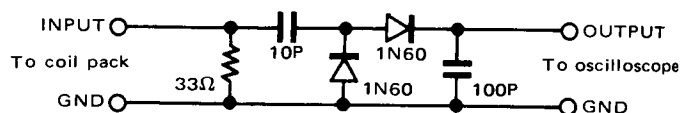
- 1) Impedance : 50Ω
- 2) Dissipation : 15W continuous or greater
- 3) Frequency limits : 60 MHz or greater

13. Spectrum Analyzer

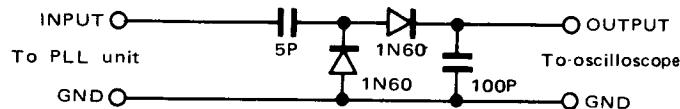
- 1) Frequency range : 100 K to 110 MHz or greater
- 2) Bandwidth : 1 kHz to 3 MHz

14. Detector

- 1) For adjustment of TX BPF



- 2) For adjustment of PLL BPF



15. Directional Coupler

16. Power supply

13.8 V DC. Min 4A

PREPARATION

Unless otherwise specified, set the controls as follows.

| | |
|--------------------|--------------------|
| POWER..... ON | RIT SW..... OFF |
| BAND 50 | NB..... OFF |
| AF MIN | F.LOCK OFF |
| RF MAX | F.STEP OFF |
| MIC MIN | VFO/MEMO VFO |
| CAR MIN | HOLD OFF |
| FUNCTION..... A | SEND/REC REC |
| RIT CEN | MEMORY 3 |
| IF SHIFT CEN | MODE SSB |
| SQL MIN | ALC/RF RF |

The output level of SSG is indicated as SSG's open circuit.

ADJUSTMENT

VOLTAGE ADJUSTMENTS

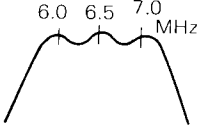
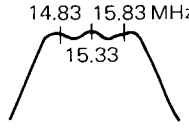
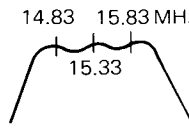
| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks |
|-------------------------------------|---|----------------|------|----------|-------------|---------------------|---------|-------------------------|---------|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| Voltage adjustment and confirmation | POWER : ON RF GAIN : MAX MODE : SSB STBY : REC | DC V.M | IF | 9V | | | | 8.55~9.45V | Confirm |
| | | | | -6V | | | | -5.9~-6.1V | Confirm |
| | | | | 5V | | | | 4.75~5.25V | Confirm |
| | | | | RFG | SW | VR3 | 3.3V | ±0.1V | |
| | | | | RXB | | | | 8.0~9.0V | Confirm |
| | | | | RB | | | | about 1.5V | Confirm |
| | | | | TBL | | | | about -5.9V | Confirm |
| | | | | TXB | | | | 0V | Confirm |
| | | | | TXB | IF | VR12 | 8.8V | ±0.1V ON AIR IND lights | |
| | RXB | | | | 0V | Confirm | | | |
| | RB | | | | about -1.4V | Confirm | | | |
| | TBL | | | | 0.75V | Confirm | | | |
| | STBY : REC | | | | | ON AIR IND goes off | Confirm | | |

PLL ADJUSTMENTS

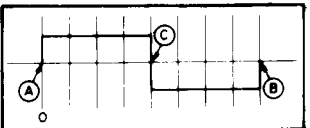
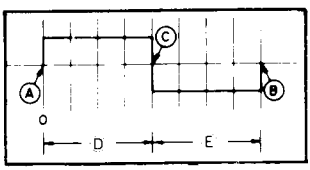
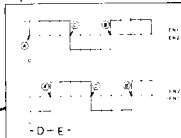
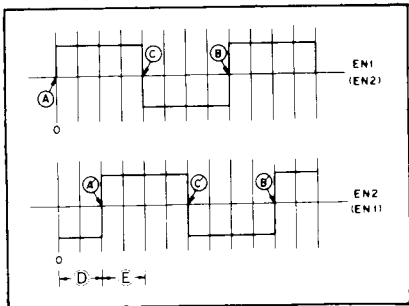
| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks | | | |
|---------------------------------------|--|----------------|---------|-------------|------------|-------|--------------|---|--|--------------|---------|------------------|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | | | | |
| 1. Adjustment of standard oscillation | 1) RIT : OFF RIT VR : CENTER | f. counter | Control | D48 cathode | Control | TC1 | 8,000,000 Hz | ±3 Hz | | | | |
| | 2) RIT : ON | | | | | TC3 | | ±50 Hz | RIT IND lights | | | |
| | 3) RIT : Turn full CW, then full CCW. | | | | | | | ±1 kHz or more | Confirm | | | |
| | 4) RIT : OFF | | | | | | | | | | | RIT IND goes off |
| | 5) MODE : CW ANT : DUMMY LOAD STBY : SEND | | | | | | | | VR3 | 8,000,800 Hz | ±50 Hz | |
| | 6) STBY : REC | | | | | | | | | | | |
| | 7) MODE : FM | | | | | | D39 cathode | Control | TC2 | 8,731,500 Hz | ±50 Hz | |
| | 8) MODE : AM | | | | | | | | | | ±200 Hz | Confirm |
| 2. VCO-1 | 1) MODE : SSB Display : 51.000.0 | DC V.M | Control | TP1 | Control | L26 | 7.0V | ±0.1V | | | | |
| | 2) Display : 50.999.9 | | | | | | | | 2.4±0.5V | Confirm | | |
| 3. VCO-2 | 1) MODE : SSB Display : 51.000.0 | DC V.M | Control | TP4 | Control | L13 | 2.3V | ±0.1V | | | | |
| | 2) Display : 50.999.9 | | | | | | | | 6.0±1.0V | Confirm | | |
| | 3) Display : 51.000.0 ↓ 51.009.9 | f. counter | | TP2 | | | | 6.000 MHz 2 kHz Steps. 4.002 MHz | This item is confirmed also after adjustment of item 2, VCO-1. | | | |
| 4. VCO-3-1 | 1) BAND : 21 Display : 21.999.9 | DC V.M | PLL | TP1 | PLL | L3 | 6.5V | ±0.1V | | | | |
| | 2) BAND : 24 Display : 24.999.9 | | | | | | | | 6.0 +0.5V -1.0V | Confirm | | |

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ADJUSTMENT

| Item | Condition | Measurement | | | Adjustment | | Specification | Remarks | |
|---------------------|--|---|---------|-----------------------------|------------|--------|--|---|---------|
| | | Test equipment | Unit | Terminal | Unit | Parts | | | Method |
| | 4) BAND : 21 Display : 21.000.0 | | | | | | 2.5±0.5V | | |
| 5. VCO-3-2 | 1) BAND : 28 Display : 29.999.8 | RF V.M | PLL | TP1 | | L6 | 1.9V | ±0.1V | |
| | 2) Display : 28.000.0 | | | | | | | 5.0±0.5V | Confirm |
| 6. VCO-3-3 | 1) BAND : 50 Display : 53.999.9 | RF V.M | PLL | TP1 | | L8 | 7.7V | ±0.1V | |
| | 2) Display : 50.000.0 | | | | | | | 3.0±0.5V | Confirm |
| 7. VCO output check | 1) BAND : 21~50 Display : 1.500.0 | RF V.M | PLL | TP2 | | | | 0.63V +3dB -2dB | Confirm |
| 8. BPF-1 | 1) MODE : SSB or CW Ground TP4 of control unit. Connect sweep GEN. RF output to control unit TP5. | Sweep generator Oscilloscope Detector | Control | Jumper wire on right of C6 | Control | L16~18 | Adjust as shown at right. |  | |
| 9. BPF-2 | 1) MODE : SSB or CW BAND : 21 or 24 | RF V.M | Control | D27 cathode | Control | L1,2 | MAX. | | |
| | 2) Remove control unit connector (1). Connect sweep GEN. RF output to jumper wire at right of C69 on control unit. | Sweep generator Oscilloscope Detector | | Connector (1) | | L4~6 | Adjust as shown at right. |  | |
| 10. BPF-3 | 1) MODE : SSB or CW BAND : 28 or 50 | RF V.M | Control | D28 cathode | Control | L3 | MAX. | | |
| | 2) Remove control unit connector (1). Connect sweep GEN. RF output to jumper wire at right of C69 on control unit. | Sweep generator Oscilloscope Detector | | Connector (1) | | L7~9 | Adjust as shown at right. |  | |
| 11. BPF-4 | | RF V.M | Control | IC11 5 PIN | Control | L30,31 | MAX. | | |
| 12. BPF-5 | 1) RIT : OFF | RF V.M | Control | D48 cathode | Control | L34,35 | MAX. | | |
| 13. MIX Balance | | Spectrum analyzer | Control | Jumper wire at right of C69 | Control | VR1 | Adjust for minimum adjacent spurious response. | | |

ADJUSTMENT

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks | |
|------------------------|---|---|---------|---|------------|-------|---|--|------------------------|---|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | | |
| 14. Encoder adjustment | 1) Remove the VFO knob and motor-drive the encoder at approx 300 rpm. | Oscilloscope | Digital | Connector ② EN1 terminal | Encoder | VR1 |  | Point C may be located anywhere. When a motor is not available, manually turn the VFO to check the duty ratio. | | |
| | 2) EN1 duty ratio adjustment : Turn a motor CW and CCW | | |  | | | After adjusting with the VFO control turned CW, check that intervals D and E are also identical when the VFO control is turned CCW. | | | |
| | 3) EN2 duty ratio adjustment : Turn a motor in the both direction. | | | Connector ② EN2 terminal | | | | | VR2 | Adjust until intervals D and E are equal to each other with point C placed at the center. |
| | 4) EN1-EN2 phase difference alignment : Same as above. | | | Connector ② EN1 and EN2 terminals | | | | | Phase adjustment screw |  |
| | |  | | Adjust until intervals D and E are equal to each other (point A' on EN2 is located in the middle of points A and C on EN1.) | | | | | | |

RX ADJUSTMENTS

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks | |
|---|----------------------------------|----------------|------|----------|------------|-------|---|-----------------|---------|--|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | | |
| 1. CAR level and frequency | 1) MODE : SSB IF SHIFT : CEN. | RF V.M | IF | CAR | IF | L1 | 0.26V Adjust CCW from peak turn slug OUT. | | | |
| | | f. counter | | | | | TC1 | 8,831,500 Hz | ±50 Hz | |
| | 2) MODE : CW | | | | | | | 8,831,500 Hz | Confirm | |
| | 3) MODE : AM | | | | | | | Stopped | | |
| | 4) MODE : FM | | | | | | | Stopped | | |
| | 5) MODE : SSB STBY : SEND | | | | | | VR2 | 8,831,500 Hz | ±10 Hz | |
| | 6) MODE : CW STBY : SEND | | | | | | VR1 | 8,830,700 Hz | | |
| | 7) MODE : AM STBY : SEND | | | | | | | 8,831,500 Hz | Confirm | |
| | 8) MODE : FM STBY : SEND | | | | | | | Stopped | | |
| 9) MODE : CW STBY : REC IF SHIFT : Turn full CW, and CCW. | | | | | | | Center frequency is standard | ±900 Hz or more | | |

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ADJUSTMENT

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks |
|-----------------------|---|---|------|----------|------------|--|---|---|---------|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| 2. 50 MHz BPF | 1) BAND : 50 ANT SW : 21~50 Remove connector ⑤ (VCO input). Connect RF output of sweep GEN. to ANT terminal. | Sweep generator Oscilloscope Detector | RF | TP1 | RF | L3,4 L6 T12 | | | |
| 3. IF | 1) BAND : 52 VFO : 52.100.0 MODE : SSB 2) MODE : FM | SSG | | EXT.SP | RF | VR1 T2~6 | MAX. | Must be 1V/8Ω or more at maximum AF gain with SSG output of -6dB. | |
| | | | | | IF | L6~8 | | | |
| 4. HF ANT Coil | 1) BAND : 21 VFO : 21.225.0 | SSG AF VM AF DUMMY LOAD Oscilloscope | | EXT.SP | RF | L9 | MAX. | | |
| | 2) BAND : 24 VFO : 24.920.0 | | | | L10 | | | | |
| | 3) BAND : 28 VFO : 28.800.0 | | | | L11 | | | | |
| 5. RX carrier balance | 1) IF SHIFT VR : CEN. RF GAIN : Turn full CCW. BAND : 52 | RF V.M | IF | TP | IF | VR3 TC3 | MIN. Adjust by repeating alternately. Sufficient when RF V.M reads minimum in the 0.03V range. | (0.01V or less) | |
| 6. S Meter | 1) BAND : 52 VFO : 52.100.0 RF GAIN : Turn full CW. IF SHIFT : CEN. MODE : CW | SSG S-Meter | | | IF | VR5 | Shut off SSG output. Adjust to mechanical φ point. | | |
| | 2) SSG output 6 dB | | | | L7 | S-1 adjust CCW from peak. (turn slug OUT). | 6 dB±4 dB | | |
| | 3) SSG output 20 dB | | | | VR4 | S-9 | 20 dB±6 dB | | |
| | 4) MODE : FM SSG output : 30 dB | | | | FM IF | VR2 | Full scale | | |
| 7. SQ | 1) SQ : 12 O'clock MODE : CW | SP. | | EXT.SP | IF | VR11 | Adjust VR slowly and stop at threshold. | | |
| 8. IF trap. | 1) BAND : 21 SSG output : 8.830 MHz 80dB | SSG AF V.M AF DUMMY LOAD Oscilloscope | | EXT.SP | RF | L29 | MIN. | 70 dB or more | |
| 9. Noise Blanker | 1) BAND : 52 NB : ON SSG output : 52.1 MHz | SSG DC V.M | RF | TP2 | RF | T7,8 | MIN. (First adjust SSG output to 60 dB, then using the minimum input as possible.) | | |

ADJUSTMENT

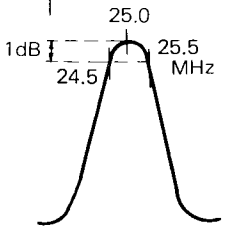
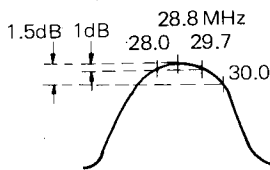
| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks |
|------|--|-----------------|------|----------|------------|-------|--|---|---------|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| | 2) Connect noise generator output to ANT terminal. | Noise generator | | | RF | T5 | Adjust in core removal direction to effective position at low input level. | Must be effective at large and small outputs. | |

TX ADJUSTMENTS

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks |
|---------------------------------|--|---|-------|---------------------------|------------|-----------------|---|-----------------------------|---|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| 1. Base idle current | 1) Remove DRV connector from RF unit. STBY : SEND | DC A.M | Final | A | Final | VR1 | If adjustment to 300 mA is not possible, 200 mA or more at position where reduced about 10 mA from about 10 mA from VR MAX. | 300 mA. (200~300 mA) | Remove jumper between A and B |
| | | | | | | | | | |
| | 2) Reconnect DRV connector STBY : REC | | | B | | VR2 | Resolder A to B | 100 mA | NOTE : First turn power supply off. |
| 2. 50 MHz TX. BPF | 1) BAND : 50 Store the following frequencies in memory ① 50.000.0 ② 52.000.0 ③ 53.999.9 VFO/MEMO : MEMO CAR VR : Full CW. Remove connector ⑤ and attach sweep GEN. STBY : SEND | Sweep generator Oscilloscope Detector Power meter Directional coupler | | ANT (Directional coupler) | RF | TC1~3 T10 | First, connect connector ⑤ and obtain peak at 52M. * There is a 52M marker output at MEMORY 2. | | |
| | Final | | | | TC1 | | | | |
| | 2) STBY : REC VFO/MEMO : VFO Reinstall connector ⑤ | | | | RF | L37,38 TC1~3 | Adjust as shown at right. When adjusting TC1,2,3 tune so that curve is raised to 52M. | | 1) Adjust at minimum inputs as possible. 2) Use MEMORY as marker. |
| 3. 21 MHz BPF. (Common with RX) | 1) BAND : 21 Store the following frequencies in memory ① 21.000.0 ② 21.225.0 ③ 21.450.0 VFO/MEMO : MEMO CAR VR : Full CW Remove connector ⑤ and attach sweep GEN. STBY : SEND | Sweep generator Oscilloscope Detector Power meter Directional coupler | | ANT (Directional coupler) | RF | L17~19 | Adjust as shown at right. | | |
| | | | | | | | | | |
| | | | | | | | Adjust as shown at right. | | 1) Adjust using the minimum input possible. 2) Use MEMORY as marker. |

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ADJUSTMENT

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks |
|--|---|---|------|------------------------------|------------|--------|---------------------------|---|---|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| | 2) STBY : REC VFO/MEMO : VFO Reinstall connector ⑤ | | | | | | | | |
| 4. 24.5 MHz BPF (Common with RX) | 1) BAND : 24 Store the following frequencies in memory. ① 24.500.0 ② 25.000.0 ③ 25.500.0 VFO/MEMO : MEMO CAR VR : Full CW Remove connector ⑤ and attach sweep GEN. Remove connector to disable transmission. STBY : SEND | Sweep generator Oscilloscope Detector Power meter Directional coupler | | ANT (Directional coupler) | RF | L20~22 | Adjust as shown at right. |  | 1) Adjust using the minimum input possible. 2) Use MEMORY as marker. |
| | 2) STBY : REC VFO/MEMO : VFO Reinstall connector ⑤. Insert connector enable transmission | | | | | | | | |
| 5. 28 MHz BPF (Common with RX) | 1) BAND : 28 Store the following frequencies in memory ① 28.000.0 ② 28.800.0 ③ 29.700.0 ④ 30.000.0 VFO/MEMO : MEMO CAR VR : Full CW Remove connector ⑤ and attach sweep GEN. STBY : SEND | Sweep generator Oscilloscope Detector Power meter Directional coupler | | ANT (Directional coupler) | RF | L23~25 | Adjust as shown at right. |  | 1) Adjust using the minimum input possible 2) Use MEMORY as marker. |
| | 2) STBY : REC VFO/MEMO : VFO Reinstall connector ⑤ | | | | | | | | |
| 6. SWR After this adjustment perform 7. Adjustment of power and 9. Adjustment of protection | 1) BAND : 53 VFO : 53.999.9 Filter unit VR1 : Full CW MODE : CW CAR VR : Full CW STBY : SEND | Power meter | | ANT (21~50) | Filter | TC1 | Power to maximum. | | |
| | 2) STBY : REC | | | | | | | | |

TS-660

ADJUSTMENT

| Item | Condition | Measurement | | | Adjustment | | | Specification | Remarks | | | | | |
|------------------|--|---|-------|------------------------------|------------|-------|-------------------------------|---|---|------|--|---|-----------------|---------|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | | | | | | |
| 13. Deviation | 1) BAND : 50 or 28 MODE : FM AG : 20 mV 1 kHz MIC connector Pins ① and ② STBY : SEND | Linear detector Power meter Directional coupler AG | | ANT (Directional coupler) | FM,IF | VR1 | 5 kHz | | | | | | | |
| | 2) AG : 2 mV | | | | | | | | | | | | 3.5 kHz or less | Confirm |
| | 3) STBY : REC | | | | | | | | | | | | | |
| 14. FM.CAR | 1) BAND : 50 or 28 MODE : FM STBY : SEND | f.counter | FM,IF | D2 cathode | FM,IF | TC1 | 8.831.500 Hz | ±100 Hz | | | | | | |
| 15. Side tone | 1) MODE : CW AF GAIN : 12 O'clock KEY jack : KEY STBY : SEND | Power meter Oscilloscope AF V.M AF DUMMY LOAD | | EXT.SP | IF | VR8 | KEY DOWN | 0.63V/8Ω | Must be no distortions at 800 Hz level. | | | | | |
| | 2) STBY : REC | | | | | | | | | VR10 | KEY DOWN | Confirm to change time to return to RX. Then set to center. | | |
| | 3) Remove KEY | | | | | | | | | | | | | |
| 16. ALC,RF meter | 1) MODE : SSB MIC GAIN : Full CCW Meter : ALC BAND : 21 STBY : SEND | Power meter Oscilloscope AF V.M AF DUMMY LOAD | | | IF | VR13 | Adjust to mechanical φ point. | <p>Meter reading</p> <p>Set point</p> <p>VR3 Adjustment</p> <p>Mechanical φ point</p> | | | | | | |
| | 2) MIC GAIN : Set S scale at S-1. MIC : AG (5 mV, 1.5 kHz) | | | | | | | | | VR7 | 1) Raise AG output 3 dB from 5 mV. 2) Adjust to ALC zone maximum. | | | |
| | 3) Meter SW : RF | | | | | | | | | VR9 | Adjust to S-8. | | | |
| | 4) STBY : REC | | | | | | | | | | | | | |

ADJUSTMENT

Micro-processor operational check

| Item | Conditions | Specification |
|-------------------|---|---|
| 1. BAND | 1) Power source connector: connect plug (13.8V) POWER SW : ON | With POWER SW ON, a tone is heard and meter lamps and display tube lights. (50.000.0) |
| | BAND : Push UP button once. | 51.000.0 is displayed and tone is heard. |
| | Push UP button continuously | 24.000.0→28.000.0→29.000.0→50.000.0 21.000.0→53.000.0→52.000.0→51.000.0 Continuous display and simultaneous tones. |
| | BAND : Push DOWN button once. | Display frequency decreases by 1 and simultaneously tone sounds. |
| | Push DOWN button continuously | Continuous display in reverse of UP and simultaneous tones heard. |
| 2. FUNCTION | 1) ANT : 21-28, 50 Two connections POWER meter FUNCTION : A, B, B-R, A-R MODE : SSB | STBY : REC→SEND→REC A : $\overset{\curvearrowright}{\rightarrow}$ → $\overset{\curvearrowright}{\rightarrow}$ → $\overset{\curvearrowright}{\rightarrow}$ B : $\overset{\curvearrowleft}{\leftarrow}$ → $\overset{\curvearrowleft}{\leftarrow}$ → $\overset{\curvearrowleft}{\leftarrow}$ B-R : $\overset{\curvearrowleft}{\leftarrow}$ → $\overset{\curvearrowright}{\rightarrow}$ → $\overset{\curvearrowleft}{\leftarrow}$ A-R : $\overset{\curvearrowright}{\rightarrow}$ → $\overset{\curvearrowleft}{\leftarrow}$ → $\overset{\curvearrowright}{\rightarrow}$ |
| | 3. F.STEP | Frequency changes at one VFO turn, frequency increases CW, decreases CCW. |
| 4. MEMORY read-in | 1) F.STEP : OFF MODE : SSB-CW-AM | 10 kHz change by one turn of VFO knob. |
| | 2) F.STEP : ON | 100 kHz change. IND lamp is lit simultaneously. |
| | 3) MODE : FM | 100 kHz change. |
| | 4) F.STEP : OFF | About 500 kHz change, IND lamp extinguished. |
| 4. MEMORY read-in | 1) BAND : 21 MEMORY : 1 M : ON | The tone sounds. |
| | 2) BAND : 24 MEMORY : 2 M : ON | The tone sounds. |
| | 3) BAND : 28 MEMORY : 3 M : ON | The tone sounds. |

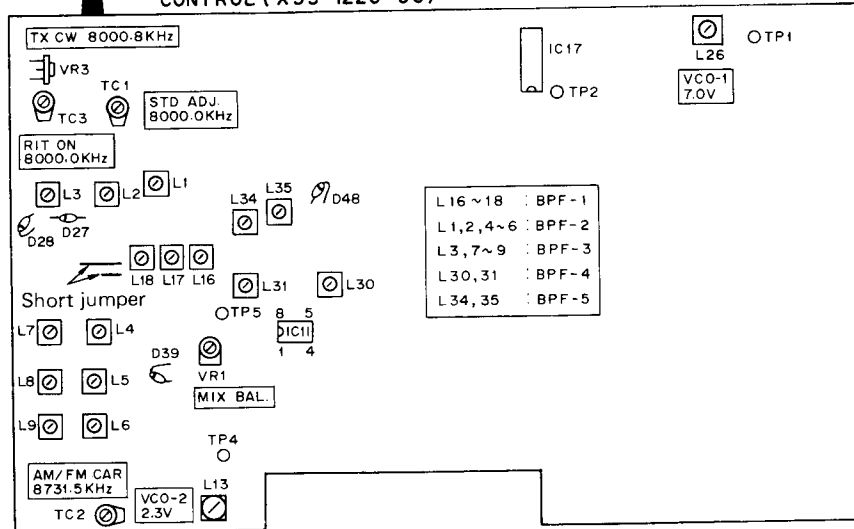
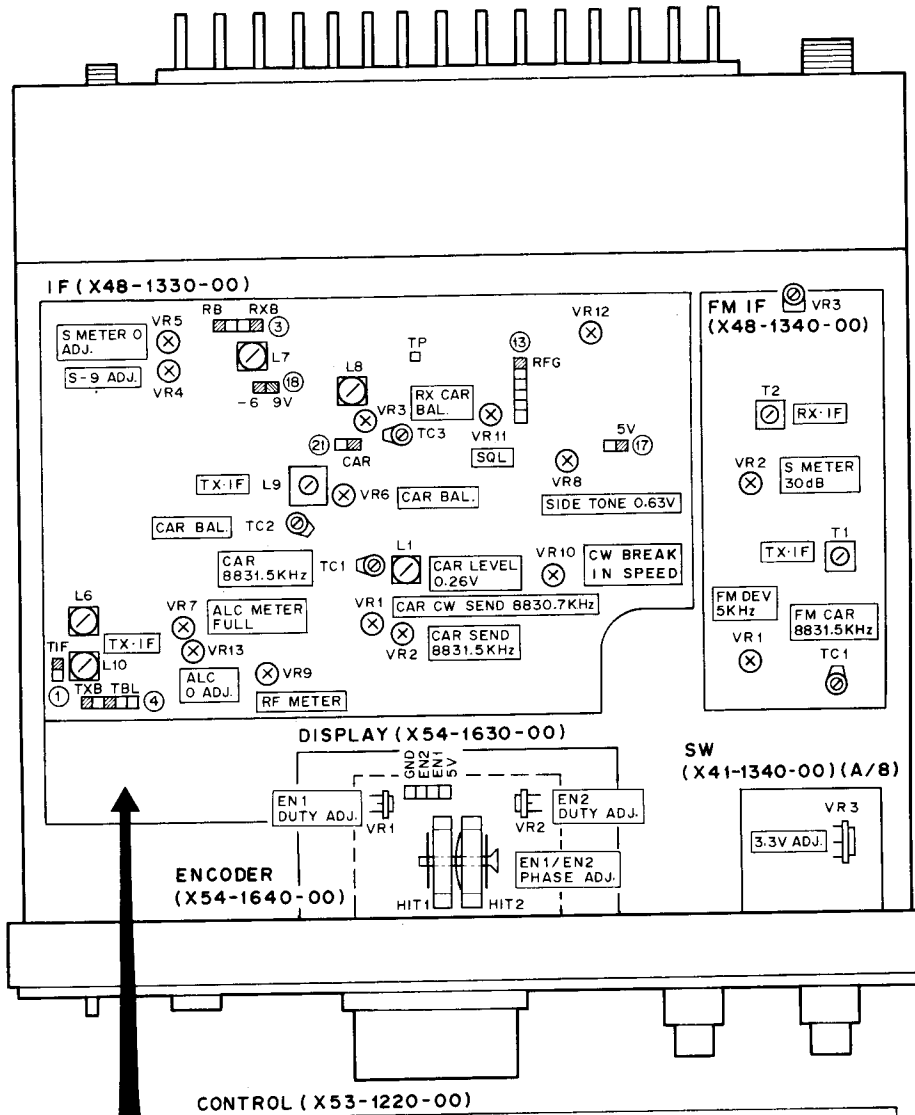
| Item | Conditions | Specification |
|-------------------------|---|--|
| | 4) BAND : 29 MEMORY : 4 M : ON | The tone sounds. |
| | 5) BAND : 50 MEMORY : 5 M : ON | The tone sounds. |
| 5. MEMORY Call | 1) BAND : 51 VFO/MEMO : MEMO MEMORY : 5 | 5 50. 4 29. 3 28. 2 24. 1 21. |
| | 2) VFO/MEMO : VFO | 51. |
| 6. SCAN and HOLD F.LOCK | 1) MEMORY : SCAN STBY seen at SEND and REC. | 1) Scan from 1st MEMORY every 2.5 sec. (REC). 2) Stop SCAN by SEND and SCAN again during REC. |
| | 2) HOLD : ON | SCAN stopped. |
| | 3) MEMORY : 1 HOLD : OFF F.LOCK : ON | VFO-BAND operation stopped. IND lamp lights, simultaneously. |
| | 4) VFO/MEMO : MEMO Switch to 1, 2, 3, 4, 5 | Switch to normal |
| | 5) VFO/MEMO : VFO F.LOCK : OFF | IND lamp extinguished. |
| | 6) MODE : FM MIC : insert (MIC accessory) Push UP once. | 10 kHz display increases by one. |
| | Push UP continuously. | Continuous increases in 10 kHz steps. |
| | Push DOWN once. | 10 kHz display decreases by one |
| | Push DOWN continuously. | Continuous decreases in 10 kHz step. |

TS-660

ADJUSTMENT

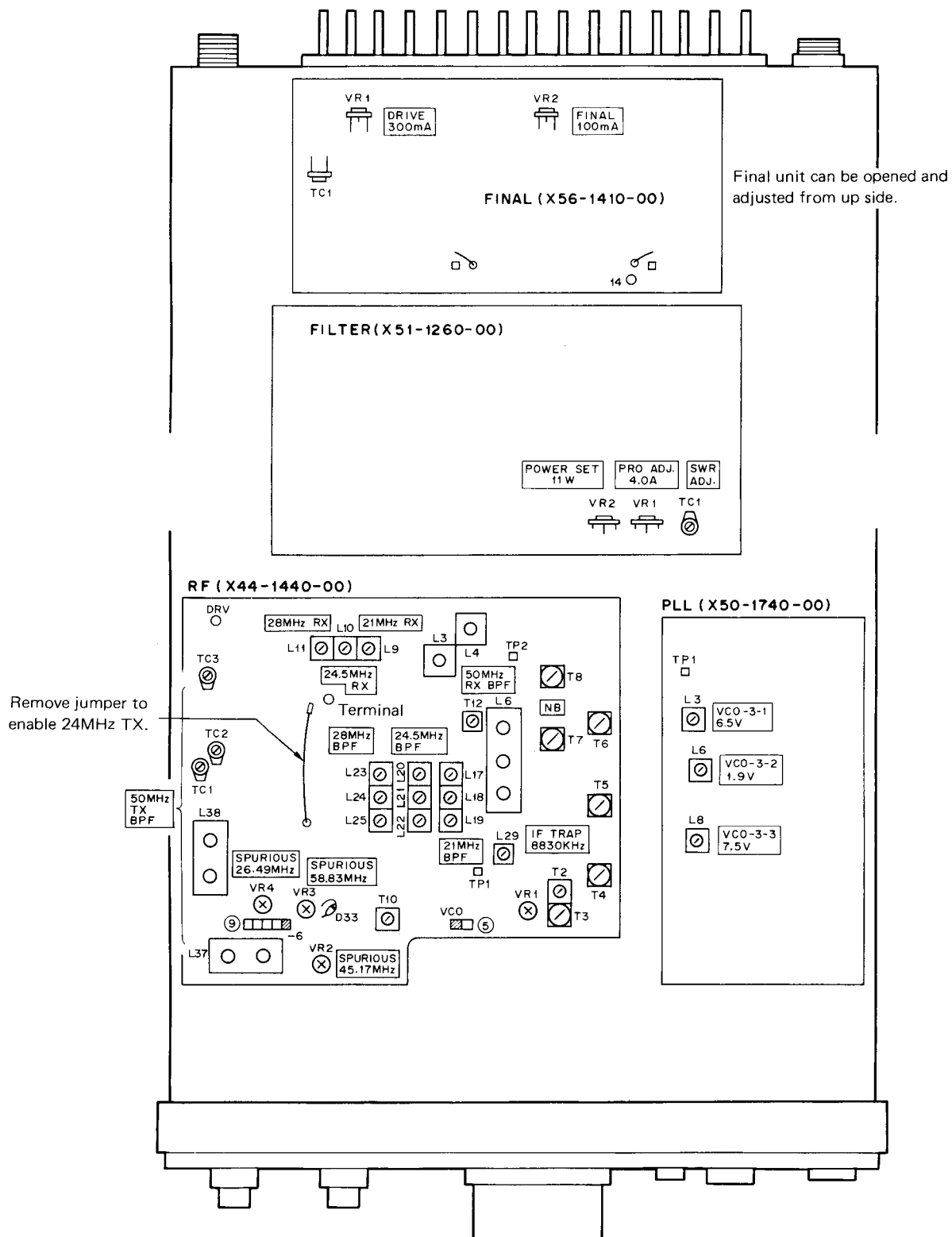
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TOP VIEW



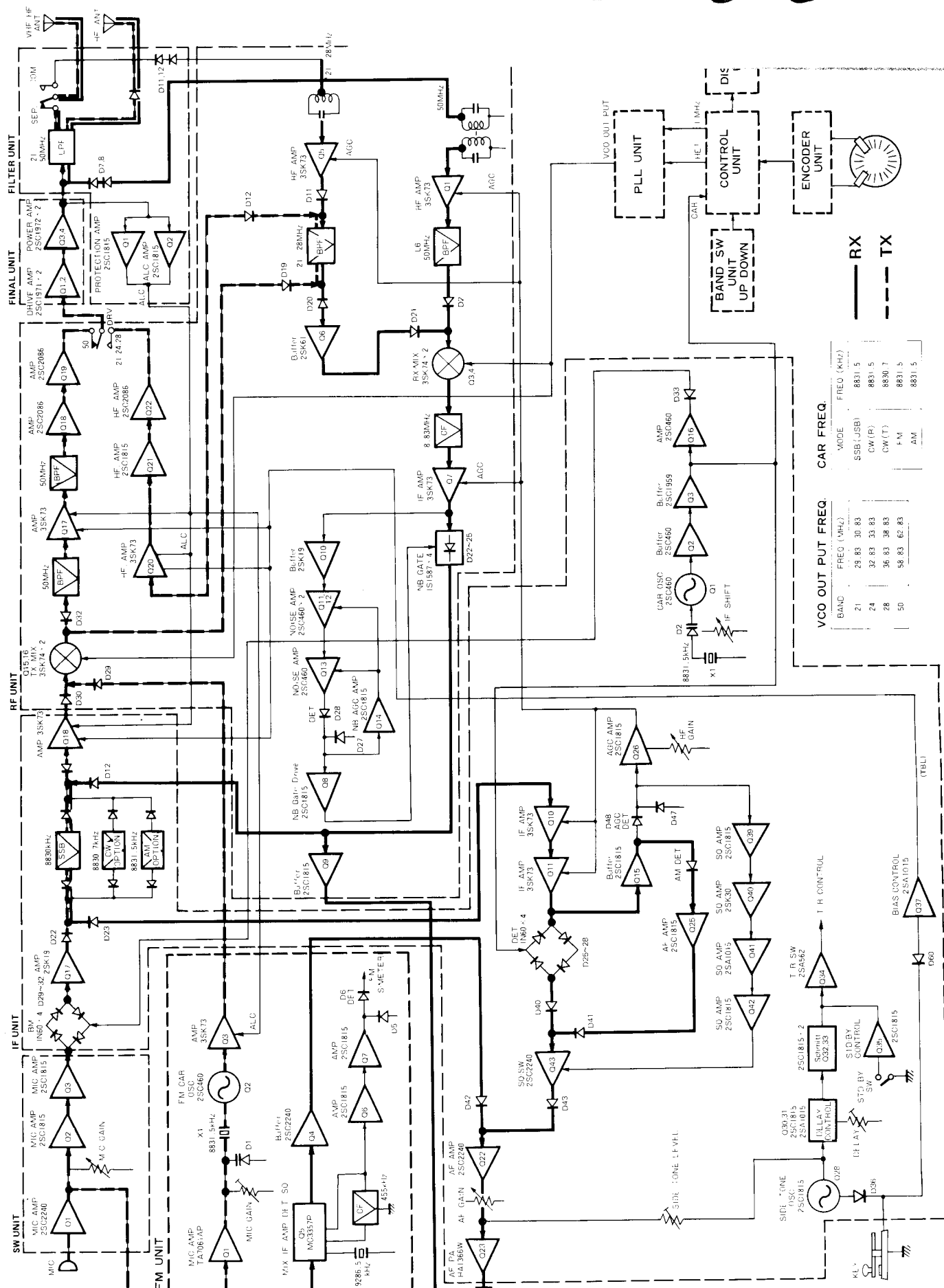
ADJUSTMENT

BOTTOM VIEW



TS-660 BLOCK DIAGRAM

CE3CBQ



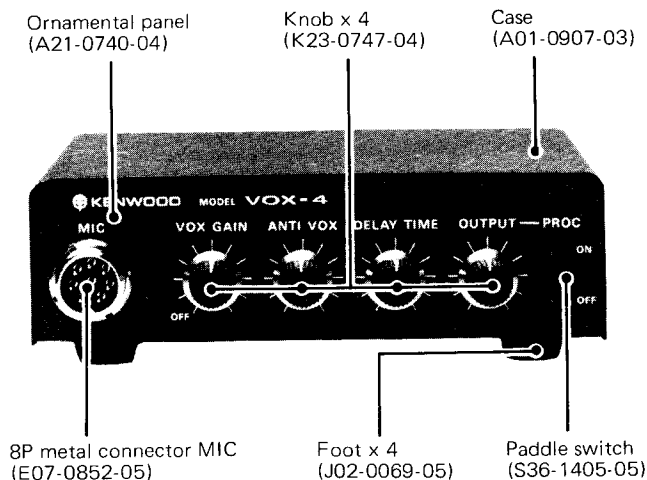
CE3CBQ

VOX-4

SPECIFICATIONS

Microphone impedance: 500 Ω ~ 50 k Ω
VOX sensitivity: Less than 5 mV (MIC input at 1.5 kHz, max. VOX GAIN)
Processor: 20 dB (compression) at 1.5 kHz, 10 mV input
Power requirement: DC 9V, 15 mA max. (supplied from transceiver)
Dimensions (mm): 132 (136)W x 39 (46) H x 114 (127) D
 (Figures in () include projections.)
Weight: 0.6 kg (1.3 lbs)

OUTSIDE VIEWS



PARTS LIST

N : New parts

| Ref. No. | Parts No. | Re- marks | Description |
|----------------------|-------------|--------------|----------------------|
| VOX-4 GENERAL | | | |
| | A01-0907-03 | N | Case |
| | A21-0740-04 | N | Ornamental panel |
| | B46-0404-00 | | Warranty card K |
| | B50-3916-00 | N | Operating manual |
| | E07-0852-05 | | 8P metal connector |
| | E30-1690-05 | N | 7P MIC cable |
| | H01-2767-03 | N | Carton case (insdie) |
| | H12-0484-03 | N | Cushion |
| | H25-0079-04 | | Protective bag |
| | J02-0069-05 | | Foot x 4 |
| | J42-0422-05 | | Cord bushing |
| | J61-0019-05 | | |
| | J61-0401-05 | | |
| | K23-0747-04 | N | Knob x 4 |

| Ref. No. | Parts No. | Re- marks | Description |
|----------|-------------|--------------|--|
| | N13-0308-04 | N | Ornamental nut x 4 Pot. |
| | N30-2004-46 | | |
| | N35-3006-45 | | Bind screw x 4 Case |
| | N87-3006-46 | | Self tapping screw x 6 |
| | N89-3006-46 | | Bind tapping screw x 4 Foot |
| | R01-1401-05 | N | Pot. 1k Ω (B) ANTI VOX |
| | R01-3418-05 | N | Pot. 10k Ω (A) OUTPUT |
| | R01-4410-05 | N | Pot. with SW 50k Ω (B) VOX GAIN |
| | R01-6402-05 | N | Pot. 250k Ω (B) DELAY TIME |
| | S36-1405-05 | N | Paddle switch |
| | X54-0001-03 | N | VOX unit |
| | X54-1650-00 | N | Processor unit |

VOX UNIT (X54-0001-03)

| | | | |
|--------|--------------|----|------------------|
| C2 | CE04W0F470 | E | 47 μ F 3.15V |
| C5 | CE04W1H3R3M | E | 3.3 μ F 50V |
| C6 | CE04W1H010 | E | 1 μ F 50V |
| C9, 10 | CE04W1H3R3 | E | 3.3 μ F 50V |
| C24 | CC45SL1H331K | C | 330pF |
| | E23-0005-04 | | Terminal x 11 |
| T1 | L13-0001-05 | | Input trans |
| | R92-0150-05 | | Short jumper |
| Q1-4 | V03-1815-06 | TR | 2SC1815 (Y) |
| Q5 | V01-1015-06 | TR | 2SA1015 (Y) |
| Q6 | V03-1815-16 | TR | 2SC1815 (GR) |
| Q7 | V03-1815-06 | TR | 2SC1815 (Y) |
| Q8 | V01-0032-05 | TR | 2SA562 (Y) |
| D1-4 | V11-0051-05 | | Diode 1N60 |
| D5 | V11-0076-05 | | Diode 1S1555 |
| D6, 7 | V11-0051-05 | | Diode 1N60 |

PROCESSOR UNIT (X54-1650-00)

| | | | |
|--------------|--------------|----|-----------------------|
| C1, 2 | CC45SL1H101J | C | 100pF |
| C3 | CE04W1H010M | E | 1 μ F 50V |
| C4 | CE04W1C100M | E | 10 μ F 16V |
| C5 | CQ92M1H153K | ML | 0.015 μ F |
| C6, 8-10, 12 | CE04W1H010M | E | 1 μ F 50V |
| C13 | CE04W1H4R7M | E | 4.7 μ F 50V |
| C14 | CE04W1H010M | E | 1 μ F 50V |
| C15 | CE04W1C100M | E | 10 μ F 16V |
| C16 | CE04W1H4R7M | E | 4.7 μ F 50V |
| C17 | CE04W1A221M | E | 220 μ F 10V |
| | E06-0853-05 | | 8P male socket MIC |
| | E23-0046-04 | | Square terminal x 7 |
| VR1 | R12-2016-05 | | Trim. pot 5k Ω |
| Q1 | V03-2240-06 | TR | 2SC2240 (GR) |
| Q2 | V03-1815-06 | TR | 2SC1815 (Y) |
| Q3 | V11-1177-26 | IC | μ PC1158H2 |
| Q4 | V03-1815-06 | TR | 2SC1815 (Y) |
| D1 | V11-0051-05 | | Diode 1N60 |

VOX-4

REQUIRED TEST EQUIPMENT

1. AF voltmeter

- 1) Frequency range 50 Hz~10 kHz
- 2) Input resistance More 1MΩ
- 3) Voltage range F.S. = 10 mV~30 V

2. AF generator (AG)

- 1) Frequency range 200 Hz~5 kHz
- 2) Output Max. 1 V, can be reduced to a minimum of 1 mV or less

* Low distortion rate

3. Oscilloscope

* Sensitivity as high as possible and external synchronization possible

4. TS-660

5. Power supply

13.8 VDC minimum 4A.
(Used as TS-660 power source)

Preparatory work

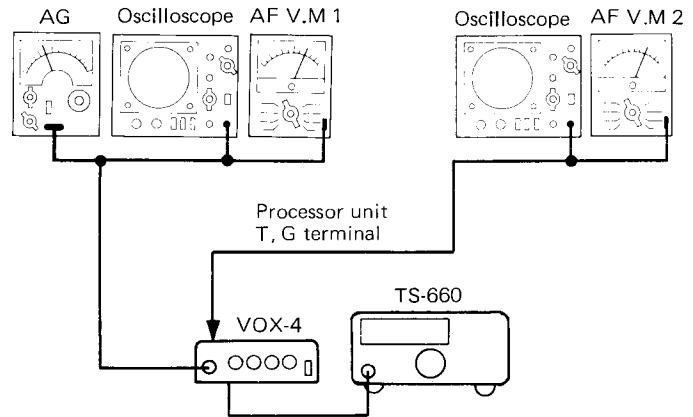
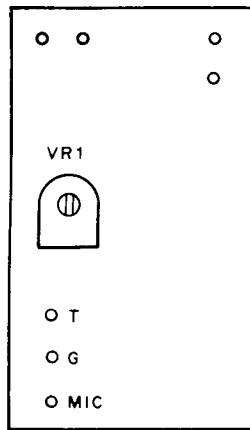
Preset control as follows unless otherwise indicated

| VOX-4 | TS-660 |
|------------|---------------------|
| VOX GAIN | OFF POWER OFF |
| ANTI VOX | CEN MODE SSB |
| DELAY TIME | CEN MIC MIX |
| OUTPUT | MIN IF SHIFT CEN |
| PROC | OFF PUSH SW all OFF |
| | RF MAX |
| | Others Optional |

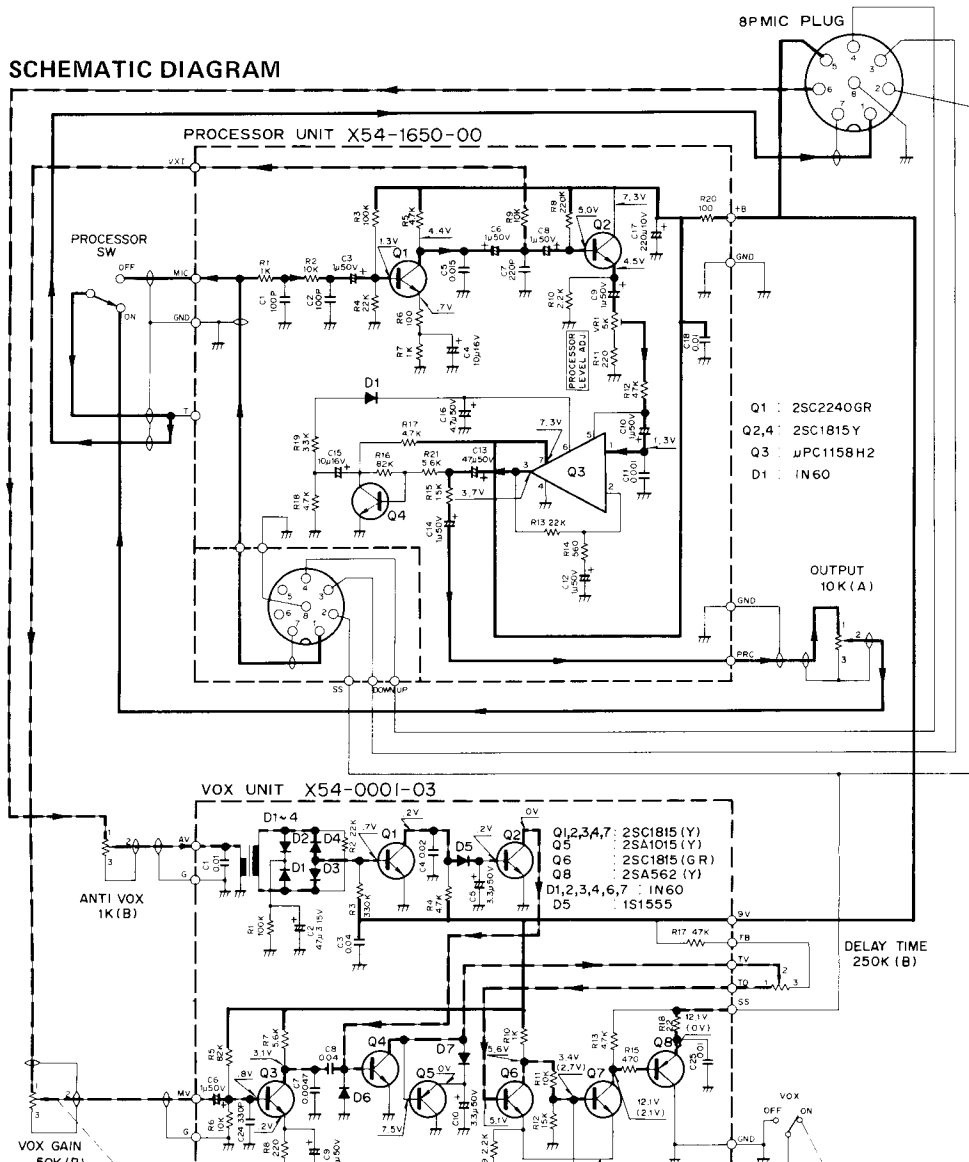
| Item | Condition | Measurement | | | Adjustment | | | Specifications | Remarks |
|-------------------------------------|---|-----------------------------------|-----------|----------|------------|-------|--------|--|--|
| | | Test equipment | Unit | Terminal | Unit | Parts | Method | | |
| 1. Confirmation of output level | AG 1.5 kHz 10 mV POWER (TS-660) : ON PROC : ON Adjust OUTPUT | AF V.M oscillo- scope AG | Processor | T.G | | | | Normal variation must be possible. Output waveform is not abnormal. | |
| | PROC : OFF | | | | | | | About 10mV, and not change when OUTPUT turned. | |
| 2. Confirmation of speech processor | 1) AG 1.5 kHz 10 mV VOX GAIN : OFF PROC : ON Adjust OUTPUT and set AF V.M level at 20 mV. | AF V.M oscillo- scope | Processor | T.G | | | | | |
| | 2) AG 1.5 kHz 1 mV | | | | Processor | VR1 | 14 mV | ±2 dB | After adjustment, reconfirm the 20mV of item 1). |
| 3. Confirmation of VOX sensitivity | AG 1.5 kHz 5 mV Adjust VOX GAIN. | AF V.M | | | | | | ON AIR lights, indicating TX. | |
| 4. Confirmation of ANTI VOX | Connect MIC to MIC terminal of VOX-4, place MIC near speaker, adjust ANTI VOX. | | | | | | | Adjustment must be possible to the point where VOX will not trip. ANTI VOX sensitivity must be at full CW. | |
| 5. DELAY TIME Confirmation | Adjust DELAY TIME | | | | | | | Control must change delay time for maintaining transmission. Maximum time must be at full CW. | |
| 6. Remote UP/DWN | Connect MIC to VOX-4 MIC terminal confirm MIC UP and DOWN operation. | | | | | | | XCVR frequency (and display) must respond to UP and DOWN buttons. | |

VOX-4

PROCESSOR UNIT (X54-1650-00)



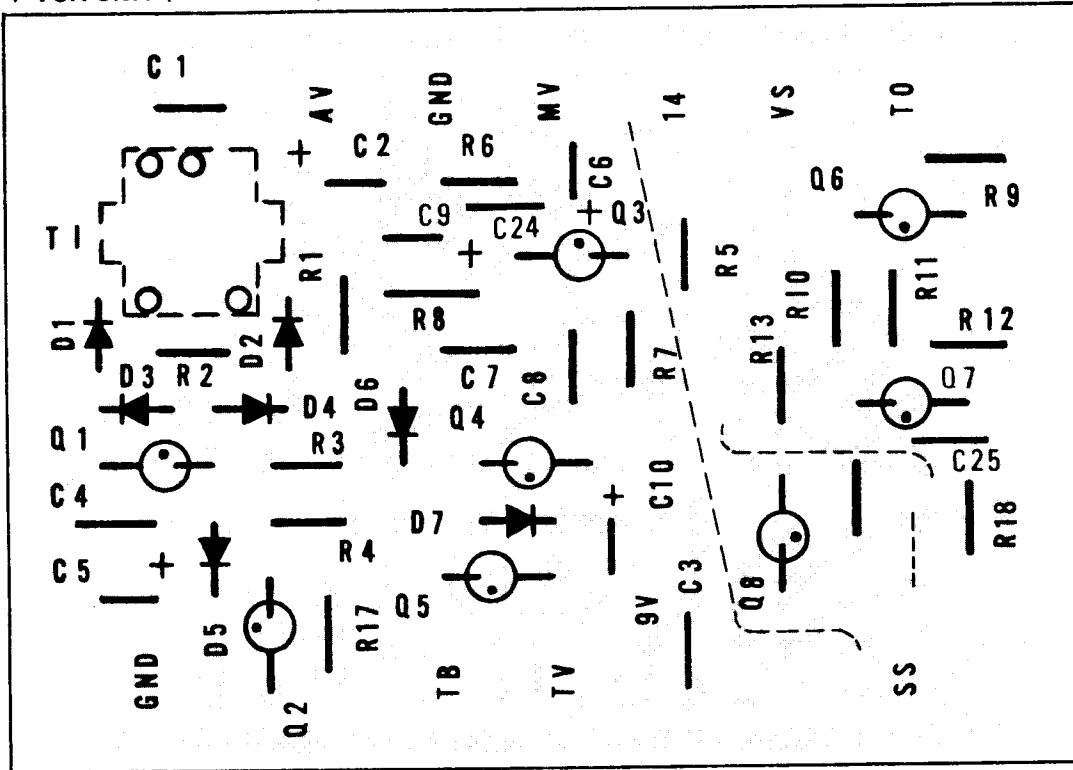
SCHEMATIC DIAGRAM



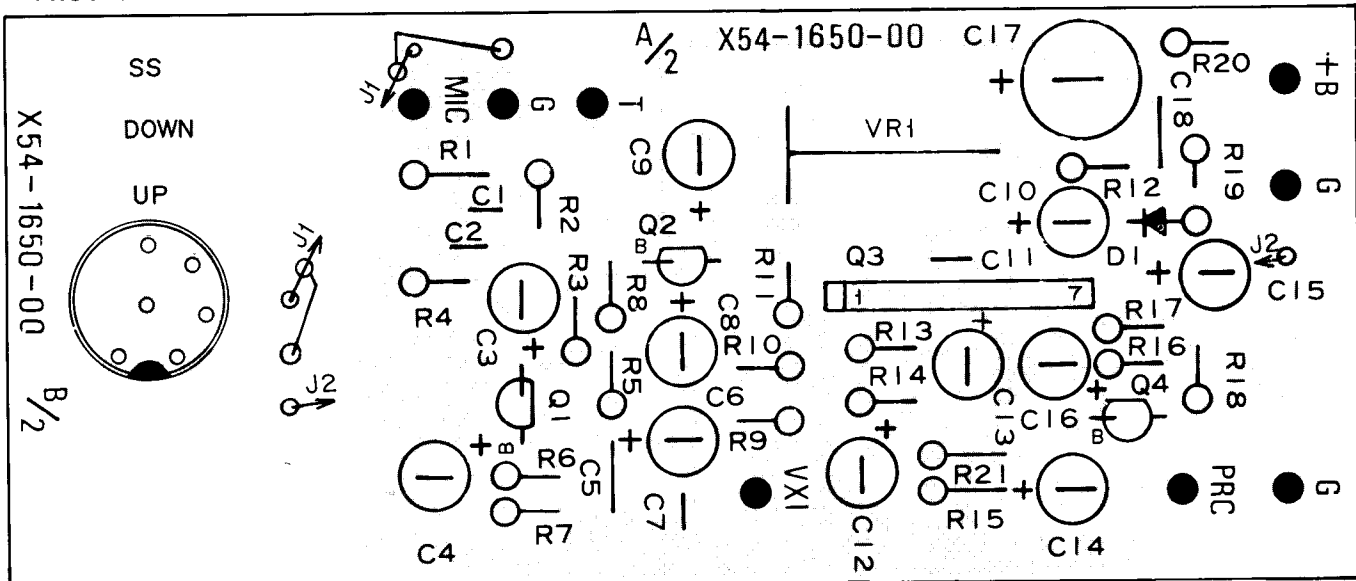
VOX-4

PC BOARDS

▼ VOX UNIT (X54-0001-03) Components side view



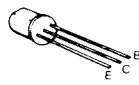
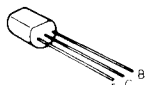
▼ PROCESSOR UNIT (X54-1650-00) Components side view



2SA1015
2SC1815
2SC2240

2SA562

μPC1158H2



TERMINAL FUNCTIONS

| Con- nector No. | Termi- nal No. | Termi- nal name | Function |
|----------------------------------|-------------------|-----------------------|---------------------------------|
| SWITCH UNIT (X41-1340-00) | | | |
| ① | 1 | MIC | MIC AMP input |
| | 2 | GND | |
| ② | 1 | GND | FM MIC AMP Output |
| | 2 | FMC | |
| ③ | 1 | AMB | AM 9V |
| | 2 | CWB | CW 9V |
| | 3 | BM | Balanced MOD. Output |
| | 4 | GND | |
| ④ | 1 | RFG | RF GAIN VOL. GND |
| | 2 | 9V | 9V LINE |
| | 3 | GND | AF GAIN VOL. GND |
| | 4 | AV2 | AF GAIN VOL. Center output |
| | 5 | GND | AF GAIN VOL. GND |
| | 6 | AV1 | AF GAIN VOL. Input |
| ⑤ | 1 | A-R | VFO-A : RX VFO-B : TX |
| | 2 | VB | VFO-B : TX, RX |
| | 3 | B-R | VFO-A : TX VFO-B : RX |
| | 4 | GND | |
| ⑥ | 1 | 9V | 9V LINE |
| | 2 | RIT | RIT ON : Control voltage Output |
| | 3 | RON | RIT ON : High level Output |
| ⑦ | 1 | SSQ | SSB : SQ VOL. Input |
| | 2 | FSQ | FM : SQ VOL. Input |
| | 3 | RXB | RX about 9V |
| | 4 | IFS | IF SHIFT VOL. Input |
| RF UNIT (X44-1440-00) | | | |
| ① | 1 | GND | VHF RX ANT Input |
| | 2 | VRA | |
| ② | 1 | HRA | HF RX ANT Input |
| | 2 | GND | |
| ③ | 1 | RIF | RX IF Output (SSB, CW, AM) |
| | 2 | GND | |
| ④ | 1 | FMI | FM RX IF Output |
| | 2 | GND | |
| ⑤ | 1 | GND | VCO Input |
| | 2 | VCO | |
| ⑥ | 1 | FMT | FM TX IF Input |
| | 2 | GND | |
| ⑦ | 1 | TIF | TX IF Input (SSB, CW, AM) |
| | 2 | GND | |
| ⑧ | 1 | RB | RX IF, RF AMP, G1 BIAS |
| | 2 | 14 | 14V LINE |
| | 3 | AGC | AGC LINE |
| | 4 | RXB | RX about 9V |
| ⑨ | 1 | -6 | -6V LINE |
| | 2 | 9V | 9V LINE |
| | 3 | TBL | TX IF, RF AMP G1 BIAS |
| | 4 | ALC | ALC LINE |
| | 5 | TXB | TX about 9V |
| ⑩ | 1 | 50 | 50M BAND Data input |
| | 2 | 28 | 28M BAND Data input |
| | 3 | 24 | 24M BAND Data input |
| | 4 | 21 | 21M BAND Data input |
| | 5 | NBS | NB switch |
| ⑪ | 1 | 50B | 50M +B Output |
| | 2 | 28B | 24~28M +B Output |
| | 3 | 21 | 21M +B Output |
| | 4 | HFB | 21~28M +B Output |

| Con- nector No. | Termi- nal No. | Termi- nal name | Function |
|------------------------------|-------------------|-----------------------|---------------------------------|
| IF UNIT (X48-1330-00) | | | |
| ① | 1 | GND | TX IF Output (SSB, CW, AM) |
| | 2 | TIF | |
| ② | 1 | RIF | RX IF Input (SSB, CW, AM) |
| | 2 | GND | |
| ③ | 1 | RB | RX IF, RF AMP, G1 BIAS |
| | 2 | 14 | 14V LINE |
| | 3 | AGC | AGC LINE |
| | 4 | RXB | RX about 9V |
| ④ | 1 | -6 | -6V LINE |
| | 2 | 9V | 9V IC Output |
| | 3 | TBL | TX IF, RF AMP, G1 BIAS |
| | 4 | ALC | ALC LINE |
| | 5 | TXB | TX about 9V |
| ⑤ | 1 | RFM | RF METER Input |
| | 2 | RL | TXB control |
| | 3 | -6 | -6V LINE |
| | 4 | 9V | 9V LINE |
| | 5 | ALC | ALC |
| ⑥ | 1 | SSB | SSB 9V |
| | 2 | CWB | CW 9V |
| | 3 | FMB | FM 9V |
| | 4 | AMB | AM 9V |
| | 5 | 9V | 9V LINE |
| ⑦ | 1 | SSB | SSB 9V |
| | 2 | CWB | CW 9V |
| | 3 | AMB | AM 9V |
| ⑧ | 1 | SS | EXT. TX/RX Control |
| | 2 | EXT | EXT. Supply for Relay (TX : ON) |
| | 3 | ELC | EXT. ALC Input |
| ⑨ | 1 | SS | MIC PTT |
| | 2 | RFM | RF METER Output |
| | 3 | SM | S METER Output |
| | 4 | ALM | ALC METER Output |
| ⑩ | 1 | AMB | AM 9V |
| | 2 | CWB | CW 9V |
| | 3 | BM | Balanced MOD. Input |
| | 4 | GND | |
| ⑪ | 1 | SSQ | SSB SQ Control |
| | 2 | FSQ | FM SQ Control |
| | 3 | RXB | RX about 9V |
| | 4 | IFS | IF SHIFT Control |
| ⑫ | 1 | GND | FM AF Input |
| | 2 | FAF | |
| | 3 | FMB | |
| | 4 | FSQ | |
| | 5 | TXB | |
| | 6 | FSM | |
| | 7 | ALC | |
| ⑬ | 1 | RFG | RF GAIN Control |
| | 2 | 9V | 9V LINE |
| | 3 | GND | AF GAIN VOL. Output |
| | 4 | AV2 | |
| | 5 | GND | |
| | 6 | AV1 | |
| ⑭ | 1 | SPO | AF IC Output |
| | 2 | GND | |
| ⑮ | 1 | GND | SPEAKER Output |
| | 2 | SPK | |

TERMINAL FUNCTIONS

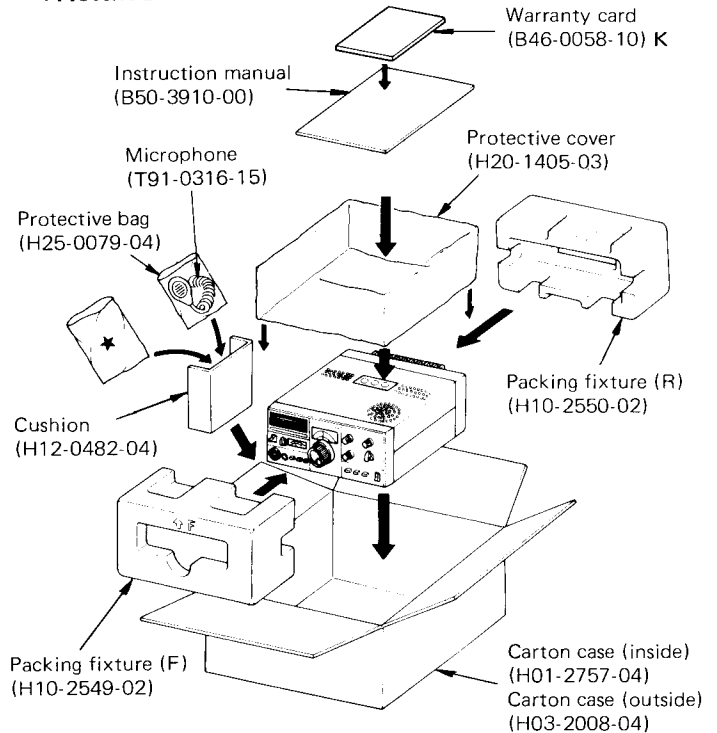
| Con- nector No. | Termi- nal No. | Termi- nal name | Function |
|-----------------------------------|-------------------|-----------------------|---|
| ⑫ | 1 | USP | AF EXT. OUT (Unswitched Speaker output) |
| | 2 | GND | |
| | 3 | GND | |
| | 4 | SPJ | EXT. SP Jack to IF |
| | 5 | KEY | Key LINE |
| | 6 | STS | Sidetone control |
| ⑬ | 1 | 5V | 5V LINE |
| | 2 | TXB | TX about 9V |
| ⑭ | 1 | 9V | 9V LINE |
| | 2 | -6 | -6V LINE |
| ⑮ | 1 | TXB | TX about 9V |
| | 2 | 14S | 14V Input |
| ⑯ | 1 | 5D | 5V IC Output |
| | 2 | GND | |
| ⑰ | 1 | CAR | CARRIER Output |
| | 2 | GND | |
| PLL UNIT (X50-1740-00) | | | |
| ⑱ | 1 | HET | HET signal Input |
| | 2 | GND | |
| ⑲ | 1 | GND | |
| | 2 | VCO | VCO Output |
| ⑳ | 1 | 50 | BAND Data 50M BAND : 9V |
| | 2 | 28 | BAND Data 28M BAND : 9V |
| | 3 | 24 | BAND Data 24M BAND : 9V |
| | 4 | 21 | BAND Data 21M BAND : 9V |
| ㉑ | 1 | GND | |
| | 2 | 1M | 1 MHz Standard signal Input |
| ㉒ | 1 | C | VCO3 Dividing Ratio Data Input |
| | 2 | B | VCO3 Dividing Ratio Data Input |
| | 3 | A | VCO3 Dividing Ratio Data Input |
| ㉓ | 1 | BLK | Display blanking output |
| | 2 | 5V | 5V LINE |
| | 3 | GND | |
| | 4 | 9V | 9V LINE |
| FILTER UNIT (X51-1260-00) | | | |
| ㉔ | 1 | ALC | ALC |
| | 2 | RFM | RF METER |
| | 3 | 9V | 9V LINE |
| | 4 | -6 | -6V LINE |
| | 5 | RL | TXB Control |
| ㉕ | 1 | 50B | 50 MHz +B |
| | 2 | 28B | 28 MHz +B |
| | 3 | 21B | 21 MHz +B |
| | 4 | HFB | 21~28 MHz +B |
| ㉖ | 1 | VRA | VHF RX ANT |
| | 2 | GND | |
| ㉗ | 1 | HRA | HF RX ANT |
| | 2 | GND | |
| CONTROL UNIT (X53-1220-00) | | | |
| ㉘ | 1 | HET | HET Output |
| | 2 | GND | |
| ㉙ | 1 | CAR | CAR Input |
| | 2 | GND | |
| ㉚ | 1 | 1M | 1 MHz Standard signal output |
| | 2 | GND | |
| ㉛ | 1 | RIT | RIT frequency control voltage input |
| | 2 | 9V | 9V LINE |
| | 3 | RON | RIT ON signal (ON : 9V) |

| Con- nector No. | Termi- nal No. | Termi- nal name | Function |
|-----------------------|-------------------|-----------------------|--|
| ⑤ | 1 | AMB | AM 9V |
| | 2 | CWB | CW9V |
| | 3 | SSB | SSB 9V |
| ⑥ | 1 | -6 | -6V LINE |
| | 2 | 5V | 5V LINE |
| | 3 | 9V | 9V LINE |
| | 4 | TXB | TX about 9V |
| ⑦ | 1 | -6 | -6V Line |
| | 2 | 5V | 5V Line |
| | 3 | GND | |
| | 4 | BLK | Blanking |
| ⑧ | 1 | 5V | 5V LINE |
| | 2 | GND | |
| | 3 | 9V | 9V LINE |
| | 4 | BLK | Blanking |
| ⑨ | 1 | NBS | NB switch |
| | 2 | 21 | 21M Band Data |
| | 3 | 24 | 24M Band Data |
| | 4 | 28 | 28M Band Data |
| | 5 | 50 | 50M Band Data |
| ⑩ | 1 | 21 | 21 MHz BAND Data |
| | 2 | 24 | 24 MHz BAND Data |
| | 3 | 28 | 28 MHz BAND Data |
| | 4 | 50 | 50 MHz BAND Data |
| ⑪ | 1 | C | VCO3 Dividing Ratio Output |
| | 2 | B | VCO3 Dividing Ratio Output |
| | 3 | A | VCO3 Dividing Ratio Output |
| ⑫ | 1 | BU | BACK UP supply input (BACK UP terminal input) |
| | 2 | 14A | BACK UP supply input (power supply terminal input) |
| ⑬ | 1 | FL | Frequency LOCK SW L : LOCK |
| | 2 | FS | F.STEP SW |
| | 3 | NBS | NB SW |
| ⑭ | 1 | c | } Display SEGMENT Data output |
| | 2 | b | |
| | 3 | a | |
| | 4 | d | |
| | 5 | g | |
| | 6 | f | |
| | 7 | e | |
| ⑮ | 1 | D1 | Display DIGIT Data output 100 Hz |
| | 2 | D2 | Display DIGIT Data output 1 k |
| | 3 | D3 | Display DIGIT Data output 10 k |
| | 4 | D4 | Display DIGIT Data output 100 k |
| | 5 | D7 | Display DIGIT Data output ch display |
| | 6 | D6 | Display DIGIT Data output 10 M |
| | 7 | D5 | Display DIGIT Data output 1 M |
| ⑯ | 1 | MUP | MIC f UP SW |
| | 2 | MDN | MIC f DOWN SW |
| | 3 | MIN | MEMORY STORE SW |
| | 4 | SH | SCAN HOLD SW |
| | 5 | MR | MEMO/VFO select switch |
| ⑰ | 1 | BG | BAND SW UNIT GND |
| | 2 | BDN | BAND DOWN SW |
| | 3 | BUP | BAND UP SW |
| ⑱ | 1 | VB | VFO-B : TX, RX |
| | 2 | A-R | VFO-A : RX, VFO-B : TX |
| | 3 | B-R | VFO-A : TX, VFO-B : RX |
| | 4 | GND | |

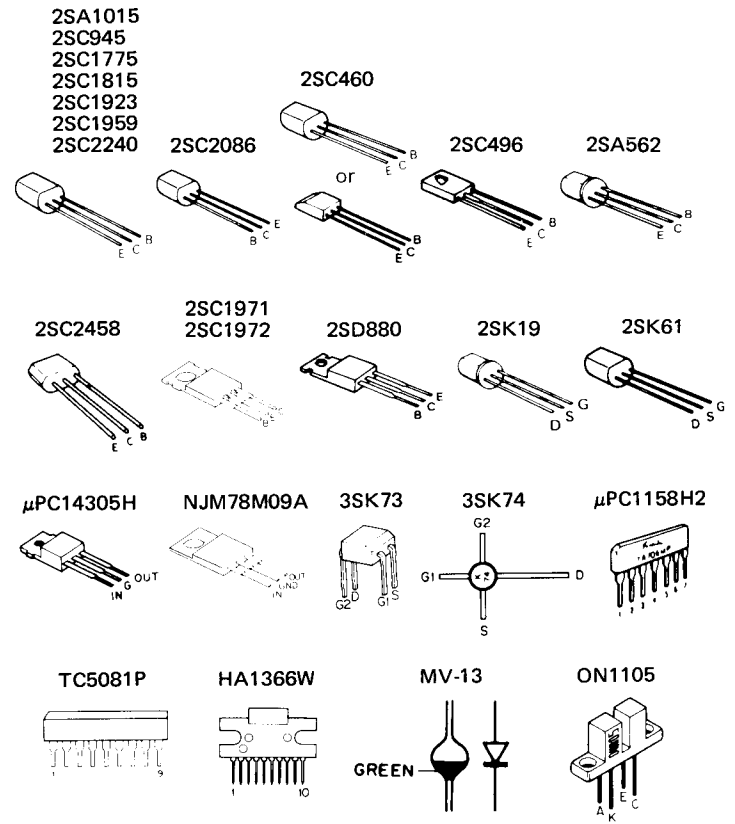
TERMINAL FUNCTIONS/PACKING

| Con- nector No. | Termi- nal No. | Termi- nal name | Function |
|-----------------------------------|-------------------|-----------------------|-------------------------------------|
| 19 | 1 | 5V | 5V LINE |
| | 2 | SC | MEMORY CH Signal : SCAN |
| | 3 | M5 | MEMORY CH Signal : 5ch |
| | 4 | M4 | MEMORY CH Signal : 4ch |
| | 5 | M3 | MEMORY CH Signal : 3ch |
| | 6 | M2 | MEMORY CH Signal : 2ch |
| 20 | 1 | GND | |
| | 2 | EN2 | ENCODER CLOCK Input |
| | 3 | EN1 | ENCODER CLOCK input |
| | 4 | 5V | 5V LINE(supply for ENCODER) |
| DISPLAY UNIT (X54-1630-00) | | | |
| 1 | 1 | GND | |
| | 2 | 5V | 5V LINE (DC-DC converter) |
| 2 | 1 | e | } Display SEGMENT Data input |
| | 2 | f | |
| | 3 | g | |
| | 4 | d | |
| | 5 | a | |
| | 6 | b | |
| | 7 | c | |
| 3 | 1 | D7 | Display DIGIT Data input CH Display |
| | 2 | D6 | Display DIGIT Data input 10 M |
| | 3 | D5 | Display DIGIT Data input 1 M |
| | 4 | D4 | Display DIGIT Data input 100 k |
| | 5 | D3 | Display DIGIT Data input 10 k |
| | 6 | D2 | Display DIGIT Data input 1 k |
| | 7 | D1 | Display DIGIT Data input 100 Hz |
| 4 | 1 | BLK | Blanking input (LOW : BLANKING) |
| | 2 | 5V | 5V LINE |
| | 3 | GND | |
| | 4 | -6 | -6V LINE (Output) |
| ENCODER UNIT (X54-1640-00) | | | |
| 1 | 1 | GND | |
| | 2 | EN2 | ENCODER CLOCK Output |
| | 3 | EN1 | ENCODER CLOCK Output |
| | 4 | 5V | 5V LINE |
| FINAL UNIT (X56-1410-00) | | | |
| | | P0 | FINAL unit output |
| | | TXB | TX about 9V |
| | | 14 | 14V LINE |
| | | DRV | RF unit output (FINAL unit input) |
| FM UNIT (X48-1330-00) | | | |
| 1 | 1 | FMC | FM MIC AMP Input |
| | 2 | GND | |
| 2 | 1 | GND | |
| | 2 | FMT | FM TX output |
| 3 | 1 | GND | |
| | 2 | FAF | FM RX : AF Output |
| | 3 | FMB | FM 9V |
| | 4 | FSQ | FM SQ output |
| | 5 | TXB | TX about 9V |
| | 6 | FSM | FM S METER Output |
| | 7 | ALC | FM ALC LINE Input |
| 4 | 1 | FMI | FM RX IF Input |
| | 2 | GND | |

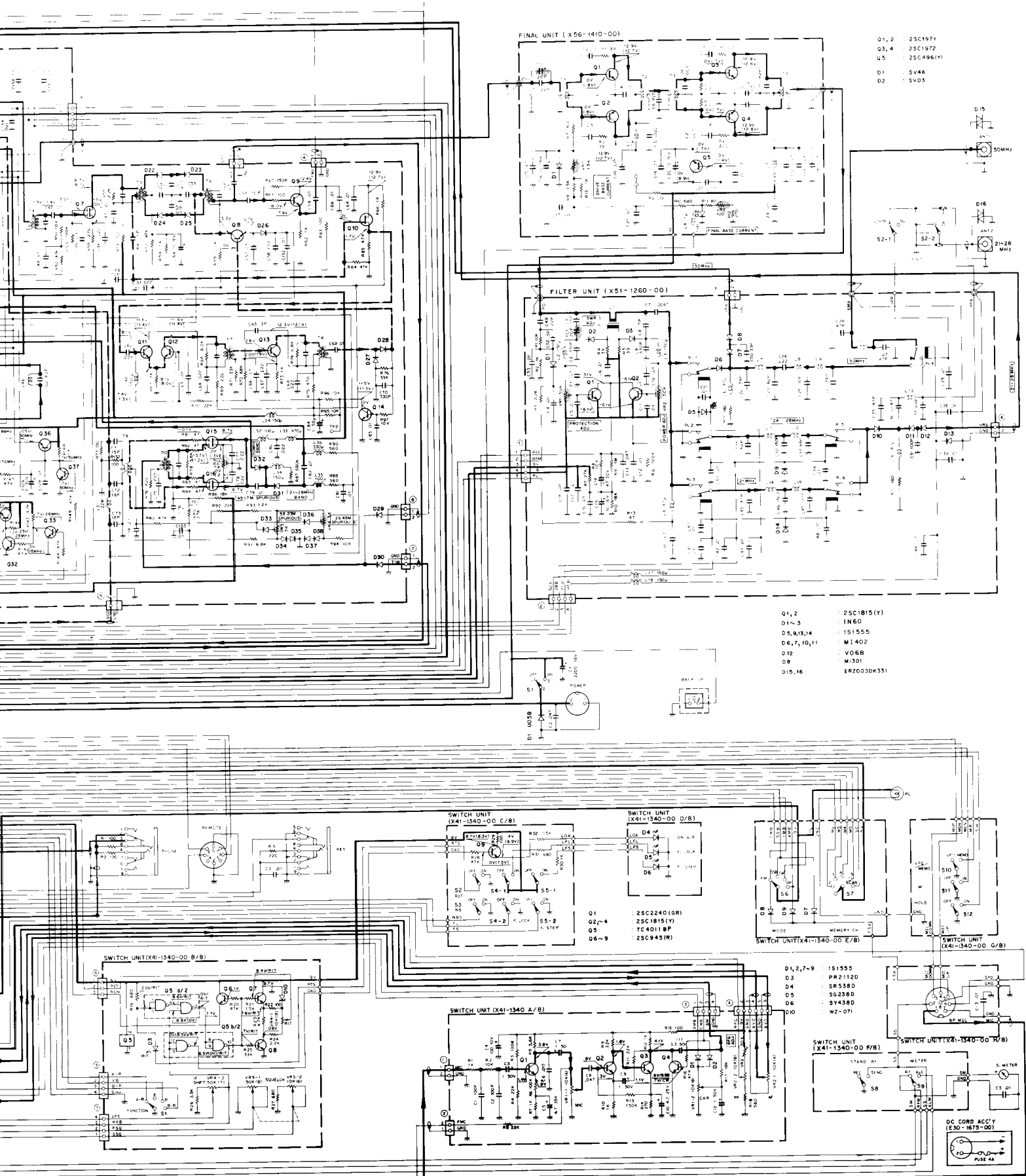
PACKING



- ★ Protective bag (H25-0112-04)
- DC cord ass'y (E30-1675-05)
- Protective bag (H25-0116-04)
- 7P DIN plug (E07-0751-05)
- Phone plug (E12-0001-05)
- Fuse 4A (F05-4022-05)



EMATIC DIAGRAM



2

3

4

5

6

7

A

B

C

D

E

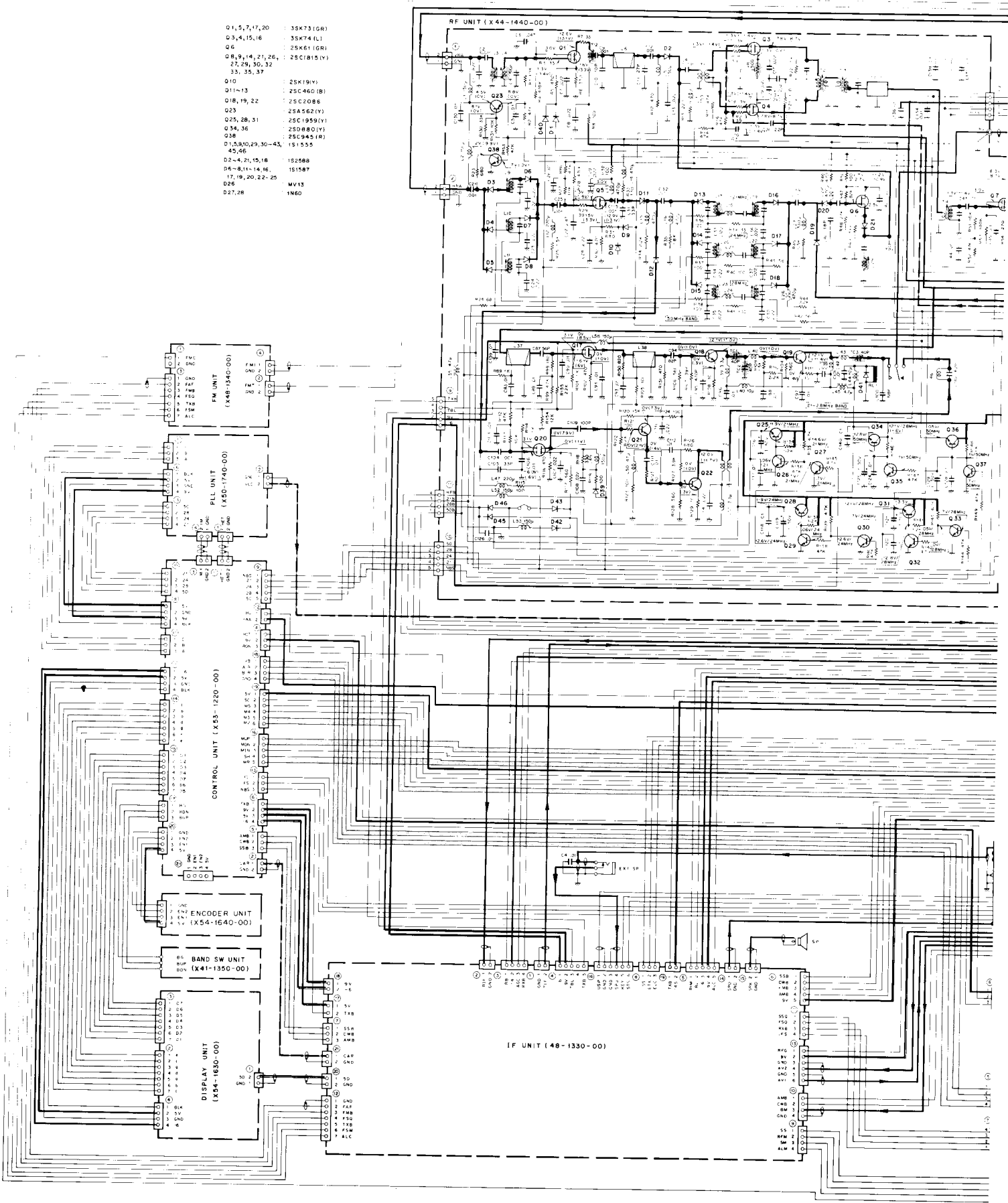
Signal Line

Control Line

Common DC Line

SCHEMATIC

- 01, 5, 7, 17, 20 : 35K731(GR)
- 03, 4, 15, 16 : 35K74(L)
- 06 : 25K61(GR)
- 08, 9, 14, 21, 26 : 25C1815(V)
- 27, 29, 30, 32 : 25C945(R)
- 33, 35, 37
- Q10 : 25K19(V)
- Q11~13 : 25C460(B)
- Q18, 19, 22 : 25C2086
- Q23 : 25A562(Y)
- Q25, 28, 31 : 25C1959(Y)
- Q34, 36 : 25D880(Y)
- Q38 : 25C945(R)
- Q15, Q10, 29, 30~43, 45, 46
- D2~4, 21, 15, 18 : 152588
- D6~8, 11~14, 16 : 151587
- 17, 19, 20, 22~25
- D26 : MV13
- D27, 28 : 1N60



SPECIFICATIONS

[Power Supply Section]

Input Voltage: AC120/220V $\pm 10\%$, 50/60 Hz
Output Voltage: DC 13.8V (standard voltage)
Output Current: 4.5A (intermittent load 50% duty cycle)

Continuous Load Current: 4A max

Output Voltage Fluctuation: Within ± 50 mV at AC120/220V $\pm 10\%$ (at load current 4A)
 Within 0.1V at 0~4A of load current (at AC120/220V)

Ripple Voltage: Less than 5 mV at 13.8V, 4A (at AC120/220V)

Power Consumption: Approx. 100W (at AC120/220V, DC 13.8V, 4A)

[General]

Dimensions: 123(124) W \times 96(106) H \times 235(250) D mm
 Figures in (): Projections included.

Weight: Approx. 3.8 kg

[Accessories]

Operating Manual: 1
DC Power Cord: 1
Fuse (1A): 1
Fuse (2A): 1
Crimp Style Terminal: 2

NOTE:

The circuit and ratings may change without notice due to development in technology.

ADJUSTMENTS

- Output voltage : Adjust to DC 13.8V by VR1.
- Over current protect : Short output terminals then adjust to DC 0.05V at point of R14 or R15 by VR2.

GENERAL

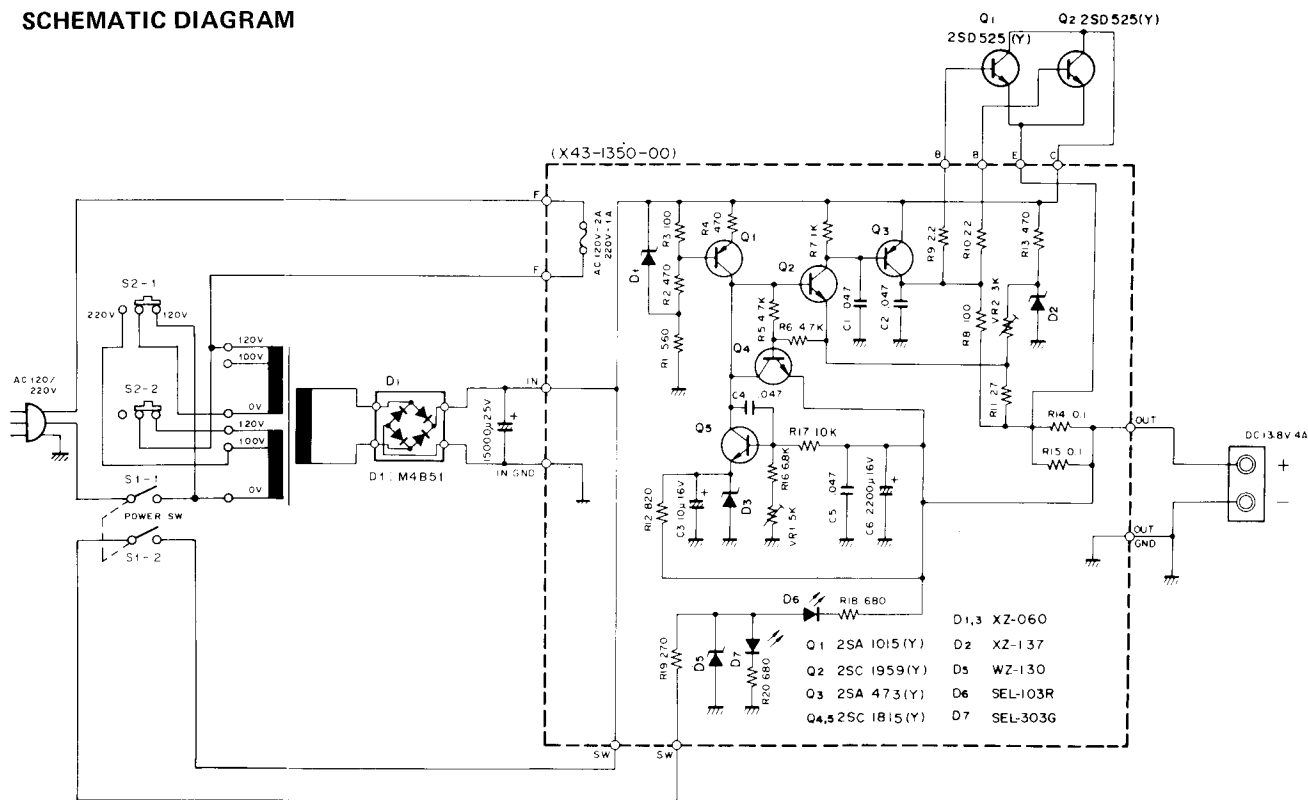
| Ref. No. | Parts No. | Description | Re- marks |
|----------|-------------|----------------------------------|--------------|
| — | C90-0808-05 | Electrolytic 15000 μ F 25WV | ☆ |
| Q1,2 | V04-0525-06 | Transistor 2SD525 | ☆ |
| D1 | V11-2163-76 | Rectifier stack M4B51 | ☆ |
| S1 | S36-2402-05 | See saw switch (power) | ☆ |
| — | L01-8056-05 | Power transformer | ☆ |
| — | A01-0732-03 | Case (A) | ☆ |
| — | A01-0733-02 | Case (B) | ☆ |
| — | A20-2336-03 | Panel (K) | ☆ |
| — | B39-0407-04 | Spacer (assistance leg) | ☆ |
| — | B50-2616-10 | Operating manual (K) | ☆ |
| — | E07-0252-05 | 2P Metal plug | ☆ |
| — | E20-0282-05 | 2P Terminal plate | ☆ |
| — | E23-0412-05 | Crimp, style terminal \times 2 | ☆ |
| — | E30-0545-05 | AC cord with plug | ☆ |
| — | E30-1620-05 | DC power supply cord | ☆ |
| — | F05-2023-05 | Fuse (2A) \times 1 | ☆ |
| — | F05-1023-05 | Fuse (1A) \times 1 | ☆ |
| — | F29-0014-05 | Insulating washer \times 2 | ☆ |
| — | H01-2592-04 | Carton case (K) | ☆ |
| — | H10-2513-02 | Styren foam cushion (F) | ☆ |
| — | H10-2514-02 | Styren foam cushion (R) | ☆ |
| — | H12-0445-04 | Cushion | ☆ |
| — | H20-1407-03 | Protection cover | ☆ |
| — | J02-0323-05 | Leg \times 4 | ☆ |
| — | J02-0409-04 | Assistance leg | ☆ |
| — | J21-2537-04 | Leg pushing metal \times 2 | ☆ |
| — | J32-0133-04 | Hex. boss \times 4 | ☆ |
| — | J41-0024-05 | Cord bush | ☆ |
| — | X43-1350-00 | AVR unit | ☆ |

AVR UNIT (X43-1350-00)

| Ref. No. | Parts No. | Description | Re- marks |
|----------------------|--------------|---|--------------|
| CAPACITOR | | | |
| C1,2 | C90-0262-05 | Ceramic 0.047 μ F 25WV | |
| C3 | CE04W1C100 | Electrolytic 10 μ F 16WV | |
| C4,5 | C90-0262-05 | Ceramic 0.047 μ F 25WV | |
| C6 | C90-0810-25 | Electrolytic 2200 μ F 16WV | |
| RESISTOR | | | |
| R1~20 | RD14BB2E000J | Carbon resistor 000 Ω $\pm 5\%$ 1/4W | |
| R14,15 | R92-0618-05 | Metal film 0.1 Ω | ☆ |
| SEMICONDUCTOR | | | |
| Q1 | V01-1015-06 | Transistor 2SA1015 (Y) | |
| Q2 | V03-1959-06 | Transistor 2SC1959 (Y) | |
| Q3 | V01-0473-06 | Transistor 2SA473 (Y) | |
| Q4,5 | V03-1815-06 | Transistor 2SC1815 (Y) | |
| D1 | V11-4162-66 | Zener diode XZ-060 | |
| D2 | V11-4161-76 | Zener diode XZ-137 | |
| D3 | V11-4162-76 | Zener diode XZ-060 | |
| D5 | V11-0297-05 | Zener diode WZ-130 | |
| D6 | V11-5160-66 | LED SEL103R | |
| D7 | V11-5160-76 | LED SEL303G | |
| MISCELLANEOUS | | | |
| VR1 | R12-2015-05 | Potentiometer 5k Ω | |
| VR2 | R12-1016-05 | Potentiometer 3k Ω | |
| — | E23-0047-04 | Terminal (square) \times 10 | |
| — | J32-0503-05 | Beads \times 4 | |

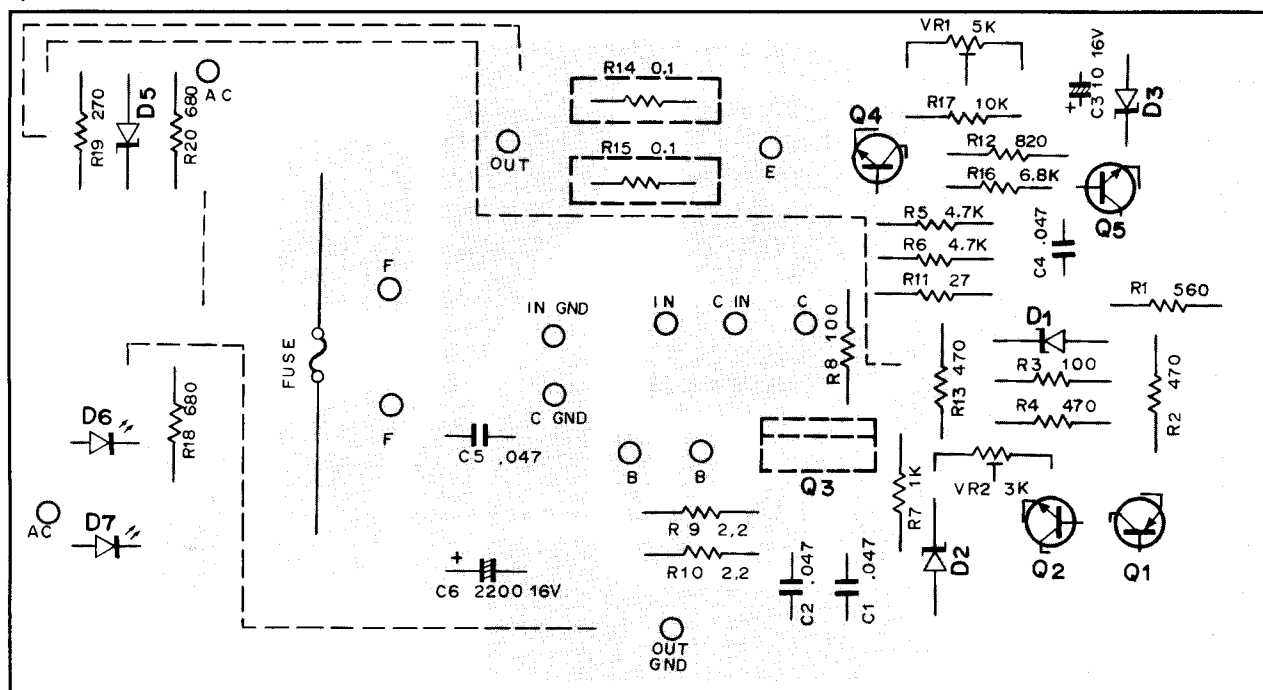
PS-20

SCHEMATIC DIAGRAM



PC BOARD

▼ AVR UNIT (X43-1350-00)



2SA1015
2SC1815
2SC1959

2SA473
2SD525

Q1 Q2
2SD525(OorY) 2SD525(OorY)

TS-660

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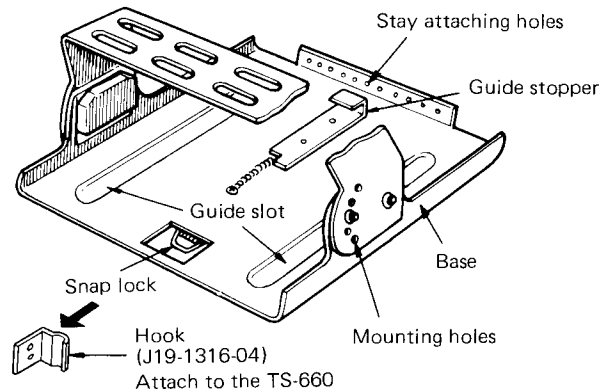
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SP-120/MB-100

SP-120 SPECIFICATIONS

SPEAKER SIZE 3"
RATED INPUT 1.0 watts
IMPEDANCE 8 ohms
FREQUENCY RESPONSE 300 Hz to 5 kHz
DIMENSIONS 4-7/8" wide x
 3-3/4" high x
 9-1/3" deep
 (excluding feet)
WEIGHT 3.1 lbs.

MB-100 OUTSIDE VIEW



PARTS LIST

N : New parts

| Ref. No. | Parts No. | Re- marks | Description |
|----------|---------------|--------------|--------------------------|
| | A01- 0739- 03 | | Case (A) |
| | A01- 0740- 03 | | Case (B) |
| | A20- 2343- 03 | | Panel |
| | A23- 1431- 04 | | Rear panel |
| | B04- 0401- 04 | | SP grill |
| | B07- 0613- 04 | | SP ring |
| | B39- 0407- 04 | | Spacer x 2 |
| | B50- 2636- 00 | | Operating manual |
| | E20- 0208- 04 | | Terminal plate |
| | E30- 1629- 05 | | SP cord |
| | G53- 0507- 04 | | Packing x 4 |
| | H01- 2611- 04 | | Carton case (Inside) |
| | H10- 2513- 02 | | Packing fixture (F) |
| | H10- 2514- 02 | | Packing fixture (R) |
| | H12- 0445- 04 | | Cushion |
| | H20- 1407- 03 | | Protective cover |
| | H25- 0077- 03 | | Protective bag |
| | J02- 0323- 05 | | Foot x 4 |
| | J02- 0409- 04 | | Assistant foot |
| | J21- 1144- 14 | | SP mounting hardware x 2 |
| | J61- 0019- 05 | | Vinyle tie |
| | T03- 0027- 15 | N | Speaker |

PARTS LIST

| Ref. No. | Parts No. | Re- marks | Description |
|----------|---------------|--------------|------------------------|
| | H01- 2604- 04 | | Carton case (Inside) |
| | H12- 0450- 03 | | Cushion |
| | H20- 1409- 03 | | Protective cover |
| | J19- 1316- 04 | | Hook |
| | J21- 2633- 04 | | Guide stopper |
| | J51- 0006- 15 | | Snap lock |
| | J54- 0401- 14 | | Stay x 2 |
| | J90- 0401- 04 | | Guide stopper (V) |
| | N09- 0008- 04 | | 6mm Hex. screw x 6 |
| | N14- 0009- 04 | | 6mm Nut x 6 |
| | N15- 1060- 46 | | Flat washer |
| | N16- 0040- 46 | | Lock washer x 2 |
| | N16- 0060- 46 | | Lock washer x 6 |
| | N19- 0609- 04 | | Nylon washer |
| | N30- 4008- 46 | | Round screw |
| | N32- 3006- 46 | | Flat screw |
| | N87- 3006- 46 | | Self tapping screw x 2 |
| | N88- 3006- 46 | | Flat tapping screw x 2 |
| | N99- 0304- 04 | | Hex. head screw x 6 |
| | W01- 0401- 04 | | Allen key |

A product of
TRIO-KENWOOD CORPORATION
 17-5, 2-chome, Shibuya, Shibuya-ku, Tokyo 150, Japan

TRIO-KENWOOD COMMUNICATIONS

1111 West Walnut Street Compton, California 90220, U.S.A.

TRIO-KENWOOD COMMUNICATIONS, GmbH

D-6374 Steinbach TS, Industriestrasse 8A, West Germany

TRIO-KENWOOD(AUSTRALIA)PTY. LTD.

4E Woodcock Place, Lane Cove N.S.W. Australia 2066