KENWOOD®

00132

SERVICE MANUAL

Model TS-660

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

ALL MODE QUAD BANDER

CONTENTS

TS-660

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 (F_3), SSB (A_{3j}), CW (A_1), AM (A_3)
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 × 94 (3-11/16") H × 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 kΩ
Audio Frequency Response:		400 ~ 2600 Hz (−6 dB)

[RECEIVER SECTION]

Sensitivity:		SSB, CW 0.25 μV for 10 dB S/N
		AM 1 μV for 10 dB S/N
		FM 1 μV for 30 dB S/N
		0.4 μV 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 μV (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.

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 osclillator, mixer, limiting amplifer, 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
	Within 0.1~1.0 MHz 30 dB or more
Ripple	(Within 455±5 kHz) 3 dB or less
Loss	5 dB or less
Input and output impedance	1.5 kΩ

Table 4 Ceramic filter CFT455F2

CIRCUIT DESCRIPTION

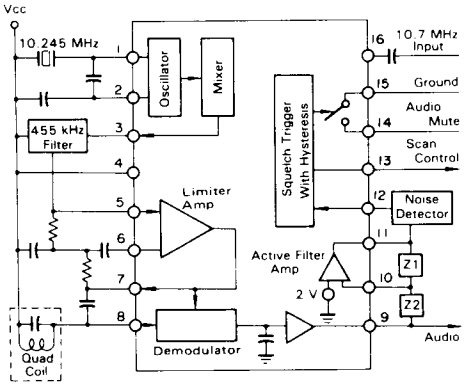


Fig. 1 MC3357P Block diagram

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 = ∞Ω		Tc = 25°C			25 ±3°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 = ∞Ω		Tc = 25°C			25 ±3°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 devided. Frequency control is achieved by a 10 Hz step digital VFO feeding an 8 bit microcomputer (μPD8048C), 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 sume 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.

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

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.

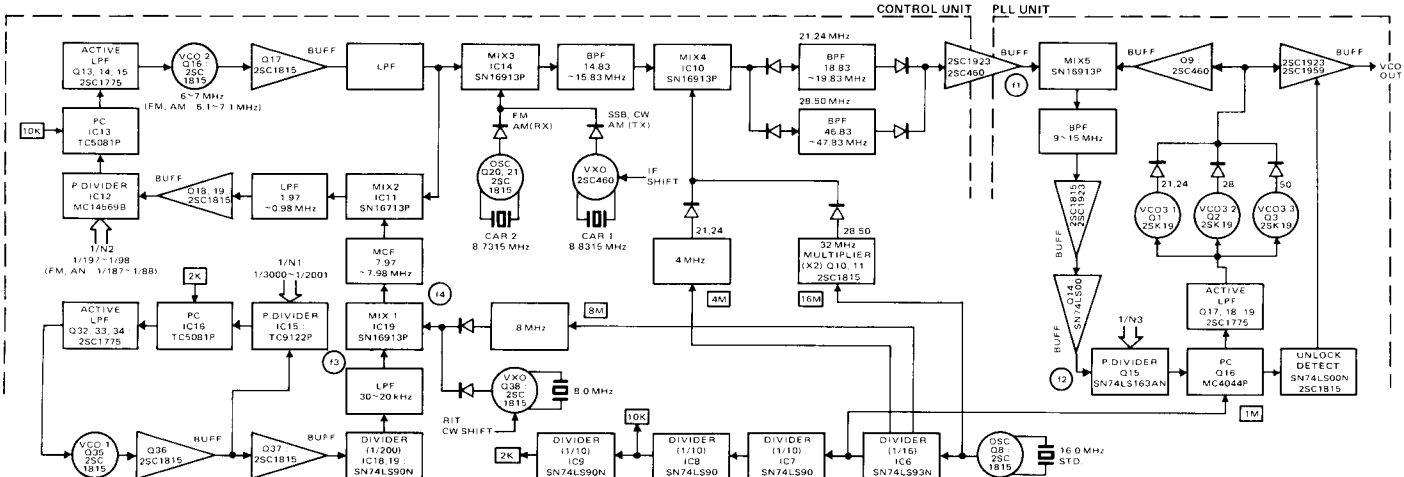
In the TS-660, there are two carrier crystal oscillator circuits. In CW, SSB, and AM TX,CAR 1 operates at 8.8315 MHz. In the FM and AM RX modes, the carrier frequency into PLL MIX 3 is lowered 100 kHz by CAR 2 : 8.7315 MHz. Simultaneously, the divide ratio 1/N2 is changed to raise the VCO 2 frequency 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

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/rotaion.

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.**

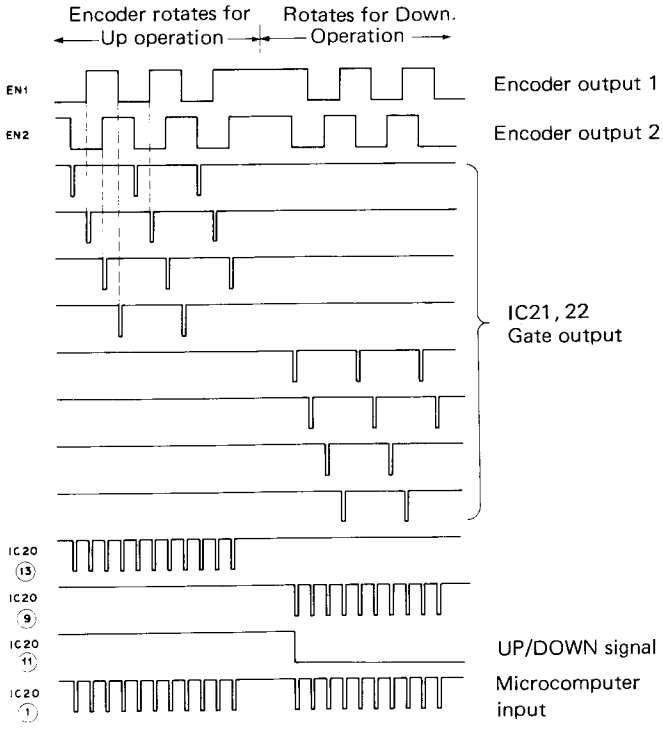


Fig. 3 Encoder output to micro-processor input timing and waveforms

● 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 (0.022μF) and R158 (150kΩ) to be approximately 100 Hz to acheive 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 (82kΩ) and C151 (10μF).

● 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 μsec. 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 (83kΩ) and C1 (1μF), 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 complied 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 : μPD8048C) 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

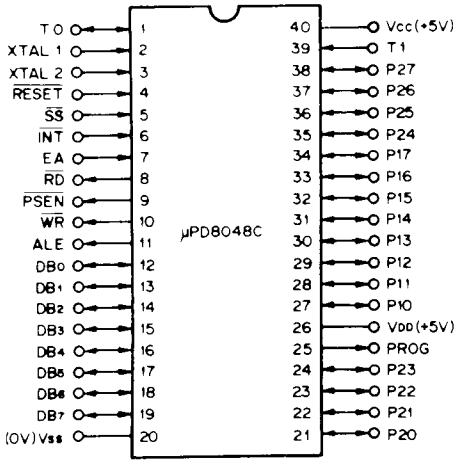


Fig. 4 μPD8048C-292 Terminal name

Item	Symbol	Rating
Operating voltage	Vcc	−0.5 ~ +7.0V
	VDD	−0.5 ~ +7.0V
Input voltage	Vi	−0.5 ~ +7.0V
Output voltage	Vo	−0.5 ~ +7.0V
Operating temperature	Topt	0 ~ +70°C
Storage temperature	Tstg	−65 ~ +150°C

Table 11 μPD8048C-292 Max Rating

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

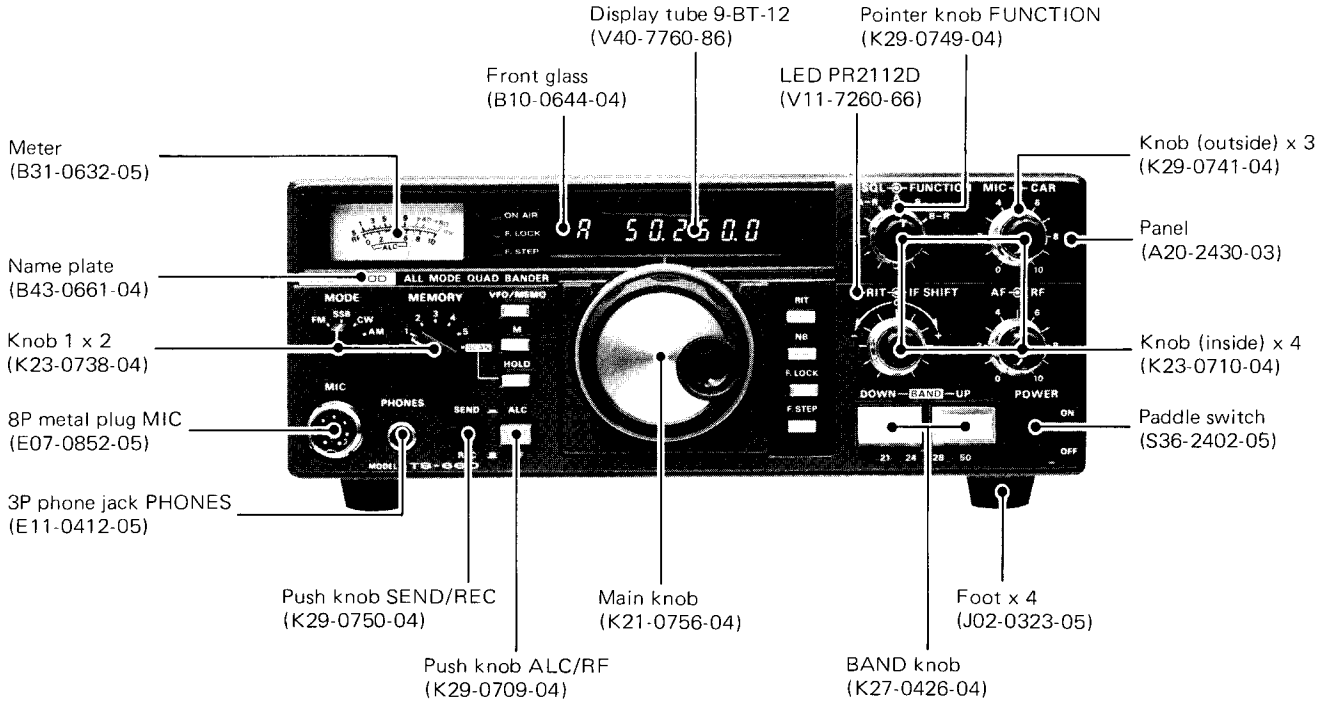
Table 12 μPD8048C-292 Terminal function

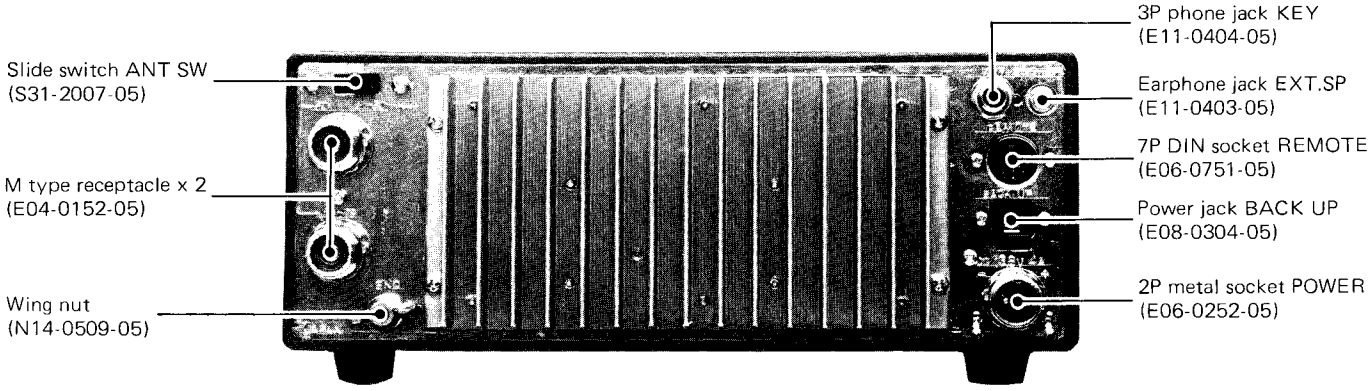
Terminal No.	Symbol	Explanation
2	P40	VCO 1 dividing ratio output (BCD)
3	P41	
4	P42	
5	P43	
1	P50	VCO 3 dividing ratio output
23	P51	
22	P52	
21	P53	
20	P60	50 MHz BAND data
19	P61	28 MHz BAND data
18	P62	24 MHz BAND data
17	P63	21 MHz BAND data
13	P70	DATA SELECTOR input
14	P71	
15	P72	
16	P73	

Terminal No.	Symbol	Explanation	
2	P40		
3	P41	Display SEGMENT output a	Lit by L
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 10 k	
17	P63	Display DIGIT output 100 k	
13	P70	Display DIGIT output 1 M	
14	P71	Display DIGIT output 10 M	
15	P72	Display DIGIT output CH display	
16	P73	Buzzer sound output	

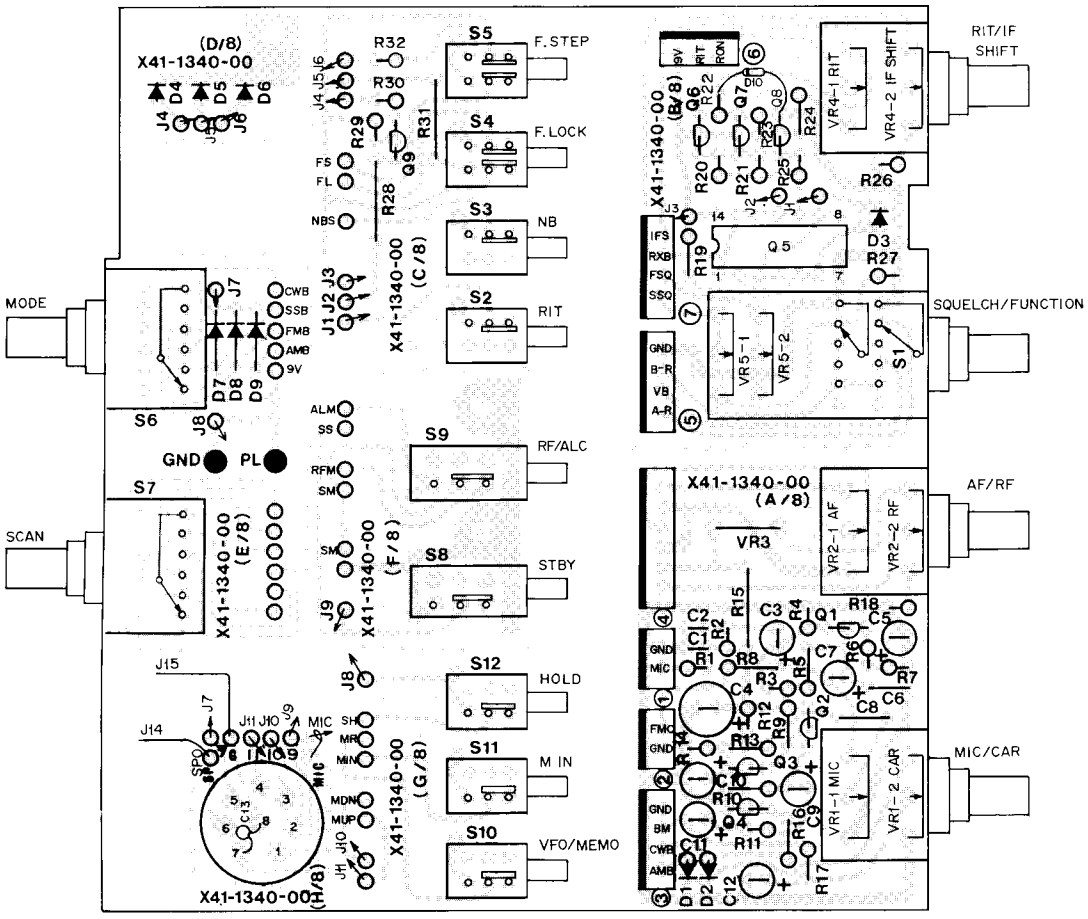
TS-660

OUTSIDE VIEWS

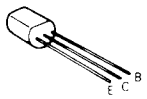




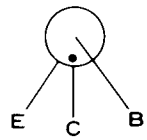
▼ SWITCH UNIT (X41-1340-00) Components side view



2SA1015
2SC945
2SC1815
2SC2240



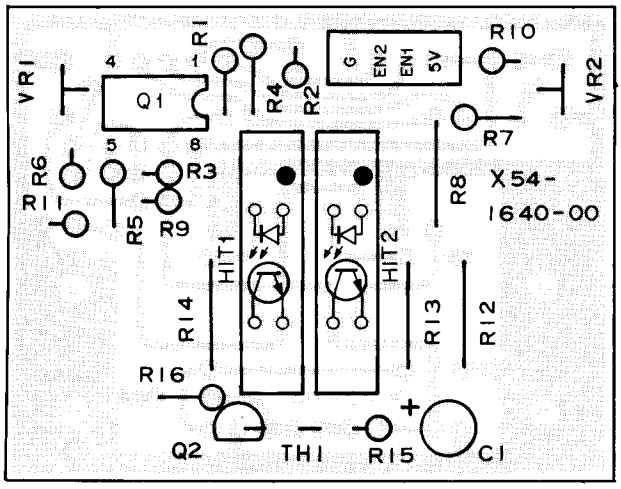
Transistor terminal indication



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

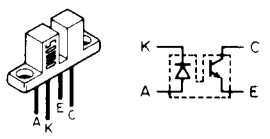
▼ ENCODER UNIT (X54-1640-00)

Components side view



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

ON1105

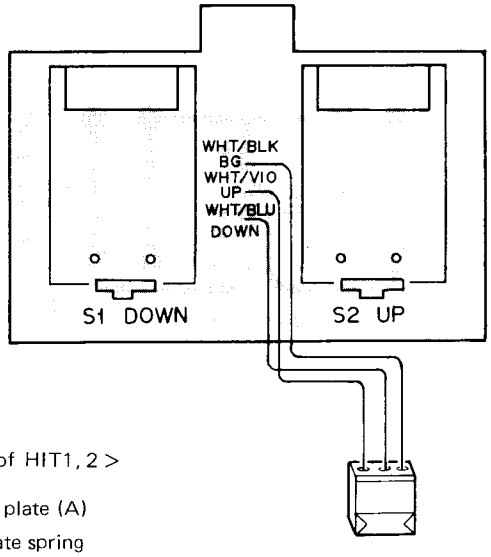


MAX. Rating

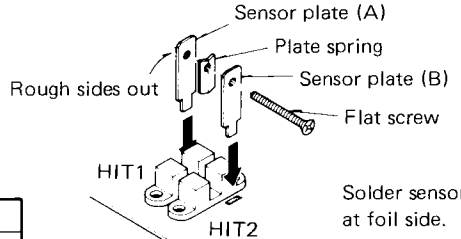
VR	IF	PD	IC	V_{CEO}	V_{ECO}	PC	T_{OP}

▼ BAND SWITCH UNIT (X41-1350-00)

Components side view



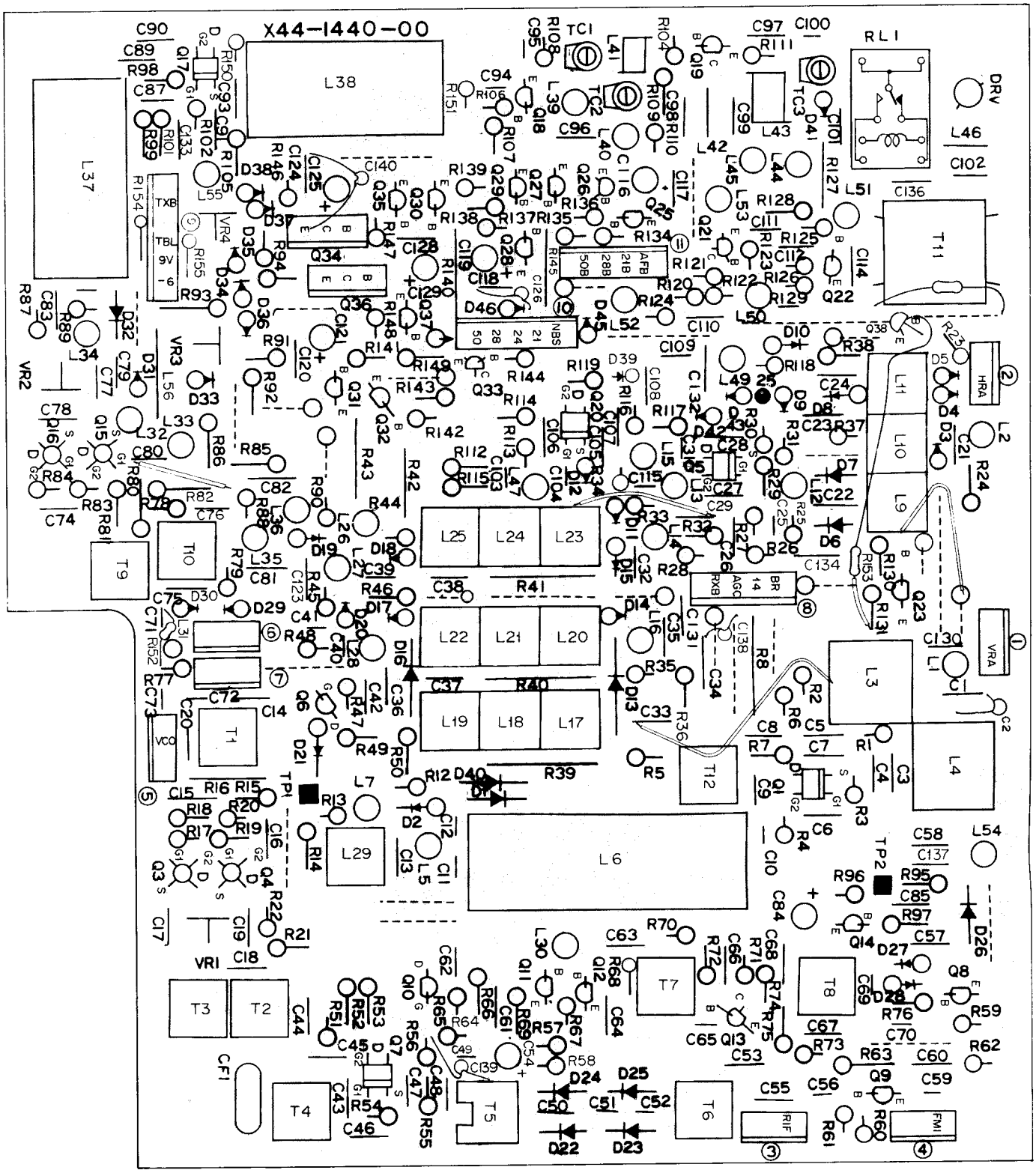
< Attachment method of HIT1, 2 >



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

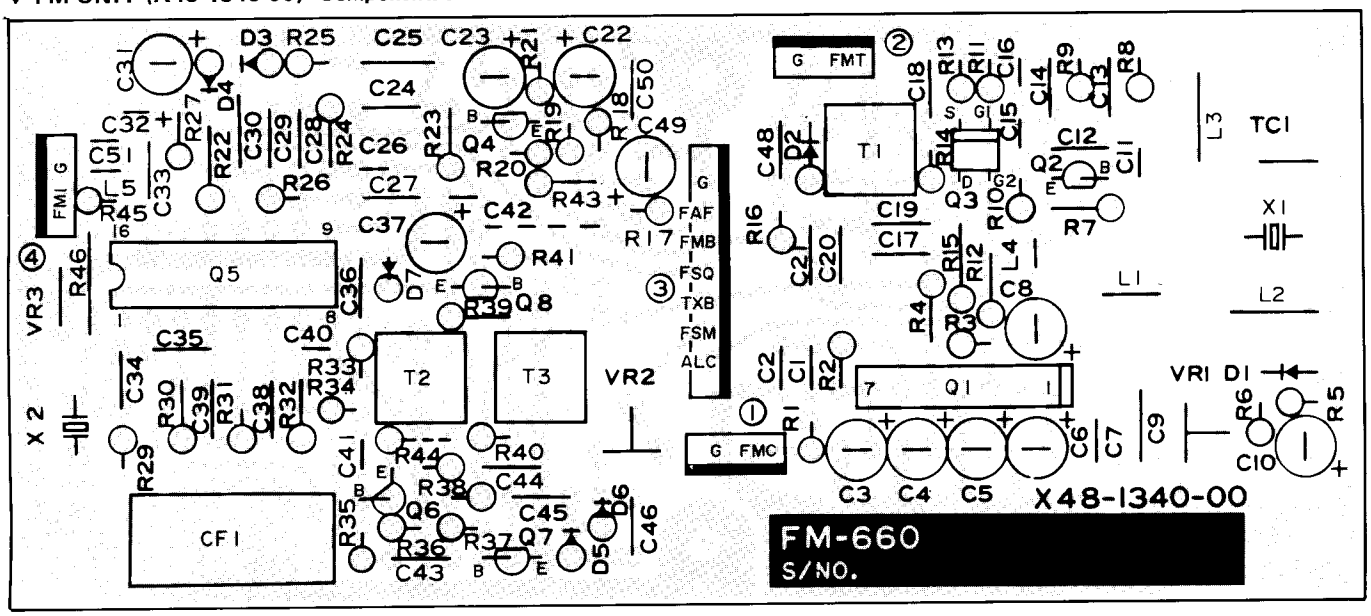
TS-660 PC BOARD VIEW

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

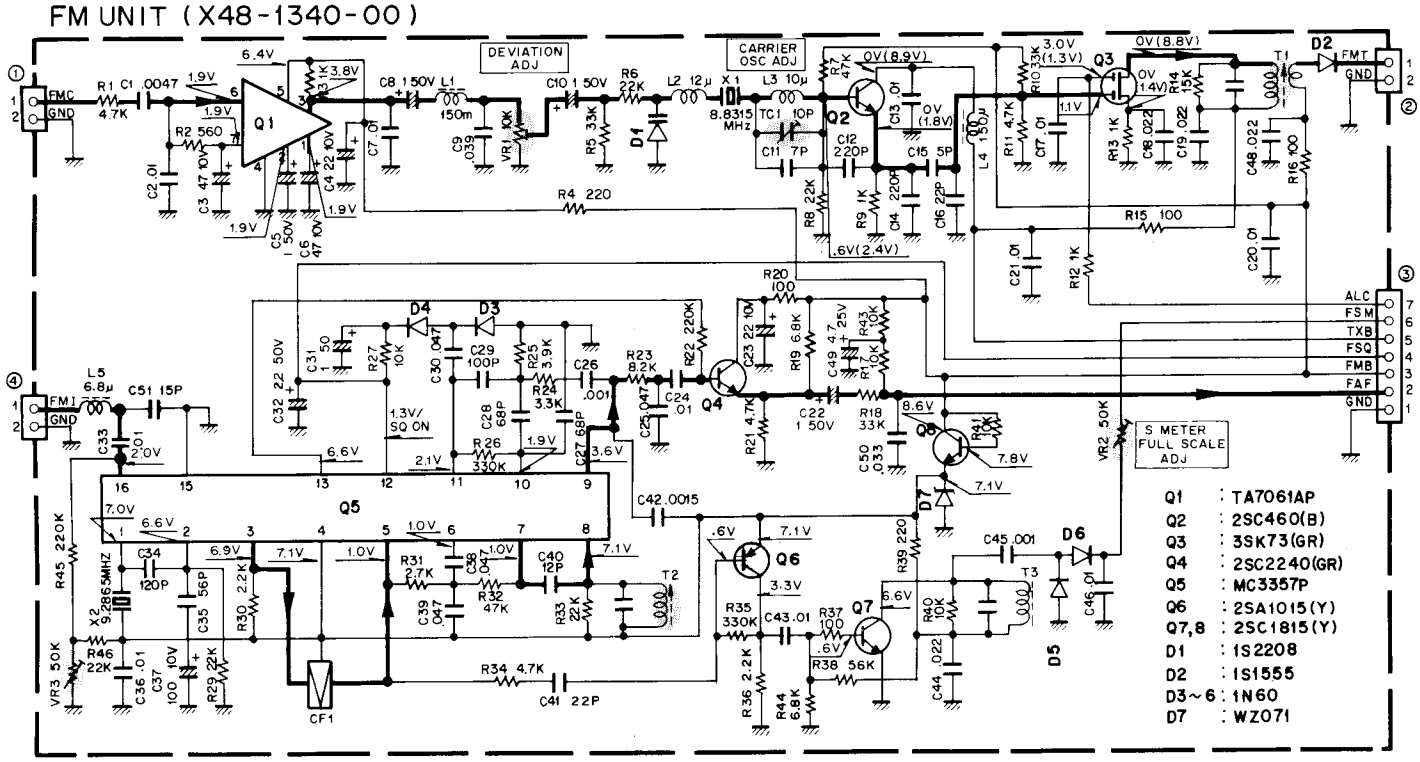


Q1, 5, 7, 17, 20 : 3SK73(GR) Q3, 4, 15, 16 : 3SK74(L) Q6 : 2SK61(GR) Q8, 9, 14, 21, 26, 27, 29, 30, 32, 33, 35, 37, 38 : 2SC1815(Y)
Q10 : 2SK19(Y) Q11~13 : 2SC460(B) Q18, 19, 22 : 2SC2086 Q23 : 2SA562(Y) Q25, 28, 31 : 2SC1959(Y) Q34, 36 : 2SD880(Y)
D1, 5, 9, 10, 29, 30~36, 40~46 : 1S1555 D2~4, 21 : 1S2586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

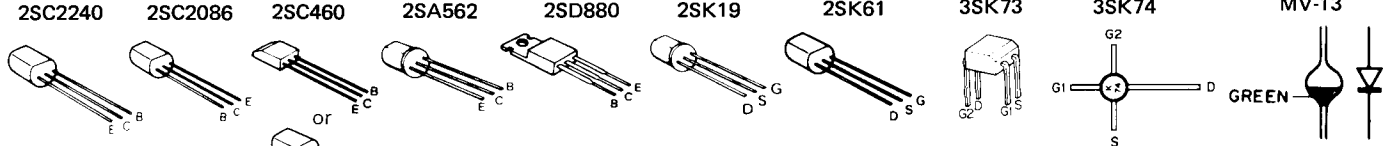
▼ **FM UNIT (X48-1340-00) Components side view**



FM UNIT (X48-1340-00)

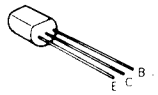


2SC1815
2SC1959
2SC2240

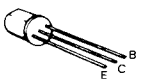


TS-660 PC BOARD VIEW

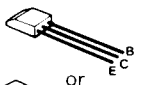
2SA1015
2SC1815
2SC1959
2SC2240



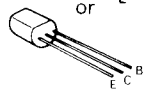
2SA562



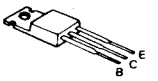
2SC460



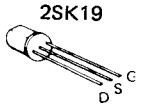
or



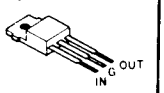
2SD880



2SK19

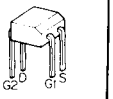


μPC14305H

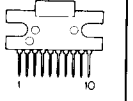


NJM78M09A

3SK73



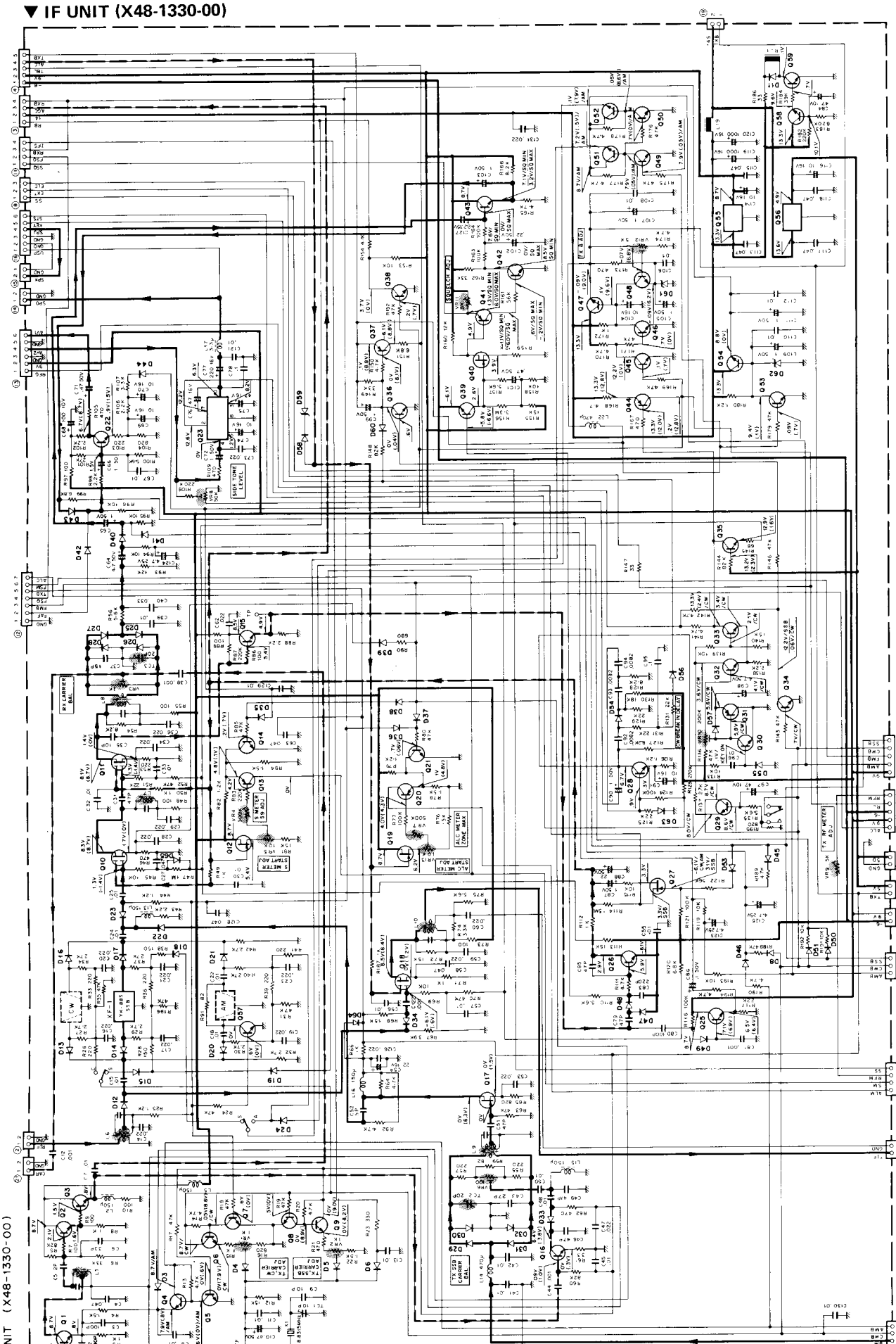
HA1366W



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

CIRCUIT DIAGRAM TS-660

▼ IF UNIT (X48-1330-00)



D2 : 1SV53A
D3~6, 8, 6, 8, 11~13, 15, 16, 18, 19 : D14, 17, 20, 21 : 1S1007
22~24, 33~46, 50, 51, 53~58, : D25~32, 47~49 : IN60
60, 63~65 : D59, : WZ-090
: 1S1555
D61 : WZ-061
D62 : XZ-094

Q47 : 2SD880(Y)
Q55 : NJM78M09A
Q56 : μPC1430SH

Q23 : HA1366 W
Q27, 40 : 2SK30(O)
Q44 : 2SA562(Y)

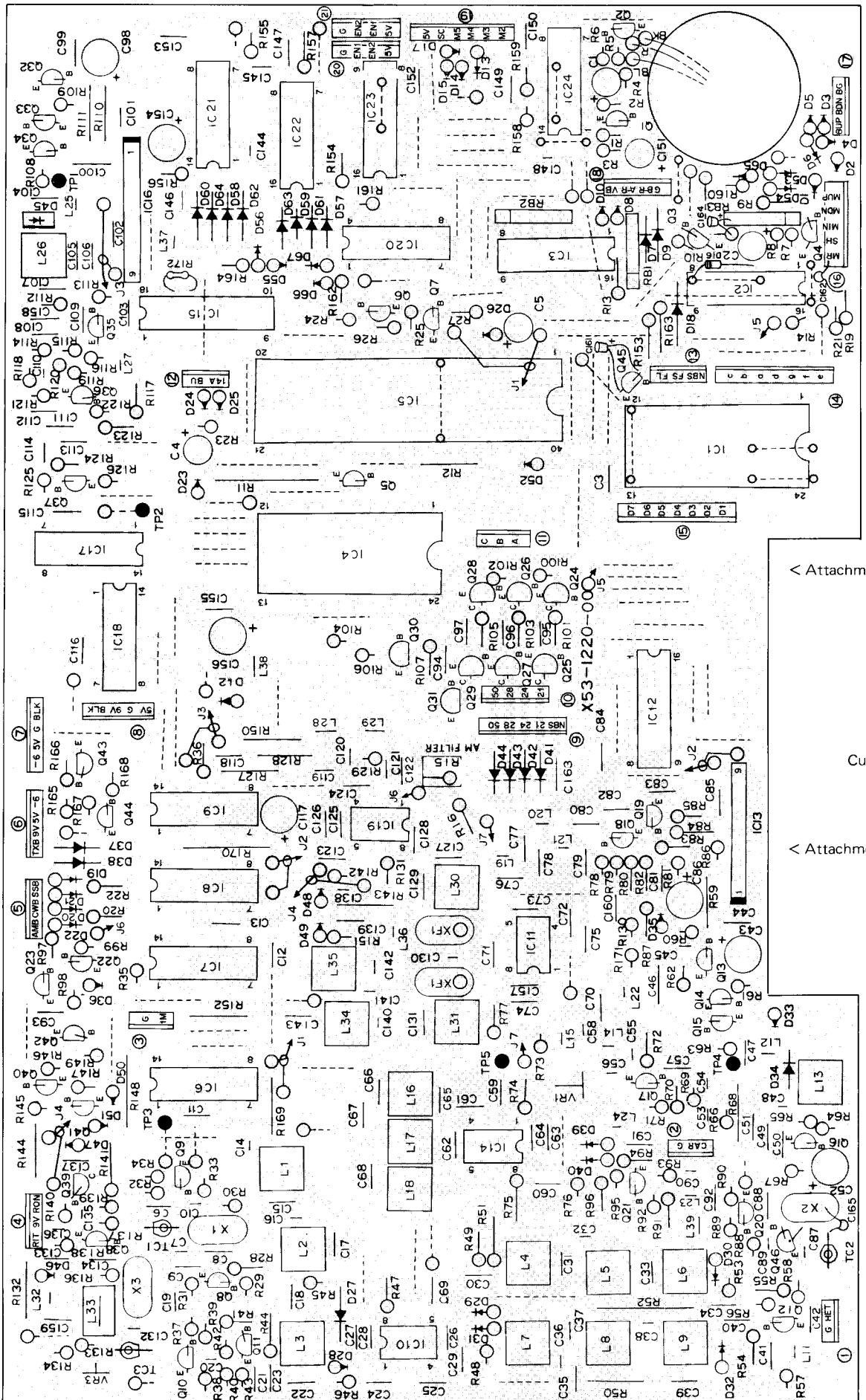
Q10, 11, 18 : 3SK73(GR)
Q13, 20, 31, 37, 41 : 2SA1015(Y)
Q 22, 43 : 2SC2240(GR)
Q 12, 17, 19 : 2SK19(GR)

: 2SC460(B)
: 2SC1959(Y)

: 2SC1815(Y)
: 2SC1815(GR)

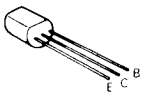
6
59
4, 15, 21, 25, 26, 28~30
5, 36, 39, 42, 45, 46,
3, 57, 58

TS-660 PC BOARD VIEW

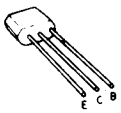


▼ CONTROL UNIT (X53-1220-00) Components side view

2SA1015
2SC945
2SC1775
2SC1815
2SC1923

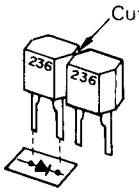


2SC2458



TC5081P

< Attachment direction of D45 >

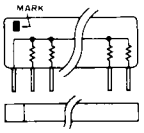


Cut D45 as shown

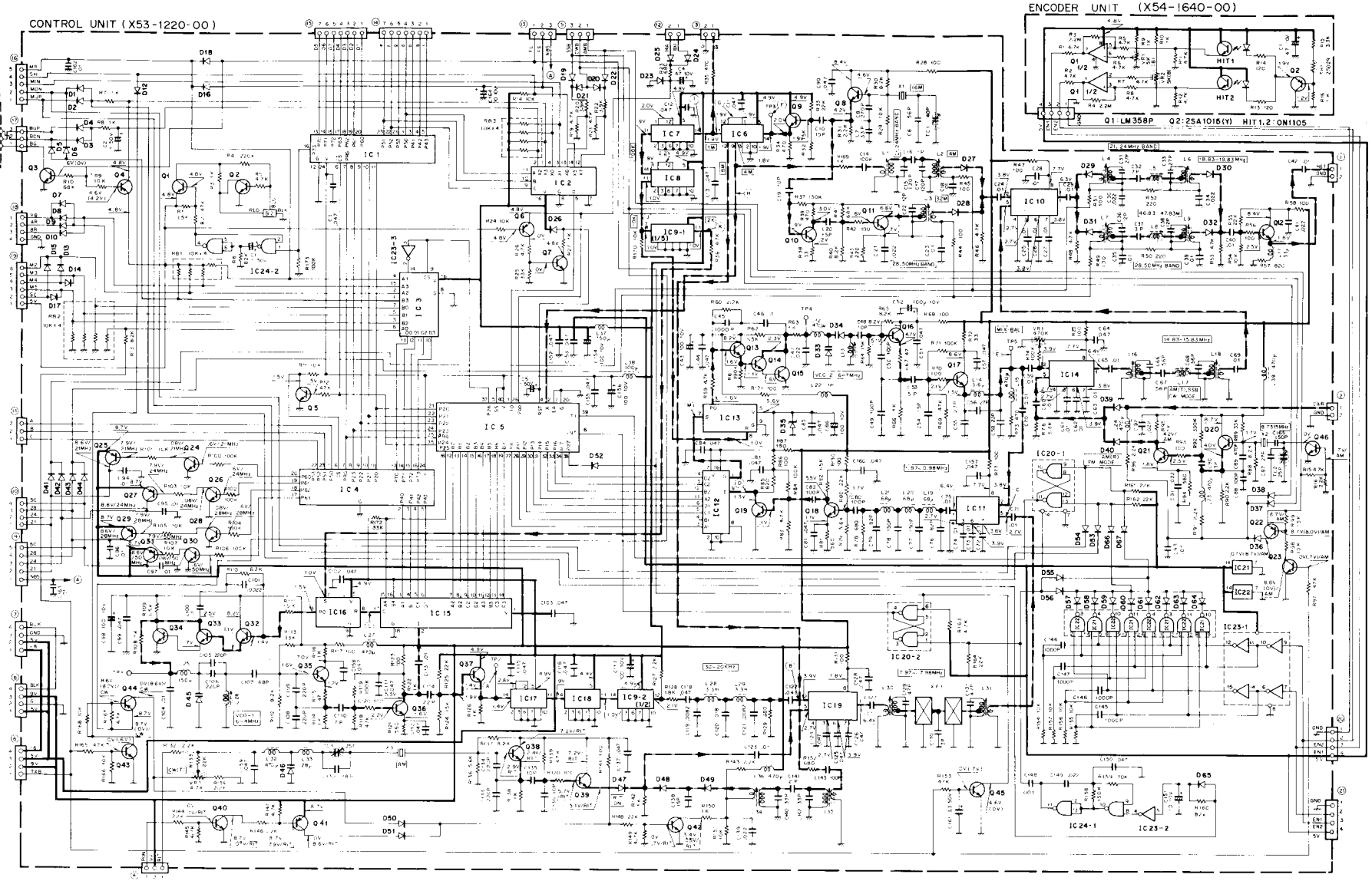
< Attachment direction of XF1 >

XF1 should be used as a pair.

< Attachment direction of resistor block >

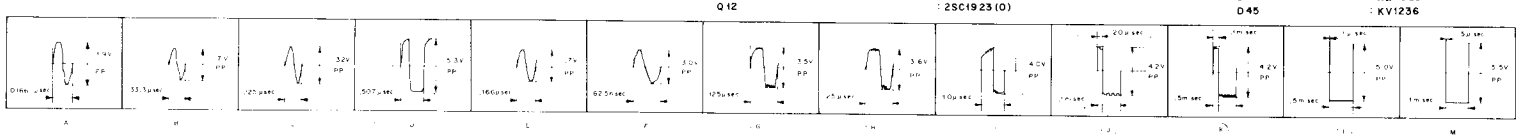


▼ CONTROL UNIT (X53-1220-00)



▼ ENCODER UNIT (X54-1640-00)

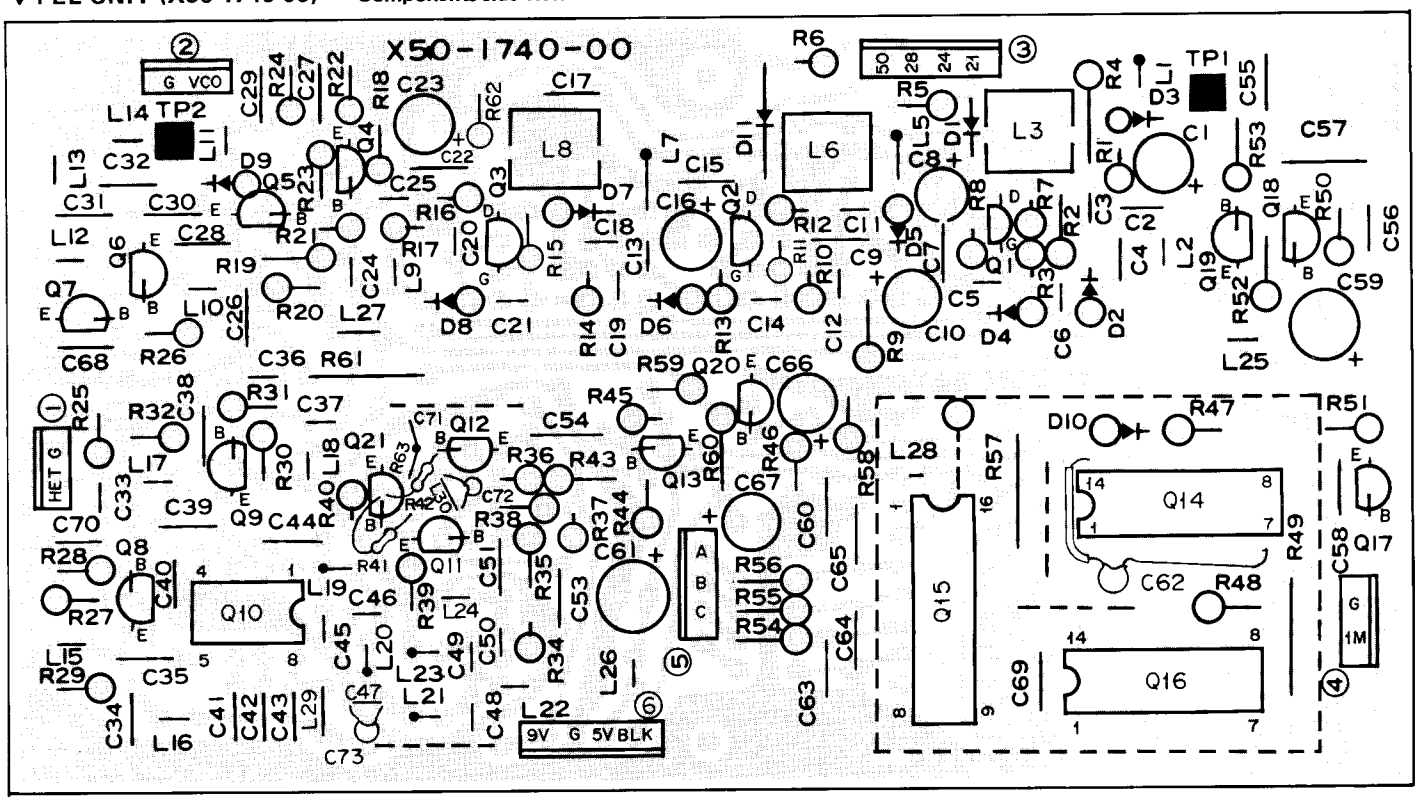
IC 1, 4	: μPD8243C	IC 6	: SN74LS93N	IC13, 16	: TC5081P	Q 1, 4, 6, 22, 25, 27, 29, 31, 41, 44	: 2SA1015(Y)	D 23	: WZ-050	D1~10, 12~22	
IC 2	: SN74LS15IN	IC7~9, 17, 18	: SN74LS90N	IC15	: TC9122P	Q 2, 8~11, 16~21, 35~39	: 2SC1815(Y)	D 27~32, 39, 40, 47~49	: 1S1587	24~26, 36~38	
IC 3	: TC4019BP	IC10, 11, 14, 19	: SN16913P	IC20~22, 24	: TC4011BP	Q 3, 5, 7, 23, 24, 26, 28, 30, 40, 42, 43, 45, 46	: 2SC1815(Y) or 2SC945(Q), 2SC2458(Y)	D 33, 34, 46	: 1SV54GC	41~44, 50~67	: 1S1555
IC 5	: μPD8048C-292	IC12	: MC14569B	IC23	: TC4049BP	Q 13~15, 32~34	: 2SC1775(E)	D 35	: XZ-055		
						Q 12	: 2SC1923(O)	D 45	: KV1236		



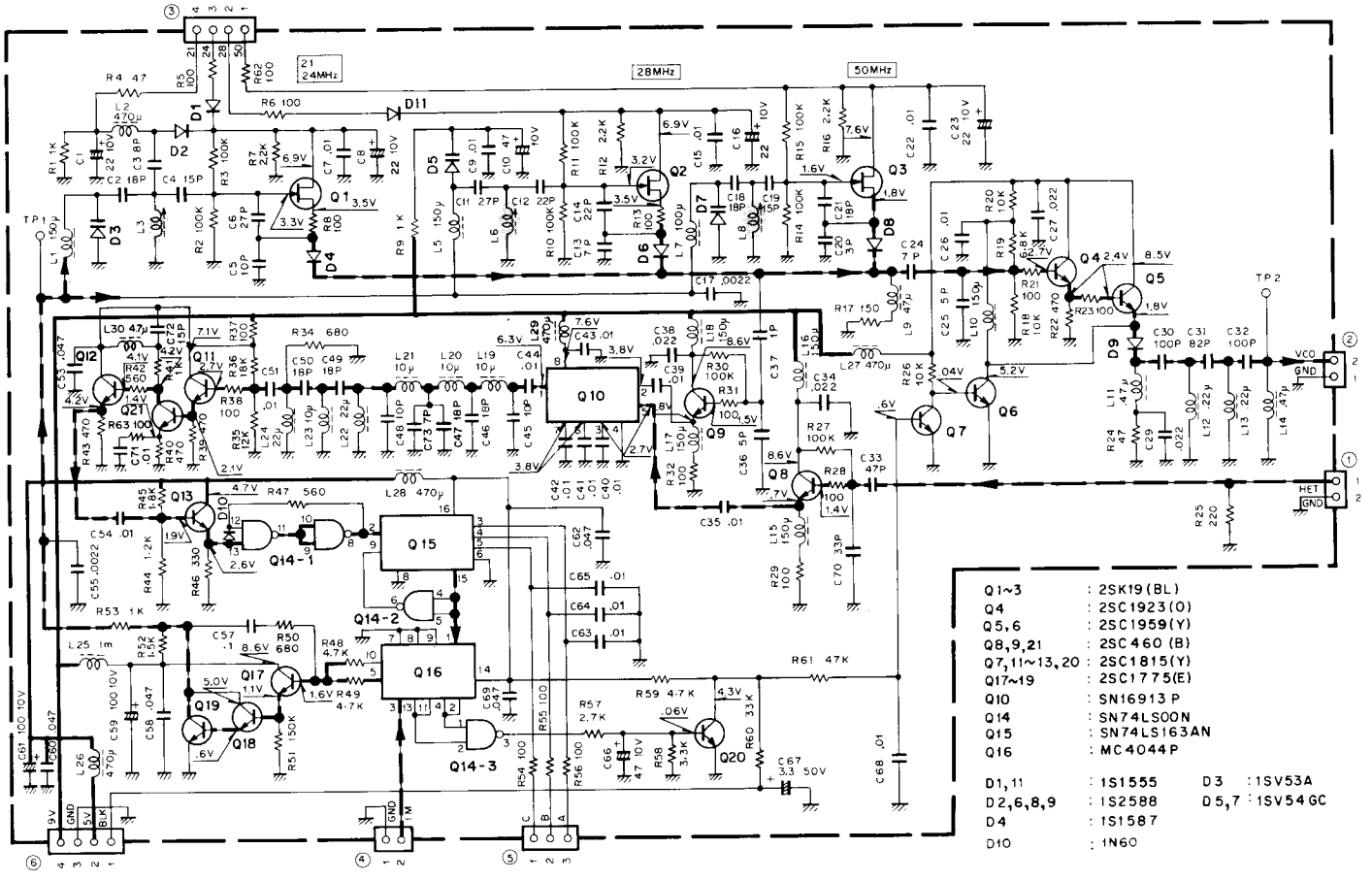
Measurement conditions f = 50.000MHz

TS-660 PC BOARD VIEW/CIRCUIT DIAGRAM

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



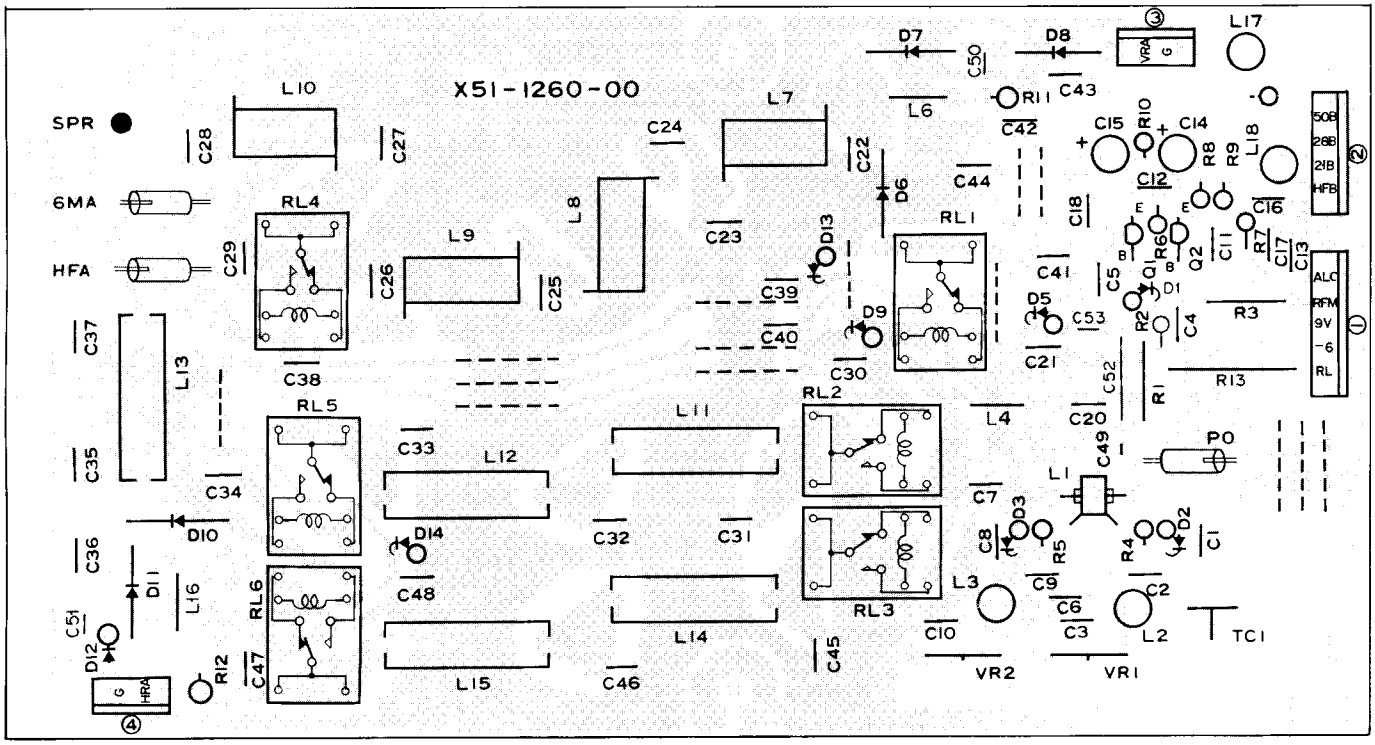
PLL UNIT (X50-1740-00)



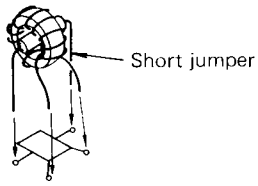
Q1~3	: 2SK19(BL)
Q4	: 2SC1923(O)
Q5,6	: 2SC1959(Y)
Q8,9,21	: 2SC460 (B)
Q7,11~13,20	: 2SC1815(Y)
Q17~19	: 2SC1775(E)
Q10	: SN16913 P
Q14	: SN74LS00N
Q15	: SN74LS163AN
Q16	: MC4044P
D1,11	: 1S1555
D2,6,8,9	: 1S2588
D4	: 1S1587
D10	: 1N60
D3	: 1SV53A
D5,7	: 1SV54GC

2SC1815 2SC1923
2SC1775 2SC1959
2SC460
2SC496
2SC1971
2SC1972
2SK19

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

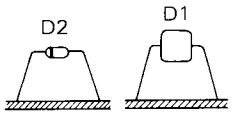


< Attachment direction of L1 >

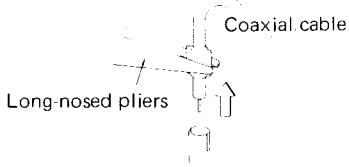


Q1, 2 : 2SC1815(Y) D1~3 : 1N60 D5, 9, 13, 14 : 1S1555
D6, 7, 10, 11 : MI402 D12 : V06B D8 : MI301

< Attachment direction of D1, 2 >

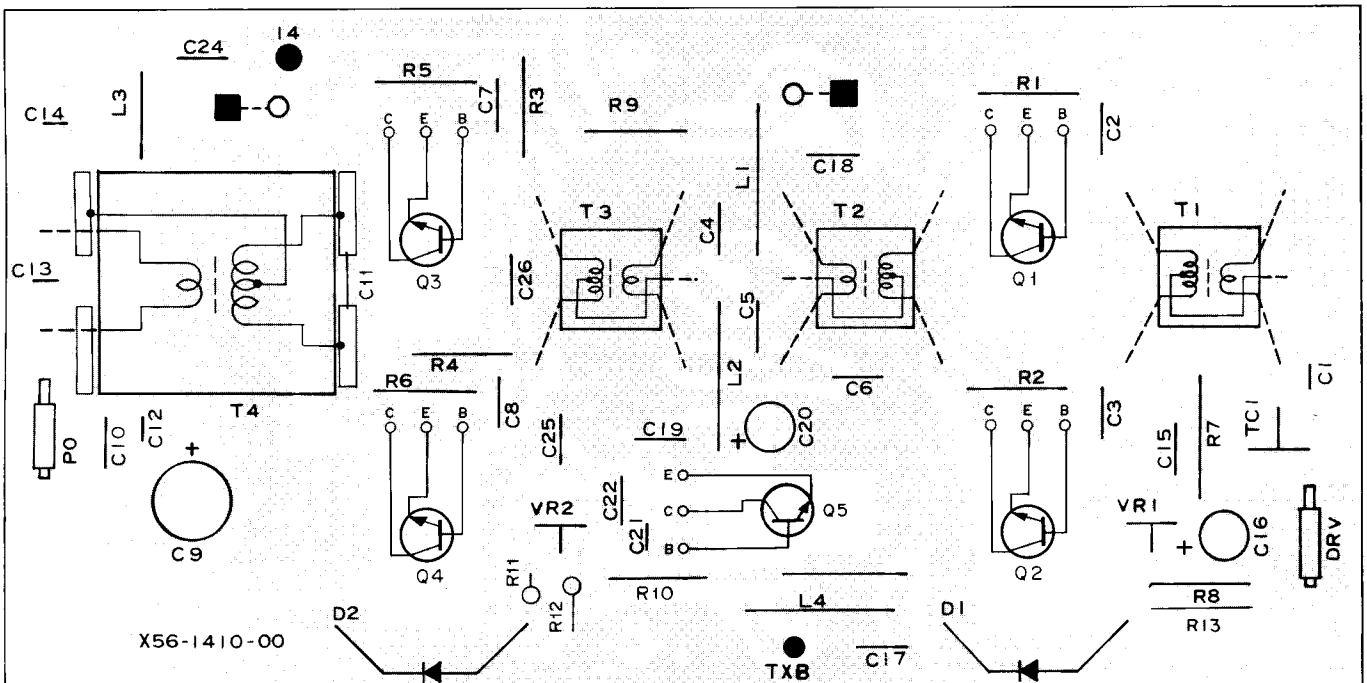


< Disconnecting the coaxial cable >



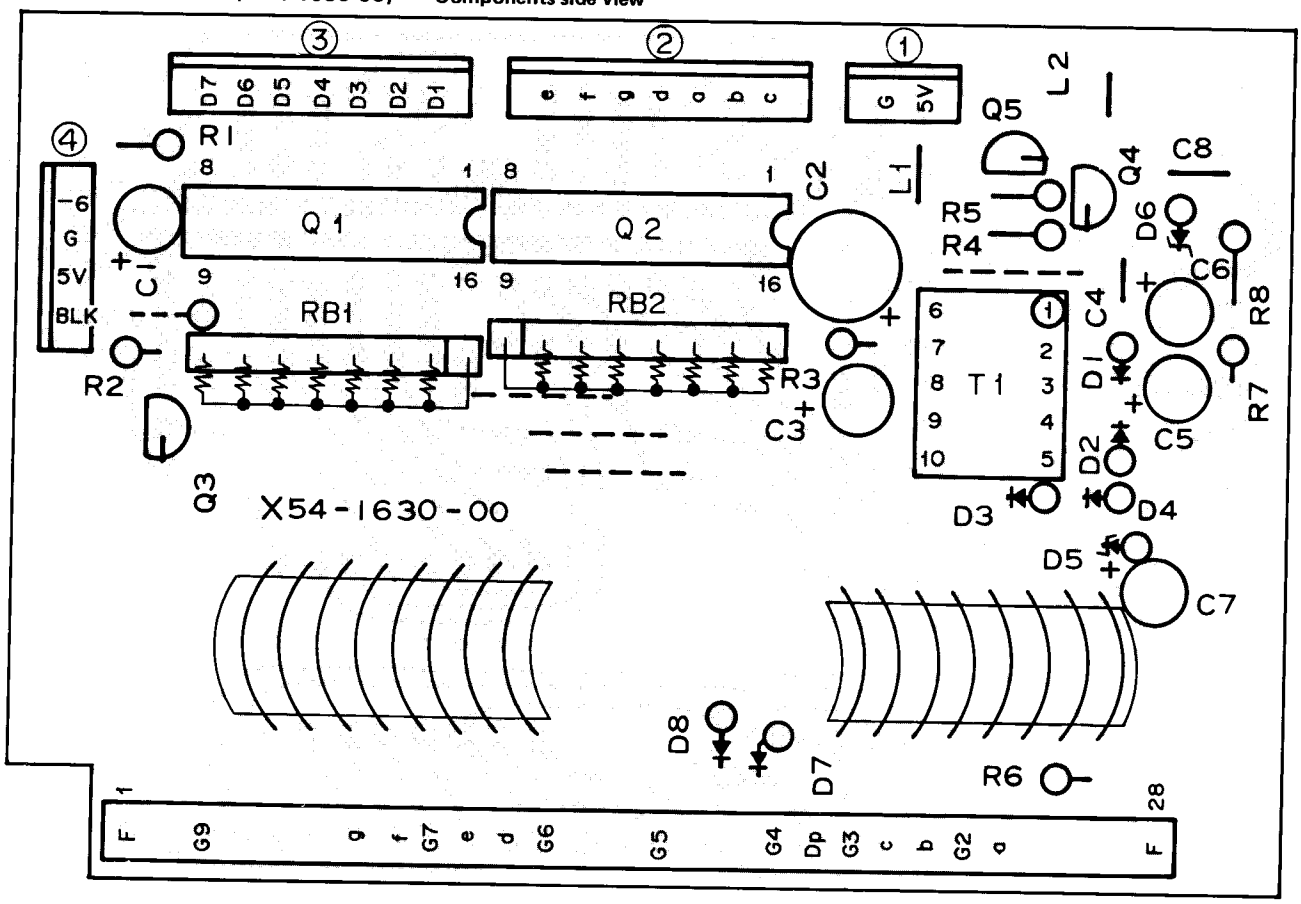
Hold the crimped metal sleeve with Pliers and pull up as shown.
Caution : DO NOT pull on the cable.

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

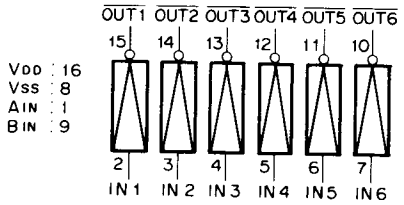


TS-660 PC BOARD VIEW/CIRCUIT DIAGRAM

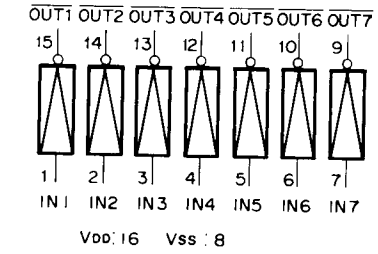
▼ DISPLAY UNIT (X54-1630-00) Components side view



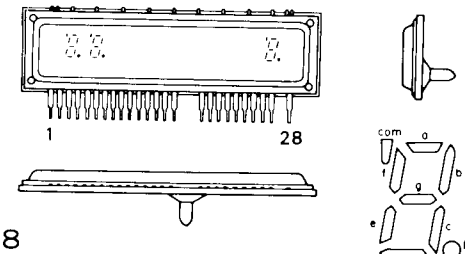
< TC5065BP Blockdiagram >



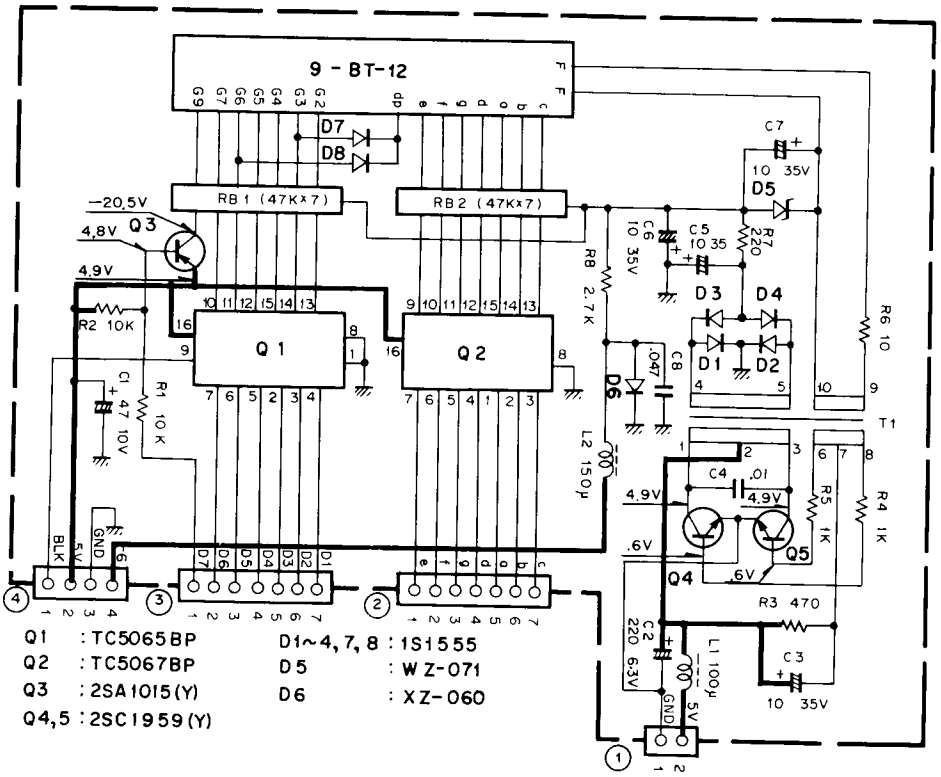
< TC5067BP Blockdiagram >



< Display tube 9-BT-12 >



DISPLAY (X54-1630-00)



Q1 : TC5065BP
Q2 : TC5067BP
Q3 : 2SA1015(Y)
Q4,5 : 2SC1959(Y)

D1~4, 7, 8 : 1S1555
D5 : WZ-071
D6 : XZ-060

PIN NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CONNECTION	F	N_C	G_9	N_C	N_C	G_8	g	f	G_7	e	d	G_6	N_C	N_C
	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


RD14BY
RD14BB (small size)


RD14CY
RD14CB (small size)

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

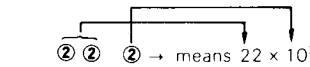
Cord	C	D	G	J	K	M	X	Z	P	No cord
(%)	±0.25	±0.5	±2	±5	±10	±20	+40 −20	+80 −20	+100 −0	More than 10 μF −10 ~ +50 Less than 4.7 μF −10 ~ +75

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



Example 221 → 220Ω 223 → 22 kΩ 225 → 2.2 MΩ
222 → 2.2 kΩ 224 → 220 kΩ

4. Tolerance
J = ±5% (Gold) K = ±10% (Silver)

CAPACITORS

Type I

CC	45	TH	1H	220	J
1'	2	3'	4	5	6

1 = Type ceramic, electrolytic, etc
2 = Shape round, square, etc
3 = Temp range
3' = Temp coefficient

Type II

CK	45	F	1H	103	Z
1	2	3	4	5	6

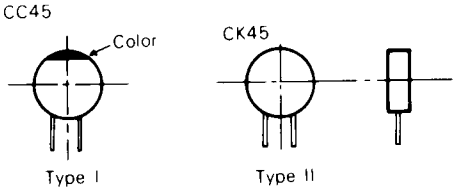
4 = Voltage rating
5 = Value
6 = Tolerance

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 = 0.001μF
103 → 0.01 μF



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

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
	XZ-060		V11-4101-20
	XZ-094		V11-4173-26
LED	PR2112D		V11-7260-66
	SG238D	N	V11-1278-16

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PARTS LIST

Item	Name	Re-marks	Parts No.
	SY438D	N	V11-1278-26
Thermistor	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
	TC4011BP		V30-0301-70
	TC4019BP		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
	J02-0407-04		Assistant foot
	J21-2573-04		Foot mounting hardware x 2
	J31-0141-04		Spacer ring MIC
	J61-0401-05		Nylon band x 4
	K21-0756-04	N	Main knob
	K23-0710-04		Knob (inside) x 4 SQL, MIC, RIT, AF
	K23-0738-04		Knob 1 x 2 MEMORY, MODE
	K27-0414-04		Push knob x 5 RIT, NB, F. STEP, M, HOLD
	K27-0415-04		Push knob x 2 VFO/MEMO, F. LOCK
	K27-0426-04	N	BAND knob x 2
	K29-0709-04		Push knob ALC/RF
	K29-0741-04		Knob (outside) x 3 CAR, IF SHIFT, RF
	K29-0749-04	N	Pointer knob FUNCTION
	K29-0750-04	N	Push knob SEND/REC
	N09-0256-05		Gnd screw x 4
	N14-0115-05		Flange nut GND
	N14-0509-05		Wing nut GND
	N15-1040-46		Washer x 2 GND
	N19-0608-04		Washer x 2 Dial scale
	N30-2604-46		Round screw x 15 2.6 x 4
	N30-3004-46		Round screw x 2 ANT SELECT SW
	N30-3008-46		Round screw Panel
	N30-4016-46		Round screw GND
	N32-2606-46		Flat screw 2.6 x 6 LED
	N32-3006-46		Flat screw x 2 Display unit
	N33-3006-46		Round flat screw x 8 SP, Panel
	N35-3006-45		Bind screw x 15 Case A, B
	N87-2606-46		Self tapping screw Front glass
	N87-3006-41		Self tapping screw x 2 Name plate
	N87-3006-46		Self tapping screw x 14
	N87-3008-46		Self tapping screw x 4 Final unit
	N87-3012-46		Self tapping screw x 32
	N88-2606-46		Flat tapping screw x 3 BAND
	N88-3006-46		Flat tapping screw x 10 Sub, Rear panel
	N89-3005-46		Bind tapping screw x 5 Lug plate, Assistant foot
	N89-3006-46		Bind tapping screw x 2 IF unit
	S31-2007-05		Slide switch ANT
	S36-2402-05		Paddle switch POWER
	S50-1406-05		Tact switch x 2
	T03-0027-15		Speaker
	T91-0316-15		Microphone
	X41-1340-00	N	Switch unit
	X41-1350-00	N	BAND switch unit
	X44-1440-00	N	RF unit
	X48-1330-00	N	IF unit
	X48-1340-00	N	FM unit
	X50-1740-00	N	PLL unit
	X51-1260-00	N	Filter unit
	X53-1220-00	N	Control unit
	X54-1630-00	N	Display unit
	X56-1410-00	N	Final unit
	X60-1170-00	N	Encoder ass'y unit

Ref. No.	Parts No.	Re-marks	Description
SWITCH UNIT (X41-1340-00)			
C1, 2	CC45SL1H101J		C 100pF
C3	CE04W1H010M		E 1μF 50V
C4	CE04W1A101M		E 100μF 10V
C5	CE04W1E4R7M		E 4.7μF 25V
C6	CQ92M1H153K		ML 0.015μF
C7	CE04W1H010M		E 1μF 50V
C8	CQ92M1H473K		ML 0.047μF
C9	CE04W1H010M		E 1μF 50V
C10	CE04W1E4R7M		E 4.7μF 25V
C11	CE04BW1C3R3M		E 3.3μF 16V (Non-pole)
C12	CE04W1H010M		E 1μF 50V
	E06-0853-05		8P male socket MIC
	E23-0047-04		Square terminal x 2
	E40-0273-05		Mini connect wafer x 2 2P
	E40-0373-05		Mini connect wafer 3P
	E40-0473-05		Mini connect wafer x 3 4P
	E40-0673-05		Mini connect wafer 6P
VR1-1, 1-2 2-1, 2-2	R19-3410-05	N	Pot. MIC/CAR, AF/RF
VR3	R12-4020-05		Trim. pot 50kΩ
VR4-1, 4-2	R19-3411-05	N	Pot. RIT/IF SHIFT
VR5-1, 5-2	S03-2401-05	N	Rotary switch with VR
	R92-0150-05		Short jumper
S1	S03-2401-05	N	Rotary switch with VR FUNCTION
S2–5	S40-2419-05		Push switch RIT, NB, F. LOCK, F. STEP
S6	S01-2431-05	N	Rotary switch MODE
S7	S01-1428-05	N	Rotary switch MEMORY
S8, 9	S40-2405-05		Push switch METER, STBY
S10	S40-2419-05		Push switch VFO/MEMO
S11	S40-2426-05	N	Push switch M
S12	S40-2419-05		Push switch HOLD
BAND SWITCH UNIT (X41-1350-00)			
S1, 2	S50-1409-05	N	Tact switch
RF UNIT (X44-1440-00)			
C1	CC45RH1H820J		C 82pF
C2	CC45RH1H101J		C 100pF
C3	CC45RH1H181J		C 180pF
C4	CC45RH1H560J		C 56pF
C9	CC45SL1H101J		C 100pF
C10	CC45SL1H100D		C 10pF
C11	CC45SL1H270J		C 27pF
C12	CC45SL1H101J		C 100pF
C20	CC45SL1H220J		C 22pF
C31	CC45SL1H330J		C 33pF
C40	CC45SL1H180J		C 18pF
C41	CC45SL1H470J		C 47pF
C48	CC45SL1H050C		C 5pF
C49	CC45SL1H100D		C 10pF
C51, 52	CC45SL1H470J		C 47pF
C54	CE04W1C100M		E 10μF 16V
C56	CC45SL1H100D		C 10pF
C65	CC45SL1H030C		C 3pF
C71	CC45SL1H150J		C 15pF
C72, 73	CC45SL1H180J		C 18pF

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PARTS LIST

Ref. No.	Parts No.	Re-marks	Description
C84	CE04W1H010M		E 1μF 50V
C87	CC45SL1H560J		C 56pF
C94	CC45SL1H820J		C 82pF
C100	CC45SL1H680J		C 68pF
C102	CC45SL1H820J		C 82pF
C105	CC45SL1H330J		C 33pF
C109	CC45SL1H101J		C 100pF
C116, 119, 121, 125, 129	CE04W1H010M		E 1μF 50V
TC1–3	C05-0309-05		Ceramic trimmer 40pF
	E04-0154-05		Mini pin jack
	E23-0046-04		Square terminal x 2
	E23-0512-05		Terminal
	E29-0413-05		1P connector (female)
	E40-0273-05		Mini connect wafer x 7 2P
	E40-0473-05		Mini connect wafer x 2 4P
	E40-0573-05		Mini connect wafer x 2 5P
	J31-0502-04		PC board collar x 4
	J42-0428-05		PC board bushing x 4
L1, 2	L40-1511-03		Ferri-inductor 150μH
L3, 4	L34-2027-05	N	ANT coil 50 MHz
L5	L40-1511-03		Ferri-inductor 150μH
L6	L79-0484-05	N	Coil block A 50 MHz
L7	L40-1511-03		Ferri-inductor 150μH
L9	L34-0983-05		BPF coil 21C
L10, 11	L34-2025-05	N	ANT coil 24 MHz
L12	L40-2211-03		Ferri-inductor 220μH
L13–16	L40-4711-03		Ferri-inductor 470μH
L17	L34-0981-05		BPF coil 21A
L18	L34-0982-05		BPF coil 21B
L19	L34-0983-05		BPF coil 21C
L20	L34-0984-05		BPF coil 24A
L21	L34-0985-05		BPF coil 24B
L22	L34-0986-05		BPF coil 24C
L23	L34-0707-05		BPF coil 28A
L24	L34-0987-05		BPF coil 28B
L25	L34-0984-05		BPF coil 28C
L26	L40-4711-03		Ferri-inductor 470μH
L27	L40-3311-03		Ferri-inductor 330μH
L28	L40-4711-03		Ferri-inductor 470μH
L29	L34-0966-05		Trap coil 8.83 MHz
L30	L40-1511-03		Ferri-inductor 150μH
L31	L40-2282-01		Ferri-inductor 0.22μH
L32	L40-1011-03		Ferri-inductor 100μH
L33	L40-4711-03		Ferri-inductor 470μH
L34	L40-1511-03		Ferri-inductor 150μH
L35	L40-1011-03		Ferri-inductor 100μH
L36	L40-3311-03		Ferri-indoctor 330μH
L37	L79-0485-05	N	Coil block B 50 MHz
L38	L79-0486-05	N	Coil block C 50 MHz
L39	L40-3392-02		Ferri-inductor 3.3μH
L40	L40-1001-03		Ferri-inductor 10μH
L41	L34-1021-05	N	Input coil
L42	L33-0222-05		Choke coil
L43	L34-1022-05	N	Output coil
L44	L40-1001-03		Ferri-inductor 10μH
L45	L40-4791-02		Ferri-inductor 4.7μH
L46	L33-0222-05		Choke coil
L47	L40-2211-03		Ferri-inductor 220μH
L49	L40-1511-03		Ferri-inductor 150μH
L50	L40-4701-03		Ferri-inductor 47μH
L51	L40-3392-02		Ferri-inductor 3.3μH
L52–54	L40-1511-03		Ferri-inductor 150μH
L55	L40-4701-03		Ferri-inductor 47μH
L56	L40-1511-03		Ferri-inductor 150μH
T1	L19-0324-05	N	Wide bandwidth trans
T2	L30-0506-05		IFT
T3	L30-0512-05	N	IFT 8.83 MHz
T4	L34-0536-05		Tuning coil
T5	L34-0942-05		Tuning coil
T6	L30-0511-05	N	IFT 8.83 MHz, NB
T7	L34-0535-05		Tuning coil
T8	L34-0536-05		Tuning coil
T9	L19-0324-05	N	Wide bandwidth trans
T10	L34-0697-05		Tuning coil
T11	L19-0328-05	N	Wide bandwidth trans
T12	L34-2026-05	N	ANT coil 28 MHz
CF1	L72-0324-05		Ceramic filter 8.83 MHz
VR1, 2	R12-0420-05	N	Trim. pot 500Ω (B)
VR3, 4	R12-1415-05		Trim. pot 3kΩ (B)
	R92-0150-05		Short jumper x 32
RL1	S51-1404-05		Relay G2E

IF UNIT (X48-1330-00)

C3	CC45SL1H101J		C 100pF
C5	CC45SL1H020C		C 2pF
C6	CC45SL1H330J		C 33pF
C9	CC45UJ1H100D		C 10pF
C10	CE04W1HR47M		E 0.47μF 50V
C27	C91-0456-05		C 0.047μF
C31	CC45SL1H470J		C 47pF
C35	CC45SL1H100D		C 10pF
C37	CC45SL1H150J		C 15pF
C40	CQ92M1H333K		ML 0.033μF
C43	CC45SL1H220J		C 22pF
C46, 49, 51	CC45SL1H470J		C 47pF
C52	CC45SL1H050C		C 5pF
C54	CE04W1C220M		E 22μF 16V
C58, 63	C91-0456-05		C 0.047μF
C64	CE04W1H4R7M		E 4.7μF 50V
C65	CE04BW1H010M		E 1μF 50V
C66	CE04W1H010M		E 1μF 50V
C68	CE04W1A101M		E 100μF 10V
C69, 70	CE04W1C100M		E 10μF 16V
C71	CE04W1HR47M		E 0.47μF 50V
C72	CE04W1H010M		E 1μF 50V
C73	CQ92M1H223K		ML 0.022μF
C74	CE04W1C100M		E 10μF 16V
C75, 76	CE04W1C470M		E 47μF 16V
C77	CE04W1C221M		E 220μF 16V
C78	CQ92M1H104K		ML 0.1μF
C79	CC45SL1H470J		C 47pF
C80	CC45SL1H101J		C 100pF
C84	CE04W1A470M		E 47μF 10V
C85	CC45SL1H470J		C 47pF
C86	CE04W1H0R1M		E 0.1μF 50V
C87	CE04W1H010M		E 1μF 50V
C88	CE04W1HR22H		E 0.22μF 50V
C90	CE04W1H010M		E 1μF 50V
C91	CE04W1C100M		E 10μF 16V

PARTS LIST

Ref. No.	Parts No.	Re-marks	Description
C92–94	CQ92M1H822K		ML 0.0082μF
C95	CQ92M1H104K		ML 0.1μF
C96	CQ92M1H103K		ML 0.01μF 50V
C97	CE04W1A470M		E 47μF 10V
C98	CE04W1H4R7M		E 4.7μF 50V
C99	CE04W1H010M		E 1μF 50V
C101	CE04W1HR47M		E 0.47μF 50V
C102	CE04W1HR22M		E 0.22μF 50V
C103	CE04BW1H010M		E 1μF 50V
C104	CE04W1C100M		E 10μF 16V
C105	CE04W1H010M		E 1μF 50V
C107	CE04W1H010M		E 1μF 50V
C109, 111	CE04W1H010M		E 1μF 50V
C113, 115	C91-0456-05		C 0.047μF
C114, 116	CE04W1C100M		E 10μF 16V
C119, 120	C90-0817-05		E 1000μF
C123–125	C90-0839-05		E 4.7μF 25V
C128	C91-0456-05		C 0.047μF
TC1	C05-0031-15		Ceramic trimmer 10pF
TC2, 3	C05-0030-15		Ceramic trimmer 20pF
	E23-0046-04		Square terminal
	E23-0512-05		Terminal x 4
	E29-0413-05		1P connector (female)
	E40-0273-05		Mini connect wafer x 9 2P
	E40-0373-05		Mini connect wafer x 2 3P
	E40-0473-05		Mini connect wafer x 4 4P
	E40-0573-05		Mini connect wafer x 3 5P
	E40-0673-05		Mini connect wafer x 2 6P
	E40-0773-05		Mini connect wafer 7P
	F20-0516-05		Insulating sheet
	F29-0014-05		Shoulder washer
	J31-0502-04		PC board collar x 6
	J42-0428-05		PC board bushing x 6
L1	L32-0201-05		OSC coil
L2	L40-1511-03		Ferri-inductor 150μH
L3	L40-2211-03		Ferri-inductor 220μH
L4	L33-0636-05		Choke coil 28μH
L5	L40-1511-03		Ferri-inductor 150μH
L6	L34-0708-05		Tuning coil
L7	L34-0535-05		Tuning coil
L8	L34-0536-05		Tuning coil
L9	L34-0567-05		Tuning coil
L10	L34-0535-05		Tuning coil
L13	L40-1511-03		Ferri-inductor 150μH
L14, 22	L40-4711-03		Ferri-inductor 470μH
L15, 16	L40-1511-03		Ferri-inductor 150μH
L17	L40-3391-03		Ferri-inductor 3.3μH
L19	L15-0016-05		Choke trans
XF1	L71-0208-05		MCF YK-88S
X1	L77-0485-05		Crystal 8.8315 MHz
	N10-2030-46		Nut x 5
	N30-3008-46		Round screw x 3
	N30-3010-46		Round screw x 2
VR1–3	R12-1414-05	N	Trim. pot 1kΩ
VR4	R12-7403-05	N	Trim. pot 500kΩ
VR5	R12-3430-05	N	Trim. pot 10kΩ

Ref. No.	Parts No.	Re-marks	Description
VR6	R12-0421-05		Trim. pot 100Ω
VR7	R12-7403-05	N	Trim. pot 500kΩ
VR8	R12-4408-05	N	Trim. pot 50kΩ
VR9	R12-2409-05	N	Trim. pot 5kΩ
VR10	R12-5408-05	N	Trim. pot 200kΩ
VR11, 12	R12-2409-05	N	Trim. pot 5kΩ
VR13	R12-3430-05		Trim. pot 10kΩ
	R92-0150-05		Short jumper x 60
RL1	S51-1410-05	N	Relay OUC-S-112D

FM UNIT (X48-1340-00)

C1	CQ92M1H472K		ML 0.0047μF
C2	CQ92M1H103K		ML 0.01μF
C3	CE04W1A470M		E 47μF 10V
C4	CE04W1A220M		E 22μF 10V
C5	CE04W1H010M		E 1μF 50V
C6	CE04W1A470M		E 47μF 10V
C7	CQ92M1H103K		ML 0.01μF
C8	CE04W1H010M		E 1μF 50V
C9	CQ92M1H393K		ML 0.039μF
C10	CE04W1H010M		E 1μF 50V
C11	CC45UJ1H070D		C 7pF
C12, 14	CC45SL1H221J		C 220pF
C15	CC45SL1H050C		C 5pF
C16	CC45SL1H220J		C 22pF
C22	CQ92M1H473K		ML 0.047μF
C23	CE04W1A220M		E 22μF 10V
C24	CQ92M1H103K		ML 0.01μF
C25	CQ92M1H473K		ML 0.047μF
C26	CE04W1A3R3M		E 3.3μF 10V
C29	CQ92M1H332K		ML 0.0033μF
C30	CQ92M1H473K		ML 0.047μF
C31, 32	CE04W1H010M		E 1μF 50V
C34	CC45SL1H121J		C 120pF
C35	CC45SL1H560J		C 56pF
C37	CE04W1A101M		E 100μF 10V
C40	CC45SL1H120J		C 12pF
C41	CC45SL1H220J		C 22pF
C49	CE04W1E4R7M		E 4.7μF 25V
C50	CQ92M1H103K		ML 0.01μF
C51	CC45SL1H150J		C 15pF
TC1	C05-0031-15		Ceramic trimmer 10pF
	E40-0273-05		Mini connect wafer x 3 2P
	E40-0773-05		Mini connect wafer 7P
	J31-0502-04		PC board collar x 6
	J42-0428-05		PC board bushing x 6
L1	L40-1541-27		Ferri-inductor 150mH
L2	L33-0640-05	N	Choke coil 12μH
L3	L33-0639-05	N	Choke coil 10μH
L4	L40-1511-03		Ferri-inductor 150μH
L5	L40-6891-01		Ferri-inductor 6.8μH
T1	L34-0535-05		Tuning coil
T2	L30-0503-05		Tuning coil
T3	L30-0199-05		Tuning coil
CF1	L72-0309-05		Ceramic filter CFT455F2

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PARTS LIST

Ref. No.	Parts No.	Re-marks	Description
X1	L77-0940-05	N	Crystal 8.8315 MHz
X2	L77-0939-05	N	Crystal 9.2865 MHz
VR1	R12-3430-05		Trim. pot 10kΩ (B)
VR2	R12-4408-05		Trim. pot 50kΩ (B)
VR3	R12-4410-05		Trim. pot 50kΩ (B)
	R92-0150-05		Short jumper

PLL UNIT (X50-1740-00)

C1	CE04W1A220M		E 22μF 10V
C2	CC45UJ1H180J		C 18pF
C3	CC45UJ1H080D		C 8pF
C4	CC45TH1H150J		C 15pF
C5	CC45UJ1H100D		C 10pF
C6	CC45UJ1H270J		C 27pF
C8	CE04W1A220M		E 22μF 10V
C10	CE04W1A470M		E 47μF 10V
C11	CC45UJ1H270J		C 27pF
C12	CC45TH1H220J		C 22pF
C13	CC45UJ1H070D		C 7pF
C14	CC45UJ1H220J		C 22pF
C16	CE04W1A220M		E 22μF 10V
C18	CC45UJ1H180J		C 18pF
C19	CC45TH1H150J		C 15pF
C20	CC45UJ1H030C		C 3pF
C21	CC45UJ1H180J		C 18pF
C23	CE04W1A220M		E 22μF 10V
C24	CC45CH1H070D		C 7pF
C25	CC45CH1H050C		C 5pF
C29	C91-0457-05		C 0.022μF
C30	CC45SL1H101J		C 100pF
C31	CC45SL1H820J		C 82pF
C32	CC45SL1H101J		C 100pF
C33	CC45SL1H470J		C 47pF
C36	CC45CH1H050C		C 5pF
C37	CC45CH1H010C		C 1pF
C45	CC45SL1H100D		C 10pF
C46, 47	CC45SL1H180J		C 18pF
C48	CC45SL1H100D		C 10pF
C49, 50	CC45SL1H180J		C 18pF
C57	CQ92M1H104K		ML 0.1μF
C59, 61	CE04W1A101M		E 100μF 10V
C66	CE04W1A470M		E 47μF 10V
C67	CE04W1H3R3M		E 3.3μF 50V
C70	CC45SL1H330J		C 33pF
C72	CC45SL1H150J		C 15pF
C73	CC45SL1H070D		C 7pF
	E23-0046-04		Square terminal x 2
	E40-0273-05		Mini connect wafer x 3 2P
	E40-0373-05		Mini connect wafer 3P
	E40-0473-05		Mini connect wafer x 2 4P
	J31-0502-04		PC board collar x 3
	J42-0428-05		PC board bushing x 3
L1	L40-1511-03		Ferri-inductor 150μH
L2	L40-4711-03		Ferri-inductor 470μH
L3	L32-0197-05		OSC coil 21M
L5	L40-1511-03		Ferri-inductor 150μH
L6	L32-0198-05		OSC coil 28M
L7	L40-1011-03		Ferri-inductor 100μH
L8	L32-0639-05	N	OSC coil 50M
L9	L40-4701-03		Ferri-inductor 47μH
L10	L40-1511-03		Ferri-inductor 150μH
L11	L40-4782-02		Ferri-inductor 0.47μH
L12, 13	L40-2282-01		Ferri-inductor 0.22μH
L14	L40-4782-02		Ferri-inductor 0.47μH
L15–18	L40-1511-03		Ferri-inductor 150μH
L19–21	L40-1001-03		Ferri-inductor 10μH
L22	L40-2201-03		Ferri-inductor 22μH
L23	L40-1001-03		Ferri-inductor 10μH
L24	L40-2201-03		Ferri-inductor 22μH
L25	L40-1021-03		Ferri-inductor 1000μH
L26–29	L40-4711-03		Ferri-inductor 470μH
L30	L40-4791-02		Ferri-inductor 4.7μH
	R92-0150-05		Short jumper x 5

FILTER UNIT (X51-1260-00)

C1	CC45SL2H150J		C 15pF 500V
C2	CC45SL1H331J		C 330pF
C8	CC45SL2H070D		C 7pF 500V
C9	CC45SL1H331J		C 330pF
C14	CE04W1HR47M		E 0.47μF 50V
C15	CE04W1C100M		E 10μF 16V
C22	CC45SL2H390J		C 39pF 500V
C23, 25	CC45SL2H820J		C 82pF 500V
C26	CC45SL2H390J		C 39pF 500V
C27, 28	CC45SL2H470J		C 47pF 500V
C31	CC45SL2H560J		C 56pF 500V
C32	CC45SL2H151J		C 150pF 500V
C33	CC45SL2H680J		C 68pF 500V
C35	CC45SL2H820J		C 82pF 500V
C37	CC45SL2H680J		C 68pF 500V
C45	CC45SL2H470J		C 47pF 500V
C46	CC45SL2H151J		C 150pF 500V
C47	CC45SL2H121J		C 120pF 500V
C49	CC45SL1H220J		C 22pF
C50	CC45SL1H330J		C 33pF
C51	CC45SL1H101J		C 100pF
C52	CC45CH1H0R5C		C 0.5pF
C53	CC45CH1H020C		C 2pF
TC1	C05-0043-05		Ceramic trimmer 20pF
	E04-0157-05		Mini pin jack A x 3
	E23-0512-05		Terminal
	E40-0273-05		Mini connect wafer x 2 2P
	E40-0473-05		Mini connect wafer 4P
	E40-0573-05		Mini connect wafer 5P
	J31-0502-04		PC board collar x 6
	J42-0428-05		PC board bushing x 6
L1	L39-0410-15	N	Detector coil
L2, 3	L40-1511-03		Ferri-inductor 150μH
L4	L33-0641-05	N	Choke coil 47μH
L6	L33-0641-05	N	Choke coil 47μH
L7	L34-3002-05	N	Filter coil
L8	L34-3003-05	N	Filter coil
L9	L34-3004-05	N	Filter coil
L10	L34-3005-05	N	Filter coil
L11	L34-0830-05		Filter coil
L12	L34-3006-05	N	Filter coil
L13	L34-0830-05		Filter coil

PARTS LIST

Ref. No.	Parts No.	Re-marks	Description
L14	L34-3007-05	N	Filter coil
L15	L34-3008-05	N	Filter coil
L16	L33-0641-05	N	Choke coil 47μH
L17, 18	L40-1511-03		Ferri-inductor 150μH
R11, 12	RS14AB3A181J		Metal film 180Ω 1W
R13	RS14AB3A470J		Metal film 47Ω 1W
VR1, 2	R12-4016-05		Trim. pot 50kΩ (B)
	R92-0150-05		Short jumper x 17
RL1–6	S51-1409-05	N	Relay

CONTROL UNIT (X53-1220-00)

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

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PARTS LIST

Ref. No.	Parts No.	Re-marks	Description
L25	L40-1511-03		Ferri-inductor 150μH
L26	L32-0640-05	N	OSC coil
L27	L40-4711-03		Ferri-inductor 470μH
L28, 29	L40-3325-04		Ferri-inductor 3.3mH
L30, 31	L34-2024-05	N	Tuning coil 8M
L32	L40-4711-03		Ferri-inductor 470μH
L33	L33-0636-05		Choke coil 28μH
L34, 35	L34-0845-05		Tuning coil 8M
L36	L40-4711-03		Ferri-inductor 470μH
L37	L40-1511-03		Ferri-inductor 150μH
L38	L40-1011-04		Ferri-inductor 100μH
L39	L40-4711-03		Ferri-inductor 470μH
X1	L77-0941-05	N	Crystal 16M
X2	L77-0942-05	N	Crystal 8.7315M
X3	L77-0943-05	N	Crystal 8M
XF1	L71-0213-05		MCF 7.975M
RB1–3	R90-0515-05		Resistor block 10kΩ x 4
VR1	R12-6401-05		Trim. pot 470kΩ
VR3	R12-1416-05		Trim. pot 4.7kΩ
	R92-0150-05		Short jumper x 101
BZ1	T95-0051-05		Buzzer

DISPLAY UNIT (X54-1630-00)

C1	CE04W1A470M		E 47μF 10V
C2	CE04W0J221M		E 220μF 6.3V
C3	CE04W1V100M		E 10μF 35V
C4	CQ92M1H103K		ML 0.01μF
C5–7	CE04W1V100M		E 10μF 35V
C8	C91-0456-05		C 0.047μF
	E40-0273-05		Mini connect wafer 2P
	E40-0473-05		Mini connect wafer 4P
	E40-0773-05		Mini connect wafer x 2 7P
L1	L40-1011-04		Ferri-inductor 100μH
L2	L40-1511-03		Ferri-inductor 150μH
T1	L19-0305-05		OSC transformer
	N30-3006-46		Round screw x 6
RB1, 2	R90-0521-05		Resistor block 47kΩ 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 220μF 16V
C11	CC45SL2H820J		C 82pF 500V
C16, 20	CE04W1C100M		E 10μF 16V
C26	CC45SL2H101J		C 100pF 500V
TC1	C05-0043-05		Ceramic trimmer 20pF
	E04-0157-05	N	Mini pin jack A x 2
	E23-0046-04		Square terminal x 2
	E23-0401-05		Round terminal
	E23-0512-05		Terminal
	F01-0761-03	N	Heat sink A
	F20-0078-05		Inshulating board
	J31-0505-04		Spacer x 6
L1, 2	L33-0025-05		RFC 1μH
L3	L33-0617-05		RFC
L4	L33-0025-05		RFC 1μH
T1	L19-0315-25		Wide bandwidth trans
T2	L19-0325-05	N	Matching trans (A)
T3	L19-0326-05	N	Matching trans (B)
T4	L19-0327-05	N	Output trans
	N30-2606-46		Round screw
	N87-3006-46		Self tapping screw x 4
	N87-3010-46		Self tapping screw x 6
R9	R92-0601-05		Cement resistor 0.22Ω
VR1	R12-1422-05		Trim. pot 1.5kΩ
VR2	R12-0408-05		Trim. pot 100Ω
	R92-0150-05		Short jumper x 3

ENCODER ASS'Y UNIT (X60-1170-00)

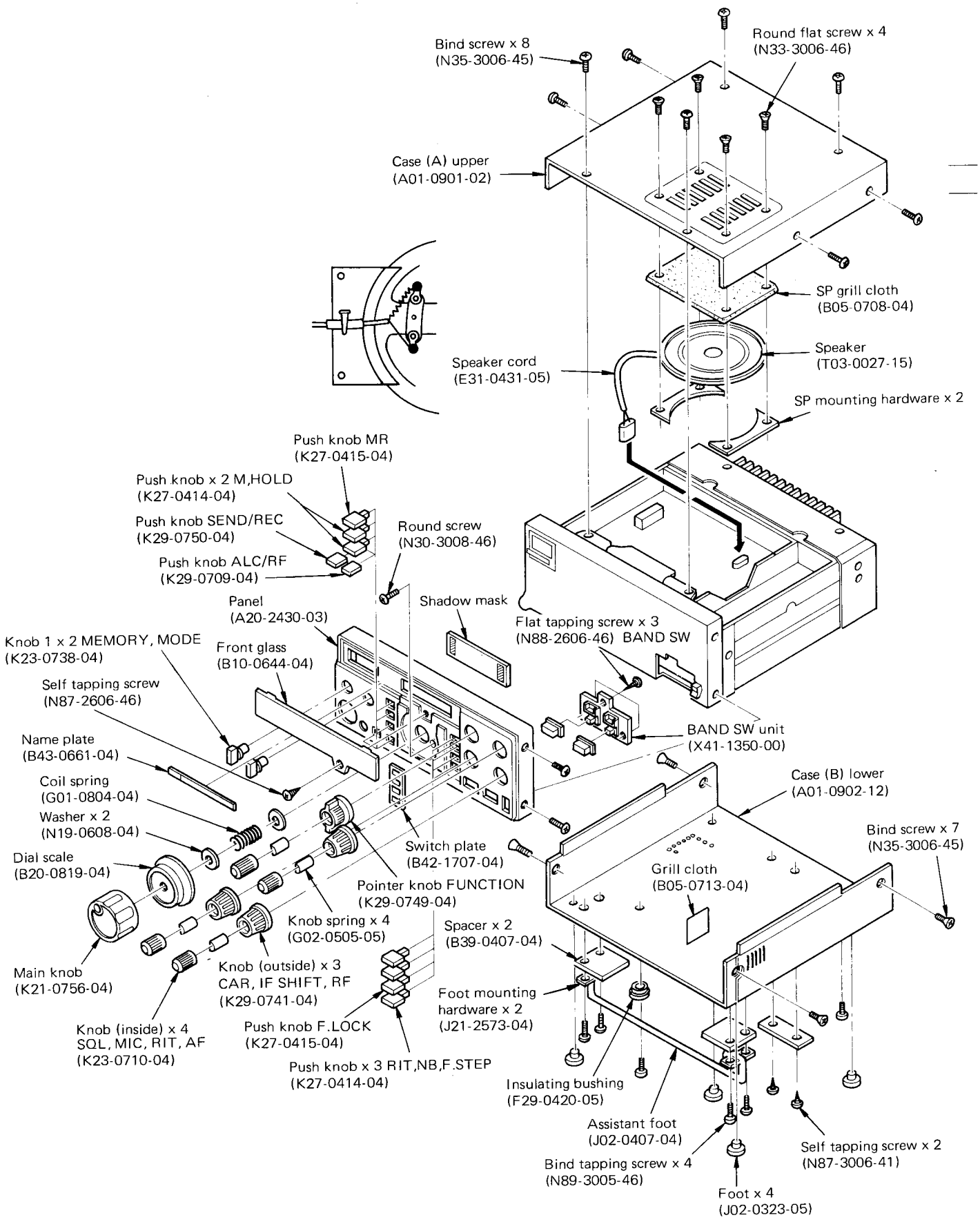
	D09-0304-04	N	Encoder slit
	D21-0818-05	N	Shaft ass'y
	N30-3006-46		Round screw x 4
	N89-3005-46		Bind tap tight screw x 3
	X54-1640-00	N	Encoder unit

ENCODER UNIT (X54-1640-00)

C1	CE04W1A470M		E 47μF 10V
	E40-0474-05		Mini connect wafer 4P
	G02-0519-04		Spring plate
	J19-1342-04		Senser mounting hardware (A)
	J19-1343-04		Senser mounting hardware (B)
	N32-3020-46		Flat screw
VR1, 2	R12-2410-05	N	Trim. pot 5kΩ (B)

Note : Encoder unit (X54-1640-00) is not available.
Please oder complete Encoder ASS'Y (X60-1170-00).

DISASSEMBLY



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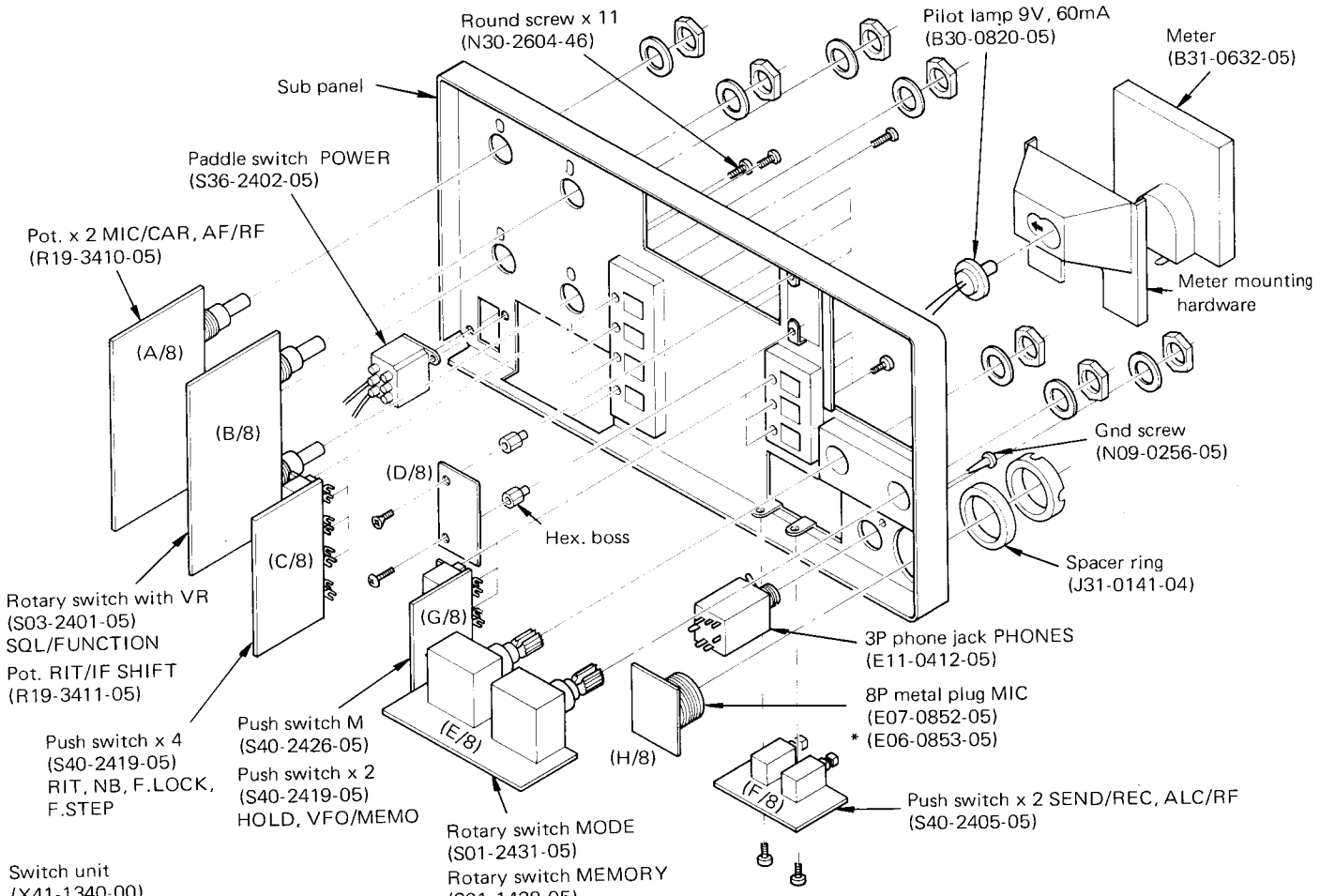
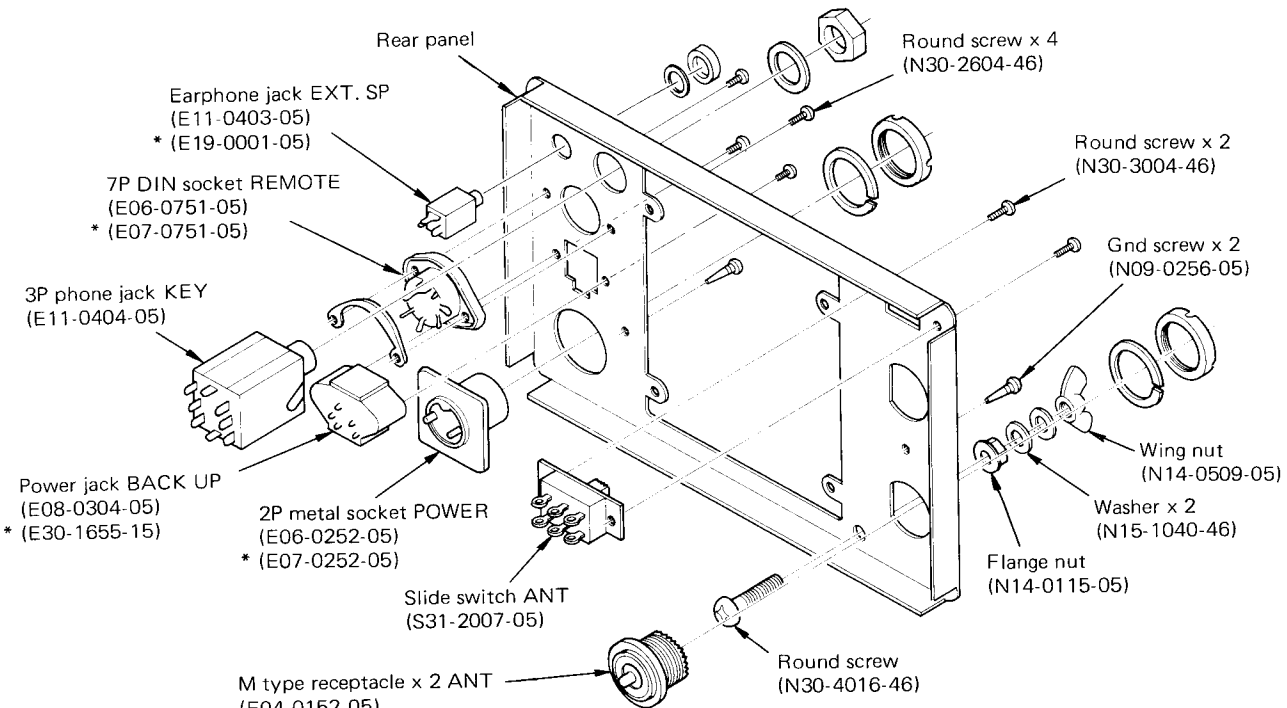
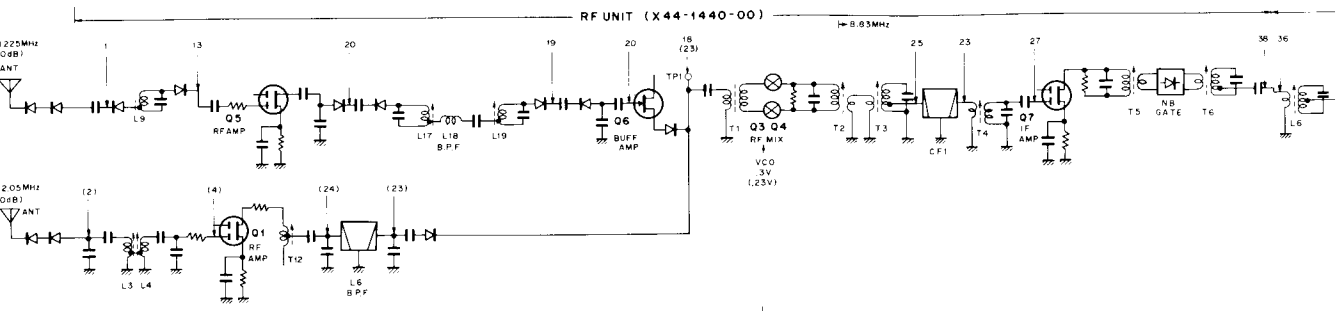
DISASSEMBLY

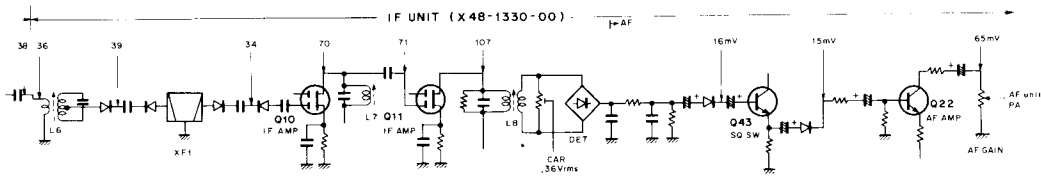


*** : Mating connector**



RECEIVER SECTION (21, 50MHz BAND SSB)

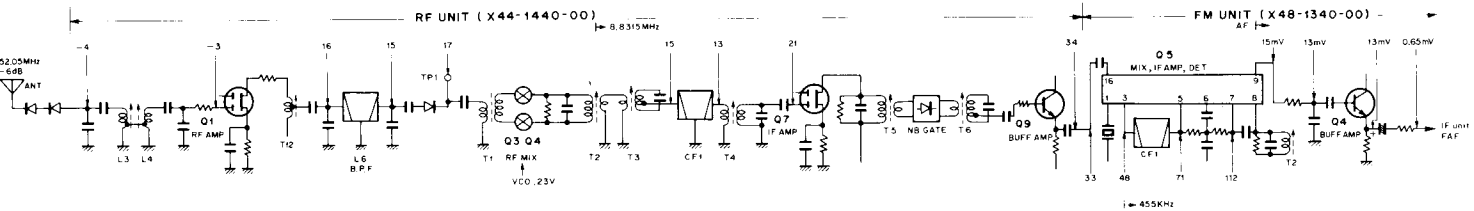




Note 1 : SSG signal at 21.225 MHz (52.05 MHz) and 0 dB is fed into the ANT terminal and, after audio output is set at 0.63V/8Ω by the AF GAIN VR, the SSG signal input levels (dBμ) at each stage required to achieve the same audio output at constant AF GAIN VR are displayed.

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

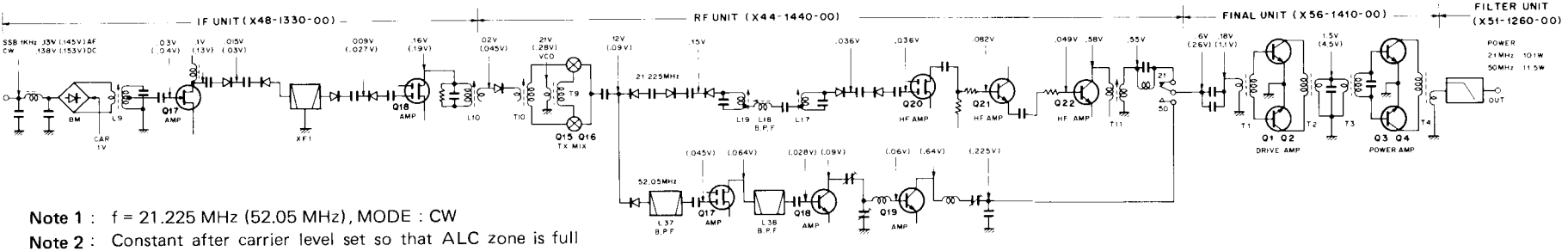
RECEIVER SECTION (50MHz BAND FM)



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/1 V
   3) Output impedance : 50 Ω
   4) AM and FM modulation can be possible.

NOTE : Generator must be frequency stable.

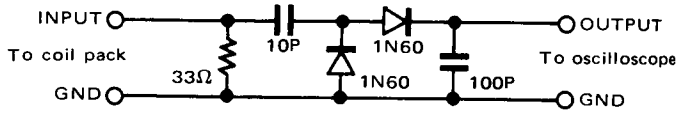
10. Frequency Counter
   1) Minimum input voltage : 50 mV
   2) Frequency range : 60 MHz or greater

11. Noise Generator
Must generate ignition noise containing harmonics beyond 60 MHz.

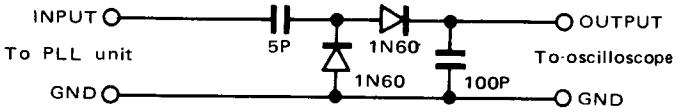
12. Power Meter
   1) Impedance : 50Ω
   2) Dissipation : 15 W continuous or greater
   3) Frequency limits : 60 MHz or greater

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

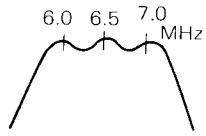
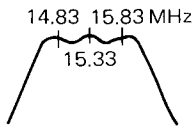
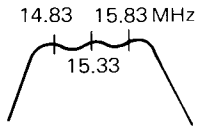
VOLTAGE ADJUSTMENTS

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
	STBY : SEND			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

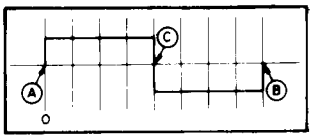
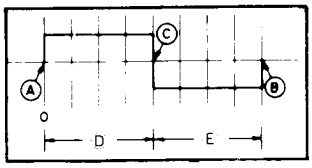
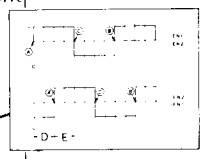
PLL ADJUSTMENTS

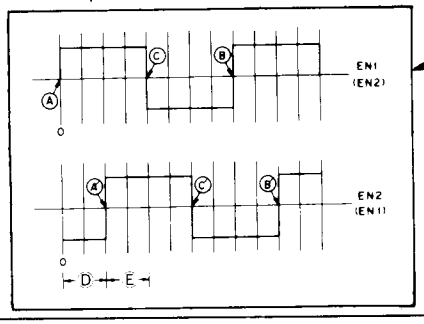
Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Adjustment of standard oscillation	1) RIT : OFF RIT VR : CENTER	f. counter	Control	D48 cathode	Control	TC1	8,000,000 Hz	±3 Hz	
	2) RIT : ON					TC3		±50 Hz	RIT IND lights
	3) RIT : Turn 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

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 : [illegible].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 Oscillo-scope 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 Oscillo-scope 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 Oscillo-scope 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

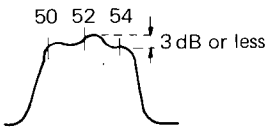
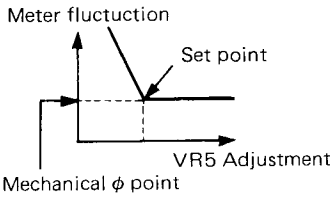
Item	Condition	Measurement: Test equipment	Measurement: Unit	Measurement: Terminal	Adjustment: Unit	Adjustment: Parts	Adjustment: Method	Specification	Remarks
14. Encoder adjustment	1) Remove the VFO knob and motor-drive the encoder at approx 300 rpm.	Oscillo-scope	Digital	Connector ⑳ EN1 terminal					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 adjust-ment : Turn a motor CW and CCW				Encoder	VR1			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 adjust-ment : Turn a motor in the both direction.			Connector ⑳ EN2 terminal		VR2	Adjust untill intervals D and E are equal to each other with point C placed at the center.		
	4)EN1-EN2 phase differ-ence alignment : Same as above.			Connector ⑳ EN1 and EN2 terminals		Phase adjustment screw	 Adjust until inter-vals D and E are equal to each other (point A' on EN2 is located in the middle of points A and C on EN1.)	EN1 (EN2) : Within 90°±10% (The difference between CW and CCW rotation must also be within this specification.)	The phases of EN1 and EN2 may be replaced with each other as indicated in the brackets.



RX ADJUSTMENTS

Item	Condition	Measurement: Test equipment	Measurement: Unit	Measurement: Terminal	Adjustment: Unit	Adjustment: Parts	Adjustment: Method	Specification	Remarks
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	

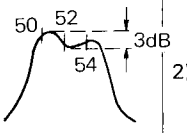
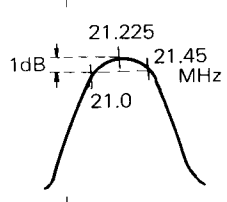
ADJUSTMENT

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 Oscillo-scope Detector	RF	TP1	RF	L3,4 L6 T12			
3. IF	1) BAND : 52 VFO : 52.100.0 MODE : SSB	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			
	2) MODE : FM				FM IF	VR3, T2	MAX		
4. HF ANT Coil	1) BAND : 21 VFO : 21.225.0	SSG AF VM AF DUMMY LOAD Oscillo-scope		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 be 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	30 dB±10 dB	
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 Oscillo-scope		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.)		

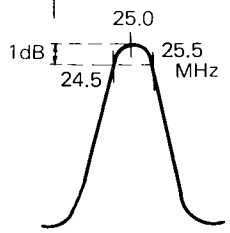
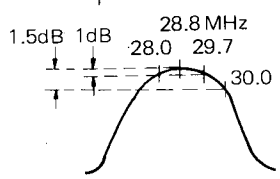
ADJUSTMENT

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 Ⓐ and Ⓑ
				B		VR2		100 mA	
	2) Reconnect DRV connector STBY : REC						Resolder Ⓐ to Ⓑ	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 conctor 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			
					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.
	2) STBY : REC VFO/MEMO : VFO Reinstall conector ⑤								
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 counpler	RF	L17~19	Adjust as shown at right.		1) Adjust using the minimum input possible. 2) Use MEMORY as marker.

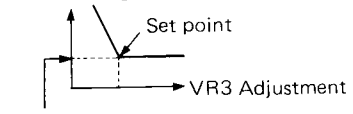
ADJUSTMENT

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. ①24.500.0 ②25.000.0 ③25.500.0 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 ①28.000.0 ②28.800.0 ③29.700.0 ④30.000.0 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								

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
7. Power	1) BAND : 28 VFO : 28.800.0 MODE : CW CAR VR : Full CW Filter uint VR1 : mechanical center STBY : SEND	Power meter		ANT (21~50)	Filter	VR2	11W		
	2) STBY : REC								
8. Spurious	1) BAND : 21,50,53 MODE : CW STBY : SEND	Spectrum analizer or Directional coupler		ANT (21~50)	RF	VR3	①f 50.000.0 (58.83M)	–60 dB or less	Power down is 2 dB or less. Repeat ① and ② and then
						VR2	②f 53.999.9 (45.17M)		
						VR4	③f 21.999.9 (26.49M)	–40 dB or less	
	2) STBY : REC								
9. Protection	1) BAND : 50 MODE : CW ANT : OPEN STBY : SEND	DC A.M			Filter	VR1	4.0A	Less than 4.5A	
	2) STBY : REC								
	3) BAND : Check each BAND STBY : SEND						If any BAND exceeds 4A, readjust to 4A. (comfirm 24.999.9)		
	4) STBY : REC								
10. Carrier balance and carrier point	1) BAND : 50 MODE : SSB MIC GAIN : Full CCW STBY : SEND	Power meter Directional coupler		ANT (21~50)	IF	VR6 TC2	Repeat alternately and adjust to minimum.	–40 dB or less from CW full power.	
	2) MIC connecnector : AG (AG : 5 mV 1.5 kHz) Adjust MIC GAIN for approx 1/2 of full RF output (NO ALC) Change AG frequency between 300 Hz and 2.7 kHz.	RF V.M AG AF V.M				TC1	Adjust so that the 300 Hz and 2.7 kHz outputs are the same.	With AG frequency of 1.5 kHz as standard, outputs at 400 Hz and 2.6 kHz must be within –6 dB.	
	3) STBY : REC								
11. TX.IF	1) MODE : CW CAR : Full CW STBY : SEND	RF V.M	IF	IF Connector ① 2 Pin (TIF)	IF	L9,10	MAX.		When peak point is not clear, reduce CAR level.
	2) STBY : REC								
12. FM-IF	1) BAND : 50 or 28 MODE : FM STBY : SEND	RF V.M	FM,IF	D2 cathode	FM,IF	T1	MAX.		
	2) STBY : REC								

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.	Meter reading  Mechanical ϕ point	
	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 toALC zone maximum.		
	3) Meter SW : RF					VR9	Adjust to S-8.		
	4) STBY : REC								

ADJUSTMENT

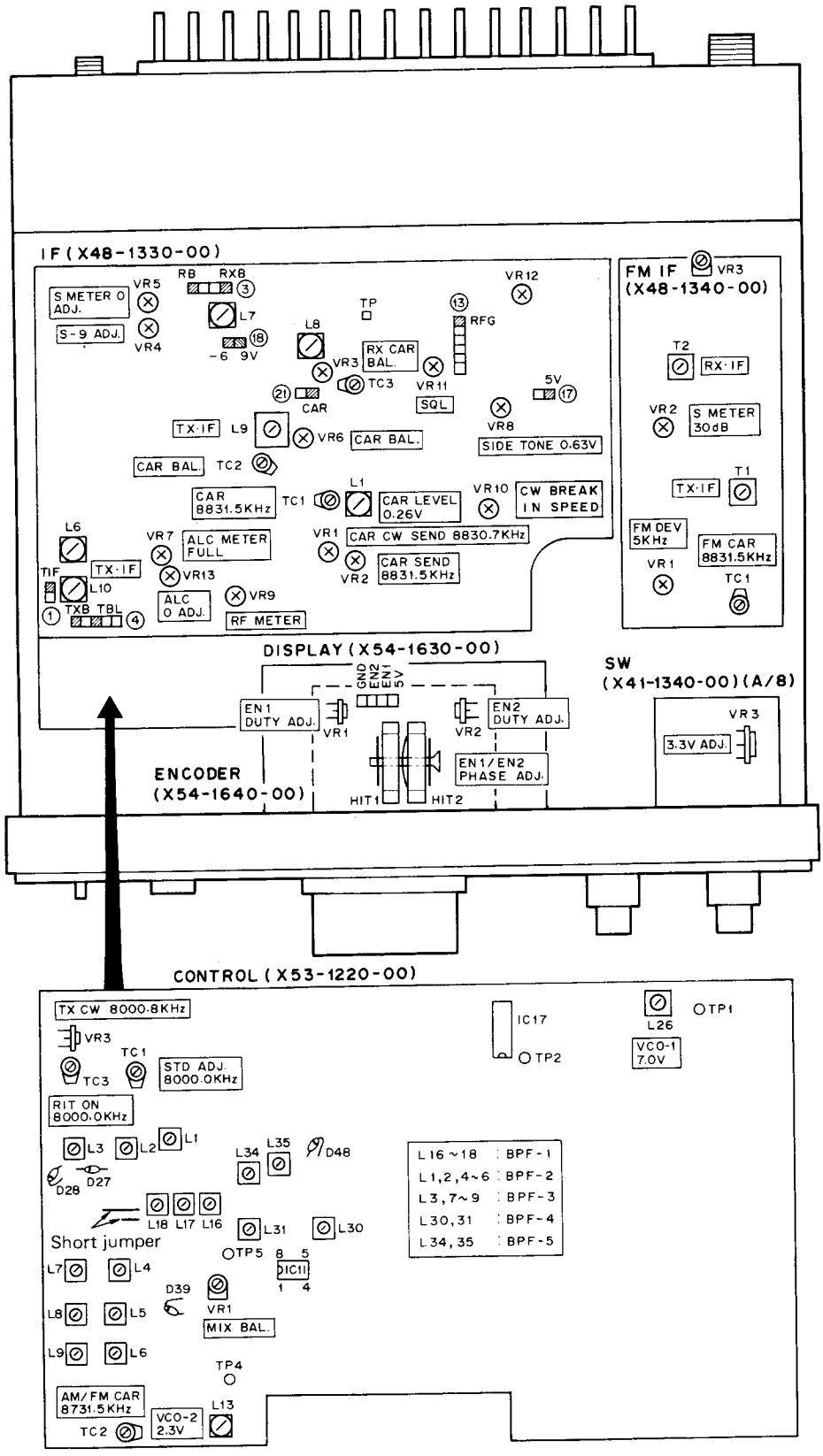
Micro-processor operational check

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 : →→ B : →→ B-R : →→ A-R : →→
3. F.STEP		Frequency changes at one VFO turn, frequency increases CW, decreases CCW.
	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.
	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 4 3 2 1	 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

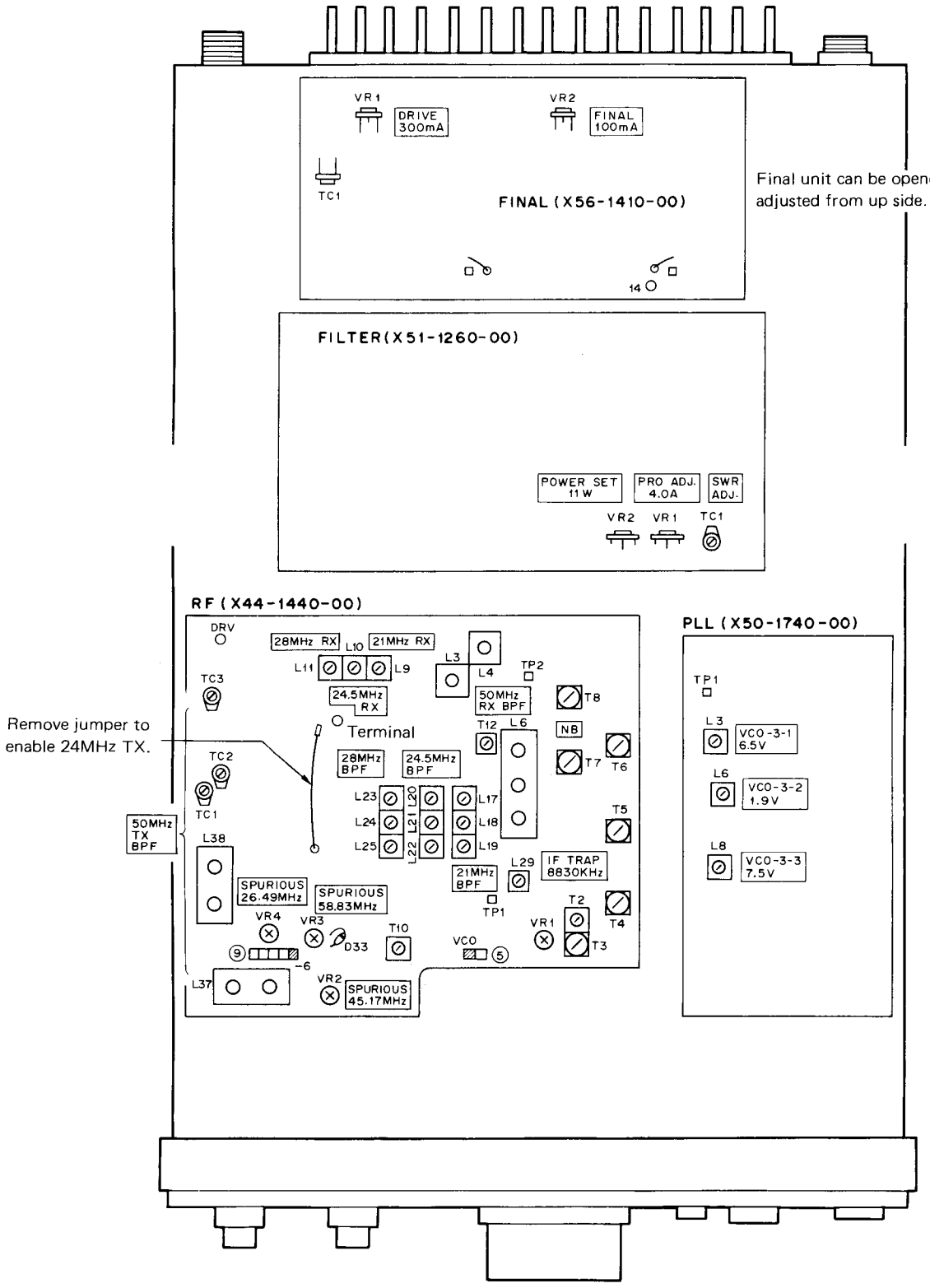
ADJUSTMENT

TOP VIEW

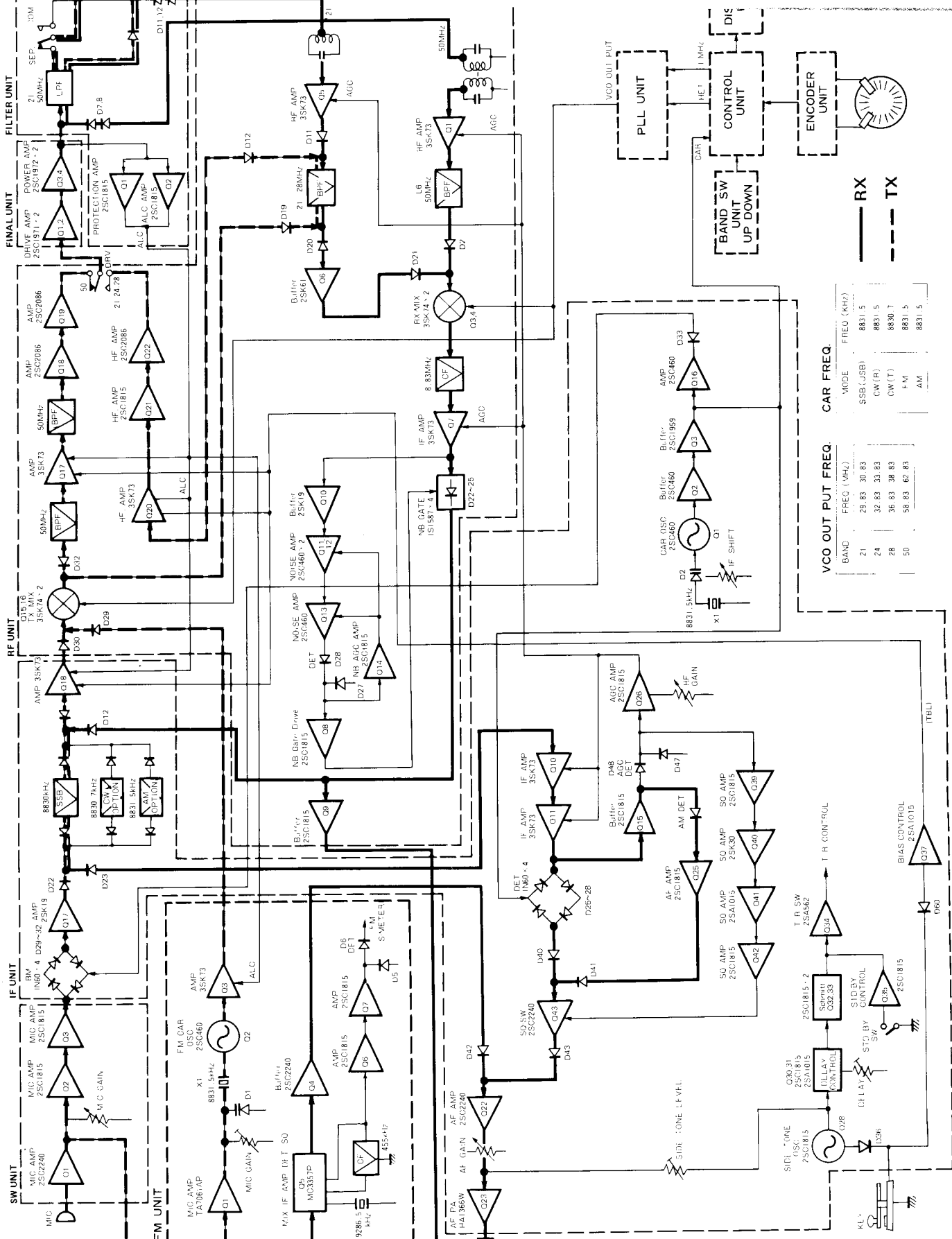


ADJUSTMENT

BOTTOM VIEW



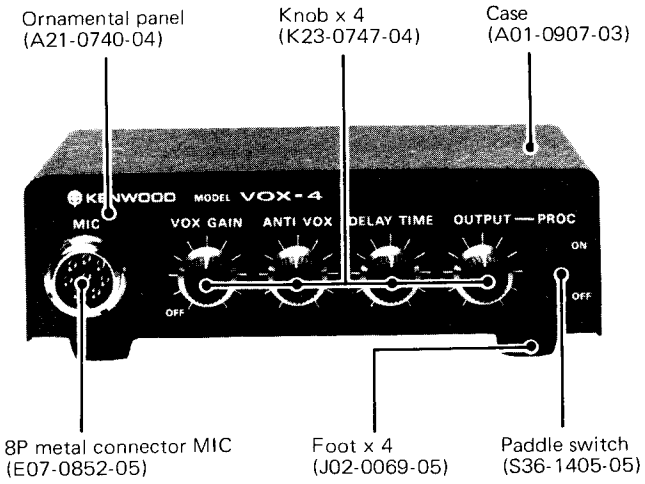
TS-660 BLOCK DIAGRAM



SPECIFICATIONS

Microphone impedance:	500 Ω ~ 50 kΩ
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.	Remarks	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
	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. 1kΩ (B) ANTI VOX
	R01-3418-05	N	Pot. 10kΩ (A) OUTPUT
	R01-4410-05	N	Pot. with SW 50kΩ (B) VOX GAIN
	R01-6402-05	N	Pot. 250kΩ (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 47μF 3.15V
C5	CE04W1H3R3M		E 3.3μF 50V
C6	CE04W1H010		E 1μF 50V
C9, 10	CE04W1H3R3		E 3.3μF 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 1μF 50V
C4	CE04W1C100M		E 10μF 16V
C5	CQ92M1H153K		ML 0.015μF
C6, 8–10,12	CE04W1H010M		E 1μF 50V
C13	CE04W1H4R7M		E 4.7μF 50V
C14	CE04W1H010M		E 1μF 50V
C15	CE04W1C100M		E 10μF 16V
C16	CE04W1H4R7M		E 4.7μF 50V
C17	CE04W1A221M		E 220μF 10V
	E06-0853-05		8P male socket MIC
	E23-0046-04		Square terminal x 7
VR1	R12-2016-05		Trim. pot 5kΩ
Q1	V03-2240-06		TR 2SC2240 (GR)
Q2	V03-1815-06		TR 2SC1815 (Y)
Q3	V11-1177-26		IC μPC1158H2
Q4	V03-1815-06		TR 2SC1815 (Y)
D1	V11-0051-05		Diode 1N60

TS-660

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

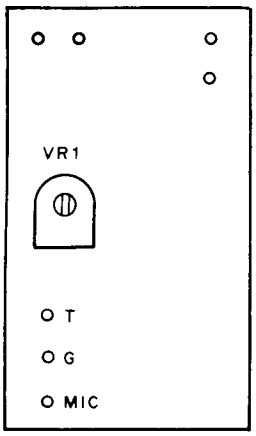
Preset controll as follows unless otherwise indicated

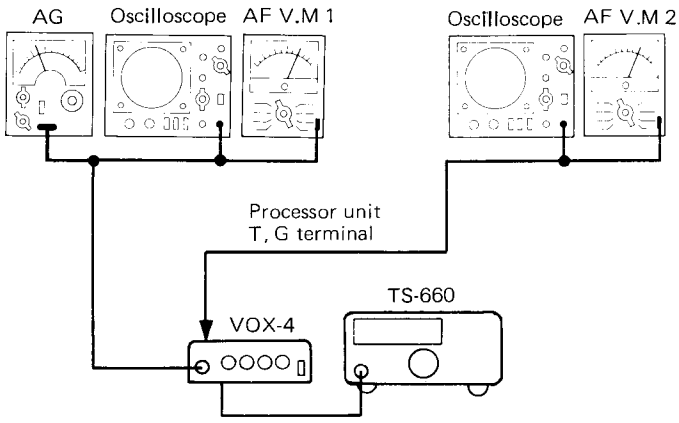
VOX-4		TS-660	
VOX GAIN	OFF	POWER	OFF
ANTI VOX	CEN	MODE	SSB
DELAY TIME	CEN	MIC	MIX
OUTPUT	MIN	IF SHIFT	CEN
PROC	OFF	PUSH SW	all OFF
		RF	MAX
		Others	Optional

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 adjusiment, 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 termianl 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.	

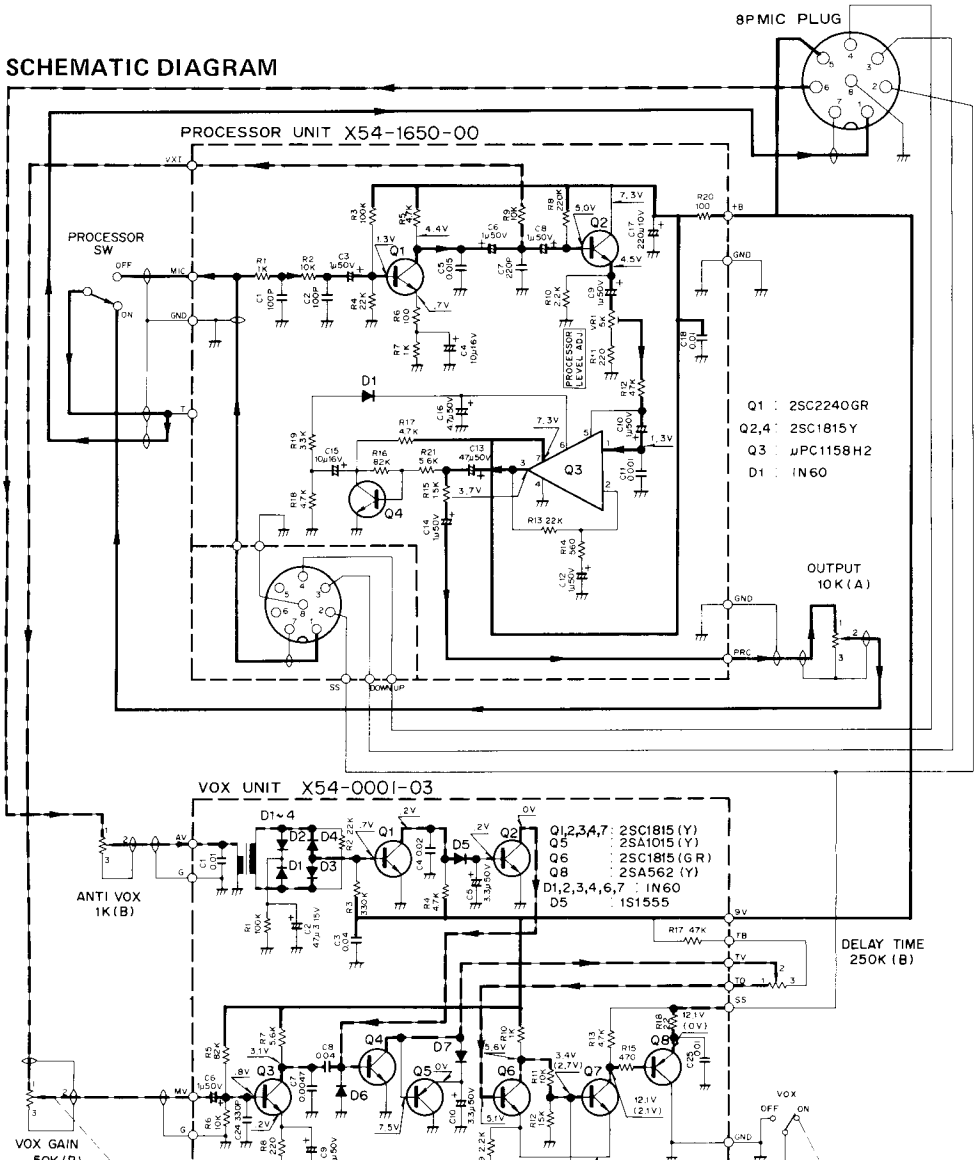
VOX-4

PROCESSOR UNIT (X54-1650-00)





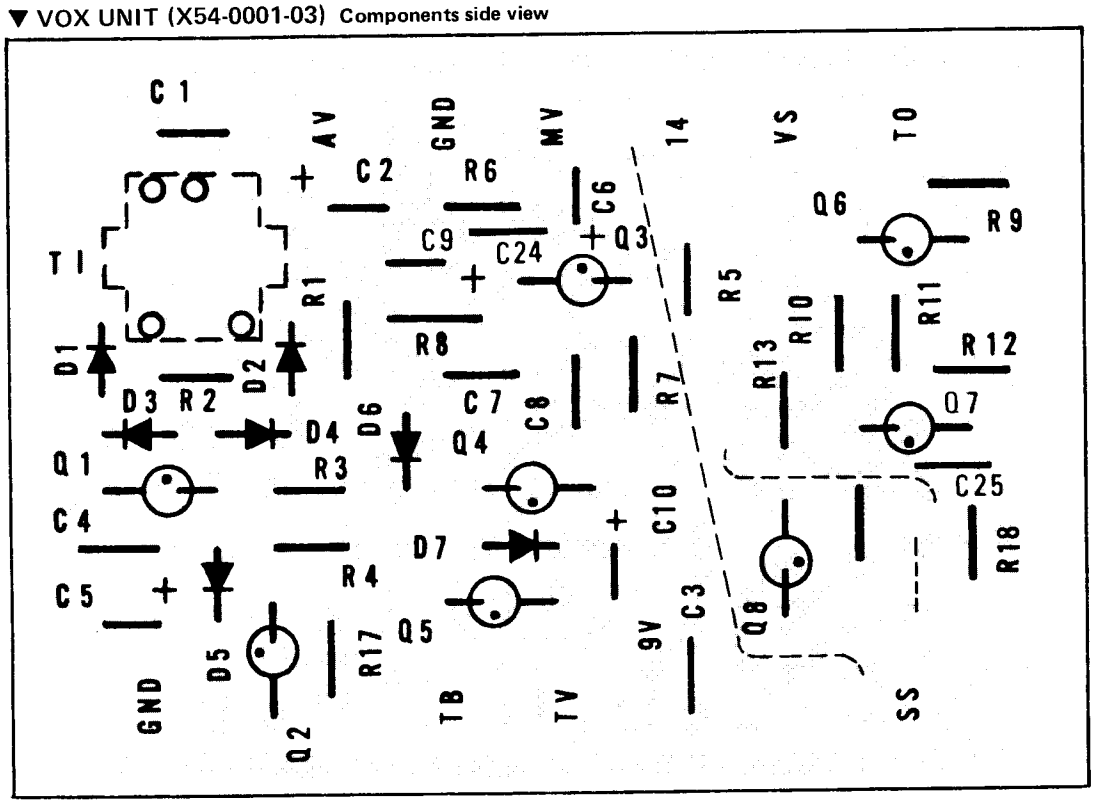
SCHEMATIC DIAGRAM



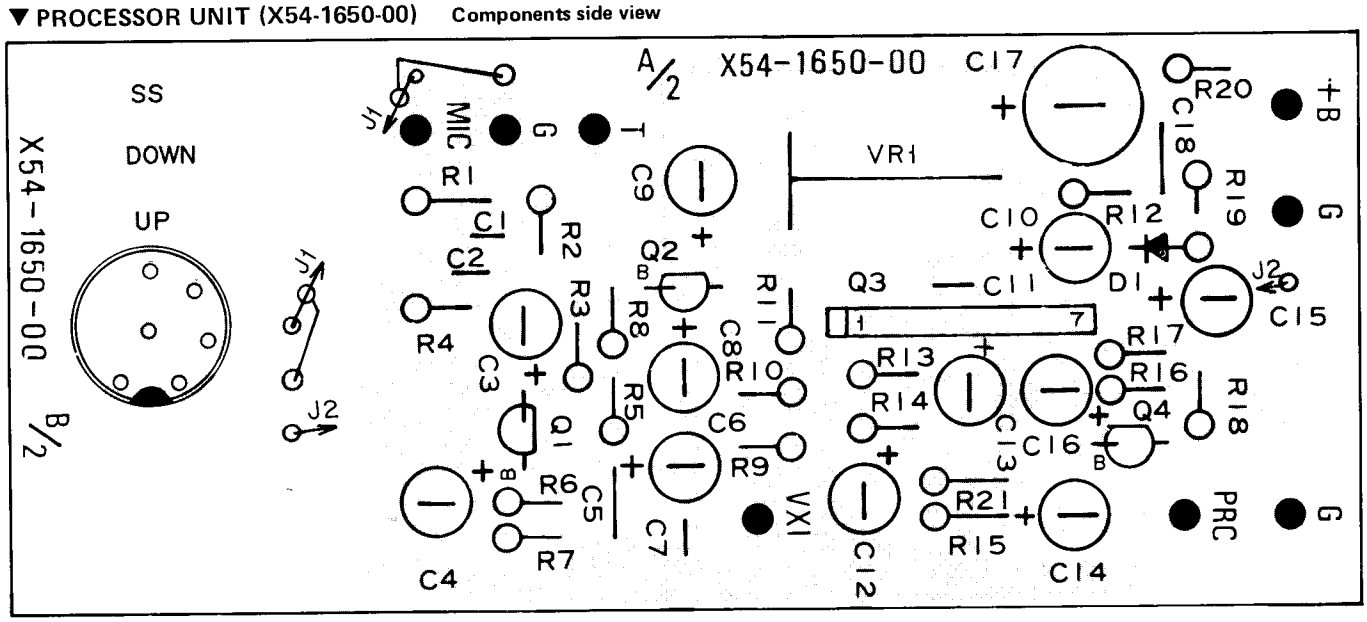
VOX-4

PC BOARDS

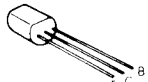
▼ VOX UNIT (X54-0001-03) Components side view



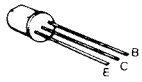
▼ PROCESSOR UNIT (X54-1650-00) Components side view



2SA1015
2SC1815
2SC2240



2SA562



μPC1158H2

TS-660

TERMINAL FUNCTIONS

Connector No.	Terminal No.	Terminal name	Function
SWITCH UNIT (X41-1340-00)			
①	1	MIC	MIC AMP input
	2	GND	
②	1	GND	
	2	FMC	FM MIC AMP Output
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	
	2	VRA	VHF RX ANT Input
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	
	2	VCO	VCO Input
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

Connector No.	Terminal No.	Terminal name	Function
IF UNIT (X48-1330-00)			
①	1	GND	
	2	TIF	TX IF Output (SSB, CW, AM)
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	Ballnced 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	
	2	FAF	FM AF Input
	3	FMB	FM 9V
	4	FSQ	FM SQ Control
	5	TXB	TX about 9V
	6	FSM	FM S METER Input
	7	ALC	ALC
⑬	1	RFG	RF GAIN Control
	2	9V	9V LINE
	3	GND	
	4	AV2	AF GAIN VOL. Output
	5	GND	
	6	AV1	AF GAIN VOL. Input
⑭	1	SPO	AF IC Output
	2	GND	
⑮	1	GND	
	2	SPK	SPEAKER Output

TS-660

TERMINAL FUNCTIONS

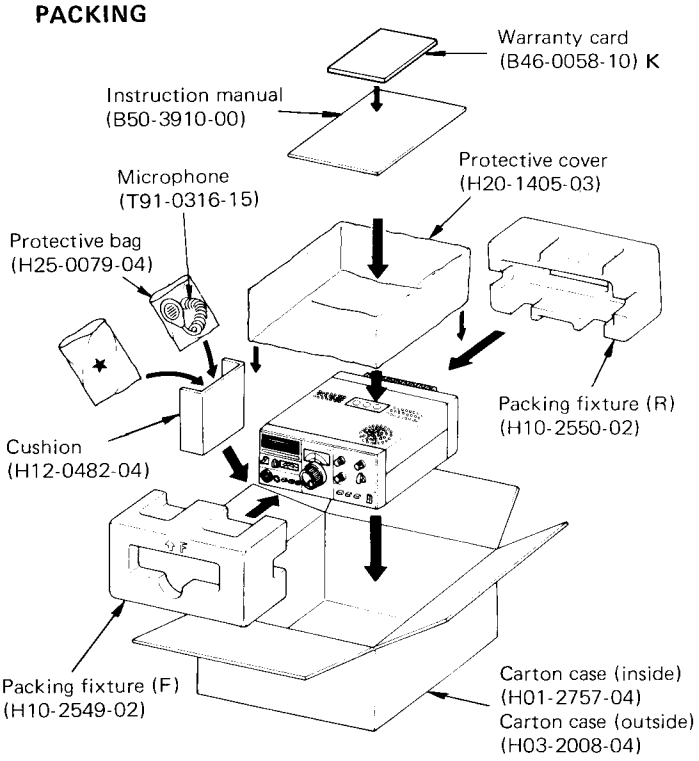
Connector No.	Terminal No.	Terminal name	Function
⑯	1	USP	AF EXT. OUT (Unswitched Speaker output)
	2	GND	
	3	GND	
	4	SPJ	EXT. SP Jack to IF
	5	KEY	Key LINE
	6	STS	Sidetone control
⑰	1	5V	5V LINE
	2	TXB	TX about 9V
⑱	1	9V	9V LINE
	2	−6	−6V LINE
⑲	1	TXB	TX about 9V
	2	14S	14V Input
⑳	1	5D	5V IC Output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

Connector No.	Terminal No.	Terminal 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	

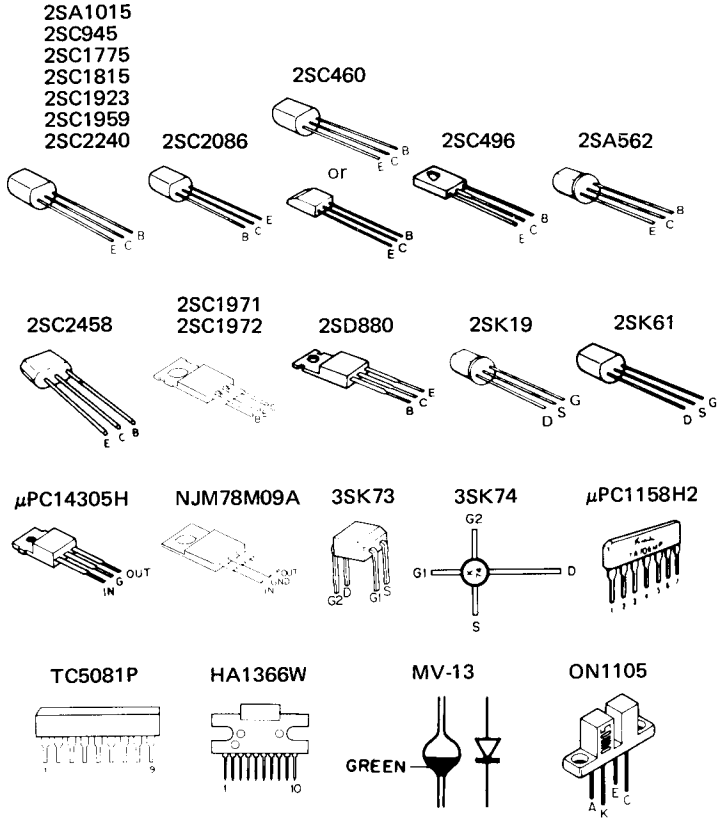
TERMINAL FUNCTIONS/PACKING

Connector No.	Terminal No.	Terminal 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	

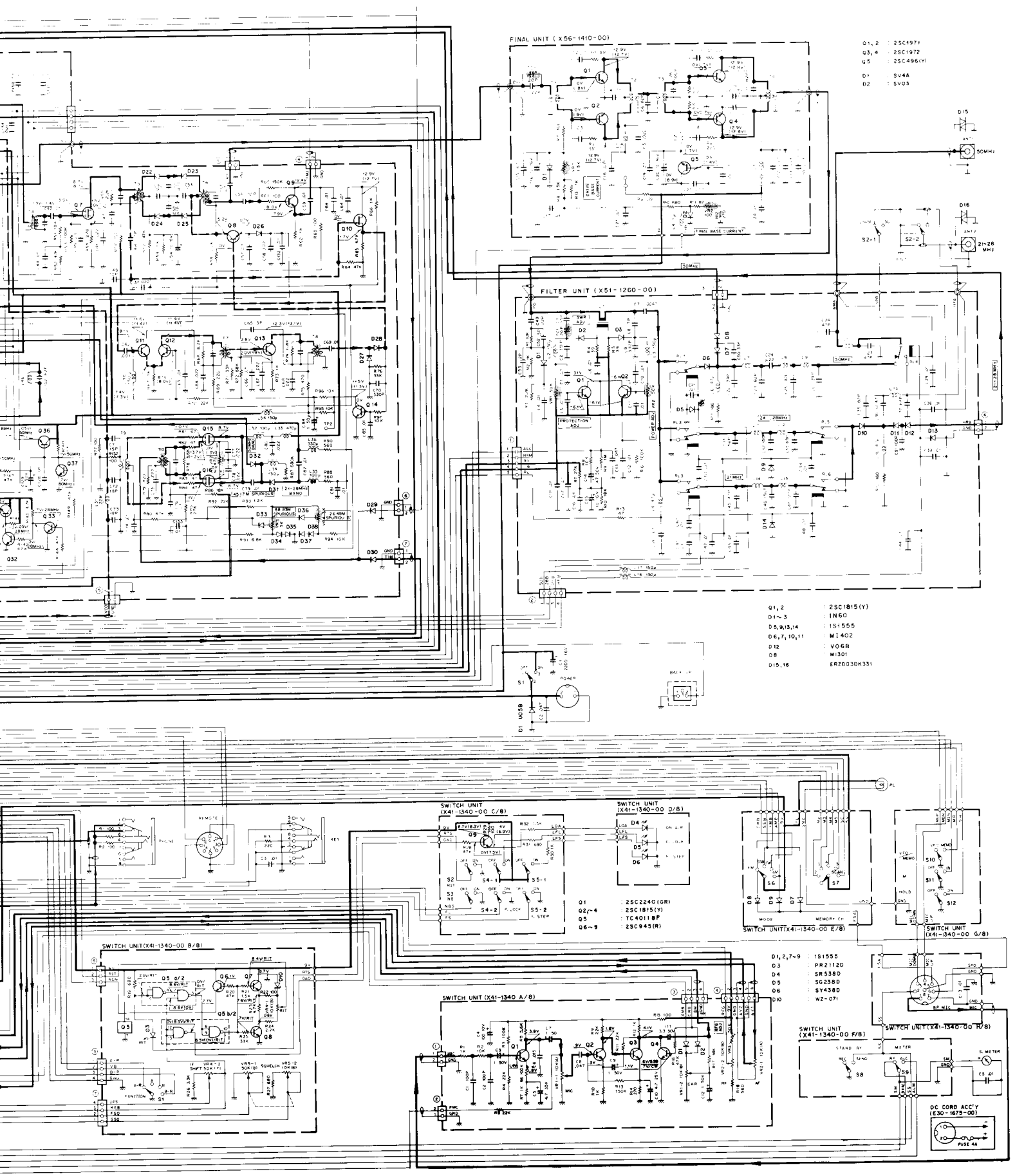
PACKING



★ 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)



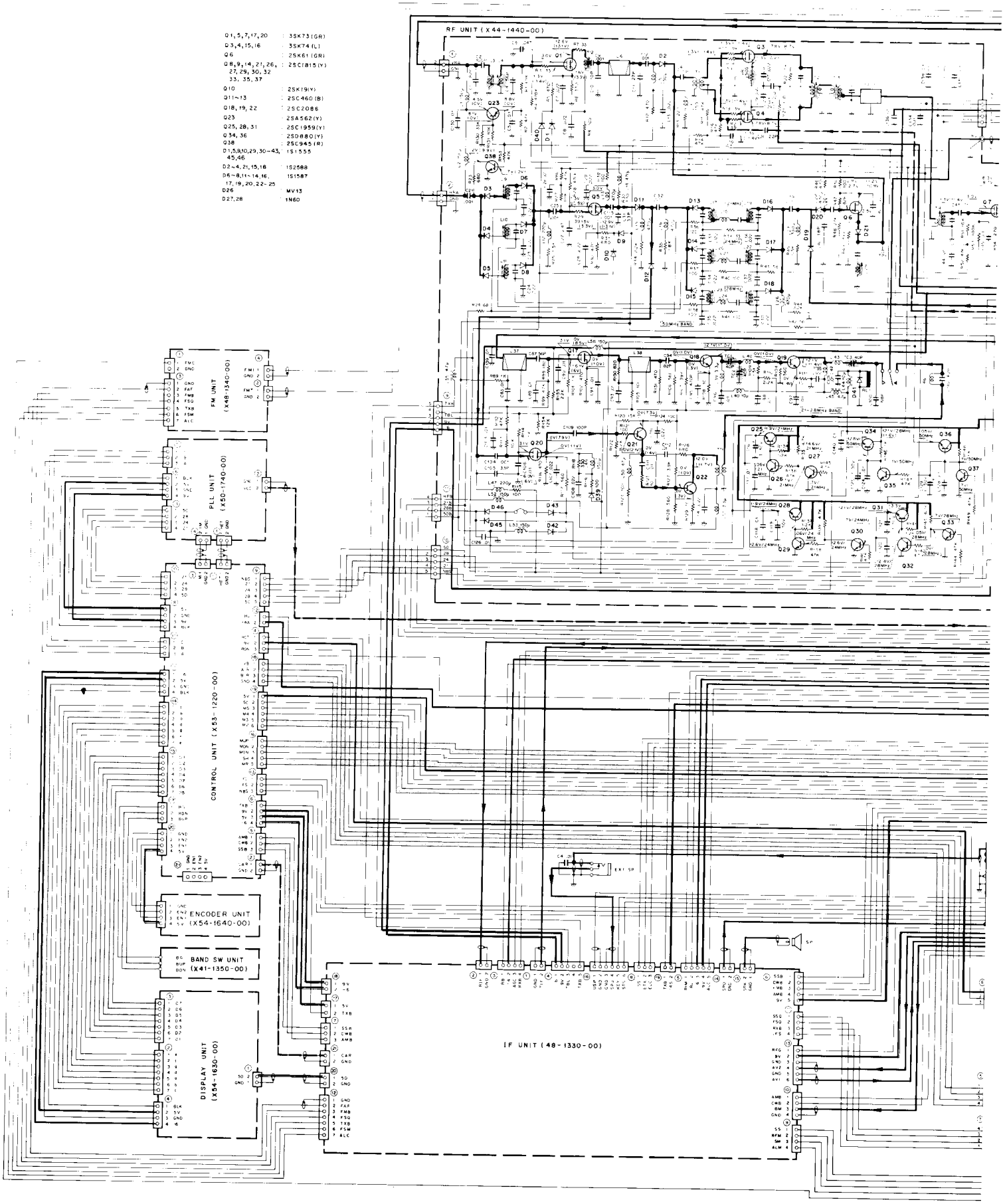
EMATIC DIAGRAM



Signal Line — Control Line — Common DC Line

SCHEMATIC

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	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)
Q38	2SC945(R)
D1,5,8,10,29,30~43,45,46	1S1555
D2~4,21,15,18	1S2588
D6~8,11~14,16,17,19,20,22~25	1S1587
D26	MV13
D27,28	1N60



TS-660

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SPECIFICATIONS

[Power Supply Section]

Input Voltage: AC120/220V ±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 ±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 × 96(106) H × 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

1. Output voltage : Adjust to DC 13.8V by VR1.
2. 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 15000μF 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 × 2	☆
–	E30-0545-05	AC cord with plug	
–	E30-1620-05	DC power supply cord	☆
–	F05-2023-05	Fuse (2A) × 1	
–	F05-1023-05	Fuse (1A) × 1	
–	F29-0014-05	Insulating washer × 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 × 4	
–	J02-0409-04	Assistance leg	☆
–	J21-2537-04	Leg pushing metal × 2	
–	J32-0133-04	Hex. boss × 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 0.047μF 25WV	
C3	CE04W1C100	Electrolytic 10μF 16WV	
C4,5	C90-0262-05	Ceramic 0.047μF 25WV	
C6	C90-0810-25	Electrolytic 2200μF 16WV	
		RESISTOR	
R1～20	RD14BB2E○○○J	Carbon resistor ○○○Ω ±5% 1/4W	
R14,15	R92-0618-05	Metal film 0.1Ω	☆
		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 5kΩ	
VR2	R12-1016-05	Potentiometer 3kΩ	
–	E23-0047-04	Terminal (square) × 10	
–	J32-0503-05	Beads × 4	

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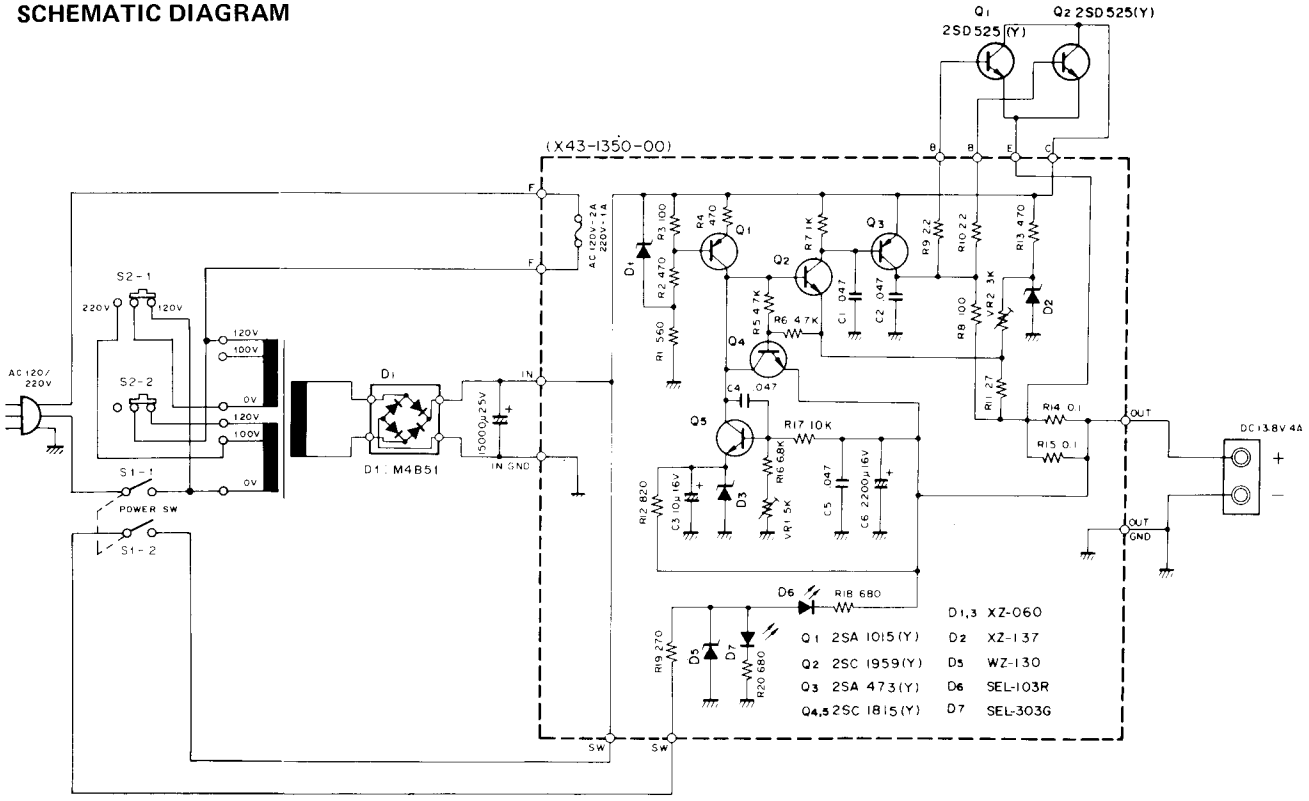
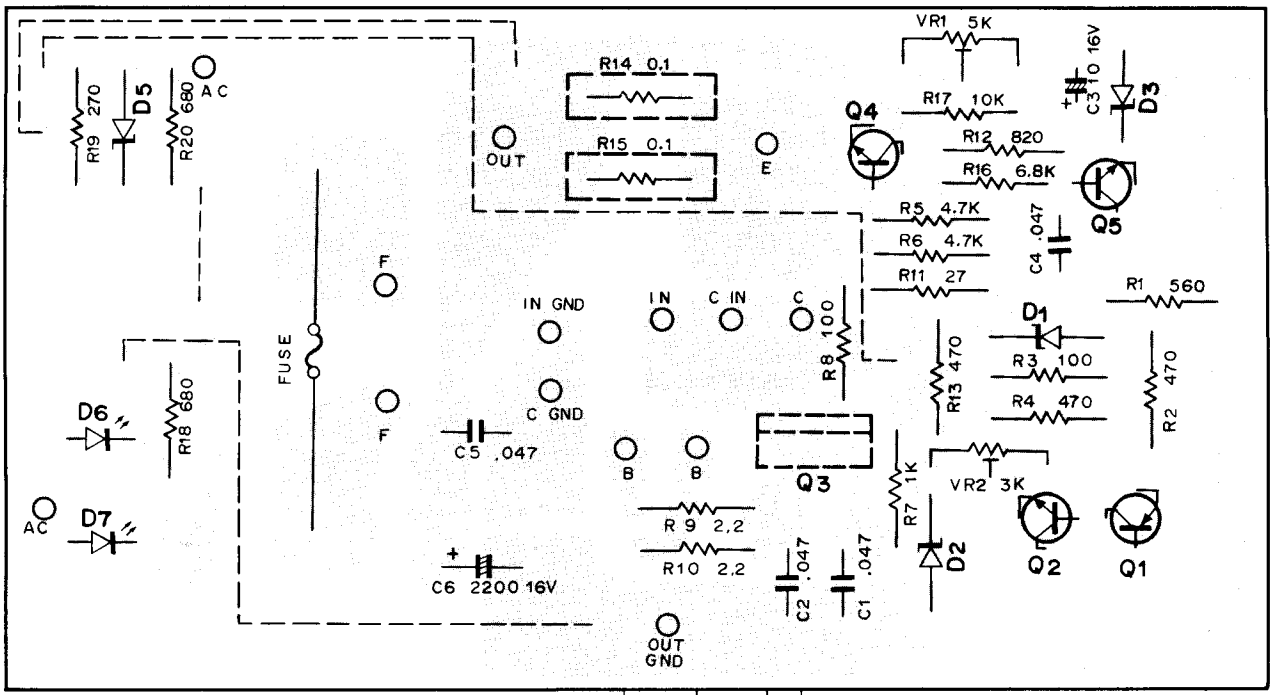
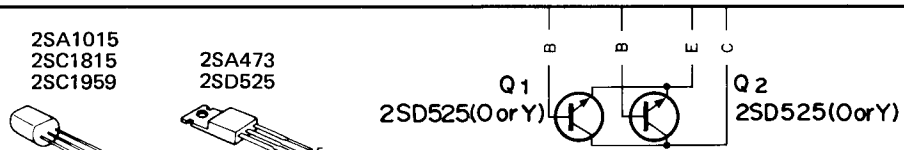
SCHEMATIC DIAGRAM



PC BOARD

▼AVR UNIT (X43-1350-00)





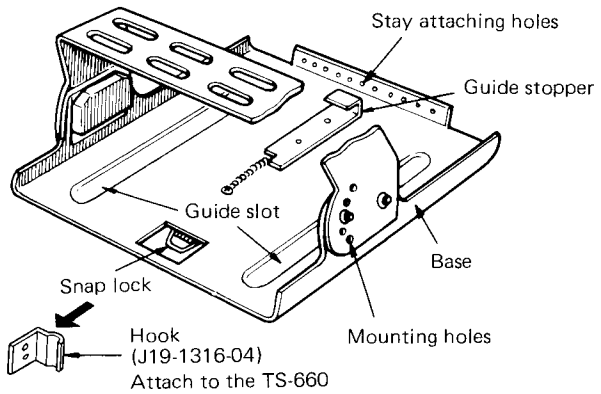
TS-660

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 cace (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

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