REVISED EDITION

KENWOOD®

SERVICE MANUAL

TS-780 SP-71

V-UHF ALL MODE DUO BANDER

CONTENTS

CIRCUIT DESCRIPTION

Outline

The TS-780 is an all mode transceiver which covers both the 144 MHz and 430 MHz bands. It uses the double conversion system in the SSB and CW modes and the triple conversion system in the FM mode.
The first IF frequency is 30.865 MHz, the second IF frequency is 10.695 MHz and the third IF frequency is 455 kHz (FM mode only).
The unit includes a built-in IF SHIFT circuit, VOX circuit (which can be used as a semi break-in circuit), noise blanker, automatic scanning circuit (5 selectable scanning bandwidths), and memory scanning circuit.

Receiver section (Note : Items in brackets pertain to the 430 MHz band).

The 144 MHz [430 MHz] antenna input signal is applied to the front end (RF unit) of the receiver section through the diode switch in the 144 MHz fianl unit [430 MHz final unit].
The front end consists of an RF amplifier with a dual gate MOS FET (Q1 : 3SK76 or 3SK92) [a 2-stage RF amplifier using a dual gate MOS FET (Q5 : 3SK76-O) and a junction FET (Q7 : 2SK125)], a helical resonator with a bandwidth of 2 MHz [10 MHz], a 1st mixer (Q3 : 3SK74) [(Q8 : 3SK48)] and the first IF monolithic crystal filter (MCF).
The 1st IF signal output from the front end is applied to the IF unit, where it is converted into the 2nd IF signal by the balanced mixer (Q1 and Q2 : 2SK125s) and filtered by the 2nd IF MCF.
The 10.695 MHz 2nd IF signal output from the 2nd IF MCF is then applied to both the SSB and FM IF circuits. In the SSB mode, the 2nd IF signal is applied to the crystal filter through the NB (noise blanker) gate, then is amplified by the IF amplifier consisting of Q9 through Q11.
The signal is then demodulated to an audio signal by the ring detector.
The noise component included in the 2nd IF signal is converted to a 455 kHz signal by the 3rd mixer (Q4 : 2SC1923 (O)), then amplified by Q5 and Q6 (2SC460(O)s) to switch the NB gate.
The AGC circuit picks up the signal from the last stage of the 2nd IF amplifier (Q11 : 3SK73(GR)), then detects and amplifies it to obtain the AGC voltage. The time constant setting of the AGC circuit is automatically switched between FAST (for the CW mode) and SLOW(for the SSB mode). The AGC voltage is applied to the 2nd IF amplifier (Q9 through Q11 : 3SK73(GR)s) and the 144 MHz RF amplifier (Q5 : 3SK76-O) [the 430 MHz RF amplifier (Q1 : 3SK92)], and is also used to drive the meter for S indication.
In the FM mode, the 2nd IF signal is applied to the 3rd mixer (Q4 : 2SC1923(O)) where it is converted to the 455 kHz 3rd IF signal.

The 3rd IF signal is filtered by the ceramic filter (CFW455E), then amplified by Q20 (TA7302P) and Q21–Q24 (2SC460 (B)s) and demodulated.
The squelch circuit consists of Q27–Q31, D30, and D31. The demodulated signal is amplified by Q27 and Q28 (2SC1815 (Y)s), then rectified by D30 and D31 to control the switching circuit consisting of Q29–Q31 (2SC1815 (Y)s) and Q32 (2SA1015 (Y)). The switching circuit turns the AF amplifier (Q33 : 2SC2240 (GR)) and the BUSY indicator on and off and applies scan stop signal SQS to pin 37 of IC3 (μPD8035LC) on the control unit board (X53-1240-XX).
In all modes, the demodulated audio signal passes through AF amplifier Q33, the active LPF (Q34 : 2SC1815 (Y)) and the AF volume control circuit, and is then amplified by the power amplifier (Q35 : MB3713) to drive the speaker.

Unit	Mode/band	Frequency generated
CAR unit	FMT	10.695 MHz
	USB	10.6965 MHz
	LSB	10.6935 MHz
	CWT	10.6957 MHz
	FMR	9.415 MHz
IF unit	TX	13.8533 MHz x 3 = 41.56 MHz
430 MHz	430 MHz band	40.85714 x 7 = 286 MHz
HET unit		41.5714 x 7 = 291 MHz
PLL unit	All modes	113.135~118.13498 MHz
		10.24 MHz

Table 1 Oscillator frequencies

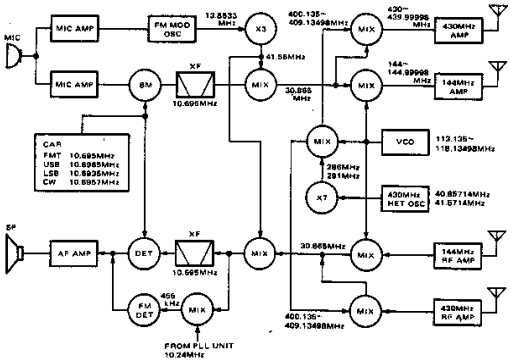


Fig. 1 Block diagram

CIRCUIT DESCRIPTION

The DSB signal output from BM is buffered by Q42 (3SK73 (GR)), then filtered by the crystal filter (XF2) so that the SSB signal is obtained. The SSB signal is applied to the balanced mixer consisting of Q51 and Q52 (2SK125s) through buffer amplifier Q43 (2SK61). The balanced mixer converts the frequency of the SSB signal from 10.695 MHz to 30.865 MHz. The 30.865 MHz SSB signal is applied to the 2-stage BPF, where spurious signals are eliminated, then is applied to the TX unit as the transmission IF signal.

In the FM mode, the audio signal from FM MIC gain control VR4 in the AVR unit (X43-1420-00) is amplified by Q45 (TA7061P) and Q48 (2SC1815 (Y)) in the IF unit. The audio signal is then applied to D46 (1SV50S) to frequency modulate the 13.8533 MHz signal generated by Q49 (2SC460 (B)). The 13.8533 MHz FM signal is tripled to obtain the 41.56 MHz FM signal used as the local signal. The local signal is mixed with the carrier (the 10.695 MHz signal obtained by unbalancing BM) by Q51 and Q52, then is applied to the TX unit as the transmission IF signal in the same manner as the SSB signal.

In the TX unit, the 30.865 MHz transmission IF signal is amplified by Q1 (3SK73(GR)), then mixed with the VCO signal by the balanced mixer consisting of Q2 and Q3 (3SK74 (M)s) [mixed with the 430 HET signal by the double balanced mixer (D15 : ND487C1-3R)] to obtain the 144 MHz [430 MHz] signal.

The 144 MHz signal is filtered by the BPFs and amplified by Q4 (2SK125), Q5 (2SC2026) and Q6 (2SC2538-22-A) to drive the 144 MHz final unit. [The 430 MHz signal is filtered by 2-pole helical resonators and amplified by Q9 (2SC2549), Q10 (3SK92), Q11 (2SC2026) and Q12 (2SC2762) to drive the 430 MHz final unit.]

In the 144 MHz final unit (X45-1200-00) [the 430 MHz final unit (X45-1210-00)], the signal is amplified by power module M57713 (final ASS'Y Q1) [M57716 (Q7)], then fed to the 144 MHz [430 MHz] antenna through the LPF.

The ALC circuit picks up the signal from terminal 14D [43D] on the TX unit and amplifies it with Q7 (2SC1815 (Y)). This signal is applied to the 2nd gate of Q1 and the 2nd gate of Q42 (in the IF unit), and is also used to drive the meter for ALC indication. The ALC circuit system can be externally controlled.

Protection is provided by decreasing the source voltage of Q1 in the TX unit and the DB volatge supplied to the final units. HI/LOW power switching in the FM mode is also obtained in the same manner.

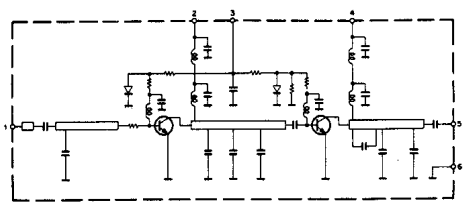
In the CW mode, keying is performed by switching the bias line to straight amplifier Q5 [Q11] in the TX unit with Q8 (2SA1015 (Y)).

Item	Symbol	Tc (°C)	Rating
Operating voltage	Vcc	25	17V
DC current	Icc	25	6A
Operating case temperature	Tc (op)	–	−30 ~ +110°C
Storage temperature	Tstg	–	−40 ~ +110°C
Base bias voltage	V_{BB}	25	10V

Table 7 Power module M57713 MAX. Rating (144 Final unit Q1)

Item	Symbol	Tc (°C)	Condition	Rating		
				MIN	TYP	MAX
Output power	Po	25	Vcc1=Vcc2=12.5V, V_{BB}=9V, Zo=ZL	17W	19W	
Total efficiency	ηT	25	f=144~148 MHz, Pin=0.2W=50Ω	40%	45%	
Power gain linearity	Gp	25	Vcc1=Vcc2=12.5V, V_{BB}=9V, Zo=ZL f=144~148 MHz, Pin=10 dBm=50Ω	21 dB	23dB	26dB

Table 8 Power module M57713 Electrical characteristic



1 : INPUT
2 : V_{CC1}
3 : BASE BIAS
4 : V_{CC2}
5 : OUT
6 : GND

Fig. 4 Power module M57713 Equivalent circuit

Item	Symbol	Tc (°C)	Rating
Operating voltage	V_{CC}	25	17V
Base bias voltage	V_{BB}	25	10V
DC current	I_{CC}	25	6A
Operating case temperature	Tc (op)	–	−30~+110°C
Storage temperature	T_{stg}	–	−40~+110°C

Table 9 Power module M57716 MAX. Rating (430 Final unit Q7)

Item	Symbol	Tc (°C)	Condition	Rating	
				MIN	TYP
Output power	Po	25	V_{CC1} = V_{CC2} = 12.5 V, V_{BB} = 9 V	18.5 W	19 W
Total efficiency	ηT	25	f = 430~440 MHz, Pin = 0.2 W	40 %	42 %
Power gain linearity	Gp	25	V_{CC1} = V_{CC2} = 12.5 V, V_{BB} = 9 V f = 430~440 MHz, Pin = 10 dBm	21 dB	

Table 10 Power module M57716 Electrical characteristic

CIRCUIT DESCRIPTION

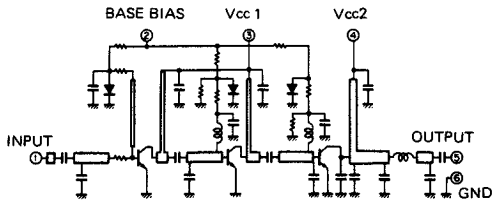


Fig. 5 Power module M57716 Equivalent circuit

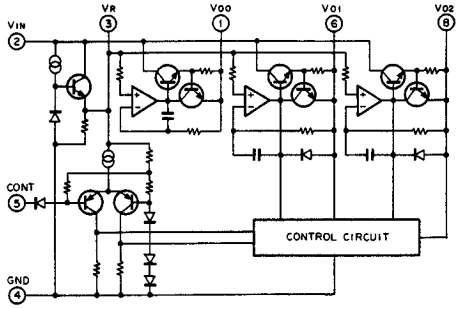


Fig. 6 MB3756 Equivalent circuit (AVR unit IC2)

HET Circuit

The VCO signal is used as the 1st local signal for 144 MHz operation. On the other hand, the 430 HET unit (X50-1790-00) is used for 430 MHz operation to generate the 1st local signal. In the 430 HET unit, Q4 (2SC460 (B)) generates 40.85714 MHz for the low band segment and 41.57143 MHz for the high band segment. Q5 (2SC2026) multiplies this to 286 MHz or 291 MHz. This 286 MHz or 291 MHz signal is amplified by the circuit consisting of two BPFs, Q6 (3SK92) and Q7 (2SK125), then mixed with the VCO signal by DBM (D1 : ND487C1-3R) to generate a 399.135 MHz–409.13498 MHz signal.

This is then amplified by the circuit consisting of two helical resonators, Q1, Q2 (2SC2549s) and Q3 (2SK125) and used as the 1st local signal for 430 MHz operation. The 2nd local signal is generated in the IF unit : Q49 (2SC460 (B)) generates a 13.8533MHz signal and Q50 (2SC1923 (O)) triples it. The 2nd local signal is frequency modulated in the FM mode, shifted by 800 Hz in the CW mode, and subject to RIT control in the SSB and CW modes by means of D46 (1SV50S).
The 10.24 MHz reference signal generated in the PLL unit is used as the 3rd local signal.

PLL Circuit

A block diagram of the PLL unit is shown in **Fig. 7**. This is a double loop PLL circuit consisting of A and B loops.

- **Loop B circuit**

The phase locked loop formed of IC7, IC8, IC12, Q21 and Q22 is called loop B. The VCO frequency is mixed with a 32.431 MHz signal to obtain a 12.7–14.698 MHz signal. This signal is divided by 100 so that a 127–146.98 kHz signal is obtained. The result is varied in 20 Hz steps because the VCO frequency is varied in 2 kHz steps.

- **Loop A circuit**

The phase locked loop formed of IC1, IC9, IC10, Q2, Q6 and Q7 is called loop A. The VCO generates a signal whose frequency is varied in 20 kHz steps over a bandwidth of about 5 MHz.

- **Reference signal generator**

Q16 generates the reference signal, which is applied to both loops A and B via buffer amplifiers. The reference signal is also used as the 3rd local signal for the receiver section.

- **Local signal generator**

The carrier frequency, which differs according to mode, is converted to 10.055 MHz±2.5 kHz. Up-conversion method is used for FM reception because the carrier frequency cannot be set to 10.695 MHz (the 2nd IF frequency). The 10.055 MHz signal is then mixed with the loop B output signal. The signal output by the mixer is filtered by the 10.192 MHz narrow band filter, then mixed with the signal from Q13 by the mixer consisting of Q3 and Q4.
The output of the last mixer is fed to the loop A mixer (IC1) as the local signal.

- **Unlock protection**

The unlock signal from the loop A PLL IC (IC9) is applied to Q10 and Q11 to generate ULB and UL signals for preventing unwanted transmission.

CIRCUIT DESCRIPTION

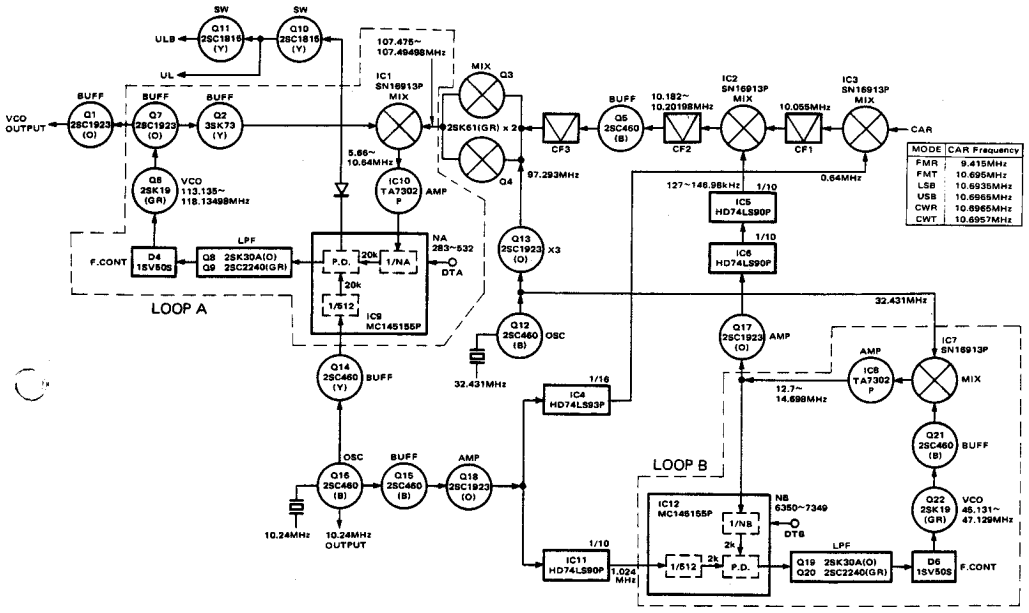


Fig. 7 PLL unit block diagram

Item	Rating
Center frequency (fo)	Within 10.055 MHz ±60 kHz
3 dB attenuation bandwidth	Within 280 ±50 kHz
20 dB attenuation bandwidth	650 kHz or less
Loss	6 dB or less
Spurious response (fo ±1.5 MHz)	30 dB or more
Input and output impedance	330Ω

Table 11 Ceramic filter (L72-0326-05) (PLL unit CF1)

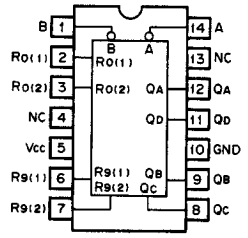


Fig. 8 HD74LS90P (PLL unit IC5, 6, 11)

Item	Rating
Nominal center frequency (fo)	10.192 MHz
3 dB bandwidth	±5 kHz or more (total width 30 kHz or more)
20 dB bandwidth	140 kHz or less
Loss	7.0 dB or less
Ripple (3 dB bandwidth)	2 dB or less
Spurious response (fo ±1.5 MHz)	15 dB or more
Input and output impedance	330Ω
Voltage capacity	DC 50V 1 minute

Table 12 Ceramic filter (L72-0327-05) (PLL unit CF2, 3)

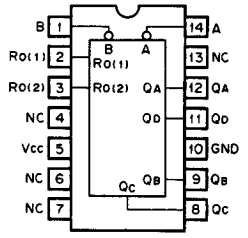


Fig. 9 HD74LS93P (PLL unit IC4)

CIRCUIT DESCRIPTION

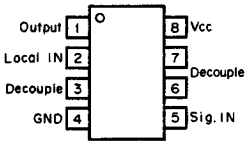


Fig. 10 SN16913P (PLL unit IC1–3, 7)

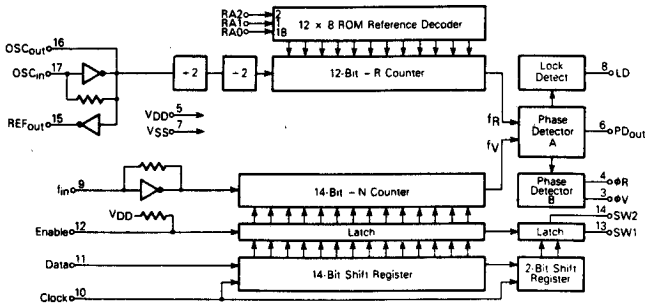


Fig. 11 MC145155P (PLL unit IC9, 12)

Control Circuit

The microcomputer used in the control unit consists of 3 IC's, a CPU (IC3 : μPD8035LC), ROM (IC4 : μPD2332C-384) and RAM (IC5 : μPD5101LC).

• Fundamental operation

CPU clock signal ALE is generated by dividing the 5.745 MHz signal produced by ceramic resonator X1 by 15 in CPU. The control program is stored in ROM and read out through the bus (DB0–DB7) in the following manner : CPU outputs an address to the bus, then the address data is latched by the address latch (IC13 and IC14) at the timing of ALE. The latched address is given to ROM. ROM outputs program data to the bus according to the given address when the CPU outputs $\overline{PSEN}$. CPU reads this program data and executes it.

The above procedures are repeated as necessary.

For example, the following procedures are used when RAM is accessed. CPU outputs the RAM address to the bus and the address is latched at the timing of ALE.

The latched address is given to RAM when RAM is enabled by the most significant bit (that is, when $\overline{CE1}$ is logical "1").

When data (a VFO frequency or memory channel) is written in RAM, CPU outputs the data to the bus and sets $\overline{WR}$ to logical "1".When data is read from RAM, CPU sets $\overline{RD}$ to logical "1" and reads the data on the bus. $\overline{WR}$ and $\overline{RD}$ are applied to the R/W and OD terminals of RAM, Respectively.

• Reset

When the line voltage reaches about 3.8 V after the power is turned ON, current flows through D1 (MA522 (R)) to turn Q1 ON. The level at pin 4 ($\overline{RESET}$) is then set to "L" and CPU is reset. As the line voltage rises further, the level at pin 4 of CPU returns to "H". CPU is reset whenever the power is switched ON or OFF, regardless of whether a backup battery is installed.

When the CPU is reset, program execution starts at program address 0 ; that is the CPU checks for the backup battery and, if it is not installed, the CPU initializes the frequency and resets the memory channels.

• Backup

During backup operation, power is supplied to RAM only. The reset signal is applied to CE2 (pin 17 of IC5) so that data to be backed up is protected when the main power is switched ON or OFF.

• Display

The 8-digit display indicates the function selected (A, B and CH No.) and the frequency in units of 100 Hz. The display is driven dynamically. The digit data is latched by the display digit latch (IC8 and IC9) for application to the display. CPU outputs 90 (HEX) to the bus before it outputs the digit data to the latch. 90 (HEX) is latched by the address latch (IC13 and IC14) at the timing of ALE. The latched data is applied to the address 90 detection gate (IC17A) to open it. Therefore, $\overline{WR}$ output from the CPU is applied to the EN terminal of the display digit latch through the address 90 detection gate. Thus, digit data output from the CPU is latched by the display digit latch.

The segment data is output from terminals P10 through P17 (pins 27 through 34) of the CPU and applied to the display.

• Display control signal generator

The signal generated by IC16 is differentiated, then shaped by IC15B. The shaped signal is applied to the $\overline{INT}$ terminal of the CPU. CPU operation is interrupted when the level at the $\overline{INT}$ terminal becomes "L" to output display data for one digit. After the display data is output, CPU continues the execution interrupted.

CIRCUIT DESCRIPTION

• PLL data

16-bit PLL serial data for loops A and B is output simultaneously from terminals DTA and DTB. A clock pulse is output for each bit, and EN is output to the PLL unit after all bits have been output.

The CPU outputs (HEX) A0 to the bus, then this data is latched by the address latch (IC13 and IC14) at the timing of ALE.

The latched data is then applied to the address A0 detection gate (IC17B), whereupon the CPU outputs $\overline{WR}$. At the same time, the CPU outputs the PLL data for loop A to DB3 and that for loop B to DB7.

Both loop A data and loop B data are output to the PLL unit through the gates (IC18C and IC18D) which are opened by the address A0 detection gate. $\overline{WR}$ is also used as the clock signal (CLK) for the programmable counters in the PLL unit. EN is output from pin 38 of the CPU.

PLL data is the same whether the frequency is 144.0000, 430.0000 or 435.0000. Data for loop A is 283 (decimal) and that for loop B is 6350 (decimal). The value for loop A (or B) increases by one as the frequency is increased by 20 kHz (or 20 Hz). The PLL data is output once when the frequency is changed.

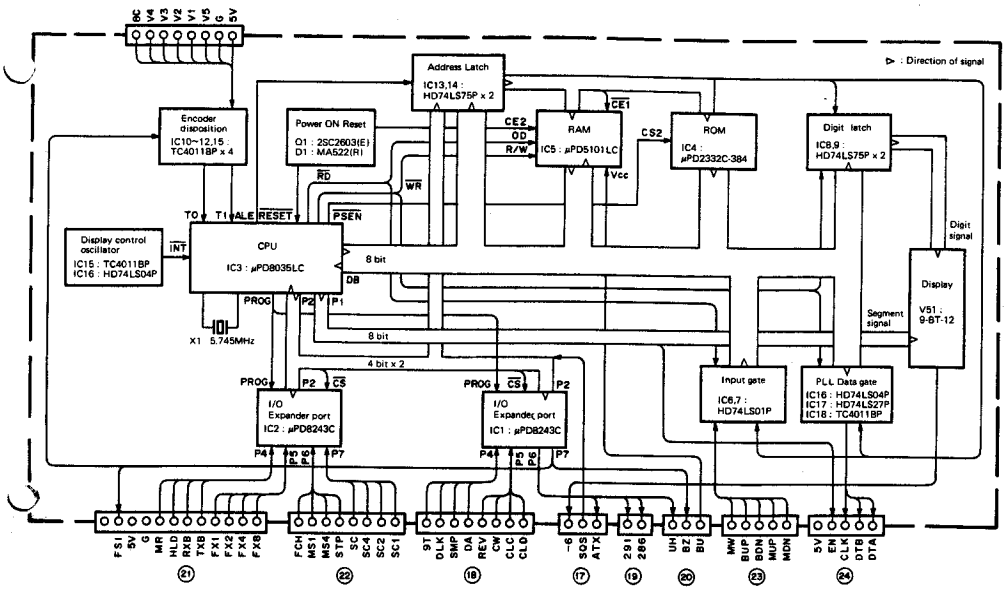


Fig. 12 Control unit block diagram

MEMORY CH

Connector Pin Name	IC Pin No.	I/O	1	2	3	4	5	6	7	8	9	10
21-FX1	IC2-1	Input	L	H	L	H	L	H	L	H	L	H
FX2	IC2-23	Input	L	L	H	H	L	L	H	H	L	L
FX4	IC2-22	Input	L	L	L	L	H	H	H	H	L	L
FX8	IC2-21	Input	L	L	L	L	L	L	L	L	H	H

FUNCTION

Connector Pin Name	IC Pin No.	I/O	A-R	A	B	B-R
21-RXB	IC2-4	Input	L	L	H	H
21-TXB	IC2-5	Input	H	L	H	L

SCAN

Connector Pin Name	IC Pin No.	I/O	0.5	1	3	5	10
22-SC1	IC2-13	Input	L	H	H	H	L
SC2	IC2-14	Input	L	L	H	L	H
SC3	IC2-15	Input	L	L	L	H	H

Table 13 Functions of terminals

CIRCUIT DESCRIPTION

Connector Pin Name	IC Pin No.	Input	Output	Description
18-9T	IC1-4	O		"H" during TX : otherwise "L".
DLK	IC1-1	O		"H" when F.LOCK is ON : otherwise "L".
SMP	IC1-2	O		"L" when TX OFFSET SW is set to SIMP : otherwise "H".
DA	IC1-3	O		"H" when TX OFFSET SW is set to "–", otherwise "L".
REV	IC1-5	O		"H" when REV SW is set to ON : otherwise "L".
CL1	IC1-22	O		"H" when PRIO.M 9 SW is set to ON : otherwise "L".
CL4	IC1-21	O		"H" when PRIO.M 10 SW is set to ON : otherwise "L".
19-291	IC1-19		O	"L" when 435-439 band segment is selected : otherwise "H".
286	IC1-18		O	"L" when 430-434 band segment is selected : otherwise "H".
17 ATX	IC1-17		O	Normally "L".
20 UH	IC1-20		O	"L" when the 2 m band is selected : otherwise "H".
BZ	IC1-16		O	"H" when buzzer is rung : otherwise "L".
21 FSI	IC1-14		O	"L" when F.STEP indicator lights : otherwise "H".
MR	IC2-2	O		"H" when MR is ON : otherwise "L".
MLD	IC2-3	O		"H" when HOLD is ON : otherwise "L".
STP	IC2-17	O		"H" when F.STEP SW is ON : otherwise "L".
SC	IC2-16	O		"H" when SCAN SW is ON : otherwise "L".

Table 14 Functions of terminals

Terminal Name	Function
PROG	Clock input terminal. Clock signals for data or commands are input to this terminal.
$\overline{CS}$	The PROG terminal is enabled so that data can be transferred between the CPU and this IC and so that commands can be input to this IC from the CPU.
PORT2	Data and commands from the CPU and data to the CPU are transferred through this port.
PORT4 ~ PORT7	Data is transgerred between this IC and external circuits through these ports. Ports are selected by port address data (commands) and I/O operations are selected by control commands.

Table 15 Functions of μPD8243C (CONT. unit IC1, 2)

Symbol	Name	Description
A0~A7	ADDRESS	Address input terminals.
DI1~DI4	DATA INPUT	Write data input terminals.
R/W	READ/WRITE	Reads are performed when the level applied to this terminal is "H", otherwise, writes are performed.
CE1	CHIP ENABLE1	The chip is enabled when the level applied to this terminal is "L" while the level at CE2 is "H".
CE2	CHIP ENABLE2	The chip is enabled when the level applied to this terminal is "H" while the level at CE1 is "L".
OD	OUTPUT DISABLE	The output terminals are enabled when the level applied to this terminal is "L", otherwise they are disabled and their output impedance is set to high.
DO1~DO4	DATA OUTPUT	Read data output terminals.
Vcc	POWER (+5V)	Terminal connected to +5V power supply
GND	GROUND (0V)	Ground terminal.

Table 16 Functions of μPD5101LC (CONT. unit IC5)

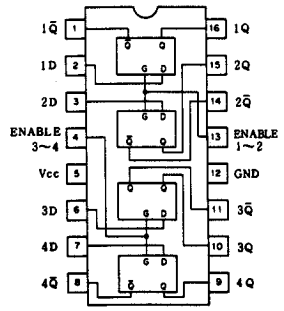


Fig. 13 HD74LS75P (CONT. unit IC8, 9, 13, 14)

Input		Output	
D	G	Q	$\overline{Q}$
L	H	L	H
H	H	H	L
X	L	Q_0	$\overline{Q_0}$

Notes) H : High level
L : Low level
X : Either level
Q0 : The state of Q immediately before the indicated input conditions are established.
$\overline{Q0}$: The complement of Q0.

Table 17 HD74LS75P truth table

CIRCUIT DESCRIPTION

• Encoder waveform shaping

Square waves with a duty ratio of 50% are applied to V1 through V4. The waves applied to V1 and V3 are 180 degrees out of phase with those applied to V2 and V4, respectively, and the wave applied to V1 leads that applied to V3 by 90 degrees. These waves are differentiated. The square waves and the differentiated waves are subjected to logical operations to obtain the VFO pulse signals.

IC10 is the gate which closes during FM CH operations. IC15C and IC15D form an RS flip-flop used for determining the direction of rotation of the encoder.

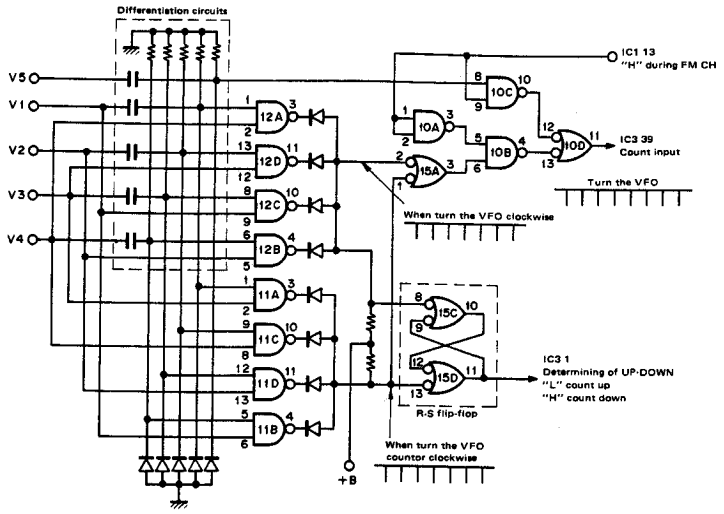


Fig. 14 Encoder waveform shaping

• UP and DOWN switch signal processing

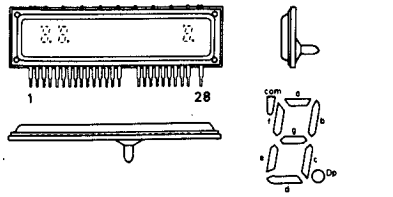
The microphone UP and DOWN switch signals and the SAND UP and DOWN switch signals are applied to gates IC6A, IC6D, IC7A and IC7D.

The CPU outputs A0 (HEX) to the bus at the prescribed timing ; this address data is latched by the address latch (IC13 and IC14), then is applied to the address A0 detection gate (IC17C). This gate opens the gates in IC6 and IC7 when the CPU outputs $\overline{RD}$ to allow the CPU to read the switch status.

• I/O expansion ports

When an I/O operation is performed through the I/O expansion ports, the CPU outputs an "L" level signal from terminal P24 or P25 (pin 35 or 36) to select IC2 or IC1.

The I/O operation is performed in 4 bit units through ports 4 through 7 (of IC1 and IC2). Ports 6 and 7 of IC1 are used only for output, while ports 4 and 5 of both IC1 and 2 are used only for input. The CPU outputs PROG as the clock signal for the expansion ports.



PIN NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CONNECTION	F	N_C	G_4	N_C	N_C	G_6	g	f	G_7	e	d	G_8	N_C	N_C
	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	G_5	N_P	N_P	G_4	D_P	G_3	c	b	G_2	a	COM	G_1	N_P	F

Fig. 15 Display tube 9-BT-12

CIRCUIT DESCRIPTION/OPTION (DC CABLE)

Pin No.	Symbol	In-put	Out-put	Description	Pulse signal
1	T0			"L" when the encoder is rotated UP and "H" when it is rotated DOWN.	
2	X1	O		System clock crystal.	
3	X2	O		System clock signal crystal : 5.745 MHz	
4	$\overline{\text{RESET}}$	O		Normally "H"	
5	$\overline{\text{SS}}$	O		Normally "H"	O
6	$\overline{\text{INT}}$	O		Interrupt input	O
7	EA			Normally "H"	
8	$\overline{\text{RD}}$		O	Outputs the clock signal for reading data through the data bus.	O
9	$\overline{\text{PSEN}}$		O	Outputs the clock signal for reading data from IC4 (ROM) at the timing of the ALE pulse.	O
10	$\overline{\text{WR}}$		O	Outputs the clock signal for writing data through the data bus.	O
11	ALE			Address latch enabling signal : 1/15 of the system clock frequency.	O
12	DB0	O	O	Data pulse	O
13	DB1	O	O	Data pulse	O
14	DB2	O	O	Data pulse	O
15	DB3	O	O	Data for memory channel } Data bus	O
16	DB4	O	O	BAND UP SW status	O
17	DB5	O	O	BAND DOWN SW status	O
18	DB6	O	O	MIC UP SW status	O

Pin No.	Symbol	In-put	Out-put	Description	Pulse signal
19	DB7	O	O	MIC DOWN SW status Data bus	O
20	Vss			Ground	
21	P20	O	O	} Data I/O port for IC1 and IC2	O
22	P21	O	O		O
23	P22	O	O		O
24	P23	O	O		O
25	PROG		O	Timing pulse for data transfer between CPU and IC1 or IC2.	O
26	VDD			5V	
27	P10		O	a } Display segment data output port	O
28	P11		O	b	O
29	P12		O	c	O
30	P13		O	d	O
31	P14		O	e	O
32	P15		O	f	O
33	P16		O	g	O
34	P17		O	p	O
35	P24		O	"L" when IC2 is enabled.	O
36	P25		O	"L" when IC1 is enabled.	O
37	P26	O		"H" when the squelch is open : otherwise "L".	
38	P27	O		Outputs EN for PLL data. Normally "H".	
39	T1	O		VFO pulse input	O
40	Vcc			5V	

Table 18 Functions of μPD8035LC

DC Operation

No DC power cable is provided with the TS-780. Purchase a DC power cable such as that shown in Fig. 15 for DC operation. Since this cable does not include a fuse, use a 7A fuse in the TS-780.

DC power cables and fuses are available at any Kenwood branch or service center. The part number of the DC power cable assembly is E30-1622-05.

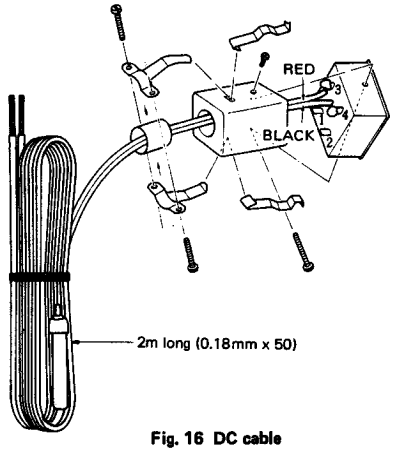


Fig. 16 DC cable

TS-780

PARTS LIST

Note 1:
K: U.S.A. T: Britain W: Europe X: Australia

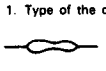
Note 2:
Only special type of resistors (example: cement, metal film, etc.) and capacitors (example: electrolytic, tantalum, mylar, temp. coeff. capacitors) are detailed in the PARTS LIST. For the value of all common type components, refer to the schematic diagram of the P.C. board illustration.
Resistors 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

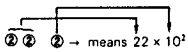

RD14BY
RD14BB (small size)


RD14CY
RD14CB (small size)

2. Wattage

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

3. Resistance value



② → means 22 x 10^2 = 2200Ω (2.2 kΩ)

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

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

Ex. **CC45TH** = −470 ±60 ppm/°C

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

3 = CK45 ○
Ceramic capacitor (type II) 3

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

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

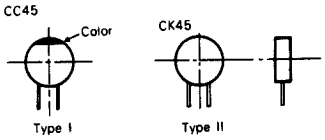
6 = Tolerance

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		



TS-780 SEMICONDUCTOR

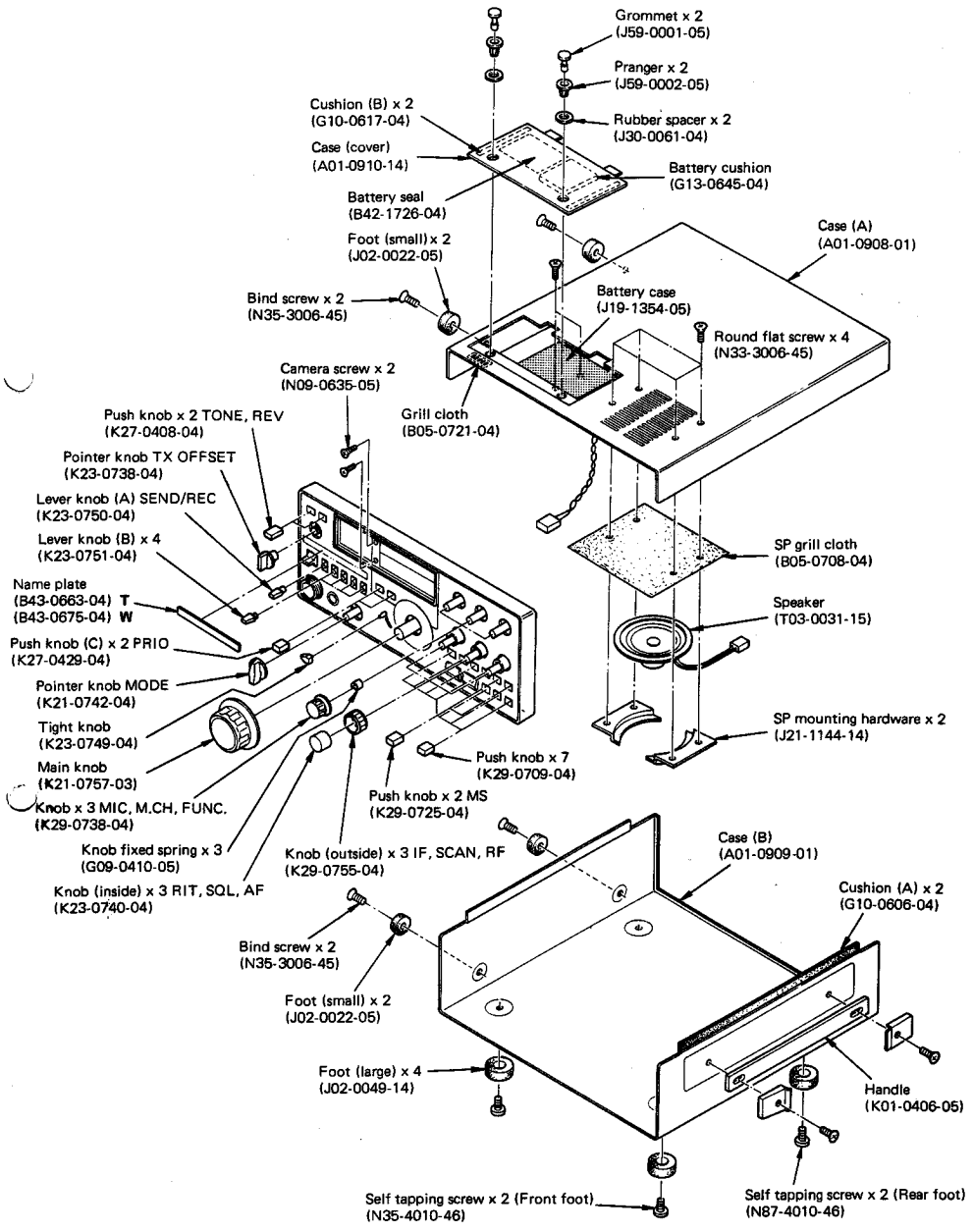
N : New parts

☆: Please note that these parts are sometimes not in stuck and it takes much time to deliver.

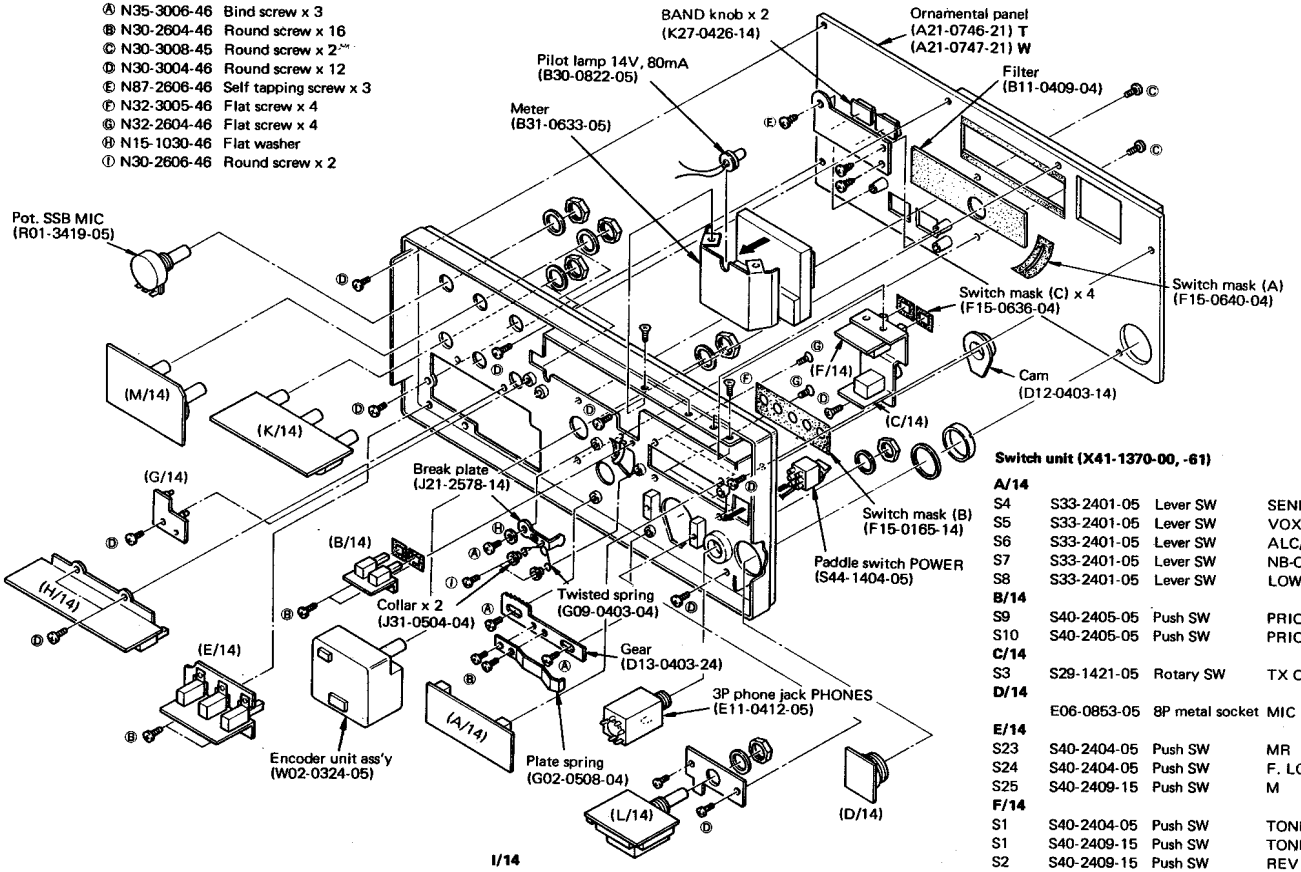
Item	Name	Remarks	Parts No.
Diode	1N60		V11-0051-05
	1N4448		V11-7766-06
	1S1555		V11-0076-05
	1S1587		V11-0370-05
	1S2588		V11-0414-05
	1SS99		V11-1277-86
	BA243S		V11-7767-06
	ITT410		V11-7761-86
	MA522(R)		V11-1173-56
	MI402		V11-5260-16
	ND487C1-3R		V11-1277-96
	U05B	☆	V11-0270-05
Vari-cap	1SV50S		V11-1260-36
	1SV54GC		V11-4173-46
	ITT310TE		

Item	Name	Remarks	Parts No.
Varistor	1S1212		V11-1262-06
	VD1223		V11-1262-46
Zener diode	XZ-049		V11-4175-46
	XZ-060		V11-4101-20
	XZ-064		V11-4104-20
	XZ-078		V11-4110-70
	XZ-080		V11-4163-46
	WZ-061		V11-0243-05
	WZ-071		V11-4160-86
LED	SEL101R (B,C)		V11-5172-86
	SG238D		V11-1278-16
	SLP144B		V11-6172-56
	SR538D		V11-1278-06
	SR539D	N	V11-1278-36

DISASSEMBLY



Ⓐ N35-3006-46 Bind screw x 3
Ⓑ N30-2604-46 Round screw x 16
Ⓒ N30-3008-45 Round screw x 2
Ⓓ N30-3004-46 Round screw x 12
Ⓔ N87-2606-46 Self tapping screw x 3
Ⓕ N32-3005-46 Flat screw x 4
Ⓖ N32-2604-46 Flat screw x 4
Ⓗ N15-1030-46 Flat washer
Ⓘ N30-2606-46 Round screw x 2



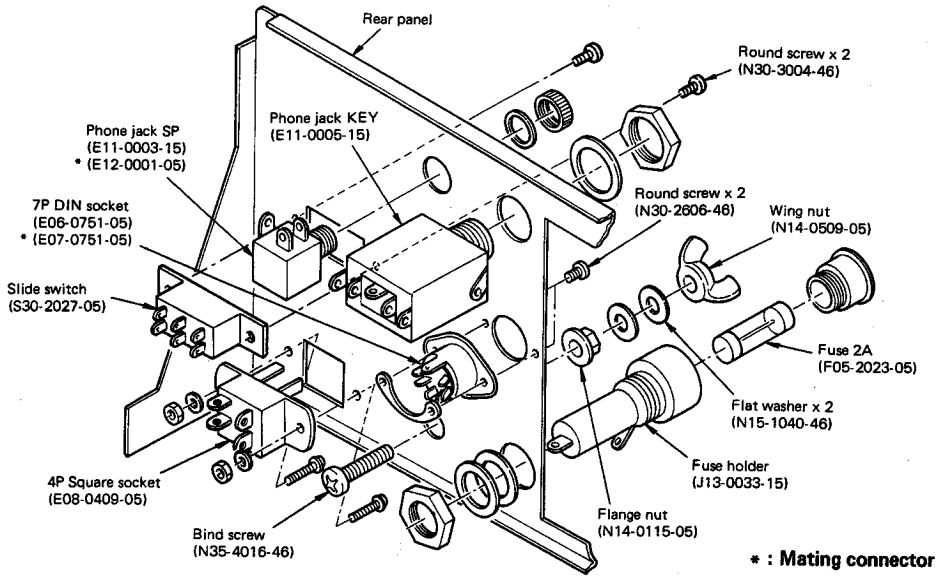
Switch unit (X41-1370-00, -61)

A/14			
S4	S33-2401-05	Lever SW	SEND-REC
S5	S33-2401-05	Lever SW	VOX-MAN
S6	S33-2401-05	Lever SW	ALC/CEN-RF/S
S7	S33-2401-05	Lever SW	NB-OFF
S8	S33-2401-05	Lever SW	LOW-HIGH
B/14			
S9	S40-2405-05	Push SW	PRIO.M
S10	S40-2405-05	Push SW	PRIO. M
C/14			
S3	S29-1421-05	Rotary SW	TX OFFSET
D/14			
	E06-0853-05	8P metal socket	MIC
E/14			
S23	S40-2404-05	Push SW	MR
S24	S40-2404-05	Push SW	F. LOCK
S25	S40-2409-15	Push SW	M
F/14			
S1	S40-2404-05	Push SW	TONE **T**
S1	S40-2409-15	Push SW	TONE **W**
S2	S40-2409-15	Push SW	REV
H/14			
S15	S40-2413-05	Push SW	F. STEP
S16	S40-2405-05	Push SW	RIT
S17	S40-2413-05	Push SW	SCAN
S18	S40-2413-05	Push SW	HOLD
S19	S40-2405-05	Push SW	MS144

I/14			
S21	S50-1409-05	Tact SW	BAND DOWN
S22	S50-1409-05	Tact SW	BAND UP
K/14			
VR1,2	R19-3412-05	Pot.	RF GAIN, AF GAIN
VR3	S03-2402-05	Pot.	SQL
S14	S03-2402-05	Rotary SW (E)	SCAN. W

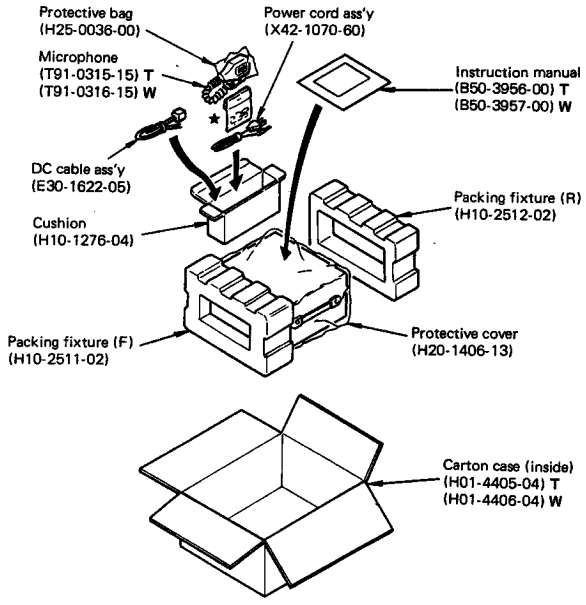
L/14			
S11	S29-2405-05	Rotary SW (A)	MODE
M/14			
S12	S29-1420-05	Rotary SW (B)	FUNCTION

DISASSEMBLY/PACKING

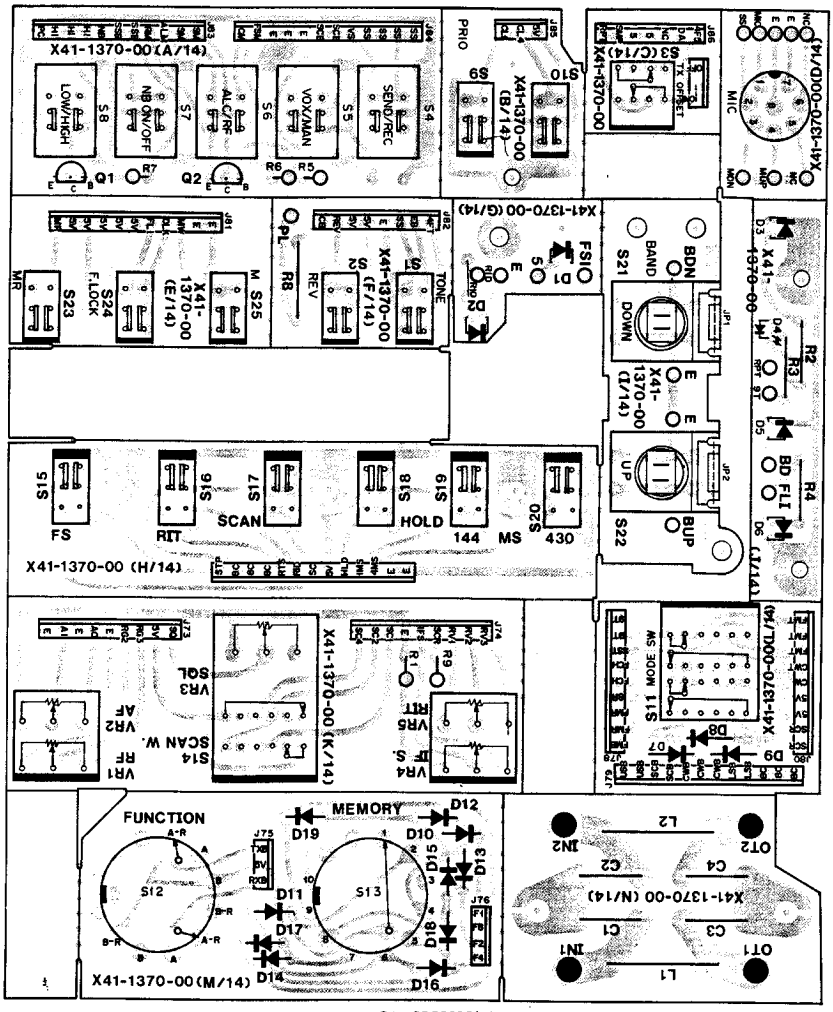


PACKING

★ Accessory bag (H25-0016-00)
7P DIN plug (E07-0751-05)
Phone plug (E12-0001-05)
Fuse 2A (F05-2023-05)
Fuse 7A x 2 (F05-7025-05)
Foot (large) x 2 (J02-0049-14)
Bind screw x 2 (N35-4025-46)

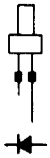


▼ SWITCH UNIT (X41-1370-XX) -51 : T, -61 : W Components side view

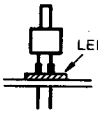


2SA1115
2SC2603

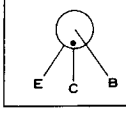
SLP-1448



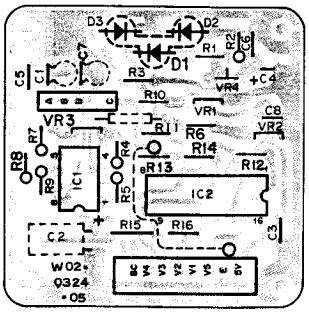
< Attachment methoc of D1, 2



Transistor termina indication



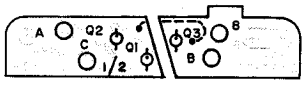
Q1 : 2SC2603(E) Q2 : 2SA1115(E)
D1 : SR539D D2 : SLP144B D3, 5, 6 : SG238D D4 : SR538D
D7~19 : 1S1555 or 1N4448



◀ ENCODER UNIT (W20-0324-05)
Components side view

IC1 : LM358P IC2 : MC14049UBCP
D1~3 : SEL101R(B or C)

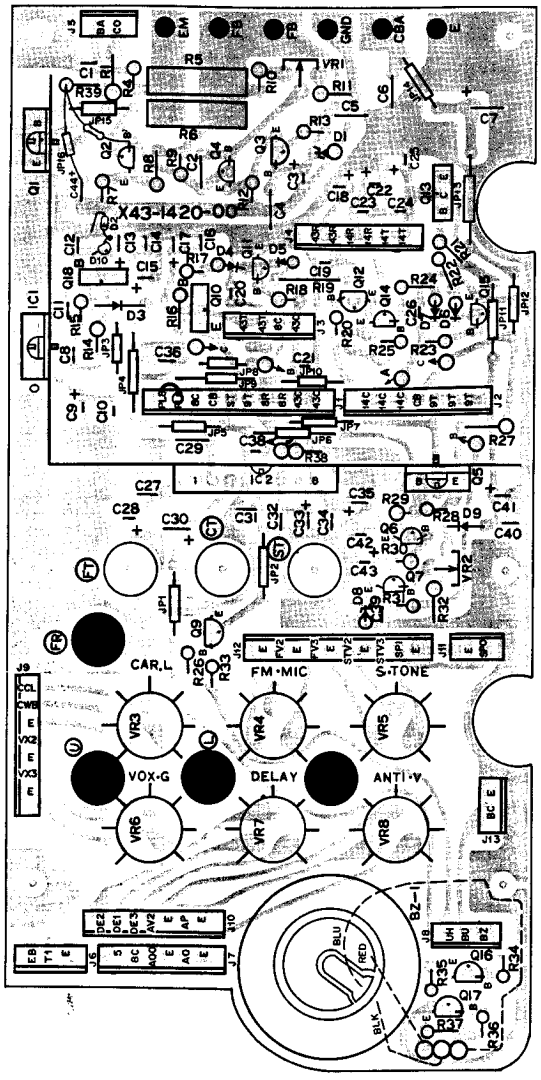
▼ ENCODER UNIT (W02-0324-05)
Components side view



Q1 : PH-101(R)
Q2, 3 : PH-102(L)

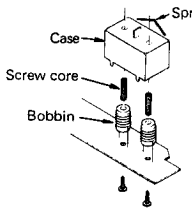
TS-780 PC BOARD VIEWS

▼ AVR UNIT (X43-1420-00) Components side view



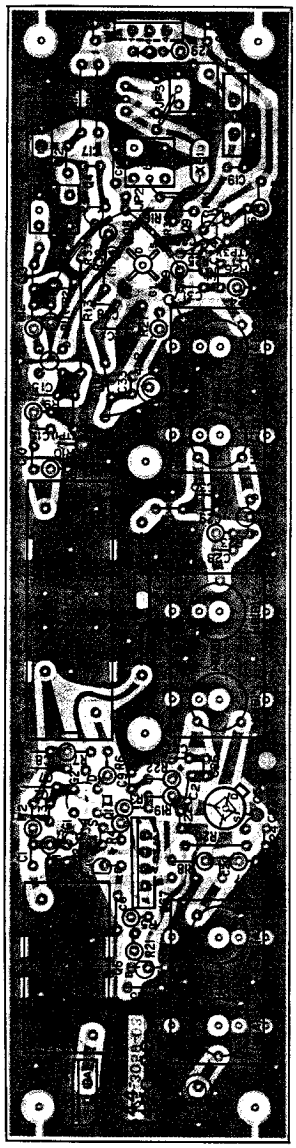
Q1, 5 : 2SA1012(Y) Q2, 6 : 2SC1959(Y) Q3, 4, 9, 11, 15~17 : 2SC1815(Y) or 2SC2603(E) Q7, 12, 14 : 2SA1015(Y) Q8 : 2SC496(Y) Q10, 13 : 2SA496(Y)
IC1 : μPC78M08H IC2 : MB3756
D1 : XZ-080 D2 : XZ-078 D3~7, 9 : 1S1555 or 1N4448 D8 : WZ-061 D10 : VD-1223

< Helical block assembly >



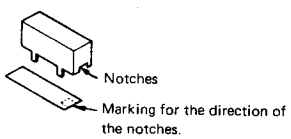
Coil	Color	Marking
HB(A)-1	Red	C
-2	Black	
HB(B)-1	Blue	B
-2	Red	
HB(C)-1	Black	A
-2	Yellow	

▼ RF UNIT (X44-1470-00)
Components side view

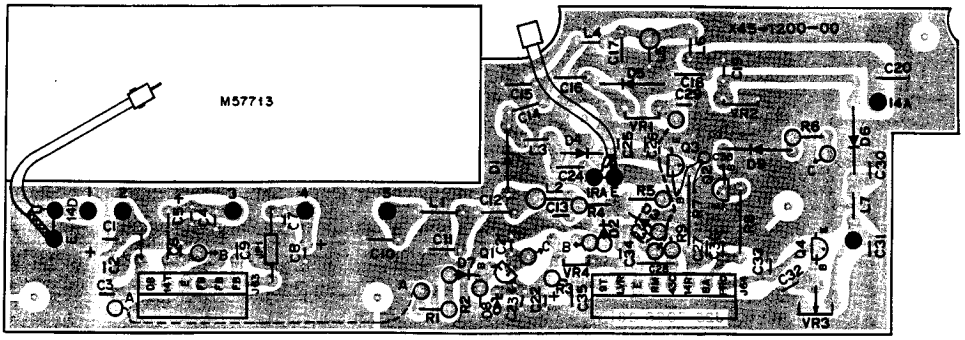


Q1 : 3SK76 or 3SK92 Q2 : 2SC2603(E) Q3,18 : 3SK97 (Q1) Q4,6,9 : 2SC1815(Y) or 2SC2603(E) Q5 : 3SK76-O Q7 : 2SK125
D1 : 1S1555 or 1N4448

< Attachment direction of HB(D), HB(E) >

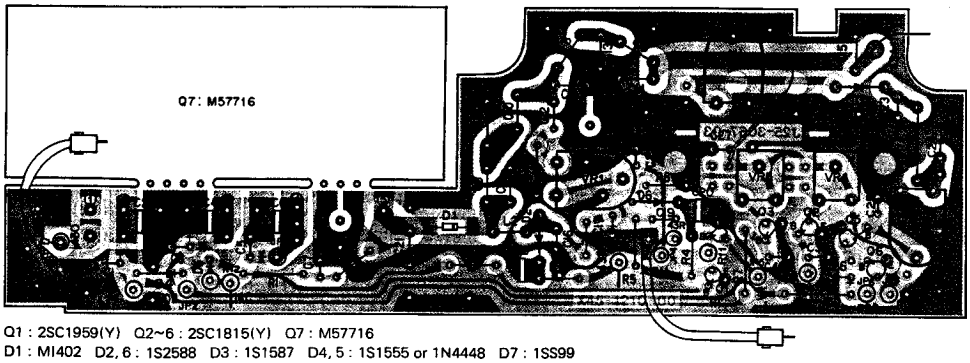


▼144 FINAL UNIT (X45-1200-00) Components side view

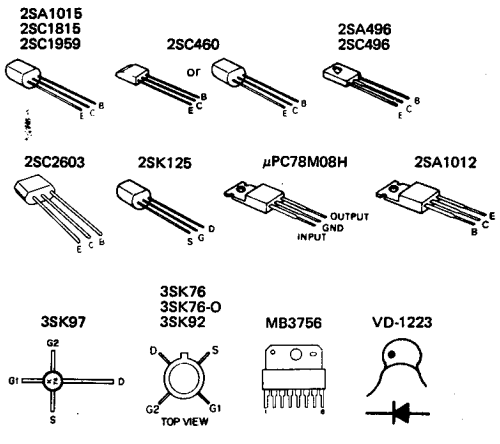


Q1 : 2SA1015(Y) Q2 : 2SC1959(Y) Q3, 4 : 2SC1815(Y) or 2SC2603(E)
D1 : MI402 D2, 3, 7, 9 : 1S1555 or 1N4448 D4 : 1S2588 D5 : 1S1587 D6 : 1N60 D8 : XZ-064

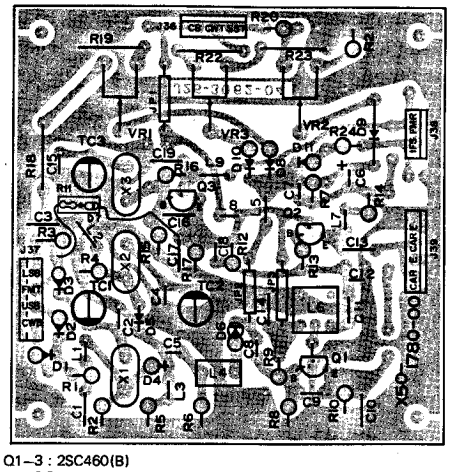
▼430 FINAL UNIT (X45-1210-00) Components side view



Q1 : 2SC1959(Y) Q2~6 : 2SC1815(Y) Q7 : M57716
D1 : MI402 D2, 6 : 1S2588 D3 : 1S1587 D4, 5 : 1S1555 or 1N4448 D7 : 1SS99



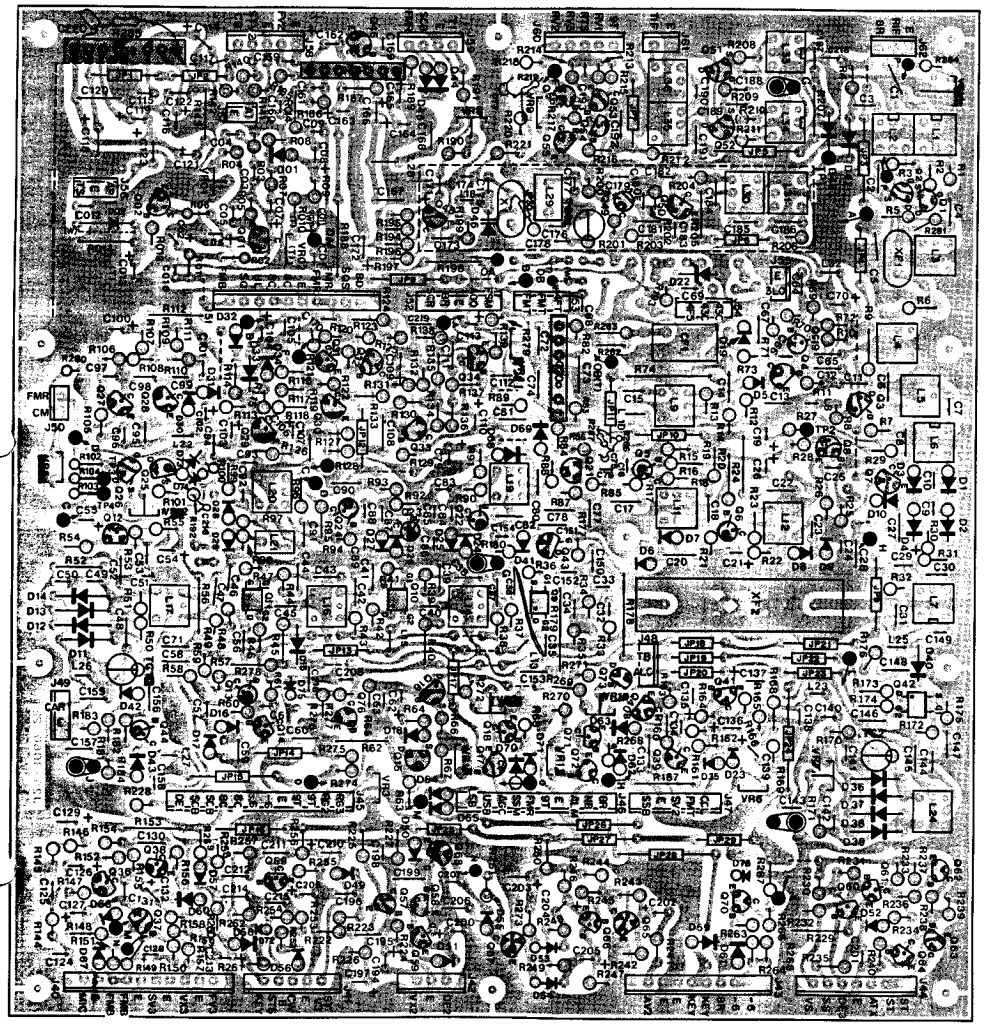
▼CAR UNIT (X50-1780-00) Components side view



Q1–3 : 2SC460(B)
D1–3,7–11 : 1S1555 or 1N4448 D4,5 : 1S2588 D6 : ITT310TE

TS-780 PC BOARD VIEW

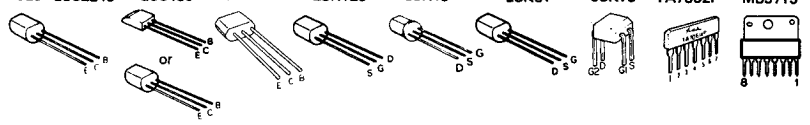
▼ IF UNIT (X48-1350-XX) -51 : T, -61 : W **Components side view**



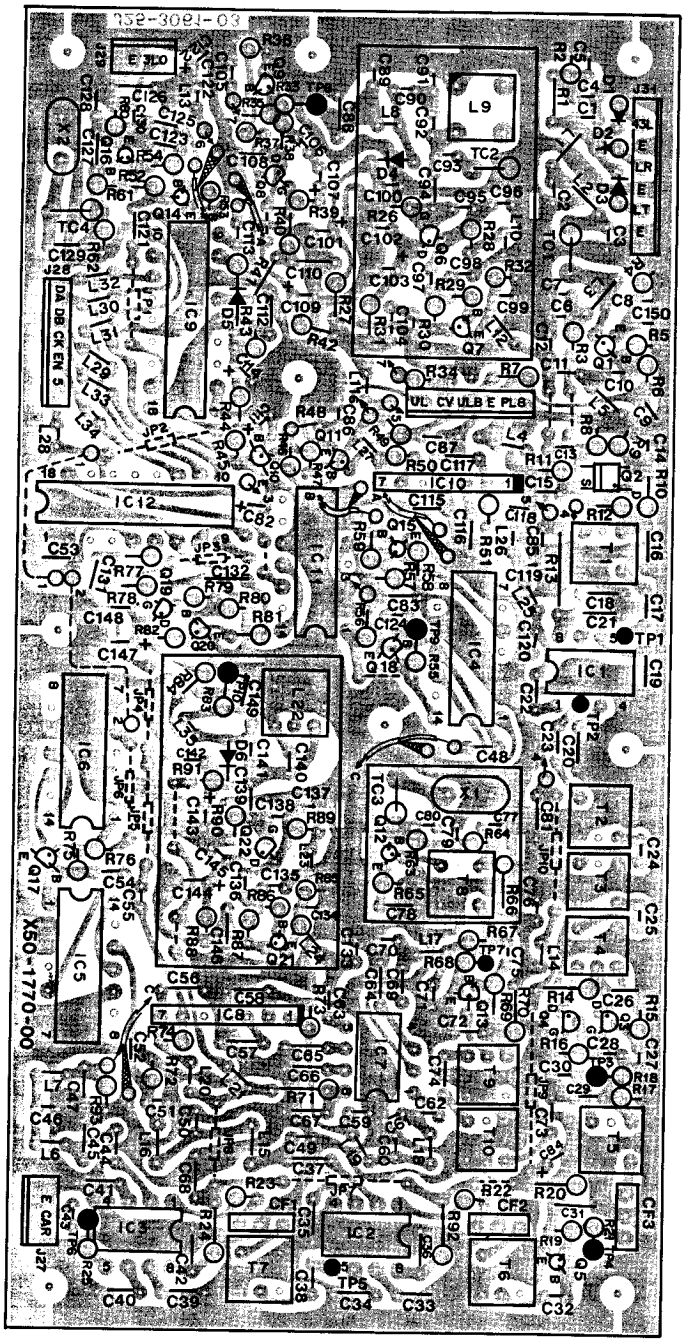
Q1, 2 : 2SK125-4 Q3, 51, 52 : 2SK125 Q4, 50 : 2SC1923(O) Q5, 6, 13, 19, 21~24, 44, 49 : 2SC460(B)
Q7, 8, 14, 27~31, 39~41, 46, 48, 53~55, 57, 58, 60, 61, 64, 65, 67~69 : 2SC1815(Y) or 2SC2603(E) Q9~11, 42 : 3SK73(GR)
Q12, 33, 36~38 : 2SC2240(GR) Q15 : 2SK30A(GR) Q16, 73 : 2SK19(Y) Q17, 32, 56, 59, 62, 66, 70, 72, 76 : 2SA1015(Y)
Q18, 34, 71 : 2SC2603(E) Q20 : TA7302P Q25, 26 : 2SK19(GR) Q35 : MB3713 Q43 : 2SK61(GR) Q45 : TA7061AP Q63 : 2SC1959(Y)
Q01, 02 : 2SC458(B)
D1~4 : 1S1587 D5, 10, 15, 18, 19, 23~27, 32, 33, 35, 40~45, 49, 52~67, 70, 71, 73, 74, 76, 77, 01, 02 : 1S1555 or 1N4448
D6~9, 11~14, 16, 17, 28~31, 36~39, 50, 51, 68, 69, 75 : 1N60 D17 : 1SS99 D22 : XZ-049 D34, 72 : 1S1212 D46 : 1SV50S
D47, 48 : 1S2588

	T	W
C011	Used	Not used
C013	Used	Not used
R010	Used	Not used
VR02	Used	Not used
D02	Used	Not used

2SA1015
2SC1815 2SC1959 2SC458 2SK30A TA7061AP
2SC1923 2SC2240 2SC460 2SC2603 2SK125 2SK19 2SK61 3SK73 TA7302P MB3713

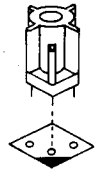


▼ PLL UNIT (X50-1770-00) Components side view

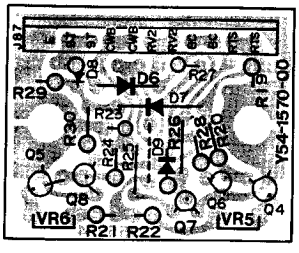


Q1, 7, 13, 17, 18 : 2SC1923(O) Q2 : 3SK73(Y) Q3, 4 : 2SK61(GR) Q5, 12, 14~16, 21 : 2SC460(B)
Q6, 22 : 2SK19(GR) Q8, 19 : 2SK30A(O) Q9, 20 : 2SC2240(GR) Q10, 11 : 2SC1815(Y) or 2SC2603(E)
IC1~3, 7 : SN16913P IC4 : HD74LS93P IC5, 6, 11 : HD74LS90P IC8, 10 : TA7302P IC9, 12 : MC145155P
D1~3 : 1S2588 D4, 6 : 1SV50S D5 : 1N60

< Attachment direction of L9



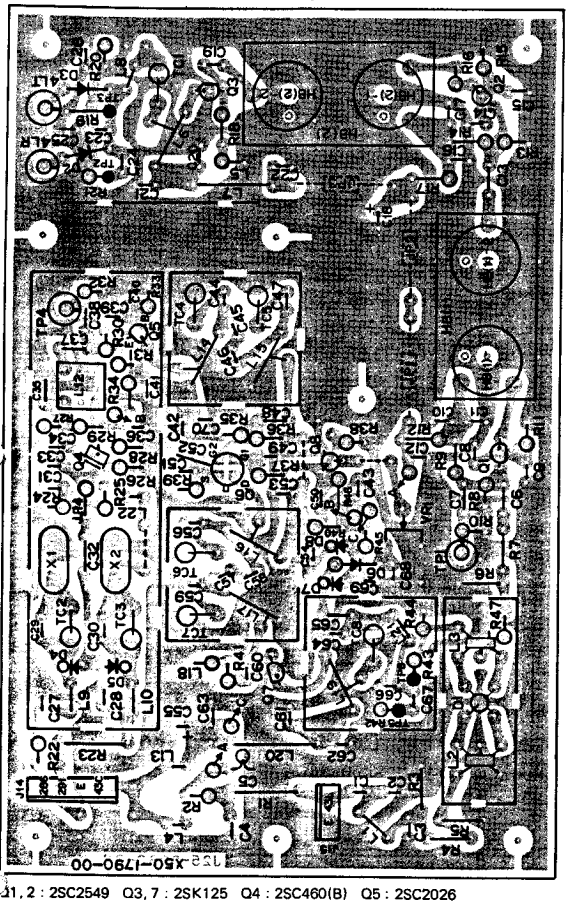
▼ CW SHIFT (J25-3055-04)
Components side view



Q4~8 : 2SC2603(E)
D6~9 : 1S1555

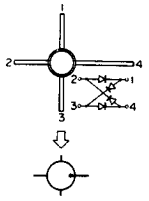
TS-780 PC BOARD VIEWS

▼ 430 HET UNIT (X50-1790-00) Components side view

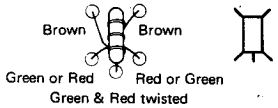


Q1, 2 : 2SC2549 Q3, 7 : 2SK125 Q4 : 2SC460(B) Q5 : 2SC2026
Q6 : 3SK92 or 3SK76 Q8 : 2SC1815(Y) or 2SC2603(E)
D1 : ND487C1-3R D2, 3 : 1S2588 D4, 5 : BA243S D6 : 1N60
D7 : 1SS99 D8 : 1S1555

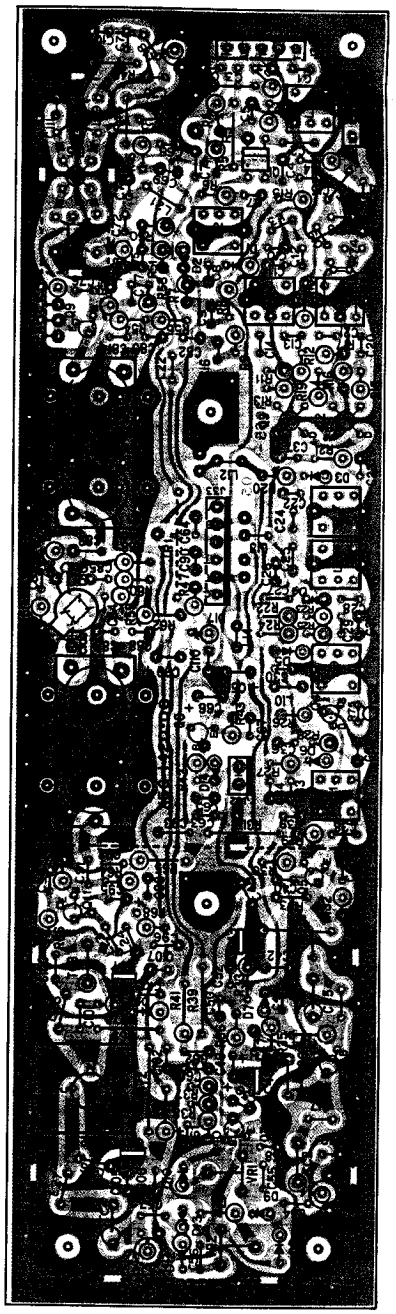
< Attachment direction of D1 >



< Attachment direction of L19, 20 (TX unit), L2, 3 (430 HET unit) >

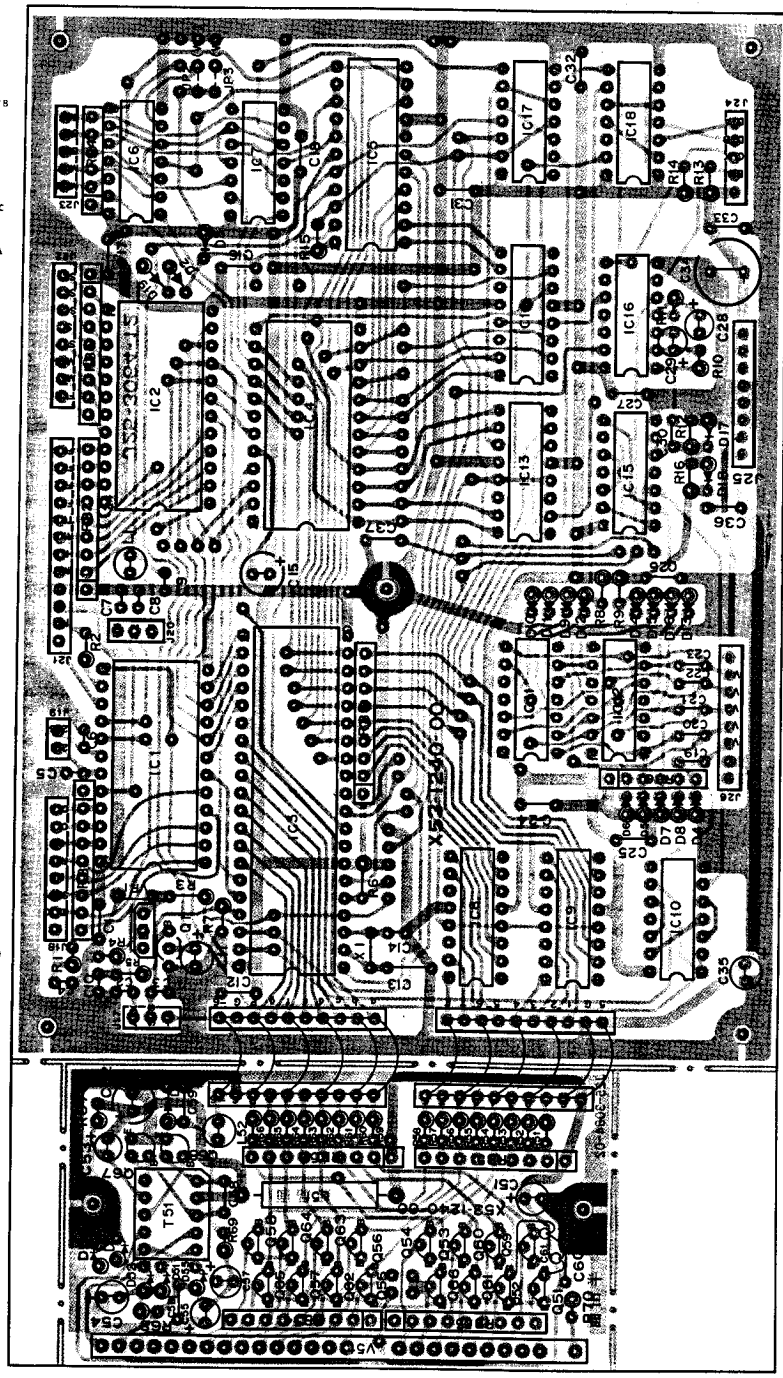


▼ TX UNIT (X56-1420-00) Components side view



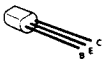
Q1 : 3SK73(GR) Q2, 3 : 3SK74(M) Q4 : 2SK125 Q5, 11 : 2SC2026
Q6 : 2SC2538-22-A Q7 : 2SC1815(Y) or 2SC2603(E) Q8 : 2SA1015(Y)
Q9 : 2SC2549 Q10 : 3SK92 or 3SK76 Q12 : 2SC2762
D1, 2 : 1S2588 D3~6 : ITT410 D7, 16 : 1S1555
D10, 11, 14 : 1S1555 or 1N4448 D8, 9, 12, 13 : 1N60 D15 : ND487C1-3R
D17 : XZ-060

▼ CONTROL UNIT (X53-1240-XX) -51 : T, -61 : W Components side view



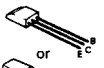
2SA1015
2SC1815
2SC1959

2SC2026
2SC2549

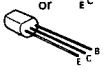


2SC2538-22-A

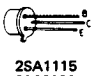
2SC460



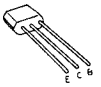
or



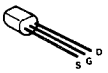
2SC2762



2SA1115
2SC2603

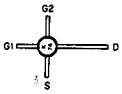


2SK125

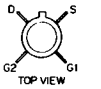


3SK73

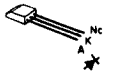
3SK74



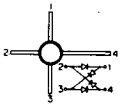
3SK76
3SK92



MA522



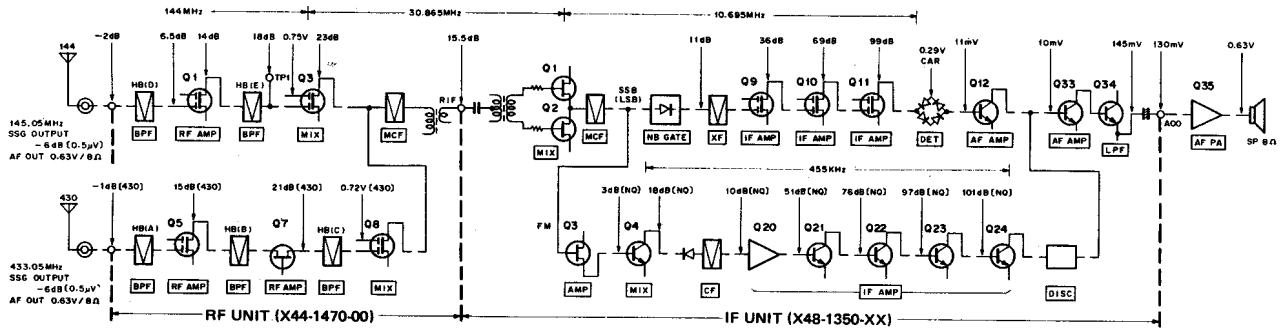
ND487C1-3R



< Attachr
direction

Q1 : 2SC2603(E) Q51~66 : 2SA1115(E) Q67, 68 : 2SC1959(Y)
IC1, 2 : μPD8243C IC3 : μPD8035LC IC4 : μPD2332C-384 IC5 : μPD5101LC IC6, 7 : HD74LS01P IC8, 9, 13, 14 : HD74LS75P IC10~12, 15, 18 : TC4011BP
IC16 : HD74LS04P IC17 : HD74LS27P
D1 : MA522(R) D2~19, 51~54 : 1S1555 or 1N4448 D55 : WZ-071 D56 : XZ-080

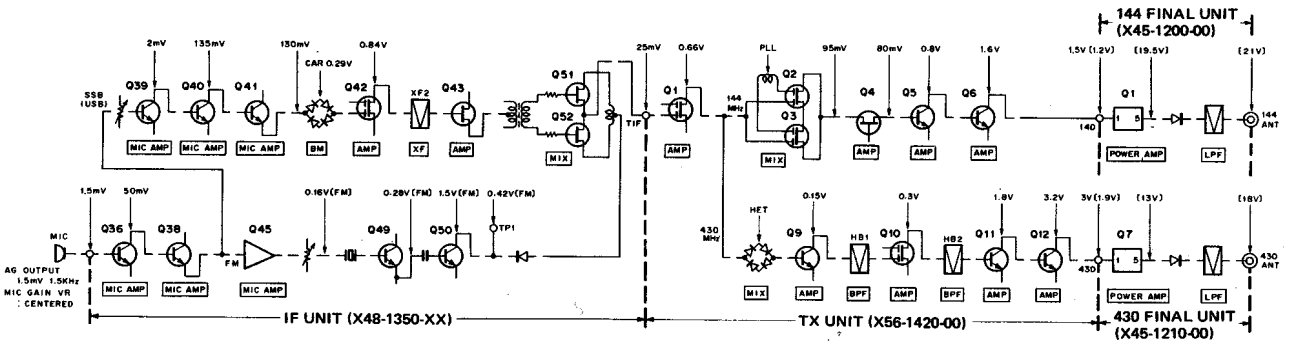
RECEIVER SECTION



Notes :

1. Each SSG level shown above is that which is applied to each point to obtain an audio output of 0.63V/8Ω when the AF GAIN VR is set so that this audio output level is obtained when a 144.50 MHZ (433.05 MHz), −6 dB SSG signal is applied to the ANT terminal.
2. Each level shown in the FM circuit is the SSG level at which the same S/N ratio is obtained as when a −6 dB SSG signal is applied to the ANT terminal.
3. Output levels at stages after ring detector are AF output levels.
4. The SSG signal is applied to each point through a 0.01μF titanium oxide porcelain capacitor.

TRANSMITTER SECTION



Notes :

1. The levels in front of terminals 14D and 43D are measured with the coaxial cable disconnected from the TX unit.
2. The levels in the microphone amplifier are measured with an audio voltmeter, and others are measured with an RF voltmeter.

ADJUSTMENT

REQUIRED TEST EQUIPMENT

1. **DC V.M**
   - High input impedance
2. **RF VTVM (RF V.M)**
   - Input impedance: 1MΩmin., 2pF max
   - Votage range: F.S = 10 mV ~ 300V
   - Frequency range: Up to 450 MHz
3. **Frequency Counter (F count)**
   - Input sensitivity: Approx. 50 mV
   - Frequency range: Up to 450 MHz
4. **DC Power Supply**
   - Voltage: 10V ~ 17V. variable
   - Current: 6A min
5. **Power Meter**
   - Measurement range Approx. : 30W, 3W, 1W.
   - Input impedance: 50 Ω
   - Frequency range: 450 MHz
6. **AF VTVM (AF V.M)**
   - Input impedance: 1MΩmin.
   - Voltage range: F.S = 1 mV ~ 30V
   - Frequency range: 50 Hz ~ 10 kHz
7. **AF Generator (AG)**
   - Output frequency: 100 Hz ~ 10 kHz
   - Output voltage: 0.5 mV ~ 1V
8. **Linear Detector**
   - Frequency range: 450 MHz
9. **Field Strength Meter**
   - Frequency range: 450 MHz
10. **Directional Coupler**
11. **Oscilloscope**
    - High sensitivity oscilloscope with horizontal input terminal
12. **SSG**
    - Frequency range: 144 MHz and 430 MHz band.
    - Modulation: AM and FM MOD.
    - Output level: −20 dB to 100 dB
13. **Dummy Load**
    - 8Ω, 5W (approx.)
14. **Noise Generator**
    - Must generate ignition-like noise containing harmonics beyond 450 MHz.
15. **Sweep Generator**
    - Sweep range: 144 MHz and 430 MHz bands
16. **Tracking generator**

Preparation

1) Unless otherwise specified. Knobs and switches should be set as follows **Table 19**.

POWER SW	ON	SSB MIC VR	MIN
SEND/REC SW	REC	RIT VR	CEN
VOX/MAN SW	MAN	IF SHIFT VR	CEN
ALC/CEN/RF/S SW	RF/S	SQUELCH VR	MIN
NB SW	OFF	RF GAIN VR	MAX
LOW/HIGH SW	HIGH	AF GAIN VR	MIN
PRIO.M [9]	OFF	F.STEP SW	OFF
PRIO.M [10]	OFF	RIT SW	OFF
TX-OFFSET SW	SIMP	SCAN SW	OFF
TONE SW	OFF	MS 144 SW	OFF
MODE SW	USB	MS 430 SW	OFF
FUNCTION SW	A	MR SW	OFF
MEMORY	1	F.LOCK SW	OFF

Table 19

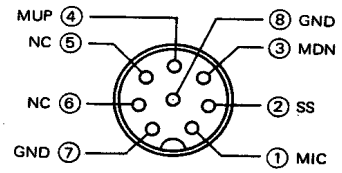


Fig. 17 MIC terminals (view from front panel side)

2) Use an insulated adjusting rod to adjust trimmers and coils.
3) To prevent damaging SSG, never set the stand by switch to SEND while adjusting the receiver section.
4) Be sure to turn the power and VOX switches OFF before connecting the power cable to a power source.

Note: The set enters the transmission mode for an instant when the power switch is turned ON with the VOX switch ON.

5) SSG output levels are those at the time the output terminal is open.

ADJUSTMENT

GENERAL ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Voltage adjustment (1)	1) Connect the AC power to the POWER terminal on the rear panel.								
	2) POWER SW : ON SEND/REC SW : REC	Digital voltmeter	AVR	FB	AVR	VR1	13.8V	±0.1V	
2. Voltage adjustment (2)	1) Connect the DC power to the POWER terminal on the rear panel. (DC 13.8V)								
	2) CALL SW : ON SEND/REC SW : SEND	Digital voltmeter	AVR	43T	AVR	VR2	9.0V		
	REC							0V	
3. Voltage check	1) Same as above.	Digital voltmeter	AVR	PL8				8.0V±0.3V	
				8C				8.2V±0.3V	
				8R				8.3V±0.3V	
	2) SEND/REC SW : SEND							Less than 0.5V	
	3) SEND/REC SW : REC		Control	−6				−6.0V±0.2V	
				5V (A)				5.0V±0.2V	
				5V (B)				5.0V±0.2V	
	4) MODE SW : FM CH		Control	FCH				5.0V±0.2V	
	5) MODE SW : FM, USB, CW, LSB			FCH				0V	
	6) PRIO.M (9) : ON PRIO.M (10) : ON		AVR	14C				8.3V	
				14R				8.3V	
	7) SEND/REC SW : SEND			14T				9.0V	
	8) SEND/REC SW : REC PRIO.M (9) : OFF (f : 433.000.0 MHz)			43C				8.3V	
				43R				8.3V	
4. SCAN.W	1) Check the voltage at each test point, switching the SCAN W SW as shown at right.	Digital voltmeter	Control (IC2)						

	SCAN.W SW				
	0.5	1	3	5	10
TP1	0V	5V	5V	5V	0V
TP2	0V	0V	5V	0V	5V
TP3	0V	0V	0V	5V	5V

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
5. Voltage check	1) MODE SW : FM SEND/REC SW : SEND	Digital voltmeter	IF	4FT				9.1V	
	REC			4F5				5.0V	
	2) SEND/REC SW : REC								

	MODE SW				
	LSB	CW	USB	FM	FM CH
FMB	0	0	0	8.2	8.2
CWB	0	8.2	0	0	0
SCB	7.6	7.6	7.6	0	0
LSB	8.2	0	0	0	0
USB	0	0	8.2	0	0
SSB	7.6	0	7.6	0	0

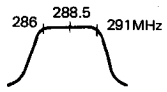
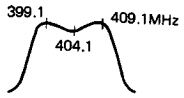
ADJUSTMENT

Item	Condition	Measurement: Test equipment	Measurement: Unit	Measurement: Terminal	Adjustment: Unit	Adjustment: Parts	Adjustment: Method	Specification	Remarks
	3) SEND/REC SW : REC only	Digital voltmeter	IF	MODE SW: LSB / CW / USB / FM / FM CH					
				FMR: 0 / 0 / 0 / 8.3 / 8.3					
				SCR: 8.3 / 8.3 / 8.3 / 0 / 0					
	4) SEND/REC SW : SEND only		MODE	FMT: 0 / 0 / 0 / 9.0 / 9.0					
				CWT: 0 / 9.0 / 0 / 0 / 0					
				SST: 9.0 / 0 / 9.0 / 0 / 0					
	5) SEND/REC SW : REC		IF	RG3	IF	VR3	3.7V	±0.05V	
	6) HI/LOW SW : HI SEND/REC SW : SEND		144 Final	DB				12.5V±0.4V	
	7) MODE SW : FM HI/LOW SW : LOW				144 Final	VR4	4.5V	±0.1V	
6. CAR	1) MODE SW : USB IF SHIFT VR : Center	RF V.M	PLL	CAR	CAR	L6 ●	Adjust the core for the maximum reading, then turn it outward until a reading of 0.3V is obtained.	0.3V±0.01V	Be sure to set th core for the ma mum reading.
	• MODE SW : LSB							0.3V±0.02V	Check
	• MODE SW : FM							0.3V±0.03V	
	2) MODE SW : USB	Frequency counter	PLL	TP6	CAR				
	: LSB					TC1	10.6965 MHz	±10 Hz	
	: FM					TC2	10.6935 MHz	±10 Hz	
	3) SEND/REC SW : SEND MODE SW : FM					TC3	9.415 MHz	±50 Hz	
						VR1	10.695 MHz	±10 Hz	
	: USB					VR2	10.6965 MHz	±10 Hz	
	: CW					VR3	10.6957 MHz	±10 Hz	
7. IF SHIFT check	1) MODE SW : USB SEND/REC SW : REC	Frequency counter	PLL	TP6			Turn the IF SHIFT VR to maximum and minimum.	More than ±1.0 kHz	No fanction in th FM mode.
	2) MODE SW : USB SEND/REC SW : SEND							Not shifted.	
8. Reference oscillator frequency	1) BAND SW : 430 MODE SW : FM CH	Frequency counter	PLL	TP9	PLL	TC4 ●	10.240 MHz	±10 Hz	
9. PLL	1) Disconnect connector No. 27 (PLL unit). SEND/REC SW : SEND	RF V.M	PLL	TP7	PLL	T8 ●	Turn the core outward until oscillation stops, then turn it inward exactly 1/2 turn beyond the point at which oscillation restarts. (0.32V)		Values in pareuth es below are for reference.
				TP3		T9,10 ●	MAX (Repeat)	(0.15V)	
		Frequency counter				TC3 ●	97.293 MHz	±50 Hz	
	2) Frequency : 439.999.9 MODE SW : FM	DC V.M		TP10		L22 ●	2.0V	±0.1V	

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
	3) Frequency : 430.000.0	DC V.M	PLL	TP10	PLL	L22		Less than 4.0V (3.5V)	Check
	4) Frequency : 430.010.0 Insert connector No. 27.	RF V.M		TP4		T6,7	MAX (Repeat)	(0.06~0.07V)	Repeat adjustment several times.
				TP2		T2~6 T9~10		(0.1~0.15V)	Repeat adjustment of T2 through T4 several times.
	5) MODE SW : FM CH Frequency : 439.9875	DC V.M		TP8		TC2	1.5V	±0.1V	The voltage varies when the shielding case is removed.
	Frequency : 430.000							Less than 6.5V (6.0V)	
	6) Frequency : 430.000	Frequency counter	PLL	D2				113.135 MHz ±100 Hz	Check
	430.0125→ 430.025.... (.... 430.025→ 430.0125) in 12.5 kHz steps							The frequency changes in 12.5kHz step.	
	MODE SW : FM Slowly shift the VFO frequency from 430.000.0							The frequency changes in 20 Hz.	
	7) MODE SW : FM CH SEND/REC SW : REC Store 430.00 in Memory CH1. MR SW : ON	Frequency counter	PLL	D2				113.135 MHz ±200 Hz	
	MODE SW : USB							113.1365 MHz ±100 Hz	
	MODE SW : CW							113.1365 MHz ±100 Hz	
	SEND/REC SW : SEND							113.1357 MHz ±100 Hz	
	MODE SW : LSB							113.1335 MHz ±100 Hz	
10. PLL output	1) MODE SW : FM CH Frequency : 433.00 SEND/REC SW : SEND	RF V.M	PLL	TP1	PLL	T1	MAX	(0.1V)	
	2)	DC V.M		UL				Less than 0.1V	Check
				ULB				Appro. 5.0V	
	Connect TP4 to GND. (Be sure to disconnect TP4 from GND after the check).			UL				Appro. 1.2V	
				ULB				Less than 0.1V	
	3) MODE SW : FM CH Frequency : 145.00 SEND/REC SW : SEND	RF V.M		LT	PLL	TC1	MAX	(0.5~0.8V)	
				3LO				More than 0.4V	Check
		Note : Reinstall the PLL shielding case if it has been removed, then perform adjustment in Step 5.5).							

ADJUSTMENT

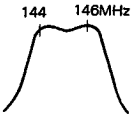
Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
11. 430 HET	1) MODE SW : FM CH Frequency : 439.9875 SEND : REC SW : REC	RF V.M	HET	TP4	HET	L12	Turn the core outward until oscillation stops, then turn it inward exactly 1/2 turn beyond the point at which ocsillation restarts. (0.048V)		
	2) Turn VR1 on the HET unit all the way to the right. Short the L11 lead (430 HET unit) to GND.	Tracking generator Spectrum analyzer Sweep generator Linear Detector Oscillo-scope		TP4 TP5		TC4~8	Adjust TC4~8 so that the waveform shown at right is observed when the output is maximum.		
	3) Set TC1 on the RF unit to minimum. TC1 	Tracking generator Spectrum analyzer Sweep generator Linear Detector Oscillo-scope	HET RF	TP1 TP4	HET	HB1 HB2 TC1	Adjust HB1, HB2 and TC1 so that the waveform shown at right is observed when the output is maximum.		
	4) Disconnect L11 from GND. Frequency : 439.9875	RF V.M	HET	TP6				More than 0.8V	Check
	Frequency : 430.00							More than 0.8V	
	5) Frequency : 430.00				HET	VR1	0.6V		
	Frequency : 439.9875	Frequency counter				TC2	286.0 MHz	±100 Hz	Repeat adjustmen
						TC3	291.0 MHz	±100 Hz	
	Frequency : 433.00	RF V.M	RF	TP3				More than 0.6V	Check
	6) Frequency : 430.00 439.9875			TP4		TC1	Adjust the band-edge levels within 1dB.	(0.06V)	

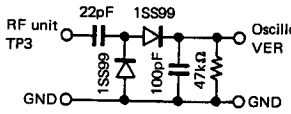
CONFIRM OF RESET VOLTAGE

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Setting	1) Connect an AVR (5V) to both pins 1 and 8 of connector of the control unit.								
	2) Set VR1 to maximum.								
2. Reset voltage	1) Decrease the AVR voltage.	DC V.M	Control	⊛ 5V			The frequency display should go out when the AVR voltage is 3.95~4.5V.		Check
	2) In case the frequency display does not go out after the AVR voltage drops below 3.95V.				Control	VR1	Set the AVR voltage to 3.95V and adjust VR1 so that the frequency display goes out.		

ADJUSTMENT

RECEIVER ADJUSTMENT (2m BAND)

Item	Condition	Measurement: Test equipment	Measurement: Unit	Measurement: Terminal	Adjustment: Unit	Adjustment: Parts	Adjustment: Method	Specification	Remarks
1. BPF	1) MODE SW : FM CH BAND SW : 144 Pull connector LR out from the RF unit. IF unit VR14 : center	Sweep generator Linear detector Oscillo-scope	RF	144 ANT TP1	RF	HB(D) HB(E)	Adjust HB(D) and HB (E) so that the wave-form shown at right is observed. (The level at 144 MHz is a little lower than that at 146 MHz).		Insert connector LR after adjustment.
2. Sensitivity	1) Turn the core of L6 in the IF unit outward as far as possible. Connect SSG to the 144 ANT connector. (MOD : 1 kHz, FM DEV : 5 kHz).	RF V.M	IF	TP1	IF	L30,31	MAX	(0.3V)	
		Frequency counter				TC3	41.560 MHz	±1 kHz	Temporary setting
		S meter			RF	L1~3	Adjust specified parts repeatedly to obtain the maximum S meter reading.	Lower the SSG output level so that the S meter reads "3".	NOTE : This ad-justment influences upon sensitivity in the 430 MHz band.
					IF	L1,2 L30,31 L3~5			
3. S meter reading in the FM mode	1) MODE SW : FM CH Frequency : 145.0125 SSG output : 60 dBμ	SSG S meter		144 ANT	IF	L20	MAX		
						VR4	Adjust VR4 so that the S meter reads "10".		
	2) Adjust the SSG output level so that the S meter reads "5".					L6	Turn the core of L6 clockwise until the S meter reads "2".		
						L3~L5	Adjust L3~5 for the maximum S meter reading.		Repeat the ad-justment.
	3) SSG output : 40 dBμ					VR4	Adjust VR4 so that the S meter reads "10".	Perform this ad-justment with set placed right-ly side up.	
4. Sensitivity in the SSB (CW) mode	1) MODE SW : USB SSG output : −14 dBμ	AF V.M SSG		EXT SP 144 ANT	IF	L7,14 L16,17	AF output : MAX Repeat the ad-justment.	Turn the core of L14 a little to the left if noise makes adjustment difficult.	
5. S meter zero adjustment	1) IF unit VR1 : center SSG output : OFF	S meter			IF	VR2	Adjust VR2 so that the S meter needle points exactly to "1" on the RF scale		
	2) Turn RF GAIN VR to the left until the S meter needle points to "4" on the RF scale.					VR2	Adjust VR2 so that the S meter needle points exactly to "1" on the RF scale.		



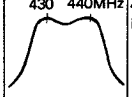
ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
6. RX carrier supression	1) RF GAIN VR : MIN	RF V.M	IF	D17	IF	TC1	MIN	(0.01V)	
7. S meter reading in the SSB (CW) mode	1) SSG output : 20 dBμ Adjust the SSG frequency for the maximum S meter reading.	S meter			IF	VR1	"S-9"		
	2) SSG output : 0 dBμ					L14	Turn the core of L14 outward until the S meter reads "S1".		
	3) SSG output : 20 dBμ					VR1	Adjust VR1 so that the S meter reads "S9".		
8. N.B	1) SSG output : 10dBμ	DC V.M	IF	TP2	IF	L9,11	MIN		
9. C.M	1) MODE SW : FM ALC/CEN-RF /S SW : ALC/CEN SSG output : OFF	DC V.M	IF	TP4 TP3	IF	VR12	Adjust VR12 so that the level at TP3 is equal to that at TP4.	If this is not possible, a difference between the two levels of within 0.6V is permissable.	No signal may be applied during th adjustment.
	2) Frequency : 145.0125	Center meter			IF	VR5	Center meter : center		
	3) SSG output : 20 dBμ Fine-adjust the SSG frequency so that the maximum AF output is obtained. Then, turn MOD OFF.						Confirm that the center meter needle swings beyond the range beyond the range between the two E's of the CENTER marking as the VFO dial is rotated right and left.		Check
10. RIT,CW SHIFT	1) MODE SW : USB	Frequency counter	IF	TP1	IF	TC3	41.560 MHz	±100 Hz	
	2) RIT SW : ON RIT VR : Center					VR9	Adjust VR9 so that the frequency is within 41.560 MHz± 20 Hz.		The RIT indicato lights.
	Turn RIT VR all the way to the right and left.							The frequency must be varied by more than ±1.5 kHz.	
	3) MODE SW : CW RIT VR : Center RIT SW : OFF				CW shift	VR6	41.5592 MHz	±20 Hz	
	4) RIT SW : ON					VR5	41.5592 MHz	±20 Hz	

ADJUSTMENT

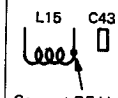
Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
	5) Confirm that SEND/ REC SW is set to SEND, then set it to REC.	Frequency counter	IF	TP1	CW Shift			41.560 MHz	Check
11. Sensitivity check	1) MODE SW : USB SSG output : −8 dBμ Frequency : 144.0125 or 145.9875	SSG AF V.M Oscillo-scope		144 ANT EXT SP				S/N : better than 12 dB	Check
	2) MODE SW : FM CH SSG output : −6 dBμ Frequency : 144.00 or 145.9875							S/N : better than 24 dB.	

RECEIVER ADJUSTMENT (70cm BAND)

Item	Condition	Measurement			Adjustmtent			Specifications	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. BPF	1) MODE SW : FM CH BAND SW : 435 Pull connector 4LR out from the RF unit.	Sweep generator Linear detector Oscillo-scope	RF	430 ANT TP3	RF	HB (A) HB (B) HB (C)	Adjust HB (A), HB (B) and HB (C) so that waveform shown at right is max-imized.		Insert connector 4LR after complet-ing the adjustment.
2. Sensitivity	1) Frequency : 435.0125 Connect the SSG to the 430 ANT con-nector . (MODE : 1 kHz DEV : 5 kHz)	S meter			RF	TC1	MAX		**NOTE** : Adjustment of sensitivity of the circuits following the IF stage is per-formed along with the 144 MHz band sensitivity adjust-ment.
	Adjust the SSG output so that the S meter reads "3".	RF V.M	RF	TP4 (R30)	HET	TC1	Adjust TC1 so that the RFV.M reading at 430.00 MHz is equal to that at 439.9875 MHz.	(0.06V)	
3. Sensitivity check	1) MODE SW : USB SSG output : −8 dBμ Frequency : 430.000.0 or 433.0125	SSG AF V.M Oscillo-scope		430 ANT EXT SP				S/N : 12 dB or better	Check
	2) MODE SW : FM CH SSG output : −6 dBμ Frequency : 430.00 or 439.9825	SSG AF V.M Oscillo-scope		430 ANT				S/N : 22 dB or better	

ADJUSTMENT

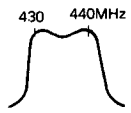
TRANSMITTER ADJUSTMENT (2m BAND)

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Setting	1) Rear panel 144 ANT connector : power meter POWER connector : DC P.S. (13.8V)								
2. Power output	1) MODE SW : CW Frequency : 145.000.0 CAR VR : MAX Turn VR3 in the 144 final unit all the way to the left. TX unit Turn VR1 all the way to the left. Turn VR2 all the way to the left. Disconnect connector 14D anc connect a 1W power meter. SEND/REC SW : SEND	RF V.M	IF	D41	IF	L24	Repeat adjustment for the maximum power meter reading.	(0.26V)	
				TIF		L33~36		(0.1V)	
			TX	D2	TX	L1,2		(0.7V)	
				D3		L4,6		(0.2V)	
				L15		L7~9 L11		 Connect RF V. M. to this point.	
					TX IF	L1 L35,36			
					TX	L2,4,6		(0.5V)	
					TX	L7~9 L11 TC1			
	2)	Power meter (1W)	TX	14D		TC1,2 L11	Repeat adjustment for the maximum power meter reading.	0.16W or more	
	Disconnect the power meter from terminal 14D on the TX unit and connect the cable connector.	Power meter (30W)		144 ANT				17W or more	Check
					TX	VR1	12W	Source current : 4.2A or less.	
3. 144 protection (1)	1) SEND/REC SW : SEND	Multimeter	144 final	TP	144 final	VR2	MIN	0.3V or less	
4. 144 RF meter	1) ALC/CEN-RF/S SW : RF/S	RF meter			144 final	VR1	Adjust VR1 so that the meter reads "8" on the RF scale.		
5. 144 protection (2)	1) Short circuit the 144 ANT connector. SEND/REC SW : SEND	Ampere meter			144 final	VR3	3A	Confirm that the source current is about 1.7A when the ANT terminal is open.	Perform this check quickly.

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
6. 144 low power	1) MODE SW : FM CH Frequency : 145.00	Power meter		144 ANT				Less than 3W	Check
	LOW/HIGH SW : LOW SEND/REC SW : SEND	Power meter (3W)			430 final	VR4	1.2W	The RF meter reading must be "4" or less.	
	2) Frequency : 144.00 or 145.9875 SEND/REC SW : SEND				TX	L6	Fine-adjust L6 so that the power output is the same at both frequencies.	0.5–2W	

TRANSMITTER ADJUSTMENT (70cm BAND)

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Setting	1) Rear panel 430 ANT connector : power meter POWER connector : DC P.S. (13.8V)								
2. Power output	1) MODE SW : CW CAR VR : MAX LOW/HIGH SW : HIGH TX unit • TC5 : Minimum • Disconnect connector 4LT • Disconnect connector 43D and connect the power meter (1W). SEND/REC SW : SEND	Tracking generator	TX	TP1	TX	HB (1) HB (2) TC3,4	Adjust HB (1), HB (2), TC3 and TC4 so that the waveform shown at right is maximized. (The shoulder on the 430 MHz side must be sharper than that on the other side).		
		Spectrum analyzer Sweep generator Oscilloscope		43D					
		Power meter (0.6W)	TX	43D	TX	TC3,4	MAX	More than 0.16W	
	2) Disconnect the power meter from terminal 43D on the TX unit and connect the cable connector.	Power meter		430 ANT	430 final	L3	MAX Adjust the coil pitch for maximum power output.	17W or more	
					TX	VR2	12W	Source current : 4.8A or less.	
3. 430 protection (1)	1) SEND/REC SW : SEND	Multimeter	430 final	TP	430 final	VR2	MIN	1.0V or less	

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
4. 430 RF meter	1) ALC/CEN-RF/S SW : RF/S SEND/REC SW : SEND	RF meter			430 final	VR1	Adjust VR1 so that the RF meter reads "8".		
5. 430 protection (2)	1) Open the 430 ANT connector terminal. TX unit VR3 : CEN SEND/REC SW : SEND	Ampere meter			430 final	VR3	3A		Perform adjustmer quickly.
6. 430 low power	1) MODE SW : FM CH Frequency : 435.00 LOW/HIGH SW : LOW IF unit VR6 : 2 o'clock position (viewed from the front panel side).	Power meter (30W)		430 ANT				Less than 3W	Check
		Power meter (3W)			430 final	VR5	1.2W	Source current : 2.5A or less RF meter reading : "4" or less	
	2) Frequency : 430.00 or 439.9875							0.5–2W	Check

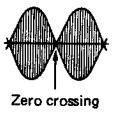
TRANSMITTER ADJUSTMENT (COMMON)

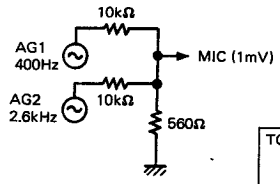
Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Carrier suppression	1) MODE SW : USB, LSB Frequency : 145.000.0 CAR VR : MIN SSB MIC VR : MIN SEND/REC SW : SEND	Spectrum analyzer (RF V.M) Power meter		144 ANT	IF	VR7 TC2	MIN (repeat)	–55 dB or less	
	2) BAND SW : 435 MODE SW : USB and LSB							–55 dB or less	
2. ALC meter	1) MODE SW : USB Frequency : 145.000.0 LOW/HIGH SW : HIGH ALC/CEN-RF/S SW : ALC/CEN	ALC meter			IF	VR10	Set VR 10 to mechanical center.		

ADJUSTMENT

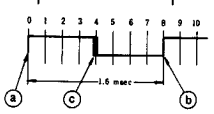
Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
2. ALC meter	2) MODE SW : CW CAR VR : MAX SEND/REC SW : SEND	ALC meter			IF	VR11	Adjust VR11 so that the meter reads "10" on the RF scale.		
	Check at the following frequencies. 144.000.0 or 145.990.0 430.000.0 or 439.990.0							"S9+40 dB" or more on the S scale	
	3) MODE SW : USB or LSB Connect AG to the MIC terminal. (1.5 kHz, 2mV) Check at the following frequencies. 144.000.0 or 145.990.0 430.000.0 or 439.990.0	ALC meter						The ALC meter needle should swing at band-edge frequences on all modes.	
3. Deviation	1) MODE SW : FM Frequency : 145.000.0 FM MIC VR : MAX Connect AG to the MIC terminal. (1 kHz, 20mV)	Linear detector		144 ANT (Directional coupler)	IF	VR8	4.5kHz		
	2) MIC input level : 2 mV				AVR	FM MIC	3.5 kHz deviation should be obtained before FM MIC VR is turned beyond the 3 o'clock position.		Check
VOX (ANTI VOX) operation check	1) MODE SW : USB VOX GAIN VR : MIN ANTI VOX VR : MIN Connect AG to the MIC terminal. (1.5 kHz, 2mV)						1) VOX should operate before VOX GAIN VR is turned beyond the 12 o'clock position. 2) The VOX relay holding time decreases as VOX DELAY VR is turned counterclockwise (and vice versa).		Check
	2) Confirm operation in the modes shown at right.						USB / FM : Operate CW : Not operate		
	3) MODE SW : USB ANTI VOX VR : MIN						VOX is not operate when turn VOX GAIN VR at condition of ANT VOX voltage (EXT. SP) is 200mV.		

ADJUSTMENT

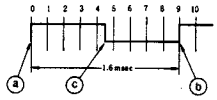
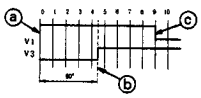
Item	Condition	Measurement			Adjustment			Specifications	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
5. SIDE TONE	1) MODE SW : CW SEND/REC SW : REC SIDE TONE VR : MAX AF GAIN VR : Center Connect the key to the terminal KEY rear panel.	AF V.M		EXT. SP	AVR	VR5	Mechanical center.	The side tone should be heard when the key is pressed. 0.3~1.26V/ 8Ω	
	2) SEND/REC SW : SEND	Power meter					The side tone should be heard and transmission start when the key is pressed.		Check
	3) SEND/REC SW : REC VOX/MAN SW : VOX DELAY VR : MIN	Power meter					The side tone should be heard and transmission start when the key is pressed. Reception should start immediately when the Key is released.		
6. Frequency response in the SSB mode	1) MODE SW : USB SSB MIC VR : CEN Connect AG to the MIC terminal. (AG1 : 400 Hz, 1 mV AG2 : 2.6kHz, 1 mV) SEND/REC SW : SEND	Oscilloscope RF V.M (power meter)		ANT	CAR	TC1	Adjust TC1 so that the waveform shown below is observed.  Zero crossing		**NOTE :** Check carrier suppression after this adjustment.
	2) MODE SW : LSB SEND/REC SW : SEND					TC2			



ENCODER ASS'Y ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
1. Setting	1) POWER terminal on the rear panel : AC Mount a motor in place of the VFO knob.	Oscilloscope	Control	㉕ 5- V1			Set the sweep control of the oscilloscope to 0.2msec/cm. Adjust the motor speed so that position ⓐ ~ ⓑ to 8 graduations on the oscilloscope screen. 	Motor speed : 300 rpm.	ⓒ point may be at any position. If a motor is not available, turn the VFO knob by hand to check the duty ratio.

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification	Remarks
		Test equipment	Unit	Terminal	Unit	Parts	Method		
2. V1 duty ratio	1) Set the sweep control of the oscilloscope to 0.1 msec/cm.	Oscilloscope	Control	㉕ 5- V1			Turn the variable control of the oscilloscope so that point ⓑ is positioned to graduation 9. 		
	2)	DC V.M			Encoder	VR3	2.7V	±0.1V	
3. V3 duty ratio	1) same as above.	Oscilloscope DC V.M	Control	㉓ 3- V3	Encoder	VR2	2.7V	±0.1V	
Phase difference between V1 and V3	1) Set the sweep control of the oscilloscope to 50μsec/cm. Do not turn the variable control.	Oscilloscope	Control	㉓ 3- V3 ㉕ 5- V1				Point ⓑ is positioned to graduation ④ ~ ⑤	Check
5. V5	1) Set the sweep control of the oscilloscope to 0.5 msec/cm.	DC V.M	Pulse generator	J1-C	Encoder	VR1	2.7V	±0.1V	
	2) MODE SW SW : FM CH						"H" level (5V) when encoder is stopped.		Check

MICROPROCESSOR OPERATION CHECK

Item	Condition	Operation check
1. Reset	1) Remove the backup battery, if installed.	
	2) POWER SW : ON	"A 144.000.0" is displayed.
2. F.STEP	1) Slowly rotate the VFO knob through one turn.	The display value varies by 10 kHz as the VFO knob is rotated through one turn.
	2) F.STEP SW : ON Slowly rotate the VFO knob through one turn.	F. STEP LED lights. The display value varies by 100 kHz as the VFO knob is Rotated through one turn.
	3) NORM/TIGHT SW : TIGHT	More force is required to turn the VFO knob than in the NORM setting.
	4) SEND REC SW : SEND Turn the VFO knob slowly	The ON AIR LED lights and the display varies.
3. FM CH	1) SEND REC SW : REC F.STEP SW : OFF MODE SW : FM CH Turn the VFO knob one click at a time.	The frequency changes by 12.5kHz every step, and changes 625kHz for one revolution of the VFO knob.
	2) F.STEP SW : ON Turn the VFO knob one click at a time.	The frequency changes by 5 kHz every step, and changes 25 kHz for one revolution of the VFO knob.
4. F.LOCK	1) F.LOCK SW : ON	The F. LOCK LED lights. The display does not change even if the VFO knob is rotated.
	2) F. LOCK SW : OFF	
5. BAND SW	1) Press BAND SW (UP) several times.	1) The 1 MHz digit display value increases by one every time the switch is pressed. 2) The buzzer sounds every time the switch is pressed.
	2) Hold down BAND SW (UP).	The 1 MHz digit display value increases continuously.
	3) Press BAND SW (DOWN) several times.	The 1 MHz digit display value decreases by one every time switch is pressed.

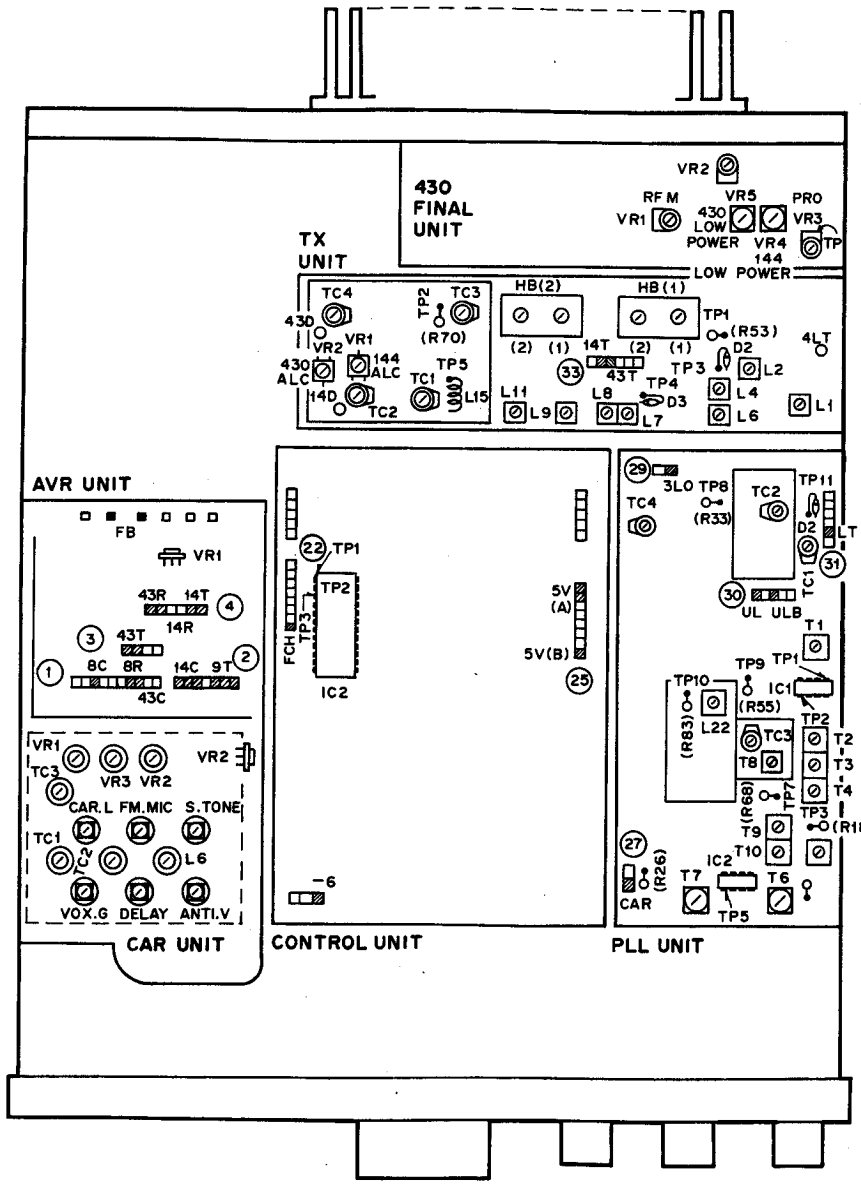
ADJUSTMENT

Item	Condition	Operation check
	4) Hold down BAND SW (DOWN).	The 1 MHz digit display value decreases continuously.
6. SCAN	1) MODE SW : FM SQL VR : MIN SCAN SW : ON	BUSY LED lights. Indication "A" flickers and the frequency varies scanning only when the SCAN SW is depressed.
	2) Turn SQL VR until BUSY LED goes out.	Scan starts.
	3) SEND/REC SW : SEND	Scan stops.
	4) SCAN SW : ON	Scan does not start.
	5) SEND/REC SW : REC SCAN SW : ON	Scan restarts.
	6) HOLD SW : ON	Scan stops.
7. PRIO. M	1) PRIO.M SW (10) : ON	"C 433.000.0" is displayed.
	2) PRIO.M SW (9) : ON	"C 145.000.0" is displayed.
	3) PRIO.M SW (9) (10) : : OFF	
8. MEMORY	1) 144 MS SW : ON	"C 145.000.0" is displayed. ("C" flickers).
	2) 144MS SW : OFF 430MS SW : ON	"C 433.000.0" is displayed. ("C" flickers).
	3) 430MS SW : OFF	
	4) MODE SW : FM CH VFO knob : 145.0125 MEMORY SW : 1 M SW : ON	The buzzer sounds when the M SW is pressed.
	5) Store the following frequencies in memory. MEMORY SW VFO knob 2 144.0250 3 144.0375 4 144.0500 5 144.0625 6 430.0750 7 430.0875 8 430.1000 9 430.1125 10 430.1250	
9. MR	1) MR SW : ON MEMORY SW : 1 2 3 4 5 6 7 8 9 10	1 144.012.5 is displayed. 2 144.025.0 is displayed. 3 144.037.5 is displayed. 4 144.050.0 is displayed. 5 144.062.5 is displayed. 6 430.075.0 is displayed. 7 430.087.5 is displayed. 8 430.100.0 is displayed. 9 C 430.112.5 is displayed. 10 C 430.125.0 is displayed.
	2) MR SW : OFF PRIO.M SW (10) ON	C 430.1250 is displayed.
	3) PRIO.M SW (9) : ON	C 430.1125 is displayed.
	4) PRIO.M SW (9) (10) : OFF	

Item	Condition	Operation check
10. MS	1) 144MS SW : ON	1 144.012.5 2 144.025.0 3 144.037.5 4 144.050.0 5 144.062.5 Memory channels should be scanned in this order. (The top letter on the display flickers.)
	2) 144MS SW : OFF 430MS SW : ON	6 430.075.0 7 430.087.5 8 430.100.0 C 430.112.5 C 430.125.0 Memory channels should be scanned in this order. (The top letter on the display flickers).
	3) 144MS SW : ON (430MS SW : ON)	Memory channels 1 through 10 should be scanned in sequential order.
	4) 144MS SW : OFF 430MS SW : OFF	
11. VFO	1) POWER SW : OFF	
	2) POWER SW : ON VFO knob : 145.00	"A 145.00" is displayed.
	3) FUNCTION SW : B	"b 144.00" is displayed.
	4) FUNCTION SW : A-R SEND/REC SW : REC SEND	"A 145.00" is displayed. "b 144.00" is displayed.
	5) FUNCTION SW : B-R SEND/REC SW : REC SEND	"b 144.00" is displayed. "A 145.00" is displayed.
	6) SEND/REC SW : REC FUNCTION SW : A	
12. B.U	1) VFO knob : 145.0125 Connect batteries (1.5V x 3) to terminal BC of the AVR unit.	
	2) POWER SW : OFF (2 sec or more).	
	3) POWER SW : ON	"A 145.0125" is displayed.
13. UP/DOWN	1) MODE SW : FM CH Connect the microphone to the MIC terminal.	
	2) Press the UP button on the microphone several times.	The buzzer sounds and the frequency increases by 12.5kHz every time the button is pressed.
	3) Hold down the UP button on the micro-phone.	The frequency increases continuously.
	4) Press the DOWN button on the microphone several times.	The frequency decreases by 12.5kHz every time the button is pressed.
	5) Hold down the DOWN button on the microphone.	The frequency decreases continuously.
	6) Disconnect the micro-phone from the MIC terminal.	

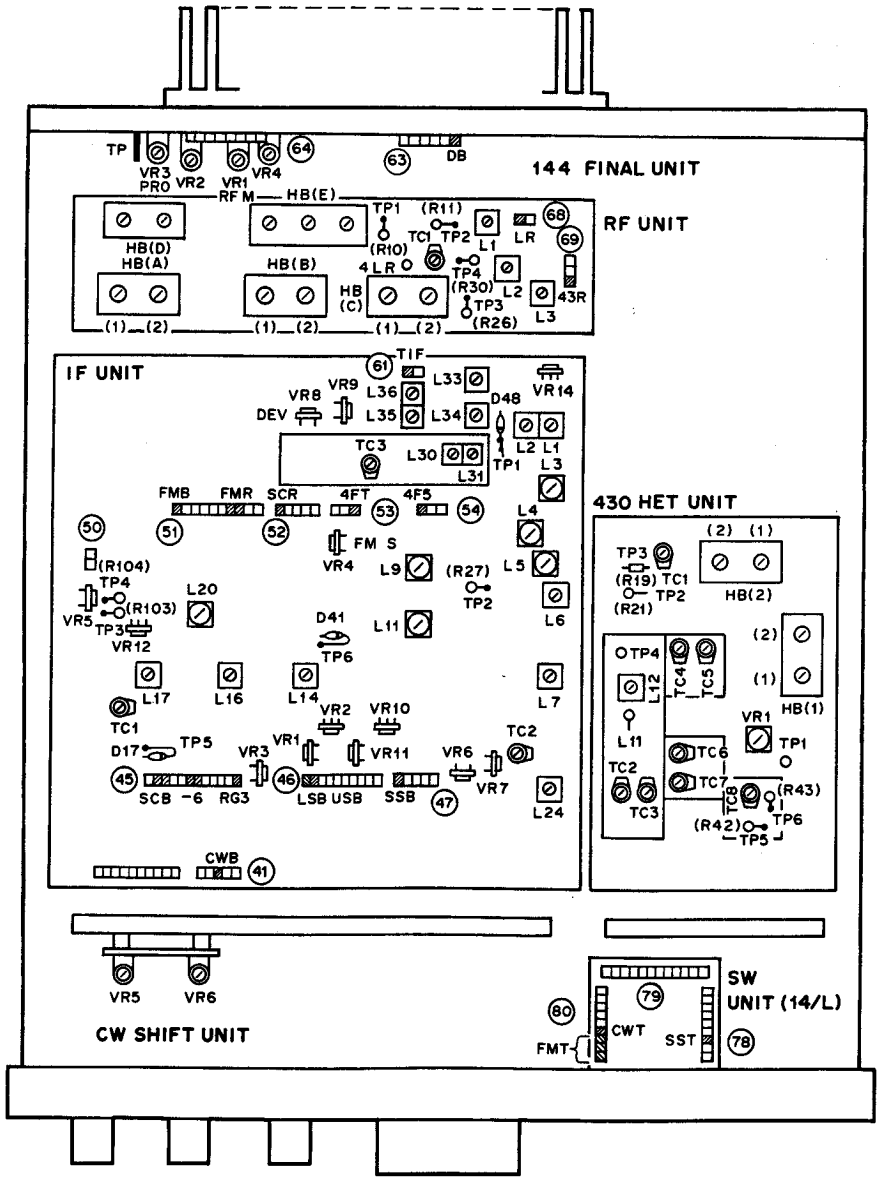
ADJUSTMENT

TOP VIEW



ADJUSTMENT

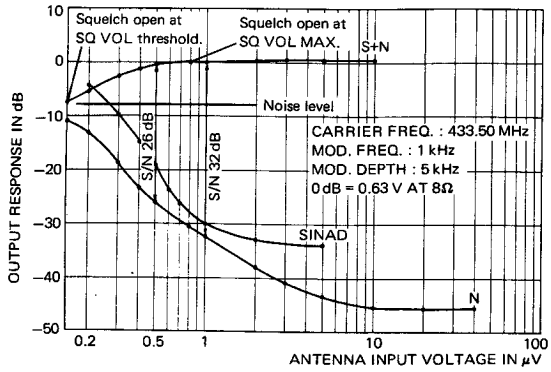
BOTTOM VIEW



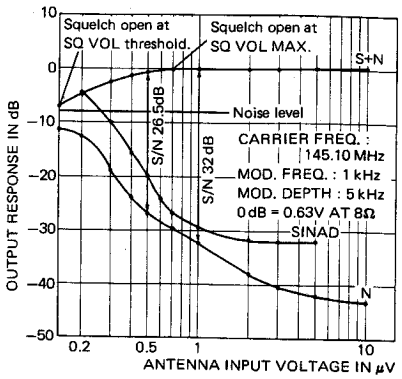
REFERENCE DATA

MODE : FM

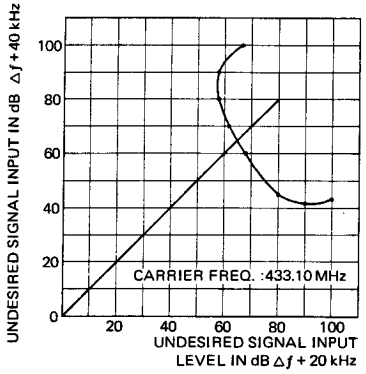
RX SENSITIVITY



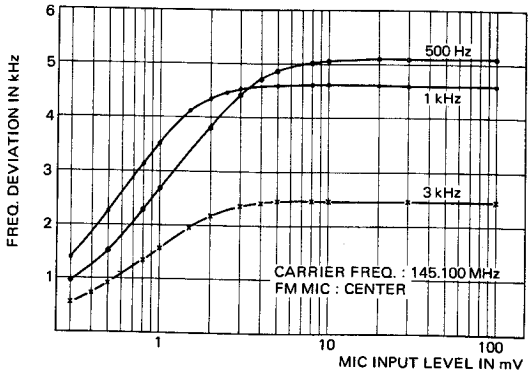
RX SENSITIVITY

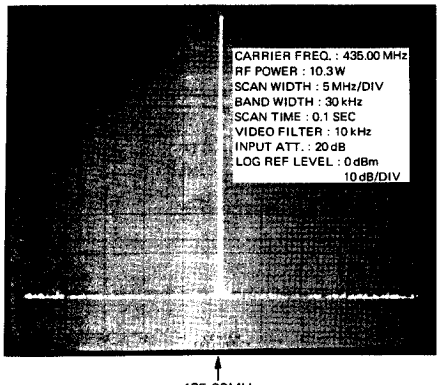


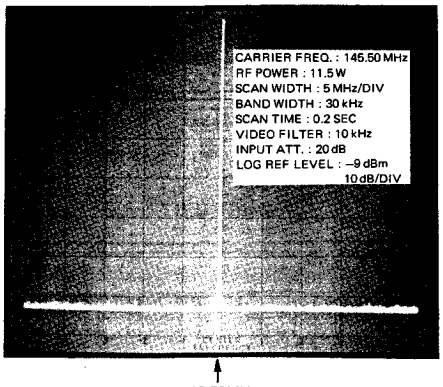
INTER MODULATION



DEVIATION







SPECIFICATIONS

GENERAL

Frequency Range	144.0 ~ 146.0 MHz	
	430.0 ~ 440.0 MHz	
Mode	SSB (USB, LSB), CW, FM	
Antenna impedance	50 Ω (144 MHz, 430 MHz)	
Voltage Requirements	220 V AC, 50/60 Hz	
	13.8 V DC ± 15%	
Power Consumption	Receive (no signal): 45 watts (220 V AC), 1.2 A (13.8 V DC)	
	Transmit: 130 watts (220 V AC), 5 A (13.8 V DC)	
Backup current (Battery)	Less than 10 μA	
Semiconductor Complement	Transistors:	149
	FETs:	35
	ICs:	41
	Diodes:	195
Dimensions	290 (W) × 124 (H) × 322 (D) mm	
	(11"-7/16) × (4"-7/8) × (12"-5/8)	
Weight	10.1 kg (22.2 lbs)	

TRANSMITTER SECTION

RF Power Output	SSB, CW, FM:	10 watts
	FM (LOW):	Approx. 1 watt
Modulation	SSB:	Balanced modulation
	FM:	Variable reactance frequency shift
Maximum frequency deviation (FM)	± 5 kHz	
Carrier Suppression	Better than 40 dB	
Unwanted Sideband Suppression	Better than 40 dB	
Spurious Radiation	Better than − 60 dB	
Microphone Impedance	500 ~ 600 Ω	
AF Response of Transmitter (SSB)	400 ~ 2600 Hz (− 9 dB)	
Repeater Frequency Shift	− 600 kHz or + 600 kHz (144.0 ~ 146.0 MHz)	
	− 7.6 MHz or − 1.6 MHz (430.0 ~ 440.0 MHz)	
RPT Tone Frequency	1750 Hz	

RECEIVER SECTION

Receiver Sensitivity	SSB, CW:	0.2 μV for 10 dB (S + N)/N
	FM:	1 μV for 30 dB (S + N)/N
		0.2 μV for 12 dB SINAD
Intermediate Frequency	1st: 30.865 MHz	
	2nd: 10.695 MHz	
	3rd: 455 kHz (FM only)	
Squelch Sensitivity	0.16 μV (At threshold)	
Audio Output	2.0 watts (with less than 10% distortion) into an 8 ohm load	
Receiver Selectivity	SSB, CW:	2.2 kHz (− 6 dB)
		4.8 kHz (− 60 dB)
	FM:	14 kHz (− 6 dB)
		30 kHz (− 60 dB)

Circuit and ratings are subject to change without notice for improvement.

A product of

TRIO-KENWOOD CORPORATION

17-5, 2-chome, Shibuya, Shibuya-ku, Tokyo 150, Japan

TRIO-KENWOOD COMMUNICATIONS

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

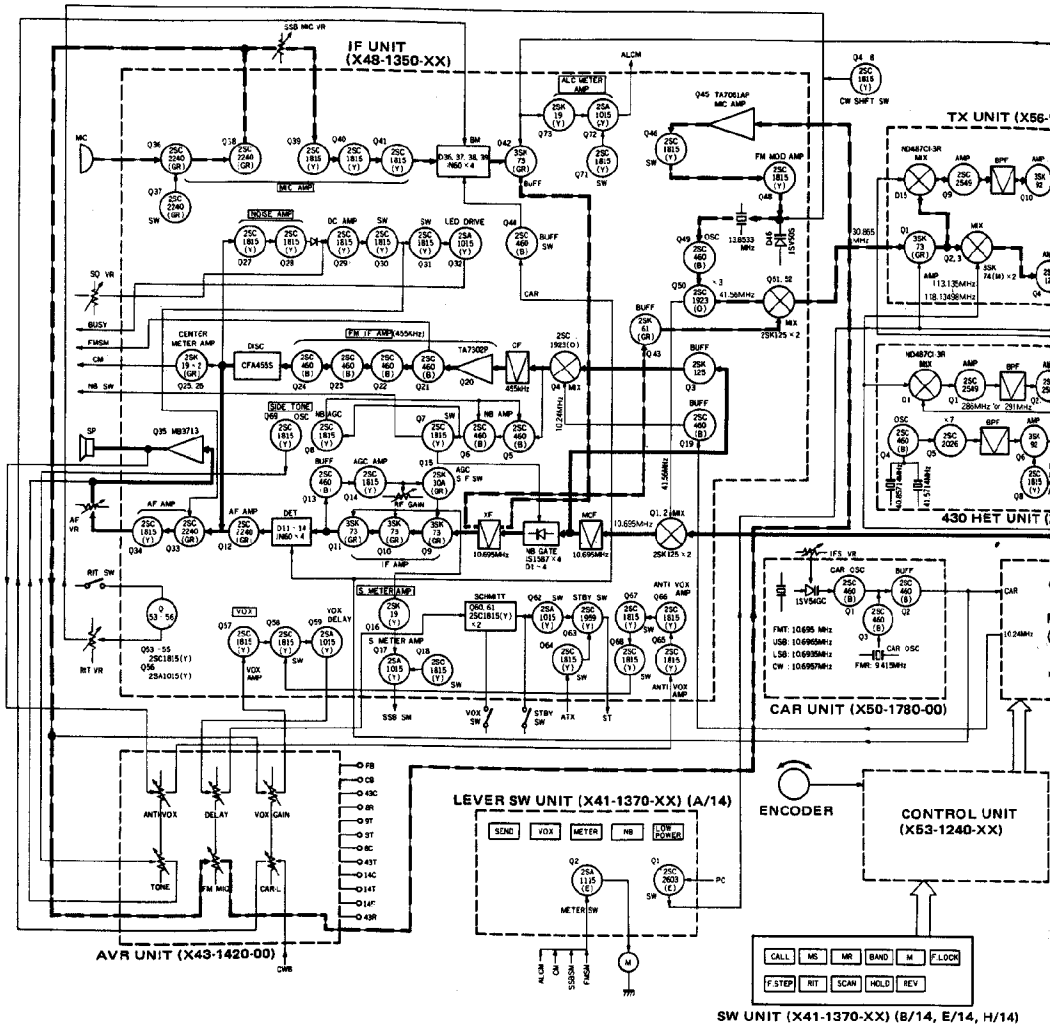
TRIO-KENWOOD COMMUNICATIONS, GmbH

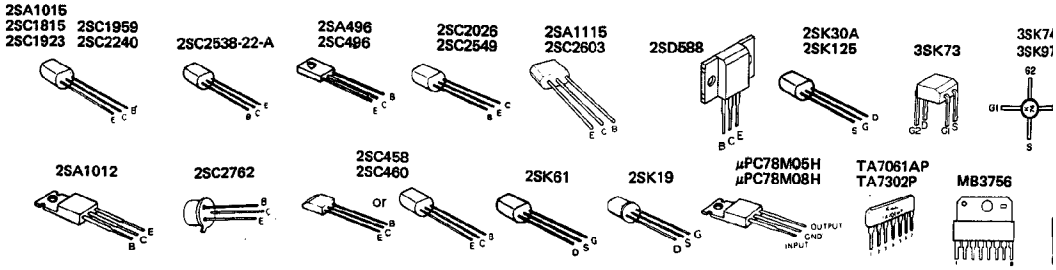
D-6374 Steinbach TS. Industriestrasse 8A. West Germany

TRIO-KENWOOD (AUSTRALIA) PTY. LTD.

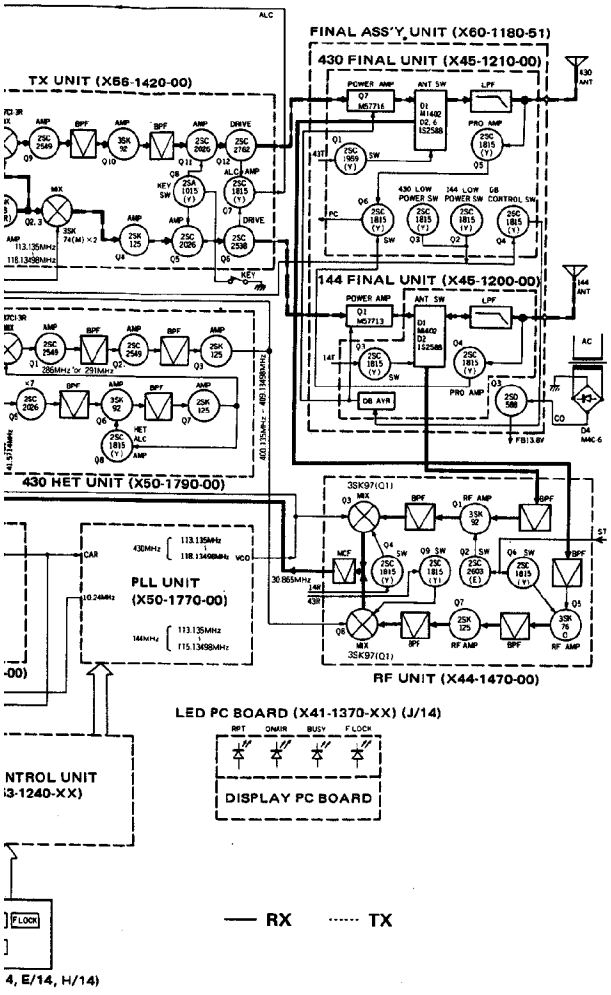
4E Woodcock Place, Lane Cove N.S.W. Australia 2066

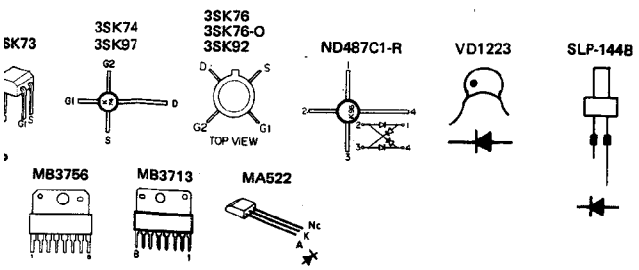
BLOCK DIA


IF UNIT
(X48-1350-XX)
TX UNIT (X56-
430 HET UNIT (
CAR UNIT (X50-1780-00)
LEVER SW UNIT (X41-1370-XX) (A/14)
ENCODER
CONTROL UNIT
(X53-1240-XX)
AVR UNIT (X43-1420-00)
SW UNIT (X41-1370-XX) (B/14, E/14, H/14)


2SA1015
2SC1815 2SC1959
2SC1923 2SC2240
2SC2538-22-A
2SA496
2SC496
2SC2026
2SC2549
2SA1115
2SC2603
2SD588
2SK30A
2SK125
3SK73
2SA1012
2SC2762
2SC458
2SC460
or
2SK61
2SK19
µPC78M05H
µPC78M08H
TA7061AP
TA7302P
MB3756

LOCK DIAGRAM/SP-71





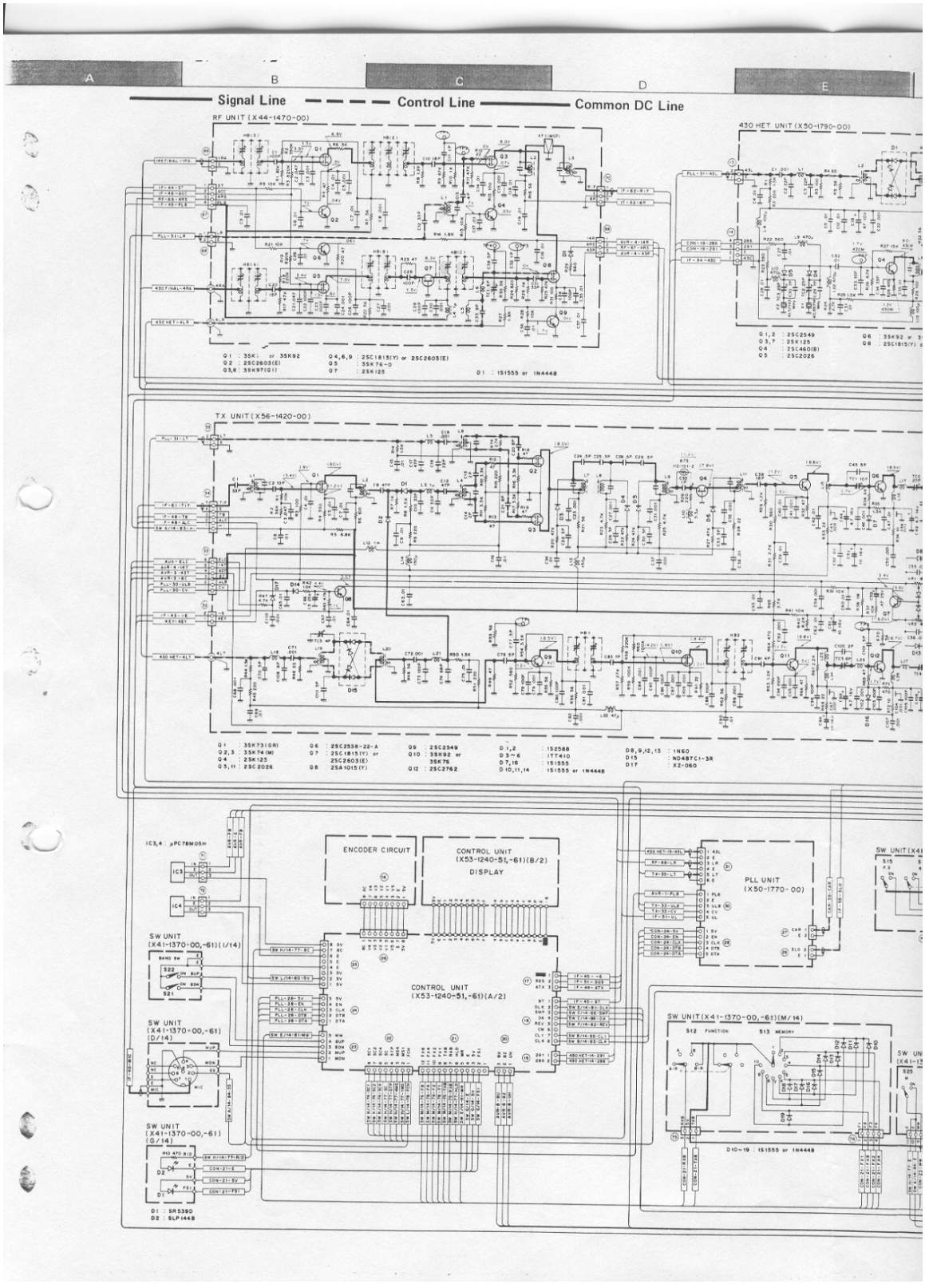
SP-71 SPECIFICATIONS

Speaker:	4.75" (12 cm)
Rated Input:	2.0 Watts
Impedance:	8 ohms
Frequency Range:	300 Hz to 5 kHz
Dimensions:	6.3" (160) (W) x 4.8" (123) (H) x 7.9" (200) (D) (mm)
Weight:	2.8 lbs (1.25 kg)

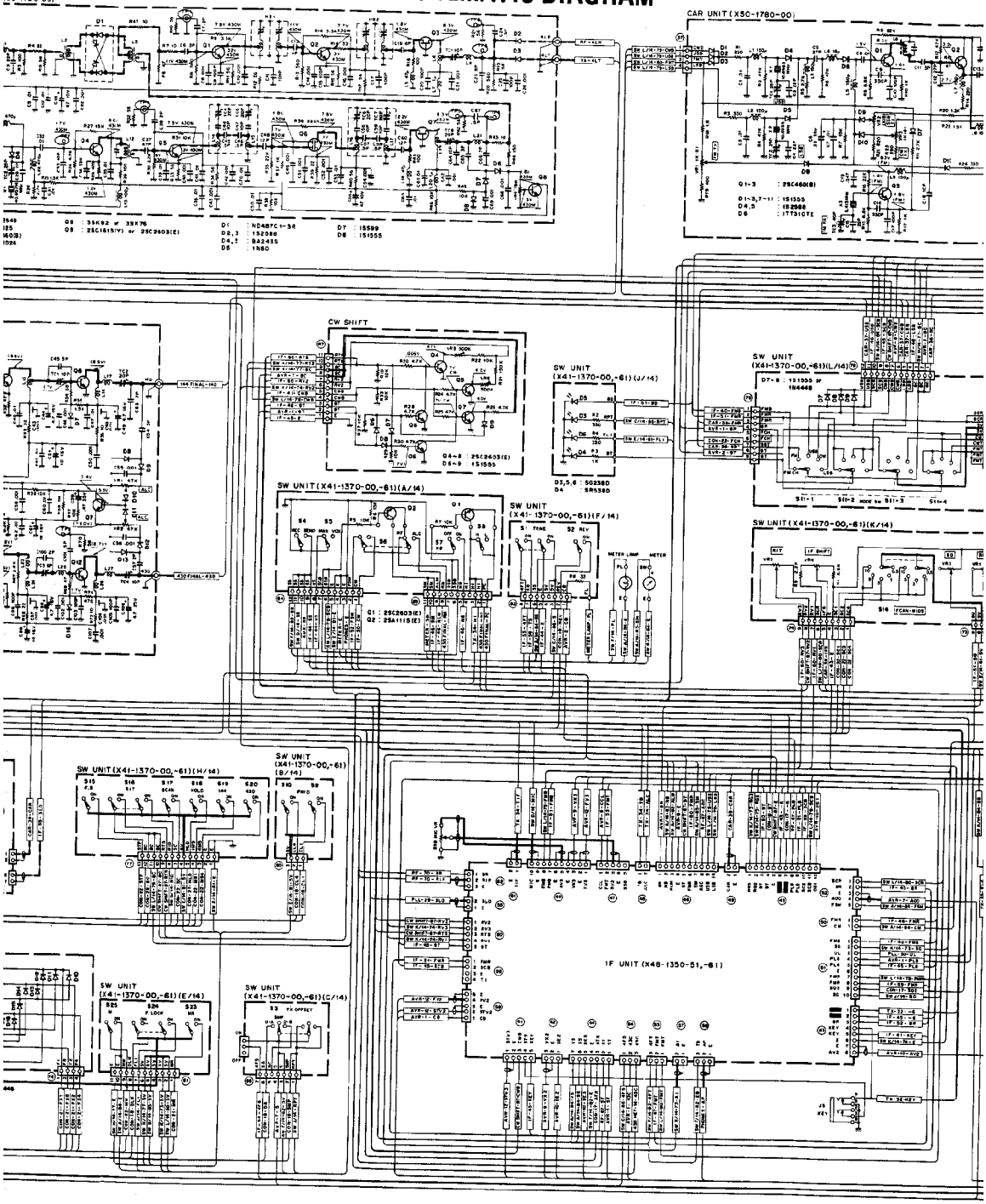
PARTS LIST

N : New parts

Parts No.	Remarks	Description	Ref. No.
A01-0915-03	N	Case (A) upper	
A01-0916-03	N	Case (B) lower	
A21-0744-03	N	Ornamental panel	
B01-0644-03	N	Panel escurcheon x 2	
B05-0702-04		Grill cloth	
B43-0668-04	N	Name plate	
B50-3931-00	N	Operating manual	
E12-0001-05		Phone plug	
E20-0208-04		Terminal board	
E29-0005-04		Y lug x 2	
H01-2782-04	N	Carton case (inside)	
H12-0402-04		Cushion x 2	
H20-0274-13		Protective cover	
H25-0049-03		Protective bag	
J01-0025-04		Assistant foot	
J02-0049-14		Foot x 4	
N15-1040-46		Flat washer x 4	
N30-4006-45		Round screw	
N30-4010-11		Round screw x 4	
N30-4024-46		Round screw x 2	
N32-3006-46		Flat screw x 6	
N35-3006-45		Bind screw x 14	
N61-3516-41			
N87-3006-41		Self tapping screw x 2	
T06-0011-05		Speaker	

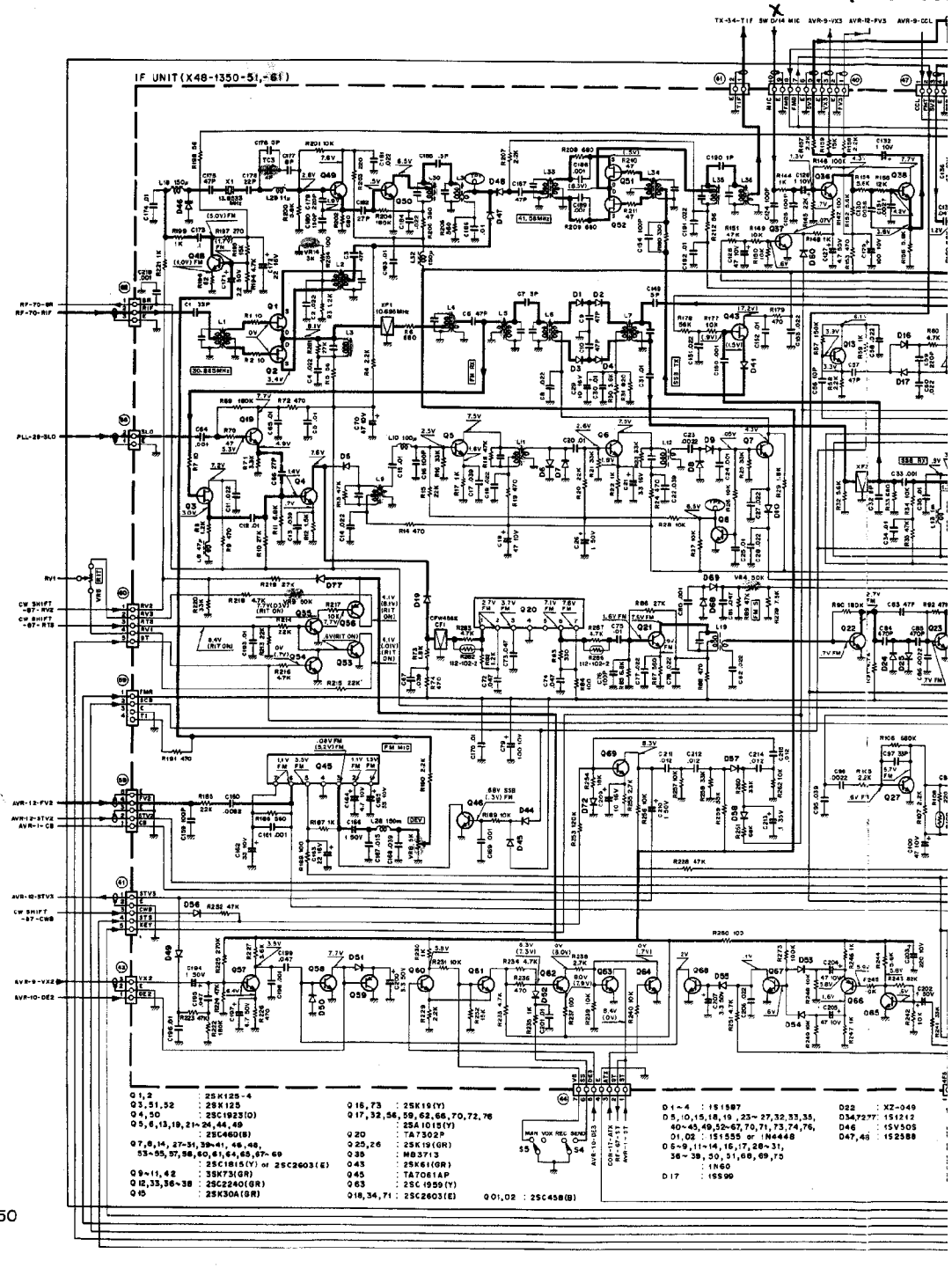

A
B
C
D
E
Signal Line
Control Line
Common DC Line
RF UNIT (X44-1470-00)
430 HET UNIT (X50-1790-00)
TX UNIT (X56-1420-00)
ENCODER CIRCUIT
CONTROL UNIT (X53-1240-51,-61)(B/2) DISPLAY
CONTROL UNIT (X53-1240-51,-61)(A/2)
PLL UNIT (X50-1770-00)
SW UNIT (X41-1370-00,-61)(I/14)
SW UNIT (X41-1370-00,-61) (D/14)
SW UNIT (X41-1370-00,-61) (G/14)
SW UNIT (X41-1370-00,-61)(M/14)
IC3,4 : μPC78M05H
D1 : SR539D
D2 : SLP144B
D10~19 : 1S1555 or 1N4448

SCHEMATIC DIAGRAM



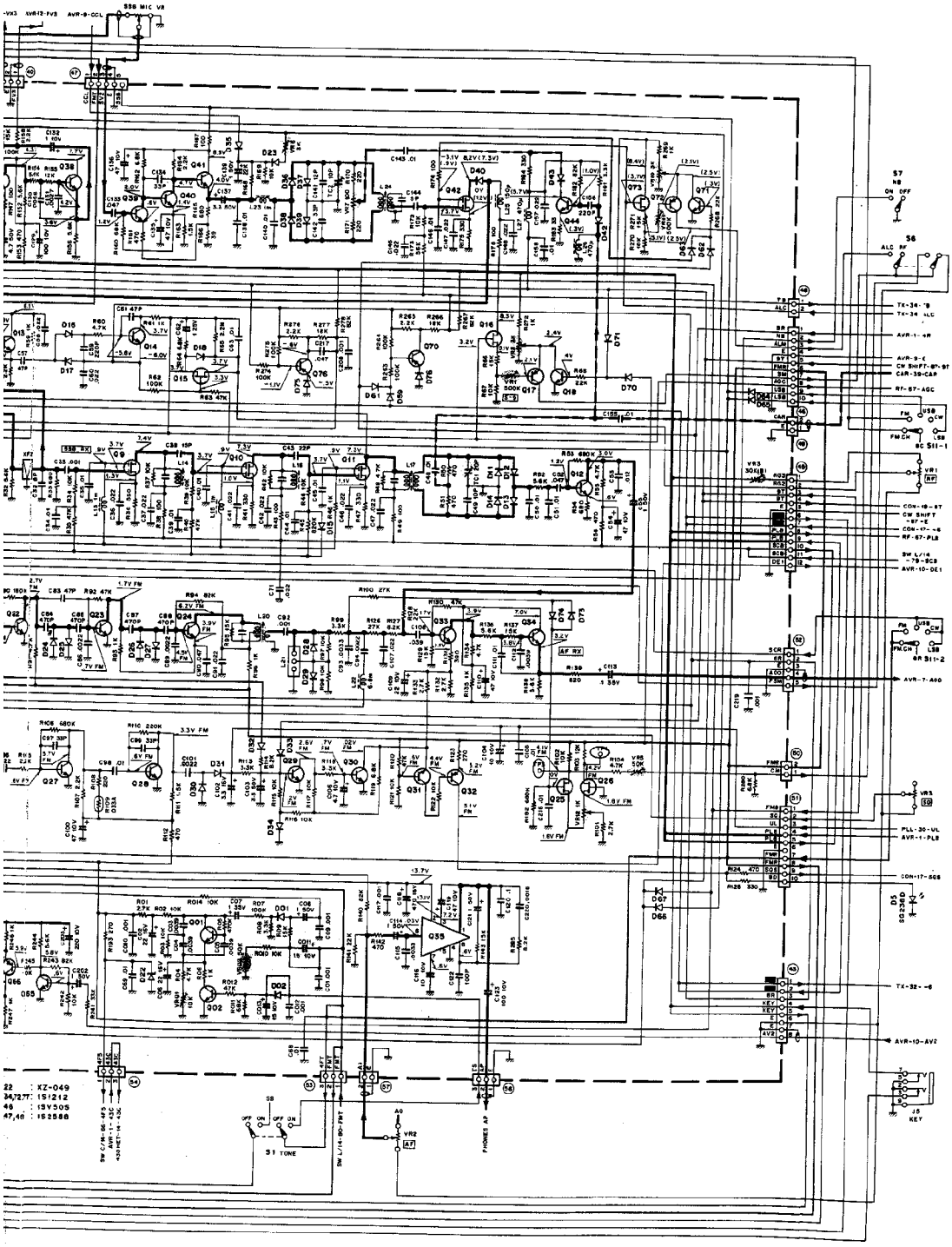
Signal Line — Control Line — Common DC Line

IF UNIT (X48-135



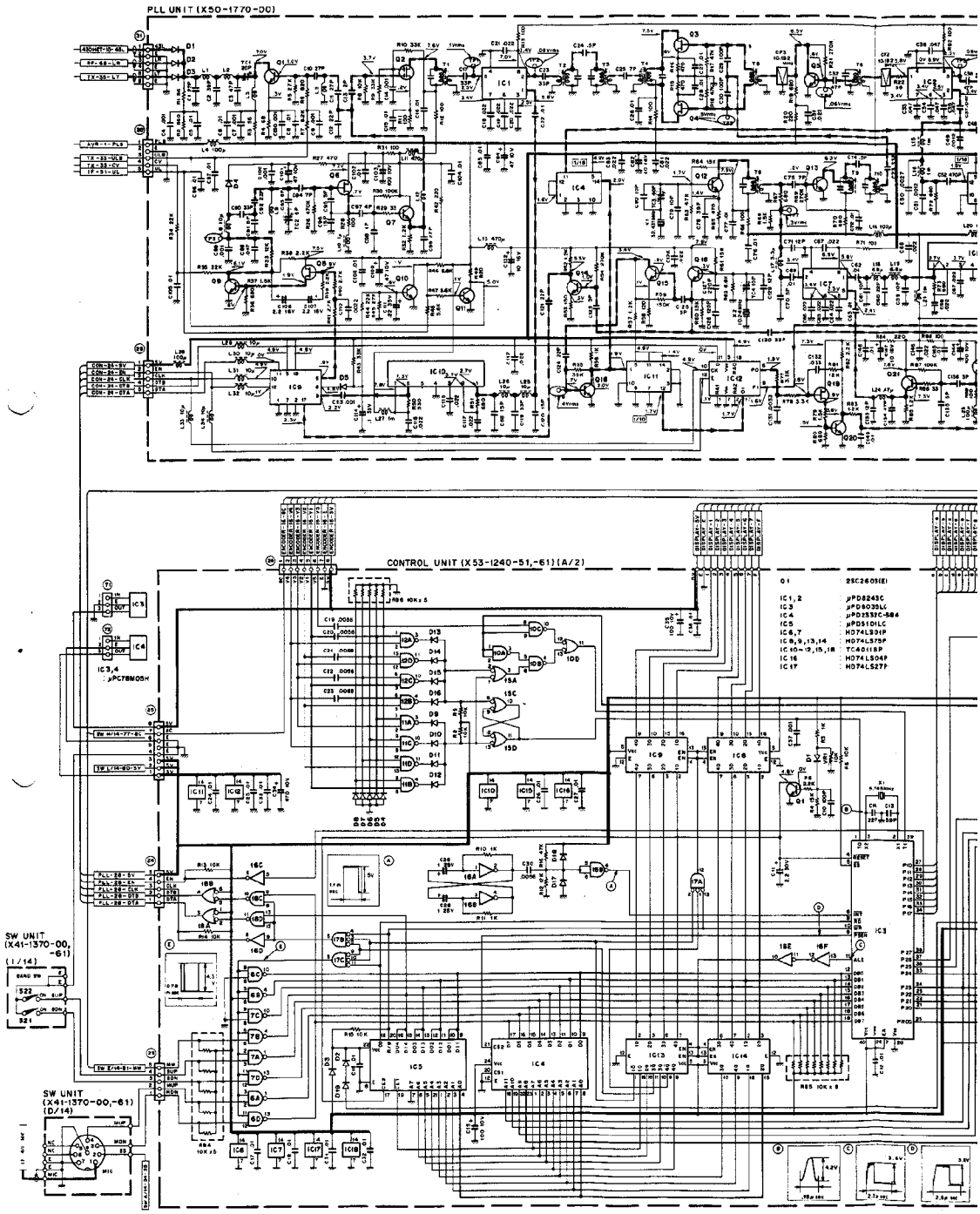
F G H I J K

T (X48-1350-XX)



Signal Line — — — Control Line ——— Common DC Line

CONTROL, PLL AND EN



F G H I J

AND ENCODER