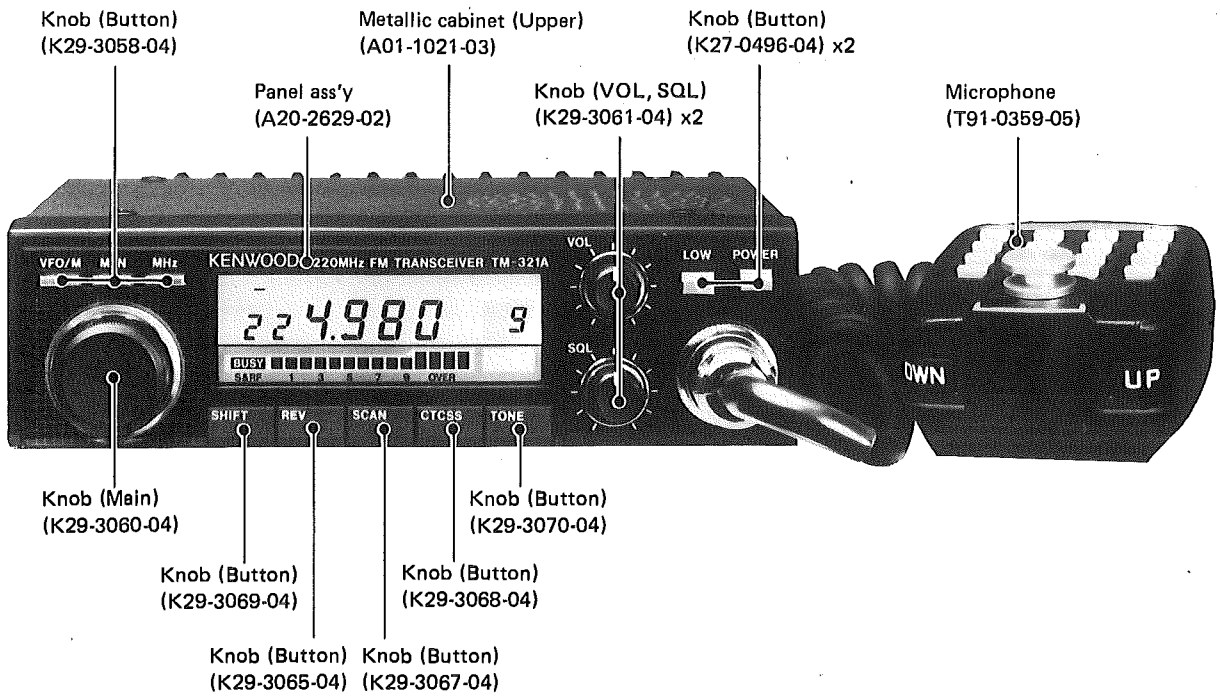
220MHz FM TRANSCEIVER

TM-321A

SERVICE MANUAL

KENWOOD

B51-3305-00 (O) 1196



CONTENTS

CIRCUIT DESCRIPTION

Frequency configuration

The TM-321A utilizes PLL synthesizer system incorporating a digital VFO (See **Fig. 1**.). The channel step can be selected as 5, 10, 15, 20, or 25kHz.

The receiver operates as a double conversion system. Received signals are mixed with the first local oscillator (189.175 ~ 194.170MHz) to produce the first intermediate frequency of 30.825MHz. The first intermediate frequency is mixed with the second local oscillator (30.370MHz) to produce the second intermediate frequency of 455kHz.

The transmitter system consists of a PLL circuit incorporating a direct oscillator and direct divider. The output is amplified by a linear amplifier prior to being transmission.

Receiver system

● **General**

Incoming signals from the antenna pass through a low-pass filter in the Transmitter Final unit and a diode transmit/receive switch, then enter the receiver front end.

After passing through two antenna coils the signals are amplified by a GaAs (galium arsenide) FET (Q1 : 3SK184 (S)). Undesired signals are removed by a 3-pole helical resonator (L3). The resulting signal is applied to the first mixer Q2 : 3SK131(V12), which employs an N channel MOS FET to obtain good 2-signal characteristics. In the first mixer (Q2) the signal is mixed with the first local oscillator from the PLL system to produce the first IF signal of 30.825MHz. Interfering Adjacent channel interference is removed from the first IF signal by a two-stage monolithic crystal filter (MCF) (L6).

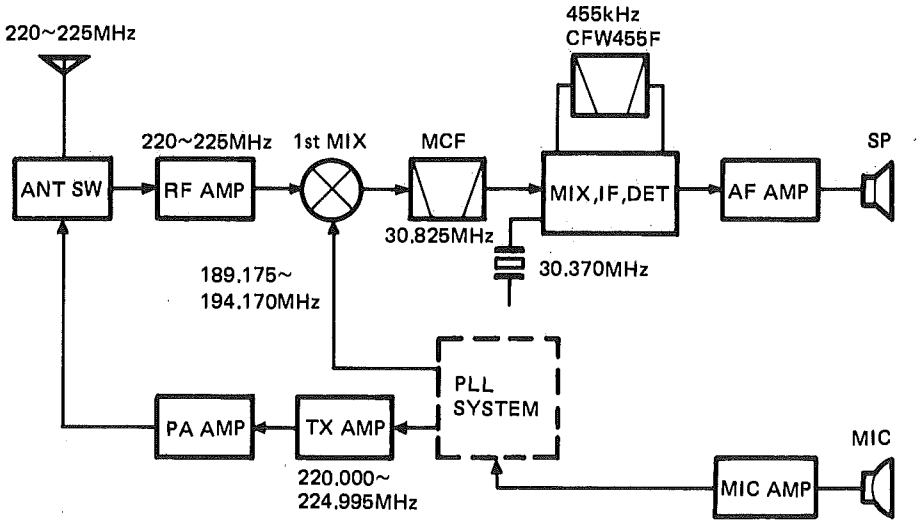


Fig. 1 Frequency configuration

CIRCUIT DESCRIPTION

The first IF signal is amplified by Q3 : 2SC2714(Y) and fed to a special narrow-FM IC (TA7761F). Here the signal is mixed with the 30.370MHz frequency from the second local oscillator to produce the 455kHz second IF signal. This signal is sharpened by passing it through a six-element ceramic filter (CFW455F). The signal is then amplified by a five-stage limiting amplifier contained in IC1. This is followed by quadrature detection which is also performed by IC1. Undesirable high-frequency components are removed from the detected signal by an active low-pass filter. The signal then passes through the audio volume control, then is amplified by the audio power amplifier (IC4), and applied to the speaker. The circuit configuration from detection onward is shown in **Fig. 2**.

- **Squelch circuit**

The noise component extracted from the detector output is filtered to remove the second intermediate frequency component (455kHz), amplified twice, and is then fed to the rectifier. After rectification, the signal passes through the squelch control to the audio limiter circuit.

- **S-meter circuit**

The S-meter output voltage of the special narrow-FM IC (TA7761F) is amplified by an inverting amplifier, then fed to the Control unit. The microprocessor converts the analog voltage to a digital signal that is used to control the LCD bar meter.

Item	Rating
Nominal center frequency (fo)	30.825MHz
Pass bandwidth	±7.5kHz or more at 3dB
Attenuation bandwidth	±28kHz or less at 40dB
Guaranteed attenuation	60dB or more within ±1MHz 40dB or more squrious
Ripple	1.5dB or less
Insertion loss	3dB or less
Terminating impedance	1.4kΩ/1PF

Table 1 MCF (L71-0270-05) characteristics (TX-RX unit L6)

Item	Rating
Nominal center frequency	455kHz±1kHz
6dB bandwidth	±6kHz or more (from 455kHz)
50dB bandwidth	±12.5kHz or less (from 455kHz)
Ripple (within 455±4kHz)	3dB or less
Insertion loss	6dB or less
Guaranteed attenuation (within 455±100kHz)	35dB or less
I/O impedance	2.0kΩ

Table 2 Ceramic filter CFW455F (L72-0315-05) characteristics (TX-RX unit L10)

CIRCUIT DESCRIPTION

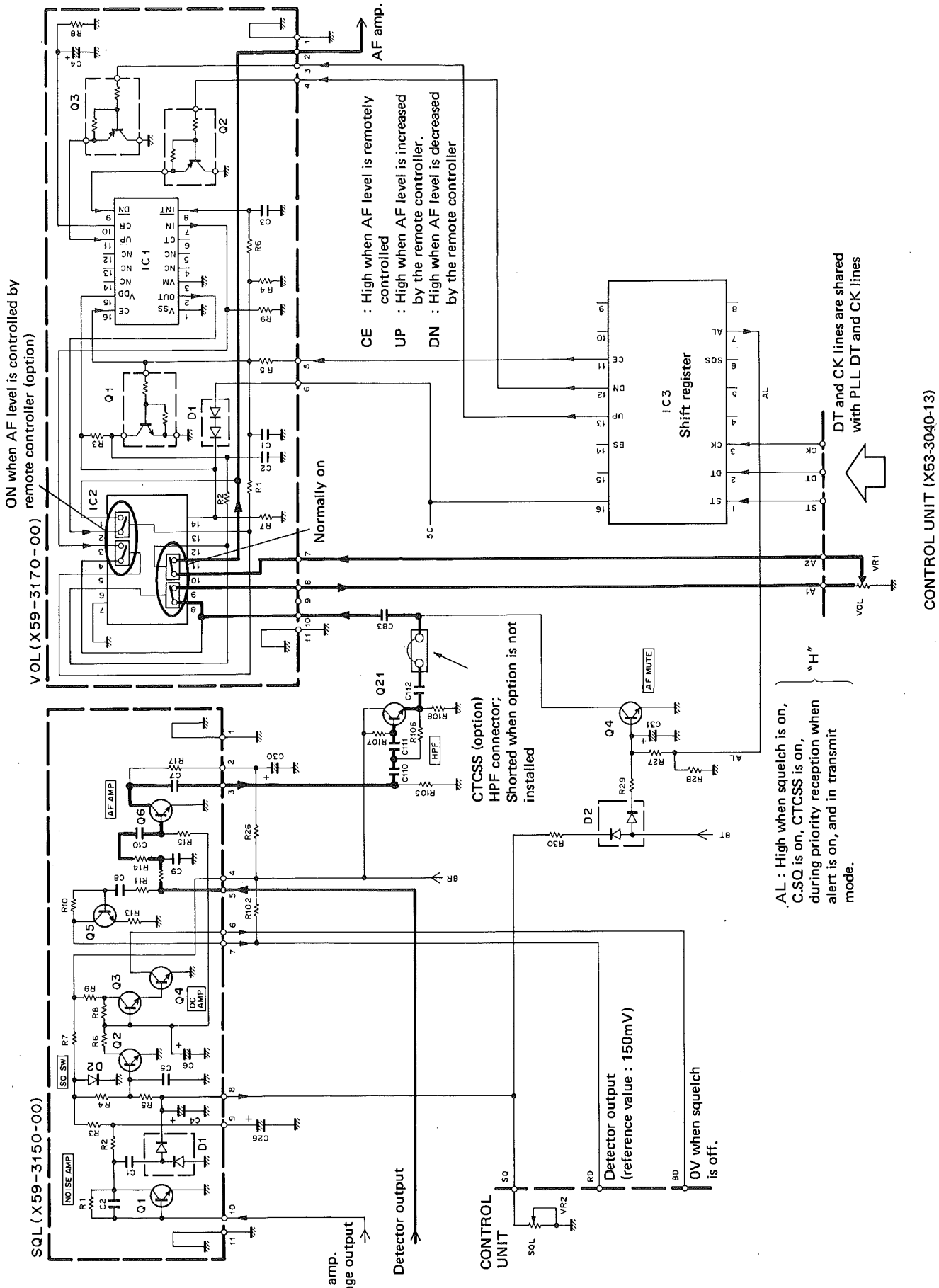


Fig. 2 Circuits from detector output onward

CIRCUIT DESCRIPTION

Transmitter system

- **General**

In the transmitter system the desired frequency is produced directly by an oscillator. Frequency modulation is obtained directly thru the use of a varactor diode.

- **Modulation circuit**

Audio signals from the microphone are applied to a three-stage operational amplifier which adds preemphasis, performs amplification and limiting, and includes a splatter filter to remove undesired high-frequency components. After amplification by the operational amplifier, part of the audio signal is applied to the microphone check circuit used in the low-power mode.

In the FM modulation circuit, the frequency of the VCO is directly modulated by a varactor diode.

- **Preamplifier stage circuit**

The output from the VCO enters the linear amplifier, which is capable of high-quality signal amplification because it operates entirely in linear mode. APC, (Automatic Power Control) is performed by controlling the collector voltage of the 3 stage final preamplifier stage.

- **Power amplifier circuit**

The drive signal is applied to the power module and amplified to the required level. In the model TM-321A heat is dissipated efficiently by a large mechanically strong heatsink.

- **APC and SWR protection circuits**

Fig. 3 shows the basic ALC (Automatic Level Control) and SWR (Standing Wave Ratio) protection circuits. The SWR protection circuit incorporates a CM coupler that detects any reflected power caused by mismatching of the antenna. After detection and amplification, this circuit acts to lower the output control voltage, which protects the power module by reducing the gain. The automatic power control (APC) circuit incorporates a diode that is used to detect a portion of the output from the power module. The detected signal is amplified and is then used to control the power control voltage. The control voltage is inversely proportional to the output, so a constant output level is maintained.

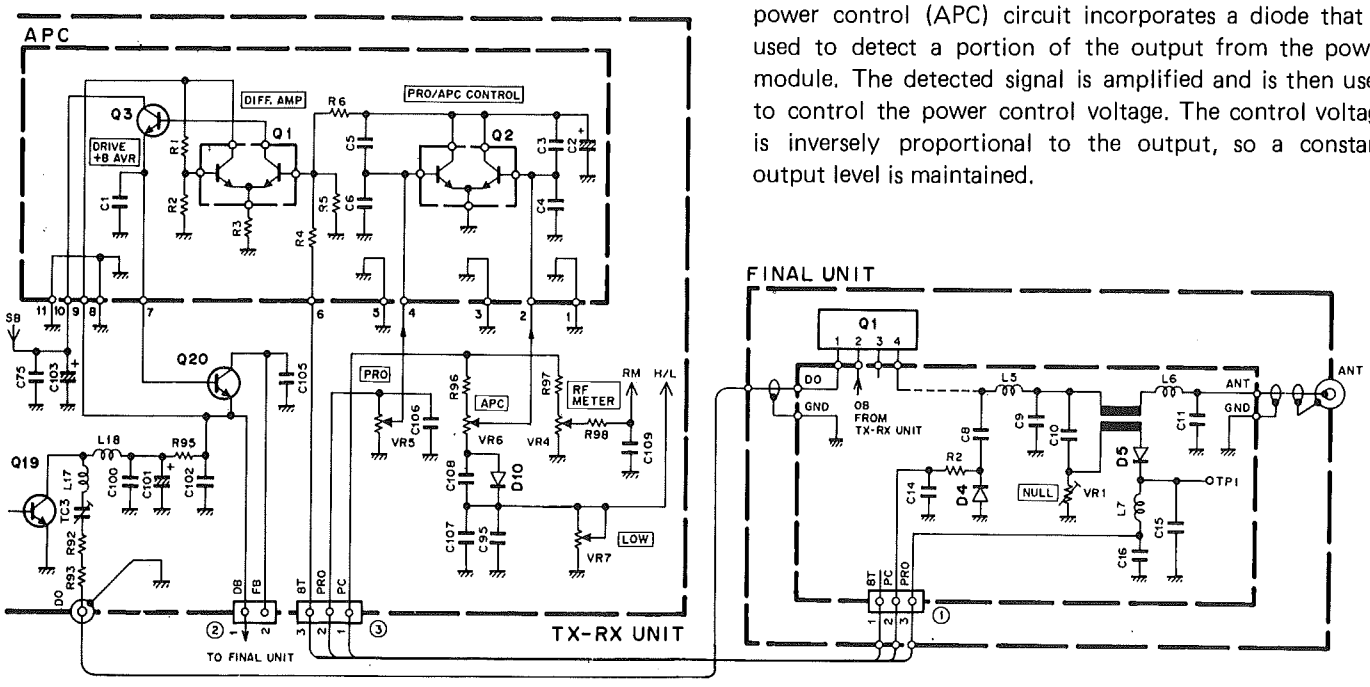


Fig. 3 APC and SWR protection circuits

Item	Symbol	TC (°C)	Unit	Condition	Specifications M57774
Operating voltage	Vcc	25	V		17
Current consumption	Icc	25	A		7
Input power	pin	25	W	$Z_G=Z_L=50\Omega$	0.6($Vcc_1 \leqq 12.5V$)
Output power	Po	25	W	$Z_G=Z_L=50\Omega$	40
Case temperature (operating)	Tc(op)		°C		−30~+110
Storage temperature	Tstg		°C		−40~+110

Table 3 Power module M57774 absolute maximum ratings (Final unit Q1)

CIRCUIT DESCRIPTION

PLL synthesizer

Fig. 4 is the PLL system block diagram. The transmitter and receiver systems of the TM-321A has independent VCOs and PLLs, but share a common low-pass filter.

The VCOs are configured as subunits. This construction minimizes outside influence and improves frequency stability.

To provide 5, 10, 15, 20, and 25kHz steps, a comparison frequency of 5kHz is obtained by dividing the 12.8 MHz frequency of the reference oscillator by 2560. In both the transmitter and receiver systems the target frequency is produced directly by the VCO, passed through one amplifier stage, then applied to a pulse-swallow PLL IC that divides the frequency, performs phase comparison, and locks the frequency.

The reference frequency division ratios (four values) and comparison frequency divison ratio are supplied to the PLL IC (M54959P) as external serial data. An internal dual-modulus (1/128 and 1/129) prescaler enables the entire pulse-swallow PLL circuit to be implemented on a single chip. (See **Fig. 5**.) The switching functions (SW1 and SW2) of the PLL IC are used to switch between the 8R (receive) and 8T (transmit) operating voltages in the transmit and receive modes.

The switch controls are applied together with frequency division ratio data from the Control unit.

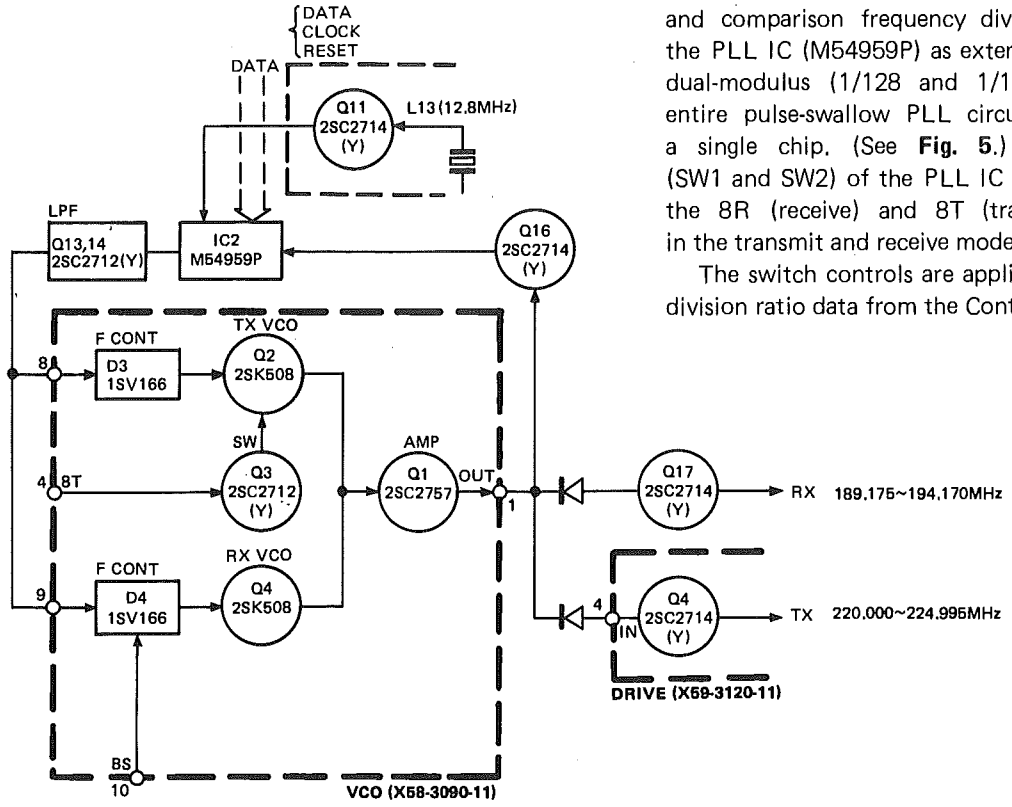


Fig. 4 PLL system block diagram

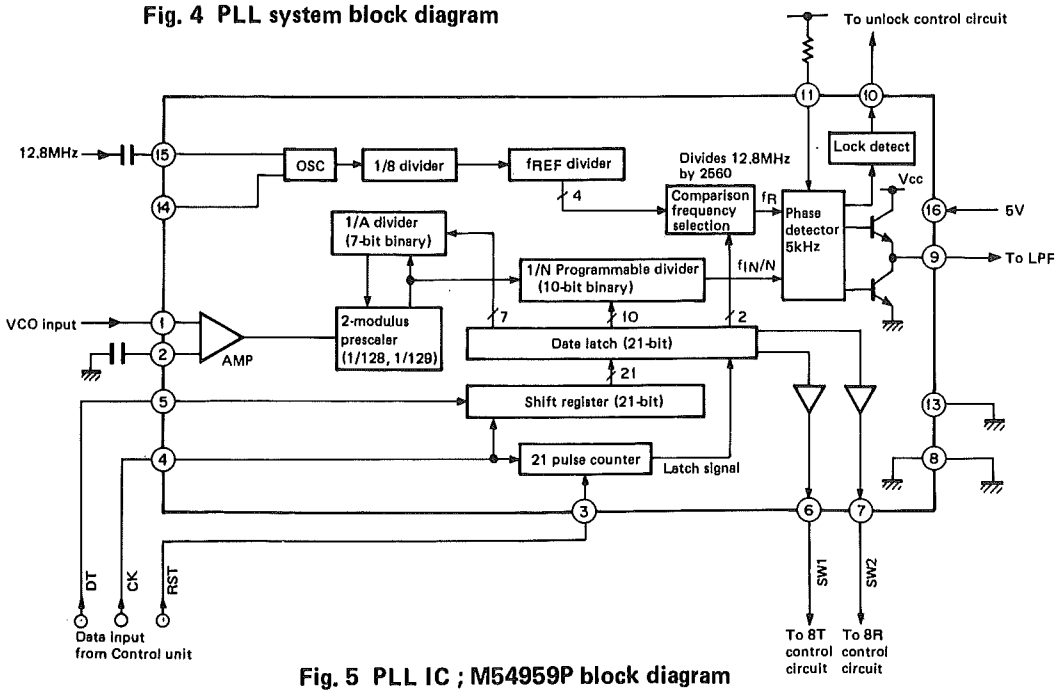


Fig. 5 PLL IC ; M54959P block diagram

CIRCUIT DESCRIPTION

At 220MHz, f_{VCO} (RX) has the following relationship to the various frequency division ratios :

$f_{VCO}=(220-30.825)=[(n \times 128)+A] \times fosc/R$

where, f_{VCO} : Frequency output by the VCO
n : 10-bit binary programmable counter setting
A : 7-bit binary programmable counter setting
fosc : 12.8MHz reference oscillator
R : 14-bit binary programmable counter setting (2560)

If n = 295 and A = 75, then ;

$f_{VCO}= [(295 \times 128)+75] \times 12800/2560$
$=[37760+75] \times 5$
$=189175kHz=189.175MHz$

- **Unlock detector circuit**

Whenever the PLL is unlocked, pin 10 of the PLL IC goes high ("H") (5.5V), turning off Q15 so that Q1 and Q2 in the module unit (drive unit) turn OFF. The result is that during receive Q17 is OFF, and during transmit Q4 and Q5 in the module unit are OFF. This halts transmit, preventing unwanted radiation from the antenna. (See **Fig. 6**.)

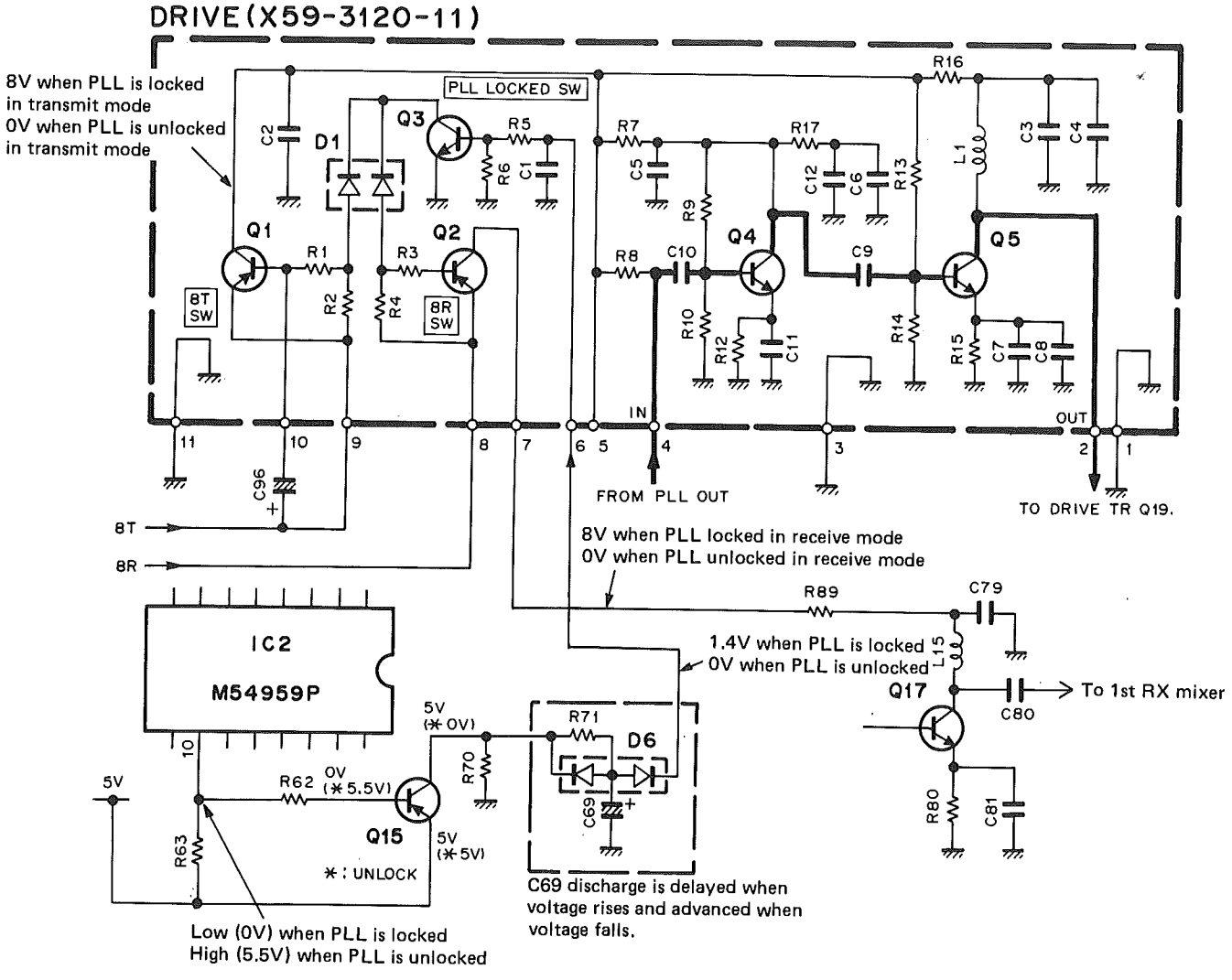


Fig. 6 PLL unlock detector circuit

CIRCUIT DESCRIPTION

Digital control unit

- **General**

The control unit consists of a microprocessor, input keys, peripheral circuits, and a display. The single microprocessor (IC3) controls all transceiver functions. The pin assignments of the microprocessor are listed on the **Table 4.**

- **Keys and rotary encoder input circuits**

Fig. 7 shows the input circuit for the keys and rotary encoder. Data from the front panel keys, microphone keys, and rotary encoder are applied directly to the microprocessor.

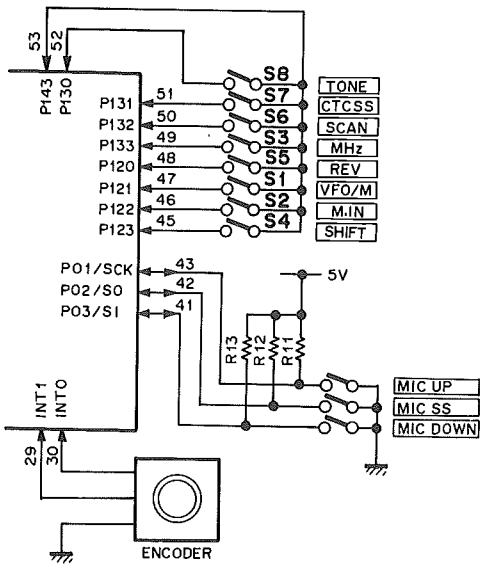


Fig. 7 Key and rotary encoder input circuits

Terminal No.	Name	I/O	Logic	Function
1	P41	O	–	Digital output of D-A conv.
2	P40	O	–	
3	P53	O	–	
4	P52	O	–	
5	P51	O	–	
6	P50	O	–	
7	$\overline{\text{RESET}}$	I	L	Reset input.
8	X2	–	–	4.194304MHz crystal oscillator.
9	X1	–	–	
10	P63	–	–	Not used.
11	P62	–	–	
12	P61	O	⌐	CTCSS shift register reset
13	P60	I	L	
14	P73	O	–	LCD driver data.
15	P72	O	⌐	LCD driver clock.
16	P71	O	H	LCD driver enable.
17	P70	–	–	Not used.
18	P83	I	L	Directional input.
19	P82	I	L	
20	P81	I	L	
21	P80	I	L	
22	P93	O	–	Not used.
23	P92	O	⌐	PLL and shift register clock.
24	P91	O	–	PLL and shift register data.
25	P90	O	L	PLL enable.
26	Vss	–	–	GND terminal (0V).
27	P13	I	L	BUSY input.
28	INT2	I	–	Encoder input.
29	INT1	I	–	
30	INT0	I	H	Remote connection detect input (only when connected).
31	PTH03	I	–	Not used.
32	PTH02	I	–	
33	PTH01	I	–	RF meter analog input.
34	PTH00	I	–	S meter analog input.
35	TI1	–	–	Not used.
36	TI0	–	–	
37	P23	O	–	
38	P22	O	H	Squelch control during remote control.
39	P21	O	H	Shift register strobe.
40	PT00	O	–	Beep oscillator output.
41	P03/SI	I/I	L/–	Microphone DOWN switch input/ serial data input.
42	P02/SO	I/O	L/–	Microphone PTT switch input/ serial data input.
43	P01/$\overline{\text{SCK}}$	I/–	L/–	Microphone UP switch input/ serial data input.
44	INT4	I	–	Backup detect input.
45	P123	I	L	SHIFT switch input.
46	P122	I	L	M.IN switch input.
47	P121	I	L	VFO/M select switch input.
48	P120	I	L	REV switch input.
49	P133	I	L	Frequency step select switch input.
50	P132	I	L	SCAN switch input.
51	P131	I	L	CTCSS switch input.
52	P130	I	L	TONE switch input.
53	P143	O	–	Pull-down pin.
54	P142	O	–	Not used.
55	P141	O	–	
56	P140	O	–	
57	NC	–	–	
58	VDD	–	–	Power supply pin (5V).
59	P33	–	–	GND terminal (0V).
60	P32	I	H	Tone detect input (when CTCSS is on
61	P31	O	–	CTCSS IC data
62	P30	O	⌐	CTCSS IC clock.
63	P43	O	–	DAC digital data output.
64	P42	O	–	

Table 4 μPD75106G-508-1B pin assignments (Control unit IC3)

CIRCUIT DESCRIPTION

● Display circuit

Located in the LCD assembly (**Fig. 8**), the display circuit consists of the LCD driver, its peripheral circuits, and the LCD. The LCD is driven with a 50% duty cycle according to serial data sent from pins P71 to P73 of the microprocessor to the LCD driver. **Fig. 9** shows the common output and segment output signals of the LCD driver.

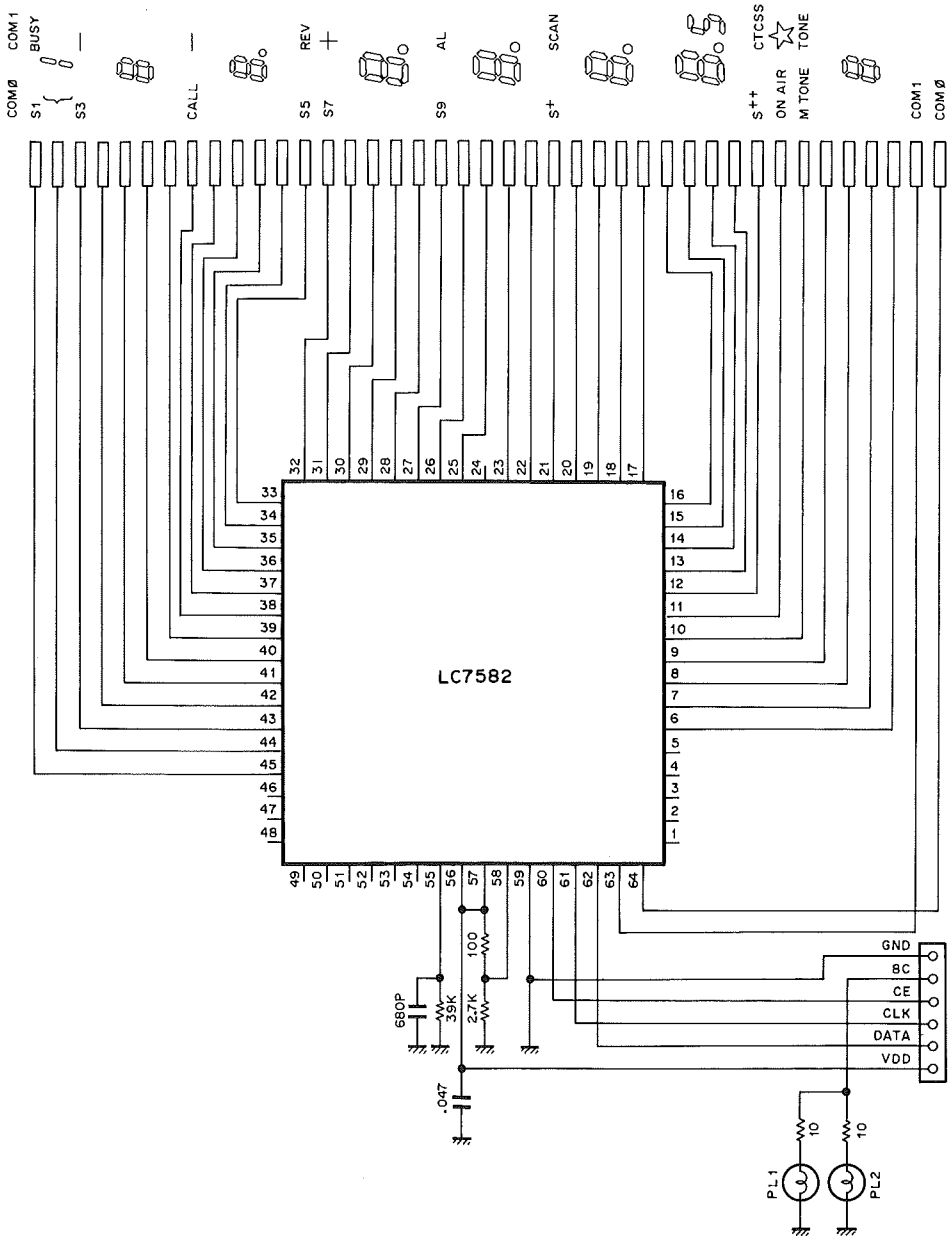


Fig. 8 LCD ass'y (B38-0303-05)

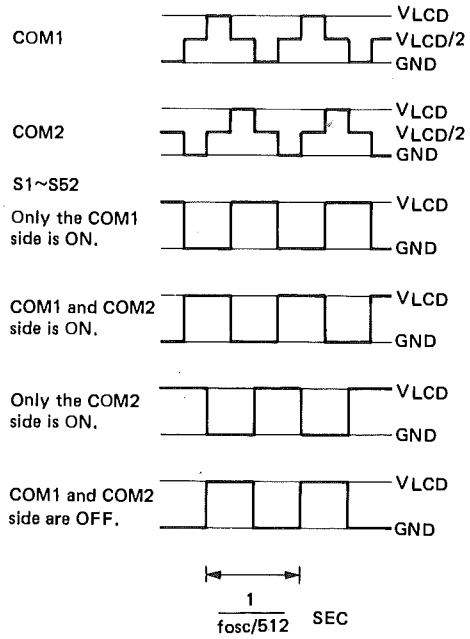
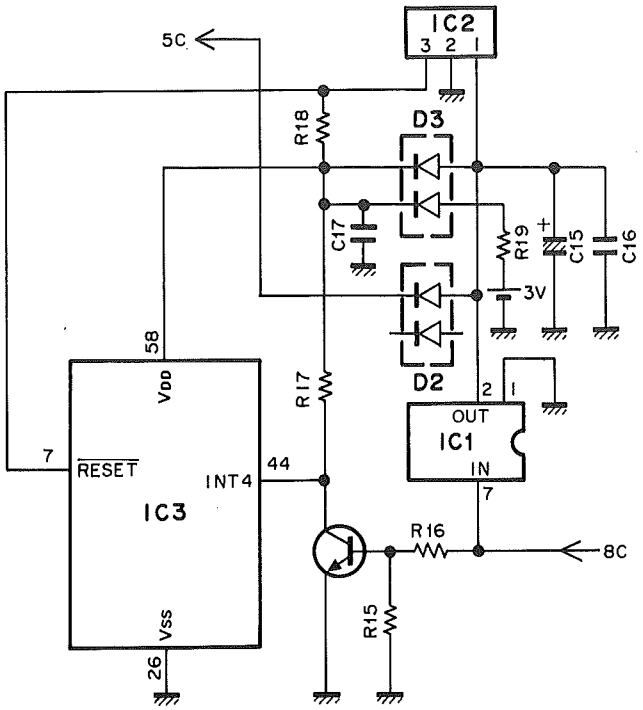


Fig. 9 LCD driver common and segment output signals

CIRCUIT DESCRIPTION

● Reset backup circuit

Fig. 10 shows the reset backup circuit. When the transceiver is turned ON, 3.0V is applied at the INT4 pin causing IC3 to enter the backup mode.



IC2 timing chart

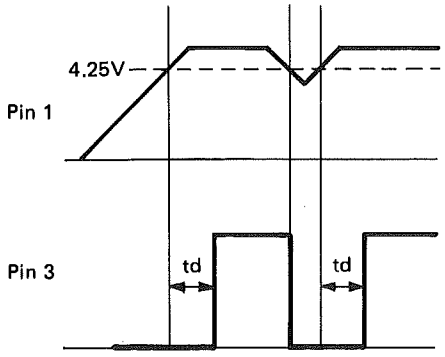


Fig. 10 Reset and backup circuit

● PLL data output

PLL data is supplied from pins P92 (CK), P91 (DT), and P90 (RST) of the microprocessor. **Fig. 11** shows the data transfer format. **Fig. 12** shows the data configuration.

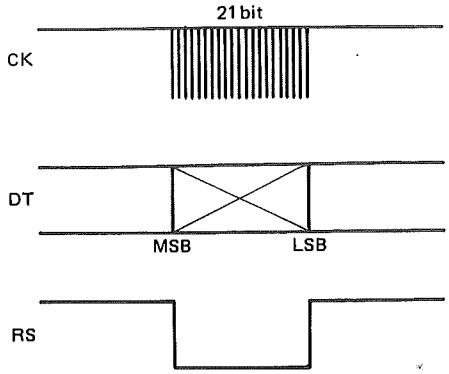
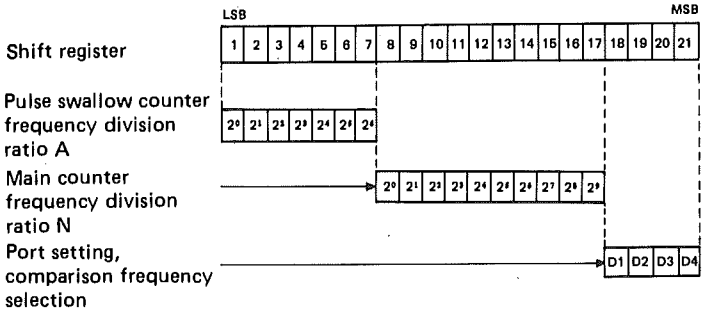


Fig. 11 PLL data transfer format



The 21-bit data is converted by the procedure below.

1. Frequency division ratio data A, N (17 bits)

F (RX display – 30.825MHz) =
[(N X 128) + A] X12.8MHz/ref

N : Frequency division ratio of main 10-bit counter
A : Frequency division ratio of 7-bit pulse swallow counter

2. Comparison frequency (ref) selection (2 bits)

Data		Phase comparison frequency	
D1	D2		
L	L	5kHz	5, 10, 15, 20 or 25kHz steps

3. Switch selection (2 bits)

Data		Output port		
D3	D4	SW1	SW2	
H	L	H	L	RX mode
L	H	L	H	TX mode

Fig. 12 PLL data configuration

CIRCUIT DESCRIPTION

● **Alert and electronic volume control output (when optional remote controller is connected)**

The alert and electronic volume control outputs are provided by pins P92 (CK), P91 (DT), and P21 (ST) of the microprocessor to the 8-bit shift register (IC3) in the TX-RX unit. P92 (CK) and P91 (DT) are also used for the PLL data. **Fig. 13** shows the data transfer format. **Fig. 14** shows the data configuration.

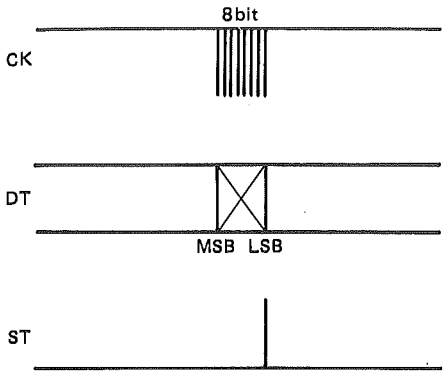


Fig. 13 Data transfer format for alert and electronic volume control

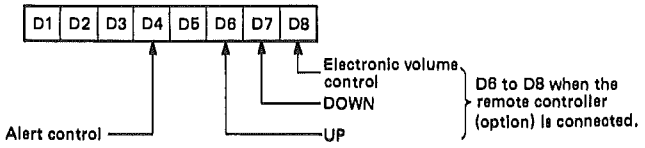


Fig. 14 Data configuration for alert and electronic volume control

● **Tone output**

The outputs from pins P40 to P43 and P50 to P53 of the microprocessor are applied to a ladder resistance network (IC4) which converts these signals into an analog waveform with 38 possible tone frequencies combinations 67.0 to 250.3Hz. **Fig. 15** shows the internal configuration of IC4.

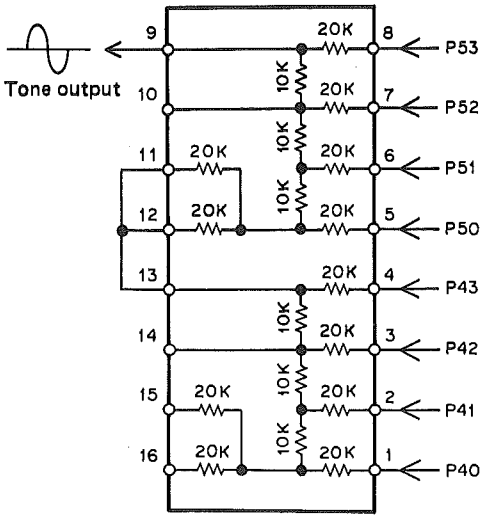


Fig. 15 Internal configuration of KRR-C001 ladder resistance network (Control unit IC4)

● **S-meter and RF meter input**

The analog voltage of the S-meter is applied to pin PTH00 of the microprocessor, and the analog voltage of the RF meter to pin PTH01. After 4-bit (16-step) analog-to-digital conversion, the resulting signal is sent to the display.

● **Busy input**

When squelch is ON and an input signal is present, a low input lights the busy indicator.

● **CTCSS unit (option) input and output**

The microprocessor sends data from pins P30, P31, and P61 to the CTCSS unit. **Fig. 16** shows the data transfer format. **Fig. 17** shows the data configuration. When a tone is detected from the CTCSS unit, a "H" is applied to pin P32 of the microprocessor to open the squelch.

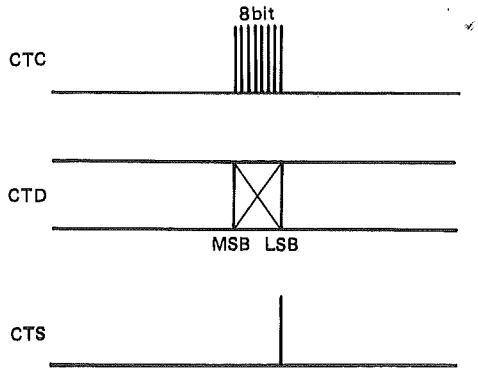


Fig. 16 CTCSS data transfer format

CTCSS unit MN6520 tone frequency select data

	D1	D2	D3	D4	D5	D6
Ex. 88.5Hz	L	H	L	H	H	H

Fig. 17 CTCSS data configuration

● **Remote control (RC-10) (option) input and output**

When the RC-10 remote control unit is connected a "H" is applied to pin INT0 of the microprocessor, switching the following pins to the functions indicated:

P03 → SI : Serial data input pin
P02 → SO : Serial data output pin
P01 → $\overline{SCK}$: Serial clock input/output pin

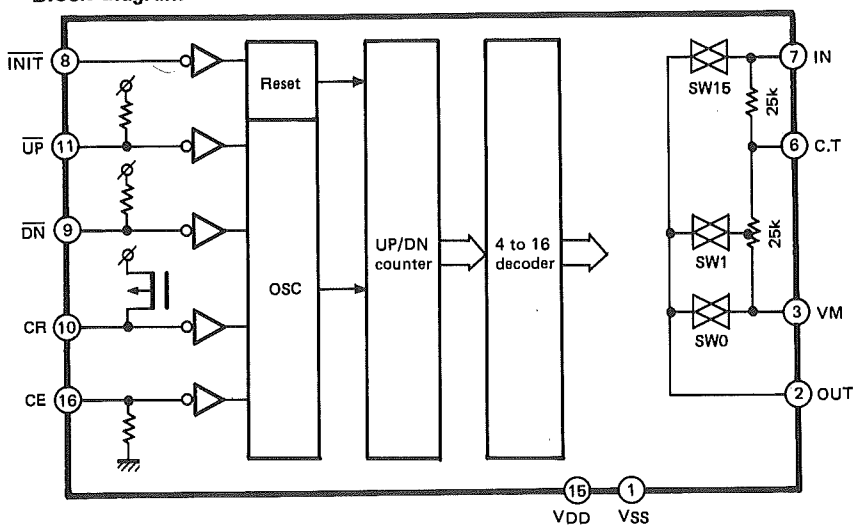
SEMICONDUCTOR DATA

Electronic volume LC7532M (VOL IC1)

● Electric characteristics

Item	Symbol	Conditions	Specifications			Unit
			Min.	Typ.	Max.	
High-frequency distortion	THD1	V_{DD}=3V, R_L=50kΩ, f=1kHz, VR MAX, V_{IN}=−20dBV		0.1	0.5	%
	THD2	V_{DD}=2.1V, R_L=50kΩ, f=1kHz, VR MAX, V_{IN}=−20dBV		0.3	1.0	%
Output in low-power mode	X OUT	At 0dBm input : f=1kHz, R_L=51kΩ		−95	−60	dB
Input impedance	R IN	$\overline{UP}$, $\overline{DN}$, CE	100		400	kΩ
Current consumption	IDD (1)	V_{DD}=3V when operating		0.035	1	mA
	IDD (2)	VDD=3V, CE="L"		4		μA

● Block diagram



DESCRIPTION OF ELEMENTS

FINAL UNIT (X45-1360-11)

Element	Function	Description
Q1	Power amplifier	Boosts power to the required level. M57774.
D1	Protection against reverse power connection	
D2,D3	Transmit/receive select	ON during transmit.
D4	High-frequency output voltage level detect	Detects high-frequency output level and controls output in the APC circuit.
D5	Reflected power detector	Adjustable with VR1.

CONTROL UNIT (X53-3040-13)

Element	Function	Description
IC1	6V AVR	
IC2	Reset IC	Outputs Reset signal and detects low voltage.
IC3	Microprocessor	Controls frequencies and general set functions.
IC4	Tone DAC	Converts digital data from IC3 (P40 to P43, P50 to P53) to an analog tone frequency.
Q1	Squelch switching	Switches squelch on/off when remote controller is connected.
Q2	Switching	Controls the microprocessor's backup detect input.
D1	Reverse current protection	Protects against external voltage applied to pin 5 of the microprocessor.
D2(1/2)	Microprocessor protection	Protects against static surge.
D2(2/2)	Voltage drop	
D3(1/2)	Reverse current protection	Prevents current from flowing to the backup battery.
D3(2/2)	Reverse current protection	Prevents backup battery current from flowing to inappropriate circuits.
D4	Microprocessor protection	Protects against static surge.

TX-RX UNIT (X57-3170-10)

Element	Function	Description
IC1	8V AVR	
IC2	PLL	Pulse-swallow type phase-locked loop.
IC3	Shift register	Controls, band switching, and electronic volume functions.
IC4	AF amplifier	Speaker output.
Q1	High-frequency amplifier	Operates in receive mode (144MHz).
Q2	First mixer	Converts the received frequency into the 30.825MHz.
Q3	High-frequency amplifier	First intermediate frequency amplifies.
Q4	AF muting	Operates when CTCSS is ON, when SQS is high, and in transmit mode.
Q5	8R switching	ON in receive mode.
Q6	8T switching	ON in transmit mode.
Q7	8T switching control	ON in transmit mode.
Q8	8R switching control	ON in receive mode.
Q9	Constant-voltage control	5V power supply for PLL.
Q11	High-frequency amplifier	Amplifies 12.8MHz to the level required for the PLL
Q13,Q14	PLL low-pass filter	
Q15	PLL unlock control	ON when the PLL is locked.
Q16	High-frequency amplifier	Amplifies the VCO output to the level required for the PLL.
Q17	High-frequency amplifier	Amplifies the VCO output to the level required for input to the 1st IF mixer (Q2).
Q19	Transmit driver (power amplifier)	Amplifies to the level required for input to the final unit power module.
Q20	+ B (DB) AVR of Q19	Operates in transmit mode.

DESCRIPTION OF ELEMENTS

Element	Function	Description
Q21	High-pass filter	Improves AF frequency characteristics in the receive mode.
D1	Limiting	Limits the first IF signal.
D2	Reversal current protection	Turns on the SQ circuit and Q4 for AL, in transmit mode for muting of the AF line.
D3	Reversal current protection	Prevents flow of RF meter current to the microphone check circuit and rectifies the microphone check output.
D4	Discharge	For discharging any residual charge on the 8T line.
D5	AVR	Zener diode for setting the AVR circuit reference voltage.
D6	Switching characteristic	Diode to provide rise and fall hysteresis on the LD line.
D7	VCO output switch	Reduces the drive circuit load in receive mode.
D8	VCO output switch	Reduces the oscillator load in transmit mode.
D9	Temperature compensation	Temperature compensation for Q19 (driver).
D10	Temperature compensation	Temperature compensation for APC circuit.
D14	S-meter circuit protection	Protect for S-meter circuit when TX to RX mode.

VCO (X58-3090-11)

Element	Function	Description
Q1	Amplifier	Operates in all modes to amplify the VCO output to the required level.
Q2	Transmit VCO	Operates in transmit mode as the PLL VCO (220MHz band).
Q3	Transmit VCO switch	Turns on the transmit VCO.
Q4	Receive VCO	Operates in receive mode as the PLL VCO.
D1	OR circuit	ORs 8T and 8R to operate Q1 at normal temperature.
D2	Transmit modulation varactor	Adds FM modulation to TX VCO.
D3	Transmit frequency control varactor	
D4	Receive frequency control varactor	

DRIVE (X59-3120-11)

Element	Function	Description
Q1	Switching	Supplies 8V to the drive circuit; switched by Q3.
Q2	Switching	Supplies 8V to the local oscillator amplifier; switched by Q3.
Q3	Switching	ON when the PLL is locked.
Q4,Q5	High-frequency amplifier	Operates in transmit mode. When checking levels near these transistors, be careful of the probe ground points.
D1	Reversal current protection	Separates Q1 and Q2.

APC (X59-3130-00)

Element	Function	Description
Q1	Differential amplifier	
Q2(1/2)	Protection control	Adjustable with VR5.
Q2(2/2)	APC control	Adjustable with VR6.
Q3	Drive stage + B AVR	

IF (X59-3140-00)

Element	Function	Description
IC1	Second local oscillator, mixer, IF amplifier, quadrature detector, noise amplifier	⑦ S-meter output. ⑪ Noise amplifier output (first stage). ⑨ Detector output ⑯ First IF signal input.

DESCRIPTION OF ELEMENTS

SQL (X59-3150-00)

Element	Function	Description
Q1	Noise amplifier	
Q2	Squelch switching	ON when squelch is on.
Q3,Q4	DC amplifier	OFF when squelch is on.
Q5	Low-frequency amplifier	For RD terminal.
Q6	Low-frequency amplifier	OFF when squelch is on.
D1	Squelch noise rectifier	
D2	Base bias setting	

MIC (X59-3160-00)

Element	Function	Description
IC1(1/2)	Low-frequency amplifier	① Output, ② Input.
IC1(2/2)	Low-frequency amplifier	For microphone check. ⑥ Input ⑦ Output.
IC2(1/2)	Limiting amplifier	① Output ② Input.
IC2(2/2)	LPF	⑥ , ⑦ Output.

VOL (X59-3170-00)

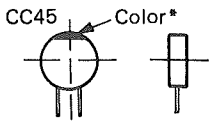
Element	Function	Description
IC1	Electronic volume control (16 steps, initialized to the 6th step from the bottom)	② Output. ⑦ Input. ⑧ Initialize input : "L" → step 6. ⑨ Increase ("L" input raises the volume 1 step). ⑪ Decrease ("L" input lowers the volume 1 step). ⑯ "H" while operating.
IC2	Bidirectional switch (4 circuits)	① – ② controlled by ⑬ . ③ – ④ controlled by ⑤ . ⑧ – ⑨ controlled by ⑥ . ⑩ – ⑪ controlled by ⑫ .
Q1	Bidirectional switch enable	ON to enable electronic volume control.
Q2	Switching	ON to decrease by 1 step.
Q3	Switching	ON to increase by 1 step.
D1	Voltage drop	

PARTS LIST

CAPACITORS

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

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



• Temperature Coefficient

1st Word	C	L	P	R	S	T	U
Color*	Black	Red	Orange	Yellow	Green	Blue	Violet
ppm/°C	0	−80	−150	−220	−330	−470	−750

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

Example CC45TH = −470±60 ppm/°C

• Capacitor value

1 0 3 = 0.01μF
0 1 0 = 1pF
1 0 0 = 10pF
1 0 1 = 100pF
1 0 2 = 1000pF = 0.001μF

2 2 0 = 22pF
1st number | Multiplier
2nd number

• Tolerance

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

Less than 10 pF

Code	B	C	D	F	G
(pF)	± 0.1	± 0.25	± 0.5	± 1	± 2

• Rating voltage

2nd word / 1st word	A	B	C	D	E	F	G	H	J	K	V
0	1.0	1.25	1.6	2.0	2.5	3.15	4.0	5.0	6.3	8.0	–
1	10	12.5	16	20	25	31.5	40	50	63	80	35
2	100	125	160	200	250	315	400	500	630	800	–
3	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	–

• Chip capacitors

(EX) C C 7 3 F S L 1 H 0 0 0 J → Refer to the table above.
1 2 3 4 5 6 7
(Chip) (CH,RH,UJ,SL)

(EX) C K 7 3 F F 1 H 0 0 0 Z
1 2 3 4 5 6 7
(Chip) (B,F)

1 = Type ..... ceramic, electrolytic, etc.
2 = Shape ..... round, square, etc.
3 = Dimension
4 = Temp. coefficient
5 = Voltage reting
6 = Value
7 = Tolerance.

Dimension

Dimension code	L	W	T
Empty	5.6 ± 0.5	5.0 ± 0.5	Less than 2.0
E	3.2 ± 0.2	1.6 ± 0.2	Less than 1.25
F	2.0 ± 0.3	1.25 ± 0.2	Less than 1.25

Dimension

Dimension code	L	W	T	Wattage
E	3.2 ± 0.2	1.6 ± 0.2	0.57	2B
F	2.0 ± 0.3	1.25 ± 0.2	0.45	2A

RESISTORS

• Chip resistor (Carbon)

(EX) R D 7 3 E B 2 B 0 0 0 J
1 2 3 4 5 6 7
(Chip) (B,F)

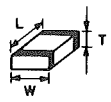
• Carbon resistor (Normal type)

R D 1 4 B B 2 C 0 0 0 J
1 2 3 4 5 6 7

Rating wattage

Cord	Wattage	Cord	Wattage	Cord	Wattage
2A	1 /10W	2E	1/ 4W	3A	1W
2B	1/ 8W	2H	1/ 2W	3D	2W
2C	1/ 6W				

Dimension



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			TM-321A			
1	1B		A01-1021-03	METALLIC CABINET(UPPER)		
2	2B		A01-1022-03	METALLIC CABINET(BOTTOM)		
4	1A	*	A20-2629-02	PANEL ASSY		
--			A20-2574-03	PANEL ASSY		
9	2A		B11-0442-04	REFRACTOR		
11	2A		B38-0303-05	LCD ASSY		
14	1B		B42-2455-04	LABEL (M4X8,MAX)		
15	1E		B46-0410-20	WARRANTY CARD		
16	1D	*	B50-8182-00	INSTRUCTION MANUAL		
--		*	B10-0699-03	FRONT GLASS		
-			B11-0446-14	REFRACTOR		
22	3D		E30-2053-05	DC CORD ASSY (ACSY)		
-			E31-3224-05	FLAT CABLE (LCD CONTROL)		
--			E31-3239-15	LEAD WITH CONNECTOR(SP)		
27	3D		F05-8021-05	FUSE (8A) ACSY		
30	2B		F20-0587-04	INSULATING SHEET(LITHUM BATT)		
31	2A		F20-0521-04	INSULATING SHEET(LITHUM BATT)		
32	2A		F29-0431-05	INSULATOR (VOL,SQL)		
-			F05-2036-05	FUSE (20A) FOR DC CORD		
36	1A		G09-0405-05	SPRING (KNOB)		
37	1B,2B		G10-0604-04	FELT (CABINET)		
38	1B		G10-0651-04	FELT (SP)		
40	2A		G13-0839-04	CUSHION (KNOB)		
42	1B		G13-0845-04	CUSHION (SP)		
43	2A		G10-0659-04	FELT (SUB PANEL)		
44	1A,1B		G53-0508-04	FELT (PANEL FRAME)		
-			G13-0838-04	CUSHION		
--			G13-0853-04	CUSHION (LCD)		
-			G53-0537-04	PACKING (SP)		
48	3E	*	H01-8125-04	ITEM CARTON BOX		
49	3D		H10-2627-02	POLYSTYRENE FOAMED FIXTURE		
51	1D		H13-0812-04	POLYSTYRENE FOAMED FIXTURE(TOP		
52	2D		H13-0814-04	BUFFER (MOUNT BRACKET)		
53	3D		H25-0049-03	PROTECTION BAG (DC CORD)		
54	2D		H25-0720-04	PROTECTION BAG (RADIO)		
55	3D		H25-0029-04	PROTECTION BAG (MIC HOOK,SCREW		
57	3D		J20-0319-24	MIC HOOK (ACSY)		
59	2D		J29-0416-03	MOUNTING BRACKET (ACSY)		
60	2A		J31-0141-04	SPACER RING (MIC)		
61	1B		J19-1422-14	HOLDER		
62	2D		J21-4147-14	MOUNTING HARDWARE(ACSY)		
--			J61-0307-05	WIRE BAND		
64	1A		K27-0496-04	KNOB(BUTTON) POWER,LOW		
66	2A		K29-3058-04	KNOB (MHZ,VFO/M,MIN)		
67	1A		K29-3060-04	KNOB (MAIN)		
68	1A		K29-3061-04	KNOB (VOL,SQL)		
69	1A		K29-3069-04	KNOB(BUTTON) SHIFT		
70	1A		K29-3065-04	KNOB(BUTTON) REV		
71	1A		K29-3067-04	KNOB(BUTTON) SCAN		
72	1A		K29-3068-04	KNOB(BUTTON) CTCSS		
73	1A		K29-3070-04	KNOB(BUTTON) TONE		

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--			K29-3057-14	KNOB RING		
77	3D		N99-0318-05	SCREW SET		
78	3D		N46-3010-46	PAN HEAD TAPPING SCREW(ACSY)		
A	1B,1C		N32-2604-46	FLAT HEAD MACHINE SCREW		
B	2A		N87-2606-46	TAPTITE SCREW (CONTROL UNIT)		
C	2A,2B		N89-2606-46	TAPTITE SCREW (SUB PANEL)		
D	1B,2B		N33-2606-45	OVAL HEAD MACHINE SCREW(CABINT		
G	1B,2B		N09-2020-05	S TIGHT SCREW (CABINET L,R)		
85	1B		T07-0246-05	LOUDSPEAKER(FULLRANGE)		
86	2D		T91-0359-05	MICROPHONE		
--			LC7582	IC(LCD DRIVER)		
94	2A		W09-0326-05	LITHUM BATTERY		
99	1B,1C	*	X45-1360-11	FINAL UNIT		
100	2A	*	X53-3040-13	CONTROL PC UNIT		
101	2B	*	X57-3170-10	TX-RX UNIT		
FINAL UNIT (X45-1360-11)						
C1 ,2			CE04CW1C100M	ELECTRO 10UF 16WV		
C3			CC45SL2H100D	CERAMIC 10PF D		
C4			CC45SL2H040C	CERAMIC 4.0PF C		
C5			CK45B2H102K	CERAMIC 1000PF K		
C6			CC45SL2H150J	CERAMIC 15PF J		
C7			CC45SL2H180J	CERAMIC 18PF J		
C8			CC45CH1H010C	CERAMIC 1.0PF C		
C9			CC45SL2H180J	CERAMIC 18PF J		
C11			CM73F2H050C	CHIP C 5.0PF C		
C12 -17			CK45B1H102K	CERAMIC 1000PF K		
110	1C		E30-2021-35	DC CABLE (HEAT SINK)		
111	1C		E30-2074-05	ANT COAX.CABLE		
-			E11-0401-05	EAR PHONE JACK		
--			E31-2066-05	COAX.CABLE (DO)		
--			E31-2090-05	COAX.CABLE (RA)		
TP1			E23-0512-05	TERMINAL		
115	1C		F01-0950-05	HEAT SINK		
--			F05-8021-05	FUSE (8A)		
120	1B		J19-1375-04	COAX.FITTING HARDWARE		
121	1C		J41-0033-05	BUSHING (DC CABLE)		
122	1C		J42-0448-05	BUSHING (ANT CABLE)		
L1			L34-0908-05	COIL (3,9.5T)		
L2		*	L34-1207-05	COIL (3,3.5T)		
L3		*	L34-1208-05	COIL (3,3T)		
L4			L34-0908-05	COIL (3,9.5T)		
L5			L34-0641-05	COIL (3,3T)		
L6		*	L34-1209-05	COIL (3,2T)		
L7			L40-1091-03	SMALL FIXED INDUCTOR(1UH)		
E	1B		N09-0626-04	SEMUS SCREW (M3X10)		
F	1B		N87-2606-41	BRAZIER HEAD TAPTITE SCREW		
R1			RD14DB2H151J	SMALL-RD 150 J 1/2W		
R2			RD14BB2C153J	RD 15K J 1/6W		
VR1			R12-0541-05	TRIMMING POT. (100)		

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D1			DSA3A1	DIODE		
D2			MI407	DIODE		
D3			MI308	DIODE		
D4 ,5			1S1587	DIODE		
Q1			M57774	POWER MODULE		
CONTROL UNIT (X53-3040-13)						
C1 ,2			CK73FB1H103K	CHIP C 0.010UF K		
C3 ,4			CC73FCH1H330J	CHIP C 33PF J		
C5 -14			CK73FB1H102K	CHIP C 1000PF K		
C15			CE04CW1C100M	ELECTRO 10UF 16WV		
C16			CK73FB1H103K	CHIP C 0.010UF K		
C17			CK73EF1C105Z	CHIP C 1.0UF Z		
-			E06-0858-05	8P METAL SOCKET		
-			E31-3231-05	CONNECTING WIRE		
-			E31-3238-05	CONNECTING WIRE(CTCSS)		
-			E40-1878-05	PIN CONNECTOR (18P)		
L1			L77-1313-05	CRYSTAL RESONATOR(4.194304MHZ)		
R1			RD41FB2B563J	CYLND CHIP C 56K J 1/8W		
R2 -5			RD41FB2B105J	CYLND CHIP C 1.0M J 1/8W		
R6			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R7			RD41FB2B105J	CYLND CHIP C 1.0M J 1/8W		
R8 ,9			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R10 -13			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R14			RD41FB2B2R2J	CYLND CHIP C 2.2 J 1/8W		
R15			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R16			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R17 ,18			RD41FB2B474J	CYLND CHIP C 470K J 1/8W		
R19			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R21 ,22			R92-0687-05	CHIP R 0 OHM		
R25			R92-0687-05	CHIP R 0 OHM		
R26			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R27			R92-0150-05	JUMPER REST 0 OHM		
VR1			R05-3441-05	POTENTIOMETER (10KA)		
VR2			R05-4420-05	POTENTIOMETER (50KB)		
S1 -8			S40-1086-05	PUSH SWITCH		
S9 ,10			S40-2458-05	PUSH SWITCH		
D1 -4			1SS184	CHIP DIODE		
IC1			LA5006M	IC(LOW SATURATION REGULATOR)		
IC2			M51951BML	IC(SYSTEM RESET)		
IC3			75106G-522-1B	IC(MICROPROCESSOR)		
IC4			KRR-C001	IC		
Q1			DTC124EK	DIGITAL TRANSISTOR		
Q2			2SC2712(Y)	CHIP TRANSISTOR		
-			W02-0388-05	ROTARY ENCODER		
TX-RX UNIT (X57-3170-10)						
C1			CC73FSL1H390J	CHIP C 39PF J		
C2			CC73FCH1H120J	CHIP C 12PF J		
C3			CC73FCH1H1R5C	CHIP C 1.5PF C		
C4			CC73FCH1H120J	CHIP C 12PF J		
C5			CC73FSL1H390J	CHIP C 39PF J		
C6			CK73FB1H102K	CHIP C 1000PF K		

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C7			CK73FB1H103K	CHIP C 0.010UF K		
C8 ,9			CK73FB1H102K	CHIP C 1000PF K		
C10			CK73FB1H103K	CHIP C 0.010UF K		
C11			CC73FCH1H020C	CHIP C 2.0PF C		
C12			CC41FCH1H050C	CYLND CHIP C 5.0PF C		
C13			CK73FB1H102K	CHIP C 1000PF K		
C14			CK73FB1H103K	CHIP C 0.010UF K		
C15			CC41FCH1H060D	CYLND CHIP C 6.0PF D		
C16			CC73FSL1H101J	CHIP C 100PF J		
C17 -19			CK73FB1H103K	CHIP C 0.010UF K		
C20			CK73FB1H102K	CHIP C 1000PF K		
C21			CE04EW1A470M	ELECTRO 47UF 10WV		
C22			CK73FB1H102K	CHIP C 1000PF K		
C23			CK73FB1H103K	CHIP C 0.010UF K		
C24 ,25			CC73FSL1H560J	CHIP C 56PF J		
C26			CE04EW1C100M	ELECTRO 10UF 16WV		
C27			CK73FB1H102K	CHIP C 1000PF K		
C28			CK73EF1C105Z	CHIP C 1.0UF Z		
C29			CK73FB1H103K	CHIP C 0.010UF K		
C30 ,31			CE04EW1A470M	ELECTRO 47UF 10WV		
C32 ,33			CK73EB1E104K	CHIP C 0.10UF K		
C34			CK73FB1H103K	CHIP C 0.010UF K		
C35 ,36			CK73FB1H102K	CHIP C 1000PF K		
C37			CE04EW1A470M	ELECTRO 47UF 10WV		
C38			CK73EB1H333K	CHIP C 0.033UF K		
C39			CE04EW1A470M	ELECTRO 47UF 10WV		
C40			CK73EF1C105Z	CHIP C 1.0UF Z		
C42			CE04EW1A470M	ELECTRO 47UF 10WV		
C43			CK73FB1H103K	CHIP C 0.010UF K		
C44			CE04EW1C100M	ELECTRO 10UF 16WV		
C45			C92-0004-05	CHIP TAN 1UF 16WV		
C46			CE04EW1A470M	ELECTRO 47UF 10WV		
C47			CK73FB1H102K	CHIP C 1000PF K		
C53			CK73FB1H103K	CHIP C 0.010UF K		
C54			CC41FCH1H150J	CYLND CHIP C 15PF J		
C55			CC73FSL1H221J	CHIP C 220PF J		
C56 ,57			CC73FSL1H101J	CHIP C 100PF J		
C59			CK73EB1H473K	CHIP C 0.047UF K		
C60			CC73FSL1H101J	CHIP C 100PF J		
C61			CK41FB1H471K	CYLND CHIP C 470PF K		
C62			CK73FB1H182K	CHIP C 1800PF K		
C63			CK73FB1H103K	CHIP C 0.010UF K		
C64			C92-0504-05	CHIP-TAN 0.68UF 20WV		
C65			CK73FB1H102K	CHIP C 1000PF K		
C66			C92-0003-05	CHIP TAN 0.47UF 25WV		
C67			CK73FB1H103K	CHIP C 0.010UF K		
C68			CF92V1H683J	MF 0.068UF J		
C69			C92-0004-05	CHIP TAN 1UF 16WV		
C70 ,71			CE04EW1A101M	ELECTRO 100UF 10WV		
C72			CC41FCH1H050C	CYLND CHIP C 5.0PF C		
C73			CK73FB1H102K	CHIP C 1000PF K		
C74			CC41FCH1H150J	CYLND CHIP C 15PF J		
C75			CK73FB1H103K	CHIP C 0.010UF K		
C76			CC41FCH1H100D	CYLND CHIP C 10PF D		
C77			CK73FB1H102K	CHIP C 1000PF K		

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C78			CC73FCH1H120J	CHIP C 12PF J		
C79			CK73FB1H103K	CHIP C 0.010UF K		
C80			CK41FB1H471K	CYLND CHIP C 470PF K		
C81			CK73FB1H102K	CHIP C 1000PF K		
C83			CK73EF1C105Z	CHIP C 1.0UF Z		
C84 ,85			CK73FB1H103K	CHIP C 0.010UF K		
C86			CK73EF1C105Z	CHIP C 1.0UF Z		
C87			CK73EB1H333K	CHIP C 0.033UF K		
C88 -90			CE04EW1A470M	ELECTRO 47UF 10WV		
C91			CE04EW1A471M	ELECTRO 470UF 10WV		
C92			CK73EB1E104K	CHIP C 0.10UF K		
C93			C90-2033-05	ELECTRO 1000UF 16WV		
C94			CC73FSL1H101J	CHIP C 100PF J		
C95			CK73FB1H102K	CHIP C 1000PF K		
C96			CE04EW1E4R7M	ELECTRO 4.7UF 25WV		
C97			CE04EW1C100M	ELECTRO 10UF 16WV		
C98			CK73FB1H102K	CHIP C 1000PF K		
C100			CK73FB1H102K	CHIP C 1000PF K		
C101			CE04EW1C100M	ELECTRO 10UF 16WV		
C102			CK73FB1H102K	CHIP C 1000PF K		
C103			CE04EW1C101M	ELECTRO 100UF 16WV		
C104			CK73FB1H103K	CHIP C 0.010UF K		
C105-109			CK73FB1H102K	CHIP C 1000PF K		
C110,111			CK73FB1H562K	CHIP C 5600PF K		
C112			CK73EB1E104K	CHIP C 0.10UF K		
C113			CK73FB1H103K	CHIP C 0.010UF K		
C119			CK73FB1H223K	CHIP C 0.022UF K		
C120			CK73FB1H103K	CHIP C 0.010UF K		
C121			CK73FB1H182K	CHIP C 1800PF K		
C122,123			CK73FB1H102K	CHIP C 1000PF K		
C124			C90-2033-05	ELECTRO 1000UF 16WV		
C125			CC73FSL1H101J	CHIP C 100PF J		
C126			CC73FCH1H020C	CHIP C 2.0PF C		
C127			CC41FCH1H150J	CYLND CHIP C 15PF J		
TC1			C05-0308-05	TRIMMING CAP (4PF)		
TC2 ,3			C05-0350-05	TRIMMING CAP (20PF)		
-			E04-0154-05	RF COAXIAL CONNECTOR		
J1			E40-5016-05	PIN CONNECTOR (2P)		
J2			E40-3237-05	PIN CONNECTOR (2P)		
J3			E40-3238-05	PIN CONNECTOR (3P)		
J4			E40-3237-05	PIN CONNECTOR (2P)		
J5			E40-3238-05	PIN CONNECTOR (3P)		
J6			E40-3237-05	PIN CONNECTOR (2P)		
J7 ,8			E40-5099-05	PIN CONNECTOR		
TP1			E40-0211-05	PIN CONNECTOR (2P)		
TP2 ,3			E23-0465-05	TERMINAL		
W1			E31-3237-05	CONNECTING WIRE		
-			F20-0581-04	INSULATING SHEET		
-			G02-0535-04	SPRING		
-			G13-0887-04	CUSHION		
L1 ,2		*	L34-4050-05	COIL		
L3			L79-0683-05	HELICAL RESONATOR		

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L4			L34-2265-05	COIL		
L5			L34-2157-05	COIL		
L6			L71-0270-05	MCF (30.825MHZ)		
L7			L34-2045-05	COIL		
L8			L77-1312-05	CRYSTAL RESONATOR(30.370MHZ)		
L9			L30-0531-05	IFT		
L10			L72-0315-05	CERAMIC FILTER (CFW455F)		
L11			L30-0503-05	IFT		
L12			L40-3392-81	CHIP INDUCTOR(3.3UH)		
L13			L77-1311-05	CRYSTAL RESONATOR(12.8MHZ)		
L14			L40-3392-81	CHIP INDUCTOR(3.3UH)		
L15			L40-3982-81	CHIP INDUCTOR(0.39UH)		
L16			L15-0308-05	LOW-FREQUENCY CHOKE COIL		
L17		*	L34-1205-05	COIL (3,3T)		
L18		*	L34-1206-05	COIL (3,4T)		
L22			L40-1092-81	CHIP INDUCTOR(1UH)		
B	1B,2B		N87-2606-46	BRAZIER HEAD TAPTITE SCREW		
R1			RD41FB2B563J	CYLND CHIP C 56K J 1/8W		
R2			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R3			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R4			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R5			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R6			RD41FB2B471J	CYLND CHIP C 470 J 1/8W		
R7			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R8			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R9			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R10			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R11			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R12			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R13			RD41FB2B100J	CYLND CHIP C 10 J 1/8W		
R14			RD41FB2B274J	CYLND CHIP C 270K J 1/8W		
R15			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R16			RD41FB2B681J	CYLND CHIP C 680 J 1/8W		
R17			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R18			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R19			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R20			RD41FB2B471J	CYLND CHIP C 470 J 1/8W		
R21			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R22			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R23			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		
R24			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R25			RD41FB2B333J	CYLND CHIP C 33K J 1/8W		
R26			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R27			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R28			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R29			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R30			RD41FB2B273J	CYLND CHIP C 27K J 1/8W		
R31			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R33			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R34			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R36			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		
R37			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R38			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		

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R39			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R40			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R41			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		
R42			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R43			RD41FB2B100J	CYLND CHIP C 10 J 1/8W		
R44			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R45 -49			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R58			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R59			RD41FB2B333J	CYLND CHIP C 33K J 1/8W		
R60			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R61			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R62			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R63			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R64 ,65			RD41FB2B272J	CYLND CHIP C 2.7K J 1/8W		
R66			RD41FB2B822J	CYLND CHIP C 8.2K J 1/8W		
R67			RD41FB2B183J	CYLND CHIP C 18K J 1/8W		
R68 ,69			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R70			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R71			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R72			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R73			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R74			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R75			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R76			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R77			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R78			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R79			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R80			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R83			RD41FB2B681J	CYLND CHIP C 680 J 1/8W		
R84			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R85			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R86			RD41FB2B2R2J	CYLND CHIP C 2.2 J 1/8W		
R87			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R88			RD41FB2B273J	CYLND CHIP C 27K J 1/8W		
R89			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R90			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		
R91			RD41FB2B151J	CYLND CHIP C 150 J 1/8W		
R92 ,93			R92-0687-05	CHIP R 0 OHM		
R95			R92-0685-05	RD 22 J 1/2W		
R96			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R97			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R98			RD41FB2B224J	CYLND CHIP C 220K J 1/8W		
R101			RD41FB2B564J	CYLND CHIP C 560K J 1/8W		
R102			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R105			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R106			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R107			RD41FB2B564J	CYLND CHIP C 560K J 1/8W		
R108			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R109			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R113			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R114-116			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R118,119			R92-0687-05	CHIP R 0 OHM		
R120			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R121-123			R92-0687-05	CHIP R 0 OHM		
R125,126			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		

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R127			RD41FB2B471J	CYLND CHIP C 470 J 1/8W		
R128			RD41FB2B333J	CYLND CHIP C 33K J 1/8W		
VR1			R12-5047-05	TRIMMING POT. (220K)		
VR2 ,3			R12-3096-05	TRIMMING POT. (10K)		
VR4 ,5			R12-3099-05	TRIMMING POT. (47K)		
VR6			R12-3096-05	TRIMMING POT. (10K)		
VR7			R12-3098-05	TRIMMING POT. (33K)		
VR8			R12-2414-05	TRIMMING POT. (5K)		
D1			1SS226	CHIP DIODE		
D2			1SS181	CHIP DIODE		
D3 ,4			1SS184	CHIP DIODE		
D5			02CZ6.2(Y,Z)	CHIP ZENER DIODE		
D6			1SS181	CHIP DIODE		
D7 ,8			BA282	DIODE		
D9 ,10			1SS181	CHIP DIODE		
D14			1SS187	CHIP DIODE		
IC1			MC7808C	IC(VOLTAGE REGULATOR/ +14V)		
IC2			M54959P	IC(FREQ SYNTHESIZER PLL)		
IC3			TC4094BP	IC(8-STAGE SHIFT/STORE BUS REG		
IC4			UPC1241H	IC		
Q1			3SK184(S)	CHIP FET		
Q2			3SK131(V12)	CHIP FET		
Q3			2SC2714(Y)	CHIP TRANSISTOR		
Q4			2SC3326(A)	CHIP TRANSISTOR		
Q5 ,6			2SB1119S	CHIP TRANSISTOR		
Q7 ,8			DTC124EK	DIGITAL TRANSISTOR		
Q9			2SC2712(Y)	CHIP TRANSISTOR		
Q11			2SC2714(Y)	CHIP TRANSISTOR		
Q13 ,14			2SC2712(Y)	CHIP TRANSISTOR		
Q15			2SA1162(Y)	CHIP TRANSISTOR		
Q16 ,17			2SC2714(Y)	CHIP TRANSISTOR		
Q19			2SC3369	TRANSISTOR		
Q20			2SD1406(Y)	TRANSISTOR		
Q21			2SC2712(Y)	CHIP TRANSISTOR		
TH1			112-502-2	THERMISTOR (5K)		
-		*	X58-3090-11	SUB UNIT (VCO)		
-		*	X59-3120-11	MODULE UNIT (DRIVE)		
-			X59-3130-00	MODULE UNIT (APC)		
-			X59-3140-00	MODULE UNIT (IF)		
-			X59-3150-00	MODULE UNIT (SQ)		
-			X59-3160-00	MODULE UNIT (MIC)		
-			X59-3170-00	MODULE UNIT (VOL)		
VCO (X58-3090-11)						
C1 ,2			CK73FB1H102K	CHIP C 1000PF K		
C3			CC73FCH1H010C	CHIP C 1.0PF C		
C4			CK73FB1H103K	CHIP C 0.010UF K		
C5			CC73FCH1H020C	CHIP C 2.0PF C		
C6			CC73FCH1H100D	CHIP C 10PF D		
C8			CC73FCH1H220J	CHIP C 22PF J		
C9			CC73FCH1H0R5C	CHIP C 0.5PF C		
C10			CC73FCH1H270J	CHIP C 27PF J		
C11			CK73FB1H102K	CHIP C 1000PF K		
C12			CC73FCH1H030C	CHIP C 3.0PF C		

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C13			CK73FB1H103K	CHIP C 0.010UF K		
C14			CC73FCH1H030C	CHIP C 3.0PF C		
C15			CC73FCH1H120J	CHIP C 12PF J		
C16 ,17			CC73FCH1H220J	CHIP C 22PF J		
C20			CC73FCH1H330J	CHIP C 33PF J		
C21			CK73FB1H102K	CHIP C 1000PF K		
TC1 ,2			C05-0345-05	CHIP TRIMMING CAP (10PF)		
-			E40-5095-05	PIN CONNECTOR (10P)		
L1			L40-3372-80	CHIP SMALL FIXED INDUCTOR(33NH		
L2		*	L34-1217-05	COIL (3,3T)		
L3 ,4			L40-3392-81	CHIP INDUCTOR(3.3UH)		
L5		*	L34-1217-05	COIL (3,3T)		
L6			L40-1092-81	CHIP INDUCTOR(1UH)		
R1			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		*
R2			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R3			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R4			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R5			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R6			RD41FB2B181J	CYLND CHIP C 180 J 1/8W		
R7			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R8			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R9			RD41FB2B152J	CYLND CHIP C 1.5K J 1/8W		
R10			RD41FB2B823J	CYLND CHIP C 82K J 1/8W		
R11			RD41FB2B224J	CYLND CHIP C 220K J 1/8W		
R12			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R13			RD41FB2B181J	CYLND CHIP C 180 J 1/8W		
R14			RD41FB2B682J	CYLND CHIP C 6.8K J 1/8W		
D1			1SS184	CHIP DIODE		
D2			1SV164	CHIP VARI-CAP DIODE		
D3 ,4			1SV166	CHIP VARI-CAP DIODE		
Q1			2SC2757(T33)	CHIP TRANSISTOR		
Q2			2SK508(K52)	CHIP FET		
Q3			2SC2712(Y)	CHIP TRANSISTOR		
Q4			2SK508(K51)	CHIP FET		
DRIVE (X59-3120-11)						
C1 -7			CK73FB1H102K	CHIP C 1000PF K		
C8			CK73FB1H103K	CHIP C 0.010UF K		
C9			CC73FCH1H220J	CHIP C 22PF J		
C10			CC41FCH1H020C	CYLND CHIP C 2.0PF C		
C11			CK73FB1H103K	CHIP C 0.010UF K		
C12			CK73EF1C105Z	CHIP C 1.0UF Z		
-			E23-0471-05	TERMINAL		
L1			L40-2272-80	CHIP INDUCTOR(22NH)		
R1 -5			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R6			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R7			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R8			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R9			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R10			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R11			RD41DB2B331J	CYLND CHIP C 330 J 1/8W		
R12			RD41FB2B680J	CYLND CHIP C 68 J 1/8W		

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R13			RD41FB2B332J	CYLND CHIP C 3.3K J 1/8W		
R14			RD41FB2B681J	CYLND CHIP C 680 J 1/8W		
R15			RD41FB2B470J	CYLND CHIP C 47 J 1/8W		
R16			RD41FB2B220J	CYLND CHIP C 22 J 1/8W		
R17			R92-0687-05	CHIP R 0 OHM		
R18			R92-0338-05	CLYND CHIP R 0 OHM		
D1			1SS184	CHIP DIODE		
Q1 ,2			2SA1162(Y)	CHIP TRANSISTOR		
Q3			2SC2712(Y)	CHIP TRANSISTOR		
Q4			2SC2714(Y)	CHIP TRANSISTOR		
Q5			2SC2759(U22,23)	CHIP TRANSISTOR		
APC (X59-3130-00)						
C1			CK73FB1H102K	CHIP C 1000PF K		
C2			C92-0501-05	CHIP TAN 1.5UF 10WV		
C3			CK73FB1H472K	CHIP C 4700PF K		
C4			CK73FB1H102K	CHIP C 1000PF K		
C5			CK73FB1H472K	CHIP C 4700PF K		
C6			CK73FB1H102K	CHIP C 1000PF K		
-			E23-0471-05	TERMINAL		
R1			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R2			RD41FB2B102J	CYLND CHIP C 1.0K J 1/8W		
R3			RD41FB2B152J	CYLND CHIP C 1.5K J 1/8W		
R4 ,5			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R6			RD41FB2B122J	CYLND CHIP C 1.2K J 1/8W		
Q1 ,2			FMW1	DIGITAL TRANSISTOR		
Q3			2SA1162(Y)	CHIP TRANSISTOR		
IF (X59-3140-00)						
C1			CK73FB1H102K	CHIP C 1000PF K		
C2			CK73FB1H472K	CHIP C 4700PF K		
C3			CC73FCH1H330J	CHIP C 33PF J		
C4			CK73FB1H472K	CHIP C 4700PF K		
C5			CC73FSL1H561J	CHIP C 560PF J		
C6			CK73FB1H472K	CHIP C 4700PF K		
C7			CK73FB1H103K	CHIP C 0.010UF K		
C8 -10			CK73EB1H104K	CHIP C 0.10UF K		
-			E23-0471-05	TERMINAL		
L1			L40-2211-81	CHIP INDUCTOR(220UH)		
L2			L33-0695-05	CHOKE COIL (1MH)		
R1 ,2			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R4			RD41FB2B332J	CYLND CHIP C 3.3K J 1/8W		
R5			RD41FB2B182J	CYLND CHIP C 1.8K J 1/8W		
IC1			TA7761F	IC(FM IF)		
SQL (X59-3150-00)						
C1			CK73FB1H102K	CHIP C 1000PF K		
C2			CC73FCH1H330J	CHIP C 33PF J		
C4			C92-0005-05	CHIP-TAN 2.2UF 6.3WV		
C5			CK73EF1C105Z	CHIP C 1.0UF Z		
C6			C92-0504-05	CHIP-TAN 0.68UF 20WV		
C7 ,8			CK73FB1E393K	CHIP C 0.039UF K		
C9			CK73FB1H153K	CHIP C 0.015UF K		

E: Scandinavia & Europe K: USA P: Canada W:Europe
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Ref. No. 参照番号	Address 位置	New Parts 新	Parts No. 部品番号	Description 部品名／規格	Destination 仕向	Remarks 備考
C10			CK73FB1H333K	CHIP C 0.033UF K		
--			E23-0471-05	TERMINAL		
R1			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R2			RD41FB2B272J	CYLND CHIP C 2.7K J 1/8W		
R3			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R4			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R5			RD41FB2B332J	CYLND CHIP C 3.3K J 1/8W		
R6			RD41FB2B682J	CYLND CHIP C 6.8K J 1/8W		
R7			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R8			RD41FB2B474J	CYLND CHIP C 470K J 1/8W		
R9			RD41FB2B472J	CYLND CHIP C 4.7K J 1/8W		
R10			RD41FB2B474J	CYLND CHIP C 470K J 1/8W		
R11			RD41FB2B273J	CYLND CHIP C 27K J 1/8W		
R12			RD41FB2B223J	CYLND CHIP C 22K J 1/8W		
R13			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
R14			RD41FB2B393J	CYLND CHIP C 39K J 1/8W		
R15			RD41FB2B273J	CYLND CHIP C 27K J 1/8W		
R16			RD41FB2B331J	CYLND CHIP C 330 J 1/8W		
R17			RD41FB2B222J	CYLND CHIP C 2.2K J 1/8W		
D1			1SS226	CHIP DIODE		
D2			1SS181	CHIP DIODE		
Q1 ,2			2SC2712(Y)	CHIP TRANSISTOR		
Q3 ,4			2SC3295(B)	CHIP TRANSISTOR		
Q5 ,6			2SC2712(Y)	CHIP TRANSISTOR		
MIC (X59-3160-00)						
C1			CK73FB1H223K	CHIP C 0.022UF K		
C2			CK73EF1C105Z	CHIP C 1.0UF Z		
C3			CK73FB1H333K	CHIP C 0.033UF K		
C4 ,5			CK73FB1H223K	CHIP C 0.022UF K		
C6			CK73EF1C105Z	CHIP C 1.0UF Z		
C7			CC73FSL1H101J	CHIP C 100PF J		
C8			CK73FB1H272K	CHIP C 2700PF K		
C9			CK73EF1C105Z	CHIP C 1.0UF Z		
C10			CC73FSL1H101J	CHIP C 100PF J		
C11			CK73FB1H821K	CHIP C 820PF K		
--			E23-0471-05	TERMINAL		
R1			RD41FB2B123J	CYLND CHIP C 12K J 1/8W		
R2			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R3			RD41FB2B563J	CYLND CHIP C 56K J 1/8W		
R4			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R5			RD41FB2B154J	CYLND CHIP C 150K J 1/8W		
R6			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R7			RD41FB2B101J	CYLND CHIP C 100 J 1/8W		
R8			RD41FB2B153J	CYLND CHIP C 15K J 1/8W		
R9			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R10			RD41FB2B561J	CYLND CHIP C 560 J 1/8W		
R11			RD41FB2B274J	CYLND CHIP C 270K J 1/8W		
R12			RD41FB2B563J	CYLND CHIP C 56K J 1/8W		
R13			RD41FB2B224J	CYLND CHIP C 220K J 1/8W		
R14 -16			RD41FB2B823J	CYLND CHIP C 82K J 1/8W		
R17			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R19 ,20			R92-0687-05	CHIP R 0 OHM		

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IC1 ,2			NJM4558M	IC(OP AMP X2)		
VOL (X59-3170-00)						
C1 ,2			CK73EB1E104K	CHIP C 0.10UF K		
C3			CK73FF1E104Z	CHIP C 0.10UF Z		
C4			C92-0004-05	CHIP TAN 1UF 16WV		
-			E23-0471-05	TERMINAL		
R1 -3			RD41FB2B473J	CYLND CHIP C 47K J 1/8W		
R4			RD41FB2B823J	CYLND CHIP C 82K J 1/8W		
R5			RD41FB2B103J	CYLND CHIP C 10K J 1/8W		
R6			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R7			RD41FB2B272J	CYLND CHIP C 2.7K J 1/8W		
R8			RD41FB2B104J	CYLND CHIP C 100K J 1/8W		
R9			RD41FB2B272J	CYLND CHIP C 2.7K J 1/8W		
D1			1SS226	CHIP DIODE		
IC1			LC7532M	IC(BILATERAL SWITCH)		
IC2			MN4066BS	IC(QUAD ANALOG SWITCH)		
Q1			DTC144EK	DIGITAL TRANSISTOR		
Q2 ,3			DTA114EK	DIGITAL TRANSISTOR		

E: Scandinavia & Europe K: USA P: Canada W: Europe
U: PX(Far East, Hawaii) T: England M: Other Areas
UE: AAFES(Europe) X: Australia

⚠ indicates safety critical components.

PARTS LIST

SEMICONDUCTOR

N : New parts

Item	Re-marks	Parts No.
Diode		1S1587
		BA282
		DSA3A1
		MI308
		MI407
Chip diode		1SS181
		1SS184
		1SS187
		1SS226
Chip zener diode		02CZ6.2(Y,Z)
Chip vari-cap diode		1SV164
		1SV166
Thermister		112-502-2
TR		2SC3369
		2SD1406(Y)
Chip TR		2SA1162(Y)
		2SB1119S
		2SC2712(Y)
		2SC2714(Y)
		2SC2757(T33)
		2SC2759(U22,U23)
		2SC3295(B)
		2SC3326(A)

Item	Re-marks	Parts No.
Digital TR		DTA114EK
		DTC124EK
		DTC144EK
		FMW-1
Chip FET		2SK508(K51)
		2SK508(K52)
		3SK131(V12)
		3SK184(S)
Power module		M57774
IC		KRR-C001
		LA5006M
		LC7532M
		LC7582
		M51951BML
		M54959P
		MC7808C
		MN4066BS
		NJM4558M
		TA7761F
		TC4094BP
		μPC1241H
		μPD75106G-522-1B

PARTS LIST

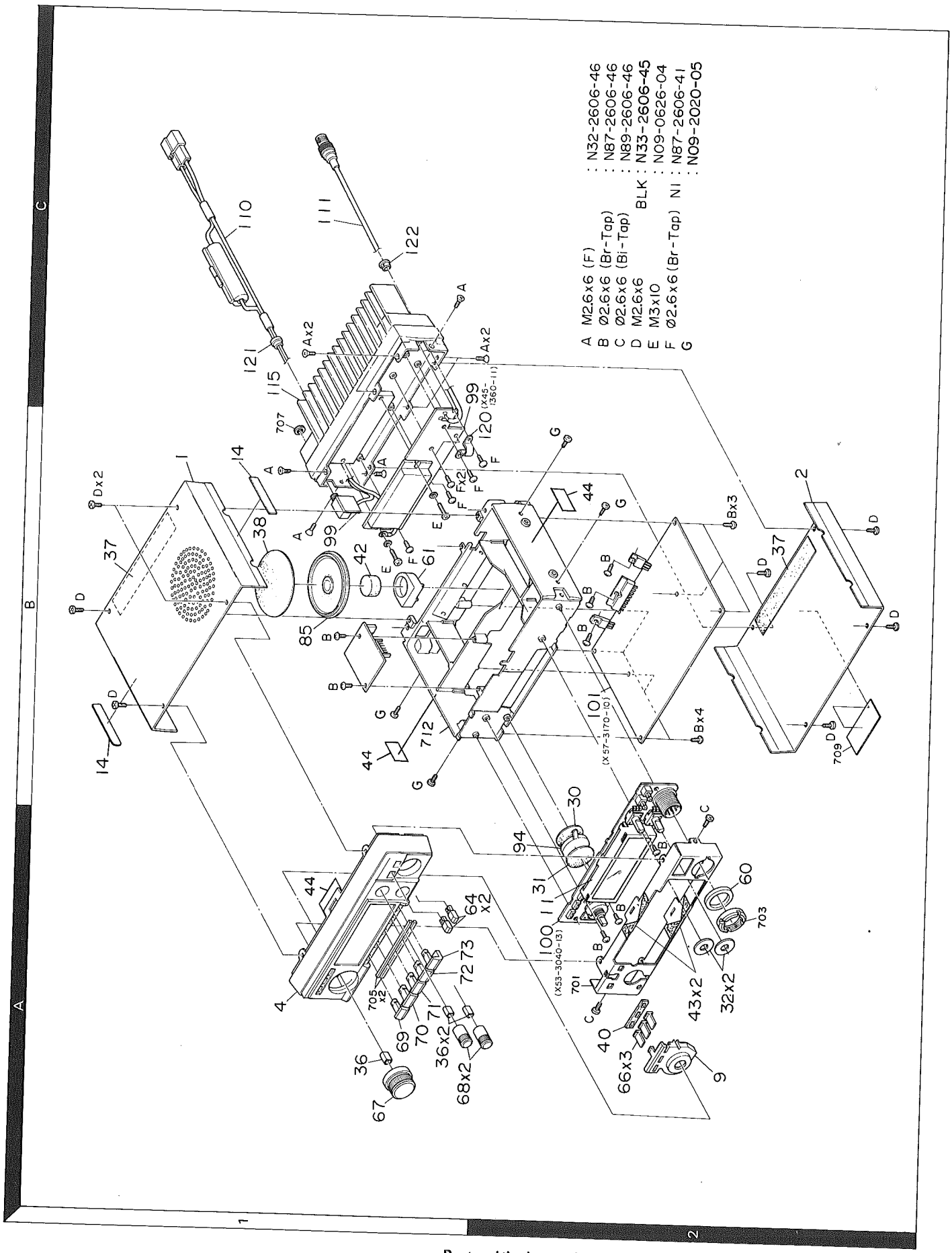
SEMICONDUCTOR

N : New parts

Item	Re-marks	Parts No.
Diode		1S1587
		BA282
		DSA3A1
		MI308
		MI407
Chip diode		1SS181
		1SS184
		1SS187
		1SS226
Chip zener diode		02CZ6.2(Y,Z)
Chip vari-cap diode		1SV164
		1SV166
Thermister		112-502-2
TR		2SC3369
		2SD1406(Y)
Chip TR		2SA1162(Y)
		2SB1119S
		2SC2712(Y)
		2SC2714(Y)
		2SC2757(T33)
		2SC2759(U22,U23)
		2SC3295(B)
		2SC3326(A)

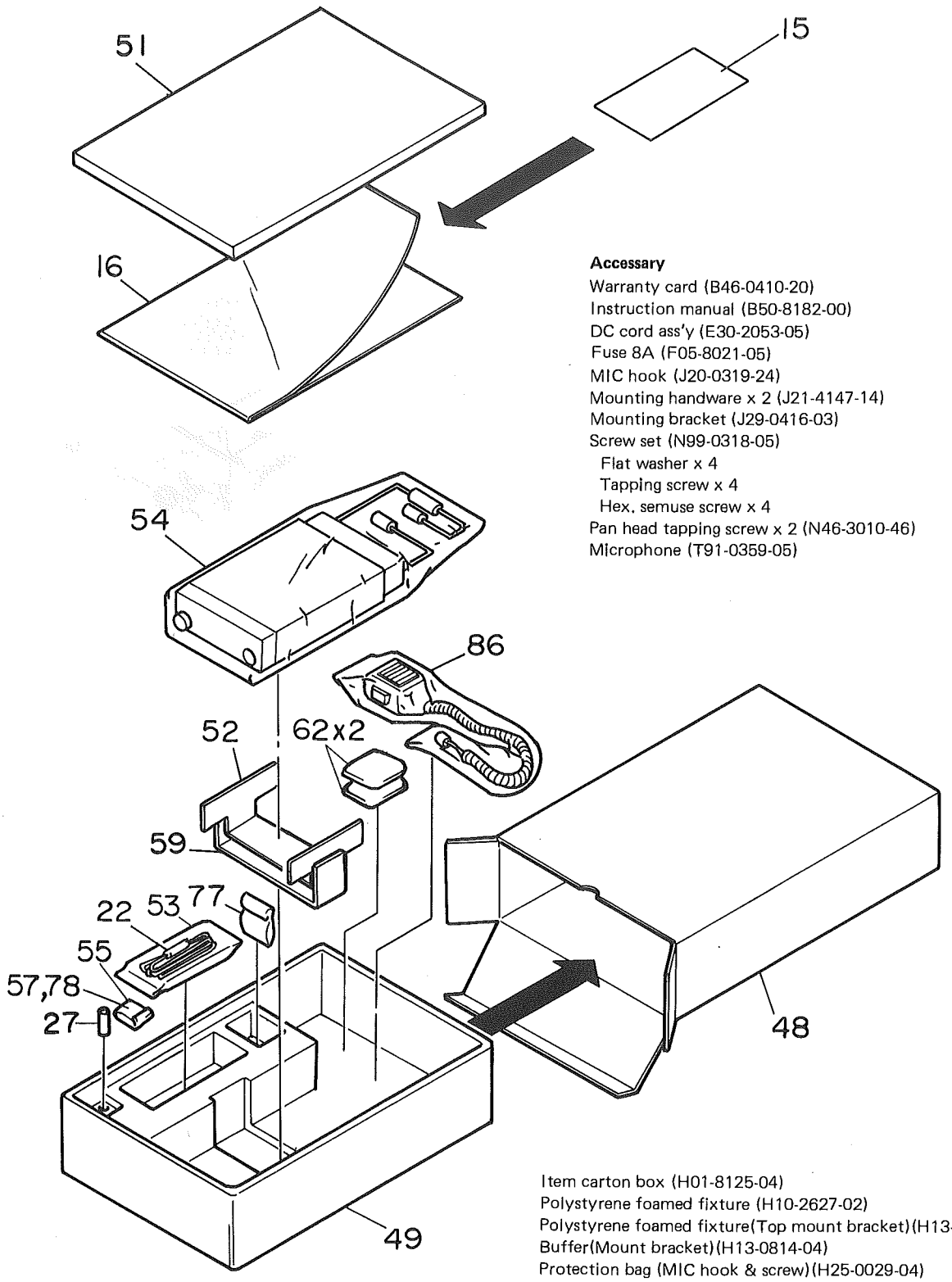
Item	Re-marks	Parts No.
Digital TR		DTA114EK
		DTC124EK
		DTC144EK
		FMW-1
Chip FET		2SK508(K51)
		2SK508(K52)
		3SK131(V12)
		3SK184(S)
Power module		M57774
IC		KRR-C001
		LA5006M
		LC7532M
		LC7582
		M51951BML
		M54959P
		MC7808C
		MN4066BS
		NJM4558M
		TA7761F
		TC4094BP
		μPC1241H
		μPD75106G-522-1B

EXPLODED VIEW



Parts with the exploded numbers larger than 700 are not supplied.

PACKING



Accessary

Warranty card (B46-0410-20)
Instruction manual (B50-8182-00)
DC cord ass'y (E30-2053-05)
Fuse 8A (F05-8021-05)
MIC hook (J20-0319-24)
Mounting handware x 2 (J21-4147-14)
Mounting bracket (J29-0416-03)
Screw set (N99-0318-05)
  Flat washer x 4
  Tapping screw x 4
  Hex. semuse screw x 4
Pan head tapping screw x 2 (N46-3010-46)
Microphone (T91-0359-05)

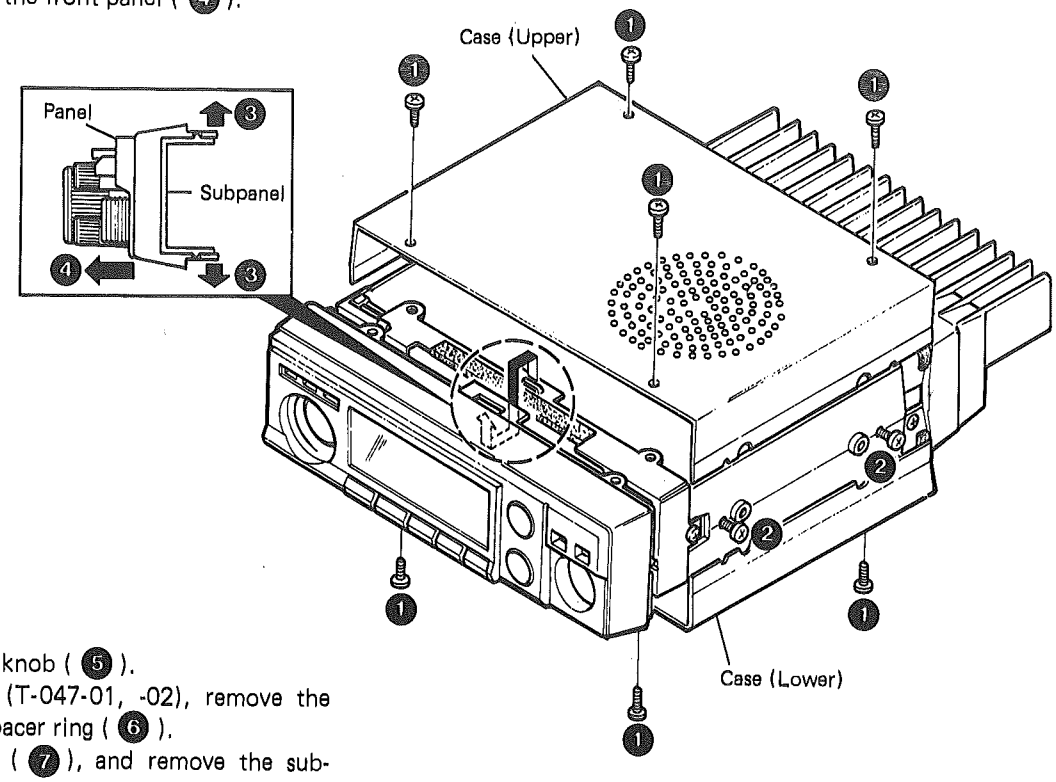
Item carton box (H01-8125-04)
Polystyrene foamed fixture (H10-2627-02)
Polystyrene foamed fixture(Top mount bracket)(H13-0812-04)
Buffer(Mount bracket)(H13-0814-04)
Protection bag (MIC hook & screw)(H25-0029-04)
Protection bag (DC cord)(H25-0049-03)
Protection bag (Radio)(H25-0720-04)

Parts with the exploded numbers larger than 700 are not supplied.

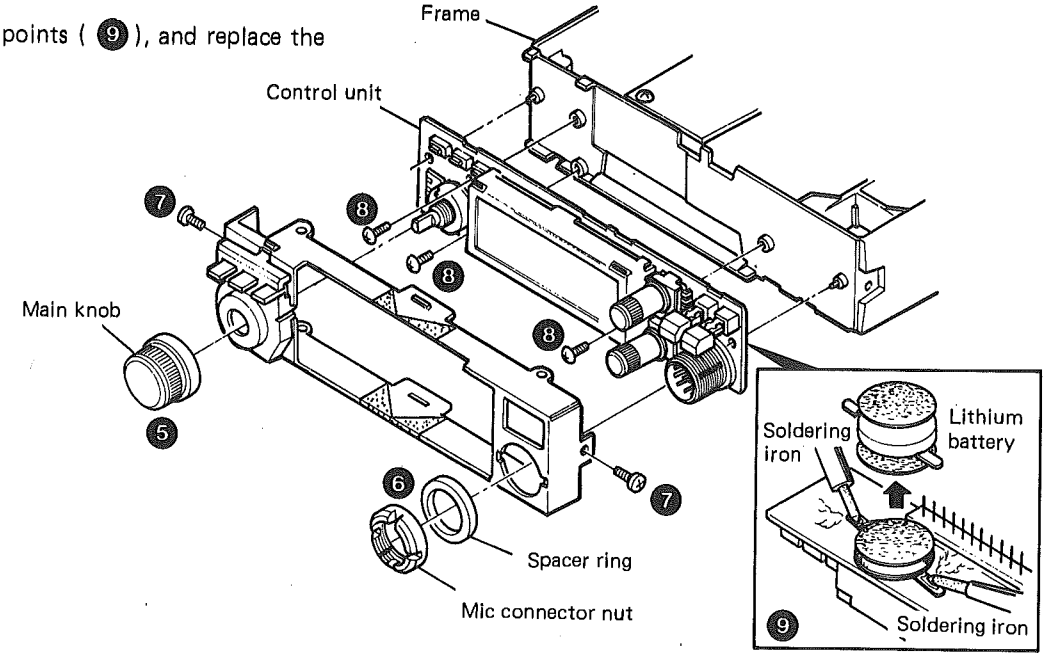
DISSASSEMBLY

Replacement of Lithium Battery

1. Remove the eight screws from the upper and lower case (❶). Loosen the four screws on the left and right panel (❷), and remove the upper and lower case.
2. Release the stoppers fixing the front panel and sub-panel (❸), and remove the front panel (❹).



3. Pull out the main control knob (❺).
4. Using the special tools (T-047-01, -02), remove the MIC connector nut and spacer ring (❻).
5. Remove the two screws (❼), and remove the sub-panel.
6. Remove three screw (❽), and remove the Control unit. As it is connected to the TX-RX unit at the rear of it via a connector pin, disconnect it gently when removing.
7. Remove solder from two points (❾), and replace the lithium battery.



ADJUSTMENT

REQUIRED TEST EQUIPMENT

1. **DC V.M**
   1) High input impedance
2. **RF VTVM (RF V.M)**
   1) Input impedance : 1MΩ min., 2pF max.
   2) Voltage range : F.S = 10mV ~ 300V
   3) Frequency range : Up to 450MHz
3. **Frequency Counter (f. counter)**
   1) Input sensitivity : Approx. 50mV
   2) Frequency range : Up to 450MHz
4. **DC Power Supply**
   1) Voltage : 10V ~ 17V, variable
   2) Current : 6A min.
5. **Power Meter**
   1) Measurement range Approx. : 50W, 3W, 1W
   2) Input impedance : 50Ω
   3) Frequency range : 450MHz
6. **AF VTVM (AF V.M)**
   1) Input impedance : 1MΩ min.
   2) Voltage range : F.S = 1mV ~ 30V
   3) Frequency range : 50Hz ~ 10kHz
7. **AF Generator (AG)**
   1) Output frquency : 100Hz ~ 10kHz
   2) Output voltage : 0.5mV ~ 1V
8. **Linear Detector**
   1) Frequency range : 450MHz
9. **Field Strength Meter**
   1) Frequency range : 450MHz
10. **Directional Coupler**
11. **Oscilloscope**
    1) High sensitivity oscilloscope with horizontal input terminal
12. **SSG**
    1) Frequency range : 144MHz and 430MHz.
    2) Modulation : AM and FM MOD.
    3) Output level : −20dB to 100dB
13. **Dummy Load**
    1) 8Ω, 50W (approx.)
14. **Noise Generator**
    1) Must generate ignition-like noise containing harmonics beyond 450MHz.
15. **Sweep Generator**
    1) Sweep range : 1440MHz and 430MHz bands
16. **Tracking generator**

PREPARATION

1) Unless otherwise specified, knobs and switches should be set as follows **Table 5**

POWER SW	ON	SHIFT SW	OFF
AF VOL VR	MIN	REV SW	OFF
SQL VOL VR	MIN	SCAN SW.	OFF
LOW SW	OFF	CTCSS SW	OFF
VFO/M SW	VFO	TONE SW	OFF

Table 5

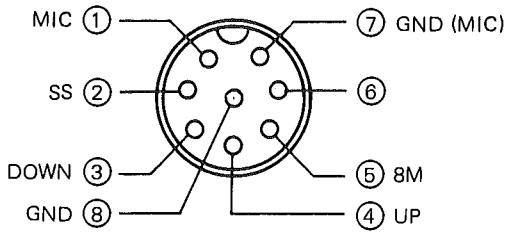


Fig. 18 MIC terminals (view from front panel side)

2) Use an insulated adjusting rod to adjust trimmers and coils.
3) To prevent damaging SSG, never connect the microphone to mic jack while adjusting the receiver section.
4) Be sure to turn the power switch OFF, before connecting the power cable to a power source.
5) SSG output levels are those at the time the output terminal is open.
6) Meter and display section should be set as follows **Fig. 19.**

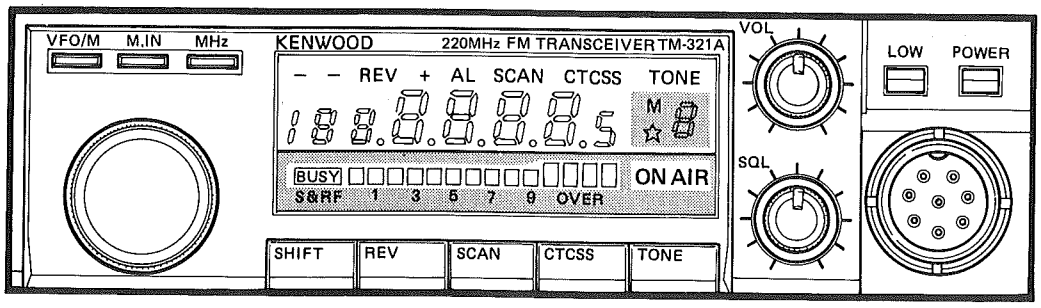


Fig. 19

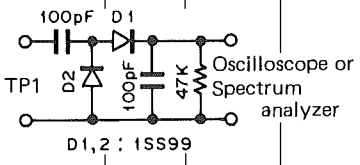
ADJUSTMENT

COMMON ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification/Remarks
		Test equipment	Unit	Terminal	Unit	Part	Method	
1. Setting	1) Power supply : 13.8V DC Power SW : OFF VOL VR : Fully counter clockwise (CCW) SQL VR : Fully counter clockwise (CCW) VR6 on TX-RX unit : Fully counter clockwise (CCW)							
2. Reset	1) Turn the power SW ON, holding the VFO/M and M.IN SW down.							Display 220.000 M□ appeared during 5 sec. then, M□ disappeared.
	2) Release the VFO/M and M.IN SW.							
3. PLL	1) RX VCO FREQ. : 220.000 Receive.	Digital volt-meter	TX-RX	TP3 (4C)	VCO	TC2 (4B)	3.0V	±0.1V
	2) TX VCO FREQ. : 220.000 Transmit.					TC1 (4B)	2.9V	±0.1V
4. TX FREQ. ADJ.	1) FREQ. : 222.500 Transmit.	f.counter Power meter	Rear panel	ANT (1E)	TX-RX	TC1 (4C)	222.500MHz	±100Hz

RECEIVER SYSTEM ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification/Remarks
		Test equipment	Unit	Terminal	Unit	Part	Method	
1. Helical	1) FREQ. : 222.500 Connect the sweep gen. to the ANT terminal and the Oscilloscope to the detector output.	Oscilloscope	TX-RX	TP1 (4E)	TX-RX	L1(3E) L2(2E) L3(3E)	Adjust for the waveform perform shown on right.	220 222.5 225
	2) Connect the spectrum analyzer to the TP1 terminal, from the TX-RX unit.							
	3) Connect the TP3 terminal to GND terminal.							
2. GAIN	1) FREQ. : 222.520 SSG output : 5dBμ MOD : OFF	Digital multi-meter	TX-RX	TP2 (4D)	TX-RX	L4(4E) L5(4E) L7(4E) L9(4E)	Repeat for MIN. Repeat the adjustment in order of L5 and L7.	Check : Accurate SSG's freq.
3. Discri	1) FREQ. : 222.520 SSG output : 20dBμ MOD : 1kHz DEV : ±5kHz	AF VM Oscilloscope 8Ω dummy load	Rear panel	SP (1B)	TX-RX	L11 (4D)	AF MAX.	
4. Tight Squelch	1) FREQ. : 222.520 SQL VR : MAX SSG output : −4dBμ MOD : 1kHz DEV : 3kHz	AF VM Oscilloscope 8Ω dummy load	Rear panel	SP (1B)	TX-RX	VR8 (4E)		Turn the VR8 clockwise to the point at which squelch just close, then turn the VR8 counter clockwise to the point at which squelch just opens.



ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification/Remarks
		Test equipment	Unit	Terminal	Unit	Part	Method	
5. Sensitivity	1) FREQ. : 222.520 SSG output : −9dBμ	AF VM Oscillo-scope 8Ω dummy load	Rear panel	SP (1B)			Check	SINAD 12dB or more.
	2) FREQ. : 220.020							
	3) FREQ. : 224.960							
6. S-meter	1) FREQ. : 222.520 SSG output : −6dBμ MOD : OFF	LCD (S-meter)			TX-RX	VR1 (4D)	Set the RF scale to reads "2 digit".	
	2) SSG output : 16dBμ						All digits light.	
	3) SSG : OFF							S-meter lights OFF.

TRANSMITTER SYSTEM ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification/Remarks
		Test equipment	Unit	Terminal	Unit	Part	Method	
1−1. RF output	1) FREQ. : 222.500 VR6 (TX-RX unit) : Fully clockwise (CW) VR1 (Final unit) : Center Transmit.	Power meter (DC power supply galvo meter)	Rear panel	ANT (1E)	TX-RX	TC2 (3A) TC3 (2B)	MAX	29W or more.
								ON AIR LCD indicated.
	2) FREQ. : 224.980 Transmit.					VR6 (3B)	28W	±4W, less than 6.5A. 28W, less than 6.5A.
	3) FREQ. : 220.000 Transmit.						Check	28W or more, less than 6.5A.
	4) FREQ. : 224.980 Transmit.							
1−2. LOW Power	1) FREQ. : 222.500 LOW SW : ON Transmit.				TX-RX	VR7 (3B)	5W	±2W, less than 3.5A.5A
2. RF meter	1) FREQ. : 222.500 Transmit.	LCD (RF meter)			TX-RX	VR4 (3B)	Set to the RF scale reads "6 digits".	
	2) LOW SW : OFF Transmit.							All digits light.
3. DEV.	1) FREQ. : 222.500 AG : 1kHz, 50mV • MS-57A/61A (Anritsu) HPS : OFF LPF : 20kHz De-emphasis : OFF	Linear detector Modula-tion analyzer Power meter	Rear panel	ANT (1E) • 4101 (WAVETEK) Filter : 25kHz/15kHz De-emphasis : OFF	TX-RX	VR3 (3C)	±4.5kHz	±200Hz
	2) AG : 1kHz, 5mV				TX-RX	VR2 (3C)	±3kHz	±200Hz

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specification/Remarks
		Test equipment	Unit	Terminal	Unit	Part	Method	
4. Protection	1) FREQ. : 222.500 Transmit.	Power meter Digital multi-meter	Final	TP1 (2E)	Final	VR1 (2E)	Dip point 	
	2) Disconnect the power meter from ANT terminal. Transmit.	DC AM (DC power supply galvo-meter)			TX-RX	VR5 (3C)	3.5A	±6A
5. TONE	1) FREQ : 222.500 TONE SW : ON Transmit	Linear detector Modula-tion analyzer Power meter f.counter	Rear panel	ANT (1E)				FREQ. : 88.0~89.0Hz DEV. : ±0.5~1kHz

Microprocessor operation check

Item	Condition	Operation check
1. Reset	1) Turn the Power switch ON holding the VFO/M and M.IN switches down.	Display 220.000 The M0 indicator and the Memory channel number display light for approx. 5 sec. after release the switches.
	2) Release the VFO/M and M.IN switches.	
2. FREQ. step selection	1) Press the M.IN switch.	M indicator lights.
	2) Press the M.IN switch, then press the REV switch within 5 sec.	Display 00000 5 Turn the Tuning control and the UP/DOWN switches to increase or decrease the figures as shown below. 20←25←5→10→15 CCW CW 15→10→5←25←20
	3) Press any switch except the LOW and the Power switches to return to the normal receive FREQ.	Receive FREQ. lights. (to return to the normal FREQ.)
3. FREQ. step selection (MHz)	1) Press the MHz switch.	The kHz digits goes off.
	2) Turn the Tuning control switch to CW or CCW.	Rotating the Tuning control switch changes the FREQ. in 1MHz step.
	3) Press any switch except the LOW and the Power switches to return to the normal receive FREQ.	The kHz digits lights.

Item	Condition	Operation check
4-1. Memory entry (simplex standard offsets)	Simplex memory channels are; M0~9, MA, b. Determine the desired FREQ., SHIFT, CTCSS, TONE FREQ. then follow the procedure below.	
	1) Press the M.IN switch.	The memory channel number display lights.
	2) Select the desired memory channel using the Tuning control or the Microphone UP/DOWN switch. This selection should be completed within 5 sec. after the M.IN switch is pressed.	
	3) Press the M.IN switch within 5 sec. after the memory channel selection is completed.	Memory entry is completed.
4-2. Odd split memory channels	1) Select the desired FREQ. using the Tuning control or the Microphone UP/DOWN switch. (as described in Item 4-1.)	

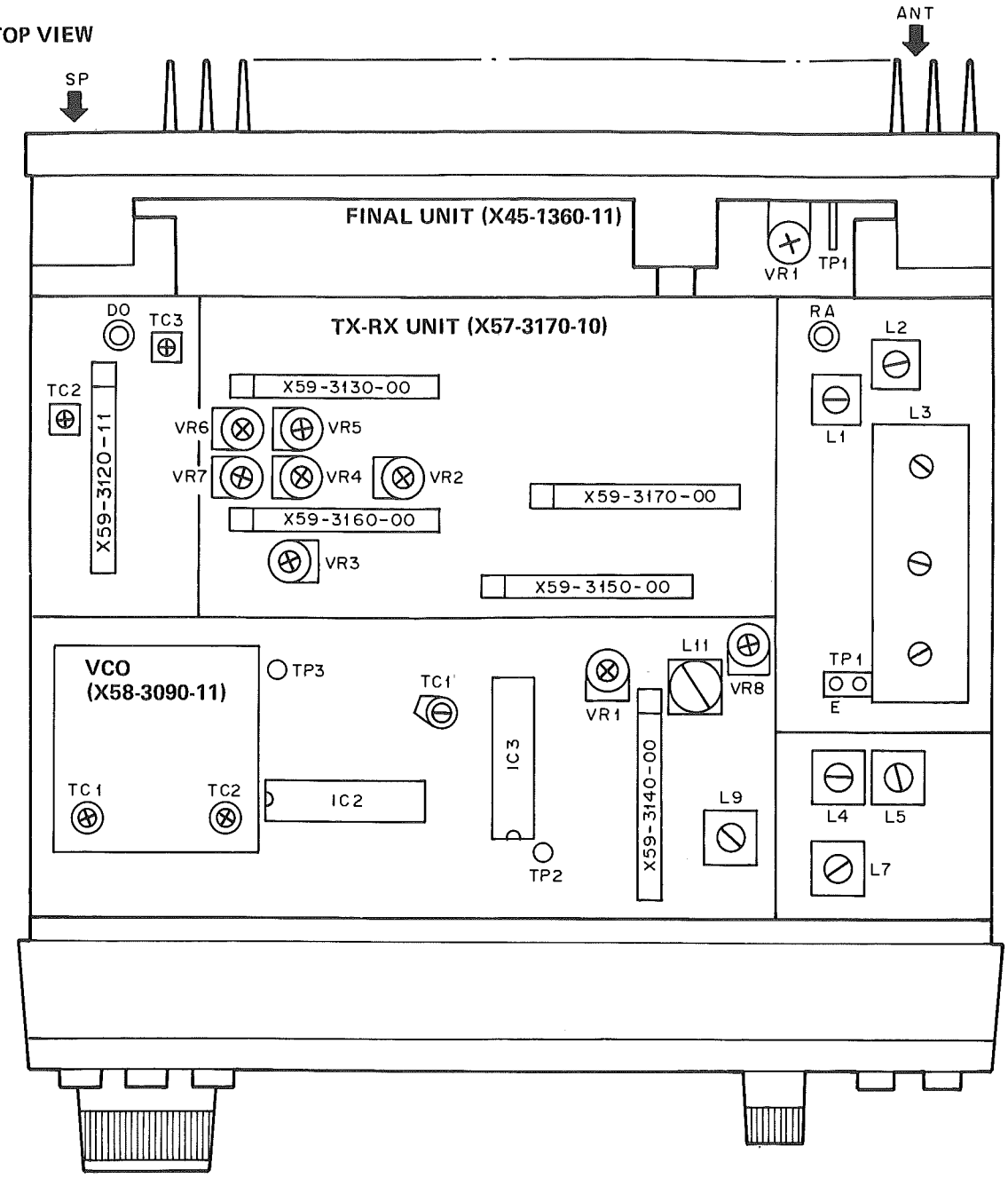
ADJUSTMENT

Item	Condition	Operation check
4–2. Odd split memory channels	2) Press the M.IN switch	The beeper sound changes. [M] indicator lights. The memory channel number display is not light.
	The receive FREQ. memory entry is completed, then changes to the waiting mode of the transmit FREQ. memory entry.	
	4) Select the desired transmit FREQ. using the Tuning control or the Microphone UP/DOWN switch.	
	5) Press the M.IN switch.	Memory entry is completed.
5. TONE FREQ.	1) Press the M.IN switch and then TONE switch. (within 5 sec. after pressing the M.IN switch.)	TONE FREQ. lights.
	2) Select the desired TONE FREQ. using the Tuning control or the Microphone UP/DOWN switch. (a value in the 67.0 to 250.3)	

Item	Condition	Operation check
5. TONE FREQ.	3) Press any switch except the LOW and the Power switches to return to the normal VFO FREQ.	Receive FREQ. lights.
6. Memory channel lockout selection	1) Press the VFO/M switch to select the memory channel mode.	[C] indicator lights.
	2) Select the desired memory channel to skip using the Tuning control or the Microphone UP/DOWN switch.	
	3) Press the M.IN switch and the SCAN switch. When the M.IN switch is pressed, the M indicator lights. The SCAN switch should be pressed within 5 sec. after the M.IN switch is pressed, or the M indicator goes off.	[★3] indicator lights. The asterisk (★) lights in the left of the memory channel number display. The indicated memory channel is skipped during SCAN operation.

ADJUSTMENT

TOP VIEW



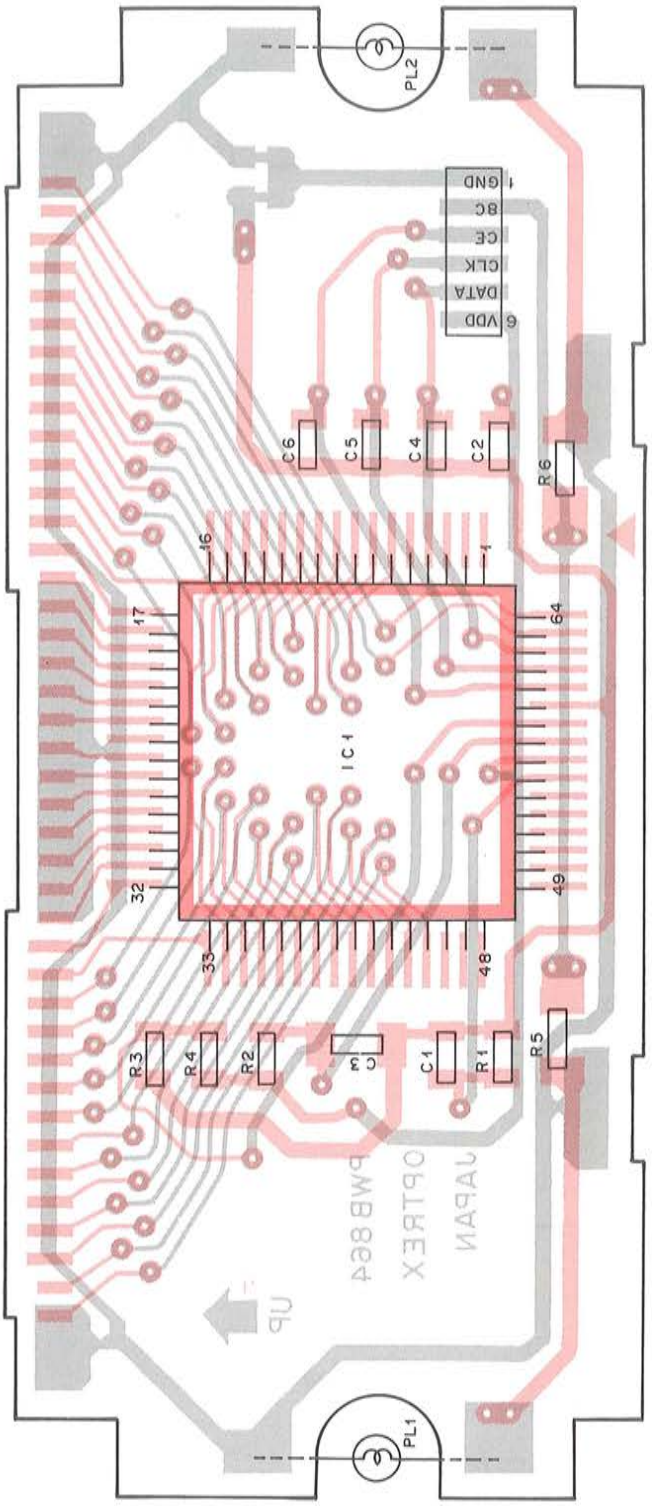
TX-RX UNIT (X57-3170-10)
VR1 : S-meter
VR2 : DEV. 1kHz, 5mV, ±3kHz
VR3 : DEV. 1kHz, 50mV,±4.5kHz
VR4 : RF meter
VR5 : PRO.
VR6 : RF output
VR7 : Low power
VR8 : Tight Squelch
L1,2,3 : Helical
L4,5,7,9 : IF GAIN
L11 : Discri
TC1 : TX frequency
TC2,3 : RF output

FINAL UNIT (X45-1360-11)
VR1 : PRO. (NULL)

VCO (X58-3090-11)
TC1 : TX VCO
TC2 : RX VCO

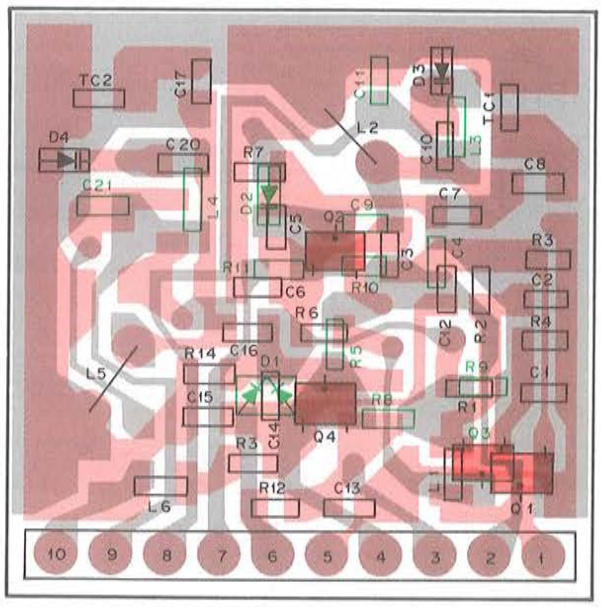
TM-321A PC BOARD VIEWS

LCD ASS'Y (B38-0303-05) Component side view



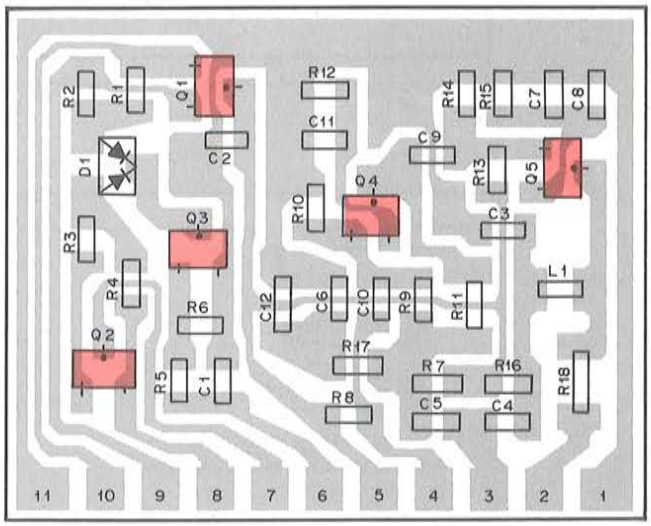
IC1 : LC7582

VCO (X58-3090-11) Component side view



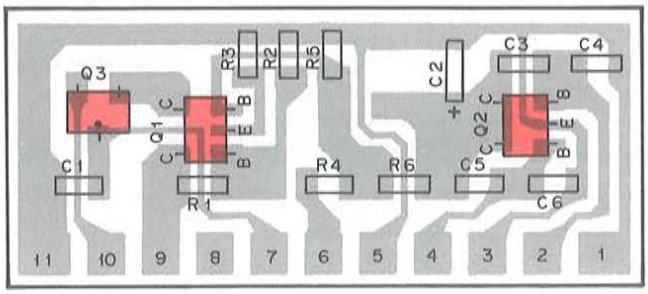
Q1 : 2SC2757(T33) Q2 : 2SK508(K52)
Q3 : 2SC2712(Y) Q4 : 2SK508(K51)
D1 : 1SS184 D2 : 1SV164
D3,4 : 1SV166

DRIVE (X59-3120-11) Component side view



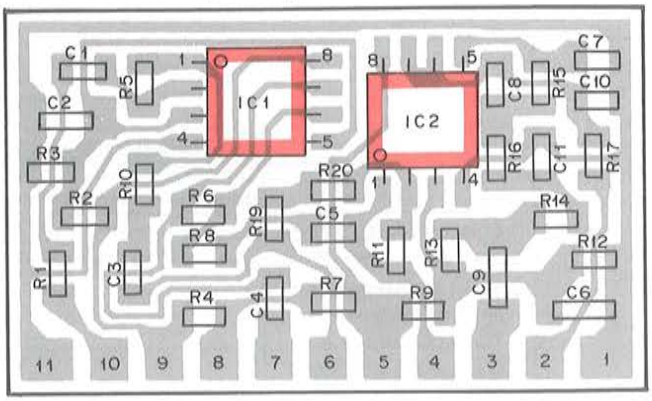
Q1,2 : 2SA1162(Y) Q3 : 2SC2712(Y)
Q4 : 2SC2714(Y) Q5 : 2SC2759(U22,U23)
D1 : 1SS184

APC (X59-3130-00) Component side view



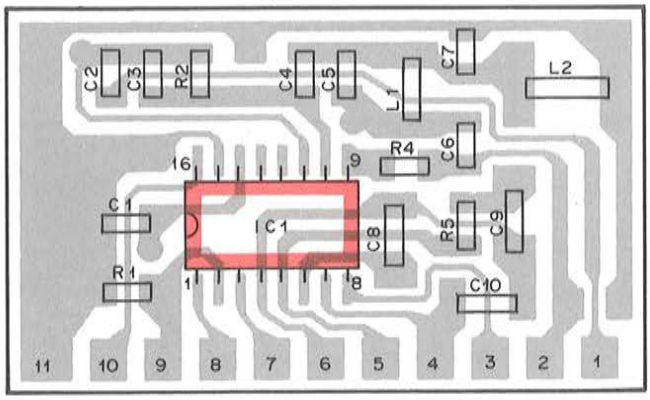
Q1,2 : FMW-1 Q3 : 2SA1162(Y)

MIC (X59-3160-00) Component side view



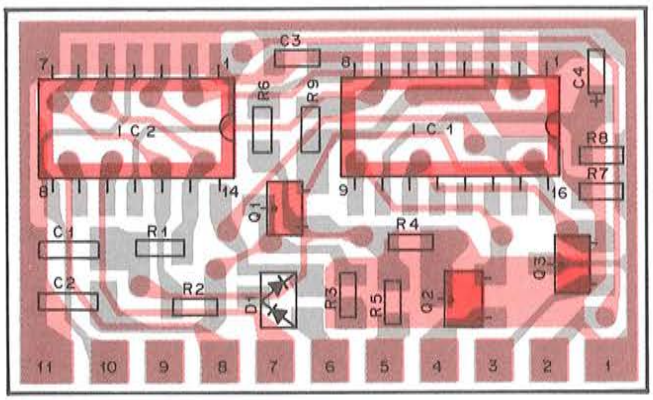
IC1,2 : NJM4558M

IF (X59-3140-00) Component side view



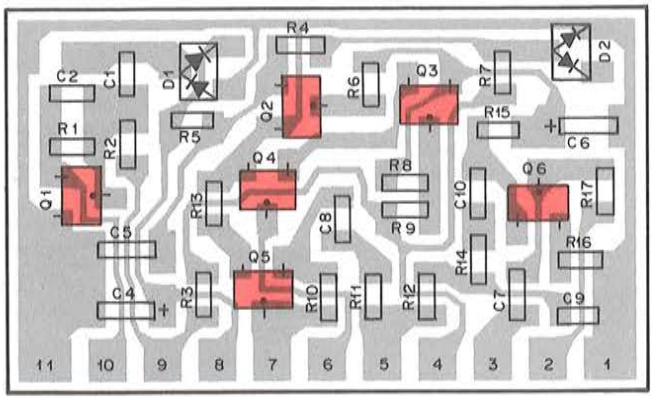
IC1 : TA7761F

VOL (X59-3170-00) Component side view



Q1 : DTC144EK Q2,3 : DTA114EK
IC1 : LC7532M IC2 : MN4066BS
D1 : 1SS226

SQL (X59-3150-00) Component side view



Q1,2,5,6 : 2SC2712(Y) Q3,4 : 2SC3295(B)
D1 : 1SS226 D2 : 1SS181

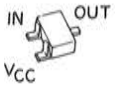
2SA1162 2SC2757
2SC2712 2SC3295
2SC2714 2SC2759

2SK508

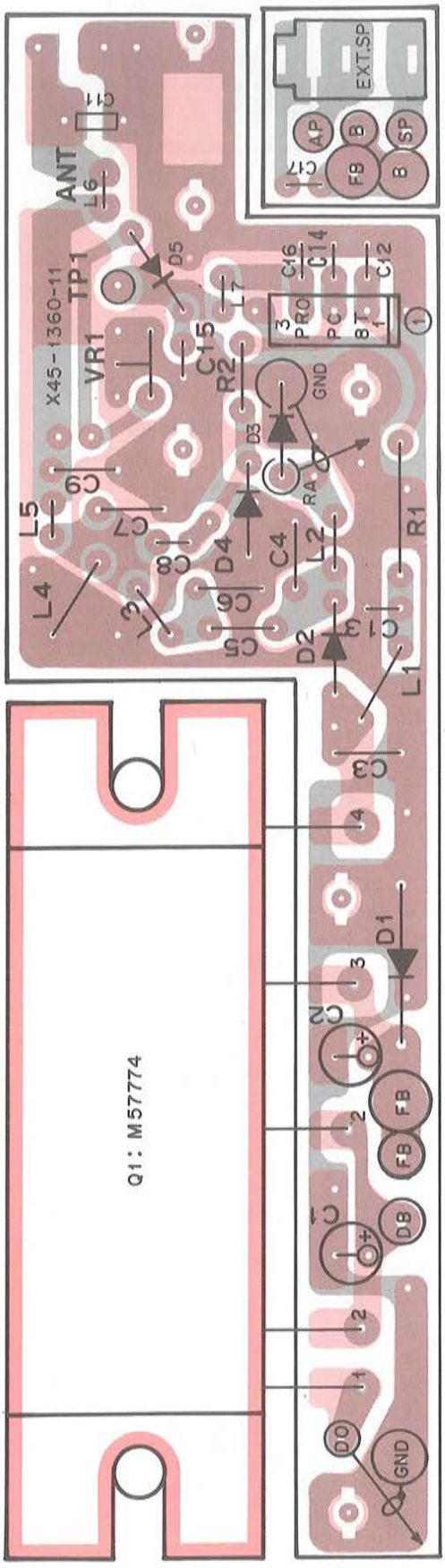
FMW-1

DTC144EK

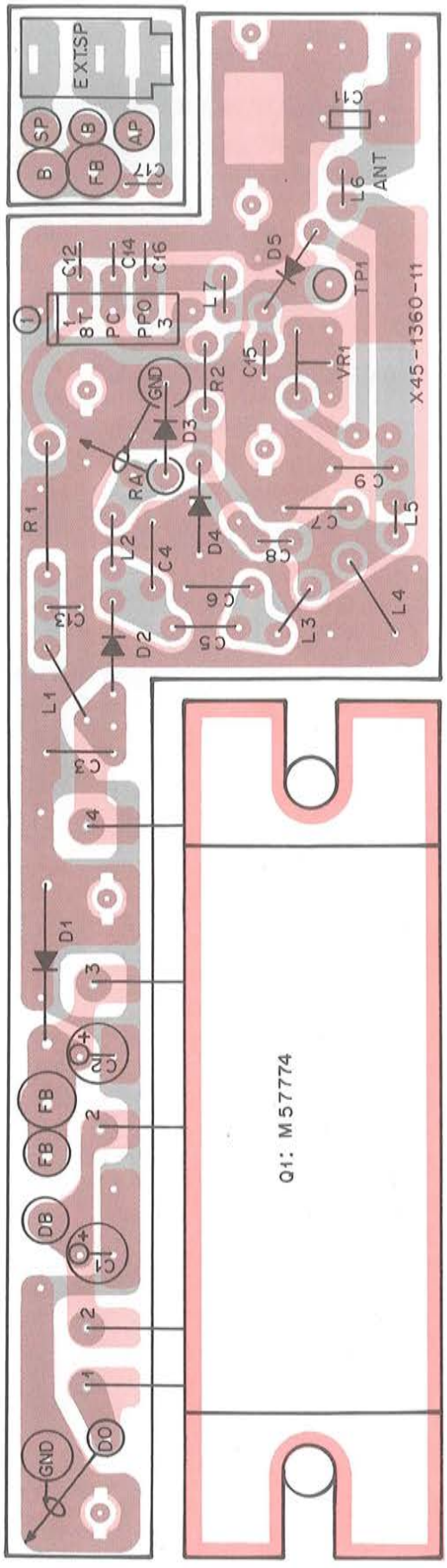
DTA114EK



FINAL UNIT (X45-1360-11) Component side view



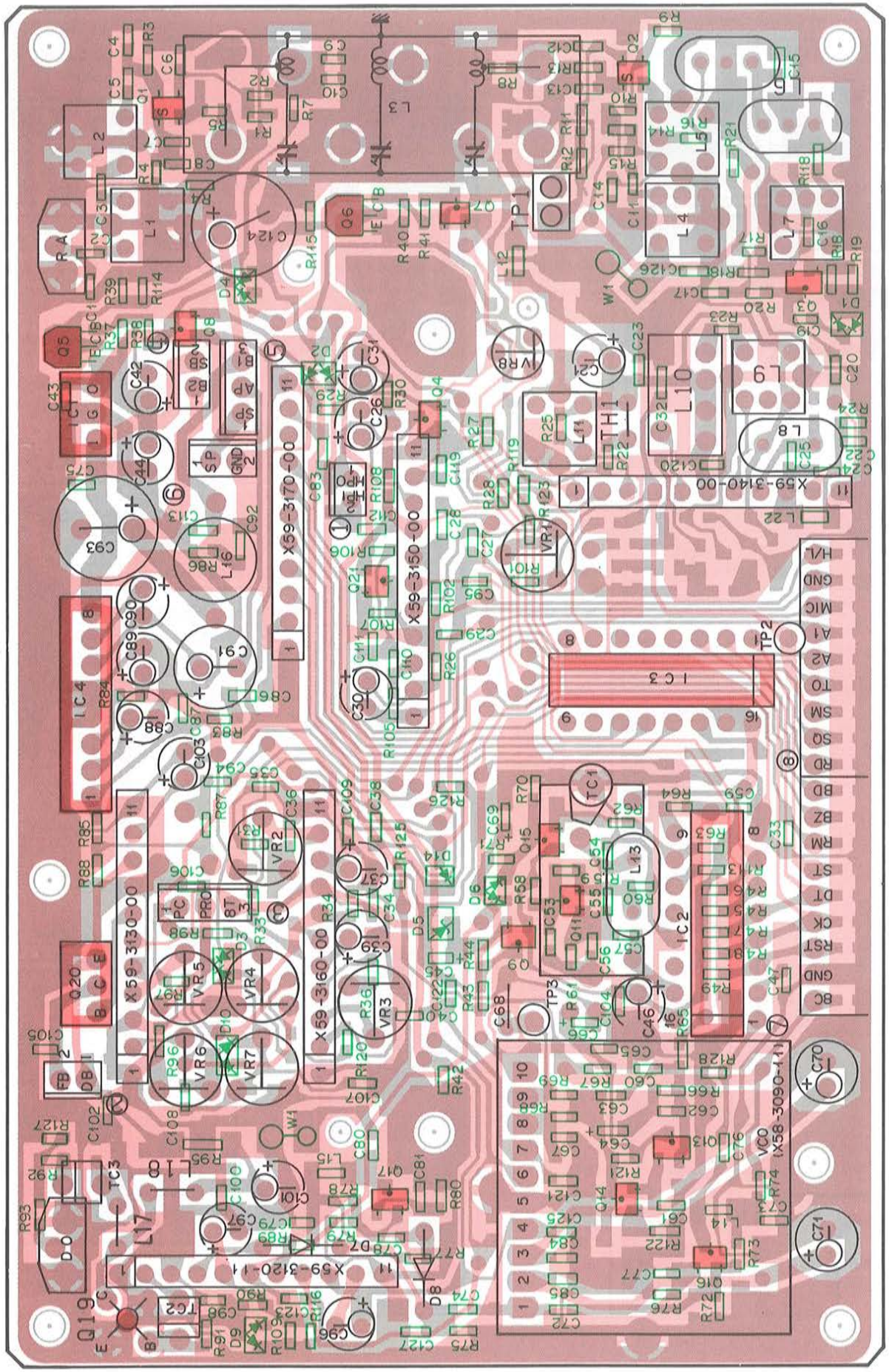
FINAL UNIT (X45-1360-11) Foil side view



Q1 : M57774
D1 : DSA3A1 D2 : MI407 D3 : MI308 D4,5 : 1S1587

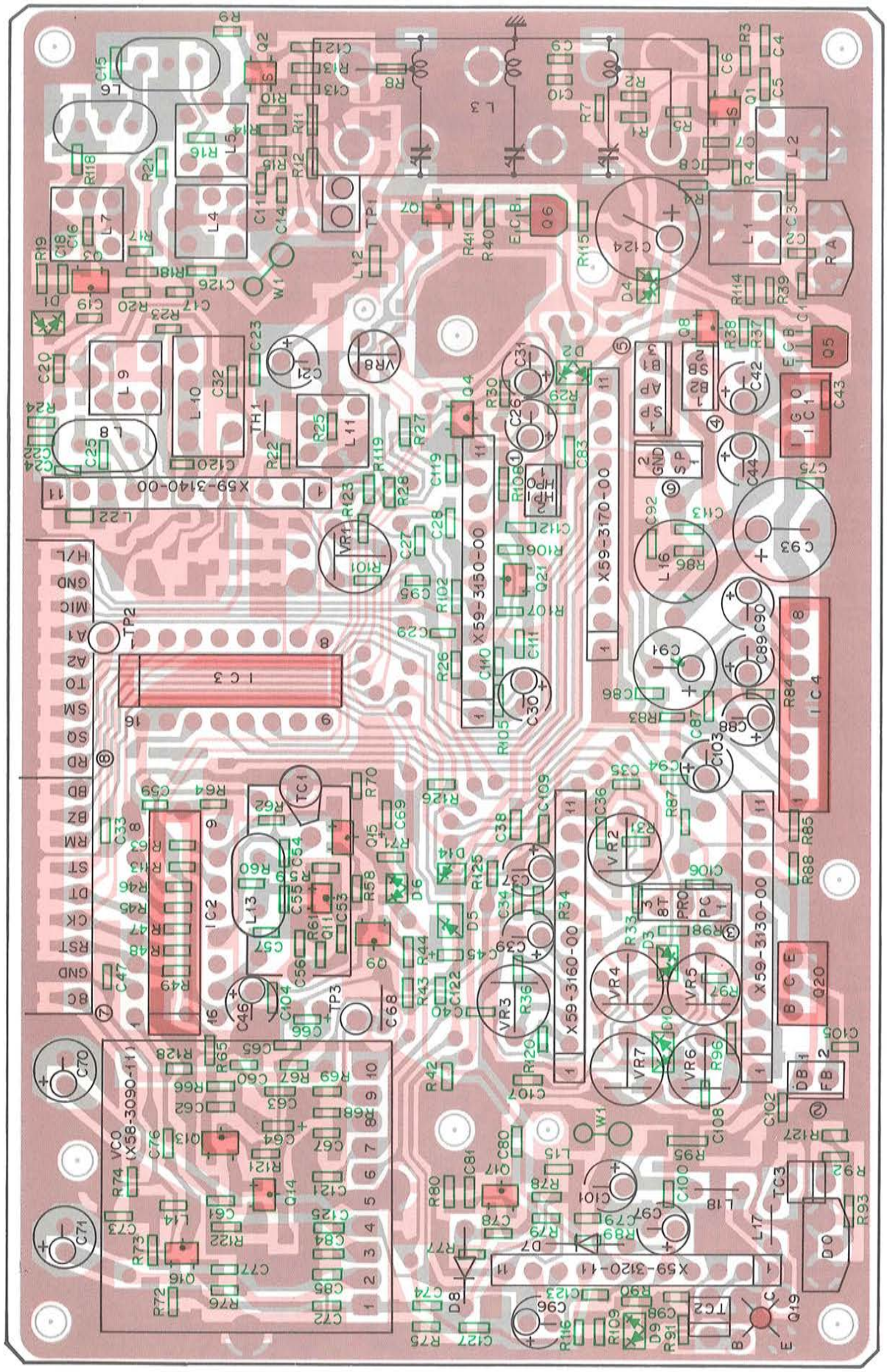
TM-321A PC BOARD VIEW

TX-RX UNIT (X57-3170-10) Component side view

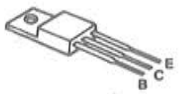


Q1 : 3SK184(S) Q2 : 3SK131(V12) Q3,11,16,17 : 2SC2714(Y) Q4 : 2SC3326(A) Q5,6 : 2SB1119S Q7,8 : DTC124EK
Q9,13,14,21 : 2SC2712(Y) Q15 : 2SA1162(Y) Q19 : 2SC3369 Q20 : 2SD1406(Y)
IC1 : MC7808C IC2 : M54959P IC3 : TC4094BP IC4 : µPC1241H
D1 : 1SS226 D2,6,9,10 : 1SS181 D3,4 : 1SS184 D5 : 02CZ6.2(Y,Z) D7,8 : BA282 D14 : 1SS187

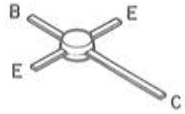
TX-RX UNIT (X57-3170-10) Foil side view



2SD1406

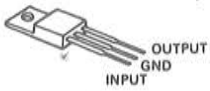


2SC3369



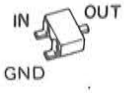
2SB1119S

MC7808C

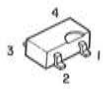


2SA1162
2SC2712
2SC2714
2SC3326

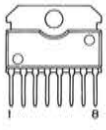
DTC124EK



3SK131
3SK184



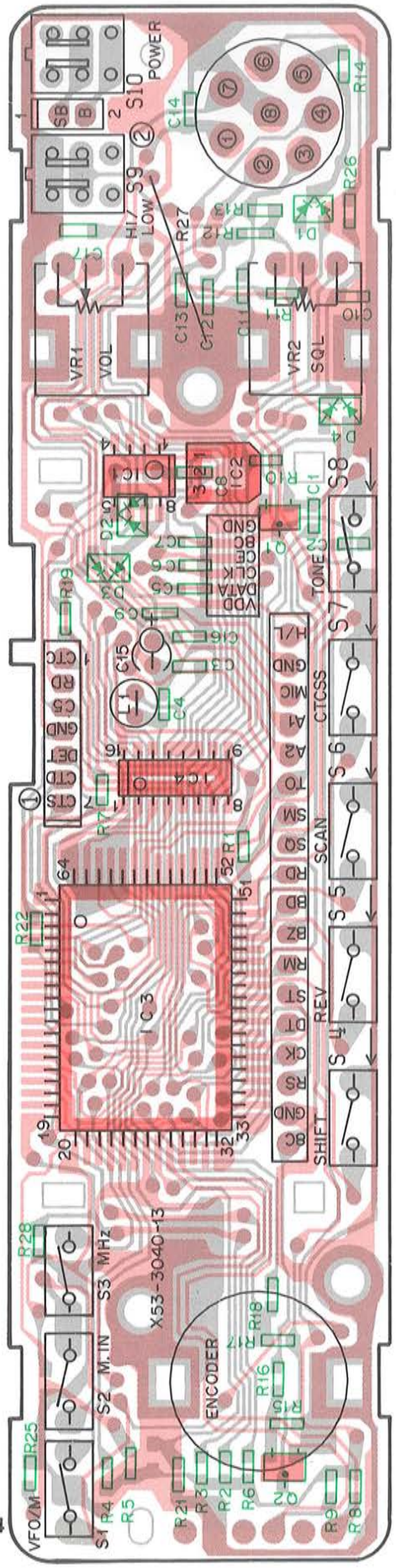
μPC1241H



TM-321A PC BOARD VIEWS

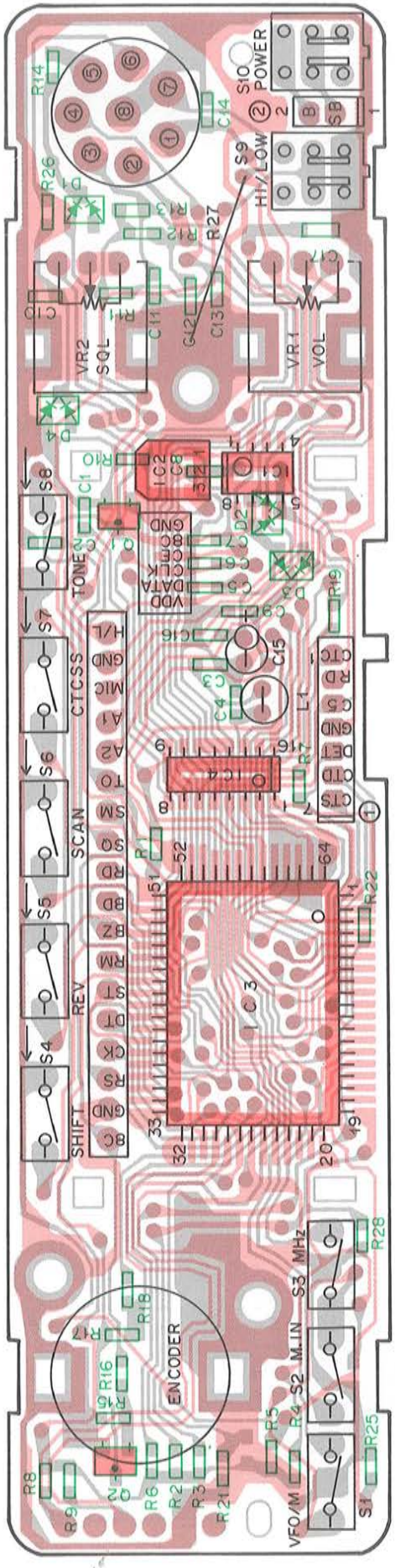
CONTROL UNIT (X53-3040-13)

Component side view



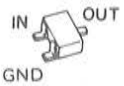
CONTROL UNIT (X53-3040-13)

Foil side view



2SC2712

DTC124EK

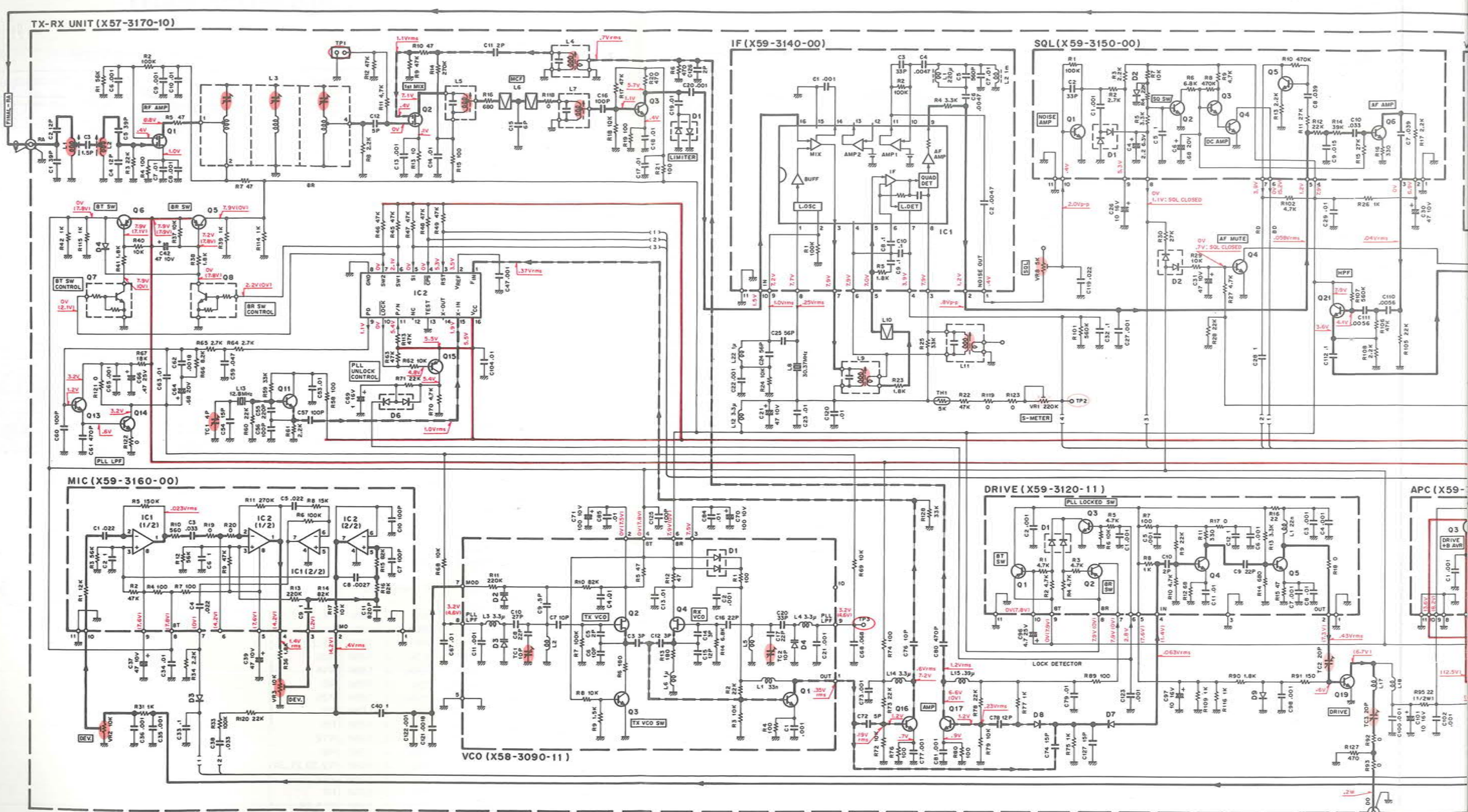


M51951BML

Q1 : DTC124EK Q2 : 2SC2712(Y)
IC1 : LA5006M IC2 : M51951BML IC3 : μPD75106G-522-1B IC4 : KRR-C001
D1–4 : 1SS184

Signal line — Control line — Common DC line

SCHEMATIC DIA



Q1	: 3SK184(S)	IC1	: MC7808C	D1	: 1SS226
Q2	: 3SK131(V12)	IC2	: M54959P	D2,6,9,10	: 1SS181
Q3,11,16,17	: 2SC2714(Y)	IC3	: TC40948P	D3,4	: 1SS184
Q4	: 2SC3326(A)	IC4	: μPC1241H	D5	: 02CZ6.2(Y,Z)
Q5,6	: 2SB1119S			D7,8	: BA282
Q7,8	: DTC124EK			D14	: 1SS187
Q9,13,14,21	: 2SC2712(Y)				
Q15	: 2SA1162(Y)				
Q19	: 2SC3369				
Q20	: 2SD1406(Y)				
TH1	: 112-502-2				

(X58-3090-11)

Q1	: 2SC2757(T33)
Q2	: 2SK508(K52)
Q3	: 2SC2712(Y)
Q4	: 2SK508(K51)
D1	: 1SS184
D2	: 1SV164
D3,4	: 1SV166

(X59-3120-11)

Q1,2	: 2SA1162(Y)
Q3	: 2SC2712(Y)
Q4	: 2SC2714(Y)
Q5	: 2SC2759(U22,U23)
D1	: 1SS184

(X59-3130-00)

Q1,2	: FMW-1
Q3	: 2SA1162(Y)

(X59-3140-00)

IC1	: TA7761F

(X59-3150-00)

Q1,2,5,6	: 2SC2712(Y)
Q3,4	: 2SC3295(B)
D1	: 1SS226
D2	: 1SS181

(X59-3160-00)

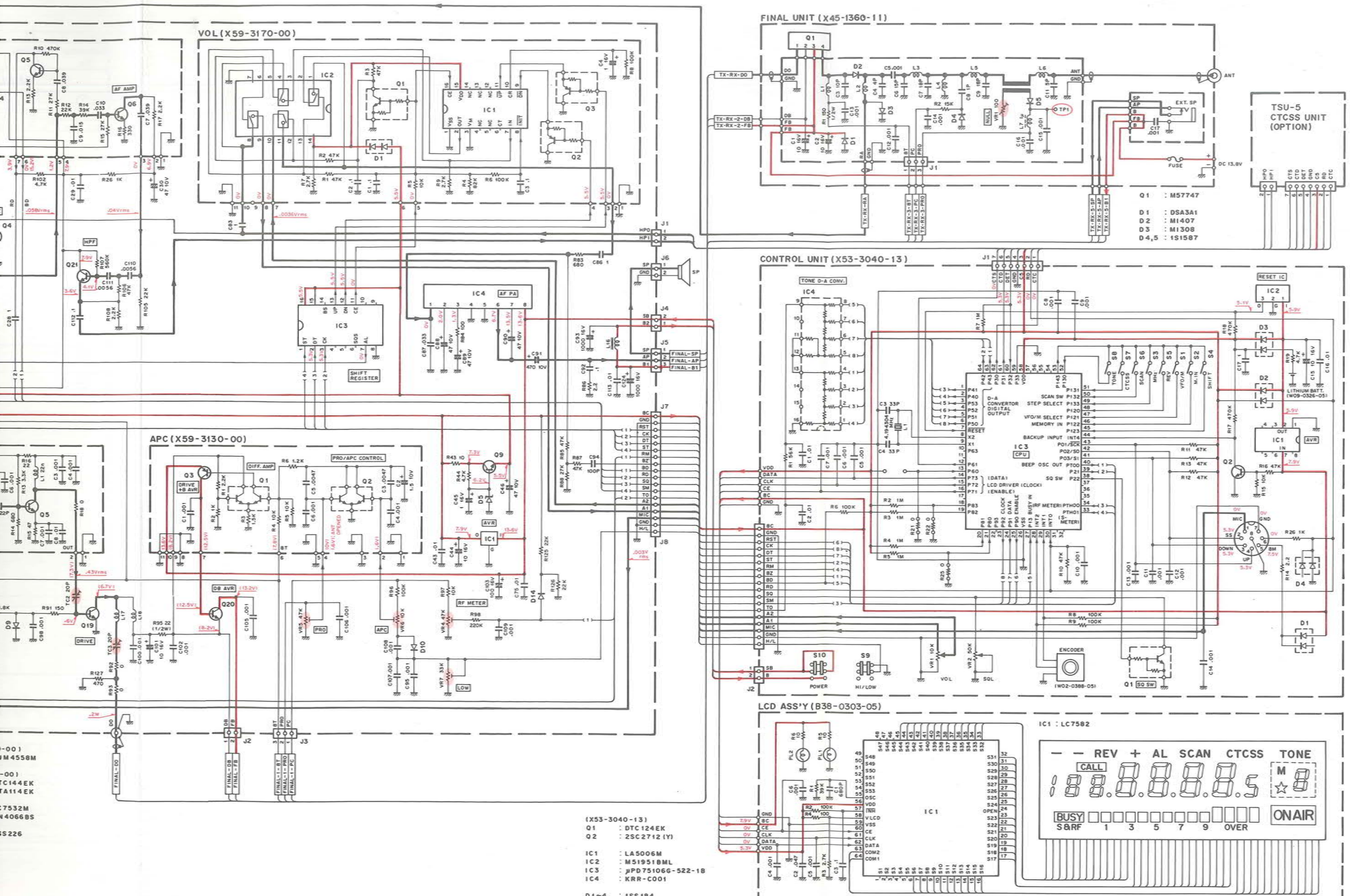
IC1,2	: NJM4558M

(X59-3170-00)

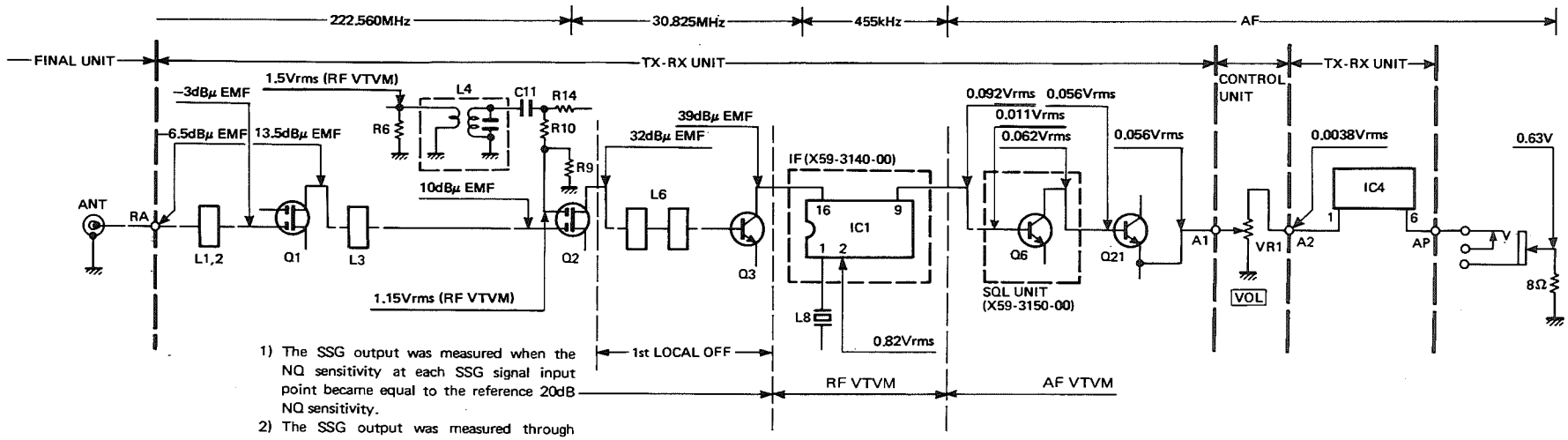
Q1	: DTC144EK
Q2,3	: DTA114EK
IC1	: LC7532M
IC2	: MN4066BS
D1	: 1SS226

SCHEMATIC DIAGRAM

Voltage measurement conditions f = 220.00 MHz, RX no signal, ( ) : TX.

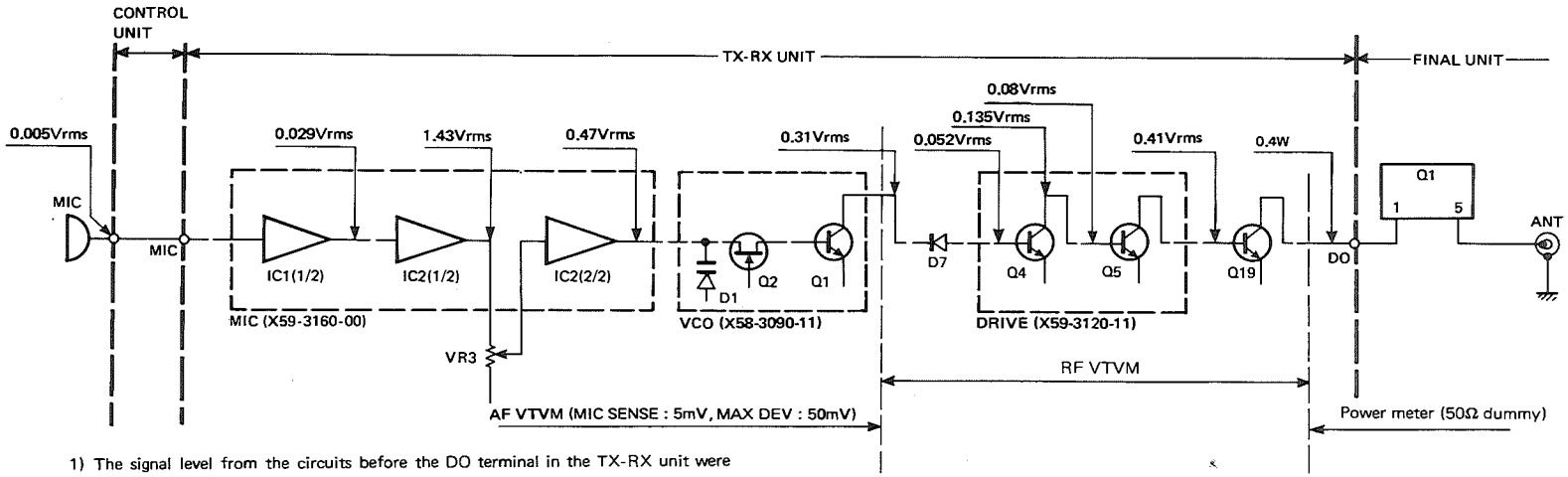


RX SECTION



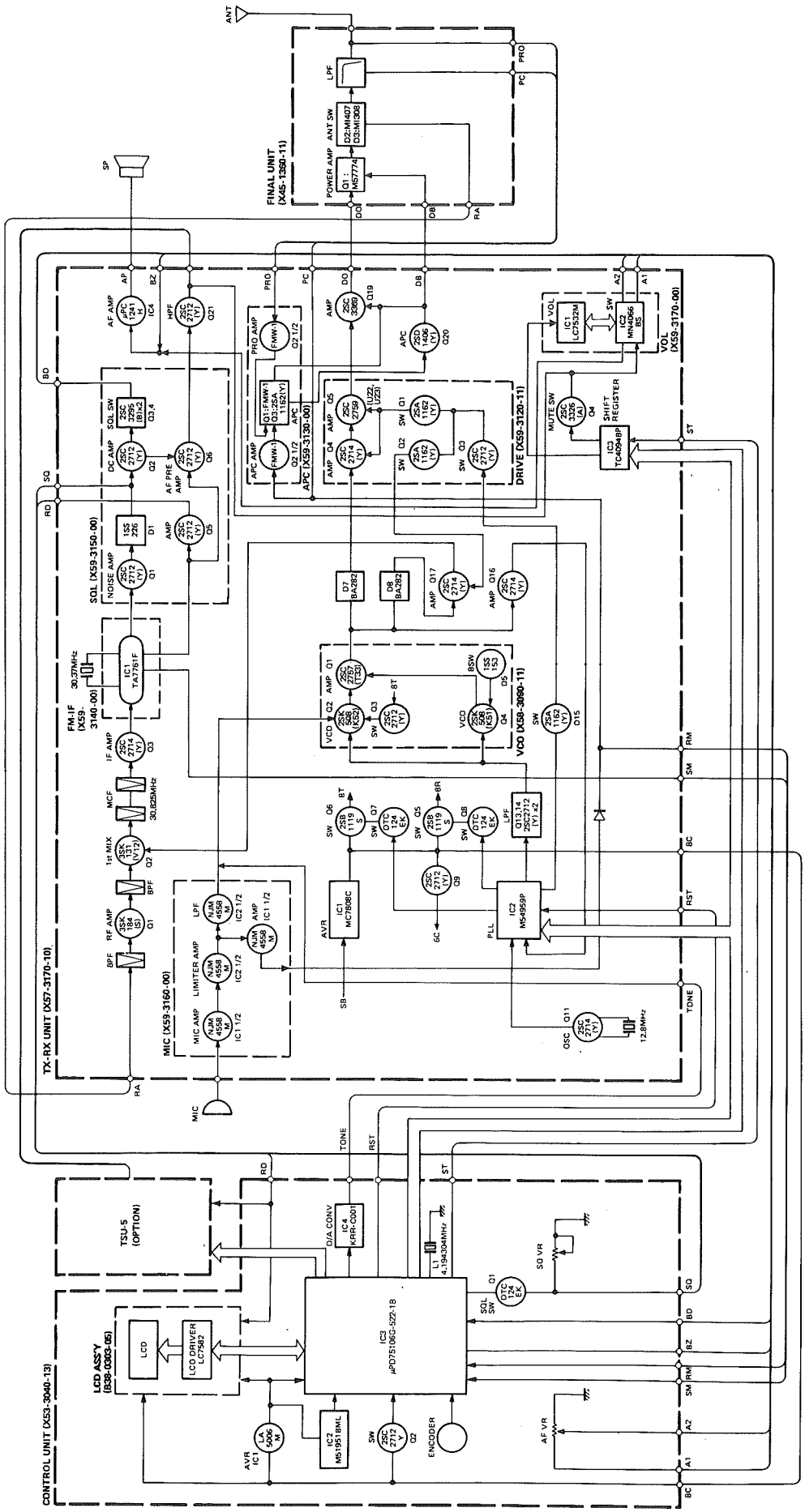
1) The SSG output was measured when the NQ sensitivity at each SSG signal input point became equal to the reference 20dB NQ sensitivity.
2) The SSG output was measured through a 0.01μF capacitor.

TX SECTION



1) The signal level from the circuits before the DO terminal in the TX-RX unit were measured with the DO coaxial cable disconnected.
2) The circuits were measured with a RF prove.
3) FREQ. : 222.560MHz

BLOCK DIAGRAM



TERMINAL FUNCTIONS

Connector No.	Terminal No.	Terminal Name	Terminal Function
FINAL UNIT (X45-1360-11)			
①	1	8T	TX + 8T
	2	PC	Auto power control
	3	PRO	Protection
		RA	RX ANT
		DO	Drive output
		AP	Audio power
		B	+ B
		SP	Speaker
		FB	Final + B
		DB	Drive +B
CONTROL UNIT (X53-3040-13)			
①	1	CTC	CTCSS IC clock
	2	RD	Remote data
	3	5C	+ 5V
	4	GND	GND
	5	DET	Tone detector output
	6	CTD	CTCSS IC data
	7	CTS	CTCSS shift register reset
②	1	SB	Switched + B (13.8V)
	2	B	+ B2
③		8C	+ 8V
		GND	GND
		RS	PLL enable
		CK	PLL & shift register clock
		DT	PLL & shift register data
		ST	Shift register strobe
		RM	RF meter
		BZ	Beep output
		BD	Busy display
		RD	Remote data
		SQ	Squelch
		SM	S meter
		TO	Tone output
		A2	AF output
		A1	AF input
		MIC	Mic AF input
		GND	GND
		H/L	Hi/low switch
④		VDD	Backup voltage
		DATA	LCD driver data
		CLK	LCD driver clock
		CE	LCD driver enable
		8C	+ 8V
		GND	GND

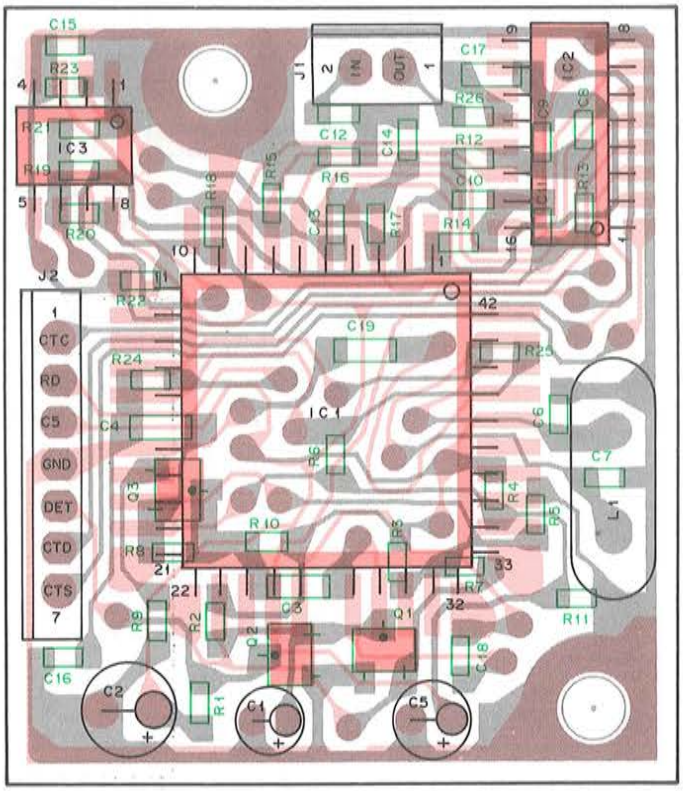
Connector No.	Terminal No.	Terminal Name	Terminal Function
TX-RX UNIT (X57-3170-10)			
①	1	HPO	
	2	HPI	
②	1	DB	Drive +B
	2	FB	Final +B
③	1	PC	Auto power control
	2	PRO	Protection
	3	8T	TX + 8V
④	1	B2	+ B2
	2	SB	Switched + B (13.8V)
⑤	1	SP	Speaker
	2	AP	Audio power
	3	B1	+ B1
⑥	1	SP	Speaker
	2	GND	GND
⑦		8C	+ 8V
		GND	GND
		RST	PLL enable
		CK	PLL & shift register clock
		DT	PLL & shift register data
		ST	Shift register strobe
		RM	RF meter
		BZ	Beep output
		BD	Busy display
⑧		RD	Remote data
		SQ	Squelch
		SM	S meter
		TO	Tone output
		A2	AF output
		A1	AF input
		MIC	Mic AF input
		GND	GND
		H/L	Hi/low switch
		RA	RX ANT
		DO	Drive output

TSU-5 (CTCSS UNIT)

TSU-5 PARTS LIST

Parts No.	New Parts	Description	Ref. No.
TSU-5			
B50-8163-00	*	Instruction manual	
E31-3248-05	*	Lead with connector	
H01-8104-03	*	Item carton box	
H21-0704-04		Protection sheet	
H25-0029-04		Protection bag	
H25-0719-04		Protection bag	
N87-2606-46		Brazier head taptite screw x 2	
X52-3060-00	*	CTCSS unit	
CTCSS UNIT (X52-3060-00)			
CC41FCH1H150J		Chip C 15pF J	C6,7
CC73FSL1H681J		Chip C 680pF J	C15
CE04CW1A100M		Electro 10μF 10WV	C1
CE04CW1A101M		Electro 100μF 10WV	C2
CE04CW1A220M		Electro 22μF 10WV	C5
CK73EF1C104Z		Chip C 0.1μF Z	C3,4
CK73EF1C105Z		Chip C 1μF Z	C17,19
CK73FB1H103K		Chip C 0.01μF K	C16,18
CK73FB1H222K		Chip C 2200pF K	C13,14
CK73FB1H272K		Chip C 2700pF K	C12
C93-0501-05	*	Chip C 680pF	C8–11
E31-3248-05	*	Lead with connector	–
E40-5016-05		Pin ass'y 2P	J1
E40-5021-05		Pin ass'y 7P	J2
L77-1333-05		X'tal 4.194304MHz	L1
RD41FB2B103J		Chip R 10k J 1/8W	R4,10,11
RD41FB2B104J		Chip R 100k J 1/8W	R1
RD41FB2B105J		Chip R 1M J 1/8W	R8,22,23
RD41FB2B122J		Chip R 1.2k J 1/8W	R26
RD41FB2B124J		Chip R 120k J 1/8W	R16
RD41FB2B153J		Chip R 15k J 1/8W	R5
RD41FB2B154J		Chip R 150k J 1/8W	R25
RD41FB2B183J		Chip R 18k J 1/8W	R3
RD41FB2B222J		Chip R 2.2k J 1/8W	R6
RD41FB2B273J		Chip R 27k J 1/8W	R19
RD41FB2B392J		Chip R 3.9k J 1/8W	R9
RD41FB2B473J		Chip R 47k J 1/8W	R2,20,21,24
RD41FB2B683J		Chip R 68k J 1/8W	R17
RD41FB2B823J		Chip R 82k J 1/8W	R7
RD41FB2B824J		Chip R 820k J 1/8W	R15,18
R92-0688-05	*	Chip R 470k	R14
R92-0689-05	*	Chip R 910k	R12,13
MN6520		IC	IC1
MN4094BS	*	IC	IC2
NJM4558M		IC	IC3
DTC114YK		Digital transistor	Q1,2
2SC2712(GR)		Chip transistor	Q3

TSU-5 PC BOARD VIEW

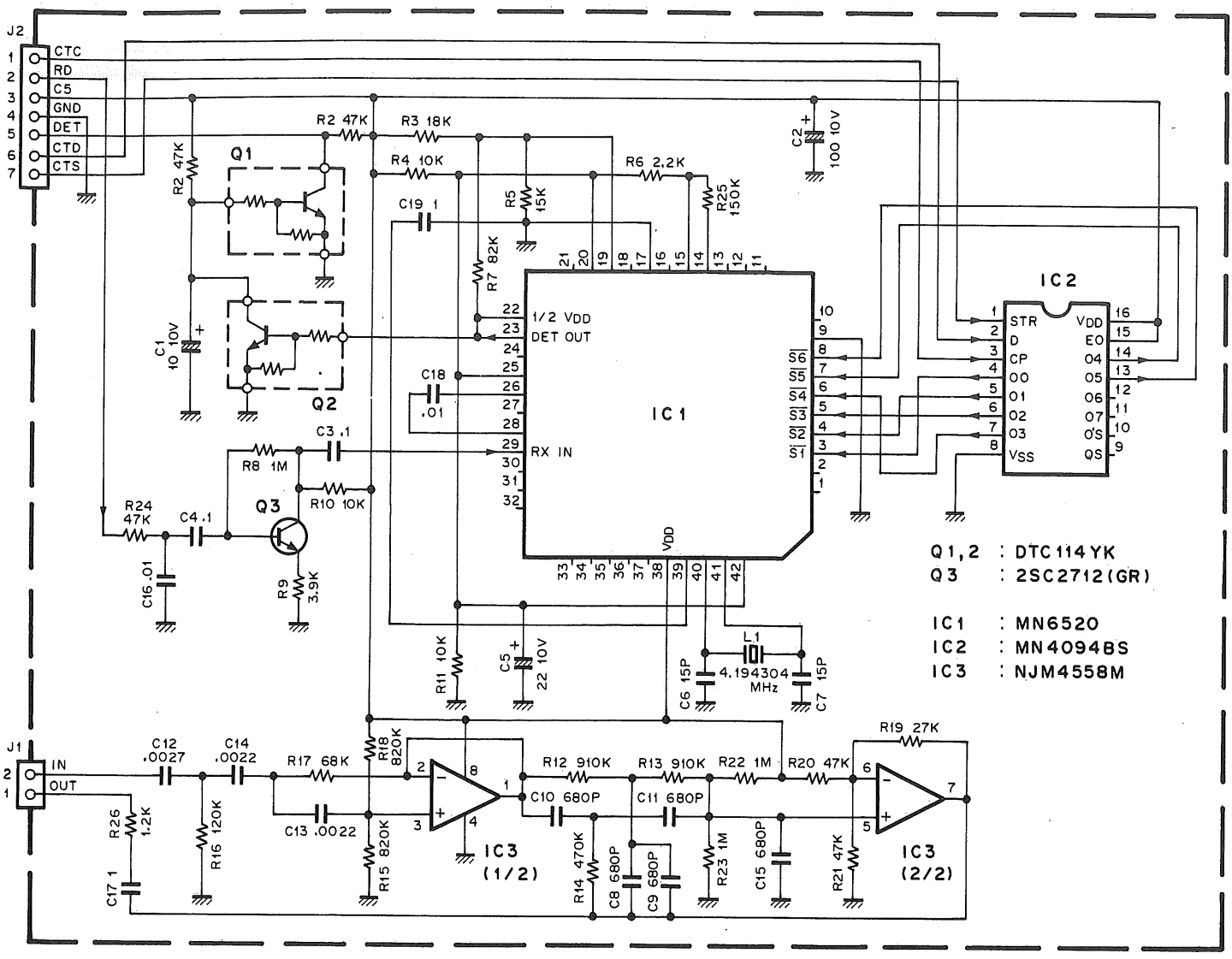


2SC2712

DTC114YK

TSU-5 (CTCSS UNIT)

TSU-5 SCHEMATIC DIAGRAM



TM-321A

SPECIFICATIONS

Specifications \ Model			TM-321A
General	Frequency range		220 to 225MHz
	Mode		F3E (FM)
	Antenna impedance		50 ohms
	Operating temperature		−20°C to +60°C (−4°F to +140°F)
	Power requirements		13.8V DC ± 15%
	Ground		Negative
	Current drain	Transmit mode (Max.)	6.5A
		Receive mode with no input signal	0.4A
	Frequency stability		Better than ± 10 x 10^{-6}
	Dimensions (Projections included, W x H x D mm)		141 x 42 x 193
	Weight		1.2kg
Transmitter	Output power*	HI	25W
		LOW	Approx. 5W Adjustable up to out 20W
	Modulation		Reactance modulation
	Spurious radiation		Less than −60dB
	Max. frequency deviation		±5kHz
	Audio distortion (at 60% modulation)		Less than 3%
	Microphone impedance		500 to 600 ohms
Receiver	Circuitry		Double conversion superheterodyne
	Intermediate frequency		30.825MHz/455kHz
	Sensitivity (12dB SINAD)		Less than 0.16μV
	Selectivity		−6dB : More than 12kHz, −60dB : Less than 28kHz
	Spurious response		Better than 70dB
	Squelch sensitivity		Less than 0.1μV
	Output (5% distortion)		More than 2W across 8 ohms load
	External speaker impedance		8 ohms

Notes :

1. Circuit and ratings are subject to change without notice due to advancement in technology.
2. * : Recommended duty cycle :
   1 minute : Transmission
   3 minutes : Reception

KENWOOD CORPORATION
Shionogi Shibuya Building, 17-5, 2-chome Shibuya, Shibuya-ku, Tokyo 150, Japan

KENWOOD U.S.A. CORPORATION
P.O. BOX 22745, 2201 East Dominguez St., Long Beach, CA 90801-5745, U.S.A.

KENWOOD ELECTRONICS DEUTSCHLAND GMBH
Rembrücker Str. 15, 6056 Heusenstamm, West Germany

KENWOOD ELECTRONICS BENELUX N.V.
Mechelsesteenweg 418 B-1930 Zaventem, Belgium

KENWOOD ELECTRONICS AUSTRALIA PTY. LTD.
(INCORPORATED IN N.S.W.)
4E. Woodcock Place, Lane Cove, N.S.W. 2066, Australia