

144MHz FM TRANSCEIVER

TM-231A/E

SERVICE MANUAL

KENWOOD

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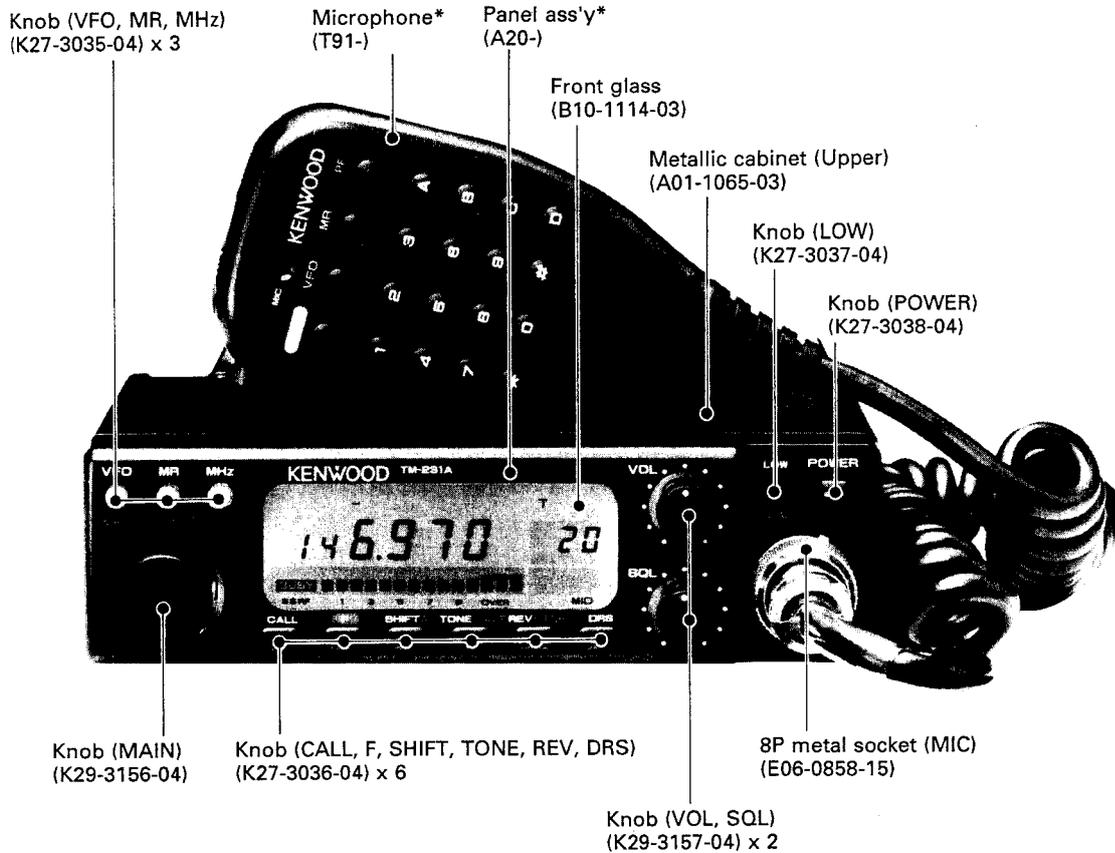


Photo is TM-231A.
* Refer to parts list on page 13.

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CIRCUIT DESCRIPTION

	TM-231A			TM-231E	
	K,P	M1	M2	T,W1	W2
TX-RX UNIT (X57-3310-XX)	-11	-21	-22	-61	-62

Table 1

Circuit Configuration By Frequency

The TM-231A/E incorporates a PLL synthesizer which uses a digital VFO to allow any channel step of 5, 10, 12.5, 15, 20, or 25kHz to be selected (See Figure 1).

The receiving system utilizes double-conversion techniques. That is, an incoming signal is mixed down to the 1st intermediate frequency (IF) of 10.7MHz, using a 1st local oscillator frequency of from 133.300 to 135.295MHz (T,W1), 133.300 to 137.295MHz (K,P,M1,M2,W2). The 1st IF signal is then mixed with the 2nd local oscillator frequency of 12.8MHz to generate the 2nd IF of 455 kHz.

The transmitting system consists of a PLL circuit which allows direct modulation and direct frequency division. Signals from the PLL circuit are amplified by a linear amplifier for transmission.

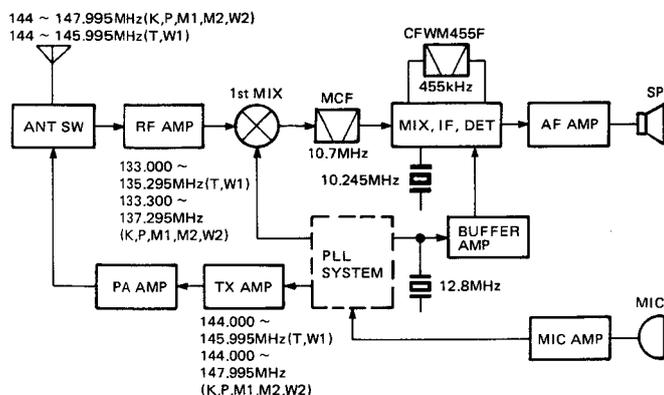


Fig. 1 Frequency configuration

Receiving System

• Overview

Incoming signals from the antenna pass through a low-pass filter in the final block of the transmitter system, and are switched to the front-end of the receiver system via a receive/transmit switching diode.

The signals are then passed through an antenna matching coil, where the high-frequency components are amplified by a GaAs FET. The signals are then fed into a three-stage bandpass filter that uses vari-cap tuning to reject unwanted signal components, and is fed

to the 1st mixer. The 1st mixer uses the N-channel MOS FET that are used in the RF stage to obtain better two-signal characteristics. The 1st mixer mixes the signal with the 1st local oscillator frequency and converts it to the 1st IF (10.7MHz). The signal then passes through two monolithic crystal filters (MCFs) to remove unnecessary near-by frequency components. The signal from the MCFs is used as the 1st IF signal.

The 1st IF signal is amplified and fed into IC1 (KCD01) in the FM IF HIC. The IF signal is then mixed with the 2nd local oscillator frequency of 10.245MHz to generate the 2nd IF of 455kHz. The 455kHz signal is then passed through a six element ceramic filter (CFWM455F), and fed back into IC1 for additional amplification. The output signal from the IC1 is then fed into a power amplifier via the audio volume control for application to the speaker.

• S-meter circuit

S-meter control voltage from IC1 (KCD01) in the FM IF HIC is fed into the control unit. The CPU converts the voltage from an analog to a digital signal in order to operate the LCD bar meter.

Item	Rating
Nominal center frequency (fo)	10.7MHz
Pass band width	±7.5kHz or less at 3dB
Attenuation band width	±25kHz or less at 40dB ±45kHz or less at 60dB
Ripple	1.0dB or less
Insertion loss	1.5dB or less
Guaranteed attenuation	70dB or more within ±1MHz (Spurious : 40dB or more at fo ~ fo + 500kHz) 80dB or more at fo - (900 - 920kHz)
Terminating impedance	3kΩ/0pF

Table 2 MCF (L71-0228-05) (TX-RX unit XF1)

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

Table 3 Ceramic filter CFWM455F (L72-0372-05) (TX-RX unit CF1)

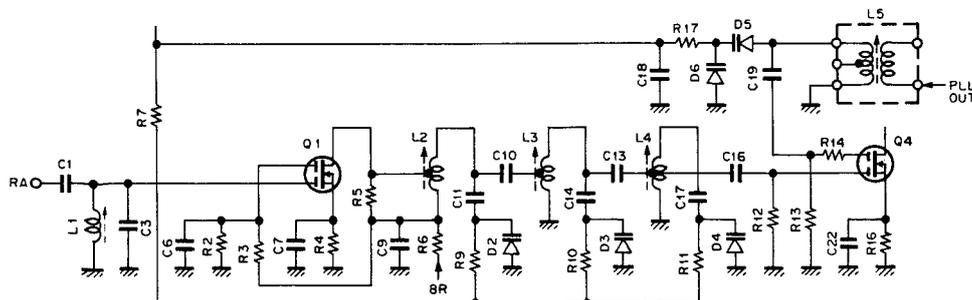


Fig. 2 Front-end section (vari-cap tuning)

CIRCUIT DESCRIPTION

Transmitting System

• Overview

The transmitter produces the target frequency through the use of direct FM-modulation via a varactor diode.

• Modulation circuit

Audio signals from the microphone are fed into the mic amplifier unit for amplification by the first transistor amplifier, and then into two operational amplifiers. The operational amplifiers form a splatter filter for pre-emphasis, amplification, limiting, and removal of unnecessary high-frequency components.

The FM modulation circuit directly FM-modulates the VCO signals, using a varactor diode.

• Pre-amplifier stage circuit

Signals from the VCO are applied to the drive HIC IC8 (KCB05). The amplifier always operates in a linear mode so that signals can be amplified without degradation. Additionally, the amplifier is designed to cover a wide range of frequencies and can produce stable output without adjustment. The APC (Automatic Power Control) controls collector voltage from the last stage of the pre-amplifier.

• Power amplifier circuit

The drive signal is amplified to the required level by the power module. The TM-231A/E uses a large heat sink for efficient heat dissipation.

• APC circuit

The APC circuit for automatic transmit output control detects part of the power module output, and amplifies it to provide a control voltage for output control. The output control voltage is in inverse proportion to the output from the power module, so it is maintained at the same level.

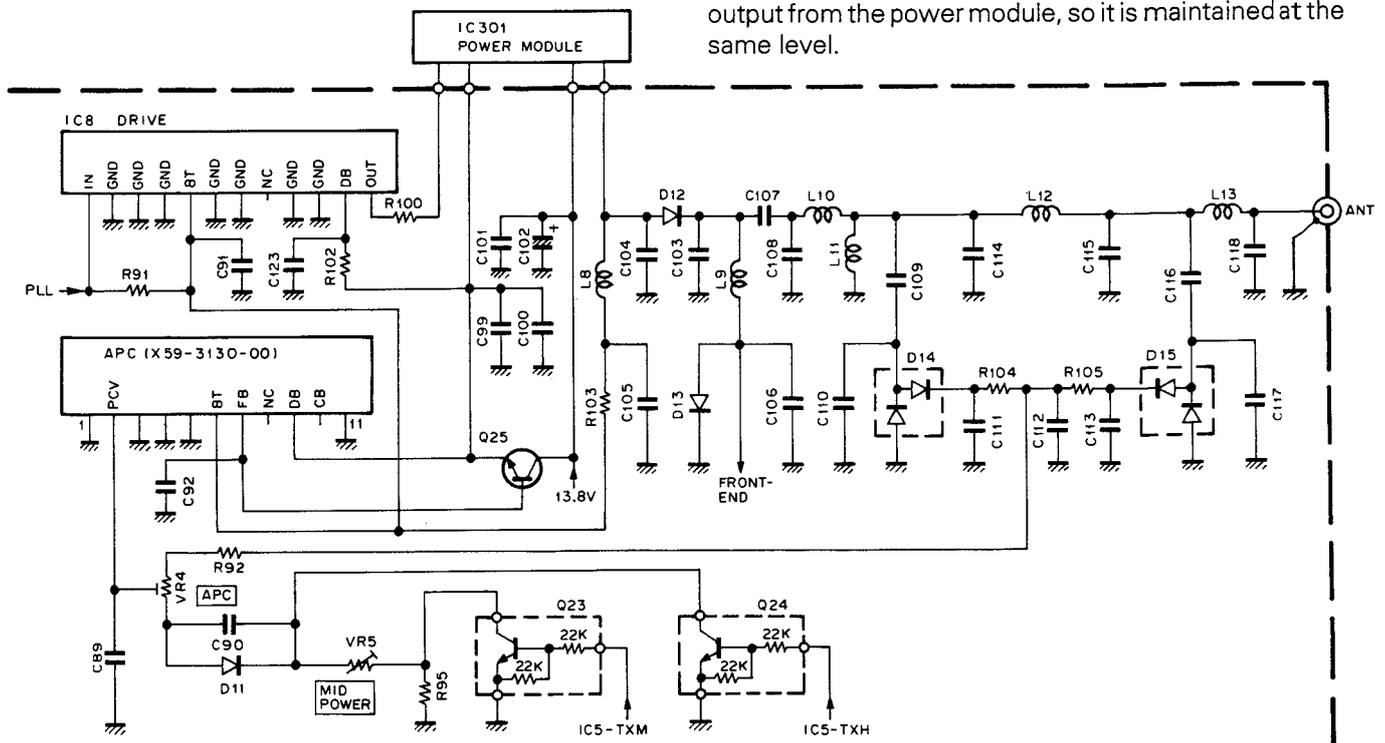


Fig. 3 Pre-amplifier stage, power amplifier, and APC circuits

(T_c = 25°C)

Item	Symbol	Condition	Rating	Unit
Operating voltage	V _{cc}		16	V
Control voltage	V _{CON}		16	V
Current consumption	I _T		14	A
Input power	P _i		600	mW
Output power	P _o	12.5V < V _{cc} ≤ 16V, V _{CON} ≤ 12.5V P _i = 0 ~ 500mW, Z _G = Z _L = 50Ω	65	W
Operating case temperature	T _{c(opr)}		-30 ~ +100	°C
Storage temperature	T _{stg}		-40 ~ +110	°C

Table 4 Power module S-AV17 maximum ratings (IC301)

CIRCUIT DESCRIPTION

PLL Synthesizer Unit

Figure 4 is the PLL and VCO block diagram. In the TM-231A/E, the PLL system is implemented as a sub-unit which is divided into the upper VCO and lower PLL blocks. The sub-unit is shielded to prevent external interference.

There are two reference frequencies, 6.25kHz and 5 kHz, available to allow 5, 10, 12.5, 15, or 25 kHz-step operation. The 6.25kHz is obtained by dividing the reference oscillator frequency of 12.8MHz by 2048, and the 5kHz is obtained by dividing it by 2560. The VCO directly generates the dial frequency. This dial frequency is amplified once and then fed into a pulse swallow-type PLL IC for frequency division and phase comparison, in order to lock the frequency.

The PLL system is locked without switching between transmit mode and receive mode. By using a signal ("H" in transmit mode) from pin 11 of the PLL IC (M54959FP), the LPF is deactivated-activated by Q52 and Q53 only for the moment when the TM-231A/E enters transmit mode. This helps produce lock more rapidly than previous methods.

In 144MHz mode, f_{VCO} (RX) is calculated by the following formula:

$$f_{VCO} = (144 - 10.7) = \{(n \times 128) + A\} \times f_{OSC} / R$$

where,

f_{VCO} : VCO output frequency

n : Binary value of the 10-bit programmable counter

A : Binary value of the 7-bit programmable counter

f_{OSC} : 12.8MHz reference frequency

R : Binary value of the 14-bit programmable counter

2560 (5, 10, 15, 20, or 25kHz step mode)

2048 (12.5kHz step mode)

In 5, 10, 15, 20, or 25kHz step mode,

$n = 208$ and $A = 36$.

Therefore, f_{VCO} is calculated as follows:

$$f_{VCO} = \{(208 \times 128) + 36\} \times 12800 / 2560$$

$$= \{26624 + 36\} \times 5$$

$$= 133300 = 133.300\text{MHz}$$

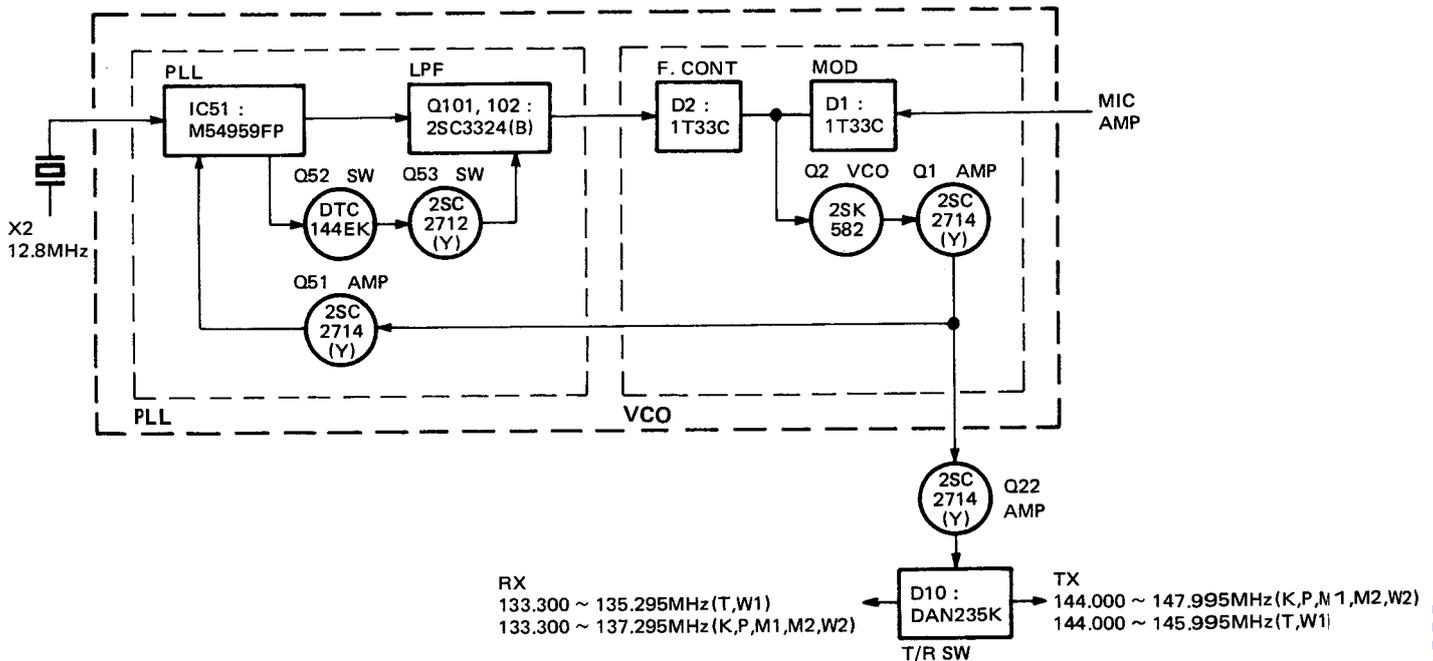


Fig. 4 PLL block diagram

CIRCUIT DESCRIPTION

• 8T (8V in transmit mode) and unlock circuits

In receive mode, the base of Q17 has 0.7V. As a result, Q17 is on, and Q16 and Q14 are off, and the collector of Q14 (8T) provides no voltage.

The CPU outputs serial data to the shift register IC5 when the PTT switch is depressed. As a result, pin 8 of IC5 becomes "L", turning Q17 off, and Q16 and Q14 on. The 8T line is therefore supplied with 8V.

The unlock circuit operates only in transmit mode. Q18 is a PLL unlocking switching transistor. Usually, the base of Q18 is supplied with 0V ("L"), and the collector is supplied with 8V ("H").

When the PLL is unlocked, the base of Q18 is supplied with 0.7V, turning Q18 on. As a result, the collector of Q18 becomes "L" (0V). This turns Q16 off and the collector of Q14 becomes 8V, turning it off. Therefore, when the PLL is unlocked, Q14 is off removing bias voltage from the 8T line. Without the 8T voltage no transmit signal is generated.

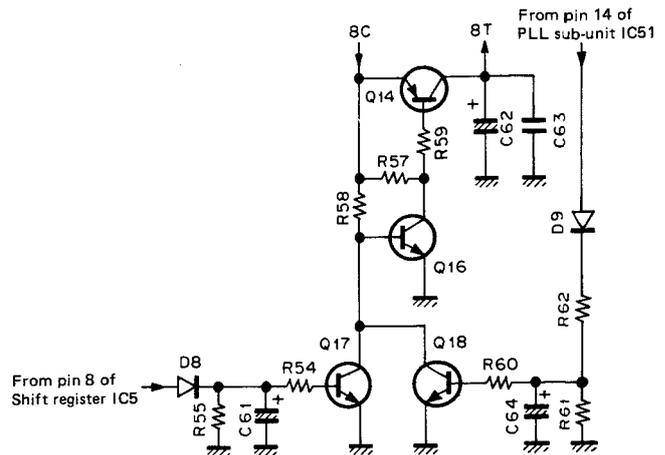


Fig. 5 8T and unlock circuits

Digital Control Unit

• Overview

The digital control unit consists of a several keys, a rotary encoder input, a display, a reset circuit, a back-up circuit, and a tone output circuit. These circuits are controlled by a single microcomputer (CPU).

• Key and rotary encoder input circuits

The keys on the panel are arranged in matrix. Key input is fed into the CPU, using a key scan technique. Output from the rotary encoder is fed directly into the CPU.

• Microphone key input circuit

The UP, DOWN, and other function keys of the microphone are directly connected to their corresponding analog input pins of the CPU. Each of the functions is activated by a voltage generated when the corresponding key is pressed.

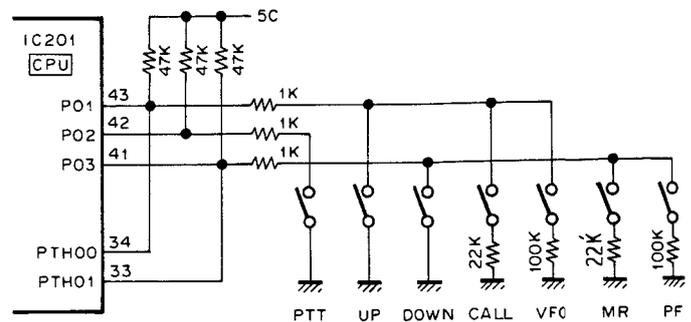


Fig. 6 Microphone key input circuit

TM-231A/E

CIRCUIT DESCRIPTION

• Reset and back-up circuits

When the TM-231A/E power is turned on, the reset circuit sends a "L" level pulse to the RESET pin of the CPU for approx. 3ms. This initiates the power-on reset sequence.

When the TM-231A/E power is turned off, the back-up circuit detects a voltage drop in the 13.8V line and sets CPU INT4 to a "H" level. This causes the CPU to enter a back-up state.

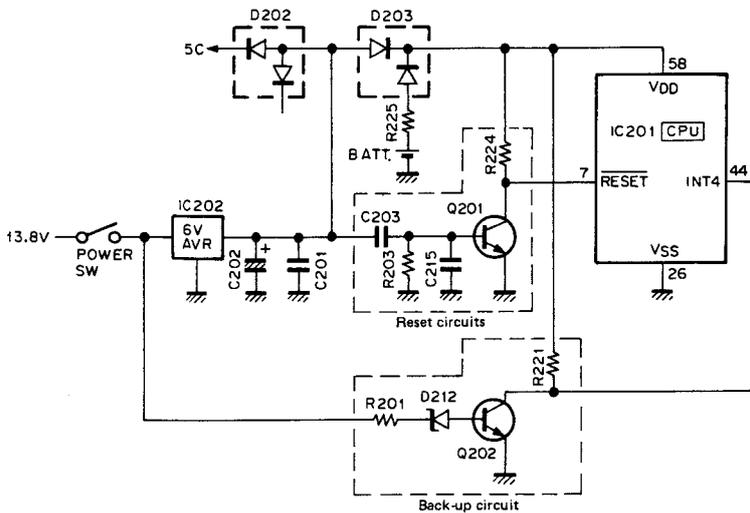


Fig. 7 Reset and back-up circuits

• Display circuit

The display circuit is contained in the LCD assembly. It consists of a LCD driver, its peripheral circuits, and an LCD. The LCD is dynamically operated at a 50% duty cycle. The LCD driver receives LCD data from P33, P141, and P140 of the CPU.

• Shift register circuit

The shift register circuit consists of IC5 (TC9174F). The IC5 receives serial data from the microcomputer to perform the controls listed below.

Pin No.	Pin name	Function
1	GND	
2	B1	Usually "H".
3	B2	Open.
4	CE	Electronic VOL select : "H" when electronic VOL selected, "L" when panel VOL selected or interface connected.
5	VOLD	Electronic VOL DOWN : "L" when DOWN key ON.
6	VOLU	Electronic VOL UP : "L" when UP key ON.
7	MUTE	AF MUTE : "H" when TX mode, AL 1ch receive mode, CTCSS, bell, or squelch is ON.
8	T/R	Transmit/receive select : "H" in RX mode, "L" in TX mode.
9	TXM	TX power select : "H" in HI or MID mode, "L" in LOW mode.
10	TXH	TX power select : "H" in HI mode, "L" in MID or LOW mode.
11	-	Open.
12	-	Open.
13	DATA	Serial data input.
14	CLOCK	Clock input.
15	EN	Enable input.
16	VDD	

Table 5

• Tone output circuit

IC203 (ladder resistor) receives signals from P40 to P43 and P50 to P53 of the CPU and converts them from digital to analog to produce 38 different waveforms from 67.0Hz to 250.3Hz. Figure 8 shows the internal configuration of IC203.

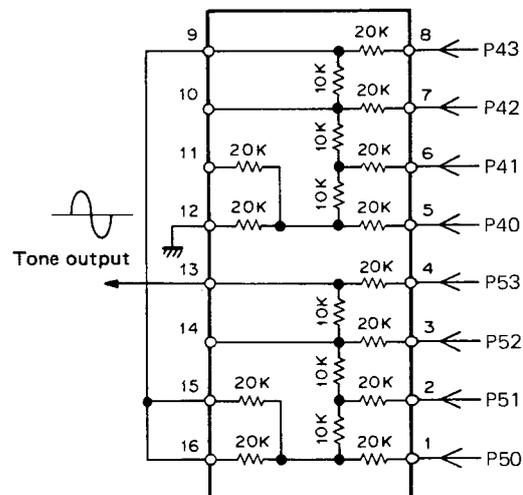


Fig. 8 Internal configuration of ladder resistor KRR-C001 (TX-RX unit IC203)

CIRCUIT DESCRIPTION

• PLL data output

PLL data is available from P21 (CK), P22 (DT), P61 (ACL), and P23 (EN1) of the CPU. Figure 9 is a timing chart for PLL data transfer, and Figure 10 shows the format of PLL data.

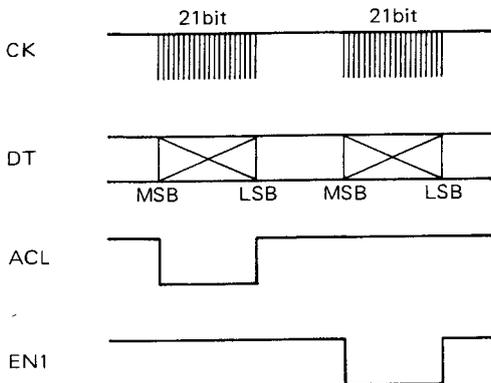
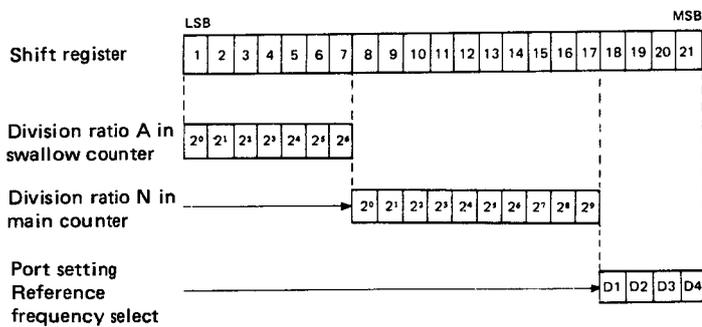


Fig. 9 timing chart for PLL data transfer



The 21-bit data is made up of the following:

1. Division ratio data A and N (17 bits)

F (display - 10.7MHz in RX mode)

$$= \{(N \times 128) + A\} \times 12.8\text{MHz} / \text{ref}$$

N : Division ratio set in 10-bit main counter (binary)

A : Division ratio set in 7-bit swallow counter (binary)

2. Reference frequency (ref) select (2 bits)

Data		Phase reference frequency	
D1	D2		
L	L	5kHz	5, 10, 15, 20, 25kHz step mode
H	L	6.25kHz	12.5kHz step mode

3. Switch select (2 bits)

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

Fig. 10 PLL data format

• Input and output of CTCSS unit (option)

The optional CTCSS unit receives data from P21, P22, an P73 of the CPU. Figure 11 is a timing chart for CTCSS data transfer, and Figure 12 shows the format of CTCSS data. When a tone from the CTCSS unit is detected, a "H" level signal is sent to P63 of the CPU, opening the squelch.

• Input and output of the remote control unit (option)

When the optional remote control unit is connected, a "H" level signal is applied to INT0 of the CPU, and the following pins have different functions:

P03 → S1 : Serial data input pin

P02 → S2 : Serial data output pin

P01 → SCK : Serial clock I/O pin

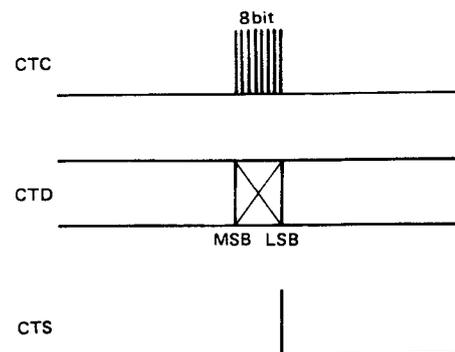
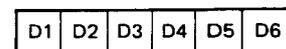


Fig. 11 Timing chart for CTCSS data transfer

Tone frequency select data for CTCSS unit



Example : 88.5Hz L H L H H H

Fig. 12 CTCSS data format

CIRCUIT DESCRIPTION

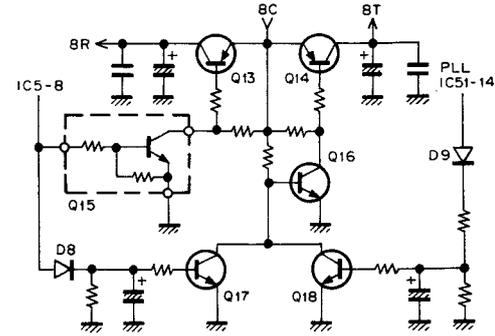
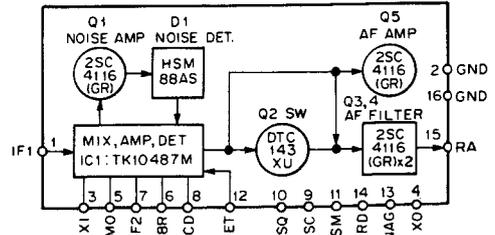
Pin No.	Pin name	I/O	Logic	Function	Pin No.	Pin name	I/O	Logic	Function	
1	P41	O	-	D/A digital output (tone).	33	PTH01	I	-	Mic DOWN input.	
2	P40	O	-		34	PTH00	I	-	Mic UP input.	
3	P53	O	-		35	T11	-	L	Not used.	
4	P52	O	-		36	T10	-	L	Not used.	
5	P51	O	-		37	P23	O	L	PLL IC enable output.	
6	P50	O	-		38	P22	O	-	PLL IC data output.	
7	RESET	I	L	Reset input.	39	P21	O	-	PLL IC clock output.	
8	X2	-	-	4.194304MHz crystal oscillator.	40	P20	O	-	Beeper output.	
9	X1	-	-		41	P03/SI	I/I	L/-	Mic DOWN/serial data input.	
10	P63	I	H	CTCSS tone matching input.	42	P02/SO	I/O	L/-	Mic PTT input/serial data output.	
11	P62	O	H	Power switch.	43	P01/SCK	I/-	L/-	Mic UP input/serial clock I/O.	
12	P61	O	-	Not used.	44	INT4	I	H	Back-up detect input.	
13	P60	I	-	Not used.	45	P123	I	L	CALL, VFO	
14	P73	O	H	CTCSS unit enable output.	46	P122	I	L	F, MR/M	
15	P72	O	H	Shift register enable output.	47	P121	I	L	SHIFT, MHz	Destination, key input.
16	P71	O	H	DRS unit VOB output.	48	P120	I	L	TONE	
17	P70	O	H	DRS unit VOA output.	49	P133	I	L	REV	
18	P83	O	-	Not used.	50	P132	I	L	LOW, DRS	
19	P82	O	H	DRS unit STBY output.	51	P131	I	L	Transmit power select.	
20	P81	O	L	DRS unit \overline{WR} output.	52	P130	I	L	Busy input.	
21	P80	O	L	DRS unit \overline{RD} output.	53	P143	O	L	Squelch control.	
22	P93	O	H	DRS unit data output.	54	P142	O	H	Dimmer control.	
23	P92	O	H		55	P141	O	-	LCD driver clock output.	
24	P91	O	H		56	P140	O	-	LCD driver data output.	
25	P90	O	H		57	NC	-	-	Not used.	
26	Vss	-	-		GND.	58	Vdd	-	-	Power supply pin.
27	INT3	I	H	DRS unit connect check.	59	P33	O	-	LCD driver enable output.	
28	INT2	I	-	Encoder input.	60	P32	O	L	Distination output.	
29	INT1	I	-		61	P31	O	L	Key output.	
30	INT0	I	H		Remote connect detect input.	62	P30	O		L
31	PTH03	I	-	S-meter analog input.	63	P43	O	-	D/A digital output (tone).	
32	PTH02	I	-	Not used.	64	P42	O	-		

Table 6 75108G-E10-1B terminal functions (TX-RX unit IC201)

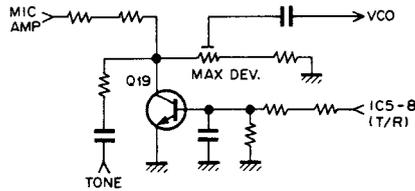
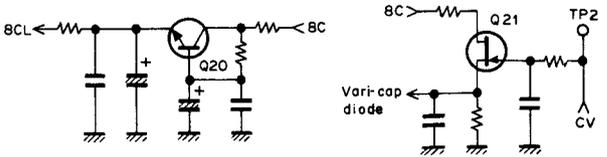
DESCRIPTION OF COMPONENTS

TX-RX UNIT (X57-3310-XX) -11 : TM-231A (K,P) -21 : TM-231A (M1) -22 : TM-231A (M2) -61 : TM-231E (T,W1) -62 : TM-231E (W2)

Component	Use/Function	Operation/Condition/Compatibility
IC1	2nd local oscillator, IF amplification, detection, low-frequency amplification, noise amplification, noise detection, squelch switching	① 1st IF signal input (10.7MHz). ③ ④ 2nd local oscillator (10.245MHz). ⑨ Busy output. ⑩ Squelch control. ⑪ S-meter output. ⑭ RD output. ⑮ Low-frequency output.
IC3	AF amplification	① AF input, ⑥ AF output.
IC4	Electronic volume control, AF switch	② AF output. ③ "L" during step-up. ④ "L" during step-down. ⑤ "H" when electronic volume selected.
IC5	Shift register	See circuit description.
IC6	5V AVR	
IC7	10V AVR	For PLL.
IC8	Transmit drive	
IC9	8V AVR	
IC201	Microprocessor	See circuit description.
IC202	6V AVR	
IC203	Tone A/D convertor	
Q1	High-frequency amplification	Operates in receive mode.
Q4	1st mixer	Converts received 144MHz-range signals to 1st IF 10.7MHz.
Q5	High-frequency amplification	Amplifies 1st IF signal.
Q9 (1/2)	RD line mute	ON when DRS unit replays.
Q9 (2/2)	AF line mute	
Q10	Low-frequency amplification	Operates when DRS unit replays.
Q12	AF line mute	Operates when transmit mode, AL 1ch receive mode, CTCSS, bell or squelch is ON.
Q13	8R switching	ON in receive mode.
Q14	8T switching	ON in transmit mode.
Q15	8R switching control	ON in receive mode.
Q16	8T switching control	ON in transmit mode.
Q17	8T switching control	OFF in transmit mode.
Q18	8T switching control	OFF when PLL locked.



DESCRIPTION OF COMPONENTS

Component	Use/Function	Operation/Condition/Compatibility
Q19	Mic line mute	ON in receive mode. 
Q20	PLL 8V ripple filter	
Q21	CV line buffer	
Q22	VCO output amplification	
Q23	TX power select	ON in HI or MID mode.
Q24	TX power select	ON in HI mode.
Q25	TX drive stage +B control	
Q26	Power switch	
Q27	Power switch control	ON when power switch is ON.
Q201	Reset switch	ON for approx. 3ms when system power turned on, usually OFF.
Q202	Back-up switch	OFF when 13.8V line becomes 7.5V or less, usually ON.
Q203	Dimmer switch	
Q204	Reset switch	ON for approx. 3ms when DRS power turned on, usually OFF.
D2 ~ 6	Vari-cap tuning	
D7 ~ 9	Reverse current prevention	
D10	VCO output switch	
D11	Temperature compensation	For APC.
D12, 13	Transmit/receive switching	

DESCRIPTION OF COMPONENTS

Component	Use/Function	Operation/Condition/Compatibility
D14, 15	Power detection	For APC.
D16	Reverse power protection	
D201~203	Reverse current prevention	
D204, 205	Microprocessor protection	
D206, 207	To be set at destination	
D209~211	To be set at destination	
D212	Back-up detection	

PLL (X58-3470-00)

Component	Use/Function	Operation/Condition/Compatibility
IC51	PLL	① VCO input 133.300 ~ 135.295MHz (T,W1), 133.300 ~ 137.295MHz (K,P,M1,M2,W2) in receive mode, 144.000 ~ 145.995MHz (T,W1), 144.000 ~ 147.995MHz (K,P,M1,M2,W2) in transmit mode. ② "L" in transmit mode. ③ "H" when PLL unlocked.
Q51	VCO output buffer	
Q52	Transmit switch	OFF in transmit mode.
Q53	Transmit switch	ON for moment when transmission starts.
Q101,102	LPF	
Q1	VCO output buffer	
Q2	VCO	133.300 ~ 135.295MHz (T,W1), 133.300 ~ 137.295MHz (K,P,M1,M2,W2) in receive mode. 144.000 ~ 145.995MHz (T,W1), 144.000 ~ 147.995MHz (K,P,M1,M2,W2) in transmit mode.
D1	For modulation in TX mode	
D2	VCO voltage control	

APC (X59-3130-00)

Component	Use/Function	Operation/Condition/Compatibility
Q1	Differential amplification	
Q2 (2/2)	APC control	
Q3	Drive stage +B AVR	

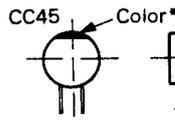
MIC AMP (X59-3610-00)

Component	Use/Function	Operation/Condition/Compatibility
IC1 (1/2)	Limited amplification	
IC1 (2/2)	LPF	
Q1	Low-frequency amplification	

PARTS LIST

CAPACITORS

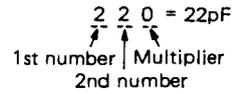
CC 45 TH 1H 220 J
1 2 3 4 5 6



Capacitor value

- 0 1 0 = 1pF
- 1 0 0 = 10pF
- 1 0 1 = 100pF
- 1 0 2 = 1000pF = 0.001μF

1 0 3 = 0.01μF



- 1 = Type ceramic, electrolytic, etc.
- 2 = Shape round, square, etc.
- 3 = Temp. coefficient
- 4 = Voltage rating
- 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

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	10μF-10~+50 4.7μF-10~+75

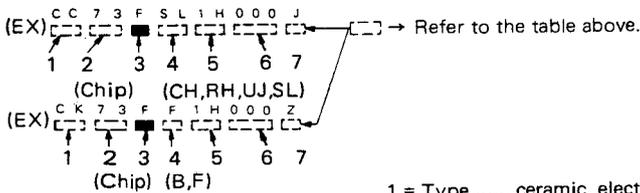
Code	B	C	D	F	G
(pF)	± 0.1	± 0.25	± 0.5	± 1	± 2

Less than 10 pF

Rating voltage

2nd word	A	B	C	D	E	F	G	H	J	K	V	
1st word	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



Dimension

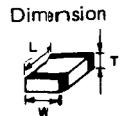
Dimension code	L	W	T
Empty	5.6 ± 0.5	5.0 ± 0.5	Less than 2.0
E	3.2 ± 0.2	1.6 ± 0.2	Less than 1.25
F	2.0 ± 0.3	1.25 ± 0.2	Less than 1.25

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

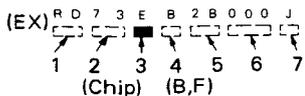
Rating wattage

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				



RESISTORS

Chip resistor (Carbon)



Carbon resistor (Normal type)



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

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TM-231A/E						
1	1B	*	A01-1065-03	METALLIC CABINET (UPSIDE)		
2	2B	*	A01-1066-03	METALLIC CABINET (BOTTOM)		
3	1C	*	A10-1292-01	CHASSIS CALKED ASSY		
4	2A	*	A20-2676-02	PANEL ASSY	KMP	
4	2A	*	A20-2678-02	PANEL ASSY	TW	
5	2B	*	A22-0760-03	SUB PANEL		
7	2B	*	B11-0462-08	FILTER		
8	2B	*	B30-0869-05	LAMP		
9	2B	*	B38-0311-15	LCD ASSY		
11	1B, 1C	*	B42-2455-04	LABEL (M4XB MAX)		
-		*	B40-3875-04	MODEL NAME PLATE	KP	
-		*	B40-3876-04	MODEL NAME PLATE	M	
-		*	B40-3877-04	MODEL NAME PLATE	TW	
-		*	B42-2454-04	SERIAL NO LABEL (PACKING)		
-		*	B42-3343-04	SERIAL NO LABEL (NAME PLATE)		
-		*	B42-3356-04	LABEL (EXT SP)		
-		*	B46-0410-20	WARRANTY CARD	K	
-		*	B46-0419-00	WARRANTY CARD	W1	
-		*	B46-0422-00	WARRANTY CARD	P	
-		*	B50-8286-10	INSTRUCTION MANUAL		
15	1C	*	E30-2137-05	DC CORD		
16	1C	*	E30-2145-05	ANT CABLE		
-		*	E30-2111-05	DC CORD		
-		*	E31-3197-05	CONNECTING WIRE (SP)		
17	1C	*	F05-1531-05	FUSE (15A)		
18	2B	*	F05-2036-05	FUSE (20A)		
19	2B	*	F12-0415-04	CONDUCTIVE SHEET		
20	2B	*	F20-0521-04	INSULATING BOARD(LITHIUM BATT)		
20	2B	*	F20-0587-04	INSULATING SHEET(LITHIUM BATT)		
22	1B	*	G02-0576-04	FLAT SPRING		
23	2A	*	G09-0405-05	KNOB FIXED SPRING		
24	1C	*	G10-0651-04	NON-WOVEN FABRIC		
25	1B, 2C	*	G10-0681-04	NON-WOVEN FABRIC (CHASSIS)		
26	2A	*	G13-0907-04	CUSHION (6 KEY)		
27	2B	*	G13-0906-04	CUSHION (3 KEY)		
-		*	H01-8216-04	ITEM CARTON BOX	MP	
-		*	H01-8217-04	ITEM CARTON BOX	TW	
-		*	H03-2768-04	OUTER PACKING CASE	MP	
-		*	H03-2769-04	OUTER PACKING CASE	TW	
-		*	H10-2658-02	POLYSTYRENE FOAMED FIXTURE		
-		*	H11-0822-04	POLYSTYRENE PLATE		
-		*	H13-0814-04	POLYSTYRENE PLATE		
-		*	H25-0029-04	PROTECTION BAG (MIC HOSE, SCREW)	KP	
-		*	H25-0049-03	PROTECTION BAG (DC CORD)		
-		*	H25-0720-04	PROTECTION BAG (TM-231A/E)		
-		*	J20-0319-24	MIC HOOK	KP	
-		*	J29-0436-03	BRACKET		
30	1C	*	J19-1434-04	HOLDER (S0)		
31	2A	*	J21-4256-08	MOUNTING HARDWARE(LCD ASSY)		
32	2B	*	K27-3035-04	KNOB (VFO, MR, MHZ)		
33	2A	*	K27-3036-04	KNOB (CALL, ETC)		

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34	2B	*	K27-3037-04	KNØB (LOW)		
35	2B	*	K27-3038-04	KNØB (POWER)		
36	2A	*	K29-3156-04	KNØB (MAIN)		
37	2A	*	K29-3157-04	KNØB (VOL,SQL)		
-			N46-3010-46	PAN HEAD TAPPING SCREW	KP	
-		*	N99-0331-05	SCREW SET		
A	2B		N09-0626-04	SCREW		
B	2B		N09-0650-05	SCREW		
C	1C, 2C		N33-2606-45	ØVAL HEAD MACHINE SCREW		
D	1C, 2B		N87-2606-46	BRAZIER HEAD TAPTITE SCREW		
E	2B		N88-2606-46	FLAT HEAD TAPTITE SCREW		
		*	T91-0379-05	MICROPHONE	M	
		*	T91-0380-05	MICROPHONE	KP	
		*	T91-0382-05	MICROPHONE	TW	
40	1C		T07-0246-05	LOUDSPEAKER(FULLRANGE)		
IC1			LC7582	IC(LCD DRIVER) (LCD DRIVER)		
		*	WD1-0414-04	WRENCH		
41	2B		WD9-0326-05	LITHIUM BATTERY		
42	2B, 2C	*	X57-3310-11	TX-RX UNIT	KP	
42	2B, 2C	*	X57-3310-21	TX-RX UNIT	M1	
42	2B, 2C	*	X57-3310-22	TX-RX UNIT	M2	
42	2B, 2C	*	X57-3310-61	TX-RX UNIT	TW1	
42	2B, 2C	*	X57-3310-62	TX-RX UNIT	W2	
TX-RX UNIT (X57-3310-XX) -11 : TM-231A (K,P) -21 : TM-231A (M1) -22 : TM-231A (M2) -61 : TM-231E (T,W1) -62 : TM-231E (W2)						
C1			CC73FCH1H040C	CHIP C 4.0PF C		
C3			CC73FCH1H070D	CHIP C 7.0PF D		
C6 ,7			CK73FB1H102K	CHIP C 1000PF K		
C8			CK73FB1H103K	CHIP C 0.010UF K		
C9			CK73FB1H102K	CHIP C 1000PF K		
C10			CC73FCH1H0R5C	CHIP C 0.5PF C		
C11			CC73FCH1H470J	CHIP C 47PF J		
C12			CK73FB1H103K	CHIP C 0.010UF K		
C13			CC73FCH1H0R5C	CHIP C 0.5PF C		
C14			CC73FCH1H470J	CHIP C 47PF J		
C15			CK73FB1H102K	CHIP C 1000PF K		
C16			CC73FCH1H150J	CHIP C 15PF J		
C17			CC73FCH1H470J	CHIP C 47PF J		
C18			CK73FB1H103K	CHIP C 0.010UF K		
C19			CC73FCH1H030C	CHIP C 3.0PF C		
C20			CK73FB1H102K	CHIP C 1000PF K		
C21			CK73FB1H103K	CHIP C 0.010UF K		
C22			CK73FB1H102K	CHIP C 1000PF K		
C23			CC73FCH1H050C	CHIP C 5.0PF C		
C24			CK73FB1H102K	CHIP C 1000PF K		
C25			CK73FB1H103K	CHIP C 0.010UF K		
C26			CC73FCH1H220J	CHIP C 22PF J		
C27			CK73FB1H102K	CHIP C 1000PF K		
C28			CC73FCH1H330J	CHIP C 33PF J		
C29			CC73FCH1H151J	CHIP C 150PF J		
C38			C92-0002-05	CHIP TAN 0.22UF 35WV		
C39 -41			CK73EF1C105Z	CHIP C 1.0UF Z		
C43			CE04EW1A470M	ELECTRO 47UF 10WV		
C44			CK73FB1H103K	CHIP C 0.010UF K		

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TM-231E : T,W1,W2

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C47			CK73EB1H104K	CHIP C 0.10UF K		
C48			CE04EW1A471M	ELECTRØ 470UF 10WV		
C49			CK73FB1H103K	CHIP C 0.010UF K		
C50			CE04EW1C470M	ELECTRØ 47UF 16WV		
C51 -53			CE04EW1A470M	ELECTRØ 47UF 10WV		
C54			CK73FB1H273K	CHIP C 0.027UF K		
C55			CC73FSL1H101J	CHIP C 100PF J		
C56			CE04EW1E4R7M	ELECTRØ 4.7UF 25WV		
C57 ,58			CK73EF1C105Z	CHIP C 1.0UF Z		
C59			CK73FB1H103K	CHIP C 0.010UF K		
C60			CE04EW1A470M	ELECTRØ 47UF 10WV		
C61			C92-0504-05	CHIP-TAN 0.68UF 20WV		
C62			CE04EW1A470M	ELECTRØ 47UF 10WV		
C63			CK73FB1H103K	CHIP C 0.010UF K		
C64			C92-0504-05	CHIP-TAN 0.68UF 20WV		
C65 ,66			CK73FB1H102K	CHIP C 1000PF K		
C67			CC73FCH1H050C	CHIP C 5.0PF C		
C68			C92-0501-05	CHIP TAN 1.5UF 6.3WV		
C69			CK73FB1H103K	CHIP C 0.010UF K		
C71			CK73FB1H102K	CHIP C 1000PF K		
C72			CK73EB1H473K	CHIP C 0.047UF K		
C73			CK73FB1H102K	CHIP C 1000PF K		
C74			CK73EF1C105Z	CHIP C 1.0UF Z		
C75 ,76			CK73FB1H102K	CHIP C 1000PF K		
C77			CK73EF1C105Z	CHIP C 1.0UF Z		
C78			CK73FB1H102K	CHIP C 1000PF K		
C79			CC73FCH1H330J	CHIP C 33PF J		
C80			CK73FB1H102K	CHIP C 1000PF K		
C81			CC73FCH1H220J	CHIP C 22PF J		
C82			CK73FB1H103K	CHIP C 0.010UF K		
C83			CE04EW1A470M	ELECTRØ 47UF 10WV		
C84			CK73FB1H103K	CHIP C 0.010UF K		
C85			CE04EW1A221M	ELECTRØ 220UF 10WV		
C86			CE04EW1C100M	ELECTRØ 10UF 16WV		
C87 ,88			CK73FB1H103K	CHIP C 0.010UF K		
C89 -92			CK73FB1H102K	CHIP C 1000PF K		
C93			CK73FB1H103K	CHIP C 0.010UF K		
C94			CE04EW1A470M	ELECTRØ 47UF 10WV		
C95 ,96			CK73FB1H103K	CHIP C 0.010UF K		
C97			CE04EW1C102M	ELECTRØ 1000UF 16WV		
C99			CK73FB1H102K	CHIP C 1000PF K		
C100			CK73EF1C105Z	CHIP C 1.0UF Z		
C101			CK73FB1H102K	CHIP C 1000PF K		
C102			CE04EW1C100M	ELECTRØ 10UF 16WV		
C103			CC45SL2H180J	CERAMIC 18PF J		
C104			CC45SL2H050C	CERAMIC 5.0PF C		
C105			CK73FB1H102K	CHIP C 1000PF K		
C106			CC73FCH1H220J	CHIP C 22PF J		
C107			CK45B2H102K	CERAMIC 1000PF K		
C108			CM73F2H180J	CHIP C 18PF J		
C109			CC73FCH1H0R5C	CHIP C 0.5PF C		
C110			CC73FCH1H020C	CHIP C 2.0PF C		
C111-113			CK73FB1H102K	CHIP C 1000PF K		
C114			CC45SL2H470J	CERAMIC 47PF J		
C115			CC45SL2H390J	CERAMIC 39PF J		

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TM-231E : T,W1,W2

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C116			CC73FCH1H0R5C	CHIP C 0.5PF C		
C117			CC73FCH1H020C	CHIP C 2.0PF C		
C118			CM73F2H180J	CHIP C 18PF J		
C119			CK73FB1H102K	CHIP C 1000PF K		
C120			C92-0511-05	CHIP-TAN 0.15UF 35WV		
C121			CK73EF1C105Z	CHIP C 1.0UF Z		
C122			CK73FB1H102K	CHIP C 1000PF K		
C123			CK73EF1C105Z	CHIP C 1.0UF Z		
C201			CK73FB1H103K	CHIP C 0.010UF K		
C202			CE04CW1C100M	ELECTRO 10UF 16WV		
C203			CK73FB1H223K	CHIP C 0.022UF K		
C204,205			CK73FB1H102K	CHIP C 1000PF K		
C206,207			CC73FCH1H330J	CHIP C 33PF J		
C208,209			CK73FB1H103K	CHIP C 0.010UF K		
C210-215			CK73FB1H102K	CHIP C 1000PF K		
C216			CK73FB1H223K	CHIP C 0.022UF K		
C217			CK73FB1H102K	CHIP C 1000PF K		
TC1			C05-0349-05	TRIMMING CAP 10PF		
CN1			E40-3237-05	PIN CONNECTOR (SP)		
CN2		*	E40-5182-05	PIN CONNECTOR (VOICE)		
CN3 ,4		*	E40-5202-05	PIN CONNECTOR (CONTROL)		
CN201,202		*	E40-5203-05	PIN CONNECTOR (TX-RX)		
CN203		*	E40-5185-05	PIN CONNECTOR (VOICE 8P)		
CN204		*	E40-5187-05	PIN CONNECTOR (VOICE 10P)		
CN205,206		*	E40-5204-05	PIN CONNECTOR (LCD)		
J1			E11-0425-05	PHONE JACK		
J101			E06-0858-15	BP METAL SOCKET		
TP1 ,2			E23-0465-05	TERMINAL		
W202		*	E31-6030-15	CONNECTING WIRE(CTCSS)		
CD1		*	L79-0855-05	CERAMIC DISCR CDB544C7		
CF1		*	L72-0372-05	CERAMIC FILTER CFWM455F		
L1 -4			L34-4080-05	COIL		
L5			L34-0956-05	COIL		
L6			L30-0005-05	IFT		
L7		*	L40-1001-48	SMALL FIXED INDUCTOR 10UH		
L8			L34-1239-05	COIL		
L9			L34-0895-05	COIL		
L10			L34-0742-05	COIL		
L11			L34-0908-05	COIL		
L12 ,13			L34-0499-05	COIL		
L14			L40-3392-48	SMALL FIXED INDUCTOR 3.3UH		
X1			L77-0946-15	CRYSTAL RESONATOR 10.245MHZ		
X2			L77-1405-05	CRYSTAL RESONATOR 12.8MHZ		
X201		*	L77-1397-05	CRYSTAL RESONATOR 4.194304MHZ		
XF1			L71-0228-05	MCF (10.7MHZ)		
R2			RK73FB2A223J	CHIP R 22K J 1/10W		
R3			RK73FB2A274J	CHIP R 270K J 1/10W		
R4			RK73FB2A101J	CHIP R 100 J 1/10W		
R5			RK73FB2A103J	CHIP R 10K J 1/10W		
R6			RK73FB2A101J	CHIP R 100 J 1/10W		
R7			RK73FB2A104J	CHIP R 100K J 1/10W		
R9 -11			RK73FB2A103J	CHIP R 10K J 1/10W		
R12 ,13			RK73FB2A473J	CHIP R 47K J 1/10W		

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R14			RK73FB2A470J	CHIP R 47 J 1/10W		
R15			RK73FB2A274J	CHIP R 270K J 1/10W		
R16			RK73FB2A470J	CHIP R 47 J 1/10W		
R17			RK73FB2A103J	CHIP R 10K J 1/10W		
R18			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R19			R92-0670-05	CHIP R 0 ΩHM		
R20			RK73FB2A101J	CHIP R 100 J 1/10W		
R21			RK73FB2A471J	CHIP R 470 J 1/10W		
R22			RK73FB2A152J	CHIP R 1.5K J 1/10W		
R23			RK73FB2A471J	CHIP R 470 J 1/10W		
R24			RK73FB2A101J	CHIP R 100 J 1/10W		
R25			RK73FB2A103J	CHIP R 10K J 1/10W		
R26			RK73FB2A473J	CHIP R 47K J 1/10W		
R28			RK73FB2A103J	CHIP R 10K J 1/10W		
R30			RK73FB2A103J	CHIP R 10K J 1/10W		
R35 ,36			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R37			RK73FB2A334J	CHIP R 330K J 1/10W		
R38			RK73FB2A331J	CHIP R 330 J 1/10W		
R40			RK73FB2A331J	CHIP R 330 J 1/10W		
R43		*	RK73FB2A3R3J	CHIP R 3.3 J 1/10W		
R44			RK73FB2A101J	CHIP R 100 J 1/10W		
R45			R92-0670-05	CHIP R 0 ΩHM		
R46			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R47			RK73FB2A473J	CHIP R 47K J 1/10W		
R48			RK73FB2A333J	CHIP R 33K J 1/10W		
R49			RK73FB2A473J	CHIP R 47K J 1/10W		
R50			RK73FB2A223J	CHIP R 22K J 1/10W		
R51			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R52			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R53			RK73FB2A334J	CHIP R 330K J 1/10W		
R54			RK73FB2A223J	CHIP R 22K J 1/10W		
R55			RK73FB2A182J	CHIP R 1.8K J 1/10W		
R56 -58			RK73FB2A103J	CHIP R 10K J 1/10W		
R59			RK73FB2A182J	CHIP R 1.8K J 1/10W		
R60			RK73FB2A223J	CHIP R 22K J 1/10W		
R61			RK73FB2A473J	CHIP R 47K J 1/10W		
R62			R92-0670-05	CHIP R 0 ΩHM		
R63			RK73FB2A102J	CHIP R 1.0K J 1/10W	TW	
R63			RK73FB2A332J	CHIP R 3.3K J 1/10W	KMP	
R64			RK73FB2A392J	CHIP R 3.9K J 1/10W	KMP	
R64			RK73FB2A563J	CHIP R 56K J 1/10W	TW	
R65 ,66			R92-0670-05	CHIP R 0 ΩHM		
R67			RK73FB2A220J	CHIP R 22 J 1/10W		
R68			R92-0670-05	CHIP R 0 ΩHM		
R69			RK73FB2A184J	CHIP R 180K J 1/10W		
R70 ,71			RK73FB2A103J	CHIP R 10K J 1/10W		
R72			R92-0670-05	CHIP R 0 ΩHM		
R73			RK73FB2A223J	CHIP R 22K J 1/10W		
R74			R92-0670-05	CHIP R 0 ΩHM		
R75 -78			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R79			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R80			RK73FB2A104J	CHIP R 100K J 1/10W		
R81			RK73FB2A471J	CHIP R 470 J 1/10W		
R82			RK73FB2A220J	CHIP R 22 J 1/10W		
R83			R92-0670-05	CHIP R 0 ΩHM		

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TM-231E : T,W1,W2

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R84			RK73FB2A122J	CHIP R 1.2K J 1/10W		
R85			RK73FB2A220J	CHIP R 22 J 1/10W		
R86			RK73FB2A223J	CHIP R 22K J 1/10W		
R87			RK73FB2A103J	CHIP R 10K J 1/10W		
R88 ,89			RK73FB2A101J	CHIP R 100 J 1/10W		
R90			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R91			RK73FB2A470J	CHIP R 47 J 1/10W		
R92			RK73FB2A104J	CHIP R 100K J 1/10W		
R94			RK73FB2A220J	CHIP R 22 J 1/10W		
R95			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R96			RK73FB2A103J	CHIP R 10K J 1/10W		
R97		*	R92-1215-05	CHIP R 470 1/2W		
R98			RK73FB2A103J	CHIP R 10K J 1/10W		
R100			R92-0670-05	CHIP R 0 0HM		
R102			R92-0685-05	RD 22 J 1/2W		
R103		*	R92-1213-05	CHIP R 100 1/2W		
R104 ,105			RK73FB2A223J	CHIP R 22K J 1/10W		
R106			RK73FB2A224J	CHIP R 220K J 1/10W		
R107			R92-0670-05	CHIP R 0 0HM		
R108			RK73FB2A273J	CHIP R 27K J 1/10W		
R201			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R202			RK73FB2A104J	CHIP R 100K J 1/10W		
R203			RK73FB2A563J	CHIP R 56K J 1/10W		
R204			RK73FB2A103J	CHIP R 10K J 1/10W		
R205			R92-0670-05	CHIP R 0 0HM		
R206			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R207			R92-0670-05	CHIP R 0 0HM		
R208-210			RK73FB2A473J	CHIP R 47K J 1/10W		
R211-213			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R215			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R216,217			RK73FB2A104J	CHIP R 100K J 1/10W		
R218			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R219			RK73FB2A473J	CHIP R 47K J 1/10W		
R220			RK73FB2A332J	CHIP R 3.3K J 1/10W		
R221			RK73FB2A474J	CHIP R 470K J 1/10W		
R222			RK73FB2A473J	CHIP R 47K J 1/10W		
R223		*	R92-1212-05	CHIP R 27 1/2W		
R224			RK73FB2A474J	CHIP R 470K J 1/10W		
R225			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R226-230			R92-0670-05	CHIP R 0 0HM		
R231			R92-0670-05	CHIP R 0 0HM	M2	
R232,233			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R234			R92-0670-05	CHIP R 0 0HM		
R235			RK73FB2A563J	CHIP R 56K J 1/10W		
R236			RK73FB2A474J	CHIP R 470K J 1/10W		
TH1		*	R92-1216-05	THERMISTER 10K		
VR1			R12-5058-05	TRIMMING PNT. 100K		
VR3			R12-3132-05	TRIMMING PNT. 47K		
VR4 ,5			R12-3126-05	TRIMMING PNT. 10K		
VR201			R05-3441-05	POTENTIOMETER 10K(A)		
VR202			R05-4420-05	POTENTIOMETER 50K(B)		
S201			S40-2458-05	PUSH SWITCH (POWER)		
S202-211			S40-1086-05	TACT SWITCH		

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D2 -6			1SV164	CHIP VARI-CAP DIODE		
D7			DLS1585	CHIP DIODE		
D8 ,9			1SS184	CHIP DIODE		
D10			DAN235(K)	CHIP DIODE		
D11			1SS181	CHIP DIODE		
D12			MI407	DIODE		
D13			MI308	DIODE		
D14 ,15			1SS226	CHIP DIODE		
D16			DSA3A1	DIODE		
D201			DLS1585	CHIP DIODE		
D202			1SS181	CHIP DIODE		
D203			1SS184	CHIP DIODE		
D204			1SS187	CHIP DIODE		
D205			1SS193	CHIP DIODE		
D206			1SS187	CHIP DIODE		KFM1
D206			1SS187	CHIP DIODE		TW1
D207			1SS187	CHIP DIODE		TW
D209		*	MA141A	CHIP DIODE		MTW
D210		*	MA141A	CHIP DIODE		
D211			1SS187	CHIP DIODE		TW
D212			O2CZ7.5(X,Y)	CHIP ZENER DIODE		
IC1		*	KCD01	H.IC (FM IF)		
IC3			UPC1241H	IC		
IC4		*	KCC02	H.IC (VOL)		
IC5		*	TC9174F	IC(CMOS I/O)		
IC6			NJM78L05UA	IC(VOLTAGE REGULATOR/ +5V)		
IC7		*	LA5010M	IC(LOW SATURATION REGULATOR)		
IC8		*	KCB05	H.IC (DRIVE)		
IC9		*	MC7808CT	IC(VOLTAGE REGULATOR/ +8V)		
IC201		*	751086-E10-1B	CPU		
IC202			NJM78L06UA	IC(VOLTAGE REGULATOR/ +6V)		
IC203			KRR-C001	IC(CHIP NETWORK)		
IC301		*	S-AV17	IC(VHF 50W PWR MODULE FOR FM/H)		
Q1			3SK184(S)	CHIP FET		
Q4			3SK131(V12)	CHIP FET		
Q5			2SC2714(Y)	CHIP TRANSISTOR		
Q9			FMG2	DIGITAL TRANSISTOR		
Q10			2SC2712(Y)	CHIP TRANSISTOR		
Q12			2SD1757(K)	CHIP TRANSISTOR		
Q13 ,14			2SB1119S	CHIP TRANSISTOR		
Q15			DTC144WK	DIGITAL TRANSISTOR		
Q16 -18			2SC2712(Y)	CHIP TRANSISTOR		
Q19			2SD1757(K)	CHIP TRANSISTOR		
Q20			2SC2712(Y)	CHIP TRANSISTOR		
Q21			2SK208(Y)	CHIP FET		
Q22			2SC2714(Y)	CHIP TRANSISTOR		
Q23 ,24			DTC124EK	DIGITAL TRANSISTOR		
Q25			2SD1406(Y)	TRANSISTOR		
Q26		*	2SB1302S	CHIP TRANSISTOR		
Q27			2SC2712(Y)	CHIP TRANSISTOR		
Q201,202			2SC2712(Y)	CHIP TRANSISTOR		
Q203		*	2SA1519	DIGITAL TRANSISTOR		
Q204			2SC2712(Y)	CHIP TRANSISTOR		
S212			W02-0388-05	ROTARY ENCODER		

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		*	X58-3470-00	SUB UNIT (PLL)		
			X59-3130-00	MODULE UNIT (APC)		
		*	X59-3610-00	MODULE UNIT (MIC AMP)		
PLL (X58-3470-00)						
C1			CC73FCH1H220J	CHIP C 22PF J		
C2			CK73FB1H102K	CHIP C 1000PF K		
C3			CC73FCH1H020C	CHIP C 2.0PF C		
C4	.5		CK73FB1H472K	CHIP C 4700PF K		
C6			CC73FCH1H010C	CHIP C 1.0PF C		
C7	-9		CK73FB1H102K	CHIP C 1000PF K		
C10			CK73FB1H472K	CHIP C 4700PF K		
C11			CK73FB1H102K	CHIP C 1000PF K		
C51			CC73FCH1H100D	CHIP C 10PF D		
C52			CK73FB1H102K	CHIP C 1000PF K		
C53			CC73FCH1H100D	CHIP C 10PF D		
C54			CK73FB1H102K	CHIP C 1000PF K		
C55			CK73FB1H223K	CHIP C 0.022UF K		
C56			CK73FB1E393K	CHIP C 0.039UF K		
C101			CK73FB1H223K	CHIP C 0.022UF K		
C102,103			C92-0009-05	CHIP TAN 4.7UF 10WV		
C104			CK73FB1H102K	CHIP C 1000PF K		
C105			C92-0003-05	CHIP TAN 0.47UF 25WV		
C106			CK73FB1H223K	CHIP C 0.022UF K		
C107			CC73FCH1H100D	CHIP C 10PF D		
C108			CC73FUJ1H220J	CHIP C 22PF J		
C109,110			CC73FB1H102K	CHIP C 22PF J		
CN1			E40-0311-05	PIN CONNECTOR (3P)		
CN2			E40-0411-05	PIN CONNECTOR (4P)		
CN3		*	E40-5201-05	PIN CONNECTOR (7P)		
		*	F11-1122-14	SHIELDING COVER		
L1			L40-1581-80	SMALL FIXED INDUCTOR 150NH		
L2	-4		L40-3391-19	SMALL FIXED INDUCTOR 3.3UH		
L5		*	L34-2336-05	COIL		
L51			L40-3392-81	SMALL FIXED INDUCTOR 3.3UH		
R1			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R2			RK73FB2A561J	CHIP R 560 J 1/10W		
R3			RK73FB2A101J	CHIP R 100 J 1/10W		
R4			RK73FB2A121J	CHIP R 120 J 1/10W		
R5			RK73FB2A470J	CHIP R 47 J 1/10W		
R6	.7		R92-0670-05	CHIP R 0 OHM		
R8			RK73FB2A101J	CHIP R 100 J 1/10W		
R9			RK73FB2A470J	CHIP R 47 J 1/10W		
R10			RK73FB2A103J	CHIP R 10K J 1/10W		
R51			RK73FB2A103J	CHIP R 10K J 1/10W		
R52			RK73FB2A223J	CHIP R 22K J 1/10W		
R53			RK73FB2A221J	CHIP R 220 J 1/10W		
R54			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R55			RK73FB2A473J	CHIP R 47K J 1/10W		
R101			RK73FB2A152J	CHIP R 1.5K J 1/10W		
R102			R92-0670-05	CHIP R 0 OHM		
R103			RK73FB2A222J	CHIP R 2.2K J 1/10W		
R104			R92-0670-05	CHIP R 0 OHM		
R105			RK73FB2A222J	CHIP R 2.2K J 1/10W		

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R106 R107-111 R112 R113 R114			RK73FB2A392J RK73FB2A473J RK73FB2A223J RK73FB2A472J R92-0670-05	CHIP R 3.9K J 1/10W CHIP R 47K J 1/10W CHIP R 22K J 1/10W CHIP R 4.7K J 1/10W CHIP R 0 OHM		
D1 ,2 IC51 Q1 Q2 Q51 Q52 Q53 Q101,102		*	1T33C M54959FP 2SC2714(Y) 2SK582 2SC2714(Y) DTC144EK 2SC2712(Y) 2SC3324(B)	CHIP DIODE IC(FREQ SYNTHESIZER PLL) CHIP TRANSISTOR FET CHIP TRANSISTOR DIGITAL TRANSISTOR CHIP TRANSISTOR CHIP TRANSISTOR		
APC (X59-3130-00)						
C1 C2 C3 C4 C5 C6 R1 R2 R3 R4 ,5 R6 Q1 ,2 Q3			CK73FB1H102K C92-0501-05 CK73FB1H472K CK73FB1H102K CK73FB1H472K CK73FB1H102K E23-0471-05 RD41FB2B222J RD41FB2B102J RD41FB2B152J RD41FB2B103J RD41FB2B122J FMW1 2SA1162(Y)	CHIP C 1000PF K CHIP TAN 1.5UF 6.3WV CHIP C 4700PF K CHIP C 1000PF K CHIP C 4700PF K CHIP C 1000PF K TERMINAL CYLND CHIP R 2.2K J 1/8W CYLND CHIP R 1.0K J 1/8W CYLND CHIP R 1.5K J 1/8W CYLND CHIP R 10K J 1/8W CYLND CHIP R 1.2K J 1/8W DIGITAL TRANSISTOR CHIP TRANSISTOR		
MIC AMP (X59-3610-00)						
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10		*	CK73FF1E104Z CK73GB1H102K CK73FB1E333K CC73GCH1H270J C92-0004-05 CK73FB1E333K CK73GB1H681K CK73GB1H332K CC73GCH1H820J CC73GCH1H101J CK73GB1H102K E23-0471-05 RK73GB1J223J RK73GB1J104J RK73GB1J561J RK73GB1J470J RK73GB1J561J RK73GB1J000J RK73GB1J394J RK73GB1J224J RK73GB1J184J RK73GB1J333J	CHIP C 0.10UF Z CHIP C 1000PF K CHIP C 0.033UF K CHIP C 27PF J CHIP TAN 1UF 16WV CHIP C 0.033UF K CHIP C 680PF K CHIP C 3300PF K CHIP C 82PF J CHIP C 100PF J CHIP C 1000PF K TERMINAL CHIP R 22K J 1/16W CHIP R 100K J 1/16W CHIP R 560 J 1/16W CHIP R 47 J 1/16W CHIP R 560 J 1/16W CHIP R 0.0 J 1/16W CHIP R 390K J 1/16W CHIP R 220K J 1/16W CHIP R 180K J 1/16W CHIP R 33K J 1/16W		

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R11			RK73FB2A473J	CHIP R 47K J 1/10W		
R12		*	RK73GB1J224J	CHIP R 220K J 1/16W		
R13 -15		*	RK73GB1J823J	CHIP R 82K J 1/16W		
R16		*	RK73GB1J000J	CHIP R 0.0 J 1/16W		
IC1			NJM4558M	IC(OP AMP X2)		
Q1		*	2SC4116(Y)	CHIP TRANSISTOR		

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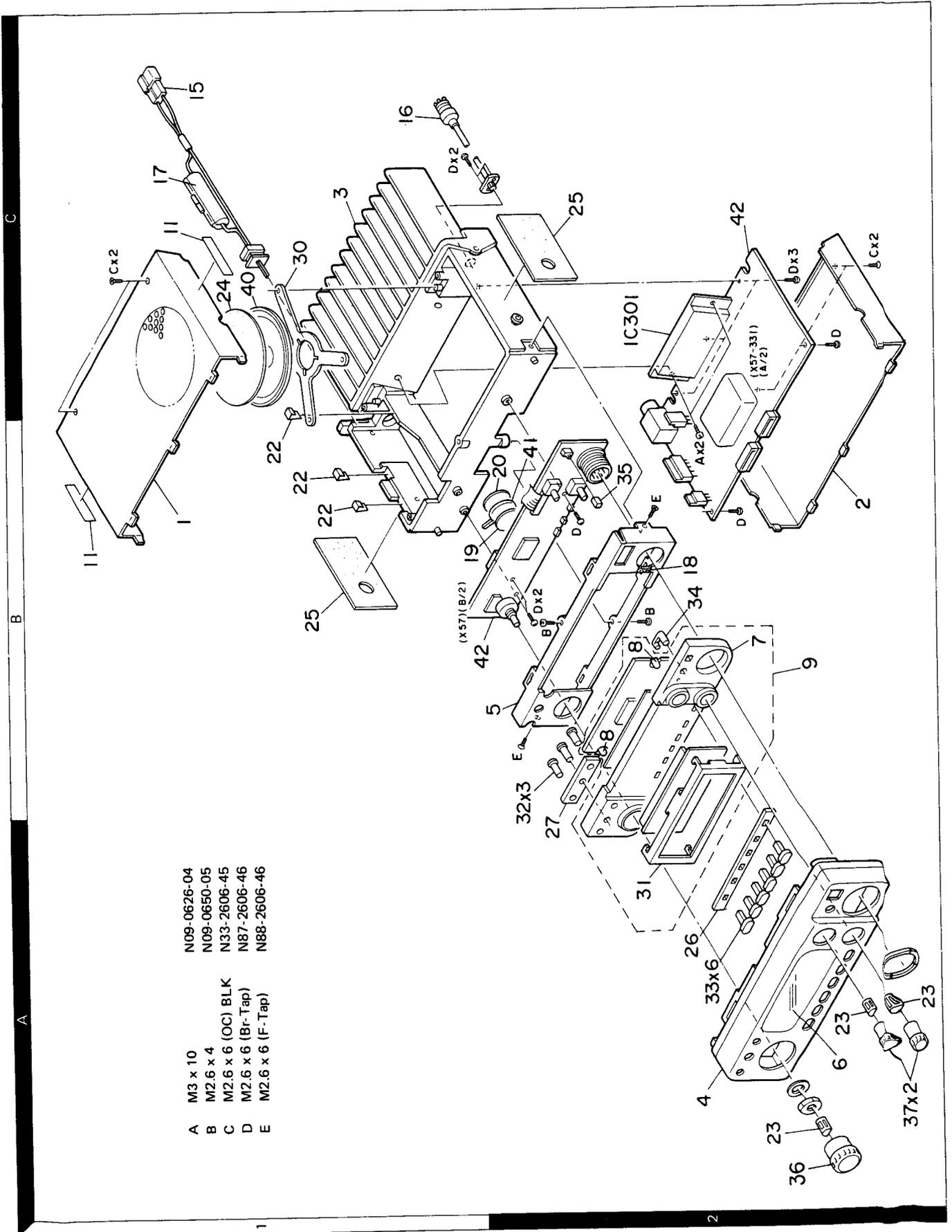
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SEMICONDUCTOR

Item	New parts	Parts No.
Diode		DSA3A1
		MI308
		MI407
Chip diode		1SS181
		1SS184
		1SS187
		1SS193
		1SS226
	*	1T33C
		DAN235(K)
		DLS1585
	*	MA141A
Chip vari-cap diode		1SV164
Zener diode		02CZ7.5(X,Y)
Transistor		2SD1406(Y)
Chip transistor		2SA1162(Y)
		2SB1119S
	*	2SB1302S
		2SC2712(Y)
		2SC2714(Y)
		2SC3324(B)
	*	2SC4116(Y)
		2SD1757(K)

Item	New parts	Parts No.
Digital transistor	*	2SA1519
		DTC124EK
		DTC144EK
		DTC144WK
		FMG2
		FMW1
FET		2SK582
Chip FET		2SK208(Y)
		3SK131(V12)
		3SK184(S)
IC		KRR-C001
	*	LA5010M
		LC7582
		M54959FP
	*	MC7808CT
		NJM78L05UA
		NJM78L06UA
		NJM4558M
	*	TC9174F
		μPC1241H
	*	75108G-E10-1B
Power module	*	S-AV17
H. IC	*	KCB05
	*	KCC02
	*	KCD01

EXPLODED VIEW

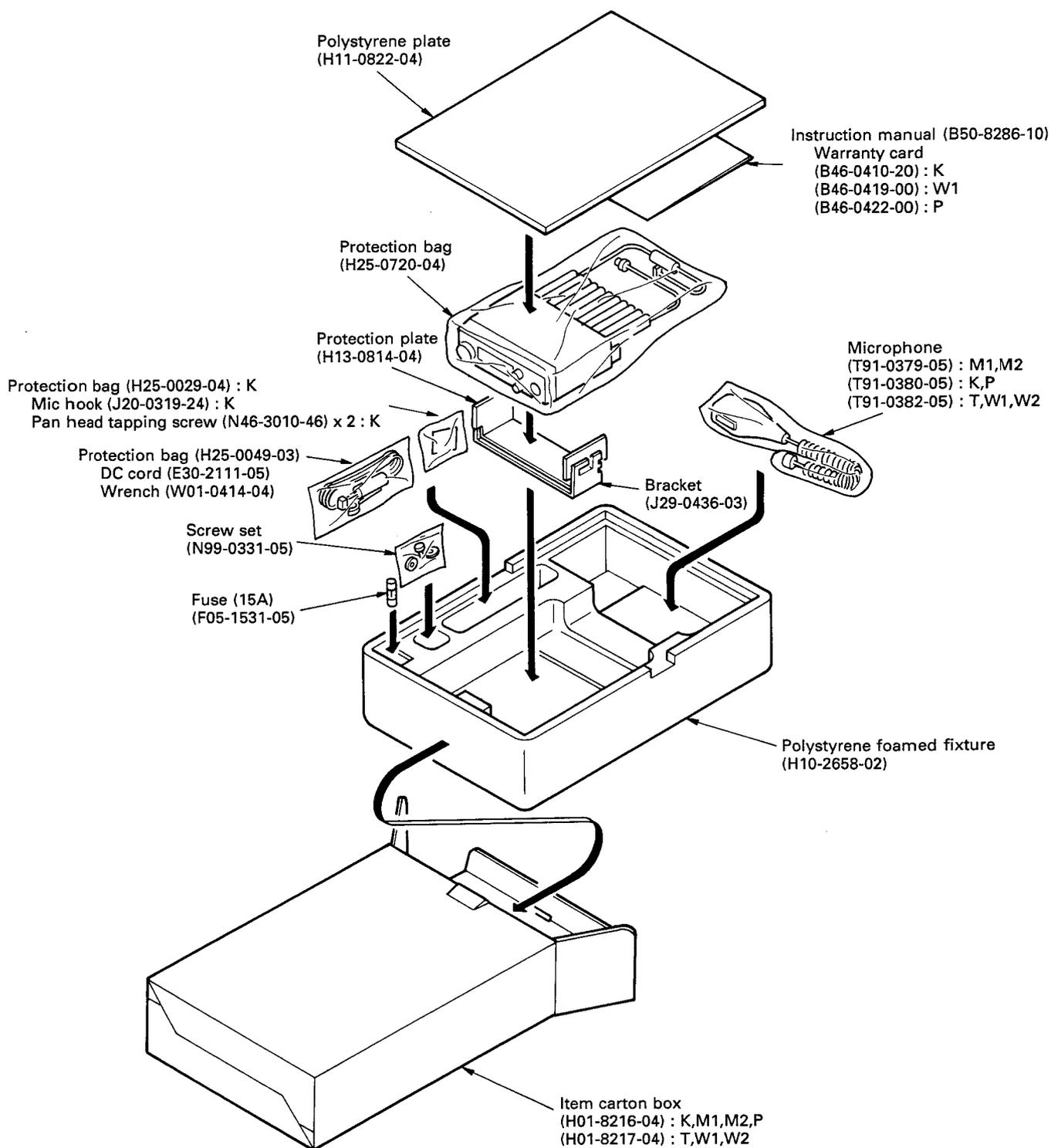


- N09-0626-04
- N09-0650-05
- N33-2606-45
- N87-2606-46
- N88-2606-46

- A M3 x 10
- B M2.6 x 4
- C M2.6 x 6 (OC) BLK
- D M2.6 x 6 (Br-Tap)
- E M2.6 x 6 (F-Tap)

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

PACKING



ADJUSTMENT

REQUIRED TEST EQUIPMENT

- 1. DC V.M and Tester**
 - 1) High input impedance
- 2. RF VTVM (RF V.M)**
 - 1) Input impedance : 1M Ω min., 2pF max.
 - 2) Voltage range : F.S = 10mV to 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 to 17V, variable
 - 2) Current : 15A min.
- 5. Power Meter**
 - 1) Measurement range : Approx. 30W, 3W, 1W
 - 2) Input impedance : 50 Ω
 - 3) Frequency range : 450MHz
- 6. AF VTVM (AF V.M)**
 - 1) Input impedance : 1M Ω min.
 - 2) Voltage range : F.S = 1mV to 30V
 - 3) Frequency range : 50Hz to 10kHz
- 7. AF Generator (AG)**
 - 1) Output frequency : 100Hz to 10kHz
 - 2) Output voltage : 0.5mV to 1V
- 8. Linear Detector**
 - 1) Frequency range : 450MHz
- 9. Spectrum Analyzer**
 - 1) Frequency range : 450MHz
- 10. Directional Coupler**
- 11. Oscilloscope**
 - 1) High sensitivity oscilloscope with horizontal input terminal
- 12. SSG**
 - 1) Frequency range : 144MHz band
 - 2) Modulation: AM and FM MOD.
 - 3) Output level : 0.1 μ V to 100mV.
- 13. Dummy Load**
 - 1) 8 Ω , 5W (approx.)
- 14. Noise Generator**
 - 1) Must generate ignition-like noise containing harmonics beyond 450MHz.

15. Sweep Generator

- 1) Sweep range : 144MHz bands

16. Tracking Generator

PREPARATION

- 1) Unless otherwise specified, knobs and switches should be set as follows **Table 7**.

POWER SW	ON	CALL	OFF
AF VOL VR	MIN	SHIFT/AL	OFF
SQL VOL VR	MIN	TONE/T. ALT	OFF
VFO	VFO	REV/STEP	OFF
MR	OFF	DRS	OFF

Table 7

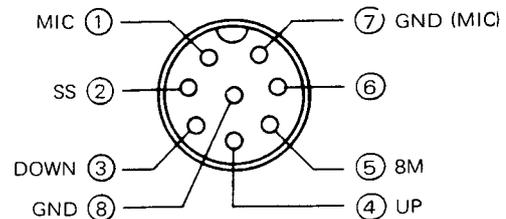


Fig. 13 MIC terminals (view from front panel side)

- 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 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. 14**.

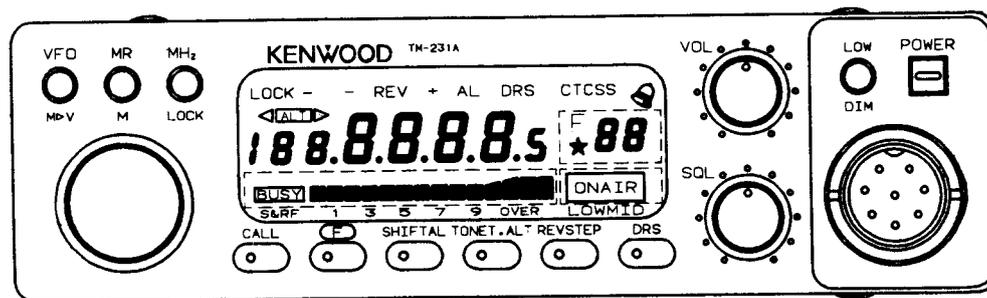


Fig. 14

ADJUSTMENT

COMMON SECTION ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
1. Setting	1) Source voltage : DC 13.8V POWER SW : OFF VOL VR : Full counter-clockwise (CCW) SQL VR : CCW TX-RX unit VR3, 4 : CCW VR1 : Center							
2. Reset	1) Turn POWER SW ON while holding down MR/M.							Display 144.000
3. PLL	1) RX VCO FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 Receive.	DVM Dummy	TX-RX Rear panel	TP2 ANT			Check	1.7 ~ 2.4V
	2) FREQ. : 136.000 K,P,M1,M2,W2 Receive.							1.0V or more.
	3) TX VCO FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 Transmit.							3.2 ~ 3.8V
	4) FREQ. : 173.995 M2,W2 Transmit.							10V or less.
4. Transmit frequency adjustment	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 Transmit.	f.counter Power meter	Rear panel	ANT	TX-RX	TC3	144.975MHz T,W1 146.000MHz K,P,M1,M2,W2	±100Hz

RECEIVER SECTION ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
1. BPF	1) FREQ. : 145.050 T,W1 FREQ. : 146.040 K,P,M1,M2 FREQ. : 146.050 W2 TX-RX unit VR1 : Center Connect the SSG to ANT. Connect the DC V.M to TP1. SSG output : -113dBm (0.5µV) SSG MOD : 1kHz SSG DEV : 3kHz	DC V.M	TX-RX	TP1	TX-RX	L1 ~ 4	Repeat for MAX.	
2. Distortion	1) FREQ. : 145.050 T,W1 FREQ. : 146.040 K,P,M1,M2 FREQ. : 146.050 W2 SSG output : -103dBm (1.7µV) SSG MOD : 1kHz SSG DEV : 3kHz	Distortion meter Oscilloscope	Rear panel	SP	TX-RX	L5, 6	Repeat for MIN.	Turn L6 core CCW until best SINAD point obtained.

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
3. Receiving sensitivity	1) FREQ. : 145.050 T,W1 FREQ. : 146.040 K,P,M1,M2 FREQ. : 146.050 W2 SSG output : -123dBm (0.16μV) SSG MOD : 1kHz SSG DEV : 3kHz	AF V.M Oscilloscope	Rear panel	SP	TX-RX	L1 ~ 6	Check	SINAD 12dB or more.
	2) FREQ. : 144.040 K,P,M1,M2 FREQ. : 144.050 T,W1,W2							
	3) FREQ. : 145.950 T,W1 FREQ. : 147.940 K,P,M1,M2 FREQ. : 147.950 W2							
4. S-meter	1) FREQ. : 145.050 T,W1 FREQ. : 146.040 K,P,M1,M2 FREQ. : 146.050 W2 SSG output : -93dBm (5μV) SSG MOD : 1kHz SSG DEV : 3kHz	LCD (S-meter)			TX-RX	VR1	All S-meter segments on (Adjust VR1 so that last segment just turns on).	
	2) SSG : OFF						Check	S-meter off.

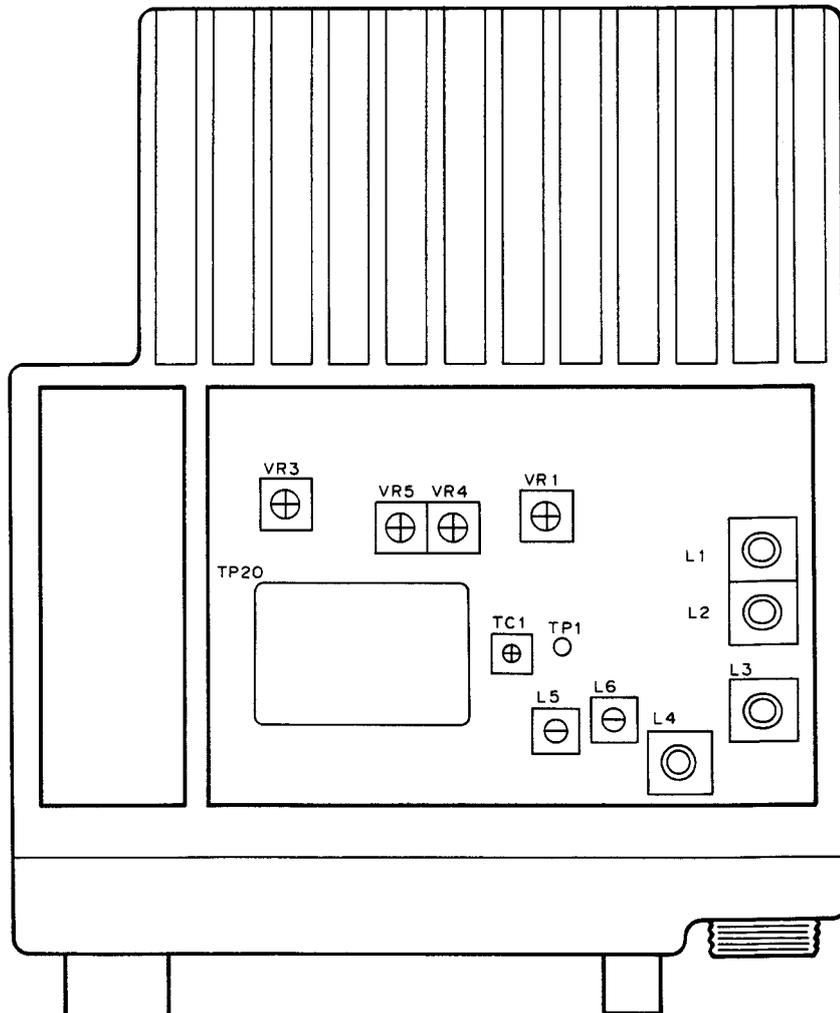
TRANSMITTER SECTION ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
1-1. APC	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 TX-RX unit VR4 : CCW Transmit.	Power meter Ammeter	Rear panel	ANT			Check	57W or more.
	2) FREQ. : 145.975 T,W1 FREQ. : 147.995 K,P,M1,M2 FREQ. : 147.950 W2 Transmit.				TX-RX	VR4	54W	ON AIR LED on. ±1W, 10.5A or less.
	3) FREQ. : 144.000 Transmit.						Check	49 ~ 59W 10.5A or less
	4) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 Transmit.						Read RF meter	All RF meter LEDs on.
1-2. MID power	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 MID SW : ON Transmit.				TX-RX	VR5	12W Read RF meter	±1W 10 RF meter LEDs on.
1-3. LOW power	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 LOW SW : ON Transmit.						Check Read RF meter	3.0 ~ 8.0W 6 RF meter LEDs on.

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
2. DEV.	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 K,P,M1,M2,W2 AG : 1kHz, 25mV T,W1,W2 AG : 1kHz, 50mV K,P,M1,M2 Transmit.	Linear detector Oscilloscope Power meter	Rear panel	ANT	TX-RX	VR2	±4.4kHz (Read higher absolute value of + or - value)	±200Hz Check for detected waveform.
	2) AG : 1kHz, 2.5mV T,W1,W2 AG : 1kHz, 5.0mV K,P,M1,M2						Check	±2.2 ~ 3.6kHz
3. Protection	1) FREQ. : 145.975 T,W1 FREQ. : 147.995 K,P,M1,M2 FREQ. : 147.950 W2 ANT : OPEN Transmit.	Ammeter					Check	11A or less.
4-1. TONE	1) FREQ. : 145.250 TONE : ON Transmit.	Linear detector Oscilloscope	Rear panel	ANT			Check	DEV. : ±0.5 ~ 1.0kHz
4-2. TONE TM-231E	1) FREQ. : 144.975 T,W1 FREQ. : 146.000 W2 Transmit.	Power meter					TONE SW of MIC : ON.	DEV. : ±2.5 ~ 5.0kHz

Adjustment Points (Top View)



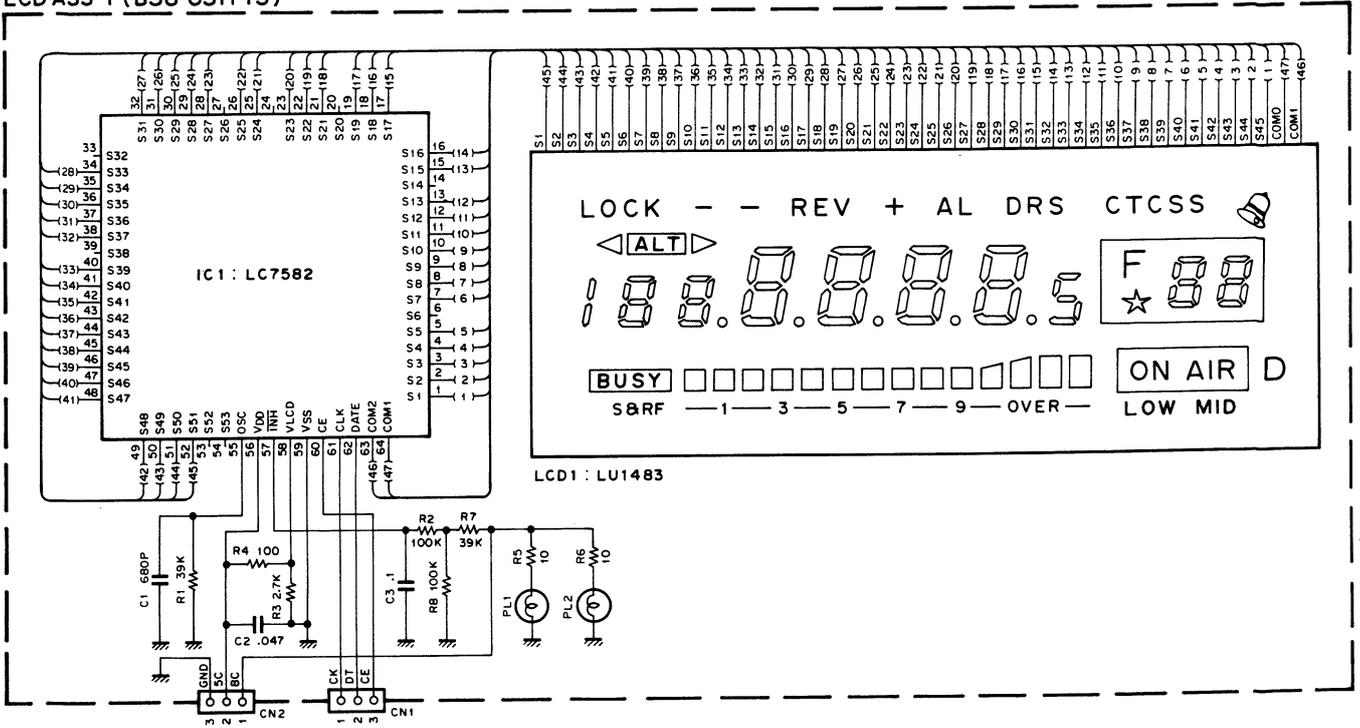
TX-RX unit (X57-3310-XX)

- VR1 : S-meter
- VR3 : ±4.4kHz at 1kHz, 25mV (T,W1,W2)
- VR3 : ±4.4kHz at 1kHz, 50mV (K,M1,M2,P)
- VR4 : APC
- VR5 : MID POWER
- L1 ~ 4 : BPF, RX sensitivity
- L5 : Distortion, RX sensitivity
- L6 : Distortion
- TC1 : TX frequency

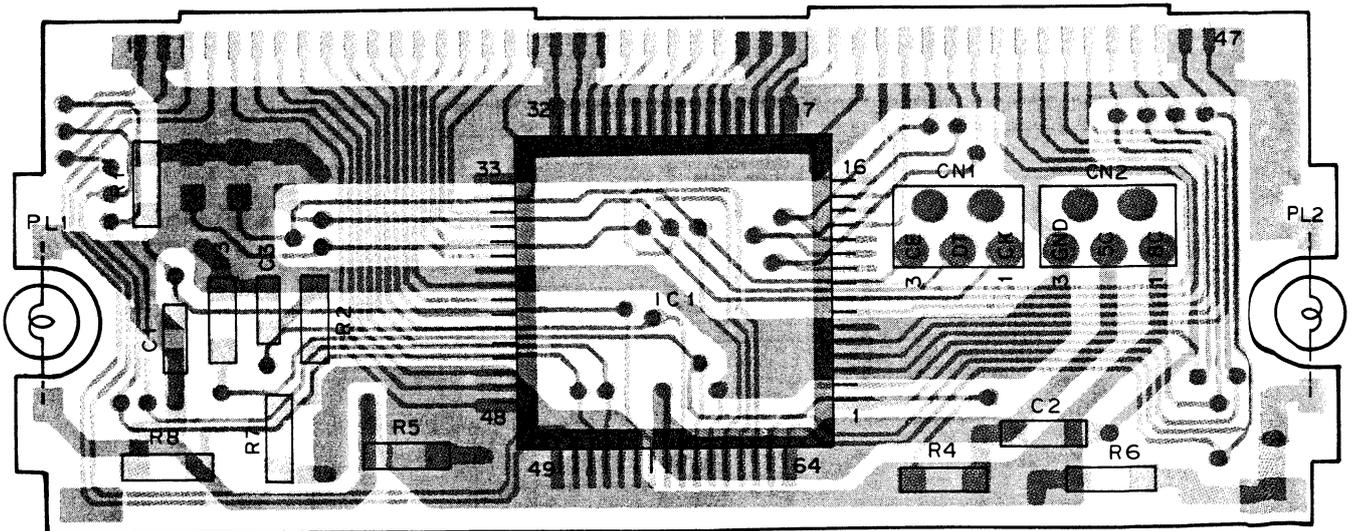
PC BOARD VIEWS/CIRCUIT DIAGRAMS TM-231A/E

LCD ASS'Y (B38-0311-15)

LCD ASS'Y (B38-0311-15)

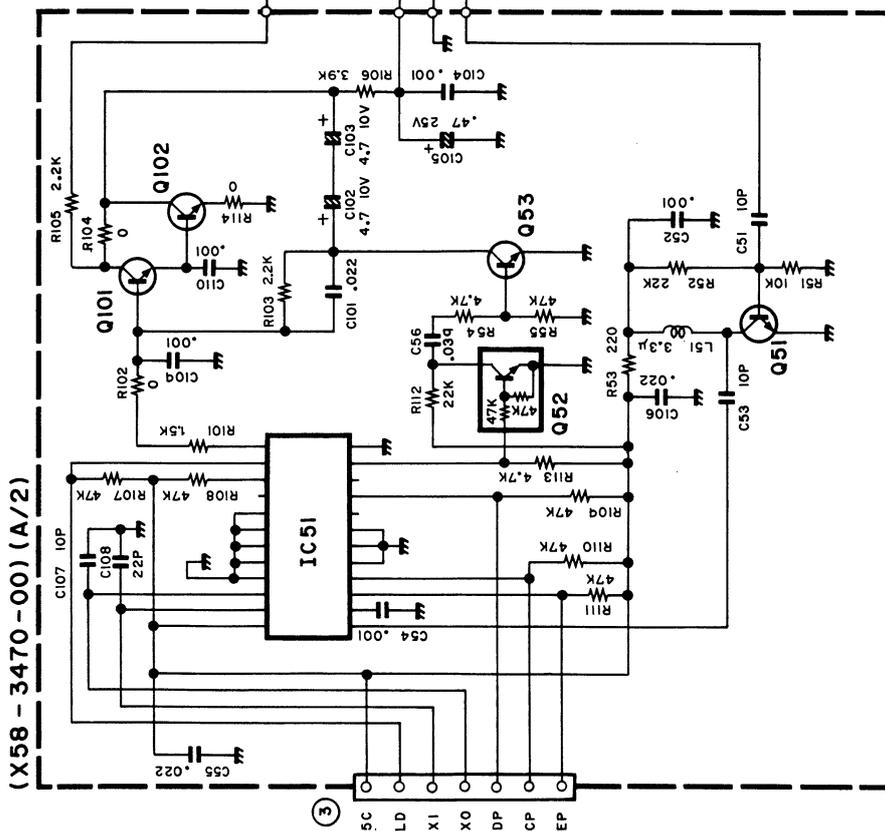
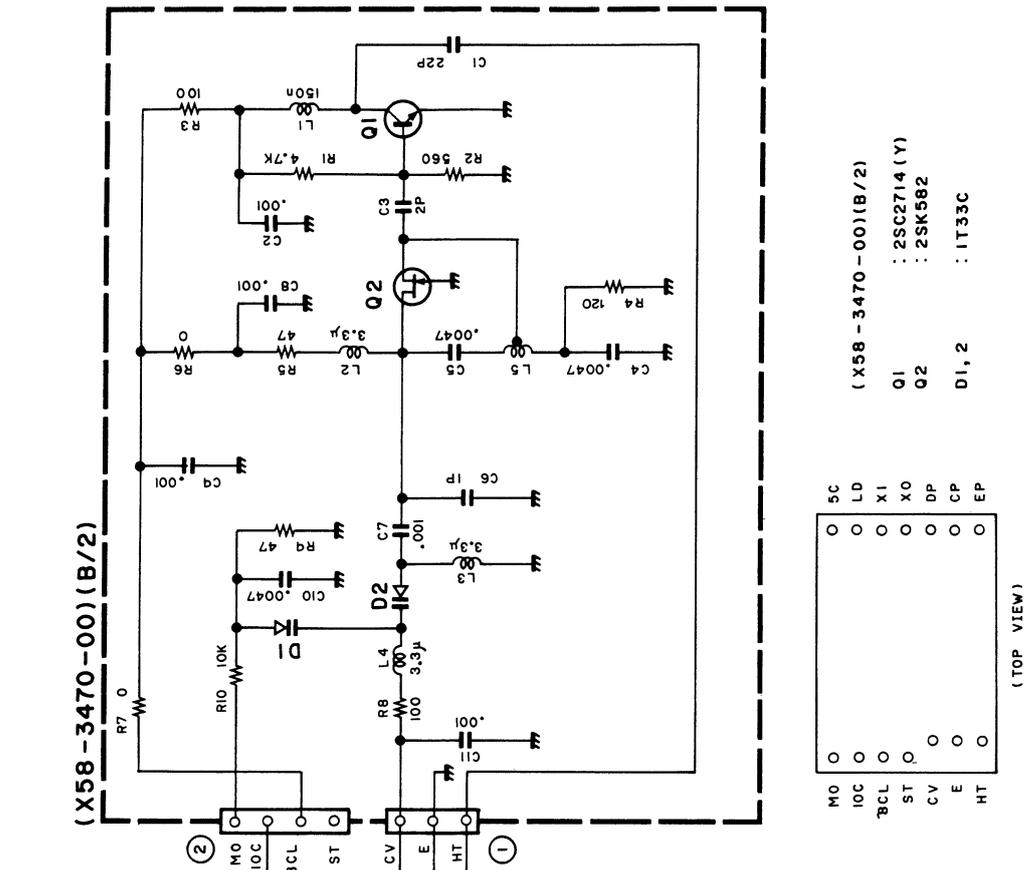


LCD ASS'Y (B38-0311-15) Component side view



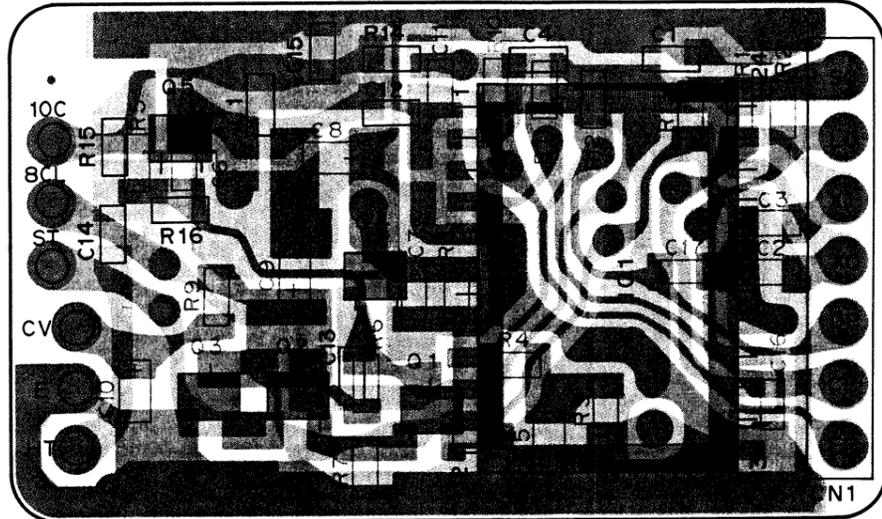
TM-231A/E CIRCUIT DIAGRAM

PLL (X58-3470-00)



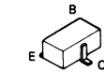
PC BOARD VIEW/CIRCUIT DIAGRAM TM-231A/E

PLL (X58-3470-00) (A/2) Component side view

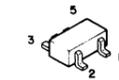


IC51 : M54959FP Q51 : 2SC2714(Y) Q52 : DTC144EK Q53 : 2SC2712(Y) Q101,102 : 2SC3324(B)

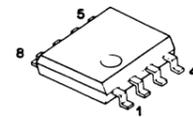
DTC144EK
2SC2712(Y)
2SC2714(Y)
2SC3324(B)
2SA1162(Y)
2SC4116(Y)



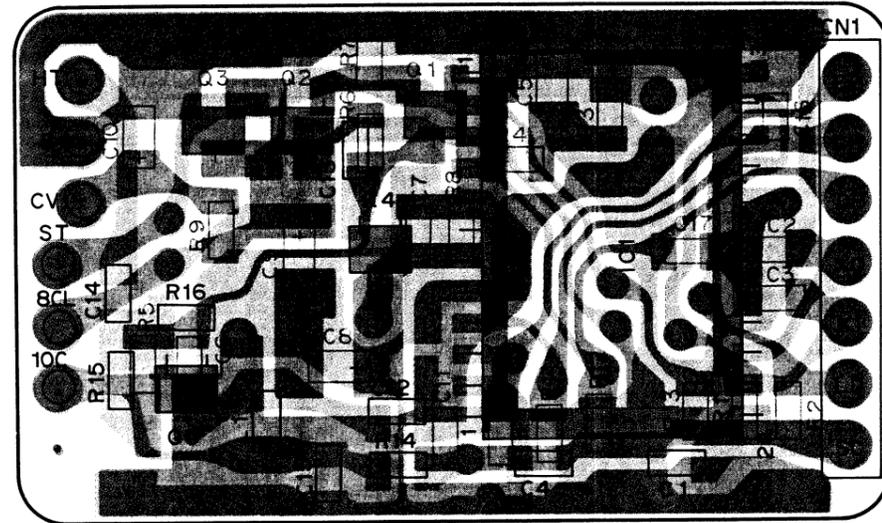
FMW1



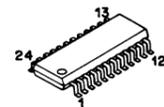
NJM4558M



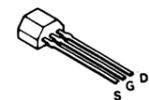
PLL (X58-3470-00) (A/2) Foil side view



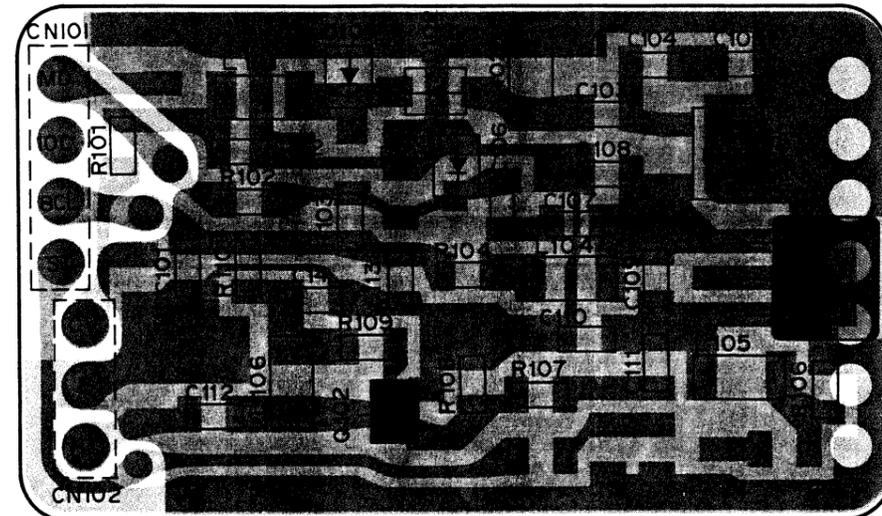
M54959FP



2SK582

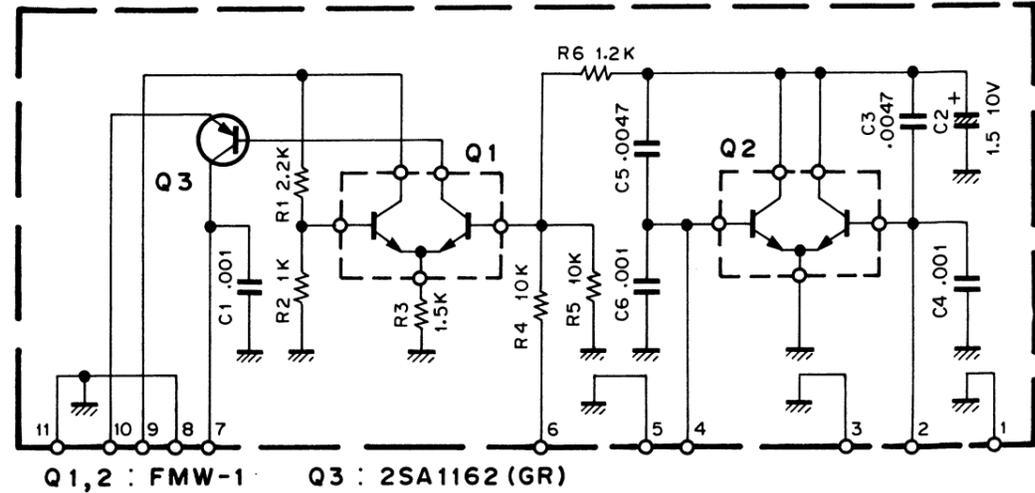


PLL (X58-3470-00) (B/2) Component side view

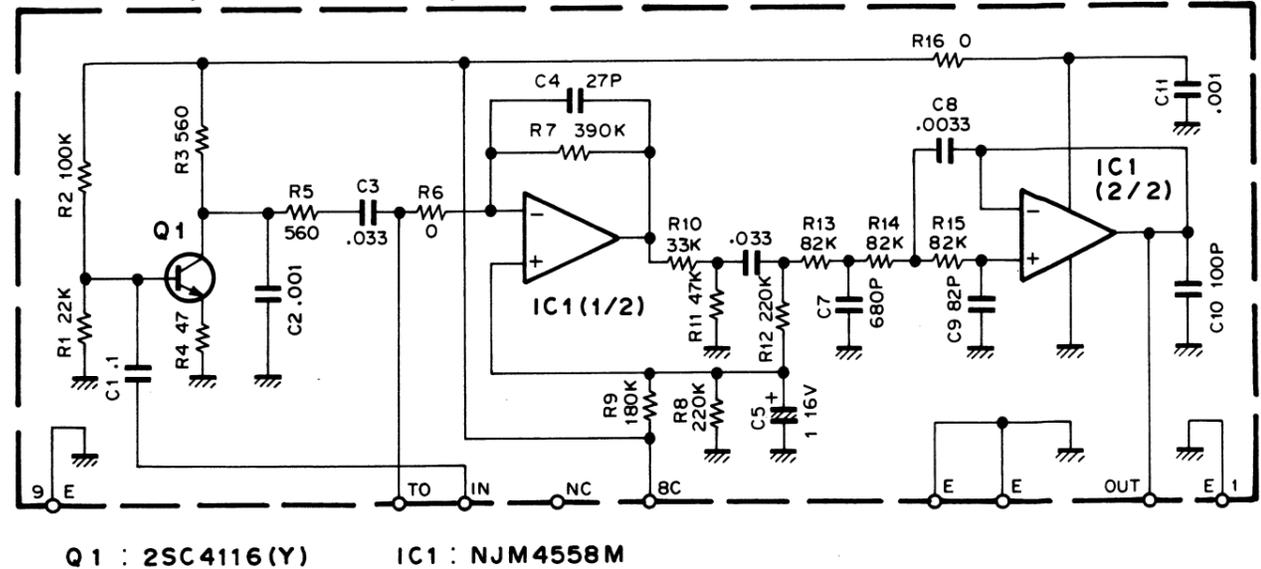


Q1 : 2SC2714 (Y) Q2 : 2SK582 D1,2 : 1T33C

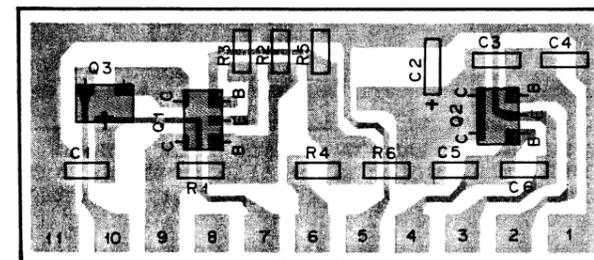
APC (X59-3130-00)
APC (X59-3130-00)



MIC AMP (X59-3610-00)
MIC AMP (X59-3610-00)

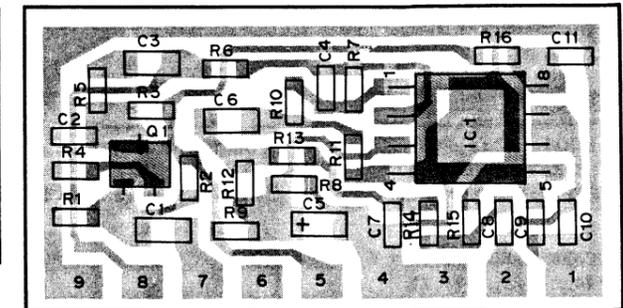


APC (X59-3130-00) Component side view



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

MIC AMP (X59-3610-00) Foil side view

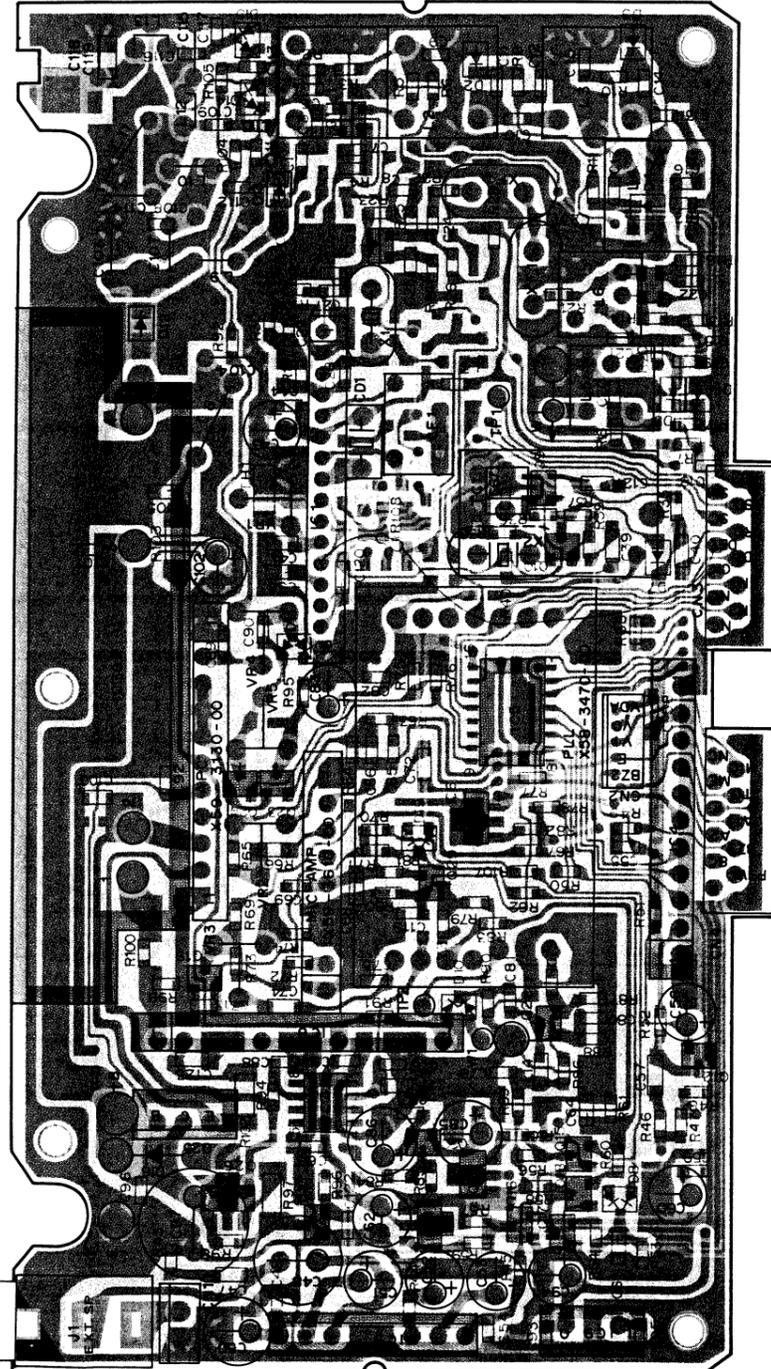


Q1 : 2SC4116(Y) IC1 : NJM4558M

TM-231A/E PC BOARD VIEWS

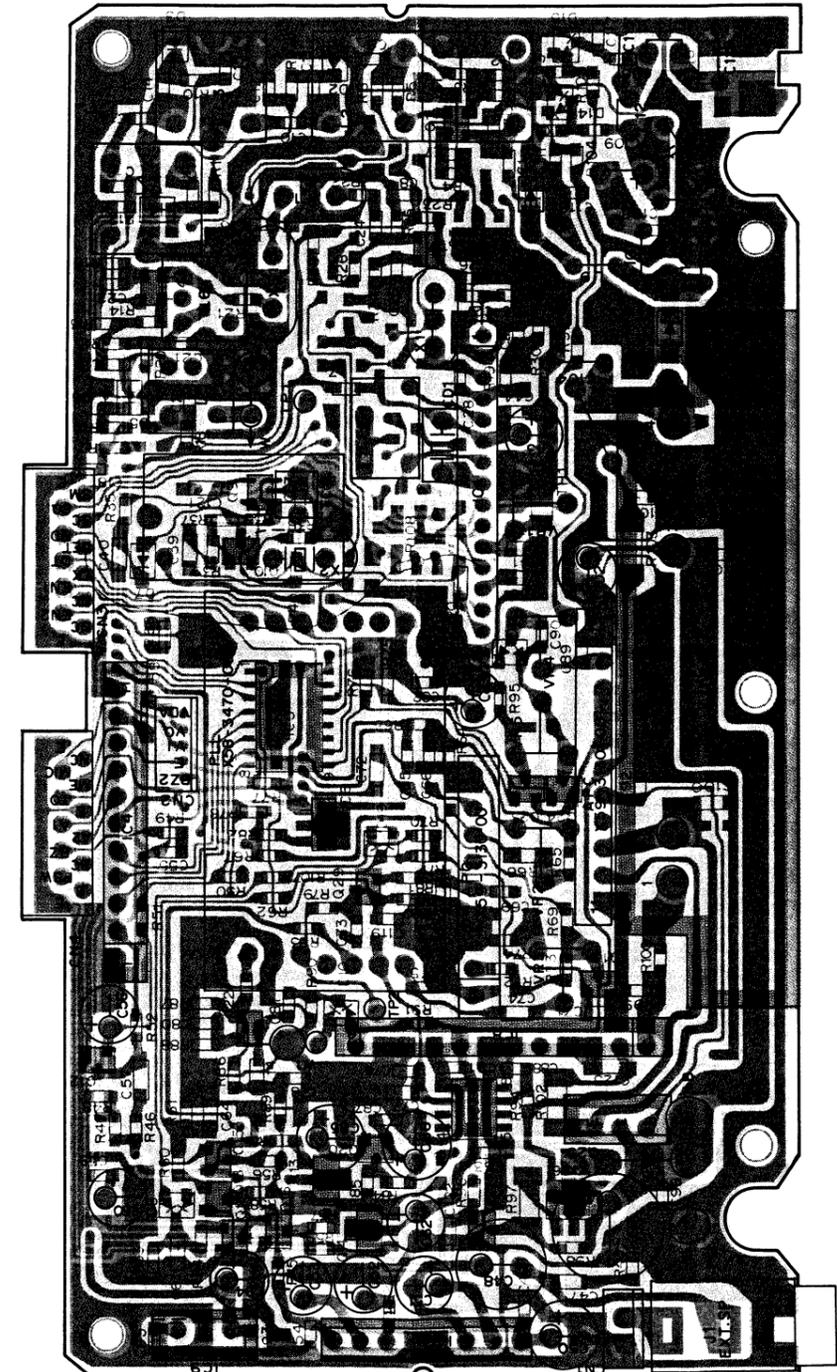
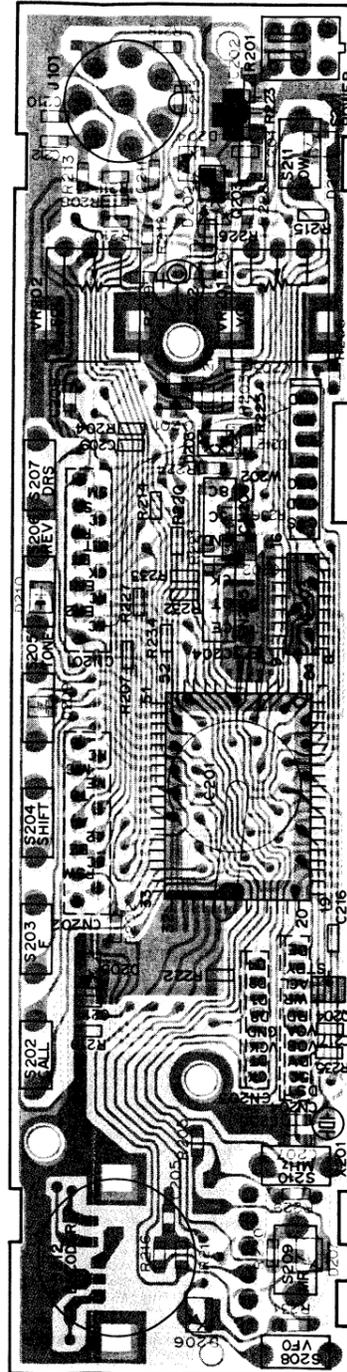
TX-RX UNIT (X57-3310-XX) Component side view

-11 : TM-231A (K,P) -21 : TM-231A (M2) -22 : TM-231A (M2) -61 : TM-231E (T,W1) -62 : TM-231E (W2)

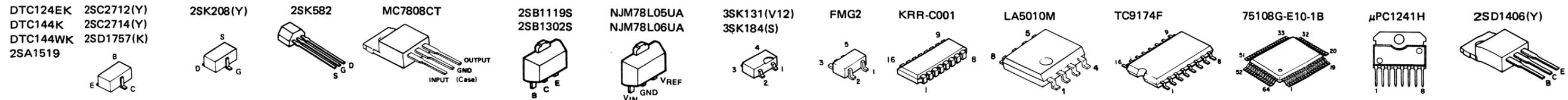


TX-RX UNIT (X57-3310-XX) Foil side view

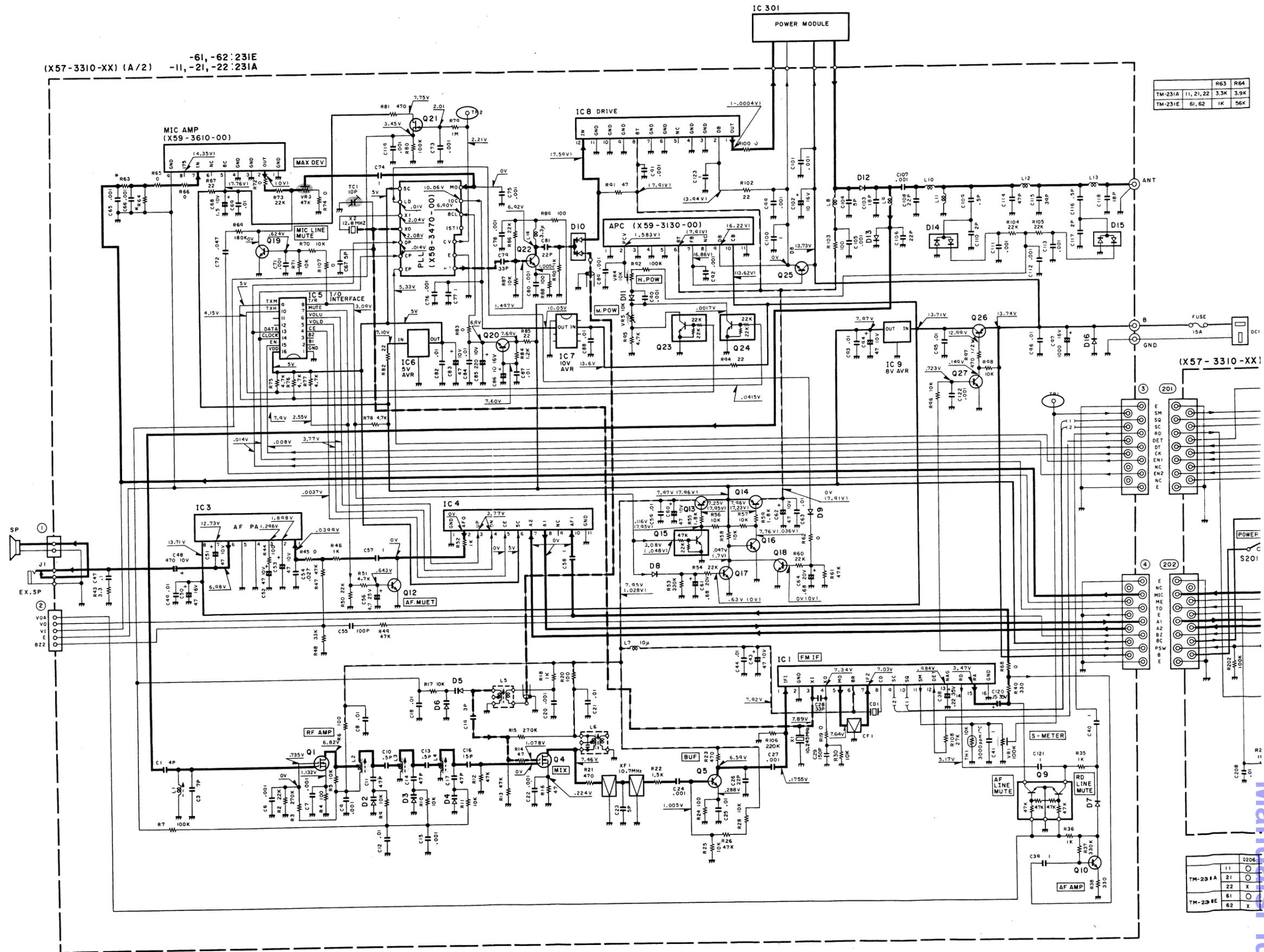
-11 : TM-231A (K,P) -21 : TM-231A (M2) -22 : TM-231A (M2) -61 : TM-231E (T,W1) -62 : TM-231E (W2)



IC1 : KCD01 IC3 : μ PC1241H IC4 : KCC02 IC5 : TC9174F IC6 : NJM78L05UA IC7 : LA5010M IC8 : KCB05 IC9 : MC7808CT IC201 : 75108G-E10-1B IC202 : NJM78L06UA IC203 : KRR-C001 IC301 : S-AV17 Q1 : 3SK184(S) Q4 : 3SK131(V12) Q5,22 : 2SC2714(Y) Q,21 : 2SK208(Y) Q,10,16,~18,20,27,201,202,204 : 2SC2712(Y) Q9 : FMG2 Q12,19 : 2SD1757 (K) Q13,14 : 2SB1119S Q15 : DTC144WK Q23,24 : DTC124EK Q25 : 2SD1406 (Y) Q26 : 2SB1302S Q203 : 2SA1519 D10 : DAN235(K) D2~6 : 1SV164 D7,201 : DLS1585 D8,9,203 : 1SS184 D11,202 : 1SS181 D12 : MI407 D13 : MI308 D14,15 : 1SS226 D16 : DSA3A1 D204,206,207,211 : 1SS187 D205 : 1SS193 D209,210 : MA141A D212 : 02CZ7.5(X,Y)



Signal line --- Control signal line --- Common DC line



	R63	R64
TM-231A	11, 21, 22	3.3K, 3.9K
TM-231E	61, 62	1K, 56K

(X57-3310-XX)

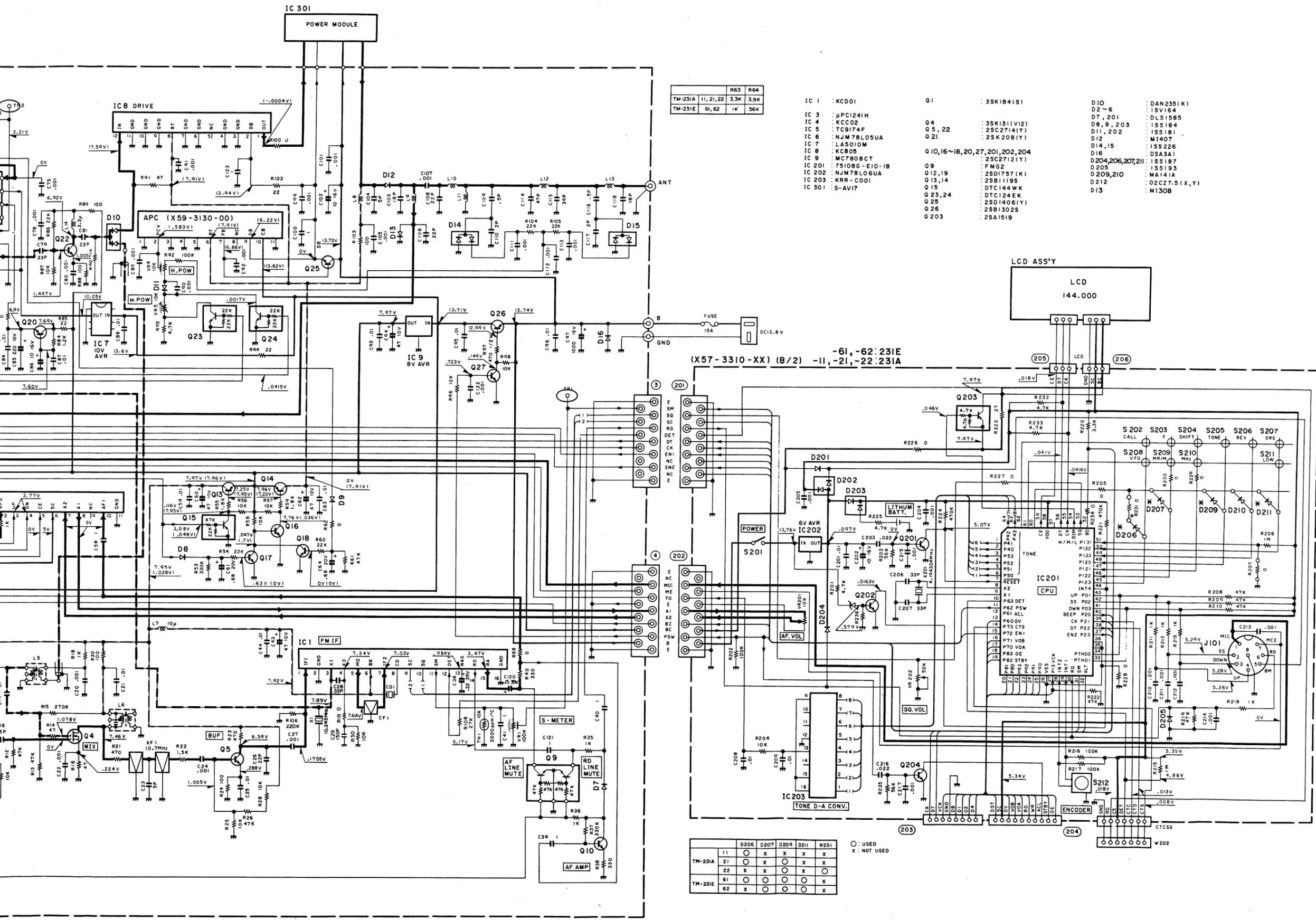
POWER S201

		0206
TM-231A	11	○
	21	○
	22	X
	61	○
TM-231E	62	X

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SCHEMATIC DIAGRAM TM-231A/E

DC line



	R63	R64
TM-231A	11, 21, 22	3.3K 3.9K
TM-231E	61, 62	1K 56K

- | | | |
|------------------------|---------------------|------------------------------|
| IC 1 : KCD01 | Q1 : 3SK184(S) | D10 : DAN235(K) |
| IC 3 : μPCI241H | Q4 : 3SK131(VI2) | D2~6 : 15V164 |
| IC 4 : KCC02 | Q5, 22 : 2SC2714(Y) | D7, 201 : DLS1585 |
| IC 5 : TC9174F | Q21 : 2SK208(Y) | D8, 9, 203 : ISS184 |
| IC 6 : NJM78L05UA | | D11, 202 : ISS181 |
| IC 7 : LA5010M | | D12 : M1407 |
| IC 8 : KB05 | | D14, 15 : ISS226 |
| IC 9 : MC7808CT | | D16 : DSA3A1 |
| IC 201 : 751086-E10-1B | | D204, 206, 207, 211 : ISS187 |
| IC 202 : NJM78L06UA | | D205 : ISS193 |
| IC 203 : KRR-C001 | | D209, 210 : MA141A |
| IC 301 : S-AV17 | | D212 : 02CZ7.5(X,Y) |
| | | D13 : M1308 |

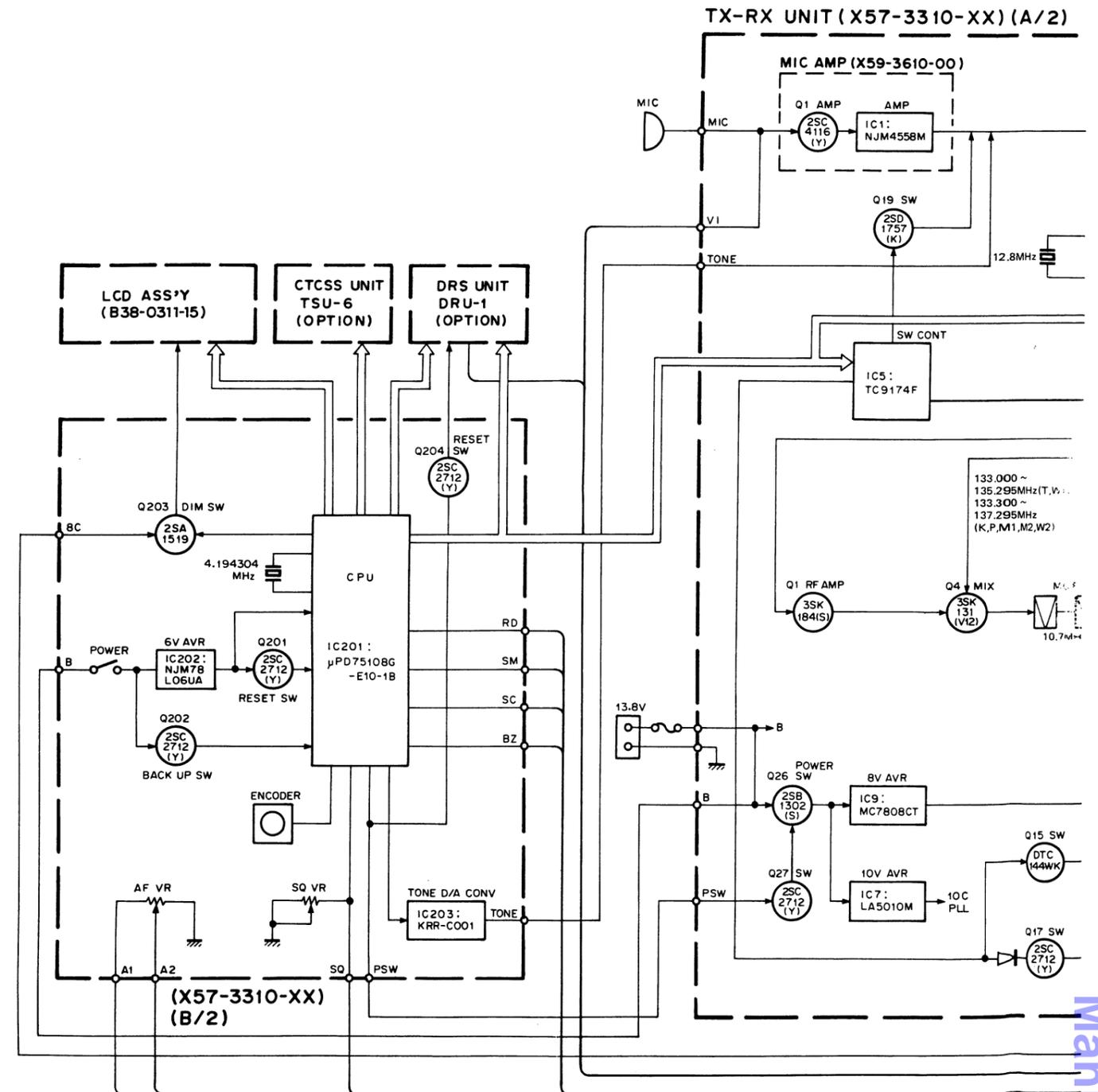
-61, -62: 231E
(X57-3310-XX) (B/2) -11, -21, -22: 231A

	D206	D207	D209	D211	R231
TM-231A	11	X	X	X	X
	21	X	X	X	X
	22	X	X	X	X
TM-231E	61	X	X	X	X
	62	X	X	X	X

○ : USED
X : NOT USED

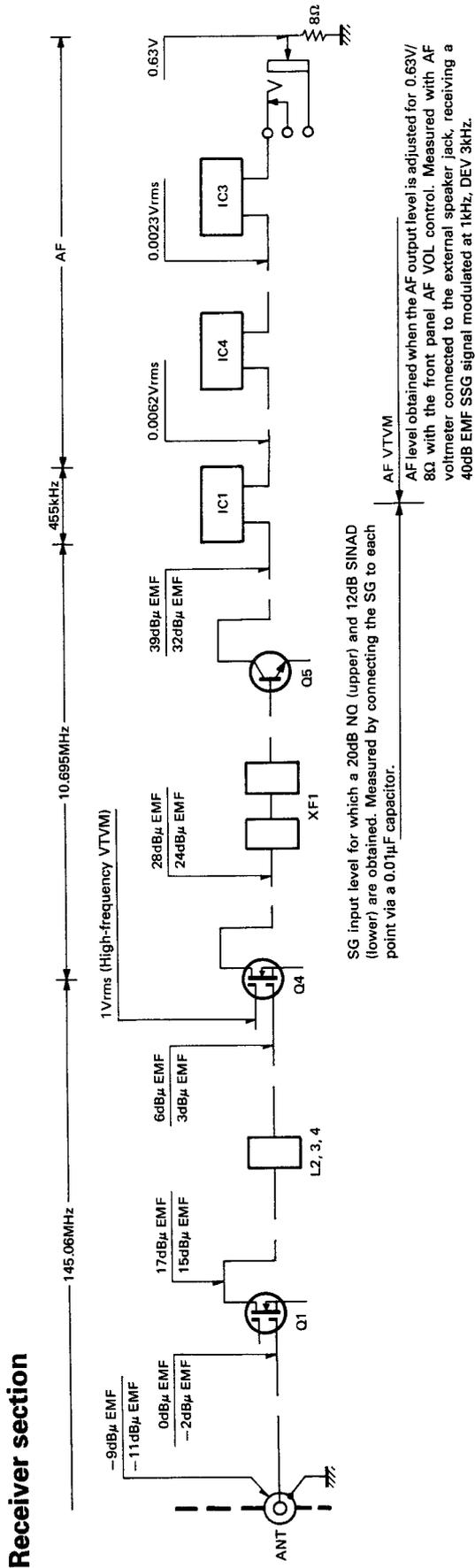
Connector No.	Terminal No.	Terminal Name	Terminal Function
TX-RX UNIT (X57-3310-XX) (A/2)			
CN1	1	SP	Speaker input.
	2	E	GND.
CN2	1	VOA	Power supply for voice memory.
	2	VO	Voice memory output.
	3	VI	Voice memory input.
	4	E	GND.
	5	BZZ	
CN3	1	E	GND.
	2	SM	S-meter output.
	3	SQ	Squelch output.
	4	SC	Squelch busy control output.
	5	RD	Audio output.
	6	DET	
	7	DT	PLL data.
	8	CK	PLL clock.
	9	EN1	PLL enable.
	10	NC	
	11	EN2	Shift register (IC5) enable.
	12	NC	
	13	E	GND.
CN4	1	E	GND.
	2	NC	
	3	MIC	Mic input (To MIC AMP unit).
	4	ME	MIC GND.
	5	TO	Tone input.
	6	E	GND.
	7	A1	Audio output (To AF VOL).
	8	A2	Audio input (To electronic volume from AF VOL).
	9	BZ	Beep input (To AF IC from CPU).
	10	8C	Common +8V.
	11	PSW	Power switch control input.
	12	B	+13.8V.
	13	E	GND.
TX-RX UNIT (X57-3310-XX) (B/2)			
CN201	1	E	GND.
	2	SM	S-meter input (To CPU IC201).
	3	SQ	Squelch input (To CPU IC201).
	4	SC	Squelch busy control input (To CPU IC201).
	5	RD	Audio input (CPU IC201).
	6	DET	
	7	DT	PLL data (From CPU IC201).
	8	CK	PLL clock (From CPU IC201).
	9	EN1	PLL enable (From CPU IC201).
	10	NC	
	11	EN2	Shift register enable (From CPU IC201).
	12	NC	
	13	E	GND.

Connector No.	Terminal No.	Terminal Name	Terminal Function
CN202	1	E	GND.
	2	NC	
	3	MIC	Mic output (From mic jack).
	4	ME	MIC GND.
	5	TO	Tone output (From IC203).
	6	E	GND.
	7	A1	Audio input (To AF VOL).
	8	A2	Audio output (To electronic volume from AF VOL).
	9	BZ	Beep output (From CPU).
	10	8C	Common +8V.
	11	PSW	Power switch control output (From CPU).
	12	B	+13.8V.
	13	E	GND.
CN203	1	CK	PLL IC clock output (From CPU P21).
	2	DT	PLL IC data output (From CPU P22).
	3	VCK	
	4	GND	GND.
	5	D8	DRS unit data.
	6	D1	DRS unit data.
	7	D2	DRS unit data.
	8	D4	DRS unit data.
CN204	1	DST	
	2	5C	Common +5V.
	3	DV	
	4	VOB	DRS unit VOB output.
	5	VOA	DRS unit VOA output.
	6	RD	DRS unit RD output.
	7	WR	DRS unit WR output.
	8	ACL	DRS unit RESET output.
	9	STBY	DRS unit STBY output.
	10	OE	
CN205	1	CE	LCD driver enable output.
	2	DT	LCD driver data output.
	3	CK	LCD driver clock output.
CN206	1	GND	GND.
	2	5C	Common +5V.
	3	8C	Common +8V.
W202	1	GND	GND.
	2	RD	CTCSS unit voice de-modulation input.
	3	C5	Common +5V.
	4	DET	CTCSS unit tone matching input.
	5	CTC	CTCSS unit clock output.
	6	CTD	CTCSS unit data output.
	7	CTS	CTCSS unit enable output.

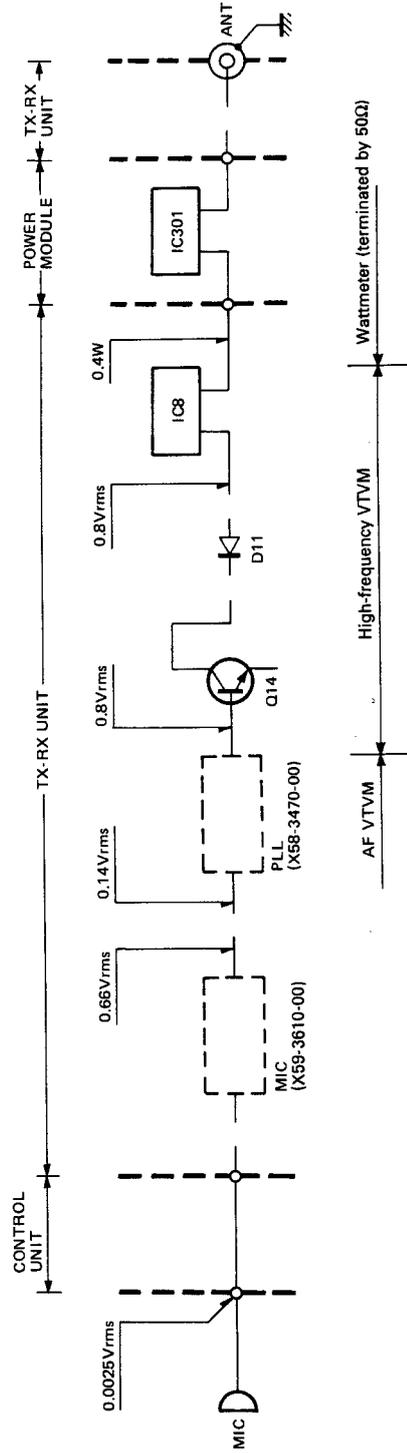


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LEVEL DIAGRAM



Transmitter section



1. AG is set so that MIC input becomes 3kHz DEV at 1kHz MOD.
2. Transmitting frequency : 145.06 MHz

TM-231A/E

DRU-1 (DIGITAL RECORDING UNIT)

DRU-1 CIRCUIT DESCRIPTION

1. Overview

The DRU-1 is a digital recording and playback unit designed to be installed inside the TM-231A/E series. This unit has the following features:

- Recording received audio (for output to the internal speaker) or transmit audio (microphone input)
- Outputting recorded audio to the internal speaker or outputting recorded audio as modulating signals during transmission
- Built-in lithium battery back-up for maintaining DRU-1 contents

2. Operations

• Recording received audio (for output to the internal speaker)

A received signal from the VO pin is fed into pin 1 (0Y) of the multiplexer IC1 (TC4052BF). It is then fed into pin 59 (MIC IN) of IC3 (TC8830F) via pin 3 (Y). The signal is amplified approx. 26dB by a mic amplifier in IC3, and output via pin 60 (C1). The signal from pin 60 is fed into pin 63 (C2) and amplified approx. 20dB. The amplified signal is applied to pin 64 (MIC OUT) and pin 65 (ADI).

• Recording transmit audio (microphone input)

Microphone input from the VI pin is amplified by Q5, and fed into pin 2 (2Y) of the multiplexer IC1 (TC4052BF). It is then supplied to IC3 (TC8830F) via pin 3 (Y) and recorded in the same way as in recording received sound.

• Outputting recorded audio to the internal speaker

D/A convertor output from pin 66 (DAO) of IC3 (TC8830F) is passed through a CR filter, and amplified by Q6. The amplified signal is then fed into pin 13 (X) of the multiplexer IC1 (TC4052BF), and output to the VO pin via pin 14 (1X).

• Outputting recorded audio as modulating signals during transmission

When sound recorded in the DRU-1 is played during transmission, the same operations as written above in outputting recorded audio to the internal speaker occur. That is, D/A convertor output from pin 66 (DAO) of IC3 (TC8830F) is passed through a CR filter, amplified by Q6, and fed into pin 13 (X) of the multiplexer IC1 (TC4052BF). The sound, however, is output via pin 11 (3X).

	VOA (pin 10)	VOB (pin 9)	On channel
Output to speaker	H	L	1X (pin 14)
Output during transmission	H	H	3X (pin 11)
Received audio recording	L	L	0Y (pin 1)
Transmit audio recording	L	H	2Y (pin 2)

Table 1 IC1 : TC4052BF operations

DRU-1 DESCRIPTION OF COMPONENTS

ACCESSORY UNIT (X42-3010-00)

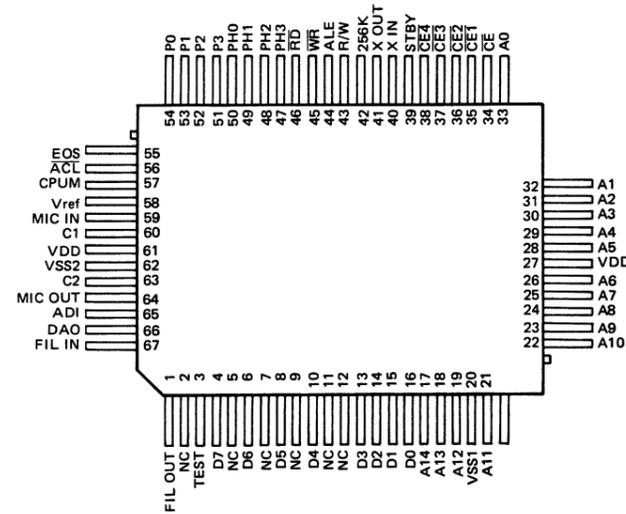
Component	Use/Function	Description
IC1	Multiplexer	See DRU-1 circuit description.
IC3	Audio recording and playback	See DRU-1 semiconductor data.
IC4~7	S-RAM	
Q5	AF amplification	Mic input amplification.
Q6	AF amplification	Playback sound amplification.
D1	Reverse current prevention	
D2	Reverse current prevention	Back-up.

DRU-1 (DIGITAL RECORDING UNIT)

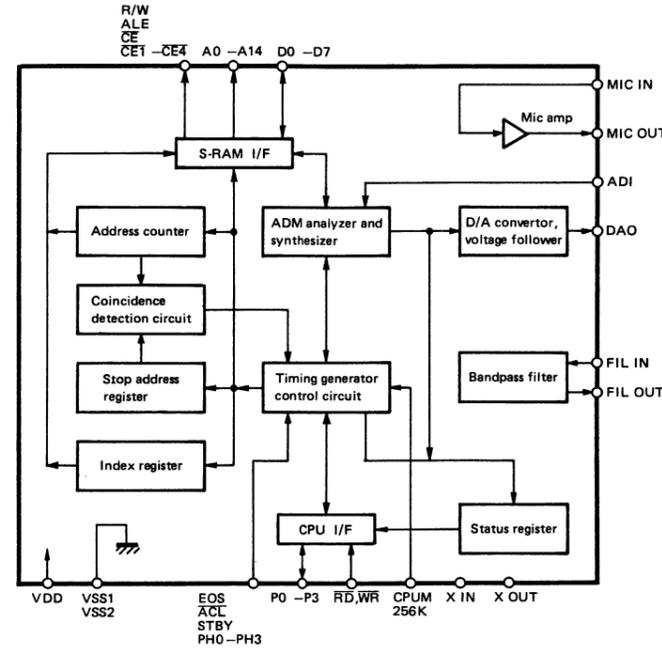
DRU-1 SEMICONDUCTOR DATA

1. Audio recording and playback : TC8830F (IC3)

• Terminal connection diagram



• Block diagram



• Terminal functions

Pin No.	Pin name	I/O	Function	Pin No.	Pin name	I/O	Function
1	FIL OUT	O	Not used.	41	X OUT	O	512kHz oscillation circuit.
2	NC	-	Not connected.	42	256K	I	64K/256K RAM select, "H" when 256K used.
3	TEST	-	Not used.	43	R/W	O	RAM read/write output.
4	D7	I/O	RAM data I/O.	44	ALE	-	Not used.
5	NC	-	Not connected.	45	WR	I	Write pulse input.
6	D6	I/O	RAM data I/O.	46	RD	I	Read pulse input.
7	NC	-	Not connected.	47~50	PH3~PH0	-	Not used.
8	D5	I/O	RAM data I/O.	51~54	P3~P0	I/O	Data bus.
9	NC	-	Not connected.	55	EOS	-	Not used.
10	D4	I/O	RAM data I/O.	56	ACL	I	Reset signal input.
11,12	NC	-	Not connected.	57	CPUM	I	"H" when CPU control enabled.
13~16	D3~D0	I/O	RAM data I/O.	58	Vref	O	Analog circuit reference voltage output.
17~19	A14~A12	O	RAM address output.	59	MIC IN	I	Mic amp. 1 input.
20	Vss1	-	GND.	60	C1	O	Mic amp. 1 output.
21~26	A11~A6	O	RAM address output.	61	Vdd	-	Power supply.
27	Vdd	-	Power supply.	62	Vss2	-	GND.
28~33	A5~A0	O	RAM address output.	63	C2	I	Mic amp. 2 input.
34	CE	-	Not used.	64	MIC OUT	O	Mic amp. 2 output.
35~38	CE1~CE4	O	RAM chip enable.	65	ADI	I	Audio analysis circuit input.
39	STBY	I	Minimum current standby when standby input is "H".	66	DAO	O	D/A convertor output.
40	X IN	I	512kHz oscillation circuit.	67	FIL IN	I	Not used.

DRU-1 (DIGITAL RECORDING UNIT)

DRU-1 PARTS LIST

× New Parts

Parts without Parts No. are not supplied.

Les articles non mentionnés dans le Parts No. ne sont pas fournis.

Telle ohne Parts No. werden nicht geliefert.

Ref. No. 参照番号	Address 位置	New Parts 新	Parts No. 部品番号	Description 部品名 / 規格	Desti- nation 仕向	Re- marks 備考
DRU-1						
-			B42-3317-04 B50-8290-00	LABEL INSTRUCTION MANUAL		
-			G10-0666-04 G10-0679-04 G13-0913-04	NON-WOVEN FABRIC NON-WOVEN FABRIC FORMED PLATE		
-			H01-8249-03 H03-2772-04 H21-0704-04 H25-0029-04 H25-0710-04	ITEM CARTON BOX OUTER PACKING CASE PROTECTION SHEET PROTECTION BAG PROTECTION BAG		
-			N87-2606-46	BRAZIER HEAD TAPTITE SCREW		
-			X42-3010-00	ACCESSORY UNIT		
ACCESSORY UNIT (X42-3010-00)						
C1			CK73FB1H103K	CHIP C 0.010UF K		
C2			CK73FB1H102K	CHIP C 1000PF K		
C3			CK73FF1E154Z	CHIP C 0.15UF Z		
C4	-6		CK73FB1H103K	CHIP C 0.010UF K		
C7			CK73EF1C105Z	CHIP C 1.0UF Z		
C8	-10		CK73FB1H103K	CHIP C 0.010UF K		
C11			CK73FF1E104Z	CHIP C 0.10UF Z		
C12			CK73FB1H103K	CHIP C 0.010UF K		
C13	,14		CK73FB1H102K	CHIP C 1000PF K		
C15			CK73FF1E104Z	CHIP C 0.10UF Z		
C16			CK73FB1H103K	CHIP C 0.010UF K		
C17			CK73FF1E104Z	CHIP C 0.10UF Z		
C19			CK73FB1H103K	CHIP C 0.010UF K		
C20			CK73FB1H102K	CHIP C 1000PF K		
C21	,22		CC73FSL1H101J	CHIP C 100PF J		
C23			CK73FB1H103K	CHIP C 0.010UF K		
C24			C92-0010-05	CHIP TAN 6.8UF 6.3WV		
C25			CK73EB1H104K	CHIP C 0.10UF K		
C26			CK73FB1H103K	CHIP C 0.010UF K		
C27			CC73FSL1H101J	CHIP C 100PF J		
C28			CK73FF1E104Z	CHIP C 0.10UF Z		
CN1		*	E40-5207-05	PIN CONNECTOR		
CN2		*	E40-5206-05	PIN CONNECTOR		
CN3		*	E40-5181-05	PIN CONNECTOR		
W1		*	E31-6005-05	CONNECTING WIRE		
W2		*	E31-6006-05	CONNECTING WIRE		
W3		*	E31-6007-05	CONNECTING WIRE		
			F20-0520-04 F20-0521-04	INSULATING BOARD INSULATING BOARD		
X1		*	L77-1398-05	CRYSTAL RESONATOR 3.579545MHZ		
X2		*	L78-0050-05	RESONATOR 512KHZ		
R1			RK73FB2A103J	CHIP R 10K J 1/10W		
R2			RK73FB2A392J	CHIP R 3.9K J 1/10W		
R3			RK73FB2A103J	CHIP R 10K J 1/10W		
R4			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R5			RK73FB2A102J	CHIP R 1.0K J 1/10W		

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.

DRU-1 (DIGITAL RECORDING UNIT)

※ New Parts

Parts without Parts No. are not supplied.

Les articles non mentionnés dans le Parts No. ne sont pas fournis.

Teile ohne Parts No. werden nicht geliefert.

Ref. No.	Address	New Parts	Parts No.	Description	Destination	Remarks
参照番号	位置	新	部品番号	部品名/規格	仕向	備考
R6			R92-0670-05	CHIP R 0 0HM		
R7			RK73FB2A223J	CHIP R 22K J 1/10W		
R8			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R9			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R10			R92-0670-05	CHIP R 0 0HM		
R11			RK73FB2A223J	CHIP R 22K J 1/10W		
R12			R92-0670-05	CHIP R 0 0HM		
R13			RK73FB2A222J	CHIP R 2.2K J 1/10W		
R14			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R15			RK73FB2A104J	CHIP R 100K J 1/10W		
R16			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R17			RK73FB2A103J	CHIP R 10K J 1/10W		
R18			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R19			RK73FB2A562J	CHIP R 5.6K J 1/10W		
R20			RK73FB2A104J	CHIP R 100K J 1/10W		
R21			RK73FB2A103J	CHIP R 10K J 1/10W		
R22			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R23			RK73FB2A564J	CHIP R 560K J 1/10W		
R24			RK73FB2A273J	CHIP R 27K J 1/10W		
R25			RK73FB2A683J	CHIP R 68K J 1/10W		
R26			RK73FB2A105J	CHIP R 1.0M J 1/10W		
R27			RK73FB2A222J	CHIP R 2.2K J 1/10W		
R28			RK73FB2A224J	CHIP R 220K J 1/10W		
R29 -31			R92-0670-05	CHIP R 0 0HM		
R32			RK73FB2A220J	CHIP R 22 J 1/10W		
R33			RK73FB2A394J	CHIP R 390K J 1/10W		
D1 +2			1SS184	DIODE		
IC1		*	TC4052BF	IC(4CH MPX/DE-MPX)		
IC2		*	LR4102N	IC		
IC3		*	TC8830F	IC		
IC4 -7		*	HM62256LFP-15T	IC		
Q1 -3			2SC2712(BL)	TRANSISTOR		
Q4			DTC144EK	DIGITAL TRANSISTOR		
Q5 +6			2SC2712(BL)	TRANSISTOR		
			W09-0326-05	LITHIUM BATTERY		

E: Scandinavia & Europe K: USA P: Canada W: Europe

U: PX(Far East, Hawaii) T: England M: Other Areas

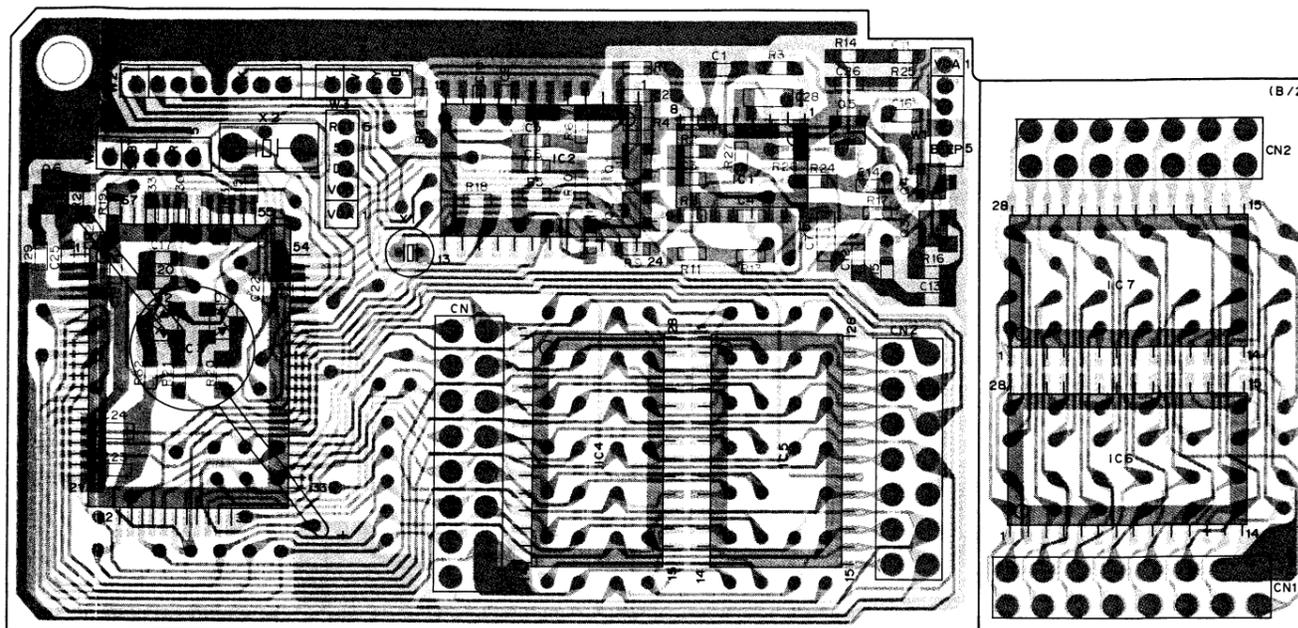
UE: AAFES(Europe) X: Australia

⚠ indicates safety critical components.

TM-231A/E DRU-1 (DIGITAL RECORDING UNIT)

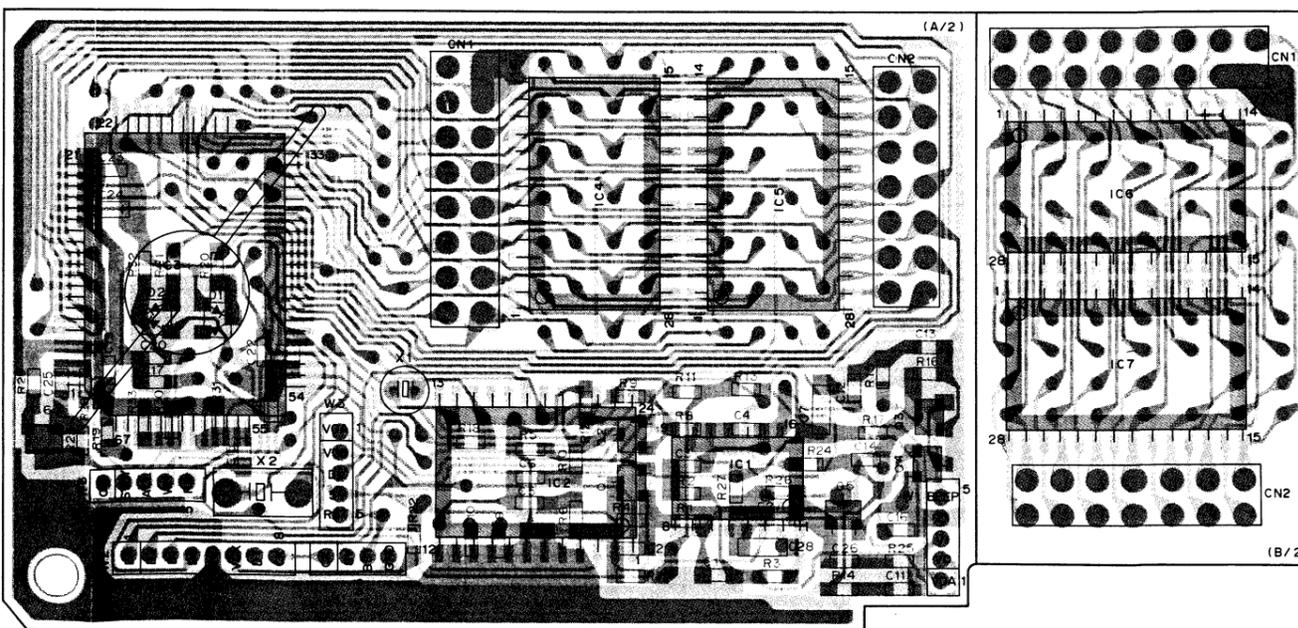
DRU-1 PC BOARD VIEWS

ACCESSORY UNIT (X42-3010-00) Component side view



IC1 : TC4052BF IC2 : LR4102N IC3 : TC8830F IC4~7 : HM62256LFP-15T Q5,6 : 2SC2712(BL) D1,2 : 1SS184

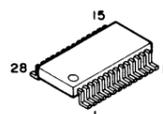
ACCESSORY UNIT (X42-3010-00) Foil side view



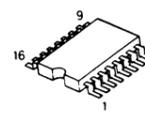
DTC144EK
2SC2712(BL)



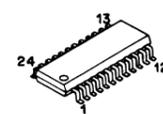
HM62256LFP-15T



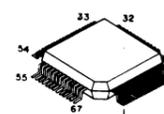
TC4052BF



LR4102N



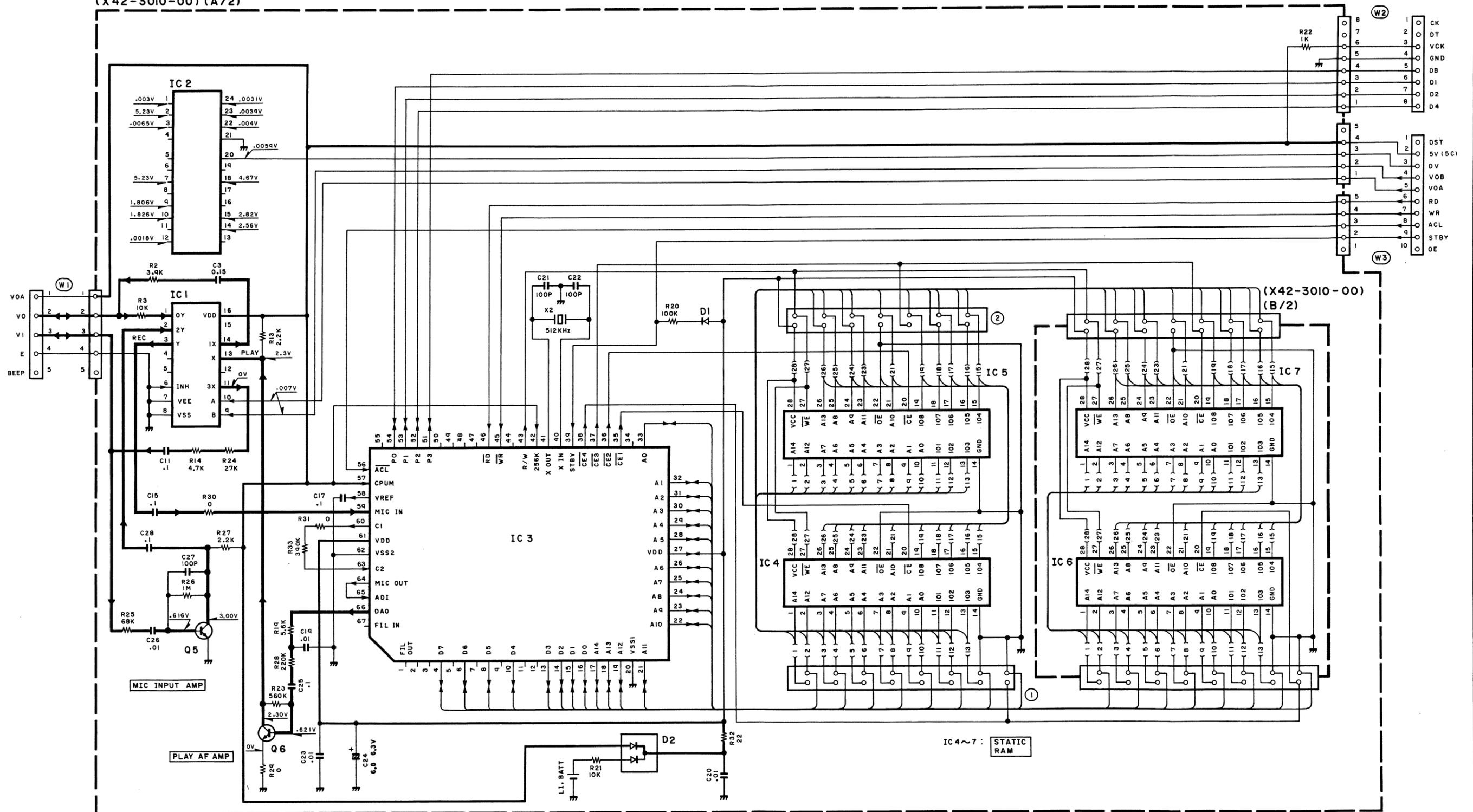
TC8830F



DRU-1 (DIGITAL RECORDING UNIT) TM-231A/E

DRU-1 SCHEMATIC DIAGRAM

(X42-3010-00) (A/2)



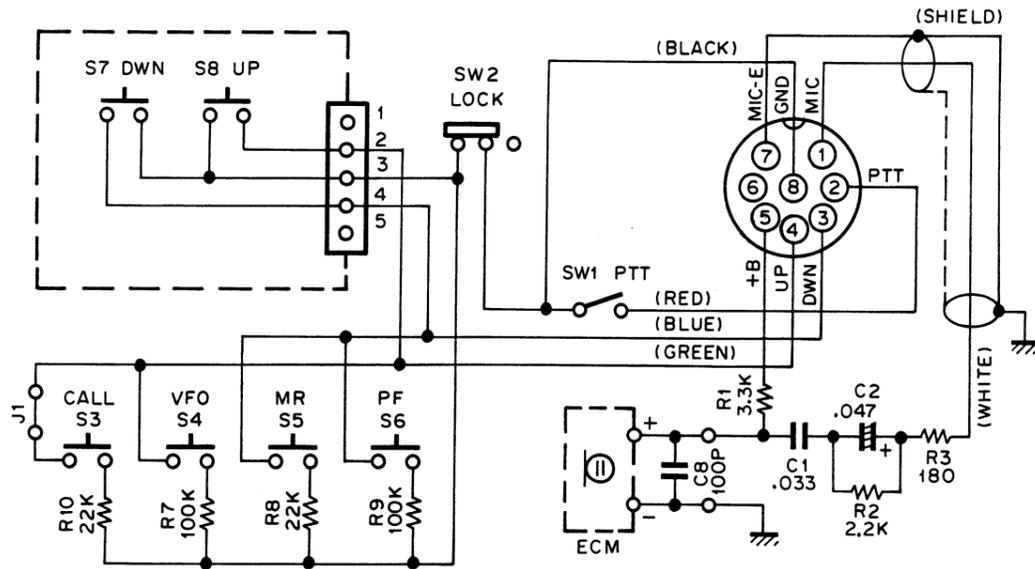
(X42-3010-00) (A/2)

- | | | | |
|--------|------------------|-------|----------------|
| IC 1 | : TC4052BF | Q5, 6 | : 2SC2712 (BL) |
| IC 2 | : LR4102N | D1, 2 | : 1SS184 |
| IC 3 | : TC8830F | | |
| IC 4~7 | : HM62256LFP-15T | | |

TM-231A/E

MC-44 (MULTI FUNCTION MICROPHONE)

MC-44 SCHEMATIC DIAGRAM



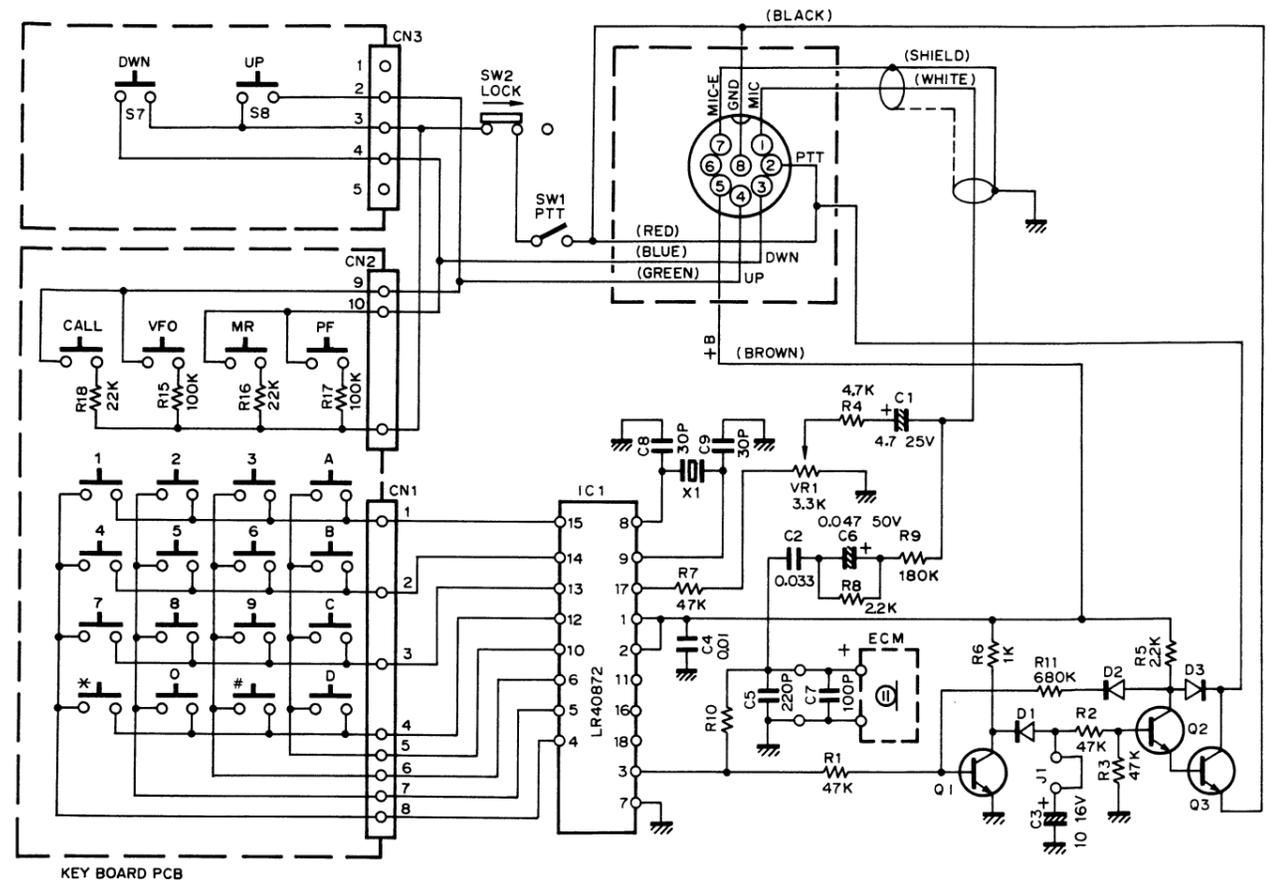
MC-44 PARTS LIST

Ref. No.	New parts	Parts No.	Description
	*	A02-0896-08	Case (Front)
	*	A02-0900-08	Case (Rear)
	*	B50-8293-08	Instruction manual
		E30-2149-08	Curl cord
	*	K29-3165-08	Knob PTT
	*	K29-3168-08	Knob UP
	*	K29-3169-08	Knob DOWN
	*	K29-3170-08	Knob CALL, VFO, MR, PF
SW2	*	S31-1422-08	Slide switch LOCK
SW1	*	S50-1431-08	Micro switch PTT
S7, 8	*	S59-1409-08	Switch UP, DOWN
	*	T91-0383-08	Microphone element (Condenser microphone)

TM-231A/E

MC-44DM/MC-44DME (MULTI FUNCTION MICROPHONE WITH AUTOPATCH)

MC-44DM/MC-44DME SCHEMATIC DIAGRAM

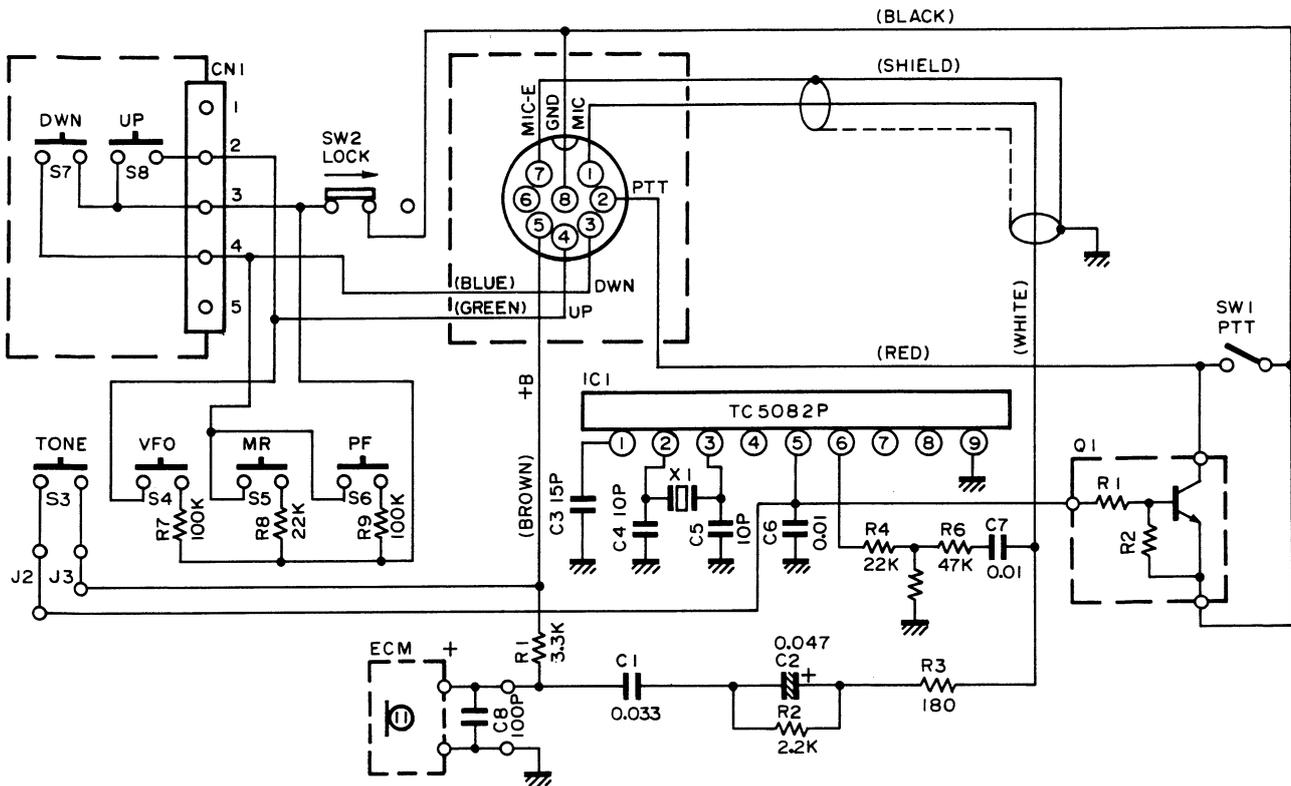


MC-44DM/MC-44DME PARTS LIST

Ref. No.	New parts	Parts No.	Description
	*	A02-0898-08	Case (Front) DTMF
	*	A20-0899-08	Case (Front) DTMF (With TONE)
	*	A02-0901-08	Case (Rear) DTMF
	*	B50-8293-08	Instruction manual
		E30-2149-08	Curl cord
	*	K29-3165-08	Knob PTT
	*	K29-3167-08	Key top DTMF
	*	K29-3168-08	Knob UP
	*	K29-3169-08	Knob DOWN
SW2	*	S31-1422-08	Slide switch LOCK
SW1	*	S50-1431-08	Micro switch PTT
S7, 8	*	S59-1409-08	Switch UP, DOWN
	*	T91-0383-08	Microphone element (Condenser microphone)

MC-44E (MULTI FUNCTION MICROPHONE)

MC-44E SCHEMATIC DIAGRAM



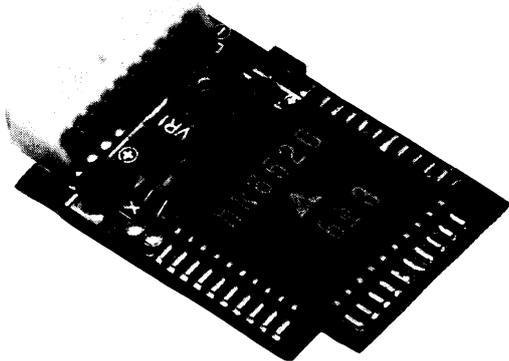
MC-44E PARTS LIST

Ref. No.	New parts	Parts No.	Description
	*	A02-0897-08	Case (Front) With TONE
	*	A02-0900-08	Case (Rear)
	*	B50-8293-08	Instruction manual
		E30-2149-08	Curl cord
		K29-3165-08	Knob PTT
	*	K29-3168-08	Knob UP
	*	K29-3169-08	Knob DOWN
	*	K29-3170-08	Knob 1750, VFO, MR, PF
SW2	*	S31-1422-08	Slide switch LOCK
SW1	*	S50-1431-08	Micro switch PTT
S7, 8	*	S59-1409-08	Switch UP, DOWN
	*	T91-0383-08	Microphone element (Condenser microphone)

TM-231A/E

TSU-6 (CTCSS UNIT)

TSU-6 EXTERNAL VIEW



TSU-6 REFERENCE DATA

TH-25's condition and MN4094BS (IC2) relationship

CTCSS switch	TONE switch	TX/RX	MN4094BS terminal		
			Q5	Q6	Q1 ~ 4, 7, 8
OFF	OFF	TX	L	H	L
		RX	L	H	L
	ON	TX	L	L	See table 2
		RX	L	H	L
ON	OFF	TX	L	L	See table 2
		RX	H	L	
	ON	TX	L	L	
		RX	H	L	

Q1 ~ 4, 7, 8 : Tone frequency setting

Q5 : TX/RX switch for MN6520 (IC1). "H" : RX, "L" : TX.

Q6 : Power switch for MN6520 (IC1). "H" : OFF, "L" : ON.

Table 1

TSU-6 PARTS LIST

* : New Parts

Ref. No.	New Parts	Parts No.	Description
CTCSS UNIT (X52-3100-00)			
C1		CK73FB1H102K	Chip C 1000pF K
C2		C92-0010-05	Tantal 6.8μF 6.3WV
C3	*	C92-0006-05	Tantal 3.3μF 4.0WV
C4, 5		CK73EB1E104K	Chip C 0.1μF K
C6		CK73EB1H223K	Chip C 0.022μF K
C7		CK73EB1E104K	Chip C 0.1μF K
C8, 9		CC73FCH1H150J	Chip C 15pF J
C10		CK73FB1H102K	Chip C 1000pF K
C11		CK73EB1E104K	Chip C 0.1μF K
C12		C92-0507-05	Chip tan. 4.7μF 6.3WV
C13	*	C92-0510-05	Chip tan. 3.3μF 4.0WV
	*	E40-5121-05	Pin connector (10P)
X1		L77-1313-05	X'tal resonator 4.194304MHz
R1-10		RK73FB2A000J	Chip resistor
R12-14		RK73FB2A000J	Chip resistor
VR1	*	R12-3460-05	Trimming pot. 33kΩ
Q1		DTC144TK	Digital transistor
Q2		DTA114EK	Digital transistor
Q3		2SC2712(GR)	Chip transistor
IC1		MN6520	IC
IC2		MN4094BS	IC

TSU-6 FINE ADJUSTMENT OF TONE FREQUENCY

The tone frequency can be fine adjusted with an interval of 0.5% step over the range of 0 to +1.5%. Ground the T1 (pin 10) and T2 (pin 9) of IC1 to obtain the desired frequency.

	T1	T2
0%	X	X
+0.5%	O	X
+1.0%	X	O
+1.5%	O	O

O : GND, X : OPEN

Table 3

Tone frequency and MN6520 (IC1) relationship

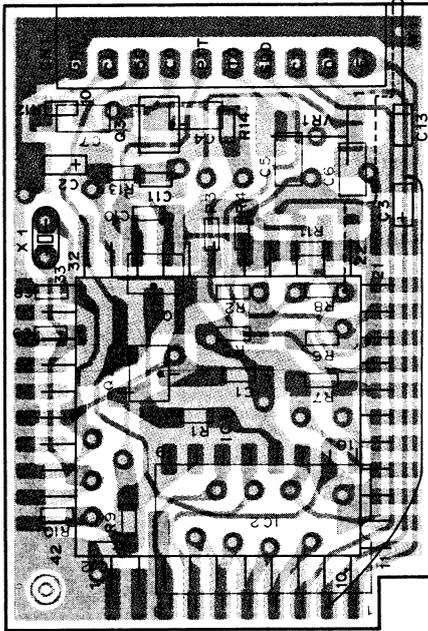
Tone frequency (Hz)	MN6520 terminal					
	S6	S5	S4	S3	S2	S1
	MN4094BS terminal					
	Q1	Q2	Q3	Q4	Q7	Q8
67.0	L	H	H	H	L	H
71.9	L	H	H	H	L	L
74.4	L	H	H	L	H	H
77.0	L	H	H	L	H	L
79.7	L	H	H	L	L	H
82.5	L	H	H	L	L	L
85.4	L	H	L	H	H	H
88.5	L	H	L	H	H	L
91.5	L	H	L	H	L	H
94.8	H	H	H	L	L	H
100.0	H	H	H	L	L	L
103.5	H	H	L	H	H	H
107.2	H	H	L	H	H	L
110.9	H	H	L	H	L	H
114.8	H	H	L	H	L	L
118.8	H	H	L	L	H	H
123.0	H	H	L	L	H	L
127.3	H	H	L	L	L	H
131.8	H	H	L	L	L	L
136.5	H	L	H	H	H	H
141.3	H	L	H	H	H	L
146.2	H	L	H	H	L	H
151.4	H	L	H	H	L	L
156.7	H	L	H	L	H	H
162.2	H	L	H	L	H	L
167.9	H	L	H	L	L	H
173.8	H	L	H	L	L	L
179.9	H	L	L	H	H	H
186.2	H	L	L	H	H	L
192.8	H	L	L	H	L	H
203.5	H	L	L	H	L	L
210.7	H	L	L	L	H	H
218.1	H	L	L	L	H	L
225.7	H	L	L	L	L	H
233.6	H	L	L	L	L	L
241.8	L	H	H	H	H	H
250.3	L	H	H	H	H	L

Table 2

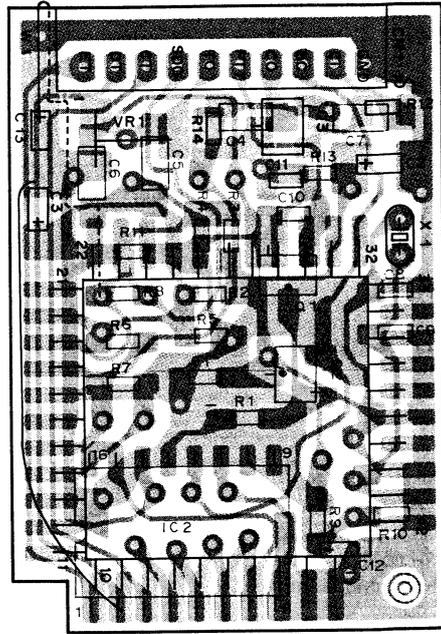
TSU-6 (CTCSS UNIT)

TSU-6 PC BOARD VIEWS

Component side view



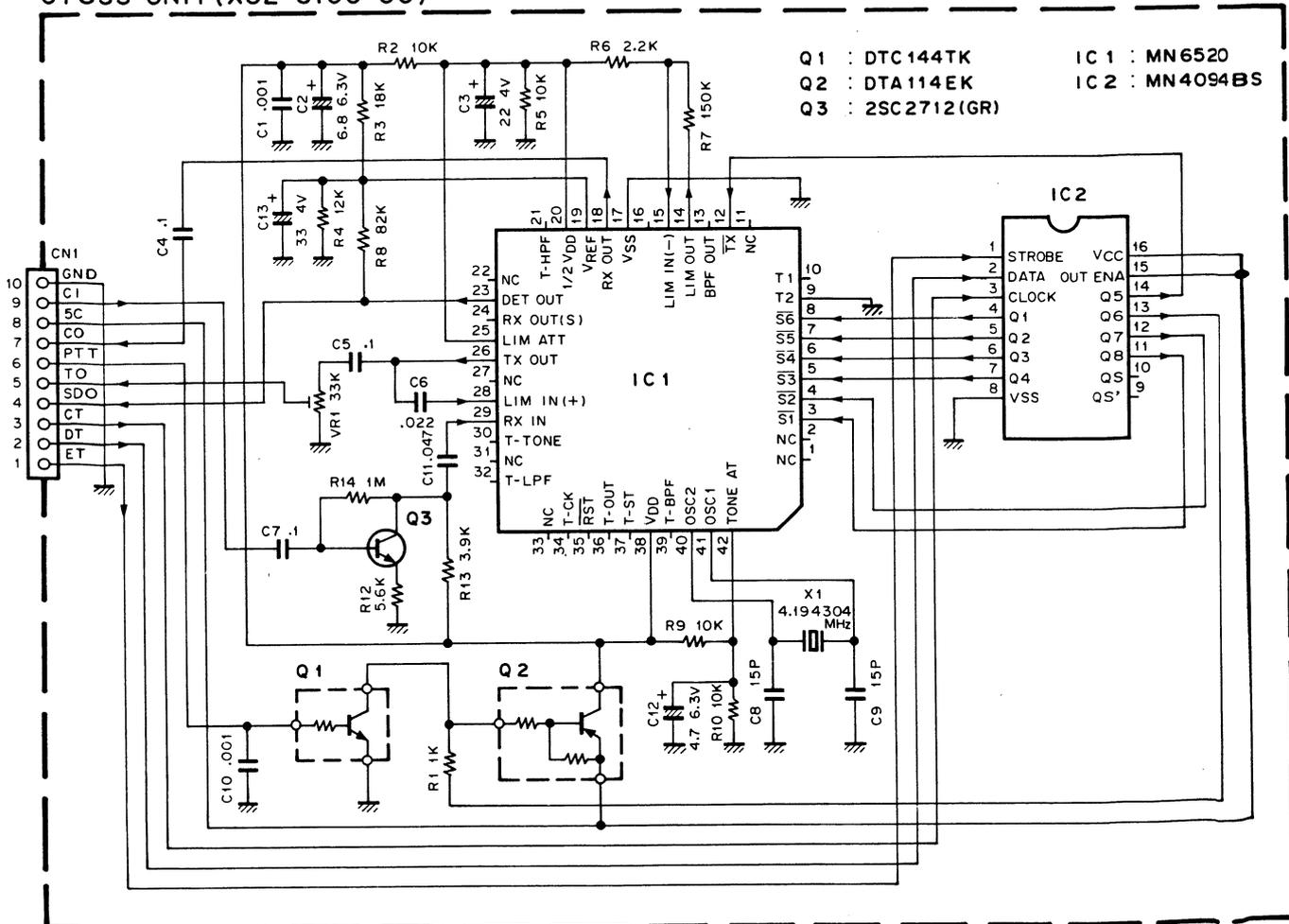
Foil side view



■ : Component side
 ■ : Foil side

TSU-6 CIRCUIT DIAGRAM

CTCSS UNIT (X52-3100-00)



TM-231A/E

SPECIFICATIONS

General

Frequency range	144 to 148MHz : TM-231A (K,P,M1,M2), TM-231E (W2) 144 to 146MHz : TM-231E (T,W1)	
Mode	F3E (FM)	
Power requirements	50Ω	
Ground	13.8V DC ±15% (11.7 to 15.8)	
Frequency stability	Less than ±10ppm	
Current drain		
Transmit mode	Less than 11A	
Receiver mode with no signal	Less than 0.6A	
Operating temperature	-20°C to +60°C (-4°F to +140°F)	
Dimensions (W x H x D)	140 x 40 x 160 mm (5-1/2" x 1-37/64" x 6-19/64") (Projection included)	141 x 42 x 171 mm (5-9/16" x 1-21/32" x 6-47/64")
Weight	1.2kg (2.65lbs)	

Transmitter

Output power*	
HI	50W
MID	10W
LOW	Approx. 5W
Modulation	Reactance modulation
Spurious radiation	Less than -60dB
Maximum frequency deviation	±5kHz
Audio distortion (at 60% modulation)	Less than 3% (300 to 3000Hz)
Microphone impedance	500 to 600Ω

Receiver

Circuitry	Double conversion superheterodyne
Intermediate frequency (1st/2nd)	10.7MHz/455kHz
Sensitivity (12dB SINAD)	Less than 0.16μV
Selectivity	
-6dB	More than 12kHz
-60dB	Less than 24kHz
Spurious response	Better than 70dB
Squelch sensitivity	Less than 0.1μV
Output (5% distortion)	More than 2W across 8Ω loads
External speaker impedance	8Ω

Notes :

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

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KENWOOD ELECTRONICS AUSTRALIA PTY. LTD.

(INCORPORATED IN N.S.W.)

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

KENWOOD & LEE ELECTRONICS, LTD.

Wang Kee Building, 5th Floor, 34-37, Connaught Road, Central, Hong Kong

KENWOOD ELECTRONICS CANADA INC.

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