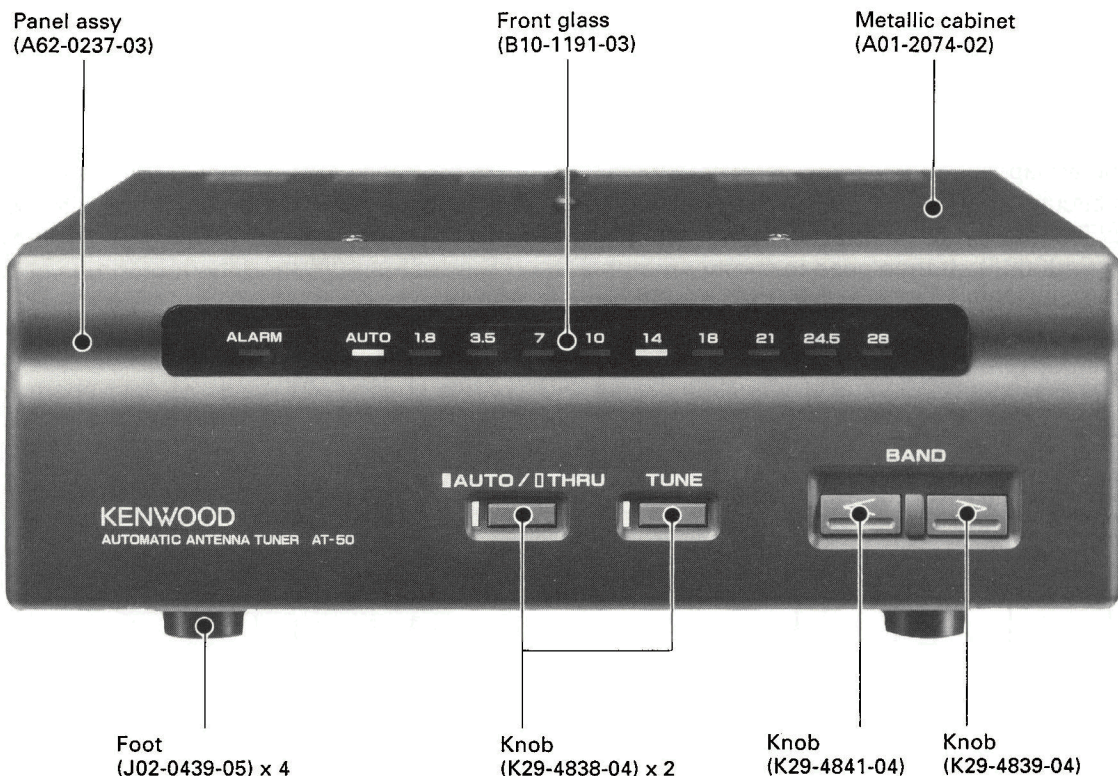


AT-50

SERVICE MANUAL



CONTENTS

CIRCUIT DESCRIPTION	2	TERMINAL FUNCTION	19
SEMICONDUCTOR DATA	6	PC BOARD VIEWS	
DESCRIPTION OF COMPONENTS	8	METER (X59-3940-01)	20
PARTS LIST	9	AT UNIT (X53-3470-00)	21
EXPLODED VIEW	14	SCHEMATIC DIAGRAM	25
PACKING	15	PG-4M (CONTROL CABLE)	28
DISASSEMBLY FOR REPAIR	16	SPECIFICATIONS	BACK COVER
ADJUSTMENT	17		

CIRCUIT DESCRIPTION

Automatic antenna tuner

The transmission power from the transmitter is passed through the current/voltage detection transformers L1 and L2, which use a toroidal core. The current and voltage components detected here are rectified by the waveform rectification circuit consisting of D3 to D5 and Q1, and D6 to D8 and Q2, and then phase compared by IC1 (SN74S74NS). The output signals from pins 8 and 9 of IC1 (\bar{Q} and Q) are passed through switch IC2 (TC4066BF) and go to motor drive IC, IC4 (BA6109U2). Variable resistor VR1 with a motor is driven to rotate variable condenser VC101 so that the phase difference of the voltage and current components decreases.

The current and voltage components detected by L1 and L2 are rectified by germanium diodes D1 and D2 (IN60) and are applied to the comparator of voltage comparison circuit IC6 (NJM2902M) as the amplitude component. The comparator output is passed through switch IC3 (TC4066BF). It then goes to another motor drive IC5 (BA6109U2), and variable resistor VR2 with a motor is driven to rotate variable condenser VC102 so that the amplitude difference decreases.

Therefore, variable condenser VC101 for capacitance adjustment is controlled so that the current and voltage phases match. Variable condenser VC102 for resistance adjustment is controlled so that the current and voltage amplitude difference decreases. The SWR is 1 when the phases match and there is no amplitude difference.

The motor speed of VR1 and VR2 is determined by the duty ratio of the pulse input to pin 8 of IC4 and IC5, and is controlled by the speed of the VSWR calculated by the CPU and the preset value.

Pulse signals SPD1 and SPD2 output from the CPU pass through Q7 and Q8 (DTC143EK), are amplified by Q5 and Q6 (2SA1204), and the resulting signals go to IC4 and IC5 as control pulses.

If the SWR is 3 or more, the motor runs at high speed since the duty cycle of the motor drive voltage pulse is 100%. If the SWR is 2, the duty cycle becomes about 50%, and the motor runs at low speed.

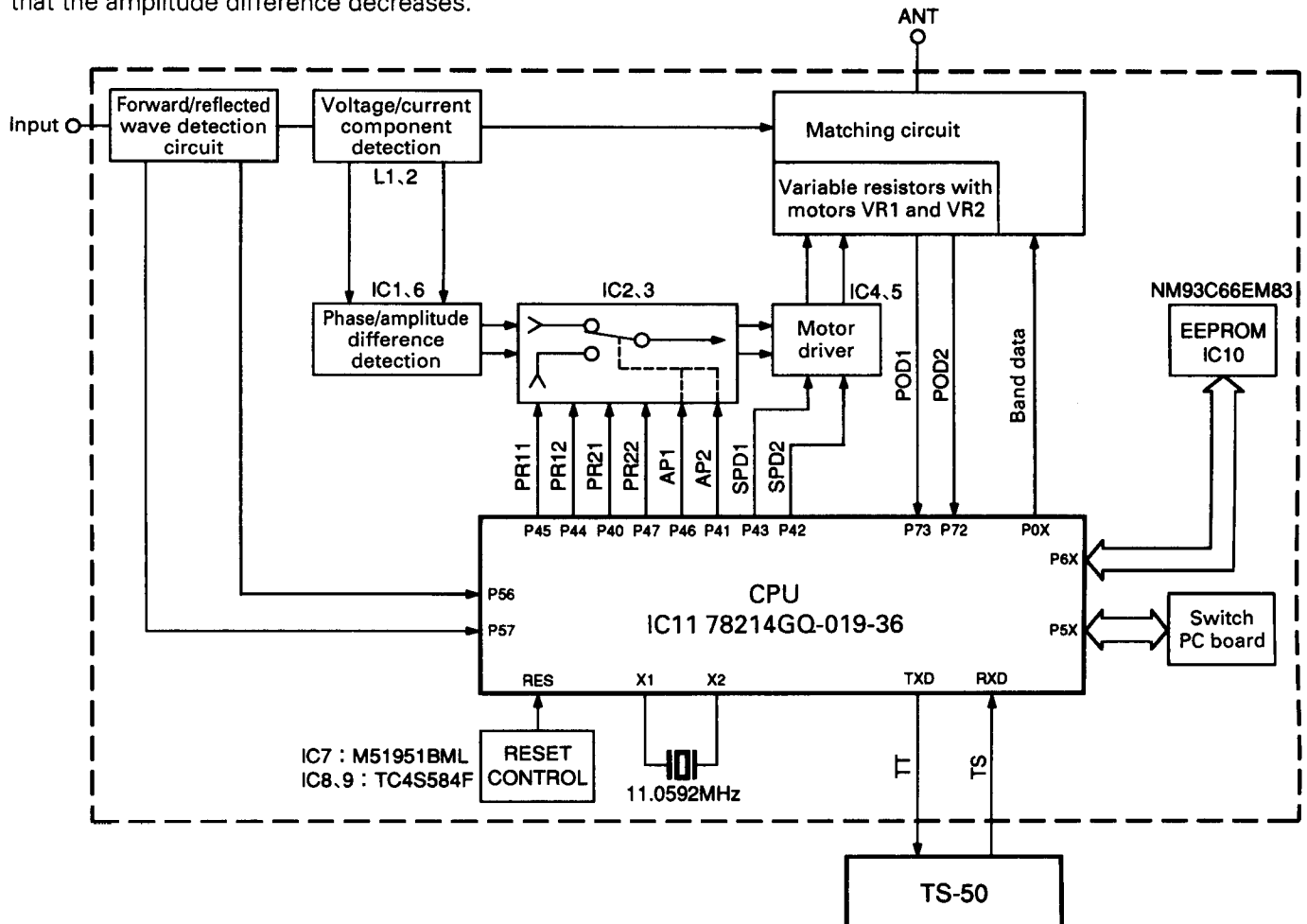


Fig.1 Block diagram

CIRCUIT DESCRIPTION

The matching circuit is type T, and the tap position from 1.8 to 30 MHz is switched by seven relays K102 to K108.

Variable resistors VR101 and VR102 with motors are linked to the rotation axes of variable condensers VC101 and VC102 with couplings. The position detection voltages of POD1 and POD2 (0 to 5 V) are generated according to the capacitance of the variable condensers. This position data is input to the CPU via the analog-to-digital converter, and is used as the reference voltage in the feedback control system for preset tuning. It is also used for preset data and end detection.

Since the variable resistors with motors used here are not endless and the rotation angle is limited, the AT-50 limits the rotation range from the minimum to the maximum capacitance of the variable condenser plus an allowance.

The microcomputer monitors POD1 and POD2 to effect this control, like the reset tuning that will be described later. If the lower limit voltage of 0.8 V or the upper limit voltage of 4.0 V is reached, the microcomputer detects that the voltage is close to one limit. AP1 and AP2 are made high to return the voltage to the other limit. If the variable capacitor is VC101, and the voltage is close to the lower limit with respect to PRE1, the voltage near the upper limit is output. If the voltage is close to the upper limit with respect to PRE1, the voltage near the lower limit is output.

The other variable condenser VC102 is fixed. If the voltage for one variable condenser exceeds the limit, it is returned to the other limit. The other variable condenser remains in the same position.

The logic of PR11 to PR22 is the same as that of IC4 and IC5, and the signal output from the CPU passes through IC2 and IC3, and goes to IC4 and IC5.

The band LEDs on the panel indicate the band and SWR. They show the SWR only during tuning; otherwise, they show the band.

• Local tuning mode

When the AUTO/THRU switch is set to AUTO, pin 3 of IC11 goes high, Q16 is turned on, the AUTO/THRU switching relay K101 closes, and AT is inserted to prepare for tuning. If variable condensers VC101 and VC102 are not at the preset position of that band, they are set to the preset position, and the AT TUNE operation starts after presetting is complete. Pin 3 of IC11 goes low and in THRU mode during presetting.

When AT TUNE is turned on in this condition, the unit waits for tuning. If CW transmission power of about 10 W is transmitted, AP1 and AP2 go high, the motor is no longer controlled by the microcomputer, but controlled in analog form, and tuning starts.

Analog control is used during tuning, except that the reverse operation ends after end detection. If the VSWR is less than 1.2, ATS goes high and Q10 turns on. If the VSWR falls below 1.2, tuning is regarded as completed, and the AT TUNE operation is terminated.

• Semi-automatic tuning mode

When the AUTO/THRU switch is set to AUTO and the band LED is set to AUTO with the UP and DOWN keys, semi-automatic tuning mode is entered. If the microcomputer in HALT mode receives a transmission signal, the VSF on the detection circuit goes high, Q19 is turned on, and the microcomputer exits the HALT mode and starts semi-automatic tuning.

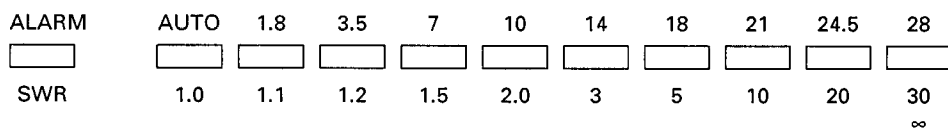


Fig.2 LED Display

AT-50

CIRCUIT DESCRIPTION

- **Automatic tuning mode**

If the TS-50 is connected to the AT-50 with the special relay cable (supplied with the AT-50), the TS-50 checks whether the AT-50 is connected by the TT and TS lines when it is turned on. The AT-50 enters automatic tuning mode when it receives an AT connection command from the transceiver. If the AT-50 is turned on after the TS-50, the AT-50 connection is not checked, and the AT-50 does not enter automatic tuning mode.

The TS-50 performs all operations in automatic tuning mode. When the AT TUNE key on the TS-50 is pressed, "AT" lights on the LCD. The AUTO/THRU LED on the AT-50 shows AUTO. Pin 3 of IC11 goes high, Q16 is turned on, AT is inserted, and tuning starts. If variable condensers VC101 and VC102 are not at the preset position for that band, they are set to the preset position, and the AT TUNE operation and TS-50 transmission start after presetting is complete. Pin 3 of IC11 goes low and in THRU mode during presetting.

- **Preset tuning mode**

When automatic, semi-automatic, or local tuning ends, the microcomputer stores the position of the variable condenser in memory as preset data for that band.

If the band is changed after tuning in another band, APRE goes high, and the microcomputer controls the motor and performs preset tuning.

The initial preset data when the microcomputer is reset is the standard data when tuning is performed with a 50Ω load in each band.

- **HALT mode**

When the microcomputer is in HALT mode, the CPU stops to prevent the microcomputer noise from being received.

The microcomputer exits HALT mode in the following cases:

- During transmission
- During presetting (The AUTO/THRU relay is in THRU mode.)
- While the AUTO/THRU, AT TUNE, UP, or DOWN switch is being held down
- When it waits for tuning in local tuning mode. (The AUTO/THRU relay is in THRU mode.)

The microcomputer is in HALT mode in all other cases.

Setting the extended functions

The following functions can be set by installing or removing jumper resistors (W23 to W27):

- **SWR display**

	*YES	NO
W23	○	×

- **Baud rate**

	*4800	9600
W24	○	×

* : Initial setting ○ : Install a jumper × : Remove the jumper

Digital Control Circuit

- **Digital control**

The A-50 digital section contains a CPU (78 214GQ-019-36) and an EEPROM (NM93C66EM83). This circuit controls various other circuits. The reset IC is an M51951BML. When the power supply voltage is dropped, backup data is written into the EEPROM, and when the power is switched on, backup data is read from the EEPROM into the CPU.

- **System reset and backup**

The power supply voltage (5-V line) is always monitored by IC7 (M51951BML) and the power supply voltage (14-V line) is always monitored by IC14 (M51951BML) to prevent destruction of data in memory by the power being switched on or off, or momentary power failure.

If the line voltage is low, IC7 outputs a reset signal and IC14 outputs a non-maskable interrupt request (NMI) to the CPU. If a signal is input to the NMI pin for 10μs or more, the IC detects a valid edge, and outputs backup data to the EEPROM (IC10).

When the power supply voltage becomes normal (including power-on), the CPU and I/O are initialized and operation resumes after the time constant set by R51 and C51.

CIRCUIT DESCRIPTION

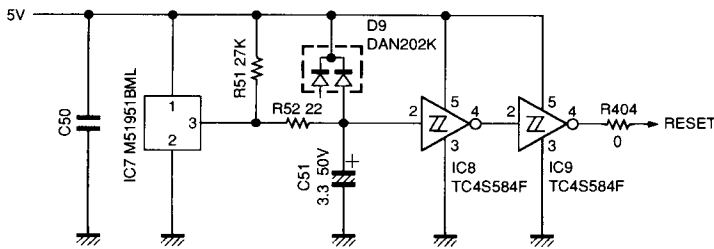


Fig. 3 System reset circuit

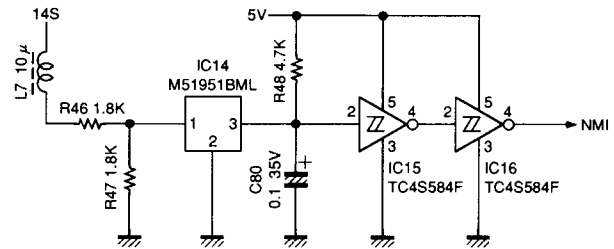


Fig. 4 System backup circuit

• Motor control signal and variable condenser A/D value read

The CPU makes AD1 (P46) and AP2 (P41) high to change motor control from analog to the microcomputer during inversion when tuning or presetting.

The motor speed after the variable condenser moves until it stops is controlled by changing the high and low duty ratios with SPD1 (43 pins) and SPD2 (42 pins). When the stop position is approached during presetting or when the SWR falls during tuning, the motor speed decreases. When the SWR becomes 1.2, the motor stops. The rotational direction of the motor during presetting is controlled by PR11 (P45), PR12 (P44) and PR21 (P40), and PR (P47). (See Table 1.)

		PR11	PR12	PR21	PR22
Motor 1	Normal rotation	H	L	/	/
	Reverse rotation	L	H	/	/
	Stop	L	L	/	/
Motor 2	Normal rotation	/	/	H	L
	Reverse rotation	/	/	L	H
	Stop	/	/	L	L

Table 1 Direction of rotation of motors 1 and 2

• EEPROM access

Since the CPU does not back up data, backup data is stored in IC10 (NM93C66EM83). If there is an input to the NMI pin when the power supply voltage is dropped, the CPU outputs backup data to IC10 CS (pin 1). When the power is turned on and the CPU receives a reset signal for the generation stabilizing time (about 40 ms), the previous backup data is read from the EEPROM.

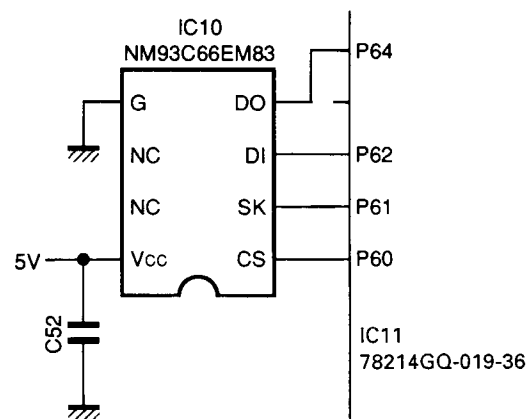


Fig. 5 EEPROM circuit

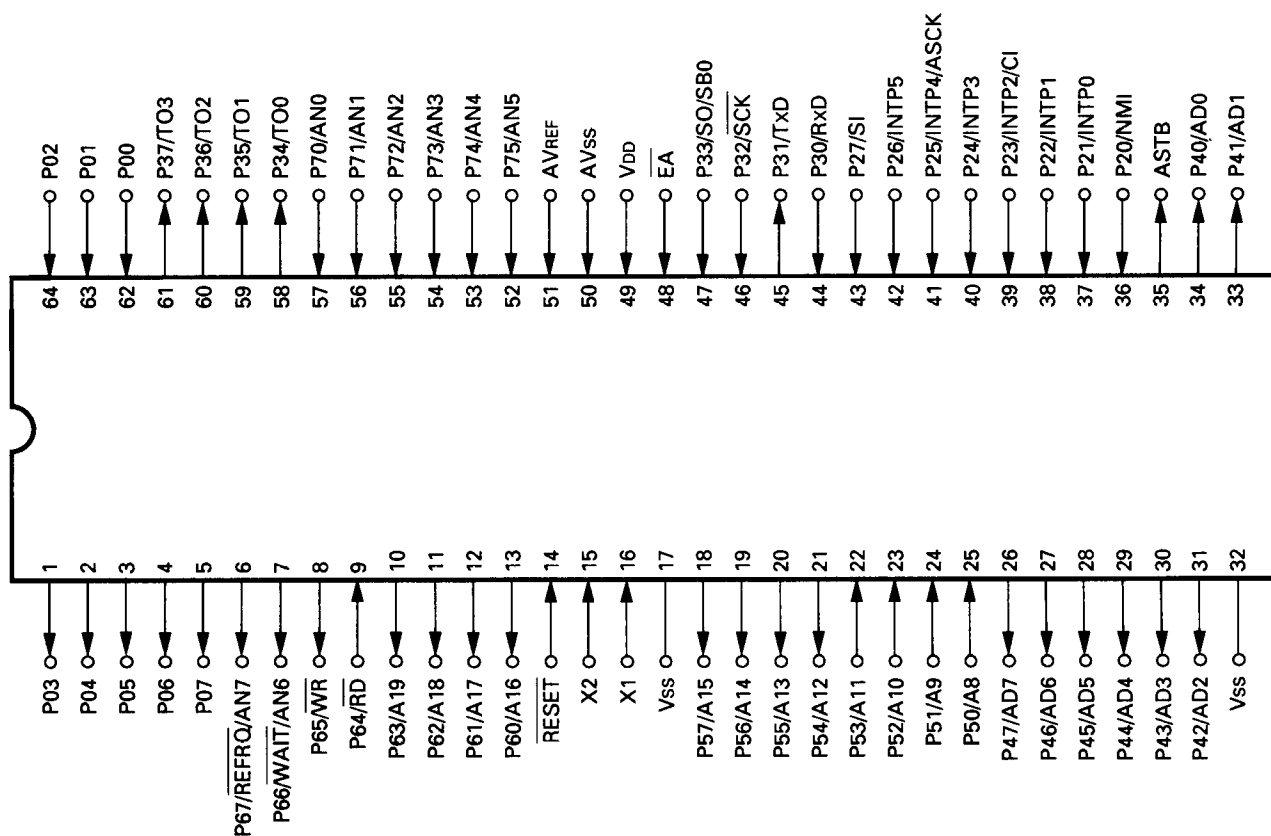
• Serial interface

The CPU has an asynchronous serial interface (TTL level) to transfer data to and from the TS-50. (Auto mode) Data format is one start bit, 8 data bits, and two stop bits; transmission speed is 4800bps. The control signal from the TS-50 is received through RXD (pin 44) and the answerback signal is sent to the TS-50 through TXD (pin 45).

SEMICONDUCTOR DATA

CPU: 78214GQ-019-36 (IC11)

• Terminal connection diagram



• Terminal function

Pin No.	Pin name	Signal name	I/O	Function	Active condition	H/L
1	P03	7A	O	7MHz band relay signal.	When 7MHz band is selected.	H
2	P04	4A	O	3.5MHz band relay signal.	When 3.5MHz band is selected.	H
3	P05	ATA	O	Through relay signal.	When AT is inserted.	H
4	P06	28A	O	28MHz band relay signal.	When 28MHz band is selected.	H
5	P07	25A	O	24.5MHz band relay signal.	When 24.5MHz band is selected.	H
6	P67		O			
7	P66		O			
8	P65		O			
9	P64	EDI	I	EEPROM data input.		
10	P63		O			
11	P62	EDO	O	EEPROM serial data.		
12	P61	ESK	O	EEPROM serial clock.		
13	P60	ECS	O	EEPROM chip select.	When EEPROM is accessed.	H
14	RESET	RES	I	CPU reset input.	When reset.	L
15	X2	X2	I	Crystal oscillator connection pin.	11.0592MHz.	-

SEMICONDUCTOR DATA

Pin No.	Pin name	Signal name	I/O	Function	Active condition	H/L
16	X1	X1	I	Crystal oscillator connection pin.	L77-1380-05.	—
17	Vss	Vss	—	Ground voltage.		—
18	P57	SAT	O	AT IN key switch input.	When AT IN key is pressed.	L
19	P56	STN	O	TUNE key switch input.	When TUNE key is pressed.	L
20	P55	SDN	O	DOWN key switch input.	When DOWN key is pressed.	L
21	P54	SUP	O	UP key switch input.	When UP key is pressed.	L
22	P53	LCK	I	LED driver serial clock.		
23	P52	LDA	I	LED driver serial data.		
24	P51	LBL	I	LED driver light control output.	When LED lights.	H
25	P50	LEN	I	LED driver enable.	Data enable.	H
26	P47	PR22	O	Preset control output.		
27	P46	AP1	O	Tuning/preset switching.	Preset.	H
28	P45	PR11	O	Preset control output.		
29	P44	PR12	O	Preset control output.		
30	P43	SPD1	O	Speed control output 1.	When the motor runs.	H
31	P42	SPD2	O	Speed control output 2.	When the motor runs.	H
32	Vss	Vss	—			
33	P41	AP2	O	Tuning/preset switching.	Preset.	H
34	P40	PR21	O	Preset control output.		
35	ASTB		O			H
36	NMI	NMI	I	13.8V power supply voltage drop interrupt input.	When the voltage drops.	
37	P21	INTP0	I			L
38	P22	INTP1	I			L
39	P23		I			
40	P24		I			
41	P25	OP1	I	Stop switch input (SWR display).	Jumper W23 is installed.	L
42	P26		I			
43	P27	OP2	I	Stop switch input (baud rate).	Jumper W24 is installed.	L
44	RXD	RXD	I	Serial control input.		
45	TXD	TXD	O	Serial output.		
46	P32		I			
47	P33		I			
48	EA	EA	I	ROMless instruction.	When the internal ROM is used.	H
49	VDD	VDD	I	Power input.	+5V input.	—
50	AVSS	AVSS	I	Analog-to-digital converter reference potential.	Analog ground potential.	—
51	AVREF	AVREF	I	Analog-to-digital converter reference voltage.	Full-scale voltage.	—
52	P75		I	GND.		
53	P74		I	GND.		
54	P73	POD1	I	Variable condenser A position voltage.	Analog input.	
55	P72	POD2	I	Variable condenser B position voltage.	Analog input.	
56	P71	V _F	I	Forward wave voltage.	Analog input.	
57	P70	V _R	I	Reflected wave voltage.	Analog input.	
58	P34	OP3	O			
59	P35	OP4	O			
60	P36	OP5	O			
61	P37		O			
62	P00	18A	I	18MHz band relay signal.	When 18MHz band is selected.	H
63	P01	14A	I	14MHz band relay signal.	When 14MHz band is selected.	H
64	P02	10A	I	10MHz band relay signal.	When 10MHz band is selected.	H

AT-50

DESCRIPTION OF COMPONENTS

AT UNIT (X53-3470-00)

Ref. No.	Use/Function	Operation/Condition/Compatibility
IC1	D-FF	Phase difference detection.
IC2	Analog switch	Control switching VR1.
IC3	Analog switch	Control switching VR2.
IC4	Motor drive	For VR1.
IC5	Motor drive	For VR2.
IC6	Comparator	Amplitude difference detection.
IC7	System reset	Reset signal generation.
IC8,9	Inverter	Reset signal waveform rectification.
IC10	EEPROM	Band and preset position data memory.
IC11	CPU	8-bit microcomputer.
IC12	Regulator	14V → 8V
IC13	Regulator	14V → 5V
IC14	System backup	Backup signal generation.
IC15,16	Inverter	Backup signal waveform rectification.
IC201,202	LED switch	Serial-to-parallel conversion.
Q1,2	Amplification	Waveform rectification.
Q3,4	Switching	On when AP is high.
Q5~Q8	Switching	Motor speed control pulse.
D1	Detection	Current amplitude detection.
D2	Detection	Voltage amplitude detection.
D3~D8	Switching	Clipper.
D9	Charging diode	Reset voltage discharging.
D10,11	Protection diode	Analog-to-digital converter input port protection.
D13,14	Switching	HALF mode termination.
D101	High-frequency rectification	Reflected wave rectification.
D102	High-frequency rectification	Forward wave rectification.
D103~D110	Switching	Spike absorption.
D111	Lightning surge protection	
D112	Protection against reverse connection	For power terminal.
D113	Surge absorption	Power line protection.
D201~D213	LED	Display LED (band, switch).
D301	Reverse flow prevention	
D302	Reference voltage	18V.
D303	Protection	Shorts the 14V line to blow the fuse if overvoltage occurs.

PARTS LIST

× New Parts

Parts without **Parts No.** are not supplied.

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

Teile ohne **Parts No.** werden nicht geliefert.

AT-50

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
AT-50						
1	1A	*	A01-2074-02	METALLIC CABINET(TOP)		
2	3B	*	A01-2075-02	METALLIC CABINET(BOTTOM)		
3	2A	*	A10-1332-02	CHASSIS (MAIN)		
4	3A	*	A62-0237-03	PANAL ASSY		
5	3A	*	B10-1191-03	FRONT GLASS		
6	3C		B42-2454-04	S/NØ LABEL(ITEM CARTON BOX)		
7	1A		B42-2455-04	LABEL(M4×8MAX)		
8	1B		B42-3343-04	S/NØ LABEL(BODY)		
9	1B		B42-3395-04	LABEL(FCC)	K	
10	3C	*	B42-4528-04	LABEL(GREEN POINT MARK)	M, E	
11	1D		B46-0419-00	WARRNTY CARD	E	
11	1D		B46-0430-00	WARRNTY CARD	K	
12	1D	*	B62-0320-00	INSTRUCTION MANUAL		
13	1B	*	B72-0521-04	MODEL NAME PLATE		
14	2B	*	C02-0025-05	VARIABLE CONDENSER(MAX 300PF)		
15	2B		D22-0402-05	JOINT(COUPLING)		
16	1B		E04-0167-05	RF COAXIAL CABLE RECEPTACLE		
17	2B		E23-0677-04	TERMINAL(GND)		
18	1D	*	E30-3145-05	TRUNK CABLE (ACSY)		
19	1D	*	E30-3155-05	CONVERSION CABLE (ACSY)		
-		*	E37-0316-05	CONNECTING WIRE		
-		*	E37-0317-05	CONNECTING WIRE (3P)		
-		*	E37-0318-05	CONNECTING WIRE (12P)		
-		*	E37-0374-05	CONNECTING WIRE		
24	1D		F06-4029-05	FUSE (4A:ACSY)		
25	2B		G02-0574-04	FLAT SPRING		
26	2A	*	G13-1389-04	CUSHION (KNØB)		
27	2D	*	H10-2765-02	POLYSTYRENE FOAMED FIXTURE(F)		
28	1C	*	H10-2766-02	POLYSTYRENE FOAMED FIXTURE(R)		
29	1D		H25-0112-04	BAG (180×250)		
30	2C		H25-0194-04	BAG (280×400)		
31	3C	*	H52-0385-04	ITEM CARTON BOX		
-		*	H62-0337-04	OUTER PACKING CASE		
33	3A, 3B		J02-0439-05	FOOT		
34	2B	*	J21-4417-04	MOUNTING HARDWARE (VC)		
-			J61-0307-05	WIRE BAND		
36	3A	*	K29-4838-04	KNØB (A/T, TUNE)		
37	3A	*	K29-4839-04	KNØB (BAND: >)		
38	3A	*	K29-4841-04	KNØB (BAND: <)		
39	1B		N15-1040-46	FLAT WASHER (GND)		
A	2B		N09-0641-05	SCREW(VARIABLE CONDENSER)		
B	1A, 3A		N33-2606-45	ØVAL HEAD MACHIN SCREW(CASE)		
C	1B		N35-4010-46	BINDING HEAD MACHINE SCREW(GND)		
D	2A, 2B		N87-2606-46	BRAZIER HEAD TAPTITE SCREW(PCB)		
E	1B		N87-3008-46	BRAZIER HEAD TAPTITE SCREW		
40	2A, 2B	*	X53-3470-00	AT UNIT (A, B, C, D/4)		

L:Scandinavia

K:USA

P:Canada

Y:PX(Far East, Hawaii)


T:England

E:Europe

Y:AAFES(Europe)

X:Australia

M:Other Areas

 indicates safety critical components.

PARTS LIST

× 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.

AT UNIT (X53-3470-00)

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
AT UNIT (X53-3470-00)						
C1 -7			CK73FB1E103K	CHIP C 0.01UF K		
C8 ,9			CK73FB1H102K	CHIP C 1000PF K		
C10			CK73FB1E103K	CHIP C 0.01UF K		
C11			CE04EW1A470M	ELECTRO 47UF 10WV		
C12 -17			CK73FB1E103K	CHIP C 0.01UF K		
C18			CK73EF1E474Z	CHIP C 0.47UF Z		
C19 -21			CK73FB1E103K	CHIP C 0.01UF K		
C22			CE04EW1A101M	ELECTRO 100UF 10WV		
C23			CK73FB1E103K	CHIP C 0.01UF K		
C24			CK73EF1E474Z	CHIP C 0.47UF Z		
C25 -27			CK73FB1E103K	CHIP C 0.01UF K		
C28			CE04EW1A101M	ELECTRO 100UF 10WV		
C30			CK73FF1E104Z	CHIP C 0.1UF Z		
C31			CK73FB1E103K	CHIP C 0.01UF K		
C32			CE04EW1E470M	ELECTRO 47UF 25WV		
C33			CK73FB1E104K	CHIP C 0.10UF K		
C34			CE04EW1A101M	ELECTRO 100UF 10WV		
C35			CK73FB1E104K	CHIP C 0.10UF K		
C36			CE04EW1E470M	ELECTRO 47UF 25WV		
C37			CK73FB1E104K	CHIP C 0.10UF K		
C38			CE04EW1A221M	ELECTRO 220UF 10WV		
C39			CK73FB1E104K	CHIP C 0.10UF K		
C40 -42			CK73FB1E103K	CHIP C 0.01UF K		
C43 ,44			CK73FB1H102K	CHIP C 1000PF K		
C45 -50			CK73FB1E103K	CHIP C 0.01UF K		
C51			CE04EW1H3R3M	ELECTRO 3.3UF 50WV		
C52			CK73FB1E103K	CHIP C 0.01UF K		
C53 ,54			CC73FCH1H100D	CHIP C 10PF D		
C55 -59			CK73FB1E103K	CHIP C 0.01UF K		
C60			CE04EW1A221M	ELECTRO 220UF 10WV		
C63 -66			CK73FB1E103K	CHIP C 0.01UF K		
C68			CK73FB1E103K	CHIP C 0.01UF K		
C69 -77			CK73FB1H102K	CHIP C 1000PF K		
C78 ,79			CK73FB1E103K	CHIP C 0.01UF K		
C80			C92-0001-05	CHIP TAN 0.1UF 35WV		
C81			CK73FF1H473Z	CHIP C 0.047UF Z		
C82 ,83			CE04EW1HOR1M	ELECTRO 0.1UF 50WV		
C101			CC45CH2H030C	CERAMIC 3PF C		
C102			CC73FSL1H101J	CHIP C 100PF J		
C103			CC73FSL1H560J	CHIP C 56PF J		
C104,105			CK73FF1H473Z	CHIP C 0.047UF Z		
C106			CC45SL2H820J	CERAMIC 82PF J		
C107			CK73FB1E103K	CHIP C 0.01UF K		
C108-123			CK73FB1E103K	CHIP C 0.01UF K		
C124			CK73EF1H104Z	CHIP C 0.1UF Z		
C201-204			CK73FB1H102K	CHIP C 1000PF K		
C205			CE04NW1A470M	ELECTRO 47UF 10WV		
C206,207			CK73FB1E103K	CHIP C 0.01UF K		
C301			CE04EW1A221M	ELECTRO 220UF 10WV		
C302			CK73FB1E103K	CHIP C 0.01UF K		
TC1			C05-0031-15	TRIM CAP 10PF		
TC101			C05-0030-15	TRIM CAP 20PF		

L:Scandinavia

K:USA

P:Canada

Y:PX(Far East, Hawaii)


T:England

E:Europe

Y:AAFES(Europe)

X:Australia

M:Other Areas

 indicates safety critical components.

PARTS LIST

× New Parts

Parts without Parts No. are not supplied.

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

Teile ohne Parts No. werden nicht geliefert.

AT UNIT (X53-3470-00)

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
CN1 , 2			E04-0154-05	RF COAXIAL CABLE RECEPTACLE		
CN3			E40-3247-05	PIN ASSY (3P)		
CN4			E40-3254-05	PIN ASSY (10P)		
CN5			E40-3255-05	PIN ASSY (11P)		
CN6			E40-3237-05	PIN ASSY (2P)		
CN7			E40-3246-05	PIN ASSY (2P)		
CN101, 102			E04-0154-05	RF COAXIAL CABLE RECEPTACLE		
CN103			E40-3247-05	PIN ASSY (3P)		
CN104			E40-3256-05	PIN ASSY (12P)		
CN105			E23-0401-05	TERMINAL (TEST)		
W22		*	E37-0371-05	CONNECTING WIRE		
W105	1B	*	E37-0370-15	CONNECTING WIRE		
W201		*	E37-0369-15	CONNECTING WIRE		
W301		*	E37-0372-05	CONNECTING WIRE		
F101	2B		F06-4029-05	FUSE (4A)		
A101, 102			J13-0075-05	FUSE HOLDER		
L1			L39-0496-05	TROIDAL COIL		
L2			L39-0415-25	TROIDAL COIL		
L3 -6			L40-1011-12	SMALL FIXED INDUCTOR(100UH)		
L7			L40-1001-12	SMALL FIXED INDUCTOR(10UH)		
L8 , 9			L40-1001-48	SMALL FIXED INDUCTOR(10UH)		
L10 -17			L40-1011-48	SMALL FIXED INDUCTOR(100UH)		
L101			L40-2221-33	SMALL FIXED INDUCTOR(2.2MH)		
L102			L39-0480-15	TROIDAL COIL		
L103			L40-2221-33	SMALL FIXED INDUCTOR(2.2MH)		
L104			L34-1276-05	COIL		
L105		*	L39-1242-05	TROIDAL COIL		
L106			L39-0495-05	TROIDAL COIL		
L107			L39-0494-15	TROIDAL COIL		
L108-116			L40-1011-15	SMALL FIXED INDUCTOR(100UH)		
X1			L77-1380-05	CRYSTAL RESONATOR(11.0592MHz)		
R1 , 2			RD14BB2E101J	RD 100 J 1/4W		
R3			RD14BB2E470J	RD 47 J 1/4W		
R4			RK73FB2A102J	CHIP R 1.0K J 1/10W		
R5			RK73FB2A181J	CHIP R 180 J 1/10W		
R6 -9			RK73FB2A103J	CHIP R 10K J 1/10W		
R10 , 11			RK73FB2A330J	CHIP R 33 J 1/10W		
R12 , 13			RK73FB2A103J	CHIP R 10K J 1/10W		
R14			RK73FB2A181J	CHIP R 180 J 1/10W		
R15			RK73FB2A563J	CHIP R 56K J 1/10W		
R16			RK73FB2A121J	CHIP R 120 J 1/10W		
R17			RK73FB2A101J	CHIP R 100 J 1/10W		
R18			RK73FB2A121J	CHIP R 120 J 1/10W		
R19			RK73FB2A563J	CHIP R 56K J 1/10W		
R20			RK73FB2A101J	CHIP R 100 J 1/10W		
R21 -23			RK73FB2A103J	CHIP R 10K J 1/10W		
R24			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R25			RK73FB2A103J	CHIP R 10K J 1/10W		
R26			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R27			RD14BB2E100J	RD 10 J 1/4W		
R28			RK73FB2A103J	CHIP R 10K J 1/10W		
R29			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R30			RK73FB2A103J	CHIP R 10K J 1/10W		

L:Scandinavia

K:USA

P:Canada

Y:PX(Far East, Hawaii)


T:England

E:Europe

Y:AAFES(Europe)

X:Australia

M:Other Areas

 indicates safety critical components.

PARTS LIST

× 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.

AT UNIT (X53-3470-00)

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
R31			RD14BB2E100J	RD 10 J 1/4W		
R32			RK73FB2A103J	CHIP R 10K J 1/10W		
R33			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R34			RK73FB2A103J	CHIP R 10K J 1/10W		
R35			RD14BB2E471J	RD 470 J 1/4W		
R36			RK73FB2A101J	CHIP R 100 J 1/10W		
R37 ,38			RK73FB2A473J	CHIP R 47K J 1/10W		
R39 ,40			RK73FB2A104J	CHIP R 100K J 1/10W		
R41 ,42			RK73FB2A100J	CHIP R 10 J 1/10W		
R46 ,47			RK73FB2A182J	CHIP R 1.8K J 1/10W		
R48			RK73FB2A472J	CHIP R 4.7K J 1/10W		
R49 ,50			RK73FB2A101J	CHIP R 100 J 1/10W		
R51			RK73FB2A273J	CHIP R 27K J 1/10W		
R52			RK73FB2A220J	CHIP R 22 J 1/10W		
R53			RK73FB2A223J	CHIP R 22K J 1/10W		
R54 -58			RK73FB2A103J	CHIP R 10K J 1/10W		
R59 -62			RK73FB2A104J	CHIP R 100K J 1/10W		
R63 -66			RK73EB2B101J	CHIP R 100 J 1/8W		
R67 -74			RK73FB2A101J	CHIP R 100 J 1/10W		
R77 -85			RK73FB2A103J	CHIP R 10K J 1/10W		
R88 ,89			RK73FB2A103J	CHIP R 10K J 1/10W		
R90			RK73FB2A334J	CHIP R 330K J 1/10W		
R101			RK73FB2A100J	CHIP R 10 J 1/10W		
R102-105			RK73FB2A330J	CHIP R 33 J 1/10W		
R106-109			RK73FB2A270J	CHIP R 27 J 1/10W		
R201-207			RK73FB2A101J	CHIP R 100 J 1/10W		
R209,210			RK73FB2A271J	CHIP R 270 J 1/10W		
R211-213			RK73FB2A391J	CHIP R 390 J 1/10W		
R214			RK73FB2A271J	CHIP R 270 J 1/10W		
R215-221			RK73FB2A391J	CHIP R 390 J 1/10W		
R222			RK73FB2A103J	CHIP R 10K J 1/10W		
R223			R92-0670-05	CHIP R 0 ΩHM		
R224-227			R92-0679-05	CHIP R 0 ΩHM		
R301			RK73FB2A470J	CHIP R 47 J 1/10W		
R302			RK73FB2A123J	CHIP R 12K J 1/10W		
R303			RK73FB2A223J	CHIP R 22K J 1/10W		
R304			RK73EB2B222J	CHIP R 2.2K J 1/8W		
R305,306			RS14DB3A181J	FL-PROOF RS 180 J 1W		
R307			RS14DB3A100J	FL-PROOF RS 10 J 1W		
R401-411			R92-0670-05	CHIP R 0 ΩHM		
R426-447			R92-0679-05	CHIP R 0 ΩHM		
VR1 ,2	2A, 2B		R10-3402-05	POTENTIOMETER 10KB		
VR3 ,4			R12-6744-05	TRIM POT. 47K		
VR101			R12-6730-05	TRIM POT. 220		
W23 -27			R92-0150-05	JUMPER REST 0 ΩHM		
W101-104			R92-0150-05	JUMPER REST 0 ΩHM		
K101			S51-2417-05	RELAY		
K102-108			S76-0401-05	RELAY		
S201,202			S70-0415-05	TACT SWITCH (A/T,TUNE)		
S203,204			S70-0411-05	TACT SWITCH (BAND: < >)		
D1 ,2			1N60	DIODE		
D3 -8			1SS226	DIORD		
D9			DAN202K	DIORD		
D10 ,11			RDS.1M(B1)	DIORD		

L:Scandinavia

K:USA

P:Canada

Y:PX(Far East, Hawaii)

T:England

E:Europe

Y:AAFES(Europe)

X:Australia

M:Other Areas

⚠ indicates safety critical components.

PARTS LIST

× 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.

AT UNIT (X53-3470-00)

MODULE UNIT : METER (X59-3940-01)

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
D13 ,14 D101,102 D103-110 D111 D112			DAP202U 1SS101 LFB01 RA301PV6Y2(0.5) U05B	DIØRD DIØRD DIØRD DIØRD (SURGE ABSØRBER) DIØRD		
D113 D201 D202 D203-205 D206			ERZ-M10DK220 B30-2005-05 B30-2006-05 B30-2007-05 B30-2006-05	DIØRD LED LED LED LED		
D207-213 D301 D302 D303 IC1			B30-2007-05 RLS73 RLZ18B SF2B41 SN74S74NS	LED DIØRD DIØRD THYRISTØR IC(FLIP-FLØP)		
IC2 ,3 IC4 ,5 IC6 IC7 IC8 ,9			MC14066BF BA6109U2 NJM2902M M51951BML TC4S584F	IC (or TC4066BF) IC(MØTØR DRIVER) IC(ØP AMP X4) IC(SYSTEM RESET) IC(SCHMITT TRIGGER)		
IC10 IC11 IC12 IC13 IC14		*	NM93C66EM83 78214GØ-019-36 UPC7808H UPC7805H M51951BML	IC(CMØS EEPROM) IC (CPU) IC(VØLTAGE REGULATØR/ +8V) IC(VØLTAGE REGULATØR/ +5V) IC(SYSTEM RESET)		
IC15,16 IC201,202 Ø1 ,2 Ø3 ,4 Ø5 ,6			TC4S584F UPD6345GS 2SC2714(Y) DTC114EK 2SA1204(Y)	IC(SCHMITT TRIGGER) IC TRANSISTØR DIGITAL TRANSISTØR TRANSISTØR		
Ø7 -18 Ø19 Ø301 Ø302			DTC143EK DTC144EK DTC114EK 2SA1182(Y)	DIGITAL TRANSISTØR DIGITAL TRANSISTØR DIGITAL TRANSISTØR TRANSISTØR		
Z1		*	X59-3940-01	MODULE UNIT		
MODULE UNIT : METER (X59-3940-01)						
C1 ,2			CK73FB1E103K E23-0471-05	CHIP C 0.01UF K TERMINAL		
R1 R2 R3 R4 ,5 R6			RK73FB2A103J RK73FB2A684J RK73FB2A224J RK73FB2A104J RK73FB2A102J	CHIP R 10K J 1/10W CHIP R 680K J 1/10W CHIP R 220K J 1/10W CHIP R 100K J 1/10W CHIP R 1.0K J 1/10W		
R7 R8 R9 R10 R11			RK73FB2A103J RK73FB2A224J RK73FB2A684J RK73FB2A104J RK73FB2A224J	CHIP R 10K J 1/10W CHIP R 220K J 1/10W CHIP R 680K J 1/10W CHIP R 100K J 1/10W CHIP R 220K J 1/10W		
R12 R13,14			RK73FB2A102J R92-0670-05	CHIP R 1.0K J 1/10W CHIP R 0 ØHM		
D1 ,2 IC1			HSM88AS LM2904M	IC (or NJM2904M)		

L:Scandinavia

K:USA

P:Canada

Y:PX(Far East, Hawaii)


T:England

E:Europe

Y:AAFES(Europe)

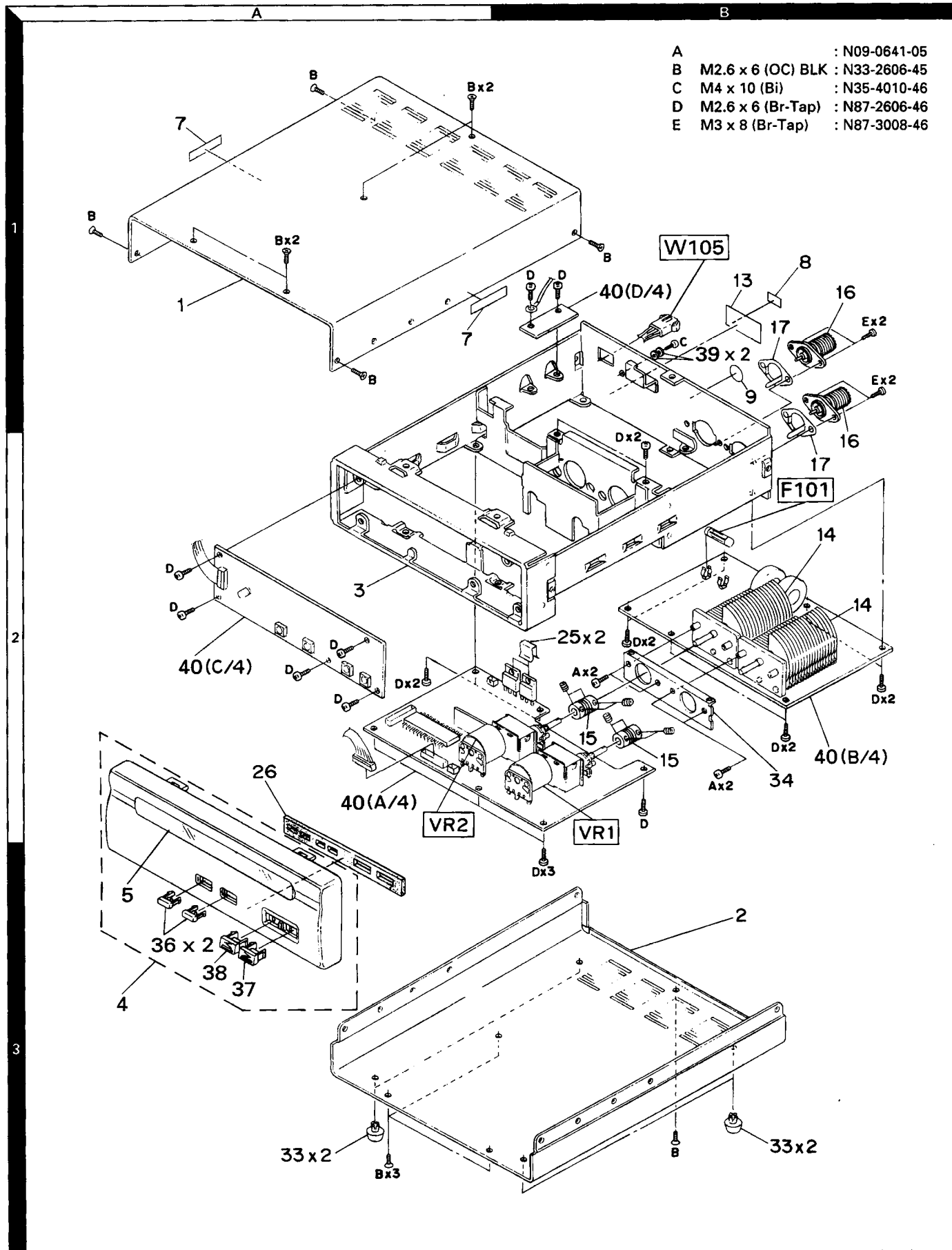
X:Australia

M:Other Areas

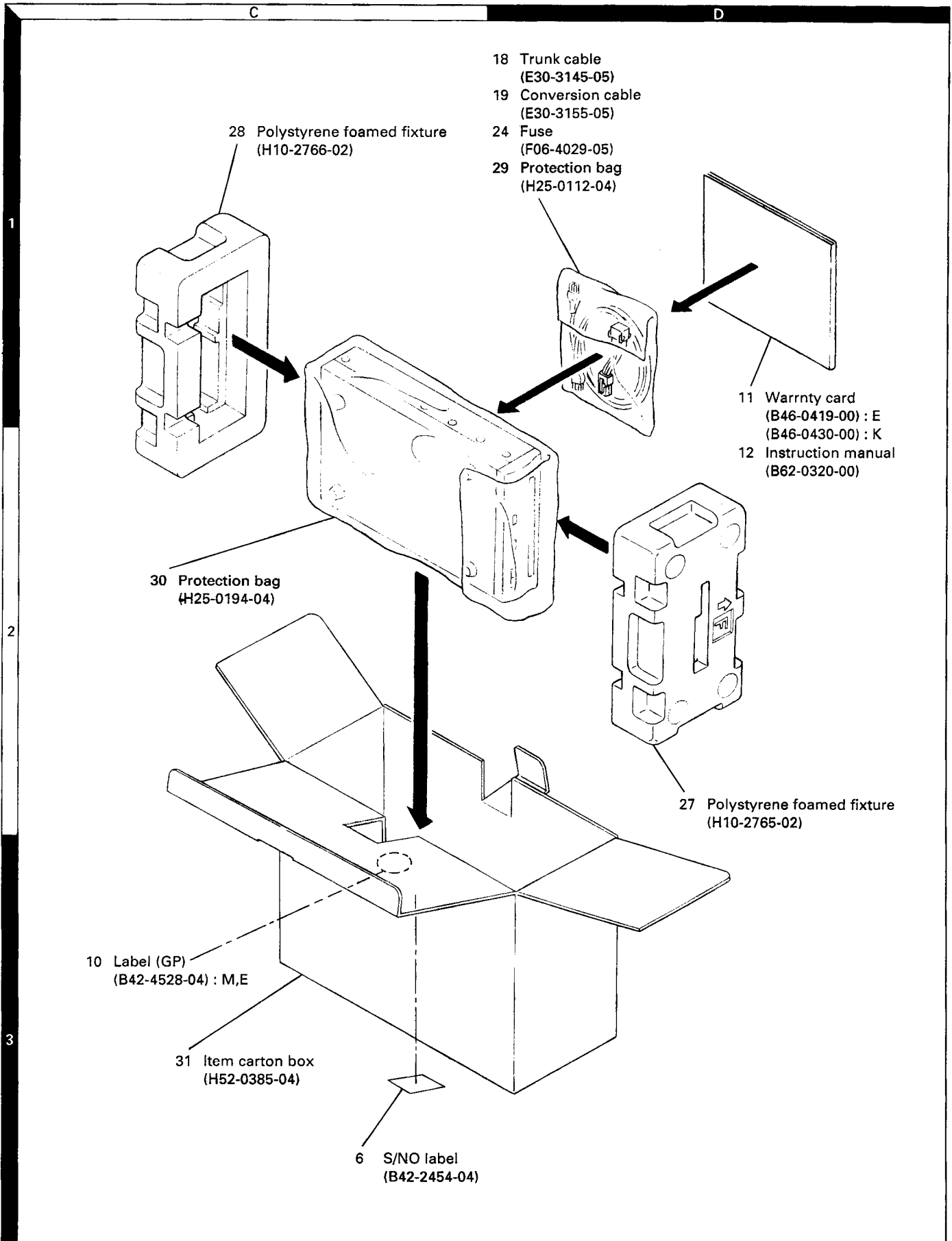
 indicates safety critical components.

AT-50

EXPLODED VIEW



PACKING



DISASSEMBLY FOR REPAIR

Variable condenser adjustment method

- **If the motor-driver variable resistor is replaced**

The motor-driver variable resistor has a slit in the shaft, and is set to the position shown Figure 1 at the factory.

To adjust the position, connect the variable condenser to the motor-driver variable resistor with the rotor plates of the variable condenser set upright.

Turn the rotor plates counterclockwise 90 degrees as shown in Figure 3. Never turn the rotor plates clockwise, otherwise tuning cannot be performed correctly.

- **If the motor-driver variable resistor is not replaced**

If the AT-50 is reset (see page 18 for the method of resetting), the motor-driver variable resistor is initialized to the 14MHz-band position. The slit position is about 15° clockwise (the dotted line in Figure 1).

Set the blades of the variable condenser to about 105° (the dotted line in Figure 3), and couple it with the motor-driver variable resistor.

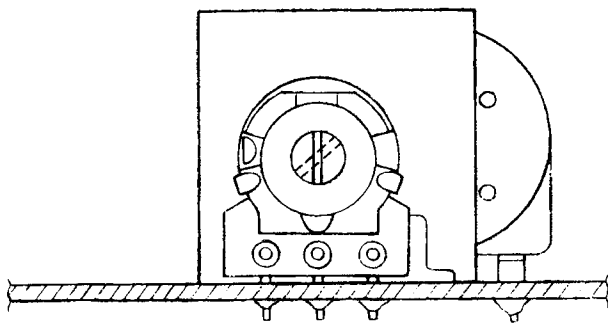


Fig. 1 Motor-driver variable resistor

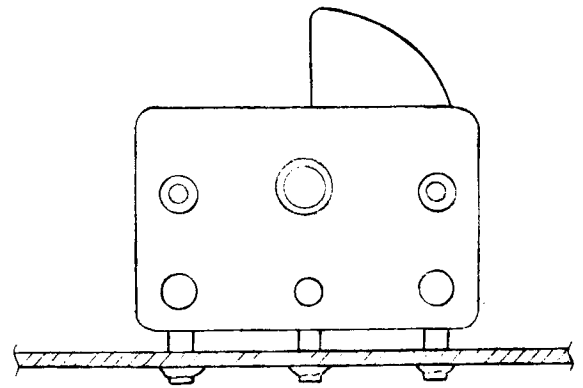


Fig. 2 Variable condenser

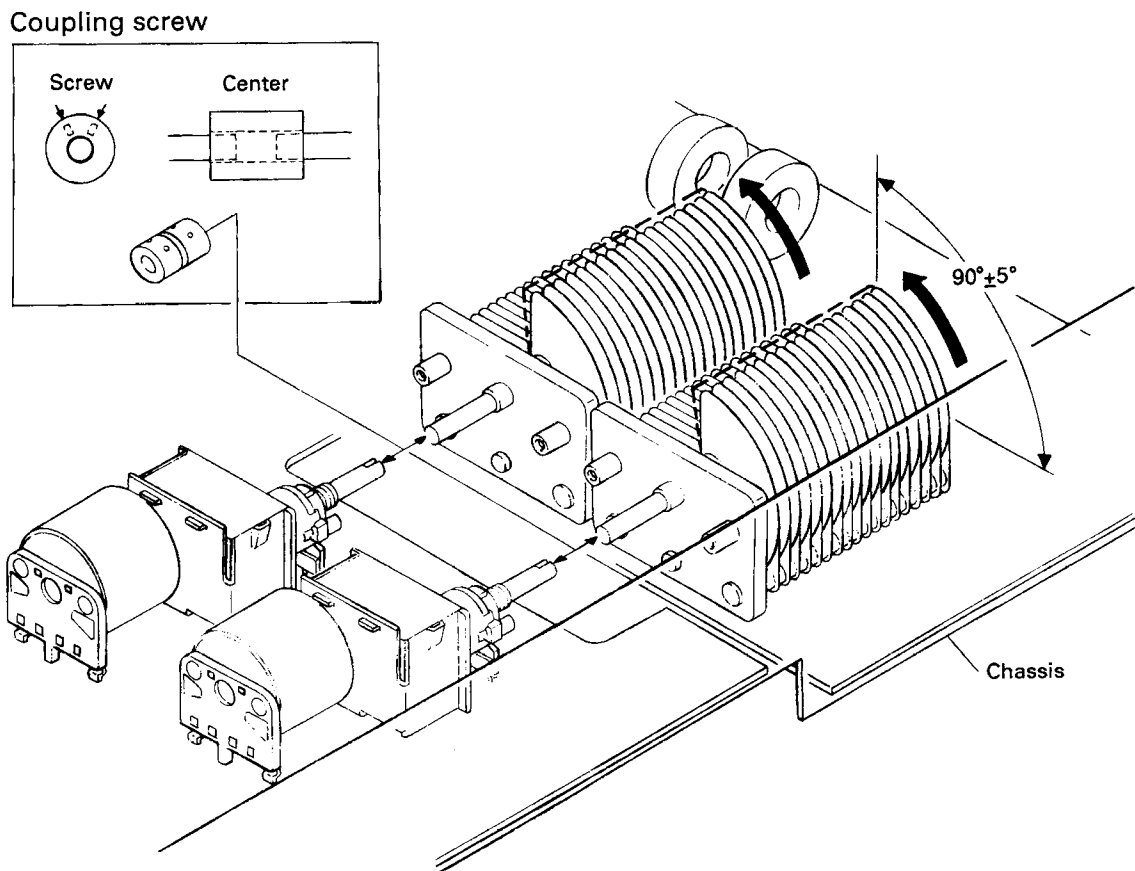


Fig. 3 Initial setting

ADJUSTMENT

Required test equipment

1. DC voltmeter (DVM)

- 1) Input resistance : More than $1M\Omega$
 - 2) Voltage range : 1.5 to 1000V AC / DC
- Note : A high-precision multimeter may be used.
However, accurate readings can not be obtained for high-impedance circuits.

2. Power meter

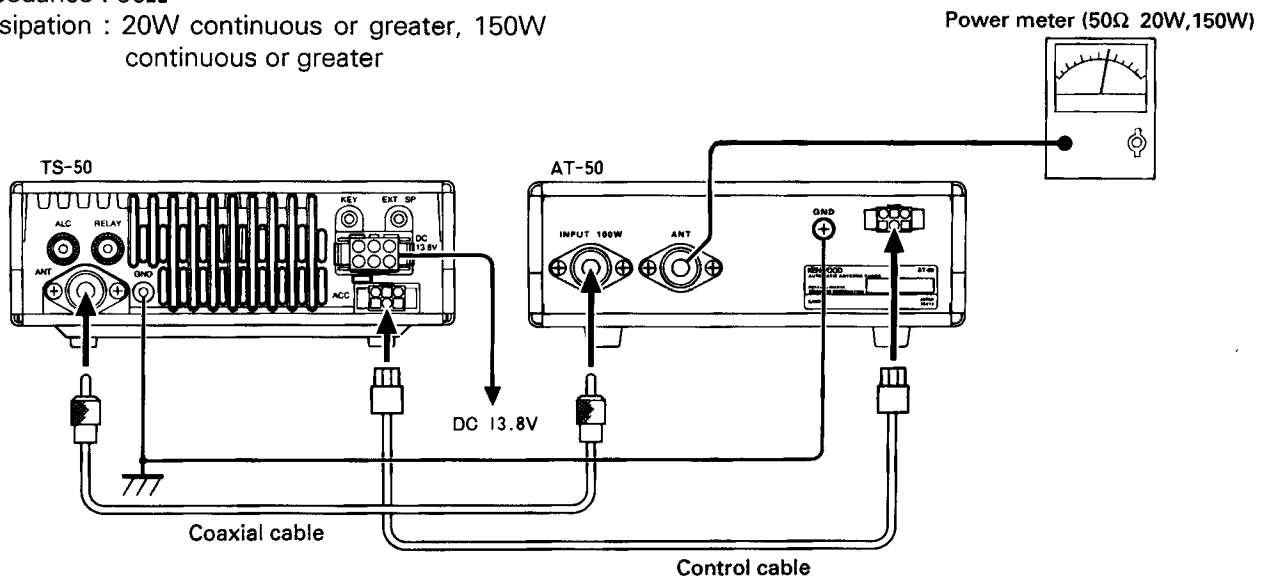
- 1) Frequency limits : 30MHz or greater
- 2) Impedance : 50Ω
- 3) Dissipation : 20W continuous or greater, 150W continuous or greater

3. RF Dummy Load

- 1) Impedance : 20Ω , 150Ω
 - 2) Dissipation : 150W or greater
- Note : The length of both the 150Ω and 20Ω dummy load cables must be 10cm or less.

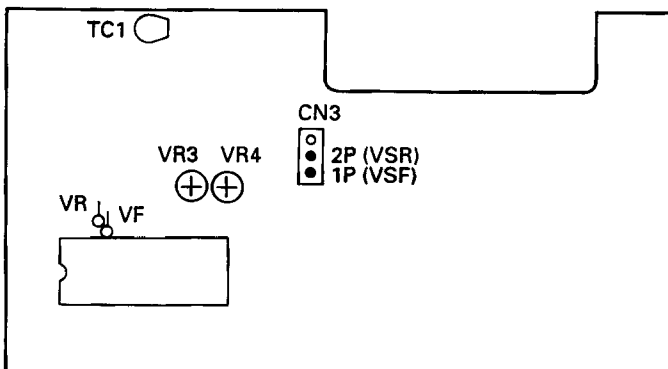
4. DC Power Supply

- 1) DC 13.8V



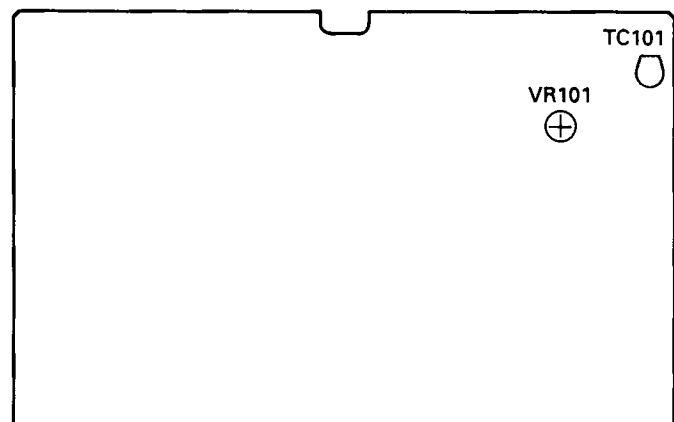
Adjustment Point

AT unit (A/4)



- TC1 : 18, 28MHz band phase
 VR3 : Power meter
 VR4 : SWR meter


AT unit (B/4)



- TC101 : Null
 VR101 : Detection circuit frequency characteristics

AT-50

ADJUSTMENT

Item	Condition	Measurement			Adjustment			Specifications/Remarks
		Test-equipment	Unit	Terminal	Unit	Parts	Method	
1. Null adjustment	1) AT-50 AUTO/THRU : THRU TS-50 Frequency : 1.91MHz MODE : CW 10W transmission	DC V.M Power meter	AT	CN3-2 pin (VSR)	AT	TC101	Minimize the voltage by turning TC101.	Reference value : 50mV or less
2. Detection circuit frequency characteristics adjustment	1) AT-50 AUTO/THRU : THRU TS-50 Frequency : 1.91MHz MODE : CW 10W transmission			CN3-1 pin (VSF)			Measure the voltage.	2.5V~3.5V
	2) AT-50 AUTO/THRU : THRU TS-50 Frequency : 29.0MHz MODE : CW 10W transmission			AT	VR101	Set the voltage to the same level as for 1.91MHz by turning VR101.		
3. Power meter adjustment	1) AT-50 AUTO/THRU : THRU TS-50 Frequency : 14.0MHz MODE : CW 10W transmission			IC11-56 pin (VF)		VR3	Set the voltage to 0.9V by turning VR3.	±0.02V
	4. SWR meter adjustment			1) AT-50 AUTO/THRU : THRU TS-50 Frequency : 1.91MHz MODE : CW 100W (When terminated with 50Ω) Dummy Terminate with 150Ω Transmission			Measure the VF voltage.	
	2) Same as 1)	IC11-57 pin (VR)	AT	VR4	Turn VR4 so that the voltage is twice as large as the VF measured in 1). (VR = VF x 2)			
5. Confirmation of automatic tuning mode	1) TS-50 AT TUNE : ON Transmit in all bands with each dummy. 20Ω dummy 150Ω dummy 50Ω power meter	Dummy 20Ω 150Ω Power meter 50Ω	Rear panel	ANT			Check	Tuning must be performed correctly.
					AT	TC1	TC1 has been adjusted to the mechanical center (180°) (see the figure at the right). If the operation is not stable and the variable capacitor vibrates slightly during the 18, 28MHz band tuning, adjust TC1 so that the variable condenser stops. (SWR must be 1.2 or less.)	
6. Reset	1) TS-50 POWER SW : OFF AT-50 Hold down the BAND < and > keys, TS-50 POWER SW : ON						Check	The BAND LED blinks.
	2) TS-50 POWER SW : OFF							

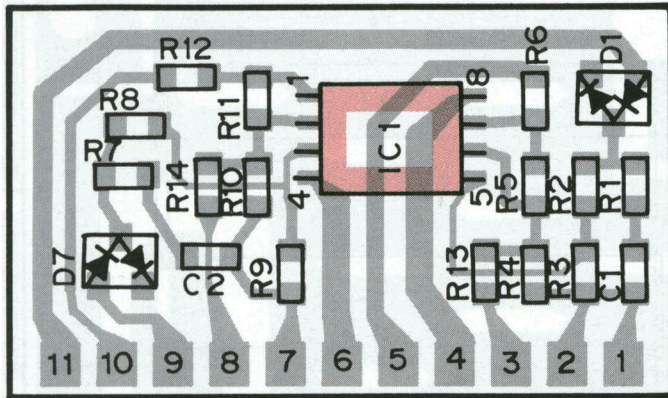
TERMINAL FUNCTION

Connector No.	Terminal No.	Terminal Name	Terminal Function
AT UNIT (X53-3470-00)			
CN1	Coaxial	AT2	AT output.
CN2	Coaxial	AT1	AT input.
CN3	1	VSF	Forward wave detection voltage input.
	2	VSR	Reflected wave detection voltage input.
	3	GND	GND.
CN4	1	TT	Serial output.
	2	TS	Serial control input.
	3	10A	AT coil tap band data, 7.5 to 10.5MHz.
	4	14A	AT coil tap band data, 10.5 to 14.5MHz.
	5	18A	AT coil tap band data, 14.5 to 21.5MHz.
	6	25A	AT coil tap band data, 21.5 to 25.0MHz.
	7	28A	AT coil tap band data, 25.0 to 30.0MHz.
	8	ATA	THRU/ON switching signal. On: Low
	9	4A	AT coil tap band data, 2.0 to 4.0MHz.
	10	7A	AT coil tap band data, 4.0 to 7.5MHz.
CN5	1	5V	5V.
	2	SAT	AUTO/THRU key switch input.
	3	STN	TUNE key switch input.
	4	SDN	DOWN key switch input.
	5	SUP	UP key switch input.
	6	LCK	LED driver serial clock.
	7	LDA	LED driver serial data.
	8	LBL	LED driver light control output.
	9	LEN	LED driver enable.
	10	GND	GND.
	11	NC	Not used.
CN6	1	NMI	Power supply voltage drop interrupt input.
	2	8V	8V.
CN7	1	14S	14V.
	2	GND	GND.
CN101	Coaxial	—	AT output.
CN102	Coaxial	—	AT input.

Connector No.	Terminal No.	Terminal Name	Terminal Function
CN103	1	VSF	Forward wave detection voltage output.
	2	VSR	Reflected wave detection voltage output.
	3	GND	GND.
CN104	1	14S	14V.
	2	GND	GND.
	3	TT	Serial uoutput.
	4	TS	Serial control input.
	5	10A	AT coil tap band data, 7.5 to 10.5MHz.
	6	14A	AT coil tap band data, 10.5 to 14.5MHz.
	7	18A	AT coil tap band data, 14.5 to 21.5MHz.
	8	25A	AT coil tap band data, 21.5 to 25.0MHz.
	9	28A	AT coil tap band data, 25.0 to 30.0MHz.
	10	ATA	THRU/ON switching signal. On : Low
	11	4A	AT coil tap band data, 2.0 to 4.0MHz.
	12	7A	AT coil tap band data, 4.0 to 7.5MHz.
CN105	—	14S	Overvoltage protection circuit 13.8V input.
W22	1	NMI	Power supply voltage drop interrupt input.
	2	8V	8V.
W105	1	14S	14V.
	2	ATG	GND.
	3	TT	Serial output.
	4	TS	Serial control input.
W201	1	GND	GND.
	2	LEN	LED driver enable.
	3	LBL	LED driver light control output.
	4	LDA	LED driver serial data.
	5	LCK	LED driver serial clock.
	6	SUP	UP key switch input.
	7	SDN	DOWN key switch input.
	8	STN	TUNE key switch input.
	9	SAT	AUTO/THRU key switch input.
	10	5V	5V.
W301	—	14S	Overvoltage protection circuit 13.8V input.

PC BOARD VIEWS AT-50

METER (X59-3940-01) Component side view



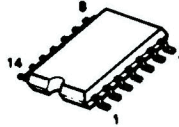
DTC114EK
DTC143EK
DTC144EK
2SA1182
2SC2714



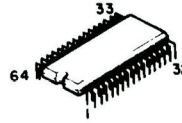
2SA1204



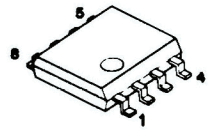
MC14066BF
TC4066BF



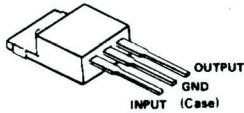
78214GQ-019-36



NM93C66EM83
LM2904M



μ PC7805H
 μ PC7808H



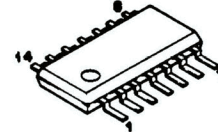
M51951BML



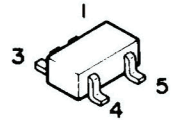
BA6109U2



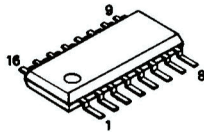
NJM2902M
SN74S74NS



TC4S584F

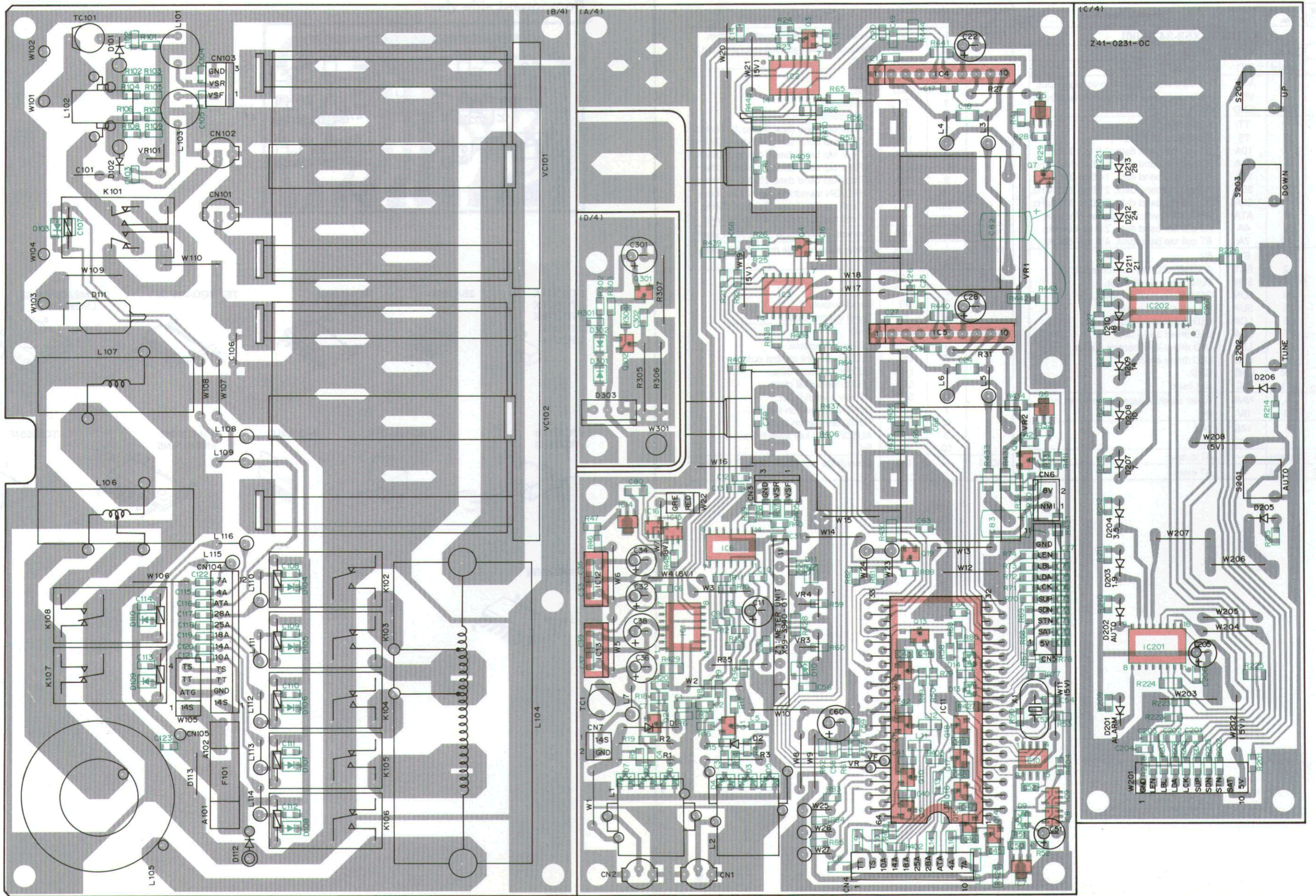


μ PD6345GS



AT-50 PC BOARD VIEWS

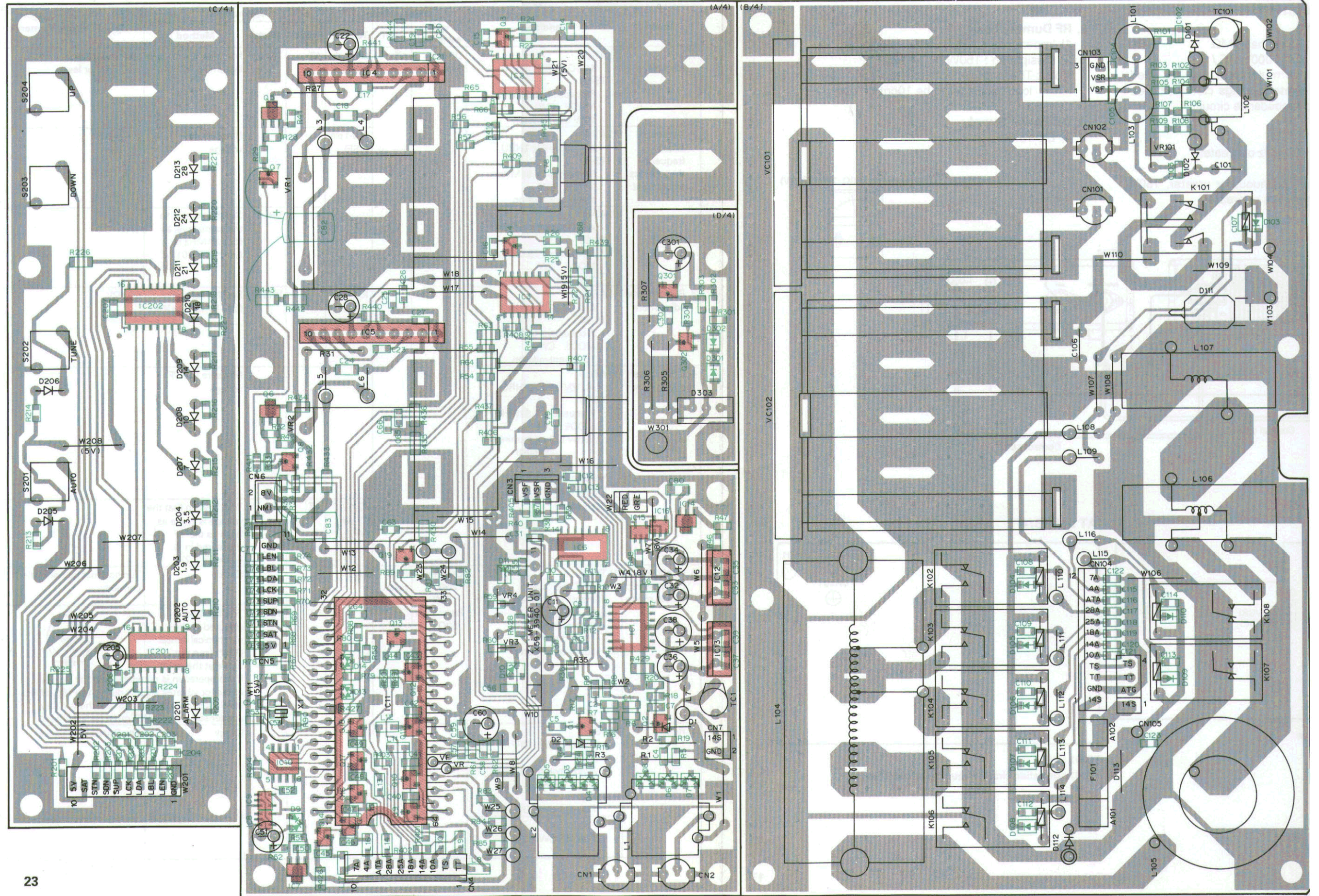
AT UNIT (X53-3470-00) Component side view



Above diagram is numbered pages 21 and 22 by Kenwood.

. This is a placeholder to keep page numbering correct in Adobe.

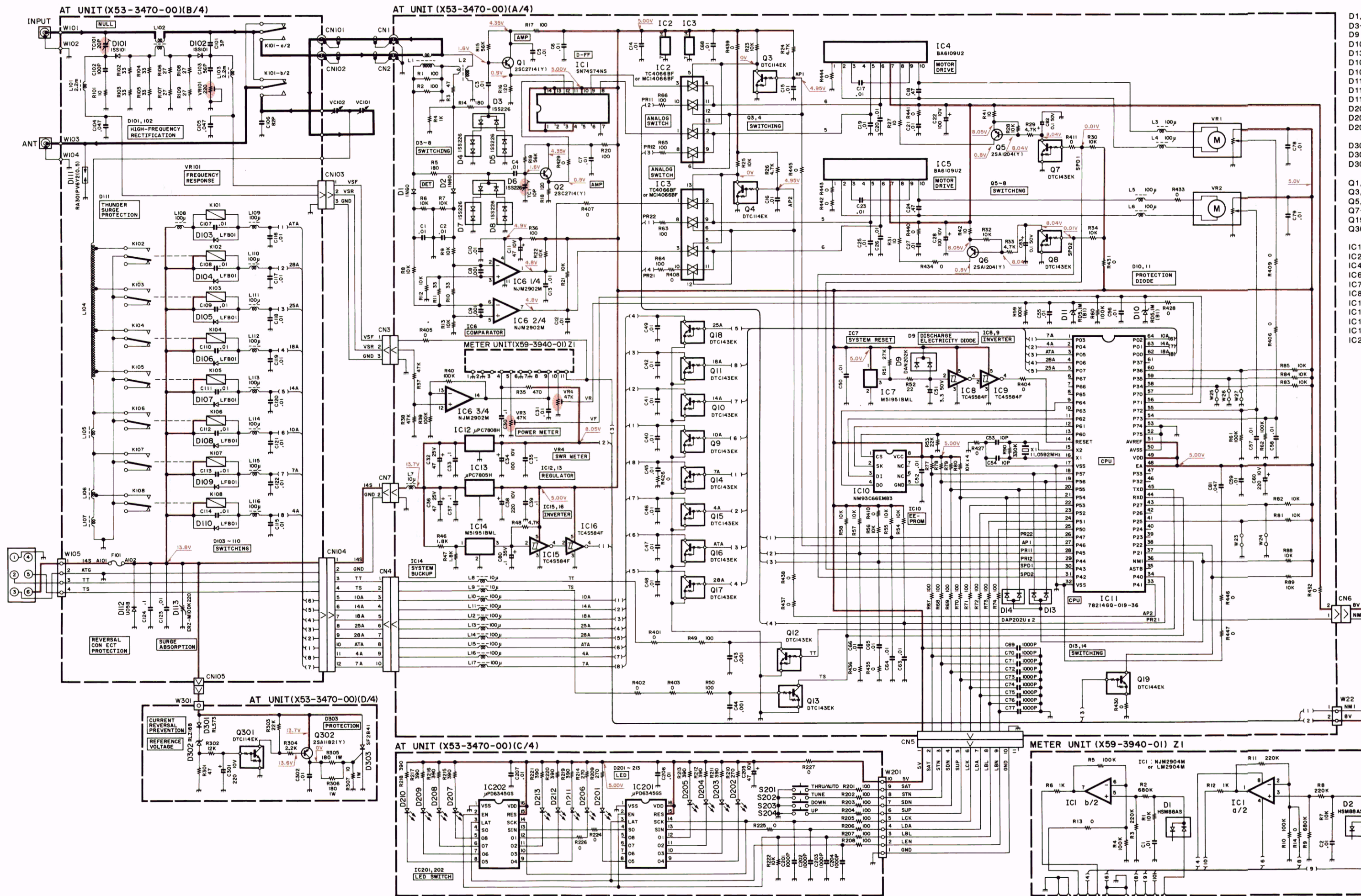
AT UNIT (X53-3470-00) Foil side view



Above diagram is numbered pages 23 and 24 by Kenwood.

. This is a placeholder to keep page numbering correct in Adobe.

SCHEMATIC DIAGRAM AT-50



- D1,2 : 1N60
 - D3-8 : 1SS226
 - D9 : DAN202K
 - D10,11 : RD5.1M(B1)
 - D13,14 : DAP202U
 - D101,102 : 1SS101
 - D103-110 : LFB01
 - D111 : RA301PV6Y2(0.5)
 - D112 : U05B
 - D113 : FRZ-M10DK220
 - D201 : B30-2005-05
 - D202,206 : B30-2006-05
 - D203-205,207-213 : B30-2007-05
 - D301 : RLS73
 - D302 : RLZ18B
 - D303 : SF2B41
-
- Q1,2 : 2SC2714(Y)
 - Q3,4,301 : DTC114EK
 - Q5,6 : 2SA1204(Y)
 - Q7-18 : DTC143EK
 - Q19 : DTC144EK
 - Q302 : 2SA1182(Y)
-
- IC1 : SN74S74NS
 - IC2,3 : MC14066BF or TC4066BF
 - IC4,5 : BA6109U2
 - IC6 : NJM2902M
 - IC7,14 : M51951BML
 - IC8,9,15,16 : TC45584F
 - IC10 : NM93C66EM83
 - IC11 : 78214GO-019-36
 - IC12 : µPC7808H
 - IC13 : µPC7805H
 - IC201,202 : µPD6345GS

Above schematic is numbered pages 25, 26 and 27 by Kenwood.

This is a placeholder to keep numbering correct in Adobe.

Above schematic is numbered pages 25, 26 and 27 by Kenwood.

This is a placeholder to keep numbering correct in Adobe.

AT-50

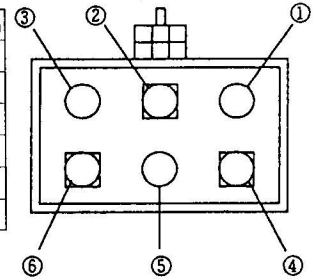
PG-4M (CONTROL CABLE)

PG-4M External View



PG-4M Wiring

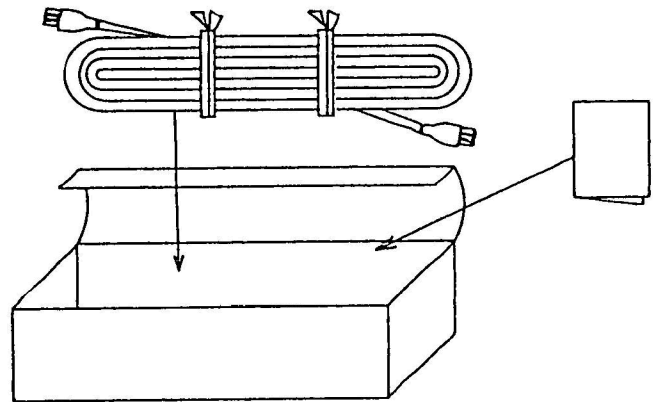
Pin No.	Wiring color	Function
1	Shield (Black)	GND
2	Violet	TT
3	Black	GND
4	-	-
5	Blue	TS
6	Red	14S



PG-4M Parts List

Ref.No.	New	Parts No.	Description
	✕	E30-3158-05	Control cable

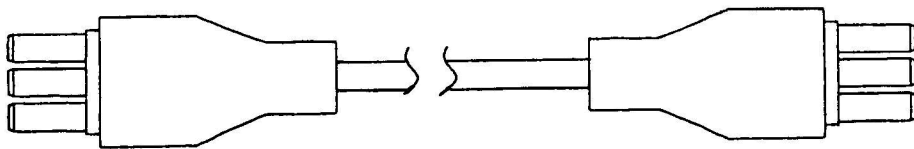
PG-4M Packing



PG-4M Dimension/Weight

Dimension 6m
Weight 400g

PG-4M Outside View



This page intentionally left blank.

AT-50

SPECIFICATIONS

Frequency range	Amateur bands from 1.8 to 29.7MHz
Voltage required	13.8V DC \pm 15%
Ground system	Negative ground
Current consumed	2A or less
Power limit (maximum throughput)	100W continuous wave (after tuning)
Operating temperature range	-20°C ~ +60°C
Input impedance	50 Ω unbalanced
Maximum VSWR (after tuning)	1.3 or less
Tuning power	6 ~ 20W
Antenna impedance range	20 to 150 Ω (SWR : approx. 2.5 or less)
Tuning time	Initial tuning time : 30 seconds or less After first preset : 3.seconds or less
Dimensions [W x H x D]	180 x 60 (68.5) x 233 (247) mm (Including projections)
Weight	2.1kg

Note : Ratings are subject to change due to technological improvement.

KENWOOD CORPORATION

Alive Mitake, 2-5, Shibuya 1-chome, Shibuya-ku, Tokyo 150, Japan

KENWOOD U.S.A. CORPORATION

COMMUNICATIONS & TEST EQUIPMENT GROUP

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, Germany

KENWOOD ELECTRONICS BENELUX N.V.

Mechelsesteenweg 418 B-1930 Zaventem, Belgium

TRIO-KENWOOD FRANCE S.A.

43, Boulevard Ney, 75018 Paris, France

TRIO-KENWOOD U.K. LIMITED

KENWOOD House, Dwight Road, Watford, Herts., WD1 8EB United Kingdom

KENWOOD ELECTRONICS NEDERLAND B.V.

Amsterdamseseweg 35, 1422 AC Uithoorn, The Netherlands

KENWOOD LINEAR S.p.A.

20125, Milano-via Arbe, 50, Italy

KENWOOD ESPAÑA S.A.

Bolivia, 239-08020 Barcelona, Spain

KENWOOD ELECTRONICS AUSTRALIA PTY. LTD.

(A.C.N. 001 499 074)

P.O. Box 504, 8 Figtree Drive, Australia Centre, Homebush, N.S.W. 2140, Australia

KENWOOD & LEE ELECTRONICS, LTD.

Unit 3712-3724, Level 37, Tower one Metroplaza, 223 Hing Fong Road, Kwai Fong, N.T., Hong Kong

KENWOOD ELECTRONICS CANADA INC.

6070 Kestrel Road, Mississauga, Ontario, Canada L5T 1S8