

# Workshop

# **SERVICE MANUAL**

**For Service Manuals Contact  
MAURITRON TECHNICAL SERVICES  
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Email:- [enquiries@mauritron.co.uk](mailto:enquiries@mauritron.co.uk)**

13 Twins  
330 pf Trap

**SM-220**



# STATION MONITOR

# SAFETY NOTICE

The following explicit definitions apply in this manual:

**NOTE** ..... If disregarded, inconvenience only—no risk of equipment damage or personal injury.

**CAUTION** ..... Equipment damage may occur, but not personal injury.

**WARNING** ..... Personal injury may occur—DO NOT DISREGARD!

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## WARNING

### HIGH VOLTAGES PRESENT

Observe all standard safety procedures regarding high RF, AC, and DC potentials.

### HIGH VACUUM CRT

The CRT (cathode ray tube) contained in this instrument is a high vacuum device, breakage of which may cause high velocity scattering of glass particles. Rough handling of the instrument, and especially the CRT, is to be avoided.

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# SECTION 1. SPECIFICATIONS

## CRT75ARB31

Phosphor .....	B31
Colour .....	Blue-Green

## TRANSMIT SIGNAL MONITOR TERMINAL

Frequency range .....	1.8 ~ 150 MHz
Maximum power .....	1.8 ~ 54 MHz (2 kW/PEP) 150 MHz (200 W/PEP)
SWR .....	1.2 or less
Deflection sensitivity .....	More than 1 DIV at 2 W/PEP input
Attenuator .....	6 steps

## TRAPEZOID WAVEFORM OBSERVATION

Frequency range .....	1.8 ~ 30 MHz
Maximum power at DRIVE terminal .....	100 W/PEP
SWR .....	1.2 or less

## TWO-TONE GENERATOR

Oscillator frequency .....	1,000 Hz 1575 Hz or both switchable
Output voltage .....	10 mV/50kΩ (at TWO TONE)

## PAN DISPLAY

Adaptor name .....	BS-5 (TS-520 series), BS-8 (TS-820 series)
Input center frequency .....	3,395 MHz (BS-5), 8,830 MHz (BS-8)
IF frequency .....	455 kHz
IF bandwidth .....	More than 1 kHz (-6 dB)
Input sensitivity .....	More than 20 dB μ/DIV
Scan width .....	±20 kHz, ±100 kHz, selectable

## HORIZONTAL AMPLIFIER

Gain adjustment .....	100B (Approximate)
Deflection sensitivity .....	More than 300 mV/DIV
Frequency response .....	DC-250 kHz or greater (EXT GAIN at MAX) DC-40 kHz (EXT GAIN at 1/2)
Input resistance/capacity .....	1 MΩ (±20%), 40 pF or less (SYNC switch at INT)
Attenuator .....	Fully variable to 0
Max. input voltage .....	100 Vp-p

## SWEEP CIRCUIT

Sweep frequency .....	10 Hz ~ 100 kHz (in 4 ranges, variable)
Sweep linearity .....	Better than 5%
Sync system .....	Synchronized sweep, internal negative sync and external sync
Sync maplitude .....	Internal ... More than 1 DIV on CRT External ... More than 2 Vp-p

## VERTICAL AMPLIFIER

Deflection sensitivity .....	More than 20 mV/DIN
Frequency response .....	2 Hz ~ 10 MHz (-3 dB)
Input resistance/capacity .....	1 MΩ, 40 pF
Overshoot .....	Less than 5%
Attenuator .....	1, 1/10, 1/100 and GND/MONITOR (Error between steps: 5% max.)
Max. input voltage .....	300V (DC + AC peak) or 600 Vp-p

## POWER SUPPLY

DIMENSIONS .....	215(W) x 153(H) x 335(D) mm
Weight .....	5 kg

## ACCESSORIES SUPPLIED

Instruction book .....	1
VHF type cable .....	1
Tone output cable .....	1
Auxiliary feet (with screws) .....	2
Warranty card .....	1

Specifications are subject to change without notice due to technical improvements.

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## SECTION 2. FEATURES

1. The SM-220 Station Monitor is specially designed for the TS-820 and TS-520 series SSB transceiver.
2. The SM-220 functions as monitor scope, oscilloscope and two-tone oscillator. An optional Pan Display scope function is available.
3. Transmit waveform from 1.8 ~ 150 MHz can be observed with the monitor scope. Applicable power levels: 2KW PEP to 54 MHz, 200W PEP to 150 MHz. Drive input/output terminals allow trapezoid waveform observation of a linear amplifier.
4. Oscilloscope sensitivity is 20 mV/div (min), and bandwidth is 2 Hz ~ 10 MHz (min). Further, the IF waveform of the TS-820/S receiver section can be directly observed from the IF-OUTPUT terminal.
5. Two Wien bridge oscillators generate 1000 Hz and 1575 Hz tone, available individually or simultaneously.
6. Optional Pan Display units available:  
The BS-8 for TS-820 series transceivers.  
The BS-5 for TS-520 series transceivers.
7. Horizontal trace tilt can be adjusted from the rear of the unit without removing the case.
8. The blue-green phosphor (B31) CRT assures excellent brightness and contrast.

## SECTION 3.CRT SPECIFICATIONS

### Dimensions

Total length ..... 250 ± 6 mm  
Max. diameter ..... 76 ± 2 mm

### Heater

Voltage ..... 6.3V  
Current ..... 0.3A

### Maximum

Plate 2 voltage (Eb2) ..... 2750V  
Grid 2 voltage (Ec2) ..... 2750V

### Operating Characteristics

Plate 2 voltage (Eb2) ..... 1500V  
Focus voltage (Eb1) ..... 75 ~ 300V  
Grid 2 voltage (Ec2) ..... 1500V  
Blanking voltage (Ec0) ..... -28.5 ~ -67.5V  
X-axis deflection factor ..... 23.1 ~ 29.1Vdc/cm  
X-axis deflection factor ..... 13.7 ~ 18.2Vdc/cm

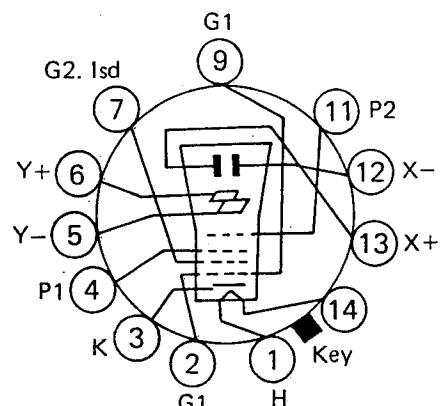
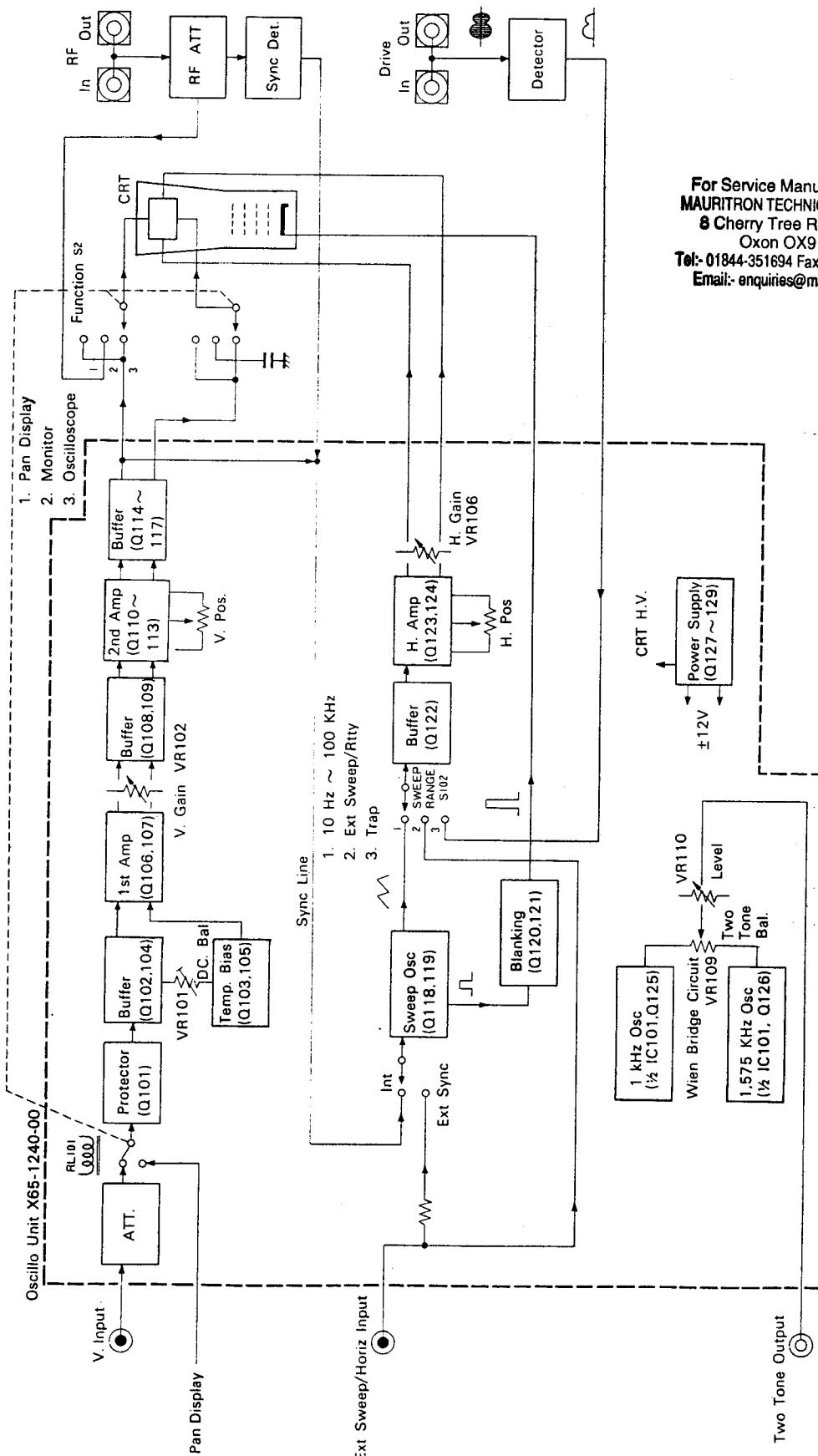


Fig. 3-1 75ARB31 Basing

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# SECTION 4. BLOCK DIAGRAM



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Fig. 4-1 SM-220 (Block Diagram)

# SECTION 5. CIRCUIT DESCRIPTION

## 1. THEORY OF OSCILLOSCOPE DISPLAY

Fig. 5-1 shows the principle of oscilloscope display. Electrons emitted from the cathode of the CRT and electrostatically deflected by the X and Y deflection plates. When a signal to be observed (a sine wave in this figure) is applied to the Y deflection plates and a saw tooth voltage is applied to the X deflection plates, the high voltage accelerated electron beam strikes the phosphor screen and the waveform (as shown in Fig. 5-2 appears on the screen).

## 2. VERTICAL CIRCUIT

When the SM-220 is used as an oscilloscope, signal is applied to the V. INPUT and may be deviated 1/1, 1/10 or 1/100 by the V. ATTENUATOR, according to the amplitude of the signal. TC101 and TC102 provide compensation of the high frequency signal components, which are lowered by the attenuator input capacitance, and stray capacitance of the amplifiers. The signal is applied to the protection circuit Q101, and the gate of Q102 via a switching relay. The gate current of Q101 begins to flow when signal peak voltage becomes less than -13V, so that Q102 is protected from breakdown.

A buffer consisting of Q102 and Q104 is combination source follower and emitter follower, so a high input impedance and a low output impedance are achieved. Q106 and Q107 form a differential amplifier, the gain of which can be varied in the range of 22 dB by VR102 (V. GAIN), bridged between the two emitters. Q103 and Q104 bias the amplifiers against temperature change. VR101 adjusts the DC Balance between the emitters of Q104 and Q105. Of the emitter voltages

are unbalanced, this difference is amplified and as the V. GAIN is adjusted the trace moves from the center of the screen. The signal, amplified by Q106 and Q107, 1st amplifier is applied to the emitter follower Q108 and Q109, and then applied to the 2nd amplifier, Q110 ~ 113. The 2nd amplifier is cascaded, and exhibits good high-frequency characteristics. TC103 corrects high-frequency response, and VR103 adjusts the Vertical Position. Q114 through Q117 form a complementary emitter follower amplifier, whose low output impedance decreases the affects of deflection plate high frequency loading. When the SM-220 is used as an oscilloscope, this emitter follower output is applied to the Y deflection plate of the CRT.

## 3. HORIZONTAL CIRCUIT

The horizontal circuit consists of a Sweep Oscillator generating saw tooth voltage, and a Horizontal Amplifier. To make the display stationary on the screen, the sweep frequency must be 1/N of the input signal frequency (as shown in Fig. 1, N = 2). That is, the sweep must be synchronized with the input signal. For this purpose, the sync signal is picked-off the vertical amplifiers Q114 ~ 117, and applied to the sweep oscillator Q118, Q119. The S4b SYNC/MARKER switch INT (internal or EXT (external) sync signal. When the SM-220 is used as an oscilloscope with INT sync, the sweep synchronizes with the V. INPUT signal. When used as a MONITOR, the sweep is synchronized with the modulated transceiver output. In the EXT position, the sweep synchronizes with a signal applied to the H. INPUT/EXT. SYNC terminal.

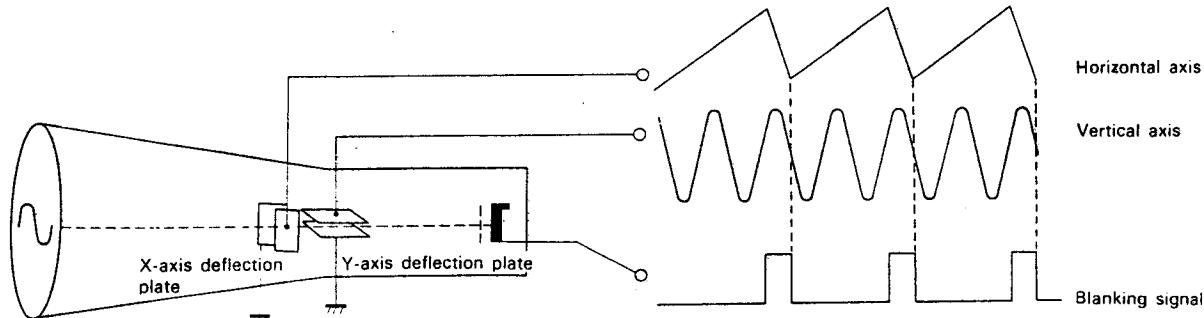
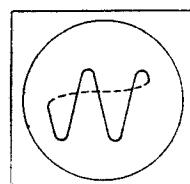


Fig. 5-1 Oscilloscope theory



Broken line doesn't appear because of blanking signal.

Fig. 5-2 Waveform on screen

# SECTION 5. CIRCUIT DESCRIPTION

Saw tooth voltage generated by the sweep oscillator is amplified by the horizontal amplifier Q112 ~ 124, and applied to the X deflection plates. When the SWEEP RANGE selector is placed in the EXT position, the H. INPUT/EXT SYNC signal is applied to the horizontal amplifier after attenuation by the SWEEP VAN/EXT. GAIN control. VR-106 (H. GAIN) sets varies the horizontal amplifier gain so the trace extends fully across the screen.

## 4. MONITOR CIRCUIT

With the function switch in the MONITOR position, transmitted RF passes through the RF-IN/OUT circuit, is RF attenuated and applied to the Y deflection plates. The attenuated signal is also detected and used as sync reference. When Trapezoid waveform is

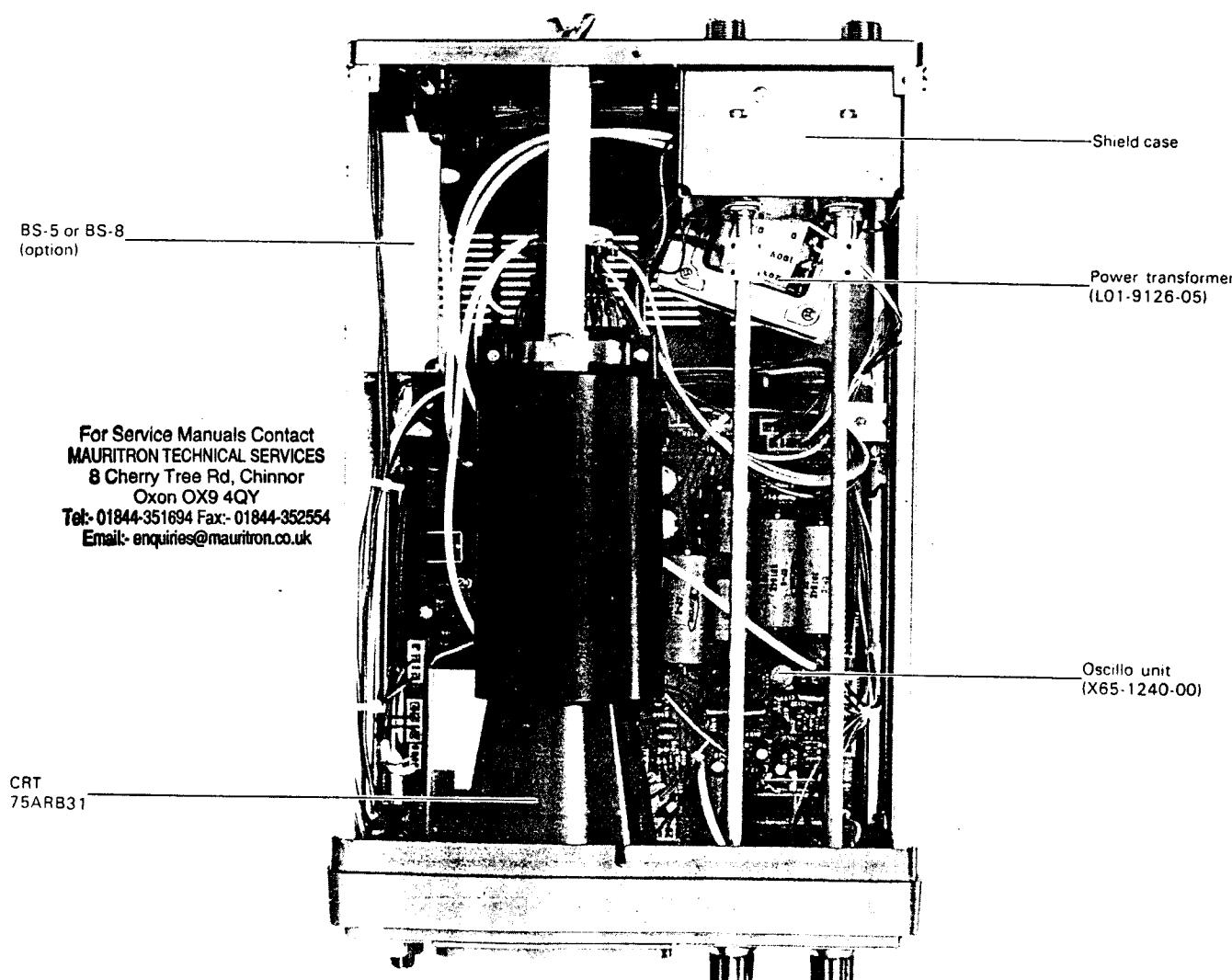
observed, modulated RF passing through the DRIVE IN/OUT circuit is detected and then applied to the horizontal amplifier.

## 5. TWO-TONE OSCILLATOR

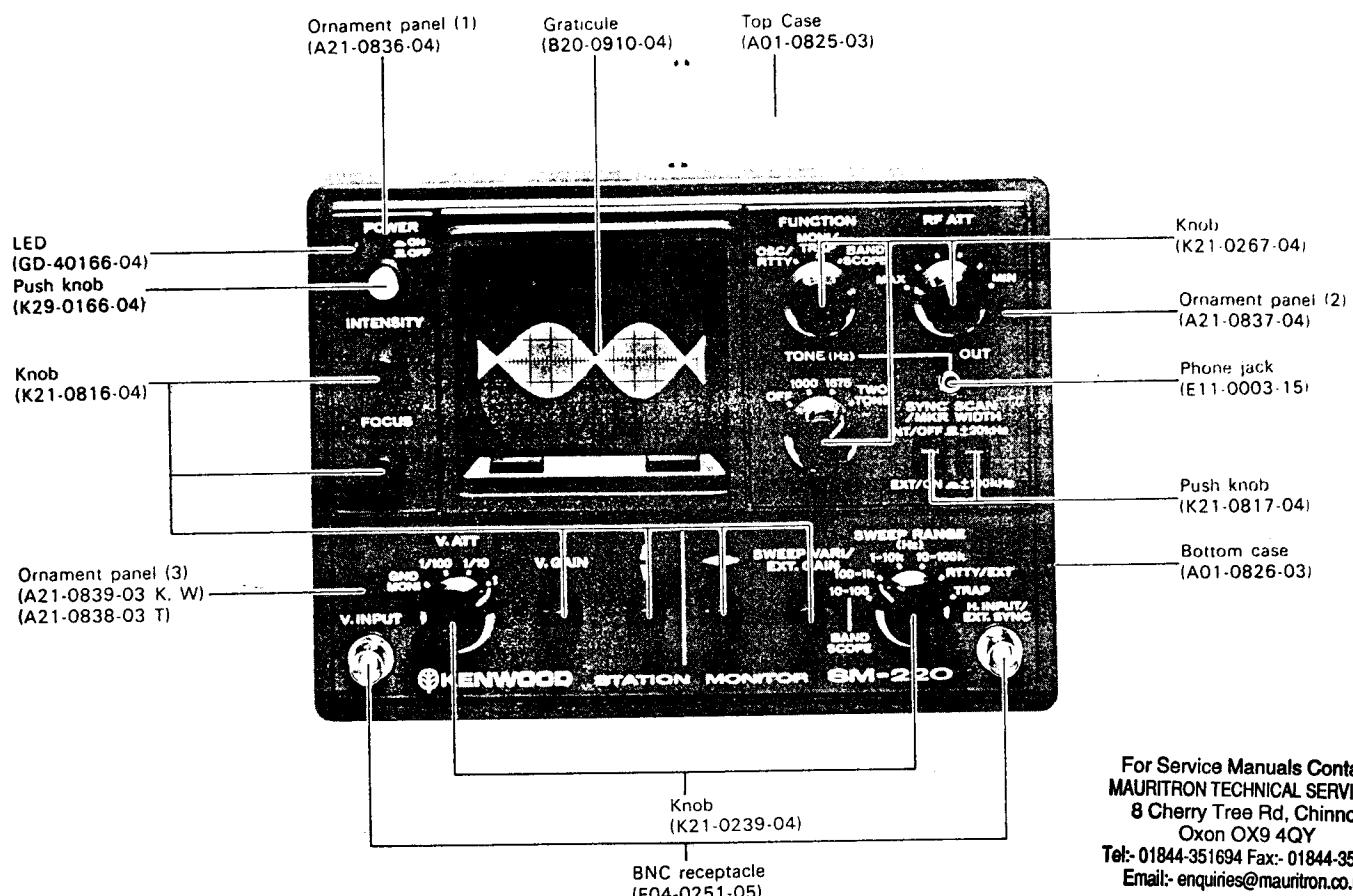
The tone generator consists of two Wien bridge oscillator operating at 1 kHz and 1.575 kHz. Q125 and Q126 act as feedback resistors to prevent temperature variation output fluctuation. VR-109 is the Two-Tone Balance adjustment and VR-110 adjusts the Output Level.

## 6. POWER SUPPLY

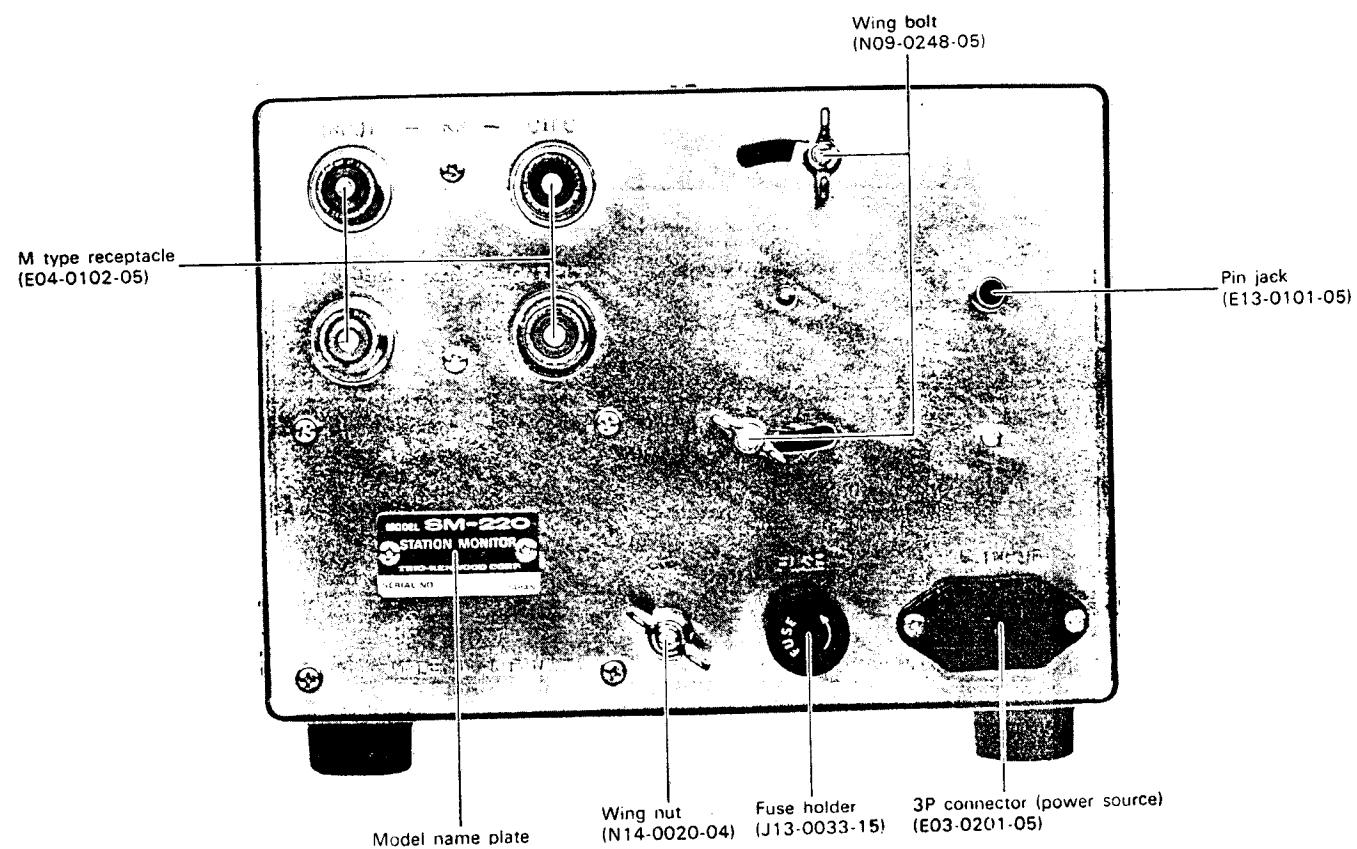
The Power Supply provides regulated +12V and -13V, +150V for the final amplifiers, and -1300V for the CRT.



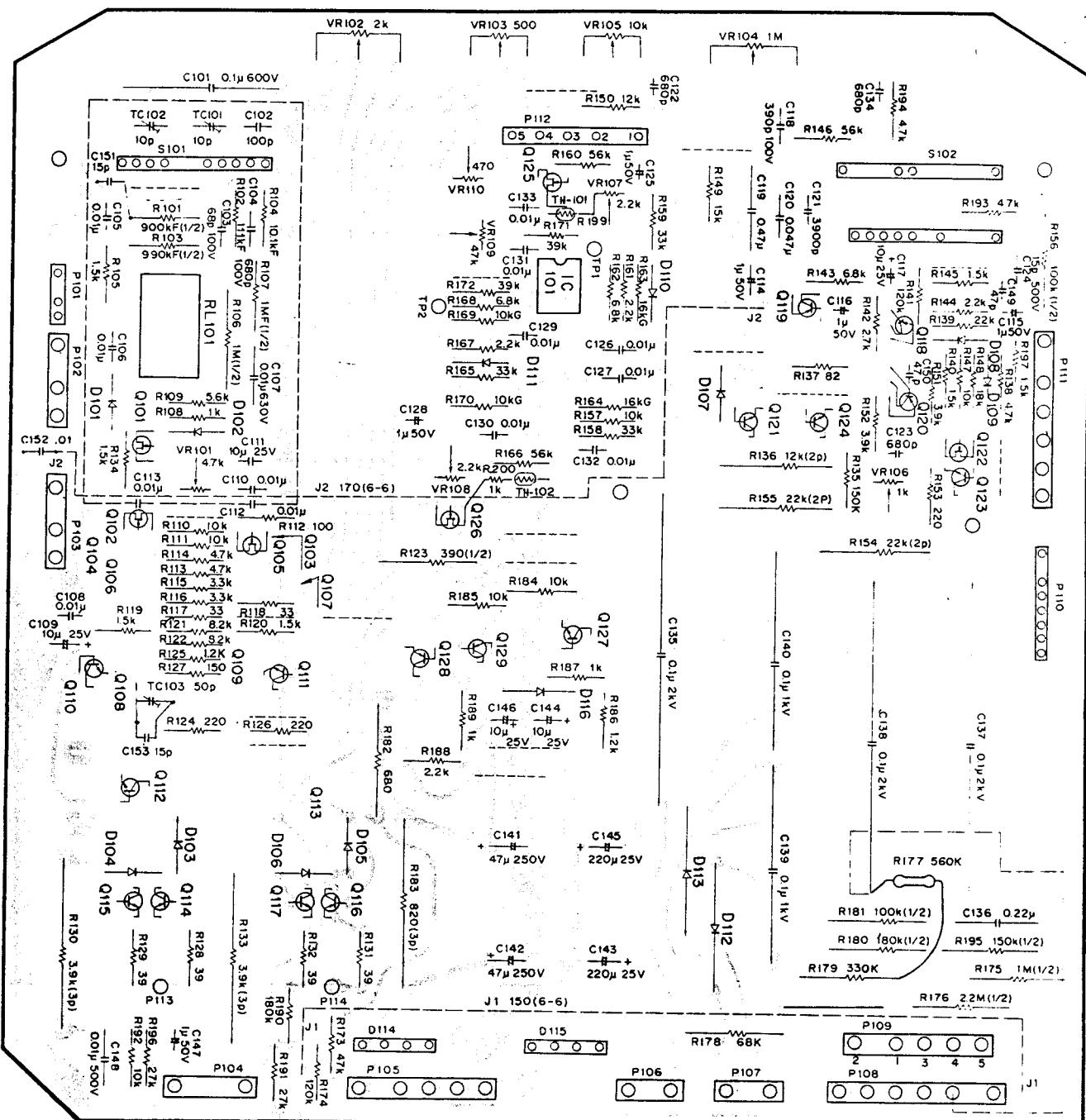
## **SECTION 6. VIEWS**



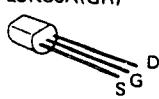
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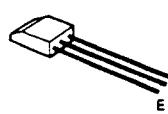
# SECTION 7. PRINTED CIRCUIT BOARDS



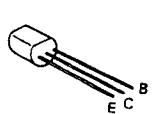
2SK30A(O)  
2SK30A(O)(IDSS)  
2SK30A(GR)



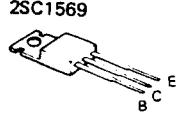
2SC535(B)



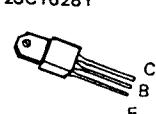
2SC1360



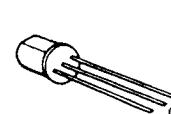
2SC1419C  
2SA755C  
2SC1569



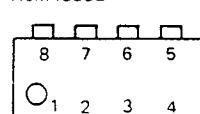
2SA818Y  
2SC1628Y



2SA495



NJM4558D



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# SECTION 8. PARTS LIST

## GENERAL (Y71-1100-00)

☆ : New parts K .... U.S.A. W .... Europe. T .... Britain

Ref. No.	Parts No.	Description	Re-marks
<b>CAPACITOR</b>			
C1.2	CC45SL3D120JMU	Ceramic 12pF $\pm 5\%$ 2kV	
C3	CC45SL2H050D	Ceramic 5pF $\pm 0.5\%$ 500V	
C4	CC45SL2H030D	Ceramic 3pF $\pm 0.5\%$ 500V	
C5	CC45SL2H010D	Ceramic 1pF $\pm 0.5\%$ 500V	
C6~7	CK45D2H103D	Ceramic 0.01μF $\pm 20\%$	
C8	CK45D2H222M	Ceramic 0.0022μF $\pm 20\%$	
C9.10	C90-0300-05	Ceramic 470pF	
C11	C91-0023-05	Ceramic 0.01μF AC250V	
<b>RESISTOR</b>			
R1	RS14AB3F561J	Metal film 560Ω $\pm 5\%$ 3W	
R2	RS14AB3D103J	Metal film 10kΩ $\pm 5\%$ 2W	
R3	RD14BY2H222J	Carbon 2.2kΩ $\pm 5\%$ 1/2W	
R4	RS14AB3D103J	Metal film 10kΩ $\pm 5\%$ 2W	
R5	RD14BY2H222J	Carbon 2.2kΩ $\pm 5\%$ 1/2W	
R6,7	RD14BY2H105J	Carbon 1MΩ $\pm 5\%$ 1/2W	
<b>SEMICONDUCTOR</b>			
D1	V11-7200-10	LED < Red >	
D2~4	V11-0370-05	Diode 1S1587	
<b>CRT</b>			
CRT		CRT 75ARB31	
<b>VR/SW/TRANSFORMER</b>			
VR1	R05-8501-05	Variable resistor 1MΩ < FOCUS >	☆
VR2	R05-8501-05	Variable resistor 1MΩ < INTENSITY >	☆
S1	S39-2006-05	Push switch < POWER >	
S2	S01-1508-05	Rotary switch < FUNCTION >	
S3	S01-1501-05	Rotary switch < RF ATT >	
S4a	S42-2503-06	Push switch < SCAN WIDTH >	
S4b	S42-2503-05	Push switch < SYNC MARKER >	
S5	S01-1506-05	Rotary switch < TONE >	
T1	L01-9126-05	Power transformer	
<b>MISCELLANEOUS</b>			
	A01-0825-03	Top case	☆
	A01-0826-03	Bottom case	☆
	A20-2724-03	Panel ass'y T	☆
	A20-2725-03	Panel ass'y K, W	☆
	A20-2726-02	Mold Panel	☆
	A21-0836-04	Ornament panel (1)	☆
	A21-0837-04	Ornament panel (2)	☆
	A21-0839-03	Ornament panel (3) K, W	☆
	A21-0838-03	Ornament panel (3) T	☆
	B07-0702-04	Escutcheon (Push switch) × 2	☆
	B09-0011-04	Rubber cap × 3	
	B20-0910-04	Graticule	☆
	B30-0707-05	Lamp ass'y	☆
	B46-0007-00	Warranty card	
	B50-2856-00	Operating manual K, W	☆
	B50-2857-00	Operating manual T	☆
	D21-0902-04	Shaft	☆
	D22-0402-05	Universal coupling	
	E01-1403-05	CRT socket	
	E03-0201-05	3P connector (power source)	
	E04-0102-05	M type receptacle × 4	
	E04-0251-05	BNC receptacle × 2	
	E11-0003-15	Phone jack	

Ref. No.	Parts No.	Description	Re-marks
—	E13-0101-05	Pin jack	
—	E22-0405-05	Lug strips × 2	
—	E23-0015-04	GND lug × 2	
—	E30-1818-05	JIS cord (Power cord) K	
—	E30-1819-05	CEE cord (Power cord) W, T	
	F05-5013-05	Fuse 0.5A × 2 K	
	F05-3011-05	Fuse 0.3A × 2 W, T	
	F11-0920-04	CRT shield	☆
	H01-2839-04	Carton	☆
	H01-2805-02	Polystyrene foam cushion [Front]	☆
	H01-2806-02	Polystyrene foam cushion [Rear]	☆
	H19-0503-03	Accessory box	☆
	H20-1709-04	Protective cover	☆
	H25-0029-04	Polyethylene bag	☆
	H25-0007-14	Polyethylene bag	☆
	J02-0049-14	Foot × 6	
	J13-0033-15	Fuse holder	
	J32-1030-14	Round boss × 2	
	J42-0002-05	Rubber bush	
	J42-0021-05	Rubber bush × 2	
	J61-0053-05	Board support × 2	
	K21-0267-04	Knob × 3 TONE, RF ATT, FUNCTION	
	K21-0816-04	Knob × 6 INTENSITY, FOCUS, V.GAIN, ▲ POSITION, ▼ POSITION, SWEEP VARI/EXT GAIN	☆
	K21-0817-04	Knob (push) × 2 SCAN WIDTH, MARKER/SYNC INT-EXT	☆
	K23-0239-04	Knob × 2 V. ATT, SWEEP RANGE	
	K29-0802-04	Knob (push) POWER	
	X42-1120-10	Coaxial cable ass'y	
	X65-1240-00	OSCILLO unit	
	X67-1020-00	BNC cord	
	X67-1070-00	Two tone output cord	

## OSCILLO UNIT (X65-1240-00)

Ref. No.	Parts No.	Description	Re-marks
<b>CAPACITOR</b>			
C101	C90-0021-05	Metal film 0.1μF 600V	☆
C102	CC45SL1H101J	Ceramic 100pF $\pm 5\%$	
C103	CM93BD2A680J	Mica 68pF $\pm 5\%$	
C104	CM93BD2A681J	Mica 680pF $\pm 5\%$	
C105.	CK45D1H103M	Ceramic 0.01μF $\pm 20\%$	
106			
C107	C91-0502-05	Metal film 0.01μF 630V	
C108	CK45D1H103M	Ceramic 0.01μF $\pm 20\%$	
C109	CE04W1E100	Electrolytic 10μF 25V	
C110	CK45D1H103M	Ceramic 0.01μF $\pm 20\%$	
C111	CE04W1E100	Electrolytic 10μF 25V	
C112.	CK45D1H103M	Ceramic 0.01μF $\pm 20\%$	
113			
C114~	CE04B8W1H010M	Electrolytic 1μF 50V	
116			
C117	CE04W1E100	Electrolytic 10μF 25V	

# SECTION 8. PARTS LIST

Ref. No.	Parts No.	Description			Re-marks	Ref. No.	Parts No.	Description			Re-marks	
C118	CM03BD2A391J	Mica	390pF	±5%		R169~	RD14BK2E000J	Carbon	000Ω	±5%	1/4W	
C119	CQ93M1H474K	Mylar	0.47μF	±10%		R170		Carbon	000Ω	±5%	1/4W	
C120	CQ93M1H473K	Mylar	0.047μF	±10%		R171~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W	
C121	CQ93M1H392K	Mylar	3900pF	±10%		R175~	RD14BY2H000J	Carbon	000Ω	±5%	1/2W	
C122,	CK45D1H681M	Ceramic	680pF	±20%		R182	RS14GB3D122J	Metal film	1.2kΩ	±5%	2W	☆
123						R183	RS14GB3F821J	Metal film	820Ω	±5%	3W	☆
C124	CE04W1C470	Electrolytic	47μF	16WV		R184~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W	
C125	CE04BW1H010M	Electrolytic	1μF	50V		R195	RD14BY2H154J	Carbon	150kΩ	±5%	1/2W	
C126,	CQ93M1H103J	Mylar	0.01μF	±5%		R196~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W	
127						R92-0150-05	Jumper resistor × 17					
C128	CE04BW1H010M	Electrolytic	1μF	50V		SEMICONDUCTOR						
C129,	CC93M1H103J	Mylar	0.01μF	±5%		IC101	V30-0217-05	IC	NJM4558D		☆	
130						Q101	V09-0015-05	FET	2SK30A-0			
C131~	CK45D1H103M	Ceramic	0.01μF	±20%		Q102~	V09-9981-05	FET	2SK30A-0 (Idss)			
133						Q104~	V03-0098-05	Transistor	2SC5358			
C134	CK45D1H681M	Ceramic	680pF	±20%		Q110~	V03-1360-06	Transistor	2SC1360		☆	
C135	C91-0509-05	Oil	0.1μF	2kV		Q111	V03-1569-06	Transistor	2SC1596		☆	
C136	CQ93M1H224K	Mylar	0.22μF	±10%		Q113	V01-0153-06	Transistor	2SA818-Y			
C137,	C91-0509-05	Oil	0.1μF	2kV		Q114	V03-0401-05	Transistor	2SC1628			
138						Q115	V01-0153-05	Transistor	2SA818-Y			
C139,	C91-0506-05	Oil	0.1μF	1kV		Q116	V03-0401-05	Transistor	2SC1628-Y			
140						Q117	V01-0037-05	Transistor	2SA496-Y			
C141,	CE04W2E470	Electrolytic	47μF	250WV		Q118~	V03-1569-06	Transistor	2SC1569		☆	
142						Q121	V09-0015-05	FET	2SK30A-0			
C143	CE04W1E221	Electrolytic	220μF	25WV		Q122	V03-1569-06	Transistor	2SC1569		☆	
C144	CE04W1E100	Electrolytic	10μF	25WV		Q123	V03-1569-06	Transistor	2SC1569		☆	
C145	CE04W1E221	Electrolytic	220μF	25WV		Q124						
C146	CE04W1E100	Electrolytic	10μF	25WV		Q125,	V09-0060-05	FET	2SK30A-GR			
C147	CE04BW1H010M	Electrolytic	1μF	50WV		Q126						
C148	CK45D2H103M	Ceramic	0.01μF	±20%		Q127	V03-0343-05	Transistor	2SC1419C			
C149,	CC45SL1H470J	Ceramic	47pF	±5%		Q128	V01-0114-05	Transistor	2SA755C			
150						Q129	V01-0037-05	Transistor	2SA495Y			
C151	CC45SL2H150J	Ceramic	15pF	±15%		D101~	V11-0076-05	Diode	1S1555			
C152	CK45D1H103M	Ceramic	0.01μF	±20%		D107						
C153	CC45SL1H150J	Ceramic	15pF	±5%		D108	V11-0051-05	Diode	1N60			
RESISTOR												
R101	RN14BK2H9003F	Metal film	199kΩ	±1%	1/2W	D109~	V11-0076-05	Diode	1S1555			
R102	RN14BK2E1113F	Metal film	111kΩ	±1%	1/4W	D111	V11-0288-05	High pressure diode HVT-22Z-3				
R103	RN14BK2H9903F	Metal film	990kΩ	±1%	1/2W	D112~	V11-0410-05	Diode (bridge)	S1QB60			
R104	RN14BK2E1012F	Metal film	10.1kΩ	±1%	1/4W	D115	V11-0249-05	Zener diode	WZ-120			
R105	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W	TH101,	V22-0033-05	Thermister	SDT-100			
R106	RD14BY2H105J	Carbon	1MΩ	±5%	1/2W	102						
R107	RD14BK2H1004F	Carbon	1MΩ	±1%	1/2W	SWITCH/TRIMMER						
R108~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W	VR101	R12-1004-05	Semi-fixed resistor	4.7kΩ			
122						VR102	R03-1020-05	Semi-fixed resistor	2kΩ (C)			
R123	RD14BY2H391J	Carbon	390Ω	±5%	1/2W	VR103	R01-0505-05	Semi-fixed resistor	500Ω (B)			
R124~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W	VR104	R03-8050-05	Semi-fixed resistor	1MΩ (B)			
129						VR105	R01-2503-05	Semi-fixed resistor	10kΩ (B)			
R130	RS14GB3F392J	Metal film	3.9kΩ	±5%	3W							
R131~	RD14BB2E390J	Carbon	39Ω	±5%	1/4W							
132												
R133	RS14GB392J	Metal film	3.9kΩ	±5%	3W							
R134~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W							
135												
R136	RS14GB3D123J	Metal film	12kΩ	±5%	1/2W							
R137~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W							
153												
R154~	RS14GB3D000J	Metal film	000Ω	±5%	2W							
155												
R156	RD14BY2H104J	Carbon	100kΩ	±5%	1/2W							
R157~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W							
162												
R163~	RN14BK2E000G	Metal film	000Ω	±2%	1/4W							
164												
R165	RN14BB2E333J	Carbon	33kΩ	±5%	1/4W							
R166~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W							
168												

## SECTION 8. PARTS LIST

Ref. No.	Parts No.	Description	Re-marks
VR106	R12-1002-05	Semi-fixed resistor 1kΩ < H. GAIN >	
VR107 ~ 108	R12-1003-05	Semi-fixed resistor 2.2kΩ	
VR109	R12-3004-05	Semi-fixed resistor 470kΩ	
VR110	R12-0003-05	Semi-fixed resistor 470Ω	
TC101, 102	C05-0404-05	Trimmer (Ceramic) 10pF	
TC103	C05-0029-15	Trimmer (Ceramic) 50pF	
<b>SWITCH/RELAY</b>			
S101	S01-1507-05	Rotary switch < V.ATT >	☆
S102	S01-2505-05	Rotary switch < SWEEP RANGE >	☆
PL101	S51-1506-05	Relay	☆
<b>MISCELLANEOUS</b>			
	E23-0046-04	Terminal x 6	
	E23-0508-04	Terminal [test point] x 2	

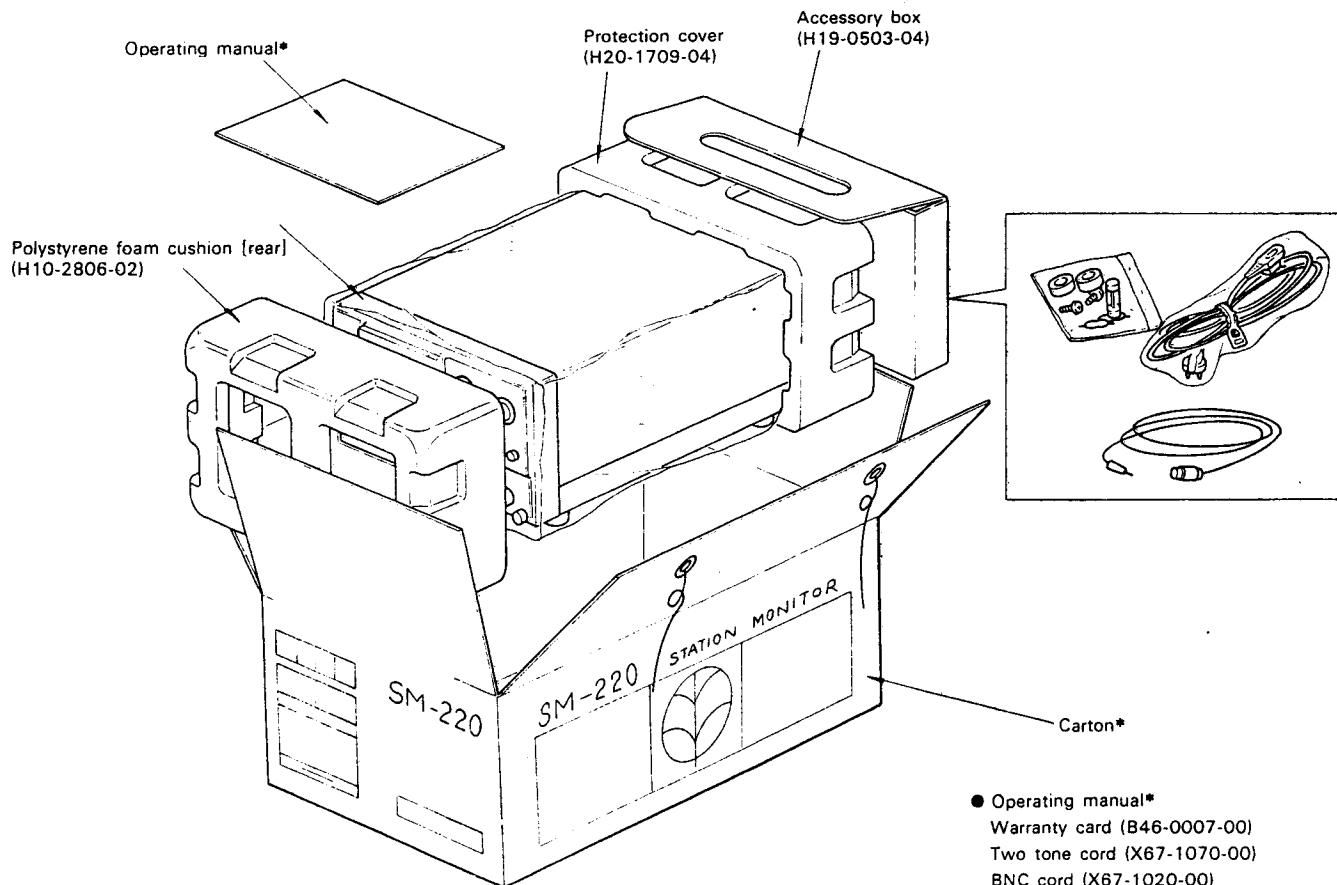
### BNC CORD (CA-41) (X67-1020-00)

Ref. No.	Parts No.	Description	Re-marks
—	E05-0357-05	BNC plug	
—	E91-0003-05	Alligator clip (black)	☆
—	E91-0004-05	Alligator clip (Red)	
—	060-0002-05	Coaxial cable	
—	H25-0016-00	Polyethylene bag	

### TWO TONE CORD (X67-1070-00)

Ref. No.	Parts No.	Description	Re-marks
—	E07-0403-05	Round plug	
—	E12-0001-05	Phone plug	
—	J42-0506-04	Rubber tube	

## SECTION 9. PACKING



\* See parts list

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- Operating manual\*
- Warranty card (B46-0007-00)
- Two tone cord (X67-1070-00)
- BNC cord (X67-1020-00)
- Power cord (supplied)\*
- Coaxial cable Ass'y (X42-1120-10)
- Polyethylene bag
- 1. Foot (w/screw) (J02-0049-14) x 2
- 2. Fuse (spare) (F05-5013-05)
- 3. Resistor 10kΩ, 150Ω

## **SECTION 10. DISASSEMBLY**

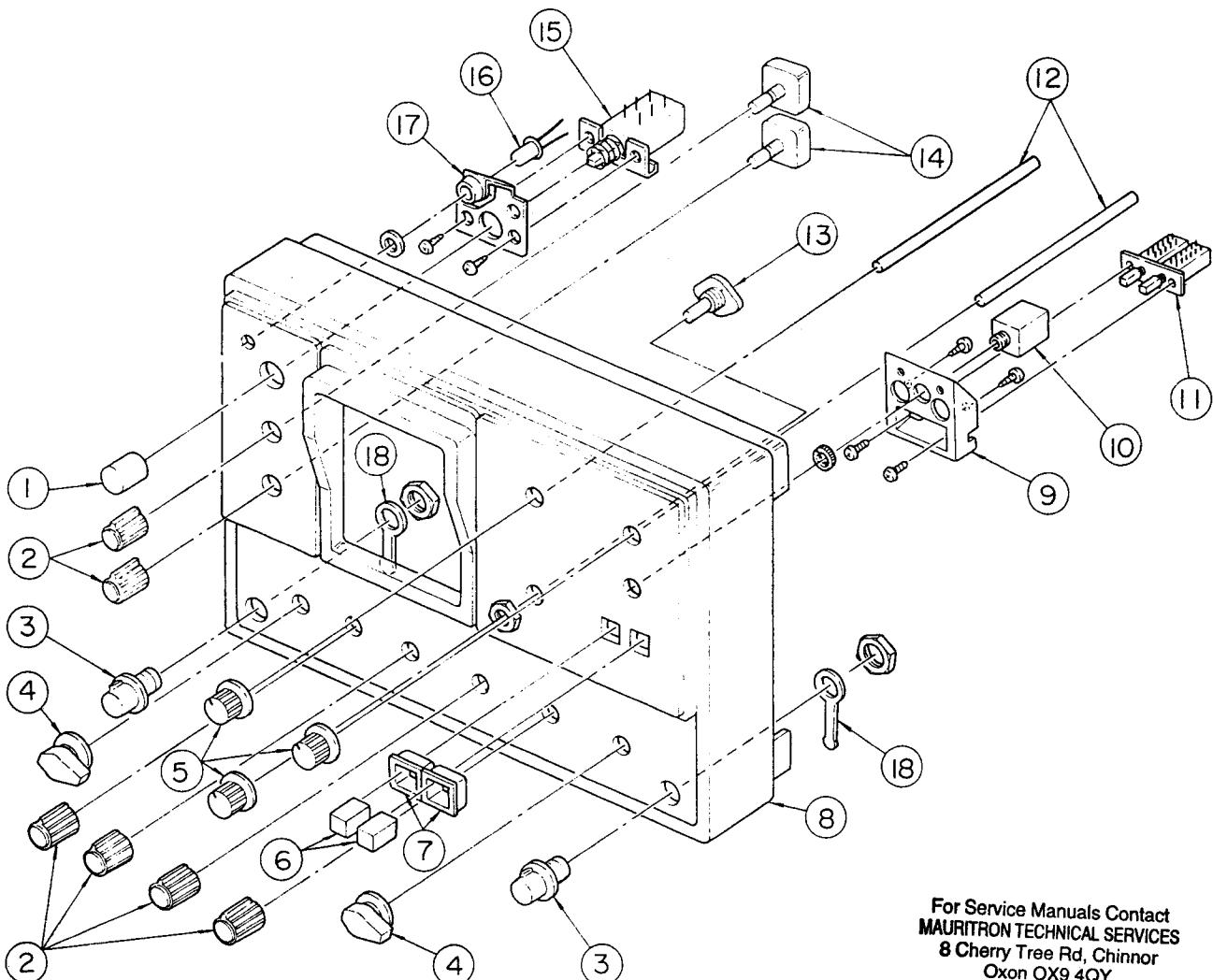


Fig. 10-1 Front Panel Disassembly

No.	Parts Name	Parts No.	Remarks	No.	Parts Name	Parts No.	Remarks
1	Knob (push)	K29-0166-04	POWER	10	Phone jack	E11-0003-05	TONE OUT
2	Knob	K21-0816-04	INTENSITY, FOCUS, V.GAIN SYNC/MKR, SCAN WIDTH	11	Push switch	S42-2503-05	SYNC/MKR, SCAN WIDTH
3	BNC receptacle	E04-0251-05	H.INPUT H.INPUT	12	Shaft	D21-0902-04	
4	Knob	K21-0239-04	V.ATT SWEEP RANGE	13	Rotary switch	S01-1506-05	TONE
5	Knob	K21-0267-04	FUNCTION, RFATT, TONE	14	Variable resistor	R05-8501-05	FOCUS, INTENSITY
6	Knob (push)	K21-0817-04	SYNC/MKR, SCAN WIDTH	15	Power switch	S39-2006-05	POWER
7	Eschtcheon (push)	B07-0702-04		16	Lamp ass'y	B30-0907-05	
8	Panel ass'y	A20-2724-03		17	Switch fittings		
9	Switch fittings			18	GND lug	E23-0015-04	

## SECTION 10. DISASSEMBLY

### 1. GRATICULE REMOVAL/INSTALLATION

Press at Fig. 10-3 arrows, and withdraw upward and out.

To reinstall, insert the bottom edge of the graticule between the front panel and the CRT, and then direct the top edge in toward the CRT.

### 2. CRT REMOVAL

- 1) Remove screws "A".
- 2) Loosen screws "B" and remove the CRT socket.
- 3) Shift the CRT to the rear arrow, and then withdraw the CRT and its fittings upward and out.

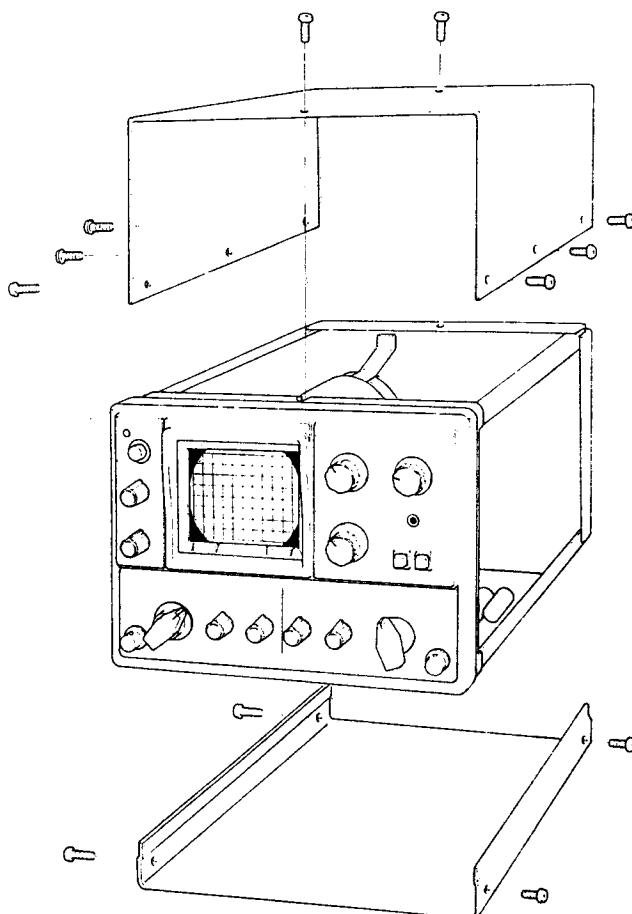


Fig. 10-2 Case Removal

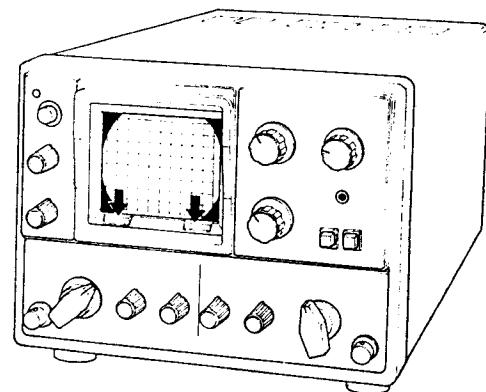
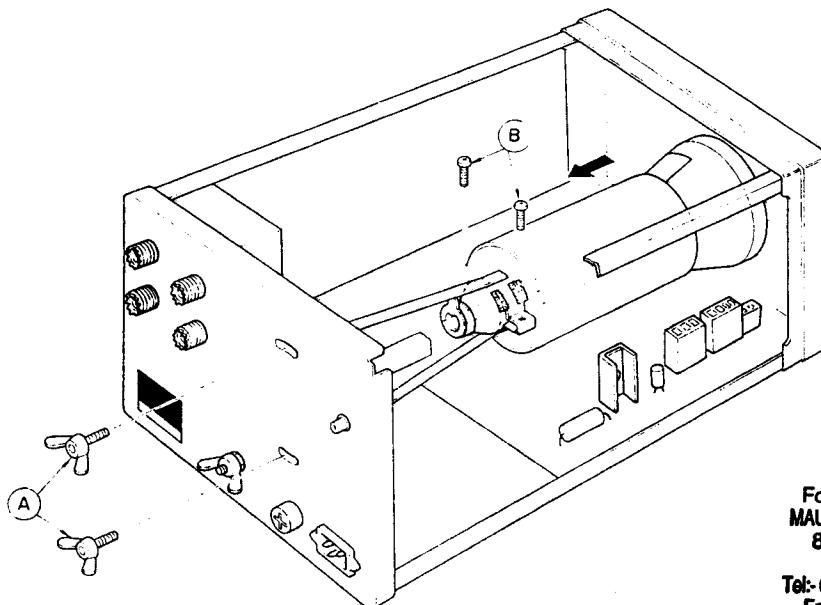


Fig. 10-3 Graticule Removal/Installation



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Fig. 10-4 CRT Removal

# SECTION 11. ADJUSTMENT

## ● Test Equipment Required

### 1. AC (Audio Generator)

Sine and squarewave generator than 5V at 1KHz.

### 2. AF VTVM

Range: 10 mV ~ 10V

### 3. HF-SG (Signal Generator)

Output 100 KHz and 12 MHz.

### 4. Oscilloscope

Frequency response generator 5 MHz, 20 mV sensitivity.

**NOTE:** SM-220 itself can be used.

## ● Adjustment Procedure

(Adjustments are shown in Fig. 11-1)

### 1. DC Balance VR-101

(Adjustable from the bottom of the case)

If vertical amplifier DC balance is not maintained, the trace or waveform will shift vertically when the V. GAIN is adjusted.

- 1) Place the V. ATT to GND/MONITOR and adjust the V. GAIN fully counterclockwise. Adjust the Position so the trace is centered.

- 2) Adjust the GAIN fully clockwise. Adjust the DC Bal VR101 until the trace returns to the screen center.

- 3) Repeat this procedure two or three times until the trace remains stationary when the V. GAIN is adjusted.

**NOTE:** Perform this procedure after the unit stabilizes, about 15 minutes.

### 2. Horizontal Gain VR-106

Place the SWEEP RANGE control in the 10—100 Hz position. If the trace does not fully extend over the screen, adjust the HOR. GAIN VR-106 as follows

- 1) Place the SWEEP RANGE control in the RTTY/EXT position and turn the SWEEP VAR/EXT GAIN control fully clockwise.

- 2) Apply a 1 kHz, 3V signal to the H. INPUT/EXT SYNC terminal. Adjust VR-106 for a trace length of 10 divs.

### 3. Vertical Attenuator (V. ATT) Frequency Response

- 1) Apply a 1 kHz square wave at approximately 50 mV, to the V. INPUT terminal. Set the V. ATT to 1 and the SWEEP RANGE to 100—1 kHz. Adjust the V. GAIN and SWEEP VARI/EXT GAIN for square wave amplitude of approximately 6 divs, and 2 ~ 4 cycles displayed. Check that the ideal waveform (as shown in Fig. 11-2) is displayed.

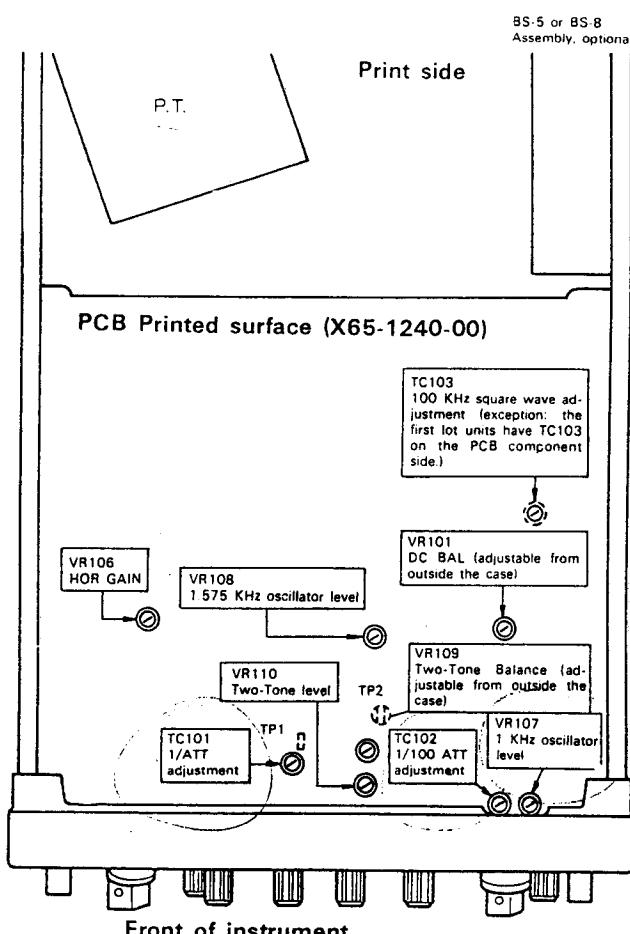


Fig. 11-1 Adjustment

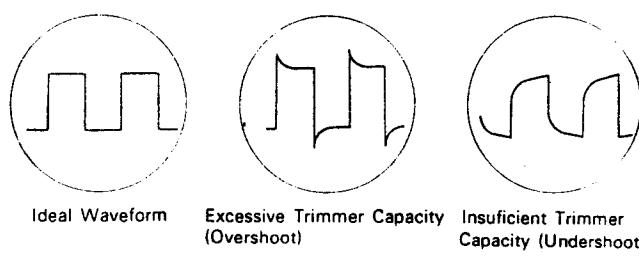


Fig. 11-2 V. ATT High-Frequency Response Compensation

TC101 & VR107 are  
TC102

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# SECTION 11. ADJUSTMENT

- 2) Set the V. ATT to 1/10 and increase the AG output level by 20 dB. Adjust TC101 for ideal waveform.
- 3) Set the V. ATT to 1/100 and increase the AG output level by 20 dB. Adjust TC102 for ideal waveform. Fig. 11-2 shows the relationship between waveform and trimmer capacity.

## 4. High-Frequency Response Adjustment

If high-frequency response is not adjusted properly, peaks may appear around 5 ~ 10 MHz, or gain may drop off at high-frequency.

- 1) Set the V. ATT to 1. V. GAIN fully clockwise, and SWEEP RANGE to 10—100 KHz. Apply an unmodulated 100 KHz signal at  $\pm 90$  dB (.35V) to the V. INPUT terminal. Adjust the SG output level for a 6 div. display.
- 2) Change the SG output frequency to 12 MHz and adjust TC103 for a 4.2 div display.

## 5. Tone Oscillator Levels

### (1) VR107, VR108

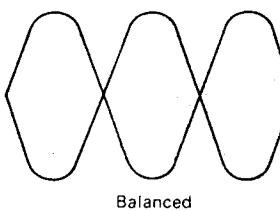
Place the TONE switch in the 1000 Hz position. Adjust VR107 for 3Vp-p (1V rms) at (test point) TP1. Then, place the TONE switch in the 1575 Hz position and adjust VR108 for 3Vp-p (WRMS) at TP2.

### (2) Two-Tone Balance VR109

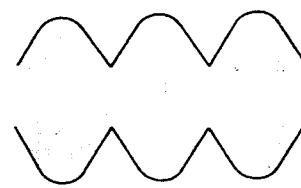
Adjust VR109 (Tone Balance) for dual output is at both the 1000 Hz and 1575 Hz switch settings, measured at the TONE OUTPUT terminal ( $\pm 7.5$  mV each tone setting).

### (3) Tone Output VR110

Adjust VR110 (Output Level) for 10 mV in the TWO-TONE mode, measured at the TONE OUTPUT terminal.



Balanced



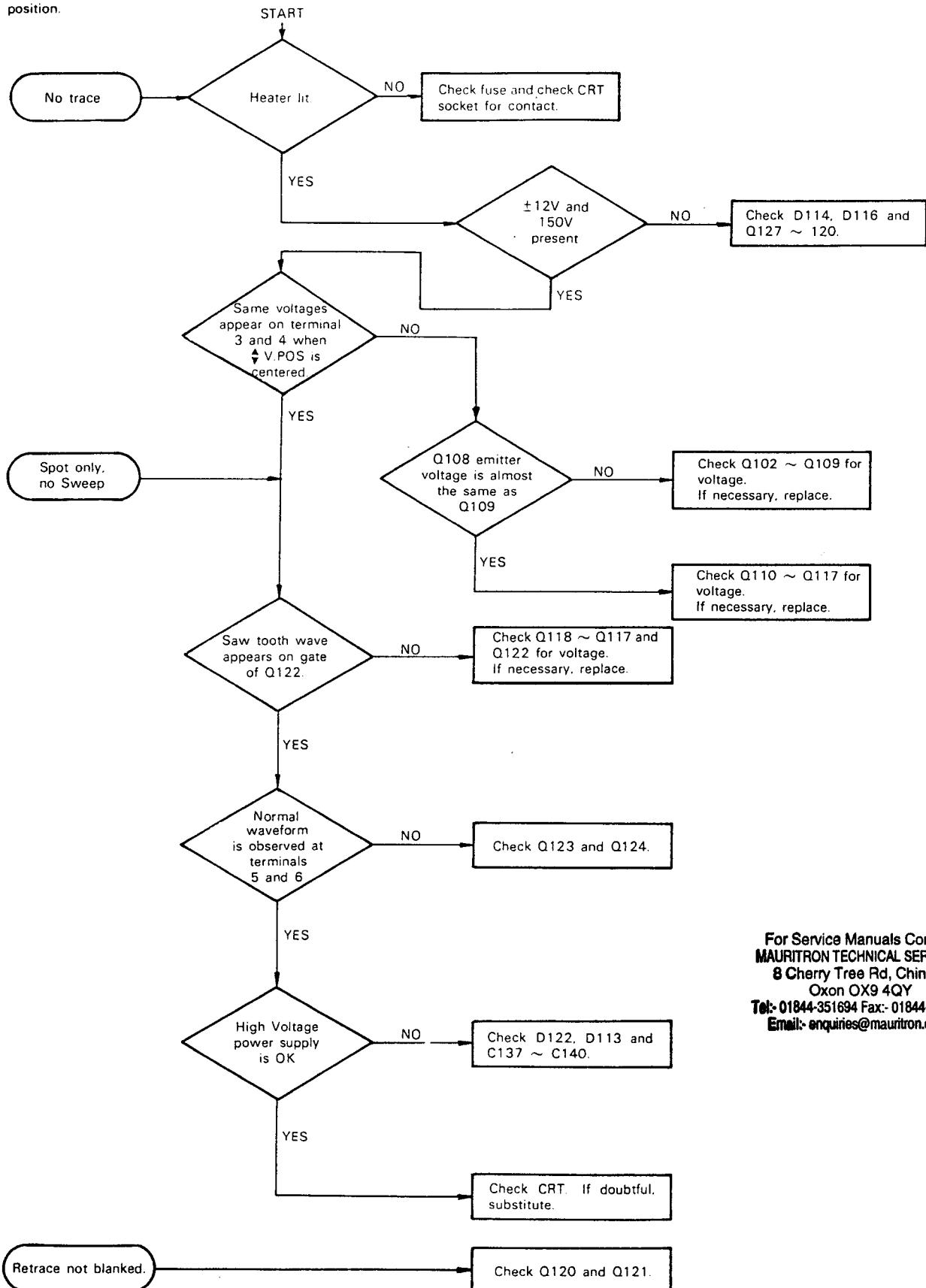
Unbalanced

Fig. 11-3 Two-Tone Oscillator Balance Adjustment

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# SECTION 12. TROUBLESHOOTING

Turn the power switch On and place the Function Switch in the Oscilloscope position.



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# SECTION 13. PAN DISPLAY OPTION

## GENERAL

To monitor signal conditions in the vicinity of your receive frequency, a Pan Display Plug-In is available as an option to the SM-220.

TS-520S series ..... BS-5

TS-820S series ..... BS-8

The BS-5 is designed to match the TS-520 series IF frequency 3395 KHz, and the BS-8 the TS-820 series IF frequency 8833 KHz.

When using either the BS-5 or BS-8, a minor wiring addition is required in the transceiver.

The Pan Display is easily installed in the SM-220, and requires no soldering-A11 connections are accomplished by multiconnectors.

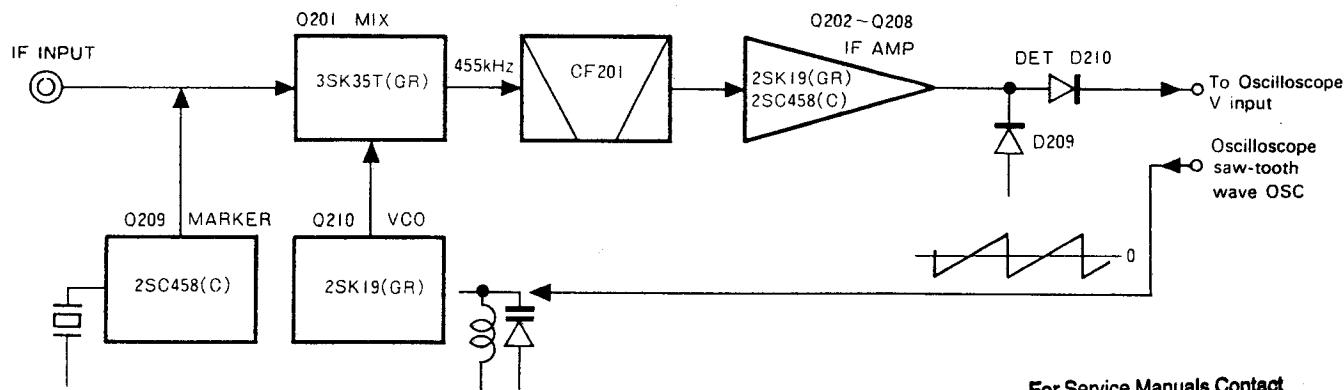
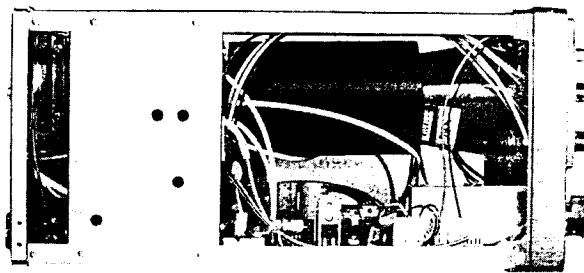


Fig. 13-1 Block Diagram

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## DESCRIPTION OF THE BS-5 AND BS-8

When the BS-5 or BS-8 is installed in the SM-220 and connected to the transceiver, signal conditions in the vicinity of the receive frequency can be displayed over a  $\pm 20$  KHz or  $\pm 100$  KHz range. The Pan Display amplifier employs a logarithmic compression system, so weak and strong signals can be monitored simultaneously. The narrow bandwidth filter permits monitoring of adjacent signals even under adverse receiving conditions, in both SSB and CW modes.

Model	FX-1082
Center Frequency	455 kHz
Insertion Loss	7 dB $\pm$ 1 dB
Band Width	More than 1.0 kHz/-6 dB Less than 3.0 kHz/-60 dB
Guaranty Attenuation	More than 60 dB at 455 $\pm$ 100 kHz

## CERAMIC FILTER RATINGS

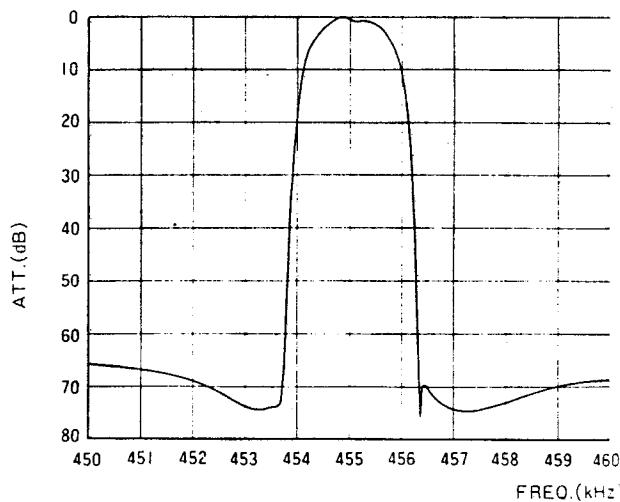
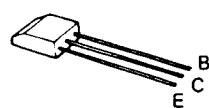
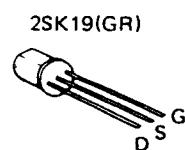
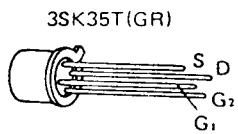
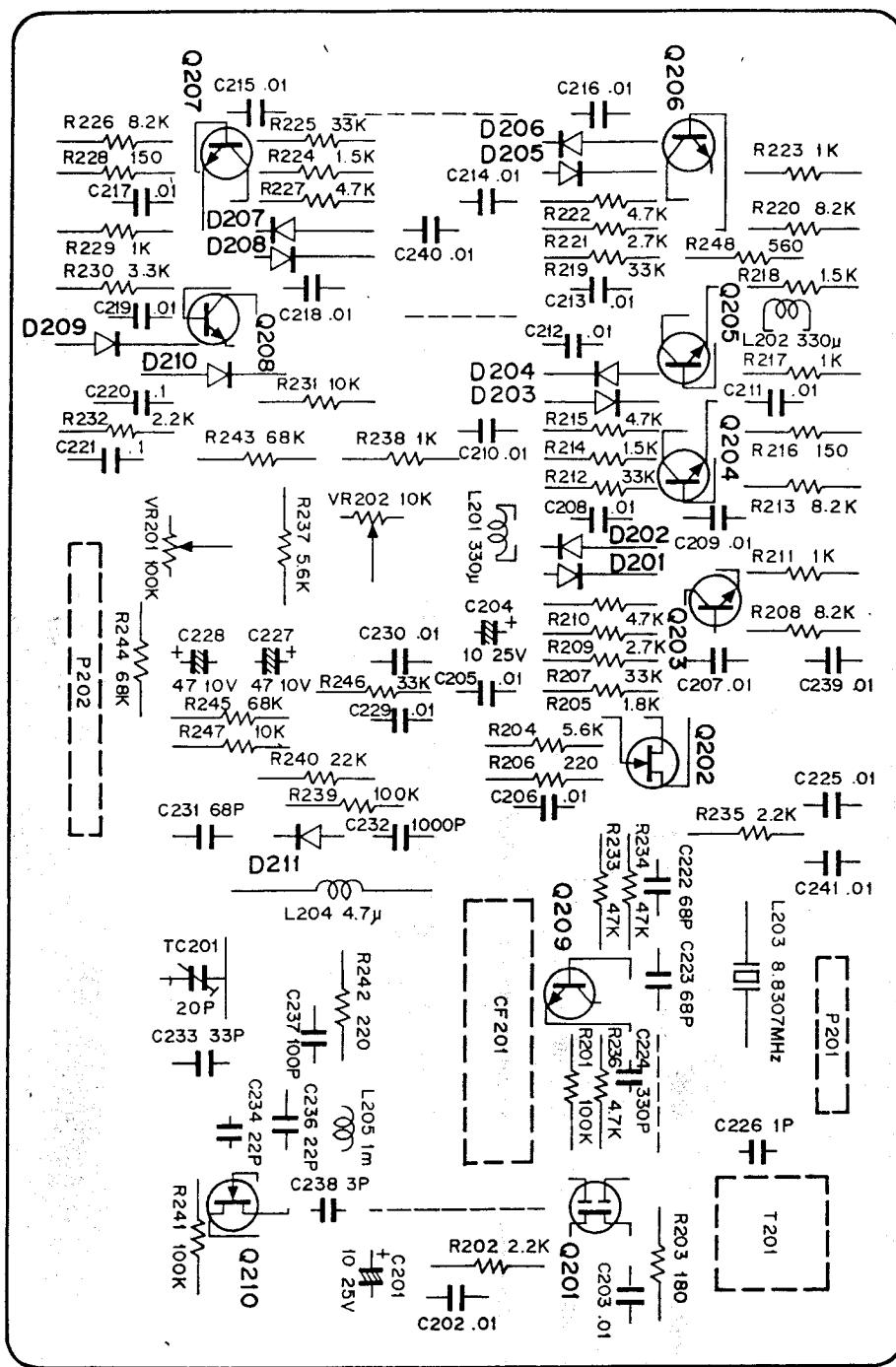


Fig. 13-2 Ceramic Filter Frequency Characteristics

## PC BOARD



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**BS-8 UNIT (X65-1250-00)**  
**BS-5 UNIT (X65-1250-01)**

## **COMPARATIVE TABLE**

Refer to Parts List and Schematic Diagram.

	C231	C232	C233	C234	C236	C237	L203	L204	T201
BS-8	68pF	1000pF	33pF	22pF	22pF	100pF	8.8307MHz	4.7μH	L34-0527-05
BS-5	1000pF	0.01μF	—	100pF	47pF	680pF	3.395MHz	20μH	L31-0286-05

# PARTS LIST

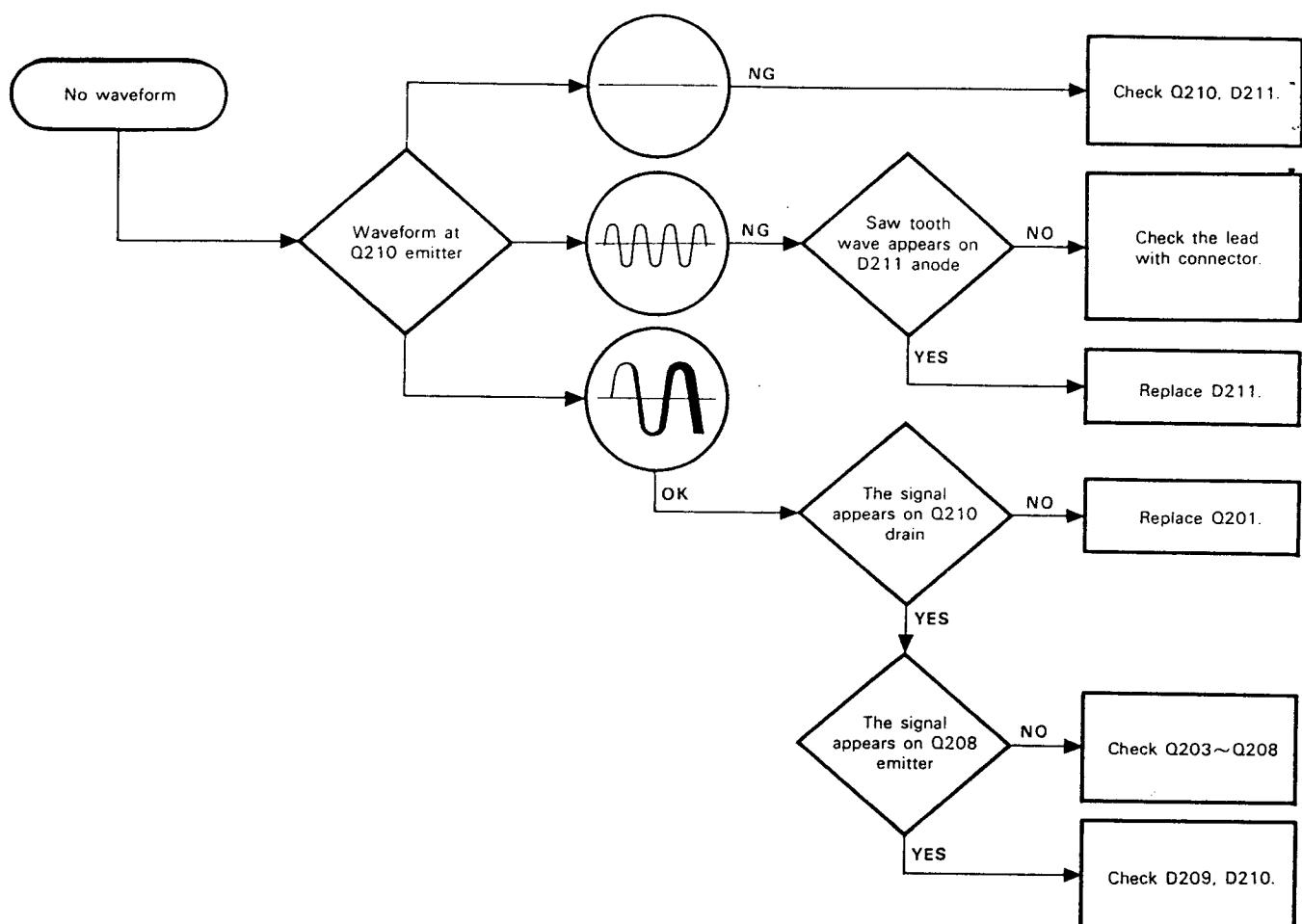
## GENERAL

☆ : New parts

Ref. No.	Parts No.	Description			Re-marks
—	CC45SL1H470J	Ceramic	47pF	±5%	BS-8
—	CC45SL1H101J	Ceramic	100pF	±5%	BS-5
—	B20-0909-04	Graticule			☆
—	B58-0903-00	Caution card			☆
—	E30-1828-05	Cord with pin plug			☆
—	E31-0573-05	Lead with connector			☆
—	H01-2842-03	Carton case			BS-8
—	H01-2844-03	Carton case			BS-8
—	H25-0016-00	Polyethylene bag			
—	H25-0029-04	Polyethylene bag			
—	J61-0053-05	Board support × 4	LCBS-4		
—	N35-3006-46	Bind screw × 8			
—	001-0801-05	Plated lead × 5			BS-8
—	060-3001-05	Coaxial cable 1.5D-XV			
—	X65-1250-00	BS-8 unit			BS-8
—	X65-1250-01	BS-5 unit			BS-5
—					☆

Ref. No.	Parts No.	Description			Re-marks
R201~	RD14BB2E000J	Carbon	000Ω	±5%	1/4W
—	R92-0150-05	Refer to schematic diagram. Jumper resistor × 4			
Q201	V09-1002-26	FET	3SK35(T)(GR)		
Q202	V09-0012-05	FET	2SK19(GR)		
Q203~	V09-0080-05	Transistor	2SC458(C)		
209					
Q210	V09-0012-05	FET	2SK19(GR)		
D201~	V11-0076-05	Diode	1S555		
208					
D209,	V11-0051-05	Diode	1N60		
210					
D211	V11-0447-05	Diode	1SV50		
VR201	R12-5002-05	Semi-fixed resistor	100kΩ		
VR202	R12-3002-05	Semi-fixed resistor	10kΩ		
TC201	C05-0013-15	Trimmer	20pF		
L201,	L40-3311-03	Ferri-inductor	330μH		
202					
L203	L77-0487-05	Crystal	8.8307 MHz	BS-8	
	L77-0123-05	Crystal	3.395 MHz	BS-5	
L204	L33-0801-05	Choke coil	4.7μH	BS-8	
	L33-0265-05	Choke coil	20μH	BS-5	
L205	L40-1025-04	Ferri-inductor	1 mH		
T201	L34-0527-05	IFT		BS-8	
	L31-0286-05	IFT		BS-5	
CF201	L72-0401-05	Ceramic filter			
P201	E40-0414-05	4P connector			
P202	E40-0914-05	9P connector			
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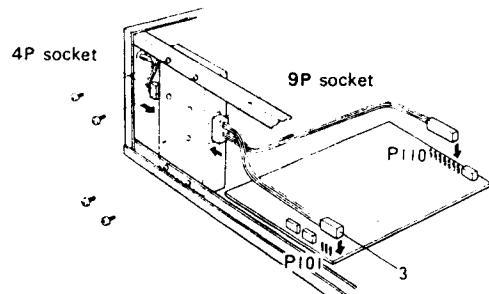
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# ADJUSTMENTS/PACKING

## INSTALLATION



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Fig. 13-3 BS-5, BS-8 Installation

## ADJUSTMENT

The BS-5 or BS-8 must be adjusted before use. For adjustment, the antenna must be disconnected from the transceiver.

1. Set the SM-220 FUNCTION switch to BAND SCOPE (Pan Display).
2. Depress the MARKER switch ON, center the display by the  $\blacktriangle\blacktriangleright$  POSITION control and center the V. GAIN control. Adjust the  $\blacktriangle$  POSITION to shift the trace to the bottom of the graticule. With the SCAN WIDTH set to the WIDE 100 KHz position, turn the scan width adjustment VR202 until the marker signal moves to the scope center line.
3. Turn the MARKER OFF. Set the transceiver RF GAIN to MAX, and the FUNCTION switch to CAL 25 KHz and peak the drive control for MAX "S" meter reading. At this time, check that 8-10 waveform peaks ("SPIKES") appear on the CRT screen, as shown in Fig. 13-5B. If necessary, reset the center frequency adjustment trimmer TC201 and the scan width adjustment VR202 (STEP2), until the waveform shown in Fig. 13-5A is obtained.

**NOTE:** Make certain you have actually adjusted the center frequency to the receiver. If necessary, find a single signal to verify this adjustments

4. Turn off the 25 KHz calibrator, turn on the marker. Set the SCAN WIDTH to the NARROW (20 KHz) position, and adjust VR201 for CENTERED marker display, as previously outlined is step 2.

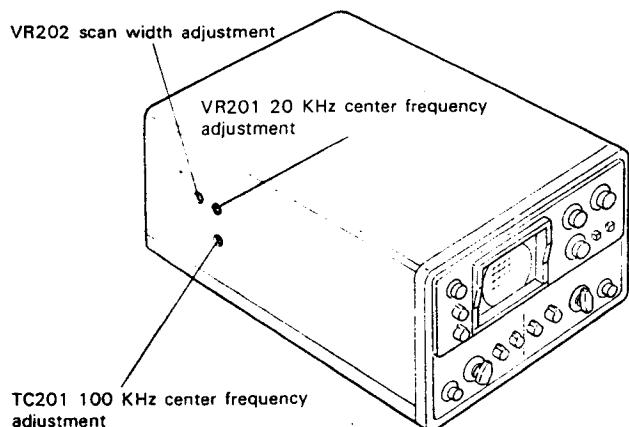


Fig. 13-4 Pan Display Adjustment

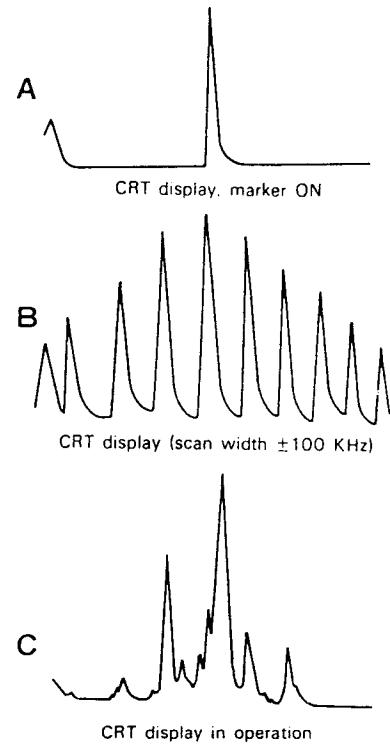
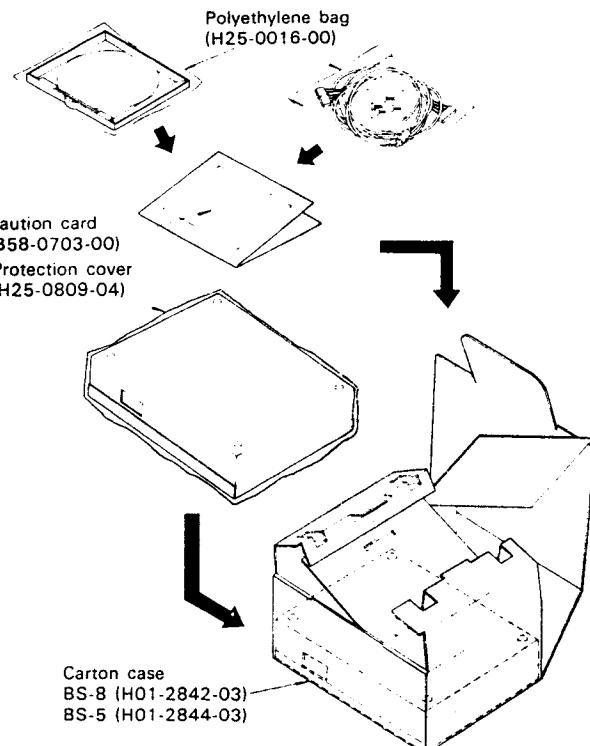


Fig. 13-5 Pan Display Waveforms

## PACKING

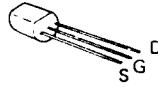


## ACCESORIES

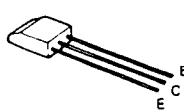
Caution card (B58-0703-00)  
 Graticule (B20-0909-04)  
 Cord with pin plug (E30-1828-05)  
 Lead with connector (E31-0573-05)  
 Bind screw x 4 (N35-3006-46)  
 Pick-up cord (060-3001-05)

## **SECTION 14. S**

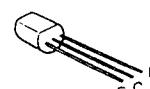
2SK30A(O)  
2SK30A(O)(IDSS)  
2SK30A(GR)



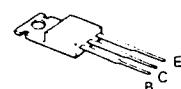
2SC535(B)



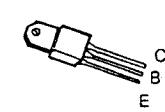
2SC1360



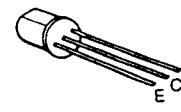
2SC1419C  
2SA755C  
2SC1569



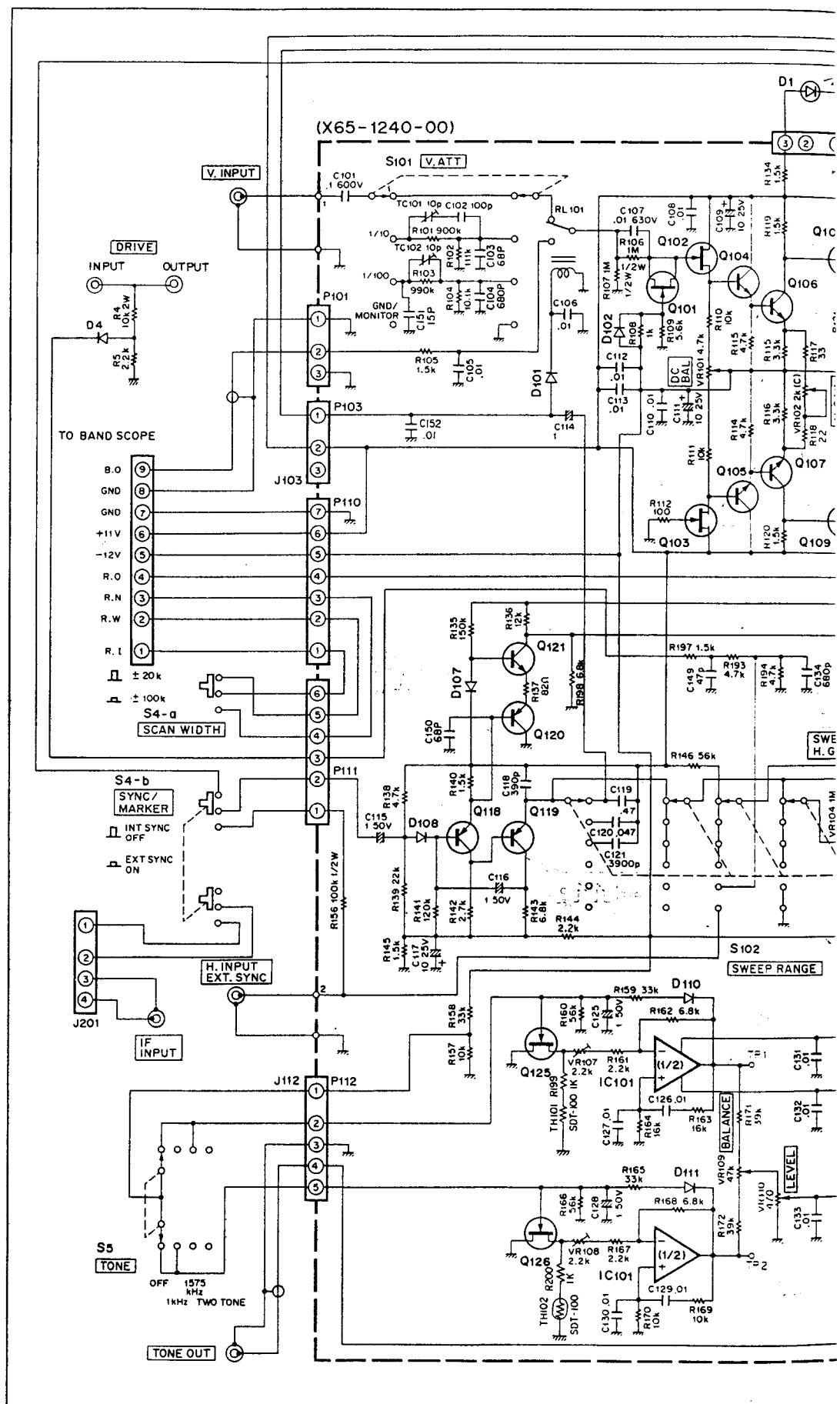
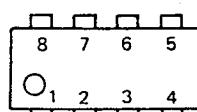
2SA818Y  
2SC1628Y



2SA495

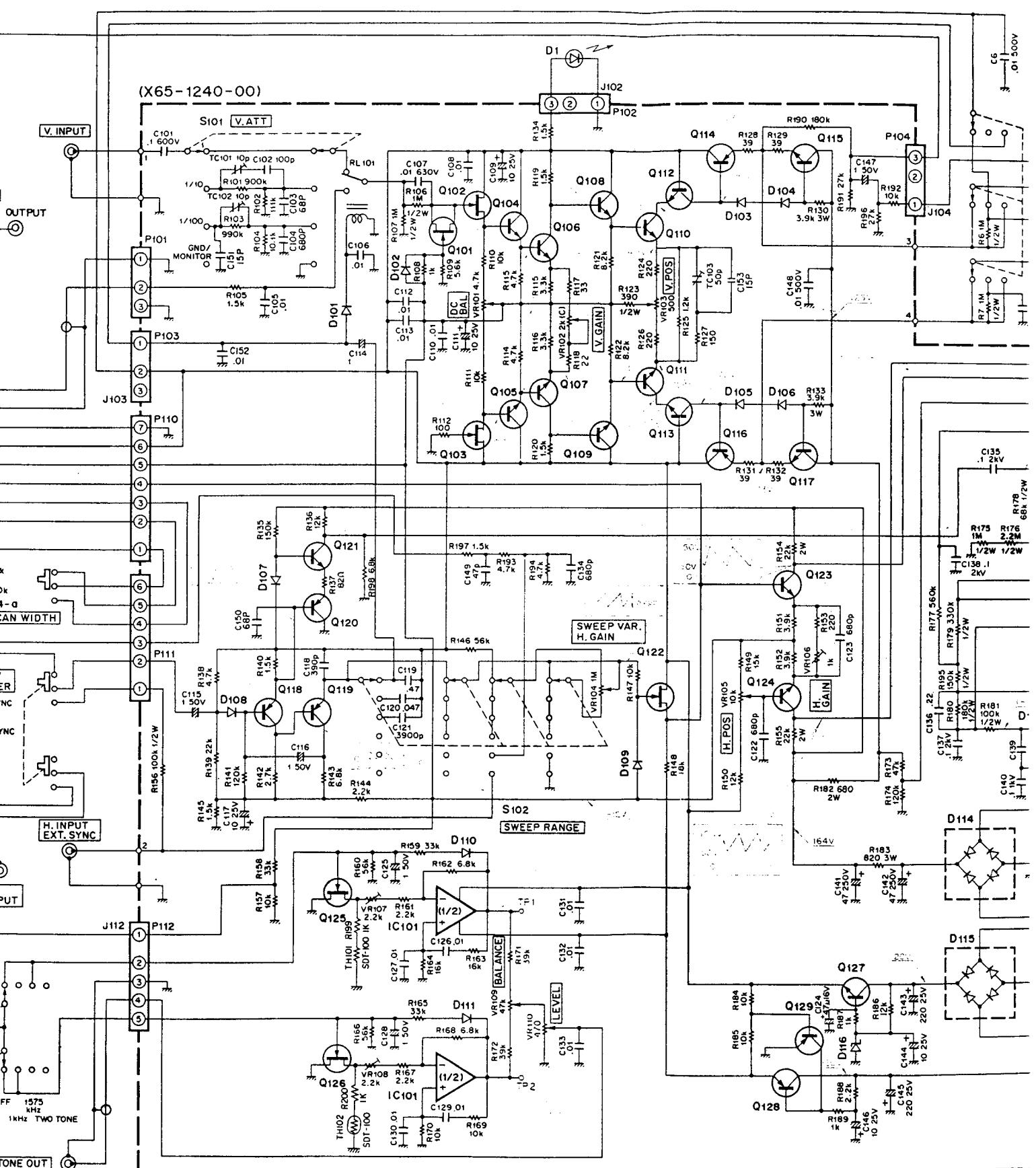


NJM4558D

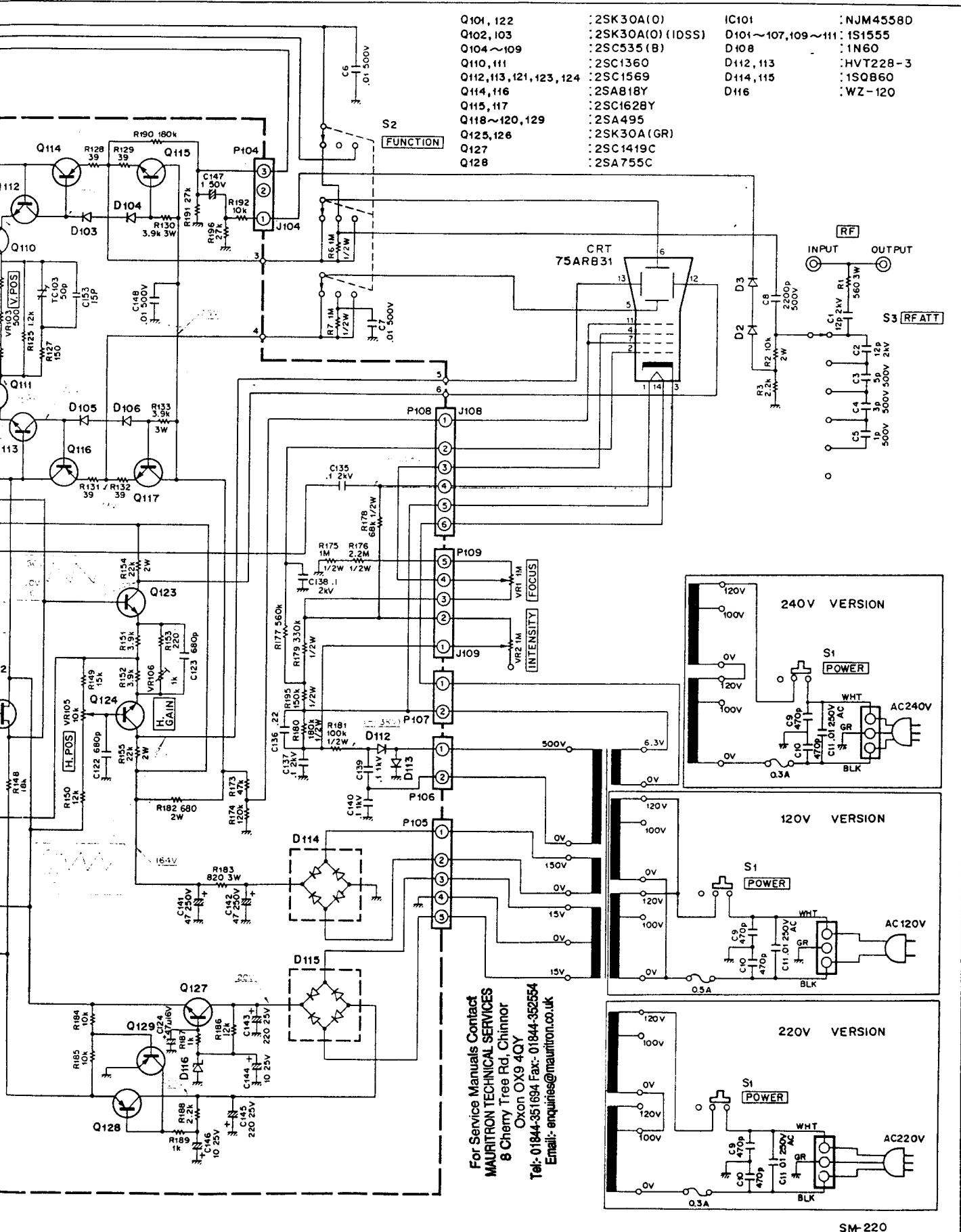


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# SECTION 14. SCHEMATIC DIAGRAM

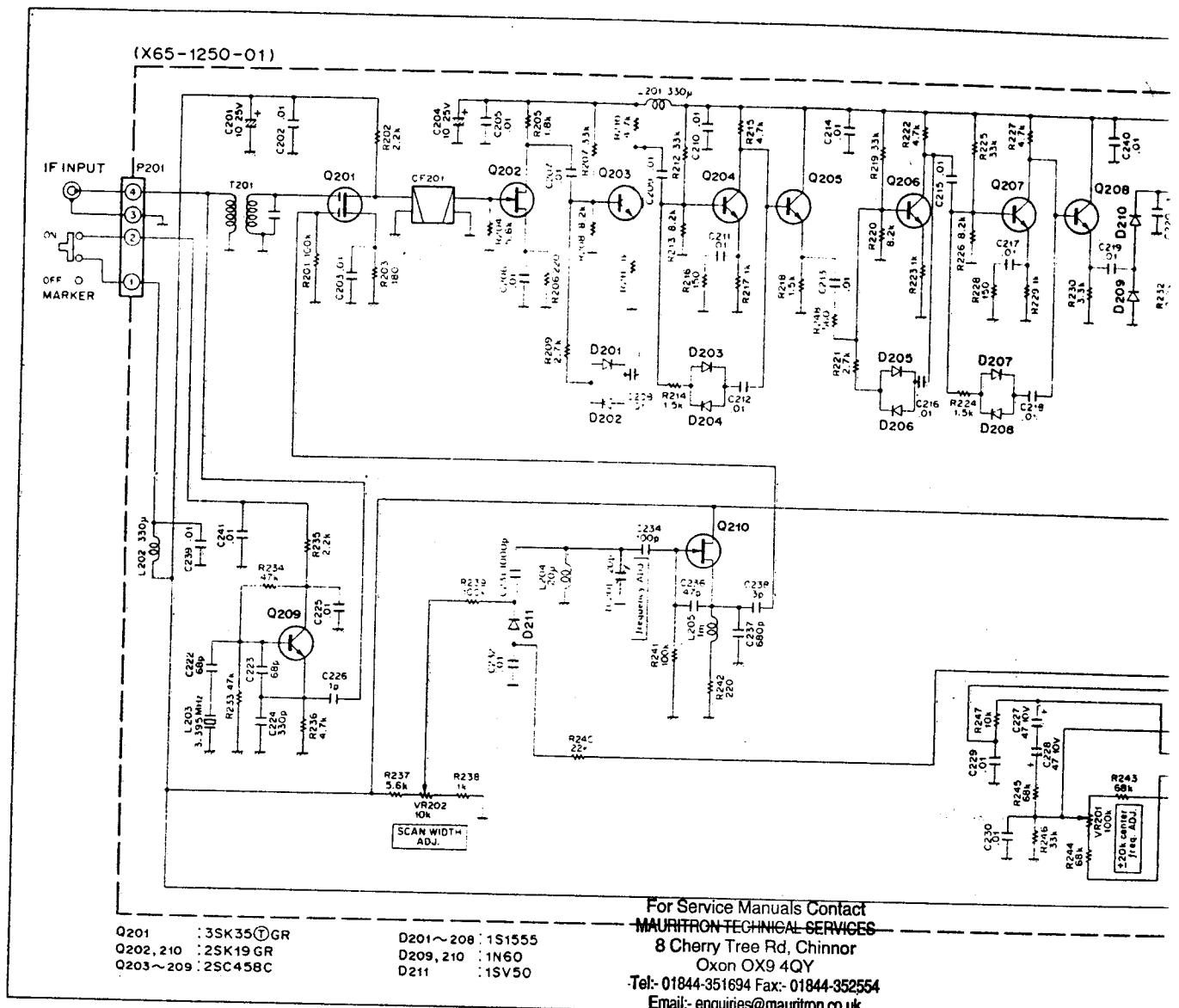


# MATIC DIAGRAM

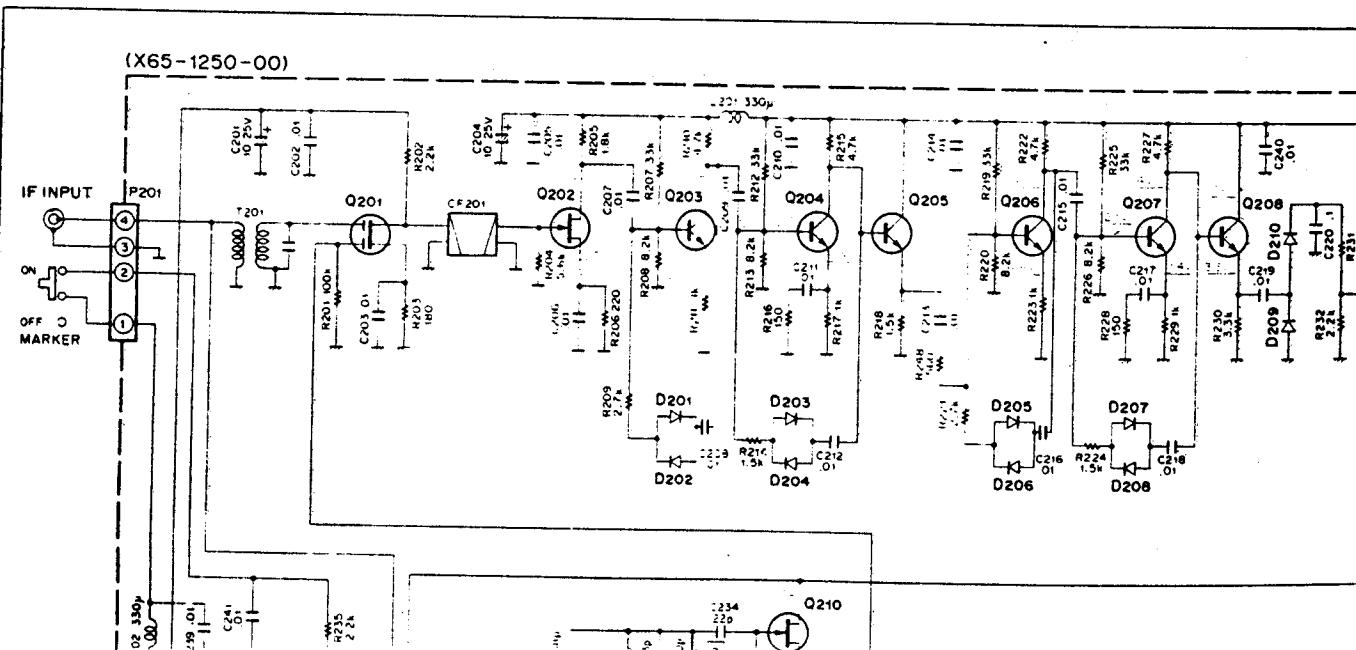


SM-220

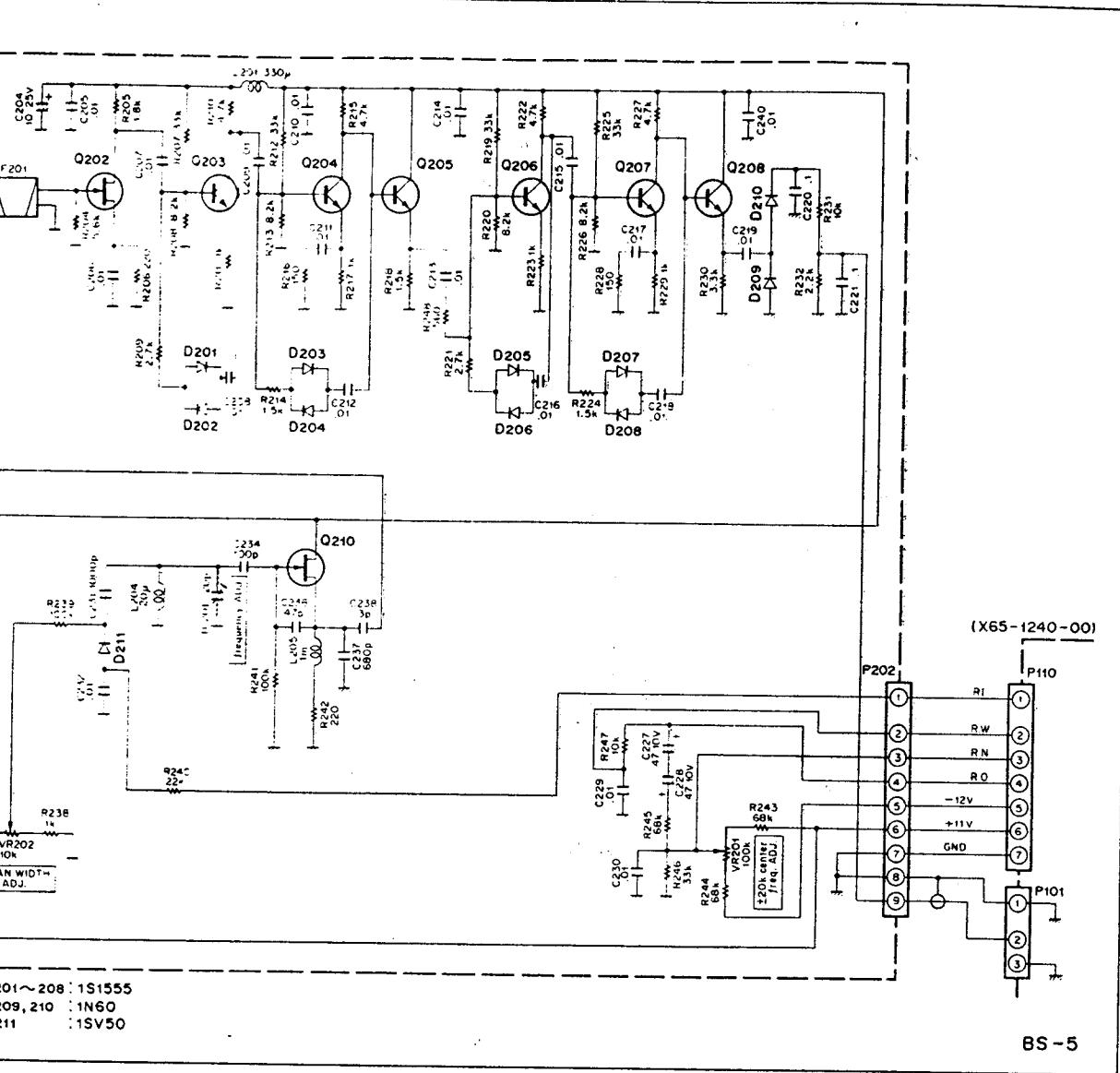
# BS-5 SCHEMATIC DIAGRAM



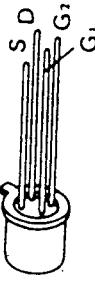
# BS-8 SCHEMATIC DIAGRAM



# BS-5 SCHEMATIC DIAGRAM



3SK35T(GR)



2SK19(GR)

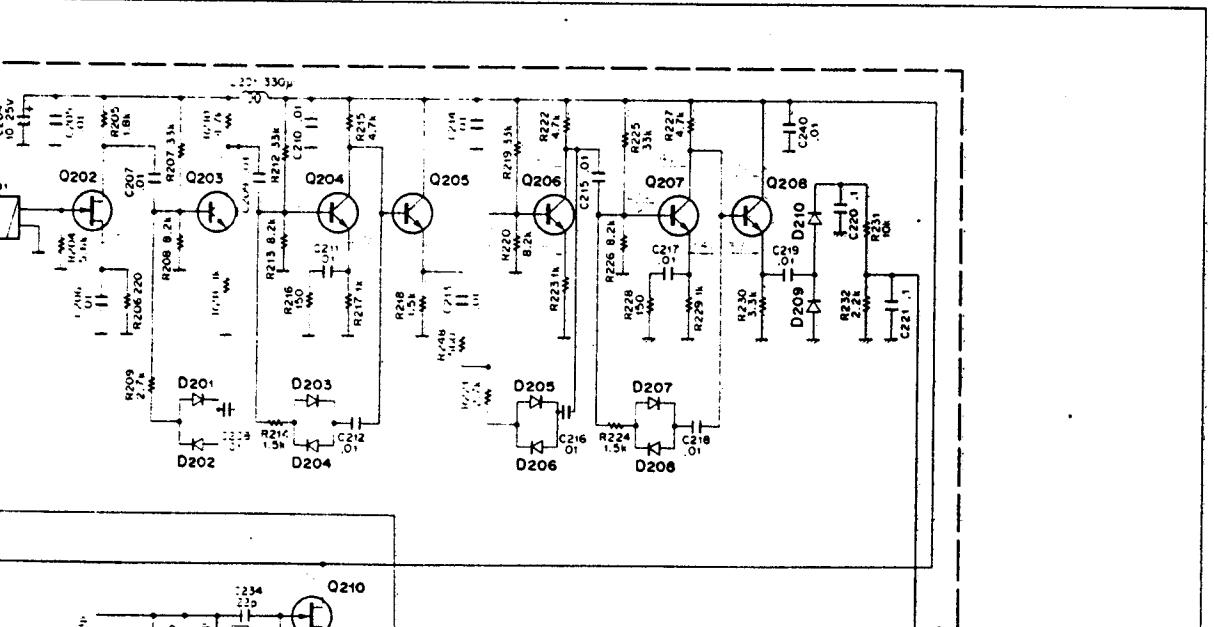


2SC458(C)

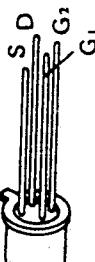


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# BS-8 SCHEMATIC DIAGRAM

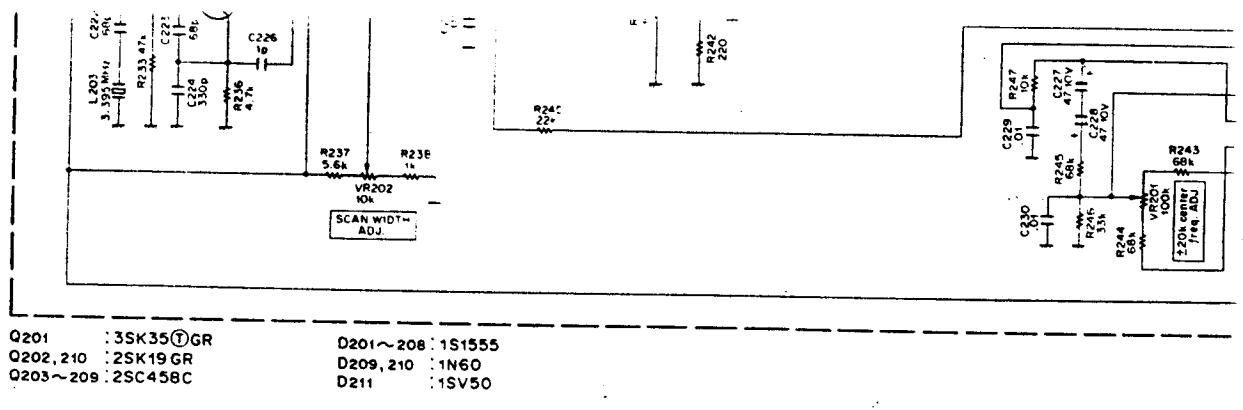


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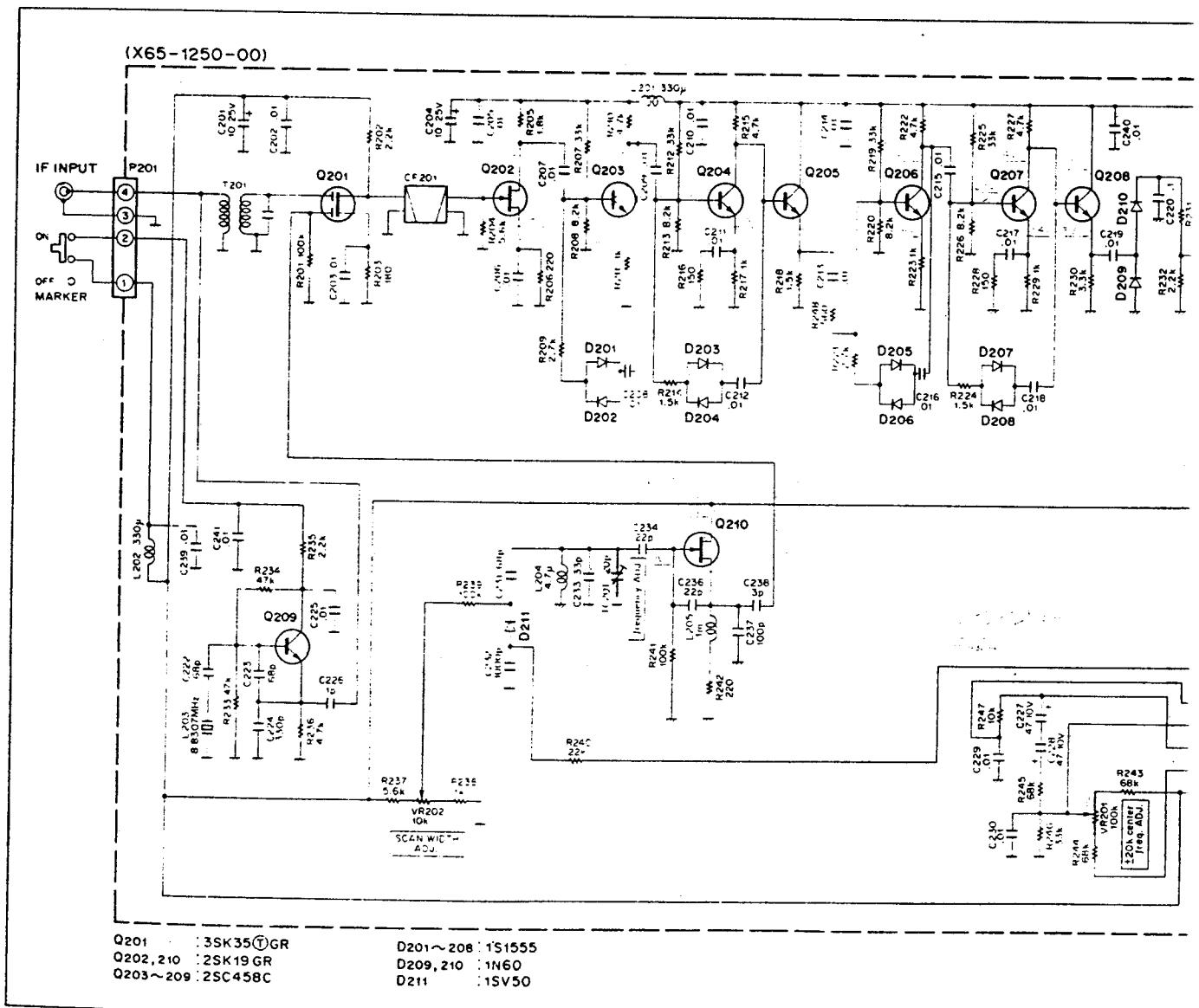
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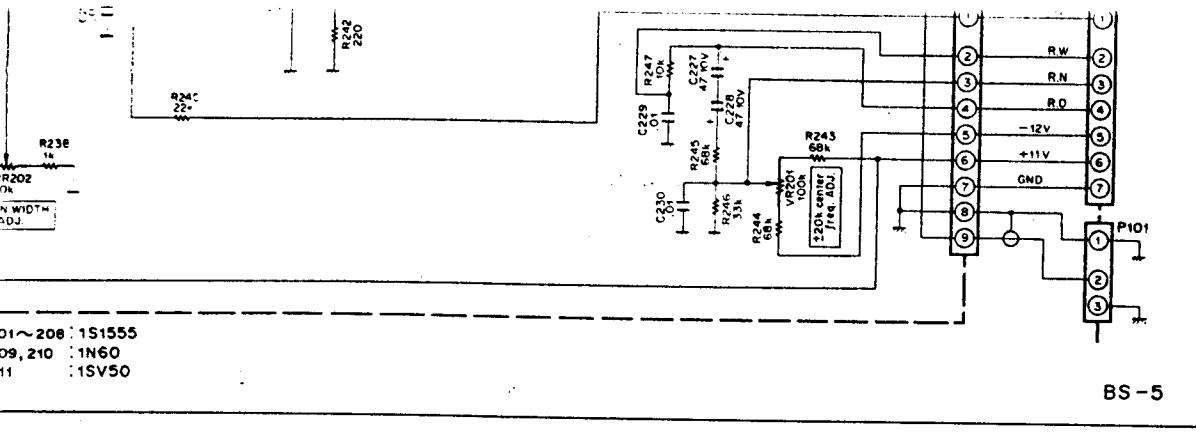




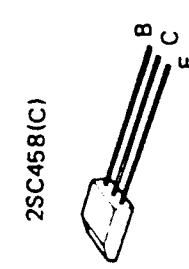
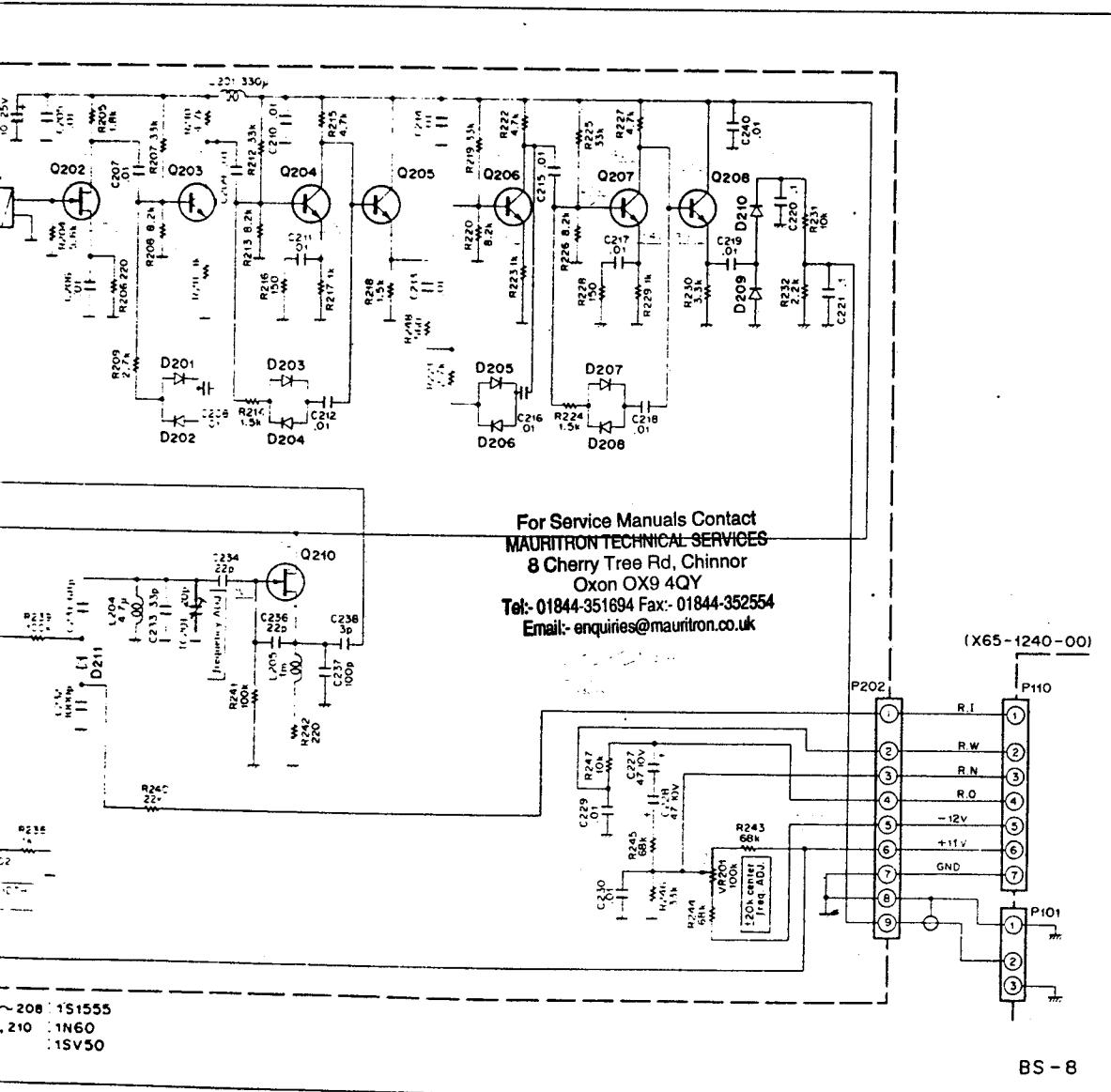
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## BS-8 SCHEMATIC DIAGRAM

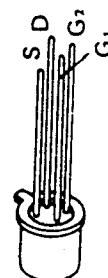




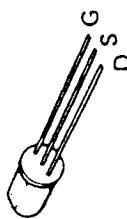
## **BS-8 SCHEMATIC DIAGRAM**



2SC458(C)



3SK35T(GR)



2SK19(GR)



2SC458(C)

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~208 : 1S1555  
,210 : 1N60  
: 1SV50