



# Model SM-220



INSTRUCTION MANUAL

Congratulations on your choice of the Model SM-220 Station Monitor Scope. You will find this to be a useful and versatile addition to your station. This unit has been carefully engineered and manufactured under rigid quality standards and should give you satisfactory and dependable operation for many years. We suggest you leaf through this manual to familiarize yourself with overall capabilities. Read all of section 4 before operating your new scope, and read those items in section 5 which pertain to your particular equipment and interests. Should any trouble arise with this unit, please contact your dealer, or the Factory.

## AFTER UNPACKING

### Shipping Container:

Save the boxes and packing in the event your unit needs to be transported for remote operation, maintenance, or service.

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!

## CAUTION

If the SWEEP RANGE selector is switched to the 1-10k or 10-100k position while the transceiver is in reception mode, the built-in oscillator of the SM-220 will interfere with reception. Avoid using these ranges in reception mode.

### NOTE:

1. As mentioned in this or any other TRIO-KENWOOD Publication, the TS-820 series applies to any model TS-820, TS-820S, TS-820V and TS-820D.  
The TS-520 series applies to any model; TS-520, S, or SE.  
Likewise, all reference to the model TL-922 Power amplifier fully applies to the TL-922A.
2. Pan Display Option  
The BS-5 (3.395 MHz input) is compatible with the TS-520 series, TS-900, R-599 series, TS-511 series and TS-510.  
The BS-8 (8.830 MHz input) is compatible with the TS-830S, TS-180S, R-820 and TS-820 series transceivers.

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\*Scope display examples (number of conditions illustrated).

## SECTION 1. SPECIFICATIONS

### CRT 76ARB31

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

### TRANSMIT SIGNAL MONITOR TERMINAL

Frequency range .....	1.8 ~ 150 MHz
Maximum power .....	1.8 ~ 54 MHz 2 kW/PEP (Pontinuous for 5 minutes at RF ATT, MAX)
	150 MHz (100 w/PEP)
SWR .....	1.2 or less
Insertion loss .....	Less than 0.9 dB (at only 144 MHz)
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, 1,575 Hz, or both, switchable
Output voltage .....	5 mV/50 k $\Omega$ (at TWO TONE)

### PAN DISPLAY

Adaptor name .....	BS-5 (3.395 MHz IF), BS-8 (8.830 MHz IF)
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 $\mu$ /DIV
Scan width .....	$\pm$ 20 kHz, $\pm$ 100 kHz, selectable

### HORIZONTAL AMPLIFIER

Gain adjustment .....	10 dB (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 M $\Omega$ ( $\pm$ 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 amplitude .....	Internal... More than 1 DIV on CRT
	External... More than 2 Vp-p

### VERTICAL AMPLIFIER

Deflection sensitivity .....	More than 20 mV/DIV
Frequency response .....	2 Hz ~ 10 MHz (— 3 dB)
Input resistance/capacity .....	1 M $\Omega$ , 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

<b>POWER SUPPLY</b> .....	117V AC $\pm$ 10%, 50/60 Hz, 20W
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<b>DIMENSIONS</b> .....	215 (W) $\times$ 153 (H) $\times$ 335 (D) mm (8-7/16 $\times$ 6 $\times$ 13-3/16 inch)
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<b>WEIGHT</b> .....	5 kg (12 lbs)
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Specifications are subject to change without notice due to technical improvement.

## SECTION 2. INTRODUCTION AND FEATURES

1. Station Monitor SM-220 is designed specifically for operation with series TS-830, TS-530, TS-820, TS-520 and TS-180S series SSB transceivers.
2. The unit is comprised of a monitor-scope, oscilloscope and two-tone audio generator. A Pan Display option is also available.
3. The monitor-scope will display transmitted waveform from 1.8 MHz to 54 MHz, 5W-2 kW PEP, and to 150 MHz, 100W PEP. Drive input terminals permit trapezoid waveform observation.
4. The oscilloscope features high sensitivity (better than 20 mV/DIV) and wide bandwidth (2 Hz ~ 10 MHz), and makes possible measurement of various waveforms. Receiver IF can be displayed directly from the TS-830S, TS-820S IF-OUTPUT terminal.
5. The two-tone audio generator provides 1000 Hz and 1575 Hz tone individually or simultaneously.
6. A plug-in Pan Display is available as an option: For the TS-830, TS-820 and TS-180 series transceivers, specify the BS-8, or for the TS-520 series specify the BS-5.
7. Horizontal trace tilt can be adjusted from the rear of the unit without removing the case.
8. The blue-green (B31) phosphor CRT assures excellent brightness and contrast for extended fatigue-free viewing.

### ACCESSORIES SUPPLIED

Instruction Manual	B50-2856-00	1
UHF type cable	X67-1020-00	1
Tone generator output cable	X67-1070-00	1
Auxiliary feet (with screws)	J02-0049-14	2
Power cable (fitted to unit)	E30-1818-05	1
Spare fuse (0.5A)	F05-5013-05	1

## SECTION 3. CABLING REQUIREMENTS AND PRELIMINARY INSTRUCTIONS

### 3.1 CONNECTING CABLE I

#### Output waveform:

When used to observe RF power output from any transceiver or transmitter, prepare one connecting cable, referring to Fig. 3-1.

#### Trapezoid waveform:

When observing trapezoid waveform from the TL-922 or any other power amplifier, three connecting cables are required.

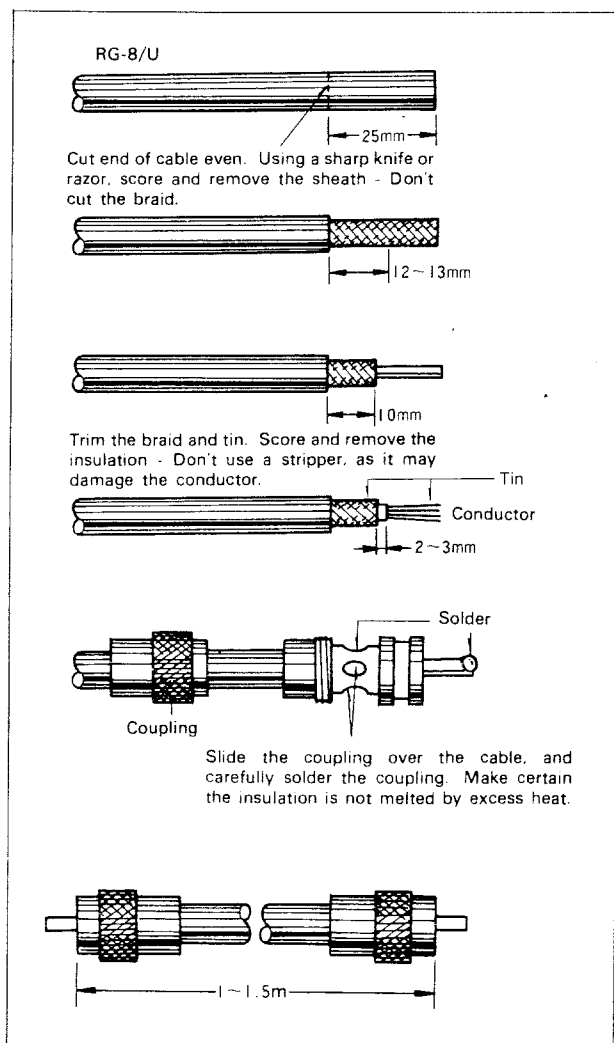


Fig. 3-1 Assembling a UHF connector cable

### 3.2 CONNECTING CABLE II

When used as an oscilloscope for testing or experimentation, prepare one connecting cable, referring to Fig. 3-2.

When observing RTTY tuning cross-patterns, two cables are required.

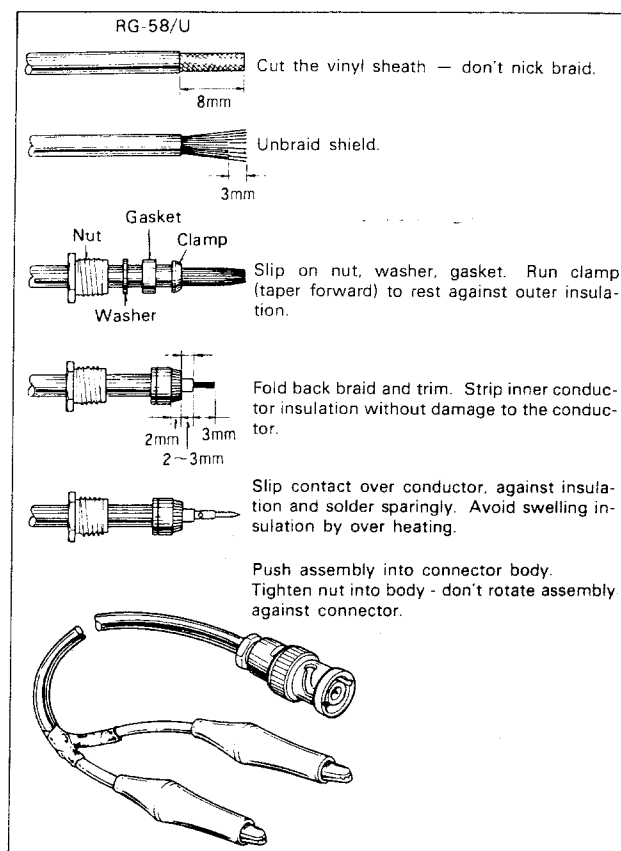


Fig. 3-2 Assembling a BNC connector cable

### 3.3 PRECAUTIONS

- Warning:** This unit contains a 1.3 kV high voltage circuit. Do not open the case unnecessarily. During adjustment or inspection, exercise care to prevent the possibility of electric shock. "Safety First"
- Caution:** When a dot is displayed on the CRT screen, reduce brightness by the INTENSITY control, or the phosphor will be damaged. A burned CRT will not be covered by warranty.
- As with all solid state equipment, do not operate this unit in high temperature or humidity environments and avoid storage or operation in direct sunlight.
- Caution:** Vertical input voltage should not exceed 600 Vp-p. Horizontal input voltage should not exceed 100 Vp-p.
- Locate the SM-220 away from strong magnetic fields (I.E. power transformers), or trace distortion may occur. Do not place directly on top of the transceiver, linear, or other power consuming equipment.

## SECTION 4. CONTROLS, INDICATORS AND CONNECTORS

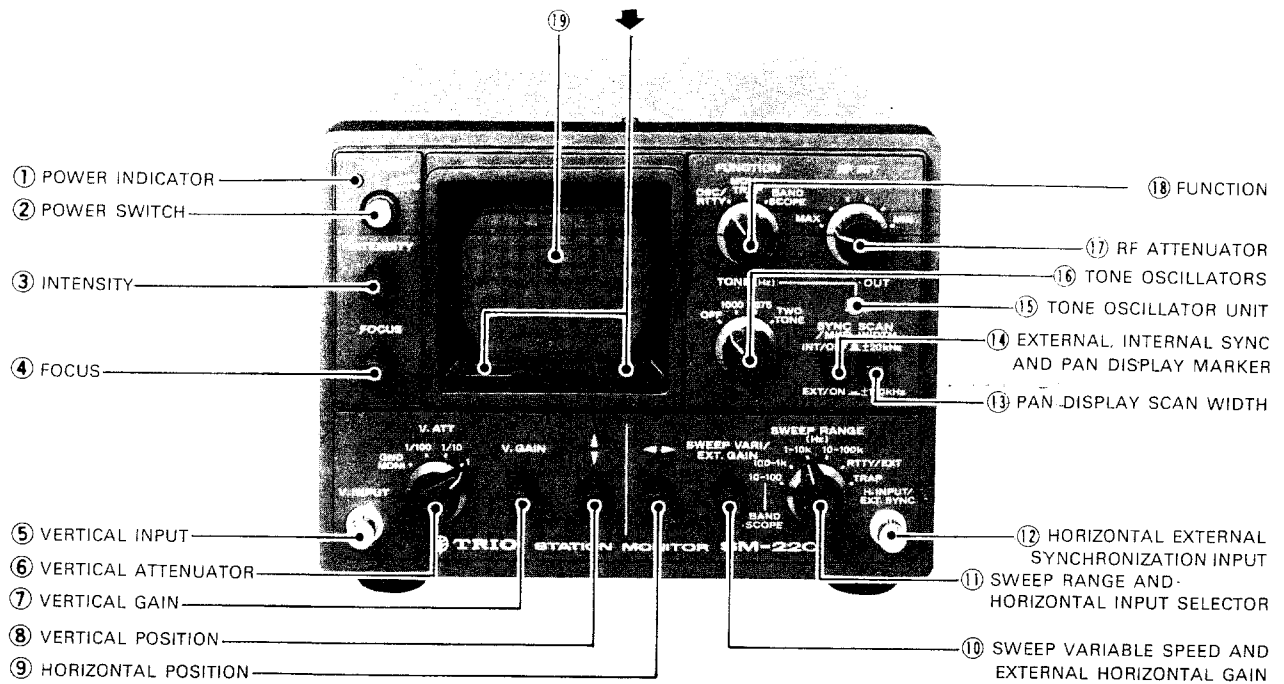


Fig. 4-1 Front panel

### ① POWER INDICATOR

This LED lights when the power switch is turned ON.

### ② POWER SWITCH

A push ON, push OFF switch controls all power to the instrument.

### ③ INTENSITY

This varies the brightness of the pattern on the scope screen. Clockwise adjustment increases the intensity.

### ④ FOCUS

Adjust this control to obtain the sharpest pattern on the scope screen.

### ⑤ V. INPUT

Vertical signal input terminal accepts oscilloscope input, or input from the transceiver IF-OUTPUT #2 terminal for received signal display.

### ⑥ V. ATT

Stepped input level control for the oscilloscope vertical amplifier. At position "1", V. INPUT signal is connected directly to the vertical amplifier. At the "1/10" and "1/100" positions, input is reduced proportionally. When the unit is used as a monitor scope, this switch should be set to GND-MONI position, at which the vertical amplifier is grounded.

### ⑦ V. GAIN

Vertical amplifier gain control. Used in conjunction with the stepped V. ATT to adjust the size of the waveform pattern on the screen.

### ⑧ ▲ POSITION

Vertical position control. This control determines the display position along the vertical axis. Adjustment clockwise shifts the pattern upward.

### ⑨ ◀▶ POSITION

Horizontal position control. This control determines the display position along the horizontal axis. Adjustment clockwise shifts the pattern to the right.

### ⑩ SWEEP VARI/EXT GAIN

This functions as the sweep fine frequency control when using the internal sweep. It is the SCAN SPEED adjustment during Pan Display operation, and during oscilloscope operation, the horizontal input gain control.

### ⑪ SWEEP RANGE

Sweep frequency selector. This switch is used in conjunction with the SWEEP VARI/EXT GAIN control (10) to obtain the desired sweep frequency. During Pan Display operation, this switch should be set to the "10-100" position and again, during RTTY or TRAP display to their appropriate positions.

### ⑫ H. INPUT/EXT SYNC TERMINAL

Horizontal input and external sync signal input terminal. Apply mark signal to this terminal when observing RTTY cross-pattern.

### ⑬ SCAN WIDTH

This switch is used during Pan Display operation, selecting either  $\pm 20$  kHz or  $\pm 100$  kHz scan width.

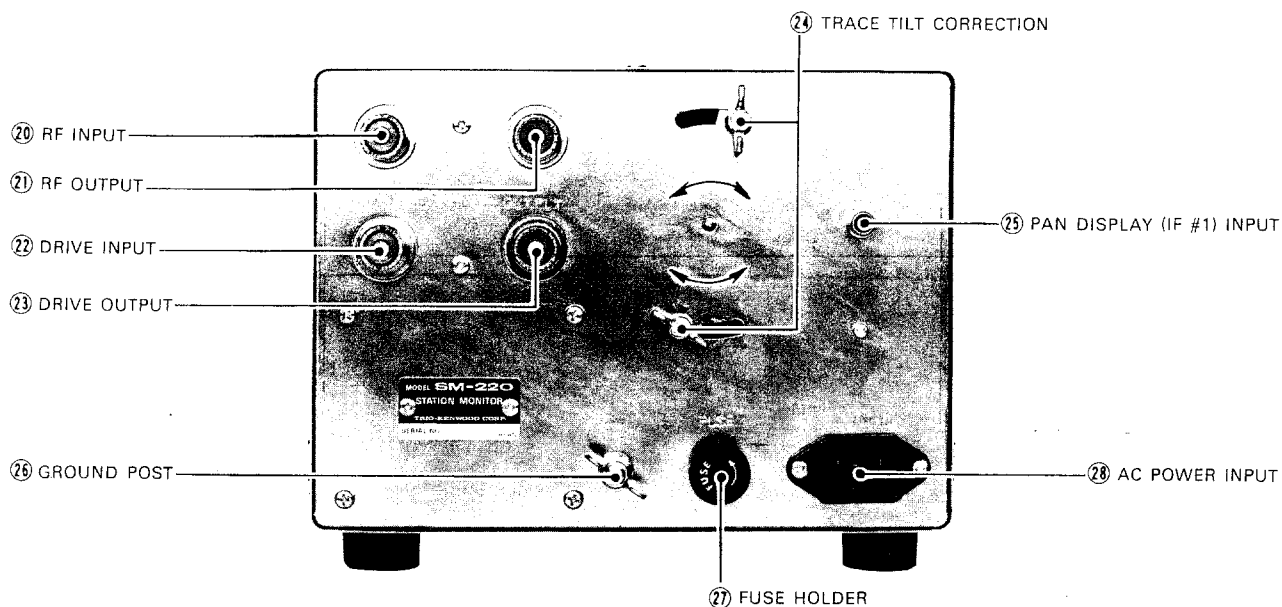


Fig. 4-2 Rear panel

#### ⑭ SYNC INT-EXT/MARKER

This switch is used during Pan Display operation to energize the in-built marker generator, or during oscilloscope operation as the sync selector. The oscilloscope is synchronized with the vertical input signal at the INT position, and at the EXT position with the signal applied to the EXT SYNC terminal (12).

#### ⑮ OUT

Output terminal for the two-tone audio generator.

#### ⑯ TWO-TONE AUDIO GENERATOR

Selects 1000 Hz, 1575 Hz or TWO-TONE audio output for transmitter tuning and testing.

#### ⑰ RF, ATT

RF input level control, used during MONI operation.

#### ⑱ FUNCTION

This switch selects the display function of the station monitor; OSCILLOSCOPE or RTTY, MONITOR or TRAPEZOID, and Pan Display.

#### ⑲ CRT AND GRATICULE

The smoked acrylic graticule affords easy waveform observation. When the Pan Display option is installed, the graticule may be replaced with the one supplied in the adapter kit. Remove by pressing at "↓" points and withdrawing out and up.

#### ⑳ RF INPUT

For observation of RF output, connect the transceiver's OUTPUT to this terminal. When observing linear amplifier trapezoid waveform, amplifier RF OUTPUT should be connected to the scope RF INPUT.

#### ㉑ RF OUT

Requires an antenna or dummy load for observation of RF signals.

#### ㉒ DRIVE INPUT

Connect to transceiver ANT terminal when observing amplifier linearity (trapezoid waveform).

#### ㉓ DRIVE OUTPUT

Connect to the linear amplifier RF INPUT terminal when observing amplifier linearity.

#### ㉔ HORIZONTAL TRACE TILT ADJUSTMENT

The scope trace may be tilted by the earth's magnetic field, depending on where the oscilloscope is used. Correct horizontal trace can be obtained by loosening the wing nuts. After adjustment, tighten the screws securely.

#### ㉕ PAN DISPLAY (IF #1 INPUT)

With the Pan Display option installed, connect the transceiver IF #1 output to this terminal.

#### ㉖ GND

Ground terminal. Connect to the transceiver ground terminal with the shortest lead possible.

#### ㉗ FUSE HOLDER

A 0.5A fuse is used for 117V AC line input, and a 0.3A fuse for 220 or 240V AC line input. If the fuse blows, check the cause before replacing with the supplied spare.

#### ㉘ AC POWER INPUT

Power cable connector. Accepts the supplied power cable.



## SECTION 5. OPERATION

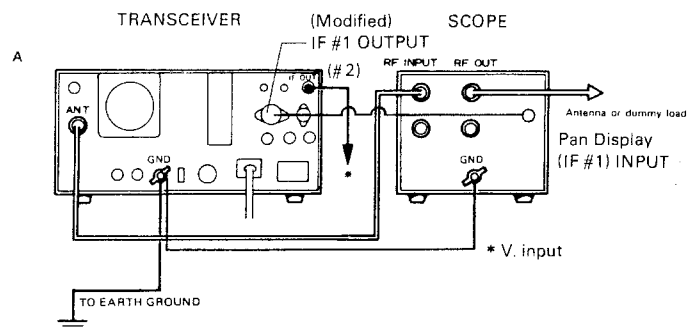
### Example A, RF output, IF Display:

TS-830, TS-180, TS-520, 530, 820

See section 5-2 for modification information.

### Connect Transceiver to Scope

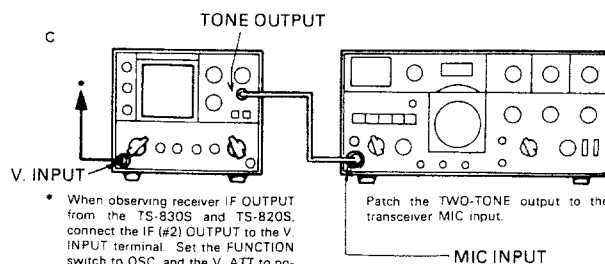
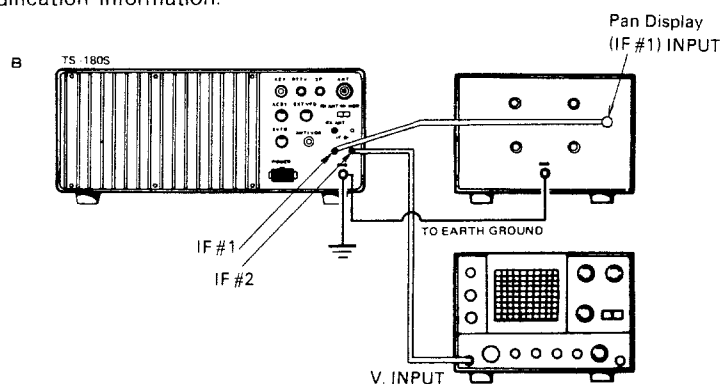
Antenna Terminal	RF Input
IF out (#2)	V. Input
IF out (#1, mixer output)	Pan Display (IF #1) input



### Example B, IF output #1 and #2:

TS-830, TS-180, TS-520, 530, 820

See section 8-6 for modification information.



• When observing receiver IF OUTPUT from the TS-830S and TS-820S, connect the IF (#2) OUTPUT to the V. INPUT terminal. Set the FUNCTION switch to OSC, and the V. ATT to position "1". The receive signal can be observed by adjusting the V. GAIN control.

Patch the TWO-TONE output to the transceiver MIC input.

Fig. 5-1. Cabling for transmit and receive displays

## 5.1 TRANSMIT SIGNAL OBSERVATION

Connect the SM-220 and transceiver as shown in Fig. 5-1.

Set the SM-220 controls as shown in Table 5-1. Adjust the transceiver for normal operation.

Speak into the microphone, the SSB signal is displayed on the CRT screen. Adjust the SWEEP-RANGE, SWEEP-VARI, and RF ATT controls for the desired display.

### Waveform examples:

Fig. 5-3 shows single tone waveforms, and Fig. 5-4 shows keyed CW waveforms.

Fig. 5-5 shows two-tone generator waveforms, when SM-220 output is patched to the transceiver microphone input terminal.

Fig. 5-6 shows voice waveforms.

## 5.2 RECEIVE SIGNAL OBSERVATION

For receive signal observation, connect the transceiver IF #2 OUTPUT terminal to the SM-220, V. INPUT terminal.

Follow the settings in Table 5-1, excepting:

FUNCTION	OSC/RTTY
V. ATT	1

Adjust the SWEEP-RANGE and SWEEP-VARI controls for the waveform desired.

### NOTE:

If the SWEEP RANGE selector is switched to the 1-10k or 10-100k position while the transceiver is in reception mode, the SM-220 sweep oscillator will interfere with reception. Avoid using these ranges in reception mode.

### NOTE, TS-820:

TS-820 IF OUTPUT #2 requires attenuation, as shown in Figure 5-2 and fabrication of a patch cord is required.

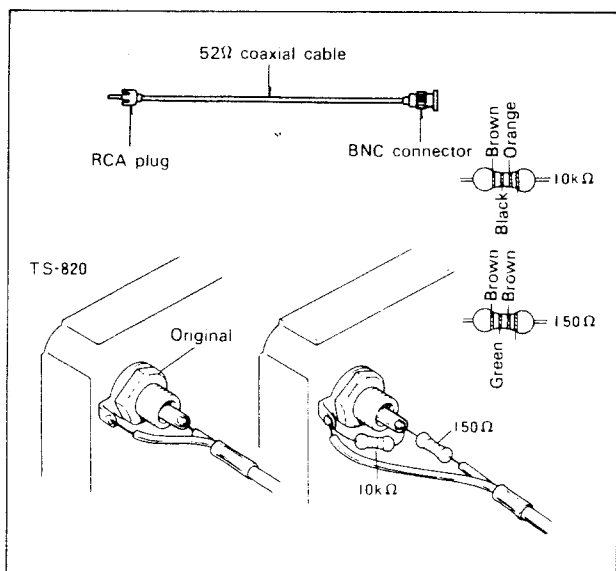


Fig. 5-2A TS-820 IF output matching

FUNCTION	MONI/TRAP
RF ATT	MIN
TONE	OFF
SYNC/MARKER	INT/OFF
SCAN WIDTH	AS DESIRED
SWEEP RANGE	10—100, 100—1K
SWEEP VARI/EXT GAIN	CENTERED
◀▶	CENTERED
▲▼	CENTERED
V. ATT	GND MONI
FOCUS	SHARPEST TRACE
INTENSITY	MINIMUM FOR GOOD TRACE VISIBILITY
POWER	ON

Table 5-1. Control settings, transmit signal observation

### NOTE, TS-520:

If, as outlined for the TS-820, a receiver IF output display is desired from your TS-520 transceiver, the following additional information applies.

### TS-520 IF #2 OUTPUT Installation (May be installed at time of BS-5 modification)

1. Remove power cable from the TS-520.
2. Remove the top cover, unplug speaker line.
3. Remove the bottom cover.
4. At the drain of Q4, add a 22 pF 25V capacitor. **Keep lead short.**
5. From the second lead of the 22 pF capacitor, add a 10k ohm 5% (or 10%) 1/4W (or 1/2W) resistor to ground. Again, keep leads short. (See Fig. 5-2B)
6. Run a 12 inch (30 cm) length of miniature 75 ohm coaxial cable from the vicinity of Q4 on the IF unit back along the wiring harness to the Remote 8P octal socket: Check for good mechanical connections, good solder connections, and no shorts.
7. Remove the 8P octal socket (2 screws) and withdraw rearward. (See Fig. 8-5, Page 20)
8. Solder the coax ground shield to Pin 1.
9. Remove the 2 speaker line leads (White/Yellow) from Pin 8, and insulate. (This prevents the possibility of feed back between the Audio and IF sections.) Connect coax inner lead to Pin 8.
10. Check for good mechanical connections, good soldering, no shorts. Reinstall the Remote socket.
11. Reinstall bottom case, reconnect the speaker, and reinstall the top case.
12. Cable-up the TS-520 and SM-220, per Fig. 5-1A. Operate per section 5-2.

**Tools Required:**

#2 Phillips screwdriver

45W (or less) soldering iron, 60/40 Rosin Core Solder

Wire stripper

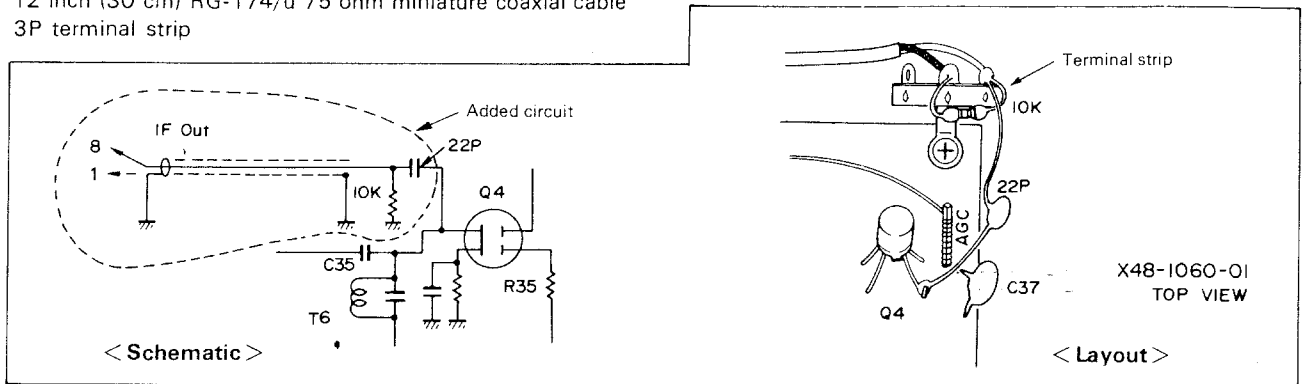
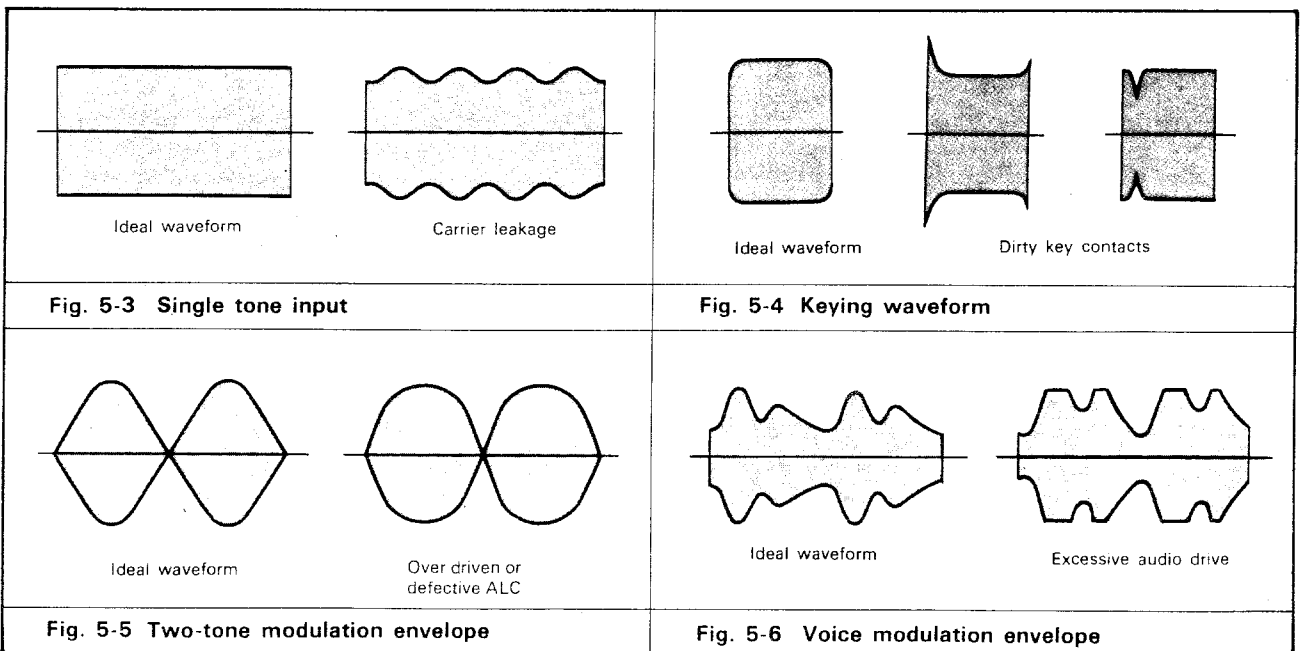
**Material Required:**

22 pF 25V capacitor

10k ohm 5%, 1/4W (or 10% 1/2W) resistor

12 inch (30 cm) RG-174/u 75 ohm miniature coaxial cable

3P terminal strip

**Fig. 5-2B TS-520 IF #2 OUTPUT installation****WAVEFORM EXAMPLES**

## TS-180S IF #2 Output

Owners of early TS-180S transceivers who desire to operate an SM-220 for IF output display will require a wiring change to the IF unit X48-1240-00. No additional parts and no adjustments are required.

Remove R77, 470 ohm, and replace with wire jumper. Remove R78, 56 ohm, and replace with old R77. The 56 ohm resistor is not used. With AGC on, gain should now be adequate for about a 3/4 screen display.

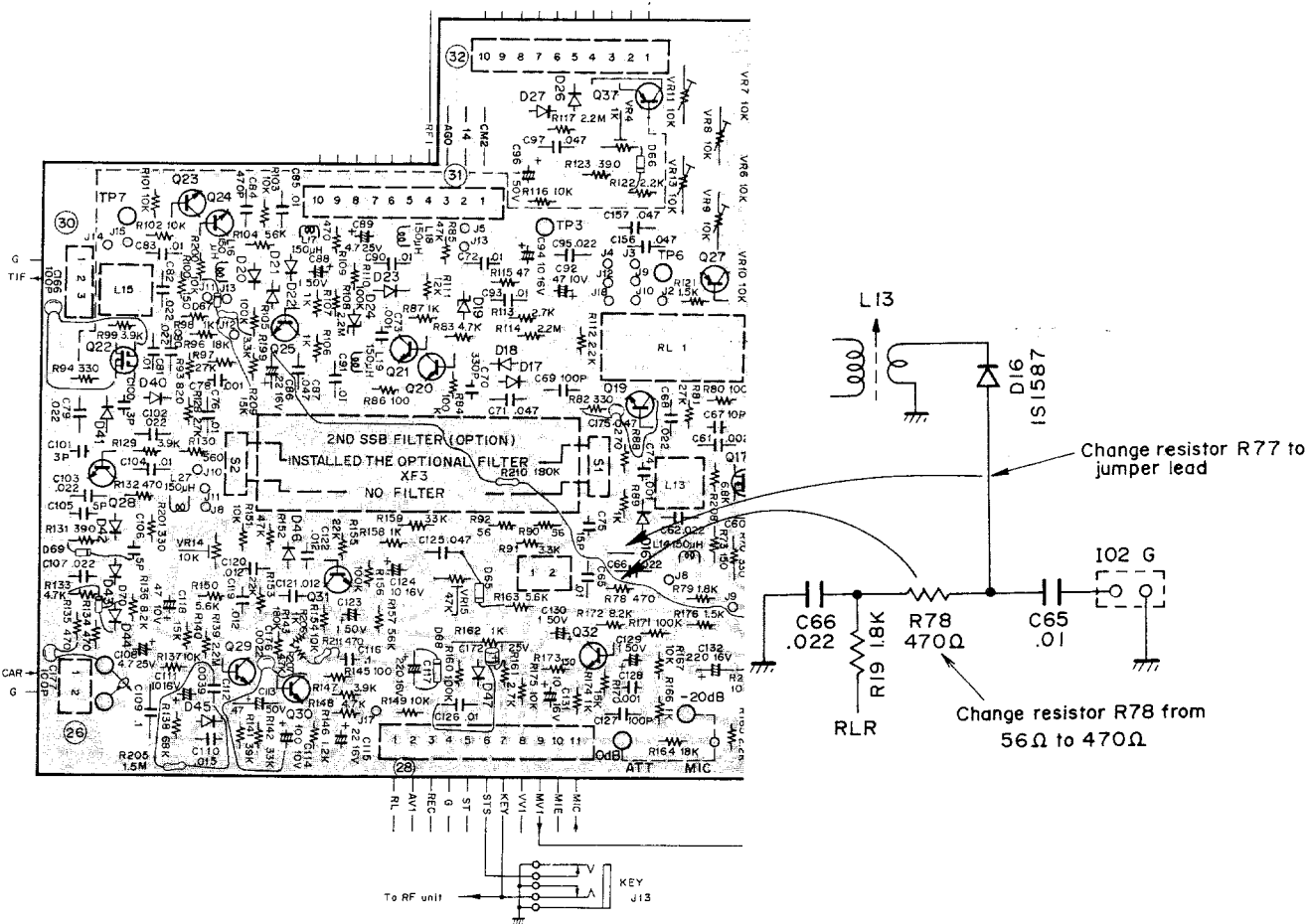


Fig. 5-7 TS-180S, for IF output display, wiring

### NOTE:

For additional display information and examples, consult such sources as the radio amateur's handbook, radio handbook, etc.

### 5.3 TRAPEZOID WAVEFORM OBSERVATION

To observe power amplifier linearity, connect the equipment as shown in Fig. 5-9.

**NOTE:**

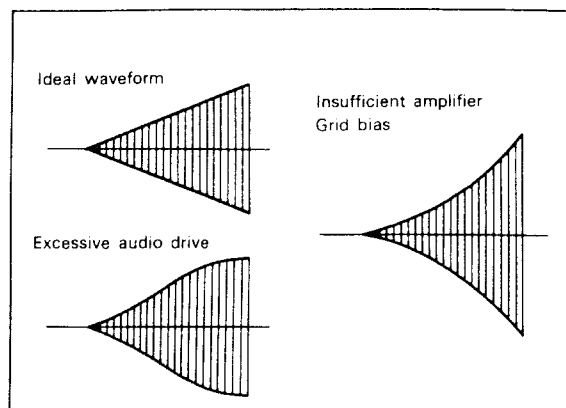
You must unplug the microphone to use the two-tone input cable.

Adjust the transceiver and linear amplifier for normal operation. Set the SM-220 controls as follows:

FUNCTION	MONI/TRAP
RF ATT	MIN
TONE	TWO TONE
MARKER/SYNC	INT
SWEEP RANGE	TRAP
SWEEP VARI/EXT GAIN	CENTERED
◀▶	CENTERED
◀▶	CENTERED
V. ATT	MONI

**Table 5-2. Control settings, trapezoid waveform observation**

When the waveform appears on the scope screen, adjust the RF ATT, SWEEP VARI/EXT GAIN, ◀▶, and ▶▶ controls for the waveform size desired. Amplifier linearity can be analyzed from the waveform displayed on the screen. Fig. 5-8 shows typical waveforms.



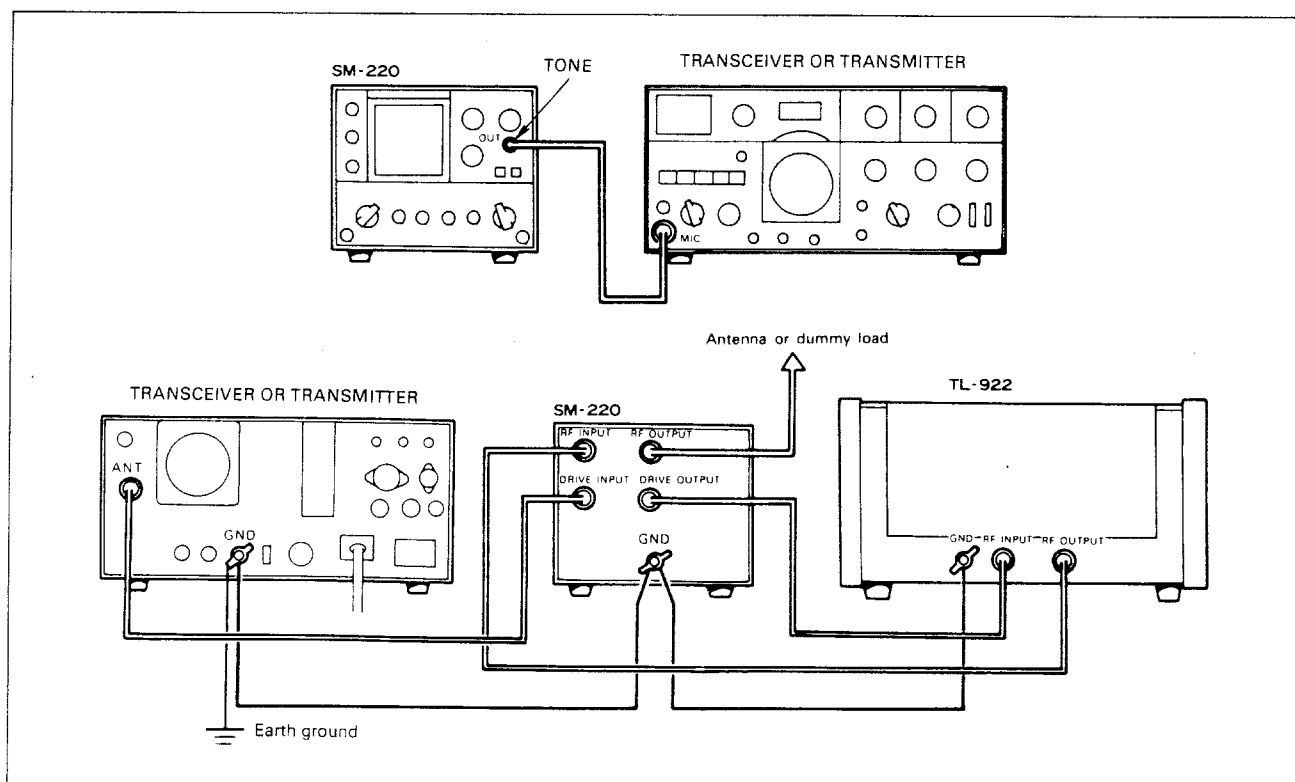
**Fig. 5-8. Trapezoid waveforms**

**CAUTION:**

Don't burn your CRT screen by allowing the "DOT" to remain displayed at high intensity during NO-TRANSMIT periods. A burned CRT is not covered by warranty. Move the dot off the screen, or reduce trace intensity.

**NOTE:**

A trapezoid pattern may be observed with the linear amplifier OFF, but it is meaningless, as it is only a display of the exciter referenced to itself.



**Fig. 5-9. Connection for trapezoid waveform observation**

## 5.4 RTTY CROSS-PATTERN OBSERVATION

To display an RTTY cross-pattern, connect the equipment as shown in Fig. 5-11. Set the SM-220 controls as follows:

FUNCTION	OSC/RTTY
SWEEP RANGE	RTTY/EXT
SWEEP VARI/EXT GAIN	CENTERED
◀▶	CENTERED
⬆⬇	CENTERED
V. GAIN	CENTERED
V. ATT	"1"
FOCUS	SHARPEST TRACE
INTENSITY	MINIMUM FOR GOOD TRACE VISIBILITY
POWER	ON

Table 5-3. Control settings, RTTY cross-pattern display

While receiving an RTTY signal, adjust the V. ATT, V. GAIN and SWEEP VARI/EXT GAIN controls for the desired display size. Fig. 5-10-A pattern shows optimum tuning. Fig. 5-10-B pattern shows off-tuning. Fig. 5-10-C pattern shows the demodulator filter "Q" to be low. A horizontal line is displayed for a Mark signal, and a vertical line is displayed for a Space signal.

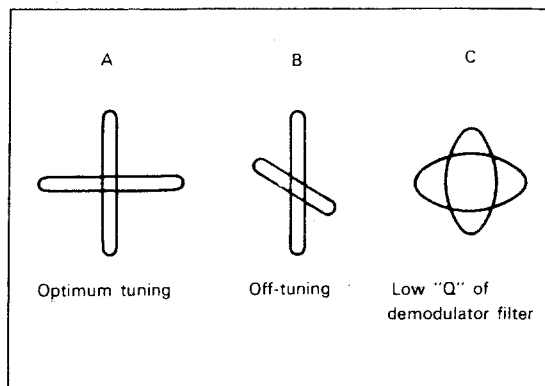


Fig. 5-10. RTTY cross-patterns

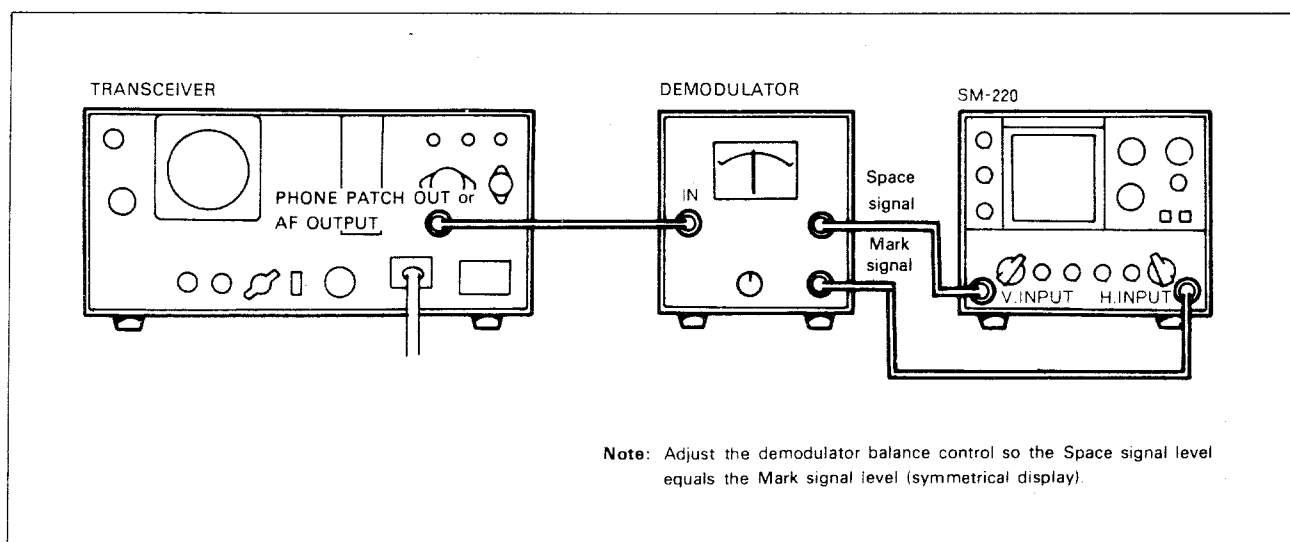


Fig. 5-11. Cabling for RTTY cross-pattern observation

## 5.5 OSCILLOSCOPE OPERATION

The SM-220 will provide excellent oscilloscope performance. It features wide bandwidth (2 Hz ~ 10 MHz) and high sensitivity (20 mV/DIV), and is designed for general transceiver measurements.

The oscilloscope permits display of various waveforms (sine, square wave, carrier, modulation envelope, SSB, etc.) in the 2 Hz 10 MHz frequency range.

For oscilloscope operation, set the FUNCTION switch

to OSC/RTTY. The signal to be measured is connected to the V. INPUT terminal.

1. Measurement of 2 Hz ~ 10 MHz waveforms (Sine, square wave, carrier, modulation envelope, SSB.)
2. Measurement of Lissajous' figures (Ex. Fig. 5-12). (Set the sweep range selector switch to RTTY/EXT, and connect an audio frequency generator as an external sweep source, to the horizontal input terminal.)

FUNCTION	OSC/RTTY
RF ATT	AS DESIRED
SWEEP RANGE	RTTY/EXT
SWEEP VARI/EXT GAIN	CENTERED
◀▶	CENTERED
▲▼	CENTERED
V. GAIN	CENTERED
V. ATT	AS DESIRED

Table 5-4. Control settings, oscilloscope operation

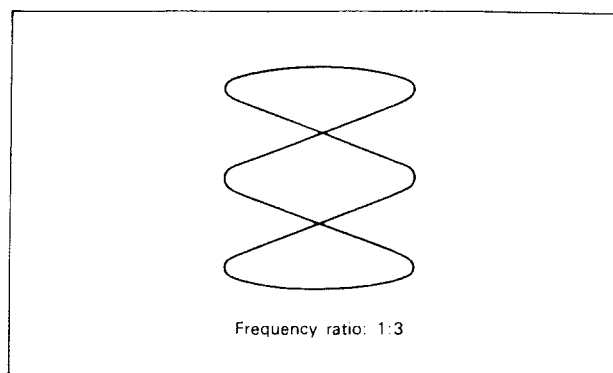


Fig. 5-12. Example, Lissajous' figure

## SECTION 6. CIRCUIT DESCRIPTION

### 6.1 VERTICAL CIRCUITS

The input signal connected to the V. INPUT is fed through a DC blocking capacitor, to the step attenuator, and is applied to the vertical amplifiers.

The vertical amplifier, a direct-coupled differential amplifier using FET input, amplifies signals from 2 Hz ~ 10 MHz. Amplifier gain is approximately 54 dB. Attenuation, gain and position controls are provided externally, and DC balance is accessed through the bottom cover.

### 6.2 HORIZONTAL CIRCUITS

The horizontal circuit is composed of a saw-tooth time base oscillator and a horizontal amplifier circuit. The saw-tooth oscillator (Q118, Q119) is provided with a DC level stabilizer.

The horizontal amplifier is a direct-coupled differential amplifier using an FET (Q122) input. Amplifier gain is approximately 30 dB, and is variable approximately 10 dB by the H. GAIN control. Sweep range, variable sweep, position and gain controls are provided.

### 6.3 MONITOR CIRCUIT AND TWO-TONE AUDIO GENERATOR

Transmit RF power is applied to the vertical deflection plates through the RF ATT. This signal is also sampled and applied via the detector circuit to the horizontal amplifier as a sync signal. During trapezoid waveform observation, exciter power from the DRIVE circuit is sampled and detected, and fed to the horizontal amplifier.

The Wien bridge two-tone generator provides a stable 1000 Hz and 1575 Hz audio signal.

### 6.4 POWER SUPPLY

The power supply provides regulated  $\pm 12V$ , 150V for the final amplifier, and 1.3 kV for the CRT.

# BLOCK DIAGRAM

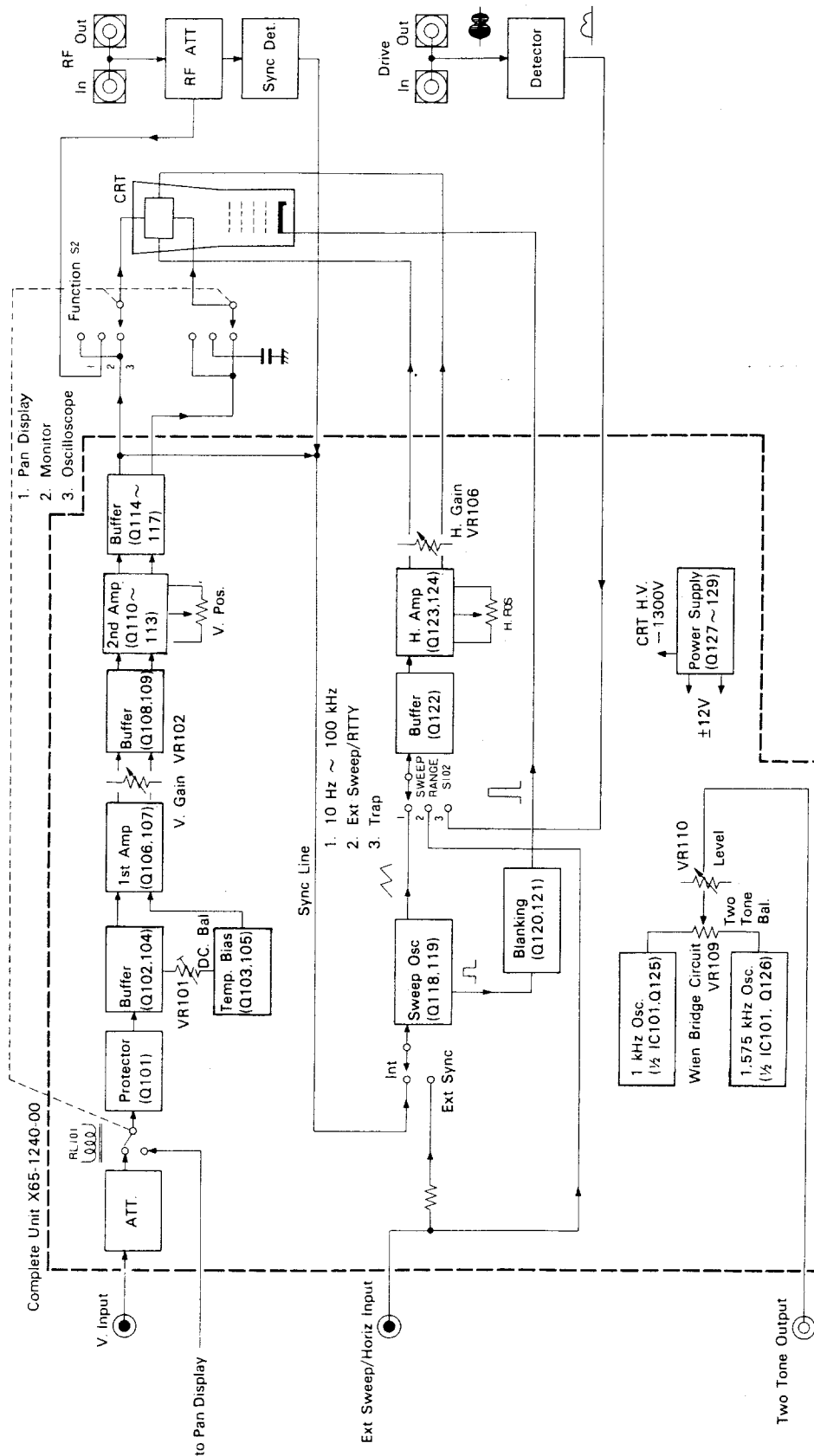


Fig. 6-1. Block Diagram



## SECTION 7. ADJUSTMENTS AND MAINTENANCE

### 7.1 GENERAL INFORMATION

Your SM-220 has been factory aligned and tested to specification before shipment. Under normal circumstances it will require no further attention if operated in accordance with the instructions in this manual. If, however, readjustment becomes necessary, the following procedures may be performed. Any other adjustments should be referred to your dealer.

Attempting further service or adjustment without factory authorization can void the instruments warranty.

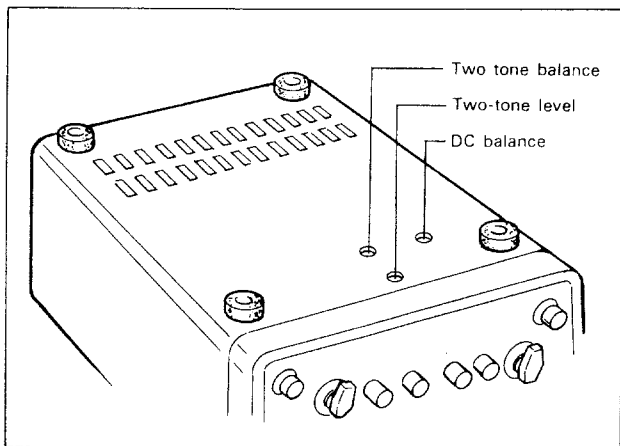


Fig. 7-1. Adjustment access (case bottom)

### 7.2 VERTICAL DC BALANCE

If the vertical trace shifts up and down as the V. GAIN control is set, adjust the DC BAL pot for a stationary display.

This adjustment should be made after the unit is stabilized (about 15 minutes).

Set the V. ATT to GND and turn the V. GAIN fully counterclockwise. Set the  $\blacktriangle$  (vertical) POSITION to the screen center line.

Turn the V. GAIN clockwise: if the trace shifts up or down, adjust the DC BAL pot (VR101 on the printed circuit board) so the trace returns to its original position. Repeat this adjustment until the trace remains stationary when the V. GAIN control is adjusted.

### 7.3 TWO-TONE BALANCE

The 1000 Hz and 1575 Hz oscillators are factory adjusted for equal level. If the displayed transmit signal waveform is not as shown in Fig. 7-2A, it indicates the two-tone generator is unbalanced due to either the transceiver IF crystal filter or MIC amplifiers characteristics. This may be corrected by adjusting the balance control, VR109 in either LSB or USB mode, whichever is used more frequently. Two-tone output level is adjusted with VR110 (two-tone level adj.).

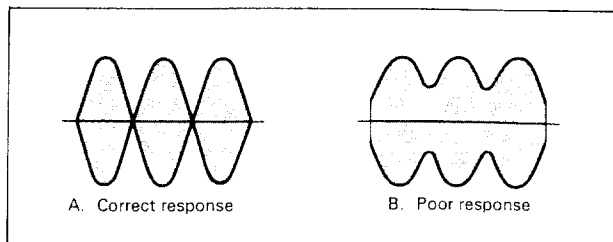


Fig. 7-2. Two-tone oscillator waveform

### 7.4 ORDERING SPARE PARTS

When ordering replacement or spare parts for your equipment, be sure to specify the following information: Model and serial number of the equipment. Schematic number of the part. Printed circuit board number on which the part is located. Part number and name, if known, and quantity desired.

#### NOTE:

A full Service Manual is available as a separate publication.

### 7.5 SERVICE

Should it ever become necessary to return the equipment for repair, pack in its original boxes and packing, and include a full description of the problems involved. Also include your telephone number. You need not return accessory items unless directly related to the service problem.

You may return your radio for service to the Authorized Kenwood Dealer from whom you purchased it. A copy of the service report will be returned with the unit. Please do not send sub-assemblies or printed circuit boards send the complete unit, in its original boxes and packing. If you want verification of receipt, please supply a self-addressed card (or letter) and you will be informed of the date of receipt and estimated service time.

#### SERVICE NOTE:

Dear OM, if you desire to correspond on a technical or operational problem, please make your note short, complete, and to the point. And PLEASE make it readable.

Please list: Model and serial number.

The question or problem you are having. Please give sufficient detail to diagnose; other equipment in the station, meter readings and anything you feel might be useful in attempting diagnosis.

#### NOTE:

1. Record the date of purchase, serial number and dealer from whom purchased.
2. For your own information, retain a written record of any maintenance performed on the unit.
3. When claiming warranty service, please include a photocopy of the bill of sale, or other proof of purchase showing the date of sale.

## SECTION 8. PAN DISPLAY OPTION

### 8-1. GENERAL INFORMATION

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.

The BS-5 is designed to match 3.395 MHz intermediate frequency equipment, and the BS-8 matches 8.830 MHz intermediate frequency.

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

When using either the BS-5 or BS-8 with a TS-520 or TS-820 series (or older) transceiver, a minor wiring addition is required in the transceiver.

#### Accessories Supplied:

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

### 8.2 DESCRIPTION OF THE BS-5 AND BS-8 PAN DISPLAY

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 viewed 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.

### 8.3 BS-5/BS-8 INSTALLATION (See Fig. 8-1)

#### WARNING:

Disconnect the AC Power Cable before opening the SM-220.

1. Remove the upper and lower cases.
2. Insert the 4-pin keyed connector (from the RCA jack) in the rear, and the 9-pin keyed connector in the front through the windows provided on each side of the adapter housing.
3. Mount the Pan Display unit to the frame with the 4 supplied screws.
4. Insert the 4-pin keyed connector in position P101, left front (adjacent to the V. ATT shield), and the 7-pin keyed connector in position P110, right side, (adjacent to the main filter capacitors).
5. Replace the original graticule with the one supplies in the Pan Display kit. (Covers remain off until adjustments are completed.)

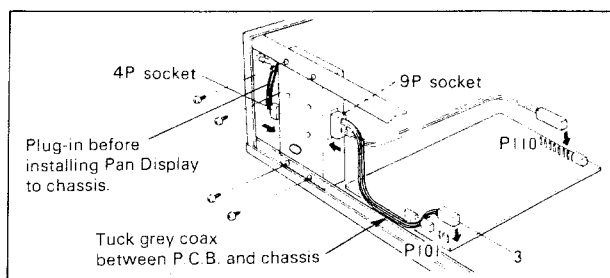


Fig. 8-1. Installing the Pan Display adapter

### 8.4 PAN DISPLAY ADJUSTMENT (See Fig. 8-2 and Table 8-1)

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

1. Cable-up the equipment as shown in Figure 5-1, page 9. Transceiver IF output #1 goes to the SM-220 IF input on the rear panel.
- NOTE:** Keep the IF #1 cable separate from other cables to prevent the possibility of unwanted oscillation.
2. Set the SM-220 FUNCTION switch to BAND SCOPE (Pan Display).
3. Depress the MARKER switch (ON), center the display by the  $\blacktriangleleft \blacktriangleright$  POSITION control and center the V. GAIN control. Adjust the  $\blacktriangleup$  POSITION to shift the trace to the bottom of the graticule.

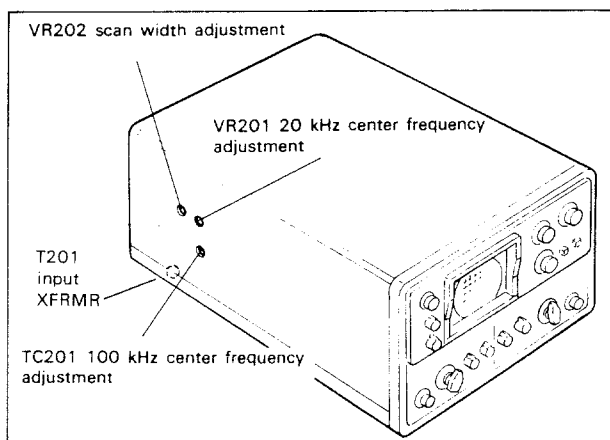


Fig. 8-2. Pan Display adjustment

4. Warm up the equipment for 15 minutes.
5. Preset TC201, VR201 and VR202 at their center. When alignment is complete, these adjustments should not be at their extreme points. This will result in an unstable or drifting Pan Display. Rather, they should be somewhat within their center range.
6. Place the radio in USB and turn the scope Marker ON. Listening on any band, you should hear the scope Marker directly injected into the transceiver IF. Peak T201, the Pan Display input transformer, for maximum

signal into the radio. If you cannot hear the scope Marker, proceed to step 7 for TS-180 transceivers. Proceed to step 12.

7. (If step 6 was successful, skip this step.)

Turn the scope Marker OFF and turn the radio 25 kHz Calibrator ON. Peak the drive control and then peak T201 for maximum scope amplitude at center screen, and approximately equal roll-off at the display edges.

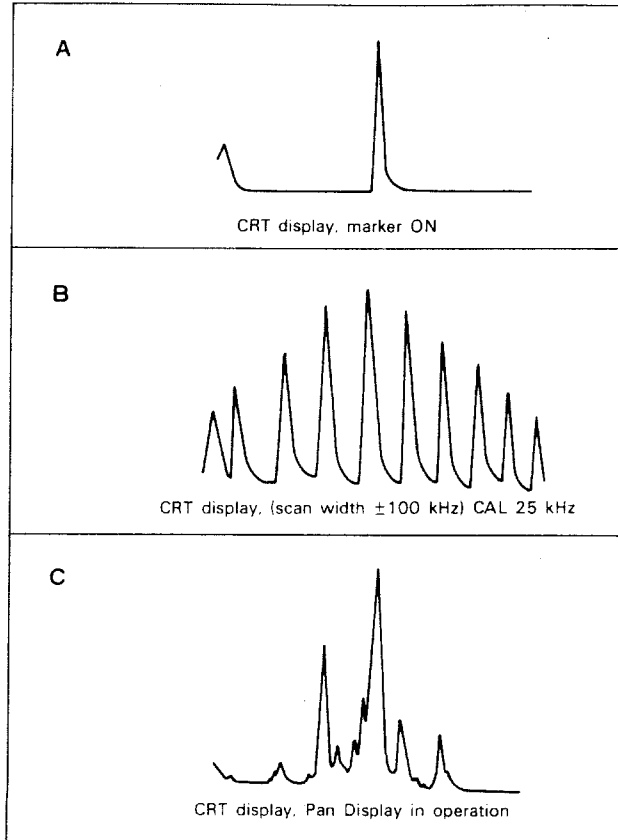


Fig. 8-3. Pan Display waveforms

8. Turn on both the scope Marker and the 25 kHz Calibrator. Tune the radio to almost zero-beat these two signals with a 2 to 5 Hz difference. You will see a display somewhat like Fig. 8-3B. One spike will rise and fall in time with the beat. This is the center frequency marker. (Turn OFF the 25 kHz Marker to verify this.)
- Using two tuning tools, alternately adjust TC201 (100 kHz fc) and VR202 (Scan width) for a display as shown in Fig. 8-3B.
9. Turn OFF the 25 kHz Calibrator to verify center frequency. Repeat step 5 if necessary.
10. With the scope Marker ON, place the  $\pm 100/20$  kHz switch to  $\pm 20$  kHz. Adjust VR201 to center the Marker on the display. When switching between the wide and narrow scope modes the Marker should remain at the center line and should not shift. Repeat this step if there is shift.

11. Replace the top and bottom covers when alignment is completed.

FUNCTION	BAND SCOPE
SYNC/MARKER	AS REQUIRED
SCAN WIDTH	AS DESIRED
SWEEP RANGE	10 ~ 100 Hz
SWEEP VARI	APPROX. 3 O'CLOCK
◀▶	CENTERED
▲▼	LOWER DIVISION
V. GAIN	CENTERED

Table 8-1. Pan Display settings

12. TS-180S only (after completing steps 1 ~ 6): If you cannot hear the scope Marker in the TS-180S, turn the Marker OFF and tune a local station on the 1.5 MHz band. Peak the drive control, and then peak T1 in the BS-8 for maximum amplitude at scope center and equal roll-off at the display edges.
- NOTE:** A BS-8 previously aligned to a TS-820 or TS-820S need only have step 6, input alignment, performed.
13. Turn on TS-180S, 1.5 MHz band, and tune to the local AM broadcast station nearest 1.6 MHz.
14. Enter this frequency in the M1 Memory. Depress the DSP/Diff pushbutton for a differential display.
15. Tune up and down approximately 100 kHz, observing the scope display. Note the vertical displacement of the original frequency to the left and right. If equal, or linear displacement is observed, stop.
16. If the display does not shift equally when tuned up or down frequency, adjust VR202 for linearity of scan width. Then reset to the center frequency (by the scope Marker or retuning the transceiver). Reset TC201 if necessary. Repeat two or three times for correct scope center frequency, and linear display.
17. Turn the TS-180S OFF, and the scope Marker ON. Switching between 100 kHz and 20 kHz scan widths, the Marker should appear at scope center, and should not shift. Repeat step 5 if there is shift.

## 8.5 OPERATION OF THE BS-5/BS-8

- Set the SM-220 FUNCTION and SWEEP VARI switch to the Pan Display (Band Scope) position.
- Temporarily disconnect the antenna or use the transceiver RF gain control or RF attenuator to reduce incoming received signals.
- Adjust the ▲ POSITION until the trace coincides with the major line at the bottom of the graticule. Turn the scope Marker ON and adjust the ▶ POSITION so the marker signal is centered.
- Turn the Marker OFF, reconnect the antenna or increase the RF gain to receive incoming signals.

A display similar to Fig. 8-3C should appear on the scope. You will see more signals on a crowded band, and few or no signals on an empty band. Adjust the sweep speed so the display doesn't flicker. Excessive scan speed will distort or elongate the display.

**NOTE:** If output #1 is taken before the noise blanker, noise on the band will not be removed by the noise blanker.

Transceiver Model	Adapter	Signal Source
TS-180 series	BS-8	IF output #1 (no change required).
TS-511 series	BS-5	NB unit X54-1000-00, NB 1 pin output through a 5 pF cap. (Not standard supplied cap.)
TS-520 series	BS-5	NB unit X54-1080-10, IN pin output through a 100 pF cap. (See detailed description section 8-6.)
R-599 series	BS-5	Same point take-off as TS-520 series.
TS-820 series	BS-8	IF unit X48-1150-00, RIF pin input through a 47 pF cap. (See detailed description section 8-6.)
TS-830 series	BS-8	IF output #1 (no change required).
TS-900 series	BS-5	NB unit X54-1040-10, pin 31 through a 1000 pF cap. (Not standard supplied cap.)

Table 8-2. Pan Display signal source

## 8.6 TRANSCEIVER MODIFICATION

TS-520 and TS-820 series transceivers have no Pan Display (IF #1) OUTPUT terminals: the coaxial cable with capacitor supplied with the adapter must be installed as follows:

1. Installation of the coaxial cable with RCA plug.  
Solder the cable to the transceiver Remote 8P (octal) plug as shown in Fig. 8-4.
2. TS-520 series IF sample cable.

### WARNING:

Disconnect the AC power cable before opening the transceiver.

Remove the cases and solder the capacitor side of the coaxial cable to the INPUT and GND terminals on the NB UNIT (X54-1080-10) printed circuit board located on the left side of the transceiver as viewed from the front. Solder the other end of the cable to the Remote 8P (octal) plug, Pin 1 and Pin 2. (Refer to Fig. 8-5.)

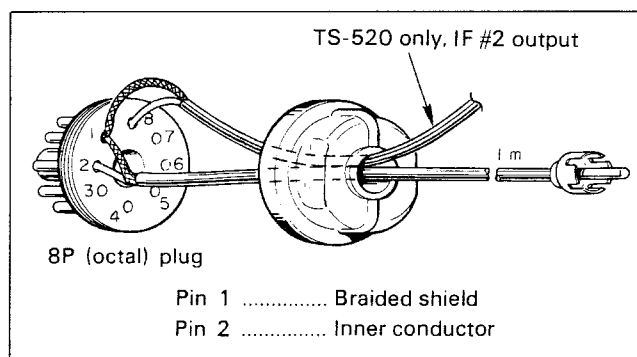


Fig. 8-4. Pan Display output cable

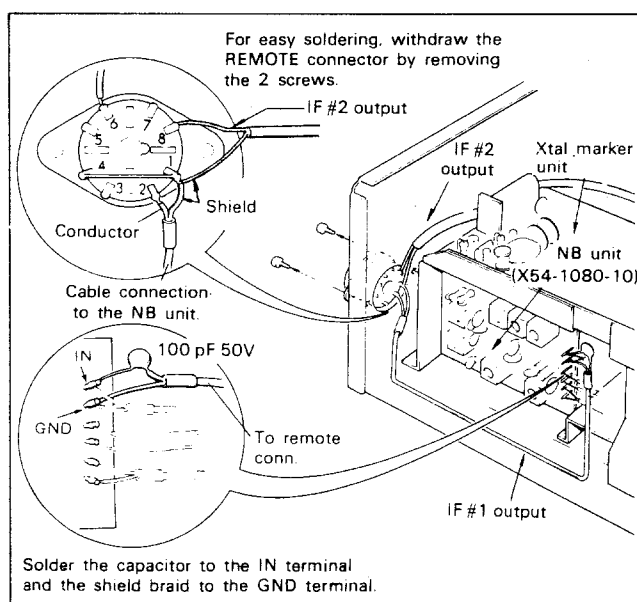


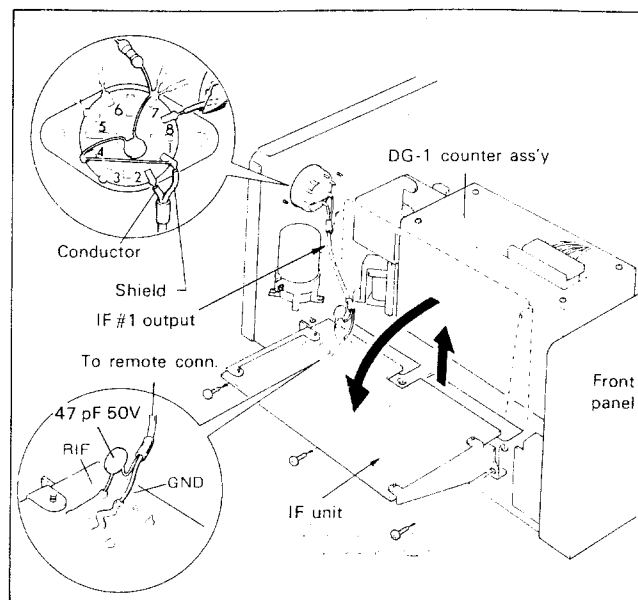
Fig. 8-5. TS-520 series IF sample cable installation

### 3. TS-820 series IF sample cable.

#### **WARNING:**

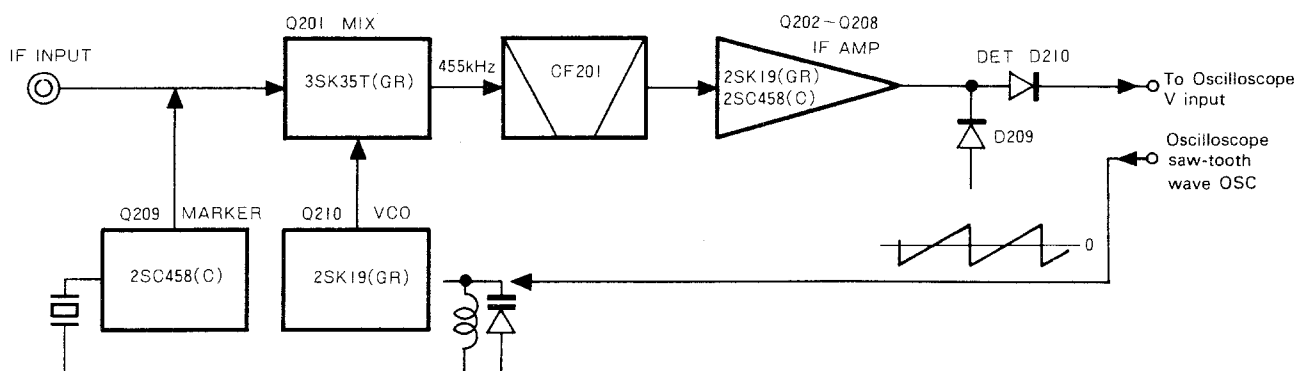
Disconnect the AC power cable before opening the transceiver.

- Remove the cases and solder the capacitor side of the coaxial cable to the RIF GND terminal on the bottom of the IF UNIT (X48-1150-00) printed circuit board, located on the left side of the transceiver as viewed from the front. Solder the other end of the cable to the Remote 8P (octal) plug: Pin 1 (shield braid) and Pin 2 (conductor). The green leads between PHONE PATCH OUT and Pin 8 of the remote plug should be cut off, soldered, and insulated. (Refer to Fig. 8.6.)
- For a received signal display (IF #2), solder the supplied matching resistors to the IF OUTPUT terminal. Leads must be as short as possible. (Refer to Fig. 5-2A, page 10)



**Fig. 8-6. TS-820 series IF sample cable installation**

### 8.7 BS-5, BS-8 BLOCK DIAGRAM



**Fig. 8-7. BS-5, BS-8 Block Diagram**

#### **BS-8 UNIT (X65-1250-00)**

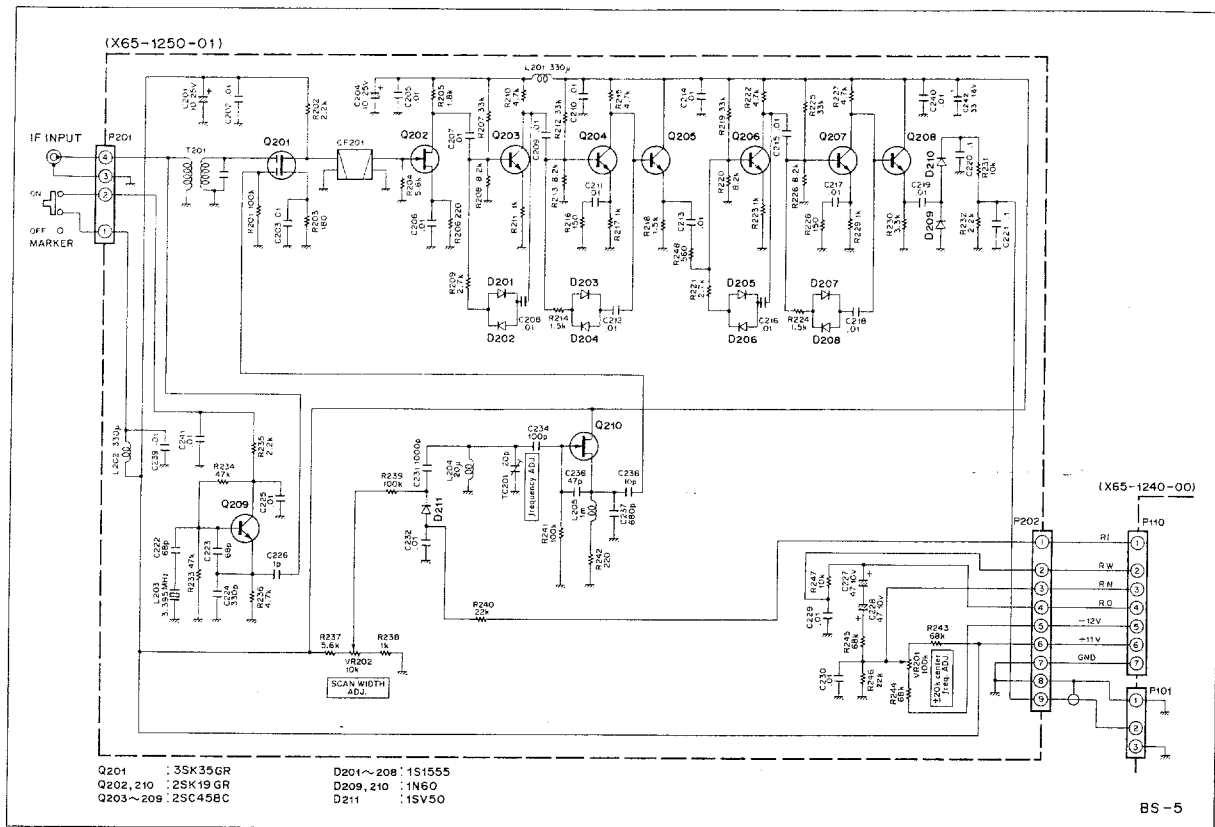
#### **BS-5 UNIT (X65-1250-01)**

#### **COMPARATIVE TABLE**

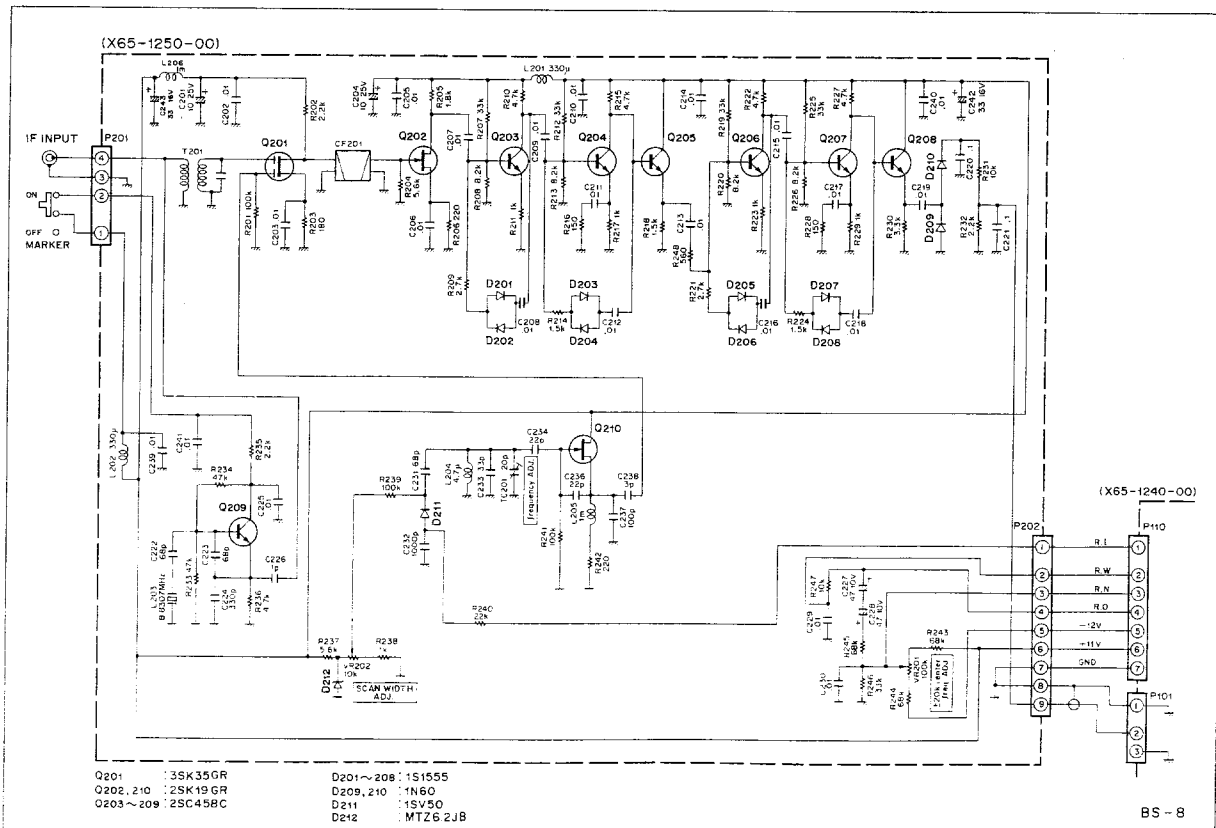
	C231	C232	C233	C234	C236	C237	L203	L204	T201
BS-8	68pF	1000pF	33pF	22pF	22pF	100pF	8.8307MHz	4.7μH	L34-0527-05
BS-5	1000pF	0.01μF	—	100pF	47pF	680pF	3.395MHz	20μH	L31-0286-05

**Table 8-3. BS-8, BS-5 Comparative table**

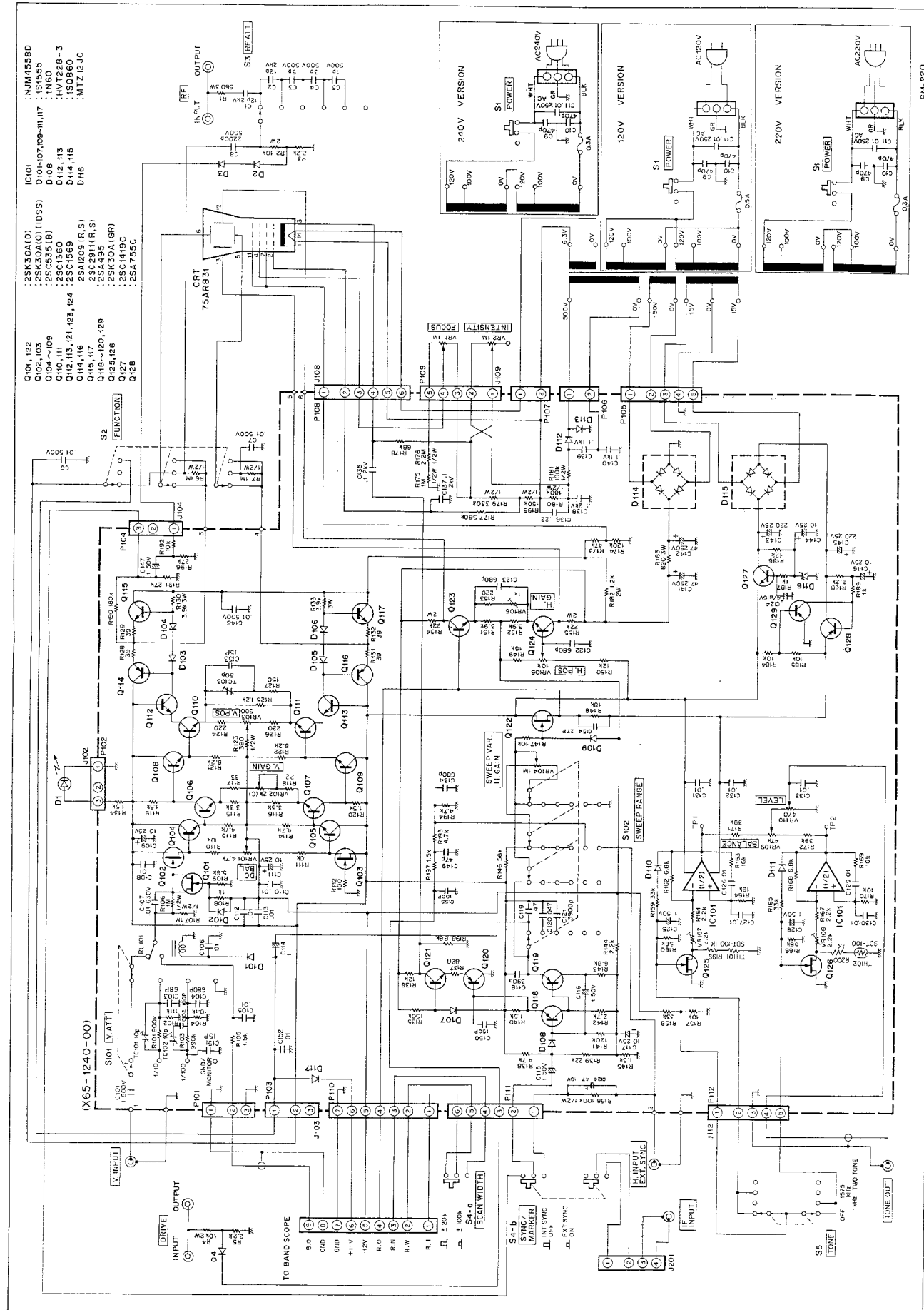
## BS-5 SCHEMATIC DIAGRAM



## BS-8 SCHEMATIC DIAGRAM

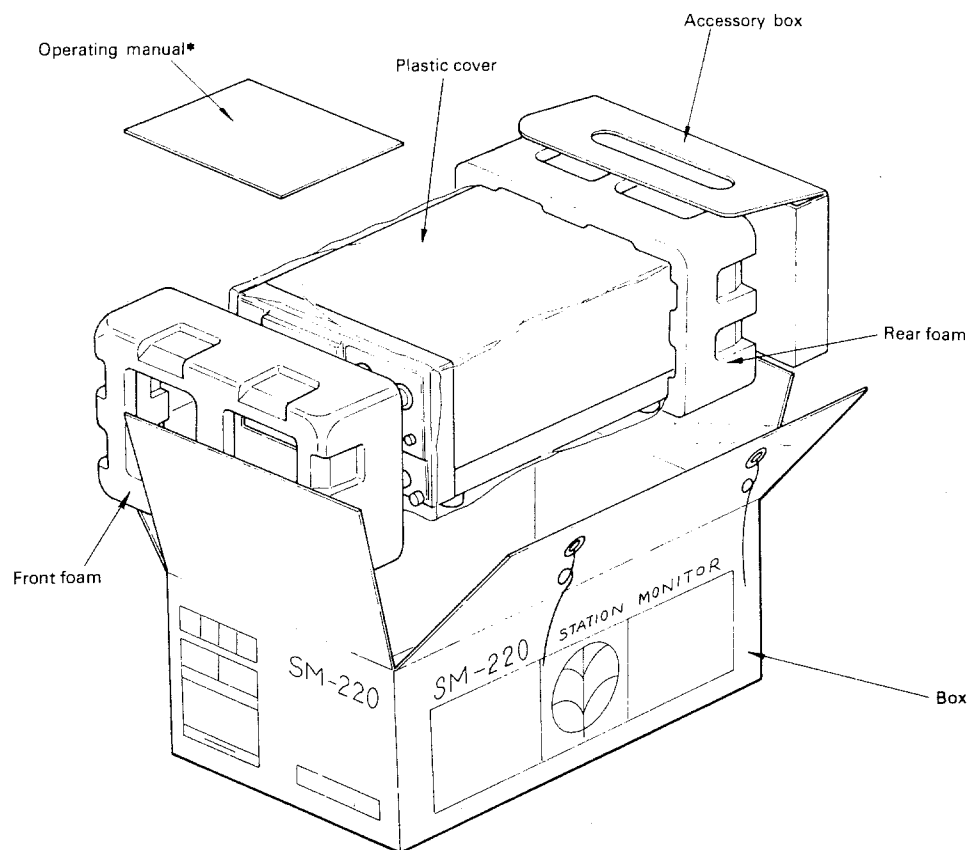


# SECTION 9. SCHEMATIC DIAGRAM SM-220

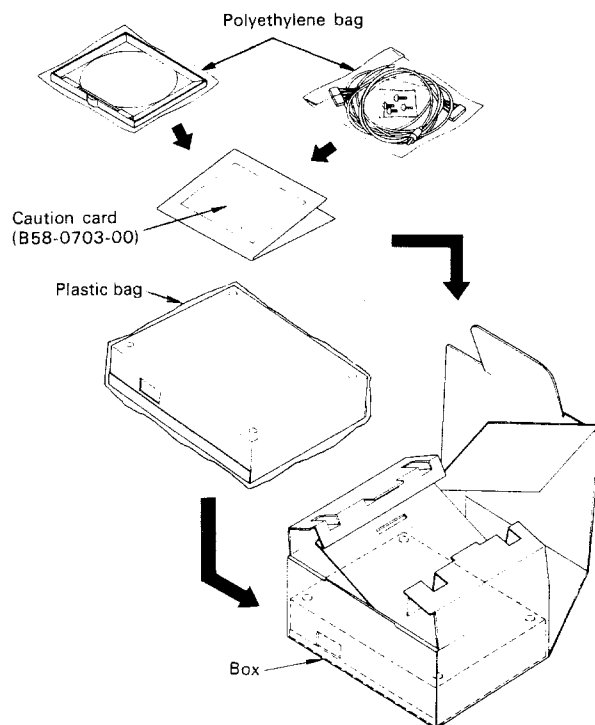


## SECTION 10. PACKING

### SM-220



### BS-5/BS-8





Model SM-220

Serial No. \_\_\_\_\_

Date of Purchase \_\_\_\_/\_\_\_\_/\_\_\_\_

Dealer \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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