



KC-6060A

SOLID STATE AUDIO LAB-SCOPE

INSTRUCTION MANUAL



WELCOME TO KENWOOD'S ALL NEW SOLID STATE CIRCUITRY

Your KENWOOD KC-6060A AUDIO LABORATORY SCOPE is part of KENWOOD's new collection of precision engineered products with space age solid state circuitry. Its superior performance is the result of KENWOOD's engineers' many years of research in the field of test instrument.

Your KC-6060A is a truly professional test instrument that incorporates all the functional features, such as a large scope and an oscillator, required to meet the standard of professional scope. KC-6060A is specially designed to test your FM tuners and amplifiers so that you may enjoy the best possible performance for listening pleasure.

Go ahead — enjoy it! Your KENWOOD KC-6060A has been made under the most rigid quality control.

Read this manual carefully before you begin to install your unit. Only by proper installation will you be able to enjoy KC-6060A's many extra features.

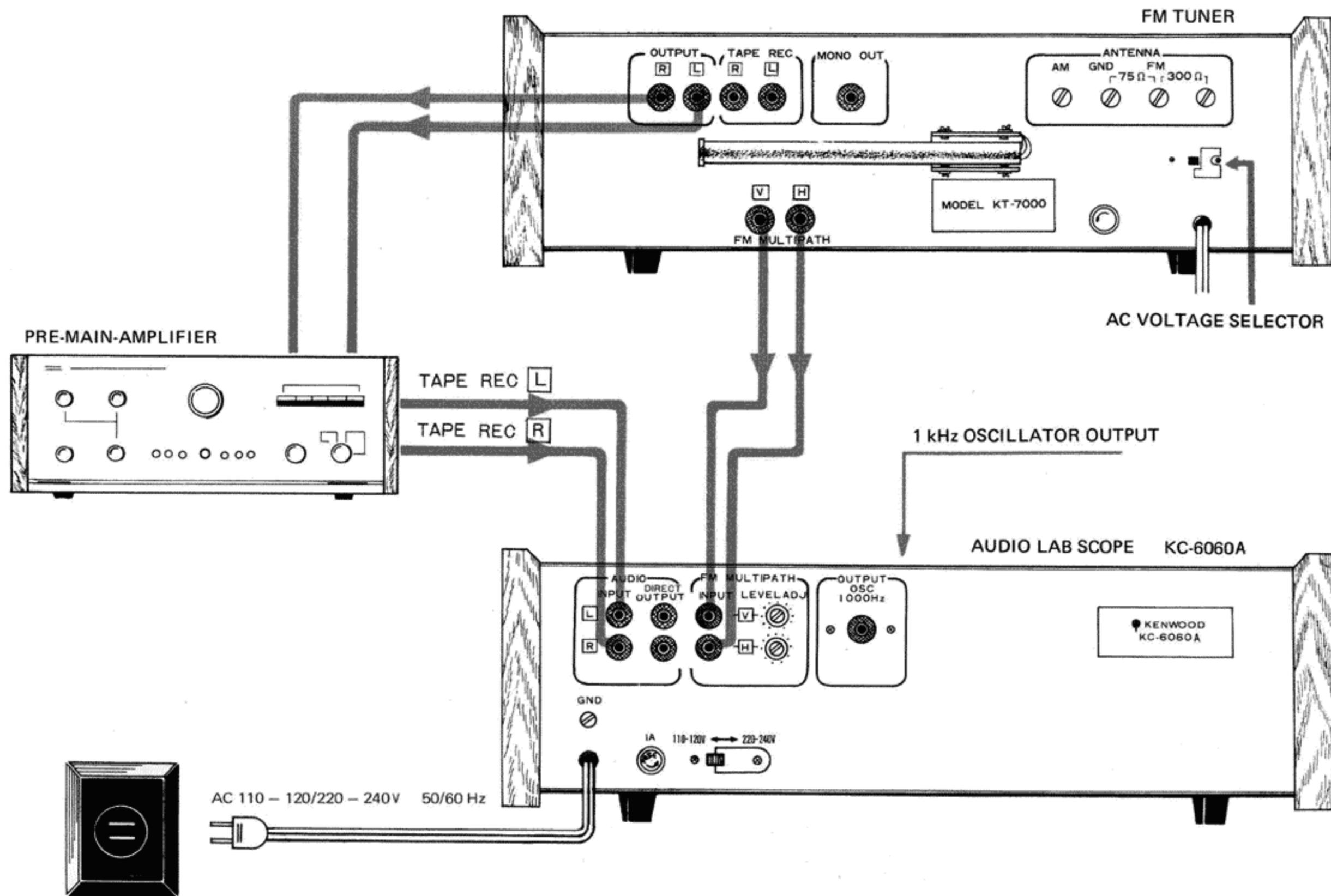
WARRANTY REGISTRATION

IMPORTANT: Fill out your warranty registration and mail it at once.

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TYPICAL SET-UP DIAGRAM



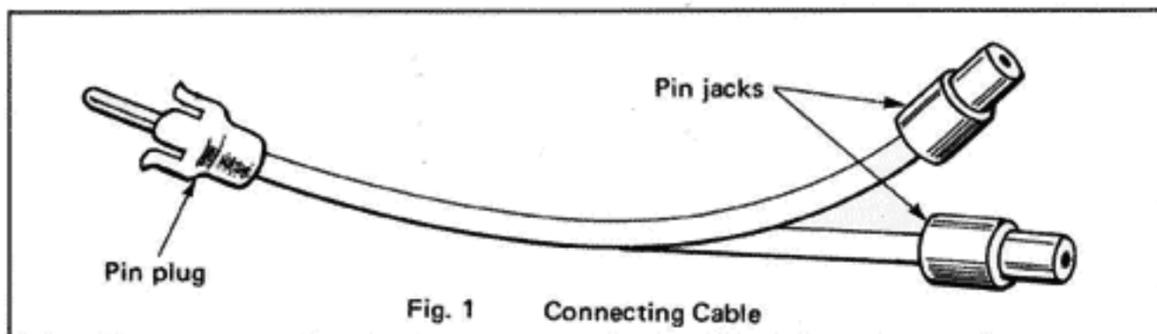
HOW TO CONNECT

■ CONNECTION WITH TUNER AND AMPLIFIER

By connecting KC-6060A to Tuner and Amplifier, you can observe FM Multipath, Audio Signal Waveform and Audio Lissajous Figures.

(1) Audio Signal Display

The shielded cable with RCA type phono plugs is supplied to connect the AUDIO INPUT jacks or terminals of KC-6060A to the TAPE REC jacks of amplifier. For using the Tape Recorder simultaneously with KC-6060A, use the cable which is shown in Figure 1.



(2) FM Multipath Display

The shielded cable with RCA type phono plugs is supplied to connect **V** and **H** FM MULTIPATH input jacks of KC-6060A to **V** (Vertical) and **H** (Horizontal) FM MULTIPATH output jacks of tuner.

(3) DIRECT OUT

The audio signal is obtained from the TAPE REC jacks of the pre-main amplifier (or tuner). If no other TAPE REC jacks are available, the DIRECT OUT jacks should be used. The INPUT jacks of KC-6060A is directly connected to the DIRECT OUT jacks.

■ FRONT PANEL AUDIO INPUT

For normal laboratory testing, use the front panel AUDIO INPUT terminals and turn the AUDIO INPUT lever switch to FRONT position. These inputs can be used when SELECTOR switch is set at WAVEFORM LEFT, WAVEFORM RIGHT or STEREO DISPLAY.

■ 1 kHz OSCILLATOR

The output jack for the built-in 1 kHz sine wave oscillator is provided on the rear panel. Output Level varies from Zero to One volt rms continuously by using 1 kHz OSC volume on front panel.

■ POWER

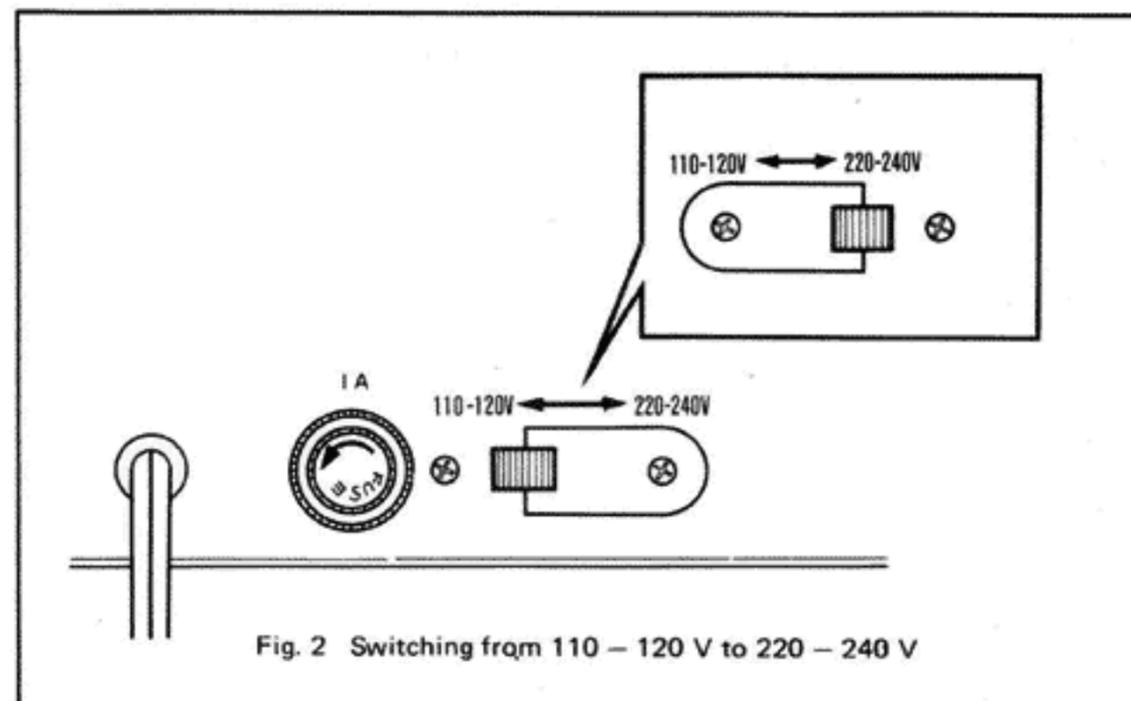
Plug the AC line cord into an outlet supplying 110-120 volts AC, 50-60 Hz.

NOTE: AC VOLTAGE SELECTION

This unit is pre-set to be used at 110-120 volts AC.

In countries with 220-240 volts AC, change the AC switch from 110-120 volts to 220-240 volts as follows:

1. Turn the power switch to "OFF".
2. Remove stopper plate affixed to the AC switch on the rear panel.
3. Set the slide switch to the right.
4. Affix stopper plate to the opposite side.



FRONT PANEL CONTROLS



1 DISPLAY SCREEN

2 SELECTOR PILOT LAMP

Indicates SELECTOR position and type of input used.

3 POSITION (horizontal)

Adjusts displayed trace along horizontal axis.

4 POSITION (vertical)

Adjusts displayed trace along vertical axis.

5 FOCUS

Sharpens the beam.

6 INTENSITY

Adjusts the beam intensity. Turning the knob clockwise increases brightness.

7 HORIZONTAL GAIN

Continuously varies sensitivity on "x" axis input to adjust the horizontal width of the trace.

8 VERTICAL GAIN

Continuously varies sensitivity on "y" axis input to adjust the vertical width of the trace.



9 POWER

Turns power on and off.

10 SWEEP VARIABLE

Varies sweep frequency continuously in each selected range.

11 SWEEP RANGE

Selects from the four frequency ranges between 10 Hz and 100 kHz.

12 1 kHz OSC

Continuously varies the level of oscillator output available to external circuits within 0 ~ 1 V (rms) range.

13 AUDIO INPUT

Switches between two sets of jacks, front and rear, for WAVEFORM LEFT and RIGHT and STEREO DISPLAY.

14 LEFT-RIGHT

RIGHT is for right channel or "x" axis input. LEFT is for left channel or "y" axis input.

15 SELECTOR

"TEST" for 0.1 V (peak-to-peak) calibration.

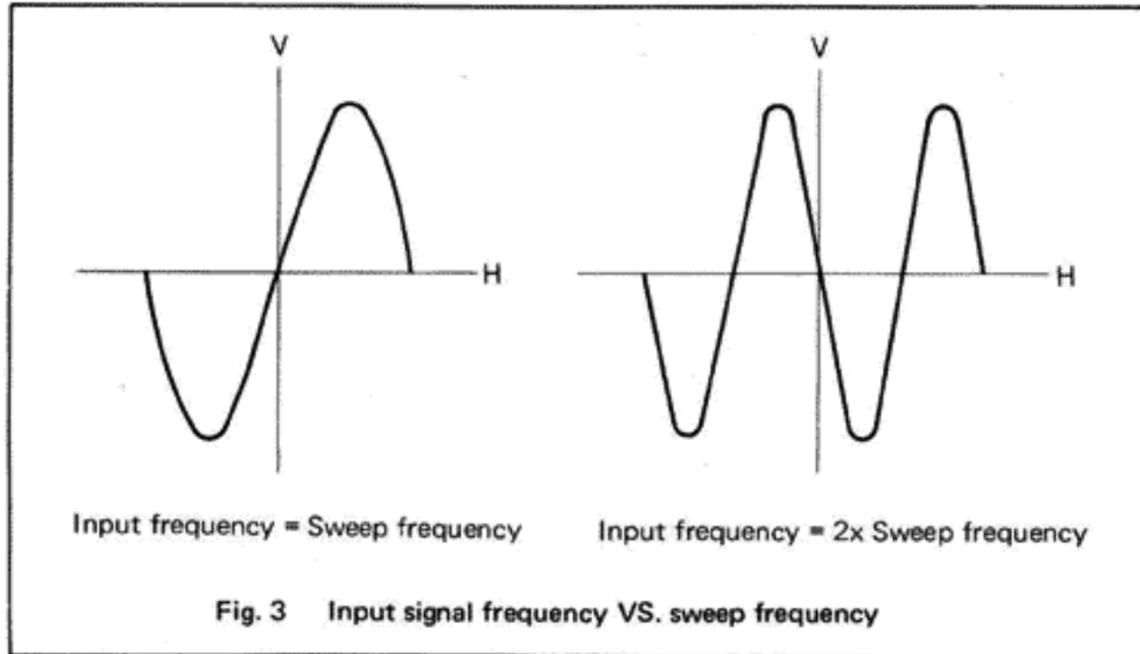
"WAVEFORM LEFT" for tracing left-channel waveform.

"WAVEFORM RIGHT" for tracing right-channel waveform.

"STEREO DISPLAY" for audio signal Lissajous figures.

"FM MULTIPATH" for tracing FM multipath waveforms.

OPERATIONAL INFORMATION



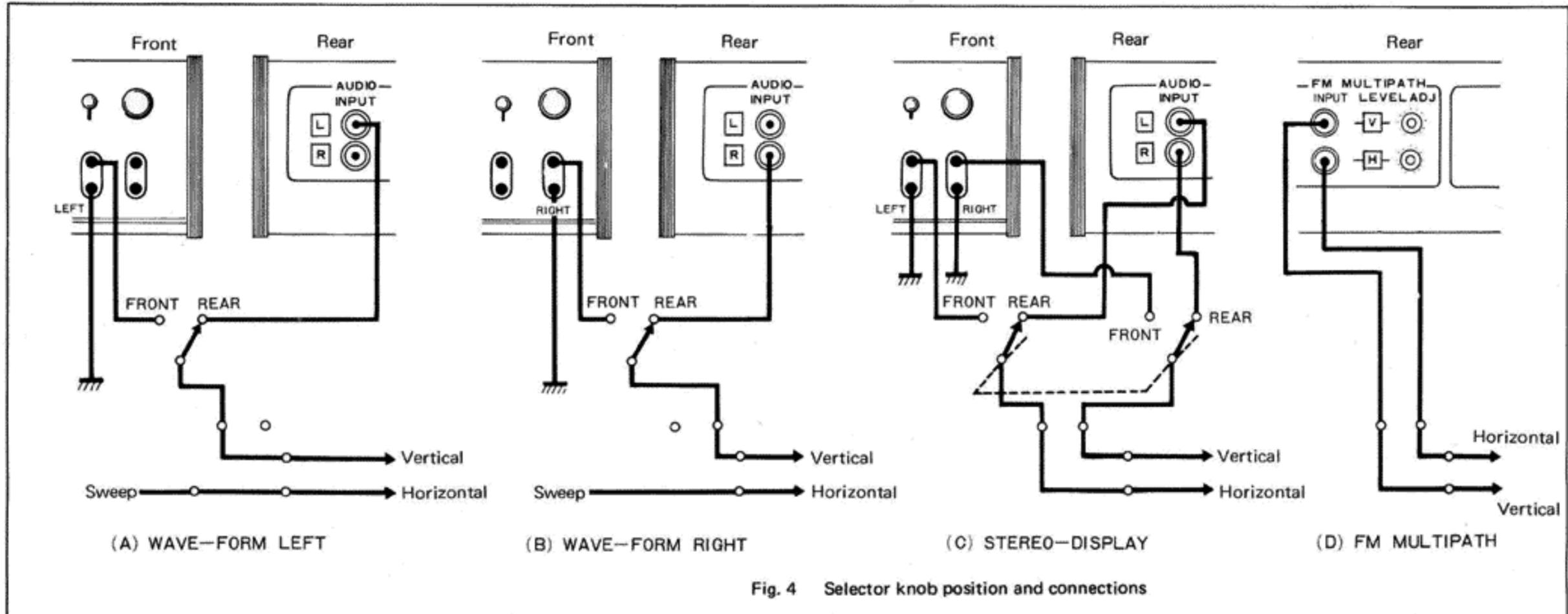
■ SPOT-KILLER CIRCUIT

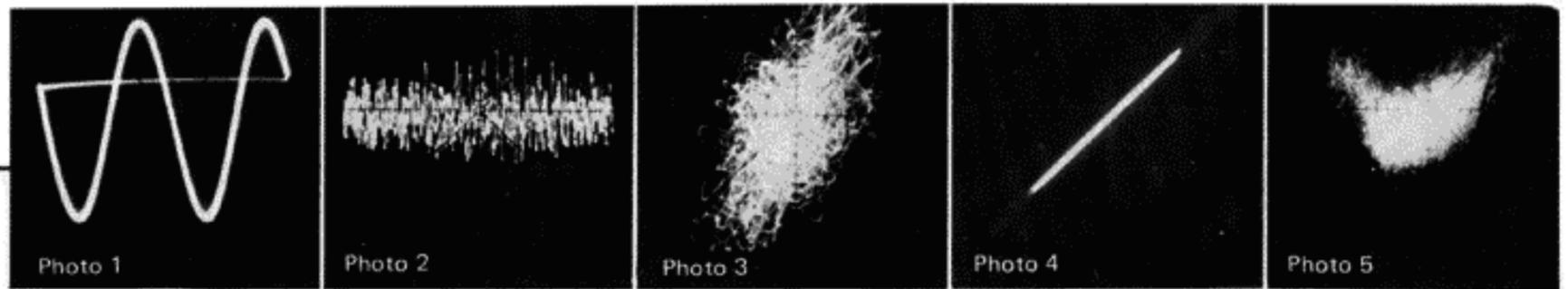
When the "x" and "y" input signals (as displayed on the screen) diminish to 10 mm, this circuit automatically starts operating to reduce the beam intensity, thereby producing a brightness suitable for small traces. When this circuit is operating, the INTENSITY knob is ineffective.

■ SWEEP VARIABLE AND SWEEP RANGE

These two are so related to each other that, if input signal frequency equals sweep frequency, one cycle of waveform appears on the screen.

$$\text{Cycles "n" of waveform} = \frac{\text{input signal frequency}}{\text{sweep frequency}}$$





For example, where input signal frequency is twice of the sweep frequency, two cycles of wave will be shown.

■ **THE FIVE POSITIONS OF THE SELECTOR KNOB PROVIDE THE FOLLOWING DISPLAYS:**

(1) **“TEST 0.1 V peak-to-peak”:**

A 1 kHz sine waveform appears on the screen. Its amplitude represents 0.1 volt peak-to-peak. For voltage measurement, compare the trace of an input signal against this reference amplitude.

(2) **“WAVEFORM LEFT”:**

Left-channel audio signal waveform appears, provided that AUDIO INPUT lever switch is in rear position. (Fig. 4 Connection “A”)

(3) **“WAVEFORM RIGHT”:**

Right-channel audio signal waveform appears, provided that AUDIO INPUT lever switch is in rear position. (Fig. 4 Connection “B”)

(4) **“STEREO DISPLAY”:**

Left-channel signal applies to the vertical section, and right-channel signal to the horizontal section, to trace Lissajous figures with these two. (Fig. 4 Connection “C”)

(5) **“FM MULTIPATH”:**

FM multipath waveform will appear with the jacks (FM MULTIPATH “V” and “H”) connected to the tuner (Fig. 4 Connection “D”)

■ **TYPICAL DISPLAYS**

► **PHOTO 1:**

With the SELECTOR knob in “TEST”, a waveform will appear, as shown. Its amplitude stands for 0.1 volt peak-to-peak.

PHOTO 2:

In “WAVEFORM RIGHT or LEFT”, a trace will appear, as shown, which represents different frequencies and intensities of sound.

► **PHOTO 3:**

Illustrates the “STEREO DISPLAY”. This is a type of Lissajous figure, from which the spread of sound and the degree of separation between right and left can be determined.

► **PHOTO 4:**

An example of a “MONAURAL DISPLAY”

► **PHOTO 5:**

An example of a FM multipath display. The significance of this display is described under a separate heading “FM multipath”

■ **WARNINGS:**

(1) **Hum**

Waveform tracing with a low sweep frequency tends to pick up hum from the AC line frequency, particularly when the signal being checked is a whole-number multiple of the line frequency. This is a tendency normal to any scope and does not interfere with the efficiency of scope performance.

(2) **Excessively High Input Level**

Do not apply an input of more than 400 volts (rms), otherwise, the Field Effect Transistors used in this scope will fail or deteriorate appreciably.

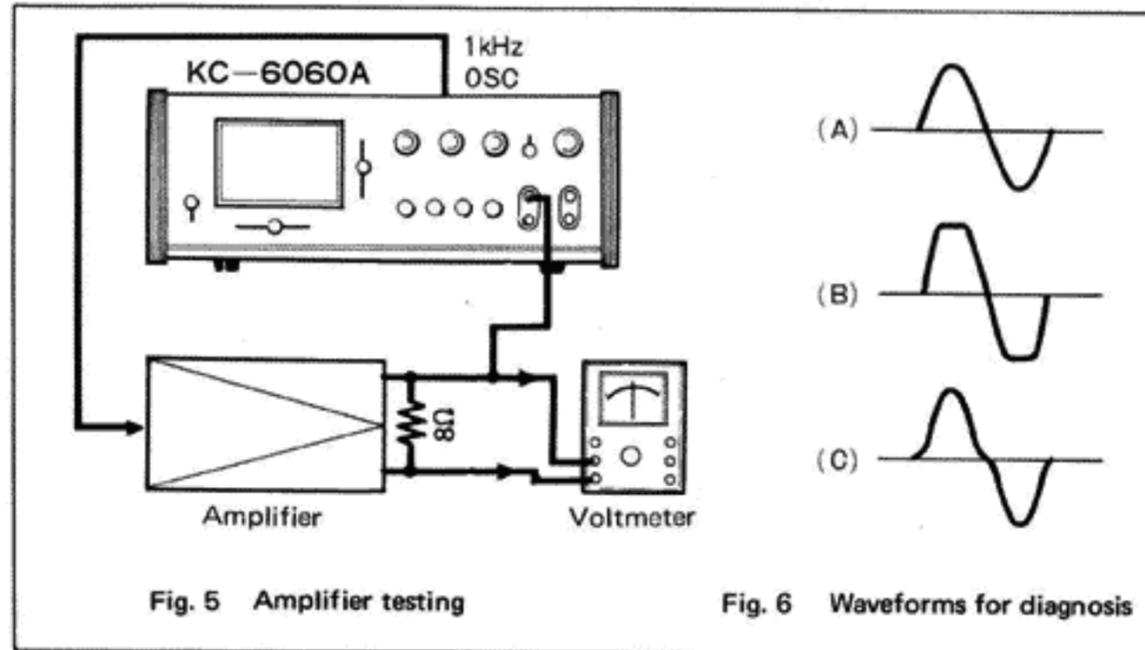
(3) **Interference by External Magnetic Field**

Do not place the scope in the vicinity of high-power devices or any device emitting high-intensity magnetic field, otherwise the scope may pick up hum even if its GAIN control knobs are turned down to zero.

(4) **Fuse**

A one-ampere fuse is used. Rotate the fuse holder counterclockwise for replacing. If a fuse fails, check carefully the reason for the blow-out before replacing the fuse. When something is wrong with the supply circuit, the fuse will be blown out again. Do not, in any case, use copper wire in place of the specified fuse.

OPERATION OF SCOPE



■ TESTING AMPLIFIER FOR LINEARITY

Fig. 5 illustrates the set-up for testing. Turn AUDIO INPUT lever switch to "FRONT" and SELECTOR switch to "WAVEFORM". Three typical waveforms are shown in Fig. 6. Waveform (A) is perfectly sinusoidal and signifies that the amplifier under test is free from distortion. Waveform (B) means poor linearity. Waveform (C) strongly suggests crossover distortion.

■ FREQUENCY RESPONSE AND PHASE CHARACTERISTICS

(A) and (B) in Fig. 7 illustrates how to check an amplifier or phono cartridge for frequency response. With SELECTOR switch in "WAVEFORM", use the Audio Frequency Oscillator. Apply 1 kHz test signal and deflect it for 40 mm amplitude. Swing the test frequency up and down to find the level at which the amplitude decreases to 28 mm ($= 1/\sqrt{2}$ of 40 mm). This level is the -3 dB point.

Let "A" mm be the displayed amplitude of the reference frequency and "a" that of another frequency, then the deviation of gain is computed by the following formula:

$$\text{Difference in gain} = 20 \log \frac{a}{A}, (\text{dB})$$

To make this computation valid, the oscillator output level must be constant and steady.

When testing a phono cartridge, shown in Fig. 7 (B), a frequency test Fig. 8 (A) will prove useful. If a flat response is noted with the use of such a record, it means that the cartridge has a flat characteristic of response, provided that equalization is accurately established.

In the same set-up as above, turning the tone control of the amplifier will alter the displayed waveform to indicate the effectiveness of its tone control. Waveforms (B) and (C), Fig. 8, are examples of such altered

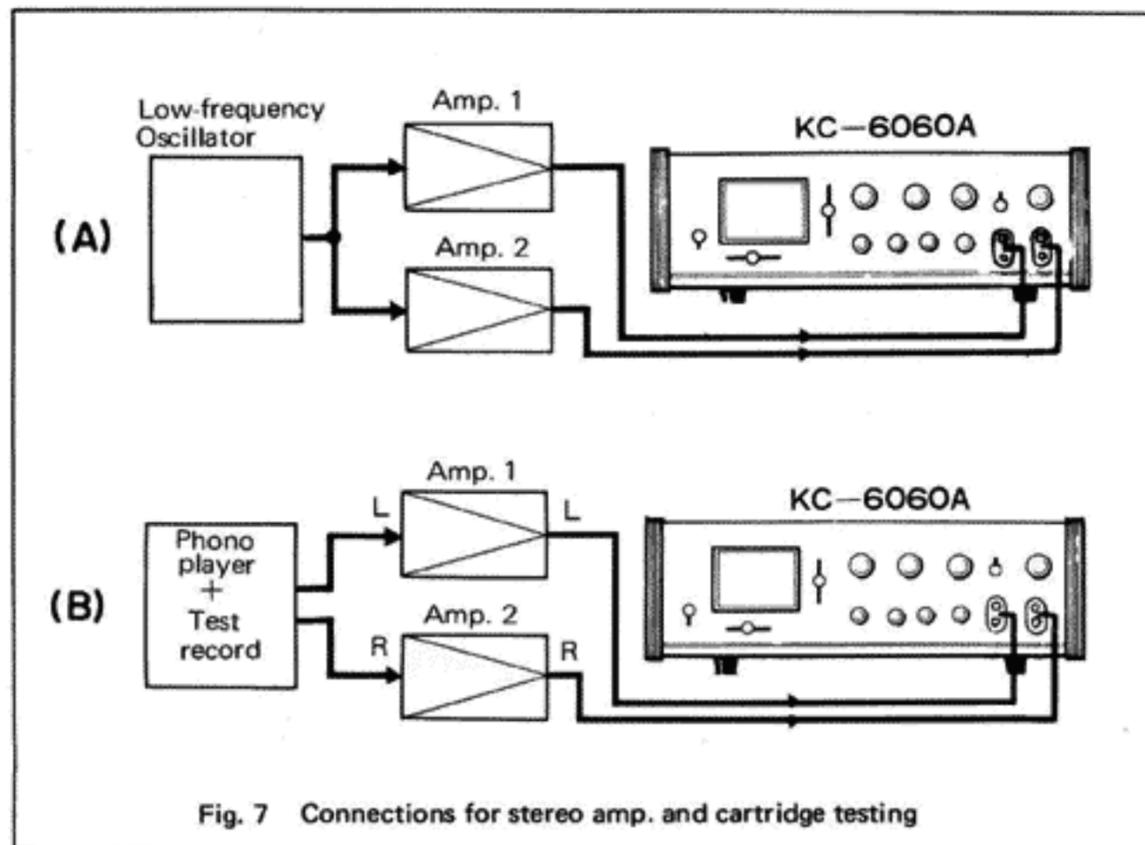


Fig. 7 Connections for stereo amp. and cartridge testing

displays. The example as shown in photo 6 was obtained by playing a Clark-Stern test record.

To check the phase characteristic, turn SELECTOR switch to "STEREO DISPLAY", and take measurements by the same method as for phase difference measurement (to be explained later). Attenuators must be used in the amplifier outputs to equalize the input sensitivities in the scope.

■ TESTING WITH SQUARE-WAVE SIGNALS

Theoretically a square wave is composed of an infinite number of sinusoidal waves that are odd harmonics of the fundamental frequency. Thus, by feeding square-wave signal into an amplifier and by displaying the output waveform on the scope screen, the frequency characteristic of the amplifier can be determined with a high degree of accuracy.

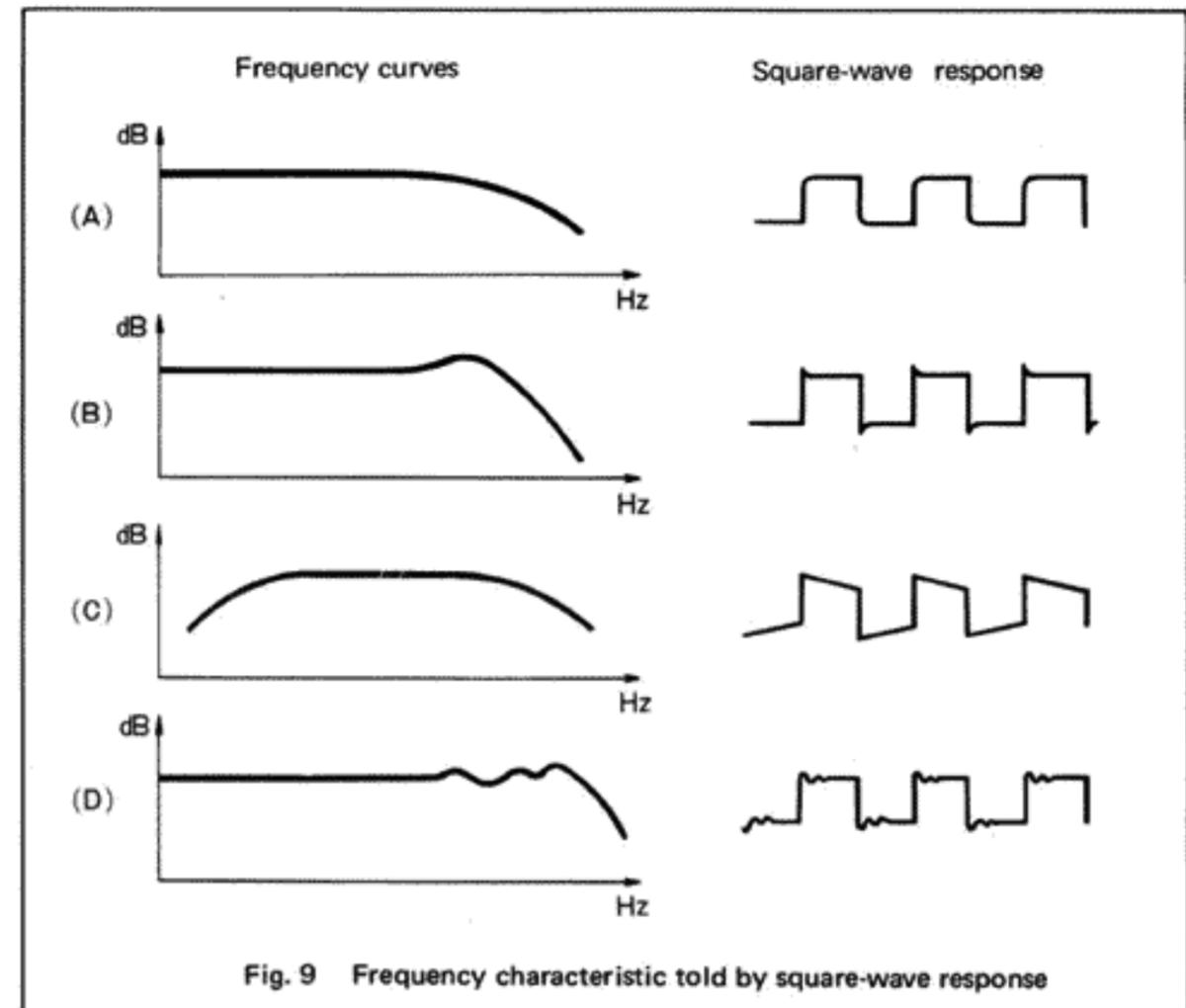
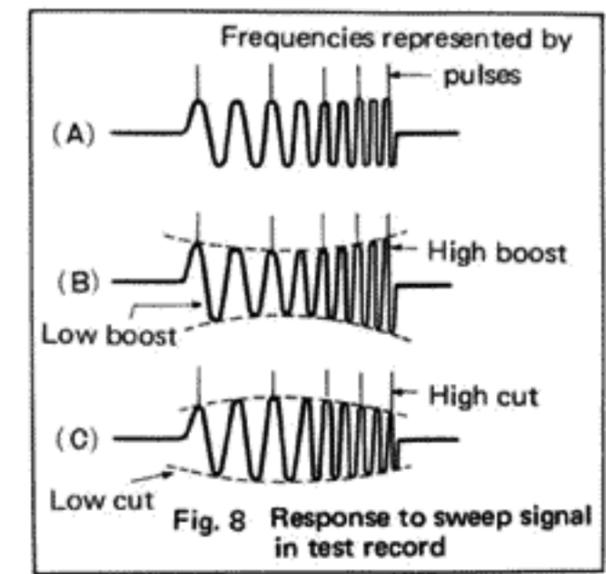
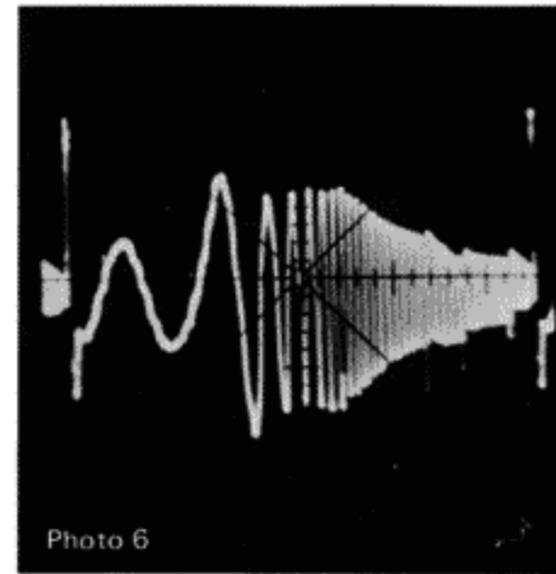
Fig. 9 shows two sets of response: (1) frequency characteristic curves and (2) different kinds of response to the same square-wave input signal. Each square-wave display (on the right side) corresponds to the frequency characteristic curve given on its left.

The inherent rise time of this scope is 2 microseconds, which is narrow enough to test audio amplifiers by square-wave signals. If square waves of 10 kHz or higher is used in this type of testing, this inherent rise time may appreciably affect the accuracy of testing.

■ MEASUREMENT OF PHASE DIFFERENCE

The following is the method of determining the difference in phase angle between two signals being fed in simultaneously. For the signal source, use a frequency test record or audio oscillator, and set-up scope as in Fig. 7 (A) for testing two amplifiers or in (B) for testing a stereo cartridge.

In Fig. 7 (B), the amplifiers should be set by means of respective tone control to present as flat a frequency characteristic as possible. If there happens to be a phase difference between the two amplifiers over the measured frequency range, it must be noted, that the measurement taken is, the sum total of differences between the amplifiers and in the cartridge itself.



OPERATION OF SCOPE

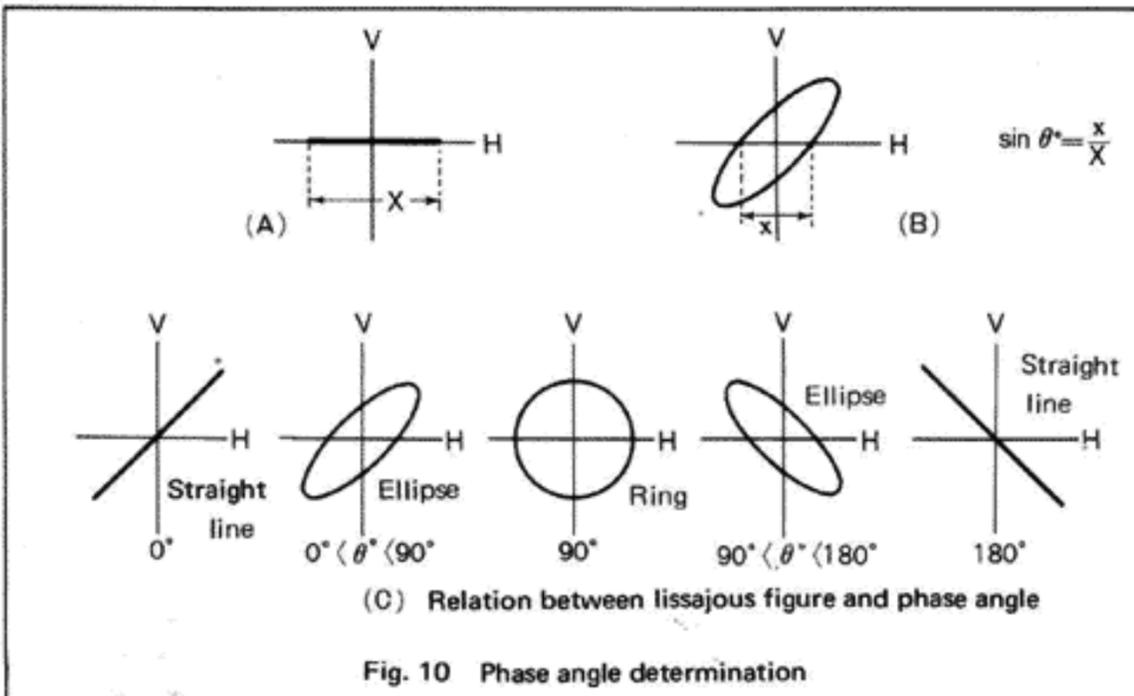
The Procedure is as Follows:

- 1) With SELECTOR switch in "STEREO DISPLAY", turn AUDIO INPUT lever to "FRONT".
- 2) Feed the two signals into front panel AUDIO INPUT terminals. On the scope screen, trace the horizontal signal to the center, as shown in Fig. 10 (A). Let this amplitude be represented by "X".
- 3) Adjust VERTICAL GAIN control to a proper vertical amplitude, so that a Lissajous figure will be traced on the screen.

The Lissajous figure can take any of the several shapes illustrated in Fig. 10 (C), depending on the difference in phase angle. The sine of this angular difference is determined by the formula:

$$\sin \theta = \frac{x}{X}, \text{ where the small "x" is the length of horizontal axis included in the Lissajous circle.}$$

The angular phase difference so determined does not tell which one of the two signals is leading. However, this question can be answered on the basis of the phase or frequency characteristic of each channel.



■ BALANCING THE TWO CHANNELS

To balance the stereo channels, proceed as follows:

- 1) First, balance the vertical and the horizontal sections of the scope with respect to sensitivity. This is accomplished by feeding the 1 kHz oscillator output signal to both vertical and horizontal inputs and by adjusting the respective gains to obtain a 45° linear trace on the screen, with SELECTOR switch in "STEREO DISPLAY" and AUDIO INPUT lever in "FRONT".
- 2) Secondly, feed the right and left amplifier output signals to the scope inputs, right and left, and connect the 1 kHz oscillator output of the scope to the AUX jack of the amplifier. Turn the MODE switch of the stereo amplifier to "MIX" and adjust the balance control to obtain a 45° line display on the screen. This balances the two channels of the stereo amplifier.

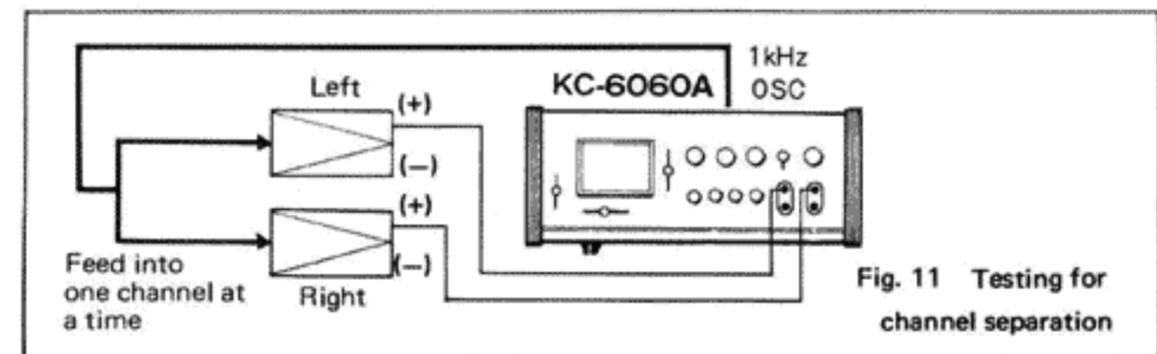
■ CHANNEL SEPARATION MEASUREMENT

For measuring the degree of separation between the two channels in a stereo amplifier, connect the scope as shown in Fig. 11.

When connecting the amplifier output to KC-6060A audio input, be sure to connect (+) to (+) and (-) to (-), otherwise you will have the amplifier damaged.

Here is how you can measure the separation by KC-6060A.

Although the following is how to measure the ratio of cross-talk from left channel to right channel, you will be able to measure the cross-talk from right to left by replacing left by right.



- 1) Connect 1 kHz oscillator output to any left channel input of the amplifier.
- 2) Set the selector switch of the KC-6060A at "WAVEFORM LEFT".
- 3) Set the 1 kHz oscillator output level as shown below:
When using any high level input of the amplifier, set the output level between 3 and 4 positions.
When using any low level input of the amplifier, set it around position 2.
- 4) Adjust the volume control of the amplifier and the Vertical Gain Control of KC-6060A to obtain the proper height display of waveform on the scope. Keep the height of display in your mind.
- 5) Change the selector switch of KC-6060A to "WAVEFORM RIGHT" position. Keep the height of display on the scope in your mind.

Assuming the vertical display you obtained at 4) is X mm and the one you obtained at 5) is Y mm, the following formula will be established:

$$\text{The ratio of the cross-talk from left channel to right channel (dB)} = 20 \log X/Y$$

Fig. 12 shows the relationship between GAIN RATIO and DECIBEL for use in quickly determining the degree of separation on the formula given above.

■ NOTE ON EARTH WIRE CONNECTION

When the front panel terminals are used for introduction of input signals as shown in Figs. 5 and 11 and the rear panel jacks are connected to the same tuner or amplifier, the earth line forms a loop. In this case, the uppers of pair terminals of front panel should be used for introduction of input signals, and lowers should not be connected.

If the earth line forms a loop, hum will arise from a high-gain amplifier. If hum is present, distortion will increase, and separation will also be adversely affected. Accordingly, correct testing and real music appreciation can not be expected.

When the rear panel jack is in no use and the front panel terminals are

connected to the right and left speakers, one of the ground terminals of front panel should not be connected.

Even in this case, separation will be adversely affected depending on the type of amplifier.

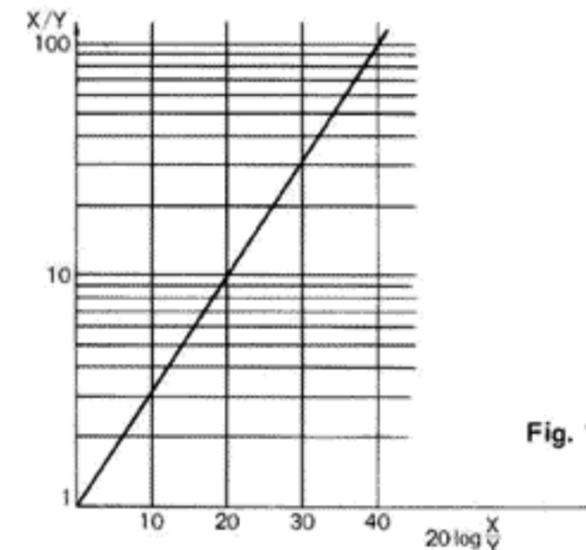


Fig. 12 Gain ratio VS. decibel

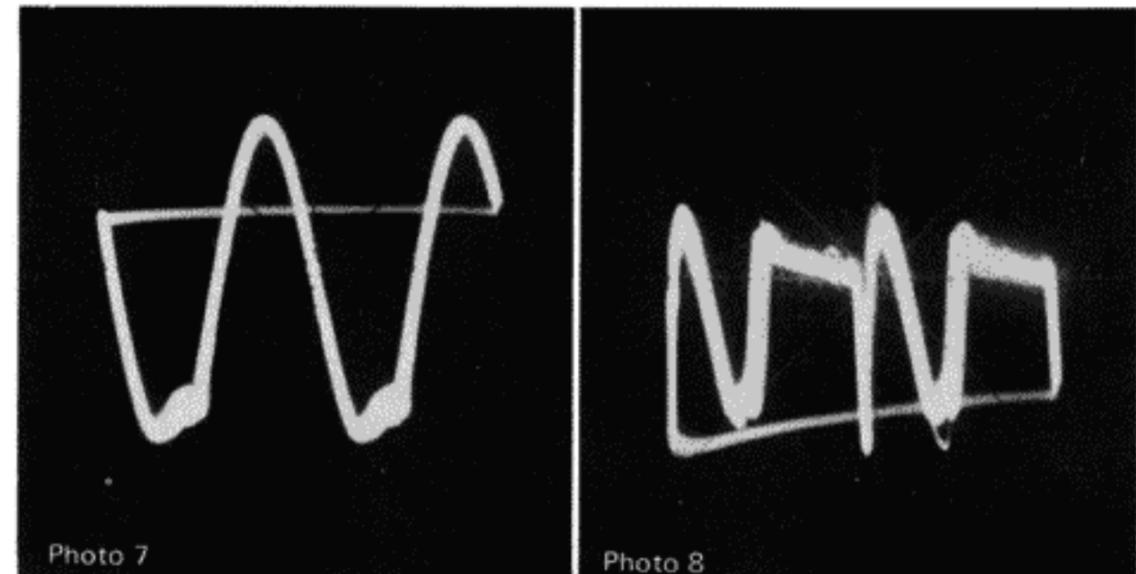


Photo 7

Photo 8

FM MULTIPATH

■ OTHER TESTS PERFORMED BY THE SCOPE

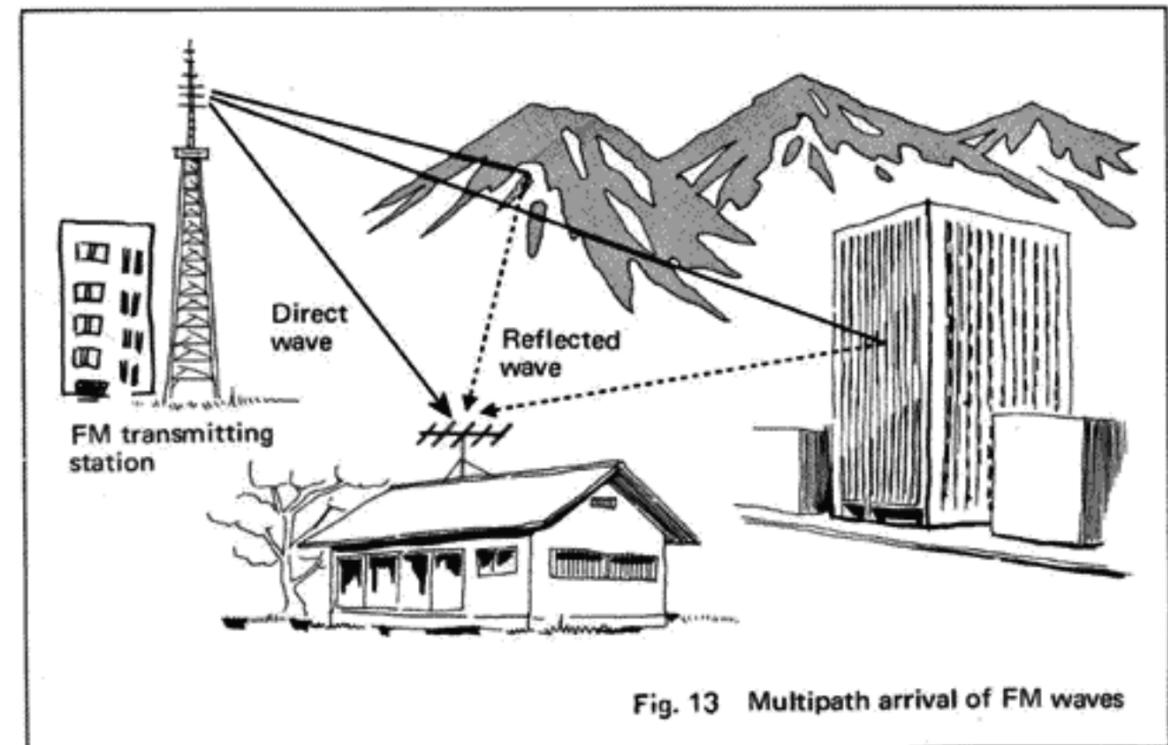
A stereo test record usually contains a number of signals in addition to those for frequency measurement. They include signals for cross-modulation, rumble, balance, phase, level, large-amplitude trackability, wow, flutter, etc. The directions furnished with the record provide full information on the methods of testing. Only two instances of such tests, which can be greatly facilitated by the use of the scope, will be mentioned here for illustration.

A erratic stylus tracking Y, will result in a waveform like those shown in Photos 7 and 8. Adjusting the stylus pressure or the tracking balance will eliminate such erratic stylus motion.

The pulse signal in the test record will reveal the transient characteristic of the cartridge in the high side of the frequency range. The trackability signal provides information necessary for determining the optimum stylus pressure.

Figure 13 shows a sample of FM signal transmission. The transmitted signals arrive at a receiving antenna over two or more paths — one direct while the others are involving reflections from buildings, hills and other obstacles. This is called FM MULTIPATH RECEPTION or merely FM MULTIPATH.

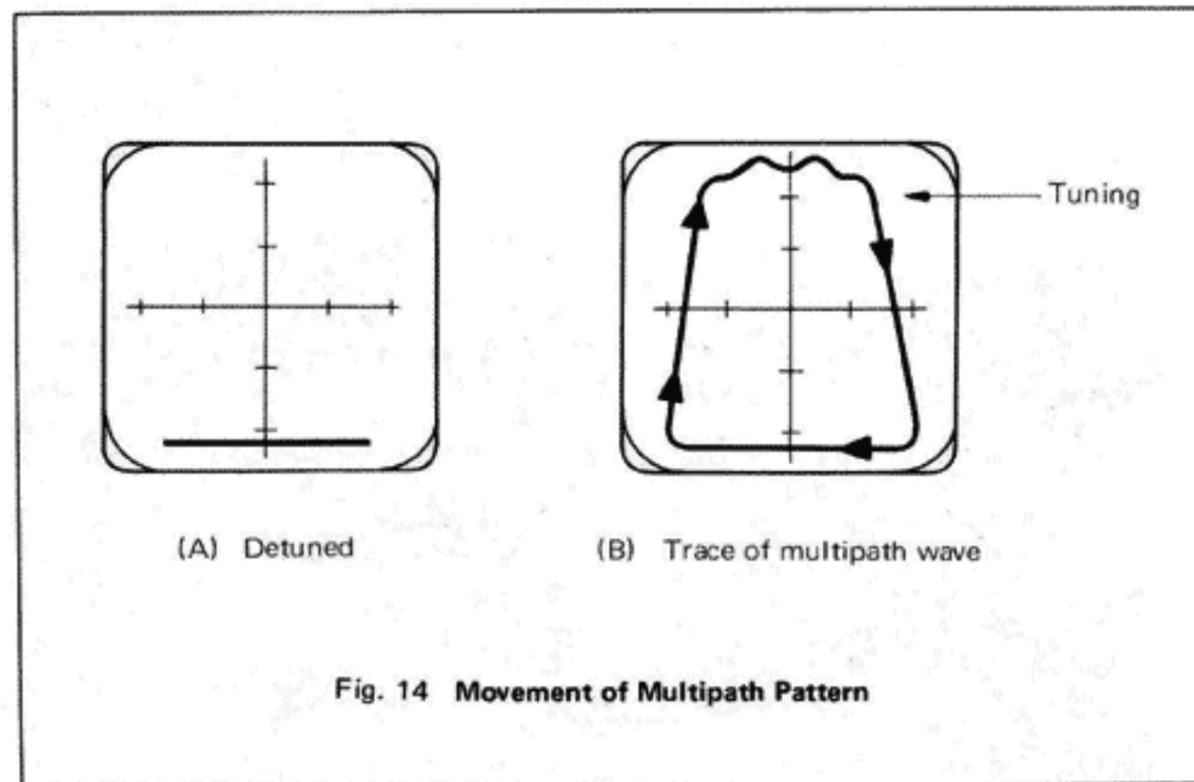
Between direct signal and reflected signals, there is a measurable time difference in reaching the receiving antenna. If these two signals are received simultaneously, there would be an ingredient of Amplitude Modulation (AM) among the desirable FM signals. The AM ingredient will affect the tuner and increasing distortion, reducing the apparent degree of channel separation and lower the signal to noise ratio. It is impossible to eliminate at the tuner section the AM ingredient which is a result of the Multipath. The only way to eliminate it is to rotate the antenna so that the most direct signals with the least undesirable multipath can be picked up.



Here is how you can determine the correct antenna direction by using KC-6060A.

The Horizontal display voltage is obtained from the tuner output. This horizontal display shows the audio signal level. On the other hand, the Vertical display voltage is derived from the tuner IF circuit. This display voltage is the AM ingredient which is produced as a result of FM Multipath. It makes Lissajous waveforms on the screen with both horizontal and vertical display signals.

When the dial knob is turned, a trace is given on the screen by a multipath component, as illustrated in Fig. 14. When the trace moves up to the highest position, the circuits are perfectly tuned. Accordingly, KC-6060A can be used as a tuning indicator.



■ LEVEL SET ADJUSTMENT

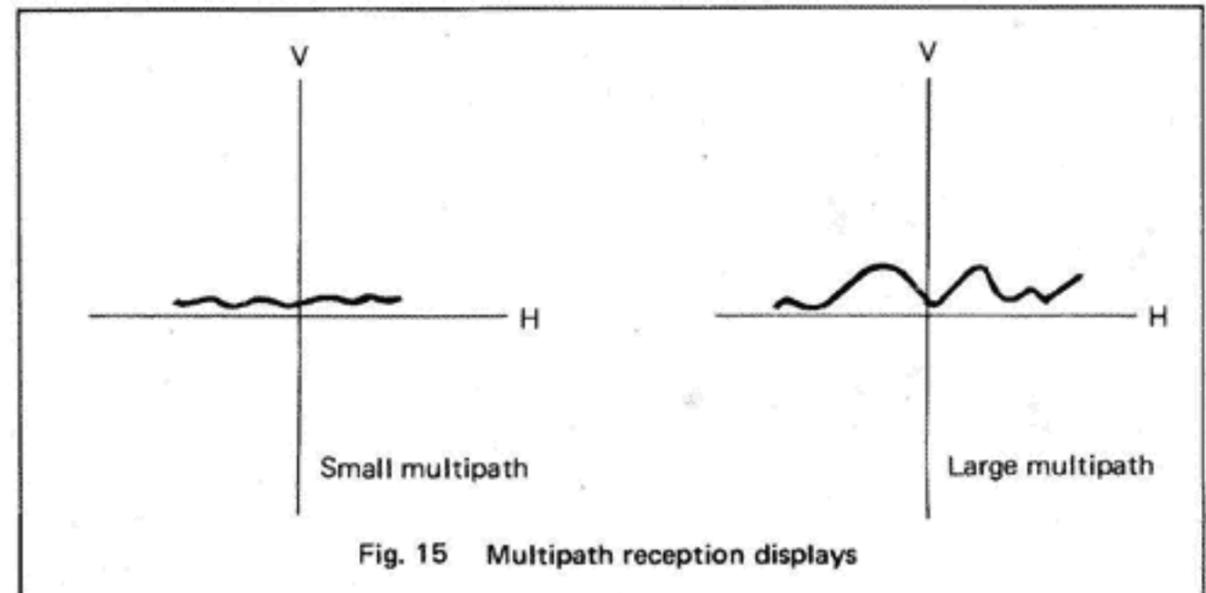
Set the selector to "STEREO DISPLAY", and adjust "VERTICAL GAIN" and "HORIZONTAL GAIN" so that Lissajous figures give a proper amplitude. With an amplifier selector knob set to monaural, Lissajous figures make an angle of 45° with the horizontal axis.

Next, set the SELECTOR to "FM MULTIPATH" and detune the dial. Then, the waveform will be positioned as shown in Fig. 14A. As the indicator is moved to the right or left, the waveform follows the trace as given in Fig. 14B (in reverse direction). Then, adjust the LEVEL SET on the rear panel so that the whole part of the pattern appears on the screen.

■ JUDGEMENT

When the circuits are perfectly tuned (the wave moves up to the highest position), set the antenna so that the multipath waveform shows a smaller amplitude (the closest possible to a straight line), and you can enjoy FM broadcast with minimum distortion and best S/N ratio.

This multipath waveform expresses the IF characteristics of a tuner, and accordingly, this KC-6060A can be used as an instrument to determine the performance of the tuner.



OPERATING HINTS

The following hints will be of helpful in the initial use of the scope.

Complaint	Possible cause	Hint
Turning on power will neither light up the lamp nor produce display.	Line cord is not fully plugged in. Fuse is blown.	Push the plug in fully or try another outlet socket. Replace fuse. If the replacement fuse also fails, there may be a serious short in the unit. DO NOT ATTEMPT TO BY-PASS THE FUSED CIRCUIT OR TO REPAIR THE UNIT YOURSELF. Please (tell them to check with the nearest KENWOOD service center.)
Neither trace nor beam spot shows up on the screen.	POSITION improperly set. INTENSITY is turned down.	Move two POSITION levers to the center. Turn INTENSITY up.
Beam spot not bright enough. INTENSITY has no effect.	SPOT-KILLER circuit at work. (Same as above)	This circuit will be cut out automatically when input signal starts coming in.
Changing brightness blurs spot or trace.	Bias level on CRT fluctuates.	Sharpen by using FOCUS.
Turning SWEEP VARIABLE all the way to the right moves the display horizontally.	This is due to transient property of SWEEP generator.	Wait a short while. (The display will return to its original position.)
Waveform vibrates just a little vertically or horizontally.	Hum due to line frequency and its harmonics, or disturbance due to external magnetic flux.	Keep the scope off any flux-emitting device. Hum due to line frequency is usually too small to interfere with proper display performance.
Waveform does not show up on both channels or on one channel.	Insufficient connection of two-pin cord. Amplifier balance control is turned all the way to one side.	Plug in fully. Adjust balance.

SPECIFICATIONS

VERTICAL AMPLIFIER

Sensitivity:	25 mV p-p/cm (63 mV p-p/inch) at front panel input 250 mV p-p/cm (630 mV p-p/inch) at rear panel input
Frequency Response :	3 Hz to 200 kHz -3 dB or less
Input Impedance :	250 k ohms
Input Capacity :	Less than 50 pF at front panel input Less than 80 pF at rear panel input

HORIZONTAL AMPLIFIER

Sensitivity :	25 mV p-p/cm (63 mV p-p/inch) at front panel input 250 mV p-p/cm (630 mV p-p/inch) at rear panel input
Frequency Response :	3 Hz to 200 kHz -3 dB or less
Input Impedance :	250 k ohms
Input Capacity :	Less than 50 pF at front panel input Less than 80 pF at rear panel input

SWEEP GENERATOR

Sweep Frequency :	10 Hz to 100 kHz in four steps
Synchronization :	Internal (-)

OSCILLATOR

Frequency :	1,000 Hz \pm 10%
Output Voltage :	Max. 1 V RMS
Calibration (TEST) :	0.1 V p-p \pm 5%

INPUT & OUTPUT :

Audio Input (Left & Right), front & rear FM Multipath (V & H)
Oscillator Output

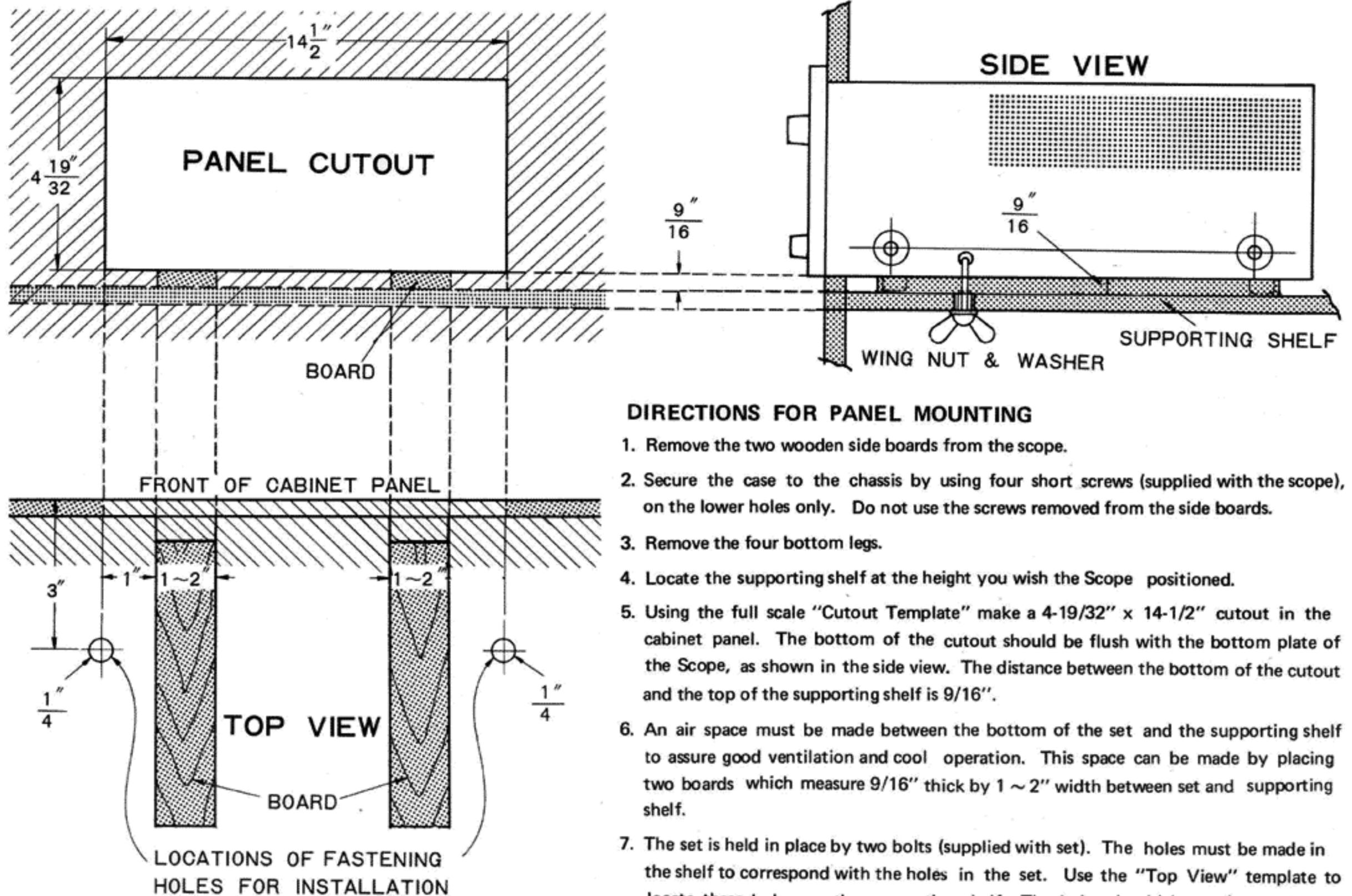
SELECTOR SWITCH :

Test, Wave Form (Left & Right), Stereo Display & FM Multipath

GENERAL

Cathode Ray Tube :	3 inches
Semiconductors :	4 FETs, 19 Transistors & 14 Diodes
Power Voltage :	AC 110-120 V/220-240 V, 50/60 Hz
Power Consumption :	25 watts
Dimensions :	16-5/16" W, 5-5/32" H, 11-1/32" D
Weight :	17 lbs.

MOUNTING TEMPLATE



DIRECTIONS FOR PANEL MOUNTING

1. Remove the two wooden side boards from the scope.
2. Secure the case to the chassis by using four short screws (supplied with the scope), on the lower holes only. Do not use the screws removed from the side boards.
3. Remove the four bottom legs.
4. Locate the supporting shelf at the height you wish the Scope positioned.
5. Using the full scale "Cutout Template" make a $4\frac{19}{32}$ " x $14\frac{1}{2}$ " cutout in the cabinet panel. The bottom of the cutout should be flush with the bottom plate of the Scope, as shown in the side view. The distance between the bottom of the cutout and the top of the supporting shelf is $\frac{9}{16}$ ".
6. An air space must be made between the bottom of the set and the supporting shelf to assure good ventilation and cool operation. This space can be made by placing two boards which measure $\frac{9}{16}$ " thick by $1\sim 2$ " width between set and supporting shelf.
7. The set is held in place by two bolts (supplied with set). The holes must be made in the shelf to correspond with the holes in the set. Use the "Top View" template to locate these holes on the supporting shelf. The holes should be made $\frac{1}{4}$ " in diameter or somewhat larger.

NOTES

KC-6060A Serial No. _____

Owner _____



KENWOOD ELECTRONICS, INC.

■ 15777 SOUTH BROADWAY, GARDENA, CALIFORNIA 90247

■ 72-02 51ST AVENUE, WOODSIDE, N.Y. 11377

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