FIG. 1-11 HIGH-FREQUENCY RESPONSE TRENDS ON DISC PLAYBACK

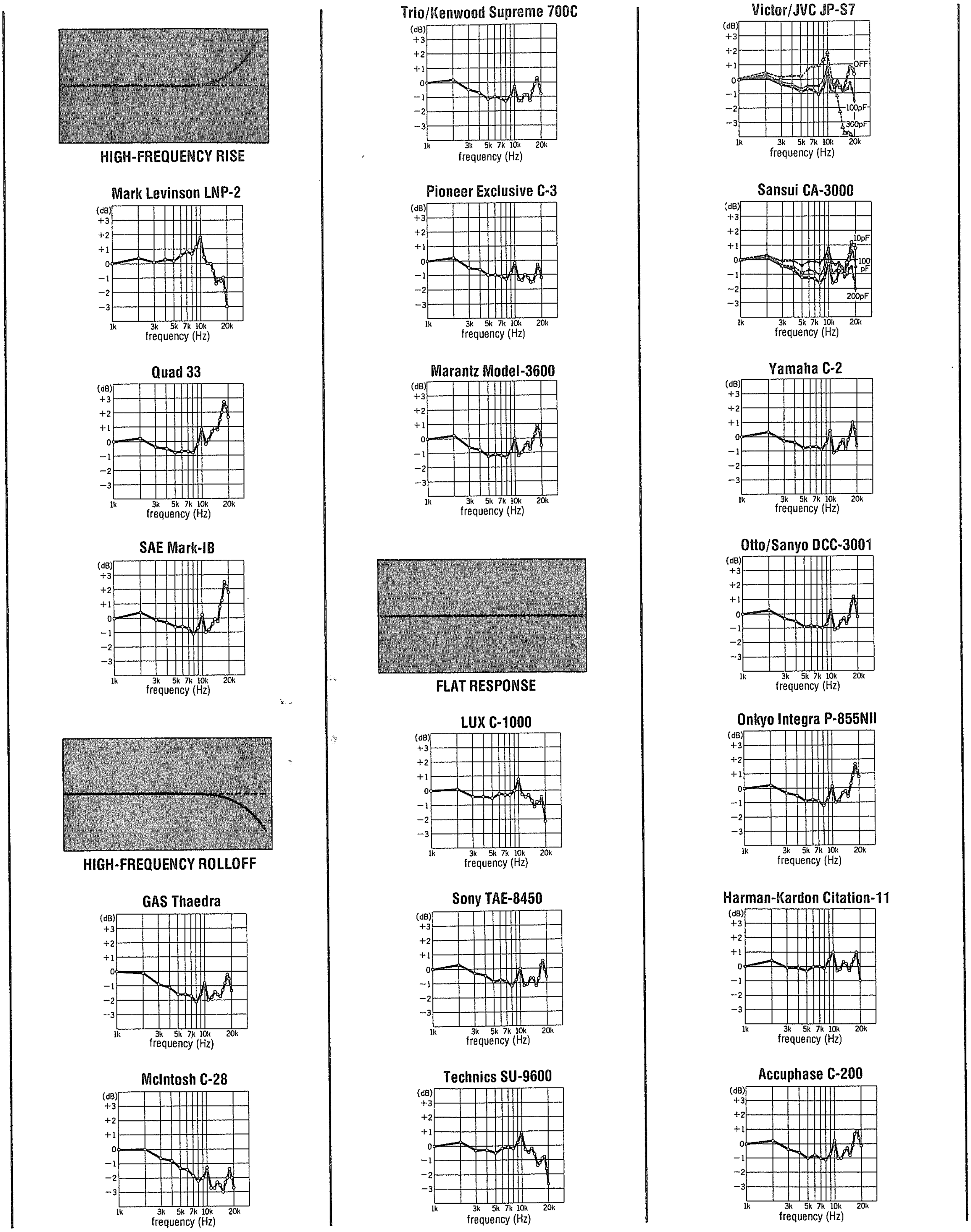


FIG. 1-12 RIAA-STANDARD CURVES

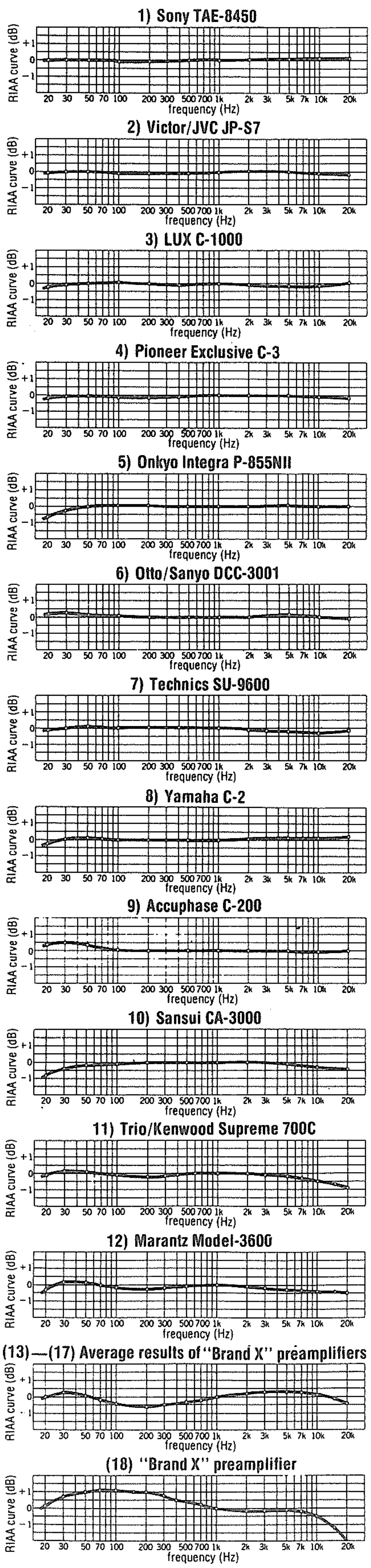
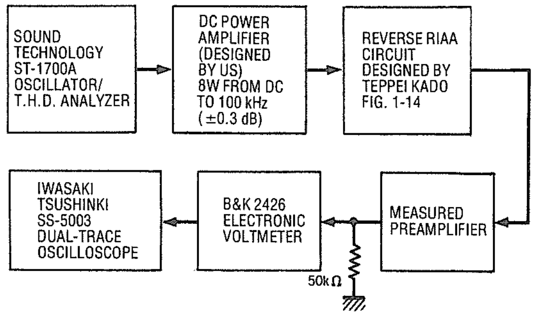
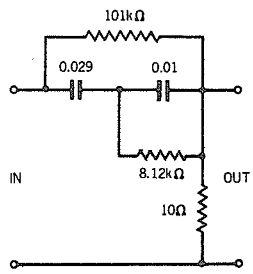


FIG. 1-13 MEASUREMENT OF DEVIATION FROM RIAA STANDARD



tached. The amount of input capacity of other amps can be judged to a certain extent from the variation tendency triggered by switching of input capacity with the Sansui CA3000 and JVC JP-S7. (The 70-Hz low-cut filter inserted at the input of the voltmeter is intended to suppress a swing of the needle caused by warp of disc and rumble of phonomotor.) The frequency response curves are presented below.

FIG. 1-14 REVERSE RIAA CIRCUIT (engineered by Teppei Kado)



SECTION C.

MEASUREMENT OF DEVIATION FROM RIAA CURVE

Input and output were same as in Section B. A 3 mV signal of 1 kHz was fed to the input, and the volume and balance controls were adjusted so as to get a 100 mV output. Then, by varying the frequency, deviation from 1 kHz was checked. This is a test supplementary to that in Section B. The reason why the reverse RIAA circuit was driven by a DC amp is that attenuation is large and input impedance is low with this circuit.

SECTION D.

MEASUREMENT OF I.M.D. AT PHONO & AUX

The measurement conditions are same as those for T.H.D. The measuring method is the so-called SMPTE method (60 Hz: 7 kHz = 4:1). But in the case of the phono equalizer, the ratio had been changed beforehand to (60 Hz: 70 kHz = 1:5.55) inside the I.M.D. meter so that this ratio could be realized at the output. The residual distortion of the I.M.D. meter is below 0.002%.

FIG. 1-15 BLOCK DIAGRAM OF I.M.D. MEASUREMENTS (PHONO AND AUX INPUTS)

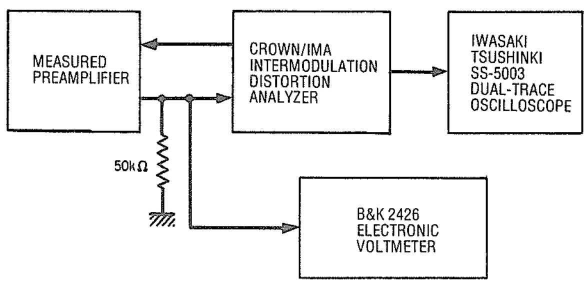


FIG. 1-16 INTERMODULATION DISTORTION (PHONO INPUT → RECORD OUTPUT)

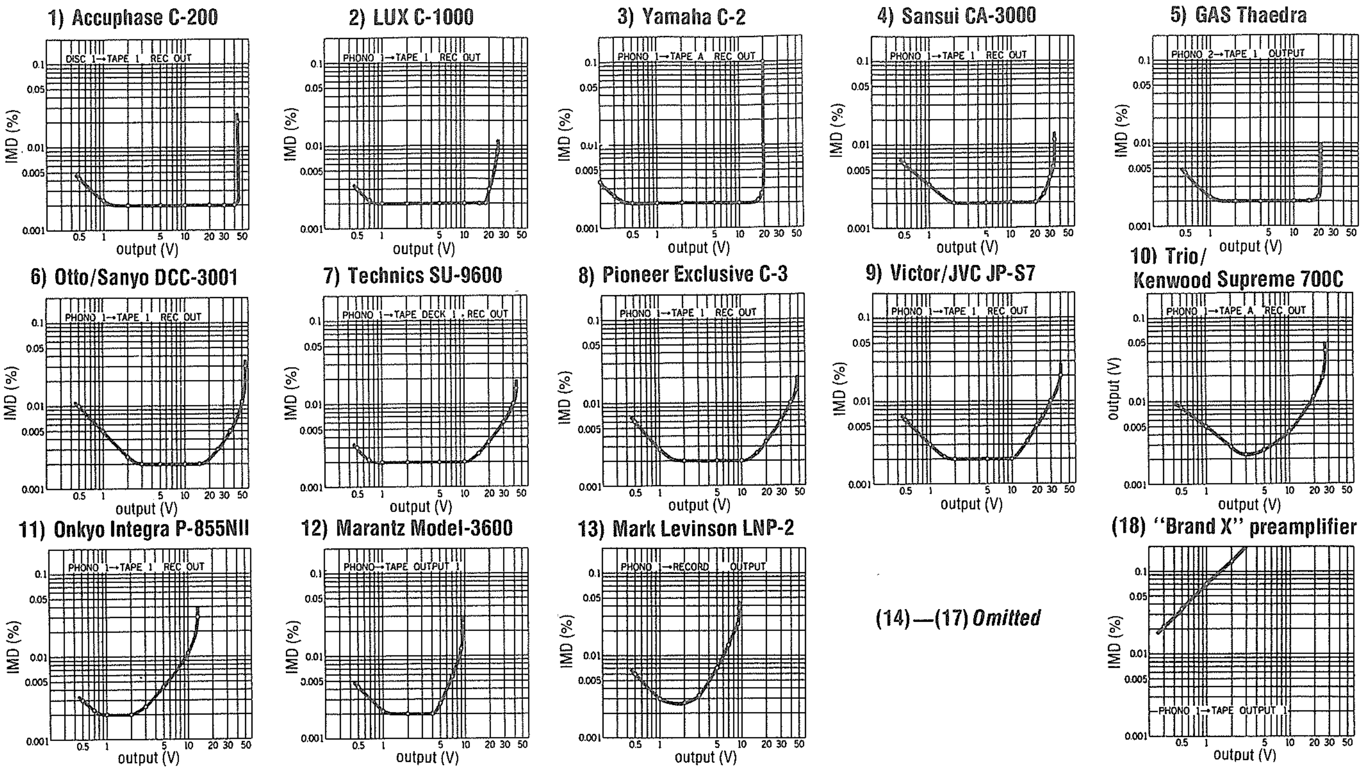


FIG. 1-17 INTERMODULATION DISTORTION (AUX INPUT → OUTPUT 1)

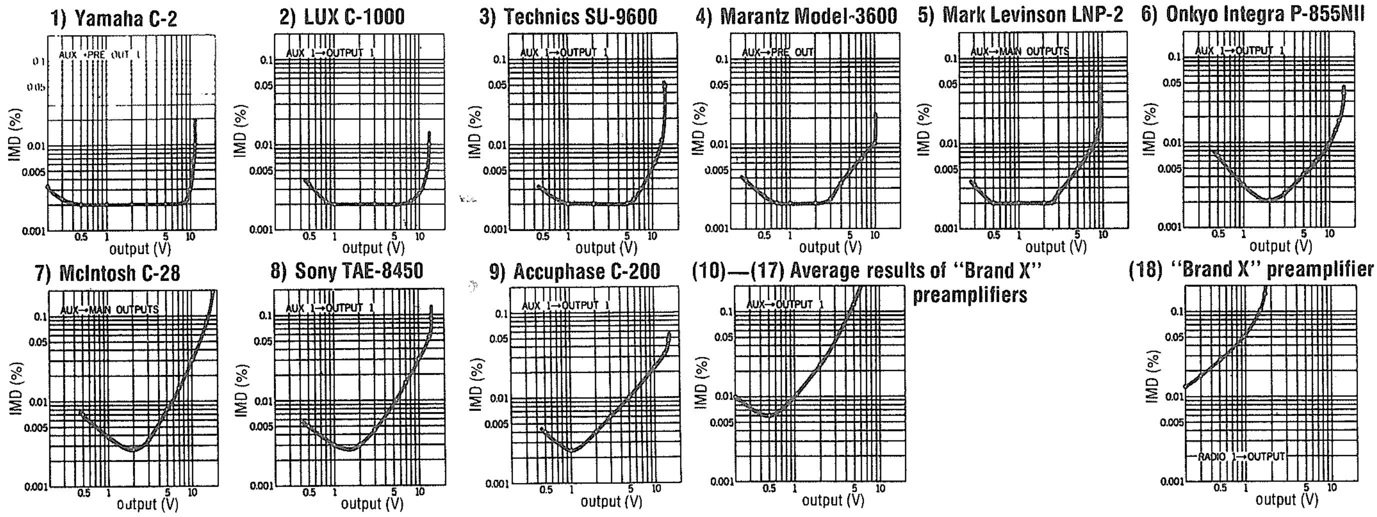


FIG. 1-18 BLOCK DIAGRAM OF THE OBSERVATION OF STEP RESPONSE

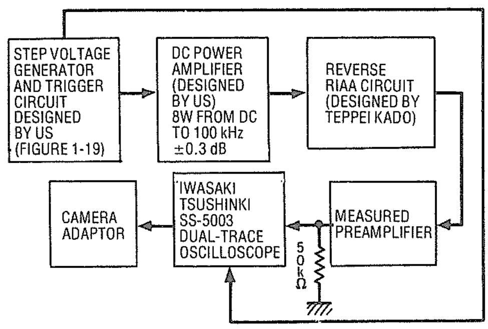
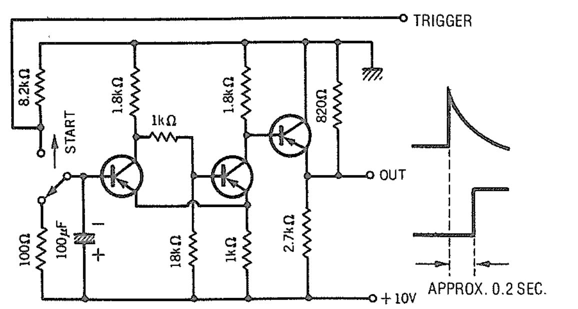


FIG. 1-19 SCHEMATIC OF STEP VOLTAGE GENERATOR AND TRIGGER CIRCUIT



SECTION E.

OBSERVATION OF STEP RESPONSE

The same input and output terminals were used as in Section B, while the other conditions are the same as those in Section A. The DC amp was adjusted to produce a step voltage of 1.5 V, and the volume and balance were adjusted to obtain a 3-division "peak" at the output. The controls of the oscilloscope were set at 0.1 sec/div and 0.05 V/div. The response of the frequency domain at the transmitting circuit (frequency response and phase shift) and that of the time domain (transient response such as step response and impulse response) are integrated into a unity, and theoretically it is possible to know the other if one is known. But it is difficult to measure the frequency response and phase shift of amplifiers at the ultra bass range, and it is rather easy to understand them if the latter is observed. (By intuition as well, it seems true).

With the perfect DC amplifier, the same waveform should appear as the one from the input voltage into the reverse RIAA circuit, but apart from its necessity, as far as I know, such an amp is available only from A&E company. While others have several time-constants at the bass, and in accordance with the sizes and mutual percentage of these time-constants the various step responses are presented. Even with the amps that show oscillations it is a mistake to understand that they are triggered by unstable negative feedback, and with contemporary amps they are considered to be such responses as are aroused by the mutual relation of the time-constants. Through their nature and our experience the explanation given in Fig. 1-20 is reasonable.

In Fig. 1-20 when the bass time-constant is large, t becomes long, and similarly E becomes large when the major time-constants are close to each other—which decide the cut-off characteristics of bass range. With the Quad 33 the response commences from the negative side because this amp is out-of-phase. Also ripples in the photographs mean the hum mixed in the course of measurement.

FIG. 1-20

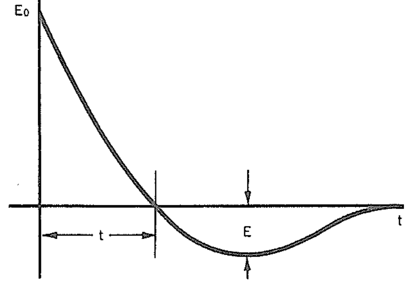
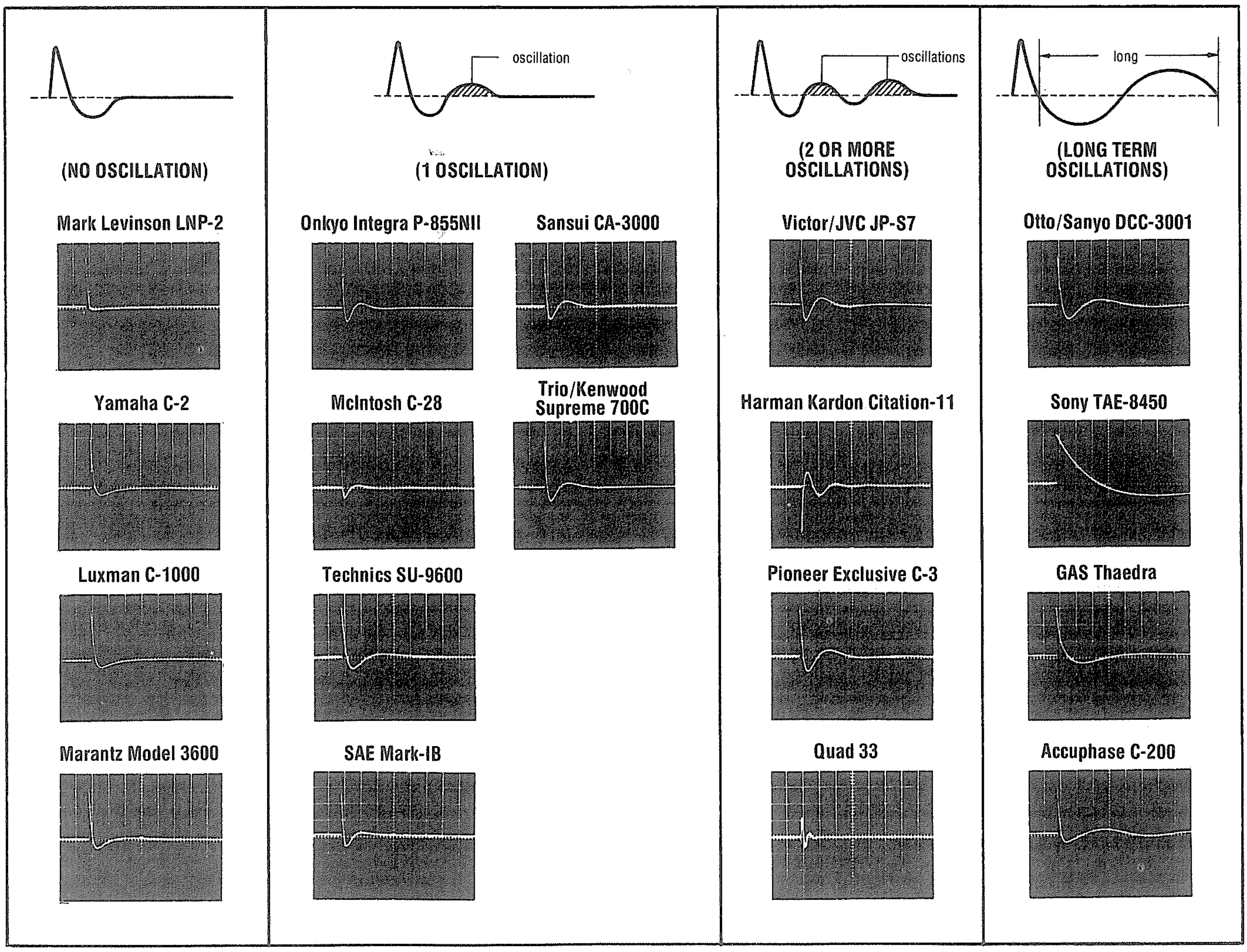


FIG. 1-21 TREND CLASSIFICATION OF RESPONSE PHOTOGRAPHS



Chapter 2

DESCRIPTION OF MEASURING CONDITIONS AND ACTUAL MEASURED DATA: POWER AMPLIFIERS

SECTION A.

MEASUREMENT OF TOTAL HARMONIC DISTORTION

This is one of the most important measurements to evaluate amplifiers, and therefore I have divided this chapter into four sections and exhaustively delved into the distortion of amplifiers.

Wave analysis of distortion by use of spectrum analyzer

Frequency is chosen at the most audible high mid-range frequency of 5 kHz, and output at −3 dB below the rated power into 8 ohm loads, both channels driven with level control at the maximum position. This makes it possi-

FIG. 2-1 BLOCK DIAGRAM OF DISTORTION WAVE ANALYSIS BY SPECTRUM ANALYZER

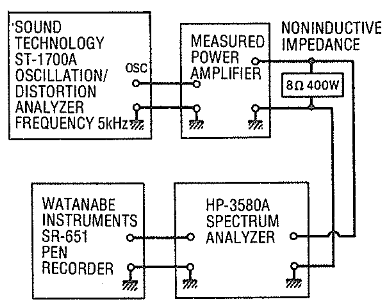


FIG. 2-2 RESIDUAL DISTORTION WAVE
Measured using ST-1700A spectrum analyzer
(5 kHz residual noise; 0.025% T.H.D.)

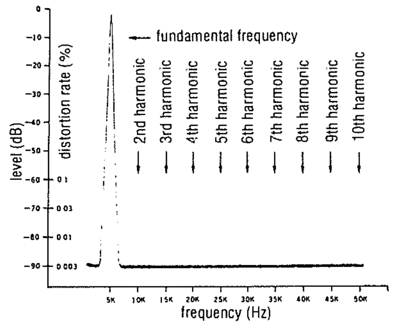
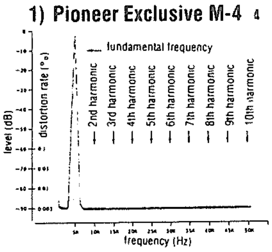


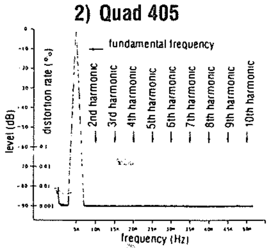
FIG. 2-3 MEASUREMENT OF TOTAL HARMONIC DISTORTION

1) Pioneer Exclusive M-4



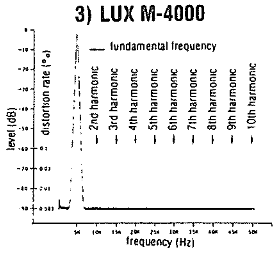
Power output: 25 W T.H.D.: 0.0025%

2) Quad 405



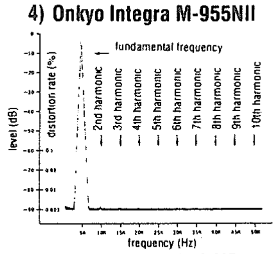
Power output: 50 W T.H.D.: 0.006%

3) LUX M-4000



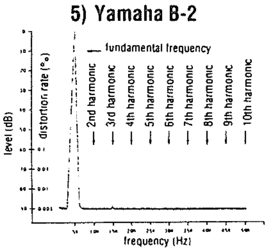
Power output: 90 W T.H.D.: 0.0027%

4) Onkyo Integra M-955NII



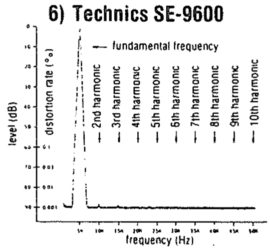
Power output: 65 W T.H.D.: 0.007%

5) Yamaha B-2



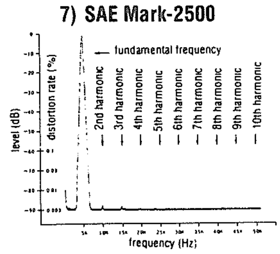
Power output: 50 W T.H.D.: 0.006%

6) Technics SE-9600



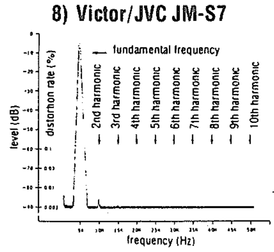
Power output: 50 W T.H.D.: 0.009%

7) SAE Mark-2500



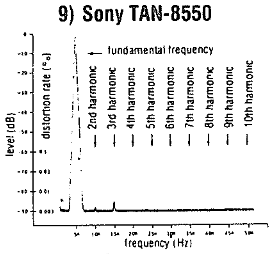
Power output: 150 W T.H.D.: 0.005%

8) Victor/JVC JM-S7



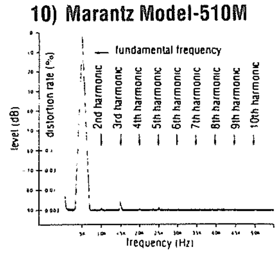
Power output: 50 W T.H.D.: 0.0055%

9) Sony TAN-8550



Power output: 50 W T.H.D.: 0.006%

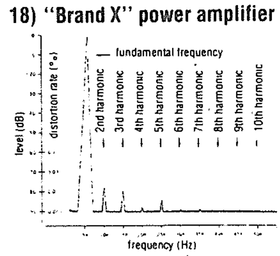
10) Marantz Model-510M



Power output: 125 W T.H.D.: 0.0085%

(11)—(17) ***Omitted***

18) "Brand X" power amplifier



Power output: 75 W T.H.D.: 0.018%

ble to observe the existence of odd and even orders of harmonic distortion (measured up to the 10th harmonic). The closer the measured data are to the residual distortion of the measuring instrument (shown in Fig. 2-2), the better in distortion the amplifier can be considered to be. If two distortion levels are equal, a smaller amount of high-order harmonics would be better. Even-order harmonics are more innocuous than odd-order ones.

Distortion analysis of high frequency (20 kHz) using photography

Frequency is taken at 20 kHz, and power output is fixed at 10 watts into 8 ohms impedance, both channels driven, with level controls at the maximum value. The advantage of this measurement is to show the existence of notch distortion in the ultra treble range which cannot be observed by the spectrum analyzer. In these data, the flatter the line an amplifier has (closer to the residual distortion of the measuring instrument as in Fig. 2.5), the lower the distortion in the ultra treble range. If two distortion levels are the same, the amplifier without such sharp distortion as notch distortion is better.

Output power vs. distortion characteristics into 4 ohm loads

Frequency was taken at 3 points: 20 Hz, 1 kHz, and 20 kHz, and power output was measured from 0.1 watt to the point just before clipping (into 4 ohm loads, both channels driven, with level control at the maximum position). The purpose of this test was to see whether or not the measured power amplifiers can drive today's low-efficiency 4 ohm loudspeakers to fullest potential; and also to test the output linearity at 4 ohms and margin of the power supply section. (Refer to Fig. 2-4 for block diagram).

It can be concluded from this measurement that the lower the distortion, the better the amplifier would be. It is the inferior model with poor linearity that shows sharp deterioration in distortion near its rated power output. The residual distortion of the distortion meter (built into the oscillator) is illustrated in Fig. 2-7.

FIG. 2-4 BLOCK DIAGRAM OF DISTORTION ANALYSIS BY PHOTOGRAPHY (20 kHz TREBLE RANGE)

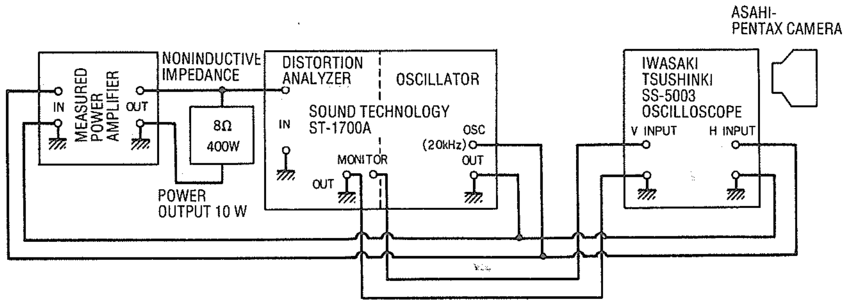


FIG. 2-5 20 kHz RESIDUAL DISTORTION WAVE OF ST-1700A DISTORTION ANALYZER (T.H.D. RATE: 0.0035%)

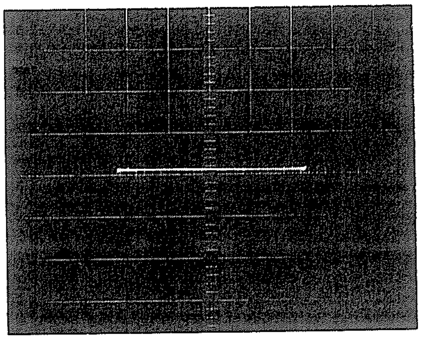
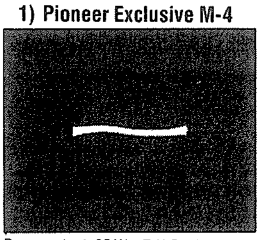


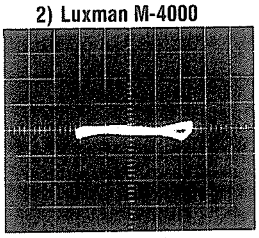
FIG. 2-6 TREBLE RANGE (20 kHz) DISTORTION ANALYSIS

1) Pioneer Exclusive M-4



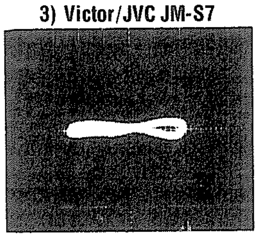
Power output: 25 W T.H.D.: 0.0045%

2) Luxman M-4000



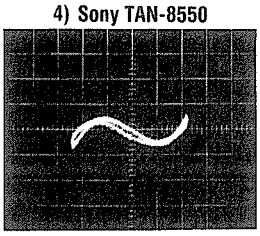
Power output: 10 W T.H.D.: 0.007%

3) Victor/JVC JM-S7



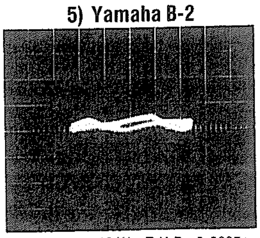
Power output: 10 W T.H.D.: 0.01%

4) Sony TAN-8550



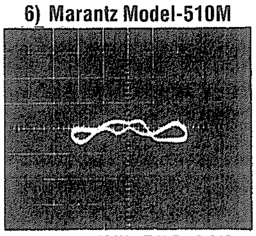
Power output: 10 W T.H.D.: 0.02%

5) Yamaha B-2



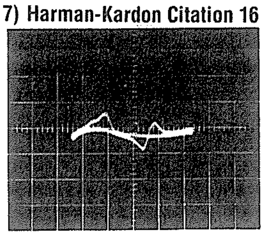
Power output: 10 W T.H.D.: 0.0085%

6) Marantz Model-510M



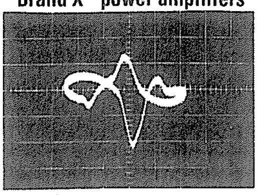
Power output: 10 W T.H.D.: 0.015%

7) Harman-Kardon Citation 16



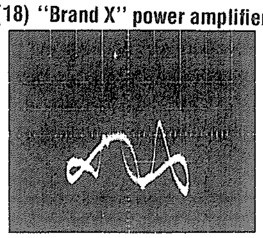
Power output: 10 W T.H.D.: 0.012%

(8)—(17) The average data of "Brand X" power amplifiers



Power output: 10 W T.H.D.: 0.03%

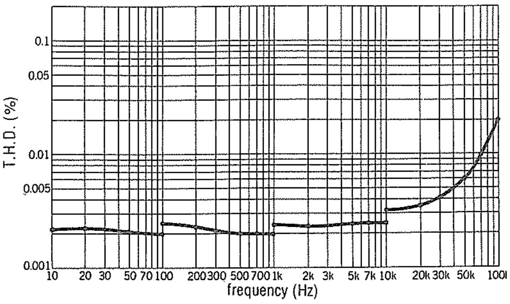
(18) "Brand X" power amplifier



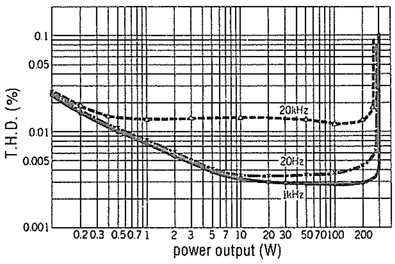
Power output: 10 W T.H.D.: 0.04%

OUTPUT POWER VS. DISTORTION AT 4 OHMS IMPEDANCE

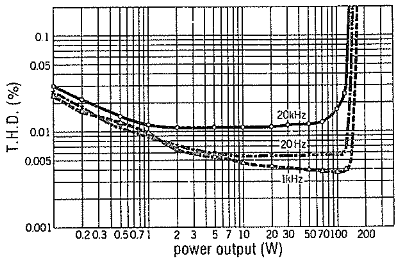
FIG. 2-7
Residual distortion of the ST-1700A distortion analyzer (measured at 3 V output)



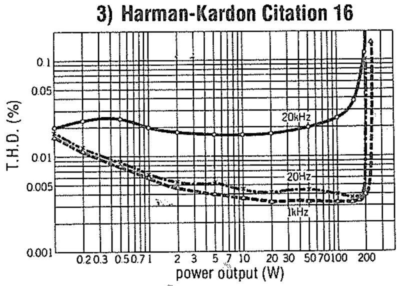
1) LUX M-4000



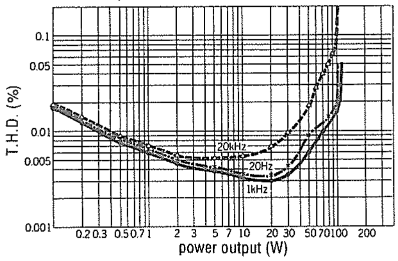
2) Yamaha B-2



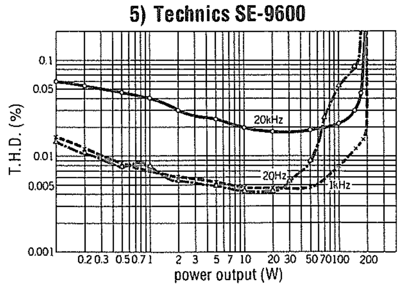
3) Harman-Kardon Citation 16



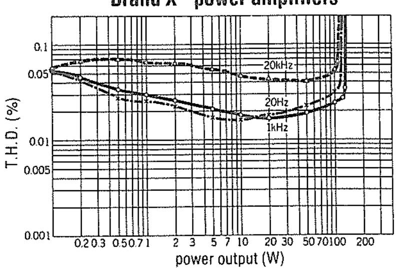
4) Pioneer Exclusive M-4



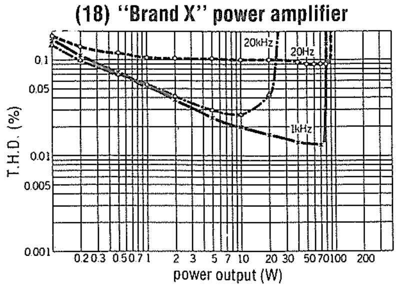
5) Technics SE-9600



(6)—(17) Average results of "Brand X" power amplifiers



(18) "Brand X" power amplifier



Frequency vs. distortion characteristics

A continuously variable frequency was applied from 10 Hz to 100 kHz, and output was measured at 3 points: the rated power, −3 dB from rated power, and 1 watt,' at the left channel only. However, in case of the rated power output, it is possible to blow out power amplifiers in the ultra treble range, so the test was made from 10 Hz to 30 kHz only. At the −3 dB point the measurement was made nearly down to 0.1% distortion into 8 ohms impedance, both channels driven, with level control at the maximum position. On this measurement, the linearity of each power output was shown throughout the entire frequency range, and the −3 dB curve indicates the power bandwidth. (Refer to Fig. 2-1 for the measurement block diagram). The way to interpret this data is the same as that above, which means that a good power amplifier will have a low distortion rate. Furthermore, a good amplifier has the smallest spread among the values at the three measured output levels.

SECTION B.

MEASUREMENT OF INTER-MODULATION DISTORTION

The I.M.D. which is generated from two signals input to a power amplifier was studied in the following two sections.

Output power vs. I.M.D.

Input was composed of two signals: 60 Hz and 7 kHz, in the ratio of 4:1, and power output was measured on both channels from 0.1 w to near the clipping point (8 ohms impedance, both channels driven, level control at maximum). The purpose of this measurement was to measure various amounts of I.M.D. triggered by an amplifier's ground-loop, as well as distortion error between left and right channels. Generally speaking, the power amplifiers with separate power supply sections for each channel seem to have had the better results, as far as this characteristic was concerned. As per the block diagram of Fig. 2-9, photographs were taken from the monitor terminals of an I.M.D. analyzer at −3 dB below the rated output. As to these data, the lower the distortion, the better the performance (similar to T.H.D., Section A). The residual distortion of this measuring instrument is 0.002%.

FIG. 2-8 FREQUENCY VS. DISTORTION RATE

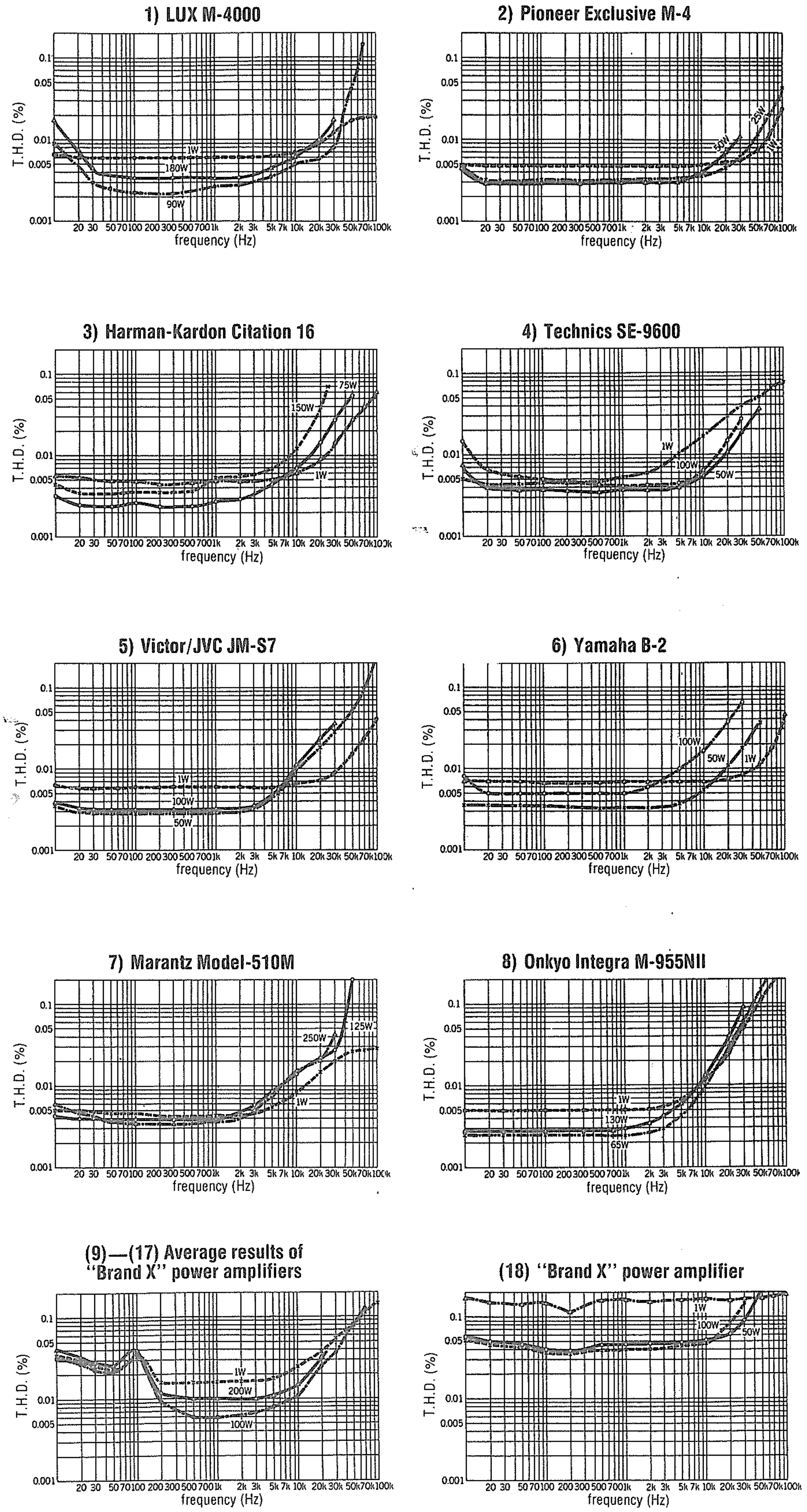


FIG. 2-9 BLOCK DIAGRAM OF OUTPUT POWER VS. I.M.D. RATE

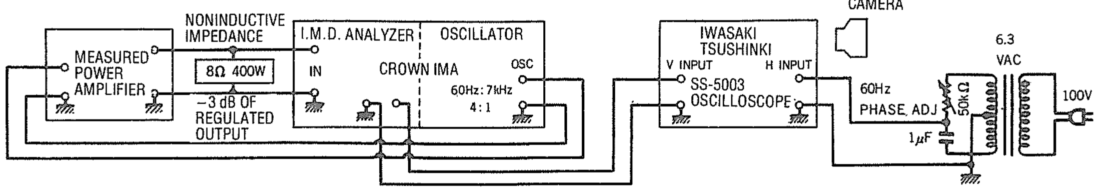
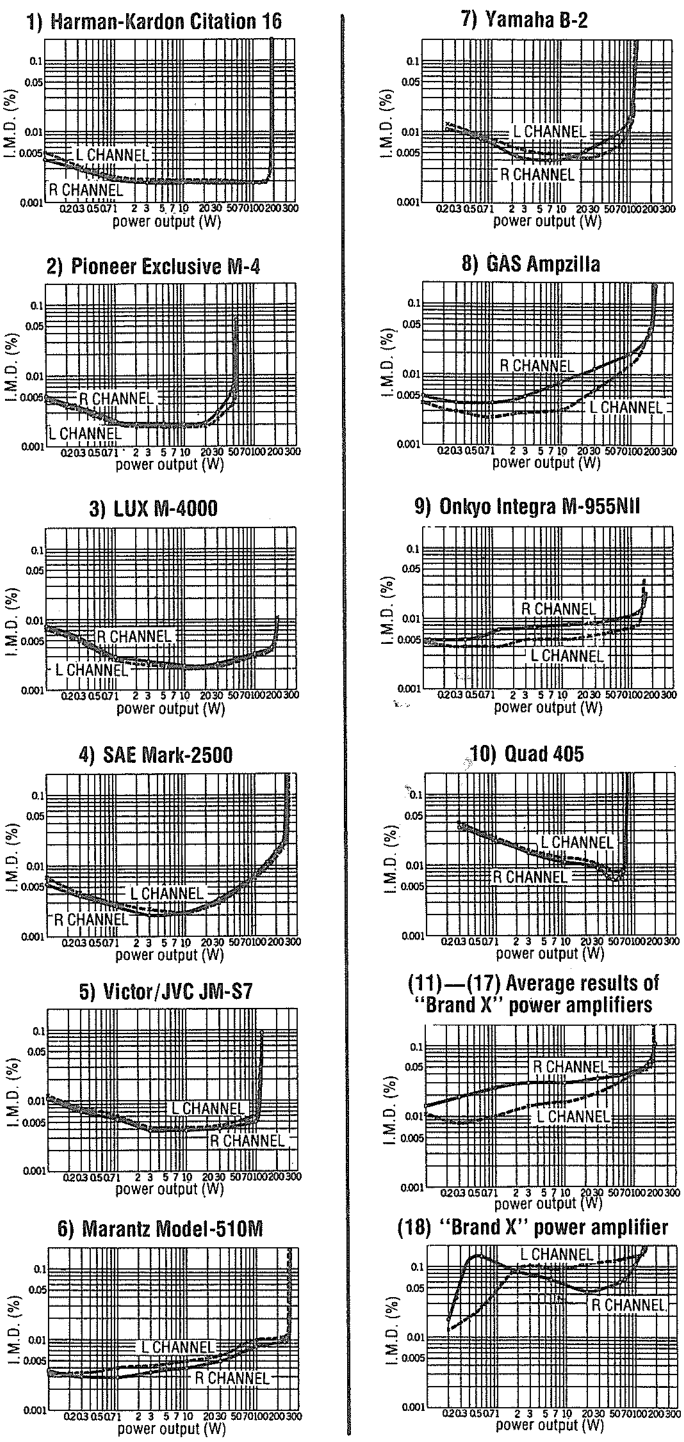


FIG. 2-10 MEASUREMENTS OF I.M.D. RATE



Wave analysis by photography

First of all, the input was composed of two signals: 60 Hz and 7 kHz in the ratio of 4:1, and output was measured at −3 dB below the rated output. (8 ohms impedance; both channels driven; level control at the maximum). The purpose of this measurement is to analyze the nature of intermodulation distortion, and to check the existence of notch distortion caused by the I.M.D. measurement method. (Refer to Fig. 2-9 for the block diagram). As per the residual distortion of the measurement instrument in Fig. 2-11, the straighter the trace on the scope, the better the performance of the amplifier. It also must be noted that when distortion levels are equal there should not be such sharp wave deterioration as occurs with notch distortion.

SECTION C.

MEASUREMENT OF RESIDUAL NOISE

The measurement of residual noise of power amplifiers is shown in the next two items. On this issue, I have attached special importance to the waveform of residual noise that affects auditory feeling. Also, speaking of S/N ratio, I have expressed it on the basis of input sensitivity, which means that the amplifier's gain is added to the generally expressed S/N ratio.

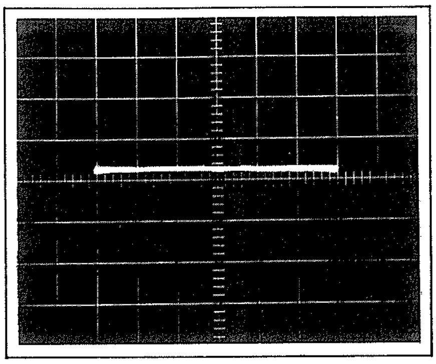
Photographic wave analysis of residual noise

The measurement was made into 8 ohm loads with level control at the minimum position. This test was conducted to check whether or not those problems which adversely affect listening feeling exist, e.g. hum from power supply source and spikes. Another aim of this measurement was to check the level of white noise.

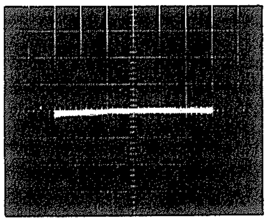
In this measurement, you can understand an amplifier will be better if the noise level is low; but when noise levels are equal, the amplifier is better whose hum and spike components are low. The residual noise of this measuring instrument is 0.02 mV.

WAVE ANALYSIS USING PHOTOGRAPHY

FIG. 2-11
Residual noise of Model IMD intermodulation distortion analyzer (I.M.D. rate: 0.002%)

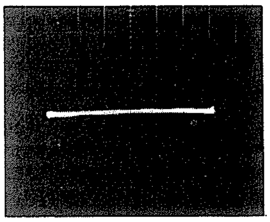


1) LUX M-4000



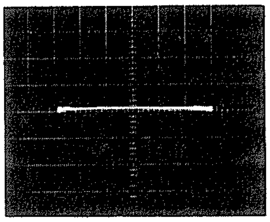
Power output: 90 W I.M.D.: 0.0028%

2) Pioneer Exclusive M-4



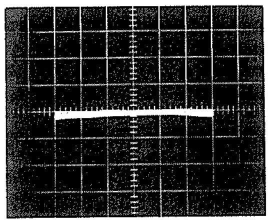
Power output: 10 W I.M.D.: 0.0055%

3) Harman-Kardon Citation 16



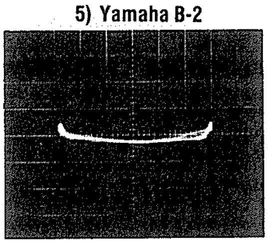
Power output: 75 W I.M.D.: 0.002%

4) Victor/JVC JM-S7



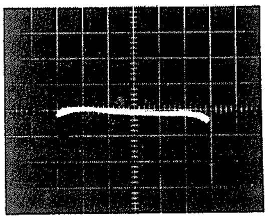
Power output: 50 W I.M.D.: 0.0047%

5) Yamaha B-2



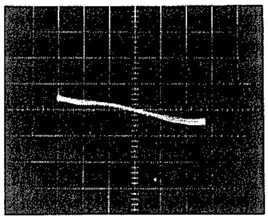
Power output: 50 W I.M.D.: 0.0055%

6) Onkyo Integra M-955NII



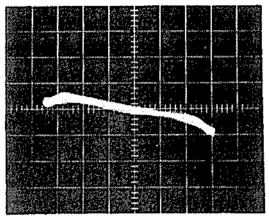
Power output: 65 W I.M.D.: 0.007%

7) Marantz Model-510M



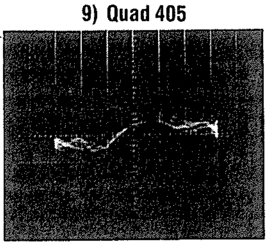
Power output: 125 W I.M.D.: 0.008%

8) Sony TAN-8550



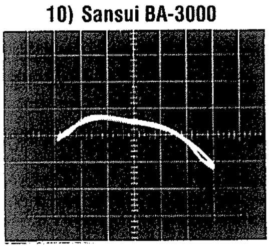
Power output: 50 W I.M.D.: 0.011%

9) Quad 405



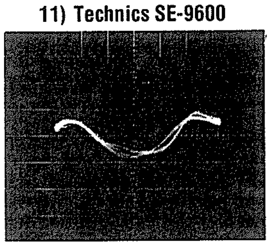
Power output: 50 W I.M.D.: 0.008%

10) Sansui BA-3000



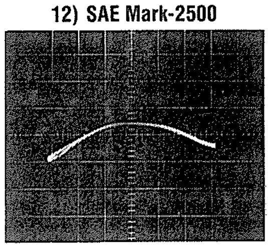
Power output: 85 W I.M.D.: 0.032%

11) Technics SE-9600



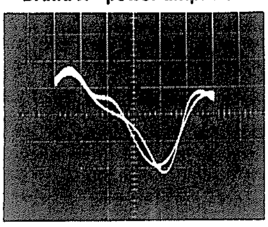
Power output: 50 W I.M.D.: 0.017%

12) SAE Mark-2500



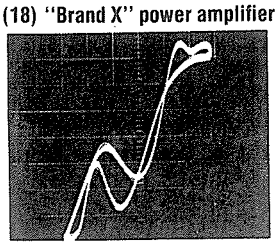
Power output: 150 W I.M.D.: 0.009%

(13)—(17) Average data of "Brand X" power amplifiers



Power output: 75 W I.M.D.: 0.045%

(18) "Brand X" power amplifier



Power output: 50 W I.M.D.: 0.064%