FIG. 2-12 BLOCK DIAGRAM OF RESIDUAL NOISE MEASUREMENTS

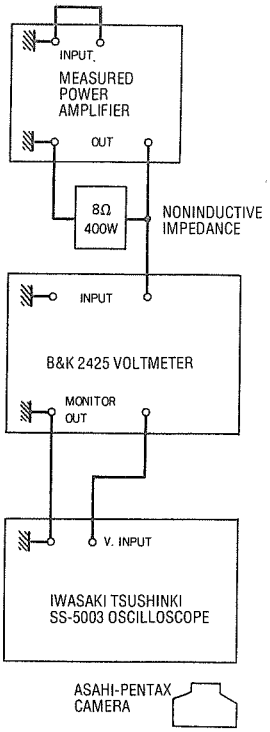


TABLE 2-13 NOISE MEASUREMENTS

1) LUX	M-4000	139.1 dB
2) Harman-Kardon	Citation 16	139.1 dB
3) SAE	Mark-2500	138.9 dB
4) Technics	SE-9600	138.5 dB
5) Marantz	Model-510M	138.3 dB
6) Yamaha	B-2	137.3 dB
7) Onkyo	Integra M-955NII	136.1 dB
8) Trio/Kenwood	Supreme 700M	135.1 dB
9) "Brand X"	power amplifier	124.0 dB

FIG. 2-14 INPUT-CONVERTED S/N RATIO COMPUTATION

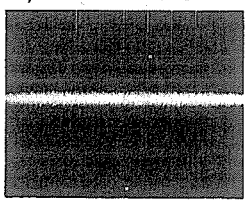
S/N RATIO OF A POWER AMPLIFIER $= 20 \log_{10} \frac{\text{OUTPUT POWER}}{\text{RESIDUAL NOISE}}$ + GAIN OF A POWER AMPLIFIER $= 20 \log_{10} \frac{\text{OUTPUT POWER}}{\text{INPUT SENSITIVITY}}$ = INPUT-CONVERTED S/N RATIO

FIG. 2-15 AN EXAMPLE OF INPUT-CONVERTED S/N RATIO COMPUTATION

S/N RATIO OF THIS POWER AMPLIFIER $20 \log_{10} \frac{40(V)}{0.0002(V)} = 106dB$ + GAIN OF THIS POWER AMPLIFIER $20 \log_{10} \frac{40(V)}{1(V)} = 32dB$ = INPUT-CONVERTED S/N LEVEL $= 138$ dB

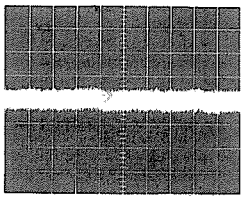
FIG. 2-16 RESIDUAL NOISE MEASUREMENTS

1) Pioneer Exclusive M-4



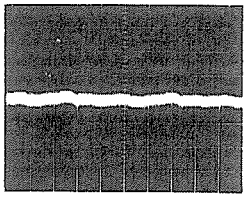
Noise level: 0.12 mV

2) LUX M-4000



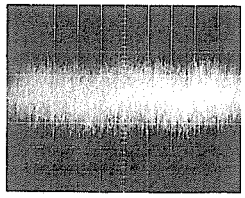
Noise level: 0.16 mV

3) Onkyo Integra M-955NII



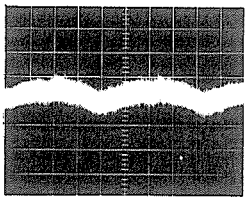
Noise level: 0.11 mV

4) Quad 405



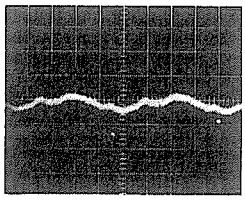
Noise level: 1.0 mV

5) McIntosh MC-2105



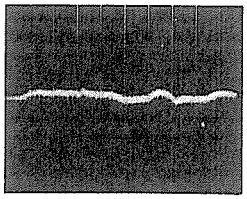
Noise level: 0.45 mV

6) Marantz Model-510M



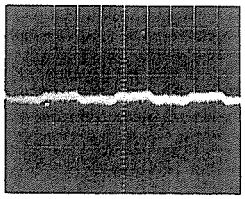
Noise level: 0.11 mV

7) Harman-Kardon Citation 16



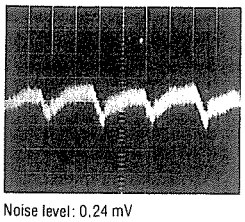
Noise level: 0.11 mV

8) Technics SE-9600



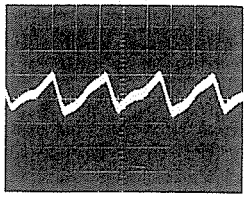
Noise level: 0.1 mV

(9)—(17) Average of "Brand X" power amplifiers



Noise level: 0.24 mV

(18) "Brand X" power amplifier



Noise level: 0.11 mV

Comparison of S/N ratios

Unlike the conventional method of expressing power amplifiers' S/N ratio by the ratio of rated power output to residual noise, here they are compared on the basis of input sensitivity with the addition of the gain of the amplifier as per Fig. 2-14. Obviously, the ratio is better if its numerical value is larger. For example, with a power amplifier whose power output is 200 watts (8 ohms impedance) with residual noise of 0.2 mV and input sensitivity of 1.0 V, the result will be what is described in Fig. 2-15. As I mentioned before, the gain of power amplifiers was not taken into consideration with the conventional S/N ratio measurement, and therefore I have made the measurement based on the value of input sensitivity. As far as the data are concerned, it is the same as with the conventional method, and the larger the S/N ratio, the better the specification.

SECTION D.

MEASUREMENT OF 20 kHz CLIPPING WAVE (BY USE OF SINE WAVE) AND MEASUREMENT OF SLEW RATE (BY USE OF SQUARE WAVE)

The purpose of this measurement is to check treble response of a power amplifier, existence of unstable factors and accumulated effect of carrier in the case of class-B operation, which is reported in the following two items.

Photographic analysis of clipping wave by the use of 20 kHz sine wave

Frequency was selected at 20 kHz, and measurement was made at the clipping point, into 8 ohms, both channels driven with level control at the maximum position. the purpose of this measurement is to observe the existence of unstable elements in the high frequencies, treble frequency response and amount of the accumulated effect of carrier in the case of class-B operation. The observation is made by photography. Fig. 2-20 designates the ideal 20 kHz clipping wave, so it can be said that anything which comes closest to the illustrated example is considered to be a fine unit on this test. Also, it is better if the existence of unstable factors and accumulated effect of carrier in class-B operation are smaller.

Measurement of slew rate

This measurement was taken with the frequency at 2 kHz by the use of a square wave at the clipping point of output power into 8 ohm loads, both channels driven, with level control at the maximum position. The purpose of this measurement is to measure the slew rate of a power amplifier and then to judge the superiority or inferiority of its treble characteristics. (Refer to Fig. 2-18 for the measurement block diagram). With this measurement, the higher the voltage in terms of μsec, the better the amplifier will be. In view of the treble characteristics of today's power transistors, however, if the slew rate is too high, instability would be increased. Normally a figure exceeding 10 V/μsec is acceptable.

SECTION E.

MEASUREMENT OF PHASE RESPONSE

These graphs describe the frequency vs. phase shift of an amplifier. Frequency is taken from 10 Hz to 100 kHz, and output power is fixed at 0.5 watt into 8 ohms, both channels driven, with level control at the maximum and medium positions. This is to test phase shift, which has a close relation to the frequency. As far as the level control is concerned, the medium position offers the maximum impedance from the volume as well as the maximum phase shift. With the D.C. amplifiers which permit on/off operation of input capacitor, the measurement was taken at the normal position.

As in the case of frequency response, an amplifier is better if its phase response is flat. Also it is favorable if the deviation is minimum between the curve with level control at the maximum position and that at the medium position. Fig. 2-23 shows the phase shift of the measuring instrument.

SECTION F.

MEASUREMENT OF RUSH-CURRENT WHEN POWER SWITCH IS TURNED ON

The measurement block diagram is shown in Fig. 2-22. To measure the rush-current, a 0.1 ohm shunt resistor made by Hewlett-Packard is used, and the voltages generated at both ends of the resistor are measured and converted into current. The AC power was turned on after confirmation of complete discharge of electrolytic capacitors, etc. (after a day's discharge), and in view of the waveform of the AC power when it is turned on, the test was repeated 10 times on each amp and the average was taken. The peak voltage thus generated was monitored by the oscilloscope and recorded by the voltmeter.

The measurement was made without loads, with the level control at the minimum position. The purpose of this measurement is to check if an adequate counter-measure is taken against possible influences on peripheral audio equipment by the large-capacity transformers and electrolytic capacitors employed in the high-power basic amps, and this has nothing to do with subtle figures. In this measurement, the smaller the rush-current, the better the quality of the amplifier. But as the rush-current increases in proportion to the capacity of transformers and electrolytic capacitors, the judgment was made from whether or not such counter-measures are provided. Normally there is no problem if the rush-current is below 40 A (peak value).

TABLE 2-17
MEASUREMENT OF SLEW RATE

Manufacturer	Model	Value
1) Yamaha	B-2	64
2) Technics	SE-9600	48
3) Sony	TAN-8550	48
4) Trio/Kenwood	Supreme 700M	43
5) Otto/Sanyo	DCP-3001	43
6) Onkyo	Integra M-955NII	40
7) Pioneer	Exclusive M-4	32
8) LUX	M-4000	30
9) Harman-Kardon	Citation 16	30
10) C/M Laboratory	CM-912	30
(11)—(17) *Omitted*	—	—
18) "Brand X"	power amplifier	12

FIG. 2-18 BLOCK DIAGRAM OF CONNECTIONS AND TESTING EQUIPMENT USED FOR ANALYSIS OF CLIPPING (20 kHz sine wave)

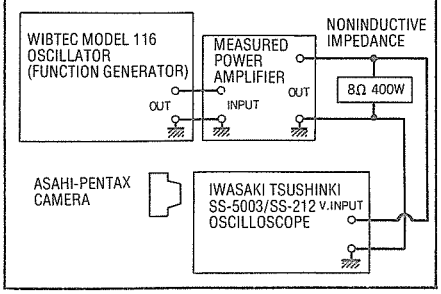
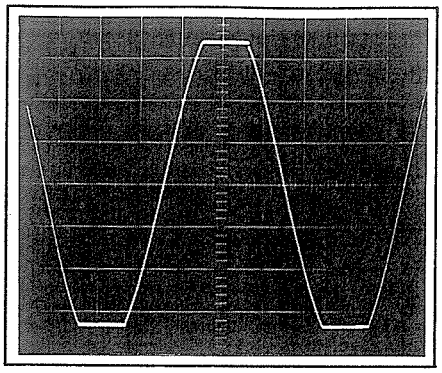


TABLE 2-19 POWER AMPLIFIERS THAT ARE PROTECTED FROM RUSH CURRENT

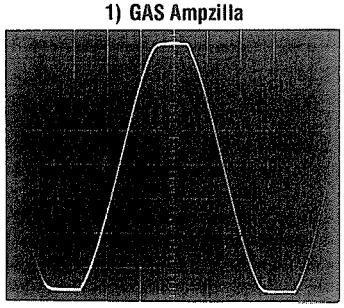
Manufacturer	Model	Rated Output (into 8-ohms)
1. Sansui	BA-3000	170W+170W
2. Trio/Kenwood	Supreme 700M	175W+175W
3. Victor/JVC	JM-S7	100W+100W
4. LUX	M-4000	180W+180W
5. Marantz	Model-510M	256W+256W

ANALYSIS OF CLIPPING WAVE USING 20 kHz SINE WAVE

FIG. 2-20 The ideal 20 kHz clipping wave

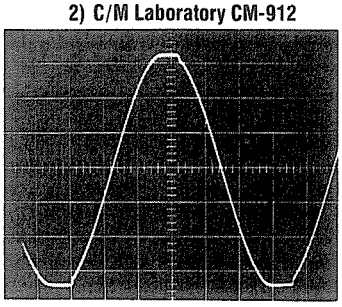


1) GAS Ampzilla



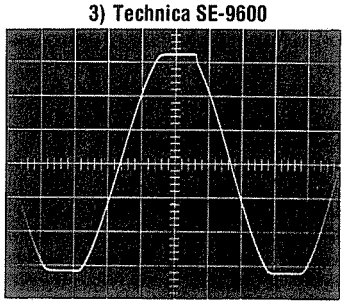
Power Output: 230 W

2) C/M Laboratory CM-912



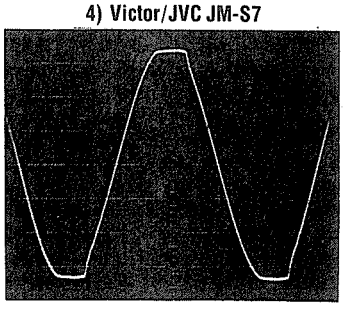
Power Output: 160 W

3) Technica SE-9600



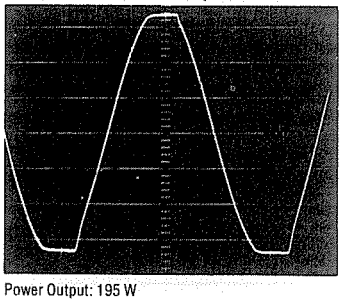
Power Output: 150 W

4) Victor/JVC JM-S7



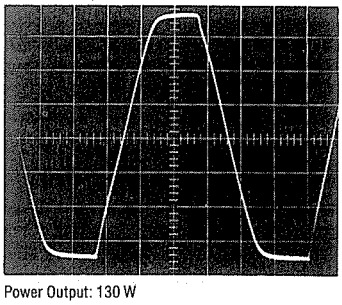
Power Output: 135 W

5) Trio/Kenwood Supreme 700M



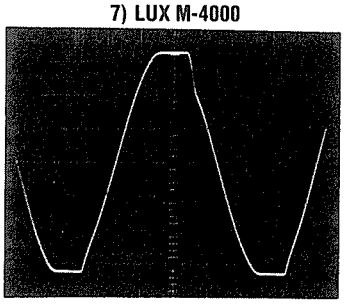
Power Output: 195 W

6) McIntosh MC-2105



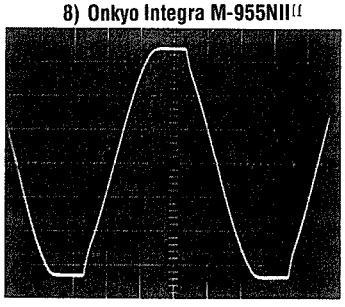
Power Output: 130 W

7) LUX M-4000



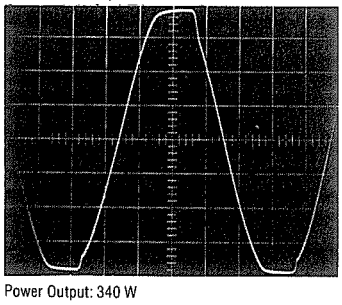
Power Output: 220 W

8) Onkyo Integra M-955NII[1]



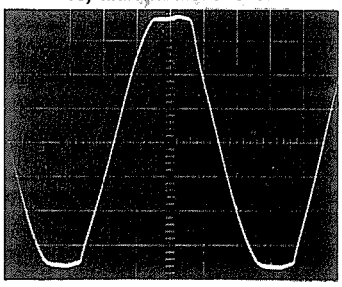
Power Output: 155 W

9) SAE Mark-2500



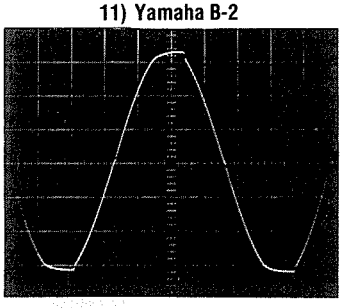
Power Output: 340 W

10) Marantz Model-510M



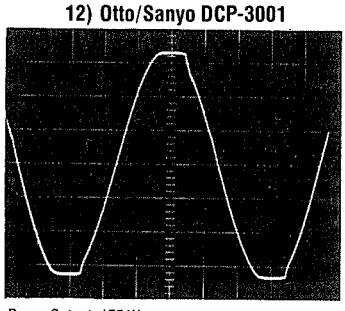
Power Output: 330 W

11) Yamaha B-2



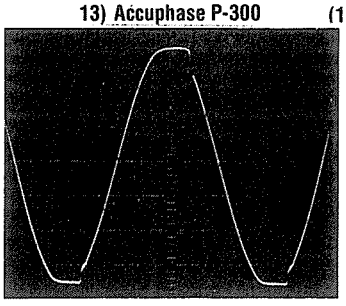
Power Output: 120 W

12) Otto/Sanyo DCP-3001



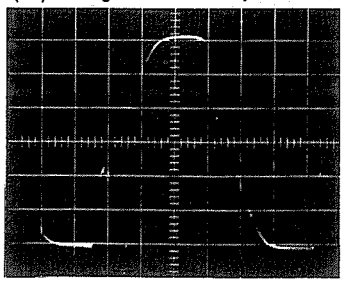
Power Output: 175 W

13) Accuphase P-300



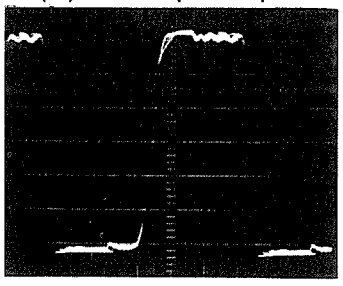
Power Output: 180 W

(14)—(17) Average of "Brand X" power amplifiers



Power Output: 155 W

(18) "Brand X" power amplifier



Power Output: 190 W

FIG. 2-21 DIAGRAM OF CONNECTIONS AND TEST EQUIPMENT USED FOR PHASE-SHIFT MEASUREMENTS

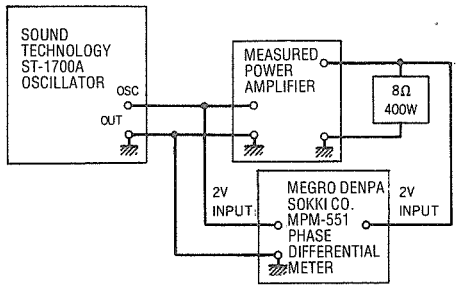


FIG. 2-22 BLOCK DIAGRAM OF MEASUREMENT OF RUSH CURRENT WHEN POWER IS TURNED ON

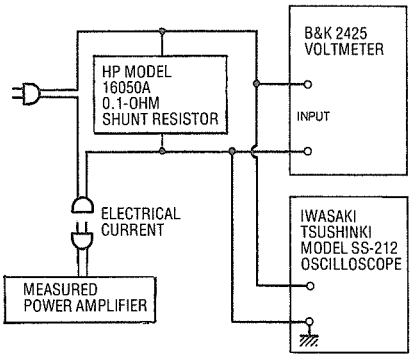
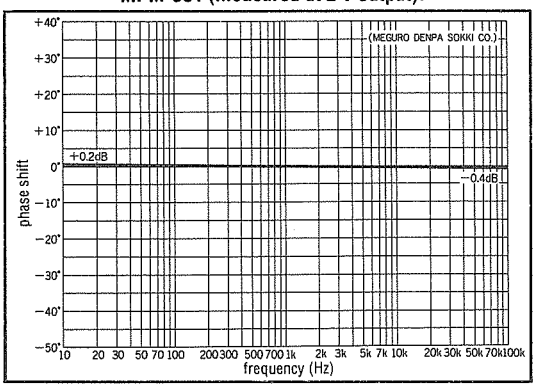
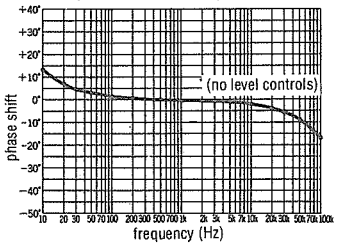


FIG. 2-23 Phase-shift of phase-shift meter model MPM-551 (measured at 2 V output).

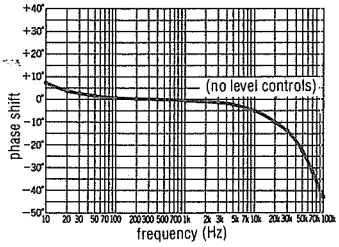


MEASUREMENT OF PHASE SHIFT

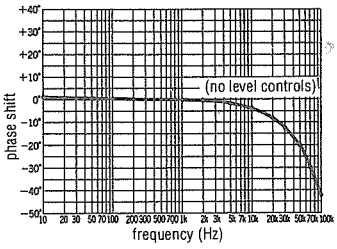
1) C/M Laboratory CM-912



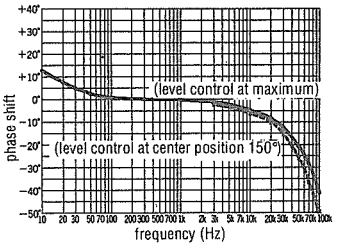
2) Pioneer Exclusive M-4



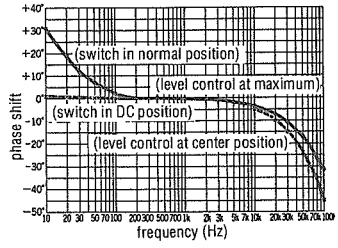
3) GAS Ampzilla



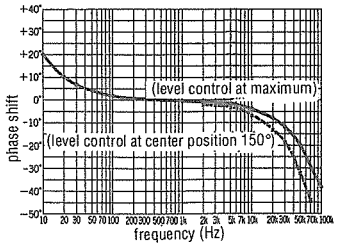
4) LUX M-4000



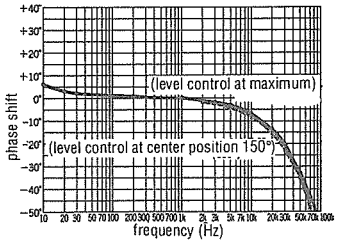
5) Yamaha B-2



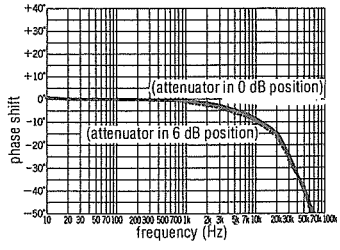
6) Onkyo Integra M-955NII



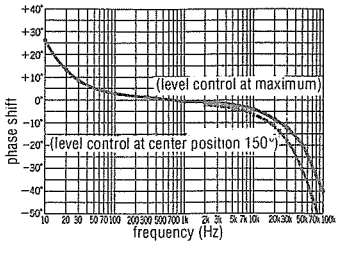
7) Marantz Model-510M



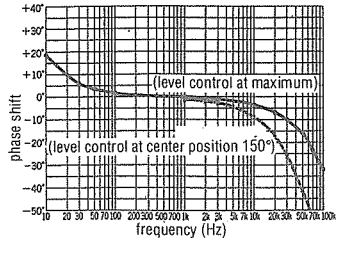
8) SAE Mark-2500



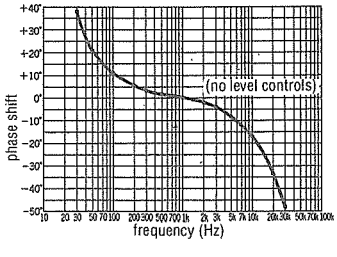
9) Sansui BA-3000



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



(18) "Brand X" power amplifier



Chapter 3

AMPLIFIERS OF HIGH APPRAISAL FROM OVERALL MEASURED CHARACTERISTICS

In overall judgment on the various items so far measured, I picked the amplifiers of high appraisal. Please go through this portion referring to the previous announcements of measured results. Note that the prices are entirely out of consideration.

SECTION A. Preamplifiers

First Rank: Luxman C-1000

To cope with the Yamaha C-2, each item shows an unimpeachable figure including T.H.D. and I.M.D. It is a common tendency to all the amplifiers ranked at the high level (not to speak of the C-1000) that the distortion at 20 Hz and 20 kHz shows almost no difference from that at the mid-range, thanks to a substantial improvement of circuitry by means of a configuration similar to that of an operational amplifier. Speaking about the S/N ratio, however, this seems a little inferior to the Yamaha C-2, though ranked at the top. On the other hand, the result of thorough study in the wiring techniques is shown in many sections. It is also highly rated that no deviation occurs in characteristics, even under fluctuation of the conditions of the volume control, etc.

First Rank: Yamaha C-2

In all aspects this shows the top-ranked data. Especially in the S/N ratio this is unrivalled. Without sticking to the circuit configuration to use FET's at all stages, the disadvantage of FET's is supplemented by bi-polar transistors, and the effective combination of FET's and bi-polar transistors is realized in the circuitry. I cannot but mention "excellent" about such characteristics despite the low impedance at each amplifying stage. The only criticism may be lodged on wiring. One may feel uneasy about the fact that various characteristics change in the neighborhood of the electrical center point of the volume control, and that separation differs between the right and left channels.

Second Rank: Mark Levinson LNP-2

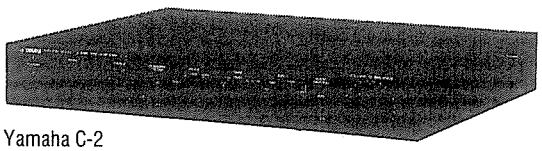
It is difficult to find drawbacks in Japanese amplifiers, while it is relatively easy with imported ones including this Mark Levinson LNP-2. In reverse, this may indicate that manufacturers have a firm design policy and concentrate on the object of usage. With the LNP-2, high quality components are used in volume control, switch, etc. The top-ranked data are shown for I.M.D. and S/N ratio. Separation is ideal with the volume at the maximum position, though it varies according to the movement of the control. On the other hand, judging from the equalizer deviation and the treble-rising trend of the cartridge response, this amp is considered to reproduce bass-heavy/treble-heavy sounds. Also, the maximum input overload at the phono terminal seems too low for this class of preamp, although this handicap is overcome by multiple level-settings.

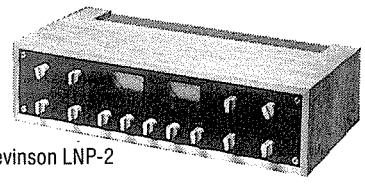
Second Rank: Accuphase C-200

The distortion characteristics are superb at 20 Hz and 20 kHz. The basic

PREAMPLIFIERS

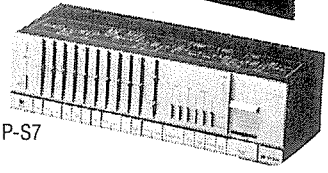

LUX C-1000

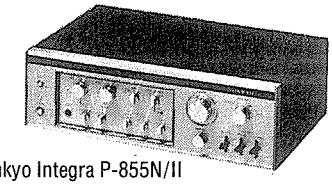

Yamaha C-2


Mark Levinson LNP-2

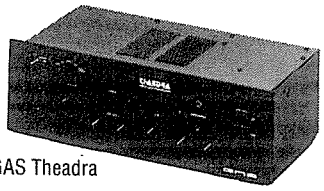

Accuphase C-200

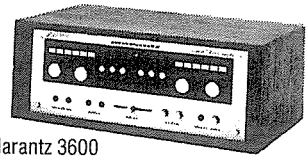

Technics SU-9600


JVC JP-S7


Onkyo Integra P-855N/II


Sony TAE-8450


GAS Theadra


Marantz 3600

construction including circuit configuration seems excellent, though this has been pretty long in the marketplace and is regarded as rather an old model. It seems that some intentional changes are made in the phase characteristics, maybe to create a favorite sound, but this has brought a disadvantageous result in my test this time.

Second Rank: Technics SU-9600

The separation is very good. As you can see from such a design policy putting stress on I.M.D., orthodox methods faithful to fundamental theory are used. A well-balanced product without specific faults.

Second Rank: JVC JP-S7

Lavish in all aspects: circuitry, components and control functions. Performance-wise, THD and IMD at the equalizer stage are very good. Something peculiar exists in the T.H.D. and I.M.D. of the intermediate amp. It is not confirmed at this time how such a peculiarity affects tonal quality, but along with variation of separation pursuant to movement of the volume control, a small doubt remains unresolved in respect to location and wiring of components. Fidelity to the RIAA curve is high, and the phono S/N radio is good.

Third Rank:
Onyko Integra P-855N/II

In separation, the figure at 1 kHz is very good. It is unsatisfactory to me that the 20 Hz distortion at the equalizer amp and 20 kHz distortion at the intermediate amp are different from those at the mid-range. The phono overload input and S/N ratio show well-balanced figures. Generally good characteristics against a relatively small investment in materials and circuitry. Skillful arrangement is salient. A fine product, especially in view of its lowest price (in Japan) among all the amps measured this time.

Third Rank: Sony TAE-8450

The maximum input overload at the phono terminal is a little bit unsatisfactory because of the necessity to make up a DC amp configuration or because of FET's selection conditions. But in overall judgment, this can be ranked at a high level. It shows the severest compliance to the RIAA characteristic.

Third Rank: GAS Thaedra

DC amp configuration is partly employed in the circuit, but the gain is subdued (perhaps to obtain stability against drift, etc.) Then I am afraid the advantages of a DC amp may be phased out. The I.M.D. at the equalizer is very good, while the characteristics at the intermediate amp (where DC amp configuration is adopted) are rather insufficient. In contrast to the Mark Levinson LNP-2, roll-off is too sharp at the treble in the cartridge response. Rather small phono input overload, which is common to imported amplifiers in general. The best phono S/N ratio besides the Yamaha C-2. A unique product full of exoticism.

Third Rank: Marantz 3600

Unlike most imported amplifiers, the design standard is similar to that of domestic amplifiers, and no conspicuous drawbacks are located. The I.M.D., T.H.D., and separation, etc. are quite uncriticizable. But the maximum input overload (100 mV at 1 kHz) is rather unsatisfactory, and is not exceptional for foreign amplifiers. Performance is good when compared with its investment in components, which is common to all the products of this company. In respect to overall balance, the best among the amplifiers of foreign make, but rather questionable as the ultimate class pre-amplifier.

SECTION B.
Power amplifiers

First Rank: Luxman M-4000

With its power output of 180 W + 180 W, the distortion shows an unparalleled figure. It is incredible that the notch distortion is removed almost perfectly at the distortion diffusion by the spectrum analyzer at 5 kHz and the distortion waveform at 20 kHz. Now that this kind of amplifier is on the market, it is not too much to say that the ineffective class-A circuit configuration is no longer needed for an audio amplifier. In the residual noise, the hum components are almost nil (maybe because of the adoption of a toroidal transformer). Phase characteristic, treble clip waveform, slew rate, etc. are on the acceptable level as compared with those of other selected amps.

First Rank: Pioneer Exclusive M-4

The output of 50 W + 50 W is a handicap. Nevertheless a supreme amplifier. This was put into the category of "Special Selection" considering its class-A mode and the scale comparable to that of high-powered amps. No notch distortion exists, though natural with a class-A amp. The residual noise is at a very low level (perhaps because the gain is very small at 26 dB). The waveform is quite natural. But the fan is a little jarring.

Second Rank: Yamaha B-2

A high quality product comparable to the Luxman M-4000 and Pioneer Exclusive M-4 in basic performance. The only difference lies in a slight inferiority under 4 ohm loads. The rated power of 100 W + 100 W should have been a little bigger in view of the excellent basic performance. Another feature is the very good slew rate. The power supply section and waveform of residual noise are a little unsatisfactory.

Second Rank:
Harman-Kardon Citation 16

Various characteristics show top-ranked data, though an unstable symptom is observed in the maximum power at the 50 Hz bass, and a disorder takes place in the clipping waveform at 20 kHz. Excellence in the 4 ohm load characteristics tells of its substantial structure in the power supply section. The I.M.D. is very good, and among the imported amps this is the most talented one. The conscientious design policy is highly rated.

Third Rank: SAE MK-2500

In spite of such high power as 300 W + 300 W, the I.M.D and T.H.D. etc. are kept at this level, to which good marks can be given. Good clipping waveform at the treble 20 kHz. But construction is rough, and also one may get nervous about the variation of distortion characteristics triggered by variation of the input level. There are some more problems: the residual noise contains a large hum component, and despite the high power no counter-measure is provided against rush current. The fan noise is pretty high.

Third Rank: Marantz 510-M

By use of a cooling fan, this amp is made very compact for the output of 250 W + 250 W. The rotation speed of this fan changes automatically according to fluctuations of temperature. Nevertheless, the noise is great. Components are selected in the light of "cost performance," and heat-sink, power transformer, etc. look poor. But these weak points are covered by the circuit technique. Both the I.M.D. and T.H.D. are good, and no problem exists with the S/N ratio. Careful attention is paid to the counter-measures against rush current when the power is switched on. On the average all items are ranked in the upper class.

Third Rank:
Onkyo Integra M 955N/II

A big feature lies in interchangeability between class-A and class-B operation. All the measured items are well studied, and the average good characteristics are obtained. Especially good are the S/N ratio and distortion characteristics. The power supply section is rather weak, though it may be unavoidable in the price bracket, and degradation of the treble distortion (into 4 ohms) as compared with that at the mid-range could make one feel uneasy. The counter-measure against notch distortion is a little unsatisfactory. Good arrangement and good circuit technique. Fine performance for the cheapest. Needless to say, the above are measured in class-B operation, and better performance can be obtained in Class-A operation.

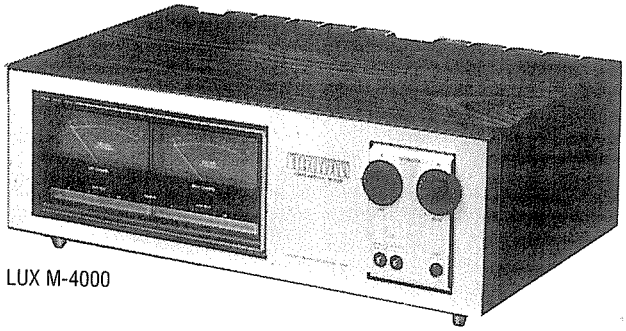
Third Rank: JVC JM-S7

A top class product for the FET configuration. The small notch distortion in the treble may be due to the merit of FET's. The distortion components are of gentle nature, but regrettably there is rather too much at the 20 kHz treble in comparison with that at the mid-range. Strange to say, spikes are salient in the residual noise despite the toroidal transformer provided. Delicate consideration is given to the overall structure and protective measure against rush-current. A unique product with DC amp configuration.

Third Rank: Technics SE-9600

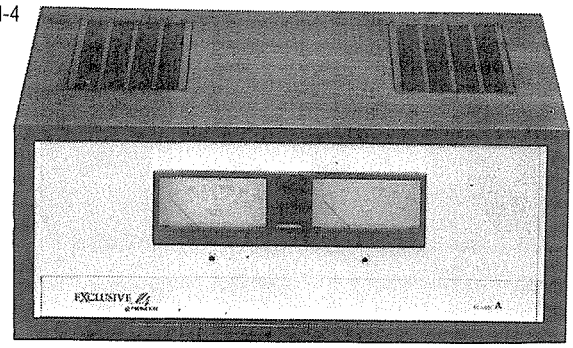
The unrivalled power supply section is reflected in the super excellence of distortion under 4 ohm loads. It may be better to convert some portion of the material cost to upgrade the power output, but as to the basic amplifier it is very favorable not to plunge into the power race, which may be called the basic policy or feature of this company. Overall performance is ranked at a high level, though more minute consideration is desired in respect to notch distortion and residual noise at the time of selection of output impedance.

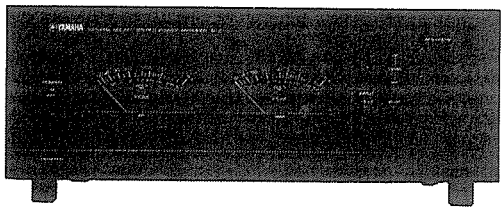
POWER AMPLIFIERS



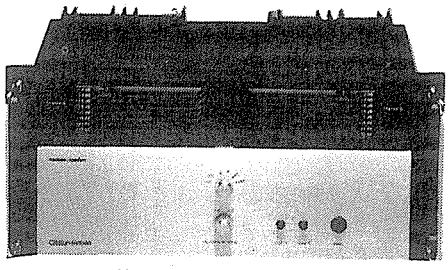
LUX M-4000

Pioneer Exclusive M-4

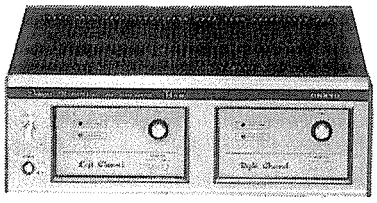




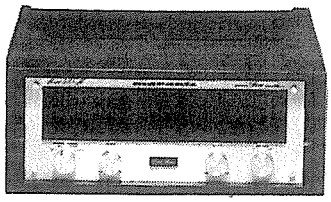
Yamaha B-2



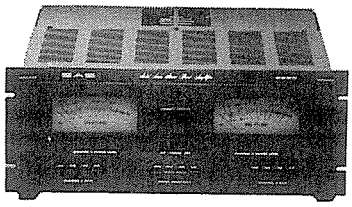
Harman-Kardon Citation 16



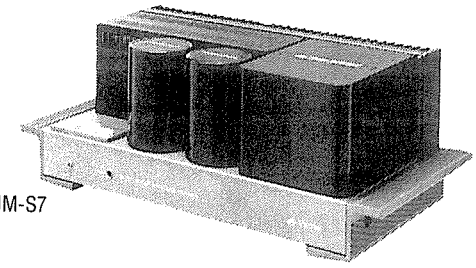
Onkyo Integra M-955N/II



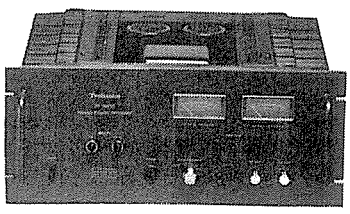
Marantz 510-M



SAE MK-2500



JVC JM-S7



Technics SE-9600

Chapter 4

CORRELATION BETWEEN MEASUREMENT ITEMS AND AUDITORY SENSATION

Separation

This matter had not been treated as such a large factor until recently, but today many controversies arise in this respect. Until now, separation exceeding 50 to 60 dB was considered satisfactory. Surely I myself, too, feel this level gives separation effect enough for normal listening. However, from the separation effect, the amplifier's construction technique and skillfulness in wiring can be judged. For example, the one with the separation characteristic of approximately 80 dB at midrange is dealt with in an almost perfect manner in respect to wiring arrangement and other related matters. On the other hand, in the case of a poor figure, it can be the cause of instability or intermodulation. Speaking from auditory feelings, sometimes this poor value is preferred among the amateurs, due to its distinctive characteristics, but the situation drastically changes depending on such conditions as the listening room, loudspeaker system, and program source. Also, sometimes a large variation of the characteristics occurs pursuant to movement of the volume control, but such an amplifier cannot be highly rated. When judging the separation effect, one had better put importance on distortion in the waveform rather than simply discuss the numerical values.

Total harmonic distortion

Lately many manufacturers have been employing a circuit configuration similar to that of an operational amplifier, and there is a remarkable improvement in the circuitry when compared to the conventional two or three-stage configuration.

The degree of perfection of the circuit can be judged especially from whether or not the characteristic at 20 Hz comes down close to that at 1 kHz in the equalizer. In the last two or three years, remarkable progress has been made in the improvement of bass distortion at the preamplifier's equalizer stage to ensure real, substantial reproduction of the bass range instead of playing cheap tricks to create a favorite sound.

Also, the difference in distortion between the mid-range and 20 kHz high frequency has been an area of severe competition among the manufacturers in recent years, and regarded as one of the main points of comparison of technical levels. But the treble distortion that accompanies the phase inversion without exception gives unpleasant feeling without such a musical effect as is sometimes available with the second harmonics at the mid-range. In most cases, the correlative difference between the treble distortion and mid-range distortion can be a guide to the overload impedance. (For example, when a tape deck with low input impedance is connected, a great deal of change takes place in the distortion rate, or the maximum output level is reduced).

Intermodulation distortion

While the T.H.D. can be minimized by possible cancellation effect of amplifying stages, this trick cannot be applied to I.M.D. The latent I.M.D. appears depending on the sources, the listening levels, and other externally connected equipment. In this respect, importance should also be attached to I.M.D.

S/N Ratio

To measure the S/N ratio there are such methods as the simple comparison of the ratio between signal and noise, and the IHF code which is to make a measurement through a filter. To judge the relative capability of an amplifier, however, it would be meaningless unless the gain of the amplifier is taken into consideration. Therefore an evaluation should be conducted taking the input into account. Importance was attached to white and pink noises, and hum at the power supply section, etc. as they are influential in auditory sensations, while inaudible noise such as 1/f noise was neglected.

Transient response

This item is in the subjective domain, and I feel that here there is an intentional factor for every manufacturer to create their favorite sound. Therefore, it is risky for me as a third person to rate all the amplifiers in order according to my subjective judgment. The response with extremely large vibrations may cause an instability in reproduced sound, but a small undulation therein can be retained on purpose. I introduced this item just for your reference. I think this can be an important factor in judging bass-tight and treble-clear crisp sound.

Phono frequency response with cartridge and equalizer deviation

The deviation of the equalizer response from the RIAA curve is caused either with the intention to realize one's desired sound or by simple error. In my opinion the equalizer curve should be designed faithful to the RIAA standard, which is to be regarded as sacred. Features relating to frequency response should be treated as a tone control. However small the deviation may be, the frequency response varies depending upon the cartridge (moving magnet type) to be connected. The tendency was checked this time with the Shure V15/III that is widely known and used as the popular cartridge. Thus the difference can be detected at the input impedance capacitor, etc. But the frequency response of a cartridge tends to vary greatly with fluctuations of temperature, though ambient conditions were fixed as much as possible. Nevertheless, a simultaneous test could not be conducted in its strict meaning, and a small difference of the measuring conditions must have been reflected in the results. Look at the data considering the peculiarity of the test disc, which is also shown on the response curve.

Waveform analysis by spectrum analyzer

It seems necessary that the distortion which decides the tonal quality should be discussed not only in terms of its numerical value, but in terms of its components and contents. The amplifier of poor inherent characteristics (relying on the NF technique only) generates uncomfortable harmonic distortion of high order. In this measurement I selected 5 kHz in the mid-range (which constitutes the base of sound) as the fundamental wave where the naked characteristics of the amp start to appear. A more noticeable difference can be detected in the treble range, which was dealt with in a separate item.

Photographic wave of T.H.D. of power amplifier

20 kHz is on the limit of the audible frequency bandwidth, and in a sense distortion at this frequency has nothing to do with auditory feelings. To remove the notch distortion, which appears noticeably at the high frequencies, there is the ineffective and uneconomical amp configuration, class-A operation. Music exists for enjoyment, and fidelity in the physical characteristics is important. But what is more important is that an amplifier does not give unpleasant feelings while listening. Notch distortion is the direct cause of unpleasant feelings,

and it is stated in the foreign magazines that such amps which make you feel tired after hours of listening have a conspicuous level of notch distortion. It is especially disturbing because human ears are very susceptible to this distortion even at a low level.

Characteristics into 4 ohm loads

Generally speaking, the power output is rated into 8 ohm loads, and it may be a nasty job to check in detail the characteristics into a 4 ohm load. But if these data are unsatisfactory, the number of speaker systems which can be used with the amps under optimum condition will be very much limited in choice. Inferior characteristics into 4 ohm loads mean a small-scale power supply section, and bad linearity of transistors. In other words, the amplifier which saved in production cost reveals its fault easily. In this respect, this item is indispensable in its correlations.

Clipping waveform at 20 kHz

It does not matter what may take place after the waveform has clipped. But this can be a convenient clue to the character of an amplifier. When the clipping wave is discontinuously hook-shaped, the treble range will be unstable and lusterless sound results. Also, judgment can be made from the slew rate which is usually observed by a square wave. The very point on which manufacturers can exert their engineering techniques is the treble characteristics, rather than the bass characteristics where a certain level can be achieved by investment in componentry.

Phase shift

The important point of a wide-range audio amp is how to make the treble and bass characteristics equal to those at the mid-range where good performance can be obtained relatively easily. One of the factors which constitutes the natural sound at both the treble and bass is the phase shift. Please watch if this characteristic varies by operation of the volume control. It is extremely unsettling if the character of an amp changes according to the rotation of the volume control.

Rush-current when power is turned on

Though this item has no direct relation to auditory sensation, it is still important with the high-powered amps measured this time, in view of the margin of variation in domestic electricity. Moreover, since whenever you use an amp you have to turn the power switch on and off, such a possible cause for anxiety should be removed by some countermeasures.

Postscript—after the measurements were finished

Postscript—after the measurements were finished

For this issue a total of 36 separate amplifiers of both domestic and foreign manufacture were measured, which included 18 preamplifiers and 18 power amplifiers. I simply would like to make a few comments as the conclusion of this report.

New and old products

Among the amplifiers measured in this issue, examples of the old products are the McIntosh C-28 and MC-2105, while examples of the new products are the Yamaha C-2 and B-2. In the terminology here, the word "old" or "new" indicates the period of development.

The McIntosh C-28 and MC-2105 have long been the target for Japanese amplifiers (as evidence, at every manufacturer I visited, the C-28 and MC-2105 were in the development room). When they are compared to today's newly developed amplifiers, however, I keenly feel they are "obsolete." What can be said overall is that the level of amplifiers has progressed as time elapsed. Therefore, I am eagerly looking forward to McIntosh's new model.

Japanese amplifiers

The integrated amplifiers of our nation are acclaimed as number one in the world. But as for separate amplifiers, the first noticeable products were the 10,000 series announced by Technics, and therefore when compared to foreign amplifiers, time-wise there is a great handicap. I was interested to know to what sort of grade they have been improved. As the amplifiers I actually measured do not comprise all the top-notch amps in the world, exact comments cannot be made, but in overall judgment it seems that the amps of Japanese make can be ranked higher than those of foreign make.

The characteristics of amplifiers in our country are similar to us Japanese people, and in an overall sense they are elaborate construction-wise as well as design-wise. Obviously some Japanese amplifiers have doubtful characteristics, but concerning the products that are ranked at high level, splendid results were obtained in all the measurement items; in other words, in general they have a well-balanced design. On the other hand, to my regret, most Japanese amplifiers resemble honor students and are wanting in intensive individuality (including external appearance). The same thing could be said of Japanese integrated amplifiers. In the near future, however, as integrated amplifiers did, separate amplifiers of domestic make will dominate the world. A look at the newest domestic units gives us clear information about this tendency.

Foreign amplifiers

I can say that design-wise as well as circuit-wise, they have originality as compared with domestic amplifiers. Irrespective of their merits, their workmanship, including features and construction, is extremely amateur-like. Such manufacturers as McIntosh, Marantz, and Quad have sufficient experience with their long careers, and their execution is very impressive. While as far as the other companies are concerned, the negative part of "amateur-like" stands out prominently, maybe because of the small scale of the company or lack of experience of young engineers, which you can see in internal construction or front panel treatment.

In regard to the characteristics, there are many models where a certain point is emphasized. For example, the I.M.D. is unrivalled, but other characteristics such as S/N are inferior. In other words, there

were not many well-balanced products. What mostly amazed me in the characteristics is that phono maximum input overload is generally low. When combined with a moving-coil cartridge (such as the Ortofon), and step-up transformer, many are seen to be clipped on a program source of wide dynamic range. Maybe the input overload of domestic amplifiers is too large, but nevertheless that of foreign amplifiers is too small. Another thing is the equalizer curve. The frequency variation within the audible frequency range is one of the factors most influential on the tonal quality of sounds. When speaking of amplifiers with high fidelity, the orthodox way of design is to keep the deviation from the equalizer curve (RIAA curve) at the minimum level, but such a characteristic was shown only by two of them, i.e., the Marantz Model 3600 and Quad 33. As far as the remainder are concerned, slightly or largely, a rise in the treble or bass was observed. The equalizer deviation of Japanese amps was at least within ± 0.3 dB, while that of some overseas amps was found to be ten times larger.

Preamplifiers

I heard many times the criticism that there were many outstanding power amplifiers, but few high-quality preamplifiers. Judging from the actual measurements for this issue, the general tendency is moving in a better direcrection. Especially, the characteristics at the equalizer stage of all the latest preamplifiers were superb, probably because of adoption of such circuits as the operational amplifier. To my regret, some models had an inferior intermediate amp when compared to the superiority at the equalizer stage. Therefore, improvement must be made on this stage in the future.

Power amplifiers

Judging from the results of measurements, in the case of basic amplifiers, both high power and high quality are difficult to make compatible. The selection of power amplifiers was made with a power output ranging from 100 to 200 watts, but there were also exceptions. Those models are the Marantz 510-M and SAE Mark-2500, whose maximum output power easily exceeds 200 watts. It is magnificent that the results are excellent despite the handicap of high power output. From this point, the basic amplifiers with less power output are considered to be advantageous. Generally speaking, the limit of coexistence of high power and high quality can be presumed to be approximately 150 watts.

Among the power amplifiers measured for this issue, apart from their power outputs, the Luxman M-4000 and Pioneer Exclusive M-4 showed the finest data. The former is of class-B operation, while the latter is of class-A operation. The only merit of class-A operation is to eliminate notch distortion, and there are too many demerits, such as small power output.

Speaking of the M-4000, in spite of its class-B operation, notch distortion was not in existence, as far as my measurements are concerned. With the advent of such an amplifier as this, the class-A constitution which is extremely inefficient, is now regarded as obsolete from the quality aspect as well. Therefore the class-B operation will remain unchanged as the main circuit configuration hereafter.