by Y. Uesugi, Uesugi Test Laboratory, Inc.

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Foreword by *Stereo Sound*

The interest in separate amplifiers has risen sharply lately among music lovers. As a result, new-product announcements of separate amplifiers with their response have been made by various audio manufacturers.

We, therefore, requested Uesugi Research Laboratory to make and report on test measurements of today's latest separate amplifiers, including power amplifiers of the 100-200 watt class and preamplifiers of an equivalent grade to those power amplifiers. Our intention in this amplifier examination is to evaluate the amplifiers solely from measurement results of physical characteristics.

Obviously, audio equipment can never be judged by measurement results alone, since the overall aspects of design, finishing touch, tonal quality, and physical characteristics must be considered for a true assessment. However, in contrast to loudspeakers and phono cartridges, the physical characteristics of amplifiers are extremely important. Because of this fact, we have published the present examination.

Originally, we planned to announce the data of all the amplifiers measured, but because of space limitations, we have published only the results of the higher-ranking amplifiers.

Introductory notes by Yoshiro Uesugi

In the three years from 1964-1966, I was employed by Eroica Electronics Industry and was in charge of circuit engineering of amplifiers. Since I am also personally interested in amplifiers, my dream was to develop an amplifier that I could really appreciate.

About three years ago, this dream became a reality by my establishing a company called Uesugi Research Laboratory which produces and distributes vacuum-tube-type preamplifiers, electronic crossover networks, power amplifiers, and custom-ordered power amplifiers.

In the research and development of amplifiers, test equipment is always necessary. While the advantages of an amplifier can be weighed by continuous listening tests, the circuitry of an amplifier cannot be perfected by listening itself. Therefore, when an amplifier engineer wants to make or improve his amplifier, he will eventually want superior test equipment. I am no exception.

Insofar as test equipment is concerned, I have long had a complete set, but I wanted the latest super-precision type equipment that can measure to approximately 0.002%. Such equipment includes a T.H.D. analyzer, an intermodulation distortion analyzer, and a spectrum analyzer that analyzes distortion. But last autumn, I finally accomplished my goal. By way of illustration, I had formerly used a Shiba-Den 796C, which had a full scale of 0.1%, so that the maximum measuring level was approximately 0.03%; by contrast, the Sound Technology 1700A that I purchased can measure to 0.0015%. The total estimated cost for this equipment was 3,000,000 Yen, but my spirits rose as my vision of an ideal amplifier took on actual form.

After my dream was realized, I wanted to measure everything as soon as possible, as a child would want to play with his toys. In fact, ever since last Autumn, I have measured every commercially available separate amplifier that has been brought into my residence.

While compiling these measurement results, I noticed many interesting points and have gained much knowledge. When I showed this data to the editor of *Stereo Sound* magazine, Mr. Harada, he was impressed enough to have these results published. Therefore, I am pleased to report on the actual measurement data of both foreign and domestic separate amplifiers in this issue.

I would just like to add that Mr. Tatsuo Nagashima has actually been measuring some equipment that might directly correspond to the models on which I am reporting. However, I know there is a difference in the serial numbers of these models, because I personally contacted the manufacturers to procure the units to be measured (mostly domestic brands). So, many amplifiers will differ slightly from those which were reported in the previous issue under the title, "Audition of the control amplifiers and power amplifiers of the world."

Finally, I wish to offer warm thanks to the manufacturers for their great cooperation and to the editing staff of this magazine for making everything possible.

—Yoshiro Uesugi

The relation between amplifiers' performance and their physical characteristics

The ideal form of an audio amplifier is, as frequently stated in the symposium of this magazine, defined that its input and output signals are in similar relation, and that there is the required sufficient amplification. But there is no ideal amplifier in this world. For there is distortion, small or large, in the amplifying components whether they are transistors, tubes or the latest FETs. In accordance with technical progress, this distortion has been made smaller as time goes by, but it is impossible to remove it completely, whatever technical advance is achieved. What is possible is to make it infinitely close to zero.

Actually an audio amplifier has to transmit and amplify the electric signals from a phono cartridge, FM tuner, or tape deck to the extent that the speaker systems are sufficiently driven. Of course, it is necessary to convert an electrical voltage signal into wattage in view of the nature of speakers. Since the electric gramophone and its related amplifier were invented, in the history of amplifiers, remarkable progress has been made in electrical characteristics: frequency response as well as distortion. Progress has also been made, gradually or rapidly, in the quality of program sources, such as from the SP disc to LP and stereo LP discs. To utilize these high quality program sources, the amplifier has been improved. It is not too much to say that in the background of the improvement of amps there is an elucidation of the relation between auditory feelings and the physical characteristics of amplifiers. It may be possible to judge the quality of an amp by a listening test, but with only this result it is impossible to develop a good amp. It is necessary to check what points of physical data contribute to superiority in auditory feelings, and make up a new trial sample with better physical characteristics. Then, if the audition test is favorable, the relation between auditory sensations and physical characteristics can be studied. The accumulation of such know-how made it possible for amplifiers to progress. Thus we can expect further progress in the future as well. This is applicable to other hi-fi components, too.

Human senses cannot respond to many things simultaneously. In a listening test the listener usually can concentrate only on a certain point, though there are individual differences. It will actually be impossible to make a complete test, including the conditions of program source, speakers, and room acoustics. Therefore, in many cases, an audition test is accomplished only partially, whatever efforts are exerted. On the other hand—regrettably, in tests by instruments—the present measurement techniques cannot express all that can be heard by human ears. Engineers and audio enthusiasts are trying to put into physical characteristics the methods to capture the entire character of amplifiers and other audio equipment, but it will be impossible to attain the faculty of human ears unless an unprecedented measuring instrument is invented. I think either measurement tests or listening tests alone are incomplete. But when both are made at the same time, an almost satisfactory evaluation result will be obtained.

In the tests this time, I did measure in as much detail as possible and as space permitted, but nevertheless I understand this is only a partial test. Therefore some amps may have superior characteristics aside from the items now tested. Please excuse me for imperfection in this respect.

From Yoshiro Uesugi's "research notes"

by Yoshiro Uesugi
Takuo Uesugi

As to the amplifiers tested and measured for this issue, I have focused on the prestige-type separate amplifiers from each manufacturer, and selected one model per manufacturer. The reason for such selection is that it takes many hours for measuring. There is no other intention. Also, as far as the vacuum tube amplifiers announced by such companies as LUX or Denon are concerned, I had to omit them, since a scanty amount of negative feedback makes it extremely inconvenient to measure them on the same basis. Thus I would like to make a test report on vacuum tube amplifiers at another possible opportunity.

I feel that image-wise, separate amplifiers are considered superior to integrated amplifiers, and for that reason, from the very outset, I have not even considered to select such separate amplifiers as are high in "cost-performance." Among separate amplifiers, there are many varieties, from low-power type to high-power type. When a comparison is made in between those two types in terms of designing/engineering, though, results generally tend to be better with the low-power configuration, partly because of characteristics of the transistor itself.

Therefore, on this particular issue, as a fundamental principle, I decided to select the power amplifiers ranging from 100 to 200 watts. Obviously, it is simpler to design and to manufacture amps in the 100-watt class as compared with 200-watt. Also, as a matter of course, better measurement results can be obtained. In this sense certain models, such as the Marantz Model 510M and the SAE Mark-2500 have handicaps since their output exceeds 200 watts. On the other hand, the Pioneer Exclusive M-4 has a low power output of 50 watts per channel, but this model is of the class-A configuration, which is very rare in today's power amplifiers. Further, its construction scale is comparable to the 200-watt class models. This is the reason why I have selected such "exceptions."

Announcement of the measurement results

The actual data obtained by measurements were classified according to the measured items, and the measured results and the units measured are listed on the following pages. I specified only those models with good measurement results; I have no intention to disclose the names of those models with poor performance, but it is impossible to judge how superior the performance of good units is unless inferior data are listed. So, for comparison, I have listed but not identified the unit whose data showed the worst results, and the unit whose performance can be regarded as average among the inferior units. As regards controversial items on which it is difficult to distinguish good data from bad, I have categorized all the available data on every unit, according to their tendencies.

TABLE 1 LIST OF THE MEASURED PREAMPLIFIERS

Manufacturer	Model	Serial No.	Price (Yen)
Pioneer	Exclusive C-3	UF1000337M	315,000
Victor/JVC	JP-S7	13000004	170,000
Sansui	CA-3000	225050008	160,000
Sony	TAE-8450	200234	285,000
Otto/Sanyo	DCC-3001	90020233	200,000
Accuphase	C-200	C5W793	165,000
Technics	SU-9600	AC5L03C009	175,000
Trio/Kenwood	Supreme 700C	020074	220,000
Onkyo/Integra	P-855NII	85100092	95,000
LUX	C-1000	5100677	230,000
Yamaha	C-2	1109	150,000
Marantz	3600	3600-03711	250,000
SAE	Mark-IB	IB-01014	398,000
Mark Levinson	LNP-2	1072	1,080,000
McIntosh	C-28	72X60	348,000
Quad	33	51555	83,000
GAS	Thaedra	500167	660,000
Harman-Kardon	Citation 11	1200049	129,000

TABLE 2 LIST OF THE MEASURED POWER AMPLIFIERS

Manufacturer	Model	Serial No.	Price (Yen)
Accuphase	P-300	H3Y062	230,000
Otto/Sanyo	DCP-3001	90010229	260,000
Pioneer	Exclusive M-4	UE1000042M	350,000
Sansui	SA-3000	245060194	190,000
Sony	TAN-8550	200207	295,000
Technics	SE-9600	E40803A006	225,000
Trio/Kenwood	Supreme 700M	940008	300,000
LUX	M-4000	A6100865	350,000
Onkyo/Integra	M-955NII	25100185	139,800
Victor/JVC	JM-S7	11000015	230,000
Yamaha	B-2	1204	200,000
Marantz	510-M	989	525,000
McIntosh	MC-2105	AH2201	458,000
Quad	405	2057	156,000
SAE	Mark-2500	26-00225	650,000
Gas	Ampzilla	110313	499,000
Harman-Kardon	Citation 16	1660445	450,000
C/M Laboratory	CM-912	0945	570,000

Chapter 1

DESCRIPTION OF MEASURING CONDITIONS AND ACTUAL MEASURED DATA: PREAMPLIFIERS

An introductory note concerning the measurement of preamplifiers

All the measurements were made on the L channel only (or its equivalent), except for separation characteristics. The input impedance of measured pre-amplifiers was set at 50 ohms, in view of power amps in general. In this case, the input of the other channel was short-circuited; the position for maximum gain was selected on such controls as attenuator, muting, output level control, and cancel circuit of a flat amplifier which is placed after the input selector switch (SAE Mark-1B, Victor/JVC JP-S7, etc.). The defeat position was selected on such supplementary circuits as low- and high-cut filters, tone controls, etc. In addition, the aux input level was set at the maximum position. Under such conditions all the preamplifiers are put into the most fundamental form, i.e. (equalizer) → (flat amplifier).

However, as to the Mark Levinson LNP-2, which uses a slightly unusual circuit configuration, the decibel gain (of input amplifier) was selected as 10 dB (of 3 interchangeable positions: 0, 10, 20 dB) with the input level control fixed at the maximum position, in order to obtain a total gain equivalent to that of the other models. As shown by the block diagram in Fig 1-1, the output level control was treated in the same way as the volume control of other tested models.

SECTION A.

MEASUREMENT OF:
TOTAL HARMONIC DISTORTION (PHONO, AUX)
NOISE (PHONO, AUX)
SEPARATION
MAXIMUM INPUT OVERLOAD OF PHONO EQUALIZER

T.H.D. of phono input

The measurement methods were as follows: phono-1 was selected as input terminal (phono-1 of GAS Thaedra is for a moving-coil cartridge, so phono-2 was used instead); tape recording output-1 (or its equivalent) was used as output terminal; with the units which allow control of input capacity and input impedance, the values closest to 100 pF (pico-farad) and 50 ohms were selected. The gain control of phono-1 was fixed (depending upon the model) as follows: Those with a 3-position selector (Onkyo Integra P-855NII) at the center position; those with continuously variable control (Luxman C-1000, Accuphase C-200, McIntosh C-28) at the electrical center position; those with a 2-position selector (Sony TAE-8450, Quad-33) at the high-gain position. The volume control was set at the minimum position, and the balance control at center position. In principle, the input voltage was measured until T.H.D. came up to 0.1%. However, as the maximum output of an oscillator is approximately 3 V, there are some units that could not be measured at 20 kHz.

In order to measure the T.H.D. with maximum accuracy, removing noises, the built-in filters of the distortion analyzer (12 dB/octave) were utilized; the 80-kHz low-pass filter was used to measure distortion at 20 Hz; a combination of the 400-Hz high-pass filter and 80-kHz low-pass filter at 1 kHz; and the 400-Hz high-pass filter at 20 kHz.

T.H.D. of aux input

The measurements were taken in the following manner: Aux-1 was selected as input terminal, while output-1 (or its equivalent) was used as output terminal. The volume control was at the maximum position, and the balance control at center position. The other steps are same as those taken for measurement of the phono T.H.D. (refer to Fig. 1-2 for the block diagram of measurements).

Noise at phono input

The appropriate volume level was set so that the total gain could be 50.5 dB (1 V output against 3 mV input) from the phono-1 terminal (or its equivalent) to output-1 (or its equivalent), and the noise level with input short-circuited was measured on the basis of input sensitivity.

The total gain of the Quad 33 and Mark Levinson LNP-2 is a little bit lower than 50.5 dB, and the measurement was made with the volume at maximum position. For the other models the same procedures described in "T.H.D. of phono input" were applied.

Under these conditions, the output of the distortion meter (used as a millivoltmeter) was connected to the oscillo-

FIG. 1-1 BLOCK DIAGRAM OF MARK LEVINSON LNP-2

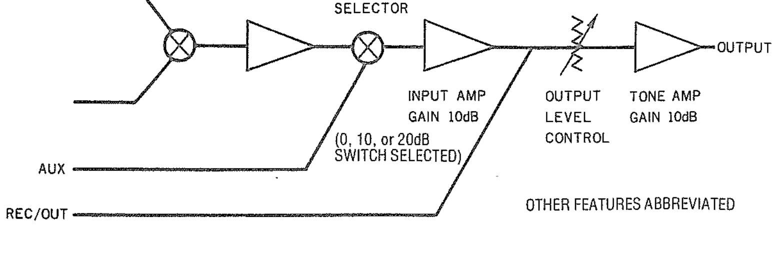


FIG. 1-2 BLOCK DIAGRAM OF T.H.D., RESIDUAL NOISE AND SEPARATION MEASUREMENTS (PHONO AND AUX INPUTS)

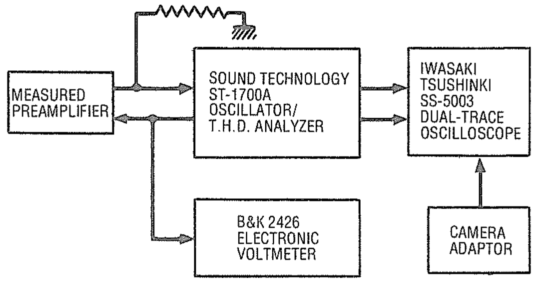
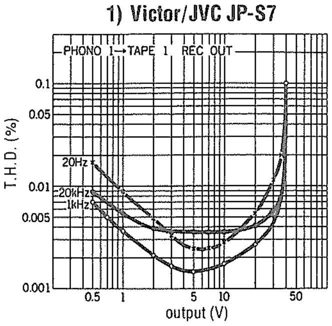
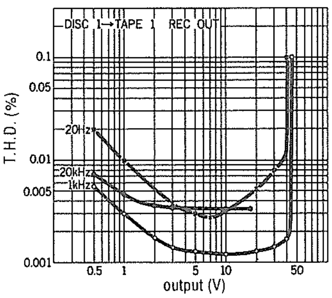


FIG. 1-3 GRAPHS OF T.H.D. AT PHONO STAGE

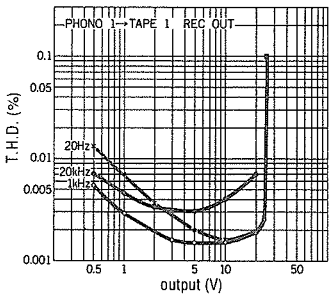
1) Victor/JVC JP-S7



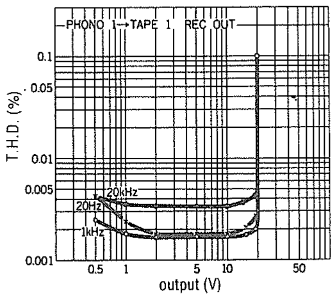
2) Accuphase C-200



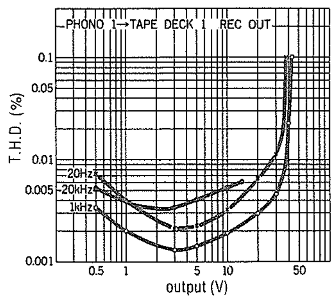
3) Luxman C-1000



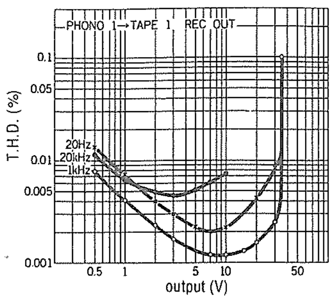
4) Yamaha C-2



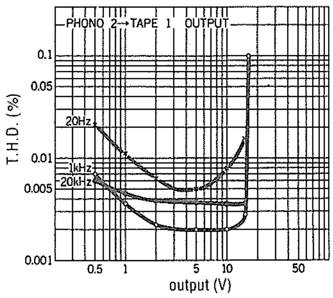
5) Technics SU-9600



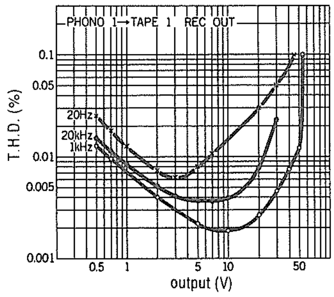
6) Sansui CA-3000



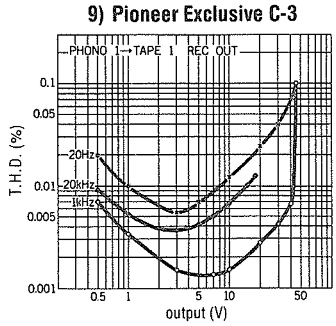
7) GAS Thaedra



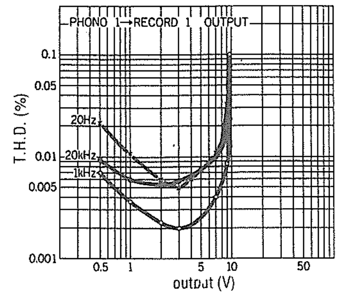
8) Otto/Sanyo DCC-3001



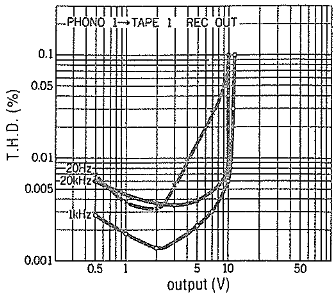
9) Pioneer Exclusive C-3



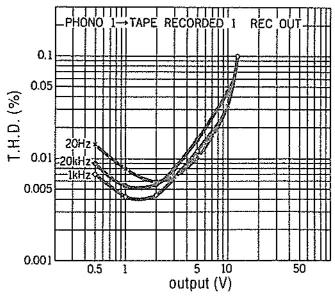
10) Mark Levinson LNP-2



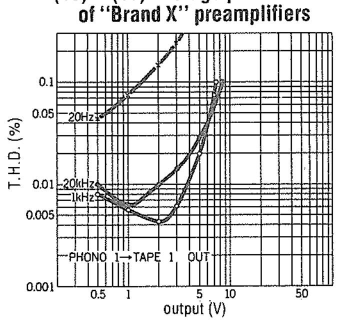
11) Onkyo/Integra P-855NII



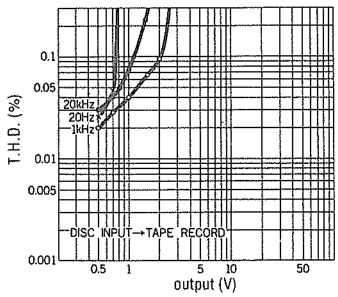
12) Sony TAE-8450



(13)—(17) Average performance of "Brand X" preamplifiers

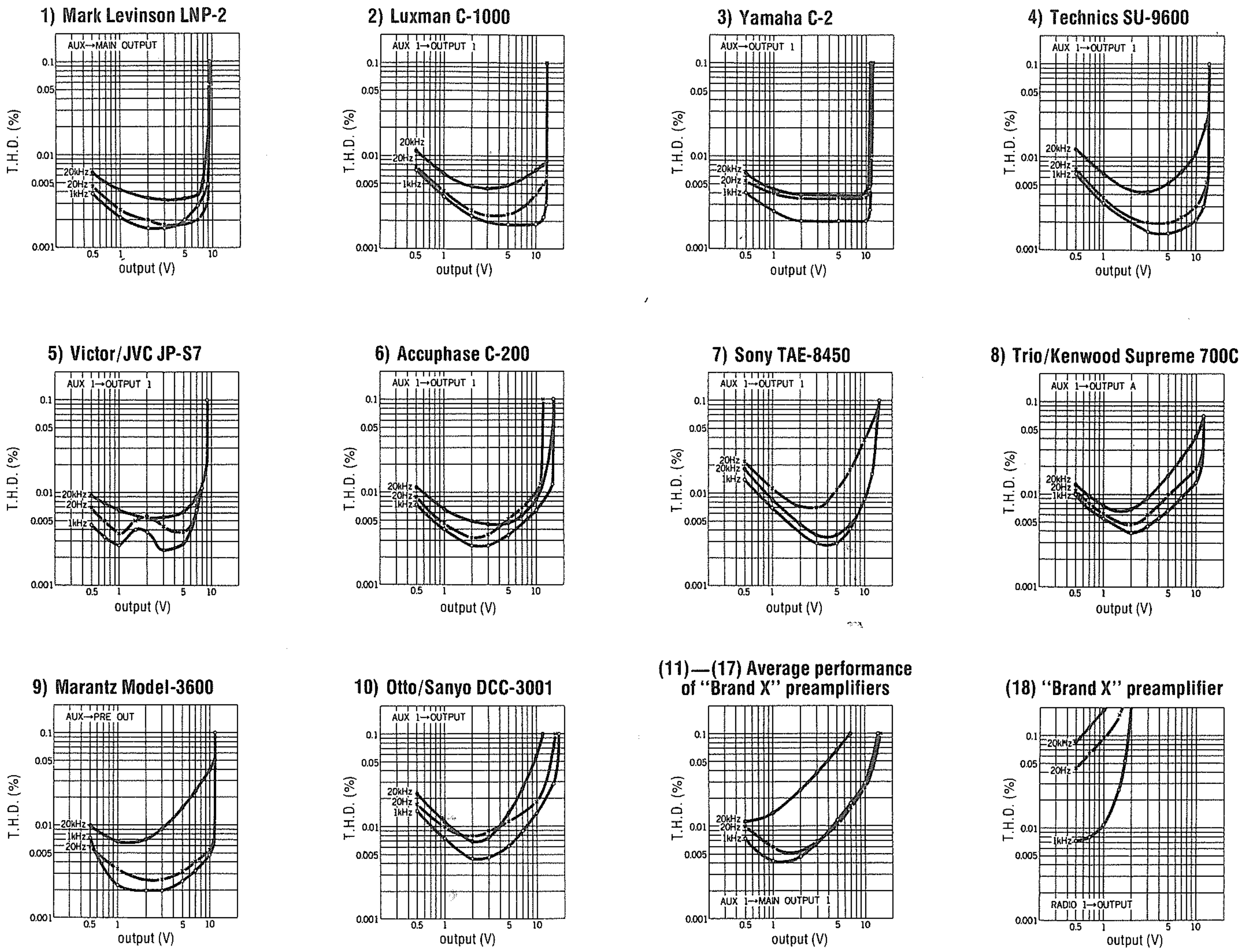


(18) "Brand X" preamplifier



**Notes: Numbers 1) through 12) showed good results; numbers (13) through (17) and (18) had poor results.
The term "Brand X" is used throughout this report to indicate amplifiers whose performance was poor.**

FIG. 1-4 GRAPHS OF T.H.D. THROUGH AUX INPUT



scope, and the waveform of noise was photographed. In this case the distortion meter was set at 1 mV full-scale range, and the oscilloscope at 1.0 V/div and 5 msec/div in the single-sweep mode. But as to the Quad and Mark Levinson, because of their insufficient gain, the level-set control of the distortion meter was adjusted so as to obtain equal gain from the amps to the screen of the oscilloscope for comparison with the other amps under the same conditions. But the conditions for printing and development of photographs cannot be identical, and also noise components of longer cycle do not appear. Therefore the photographs do not always correspond to the measured figures. (Refer to Fig. 1-2 for the measurement block diagram).

Separation

Separation was measured from the phono-1 terminal (or its equivalent) to output-1 (or its equivalent). The volume was fixed at the maximum position, and the balance control was set at mid-position. The other conditions remain unchanged from those for measurement of T.H.D. The input was adjusted to obtain 5 V at the output terminal, and the separation from the other channel (whose input was short-circuited) was measured (except for the Quad 33 whose output

TABLE 1-5 MEASURED NOISE LEVEL DATA (PHONO INPUT → RECORD OUTPUT)

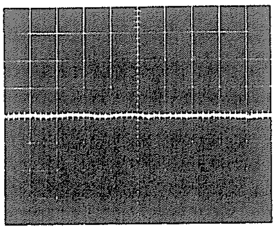
Manufacturer	Model	Noise Level
1. Yamaha	C-2	0.26 μV
2. GAS	Thaedra	0.45 μV
3. Marantz	Model 3600	0.69 μV
4. Victor/JVC	JP-S7	0.75μV
5. LUX	C-1000	0.78 μV
6. Technics	SU-9600	0.78 μV
7. Mark Levinson	LNP-2	0.81 μV
8. Sony	TAE-8450	0.84 μV
9. Onkyo	Integra P855NII	0.84 μV
10. McIntosh	C-28	0.84 μV
11. Quad	33	0.84 μV

TABLE 1-6 MEASURED NOISE LEVEL DATA (AUX INPUT → PREAMP OUTPUT)

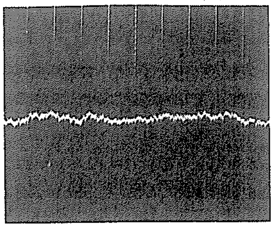
Manufacturer	Model	Noise Level
1. Yamaha	C-2	2.6 μV
2. Mark Levinson	LNP-2	3.0 μV
3. Marantz	Model-3600	4.1 μV
4. Trio/Kenwood	Supreme 700C	4.3 μV
5. GAS	Thaedra	5.8 μV
6. Accuphase	C-200	6.0 μV
7. SAE	Mark-IB	7.0 μV
8. McIntosh	C-28	7.0 μV
9. LUX	C-1000	7.5 μV
10. Sansui	CA-3000	7.6 μV

FIG. 1-7 NOISE LEVEL PHOTOGRAPHS

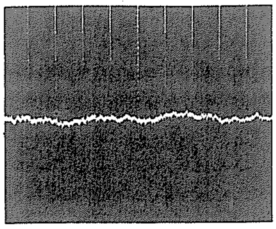
1) Yamaha C-2



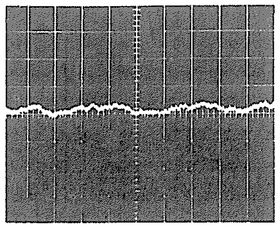
2) Marantz Model-3600



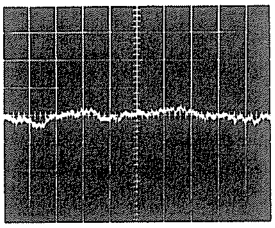
3) GAS Thaedra



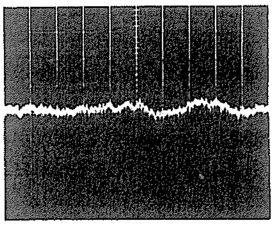
4) LUX C-1000



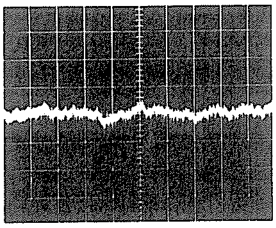
5) Quad 33



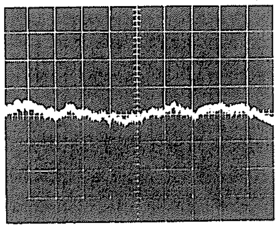
6) Victor/JVC JP-S7



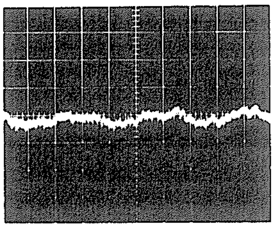
7) Technics SU-9600



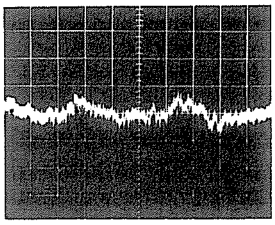
8) Mark Levinson LNP-2



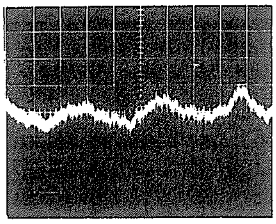
9) Sony TAE-8450



(10)—(17) Average performance of "Brand X" preamplifiers

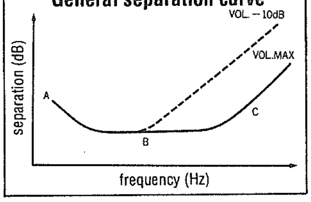


18) "Brand X" preamplifier

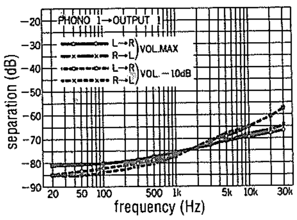


SEPARATION RESPONSE

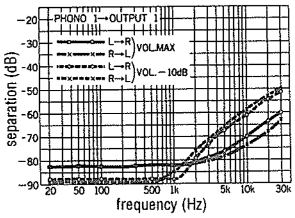
FIG. 1-8
General separation curve



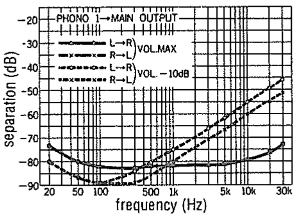
1) LUX C-1000



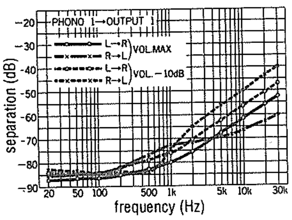
2) Onkyo Integra P-855NII



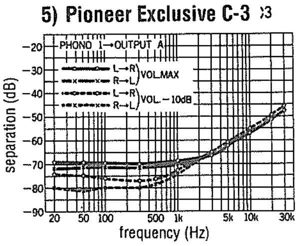
3) Mark Levinson LNP-2



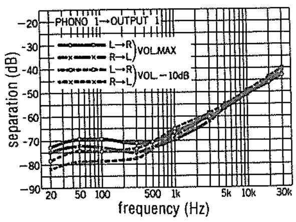
4) Yamaha C-2



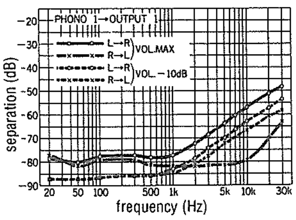
5) Pioneer Exclusive C-3



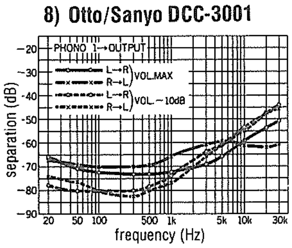
6) Sansui CA-3000



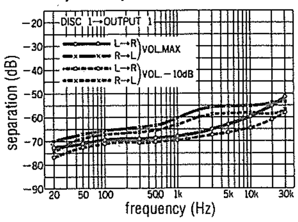
7) Technics SU-9600



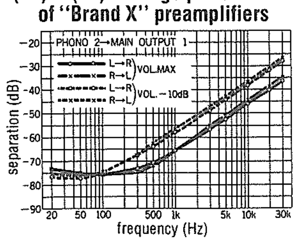
8) Otto/Sanyo DCC-3001



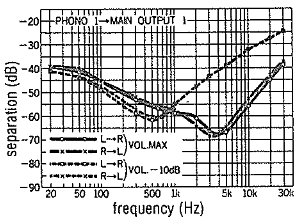
9) Accuphase C-200



(10)—(17) Average performance of "Brand X" preamplifiers



18) "Brand X" preamplifier



was set at 1 V). The line —O—O—O— shows the separation characteristic "L→R," while the line —X—X—X— means "R→L."

Moreover, to discover variations of separation characteristics caused by variations of the volume control, another measurement was conducted with the volume at the −10 dB position under the same 5 V output. The separation characteristics of "L→R" are shown in this case by the line ---O---O---O--- and the "R→L" by the line ---X---X---X---. Recently some have been attaching importance to these characteristics.

For example, suppose the noise voltage is 1 μV on the basis of input sensitivity, and equalizer and flat amp stages have 40 dB and 20 dB gain respectively (totalling 60 dB), you can get the output of 1 mV which stands at about −74 dB as compared with the 5 V output. Actually −70 dB to −85 dB would be the measurable limit of separation, and when the volume level is reduced by −10 dB the limit would be lowered by the same degree. (Refer to Fig. 1-2 for the measurement block diagram).

Fig. 1-8 shows the general separation curve, wherein the "A" portion is considered to be caused by coupling through the power-supply source and the "B" portion seems to represent the measurable limit of noise. The "C" portion is considered to be triggered by coupling of statics. The amplifier which does not show sufficiently low level of the "B" portion must have been influenced by the power source (starting from fairly high frequencies), or the common impedance of grounding line. With the contemporary amplifiers which give a rise at the "B" portion, there must be some technical problems, and also the rise at the "A" portion should remain very slight. While the rise of the "C" portion is in a sense unavoidable with amplifiers of many facilities, there are some models where this portion is held to a low level. The degree of separation deterioration with volume reduced by −10 dB can be a guide to how carefully the amplifier is designed.

Maximum input overload of phono equalizer

Phono-1 was taken as input, and the gain at the equalizer stage (at 1 kHz) and the maximum input overload voltage were specified. But with the Mark Levinson LNP-2, as you can see from Fig. 1-1, the input overload voltage at phono equalizer varies with the adjustment of the gain of input amp section, and the gain and the maximum input overload were shown at each position of the gain control.

TABLE 1-9 PHONO EQUALIZER GAIN AND MAXIMUM INPUT OVERLOAD (1 kHz, rms)

Manufacturer/Model	Gain (dB)	Maximum input overload (1kHz)
Yamaha C-2	35.3 dB	330 mV
Pioneer Exclusive C-3	35.7 dB	790 mV
Victor/JVC JP-S7	39.9 dB	385 mV
Sansui CA-3000	30.6 dB	945 mV
Sony TAE-8450	31.0 dB/40.8 dB	405 mV/131 mV
Otto/Sanyo DCC-3001	40.0 dB	505 mV
Accuphase C-200	30.4 dB-39.7 dB	1250 mV-430 mV
Technics SU-9600	33.2 dB	945 mV
Trio/Kenwood Supreme 700C	30.0 dB	262 mV
Onkyo Integra P-855NII	25.7 dB/31.8 dB/37.7 dB	690 mV/330 mV/167 mV
LUX C-1000	31.1 dB-40.3 dB	715 mV-247 mV
Marantz Model-3600	40.7 dB	103 mV
SAE Mark-IB	41.7 dB	76 mV
Mark Levinson LNP-2	30.2 dB/40.3 dB/50.1 dB	256 mV/90 mV/26.2 mV
McIntosh C-28	31.8 dB-42.5 dB	460 mV-136 mV
Harman-Kardon Citation 11	34.5 dB	107 mV
Quad 33	27.4 dB/33.8 dB	134 mV/46 mV
GAS Thaedra	42.0 dB	110 mV

SECTION B.

MEASUREMENT OF VARIATIONS OF FREQUENCY RESPONSE OF PHONO CARTRIDGE BY USE OF PREAMPLIFIERS

Input was selected at phono-1 and output at output-1 (or its equivalent). As to those models which are provided with input impedance selector and gain adjustor, the same procedures were adopted as those explained in Section A. The volume control (the balance control as well in the cases of detented volume) was adjusted to yield an output of 100 mV with the input signals of 1 kHz −10 dB placed at the outset of the test disc (Test Disc No. 2 issued by the German Hi-Fi Society), and this point was regarded as 0 dB.

It is generally known that the moving magnet type cartridge tends to vary in treble response due to load impedance, but even if all the pre-amps have the same 47k ohm load impedance, a subtle difference is aroused in the treble frequency response, because the load capacity is differently diffused from the input terminal to the equalizer board and the input capacity of equalizer circuit itself is also added. This test is to detect such a difference, but both disc and cartridge are very sensitive to temperature, and therefore it is rather difficult to make an exact comparison among so many amps. The error of ± 0.5 dB seems to exist up to 15 kHz, and thereafter in the vicinity of the mechanical resonance point, it would be ±1 dB.

This also includes RIAA deviation and undulation (if any) of frequency response at the flat amp, and therefore it may be possible to regard this as an overall characteristic with a cartridge at-

FIG. 1-10 BLOCK DIAGRAM FOR MEASUREMENTS OF FREQUENCY RESPONSE OF A PHONO CARTRIDGE THROUGH PREAMPLIFIERS