Measuring Computer P400

ortofon

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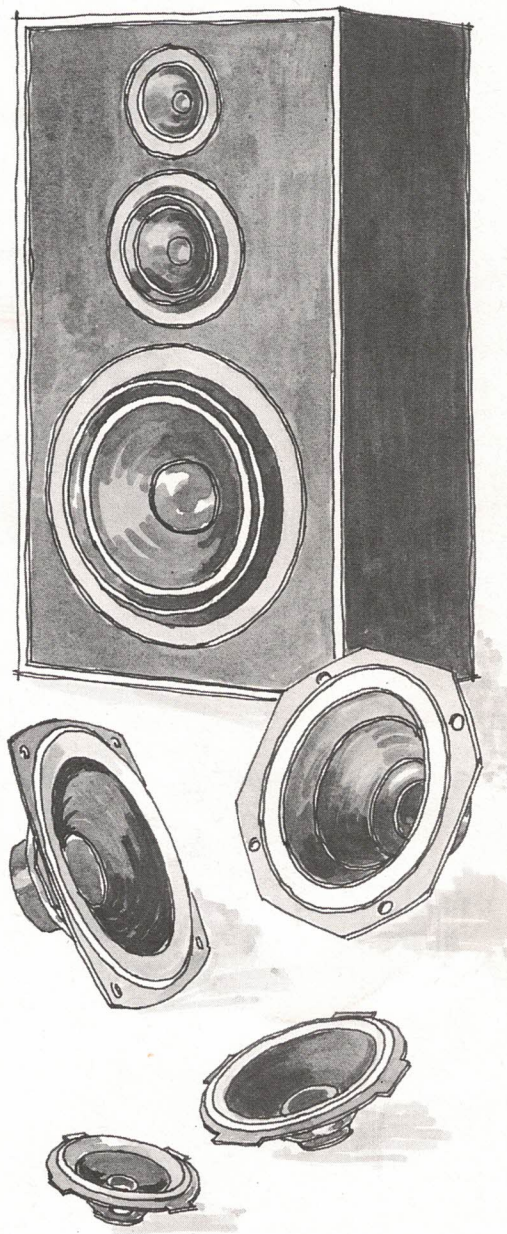
INFORMATION

LOUDSPEAKERS



INTRODUCTION

Ortofon is one of the leading manufacturers of quality pick-up cartridges. The company was founded in 1918 with the objective of developing a sound system for the movie industry. Over the years, Ortofon has been active in the areas of cutter heads, cutting lathes, amplifiers, microphones, tonearms, and pick-up cartridges.

The need for a stringent quality control of our products led to the development of micro-processor controlled test systems which have replaced conventional measuring instruments and test procedures. Based on this experience and a thorough market analysis, a new concept was developed for an advanced quality assessment of acoustical transducer performance. The industry demanded a system for use right on the production floor – not another laboratory instrument.

Ortofon developed the Measuring Computer P400 for just that purpose: a fast measurement system with high repeatability for a few, but most relevant, acoustical performance criteria:

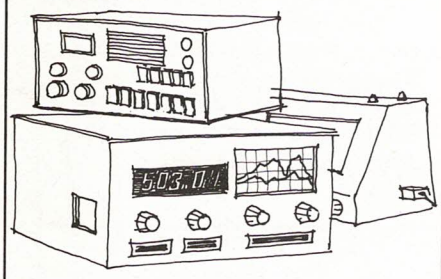
FREQUENCY RESPONSE
EFFICIENCY/SENSITIVITY
RUB & BUZZ
POLARITY
IMPEDANCE

Individual drivers and HiFi-speaker systems, TV and radio speaker units, car speakers and miniature speakers can be tested in a matter of seconds – through incoming inspection, in-line testing in a production environment, final inspection or random AQL-testing.

The test results are transferable via an IEEE 488/IEC 625 and RS 232 interface so that a permanent record of each speaker or speaker system can be kept. Yield and trend analysis can subsequently be carried out on a remote computer which permits an instant reaction to deviations from established production standards. This is effective production management!

MEASURING COMPUTER P400

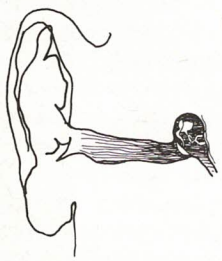
1'



QUALITY ASSESSMENT OF THE ACOUSTICAL PERFORMANCE OF LOUDSPEAKERS

Manufacturers of acoustic transducers have used swept sine wave signals to assess the performance of their products for over twenty years. A wide variety of test instruments is available. However, the equipment is mainly designed for use in a laboratory environment. This is probably one of the reasons why most manufacturers do not apply these instruments in their production lines – they use their ears!

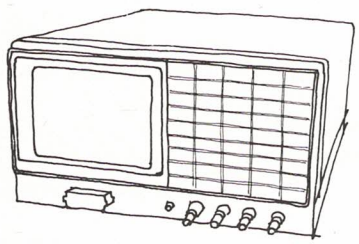
The ear is an excellent "instrument". It has never been surpassed by any type of mechanical, electrical or electronic device – and it probably never will be! Despite the admirable ability of the ear to determine sound and to differentiate between various types of sound, it is still "mounted" close to our brain (for which we sound people have to be truly grateful). There is, however, one single disadvantage: The ear/brain combination can only make a SUBJECTIVE judgment.



From a manufacturer's point of view, the *subjective* assessment of an industrial product is unsatisfactory. The manufacturer prefers an OBJECTIVE determination of relevant product quality criteria. The ear/brain combination suffers from fatigue problems during the course of a working day, the influence of, for instance, nasal congestion etc. Furthermore, a difference between the listening ability of various operators does exist. Regardless of the abovementioned well-known problems, the subjective evaluation of the acoustical performance of a speaker is still widely used in the industry. Therefore, the question will arise: can measurements be correlated to the sound perception of the ear under production conditions? Yes, they can!

2'

A MODERN APPROACH



The new Measuring Computer P400 was designed by Ortofon expressly for this purpose. The P400 is a computer controlled signal generator and response analyser which can be programmed to perform exact and repeatable tests of frequency response, efficiency/sensitivity, rub & buzz, polarity/electrical phase, and impedance in a very short period of time. Reference limit information can be individually programmed into the computer by the user and the measured data are compared to these limits. After that a GO/NO GO condition is displayed on the front panel colour CRT.

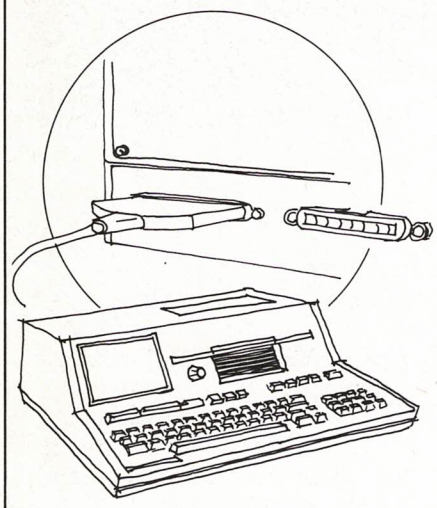
The test programme is stored in a virtually indestructible EE-PROM memory module which is exchangeable. The Measuring Computer is operated by a simple push button switch which initiates the test. No control settings or adjustments are needed or available to the test operator. The programme is run and controlled from the EE-PROM cassette module.
If it is necessary to switch frequently between test programmes, a remote memory (for instance a floppy disc station) can be connected to the P400 via the IEEE 488/IEC 625 interface bus. Quick programme changes can be made using an appropriate controller. The additional memory capacity will also accept special software written by the user, i.e. for Q calculations, a classification into several categories, or controlling an external system.

Programme Example for HP 85 B:

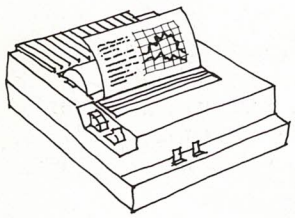
To set up the Measuring Computer P400 for transferring a frequency response curve measured in channel A to the controller and returning the curve to the P400 as a B-curve.

```
100 Control 7,16 ;
    128+2,13,10
110 DIM D$(5000), D1$(5000)
120 Output 706 ;
    "FM3,GA2,GB2,0AS 3"
130 IOBUFFER D$
140 IOBUFFER D1$
150 Output 706 ; "CA2,"
160 Trigger 706
170 Output 706 using "#,K,/" ;
    "GC1-2"
180 Transfer 706 to D$ FHS ;
    EOI
190 Disp "transfer from"
200 Output 706 using "#,K,/" ;
    "SC3-2"
```


```
210 Transfer D$ to 706 FHS
220 Disp "transfer to"
250 Stop
```



The remote memory and controller system is well suited for statistical analysis and calculations of the incoming data when appropriate software is provided. A permanent record of each speaker or speaker system can also be stored. Yield and trend analysis can be carried out permitting an instant reaction to deviations from established production standards.

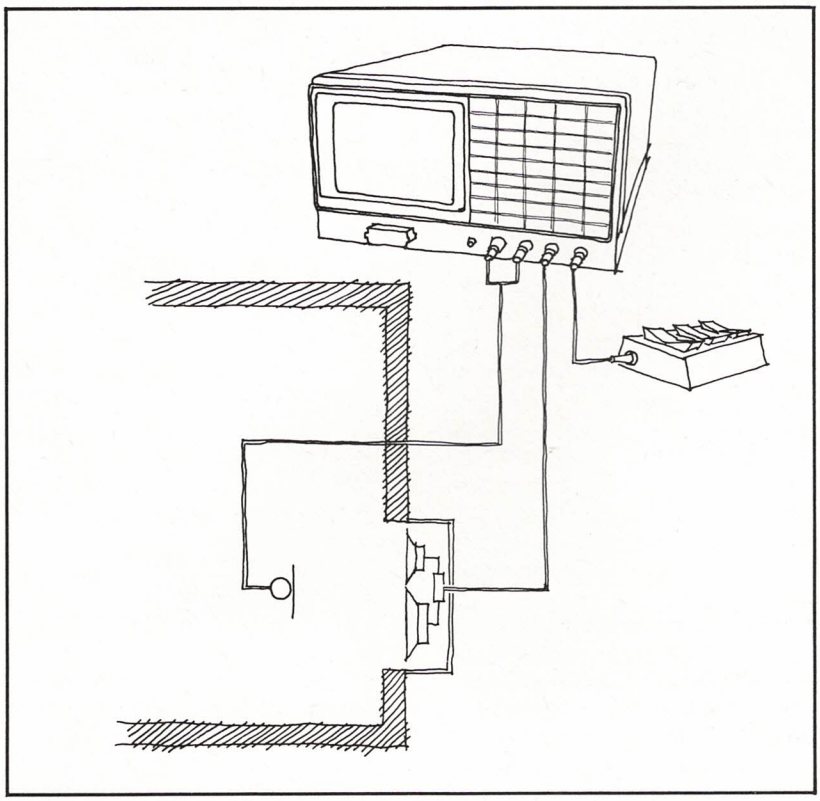


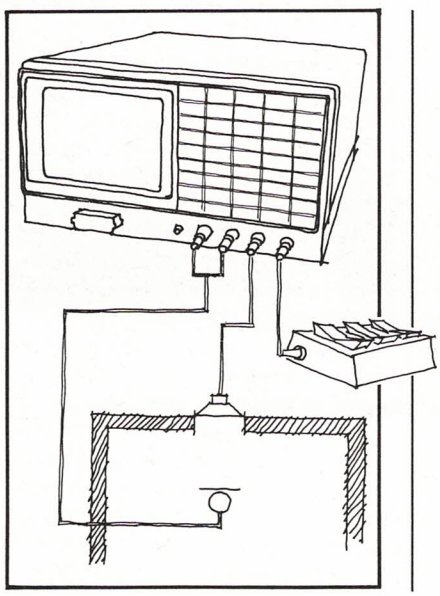
A thermal printer can be connected to the P400 via an RS 232 serial output port. Measuring data can be printed out and curves plotted in 20 .... 80 seconds – depending on the amount of information required.

3'

THE MEASURING SET-UP

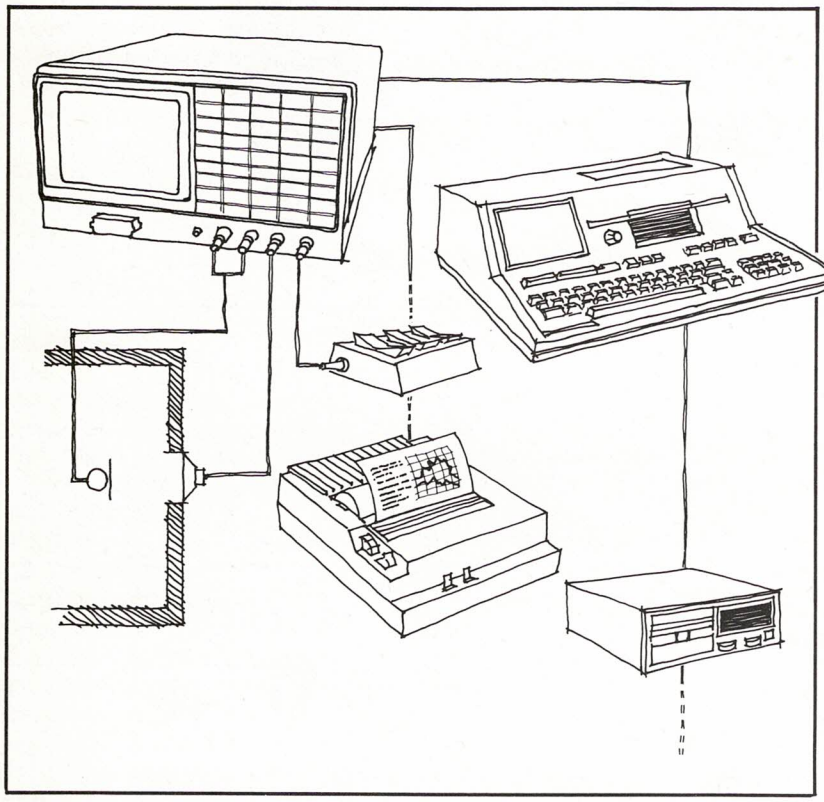
The Measuring Computer P400 uses swept sine wave signals to excite the speaker. The movement of the coil allows special distortion measurements to be carried out. Therefore, the result of this RUB & BUZZ test cannot be obtained by using noise or impulse signals.
The use of sine wave signals and a highly sensitive distortion filter requires some form of damping from external noise influence during the measurement.





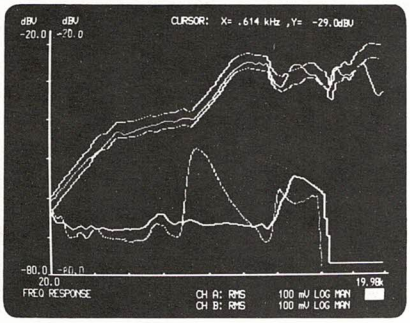
The measuring microphone requires a pre-amplifier and a power supply (depending on the type of microphone). The output voltage from the microphone can be split up for channel A and B permitting frequency response and rub & buzz characteristic to be determined in parallel with one sweep only.
The output from the P400 is connected to the speaker. Either constant voltage or constant current may be chosen.
In automatic operation, the external keybox is connected which means that the computer is solely controlled from the EE-PROM cassette.

A complete set-up including printer, external memory and controller has the following typical configuration:

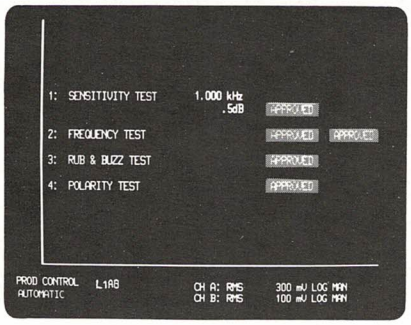


The Measuring Computer P400 is provided with the necessary amount of basic software enabling the user to make his own individual test programmes by using the front panel keyboard together with the colour CRT display. The programming is carried out by selecting from a number of menus and submenus which allows a fast and easy procedure. A trained person can make a complete initial programme in a couple of minutes.
Test programmes can be stored on the EE-PROM cassette module or in an external memory – whichever is most suitable for the purpose.
The Measuring Computer P400 can be operated manually (under programming and checkout) and semi-automatically by an external keybox (with an operator). A fully integrated and automatic system will be operated by a robot, thus eliminating the operator.

Measuring results can be displayed as curves together with their associated references and/or tolerance bands.



Alternatively, a GO/NO GO signal can be displayed on the CRT right behind the corresponding parameter (APPROVED in green colour or REJECTED flashing in red colour).



4'

FEATURES, ADVANTAGES, BENEFITS

What can be gained from an advanced quality assessment of the acoustical performance of loudspeakers?
The Measuring Computer P400 enables a speaker manufacturer:

- to carry out *objective* measurements which are based on a close correlation to a subjective evaluation (listening).
- to determine a few but most relevant parameters within a few seconds and compare their values 2,000 times over the selected frequency range to established references and tolerances.
- to run the tests right on the production floor (in-line) without influence from the operator on the test programme or the measuring results. This represents a high degree of safety.
- to change programmes quickly and easily by exchanging EE-PROM cassettes or to get access to additional software from a floppy disc.
- to make statistical evaluations of the measuring results and at any time keep track of yield, performance, manufacturing problems etc.

The advantages and benefits obtainable are as follows:

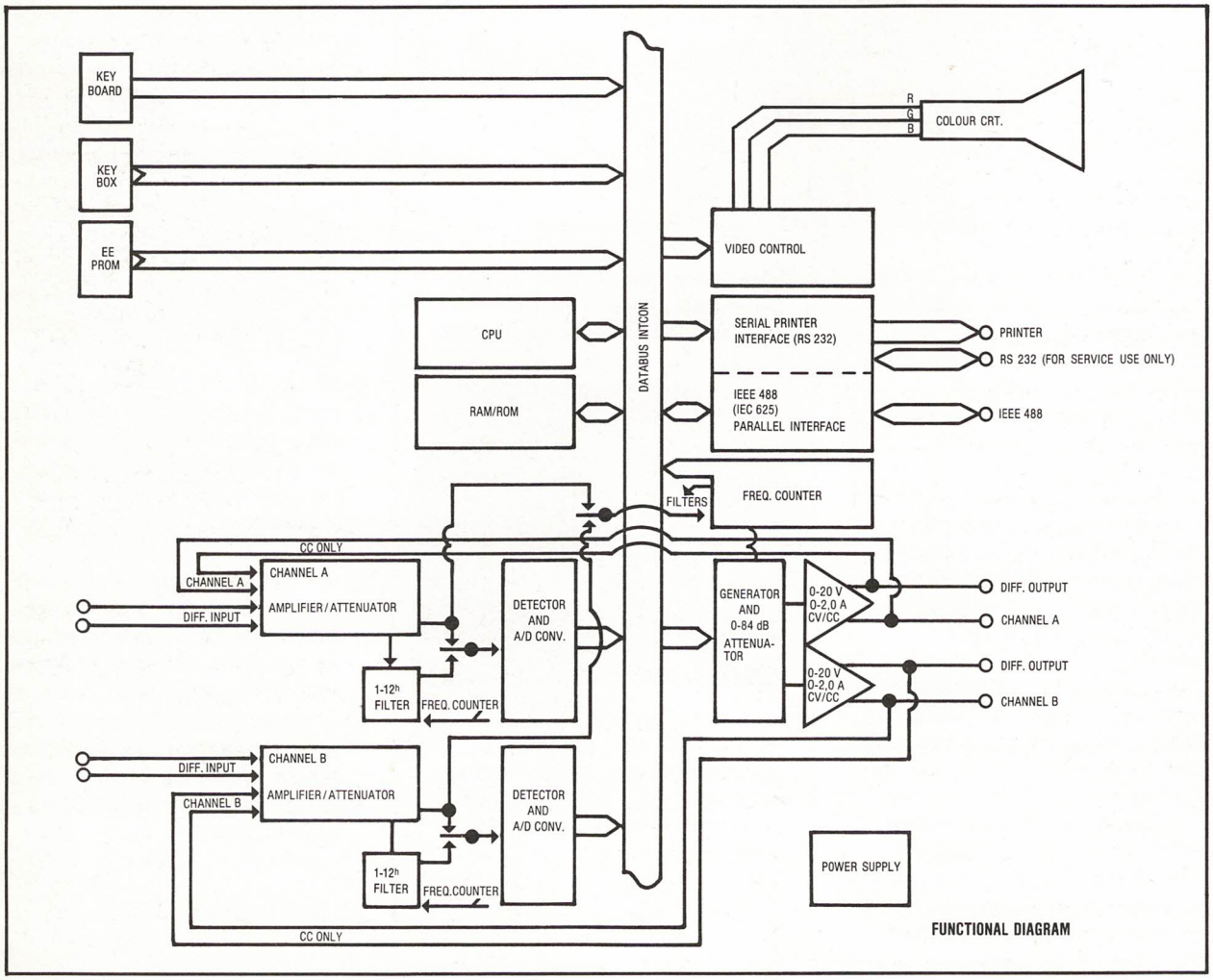
- objective control of production performance,
- higher yield because operator fatigue is avoided,
- better uniformity of acoustical performance criteria,
- instant reaction to deviations from established company standards,
- permanent record of each speaker in external memory and/or central computer.

LEADING TO → MORE CONSISTENT PRODUCT SPECIFICATIONS AND LOWER COSTS → WHICH WILL MAKE YOU → MORE COMPETITIVE

5' THE MEASURING COMPUTER P400

Basic Structure

The basic modules of the computer can be described as follows:



FUNCTIONAL DIAGRAM

CPU
The micro processor in the P400 is a Motorola 6809 extended with a 6829 MMU controller. The clock frequency is 1 MHz.

ROM
A total of 137 kByte **R**ead **O**nly **M**emory is provided for the internal programme.

RAM
A 64 kByte **R**andom **A**ccess **M**emory is available for keyboard settings, measured data, and reference curves.

EE-PROM
Exchangeable cassettes containing 2 or 4 kByte **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory are available for storing P400 settings and reference curves.
2 kByte cassettes can store one full programme
4 kByte cassettes will typically store three full programmes.
8 kByte cassettes (7 programmes typically) and 16 kByte cassettes (14 programmes typically) are under preparation.
EE-PROM cassettes are insensitive to magnetic fields and shocks.

Keyboard
The P400 is menu and cursor oriented. The most common settings are pre-selected for easy operation. Once programmed, all relevant settings and references are stored in an EE-PROM or external memory. When the keybox is connected, the operator does not have access to the keyboard and is left with only three keys with which to select and run programmes.

Keybox
With the keybox connected to the P400 the operator can only:

select programmes from the EE-PROM memory,
select part of a programme or **run** a programme.

The operator is unable to change anything in the programme. This ensures safety and easy usage in a production environment.

Frequency Counter
The counter function and the x-axis of the display is controlled by the output of the frequency counter. The input of the counter is normally connected to the output of the generator but the output of either the A or B channel can be selected. The period of the frequency is measured within 14 nanoseconds and converted into frequency.

Video Control
It is possible to display colour graphics and numerical data on the CRT.
The 10″ colour CRT is a true high resolution RGB monitor and is able to display 8 colours having an approx. 250×250 points graphics area superimposed on an alphanumeric field with 24 lines of 70 characters, each character being 8×13 dots.
By using the zoom function, the full internal resolution of approx. 2000 points (x-axis) and 4000 points (y-axis) can be displayed for parts of a curve.

Generator
A sinusoidal signal is generated from a pre-programmed 12× 4096 RAM. In a D/A converter these data are converted into a low distortion sine wave (harmonics and spurius responses more than 70 dB down). This sine wave can be pulsed for polarity tests, manually controlled for listening tests or swept for automatic measurements.
The sweep is hyper-exponential: a very slow sweep speed at low frequencies, and a rapidly increasing sweep speed at higher frequencies. An exponential sweep is optional.
The sweep range is programmable between 5 Hz and 20 kHz. Sweeping from low to high frequencies, or alternatively from high to low frequencies, is possible. This is a valuable feature for testing larger woofers.
The output of the generator is sent to the frequency counter and an attenuator, permitting output level adjustments between 0 and – 84 dB.

Analog Measuring Amplifiers
The P400 has two identical measuring channels A and B.
The two inputs have a full scale sensitivity of 10 mV – 100 V.
AC or DC coupling can be programmed.
The output from either channel can be selected and measured in the frequency counter. Each output is, either direct or through a rub & buzz filter, converted into a linear or logarithmic expression for DC-value, AC-average value, AC-absolute value, + peak, – peak or RMS-(AC)-value of the signal (with selectable time constants in the RMS-case), before it is connected to a 12 bit A/D converter.

Rub & buzz Filters
Tracking filters can be locked into the frequency of the internal generator. A center frequency from the fundamental up to the 12th harmonic can be selected.
The design of the filters has been based on a large number of field measurements rather than scientific data. This empiric approach has resulted in a flexible filter system adaptable to various rub & buzz conditions.
All filters from the 3rd harmonic and above have 20 dB gain.

Detectors
True RMS detectors are used with 60 dB dynamic range and logarithmic and linear outputs.

A/D converters
The analog signal is converted into a digital form in the 12 bit A/D converters (0.02 dB resolution in logarithmic mode).

Output amplifiers:
(standard = VA1)
The output amplifier is of traditional constant voltage type (max. 8 V RMS, 1 A).
The output is thermal-protected and referred to ground.

(optional = CVA2)
For output voltages up to 20 V RMS and currents up to 2 A (not simultaneously), CVA2 amplifiers are used. These amplifiers can operate both in normal constant voltage mode and as a constant current source. When constant current is selected, the output signal is fed directly to the input of the measuring amplifiers. In this mode impedance and a special rub/buzz measurement can be made (without using a microphone). Two CVA2's are mounted in the P400, one for each channel A and B.

The CVA 2 outputs are differential and must not be connected to the analog or chassis ground of the P400.

IEEE 488 Interface output (optional)

For use with an external controller the P400 can be provided with an IEEE control board.
All functions that can be controlled from the keyboard (as well as a few additional ones) can be controlled over the IEEE 488 (IEC 625) bus.
Furthermore, an external controller can store a larger number of programmes in the same way as the EE-PROM. Also calculation of i.e. Q, resonance, frequency bandwidth or statistics can be made via the bus and a controller.
The IEEE bus is also a suitable basis for integrating the P400 into automated systems.

Printer output (optional)

An RS 232 output is available for use with the external printer Olivetti TH 240.

Power supply

The P400 can operate on 100, 120, 220 or 240 V within 10% of nominal setting and at a line frequency of 50 or 60 Hz.
It is recommended that the P400 is grounded via the mains cable for safety and reduced noise sensitivity.

P400 Specifications

Measuring Inputs:	
Individual channels	2 (A & B)
Full scale sensitivity	10 mV – 100 V
Display dyn. range (log-mode)	60 dB
Scale	log/lin
Frequency ranges	1 Hz – 100 kHz
Detector modes	RMS, DC, AC Average, AC absolute, + peak, – peak (lin./log. modes for all)
Resolution x, y (12 bit)	2000/4000 points (approx. values)
S/N ratio	> 80 dB

Filters (standard):	
Individual channels	2 (A & B)
Type	Tracking: Constant relative bandwidth
Center frequency	Fundamental to 12th harmonic
Gain fundamental and 2nd harmonic	0 dB
Gain 3rd to 12th harmonic	20 dB
S/N ratio 5 Hz – 5 kHz	> 80 dB

Other filters exist for special applications and can be offered on request.

Generator:	
Frequency range	5 Hz – 20 kHz: Frequency crystal derived Amplitude precision voltage Reference based
Modes	Sine wave Pulsed sine wave Swept sine wave
Sweep: standard	Hyper-exponential
optional	Exponential
Distortion: Harmonics	< – 70 dB
Spurius responses	< – 70 dB
Attenuator	0 – – 84 dB

Output (standard VA1):	
Output voltage max.	8 V RMS
Output current max.	1 A
Output impedance, incl. DIN connector	50 mOhm

Output (CVA2):	
Constant voltage:	
max. low range	5 V RMS
max. high range	20 V RMS
Output impedance, incl. DIN connector	150 mOhm
Constant current:	
max. low range	20 mA
Output impedance	20 kOhm 10 Hz – 1 kHz decreasing at high frequency
max. high range	2 A
Output impedance	> 1 kOhm 10 Hz – 1 kHz decreasing at high frequency

Frequency Counter:

Frequency range 1 – 130,000 Hz with 3½ digit display

The period of the frequency is measured and converted into frequency.

Display:

RGB – CRT	10″ 8 colour CRT
resolution x, y	250/250 display points
y scale, log	60 dB
x scale, time based	0.1 sec. to 6000 sec. full scale
x scale, frequency based	2–5 decades in approx. ⅓ decade steps
x zoom, reversible	2,4,8
y zoom, reversible	2,4,8,16
Interface (optional)	RS 232 for Olivetti Graphic Printer IEEE 488 for external controller RS 232 for service use
Controller I/O	IEEE 488 IEC 625 GPIB HP-IB
Transfer rate	Typ. 40 µs/Byte, however depending on type of controller and length of interface cable, which can limit transfer speed
Graphic printer	Olivetti TD 240 (modified) via RS 232 output
Transfer rate	19200 baud
Time/plot (TH 240)	20–80 sec.

General:

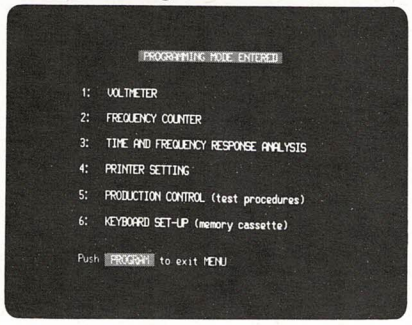
CPU	Motorola 6809, 8 bits
Total RAM internal	(min.) 103 kByte
Total ROM internal	137 kByte
EE-PROM external One test programme requires 2 KBytes of storage capacity	2 or 4 kByte (8 and 16 kByte under preparation)
Power requirements	100/120 V ± 10% 220/240 V ± 10% 50/60 Hz
Power consumption	250 watt
Dimensions: Width	44 cm/17.3 in.
Height	25 cm/ 9.6 in.
Depth	56 cm/27.5 in.
Weight	35 kg/77 lbs. (Shipping weight)
Operating temperature	15–40° C/59–104° F
Rel. humidity	20–80%

Ortofon reserves the right to change specifications without notice

Programming the P400

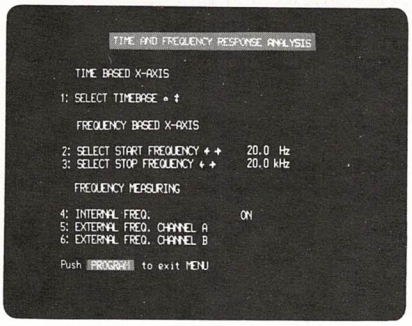
Ortofon is providing the instrument with an appropriate amount of software to enable the user to "write" his own individual test programmes for each type/model of speaker. The Measuring Computer P400 is programmed via the front panel soft-touch keyboard. Menus and sub-menus appear on the colour CRT screen and the necessary steps can be taken by the programmer in plain language (English). Knowledge of typical computer languages like Basic, Assembler etc. is not necessary.

Programming mode



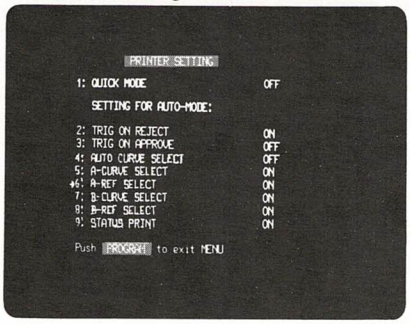
Main operation can be chosen by addressing 1 3

Time and freq. response analysis



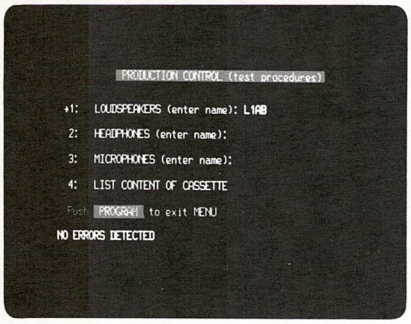
Item 3 of programming mode. Select time or frequency base for x-axis

Printer setting



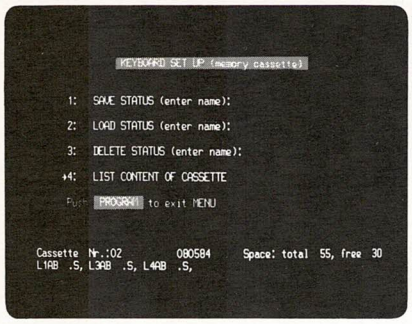
Item 4 of programming mode. Select automatic trigger mode for printer

Programme test procedure



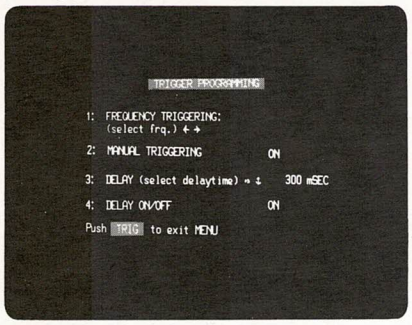
Item 5 of programming mode. Choose L1 for speakers

Keyboard programming



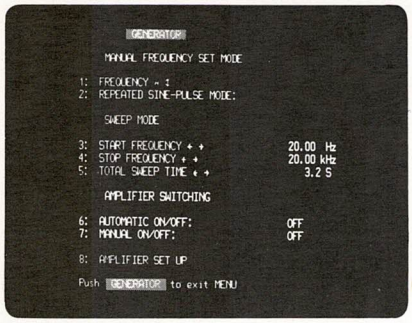
Item 6 of programming mode. Programme measuring conditions (keyboard status)

Trigger



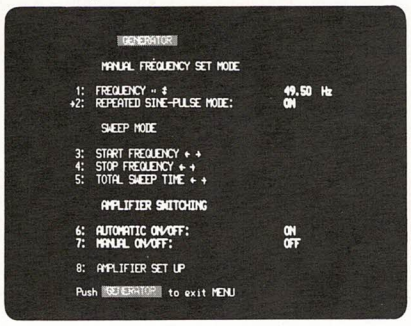
Select measuring delay in msec.

Generator



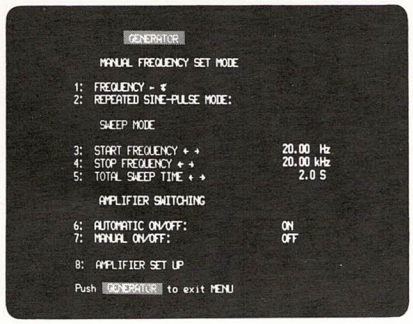
Main menu for built-in sine oscillator

Polarity



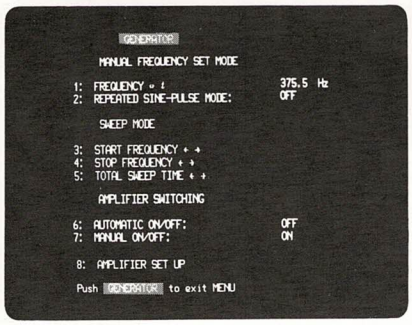
Choose frequency of sine pulses and switch sine pulse mode ON

Sweep



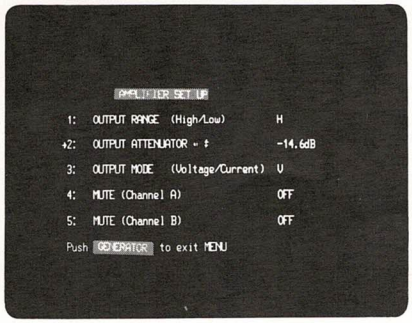
Select start and stop frequency and sweep time

Manual/automatic



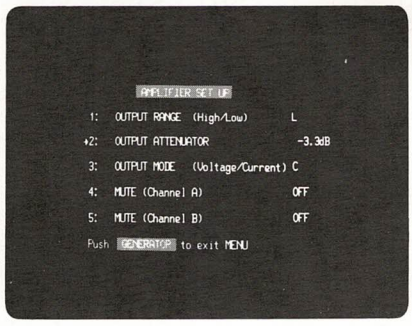
Choose manual or automatic operation for sweep and measurement

Amplifier



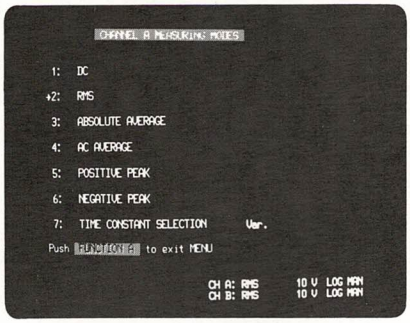
Item 8 of generator menu. Select low/high range, constant voltage/ current output

Impedance



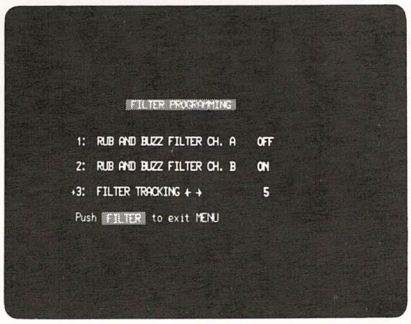
Constant current setting (L/H)

Functions



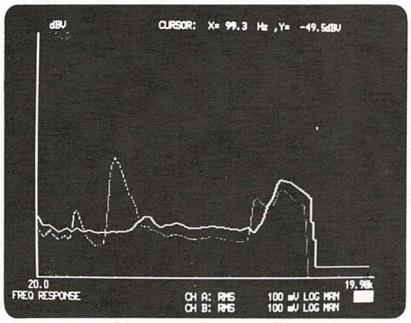
Measuring parameters and time constant selection. Separate for channel A, B

Filter



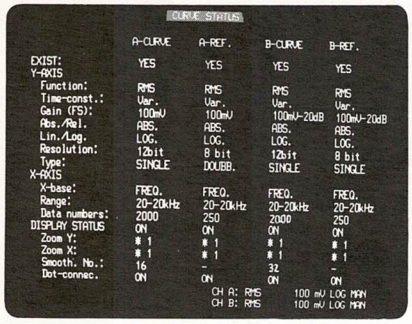
Rub & buzz filter to be centered on fundamental or any harmonic up to the 12th. Separate for channel A, B

Cursor

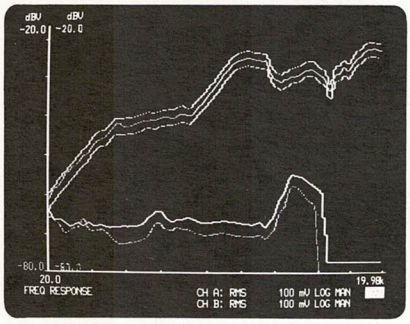


Several functions are addressed by the cursor. x-y position of cursor displayed

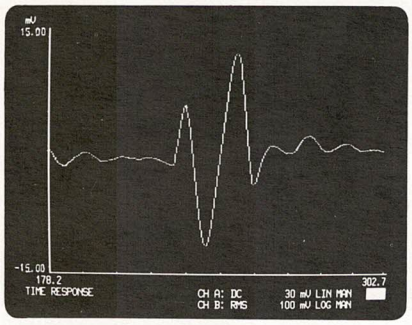
Status



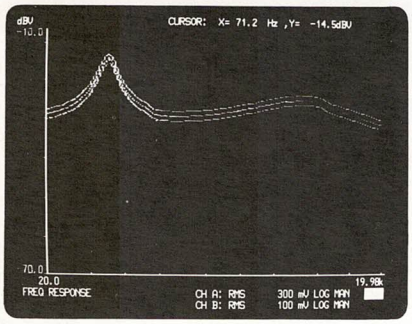
Measuring conditions for curves and references



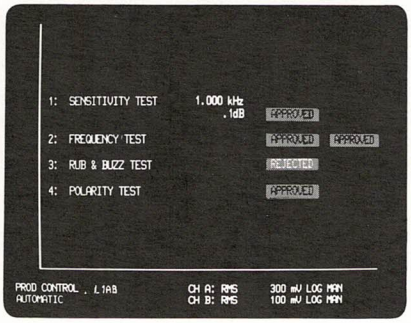
Typical frequency response (green) 20 Hz – 20 kHz with upper and lower limits (yellow) and below typical rub & buzz (distortion) curve (red) with upper limit (blue)



Polarity determination



Impedance curve



Display of automatic operation: GO/NO GO indication

Green: APPROVED
Flashing red: REJECTED

Internal Memory

The Measuring Computer P400 is provided with an internal RAM/ROM memory of 79/137 KByte. This capacity can store one (1) complete measuring cycle including all relevant references and tolerances **at a time.** This means that a new measuring cycle erases all data from the previous run. Similarly, the data are erased when the instrument is switched off.

External Memory

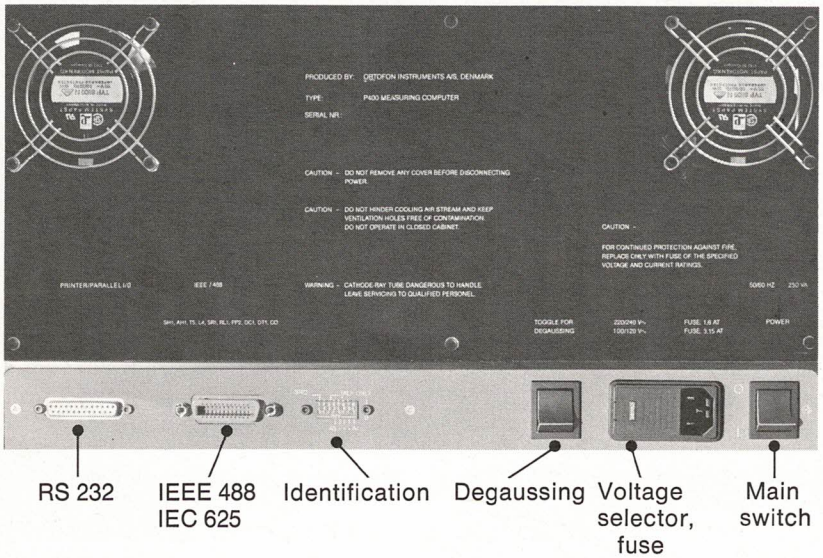
The external memory is an exchangeable EE-PROM cassette of 2 Kb or 4 Kb capacity (1 or typically 3 complete test programmes respectively). Cassettes of 8 kb (typically 7 programmes) and 16 kb (typically 14 programmes) capacity are under preparation.

The virtually indestructible **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory module.

Interface

A memory extension can easily be provided via the IEEE 488/ IEC 625 interface and a suitable controller (tape recorder, floppy disc, hard disc etc.).

Rear of instrument showing serial and parallel interface ports



System Configuration

Ortofon Measuring Computer:

Basic instrument P400

Const. voltage output
0 dB = 8V RMS

1 EE-PROM cassette 2 Kb

Options and accessories:

Const. voltage output
L: 0 dB = 5 V RMS
H: 0 dB = 20 V RMS

Const. current output
L: 0 dB = 20 mA
H: 0 dB = 2 A

EE-PROM cassettes 4 Kb

GPIB interface
IEEE 488/IEC 625

Serial output port RS 232

Thermal printer/plotter
TH 240 Olivetti

Special filters

Compressor unit for keeping constant sound pressure level

Measuring Parameters

The Measuring Computer P400 is capable of measuring the following acoustical parameters:

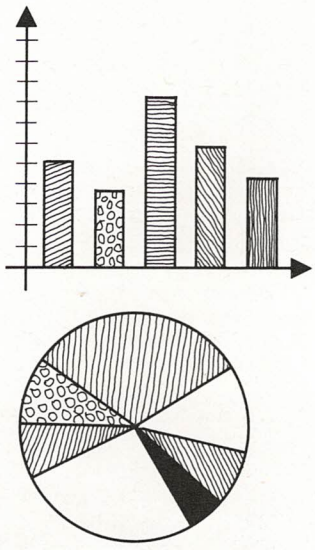
- time response
  100 ms – 6000 sec.
- frequency response
  5 Hz – 20 kHz
- efficiency/sensitivity at one chosen frequency
  5 Hz – 20 kHz
  1 kHz typ.
- rub & buzz (rubbing voice coil, chips in gap, compliance tick, buzz and rattle by loose parts etc.).
- polarity/electrical phase
- swept impedance (numerical value) 5 Hz – 20 kHz

When using a suitable external controller, dedicated software will allow the determination/ calculation of additional acoustical criteria, such as:

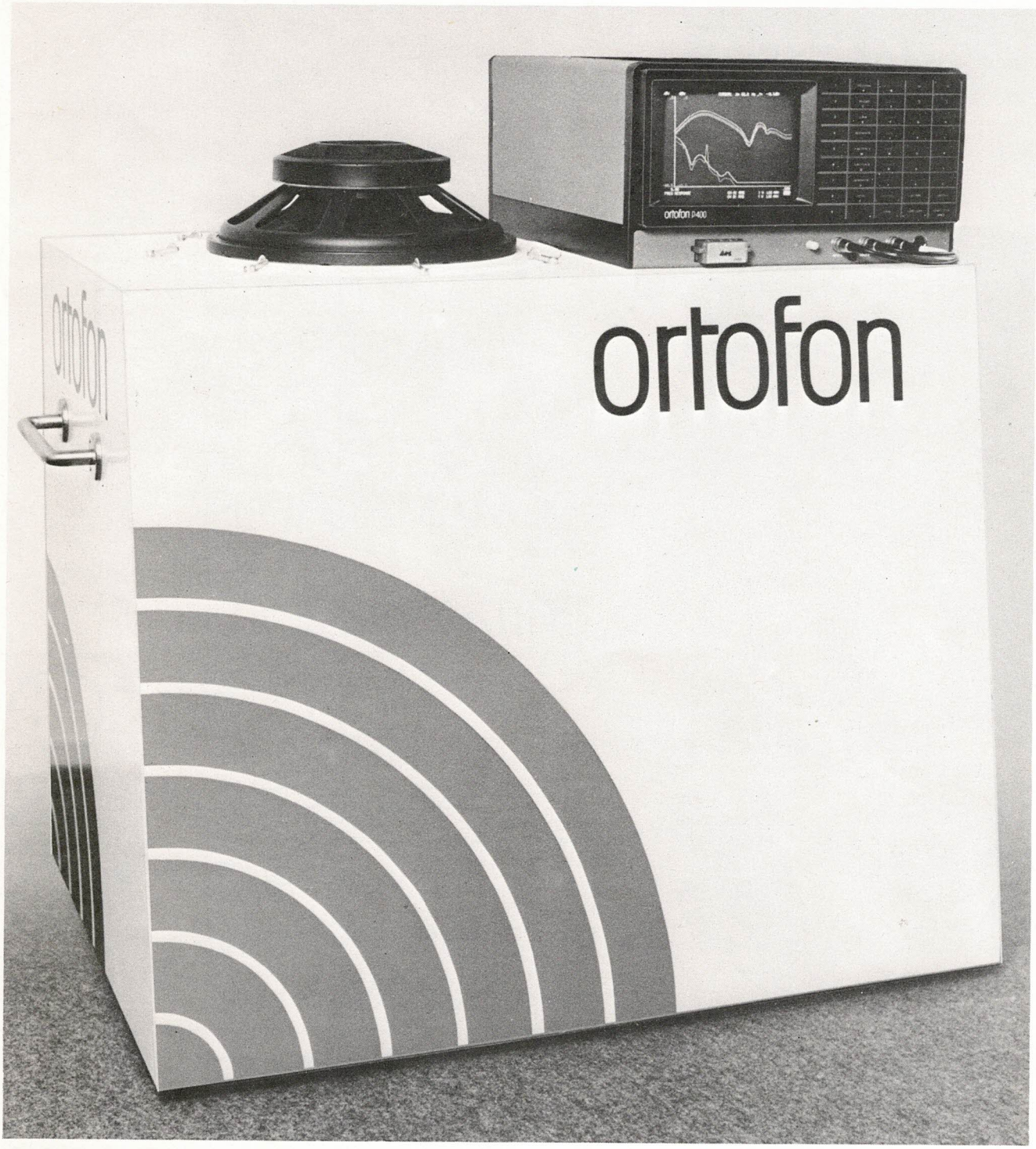
- Selection of speaker drivers into several categories by comparing for instance the frequency or impedance characteristic with several references/tolerance bands.
- Determination of the efficiency/sensitivity of a speaker at **several** frequencies and calculation of the arithmetical average.
- Measurement of the swept impedance of a speaker, determination of its DC resistance, and calculation of its damping characteristic and resonance frequency.

Additionally, a statistical evaluation of the measuring results can be carried out, for instance at the end of a working day:
Quantity of speakers tested (produced)
Quantity of acceptable units (% = yield)
Quantity of rejects (%)
Failure analysis of the rejects
Day to day/week/month/year comparison
Etc., etc.

A plot of the statistical data will further improve the survey:



Alternative system configurations are available for production testing of headphones (earphones, stereoheadsets), microphones (incl. compressor loop) and dynamic transducers used in telephone- and communication equipment.



Typical measuring set-up with built-in microphone

ortofon

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