Sound Pressure-level Meter

A simple battery-operated instrument using a crystal microphone cartridge to obtain flat response in the range 20Hz to 5kHz

by J. L. Linsley Hood

Many readers with an interest in the reproduction of recorded music must have attempted the construction of their own loudspeaker enclosures at some time or other. When this attempt is successful, it can be very gratifying, particularly if the enclosure design contains some elements of novelty, since the constructor can be reasonably certain that nothing quite like it exists anywhere else.

Unfortunately the matching of enclosures to the characteristics of driver units can present considerable difficulties even to the experienced. A complex design of enclosure, and the use of multiple drivers with electrical crossover networks makes the task of obtaining a clean sound even more difficult. While the ear is remarkably tolerant of non-uniformities in frequency response, provided that these are not too large in magnitude or steep in slope, the presence of unwanted large magnitude peaks in the frequency response curve is the undoubted cause of the 'booms', 'honks' and 'squawks' which can make unsuccessful systems so tiring to listen to. If these can be eliminated or lessened by the judicious use of some strategically placed damping material, or some adjustment to the dimensions of the enclosure, a great improvement can often be made to the quality of the sound.

Room acoustics play a very important part in the final performance of most loudspeaker systems, to the extent that an alteration in the position of the reproducer in relation to the walls and other large objects of furniture can sometimes alter the performance significantly.

Use of impedance measurements

If the loudspeaker system is driven from a source which has an impedance higher than that of the loudspeaker, and is fed with a variable frequency signal from an a.f. signal generator or a test record, the frequencies of the cone, enclosure and sometimes even room resonances can often be identified by noting the frequencies at which peaks occur in the a.c. voltage developed across the loudspeaker terminals.

However, from personal observations, audible peaks in the sound output do not always show up as corresponding peaks in the speaker impedance curve, and humps in the impedance curve do not always result in an increase in sound output level at that frequency, when the loudspeaker is driven from an amplifier having a low output impedance.

For these reasons it is very helpful to the would-be loudspeaker constructor if he has a 'flat-response' sound measuring instrument to check the performance of his designs.

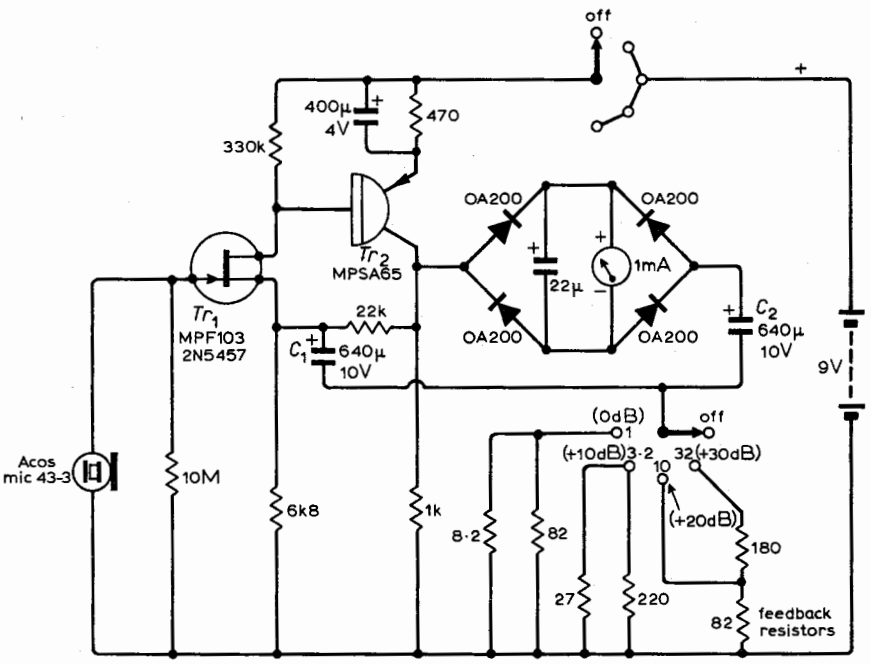


Fig. 1. Circuit of sound pressure-level meter.

Design of sound pressure-level meter

The measurement of sound levels is a complex task even with elaborate equipment and carefully designed anechoic environments, and any simple instrument used in uncontrolled surroundings is likely to give imprecise and possibly misleading results. (However, measurement made out of doors with the speaker supported some feet above a lawn may not be too far removed from the anechoic ideal.)

We are concerned to measure the flatness of the speaker's output when it is fed with a constant amplitude sine wave. For this test the measuring instrument should have as flat a response as possible.

Pressure sensitive crystal and ceramic piezo-electric microphone units are relatively cheap and robust, and can provide a flat frequency response coupled with an excellent low-frequency sensitivity. They have a relatively limited high-frequency performance, but a flat response over the range 15Hz-5kHz is considered adequate for sensible test purposes outside the laboratory.

The instrument's circuit is given in Fig. 1. An Acos MIC43-3 crystal microphone unit is used with an f.e.t. amplifier. In order to avoid shunting the drain load-resistor of the f.e.t. a p-n-p Darlington transistor is used as the following amplifier stage. The measuring section is a negative feedback a.c.

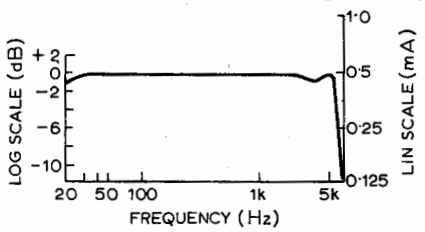
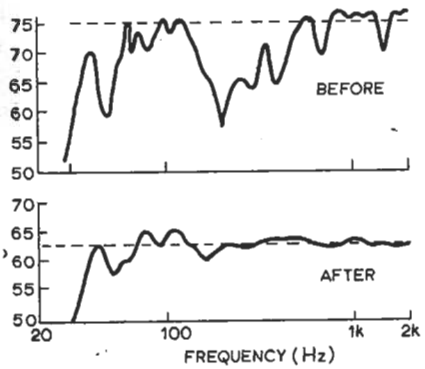


Fig. 2. Response of sound pressure-level meter using Acos MIC 43-3 crystal microphone.



g. 3. Response curve, in the range)Hz-2kHz, of experimental column aded loudspeaker system before and after modifications.

millivoltmeter circuit. A d.c. feedback path is provided to the positive end of C_1 to ensure stability of the d.c. working point. A five position wafer switch is used to give an 'off' position and four sensitivity ranges. To minimize switch-on meter 'kicks' the least sensitive range is used as the position adjacent to the 'off' position. Sensitivities are arranged in the ratio 1:3.2:10:32, which gives a decibel scale continuity of +30, +20, +10 and 0dB.

A 1mA f.s.d. meter is used for readout and the values of the feedback resistors chosen to give full-scale deflection sensitivities of 10, 32, 100 and 320mV at the gate of the f.e.t.

The '0dB' point was chosen arbitrarily as half-scale deflection on the most sensitive range, and the scale was then marked out with the range +6dB to −20dB (5% deflection). The microphone elements will inevitably vary somewhat in sensitivity, but with two of the three different units of this type tried the half-scale deflection of the meter corresponded on average to normal conversation at about six feet distance. (The third unit was about 50% less sensitive but had a rather better h.f. response.) This sound level is probably of the order of +55dB with reference to the normal 1kHz '0dB' level of the Fletcher Munson curve, and this gives the instrument a usable range of approximately 35-92dB in sound pressure level.

The frequency response of the instrument was determined by the use of a high-quality headphone element in close proximity to the microphone, but separated from it by a $\frac{1}{4}$ in layer of open-pore polyurethane foam to minimize air column resonances. The curve is shown in Fig. 2. This is in agreement with the response curve for the microphone capsule published by the manufacturers.

Finally, as an example of one of the uses to which such an instrument can be put, the response curve of an experimental column loaded loudspeaker enclosure, using a Wharfedale 'Golden' 10in RS/DD bass driver unit is shown in Fig. 3. The upper curve is the original performance following optimization by input impedance determinations, and the lower curve shows the response of the system after some modification to the column dimensions and the addition of suitable damping material. Although the final frequency response is still not as flat as desired in the two lower octaves, the large and unsuspected trough in the 200-400Hz region has gone, and the series of column resonance absorption slots filled in, with an audible improvement in the system performance. The penalty paid was an approximate 10dB reduction in overall sensitivity.

The completed sound pressure-level meter.

Announcements

The Science Research Council has awarded a grant of £59,160 for research into galactic and extra-galactic radioemissions and other problems in **radio astronomy** under Professor Sir Bernard Lovell at Manchester University.

Two short courses in detection, estimation, and modulation theory will be presented by Professor Harry Van Trees in Brussels, Belgium; Part I, June 26-30; Part II, July 3-7. Further details are available from Dr. Harry L. Van Trees, 27 Grove Hill Avenue, Newtonville, Mass. 02160, U.S.A.

The 1973 **German International Radio and TV Exhibition** will be held in Berlin from August 31st to September 9th.

Thomson-CSF Electronic Tubes Ltd, Bilton House, Uxbridge Road, London W5 2TT, has been recently formed to promote the sales of Thomson-CSF professional electronic tubes in the United Kingdom. Mr. George W. Bailey is to take charge of sales activities.

GEC-AEI Telecommunications Ltd, P.O. Box 53, Telephone Works, Coventry CV3 1HJ, have changed the name of the company to **GEC Telecommunications Ltd.**

Airtech Ltd, Haddenham, Bucks, have completed negotiations with Standard Telephones and Cables Ltd, to take over all activities previously carried out by the Avionics Division of S.T.C. in respect of commutated aerial direction finder equipments.

Synergistic Products Inc., Santa Ana, California, manufacturers and distributors of numerically controlled wire wrap, dual in-line package insertion and printed circuit board drilling systems have formed an associate U.K. company, **Cavitron (Europe) Ltd,** 37 Thame Road, Haddenham, Nr. Aylesbury, Bucks, to market Synergistic products in the U.K. and to provide a contract numerically-controlled wire wrapping service. It will also be responsible for the installation (including operator training), and after-sales servicing of Synergistic equipment throughout Europe.

The Industrial Electronic Division of Thorn Bendix Ltd, based at Nottingham, has been merged with Thorn Automation of Rugeley to form a single company under the name of **Thorn Automation Ltd.**

Electrocomponents Associated Ltd, have formed a new company, **Electroplan Ltd,** 13-17 Epworth Street, London E.C.2, to distribute equipment and accessories in the instrumentation, process control and allied fields.

Photo Controls Ltd, Randalls Road, Leatherhead, Surrey, have been appointed U.K. distributors for **photocell-lamps** manufactured by Moririca Electronics Ltd, of Japan.

The Electronics and Instruments Division of Bell & Howell Ltd, has acquired the sole U.K. marketing rights for the **Anadex Instruments Inc.** (California) range of industrial analogue and digital measuring, indicating and controlling equipment.

Martron Associates of Marlow, Bucks, has been appointed U.K. and Eire distributor for the **Yokogawa Electric Works** (Japan) range of instruments, including chart, X-Y and photo-recorders, electrical standards, panel meters, and digital and industrial instruments.

Techmation Ltd, 58 Edgware Way, Edgware, Middx. HA8 8JP, have been appointed exclusive agents in the British Isles for the range of **lasers** made by Hughes Aircraft Company and the Santa Barbara Research Centre's range of infra-red detectors.

ITT Components Group, Electromechanical Product Division, West Road, Harlow, Essex, are now responsible for the marketing and servicing of **ITT Metrix** (France) range of instruments in Britain.

British Enkalon announce that they are to acquire Akzo's right to a 60% interest in Brand-Rex Ltd, a company formed to develop, manufacture and sell wire and cable in Western Europe.

Arrangements have been made by Perfection Parts Ltd, of 59 Union Street, London S.E.1 for the marketing of a range of modular etching equipment, which is manufactured by **Transaco** of Stockholm.

J.E. Sugden & Co. Ltd, have moved from Bradford Rd, to Carr Street, Cleckheaton, Yorkshire, BD19 5LA. Tel: Cleckheaton 2501.

Semiconductor Production Equipment Co. Ltd, (Centronic), have moved to premises at 100 High Road, Byfleet, Surrey. Tel: Byfleet 48031.

Hamlin Electonics have moved from London to 14 New Road, Southampton SO2 0AA. Tel: 0703 32832.

The London sales office of **General Instrument Microelectronics Ltd,** is now at 57/61 Mortimer St, London W1N 7TD. Tel: 01-636 2022.