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A PORTABLE FIELD NOISE MICROCOMPUTER

L.M. Linnett and B.C. Ross

Health and Safety Executive, Edinburgh, U.K.

INTRODUCTION

High noise levels exist in many areas of employment. It has been estimated[1] that over one million persons in manufacturing industry in Britain are exposed to noise which is liable to cause hearing damage. This estimate excludes persons working in construction, forestry, railways, airports etc. where high noise levels also exist.

Noise induced hearing loss is a function of both sound level and exposure duration. It is now generally accepted that the "equivalent continuous sound level normalised to 8 hours" (Leq (8hr)) in dB(A), which is derived from these variables, is directly related to the risk of hearing loss. This quantity is obtained by integrating the square of the 'A' weighted sound pressure level with respect to time.

Since 1972, when the Code of Practice for reducing the exposure of employed persons to Noise[2] was published, the recommended unprotected maximum exposure has been 90dB(A) Leq 8 hr. This figure is given as an action level in the Health and Safety Commission consultative document for protection of hearing at work published in 1981. In 1982 a proposal for a European Community directive[3] suggested that the daily maximum exposure be 85 dB(A) Leq 8 hr. Amongst other things, these documents require that records of workforce exposure are kept, noise is reduced and adequate hearing protection be provided and worn where necessary.

Compliance with these requirements can involve the use of a wide range of measuring and analysis instruments each of which has been designed to measure only one of the required quantities. For example, the two methods of estimating noise exposure are workplace sampling with a sound level meter, and personal sampling with a dosemeter carried by the worker. With workplace sampling an integrating sound level meter is placed at a person's normal working position and a sample Leq is obtained which when combined with the estimated exposure time gives the Leq 8hr. Clearly this technique is limited to situations where a worker's movements are restricted. When persons move from one area to another or work in places where it is not possible to place a meter at their working position, personal sampling may be necessary. For example, a comparison of sound level meter and dosemeter sampling techniques in coal mines has shown that the former underestimated the Leq by an average of 2.5 dB(A)[4].

When hearing protection data is required octave band frequency analysis must be undertaken. This data can be obtained by either a manually operated filter set attached to a sound level meter or by on site tape recordings. Traditional dosemeters do not have built in filter sets so that in the case of the mobile worker it is difficult to assess the attenuation required by protectors to reduce noise to a safe level. Furthermore, data acquisition, processing and hearing protector prescription are time consuming when carried out by conventional methods.

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In order to formulate noise control strategies, it is generally necessary to collect data regarding the time history of noise exposure. With traditional workplace and personal sampling techniques this again involves a considerable manpower effort especially during data processing.

With the introduction of microprocessors it has been possible to develop a portable sampler with the potential to fulfil all the data collection and processing requirements for exposure estimation, time history analysis and hearing protector prescription, and present the results in a form specified by the user.

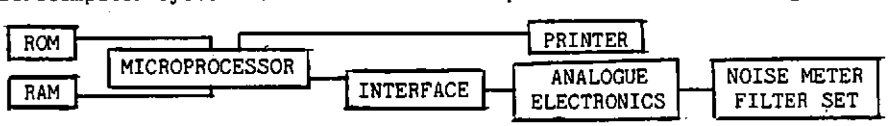
DEVELOPMENT BACKGROUND

About three years ago the field laboratories of the Health and Safety Executive were equipped with Research Machines 380Z microcomputers. One of the first uses was to use this system for noise analysis. Essentially the system was used to obtain third octave and octave band data from tape recordings made in factories or using standard noise meters equipped with octave band filter sets, the octave data could be obtained and entered into the computer manually. The computer then calculated the dB(A) value of the noise and also the reductions necessary for each octave band to reduce the noise to the 90 dB(A) and 85 dB(A) levels. A search of about 100 hearing protectors would then be made and finally a complete report of the noise analysis would be printed out, giving details of suitable hearing protectors and the levels to which they should reduce the noise.

It soon became apparent that a general purpose portable microcomputer with suitable input/output circuitry where only the software (ie programme) had to be altered to change the application would be of great value for everyday noise measurement and analysis in the field. Also the software should be able to be written on a laboratory microcomputer (in a high speed language if necessary) and down loaded into the portable microcomputer. The prototype microcomputer was designed to interface with a commercial sound level meter and octave band analyser. It is envisaged that the system will be modified to incorporate an octave band filter set (Reticon R5606) so dispensing with the need to sample through a sound level meter. This will allow the microcomputer to be carried on the person.

DESCRIPTION OF SYSTEM

The microcomputer system is best described in parts as outlined in figure 1.



The heart of the system is the microprocessor. The one chosen for this application was the INTEL 8085. This was chosen since assembly language software could be written on the host RML 380Z microcomputer, tested on this, and be compatible with the 8085 microprocessor. (A few minor differences exist but these may be ignored. More will be said on this later.) Finally a CMOS version of this microprocessor existed and this would be essential in a portable instrument, because of the power restrictions.

The ROM (read only memory) chosen was the Hitachi 21C16 chip, again a CMOS chip. This holds up to 3 K bytes of data or program and provision for four such ROMs was incorporated in the final design. The RAM (random access memory) ie where field acquired data or temporary data could be stored, was a 2 K byte Hitachi CMOS chip type 6116.

The printer used was a miniature dot matrix computer printer. This was small, had a full character set including a graphics capability, had ribbon and paper which could be easily changed in the field and also had fairly low power consumption.

A considerable amount of time and effort was put into the design and implementation of the system software, and the means by which it could be loaded from the host RML 380Z system to the portable microcomputer.

First, since the software had eventually to reside in a 27C 16 EPROM chip, an EPROM programmer had to be designed and built for this chip. The software necessary for loading data into the thin chip, and for verifying the chip's contents all had to be first developed. The design and implementation of the hardware and software for this EPROM programmer will not be discussed here. The details of this will appear in a later article. In this present article the EPROM programmer is first looked upon simply as a box which allows a 27C 16 EPROM chip to be loaded into it, connected to the 380Z microcomputer and then have the 380Z download a program or data from a certain area of its memory to the 27C 16 chip. It should be mentioned at this stage that the 27C 16 chip being an EPROM (erasable, programmable, read only memory) allows programs stored in it to be erased, modified etc. These facilities are useful in the development stage of such a noise microcomputer.

The software controls the switches on the microcomputer. At switch on the software steps the microprocessor through a test sequence. On the computer there are several switches and lamps which must be controlled. These are -

a) RESET BUTTON - allowing any data stored in RAM to be cleared, ready for data acquisition.

b) RUN BUTTON - This causes data acquisition to begin and allows sampling of the noise signal through each octave band filter. As each octave band is sampled, ie they are sampled serially not in parallel, a light is illuminated to show which filter is being sampled.

c) REPRINT BUTTON - This button allows the reprinting of the last set of results provided the reset or on/off buttons have not been pushed. This facility was included to allow multiple printouts of data to be produced for say employers, employees etc.

The software controlling these switches, the lamps, and printer was written in assembly language.

Once the data has been acquired, the noise microcomputer then performs the calculations necessary to provide a printout of suitable protectors for the noise being sampled. Some of these routines were written in FORTRAn and linked to the assembly program, before being downloaded to the 27C 16 EPROM.

CONCLUSION

A portable microcomputer has been developed which allows data to be acquired and processed, and displayed on site or later at the demand of the user.

The system could be used for a wide range of requirements simply by changing the software. Each piece of software could be on a separate chip which the user can change to suit his needs. Examples are industrial noise exposure determination, hearing protection prescription, building reverberation studies, and environmental noise evaluation.

Use of microprocessors simplify and speed up data acquisition and processing thus reducing the costs involved. This will greatly benefit organisations who are required to undertake noise surveys as part of a health and safety programme.

The authors wish to thank Mr A Hall, Deputy Chief Inspector of Factories for his encouragement throughout the work.

REFERENCES

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