Proceedings of the Institute of Acoustics

COMPUTERISED AUTO-TESTING OF SOUND LEVEL METERS

C.P.Stollery

Cirrus Research Ltd., Hunmanby, N.Yorks. U.K.

INTRODUCTION

This paper will attempt to show how, with the use of a computer the testing of a sound level meter to International standards may be performed with the minimum of human effort. A proposal for such a test system is presented and the limitations highlighted. The paper will also show how such a system may improve quality control whilst saving time and money, thus offering a benefit to the end user.

In 1987 the Health and Safety Executive published a paper [1] describing tests performed on sound level meters, from several different companies, described in the International standards IEC 651 for sound level meters and IEC 804 for integrating sound level meters. This report showed that whilst the better manufacturers claimed a certain class for a particular sound level meter 38% of all sound level meters tested failed to meet the manufacturers specified grade. Whilst the manufacturers were not necessarily being deceitful about the performance of their sound level meters a need for quality improvement was recognised by most of the reputable companies and Cirrus started an immediate quality audit of their system.

CLASSIFICATION OF SOUND LEVEL METERS.

Sound level meters may be grouped into two:-

1. A sound level meter for measuring sound pressure levels (IEC 651)

2. An integrating sound level meter for measuring Leq and SEL. (IEC 804)

There is a further classification to be made which relates to the accuracy of the instrument called the type:-

Type 0	- To be used as a laboratory reference standard.
Type 1	- For field use where the acoustic environment can be closely controlled or specified.
Type 2	- For general field use.
Type 3	- Field noise survey applications.

It is clear that the lower the type of the instrument, the more expensive the test becomes relative to the selling price of the final instrument. There is not a big difference in the tests required between a type 0 unit and a type 3, it is mainly the tolerances which are different. Thus, while at the type 0 level, it is sheer performance which is sought, for a type 3 instrument, cost is the overriding factor.

The production testing as opposed to type testing of a sound level meter to the appropriate standard requires a sine burst generator, a digital voltmeter, a competent engineer and nearly an hour of time, assuming the unit is functioning perfectly. The main problem occurs with the time requirement. For high volume production of type 3 units, half an hour of test after each unit has been made to function is not viable. At present, as with most producers, the solution is batch testing, i.e. a representative sample of a batch of sound level meters is fully tested to every point required by the letter of the IEC specification, whilst the remainder are subjected to a subset of tests on each production unit. This releases engineering time but quality control may suffer as a consequence as the HSE paper demonstrated.

The answer, as usual, involves a computer. If the operation is computerised the procedure is greatly speeded up as the computer can guide an unskilled technician through each test whilst acquiring, collating, displaying and keeping a permanent record of the parameters of each sound level meter before issuing a serial number and allowing the sound level meter to be sold.

Cirrus Research recognised the need for a computerised auto test system in 1984 for the high volume production of the type 3 Leq meter the CRL 2.22 used for the Open University course T234. The dedicated unit built to do this was described in 1985 [2]. This system is still used in 1989 and works well, indeed, with minor modifications to tighten tolerances in the light of experience, the same system has just completed testing a batch of several hundred units to type 1 standards, mainly for the Health and Safety Executive, in a time impossible using manual techniques. However, as Cirrus Research produce a wide range of different sound level meters, a versatile computerised test system is now required that is not dedicated to one particular model of sound level meter. Such a test system is described below.

THE NEW SYSTEM

The block diagram of the system appears in figure 1.

The system is designed around a fast IBM compatible computer using the IEEE488 instrumentation bus. This is a well documented interface enabling a number of different items of instrumentation equipment to communicate with a controlling device, in this case the computer.

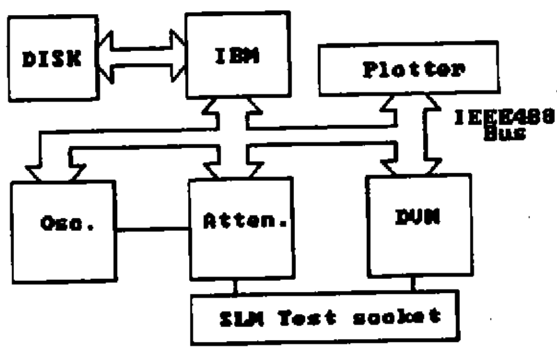

Figure 1

The sound level meter is tested with the microphone replaced by an electrical signal input from an IEEE controlled oscillator with a high accuracy digital

COMPUTERISED AUTO-TESTING OF SOUND LEVEL METERS

Voltmeter, (DVM), used to read various test points. There are two main requirements for an oscillator in this test system, purity and controllability.

Purity is obviously required for accurate measurements of the frequency response. A sine wave with a total harmonic distortion of better than -80dB is required for high level low frequency measurement of filters etc. Furthermore a good degree of controllability is required, allowing single or multiple cycle sine bursts for testing to IEC 804 including appendix 6, Youngs test. Frequency sweeps are not necessarily required but preprogrammed amplitude versus frequency characteristics are an advantage when testing weighting functions although this can be done by the software.

These two requirements conflict somewhat amongst the current market of function generators. Digital waveform synthesizers can provide excellent controllability but purity is a problem, whilst R-C oscillators provide the purity but are difficult to control. Suitable generators do exist but unfortunately at a high price.

A precision attenuator capable of attenuating in steps of at least 0.1dB is required to set different input levels. This would normally be part of the oscillator. The test signal is then fed into the sound level meter via a special test socket interface which also provides a number of test points that the DVM can access. The DVM under software control, reads the output on each pin and communicates the results back to the computer which performs the analysis.

All future Cirrus Research products are expected to have a standard auto tester socket fitted, allowing them to be plugged into this test system. The test points are loosely based on the DP15 interface described in 1979 [3] although over the last decade there have been many additions to this. Up to 40 different test points in the circuitry can be brought out to this socket where the DVM can read them or the oscillator can feed in signals. Suitable test points include battery voltage, power supply lines, RMS signal, log output etc. Also, on the newer computer based instruments, a digital communications bus is incorporated, which can be connected directly to the computer so that digital sound level meters can communicate during testing using their 'on-board' computer.

The standard tests are designed so that the majority of tests can be performed by replacing the microphone by an electrical signal and measuring the DC output of the sound level meter with a DVM. Thus only 3 connections are actually required. Having more than this enables other test points to be measured and thus the system can also be used as a fault diagnosis system used in the design of new sound level meters.

THE INTERNATIONAL STANDARDS

The testing defined by the two international standards is grouped into several blocks. The following are common both to IEC 651 and IEC 804.

1. Directional characteristics
2. Frequency weighting characteristics
3. Sensitivity to various environments

Testing for IEC 651 also includes:-

4. Time weighting,detector and indicator characteristics

and IEC 804 includes:-

5. Integrating and averaging characteristics
6. Indicator characteristics
7. Overload sensing and indicator characteristics.

Two of these tests are not possible to perform using the proposed test system namely 1 and 3.The directional characteristic test does not pose a real problem as the only factors affecting it can be the physical size and shape of the case and the microphone not the quality of the internal components. The tight engineering tolerances on the case mechanics mean that there is no noticeable change in the direction characteristic due to the case between different instruments of the same type. As the microphone is generally sold as a separate item and subjected to its own directional test this procedure is only really required on a few representative samples of the final design of a sound level meter. Naturally, each combination of microphone and instrument must be checked to ensure compatibility.

The other test not covered by the system proposal is the sensitivity to various environments such as low and high temperatures, humidity, magnetic and electrostatic fields and mechanical vibration. Whilst it is perfectly possible to include thermal chambers, electromagnets and vibration testers within the IEEE488 framework of the test system, it is not really viable as this would increase the cost of such a system and significantly add to the test time. As these parameters of a sound level meter do not appreciably change from unit to unit, they can be performed on a few final production samples which should be sufficient to be sure of the whole batch.

While the tolerances of the tests are laid down in IEC 651 etc. it is not reasonable to use all of these in an electrical test. For example, the tolerances of the 'A' weighting, if used in the electrical testing would automatically put any unit out of tolerance when the microphone was added. As a good rule of thumb, at Cirrus, we allow 1/3 of the type 1 tolerances for ALL lower classes, thus ensuring that the final unit complies with the specification.

We are aware that some smaller producers use the whole of the 'A' weighting tolerances in their electrical testing and this must mean that a high proportion of units fail to meet the standard. For type '0' units, the tolerances are more nearly 50:50 between the microphone and the electronics.

Also, there must be a gap between the test tolerances and the sales specification, usually IEC 651. Thus, if there is any drift of parameters, or quantisation error in the computer, there is some leeway before an instrument is out of specification.

SOFTWARE REQUIREMENT.

Such a test system is designed to be independent of a particular sound level meter design and so it would be very complicated to have a single item of software that could test all current and future sound level meters. As many of the tests are the same for IEC 651 and IEC 804 the software can have a main core written in 'C' language which is common to all sound level meters. The main core will refer to a 'personality file' which is specific to each design of sound level meter. The personality file contains all the information regarding the type of sound level meter and what further tests are required over and above the common core. These further tests are then written as 'C' modules which the main core can refer to. In this way the test system can be configured for virtually any future sound level meter or for that matter any future sound level meter standard proposed by TC29.

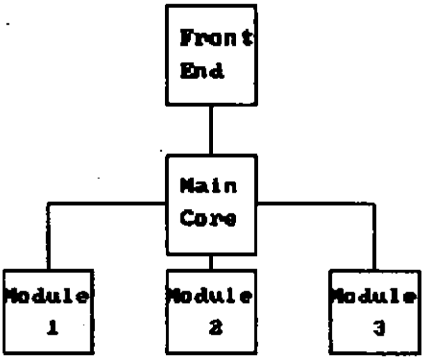

Figure 2

CONCLUSION.

An automated test system has been described that is independent of sound level meter design and can be configured to perform a vast range of tests on a sound level meter. This system, currently in commissioning at Cirrus, can also be used as a trouble shooting and fault diagnosis center for the sound level meter designer.

As well as testing a sound level meter, the system will store several vital parameters of the instrument and can collate information from a whole batch of instruments to obtain information regarding the spread of performance. This information could then be used to modify the design and perhaps locate problem areas in existing designs. Further, when type 1 instruments come back for their annual re-calibration, their performance can be compared to the previous years performance to see how robust the design is.

All these advantages lead to a more reliable and rugged sound level meter that the user can trust to make accurate measurements.

REFERENCES

1. Walles E. J. 'Does your sound level meter meet its specification? A users experience'. Proc. Inst Acoustics, Vol. 9 Part 7 (1987),

2. Frankish K.D. and Wallis A.D. 'Large Scale Automatic testing of Leq Meters' Proc. Internoise pp 1291 -1294 Munich Germany, Aug. 1985

3. Wallis A. D. 'The Plug-in Concept of a new Acoustic Measuring System' Noise and Vibration Control pp 122-142 May/June 1981