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MICROPROCESSOR CONTROLLED GRAPHIC RECORDING

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INTRODUCTION

The provision of a hard copy recording of any time varying parameter is an important feature of any scientific investigation. Acoustic studies are no exception where it has been the practice to record reverberation decays, acoustic time history and frequency spectra.

The task of recording any signal has traditionally been undertaken by pen recorders and for acoustic applications these have of necessity been a sophisticated design incorporating a range of paper speeds and high pen speed response in order to cater for the very dynamic nature of sound.

Recent developments in recording technology have now permitted the mechanical recording system outlined above to be superceded by an all-electronic recorder possessing the following important characteristics:

1. Exponential writing response per international sound level meter standards.
2. Digital time annotation of trace.
3. Waveform envelope recording of sound pressure signal to 10KHz.
4. Transient waveform recording to 10KHz.
5. Frequency recording with standard filter sets providing variable averaging to suit 'BT' considerations.
6. Only one paper stock for all applications.

Recorder development

The first recording devices capable of fulfilling the special requirements necessary to record sound were sophisticated mechanical assemblies. In consequence they were rather heavy, mains powered laboratory devices. Whilst these instruments were very accurate their lack of portability became an obstacle in many typical acoustic investigations, auditoium acoustics and community noise investigations for example. User demands for a battery powered portable recorder were recognised by specialist manufacturers during the last decade and the most recent of these pen recorders has enabled the pen response to reproduce the ballistic characteristics of sound level meters which is important in time history recording. However ancillary instruments have still been required to provide an input signal. The logical development was therefore a portable recorder with inbuilt measuring amplifier. This was the design concept reached in the mid 1970s but at this time several new electronic developments occurred which were complementary to this concept.

All-electronic recording

In the computer industry manufacturers were searching for ways of providing fast printing systems. The electrical discharge dot matrix printer was used by an increasing number of manufacturers for this task. The recording principal was to create a paper sandwich of one layer of backing paper, a layer of graphite and a thin deposited aluminised surface layer which would be electrically conducting. An electrical arc could be made to pass from an electrode to the surface of the paper vapourising the thin aluminised surface to leave a black dot on a silver background. The dot-matrix application of this technique enables rapid alpha-numeric printing with a stable non-ageing hard copy suitable for photocopying.

A refinement of this system has been to replace the moving dot-matrix head with a static 'comb' of 100 electrodes extending across the width of the recording paper. By correct 'sequencing' of the firing order of the electrodes then both graphic traces and alpha-numeric characters may be recorded at very high speed. A natural development of this recording technique is to place the 'sequencing' operation under the control of a microprocessor.

Microprocessor-based all electronic recording

Because of the enormous flexibility offered by microprocessor technology there was a strong demand from the electronics industry for low power consumption microprocessors for portable instrument applications. During the last five years enormous advances have been made in this area and it is the application of one such device which permits the recorder's versatility to be realised. The microprocessor allows a 30 μsec sequencing cycle for electrode firing to be maintained which permits simultaneous grid and signal recording, digital time annotation and alpha-numeric frequency annotation.

The original concept of a battery powered recorder with a built-in sound level meter has been achieved but many new additional benefits have been derived. The recorder is capable of many tasks but none more innovative than its ability to capture and record transient waveform. This is achieved by placing a 1928 sample digital memory between the printer and the A/D convertor. A threshold is established at $\pm$30% of full-scale input, but the absolute value of this trigger can be varied using the measuring amplifier gain controls. On exceedance of the threshold the signal is captured and includes 128 pre-trigger samples. The time of occurence is automatically printed together with the waveform and time-base graticule, and on completion of printing the memory is re-armed to await the next transient.

Future developments

Spare program capacity has been retained to enable further system development. Two projects have immediately been identified and are nearing completion. The first of these options has been the creation of an Leq (equivalent continuous sound level) program, in which a histogram-type display is used to provide an Leq history. Different measurement periods from a few seconds up to one hour may be selected.

Incorporated in the recorder is a clock with a resolution of 4msec and digitised sound level to a resolution of 0.1dB. The measurement of reverberation time can therefore be undertaken digitally and the calculated values printed on the recording. By incorporating a control sequence to frequency analyzers and noise generators a simple low-cost building acoustics investigation program will result.

In the field of vibration then a multi-channel device with triggered capability is under study for structural vibration investigations.

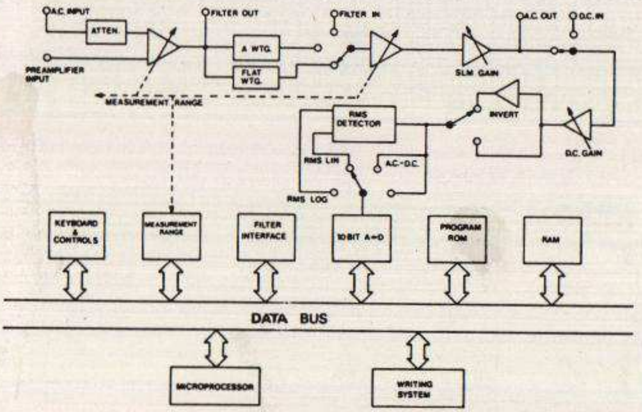

Fig 1 General Block Diagram CEL-160 Series

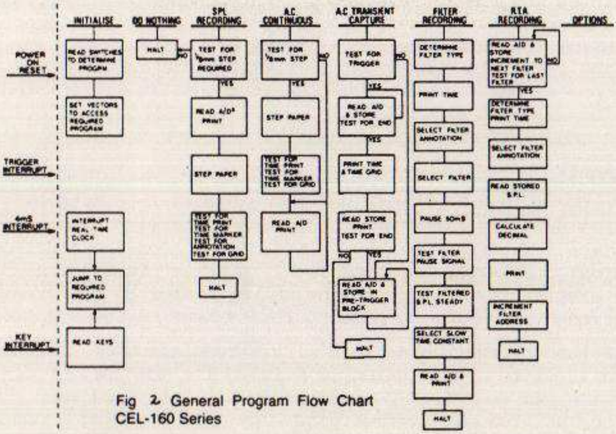

Fig 2 General Program Flow Chart
CEL-160 Series

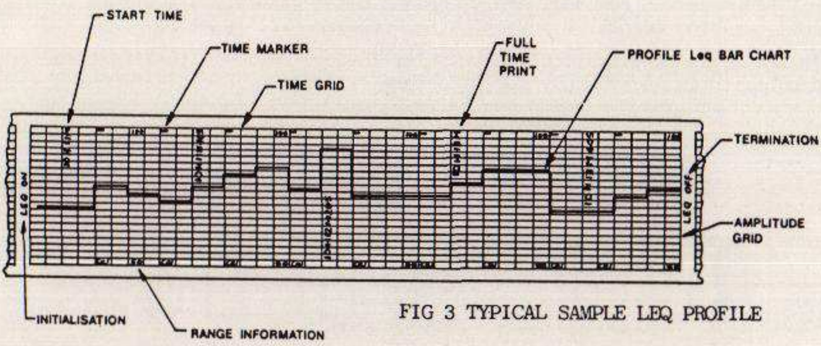

FIG 3 TYPICAL SAMPLE LEQ PROFILE

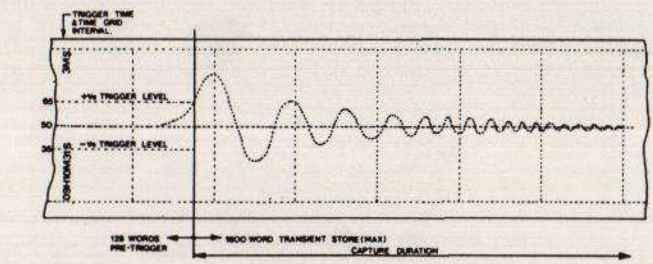

FIG 4 SAMPLE TRANSIENT WAVEFORM