Proceedings of The Institute of Acoustics

A LOW POWER DIGITAL INTERFACE FOR HAND HELD SOUND LEVEL METERS

A J W Myles

CEL Instruments Limited, 35 Bury Mead Road,
Hitchin, Herts, SG5 1RT England

INTRODUCTION

In order to take advantage of the new low-cost computing power offered by the home computer, it is necessary first of all to get the data into the computer and some conversion of the physical phenomenon of sound into the digital language of a computer is required.

The work-horse of all acoustic measurements is the precision grade sound level meter, and two obvious locations for analogue to digital conversion present themselves.

First for consideration is immediately following the microphone, where the analogue to digital converter would need to possess sufficient resolution to represent the amplitude range of the microphone and sufficient speed to adequately represent the frequency range. These requirements are well known to be 120dB range over a 20KHz bandwidth. This latter requirement simply gives rise to a sampling frequency requirement of 50KHz, due to Nyquist, whilst the amplitude range requires further consideration.

The resolution of a digital word is determined by the number of "bits" in the binary number equivalent of the decimal number. In this case we have a decibel number which is a decimal ratio, of 10^6 to 1. In decimal to binary conversion a value of 1000 (10^3) is approximated to by 2^{10} (1024), so that the binary equivalent of 10^6 is 2^{20}, thus giving a required resolution of 20 bits + 1 sign bit to describe the output range of the microphone. Home computers are unable to handle such large numbers and at such speed.

The next most logical choice for the location of the A to D converter is therefore following a conventional analogue RMS detector. This location benefits from the latest design RMS circuits which produce a voltage output which is linearly proportional to decibels, so that 10 data bits could describe a 100dB range to 0.1dB resolution.

This paper discusses the implementation of a digital interface with reference to two specific instruments: CEL 393 which possesses multiple parameter/multiple interval processing and the CEL 493 which possesses multiple parameter processing within a 100dB dynamic range. Both instruments are battery-powered which is a significant limitation on interface design.

A LOW POWER DIGITAL INTERFACE FOR HAND HELD SOUND LEVELMETERS

International Interface Standards

There are two ways in which a computer can directly receive digital data. It can be either bit serial or bit parallel. In the former case only one signal line is actually receiving data, as the name implies, serially one bit after another, with additional bits to define when a data word starts and when it stops. In the latter case there are as many data lines as there are bits in the word, and with the data-bits arranged in parallel form, each line simultaneously accepts a data bit, therefore providing an advantage of speed of response.

However, for data to be reliably transferred from one system to another compatibility must be established, and is achieved by functioning within defined standards under a "communications protocol".

Business computer giants like IBM and ICL operate individual communications protocols, but smaller computer manufactureres offer interfaces which will operate to either the parallel interface standard IEEE 488 or to CCITT V24/V28, EIA RS232 serial interface recommendation. These publications establish the signal levels which should be used, pin and line wiring configurations, and acceptable control words for use in computer software. However in the same way that many computer manufacturers offer various dialects of BASIC, there are many minor variations to IEEE 488 and RS232 interfaces, and reliable data transfer cannot be guaranteed without recourse to special engineering.

Computer interfaces as defined by the standards above can be simplex; that is uni-directional; half-duplex, that is bi-directional but used in only one direction at a time; or full duplex, that is transmission in both directions simultaneously. Quite clearly the more complex the operation of the interface, then the more complex the electrical circuitry and both the more space and more power consumed. Against the background of a small, compact battery-powered hand-held sound level meter then neither of these standards are appropriate. Nevertheless an effective serial interface can be established which enables this type of instrument to be successfully used with many computers equipped with an RS232C interface port.

In its simplest sense any logic line is a stream of alternating high and low signals referenced to OV which is a state maintained by a further interface line. Adhering to the voltage levels illustrated in figure 1 will only ensure that a signal can be passed between the communicating devices. For it to be reliably and accurately received it must also be established when data is ready to be sent, when it is ready to be received and at what speed it can be accepted. In practice for a simple data transfer to take place many of the control lines defined in figure 2 can be ignored and a communication interface established with only 3 or 4 lines.

A LOW POWER DIGITAL INTERFACE FOR HAND HELD SOUND LEVEL METERS

The CEL Low-Power Digital Interface

The RS 232 recommended voltage levels for logic high and logic low are in the range of +/-5V to +/-25V. Low-power designs where logic voltage levels of 0V and 5V are common can ensure a useable data stream output by combining logic low and signal reference at 0V and by using logic high at 5V. Thus two lines are used for data and two further lines are used for "handshaking". A "request-to-send" line from the sound level meter establishes when data is ready to send and a "clear-to-send" line establishes when the receiving device is ready to receive data.

An active interface unit receives the logic levels of 0V and 5V and converts them to symmetrical levels of +/- 9V for acceptance by an RS 232 serial input port.

Implementation in the CEL 493 Sound Level Meter

The interface is implemented in its entirety in the CEL 493 Precision Integrating Impulse Sound Level Meter, where simplicity of design has been made a virtue. The existing design standard for sound level meters - IEC 651- is about to be joined by a new standard - IEC 804 - describing integrating instruments. Both standards quantify the subjective concept that a wide dynamic range instrument is necessary for measurement of all noise types including impulsive. The CEL 493 implements a 100dB dynamic span for all noise types including implusive, thus ensuring that a single standard measurement range of 35dB(A) to 135dB(A) will fulfill most measurement requirements.

The CEL Low Power Digital Interface allows the CEL 493's currently displayed result and status to be continuously output for printing or for further data reduction. Every 1/2 second a new result is calculated and output to the digital interface.

Each answer consists of 5 bytes where each byte consists of 1 start bit, 8 data bits and 2 stop bits, and is output at 4800 baud. The first two bytes are status bytes defining the selected frequency weighting, selected measurement parameter, selected time constant, reset status, pause status, overload status and parameter numeric hundreds digit status. The final three bytes hold the tens, units and decimal numeric values of the answer in ASCII code.

The result is available for output when the "request-to-send" line is set low, and each of the 5 bytes is output when the "clear-to-send" line is sensed low. The interface is capable of outputting 32 characters per 1/2 second and so the "clear-to-send" line can be used to hold-up the CEL 493 between complete blocks of 5 bytes so that the receiving device can process the data.

Allied to the Low-Power Interface are three control lines which enable remote control of the reset and pause functions, and also parameter selection. Measuring intervals and parameter selection can therefore be controlled externally, and transmitted answers contain all the status information required to describe the result.

A LOW POWER DIGITAL INTERFACE FOR HAND HELD SOUND LEVEL METERS

Implementation in the CEL 393 Computing Sound Level Meter

The CEL Low-Power Digital Interface has been slightly modified in its implementation in the CEL 393. In this meter further computer data reduction software has been incorporated in the instrument enabling it to perform multiple function/multiple interval processing. Since the answers generated require memory for storing, then the interface can be simplified as the meter no longer requires to tell the computer that data is available: the memory can be emptied at the convenience of the computer and the "request-to-send" line can be dispensed with.

Thus data can be reduced and answers accumulated in the CEL 393 prior to activation of the interface. This technique is well illustrated by the Noise Rating Curve Software which has been written for the Epson HX-20 Microcomputer.

The Epson HX-20 incorporates an integral printer and a microcassette drive, yet is battery powered and ideal for field work. Up to 35 octave band spectra can be stored in the CEL 393 memory prior to connection of the CEL 4351 Interface Kit. Software enables the contents of the memory to be written to cassette and filed with or without print out as requested by the operator. Stored files can then be read back from the cassette and using the NR programme, each spectrum can be described by its NR value.

Data formatting is also slightly different in the interface implementation in the CEL 393, because of the large number of function mnemonics which are capable of generation.

Each answer consists of 5 bytes as described previously. The first byte contains an ASCII code which defines the parameter, and which the receiving printer/computer must decode to the relevant answer. Four bytes are then used to describe the numeric value of the answer. The "clear-to-send" handshake line ensures that answers can be copied as generated or the contents of the memory can be emptied retrospectively. Data is output at a rate of 1200 baud.

Conclusion

The limitation to using low cost computers to greater advantage has hither to been the difficulty in providing easy availability of the data without recourse to typing it in through the key-pad. The CEL Low-Power interface now ensures that this is no longer the case. The choice of NR calculation has been selected as an illustration because it is universally understood. The range of applications however is limited only by the "genius" of the user.

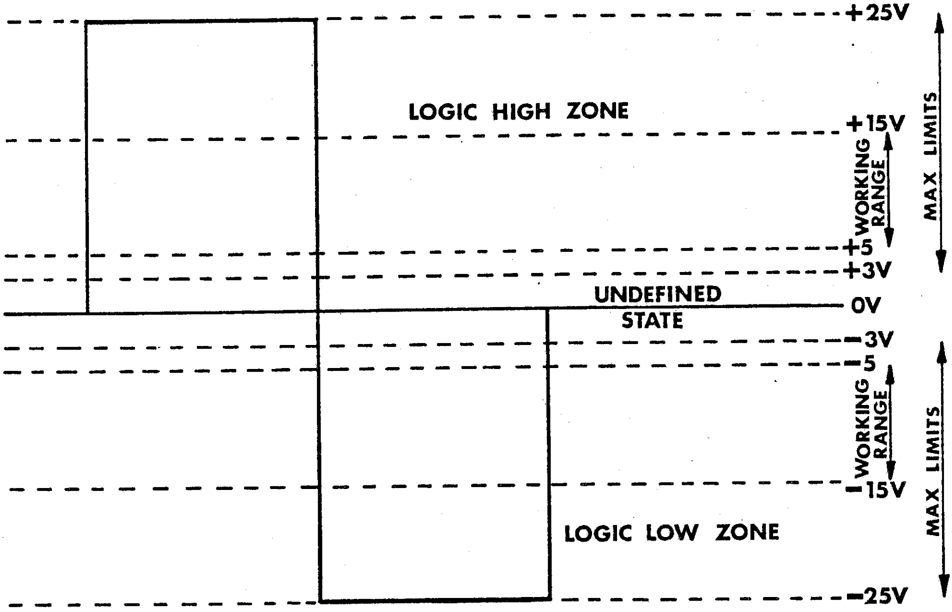

Fig 1 **EIA RS 232 Recommended Voltage Levels**

Fig 2 EIA RS 232 Recommended Voltage Levels

Interchange Circuit Name	EIA RS 232 Pin Nos
Signal Ground or Common Return	7
Transmitted Data	2
Received Data	3
Request to send	4
Ready for sending	5
Data Set Ready	6
Data Terminal Ready	20
Data Channel received line signal detect	8
Transmitter Timing Element (from DTE)	9
Data Signalling rate selector	11 & 23
Backward channel received line signal detect	12
Backward channel ready	13
Transmitted backward channel data	14
Transmitter timing element (from DCE)	15
Received backward channel data	16
Receiver timing element	17
Transmit backward channel line signal	19
Data Terminal Ready	20
Calling Indicator	22
Select Standby	24
Standby Indicator	25