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A TACTILE PEAK PROGRAMME METER FOR BLIND SOUND ENGINEERS

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INTRODUCTION

Visually impaired sound engineers need alternatives to the usual visual representations of audio signal levels. In many cases an audible level monitoring device, such as the one described by Angus and Malyon [1], is inappropriate. This is either because the audible "beep" disturbs other normally sighted studio personnel or because the level quantisation is too crude for accurate level monitoring. This paper describes an instrument that was developed for the BBC to provide a tactile readout of Peak Program Meter (PPM) levels in a manner that was compatible with their normal studio practice. This would allow visually impaired studio personnel to operate normally within the organisation. The paper will describe the specification, the hardware and the software of the device.

SPECIFICATION

The meter "displays" four channels of related information associated with a stereo signal. These are the A, B, M and S signals that are normally displayed visually in the studio. The meter has to display these signals in a tactile fashion that is both easy for the operator to feel and inaudible to other studio personnel. The requirement for inaudibility ruled out many possible electro-mechanical arrangements that involved vibration. The need for the operator to have easy access to the meter implied that the transducer should be similar in size to standard Braille characters. A standard 8 dot extended Braille piezoelectric transducer was finally chosen. This had the advantages of speed, silence and minimal moving parts. By using six of these cells, placed side by side as shown in Figure 1, it was possible to display the four required signals.

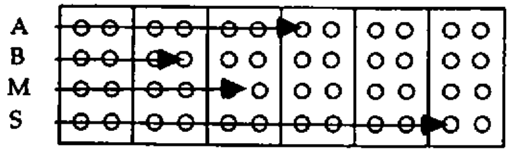

Figure 1. Braille Cell Arrangement for the Tactile PPM

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For ease of use we also decided to show the levels as moving bars rather than dots as this would make it easy for operator to feel the reference point for the levels. With twelve dots available we were able to make the instrument resolve half a PPM unit in its normal mode of operation. However, for some tasks, such as tape line-up, more resolution is required and so a switch is provided which expands the scale to quarter PPM units over a reduced dynamic range. The audio inputs are at standard line levels and use standard connectors. In order to drive the Braille cells efficiently, minimise development time, and allow for future enhancements we chose a microprocessor based system and used existing PPM cards to provide the input signals.

HARDWARE

The hardware consists of two Peak Program Meter (PPM) drive cards, an 8 bit 8 channel analogue to digital (A/D) converter, single chip microprocessor, Braille cell transducers, two user switches and a power supply. A block diagram of the system is shown in Figure 2.

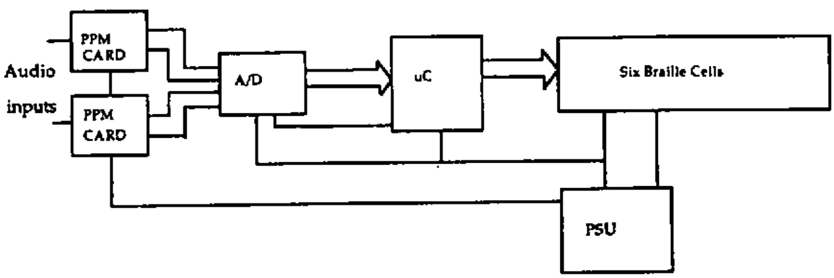

Figure 2. A Block Diagram of the Tactile Peak Program Meter

The PPM cards are pre-calibrated to a BBC standard and are employed to convert the audio inputs to voltage outputs representing the left, right, sum and difference PPM levels of each channel. These four voltages are fed into the A/D that converts them to an 8 bit word ready for the processor to read.

For space and ease of PCB layout a 8048 series single chip microprocessor is used which has on chip program memory and a small amount of data memory for variables. The outputs from the processor are fed to the logic section of the Braille cells.

The cells are piezoelectric crystal devices that require a high voltage for them to operate. Figure 3 shows how they work. A relatively high current is drawn by the cells to change from one state to the other but then reduces considerably when in a stable state. As current flows through the piezoelectric crystal it will bend thus moving the plastic pin up or down dependant upon which crystal is energised. The cells are supplied as a matrix of 2 columns x 4 rows that would normally represent a single Braille unit.

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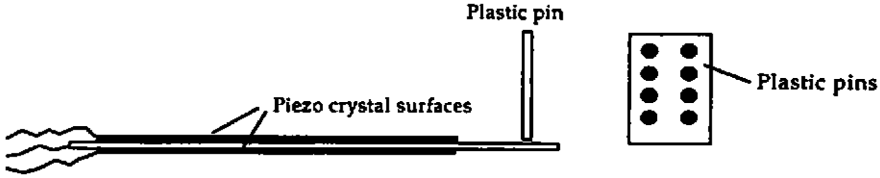

Figure 3. Mode of Operation of the Piezoelectric Braille Cell

Six units were fitted side by side to give a matrix of 12 columns x 4 rows which were then addressed as 4 separate rows. Each cell in a row represents ½ PPM unit and the total range displayed is between 2 and 7 PPM units inclusive, the last column not being used for PPM output. An alternative expanded range can be switched in by the user which converts the display to ¼ PPM unit resolution with a range between 2.75 and 5.25 PPM units.

To ensure accurate response to the audio input the battery voltage is monitored and when it drops below a preset value the cells are suppressed and the last (most significant) two columns are raised permanently to indicate to the user of this condition.

SOFTWARE

The PPM software was written in assembly language for an 8048 series microprocessor. Its task is to read the values of the four input channels (A, B, M and S) and convert these to a form which can be output to the Braille cells serially. The mode and expand switches alter the channels and scaling of the data presented. The battery condition is also monitored. Figure 6 shows the state transitions involved in this continuous process.

The Braille cells consist of eight pins which are activated by clocking serial data through them in the following manner (Figure 4). Because of this data flow it was necessary to shuffle the four level values together before sending the data to the Braille cells.

The PPM cards do not provide an output that is exactly compatible with the Braille cells so a mapping algorithm (see Figure 5) was devised to give an accurate output given the limited resolution of the output device.

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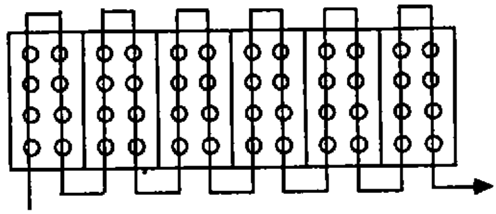

Figure 4. Data Flow Through the Braille Cell Array

```
signal = 1    /* signal is threshold to compare against */
FOR (all Braille cells) {
    serial_output[current Braille cell] = 0
            /* Do upper nibble of ADC value first */
    output_mask = 10H
    FOR (adc index 1 - 4) {
            IF (adc_value[adc_index] >= signal )
                    BITWISE OR (serial_output[current Braille cell] with mask)
            SHIFT LEFT(mask)
    }
    INCREMENT (signal)
            /* Now do lower nibble */
    output_mask = 01H
    FOR (adc index 1 - 4) {
            IF (adc_value[adc_index] >= signal )
                    BITWISE OR (serial_output[current Braille cell] with mask)
            SHIFT LEFT(mask)
    }
}
```

Figure 5 . Algorithm for Mapping Input Signals to Braille Cells

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CONCLUSION

We have described a tactile PPM meter which further enhances the independence of visually impaired studio personnel and so allows them to participate more fully in the creative aspects of the profession.

REFERENCES

1 Angus, J A S and Malyon, N J "Audio Level Monitoring for Blind Sound Engineers/Recordists," *Audio Engineering Society 91st Convention* , **Preprint 3219 (J-1)**

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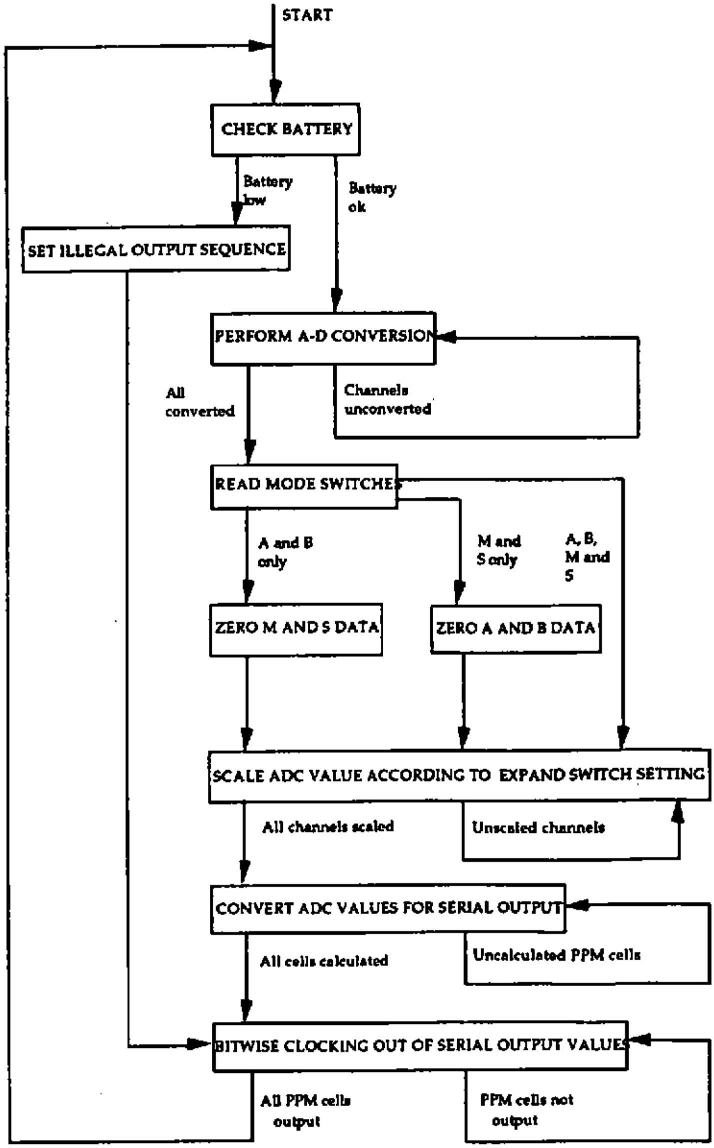

Figure 6. The State Transition Diagram of the Tactile PPM