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IMPLEMENTATION OF REALTIME OCTAVE FILTER ANALYSIS FUNCTION IN A HAND–HELD TYPE SOUND LEVEL METER

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1. INTRODUCTION

In acoustic measurement, frequency analysis is indispensable for accurate determination of noise and sound characteristics. In conventional acoustic measurement, octave filter analysis and therefore octave filter bank analyzers have been used. The early analyzer models employed analog circuits consisting of discrete elements. They were large in size and not easy to use on site. Therefore, sound was recorded on site and analyzed later in the laboratory consuming a long period of time.

Recent progress in digital signal processing technology and electrical elements, on the other hand, have cultivated the possibilities of digital sound level analyzers. In particular, as the performance of digital signal processors (DSPs) have been improved, high-performance and portable digital sound level meters have been making their way onto the market. These meters utilize DSPs to perform all kinds of signal processing, such as rms conversion and frequency weighting[1]. Conventional digital sound level meters can perform octave filter analysis on specific frequencies, however, analysis was limited to steady state sound because band switching was necessary for analysis of the entire acoustic frequency band.

This paper describes a hand-held type sound level meter which can perform realtime octave filter analysis based on digital signal processing.

2. FILTER STRUCTURE

When configuring an octave filter bank which performs realtime operation by the use of a digital signal processor (DSP), based on the relationship between the program capacity and the calculation time, a combination of a down-sampling filter, a low-pass filter, and an octave band-pass filter is required.

If the center frequency of the filter is equal to the 2's power sequence specified by the IEC1260, the down sampling rate is 1/2 and the structure and coefficient are the same with respect to all digital filters. However, if the center frequency is equal to the 10's power sequence specified by the IEC1260, they differ for each filter bank. As the JIS1531 standard of Japan approves only the 10's power sequence, optimization of the program and coefficient is necessary to configure digital octave filter banks which operate in realtime.We have designed an IIR filter shown in Fig.1, for the purpose of configuring an octave filter bank with the center frequency corresponding to the 10's power sequence.

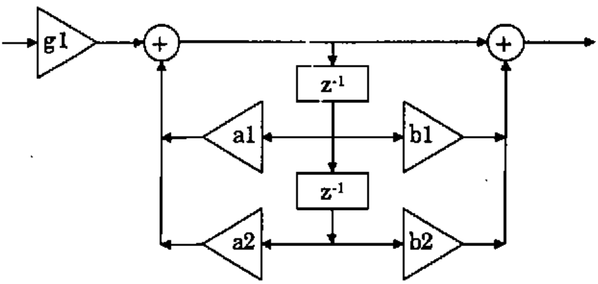

Fig.1 Basic Block Diagram of the Octave Filter

A sharp attenuation characteristic necessary for an octave bandpass filter is obtained by connecting three 2nd order IIR filters in cascade to configure a 6th order Butterworth filter. Filter coefficients (a1, g1,a2, b1, and b2) are which differ for the center frequency of the filter.

3. FILTER PERFORMANCE

To check the performance of the octave filter bank consisting of the digital filter mentioned earlier, filter characteristics are measured by the feeding of electrical signals. Fig.2 shows the frequency characteristics of the 1/3 octave filter with 1 kHz center frequency. The bold lines show measured values and the normal lines show tolerances specified by the IEC1260 Type 1. Thus the filter characteristics fully meet the standard. When the filter configuration shown in Fig.1 is used, characteristics may be deteriorated at higher bands and asymmetric characteristics with respect to the center frequency may result. With this filter, however, such characteristic deterioration is not exhibited, and sufficient filtering quality is maintained.

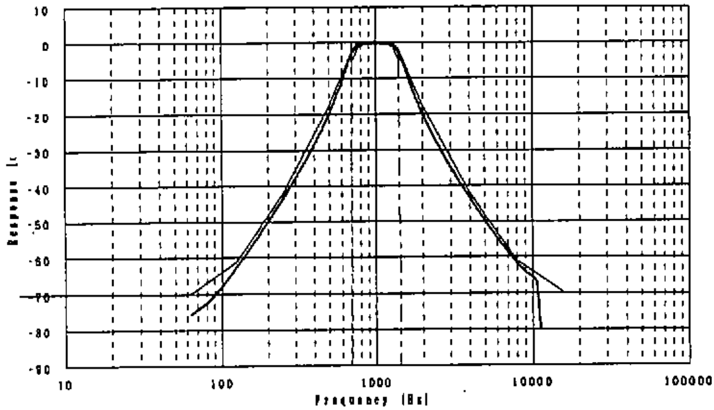

Fig.2 Frequency Characteristics of the 1/3 Octave Band Filter

4. SOUND LEVEL METERS WITH THE OCTAVE FILTER ANALYSIS FUNCTION

As for the octave band filter mentioned here is realized by means of the DSP software, it can easily be implemented in a sound meter with the DSP, simply by modifying the software. This section introduces an example implementation of the octave band filter into the LA-5110 digital sound meter from Ono Sokki. The LA-5110 performs almost all calculations necessary for sound level measure-ment by means of the DSP. Since it mounts the EEP-ROM with sufficient capacity to store the basic software. the octave filter analysis software can easily be implemented. Fig.3 shows an example display when the 1/3 octave filter analysis function is executed. As analysis is performed in realtime, the display is updated in succession. Filter analysis with frequency compensation characteristics, dynamic characteristics, time averaging, and any combination of them is also possible.

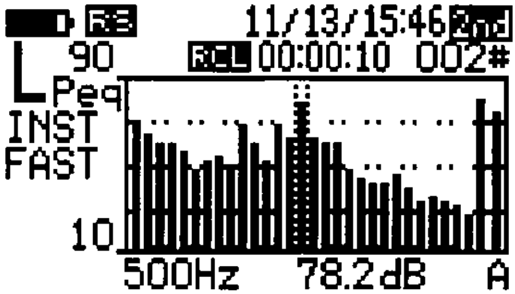

Fig.3 Display Example for the 1/3 Octave Filter Analysis (LA-5110)

The display section of the LA-5110 consists of a dot-matrix LCD (128 x 64 dots) with a 55 x 27 mm display area, allowing the octave band level to be displayed in the form of bar graphs. In addition, if display mode switching is performed, numerical display can be made. By combining the Tact Max mode with the 1/1 octave filter analysis, NC values proposed by Beranek, L.L as the indoor sound level evaluation value can also be calculated. In Japan, NC values are widely used for evaluation of sound levels in offices.

5. SUMMARY

Thanks to technical innovations of digital signal processing and electrical elements, compact-size and battery-operated sound analyzers have become available. As an example, this material has introduced filter analyzer built in fully digital sound level meters.

REFERENCE

[1] A.Takazawa, T.Amanuma, T.Kanamori, K.Yamaguchi, Inter-noise 95, 1055-1058 (1995).