Application Notes

1/n-octave Analysis using the Multichannel Analysis System Type 3550

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❍FEATURES:

❍ Fractional octave synthesis from 1/1 to 1/24

❍ Innovative analysis producing logarithmic frequency axis

❍ Standardized filter characteristics

❍ Two channels with four “detectors”

❍BENEFITS:

❍ Optimization of bandwidth when dealing with e.g. noise sources with varying speed, source location, quality control

❍ Broad frequency range from 1Hz to 16kHz octave band centre frequencies (15 octaves, $4^1/_2$ decades)

❍ Fulfils amplitude response in ISO 225

❍ Many parameters calculated for each set of measured data

Innovative synthesis

FFT analyzers are widely used for measuring noise signals. The representation of the data obtained is usually on a linear frequency axis with few lines at low frequencies and many at the high frequencies. To render the presentation of the data more acceptable for acoustical purpose, such as noise control reports, synthesis can be performed to obtain results in synthesized filter bands, usually in octaves or third octaves. The implementation of such a synthesis is straightforward but the useful frequency range is limited due to a dearth of lines in the desired band at low frequencies.

Eleven measurement modes are available with the Multichannel Analysis System Type 3550 including, naturally, a spectrum averaging mode. When the system is used as a two channel system a special 1/n-octave spectrum averaging mode is available.

In the spectrum averaging mode simple, conventional synthesis is available as post processing of the measured data. In the 1/n-octave spectrum averaging mode the analyzer the analyzer performs a sophisticated measurement which presents the results of 15 parallel FFT calculations over 15 octaves on a logarithmic axis either as “narrow” data or as “1/n-octave”. In the narrow mode, 44 lines are displayed within each octave on a linear axis. The absolute resolution in this mode is thus fine at low frequencies and becomes coarser at higher frequencies. Furthermore the resolution within each octave varies from approximately 3.3% to 1.7% as shown in Fig.1. When displayed as 1/n-octave, any fractional octave from 1/1 to 1/24 may be chosen. The 1/1- and 1/3-octave filters fulfil the amplitude response limitations set by ISO 225 from 1966. For the spectrum averaging mode the resolution for a frequency range of up to 22kHz is 32Hz. The resolution of both modes are compared in Fig.1. Thus 1/n-octave analysis gives a resolution at low frequencies, which would require many consecutive measurements (or “passes”) using conventional synthesis techniques. Another application is the selection of the optimum bandwidth for an analysis, to expose only the desired amount of detail, e.g. in noise control work, quality control.

Noise measurements on an electric power drill

Noise measurements were performed on an electric power drill as part of a noise control survey. As the analyzer contains effectively 4 detectors, for each measurement position with an intensity probe several quantities can be calculated, e.g. active intensity, reactive intensity, pressure and particle velocity. In this note, however, only sound intensity (active intensity) will be used to illustrate the possibilities of 1/n-octave analysis. Most of the noise lies in the frequency range from 1kHz to 8kHz as indicated in Fig.2. The sound intensity data are shown in the unipolar format, that is, both positive and negative intensity levels are shown in the same direction but the negative values are shaded. By changing the display parameters the data can be represented as shown in Fig.3. Here the 1/12-octave analysis was judged to be too coarse (notice how one region of negative intensity has been incorporated into the neighbouring columns) and the 1/24-octave too fine for the job in hand. By flipping through the other possibilities a compromise of 1/16-octave was select-

ed (Fig.2). A closer comparison of the narrow and the 1/16-octave representations is shown in Fig.4, this time in the bipolar format over the three ctaves from 1kHz to 4kHz. Positive and negative intensity each has its own direction, up and down from the centre line respectively. In the narrow format, 44 lines can be seen in each octave.

Summary

1/n-octave spectrum averaging is an innovative way of measuring and synthesizing FFT data to produce a presentation on a logarithmic axis over a wide frequency range while avoiding the disadvantages of the "usual" synthesis techniques. Applications include the optimization of data representations in many fields including condition monitoring, noise control and servo systems.

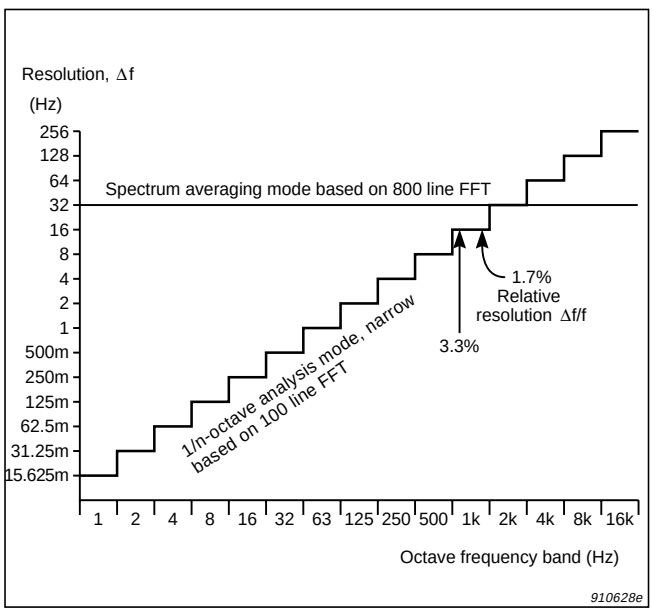

Fig.1 Resolution for spectrum averaging mode and 1/n-octave analysis mode

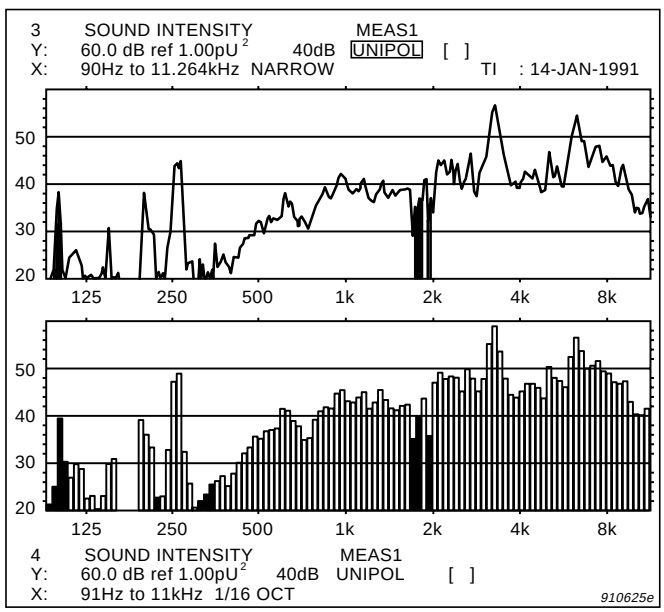

Fig.2 Resolution for spectrum averaging mode and 1/n-octave analysis mode

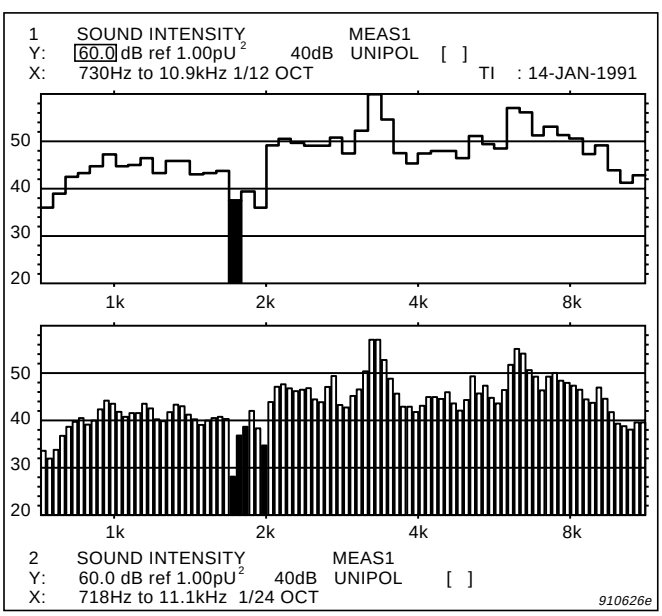

Fig.3 Upper graph, 1/12-octave judged to be too coarse. Lower graph, 1/24-octave judged to be too fine

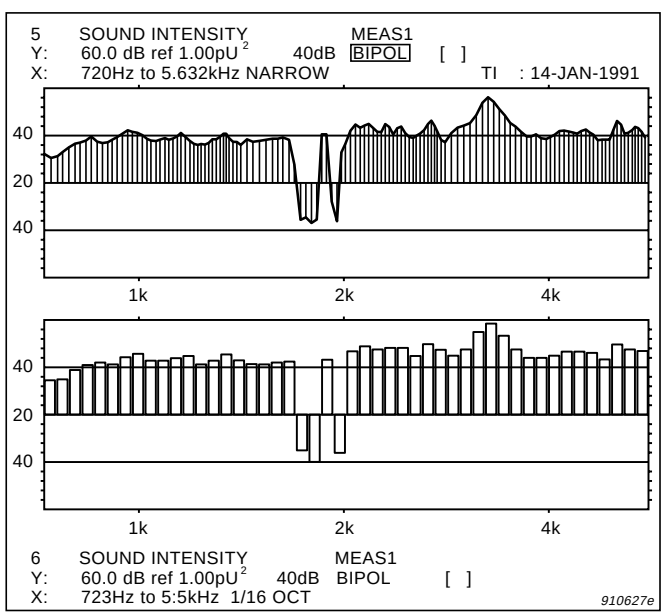

Fig.4 Comparison of the narrow and 1/16-octave representations over three octaves, in the bipolar format

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