Adaptive Algorithm for Interpretation of Low-frequency Noise DFT

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In the electronics low-frequency noise is often used for reliability estimation of semiconductor devices. Spectral power density of this noise proportional to $1/f^{\gamma}$, where γ is the spectral exponent. In [1] shown, that for spectral analysis of non-white noise exists optimum resolution bandwidth. Total mean square error of the estimate is minimal when analysis filter bandwidth is optimum. In [1] it is shown that DFT could be represented as result of processing by filters with different bandwidths by means of frequency averaging. In [2] formula optimum resolution bandwidth for low-frequency noise as a function of spectral exponent is given. But it is not considered its applicability to the DFT, as well as a method for finding spectral exponent before main measurement.

The simplest method of exponent measurement is measure power spectral density (PSD) of noise on two frequencies [2]. As known, there is bias error of PSD measurement. This systematic error is depending on γ and relative bandwidth of analyzing filter. Obviously this systematic error has impact on error of exponent measurement.

But influence of systematic errors is compensated when relative analysis bandwidths are equal. In this regard, we propose the following algorithm.

On the first stage of processing spectral exponent is calculating. PSD values needed to calculate the spectral exponent obtaining after frequency averaging. Frequency averaging is carrying out so that the relative bandwidth be quite wide, but constant.

On the second stage relative optimum bandwidth is calculating by known spectral exponent. Then frequency averaging the same DFT result is carrying by determined relative optimum bandwidth.

This algorithm is especially useful when using DFT, because we may change analysis bandwidth for the same measurement.

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1. A. Piersol, *Shock Vib.* **1**, 33 (1993).
2. V.A. Sergeev, O.A. Dulov, *Meas. Tech.* **51**, 1122 (2008).