DISTORTION EQUALIZER FOR FM DEMODULATORS

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TO

SANGEETA

Soni, Basant, Hemant, Shishir

and

My Parents

CERTIFICATE

This is to certify that the thesis entitled,'Distortion Equalizer for FM Demodulators' being submitted by U.C. Verma, to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of 'Doctor of Philosophy', is a record of bonafide research carried out by him under our supervision and guidance and in our opinion, it has reached the standard fulfilling the requirements of regulations to the degree.

The results contained in this thesis have not been submitted to any other institute for the award of any degree or diploma

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ABSTRACT

FM demodulators contain some inherent nonlinear subsystems which result in distortion of the output signal. This thesis is concerned with equalizer structures which when cascaded to FM demodulators would yield an undistorted signal.

Synthesis of such distortion equalizers has been based on the functional approach. In this, the distorted signal at the demodulator output is expressed as the sum of linear and nonlinear functionals of the input modulating signal. The linear functional, therefore, can be derived by substracting the nonlinear functional from the demodulator output. Under certain conditions it is possible to get an inversion of the linear functional. This effectively forms the basis for the design of equalizer structures.

Implementation of this scheme, as such, is not practicable due to the infinite number of terms involved in the expansion of the nonlinear functional. However, under certain constraints, it has been shown that terms beyond the fifth order are of negligible consequence; the equalizer structure thereby gets simplified and becomes practicable.

Two forms of the equalizer structures have been proposed for the PLL, namely, the open-loop and the closed-loop structures. The PLL is considered to have a loop filter,

of the lead-lag, proportional plus integral or simple lag type and the nonlinearities considered are either in the VCO or in the phase detector or both.

The synthesized structure has been simulated on a digital computer and the outputs of the PLL and PLL-equalizer combination are compared on the basis of total harmonic distortion (THD) as the figure of merit. The results show impressive reduction in the THD on account of the use of equalizers.

Hardware implementation of the equalizer structure has been carried out using the most common NE 565 PLL chip. Loop filter of lead-lag type has been used. The FM signal needed for experimentation is generated through the NE 566 VCO chip. The test modulating signals used are of the single tone or multitone types.

Statistical analysis has been carried out for the PLL and the synthesized equalizer structure, using a frequency domain method proposed by Bedrosian and Rice. Closed form expressions are thereby obtained for spectral density and ensemble average at the PLL as well as equalizer output. From these expressions the output SNR vs input SNR characteristics have been obtained for both the outputs.

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