SOME ASPECTS OF PHASE-LOCKED LOOP BEHAVIOUR IN THE PRESENCE OF NOISE

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SUMMARY

This thesis has been concerned with some aspects of the phase-locked loop (PLL) behaviour in the presence of noise, particularly when operating in a non-linear manner. Some of the more important results are listed below.

Using the techniques of digital simulation and observations on an experimental model, the author has examined in detail the cycle-slipping phenomenon due to noise in a second order and to a lesser extent a third order PLL. In particular the existence of bursts of multiple cycle-slipping due to the inertia of the second and third order PLLs has been demonstrated. These bursts tend to be distributed in a Poissonian manner.

If the loop parameters are such as to permit a stable limit cycle, then it has been shown that the presence of noise can cause the PLL's operation to jump back and forth between the stable inlock position and the limit cycle.

The cycle-slipping rate, as well as being dependent on the noise level, has also been shown to be a function of the tracking error of the input signal,

and furthermore is the main factor causing the threshold in the PLL. Results from the simulation have been used to determine the bandwidth of a second order PLL to optimize the threshold performance when demodulating sinusoidal FM.

A new approach to the narrowband PLL preceded by a band-pass limiter has been presented, where the hard-limited input signal plus noise is treated as a phase-modulated carrier rather than as a signal plus noise.

A phase-locked system where the signal phase information is only supplied at instants determined by a Poisson process has been analyzed and an equivalent low-pass model of the system derived.

An explanation for an asymmetrical property of the output from a maximal-length shift-register when used as a pseudo-random noise generator was found.

Summing up, the author believes that this thesis has increased our understanding of several aspects of the PLL operation in the presence of noise, especially in regard to non-linear behaviour such as cycle-slipping.