TV MODULATOR PHASE NOISE - MEANINGFUL PERFORMANCE CRITERIA, SPECIFICATION AND NEW MEASUREMENT METHODS

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Over recent years, frequency synthesized TV modulators have gradually replaced many single frequency crystal controlled TV modulators, thereby introducing higher levels of modulator phase noise in CATV systems. While these degradations in many applications are insignificant, they present serious observable signal quality degradation effects in some instances such as reduced Direct-Pick-Up (DPU) rejection in off-air phase-locking and other signal quality degradation effects in coherent head-end applications.

Current practice of specifying phase noise levels in dBc/Hz at some offset frequency (typically 20 Khz) provides only limited value in comparing modulators, much less in providing a meaningful criteria for predicting picture quality or whether Precision Demodulators with synchronous detection can lock on a given modulators' signal. This paper shows that a more relevant criterion of **Total Integrated Phase Noise** (TIP Noise) obtained by integrating the phase noise density over a frequency band centered about the picture carrier frequency should be used to compare performance of TV signal sources. TIP noise is measured in **degrees RMS** and thus provides a meaningful measure of the total phase fluctuations of the RF phase.

As an example of a specific picture quality degradation that can be predicted by the use of the TIP Noise measure, it is shown through analysis that a TIP Noise of more 5° - 10° RMS in an off-air phased-locked modulator produces noticeable degradations in DPU rejection. In fact, it is suggested that these visible degradations may be experienced by an increasing number of subscribers who receive signals from "upgraded" head-ends that now employ new synthesized modulators having TIP Noise between 20° to 150° RMS instead of the crystal controlled modulators with superior performance with less than 5°RMS TIP Noise.

A new measurements method using a Network Analyzer for TIP Noise is presented along with some typical measurement results for single frequency crystal controlled and several synthesized modulators used by the cable industry.

The effects of phase noise in a coherent head-end is also discussed and the TIP Noise criteria is used to explain several known phase-locking degradation effects that have been observed by those who compared picture quality performance between the phase-locked and the phase-unlocked modes. It is shown that the improvements expected in phase-locked coherent head-ends cannot be fully realized unless modulator TIP Noise is better than 5° RMS. Unfortunately, many of the new "phase-locked" modulators are better defined as "frequency locked" rather than "phase-locked" since the excessive TIP Noise reaching instantaneous values of more than 180 degrees frustrates the maintenance of a truly fixed phase relationship with their respective reference signals. Modifications that improve these deficiencies in modulators are presented.