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WH2 New pseudorandom sequence measurement technique for subcarrier multiplexed distribution networks

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The nonlinear characteristics of subcarrier network electronic, optoelectronic, and optical components set an upper limit to the available carrier to noise ratio (CNR). Conventionally, the harmonic and intermodulation distortion of system components such as semiconductor lasers has been assessed with multitone tests (e.g., Ref. 1). While these measurements give an accurate account of laser nonlinearity, they do not reflect the spectral characteristics of active communication channels. The statistical properties of the subcarrier channel signal ensemble must also be considered since peak signal clipping can introduce further CNR degradation.[2] These issues are common to frequency-division-multiplex radio systems where it has been found that Gaussian statistics only apply with more than sixty speech signals (e.g., Ref. 3). Consequently, a new test procedure for the emerging subcarrier optical network systems is required.

We describe, we believe, for the first time, a distortion measurement technique based on the broadband noiselike spectral properties of pseudorandom sequences. The procedure is an enhancement of the established CCIR noise-load test.[4] Figure 1 shows the test principle. Intermodulation, harmonic, and clipping distortions are measured at a given frequency by phase-locking a test signal generator to that frequency. The required spectral component is then removed with an appropriate antiphase signal. Nonlinear effects in the vacant slots as determined by the remaining out-of-slot sources are then measured with a spectrum analyzer.

As phase-lock is acquired from the transmitted P.R.B.S., the method is considered suitable for subcarrier network assessment in the field. Additionally, because there is no intrinsic requirement for a conducting transmission medium, lock acquisition and cancellation signal injection may be applied to installed fiber systems with appropriate optoelectronic interfaces. All-optical components such as laser and fiber amplifiers may, therefore, be distortion characterized in realistic channel loading conditions.

Figure 2 shows the test setup used to carry out a preliminary distortion measurement on a packaged tailed isolated 1.55-μm DFB laser (Toshiba TOLD383S). The 1.4-Gbit/s NRZ 2^7-1 P.R.B.S. consists of 127 discrete spectral components at 11.024-MHz spacing within a 1.4-GHz bandwidth. For a 0-dBm generator output level, the mean power of each component is approximately −21 dBm. The test signal is injected at point *A*, and measurements are carried out at *B*. Figure 3(a) is an illustrative spectrogram of a 1.4-Gbit/s 2^7-1 NRZ P.R.B. test sequence segment with a 727.53-MHz component removed. Figure 3(b) shows the measured signal to distortion ratio over a 1.4-GHz frequency range with total optical modulation indices ranging from 20 to 80%.

Summarizing: We have described a novel subcarrier network distortion measurement procedure and presented preliminary results from tests on a commercially available DFB laser. The technique is suitable for field use as the necessary phase-lock is acquired from a transmitted P.R.B.S. With appropriate electrooptic interfaces, the method is applicable to laser and fiber amplifier measurements.

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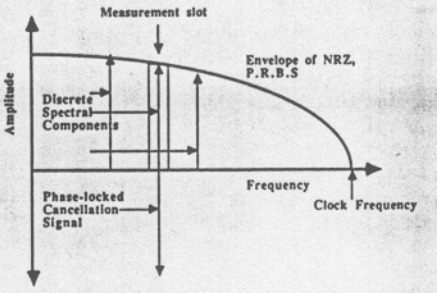
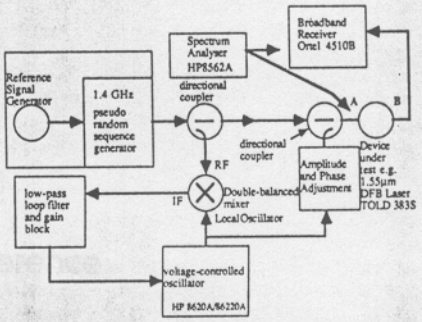
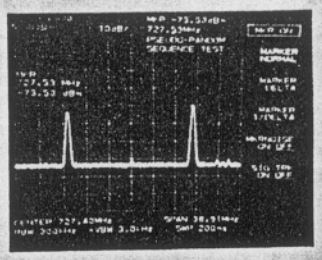
2. A. A. M. Saleh, "Fundamental Limit on Number of Channels in Subcarrier-Multiplexed Lightwave CATV System," Electron. Lett. 25, 776–777 (1989).
3. M. T. Hills and B. G. Evans, *Transmission Systems* (George Allen and Unwin, London, 1973), Vol. 1, pp. 92–93.
4. R. G. Medhurst, "Echo Distortion in Frequency Modulation," Electron. Radio Eng. 253–259 (July 1959).



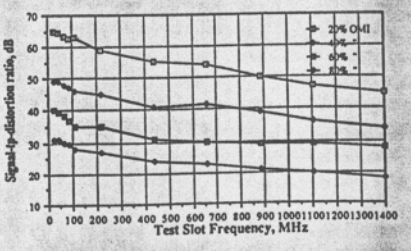
WH2 Fig. 1. Schematic diagram of pseudorandom sequence measurement principle.



WH2 Fig. 2. Pseudorandom sequence laser measurement experiment.



(a)



(b)

WH2 Fig. 3. (a) Illustrative spectrogram of 1.4-Gbit/s P.R.B.S. test signal segment with canceled 727.53-MHz component. (b) Signal-to-distortion ratio for TOLD 383S DFB laser.