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PREDISTORTION LINEARIZER WITH NOVEL TEMPERATURE COMPENSATION TECHNIQUE FOR SATELLITE TRANSPONDER

Abstract

This paper addresses the design, implementation and characterization of a diode-based predistortion type linearizer to improve nonlinear performance of a satellite transmitter using high power amplifiers such as traveling wave tube amplifiers (TWTAs) and solid-state power amplifiers (SSPAs). The paper also discusses different aspects of a predistortion type linearizer for satellite transponders such as flexibility to obtain various combinations of amplitude and phase nonlinearity, broadband frequency performance and temperature compensation over a wide range. It also discusses the use of equalizers and limiter to enhance the performance of the linearizer. Among the various types of linearizers, diode-based predistortion linearizers are most popular for satellite communication systems for its simplicity and low power consumption [1-8]. Pre-distortion linearizer creates inverse nonlinearity of the transmitting amplifier in order to compensate for the distortion. The proposed linearizer is a very compact, combining a non-liner arm and linear arm with 90o phase shift. Non-linear arm consists of two numbers of Schottky barrier diodes in a 3-dB 90o hybrid and linear arm consists of two numbers of p-i-n diode with another 3-dB 90o hybrid coupler. This linearizer is a very versatile in characteristics, only selecting the DC bias current of the diodes any combination of amplitude and phase characteristic can be achieved for different power amplifiers encountered in practice. Diode based active equalizers used at the input and output of the linearizer to make the linearizer more flexible for performance optimization and to achieve required broadband frequency performance. A Schottky diode based limiter circuit is cascaded with the linearizer to restrict the post-saturation reduction of output power that will improve the nonlinerity near saturation and to protect the TWTAs/SSPAs and active devices used in the post amplifier from RF overdrive condition. RF impedances of the Schottky and p-i-n diode are sensitive to the operating temperatures that determine the performance of the linearizer. Therefore, amplitude and phase characteristics of the diode-based linearizer are very sensitive to the operating temperature [9, 10]. Here different temperature compensation techniques are discussed and implementation of a novel temperature compensation technique is presented to achieve temperature compensated performance over -20 deg.C to +80 deg.C. The proposed linearizers are developed at L, S, C and Ku band frequency for India's navigation payload (IRNSS) and various communication payload transponders (INSAT/GSAT). Test results show that the linearizers are capable to compensate different combination of amplitude and phase distortion of the power amplifiers up to 12 dB and 60deg. respectively. The linearizers are also evaluated with respective TWTAs and test results are presented. REFERENCES [1] A. Katz, R. Sudarsanam, C. Aubert, "A reflective diode linearizer for spacecraft applications," in IEEE MTT-S Int. Microw. Symp. Dig., June 1985, pp. 661-664. [2] N. Imai, T. Nojima, and T. Murase, "Novel linearizer using balanced circulators and its application to multilevel digital radio systems," IEEE Trans. Microw. Theory Tech., vol. 37, no. 8, pp. 1237-1243, Aug. 1989. [3] K. Yamauchi, K Mori, M. Nakayama, Y. Mitsui, T. Takagi, "A microwave miniaturized linearizer using a parallel diode with a bias feed resistance," IEEE Trans. Microw. Theory Tech., vol. 45, no. 12, pp. 2431-2435, Dec. 1997. [4] K. Yamauchi, K. Mori, M. Nakayama, Y. Itoh, Y. Mitsui, and O. Ishida, "A novel series diode linearizer for mobile radio power amplifiers," in IEEE MTT-S Int. Microw. Symp. Dig., 1996, pp. 831-834. [5] C. Haskins, T. Winslow, S. Raman, "FET

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