VERIFYING AN OPTICAL RECIRCULATION LOOP APPLICATION IN ADVANCED PHOTONICS-BASED MICROWAVE DEVICES

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Using modeling in VPIphotonics Design Suite and experimental verification, a detailed analysis of optical recirculation loop application in two key photonics-based microwave devices, such as a comb generator and super-wideband time-delay assembly, is carried out.
Keywords: Photonics for microwave application, optical recirculation loop

1. Introduction

Photonics approach is taking on a new role in the next generation mobile communication, radar, and instrumentation systems of microwave (MW) band [1] providing outstanding technical and economic characteristics that were previously considered impossible. In particular, this approach is effectively applied to the generation, frequency conversion, transmission, and processing of MW signals. Among the means that implement the above operations, an important place is occupied by the optical recirculation loop (ORL) [2, 3], which advantageously uses 4 orders of magnitude lower losses in the optical fiber compared with the coaxial cable and their independence from the MW signal frequency.
Following it, in this paper we review by the computer-aided simulation and verify by the experiments the benefits of ORL application in two key photonics-based microwave devices, such as a comb generator (CG) and super-wideband time-delay assembly (TDA).

2. Layout Description

Fig. 1 shows the generalized layout of an ORL-based MW CG. In the Figure, green lines indicate the optical connection; black lines indicate the MW inputs and output. As seen, there are three sections in it that include electric-to-optical converter containing semiconductor laser module (SLM) and electro-optical modulator (EOM1); ORL containing X-coupler, EOM2, and optical amplifier (OA) needed for the ORL loss compensation; and photodetector module (PDM) as optical-to-electric converter. To generate a comb, a reference radio signal is applied to the EOM2 input. Note that the layout of Fig. 1 can be easily converted to a TDA by eliminating the EOM2 from the ORL circuit.

3. Simulation and Experimental Results

Fig. 2 exemplifies the VPIphotonics Design Suite's simulation result referred to a spectrum of multi-wavelength optical frequency comb at the ORL output. As seen, the spectrum includes as many as 21 optical carriers with the spacing of 0.3 GHz and the level non-uniformity of less than 5 dB. In addition, Fig. 3 exemplifies the experimental results of measuring the noise characteristics of the TDA under test for two types of SLM based on standard DFB laser from EMCORE (blue) and narrow-linewidth laser from TERAXION (red).

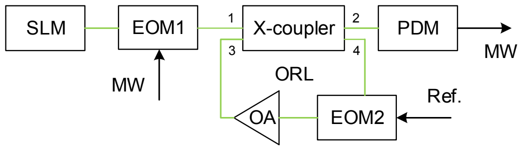

Fig. 1 The generalized layout for an ORL-based MW comb generator

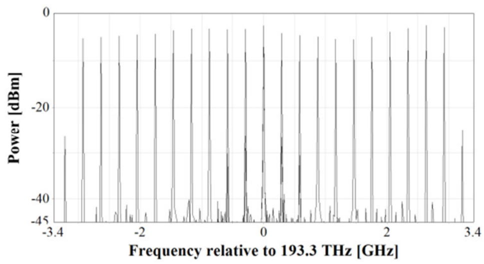

Fig. 2 Example of a spectrum of multi-wavelength optical frequency comb at the ORL output

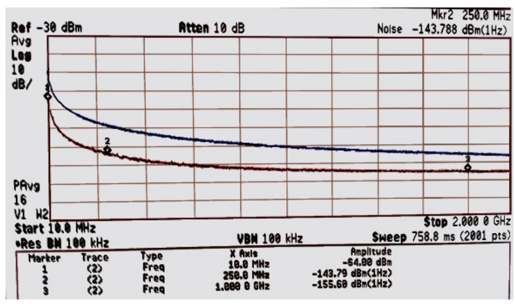

Fig. 3 Example of the noise characteristics of the TDA under test for two types of SLM

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