METHOD AND SYSTEM FOR DETECTING AND CHARACTERIZING RADIO FREQUENCY SIGNALS FOR MILITARY AND CIVIL APPLICATIONS

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EXCERPT: In FIG. 3 below, there is shown a system for Brillouin-based Radio Frequency (RF) signal detection and characterization. The system operates on the principles of stimulated Brillouin scattering (SBS) in an optical fiber, in particular, the combined Brillouin gain and loss in an optical fiber.

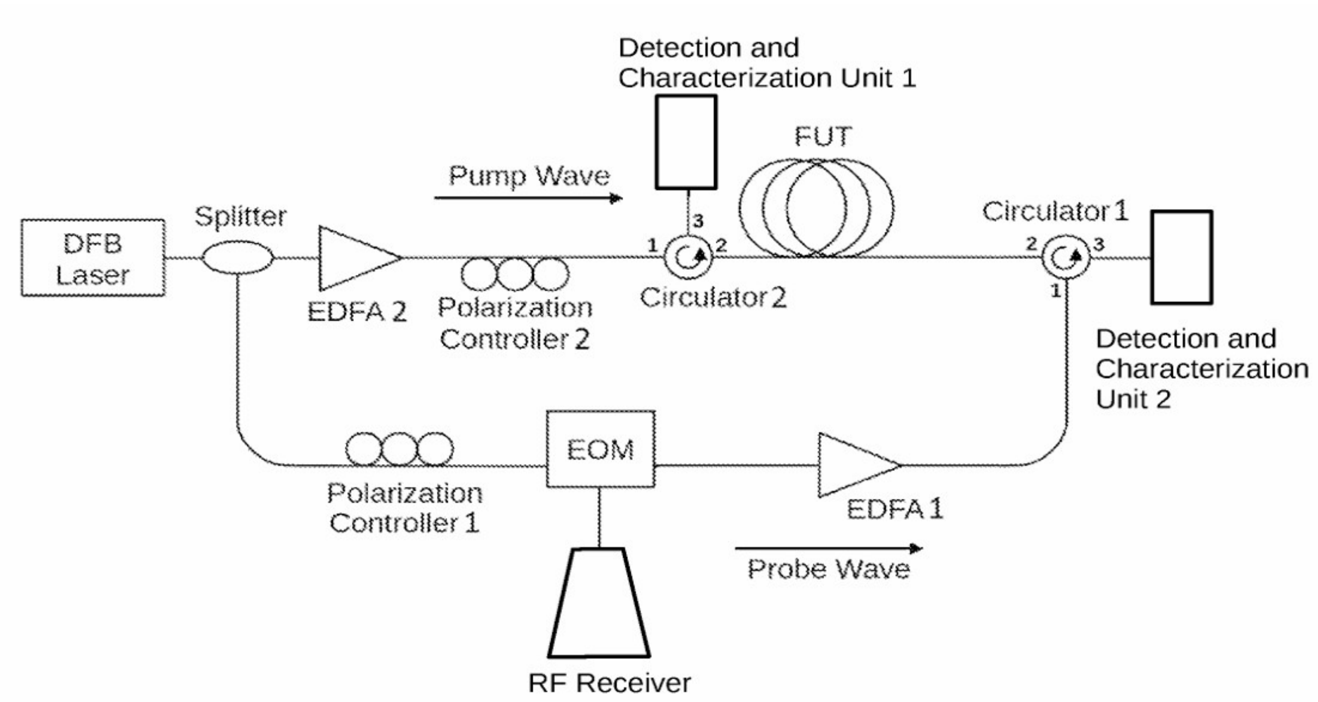

FIG. 3

Instead of employing an RF signal generator to drive an electro-optic modulator (EOM), there is an RF receiver which captures RF signals from the surroundings (in the environment) and directs them into the EOM for modulating an optical signal. The RF receiver may be a standard receiver as known in the industry, for example a waveguide which captures RF signals and guides them into a coaxial cable which is connected to an EOM. Other types of receivers include satellite dishes, RD antennas and any other devices which can capture and optionally amplify and/or guide RF signals. An RF receiver may be optional, if the EOM is directly exposed to the RF signal, and RF signal is strong enough to modulate the EOM.

The RF receiver captures an external RF signal, which may be amplified by an amplifier (not shown in FIG. 3), if required, before supplying the output RF signal to the EOM. The output RF signal is in the Brillouin frequency range, i.e. when the RF signal is supplied to the EOM, the EOM modulates the optical signal and creates two side-bands which are shifted in frequency from the optical signal. When the frequency difference between each side-band and the optical signal is the Brillouin frequency, the resulting signals become the pump wave, Stokes wave (SW) and the anti-Stokes wave (ASW), which are subsequently injected into the fiber under test (FUT) and counter-propagated with the pump wave injected into the other side of the FUT, thereby activating a combined Brillouin gain and loss regime.

The FUT experiences Brillouin gain and loss by the capture of an RF signal being fed into the EOM, which is in the Brillouin frequency range. In the absence of external RF signal being captured and fed into the EOM, the EOM does not create the sidebands of the SW and ASW (probe wave), and therefore Brillouin gain and loss does not occur. In other words, combined Brillouin gain and loss is only activated by the captured RF signals which are in the Brillouin frequency range.

The advantage of the system is that Brillouin gain and loss is activated by the presence of an RF signal, or external RF signal modulation. In the absence of the RF signal, the system remains passive, and is activated only in the presence of RF signal in the Brillouin range.

Information about the waveform of the RF signal, once "translated" into light via Brillouin scattering, is detected by the Detection and Characterization Unit, including an Optical Spectrum Analyzer (OSA), or by an optical power meter. The measured optical signal contains information about the RF signal, such as the frequency, waveform pattern, repetition pattern and duration of the RF signal are reproduced in the corresponding characteristics of the pump wave, Stokes wave or anti-Stokes wave.

NATO has designated various RF bands (frequency ranges) in the context of electronic warfare (EW). The I-band is designated for RF signals of about 8-10 GHz, and the J-band is designated for RF signals of about 10-20 GHz. Together, the I- and J- bands combine to create the X-band, which has an RF range of about 8-20 GHz. The X-band is popular for military applications for airborne radars for performing functions of interceptor, fighter and for attacking enemy fighters and ground targets, as well as missile guidance systems. Also, the X-band is used for maritime civil and military radar navigation, as well as in space environments, for spaceborne imaging radars for military electronic intelligence and civil geographic mapping. The civil applications for RF signal detection include RF navigation and communication, electronic intelligence, and geographic mapping.[11]

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1 D. Micheli et al., "Synthesis of Radar Absorbing Materials for Stealth Aircraft by using Nanomaterials and Evolutionary Computation," 29th Congress of the International Council of the Aeronautical Sciences (Sept. 2014), ResearchGate.