Optical pulse generation using a low-voltage electro-optic phase modulator and a super-structured fiber Bragg grating

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Abstract: In this work we present a novel scheme for an all-fibre optical microwave signal filtering and ultra-wide-bandwidth pulse generation. The proposed system consists of a laser source, a low-voltage electro-optic phase modulator (EO-PM) and a super-structured fiber Bragg grating (SFBG) used in transmission and subsequent propagation through a standard fiber. As an example, we propose optical phase to intensity modulation conversion and reshaping, which generates gaussian doublet-like pulses starting from an input gaussian electrical signal to the EO-PM. Further applications in the microwave photonics and pulsed optical sources will also be suggested.

Keywords: Low-voltage electro-optic modulators, fiber Bragg gratings, optical signal processing, microwave photonics

1. Introduction

Recently, the interest in all-optical processing of microwave and millimeter-wave signals is growing because of the advantages with respect to electronic processing. Indeed, the larger time-bandwidth products, insensitivity to electromagnetic interference, low loss, light weight and high data-transfer capacity are promising features in microwave photonics links [1]. In particular, ultra-wide-bandwidth (UWB) pulse technology is currently considered in order to fully exploit the advantages provided by optics. This technology allows wide bandwidth operation especially for antenna remoting applications. To this end, some configurations to generate UWB pulses have been proposed, based on uniform fiber Bragg gratings used in reflection and a dispersive medium [2,3].
In this work we propose the use of an ad-hoc designed SFBG used in *transmission* to generate gaussian doublet-like pulses with the additional use of a standard fiber. In a similar way, SFBG can be designed also to generate short optical pulses, e.g. for seeding of amplifiers.

2. System design and applications

The setup scheme of the UWB signal generator is presented in figure 1 together with the SFBG response. The light of a laser diode (LD) operating at fixed wavelength is modulated by an EO-PM which has a low switching voltage (V_π<3V @ 10GHz) and the driving signal is a Gaussian pulse with a FWHM of 170 ps (see fig. 2(a)). The optical processing of the signal is first obtained by a uniform (non chirped) SFBG of length L=6 cm, which was designed via an inverse scattering technique [4] and the optical isolator (OI) is used to avoid power back reflection from the grating.

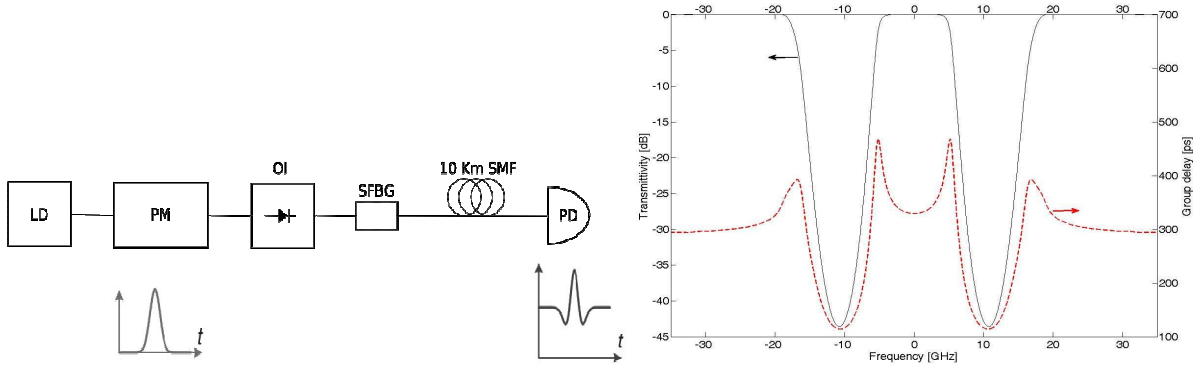
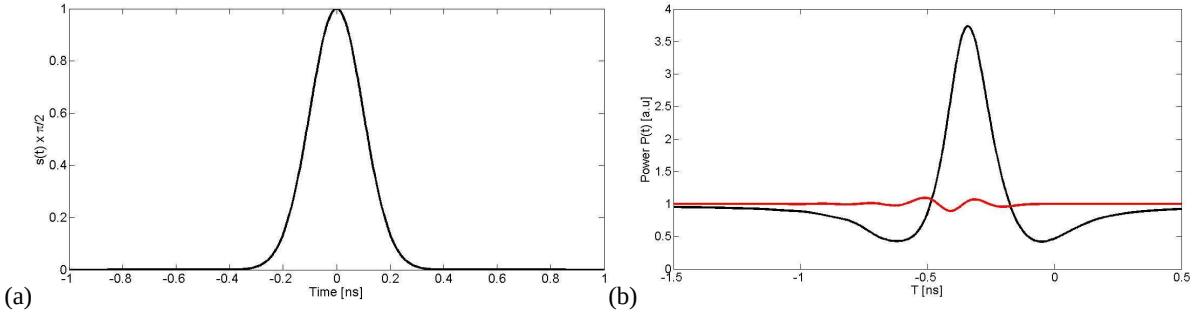


Figure 1. Scheme of the proposed UWB pulse generation setup(left) and SFBG spectral response (right).

The SFBG realize the optical phase to intensity modulation conversion so that after propagating in a 10 km SMF fiber with a typical dispersion of 16 ps/nm/km and neglecting the nonlinear effects, we obtain the Gaussian doublet-like pulse. In figure 2(b) we show the amplitude of the signal at the output of the grating and the final doublet pulse after 10 km propagation which shows a peak power >3 times the average power and has a central peak FWHM of 158 ps. The DC component of the signal can be filtered out by a phase-shifted FBG or by coherent detection methods. Thus, the gaussian doublet pulse obtained is suited for UWB pulse propagation, in particular for applications of antenna remoting.



(a) (b)

Figure 2. Power profile of the (a) Gaussian signal *s(t)* modulating the phase in the EO-PM (power of light is P_0=1 a. u.), (b) at the output of the grating (red) and after 10 km of propagation into standard SMF fiber (black).

The advantage of this approach with respect to previous ones is the use of the transmission SFBG to avoid the optical circulator needed in the reflection configuration which allows to reducing the overall optical loss and the form factor. Beside, the low-voltage phase modulator lowers the typical power consumption and thus the cost of the microwave photonics link. Moreover, a reduction of the length with respect to the standard fiber can be obtained by the use of high dispersive or photonic crystal fibers as a substitute for the standard SMF. Experimental measurements of the proposed scheme are being carried out.

Apart from the UWB pulse generation, the design methodology proposed can also be exploited to obtain different target pulses which can be slightly tunable in width by only adjusting the original Gaussian pulse. In this way, the suggested configuration can be used as adjustable seeding for optical pulsed sources.

3. Conclusion

We proposed a novel scheme for optical pulse generation based on a low-voltage EO-PM, a SFBG used in transmission and 10 km standard SMF. This approach can be employed in UWB microwave pulses especially in the field of antenna remoting and for adjustable seeding of optical pulsed sources.

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