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GENERATION AND ANALYSIS OF FILTERLESS QUADRUPLE ROF UPCONVERSION SYSTEM BASED ON CASCADED MZM CONFIGURATION

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ABSTRACT
In this paper, Cascaded MZM configuration(CMC) based quadruple RoF upconversion system has been analyzed. Both MZMs operate at Minimum Transmission Bias point (MITB) for upconversion of 10 GHz RF local oscillator (LO) signal into 40 GHz electrical signal. The performance of system has been evaluated in terms of optical sideband suppression ratio (OSSR) and RF spurious sideband suppression ratio (RFSSR). The effect of MZM extinction ratio and LO signal frequency on OSSR and RFSSR is evaluated. LO signal is varied from 1 GHz to 10 GHz to investigate tunability of quadruple Mm-wave signal. No optical filter is needed to obtain high frequency signal with spectral purity.

KEYWORDS: *Radio-over-Fiber, Upconversion, Mach-Zehnder modulator, Cascaded MZM configuration, Quadruple, Sideband suppression ratio.*

1. INTRODUCTION

Millimeter waves (Mm) are considered as backbone of broadband and high speed communication. RoF based upconversion systems are more effective and efficient as compared to electronic generation of millimeter waves. MZM based external modulation is quite effective and popular technique for upconversion. Various MZM configurations have been used to achieve frequency multiplication factor of 4, 6, 8, 10, 12, 16, 18, and 24 [1-14]. Quadruple signal can be generated using single MZM [1], Dual parallel MZM configuration [13, 14] and cascaded MZM configuration [2,3,4]. In this work, CMC based quadruple upconversion technique has been investigated. This paper is organised in various sections. Basic principle of frequency quadruple scheme is described in section 2. Section 3 contains the details of simulation variables. Results and conclusion are shown and discussed in section 4 and 5 respectively.

2. PRINCIPLE

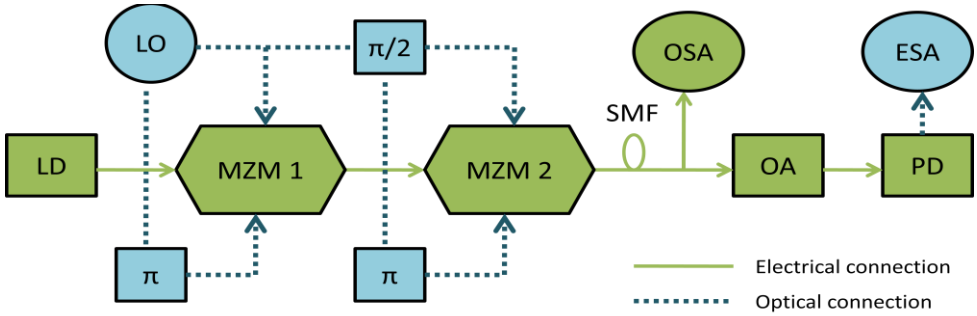

Fig. 1. Block diagram of Cascaded MZM configuration based quadruple RoF upconversion scheme

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CMC based frequency quadrupling scheme is depicted in Fig. 1. Input to MZM 1 is provided by continuous wave (CW) laser diode (LD). Optical Output of MZM1 is applied as input signal to second MZM. Each MZM is operated at MITB. It ensures the suppression of career and even order sidebands. lower arm of MZM 1 is given 10 GHz LO signal with 180 degree shift. Upper arm and lower arm of second MZM are provided phase shift of 90 and 270 degree respectively. MZM1 output is dominated by first and third order terms while even order terms and career have comparatively less magnitude. Additional phase shift of 90 degree ensures higher and lower second order terms dominate. This cascaded scheme along with optimized modulation index, generate 40 GHz electrical signal at output of photodiode.

3. SIMULATION SETUP

Optisystem v.18 software is used for simulation of quadruple upconversion setup. Zero dBm optical power Output signal of CW laser is at 1552.52 nm central frequency (193.1 THz) with 10 MHz spectral width. LO produces a 10 GHz RF sinusoidal output signal and it is applied to both MZM. The modulation index, RF voltage and switching bias voltage of each MZM are kept at 2.128, 2.71 volt and 4 volt respectively. Both MZMs are set at 30 dB extinction ratio and 2 dB insertion loss. The output of MZM 2 is transmitted using 35 km length Single Mode Fiber. optical signal received at other end of fiber is amplified by 21 dB gain and 4 dB noise figure Optical amplifier. 40 GHz electrical signal is recovered by pin photodiode. Dark current and responsivity of photodiode are set at 10 nA and 1 A/W respectively.

4. RESULTS AND DISCUSSION

MZM1 output Optical signal shows dominance of odd sidebands whereas even order terms and career are suppressed. Optical spectrum of MZM 2 output signal confirms that upper and lower 2nd order sidebands have significant higher power in comparison to undesired frequency terms. The observed value of performance parameter OSSR is 32 dB. Beating of 2nd order sidebands at photodiode results into quadruple 40 GHz electrical signal. Electrical spectrum of photodiode output is presented in Figure 4. It shows that 40 GHz frequency signal has 27 dB RFSSR and -20 dBm power.

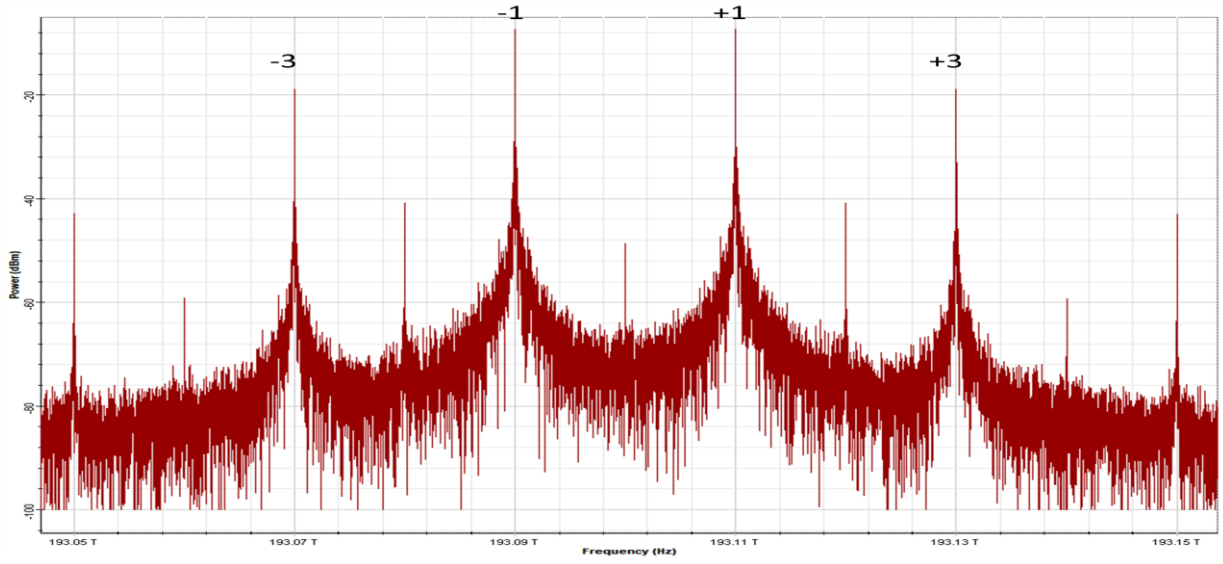

Fig. 2. The optical spectrum of MZM1 output signal

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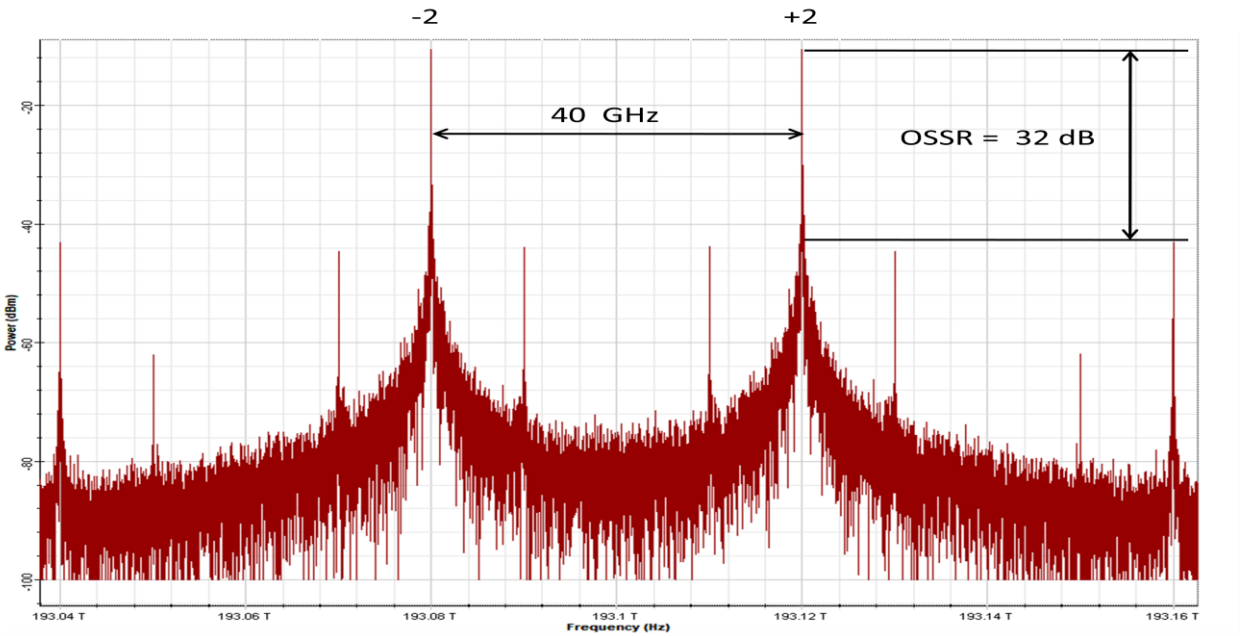

Fig. 3. The optical spectrum of MZM2 output signal

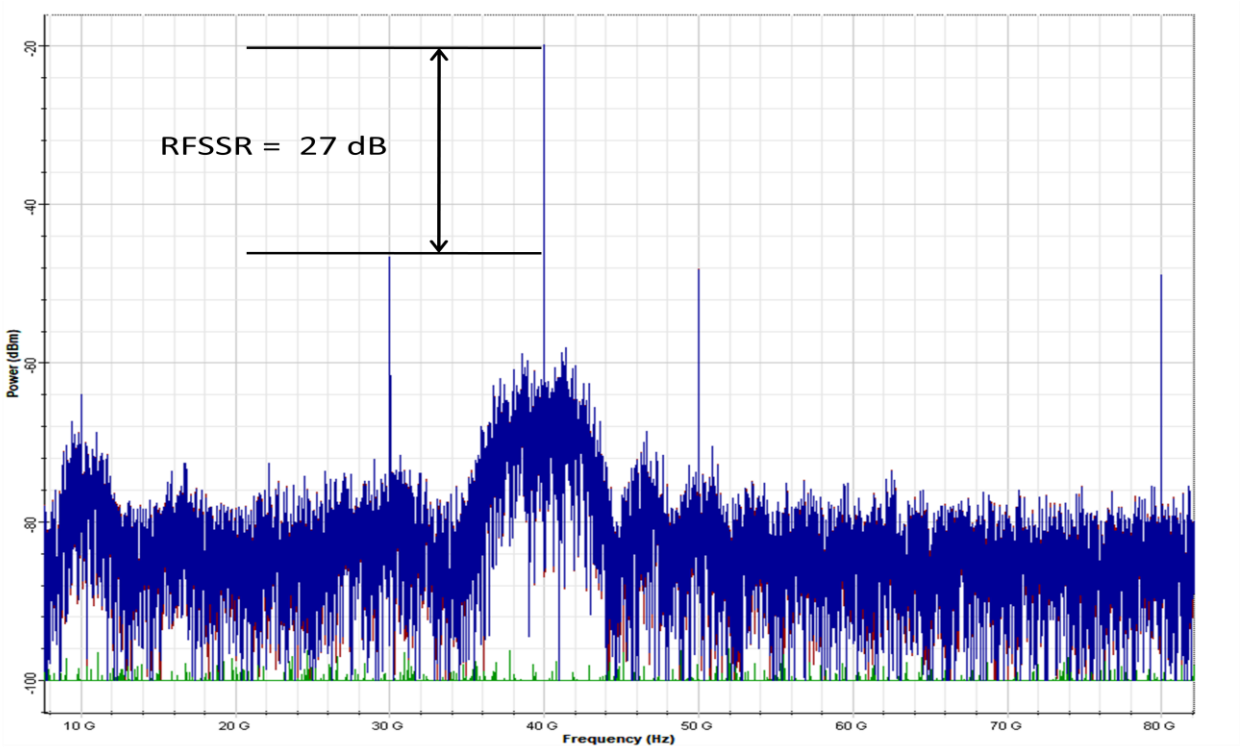

Fig. 4. The Electrical spectrum of photodetector output signal

Figure 5 reveals that OSSR sees no changes with variation in MZM extinction ratio. RFSSR exhibits increase from 27 dB to 29 dB and thereafter it remains same.

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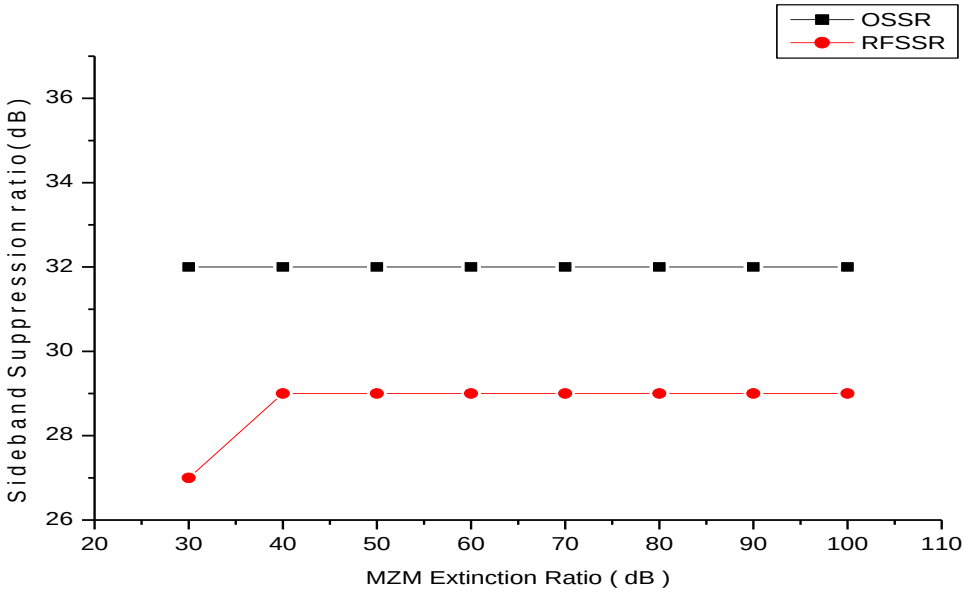

Fig. 5. Variation of OSSR and RFSSR with MZM Extinction Ratio

Figure 6 reveals that LO frequency variation doesn't cause any change in OSSR whereas RFSSR value varies in range of 22 dB to 33 dB. Frequency tunability of quadrupler has been investigated. RF output power remains same i.e -20 dBm as LO frequency is varied.

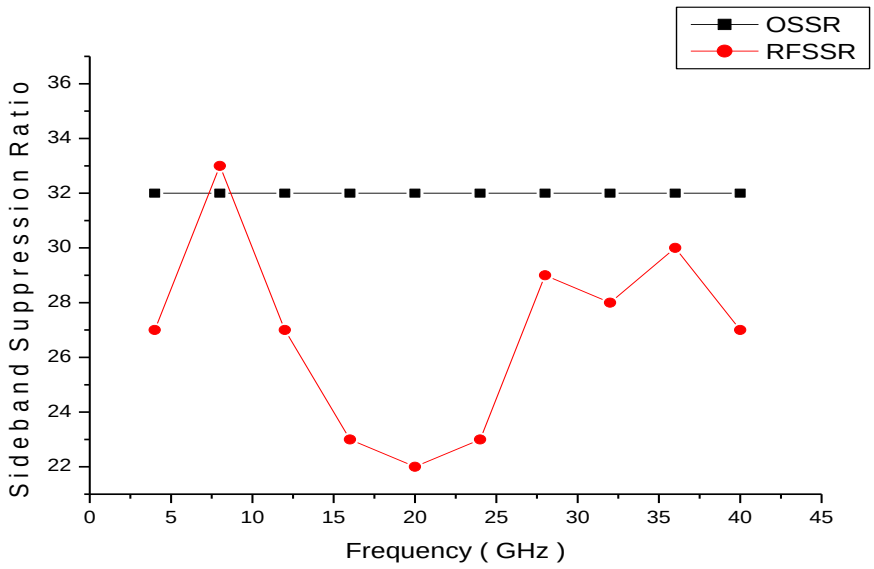

Fig. 6. Variation of OSSR and RFSSR with LO frequency

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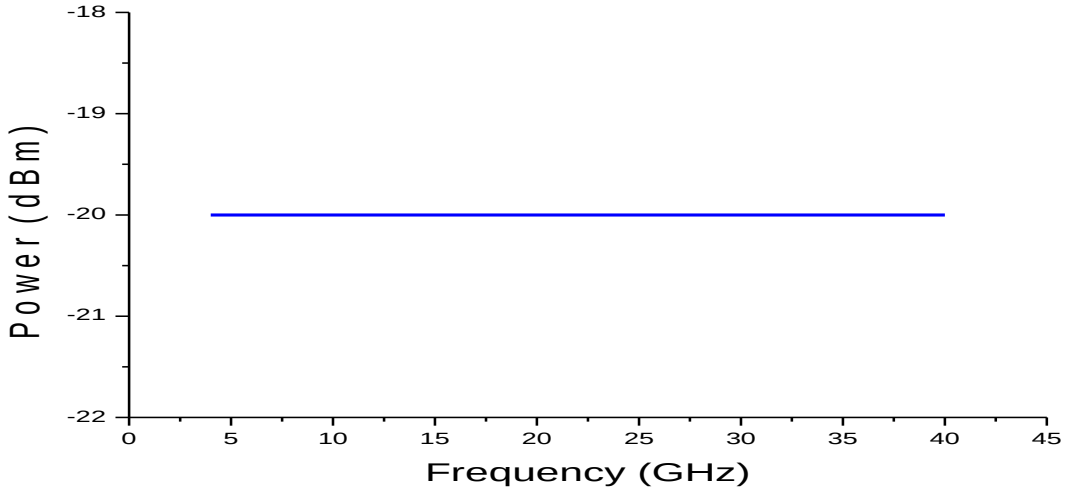

Fig. 7. Frequency response of Quadrupler

5. CONCLUSION

CMC based Filterless photonic generation of mm-waves, is analysed in this paper. 10 GHz LO signal is upconverted into 40 GHz electrical signal using optimum MZM parameters and electrical phase shift of applied LO signal. The values of performance parameters OSSR and RFSSR are obtained as 32 dB and 27 dB respectively. It is observed that OSSR sees no changes with the variation of MZM extinction ratio and LO signal frequency. Frequency response of Quadrupler reveals that tunable signal 4 GHz to 40 GHz is achieved as LO signal is varied from 1 to 10 GHz.

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APPENDIX: ABBREVIATIONS

CMC	Cascaded MZM Configuration
CW	Continuous wave
ESA	Electrical spectrum analyzer
LD	Laser Diode
LO	Local Oscillator
MITB	Minimum Transmission Bias point
Mm	Millimeter
MZM	Mach-Zehnder Modulator
OA	Optical amplifier
OSSR	optical sideband suppression ratio
OSA	Optical spectrum analyzer
PD	Photodetector
RFSSR	Radio frequency spurious sideband suppression ratio
RoF	Radio over fiber
SMF	Single mode fiber

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