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Performance of MM-Waves Signals Transportation Technique for Radio over Fiber over System on Fiber Dispersive Links

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ABSTRACT
This time domain analytical analysis of Radio over Fiber (RoF) system is derived regarding the performance evaluation of external modulation schemes such as optical single side band (OSSB), optical double side band (ODSB) and optical vestigial side band (OVSB) based on mach-zehender modulator (MZM) and phase modulator (PM). It is found that performance related signal to noise ratio is deeply related to the bandwidth of receiver filter and the influence of phase noise is more dominated from a radio frequency signal oscillator rather than the form a laser source in a small differential delay environment. Further, commercial available, economic laser with OVSB scheme help the telecom industry to reduce the designing cost of RoF system.

Keywords
Optical single side band (OSSB), Optical double side band (ODSB), optical vestigial side band (OVSB), MZM configuration, radio over fiber.

1. INTRODUCTION
The level of data traffic ever increasing due to demands of subscriber for voice, data and multimedia service that involve the access network to support the high data rates at any time and any where economically. For satisfied the demands, wideband communication system are necessary in both wired system and wireless system [1]. RoF system is a capable for the next generation wireless network as it has capability to achieve multi-gigabit per second data rate to support bandwidth incentives applications. Optical signal sideband modulation has become an attractive technology for achieving long distance RoF system based on transmission highly precise optical sensing. Highly optical resolution optical vector network analysis, Optical wave length conversion, and optical coherence tomography. The OSSB scheme is not affected by the errors induced by the fiber chromatic dispersion, which is serves in the conventional optical double sideband modulated RoF transmission system. Optical single sideband modulation scheme can be implemented various schemes. Majority two schemes such as preferred optical filter and 90° phase shift procedure [2]. There are two technique generate the optically modulated RF signal: direct and external modulation scheme. Direct modulation scheme suffer from the laser frequency chirp effect and results severe degradation of the system performance. However it can eliminate by using the external modulation scheme. The external modulation scheme is employed the conventional optical double sideband scheme can degrade the received RF signal power due to fiber chromatic dispersion significantly. The overcome the power degradation, an OSSB scheme generated by using a phase shifter and a mach- zehender modulator is employed [3]. OVSB scheme using concatenated MZM and PM configuration. In this scheme by tuning appropriately parameter of the modulator, an equal sideband intensity based scheme generated. It can generate the different sideband modulation schemes. In this paper, investigate the SNR penalty due to the phase noise from a laser and an RF oscillator using the external modulation schemes. For the SNR penalty, the autocorrelation function and PSD function of a received photocurrent are evaluated. The bandwidth of an electrical filter is dealt in the SNR penalty. Since phase noise result increase of required bandwidth and the increased the bandwidth causes an additional SNR penalty. It shows that the phase noise from the RF oscillator, rather than from laser, is relatively the dominant parameter in the short optical distance [1].

RoF system in which data are mixed with RF oscillator and optically modulated by MZM and PM. this signal is then reach to the photo detector (PD) through a single mode fiber. The input signals x_0 (t) and $x_1(t)$ can be expressed as:

$$x_0\,(\mathrm{t}) = \mathrm{A}\ \exp\mathrm{j}\big(\omega_0\mathrm{t} + \emptyset_0(\mathrm{t})\big) \tag{1.1}$$

$$x_1\,(\mathrm{t}) = \mathrm{V}_1\ \cos(\omega_1\mathrm{t} + \emptyset_1(\mathrm{t})) \tag{1.2}$$

Where, x_0 (t) is the optical signal from a laser, x_1 (t) is the RF input signal. A , V_1 are the amplitude from the laser diode (LD) and RF oscillator, respectively $\omega_0\mathrm{t}$ & $\omega_1\mathrm{t}$ angular frequency. $\emptyset_0(\mathrm{t})$ & $\emptyset_1(\mathrm{t})$ phase noise ratio.

After optically modulated x_1 (t) by x_1 (t) with a MZM, the output signal of the MZM is:

$$\begin{aligned} E_{OSSB}(0,t) = \frac{A.L_0}{\sqrt{2}}\,\{&expj[\omega_0\mathrm{t} + \gamma\pi + \emptyset_0(\mathrm{t}) \\ &+ \alpha\pi\cos(\omega_1\mathrm{t} + \emptyset_1(\mathrm{t})] \\ &+ expj[\omega_0\mathrm{t} + \emptyset_0(\mathrm{t}) \\ &+ \alpha\pi\cos(\omega_1\mathrm{t} + \emptyset_1(\mathrm{t}) + \theta]\} \end{aligned} \tag{1.3}$$

$E_{ODSB}(0,t) = \frac{A.L_0}{\sqrt{2}}\,\{expj[\omega_0\mathrm{t} + \pi + \emptyset_0(\mathrm{t}) + \alpha\pi\cos(\omega_1\mathrm{t} +$ $\emptyset 1(\mathrm{t}) + expj\omega 0\mathrm{t} + \emptyset 0\mathrm{t} +$ $\alpha\pi\cos(\omega 1\mathrm{t} + \emptyset 1(\mathrm{t}) + \pi$
(1.4)

Where,x_1(t) denotes the phase shift version of x_1(t). γ = (V_{dc}/V_π) and $\propto = V_1/\sqrt{2}V_\pi$, normalizing dc and ac value, V_π is

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the switching voltage of the MZM. L_0 is the insertion loss. And the θ is the phase shift by the phase shifter. For generating the OSSB scheme θ and γ are set to $\pi/2$ and 1/2, and the ODSB scheme θ and γ are set to π and 1. The OSSB, ODSB and OVSB scheme at the MZM can be modeled as follow:

$E_{ODSB}(0,t) = \frac{A.L_0}{\sqrt{2}}\left[\left\{\sum_{m=-\infty}^{\infty}(j^m) j_m(\alpha\pi) expj(\omega_0 t +\right.\right.$ ∅0t)+π2m((ω1t+∅1t)– m=−∞∞(jm)jmαπexpjω0t+∅0t+mπ+mγ

$E_{OSSB}(0,t) = AL_0\left\{J_0(\alpha\pi)expj\left(\omega_0 t + \emptyset_0(t-\tau_0) - \emptyset_1 +\right.\right.$ π4−2J1απexpjω0t+ω1t+∅0t+∅1t

$E_{ODSB}(0,t) = \frac{AL_0}{\sqrt{2}}\left\{J_0(\alpha\pi)expj\left(\omega_0 t + \emptyset_0(t-\tau_0) - \emptyset_1 +\right.\right.$ π2+J1απexpjω0t+ω1t+∅0t−τ++∅1t−τ+−∅2

$$E_{OSSB}(L,t) = A\cdot L_0 L_1 \cdot 10^{\frac{-\alpha_0 L_2}{20}}\cdot J_0(\alpha\pi) \times\left\{\exp j\left(\omega_0 t + \emptyset_0(t-\tau 0) - \emptyset_1 + \frac{\pi}{4}\right) - \frac{\sqrt{2}\,J_1(\alpha\pi)}{J_0(\propto\pi)}\exp j(\omega_0 t + \omega_1 t + \emptyset_0(t-\tau_+) + \emptyset_1(t-\tau_+) - \emptyset_2)\right\} \quad (1.5)$$

$E_{OVSB}(L,t) = \left[A\cdot L_0 L_1\cdot 10^{\frac{-\alpha_0 L_2}{20}}\right]\left\{PJ_0(\emptyset)e^{j\omega_2 t} +\right.$ 2.PJ1∅ejω2+ω3t (1.6)

$E_{ODSB}(L,t) = A\cdot L_0 L_1\cdot 10^{\frac{-\alpha_0 L_2}{20}}\cdot\frac{J_0(\alpha\pi)}{\sqrt{2}}\times\left\{\exp j\left(\omega_0 t +\right.\right.$ ∅0t−τ0−∅1+π2−2 J1απJ0∝πexpjω0t+ω1t+∅0t−τ++∅1t−τ+−∅2 (1.7)

Where, L_1 denotes an additional loss in the optical links, α_0 is the single mode fiber (SMF) loss, L_2 is the transmission distance of the SMF, and τ_0 and τ_+ define group delays for a center angular frequency of ω_{LD} and an upper sideband frequency of $\omega_0+\omega_1$.$\emptyset_1$ and $\emptyset_2$ are phase – shift parameter for specific frequencies due to the fiber chromatic dispersion. Where equation 2 shows the expression of the MZM produce infinite number of sidebands at frequencies ($\omega_2 \pm \omega_3$), ($\omega_2 \pm 2\omega_3$) and so on. So taking a first order side band. Where ω_2 and ω_3 are the frequencies of optical carrier and electrical signal respectively. A and A_c is the amplitude and amplitude of the optical carrier respectively. Assuming q $=A_c\cos(c)\,J_0(m)$, m=$\frac{\pi|M(t)|}{V_\pi}$ *and* $c=\frac{\pi V_b}{V_\pi}$, V_π is the half wave voltage of modulator and V_b is the applied dc bias voltage to the modulator, M(t)= $V_{in}\cos(\omega_3 t)$ is the modulated electrical signal. $\emptyset$ is the PM index in radian

By using a square –law model, the photocurrent (PD),$i_{pd}(t)$ calculated equation (1.5), (1.6), (1.7)

$$i_{pd}(t) \cong R|E(L,t)|^2$$

Where R denotes the responstivity of the PD and $|.|^2$ is the square law detection.

$i_{pdOSSB}(t)$=R.A_1^2[B+2$\alpha_1$cos (ω_1+$\emptyset_0(t-\tau_+)$−$\emptyset_0(t-$ τ0+∅1t−τ+−∅2+∅1 (1.8)

Where, for OSSB scheme

$$A_1 = A.L_0 L_1\cdot 10^{\frac{-\alpha_0 L_2}{20}}\cdot J_0(\alpha\pi)$$

$$\propto_1 = \frac{\sqrt{2}\,J_1(\alpha\pi)}{J_0(\propto\pi)}$$

$$B = 1+\alpha_1^2$$

$i_{pdOVSB}(t)$ =R.A_2^2[B_1+2$\alpha_2$cos (ω_3+$\emptyset_0(t-\tau_+)$−$\emptyset_0(t-$ τ0+∅1t−τ+−∅2+∅1)] (1.9)

Where, OVSB scheme

$$A_2 = A.L_0 L_1\cdot 10^{\frac{-\alpha_0 L_2}{20}}\cdot J_0(\alpha\pi).P.J_0(\emptyset)$$

$$\propto_2 = \frac{2\,J_1(\alpha\pi)}{J_0(\propto\pi)}$$

$$B_1 = 1+\alpha_2^2$$

i_{pdODSB} (t)=R.A_3^2[B_2+2$\alpha_3$cos (ω_1+$\emptyset_0(t-\tau_+)$−$\emptyset_0(t-$ τ0+∅1t−τ+−∅2+∅1)] (1.10)

Where, for the ODSB scheme,

$$A_3 = A.L_0 L_1\cdot 10^{\frac{-\alpha_0 L_2}{20}}\cdot\frac{J_0(\alpha\pi)}{\sqrt{2}}$$

$$\propto_3 = \frac{J_1(\alpha\pi)}{J_0(\propto\pi)}$$

$$B_2 = 1+\alpha_3^2$$

The autocorrelation function $R_I(\tau)$ is obtained as:

$R_I(\tau)$= <$i_p(t)\cdot i_p$((t+τ)>

$$\frac{R_{OSSB}(\tau)}{R^2A_1^4} = B^2 + \begin{cases} 2\alpha_1^2\cos(\omega_1\tau)\,e^{-2\gamma_t|\tau|}, & |\tau|\le\tau_1 \\ 2\alpha_1^2\cos(\omega_1\tau)\times e^{-2\gamma_0\tau_1-\gamma_{1|\tau|}}, & |\tau|>\tau_1\tau_1 \end{cases} \quad (1.11)$$

$$\frac{R_{OVSB}(\tau)}{R^2A_2^4} = B_1^2 + \begin{cases} 2\alpha_2^2\cos(\omega_1\tau)\,e^{-2\gamma_t|\tau|}, & |\tau|\le\tau_1 \\ 2\alpha_2^2\cos(\omega_1\tau)\times e^{-2\gamma_0\tau_1-\gamma_{1|\tau|}}, & |\tau|>\tau_1 \end{cases} \quad (1.12)$$

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$$\frac{R_{ODSB}(\tau)}{R^2A_3^4} = B_2^2 + \begin{cases} 2\alpha_3^2\cos(\omega_1\tau)\,e^{-2\gamma_t|\tau|}, & |\tau| \le \tau_1 \\ 2\alpha_3^2\cos(\omega_1\tau)\times e^{-2\gamma_0\tau_1-\gamma_{1|\tau|}}, & |\tau| > \tau_1 \end{cases} \quad (1.13)$$

Where whereΔV_0 and ΔV_1 are the linewidths for the laser and the RF oscillator, respectively, $2\gamma_0$ (= $2\pi\Delta V_0$) and $2\gamma_1$ (= $2\pi\Delta V_0$) define the angular full-linewidth at halfmaximum (FWHM) of the Lorentzian shape for the laser and the RF oscillator, respectively, and 2 γ_t is related to the total line width. Note that the$2\gamma_t$ is given not as $2\pi\Delta V_0 + 2\pi\Delta V_1$ but$2\pi\Delta V_0 + \pi\Delta V_1$. $\tau_{1(=}\tau_+ - \tau_0)$ is the differential delay due to the fiber chromatic dispersion and is dependent on the wavelength λ, the carrier frequency f_{RF}, the fiber chromatic dispersion D, and the optical transmission distanceL_2

$$\tau_1 = D.L_2.\lambda^2\frac{f_1}{C} \quad (1.14)$$

Where c is the light velocity. When $\gamma_1$is equal to 0. The PSD function of the photocurrent is given by the Fourier transform of (1.11) (1.12) and(1.13). The shot noise term at the PD is omitted here since the noise power can be evaluated by the product of bandwidth and noise density level. The PSD function S_I(f) can be written as:

$$S_I(f) = F\langle R_I(\tau)\rangle$$

$$\frac{S_{IOSSB}(f)}{R^2A_1^4} = B^2\,\partial(f) + \alpha_1^2\left\{\int_{-\tau_1}^{0}\left(e^{\tau(j\omega_d+2\gamma_t)} + e^{\tau(-j\omega_d+2\gamma_t)}\right)e^{\tau(-j\omega)}d\tau + \int_0^{\tau_1}\left(e^{\tau(j\omega_d-2\gamma_t)} + e^{\tau(-j\omega_d-2\gamma_t)}\right)e^{\tau(-j\omega)}d\tau + \right\} + e^{-2\gamma_0|\tau|}\left\{\int_{-\tau_1}^{\infty}\left(e^{\tau(j\omega_d-2\gamma_1)} + e^{\tau(-j\omega_d-2\gamma_1)}\right)e^{\tau(-j\omega)}d\tau\right\} \quad (1.15)$$

$$\frac{S_{IOVSB}(f)}{R^2A_2^4} = B_1{}^2\,\partial(f) + \alpha_2^2\left\{\int_{-\tau_1}^{0}\left(e^{\tau(j\omega_d+2\gamma_t)} + e^{\tau(-j\omega_d+2\gamma_t)}\right)e^{\tau(-j\omega)}d\tau +\right.$$

0τ1eτjωd−2γt+eτ−jωd−2γteτ(−jω)dτ++e−2γ0τ−τ1∞eτjωd−2γ1+eτ−jωd−2γ1eτ−jωdτ (1.16)

$$\frac{S_{IODSB}(f)}{R^2A_3^4} = B_2{}^2\,\partial(f) + \alpha_3^2\left\{\int_{-\tau_1}^{0}\left(e^{\tau(j\omega_d+2\gamma_t)} + e^{\tau(-j\omega_d+2\gamma_t)}\right)e^{\tau(-j\omega)}d\tau +\right.$$

0τ1eτjωd−2γt+eτ−jωd−2γteτ(−jω)dτ++e−2γ0τ−τ1∞eτjωd−2γ1+eτ−jωd−2γ1eτ−jωdτ (1.17)

The received RF carrier power is obtained as

$$P_{REC} = 2\int_{f_{1-\frac{B_1}{2}}}^{f_{1+\frac{B_1}{2}}} S_I(f)df$$

$$P_{RECOSSB} = \frac{4R^2A_1^4\alpha_1^2}{\pi}e^{-2\gamma_t\tau_1.\tan^{-1}\left(\frac{\pi B_1}{\gamma_1}\right)} \quad (1.18)$$

$$P_{RECOVSB} = \frac{4R^2A_2^4\alpha_2^2}{\pi}e^{-2\gamma_t\tau_1.\tan^{-1}\left(\frac{\pi B_1}{\gamma_1}\right)} \quad (1.19)$$

$$P_{RECODSB} = \frac{4R^2A_3^4\alpha_3^2}{\pi}e^{-2\gamma_t\tau_1.\tan^{-1}\left(\frac{\pi B_1}{\gamma_1}\right)} \quad (1.20)$$

For evaluating the total RF power excluding dc power, utilizing equ (1.18) (1.19) (1.20) and putting$\tau_1 = 0$. Total power is obtained as :

$$P_{IOSSB} = 2R^2A_1^4\alpha_1^2 \quad (1.21)$$

$$P_{IOVSB} = 2R^2A_2^4\alpha_2^2 \quad (1.22)$$

$$P_{IODSB} = 2R^2A_3^4\alpha_3^2 \quad (1.23)$$

The percentage of received power which considers the effect of the filter bandwidth (B_{RF}) at an electrical receiver, is found as the ratio between the total carrier power ant the required power as:

$P=\frac{P_{REC}}{P_I}$ for $2\gamma_t\tau_t \ll 1$ and $\gamma_t \ll \gamma_1$

$$\cong \frac{2}{\pi}e^{-2\gamma_t\tau_t}.\tan^{-1}\left(\frac{\pi B_1}{\gamma_1}\right) \quad (1.24)$$

The required bandwidth for the P ratio is obtained as:

$$B_1 = \frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)$$

The required bandwidth increases as we need more received signal power. Note that the required bandwidth for a specific received carrier power is dominantly dependent on the phase noise from the RF oscillator rather than that from the laser for $2\gamma_t\tau_t \ll 1$ and $\gamma_{t\ll}\ \gamma_1$ However, when $2\gamma_t\tau_t$ is not enough to be ignored and$e^{\gamma_t\tau_t}p$ apapproaches 1, B_1 will be infinite. In this paper, we focus on the range of $e^{\gamma_t\tau_t}p < 1$

the SNR penalty induced by the differential delay from the fiber chromatic dispersion and the line widths from the laser and the RF oscillator is found as:

$$\text{SNR} = \frac{Carrier\ power}{noise\ power}$$

$$SNR = \frac{P_I}{2B_{RF}.\frac{N_0}{2}}$$

$$SNR_{OSSB} = \frac{2R^2A_1^4\alpha_1^2\ \text{p}}{N_0\frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)} \quad (1.25)$$

$$SNR_{OVSB} = \frac{2R^2A_2^4\alpha_2^2\ \text{p}}{N_0\frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)} \quad (1.26)$$

$$SNR_{ODSB} = \frac{2R^2A_3^4\alpha_3^2\ \text{p}}{N_0\frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)} \quad (1.27)$$

$$SNR_{OSSB} = \frac{1.129 * 10^{-4}\ \text{p}}{N_0\frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)} \quad (1.28)$$

$$SNR_{OVSB} = \frac{3.46 * 10^{-5}\ \text{p}}{N_0\frac{\gamma_1}{\pi}\tan\left(\frac{\pi}{2}e^{2\gamma_t\tau_t}p\right)} \quad (1.29)$$

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$$SNR_{OSSB} = \frac{1.41 * 10^{-5}\ \mathrm{p}}{N_0 \frac{\gamma_1}{\pi} \tan\left(\frac{\pi}{2} e^{\,2\gamma_t\tau_t} p\right)} \qquad (1.30)$$

Thus it is observed that the SNR is independent on the percentage of received power which is function of required bandwidth phase noise from RF oscillator & laser line width, length of fiber and RF signal power.

2. PRINCIPLE MODEL DIAGRAM

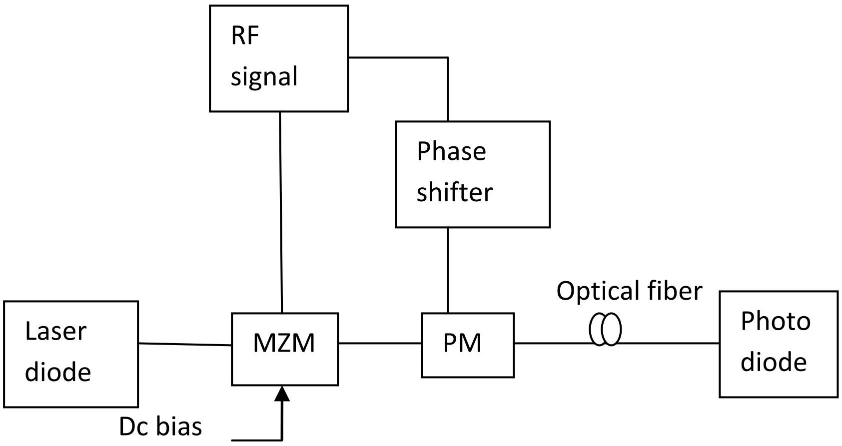

Fig 1.1: optical spectrum of optical single sideband modulation, optical double sideband, optical vestigial sideband modulation scheme

3. RESULT AND DISCUSSION

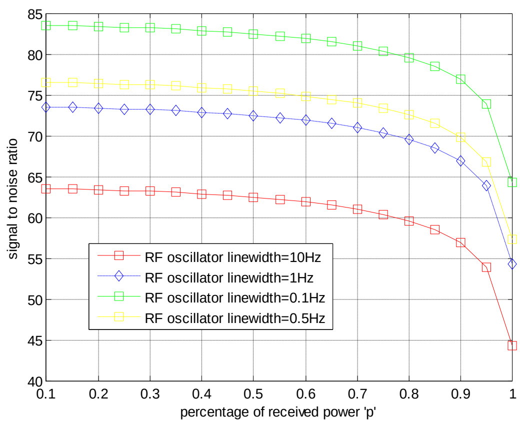

Fig 1.2 signal to noise ratio in terms of percentage of received power different value on RF oscillator line width modulated by OSSB scheme

SNR is sketched in fig 1.2 the line width of RF oscillator has been swept from 0.5Hz to 10Hz.The variation of signal to noise ratio w.r.t to percentage of received power. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OSSB external modulation scheme are observed 63.48dBm, 73.48dBm, 83.48dBm and 76.495dBm at 0.1 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz . The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OSSB external modulation scheme are observed 62.45dBm, 72.45dBm, 82.45dBm and 75.46dBm at 0.5 respectively with RF oscillator line width 10Hz,

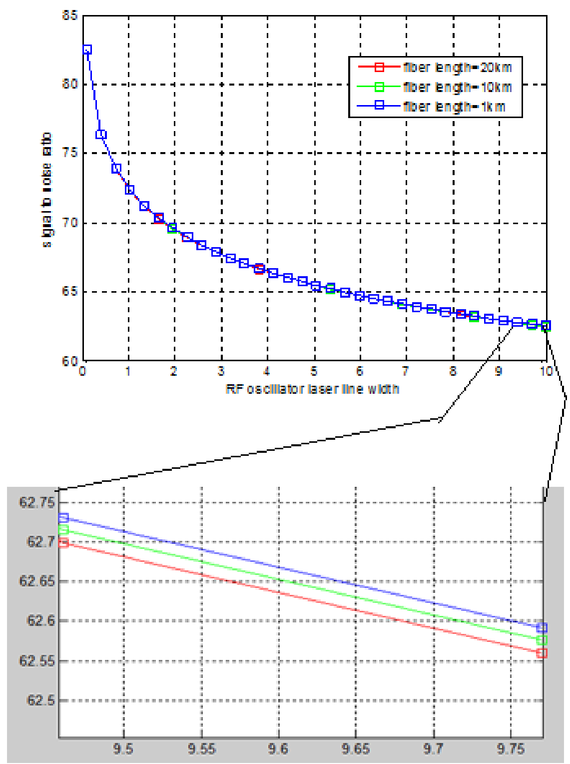

Fig 1.3 signal to noise ratio in terms of RF oscillator line width different value on fiber length modulated by OSSB scheme

1Hz, 0.1Hz and0.5 Hz. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OSSB external modulation scheme are observed 53.82dBm, 64.19dBm, 73.82dBm and 66.83dBm at 0.9

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respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz.

SNR is sketched in fig 1.3 the fiber length has been swept from 20 km to 1km.The variation of signal to noise ratio w.r.t to RF oscillator laser line width. The value of RF oscillator laser line width is varied from 0.1 Hz to 10Hz. the signal to noise ratio value for OSSB external modulation scheme are observed 83.45dBm, 83.47dBm, 82.49dBm and 83.5dBm at 0.1Hz respectively with fiber length 20km, 10km and 1km.the signal to noise ratio value for OSSB external modulation scheme are observed 62.46dBm, 62.48dBm and 62.49dBm at 10 Hz respectively with fiber length 20km, 10km and 1km.

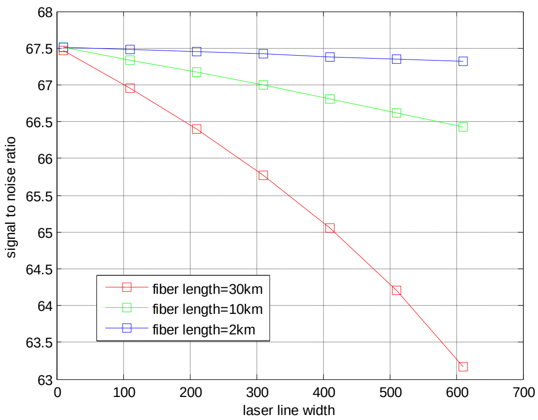

Fig 1.4 signal to noise ratio in terms of laser line width different value on laser length of fiber modulated by OSSB scheme

SNR is sketched in fig 1.4 the fiber length has been swept from 30 km to 2km.The variation of signal to noise ratio w.r.t to laser line width. The value of laser line width is varied from 10MHz to 624MHz. the signal to noise ratio value for OSSB external modulation scheme are observed 67.5dBm, 67.5dBm and 67.5dBm at 10MHz respectively with fiber length 30km, 10km and 2km.

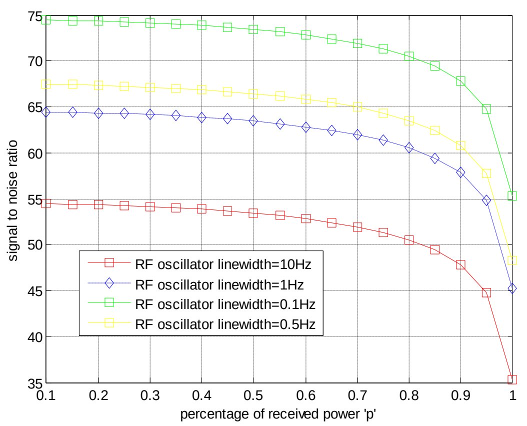

Fig 1.5 signal to noise ratio in terms of percentage of received power different value on RF oscillator line width modulated by ODSB scheme

The signal to noise ratio value for OSSB external modulation scheme are observed 67dBm, 67.5dB and 67.4.dBm at 10MHz respectively with fiber length 30km, 10km and 2km.the signal to noise ratio value for OSSB external modulation scheme are observed 63.2dBm and 67.4dBm and 66.49dBm at 624 MHz respectively with fiber length 30km, 10km and 2km.

SNR is sketched in fig 1.5 the line width of RF oscillator has been swept from 0.5Hz to 10Hz. The variation of signal to noise ratio w.r.t to percentage of received power. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for ODSB external modulation scheme are observed 54.49dBm, 64.44dBm, 74.44dBm and 67.46dBm at 0.1 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz . The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for ODSB external modulation scheme are observed 53.42dBm, 63.42dBm,73.42dBm and 66.43dBm at 0.5 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for ODSB external modulation scheme are observed 44.78dBm, 54.78dBm, 64.78dBm and 57.79 dBm at 0.9 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz.

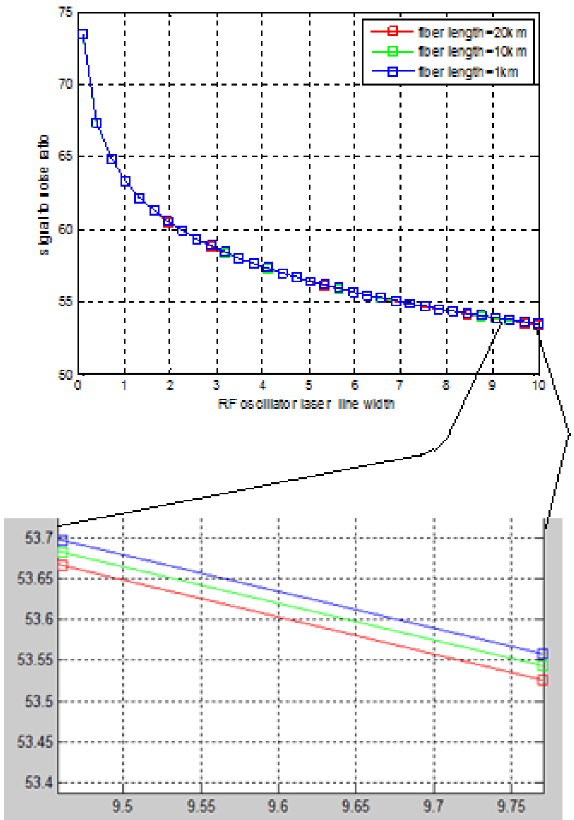

Fig 1.6 RF signal to noise ratio in terms of oscillator line width different value on length of fiber width modulated by ODSB scheme

SNR is sketched in fig1.6. The fiber length has been swept from 20 km to 1km.The variation of signal to noise ratio w.r.t to RF oscillator laser line width. The value of RF oscillator laser line width is varied from 0.1 Hz to 10Hz. the signal to noise ratio value for ODSB external modulation scheme are observed 73.42dBm, 73.41dBm and 73.45dBm at 0.1Hz respectively with fiber length 20km, 10km and 1km.the signal to noise ratio value for ODSB external modulation scheme are

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observed 53.43dBm, 53.44dBm and 53.46dBm at 10 Hz respectively with fiber length 20km, 10km and 1km.

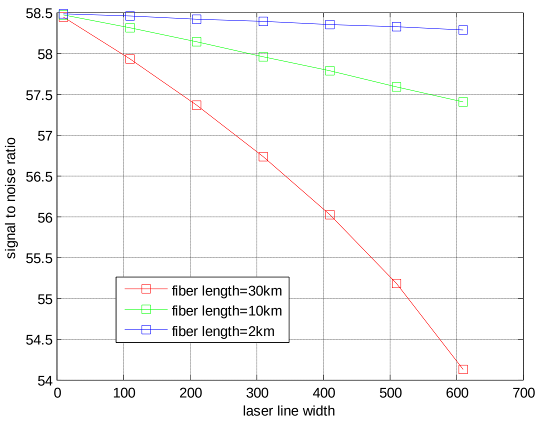

Fig 1.7 signal to noise ratio in terms of laser line width different value on fiber length of fiber modulated by ODSB scheme

SNR is sketched in fig 1.7 the fiber length has been swept from 30 km to 2km.The variation of signal to noise ratio w.r.t to laser line width. The value of laser line width is varied from 10MHz to 624MHz. the signal to noise ratio value for OSSB external modulation scheme are observed 58.5dBm, 58.5dBm and 58.5dBm at 10MHz respectively with fiber length 30km, 10km and 2km. The the signal to noise ratio value for OSSB external modulation scheme are observed 58dBm, 58.49dB and 58.4.dBm at 10MHz respectively with fiber length 30km, 10km and 2km.the signal to noise ratio value for OSSB external modulation scheme are observed 54.2dBm and 57.4dBm and 58.35 Hz at 624 MHz respectively with fiber length 30km, 10km and 2km.

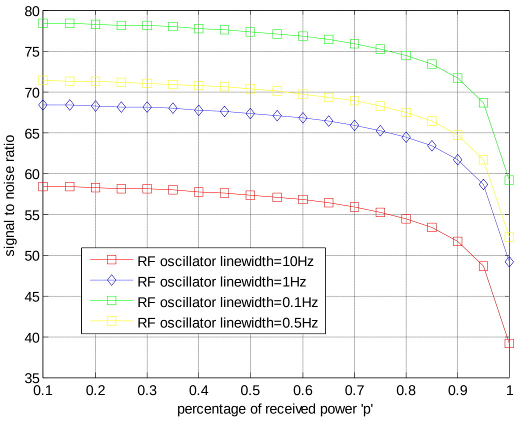

Fig 1.8 signal to noise ratio in terms of percentage of received power different value on oscillator laser line width modulated by OVSB scheme

SNR is sketched in fig 1.8. the line width of RF oscillator has been swept from 0.5Hz to 10Hz. The variation of signal to noise ratio w.r.t to percentage of received power. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OVSB external modulation scheme are observed 58.34dBm, 68.34dBm, 78.34dBm and 71.35dBm at 0.1 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz . The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OVSB external modulation scheme are observed 57.03dBm, 67.31dBm, 77.31dBm and 70.30dBm at 0.1 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz. The value of percentage of received power is varied from 0.1 to 0.9. the signal to noise ratio value for OVSB external modulation scheme are observed 48.68dBm, 58.68dBm, 68.68dBm and 61.69dBm at 0.1 respectively with RF oscillator line width 10Hz, 1Hz,0.1Hz and0.5 Hz.

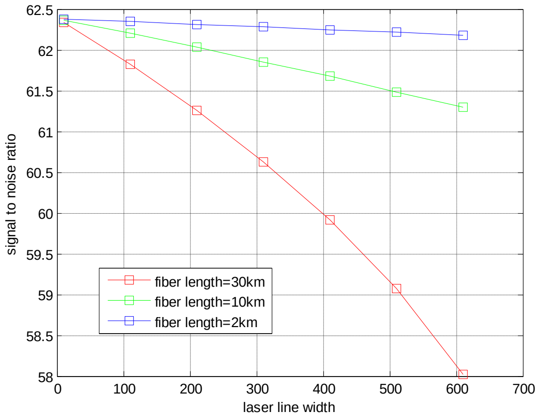

Fig 1.9 signal to noise ratio in terms of laser line width different value on fiber length of fiber modulated by OVSB scheme

SNR is sketched in fig 1.9 the fiber length has been swept from 30 km to 2km.The variation of signal to noise ratio w.r.t to laser line width. The value of laser line width is varied from 10MHz to 624MHz. the signal to noise ratio value for OSSB external modulation scheme are observed 62.33dBm, 62.36dBm and 62.37dBm at 10MHz respectively with fiber length 30km, 10km and 2km.the signal to noise ratio value for OSSB external modulation scheme are observed 58.02dBm and 61.29dBm and 62.17 dBm at 624 MHz respectively with fiber length 30km, 10km and 2km.

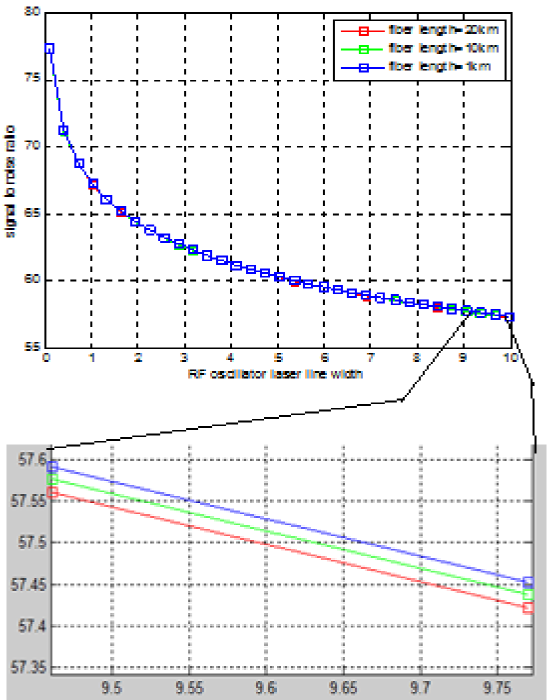

Fig 1.10 signal to noise ratio in terms of RF oscillator line width different value on fiber length modulated by OVSB scheme

SNR is sketched in fig 1.10 the fiber length has been swept from 20 km to 1km.The variation of signal to noise ratio w.r.t to RF oscillator laser line width. The value of RF oscillator laser line width is varied from 0.1 Hz to 10Hz. the signal to noise ratio value for OVSB external modulation scheme are observed 77.31dBm, 77.33dBm and 77.35dBm at 0.1Hz respectively with fiber length 20km, 10km and 1km. the signal to noise ratio value for OVSB external modulation scheme are observed 57.32dBm, 57.34dBm and 57.35dBm at 10 Hz respectively with fiber length 20km, 10km and 1km.

4. CONCLUSION

In this paper, the mathematical analysis is derived for external modulation scheme such as OSSB, ODSB and OVSB based on MZM and PM. The RoF system performance parameter, SNR is evaluated in terms percentage of received power, RF oscillator laser line width, laser line width. It is concluded that OVSB scheme is utilized in designing RoF system and prove to be cost effective in compare with OSSB and more performance efficient than ODSB scheme. Finally, It is predicted that the RoF system will become backbone of next generation mobile communication system.

5. REFERENCES

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