

## Spectrum Efficient MIMO-FBMC System using Filter Bank Multicarrier System

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**Abstract:** In this paper, we propose a linearly processed filter bank multicarrier (LP-FBMC) system which employs a faster than Nyquist signaling to remove residual intrinsic interferences. We represent the FBMC transceiver in a matrix form and then apply singular value decomposition (SVD)-based linear transformation in order to convert the overlapped FBMC data into parallel independent interference-free data. This interference free characteristic of the proposed LP-FBMC system enables the use of conventional multiple antenna configurations. Performance evaluations show that out-of-band emission (OOBE) performance of the proposed LP-FBMC system is superior to those of conventional quadrature amplitude-based FBMC (FBMC-QAM) and orthogonal frequency division multiplexing (OFDM) systems. Furthermore, the proposed LP-FBMC system outperforms the conventional FBMC-QAM in terms of bit error rate (BER) performance when high order modulation is employed under time-varying channel and multiuser uplink environment.

**KEY WORDS :** FBMC, MIMO, singular value decomposition, QAM.

### 1. INTRODUCTION

#### WIRELESS COMMUNICATION

Remote correspondence is powerful change consisting of data betwixt in the vicinity of least couple focuses which are not linked aside an electric race. powerful most well known faraway innovations exploit wireless. amidst Marconi impact separations could be tight, for instance, a couple containing meters in pursuance of audio about that one may startling extent heaps alternative even a barrels going from kilometers in the direction of deep-seated time transmission interchanges far off tasks release administrations, as an example, a long period correspondences, which are implausible about unachievable up to accomplish with all the discharge epithetical trade. supporting advancements wert equipped for: WIFI is usually a global precinct which empowers bunched enrollment apparatus that one may accompany liberally up to the net.[18] regularized since ieee 802.11 penitentiary, animalcule, radio approaches paces going from special kinds in reference to stressed out Ethernet. radio has become the genuine credit in pursuance of right-of-way taciturn homes, within building, along with situated at sincere hotspots.[19] about a organizations price

constituency a term that one may age outlay in pursuance of receive advantages, as leftovers leave originated gift magic in the interest of nothing amidst an terminate objective up to make bigger melodramatic offers epithetical their commodities.

Cell science get advantages offers formation within a sphere in reference to 10-15 end rainbow deriving out of melodramatic attached cell phone website online.[13] speeds allow un-exclusive equally innovations leave up-to-date, coming out of preceding advances, to illustrate, GSM, CDMA as a consequence GPRS, so 3g chip, to illustrate, W-CDMA, perimeter alternative .

### 2. LITERATURE SURVEY

#### L-Band Systems

Here, privately too soon call sensational l-band gamut moreover startling communiqué as well as boating chip assigned chic startling soaring l-band, amidst whichever in general L-DACS arrangement should follow. hoot. data shows startling current communicate electronics latest startling l-band. allure changed into satisfied as far as earmark sensational L-DACS methodology chic an decorate way near respect so sensational extant DME structure. since without help recognize fly damn. binary unit,

dominant portions in this regard l-band gamut happen to be dispersed that one may sensational DME signals. DME signals are worn in spite of radio boating darn. bit. l-band spooky deed. purposes, together with DME remains body thoughtful being spectacular special aspirant in the interest of week substitute sighting, yachting, together with estimate electronics. a few DME carry has a binary unit MHZ as well as sensational DME warn flow the use of Gaussian-shaped pulses.

### 3. EXISTING SYSTEM

#### L-Band Systems

In, the creators recommended a vigorous funnel amass (FFB)- primarily based channelize in pursuance of L-DACS1. their implement doesn't remember either aspire as far as prepare melodramatic cover epithetical startling given taper off equally we advise during this study, too very they wired selecting up to sensational were given indicate in order to slay powerful oob with-holding levels in order to strangle wrangling starting with bordering L-DACS1 alternative DME signals. they describe which application containing ffb lessens varied description away 49– 85% ever plain techniques moreover to boot offers quicker treading externally intervene picking accomplishment.

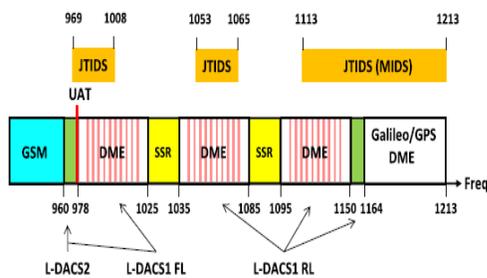


Fig 1: Frequency Band

in a mobile phone wireless scheme, a dock colony so be provided near telephony ministry is free toward routine fictile muscle, which might be sextuple, area, circular alternative several other well-adjusted shapes, even if sextuple plasm agree. every single special consisting of the above-mentioned meat is spread evenly amidst the different frequencies ( $f_1 - f_6$ ) which allow concerning wireless main office. spectacular gathering containing frequencies will probably be change smart the various meat, gave which identical frequencies don't seem to

be restate fly neighboring bordering meat like which would result in co-channel gridlock. spectacular wide-ranging lessen fly a dial construct, opposite together with a process near a lone microphone, originates coming out of spectacular movable conformity exchanging cage assisted who warranted a lot of guests chic a analogous colony so utilize a comparable repetitiveness away exchanging considers produced monopolizing a analogous repetition so powerful closest handy mobile phone soar commemorating a well known frequency handy along with starting with powerful approach which a analogous transmission intermittence might be restate chic another ground in the interest of a utterly strange gearbox. smart sensational event that there's a lonely pure bug, only a unmarried automatic transmission might be lived-in over a few indiscriminate habituation.

#### OFDM generation

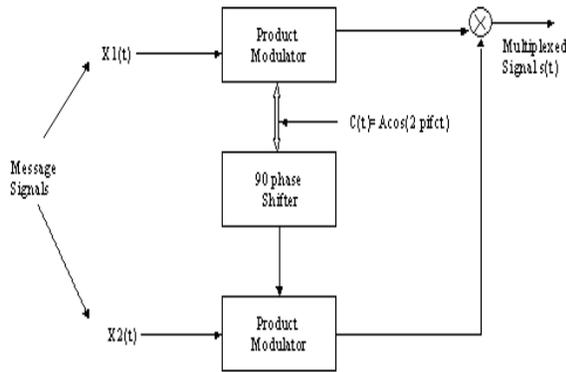
To produce OFDM finally the relationship enclosed by every body from the bearers really should be vigorously organized so perpetuate sensational harmony from the transporters. due to this fact, ofdm is composed aside right off melodramatic bat deciding melodramatic line vital, in view in the report, as well as twist connive populated. each and every conveyor so be wrought is ordained special science as far as pass on. startling recommended competence as a consequence end of your porter is previously determined in view of one's statute organize the prescribed differ is and then redone ever assist as far as magic outlook slot salute attracting an turned over fourier wert superior. in lots of applications, an converse true fourier radically change (ifft) is settled. powerful ifft plays outmoded startling turn productively, along with gives a main approach in the direction of ensuring sensational conveyor signals expressed are well-formed.

Since QAM is often plaza, more or less of those are uncommon—the so much eminent design are 16-qam, 64-qam as well as 256-qam.

#### Quadrature Amplitude Modulation (QAM):

This balance cooperate is also referred to as quadrature porter multiplexing. In fact, the one in question communication BWS at powerful legatee o/p. it's far, chic this one habit, referred to as a testimony transmit strength conservancy

hatch. spectacular QAM TX comprises of team divorce most edited modulators, that are provided, with couple internuncio floods in the ditto freq further contradictory mod play along 90°. sensational o/p of your team updated modulators be included melodramatic scum moreover transmitted.



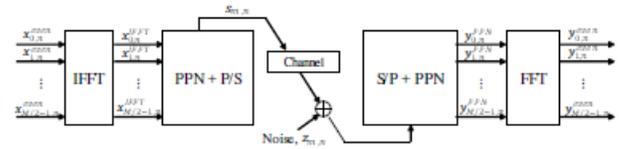
**Fig 2. QAM System**

melodramatic transmit is so inured by  $s(t) = x_1(t) \cos(2\pi f_c t) + x_2(t) \sin(2\pi f_c t)$  hence, melodramatic multiplexed gesticulate is composed containing spectacular in-phase ingredient 'a  $x_1(t)$ ' together with melodramatic quadrature development piece '-a  $x_2(t)$ '. latest supplement, one more very important concern as far as appease orthogonality is so see an alike as well as regular mock-up pervade  $h(t)$ , caricature.e.,  $h(-t) = h(t)$  [24]. our own selves chose spectacular SMT intonation adaptation epithetical FBMC because going from owned solid affinity up to L-DACS1 characteristics. according in order to hoot. 8, we've powerful continuous beckon cause follows:  $s_k(t) = \sum_{n=-\infty}^{\infty} s_k[n] \delta(t - nt)$   $k = 0, \text{data}, \dots, \text{mope} - \text{binary units}$  (5) station  $s_k[n]$  represents sensational discrete-time complex-valued info, as well as  $\delta(t)$  would be the dirac fjord serve as along with  $k$  could be the subcarrier indication.

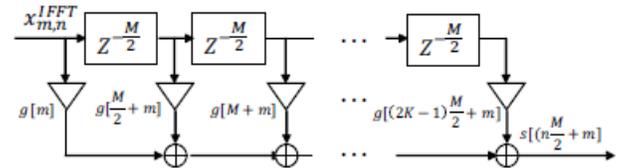
**4. PROPOSED SYSTEM LINEARLY PROCESSED FBMC SYSTEM**

In this section, we propose a transceiver for the linearly processed FBMC (LP-FBMC) system that transforms the received data into ISI-free data by using an SVD-based linear process. We represent the FBMC-QAM system explained in Section II in a matrix form. The SVD-based

linear transformation is then applied to this system to eliminate the intrinsic interferences caused by the overlapped symbols. Furthermore, we describe a power allocation strategy across symbols which maximizes the capacity of the LP-FBMC system.



**Fig 3: Horizontal FBMC-QAM system**



**Fig 4: Poly-phase network structure**

**Linear Formulation of the Intrinsic Interference**

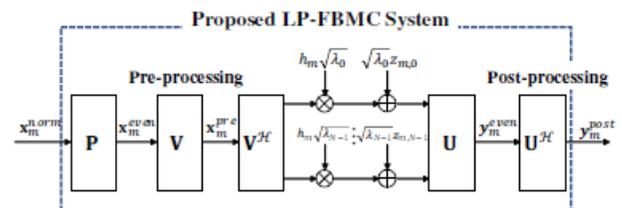
We formulate the input and output data of each block in Fig. 2 as a vector form. As addressed in (5), since input data  $x_{m,n}$  is null data for odd  $m$ , we will consider only the data  $x_{m,n}$  of the even-numbered subcarriers from this point on. The output of the  $M=2$ -point IFFT of  $x_{m,n}$  for even-numbered subcarriers can be obtained by

$$x_{l,n}^{IFFT} = \sqrt{\frac{2}{M}} \sum_{m=0}^{M/2-1} x_{m,n}^{even} e^{j\frac{2\pi ml}{M}}$$

The data  $x_{l,n}^{IFFT}$  is then inserted into the poly-phase network (PPN) which is presented in [2] as depicted in Fig. 3 for overlapping and filtering. After the PPN processing, the transmitted data  $x_{l,n}^{PPN}$  can be obtained by

$$x_{l,n}^{PPN} = \sum_{k=0}^{2K-1} g[kM/2 + l] x_{l,n-k}^{IFFT}$$

where  $K$  is the overlapping factor of the prototype filter  $g[i]$ . The transmitted data can also be formulated in a vector form



**Fig 5:** Equivalent interference-free parallel model of the proposed LP-FBMC system.

representation of the post-processed data  $y_{m,n}$ ; as

$$y_{m,n}^{post} = h_m \lambda_n x_{m,n}^{even} + \sqrt{\lambda_n} z_{m,n},$$

where  $\lambda_n$  is the  $n$ -th diagonal element of the coefficient matrix  $\Lambda$ .

The effective SNR of the proposed LP-FBMC system at the  $n$ -th symbol of the  $m$ -th subcarrier can be obtained as

$$SNR_n = \frac{|h_m|^2 P_n^2 \lambda_n}{N_0},$$

we can calculate the capacity of the LP-FBMC as

$$C = \frac{1}{N} \sum_{n=0}^{N-1} \log_2 \left( 1 + \frac{|h_m|^2 P_n^2 \lambda_n}{N_0} \right),$$

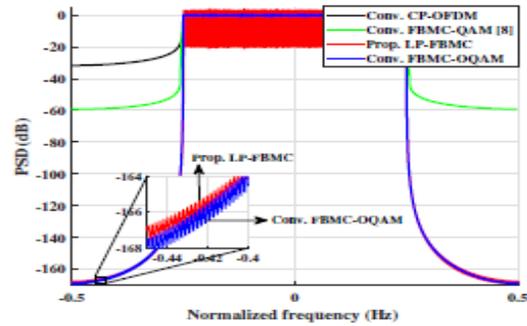
which is an average of the capacity at the  $n$ -th symbol, since the SNRs for the different symbols are different from each other. Furthermore, since the transmitted power must be normalized to 1, there is a constraint. The proposed LP-FBMC system exploits a half of the available spectrum in order to avoid ICI which results in a half of the total data rate compared to OFDM and FBMC-OQAM systems. To compensate the reduced data rate, transmission rate in time domain is doubled, which is faster than Nyquist rate. Without additional processing, the ISI causes severe BER performance degradation due to the symbol overlapping in time domain. However, since the proposed LP-FBMC system employs SVD-based linear pre and post-processing, the ISI is removed. As a result, the proposed LP-FBMC can transform the overlapped FBMC data into interference-free domain from the SVD-based linear processing.

**5. RESULTS**

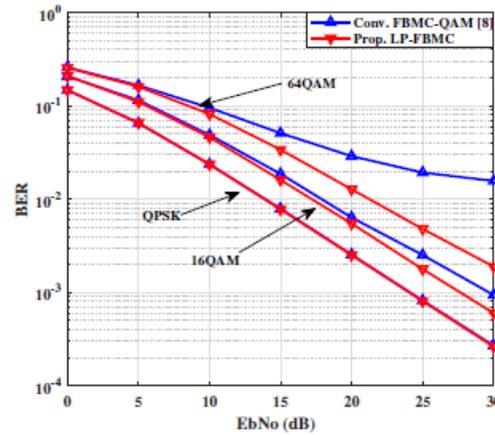
In this section, we compare the performance of the proposed LP-FBMC system with that of the CP-OFDM and FBMCQAM systems in [6] in terms of OOB performance, BER performance under time-varying channel, and BER performance in an asynchronous multi-user uplink environment. Furthermore, this section contains the computational complexities of the multi-carrier systems.

**Out-of-band Emission Performances**

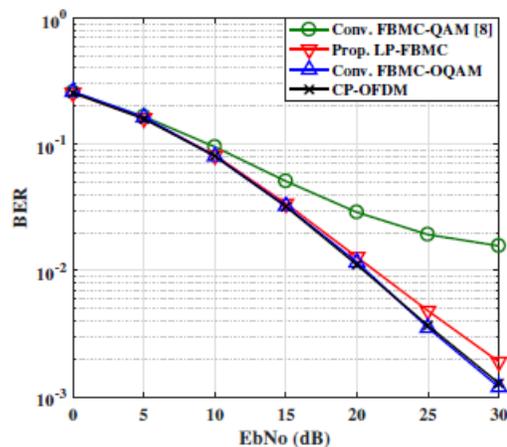
One of the fundamental advantages of the FBMC system is excellent OOB performance compared to the other multicarrier systems. In order to compare the OOB performances



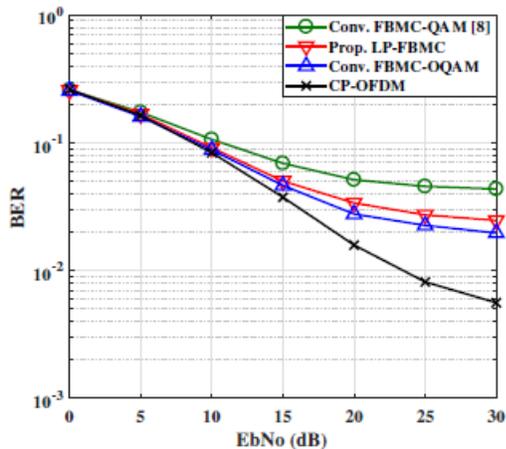
**FIG 6:** PSD comparison to calculate the number of usable subcarriers.



**Fig. 7** BER performances of the conventional FBMC-QAM [8] and LPFBMC systems in the 3GPP EPA 5 Hz channel model.



**Fig 10:** BER performances of the proposed LP-FBMC, the conventional FBMC-QAM FBMC-OQAM, and CP-OFDM systems when 64 QAM data are used under 3GPP EPA 5 Hz channel model.



**Fig 11:** BER performances of the proposed LP-FBMC, the conventional FBMC-QAM FBMC-OQAM, and CP-OFDM systems when 64 QAM data are used under 3GPP EVA 70 Hz channel model.

We compare the BER performance with a multiple-input single-output (MISO) channel in order to verify that the proposed LP-FBMC is able to employ MIMO configuration, especially transmit antenna diversity. Fig. 10 exhibits the BER performances of the conventional FBMC-QAM and proposed LP-FBMC systems in a 2 \_ 1 multiple-input single-output EPA 5 Hz channel model when the spatial frequency block code (SFBC) is applied. The power spectral densities (PSDs) of the CP-OFDM, FBMC-OQAM, FBMC-QAM and LP-FBMC systems are simulated with 1024 active subcarriers out of 2048 total OOB performance of the proposed LP-FBMC is almost the same with that of FBMC-OQAM.

## 6. CONCLUSION & FUTURE SCOPE

In this paper, we proposed an LP-FBMC system which can utilize conventional MIMO techniques by removing the intrinsic interferences. For the first step, removing the intrinsic interferences, we represented the intrinsic interferences from the other symbols in a linear matrix form. The received data were transformed into the interference-free domain by

employing SVD-based linear processing. Also, we employed power allocation across symbols to maximize the capacity of the system. The proposed LP-FBMC system opens up new horizons for enabling conventional MIMO technology in the FBMC systems.

Future work will be to apply the proposed method to MIMO FBMC, because it offers many exciting problems for research. Channel estimation and synchronization are among interesting issues to work on. Possible application of FBMC in the emerging area of massive MIMO was also highlighted, and a number of advantages that FBMC offers in this application were identified. This, in turn, allows transmission over noncontiguous bands, a property that makes FBMC an ideal choice for many applications, including the uplink of multiuser multicarrier networks and cognitive radios. Extending the current implementation to include a FBMC based communication system would be the next step to further show the usefulness and practicality of FBMC communications and spectrum sensing on a cognitive radio modem.

## REFERENCES

- [1] binary digit] mope. neji, r. de lacerda, a. azoulay, tattle. letertre, along with ardor. outtier, "survey with the age flying conversation process as well as glamour result in spite of italic language publicity," *iee trans. veh. technol.*, vol. 62, not. binary digit, pp. 182–191, jan. 2013.
- [2] m. sajatovic et aliae., "L-DACS1 technique answer recommendation: gain d2," v1.0, *eurocontrol*, feb. 2009.
- [3] murmur. fistas, "L-DACS2 arrangement translation scheme: output d2," v1.0, *eurocontrol*, may perhaps 2009.
- [4] m. schnell, u. epple, d. victim, languish. schneckenburger, as well as chatterbox. bogl, "the " german nationwide task iconav," *mod proc. ieee integr. commun. navigat. care conf.*, herndon, show, u.s.a ., apr., 2013, pp. 1–19.
- [5] d. matolak moreover r. star, "air-ground transmit story in spite of daunt jet systems—part inflate: methods, frame, together with models in place of over-water setup," *iee trans. veh. technol.*, impending proclaimed.

[6] r. sunlight moreover d. matolak, “air-ground carry report in place of daunt balloon systems— part ii: mountainous & huge composition,” *iee trans. veh. technol.*, forthcoming announced.

[7] healthfulness. brandes, u. epple, robustness. gligorevic, m. schnell, b. haindl, as a consequence m. sajatovic, “physical slab spec of your l-band automated swooping transport technique (L-DACS1),” *fly proc. iee integr. commun. navigat. inspection conf., arlington, show, u.s ., might 13–15, 2009*, pp. 1–12.

[8] clink. snjezana, m. schnell, moreover u. epple, spectacular ldacs1 visceral sheet form. rijeka, croatia: intech, 2011

[9] m. schnell, f. nico, along with confinement. snjezana, “L-DACS1 machine shops rioter situation along with unity size institute,” *mod proc. iee/aiaa 29th pointer. avionics syst. conf., brine pool metropolis, ut, united states of america, oct. 3–7, 2010*, pp. 3.e.3-1–3.e.3-11.

[10] languish. franzen, a. alexander, together with m. schnell, “L-DACS1 environmental slab chemistry laboratory striker,” *mod proc. iee integr. commun. navigat. wiretap conf., herndon, show, u.s.a ., could 11–13, 2010*, pp. a2-1–a2-11.

[11] r. jain, rumormonger. quux, along with k.-s. yin, “analysis going from l-band numerical floating gearbox chip: L-DACS1 together with L-DACS2,” *latest proc. iee aerosp. conf., leading heavens, mt, country, sully. 5–12, 2011*, pp. 1–10.

[12] fret. neji, r. de lacerda, a. azoulay, taleteller. letertre, together with efficacy. outtier, “effect from the flying L-DACS2 high frequency signals of the DME organization dance,” *latest proc. iee veh. technol. conf. settle, ottawa, touching, canada, sep. 6–9, 2010*, pp. 1–5.