International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design of MBMS-OFDM Multi Port Modulation Based Communication Model with less ACI and Reduce OOB Power

Anushri Vishwakarma[1], Mr.Divyanshu Rao[2], Mr.Ravi Mohan[3]*

[1]MTech Research Scholar, Electronic and Communication Department, Shri Ram Institute of Technology, Jabalpur, Madhya Pradesh 48200, India
[2] Professor, Electronic and Communication Department, Shri Ram Institute of Technology, Jabalpur, Madhya Pradesh 48200, India
[3] HOD & Professor, Electronic and Communication Department, Shri Ram Institute of Technology, Jabalpur, Madhya Pradesh 48200, India

ABSTRACT:

This work describes a multi-port modulator-based cellular RF transmitter architecture and its use in an OFDM context. This research demonstrates how to use a multi-port modulator-based RF transmitter in an OFDM environment, as well as how previous work that was limited to single-carrier transmission may be expanded to multi-carrier transmission. This paper describes a multi-port modulator-based cellular transmitter architecture and its use in an OFDM context.. This work demonstrates that a multi-port modulator-based transmitter may be used in an OFDM environment, as well as that prior work that was limited to single-carrier transmission can be expanded to multi-carrier transmission. Three hybrid couplers, a Wilkinson power combiner, and CMOS Ron resistor banks make up the proposed multi-port modulator, which can be easily implemented into a small chip area.It eliminates the need for DACs and mixers, which are required in traditional RF transmitters. By sending OFDM signals following the 3GPP standard at 1.84 GHz carrier with 1.4 MHz bandwidth, the performance was assessed in a MATLAB simulation environment and confirmed on MTALAB. For QPSK and 16-QAM transmissions, the prototype chip obtained EVMs of 16.1 percent and 14.6 percent, respectively. In an OFDM environment, where I/Q signals have 8.3 equal number of bits resolutions, this paper implements a new RF transmitter based on a multi-port modulator for multiple subcarriers.

I-INTRODUCTION

Basically, OFDM modulation scheme transfers the data over multiple low-rate subcarriers which are orthogonal to each other rather than single high rate carrier in conventional cognitive radio networks. It proves advantageous as it reduces the Inter-Symbol Interference, helps in spectrum sensing and also provides the interoperability. However, it causes Peak-to-Average Power Ratio and reduces the spectral efficiency of OFDM based CR systems.

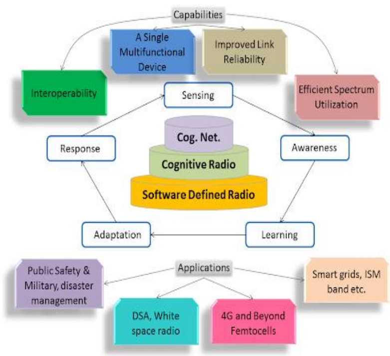


Figure 1 – Advantages of using OFDM with Cognitive Radio (SDR)

Multimedia Broadcast Multicast Services (MBMS) is a point-to-multipoint interface specification for existing 3GPP cellular networks, which is designed to provide efficient delivery of broadcast and multicast services, both within a cell as well as within the core network. For broadcast transmission across multiple cells, it defines transmission via single-frequency network configurations. The specification is referred to as Evolved Multimedia Broadcast Multicast Services (eMBMS) when transmissions are delivered through an LTE (Long Term Evolution) network. eMBMS is also known as LTE Broadcast.

The multi-port network topology is represented in Figure 2, This is a typical multi-port configuration, composed of three 90-degrees hybrid couplers and a Wilkinson power divider. Output multi-port signals are combinations of the input RF and LO signals with different relative phase shifts of 0, pi/2, -pi/2, and pi/4 rad. The design of the 90-degrees hybrid couplers is the most difficult part, as a three-octave tight coupler is required. Branch-line and rate- race couplers are suitable for obtaining tight coupling values, such as 3 dB. However, these couplers are inherently narrowband circuits (< 20% bandwidth). The use of 3 dB Lange couplers enhances the bandwidth, but only up to one octave. A tight coupler can also be obtained by connecting two couplers in tandem. A three-octave 3 dB coupler can be obtained from the tandem connection of two 8.34 dB multisession couplers. However, such large bandwidth will require a high coupling level of the central section, and edge-coupled structures do not provide coupling levels higher than 8dB. Broadside-coupled lines are more suitable, as they achieve coupling levels up to 2 or 3dB. Consequently, we have implemented a seven section 3 dB tandem coupler with broadside-coupled straplines. Its maximum phase and amplitude imbalances are 4± and 1.2 dB over the entire frequency range. The power divider used is LYNX 111.A0214, whose characteristics are: 0.5{6 GHz frequency range, 0.8 dB insertion loss, 18 dB isolation, 0:2 dB amplitude imbalance and 3-degree phase imbalance}. The detailed description of the multi-port network design is described in [12].

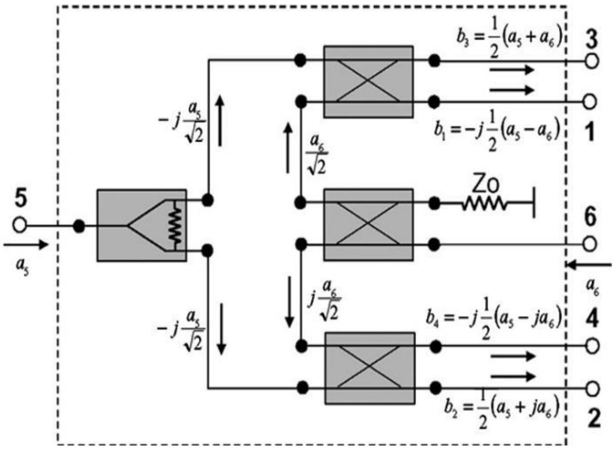


Figure 2: Multi port (six port) Correlator

Table -1 Literature Work

Publisher	Topic	Summary	Outcome
Nadia Chagtmi et al [1]/ IEEE Proceeding/2018	Six-port Based High Performance Concurrent Dual-Band Receiver	approach is based on behavioural nonlinear modelling that jointly compensates for the frequency response, nonlinearity and memory effects of the receiver	0.45 ACI observed at 21 dB noise when 2 MHz bandwidth frequency band used
X Song et al [2]/ IEEE Proceeding/2018	A Six-port Transceiver for Frequency-Division Duplex Systems	transceiver that consists of a single six-port correlator and four Schottky diodes can realize both modulation and demodulation simultaneously at different frequencies	0.5 percent ACI obtained at 27 dB when 2.68-2.9 GHz frequency band used.
Rashid Mirzavand et al [3]/ Asia-Pacific Microwave Proceedings/2016	Five-Port Receiver Implementation in Ka-Band for Software-Defined Radio	five-port Ka-band direct conversion receiver based on Six-port structures has been presented that is very suitable for software defined radio applications.	0.00732 BER obtained with 23-29 GHz frequency band used.
N. S. A. Arshad et al [4]/ IEEE Symposium/2014	QPSK Modulation Using Six-Port Device	six-port device is a 6-port replacing the high-cost mixer in conventional transmitter. six-port network can be functioned as a digital modulation by connecting port 1 to local oscillator and port 3 to port 6 to either open and short termination	2.5 percent ACI observe at 10 dB with 2.2-4 GHz frequency band used

II-METHODOLOGY

In this letter work a multi-port transceiver proposed for realizing the frequency-division duplex (FDD) systems implemented with a diode-based module is studied and experimentally demonstrated. The proposed transceiver that consists of a single multi-port correlator and the four Schottky diodes can achieve both modulation and demodulation simultaneously at different frequencies, which can greatly reduce cost and complexity of such systems. The FDD system prototypes based on a multi-port transceiver are developed, and the modulation and demodulation performances are evaluated by using quadrature amplitude modulation (QAM) signals at 2.9 and 2.68 GHz, respectively. With the calibration based on the time-delay radial basis function neural networks (TDRBF-NNs), the error vector magnitudes (EVMs) performance of the FDD systems based on the proposed transceiver is found below 2%.

The principle of operation of the multi-port receiver is based on the measurement of four independent powers, when the local oscillator (LO) and RF signals are introduced into the remaining two ports. A multi-port receiver consists of a linear and passive multi-port network and four powers detectors, as it is shown in Figure 1. Original I-Q components are regenerated from the four powers observations and some constant parameters depending on system response, known as calibration constants. General demodulation equations in multi-port receivers are expressed as follows:

$$I(t) = \sum_{i=3}^{9} h_i P_i(t)$$

$$Q(t) = \sum_{i=3}^{9} n_i P_i(t)$$

Where h_i and n_i are the calibration constants. A calibration process is required to calculate them.

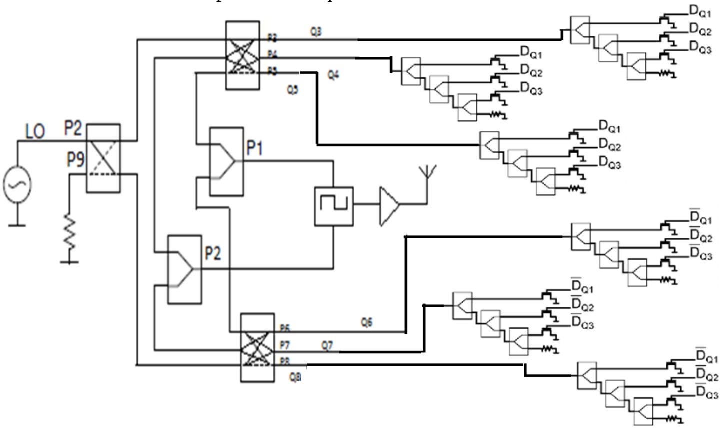


Figure 3 Proposed Multi port modulator for cognitive radio system

Physical calibration methods use external physical standards terminals to calibrate the system. Nevertheless, this procedure is impractical for a multi-port receiver. Real-time calibration methods are more suitable, as they can be performed while the system is operating. In Section 4 we present a real-time auto-calibration method, especially suited for broadband and high data rate applications. The goal is to create a reconfigurable radio front-end for mobile broadband applications. Because all cellular and WLAN communications occur within that frequency range, the goal of an SDR for mobile applications can now be simplified to receiving every standard up to 6 GHz. As a result, we developed a prototype 6985850MHz (three-octave) multi-port receiver. The system can handle signals with a bandwidth of up to 100 MHz and a variety of modulation schemes.

The multi-port network topology is represented in Figure 5.1. This is a typical multi-port configuration, composed of three 90-degrees hybrid couplers and a Wilkinson power divider. Output multi-port signals are combinations of the input RF and LO signals with different relative phase shifts of $0, \pi/2$ $, -\pi/2$, and π rad.

The design of the 90-degrees hybrid couplers is the most difficult part, as a three-octave tight coupler is required. Branch-line and rate-race couplers are suitable for obtaining tight coupling values, such as 3 dB. However, these couplers are inherently narrowband circuits (< 20% bandwidth). The use of 3 dB Lange couplers enhances the bandwidth, but only up to one octave. A tight coupler can also be obtained by connecting two couplers in tandem. A three-octave 3 dB coupler can be obtained from the tandem connection of two 8.34 dB multisession couplers. However, such large bandwidth will require a high coupling level of the central section, and edge-coupled structures do not provide coupling levels higher than 8dB. Broadside-coupled lines are more suitable, as they achieve coupling levels up to 2 or 3dB. Consequently, we have implemented a seven section 3 dB tandem coupler with broadside-coupled straplines. Its maximum phase and amplitude imbalances are 4^o and 1.2 dB over the entire frequency range. The power divider used is LYNX 111.A0214, whose characteristics are: 0.5{6 GHz frequency range, 0.8 dB insertion loss, 18 dB isolation, ± 2dB amplitude imbalance and $\pm 3^o$ phase imbalance.

The design criterion of a multi-port junction consists of achieving a good distribution of the q_i points [10]. In general, the closer the magnitudes of qi, and the larger the differences between the arguments of q_i, the better will be the performance of the circuit. Nevertheless, the multi-port network can provide good results even when the ratios of the magnitudes of q_i are greater than 4, and the phase differences between q_i are smaller than 25^o. When RF and LO input ports are completely isolated, the equivalent q_i-points of the multi-port network can be expressed in terms of scattering parameters as:

$$q_i = -\frac{S_{i1}}{S_{i2}}; \qquad i = \{3,4,5,6\}$$

Ideally, in our multi-port network topology (Figure 5.2) the magnitudes of q_i-points are equal to 1, and the arguments differ 90 degrees. The measured q_i-points of the developed multi-port network satisfactorily fulfil these requirements, as it can be seen in Figure 5.2.

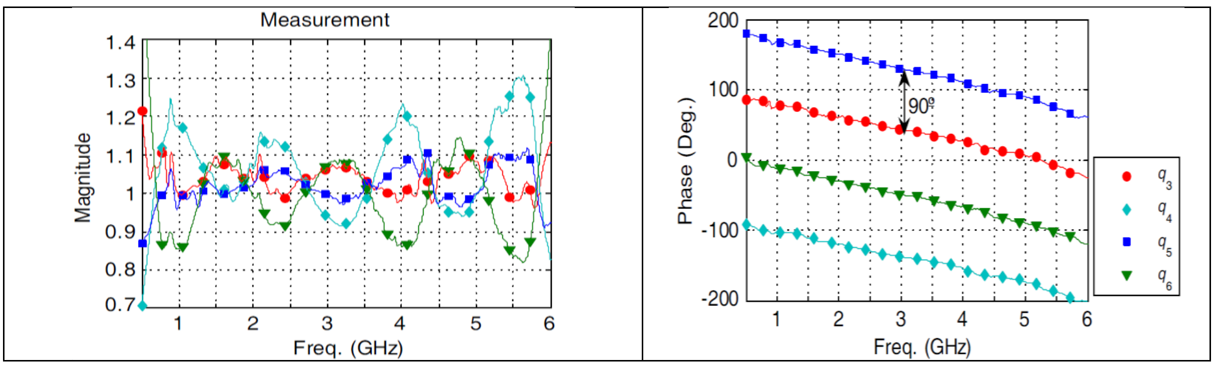


Figure 4 Simulated and measured qi-points of the multi-port network. (a) Magnitudes. (b) Phases

The magnitudes of qi are in the range of 0.7 to 1.5 from 500MHz to 6 GHz, and the maximum error in the relative phase differences is 10± over the theoretical 90±. Therefore, according to [3], the operating frequency range of the multi-port network could be enlarged.

Figure 5 shown below is the 5G cogitative radio-based system, to enhance the spectrum sensing performance and allow multiple radio links on same device, proposed work did some modification in this system. This proposed technique uses multiple FFT and IFFT modules for multiple channel support, in proposed design total eight Channel are considering hence eight isolated FFT are in use. Hybrid technique uses interleave at input end & also using de-interleave at receiver.

As shown in Figure 5, radio section; quarter-wavelength open stubs at A and B are added to block high-frequency RF signal. In addition, an impedance value at A and B is zero. Capacitor (C1) with a capacitance of 0.1 pF is added to block the baseband signal and dc bias. This bias-tee structure can help as much RF signal and baseband signal power flow to the diode as possible, which can improve the modulation and demodulation efficiencies. Therefore, when RF short is achieved at selected frequency, impedance at E can be calculated as, see D_E, as shown at the bottom this page was propagation constant $\beta = 2\pi/\lambda$and Q_{Diode} consists of dynamic resistance, junction resistance, junction capacitance, and parasitic parameters of the diode. Avago HSCH-5314 diodes are adopted to implement the design. The diodes have low junction capacitance and parasitic parameters. The bias voltage can change the junction resistance continuously. Therefore, with known Q_1 and state of diode, the desired impedance of diode-based module as a function of bias voltage can be achieved by changing the length of D_{Q1}, D_{Q2} and D_{Q3}.

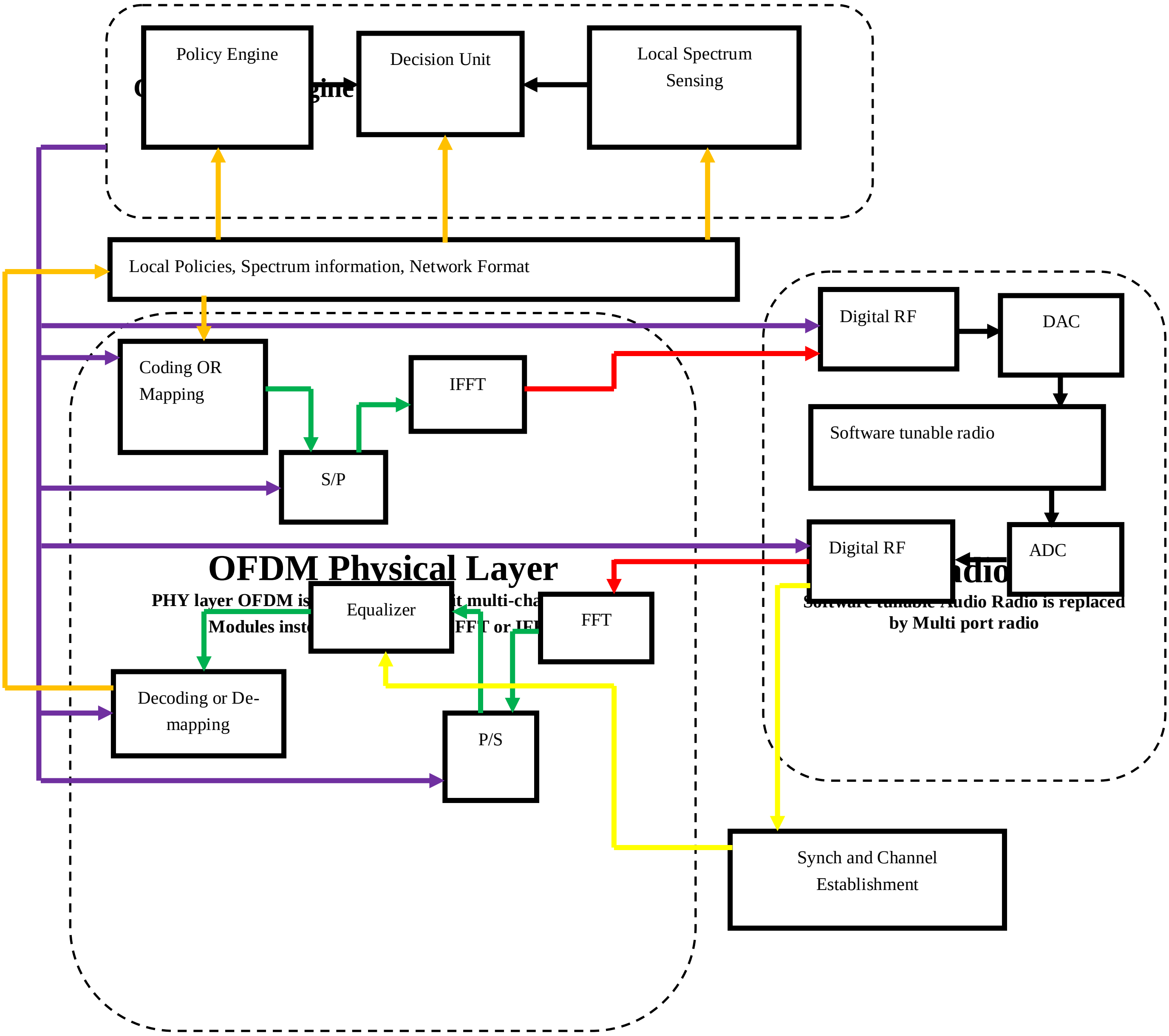


Figure 5 Proposed SDR System with multiport modulator

III-RESULTS

The prototype design achieved BER of 16.1 % and 14.6 % for QPSK and 16-QAM transmissions, respectively. This is a report implementing a new RF transmitter based on a multi-port modulator for multiple subcarriers in an OFDM environment. MATLAB recreation is performed & examination of results is gotten on premise of BER & comparing available in traditional framework, proposed framework utilizing Split FFT&8 port Modulation framework which is compared with strategies such as multi-port modulation with DWT. Figure 6 shows SDR Parameters Setting in the GUI

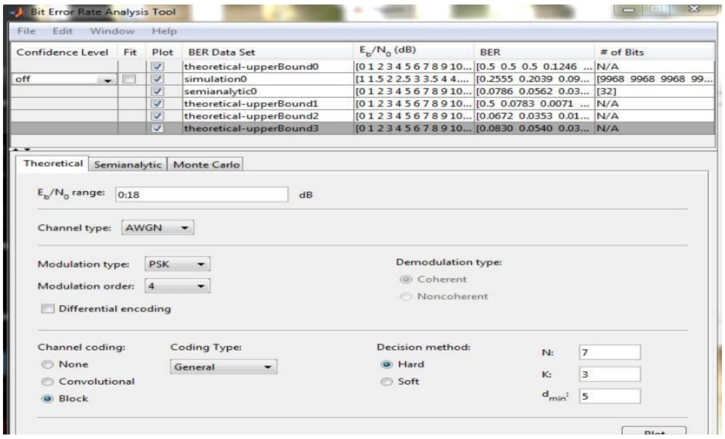


Figure 6: SDR Parameters Setting in the GUI

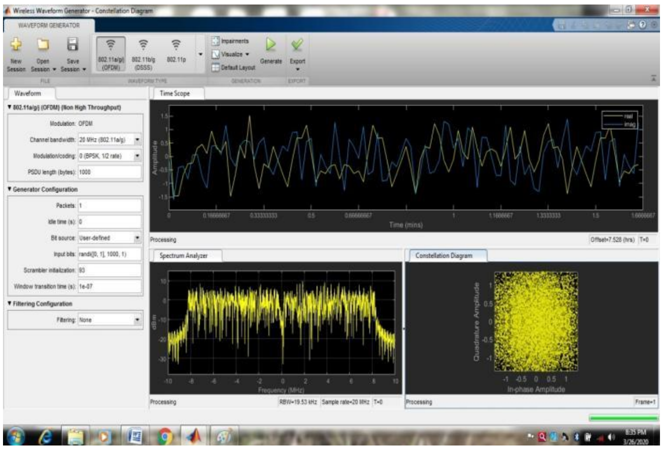


Figure 7: 16 PSK modulated with proposed multi-port modulator on SDR

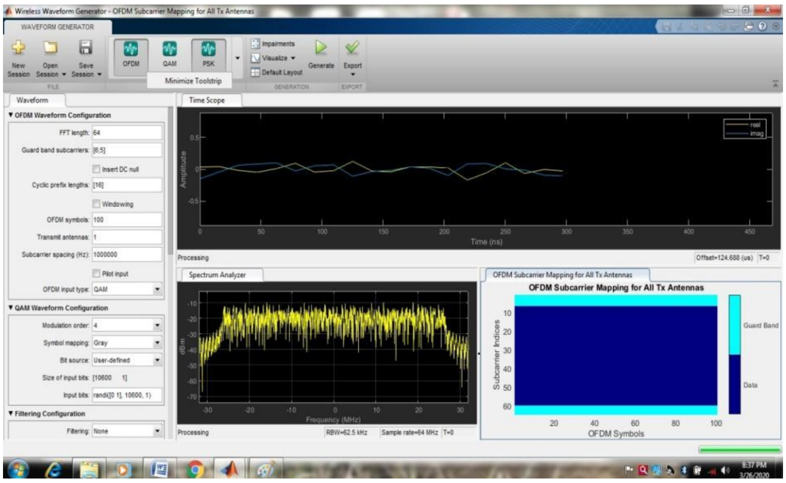


Figure 8: SDR Single channel modulation on multi-port modulator

From the figure we can observe the PAPR of the proposed work and the peaks looks closer to the average value of the subcarriers of the SDR signals, as the difference between peaks and average reduces PAPR also gets reduces.

Table 1 below shows the Percentage of Adjacent Channel Interference (ACI) obtained when different amount of noisy massage signals is modulated on SDR on 9 modulating ports frequency ranges starts from 1GHz to 30 GHz.

Table 1 Percentage of ACI v/s SNR

BW:1Ghz-30Ghz		
SN	Amount of Noise in dB	Percentage of Adjacent Channel Interference (ACI)
1	5	0.632
2	10	0.501
3	15	0.436
4	20	0.395
5	25	0.357
6	30	0.338

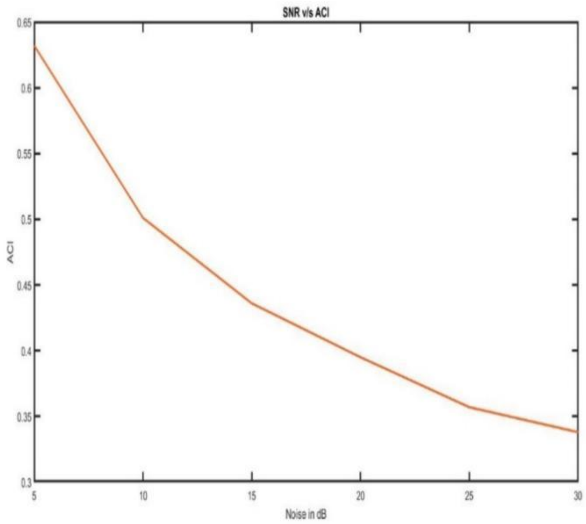


Figure 9 Percentage of ACI v/s SNR

Table 2 below shows the Bit Error Rate obtained when different amount of noisy massage signals is modulated on SDR on 9 modulating ports frequency ranges starts from 1GHz to 30 GHz.

Table 2 Bit Error Rate v/s SNR

BW:1Ghz-30Ghz		
SN	Amount of Noise in dB	Bit Error Rate
1	0	0.0032
2	3	0.0025
3	6	0.0022
4	9	0.00201
5	12	0.00181
6	15	0.00172
7	18	0.00164
8	21	0.00158
9	24	0.00151
10	27	0.001401

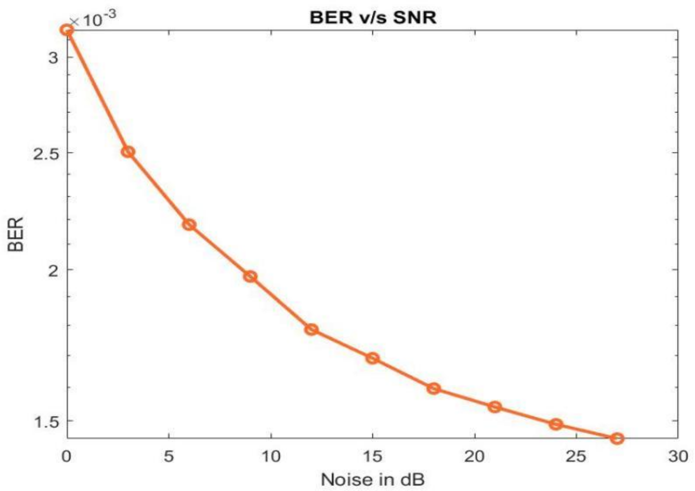


Figure 10 BER v/s SNR

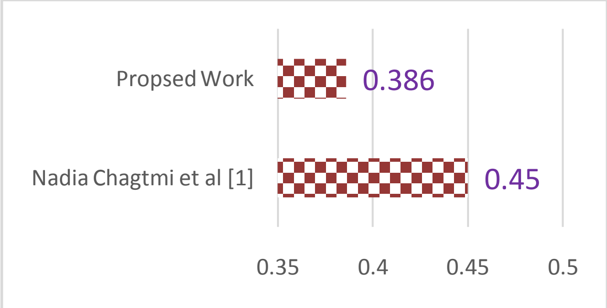
From the table 3, 4 and figure above it can be observe that with proposed multi-port modulation in OFDM we get lowest BER and ACI as compare with available work.

Table 3 Method and Outcome Comparative results

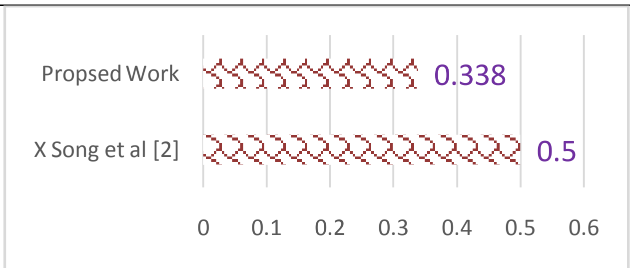
Author	Summary	Outcome
Nadia Chagtmi et al [1]	approach is based on behavioural nonlinear modelling that jointly compensates for the frequency response, nonlinearity and memory effects of the receiver	0.45 ACI observed at 21 dB noise when 2 GHz bandwidth frequency band used
X Song et al [2]	transceiver that consists of a single six-port correlator and four Schottky diodes can realize both modulation and demodulation simultaneously at different frequencies	0.5 percent ACI obtained at 27 dB when 2.68-2.9 GHz frequency band used.
Rashid Mirzavand et al [3]	five-port Ka-band direct conversion receiver based on six-port structures has been presented that is very suitable for software defined radio applications.	0.00732 BER obtained with 23-29 GHz frequency band used.
N. S. A. Arshad et al [4]	multi-port device is a 6- port replacing the high-cost mixer in conventional transmitter. six-port network can be functioned as a digital modulation by connecting port 1 to local oscillator and port 3 to port 6 to either open and short termination	2.5 percent ACI observe at 10 dB with 2.2-4 GHz frequency band used
Proposed Work	MBMS-OFDM multi-port modulation-based communication model developed for cognitive radio with for frequency ban d ranges from 1GHz to 30 GHz.	0.632 percent ACI observe at 5 dB with 1Ghz-30Ghz frequency range. 0.501 percent ACI at 10 dB with 1Ghz-30Ghz frequency range. 0.436 percent ACI at 15 dB with 1Ghz-30Ghz frequency range. 0.395 percent ACI at 20 dB with 1Ghz-30Ghz frequency range. 0.357percent ACI at 25 dB with 1Ghz-30Ghz frequency range. 0.338 percent ACI at 30 dB with 1Ghz-30Ghz frequency range.

Table 4 Analytical Comparison

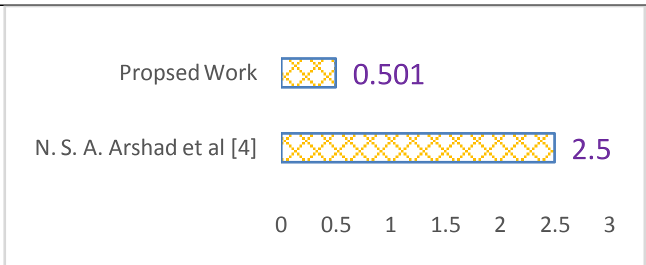
ACI observed 21 dB noise when 2 GHz bandwidth frequency	
Nadia Chagtmi et al [1]	0.45
Proposed Work	0.386



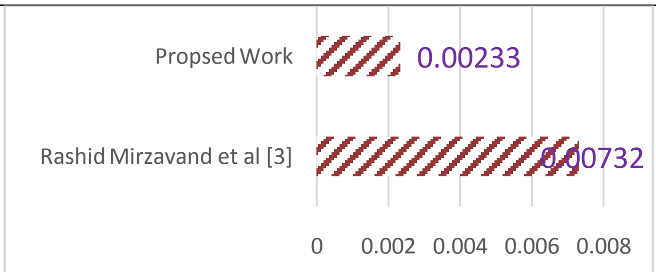
ACI observed 27 dB noise when 2.9 GHz bandwidth frequency	
X Song et al [2]	0.5
Proposed Work	0.338



ACI observed 10 dB noise when 4 GHz bandwidth frequency	
N. S. A. Arshad et al [4]	2.5
Proposed Work	0.501



BER observed 5 dB noise when 26 GHz bandwidth frequency	
Rashid Mirzavand et al [3]	0.00732
Proposed Work	0.00233



IV-CONCLUSION

For downlinks in future high-speed high-carrier-frequency wireless communication systems, a multi-port direct modulator with carrier leakage suppression is proposed and experimentally verified. To be able to tolerate high carrier frequencies while also reducing inter carrier symbol (ICI) and inter symbol interference (ISI). If there is a static element in the reflection coefficient, a multi-port modulator that uses variable reflection coefficients at certain ports to generate modulated RF may suffer from LO leakage. It is well known that LO leakage to the RF port causes not only undesirable LO signal emission, but also impairs receiver system performance due to a dynamic dc offset and second-order non-linearity at the detected baseband signal.This paper describes a multi-port modulator-based cellular transmitter architecture and its use in an OFDM context. This work demonstrates that a multi-port modulator-based transmitter may be used in an OFDM environment, as well as that prior work that was limited to single-carrier transmission can be expanded to multi-carrier transmission. With a more comprehensive solution, software reliability can be enhanced, regulatory concerns may be investigated, and fears about undesired adaptations can be alleviated. It could be interesting to study the idea of designing a passive network that can do pulse shaping, such as Root-raised-cosine filtering, to improve the performance of the multi-port modulator. Techniques for recovering carriers that can be used with ten-port radios.

REFERENCES

N. Chagtmi, A. Harguem, N. Boulejfene and F. M. Ghannouchi, "Six-port Based High Performance Concurrent Dual-Band Receiver," 2018 Asia-Pacific Microwave Conference (APMC), 2018, pp. 875-877, doi: 10.23919/APMC.2018.8617281.

X. Song et al., "A Six-port Transceiver for Frequency-Division Duplex Systems," in IEEE Microwave and Wireless Components Letters, vol. 28, no. 10, pp. 936-938, Oct. 2018, doi: 10.1109/LMWC.2018.2860781.

Rashid Mirzavand and Abbas Mohammadi, "Five-port receiver implementation in Ka-band for software-defined radio," 2006 Asia-Pacific Microwave Conference, 2006, pp. 480-483, doi: 10.1109/APMC.2006.4429468.

N. S. A. Arshad, W. L. Cheor, S. Z. Ibrahim and M. S. Razalli, "QPSK modulation using six-port device," 2014 IEEE Symposium on Wireless Technology and Applications (ISWTA), 2014, pp. 58-63, doi: 10.1109/ISWTA.2014.6981196.

X. Song et al., "Six-port Direct Modulator with Carrier Suppression Technology for High-Speed High-Frequency Wireless Communications," in IEEE Microwave and Wireless Components Letters, vol. 27, no. 8, pp. 745-747, Aug. 2017, doi: 10.1109/LMWC.2017.2723950.

A. O. Olopade, A. Hasan and M. Helaoui, "Concurrent Dual-Band Six-port Receiver for Six-Standard and Software Defined Radio Applications," in IEEE Transactions on Microwave Theory and Techniques, vol. 61, no. 12, pp. 4252-4261, Dec. 2013, doi: 10.1109/TMTT.2013.2288690.

B de la Morena-Alvarez Palancia and M. Burgos-Garcia, "Four-octave six-port receiver and its calibration for broadband communications and softwaredefined ratio", Prog. Electromangn. Res, vol. 116, pp. 1-21, 2011

J. Osth, A. Serban, Owais, M. Karlsson, S. Gong, J. Haartsen, et al., "Six-port Gigabit demodulator", IEEE Trans. Microw. Theory Tech, vol. 59, no. 1, pp. 125-131, Jan. 2011.

M. Olopoade, A. Hassan and M. Hellaoui, "'Concurrent dual ban six-port receiver for multi standard and software defined radio applications'", IEEE Transactions on microwave theory and techniques, vol. 61, no. 12, pp. 4252-4261, Dec. 2013.

A. Hasan and M. Helaoui, "Novel modeling and calibration approach for sixport receivers mitigationg system imperfections and hardware impairments", IEEE Transactions on Microwave Theory and techniques, vol. 60, no. 8, pp. 2644-2553, 2012.

T. Liu, S. Boumaiza and F. M. Ghannouchi, "Augmented Hammerstein Predistorter for Linearization of broad-band Wireless Transmitters'", IEEE transactions on microwave theory and techniques, vol. 54, no. 4, pp. 1301-1307, 2006.

M. D. McKinley, K. A. Remley, M. Myslinksi, J. S. Kenney, D. Suchreurs and B. Nauwelaers, "'EVM calculation for broadband modulated signal'", Proc. 64 th ARFTG Conf Dig, pp. 45, Dec. 2004

S. O. Tatu, A. Serban, M. Helaoui and A. Koelpin, "Sixport technology: The new rise of an old concept", IEEE Microw. Mag., vol. 15, no. 7, pp. S34-S44, Nov./Dec. 2014.

H. S. Lim, W. K. Kim, J. W. Yu, H. C. Park, W. J. Byun and M. S. Song, "Compact six-port transceiver for time-division duplex systems", IEEE Microw. Wireless Compon. Lett., vol. 17, no. 5, pp. 394-396, May 2007.

S. Abielmona, H. V. Nguyen, C. Caloz, K. Wu and R. G. Bosisio, "Compact multilayer ultra-wideband six-port device for modulation/demodulation", Electron. Lett., vol. 43, no. 15, pp. 813-814, Jul. 2007.

Y. Zhao, C. Viereck, J. F. Frigon, R. G. Bosisio and K. Wu, "Direct quadrature phase shift keying modulator using six-port technology", Electron. Lett., vol. 41, no. 21, pp. 1180-1181, Oct. 2005.

Y. Zhao, J.-F. Frigon, K. Wu and R. G. Bosisio, "Multi(six)-port impulse radio for ultra-wideband", IEEE Trans. Microw. Theory Techn., vol. 54, no. 4, pp. 1707-1712, Jun. 2006.

J. Osth, M. Karlsson, A. Serban and S. Gong, "M-QAM six-port modulator using only binary baseband data electrical or optical", IEEE Trans. Microw. Theory Techn., vol. 61, no. 6, pp. 2506-2513, Jun. 2013.