A Generalized Architecture of OFDM Modulator

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Abstract— **In the world of advanced communication orthogonal frequency division multiplexing (OFDM) plays a very excellent role in various wireless communications such as digital audio broad casting (DAB), Digital video Broadcasting (DVB), 802.11A, Chinese Multimedia Mobile Broad casting (CMMB) etc. Project enact on methodology like Beacon, Constellation Mapping ,Sub-carrier index, Inverse Fast Fourier Transform (IIFT),Cyclic bits, Guard intervals, Configuration Blocks in order to obtain a generalized architecture of OFDM modulator for different wireless communications like DAB, DVB, 802.11a based on FPGA platform.**

Keywords— OFDM,Iift,Generalized,Multicarrier .

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is form of collective carrier modulation comprising of compactly spaced carrier modulated signal. OFDM bifurcates high stream data by placing it on a slow modulated band of narrow and compactly spaced sub carriers. DAB, DVB are the two important techniques were OFDM is widely implemented. Information signal is applied onto the carrier the side bands expands on both left and right of the band, hence the receiver demodulator should be wide enough to receive the entire signal and demodulate the entire widened signal via filtering action ,hence interference is avoided as the carriers are orthogonal.

Digital Audio Broadcasting incorporates the carrier scheme termed as ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) .DAB'S information contents are bifurcated into colossal no of streams that are low bit rates information. Bits are intern applied to modulate the carrier that is orthogonal. DAB incorporate services that contain data and audio services. Services information is unique and intern has the maximum error correction prospective.

IEEE 802.11a was an amendment to wireless local network specifications that set condition for orthogonal frequency division multiplexing (OFDM) communication system. It gives protocol that lets transmission and reception of data at rates of 1.5 to 54Mb/s. The OFDM Signal that is used in 802.11 consists of 52 subcarriers. Out of which 48 are used for data transfer and four are used as pilot subcarriers. Difference between individual subcarriers is 0.3125 MHz's .This is because that 20 MHz bandwidth is divided by 64. Even though only 52 subcarriers are used other remaining space is used as guard for different channels.

II BACKGROUND

Table 1 shows OFDM parameters for DAB and 802.11A Wireless Standards.

TABLE 1: OFDM PARAMETERS

PARAMETRS	WIRELESS STANDARDS	
	DAB Transmission Mode 3	IEEE 802.11A
Sub-Carrier spacing (T)	0.487us	0.05us
Total symbol duration(Ts)	156us	4us
Useful Symbol Duration(Tu)	125us	3.2us
Guard interval duration(Tg)	31us	0.8us
No of Sub-Carriers	192	52
Total IFFT	256	64

As depicted in table various timing parameters for standards like Digital Video Broadcasting (DAB), IEEE 802.11A are diverge. The structure of OFDM is below with timing contents.
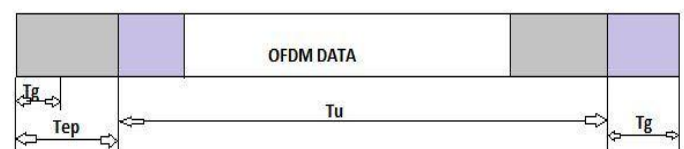

FIGURE 1: OFDM STRUCTURE

This OFDM Structure makes it Possible to develop" A Generalized Architecture for OFDM Modulator". Implementation is discussed below

III IMPLEMENTATION

This section divides the project into five main functional blocks: Constellation Mapping, Sub Carrier Indexing, Beacon Inverse Fast Fourier Transforms (IIFT), Cyclic Prefixes, Guard Intervals and configuration Blocks.
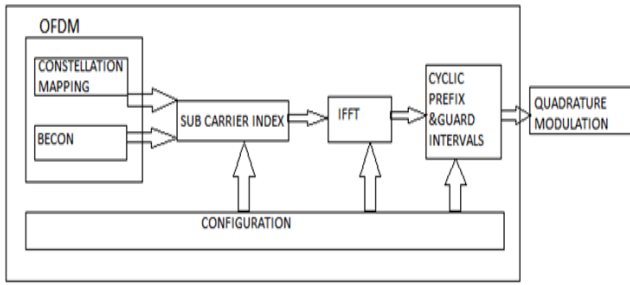
FIGURE 2: BLOCK DIAGRAM

A. CONSTELLATION MAPPING

It is way of presenting the signals that are modulated via a constellation Diagram. Project enacted here involves Quadrature phase shift Keying, the Constellation Diagram is as shown below.
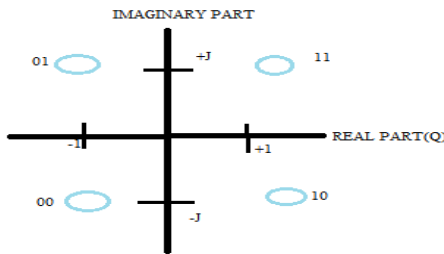

FIGURE 3: QPSK CONSTELLATION DIAGRAM

The modulation configuration is given as input to select a network type either DAB or IEEE 802.11a. The data input is also feed to this block, using QPSK constellation mapping Technique +1 and -1 are enacted utilizing different 16-bit Frame structure processed by Fixed Point Algorithm and stored in ROM, the outturn is feed to Buffer
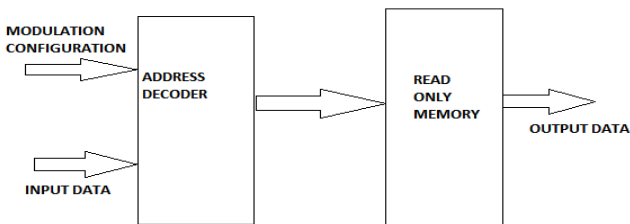

FIGURE 4: CONSTELLATION MAPPING

B. BEACON

Beacon, also termed as synchronization, involves recognizable sequence provoked by a specific formula. Adders, Multipliers are basic resources essential for its enactment. This paper encompass of formula and out-turn is memorized in ROM performing procedure of fixed point.

C. INVERSE FAST FOURIER TRANSFORM (IFFT)

Speed and Length are essential factor that intern determine the maximum bandwidth that can be achieved, by which the IFFT core is chosen for the system. Wireless Standards like Digital Audio Broadcasting, IEEE 802.11a has a different IFFT Length, 256 point IIFT for DAB, 64 point IFFT for IEEE 802.11a

FFT Equation below is bi-furcated in even part and odd part. If odd part is equalized to zero, then first halt of outturn of even part, even part equalized to zero then outturn of first half is of odd part.

$$X(m) = \sum_{n=0}^{(N/2)-1} x(2n)W_{N/2}^{nm} + W_N^m \sum_{n=0}^{(N/2)-1} x(2n+1)W_{N/2}^{nm} \quad (1)$$

$$X(m+N/2)$$
$$= \sum_{n=0}^{(N/2)-1} x(2n)W_{N/2}^{nm} - W_N^m \sum_{n=0}^{(N/2)-1} x(2n+1)W_{N/2}^{nm}$$

$$(2)$$

$n=0, 1, 2..... (N/2)-1$
$m=0, 1 ... (N/2)-1$
$W_{N=e}^{-j2\pi/N}$

From equation -3, IFFT numeration can be evaluated by FFT

$$X(n) = 1/N[\sum_{K=0}^{N-1} X^*(K)W_N^{nk}]1^* \quad (3)$$

N-Point IFFT can be evaluated via 2N-point IFFT core, at time were odd part is equalized to zero. Determination max IFFT length, other IFFT length can be eligible figured out.

D. SUB-CARRIER INDEX

Signals has valid Sub-Carriers as well as Null sub-Carriers, the position of Null Sub-carriers are divergent with respect to Valid Sub-Carriers. Starting and Ending indexes of valid indexes are noted and stored. Generated counter indicates the IFFT indexes, correlation with Starting and Ending, Sub-.Carrier Index allotted at right Position.

Figure 5 shows the IFFT input sequence, points a, b, c, d represent edges of sub-Carriers.
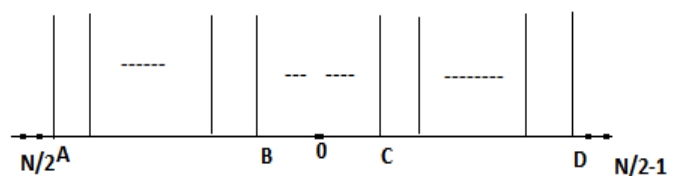

FIGURE 5. IFFT INPUT SEQUENCE

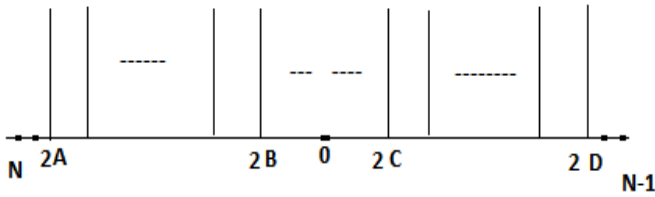Calculating N-point IFFT by 2N-point IFFT core, the outturn indicated in figure below.

FIGURE 6. 2N-POINT IFFT INPUT SEQUENCE

E. CYCLIC PREFIX AND GUARD INTERVALS

Wireless standard constitute of unlike lengths of guard intervals and cyclic prefix. The out-turn of IFFT forwarded to block of cyclic prefix and guard intervals were OFDM symbol lengths is utilized to store data. The storage methodology is shown is figure 7.
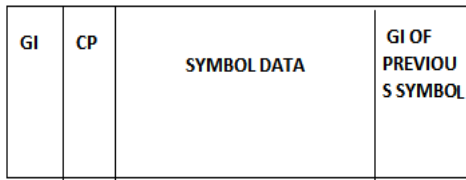

FIGURE 7: STORAGE METHEDOLOGY

Two port works together for receiving the data part, one port work body ordering of data, other port is for writing address from beginning. This step moves the IFFT data into RAM. Variable length of cyclic prefix has no effect on data sequence.

Three parameters g_data is data stored in ROM, g_b is current data, g_a data previous symbol. The operation of guard intervals is as shown in figure below.
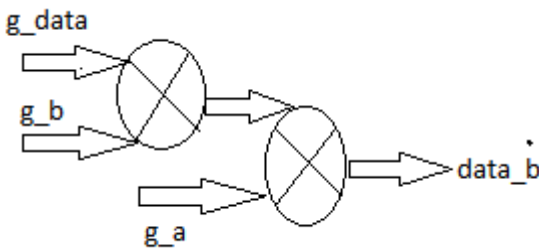

FIGURE 8: GUARD INTERVAL OPERATION

The calculated output data_b is back written to RAM, current GI data is evaluated and 8 clock cycles are required for this operation.

F. CONFIGURATION

This provides all parameters like the length of IFFT for IFFT block, Length of guard intervals, cyclic prefix, Inserting zero position for Sub-carrier block, synchronization information for Beacon .In this project symbol 0 is configured for DAB, symbol 1 is configured for

IEEE.802.11a for evaluation of IFFT length, Sub-Carrier Indexing and Cyclic and guard Intervals
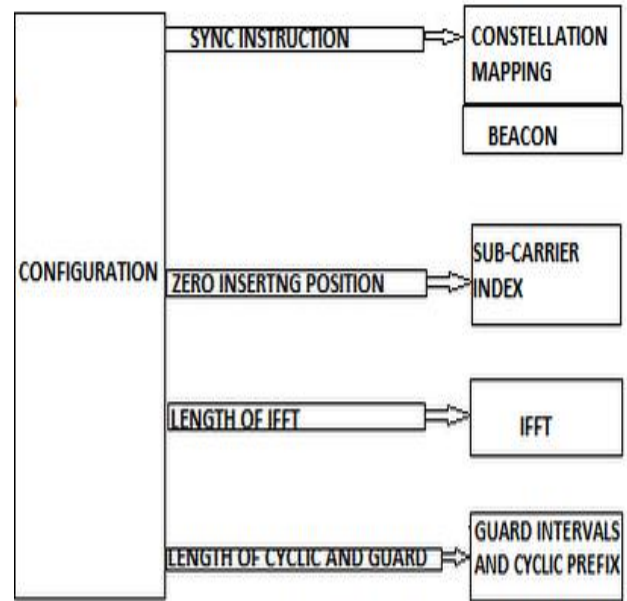

FIGURE 9: CONFIGURATION PARAMETERS.

IV. RESULT

After simulation of the design utilizing Xilinx 14.2, the timing parameters of Table 1 is successfully obtained and verified
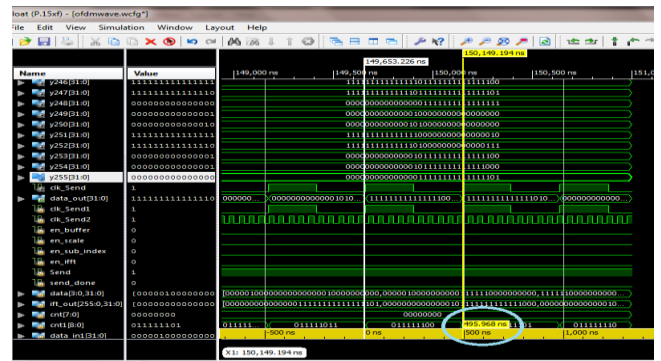
A. DIGITAL AUDIO BROADCASTING
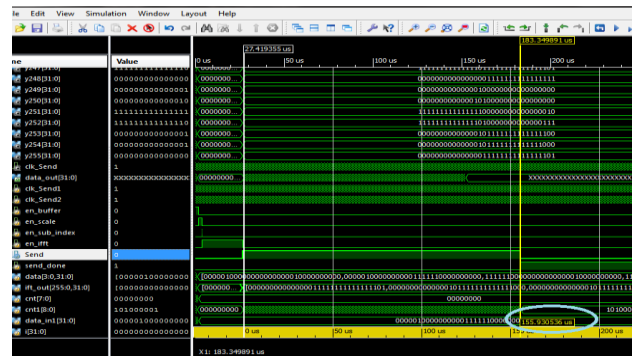

FIGURE10:WAVEFORM OF SUB-CARRIER SPACING(T)

FIGURE11:WAVEFORMOFTOTALSYMBOL DURIATION

From the figure shown above the following calculation is carried out and compared with theoretical references indicated in Table 1.

Sub-Carrier spacing(T)	Guard interval timing(Tg) (T*64)	Useful Symbol duration(Tu) (T*256)	Total Symbol duration(Ts) (Tg+Tu)
0.495us	31.68us	125.32us	157us

TABLE 2: DAB RESULT

B. IEEE 802.11A

From the figures shown below the following calculation are carried out and compared with theoretical value of Table 1.

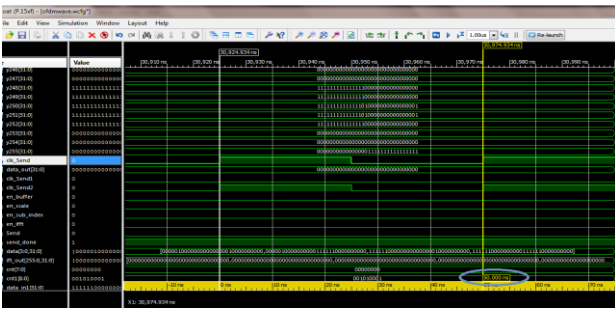| Sub-carrier spacing(T)	Guard interval timing (Tg) (T*16)	Useful symbol duration(Tu) (T*64)	Total symbol duration(Ts) (Tg+Tu)
0.0512us	0.8us	3.12us	3.92us

TABLE 3: IEEE 802.11A RESULT

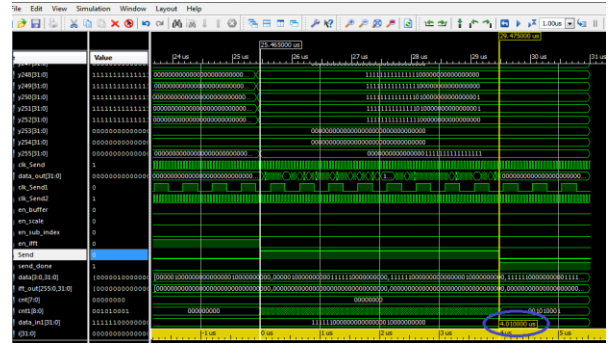Figure 12:waveform OF Sub- Carrier Spacing(T)

Figure 13: waveform of total symbol duriation(Ts)

V. CONCLUSION

In this paper, we enact, A Generalized Architecture for OFDM modulator in DAB, IEEE 802.11a, standards of wireless communication. Involving Quadrature Phase Shift Keying (QPSK) for Transmission Mode 3, respective to DAB, and simulated by Xilinx 14.2.Successful obtained Timing Parameters and verified with the theoretical timing parameters. Hence the complexity of using different Modulation Schemes for Different Kind of wireless Standards schemes is reduced.

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