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# Analysis of Digital Video Broadcasting - Terrestrial Second Generation (DVB-T2) Based on OFDM System on Transmission Aspect

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***Abstract—*** *DVB-T (Digital Video Broadcasting – Terrestrial) that was first published in 1997 is the DVB European-based consortium standard for the digital broadcast transmission and now become standard in over the world. This systems able to transmits a huge datas fastly with compressed digital data using OFDM modulation. And nowdays DVB-T have been develop into better qualification that we call Digital Video Broadcasting Second Generation (DVB-T2). The purpose of this paper is to provide a MATLAB simulation of the processing signal involved on OFDM of DVB - T2 and compare between 2K-mode and 8K-mode. With the delay taken care of so the differences is small, and the reception result is straightforward. The large value of PAR 8K mode is bigger than 2K mode. It shows that 2K mode is more stabil than 8K mode, so 2K system is more appropriate for mobile transmission. But in Single Frequency Network (SFN) 8K mode system is better because have bigger space transmitter.[7].*

***Keywords—*** *Digital Video Broadcasting - Terrestrial Second Generation (DVB-T2); DVB-T; Orthogonal Frequency Division Multiplexing (OFDM).*

## I. INTRODUCTION

DVB is a common standard that is accepted internationally for digital video broadcasting. DVB systems distribute data using a variety of approaches, satellite (DVB-S), cable (DVB-C), terrestrial (DVB-T) and digital terrestrial for handheld (DVB-H). DVB standards maintained by the DVB Project, an industry consortium with more than 270 members issued by JTC (Joint Technical Committee), CENELEC (European Committee for Electrotechnical Standardization) and the EBU (European Broadcasting Union) [2].

In the DVB standard using MPEG-2 compression standard as a data container. With the conception of the transmission of digital information can be done flexibly without needed to impose limits what type of information will be stored in the container the data. MPEG2 transport stream packets of constant length that has been optimized for DVB-T. Length MPEG-2 TS packet is 188 bytes, which consists of 4 byte header and a 184 byte payload. The payload consists of video, audio or data in general. While the header is composed of various essential items for packet transmission.

In Figure 1 can be explained some of functions parts of the header. The first header byte is the length of the packet sync byte with 8 bits. Sync byte is used for synchronization or the initial identification of a transport stream packet. While transport error indicator is used to identify the error bit in the TS packet. For a packet identifier (PID) has a length of 13 bits package serves to identify the TS packets carrying data of the same elementary stream.

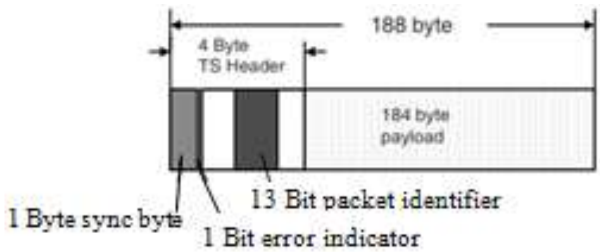


Fig. 1. MPEG2 Transport stream packets.

Protocol and format of TS to DVB-T is compatible parts in the MPEG-2 specification defined in ISO / IEC 13818-1. This format is based on the approach to the transport stream packet length which fixed and has been optimized for DVB-T.

In the case of DVB-T, there are two choices for the number of carriers known as 2K or 8K. These are actually 1705 or 6817 carriers that are approximately 4kHz or 1kHz apart. Sudipta Ghosh and Ankit Bass has done research about Implementation DVB-T using OFDM on Physical Media Dependent Sub Layer for 2K mode. In this research compare 2K mode and 8K mode for transmission aspect.

DVB-T offer different modulation scheme. DVB-T is a digital transmission system that delivers a series of data at the symbole rate. DVB-T using OFDM in order to helps the receiver to counter the effect of multipath in urban environment. The effect of multipath can be countered by using guard interval bit insertion. DVB-T has been adopted for digital television broadcasting by many countries, using mainly VHF 7 MHz and UHF 8 MHz [5].

## II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM)

OFDM (Orthogonal Frequency Division Multiplexing) is a multicarrier transmission technique, where inter subcarriernya one another mutually orthogonal. Due to the nature of this orthogonality between adjacent subcarriers can be made without causing overlapping intercarrier interference (ICI). This would make OFDM has higher spectral efficiency.

OFDM is a modulation technique that is used for DVB-T standard. With OFDM modulated data are transmitted in parallel via subcarriers. The concept of OFDM is to divide the data rate wideband information signal into parallel rows of



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data with a data rate that is lower then parallel data is modulated with mutually orthogonal subcarriers. This is one of the advantages of OFDM, since the original channel is frequency selective fading will be perceived as flat fading by each subcarrier, so the signal distortion due to multipath fading canal treatment is reduced. To shorten the computing time can be implemented algorithm fast Fourier transform (FFT).

The disadvantage of OFDM is the peak average power ratio, this is because the power of the transmitted signal is the sum of the power of the subcarrier so the impact on the power amplifier. The expression for one OFDM symbol starting at t = ts as follows :

$$s(t)=\mathrm{Re}\left\{\sum_{i=-\frac{N_s}{2}}^{\frac{N_s}{2}-1} d_{i+N_s/2}\exp\left(j2\pi\left(f_c-\frac{i+0.5}{T}\right)(t-t_s)\right)\right\},\ t_s\le t\le t_s+T \quad (2.1)$$

$s(t) = 0, t < t_s$

$t > t_s + T$

Where :

$d_i$ = complex modulation symbol

$N_s$ = number of subcarriers

T = symbol duration

$f_c$ = frequency carrier

IFFT and FFT process is key in OFDM. IFFT serves as a symbol of manufacture (modulator) OFDM and FFT as decomposers of OFDM symbols (demodulator) [6]. FFT and IFFT equation can be written as follows.

FFT:

$$x(k)=\sum_{n=0}^{N-1}x(n)sin\left(\frac{2\pi kn}{N}\right)+j\sum_{n=0}^{N-1}x(n)cos\left(\frac{2\pi kn}{N}\right) \quad (2.2)$$

IFFT:

$$x(k)=\sum_{n=0}^{N-1}x(n)sin\left(\frac{2\pi kn}{N}\right)-j\sum_{n=0}^{N-1}x(n)cos\left(\frac{2\pi kn}{N}\right) \quad (2.3)$$

Where :

x(k) = number of FFT/IFFT

N + number of subcarriers

Input of the IFFT OFDM signal is a time domain, it is does’nt matter because IFFT is a mathematical concept, so no matter what the output and input of the system, as long as the input have amplitudes of several sinusoidal, IFFT will produce a value in the form of time domain [4].

## III. Digital Video Broadcasting Terrestrial Transmission

The system transmits compressed digital data in an MPEG transport stream using OFDM modulation. There are two choices for the number carriers known as 2K-mode and 8K-mode which is actually 1705 or 6817 number of carriers that approximately 4 kHz or 1 kHz apart. And in this simulation is compared between 2K-mode and 8K-mode. A block diagram of the generation of one OFDM symbol is shown in Figure 2.

On 2K-mode number of carriers are 1705 and 8K-mode number or carriers are 6817. T is defined as the elementary period for a baseband signal. Parameter values used in simulation is shown on table 1.

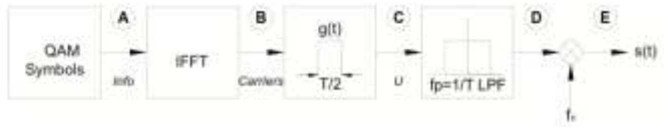


Fig. 2. OFDM symbol generation simulation.

TABLE 1. Parameter values used in simulation.

| Parameter | 2K mode | 8K mode |
|---|---|---|
| Carrier | 2048 | 8192 |
| Used Carrier | 1705 | 6817 |
| Scattered Pilots | 142/131 | 568/524 |
| Continual Pilots | 45 | 177 |
| TPS Carrier | 17 | 68 |
| Payload Carrier | 1512 | 6048 |
| Duration $T_u$ | 224 µs | 896 µs |
| Carrier Spacing $1/T_u$ | 4464 Hz | 1116 Hz |

A block diagram of the transmitter design system DVB-T2 using OFDM is shown on figure 3.

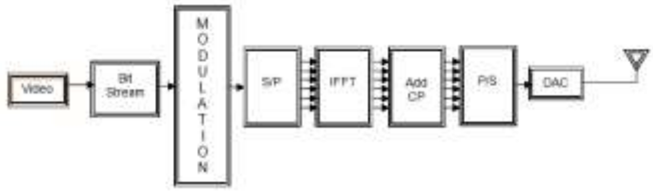


Fig. 3. Transmitter design system DVB-T2 using OFDM.

In figure 4 and figure 5, we see the result of this operation and the signal carriers uses T/2 as its time period and it's a discrete time baseband signal.

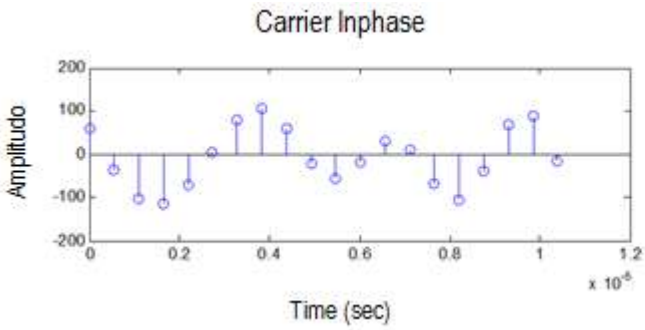


Fig. 4. Time response of signal carriers 2K mode.

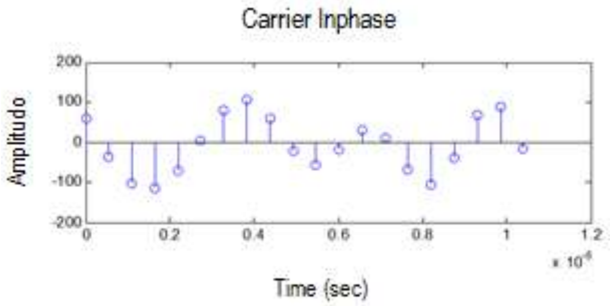


Fig. 5. Time response of signal carriers 8K mode.



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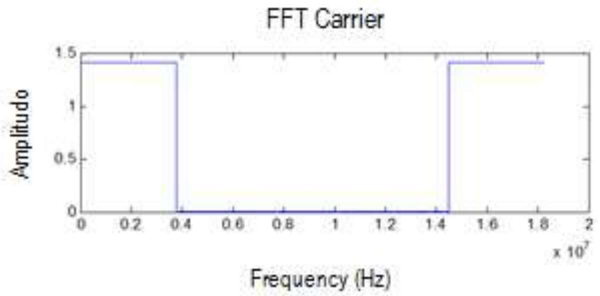


Fig. 6. Frequency response of signal carriers 2K mode.

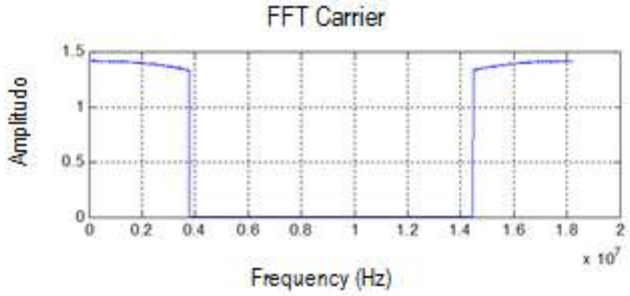


Fig. 7. Frequency response of signal carriers 8K mode.

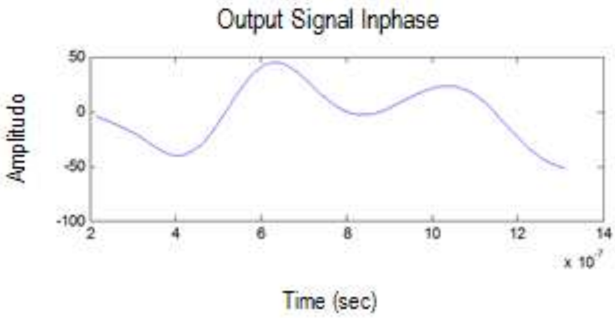


Fig. 8. Time response of signal output 2K mode.

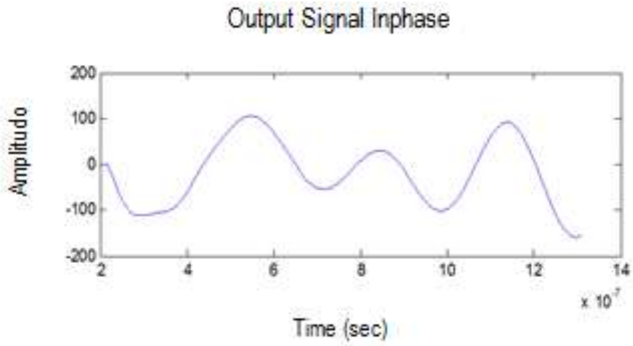


Fig. 9. Time response of signal output 8K mode.

OFDM occur in the continuous time domain, therefore we must apply transmit filter, g(t), to the complex signal carriers. The filter output of 2K mode and 8K mode shown in Figure 8 and Figure 9.

The filtering process produce delay approximately 2x10-7. And on frequency response show baseband spectrum with subcarrier 853 to 1705 are located at the right of 0 Hz and 1 to 852 are to the left of 4 fc Hz for 2K mode. For 8K mode subcarrier 3408 to 6817 are located at the right of 0 Hz and 1 to 3407 are to the left of 4 fc Hz.

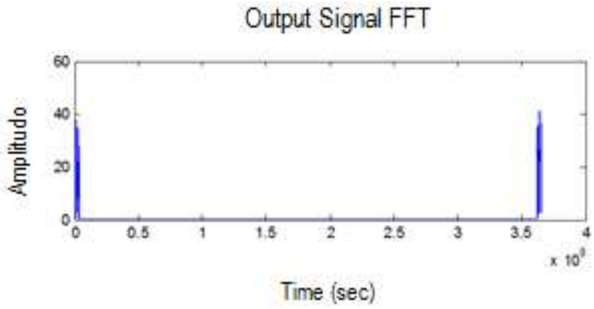


Fig. 10. Frequency response of signal output 2K mode.

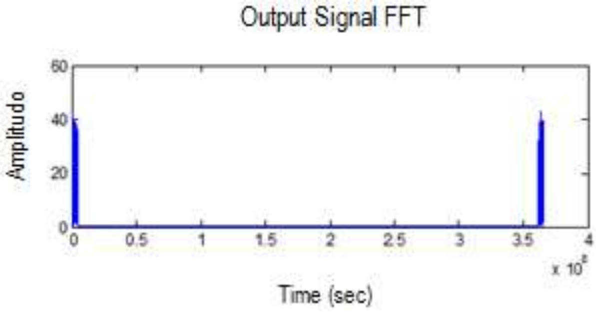


Fig. 11. Frequency response of signal output 8K mode.

The complete output signal are shown in Figure 12 and Figure 13.

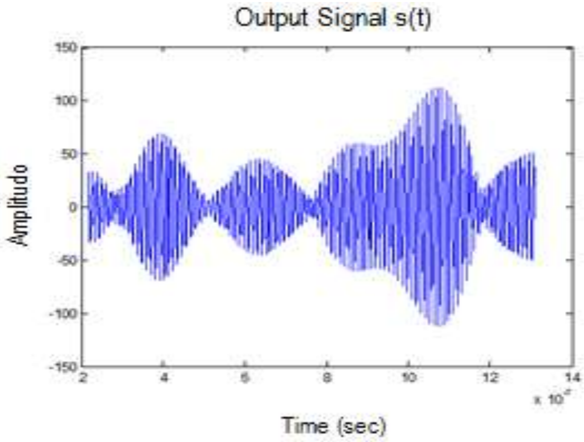


Fig. 12. Time response of signal output 2K mode.

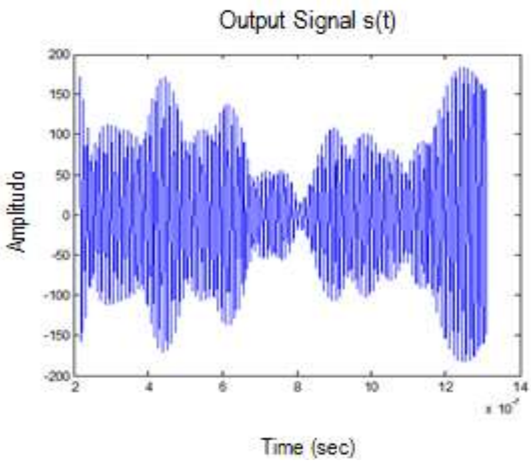


Fig. 13. Time response of signal output 8K mode.

The first thing to notice is there are differences between output 2K mode and 8K mode. We can observe the large value of PAR 8K mode is bigger than 2K mode. It shows that 2K mode is more stabil than 8K mode, so 2K system is more appropriate for mobile transmission. But in Single Frequency Network (SFN) 8K mode system is better because have bigger space transmitter.[7]

## IV. Digital Video Broadcasting Terrestrial Reception

A block diagram of OFDM reception simulation is shown figure 14.

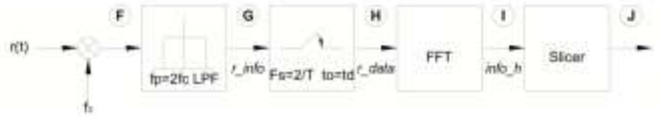

Fig. 14. OFDM reception simulation.

OFDM is very sensitive in timing and frequency offset. Even in this ideal simulation, we must consider about the delay produced by filtering. In this simulation we use delay Td = 64/Rs. A block diagram of receiver design system DVB-T2 using OFDM is shown in figure 15.

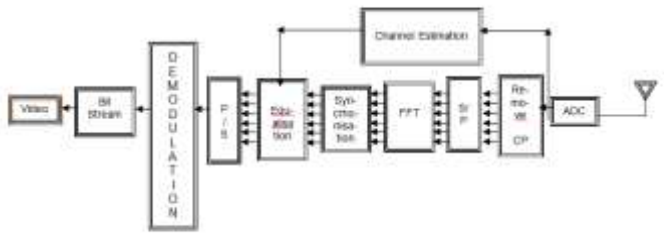

Fig. 15. Receiver design system DVB-T2 using OFDM.

With the delay taken care of so the differences is small, and the reception result is straightforward. The result of simulation are shown in figure 16 until figure 19.

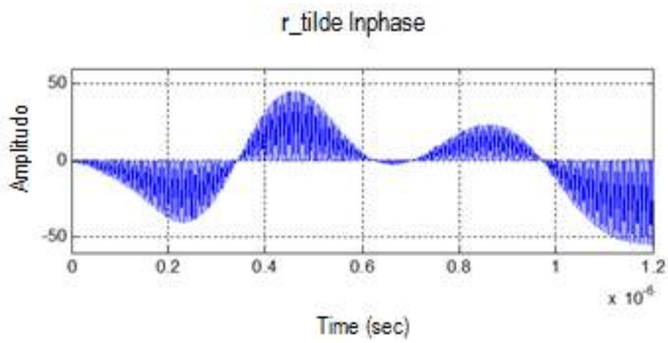

Fig. 16. Time response of signal output 2K mode.

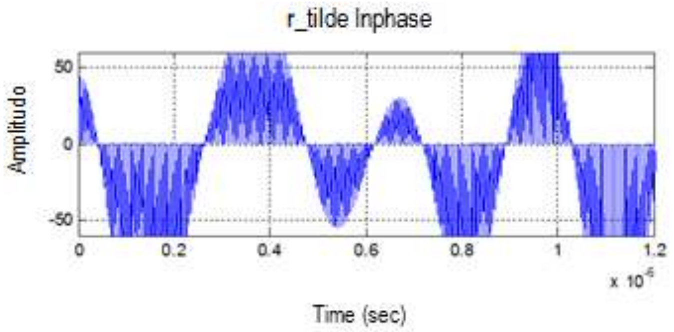

Fig. 17. Time response of signal output 8K mode.

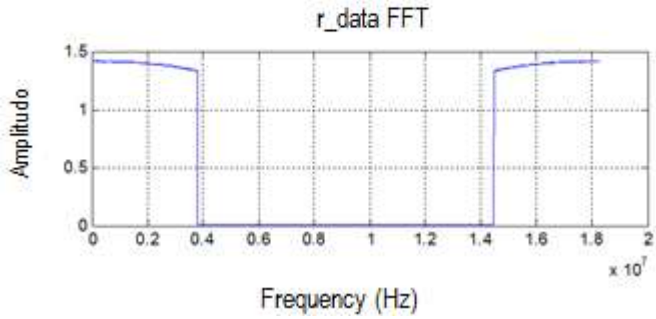

Fig. 18. Frequency response of signal output 2K mode.

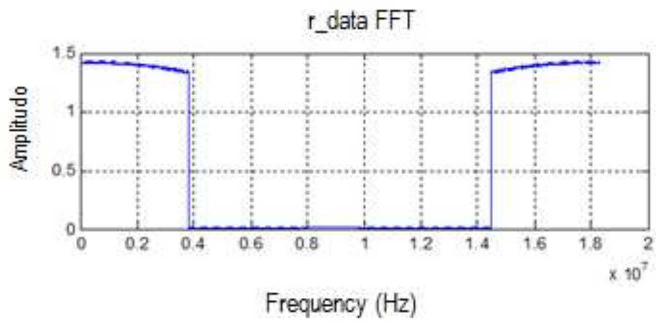

Fig. 19. Frequency response of signal output 8K mode.

## V. Conclusions

In this paper we have figure out performance comparison between 2K mode and 8K mode on DVB-T.The presented comparison is presented into account many different parameters such as number of carriers, number of used carriers, and duration $T_u$.The transmission and reception have been simulated using Matlab. We observe that between 2K-mode and 8K-mode has similiar performance. With the delay taken care of so the differences is small, and the reception result is straightforward. The large value of PAR 8K mode is bigger than 2K mode. It shows that 2K mode is more stabil than 8K mode, so 2K system is more appropriate for mobile transmission. But in Single Frequency Network (SFN) 8K mode system is better because have bigger space transmitter.[7]

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