*ISBN 978-602-53531-8-5*

# Implementation of Digital Communication System on DSK TMS320C6713

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**Abstract**

Communication system using digital modulation has been used widely on telecommunication system nowadays, including voice communication, video or data. In this research author make a system implementation digital communication using modulation techniques ASK, FSK, BPSK, dan QPSK that passed into AWGN channel (Additive White Gaussian Noise) then added Rayleigh on DSK device (Digital Signal Processing Starter Kit) TMS320C6713 type. Furthermore, the designed system was evaluated. The evaluation of modulator signal output was in accordance with characteristic each modulation, but the received information signal was different from the sent information signal. BER performance that resulted from each system was fluktuatif. Both of these were caused by the AWGN channel and Rayleigh and the system did not use the signal quality improvement techniques of received information. The most efficient system in terms of memory usage on TMS320C6713 DSK is a system with FSK modulation, with a value of 1.15719697%. While most large systems use a memory is ASK communication systems with a value of 1.191666667% efficiency.

*Keywords: Digital Modulation, AWGN, Rayleigh, BER, DSK TMS320C6713*

## Introduction

Telecommunications technology is currently growing very rapidly as a result of the increasing needs of the community in activities or work. Communications technology effectively and efficiently continue to be developed by human to obtain a telecommunication system better than the existing telecommunications system. Therefore, many telecommunications researchers in the world continue to compete until now in order to improve the performance of a telecommunications system.

M-file of the simulation conducted found that the bit error rate (BER) at the BPSK and QPSK are equal in value. This is due to the process of sending data between BPSK (Binary Phase Shift Keying) and QPSK (Quadrature Phase Shift Keying) to within one bit. From these results indicate that the simulator results are in accordance with the theory of BER in digital modulation techniques when passed in AWGN channel (Sa'iyanti, N.P.. Pratiarso, A.,2011; Darlis, A.R, 2015).

Implementation modulation and demodulation on DSK TMS320C6416T to the type of modulation QAM (Quadrature Amplitude Modulation), 16 QAM and 64 QAM is concluded that there worst performance in 64 QAM modulation. This result is due to the BER values obtained worse. When compared with the value of BER of 10-5 BER value, the value of 64 QAM modulation BER is greater than 10-5. As for QAM and 16 QAM modulation BER values that are less than 10-5 (Aryanta, D. et al, (2015); Lidyawati, L. et al, (2015)).

There are several advantages when using TMS320C6713 DSK, which has a very quick process because TMS320C6713 DSK has a larger clock is 225 MHz. TMS320C6713 DSK is a specific application processor is a processor made specifically for certain applications (Nugraha, 2011).

From these studies, the author had the idea to create a digital communications system implementation on the device DSK (Digital Signal Processing Starter Kit) type TMS320C6713. This research will be conducted digital communication system simulation using Matlab software version r2007a and implementation of digital communication systems on the TMS320C6713 DSK. In the simulation and implementation will use a modulation technique ASK, FSK, BPSK and QPSK(Wahyudi, R.A., (2008)). A telecommunications system is always passed on certain tracks or channels that cause noise (interference signal channel). In this study, all modulation will be passed on channel AWGN (Additive White Gaussian Noise) and Rayleigh (Harada dan Prasad, (2002)).

The purpose of this study include the simulated digital communication system that is passed in AWGN channel and Rayleigh using Matlab software version r2007a format m-file, create a simulation of digital communication system that is passed in AWGN channel and Rayleigh using software matlab version r207a using Simulink, implementing on system design software with simulink Matlab version r2007a on TMS320C6713 DSK (Yeh, H.G. et al, (2007); Ghariani, N. et al, (2011)).

## 2. Methodology

In order for this research is more focused and clear the authors limit the study to be discussed, while the boundary problem is the modulation used modulation techniques ASK, FSK, BPSK and QPSK, the channels used in the system using the AWGN channel and Rayleigh, and do not use the technique improvement of signal quality information received.

Digital communication system is the process of delivering information from the sender to the receiver where the signal information sent or received is digitized, the signals are expressed in the form of bits of data (eg with the numbers 0 and 1). The main part of the digital communication system is the sender, the medium through which the transmitted signal, and a receiver (Emir, H. et al, (2007). With the hope of the received signal is equal to the signal sent by the sender information. Block diagram of a digital transmission system can be seen in Figure 1.

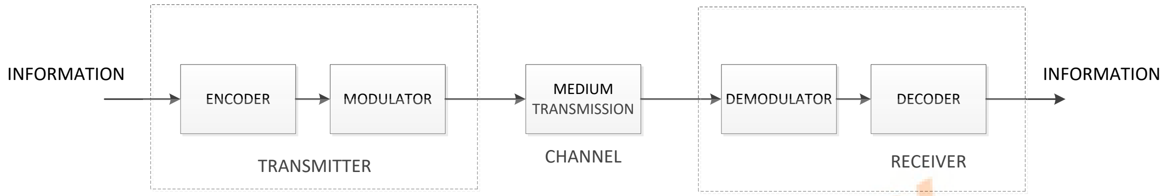



**Fig. 1 : Diagram block system Digital Transmission System**

If we construct a mathematical model for the received signal at the receiver, the channel through which the signal is assumed to undermine, by white Gaussian noise. When a signal is sent, white Gaussian noise, and received signal is modeled as (t), n (t0, and r (t), then the received signal:

$$r(t) = s(t) + n(t) \quad (1)$$

Where n (t) is a function of the AWGN process with the probability density function (pdf) and the power spectral density, the following equation:

$$\varphi_{nn}(f) = \frac{1}{2} N_0 [\frac{W}{Hz}] \quad (2)$$

Where $N_0$ is constant and often referred to as the power density noise (noise power density).

In multipath propagation, signal reception sometimes strengthen or weaken. This phenomenon is called multipath fading, and the received signal level change from time to time. Multipath fading increase data errors at the receiver, when the digital radio signal transmitted from the sender through terrestrial channels.

Rayleigh fading is often used as a realistic approach that is good enough for the wireless channel conditions non-LOS (Line Of Sight) and multipath. In the fading Rayleigh happen multiplication distortion h (t) with the transmission signal s (t), with n (t) is the noise, so that the received signal can be approximated by y (t) = [(h (t) • s (t)] + n (t) (Baddour, K. E. et al., (2005); Komninakis, C., (2008); Mathumisaranon, T. et al, (2013)).

Digital Signal Processing (DSP) processor, such as processor family TMS320C6x is a high-speed microprocessor with the type of architecture and instruction set specifically for signal processing. C6x notation indicates that the processor is a member of the Texas Instruments (TI) TMS320C6000 processor family (Texas Instrument. (2001); Kharel, R. et al, (2010); Maji, P. et al, (2012)). Architecture of digital signal processor C6x devoted to numerical calculations are very complex. Based on the architecture very longinstruction - word (VLIW) processor TI C6x considered as the best compared to others. DSP processor is closely related to signal processing in real-time (Ghariani, N. et al, (2011)).

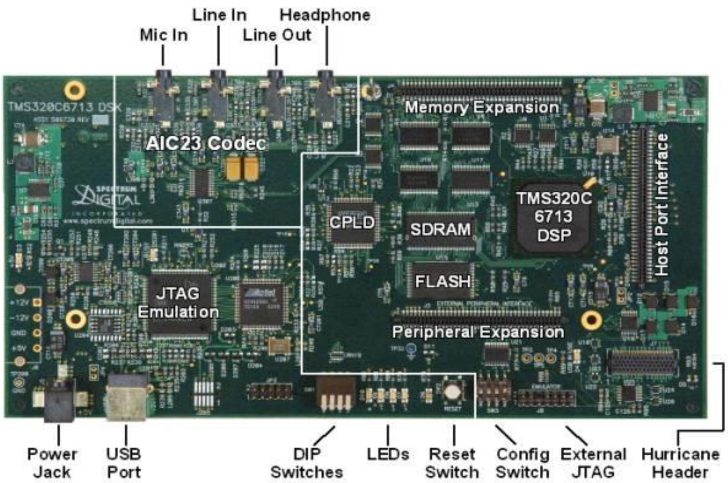


**Fig. 3 : DSK TMS320C6713 Board**

In this study conducted several stages of the simulation with m-file format, the simulation in Simulink and Simulink implementation of the TMS320C6713 DSK. Figure 4 shows the process flow of the making of this study. In this study will be made of digital communication system with five different types of modulation is ASK, FSK, BPSK and QPSK.

For a channel that is used is the AWGN channel and Rayleigh channel. Specifications of the canal Rayleighyang made are reflected signal to produce a third doppler frequency of 0.01 Hz. The first reflected signal gain of 10 dB and strengthening delay of 1 ms, the second reflected signal gain reinforcement 0:05 dB and 0.05 ms delay, and the third reflected signal gain of 20 dB attenuation and delay of 0.2 ms.

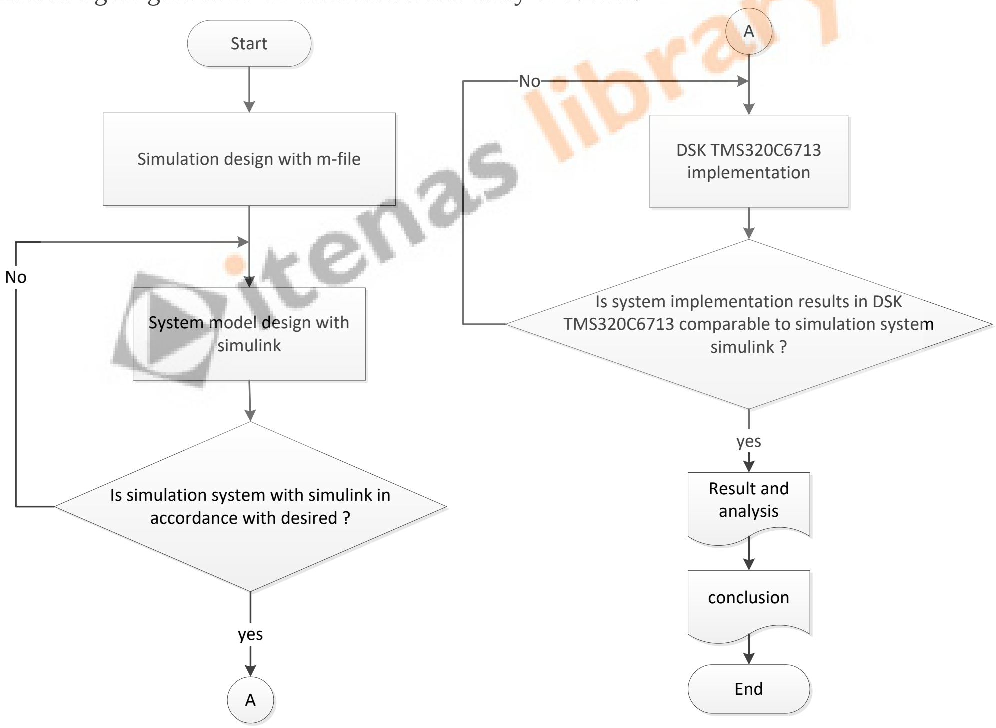



**Fig. 4 : System Flowchart Diagram**

The digital communication system created is a digital communication system using modulation ASK, FSK, BPSK and QPSK.

Digital communications system modeling with Simulink format created for implementation on TMS320C6713 DSK. But in Simulink modeling simulation can be performed before modeling is implemented on the device. Modelling made a total of five models, namely for systems with modulation ASK, FSK, BPSK and QPSK Of the five systems made, simply modeling made like Figure 5.

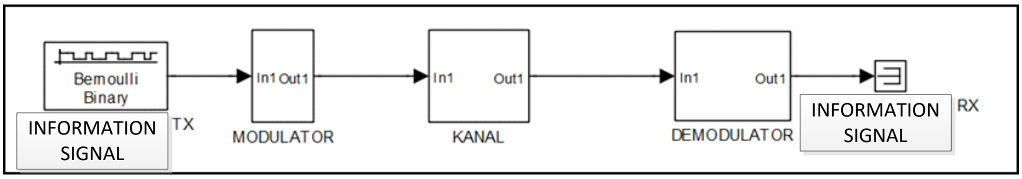



**Fig. 5 : Simulink Modeling**

## 3. RESULTS AND DISCUSSION

On systems that have been carefully tested to observe the shape of the signal generated by the system and testing the performance of BER (Bit Error Rate).

The output signal is taken on the simulation ¬m-file and Simulink are signaling information is transmitted, the signal modulator output signal after passing through the canal, and the information signal is received. While the implementation stages, the signal is taken from information transmitted signal, the modulator output signal, and the signal demodulation results. In the test signal generation information used in the form of a digital signal with an infinite amount of data, the value of Eb / N0 (Comparison of Bit Energy to Noise Energy) by 40 dB.

The test signal at the implementation stage done twice integration of the device, the first integration output signal modulator for testing and integration of the two to take the information received after the signal demodulator block. The tools used for image capture signal is 1 oscilloscope, 1 audio generator, one device is a PC (Personal Computer), and the TMS320C6713 DSK. In a system that will be implemented written blocks DSK board, pulse generator, and Block DAC (line out DSK).

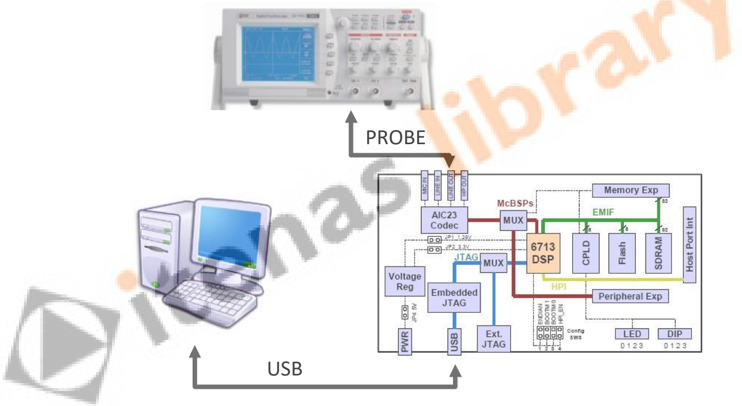
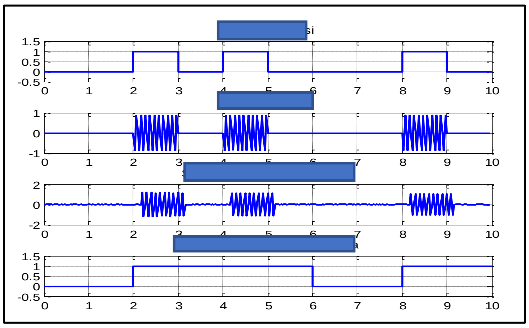


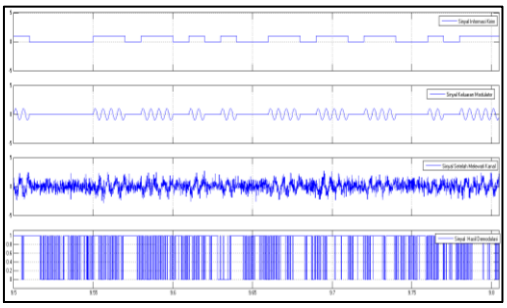

**Fig. 6 : The Composition of Signal Testing Tool Implementation at TMS 320C6713 DSK**

Block pulse generator is used as an information signal generator. The resulting information signal has an amplitude value of 1 volt, the bit period of 0.02 seconds, and a pulse width of 50% of the width of the signal of the period. The signals generated in the form of data bits 1 and 0 are repeated periodically over 0.01 seconds.

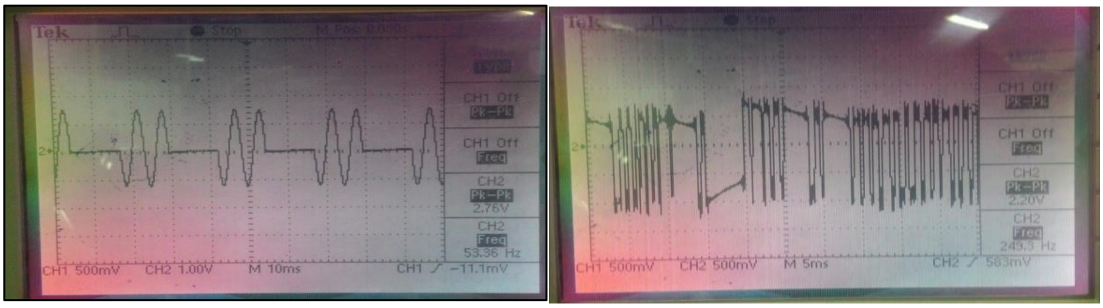
While signaling information used for decision QPSK modulation signal is converted into an information signal predetermined information data bits QPSK signal so that the phase change due to changes in the data bits of information can be observed. Block information signal pulse generator is converted into a block of repeating sequences of stair to generate the desired information signal.



**(a)**



**(b)**

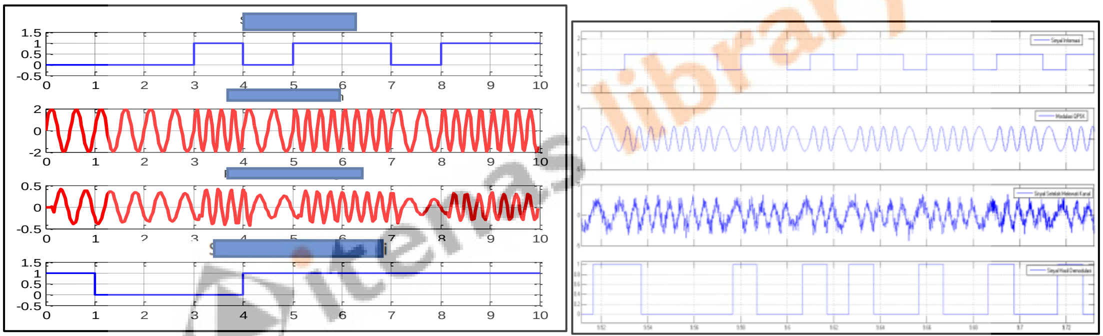


(c) (d)

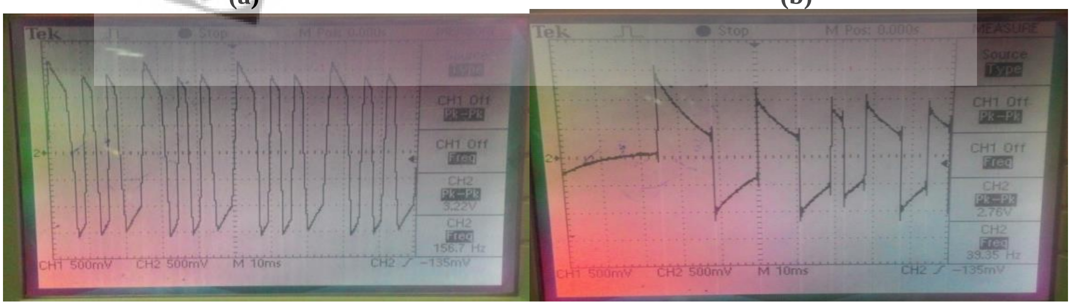
**Fig.7 : Output Signal System ASK (a) *m-file* (b) Simulink (c) Implementation of Modulator output Signal (d) Implementation Signal after Demodulation**

Results of testing the output signal m-file shown in Figure 7 (a), Simulink output signal in Figure 7 (b), a modulator output signal implementation results in Figure 7 (c), and implementation of signal demodulation results in Figure 7 (d) . From Figure 7, the signal after passing through the channel on the simulation of m-file get a delay between 0 to 0.3 seconds. The signal after passing through the channel Simulink simulation results have strengthened the amplitude at every second.

Results of testing the output signal m-file shown in Figure 8 (a), Simulink output signal in Figure 8 (b), a modulator output signal implementation results in Figure 8 (c), and implementation of signal demodulation results in Figure 8 (d). From Figure 8 Value amplitude of the signal after passing through the canal on the simulation of m-file damped to 1.6 volts. Signal demodulation results with Simulink simulation opposite to the information signal is sent, the information signal is supposed to be one received data bits are data bits 0 and vice versa continuously. As in 9.54 to 9.56 seconds.



(a) (b)



(c) (d)

**Fig. 8 : Output Signal FSK System (a) *m-file* (b) Simulink (c) Implementation of Modulator Output Signal (d) Implementation signal after Demodulation**

Results of testing the output signal m-file shown in Figure 9 (a), Simulink output signal in Figure 9 (b), the results of the implementation of a modulator output signal in Figure 9 (c), and implementation of signal demodulation results in Figure 9 (d). From Figure 18, the signal after passing through the canal on the simulation of m-file delayed by 0 to 0.2 seconds and experienced a phase change at 180 °. The signal after passing through the canal Simulink simulation results undergo a phase shift of 180 °.

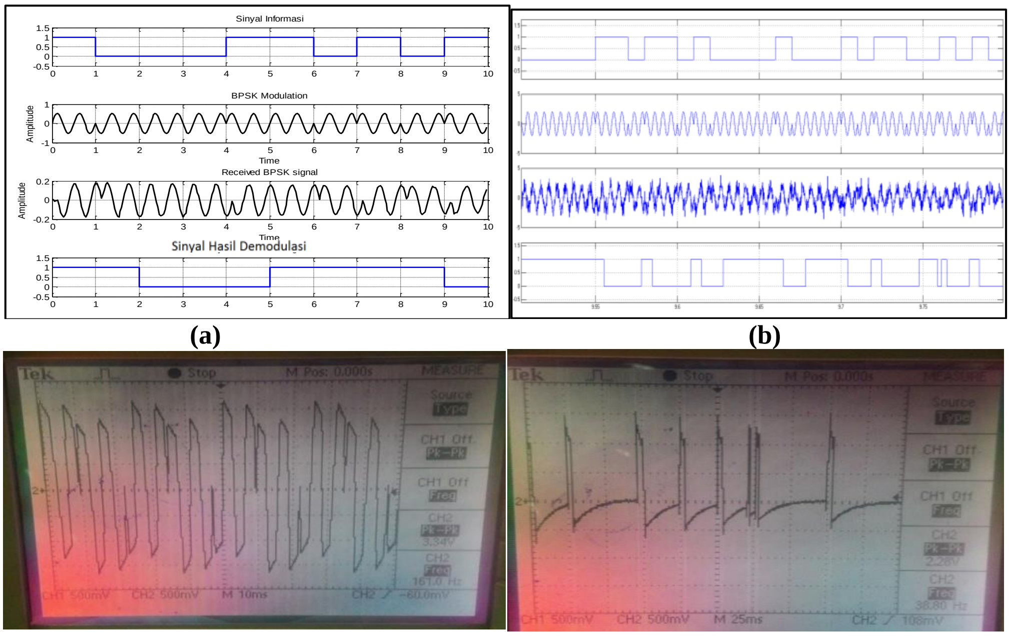



**Fig. 9 : Output Signal BPSK Sytem m-file (b) Simulink (c) Implementation of Modulator Output Signal (d) Implementation Signal after Demodulation**

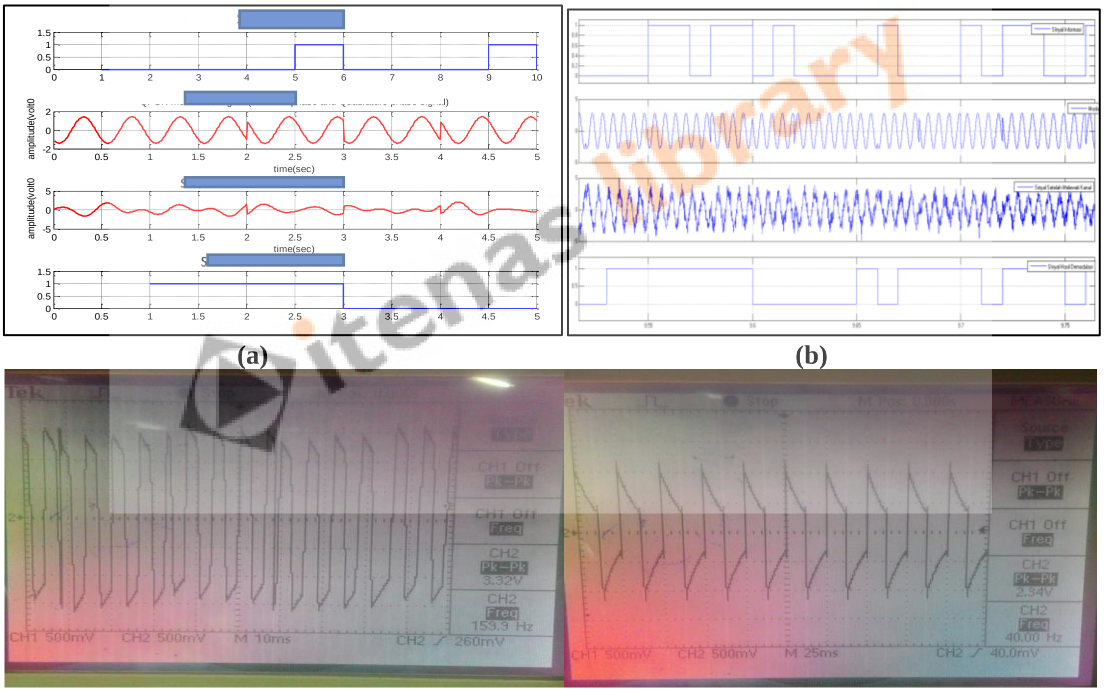



**Fig.10 : Output Signal QPSK System(a) *m-file* (b) Simulink (c) Implementation of Modulator Output Signal (d) Implementation Signal after Demodulation**

Results of testing the output signal m-file shown in Figure 10 (a), Simulink output signal in Figure 10 (b), a modulator output signal implementation results in Figure 10 (c), and implementation of signal demodulation results in Figure 10 (d). The signal after passing through the canal on the simulation of m-file get every second damping constant and the signal is not worth the experience the phase shift between 150 ° to 180 °. The signal after passing through the canal Simulink simulation results undergo a phase shift between -150 ° to -180 ° and the amplitude value also rose that is not constant, shown in Figure 19.

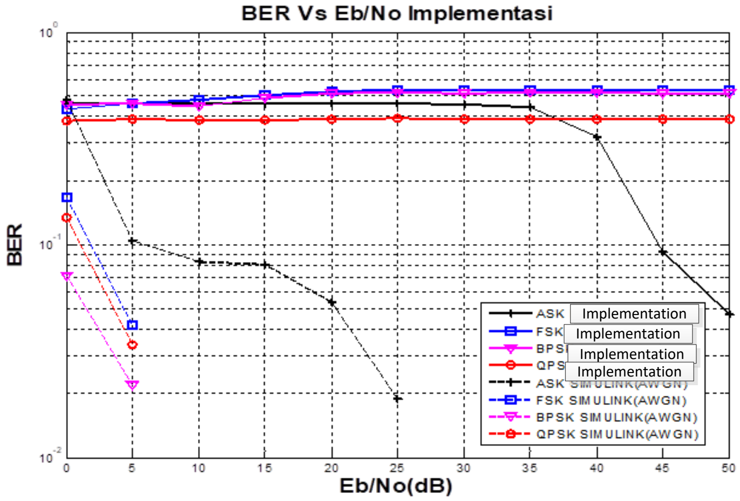



**Fig. 11 : BER Curve against Eb/N0 System Implementation Stage ASK, FSK, BPSK, and QPSK**

Simulink simulation of BER performance shown in Figure 11 are depicted with dashed lines, while the BER performance results of the implementation depicted without the dotted line. Black curve shows the communication system ASK, FSK communication system in blue, BPSK communication system with the color pink, and communication systems QPSK with red color. Comparison of each system in the implementation phase of the BER performance is shown in Figure 11. Up and down performance occurs when indigo Eb / N0 is increased. At Eb / N0 of 0 dB, in the implementation of the system performance QPSK modulation is better than the other three by a margin of 0.076 against the BER of ASK, BPSK 0.05 on, and 0.073 to BPSK. But when Eb/N0 is increased to 50 dB ASK BER performance is better than the three other modulation by the difference in value of the QPSK BER of 0.342, 0.491 against FSK, BPSK and 0.47 against.

TMS320C6713 DSK device has a data storage capacity of 264 kbytes (TexasInstrument, 2001). Storage capacity constraints become one of the important stages of implementation on the device, so that the efficiency of the system can be observed in terms of data storage capacity.

Observations made by taking the storage capacity of the data memory value of any system that has been implemented (Darlis, 2011). Then calculate the equation 3 for making the comparison value memory used to the total memory capacity of DSK (y) in units of percent

$$y = \frac{used\ memory}{DSK\ total\ memory} \cdot 100\% \qquad (3)$$

**Table 5 : Memory used on DSK for each system**

| Modulation | *Memory (bytes)* | y(%) |
|---|---|---|
| ASK | 3146 | 1,191666667 |
| FSK | 3055 | 1,15719697 |
| BPSK | 3078 | 1,165909091 |
| QPSK | 3096 | 1,172727273 |

Observations memory on implementation, to a communication system with ASK modulation using a memory of 3146 bytes with the y value of 1.191666667%, for communication with FSK modulation system using a memory of 3055 bytes and the y value of 1.15719697%, for communication systems with BPSK modulation using a memory of 3078 bytes and the y value of 1.165909091%, and communications systems with the QPSK modulation using a memory of 3096 bytes and the y value of 1.172727273%.

The result of the four systems were implemented, the most efficient system is a communication system using FSK modulation with a value of 1.15719697%. While most systems use a memory is a communication system using ASK modulation with a value of 1.191666667% efficiency.

From the observation memory used by each system to the implementation stages, if a comparison of each system with the characteristics of the modulation results of observations memory as opposed to BER test results. On the results of the BER performance, systems with ASK modulation best when Eb / N0 of 40 dB to 50 dB. While the memory used by DSK for system implementation with ASK modulation, using the ASK system memory compared to most other systems, with the unused memory of 3146 bytes.

## 5. CONCLUSION

From the results of the testing and performance analysis of communication system that has been done, then we got some conclusions, namely:

1. In the communication system with ASK modulation, required Eb / N0 of 50 dB so that BER performance difference between implementations with Simulink simulations that were previously worth 0.21 into 0,014.
2. In communication with FSK modulation system, required EB / N0 35 dB and 50 dB difference in value BER of implementations with Simulink relatively constant at 0.1004.
3. BER performance of a communication system with BPSK modulation at the time of implementation of the BER difference is greater than the average differences Simulink simulation - BER average of 0.08.
4. In communication systems using QPSK modulation BER performance in the implementation of relatively constant with average BER value - average of .387.
5. In the implementation phase on the condition of Eb / N0 0 to 37 dB the best system in terms of BER performance is a communication system with QPSK modulation compared to the three other modulation.
6. In the implementation phase on the condition of Eb / N0 of 50 dB-generating system BER performance is greatest communication system with ASK modulation compared with the three other modulation BER value of 0.047.
7. The most efficient systems in terms of memory usage on TMS320C6713 DSK is a communication system using FSK modulation with a value of 1.15719697%. While most systems use a memory is a communication system using ASK modulation with a value of 1.191666667% efficiency.

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