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Amplitude and Frequency Shift Keying Infrared Transmitter

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Abstract: In this paper, an infrared transmitter is designed using Amplitude and Frequency Shift Keying using the direct modulation where this transmitter give an opportunity for users to select the modulation signal that need to be transmitted. This transmitter is capable of transmitting signal to 353.498MHz with gain bandwidth of 12.010dB. The performance of the designed system is enhanced compared to existing transmitters. The designed can be used in existing communication system to improve the transmission of the signals for long haul communication.

Keywords: Bandwidth enhancement, Direct modulation Infrared transmitter, Modulation Scheme.

1. Introduction

Nowadays, there are many products was created with the latest technology. These creations have been carried out to allow human beings to experience a better life. For example, Optical Wireless Infrared (IR) is now a promising technology for long haul communication that can offer the high data rate transmission [1]. It has discussed that for optical indoor wireless systems, for the transmission of the signals Laser Diodes (LDs) or Light Emitting Diodes (LEDs) are utilized [2]. For the reception of the signals photo-diodes are utilized for optical signals [2].

It is also discussed in [3] that Infrared transmission doesn't interfere with Radio Frequency systems [3]. Therefore, infrared optical wireless transmitter with various modulation techniques was created in order to transmit the more than one detector scheme to the receiver to provide the better communication. Furthermore, the several of modulation techniques that can be transmit from this device can give the opportunity for the user to select which modulation that they need to transmit. Since LD is the main part for this device, it is capable to send the data with higher modulation bandwidth with linear electrical to optical signal conversion efficiency is better than LED and long range distance compare to the LED. So from these advantages of LD than LED, it is more reliable for this project to use this light source as a transmitter.

2. Background and Literature Review

The optical transmitter are designed using different modulation schemes such as Amplitude Shift Keying, Frequency Shift Keying. There are various design of optical transmitter are proposed by diffident researchers as in [4-8]. However, in this paper, the most relevant work is demonstrated to compare the performance of designed Infrared transmitter. It is discussed in [9] that a transmitter is designed using ASK modulation wave. The transmitter was designed using synchronization of modulates signal. A drive circuit executes a push-pull operation based on the modulated signal and a resonance circuit resonates under the push-pull operation of the drive circuit to transmit a transmission signal. The designed system in [9] provides a signal transmitter using ASK modulation wave which generates a transmission signal in a sharp signal waveform. The transmitter using FSK was proposed in [10]. The transmitter was designed using FSK to produce a specific output level frequency. In the paper, a capacitor is coupled in parallel with the oscillator circuit to provide the process of switching capacitor with oscillator circuit in order to change

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the output frequency [10]. In the next, the methodology for the proposed optical transmitter using ASK and FSK is discussed.

3. Research Methodology

The designed Infrared transmitter is developed using ASK and FSK modulation schemes. The designed system is developed using three main circuit that is i.e. modulated signal, bandwidth gain and laser driver circuit. The transmitter is designed using both amplitude and frequency modulation and transmitter will choose either of them depends upon the need of the circuit design. Since there are limitation of bandwidth from modulation signal that had generated, so the bandwidth of this signal need to be step up in order to fulfill the required range of LD bandwidth. This project that consist bandwidth gain circuit used two Op-Amps that is LMH6624 (Ultra Low Noise Wideband Operational; SOIC-8 packages) and AD9631 (Ultra Low Distortion, Wide Bandwidth Voltage Feedback Op-Amp) where both op-amps is cascade in order to gain the modulation bandwidth. The combination of Op-Amp LMH6624, resistor and capacitor will operate as an active high pass filter where it will pass high frequencies and reject low frequencies while Op-Amps AD9631 operate as non-inverting amplifier where it means the output is in phase and the same polarity as the input (from Op-Amps LMH6624). From the bandwidth gain circuit, the signal will be sent to laser driver circuit before it will be transmit to propagation medium. This circuit operates from ±5V supplies (Op-Amp OPA227) and it is inverting; i.e., drives from 0A to 2A into a laser diode with a 0V to –2V input. A very low noise bipolar input Op-Amp allows this circuit to achieve a low noise output current, an important consideration in dense channel spacing systems. The designed transmitter is developed numerically and performance of the designed system is carried using simulation.

3.1 Transmitter design using ASK modulation

In this circuit, the theoretical analysis is analyzed like DC fixed bias circuit of transistor. Some assumption must be made up since the value of β (ic/ib) is not shown in transistor BC547 data sheet and the value of VBE is assumed to be 0.7V(Si) in order to obtain the value of VCE.

The analysis as follow:

$$1.5V - i_b(R1) - 0.7V - i_e(R2) = 0$$
$$0.8V - i_b(R1) - i_e(R2) = 0$$
$$0.8V - i_b(R1) - (\beta + 1)(R2)i_b = 0$$
$$0.8V = i_b\big(R1 + (\beta + 1)(R2)\big)$$
$$i_b = \frac{0.8V}{(R1 + (\beta + 1)(R2))}$$

Let say β=50,

$$i_b = \frac{0.8V}{(1k\Omega + (50 + 1)10k\Omega)} = 1.566uA$$
$$i_c = \ \beta i_b = 50(1.566uA) = 78.3uA$$
$$i_e = \ i_b + i_c = 1.566uA + 78.3uA = 79.866uA$$

Nodal voltage:

$$V_{CE} = V_{CC} - i_e(R2)$$
$$V_{CE} = 1.5V - (79.866uA)(10k\Omega) = 0.701V$$
$$V_C = V_{CC} = 1.5V$$
$$V_E = V_{CC} - V_{CE} = V_C - V_{CE}$$
$$V_E = 1.5V - 0.701V = 0.799V$$
$$V_B = V_{BE} + V_C = 0.7V + 0.799 = 1.499V$$
$$V_{BC} = V_B - V_C = 1.499V - 1.5V = -0.001V$$

The ASK design circuit for the design transmitter is shown in Fig. 1. In the designed ASK transmitter, the DC fixed bias is introduce with of β (ic/ib).

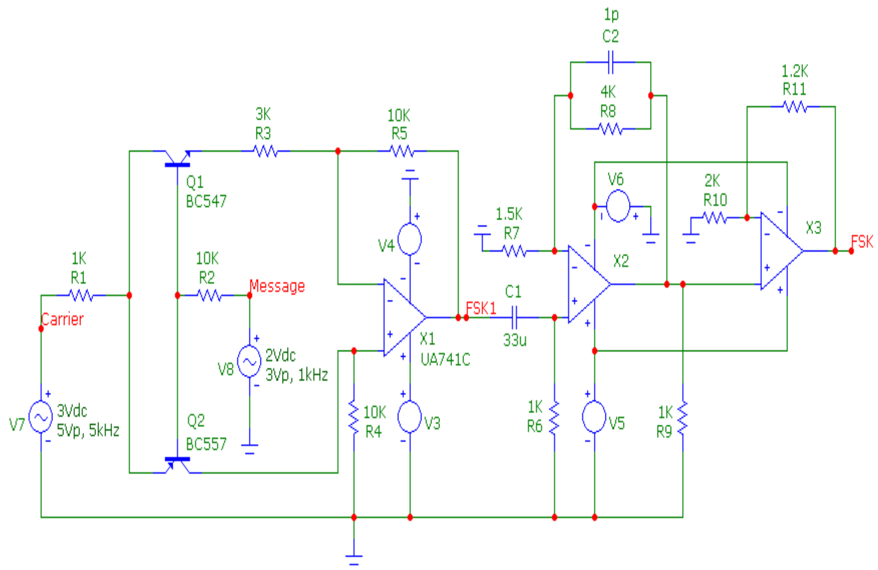

Fig. 1 - FSK modulation technique circuit simulation.

3.2 Transmitter design using FSK modulation

In this circuit, the theoretical analysis is analyzed for designed transmitter using FSK modulation. The analysis is shown as follow:

$$V_{FSK} = \left(1+\frac{R5}{R3}\right)(Vb(t) - \left(\frac{R5}{R3+R5}\right)Va(t))$$

$$V_{FSK} = \left(1+\frac{10k\Omega}{3k\Omega}\right)(Vb(t) - \left(\frac{10k\Omega}{3k\Omega+10k\Omega}\right)Va(t))$$

$$V_{FSK} = 4.333\ (Vb(t) - 0.769Va(t))$$

The FSK design circuit for the design transmitter is shown in Fig. 2. In the designed FSK transmitter, the DC fixed bias is introduce with of β (ic/ib).

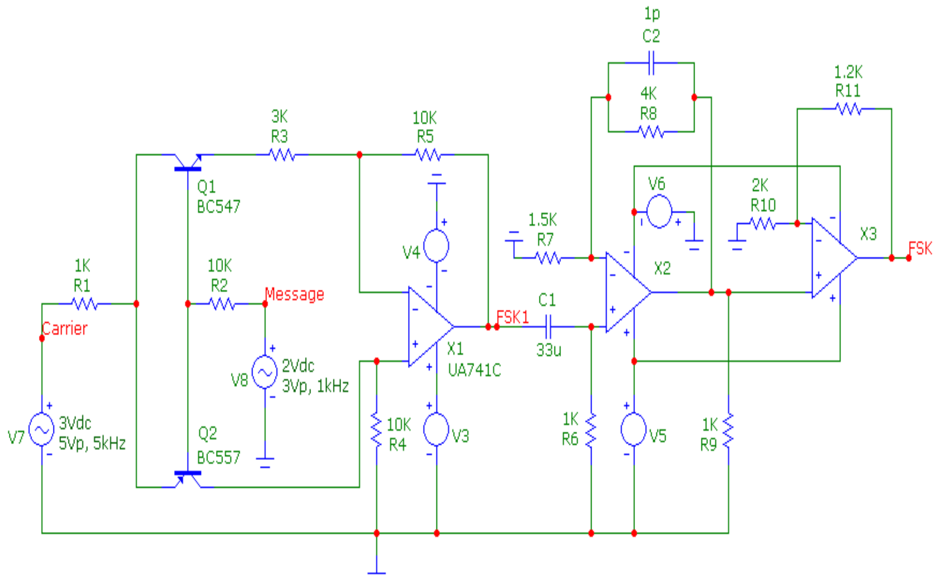

Fig. 2 - FSK modulation technique circuit simulation.

In the next section, the result for the design transmitter is discussed.

4. Results and Discussion

The transmitted signal is used to represent binary signals. The main component in this circuit in order to obtain the ASK signal is transistor Q1, BC547 (NPN) where it is operate like a multiplier to multiply the message signal and carrier signal. Since the modulation signal that generate having a small bandwidth, thus this circuit is consists of two Op-Amps, LMH6624 and AD9631 that cascade together in order to increase the bandwidth of modulation signal to 353.498MHz with 12.010dB that in suitable range for LD application as shown in Fig. 3.

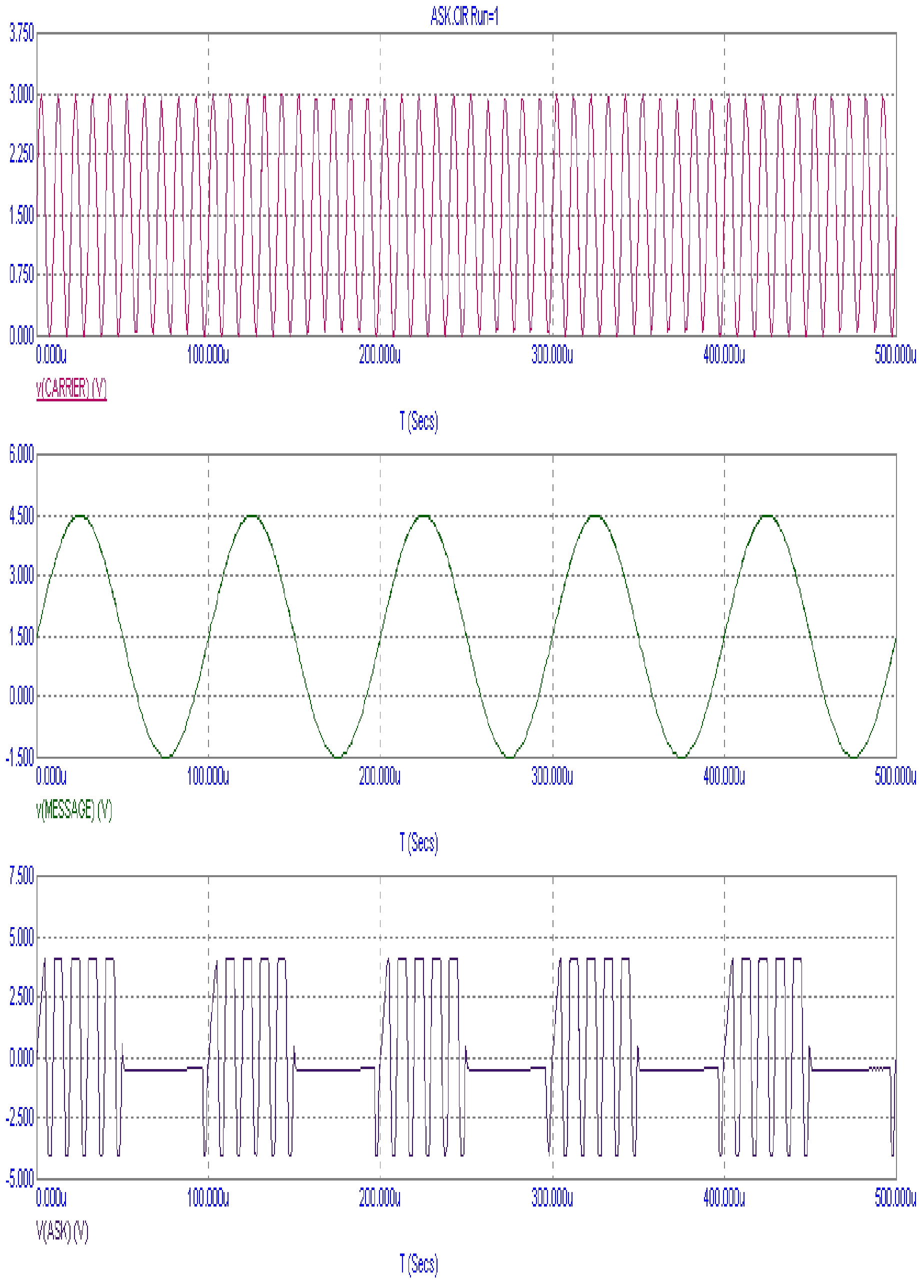

Fig. 3 - Transient analysis for ASK modulation technique circuit.

The transmitter designed using FSK is developed using binary FSK. FSK modulation signal is only shifted the frequency but keeping amplitude and phase in constant, so there is different frequency at '1' and '0' of message signal. The transistor Q1, BC547 (NPN) and transistor Q2, BC557 (PNP) is used to shift the frequency while resistor, R3 is control the space frequency where the increasing of its value will decreasing the space frequency. An Op-Amps LMH6624 and AD9631 are used to gaining the bandwidth to 353.498MHz with 12.010dB gain as shown in Fig. 4.

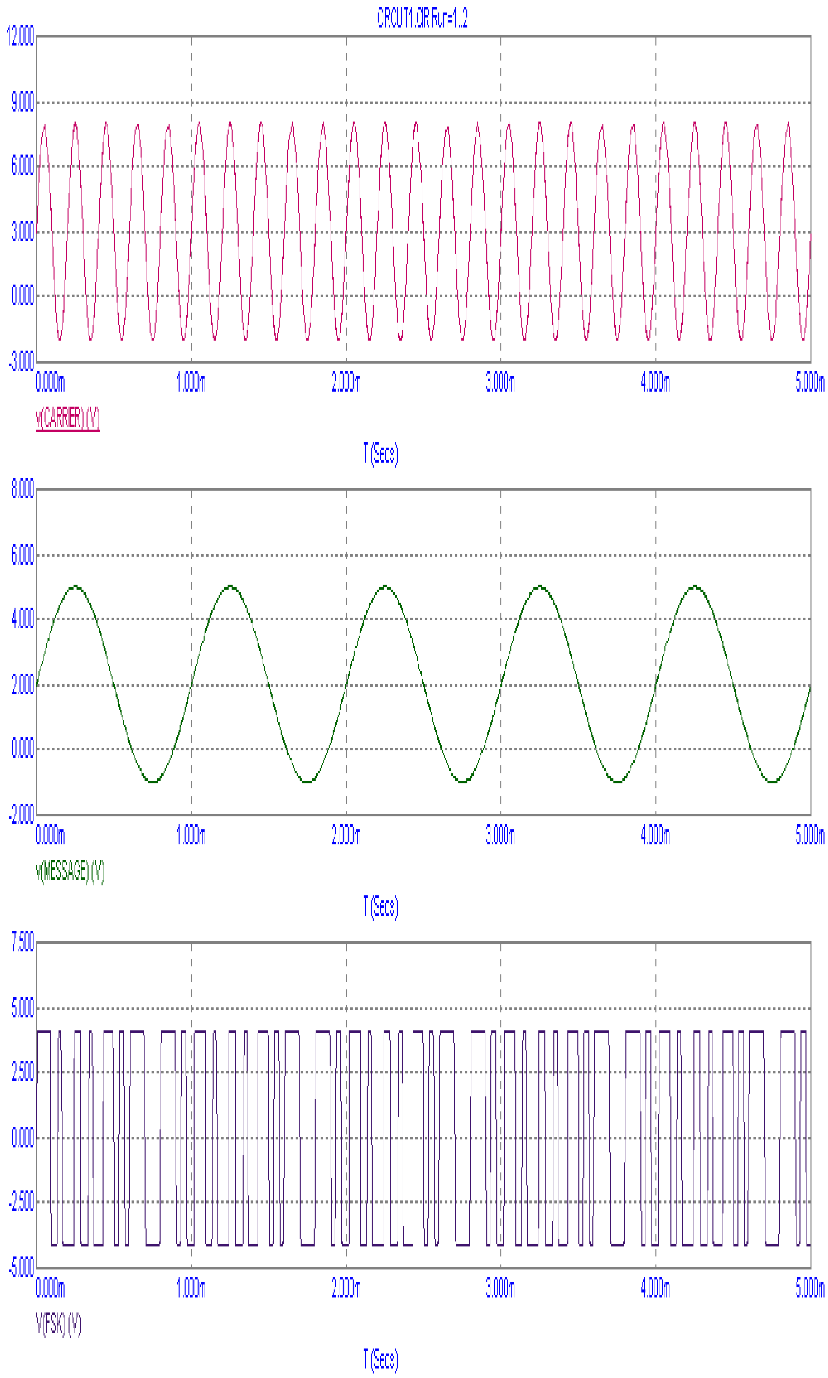

Fig. 4 - Transient analysis for FSK modulation technique circuit.

5. Conclusion

The designed transmitter capable of transmitting two different types modulation techniques that is ASK and FSK, has been achieved. The ASK and FSK transmitter capable of transmitting 353.498MHz and gain bandwidth of 12.010dB.

References

[1] H. Haas, C. Chen, and D. O'Brien. (2017) "A guide to wireless networking by light," Progress in Quantum Electronics, 55, pp. 88-111.

[2] F. Zafar, M. Bakaul, and R. Parthiban. (2017) "Laser-Diode-Based Visible Light Communication: Toward Gigabit Class Communication," IEEE Communications Magazine, 55, pp. 144-151.

[3] C. Singh, J. John, Y. Singh, and K. Tripathi. (2002). "A review of indoor optical wireless systems," IETE Technical review, 19, pp. 3-17.

[4] E. L. Wooten, K. M. Kissa, A. Yi-Yan, E. J. Murphy, D. A. Lafaw, P. F. Hallemeier, et al. (2000) "A review of lithium niobate modulators for fiber-optic communications systems," IEEE Journal of selected topics in Quantum Electronics, 6, pp. 69-82.

[5] M. S. Borella, J. P. Jue, D. Banerjee, B. Ramamurthy, and B. Mukherjee. (1997)"Optical components for WDM lightwave networks," Proceedings of the IEEE, 85, pp. 1274-1307.

[6] C. Wang, H. Wang, and Y. Ji. (2018) "Multi-bit wavelength coding phase-shift-keying optical steganography based on amplified spontaneous emission noise," Optics Communications, 407, pp. 1-8.

[7] M. Figueiredo and C. Ribeiro. (2017) "OFDM-Based VLC Systems FPGA Prototyping," Visible Light Communications: Theory and Applications, p. 443.

[8] J. C. Pederson, "Pulsed light communication key," ed: Google Patents, 2017.

[9] Takahide Kitahara, Mitsugi Ohtsuka, Noritoshi Furuta and Fumio Asakura, (2003), “Signal transmitter utilizing ASK modulation wave”, Kariya and Okazaki (JP).

[10] K. Zhan, J. Kang, G. Wang, T. Kamgaing, R. Khanna, G. Dogiamis, et al.. (2017) "A low-power FSK/spatial modulation transmitter for mm-wave wireless links," in Microwave Symposium (IMS), 2017 IEEE MTT-S International, pp. 801-804.