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FM DATA TRANSMISSION THROUGH OPTICAL FIBER

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ABSTRACT

Presnted is a new optical transmission system to transmit the FM control signal (80 MHz) through an optical fiber by the use of an inexpensive LED having a cutoff frequency of as low as 30 MHz. Studies are carried out on the division of the FM signal frequency at 80 MHz by a factor of four. The FM signal frequency is, after the transmission through the optical fiber, then multiplied by a factor of four so as to obtain the normal FM control signal.

1. INTRODUCTION

Since the optical system has lower attenuation and greater bandwidth, high frequency signals can be transmitted through it. The transmission of the FM control signal through an optical fiber however needs higher cost since the optical components operating at FM control signal frequency are expensive. If the FM control signal frequency is converted into a lower frequency in order to use inexpensive optical components, the total cost of the system will be reduced.

For optical fiber communication system requiring an operating frequency greater than approximately 50 MHz, laser diodes (LDs) are preferred to be used in place of LEDs. Although the signal quality at the optical receiver is greatly deteriorated due to laser diodes noises and its nonlinearity. LEDs are attractive not only in cost effectiveness but also in circuit configuration because the LED systems are free from thermal fluctuation and modal noises.

2. PROPOSED SYSTEM OUTLINE

Although an FM signal can be converted into another signal at lower frequency by means of the heterdyne method, in the other method being considered, an FM signal is fed to a one by four frequency division circuit to divide its frequency by a factor of four.

The block diagram of the system is illustrated in Fig.(1). The frequency division circuit was simply made of two stages of flip flops. The waveforms at the input and output terminals of the flip flops are shown in Fig.(2). When the signal is received through the optical fiber, it must be returned back to the transmitter input frequency, and so the frequency is multiplied by four.

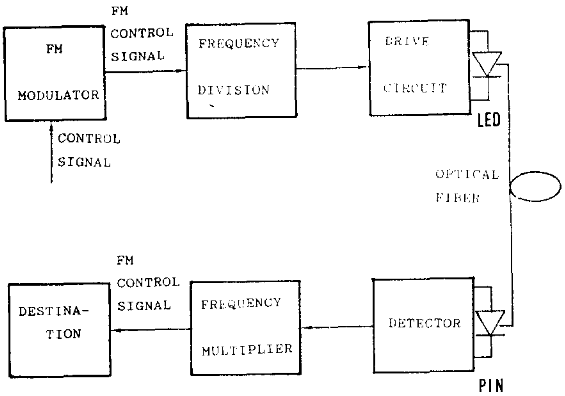

Fig.(1) System block daigram.

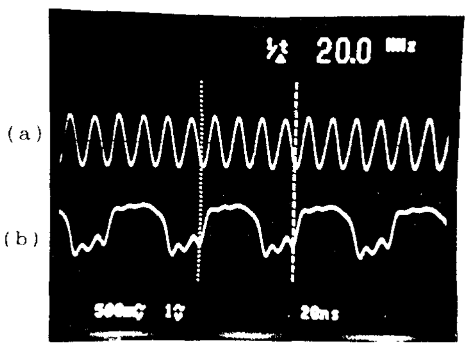

Fig.(2) Input and output signal waveforms of the frequency division circuit.

(a) Input signal waveform at 80 MHz.

(b) output signal waveform at 20 MHz.

3. CIRCUITS USED IN PROPOSED SYSTEM

In order to count down the frequency of the FM control signal by a factor of four, the FM signal frequency is frist divided by two by using a flip flop and then by a factor of two again by another flip flop to obtain the FM signal frequency divided by four. The circuit configuration of the frequency division circuit with an LED drive circuit is illustrated in Fig.(3). When the signal is received through the optical fiber, it must be detected and amplified, and the detector circuit is shown in Fig.(4). After the signal is detected, it must be returned back to the transmitter input frequency, so the frequency is multiplied by four. The frequency multiplier circuit was simply made of XOR's logic gates. The logic circuit diagram of the frequency multiplier which multiplys the frequency by a factor of four is shown in Fig.(5).

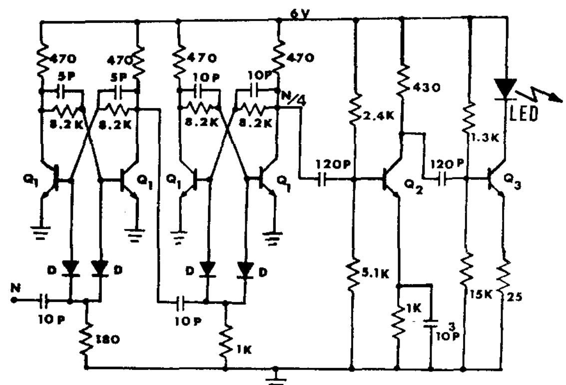

Fig.(3) Diagram of the frequency division circuit with an LED drive circuit.

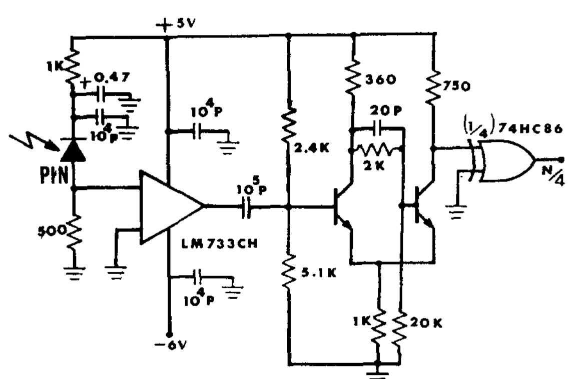

Fig.(4) Detector circuit diagram.

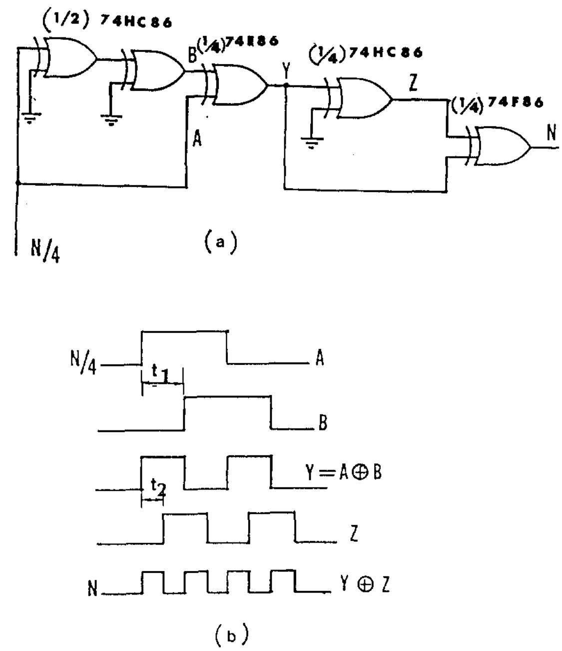

Fig.(5) Frequency multiplier.

(a) Logic circuit diagram.

(b) Waveforms.

4. PERFORMANCE

The FM control signal is trasmitted at a center frequency of 80 MHz. An LED emits the optical FM signal at 850 nm with an amplitude of 0.5 Vp-p.
The multiple-mode-GI optical fiber was used as transmission media to connect the transmitter to the receiver during experiment. A PIN diode was used to receive the optical FM control signal at 850 nm. The signal from the optical detector is coupled to LM733CH differential amplifier and fed to the schmitt trigger in order to obtain TTL output logic level. After the signal was detected and amplified, the first two stages of XOR's CMOS 74HC86 are used as a delay of the first doubler stage to delay the signal by time t1 which equals to 12.5 ns and the third stage of XOR's 74F86 to double the signal. The 74HC86 type of IC having an output voltage large enough to enable the stage of XOR's 74F86 to double the signal. The last two stages of XOR's are used as the second doubler. The first stage of the second doubler delays the signal by time t2 which equals to 6.25 ns. The second stage of the second doubler is used as the gate to generate the output signal. Thus we can multiply the signal by a factor of four. The transmitted and received optical signals are compared as shown in Fig.(6). The upper waveform in Fig.(6) shows the transmitted optical signal, and the lower waveform in Fig.(6) shows the received signal multi- plied by four. Fig.(7) shows the distortion factor versus modulating signal frequency (control signal frequency) at a deviation frequency of 75 kHz. In the transmission experiment using a 1 km optical fiber cable, the distortion factor of the received signal was limetted approximately to 3% when the frequency band of the input control signal was 2-20 kHz.

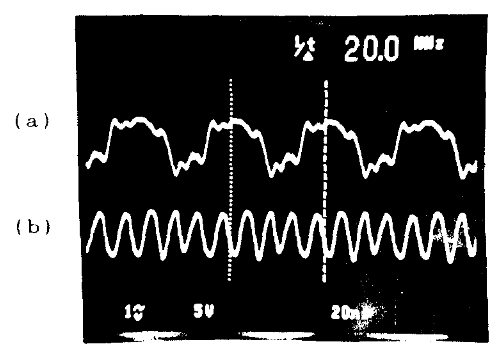

Fig.(6) Transmitted and received signal waveforms.

(a) Input signal waveform at 20 MHz.

(b) Output signal waveform at 80 MHz.

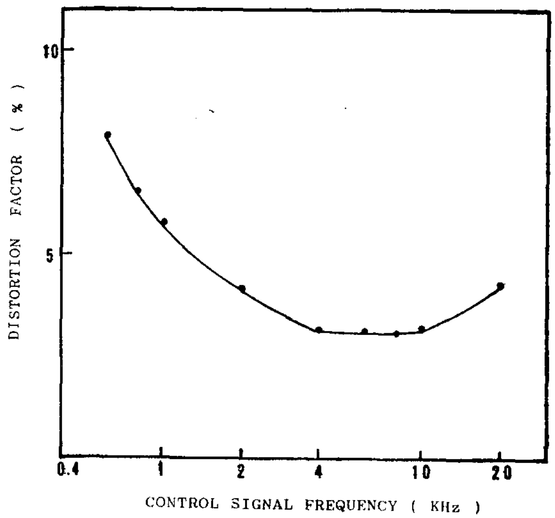

Fig.(7) Distortion factor versus control signal frequency when an optical fiber of 1 km was used.

5. CONCLUSION

Based on a laboratory experiment the followings are concluded.

Lowering the frequency makes the optical trasmitter and receiver circuits more inexpensive with simpler circuit configuration. Optical FM signal transmission system using LED's are attractive for applications in noisy industrial environments such as high or low temperature, shock and vibration, and high or low pressure.

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