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Designs of VLC Transceiver Circuits for Reading Light Transmission of High-Quality Audio Signals on Commercial Airliners

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Abstract—Based on visible light communication (VLC) technology, three designs of audio transmitters and receivers have been built and tested successfully. The simplicity of these circuits and the very few components that are used enable them to be mass manufactured for use on passenger aircrafts. The receiver circuits can be implemented on headphones. The transmitter circuits can be integrated with LED reading lights above passengers’ seats. The circuits presented here have different performance characteristics and sound quality, depending on the type of audio ICs that are used.

I. INTRODUCTION

In [1][2], the authors conducted experiments and investigated the LED transmission of visible light for data communication on a passenger plane. However, there is lack of literature reviews on actual VLC audio circuits for headphone applications and audio IC tests. For example, we found no study of such audio transmitter and receiver circuits that can be implemented readily on an aircraft or space shuttle.

Therefore, we started this project by reviewing the cross-section of the *Airbus A380* passenger plane cabin [3] to find out the distance between the reading lights and the passenger’s head (Fig. 1). We are able to estimate that this distance is between 570mm and 740mm. The reading lights are high-brightness, bulbless, warm-white LEDs that have about 150 degrees of movement in the X and Y axes.

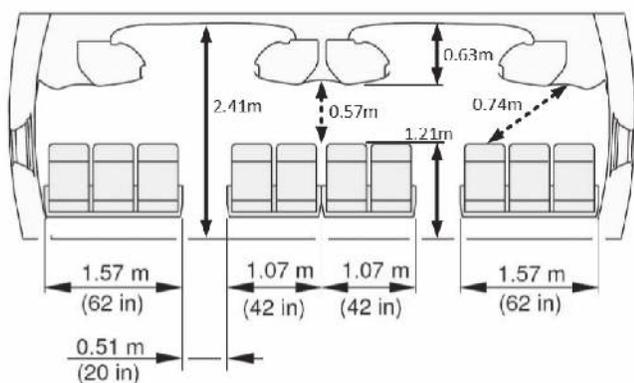


Fig. 1. Cross-sectional dimensions of the economy passenger cabin of *Airbus 380* [3].

In the sections below, three sets of circuits are presented. Shown in Fig. 2, each transmitter is built to work with a 25mA LED with a concentrator. Each receiver can be integrated with a headphone like the prototype shown in Fig. 2. For the convenience of readers, we present all the circuits in the simplest form. For stereo designs, these circuits can be duplicated to send the L channel and R channel at the same time. All the ICs are high performance audio chips. All the circuits are powered using 5V DC.

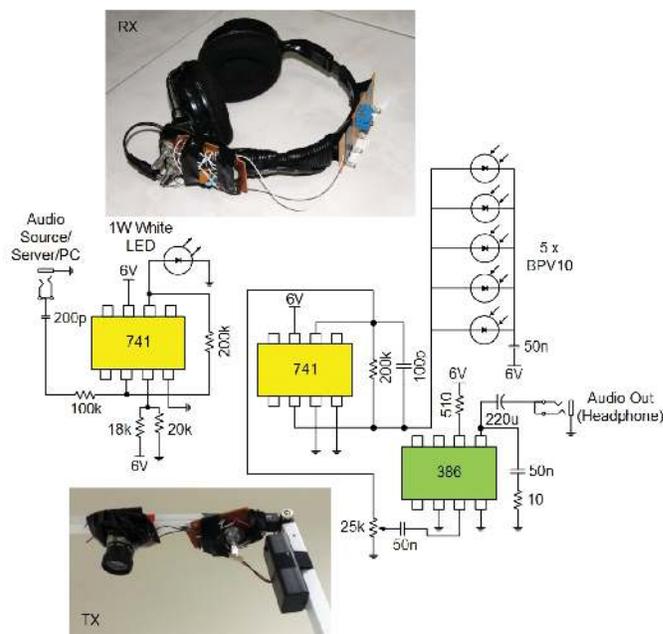


Fig. 2. Basic circuit and constructed prototype for airline entertainment VLC audio transmission system.

II. OPA2134

Having a slew rate of $(20V/\mu s)$, OPA2134 is used for its wide output swing to within 1V of the rails. This circuit (Fig. 3) produces clear and distinctive sounds. It has the loudest volume compared to the other two circuits. TL072 is used as a preamplifier because it has a suitable slew rate $(13V/\mu s)$ for amplifying audio signals in the form of light. TL062 has a

