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Team Big Type D Energy

What Makes a Quality Bluetooth Circuit Board?

I. Introduction

Speakers are powerful analog devices and recently they have become smaller and easier to use with the addition of Bluetooth connections. This paper will explore the current Bluetooth transmitters and receivers that are on the market that are low power, have low latency, and should be able to connect to multiple devices. This paper will also attempt to determine what aspects can quantify/qualify a Bluetooth board as being quality.

II. Fundamentals of Operation

At their most basic, Bluetooth modules take in audio data via the Bluetooth communication protocol, then transmit the data out through a serial connection. Bluetooth is a very common short-range radio frequency (RF) communication standard. Primarily, the technology is used to establish a wireless personal area network (WPAN) that allows users to create networks between all different types of devices in order to transfer data. The technology works in the unlicensed ~2.4GHz band. The Bluetooth chip itself also uses a wide spectrum with frequency hopping at a rate of 1600 hops/sec to minimize interruptions from conflicting signals [1].

Bluetooth networks are also called piconets, and each piconet uses a master/slave model to control dataflow. One master can be connected to up to seven different devices as slaves. Creating a Bluetooth connection between devices is a process that has 3 main stages. The first stage is inquiry, where the devices attempt to discover each other by sending out a request then listening. The second stage is known as paging, or connection, where the two devices connect to each other using the Bluetooth addresses found during the inquiry stage. The third stage is connection, where the device can be used to transfer data actively or can be put into a low power mode until the master wakes the slave back up [2].

III. Quality of Bluetooth Boards

Bluetooth circuit boards contain at least 2 inductors which are used to tune the impedance of the antenna in order to increase signal quality and improve the sending and reception of data. There will at least be 4 IO pins that are for the State, Enabled, communication and power supply connections. Beyond these

minimums, the circuit board could have things such as voltage regulators, extra chips, or crystal clocks to improve functionality [3].

When it comes to Bluetooth speaker circuit boards, there are a few things to look for when selecting a quality board. A quality Bluetooth IC will support Bluetooth 4.0, have the option for line-in (AUX) audio, come with lithium battery chargers, and have voltage regulators. In the case of using Bluetooth for speakers, the module should be paired with EEPROM at a frequency of 128Kbit that will use a serial interface to communicate with the Bluetooth module. Lastly, careful attention should be paid to the antenna – what kind it is (trace, patch) and how many inductors it has in order to be able to fine it.

There are three main quantifiable factors to focus on: transmission rate, transmission range, and power consumption. The transmission rate is important because it affects what kinds of information can be transmitted. For high quality music to a speaker, a higher transmission rate is required. The two enhanced data rates would be ideal for this application: $\pi/4$ -DQPSK at 2 MB/s and 8DPSK at 3 MB/s. Bluetooth modules can also be filtered by power class. This is relevant because a higher power class translates to a higher maximum output and thus transmission distance, by the inverse square law. Most mobile devices, including speakers, are in the 2nd class, which has a 10m radiation distance from a maximum power of 4dBm, and which don't require power control. Lastly comes the power consumption which is typically listed by manufacturers as transmit and receive power. By taking this evidence and testing, an accurate evaluation can be made as to which module should be used for the application. Battery life is enormously important to portable Bluetooth devices, so some sacrifices might have to be made to transmission rate and range in order to reduce power consumption, as the consumption is largely a function of the former two aspects [4], [5].

IV. Commercially Available Devices

Bluetooth devices have proliferated the market today that demands portability, long battery life, and ease of use [6]. One of the most common types of Bluetooth modules is the HC-05 Bluetooth Serial Port Protocol (SPP) module. This module supports up to Bluetooth 2.0, with a transfer of data at 2.4GHz and a modulation of 3Mbps. The module only contains a single chip Bluetooth system with CMOS technology that enables adaptive frequency hopping, all on a small 12.7mm x 27mm footprint [3].

However, today there also exists the HM-10 Bluetooth module, which supports up to Bluetooth 4.0, with multiple different RF power modes, but it draws 8.5mA of power when active [7]. It is therefore evident that with more functionality and configuration options comes a higher power consumption. Bluetooth 4.0 is the current new standard, which emphasizes and optimizes the data transmission rate. Older Bluetooth is more low-energy and focuses on simple information transmission in order to preserve

the battery life of the device [4]. Although there are many different modules on the market, each will need to be seriously evaluated against each other and against the engineering requirements of the project in order to meet the customer's demands.

References

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