Bluetooth connection gfsk

BACKGROUND OF BLUETOOTH TECHNOLOGY:

Bluetooth was originally formed by the following five entities:

IBM

INTEL

ERICSSON

NOKIA

TOSHIBA

The initial five have grown to well over a thousand companies at this point and the number is increasing. Though Bluetooth is not quite as popular as 802. 11, there are number of applications for a wide array of divergent wireless devices.

For interesting background where exactly Bluetooth get its name? Contrary to what your dentist might think it is not from eating blueberries. The actual origin of this term is formed from a tenth century Scandinavian king whose name was HARALD BLUETOOTH. The connection is that in his real life he managed to unite several disparate kingdoms under one area. The idea was to make Bluetooth encompass a kingdom of different devices and to create a convergence of many different devices under the umbrella of one global specification.

1. 2 WHAT IS BLUETOOTH WIRELESS TECHNOLOGY?

Bluetooth wireless is an open specification for a low-cast , low power, short-range radio technology for ad hoc wireless communication of voice and data any where in the world. Let's examine each of these attributes

An open specification means that the specification is publicly available and royalty free

Short range radio technology means device can communicate over the air using radio waves at a distance of 10 meters. With higher transmission power the range increases to approximately 100 meters.

Because communication is with in a short range, the radios are low power and are suited for portable, battery-operated devices.

Bluetooth wireless technology supports both voice and data, allowing devices to communicate either type of content

2. BLUETOOTH MODULATION

2. 1 Modulation Introduction

Bluetooth uses Gaussian frequency shift keying (GFSK). More explicitly, Bluetooth 0. 5 BT Gaussian filtered frequency shift keying (2FSK) also referred to as binary frequency shift keying (BFSK) at one M symbols/s with a channel spacing of 1MHz. Since only two frequencies are used one bit is one symbol (i. e. one indicates a positive frequency deviation (normally 157. 5 KHz) from the carrier, and a zero indicates a negative frequency deviation (normally 157. 5 KHz) from the carrier).

The figure shows that amplitude versus time as well as constellation diagram plot of 2FSK modulation that is used for Bluetooth. The frequency deviation range is between 140 & 175 KHz.

2. 2 Summary of Bluetooth modulation requirements

To receive Bluetooth qualification, a radio must have the following modulation characteristics:

- GFSK with BT at 0. 5
- Symbol rate of 1 mega symbols per second (Ms/s), corresponding to a data rate of 1 Mb/s modulation index beta between 0. 28 & 0. 35
- Binary 1 with a positive fd and 0 with a negative fd
- Symbol timing better than +20, -20 parts per million (PPM)
- Zero crossing error not greater than 1/8 of a symbol period
- The fd corresponding to a 1010 sequence to be at least 80 % of fd corresponding to a 00001111 sequence
- Minimum fd equal to 115 KHz

Most of the previous modulation characteristics are self explanatory except perhaps the last two. If the modulation index is between 0. 28 & 0. 35, then equation 3. 18 tell us that the corresponding fd must be between 140 & 175 KHz. This can be considered a “ steady state” fd for a long sequence of binary ones or zeroes. Due to the ISI inherent in GFSK its possible that fd may not reach its maximum value for a binary sequence that alternates between 1 & 0. The specification requires that fd under these conditions

reach at least 115 KHz, which is about 80 % of the minimum steady state fd of 140 KHz.

2. 3 Bluetooth Data Rates and Data Packets

The theoretical maximum data rate is 1 Mbps, but due to overhead, the maximum realizable asymmetric data rate is reduced to 723. 2 Kbps. This is also a bit misleading because the reverse link has a much lower data rate. The table shows is a summary of the possible data rates for the various packet sizes.

The information is transmitted in a packet in a time slot. Each time slot corresponds to an RF hop frequency. A packet of information can be transmitted in one time slot, three time slots, or five time slots. Naturally, a five slot packet carries more information than a three slot packet, which carries more than a one slot packet. Data high rate (DH) achieves higher data rates by using less error correction in the packets. Data medium (DM) rate achieves a lower bit error rate probability by using more error correction in the packets. A Bluetooth packet is shown in the figure.

2. 4 Bluetooth Modulated Signal

A modulated signal can be denoted as:

Where fc is the carrier frequency, T is the bit period, h is the modulation index and x(t) is the input of the modulator. The above equation can be viewed as the output of a voltage controlled oscillator with an input of x(t). In FSK modulation, x(t) is a binary signal whereas in GFSK modulation, the

binary signal is first passed through a low pass Gaussian filter to produce x(t). This is shown in below figure.

GFSK modulation is determined by two parameters: the modulation index (h) and the bandwidth of the Gaussian filter. The Gaussian filter is usually characterized by the bandwidth-time product (BT), which is equal to the 3-db bandwidth of the Gaussian filter (B) times the bit period (T).

In Bluetooth the bit rate is 1Mb/s, BT is 0. 5 in the modulation index varies from 0. 28 to 0. 35, the figure above shows the simulated spectrum of a Bluetooth signal.

Note that the well known Gaussian minimum shift keying (GMSK) is a special case of GFSK in the modulation index 0. 5.

2. 5 Frequency Hopping

The physical connection of Bluetooth uses frequency hopping at 1 MHz hops at the actual carrier is spread spectrum modulated. This is known as frequency hop spectrum and is used to improve immunity from interference - mainly from IEEE 802; WiFi WLAN shares the same spectrum as other users of the ISM band for example transitorily operated microwave ovens.

There is a fundamentally sound reason for this approach. WLANs occupy significantly more bandwidth than 1 MHz and employ SS techniques, in which a pseudo-random code is used to modulate the information transmitted. At the receiver the same pseudo-random code has to be available to de-modulate it successfully called co-relation. As a result, many WLANs using different pseudo codes can transmit simultaneously without mutual

interference. The Bluetooth frequency-hop system appears as an un-correlated noise like signal to a WLAN receiver and what is more its signal energy is spread over the entire band of the WLAN by the de-correlated demodulation process. SO in practice mutual interference amounts only to a raised noise floor for both systems. A raise noise floor simply reduces the available carrier to noise and hence reduces the range possible. This is the main effect of mutual interference. An exception can occur when signals are so strong because of the close proximity of the antennas, that they overwhelm a receiver.

Bluetooth frequency rate is chosen to be 1600 hops per second with a 625 us dwell time per hop. The minimum dual time of 625 us corresponds to a single time slot. Part of this hop timing is taken up by the guard time 220 us allowing the hardware based frequency synthesizer time to settle. The transmission channel is derived from the time slots, spread over 79 or 23 frequencies. The frequency hoping scheme uses time division multiplexing (TDMA), as illustrated in the figure, where the frequency step n= 1MHz.

2. 6 Piconets

A piconet is formed by two or more devices discover each other and begin to communicate. A piconet can have up to eight devices, with one device acting as a master and the rest acting as slsaves. The first device initiates transmission becomes the master, although the specification provides for a master and slave unit to exchange roles. A specific frequency-hopping sequence is used by all devices within each piconet. The figure shows the

simplest example of a piconet. In the figure, a cell phone is downloading the address book and telephone number information to the user's laptop.

In this example the laptop acts as the master. The application software running on the laptop contacts the cell phone when it is within range, and requests that it synchronize its database with the one stored on the laptop.

As stated earlier a single piconet can have up to eight devices. The reason for this limit is simple:

The address is only three bit long. This means that in binary only the value of 0 - 7 can be stored in the address field. The master has no address but zero is reserved for broadcast messages; so the only addresses remaining for use by slaves are 1 - 7. However, a device can participate in two different piconets called a scatternet. The figure shows an example of a larger piconet, in which one master controls multiple slaves in a piconet.

You can see that its possible to link various devices in a piconet. You can download digital images from your digital camera to the laptop, use more than one Bluetooth-enabled cell phone to place voice calls and even contact a personal digital assistant PDA to the laptop to exchange information. Another interesting thing to note in this figure is that you can also use a single connection to the internet without having to have a direct cable connection to the modem or broadband connection.

2. 7 Scatternets

A device can be master of only one piconet. The device can, at the same time, also be a slave in another piconet that is within range. A slave can also

participate in two different piconets that are within its range. However, because the master device determines the hoping pattern used for a piconet, a device cannot be a master of more than one piconet. An example of a simple scatternet is shown in figure.

In this figure, a laptop computer communicates with devices in both piconets. Note that the laptop is a slave in both piconets. It is possible, however, for the laptop to be a master in one piconet and a slave in another (as shown in the figure). When a device is member of two piconets it keeps track of both frequency-hoping patterns and occasionally listens in on the correct frequency on each of the two piconerts so that it can stay in touch with both piconets. A master device transmits a packet to its slaves occasionally to maintain the link, base band on negotiations between the master and its slave devices. Thus, a device that is a member of two piconets must listen for these transmissions (or make them if it's the master in one piconet) within the time frame negotiated for each of the piconets of which it is member. The above explanation can be understand better with the below figure.

Bluetooth transmitter consists of

- CODE MAPING
- PFD
- BALUN
- AMPLIFIERS
- AMPLIFIER DETECTOR

- CHARGE PUMP
- T/R SWITCH
- PFD/CP
- CAP ARRAY

3. Advantages and Disadvantages of Bluetooth

The main advantage of Bluetooth is its compact form and portability. This technology can be manufactured cheap and can be integrated to micro-levels easily. Bluetooth signals are very resistant to weather conditions and can often operate where other technologies may fail. Despite its short range the technology can be very effective and cheap where long distance coverage is not required. In modern hardware Bluetooth is being used widely. Almost all platforms are benefiting from its cheap production such as cell phones, gaming consoles, computer peripheral devices etc. Even computers can achieve LAN connectivity using Bluetooth. Another great feature of this technology is its less power consumption.

The only disadvantage of this technology is perhaps its short range and limited connections i. e. only up to eight devices can connect be connected simultaneously.

4. Conclusion

The main aims of Bluetooth are to provide universal radio interference for ad hoc wireless connectivity at low cost, delivering modest speed (1-3Mbps) short range (1-100M) and low power consumption.

Bluetooth is a very powerful tool. This technology has proven to be very cost effective and powerful. Over the years we have seen rapid enhancements in this technology. This technology has replaced the previously famous infrared technology which was dependent on line of sight connections. Through Bluetooth one can achieve an effective data transfer rate and easier connectivity regardless the weather conditions.

References

1. Kumar Bala C, Klien Paul, Thomson Tin, Thomson J. Timothy; Bluetooth application programming with Java applications

2. Iniewski Krzysztof; Wireless Technologies: Circuit, Systems, Devices

3. Miller Stewart S.; WiFi Security

4. Patrick David, Morrow Robert; Wireless network Co-Existence

5. Ganguly Madushree; Getting Started With Bluetooth

6. Kelly Jod, Schaub Keith B.; Production Testing of RF and System-on-Chip Devices for Wireless

7. Nicholas Randall K., Lekkas Panos C.; Wireless Security: Models, Threats and Solution

8. Golrnie Nada; Coexistance in Wireless Networks: Challenges and System Solutions

9. Prabhu C. S. R., Reddi Prathap A.; Bluetooth Technology and its Applications with Java and J2ME

10. Zolfaghari Ali Raza; Low-Power CMOS Design for Wireless Transceivers

11. Morrow Robert, Laroka James; Demystified: Operation and Use

12. Muller Scott; Upgrading and Repairing Networks

13. Hill Goff; The Cable and Telecommunication Professional References

PSTN, IP