Receiver for the T-Patch GPS

Digital Matter Embedded

1 Introduction

This document provides some basic information about the receiver that will be used to receive transmissions from the T-Patch GPS radio tag. Its operation is outlined for the purpose of the T-Patch GPS FCC compliance testing. It is intended that this document goes hand in hand with the T-Patch GPS FCC Specification document.

2 Receiver Operation

2.1 Brief Overview

In order to receive data from a T-Patch GPS device, the receiver has to be able to receive the FHSS messages sent from the T-Patch. As a T-Patch GPS device spends the bulk of its life 'sleeping' in low power mode, there is no way that the transmitter and receiver can have knowledge of what channel the other device is currently on. The receiver therefore continuously scans through all frequencies that are used by the devices as described in the T-Patch GPS description document, waiting for a message. The T-Patch sends a long preamble so that the receiver has enough time to scan every frequency in the relevant hop table while the T-Patch is transmitting. When the receiver detects preamble on a channel, it remains on that channel and waits for the synchronisation and remainder of the message. Once the message has been received, it resumes its scan through all channels. If it does not detect any preamble on a channel, or detects an invalid preamble, it will change to the next channel.

2.2 Detailed Description

As described in the T-Patch GPS FCC Specification document, when a T-Patch GPS device transmits, it transmits a total of 344 nibbles (172 bytes) of preamble to allow the receiver to find and 'lock' onto the channel. At 38,400 kbps, this equates to 35.83ms of preamble. Waiting for a minimum of 6 nibbles (3 bytes) of valid preamble, the receiver will take 35.6ms to scan through 57 channels (625uS per channel). If the receiver receives a valid preamble of 4 nibbles, it will continue to wait for an additional 4 nibbles to confirm that the preamble is valid before waiting for the synchronisation characters.

From the above timing, it can be seen that the receiver will be able to cycle through all channels within the length of the preamble being transmitted. In this way, the receiver is synchronised with the transmitter.

6/25/2013

CASEY STEPHENS

2.3 Continuous Data Transfer (Proposed for possible future use)

Currently the T-Patch message payload is less than 64 bytes. This is the upper limit for single messages of the T-Patch as it is the physical size of the transmit buffer of the radio device. The maximum T-Patch message length is 245 bytes (172 byte preamble, 7 byte header and sync, 64 byte payload, 2 byte checksum). At a rate of 38,400 bps this equates to 51ms of on the air time per message which is well below the FCC channel dwell time of 400 ms. The T-Patch does not currently support longer messages requiring multiple channels as it sends a single message during each wake cycle before entering a low power mode for at least 30 seconds. When the device wakes up, it transmits a new message on a new randomly selected channel. If continuous data transfer were to be utilised, the following paragraphs explain how this would be accomplished.

Part of the T-Patch message 'payload' would contain a 'control' byte with information about any messages that may follow, including the channel on which the receiver must expect the message. Once the message has been received, the receiver will switch to the specified channel and wait for the next message if there is more data to come.

For continuous data transfer, the data will be split and transmitted in 64 byte 'packets' which include a 'control' byte containing channel information as explained above. This is defined by the Si1010's FIFO transmit buffer size, as the buffer is 64 bytes deep.

The T-Patch will begin by transmitting its first message with the first 64 bytes on a randomly selected channel. When it has finished transmitting the message, it will begin the transmission of the next message with the next 64 bytes of data, and so on. The subsequent transmissions will occur on different channels.

The receiver will remain synchronised to the transmitter through the information contained in the 'control' byte, and will know when to expect data and when there is no more data to be sent. Once there are no more messages to receive, it will return to scanning for messages.

The 'control' byte included in the message contains information about messages to follow, including the channel on which the next message will be transmitted. Each message transmitted in a continuous data transfer will contain this information. The structure of this byte is outlined below.

In the 'control' byte a total of 6 bits are used to indicate the channel, and the remaining two bits are used to indicate if the message is the first, last, a message in between, or a standalone message. From this, the receiver will be synchronised to the transmitter as it will know which channel the transmitter will be transmitting on next, and whether to expect another message or not.

Control Byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data Ctrl[1]	Data Ctrl[0]	Channel [5]	Channel [4]	Channel [3]	Channel [2]	Channel [1]	Channel [0]

6/25/2013

CASEY STEPHENS

Data Ctrl (bits 6 & 7)

00	Standalone message
01	First message of multiple messages
10	Interim message of multiple message
11	Last message

Channel (bits 0 – 5)

The channel value is the 6 bit channel number for the next channel to be used. There are 57 channels used in total and therefore 6 bits will be sufficient to represent all of them. If the next message is to be transmitted on the same channel, then the number will not change between messages, and the receiver will remain on that channel.

2.4 Receiver Specifications

The receiver is based on a Silicon Laboratories Si4432. The Si4432 is the exact same RF front end that is used in the Si1010 on the T-Patch GPS, except that it is embedded with a CPU in the Si1010. All passive matching circuitry etc. is the same as the T-Patch GPS board. The receiver is also configured in exactly the same way that the T-Patch GPS is configured, except that it is a receiver. The configuration is shown below.

- 25.5 MHz Bandwidth (902.250 MHz - 927.750 MHz)
- 171 channels across the above range
- 150 kHz channel separation
- 120 kHz channel bandwidth
- 38.4 kbps data rate
- Three hopping tables of 57 channels each

The hop table allocation is shown below. While each channel is 150 kHz apart, with the configuration below, adjacent channels on the table are 450 kHz apart.

Table A channels	Table B channels	Table C channels
0 (902.250 MHz)	1 (902.400 MHz)	2 (902.550 MHz)
3 (902.700 MHz)	4 (902.850 MHz)	5 (903.000 MHz)
6 (903.150 MHz)	7 (903.300 MHz)	8 (903.450 MHz)
9 (903.600 MHz)	10 (903.750 MHz)	11 (903.900 MHz)
…	…	…
168 (927.450 MHz)	169 (927.600 MHz)	170 (927.750 MHz)

6/25/2013

CASEY STEPHENS