33-1253 Designated frequency hopping algorithm:

Pseudorandom Frequency Hopping Sequence

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system.

The frequency hopping is implemented in 18 non-overlap channels. The hopping is sequentially after the contents of the frequency hopping table CH01, CH08, CH14.... CH11, CH17, CH06 and so on.

The example of the hopping sequence channels table shown below.

Hopping table. (Total 18 channel frequencies in each sequences)

Channel Table	
Channel 01	2404.320 MHz
Channel 02	2408.300 MHz
Channel 03	2412.310 MHz
Channel 04	2416.290 MHz
Channel 05	2420.330 MHz
Channel 06	2424.310 MHz
Channel 07	2428.310 MHz
Channel 08	2432.310 MHz
Channel 09	2436.330 MHz
Channel 10	2440.310 MHz
Channel 11	2444.320 MHz
Channel 12	2448.320 MHz
Channel 13	2456.310 MHz
Channel 14	2460.330 MHz
Channel 15	2464.340 MHz
Channel 16	2468.320 MHz
Channel 17	2472.350 MHz
Channel 18	2476.350 MHz

Sequence 1	
Channel 01	2404.320MHz
Channel 08	2432.310MHz
Channel 14	2460.330MHz
Channel 03	2412.310MHz
Channel 10	2440.310MHz
Channel 16	2468.320MHz
Channel 05	2420.330MHz
Channel 12	2448.320MHz
Channel 18	2476.350MHz
Channel 07	2428.310MHz
Channel 13	2456.310MHz
Channel 02	2408.300MHz
Channel 09	2436.330MHz
Channel 15	2464.340MHz
Channel 04	2416.290MHz
Channel 11	2444.320MHz
Channel 17	2472.350MHz
Channel 06	2424.310MHz

Sequence 2	
Channel 07	2428.310 MHz
Channel 16	2468.320 MHz
Channel 08	2432.310 MHz
Channel 17	2472.350 MHz
Channel 09	2436.330 MHz
Channel 18	2476.350 MHz
Channel 10	2440.310 MHz
Channel 01	2404.320 MHz
Channel 11	2444.320 MHz
Channel 02	2408.300 MHz
Channel 12	2448.320 MHz
Channel 03	2412.310 MHz
Channel 04	2416.290 MHz
Channel 13	2456.310 MHz
Channel 05	2420.330 MHz
Channel 14	2460.330 MHz
Channel 06	2424.310 MHz
Channel 15	2464.340 MHz

The sequences are generated by Matlab RAND function in which calculate uniformly distributed random numbers. The first 18 channels are grouped into Sequence 1. Sequence 2 is generated by the same function with only the same 18 channels are selected (in different order).

Equal Hopping Frequency Use

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

In a clean RF environment, which means few or no other RF transmitters nearby, the nRF24Z1 will use all the channels in hopping table.

A synchronized frequency hopping table is kept in the ARX by use of the service channel superimposed on the audio stream.

In summary: All channels will on average be used equally. Thop depends on the audio rate, you can find values below:

Fs=44.1kHz : Thop=2.9ms

<u>System Receiver Input Bandwidth</u>

Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

It's the same RF device, the only difference is that one is set as a transmitter and the other in receive mode. Main data stream is one-way audio, which is why they are referred to as a transmitter and receiver. The receiver bandwidth is 4000kHz where the 20dB bandwidth of transmitter is 2450kHz.

<u>System Receiver Hopping Capability</u>

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

A two-way low speed data and control channel makes it possible to exchange information. The ARX will start every frame with a ACK on new channel, the ACK will also contain the next 8 channels to use in the hopping scheme. This way even if a ACK is lost, both devices will know which channels to use next.

<u>Section 15.247(h)</u>

Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters

Since the banning list was disabled. So our device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters. Moreover, our device has a unique user ID for link registration. So no other FHSS system can join the link with our device.

Data frame structure:

Each ATX frame consist of 8 packets. Each packets will have
- 1 byte preamble
- 9 bytes address and control data
- 64 bytes audio data
- 2 bytes CRC

Each ARX acknowledge packet consist of
- 1 byte preamble
- 27 bytes address and control data
- 2 bytes CRC

All bits are "ON" in the worst case for both ATX and ARX.

ATX
1. The maximum transmitting time is 1.32ms and it is fixed.
2. One frame in each hop and carry a fixed number of frame.

ARX
1. The maximum transmitting time is 164us and it is fixed.
2. One frame in each hop and carry a fixed number of frame.

Remarks
Only one frame will be transmitted in each hop and the hopping time is 2.9ms which is mentioned as above. The transmitter (dongle unit) will waiting the acknowledge packet from the receiver (headphone unit) after the frame transmitted.