1. Describe how the EUT meets the definition of a frequency hopping spread spectrum system, found in Section 2.1, based on the technical description.

Note: *From section 2.1 of the FCC Rules: A spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the frequency carrier. The frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. The wide RF bandwidth needed by such a system is not required by spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop. The test of a frequency hopping system is that the near term distribution of hops appears random, the long term distribution appears evenly distributed over the hop set, and sequential hops are randomly distributed in both direction and magnitude of change in the hop set.*

The module uses a conventional radio using GFSK modulation. The radio is frequency agile and 101 channels have been defined across the 902 – 928 MHz band. Three channel sequences (hopping patterns) have been defined that use either 50 or 58 of the 101 available channels. These sequences were chosen in a pseudorandom fashion. The user selects which hopping pattern is used and both sides of the link must be set to the same pattern.

The transmitter is normally off until there is data ready to be sent. When data is ready to send, the module selects the next channel from its hopping pattern and begins transmitting data. Tranmissions take a maximum of 160ms. Once the transmitter reaches the end of the hopping pattern, it returns to the first channel in the pattern and repeats the cycle.

The receiver follows the transmitter through the hopping pattern based on common timing while synchronizing the timing after every transmission using an message sent on the return channel.

The pseudorandom selection of the channels makes the near term distribution of the hops appear random. The cyclic and sequential use of the channels means that all channels are used the same on average over the long term.

2. 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, found in Section 2.1.

There are three user-selectable channel hopping sequences that each use either 50 or 58 channels out of a total of 101 channels defined for the radio. Modules which communicate must both select the same hopping sequence. The channel sequences were generated using a Wichman-Hill randomization procedure embedded in the Microsoft Excel 2010 software tool.

3. 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).

Each transmitter uses one of three channel hopping patterns, each containing either 50 or 58 channels spread across one of three subbands of 902-928 MHz spectrum. The main hopping pattern uses 58 channels from within the 906.12 - 924.12MHz band, the low hopping pattern uses 50 channels from within the 902.62 - 914.87 band, and the high hopping pattern uses 50 channels from within the 914.87 - 927.62 MHz band. Data is sent periodically (i.e. every 60 seconds) with a pseudorandom added time delay (i.e. 0-59 seconds). The unit transmits on a channel corresponding to the time slot chosen for up to 160ms, then uses the next channel in the hopping pattern at the time of the next data transmission. After transmitting on the last channel in pattern, the unit cycles back to the first channel in the pattern. After the 160 mSec data packet is sent, the transmitter turns off. In this manner, each new transmission event begins on a randomly selected channel from the pseudorandom hopping sequence.

The cyclic and sequential use of the channels means that all channels are used the same on average over the long term.

4. 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.

The receiver's IF filter bandwidth is sufficient to capture the full deviation of the transmitter plus margin to allow for part-to-part variations as well as temperature drift. Its RF frequencies and channelization are identical to the transmitter so that they are aligned during operation. This ensures reliable operation, the best sensitivity and the best system range.

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

The receiver remains in listen—only mode until a synchronizing packet is seen from the transmitter. The synchronizing packet contains local clock timing information. The local clock is set to agree with the transmitter clock to subsecond resolution and the hopping sequence in the transmitter and receiver remain in synch within the limits of the clock drift. If a resynch is required i.e. due to clock drift or power loss, the receiver repeats the listen-only mode and synchronization of the local clock.

After the receiver clock is synchronized, it changes to the next channel in the common hopping pattern at the same time as the transmitter.

System timing is fixed on both sides, so the transmitter and receiver can easily calculate the channel time slot from the local time.

6. Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system.

All messages fit within a single timeslot, and a new frequency is selected for each timeslot. The hopping algorithm is guaranteed to return each channel equally (see description above). This ensures that all enabled channels are used equally over a period of (number of hops times the number of used channels).

7. 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.

The channelization and hopping patterns were developed specifically for these radios. It is very unlikely that they would be the same for a different FHSS system.