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TRM-915-R250 Spread Spectrum Compliance

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 FSK modulation. The radio is frequency agile and 32 channels have been defined across the 902 – 928MHz band. Six channel sequences (hopping patterns) have been defined that consist of 26 of the 32 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. A timer is used to ensure that each channel is used for a maximum of 396ms. If the timer runs out and there is still data to be sent, the radio moves to the next channel in the hopping pattern and resumes transmitting. Once the transmitter reaches the end of the hopping pattern, it returns to the first channel in the pattern and repeats the cycle.

When the receiver detects a valid packet, it computes the channel's dwell time slot using the known time from the start of the transmission's preamble to the sync word in the packet. This way, even if the receiver does not catch the first bits of the transmission, it can still synchronize to the transmitter. The receiver follows the transmitter through the hopping pattern based on common timing while synchronizing the timing on every hop using the preamble and sync word of the first packet sent on that hop.

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 6 user-selectable channel hopping sequences that each use 26 channels out of a total of 32 channels defined for the radio. Modules which communicate must both select the same hopping sequence.

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The channel sequences were chosen using 5-bit pseudo-random, maximal-length polynomials and selected due to their low probability of cross-correlation intercept.

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 6 channel hopping patterns, each containing 26 channels spread across the 902-928MHz band. With continuous data to send, the unit transmits on a channel for up to 396ms, then moves the next channel in the hopping pattern to continue data transmissions. After transmitting on the last channel in pattern, the unit cycles back to the first channel in the pattern.

After all available data is sent and transmission stops, and the timing slots for the current channel expires, the transmitter turns off. The next time data is ready to be sent, the transmitter starts on the next channel in the pattern. In this manner, each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event

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 first packet transmitted on a given channel has a preamble long enough to be detected by a scanning receiver and a sync bit in the header designating it as starting at the beginning of a channel time slot.

The receiver first locks to a transmitted signal by scanning each of the assigned channels for a preamble. When a preamble is detected and a properly formatted packet received, the receiver checks the sync flag in the packet header. If the flag is set, the receiver synchronizes with the transmitter by setting the channel expiration time, knowing the fixed time offset from the beginning of transmission to the sync word.

After the receiver is synchronized, it changes to the next channel in the common hopping pattern at the same time as the transmitter. The first transmission at the new channel also has the first packet flag set, allowing the receiver to resynchronize with the first message of each new transmission channel.

System timing is fixed on both sides, so the transmitter and receiver can easily calculate the channel time slot from the sync word. By synchronizing on the first packet on each channel the system calibrates itself and removes error due to oscillator drift.

6. 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 the TRM-915-R250 radios. It is very unlikely that they would be the same for a different FHSS system.

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