MOJIX Response to TCB Questions

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1. FCC Section 15.203 and MOJIX response

Section 15.203:
Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where the EUT must be professionally installed.

In order to demonstrate that professional installation is required, the following three points must be addressed: (a) the application (or intended use) of the EUT, (b) the installation requirements of the EUT, and (c) the method by which the EUT will be marketed

MOJIX Response

Antenna of the EUT is permanently soldered to the transmitter and cannot be replaced (i.e., It is soldered directly to the transmitter printed circuit board.)

2. FCC Section 15.204 and MOJIX response

Section 15.204:
Provide the following information for every antenna proposed for use with the EUT:
(a) type (e.g., Yagi, patch, grid, dish, etc.),
(b) manufacturer and model number, and
(c) gain with reference to anisotropic radiator.

MOJIX Response

a) EUT uses a patch antenna at 902 - 928 MHz
b) Patch antenna is designed by Mojix Inc. P/N: 445-001-000
c) Antenna gain is 6 dBi.

3. FCC Section 15.247 and MOJIX response

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Section 15.247(a):
Describe how the EUT meets the definition of a frequency hopping spread spectrum system, found in Section 2.1, based on the technical description. *Definition of Frequency Hopping Systems per FCC Rules sec. 2.1*

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 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 over the hop set, and sequential hops are randomly distributed in both directions and magnitude of change in the hop set.

Mojix Response

EUT's RF carrier signal hops over the 902 - 928 MHz band. The frequency hopping sequence is generated using a 32 bit Galois LFSR, which generates permutations of the 50 frequencies.

These permutations are generated by repeatedly selecting one of N entries by using the 16 bits as a floating point number between 0 and 1. An example of the sample Sequence (100 items) is:

22 21 19 17 42 41 6 7 34 44 20 39 36 15 14 18 28 31 9 16 4 30 48 0 35 37 47 3 38 8 27 33 11 10 32 26 24 45 5 25 13 40 12 1 2 43 46 49 29 23 13 7 18 29 1 23 35 36 14 27 9 25 47 48 41 43 44 6 26 49 34 11 40 32 10 38 33 45 0 28 15 17 46 24 20 21 19 31 30 2 39 22 12 3 16 4 42 5 8 37

EUT's synthesizer hops to hopping frequencies in the range of 902-928 MHz band. The channel step size is 500 KHz and a minimum of 50 channels are used.

EUT uses DSB-ASK, PR-ASK and SSB-ASK modulations, to modulate the carrier frequency. The modulation process first generates the transmit I/Q baseband data digitally. Using this digital data, analog I/Q signals are generated through a DAC. The digitally generated I/Q signals are used to directly modulate the hopping RF carrier signal using a complex mixer. The modulated RF signal is amplified and level corrected, to meet the maximum radiated power requirements, before being radiated by the antenna.

4. FCC Pseudorandom Frequency Hopping Sequence and MOJIX response

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, found in Section 2.1.

Mojix Response

The hopping sequence is generated using a 32 bit Galois LFSR to generate permutations of the 50 frequencies. These permutations are generated by repeatedly selecting one of N entries by using the 16 bits as a floating point number between 0 and 1. An example is:

Sample Sequence (100 items):

22 21 19 17 42 41 6 7 34 44 20 39 36 15 14 18 28 31 9 16 4 30 48 0 35 37 47 3 38 8 27 33 11 10 32 26 24 45 5 25 13 40 12 1 2 43 46 49 29 23 13 7 18 29 1 23 35 36 14 27 9 25 47 48 41 43 44 6 26 49 34 11 40 32 10 38 33 45 0 28 15 17 46 24 20 21 19 31 30 2 39 22 12 3 16 4 42 5 8 37

5. FCC Equal Hopping Frequency use and MOJIX response

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).

Mojix Response

The generated sequence is guaranteed to hop to every channel with perfect evenness, as it does a permutation of the 50 channels each time. This gives short term randomness, while preserving long term equal use of the channels. The sequence do not reset between transmissions, resulting in a continuing random sequence. The sequence of channels is reset on system power off & on.

6. FCC System Receiver Input Bandwidth and MOJIX response

System Receiver Input Bandwidth 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.
Mojix Response EUT receiver uses direct down conversion architecture and has two sets of filters that set the bandwidth: first is the analog anti aliasing filter which has a bandwidth of 1 MHz and that is followed by the digital filter that is rate matched to our transmit signal.

7. FCC System Receiver Hopping Capability and MOJIX response

System Receiver Hopping Capability Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals
Mojix Response EUT uses a common synthesizer for generating the carrier frequency for transmitting RF signals and demodulating the received signal. Hence, when the synthesizer hops, both the transmit and receive center frequencies hop simultaneously to the new common channel.

8. FCC RF Exposure compliance requirements and MOJIX response

RF Exposure Compliance Requirements

Spread spectrum transmitters operating under Section 15.247 are categorically excluded from routine environmental evaluation for demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance. As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to the public (users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Sections 1.1307, 2.1091 and 2.1093). Unless a device operates at substantially low output power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s), in order to determine compliance with the RF exposure guidelines. In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed: (1) calculations that estimate the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits (defined for free-space), (2) antenna installation and device operating instructions for installers (professional and/or unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirements, (3) any caution statements and/or warning labels that are necessary in order for a device to comply with the exposure limits, and (4) any other RF exposure related issues that may affect MPE compliance.

Mojix Response

EUT is not a mobile device and will be installed on fixed locations. EUT uses a fixed 6 dBi gain antenna, and the maximum output power from the EUT is +30 dBm.

The MPE estimate from 1.1310 Table 1 is:
3.006 mW/cm^2 at 902 MHz.

Using the power density formula

$PD = (G*P)/4\pi R^2$

Where G = Transmit Antenna Gain = 6 dBi = 4
P = Maximum Transmit Power = 30 dBm = 1000 mW
PD = Power Density = 3.006 mW/cm^2 (maximum permitted level)

Using 3.006 limit as PD and solving for R

R = 10.29 cm (minimum distance for MPE)

Therefore, there will be no warning label on the EUT or no RF exposure warning will be included in the manual.

9. FCC Installation/operation manual requirements and MOJIX response

Installation/Operation Manual Requirements Submit a copy of the information/instructions that will be included in the installation/operation manual pertaining to: (a) correct peak output power settings required for compliant operation for every antenna proposed for use with the EUT, (b) point-to-point operational requirements and responsibilities, (c) any RF exposure compliance requirements.
MOJIX Response See attached MOJIX Operational manual

10. FCC Section 15.247 (g) and MOJIX response

Section 15.247(g): Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system.
Mojix Response EUT is a frequency hop system. EUT ‘s frequency hopping PN sequence is designed to randomly hop to the entire set of frequencies. This hopping is regardless of whether it is requested to do continuous inventories or short bursts of activity, the frequency hopping characteristics will be identical for either case. The overall time for hopping to all frequencies will be longer for burst activity, due to the periods where no transmission is occurring.

11. FCC Section 15.247 (h) and MOJIX response

Section 15.247(h): 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.
Mojix Response EUT does not have interface or capability for external control and initialization of the hopping sequence generator. EUT uses PN sequence for generating frequency hopping channels. The PN sequence generator do not reset between transmissions, resulting in a continuous random sequence. The PN sequence generator only resets at power on/off. Hence, EUT complies with the requirement of not having the capability of coordinating frequency-hopping pattern with other FHSS systems.