ET Docket No. 09-38

STARKEY

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Federal Communications Commission
Office of the Secretary

DATE: 10/8/2008

FROM: Jeff Solum

SUBJECT: Waiver to Part 15.247

Background Information:

Starkey Labs Inc. is interested in facilitating audio enhancement for the hearing impaired via the use of digital audio equipped assistive listening devices. To accomplish this, Starkey Labs Inc. of Eden Prairie, MN has made a significant investment in ultra low power communication devices in the 915 MHz ISM band. These ultra-low power RF communication devices will use a minimum amount of bandwidth to accomplish the communications necessary for maintaining a high quality of life for the hearing impaired. Starkey is interested in lowering the bandwidth limits in section (a)(2) of part 15.247 to any bandwidth that is limited in power to the power spectral density as specified in part 15.247(e) 8 dBm/3 KHz power spectral density.

(1) We need a better understanding of what types of devices Starkey Labs is looking to operate in the 900 MHz band and the technical characteristics of their design and operation.

Specific devices for use in this band include:

1. Assistive listening devices for sending digital audio information to a hearing aid wearer for the purpose of improving the signal to noise ratio of audio information presented in a classroom, auditorium, place of worship, etc. The specific devices may include two-way communication with the hearing aid wearer. Range of these devices should be on the order of 30 meters for indoor propagation. Anticipated bandwidth requirements is for 300 KHz OBW modulation is 2-FSK. Host devices would be equipped with receivers having a sufficient sensitivity to do listen before talk and will employ an adaptive frequency selection algorithm.
2. Wireless devices for public service announcements and alarms. These devices may improve or even save the lives of the hearing disabled.

(2) We would like to understand why the devices can't operate in the 900 MHz band under rule section 15.249 (for narrower bandwidths), or in the 217 MHz band under the LPRS rules in Part 95 (either under the current rules or waiver of certain LPRS rules).

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Under the current rules Starkey can either operate under rule 15.249 in which case the power output is limited to -1.5 dBm ERP which limits the range of operation to roughly 4 meters in free space given the physical size and power constraints of a radio subsystem that is part of a hearing instrument. At 900 MHz the current state of the art permits an antenna with an efficiency no greater than -25 dBi within the physical size of a hearing instrument.

Link Budget example
Transmit power = -1.5 dBm
Transmit antenna efficiency = 0 dBi
Free space loss over 4 meters (Friis eq) = -43.7 dB
Receiver antenna efficiency = -25 dBi
Receiver sensitivity = -90 dBm for 1E-3 BER
Body Shadow effects = -15 dB
Indoor Multi-path effects = -10 dB

-1.5 -43.7 – 25 -15 - 10 = -95.2 dBm (This example shows there is insufficient power at 4 meters to achieve 1E-3 BER)

Under Part 95 LPRS rules at 217 MHz, the allocation is for <50 KHz channels and the transmission is limited to one way voice communication. In order to send medium fidelity digital audio signals approximately 200 Kbits/sec is necessary. Given a 50 KHz bandwidth allocation it will be necessary to use higher order modulation schemes requiring a large amount of signal processing at the receiver. Such signal processing of the input signal is not currently possible given the energy capacity of a hearing aid battery.

In addition the allocation is limited to 1 MHz total bandwidth which may be insufficient for multiple digital audio streams within range of one another. The current deployments of systems in this band are narrow band FM systems. Starkey, along with other hearing aid manufacturers, envision future systems employing digitally modulated signals that can transmit high fidelity audio.

To use the band allocated currently at 217 MHz effectively, the hearing industry would require the following modifications.

Allow two-way voice and data communication
Occupied bandwidth up to 300 KHz
3 MHz total bandwidth
Max power spectral density of = 6 dBm/10 KHz
Max power of +20 dBm (This is no change from the present max power)

Alternatively Starkey could increase the occupied bandwidth of our present system to 500 KHz, as other users of the ISM band have done, to permit the use of up to +30 dBm ERP under the current rules of 15.247. This unfortunately promotes inefficient use of the ISM

band. Users willing to increase their occupied bandwidth to meet the bandwidth requirements are rewarded with a higher ERP limit even if the necessary bandwidth for their application is well below that of 500 KHz. Using this bandwidth requires the receiver bandwidth to increase over what is needed for transmission of relatively low data rate signals, thus reducing the link margin due to the increased noise equivalent bandwidth of the system. To make up for the reduced link margin the transmitter would have to operate at an even higher power level. So for example a signal requiring a +17 dBm ERP for a preferred range of 25 meters using 250 KHz OBW would now require +20 dBm using 500 KHz OBW to achieve the same link margin. This example illustrates the bandwidth inefficiency that is currently being promoted by 15.247 under the current rules.

15.247 does not define the modulation technique it is simply stated that the signal must be "digitally modulated" implying there is a transmission of binary information over the channel. FSK is one such technique. By increasing the modulation index or stated otherwise the tone spacing, relatively low data rate information can be sent in a channel occupying the 500 KHz necessary bandwidth which will then meet the requirement of 15.247 and allow such systems to transmit +30 dBm ERP. Starkey proposes that specifying a power spectral density for digitally modulated signals, such as the one already specified in 15.247(e) of 8dBm/3KHz, will promote the most efficient use of the available bandwidth.

Frequency hopping and spread spectrum techniques require additional power consumption over direct modulation techniques. Fast frequency hopping requires additional current in the PLL to rapidly tune the synthesizer. Direct sequence spread spectrum techniques require high speed switching at RF which increases the overall power consumption of the system. In addition these techniques require synchronization overhead which increases the power consumption and lowers the effective throughput of the system.

(3) Starkey Labs should provide an interference analysis of its proposed operations vis-à-vis authorized Federal (radiolocation, fixed and mobile) and non-Federal (LMS, amateur, ISM) services in the 900 MHz band. Also, Starkey Labs should take into account the pending rulemaking to modify the LMS rules for the 900 MHz band (WT Docket 06-49).

Starkey employs the use of an adaptive frequency selection algorithm by the host device that monitors the channel for a clear portion of spectrum in which to operate. The host device selects the channel for use. By selecting a clear channel for operation, Starkey assistive listening devices avoid harmful interference from other wireless systems and additionally minimize interference to other wireless devices from the Starkey assistive listening system.
By granting the waiver Starkey host devices will use a narrower bandwidth than the minimum bandwidth required under 15.247 thus reducing potential interference.

Starkey has conducted experiments and field trials using it's experimental license (0695-EX-PL-2007) and found the range to be sufficient to perform all of the streaming digital audio use cases. In addition Starkey has tested other part 15 devices such as 900 MHz handsets, and found no harmful or unexpected effects on these systems in the face of the Starkey experimental equipment.

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