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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Request of SENSIFREE, Inc. for Waiver of	)
Part 15 of the Commission's Rules Applicable	)
to Ultra-Wideband Devices for a Pulsed,	)
Frequency-Hopped Body-Worn Medical Device	)

ET 15-284

To: The Chief, Office of Engineering and Technology
Via: Office of the Secretary

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REQUEST FOR WAIVER

Sensifree, Inc. (Sensifree), by and through counsel and pursuant to Section 1.3 of the Commission's Rules (47 C.F.R.§1.3) hereby respectfully requests a waiver [1] of the Commission's rules and test procedures governing ultra-wideband (UWB) devices, (including but not necessarily limited to Section 15.503(d) of the Commission's rules), so as to permit Sensifree to obtain certification for and to market in the United States a body-worn UWB heart rate monitoring device (referred to herein as the "Heart Rate Sensor" or "HRS"). In support of the relief requested, especially with respect to the need for clarity and flexibility in the application of the Commission's requirement that ultra-wideband (UWB) devices meet a fractional bandwidth minimum of 0.20 or 500 megahertz "at any point in time," Sensifree states as follows:

1. Sensifree is a United States Corporation which is a wholly-owned subsidiary of Sensifree, Ltd., a multinational business entity headquartered in Israel. Sensifree manufactures, among other electronic products, the HRS. This is a high-quality, body-

[1] The Commission is authorized to grant a waiver pursuant to Section 1.3 of the Commission's rules if the petitioner demonstrates good cause for such action. See, *ICO Global Communications (Holdings) Limited v. FCC*, 428 F.3d 264 (D.C. Cir. 2005); *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969)

worn digital heart rate monitor which electromagnetically senses changes in the user's artery diameter (which is caused by the repetitive cycle in blood pressure inside the artery). The sensing is performed by inducing through the device a weak electromagnetic field in the organ to be sensed (typically the user's wrist), and the change in the field resulting from the artery diameter change is thus determined.[2] Because the device is body-worn, motion artifacts are (necessarily) attenuated by means of an UWB signal which separates the time difference between different reflection paths. The design of the device is based on stepped-frequency radar, and uses an UWB pulsed, frequency-hopped emission.

2. The Sensifree HRS device can be wrist-worn, or worn on the upper arm, chest, back, top of the foot, and elsewhere on the human body. The transmitter emits consecutive pulses bunched into a cycle using on-off pulses over the frequency range of the device which vary in number and duration depending on the different body locations. The typical transmit power at the antenna ports is -5 dBm and the duration of the pulses are 5 microseconds per frequency each. The entire transmit cycle comprises N pulses, evenly distributed within the transmit frequency range (where N is typically 16), which are repeated every 33.33 milliseconds. For use in the United States, a wrist-worn device operates between 5 and 10 GHz; an arm-worn device would operate between 3.1 and 7 GHz; and a chest-worn device would operate between 3.1 and 4.1 GHz. The device is marketable in other frequency ranges in Europe, China and Japan. It has the distinct public interest benefit of providing to users lightweight, comfortable, accurate biometrics

[2] The HRS does not appear to be a Medical Imaging System as defined in Section 15.503(g), which is narrowly defined as "a field disturbance sensor that is designed to detect the location or movement of objects within the body of a person or animal" though a broad reading of that definition could be deemed inclusive.

and it consumes very low power. It has virtually no interference potential to narrowband emissions or otherwise. It permits heart patients free mobility, independence and safety while conducting normal activities.

3. Sensifree's development of this and similar important biometric products for use in the United States is inhibited by, among other things, the inflexibility of the Commission's minimum bandwidth rule for UWB devices. Section 15.503(d) of the Commission's Rules governing the operation of UWB devices contains the requirement that UWB devices meet a fractional bandwidth minimum of 0.20 or 500 megahertz "at any point in time." [3] This absolute requirement is particularly complicated because it does not appear possible to comply with it using <u>any</u> practical emission mode and therefore a waiver is required.

4. With an occupied bandwidth between 1 and 5 gigahertz, the HRS device would be considered a UWB device but for the fact that, for an intentional radiator to meet the requirements of Section 15.503(d) of the Rules, the device must have an instantaneous bandwidth of at least 500 MHz.[4] The rules do not define what period of time constitutes an instantaneous measurement interval. However, the prevailing staff interpretation of the term "at any point in time" is that, for stepped or hopped frequency emissions, each step or hop is the instantaneous bandwidth of the device, and therefore, since each step or hop

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[3] Section 15.503(d) of the Commission's Rules states as follows:

§ 15.503 Definitions.
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(d) Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

[4] UWB devices in the European Union are not defined in terms of a minimum, "instantaneous" bandwidth as they are in the United States. Communications devices require a minimum operating bandwidth of only 50 MHz (at -23dB relative to the maximum spectral power density) *(see* ETSI EN 302 065 vl.l.1 (2008-02)).

is less than 500 MHz, the device does not meet the UWB definition. UWB test procedures should accommodate non-impulse transmitters by permitting measurements to be made with any hopped, pulsed, stepped or gating functions active. Sensifree therefore requests waiver of this rule for its HRS device.

5. The Commission did grant a waiver for a UWB stepped frequency OFDM device in 2005. However, the *First Report and Order* in the UWB docket[5] specifically stated that measurements on a stepped frequency or frequency hopping modulated system are performed with the stepping sequence or frequency hop *stopped*. The Commission further noted that with the sweep, step function or hopping stopped, it is *unlikely* that swept frequency (linear FM or FMCW) or stepped frequency modulated emissions would comply with the fractional bandwidth or minimum bandwidth requirements. Thus, Sensifree calls upon the Commission for a waiver of Section 15.503(d) of the Rules governing the operation of UWB devices relative to the requirement that UWB devices meet a fractional bandwidth minimum of 0.20 or 500 megahertz "at any point in time."

6. The definition of UWB relative to minimum bandwidth requirements adopted in the UWB *First Report and Order* reads as follows:

> Section 15.503 Definitions.
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> (a) UWB Bandwidth. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M.
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> (b) Center frequency. The center frequency, f_C, equals $(f_H + f_L)/2$.

[5] *See,* the *First Report and Order* in ET Docket No. 98-153, 17 FCC Rcd 7435 (2002); *Erratum* in ET Docket No. 98-153, 17 FCC Rcd 10505 (2002).

(c) Fractional bandwidth. The fractional bandwidth equals $2(f_H - f_L)/(f_H + f_L)$.

(d) Ultra-wideband (UWB) transmitter. An intentional radiator that, **at any point in time**, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

(emphasis added)

7. The Commission decided in that proceeding that the –10 dB fractional bandwidth should be 0.20, and that the minimum bandwidth limit would be 500 megahertz for UWB devices. The Commission noted, ***"as long as the transmission system complies with the fractional bandwidth or minimum bandwidth requirements at all times during its transmission, we agree that it should be permitted to operate under the UWB regulations."*** The rule therefore seems to require without exception that the minimum bandwidth requirement be achieved at all times *(i.e. in all possible operation modes of the device)* during the transmission, regardless of modulation or emission type.

8. This requirement, that the minimum bandwidth must be met "at all times," precludes the use of essentially all modulation schemes, except a continuous-wave signal of at least 500 MHz bandwidth. Pulsed emissions, frequency-hopping emissions, swept frequency (*e.g.*, FMCW), and stepped frequency systems are all precluded by this requirement, if the requirement is strictly construed and applied. The requirement that the minimum 500 MHz bandwidth be achieved "at any point in time," in combination with the requirement that the signal must be measured *with and without modulation* [6] makes any UWB device impossible of compliance. For some UWB applications,

[6] The term "modulation" in this context further detracts from the clarity of the rule. What the modulation is in this case is determinative but unclear. Is it the step sequence for the frequency hopped signal, or for FMCW, the ramp? If so, then the absence of modulation leaves only the carrier. If, however, the modulation is on the basic signal, then the rule is far more permissive. If the hopping or the ramp is the modulation, then even pulsed signals will fail to meet the minimum bandwidth test, because in that case, the PRF generation of the signal is comparable to the modulation of the FMCW or the frequency hopping emission.

emissions other than pulse or OFDM are more appropriate. Examples are frequency hopping, frequency stepping, FMCW, or pseudo-noise coding. In "normal" operation, each of these emissions is capable of meeting or exceeding a 500 MHz bandwidth. For most of these applications it makes no sense to switch off the modulation, as that would leave only the signal basic form. As an example of the problem, with FMCW, the signal is usable only with modulation. Without modulation, there is only a carrier. To send out only the carrier makes no sense, and it is not efficient.

9. An alternative interpretation, which would make sense, is to prohibit UWB sensors or other devices which are capable of switching off the modulation or which could change to an *operating mode* in which the emission is than less than 500 MHz. Alternatively, a requirement could be implemented that would provide that in all modes of operation of the UWB device, the necessary or occupied bandwidth must be greater than 500 MHz. To have to switch off the modulation for compliance testing makes UWB products, including that of Sensifree unworkable, absent a waiver for each one.

10. An additional issue, and one directly encountered by Sensifree, is the measurement time of the measurement receiver during which the minimum bandwidth requirement must be met (e.g., one millisecond). It is clear that the requirement cannot be fulfilled in no time or during an unspecified time, but within a certain time delta. Measurement procedures now require that measurements of swept frequency devices be made with the frequency sweep stopped. 47 C.F.R. §15.31(c). This requirement was enacted apparently because the measurement procedures for swept frequency devices were undetermined at the time of the first UWB Report and Order. Likewise, interference aspects of swept frequency devices were undetermined due to the fact that measurement

results obtained from measurements taken with the sweep active would differ from those with the sweep stopped. Similarly, measurements on a stepped frequency or frequency hopping modulated system are performed with the stepping sequence or frequency hop stopped. With the sweep, step function or hopping stopped, it is unlikely that swept frequency (linear FM or FMCW) stepped or hopped frequency modulated emissions would comply with the fractional bandwidth or minimum bandwidth requirements. The Commission admitted in the UWB *First Report and Order* that it is "unlikely that frequency hopping systems would comply unless an extremely wide bandwidth hopping channel is employed." It did not, however, indicate how the "at any point in time" condition could possibly be literally complied with by any modulation scheme.

11. In 2003, the Commission issued a *Memorandum Opinion and Order and Further Notice of Proposed Rule Making* in the UWB docket,[7] which made no change in the minimum bandwidth requirement but did state: "The rules adopted in the *R&O* also permit UWB devices to comply with the minimum bandwidth requirement due to the use of a high speed data rate or the use of other modulation techniques instead of the width of the pulse or impulse signal." In December of 2004, the Commission issued a *Second Report and Order and Second Memorandum Opinion and Order*, [8] which addressed proposed changes in operational standards for unlicensed devices that may apply simply due to the bandwidth of the transmission system. The Commission said that its standards for unlicensed devices must reflect emission limits that reduce the potential for causing harmful interference to authorized radio services. The emission limits applied to UWB

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[7] *Memorandum Opinion and Order and Further Notice of Proposed Rule Making* in ET Docket No. 98-153, 18 FCC Rcd 3857 (2003).

[8] *Second Report and Order and Second Memorandum Opinion and Order ("2nd R&O") in ET Docket No. 98-153, 19 FCC Rcd 24525 (2004).*

ensure a low probability of causing harmful interference, *and the minimum bandwidth requirement could have the opposite effect than what is intended: it could cause a manufacturer to design transmitters that occupy more bandwidth than is operationally necessary or transmitters that inject noise in order to increase the occupied bandwidth simply to permit operation under the UWB regulations. This would place greater energy in frequency bands where operation is not necessary for the system to function and increase the interference potential.* So, the Commission realized that a minimum bandwidth standard (and, obviously, the measurement procedure for determining the minimum bandwidth) could be counterproductive to reducing whatever minimal potential there might be for harmful interference, and it proposed to eliminate the definition of an ultra-wideband transmitter in 47 C.F.R. § 15.503(d). The Commission recognized that it is the limit on emission levels (and particularly the limit on spectral power density) that primarily controls interference potential, not whether or not the minimum bandwidth is met "at all times." The Commission proposed to permit the operation of any transmission system, regardless of its bandwidth, as long as it complies with the standards for UWB operation set forth in Subpart F of 47 C.F.R. Part 15 and based the resolution bandwidth used for the peak power measurement to 10 percent of the -10 dB bandwidth of the emission. NTIA opposed eliminating the bandwidth requirements, stating that the supporting comments offered no technical support and expressing concern that such a change would permit operation in the restricted bands regardless of the bandwidth of the unlicensed emission. Ultimately, the Commission said it found "no necessity at this time to eliminate the UWB minimum bandwidth requirements." It said that such changes "could be disruptive and could further delay the introduction of UWB devices" and that

any operation in the restricted bands should be subject to the additional technical standards and operational parameters specified in the UWB regulations. Changes to the minimum bandwidth requirements for UWB devices were deferred "until additional experience has been gained with this equipment."

12. It is not clear from that discussion that the Commission recognized that its requirement that the minimum bandwidth of a UWB device must be achieved "at all times" during a transmission constituted a preclusive limit on UWB deployment and would preclude some or all UWB products (since none, including pulsed emission UWB devices, can meet this absolute restriction). The rule is not at all clear, and on its face is completely preclusive, *unless* a common-sense interpretation is applied. The "at any point in time" regulation, in order to make sense, must mean "at any point in time in the normal operating mode of the device." Absent such an interpretation, every UWB device that would not, at all times during its transmit cycle, meet the minimum bandwidth requirement (which Sensifree suggests is every UWB device) will require a waiver from the Commission. Instead, a practical interpretation of the Section 15.503(d) definition of minimum bandwidth is called for, focusing on the - 10 dB requirement and the fractional bandwidth requirement, and applying the "at any point in time" provision to mean that the minimum bandwidth must be complied with at all times during the normal operating cycle of the emission being utilized.

13. For the HRS device, Sensifree requires a waiver. But more generally, and for the future, the Commission should provide, for all UWB devices, the opportunity to apply a practical interpretation of the Section 15.503(d) definition of minimum bandwidth, focusing on the - 10 dB requirement and the fractional bandwidth requirement, and to

apply the "at all times" provision to mean that the minimum bandwidth must be complied with at all times during the normal operating cycle of the emission being utilized by a UWB device.

14. It is suggested that Sensifree is entitled to a waiver in this instance, as the Commission has repeatedly waived the UWB technical rules under similar circumstances. Since the adoption of the UWB rules in 2002, the Commission has shown a willingness to waive its technical restrictions for UWB devices when it believes the device presents little threat of harmful interference and the requested waiver would further important public interest goals. A 2005 waiver granted to the Multiband OFDM Special Interest Group [9] relaxed the UWB measurement procedures for stepped frequency devices after the Commission determined that these devices would cause less interference than pulsed emitters operating over the same spectrum. A 2007 waiver to Curtiss-Wright Controls [10] for a perimeter intrusion detection system was based on the decision that the location of the system and coordination with NTIA greatly reduced any chance of interference that might otherwise be caused by an increase in the average and peak emission limits of Section 15.511. A 2008 waiver granted to UltraVision Security Systems [11] to permit operation of a UWB surveillance system below 960 MHz was based on a determination that there would be little chance of interference from a device intended to be buried in the ground. Most recently, the Commission granted another

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[9] *See Petition for Waiver of the Part* 15 *UWB Regulations Filed by the Multi-band OFDM Alliance Special Interest Group,* ET Docket No. 04-352, Order, 20 FCC Rcd 5528 (2005)

[10] *Curtiss-Wright Controls Inc. Embedded Computing Petition for Waiver of the Part* 15 *UWB Regulations,* DA 07-198, Order, 22 FCC Red 815 (2007).

[11] *Ultra Vision Security Systems, Inc. Request for Interpretation and Waiver of Section 15.511(a) & (b) of the Commission's Rules for Ultra-Wideband Devices,* ET Docket No. 06-195, Order, 23 FCC Red 17632 *(2008).*

waiver to Curtiss-Wright Controls [12] of Sections 15.503(d) and 15.521(d) of the UWB rules for a ground penetrating radar system. In each of these waiver decisions, the Commission considered the public benefits of these novel UWB technologies and imposed reasonable conditions on use to assure there would be little likelihood of interference while it obtained additional data from their operations. The Sensifree body-worn biometrics device has a far lower interference potential[13] than do any of the other devices and an equally compelling public interest justification. The HRS device is completely non-intrusive for the user and allows ultimate mobility and accurate monitoring.

15. As noted above, the Commission may waive a rule for good cause shown. 47 C.F.R. § 1.3. Waiver is appropriate if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule. *Northeast Cellular*, 897 F. 2d 1164, 1166 (D.C. Cir. 1990). Generally, the Commission may grant a waiver of its rules in a particular case if the relief requested would <u>not</u> undermine the policy objective of the rule in question and would otherwise serve the public interest. *WAIT Radio v. FCC*, 418 F2d 1153, (DC Cir 1969); *Dominion Video Satellite, Inc., Order and Authorization*, 14 FCC Rcd 8182 (Int'l Bur. 1999). In *WAIT Radio*, it was held that even if the overall objectives of a general rule have been adjudged to be in the public interest, it is possible that application of the rule to a specific case may not serve the public interest if an applicant's proposal does not undermine the public interest policy served by the rule. 418 F. 2d at 1157. In discussing

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[12] *Curtiss Wright Controls, Inc. for waiver of Sections 15.503(d) and 15.521(d) of the ultra-wideband rules for its ground penetrating radar system*, ET Docket 10-167, 27 Fed. Reg. 234 (2012)

[13] The antenna is unidirectional facing the skin of the wearer and outward emissions are attenuated by the antenna design. This, coupled with the exceptionally low power and short range of the device makes interference to other radio services highly unlikely.

the treatment of requests for waivers of established rules, the court in *WAIT Radio* emphasized that the agency's discretion in applying general rules is intimately linked to the existence of "a safety valve procedure" to permit consideration of an application for exemption based on special circumstances. *Id.* Indeed, the court considered a rule most likely to be undercut if it does not take into account "consideration of hardship, equity, or more effective implementation of overall policy..." *Id.* at 1159.[14] The Commission's waiver authority, per Section 1.925 of the Commission's Rules, 47 C.F.R. § 1.925, allows the Commission to grant a waiver if it is shown that (a) the underlying purpose of the rule(s) would not be served or would be frustrated by application to the instant case, and grant of the requested waiver would be in the public interest; or (b) if there are unique or unusual factual circumstances in a specific case where application of the rule would be inequitable, unduly burdensome or contrary to the public interest, or the applicant has no reasonable alternative. In this case, the latter rationale is specifically applicable to the Sensifree HRS device, which has no interference potential to narrowband or wideband services operating within the UWB frequency range, and which in normal operation far exceeds the 500 MHz minimum bandwidth which should qualify it as an UWB device. This device has clear public interest benefits in terms of facilitating independent living and movement for heart patients consistent with ensuring their safety.

Therefore, the foregoing considered, Sensifree, Inc., respectfully requests that the Commission grant the requested waiver, so that an application for equipment

[14] The Commission, when it adopted its UWB rules, shortly thereafter issued an Order, 17 FCC Rcd. 13522 (2002) grandfathering the operation of certain UWB wall imaging devices. In so doing, the Commission stated that it was "clear that several public safety benefits result from the continued operation of existing.. wall imaging systems currently in use. It is equally clear that existing devices may not comply with the UWB regulations that were adopted in the Order. Further, we are not aware of any reports of harmful interference resulting from the long-term use of ... wall imaging systems in the past. Accordingly, we believe that permitting the continued operation of these devices is precisely the type of special circumstance for which the "safety valve procedure" cited by the courts should be applied.

authorization can be obtained and the Sensifree Heart Rate Sensor can be made available to the public in the United States.

Respectfully submitted,

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