## ART-Fi comments on *FCC 13-39 - FIRST REPORT AND ORDER FURTHER NOTICE OF PROPOSED RULE MAKING AND NOTICE OF INQUIRY* as released on March 29, 2013

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Comment 1:

As stated in §209, the intent of the Commission is "to adequately protect the public without imposing an undue burden on industry". For achieving this goal, the Commission requests for comments "on a wide range of questions that will enable to weigh costs and benefits". "Cost" is here intended as "the overall costs of the regulation".

With the introduction of the LTE technology, the cost of the regulation has dramatically increased on the side of the manufacturers. This is in particular due to the huge number of possible test conditions and covered frequency bands which are enabled by the LTE. The Commission has done remarkable work in devising procedures for minimizing the number of test cases based on conducted power assessment, see e.g. KDB 941225 D05. Nevertheless the cost associated with LTE devices testing is still very high. The case of SONY XPERIA ZL mobile phone (FCCID P7YM-0230 - test report available on the FCC website) is taken here as an example. This phone covers GSM850, PCS1900, UMTS FDD Band 2, UMTS FDD Band 4, UMTS FDD Band 5, LTE Band 2, LTE Band 4, LTE Band 5, LTE Band 17, and WLAN 2.45GHz, WLAN 5.8GHz. From the SAR test report of this phone, it can be seen that testing of LTE bands represents about 62% of the total amount of measurements for SAR compliance evaluation (210 SAR tests over 340). In this case, the cost of compliance evaluation for LTE bands is more than 2.5 times the total cost involved for all the other bands.

ART-Fi would request the Commission to consider enabling the use of faster SAR measurement alternatives to reduce this burden, especially relating to the LTE technology. IEC and IEEE international standards committees in which the Commission participates have worked hard on defining procedures for using so called "fast SAR" methods in order to efficiently identify the highest SAR test conditions. The 2013 revision of IEEE P1528 which has been recently accepted will be the first published international standard describing such procedures.

It is noteworthy that there are two classes of techniques allowing faster SAR assessment:

(1) based on the same hardware as conventional full SAR techniques but with different software and/or protocol;

(2) based on a different innovative hardware.

The second category now appears in the "informative" Annex H of the IEEE P1528-2013 standard. Yet this second category, which contains a class of approaches based on the use of probe-arrays, is the most promising one in order to achieve the goals of the FCC:

- "to adequately protect the public" by making it possible to provide a broader and more accurate coverage of possible test conditions (accuracy is discussed below considering the use of conducted power measurements)

- "without imposing an undue burden on industry". Fast SAR techniques based on probe-arrays allow a SAR measurement in a few seconds.

An example of SAR system using probe-arrays is the ART-MAN which has been developed by ART-Fi (www.art-fi.eu/art-man). Using an automated sweeping of LTE modes by controlling the base station simulator, ART-MAN is capable to assess the SAR of a given LTE mode in about 12 seconds (4 seconds for the SAR measurement, 8 seconds for changing communication mode). When including fluid preparation, positioning and battery charging, one SAR test on a traditional robot SAR system takes a little more than 30 minutes on average. ART-MAN can hence reduce the measurement time by a factor up to 150 and no fluid preparation is needed. Using ART-MAN for determining the highest SAR conditions in a given LTE band can hence drastically reduce the overall cost of compliance demonstration on LTE bands.

Another important point is that, even if the conducted power assessment is a relevant tool to determine highest SAR conditions, this tool also has limitations. Indeed, conducted power measurements are made over 50 Ohms. However, a mobile phone antenna is not 50 Ohms at every frequency and even less when the phone is, for example, placed with the antenna facing the flat phantom at e.g. a 10mm distance. Indeed, conducted power measurements do not take into account this tuning/detuning effect. Although in general, higher power conditions give higher SAR, it is possible that between two high power conditions the one with lower power gives a higher SAR because of the impedance at the antenna input. Hence, using faster SAR alternatives could be of real help to screen efficiently through the modes with conducted power above a certain threshold, and accurate evaluate peak spatial-average SAR for those modes. Finally, it is noteworthy that, if manufacturers can assess the conducted power of their phones easily, other institutions which would like to measure this power may have more difficulties. This is the case when the considered phone does not provide an easy access to the output of the power amplifier.

Because of all the reasons mentioned above, enabling the use of faster SAR measurement alternatives based on probe arrays would help in establishing more cost-effective approaches. However, ART-Fi is conscious that a prerequisite for this is that the accuracy of the faster method used is appropriately demonstrated. ART-Fi would then like to encourage the Commission to consider enabling the use of faster SAR measurement alternatives based on probe arrays for determining the highest SAR conditions if the uncertainty of the method is correctly demonstrated and proved to be below a certain level. This is by the way compatible

with §39 of FCC 13-39 stating that “Parties will continue to be able to demonstrate compliance with our rules by other means if based on sound validated methodologies.”

Comment 2: §40 states the intention of the Commission “to develop policies on procedures in the KDB to reliably determine the compliance of new and increasingly complex devices”. With the emergence of recent technologies, a variety of complex modulated signals showing rapid variations and high peak-to-average ratios have been introduced. The recently accepted international standard IEEE P1528-2013 states that “the non-linear response of the diode detector fi(Vi) [...] should be linearized.” This function depends on both the rms value of Vi but also on the type of signal. As a consequence, probe calibration for diode-detected probes should include the determination of fi(Vi) for each signal type, especially for “communication protocols employing complex modulations with stochastic envelopes”. [Nadakuduti et al., Effect of diode response of electromagnetic field probes for the measurements, IEEE Trans. EMC, Vol. 54, No. 6, Dec. 2012] shows measurement errors which can reach -1.5dB up to 2.2dB (worst case errors are obtained for 802.11a/h). -1.5dB corresponds to an underestimation of the measured SAR.

First, the financial impact for the system user relating to the extra cost on probe calibration is significant as a correction of coefficients has to be established for each communication protocol. This certainly does not match with the intention of the Commission to provide “cost-effective” procedures (§209 of FCC 13-39). On the other hand, correction of probe linearity has limitations and previously cited paper claims that linearization errors can be reduced within +/-0.4dB. There is hence still a non-negligible remaining error. In addition, it is noteworthy that ART-Fi is not aware of any other published material confirming that the error can be reduced to such a level by the correction proposed in this paper.

For the reasons previously mentioned in this comment, and for the purpose of devising rules and procedures which will be suitable for ensuring a fast adaptation to future communication technologies, ART-Fi would like to ask the Commission to extensively review the benefits of cost-effective innovative solutions to overcome the limitations of traditional diode-detected probes. ART-Fi also would like to encourage the Commission to consider the potential of alternative techniques which are more modulation / communication protocol independent. As an example, the recently released ART-MAN SAR measurement technology by ART-Fi (see attached document published in Proceedings of IEEE International Workshop on Antenna Technology, iWAT, March 2013) involves the use of radiofrequency probes. ART-MAN probes are composed of small sensors connected to lines directly transmitting RF signals. Such probes do not by essence introduce non-linearities depending on the modulation. The output signals of those probes enter a downconverter and a 250MSPS digitizer. Numerical signals are used to compute complex FFTs. The whole measurement chain accomplishes similar work as a vector signal analyzer. This ensures an accurate monitoring of the signal envelope and representation of the power spectrum. Such a modulation independent measurement technology could help in addressing issues relating with complex modulated signals currently in use and to more quickly adapt to future communication technologies.