

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS, INC.,
Petitioner,

v.

CONSTELLATION DESIGNS, LLC,
Patent Owner.

Case No. IPR2023-00228
U.S. Patent No. 10,693,700

**DECLARATION OF ALBERT GUILLÉN I FÀBREGAS REGARDING
PATENT OWNER'S PRELIMINARY RESPONSE FOR *INTER PARTES*
REVIEW OF US 10,693,700**

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I, Dr. Guillén i Fàbregas, hereby declare as follows:

I. Introduction

1. My name is Albert Guillén i Fàbregas. I have been retained in the above-referenced *inter partes* review proceeding by Constellation Designs, LLC, to evaluate United States Patent No. 10,693,700 (the “700 patent”) against certain references that are presented by the Petitioner. As detailed in this report, it is my opinion that the Petition does not establish that any of the challenged claims are anticipated or rendered obvious by the references presented by the Petitioner. If requested by the Patent Trial and Appeal Board, I am prepared to testify at trial about my opinions expressed herein.

II. Qualifications

2. I have over twenty years of experience in the field of information theory, coding theory and digital communications. I am currently an Associate Professor in Information and Data Science at the Department of Engineering, University of Cambridge. In my work and research, I have researched and written about Information Theory, Communication Theory, Coding Theory, and Statistical Inference.

3. Prior to my appointment at the University of Cambridge, I held appointments at the New Jersey Institute of Technology, Telecom Italia, European

Space Agency, Institut Eurécom, University of South Australia, Universitat Pompeu Fabra (ICREA Research Professor) and the University of Cambridge.

4. I studied and received a Telecommunication Engineering Degree and a Electronics Engineering Degree from Universitat Politècnica de Catalunya and Politecnico di Torino, respectively in 1999. I obtained my Ph.D. in Communication Systems from École Polytechnique Fédérale de Lausanne in 2004.

5. In addition to my undergraduate and graduate level studies and academic qualifications, I have also received Starting and Consolidator Grants from the European Research Council. Additionally, I am a member of the Young Academy of Europe, Fellow of the Institute of Electrical and Electronics Engineers (IEEE), Fellow of the Institute of Mathematics and its Applications (IMA), Editor of Foundations and Trends in Communications and Information Theory (Now Publishers) and previously of the IEEE Transactions on Information Theory (2013-2020) and IEEE Transactions on Wireless Communications (2007-2011). I was a General co-Chair of the 2016 IEEE International Symposium on Information Theory, Barcelona, July 2016 and a Technical Program Committee (TPC) co-chair of the 2013 IEEE Information Theory Workshop, Sevilla, Sept. 2013. Additionally, I am a TPC co-chair of the 2023 IEEE International Symposium on Information Theory, Taiwan.

6. I have authored or co-authored over two hundred (200) publications and technical reports in the areas of digital communications, information theory, coding theory, wireless communications, and statistical inference. My publication and patents are listed on my curriculum vitae, which is attached hereto as EX2013.

7. As a result of my background in information theory and digital communications, I have extensive knowledge regarding the state of the technical art in this area at the time of filing of the ‘700 patent.

8. One of my papers was cited and relied upon by Petitioner. Specifically, I am co-author of the De Gaudenzi reference *De Gaudenzi* cited by the Petitioner as EX1014, an article titled “Turbo-coded APSK modulations design for satellite broadband communications” which was published in International Journal of Satellite Communications and Networking, Vol. 24, 2006 at pp. 261-281.

III. Materials Considered

9. In preparing this declaration, I have reviewed the specification and claims of U.S. Patent No. 10,693,700 (“‘700 Patent” (EX1001)) and the file history of the ‘700 patent (EX1002). I understand the ‘700 patent was issued on June 23, 2020 from U.S. Patent Application No. 16/726,037, which forms part of a chain of continuations including application Ser. No. 12/156,989 filed Jun. 5, 2008 and

issued on Jul. 12, 2011 as U.S. Pat. No. 7,978,777, which claimed priority to U.S. Provisional Application 60/933,319 filed Jun. 5, 2007. (EX1010).

10. I have also reviewed the Petition, declaration of Dr. Bertrand Hochwald (EX1003) and all publications and exhibits cited in the Petition and declaration of Dr. Bertrand Hochwald including:

- U.S. Patent Publication No. 2004/0054960 to Erooz et al. (“Erooz” EX1004);
- ETSI EN 300 744 V1.2.1, *Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television*, July 1999 (“DVB-T” EX1005);
- D. Sommer and G.P. Fettweis, *Signal Shaping by Non-Uniform QAM for AWGN Channels and Applications Using Turbo Coding*, January 2000 (“Sommer” EX1006); and
- De Gaudenzi et al. *Turbo-coded APSK modulations design for satellite broadband communications*, Int. J. Satell. Commun. Network. 2006; 24:261-281, Published online 19 May 2006 in Wiley InterScience (“De Gaudenzi” EX1014).

IV. IEEE International Symposium on Information Theory in Nice, France

11. I attended the IEEE International Symposium on Information Theory held in Nice, France in June of 2007. I was the co-author of four articles presented

in the symposium and I presented two of them myself. During that symposium, I attended the presentation of the M. F. Barsoum, C. Jones, and M. Fitz, “Constellation design via capacity maximization” in *Proc. IEEE Int. Symp. Inf. Theory*, Nice France, June 2007, pp. 1821-1825. It is my understanding that this article formed the basis for U.S. Provisional Patent Application No. 60/933,319 and to which the ‘700 patent claims priority.

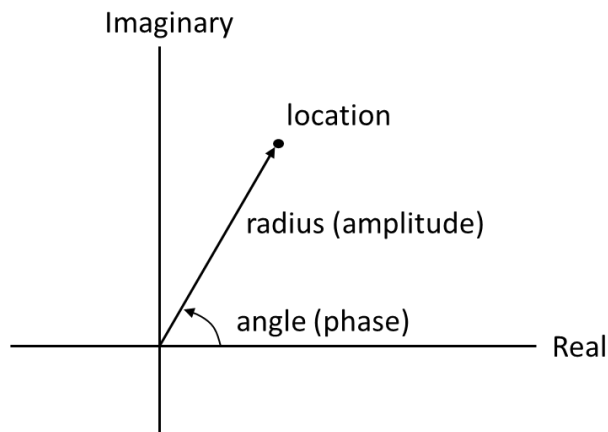
12. I recall, during that symposium in Nice France, thinking that the presentation of the work by Barsoum, Jones and Fitz was genuinely original and interesting. I was impressed by the scope of the work: embarking into a full constellation optimization (both locations and labels) to result in non-uniform (in all degrees of freedom) constellations is a challenging and commendable project. I recall speaking to a colleague regarding the concepts described during the presentation. Despite having worked on the bit-interleaved coded modulation, capacity analysis and information theory for a number of years, I did not make a connection between the materials presented in Nice France and my own work as described in *De Gaudenzi*.

V. De Gaudenzi

A. *De Gaudenzi* Uses Only APSK Constellations

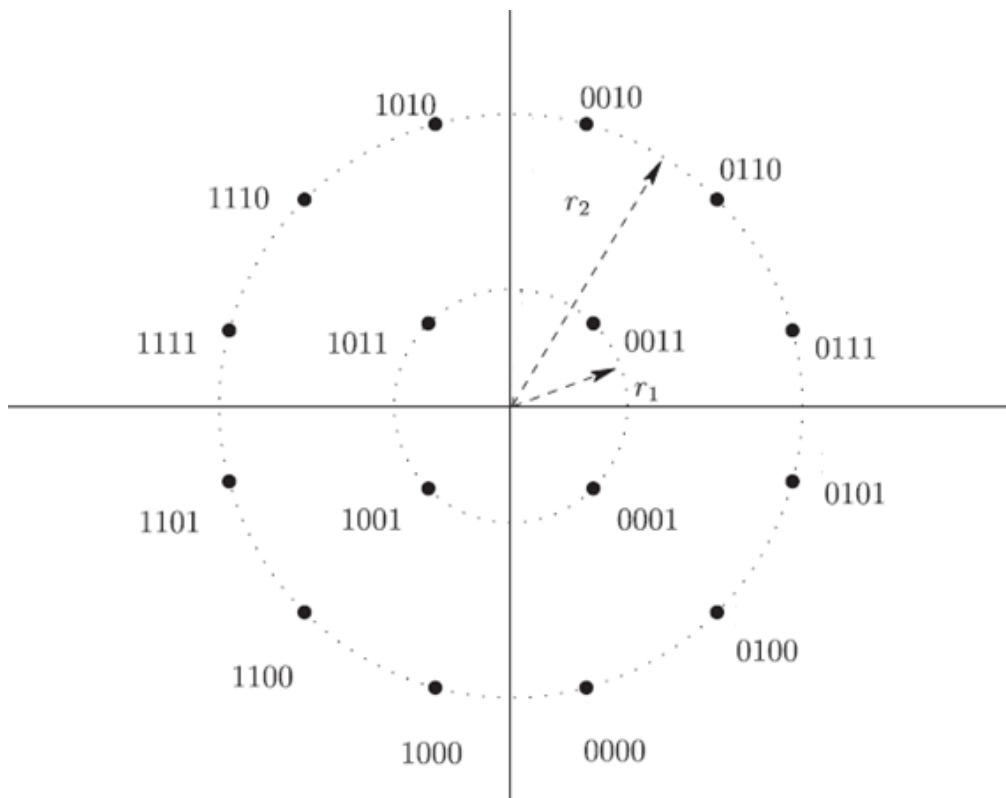
13. As noted above, I am a co-author of *De Gaudenzi*. (EX1014). I personally performed many of the optimizations described in *De Gaudenzi* and analyzed the performance of the constellations described in *De Gaudenzi*.

14. *De Gaudenzi*, concerns Amplitude Phase Shift Keying (APSK) constellations, in which the constellation point locations are indicated by two signal characteristics, amplitude and phase. (EX1014 at 4-5). To illustrate, the following figure depicts that a constellation point location can be represented in polar coordinates by a radius (the amplitude) and an angle (the phase).



15. Because both amplitude and phase are used to indicate a constellation point's location, in APSK, different constellation points can have the same amplitude but still be at different locations because they have different phases. For

example, the following figure from *De Gaudenzi* depicts two “rings” of constellation points. (EX1014 at 4-5). Each ring of constellation points has the same amplitude (represented by the radius in the polar coordinates) but each constellation point within the ring has a different phase (represented by the angle in polar coordinates). (EX1014 at 4-5).



16. Thus, in this illustrated constellation, each of the bit sequences 0001, 0011, 1001, and 1011 have the same amplitude r_1 (and thus are positioned on the inner r_1 ring) but their locations at that amplitude are distinguished by their

different respective phases (positioned at 90 degree intervals around the r_1 ring). (EX1014 at 4-5). Likewise, the remaining bit sequences (0000, 0100, 0101, etc.) share the same larger amplitude r_2 (and are thus positioned on outer ring r_2) but have different locations because of their different phase positions at that ring/amplitude. (EX1014 at 4-5).

1. ***De Gaudenzi* Describes Maintaining Uniform Phase and Varying a Ring Ratio of an APSK**

17. As explained above, in *De Gaudenzi*, each constellation point's location is defined by two signal characteristics, namely the signal's amplitude and its phase. (EX1014 at 4-5). As part of its optimization process, *De Gaudenzi* places constraints on the available locations including constraints on the number of constellation points located at each ring (amplitude) and the differences in phase for each of those locations. (EX1014 at 4-8).

18. For example, *De Gaudenzi* puts restrictions on the phase aspect of the constellation point locations. (EX1014 at 4). At each ring/amplitude, *De Gaudenzi* requires that the constellation points be uniformly spaced in phase. (EX1014 at 4-5). In the above 2-ring embodiment, the 4 constellation points at the inner ring/amplitude must be a uniform 90 degrees apart in phase, even if different phases (and thus different locations) would result in improving capacity. (EX1014 at 4-8). Likewise, the 12 constellation points at the outer ring/amplitude must be a

uniform 30 degrees apart in phase, even if different phases (locations) would result in improving capacity. (EX1014 at 4-5).

19. Thus, for each constellation in our optimization process, we preselected the number of points in each ring and required there be a uniform phase spacing between points of each ring. Further, we did not optimize over the individual point locations or labels, only the ring ratio and phase offset.

2. *De Gaudenzi's Teachings are focused on APSK constellations and Not QAM constellations*

20. My co-authors and I did not develop nor did we describe optimizing rectangular QAM constellations. Moreover, the techniques we did describe in *De Gaudenzi* could not be easily applied to a rectangular QAM constellation.

21. *De Gaudenzi's* teachings are focused on improving only the capacity of highly constrained multi-ring APSK constellations in which the amplitude and phase of a signal is modulated. The number of points in each amplitude ring are preselected, and *De Gaudenzi* teaches optimizing joint capacity by maintaining uniform phase and varying a ring ratio.

22. A rectangular QAM constellation modulates (varies) the amplitude of two components of a sinusoid (the in-phase and quadrature components) that are offset in phase by one-quarter cycle. But a rectangular QAM constellation does not

have a ring ratio, rendering the techniques of *De Gaudenzi* inapplicable to a rectangular QAM constellation.

23. In *De Gaudenzi*, we stated that “[w]e propose new criteria for the design of digital QAM constellations of 16 and 32 points, with special emphasis on the behavior on nonlinear channels.” (EX1014 at 4). This statement in *De Gaudenzi* refers generally to APSK’s as related to QAM in that APSK’s can be represented in the real and imaginary dimensions. This statement is therefore not to be interpreted as the teachings of *De Gaudenzi* can directly be applied to a rectangular QAM nor does it suggest the teachings of *De Gaudenzi* could easily be applied to a rectangular QAM constellation.

24. Thus, my co-authors and I did not develop nor did we describe optimizing rectangular QAM constellations. Moreover, the techniques we did describe in *De Gaudenzi* could not be easily applied to a rectangular QAM constellation. Our statement regarding the design of digital QAM constellations does not suggest our techniques can or should be applied to a rectangular QAM constellation, we merely noted that APSK constellations are related to QAM in that APSK’s are complex-plane constellations, i.e., they can be represented in the real and imaginary dimensions.

3. ***De Gaudenzi* Describes and is Applicable to Non-Hierarchical Constellations**

25. *De Gaudenzi* is directed to a non-hierarchical system that supports only one data stream and can only have one associated code rate at a time. The techniques of *De Gaudenzi*, which sought to improve the capacity of a constellation representing a single data stream, could not easily be applied to a hierarchical constellation in which two data streams are represented.

26. *De Gaudenzi* describes optimizing joint capacity for constellations operated at one code rate at a given time. The techniques of *De Gaudenzi* could not easily be applied to a constellation operating at two code rates at the same time.

27. Thus, my co-authors and I did not develop and did not describe optimizing hierarchical constellations. Instead, our optimization process only considered non-hierarchical APSK constellations in which a single data stream is represented and which only has one code rate associated with it at any one time. In my opinion, it is not clear or straightforward how to apply the techniques I disclosed in *De Gaudenzi* to a hierarchical system. For instance, my techniques were directed towards improving joint capacity for a constellation representing a single data stream that could only be used with a single code rate at any one time, and could not be used with a hierarchical constellation having two code rates at any one time.

VI. *De Gaudenzi's* Optimization Technique Cannot Easily Be Applied to Optimize a Hierarchical and Rectangular QAM Constellation

28. In my opinion, *De Gaudenzi's* teachings related to non-hierarchical APSK constellations cannot easily be applied to *DVB-T's* hierarchical QAM constellations. For example, it is not clear or straightforward how the optimization techniques I described in *De Gaudenzi* could be used to optimize the constellations of *DVB-T* that required both a high priority code rate and a low priority code rate.

29. Further, the constellations that I and my co-authors described were directed towards non-hierarchical APSK systems. These constellations were non-hierarchical and, as a result, required only a single code rate be specified at any given time for use with the constellations. In my opinion, it is not clear or straightforward how the optimization techniques I described in *De Gaudenzi* could be used to optimize the constellations of *DVB-T* that required both a high priority code rate and a low priority code rate.

30. Even further, the technique I describe in *De Gaudenzi* addresses APSK constellations to improve capacity of a single data stream. It is therefore unclear to me how one even could apply the *De Gaudenzi* teachings to a hierarchical constellation such as *DVB-T's* constellations.

31. Indeed, it is not clear how to apply the teachings of uniform phase and varying ring ratio to a rectangular QAM, which is composed of a sinusoid having

two amplitude components offset by 90 degrees and which are independently modulated. It is not clear to me how to apply the teachings of uniform phase and varying ring ratio when there is no ring ratio to vary and no ring phase to maintain as uniform.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: 14 April 2023



Dr. Guillén i Fàbregas