

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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APPLE INC.  
Petitioner

v.

INVT SPE LLC  
Patent Owner

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Case No. 2018-01477  
U.S. Patent No. 7,848,439

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**DECLARATION OF DR. ANDREW C. SINGER**

I, Andrew C. Singer, hereby declare the following:

## I. INTRODUCTION

1. I, Andrew C. Singer, have been retained by counsel for Petitioner as a technical expert in the above-captioned case. Specifically, I have been asked to render certain opinions in regards to the IPR petition with respect to U.S. Patent No. 7,848,439 (“the ’439 Patent”). I understand that the Challenged Claims are claims 1-11. My opinions are limited to those Challenged Claims.

2. My compensation in this matter is not based on the substance of my opinions or the outcome of this matter nor do I have any financial interest in the outcome of this proceeding. I am being compensated at an hourly rate of \$500 for my analysis and testimony in this case.

3. In reaching my opinions in this matter, I have reviewed the following materials:

- Exhibit 1001 – U.S. Patent No. 7,848,439 to She (“the ’439 Patent”);
- Exhibit 1004 – U.S. Patent No. 6,904,283 (“Li”);
- Exhibit 1005 – U.S. Patent No. 7,885,228 (“Walton”);
- Exhibit 1006 – U.S. Patent No. 7,221,680 (“Vijayan”);
- Exhibit 1007 – John C. Proakis and Masoud Salehi, *Communication Systems Engineering*, Prentice Hall (1994) (“Proakis”);
- Exhibit 1008 – Edfors, Ove et al. “An introduction to orthogonal frequency-division multiplexing.” September 1996.  
<http://users.cecs.anu.edu.au/~thush/engn3214/OFDM.pdf> (“Edfors”);
- Exhibit 1009 – Paulraj, Arogyaswami et al. *Introduction to Space-Time Wireless Communications*. Cambridge University Press. 2003 (“Paulraj”); and
- Exhibit 1010 – U.S. Patent No. 3,488,445 (“Chang”);

**A. Background and Qualifications**

4. I am currently a Professor in the Department of Electrical and Computer Engineering, where I hold a Fox Family endowed Professorship. I also serve as Associate Dean for Innovation and Entrepreneurship for the College of Engineering at the University of Illinois at Urbana Champaign.

5. I received a Bachelor of Science degree in Electrical Engineering and Computer Science from Massachusetts Institute of Technology in 1990; a Master of Science degree in Electrical Engineering and Computer Science from Massachusetts Institute of Technology in 1992; and a Ph.D. in Electrical Engineering from Massachusetts Institute of Technology in 1996.

6. Since 1990, I have been active in the signal processing and communications fields. I have authored and/or co-authored numerous publications, including books and refereed journal publications and conference articles on the topic of signal processing and communication systems and devices. A focus of many of these publications is on methods for adaptive modulation, coding, transmission, and reception in wireless communication systems in general, and in orthogonal frequency division multiplexing (OFDM) and orthogonal frequency division multiple-access (OFDMA) systems in particular.

7. I have designed, built, and patented various components of communication and signal processing systems. These include various radio-frequency, SONAR, LIDAR, air-acoustic and underwater acoustic signal processing systems as well as wire-line, wireless, optical and underwater acoustic communication systems. An important aspect in many of these systems is the design of adaptive modulation, coding and transmission for wireless communication systems.

8. I have taught both undergraduate and graduate level courses in signal processing, and communication systems. For example, I have taught Digital Signal Processing and Embedded DSP Laboratory classes. Additional examples of courses I have taught at the University of Illinois at Urbana Champaign include: Advanced Digital Signal Processing; Digital Signal Processing; Digital Signal Processing Laboratory; Probability with Engineering Applications; Random Processes; Optical Communication Systems; Advanced Lectures in Engineering Entrepreneurship; Embedded DSP Laboratory; Developing Design Thinking; Technology Commercialization; and Senior Design Laboratory. I have also overseen numerous PhD and Master's students researching topics related to signal processing and communication systems.

9. I was the co-founder and CEO of Intersymbol Communications, Inc., a communications component manufacturer focused on the development of signal

processing-enhanced components used in optical communication networks. Intersymbol Communications, Inc. was acquired by Finisar Corporation, the world's largest supplier of optical communication modules and subsystems.

10. I was appointed the Associate Dean for Innovation and Entrepreneurship in the College of Engineering, where I direct a wide range of entrepreneurship activities. These include the campus-wide Illinois Innovation Prize, celebrating our most innovative students on campus, as well as our annual Cozad New Venture Competition. I am also the Principal Investigator for the National Science Foundation's Innovation Corps Sites program at the University of Illinois, working with faculty and student startup companies.

11. My research and commercial experience led to my authoring of numerous papers. I have authored over 200 papers on digital signal processing and communication systems, several of which were voted "Best Paper of the Year" by technical committees of the IEEE. Citing these and other contributions, I was elected Fellow of the Institute of Electrical and Electronics Engineers ("IEEE") "for contributions to signal processing techniques for digital communication." I was also selected as a Distinguished Lecturer of the Signal Processing Society.

12. I hold ten granted U.S. patents, all in the field of communication systems.

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