

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. TBD  
U.S. Patent No. 7,764,711

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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. 7,764,711 (“the ’711 Patent”). I understand that the Challenged Claims are claims 1-6. 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. I have no financial interest in Petitioner. I am being compensated at an hourly rate of \$500 for my analysis and testimony in this case.

### **A. Materials Reviewed**

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

- Exhibit 1001 – U.S. Patent No. 7,764,711 to Sudo (“the ’711 Patent”);
- Exhibit 1002 – File History of U.S. Patent No. 7,764,711;
- Exhibit 1005 – U.S. Patent No. 6,067,290 to Paulraj et al. (“Paulraj”);
- Exhibit 1006 – Howard Huang, Harish Viswanathan, and G.J. Foschini, *Achieving High Data Rates in CDMA Systems Using BLAST Techniques*, IEEE Global Telecommunications Conference – Globecom ’99 (1999) 2316-2320 (“Huang”);
- Exhibit 1008 – U.S. Patent No. 7,095,709 to Walton et al. (“Walton”);
- Exhibit 1009 –U.S. Patent Application Publication No. 2002/0193146A1 to Wallace et al. (“Wallace”);

- Exhibit 1010 – John C. Proakis and Masoud Salehi, Communication Systems Engineering, Prentice Hall (1994) (“Proakis”);
- Exhibit 1011 – Hemanth Sampath, Shilpa Talwar, Jose Tellado, Vinko Erceg, Arogyaswami Paulraj, *A Fourth-Generation MIMO-OFDM Broadband Wireless System: Design, Performance, and Field Trial Results*, IEEE Communications Magazine, Volume: 40, Issue: 9, (September 2002, 143-149) (“Sampath”);
- Exhibit 1012 – U.S. Patent No. 2,219,749 to A. A. Oswald (“Oswald”);
- Exhibit 1013 – Lizhong Zheng and David N.C. Tse, *Diversity and Multiplexing: A Fundamental Tradeoff in Multiple Antenna Channels*, IEEE Transactions on Information Theory, Vol. 1, No. 8 (August 2002) (“Zheng”);
- Exhibit 1014 – Siavash M. Alamouti, *A Simple Transmit Diversity Technique for Wireless Communications*, IEEE Journal on Select Areas in Communications, Vol. 16, No. 8 (October 1998, 1451-1458) (“Alamouti”);
- Exhibit 1015 – U.S. Patent No. 5,345,599 to Paulraj et al. (“Paulraj ‘599 Patent”); and
- Exhibit 1016 – David Gesbert, Mansoor Shafi, Da-shan Shiu, Peter Smith, and Ayman Naguib, *From Theory to Practice: An Overview of MIMO Space-Time Coded Wireless Systems*, IEEE Journal on Selected Areas in Communications, Vol. 21, No. 3 (April 2003, 281-302) (“Gesbert”).

## **B. 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 improving the efficiency and performance of systems that employ arrays of multiple transmitting elements, multiple receiving elements, and systems that employ both multiple transmitting and receiving elements. Such systems are often referred to as multiple-input / multiple-output, or MIMO systems.

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 signal processing, modulation, and coding algorithms and architectures for array-based and MIMO 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 the co-founder and CEO of OceanComm, Inc., an underwater acoustic communications component manufacturer focused on the development of acoustic communications links for the subsea industry.

11. 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

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