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UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF OREGON
PORTLAND DIVISION

FEREYDUN TABAIAN and AHMAD ASHRAFZADEH, Plaintiffs, v. INTEL CORPORATION, Defendant.	Civil Action No.: 3:18-cv-0326 **COMPLAINT FOR PATENT INFRINGEMENT** **DEMAND FOR JURY TRIAL**

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This is an action for patent infringement against Defendant Intel Corporation ("Intel") by Plaintiffs Fereydun Tabaian and Ahmad Ashrafzadeh (collectively, "Plaintiffs"). Plaintiffs respectfully show the Court as follows:

INTRODUCTION AND NATURE OF CASE

1. This is a case for infringement of the following patent: U.S. Patent No. 7,027,944, "Programmable Calibration Circuit and Power Supply Current Sensing and Droop Loss Compensation," issued on April 11, 2006 ("the '944 patent"). The '944 patent is owned by Fereydun Tabaian and Ahmad Ashrafzadeh, is attached as Exhibit 1 hereto, and is incorporated by reference into this complaint.

2. The '944 patent discloses a circuit for using calibration for precise voltage regulation. The invention described in the patent provides circuits and methods for addressing voltage regulator current sensing variations, voltage droop, manufacturing variations, temperature dependencies, and mismatched phase outputs in a multiphase power regulator. The invention advantageously provides circuits and methods to properly power a computer processor or integrated circuit chip according to the unique power specifications of the processor or chip.

3. The invention described in the '944 patent is a technological advancement that makes it practical to integrate the voltage regulator for the processor onto the processor die itself, rather than rely solely on mother board voltage regulators. The invention also provides increased power efficiencies by allowing power to be more accurately and consistently delivered to the processor, and enables manufacturing efficiencies through more precise calibration.

4. Intel developed its Fully Integrated Voltage Regulator ("FIVR") technology, with full knowledge of the '944 invention, employing the '944 invention as one of FIVR's key components. Intel employees involved in the development of the FIVR technology, such as

Edward Burton, Douglas Huard and Robert Greiner, referred to the '944 patent in their own patents and applications related to this technology, which they assigned to Intel, such as in U.S. patent no. 7,685,441 (Burton, et al.), U.S. patent no. 7,466,176 (Huard et al.) and published application no. US20070262879 (Greiner et al.). FIVR is or will be included in at least the following families of Intel processors: Haswell, Broadwell, Ice Lake, and Tigerlake, as well as certain Skylake processors (collectively, the "Infringing Products").

5. The FIVR components of these Intel processors infringe the '944 patent.

THE PARTIES

6. Plaintiff Fereydun ("Tony") Tabaian is an individual and a resident of California. Plaintiff Tabaian is one of the inventors listed on the '944 patent.

7. Plaintiff Ahmad Ashrafzadeh is an individual and a resident of California. Plaintiff Ashrafzadeh is one of the listed inventors on the '944 patent.

8. Defendant Intel Corporation is a corporation organized under the laws of the State of Delaware. Intel may be served with process by and through its Registered Agent, CT Corporation System, 780 Commercial Street, Suite 100, Salem, Oregon 97301.

9. Plaintiffs have standing and capacity to file suit. Plaintiffs own 100% of the '944 patent. Plaintiffs have the exclusive right to enforce the '944 patent, including to pursue and collect damages, royalties, and other amounts owed. Plaintiffs Tabaian and Ashrafzadeh are suing in their individual capacities.

10. The correct defendant is being sued in its correct capacity.

JURISDICTION & VENUE

11. This Court has subject matter jurisdiction under 28 U.S.C. §§1331 and 1338(a). This is a civil action for patent infringement, arising under Title 35, United States Code,

including under 35 U.S.C. §§ 271 and 281–85. The specific facts supporting Intel's patent infringement are set forth in detail in the Facts section below and incorporated by reference herein.

12. Personal jurisdiction exists in Oregon over Intel. Intel developed the infringing FIVR technology primarily from its Hillsboro, Oregon office(s). A substantial part of the evidence at issue, including many of the key witnesses and documents, are in the greater Portland area, including Hillsboro. The meetings between Plaintiffs and Intel at which the '944 invention was disclosed also took place in Hillsboro, as discussed in more detail below.

13. Further, Intel has purposely directed the sale of the Infringing Products towards the State of Oregon and sells or plans to sell the Infringing Products through established distribution networks in Oregon. Among other things, Intel sells and plans to sell the Infringing Products to various computer manufacturers, knowing that those manufacturers will sell computers containing the Infringing Products in Oregon. Further, Intel specifically markets its processors, including the Infringing Products in Oregon, through its "Intel Inside" and "Intel Retail Edge" marketing programs. Thus, Intel has purposefully availed itself of the benefits of the State of Oregon, and the exercise of jurisdiction over Intel would not offend traditional notions of fair play and substantial justice.

14. Venue is proper in this District and in the Portland Division pursuant to 28 U.S.C. § 1400(b). Intel has committed acts of infringement in this district. As set forth in detail herein, among other things, Intel sells and offers for sale the Infringing Products in this district. Intel also has numerous regular and established places of business in this district; Intel's website lists 10 Intel "campuses" in this district, https://www.intel.com/content/www/us/en/location/usa.html (accessed Dec. 6, 2017).

FACTS

I. BACKGROUND ON THE '944 INVENTION, ITS DISCLOSURE TO INTEL, AND INTEL'S DEVELOPMENT OF FIVR.

15. Plaintiff Tony Tabaian has a Master of Science degree in Electrical Engineering from Texas Tech University. Plaintiff Ahmad Ashrafzadeh has a Bachelor of Science degree in Electrical Engineering from the New York Institute of Technology. Among other positions, Plaintiff Ahmad Ashrafzadeh was the Vice President of Business and Technology Development at Fairchild Semiconductor from November 2012 to July 2015. He is currently the founder of Nova Semiconductor and involved in several other business ventures in system integration.

16. In the early 2000's, Plaintiffs formed NuPower Semiconductor ("NuPower"). NuPower specialized in the engineering design of components for computers and related equipment, including the electrical engineering design of voltage regulators for computer processors.

17. In 2002-03, Plaintiffs developed the '944 invention and filed a provisional patent application for this invention on June 30, 2003.

18. The '944 invention was designed specifically for Intel processors, as Intel was at the time of the invention the largest manufacturer of processors in the world, and remains so today. In the spring of 2003, Plaintiff Tony Tabaian contacted Jason Chen, the Vice President and Co-Director of the Sales and Marketing Group at Intel, about the '944 invention.

19. Intel was highly interested. The parties entered into a written Non-Disclosure Agreement dated July 11, 2003. Plaintiffs also specifically informed Intel that a provisional patent application had been filed for the technology.

20. At Intel's request, Plaintiffs met with Intel 2-3 times at Intel's offices in the Portland area, from July to September 2003. Plaintiffs made lengthy, detailed presentations at

these meetings and disclosed, among other things, the details of the ’944 invention, pursuant to the Non-Disclosure Agreement. Approximately 15 persons attended these meetings, including numerous Intel engineers.

21. The fact that Intel requested these meetings on the ’944 technology was highly significant. Only a small minority of companies make it through this many levels of review from Intel.

22. However, in late September/early October 2003, Intel informed Plaintiff Tabaian that it was not interested in discussing the ’944 technology further. Intel gave no reason for its decision.

23. The ’944 patent issued April 11, 2006. In May 2006, Intel engineers filed at least eight (8) separate patent applications with the United States Patent and Trademark Office, citing the ’944 patent as prior art.

24. During this same general time period, Intel was proceeding to develop its FIVR technology, employing the ’944 invention as one of FIVR’s key components. FIVR was primarily developed in Hillsboro.

25. FIVR is the enabling technology behind key improvements for Intel’s microprocessors including, but not limited to, a 50% or more increase in battery life for mobile products, a factor of 2 to 3 increase in peak available power (which converts into burst performance), and the freeing up of mother board space that can be used to add platform features or reduce platform dimensions.

26. FIVR also provides manufacturing efficiencies through more effective “binning” and tuning. After manufacturing, processors go through rigorous testing to ensure that they perform at their labeled clock speed and power rating. The processors are separated into

different thresholds—known as binning—with slower processors generally being sold at lower prices and lower profit margins. FIVR allows the potential for increased clock speeds with the same processor, providing for a greater manufacturing yield of faster processors and/or lower power dissipation.

27. Intel has estimated that FIVR will reduce manufacturing costs by several billion dollars over the product lifetime. Edward A. Burton *et al.*, FIVR – Fully Integrated Voltage Regulators on 4th Generation Intel® Core™ SoCs, APPLIED POWER ELECTRONICS CONFERENCE AND EXPOSITION (APEC), 2014 TWENTY-NINTH ANNUAL IEEE (March 2014), at 434.

28. Intel introduced its first commercial FIVR products in the second quarter of 2013 and has continued to introduce new commercial FIVR products into 2018. On information and belief, Intel will introduce yet additional commercial FIVR products into at least 2019.

II. FIVR INFRINGES THE ’944 PATENT.

29. On information and belief as alleged in detail below, Intel has infringed and continues to infringe the ’944 patent, at least under 35 U.S.C. § 271(a) and 35 U.S.C. § 271(f), by making, using, importing, selling, and offering for sale the Infringing Products, in or to, the United States, and exporting components thereof from the United States, during the term of the ’944 patent. Discovery may show that Intel has infringed and continues to infringe under additional sub-sections of 35 U.S.C. § 271, as well. For example, to the extent that Intel makes the Infringing Products outside the United States, and induces their importation into the United States, Intel is liable also for infringement under at least 35 U.S.C. § 271(b).

30. Plaintiffs have been damaged as a result of Intel’s infringing conduct. Intel is therefore liable to Plaintiffs for damages of not less than a reasonable royalty, together with interest and costs as fixed by this Court.

31. As set forth above, the Infringing Products include at least the Intel products bearing the prerelease code-names Haswell, Broadwell, Ice Lake, Tigerlake and certain Skylake products. These processors are, or are planned to be, available in numerous product models. The Infringing Products that have been commercially released as of the date of this complaint are installed in numerous laptops, desktops, and servers. A list of model numbers for the Infringing Products that have been commercially released is attached as Exhibit 2. Intel's infringing conduct has been occurring since at least June 2013 and is continuing as of the date of this complaint.

32. Intel has sold Infringing Products to all major computer manufacturers. Press reports indicate that Intel is expected to launch the Ice Lake processors for commercial sale in 2018 and the Tigerlake processors for commercial sale in 2019.

33. Infringement of the '944 patent occurs by reason of the voltage regulation circuitry implemented in the Infringing Products. More specifically, the manner in which Intel incorporates its FIVR technology infringes at least claims 1-2, 5-11, 13-14, 16, and 18-25 of the '944 patent. The Infringing Products meet each and every limitation of each of the foregoing patent claims.

34. The FIVRs implemented in the Infringing Products are high frequency multi-phase buck regulators that are integrated into the processor die.

35. Intel cannot practically incorporate FIVRs in the Infringing Products in the manner that it has done so without infringing one or more claims of the '944 patent.

36. The use of the FIVR technology in these chips is one of the primary features of these chips that distinguish them from other, generally older technology Intel processor chips.

A. Infringement of Claim 1

37. Each of the Infringing Products includes a circuit comprising a regulator circuit and a calibration control circuit. By its very nature, a FIVR—Fully Integrated Voltage Regulator—includes a regulator circuit.

38. The FIVR architecture requires the use of calibration in order to meet FIVR power performance and efficiency objectives. The Power Control Unit ("PCU") and/or FIVR Control Module ("FCM") within the Infringing Products comprise a calibration control circuit.

39. The calibration control circuit that is a part of each of the Infringing Products includes a controller, an interface with nonvolatile memory, droop outputs, sense outputs, load voltage input, and temperature input. The PCU dynamically configures each FCM based on the current activity level of the domain. Temperature sensors, implemented with analog-to-digital converters, are located throughout the die. The PCU takes temperature sensor input as it monitors conditions on the die.

40. Each FIVR is independently programmable to achieve optimal operation given the requirements of the domain it is powering. The settings are optimized by the PCU, which specifies the input voltage, output voltage, number of operating phases, and a variety of other settings to minimize the total power consumption of the die.

41. Each of the PCU and FCM include a controller, as reflected in the names of these circuit elements—Power Control Unit and FIVR Control Module.

42. The desired output voltage of a FIVR is specified in a voltage identification code ("VID") that is received from the PCU or FCM. The VID codes may be expressed as hexadecimal values. For each increment of a VID code value, the corresponding voltage value would increment by a specific voltage increment. For example, in at least some embodiments of

the Infringing Products, the voltage value would increase by 0.01 volts per hexadecimal VID increment. Thus, if a VID code with a hexadecimal value of 0x33 corresponded to a voltage value of one (1) volt, a VID code with a hexadecimal value of 0x34 would correspond to a voltage value of 1.01 volts, a VID code with a hexadecimal value of 0x35 would correspond to a voltage value of 1.02 volts, and—skipping ahead several increments—a VID code with a hexadecimal value of 0x3F would correspond to a voltage value of 1.12 volts, and so on.

43. A FIVR produces an output load voltage specified by the VID reference code by means of a feedback loop whereby the FIVR load voltage is input back to the FCM for comparison with the voltage specified by the VID reference code. This comparison then effects an adjustment of the output voltage based on a comparison of the load voltage with the voltage specified by the VID.

44. Because of manufacturing tolerances and the temperature sensitivity of the components of a voltage regulator, absent calibration, the actual voltage produced by a FIVR may differ from the desired output voltage as specified by the VID supplied to the FIVR by the PCU or FCM.

45. Intel implements calibration in its FIVR products, *inter alia*, by means of determining an offset VID value based on temperature sensor data among other possible inputs. The calibration control circuit then calculates a calibrated VID value by adding or subtracting the offset VID to the nominal VID code value. The calibrated VID value is then converted to a voltage value by means of a digital to analog converter

46. The calibrated voltage and the feedback of the load voltage is used by the FCM to generate signals that control the output of the multi-phase voltage regulator circuitry contained in the FIVR.

47. The droop function, also known as load line or active voltage positioning, is used in a voltage regulator to automatically lower the output voltage based on the output current. This provides more headroom in the case of load transients. Effective droop function implementation requires accurate current sensing and accurate ratio settings at which the load current adjusts the voltage regulator output voltage.

48. Intel implements the droop function in its FIVR products by means of determining an appropriate voltage setting based on temperature sensor, current sensor, and load voltage information, as well as load line information stored in nonvolatile memory.

49. The VID offset values are determined by means of a calibration process whereby the processor die is controlled over a range of temperatures and the current measured with various workloads. VID offset as a function of temperature and current is then stored in a lookup table held in nonvolatile memory, with an interface to the calibration control circuit, for use in generating a calibrated voltage when the FIVR is in operation.

50. Alternatively, each FIVR has built-in circuitry known as Integrated Frequency Domain Impedance Meter ("IFDIM"), which can be used to calibrate the FIVR post-manufacture.

51. In at least the Intel Xeon E5 family of processors identified in Exhibit 2, Intel determines the optimal voltage-frequency curves for individual processor cores by means of a calibration process taking temperature into account and stores calibration data in nonvolatile memory.

52. Thus, the calibration control circuit that is a part of each of the Infringing Products includes a controller, an interface with nonvolatile memory, droop outputs, sense outputs, load voltage input, and temperature input.

53. As described above, nonvolatile memory stores calibration data.

54. As described above, the calibration control circuit that is a part of each of the Infringing Products interfaces with a regulator circuit via sense outputs, droop outputs, and a load voltage input.

55. As described above, the calibration control circuit that is a part of each of the Infringing Products interfaces with the nonvolatile memory to store calibration data.

56. As described above, the calibration control circuit that is a part of each of the Infringing Products interfaces with a temperature input to receive temperature data.

57. As described above, the temperature data is used by the calibration control circuit that is a part of each of the Infringing Products to adjust sense outputs and droop outputs.

58. As described above, the calibration control circuit that is a part of each of the Infringing Products interfaces with a temperature input and load voltage input to calibrate calibration data stored in nonvolatile memory.

B. Infringement of Claim 2

59. The Infringing Products infringe claim 2 in that, in addition to meeting each and every limitation of claim 1, the regulator circuit in each of the Infringing Products is a buck voltage regulator, as reflected in publications authored by Intel engineers describing the implementation of FIVR.

C. Infringement of Claim 5

60. The Infringing Products infringe claim 5 in that, in addition to meeting each and every limitation of claim 1, the calibration control circuit in each of the Infringing Products adjusts sense outputs and droop outputs according to data stored in nonvolatile memory, as described in paragraphs 42-51, above, and paragraph 61, below.

61. The calibration control circuit in each of the Infringing Products interfaces with nonvolatile memory that holds load line function parameters, and related calibration data, and at least in the Xeon E5 family of Infringing Products, nonvolatile memory also stores calibration data related to optimal voltage-frequency curves.

D. Infringement of Claim 6

62. The Infringing Products infringe claim 6 in that, in addition to meeting each and every limitation of claim 1, the nonvolatile memory in each of the Infringing Products stores regulator performance parameters, as described in paragraphs 42-51, and 61, above.

E. Infringement of Claim 7

63. The Infringing Products infringe claim 7 in that, in addition to meeting each and every limitation of claim 1, the nonvolatile memory in each of the Infringing Products stores application specific power curve data, as described in paragraphs 42-51, and 61, above.

F. Infringement of Claim 9

64. The Infringing Products infringe claim 9 in that, in addition to meeting each and every limitation of claim 1, the nonvolatile memory in each of the Infringing Products stores data for droop outputs and sense outputs where the data is based on load voltage input and temperature input, as described in paragraphs 42-51, above.

G. Infringement of Claim 10

65. The Infringing Products infringe claim 10 in that, in addition to meeting each and every limitation of claim 1, each sense output in each of the Infringing Products comprises a digital to analog converter with registered input and an amplifier buffer.

H. Infringement of Claim 11

66. The Infringing Products infringe claim 11 in that, in addition to meeting each and every limitation of claim 1, the droop output in each of the Infringing Products comprises a digital to analog converter with registered input and an amplifier buffer.

I. Infringement of Claim 13

67. The Infringing Products infringe claim 13 in that, in addition to meeting each and every limitation of claim 1, the load voltage input in each of the Infringing Products comprises an analog to digital converter with registered output, as reflected in publications authored by Intel engineers describing the implementation of FIVR.

J. Infringement of Claim 14

68. The Infringing Products infringe claim 14 in that, in addition to meeting each and every limitation of claim 1, the temperature input in each of the Infringing Products comprises a temperature sensor, an amplifier, and an analog to digital converter with registered output.

K. Infringement of Claim 18

69. The Infringing Products infringe claim 18 in that, in addition to meeting each and every limitation of claim 1, the calibration control circuit in each of the Infringing Products includes an external interface to an external controller.

L. Infringement of Claim 19

70. The Infringing Products infringe claim 19 in that, in addition to meeting each and every limitation of claims 1 and 18, the external interface to an external controller in each of the Infringing Products allows the external controller to interface with the calibration control circuit, monitor the load voltage input, monitor the temperature input, control sense outputs, droop output, read the nonvolatile memory, and write to nonvolatile memory.

M. Infringement of Claim 20

71. The Infringing Products infringe claim 20 in that, in addition to meeting each and every limitation of claims 1 and 18, the external interface to an external controller in each of the Infringing Products is selected from a group consisting of a processor and a state machine.

N. Infringement of Claim 21

72. The Infringing Products infringe claim 21 in that, in addition to meeting each and every limitation of claim 1, the regulator circuit calibration data in each of the Infringing Products is stored in a lookup table within nonvolatile memory, as described in paragraph 49, above.

O. Infringement of Claim 22

73. The Infringing Products infringe claim 22 in that, in addition to meeting each and every limitation of claim 1, the calibration control circuit controller in each of the Infringing Products is selected from the group consisting of a state machine and a processor.

P. Infringement of Claim 23

74. The Infringing Products infringe claim 23 in that, in addition to meeting each and every limitation of claim 1, the calibration control circuit in each of the Infringing Products includes an error output.

Q. Infringement of Claim 24

75. The Infringing Products infringe claim 24 in that, in addition to meeting each and every limitation of claims 1 and 23, the error output referred to in the paragraph 74, above, comprises a digital to analog converter with registered input and an amplifier buffer.

R. Infringement of Claim 25

76. The Infringing Products infringe claim 25 in that, in addition to meeting each and every limitation of claims 1, 23 and 24, the calibration control circuit in each of the Infringing Products interfaces with the regulator circuit via the error output referred to in the paragraph 74, above.

77. Plaintiffs have suffered extensive injuries as a result of Intel's infringement. Plaintiffs estimate that, in total, millions of Infringing Products have been sold to date—all of which infringe the '944 patent.

CAUSES OF ACTION

I. DIRECT INFRINGEMENT OF THE '944 PATENT PURSUANT TO 35 U.S.C. §§ 271 AND 281-285.

78. Plaintiffs re-allege all of the above allegations as though fully set forth herein.

79. Plaintiffs are the owners of the '944 patent and, without limitation, have the rights to sue and collect damages for all past, present or future infringement thereof.

80. As set forth in detail above, on information and belief, Intel has and is making, using, importing, offering to sell, and selling Infringing Products that practice the '944 invention without Plaintiffs' authorization, in the United States, during the term of the '944 patent.

81. On information and belief, Intel has and continues to directly infringe numerous claims of the '944 patent as detailed above, literally and/or under the doctrine of equivalents, through the Infringing Products.

82. Intel may have infringed or continues to infringe the '944 patent, literally and/or under the doctrine of equivalents, through other versions of FIVR or voltage regulators, utilizing the same or reasonably similar functionality. Plaintiffs reserve the right to discover and pursue claims of infringement regarding all such additionally infringing products.

83. Plaintiffs have been and continue to be damaged by Intel's infringement of the '944 patent.

DAMAGES AND OTHER RELIEF REQUESTED

84. Plaintiffs seek all available damages and other relief at law and in equity against Intel to which Plaintiffs are entitled, including but not limited to all damages authorized under 35 U.S.C. sections 284 and 285, including:

- Damages adequate to compensate for the infringement and not less than a reasonable royalty;
- Interest and costs;
- Increased damages up to three times; and
- An award of reasonable attorney fees.

CONDITIONS PRECEDENT

85. Any conditions precedent have occurred, have been performed, and/or have been waived.

86. No patent marking was required by 35 U.S.C. § 287 with respect to the '944 patent.

87. Plaintiffs have maintained the term of the '944 patent in part by compliance with 35 U.S.C. § 41(c)(1) on September 16, 2015.

DEMAND FOR JURY TRIAL

88. Pursuant to Fed. R. Civ. P. 38, Plaintiffs demand a trial by jury on all issues triable of right by a jury in this case.

PRAYER FOR RELIEF

89. WHEREFORE Plaintiffs Fereydun Tabaian and Ahmad Ashrafzadeh sue and pray for all damages and all other relief, at law and in equity, to which they may be entitled

against Intel Corporation, including but not limited to all damages authorized under 35 U.S.C. sections 284 and 285, including damages adequate to compensate for the infringement and not less than a reasonable royalty; interest and costs; increased damages up to three times; and an award of reasonable attorney fees.

Dated February 21, 2018.

Respectfully Submitted,

By: */s/ Jeffrey S. Love*

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