

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA, INC.,
Petitioner

v.

RELINK US LLC,
Patent Owner

Case IPR2024-00389
U.S. Patent 9,793,755

DECLARATION OF DR. DAVID S. RICKETTS

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I, Dr. David S. Ricketts, declare under penalty of perjury as follows:

I. INTRODUCTION AND BACKGROUND

1. I have been retained as an expert witness on behalf of Relink US LLC (“Relink”) and have been asked to provide my expert opinions regarding U.S. Patent No. 9,793,755. EX1001 (“the ’755 patent”).

2. In this declaration I provide my independent analysis of the ’755 patent in light of the materials cited below and discussed herein and my knowledge and experience in this field during the relevant time frame. I have been asked to consider what one of ordinary skill in the art at the time of the invention of the ’755 patent (a “POSITA,” *see* Section V below) would have understood from the specification, including scientific and technical knowledge related to the patent. I have also been asked to consider whether certain references anticipate or would have rendered obvious the inventions described in the claims of the ’755 patent.

3. My findings, as explained below, are based on my study, experience, and background in the fields discussed below, informed by my education and my extensive experience in the field of power generation and distribution. I have also relied on my review and analysis of the references identified by Dr. Collins, information provided to me, and information that I have independently reviewed.

4. I am being compensated for my independent analysis as an expert with respect to this *inter partes* review proceeding. My compensation is not

contingent in any way on the content of my analysis, the opinions that I offer, or the outcome of this proceeding. I have no financial interest in Petitioner (Tesla) or Patent Owner (Relink) and I have no financial interest in the '755 patent.

II. QUALIFICATIONS

5. My qualifications for forming the opinions given in this declaration are summarized here and are addressed more fully in my curriculum vitae, which is submitted as EX2002. That exhibit also includes a list of my publications.

6. I am currently a Full Professor of Electrical and Computer Engineering at North Carolina State University. In my position I conduct research and teach undergraduate and graduate students in the area of electrical and computer engineering. The courses I teach include Power Systems, Power Management Integrated Circuit (“IC”) Design, Advanced Analog IC Design, Radio System Design, and Analog Circuit Laboratory. I also lead a research group that conducts research and design of electrical and electronic circuits, including power system circuits, millimeter wave and microwave circuits and systems, wireless power transfer circuits, power electronics and nano-electronic and nano-phonic devices. I lead research in power electronics and power conversion integrated circuits. I have served in my current position since 2012.

7. I have collaborated with numerous industries in power electronics, wireless power, radio frequency circuits and others. During this time I worked with engineers of varying experience, including those with 2-20 years.

8. Prior to my current position, I served as an Assistant Professor of Electrical and Computer Engineering and held a courtesy appointment in the Materials Science Department at Carnegie Mellon University from 2006 to 2012. I taught undergraduate and graduate device physics, which included photovoltaic (solar) devices.

9. I received my B.S. and M.S. in Electrical Engineering in 1995 and 1997, respectively, from Worcester Polytechnic Institute in Worcester, Massachusetts. I received my Ph.D. in Electrical Engineering from Harvard University in Cambridge, Massachusetts in 2006.

10. Prior to entering academia, I worked as an engineer in private industry holding several engineering and managerial positions where I developed and oversaw the development of electrical and electronic circuits, including those related to power transfer, power conversion, and semiconductor design in wired and wireless circuits and systems.

11. From 1995 to 1999, I held a position as an engineer and senior engineer at American Power Conversion, where I designed uninterruptable power supplies (UPS), AC-DC converters, and DC-DC converters. The converters that I

designed and developed were originally developed for solar power systems and microgrids, including to convert DC power sourced from renewable energy sources, including solar panels, to AC energy used to power homes. This technology also included functionality for transferring energy from the solar panels directly to the grid, as well as microgrid, at home solar installations and voltage and current inverters. During my time in industry, I also developed AC-DC and DC-DC converters, as well as battery chargers.

12. From 1999 to 2001, I held a position as a Principal Consultant at Renaissance Design, Inc., where I designed power management ICs for power converters, including DC-DC converters and DC-AC inverters.

13. From 2000 to 2002, I held a position as a Manager of New Product Development at ON Semiconductor Corp., where I was responsible for six product development teams, including market analysis, business development, system design, and integrated circuit design and testing. In that role I oversaw the development of over twenty power management ICs, also known as power ASICs, in bipolar, CMOS, and BiCMOS technologies. These ICs related to DC-DC power converters among other power electronic circuits.

14. From 2002 to 2003, I held the position of Advanced System Engineering Manager at ON Semiconductor Corp., where I directed a team of system engineers to develop multi-phase power management ICs.

15. In 2006 I received my Ph.D. on the topic of advanced oscillator topologies. My work on integrated circuit oscillators was included in the 2008 McGraw-Hill Yearbook of Science and Technology and discussed in *Nature*, the pre-eminent science journal. In addition, my work on advanced materials for circuits included the first Si-Ge shell-core nanowire oscillator on plastic.

16. As shown in my curriculum vitae I have published two books, at least 50 academic journal papers, and 78 conference papers related to power transfer electronics and circuits, RF systems, magnetic circuits and materials, analog circuits, RF circuits and nanoscale devices. EX2002.

17. I am the recipient of the National Science Foundation CAREER award for work in emerging magnetic devices known as spin-torque oscillators. I also received the Defense Advanced Research Projects Young Faculty Award for my work in emerging magnetic devices.

18. My current curriculum vitae, provided in Exhibit 2002, contains more information on my background and experience.

19. No part of my compensation is contingent upon the outcome of this *inter partes* review or any district court litigation between the parties. I have no other interests in this *inter partes* review, any litigation between the parties, or with any of the parties.

20. Because of my background, training, and experience, I am qualified as an expert in the technical areas relevant to the '755 patent and I am a POSITA.

III. MATERIALS CONSIDERED

21. In preparing this declaration and forming my opinions, I have considered: the claims, specification, and prosecution history of the '755 patent; the Petition and declaration by Dr. Collins (including all materials cited in each); and all materials cited and discussed in this declaration. As part of my analysis for this, I have also considered my own knowledge and experience, including my work and experience with uninterruptible power supply systems, power converts, and power sources (including batteries and renewable power generation sources).

IV. LEGAL PRINCIPLES

22. Counsel for Patent Owner has informed me of legal principles that apply in this proceeding.

23. It is my understanding that assessing the validity / patentability of a U.S. patent claim based on a prior art analysis requires two essential steps. First, one must analyze the terms of the patent claims to understand what meaning one of ordinary skill in the art would give the terms. Second, one may then assess validity by comparing a patent claim to the "prior art." I understand that the teaching of the prior art is viewed through the eyes of a person of ordinary skill in the art at the time

the invention was made. My opinion as to what constitutes a relevant person of ordinary skill in the art is set forth below.

24. I have been informed that in order to anticipate a patent claim under 35 U.S.C. § 102, a single prior art reference must explicitly or inherently disclose every feature of the claim. I understand that a prior art reference merely capable of being modified so as to operate in the same manner as the patented device does not anticipate. I understand that, to establish inherency, the missing characteristic must be necessarily present in the single reference, and that it would be so recognized by persons of ordinary skill in the art. I also understand that the missing descriptive material cannot merely be probably or possibly present. I further understand that obviousness is not inherent anticipation, and that it is insufficient that a missing limitation is so similar to a limitation actually disclosed in the reference that one of ordinary skill in the art would see the substitution as obvious. I also understand that, if it is necessary to reach beyond the boundaries of a single reference to provide missing disclosure of the claimed invention, the proper ground for asserting invalidity is not anticipation, but obviousness.

25. I understand that a claim is invalid as obvious under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time of the invention to a person having ordinary skill in the art. I have been

informed that the following factors are used to determine whether or not the claimed subject matter would have been obvious: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the field of the invention; and (iv) any relevant objective considerations of non-obviousness.

26. I also understand that a party asserting obviousness based on a combination of prior art references must demonstrate that one of ordinary skill in the art would have been motivated to combine the teachings of those references to achieve the claimed invention and that the skilled artisan would have had a reasonable expectation of success in doing so. It is my understanding that it is not enough to show that one skilled in the art could combine elements of multiple references, but instead there must be some reason that would have prompted a person of ordinary skill in the art to combine the elements in the way the claimed invention does. I understand that there must be some reasoned explanation as to why one of ordinary skill in the art would combine the references.

27. I understand that a combination of references would not have been obvious if the alleged modification(s) to be made to the reference(s) would have been inconsistent with the reference's stated goals or would have rendered the combination inoperable for its intended purpose. I further understand that for something to have been obvious, the party asserting obviousness must explain why

a POSITA would have selected components for combination in the manner claimed.

28. I have been informed that a prior art reference must be considered in its entirety, i.e. as a whole, including portions that would lead away from the claimed invention.

29. It is my further understanding that obviousness cannot be based on a hindsight combination of components selected from prior art references. I also understand that an invention would not have been obvious simply because all of the elements of the invention may have been known separately in the prior art.

V. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

30. Counsel for Patent Owner has informed me that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. In my opinion, the relevant field of art for the '755 patent is that of uninterruptible power supply systems for stand-alone and/or grid-type applications, including converters and power generation components.

31. For the purpose of this Declaration, and based on my opinions herein, the time of invention for the '755 patent is July 2015. However, I understand that the conception dates of the inventions may have been earlier than that date. Any earlier conception date in the early to mid-2010s would not alter my opinion regarding a person of ordinary skill in the art.

32. I have been informed by counsel for Patent Owner that the person of ordinary skill is generally familiar with the type of problems encountered in the field and the prior art solutions to those problems and possesses an ordinary level of creativity.

33. In my opinion, a POSITA would include someone who had a bachelor's or graduate degree in electrical engineering or related degree, with knowledge of uninterruptible power supply systems and approximately two years of industry experience with uninterruptible power supply systems, including those having power sources and converters.

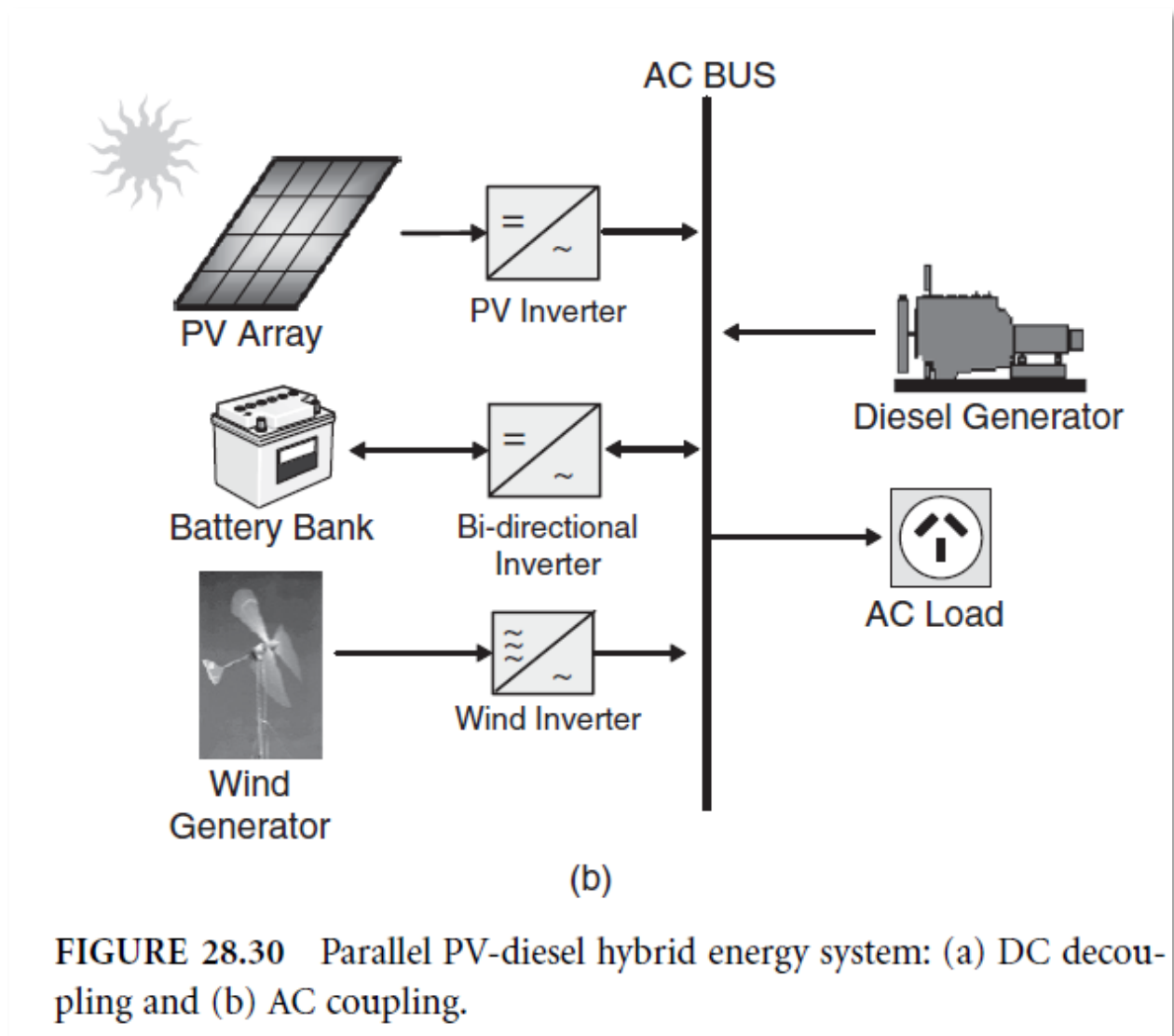
34. I understand that Petitioner's expert, Dr. Collins, opined that a person of ordinary skill in the art "would have had at least a bachelor's degree and a master's degree in electrical engineering or a related degree, as well as possessing at least two years of experience with grid-tied power supplies having electric energy sources including photovoltaic and battery systems." EX1003, ¶23, Collins Decl., ¶23.

35. While our definitions are similar somewhat, it is my opinion that a POSITA would necessarily have experience with power converters and further have industry experience with power systems having converters and energy sources. Nevertheless, my opinions set forth below are applicable under both my definition and Dr. Collins' proposed definition of a POSITA.

VI. BACKGROUND OF THE TECHNOLOGY

A. Overview of Energy Sources

36. Energy sources are systems or devices that supply energy, usually to a load. Example energy sources include alternating current energy source, such as generators and wind-turbines and direct current energy sources, such as batteries and photo-voltaic cells (solar cells). Utility grids may be powered by a multitude of energy sources, however electrical generators are still the most common, and primarily powered by conventional combustion, steam (nuclear), or hydro-electric.



(EX2009, 738)

37. With the necessity to reduce carbon emissions, renewable energy sources are being developed both to support the utility grid, micro-grids, and local power systems, such as for a home or building. Two common renewable sources shown above are photovoltaic arrays and wind turbines.

38. Photovoltaic (PV) arrays consist of large assemblies of photovoltaic cells, which are often formed using semiconductor junctions, e.g. PN junction.

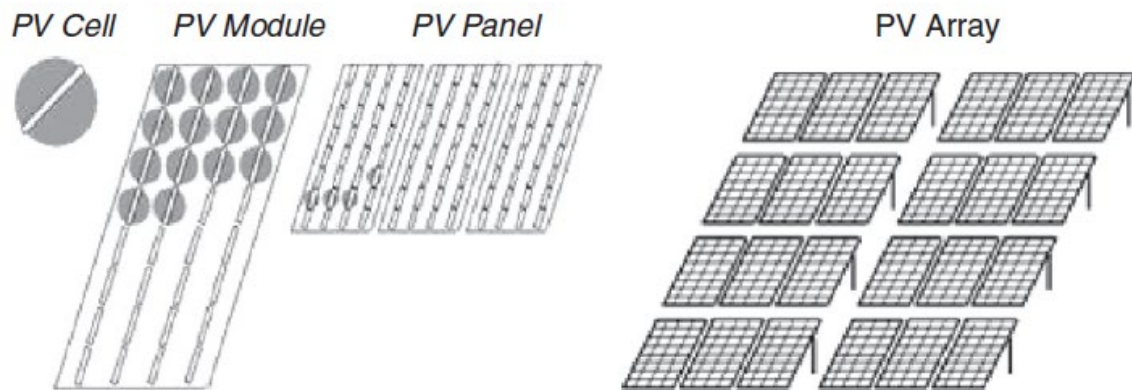


FIGURE 28.4 PV generator terms.

(EX2009, 725)

39. PV cells generate current (electrons) from incoming sunlight (photons). PV cells output a relatively constant current for a wide range of voltages. Since power, P , is related to current and voltage, $P=V \times I$ (for direct current (dc) systems), the output power of a PV cell (or array) is dependent on the voltage of its output. Since a PV cell is a current source, its output voltage may be determined by an external controller. If there is no external controller, then the load sets the output voltage using Ohms law, $V=I \times R$, where R is the load and I is the constant current of the PV cell or array. The power produced by the PV array is therefore variable and can be adjusted by adjusting the voltage the PV array sees at its output.

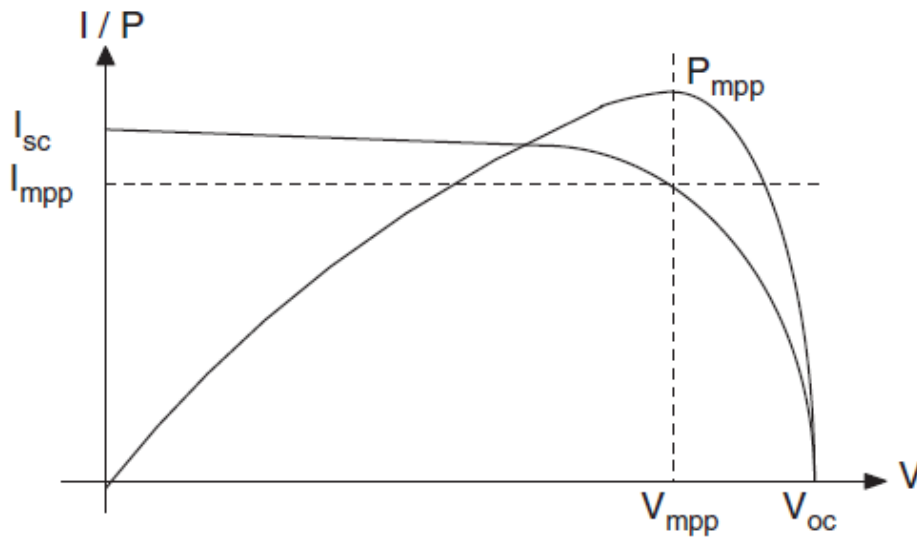


FIGURE 28.3 Current vs voltage ($I-V$) and current power ($P-V$) characteristics for a solar cell.

(EX2009, 725)

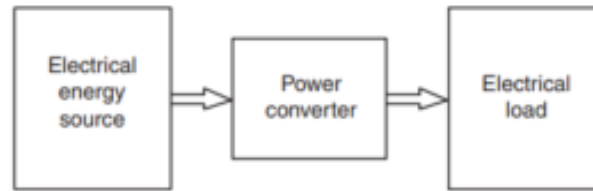
40. Wind turbines are another renewable source. They convert wind energy into electrical energy using large fins or blades. Specifically, wind turns the fins of blades of the turbine, and that energy is used to generate power.

41. The power produced (and outputted) from a wind turbine is adjustable by changing the blade pitch angle. *Id.*, 724. If the pitch angle can be controlled such that more or less of the surface area of the blade is exposed to the direction of the wind. In this way, the turbine harvests more or less energy from the wind, thus controlling the generated power.

B. Overview of Power Converters

42. In both alternating current and direct current systems, power is related to current and voltage¹. Power is energy per unit time, e.g. the energy sourced by an energy source is its power times time, such as Wh (Watt-hours). The energy source, which provides the power, often does not provide the voltage or current that the load prefers. For example, high-voltage electrical lines can be several thousand volts, however a home requires only 120V (or 240V). It is therefore often necessary to convert the voltage and current of the energy source to the voltage and current needed by the load. Energy is conserved, such that if a load needs a lower voltage, it will need to use higher current and visa versa. For a utility grid powering a home, for example, the alternating current electricity can be converted using a simple transformer, because the source and load are both alternating current. For systems with both alternating current and direct current sources and/or loads, a converter or inverter is needed. As shown below, for example, a power converter may be placed between an electrical energy source and an electrical load to modify the power from the source to a form that maybe used by the load:

¹ In direct current systems, it is simply $P=V \times I$. In alternating current systems, P is related to the root-mean-squared (rms) of the voltage and current and the angle between the current and voltage.



(EX2009, 2)

43. Converters take the input power and convert it to an output with the same power, but a different voltage-current relationship or a different form. Converters typically provide DC-DC conversion, where the input and output are both direct current. A converter can increase the voltage or decrease the voltage. The current would then decrease or increase, respectively, as power is conserved. An example is a PV cell used to charge a battery. The battery may be 5V, and the PV array may 12V. A DC-DC converter is then needed to convert the PV output to the battery voltage. *Id.*, 4.

44. An inverter converts a direct current input into an alternating current output (DC-AC). An example is a PV array that supplies power to the utility grid. The direct current output is converted into the alternating current needed by the utility grid. *Id.*

45. A rectifier converts alternating current to direct current (AC-DC). *Id.*, 11. A rectifier can be passive (no active control) or it can be active and use switches and a controller.

46. A bidirectional converter (DC-DC, DC-AC, or AC-DC) can convert power at its input to power at its output and also convert power at its output to power at its input. EX2009, 738. An example is an uninterruptible power supply (UPS) that includes a battery and a bidirectional converter. The battery can source energy to the bidirectional converter, which converts the direct current power of the battery to a much higher voltage (e.g. 120V), alternating current at its output. When alternating current is present at the bidirectional converter's output, such as when connected to a utility grid, it can then convert the high-voltage alternating current input to a lower voltage direct current suitable to charge the battery. *Id.*

C. Overview of Functions

47. In general, a function is a mathematical concept that assigns each element of one set to a single element of another set. In my experience, a function is a very common concept in the field of electrical engineering, and also more generally in engineering and mathematics. As an example, and as described in the Authoritative Dictionary of IEEE Standards Terms, 7th Edition, where “ u is a function of x ” is written by $u = f(x)$. EX2004, 468. That is, by using x as an input (aka variable) to a formula, it provides a specific output, u . An example of a function is $u = 5 + x$. Here, when $x = 5$, $u = 10$; when $x = 6$, $u = 11$; etc. Each value of the variable (x) results in one specific value of u . That is, each value of x (value of a first set) is assigned to “exactly one member in the second [set],” (set of values

for u). EX2005, 659 (defining a function as “a mathematic rule between two sets which assigns to each member of the first, exactly one member of the second”).

48. The concept of a function was described as early as the 19th century:

If a variable y is so related to a variable x that whenever a numerical value is assigned to x , there is a rule according to which a unique value of y is determined, then y is said to be a function of the independent variable x .

EX2008 (Britannica). “That is, $f(x)$ [a function of x] can not have more than one value for the same x .” *Id.*

49. As I discuss in more detail below, the specification of the ’755 patent claims “an output power as a function of a frequency” and provides an example function of such in the specification. The specification describes that an output power may be linearly decreased from 100% to 40% when the frequency increases from 50.2 Hz to 50.5 Hz. ’755 Pat., 6:29-34. The function thus can be expressed using the following formula: $\text{Power Output (\%)} = 200 \cdot (50.7 - \text{Frequency (Hz)})$. In this description, frequency is the input, or variable, and each input (frequency) maps to a single power output, which is a defining characteristic of a function.

D. Overview of the '755 Patent

50. The '755 patent, titled “Uninterruptible Power Supply and Method for Managing Power Flow in a Grid-Tied Photovoltaic System,” was filed on July 28, 2015 and issued on October 17, 2017. '755 Pat., cover page.

51. The '755 patent generally relates to power systems with current source inverters, which is the same type of systems that I designed and developed in industry. Conventional systems with uninterruptible power supplies and energy sources included either grid-tied inverters or stand-alone inverters. '755 Pat., 1:41-46. Grid-tied inverters were current-source inverters “used to pump power into the utility grid.” *Id.* Stand-alone inverters included voltage-source inverters used to power loads when a grid was not connected. *Id.* The '755 patent envisioned a system that could “provide both grid-tied capability and backup power in the event of an outage, as long as the cost of the final system is not substantially higher than the grid-tied system alone.” *Id.*, 1:55-59.

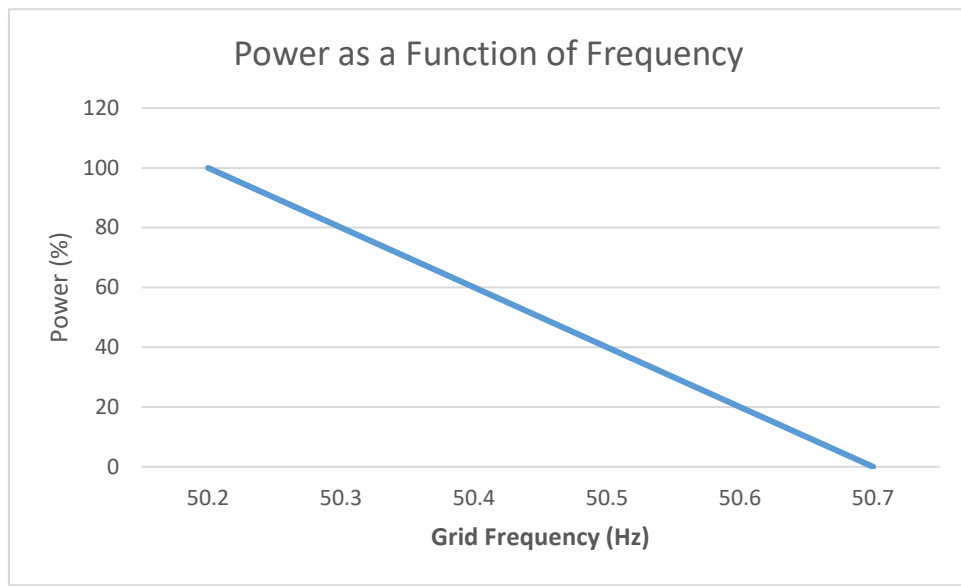
52. The inventors noted that, consistent with my knowledge and experience, grid-tied inverters were more prevalent and cost efficient; however they were not incorporated in stand-alone systems because stand-alone setups have a limit on the amount of current they can receive. *Id.* 1:41-46. For example, in a home-back up system, if the load (the components of the home using energy) requires less current than produced by the current-source inverter, then the unused

current would still flow into the home, as it would have nowhere else to go. This was (and is) unacceptable, as it would cause safety concerns and damage the home's electronics. For example, electrical components could overheat, catch fire, or cause electrical shock. A current source inverter could therefore not be used alone in a home back-up system, and, indeed, could not control the voltage of the home back-up system.

53. Because of this, stand-alone systems used voltage-source inverters, which allowed the home's electronics or other electrical components to draw current only as needed. However, the voltage-source inverters were not compatible for grid-tied connection as the voltage-source inverter controller (of voltage) could conflict with the voltage of the grid.

54. The inventors recognized at the time of the invention that some current-source inverters were configured to “gradually reduce output power when the grid frequency deviate[d] beyond a set limit.” ’755 Pat., 1:28-30. Those “current-source inverters [were] designed to limit power when the frequency of the grid ... varies by a predetermined amount.” *Id.* at 6:29-34. As the ’755 patent describes, “current-source inverters may be designed to linearly decrease their power output from 100% to 40% when the frequency increases from 50.2 Hz to 50.5 Hz.” *Id.* Parsing out this example, the current-source inverter operates at 100% at a grid frequency of 50.2 Hz, 80% at 50.3 Hz, 60% at 50.4 Hz, and 40% at

50.5Hz. And as is apparent, each frequency in the operating range directly correlates to a single output power; the output power is a function of frequency. In the example above, the function can be expressed using $\text{Power (\%)} = 200 * (50.7 - \text{Frequency (Hz)})$. This is illustrated graphically in the graph that I made, below:

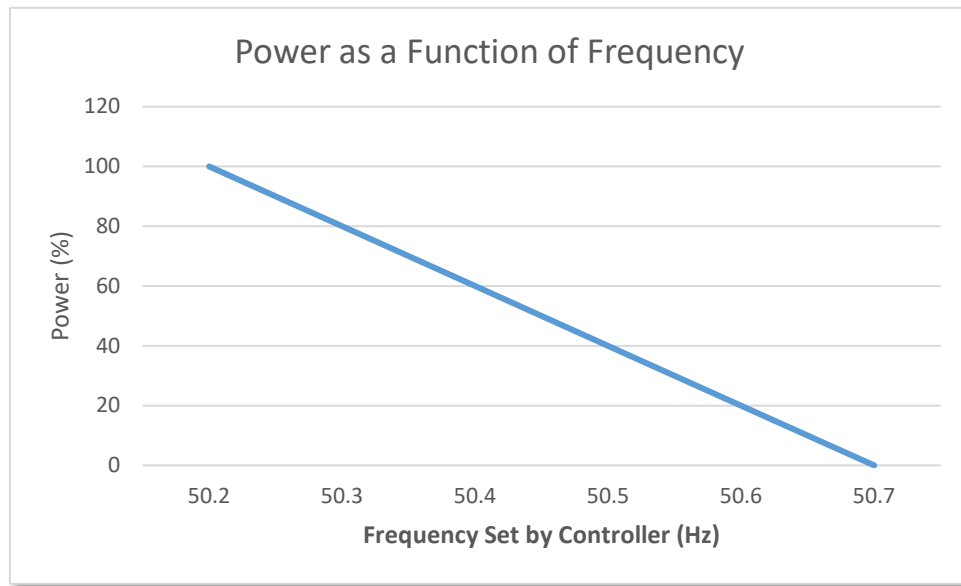


55. These conventional grid-tied inverters require a voltage source to operate, which is generally provided by the grid. Thus, they were inoperable in an off-grid scenario. What the inventors recognized, however, is that they could develop a new controller that could emulate the grid from the inverters' point of view to adjust their power output, even without the presence of grid voltage or frequency. Specifically, the controller of the '755 patent controls the frequency of the converter/inverter 302 such that it mimics grid frequency by “produc[ing] a

sinusoidal voltage having a frequency that [could be] used to limit (and thus regulate) power produced by the micro-inverters.” *Id.* at 6:65-7:2.

56. The inventive controller allowed for current-source inverters to charge a battery: when the battery is low, the controller “sets the frequency ... to the nominal frequency [e.g., 50.2 Hz in the example above], thus allowing maximum power flow from the micro-inverters.” *Id.* at 8:58-64. As the battery becomes fully charged, “the controller 301 adjusts the frequency ... to cause the micro-inverters to reduce their power output until the battery ... is being trickle-charged.” *Id.* Using the function above, for example, the controller could raise the system frequency to 50.69 Hz, which would result in a 2% power output from the current-source inverter. *Id.* at 6:29-34.

57. The novel controller of the ’755 patent sets the system frequency to control the current-source inverter. ’755 Pat., 2:46-53. This functionality is claimed in the ’755 patent: the current-source inverter is “configured to adjust an output power as a function of a frequency of the [AC] voltage source.” ’755 Pat., claims 1, 18, 20. That is, just as is described in the specification, the current-source inverter is configured to provide one specific output power for each frequency, as shown in the below example.



58. As one can see, the graph above is similar to the previous graph illustration I made. The difference is that here, the frequency is set by the controller, not the grid.

59. As claimed, the controller is “configured to regulate a power flow of the current-source inverter by adjusting a frequency of the [AC] voltage source.” ’755 Pat., claims 1, 18, 20. That is, the controller is configured to raise or lower the system frequency that is being sourced to a load to regulate the power flow from a current-source inverter.

60. With the solution of the ’755 patent, a current-source inverter could pump all power generated from an array of solar panels into the grid while grid-connected, and the current-source inverter could also provide only the amount of current needed for system components in off-grid mode, thus providing “a system

that can provide both grid-tied capability and backup power in the event of an outage, [with] the cost of the final system [] not [being] substantially higher than that of the grid-tied system alone.” ’755 Pat., 1:55-59.

E. Prosecution History of the ’755 Patent

61. I also analyzed the prosecution history of the ’755 patent in forming my opinions. I was asked to offer an opinion on whether the Examiner made a mistake or material error in issuing the claims in light of the prior art, including the Serban Patent and Serban Paper that I discuss below. I understand that examples of material error include “misapprehending or overlooking specific teachings of the relevant prior art where those teachings impact patentability of the challenged claims” and “an error of law, such as misconstruing a claim term, where the construction impacts patentability of the challenged claims.” In my opinion, the Examiner made no mistake or material error.

62. I understand that Petitioner and Dr. Collins allege that the Examiner made a material error by issuing the claims only because the prior art of record in the prosecution history of the ’755 patent failed to disclose or suggest a first alternating power port. *See* EX1003, ¶83. Upon review of the prosecution history, I disagree.

63. In my opinion, upon full review of the prosecution history, it would be (and would have been at the time of prosecution) readily apparent to a POSITA

that the Examiner did not issue the claims because he found the prior art did not disclose a first alternating current power port. This is apparent from the notice of allowance, where the Examiner stated that the Yu reference actually did disclose “an alternating current power port coupled to the bi-directional converter.”

EX1002, 24. As the Examiner stated in the notice of allowance that Yu’s system includes an alternating current power port, I disagree with Dr. Collin’s that the notice of allowance demonstrates that the Examiner only allowed the claims because he determined that the prior art did not disclose an alternating power port.

64. Instead, what would have been apparent to a POSITA from the Examiner’s statement is that the prior art did not disclose the “AC power port” as claimed. And as claimed, the AC power port must be connected to a current-source inverter that is “configured to adjust an output power as a function of a frequency of the alternating current voltage source.” *See, e.g.,* ’755 Pat., claim 1. As I discuss below, the Petition fails to establish that this element was disclosed in any prior art reference, including Serban. As such it is my opinion that the Dr. Collins fails to demonstrate that the Examiner made any mistake.

VII. SUMMARY OF CERTAIN REFERENCES

65. Below I provide a summary of certain references that are relevant to this declaration and my opinions expressed herein.

A. Serban (EX1005)

66. U.S. Patent Pub. No. 2011/0043160 by Serban (“Serban”) was related to systems where “distributed power generation modules” and other system components, such as loads, were “positioned far away from each other.” EX1005, Abstract, ¶29. Serban relates to controlling components of the system using communication messages. Serban noted that components could receive control messages via “wired communication.” *Id.*, ¶2. However, Serban was concerned that the wired communication “prevents control devices from being placed far apart from one another and requires additional control wiring.” *Id.* Serban’s proposed solution was to remove dedicated communication lines and instead send the communications via the electrical transfer wire that was already present between components. *Id.* ¶4. What Serban proposed, was, instead of having two separate lines, one to send communications and one for transferring power, combine the two lines to have a single line that transferred both power and communications. *See, e.g., id.*, Abstract, ¶43.

67. Specifically, Serban disclosed a hybrid converter. The hybrid converter could receive power (e.g., from a grid, genset, or PV array), and could output power (e.g., to a load). *See* Serban, Fig. 1. Further, the hybrid converter could send communications by using a “pattern generator algorithm.” *See id.* In Serban, the generated communications pattern is sent over the “AC line”—which

transfers power—by injecting the pattern in the “frequency or voltage” of that line.

Id. ¶4. Thus the same line could be used for transferring power and communicating messages.

68. The hybrid converter may use a look up table to determine which pattern to generate and then may generate that pattern by modulating the frequency, phase angle, and amplitude on the AC line. *Id.* ¶31. A receiving component then may receive the communications pattern and look up a resulting command. Serban describes the communication pattern being generated by various, “control alternatives,” including “Fast Fourier Transform,” “proportional-integral-derivative control,” “fuzzy logic,” and “a wavelet.” *Id.* ¶46. The control alternatives are injected in the line as a short command, a communications packet, that includes data for control. *Id.*

69. A POSITA would have understood that Serban’s functionality is distinct from the claimed functionality of the ’755 patent that I described above, where an output power is adjusted as a function of a frequency of the AC voltage source. Unlike the ’755 patent, Serban’s methods do not control power as a function of frequency via an adjustment to the frequency of the system, but instead inject a short anomaly into the line. *Id.* For example, Serban uses a short “ripple” in the line. EX1005, ¶¶47-51.

70. In fact, it is my opinion that Serban teaches away from the solution of the '755 patent. Serban recognized that the communications packet sent by a frequency variation pattern must precisely follow a “specific pattern” or otherwise, the system could not function properly. *Id.* ¶¶4, 45. Further, Serban disclosed that the specific pattern has to “be distinguishable from other patterns created by electrical devices in the power system that cause the frequency or voltage of the AC line to vary.” *Id.* ¶39. Thus, Serban teaches to *not* use the solution of the '755 patent. In Serban, the power output is adjusted using communication via precise patterns that are created by a controller. Serban prohibits using patterns normally found on the grid, which can be generated, for example, from gen-sets and other power sources. EX1005, ¶39. For example as I described above, output of the controller described in the '755 patent produces frequency changes that are like those seen in a grid system. As such, it is my opinion that Serban’s approach is contrary to the solution of the '755 patent as Serban’s hybrid-converter cannot “mimic” the grid, but rather must be distinct from grid frequency or voltage changes.

71. Serban discloses that the communications patterns can be received by a “PV inverter,” which thus requires a receiver for receiving the communications. Serban discloses that the PV inverter must include a “second controller” that carries out pattern detection. EX1005, ¶¶19-21. The second controller detects the

patterned communication sent from the hybrid converter and can change its operation based on that communication. *Id.*, ¶43. For example, Serban's claim 1 states that the Serban PV inverter includes a "second controller programmed with machine-readable instructions for carrying out the pattern detection algorithm." In the reverse operation of the hybrid converter, the second controller can sense a pattern and then use a look up table to determine how to operate after receiving that patterned communication. *Id.*, ¶44. To sense the pattern, Serban describes using a "PI frequency controller" or "wavelet frequency tracking WT and pattern," which can detect "Morlet wavelet transform." *Id.*, ¶52. Again here Serban differs from the '755 patent. The '755 patent requires no special receiver in the PV inverter or specialized pattern detection, which allows the "cost of the final system is not substantially higher than the grid-tied system alone." *Id.*, 1:55-59.

72. Serban illustrates his control technique in Fig. 6:

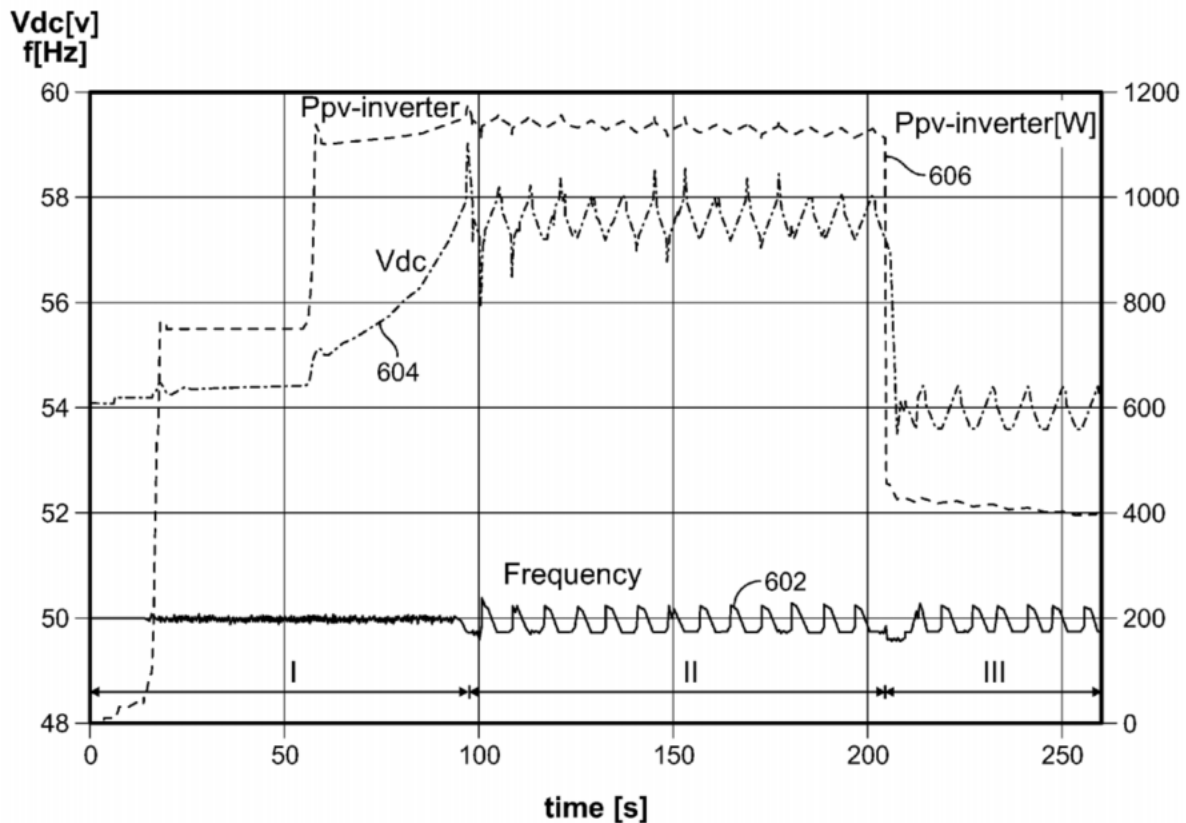
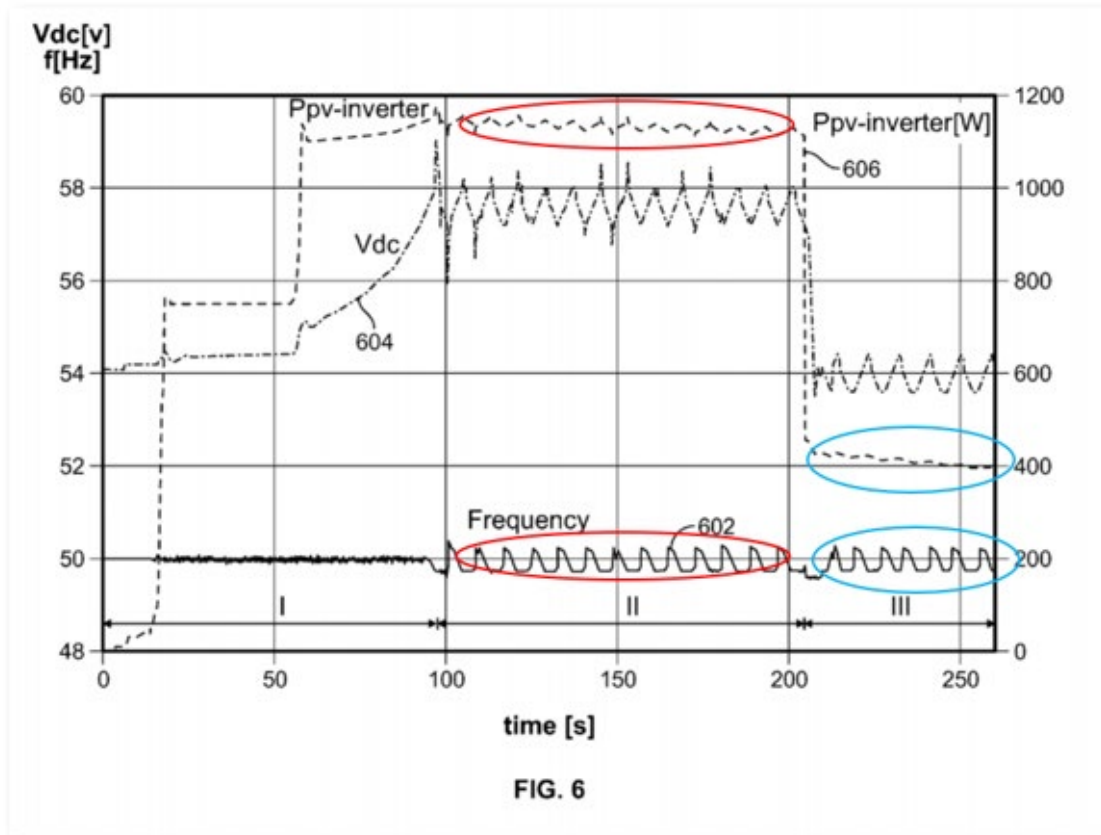


FIG. 6

The frequency is shown near the bottom of Fig. 6, line 602, and the power output of the PV inverter (Ppv-inverter) is shown near the top, line 606. *See also* EX1005, ¶55. Around the 50 second mark, Ppv-inverter increases nearly 400 watts, a great deal. However, the frequency remains seemingly unchanged at 50 Hz before and after the 50 second mark. Further, even though the frequency line 602 is identical in parts II and III (e.g., 175 and 225 second marks), Ppv is very different. This figure visually illustrates what Serban describes in the specification: Ppv is not controlled as a function of frequency. As shown, the same frequency results in very

different power outputs. Instead, it is the patterned communications that provide the instruction to the alleged PV inverter. *Id.* As shown below one frequency (e.g., a frequency at 50 Hz results in different power outputs.



As shown in the red circles, the frequency is often exactly at 50 Hz, and the power is near 1200W. In the blue circle, the frequency is likewise exactly at 50 Hz, but the power is near 400W. Even within the blue circles, the frequency is exactly at 50 Hz many times, but the power is decreased each time.

B. Serban Patent (EX1015)

73. U.S. Patent No. 8,159,178 (the “Serban Patent”) (EX1015) is the issued version of Serban. *Compare* EX1015, cover page *with* EX1005, cover page (both documents list Appl. No. 12/545,234). I analyzed the prosecution history of the ’755 patent and understand that the Examiner considered the Serban Patent before allowing the issued claims of the ’755 patent. EX1002, 36.

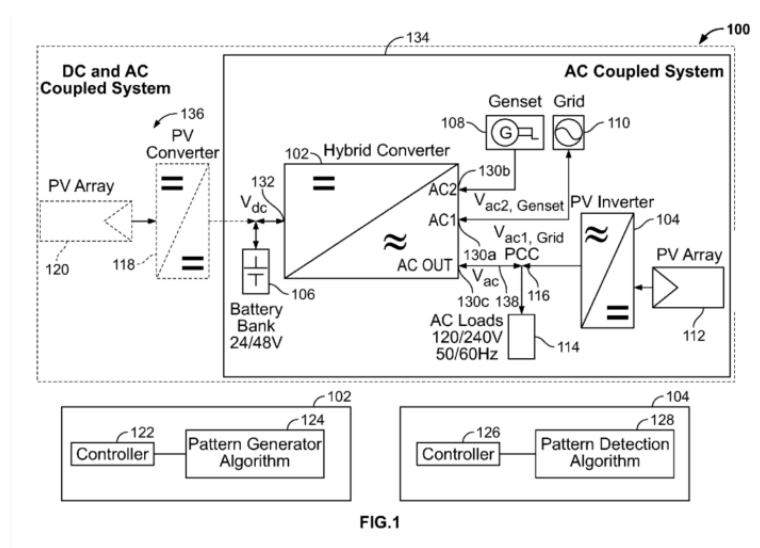
74. I was asked to determine if the Serban Patent includes substantially the same disclosure as Serban. In my opinion, Serban and the Serban Patent include near identical disclosure. I analyzed both documents and both include an identical disclosure, save for some patenting formalities. For example, the cover page (and second page) of the Serban Patent lists prior publication data and references cited. However, it is my opinion that the technical disclosure of the two documents is identical.

C. Serban Paper (EX2003)

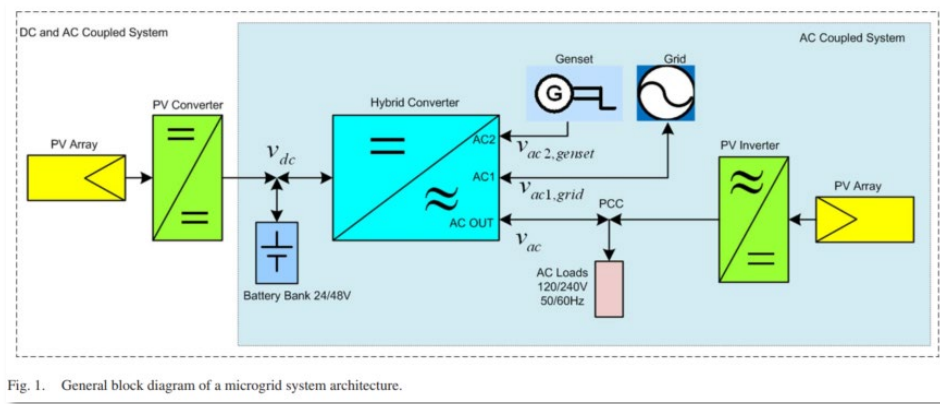
75. Exhibit 2003 is a paper titled “A Control Strategy for a Distributed Power Generation Microgrid Application with Voltage-and Current-Controlled Source Converter” (the “Serban Paper”). The Serban Paper was included in volume 25 IEEE Transactions on Power Electronics with a date of December 2010. EX2003, 1. The Serban Paper was authored by Emanuel and Helmine Serban. *Id.* Emanuel Serban is the inventor listed on the face of Serban and the Serban Patent.

EX1005; EX1015. I analyzed the prosecution history of the '755 patent and understand that the Examiner considered the Serban Paper before allowing the issued claims of the '755 patent. EX1002, 36.

76. I was asked to determine if the Serban Paper includes substantially the same disclosure as Serban. In my opinion, Serban and the Serban Paper include the same relevant disclosures. By “relevant” disclosures, I mean disclosures of Serban that Dr. Collins relies upon in his opinions. As shown below, for example, both documents include a substantially similar figure of the overall Serban system.



Serban, Fig. 1



Serban Paper, Fig. 1

77. As can be seen, absent coloring and minor, non-substantive formatting, the figures are identical, save for the Serban Paper does not illustrate the controller and pattern generator/detection algorithm in Fig. 1. However, the controller and pattern generator/detection algorithm are described in the Serban Paper, just as they are in Serban. *See* EX2003, 2988 (discussing “pattern variation,” “wavelet method,”). Serban and the Serban Paper describe the same system. To demonstrate that the two portions of Serban relied upon by Dr. Collins for the independent claims are disclosed in the Serban Paper, I created the table below.

Serban	Serban Paper
Claim 1[P]	Claim 1[P]
Fig. 1	Fig. 1
¶ 19 (grid-connect mode, island mode)	2982 (“grid-connected mode” and “islanded mode”)

¶25 (“The AC loads 114 can be powered by both the PV inverter 104 and the utility grid”) ¶¶24, 27 (In islanded mode “[e]nergy for the AC loads 114 can be sourced by either or both of the PV array 112 and the battery 106”) ¶24 (“seamless transfer of power when the utility grid 110 fails”)	2984 (“The ac loads can be powered by both PV inverter and utility grid”) 2984 (“In island mode ... energy can be sourced by one or both of ... solar array and battery bank”) 2983 (“seamless transfer of [power from] hybrid converter when utility grid fails”)
Claim 1[A] Fig. 1 (“hybrid converter”) ¶11 (“four-quadrant pulse width modulated (PWM) bidirectional energy converter”) ¶27 (“voltage-controlled source mode” “controls the AC voltage and frequency on the AC line”)	Claim 1[A] Fig. 1 (“hybrid converter”) 2982 (“four-quadrant PWM bidirectional energy converter”) 2982 (“voltage-controlled source converter” where the ac voltage and frequency are controlled”)
Claim 1[B] Fig. 1 (left side arrow between “hybrid converter” and v_{dc}) ¶ 22 (“DC port”)	Claim 1[B] Fig. 1 (left side arrow between “hybrid converter” and v_{dc}) 2986 (“dc port”)
Claim 1[C] Fig. 1 (bottom right-side arrow between “AC OUT” and “PCC”)	Claim 1[C] Fig. 1 (bottom right-side arrow between “AC OUT” and “PCC”)

¶ 21, 22 (PV inverter receives DC input from PV array and outputs an AC current) Abstract (“vary[ing] the line frequency” ... “to cause a PV inverter to modify its power output”) ¶28 (inverter detects “the modified output and, in response to that detection causes the current or voltage applied” to be changed) ¶ 28 (disconnect or reduce current produced)	2984 (“The PV inverter harvests the dc solar energy and operates in ac current-controlled mode”) 2991 (“varying the microgrid line frequency” and then “the PV inverter adjusts its output”) 2988 (“PV inverter [] will sense a specific frequency change pattern and ... adjust its local ac current”) 2986 (“inverter may disconnect”); 2988 (“adjust local ac current”)
Claim 1[D] Fig. 1 (hybrid converter, PV inverter, and respective controllers and pattern algorithms) ¶17 (hybrid converter includes a controller that modifies output at a first AC output) ¶¶17, 20, 55 (controller of PV inverter detects pattern and changes current or voltage).	Claim 1[D] Fig. 1 (hybrid converter, PV inverter, and respective controllers and pattern algorithms) 3986 (“hybrid converter with ... control structure” for “line-frequency control variation”) 2988 (“PV inverter with frequency-detection function control”); <i>id.</i> (“frequency-detection function is proposed for implementation of the PV inverter, which will sense a specific frequency change pattern and to adjust its local ac current”)

78. I understand that for the remaining independent claims, 18 and 20, Dr. Collins contends that they include all elements of claim 1, with additional

limitations. *See* EX1003, ¶¶272-274. As the Examiner found that the disclosure of Serban does not anticipate or render obvious claim 1, then I understand that under Dr. Collins’ analysis, the Examiner also found that Serban’s disclosure does not anticipate or render obvious any of these remaining independent claims (and thus any dependent claim). Nevertheless, as the Serban Patent and Serban Paper describe the same system in material respects, concepts of the dependent claims are explained as well. For example, for claim two, all documents describe a battery charging profile and regulating the dc voltage or current to the battery. Serban, ¶22, 28; Serban Paper, 2983. For claim 5, all describe transferring energy from battery to AC loads or grid. Serban, ¶25; Serban Paper, 2983. For claim 6, all have the substantially same Fig. 1. For claim 7, all discuss “disconnect” and “frequency limit.” Serban, ¶¶28, 43; Serban Paper 2988.

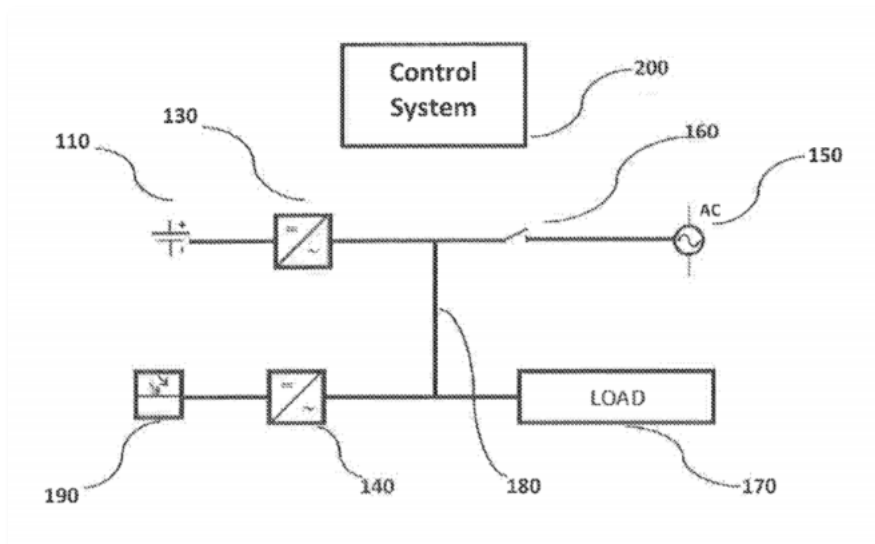
79. In my opinion, all three Serban references includes substantially the same relevant disclosures.

D. Somani (EX1007)

80. U.S. Patent Pub. No. 2017/0005473 by Somani (“Somani”) is titled “Islanding a Plurality of Grid Tied Power Converter.” Somani was filed June 29, 2016, which is almost a year after the filing date of the ’755 patent.

81. Somani discloses a “microgrid system” having “a variety of interconnected distributed energy resources,” including “distributed power sources

(e.g., distributed generators, battery banks, and/or renewable resources such as solar panels or wind turbines to provide power supply to a grid (e.g., a microgrid having local loads and/or a utility grid).” EX1007, ¶¶4-5. As Somani describes, these distributed power sources are each coupled to a “power converter,” which converts power from a power source from one form to another. *Id.* ¶4. As I describe above (Section VI.B), characteristics of power may be modified. For example, DC power may be converted to AC power (via an inverter). AC power may be converted to DC power (via a rectifier). Characteristics of AC power, such as the amplitude or phase may be modified, and even characteristics of DC power, such as voltage, may be modified. Somani discloses that its “power converters” convert characteristics of power. For example, the converter takes the power it receives and converts it from DC to AC, AC to DC, or takes AC power and modulates its phase or frequency. *Id.* Somani discloses that the power converters of the system are “coupled to a load” via a PCC—which is short for a point of common coupling. This allows the distributed energy sources to “provide a combined power converter output to the load.” *Id.*, Abstract. Somani shows his system in Fig. 1B:



Somani Fig. 1B

82. Somani’s system includes “energy sources ... to provide power to the load,” including a “battery 110” and “solar array 190.” *id.*, ¶¶70, 77. A solar array is an array of solar panels. *See* Section VI.A, above. As also shown, each of the energy sources is connected to a “power converter” (130 and 140) for converting the power sourced from the energy source. *Id.*, Abstract.

83. Somani describes placing the system in “islanded” mode. *Id.*, ¶65. Islanded mode means that the system is “islanded” from outside sources such as the grid. Islanded mode may also be described as “off grid” mode. Somani discloses a disconnect switch 160, which “disconnects the grid 150 from the microgrid,” or places the system in islanded or off-grid mode. *Id.*, ¶65. For example, “[u]pon failure of the utility 150, such as a blackout, disconnect 160 is

opened via commands from control system 200,” and the load may source power from distributed power sources 110 (battery) and 190 (solar panels). *Id.*, ¶72.

84. So that the distributed power sources can work together to power the load, Somani recognizes that the output of the power converters should be synchronized:

To facilitate the transition and synchronization, the power system 200 saves the last known grid voltage, grid frequency, and grid phase angle. Thus, when disconnect 160 disconnects from grid 150, the control system has a snapshot of the sine wave of grid 150 at the time the plurality of power converters disconnected from grid 150. Through the control system 200, the power converters can know where the sine wave is at the point where the islanding switch is commanded by power system 200 to open, and the power converters can pick up the sine wave from that spot so the critical loads do not see much of a transient, if any, as they transition from grid-tied mode to microgrid mode.

Id., ¶81.

85. The Somani system “synchronize[s] the plurality of power converters” including the “output frequency of the power converter.” *Id.*, ¶83. Synchronizing output frequency of the power converters “facilitates the sharing of active power among the power converters.” *Id.*, ¶84. If multiple converters that are connected at

a PCC provided different voltage and frequency, the converters and system would become unstable and/or overwhelmed. The synchronization is to control the direction of power flow in the system as well as to provide stable power to a load; it does not affect the amount of power from the power converters, as that is determined by the load.

86. Somani discloses that the system 200 communicates through power line communication, such as X10, which applies a high-frequency AC communication signal onto the power lines to communicate between desperate converters. EX1003, ¶58. In addition, communication may be “a fiber optic link, or other high speed link.” *Id.*, ¶78. Somani further describes communication as “fast communication signals may be required between the master and slave devices to make sure that all of the devices are aligned and operating at the same frequency as the frequency of the microgrid.” *Id.*, ¶93. That is, Somani discloses an independent communication means to control the power converters. This is necessary in Somani’s system, as the converters need to be quickly synchronized. *Id.*

87. Somani discloses a control system 200 that utilizes “fast communication signals ... between the master and slave devices to make sure that all of the devices are aligned and operating at the same frequency as the frequency of the microgrid.” *Id.*, ¶93. The controller “adjustments” are to synchronize the power converters by synchronizing their phase or frequency.

88. Somani also describes different functionality of the controller “in addition” to the synchronization control. Particularly, Somani discloses that when the system includes a battery and “renewable generation,” the controller may monitor the battery to determine whether it is “getting overcharged.” *Id.*, ¶90. To prevent overcharging, Somani proposes communicating directly with the renewable resource itself to “turn[] off the generation,” “commanding the renewable resource to produce less,” “signal the resource to produce less,” or removing the renewable resource from the system entirely by “tripping the renewable resource offline by changing the microgrid frequency beyond the nominal frequency.” *Id.*, ¶ 90. That is, Somani proposes that the solar array 190 be tripped, or removed from the system when the system does not need power from it. As the controller works directly with the renewable resource, Somani does not disclose that the *power converter* is configured to make any adjustment of power output.

VIII. DETAILED ANALYSIS OF PETITION GROUNDS

89. As I describe in detail below, it is my opinion that Dr. Collins and the Petition fail to demonstrate any reasonable likelihood of success that any claim of the '755 patent is invalid.

A. Serban Fails to Anticipate or Render Obvious the Challenged Claims.

90. In my opinion, Dr. Collins and Petitioner fail to show that Serban anticipates or would have rendered obvious any claim of the '755 patent.

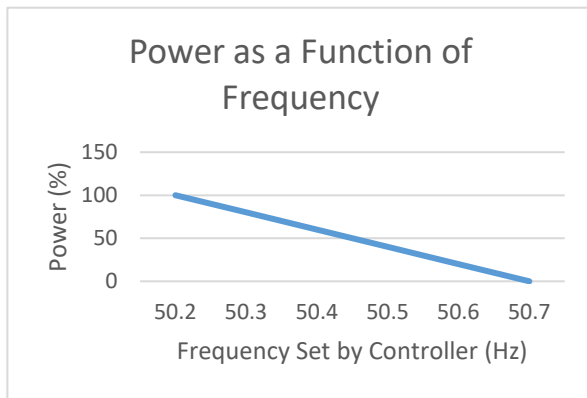
91. As I discussed in my overview of Serban, above, Serban uses a different control algorithm than as described and claimed in the '755 patent. As a result, Serban fails to disclose or suggest multiple elements of the independent claims of the '755 patent, including a “current-source inverter [that] is configured to adjust an output power as a function of a frequency of the alternating current voltage source” and “a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.”

92. First, it is my opinion that Serban fails to disclose or suggest a “current-source inverter [that] is configured to adjust an output power as a function of a frequency of the alternating current voltage source,” as recited in each independent claim of the '755 patent. As explicitly required, the current-source inverter must be configured to adjust an output power *as a function of* a frequency of the AC voltage source. As I discussed above, this means that for every frequency, there is a corresponding power output. *See* Section VI.C, above. As I describe above, a POSITA would have recognized that for a function, each variable (frequency in this case) is correlated to an output power. And indeed, this

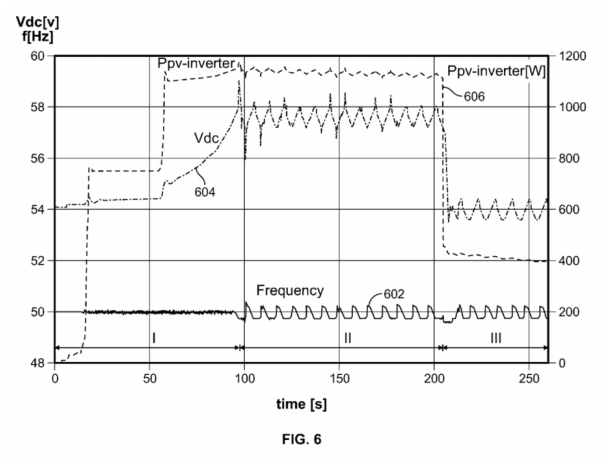
is what is described in the '755 patent, where the power output described in the embodiment of the specification is determined by the following function: Power Output (%) = $200 * (50.7 - \text{Frequency (Hz)})$. '755 Pat., 6:29-34; *see also* Section VI.C and VI.D, above.

93. Serban does not teach this requirement of the claims because in Serban, a single frequency can map to any number of power outputs, which is not *a function* of frequency. Indeed, it is my opinion that Serban teaches away from the claimed UPS of the '755 patent. Serban requires a PV inverter that has its own internal controller. Instead of adjusting output power as a function of frequency, Serban discloses using communication patterns for controlling its PV inverters. *See* Section VII.A. Unlike the invention described in the '755 patent, where the output power is a function of the frequency, any frequency of Serban can result in any number of power outputs:

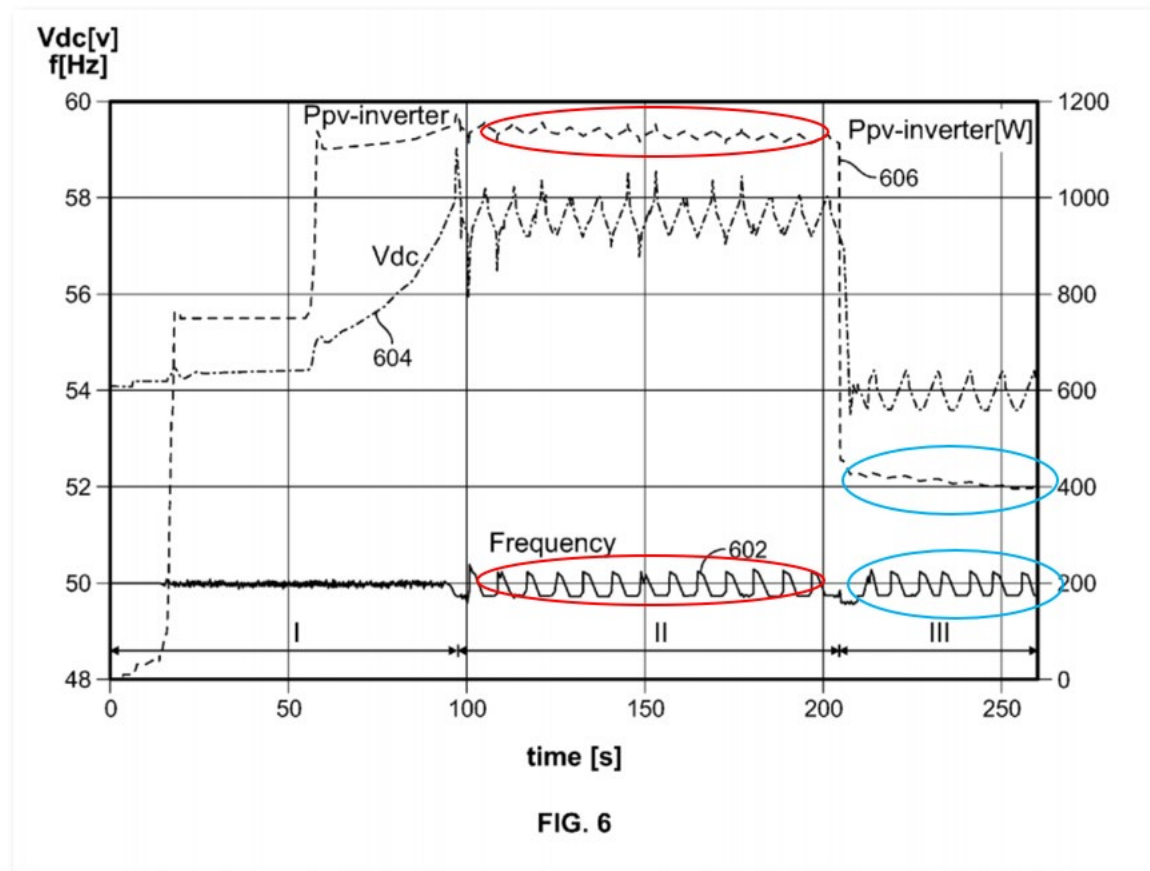
'755 Solution



Serban Solution



94. As shown in the graph above, when the frequency is 50, the power output of the alleged current-source inverter, Ppv, could be approximately 700 watts (around 25s), it could be nearly 1200 watts (around 150s), it could be approximately 600 watts (around 250s). Even within the same time periods (time periods I, II, and III as described in Serban's Fig. 6), the power output differs for the same frequency, as I discuss in Section VII.A.



95. In Serban, a given frequency does not result in a single power output. For any frequency, one could not determine what the output power would be as the frequency does not correlate to a power output. In my opinion, the alleged current-source inverter is not configured to adjust an *output power as a function of a frequency*. See also my Section VI.C.

96. I reviewed Dr. Collins' declaration, and he does not explain why it is his opinion that Serban discloses the "as a function" requirement of the claims. Dr. Collins' opinions are stated in paragraphs 133-134 of his declaration, where he opines that "Serban's PV inverter 104 detects the frequency changes and adjusts its

output accordingly.” *Id.*, ¶ 134. The quotes in Dr. Collins’ analysis clearly show that the “frequency changes” are the “predetermined patterns” that I discuss above and in Section VII.A. *See* EX1003, ¶133. Dr. Collins does not offer any opinion of how these patterns disclose the “is a *function of* the frequency of the AC voltage source.” In fact, Dr. Collins does not address this limitation at all, other than quoting the entire limitation of the claim. *See id.* ¶¶133-136.

97. As I describe in Section VI.E, a POSITA would understand that for the power output to be regulated as a function of a frequency, the power output must be able to be determined based on the frequency and that each frequency would correlate to a single power output. Given Serban’s different techniques, it does not disclose a “current-source inverter is configured to adjust an output power *as a function of a frequency* of the alternating current voltage source.”

98. **Second**, Serban also does not teach or suggest “a controller configured to regulate a power flow of the current-source inverter by *adjusting a frequency of the alternating current voltage source*,” as recited in independent claims 1, 18 and 20. As discussed above, Serban—at best—discloses sending a short communication on the AC line. There is no “adjustment” of the *voltage source* for control, as any communication pattern in the AC line does not adjust the overall system frequency of the voltage source.

99. In fact, it is my opinion that a POSITA would understand Serban to teach away from (and expressly prohibit) *adjusting* the frequency of the *AC voltage source* as taught in the '755 patent where the output power is adjusted as function of frequency (e.g., $\text{Power Output (\%)} = 200 * (50.7 - \text{Frequency (Hz)})$). Serban describes his system as requiring distinct patterns that cannot be created or detected by other portions of the system. Serban recognized that the communications in the form of frequency variation must precisely follow a “specific pattern.” *Id.* ¶¶4, 45. And for the system to work, that specific pattern must “be distinguishable from other patterns created by electrical devices in the power system that cause the frequency or voltage of the AC line to vary.” *Id.* ¶39. That is, in Serban’s system, there can be no adjustment of the frequency of the AC voltage source, which is created and varied by various components in the system including the grid, the gen-set, and AC loads. Rather than adjusting, Serban mandates short communications packets that are undetectable by the components that are sourced by the AC voltage source.

B. The Additional References Do Not Cure the Deficiencies of Serban.

100. In my opinion, the additional references that Dr. Collins combines with Serban do not cure the deficiencies of Serban. In the section above, I discuss two deficiencies. While Dr. Collins opines that Serban, alone, renders claim 1 obvious, he does not opine that Serban renders obvious those missing claim

limitations (i.e., limitations 1[c] and 1[d]). *See* EX1003, ¶¶ 197-200. With respect to the additional references, Matan, Wilhelm, PVI, and Wu, Dr. Collins offers no opinion that they cure any of the deficiencies that I identified above.

C. Somani Fails to Anticipate or Render Obvious the Challenged Claims.

101. First, in my opinion, Petitioner and Dr. Collins fail to demonstrate that Somani is supported by the earlier Somani provisional. I understand that Somani thus does not qualify as “prior art,” and cannot be used in invalidity purposes. Second, even assuming that Somani is prior art, it is my opinion that the challenged claims would not have been anticipated by Somani or obvious in view of Somani.

1. Somani is not prior art.

102. In my opinion, Dr. Collins fails to demonstrate that the portions of Somani on which he relies are supported by the Somani provisional (EX1008). I have been informed that, because of this, Somani is not prior art and cannot be used as a prior art reference against the ’755 patent. Somani was filed nearly a year after the filing date of the ’755 patent, and thus does not qualify as prior art. However, I have been informed that Somani can have a prior art date as of the Somani provisional application, but only if, at a minimum, the Somani provisional describes the subject matter relied upon by Dr. Collins and Petitioner. I have been informed that it is the patent challenger that has the burden to explain why Somani

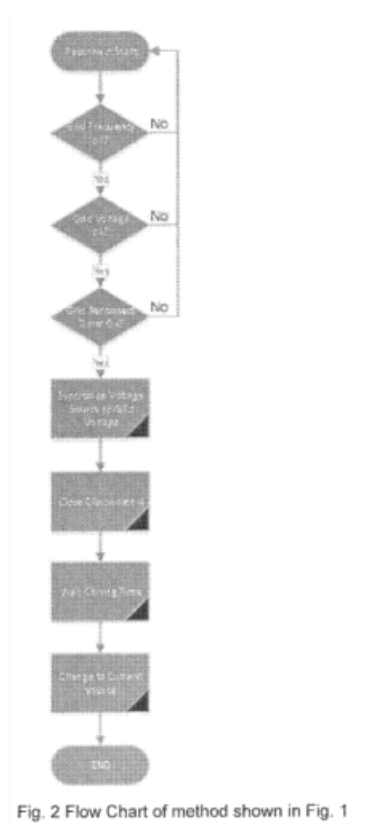
is entitled to the date of its provisional application. I have also been informed that if Petitioner relies upon material that is not in the provisional, it must explain why the material is supported. After considering the materials discussed herein, including Somani, the Somani provisional, the Petition and Dr. Collins' declaration, it is my opinion that Dr. Collins and Petitioner have not shown, and cannot show, that the portions of Somani relied upon are supported by the Somani provisional.

103. While Dr. Collins provided a table comparing Somani's provisional to claim 1 of Somani, he provided no similar chart or analysis comparing the Somani provisional to the portions of Somani that he relies upon. *See* EX1003, ¶90. Neither Dr. Collins nor Petitioner provide any explanation or analysis how the Somani provisional supports disclosure of Somani relied upon by Dr. Collins. In his declaration, Dr. Collins explains that Somani qualifies as prior art because Somani includes a priority claim to the provisional, was filed within a year of the provisional, and has a common inventor. EX1003, ¶89. However, I have been informed that this alone is insufficient, as the alleged invalidating disclosure of Somani must also be supported by the provisional for Somani to receive a prior art date as of the provisional.

104. Dr. Collins merely stated that "claims 1-20 of the '755 patent are disclosed in ... the provisional" as he says he will "explain in Sections XII.E-

XII.G” of his declaration. *Id.*, ¶ 89. However, Dr. Collins offered no such explanation, as, in these sections, Dr. Collins did not discuss the provisional. Dr. Collins only cited to various full pages of the provisional in string cites. As an initial matter, portions of Dr. Collins’ citations to Somani do not include corresponding citations to the Somani provisional. *See, e.g.*, EX2002, ¶282. Further, Dr. Collins relies on aspects of Somani that a POSITA would understand are clearly not disclosed or supported by the Somani provisional, without offering any explanation to the contrary.

105. As another example, independent claim 18 includes a limitation that “the current-source inverter is configured to disconnect from the alternating current voltage source for a predetermined outage period when the alternating current voltage source frequency goes outside of a predetermined frequency limit” For this limitation, Dr. Collins relies upon quotes from Somani regarding a preset time for grid connection to help ensure that the voltage and frequency are stable. EX1003, ¶304. The only corresponding disclosure that Dr. Collins (or Petitioner) identifies is Fig. 2 of the provisional, which I include below:



EX1008, Fig. 2

106. As shown, Figure 2 does not include the corresponding quotes or disclosure that Dr. Collins relies upon from Somani, and the Somani provisional does not. It does not appear to discuss disconnecting/reconnecting when grid frequency goes outside a predetermined limit, nor any predetermined outage period or predetermined frequency limit. Dr. Collins offers no explanation how the concepts and disclosure he relies upon in Somani are supported by Fig. 2 of the provisional.

107. As another example, the claims require a controller configured to regulate a power flow of the current-source inverter” Here, Dr. Collins relies

upon an annotated version of Somani's Figure 2, highlighting a "Master Controller" and a "Power Converter Controller." EX1003, ¶ 292. While Dr. Collins compares the annotated figure to a figure of the '755 patent for his analysis (*id.*, ¶ 293) the figure is not included in the provisional; nor is any of the annotated portions of the figure.

108. Dr. Collins also cites to Figure 4 of the Somani provisional for this concept. *Id.*, ¶292. However, Figure 4 of the provisional is plainly different and does not disclose the controller components that Petitioner highlighted in Somani's Fig. 2; indeed, the provisional figure does not disclose any controller component at all. EX1008, Fig. 4.

109. Dr. Collins further quotes a portion of the Somani provisional stating that a controller can be internal or external inverter 31. *Id.* ¶ 292. However, that does not disclose the "master controller" and "power converter controller" functionality that Dr. Collins relies upon in his invalidity analysis.

110. It is my opinion that Dr. Collins and Petitioner rely on passages and illustrations that are not present in the Somani provisional, with no explanation of how the disclosure of Somani is supported. In my opinion, a POSITA would recognize that the new material of Somani is not supported by its provisional.

2. Somani fails to disclose or suggest the claims of the '755 patent

111. Even if Somani were prior art, it is my opinion that Dr. Collins fails to demonstrate that Somani anticipates or renders obvious any claim of the '755 patent. In my opinion, Somani fails to disclose or suggest multiple limitations of the asserted claims, including a “current-source inverter [that] is configured to adjust an output power as a function of a frequency of the alternating current voltage source” and a “controller configured to regulate a power flow of the current-source inverter.”

112. *First*, it is my opinion that Somani fails to disclose or suggest a “current-source inverter [that] is configured to adjust an output power as a function of a frequency of the alternating current voltage source,” as recited in the claims of the '755 patent.

113. As I discussed above in my summary of Somani, Somani only discloses controlling an alleged current source inverter to synchronize power converters (e.g., their frequency) so that their respective power generators can share the load. Somani is explicit throughout that in this synchronization scenario, it is the *power converter* that is controlled by a separate communication mechanism, e.g. X10, fiber, etc..EX1007, ¶80 (the control system 200 transitions the plurality of power converters ... and synchronizes the power converters), ¶81 ([t]hrough the control system 200, the power converters can know where the sine

wave is” and “the power converters can pick up the sine wave from that spot so the critical loads to not see much of a transient”), ¶ 83 (controller reducing *frequency* to synchronize converters); ¶ 87 (in transitioning from grid mode, synchronizing power converters). For this element, Dr. Collins does not rely on any of the foregoing synchronization control of the power converter because it does not disclose any power converter being “configured to adjust an *output power* as a function of a frequency of the alternating current voltage source.” *See* EX1003, ¶290.

114. Instead, Dr. Collins relies on a different disclosure of Somani at paragraphs 90 and 95. Just as Somani’s synchronization control disclosure was clear that it was the power converters being controlled, it is equally clear that Somani does not disclose the power converters being controlled in different scenario described in paragraphs 90 and 95. Instead, the functionality of paragraphs 90 and 95 clearly discloses a different component of the system, the “renewable power resource.” EX1007, ¶¶ 90, 95; *see also* my discussions in Section VI.A-B, which describes power converters and energy sources as being different components. A POSITA would have understood that in any system, including Somani’s system, the energy sources and power converters are different system components with different functions.

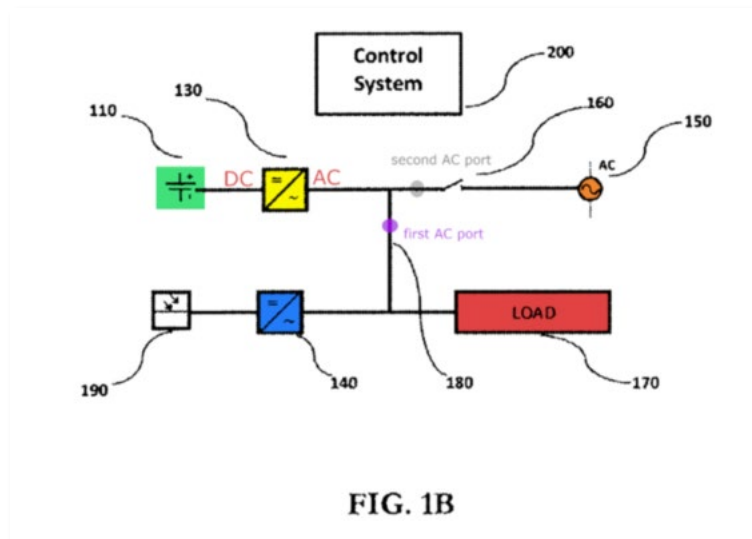
115. In Somani’s paragraphs 90 and 95, the disclosures recognize that in some off-grid instances, a battery may be overcharged. *Id.*, ¶90. To help prevent this, Somani discloses a controller that may perform control “in addition” to the synchronization control. *Id.* Specifically, Somani discloses controlling the “renewable power resources” and **not** the power converter. In my opinion Dr. Collins is thus incorrect in his summary of Somani. He opines that “the master power converter may ‘trip[] the renewable resource [e.g., PV inverter 140 and solar array 190] offline ...’” (EX1003, ¶ 290), with the bracketed insert of the quote being added in the declaration and not present in Somani. *See* EX1007, ¶90.

116. However, Dr. Collins’ bracketed additions to the quote are not correct. Paragraphs 90 and 95 of Somani do not mention a power converter. Instead, Somani discusses commanding the “renewable resource.” *Id.* ¶ 90. And Dr. Collins does not explain or provide any citation to why Somani’s “renewable resource” would mean “PV inverter 140 and solar array 190.”

117. A POSITA would understand the renewable resource in this example to be the solar array, but not a power converter, which is a separate component that does not source any energy. Somani clearly differentiates a power source, the converter and the grid: “a power converter, such as the power inverter, for converting power between a power source and the grid.” EX1007, ¶4. The power source clearly does not include the power converter, as the power converter is

between the power source and the grid. Indeed, Somani is careful to explain that the “renewable resource” is the solar panels (an array of panels, or a solar array) or a wind turbine. *Id.*, ¶4. Somani likewise explains that a power converter is a different component that converts power from a renewable resource. *Id.* This is also how a POSITA would have understood the terms and Somani’s disclosure in the 2015 period, as I discuss above in Section VI.

118. In my opinion, Dr. Collins improperly treats the separate components together as one: Somani explicitly teaches that the PV inverter and solar array are two distinct components. EX1007, ¶4; *see also* EX1003, ¶28 where Dr. Collins’ declaration includes a modified Fig. 1B separately coloring power converter 140 from solar array 190:



119. In my opinion, Somani is clear that only the solar array is the renewable resource, not the separate “PV inverter,” which is a power converter. Dr. Collins offers no explanation to the contrary. *See* EX1003, ¶290.

120. I also note that earlier in his declaration, Dr. Collins recognized that the “renewable resource” is “solar panels,” and not the separate power converter. *Id.* ¶91. It is thus unclear why Dr. Collins opines to the contrary in his claim-by-claim analysis.

121. In my opinion, a POSITA would understand Somani to be clear that the power converter 140 does not “adjust an output power as a function of a frequency of the alternating current voltage source.” Instead, Somani discloses that the separate “solar array 190,” what Somani discloses as a “renewable energy source,” (which is not the alleged current-source inverter) is configured to trip itself offline in response to communications from the controller.

122. ***Second***, similar to the deficiencies I discuss above in relation to the Serban reference, Somani likewise fails to teach or disclose the alleged current source inverter—or any other component of the system—being configured to adjust an output power ***as a function*** of frequency. In my opinion, a solar panel tripping offline does not disclose is not an adjustment of output power as a function of frequency. While Dr. Collins relies on Somani as disclosing that the solar panels are tripped offline “by changing the microgrid frequency beyond the

nominal frequency,” Dr. Collins does not explain how the frequency behaves in the nominal frequency, including whether each frequency maps to a single output power.

123. **Third**, in my opinion, Somani’s controller is not configured to “regulate a power flow of *the current-source inverter* by adjusting the alternative current voltage source.” As I discuss above, Somani’s alleged controller merely instructs the solar panel to “trip” or remove itself from the system. While tripping the solar array offline may cut off power going to the power converter, the power converter is nevertheless still converting 100% of the power it receives—there is no regulation of power flow.

D. The Additional References Do Not Cure the Deficiencies of Somani.

124. In my opinion, the additional references that Dr. Collins combines with Somani do not cure the deficiencies of Somani. In the section above, I discuss three deficiencies. While Dr. Collins opines that Somani, alone, renders claim 1 anticipated, he does not opine that Somani renders obvious those two claim limitations. *See* EX1003, ¶321. Instead, Dr. Collins merely opines that because he believes that Somani anticipates the elements, it also renders them obvious. *Id.*

125. With respect to the additional references, Matan, Wilhelm, and Wu, Dr. Collins offers no opinion that they cure any of the deficiencies that I identified above.

IX. CONCLUSION

126. This declaration reflects my opinions as currently held. However, my analysis may continue such that I may consider additional information that may result in additional observations.

127. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further 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.

Executed this eighth day of May, 2024, at Raleigh, North Carolina.



Dr. David S. Ricketts