

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA, INC.,
Petitioner,

v.

RELINK US LLC,
Patent Owner.

Case No. IPR2024-00389
U.S. Patent No. 9,793,755

DECLARATION OF EDWARD R. COLLINS, JR., PH.D.

U.S. PATENT NO. 9,793,755 (CLAIMS 1-20)

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EXHIBIT LIST

EXHIBITS FILED BY PETITIONERS	
Ex-1001	U.S. Patent No. 9,793,755 (“’755 Patent”)
Ex-1002	File History of the ’755 Patent
Ex-1003	Declaration of Dr. Randy Collins
Ex-1004	Curriculum Vitae of Dr. Randy Collins
Ex-1005	U.S. Patent Application Publication No. 2011/0043160 (“Serban”)
Ex-1006	U.S. Patent Application Publication No. 2010/0208501 (“Matan”)
Ex-1007	U.S. Patent Application Publication No. 2017/0005473 (“Somani”)
Ex-1008	U.S. Patent Provisional Application 62/188,278 (“’278 Provisional”)
Ex-1009	U.S. Patent No. 5,500,561 (“Wilhelm”)
Ex-1010	Solectria PVI 6500-7500 Installation and Operation Manual (“PVI”), available at https://web.archive.org/web/20140711094535mp_/http://www.solen.com/manuals/PVI_6500-7500_Manual.pdf

Ex-1011	IEEE Standard 1547-2003, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems, The Institute of Electrical and Electronics Engineers, Inc. (July 28, 2003)
Ex-1012	File History of Somani
Ex-1013	U.S. Patent No. 7,787,267 (“Wu”)
Ex-1014	Internet Archive Affidavit and Exhibits
Ex-1015	U.S. Patent No. 8,159,178 (“Serban patent”)
Ex-1016	<i>Relink US LLC v. Tesla, Inc.</i> , Civ. No. 1:23-cv-01093-DII (W.D. Tex., filed Sep. 16, 2023), Dkt. No. 35 (Order Granting Joint Motion for Extension of Time to Take Venue Related Discovery and Complete Briefing on Defendant’s Motion to Transfer Venue)
Ex-1017	Teodorescu, Remus, Marco Liserre, and Pedro Rodriguez. <i>Grid converters for photovoltaic and wind power systems</i> . John Wiley & Sons, 2011. (excerpted)
Ex-1018	Wayback printout – Eversol TL1500, Residential, Solar Inverters (“Eversol TL1500”), available at https://web.archive.org/web/20140404041325/http://www.zeversolar.com/products/product-detail/product/detail/en-eversol-tl1500/
Ex-1019	Webpage - Solectria Solar PV Inverters and PV System Products, Discontinued Products, available at https://solectria.com/support/documentation/
Ex-1020	TMS320F2812 DSP Manual, available at https://www.ti.com/lit/ds/symlink/tms320f2812.pdf?ts=1705102

	438423&ref_url=https%253A%252F%252Fwww.google.com%252F
Ex-1021	Webpage - PVI 3000-7500, available at https://solectria.com/support/documentation/discontinued-products/pvi-3000-5300/
Ex-1022	PVI, available at https://solectria.com/site/assets/files/1493/pvi_6500-7500_manual.pdf
Ex-1023	Yilmaz, Murat, and Philip T. Krein. “Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles.” <i>IEEE Transactions on Power Electronics</i> 28.5 (2012): 2151-2169.
Ex-1024	Schneider Electric Xantrex XW6048 Hybrid Inverter-Charger Operation Guide, available at https://www.solar-electric.com/lib/wind-sun/XW-manual.pdf
Ex-1025	Bouloumpasis, Ioannis, et al. “Current harmonics compensation in microgrids exploiting the power electronics interfaces of renewable energy sources.” <i>Energies</i> 8.4 (March 25, 2015): 2295-2311.
Ex-1026	Miret, Jaume, et al. “Selective harmonic-compensation control for single-phase active power filter with high harmonic rejection.” <i>IEEE Transactions on Industrial Electronics</i> 56.8 (2009): 3117-3127.
Ex-1027	U.S. Patent Application Publication No. 2008/0122293 A1
Ex-1028	<i>Radiant Vision Systems v. Admesy</i> , 1:21-cv-01115 (WDTX), Dkt. No. 27

Ex-1029	<i>Katana Silicon Technologies LLC v. GlobalFoundries, Inc.</i> , 1:22-cv-00852, Dkt. No. 39
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I, Edward R. Collins, Jr., Ph.D., declare as follows:

I. ENGAGEMENT

1. I have been retained by Tesla, Inc. (“Tesla” or “Petitioner”) in connection with the above-captioned petition for *Inter Partes* Review (“IPR”) of U.S. Patent No. 9,793,755 to Paul Garrity and Aaron Jungreis (“the ’755 Patent,” Ex-1001). I understand that the ’755 Patent is currently assigned to Relink US LLC (“Patent Owner” or “PO”).

2. I have been asked by Petitioner to offer opinions regarding the ’755 Patent, including a review of claims 1-20 (which I may refer to subsequently as the “challenged claims”) in view of certain prior art. This declaration sets forth the opinions I have reached to date regarding these matters.

3. I am being compensated by Petitioner at my standard hourly consulting rate for my time spent on this matter. My compensation is not contingent on the outcome of the IPR or on the substance of my opinions.

4. I have no financial interest in Petitioner or Patent Owner.

II. PROFESSIONAL BACKGROUND

5. My qualifications are set forth in my curriculum vitae, a copy of which is attached as an Exhibit 1004 (Ex-1004). Exhibit 1004 also includes a list of my publications and the cases in which I have testified at deposition, hearing, or

trial within the past four years. A few aspects of my professional background (which are also in my curriculum vitae) are discussed below.

6. I hold a B.S. degree in Electrical Engineering from North Carolina State University (1984) and a Ph.D. in Electrical Engineering from the Georgia Institute of Technology (1989).

7. I am currently the Dean of the College of Engineering and Technology at Western Carolina University, and a tenured full professor. Concurrently, I am a Professor Emeritus of Electrical and Computer Engineering at Clemson University. From 1989 – 2022, I was a faculty member at Clemson, beginning as an Assistant Professor and subsequently being promoted through the ranks of Associate and full Professor. Additionally, I have served in a variety of administrative roles concurrently with my faculty duties, all related to engineering, including Associate Dean for the College of Engineering and Science (2008-2014); Executive Director of Academic Initiatives (2014-2016) in the College of Engineering and Science; Interim Associate Vice President – Charleston (2016-2019); Interim Executive Director of the Energy Innovation Center (2019-2021); and Technical Advisor of the Energy Innovation Center (2021-2022). In these roles, I routinely publish scientific papers and present the results of my research in the field of electrical engineering.

8. I am a named inventor on three issued patents at the United States Patent and Trademark Office in the field of electrical engineering. I have taught thousands of students in undergraduate electrical engineering courses. Additionally, I have taught hundreds of graduate students (at both the Master's and Ph.D. level) and have supervised the research and thesis/doctoral work for more than 30 graduate students. My teaching at both the undergraduate and graduate level as well as my research activities have focused on the circuitry and systems for the delivery and control of electrical power for various applications, particularly as relates to electrical power, energy conversion, electric motor control and electric power system grid compatibility. I have taught numerous courses at the undergraduate and graduate level on power electronics and power conversion, with applications for batteries, PV systems, and electric machines (motors/generators) and systems such as chargers and uninterruptible power supplies. Over the years, I have taught numerous seminars and workshops to working professionals on similar topics, including power conversion, electric grid integration and compatibility, protection, control, and power quality. Specifically, topics have included design, operation, and analysis of power converters (inverters, dc/dc converters, and rectifiers). Often, the focus of these workshops has been on systems incorporating these converters and the interaction of these systems with the electric power grid and loads. Topics include considerations such as harmonic

distortion and filtering, reactive power control and power factor, and ride-through during grid faults.

9. The research by my graduate students under my supervision has focused on power and energy conversion, electric power quality, and grid integration, as described above. This work resulted in many theses/dissertations and research papers published in journals and conference proceedings on these aforementioned topics.

10. As part of a large research effort, we developed a hardware-in-the-loop electric grid emulation system that could emulate electric grid in real time, including nominal (steady-state), transient and harmonic distortion conditions. One of my graduate students and I (along with another inventor) were issued a patent for an aspect of this system: US Patent No. 9,651,629, “Hardware-In-The-Loop Grid Simulator System and Method.” This grid emulation system was used for testing and evaluating grid-tied systems, such as battery systems and photovoltaic inverters. For several years, I managed/directed this work, which included standards testing at the direction of industry, such as those included in UL 1741 and IEEE 1547.

11. I am a senior member of the Institute of Electrical and Electronics Engineers (“IEEE”) and the IEEE’s Standards Association (“SA”), which are the leading technical society and standards setting bodies, respectively, for electrical

engineering in the United States. I have been an active member of several committees writing international standards for power quality. I am the past chair of IEEE Standard 1159-2009 (Recommended Practice for Monitoring Electric Power Quality). I also have been a member of multiple IEEE working groups and standards committees, as well as a member of several IEEE societies, including the Power and Energy Society, the Aerospace and Electronic Systems Society, the Power Electronics Society, the Industry Applications Society, and the Industrial Electronics Society.

12. I have presented full papers at IEEE conferences more than 30 times and served as a technical paper reviewer for the IEEE and other professional publications and conferences for many years.

13. I am a registered professional engineer in the state of South Carolina from 1993 to the present, and previously served on the South Carolina's Board of Registration for Professional Engineers and Surveyors Portfolio Review Committee, which is a state-level technical review panel for certain types of applicants seeking engineering licensing applications.

14. For many years, I have served on the National Council of Examiners for Engineering and Surveying (NCEES) committees for professional engineering licensing examinations. These committees develop licensing examinations for professional engineering registration for engineers nationwide. Currently, I serve

as a member of the Electrical Engineering module and am the past Chair of the Fundamentals of Engineering Examination committee.

15. I have won many awards for my academic work in the engineering field, including being named Provost Fellow at Clemson University for the 2013-2014 academic year and receiving the university's Elliott Award for Off-Campus, Continuing and Distance Education in 2015 for my efforts in engineering education for traditional students and working professionals. In 2012, I was named an American Council on Education (ACE) Fellow.

16. Two prize paper awards in recognition of my research contributions include the IEEE Power and Energy Society Prize Paper Award for Best Transactions Paper, July 2009 for "Voltage Sags and Distributed Synchronous Generator Control Response: A Case Study." This paper involved a grid-tied electrical generator acting as a distributed energy resource (DER) and its response to an AC grid fault. Another prize paper awarded to a PhD student under my supervision was "Harmonic resonance repercussions of PV and associated distributed generators on distribution systems," S. S. Rangarajan, E. R. Collins, and J. C. Fox, at the 2017 IEEE North American Power Symposium (NAPS). The topic of this paper focused on harmonic distortion caused by photovoltaic inverters in a power system.

17. For decades, I have served as a consultant to a broad range of industry, electric utilities, aviation, and attorneys on issues related to power systems, power electronics, power conversion, power supplies, power distribution, electric motors and motor control, industrial automation, and adjustable speed drives, with applications to systems such as PV, batteries, and wind energy.

18. Through my educational background, research, teaching, and consulting duties, I have developed a thorough understanding of power systems, power electronics, electric motors and motor controllers, electric grid integration and compatibility, and electric power quality, including from the perspective of one skilled in the art in time period at issue (which I discuss more below).

19. Additional information regarding my background, qualifications, publications, and presentations is provided in my CV, which I understand has been submitted as Exhibit 1004.

III. MATERIALS REVIEWED

20. In forming my opinions, I have reviewed the '755 Patent and considered each of the documents listed in the Exhibit List above and all other materials discussed herein. In reaching my opinions, I have relied upon my experience in the field and also considered the viewpoint of a person of ordinary skill in the art as of the time of the earliest claimed priority date of the '755 Patent, *i.e.*, July 28, 2015. As explained below, I am familiar with the level of a person of

ordinary skill in the art (“POSA”) regarding the technology at issue as of that time, and all of the opinions I have formed have been assessed from the perspective of the POSA.

IV. DESCRIPTION OF THE RELEVANT TIMEFRAME, THE RELEVANT FIELD, AND A PERSON OF ORDINARY SKILL IN THE ART

21. I understand that the ’755 Patent was filed on July 28, 2015 and does not claim priority to any earlier applications. Thus, for purposes of my analysis, I have treated the effective filing date for claims 1-20 of the ’755 Patent as July 28, 2015. I reserve the right to update my analysis should Patent Owner assert a different priority date.

22. I have received and understand the specification, claims, and file history of the ’755 Patent.

23. In my opinion, a POSA at the time of the effective filing date of the ’755 Patent 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. And, as I noted above, my opinions presented herein are as viewed through the eyes of a POSA prior to July 28, 2015.

24. I also note that the POSA would have been familiar with the aspects that the ’755 Patent admits as being part of the prior art, including:

- Prior-art systems of Figures 1 and 2;
- Providing battery power to the grid (Ex-1001, 5:42-47);
- Gradually reducing output power of grid-tied photovoltaic inverters when the grid frequency deviates beyond a set limit (*id.*, 1:28-30);
- Frequency relays which monitor the voltage and the frequency of the grid and disconnect all photovoltaic inverters from the grid if the voltage or frequency deviates beyond a predetermined range (*id.*, 1:31-36); and
- Using local battery or other storage for local peak power reductions. (*id.*, 1:66-2:2).

V. **TECHNOLOGY BACKGROUND**

A. **Introduction to Electric Systems**

1. **Electric power sources**

25. Generally, electrical power systems can be supplied by two different types of configurations, DC or AC. The term “DC” means direct current and the term “AC” means alternating current. It is important to understand that these terms generally refer to the nature of the electrical voltage in the system, and not necessarily the current.

26. Electrical voltage can be viewed as analogous to water pressure in a plumbing system. A water pipe can have pressure within it, without having any

flow of water. If a valve is turned on, water flow can occur. Similarly, in an electrical system, the pressure is provided by the voltage, and if a path is provided, there can be a flow of electrical current. The electrical voltage is analogous to pressure and the electrical current is analogous to flow. The presence of voltage does not necessarily imply that a current is flowing.

27. In a DC system, the voltage generally does not alternate in polarity. A DC source can be configured as a source of electrical voltage (where the voltage is supplied at a certain level or controlled in a certain way). Most DC sources are voltage sources, and sometimes the voltage output of those voltage sources can be controlled, and in others it is fixed. In a DC voltage source system, the current flowing from the source is not controlled by the source. Instead, the current is determined by the circuit and system into which the source is connected to. A battery is an example of a DC power source that provides a voltage, and would be considered a “DC voltage source.”

28. Conversely, a DC current source is a power source where the current flowing from the source is controlled (or regulated), and the voltage is not controlled by the source. In this case, the voltage is dependent upon the system into which the source is connected. Generally, DC current sources are more complicated than a simple battery, and require many components and a dedicated control system.

29. An alternating current (AC) system is one in which one or more of the voltage and current attributes alternate in polarity. While both the voltage and current both generally alternate in such a system, it is possible that only one of the parameters alternates. Most often, it is the voltage that alternates and is designed to have characteristics that are at specific values with corresponding tolerances on these characteristics. In a linear AC system, the voltages and currents will ideally have a sinusoidal shape that alternates around zero.

30. The electrical power grid (i.e., the electric utility system) is an AC system. The voltage of the AC power grid generally has specific design values with tolerances (e.g., $\pm 5\%$) and the rate at which the system alternates in polarity (i.e., the frequency) has tolerances as well (e.g., ± 0.5 cycles/second or hertz (Hz)).

31. An electric load is a term used for a consumer of electrical power. A load can be a single device (such as a refrigerator), could be a collection of devices (such as a house or apartment building), or an entire network (such as an electrical grid that is receiving power).

32. In a power system, the sources and loads are interconnected to each other through a common set of electrical conductors (e.g., wires) that may be referred to as a bus. Another term used for this interconnection is the “power of common connection” or PCC. The components or systems connected to the PCC all will have the same voltage and frequency in a typical AC power system.

33. Electrical circuits and systems are interconnected using electrical conductors. Often, switches are used in these systems so that different parts of the systems can be readily connected or disconnected from each other on the bus or at the PCC. There are different types of switches, including a “contactor” or “relay.” Sometimes these switches are controlled by another system and not manually. Sometimes a relay may control another switch, and relays may incorporate sensing to control switches or systems when certain attributes exceed thresholds. Switches used to transition power from one place to another and/or isolate portions of a system may be called “transfer switches.” These are generally controlled by a system to prevent inadvertent switching interconnections that could be dangerous. Protective devices such as circuit breakers and fuses are examples of switches that operate in the case of an electrical “fault” or failure that usually results in an excessive current.

34. In an electrical system, there must be a balance of the power consumed by the loads and the power that is delivered by the sources. (There can be multiple sources and loads interconnected within a system simultaneously.) In an AC system where this balance is not maintained, the electrical frequency attribute is usually affected. Excess power in the system tends to increase the frequency and vice versa. Protective relays (such as voltage-frequency relays) can be used to perform protective functions if a variable such as voltage or frequency

exceeds a threshold. A control system can perform these same protective relay functions. For example, if the frequency becomes too high due to a power imbalance somewhere in the system (more power being sourced than is being consumed), a control system might decrease the power output of an inverter which in turn would reduce the power imbalance and the frequency excursion.

2. Electric power converters

35. AC and DC power sources can be created using various techniques, including from electronic devices. Some types of power sources are created by electronic systems called “power converters.” Power converters are sometimes called power supplies. Power converters often create a desired electrical source from another source that provides electrical power in a different form. For example, a battery that provides DC power can be converted into an AC power source using a power converter. Power converters that create AC from a DC source are called “inverters” since they are inverting the polarity of the DC source into an AC source. The inverter can be controlled such that its output attributes are controlled to be specific values. The inverter can create a controlled voltage with a controlled frequency, and those inverters are known as “voltage source inverters.” An inverter that is controlled to create a controlled AC current with a controlled frequency is called a “current source inverter.” The DC source for inverters could be, for example, a battery or a photovoltaic (PV) solar cell array.

36. A power converter that converts AC power into DC power is called a “rectifier.” Rectifiers can be uncontrolled, and basically convert the AC that is supplied to them into DC, according to the system conditions and configuration. A controlled rectifier contains electronic components and controls to enable control of the rectification process, therein enabling some control of the power that is passing through the rectifier. Another well-known configuration is an “active rectifier,” which has components and controls that enables more precise control of specific attributes of the voltage and/or current that is passing through the rectifier. Such systems could be used in battery charging systems where high precision control of the current and voltage supplied to the battery is needed for performance and protection of the battery, as well as quality and performance attributes of the current and voltage flowing into and out of the rectifier.

37. Some power conversion systems might require bidirectional flow of power. In other words, a battery charger that transfers electric power from an AC utility source to the DC battery (rectification) might also be utilized for discharging the battery into the AC utility system (inversion). Thus, a power converter might operate bidirectionally, and the same system could be used as both a rectifier and an inverter, with the direction of power flow determining the operating mode. (In other words, if the battery is charging, the bidirectional power converter is

operating as a rectifier, and if the battery is discharging and supplying the grid, the bidirectional power converter is operating as an inverter).

38. Sometimes, power conversion systems are interconnected. For example, a rectifier might be connected to an inverter, so that one AC system could be interconnected to another AC system where the attributes such as frequency or voltage might not match each other. If the rectifier in such a system is an active rectifier, the active rectifier is called an “active front end” or AFE, which implies that the “front end” of the power converter is a rectifier connected to the AC utility grid (or an AC power source), and such systems can control the attributes and quality of the power that is consumed from AC system. These systems are often bidirectional.

3. Electric symbols

39. To facilitate understanding of electric diagrams discussed in this declaration, I provide the following table that explains the meaning of common symbols in the electric field, consistent with IEC 60617, which includes graphical symbols for use in electrotechnical diagrams published by International Electrotechnical Commission, a well-known international standard organization.

Symbols	Meaning
=	Direct Current (DC)
~ or ≈	Alternating Current (AC)

	AC Voltage Source
	Battery or DC Voltage Source
	AC/DC Converter or DC/AC Inverter

B. Grids and microgrids

40. A utility grid is generally an AC system that essentially has a fixed voltage and frequency. It is typically modeled by engineers as an ideal voltage source. When sources of electrical power are connected to the grid (usually through an inverter), they are called “grid-tied.” Their capacity is usually relatively small compared to the grid, therefore they cannot readily alter the grid’s frequency and voltage. As a result, inverters in these systems are often controlled as current sources so that they supply the power to the grid via the current they produce; the grid establishes the voltage and frequency. Grid-tied inverters are sometimes called “grid following” converters, since their output currents follow the voltage and frequency of the grid. Another related term is called “grid-connected.”

41. Since the utility is supplying the voltage and frequency of the grid and the bus (e.g., at the PCC), the controller of the current source inverters relies on the grid in order to operate. If the grid faults or fails, and the voltage and/or frequency

fall out of tolerance, current source inverters are designed to trip off or disconnect.

Micro-inverters used in some PV systems are examples of inverters that would have this behavior since they are designed as current source inverters.

42. Some inverters, particularly those connected to larger energy sources such as batteries, can operate as voltage source inverters. In this case, they can be used to provide an AC voltage and frequency to a bus. For an uninterruptable power supply system, a voltage source inverter is needed in order to provide a source of voltage and frequency to the bus (and loads) if the utility fails. Some power converters can be used in multiple modes by changing how they are controlled. For example, a bidirectional converter connected to a battery might have its active rectifier used to charge a battery from the AC utility (grid) bus or as a current source inverter to supply power to the AC utility bus during normal conditions. And during grid failure or fault conditions on the AC grid, switches will disconnect the grid and the loads will be supplied from the bidirectional converter. In this case, the battery will supply the power for the grid, and the bidirectional converter will operate as an inverter, and its controls will transition from a controlled current source (i.e., a current source inverter) to a controlled voltage source (i.e., a voltage source inverter). The bidirectional converter becomes the source of voltage and frequency for the system. This type of system is known as a “grid forming” converter. This configuration where a smaller

network (e.g., microgrid) is disconnected from a utility grid and powered from sources, such as grid forming inverters, is also known as an “island” condition. If microinverters are connected to this bus in an island condition, they can operate as current source inverters using the voltage and frequency references provided by the bidirectional converter acting as a grid-forming converter (i.e., voltage source inverter). The loads can be unaffected by these transitions if the controls are implemented properly. In other words, the loads are provided with an uninterruptible supply of power, i.e., from a UPS. *See also* Ex-1017, pp. 20-27.

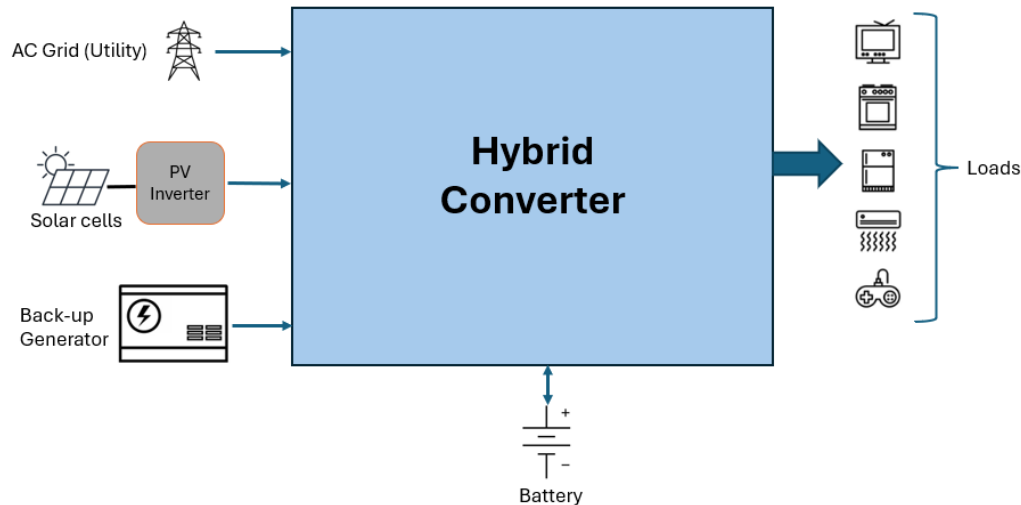
43. As I described above, a microgrid is small grid network, comprised of sources and loads, that is disconnected (or disconnectable) from a larger AC utility grid. When disconnected, the microgrid is considered an island. Sometimes, these microgrid systems may have distributed sources of electrical power (i.e., a plurality of smaller sources instead of large centralized generation). Since they tend to be smaller and can be separated from a large AC utility grid, and because they may have multiple sources of electric power from devices such as inverters, they may have special considerations for protection and control. Standards are in place, such as IEEE 1547, that describes the operation of converters during islanding conditions, among others. IEEE Standard 1547 was first introduced in 2003. *See* Ex-1011.

C. Grid-tied Photovoltaic System

44. A Grid-tied Photovoltaic (“PV”) or Solar system, as its name suggests, is a PV system that maintains a connection to the electricity grid. These systems generate electricity from the sun, which can be used to power the load or export to the grid. If the home or business requires more power than what is available from the solar panels, the additional power can be imported from the utility grid.

45. However, in a pure grid-tied PV system that uses current source inverters, if the grid fails, the solar panels and their inverters, which can only provide current, cannot provide controlled voltage to the load. Ex-1001, 1:42-44. There are techniques to keep necessary appliances like refrigerators and air conditioners powered up during grid outages, including having a backup generator available or by adding battery backup to your grid-tied system, which changes a pure grid-tied PV system into what is commonly known as a hybrid solar system or hybrid PV system. This comprises a common type of microgrid.

46. A typical hybrid solar/PV system is depicted below:



47. When the AC grid is normal, the system is in grid-tied mode, where the hybrid converter receives AC power that (1) powers the loads and (2) is converted to DC power to charge the battery. The DC power generated by the solar panels may also be used to power the loads via the PV inverter. If the AC grid fails, the system transitions into islanded mode, where the PV inverter and/or the battery become the power sources for the loads. The back-up generator is optional, which could be a “genset” (a combustion engine-driven generator) that can provide additional AC power if needed.

1. Solar panels

48. A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that produce excited electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Generally, power conversion devices are needed to convert the

DC output of the panels into power that is compatible with the intended use. Solar panels are also known as solar cell panels, solar electric panels, or PV modules.

The solar panel is an essential component of any PV system.

49. Solar panels are usually arranged in groups called arrays or systems.

A basic PV system consists of one or more solar panels, a PV inverter that converts DC electricity to alternating current (AC) electricity, and sometimes other components such as controllers, meters, and trackers.

2. PV inverter

50. As I mentioned above, a PV (or solar) inverter is a type of power converter which converts the variable direct current (DC) output of a photovoltaic solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid through a grid-tie, or used by a local, off-grid electrical network (islanded system).

51. Photovoltaic inverters include grid-tied inverters and stand-alone inverters. Grid-tied inverters act as a current source and can only be used to provide power into a bus connected to established utility grid. Grid-tied inverters are designed to shut down automatically upon loss of utility (grid) supply, for safety reasons. They do not provide backup power during utility outages.

52. Stand-alone inverters are used in stand-alone power systems (no utility grid) where the inverter draws its DC energy from batteries charged by

photovoltaic arrays. An inverter in a stand-alone system will typically act as a voltage source inverter. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source when available. These systems can act as a voltage source and can provide power to a load in the absence of an electric utility grid. “As an important source of distributed generation (DS) the PV systems need to comply with a series of standard requirements in order to ensure the safety and the seamless transfer of the electrical energy to the grid.” Ex-1017, p. 9. Exhibit 1017 “introduce[s] the most relevant standard requirements from the main market areas.” *Id.*

3. Hybrid Inverter or hybrid converter

53. The hybrid inverter is configuration on a power converter that is comprised of several functions, including a grid-tied inverter. It is a system that has been widely used in grid-tied PV systems, wherein the hybrid inverter is created by combining a solar inverter and a battery charger/inverter into a single unit. It can (1) take DC power from the solar panels and invert it to AC power that is usable in a home or export to the grid, and (2) take AC power from the grid and use it to power the AC load and charge DC batteries. In other words, a hybrid inverter is able to perform both DC to AC and AC to DC bidirectional conversion.

54. Typically, a system that can perform DC to AC conversion is called an inverter, such as the PV inverters I discussed above. Some of these same

systems can perform rectification. Thus, a more generic term often used is “converter.” Therefore, hybrid inverters are also sometimes called hybrid converters.

55. Serban (Ex-1005) was filed by Xantrex Technology Inc. and mentions an Xantrex hybrid converter: “A suitable hybrid converter includes a 6 kVA XW6048 converter module by Xantrex Technology, Inc.” Ex-1005, ¶18. Exhibit 1024 is an operation guide for this XW6048 converter, which I downloaded from Xantrex’s website at <https://www.solar-electric.com/lib/wind-sun/XW-manual.pdf>.

56. As shown in Exhibit 1024, this operation guide was publicly accessible at least as early as 2012. Ex-1024, p. 4. As also shown in Exhibit 1024, the XW6048 hybrid converter is also called “hybrid inverter/charger,” which confirms my description of hybrid inverters above.

57. The XW6048 hybrid inverter/charger comprises a battery charger that charges the batteries in a specialized manner, including a multistage charging process where the current and voltage are precisely controlled to the battery. The charging process is available “[w]henver qualified AC power is present at the inverter’s input.” Ex-1024, p.47. In this case, the power conversion system of the XW6048 is acting in rectification mode (AC to DC). *Id.*, pp. 46-53. The charger function of the XW6048 hybrid converter controls the battery charging for capacity and battery health. The same power conversion system of the XW6048 can be

used to transfer the battery's energy to the AC bus through an inversion process.

The energy to the bus is precisely controlled for attributes such as voltage, current, and frequency, over a range of the DC battery voltages as the state of charge of the battery changes. The inverter can support many grid functions, and support the loads if the AC grid fails. *Id.*, pp. 55-62. As described by the XW6048 Operation Guide (Ex-1024), the hybrid converter is bidirectional, acting as both an inverter (DC to AC) when discharging the battery and a rectifier (AC to DC) when charging the battery. Notably, the electrical specifications of the XW6048 are the same for all modes of operation (inversion or charging), as shown in Table A-1. *Id.*, p. 102. The AC "Waveform" is listed as "True Sine Wave" and the "Total Harmonic Distortion" is listed as "< 5% at rated power", without any notation regarding the mode of operation (inversion or charging/rectification). *Id.*, p. 102. This implies to a POSA that the same inverter system is being used for charging, as an active rectifier or active front end.

D. Islanding and Anti-Islanding

58. At times, a power failure of the utility grid or other service interruption will occur that causes the loads to be disconnected from and not receive power from the utility grid. However, backup power systems are available where a distributed generator (DG), such as an engine-driven generator, can provide power to the loads. In this situation, the DC generator will be

disconnected from the faulty utility grid, but will energize the portion of the utility grid connected to the loads. This condition, known as “islanding,” occurs when a load or a portion of the utility grid becomes isolated from the rest of the grid yet continues to receive power from a generator or other source of AC power.

59. “Islanding” can be problematic because, for example, (1) utility workers sent out to repair the utility grid may not be aware that the portion of the utility grid is receiving power from a DG even though the utility grid itself is not powered. Serious injury or death may occur should a worker make contact with a portion of the energized utility grid; (2) the utility has little or no control over the voltage or frequency supplied to an islanded location which creates the possibility of damage or potential hazards in the island; (3) restoration of normal service is problematic when the fault is cleared; and so on. Ex-1027, ¶¶3-6.

60. To solve this issue, there have been many systems developed that attempt to quickly and effectively detect islanding and remove electrical sources (e.g. generators or inverters) from systems that should not be energized. These controls are called “anti-islanding” systems.

61. One key component in a hybrid PV system that is capable of detecting islanding or grid faults is the inverters. Many solar inverters are designed to be connected to a utility grid, and will not operate when they do not detect the presence of the grid. They contain special circuitry to precisely synchronize with

the voltage, frequency and phase of the grid. When a grid is not detected, grid-tie inverters will not produce power to avoid energizing an islanded or faulted system, which can cause safety issues.

62. For example, Xantrex XW6048 hybrid converter, which was mentioned in Serban, has islanding protection function, which “makes sure no one working on the utility grid is harmed by a distributed energy source, such as the Xantrex XW Series Inverter/Charger” and “prevents loads connected to the Xantrex XW Series Inverter/Charger from being damaged by fluctuating utility grid input.” Ex-1024, p. 16. As mentioned in this operation guide, islanding is regulated by safety regulations “such as IEEE 1547 and UL 1741 in North America” (*id.*), both of which are mentioned in Serban.

63. IEEE 1547-2003 is the IEEE Standard for Interconnecting Distributed Resources with Electric Power System, published in 2003. Ex-1011. IEEE 1547-2003 “includes general requirements, response to abnormal conditions, power quality, islanding, and test specifications and requirements for design, production, installation evaluation, commissioning, and periodic tests.” *Id.*, p. 3. “The stated requirements are universally needed for interconnection of distributed resources (DR), including synchronous machines, induction machines, or power inverters/converters and will be sufficient for most installations. The criteria and requirement are applicable to all DR technologies...” *Id.* For example, in Section

4.2.4 titled “Frequency,” this standard requires that “[w]hen the system frequency is in a range given in Table 2 [below], the DR shall cease to energize the Area EPS within the clearing time as indicated,” where EPS is electric power system (*i.e.*, the grid). Ex-1011, p. 19.

Table 2—Interconnection system response to abnormal frequencies

DR size	Frequency range (Hz)	Clearing time(s) ^a
≤ 30 kW	> 60.5	0.16
	< 59.3	0.16
> 30 kW	> 60.5	0.16
	< {59.8 – 57.0} (adjustable set point)	Adjustable 0.16 to 300
	< 57.0	0.16

^aDR ≤ 30 kW, maximum clearing times; DR > 30 kW, default clearing times.

Ex-1011, p. 20. As another example, in Section 4.3.3 titled “Harmonics,” this standard requires that “[w]hen the DR is serving balanced linear loads, harmonic current injection into the Area EPS at the PCC shall not exceed the limits stated below in Table 3.” *Id.*

Table 3—Maximum harmonic current distortion in percent of current (I)^a

Individual harmonic order <i>h</i> (odd harmonics) ^b	<i>h</i> < 11	11 ≤ <i>h</i> < 17	17 ≤ <i>h</i> < 23	23 ≤ <i>h</i> < 35	35 ≤ <i>h</i>	Total demand distortion (TDD)
Percent (%)	4.0	2.0	1.5	0.6	0.3	5.0

^a I = the greater of the Local EPS maximum load current integrated demand (15 or 30 minutes) without the DR unit, or the DR unit rated current capacity (transformed to the PCC when a transformer exists between the DR unit and the PCC).

^b Even harmonics are limited to 25% of the odd harmonic limits above.

Ex-1011, p. 21. *See also* description of IEEE 1547, as well as other international standards for PV systems in Exhibit 1017. Ex-1017, pp. 10-19.

E. Harmonic Distortion Correction

64. Electronic systems, including inverters, rectifiers, and many types of loads, can alter the smooth sinusoidal shape of the voltage and flow of current. When this happens, the voltage and/or current are characterized as having “harmonic distortion.” The term “harmonics” refers to a mathematical means of modeling the shape of the voltage and/or current relative to the sinusoidal shape. In the context of power system, harmonic distortion is the presence of unwanted frequency components in a power system. These unwanted components are integer multiples of the fundamental frequency (usually 50 or 60 Hz) and can significantly impact the performance and reliability of the power system.

65. A primary cause of harmonic distortion is the presence of non-linear loads. *See, e.g.*, Ex-1025, p. 2 (“Specifically, harmonic distortion occurs due to loads supplied by converters as well as to RES [Renewable Energy Source] interfaced to the grid through inverters.”); *see also* Ex-1026, p. 1 (“Nowadays, the amount of harmonic currents flowing into the grid is growing rapidly due to polluting loads”). These loads draw current in a non-sinusoidal manner, causing the current waveform to be distorted. Examples of non-linear loads include power electronic devices such as rectifiers, inverters, adjustable speed drives, and

electronic equipment like computers, fluorescent lights, and LED lamps. The switching operations in these devices generate harmonics, which can then propagate through the power system.

66. Harmonic distortion can be voltage or current. Voltage harmonics are distortions on the voltage waveform that occur at multiples of the fundamental frequency. These distortions are generally caused by non-linear loads drawing non-sinusoidal current from a sinusoidal voltage source. Voltage harmonics can lead to several problems, including additional losses and heating in electrical machines, misoperation of protective devices, and malfunctions in sensitive electronic equipment.

67. In contrast, current harmonics are distortions on the current waveform, often generated by non-linear loads. These loads draw current that is not in a smooth sinusoidal manner, resulting in harmonic current components. These harmonic currents can cause excessive heating in neutral conductors, transformers, and motors, leading to premature equipment failure. Because harmonic distortion was so well known and understood before the '755 patent, a POSA would have understood that when terms like “distortion current” and “distortion voltage” are used in the context of a PV system, they were referring to harmonic distortion current and harmonic distortion voltage respectively.

68. There are various methods of smoothing or minimizing the harmonics, which include filters. Filters come in various forms, and can be passive or active. Passive filters are comprised of electrical components that are not electronically controlled. Active filters are comprised of systems where there is electronic control to provide precise targeting of harmonic distorting components. Active filters can be stand-alone systems, and in other cases, active filtering can be incorporated directly into a power converter. For example, an active rectifier may perform this function.

69. Harmonic Distortion is regulated by multiple standards. For example, IEEE 519-1992 (IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) standard “dictate[s] that the percentage of the Total Harmonic Distortion (THD) in every node of the system and for every devices which is connected to it should be less than 5%.” Ex-1025, which was published March 25, 2015, p. 3. As another example, IEEE 1547-2003 (IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems), published in 2003, defines the maximum harmonic current distortion in a distributed resource (DR) like a grid-tie inverter, as shown below.

Table 3—Maximum harmonic current distortion in percent of current (I)^a

Individual harmonic order h (odd harmonics) ^b	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	Total demand distortion (TDD)
Percent (%)	4.0	2.0	1.5	0.6	0.3	5.0

^a I = the greater of the Local EPS maximum load current integrated demand (15 or 30 minutes) without the DR unit, or the DR unit rated current capacity (transformed to the PCC when a transformer exists between the DR unit and the PCC).

^b Even harmonics are limited to 25% of the odd harmonic limits above.

Ex-1011, p. 21; Ex-1017, pp. 12-16.

70. Harmonics may be eliminated or cancelled. Harmonics may be eliminated (or diminished) by using filters. Harmonic filters can block or redirect the harmonic content. Harmonic cancellation involves injecting or adding signals (e.g., currents) that are in opposition to the offending signals. For example, a system could supply a harmonic current at the same frequency and magnitude as that created by another system, but shifted out of phase, such that when combined, they cancel each other.

F. Power Factor Correction

71. Power factor (“PF”) is the ratio of active power to apparent power. Active power (sometimes called real power or true power) is often measured in thousands of watts, or kilowatts (kW). Active power is the power used by motors, lights, and other devices to produce useful work or heat energy. Active power may refer to the resistive elements of a circuit that performs the work. In a system where there is only active power associated with a source or load, the current and

voltage both alternate positively and negatively in unison with each other (i.e., in phase with each other and zero displacement angle between them).

72. Reactive power is often measured in units of kilo-volt-ampere-reactive (kVAR). It refers to the energy stored and released by the capacitive and inductive elements in a circuit. “As is understood in the art, the term ‘reactive power’ refers to the power associated with voltage and current out-of-phase by 90 degrees. Power in which the angle is out-of-phase by some other amount, for example, 80 degrees or 30 degrees, is a ‘mixture’ of both active and reactive power.” Ex-1006, ¶122.

73. The apparent power is often measured in thousands of volt-amperes or kilo-volt-amperes (kVA) and is the magnitude of the vector sum of active power and reactive power. Thus, apparent power is the total burden placed on an electrical system.

74. Matan illustrates the relationship between, active power 1614, reactive power 1616, and apparent power 1612 in its Figure 16B below, known in electrical engineering as a “power triangle.”

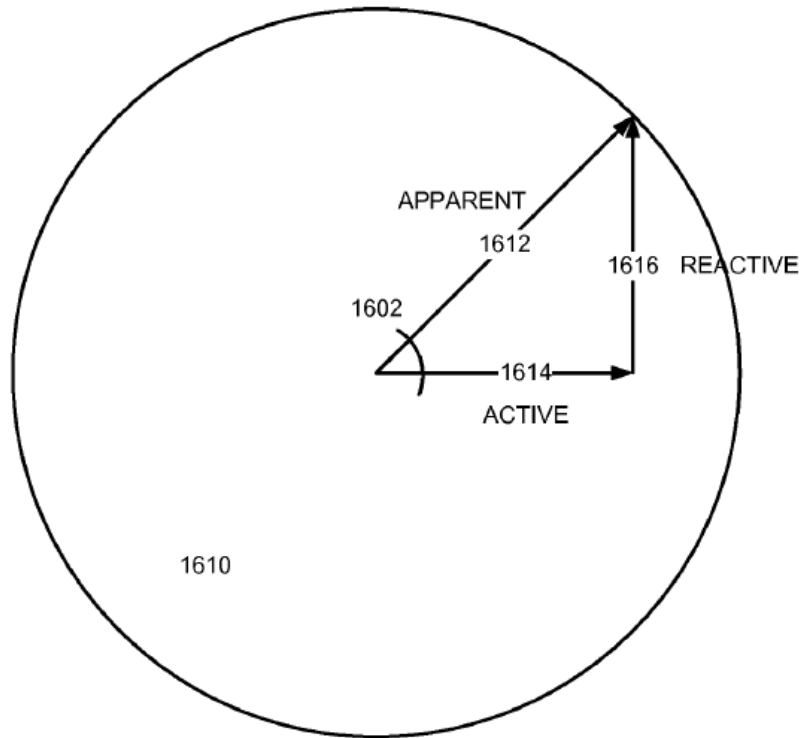


FIG. 16B

Ex-1006, Fig. 16B. The power factor is the ratio of active power 1614 to apparent power 1612, *i.e.*, cosine of “phase angle 1602.” *Id.*, ¶125. This phase angle 1602 is also called “displacement angle.”

75. When a system runs at “unity power factor” or a $PF = 1$, the system has zero reactive power and all of the power flowing is real. In this case, the phase angle between the voltage and the current (or displacement angle) is zero, *i.e.*, the voltage and current are in-phase. *See, e.g.*, Ex-1006, ¶31. Generally, this is the most efficient operating point for an inverter from a capacity and efficiency point-of-view. Thus, many inverter (or converter) systems for battery charging and PV

are set up and controlled to operate at unity power factor (or as close as it can).

Generally, the electric utility desires a power factor close to unity, and may penalize consumers of electrical power if the power factor is below a threshold.

76. However, the grid or the system in which the inverter is connected might need the inverter (or converter) to supply reactive power. *See, e.g.,* Ex-1006, ¶145 (“The best benefit may not always be a power factor of unity. As described above, the power factor may be best set at a value based on power grid conditions as well as tariff conditions.”). In that case, the power factor will be something other than unity, and the displacement angle will be something other than zero. The inverter (or converter) must supply the combination of the real and reactive power if the PF is something other than $PF=1$. Thus, the capacity of the inverter to provide active power is reduced if the inverter is also supplying reactive power. In the case where an inverter in a distributed energy resource (like a solar inverter) is supplying reactive power, this is often viewed as an “ancillary service” since that is not its main function but it is a feature that can provide benefit beyond just active power. There has been a fair bit development of these ancillary services in these systems.

77. Power factor correction (PFC), or power factor conditioning, aims to improve power factor, and therefore power quality. Often, power factor correction is accomplished by connecting capacitors to the system which produce reactive

energy in opposition to the reactive power consumed by loads. There are various ways of “correcting” or “conditioning” the power factor of a system which has a poor or low power factor besides capacitors. With the advent of controllable inverters, these electronic systems can be controlled to provide reactive power to the AC system and improve the overall power factor of the systems connected to the AC system. Inverters connected to energy sources such as PV or batteries are primarily concerned with providing active power to the AC system through the inverters (at a power factor close to 1), but it is possible to control them such that they provide reactive power in addition to active power, and thus can contribute to improving the overall power factor of the AC system they are connected to.

78. Before the '755 patent, there existed commercially available PV inverters that are capable of providing near unity PF, but also with adjustable PF, as shown below.

Output data	
Rated AC power [W]	1500
Max. apparent AC Power [VA]	1650
Rated AC grid voltage [V]*	220,230,240
Rated AC grid frequency [Hz]*	50
AC voltage range [V]*	180-280
AC frequency range [Hz]	According to local codes
Rated current @ 230 Vac [A]	6.5
Max. current [A]	9
Power factor	> 0.99 (0.95 inductive ... 0.95 capacitive)
Harmonic distortion (THD) at rated output	< 2 %
Power consumption at night [W]	< 1
Power consumption at standby [W]	6

Ex-1018; Ex-1014; *see also* Ex-1017, p. 16.

VI. OVERVIEW OF THE '755 PATENT

79. I have reviewed the '755 Patent and understand that Paul Garrity and Aaron Jungreis are named as the inventors on this patent. The '755 Patent relates to “systems and methods for managing power flow in grid-tied photovoltaic systems.” Ex-1001, 1:7-8. The '755 Patent discloses two prior art systems. The first “typical prior art configuration” ('755 Patent's Figure 2 below) includes “[t]he utility grid 100 [that] feeds or receives AC power from a bidirectional current-source/sink power converter 201 [yellow] which, in turn, receives or sources DC power from a battery 202 [green].” *Id.*, 5:37-42.

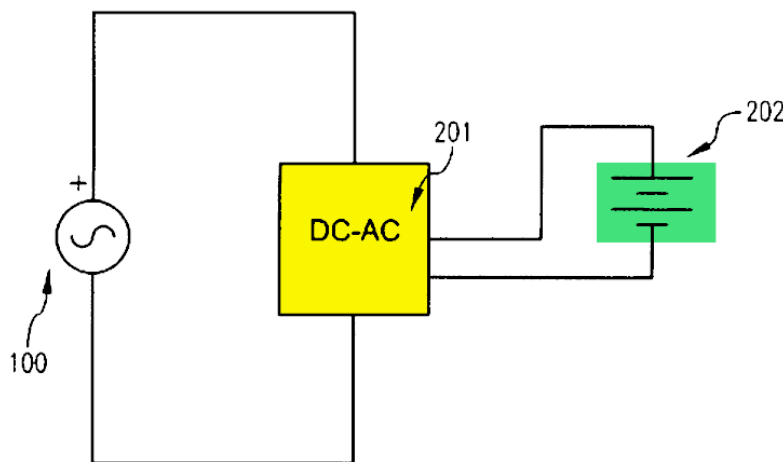


FIG. 2 (PRIOR ART)

Ex-1001, Fig. 2. In this prior-art system, when the utility grid 100 has excess capacity, the grid 100 sources AC power to charge the battery 202 via the power

converter 201, and when the grid 100 requires more capacity, the battery 202 sources DC power to the utility grid 100 via the power converter 201. *Id.*, 5:42-47. Note that unless otherwise stated, I added the coloring to the figures in this declaration. Bolded text has also been added throughout my declaration for emphasis unless otherwise indicated.

80. The second prior-art system in the '755 Patent depicts, in Figure 1, the use of micro-inverters.

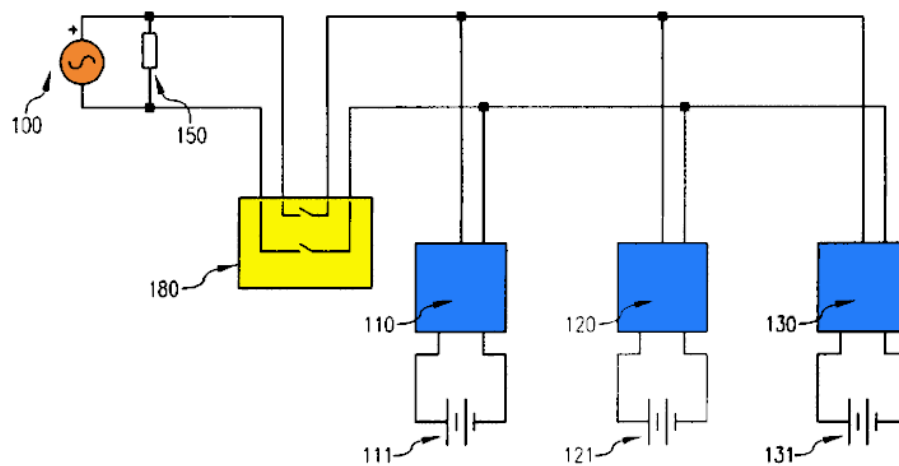


FIG. 1 (PRIOR ART)

Ex-1001. Fig. 1. “A first micro-inverter [blue] 110 receives DC power from a photovoltaic module 111.” *Id.*, 5:6-8. “The micro-inverter 110...sources power to the grid 100 [orange]...” *Id.*, 5:8-11. Second and third micro-inverters 120, 130 [blue] draw power from the second and third photovoltaic modules 121, 131, respectively, and function substantially identically to the first micro-inverter 110.

Id., 5:11-14. Specifically, this prior art system includes a voltage-frequency relay 180 (yellow) that controls the output of micro-inverters 110, 120, and 130 based on voltage or frequency of the utility grid 100:

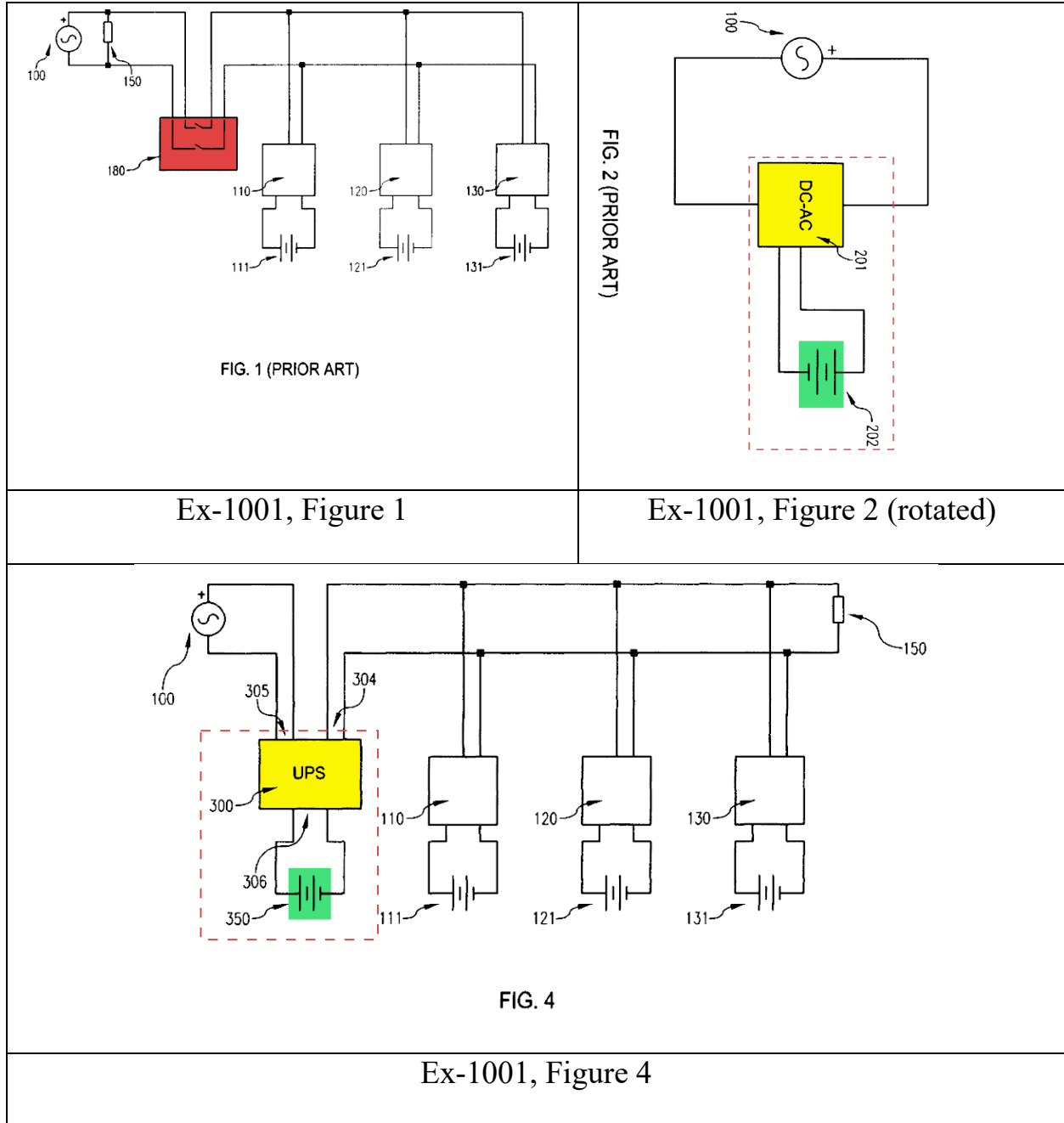
A voltage-frequency relay 180 **monitors the voltage and frequency of the utility grid 100. When either the voltage or frequency of the utility grid 100 deviates outside of a predetermined range** (which varies from one region of the world to another), the voltage-frequency relay 180 **opens internal switches to disconnect the micro-inverters 110,120,130**, thus providing an additional level of safety to prevent the micro-inverters 110,120,130 from pumping power into the utility grid 100 that may be, e.g., shut down for repair or maintenance.

Ex-1001, 5:17-26. According to the '755 Patent, the prior art system in Figure 1 above is problematic because “when the utility grid 100 is not producing power, it is not possible to operate the house load 150 from the prior art micro-inverters” (because the micro-inverters are current sources and have nothing to synchronize with). *Id.*, 5:34-36. “[V]oltage-frequency relays add cost to photovoltaic systems beyond what would otherwise be required.” *Id.*, 1:39-40.

81. To allegedly solve these problems, the '755 Patent seeks to replace Figure 1's voltage frequency relay 180 (red) with Figure 2's bidirectional converter

201 (yellow) and battery 202 (green), resulting in the configuration in Figure 4.

These figures are below:



Without a voltage-frequency relay, the '755 Patent proposes using “a controller configured to regulate a power flow of the current-source inverter [e.g., micro-

inverter(s)] by adjusting a frequency of the alternating current voltage source [e.g., bidirectional converter].” Ex-1001, 3:9-12.

82. Thus, when comparing the admitted prior-art systems to claim 1, it is my opinion that the only difference appears to be the controlling of the micro-inverter output based on the frequency of the bidirectional converter, *e.g.*, reducing the micro-inverter output when the battery is fully charged. Ex-1001, 8:18-21. In my opinion, this was neither new nor non-obvious. For example, Serban and Somani both teach this exact feature as well as the other limitations of claim 1, as I will explain below.

83. I also reviewed the prosecution history of the '755 Patent. I understand that the application resulting in the '755 Patent received a first-action allowance. The Examiner indicated allowability of claim 1 because “the prior art of record does not disclose or suggest, *inter alia*, a first alternating current power port as claimed.” Ex-1002, p. 24. In my opinion, that determination was incorrect as the claimed “first alternating current power port” is taught in both Serban and Somani and is something that was abundantly well-known given the background knowledge I outlined earlier.

VII. OVERVIEW OF THE PRIOR ART

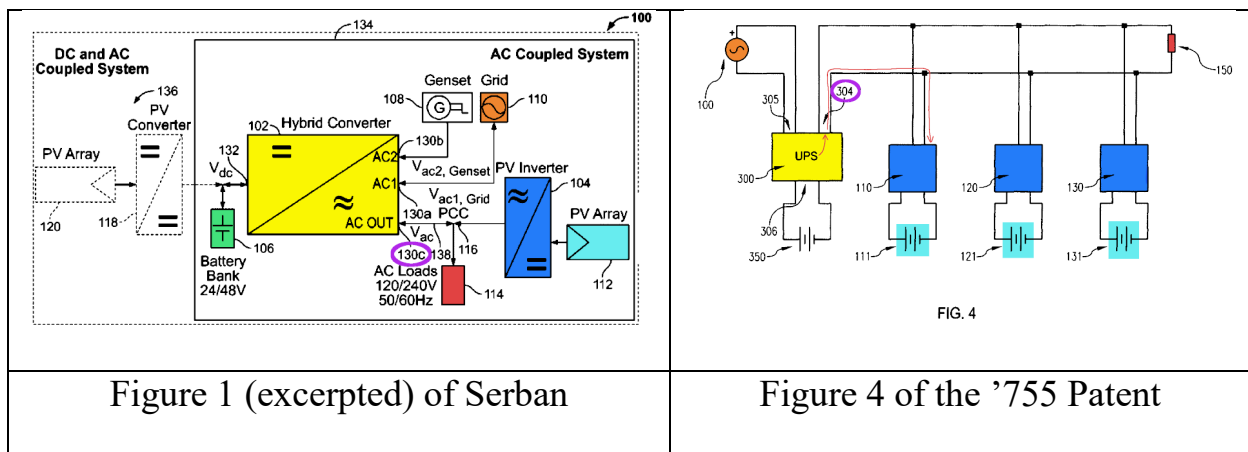
A. Serban

84. I understand that the Examiner was provided with a version of a patent to Serban while he was considering whether to grant a patent (this process of examining an application and determining whether to issue a patent I understand is referred to as patent “prosecution”). However, based on my review of the ’755 Patent prosecution history, I understand that this patent to Serban was listed on an Information Disclosure Statement (IDS) during prosecution of the ’755 Patent (Ex-1002, p. 43), and the Examiner never substantively discussed that reference at all.

85. My opinions here are based on a different reference that also has Serban listed, which is the Serban published application (Ex-1005), which is a different published document as compared to the Serban patent (Ex-1015). I further understand that none of the secondary references that are combined with Serban (*i.e.*, Matan, PVI, Wilhelm, and Wu) was before the Examiner and, in turn, none of the combined teachings proposed herein have previously been considered. Moreover, my opinions here also rely on Somani, which is a new reference that, in my opinion, separately anticipates and renders obvious many claims of the ’755 Patent.

86. My opinions as to certain combinations of references presented here are material and not cumulative of previous art considered by the Examiner and Serban is highly relevant to the claims of the '755 patent.

87. Like the '755 Patent, Serban discloses “[a] control strategy... that varies the line frequency [of a bidirectional converter]... according to a predetermined pattern to cause a PV inverter to modify its power output and thereby avoid overcharging a battery.” Ex-1005, Abstract, ¶17. As I show below, Serban discloses the exact same alternating current power port (purple circle) that the Examiner thought was not in the art. Note that I have added colors to figures from the references to visually illustrate to the reader and make clear where certain features are found in the references



B. Somani

88. I understand that the Examiner was not aware of Somani (Ex-1007) during prosecution. I also understand that Somani was filed June 29, 2016, published January 5, 2017, and claims priority to U.S. Provisional Application No.

62/188,278 (“Somani Provisional,” Ex-1008), which was filed on July 2, 2015. I have been informed that Somani qualifies as prior art.

89. As I will explain in Sections XII.E-XII.G below, claims 1-20 of the ’755 Patent are disclosed in Somani, and also in the provisional to which Somani claims priority, alone or in combination with other prior art. Moreover, as shown on its Application Data Sheet (ADS), Somani included a priority claim to the Somani Provisional on the date that it was filed; Somani was filed within one year of the Somani Provisional; and Somani and the Somani Provisional have common inventors (Apurva Somani and John C. Palombini). I have been informed that these facts are sufficient to show that Somani qualifies as prior art to the ’755 Patent.

90. Further, it is also my opinion that at least one claim in Somani is supported by the Somani Provisional, as I show in the table below.

Somani’s claim 1	Example Support in Somani Provisional (Ex-1008)
A power system comprising:	Ex-1008, p.15 (“Upon failure of the utility (blackout), disconnect 4 is opened by the controller..., transitions the system to micro-grid mode.”). <i>Id.</i> , Fig. 1:

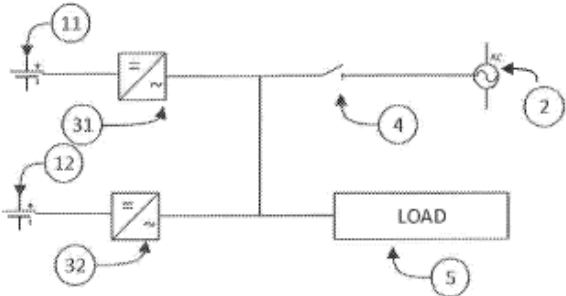


Fig. 1: Use of Inverter Control Method with Two battery sources.

Id., Fig. 3:

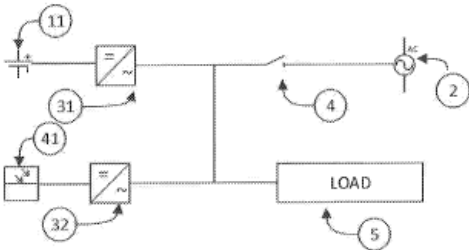


Fig. 3: Implementation of Method using one Battery source and one Solar Source

a plurality of **power converters** coupled together at a **point of common coupling (PCC)**, wherein the power converters are configured to be coupled to **a load** at the PCC and the power converters are configured to **provide a combined power converter output to the load**;

Ex-1008, pp.11-12:

Table 1: Description of Elements in Fig. 1 and Fig. 3

Element	Description
1N	DC Energy Source. Depicted as a battery for demonstration, but could be any DC source, generator, wind, PV, fuel cell, etc..
2	Grid Source, this is typically the utility grid, but could be any AC source connected to the microgrid, may also be part of the microgrid.
3N	Inverters, these inverter the DC->AC and AC->DC if battery application
4	Disconnect, this is the means by which to separate the microgrid from AC Source 2. This disconnect could be a breaker, contactor, etc..
5	Load, this is what is consuming the energy. It is shown here on the AC side but could also be a DC load. Additionally there may be no load at all.

Id., Fig. 3:

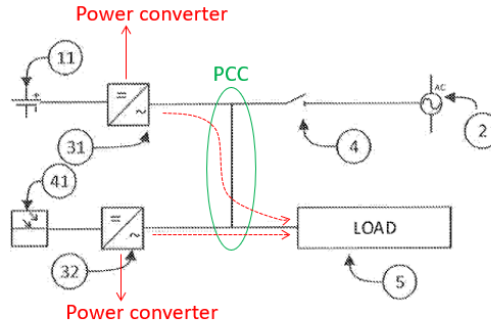


Fig. 3: Implementation of Method using one Battery source and one Solar Source

Id., p.17 (“Active synchronization: In this approach, the LAPES controller matches the voltage signal on the **PCC micro-grid side** to those of the **PCC on the grid side** immediately before closing the islanding devices, such as a circuit breaker.”)

a **switch** coupled to the PCC, wherein the switch is configured to be coupled in series **between the PCC and an external grid** such that when the switch is closed the power system is in a **grid-tied** configuration and such that when the switch is open the power system is in an **microgrid** configuration;

Ex-1008, pp.11-12:

Table 1: Description of Elements in Fig. 1 and Fig. 3

Element	Description
1N	DC Energy Source. Depicted as a battery for demonstration, but could be any DC source, generator, wind, PV, fuel cell, etc..
2	Grid Source, this is typically the utility grid, but could be any AC source connected to the microgrid, may also be part of the microgrid.
3N	Inverters, these invert the DC->AC and AC->DC if battery application
4	Disconnect, this is the means by which to separate the microgrid from AC Source 2. This disconnect could be a breaker, contactor, etc..
5	Load, this is what is consuming the energy. It is shown here on the AC side but could also be a DC load. Additionally there may be no load at all.

Id., Fig. 3:

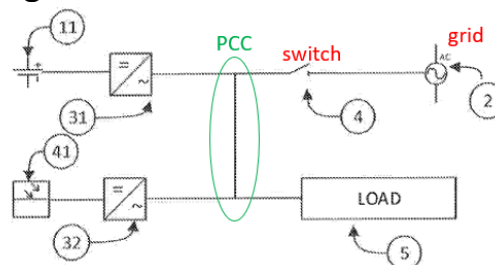


Fig. 3: Implementation of Method using one Battery source and one Solar Source

	<i>Id.</i>, p.15 (“Upon failure of the utility (blackout), disconnect 4 is opened by the controller..., transitions the system to micro-grid mode... Once the disconnect is closed all the inverters, in the example 31, transitions back to current source operation mode.”). <i>Id.</i>, p.11 (“upon detection of abnormal grid voltage and/or frequency conditions, the cluster of units can seamlessly transition to islanded mode, form a micro-grid and continue powering the critical island load... When the grid voltage is within bounds again, the cluster of units will automatically synchronize the output voltage with the grid voltage and seamlessly transition to grid-tied operation.”). <i>Id.</i>, p.17 (“Energy is being used from source 11 and source 41 to provide power to the load, 5”)
a control system comprising one or more controllers coupled to the plurality of power converters, the control system being configured to:	Ex-1008, Fig. 1: Fig. 1: Use of Inverter Control Method with Two battery sources. <i>Id.</i>, p.12 (“disconnect 4 is opened by the controller (need to create identifier)”). <i>See also</i> pp.15, 18-20.
enable the switch to open	Ex-1008, p.12 (“disconnect 4 is opened by the

and **close** in response to a signal received from one or more sensors for **monitoring the external grid**;

controller”);

Id., p.13 (“the disconnect 4 is **closed**.”) *See also* pp.15, 18-20.

Id., Fig. 4:

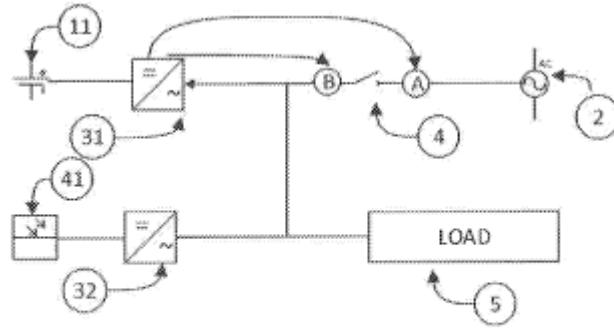


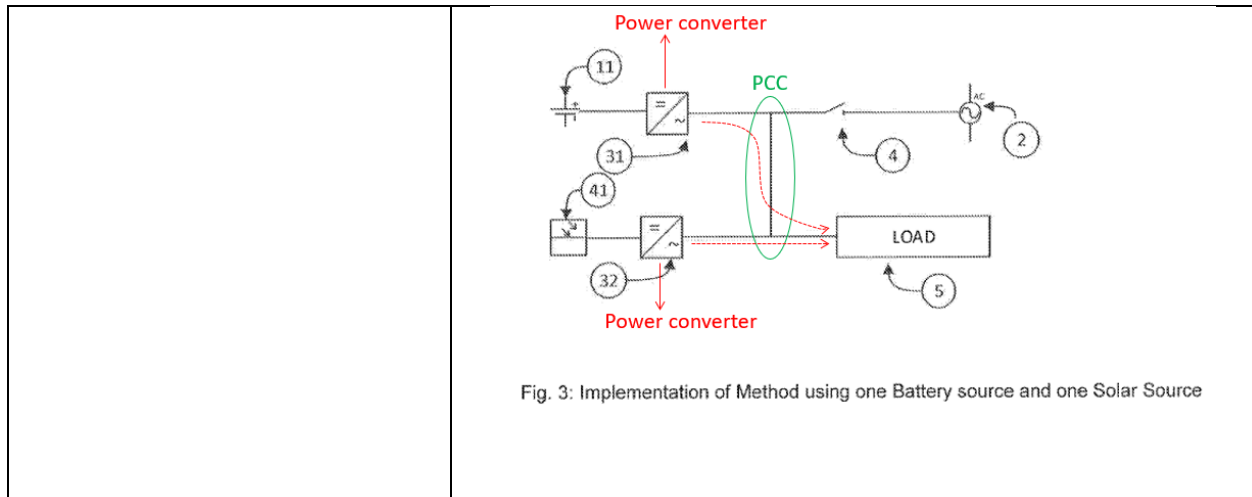
Fig. 4: Implementation of Control Scheme

Id., p.18 (“Commercially available transducers are used at measuring points A and B to provide a voltage signal to the inverter 31 for **monitoring the voltage on both sides of switch 4**.”).

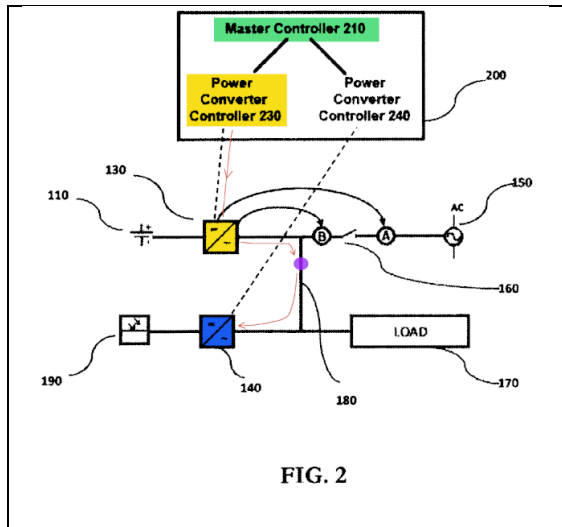
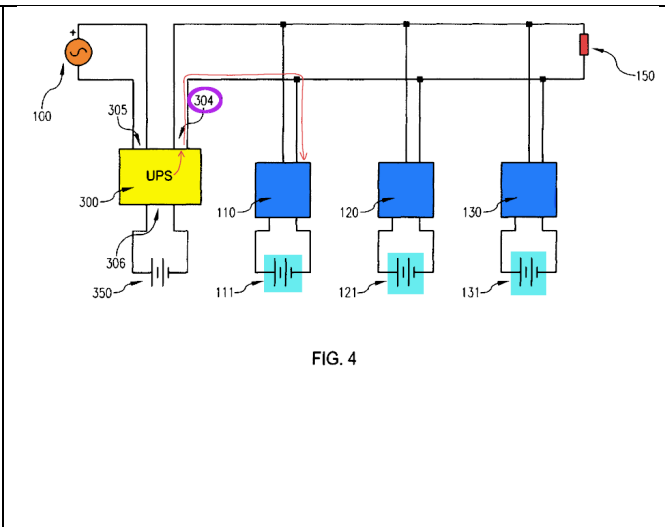
Id., p.19 (“The invention **monitors the AC voltage and frequency on the ‘utility’ side of the disconnect switch 4 at point B**. The voltage and frequency are compared to voltage and frequency boundaries. If either, or both, of the voltage and/or frequency violates the permitted range the system will **transition from grid tied to microgrid**.”).

Id., p. 15 (“Upon failure of the utility (blackout), disconnect 4 is opened by the controller (need to create identifier), transitions the system to micro-grid mode. In this mode inverter (31) transitions from current source mode to voltage source mode to continue to supply load, 5, with energy during the utility outage” indicating that the inverter is operating in a current control mode when the switch is closed.).

enable the power converters to operate in a current control mode when the switch is closed and when the power system is in the grid-tied configuration	Ex-1008, p.11 (“upon detection of abnormal grid voltage and/or frequency conditions, the cluster of units can seamlessly transition to islanded mode, form a micro-grid and continue powering the critical island load... When the grid voltage is within bounds again, the cluster of units will automatically synchronize the output voltage with the grid voltage and seamlessly transition to grid-tied operation.”). <i>Id.</i>, p.13 (“Once the disconnect is closed all inverters, in the example 31 and 32, transition back to current source operation mode.”).
transition the plurality of power converters from grid-tied mode to microgrid mode and synchronize the power converters such that the power converters share the load.	Ex-1008, p.11 (“upon detection of abnormal grid voltage and/or frequency conditions, the cluster of units can seamlessly transition to islanded mode, form a micro-grid and continue powering the critical island load... When the micro-grid is formed, the inverters unit will share the load equally both in steady state and transients. Further enhancement is proposed to implement unequal load sharing based on remaining battery energy (state of charge) of individual inverters.”). <i>Id.</i>, p.18 (“one of the generation or storage devices can act as a microgrid master which attempts to control the output voltage amplitude and frequency... Fast communication signals are required between the master and slave devices. These signals include the current references and synchronization signals.”). <i>Id.</i>, p. 15. <i>Id.</i>, Fig. 3:



91. Like the '755 Patent, Somani discloses “islanding a plurality of grid-tied power converters to form a microgrid.” Ex-1007, ¶3; Ex-1008, p.11. In particular, when the system is in microgrid mode, Somani teaches “increasing the microgrid frequency to signal the resource to produce less, or tripping the renewable resource [such as solar panels] offline by changing the microgrid frequency beyond the nominal frequency.” Ex-1007, ¶¶4, 90; Ex-1008, pp.15, 18. As I show below, Somani discloses the exact same alternating current power port (purple) that the Examiner thought was not in the art.

 FIG. 2	 FIG. 4
Figure 2 of Somani	Figure 4 of the '755 Patent

C. Matan

92. I understand that the Examiner was not aware of Matan (Ex-1006) during prosecution. Matan discloses “[a] power transfer system provides power factor conditioning of... generated power... received from a local power source,” such as solar cells. Ex-1006, Abstract, ¶3. Matan’s power factor conditioning includes its PV inverter capable of adjusting the power factor to be “at or near unity” or “any desired power factor to compensate for conditions of power on power grid.” *Id.*, ¶¶31-32. Moreover, Matan’s PV inverter also can produce AC currents “relatively free of harmonic distortion” and additionally “provides harmonic distortion correction.” *Id.*, ¶35.

D. Wilhelm

93. I understand that the Examiner was not aware of Wilhelm (Ex-1009) during prosecution. As I will explain below, Wilhelm teaches the simple and well-known concept of sourcing battery power when the grid demand exceeds a certain threshold. *See, e.g.*, Ex-1009, 8:56-59, 8:60-9:12.

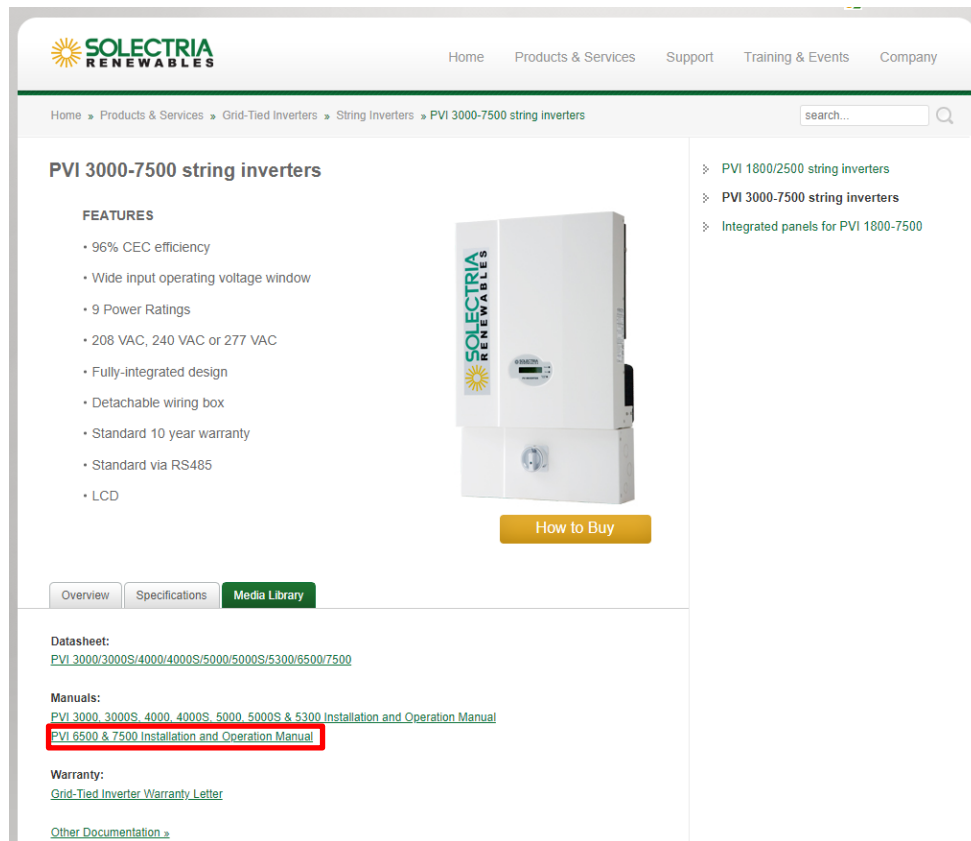
E. PVI

94. I understand that the Examiner was not aware of PVI (Ex-1010) during prosecution. As I will explain below, PVI teaches the simple and well-known concept of disconnecting PV inverters for certain time periods in case of grid outage. Ex-1010, p.8.

95. PVI was published (and material was also “in public use” and/or “otherwise available to the public) at least as early as July 11, 2014. PVI’s public availability is also confirmed by the Wayback machine provided by Internet Archive, which I am familiar with. For example, as indicated in Exhibit 1014 and its Exhibit B, the link leading to Exhibit 1010 and the full text of PVI contained thereon were publicly accessible at least as early as July 11, 2014. *See* Ex. B to Ex-1014.

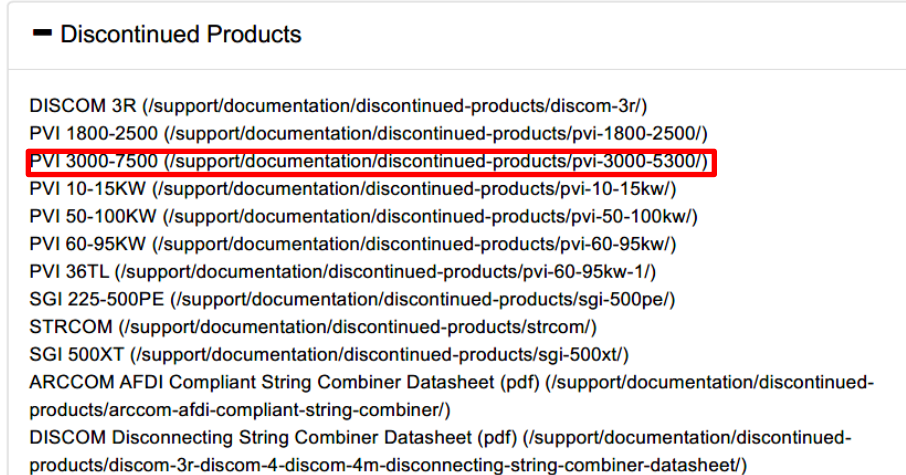
96. In my opinion, a POSA would have been able to find and rely on PVI. For example, a POSA would have been able to download PVI from Solectria’s

own product webpage (as shown below), which was publicly accessible at least as early as May 23, 2013.



Ex. A to Ex-1014 (excerpted). By clicking on the link (red) under “Media Library” tab, a POSA would have been able to download a copy of PVI, i.e., Ex. B to Ex-1014.

97. Based on the Solectria’s own website, the PVI 3000-7500 string inverters have been discontinued:



Ex-1019 (<https://solectria.com/support/documentation/>), p. 2. By clicking on the link (red) above, I was directed to the following webpage, where I was able to download a copy of PVI (Ex-1022).

PVI 3000-7500

The PVI 3000-7500 residential, string inverters were offered by Solectria from 2008-2013. They were discontinued in Q4 2013 when Solectria introduced the PVI 3800-7600TL (/pv-inverters/residential-tl-string-inverters/pvi-3800-7600tl/) line (transformerless, residential, string inverters).

Materials & Documents

- PVI 3000-7500 Datasheet (/site/assets/files/1493/pvi_3000-7500_datasheet-2.pdf)
- Integrated Panels Datasheet (/site/assets/files/1493/integrated_panels_datasheet-1.pdf)
- PVI 6500/7500 Installation & Operation Manual (/site/assets/files/1493/pvi_6500-7500_manual.pdf)**
- PVI 3000-5300 Installation & Operation Manual (/site/assets/files/1493/pvi_3000-5300_manual.pdf)
- UL 1741 Listing Verification - PVI 3000S-5300 (/site/assets/files/1493/pvi_3000s-5300_ul1741_listing_verification-1.pdf)
- UL 1741 Listing Verification - PVI 6500/7500 (/site/assets/files/1493/pvi_6500-7500_ul1741_listing_verification.pdf)

Ex-1021, p. 1.

98. I compared Ex-1010, a copy of PVI downloaded from Wayback Machine (https://web.archive.org/web/20140711094535mp/http://www.solren.com/manuals/PVI_6500-7500_Manual.pdf) and Ex-1022, a copy of PVI downloaded from

Solectria's official website (https://solectria.com/site/assets/files/1493/pvi_6500-7500_manual.pdf) using the compare function in Adobe Acrobat and the pages in these two documents are identical.

99. Based on my experience, all this information indicates to me that PVI was publicly available before the earliest priority date of the '755 Patent, and that Exhibit 1010 is a true and correct copy of PVI, and I am confident of its authenticity.

F. Wu

100. I understand that the Examiner was not aware of Wu (Ex-1013) during prosecution. As I will explain below, Wu teaches the simple and well-known concept of injecting compensating current for harmonic distortion correction. *See, e.g.*, Ex-1013, 1:50-67, 4:8-16.

VIII. CLAIM CONSTRUCTION

101. I understand that claim construction is the process of determining the meaning of a term or phrase in a patent claim. I understand that the proper construction of a term is how a POSA would have understood the term based on its use in the claims, specification, and file history of the patent. I further understand that the claims are construed before the Board according to the same claim construction standard that applies in district courts. I have followed these principles in my analysis throughout this declaration. For the purpose of this

declaration, I do not believe that any express constructions are needed and have applied the plain and ordinary meaning of all terms.

IX. ANTICIPATION

102. I have been instructed as to the definition of “anticipation” in the context of the patent laws.

103. I understand that anticipation of a claim requires that every element of a claim be disclosed expressly or inherently in a single prior art reference, in combination, as claimed. I understand that a single prior art reference may anticipate claims without expressly disclosing a feature of the claimed invention if that feature is necessarily present, or inherent, in that reference. I understand that a reference is read from the perspective of one of ordinary skill in the art at the time of the invention.

X. OBVIOUSNESS

104. I have been instructed as to the definition of “obviousness” in the context of the patent laws.

105. It is my understanding that even though an invention may not have been identically disclosed or described before it was made by an inventor, in order to be patentable, the invention must also not have been obvious to a POSA before the Priority Date.

106. It is my understanding that obviousness is a question of law based on underlying factual issues including the scope and content of the prior art, the level of skill in the art, and any differences between the prior art and the claimed invention.

107. I understand that the scope and content of prior art for deciding whether the invention was obvious includes at least prior art in the same field as the claimed invention. The prior art can also come from different fields that a POSA would have considered when trying to solve the problem that is addressed by the invention. I understand that prior art that under either (or both) of these standards is referred to as being analogous art.

108. I understand that one may find obviousness if, at the time of the patent's alleged invention, there was a reason that would have prompted a POSA to combine the known elements in a way the claimed invention does.

109. I have also been informed that obviousness can be evaluated based on the following considerations: (1) whether the claimed invention was merely the predictable result of using prior art elements according to their known function(s); (2) whether the claimed invention provides an obvious solution to a known problem in the relevant field; (3) whether the prior art teaches or implies the desirability of combining elements claimed in the invention; (4) whether the prior art teaches away from combining elements in the claimed invention; (5) whether it

would have been obvious to try the combinations of elements, such as when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions; and (6) whether the change resulted more from design incentives or other market forces.

110. I understand that impermissible hindsight is not allowed in an obviousness analysis.

111. I also understand that, when considering the obviousness of a patent claim, I should consider whether a teaching, suggestion, or motivation to combine the references exists, and that this can also be a safeguard against impermissibly applying hindsight when considering the prior art. I understand that this test should not be applied rigidly, but that the test can be important to avoid such hindsight.

XI. OPINIONS REGARDING PATENTABILITY

112. In my opinion, claims 1-7, 13, and 18 are anticipated by Serban. Additionally, claims 1-7 and 13-18 are rendered obvious by Serban in view of Matan. Claims 8-12 and 19-20 are rendered obvious by Serban in view of Matan and Wilhelm. Claims 7, 13, and 18-20 are rendered obvious by Serban in view of Matan, Wilhelm, and PVI. Claim 14 is rendered obvious by Serban in view of Wu.

113. Moreover, in my opinion, claims 1-3, 5-7, 13 and 18 are anticipated by Somani. Additionally, claims 1-13 and 15-20 are rendered obvious by Somani

in view of Matan and Wilhelm. Claim 14 is rendered obvious by Somani in view of Wu.

114. I have based my opinion on the following references:

- **Serban:** U.S. Patent Application Publication No. 2011/0043160 titled “AC Connected Modules with Line Frequency or Voltage Variation Pattern for Energy Control” to Emanuel Serban (“Serban,” Ex-1005), was filed **August 21, 2009** and published **February 24, 2011**. I understand that Serban is prior art to the ’755 Patent.

- **Somani:** U.S. Patent Application Publication No. 2017/0005473 titled “Islanding a Plurality of Grid Tied Power Converters” to Apurva Somani and John C. Palombini (“Somani,” Ex-1007) is based on a provisional application filed **July 2, 2015** and was published January 5, 2017. I understand that Somani is prior art to the ’755 Patent.

- **Matan:** U.S. Patent Publication 2010/0208501 A1 titled “Power Transfer Management for Local Power Sources of a Grid-tied Load” to Stefan Matan *et al.* (“Matan,” Ex-1006) was published **August 19, 2010**. I understand that Matan is prior art to the ’755 Patent.

- **Wilhelm:** U.S. Patent No, 5,500,561 titled “Customer side power management system and method” to William G. Wilhelm (“Wilhelm,” Ex-

1009) was issued **March 19, 1996**. I understand that Wilhelm is prior art to the '755 Patent.

- **PVI**: PVI is a PV inverter user manual titled “Solectria PVI 6500-7500 Installation and Operation Manual” (“PVI,” Ex-1010) that was published, in public use, or otherwise available to the public at least as early as **July 11, 2014**. Ex-1014; *supra* Section VII.E. I understand that PVI is prior art to the '755 Patent.

- **Wu**: U.S. Patent No, 7,787,267 titled “Active power filter” to Chin-chang Wu *et al.* (“Wu,” Ex-1013) was issued **August 31, 2010**. I understand that Wu is prior art to the '755 Patent.

115. In my opinion, the challenged claims of the '755 Patent are unpatentable based on the following reasons:

- (1) Claims 1-7, 13, and 18 are anticipated by Serban;
- (2) Claims 1-7 and 13-18 are rendered obvious by Serban in view of Matan;
- (3) Claims 8-12 and 19-20 are rendered obvious by Serban in view of Matan and Wilhelm;
- (4) Claims 7, 13, and 18-20 are rendered obvious by Serban in view of Matan, Wilhelm, and PVI;
- (5) Claims 1-3, 5-7, 13, and 18 are anticipated by Somani;

(6) Claims 1-13 and 15-20 are rendered obvious by Somani in view of

Matan and Wilhelm;

(7) Claim 14 is rendered obvious by Serban in view of Wu; and

(8) Claim 14 is rendered obvious by Somani in view of Wu.

XII. MY OPINIONS AS TO THE CHALLENGED CLAIMS OF THE '755 PATENT

A. My Opinions as to Claims 1-7, 13, and 18 in view of Serban alone

1. Claim 1

116. In my opinion, claim 1 is unpatentable because it is anticipated by Serban. Claim 1 of the '755 Patent recites the following. I address each of these limitations in my analysis below.

1[P] An uninterruptible power supply comprising:

1[A] a bi-directional converter configured to operate as an alternating current voltage source;

1[B] a direct current power port configured to be coupled to a battery;

1[C] a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and

1[D] a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.

a. 1[P]

117. If 1[P]’s recitation of *an uninterruptible power supply* (UPS) is limiting, it is my opinion that Serban discloses it.

118. I note here that throughout this declaration, besides citation indicators, italics are used exclusively to identify language from claims 1-20 of the ’755 Patent.

119. In my opinion, Serban’s power system 100 discloses a UPS. Serban’s power system 100 (Figure 1 below) uses “any one of three configurations or modes” to ensure an uninterruptible supply of power to AC loads 114 (red) using power sourced from a grid 110 (orange), a battery 100 (green), and a photovoltaic (PV) array 112 (light blue) at different points in time. Ex-1005, ¶19; *see also id.*, Abstract.

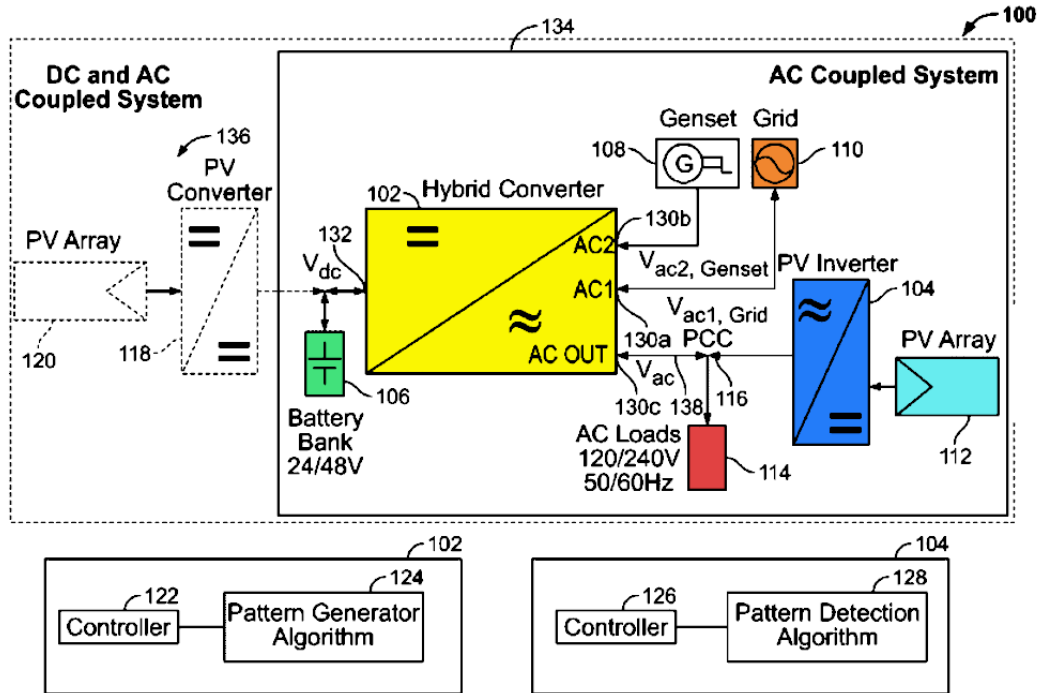


FIG.1

Ex-1005, Fig. 1. Specifically, in grid-connected mode, “[t]he AC loads 114 [red] can be powered by both the PV inverter 104 [blue] and the utility grid 110 [orange].” *Id.*, ¶25.

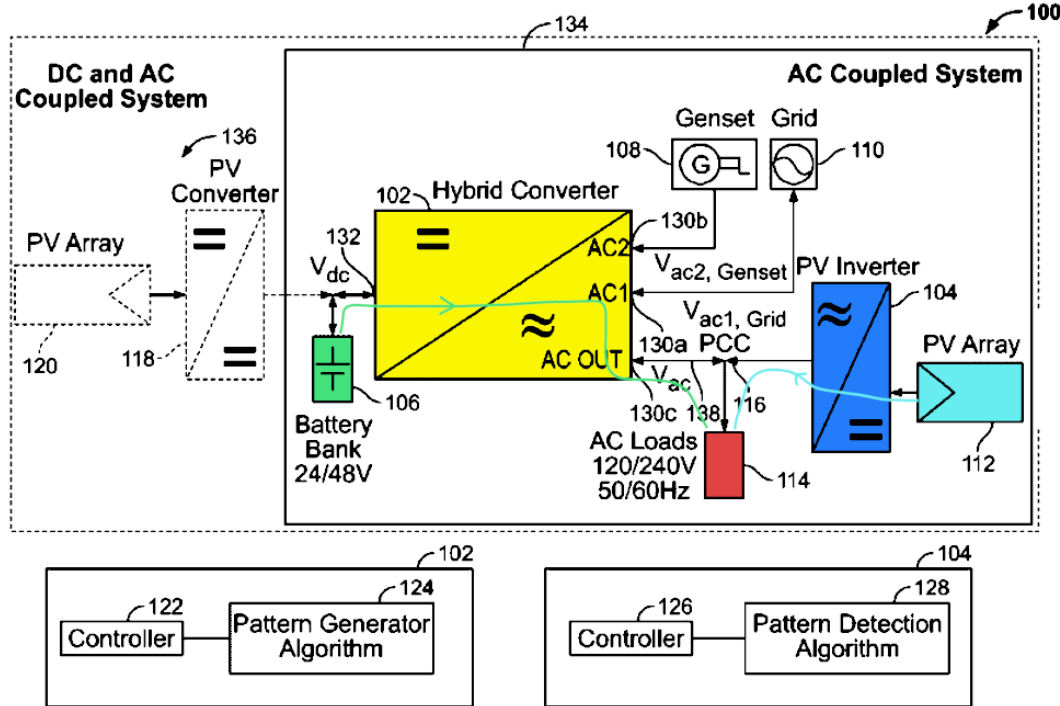


FIG.1

Ex-1005, Fig. 1. Serban also has a genset-connected mode that makes use of genset 108 (e.g., a fuel-powered engine-driven generator). *Id.*, ¶¶25-26;

120. With these modes available, Serban’s AC load 114 is powered without interruption. Ex-1005, ¶4 (stating that Serban’s system enables “stable and robust DPG [distributed power generation] control operation under **transients and dynamic conditions** at the DC and AC ports of the hybrid converter”) and ¶24 (describing Serban’s “**seamless transfer of power when the utility grid 110 fails.**”). In particular, when the utility grid 110 fails, the PV array 112, battery 106, and genset 108 all act as automatic backup electric power to ensure that the AC loads 114 are powered without interruption. This is consistent with what a POSA

would have understood what a UPS is—a device or system that provides quality and continuity of an AC power source.

121. This is just like the '755 Patent's UPS 300, which sources power from a battery and/or photovoltaic panels when a grid suffers outages. For example, the '775 Patent illustrates in Figures 5B-5D its system behavior when an electric utility grid is suffering an outage. As shown in Fig. 5B, immediately following a grid outage, the grid (orange) is disconnected and so are the PV inverters (blue).

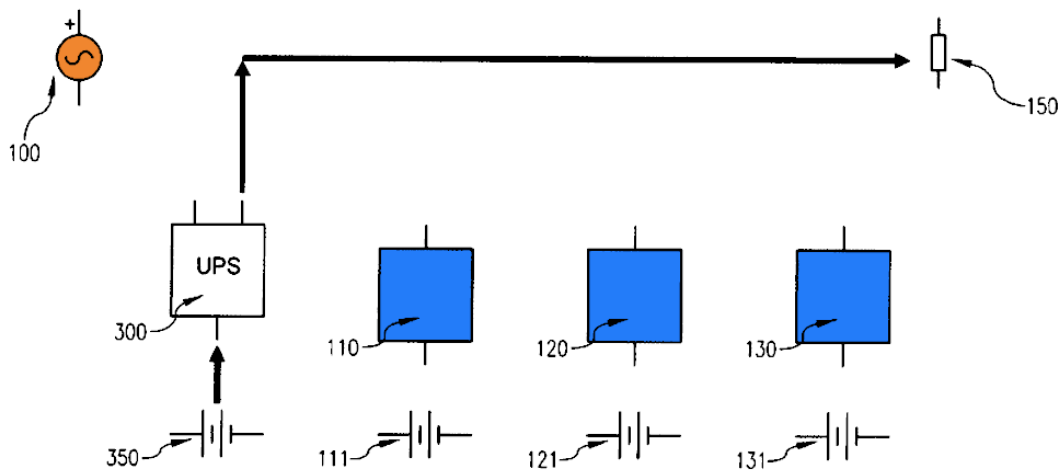


FIG. 5B

Ex-1001, Fig. 5B. In this situation, “[t]he UPS 300 uses power from the battery 350... to provide power to the load 150.” *Id.*, 8:2-5. (The thick black arrows show the power flow.) After the initial startup wait time, the PV inverters are connected back to the power system and are used to provide power to the load. If “the micro-inverters 110,120,130 provide more power than is needed to supply the load 150[,]

[e]xcess power [blue] is used to charge the battery 350 [green],” as shown in

Figure 3C below. *Id.*, 8:11-15.

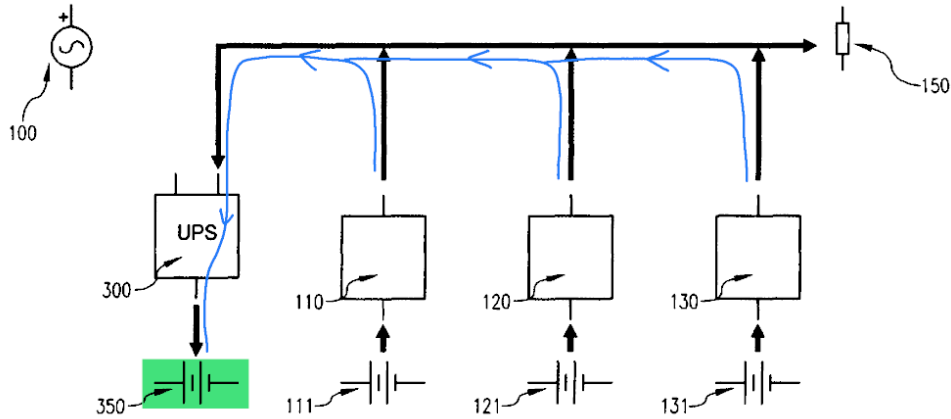


FIG. 5C

Ex-1001, Fig. 5C. Otherwise, if “the micro-inverters 110,120,130 provide less power than is needed to supply the load 150[,] [s]upplemental power [green] is provided by the battery 350 to fulfill the power needs of the load 150 [red],” as shown in Fig. 5D below. *Id.*, 8:22-27.

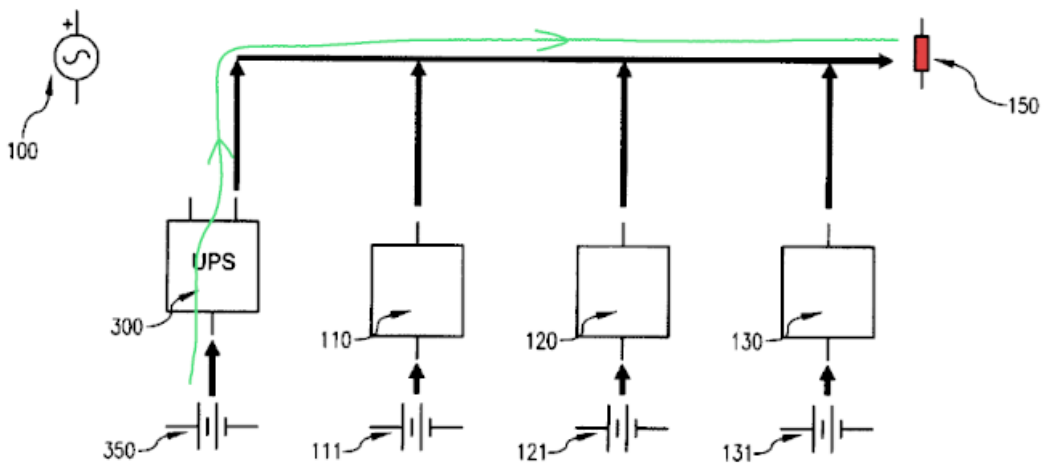


FIG. 5D

Ex-1001, Fig. 5D. As a result, the '755 Patent's load is powered in the event of a grid outage, *i.e.*, by the battery, the PV inverters, or both.

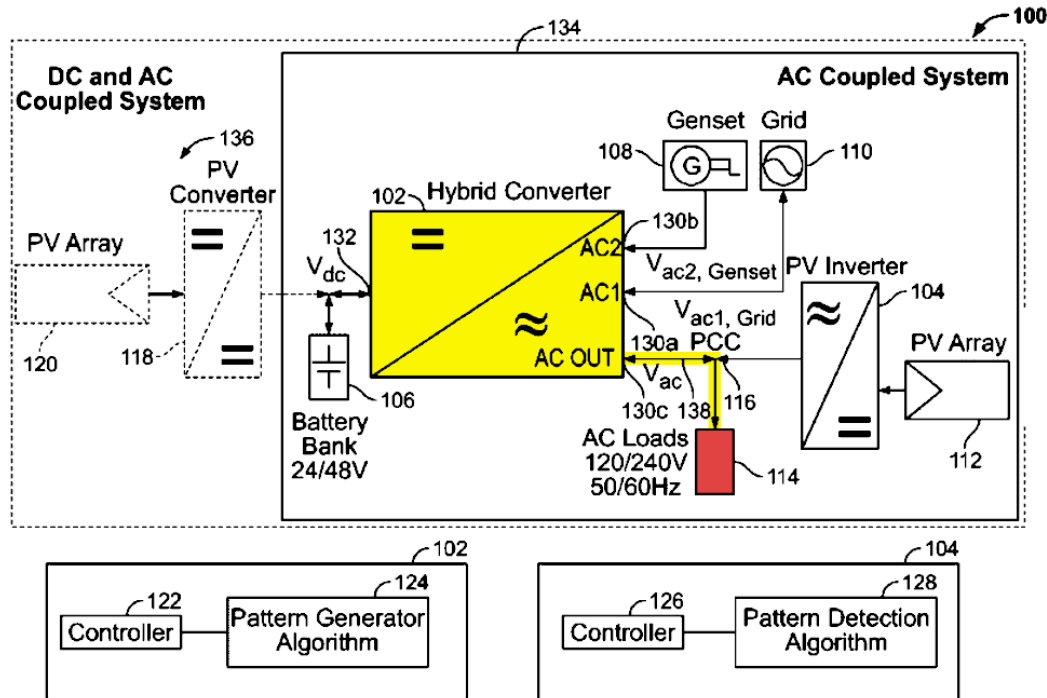
122. I note that a POSA would have understood that Serban's power system 100 sources AC power from the grid 110 but the Serban's power system 100 does not include the entire grid. This is consistent with the '755 Patent. *See, e.g.*, Ex-1001, Fig. 4.

123. Therefore, in my opinion, Serban discloses *an uninterruptible power supply* (*i.e.*, power system 100).

b. 1[A]

124. In my opinion, Serban teaches 1[A]'s *bi-directional converter configured to operate as an alternating current voltage source*.

125. As shown below, Serban's hybrid converter 102 (yellow) includes "a four-quadrant pulse width modulated (PWM) **bidirectional energy converter** (hybrid converter)." Ex-1005, ¶22.



Ex-1005, Fig. 1.

127. Therefore, in my opinion, Serban discloses *a bi-directional converter* (i.e., hybrid converter 102) *configured to operate as an alternating current voltage source* (e.g., “voltage-controlled source mode and controls the AC voltage... on the AC line 138”).

c. $\frac{1[B]}{[A]}$

128. In my opinion, Serban teaches 1[B]’s *direct current power port configured to be coupled to a battery*.

129. As shown below, Serban discloses a “DC port 132 [purple] of the hybrid converter 102 [yellow]” that is coupled to a battery bank 106 (green). Ex-1005, ¶22.

connected).

130. Therefore, it is my opinion that Serban discloses *a direct current power port (i.e., DC port 132) configured to be coupled to a battery (i.e., battery bank 106).*

d. 1[C]

131. In my opinion, Serban teaches *a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source.*

132. As shown below, Serban's AC port 130c (purple) is coupled to both the hybrid converter 102 (yellow) (i.e., *coupled to the bi-directional converter*) and the PV inverter 104 (blue) (i.e., *configured to be coupled to a current-source inverter*).

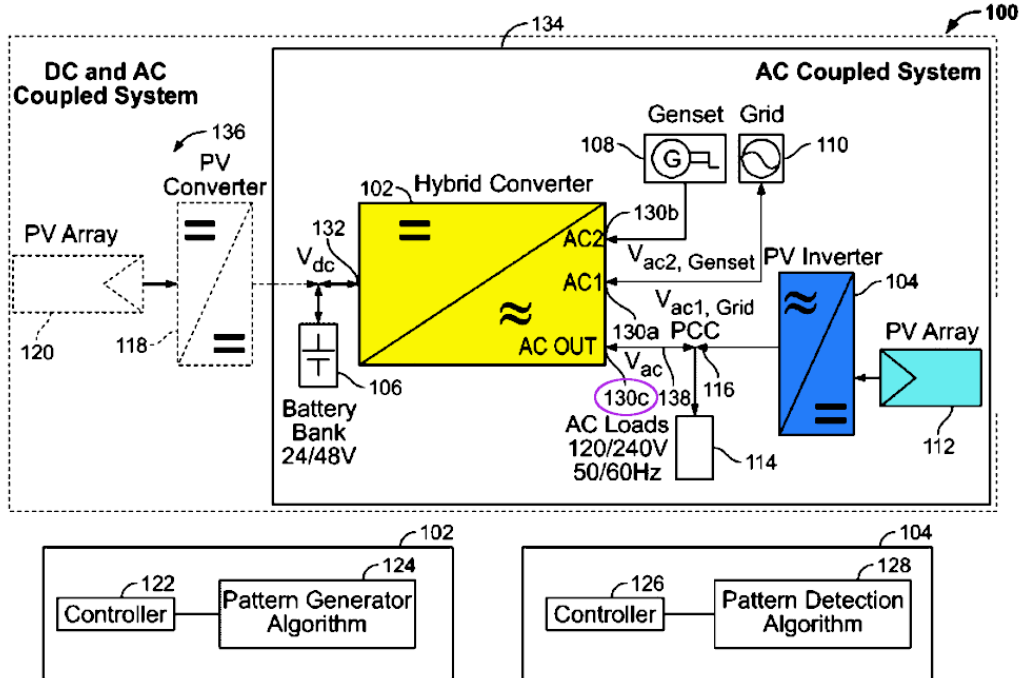


FIG.1

Ex-1005, Fig. 1. In my opinion, the PV inverter 104 (blue) is a current-source inverter because it receives “DC input... from... PV array[] 112 [light blue]” and “outputs... an AC current.” Ex-1005, ¶¶21, 23. Further, “PV Inverter 104 operates in a current-controlled mode, ...controlling the AC current in magnitude and phase.” *Id.*, ¶23. A POSA would understand this to mean the inverter 104 is configured as a current-source inverter.

133. Moreover, Serban discloses “**var[ying] the line frequency** or voltage according to a predetermined pattern **to cause a PV inverter to modify its power output** and thereby avoid overcharging a battery.” Ex-1005, Abstract; *see also id.*, ¶28. Serban’s hybrid converter 102 changes the frequency of V_{ac} , *i.e.*, at its AC port 130c. *Id.*, ¶17 (noting that converter 102 “**produces a modified output at a**

first AC output 130 c that varies the characteristic (e.g., **frequency** or voltage) of the AC line according to a first predetermined pattern that is produced by a first function.”).

134. Serban’s PV inverter 104 detects the frequency changes and adjusts its output accordingly. *See, e.g., id.*, ¶20 (explaining that inverter 104 detects “**the modified output produced by the first module 102**, and, in response to that detection, **causes the current or voltage** applied to the battery 106 for charging the battery 106 to be **changed via the first module 102.**”); ¶28 (“line frequency or voltage variation can be used as **interaction parameters between the hybrid converter 102 and the PV inverter 104.**”). Serban explains that “[t]he PV inverter 104 may **disconnect** because the AC line 138 frequency would exceed its frequency range limits or may **reduce its current produced** from the PV array 112 if a specific control is implemented by monitoring the AC line frequency, the agent of communication control.” *Id.*, ¶28.

135. I note that the ’755 Patent admits that “grid-tied photovoltaic inverters [] gradually reduc[ing] output power when the grid frequency deviates beyond a set limit” was required by “many electric utilities world-wide” before the ’755 Patent. Ex-1001, 1:26-30.

136. Therefore, it is my opinion that Serban discloses *a first alternating current power port* (i.e., AC port 130) *coupled to the bi-directional converter* (i.e.,

hybrid converter 102) *and configured to be coupled to a current-source inverter* (i.e., PV inverter 104), *wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source* (i.e., PV inverter 104 modifies its output power, such as by disconnecting or reducing current, in response to frequency changes).

e. 1[D]

137. In my opinion, Serban teaches *a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.*

138. As I have explained above, Serban discloses that its PV inverter 104 adjusts its output power by disconnecting or reducing the current based on frequency changes from the hybrid converter 102.

139. In my opinion, those frequency changes, which regulate power flow for Serban's PV inverter, are done through controller 122 because it modifies the frequency of the hybrid converter 102. Specifically, Serban's hybrid converter 102 "includes a first **controller 122** [red] programmed with machine-readable instructions for carrying out the generator pattern algorithm 124 [orange]," which is used to "produce[] a modified output at a first AC output 130c [purple] that varies the characteristic (e.g., frequency or voltage) of the AC line." Ex-1005, ¶17.

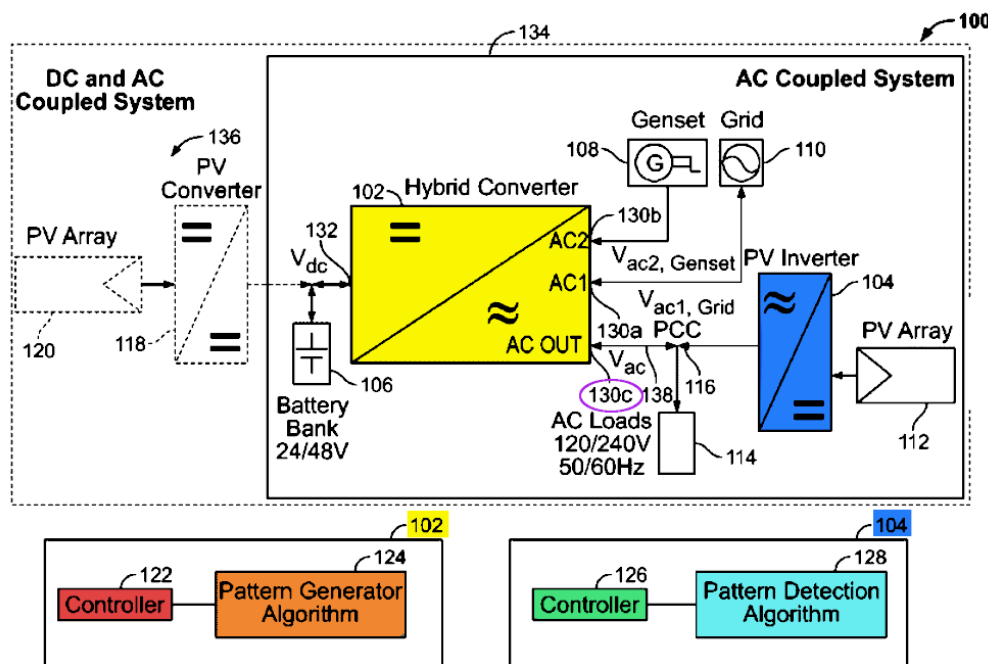


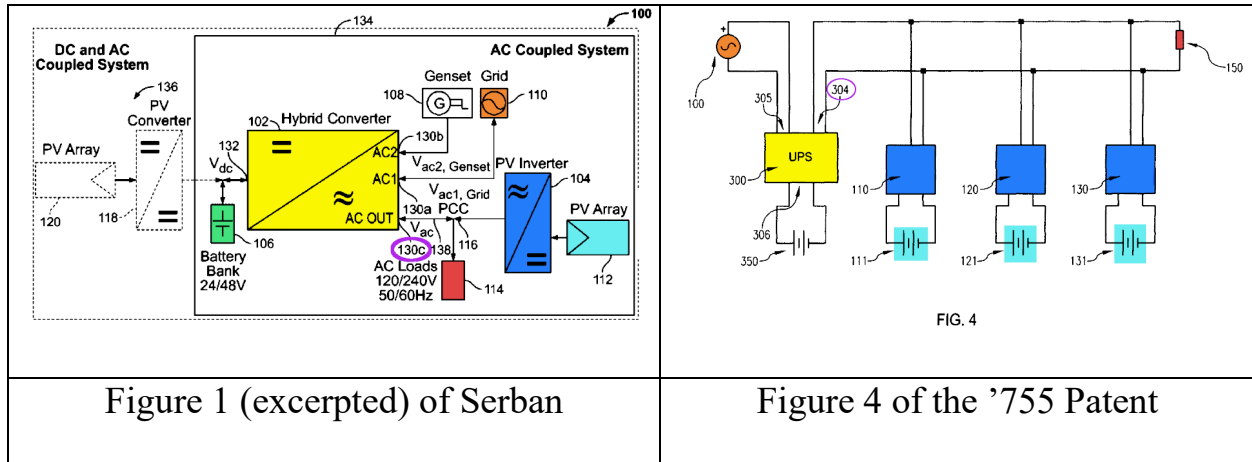
FIG.1

Ex-1005, Fig. 1. The controller 126 (green) of the PV inverter 104 (blue) “detects, via a pattern detection algorithm 128 (light blue), the modified output produced by the... [hybrid converter] 102, and, in response to that detection, causes the current or voltage applied to the battery 106 for charging... to be changed via the... [hybrid converter] 102.” *Id.*, ¶20; *see also* ¶55 (“The pattern generator algorithm 124 of the hybrid converter 102 starts to decrease the line frequency..., which is monitored by the pattern detection algorithm 128 of the PV inverter, which starts to decrease its output power $P_{pv-inverter}$...”).

140. In my opinion, this is just like the '755 Patent's embodiment, in which controller 301 of the UPS 300 (yellow) controls the frequency at port 304 (purple

circle), causing the output power change of the PV inverters 110, 120, and 130

(blue) to change. Ex-1001, 8:18-21. See side-by-side figure comparison below.



141. Therefore, it is my opinion that Serban discloses *a controller* (e.g., controller 122) *configured to regulate a power flow of the current-source inverter* (i.e., disconnecting or reducing the output current or power of the PV inverter 104) *by adjusting a frequency of the alternating current voltage source* (i.e., adjusting the frequency at AC port 130c according to the generator pattern algorithm 124).

2. Claim 2

142. Claim 2 depends from claim 1, and recites the following:

2. The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.

143. As I have explained above, claim 1 is disclosed by Serban. *Supra* Section XII.A.1. Claim 2 adds that *the controller is configured to regulate the*

power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state, which, in my opinion, is disclosed by Serban.

144. To begin with, I note that the term “ideal” is a subjective term and the specification of the ’755 Patent does not limit the boundaries thereof. For purposes of this declaration, I have interpreted an “ideal charging state” as some limit on the battery’s charging state.

145. As I have explained in Section XII.A.1.e, Serban’s controller 122 is configured to regulate the power flow of the PV inverter 104.

146. Serban discloses using its power-flow regulation of the PV inverter 104 is to maintain battery 106 at a predetermined ideal charging state and not overcharge the battery. For example, Serban discusses this situation when the system is in islanded mode when “the solar energy is greater than the load demand by the loads 114,” so “the surplus of power will flow [light blue] from the PCC 116 through the hybrid converter 102 (yellow), **eventually overcharging the battery 106 [light blue]**.” Ex-1005, ¶27.

control is implemented by monitoring the AC line frequency, the agent of communication control.

Ex-1005, ¶28; *see also, id.*, ¶4. According to Serban, battery charging profile (e.g., bulk, absorption, or float stages) may be determined by “a conventional battery charge algorithm,” which is used to “regulate[] the **DC voltage or current to the battery 106 within prescribed limits.**” *Id.*, ¶22. Serban teaches the inverter behavior when the battery charge and frequency limits have been exceeded. *See, e.g., id.*, ¶4 (“The PV inverter ceases to convert power until the AC line frequency limits are restored to the normal range as the battery DC level falls back **within the specified set point limits.**”); *see also id.*, ¶18; ¶35 (“the **maximum current limit** acceptable to the battery 106.”); ¶55 (“When the battery voltage exceeds a **predetermined current or voltage** resulting in an overcharging condition, the hybrid converter 102... begins to reduce the AC line frequency...”).

148. Therefore, in my opinion, Serban discloses that *the controller* (e.g., controller 122) *is configured to regulate the power flow of the current-source inverter* (e.g., disconnecting or reducing the current of the PV inverter 104) *to maintain the battery at a predetermined ideal charging state* (e.g., maintain DC voltage or current to battery 106 within “prescribed limits” or “battery charging limit requirements,” or avoid overcharging).

3. Claim 3

149. Claim 3 depends from claim 1, and recites the following:

3. The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.

150. As I have explained above, claim 1 is disclosed by Serban and I discussed this above in Section XII.A.1. Claim 3 adds *a second alternating current power port configured to be coupled to an alternating current grid*, which, in my opinion, is disclosed by Serban.

151. Serban's Figure 1 shows "a first AC input 130a [purple] for receiving energy from the utility grid 110 [orange]." Ex-1005, ¶18.

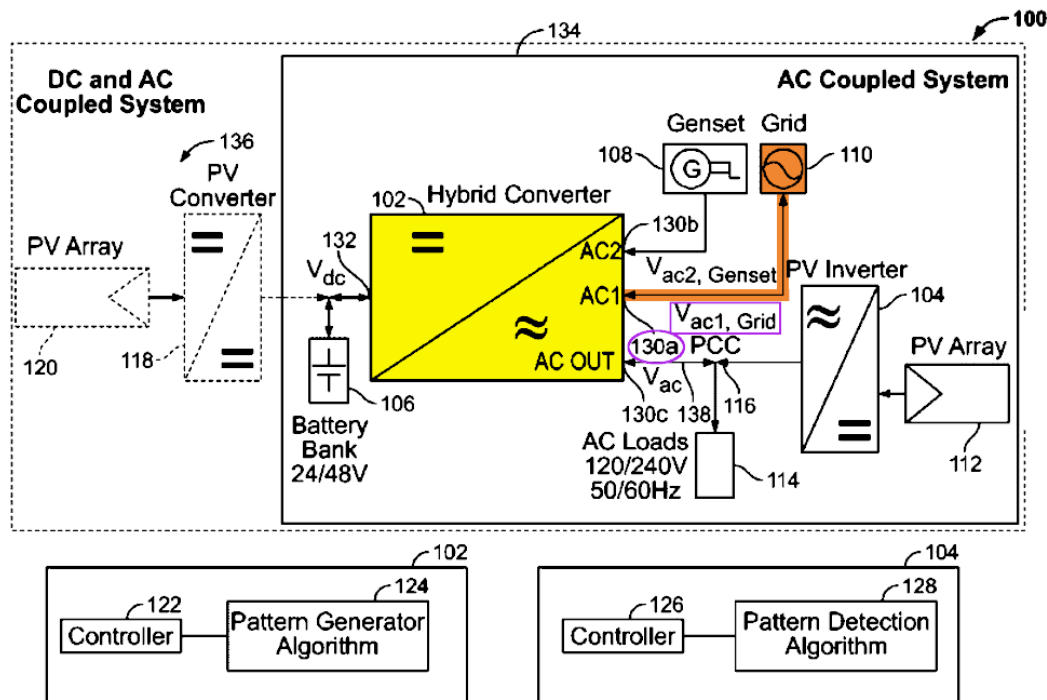


FIG.1

Ex-1005, Fig. 1. According to Serban, AC port 130a is also used by the hybrid

converter 102 for feeding energy to the utility grid 110 (indicated with bidirectional arrow (orange)). *See id.*, ¶24 (“When the power system 100 is in grid-connected mode, **the available energy from the battery 106 is transferred** to the AC loads 114 or **back to the utility grid 110** through the bidirectional hybrid converter 102...”).

152. In my opinion, Serban’s utility grid 110 is an AC grid because the port 130a is an “AC input... for receiving energy from the utility grid 110.” Ex-1005, ¶18. The “GRID” 110 is depicted in Figure 1 with a sinusoidally shaped symbol, which a POSA would recognize as an alternating current (AC) source, which in this context a POSA would understand is an AC utility grid. Moreover, Serban discloses that the utility grid 110 has frequency and phase, which a POSA would have understood to be unique parameters of an AC system. *See, e.g., id.*, ¶41 (“the minimum and maximum frequency range for **50 Hz grid-systems** can be 51-48 Hz or for **60 Hz grid-systems** can be 60.5-59.3 Hz.”); ¶44 (mentioning “grid frequency $f(t)$ and phase θ_0 ”).

153. Therefore, it is my opinion that Serban discloses *a second alternating current power port* (e.g., AC port 130a) *configured to be coupled to an alternating current grid* (e.g., utility grid 110).

4. Claim 4

154. Claim 4 depends from claim 1, and recites the following:

4. The uninterruptible power supply as set forth in claim 1, in which the bi-directional converter is also configured as an active rectifier.

155. As I have explained above, claim 1 is disclosed by Serban as I explained above in Section XII.A.1. Claim 4 adds that *the bi-directional converter is also configured as an active rectifier*, which, in my opinion, is disclosed by Serban.

156. The '755 Patent does not provide specifics as to the recited “active rectifier” besides thrice repeating that “[t]he power converter 302 functions as a rectifier.” Ex-1001, 7:66-67, 8:32, 8:43. Since these three references to “a rectifier” all follow discussions regarding charging the battery 350 (*id.*), it is my opinion that a POSA would have understood that the recited “active rectifier” is used to rectify voltage/current into the battery for charging. An active rectifier is well understood by a POSA to refer to a rectifier configured for being able to actively control the rectification process (e.g., using transistors), including rectifying voltage/current for battery charging and regulating charging current. *See, e.g.*, Ex-1023, p. 1 (“chargers with an active rectifier front end can mitigate this [deleterious harmonic effects on electric utility distribution systems].”); p. 4 (“A typical bidirectional charger has two stages: an active grid-connected bidirectional ac–dc converter that enforces power factor and a bidirectional dc–dc converter to regulate battery current”).

157. In my opinion, like the '755 Patent, Serban also discloses its hybrid converter 102 “operates in an **active rectifier mode** with optional power factor correction (PFC).” Ex-1005, ¶22. “In the **active rectifier mode**, the hybrid converter 102 **converts AC to DC energy and regulates the DC voltage or current to the battery 106 within prescribed limits**, such as in accordance with a conventional battery charge algorithm that determines a charging profile (e.g., bulk, absorption, or float stages) for the battery 106 (e.g., 24/48V).” *Id.*; see also ¶25 (“The hybrid converter 102 operates in **active rectifier mode**, charging the battery 106 so as not to exceed the grid current capacity.”).

158. Therefore, it is my opinion that Serban discloses that *the bi-directional converter* (i.e., hybrid converter 102) *is also configured as an active rectifier* (e.g., operate in an active rectifier mode).

5. Claim 5

159. Claim 5 depends from claim 4, and recites the following:

5. The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.

160. As I have explained above, claim 4 is disclosed by Serban. *Supra* Section XII.A.4. Claim 5 adds *the bi-directional converter is also configured as an alternating current source*, which, in my opinion, is disclosed by Serban.

161. I note that the '755 Patent does not explain what it means to configure its *bi-directional converter* as an *alternating current source* other than mentioning it once in passing. *See* Ex-1001, 3:19-20. Generally, a POSA would have understood that an alternating current (AC) source could be an AC voltage source or AC current source. I also understand that the scope of dependent claim 5 should be different and narrower than independent claim 1. Therefore, since claim 1 of the '755 Patent already recites that “a bi-directional converter configured to operate as an **alternating current voltage source**,” a POSA would have understood claim 5’s “alternating current source” to refer to “**alternating current [current] source**,” which is confirmed by the '755 Patent’s specification. For example, the '755 Patent describes its bidirectional converter “may be... a current-source inverter and a voltage-source inverter... coupled together...” Ex-1001, 7:29-34; *see also, id.*, 6:55-57 (“The power converter 302 may function as either a **current-source converter** or a voltage-source converter and may provide bi-directional power flow.”). Therefore, in my opinion, a POSA would have understood claim 5 to refer to the bidirectional converter being configured as a “current-source converter” and therefore becoming an “alternating current [current] source” in addition to its function as an *alternating current voltage source* (recited in claim 1).

162. The '755 Patent's bidirectional converter operates as a current-source converter when the grid is connected, and the bidirectional converter sources power from the battery to the load. As shown in Figure 5F of the '755 Patent below, "when the micro-inverter power is lower than required by the load 150 [red], and the power that would typically be drawn from the grid 100 [orange] would exceed the allowable peak load, **the battery 350 [green] provides sufficient to power to keep the grid power below the allowable peak load power.** The power converter 302 [of UPS 303 (yellow)] functions as a **current-source inverter.**" Ex-1001, 8:33-39. Thus, in my opinion, a POSA would have understood that having the battery 350 "provide[] sufficient power" means that DC from the battery 350 (green) is inverted to produce a source of AC power that is then provided to the load 150 (red) and reduces the power needed from the grid "to keep the grid power below the allowable peak load power." *Id.*

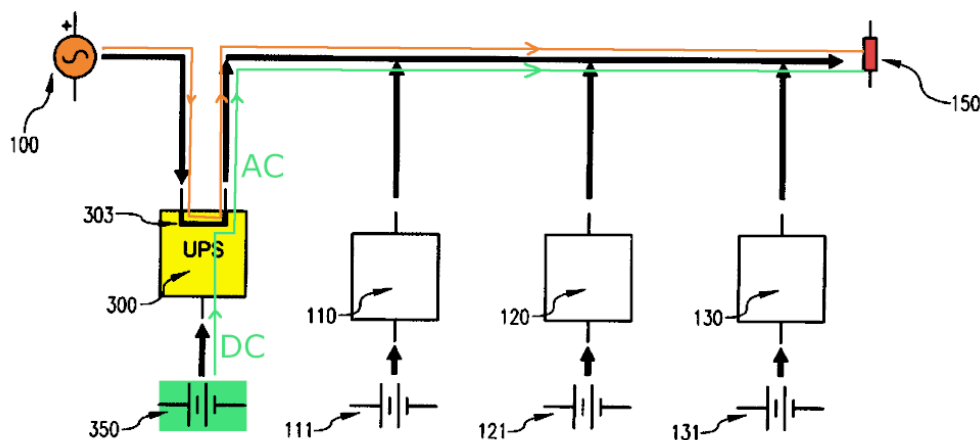


FIG. 5F

Ex-1001, Fig. 5F. Thus, according to the '755 Patent, the bidirectional converter functions to provide a source of current when (i) the grid is connected, and (ii) power is sourced from the battery to the load, because the bidirectional converter is functioning to provide a AC current to the load in addition to the grid, wherein the grid is providing the voltage and frequency to which the bidirectional converter is synchronized. .

163. In my opinion, Serban teaches the same. For example, Serban discloses that when in grid-connected mode, its bidirectional converter sources power from its battery to the load and the grid. *See, e.g.*, Ex-1005, ¶24 (“When the power system 100 is in **grid-connected mode**, the available **energy from the battery 106 is transferred to the AC loads 114 or back to the utility grid 110** through the bidirectional hybrid converter 102, which operates **in current-controlled source mode**.”). In my opinion, transferring “energy from the battery 106 ... to the AC loads 114 or back to the utility grid 110” means that Serban’s hybrid converter 102 is producing an alternating current source to provide power for the AC loads 114 or the utility grid 110, or both concurrently. At a minimum, a POSA would have understood that a bidirectional converter operating in “current-controlled source mode” while connected to an AC grid means that the bidirectional converter operates as a current-source inverter.

164. Therefore, it is my opinion that Serban discloses that *the bi-directional converter* (i.e., hybrid converter 102) *is also configured as an alternating current source* (e.g., provides a source of AC to the AC loads 114 or the utility grid 110 while in current-controlled source mode).

6. Claim 6

165. Claim 6 depends from claim 5, and recites the following:

6. The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.

166. As I have explained above, claim 5 is disclosed by Serban. *Supra* Section XII.A.5. Claim 6 adds that *the first alternating current power port is also configured to be coupled to a load*, which, in my opinion, is disclosed by Serban.

167. As shown below, Serban's AC port 130c (purple) is connected to a load 114 (red), and arrows between these components indicate current flow from AC port 130c to the load.

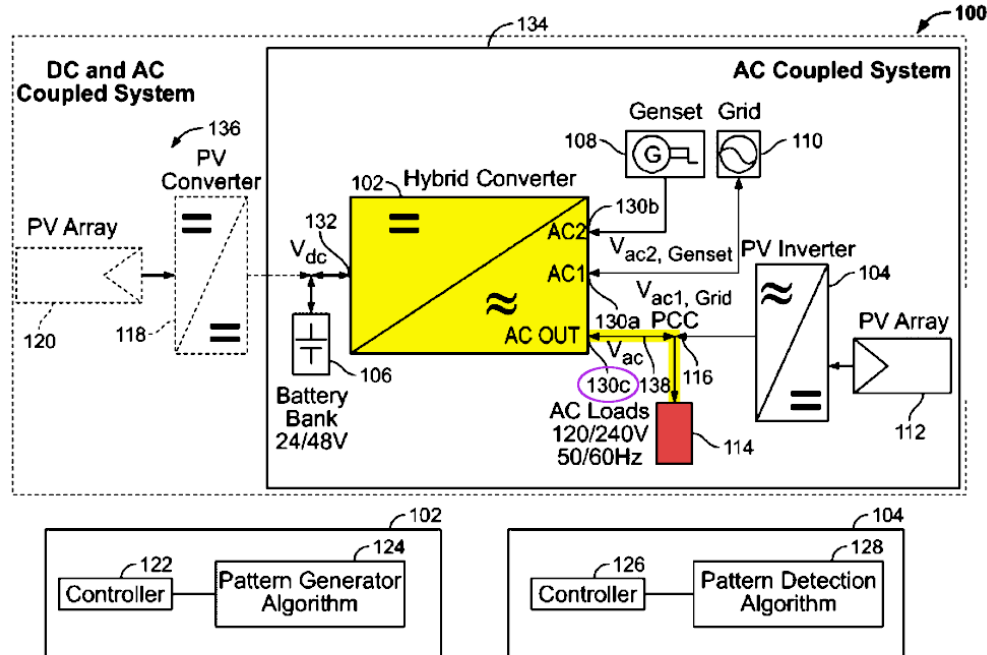


FIG.1

Ex-1005, Fig. 1.

168. Therefore, it is my opinion that Serban discloses that *the first alternating current power port* (e.g., AC port 130c) *is also configured to be coupled to a load* (e.g., load 114).

7. Claim 7

169. Claim 7 depends from claim 6, and recites the following:

7. The uninterruptible power supply as set forth in claim 6,

7[A] in which 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, and

7[B] in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.

170. As I have explained above, claim 6 is disclosed by Serban. *Supra* Section XII.A.6. Claim 7 adds 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*, while also adding that *the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period*. In my opinion, Serban teaches all of these.

171. Regarding inverter disconnection, in Serban, when power system 100 is in islanded mode (graphically depicted as an example using the orange cross below), the PV inverter 104 can be disconnected (graphically depicted as an example using the blue cross below) to avoid overcharging the battery 106 (green).

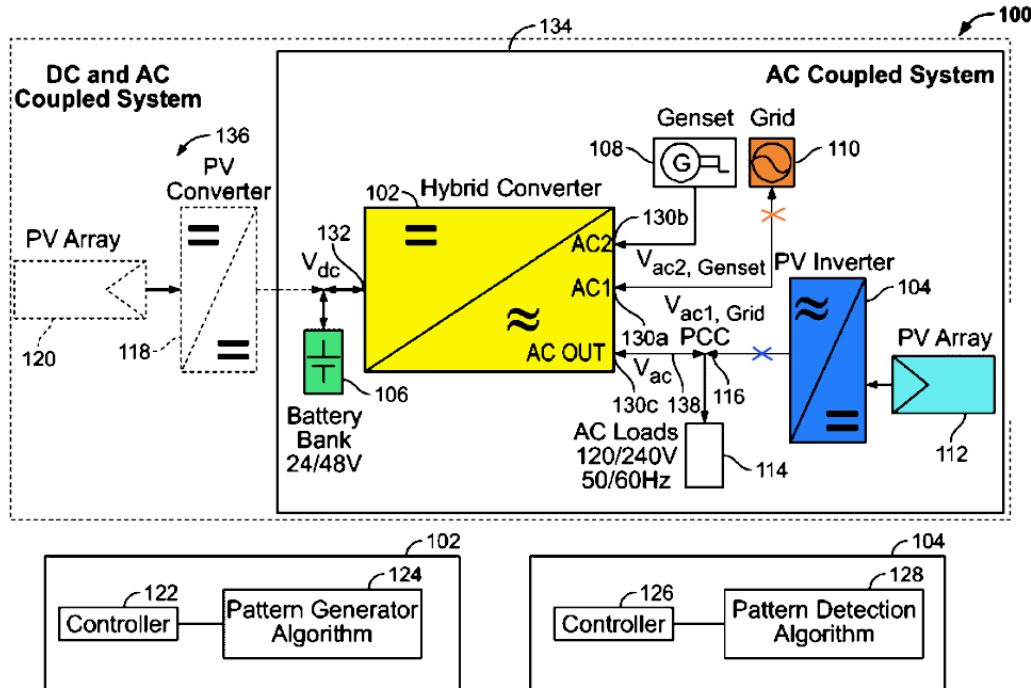


FIG.1

Ex-1005, Fig. 1. For example, Serban discloses that “[i]n the islanded mode, the AC line 138 frequency is set by the hybrid converter 102... When the **minimum frequency limit** is reached, the PV inverter 104 **disconnects from the AC network**, interrupting power to the DC port.” *Id.*, ¶42; *see also* ¶28 (noting PV inverter 104 disconnection “because the AC line **138 frequency would exceed its frequency range limits.**”). In fact, the ’755 Patent admits that “to increase the safety of utility systems,... disconnect[ing] all photovoltaic inverters from the grid if the voltage or frequency deviates beyond a predetermined range” was already well-known and required by “most photovoltaic systems” before the Patent. Ex-1001, 1:30-36.

172. Before entering islanded mode, when in grid-connected mode, “the hybrid converter 102 [yellow] operates as a current-controlled source converter [green arrow]... [and] the utility grid 110 [orange] generates the AC voltage and frequency.” Ex-1005, ¶22.

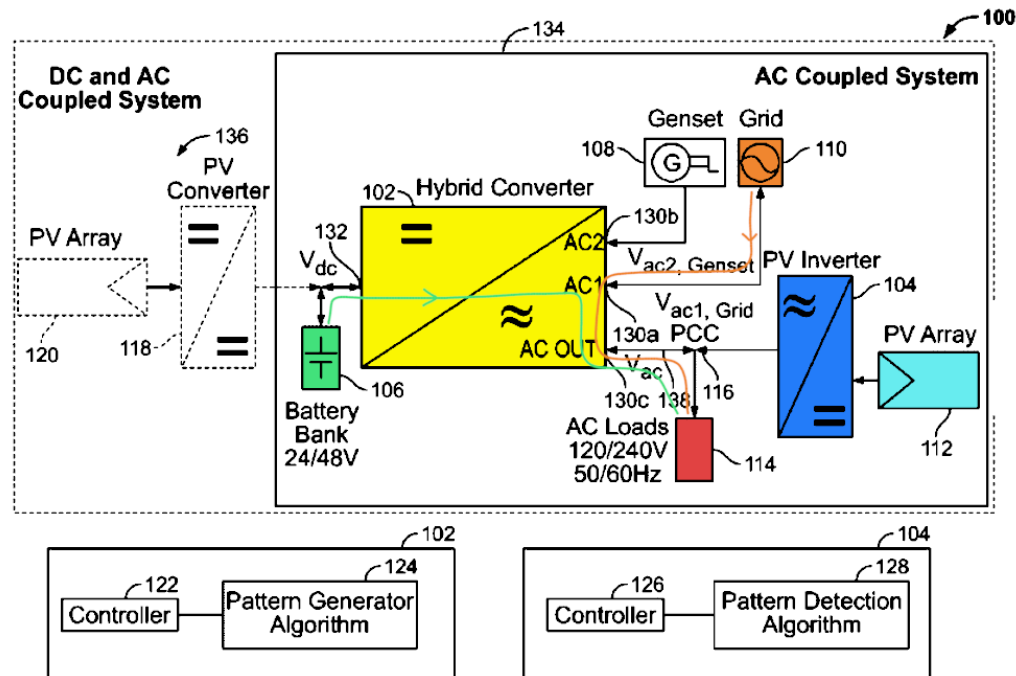


FIG.1

Ex-1005, Fig. 1. Thus, a POSA would have understood that before entering islanded mode, the AC line 138 frequency is controlled by (e.g., the same as) the grid frequency, e.g., via the “integrated transfer switch[] on [] AC port[] 130a.” *Id.*, ¶26. In fact, it was well understood that a switched connection ensures the frequency and voltage are the same at the ports on either side of the switch. At the time the utility grid 110 fails, the grid frequency and/or voltage is no longer within a certain range (and can disappear entirely). The AC line 138 frequency also

exceeds the minimum frequency limit (e.g., drops to zero), causing disconnection of the PV inverter 104. In Serban, such frequency range limit is called “anti-islanding limit,” which is “defined by the Underwriters Laboratory (UL) 1741 or the Institute of Electrical and Electronics Engineers (IEEE) 1547 Standards or other anti-islanding limits imposed by requirements from other countries.” *Id.*, ¶37. “For example, the anti-islanding limit can be between 59-61 Hz for a 60 Hz rated frequency on the AC line 138. Preferably, the frequency pattern is varied within ± 0.4 Hz (e.g., or 59.6-60.4 Hz for a 60 Hz rated fundamental frequency or 49.6-50.4 Hz for a 50 Hz rated fundamental frequency).” *Id.* Serban also illustrates in its Figure 7 how the anti-islanding limit is used to control the power system behavior. As shown below, when the AC line frequency f (red) is disturbed and “decreased beyond the anti-islanding limit (yellow) of the PV inverter 104,” the output of PV inverter 104 is decreased (blue) to zero (which a POSA would have understood to imply a disconnection of the PV inverter 104) and is maintained disconnected for some time period.

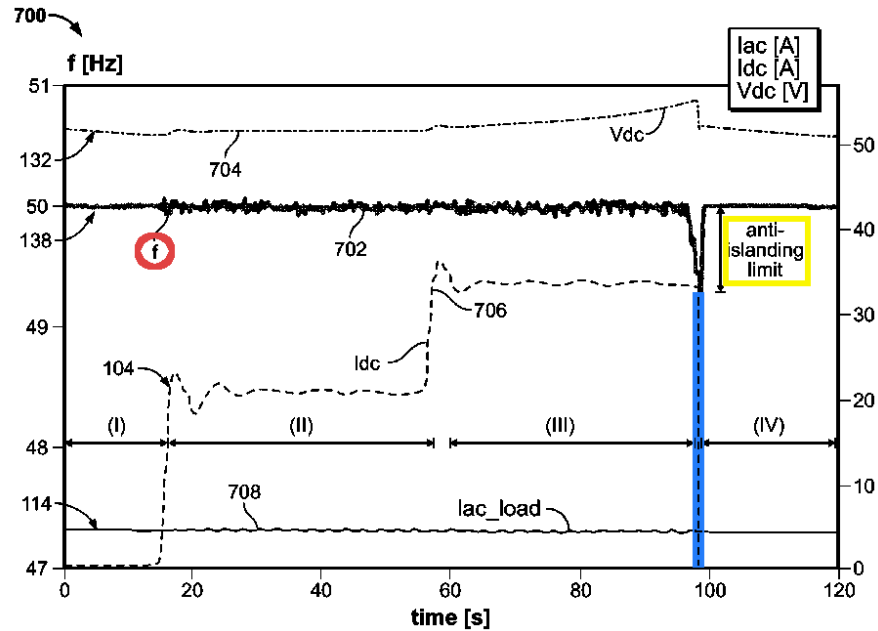


FIG. 7

Ex-1005, Fig. 7. *See also* my description of anti-islanding in Section V.D above.

173. To summarize, it is my opinion that there are at least two PV-inverter-disconnection scenarios in Serban: (i) while in islanded mode and frequency limits are reached and (ii) when the grid fails and a transition into islanded mode occurs. PV inverter 104 (blue) is connected to the AC network at the point of common coupling (PPC) (purple), which is coupled to port 130c of the hybrid converter 102 (yellow), so in my opinion, a POSA would have understood that when the PV inverter 104 (blue) disconnects from the AC network, *i.e.*, from the PCC (purple), it is disconnected from the hybrid converter 102 (yellow).

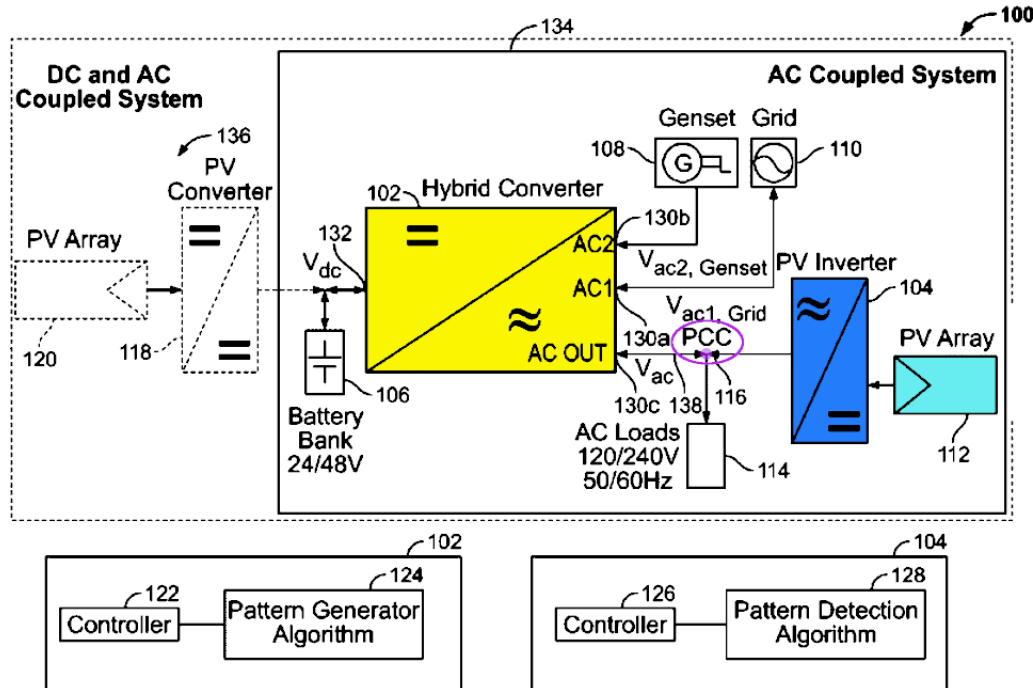


FIG.1

Ex-1005, Fig. 1.

174. While in islanded mode after either disconnection scenario, Serban discloses that “[t]he PV inverter **ceases to convert power until the AC line frequency limits are restored** to the normal range.” *Id.*, ¶4. In other words, the PV inverter 104 remains disconnected from the AC network until the hybrid inverter 102 restores the AC line frequency back to normal range.

175. The ’755 Patent provides no guidance as to what it means for an outage to be predetermined (the Patent repeats the phrase and provides no specifics). Regardless, in my opinion, the period of time during which Serban’s PV inverter remains disconnected is predetermined at least because it is (or necessarily is) entirely dependent on (and determined by) an amount of time taken

by the hybrid converter 102 to restore the AC line 138 to a normal frequency range. To the extent that the *predetermined outage period* refers to something predetermined about a grid outage specifically, it is my opinion that Serban's frequency range limit is predetermined and therefore the grid failure is predetermined in the sense that the conditions that trigger the grid failure are predetermined. For example, "the minimum and maximum frequency range for 50 Hz grid-systems can be 51-48 Hz or for 60 Hz grid-systems can be 60.5-59.3 Hz," Ex-1005, ¶41, and if the frequency on AC line 138 moves outside of these predetermined ranges, then an outage occurs.

176. As to sourcing power to the load, it is my opinion that Serban discloses that its controller 122 is configured to control the hybrid converter 102 to source power to the load when the PV inverter 104 is disconnected. Serban discloses that "[w]hen the power system 100 is in islanded mode [*i.e.*, when the utility grid 110 is not available],... [e]nergy for the AC loads 114 can be sourced by either or both of the PV array 112 [light blue] and the battery 106 [green]." Ex-1005, ¶27.

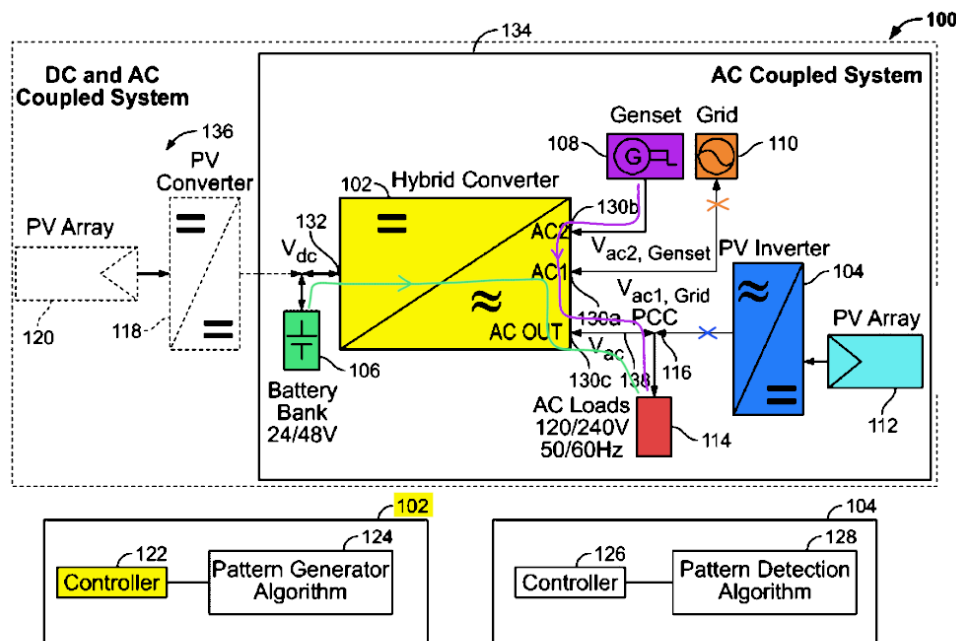


FIG. 1

Ex-1005, Fig. 1. In my opinion, a POSA would have understood that because Serban’s controller 122 is “(a) a microprocessor, (b) a microcontroller, and/or (c) any other suitable processing device” (*id.*, ¶59), it is therefore capable of controlling the power flow at each port of the hybrid converter 102, including power flow from battery (green) and/or genset (purple) to the load (red).

177. Therefore, it is my opinion that Serban discloses that *the current-source inverter* (i.e., PV inverter 104) *is configured to disconnect from the alternating current voltage source* (i.e., hybrid converter 102) *for a predetermined outage period* (e.g., period of time during which PV inverter is disconnected until the hybrid converter 102 restores the AC line frequency back to normal) *when the alternating current voltage source frequency goes outside of a predetermined frequency limit* (e.g., causing the AC line frequency to drop to zero and outside of

predetermined frequency range limit for a grid system), and that *the controller* (i.e., controller 122) *is configured to control the bi-directional power converter* (i.e., hybrid converter 102) *to source power to the load* (i.e., load 114) *during the predetermined outage period.*

8. Claim 13

178. Claim 13 depends from claim 7, and recites the following:

13. The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.

179. As I have explained above, claim 7 is disclosed by Serban. *Supra* Section XII.A.7. Claim 13 adds that *the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit,* which, in my opinion, is disclosed by Serban.

180. As I have explained in Section XII.A.7 (claim 7), when the utility grid 110 fails (e.g., when the grid frequency and/or voltage exceeds a certain range), the PV inverter 104 is disconnected from the AC network, and a POSA would have understood that disconnecting from the AC network is disconnecting from the hybrid converter 102. This teaching is unsurprising as the Patent itself admits that disconnecting the PV inverter from the grid upon grid failure was well-known. For

example, the Patent states that “[a] voltage-frequency relay 180 monitors the voltage and frequency of the utility grid 100. **When either the voltage or frequency of the utility grid 100 deviates outside of a predetermined range** (which varies from one region of the world to another), the voltage-frequency relay 180 [yellow] **opens internal switches to disconnect the micro-inverters 110,120,130 [blue]....**” Ex-1001, 5:17-23.

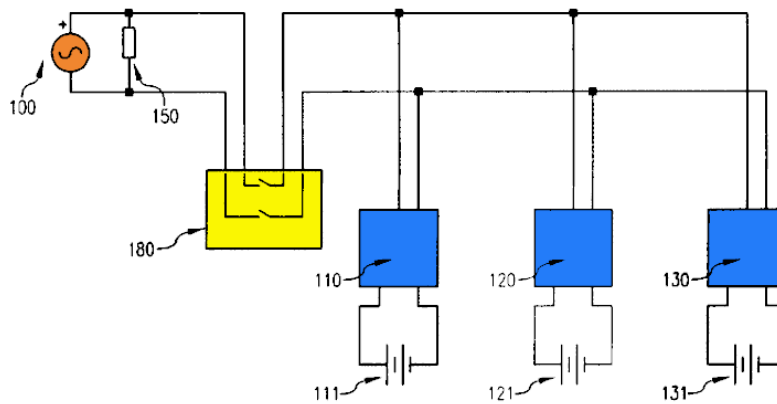


FIG. 1 (PRIOR ART)

Ex-1005, Fig. 1.

181. While Serban’s hybrid converter 102 (yellow) and PV inverter 104 (blue) have their own controllers (*i.e.*, controller 122 (red) and controller 126 (green), respectively), Serban discloses that “various functions of the different modules and units can be **combined** or segregated” and “blocks described may be... **combined**.” Ex-1005, ¶¶58-59. A POSA would understand certain control functions may be combined (integrated) and/or distributed. Serban also indicates

that control functions 122 and 126 (along with others) can be integrated on a single DSP. *Id.*, ¶56 (“The **control functions 122, 124, 126, 128** are implemented as a 32-bit TMS320F2812 DSP running at 150 MHz.”).

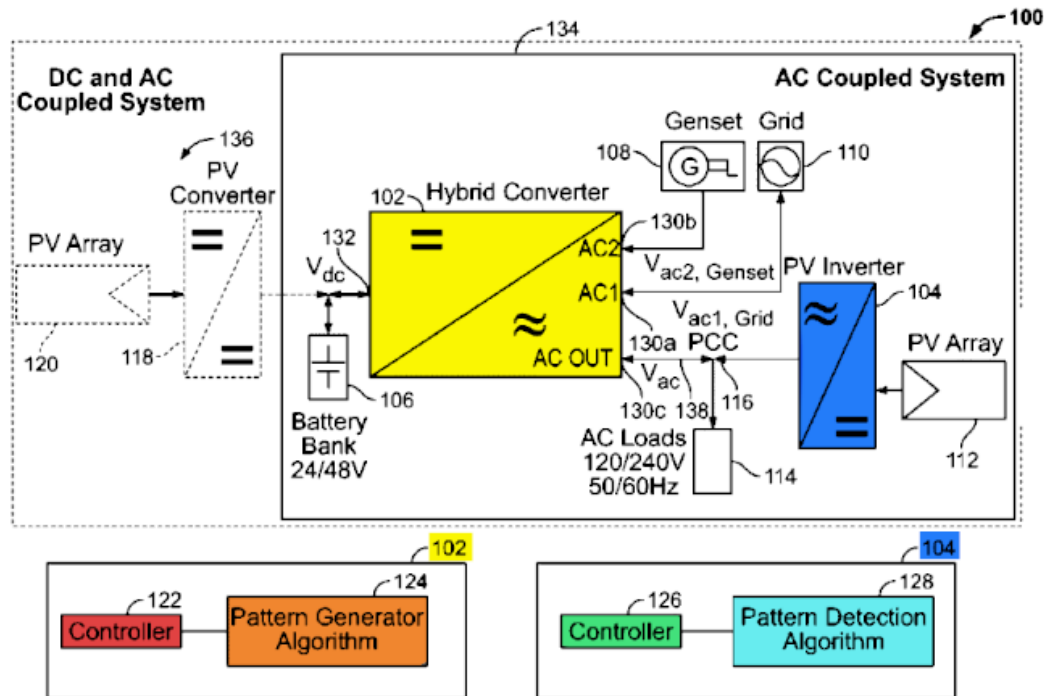


FIG.1

Ex-1005, Fig. 1. Thus, in my opinion, a POSA would have understood that controller 122 and controller 126 of Serban may be combined into a single controller (at a minimum, would have at once envisioned this), which is referred to as “Serban’s Controller” hereinafter. It is also my opinion that a POSA would have understood that Serban’s Controller is capable of performing not only those functions relevant to Pattern Generator Algorithm 124 and Pattern Detection Algorithm 128, but also various other controls needed by its power system 100, such as power conversion between battery 106, genset 108, grid 110, and PV

inverter 104, the transfer switches, as well as interfacing with these power sources and systems, including disconnecting the PV inverter 104.

182. Therefore, it is my opinion that Serban discloses that *the controller* (e.g., Serban's Controller) *is configured to disconnect the current-source inverter* (e.g., PV inverter 104) *from the alternating current grid* (e.g., utility grid 110) *when a voltage or frequency of the alternating current grid goes outside of a predetermined limit* (e.g., when the grid fails).

9. Claim 18

183. Claim 18 combines claims 1, 2, and 5-7 and is disclosed for reasons provided above, as the way that claim 18 combines this earlier features is shown in the table below.

Claim 18	Claims 1, 2, 5-7	Sections
18[P]: An uninterruptible power supply comprising:	1[P]: An uninterruptible power supply comprising:	XII.A.1.a
18[A]: a bi-directional converter configured to operate as an alternating current voltage source and as an alternating current source;	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.A.1.b
	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.A.5
18[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.A.1.c

18[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a load, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source, and	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and 6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.A.1.d
18[D]: wherein 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period; and	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	XII.A.7
18[F]: a controller configured to—regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source, and	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.	XII.A.1.e

18[G]: [a controller configured to—]regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	XII.A.2
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B. My Opinions as to Claims 1-7 and 13-18 based on Serban in view of Matan.

1. Motivation to Combine Serban with Matan

184. In my opinion, Serban and Matan qualify as **analogous art** at least because they are in the **same field of endeavor** as the Patent, *i.e.*, grid-tied photovoltaic systems. For example, the Patent is concerned with “managing power flow in grid-tied photovoltaic systems.” Ex-1001, 1:7-8. Serban similarly teaches “[a] control strategy for distributed power generation modules in a power system” that includes PV arrays and a utility grid. Ex-1005, Abstract, ¶4. Matan “relate[s] to management of power transfer from a local power source [such as solar cells] to a load that is tied to a utility power grid.” Ex-1006, ¶¶2-3. At a minimum, it is my opinion that Serban and Matan are reasonably pertinent to at least one problem of controlling inverter outputs to address problems with system performance as identified by the ’755 Patent. *Compare* Ex-1001, 8:18-21 (“the power converter 302 may adjust the frequency of the voltage across the micro-inverters 110,120,130 to cause the power output of the micro-inverters 110,120,130 to be

reduced.”) *with* Ex-1005, ¶28 (“The PV inverter 104 may disconnect because the AC line 138 frequency would exceed its frequency range limits...”); Ex-1006, ¶74 (“control[ing] harmonic distortion of the output current signal and the phase shift between the grid voltage and the output current signal of a grid-tied solar photovoltaic or other source”); ¶45 (“In one embodiment, the dynamic modification of the parameters is performed with a table-based method for adaptively modifying the produced AC current waveform to correct power-factor and to reduce total harmonic distortion.”).

185. **Harmonic distortion correction.** In my opinion, a POSA would **have been motivated** to incorporate Matan’s harmonic distortion correction into Serban.

186. Serban explicitly teaches that the goal of the system is to “control the power flow for energy prioritization and system efficiency maximization.” Ex-1005, ¶4. Serban teaches several ways to maximize efficiency, including that its “PV inverter 104 is preferably transformerless due to its higher efficiency and smaller size and weight” (*id.*, ¶23), that “the PV array 112 [is] connected at the PCC 116 through the PV inverter 104 for maximizing energy conversion efficiency” (*id.*, ¶25), as well as synchroniz[ing] [the output of the PV inverter 104] with the grid frequency $f(t)$ and phase Θ_0 to achieve a unity power factor” (*id.*, ¶44). In my opinion, from Serban’s instructions, a POSA would have sought

to further maximize system efficiency, so would have looked to similar references, like Matan, for system-efficiency improvements, such as by harmonic distortion correction.

187. Matan teaches that “the power transfer from the source to the load is further improved with reduction of harmonic distortion.” Ex-1006, ¶27. Moreover, unlike “[p]revious harmonic distortion techniques [that] use[s] a hardware-based method or Fast Fourier Transform (FFT)[,]... [Matan]’s table-based method implemented on a processor or controller reduces cost per inverter and scales better than typical hardware implementations.” *Id.*, ¶35. Therefore, it is my opinion that a POSA looking to achieve efficiency gains for Serban’s system would have utilized Matan’s teachings at least to reduce costs per inverter and achieve better scalability.

188. Moreover, Matan explicitly states that “harmonic distortion correction” is required by regulations. Ex-1006, ¶75 (noting that regulations “require that the current be reduced in harmonic distortion.”). As I also mentioned in Section V.E, harmonic distortion is limited by multiple standards, such as IEEE 519-1992 and IEEE 1547-2003. Thus, in seeking to build a regulatory-compliant and standard-compliant version of Serban’s PV inverter, it is my opinion that a POSA would have been motivated to include harmonic mitigation techniques.

Existing PV inverters before the Patent included the maximum harmonic distortion as a parameter on their spec sheets:

Grid output (AC)	
Startup current	<2A
Maximum grid backfeed current	0 A
Waveform	True sine
Power factor	>0.99 @ nominal power
Total Harmonic Distortion	<3%
DC Component	<0.5%
Phase	Split Phase or Single phase

Ex-1010, p.67. Therefore, in my opinion, a POSA implementing Serban's system would have been motivated to include harmonic distortion reduction capabilities for its PV inverter 104 and would have looked to references like Matan for efficiency gains and to achieve regulatory compliance. At minimum, since harmonic distortion mitigation techniques were well known before the '755 Patent and limits on harmonic distortion were part of regulatory requirements and standards, it is my opinion that incorporating harmonic distortion mitigation into Serban would have been combining prior art elements according to known methods and applying a known technique (*i.e.*, harmonic distortion correction) to a known device ready for improvement (*i.e.*, Serban's system).

189. In my opinion, a POSA would have had a **reasonable expectation of success** in incorporating Matan's harmonic distortion correction into Serban. Harmonic distortion correction was a regulatory and standard requirement and would have been something that a POSA would have routinely implemented for

compliant systems. In addition, Matan provides a detailed explanation for controlling harmonic distortion, e.g., in its Figure 5:

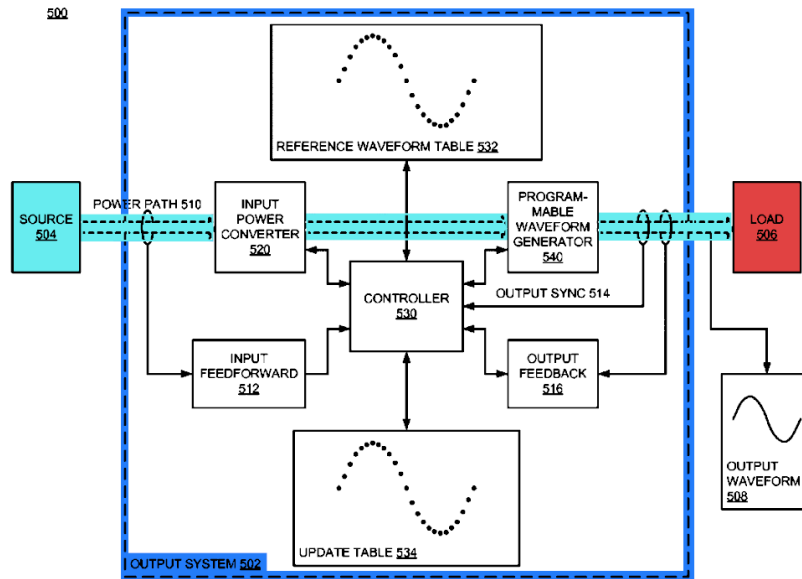


FIG. 5

Ex-1006, Fig. 5; *see also id.*, Fig. 6; *id.*, ¶11. As shown, Matan's output system 502 (blue) resides between the power source 504 (light blue) and the load 506 (red). Thus, in my opinion, to add Matan's harmonic distortion correction to Serban, a POSA would have incorporated Matan's output system 502 (above) into Serban's PV inverter 104 (blue) and would have reasonably expected it to work.

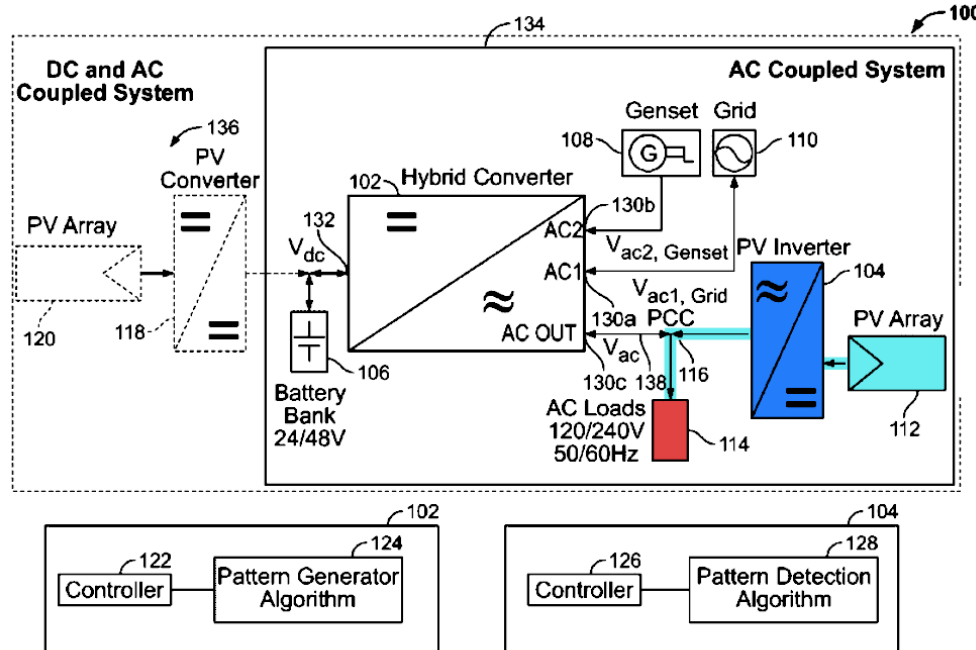


FIG.1

Ex-1005, Fig. 1. Moreover, both Serban's system and Matan's system employ a controller, and it is my opinion that a POSA would have found it straightforward and routine to adapt Serban's Controller (e.g., through straightforward software and/or firmware updates) to perform functions of Matan's controller 530.

190. **Power-factor conditioning.** I note that Matan uses the terms power-factor correction, power-factor control, and power-factor conditioning in the disclosure. In my opinion, a POSA would have understood the meaning and implication of these terms in context. If one has to distinguish these terms, a POSA would have understood that power-factor correction generally implies creating a power factor that is closer to 1, i.e., unity power factor, while power-factor conditioning often implies adjusting power factor as desired, which could be values other than 1, such as due to tariffs or due to an attempt to regulate the power

factor at the system level. Power-factor control tends to be a broader term, which a POSA would have understood to cover both power-factor correction and power-factor conditioning.

191. In my opinion, a POSA would **have been motivated** to incorporate Matan's power-factor conditioning into Serban's system as well.

192. Serban teaches several ways to "control the power flow for energy prioritization and system efficiency maximization," including "power factor correction (PFC)," but does not go into implementation details for PFC. Ex-1005, ¶4. In my opinion, a POSA implementing Serban's system would have been motivated to look to other references, like Matan, for details on how to implement PFC.

193. While Serban mentions the desirability of "achiev[ing] a unity power factor" (Ex-1005, ¶44), which Matan too acknowledges (Ex-1006, ¶44), Matan goes even further and recognizes that "[t]he best benefit may not always be a power factor of unity... [and] the power factor may be best set at a value based on power grid conditions as well as tariff conditions." Ex-1006, ¶145. For example, according to Matan, "California... required utilities operating in that state to pay solar PV owners for both active and reactive power when these owners supply them to the grid... Therefore, there is considerable benefit to PV owners to supply a mix of both types of power depending on their agreed tariff and/or PPA." *Id.*,

¶127. “The utilities therefore have an incentive to produce tariffs encouraging PV owners to construct power factor controlling PV systems, while PV owners have the incentive to use them on their PV systems. Supplying power to the grid from a PV (or other local source) system based on grid conditions (e.g., time of day, reactive and/or active power needs) can create a benefit to both the utility and the consumers.” *Id.*, ¶128. Thus, in my opinion, a POSA looking to improve Serban’s system performance, efficiency, and economic benefit, especially in states such as California, by taking into account “power grid conditions as well as tariff conditions” would have been motivated to implement power-factor control in Serban using Matan’s implementation details.

194. In addition, adjusting power factor (to a value other than 1) was already implemented in commercially available PV inverters.

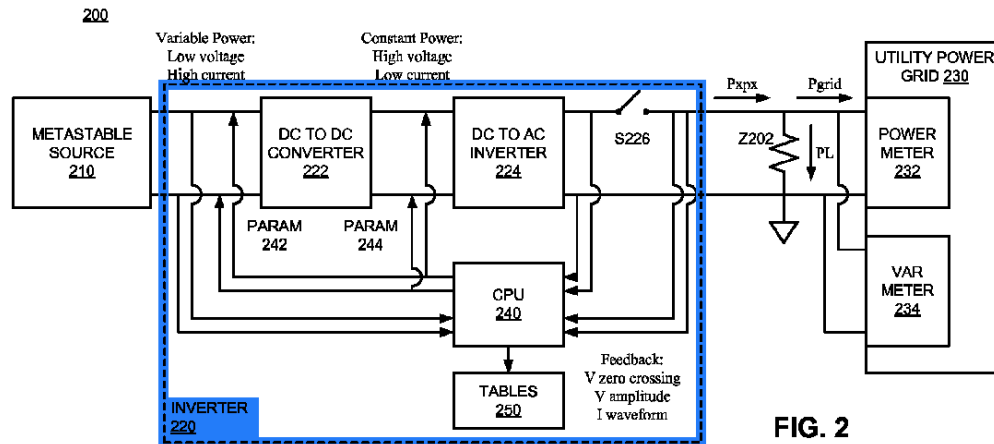
Output data	
Rated AC power [W]	1500
Max. apparent AC Power [VA]	1650
Rated AC grid voltage [V]*	220,230,240
Rated AC grid frequency [Hz]*	50
AC voltage range [V]*	180-280
AC frequency range [Hz]	According to local codes
Rated current @ 230 Vac [A]	6.5
Max. current [A]	9
Power factor	> 0.99 (0.95 inductive ... 0.95 capacitive)
Harmonic distortion (THD) at rated output	< 2 %
Power consumption at night [W]	< 1
Power consumption at standby [W]	6

Ex-1018; Ex-1014. Thus, it is my opinion that a POSA would have found it

obvious (including based on market pressures requiring such a feature to produce a competitive product) to incorporate such a commercially adopted and standard feature into Serban's PV inverter 104. In my opinion, beyond this explicit motivation, this combines prior art elements according to known methods and applies a known technique (*i.e.*, Matan's power-factor conditioning) to a known device ready for improvement (*i.e.*, Serban's system).

195. In my opinion, a POSA would have had a **reasonable expectation of success** in incorporating Matan's power-factor conditioning into Serban's system. As mentioned, power-factor conditioning was well-known for inverter systems and was used in existing PV inverters as well as other inverter systems that are connected to an AC system. Generally, the feature is implemented by controlling the converter's circuitry so that the current is synchronized with the voltage but with a non-zero displacement angle. Thus, it is also my opinion that a POSA would have found it straightforward to follow existing techniques to implement such a standard feature in Serban because of the well-known hardware and software modifications needed.

196. Moreover, Matan instructs via Figure 2 how to implement its power factor correction or conditioning in an inverter 220 (*e.g.*, a PV inverter).



Ex-1006, Fig. 2; *see also id.*, Figs. 3, 17-23. *See also*, for example, discussion in *id.*, ¶¶118, ¶126, and ¶¶144-145. Therefore, it is my opinion that implementing Matan’s power-factor conditioning in Serban was straightforward and a POSA would have reasonably expected it to work.

2. Claims 1-7, 13, and 18

197. In my opinion, Serban-Matan renders obvious claims 1-7, 13, and 18 because Serban anticipates those features for the reasons I have explained in Section XII.A. The Serban-Matan combination adds harmonic distortion and power factor conditioning features on top of Serban’s teachings, so those features from Serban remain in the Serban-Matan system. Beyond the express or necessary disclosures in Serban, if PO contends that certain features were not anticipated, it is my opinion that those were at least rendered obvious by Serban-Matan.

198. As one example, to the extent PO argues that Serban does not explicitly disclose disconnecting PV inverter 104 in case of grid failure (*see*

Section XII.A.7 (claim 7), it is my opinion that a POSA would have found it obvious in view of Serban's teachings. As I explained in Section XII.A.7, Serban discloses reducing the output of PV inverter to zero when the grid frequency goes beyond the anti-islanding limit. In my opinion, a POSA would have understood that there are only a limited number of ways of reducing the output of PV inverter to zero, which includes disconnecting or turning off the PV inverter, or disconnecting or turning off the solar cells. A POSA facing with these options would have found it obvious to try each of them. Moreover, Serban already discloses that "[t]he PV inverter 104 may **disconnect** because the AC line 138 frequency would exceed its frequency range limits" (Ex-1005, ¶28), a POSA would have found it obvious to disconnect the PV inverter in the event of grid failure.

199. As another example, to the extent PO argues that Serban does not explicitly disclose the controller 122 controlling the power flow of the hybrid converter 102, it is my opinion that a POSA would have found it obvious in view of Serban's teachings. If the system is in the islanded mode then necessarily the power flow is controlled in order to follow the load. The hybrid converter must also vary its output to balance the load with the battery output and the PV inverter output. And the hybrid converter must change its output to accommodate the battery charging states.

200. As one other example, to the extent PO argues that Serban does not explicitly disclose a single controller performing control functionalities of its power system, it is my opinion that a POSA would have found it obvious to do so. For example, Serban discloses using a DSP to implement its controllers. Ex-1005, ¶56. In my opinion, a POSA would have understood that it is much more cost effective to use a single DSP to implement all the controllers (i.e., as a single controller, or “Serban’s Controller”) than to implement each controller using a separate DSP. A POSA would have understood that this would not only reduce the number of DSP chips needed, but also reduce the footprint for the circuit board, making the resulted system more compact.

3. Claim 14

201. Claim 14 depends from claim 6, and recites the following:

14. The uninterruptible power supply as set forth in claim 6, in which the controller is configured to regulate a power flow of the current-source inverter so as to cancel a distortion current produced by the load.

202. As I have explained above, claim 6 is rendered obvious by Serban. *Supra* Section XII.B.2. The Serban-Matan combination adds features on top of those disclosed by Serban alone, as discussed in Section XII.A, so those features from Serban remain in the Serban-Matan system.

203. Claim 14 adds that *the controller is configured to regulate a power flow of the current-source inverter so as to cancel a distortion current produced by the load*, which, in my opinion, is taught or suggested by Matan.

204. Matan’s system provides “total harmonic distortion control.” *Id.*, ¶27. Matan’s inverter 120 (blue) receives DC power from source 110 (light blue) and “dynamically **produce[s] maximum AC current [red] relatively free of harmonic distortion.**” *Id.*, ¶31.

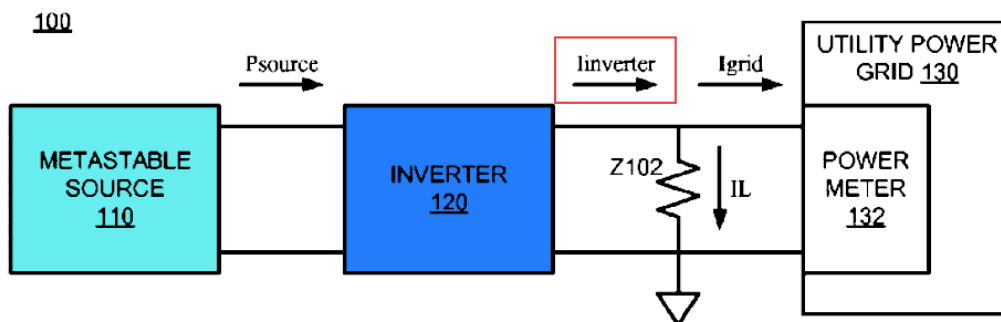


FIG. 1

Ex-1006, Fig. 1.

205. Matan illustrates in Figure 5 “a system that controls harmonic distortion with a software feedback control subsystem coupled to a hardware waveform controller.” Ex-1006, ¶58.

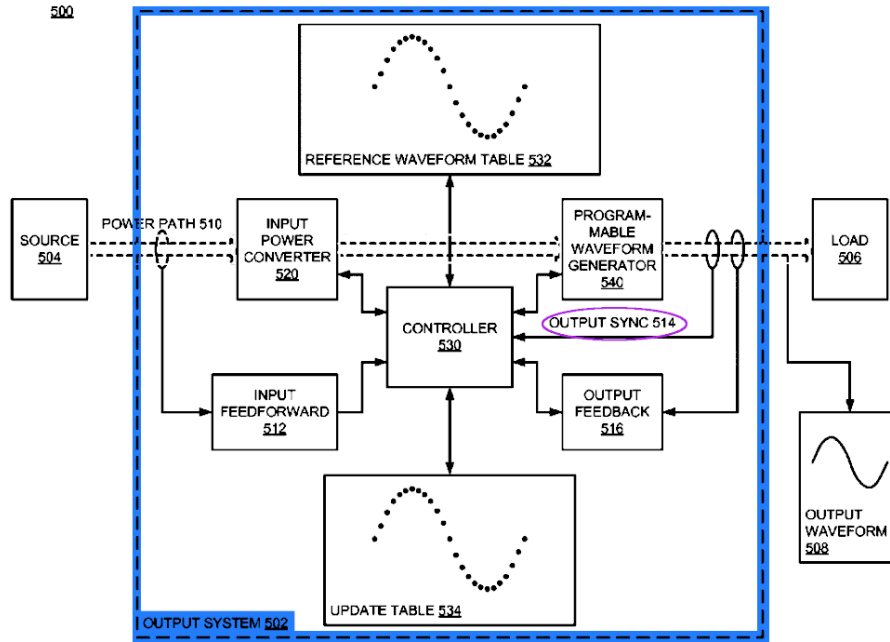


FIG. 5

Ex-1006, Fig. 5. In particular, this output system 502 (blue) “is able to incorporate specific timing, phasing, or other frequency information [i.e., input synchronization data], into generating output waveform 508.” Ex-1006, ¶62.

“[S]uch input synchronization data arrives from real-time **load information**, in which case it may be referred to as ‘load synchronization input’... [and] indicated... as output sync 514 [purple].” *Id.* In other words, Matan’s total harmonic distortion correction takes into account the load’s real-time timing, phasing, and other frequency information and therefore reduces the harmonic distortion current produced by the load. Thus, in my opinion, a POSA would have understood that Matan’s reducing total harmonic distortion necessarily includes correcting harmonic distortion current produced by the load. I note that Harmonic distortion was commonly understood as harmonic distortion current.

206. Matan further discloses that “[b]ased on output feedback 516, output system 502 [blue] generates update table 534 [yellow]... [which] includes entries or points to indicate how to modify the operation of generator 540 to provide an output more closely matching the waveform of reference waveform table 532 [green].” Ex-1006, ¶166. The values in the update table 534 “are applied to the hardware that controls the output of generator 540 to cause the output signal to converge on the desired ideal waveform” and thereby canceling the harmonic distortions in the system.

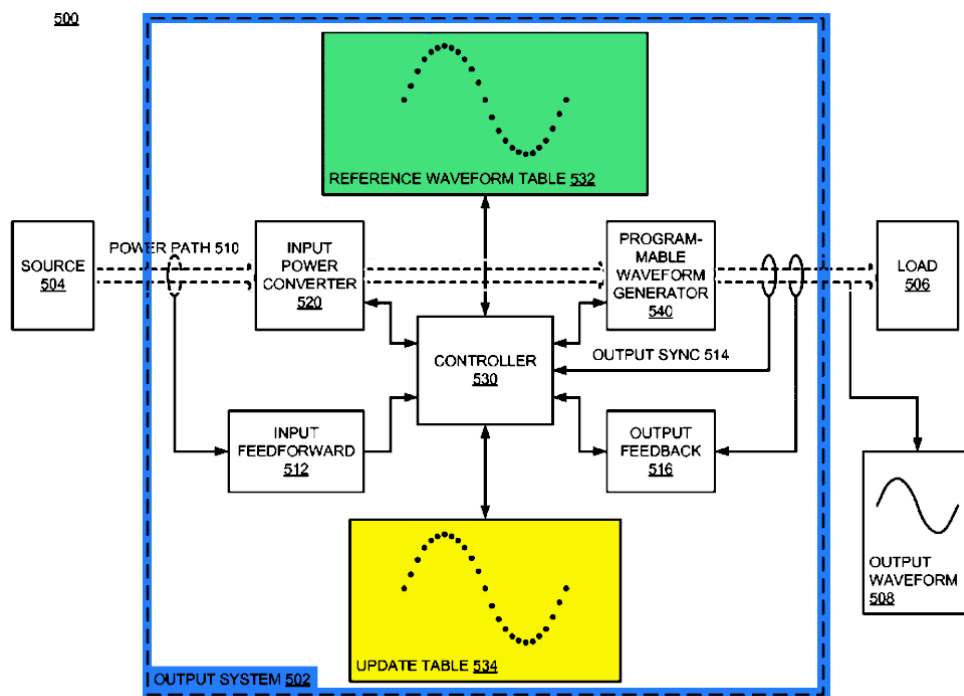


FIG. 5

Ex-1006, Fig. 5.

207. Therefore, it is my opinion that Serban-Matan renders obvious that *the controller* (e.g., Serban’s Controller) *is configured to regulate a power flow of the*

current-source inverter (e.g., AC current of Serban's PV inverter 104) *so as to cancel a distortion current produced by the load* (e.g., Matan's harmonic distortion correction).

4. Claim 15

208. Claim 15 depends from claim 1 and recites the following:

15. The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate a power flow of the current-source inverter to produce an alternating current that is displaced from the grid voltage.

209. As I have explained above, claim 1 is rendered obvious by Serban.

Supra Section XII.B.2. The Serban-Matan combination adds features on top of those disclosed by Serban alone, as discussed in XII.A, so those features from Serban remain in the Serban-Matan system.

210. Claim 15 adds that *the controller is configured to regulate a power flow of the current-source inverter to produce an alternating current that is displaced from the grid voltage*, which, in my opinion, is taught or suggested by Serban-Matan.

211. Matan discloses implementing power-factor correction in a PV inverter (blue). Ex-1006, ¶52.

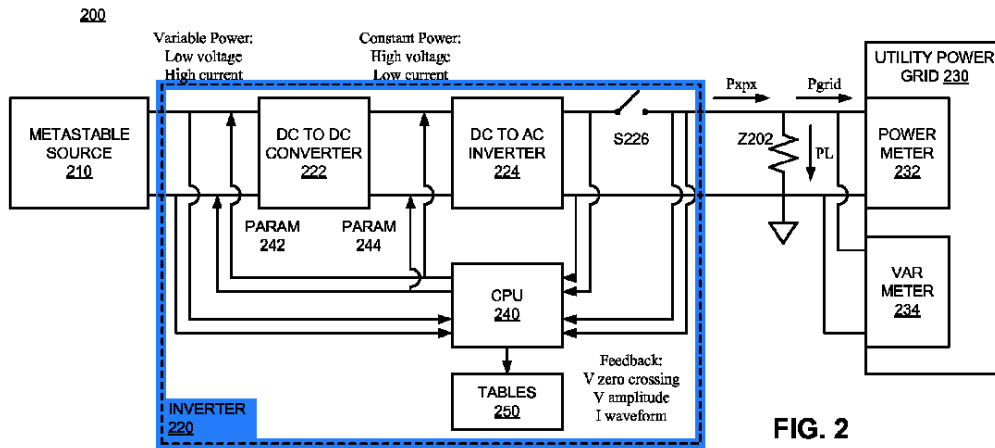


FIG. 2

Ex-1006, Fig. 2.

212. According to Matan, “the AC current [red] [generated by PV inverter 120, blue] may be intentionally changed to be out of phase to a certain extent with respect to the AC voltage signal of the grid [orange].” Ex-1006, ¶ 32.

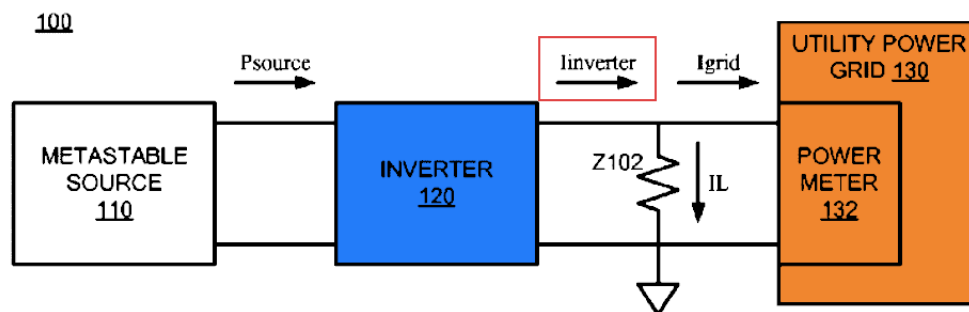


FIG. 1

Ex-1006, Fig. 1. In this way, “the single inverter 120 [blue] can deliver power at any desired power factor to compensate for conditions of power on power grid 130.” *Id.*, ¶32. As I also explained in Section V.F, power factor control was also well known and implemented in commercially available PV inverters before the ’755 Patent.

213. By incorporating Matan's power-factor conditioning into Serban's system, it is my opinion that PV inverter 104 would then deliver any desired power-factor of the PV inverter 104 based on grid conditions, as taught by Matan.

214. Therefore, it is my opinion that Serban-Matan renders obvious that *the controller* (e.g., Serban's Controller) *is configured to regulate a power flow of the current-source inverter to produce an alternating current that is displaced from the grid voltage* (e.g., changing the AC current output by Serban's PV inverter 104 to be out of phase to a certain extent with respect to Serban's AC grid, as taught by Matan).

5. Claim 16

215. Claim 16 depends from claim 15 and recites the following:

16. The uninterruptible power supply as set forth in claim 15, in which an amount of displacement of the alternating current is determined by a preset limit.

216. As I have explained above, claim 15 is rendered obvious by Serban-Matan. *Supra* Section XII.B.4. Claim 16 adds that *an amount of displacement of the alternating current is determined by a preset limit*, which, in my opinion, is taught or suggested in Matan.

217. I note that the Patent provides no specific examples as to what *an amount of displacement* means, nor any examples of a *preset limit* for determining that amount. Against this backdrop, it is my opinion that a POSA would have

understood that displacement means the displacement angle between the voltage and the current (which is directly related to power factor), and Matan constrains those using preset limits when making power-factor corrections. According to Matan, “[t]he maximum power factor equals 1, when phase angle 1602 has a value of 0. The minimum power factor equals 0, when phase angle 1602 is 90 degrees.” Ex-1006, ¶125. Thus, in my opinion, Matan discloses that amount of phase displacement is limited by a preset limit, *i.e.*, no more than 90 degrees.

218. Moreover, use of a preset limit was common at the time and is not innovative. Thus, should PO argue that use of a preset limit distinguishes claim 16 from the prior art, it is my opinion that such a trivial difference does not rise to the level of a nonobvious innovation. In my opinion, a POSA’s general background knowledge in this field is replete with use of preset limits for power factor (and hence current displacement angle), so that difference (even if it exists) is obvious. Ex-1018.

219. Therefore, it is my opinion that Serban-Matan renders obvious that *an amount of displacement of the alternating current is determined by a preset limit* (e.g., phase-shift amount is determined by preset limits).

6. Claim 17

220. Claim 17 depends from claim 15 and recites the following:

17. The uninterruptible power supply as set forth in claim 15, in which the amount of displacement of the

alternating current is controlled through external communication with the controller.

221. As I have explained above, claim 15 is rendered obvious by Serban-Matan. *Supra* Section XII.B.4. Claim 17 adds that *the amount of displacement of the alternating current is controlled through external communication with the controller*, which, in my opinion, is taught or suggested by Matan.

222. Matan discloses setting the power factor (and thereby the amount of phase shift) “based on power grid conditions as well as tariff conditions.” Ex-1006, ¶145. For example, as shown in Figure 17 below, Matan’s PV inverter 1720 (blue) “controls the power factor at point ‘A’... through electrical measuring meter 1730 [red].” *Id.*, ¶129.

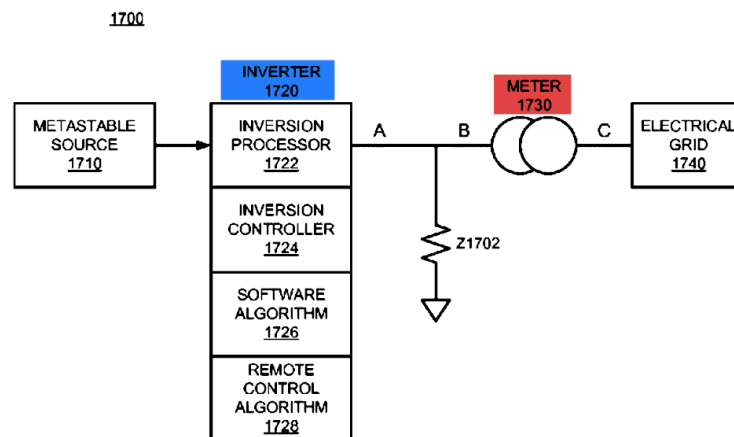
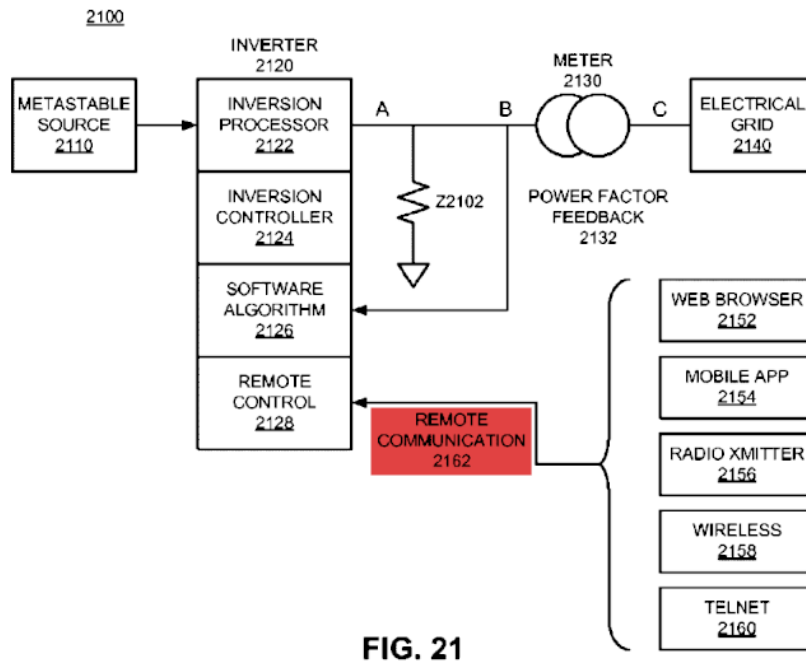


FIG. 17

Ex-1006, Fig. 17. “[M]onitoring can be done by the utility (for example, by using **WiFi (e.g., 802.1x wireless systems)**) for all or many of the arrays in a neighborhood or geographic area.” *Id.*, ¶130. Matan also discloses that “an

inverter can apply changes in response to a **remote command**. The command may indicate a desired power factor, a delta or correction value, a relative value that can be applied, or may indicate to measure locally and correct based on measured values.” *Id.*, ¶138.

223. As illustrated in Matan’s Figure 21, “remote communication [red] may allow for utility control of the power factor setting, rather than owner control.” Ex-1006, ¶143.



Ex-1006, Fig. 21.

224. In my opinion, since Serban’s Controller controls the output of the PV inverter 104, a POSA would have understood that, in the Serban-Matan system and following Matan’s teachings, the amount of displacement is communicated (either

by owner control or through remote communication, consistent with Matan's teachings) to Serban's Controller for performance of power-factor conditioning.

225. Therefore, it is my opinion that Serban-Matan renders obvious *the amount of displacement of the alternating current is controlled through external communication with the controller* (e.g., owner control or remote communication with Serban's Controller, as taught by Matan).

C. My Opinions as to Claims 8-12 and 19-20 based on Serban in view of Matan and Wilhelm.

1. Motivation to Combine Serban with Matan and Wilhelm

226. In my opinion, Serban, Matan, and Wilhelm are **analogous art** at least because they are in the **same field of endeavor** as the Patent, *i.e.*, grid-tied photovoltaic systems. Serban and Matan are in that field of endeavor (*supra* Section XII.B.1). So is Wilhelm, which concerns "reduc[ing] the peak power demand of a customer from an electric power utility by controllably directing power from [a secondary source of electric power, such as] a storage battery" or "a power generator or photovoltaic device" to a load. Ex-1009, 2:41-49; 12:66-13:4. It is my opinion that at a minimum, Serban, Matan, and Wilhelm are reasonably pertinent to at least one problem, such as load demand management, identified by the '755 Patent. *Compare* Ex-1001, 6:62-65 ("When operating as a current-source inverter for peak load regulation, the power converter 302 may use power from the

DC port 306 to inject current into the AC port 305.”) *with* Ex-1005, ¶24 (“When the power system 100 is in grid-connected mode, the available energy from the battery 106 is transferred to the AC loads 114 or back to the utility grid 110 through the bidirectional hybrid converter 102, which operates in current-controlled source mode.”); Ex-1006, ¶117 (“the operation of system 1400 can be modified to provide power having other characteristics that may be more desirable to grid 1430 (e.g., the utility company), particularly at times of peak power consumption.”); Ex-1009, 1:19-27 (“the invention relates to apparatus and a method for shifting loads by buying and storing electrical power at the customer side during off-peak power demand periods and using the stored electrical power during high demand times.”); 2:41-57.

227. **Matan’s battery-to-grid power sourcing.** In my opinion, a POSA would **have been motivated** to incorporate Matan’s battery-to-grid power sourcing into Serban. Incorporating Matan’s battery-to-grid power sourcing in Serban would have furthered the motivating system-efficiency goals discussed above (Section XII.B.1).

228. As Matan discloses, supplying power to the grid from a PV system or a battery based on grid conditions creates a benefit to both the utility and the consumers. Ex-1006, ¶128. This is because the consumers are compensated by doing so and “the utilities therefore save considerable sums.” *Id.*, ¶¶126-127.

Thus, it is my opinion that a POSA would have been motivated to enable Serban's system to sell battery power to the grid to maximize its system power efficiency (e.g., so that excess or unused power in the system is not wasted), and thereby fueling a desire to incorporate Matan's battery-to-grid power sourcing. In my opinion, in addition to the system-efficiency gains, further motivation existed in building a power-supply product (in implementing Serban's teachings in a commercial product) that was marketable to a broader base of consumers. *See* Ex-1006, ¶116 (customer compensated for providing power to the grid); ¶127 (noting utilities paying solar PV owners who supply power to the grid).

229. In my opinion, a POSA would also have had a **reasonable expectation of success** in incorporating Matan's battery-to-grid power sourcing into Serban. Serban already had a hardware configuration through which power is able to flow from the battery 106 to the grid 110 (Ex-1005, Fig. 1) and, therefore, no change to Serban's hardware is likely to be needed.

230. In my opinion, the software and/or firmware changes to incorporate Matan's teachings into Serban were straightforward for a POSA, exercising only ordinary skill. Matan's battery-to-grid power source was acknowledged by the '755 Patent to be existing prior art technology (*see* Ex-1001, 5:42-47) and was nothing new or challenging to implement. Matan also states that "[t]he State of California, United States, recently required utilities operating in that state to pay

solar PV owners for both active and reactive power when these owners supply them to the grid. It is expected that other states will follow suit.” Ex-1006, ¶127. Matan also indicates that its battery-to-grid power sourcing was in use even before Matan, with more deployment expected thereafter (*id.*), so in my opinion, the straightforwardness of incorporating this feature into Serban would have been well-known.

231. **Wilhelm’s trigger condition.** In my opinion, a POSA would **have been motivated** to incorporate Wilhelm’s trigger condition into the Serban-Matan system.

232. Matan teaches supplying battery power to the grid “based on grid conditions (e.g., time of day, **reactive and/or active power needs**).” Ex-1006, ¶128. Matan also teaches that “[t]he tariff structure requires the customer to pay more, for example, if the power is used during peak demand hours, when the utility has little reserve available for emergencies.” *Id.*, ¶5. Thus, in my opinion, it was known that a higher utility demand can be mitigated through battery-to-grid power flow.

233. It is my opinion that as a part of incorporating battery-to-grid power sourcing into Serban-Matan, a POSA building that system would have been motivated to understand the circumstances under which the battery-to-grid sourcing features should be enabled. In my opinion, this would have led a POSA

to consult analogous references for additional details and options on such an implementation, like Wilhelm, for details on triggering Matan's battery-to-grid power sourcing based on utility demands.

234. Moreover, the goal of Serban's system is to "control the power flow for energy prioritization and system efficiency maximization." Ex-1005, ¶4. In my opinion, a POSA looking to better prioritize energy and maximize system efficiencies would have been motivated to utilize Wilhelm's trigger condition to determine when to activate battery-to-grid functions, thereby ensuring that power from the battery is provided to the grid at times when the grid needs it most.

235. It is my opinion that a POSA would also have had **reasonable expectation of success** in incorporating Wilhelm's trigger condition into the Serban-Matan system. Use of a threshold was well known before the '755 Patent, and would only require minor modification to Serban-Matan's software and/or firmware. If the system was digital and there was an appropriate signal coming from a system to initiate the trigger, the condition implementation should only require some minor code modifications. Thus, in my opinion, a POSA would have found it straightforward to incorporate Wilhelm's trigger condition into the Serban-Matan system, and have reasonably expected the modified Serban-Matan-Wilhelm system to work.

2. Claim 8

236. Claim 8 depends from claim 6 and recites following:

8. The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.

237. As I have explained above, claim 6 is rendered obvious by Serban.

Supra Section XII.B.2. The Serban-Matan combination adds features on top of those disclosed by Serban alone, as discussed in Section XII.A, so those features from Serban remain in the Serban-Matan system. Claim 8 adds that *the controller includes a predetermined power level set-point*, while also adding that *the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point*, which, in my opinion, is taught or suggested by the Serban-Matan-Wilhelm combination.

238. Matan discloses “[s]upplying power to the grid from a PV (or other **local source**) system based on grid conditions (e.g., time of day, reactive and/or active **power needs**) can create a benefit to both the utility and the consumers.” Ex-1006, ¶128; *see also* ¶129. Matan’s local source includes “photovoltaic cells or panels, a **battery or batteries**...” *Id.*, ¶81. Thus, in my opinion, Matan discloses

sourcing power from the battery to the AC grid based on grid conditions such as power needs.

239. Wilhelm discloses that power may be sourced from the battery (to the load) when “the amount of power drawn from the utility by the customer [] **exceeds the set point threshold.**” Ex-1009, 8:56-59. For example, Wilhelm discloses an exemplary scenario where “the customer’s demand has increased to 850 K watts, which is 50 K watts over the 800 K watt set point threshold set in the management system” and that Wilhelm’s “**load** controlled by the system **will draw** 50 K watts of power from the utility through the AC-to-DC converter 38 and **50 K watts of power from the storage battery.**” *Id.*, 9:3-9.

240. As I have explained in Section XII.C.1, a POSA would have been motivated to incorporate Matan’s battery-to-grid power sourcing capability into Serban’s system while making use of Wilhelm’s trigger condition, *e.g.*, activate the battery-to-grid feature from Matan when Wilhelm’s trigger condition occurs (power drawn from the utility grid exceeds a set point threshold).

241. In my opinion, because Serban’s Controller controls power conversion and interfaces with both the grid 110 and the battery 106 (Section XII.B.2), a POSA would have found it obvious to use Serban’s Controller to control the battery-to-grid power sourcing in the Serban-Matan-Wilhelm system. It is also my opinion that because Serban’s Controller includes a processing device

executing software stored in a non-volatile memory, such as “a flash memory”

(Ex-1005, ¶59), a POSA would have found it obvious to store Wilhelm’s set point threshold in Serban’s non-volatile memory.

242. Therefore, it is my opinion that Serban-Matan-Wilhelm renders obvious that *the controller* (e.g., Serban’s Controller) *includes a predetermined power level set-point* (e.g., Wilhelm’s set point threshold), and that *the controller is configured to source power from the battery to the alternating current grid* (e.g., source power from Serban’s battery 106 to Serban’s grid 110, per Matan) *when the power sourced from the alternating current grid exceeds the predetermined power level set-point* (e.g., “the amount of power drawn from the utility by the customer [] exceeds the set point threshold,” per Wilhelm).

3. Claim 9

243. Claim 9 depends from claim 8 and recites the following:

9. The uninterruptible power supply as set forth in claim 8, in which the controller includes a non-volatile memory element configured to store the predetermined power level set-point.

244. As I have explained above, claim 8 is rendered obvious by Serban-Matan-Wilhelm. *Supra* Section XII.C.2. Claim 9 adds that *the controller includes a non-volatile memory element configured to store the predetermined power level set-point*. In my opinion, this was an obvious feature of Serban-Matan-Wilhelm, as noted above.

4. Claim 10

245. Claim 10 depends from claim 8 and recites the following:

10. The uninterruptible power supply as set forth in claim 8, in which the controller includes a real-time clock, and in which the predetermined power level set-point varies as a function of the time of day as determined by the real-time clock.

246. As I have explained above, claim 8 is rendered obvious by Serban-Matan-Wilhelm. *Supra* Section XII.C.2. Claim 10 adds that *the controller includes a real-time clock*, while also adding that *the predetermined power level set-point varies as a function of the time of day as determined by the real-time clock*, which, in my opinion, is taught or suggested in Serban-Matan-Wilhelm.

247. Matan discloses that “determining a power transfer strategy includes determining or identifying and selecting power distribution rules,” which “can be applied consistently, or may be adjusted for any of a number of scenarios (e.g., **change in demand, time of day...**” Ex-1006, ¶¶ 90, 95. Matan also mentions “a sunrise/sunset schedule and using logic to determine peak sun hours.” *Id.*, ¶93; *see also* ¶5. Therefore, it is my opinion that a POSA implementing the set point threshold triggering battery-to-grid power sourcing in Serban-Matan-Wilhelm would have obviously included time-of-day variations, at least to reflect the variation in grid demands throughout the day. In fact, Wilhelm also recognizes that “the customer’s daily power demand” may vary based on “time of day” and

thresholds are set accordingly. Ex-1009, 6:3-9. Thus, a POSA would have understood that Wilhelm's "set point threshold" for triggering battery-to-grid power sourcing is also set to vary based on "time of day."

248. Matan also teaches that "[t]ime of day [] is determined by a clock input." Ex-1006, ¶150. In my opinion, a POSA would have found it obvious to use a real-time clock on Serban's Controller to provide this clock input, at least because a POSA would have known that standard controllers are capable of implementing real time clocks on their logic boards. *See, e.g.*, Ex-1020, p. 93 ("time stamping of messages" function indicates existence of real time clocks), p.107 ("Uses a 32-bit time stamp on receive and transmit message").

249. Therefore, it is my opinion that Serban-Matan-Wilhelm renders obvious that *the controller* (e.g., Serban's Controller) *includes a real-time clock*, and that *the predetermined power level set-point varies as a function of the time of day* (e.g., Wilhelm's set point threshold varies based on the time of day) *as determined by the real-time clock*.

5. Claim 11

250. Claim 11 depends from claim 8 and recites the following:

11. The uninterruptible power supply as set forth in claim 8, in which the controller further includes a calendar function, and in which the predetermined power level set-point varies as a function of the day as determined by the calendar function.

251. As I have explained above, claim 8 is rendered obvious by Serban-Matan-Wilhelm. *Supra* Section XII.C.2. Claim 11 adds that *the controller further includes a calendar function*, while also adding that *the predetermined power level set-point varies as a function of the day as determined by the calendar function*, which, in my opinion, is taught or suggested by Serban-Matan-Wilhelm.

252. Matan discloses that “[t]ime based rules allow the distribution of power to be based on the time of day, or **time of week**.” Ex-1006, ¶93. Therefore, it is my opinion that a POSA implementing the set point threshold triggering battery-to-grid power sourcing in Serban-Matan-Wilhelm would have obviously used a calendar function of Serban’s Controller to vary the threshold based on the day of week. A POSA would have known that power demands vary differently during the week than on the weekend, for example. This is also true for holidays versus workdays. It was also well known to adjust power system behaviors from seasonal changes in load and in PV output. It is further my opinion that a POSA would have found it obvious and straightforward to use a conventional calendar function in order to determine the day of week.

253. Therefore, it is my opinion that Serban-Matan-Wilhelm renders obvious that *the controller* (e.g., Serban’s Controller) *includes a calendar function*, and that *the predetermined power level set-point varies as a function of the day*

determined by the calendar function (e.g., Wilhelm’s set point threshold various based on the day of week) *as determined by the calendar function*.

6. Claim 12

254. Claim 12 depends from claim 8 and recites the following:

12. The uninterruptible power supply as set forth in claim 8, in which the controller is provided with a communication element, and the communication element is configured to receive a real-time update of the power level set-point.

255. As I have explained above, claim 8 is rendered obvious by Serban-Matan-Wilhelm. *Supra* Section XII.C.2. Claim 12 adds that *the controller is provided with a communication element, and the communication element is configured to receive a real-time update of the power level set-point*, which, in my opinion, is taught or suggested by Serban-Matan-Wilhelm.

256. Matan discloses that “the power distribution rules can be applied consistently, or may be adjusted for any of a number of scenarios,” and specifically mentions using any “**other variable condition**” for the adjustment. Ex-1006, ¶95. Matan discloses using communication mechanisms to set up parameters, such as power factor, remotely. *Id.*, ¶146, Fig. 21. “Such mechanisms may include communication, for example, over the internet by web browser 2152, by cell-phone or other mobile application 2154, by radio transmitter ..., or by another communication mechanism.” *Id.*, ¶147. Therefore, it is my opinion that a POSA

would have understood that the set point threshold that triggers battery-to-grid power sourcing in the Serban-Matan-Wilhelm system is settable remotely via communication.

257. Moreover, Serban discloses that its “control functions 122, 124, 126, 128 are implemented as a 32-bit TMS320F2812 DSP running at 150 MHz.” Ex-1005, ¶56. In my opinion, because TMS320F2812 DSP has serial communication capabilities (Ex-1020, p.117), it would have been obvious to a POSA to use Serban’s TMS320F2812 DSP as a communication element for remotely receiving real-time update of the set point threshold. Wilhelm similarly teaches “remotely control when load shifting at the customer side is to occur by transmitting a signal to the modem 124 to control relay 112.” Ex-1009, 12:48-60.

258. Therefore, it is my opinion that Serban-Matan-Wilhelm renders obvious that *the controller* (e.g., Serban’s Controller) *is provided with a communication element* (e.g., communication element of Serban’s TMS320F2812), *and the communication element is configured to receive a real-time update of the power level set-point* (e.g., update the set point threshold via remote communication).

7. Claim 19

259. Claim 19 includes the limitations of claims 1-3, 5-8, and 13 and is rendered obvious for the same reasons, as shown in table below.

Claim 19	Claims 1-3, 5-8, 13	Sections
19[P]: The uninterruptible power supply as set forth in claim 18,	Claims 1, 2, and 5-7	XII.B.2
19[A]: further including a second alternating current power port configured to be coupled to an alternating current grid, and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.B.2
19[B]: in which the controller is further configured to— source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds a predetermined power level set-point; and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.	XII.C.2
19[C]: [the controller is further configured to—] disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	XII.B.2

8. Claim 20

260. Claim 20 includes limitations of claims 1-3, 5-8, and 13 (and adds *managing power flow in a grid-tied photovoltaic system* in 20[P], *house load* in 20[C-D], and *utility grid* in 20[F] and 20[I-J]) and is rendered obvious for the same reasons as shown in table below.

Claim 20	Claims 1-3, 5-8, 13	Sections
20[P]: An uninterruptible power supply for managing power flow in a grid-tied photovoltaic system, the uninterruptible power supply comprising:	1[P]: An uninterruptible power supply comprising:	XII.B.2
20[A]: a bi-directional converter configured to operate as an alternating current voltage source and as an alternating current source;	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.B.2
	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.B.2
20[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.B.2
20[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a house load, wherein the current-source inverter is configured to adjust an output power as a function of a	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and	XII.B.2

frequency of the alternating current voltage source, and	6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.B.2
20[D]: wherein 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, and in which the controller is configured to control the bi-directional power converter to source power to the house load during the predetermined outage period	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	XII.B.2
20[F]: a second alternating current power port configured to be coupled to an alternating current utility grid; and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.B.2
20[G]: a controller configured to—regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source, and	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.	XII.B.2
20[H]: [a controller configured to—] regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state,	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a	XII.B.2

	predetermined ideal charging state.	
20[I]: [a controller configured to—] source power from the battery to the alternating current utility grid when the power sourced from the alternating current utility grid exceeds a predetermined power level set-point, and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.	XII.C.2
20[J]: [a controller configured to—] disconnect the current-source inverter from the alternating current utility grid when a voltage or frequency of the alternating current utility grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	XII.B.2

261. With respect to 20[P], to the extent limiting, Serban-Matan-Wilhelm teaches or suggests *managing power flow in a grid-tied photovoltaic system* since Serban-Matan-Wilhelm manages power flow between PV and other components tied to the grid. Section XII.A.3.

262. With respect to 20[C-D], Serban-Matan-Wilhelm’s load is *house load*. Ex-1006, ¶28 (“grid-tied (local) load (e.g., a house, apartment, cabin, or other

dwelling)); ¶30 (“Load Z102 represents a consumer premises (e.g., a home) tied to grid 130.”).

263. With respect to 20[F] and 20[I-J], Serban-Matan-Wilhelm’s grid is a *utility grid*. Ex-1005, ¶18 (“a first AC input 130a for receiving energy from the utility grid 110.”); Section XII.A.3.

D. My Opinions as to Claims 7, 13, and 18-20 based on Serban in view of Matan, Wilhelm, and PVI.

1. Motivation to Combine Serban-Matan-Wilhelm with PVI

264. In my opinion, like Serban, Matan, and Wilhelm, PVI qualifies as **analogous prior art** at least because it relates to grid-tied photovoltaic systems and is thus in the **same field of endeavor** as the Patent. Ex-1001, 1:7-8, Ex-1005, Abstract, ¶4; Ex-1006, ¶¶2-3; Ex-1009, 2:41-45; 12:66-13:4; Ex-1010, p.1. At a minimum, it is my opinion that PVI, like Serban, Matan, and Wilhelm, is reasonably pertinent to at least one problem identified by the Patent, because it teaches attaching additional power sources to the grid. Ex-1010, p.8; Ex-1001, Fig. 4; Ex-1005, Fig. 1; Ex-1009, Ex-1009, 9:3-9.

265. In my opinion, a POSA would have been motivated to incorporate PVI’s time-delayed inverter re-connect technique into Serban-Matan-Wilhelm. For example, one straightforward resource a POSA would have consulted to understand certain implementation details for the combination, including Serban’s

PV inverter 104, would have been commercially available PV inverters, which would have led a POSA to the PVI publication.

266. Moreover, it was well known that PV inverters are regulated by various standards. Therefore, it is my opinion that a POSA implementing Serban's PV inverter 104 would have looked to materials such as PV inverter user manuals and applicable standards to understand common requirements and features, and would have been motivated to incorporate those features, including PVI's time-delayed inverter re-connect technique into the Serban-Matan-Wilhelm.

267. In my opinion, a POSA would have had **reasonable expectation of success** in incorporating PVI's time-delayed inverter re-connect technique into the combination. Delaying a process for a predetermined duration of time was well known. *See, e.g.*, Ex-1006, ¶88 ("a timer mechanism that enables the system to wake up after a period of time (e.g., 5 minutes)"). In my opinion, a POSA would not have had any difficulty implementing such a feature. Moreover, as I mentioned above, PVI's time-delayed inverter re-connect technique was well known and had already been implemented in commercially PV inverters. Inverters must meet standards in order to be integrated into utility systems, such as IEEE 1547 which was in force in 2015. And the fact that the PV disconnect feature was required by standards further confirms that it would have been implemented by a POSA with undue experimentation because the standards would not be in place if

this was not possible to implement. A POSA would have known that PVI's time-delayed inverter re-connect technique would need to be implemented since a disconnected due to a grid fault would need to have a way to be reconnected. The IEEE standards (and requirements of the utilities) require the disconnect and also guide how you would reconnect. A POSA would have known that you would have to do this. In my opinion, it would have been simple and routine to implement such a technique with a reasonable expectation of success.

2. Claim 7

268. To the extent that claim 7's *predetermined outage period* requires a predetermined duration of time (it does not), it is my opinion that PVI discloses that.

269. PVI describes a grid-tied photovoltaic inverter that "disconnect[s] from the grid during abnormal frequency or voltage events ... the inverter will monitor the grid and reconnect to it 5 minutes after the grid has come back to normal." Ex-1010, p.8; *see also* p.68 (after "a grid failure, the inverter waits 300 seconds before the next connection to the grid.").

270. Therefore, it is my opinion that Serban-Matan-Wilhelm-PVI renders obvious that *the current-source inverter* (e.g., Serban's PV inverter 104) *is configured to disconnect from the alternating current voltage source* (e.g., Serban's hybrid converter 102) *for a predetermined outage period* (e.g., 5 minutes

as taught by PVI) *when the alternating current voltage source frequency goes outside of a predetermined frequency limit* (e.g., Serban’s AC line frequency outside of predetermined frequency range limit for a grid system), and that *the controller* (e.g., Serban’s controller 122) *is configured to control the bi-directional power converter* (e.g., Serban’s hybrid converter 102) *to source power to the load* (e.g., Serban’s load 114) *during the predetermined outage period*.

3. Claim 13

271. Claim 13 depends from claim 7, which is rendered obvious by Serban-Matan-Wilhelm-PVI. Section XII.D.2. In my opinion, claim 13 is also rendered obvious by Serban-Matan-Wilhelm-PVI. The capability to use Serban’s Controller for inverter-disconnection features was obvious (Section XII.B.2), including when using PVI’s time-based threshold in the combination.

4. Claim 18

272. Claim 18 combines claims 1, 2, and 5-7, and is rendered obvious by Serban-Matan-Wilhelm-PVI for the same reasons, as shown in the table below.

Claim 18	Claims 1, 2, 5-7	Sections
18[P]: An uninterruptible power supply comprising:	1[P]: An uninterruptible power supply comprising:	XII.B.2
18[A]: a bi-directional converter configured to operate as an alternating	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.B.2

current voltage source and as an alternating current source;	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.B.2
18[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.B.2
18[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a load, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source, and	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and	XII.B.2
	6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.B.2
18[D]: wherein 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	XII.B.2

the predetermined outage period; and		
18[F]: a controller configured to—regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source, and	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.	XII.B.2
18[G]: [a controller configured to—]regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	XII.B.2

5. Claim 19

273. Claim 19 includes the limitations of claims 1-3, 5-8, and 13 and is rendered obvious by Serban-Matan-Wilhelm-PVI for the same reasons, as shown in the table below.

Claim 19	Claims 1-3, 5-8, 13	Sections
19[P]: The uninterruptible power supply as set forth in claim 18,	Claims 1, 2, and 5-7	XII.D.4
19[A]: further including a second alternating current power port configured to be coupled to an alternating current grid, and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.B.2

19[B]: in which the controller is further configured to— source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds a predetermined power level set-point; and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.	XII.C.2
19[C]: [the controller is further configured to—] disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	XII.B.2

6. Claim 20

274. Claim 20 includes limitations of claims 1-3, 5-8, and 13 (and adds *managing power flow in a grid-tied photovoltaic system* in 20[P], *house load* in 20[C-D], and *utility grid* in 20[F] and 20[I-J]) and is rendered obvious by Serban-Matan-Wilhelm-PVI for the same reasons, as shown in the table below.

Claim 20	Claims 1-3, 5-8, 13	Sections
20[P]: An uninterruptible power supply for managing power flow in a grid-tied	1[P]: An uninterruptible power supply comprising:	XII.B.2

photovoltaic system, the uninterruptible power supply comprising:		
20[A]: a bi-directional converter configured to operate as an alternating current voltage source and as an alternating current source;	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.B.2
	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.B.2
20[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.B.2
20[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a house load, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source, and	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and	XII.B.2
	6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.B.2
20[D]: wherein 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, and in which the	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the	XII.D.2

controller is configured to control the bi-directional power converter to source power to the house load during the predetermined outage period	controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	
20[F]: a second alternating current power port configured to be coupled to an alternating current utility grid; and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.B.2
20[G]: a controller configured to—regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source, and	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.	XII.B.2
20[H]: [a controller configured to—] regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state,	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	XII.B.2
20[I]: [a controller configured to—] source power from the battery to the alternating current utility grid when the power sourced from the alternating current utility grid exceeds a predetermined power level set-point, and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.	XII.C.2

20[J]: [a controller configured to—] disconnect the current-source inverter from the alternating current utility grid when a voltage or frequency of the alternating current utility grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	XII.D.3
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275. With respect to 20[P], to the extent limiting, Serban-Matan-Wilhelm-PVI teaches or suggests *managing power flow in a grid-tied photovoltaic system* since Serban-Matan-Wilhelm-PVI manages power flow between PV and other components tied to the grid. Section XII.A.3.

276. With respect to 20[C-D], Serban-Matan-Wilhelm-PVI’s load is *house load*. Ex-1006, ¶28 (“grid-tied (local) load (e.g., a house, apartment, cabin, or other dwelling)"); ¶30 (“Load Z102 represents a consumer premises (e.g., a home) tied to grid 130.”).

277. With respect to 20[F] and 20[I-J], Serban-Matan-Wilhelm-PVI’s grid is a *utility grid*. Ex-1005, ¶18 (“a first AC input 130a for receiving energy from the utility grid 110.”); Section XII.A.3.

E. My Opinions as to Claims 1-3, 5-7, 13, and 18 in view of Somani alone

1. Claim 1

a. 1[P]

278. If 1[P] is limiting, it is my opinion that Somani discloses it.

279. As I have explained above, it is my opinion that a POSA would have understood a UPS to refer to a system that provides continuous power, without delay or transients, even when the normal power supply fails. *See* Section XII.A.1.a. Somani discloses a power system in Figure 1B where “the load 170 [red] may be powered by external grid/AC source 150 [orange] and solar power from inverter 140 [blue].” Ex-1007, ¶68; Ex-1008, p.15.

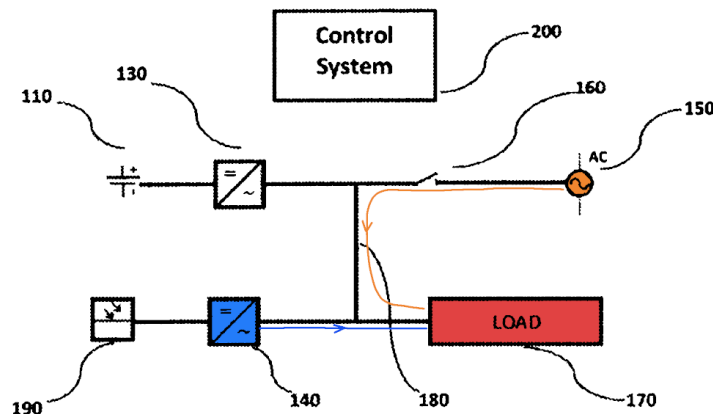


FIG. 1B

Ex-1007, Fig. 1B.

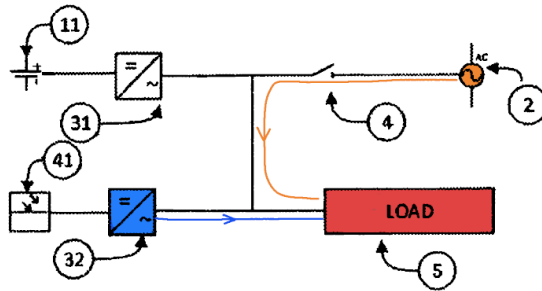


Fig. 3: Implementation of Method using one Battery source and one Solar Source

Ex-1008, Fig. 3.

280. Somani then discloses that “[u]pon failure of the utility 150 [orange],... [c]ontrol system 200 may be programmed to **transition the system to microgrid mode**. In this mode, energy storage inverter 130 transitions from current source mode to voltage source mode to **continue to supply load 170 with energy during the utility outage**.” Ex-1007, ¶72; Ex-1008, p.15.

281. Therefore, it is my opinion that Somani discloses *an uninterruptible power supply* (i.e., Somani’s power system).

b. 1[A]

282. Somani discloses that “**power converter 130 [yellow] is a bi-directional power inverter** that provides energy from or to battery 110 [green].” Ex-1007, ¶70. “Upon failure of the utility 150 [orange X],... [i]f the solar production is greater than the power needed by the load, the additional energy may be used, for example, **to charge [blue pathway] battery 110**. If the solar production is below the demand of the load 170, **battery 110 may discharge**

[green pathway] to provide the additional power needed for operation.” *Id.*, ¶72;

Ex-1008, p.15.

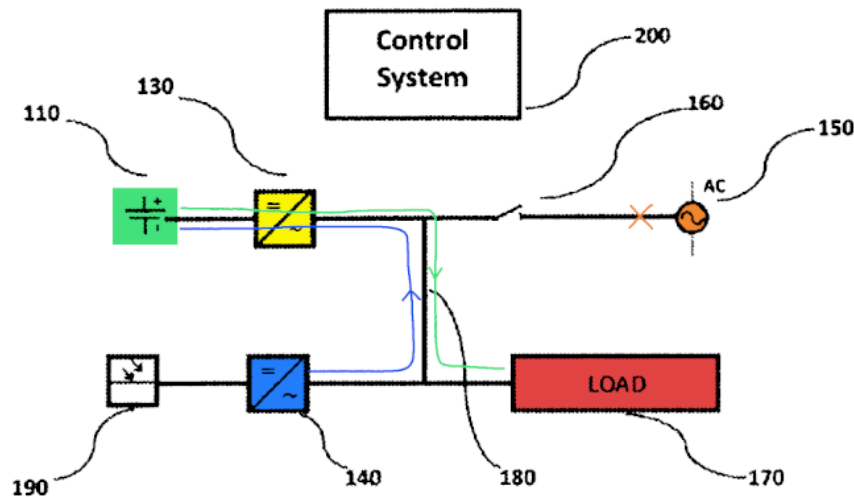


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

283. Somani’s bidirectional power converter 130 is configured to operate as a voltage source because upon power failure, the bidirectional power converter 130 “transitions from current source mode to **voltage source mode** to continue to supply load 170 with energy during the utility outage.” Ex-1007, ¶72; Ex-1008, p.15; Ex-1007, ¶82 (noting same); Ex-1008, p.19.

284. Moreover, Somani’s bidirectional power converter 103 receives/outputs alternating current because the right side of the bidirectional power converter 103 (Figure 1B below) is connected (yellow line) to “external grid/AC source 150 [orange].” Ex-1007, ¶63; Ex-1008, p.11. The “~” symbol

(purple) indicates alternating current—confirmed also by the “AC” text right next to it. See Section V.A.3.

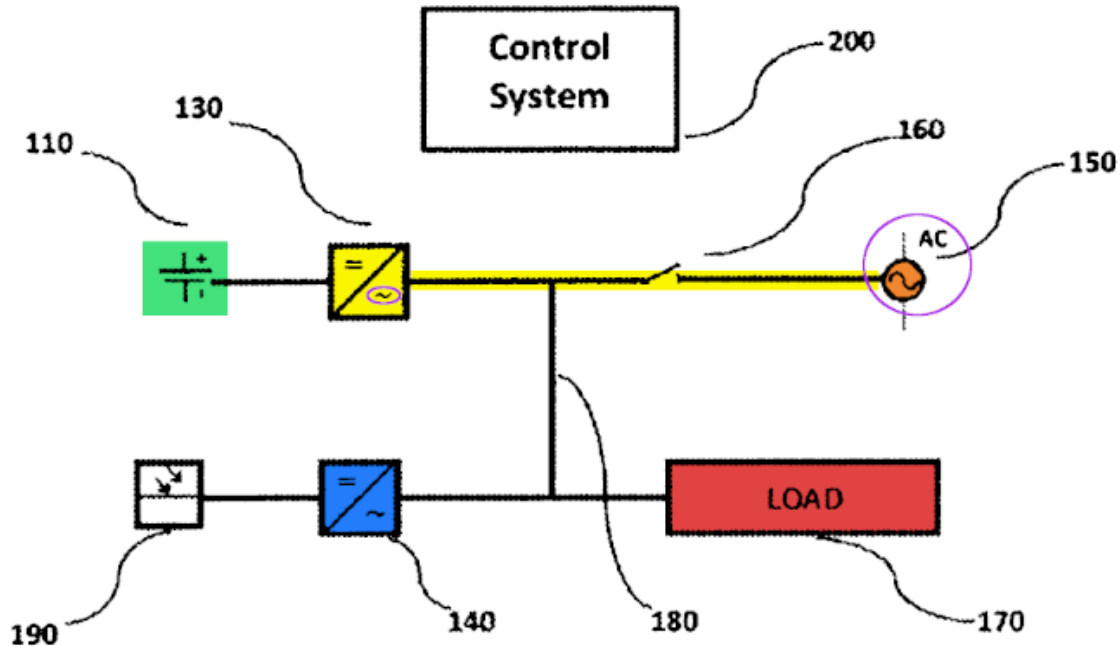


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

285. Therefore, it is my opinion that Somani discloses *a bi-directional converter* (i.e., bidirectional power converter 103) *configured to operate as an alternating current voltage source* (e.g., operate in voltage source mode).

c. 1[B]

286. Somani discloses that “a battery energy storage inverter 130 [yellow] may be coupled with battery 110 [green].” Ex-1007, ¶70; Ex-1008, p.15. By describing this coupling and showing a line between the battery 110 and the

inverter 130 at a port (purple) where DC flows out of inverter 130 and to battery 110 (as reflected by the “=” symbol), it is my opinion that Somani expressly discloses a DC port coupling these components.

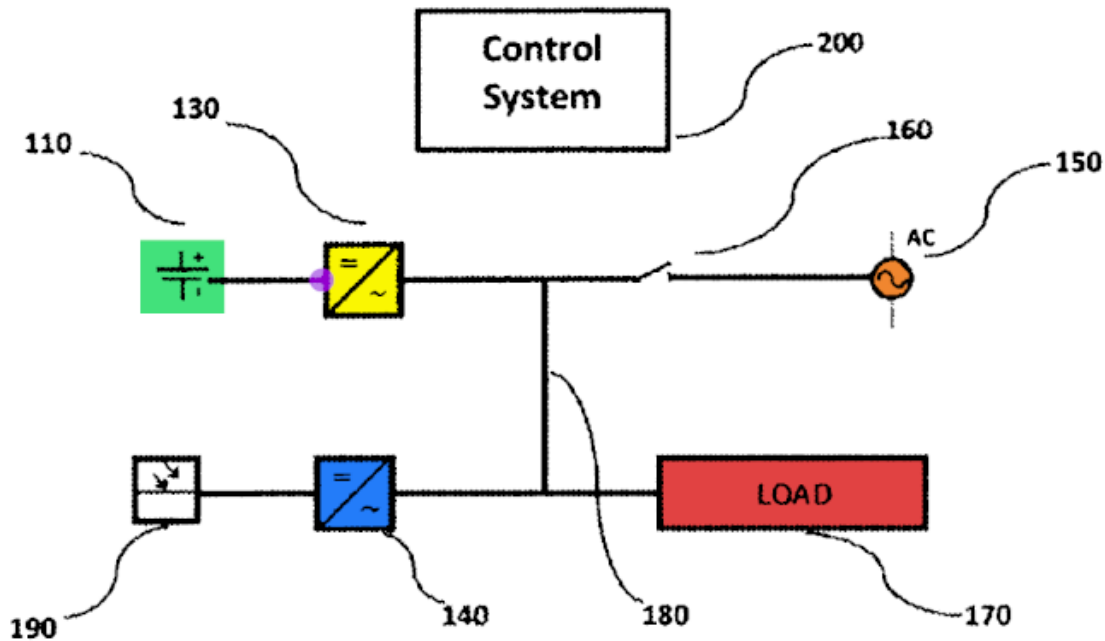


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

287. In my opinion, at a minimum, since DC power flows between the battery and converter 130 (Ex-1007, ¶73; Ex-1008, p.11), a DC port is necessarily used to couple these components.

288. Therefore, it is my opinion that Somani discloses *a direct current power port* (i.e., bidirectional power converter 130's port connected to the battery 110) *configured to be coupled to a battery* (i.e., battery 110).

d. 1[C]

289. As shown below, the right side of the bidirectional power converter 130 (yellow) outputs/receives alternating current. *See* Section XII.E.1.b. The bidirectional power converter 130 is coupled to a “PV inverter 140 [blue]... [that] operate[s] in **current source [mode]**,” Ex-1007, ¶82, Ex-1008, pp.15, 19, to provide AC current to the load 170 [red]. *See also* Ex-1007, ¶67 (“the PCC is an... AC bus 180 [which] interfaces with local load 170 on the microgrid.”); Ex-1008, 17, Fig. 3. At minimum, Somani necessarily has AC ports (purple and grey) coupled to the bidirectional power converter 130 at the AC side.

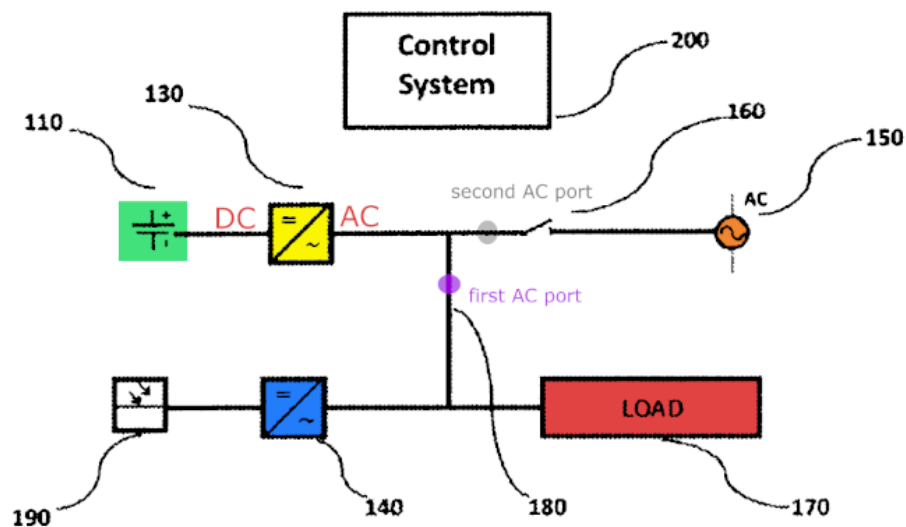


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3. Somani also discloses a “master/slave configuration... [where] one of the power converters can act as a microgrid master which attempts to control the output voltage amplitude and frequency.” Ex-1007,

¶91; Ex-1008, p.18. So, Somani discloses that the bidirectional power converter 130 (yellow) is a master power converter and the PV inverter 140 (blue) is a slave power converter. I note that Somani's 130 and 140 are converters functioning as inverters. Ex-1007, ¶64; Ex-1008, p.12. Thus, references to 130 and 140 are interchangeable between PV inverter or PV converter.

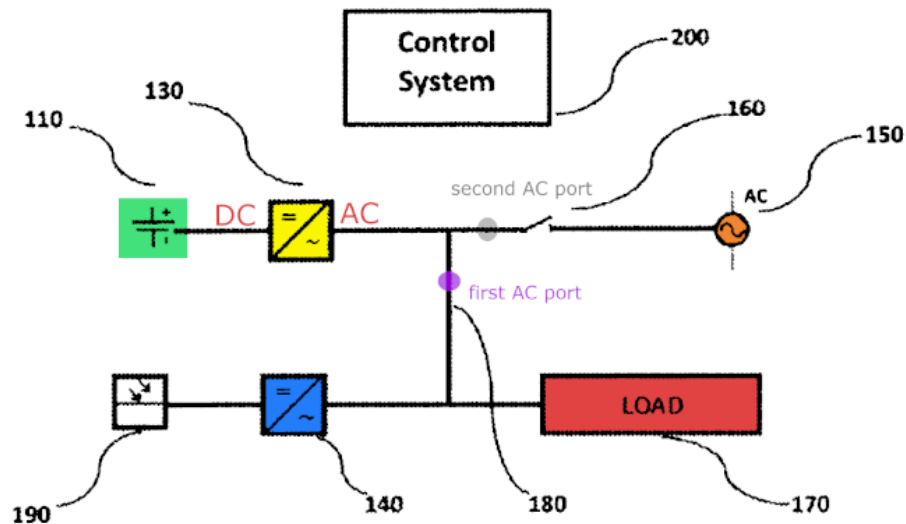


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

290. Somani further discloses that, to avoid over-charging in microgrid mode (utility grid disconnected), the master power converter may “trip[] the renewable resource [e.g., PV inverter 140 and solar array 190] offline by **changing the microgrid frequency** [e.g., frequency of the master power converter 130] **beyond the nominal frequency.**” Ex-1007, ¶90; Ex-1008, p.18. “When the storage devices [e.g., batteries 110] are sufficiently depleted to be able to accept

charge again, the renewable devices may be brought back online by **restoring the microgrid frequency to nominal values** and allowing the generation devices to reconnect to the microgrid.” Ex-1007, ¶95; Ex-1008, p.18. Thus, adjusting the frequency of the bidirectional power converter 130 to beyond or within the nominal frequency causes the PV inverter 140 to provide output power (when online) or not (when offline). In other words, Somani’s PV inverter 140 *is configured to adjust an output power* where the output goes from zero to some higher value (or vice versa) in response to frequency changes of the master power converter 130.

291. Therefore, it is my opinion that Somani discloses *a first alternating current power port coupled to the bi-directional converter* (i.e., AC power port coupling the bidirectional power converter 130 with power inverter 140) *and configured to be coupled to a current-source inverter* (i.e., PV inverter 140), *wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source* (e.g., the PV inverter 140 varies its output power from zero to a higher value (or vice versa) based on the frequency of the bidirectional power converter 130).

e. 1[D]

292. As I just explained above, Somani’s PV inverter 140 provides or does not provide output power based on whether the frequency of the bidirectional

power converter 130 is within or beyond nominal frequency. Such power regulation is done through a controller, such as “controller 230 [yellow] of inverter 130... [or] a master controller [green] external to any power converter.” *See, e.g.*, Ex-1007, ¶82; Ex-1008, p.19 (“In this example it is assumed that the invention (control scheme, logic) is housed in the controller of inverter 31. It could also be that there is a controller external to any inverter that houses this control scheme.”).

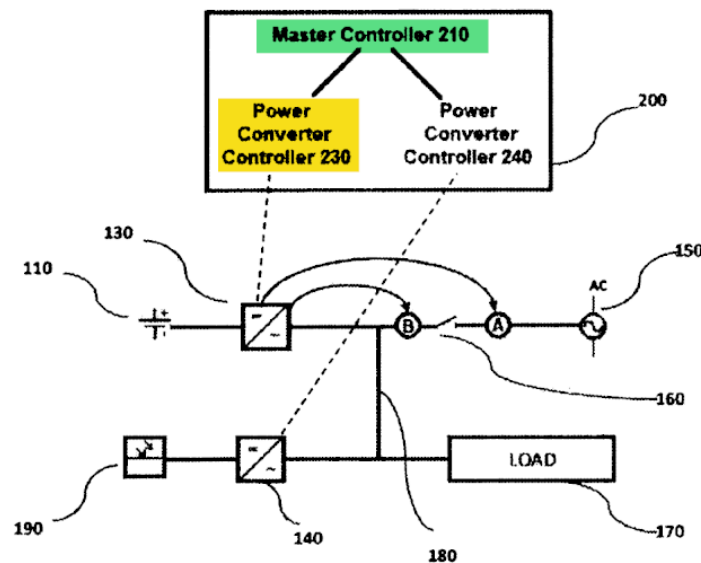


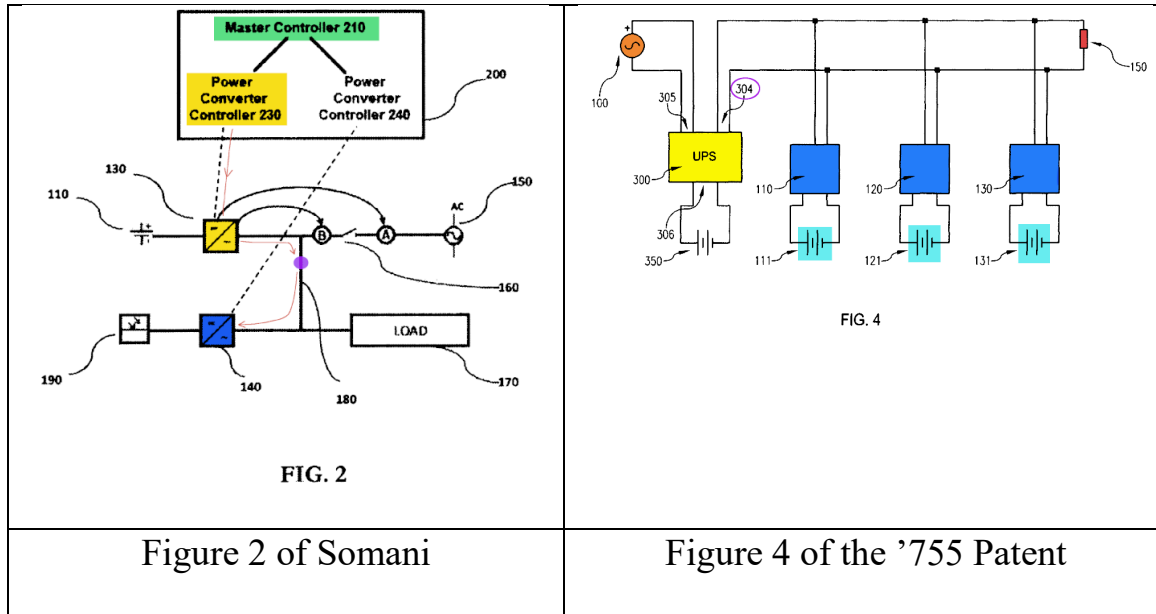
FIG. 2

Ex-1007, Fig. 2; Ex-1008, Fig. 4.

293. This is the same as the embodiment described in the '755 Patent. As I have explained above, Somani's power converter controller 230 (yellow) or master controller 210 (green) controls the frequency at its AC power output port (purple), causing the output power change of the PV inverter 140 (blue) to change.

Similarly, the '755 Patent's controller 301 of the UPS 300 (yellow) controls the

frequency at port 304 (purple), causing the output power change of the PV inverters 110, 120, and 130 (blue) to change. Ex-1001, 8:18-21. *See* side-by-side figure comparison below.



294. Therefore, it is my opinion that Somani discloses *a controller* (e.g., controller 230 or master controller 210) *configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source* (e.g., the PV inverter 140 provides or does not provide output power based on frequency of the bidirectional power converter 130).

2. Claim 2

295. As I have explained above in Sections XII.E.1.d-XII.E.1.e, Somani’s controller 230 or master controller 210 regulates power flow by tripping the PV inverter 140 offline is to avoid overcharging. “When the... [battery is] sufficiently

depleted to be able to accept charge again,” the PV inverter 140 is brought back online, thereby ensuring that the battery maintains a certain charging state. Ex-1007, ¶¶90, 95; Ex-1008, p.18.

296. Therefore, it is my opinion that Somani discloses that *the controller* (e.g., controller 230 or master controller 210) *is configured to regulate the power flow of the current-source inverter* (e.g., controlling the PV inverter 140 to be offline or online) *to maintain the battery at a predetermined ideal charging state* (e.g., avoid overcharging the battery 110, and maintain the battery 110 at certain charging state).

3. Claim 3

297. As shown below, Somani discloses a port at the right side of the bidirectional power converter 130 connected to “external grid/AC source 150.” Ex-1007, ¶72; Ex-1008, p.11. It is my opinion that Somani’s bidirectional power converter 130 expressly, or at least necessarily, has an AC power port (gray) coupled to the AC grid 150. While the claim does not expressly require it, if Patent Owner argues that more than one AC power port is required, it is my opinion that the AC power port between converter 130 and the grid 150 is a different power port from the one between converter 130 and inverter 140.

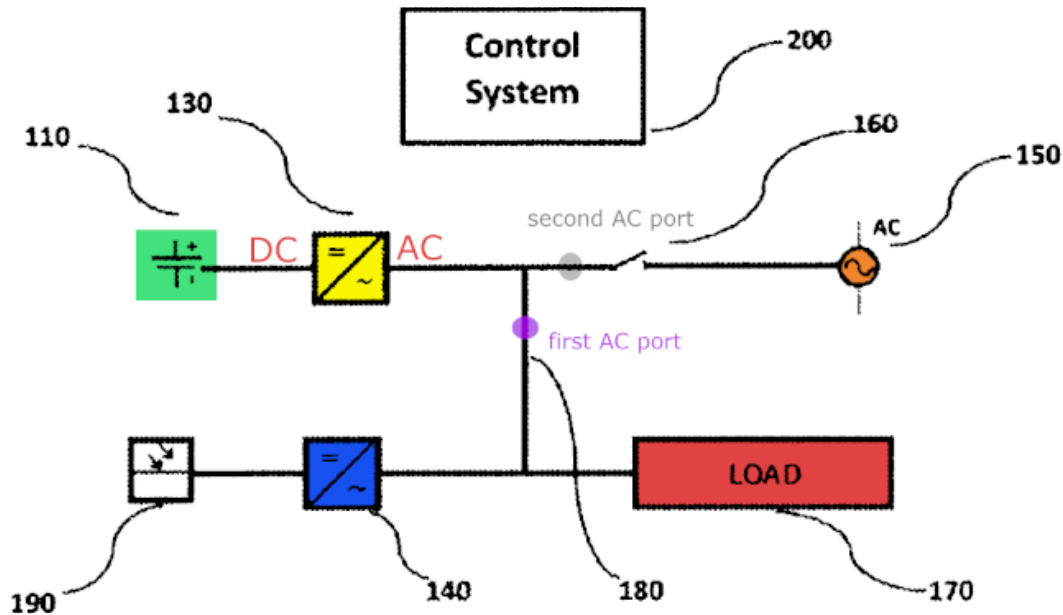


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

298. Therefore, it is my opinion that Somani discloses *a second alternating current power port* (e.g., AC port between bidirectional power converter 130 and AC grid 150) *configured to be coupled to an alternating current grid* (e.g., utility grid 110).

4. Claim 5

299. Somani discloses that “[u]pon failure of the utility 150, such as a blackout,... the system [is transitioned] to microgrid mode. In this mode, energy storage inverter 130 transitions from **current source mode** to voltage source mode...” Ex-1007, ¶72; Ex-1008, pp.13, 15. Thus, when utility 150 is normal,

Somani's bidirectional power converter is a current source, which provides AC (Section XII.E.1.b).

300. Therefore, it is my opinion that Somani discloses that the bidirectional converter (i.e., bidirectional power converter 130) is also configured as an alternating current source (e.g., operates in current source mode when utility 150 is normal).

5. Claim 6

301. Somani's bidirectional power converter 130 (yellow) is connected (yellow line) to the load 170 (red). Ex-1007, ¶72 ("energy storage inverter 130... suppl[ies] load 170 with energy during the utility outage."); Ex-1008, p.15.

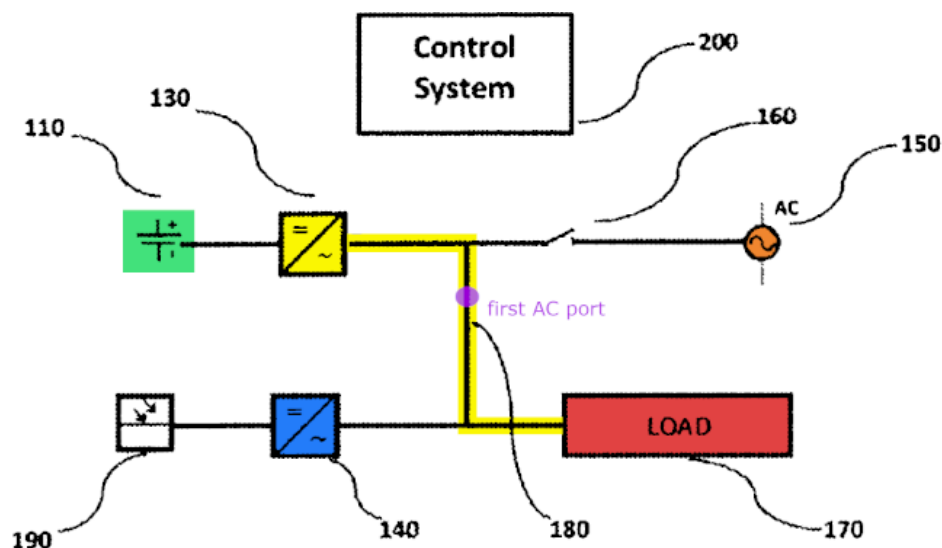


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

302. Therefore, it is my opinion that Somani discloses that *the first alternating current power port* (e.g., AC power port between bidirectional power converter 130 and load 170) *is also configured to be coupled to a load* (e.g., load 170).

6. Claim 7

303. Somani's load 170 sources power from three different places: grid 150, PV array 190, and battery 110. Upon grid failure, the grid 150 is disconnected and the load may be powered by the battery 110 (green), which is done via the bidirectional converter 130 (yellow). Ex-1007, ¶72; Ex-1008, pp.12-13.

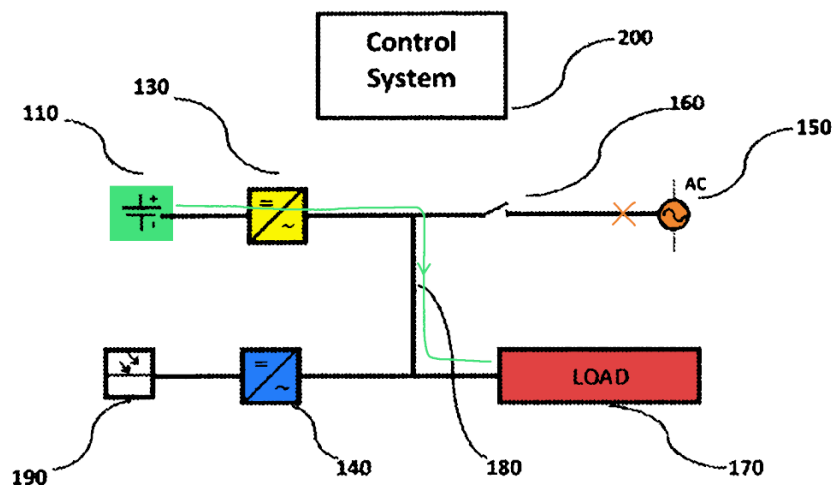


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

304. Additionally, Somani notes that “a preset amount time may need to pass prior to reconnecting to the grid to help ensure that the voltage and frequency are stable.” Ex-1007, ¶108; Ex-1008, Fig. 2. Somani provides a “preset time” (570, yellow) before its “power converters will transition to current source mode and the operation will resume to grid-tied mode,” which includes the use of inverter 140 again. Ex-1007, ¶110; Ex-1008, Fig. 2.

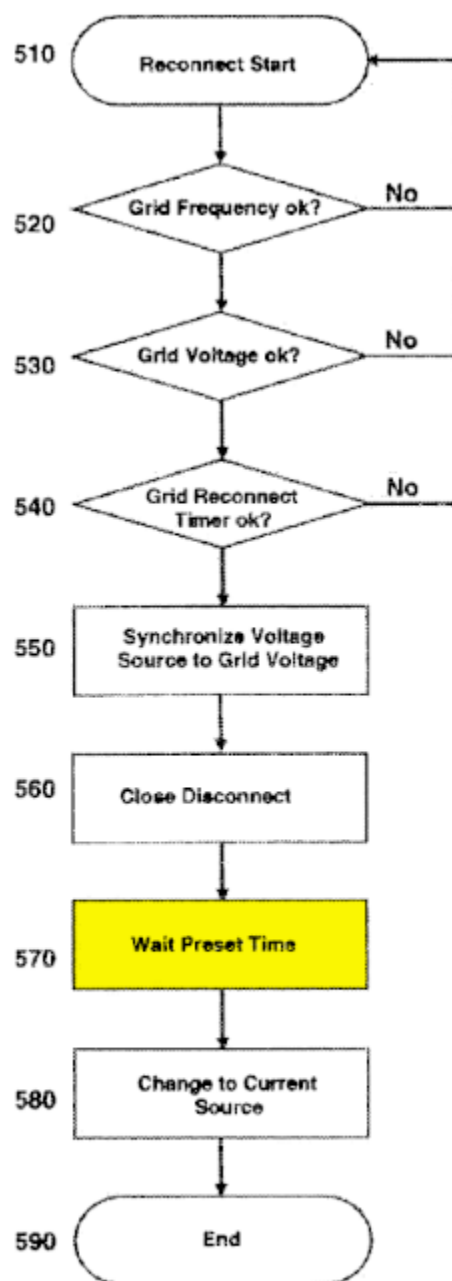


FIG. 5

Ex-1007, Fig. 5; Ex-1008, Fig. 2. In fact, the '755 Patent admits that “to increase the safety of utility systems,... disconnect[ing] all photovoltaic inverters from the grid if the voltage or frequency deviates beyond a predetermined range” was

already well-known and required by “most photovoltaic systems” before the Patent. Ex-1001, 1:30-36; 5:18-26 (“When either the voltage or frequency of the utility grid 100 deviates outside of a predetermined range (which varies from one region of the world to another), the voltage-frequency relay 180 opens internal switches to disconnect the micro-inverters 110,120,130, thus providing an additional level of safety to prevent the micro-inverters 110,120,130 from pumping power into the utility grid 100 that may be, e.g., shut down for repair or maintenance.”).

305. Therefore, it is my opinion that Somani discloses that *the current-source inverter* (i.e., Somani’s PV inverter 140) *is configured to disconnect from the alternating current voltage source* (e.g., Somani’s bidirectional power converter 130) *for a predetermined outage period* (e.g., an amount of time when AC frequency is out of limits until current source mode is resumed) *when the alternating current voltage source frequency goes outside of a predetermined frequency limit* (e.g., grid failure), and that *the controller* (e.g., Somani’s controller 230 or master controller 210) *is configured to control the bi-directional power converter* (e.g., Somani’s bidirectional power converter 130) *to source power to the load* (e.g., Somani’s load 170) *during the predetermined outage period.*

7. Claim 13

306. Somani discloses that “[u]pon failure of the utility 150 [orange], such as a blackout, disconnect 160 [blue] is opened via commands from control system 200.” Ex-1007, ¶72; Ex-1008, p.15; *see also* Ex-1007, ¶84 (“power system 200 determines that the **grid voltage and/or frequency are out of bounds...** and opens the islanding switch”); Ex-1008, p.18; Ex-1007, ¶61 (“Exemplary values for the voltage bounds are: Lower bound—12%, Upper bound=+10%. Example values for the frequency bounds are: Lower bound=57 Hz, Upper bound=60.5 Hz.”); Ex-1008, p.18.

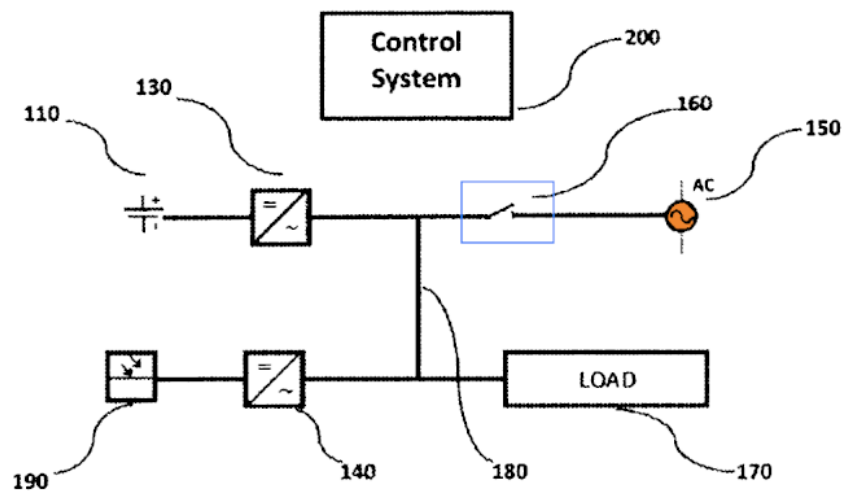


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

307. Somani also discloses that “[o]nce the utility 150 is restored, the AC voltage of the microgrid is synchronized with the AC voltage of the utility grid 150

and the disconnect 160 is closed.” Ex-1007, ¶72; Ex-1008, p.15. Thus, Somani discloses that when the grid fails, *e.g.*, the voltage and/or frequency is out of bounds, Somani’s control system including Somani’s controller disconnects the grid 150 from the microgrid via disconnect switch 160, thereby disconnecting the PV inverter 140 from the grid 150.

308. Somani discloses “upon failure of the utility 150 such as a blackout, disconnect 160 is opened by the control system”. Ex-1007, ¶¶68, 72, 79; Ex-1008, pp. 12, 15. Further, once the utility 150 is restored, control system 200 directs the AC voltage of the microgrid to be synchronized with the AC voltage of the utility 150 and directs the disconnect 160 to close. Ex-1007, ¶¶ 69, 72; Ex-1008, pp. 13, 15. Therefore, Somani describes that the control system has control logic that monitors grid parameters, such as voltage and frequency, and directs the disconnect to open or close depending on the grid conditions as well as other conditions within the microgrid. *See also*, for example, ¶84, ¶96, ¶98, ¶110-111. Somani further describes that its control logic “may be implemented by a master controller external to any power converter.” Ex-1007, ¶82; Ex-1008, p.19. Thus, Somani’s control logic, which includes directing the disconnect to open or close depending on the grid conditions as well as other conditions within the microgrid, is implemented in Somani’s master controller. Therefore, in my opinion, a POSA would have understood that this master controller in Somani, referred to as

“Somani’s Controller” performs any function for Somani’s power system, including power-conversion operations between battery 110, grid 150, and PV array 190, as well as interfacing with these power sources, including disconnecting the PV inverter 140.

309. Therefore, it is my opinion that Somani discloses that *the controller* (e.g., Somani’s Controller) *is configured to disconnect the current-source inverter* (e.g., PV inverter 140) *from the alternating current grid* (e.g., grid 150) *when a voltage or frequency of the alternating current grid goes outside of a predetermined limit* (e.g., when the grid voltage and/or frequency is out of bounds).

8. Claim 18

310. Claim 18 combines claims 1, 2, and 5-7, and is therefore disclosed for the same reasons provided above, as shown in the table below.

Claim 18	Claims 1, 2, 5-7	Sections
18[P]: An uninterruptible power supply comprising:	1[P]: An uninterruptible power supply comprising:	XII.E.1.a
18[A]: a bi-directional converter configured to operate as an alternating current voltage source and as an alternating current source;	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.E.1.b
	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.E.4

18[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.E.1.c
18[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a load, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source, and	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and	XII.E.1.d
	6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.E.5
18[D]: wherein 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period; and	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	XII.E.6
18[F]: a controller configured to—regulate a power flow of the current-source inverter by	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a	XII.E.1.e

adjusting a frequency of the alternating current voltage source, and	frequency of the alternating current voltage source.	
18[G]: [a controller configured to—]regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	XII.E.2

F. My Opinions as to Claims 1-13 and 15-20 based on Somani in view of Matan and Wilhelm

1. Motivation to Combine Somani with Matan and Wilhelm

311. In my opinion, Somani, Matan, and Wilhelm qualify as **analogous art** at least because they are in the **same field of endeavor** as the '755 Patent, *i.e.*, grid-tied photovoltaic systems. Ex-1001, 1:7-8; Ex-1007, Fig. 1B; Ex-1008, Fig. 3; Ex-1006, ¶¶2-3; Ex-1009, 2:41-45; 12:66-13:4. These references are at least reasonably pertinent to at least one problem in the Patent as each reference involves load demand management *Compare* Ex-1001, 6:62-65 *with* Ex-1007, ¶5; Ex-1008, p.12; Ex-1006, ¶117; Ex-1009, 1:19-27.

312. **Matan's Power-Factor Conditioning.** In my opinion, a POSA would **have been motivated** to incorporate Matan's power factor conditioning into Somani. Somani teaches active and reactive currents in the power system and relevant control. Ex-1007, ¶¶32-33; Ex-1008, p.18; *see also* my discussion in

Section XII.F.9. It is my opinion that a POSA looking to improve Somani's control of active and/or reactive currents would have also consulted other references, like Matan, while implementing such control, and would have thereby encountered Matan's power factor conditioning.

313. Moreover, adjusting power factor (to a value other than 1) was implemented in PV inverters on the market before the '755 Patent. Ex-1018, p.2. Thus, it is my opinion that a POSA would have found it obvious to incorporate such a commercially adopted and standard feature into Somani's PV inverter 140.

314. For similar reasons I have explained in Section XII.B.1, it is my opinion that a POSA would have had a **reasonable expectation of success** in incorporating Matan's power-factor conditioning into Somani.

315. **Wilhelm's trigger condition.** In my opinion, a POSA would **have been motivated** to incorporate Wilhelm's trigger condition into the Somani-Matan system.

316. Somani discloses sourcing power from battery to the grid "where appropriate." Ex-1007, ¶8; Ex-1008, pp.12, 17. In my opinion, a POSA would have been motivated to look to other references, such as Wilhelm, for implementation details of when it is appropriate to provide battery power to the grid.

317. As I have explained in Section XII.C.1, a POSA would have understood that it is unreasonable to constantly source power from the battery to the grid and would have been motivated to look to similar references, like Wilhelm, for teachings on when to trigger Somani-PVI-Matan's battery-to-grid power sourcing.

318. Moreover, Somani discloses that "[d]uring normal operation, the batteries 110 and 120 may provide other value streams such as participating in an ancillary services market, providing peak reduction, providing renewables integration, etc." Ex-1007, ¶68; Ex-1008, p.12. Thus, in my opinion, a POSA would have been motivated to look to similar references, like Wilhelm, for teachings on how to implement these features, which includes sourcing battery power to the grid.

319. In my opinion, a POSA would also have had **reasonable expectation of success** in incorporating Wilhelm's trigger condition into the Somani-Matan system. As I have discussed above, use of a threshold was well known before the '755 Patent, and would only require minor modification to Somani-Matan's software. Thus, it is my opinion that a POSA would have found it straightforward and routine to incorporate Wilhelm's trigger condition into the Somani-Matan system, and have reasonably expected the modified Somani-Matan-Wilhelm system to work.

320. Since Matan’s harmonic distortion correction, and Wilhelm’s trigger condition were all well known before the ’755 Patent, it is my opinion that incorporating each feature into Serban’s system would simply be combining prior art elements according to known methods and applying a known technique to a known device ready for improvement.

2. Claims 1-3, 5-7, 13, and 18

321. As I explained in Section XII.E, Somani anticipates claims 1-3, 5-7, 13, and 18. Somani’s features relied on for anticipation (Section XII.E) remain in Somani-Matan-Wilhelm, so in my opinion, claims 1-3, 5-7, 13, and 18 are also obvious in view of the combination.

3. Claim 4

322. As I have explained in Section XII.A.4, a POSA would have understood that the *active rectifier* rectifies voltage/current into the battery for charging and is used to regulate certain variables.

323. Somani discloses the same—battery 110 is charged via the bidirectional power converter 130. *See, e.g.,* Ex-1007, ¶70 (“**power converter 130** is a bidirectional power inverter that **provides energy** from or **to battery 110**”); Ex-1008, pp.12, 14. In my opinion, it was well known before the ’755 Patent that charging a battery requires proper voltage/current conditions. *See, e.g.,* Ex-1005, ¶¶22, 28, 35, 43; Ex-1023. Therefore, in order to properly charge Somani’s battery

110, a rectifier with appropriate control of current is necessarily needed. In my opinion, a POSA would have known that there existed limited number of ways to implement such a charging system. They would include (i) using a passive or active rectifier, and (ii) those rectifiers could be used within Somani's bidirectional power converter or separate from (but in conjunction with) Somani's bidirectional power converter. Facing with these limited options, it is my opinion that a POSA would have found it at least obvious to try each of them. Choosing one implementation among these limited options is nothing novel or nonobvious. Thus, in my opinion, a POSA would have found it obvious to at least try using Somani's bidirectional power converter 130 (yellow) to actively rectify AC current from the grid (orange) or PV inverter 140 (blue) to produce DC that is then used to charge the battery 110 (green).

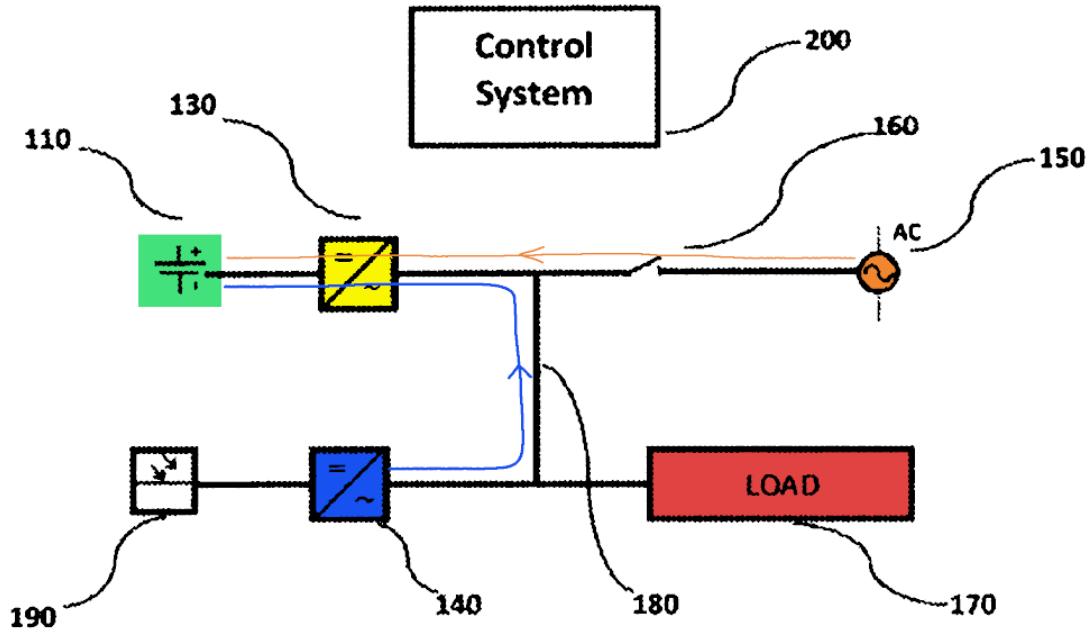


FIG. 1B

Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

324. Therefore, in my opinion, Somani-Matan-Wilhelm renders obvious that *the bidirectional converter* (i.e., bi-directional power converter 130) *is also configured as an active rectifier* (e.g., rectifies battery 110's charging voltage/current).

4. Claim 8

325. Somani discloses sourcing power from battery to the grid. *See, e.g.*, Ex-1007, ¶8 (“The energy storage units [such as a battery] can [] supply this power to... the main utility grid where appropriate.”); Ex-1008, p.12, p.17 (“Energy is

being used from source 11 [*i.e.*, battery] and source 41 to provide power to... the utility to support other loads.”).

326. As I have explained above, a POSA would have been motivated to incorporate Wilhelm’s trigger condition, e.g., when power drawn from the utility grid exceeds a set point threshold, to trigger Somani-Matan’s battery-to-grid power sourcing event. Section XII.F.1.

327. In my opinion, because Somani’s Controller controls the power conversion (Section XII.E.7), a POSA would have understood to use Somani’s Controller for controlling battery-to-grid power sourcing in the Somani-Matan-Wilhelm system and would have found it obvious to store Wilhelm’s set point threshold in Somani’s Controller for easy access by the control program.

328. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani’s Controller) *includes a predetermined power level set-point* (e.g., Wilhelm’s set point threshold), and that *the controller is configured to source power from the battery* (e.g., Somani’s battery 110) *to the alternating current grid* (e.g., Somani’s grid 150) *when the power sourced from the alternating current grid exceeds the predetermined power level set-point* (e.g., “the amount of power drawn from the utility by the customer [] exceeds the set point threshold” as taught by Wilhelm).

5. Claim 9

329. Matan discloses that a controller “include[s] appropriate memory or storage components (e.g.,...Flash) to store... values...” Ex-1006, ¶60. In my opinion, using Matan’s non-volatile memory in Somani’s Controller to store Wilhelm’s set point threshold was nothing more than combining known elements according to their known functions to achieve predictable results in Somani-Matan-Wilhelm.

330. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani’s Controller) *includes a non-volatile memory element* (e.g., Matan’s memory) *configured to store the predetermined power level set-point* (e.g., Wilhelm’s set point threshold).

6. Claim 10

331. As I have explained in Section XII.C.4, Matan discloses that power distribution rules vary as a function of the time of day as determined by a real-time clock. In addition to reasons explained in Section XII.F.1, it is my opinion that a POSA would also have been motivated to incorporate Matan’s “time of day” feature into Somani-Matan-Wilhelm, such that the set point threshold that triggers battery-to-grid power sourcing in the Somani-Matan-Wilhelm system also varies as a function of the time of day as determined by a real-time clock.

332. As I discussed in Sections XII.E.7 and XII.F.2, Somani's Controller controls the power conversion, including battery-to-grid power sourcing, in the Somani-Matan-Wilhelm system. Thus, in my opinion, a POSA would have found it obvious to include Matan's the real-time clock in Somani's Controller.

333. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani's Controller) *includes a real-time clock*, and that *the predetermined power level set-point varies as a function of the time of day* (e.g., Wilhelm's set point threshold various based on the time of day as taught by Matan) *as determined by the real-time clock*.

7. Claim 11

334. As I have explained in Section XII.C.5, Matan discloses that “[t]ime based rules allow the distribution of power to be based on the time of day, or **time of week**.” Ex-1006, ¶93. In addition to reasons explained in Section XII.F.1, it is my opinion that a POSA would also have been motivated to incorporate Matan's “time of week” feature into Somani-Matan-Wilhelm, such that the set point threshold that triggers battery-to-grid power source in the Somani-Matan-Wilhelm system varies based on the day of week. In my opinion, in order to determine the day of week, a POSA would have found it obvious to use a calendar function. As I discussed in Sections XII.E.7 and XII.F.2, Somani's Controller controls the power conversion, including battery-to-grid power sourcing, in the Somani-Matan-

Wilhelm system. Thus, in my opinion, a POSA would have found it obvious to include the calendar function in Somani's Controller.

335. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani's Controller) *includes a calendar function*, and that *the predetermined power level set-point varies as a function of the day determined by the calendar function* (e.g., Wilhelm's set point threshold varies based on the day of week as taught by Matan) *as determined by the real-time clock*.

8. Claim 12

336. As I have explained in Section XII.C.6, Matan discloses power distribution rules vary based on different conditions and parameters can be set up via remote communication. In addition to reasons I explained in Section XII.F.1, it is my opinion that a POSA would also have been motivated to incorporate Matan's remote communication feature into Somani-Matan-Wilhelm, such that the set point threshold that triggers battery-to-grid power sourcing in the Somani-Matan-Wilhelm system is settable remotely via communication. Thus, in my opinion, Somani's Controller necessarily includes a communication element for receiving real-time update of the set point threshold from remote, or at least obvious to a POSA.

337. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani's Controller) *is provided with a communication element, and the communication element is configured to receive a real-time update of the power level set-point* (e.g., update the set point threshold via remote communication as taught by Matan).

9. Claim 15

338. In my opinion, Somani teaches non-unity power factor. As I explained in Section V.F, power factor is related to reactive power, and in particular, the power factor is 1 only when there exists no reactive power. Therefore, a POSA would have understood that existence of reactive power necessarily indicates non-unity power factor, which indicates existence of displacement phase angle between voltage and current. For example, Somani discloses existence of reactive power several times. *See, e.g.,* Ex-1007, ¶32 (“a master controller being configured to: enable its power converter to operate in voltage control mode by controlling the voltage amplitude and frequency; and generate active and reactive current commands for the slave controllers to follow. One or more of the slave controllers may be configured to receive the active and reactive current commands from the master controller and enable their power converters to operate in current control mode.”), ¶33; Ex-1008, p.16 (“For example, in ac micro-grids it is important that distributed resources are able to

provide real and reactive power to the specified load range.”), p.18 (“A droop control can be implemented on the interfacing power electronics that changes the output frequency based on load active power and output voltage amplitude based on load reactive power... This master commands the slave devices to output a certain level of active and reactive currents.”). Reactive power can only exist if there is a displacement between the angle of the current and voltage. Thus, a POSA immediately knows that if the controller can regulate reactive power, then the controller can produce a current with a displacement angle. Thus, Somani discloses that the controller is configured to produce an alternating current displaced from the grid voltage.

339. As I have explained in Section XII.B.4, Matan discloses implementing power-factor conditioning in a PV inverter, including “intentionally chang[ing] the PV inverter output to be **out of phase** to a certain extent with **respect to the AC voltage signal of the grid.**” Ex-1006, ¶ 32.

340. As I have explained in Section XII.F.1, a POSA would have been motivated to incorporate Matan’s power-factor conditioning into Somani such that PV inverter 140 can deliver any desired power factor based on grid conditions. This is also confirmed by Somani that teaches producing reactive power.

341. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *the controller* (e.g., Somani’s Controller) *is configured to regulate a*

power flow of the current-source inverter to produce an alternating current that is displaced from the grid voltage (e.g., changing the AC current output by Somani's PV inverter 140 to be out of phase to a certain extent with respect to Somani's grid 150, as taught by Matan).

10. Claim 16

342. As I have explained in Section XII.B.5, Matan discloses that amount of phase displacement is limited by a preset limit, *i.e.*, no more than 90 degrees.

343. As I have also explained in Section XII.B.5, use of a preset limit was common at the time and is in no way innovative, and to the extent any difference exists between claim 16 and Somani-Matan-Wilhelm, such trivial difference does not rise to the level of a nonobvious innovation.

344. Therefore, it is my opinion that Somani-Matan-Wilhelm renders obvious that *an amount of displacement of the alternating current is determined by a preset limit* (e.g., the amount of phase shift is determined by preset limits).

11. Claim 17

345. As I have explained in Section XII.B.6, Matan discloses setting the power factor (and thereby the amount of phase shift) via remote communication. Since Somani's Controller controls the output of the PV inverter 140, it is my opinion that a POSA would have understood that, in the Somani-Matan-Wilhelm

system, amount of displacement would be communicated to Somani's Controller for power-factor conditioning.

346. Therefore, it is my opinion that Serban-Matan-Wilhelm renders obvious that *the amount of displacement of the alternating current is controlled through external communication with the controller* (e.g., controlled via remote communication with Somani's Controller, as taught by Matan).

12. Claim 19

347. Claim 19 includes the limitations of claims 1-3, 5-8, and 13 and is renders obvious by Somani-Matan-Wilhelm for the same reasons, as shown in the table below.

Claim 19	Claims 1-3, 5-8, 13	Sections
19[P]: The uninterruptible power supply as set forth in claim 18,	Claims 1, 2, and 5-7	XII.F.2
19[A]: further including a second alternating current power port configured to be coupled to an alternating current grid, and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.F.2
19[B]: in which the controller is further configured to— source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds a predetermined power level set-point; and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when	XII.F.4

	the power sourced from the alternating current grid exceeds the predetermined power level set-point.	
19[C]: [the controller is further configured to—] disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating current grid goes outside of a predetermined limit.	XII.F.2

13. Claim 20

348. Claim 20 includes limitations of claims 2, 3, 8, and 13 (and adds *managing power flow in a grid-tied photovoltaic system* in 20[P], *house load* in 20[C-D], and *utility grid* in 20[F] and 20[I-J]) and is renders obvious for the same reasons as shown in table below.

Claim 20	Claims 1-3, 5-8, 13	Sections
20[P]: An uninterruptible power supply for managing power flow in a grid-tied photovoltaic system, the uninterruptible power supply comprising:	1[P]: An uninterruptible power supply comprising:	XII.F.2
20[A]: a bi-directional converter configured to operate as an alternating	1[A]: a bi-directional converter configured to operate as an alternating current voltage source;	XII.F.2

current voltage source and as an alternating current source;	5: The uninterruptible power supply as set forth in claim 4, in which the bi-directional converter is also configured as an alternating current source.	XII.F.2
20[B]: a direct current power port configured to be coupled to a battery;	1[B]: a direct current power port configured to be coupled to a battery;	XII.F.2
20[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter and to a house load, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source, and	1[C]: a first alternating current power port coupled to the bi-directional converter and configured to be coupled to a current-source inverter, wherein the current-source inverter is configured to adjust an output power as a function of a frequency of the alternating current voltage source; and	XII.F.2
	6: The uninterruptible power supply as set forth in claim 5, in which the first alternating current power port is also configured to be coupled to a load.	XII.F.2
20[D]: wherein 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, and in which the controller is configured to control the bi-directional power converter to source power to the house load during the predetermined outage period	7: The uninterruptible power supply as set forth in claim 6, in which 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, and in which the controller is configured to control the bi-directional power converter to source power to the load during the predetermined outage period.	XII.F.2

20[F]: a second alternating current power port configured to be coupled to an alternating current utility grid; and	3: The uninterruptible power supply as set forth in claim 1, further including a second alternating current power port configured to be coupled to an alternating current grid.	XII.F.2
20[G]: a controller configured to—regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source, and	1[D]: a controller configured to regulate a power flow of the current-source inverter by adjusting a frequency of the alternating current voltage source.	XII.F.2
20[H]: [a controller configured to—] regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state,	2: The uninterruptible power supply as set forth in claim 1, in which the controller is configured to regulate the power flow of the current-source inverter to maintain the battery at a predetermined ideal charging state.	XII.F.2
20[I]: [a controller configured to—] source power from the battery to the alternating current utility grid when the power sourced from the alternating current utility grid exceeds a predetermined power level set-point, and	8: The uninterruptible power supply as set forth in claim 6, in which the controller includes a predetermined power level set-point, and in which the controller is configured to source power from the battery to the alternating current grid when the power sourced from the alternating current grid exceeds the predetermined power level set-point.	XII.F.4
20[J]: [a controller configured to—] disconnect the current-source inverter from the alternating current utility grid when a voltage or frequency of the alternating current utility grid goes outside of a predetermined limit.	13: The uninterruptible power supply as set forth in claim 7, in which the controller is configured to disconnect the current-source inverter from the alternating current grid when a voltage or frequency of the alternating	XII.F.2

	current grid goes outside of a predetermined limit.	
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349. With respect to 20[P], to the extent limiting, Somani-Matan-Wilhelm teaches or suggests *managing power flow in a grid-tied photovoltaic system* since Somani-Matan-Wilhelm manages power flow between PV and other components tied to the grid. Ex-1007, Fig. 1B; Ex-1008, Fig. 3.

350. With respect to 20[C-D], Somani-Matan-Wilhelm's load is *house load*. Ex-1006, ¶28 ("grid-tied (local) load (e.g., a house, apartment, cabin, or other dwelling)"); ¶30 ("Load Z102 represents a consumer premises (e.g., a home) tied to grid 130.").

351. With respect to 20[F] and 20[I-J], Somani-Matan-Wilhelm's grid is a *utility grid*. Ex-1007, ¶58 ("the power converters are connected to an external grid such as a utility grid"); Ex-1008, p.11.

G. My Opinions as to Claim 14 based on Serban in view of Wu and Somani in view of Wu

1. Analogous Art

352. In my opinion, Serban, Somani, and Wu are at least reasonably pertinent to a problem allegedly solved by the '755 patent, as Serban, Somani, and Wu all address problems with system performance in the context of DC inverters. *Compare* Ex-1001, 3:7-9 ("the current-source inverter may be configured to adjust

an output power as a function of a frequency of the alternating current voltage source.”) *with* Ex-1005, Abstract (“cause a PV inverter to modify its power output and thereby avoid overcharging a battery.”); Ex-1007, ¶95 (“adjust the microgrid frequency to trip the generation sources offline”); Ex-1008, p.18; Ex-1013, 4:8-16 (“Through the filtering circuit 32, the compensating voltage generated by the inverter 31 converts into a compensating current. The compensating current is injected into the power line set 4 for compensating for the power loss of the active power filter and for selectively compensating the load 2 for a compound of the harmonic currents of specific orders and/or a fundamental reactive current.”).

2. Motivation to Combine Serban or Somani with Wu

353. In my opinion, in building the systems described in Serban or Somani, a POSA would have had a motivation to ensure that its system remained compliant with regulations. It is also my opinion that a POSA also would have had a motivation to further improve system efficiency, such as by harmonic distortion correction. In my opinion, this would have led a POSA starting from Serban or Somani to Wu’s teachings related to a regulatory-compliant and efficient harmonic distortion correction technique.

354. In my opinion, a POSA would have had a **reasonable expectation of success** in incorporating Wu’s harmonic distortion correction into Serban’s or Somani’s systems. It was well known before the ’755 Patent that controlling

harmonic distortion below certain limits was required by regulations and would have been straightforward to implement for a POSA, such as through configuring the semiconductor switches and/or use of passive filtering devices. Moreover, Wu provides detailed explanation of how to cancel harmonic distortion produced by the load using an active power filter.

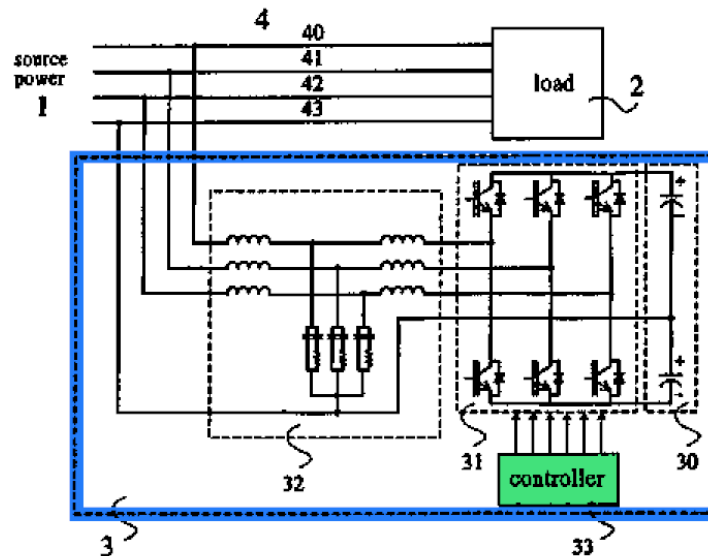


FIG.3

Ex-1013, Fig. 3 (active power filter 3, blue). Thus, it is my opinion that to incorporate Wu's harmonic distortion correction, a POSA would have understood to incorporate Wu's active power filter into Serban's PV inverter 104 or Somani's Inverter 140 and have expected to result in a working system. Moreover, it is further my opinion that a POSA would have understood that Serban's Controller or Somani's Controller may be adapted to perform functions needed as Wu's

controller 33 (green).

3. Claim 14

355. As shown below, Wu discloses “an active power filter 93 [blue]... for providing a **compensating current**... [that] is injected into a power line between the power source 91 and the load 92 to **suppress the harmonic current of the load 92.**” Ex-1013, 1:47-55.

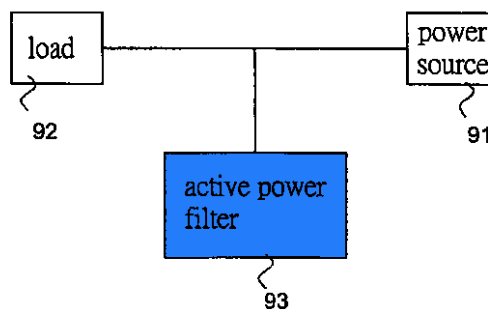


FIG.1
PRIOR ART

Ex-1013, Fig. 1.

356. As also shown in Figure 3 below, Wu discloses that “[t]hrough the filtering circuit 32, the compensating voltage generated by the inverter 31 converts into a compensating current. **The compensating current** is injected (blue) into the power line set 4... for **selectively compensating the load 2 (red) for a compound of the harmonic currents of specific orders**...” Ex-1013, 4:8-16.

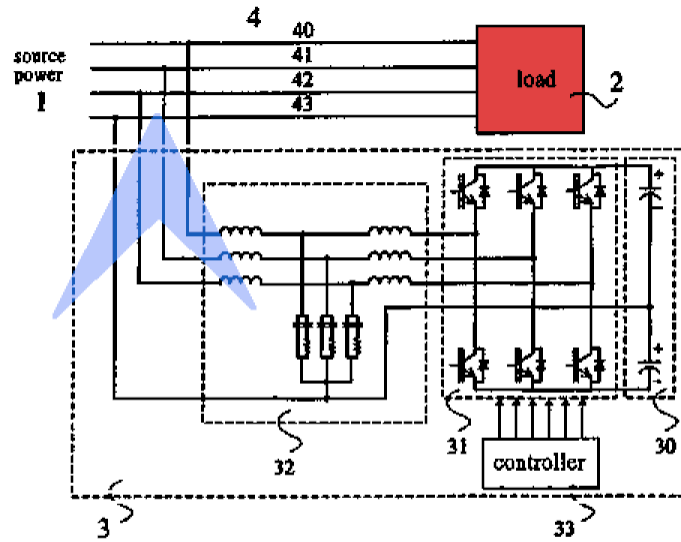


FIG.3

Ex-1013, Fig. 3.

357. Therefore, it is my opinion that Serban or Somani plus Wu renders obvious that *the controller* (e.g., Serban's or Somani's Controller) *is configured to regulate a power flow of the current-source inverter* (e.g., Serban's PV inverter 104 or Somani's PV inverter 140) *so as to cancel a distortion current produced by the load* (e.g., inject a compensating current to suppress harmonic current of Serban's load 114, as taught by Wu).

XIII. CONCLUDING STATEMENTS

358. In my opinion, claims 1-7, 13, and 18 are anticipated by Serban. As such, in my opinion, these claims should be found unpatentable and cancelled.

359. In my opinion, claims 1-7 and 13-18 are rendered obvious by Serban in view of Matan. As such, in my opinion, these claims should be found unpatentable and cancelled.

360. In my opinion, claims 8-12 and 19-20 are rendered obvious by Serban in view of Matan and Wilhelm. As such, in my opinion, these claims should be found unpatentable and cancelled.

361. In my opinion, claims 7, 13, and 18-20 are rendered obvious by Serban in view of Matan, Wilhelm, and PVI. As such, in my opinion, these claims should be found unpatentable and cancelled.

362. In my opinion, claim 14 is rendered obvious by Serban in view of Wu. As such, in my opinion, this claim should be found unpatentable and cancelled.

363. In my opinion, claims 1-3, 5-7, 13 and 18 are anticipated by Somani. As such, in my opinion, these claims should be found unpatentable and cancelled.

364. In my opinion, claims 1-13 and 15-20 are rendered obvious by Somani in view of Matan and Wilhelm. As such, in my opinion, these claims should be found unpatentable and cancelled.

365. In my opinion, claim 14 is rendered obvious by Somani in view of Wu. As such, in my opinion, this claim should be found unpatentable and cancelled.

366. 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 and that such willful false statements may jeopardize the results of these proceedings.

Date: January 31, 2024

A handwritten signature in black ink, appearing to read "E. R. Collins, Jr.", written in a cursive style.

Edward R. Collins, Jr., Ph.D., PE