

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA, INC.,
Petitioner

v.

CHARGELOGIC LLC,
Patent Owner

Case IPR2026-00377
U.S. Patent 10,090,567

DECLARATION OF SAMUEL RUSS, PH.D.

TABLE OF CONTENTS

EXHIBIT LIST	6
I. INTRODUCTION	9
II. BACKGROUND AND QUALIFICATIONS	9
III. LEGAL STANDARDS	11
A. Patentability	12
B. Prior Art.....	16
C. Inherency	17
D. Person of Ordinary Skill In The Art.....	18
E. Claim Construction.....	19
IV. BASES FOR OPINIONS	20
V. LEVEL OF ORDINARY SKILL IN THE ART	21
VI. CLAIM CONSTRUCTION	23
A. “cost of power” (Claims 1[c], 8[e], 15[e])	23
B. “threshold level of battery charge” (Claims 15[d]).....	25
VII. OPINIONS ON GROUND 1	26
A. Independent Claim 1	26
1. Claim 1[a]: “the vehicle charger comprising: an electrical power cord releasably attachable to at least one of the vehicle and a power source”	26
2. Claim 1[b]: “a third controller electrically coupled to the electrical power cord; at least one of a transmitter and a receiver coupled to the third controller and adapted for	

communication with the first controller and the second controller”	31
3. Claim 1[c]: “wherein the third controller is responsive to at least one signal from the first controller by automatically changing a charging state of the vehicle charger at a time associated with a cost of power to the battery reaching a threshold cost of power to the battery, the at least one signal related to a cost of electrical power, changing the charging state of the vehicle charger including automatically starting charging when the cost of electrical power is equal to or less than the threshold cost of power,”	37
4. Claim 1[d][i]: “wherein the third controller is responsive to at least one signal from the second controller by changing a charging state of the vehicle charger to start charging,”	43
5. Claim 1[d][ii]: “the at least one signal from the second controller being received by the third controller in response to a user selecting a user-manipulable control on a screen associated with the second controller”	54
B. Dependent Claim 3	62
VIII. OPINIONS ON GROUND 2	62
A. Independent Claim 15	62
1. Claim 15[a]-[b]: “[a] a display mounted within the vehicle within reach of a user seated within the vehicle; [b] a user-manipulatable control within reach of the user seated within the vehicle and by which a user can enter a time of day; and”	62
2. Claim 15[d]: “wherein the controller supplies electric power to the battery if a level of battery charge is below a threshold level of battery charge independent of the time of day entered by the user, the controller supplying electric power to the battery at least until the threshold level of battery charge is reached,”	70
3. Claim 15[e]: “wherein the controller automatically starts	

battery charging when a cost of electrical power to the battery is equal to or less than a threshold cost of power to the battery, and”	75
4. Claim 15[f]: “wherein the controller is responsive to at least one signal from the remote controller by changing the supply of electric power to the vehicle battery to start charging, the at least one signal from the remote controller being received by the controller in response to a user selecting a second user-manipulable control on a screen associated with the remote controller.”	76
IX. OPINIONS ON GROUND 3	77
A. Independent Claim 8	77
1. Claim 8[b]: “a display coupled to the controller and adapted to display a time; and”	77
2. Claim 8[d]: “wherein the controller automatically changes the supply of electric power to the vehicle battery during the course of the charging session by at least one of a group consisting of increasing a rate of charge of the battery, decreasing the rate of charge of the battery, starting battery charging, and stopping battery charging based at least in part upon the time needed to charge the vehicle battery by the time of day entered by the user,”	77
3. Claim 8[e]: “wherein the controller automatically changes the supply of electric power to the vehicle battery at a time associated with a cost of power to the battery reaching a threshold cost of power to the battery, wherein changing the charging state of the vehicle charger includes automatically starting charging when the cost of power to the battery is equal to or less than the threshold cost of power, and”	82
4. Claim 8[f]: “wherein the controller is responsive to at least one signal from the remote controller by changing the supply of electric power to the vehicle battery to start charging, the at least one signal from the remote controller being received by the controller in response to a user selecting a second user-	

	manipulable control on a screen associated with the remote controller.”	82
X.	OPINIONS ON GROUND 4–9.....	84
XI.	CONCLUSION.....	85

EXHIBIT LIST

Exhibit No.	Description
2001	March 26, 2025 USPTO Memorandum on Interim Processes for PTAB Workload Management, available at https://www.uspto.gov/sites/default/files/documents/InterimProcesses-PTABWorkloadMgmt-20250326.pdf (“Process Memorandum”)
2002	March 11, 2026 Squires Memorandum on Additional Discretionary Institution Considerations – U.S. Manufacturing and Small Business Use of AIA Proceedings, available at https://www.uspto.gov/subscription-center/2026/uspto-issues-additional-discretionary-institution-facts (“Small Business Memorandum”)
2003	Excerpts from File History of U.S. Patent Application 18/298,152 (issuing as U.S. Patent No. 12,272,189)
2004	USPTO Reexaminations – FY 2026, Quarter ending 6/30/2026, available at https://www.uspto.gov/sites/default/files/documents/reexamination-op-stats.pdf
2005	Tesla, Inc. Form 10-K for the Year Ending December 31, 2025
2006	Complaint for Patent Infringement and Jury Demand, <i>ChargeLogic LLC v. Tesla, Inc.</i> , C.A. No. 7:26-cv-00100 (W.D. Tex. March 23, 2026)
2007	Shareholder Deck for Q2 2026 Update, Tesla Investor Relations, July 22, 2026, available at https://assets-ir.tesla.com/tesla-contents/IR/TSLA-Q2-2026-Update.pdf
2008	NHTSA Part 583 American Automobile Labeling Act Report for 2026, available at https://www.nhtsa.gov/part-583-american-automobile-labeling-act-reports
2009	CM/ECF Docket Report, <i>ChargeLogic LLC v. Tesla, Inc.</i> , C.A. No. 7:26-cv-00100 (W.D. Tex.) (as of August 23, 2026)

Exhibit No.	Description
2010	Joint Proposed Scheduling Order, <i>ChargeLogic LLC v. Tesla, Inc.</i> , C.A. No. 7:26-cv-00100, Doc. 34-1 (W.D. Tex. Aug. 10, 2026)
2011	RESERVED
2012	Expert Declaration of Samuel Russ, Ph.D.
2013	U.S. Patent No. 8,427,103
2014	U.S. Patent No. 9,950,635
2015	Tesla Home Charging Website, <i>available at</i> https://www.tesla.com/home-charging (last accessed Aug. 26, 2026)
2016	RESERVED
2017	U.S. Patent No. 8,618,771
2018 - 2020	RESERVED
2021	U.S. Patent No. 8,004,109
2022	Apple, “Apple Reinvents the Phone with iPhone” (Jan. 9, 2007), <i>available at</i> https://www.apple.com/newsroom/2007/01/09Apple-Reinvents-the-Phone-with-iPhone/ (last accessed Sept. 9, 2026)
2023	RESERVED
2024	The American Heritage Dictionary (2 nd College Ed. 1982) – “remote” definition
2025	Microsoft Computer Dictionary (5 th Ed.) – “remote PC” definition
2026	Microsoft Computer Dictionary (3 rd Ed.) – “remote terminal” definition
2027	U.S. Patent No. 10,809,829

Exhibit No.	Description
2028	U.S. Patent No. 11,258,107 (“the ’107 Patent”)
2029	Tesla, “Elon Musk,” <i>available at</i> https://www.tesla.com/elon-musk (last accessed Sept. 15, 2026)

I. INTRODUCTION

1. I have been retained as a technical expert by ChargeLogic LLC (“ChargeLogic” or “Patent Owner”) and asked to provide my objective and unbiased opinions concerning the patentability of U.S. Patent No. 10,090,567 (“the ’567 Patent”). Specifically, I have been asked to provide my opinions on the patentability of the challenged claims of the ’567 Patent in view of the grounds advanced in the pending Petition for *Inter Partes* Review filed by Tesla, Inc. (“Tesla” or “Petitioner”) against the ’567 Patent (IPR2026-00377), the state of the art at the time of the claimed inventions, and the knowledge of a person of ordinary skill in the art at the time of the claimed inventions.

II. BACKGROUND AND QUALIFICATIONS

2. My Curriculum Vitae is attached hereto as Appendix A.
3. In forming the opinions expressed in this Declaration, I have considered and relied upon my education, background, and experience. In addition, I have reviewed and relied upon materials preparing of this Declaration, as described herein.
4. I received a Bachelor’s degree in Electrical Engineering from the Georgia Institute of Technology (“Georgia Tech”) in 1986 and a Ph.D. in Electrical Engineering from Georgia Tech in 1991.

5. From 2007 to the present, I have been a member of the faculty of the University of South Alabama as an Assistant and Associate Professor in the Department of Electrical and Computer Engineering. During that time, I have won awards for excellent teaching.

6. I am active in the Institute of Electrical and Electronic Engineers (“IEEE”) and am a Distinguished Lecturer for the IEEE Consumer Electronics Society. As a consultant, I have conducted briefings for members of the financial community on technology trends in the cable, satellite, and Internet Protocol Television (“IPTV”) sectors.

7. I also served on the faculty of Mississippi State University from 1994 to 1999 as an Assistant Professor in the Department of Electrical & Computer Engineering, where I taught circuit board design and two-way interactive video classes, among other things.

8. I have also authored at least 15 journal articles and at least 31 conference papers.

9. With regard to batteries and battery charging, the subject matter associated with the ’567 Patent, I have actively developed numerous systems that used batteries and battery chargers.

10. From 1999 to 2000, I developed a portable version of a payment terminal. To complete the design based on Nickel Metal Hydride (“NiMH”)

batteries, I had to consider thermal issues, charge management, and charge memory associated with incomplete discharging.

11. From 2016 to 2022, I managed the design of a fully functional satellite that was successfully deployed in orbit in 2022. The satellite included a maximum power-point tracking solar battery charger and Lithium-Ion batteries. The batteries required a special safety rating for safe storage on the International Space Station and I architected the software specifically for very low power consumption. I overhauled the EE 457 Embedded Systems course to include components of safety and ethics, and I use batteries and battery chargers as examples of systems with significant safety risks. I also teach specifically on battery charging and battery chemistry so that students can be prepared for battery-equipped systems.

12. I have no financial interest in ChargeLogic or the '567 Patent. I am being compensated for my time spent in connection with these proceedings at an hourly rate. I am also being reimbursed for reasonable expenses, such as travel expenses. My compensation is not contingent on my opinions, on the outcome of any matter, or on any of the technical positions I explain in this declaration.

III. LEGAL STANDARDS

13. I am not an attorney. For purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my opinions, as set forth below.

A. Patentability

14. I understand that for an invention claimed in a patent to be valid and patentable, it must be, among other things, new and not obvious in light of what was known and came before it. That which was known or came before the claimed invention is generally referred to as “prior art.”

15. I understand that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can show that the claim was obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

16. I understand that, for a patent claim to be “anticipated” by the prior art, each and every element or requirement of the claim must be found, expressly or inherently, in a single prior art reference. Further, I understand that anticipation requires that the single prior art reference must disclose the elements of the claim arranged or combined in the same way as in the claim. It is my understanding that whether a claimed invention is obvious is a question of law, with underlying factual inquiries that are determined from the perspective of a person of ordinary skill in the art at the time of the claimed invention.

17. It is my understanding that a claimed invention is obvious if the differences between the claimed invention and the prior art are such that the claimed

invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art (a “POSITA”).

18. It is my understanding that obviousness requires consideration of the following underlying factual inquiries:

- determining the scope and content of the prior art;
- ascertaining the differences between the claimed invention and the prior art;
- resolving the level of ordinary skill in the art; and
- evaluating objective evidence or “secondary considerations” of non-obviousness, such as experimental results, commercial success, long-felt but unresolved needs, failure of others, industry praise, and unexpected results.

19. It is my understanding that a reference must be analogous art to the claimed invention in order to be properly considered for use in an obviousness inquiry. It is my understanding that a reference is analogous art to the claimed invention if:

- The reference is from the same field of endeavor as the claimed invention (even if it addresses a different problem); or
- The reference is reasonably pertinent to the problem faced by the inventor (even if it is not in the same field of endeavor as the claimed invention).

20. It is my understanding that whether a reference is reasonably pertinent depends on how the problem faced by the inventor is reflected, either explicitly or implicitly, in the specification.

21. It is my understanding that the following are exemplary rationales that may support a conclusion of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of known techniques to improve a similar method or product in the same way;
- Applying a known technique to a known method or product ready for improvement to yield predictable results;
- Obvious to try – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

22. In addition to the above, I understand that a person of ordinary skill in the art may resort to logic, judgment and common sense available to him or her at the time of the invention or prior to the invention to find a claim feature obvious, even if the prior art relied on does not explicitly state or teach that feature. I understand that when common sense is relied on to find a feature obvious, the reasoning for that conclusion must be articulated with sufficient clarity.

23. I also understand that a patent claim is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. An obviousness determination requires finding both that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so. I understand that it is important to be careful not to allow hindsight reconstruction of references to produce the claimed invention, without any explanation as to how or why the references would be combined to produce the claimed invention.

24. Regarding “objective evidence” or “secondary considerations,” I understand that for such evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a “nexus”) between the claim and the evidence. I also understand that such objective evidence may include: commercial success of products covered by the patent claims; long-felt need for the invention; failed

attempts by others to solve the problem addressed by the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making or use of the invention; and that the patentee proceeded contrary to the accepted wisdom of the prior art.

25. I understand that a person of ordinary skill is also a person of ordinary creativity. I further understand that the obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, but instead can take into account “ordinary innovation” that does no more than yield predictable results, which are inferences and creative steps that a person of ordinary skill in the art would be understood to employ.

26. I understand that sometimes it will be necessary to look to interrelated teachings of multiple patents and publications; the effects of demands known to the relevant field or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art. I understand that all these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.

B. Prior Art

27. I understand that for purposes of this proceeding, prior art includes patents and printed publications (e.g., journal articles) in or outside the United States

before the effective filing date of the claimed invention. I also understand that prior art includes U.S. patents, published U.S. patent applications, and published international applications (pursuant to the Patent Cooperation Treaty) that themselves have an effective filing date before the effective filing date of the claimed invention, as long as they name another inventor.

C. Inherency

28. I understand that if a prior art reference does not expressly set forth a particular claim element, the prior art may still disclose that element if it is “inherent” in its disclosure. To establish inherency, it is my understanding that evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference. It is my understanding that inherency may not be established by probabilities or possibilities. In other words, it is my understanding that the mere fact that a certain thing may result from a given set of circumstances is not sufficient to establish inherency.

29. I understand that under the principles of inherency, if a prior art device, in its normal and usual operation, would necessarily perform a claimed method, then the method will be considered to be anticipated by the prior art device. I also understand that when the prior art device is the same as a device described in the specification for carrying out the claimed method, it can be assumed that the device will inherently perform the claimed process.

D. Person of Ordinary Skill In The Art

30. I understand that “a person of ordinary skill in the art” or POSITA is a hypothetical person who is presumed to have known the relevant art at the time of the invention. Such a person would necessarily have the capability of understanding any scientific and engineering principles applicable to the pertinent art.

31. I understand that factors that may be considered in determining the level of ordinary skill in the art include, but are not limited to, the following:

- a. the educational level of the inventor;
- b. the type of problems encountered in the art;
- c. prior art solutions to those problems;
- d. the rapidity with which innovations are made;
- e. the sophistication of the technology; and
- f. the educational level of active workers in the field.

32. I understand that a person of ordinary skill in the art is not a real person, but rather is a hypothetical individual having the qualities reflected by the factors above. This hypothetical person has knowledge of all prior art in the relevant field as if it were arranged on a workshop wall and takes from each reference what it would teach to a person of ordinary skill in the art.

33. I understand that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton. In many cases a person of ordinary skill will be able to fit the teachings of multiple prior art references together like pieces of a puzzle.

34. I understand that a person of ordinary skill in the art can collaborate with one or more other persons of ordinary skill in the art for one or more aspects with which the other person may have superior expertise, experience, and/or knowledge.

E. Claim Construction

35. It is my understanding that claim construction, or the interpretation of the claims of a patent, is ultimately a question of law. I have been informed that claim terms are generally presumed to carry their ordinary and customary meaning. However, I understand that a patent applicant is his own lexicographer and is entitled to provide alternate definitions of words in common usage, but if the patent applicant uses a term that is in common usage without providing an alternate definition, then that term should generally be understood as having its common meaning.

36. I understand that a person of ordinary skill in the art is deemed to read a claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent specification and the “file history” of the patent developed during examination by the Patent Office.

37. I understand that the claims, the specification, and the file history are referred to as “intrinsic evidence,” and are to be read as a person of ordinary skill in the art at the time of the invention would have done at the time of the alleged invention.

38. In addition to the intrinsic evidence, I understand that the court or tribunal may also consider other relevant evidence, which is called “extrinsic evidence,” concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Such evidence includes the testimony of qualified expert witnesses. Although extrinsic evidence may be used to resolve ambiguities that may exist after reviewing the intrinsic evidence, I understand that extrinsic evidence cannot be used to contradict a claim construction that is clear from the intrinsic evidence.

39. I understand that some claims are independent, and that those independent claims are complete by themselves. Other claims refer to these independent claims, or other dependent claims, and are “dependent” on those claims. The dependent claims include all of the limitations of the claims on which they depend.

IV. BASES FOR OPINIONS

40. The opinions set forth in this Declaration are my own. In forming the opinions herein, I have considered the Petition for *Inter Partes Review* filed in the

IPR proceedings referenced above and exhibits thereto, as well as the additional materials cited in this Declaration (including the exhibits to the Patent Owner's Response cited herein), and my education, training, and experience.

41. My analysis of the materials relating to this matter is ongoing and I will continue to review any new material that is provided to me. This Declaration represents certain opinions that I have formed to date and the bases for those opinions. I reserve the right to revise, supplement, and/or amend my opinions based on new information presented to me and on my continuing analysis of the materials cited herein or later provided to me.

V. LEVEL OF ORDINARY SKILL IN THE ART

42. I understand that Petitioner's expert, Mr. Andrews, provides the following opinion on the level of a POSITA as of August 18, 2008:

[A] POSITA at the time of the '567 Patent would have had at least a bachelor's degree in electrical or mechanical engineering (or an equivalent field) and at least two years of work experience involving automotive systems, including electric vehicle battery charging systems. Additional industry experience or technical training may offset less formal education, while advanced degrees or additional formal education may offset lesser levels of industry experience.

Ex. 1003 ¶ 29.

43. For purposes of this Declaration only, I have applied the definition of a person having ordinary skill in the art ("POSITA") proposed by Petitioner but with

the one modification. Specifically, the proposed definition should not require “automotive systems” experience generally, which would include experience with transmissions, cooling systems, and other systems unrelated to batteries or battery charging. Instead, the industry experience should simply require at most two years of experience with electric battery chargers, which can be offset by higher levels of relevant education. Although the ’567 Patent focuses on electric vehicle battery chargers, a POSITA would not require specific experience with such chargers if they have sufficient experience with other types of chargers. For example, I have considerable experience with battery chargers for satellite systems and for portable payment terminals, which are not meaningfully different in terms of technical complexity or complexity of operation as compared to vehicle chargers.

44. My education and experience exceed that of a POSITA as described above and qualify me to testify as to the knowledge of a POSITA under any reasonable definition. *Supra* Section II (“Background and Qualifications”). Moreover, even under Petitioner’s proposed level of ordinary skill in the art, I qualify based on my significantly higher level of education, which offsets the requirement of any specific industry experience.

45. All references to a POSITA here are made pursuant to this modified definition. However, my application of that definition is not a reflection of my

agreement or disagreement with it. I reserve the right to provide my own opinion on the level of ordinary skill should there be further proceedings.

46. With these understandings, my testimony herein relates to the knowledge and understanding of a POSITA as of August 18, 2008. I understand this is the priority date applied by Petitioner, and I have been asked to use this date for the purposes of my testimony. I have formed no opinion on whether this date is the appropriate date, nor have I been asked to do so.

VI. CLAIM CONSTRUCTION

A. “cost of power” (Claims 1[c], 8[e], 15[e])

47. I understand that the Petition applies the “ordinary and customary meaning of the claim terms” to all terms but one: “cost of power,” which appears in all three independent claims. *See* Pet., 3 (“For all terms not included below, Petitioner applies the ordinary and customary meaning of the claim terms.”), *Id.* (“Otherwise, Petitioner applies the plain and ordinary meaning of all claim terms”). Specifically, the Petition proposes that this phrase be construed to mean “monetary price of power.” *Id.* at 3. The entirety of Petitioner’s discussion of that construction is as follows:

Petitioner proposes that the phrase “cost of power” be construed as “monetary price of power.” *See* claims 1[c], 8[e], 15[e]. *See e.g.*, EX1001, 18:7-8 (“desired cost of power (e.g., \$0.50/hr....”).

Otherwise, Petitioner applies the plain and ordinary meaning of all claim terms.

Id.

48. It is my understanding that, generally speaking, the plain and ordinary meaning of a claim term applies unless the patentee explicitly redefines the term or disavows its full scope. The Petition does not identify any disavowal or disclaimer that would lead a POSITA to interpret “cost of power” any differently than its plain and ordinary meaning. Although the Petition cites to a single sentence from the Specification of the ’567 Patent—Ex. 1001, 18:7-8—that is merely an example and, in my opinion, nothing in it would be understood by a POSITA to be a disclaimer or disavowal of claim scope. Indeed, the sentence relied on provides “\$0.50/hr” as an example (“e.g.”), and so a POSITA would not understand that to be limiting.

49. I also observe that Petitioner’s expert, Mr. Andrews, does not appear to support the express construction. He states only: “I have been instructed to apply” the express construction. Ex. 1003 ¶ 28. He offers no opinion that the construction is correct or that a POSITA would have understood the phrase that way, which in my experience is uncommon in expert declarations on validity issues. If Mr. Andrews agreed with Petitioner’s express construction, I would expect him to opine on it in his declaration just as he opines on many other validity issues.

B. “threshold level of battery charge” (Claims 15[d])

50. I also note that Petitioner takes inconsistent claim construction positions across related IPR proceedings without explanation. Petitioner is concurrently challenging related U.S. Patent Nos. 11,258,107 and 11,721,844 in IPR2026-00378 and IPR2026-00380, respectively. I note that I am also preparing declarations in those IPRs and am well aware of them. Those patents share a common specification with the '567 Patent. Petitioner proposed that “threshold level of charge” in the '107 Patent and '844 Patents not be accorded its plain and ordinary meaning, but instead be construed to mean “a level of charge that is less than the charge level at which charging stops.” *See Tesla, Inc. v. ChargeLogic LLC*, IPR2026-00378, Paper 1 at 2-3, 12; *Tesla, Inc. v. ChargeLogic LLC*, IPR2026-00380, Paper 1 at 2-3, 9. Although those phrases lack the additional term “battery” present in the phrase here, a POSITA would, in my opinion, find no basis for construing it differently than in the '107 and '844 Patents, as the patents are all directed to a *battery* charger. The inconsistency in claim construction positions is not merely academic: if plain and ordinary meaning suffices in this proceeding, the Petition does not explain why a departure from that meaning is necessary in the '107 and '844 IPRs—and if the departure is necessary there, Petitioner’s mapping here is unsupported.

VII. OPINIONS ON GROUND 1

51. The Petition asserts that the combination of Sutardja, Kelty-218, and Pollack renders obvious claims 1-3 and 6 of the '567 Patent. Pet., 2. Based on my analysis, I have concluded that this combination would not have rendered any of these claims obvious to a POSITA for the reasons explained below.

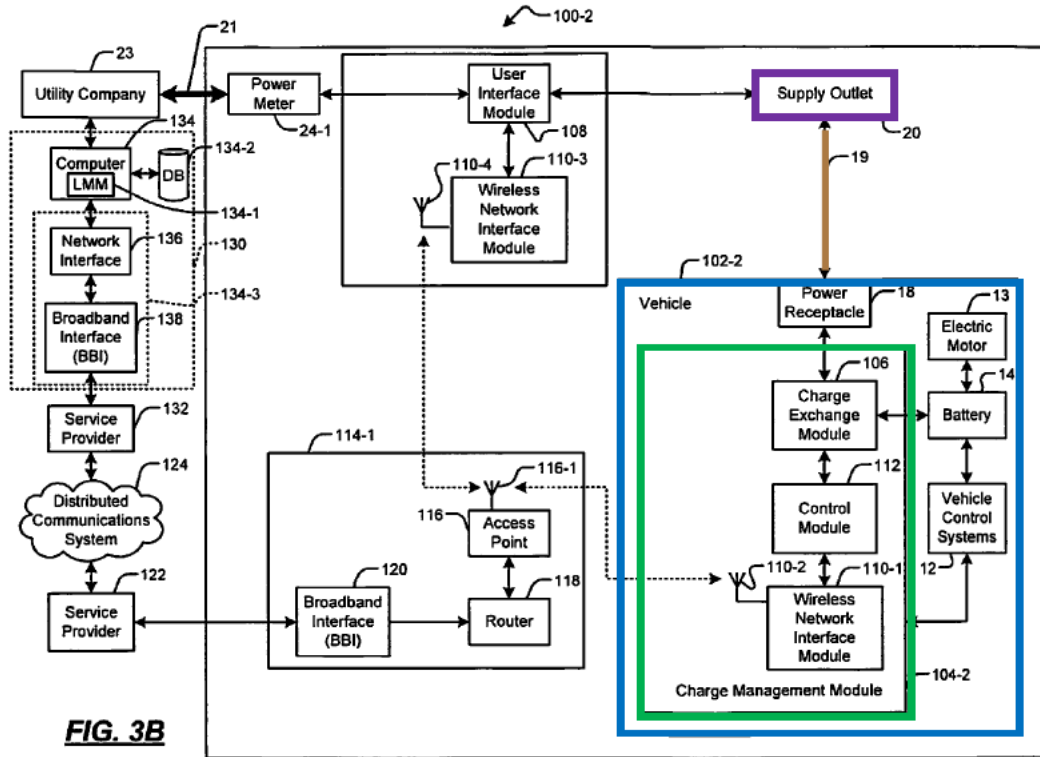
A. Independent Claim 1

1. Claim 1[a]: “the vehicle charger comprising: an electrical power cord releasably attachable to at least one of the vehicle and a power source”¹

52. The Petition states that this limitation is taught by Sutardja-Kelty-218-Pollack (Ground 1). Specifically, it asserts:

Sutardja teaches a *vehicle charger (CMM 104-2) comprising an electrical power cord (a cable and connector 19) releasably attachable to at least one of the vehicle (vehicle 102) and a source of power (supply outlet 20)*. Sutardja depicts a “*cable and connector 19*” (“*electrical power cord*”) that connects the *electric vehicle 102* with a *supply outlet 20*:

¹ I use the same claim element reference letters set forth in the Petition.



Pet., 17-18 (footnote omitted). Petitioner thus alleges that the claimed “vehicle charger” *is* the combination of **CMM 104-2** and **connector/cable 19**. This is consistent with Petitioner’s mapping in the co-pending IPR challenging the related ’107 Patent. *See Tesla, Inc. v. ChargeLogic LLC*, IPR2026-00378, Paper 1 at 7 (“Sutardja teaches a *battery charger (i.e., CMM 104-1 with connector/cable 19)* comprising an *electrical power cord (cable/connector 19)*....”) (footnote omitted).²

53. In my opinion, this mapping is unfounded and illogical. Specifically, the Petition identifies the claimed “vehicle charger” as the combination of CMM

² All *italic-bold* emphasis and alterations have been added unless otherwise indicated.

104-2 and connector/cable 19, yet those two components are completely separated by a third component—power receptacle 18—that the Petition does not identify as forming any part of the “battery charger.” A POSITA would find it difficult to understand how connector/cable 19 and CMM 104-2 can be considered part of the claimed “battery charger” when both components are completely separated from one another by another component that the Petition excludes from the “vehicle charger.” Mr. Andrews also does not explain this theory; he simply repeats the same mapping nearly *verbatim*. Compare Pet. at 7-8 with Ex. 1003 ¶¶ 97-98. Consequently, a POSITA would find Petitioner’s mapping to be implausible.³

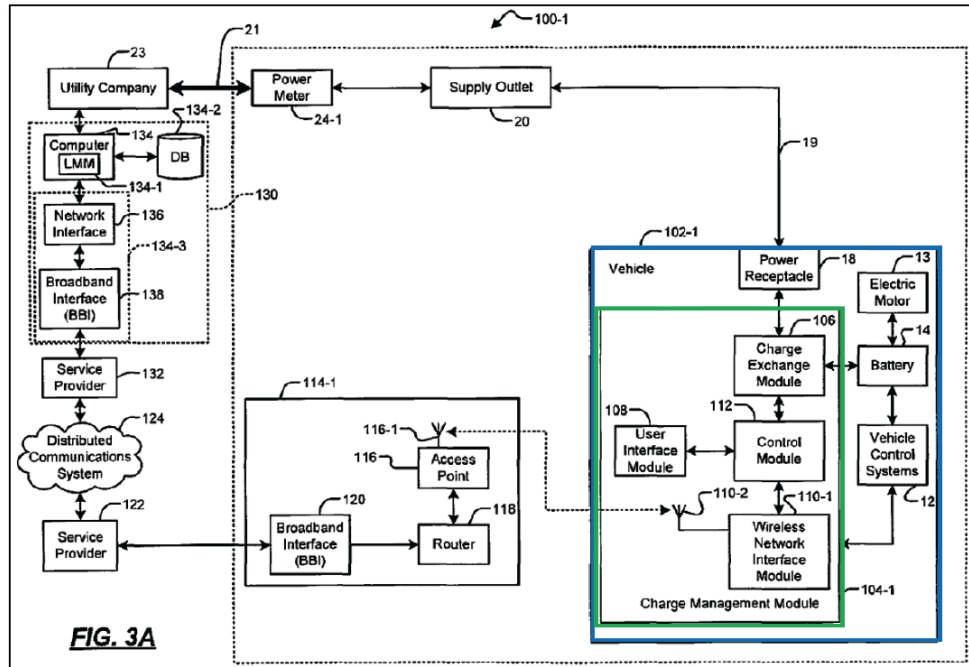
54. Petitioner does not explain how the connector/cable 19 and CMM 104-2 can be considered part of the claimed “vehicle charger” when both components are completely separated from one another by another component that the Petition asserts is *not* part of the “vehicle charger.” Petitioner’s expert, Mr. Andrews, also does not explain how this can be. Instead, he simply repeats the same mapping set forth above nearly *verbatim*. Compare Pet., 17-19 with Ex. 1003 ¶¶ 124-26. Just as

³ The issue here is not whether the combination of the CMM 104-2, receptacle 18 and connector/cable 19 can be considered a “vehicle charger”—which I have not been asked to provide an opinion on. Instead, the issue is whether the CMM-104-1 and connector/cable 19 can be considered the claimed “vehicle charger” *without* the receptacle 18 being part of the alleged charger as specifically proposed by Petitioner.

it is generally improper for a petitioner to map separately recited claim elements onto a single unified structure, it is equally improper to divide the “battery charger” identification across a structural element (power receptacle 18) that ***Petitioner itself*** contends is not part of the “vehicle charger.” *See Becton, Dickinson & Co. v. Tyco Healthcare Grp., LP*, 616 F.3d 1249, 1254 (Fed. Cir. 2010) (“Where a claim lists elements separately, the clear implication of the claim language is that those elements are distinct components of the patented invention.”) (cleaned up).⁴

55. Moreover, in the co-pending IPR challenging the related ’844 Patent, Petitioner only identifies **CMM 104-1** as the “battery charger”—not the cable/connector 19:

⁴ The issue before the Board is not whether the combination of the CMM 104-1, receptacle 18 and connector/cable 19 can be considered a “vehicle charger,” but instead whether the CMM-104-1 and connector/cable 19 can be considered the claimed “vehicle charger” ***without the receptacle 18*** being part of the alleged charger as ***specifically proposed by Petitioner***.



Tesla, Inc. v. ChargeLogic LLC, IPR2026-00380, Paper 1 at 5-6. Similarly, Petitioner refers only to “CMM 104-1” (not the connector/cable 19) as the “vehicle charger” when attempting to invalidate other claim limitations of the ’567 Patent. *See e.g.*, Pet., 38 (“Sutardja’s **third controller (modules 112/106)** further changes a charging state of the **vehicle charger (CMM 104-2)**....”). Petitioner appears to avoid mentioning the connector/cable 19 as being part of the “vehicle charger” when not required for invalidity because Petitioner’s mapping is illogical as explained above, or perhaps because the mapping in each Petition has been arbitrarily shifted to map to the claim language, all instances of hindsight bias.

56. Because a POSITA would understand that the claimed “battery charger” cannot encompass two components that are completely separated by a

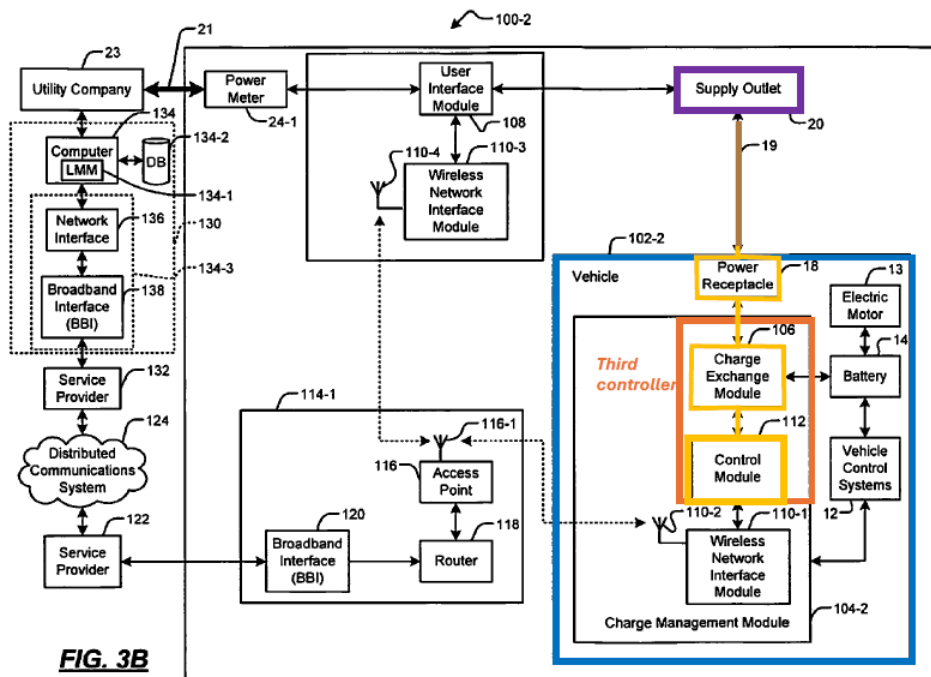
component that *the Petition does not consider* to be part of the “battery charger,” it is my opinion that Ground 1 is not supported as to this limitation.

2. Claim 1[b]: “a third controller electrically coupled to the electrical power cord; at least one of a transmitter and a receiver coupled to the third controller and adapted for communication with the first controller and the second controller”

57. For this limitation, the Petition asserts:

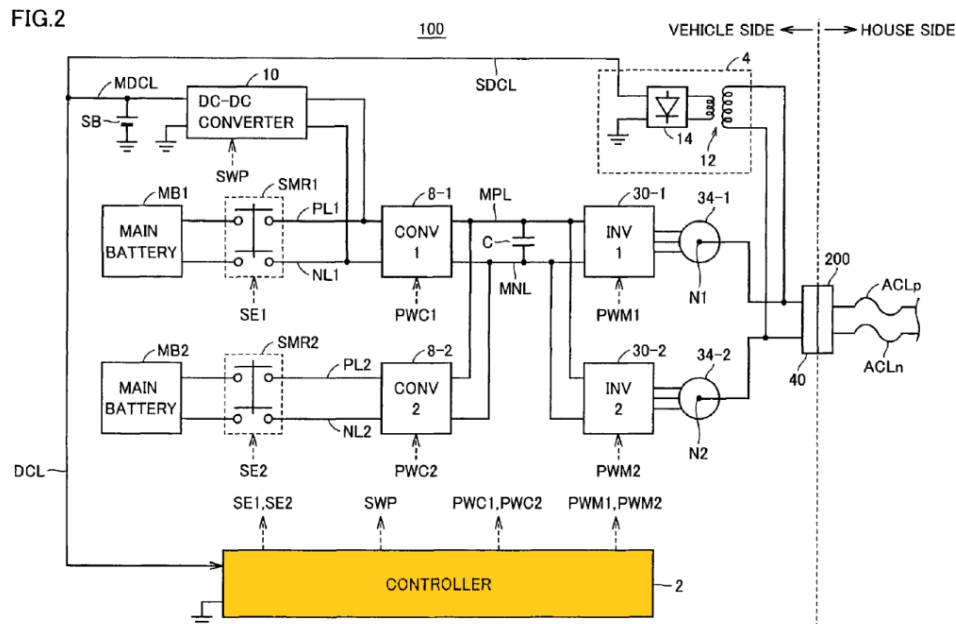
Sutardja teaches *vehicle charger (CMM 104-2) comprising a third controller (modules 112/106) electrically coupled to the electrical power cord (cable and connector 19).*

Fig. 3B shows Sutardja’s *modules 112/106 (“third controller”)* electrically coupled to the *cable and connector 19 (“electrical power cord”)* via intervening charging circuitry:



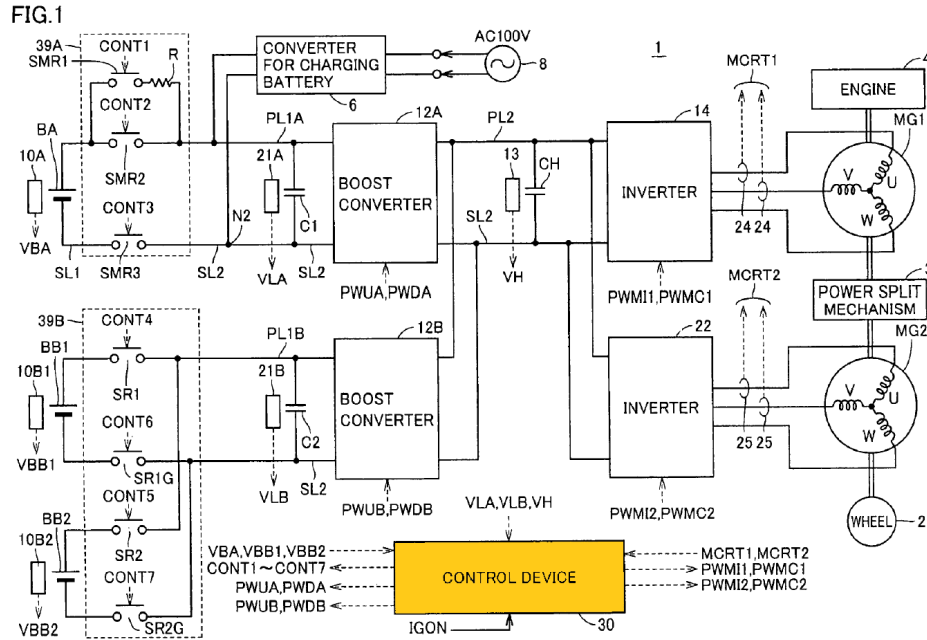
58. Sutardja explicitly refers to element 112 as the “*control module*,” but the Petition maps the “controller” to both the “control module” 112 and “charge exchange module” 106. However, neither Petitioner nor its expert explains why the claimed “controller” expands beyond “control module” 112. They simply conclude that it does without any elaboration.

59. The prior art demonstrates why this is problematic. For example, U.S. Patent No. 8,618,771 (assigned to Toyota) depicts its “controller 2” (orange) as a single contiguous device:



Ex. 2017.

60. Similarly, U.S. Patent No. 8,004,109 (also assigned to Toyota) depicts its “control device” 30 (orange) as a single contiguous device:

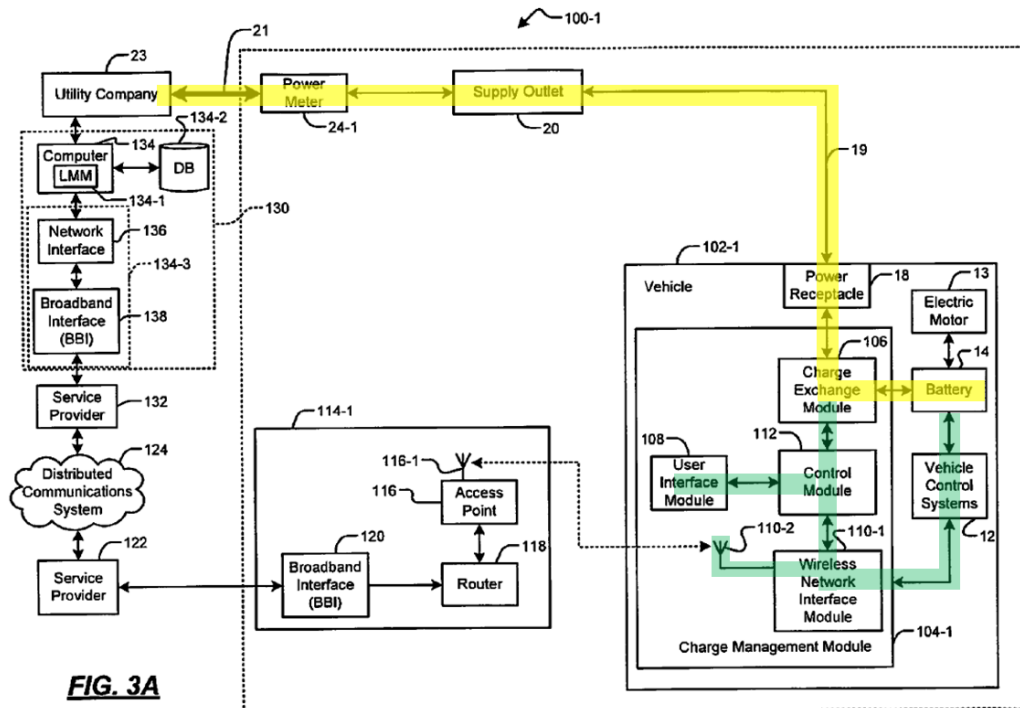


Ex. 2021. In contrast, the Petition identifies the alleged “controller” of Sutardja as encompassing *both* “control module 112” and “charge exchange module” 106 without any claim construction or explanation to support this mapping. A POSITA would typically understand the “control module” of an electronic device to be the “controller” of the device, absent additional information reflecting (i) that additional hardware/circuitry of the electronic device performs the function of a controller or (ii) that the meaning of “controller” in the particular context would encompass additional hardware/circuitry.

61. Petitioner’s unexplained “controller” mapping is material, because the language of element 1[b] requires that the “controller” is “electrically coupled to the electrical power cord.” However, control module 112 is *electrically isolated* from the power by charge exchange module 106, which is the component that electrically

interacts with the cable and power supply. Thus, the control module 112 is neither directly nor indirectly “electrically” coupled to the cable/connector 19.

62. A POSITA would understand that when two components are “electrically coupled” they must at least be able to interact electrically with one another. As shown below, “charge exchange module” 106 is “electrically coupled” to the “cable and connector” 19 because it “exchange[s] charge between the battery 14 and the power receptacle 18” (Ex. 1004 ¶ [0242]) via the yellow path. Thus, the electrical interaction is the exchange of power between them.



63. In contrast, nothing in Sutardja teaches or suggests that “control module” 112 is capable of electrical interaction with the “cable and connector” 19. To the contrary, Sutardja teaches that the control module 112 “may communicate

with the charge exchange module 106, the user interface module 108, and the wireless network interface module 110-1 and may control the operation of the CMM 104-1.” Ex. 1004 ¶ [0243]. While “control module” 112 electrically interacts with those components, it cannot electrically interact with the “power receptacle” 18 or the “cable and connector” 19 because (1) the *only* thing sent or received over those components is power, and (2) the “charge exchange module” 106 *exclusively* handles the exchange of that power. Ex. 1004 ¶ [0242] (“[T]he charge exchange module 106 charges the battery 14 using the power received from the utility company 23 via the supply outlet 20 and may return charge from the battery 14 to the utility company 23 via the supply outlet 20.”). Consequently, a POSITA would understand that although the control module 112 is “electrically coupled” to charge exchange module 106 as indicated in green (i.e., those two components exchange electrical signals with one another), control module 112 is not “electrically coupled” to receptacle 18 (or the “cable and connector” 19), because control module 112 and receptacle 18 are electrically isolated from one another by the charge exchange module 106. A POSITA would understand that this isolation is important because it protects control module 112 from potentially damaging currents and voltages. That is, a POSITA would understand that the isolation is important from a design standpoint and that the control module 112 was specifically designed not to be electrically coupled.

64. The Petition further argues that the specification teaches that “‘coupled’ and variations thereof [is] used broadly and encompass both direct and indirect” connections. Pet., 19. But the claim does not recite a *physical* coupling. The claim requires an *electrical* coupling, which requires that the two components be able to interact *electrically*, whether directly or indirectly. Thus, even under the broadest reading of “coupled,” the coupling must still be *electrical*, and an indirect connection through an intervening component that blocks any electrical interaction is not one. As explained above, the charge exchange module 106 acts as a barrier to any electrical interaction between the control module 112 and power receptacle 18—the control module 112 electrically interacts with the charge exchange module 106 (by exchanging *data signals*) and the charge exchange module 106 electrically interacts with receptacle 18 (by exchanging *power*). There is thus no direct or indirect electrical interaction between the control module 112 and the receptacle. Nor could there be, because the receptacle 18 deals in *power*, not *data signals*. Thus, if it is determined that the Petitioner has not adequately explained why the claimed “controller” would extend beyond the “control module” 112 and also encompass the

“charge exchange module” 106, it would present a significant problem for the obviousness theory.⁵

- 3. Claim 1[c]: “wherein the third controller is responsive to at least one signal from the first controller by automatically changing a charging state of the vehicle charger at a time associated with a cost of power to the battery reaching a threshold cost of power to the battery, the at least one signal related to a cost of electrical power, changing the charging state of the vehicle charger including automatically starting charging when the cost of electrical power is equal to or less than the threshold cost of power,”**

a. Technical Analysis of the Obviousness Rationales

65. The Petition asserts that it would have been obvious to modify the alleged “third controller” (modules 112/106) of Sutardja based on Kelty-218 so that the “third controller” automatically starts charging based on a cost-of-power threshold. Specifically, the Petitioner states:

the *third controller* (modules 112/106) (1) automatically starts charging (*chang[e] a charging state*) (2) in response to at least one signal from the *first controller* (LMM of computer 134), the signal relating to a cost of power, and (3) *automatically starts charging when the cost of*

⁵ I understand that the sole issue here is whether Petitioner has adequately *explained why* the components identified in Sutardja constitute the claimed “controller.” I have not been asked to provide my opinion on whether those components would collectively qualify as the “controller,” because it is my understanding that it is the Petitioner’s burden to first explain how they do. As such, neither I nor ChargeLogic take a position on the issue of whether the identified components would collectively qualify as the claimed “controller” under the appropriate construction of that term.

*electrical power is equal to or less than the threshold cost of power,
as taught by Kelty[.]*

Pet., 28-29. This obviousness theory suffers from a significant, fundamental problem because it is *the LMM of computer 134*—not the alleged “third controller” (modules 112/106)—that makes and effectuates cost-based charging decisions in Sutardja. The Petition thus places that function at the incorrect component in the combination. In Sutardja’s disclosed architecture, the cost-based decision-making function resides at the utility company level, within the LMM of computer 134. While modules 112/106 are downstream executors that act on the LMM’s scheduling decisions, they do not independently evaluate cost, compare cost to a threshold, or decide whether cost justifies initiating a charge.

66. Sutardja’s Figure 8A method—the same method Petitioner relies on (Pet. 25–27)—is written from the LMM’s perspective and confirms that cost-based charging decisions are made by the LMM 134-1, not by modules 112/106. More specifically, (1) the LMM “analyze[s] the charging parameters and determine[s] the load on the distribution system” (step 206); (2) the LMM “determine[s] whether the user demands charge at normal priority” (step 207); (3) the LMM “transmit[s] alternate charging parameters including additional cost to the user” (step 216); (4) the LMM “wait[s] until time to supply power arrives” (step 220); and (5) the LMM “suppl[ies] power to the battery 14 according to either the charging parameters received from the CMM 104 and/or the user or the alternate charging parameters”

(step 222). Ex. 1004 ¶¶ [0275]–[0278], Fig. 8A. At no point in this method do modules 112/106 evaluate cost, compare cost to a threshold, or make any cost-based charging decision. The LMM 134-1, which the Petition maps to the “first controller,” is the sole entity that determines *whether* and *when* to supply power based on cost.

67. The Petitioner’s expert attempts to bridge this gap by noting that modules 112/106 receive “alternate charging parameters” from the LMM that include cost information. Ex. 1003 ¶¶139-140. However, a POSITA would understand that receiving cost-related information as part of a scheduling decision already made by the LMM is not the same as being “responsive to at least one signal from the first controller by automatically changing a charging state . . . at a time associated with a cost of power . . . reaching a threshold cost of power.” The claim requires the *third* controller to make the “cost of power”-based charging decision—to compare cost to a threshold and automatically change the charging state when that threshold is reached. Modules 112/106 do not perform this function. They receive the LMM’s scheduling output and execute it; the cost evaluation that produced that schedule occurred entirely within the LMM.

68. By contrast, modules 112/106 of Sutardja perform only local execution functions. Pursuant to Sutardja’s Figure 9A method, control module 112 “determine[s] whether the time to charge the battery 14 has arrived” (step 316), and, if so, “the charge exchange module 106 may receive the charge from the supply

outlet 20 and may charge the battery 14” (step 320). Ex. 1004 ¶ [0282]. In Sutardja’s system, modules 112/106 check the clock and activate the charging hardware—they do not evaluate cost of power, compare cost to a threshold, or decide whether cost justifies initiating a charge. A POSITA would understand that it makes sense for modules 112/106 to have access to a local clock and little else. Indeed, the cost-based decisions have already been made by the LMM 134-1 at the utility level before power ever reaches the supply outlet.

69. Sutardja itself confirms this division of functions as between LMM 134-1 and modules 112/106. Paragraph [0263] states: “*the utility company 23* may control charging times, etc. of the batteries in multiple vehicles without loading the power distribution system.” Ex. 1004 ¶ [0263]. And paragraph [0262] states: “*The utility company 23 may charge the battery 14* between 9 pm and 6 am without interacting with the user.” *Id.* ¶ [0262]. It is the utility company—acting through the LMM—that “control[s] charging times” and determines when to supply power. Modules 112/106 charge the battery when the utility makes power available at the scheduled time, but they do not independently decide *when* to charge based on cost.

70. The Petition acknowledges that Sutardja alone does not teach this limitation, and instead proposes combining Sutardja with Keltly-218. However, in my opinion, the proposed modification presents an additional issue: it targets a different component than the one that performs cost-based decisions in Sutardja’s

architecture, which creates an inconsistency in how the proposed combination of prior art. Specifically, Claim 1[c] requires the “third controller” to be “responsive to at least one signal from the first controller by automatically changing a charging state of the vehicle charger at a time associated with a cost of power to the battery reaching a threshold cost of power.” But in Sutardja, the entity that evaluates cost and decides when to supply power based on cost is the LMM, which is the same entity Petitioner maps as the “first controller.” Petitioner’s theory needs the “first controller” to *send* a cost signal and the “third controller” to *respond* to it by changing the charging state. In Sutardja, however, the LMM both evaluates cost *and* effectuates the charging decision based on that evaluation. The alleged “third controller” (modules 112/106) executes the LMM’s scheduling decision—it charges the battery when the scheduled time arrives and power is available, but nothing teaches that it “automatically chang[es] a charging state . . . at a time associated with a cost of power . . . reaching a threshold cost of power” in response to any signal.

71. Additionally, the proposed modification—adding Kelty-218’s cost-threshold functionality—does not appear to address this issue; rather, it compounds it. Petitioner proposes modifying modules 112/106 to “ (3) automatically start[] charging . . . when the cost of electrical power is equal to or less than the threshold cost of power, as taught by Kelty.” Pet. 28–29. However, Petitioner does not explain why a POSITA would have modified modules 112/106 to perform cost-responsive

functions when Sutardja is specifically designed so that the LMM 134-1—not modules 112/106—performs *all* cost-based decisions. A POSITA would readily grasp that the power company is in, by far, the best position to gather the information and make decisions. Moving decision-making is not a problem that requires a solution – it is a feature that makes sense in the context of Sutardja. If anything, a POSITA seeking to add Kelty-218’s cost-threshold functionality to Sutardja would logically have added it to the LMM, because that is the component Sutardja designates for cost-based decision-making. Indeed, Petitioner’s own mapping reveals this internal tension: Kelty-218’s charging cost circuit 212 resides in a “computer in a home”—the same home computer Petitioner maps as the “second controller”—yet Petitioner proposes adding Kelty’s cost-threshold function to the alleged *third* controller (modules 112/106) rather than the alleged second controller or the first controller (LMM-134). The Petition does not offer an explanation for this approach. Petitioner’s theory would require a POSITA to depart from Sutardja’s own architecture and relocate cost-based decision-making from the utility-company LMM to the in-vehicle CMM—a significant redesign of Sutardja’s system that Petitioner does not specifically address or justify.

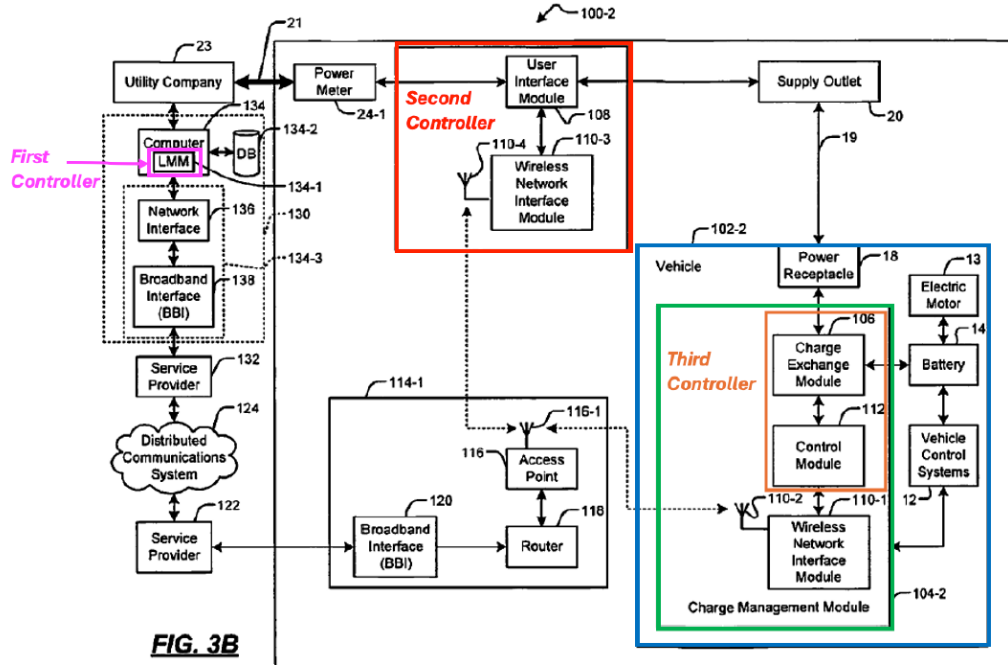
72. In my opinion, modifying module 112/106 to perform cost-based decision making does not appear to follow from the teachings of the prior art references themselves. Rather, it would require departing from the specific

architecture of Sutardja's system. To the extent it would have been obvious to implement Kelty-218's purported cost-based threshold charging into Sutardja, a POSITA would have implemented that functionality at the LMM 134-1 (alleged "first controller") consistent with Sutardja's architecture rather than including that functionality at the alleged "third controller."

4. Claim 1[d][i]: "wherein the third controller is responsive to at least one signal from the second controller by changing a charging state of the vehicle charger to start charging,"

73. The preamble requires "a second controller remote from the vehicle and the vehicle charger," and element 1[b] recites "the second controller." Thus, the claimed "second controller" is required to be "*remote* from the vehicle and vehicle charger." The Petition itself acknowledges that the second controller must be "remote" based on its invalidity analysis. Pet., 11-13.

74. The Petition proposes that it would have been obvious to implement the alleged "second controller" (**red** below) of Sutardja "on the processor of Kelty-218's *home* computer" as shown in the Petitioner's annotated Figure 3B of Sutardja. Pet., 14.



In proposing this combination, the Petition not only proposes implementing the alleged “second controller” on the “home computer” of Kelty-218, but also implicitly proposes relocating the “second controller” to a *different* location within the home than that shown in Figure 3B. This relocation is necessary for the Petition’s theory because, without it, the alleged “second controller” remains exactly where Sutardja already places it—and Petitioner does not contend that the alleged “second controller” as located in Figure 3B is “remote.”

75. As explained below, there is no basis for combining Sutardja and Kelty-218 as proposed and, even if there were, the combination still would not possess all limitations of the claims.

a. Technical Analysis of the Obviousness Rationales

76. The Petition states that “it would have been obvious to implement Sutardja’s UIM-WNIM on the processor of Kelty-218’s *home* computer.” Pet. 14. In my opinion, this obviousness theory presents significant problems for at least two reasons. It would not have been obvious to a POSTA to make the proposed combination.

77. First, Sutardja already teaches that the alleged “second controller” (**red**) is located in a “*home*” and performs exactly the same functions in Figure 3B as Petitioner attributes to the proposed combination with Kelty-218. Ex. 1004 ¶ [0239] (“A vehicle 102-1 is charged at a location such *as a home*...”). Specifically, in the Figure 3B embodiment on which the Petition relies, Sutardja discloses that “CMS 100-2 may include the user interface module 108 that is arranged outside a vehicle 102-2.” *Id.* ¶ [0247]. The user interface module 108 is itself a processor-based device—i.e., a *computer*. *Id.* ¶ [0228] (defining “module” as “electronic circuit, a processor (shared, dedicated, or group) and memory that execute one or more software or firmware programs”). This external user interface module 108 “may comprise a keypad, a display, a microphone, and/or a speaker” and allows “[a] user of the vehicle 102-1 . . . *to set charging parameters for charging the battery 14.*” *Id.* ¶ [0243]. Interface module 108 communicates with the alleged vehicle charger (CMM 104-2) wirelessly through wireless network interface module 110-3, which

“include[s] an antenna 110-4” enabling communication “with a CMM 104-2 in the vehicle 102-2 via the user LAN 114-1.” *Id.* ¶¶ [0247], [0243]. Thus, Sutardja’s UIM-WNIM 108 *already functions as a home computer located outside the vehicle*, at the *user’s home*, through which the user controls the alleged charger wirelessly.

78. Sutardja’s UIM-WNIM in Figure 3B is thus already a “home” computer dedicated to managing vehicle charging, which is the same role Petitioner assigns to Kelty-218’s “home computer.” Because Sutardja’s UIM-WNIM already provides the functionality attributed to the combination, a POSITA looking to add a computer-based charging interface to Sutardja’s system would have recognized that Sutardja *already provides one*. In other words, there is no gap in Sutardja’s disclosure for Kelty-218 to fill. It appears then that the only purpose of this proposed combination is to support the argument that it would have been obvious to move the “second controller” to an alleged “remote” location.

79. Second, Kelty-218 itself does not appear to teach that its computer is in *any particular* location within the home. Kelty-218 instead states only that its charging cost circuit 212 may be “part of a computer in a *home*” to distinguish it from “part of a computer *onboard a vehicle* (e.g., the vehicle management system 116 of FIG. 1).” Ex. 1005 ¶ [0026]. Stated differently, Kelty-218 uses the term “home” in the same manner as Sutardja—to refer to the home premises generally, as opposed to the vehicle itself. This is significant: because Kelty-218 does not

identify *any particular* location within the home, it does not teach or suggest placing the alleged “second controller” of Sutardja at a home location *different* from the one already depicted in Figure 3B. A POSITA implementing Sutardja’s UIM-WNIM on Kelty-218’s “home computer” would simply be substituting one home-based device for another in the same location shown in Figure 3B—because that location is also in a “home” per Sutardja. Ex. 1004 ¶ [0239]. The Petition does not identify anything in Kelty-218 that teaches or suggests a *particular* home location, and thus does not provide a teaching or suggestion to move the alleged “second controller” to a purportedly “remote” location as asserted by the Petition.

b. Whether the Combination Possesses All Claim Limitations.

80. As explained above, even if there were a motivation to combine, at most the combination would result in Sutardja’s “home” UIM-108 being replaced by Kelty-218’s “home computer”—meaning the alleged “second controller” remains in the exact same location as depicted in Figure 3B. Petitioner does not contend that UIM-108—as located in Figure 3B—is “remote,” and therefore the proposed combination does not possess all claim limitations.

81. Even if there were a motivation to place UIM-108 on a “home computer” at a different location within the home based on Kelty-218, the combination would *still* not yield a “second controller” that is “remote from the vehicle and the vehicle charger” as the claims require. A POSITA would understand

that a “remote” device is one situated at different premises—not merely in a different room of the same premises.

82. For one, the general purpose dictionary definition for “remote” is “located *far away*.” Ex. 2024. Similarly, the Microsoft Computer Dictionary Definition for “remote PC” is “[t]he computer or network that a remote user is accessing *via a modem*” and for “remote terminal” is “[a] terminal that is located *at a site removed from the computer to which it is attached*. Remote terminals rely on *modems and telephone lines to communicate with the host computer*.” Ex. 2025; Ex. 2026. A POSITA would similarly understand that a “remote” device is one that communicates with a device that is situated off-premises, such as a computer located off premises that communicates using network infrastructure (e.g., public telephone or cellular network).

83. The claim language confirms that “remote” imposes a meaningful spatial limitation. The preamble of Claim 1 requires “a second controller remote from the vehicle and the vehicle charger.” Independent Claims 8 and 15 similarly require “a computer remote from the vehicle and vehicle charger, the computer including a remote controller.” The repeated use of “remote”—as both an adjective modifying the controller and as a spatial qualifier in the prepositional phrase “remote from”—confirms that the term requires the controller to be situated at premises

different from the place where the vehicle is parked and the charger is located—not merely in a different room at the same premises.

84. The specification consistently associates “remote” with off-premises entities—it does not associate it with devices at the same home or premises. The ’567 Patent identifies only two categories of “other controller” with which the charger communicates: (1) “one or more processors of a server or other computer associated with a power utility providing power to the vehicle charging cord 22”; and (2) “one or more processors of a personal computer, phone, PDA, or other processor-based device associated with a user of the vehicle charging cord 22.” Ex. 1001, 9:1–12. The specification’s primary disclosed embodiment of a “remote” controller is “a remote computer of a power utility 48,” which is “located anywhere between the location 16 of the user and the sources of power 12” and may be “at a facility where power is generated, at an office of the power utility 48, [or] at any of a number of substations.” *Id.* at 9:6–15, 9:47-50. Every disclosed location for the “remote” controller is off the user’s premises—at a power plant, utility office, or substation.

85. The specification does describe communication between the charger and a “user’s computer” as an alternative. Ex. 1001, 10:31–53. But the specification’s description of this communication is revealing: the user’s computer communicates with the charger via “a residence-based, office-based, or other facility-based PLC [i.e., powerline communication] system . . . (via the electrical

system of the residence, office, or other facility)” or via “wireless personal area network (WPAN) (using, for example, ZigBee®, Bluetooth®, or any other WPAN wireless technology), wireless local area network (WLAN), and the like.” *Id.* at 10:34–46. The specification characterizes these communications as *local* communications—they use local-area protocols (WPAN, WLAN, PLC) that, by definition, operate within a confined geographic area. Indeed, the wireless-networking abbreviations literally recite “personal area” and “local area”. The specification never refers to the user’s home computer as a “remote” controller and never even uses the term “remote” in the cited discussion. To the contrary, the only computer described as “remote” in the specification is that of the power utility 48—the specification draws a clear architectural line between the on-premises user’s computer (communicating over local protocols) and the off-premises utility controller (communicating over power lines, substations, and repeaters spanning the distance between the user’s location and the power source).

86. Further, the specification’s alert-notification embodiments confirm this distinction. When an event occurs during charging (e.g., power loss or charge completion), the specification describes two distinct communication paths: (1) the charger sends a signal to “the power utility 48 (i.e., to the controller 50 of the power utility 48)”; and separately, (2) the charger sends an alert “to a computer, phone, PDA, or other device of the user” via the user’s computer or by “automatically

generating a text message or e-mail.” *Id.* at 22:30-43. In the ’107 Patent (Ex. 2028), claims require sending a signal “to a portable controller remote from the vehicle and the vehicular battery charger,” and the specification identifies the exemplary portable controller as a “phone” or “PDA” that can receive text messages and e-mails while the user is away from the charging location. The consistent thread across the patent family is that a “remote” device is one the user carries or accesses *away from* the charging premises—not a desktop computer plugged into the same home’s electrical system.

87. The prosecution history further confirms that “remote” requires an off-premises device. During prosecution of the ’567 Patent, the applicant amended the claims to add the “second controller remote from the vehicle and the vehicle charger” limitation and the “remote controller” limitation. Ex. 1002, 83–88. These amendments were made to distinguish the claimed invention over prior art that taught only on-premises or co-located user interfaces. Specifically, the applicant argued:

The controller associated with the computer is remote from both a vehicle and the vehicle charger for that vehicle, but the controller wirelessly communicates with the controller of the vehicle charger. The computer could be, for example, a processor-based device ***such as a phone or similar device that is remote from*** the vehicle and the vehicle charger.

Id. at 90–91. The applicant then argued that the combination of Hobbs, Matsumura,

Nor, Ferro, and other prior art “fails to disclose or suggest” the “remote” controller limitations, stating: “Hobbs does not contemplate or even mention wireless communication with a vehicle charger, let alone initiating a manual charge of a vehicle battery based on a signal received wirelessly from a *remote* computer (e.g., *a phone*, etc.).” *Id.* at 91. The applicant’s exemplary “remote” device—a phone—is a portable device the user carries away from the charging premises. It is not a stationary home computer on the same LAN as the charger or a device restricted to the same premises as the vehicle and charger.

88. The Petition’s proposed combination of art places the alleged “second controller” on Keltly-218’s “home computer,” which is, by definition, a computer located in the user’s home—the same location where Sutardja’s vehicle is parked and charged. A home computer communicating with a vehicle charger plugged into an outlet in the same home is not “remote from the vehicle and the vehicle charger”—it is *local* to them. The alleged second controller and the vehicle charger are connected over a *local* area network (“wireless LAN 114-1”) at the home. Ex. 1004 ¶ [0247]. Petitioner’s own declarant, Mr. Andrews, acknowledges that Sutardja’s UIM-WNIM communicates with the vehicle charger “via the user LAN 114-1.” Ex. 1003 ¶ 113. A device communicating over a LAN at the same residential location as the vehicle and charger is, by definition, a *local* controller—not a remote one.

89. The Petition effectively acknowledges this point. In arguing for the motivation to combine, the Petition emphasizes the benefits of controlling charging “without going outside” and “without leaving their home.” Pet., 13. These descriptions indicate that the user, the alleged second controller, the vehicle, and the charger are all at the same home location. A POSITA would understand that a controller operating over a home LAN to communicate with a charger plugged into the home’s supply outlet is *local* to the vehicle and charger, not remote from them. Because the claims require a second controller that is “*remote from* the vehicle and the vehicle charger,” the proposed Sutardja-Kelty combination does not disclose this limitation.

90. Additionally, the Petition’s position that relocating UIM-108 to another location within the home makes it “remote” is inconsistent with testimony from Petitioner’s own expert. Specifically, Mr. Andrews opines:

[I]t was well known that the user may wish to charge a vehicle away from home and sit in their vehicle during charging and would greatly benefit from a user interface inside the vehicle. Other times the user may be *at home* or in an office, and would want to be able to control the charging parameters *locally, for example on a computer*.

Ex. 1003 ¶ 189. This is an acknowledgment by Mr. Andrews that controlling charging from a home computer constitutes *local* control. If implementing UIM-108 on Kelty-218’s “home computer” enables the user to control charging parameters

“locally,” then the resulting device is—by Mr. Andrew’s own characterization—a *local* controller. A local controller is, by definition, not a “remote” one.

91. In summary, the proposed combination of Sutardja and Kelty-218 does not satisfy the claim requirements on multiple independent grounds. Sutardja already teaches an external *home* “computer” (UIM-108), which undermines the need to supplement it with Kelty-218. Neither reference provides a motivation to relocate the alleged second controller to a different location. And even accepting the Petition’s proposed modification as obvious, the resulting combination would produce only a locally situated second controller connected over a home *LAN*—not the “remote” second controller required by the challenged claims. For these reasons, A POSITA would not find the combination of Sutardja and Kelty-218 to render this limitation obvious.

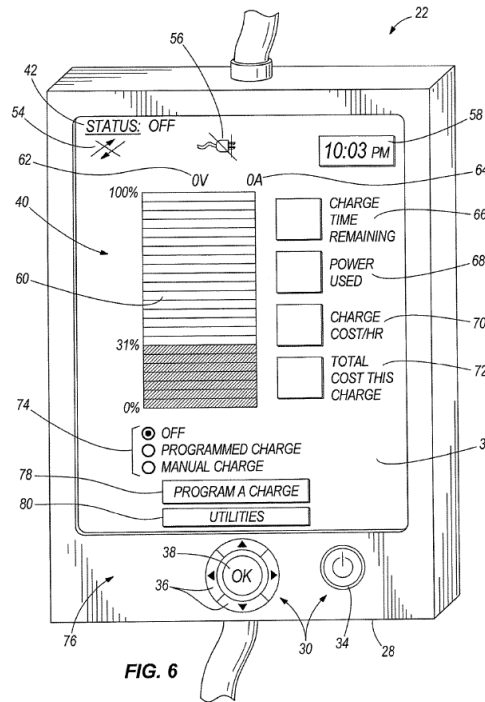
5. Claim 1[d][ii]: “the at least one signal from the second controller being received by the third controller in response to a user selecting a user-manipulable control on a screen associated with the second controller”

a. Whether the Combination Possesses All Claim Limitations.

92. The Petition acknowledges that Sutardja does not disclose “a user-manipulable control *on a screen* associated with the second controller.” Pet., 33. The Petition instead proposes that a “POSITA would have been motivated and would have found it obvious to further modify Kelty’s computer implementing Sutardja’s

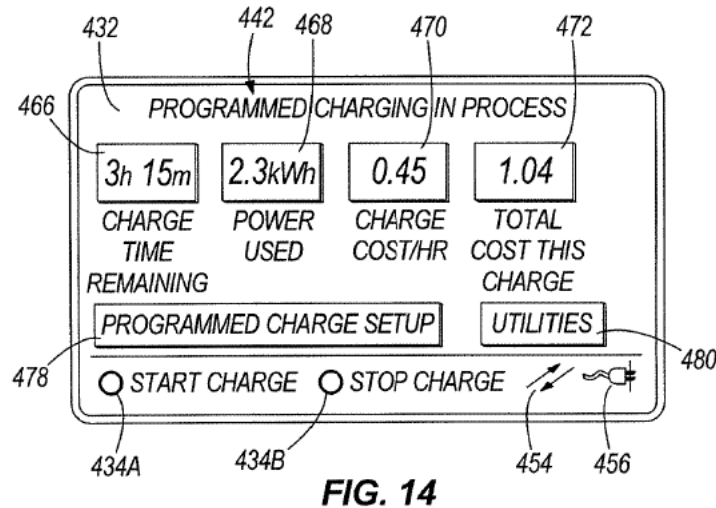
UIM-WNIM according to Pollack's teachings such that (1) UIM 108 presents *screen-based user-manipulable controls, including checkboxes, icons, menus, and manual charging overrides.*" *Id.* at 34. However, even if it would have been obvious to combine Pollack with Sutardja-Kelty-218 as proposed, the combination would not possess "a user-manipulable control *on a screen*" as required by Claim 1[d][ii]. As explained below, "a user-manipulable control on a screen" requires the screen itself to have interactive input capability—such as a touch screen—through which the user can physically control. A passive display that merely renders a graphical depiction of "checkboxes, icons, menus or manual charging overrides" does not satisfy this limitation.

93. The specification discloses two distinct interface embodiments that confirm this. In the first embodiment (FIGs. 5–11, 15), "a display 32 *in conjunction with* a number of button-type user-manipulatable *controls* 34, 36, 40 is employed." Ex. 1001, 8:6-10, 47–49.



The user-manipulatable **controls** 30—including a power button 34, navigation buttons 36, and a select button 38—are *physical buttons on the housing 28, separate from the display 32*. *Id.* at 8:14–19. The display 32 present “navigation **buttons**” (78, 80, 82, 84) that are *visually displayed* but are selected by the user using the *physical controls* on the housing: “each screen 40, 40A, 40B is accessed by selecting a navigation button, **such as by using navigation button 36** in the illustrated embodiment to highlight a desired navigation button on the screen 40, 40A, 40B.” *Id.* at 14:17–25, 15:38-56. In this embodiment, the controls (e.g., 36) are *adjacent to* a screen but not *on* the screen—the user interacts with physical hardware to control, not the screen surface.

94. In the second embodiment (FIGs. 13, 14, 16), the specification describes an “in-console display 432” that is expressly identified as “a touch screen display 432.” *Id.* at 26:33-36, 27:6-7.



The touch screen display “can include separate buttons 434A, 434B to start or stop a charging session.” *Id.* at 27:65-67. These control buttons are *on the screen*—they are interactive elements on the touch screen that the user can control by selecting the touching the screen surface.

95. The specification draws a bright line between these two embodiments: “Although a display 32 in conjunction with a number of button-type user-manipulatable controls 34, 36, 40 is employed in the embodiment of FIGs. 2, 5-11 and 15, in other embodiments, **the display 32 and any number of the button-type user-manipulatable controls 34, 36, 40 can be replaced by a touch screen** (not shown). **The touch screen can enable a user to display options, navigate between**

two or more screens, and *select options by inputting commands directly into the display 32.*” *Id.* at 8:47–56. The specification thus explains that a touch screen *replaces* separate physical buttons by enabling the user to “select options by inputting commands **directly into** the display.” *Id.* A control that is “on a screen” is one that the user interacts with directly on the screen surface.

96. The specification further confirms this when discussing what happens if the touch screen is *replaced* by a non-interactive display: “Although the in-console display 432 illustrated in FIG. 14 is a touch screen display 432, the display 432 can be any other type of display For example, the touch screen display 432 can be replaced by a display such as that shown in FIGs. 5-11 or FIG. 12, **in which cases the vehicle charging system can include navigation buttons (e.g., adjacent the display 432) enabling a user to navigate through a screen.**” *Id.* at 28:5-13. When the touch screen is replaced by a passive display, the controls move *off-screen*—they become “navigation buttons . . . **adjacent** the display.” *Id.* The specification thus distinguishes between a control that is “on a screen” (the touch screen embodiment) and a control that is “adjacent” to a screen (the passive-display embodiment). In fact, the specification makes clear that it is the touchscreen that provides the “user-manipulable control” in the FIG. 14 embodiment when it states that the touchscreen can be replaced by “***other*** user-manipulatable controls.” *Id.* at 28:13-17.

97. Claim differentiation further confirms this distinction. Claim 1[d][ii] recites a “user-manipulable control **on a screen** associated with the second controller.” Independent Claims 8 and 15, by contrast, recite the “display” and “user-manipulatable control” as *separate elements*: Claim 8 recites “a display coupled to the controller” (8[b]) and separately “a user-manipulatable control **coupled to the controller**” (8[c]); Claim 15 recites “a display mounted within the vehicle” (15[a]) and separately “a user-manipulatable control **within reach of the user**” (15[b]). In Claims 8 and 15, the display and the control are claimed as distinct elements—not as a control “on a screen.” This is consistent with the FIGs. 5–11 embodiment, where physical buttons sit alongside a passive display. Under claim differentiation, “on a screen” requires the control to be *part of an interactive screen*—i.e., a **control** that the user physically interacts with through the screen surface, such as a touch screen button. *See e.g.*, Ex. 2027, 1:24-34 (“A touchscreen is a device for inputting a **user’s command** by selecting an instruction shown on a screen of a display or the like with the hand of the user or an object.”). Indeed, the claim refers to a user-manipulatable control “on a **screen**” (e.g., touchscreen).

98. The Petition’s own cited art is consistent with this distinction. Specifically, the Petition relies on Pollack (Ex. 1006) to supply this limitation. Pollack teaches a user interface that “displays checkboxes, icons, and/or menus for user-selection of preferences, constraints, customizations, and optimizations.” Ex.

1006, claim 12. However, Pollack’s disclosure of *displayed* checkboxes and icons does not establish that these are controls “on a screen” as required by the claims. A displayed checkbox is a graphical element rendered on a display—the user may interact with it through a separate input device rather than through the screen itself. Petitioner’s expert acknowledges that Sutardja “does not depict specific examples of displayed controls” and argues that Pollack would “supply a known **graphical implementation** for functionality that Sutardja’s system was already configured to receive and process.” Ex. 1003 ¶ 166. But graphical elements on a passive display are not **controls** “on a screen”—the user cannot control anything by touching those graphical elements; the user controls using separate physical hardware such as the “user-manipulatable controls” 30 of Figure 5. Thus, in such an embodiment, the “controls” are the physical buttons, not the displayed graphical elements.

99. It is notable that Mr. Andrews specifically discusses “well-known touch screen technology” when attempting to justify the obviousness of combining Pollack with Sutardja. *Id.* First, I observe that this discussion is not in the Petition and the exhibits discussed by Mr. Andrews, such as Exhibits 1043 and 1044, are not cited or discussed in the Petition. Additionally, and significantly, ***the Petition does not allege that Pollack teaches touchscreen technology*** and Mr. Andrews himself confirms that the Petition is only proposing modifying Sutardja to include “***Pollack’s checkboxes, icons, menus, and overrides.***” *Id.* As such, even if the Petition could

have alleged modifying Sutardja to incorporate a touch screen, that is not what the Petition proposes. Instead, the Petition proposes only that Pollack teaches user-manipulatable controls in the form of “checkboxes, icons, menus, and manual charging overrides.” Pet., 34. Nor are any of the Petition’s proposed motivations to combine (referred to as “MTCs”) on this limitation directed toward touchscreen technology. *Id.* at 34-37.

100. For these reasons, the proposed combination of Sutardja, Kelty-218, and Pollack does not to teach or render obvious “a user-manipulable control on a screen associated with the second controller” as required by Claim 1[d][ii]. The claim requires a user-manipulable control *on a screen*. A passive display that merely shows a graphical representation of a button, with user control occurring through separate physical hardware (e.g., button, mouse, keyboard), does not satisfy this limitation. While such an embodiment may provide for physically-resilient controls in “dirty” environments (e.g., a garage), the claims specifically require that the user-manipulable control be “on the screen” (e.g., a mobile phone touch screen). In other words, one cannot argue that a POSITA would regard separate physical buttons versus touch screen a routine “either-or” decision – a POSITA may well have decided that physical buttons were better for the particular environment.

B. Dependent Claim 3

101. Dependent Claim 3 recites: “The vehicle charger of claim 1, further comprising a display coupled to the third controller, the display displaying a level of charge of the battery.”

102. In my opinion, this limitation is not obvious for the same reasons discussed with respect to Claim 15[a]. *Infra* Section VIII.A.1.

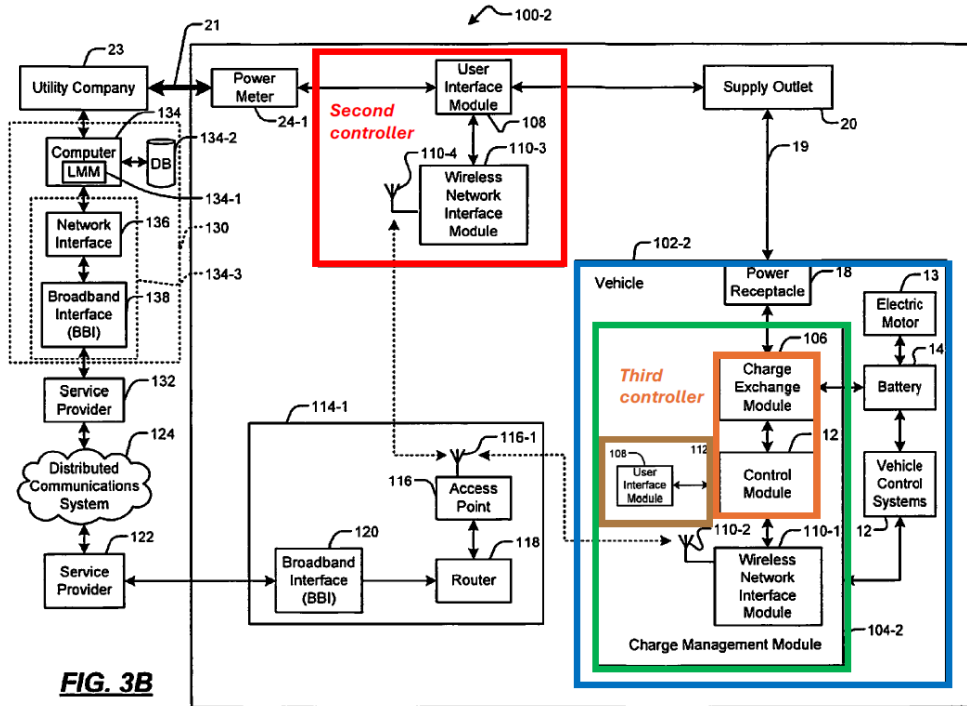
VIII. OPINIONS ON GROUND 2

103. The Petition asserts that the combination of Sutardja, Kelty-218, Pollack and Boll render obvious claims 4, 15-17, and 19 of the '567 Patent. Pet., 2. Per my analysis below, it is my opinion that this combination would not have rendered any of these claims obvious to a POSITA.

A. Independent Claim 15

- 1. Claim 15[a]-[b]: “[a] a display mounted within the vehicle within reach of a user seated within the vehicle; [b] a user-manipulatable control within reach of the user seated within the vehicle and by which a user can enter a time of day; and”**

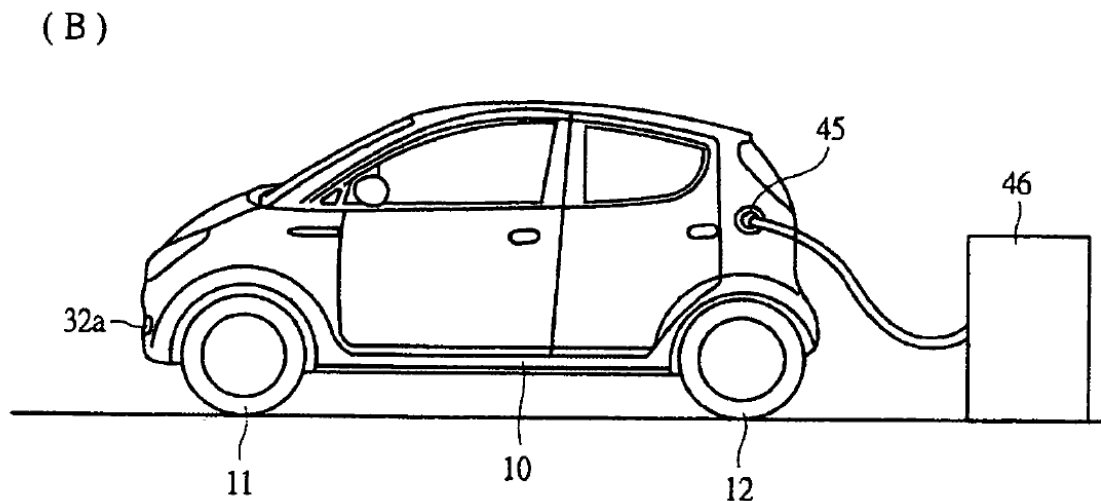
104. The Petition proposes combining Figures 3A and 3B of Sutardja to create what it refers to as a “combined” embodiment (shown below), so and then further modifying Sutardja based on the in-vehicle “display” of Pollack:



Pet., 44-48. Specifically, the Petition states that a “POSITA would have recognized the UIM 108 of Fig. 3A (providing a local display/input interface coupled to the charger) and the user interface outside of the vehicle configuration of Fig. 3B are complementary, and combining them *would allow both local and remote interaction* with the same charging system.... Such a combination would have been consistent with well-known EV charging system design practices prior to the priority date of the ’567 Patent.” *Id.*, at 45. This motivation is not supported by the technical disclosures of the cited references and instead appears to reflect a hindsight-based reconstruction of the claimed invention.

105. Sutardja is directed to a *home or work* battery charging system. *See* Ex. 1004 ¶ [0229], [0239]. Sutardja teaches that the user interface module 108 may be

in the vehicle (FIG. 3A) or, *alternatively*, outside the vehicle (FIG. 3B). A POSITA would recognize that, in a home or work charging context, the vehicle and charger are in close proximity, eliminating any practical utility of having an identical user interface module 108 both inside the vehicle and outside the vehicle as shown in the “combined” embodiment. Ex. 1004 ¶¶ [0234] (“The user interface modules may be arranged inside vehicles as shown in FIGS. 3A, 4A, and 5A or outside vehicles as shown in FIGS. 3B, 4B, and 5B.”), [0241], [0247]. A POSITA would understand that at the time of the invention, and to this day, vehicles park adjacent the charger power supply because charging cables and their vehicle connectors are thick, would present a tripping hazard, and would risk being damaged if extended any meaningful distance. *Id.* Figure 4(B) of U.S. Patent No. 8,427,103 exemplifies this—it shows a vehicle charger 46 within feet of the vehicle 10 being charged via a thick cable:



Ex. 2013; *see also* Ex. 2014, Fig. 2 (showing thick cable 70 connecting charging

station 62 to electric vehicle 12).

106. In fact, Tesla's own website shows that the power supply resides adjacent the vehicle being charged and that the wall-charger does *not* have a user interface for inputting charge levels:



107. A POSITA would understand that this is why Sutardja presents FIGS. 3A and 3B as alternatives—it does not teach or suggest a system having the user interface module 108 in both places (i.e., feet apart). Ex. 1004 ¶¶ [0234], [0241], [0247]. A POSITA would have had no technical reason to include the user interface module 108 both in the vehicle and feet away from the vehicle at the source of power. *Id.*

108. The Petition’s own statements support this understanding. For example, the Petition acknowledges that “*other than the placement* of the user interface and WNIM, the embodiments in Fig. 3A and 3B are ‘substantially similar’” and “[*b*oth *embodiments perform the same underlying functions*, including receiving user-defined charging parameters, communicating with external systems (e.g., utility providers and remote computing devices), and controlling charging of the vehicle battery based on those parameters.” Pet., 44-45. Because both embodiments “perform the same underlying functions” and the only difference is the “placement” of the user interfaces either in the vehicle or within feet of the vehicle, the Petition does not identify a technical problem that combining them would solve. A POSITA would not have identified a shortcoming in Sutardja that the combined Figure 3A/3B embodiment addresses. *Id.*

109. The Petition characterizes the hypothetical embodiment as “allow[ing] both local and *remote* interaction with the same charging system.” Pet., 45. However, both interfaces in the hypothetical embodiment are local—just as a “local area network” is local. Sutardja explicitly teaches that the user interface module 108 of Figure 3B is “outside a vehicle 102-2” and depicts it adjacent to both the supply outlet 20 and the vehicle 102-2. Ex. 1004 ¶ [0247]. Based on this disclosure, the external interface 108 in the hypothetical embodiment would not be “remote”—it sits feet away from the vehicle and from the internal interface 108, and therefore is local. Indeed, having *only* the internal interface 108 or *only* the external interface 108 allows “local control by the user” and remote coordination with the utility—the Petition does not explain how having *both* would “improve system flexibility.” It would not.

110. Moreover, the Petition later contradicts its “remote” characterization when it argues that having both the internal and external interface 108 “would improve system flexibility by enabling both *local control by the user* and remote coordination with utility systems...” Pet., 46; *see also* Ex. 1003 ¶ 189 (alleging that having the UIM inside and outside the vehicle would allow the user to “control the charging parameters *locally*”). In other words, the Petition and Mr. Andrews acknowledge that having the interface 108—whether inside the vehicle or outside the vehicle as taught by Sutardja—results in a “local” interface, not a “remote” one.

111. The Petition also relies on Mr. Andrews for the proposition that the combination “would have been consistent with well-known EV charging system design practices prior to the priority date of the ’567 Patent.” Ex. 1003 ¶ 189 (cited by Pet., 45). The only evidence cited by Mr. Andrews is Ex. 1024 and Ex. 1042, neither of which is cited, discussed, or even alluded to anywhere in the Petition. Even setting that procedural issue aside, Mr. Andrews acknowledges that Ex. 1024 teaches a user using a “home **PC**” wirelessly connected to an in-vehicle “user interface. *Id.* Sutardja does not teach a PC (i.e., personal computer) but instead a user-interface located feet from the vehicle in-line with the power meter. Even if a reason existed to have an additional UIM on a “home PC,” that same reason does not apply to Sutardja, where the external UIM is located “outside” the vehicle. With respect to Ex. 1042, Mr. Andrews contends that it “confirms that EVs were expected to be charged *away from home at publicly accessible charging stations.*” *Id.* However, Sutardja is directed toward a **home or work** charger—where the EV is charged **at home** or **at work** where the user would remain on-premises.

112. Mr. Andrews further argues that “it was well known that the user may wish to charge a vehicle away from home and sit in their vehicle during charging and would greatly benefit from a user interface inside the vehicle.” Ex. 1003 ¶ 189. Mr. Andrews does not provide evidence to support the premise that users would “sit in their vehicle” while the vehicle charges **at home or at work** (i.e., the context of

Sutardja). In a home or work charging scenario, a user would wait indoors rather than remain in the vehicle during charging. Additionally, Mr. Andrews does not explain why a user would “greatly” benefit from a user interface 108 inside the vehicle when one is located feet away outside the vehicle. And if the in-vehicle interface 108 would “greatly benefit” the user as alleged, that would eliminate the need for the user interface 108 located outside the vehicle.

113. The Petition next argues that having two user interface modules 108 adjacent to one another “would improve system flexibility by enabling both local control by the user and remote coordination with utility systems, which were known to manage charging based on load and cost considerations.” Pet., 45. This reasoning does not follow, because “local control by the user” and “remote coordination with utility systems” is accomplished by *a single* user interface module 108—whether located in the vehicle or outside it. Neither Petitioner nor Mr. Andrews explains how having two interfaces 108 within feet of one another would actually improve system flexibility.

114. The Petition also argues that the combined embodiment “would facilitate more efficient implementation of user-defined charging preferences—such as scheduling and cost-based charging—which were known to depend on both user input and communication with external systems.” Pet., 46. But just as with the “second” reason immediately above, Petitioner does not actually explain how having

two user interfaces 108 as shown in combined Figure 3 would “facilitate more efficient implementation.”

115. In short, no evidence exists to support that it would have been obvious to implement the user interface 108 of the home/work charger of Sutardja both inside and within feet outside the vehicle. Indeed, Tesla’s own commercial EV battery charger does *not* have an interface on the wall-mounted charger, which is consistent with the view that such a duplicative interface would be unnecessary given that the vehicle itself has the necessary interface. *See* Ex. 2015, 2, 4. The stated obviousness rationales are not grounded in the teachings of the cited references. Moreover, because there would have been no benefit to having the user interface 108 both inside and outside the vehicle as depicted in the hypothetical embodiment, the increased cost and complexity associated with adding an additional user interface 108 would have discouraged POSITA from doing so.

2. Claim 15[d]: “wherein the controller supplies electric power to the battery if a level of battery charge is below a threshold level of battery charge independent of the time of day entered by the user, the controller supplying electric power to the battery at least until the threshold level of battery charge is reached,”

116. As an initial matter, I note that the Petition proposes plain and ordinary meaning for “threshold level of battery charge” despite taking the position that plain and ordinary meaning should not apply for the indistinguishable phrase “threshold level of charge” in the ’107 and ’844 IPRs. The ’567, ’107 and ’844 Patents share a

common specification, and this inconsistency warrants consideration. *Supra* Section VI.B. Further, in the '107 and '844 IPRs Petitioner proposed that term be expressly construed to mean “a level of charge that is less than the charge level at which charging stops.” *Id.* However, the Petition here does not appear to have shown how the prior art satisfies this limitation under that express construction in this proceeding.

117. Even setting those issues aside, the prior art does not teach this claim limitation. Claim 15[d] requires the controller to supply electric power to the battery if the battery charge level is below a threshold “*independent of the time of day entered by the user.*” This limitation has two prerequisites: (1) the user must have entered a time of day for charging, and (2) the controller must override that user-entered time by supplying power based solely on battery charge level, regardless of whether the user’s entered time has arrived. The Petition states that a “POSITA would have been motivated and would have found it obvious to modify Sutardja’s *controller (modules 112/106)* to supply power to the battery if a level of battery charge is below a threshold level of charge *independent of time and until the threshold battery charge level is reached*, as taught by Kelty.” Pet., 60. However, none of the cited references—individually or in combination—teach a system where the controller overrides the user-entered time by supplying power.

118. Sutardja allegedly teaches supplying electric power to a battery “based on charging parameters (e.g., daily charging times),” and Kelty-218 purportedly teaches “selectively charging a battery based on charging-cost conditions and target battery charge levels.” *Id.* at 59-60. The Petition represents that Kelty-218 teaches the “independent of time of day” requirement (*id.* at 59), but based on my review, Kelty-218 does not appear to teach this feature.

119. A POSITA would understand that a system cannot make a charging decision “independent of the time of day entered by the user” if the user never enters a time of day in the first place. And Kelty-218 does not teach or disclose a user entering a time of day. Indeed, the Petition does not contend that Kelty-218 does so, alleging:

Kelty teaches selectively charging a battery based on charging-cost conditions and target battery charge levels. EX1005-Kelty, Abstract, [0014]. Kelty’s “*charging circuit 208 is turned on until the battery reaches a first energy stored level*” (e.g., 80% of full stored energy to improve calendar life) during a first time period when charging costs are below a threshold, and optionally charging the battery to a higher “second energy stored level” (e.g., 90% or full stored energy) during a second time period when the charging costs may be higher.

Id. at 59-60. Nothing identified by the Petition teaches that a user in Kelty-218 enters a time of day such that Kelty-218 could make any decisions “independent of” that user-provided setting. For Kelty-218 to teach the “independent of” requirement, the

user in Kelty-218 must have already provided a “time of day” as required by the claim.

120. While Sutardja allegedly teaches a user entering a time of day (*id.* at 57-58), the Petition acknowledges that Sutardja does not teach the “independent of” requirement. Thus, Sutardja **independently** teaches simply following its charging schedule and Kelty-218 **independently** teaches following its charging schedule—neither reference teaches or suggests charging independent of a user-provided time of day input. Thus, even when combining Kelty-218 with Sutardja, that combination of art does not supply this missing claim requirement.

121. The Petition’s motivation to combine—that “a POSITA would have been motivated to modify Sutardja so that the vehicle maintained a minimum charge level regardless of the time of day or associated cost, ensuring that the vehicle remained usable for routine needs” (Pet., 60)—does not address this gap. In Sutardja, the user requests “a full charge daily between 9 pm and 6 am.” Ex. 1004 ¶ [0262]. If the user wants the vehicle charged for morning use, Sutardja’s system already achieves that result through the user’s own charging parameters—the user specifies a full charge by 6 am, and the utility delivers it. There would be no need to “override” the user’s time entry because the user’s parameters already ensure a full charge by the user’s specified time. Petitioner does not explain why a POSITA would have added an override mechanism to a system in which the user already specifies the

desired charge level and completion time. If anything, Sutardja effectively teaches away from the claim language – the form of time entry of Sutardja (specifying a charge-completion time) sets up a system where the charging process needs no further information or ability to override. The system, via electric-utility control, satisfies the user’s wishes. In other words, the claimed override feature is not a problem inside Sutardja that a POSITA would feel the need to fix.

122. Moreover, even setting aside the absence of a user-entered time, Kelty-218’s charging decisions are themselves time-dependent—not time-**independent**. Kelty-218 teaches charging to a first energy stored level “during a first time period” and charging to a second energy stored level “during a second time period.” Ex. 1005 ¶ [0040]. Kelty-218 expressly states: “In various examples, the *first time period is coincident with the time of day* in that a first charging cost rate is within in a first cost range.” *Id.* Kelty-218 further teaches that the “second time period” may be “user selected” and “coincident with a period of time in which a charging cost rate fits into a second cost range.” *Id.* ¶ [0041]. Thus, Kelty-218 does not teach charging “independent of” time—it teaches charging to particular energy levels *during particular time periods that are themselves determined by cost*. Thus, the combination of Sutardja and Kelty-218 would produce a system that charges to a first level during one time period and to a second level during another time period—

both time-dependent—not a system that charges independently of the time of day entered by the user.

123. It appears that Petitioner recognizes this, as Petitioner attempts to establish this limitation through argument, stating that:

A POSITA would have been motivated to modify Sutardja so that the vehicle maintained a minimum charge level *regardless of the time of day or associated cost*, ensuring that the vehicle remained usable for routine needs, such as driving to work, as well as unexpected or emergency trips. EX1003-Dec., ¶225. Because those needs may arise outside a user-entered charging schedule, the modification would improve reliability and usability of the vehicle.

Pet., 60. This single passage is the entire basis for Petitioner contending that the “independent of” limitation is taught by Sutardja-Kelty-218. Notably, the Petition does not identify any portion of Sutardja or Kelty-218 that teaches or suggests this limitation, instead relying primarily on Mr. Andrews’ testimony. Indeed, Petitioner does not cite *any* prior art or other evidence showing that this limitation was known or obvious at the time of the invention.

3. Claim 15[e]: “wherein the controller automatically starts battery charging when a cost of electrical power to the battery is equal to or less than a threshold cost of power to the battery, and”

124. Petitioner refers back to Claim 1[c] for this limitation. The prior art does not render this limitation obvious for the same reasons discussed with respect to Claim 1[c]. *Supra* Section VII.A.3.

4. Claim 15[f]: “wherein the controller is responsive to at least one signal from the remote controller by changing the supply of electric power to the vehicle battery to start charging, the at least one signal from the remote controller being received by the controller in response to a user selecting a second user-manipulable control on a screen associated with the remote controller.”

a. Technical Analysis of the Obviousness Rationales

125. Claim 15[pre] recites a “vehicle charger adapted for wireless communication with a **computer remote from the vehicle and vehicle charger, the computer including a remote controller**, the vehicle charger comprising” and Claim 15[f] recites “**the remote controller**.” Petitioner maps the “remote controller” to “**Kelty’s computer implementing Sutardja’s UIM-WNIM**,” which is the same structure that Petitioner mapped the “remote” second controller of Claim 1[pre] and Claim 1[d][i].

126. For the same reasons discussed with respect to those limitations, in my opinion Petitioner has not demonstrated that it would have been obvious to implement Sutardja’s UIM-WNIM on Kelty-218’s “home computer.” *Supra* Section VII.A.4.a.

b. Whether the Combination Possesses All Claim Limitations.

i. “remote controller”

127. Even if it had been obvious to implement Sutardja’s UIM-WNIM on Kelty-218’s “home computer” and to move that computer into a different location

on the home premises, it would still not result in the claimed “*remote* controller” as previously explained. *Supra* Section VII.A.4.b.

ii. “user-manipulatable control on a screen”

128. Petitioner relies on Pollack for the “user-manipulatable control on a screen,” just as it did with respect to this limitation in Claim 1[d][ii]. However, in my opinion, even if Pollack is combined with Sutardja-Kelty-218 as proposed, the combination does not disclose this limitation for the same reasons discussed with respect to Claim 1[d][ii]. *Supra* Section VII.A.5.

IX. OPINIONS ON GROUND 3

129. The Petition asserts that the combination of Sutardja, Kelty-218, Pollack, and Gale renders obvious claim 8 and 10-12 of the ’567 Patent. Pet., 2. This combination would not have rendered these claims obvious to a POSITA for the reasons explained below.

A. Independent Claim 8

1. Claim 8[b]: “a display coupled to the controller and adapted to display a time; and”

130. In my opinion, this limitation is not obvious for the same reasons discussed with respect to Claim 15[a]. *Supra* Section VIII.A.1.

2. Claim 8[d]: “wherein the controller automatically changes the supply of electric power to the vehicle battery during the course of the charging session by at least one of a group consisting of increasing a rate of charge of the battery, decreasing the rate of charge of the battery, starting battery charging, and stopping

battery charging based at least in part upon the time needed to charge the vehicle battery by the time of day entered by the user,”

131. Claim 8[d] requires the controller to automatically change the supply of electric power “based at least in part upon *the time needed to charge the vehicle battery by the time of day entered by the user.*” This is a computation-dependent limitation: the controller must (1) calculate or consider the time required to charge the battery, and (2) use that calculation at least in part in conjunction with the user-entered completion time to determine when to start or stop charging. The proposed combination of Sutardja and Gale does not render this limitation obvious for at least four reasons.

132. First, Sutardja’s modules 112/106 do not calculate the “time needed to charge” the vehicle battery. Claim 8[d] requires the “controller” to change the supply of electric power based on “the time needed to charge the vehicle battery by the time of day entered by the user.” Petitioner maps the “controller” of Claim 8 to Sutardja’s modules 112/106. Pet., 63–64. But in Sutardja, modules 112/106 do not calculate the time required to charge the battery. Instead, modules 112/106 perform only local execution: control module 112 “determine[s] whether the time to charge the battery 14 has arrived” (step 316 of Fig. 9A) and, if so, the charge exchange module 106 “receive[s] the charge from the supply outlet 20 and may charge the battery 14” (step 320). Ex. 1004 ¶ [0282]. The scheduling computation—determining *when* to supply power based on the user’s requested time, the load on the distribution system, and

the time required to complete charging—is performed by the LMM 134-1 at the utility company. *Id.* ¶ [0253] (“The LMM 134-1 may analyze the load on the distribution system based on the requested charging parameters from multiple customers. The LMM 134-1 may determine a schedule for charging batteries in multiple vehicles.”); [0275]–[0278], Fig. 8A (steps 206–222). This is the same “wrong component” problem identified with respect to Claim 1[c]. *Supra* Section VII.A.3. The claim requires *the controller*—alleged modules 112/106—to use the time-needed-to-charge calculation in managing the charging session. But in Sutardja, modules 112/106 do not possess or use this information; the LMM does.

133. Second, Gale itself teaches the charge-time calculation at the utility level—not the vehicle-charger level—which is inconsistent with Petitioner’s mapping. Petitioner relies on Gale for the proposition that a controller determines “the length of the period required to fully recharge the battery 28 from its current state of charge” and uses that to “compute time to start charging.” Pet., 67 (citing Ex. 1008 ¶¶ [0041]–[0042], Fig. 12). But Gale’s controller 30 does not use this information in isolation. Gale expressly teaches that controller 30 “initiates communications transmitted through the charger 24 to the electric utility 10 and responds to communications from the utility” and that the system “transmit[s] to the electric power utility the length of time required to recharge the battery and the desired time” so that the battery is recharged “during a period when projected load

demand is lower than peak demand.” Ex. 1008, Abstract, ¶¶ [0008], [0027]. In other words, Gale’s charge-time calculation is transmitted *to the utility* for scheduling purposes—exactly the same architecture as Sutardja’s LMM-based scheduling.

134. This presents a problem for Petitioner’s theory. Petitioner’s argument requires Gale’s charge-time computation to be incorporated into on-board vehicle modules 112/106—the alleged “controller” of Claim 8—so that modules 112/106 can change the supply of electric power “based at least in part upon the time needed to charge.” But Gale teaches transmitting the charge-time information to the *utility*, which then schedules charging based on projected load demand. Ex. 1008, Abstract. If anything, a POSITA incorporating Gale’s teaching into Sutardja would logically have transmitted the charge-time information from the CMM to the LMM at the utility company—consistent with both Sutardja’s and Gale’s disclosed architectures—not relocated the scheduling function into modules 112/106. In other words, the system of Gale works harmoniously with the existing system of Sutardja, relying on the electric utility for calculations because the utility has access to more information, such as power costs and the state of the power grid. Petitioner’s theory would thus require a POSITA to disregard both Sutardja’s and Gale’s express architecture in favor of a modification that neither reference teaches or suggests. The petition cannot justify a specific implementation based on two references that do not

teach the implementation. Additionally, this raises concerns about whether the proposed modification reflects hindsight reconstruction.

135. Third, the motivation to combine Sutardja with Gale is provided in conclusory terms. Petitioner's motivation to combine is essentially a single sentence: "A POSITA would have recognized that incorporating Gale's time it takes to charge the vehicle into Sutardja's scheduled time the user wishes their vehicle to charge would have improved overall efficiency of Sutardja's system since as an example in order to charge between 9-6pm, it would be necessary to know how long the car must charge and a POSITA would have had a REOS." Pet., 68. Petitioner thus says it would have been obvious to know how long charging takes because "it would be necessary to know." That formulation does not appear to provide an independent reason for the combination.

136. Fourth, Petitioner does not identify *which component* of Sutardja's system would be modified to incorporate Gale's charge-time calculation, or *how* the modification would be implemented. Would the charge-time calculation be added to modules 112/106 (the mapped "controller")? To the LMM? To the overall CMS? The Petition does not address this and it is not entirely clear how Petitioner proposes combining the references. For example, if Petitioner is arguing that it would be obvious to modify the LMM 134 based on Gale, even if that were obvious it would

not result in the alleged “controller” (modules 112/106) having the claimed functionality.

137. For these reasons, it is my opinion that Claim 8[d] would not have been obvious over Sutardja-Kelty-218-Pollack-Gale. Any alleged charge-time computation in Sutardja and Gale resides at the utility-level, not at the in-vehicle/user level. The Petition does not explain why a POSITA would impart Gale’s *utility-level* functionality into the *on-board* vehicle modules 112/106. Nor does Petitioner explain which component would be modified or how the resulting system would satisfy the claim.

3. Claim 8[e]: “wherein the controller automatically changes the supply of electric power to the vehicle battery at a time associated with a cost of power to the battery reaching a threshold cost of power to the battery, wherein changing the charging state of the vehicle charger includes automatically starting charging when the cost of power to the battery is equal to or less than the threshold cost of power, and”

138. Petitioner refers back to Claim 1[c] to address this limitation. For the same reasons discussed with respect to Claim 1[c], in my opinion the prior art does not render this element obvious. *Supra* Section VII.A.3.

4. Claim 8[f]: “wherein the controller is responsive to at least one signal from the remote controller by changing the supply of electric power to the vehicle battery to start charging, the at least one signal from the remote controller being received by the controller in response to a user selecting a second user-manipulable control on a screen associated with the remote controller.”

a. Technical Analysis of the Obviousness Rationales

139. Claim 8[Pre] recites a “vehicle charger adapted for wireless communication with **a computer remote from the vehicle and vehicle charger, the computer including a remote controller**” and Claim 8[f] recites “**the remote controller**.” Petitioner maps the “remote controller” to “**Kelty’s computer implementing Sutardja’s UIM-WNIM**,” which is the same structure that Petitioner mapped the “remote” second controller of Claim 1[pre] and Claim 1[d][i]. For the same reasons discussed with respect to those limitations, it would not have been obvious to implement Sutardja’s UIM-WNIM on Kelty-218’s “home computer.” *Supra* Section VII.A.4.a.

b. Whether the Combination Possesses All Claim Limitations.

i. “remote controller”

140. Even if it had been obvious to implement Sutardja’s UIM-WNIM on Kelty-218’s “home computer” and to move that computer into a different location on the home premises, it would still not result in the claimed “**remote** controller” as I previously explained. *Supra* Section VII.A.4.b.

ii. “user-manipulatable control on a screen”

141. Petitioner relies on Pollack for the “user-manipulatable control on a screen,” just as it did with respect to this limitation in Claim 1[d][ii]. However, as I previously explained, even if Pollack is combined with Sutardja-Kelty-218 as proposed, the combination does not disclose this limitation. *Supra* Section VII.A.5.

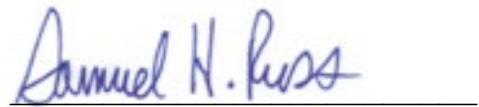
X. OPINIONS ON GROUND 4–9

142. Grounds 4 through 9 are each directed toward dependent claims that depend from Claims 1, 8, or 15. Because none of the independent claims would have been obvious for the reasons set forth above, the dependent claims also would not have been obvious. Moreover, Petitioner does not contend that any of the additional references cited in Grounds 4–9 (Uchida, Zhang, Evans) address the deficiencies identified above. Accordingly, Grounds 4 through 9 cannot demonstrate obviousness for the same reasons as the grounds directed to the independent claims.

XI. CONCLUSION

143. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and 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. I further declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Dated: September 23, 2026

A handwritten signature in blue ink that reads "Samuel H. Russ". The signature is written in a cursive style and is positioned above a horizontal line.

Samuel Russ, PhD.

APPENDIX A

Curriculum Vitae of Dr. Samuel H. Russ

Personal

Mailing Address: 150 Student Services Dr., SH 4119, Mobile, AL 36688
Phone: (251) 461-1378
e-mail: sruss@southalabama.edu
Citizenship: U.S.

Education

Ph.D. in Electrical Engineering, Georgia Institute of Technology, 1991.
Thesis Title: *An Information-Theoretic Approach to Analysis of Computer Architectures and Compression of Instruction Memory Usage*
Thesis Advisor: Dr. Cecil O. Alford
Bachelor's of Electrical Engineering (with Highest Honor), Georgia Institute of Technology, 1986.

Employment

Aspect Aerospace

2023 – Present

Co-Founder and CTO: Pursue venture capital investments, work with potential customers, develop engineering plan for the company, write grant proposals, supervise patenting process. Write and obtain grant funding. Develop satellite architectures and products including power system and battery charging.

University of South Alabama

2007 – Present

Interim Chair, Department of Electrical and Computer Engineering (2015-2016)

Associate Professor, Department of Electrical and Computer Engineering (2011-present)

Assistant Professor, Department of Electrical and Computer Engineering

Developing new class in signal integrity, developing cross-disciplinary collaborative research efforts, updating labs and class materials, teaching both undergraduate and graduate classes. Pioneering coursework in embedded-system safety includes battery chemistries, chargers, and safety issues. Developed and launched a fully functional CubeSat satellite that included a power system with solar power and a battery charger, and optimized the software for minimal power consumption.

Scientific-Atlanta (Later Cisco, Now Technicolor)

2000 - 2007

Manager, Advanced Technologies R&D, Explored major new technologies including home networking and multi-room video distribution; oversaw construction of prototypes and demonstrations; demonstrated technologies at trade shows and to stock analysts; managed group of approximately 10 designing set-top boxes for the cable television industry including all phases of high-volume electronic design including layout, high-speed digital design, emissions considerations, gate array conversion, and designing with custom ASICs; supervised cross-functional team to increase hard drive reliability; wrote numerous patent applications. Products deployed widely, including Time Warner Cable and Cablevision.

IVI Checkmate (Now Ingenico)

1999 – 2000

Matrix Manager, Electrical Engineering, Supervised staff of approximately 6 electrical engineers, oversaw assignments, allocated time across multiple projects, worked to coordinate project schedules with priorities, assisted in sales and other customer communications.

Staff Electrical Engineer, Oversaw major design overhaul of touch-pad payment system including embedded-systems design, power-system design, battery-powered operation, optimization of charging including thermal issues, and system layout and schematic capture. System deployed widely at Wal-Mart, Home Depot, and others.

Mississippi State University

1994 - 1999

Thrust Leader, Computing Systems Research Thrust and Systems Integration Group, NSF Engineering Research Center -- Coordinate research plans and NSF reporting for 6 faculty and 3 full-time staff, assist in development of strategic plans and pursuit of funding opportunities, oversight of development of the ERC-wide integrated testbed. Managed multi-year research project in distributed computing that included 11 students and 5 faculty.

Assistant Professor, Department of Electrical & Computer Engineering -- Developed all-new graduate class in circuit board design, authored textbook chapter, developing new undergraduate lab, pioneered teaching classes over 2-way interactive video.

Dickerson Vision Technologies (Now Cognex)

1992 - 1994

Director of Manufacturing--Oversaw the development and implementation of a manufacturing plan for the company.

Senior Applications Engineer--Developed firmware and user-interface software for the company's proprietary hardware, Assisted in development of machine vision system hardware, Assisted in sales duties.

Georgia Institute of Technology

1987 - 1991

Graduate Research Assistant--Helped design five VLSI chips while developing two custom CPU's, Silicon-compiler-based computer chip design, including initial design, full functional simulation, size and timing optimization, and manufacturing test development.

Publications

Books

1. Samuel H. Russ, *Signal Integrity: Applied Electromagnetics and Professional Practice*, Springer, 2016. (Textbook)
2. Samuel H. Russ, *Signal Integrity: Applied Electromagnetics and Professional Practice*, Second Edition, Springer, 2022. (Textbook)

Book Chapters

1. Samuel H. Russ, "High-Speed Digital Effects", Chapter 10 of John Kraus and Daniel Fleisch, *Electromagnetics with Applications, Fifth Edition*, McGraw-Hill, 1998. (Textbook)
2. Samuel Russ, Bret Webb, Jonathan Holifield and Justin Walker (2011). "PILS: Low-Cost Water-Level Monitoring, Environmental Monitoring", Dr. E.O. Ekundayo, Ph.D., (Ed.), pp. 137-156, ISBN: 978-953-307-724-6, InTech, (Peer-reviewed)

Journal and Magazine Articles

1. Samuel Russ, "The Threat of Malicious Circuit-Board Alteration: Attack Taxonomy and Examples," *Electronic Device Failure Analysis*, Vol. 23, Issue 3, August 2021, pp. 13-22.
2. Mink DM, McDonald J, Bagui S, Glisson WB, Shropshire J, Benton R, Russ S. Near-Real-Time IDS for the U.S. FAA's NextGen ADS-B. *Big Data and Cognitive Computing*. 2021; 5(2):27. <https://doi.org/10.3390/bdcc5020027>
3. S. H. Russ and J. Gatlin, "Ways to hack a printed circuit board: PCB production is an underappreciated vulnerability in the global supply chain," *IEEE Spectrum*, vol. 57, no. 9, pp. 38-43, Sept. 2020.
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5. Samuel H. Russ, Tho D. Ha, and Jonathan H. Shapiro, "Simulation-based Optimization of Wear Leveling for Solid-State Disk Digital Video Recording," *IEEE Transactions on Consumer Electronics*, Vol. 60, No. 3, Nov. 2014, pp. 363-367.

6. Samuel H. Russ and Salim Alsharif, "Packet Loss Behavior of HomePlug AV Traffic at Video Bit Rates", *IEEE Transactions on Consumer Electronics*, Vol. 57, No. 2, May 2011, pp. 823-826.
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9. Samuel H. Russ, and Ramesh Nallur, "A Framework for Calculating Fundamental DVR Performance Limits", *IEEE Transactions on Consumer Electronics*, Vol. 55, No. 1, Feb. 2009, pp. 132-138.
10. Ioana Banicescu, Sheikh Ghafoor, Vijay Velusamy, Samuel H. Russ, Mark Bilderback, "Experiences from integrating algorithmic and systemic load balancing strategies", *Concurrency and Computation: Practice and Experience*, Volume 13, Number 2, pp. 121-139 (2001).
11. Roger L. King, Samuel H. Russ, Aric B. Lambert, Donna S. Reese, "An artificial immune system model for intelligent agents", *Future Generation Computer Systems*, Volume 17, Issue 4, pp. 335 - 343 (January 2001).
12. Dr. Samuel H. Russ, Jonathan Robinson, Matt Gleeson, Brad Meyers, and Chun-Heong Tan, "Using Hector to Run MPI Programs over Networked Workstations", *Concurrency - Practice and Experience*, Vol. 11, No. 4, pp. 189-204 (1999).
13. Russ, S.H. Reece, K. Robinson, J. Meyers, B. Rajan, D. Rajagopalan, L. Chun-Heong Tan, "Hector: an agent based architecture for dynamic resource management", *IEEE Concurrency*, Vol. 7, No. 2, pp. 47-55, Apr-Jun 1999.
14. Dr. Samuel H. Russ, Jonathan Robinson, Dr. Brian K. Flachs, and Bjorn Heckel, "The Hector Distributed Run-Time Environment", *IEEE Transactions on Parallel and Distributed Systems*, Vol. 9, No. 11, pp. 1102-1114 (1998).
15. S.H. Russ and C.O. Alford, "Coupled Noise and Its Effects on Modern Packaging Technology", *IEEE Transactions on Components, Hybrids, and Manufacturing Technology*, Volume 13, Number 4, December 1990, pp. 1074-1082.

U.S. Patents

1. U.S. Patent Number 6,748,080, "Apparatus for entitling remote client devices", Samuel Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, June 8, 2004.
2. U.S. Patent Number 7,181,010, "Apparatus for entitling remote client devices", Samuel Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, February 20, 2007.
3. U.S. Patent Number 7,360,233, "Broadcast carousel system access for remote home communication terminal", Samuel Russ, Michael Gaul, and Anthony Wasilewski, April 15, 2008.
4. U.S. Patent Number 7,360,235, "Systems and methods for operating a peripheral record/playback device in a networked multimedia system", David Davies, Samuel Russ, and Irvan Krantzler, April 15, 2008.
5. U.S. Patent Number 7,499,822, "Analog set-top calibration patterns in manufacturing", Leo Montreuil, Wayne B. Williams, Samuel H. Russ, and Robert Kriete, March 3, 2009
6. U.S. Patent Number 7,505,592, "Apparatus for entitling and transmitting service instances to remote client devices", Samuel H. Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, March 17, 2009
7. U.S. Patent Number 7,516,470, "Locally-updated interactive program guide", Samuel H. Russ and Michael Gaul, April 7, 2009
8. U.S. Patent Number 7,826,711, "Digital Video Disc (DVD) Player or Digital Video Recorder (DVR) Playback with Memory", Samuel H. Russ, Nov. 2, 2010.
9. U.S. Patent Number 7,849,486, "Networked subscriber television distribution", Samuel H. Russ, David Lett, Jonathan Robinson, and Michael Gaul, Dec. 7, 2010.

10. U.S. Patent Number 7,860,250, "Apparatus for entitling and transmitting service instances to remote client devices", Samuel H. Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, Dec. 28, 2010.
11. U.S. Patent Number 7,861,272, "Networked subscriber television distribution", Samuel H. Russ, David Lett, Jonathan Robinson, and Michael Gaul, Dec. 28, 2010.
12. U.S. Patent Number 7,870,584, "Interactive program guide with selectable updating", Samuel H. Russ and Michael Gaul, Jan. 11, 2011.
13. U.S. Patent Number 7,876,998, "DVD playback over multi-room by copying to HDD", William Wall and Samuel H. Russ, Jan. 25, 2011.
14. U.S. Patent Number 7,908,625, "Networked multimedia system", Neil C. Robertson, David B. Lett, Samuel H. Russ, Bohdan S. Prus, Michael A. Gaul, and Ajith N. Nair, March 15, 2011.
15. U.S. Patent Number 7,937,737, "Field qualification of disk drives in consumer electronics devices", Samuel H. Russ and Mark R. Murray, May 3, 2011.
16. U.S. Patent Number 7,961,780, "Generated set top calibration patterns in manufacturing", Leo Montreuil, Wayne B. Williams, Samuel H. Russ, and Robert Kriete, Jun. 14, 2011.
17. U.S. Patent Number 7,978,720, "Digital media device having media content transfer capability", Samuel H. Russ, Christopher L. Stallings, July 12, 2011.
18. U.S. Patent Number 8,046,806, "Multiroom point of deployment module", William E. Wall, Samuel H. Russ, Oct. 25, 2011.
19. U.S. Patent Number 8,127,236, "Proximity detection using wireless connectivity in a communications system", Paul J. Claussen, Ajith N. Nair, and Samuel H. Russ, Feb. 28, 2012.
20. U.S. Patent Number 8,181,205, "PVR Channel and PVR IPG Information", Samuel H. Russ, Michael A. Gaul, and Dariusz S. Kaminski, May 15, 2012.
21. U.S. Patent Number 8,208,796, "Systems and methods for prioritizing the storage location of media data", Bohdan Prus and Samuel H. Russ, June 26, 2012.
22. U.S. Patent Number 8,280,229, "DVD playback over multi-room by copying to HDD", William E. Wall and Samuel H. Russ, October 2, 2012.
23. U.S. Patent Number 8,295,338, "Generated set top calibration patterns in manufacturing", Leo Montreuil, Wayne B. Williams, Samuel H. Russ, and Robert A. Kriete, October 23, 2012.
24. U.S. Patent Number 8,364,015, "Stretch and zoom bar for displaying information", Samuel H. Russ and Gary Hibbard, January 29, 2013.
25. U.S. Patent Number 8,549,567, "Media content sharing over a home network", Samuel H. Russ, David B. Lett, Jonathan Robinson, Michael A. Gaul, October 1, 2013.
26. U.S. Patent Number 8,627,385, "Systems and methods for operating a peripheral record playback device in a networked multimedia system", David B. Davies, Samuel H. Russ, Irvan J. Krantzler, January 7, 2014.
27. U.S. Patent Number 8,966,550, "Home communication systems," David B. Davies, Samuel H. Russ, Irvan J. Krantzler, February 24, 2015.
28. U.S. Patent Number 9,762,970, "Access of stored video from peer devices in a local network," David B. Davies, Samuel H. Russ, and Irvan J. Krantzler, September 12, 2017.
29. U.S. Patent Number 10,412,439, "PVR Channel and PVR IPG Information", Samuel H. Russ, Michael A. Gaul, and Dariusz S. Kaminski, Sep. 10, 2019.

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1. European Patent Number EP1543680B1, "Locally-updated interactive program guide", Samuel Russ and Michael Gaul, Feb. 17, 2010.
2. European Patent Number EP1673937B1, "Proximity detection using wireless connectivity in a communications system", Paul Claussen, Ajith Nair, and Samuel Russ, April 21, 2010.
3. European Patent Number EP1604523B1, "Method for determining the encryption of a service content depending on the fidelity of the reformatting of said content", Samuel Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, Nov. 21, 2012.

4. European Patent Number EP1552699B1, "Networked multimedia system", Neil Robertson, David Lett, Samuel Russ, Bohdan Prus, Michael Gaul, and Ajith Nair, Dec. 18, 2013.
5. European Patent Number EP1334617B1, "Networked Subscriber Television Distribution", Samuel Russ, David Lett, Jonathan Robinson, and Michael Gaul, April 1, 2015.
6. European Patent Number EP1920601B1, "Multiroom Point of Deployment Module," William Wall and Samuel Russ, May 4, 2016.
7. European Patent Number EP1510033B1, "Apparatus for Entitling Remote Client Devices," Samuel H. Russ, Michael Gaul, Anthony Wasilewski, and Howard Pinder, April 26, 2017.
8. European Patent Number EP1540946B1, "Broadcast Carousel System Access for Remote Home Communications Terminal via a Gateway Device," Samuel Russ, Michael Gaul, and Anthony Wasilewski, April 18, 2018.
9. European Patent Number EP2008280B1, "Method and Device for Prioritizing the Storage Location of Media Data," Bohdan Prus and Samuel Russ, September 26, 2018.

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2. McDonald, Jeffrey Todd, Jennifer Parnell, Todd R. Andel, and Samuel H. Russ. "Effectiveness of Adversarial Component Recovery in Protected Netlist Circuit Designs." In *SECURITY*, pp. 181-192. 2022.
3. S.H. Russ, M. Khan, S. Latif, "Surreptitiously Adding a WLAN Antenna to a Printed Circuit Board" 2022 IEEE Physical Assurance and Inspection of Electronics (PAINE), Huntsville, AL, USA, 2022.
4. J. Todd McDonald, Rebecca C. Clark, Lee M. Hively, and Samuel H. Russ. 2022. "Phase space power analysis for PC-based rootkit detection." In *Proceedings of the 2022 ACM Southeast Conference (ACM SE '22)*. Association for Computing Machinery, New York, NY, USA, 82–90. <https://doi.org/10.1145/3476883.3520212>
5. S. H. Russ, "Surreptitiously Adding a Microcontroller to a Printed Circuit Board," 2021 IEEE Physical Assurance and Inspection of Electronics (PAINE), Washington, DC, USA, 2021.
6. S.H. Russ, "Circuit Board Security Vulnerabilities and Counteractions", IPC APEX EXPO 2021.
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12. E. Spencer, D. Clark, R. Gollapalli, S. Russ and B. Kerrigan, "A System On Chip design for fast time domain impedance spectroscopy," 2017 IEEE 60th International Midwest Symposium on Circuits and Systems (MWSCAS), Boston, MA, 2017, pp. 124-127.
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 19. Samuel H. Russ, “Using Student ID Numbers to Create Customized Homework Problems”, *Proceedings of the 2012 ASEE Southeastern Section Conference*, April 1-3 2012, Starkville, MS, Paper ID 606.
 20. Samuel H. Russ and Ramesh Nallur, “Digital Video Recording Onto Solid-State Disks”, *2011 Digest of Technical Papers, 2011 International Conference on Consumer Electronics*, pp. 495-496. (2nd place in best paper contest, 2011.)
 21. Mohammad Mushtaq, Samuel H. Russ, and Mohammad S. Alam, “Variable FEC to Reduce ECC Overhead in Digital Video Transmission”, *2011 Digest of Technical Papers, 2011 International Conference on Consumer Electronics*, pp. 215-216.
 22. Samuel H. Russ and Salim Alsharif, “Behavior of HomePlug AV Traffic At High Sustained Bit Rates in the Home”, *2011 Digest of Technical Papers, 2011 International Conference on Consumer Electronics*, pp. 682-683.
 23. Samuel H. Russ, Viswakalyan Perepa, Silas Leavesly, and Bret Webb, “Novel Low-Cost Salinity Sensor for Embedded Environmental Monitoring”, *Proceedings of IEEE Southeastcon 2010*, March 18-21, 2010, pp. 53-56.
 24. Samuel H. Russ and Kung-Hsien Chen, “Thermally Conductive Circuit Boards”, *Proceedings of the 59th Electronic Components and Technology Conference (ECTC 2009)*, May 2009, pp. 465-468.
 25. Samuel H. Russ and Sasan Haghani, “Behavior of 802.11g Traffic at High Sustained Bit Rates in the Home”, *2009 Digest of Technical Papers, 2009 International Conference on Consumer Electronics, Jan. 2009*, pp. 423-424.
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 27. Samuel H. Russ, “Home Networking: Extending Cable’s Reach”, *The Complete Technical Paper Proceedings from NCTA*, 2001, pp. 160-165.
 28. Samuel H. Russ, Rashid Jean-Baptiste, Tangirala Shailendra Krishna Kumar, and Marion G. Harmon, “Transparent Real-Time Monitoring in MPI”, *IPPS/SPDP Workshops 1999*, in *Parallel and Distributed Processing*, Lecture Notes in Computer Science, vol. 1586, Springer-Verlag, 1999, pp. 1327-1334.
 29. Roger L. King, Aric B. Lambert, Samuel H. Russ, and Donna S. Reese, “The Biological Basis of the Immune System as a Model for Intelligent Agents”, *IPPS/SPDP Workshops 1999*, in *Parallel and Distributed Processing*, Lecture Notes in Computer Science, vol. 1586, Springer-Verlag, 1999, pp. 156-164.
 30. Aric Lambert, Roger King, Sam Russ, and Donna Reese, “Intelligent Control Agents for Resource Management of Heterogeneous Parallel Computing”, *Computational Intelligence for*

Modeling, Control, and Automation (CIMCA 98) in Concurrent Systems Series, vol. 55, IOS Press, 1999, pp. 116-121.

31. Samuel H. Russ and Adam Gaither, “Developing An Integrated Environment for Computational Field Simulation”, *Object-Oriented Methods for Inter-Operable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, pp. 50-57.
32. Samuel H. Russ, Ioana Banicescu, Sheikh Ghafoor, Bharathi Janapareddi, Jonathan Robinson, and Rong Lu, “Hectiling: An Integration of Fine and Coarse-Grained Load-Balancing Strategies”, *Proceedings of the Seventh International Symposium on High Performance Distributed Computing*, August 1998, IEEE Computer Society, pp. 106-113.
33. Samuel H. Russ, “An Architecture for Rapid Distributed Fault Tolerance”, 3rd International Workshop on Embedded High-Performance Computing, in J. Rolim, Editor, *Parallel and Distributed Processing*, Lecture Notes in Computer Science, vol. 1388, Springer-Verlag, 1998, pp. 925-930.
34. Dr. Samuel H. Russ, Brad Meyers, Jonathan Robinson, Matt Gleeson, Laxman Rajagopalan, Chun-Heong Tan, and Bjørn Heckel, “User-Transparent Run-Time Performance Optimization”, *Proceedings of the 2nd International Workshop on Embedded HPC Systems and Applications*, Geneva, April 1997.
35. J. Robinson, S.H. Russ, B. Flachs, and B. Heckel, “A Task Migration Implementation of the Message-Passing Interface”, *Proceedings of the 5th High Performance Distributed Computing Conference (HPDC-5)*, August 1996, IEEE Computer Society, pp. 61-68.
36. S.H. Russ, B. Flachs, J. Robinson, and B. Heckel, “Hector: Automated Task Allocation for MPI”, *Proceedings of the 10th International Parallel Processing Symposium*, April, 1996, IEEE Computer Society, pp. 344-348.
37. W.S. Tan, C.O. Alford, and S.H. Russ, “GT-EP: A Novel High-Performance Real-Time Architecture”, *Proceedings of the 18th International Symposium on Computer Architecture*, May 1991, pp. 12-21.

Reports

1. Aric B. Lambert, Roger L. King, Samuel H. Russ, Donna S. Reese, “Adaptive Analysis for the Design of Hardware Agents Using the Artificial Immune System Model for Resource Management of Heterogeneous Systems”, Miss. State Technical Report No. MSSU-COE-ERC-98-10, Aug. 1998.
2. Daniel H. Linder, Robert B. Reese, Jon Robinson, and Samuel H. Russ, “JavaCADD: A Java-based Server and GUI for Providing Distributed ECAD Services”, Mississippi State University Technical Report No. MSSU-COE-ERC-98-07, May 1998.
3. Samuel H. Russ, “Using Hector in an Architecture for Rapid Distributed Fault Tolerance”, Mississippi State Technical Report No. MSSU-EIRS-ERC-97-17, December 1997.
4. Samuel H. Russ, Jonathan Robinson, Matt Gleeson, and Jose Figueroa, “Dynamic Communication Mechanism Switching in Hector”, Mississippi State Technical Report No. MSSU-EIRS-ERC-97-8, September 1997.
5. Samuel H. Russ, Brian Flachs, Jonathan Robinson, and Bjorn Heckel, “Hector: Automated Task Allocation for MPI”, Mississippi State Technical Report No. MSSU-EIRS-ERC-95-6, September, 1995.

Funded Grants and Contracts

University of South Alabama

1. National Space Grant Foundation, Aug. 2018-May 2019, “Automation Infrastructure for Gateway Biological Laboratory,” PI, \$28,062.
2. Nfina (Local Mobile Company), March 2018 – March 2019, “Redhawk”, PI, \$119,881.

3. NASA, May 2016 – Present, “Spatially Resolved Measurements Of Plasma Density Irregularities In The Ionosphere F Region For Scintillation Studies”, Co-I, \$100,000.
4. Marine Environmental Science Consortium (GRI), Jan. 2011-Dec. 2011, “Conductivity Based In-Situ Hydrocarbon Sensor”, PI, \$9,338.
5. University of South Alabama Research Council (USARC), Feb. 2008 – Feb. 2009, “Instrumentation of Hurricane Forecast Models for Performance Optimization”, \$5,000 for one year.

Mississippi State University

1. National Science Foundation, April 1998-March 1999, “An ERC-CREST Partnership in Distributed and Computational Systems”, PI, \$100,000/year, renewable for 5 years.
2. Office of Naval Research, Nov. 1996-Nov. 1998, “Distributed Visualization and Virtual Environments for Oceanography and Meteorology”, Co-PI, \$200,000.
3. U.S. Army Waterways Experiment Station, July 1996-July 1999, “Efficient Parallel Wave Modeling”, PI, \$200,000, Funded under CHSSI (Common HPC Scalable Software Initiative) of the DoD. (\$50,000 actually funded.)
4. NSF Engineering Research Center for Computational Field Simulation, April 1995- May 1999, “Heterogeneous Computing Testbed (CA 8)”, PI, By year: \$34,983/\$70,111/\$55,916. Funded through NSF Engineering Research Center.

Dickerson Vision Technology

1. Small Business Innovations Research Program of the NSF, Division of Industrial Interface, September 1993 - February 1994, Award No. III-9260914. (\$50,000 Phase I contract conducted at Dickerson Vision Technologies.)

Technology Transfer and Licensing

Hector Distributed Run-Time Environment licensed by MPI Software Technology, Inc., Starkville, MS in June 1998 (while at Mississippi State University)

Students Advised (Major Professor)

Level	At USA	At MSU
Ph.D.	--	0
Masters	3	9

Courses Created and Enhanced

University of South Alabama

EE 264 Microprocessor Systems and Interfacing – Replaced 68HC11 with Freescale 9S12 architecture and redesigned the entire course, Introduced use of 68HC11 simulator and accompanying podcast to enhance student’s ability to visualize microprocessor operation

EE 268 Digital Logic Design Lab – Updated one lab experiment

EE 368 Microprocessor Systems Lab – Developed all-new sequence to tie EE 368 to senior projects with hands-on experiments like motors, photocells, and servomotors.

EE 401 Introduction to ECE Design – Completely overhauled the first-semester senior project course. Added lectures on professionalism, career development, and legal aspects of engineering. Structured the course so that reports would lead up to their senior-project reports.

EE 404 ECE Design – Completely overhauled the second-semester senior project course by requiring better projects and adding material on giving effective presentations. Obtained very enthusiastic response from the department’s Industrial Advisory Board.

EE 446 – Obtained donation of boards from Freescale and redesigned all of the experiments to develop more interesting demonstrations and to switch from assembly language to C.

EE 457/557 – Developing series of podcasts to augment in-class lectures with materials related to embedded systems and professional development.

EE 469/569 Advanced Digital System Design – Developed all-new course in high-speed circuit board design from an electromagnetics perspective, and authored a textbook for the course. Added a lab experience in 2009.

EE 560 Advanced Computer Architecture – Selected new textbook for the class and developed lecture materials to match

EG 101 – Developed systematic curriculum shared by all sections including “checklists” for instructors, handouts, and lecture materials. Introduced motors project, which has become the most popular EG 101 project.

Mississippi State University

EE 8993 High Speed Digital Design -- Offered on video nationwide, it features pioneering treatment of high-speed circuit board design from an electromagnetics perspective. Material from the class has been included in one of the best-known electromagnetics textbooks, and it continues to be one of the most popular graduate classes in the department.

EE 4743 Computer Aided Digital Design -- Added breakthrough educational technology to permit remote access to logic synthesis capabilities. Offered on live two-way video starting Fall 1998.

Courses Taught

University of South Alabama

EE 220, Circuit Analysis I, 1 course.

EE 263, Digital Logic Design, 2 courses.

EE 264, Microprocessor Sys-Interfacing, 4 courses.

EE 268, Digital Logic Design Lab, 1 course.

EE 368, Microprocessor Sys Interf Lab, 14 courses.

EE 401, Intro Elec and CpE Design - W, 7 courses.

EE 404, Elec and Comp Eng Designs-W, 7 courses.

EE 440, HDL Logic Synthesis, 1 course.

EE 446, Embedded System Design Lab, 2 courses.

EE 457, Embedded System Design, 10 courses.

EE 469, Signal Integrity, 5 courses.

EE 534, VLSI Design Systems, 1 course.

EE 540, HDL Logic Synthesis, 1 course.

EE 548, Computer-Network Security, 5 courses.

EE 557, Adv. Embedded System Design, 8 courses.

EE 560, Adv Computer Architecture, 3 courses.

EE 569, Signal Integrity, 5 courses.

EG 101, Intro to Engineering & Design, 5 courses.

EG 231, Intro to Ethics and Economics, 2 courses.

Mississippi State University

Number Description

EE 2111 Electrical Lab I

Class Description

Accompanies introductory digital class

EE 2713 Digital Devices
 EE 4723 Microcomputers II
 EE 4743 Computer Aided Digital Design
 EE 8993 High-Speed Digital Design

Introductory digital class
 Microcontroller interfacing
 VHDL, logic design, and synthesis
 Signal integrity and high-speed design

Honors and Awards

University of South Alabama College of Engineering “Teacher of the Year” 2015

Mobile Area Council on Engineering “Engineering Educator of the Year” 2015

Technology and Engineering Emmy® Award, 2012, for “Pioneering Development of Multi-Room DVR.” Awarded to Cisco. I managed the groups that built the first prototypes, gave public demonstrations, wrote numerous patent applications, and developed the first mass-production set-top containing Multi-Room DVR.

2nd Place in “Best Paper – Storage Category” at ICCE 2011. The paper is “Digital Video Recording Onto Solid-State Disks” as noted in Conference publications above.

Attendee, “Top Prof” Banquet – University of South Alabama chapter of Mortar Board, 2009,2010

Tau Beta Pi Engineering Professor of the Year – University of South Alabama chapter of Tau Beta Pi, 2008. One of two highest awards in the College of Engineering for teaching, and the only award voted on by honor students in the College.

Finalist, 53rd International Science and Engineering Fair, 1983, Albuquerque, NM.

Professional Activities

Expert Witness Engagements

Case	Jurisdiction and Case Number	Year(s)	Witness for	Expert Reports	Dep.	Trial	IPR* Rep.
WNE Holdings v. Rockwell Automat.	Southern District of Alabama	2011	Plaintiff	1	0	0	0
Personalized Media Corp. (PMC) v. Echostar	Eastern District of Texas	2010-2015	Plaintiff	2	3	0	0
Pegasus v. DirecTV et al.	Delaware	2011-13	Plaintiff	1	0	0	0
Apple v. Samsung	Int’l Trade Commission 337-TA-796	2012	Respondent	4	1	1	0
EON v. MobiTV et al.	Delaware	2013	Defendant	1	1	0	0
PMC v. Zynga	Eastern District of Texas	2013	Plaintiff	1	5	0	4
OpenTV v. Netflix	Delaware	2014	Defendant	0	0	0	0
Kaplan v. OnForce	N.D. California	2014	Defendant	0	0	0	1
Intellectual Ventures v. J.P. Morgan Chase	Southern District of New York	2013-2019	Defendant	2	2	0	0
PMC v. Amazon	Delaware	2014-2015	Plaintiff	1	9	0	5
Better Mouse Corp. v. Steelseries et al.	Eastern District of Texas	2015-2016	Plaintiff	2	0	1	0

Case	Jurisdiction and Case Number	Year(s)	Witness for	Expert Reports	Dep.	Trial	IPR* Rep.
SyncPoint v. Nintendo et al.	Eastern District of Texas	2015	Plaintiff	2	1	0	0
TQ Beta v. Dish	USPTO (IPR)	2016	Defendant	1	1	0	0
Script v. ADT et al.	Eastern District of Texas	2016	Plaintiff	2	2	0	0
Sony v. Pace	USPTO (IPR)	2016	Defendant	0	1	0	4
PMC v. Apple	EDTX and USPTO (IPR)	2016-2021	Patent Owner	2	1	1	2
PMC v. Samsung	Eastern District of Texas	2016	Patent Owner	2	0	0	0
Music Choice v. Stingray	Eastern District of Texas	2016-2019	Plaintiff	2	2	0	4
Broadcom v. AMD	USPTO (IPR)	2016	Petitioner	0	0	0	1
Tech Pharmacy v. Alixa et al.	Eastern District of Texas	2017	Plaintiff	2	2	1	0
Rovi v. PMC	Eastern District of Texas, Arbitration	2017	Defendant	0	1	0	0
Implicit v. Trend Micro	Eastern District of Texas	2017	Defendant	2	1	0	0
Implicit v. Palo Alto	Eastern District of Texas	2018	Defendant	1	1	0	0
Invensas v. Samsung	Eastern District of Texas	2018	Plaintiff	2	1	0	0
Selective Signals v. Palo Alto	USPTO (IPR)	2018	Petitioner	0	1	0	1
Rovi Tivo v. Various	Canada	2018	Plaintiff	0	0	0	0
Implicit v. Netscout	Eastern District of Texas	2018	Defendant	0	0	0	0
Rovi Tivo v. Comcast	USPTO (IPR)	2019-2020	Plaintiff	0	4	0	5
Rovi Tivo v. Comcast	ITC	2019-2020	Petitioner	2	1	1	0
BBitv v. OpenTV	California	2019	Defendant	0	0	0	0
Roku v UEI	USPTO (IPR)	2019-Now	Petitioner	0	6	0	8
MV3 v Roku	Western District of Texas	2019-2020	Defendant	2	2	1	0
BBitv v Dish	USPTO (IPR)	2019-2020	Petitioner	0	3	0	6
PMC v Google	Eastern District of Texas	2020	Plaintiff	1	1	0	0
PMC v Netflix	Southern District of New York	2020	Plaintiff	2	0	0	0
UEI v Roku <i>et al.</i>	ITC	2020-2021	Respondent	1	1	1	0
BBitv v Dish	Western District of	2020-	Defendant	1	5	0	6

Case	Jurisdiction and Case Number	Year(s)	Witness for	Expert Reports	Dep.	Trial	IPR* Rep.
	Texas	2021					
Flexiworld v Amazon <i>et al.</i>	Western District of Texas	2020-Now	Defendant	0	0	0	0
Flexiworld v Roku	Western District of Texas	2021-2022	Defendant	2	0	0	0
Roku v UEI <i>et al.</i>	ITC	2021-2022	Complain.	1	0	1	0
Roku v DivX	USPTO (IPR)	2021	Petitioner	0	0	0	1
Apple v Identity	USPTO (IPR), Ex Parte Re-Exam, Western District of Texas	2022-2024	Patent Owner	2	1	1	6
Audi v Aprese	USPTO (IPR)	2022	Petitioner	0	0	0	2
paSafeShare	Ex Parte Re-Exam, Western District of Texas	2021-Now	Patent Owner, Plaintiff	1	0	0	3
PerfectVision v PPC Broadband	USPTO (IPR)	2022-Now	Petitioner	0	0	0	1
Google v Nobots	USPTO (IPR)	2022	Patent Owner	0	2	0	4
Fall Line v Various	Eastern District of Texas	2022-Now	Plaintiff	6	2	1	0
Assa Abloy v CPC	USPTO (IPR)	2023-2024	Patent Owner	0	2	0	4
IOENGINE v Roku	Western District of Texas	2023-2024	Defendant	5	2	1	0
Gratuity v Toast	USPTO (IPR)	2023-2024	Petitioner	0	1	0	1
Lexos v Ebay	USPTO (IPR)	2024	Patent Owner	0	1	0	1
Entropic v Various	USPTO (IPR) Eastern District of Texas	2024-Now	Patent Owner / Plaintiff	3	6	0	7
Roku v Anonymous	USPTO (IPR)	2024	Petitioner	0	0	0	6
Adeia v Videotron	Fed. Court of Canada	2024-2025	Plaintiff	2	0	1	0
AMD v Concurrent	USPTO (IPR)	2024-Now	Petitioner	1	0	0	0
TrueSight v Samsung	Eastern District of Texas	2025	Defendant	2	1	0	0
Sandpiper v Various	USPTO (IPR)	2025-Now	Patent Owner	0	0	0	1
Mood v Eglä	USPTO (EPR)	2026	Petitioner	0	0	0	1

* Includes reports submitted for IPRs, CBMRs, and Re-Exams

Invited Lectures

“Real-time Monitoring in MPI”, Florida A&M University, Tallahassee, FL, August 1998

Consulting

Consulted with various investment firms concerning telecommunications market, 2007 – 2011.
Cox Communications – DVR Reliability – 2015

Society Memberships

Institute of Electrical and Electronic Engineers (Senior Member), IEEE Consumer Electronics Society, IEEE Computer Society, Eta Kappa Nu, Tau Beta Pi, Phi Kappa Phi, Gamma Beta Phi
Secretary, Northeast Mississippi Subsection of the IEEE, 1994-95

Article Reviewer

Computers and Electrical Engineering, Supercomputing '94, IEE Transactions, Concurrency: Practice and Experience, International Parallel Processing Symposium, IEEE Transactions on Education, IEEE Transactions on Parallel and Distributed Systems, ICT 2012, ICAEE 2012

Proposal Reviewer

Army Research Office, National Science Foundation, U.S. Department of Energy

University Service

Chair, Search Committee, ECE Department – Search for Assistant Professor positions, 2008-now (chair since 2011)

Member, ECE Department Undergraduate Affairs Committee, 2015-now

Member, College of Engineering Academic Standards Committee, 2016-now

Member, Search Committee, College of Engineering – Search for 2 Associate Dean positions, 2015

Member, Search Committee, College of Engineering – Search for Associate Dean positions, 2008-09

Member, University of South Alabama Council on International Education, 2008-15

Chairman, ECE Department “Open House” Committee, 2008-09

Conducted open house and other demonstrations for the department, 2008-now

Chairman, ECE Department Recruiting and Retention Committee, 2007-08

Updated and conducted experiment for ACE program, 2007

Member, Hearin Undergraduate Committee, 1998

Department Coordinator, United Way Campaign, 1995

Award Referee, 1995 Instructional Paper Award, MSU College of Engineering