

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LENNOX INDUSTRIES INC.,
Petitioner,

v.

ROSEN TECHNOLOGIES LLC,
Patent Owner.

Case No. IPR2023-00717
Patent 7,156,318 B1

**DECLARATION OF R. JACOB BAKER, PH.D., P.E. IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1, 3-5, 7, 9, 11 AND
14 OF U.S. PATENT NO. 7,156,318 B1**

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Appendix A: CV of R. Jacob Baker, Ph.D., P.E.

I, R. Jacob Baker, Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. My name is R. Jacob Baker, Ph.D., P.E., and I am a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas. I have been retained by counsel for Lennox Industries Inc. (the “Petitioner”) in connection with the above-captioned *inter partes* review (“IPR”) of Claims 1, 3-5, 7, 9, 11, and 14 of U.S. Patent No. 7,156,318 B1 (the “’318 Patent”), entitled Thermostat System With Touchscreen With User Interfaces Or Operational Algorithms Via A Remote Correspondent, by named inventor Howard Rosen. I understand that the ’318 Patent is assigned to Rosen Technologies LLC (the “Patent Owner”). I have been asked to provide technical review, analysis, insights, and opinions regarding the ’318 Patent and the prior art references that form the basis for the ground of unpatentability set forth in the Petition for *Inter Partes* Review of the ’318 Patent (the “Petition”). I have been asked to provide a declaration regarding my opinions on the validity of Claims 1, 3-5, 7, 9, 11, and 14 of the ’318 Patent.

2. This declaration sets forth the opinions I have formed in this IPR and provides the bases and reasons for those opinions. I have summarized in this section my educational background, professional experience, and publications. My education and professional experience are described in my curriculum vita, attached to this declaration as Appendix A.

3. This declaration is based on information currently available to me. I declare that I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently.

4. I am being compensated at my usual consulting rate of \$765 per hour for my work on this matter. I am also being reimbursed for any incurred expenses. My compensation is in no way dependent upon my opinions or testimony or the outcome of this proceeding. I have no other interests in this proceeding or with Petitioner or Patent Owner.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

5. My qualifications generally are set forth in my Curriculum Vitae, which is attached as **Appendix A**. Appendix A also includes a list of the publications I have authored and a list of the other cases in which I have testified during the last four years.

6. I have been working as an Engineer since 1985 and I have been teaching Electrical and Computer Engineering courses since 1991. I am currently a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (“UNLV”).

7. I received B.S. and M.S. degrees in Electrical Engineering from UNLV in 1986 and 1988, respectively. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno, in 1993.

8. My doctoral research, culminating in the award of a Ph.D., investigated the use of power MOSFETs in the design of very high peak power, and high-speed, instrumentation. I developed techniques to reliably stack power MOSFETs to switch higher voltages, that is, greater than 1,000 V and 100 Amps of current with nanosecond switching times. This work was reported in the paper entitled “Transformerless Capacitive Coupling of Gate Signals for Series Operation of Power MOSFET Devices,” published in the IEEE Transactions on Power Electronics. The paper received the Best Paper Award in 2000.

A. Industry Experience

9. I have done technical and expert witness consulting for over 200 companies and their subsidiaries since I started working as an engineer in 1985. From 1985 to 1993, I worked for EG&G Energy Measurements and the Lawrence Livermore National Laboratory designing nuclear diagnostic instrumentation for underground nuclear weapon tests at the Nevada test site. During this time, I designed, and oversaw the fabrication of, over 30 electronic and electro-optic instruments, including high-speed cable and fiber-optic receiver/transmitters, PLLs, frame and bit-syncs, data converters, streak-camera sweep circuits, Pockel’s cell drivers, micro-channel plate gating circuits, charging circuits for battery backup of equipment for recording test data, and analog oscilloscope electronics.

10. My work during this time, as one example, had a direct impact on my doctoral research work using power MOSFETs, subsequent publishing efforts, and industry designs. In addition to the 2000 Best Paper Award from the IEEE Power Electronics Society, I published several other papers in related areas while working in industry. I hold a patent, Patent No. 5,874,830, in the area of power supply design, titled, “Adaptively biased voltage regulator and operating method,” which was issued on February 23, 1999. I have designed dozens of linear and switching power supplies for commercial products and scientific instrumentation.

11. I am a licensed Professional Engineer and have extensive industry experience in circuit design, fabrication, and manufacture of Dynamic Random Access Memory (DRAM) semiconductor integrated circuit chips, Phase-Change Random Access Memory (PCRAM) chips, and CMOS Image Sensors (CISs) at Micron Technology, Inc. (“MTI”) in Boise, Idaho. I spent considerable time working on the development of flash memory chips while at MTI. My efforts resulted in more than a dozen patents relating to flash memory. One of my projects at MTI included the development, design, and testing of circuit design techniques for a multi-level cell (MLC) flash memory using signal processing. This effort resulted in higher-density memories for use in solid-state drives and flash memory cards having an ATA interface that are ubiquitous in consumer electronics, including cameras and data storage systems. Further, the use of higher-density memory can result in fewer

changes in the flash translation layer for logical-to-physical addressing, less need for garbage collection, and larger data segments that can improve a computing system's performance. Another project I worked on at MTI focused on the design of buffers for high-speed double-data rate DRAM, which resulted in around 10 U.S. patents in buffer design. Among many other experiences, I led the development of the delay locked loop (DLL) in the late 1990s so that MTI DRAM products could transition to the DDR memory protocol, used in mobile and non-mobile (server, desktop, cell phones, tablets, etc.) computing systems as main computer memory, for addressing and controlling accesses to memory via interprocess communications (IPC) with the memory controller (MC). I provided technical assistance with MTI's acquisition of Photobit during 2001 and 2002, including transitioning the manufacture of CIS products into MTI's process technology. Further, I did consulting work at Sun Microsystems and then Oracle on the design of memory modules during 2009 and 2010. This work entailed the design of low-power, high-speed, and wide interconnection methods with the goal of transmitting data to/from the memory module and the MC at higher speeds.

12. I have extensive experience in the development of instrumentation and commercial products in a multitude of areas including: integrated electrical/biological circuits and systems, array (memory, imagers, and displays) circuit design, CMOS analog and digital circuit design, diagnostic electrical and

electro-optic instrumentation for scientific research, CAD tool development and online tutorials, low-power interconnect and packaging techniques, design of communication/interface circuits (to meet commercial standards such as USB, firewire, DDR, PCIe, SPI, etc.), circuit design for the use and storage of renewable energy, and power electronics. For example, a part of my research at Boise State, for many years, focused on the use of Thru-Silicon-Vias (TSVs), aka Thru-Wafer Vias (TWVs), for high-density packaging. These packaging techniques were utilized in the memory module development work I did with Sun Microsystems and Oracle. As another example, I designed circuitry for use in implementing Universal Serial Bus (USB) interface circuits while I did consulting at Tower Semiconductor. I designed PCI communication circuits for IPC between a Graphics Processor Unit (GPU) and memory while consulting for Rendition, Inc.

13. My current research work is focused in part on the design of integrated circuits for wireless sensing using LIDAR (Light Detection And Ranging). I have worked with several companies in the development of these circuits and systems including Freedom Photonics, Aeries Photonics, and FLIR. In the early 1990s, I worked on wireless systems for wideband impulse radar while at Lawrence Livermore Laboratory. Further, part of my research for several years focused on the digitization of IQ channels using delta-sigma modulation. The knowledge and experience gained from this effort are reflected in my textbook CMOS Mixed-Signal

Circuit Design and a presentation, which I have presented at several universities and companies,

http://cmosedu.com/jbaker/papers/talks/BP_DSM_talk.pdf.

B. Academic Experience

14. I was an adjunct faculty member in the Electrical Engineering departments of UNLV and UNR from 1991-1993. From 1993 to 2000, I served on the faculty at the University of Idaho as an Assistant Professor and then as a tenured Associate Professor of Electrical Engineering. In 2000, I joined a new Electrical and Computer Engineering program at Boise State University (“BSU”), where I served as department chair from 2004 to 2007. At BSU, I helped establish graduate programs in Electrical and Computer Engineering including, in 2006, the university’s second Ph.D. degree. In 2012, I re-joined the faculty at UNLV. Over the course of my career as a professor, I have advised more than 100 masters and doctoral students.

15. I have been recognized for my contributions as an educator in the field. While at Boise State University, I received the President’s Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001). In 2007, I received the Frederick Emmons Terman Award (the “Father of Silicon Valley”). The Terman Award is bestowed annually upon an outstanding young electrical/computer

engineering educator in recognition of the educator's contributions to the profession.

In 2011, I received the IEEE Circuits and Systems Education Award. I received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor Award every year it was awarded while I have been back at UNLV.

16. I have authored several books and papers in the electrical and computer engineering area. My published books include CMOS Circuit Design, Layout, and Simulation (Baker, R.J., Wiley-IEEE, ISBN: 9781119481515 (4th ed., 2019)) and CMOS Mixed-Signal Circuit Design (Baker, R.J., Wiley-IEEE, ISBN: 9780470290262 (2nd ed., 2009) and ISBN: 9780471227540 (1st ed., 2002)). I co-authored DRAM Circuit Design: Fundamental and High-Speed Topics (Keeth, B., Baker, R.J., Johnson, B., and Lin, F., Wiley-IEEE, ISBN: 9780470184752 (2008)), DRAM Circuit Design: A Tutorial (Keeth, B. and Baker, R.J., Wiley-IEEE, ISBN: 0-7803-6014-1 (2001)), and CMOS Circuit Design, Layout and Simulation (Baker, R.J., Li, H.W., and Boyce, D.E., Wiley - IEEE, ISBN: 9780780334168 (1998)). I contributed as an editor and co-author on several other electrical and computer engineering books.

C. Other Relevant Experience

17. I have performed technical and expert witness consulting for more than 200 companies and their subsidiaries and given more than 50 invited talks at conferences, companies, and universities. Further, I am the author or co-author of

more than 100 papers and presentations in the areas of electrical and computer engineering design, fabrication, and packaging.

18. I currently serve, or have served, as a volunteer on the IEEE Press Editorial Board (1999-2004); as editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018); as the Technical Program Chair of the 2015 IEEE 58th International Midwest Symposium on Circuits and Systems (MWSCAS 2015); on the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016); as a Distinguished Lecturer for the SSCS (2012-2015); the Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for IEEE Solid-State Circuits Magazine; IEEE Kirchhoff Award Committee (2020-2023); and advisor for the student branch of the IEEE at UNLV (2013-present). These meetings, groups, and publications are intended to allow researchers to share and coordinate research. My active participation in these meetings, groups, and publications allowed me to see what other researchers in the field have been doing.

19. In addition to the above, I am an IEEE Fellow for contributions to semiconductor memory design and a member of the honor societies Eta Kappa Nu and Tau Beta Pi.

III. MATERIALS CONSIDERED

20. The analysis that I provide in this declaration is based on my education, research, experience, and professional judgment, as well as the documents I have

considered, including the '318 Patent (Exhibit 1001) and its prosecution history (Exhibit 1003). I have reviewed and am familiar with the specification of the '318 Patent. I have reviewed and am familiar with the file history of the '318 Patent.

21. In preparing this declaration, I have also reviewed and am familiar with the following prior art used in the Petition and in my declaration below:

Exhibit 1004 – U.S. Patent No. 6,032,867 by Dushane (“*Dushane*”) was filed on September 11, 1998 and published on March 7, 2000, more than one year before the September 3, 2003 priority date of the '318 Patent. I understand from counsel for Petitioner that *Dushane* qualifies as prior art under at least pre-AIA 35 U.S.C. §§ 102(a), (b), and (e).

Exhibit 1005 – International Patent Application Publication No. 2003/040839 by Geiwitz (“*Geiwitz*”) was filed on October 22, 2002 and published on May 15, 2003, before the September 3, 2003 priority date of the '318 Patent. The provisional application of Geiwitz (“*Provisional*”) was filed on October 22, 2001. Ex. 1005, 1:8-10. I understand from counsel for Petitioner that *Geiwitz* expressly claims the priority benefit of the *Provisional* and qualifies as prior art under at least pre-AIA 35 U.S.C. §§ 102(a) and (e).

Exhibit 1009 – U.S. Patent Application Publication No. 2003/0142121 by Rosen (“*Rosen*”) was filed on January 30, 2002 and published on July 31, 2003, which is more than one year before the September 3, 2003 priority date

of the '318 Patent. I understand from counsel for Petitioner that *Rosen* qualifies as prior art under at least pre-AIA 35 U.S.C. §§ 102(a) and (b).

Exhibit 1010 – “EmbeddedButtons: Supporting Buttons in Documents” was written by Eric A. Bier (“*Bier*”) and published in *ACM Transactions on Information Systems*, Volume 10, Issue 4, in 1992. I understand from counsel for Petitioner that *Bier* qualifies as prior art under at least pre-AIA 35 U.S.C. §§ 102(a) and (b).

Exhibit 1012- According to Jean Francios Boileau, a representative of Domotique Secant Inc., the *Cardio Manual* was distributed to the public without restriction by Domotique Secant Inc. in the United States between early 1996 and 2000, and was distributed in other countries since 1995, before the September 3, 2003 priority date of the '318 Patent. Ex. 1014, 10. I understand from counsel that *Cardio Manual* is prior art to the '318 Patent at least under 35 U.S.C. §§ 102(a), and (b).

Exhibit 1013 – U.S. Patent Application Publication No. 2003/0034898 by Shamoon (“*Shamoon*”) was filed on November 13, 2001 and published on February 20, 2003, which is before the September 3, 2003 priority date of the '318 Patent. I understand from counsel for Petitioner that *Shamoon* qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(a).

22. I have considered the following documents in my analysis below:

Exhibit No.¹	Description
1001	U.S. Patent No. 7,156,318 (“’318 Patent”)
1003	Prosecution File History of the ’318 Patent
1004	U.S. Patent No. 6,032,867 to Dushane (“ <i>Dushane</i> ”)
1005	International Patent Application Publication No. 2003/040839 by Geiwitz (“ <i>Geiwitz</i> ”)
1006	Joint Claim Construction Statement, <i>Rosen Technologies LLC v. Lennox Industries, Inc.</i> , No. 3:22-cv-00732-K (N.D. TEXFeb. 2, 2023)
1007	Geiwitz U.S. Provisional Application 60/339,511, filed October 22, 2001 (“ <i>Provisional</i> ”)
1008	Transcript of Deposition of Howard J. Rosen, December 14, 2022, <i>Rosen Technologies LLC v. Lennox Industries, Inc.</i> , No. 3:22-cv-00732-K (N.D. Tex.) (“Inventor’s Deposition”)
1009	U.S. Patent Application Publication No. 2003/0142121 by Rosen (“ <i>Rosen</i> ”)
1010	“EmbeddedButtons: Supporting Buttons in Documents” by Eric A. Bier (“Bier”)
1011	Scheduling Order, <i>Rosen Technologies LLC v. Lennox Industries, Inc.</i> , No. 3:22-cv-00732-K (N.D. Tex. Sept. 1, 2022)
1012	Cardio Manual by Domotique Secant Inc. (“ <i>Cardio Manual</i> ”)
1013	U.S. Patent Application Publication No. 2003/0034898 (“Shamoon”)

¹ Citations to issued patents (Exhibits 1001, 1004, 1016, 1019, and 1025) are made by column and line number. Citations to patent application publications (Exhibits 1009 and 1013) are made by paragraph number. Citations to Exhibits 1005, 1008, and 1015 are to the page and line number. Citations to Exhibits 1006, 1011, 1017, 1018, 1021, 1022, 1024, 1026, and 1027 are to the original page numbering in the exhibits. Citations to Exhibits 1003, 1007, 1010, 1012, 1014, 1020, and 1023 are to the page number added by the exhibit label.

Exhibit No.¹	Description
1014	Statutory Disclaimer and Declaration of Howard Rosen entered in U.S. Patent No. 6,824,069 (“The Disclaimer”)
1015	International Patent Application Publication No. WO 02/48851 A2 by Smith (“Smith”)
1016	U.S. Patent No. 5,460,327 to Hill (“Hill”)
1017	IPR2022-01402 Patent Owner’s Preliminary Response
1018	IPR2022-01402 Petition
1019	U.S. Patent No. 7,083,109 to Pouchlak (“Pouchak”)
1020	Intel [®] 386ex Data Sheet, May 1996 (“Intel Data Sheet”)
1021	Excerpts of Microsoft Computer Dictionary (4 th ed., 1999)
1022	<i>Motif Programming Manual</i> , Volume 6 A by Dan Heller and Paula M. Ferguson (“MOTIF”)
1023	Electronic Order Granting Unopposed Motion to Amend Scheduling Order, <i>Rosen Technologies LLC v. Lennox Industries, Inc.</i> , No. 3:22-cv-00732-K (N.D. Tex. March 13, 2023)
1024	“A Taxonomy of Internet Appliances” by Sharon Eisner Gillett, William H. Lehr, John T. Wroclawski, and David D. Clark
1025	U.S. Patent No. 7,084,859 to Pryor (“Pryor”)
1026	Plaintiff’s Amended Disclosure of Asserted Claims and Preliminary Infringement Contentions, <i>Rosen Technologies LLC v. Lennox Industries, Inc.</i> , No. 3:22-cv-00732-K (N.D. Tex. Nov. 21, 2022)
1027	<i>PC Hardware: A Beginner’s Guide</i> by Ron Gilster

IV. UNDERSTANDING OF APPLICABLE LEGAL STANDARDS

23. Although I am not an attorney, I have a general understanding of the applicable legal standards pertaining to the patentability issues presented in this proceeding. My understanding of legal principles as described in this section is based on communication of those principles to me by Petitioner’s legal counsel. The analysis in this declaration is in accordance with the legal principles outlined below.

24. I understand that, in this *inter partes* review, Petitioner has the burden of proving that each challenged claim is unpatentable by a preponderance of the evidence.

A. My Understanding of Claim Construction

25. I have been informed by counsel that a purpose of claim construction is to determine what a person of ordinary skill in the art (“POSITA”) would have understood the claim terms to mean. I understand that during an IPR proceeding, claims are to be construed in light of the specification as would be read by a POSITA at the time the application was filed. I understand that claim terms are given their ordinary and customary meaning as would be understood by a POSITA in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In this case, the claim term will receive the definition set forth in the patent.

26. I understand that the prosecution history can inform the meaning of the claim language by demonstrating how the inventors understood the invention and whether the inventors limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be. I understand that extrinsic evidence may also be consulted in construing the claim terms, such as dictionary definitions and expert testimony.

27. I further understand that 35 U.S.C. §112 ¶6 created an exception to the general rule of claim construction. I understand that patent claims may be drafted in means-plus-function format, in which a claim limitation is expressed as a means or step for performing a specified function, without a recital of structure. I understand that, under §112 ¶6, a limitation will be presumed to be a “means-plus-function” limitation if (a) the claim limitation uses the word “means”; (b) the word “means” is modified by functional language; and (c) the word “means” is not modified by sufficient structure for achieving the specified function.

28. I understand that a means-plus-function limitation should be interpreted to cover only the recited function and the corresponding structure for performing the function as described in the specification, as well as equivalent structures. I understand that a structure is deemed equivalent to the corresponding structure in the specification only if the difference between them is insubstantial. For example, two structures may be deemed equivalent if they perform the same function in substantially the same way to achieve substantially the same result. I further understand that a structural equivalent must have been available at the time of issuance of the claim.

B. My Understanding of Obviousness

29. I understand that a patent claim is unpatentable if, at the time of the invention, it would have been obvious to one of ordinary skill in the art to combine

the teachings of the prior art to yield the patent claim. I also understand that it is not required (although it is acceptable) that each element of a patent claim be found in a single reference in order to find a patent claim obvious. This means that even if all of the requirements of the claim cannot be found in a single prior art reference that would anticipate the claim, the claim can still be invalid. For a patent claim to be found obvious, all the elements of the patent claim may be found in a combination of references at which a POSITA would have been reasonable expected to arrive.

30. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of ordinary skill in the pertinent art; and (4) other objective considerations identified below. I understand that an invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a POSITA at the time the invention was made.

31. I understand that a showing of obviousness requires some articulated reasoning with a rational underpinning to support the combination of references. I understand that in consideration of the issue of obviousness it is important to identify whether a reason existed at the time of the invention that would have led a person of ordinary skill in the pertinent art to combine elements of the references in a way that yields the claimed invention.

32. I understand that a POSITA is assumed to have knowledge of all prior art references. I also understand that when considering the obviousness of a patent claim, one may consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissibly applying hindsight when considering the prior art. I understand this test should not be rigidly applied, but that the test can be important to avoiding such hindsight.

33. I understand that a POSITA can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a motivation to combine the references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a POSITA would employ to combine the known elements in the prior art in the manner claimed by the patent-at-issue. I understand that one should avoid “hindsight bias” and ex post reasoning in performing an obviousness analysis. This does not mean, however, that a POSITA does not have recourse to common sense for purposes of the obviousness inquiry.

34. I understand that a claim may be considered unpatentable for obviousness for various reasons. I have been informed that the following exemplary rationales may support a finding of obviousness:

- A) combining prior art elements according to known methods to yield predictable results;
- B) simply substituting one known element for another to obtain predictable results;
- C) use of a known technique to improve similar devices (methods, or products) in the same way;
- D) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- E) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- F) a predictable variation of work in the same or a different field of endeavor, which a POSITA would be able to implement;
- G) if, at the time of the alleged invention, there existed a known problem for which there was an obvious solution encompassed by the patent's claim;
- H) known work in one field of endeavor that prompts variations of it for use in either the same field or a different field based on technological incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and/or

I) 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 multiple prior-art references or teachings to arrive at the claimed invention.

35. I understand that even if a prima facie case of obviousness is established, the final determination of obviousness must also consider objective indicia of nonobviousness, which I understand are also referred to as “secondary considerations,” if presented. I understand that these objective indicia can be important evidence as to whether a patent is obvious or nonobvious. Such secondary considerations include: (1) commercial success of products covered by the patent claims; (2) a long-felt but unsolved need for the invention; (3) failed attempts by others to make the invention; (4) copying of the invention by others in the field; (5) unexpected results achieved by the invention as compared to the closest prior art; (6) praise of the invention by the infringer or others in the field; (7) the taking of licenses under the patent by others; (8) expressions of surprise by experts and those skilled in the art at the making of the invention; and (9) the patentee proceeded contrary to the accepted wisdom of the prior art. I further understand that secondary considerations evidence is only relevant if the offering party establishes a connection, or nexus, between the evidence and the claimed invention.

36. I also understand that “obviousness” is a legal conclusion based on the underlying factual issues of the scope and content of the prior art, the differences

between the claimed invention and the prior art, the level of ordinary skill in the prior art, and any objective indicia of non-obviousness. For that reason, I am not rendering a legal opinion on the ultimate legal question of obviousness. Rather, my testimony addresses the underlying facts and factual analysis that would support a legal conclusion of obviousness, and when I use the term obvious, I am referring to the perspective of a POSITA at the time of invention.

C. Level of Ordinary Skill in the Art

37. I understand that an assessment of the claims of the '318 Patent should be undertaken from the perspective of a POSITA as of the earliest claimed priority date. I understand that a POSITA is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

38. I understand that to determine the appropriate level of a POSITA, the following factors may be considered: (1) the types of problems encountered by those working in the field and prior art solutions thereto; (2) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (3) the educational level of active workers in the field; and (4) the educational level of the inventor.

D. Priority Date

39. I understand that, subject to the next paragraph, the asserted “priority date” of a patent is the earlier of: (a) the date on which a patent application is filed; or (b) the date on which an earlier-filed patent application is filed if the patentee claims the benefit of priority to that earlier-filed patent application.

40. I understand that it is not enough for a patent to merely claim the benefit of an earlier-filed application, but that additional criteria must be met. In particular, the prior application itself must describe the claimed invention, and must do so in sufficient detail that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought. First, I understand that a priority-date analysis is on a claim-by-claim basis. Second, I understand that, in order for a patent claim to be entitled to the filing date of an earlier patent application, a “Section 112 analysis” must be conducted. I am informed that a “Section 112” analysis encompasses looking to the earlier patent application, and ascertaining whether that earlier patent application meets both the written-description and enablement requirements as of the filing date of the earlier application. I understand that it is not enough that the claim would have been obvious from the earlier application, but that application itself must describe the claimed invention.

41. I understand that in order to satisfy the written description requirement the earlier application must reasonably convey to those skilled in the art that the

inventors had possession of the subject matter of the patent as of the filing date of the earlier application. I have been informed that it is the disclosures of the earlier patent application that count, and that while the meaning of terms, phrases, or diagrams in the earlier patent application must be interpreted from the vantage point of one skilled in the art, all of the claimed limitations must appear in the specification. Further, I understand that this analysis is not a question of whether one skilled in the art might be able to construct the claimed invention from the teachings of the disclosure. The question is not whether a claimed invention is an obvious variant of that which is disclosed in the specification; rather, I understand that an earlier application must itself describe each of the claim limitations.

42. I also understand that in order to satisfy the enablement requirement, the earlier application must enable a person of ordinary skill in the art to practice the claimed invention without undue experimentation.

V. OVERVIEW OF THE '318 PATENT

43. I have reviewed the '318 Patent, which is entitled "Programmable thermostat incorporating a liquid crystal display selectively presenting adaptable system menus including changeable interactive virtual buttons." Ex. 1001, Cover. I understand that the '318 Patent was filed on September 3, 2003, which serves as the '318 Patent's priority date.

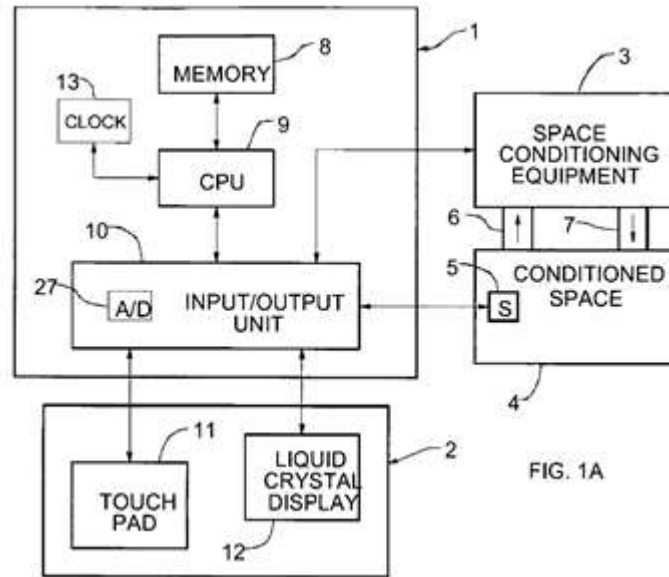
A. Subject Matter

44. The '318 Patent concerns “a programmable thermostat incorporating an interactive liquid crystal display (LCD),” where “the LCD selectively presents adaptable menus, including variable representations of virtual buttons.” Ex. 1001, 1:25-29. The '318 Patent describes and claims a thermostat system for controlling space conditioning equipment. *Id.* at 13:5-6. The claimed system includes conventional components such as an environmental condition sensor, a touch screen for interactive interface with a user, a processor including a central processing unit, real time clock, memory, and input/output unit, and a control program. *Id.* at 13:7-29. In the “Background of the Invention” section, the '318 Patent teaches that “[t]hermostats have been used for many years as temperature sensitive switches which control heating and/or cooling equipment for conditioning a space.” *Id.* at 1:35-37. Furthermore, the '318 Patent admits that “[m]any modern thermostat systems include a real time clock, a memory and a data processor to run a process control program stored in the memory,” and “are programmable by the user.” *Id.* at 1:51-54, 1:66-67. Additionally, the '318 Patent admits that “[i]n some modern thermostats, “virtual” buttons are presented on the LCD itself which is juxtaposed with a touch pad to effect an interactive touch screen.” *Id.* at 2:6-9. Thus, the '318 Patent acknowledges that the majority of the elements of its thermostat system were well known in the art and in use before the priority date of the '318 Patent.

45. The '318 Patent purports to address difficulties with successfully programming thermostat systems. The '318 Patent asserts that programmable thermostat systems are “difficult to program” for some users “because the user interfaces which have been employed in prior art programmable interfaces are not highly intuitive.” *Id.* at 2:11, 2:13-15. The patent describes that “[p]rogrammable thermostat systems have incorporated fixed position real or virtual buttons, at least some of which have multi-functions,” and “[t]he user must usually refer to and attempt to decipher a programming manual (which is often difficult for the average user to readily understand) as the programming proceeds.” *Id.* at 2:15-22. According to the '318 Patent, this “programming process is so complex to follow while trying to remember the instructions that many users give up, and the full capabilities of the thermostat system cannot be utilized.” *Id.* at 2:22-25.

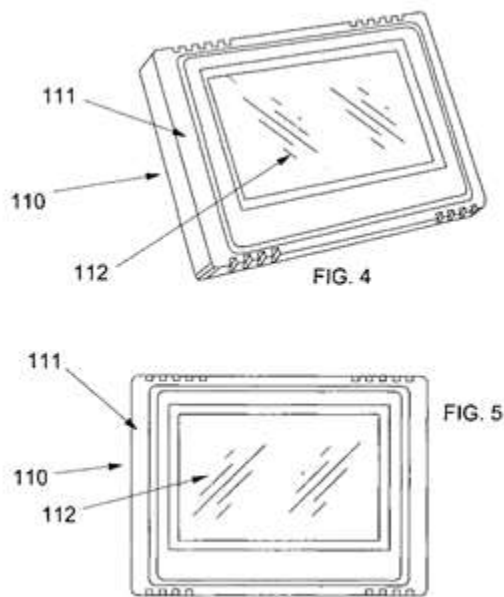
46. Figure 1a of the '318 Patent “is a block diagram of a space conditioning system incorporating a programmable thermostat according to the present invention.” *Id.* at 4:35-37. The thermostat system includes admittedly conventional components including a “processor 1, a touch screen 2 and a temperature sensor 5 which is disposed in a conditioned space 4.” *Id.* at 5:34-36. The processor includes “a central processing unit (CPU) 9 in communication with a memory 8 for storing data and program information and also, via an input/output unit (I/O unit) 10, a touch pad 11 and an LCD 12 which together constitute the touch screen 2.” *Id.* at 5:45-49.

“A settable real time clock 13 is used to keep time in the thermostat system to facilitate diverse operations.” *Id.* at 5:52-54.



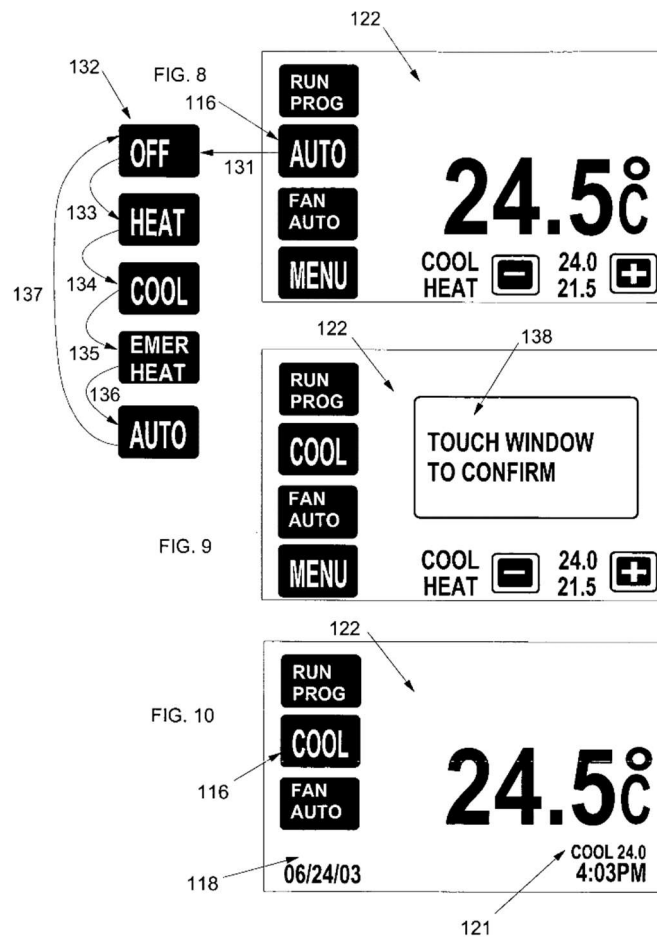
Id. at Fig. 1a.

47. The '318 Patent describes employing a “different type of thermostat user interface; viz., the touch screen 2, in which the touch pad 11 and LCD 12 are integrated and coordinated ... and which, in conjunction with the processor 1, provides a programmable thermostat system which is very much easier to program than in the prior art.” *Id.* at 6:50-55. “FIGS. 4 and 5 show an exemplary touch screen thermostat 110 with a housing 111 and touch screen 112,” where there are no physical buttons and “all the functions and displayed information of the programmable thermostat are available to a user by observation and interaction with the touch screen 112.” *Id.* at 7:36-42.



Id. at Figs. 4-5.

48. Figs. 8-10 show various interactive conditions of the patented invention. *Id.* at 8:21-22. “FIG. 8 illustrates that virtual button 116 can undergo step 131 in response to a user touch,” causing “a change in the operating state of thermostat 110 and a change of the legend associated with virtual button 116 to one of the virtual buttons in column 132.” *Id.* at 8:22-26. “FIGS. 9 and 10 illustrate an exemplary operation of changing, confirming and showing the change made by touching virtual button 116 twice,” where a virtual button changes “from the ‘auto’ mode to the ‘heat’ mode on the first touch and, on the second touch, has changed from the ‘heat’ mode to the ‘cool’ mode.” *Id.* at 8:51-58. “[A] temporary active virtual button 138 is now displayed for a user to confirm that the user wishes to select the currently displayed function; i.e., ‘cool,’” and touching said virtual button causes the changes displayed in Fig. 10. *Id.* at 8:58-60.



Id. at Figs. 8-10.

B. Listing of Challenged Claims

49. Below I provide a listing of Claims 1, 3-5, 7, 9, 11, and 14 (collectively, the “Challenged Claims”) of the ’318 Patent. I will refer throughout this declaration to the elements of the claims with reference to the number and letter designations that have been added in the left column (e.g., “1[pre],” “1[a],” “1[b],” etc.).

Claim 1	
1[Pre]	A programmable thermostat system for controlling space conditioning equipment comprising:

1[a]	A) at least one environmental condition sensor providing an electrical signal indicative of the ambient temperature of a conditioned space in which said environmental condition sensor is situated;
1[b]	B) a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen for interactive interface with a user;
1[c]	C) a processor, said processor including: 1) a central processing unit;
1[d]	2) a real time clock;
1[e]	3) a memory coupled to said central processing unit for storing program and data information; and
1[f]	4) an input/output unit coupled between said processor and said touch screen for carrying out information transfer therebetween, said input/output unit further including: a) a sensor input coupled to each said environmental condition sensors for receiving said electrical signal therefrom; and b) a control output coupled to the space conditioning equipment for issuing control signals thereto; and
1[g]	D) a control program stored in said memory for causing said central processing unit to communicate through said input/output unit to selectively:
1[h]	1) establish on said liquid crystal display: a) a representation of a first virtual button at a first predetermined position on the liquid crystal display; and
1[i]	b) a first legend indicative of a first control function of said thermostat, which first control function is for controlling a first space conditioning equipment component, which first control function is active when the first legend is viewable;
1[j]	2) read the position on the touch pad juxtaposed with said first predetermined position on said liquid crystal display to determine if the representation of said first virtual button has been touched;

1[k]	3) if the first virtual button has been touched: a) determining that the thermostat has been directed to control a second space conditioning equipment component;
1[l]	b) activating a second control function for controlling the second space conditioning equipment component; and
1[m]	c) displaying on said liquid crystal display a second legend indicative of said second control function of said thermostat, which second control function is for controlling the second space conditioning equipment component, which second control function is active when the second legend is viewable.
Claim 3	
3	The programmable thermostat system of claim 1 in which the space conditioning equipment components include at least one of: a heater, a compressor type air conditioner and a heat pump.
Claim 4	
4	The programmable thermostat system of claim 3 in which if the first virtual button is been touched again after step D)3), determining that the thermostat controls a third space conditioning equipment component, activating a third control function for controlling the third space conditioning equipment component, and changing the second legend to a third legend indicative of the third control function of the thermostat.
Claim 5	
5	The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heater and the graphic includes the word “heat” associated with said virtual button when the heater is controlled.
Claim 7	
7	The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is an air conditioning system

	and the graphic includes the word “cool” associated with said virtual button when the air conditioning system is controlled.
Claim 9	
9	The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “heat” associated with said virtual button when the heat pump is controlled while operating in its heating mode.
Claim 11	
11	The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “cool” associated with said virtual button when the heat pump is controlled while operating in its cooling mode.
Claim 14	
14	The programmable thermostat system of claim 1 in which said liquid crystal display is a dot matrix type.

C. Prosecution History

50. The '318 Patent was filed as Application No. 10/654,235 on September 3, 2003. *Id.* at Cover.

51. The prosecution history for the '318 Patent is minimal. During prosecution, the Examiner never issued an office action rejecting the claims. A Notice of Allowance and Fee(s) Due was mailed on October 23, 2006. Ex. 1003, 024. In its Reasons for Allowance, the Examiner stated that “the prior art does not teach the programmable thermostat system combinations as recited, and in particular the stored program features recited in section D, subsection 3 of each of these

claims.” *Id.* at 025. As can be seen from the face of the ’318 Patent, the Examiner cited twenty-nine references (twenty-eight of which were identified by Applicant in information disclosure statements). Ex. 1001, Cover; Ex. 1003, 039-043, 164-65. Except for the *Cardio Manual*, none of the other prior art references relied upon in Grounds 1-2 were considered by the Examiner during prosecution of the ’318 Patent.

D. Priority Date

52. The ’318 Patent originally claimed priority as a continuation-in-part of Application No. 10/060,768, filed on January 30, 2002, now U.S. Patent No. 6,824,069 (’069 Patent). Ex. 1003, 047. Importantly, however, on February 4, 2005, the Applicant amended the specification to disclaim the “benefit of the earlier filing date of Serial No. 10/060,768” and accepted the “date on which the application was actually filed with the USPTO” as the filing date of the application. *Id.* Applicant further disclaimed all claims corresponding to the ’069 Patent, seeking to “sever all connection between U.S. Patent No. 6,824,069 and the present application.” *Id.* Thus, the priority date of the ’318 Patent, as disclosed on the face of the patent, is the September 3, 2003 filing date. Ex. 1001, Cover.

E. Level of Ordinary Skill in the Art

53. I have been asked to consider the level of ordinary skill in the field that someone would have had at the time the claimed invention was made. My opinions regarding the level of ordinary skill in the art are based on, among other things, my

over 30 years of experience in the field of electrical engineering and computer science, as well as: the levels of education and experience of persons working in the field, the types of problems encountered in the field; and the sophistication of the technology.

54. Based on the disclosure of the '318 Patent, in my opinion a POSITA as of September 3, 2003 would have had a Bachelor of Science degree in Electrical Engineering or a year or two of experience working with or designing processor-based systems with network connectivity. This level of skill is approximate, and more experience would compensate for less formal education and vice versa.

55. Based on my education and experience, I meet this definition of one of ordinary skill in the art, and I believe that I am qualified to provide opinions about how a POSITA at the relevant time would have interpreted and understood the '318 Patent and the prior art relied upon herein. Although my qualifications and experience exceed those of a POSITA, both in September 2003 and today, I have nevertheless applied the perspective of a POSITA in rendering my opinions below.

56. My opinions below explain how a POSITA would have understood the technology described in the '318 Patent and the prior art references I have identified herein around the September 3, 2003 timeframe. For purposes of this declaration, in general, and unless otherwise noted, my testimony below refers to the knowledge of one of ordinary skill in the art during the time period around the priority date of

the '318 Patent. I would have been a person with at least ordinary skill in the art at that time.

F. Claim Construction

57. It is my understanding that in order to properly evaluate the '318 Patent, the terms of the claims must first be interpreted. It is my understanding that the claims are to be construed according to the same claim construction standard that district courts use. I have been informed by counsel for Petitioner that the challenged claims of the '318 Patent are to be given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention in light of the specification and the prosecution history pertaining to the patent.

58. In order to construe the claims, I have reviewed the entirety of the '318 Patent along with the prosecution history of the '318 Patent. Except as set forth below, it is my opinion that a POSITA would have understood each term of the challenged claims according to their plain and ordinary meaning as understood by a person of ordinary skill in the art.

59. For purposes of this declaration, I have been asked to make certain assumptions regarding the meaning of the claim language and provide an opinion as to obviousness based upon those assumptions.

60. I understand that in the related district court litigation, Patent Owner contends that the claimed “sensor input coupled to each said environmental

condition sensors for receiving said electrical signal therefrom” in element 1[f], “control output coupled to the space conditioning equipment for issuing control signals thereto” in element 1[f], and “control program stored in said memory for causing said central processing unit to communicate through said input/output unit to selectively” perform functions recited in elements 1[h]-1[m] are not subject to 35 U.S.C. § 112, ¶6. Ex. 1006, 47-59. Instead, the Patent Owner contends that these terms have their plain, ordinary meaning. *Id.* That is what I have assumed for purposes of my analysis here without conceding that those constructions are correct.

61. I also understand that in the related district court litigation, Patent Owner further contends that the terms “an input/output unit coupled between said processor and said touch screen for carrying out information transfer therebetween . . .” in element 1[f] and “the graphic” in Claims 5, 7, 9, and 11 are not indefinite. *Id.* at 47.

62. For purposes of this declaration, I was asked to apply Patent Owner’s “plain and ordinary meaning” interpretation for these terms. For purposes of this declaration, I have applied Patent Owner’s “plain and ordinary meaning” interpretations, without conceding they are correct.

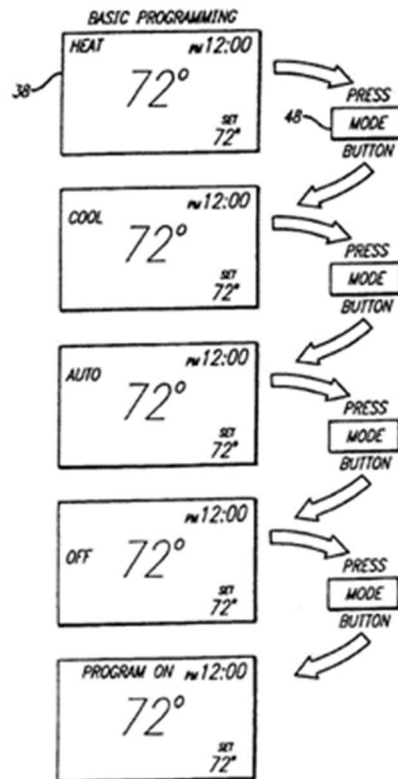
VI. TECHNOLOGY BACKGROUND AND STATE OF THE ART

63. Before providing my analysis of the '318 Patent and the prior art references, as included below, a background discussion of the state of the art of thermostat systems and the technologies they employ is helpful.

A. It was known to use Touchscreens with Virtual Buttons To Replace Physical Buttons of a Device

64. While Claim 1 of the '318 Patent is lengthy, it lacks substance. What Claim 1 essentially claims is having a virtual mode button on the screen of a thermostat to switch between heating mode and cooling mode. Of course many thermostats had physical mode buttons that could switch between heating and cooling mode and then displayed on the screen of the thermostat an indication of what mode the thermostat was in.

65. For example, *Dushane* discloses a thermostat with a physical button that is used to switch between modes of a thermostat—causing a legend to appear on an LCD screen indicating what mode the thermostat is in. *See* Ex. 1004, Fig. 6. As illustrated in Figure 6, the appropriate legend is displayed when the corresponding “operating mode for the controlled apparatuses is selected,” as “[w]hen the sub-field ‘COOL’ is activated, the user is provided with a visible indication that a cooling operation has been selected” *Id.* at 11:22-24; 11:27-29.



Id. at Fig. 6.

66. Just like the '318 Patent, each press of the mode button causes the thermostat of *Dushane* to cycle through multiple modes and display a legend indicating the mode on the screen of the thermostat. *See id.* However, *Dushane* uses a mode button on a keypad, rather than a virtual mode button on a touch screen. *See id.* at 12:66-67.

67. But there was ample teaching in the prior art that one could replace physical buttons with virtual buttons on a touch screen. For example, a September, 2000 paper entitled, "A Taxonomy of Internet Appliances" first explains that it makes sense for thermostats to be connected to the Internet. Ex. 1024, 9 (footnote

10). The reference then teaches that for any Internet appliance, virtual buttons on a screen could be substituted for physical buttons: “They appear as fixed function to users, with buttons for common activities. The buttons made be made of plastic and do things like fetch email ... display particular Web pages . . .or select items from an on-screen menu (Internet connected mobile phones). Alternatively, they may be “soft” buttons displayed on a screen . . .” *Id.* at 14-15.

68. Another place one finds a thermostat is the dashboard of a car to adjust the heating and air conditioning temperature. Prior art also suggests replacing physical buttons for such an interface with virtual buttons. For example, *Pryor*, filed in 2001 (U.S. Patent No. 7,084,859), teaches this substitution: “A touch screen and/or tactile display such as disclosed above could be used to replace all the display and actuation functions of the conventional dashboard, while at the same time vastly augmenting the potential scope of their application, as it can be reprogrammed to serve different needs in the vehicle at different times. One moment it can be used for heat and radio volume, the next for internet surfing, or camera image viewing (e.g. of the road behind the car) etc. The things to touch are programmably displayed.” Ex. 1025, 55:49-57.

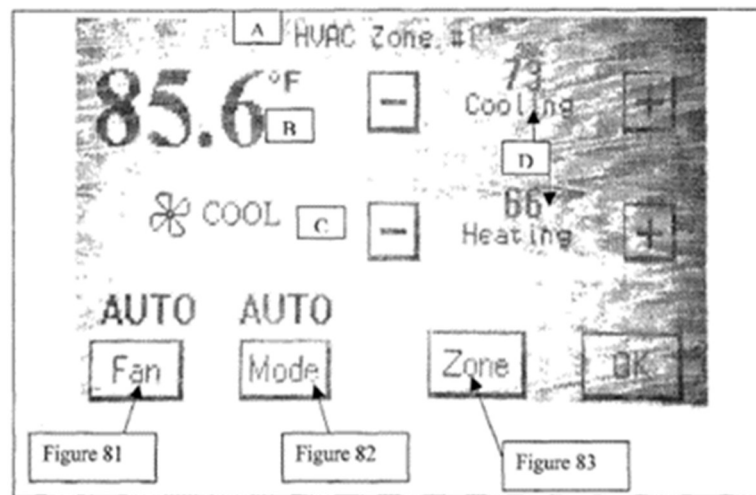
B. It was known to use Touchscreens in Thermostats

69. The '318 Patent itself states that some modern thermostats have used “‘virtual’ buttons” on an “interactive touch screen.” Ex. 1001, 2:7-9. This is not

surprising as multiple references disclose the use of a touch screen in addition to the *Pryor* and *Taxonomy* references discussed in the prior section.

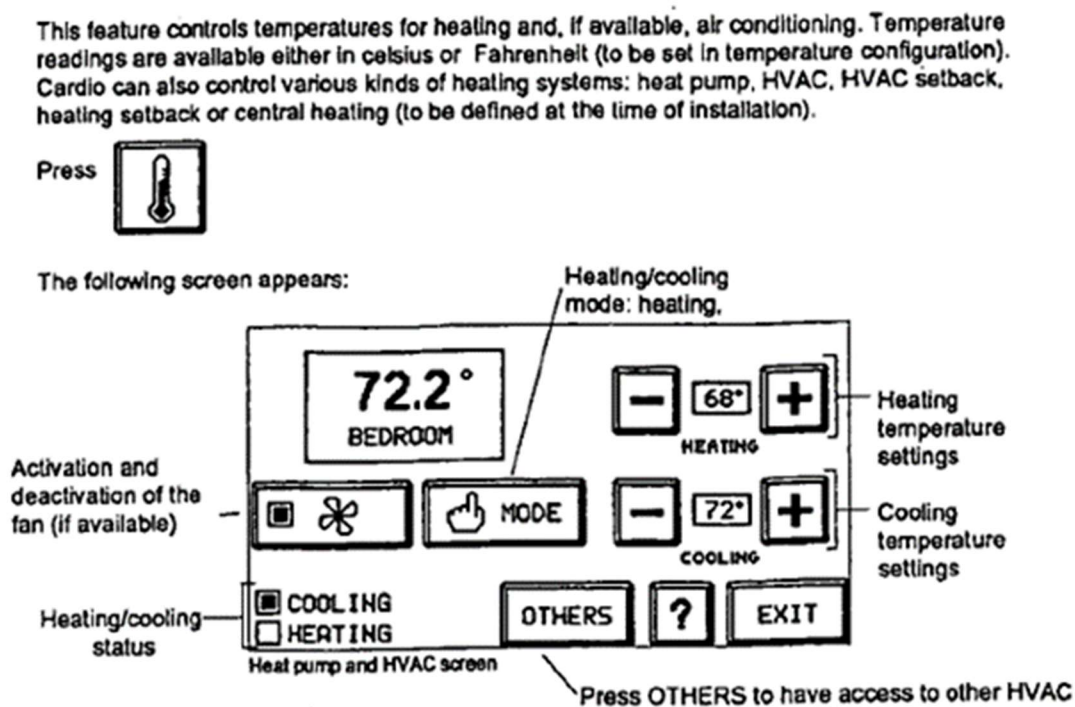
70. *Smith*, World Application 02/48851, published on June 20, 2002, discloses a thermostat with a “touch-sensitive screen which allows the user to input data without the need for a keyboard or mouse.” Ex. 1015, 3:11-12. “This configuration provides for very flexible graphical display of information along with a very user friendly data input mechanism. The display unit 200 may be very similar to the touch screen display used in a hand-held personal digital assistant ("PDA"), such as a Palm brand PDA manufactured by 3Com, a Jornada brand PDA manufactured by Hewlett Packard, etc. Of course the graphical user interface system could also be manufactured to be integrated with a thermostat itself. In such an embodiment, a touch-sensitive LCD display is coupled with the thermostat's existing central processing unit and RAM.” *Id.* 3:19-4:6.

71. *Geiwitz*, discussed in detail below, disclosed a dot-matrix type touch screen with virtual buttons for use in a thermostat:



Ex. 1007, 56.

72. *Cardio Manual*, first published in the US in 1995, also discloses a dot-matrix type touch screen with virtual buttons for use in a thermostat:



Ex. 1012, 7.

73. As discussed above, prior to the September 3, 2003 priority date of the '318 Patent, all of the technology at issue in the challenged claims was well known and broadly applied in various commercial applications. In my opinion, no individual elements of the challenged claims of the '318 Patent were novel at the time of the alleged invention, and there was nothing novel or inventive about the manner in which those elements were combined in the challenged claims. Further, there were no technological barriers to combining these known elements to form the claimed inventions. Indeed, combining these elements would have yielded predictable results.

VII. APPLICATION OF THE PRIOR ART TO THE CHALLENGED CLAIMS

74. I have been asked to provide my opinion as to whether the challenged claims of the '318 Patent would have been anticipated by the prior art or obvious in view of the prior art. The discussion below provides a detailed analysis of how the prior art references I reviewed disclose, teach, or suggest the limitations of the challenged claims of the '318 Patent.

75. As part of my analysis, I have considered the scope and content of the prior art and any potential differences between the claimed subject matter and the prior art. I have conducted my analysis as of the filing/priority date of the '318

Patent: September 3, 2003. I have also considered the level of ordinary skill in the pertinent art as of that date.

76. Below, I describe in detail the scope and content of the prior art, as well as any differences between the subject matter claimed and the prior art, on an element-by-element basis for each challenged claim of the '318 Patent. The analysis supports my finding that the differences between the claims of the '318 Patent and the prior art discussed herein are such that the subject matter as a whole would have been obvious at the time of the priority date of the '318 Patent to a POSITA.

77. In the grounds below, I describe on an element-by-element basis how the prior art discloses or teaches all elements of Claims 1, 3-5, 7, 9, 11, and 14 of the '318 Patent.

A. Grounds of Unpatentability

78. I have reviewed and analyzed the prior art references and materials listed in Section III above. In my opinion, the challenged claims of the '318 Patent are rendered obvious based on the following prior art set forth in Grounds 1-2 below:

Ground	'318 Patent Claims	Basis for Challenge under §103
1	1, 3-5, 7, 9, 11, and 14	<i>Geiwitz</i> in view of <i>Rosen</i> and <i>Bier</i> and the common knowledge of a POSITA
2	1, 3-5, 7, 9, 11, and 14	<i>Dushane</i> in view of <i>Cardio Manual</i> , <i>Bier</i> , and the common knowledge of a POSITA.

B. Summary of Prior Art

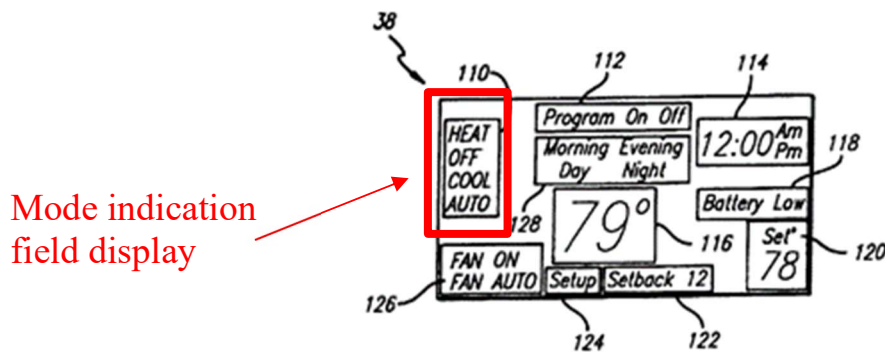
1. Overview of *Dushane* (Exhibit 1004)

79. *Dushane* (U.S. Patent 6,032,867) was filed on September 11, 1998 and published on March 7, 2000, more than one year before the September 3, 2003 priority date of the '318 Patent. Ex. 1004, Cover. I understand from counsel for Petitioner that *Dushane* is prior art to the '318 Patent at least under 35 U.S.C. §§ 102(a), (b), and (e).

80. Similar to the '318 Patent, *Dushane* relates to programmable thermostat systems, namely, “sensors utilized to sense the temperature of a zone for control of a heating, ventilation, and air conditioning (HVAC) system.” *Id.* at 1:8-10. *Dushane* explains that in thermostat design, a “principle consideration is that the thermostat project from the mount on the wall into the space as little as possible” because there are “functional and safety advantages.” *Id.* at 1:28-30; 1:36. According to *Dushane*, the present invention comprises an adaptation that projects “past and into the vertical mounting support wall a substantial portion of the at least one printed circuit board for location of substantially all the operational components of a programmable thermostat.” *Id.* at 1:67-2:3.

81. Similar to the '318 Patent, *Dushane* describes a programmable thermostat system including “a user input mechanism adapted to receive

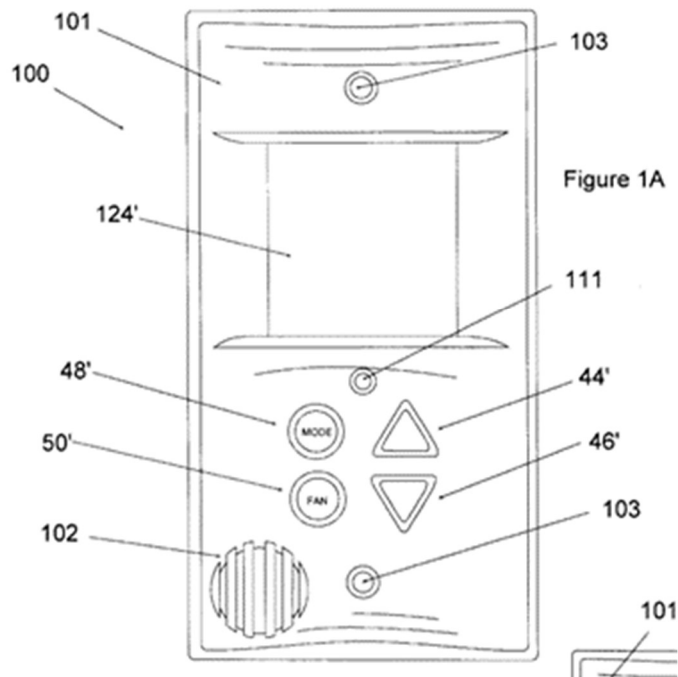
programming inputs from users, to have a display adapted to display indicia of the programming inputs, a controller adapted to be programmable in response to the input signals according to a plurality of programming modes and to generate and provide control signals to one or more environmental control apparatuses.” *Id.* at 4:37-44. *Dushane* further describes “a mode indication display field 110 which includes “HEAT”, “OFF”, “COOL” and “AUTO” sub-fields,” where “[o]ne of the aforementioned sub-fields is activated depending upon which operating mode for the controlled apparatuses is selected.” *Id.* at 11:19-24.



Id., Fig. 4 (annotated).

82. *Dushane* further teaches controlling different environmental control apparatuses depending on the activated mode, such as providing control signals to a “heating apparatus such as a furnace” during the HEAT mode and to “a cooling apparatus such as an air conditioner” during the COOL mode. *Id.* at 12:56-59. Unlike the ’318 Patent, however, *Dushane* employs a physical button (rather than a virtual one) to switch between modes of the thermostat. *See id.* at Fig. 1a; 12:66-67.

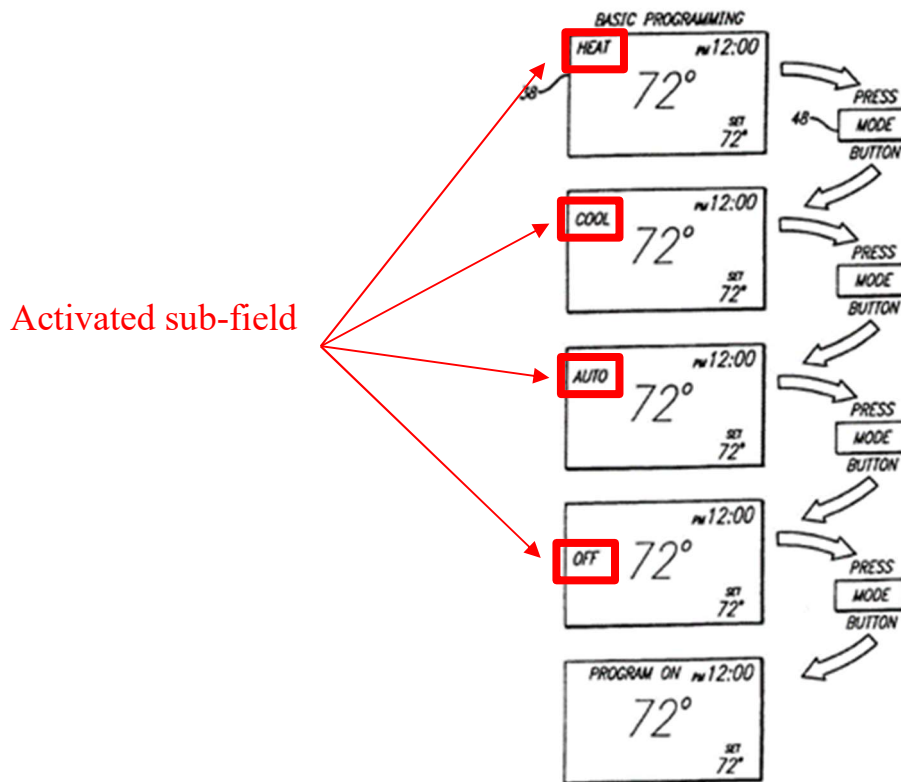
83. *Dushane*'s thermostat also has a mode button to switch between modes, but the mode button is a physical switch, rather than a virtual button. Figure 1A of *Dushane*, reproduced below, shows a cover plate 100 and associated circuit boards which "comprise an assembly of a programmable thermostat." *Id.* at 5:30-31.



Id. at Fig. 1a (illustrating that mode button 48 is used to switch modes).

84. *Dushane* further teaches putting a legend on the LCD screen to tell the user what mode the thermostat is in. *Dushane* discloses one of the sub-fields being activated when the corresponding "operating mode for the controlled apparatuses is selected." *Id.* at 11:23-24. For example, *Dushane* describes providing a user "with a visible indication that a heating operation has been selected" "when the sub-field 'HEAT' is activated." *Id.* at 11:24-26. "When the sub-field 'COOL' is activated,

the user is provided with a visible indication that a cooling operation has been selected,” and when the sub-field ‘AUTO’ is illuminated, an indication is provided that “the system will automatically changeover between heat and cool modes as the temperature varies.” *Id.* at 11:26-34.



Id. at Fig. 6 (annotated) (shows *Dushane*’s mode indication display field displaying the subfield indicative of the activated mode).

85. Thus, just like the ’318 Patent, the legend displayed on the screen changes as the mode button is pressed.

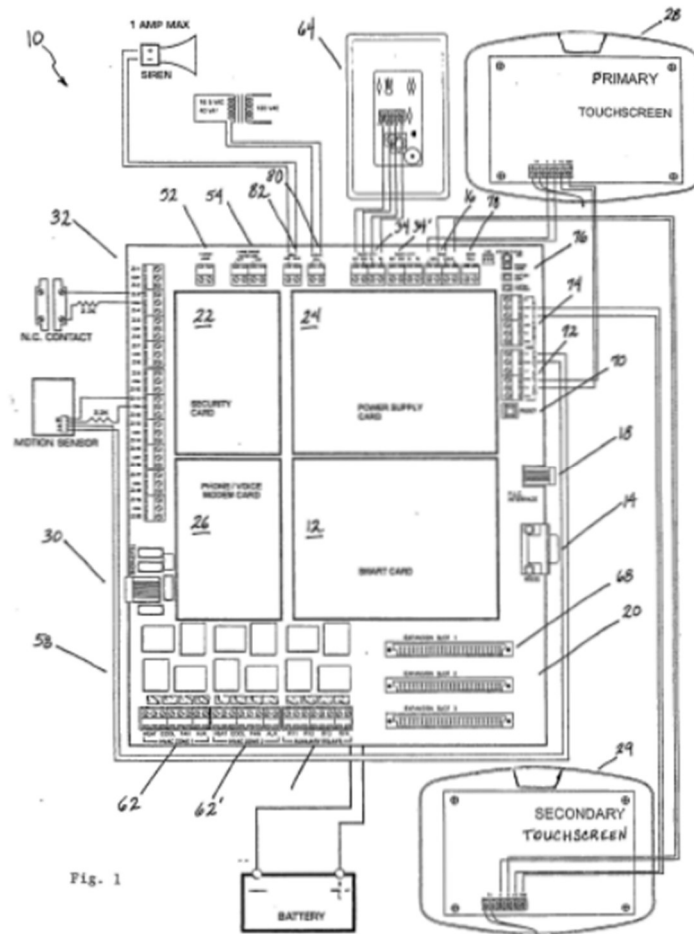
2. Overview of *Geiwitz* (Exhibit 1005)

86. *Geiwitz* (International Patent Application Publication No. 2003/040839) was filed on October 22, 2002 and published on May 15, 2003, before the September 3, 2003 priority date of the '318 Patent. Ex. 1005, Cover. I understand from counsel for Petitioner that *Geiwitz* is prior art to the '318 Patent at least under 35 U.S.C. §§ 102(a), and (e).

87. *Geiwitz* “relates to a programmable automation and control system accessible by touch-screen, “smart” key, telephone, Internet, radio frequency and infrared signals.” *Id.* at 1:17-18. *Geiwitz* explains that one “difficulty encountered when combining control of various subsystems into a single system is a cumbersome user-interface that is difficult for the user to navigate.” *Id.* at 2:18-19. According to *Geiwitz*, the present invention provides “direct automation and control of lighting, power outlets, security devices, heating, ventilation and air conditioning (HVAC), access to the system, information logging, audio control, energy management, messaging, and time and task management” through a dedicated touchscreen. *Id.* at 3:26-28.

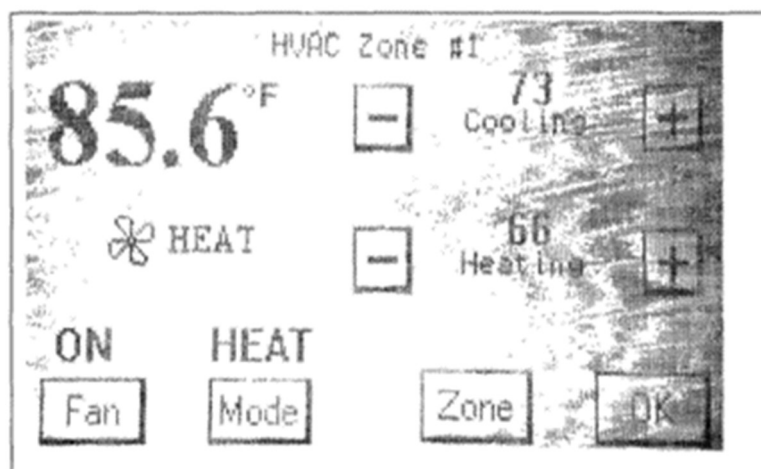
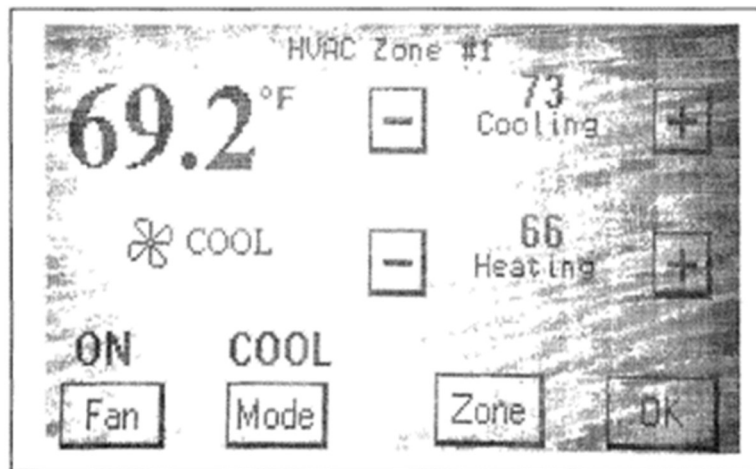
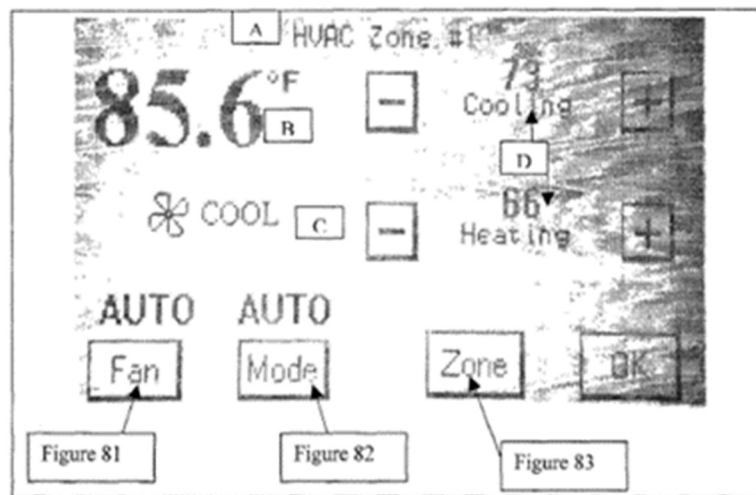
88. Similar to the '318 Patent, *Geiwitz* describes “a programmable and expandable building automation system” that “receives analog inputs from sensor devices for monitoring building environments.” *Id.* at 4:6; 4:12. *Geiwitz* further describes a touchscreen for user interface with the system and a smart card

comprising “an embedded high-speed programmable microprocessor for control of building subsystems and devices.” *Id.* at 4:9-10.



Id. at Figure 1.

89. *Geiwitz* describes having an HVAC control screen that displays the current temperature, “as measured by a thermistor in the touchscreen.” *Id.* at 25:4. *Geiwitz* further describes adjusting temperature set points and selecting a virtual ‘Mode’ icon to adjust the “the operational mode of the controlled HVAC unit” by cycling “through the options of heat, cool, and auto.” *Id.* at 25:11-12.



Ex. 1007, 56-58.

90. Thus, *Geiwitz* discloses the apparently alleged point of novelty of the '318 Patent: It displays a virtual mode button and a legend that indicates what mode the thermostat is in and that it is controlling a particular type of space conditioning equipment.

a) *Geiwitz* is Entitled to the filing Date of its Provisional Application

91. *Geiwitz* expressly claims the priority benefit of provisional application 60/339,511, filed on October 22, 2001 ("*Provisional*" Ex. 1007). Ex. 1005 1:8-10. I understand from counsel for Petitioner that if the *Provisional* provides written description support for at least one claim of *Geiwitz* and the *Geiwitz* material relied upon was also in the *Provisional*, then *Geiwitz* is entitled to the filing date of the *Provisional* as its prior art date. In my opinion, there is support for Claim 1 of *Geiwitz* in the provisional application as set forth in the following chart.

<i>Geiwitz Claim 1</i> (Ex. 1005, 40:4-10)	<i>Provisional</i> Support (Ex. 1007)
1. A building automation and control system comprising:	Title, p. 4
an open architecture system platform in direct communication with a plurality of subsystems or devices located in proximity to a building;	pp. 4, 10-13, 0413, Fig. 383.

smart card in communication with said system platform for control of said system platform, subsystems or devices, said smart card comprising a programmable microprocessor; and	pp. 7, 9, 170-71, 413; Figs. 383, 428, 450-455.
A touchscreen for user-interface with said system platform.	pp. 8, 14-16, 20-22, 56-58, 413; Figs. 1-3, 80-85, 125, 200-208, 249, 436-440.

3. Overview of *Rosen* (Exhibit 1009)

92. *Rosen* (U.S. Patent Application Publication No. 2003/0142121) published on July 31, 2003, before the September 3, 2003 priority date of the '318 Patent. Ex. 1009, Cover. I understand from counsel for Petitioner that *Rosen* is prior art to the '318 Patent at least under 35 U.S.C. § 102(a).

93. *Rosen* relates to “a programmable thermostat system incorporating an integrated liquid crystal display/touch pad unit, constituting a touch screen, for interactive intuitive interface with a user to facilitate programming the thermostat system.” *Id.* at ¶0001. According to *Rosen*, because “prior art programmable interfaces are not highly intuitive,” one fundamental problem with the prior art programmable thermostat systems is that “they are difficult to program and some

users are unable to successfully program them.” *Id.* at ¶0005. To address said problem, *Rosen* discloses a “touch screen 2, in which the touch pad 11 and LCD 12 are integrated and coordinated.” *Id.* at ¶0024. Figure 2 of *Rosen* shows an exploded view of an embodiment of said touchscreen.

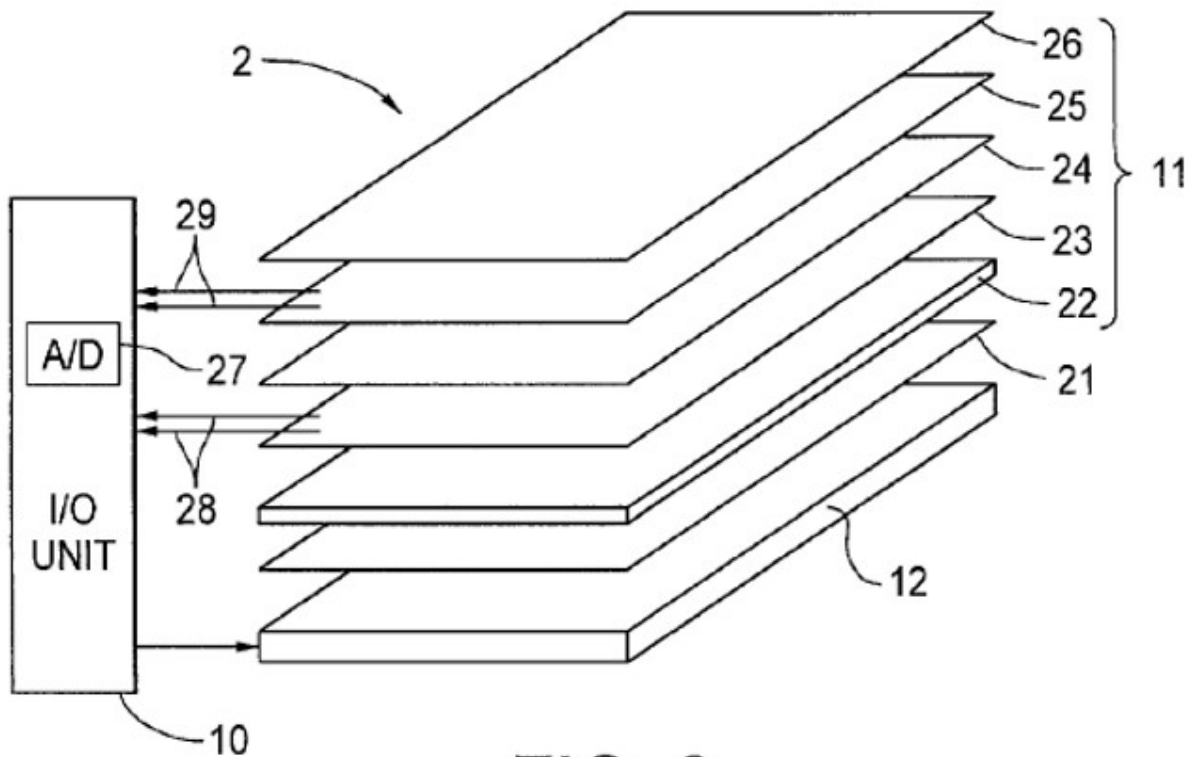
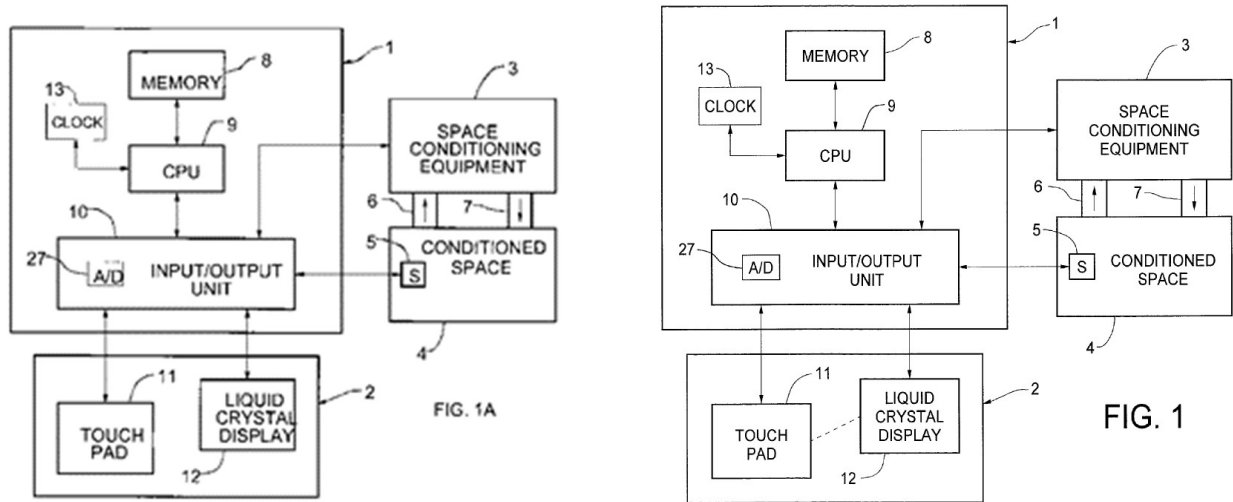


FIG. 2

Id. at Fig. 2; *see id.* at ¶0025.

94. *Rosen* explains that “[b]y the use of a touch screen constituting a transparent touch pad juxtaposed over a liquid crystal display in a programmable thermostat system, programming is greatly simplified by the fact that various menus can have ergonomically variously placed ‘buttons’ along with intuitively variously

placed messages associated with each button.” *Id.* at ¶0037. Figure 1 of Rosen is identical to Figure 1 of the ’318 Patent.



Id. at Fig. 1; Ex. 1001, Fig. 1A.

95. Thus, the hardware elements of Claim 1 are all disclosed by *Rosen*.

4. Overview of *Bier* (Exhibit 1010)

96. *Bier*, a publication entitled, “EmbeddedButtons: Supporting Buttons in Documents,” was written by Eric Bier and published in October, 1992 in ACM Transactions on Information Systems, Vol. 10, No. 4, pp. 381-407. Ex. 1010, 3. I understand from counsel for Petitioner that *Bier* is prior art to the ’318 Patent at least under 35 U.S.C. §§ 102(a), and (b).

97. *Bier* relates to virtual buttons. *Id.* These virtual buttons can be used in electronic documents and editing software, including for use with touch screens: “Recent software applications allow buttons to be inserted into the text, graphics, and other media of electronic documents, where a button is a visible object that can

be pressed, for instance, by clicking with a mouse, pointing with a touchscreen, or selecting with keyboard arrow keys. Because this integration of buttons and documents provides significant advantages to both users of and creators of software applications, we expect that buttons will be common in future electronic documents. While some existing editors already provide for buttons, there is a need for a general facility to make buttons available in more editors and different media.” *Id.* at 3-4.

98. While these buttons can be used in documents, they can also be used for control purposes as taught by *Bier*. “EmbeddedButtons supports the use of documents as control panels.” *Id.* at 19; *see also id.* at 4. In particular, multistate buttons can be used for control purposes: “When documents are used as control panels, applications can use multistate and radio buttons to store and display application state.” *Id.* at 20. A POSITA would have understood that the multistate buttons of *Bier* could be used in any user interface. The techniques taught in *Bier* to implement these buttons in software are applicable to any user interface software using virtual buttons for control.

99. *Bier* teaches “multistate buttons,” which have multiple states and which have a legend on the button itself that changes as the state of the button changes. *Id.* at 8. This is described as follows: “When pressed, a multistate button changes state (represented internally by a variable that belongs to the button) and updates its appearance to display its new state. For example, a textual button may change its

font, the relative color of its text and background, or its text contents, as shown in Figure 6.” *Id.* at 8.

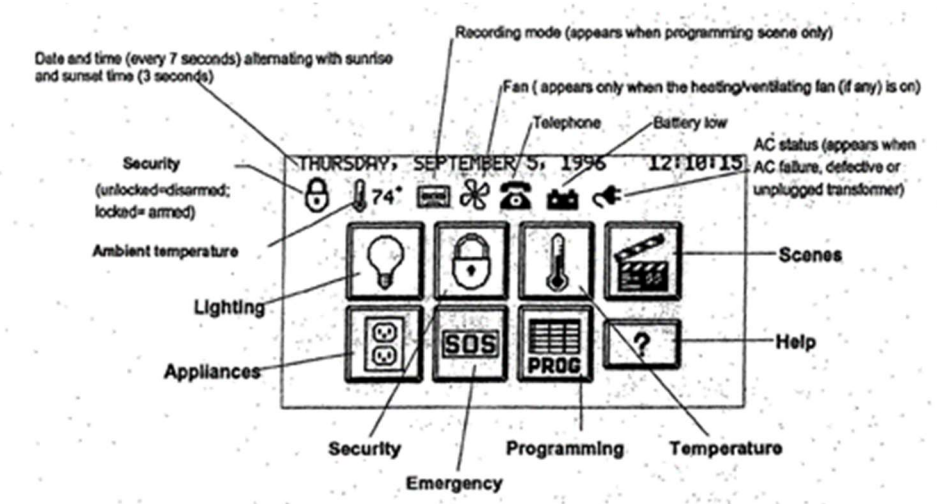
5. Overview of *Cardio Manual* (Exhibit 1012)

100. According to Jean Francios Boileau, a representative of Domotique Secant Inc., the *Cardio Manual* was distributed to the public without restriction by Domotique Secant Inc. in the United States between early 1996 and 2000, and was distributed in other countries since 1995, before the September 3, 2003 priority date of the ’318 Patent. Ex. 1014, 10. I understand that *Cardio Manual* is prior art to the ’318 Patent at least under 35 U.S.C. §§ 102(a), and (b).

101. Inventor Rosen admits that “[t]he ‘Cardio manual’ has been proven to me to have been available to the public since 1995.” *Id.* at 8. Inventor Rosen further admits that the *Cardio Manual* describes a product featuring “a tactile surface integrated with a liquid crystal display (LCD) to constitute what we call in industry a ‘Touch Panel’ or ‘Touch Screen,’” where a user can “control the temperature of his home while various significant sectors of the associated the Touch Panel have text or pictograms.” *Id.*

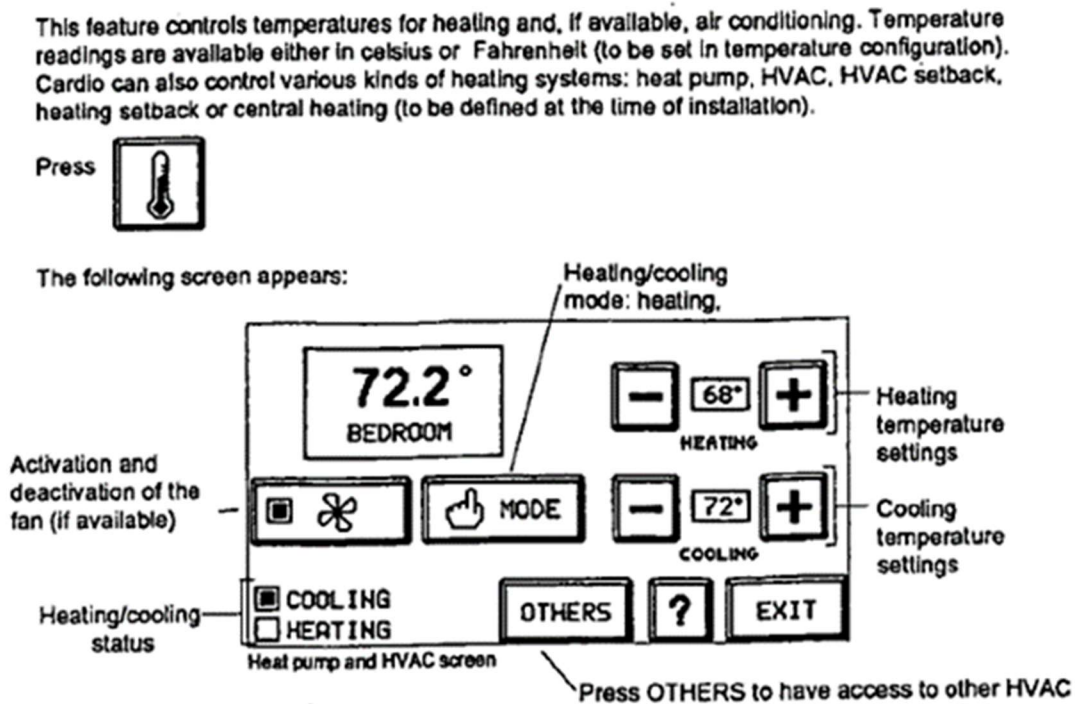
102. *Cardio Manual* describes having a touch screen that “offers user friendly features” and only requires a “light touch” to “turn on the screen and execute the commands.” Ex. 1012, 2. As shown in the figure below, *Cardio Manual* further discloses a navigational screen that “enables the user to directly control all of the

basic functions that Cardio manages,” including a temperature and programming section. *Id.* at 3.



Id.

103. *Cardio Manual*’s temperature screen allows user to control the mode that the thermostat is in through a virtual mode button with a legend indicating whether the thermostat is in heating mode or cooling mode. *Id.* at 7.



Id.

104. As is evident from the picture above, the virtual mode button is used to change from heating mode to cooling mode and vice versa. *See id.* The mode is displayed in the lower left hand corner where the status is either “cooling” or “heating” with a box darkened next to the mode the thermostat is currently operating in. *See id.*

C. Ground 1: Claims 1, 3-5, 7, 9, 11, and 14 are obvious over *Geiwitz* in view of *Rosen* and *Bier* and the common knowledge of a POSITA.

105. Based on the following analysis, I conclude that a POSITA at the relevant time (September 3, 2003) would have understood the limitations of Claims

1, 3-5, 7, 9, 11, and 14 were expressly disclosed, taught, or suggested by *Geiwitz* in view of *Bier*, *Rosen*, and the common knowledge of a POSITA.

**1. A POSITA Would Have and Could Have Combined
Geiwitz with *Rosen* and *Bier***

106. It would have been obvious to a POSITA to combine the thermostat system of *Geiwitz* with *Rosen* and *Bier*. Modifying *Geiwitz* to incorporate the features of *Rosen* and *Bier* would merely involve the replacement of known elements with the other known elements, to obtain predictable results.

**a) Rationale and motivation for combining
Geiwitz's with *Rosen***

107. It would have been obvious to a POSITA to modify *Geiwitz's* thermostat based upon the teachings of *Rosen*. Both references disclose touch screen thermostats and collectively disclose conventional options for various hardware elements that were common knowledge of a POSITA. A POSITA designing a thermostat with a touch screen would consider all the options available for the components of the system that are conventional components being used for their intended purpose. A POSITA would have been motivated to consider all conventional options because design is faster and a resulting product normally is cheaper when conventional off the shelf components are used.

108. The '318 Patent teaches, as it must, that some modern thermostats use a touch screen with virtual buttons presented on an LCD juxtaposed with a touch

pad. Ex. 1001, 2:6-9. Inventor Rosen agreed that there was nothing new about a touch pad juxtaposed with an LCD display. Ex. 1008, 158:16-23; 160:21-161:13. The '318 Patent also states that the processor components were available off the shelf. Ex. 1001, 6:34-42. These processor components are common knowledge of a POSITA. As the '318 Patent teaches, they are available off the shelf. *Id.* The '318 Patent further teaches that other components such as the temperature sensor, sensor output, real time clock, memory, and processor are common knowledge of a POSITA in modern thermostats. *Id.* at 1:35-2:10, 6:11-33. The *Rosen* reference further teaches that these components are conventional. Ex. 1009, ¶¶0003-0004. Inventor Rosen agrees that the components of the processor were prior art elements used in thermostats. Ex. 1008, 166:10-25. These components are also being used for their intended purpose in the '318 Patent and in a conventional way. There is not a single hardware component included in Claim 1 that had not been used in a thermostat before as admitted by the '318 Patent. A POSITA designing a thermostat with a touch screen would naturally consider all known options for these components for a thermostat to speed up the design process and facilitate the use of off the shelf components.

109. It would have been obvious to a POSITA to modify *Geiwitz's* thermostat system to incorporate *Rosen's* touchscreen constituting a transparent touch pad juxtaposed over a liquid crystal display. As noted below, my view is that

Geiwitz discloses an LCD with a transparent touch pad juxtaposed over the display even though those exact words do not appear in the reference. Even if didn't, however, modifying *Geiwitz* to incorporate the touch screen of *Rosen* would merely involve the simple replacement of one known prior art device (the touchscreen of *Geiwitz*) with another (the touch screen of *Rosen*) to obtain predictable results (a thermostat system with a transparent touch pad juxtaposed over a liquid crystal display to constitute a touch screen for interactive interface with a user). In both references, the touch screen is being used for its intended purpose—an interface with the user of the thermostat to receive input from the user and to display information to the user. Thus, using the *Rosen* touchscreen amounts to a simple substitution of known touchscreen for another. And of course the results would have been predictable because it would have been straightforward for a POSITA to use either touch screen in a thermostat as taught by these references. To the extent the Patent Owner argues the touchscreen of *Geiwitz* does not meet the limitation, the touchscreen of *Rosen* does. Moreover, a POSITA would have been motivated to incorporate *Rosen*'s touchscreen into *Geiwitz*'s thermostat system due to the benefits of *Rosen*'s touchscreen recited in the reference.

110. As an initial matter, *Rosen* is analogous art to the '318 Patent and *Geiwitz*, because all are in the same field of endeavor. Similar to *Geiwitz* and the

'318 Patent, *Rosen* relates to “the art of thermostats.” Ex. 1009 at ¶001; *compare id.* with Ex. 1005, 3:26-27; Ex. 1001, 1:25-26.

111. A POSITA would have been motivated to combine *Geiwitz* with the touch screen of *Rosen* to improve the ease of programming *Geiwitz*'s thermostat system. *Geiwitz* discloses having a touchscreen that “functions as the as the primary user interface for the system,” allowing a user to “interface with and navigate through system 10 in an efficient and user-friendly manner.” Ex. 1005, 19:6, 9:16-17. *Rosen* describes “a transparent touch pad juxtaposed over a liquid crystal display,” constituting a touch screen. Ex. 1009, Abs. *Rosen* further explains that said touch screen greatly simplifies the user programming experience because “various menus can have ergonomically variously placed ‘buttons’ along with intuitively variously placed messages associated with each button.” *Id.* at ¶0037. For example, *Rosen* discloses having a separate screen for programming temperature, with different corresponding alphanumeric messages appearing depending on which buttons the user presses. *See id.* at ¶0033, Figs. 4-10. For at least this reason, a POSITA would have been motivated to modify *Geiwitz* to incorporate the touch screen of *Rosen* (i.e., the transparent touch pad juxtaposed over a liquid crystal display). Both references disclose prior art options used in a conventional matter that are a matter of design choice when creating a thermostat with a touch screen.

112. Furthermore, a POSITA would have been motivated to combine *Geiwitz's* system with *Rosen's* ability to determining if a virtual button has been touched by reading the position on the touch pad juxtaposed with the predetermined position of the button so that the touchscreen of *Rosen* can function as intended. *Rosen* discloses determining if a virtual button has been touched by reading the position on the touch pad juxtaposed with the predetermined position of the button. *Id.* at Abs., ¶0007, Claim 1. As discussed above, a POSITA would have been motivated to use the touch screen of *Rosen*, and if one did so, a POSITA would have been motivated to modify the system so that a user would interact with the touch screen as taught by *Rosen*.

113. Inventor *Rosen* agrees that this method of determining whether a virtual button has been touched was known in the prior art:

7 Q. Let me finish my question. My
8 question is is it in the general knowledge of a
9 person of ordinary skill in the art before your
10 invention that you could use a control program to
11 read the position on a touch pad juxtaposed with a
12 predetermined position to determine if a
13 representation of a button had been touched?
14 A. Yes.
15 Q. Okay, that's something that had
16 been done in the prior art, correct?

17 A. Correct.

Ex. 1008, 272:7-17. Because this was within the general knowledge of a POSITA, it would have been obvious for a POSITA to use a control program of this type to read the virtual button.

114. There must be some way of determining whether the virtual button has been touched. Otherwise, the touchscreen interface could not receive input from the user using the virtual buttons. Based upon Inventor Rosen's testimony, it was common knowledge that a control program could determine if the button was touched in this manner and *Rosen* teaches that technique. It is simply a matter of design choice to choose this option that is taught in the prior art to determine if the button was pressed.

115. A POSITA would have had a reasonable expectation of success in making the combination of *Geiwitz*'s system and *Rosen*'s touchscreen constituting a transparent touch pad juxtaposed over a liquid crystal display. As an initial matter, a POSITA would have recognized the strong similarities between the systems of *Geiwitz* and *Rosen*. Thus, a POSITA would have understood that *Rosen*'s touchscreen constituting a transparent touch pad juxtaposed over a liquid crystal display could be readily incorporated into the thermostat system of *Geiwitz* to replace and/or enhance *Geiwitz*'s touchscreen. A POSITA would have understood

that using the *Rosen* touchscreen just substitutes one known prior art interface for another. It would have been well within the abilities of a POSITA to modify *Geiwitz*'s thermostat system to include a touchscreen constituting a transparent touch pad juxtaposed over a liquid crystal display as disclosed in *Rosen*.

116. It would have been obvious to a POSITA to modify *Geiwitz*'s thermostat system to incorporate *Rosen*'s processor with a central processing unit, real-time clock, a memory coupled to said CPU for storing program and data information, and an input/output unit coupled between the processor and the touch screen for carrying out information transfer therebetween, as well as a sensor input and a control output. Modifying *Geiwitz* to incorporate the processor of *Rosen* would merely involve the simple replacement of prior art devices (the processor, CPU, real-time clock, a memory, and an input/output unit of *Geiwitz*) with other prior art devices (the processor of *Rosen* and its subcomponents) to obtain predictable results (a thermostat system with a processor containing a central processing unit, real-time clock, a memory coupled to said CPU for storing program and data information, and an input/output unit coupled between the processor and the touch screen for carrying out information transfer therebetween, and a sensor input and a control output).

117. As discussed above, the '318 Patent teaches that each of these components was available off the shelf. As also explained above, it was common

knowledge to include these elements in a thermostat, including one with a touch screen. Furthermore, as discussed above, the devices are being used in the '318 Patent in a conventional manner. Thus, it would have been obvious to substitute any of the known off the shelf components of *Rosen* for any elements of the processor of *Geiwitz* if Patent Owner contends that *Geiwitz* is missing any of these elements. As discussed above, there is often a motivation to use conventional off the shelf components when designing a product to reduce design development time and to decrease the cost of the final product. Mass produced parts tend to be cheaper than custom made parts used in smaller quantities. Thus, there is a motivation to use the conventional off the shelf parts taught by *Rosen* for each of the parts of the processor to the extent Patent Owner contends any of them are not taught by *Geiwitz*.

118. As discussed below, *Geiwitz* discloses having a processor, central processing unit, real-time clock, a memory coupled to said CPU, and an input/output unit coupled between the processor and the touch screen for carrying out information transfer therebetween, and containing a sensor input and a control output. *Infra* §VII.B.2. To the extent Patent Owner contends any of these elements are missing from *Geiwitz*, *Rosen* discloses a processor containing all of these elements. *Infra* §VII.B.3.

119. For the reasons stated above, it would have been obvious for a POSITA to combine the touchscreen thermostat of *Geiwitz* with the processor of *Rosen* in order to simplify the design process and reduce the expense of *Geiwitz*'s system.

120. A POSITA would have had a reasonable expectation of success in making the combination. It would have been well within the abilities of a POSITA to modify *Geiwitz*'s thermostat system to include processor containing a central processing unit, real-time clock, a memory coupled to said CPU for storing program and data information, and an input/output unit coupled between the processor and the touch screen for carrying out information transfer therebetween, as well as a sensor input and a control output as disclosed in *Rosen*. As discussed above, these are conventional components being used for their intended purpose. Thus, it would have been a routine matter for a POSITA to use these components in a thermostat as taught by *Rosen*.

121. Also, I agree with Inventor Rosen that it is common knowledge of a POSITA that functions of various circuits, particularly in a digital system such as is claimed in the '318 Patent, can be implemented in one or more integrated circuits. Ex. 1001, 6:34-42. It is not inventive to have the different functions in one chip or a collection of chips. It is a matter of design choice as to how many chips to use. Here, there is a motivation to use the *Rosen* architecture because that reference teaches that off the shelf components can be used for the processor. *See id.*

**b) Rationale and motivation for combining
Geiwitz with *Bier*.**

122. It would have been obvious to a POSITA to modify *Geiwitz*'s thermostat system to incorporate *Bier*'s positioning of legends indicative of a control function directly on the virtual button itself. Modifying *Geiwitz* to incorporate the positioning of legends as disclosed in *Bier* would merely involve the simple substitution of one known element (*Geiwitz*'s positioning of legends) for another (*Bier*'s positioning of legends) to obtain predictable results (a thermostat system with a legend indicative of the current control function positioned directly on the virtual button, where said legend changes to indicate the current control function).

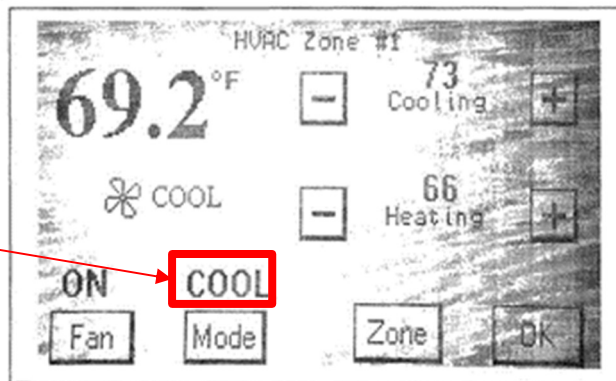
123. *Bier* is analogous art to the '318 Patent and *Geiwitz* because it is reasonably pertinent to the user interfaces of thermostat systems, like the '318 Patent, and *Geiwitz*. See Ex. 1001, 1:25-27; Ex. 1005, 3:26-27. *Bier* relates to user interface design in computers—specifically the use of buttons in documents and for use in “control panels.” Ex. 1010, 4, 19. Thermostat systems conventionally include digital user interfaces that, like computer interfaces with control panels, are designed to be easily programmable by users using virtual buttons. The user interface of a thermostat is a type of “control panel.” Therefore, references discussing the use of virtual buttons in connection with a screen of some type (e.g. a computer) would logically commend themselves to an inventor's attention in considering issues with

designing thermostat user interfaces. Thus, *Bier* is analogous art to the '318 Patent, and *Geiwitz*.

124. Furthermore, although *Bier* teaches using a mouse rather than a touchscreen, a touchscreen and mouse are both human interface devices allowing input from the user. A touchscreen takes input from a user in a way that is highly similar to a mouse. The underlying software for both commonly produces inputs events within the software that are very similar if not identical. The input event, whether from touchscreen or mouse, provides an event that says there was a press or release on a certain location on the screen. Therefore, a POSITA would naturally have considered graphical elements such as *Bier* for use in situations where the user can provide input corresponding to a particular location on the screen, whether that screen is a CRT or LCD and whether the input is via touch or mouse click.

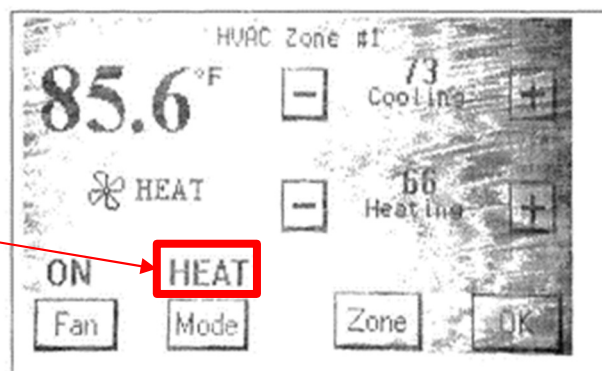
125. A POSITA would have been motivated to combine *Geiwitz* with *Bier* to conserve space on *Geiwitz*'s touchscreen. *Geiwitz* discloses having legends indicating the current control function appear directly above the 'Mode' icon on the screen, changing the legend when the current control function changes. See Ex. 1007, 57-58; Ex. 1005, 25:11-13.

Figure 84



Legend indicating
current control
function

Figure 85



Legend indicating
current control
function

Ex. 1007, 57-58 (annotated).

126. *Bier* describes “multistate buttons” where a legend indicative of the current state appears on the virtual button and changes when pressed, as discussed above. Ex. 1010, 8.

127. It would have been obvious to a POSITA that putting the legend on the button itself would save space. For at least this reason, a POSITA would have been motivated to modify *Geiwitz* to incorporate the legend positioning of *Bier* (i.e., placing the legends indicative of control functions on the virtual button itself).

128. A POSITA would have had a reasonable expectation of success in making the combination of *Geiwitz*'s system and *Bier*'s positioning of legends indicative of a control function directly on the virtual button itself. As an initial matter, a POSITA would have recognized that *Bier* logically commends itself to issues with the user interface of *Geiwitz*. Thus, a POSITA would have understood that *Bier*'s positioning of legends indicative of a control function directly on the virtual button could be readily incorporated into the thermostat system of *Geiwitz* so that *Geiwitz*'s legends appear directly on *Geiwitz*'s virtual button. It would have been well within the abilities of a POSITA to modify *Geiwitz*'s thermostat system to include a legend indicative of the current control function positioned on the virtual button itself. Doing so would involve a simple software change. The button itself is simply a graphic on a screen. As is taught by *Bier*, one can program the software to make the button have one graphic when in a first state and another graphic when in a second state. This is just a matter of linking the graphic being displayed with the state of the button in software. This would have been an easy matter for a POSITA.

2. Claim 1

a) Admissions in the Patent

129. Each of the *seven* elements 1[Pre]-1[f] are disclosed by *Geiwitz* alone or in view of *Rosen*, as discussed below. Each of these elements is also common

knowledge of a POSITA as admitted by the '318 Patent and its inventor, Inventor Rosen. Ex. 1001, 6:34-42; Ex. 1008, 150:14-153:25 (Inventor Rosen admitting that all of the hardware components in Claim 1 are off-the-shelf components available in the prior art). Programmable thermostats for controlling space conditioning equipment were well known in the art, as acknowledged by the '318 Patent. Ex. 1001, 1:51-58 (“Many modern thermostat[s] ... run a process control program ... to send control signals to the heating and/or cooling equipment to closely control the temperature of the conditioned space.”).

130. The '318 Patent does not purport to have invented an environmental condition sensor for providing an electrical signal indicative of the ambient temperature of a conditioned space or improved upon existing environmental condition sensors. It was well known in the art that thermostat systems include an environmental condition sensor for providing an electrical signal indicative of the ambient temperature of a conditioned space, as acknowledged by the '318 Patent. *Id.* (“Many modern thermostat[s] include ... a process control program stored in the memory to accurately *measure the temperature of a temperature sensor disposed in the conditioned space* and make decisions to *send control signals* to the heating and/or cooling equipment to closely control the temperature of the conditioned space.”) (emphasis added). The '318 Patent itself further admits that the temperature

sensor and its accompanying functionality as required by the claims was “very well known in the art”:

Thus, *in the usual manner* during normal operation, *the temperature sensor 5 sends an electrical signal* (e.g., if the sensor 5 is a simple thermistor, a resistance value; several types of temperature sensors are widely used) *representative of the temperature within the conditioned space 4* which the processor can compare against a previously entered set point to determine if control signals need to be sent to the space conditioning equipment 3. For example, if the temperature in the conditioned space 4 is found to be too low when operation is in the heating mode, the processor 1 signals the space conditioning equipment 3 to circulate, through ducts 6, 7, air from/to the conditioned space 4 which is heated by the space conditioning equipment before return to the conditioned space. This heating phase continues until the sensor 5 indicates that the space is now too hot (or approaching too hot) with reference to the set point such that the processor 1 sends signal(s) to the space conditioning equipment 3 to cease the heating function, *all as very well known in the art.*

Id. at 6:12-29 (emphasis added).

131. Furthermore, Inventor Rosen admits that he did not invent a new temperature sensor in the '318 Patent. Ex. 1008, 153:13-15 (“Q: You did not invent a new temperature sensor in the '318 Patent, correct? A. Correct.”)

132. The '318 Patent does not purport to have invented “a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen for interactive interface with a user,” or improved upon existing versions of this element. It was well known in the art that thermostat systems may include a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen. Ex. 1001, 2:6-9 (“In some modern thermostats, “virtual” buttons are presented on the LCD itself which is juxtaposed with a touch pad to effect an interactive touch screen.”) Additionally, Inventor Rosen admits that he did not invent a new touchscreen in the '318 Patent. Ex. 1008, 153:10-12 (“Q: ...you did not invent a new touchscreen in the '318 Patent, correct? A. Correct.”)

133. The '318 Patent does not purport to have invented “C) a processor, said processor including: 1) a central processing unit; 2) a real time clock, 3) a first memory coupled to said central processing unit for storing program and data information; and 4) an input/output unit” or improved upon existing versions of these elements. It was well known in the art that thermostat systems include these elements, as acknowledged by the '318 Patent. Ex. 1001, 1:51-58. The '318 Patent admits that “[m]any modern thermostat[s] include a real time clock, a memory and a data processor to run a process control program stored in the memory to accurately measure the temperature of a temperature sensor disposed in the conditioned space

and to send control signals to the heating and/or cooling equipment to closely control the temperature of the conditioned space.” *Id.*

134. The ’318 Patent also states that “all the processor components with all the necessary interface conditioning circuits are available off-the-shelf.” *Id.* at 6:34-36. Further, Inventor Rosen admits that he did not invent a new CPU, real-time clock, memory, or input/output unit in the ’318 Patent. Ex. 1008, 152:8-21.

135. Moreover, it was well known in the art that thermostat systems include “a) a sensor input coupled to said temperature sensor for receiving said electrical signal therefrom; and b) a control output coupled to the space conditioning equipment for issuing control signals thereto” as acknowledged by the ’318 Patent. Ex. 1001, 4:47-65. The ’318 Patent states that the electrical signals from the temperature sensor and issued to the space conditioning equipment as required by the claims were “very well known in the art”:

Thus, *in the usual manner* during normal operation, the temperature sensor 5 sends an electrical signal (e.g., if the sensor 5 is a simple thermistor, a resistance value; several types of temperature sensors are widely used) representative of the temperature within the conditioned space 4 which the processor can compare against a previously entered set point to determine if control signals need to be sent to the space conditioning equipment 3. For example, if the temperature in the conditioned space 4 is found to be too low when operation is in the heating

mode, the processor 1 signals the space conditioning equipment 3 to circulate, through ducts 6, 7, air from/to the conditioned space 4 which is heated by the space conditioning equipment before return to the conditioned space. ***This heating phase continues until the sensor 5 indicates that the space is now too hot (or approaching too hot)*** with reference to the set point such that the ***processor 1 sends signal(s) to the space conditioning equipment 3 to cease the heating function, all as very well known in the art.***

Id. (emphasis added); *see also id.* at 1:51-58 (“Many modern thermostat[s] ... run a process control program stored in the memory to accurately measure the temperature of a temperature sensor disposed in the conditioned space and to send control signals to the heating and/or cooling equipment to closely control the temperature of the conditioned space.”).

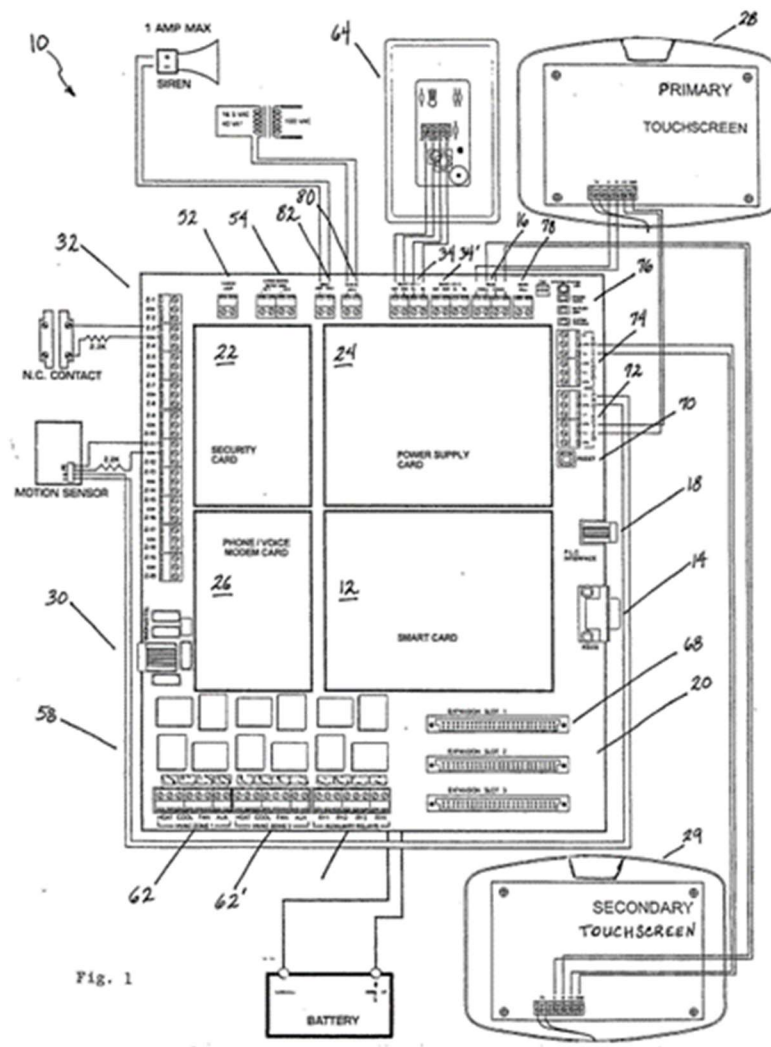
136. Moreover, it was well known in the art that thermostat systems include “a real time clock” as acknowledged by the ’318 Patent. *Id.* at 1:51-52 (“[m]any modern thermostat[s] include a real time clock”). Furthermore, Inventor Rosen admits that he did not invent a new real-time clock in the ’318 Patent. Ex. 1008, 152:12-14 (“Q: You did not invent a new real-time clock in the ’318 Patent, correct? A. Correct.”)

137. It was also well known in the art that thermostat systems include memory, as acknowledged by the '318 Patent. Ex. 1001, 1:51-4 (“Many modern thermostat[s] include ... a memory”). The '318 Patent further admits that all the processor components with all the necessary interface conditioning circuits are available off-the-shelf.” *Id.* at 6:34-36. Inventor Rosen admits that he did not invent a new real-time clock in the '318 Patent. Ex. 1008, 152:8-11 (“Q: In the '318 Patent, you did not invent a new memory, correct? A. Correct.”)

138. Further, it was well known in the art for thermostat systems to include a control program stored in memory, as acknowledged by the '318 Patent. Ex. 1001, 1:51-54 (“Many modern thermostat[s] include a ... control program stored in the memory”).

b) 1[Pre]: “A programmable thermostat system for controlling space conditioning equipment comprising:”

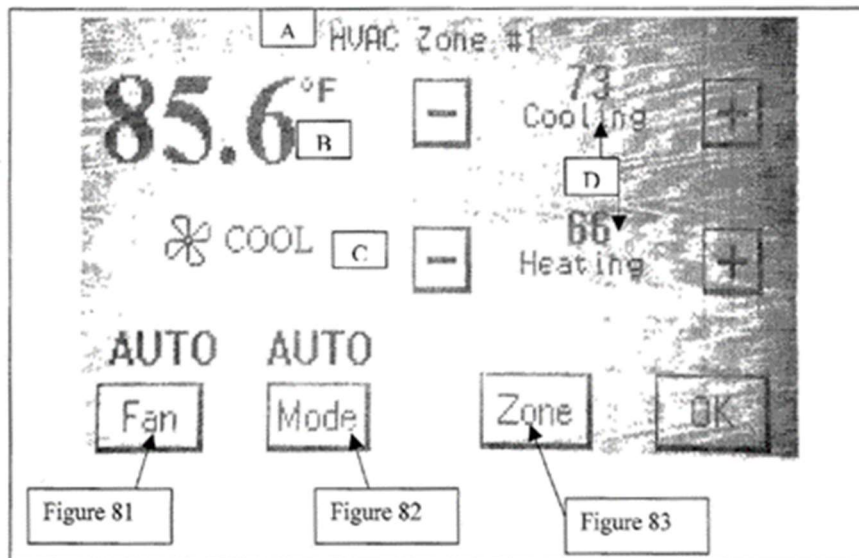
139. If the preamble is limiting, *Geiwitz* discloses it. *Geiwitz* discloses “a building automation and control system that is programmable” and includes a thermostat system with programmable temperature set points and modes of operation, e.g., “cool,” “heat,” and “auto.” Ex. 1005, 4:26-27, 25:1-13. Figure 1 of *Geiwitz*, reproduced below, shows schematic of the preferred embodiment of said “building automation and control system.” *Id.* at 5:21-22.



Id. at Fig. 1.

140. Users may program HVAC scheduling events by scheduling particular thermostat operations and temperature ranges at set dates and times. *Id.* at 30:12-17, 37:27-30; *see also* Ex. 1007, 56, 113-17 (showing screens for programming HVAC scheduling events). Furthermore, Figure 80 of *Geiwitz's Provisional* shows the “primary navigation screen for manipulating the controlled HVAC zones within the system,” as shown below. Ex. 1007, 56.

Figure 80



Id. at Fig. 80.

141. *Geiwitz* further discloses that the thermostat is controlled by a smart card 12 including a “programmable” microprocessor. Ex. 1005, 5:4-14; 8:28-9:4. Similarly, *Geiwitz’s Provisional* discloses that the system is “microprocessor based” and “is programmable both on-site and remotely.” Ex. 1007, 4. The *Provisional* further describes the system as “very flexible, and” “driven by software and firmware,” indicating that *Geiwitz’s* system is programmable. *Id.*

142. One function of *Geiwitz’s* system is to provide “control of ... heating, ventilation and air conditioning (HVAC)” equipment, and thus is directed to controlling space conditioning equipment as recited in preamble 1[pre]. Ex. 1005 3:26-27.

143. A POSITA would have understood *Geiwitz*'s HVAC equipment to be “space conditioning equipment” because HVAC equipment controls the environmental condition of a space. For example, the '318 Patent interchangeably refers to “space conditioning equipment” as a “heating/cooling equipment unit,” identifying both terms by the same reference number (“3”). Ex. 1001, 5:63-65; *see id.* at 6:8-6:28. Accordingly, *Geiwitz* discloses preamble 1[Pre].

144. The cited material was also in the *Provisional*. Ex. 1007, 4, 15-16, 56-58, 495 (Fig. 383).

145. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

c) “1[a]: A) at least one environmental condition sensor providing an electrical signal indicative of the ambient temperature of a conditioned space in which said environmental condition sensor is situated;”

146. *Geiwitz* discloses element 1[a]. *Geiwitz* describes having “internal and external temperature sensors” as inputs to the system. Ex. 1005, 10:30; *see also* Ex. 1007, 56. *Geiwitz* further teaches having a “thermistor that is on the face of touchscreen 28 for a reading of ambient temperature,” where said thermistor is directed to measure the current temperature in the controlled HVAC zone. Ex. 1005,

14:9-10; *see id.* at 25:2-13. A temperature sensor is an “environmental condition sensor.”

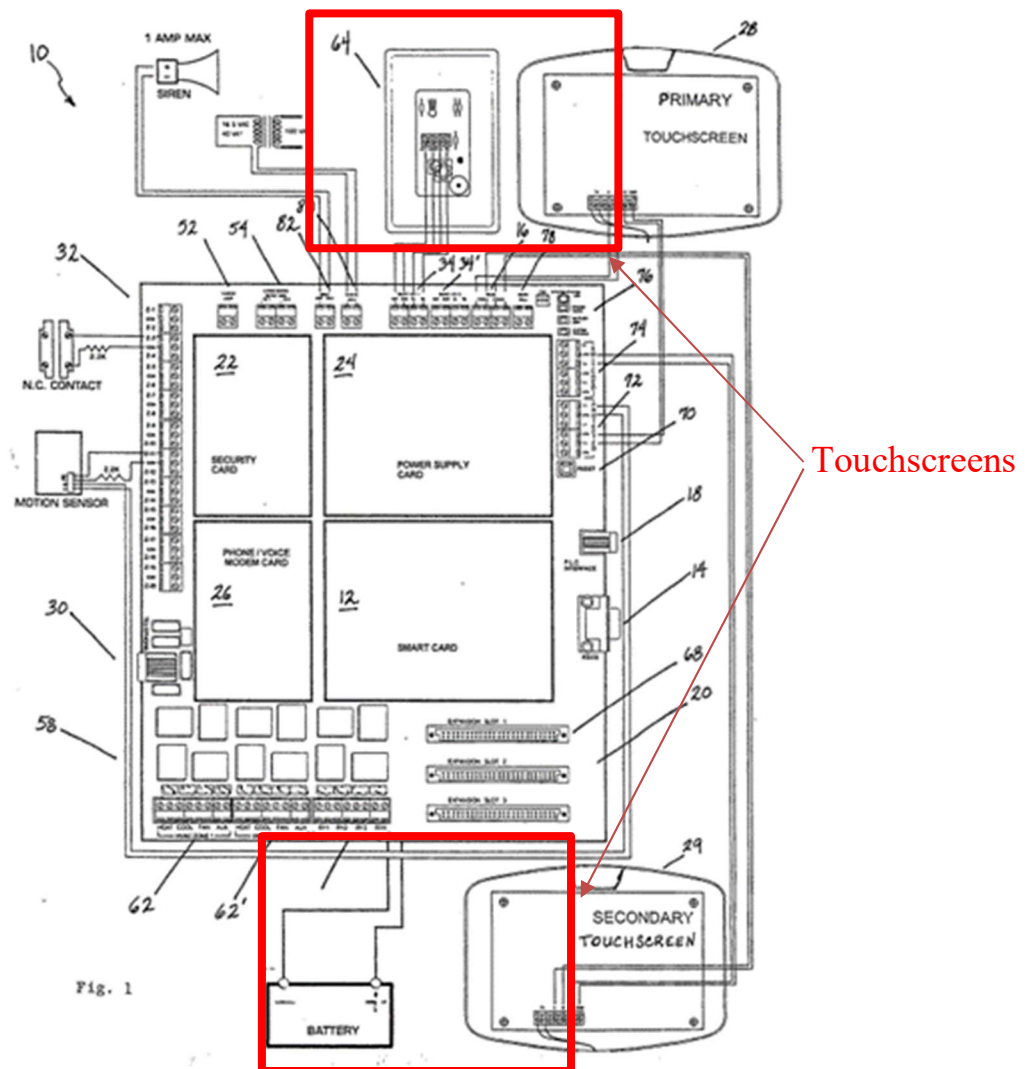
147. A POSITA would have understood that *Geiwitz*’s “thermistor” provides an electrical signal that varies according to the ambient temperature and is therefore indicative of ambient temperature of the conditioned space in which the temperature sensor is situated. *Geiwitz*’s disclosure is consistent with the ’318 Patent disclosing that the temperature sensor can be “a simple thermistor.” Ex. 1001, 6:11-15. A POSITA would have understood *Geiwitz*’s “temperature sensor” as disclosing the claimed “environmental condition sensor,” especially given that the ’318 Patent specification uses the term “temperature sensor” in place of “environmental condition sensor.” Ex. 1001, 5:35. Accordingly, *Geiwitz* discloses element 1[a].

148. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the ’318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

d) 1[b]: “(B) a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen for interactive interface with a user;”

149. *Geiwitz* or *Geiwitz* in view of *Rosen* discloses element 1[b]. According to *Geiwitz*, “[t]ouchscreen 28 functions as the as the primary user interface for the system,” allowing a user to “interface with and navigate through system 10 in an

efficient and user-friendly manner.” Ex. 1005, 19:6, 9:15-17, *see id.* at 25:11, Fig. 14; *see also* Ex. 1007, 8, 56-58, 1017-21. Thus, it is an interactive interface. *Geiwitz*’s touchscreen “allow[s] the user to set and change parameters of the system, as well as upload and download information” through a transmitter in the system. Ex. 1005, 19:6-8. *Geiwitz*’s system “can be operated by one or more touchscreens, preferably up to twelve touchscreens.” *Id.* at 19:9-10. Annotated Figure 1 below illustrates an embodiment of *Geiwitz*’s system featuring a primary and secondary touchscreen.

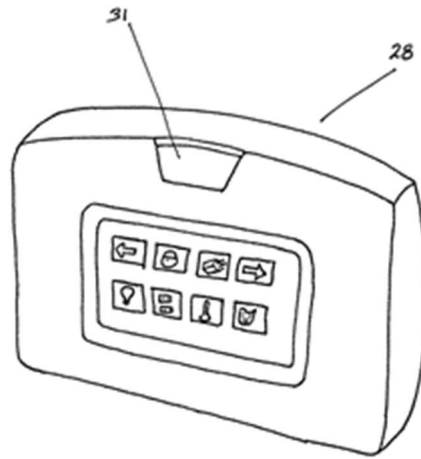


Id. at Fig. 1 (annotated).

150. Additionally, *Geiwitz* incorporates by reference U.S. Provisional Patent Application No. 60/339,511 (“*Provisional*”). *Id.* at 1:8-10. The *Provisional* incorporated by reference in *Geiwitz* further describes a system where “[t]he touch screen functions as the primary user interface.” Ex. 1007, 14. The *Provisional* incorporated by reference in *Geiwitz* also lists an “LCD and backlight circuit” as being part of said touchscreen. *Id.* at 8; *see also id.* at 56-58, 436. In addition,

Geiwitz Figure 15 shows an “LCD CONNECTOR” in connection with the control circuitry for the touchscreen. Ex. 1005, 7:7-8; Fig. 15. The V_{adj} referenced in Figure 15 is a commonly used signal to adjust the contrast of an LCD. Thus, the touchscreen has a liquid crystal display.

151. Based on *Geiwitz*'s disclosure that a user interfaces with its programmable thermostat system using a touchscreen with an LCD component, a POSITA would have understood *Geiwitz* as disclosing, or at least rendering obvious, the claimed “transparent touch pad juxtaposed with a liquid crystal display to constitute a touchscreen for interactive interface with the user.” Ex. 1001, 13:11-13. A POSITA would have understood that the touch-sensitive component (i.e., touch pad) of a touchscreen, such as the touch screen described in *Geiwitz*, is conventionally transparent so as to not obscure the display underneath. See Ex. 1005, Fig. 14. The following figure from *Geiwitz* shows virtual buttons visible on the touch screen, disclosing to a POSITA that the touch pad is transparent. *Id.* at 14:4-5.



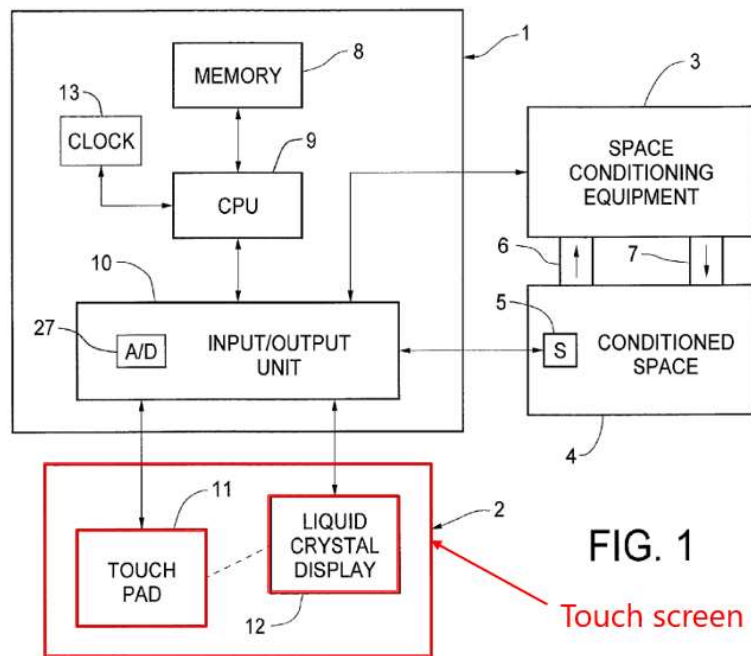
Id. at Fig. 14 (showing “a perspective view of a touchscreen 28,” where “[n]avigational icons are displayed on the touchscreen.” *Id.* at 14:4-5).

152. This transparency enables a user to determine where to make contact with the touch screen to interface with the system. Furthermore, a POSITA would have understood the touch-sensitive component (i.e., touch pad) to be juxtaposed with the LCD so that the touch pad could register user touches on the LCD screen in the location where virtual buttons are located. *See id.* at 25:1-13. These were conventional prior art features of touchscreens that were well known in the art before the priority date of the '318 Patent. Indeed, the inventor of the '318 Patent, Inventor Rosen, admitted that he did not invent a touchscreen juxtaposed with a liquid crystal display, and that before the invention of the '318 Patent, such touchscreens were commercially available. Ex. 1008, 158:17-23.

153. Based on *Geiwitz's* disclosure of using a touchscreen with an LCD component as a user interface for a programmable thermostat system, a POSITA

would have understood *Geiwitz* as disclosing, or at least rendering obvious, the claimed “transparent touch pad juxtaposed with a liquid crystal display to constitute a touchscreen for interactive interface with the user.” Ex. 1001, 13:11-13. Thus, *Geiwitz*, discloses element 1[b].

154. Additionally or alternatively, *Geiwitz*, in view of *Rosen*, discloses element 1[b]. As discussed above, *Geiwitz* discloses having a touchscreen with an LCD component constituting a user interface. Ex. 1005, 19:6; Ex. 1007, 8; *Supra*, §VII.C.2.d. Similar to *Geiwitz*, *Rosen* relates to a “programmable thermostat system for controlling space conditioning equipment.” Ex. 1009, Abs. *Rosen* discloses “[a] programmable thermostat system for controlling space conditioning equipment” that includes “a transparent touch pad juxtaposed over a liquid crystal display to constitute a touch screen for interactive interface with a user.” *Id.*; *see also id.* at Figs. 1-2, ¶¶0020, 0026. Figure 1 of *Rosen* shows a thermostat system with “a touch pad 11 and a liquid crystal display (LCD) 12 which constitute the touch screen 2.” *Id.* at ¶0020.



Id. at Fig. 1 (annotated).

155. Furthermore, Figure 2 of *Rosen* depicts “[a] transparent touch pad 11, constituting generally planar layers 22-26, is juxtaposed over a flat panel LCD 12.”

Id. at ¶0026.

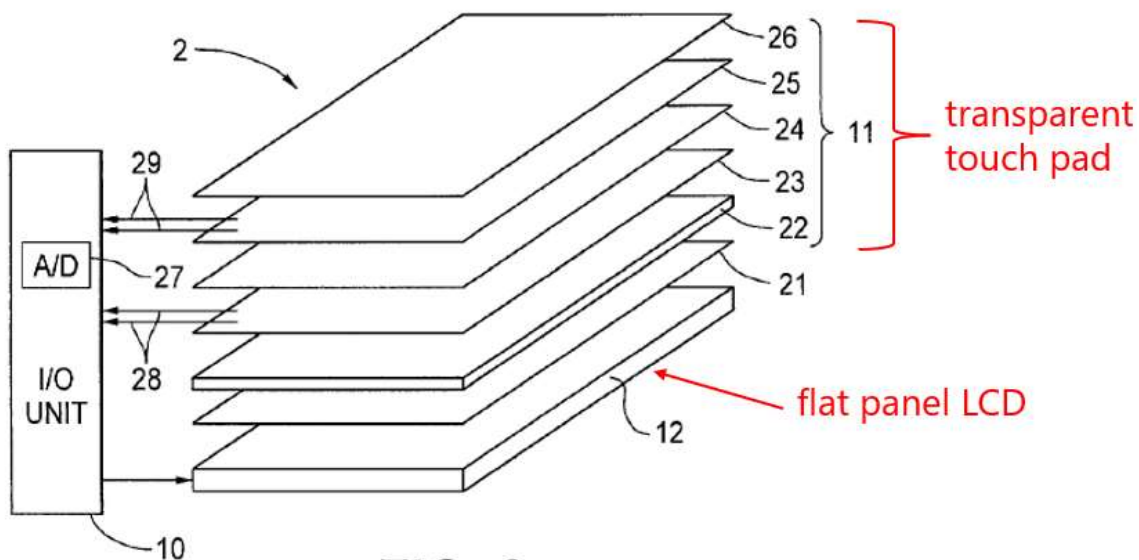


FIG. 2

Id. at Fig. 2 (annotated).

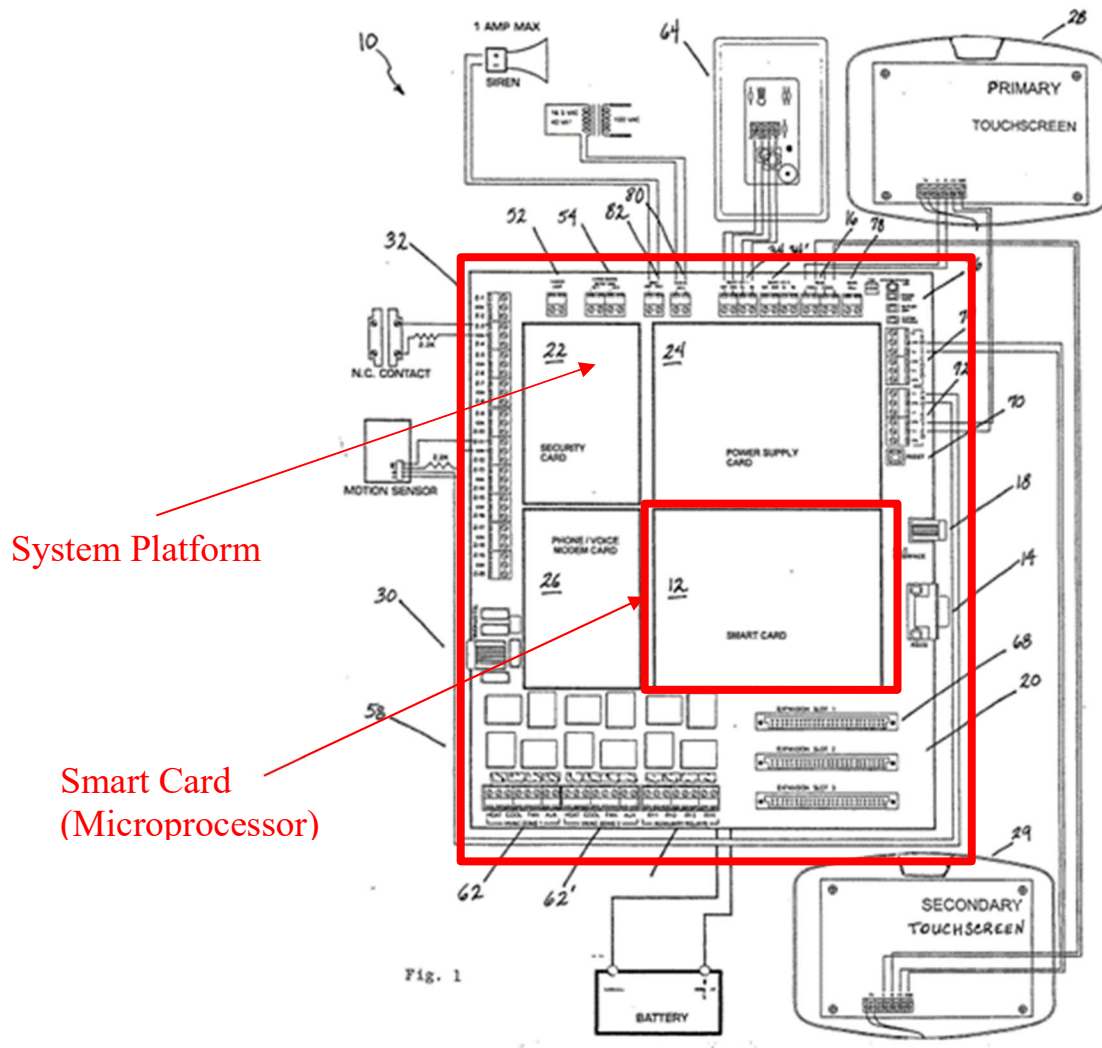
156. Thus, *Rosen* discloses “a transparent touch pad juxtaposed over a liquid crystal display to constitute a touch screen for interactive interface with a user.” It would have been obvious for a POSITA to substitute the touchscreen of *Rosen* for that of *Geiwitz* because of the advantages of *Rosen*’s touchscreen, such as having various menus with “ergonomically variously placed “buttons” along with intuitively variously placed messages associated with each button.” *See id.* at ¶0037, Figs.4-10. *Rosen*’s touchscreen provides users with greater instruction and usability while programming the thermostat as opposed to *Geiwitz*, where messages are not associated with the buttons. *See id.*; Ex. 1007, 56-58. Thus, *Geiwitz*, in view of *Rosen*, discloses element 1[b].

157. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the ’318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

**e) 1[c]: “C) a processor, said processor including
1) a central processing unit;”**

158. *Geiwitz* or *Geiwitz* in view of *Rosen* and the common knowledge of a POSITA discloses element 1[c]. *Geiwitz* teaches having a system platform controlled by a “programmable smart card 12,” (which qualifies as a processor having the components discussed for elements 1[c]-1[g]) as seen in the figure below.

Ex. 1005, 10:19; *see also* Ex. 1007, 4, 7, 170-171, 945 (Fig. 383), 999 (Fig. 426), 1032 (Fig. 451).



Ex. 1005, Fig. 1 (annotated).

159. *Geiwitz*'s smart card contains a CPU, as it "comprises an embedded high-speed programmable microprocessor for control of building subsystems and devices." *Id.* at 4:9-10; *see also id.* at 10:21-23, Fig. 21; Ex. 1007, 9, 999 (Fig. 426); 170-71, 1031-36. Suitable microprocessors for *Geiwitz*'s system "include[] the

commercially-available Intel® 386ex processor.” Ex. 1005, 10:21-23. Smart card 12 “automatically updates the icons and menus of touch screen 28 as appropriate” and may be replaced with another microprocessor to further “alter the capabilities of the system.” *Id.* at 10:24-27. A microprocessor is a central processing unit on a single chip. Ex. 1021, 290; Ex. 1020, Fig. 1, 5 (Intel 386 processor is a CPU).

160. A POSITA would have understood that *Geiwitz’s* system platform containing a smart card microprocessor discloses, or at least renders obvious, a processor having the various components discussed in elements 1[d]-1[g]. A POSITA would have understood that *Geiwitz’s* smart card discloses, or at least renders obvious, the claimed processor having a central processing unit (CPU), given that said smart card is responsible for the control of the whole system and contains a microprocessor. A POSITA would have understood that a microprocessor is essentially a single-chip implementation of a CPU. For example, in the *Inventor’s Deposition*, Rosen states that “of course” a CPU could be a microprocessor. Ex. 1008, 92:24-93:5. Thus, *Geiwitz*, discloses, or at least renders obvious, element 1[c].

161. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the ’318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42. In addition, this element is disclosed by *Rosen*. See, e.g., Ex. 1009, ¶¶0007; 0020.

f) 1[d]: “2) a real time clock;”

162. *Geiwitz* or *Geiwitz* in view of *Rosen* and the common knowledge of a POSITA discloses element 1[d]. *Geiwitz*'s system includes a "real-time clock circuit," as shown in the schematic below. Ex. 1005, 16:5-6; *see also* Ex. 1007, 9, 113-14, 945 (Fig. 383), 1033 (Fig. 452).

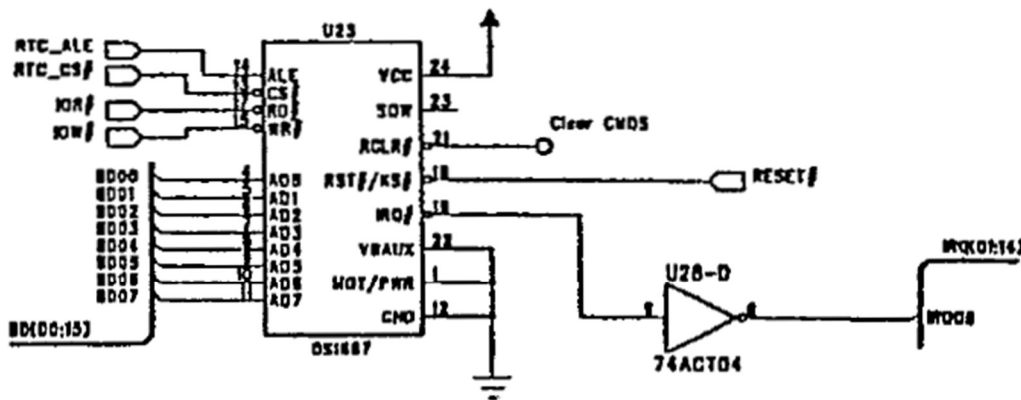


Fig. 22c

Ex. 1005, Fig. 22c (showing a schematic of the real-time clock circuit in *Geiwitz's* system).

163. This real-time clock circuit is included on the system platform containing the smart card because the clock circuit shown in Figure 22c depicts multiple simple connections adapted for the circuit board of either the smart card itself or alternatively, the system platform in Figure 1—both of which are part of the claimed processor. *Id.* at Figs. 1 and 22c; *see also id.* at 8:30-9:1, 30:12-17. Also,

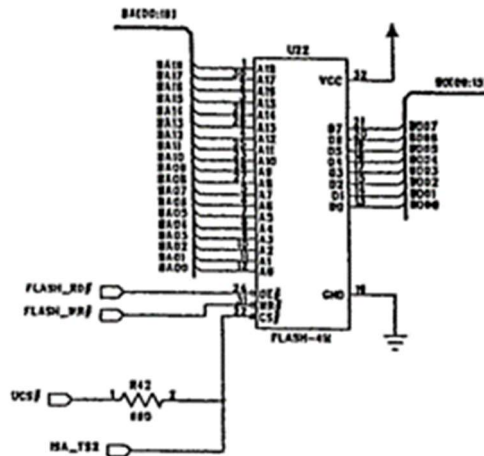
the clock circuit of Figure 22 is the circuit supporting “real-time” operations. Ex. 1005, 8:30-9:1. Real time operations would include the conventional ability to operate HVAC equipment according to calendar dates and times of a programmed schedule. *Id.* at 30:12-17.

164. Furthermore, the *Provisional* of *Geiwitz* discloses having a “Real-Time clock circuit” as part of the system’s processor module. Ex. 1007, 9. It would have been obvious to a POSITA that a real-time clock circuit constitutes a real-time clock. Thus, *Geiwitz*, discloses, or at least renders obvious, element 1[d].

165. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the ’318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42. In addition, this element is disclosed by *Rosen*. See, e.g., Ex. 1009, ¶¶0007, 0020.

g) 1[e]: “3) a memory coupled to said central processing unit for storing program and data information; and”

166. *Geiwitz* or *Geiwitz* in view of *Rosen* and the common knowledge of a POSITA discloses multiple options for element 1[e]. *Geiwitz* discloses having an “external flash memory for smart card 12,” as shown in the schematic below. Ex. 1005, 16:4.



Id. at Fig. 22b (showing a schematic of the external flash memory for smart card 12).

167. *Geiwitz* also discloses having a “flash memory socket chip that serves as mass storage memory for system 10.” *Id.* at 16:13-14; *see id.* at 16:4-12, Fig. 25c. It also includes SDRAM memory. *Id.* at Figure 23b. Thus, *Geiwitz* teaches a memory being coupled to a smart card’s microprocessor via data and address buses and bus drivers. *See* Ex. 1005, Figs. 21, 22b, 23b, 24c. The *Provisional* also has disclosure regarding memory. *See* Ex. 1007, 4, 9, 14, 23, 56-58, 61, 113-14, 170-71, 1032-33 (Figs. 451-52), 1035-36 (Figs. 454-55). The *Provisional* makes clear the memory circuits were disposed on the smart card. *See id.* at 9, 1033 (Fig. 452), 1035-36 (Figs. 454-54) (which correspond to Ex. 1005, Figs. 22b, 24c, and 23b).

168. The memory was coupled to the smart card's microprocessor via buses and bus drivers which a POSITA would have understood (or were at least obvious) to be used by the CPU to provide conventional read/write operations. Ex. 1005,

Figs. 21, 22b, 23b, 24c. A microprocessor cannot function without a program stored in memory for it to access and execute.

169. *Geiwitz* further discloses storing various data and program information in its memory. *Geiwitz* describes its smart card as “automatically updat[ing] the icons and menus of touch screen 28 as appropriate.” *Id.* at 10:27; *see id.* at 19:13-17. Program information would need to be stored to generate these displays. *Geiwitz* also describes having user programming, such as adjusting temperature set points and controlling HVAC operations. *Id.* at 25:1-13, 19:7-8, 30:12-17, 34:3-5. A POSITA would have understood that these icons, menus and user programming constitute program information, as these items are used by the system software program to render the image displayed on *Geiwitz*’s touchscreen and to control the associated HVAC equipment. A POSITA would have further understood that data such as the current temperature from *Geiwitz*’s thermistor and system status (Ex. 1005, 14:9-10, 25:1-13, 19:8-9) constitutes data information stored in memory. These examples constitute program and data information as the ’318 Patent uses those terms. *See* Ex. 1001, 5:45-52; 5:63-66.

170. It would have been obvious to a POSITA that this program and data information was stored in the memory coupled to *Geiwitz*’s smart card because this was the conventional operation for a CPU like *Geiwitz*’s smart card, and *Geiwitz*

taught having its smart card determine its touch screen system operation. Ex. 1005, 10:26-27. Thus, *Geiwitz*, discloses, or at least renders obvious, element 1[e].

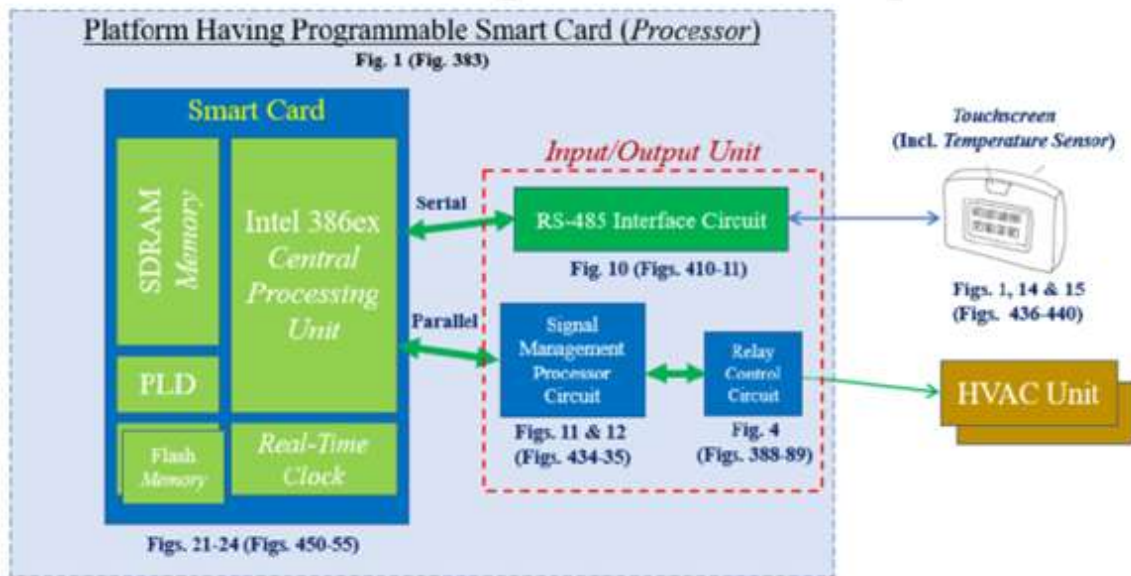
171. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42. In addition, this element is disclosed by *Rosen*. See, e.g., Ex. 1009, ¶¶0007, 0020.

h) 1[f]: 4) an input/output unit coupled between said processor and said touch screen for carrying out information transfer therebetween, said input/output unit further including: a) a sensor input coupled to each said environmental condition sensors for receiving said electrical signal therefrom; and b) a control output coupled to the space conditioning equipment for issuing control signals thereto; and

172. *Geiwitz* or *Geiwitz* in combination with *Rosen* and the general knowledge of a POSITA discloses element 1[f]. The '318 Patent discloses an input/output unit that is internal to the processor and provides an interface for communication between the processor components and the touchscreen. Ex. 1001, Fig. 1A, 3:26-28, 5:45-49. To the extent element 1[f] is amendable to construction, which I understand Petitioner does not admit, I make the assumption that it would include the aforementioned preferred embodiment. Therefore, if the claim is amendable to construction, an input/output unit internal to a processor and providing

an interface for communication between processor components and the touchscreen constitutes “a processor including an input/output unit coupled between said processor and said touchscreen.” *Id.* at 13:19-20. *Geiwitz* has an input/output unit internal to the platform having a programmable smart card and provides the interface for communication between the components of that processor and the touchscreen 28 satisfying this element in the same manner as the preferred embodiment.²

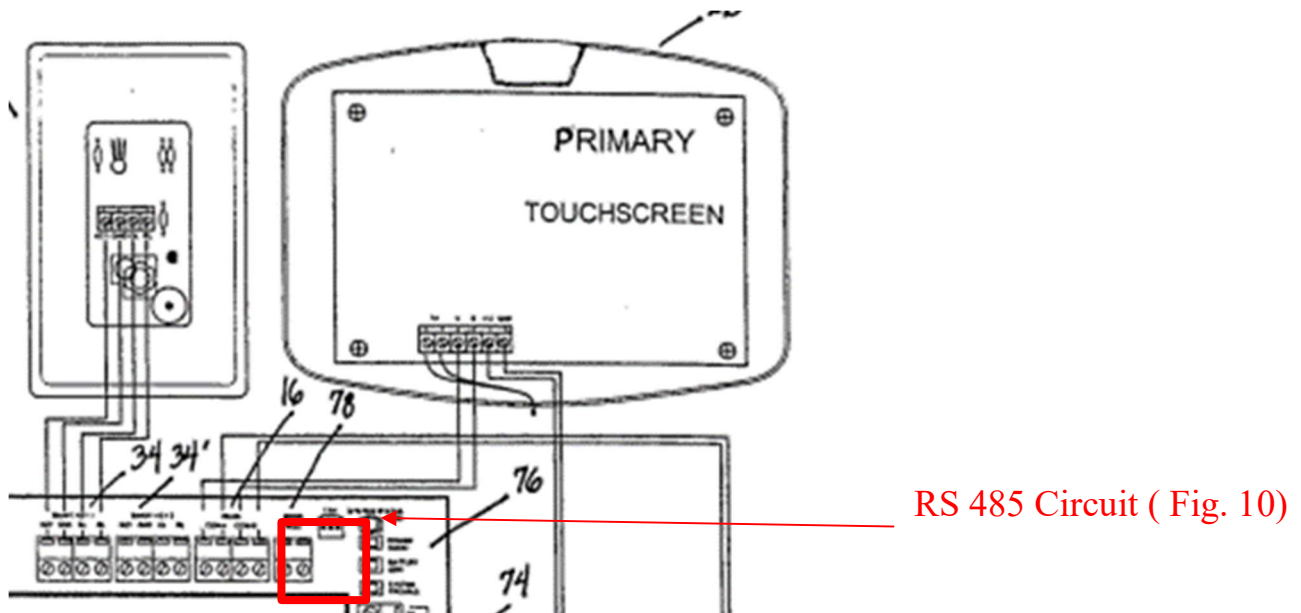
173. The following Block Diagram from Unified Patent’s IPR Petition (IPR2022-01402) summarizes how a POSITA would map the components of *Geiwitz* to element 1[f]:



² The cited material was also in the Provisional application. Ex. 1007, 4, 7, 11, 170-71, 413, 945 (Fig. 383), 983-84 (Figs. 410-11), 1017-21 (Figs. 436-440), 1032 (Fig. 451).

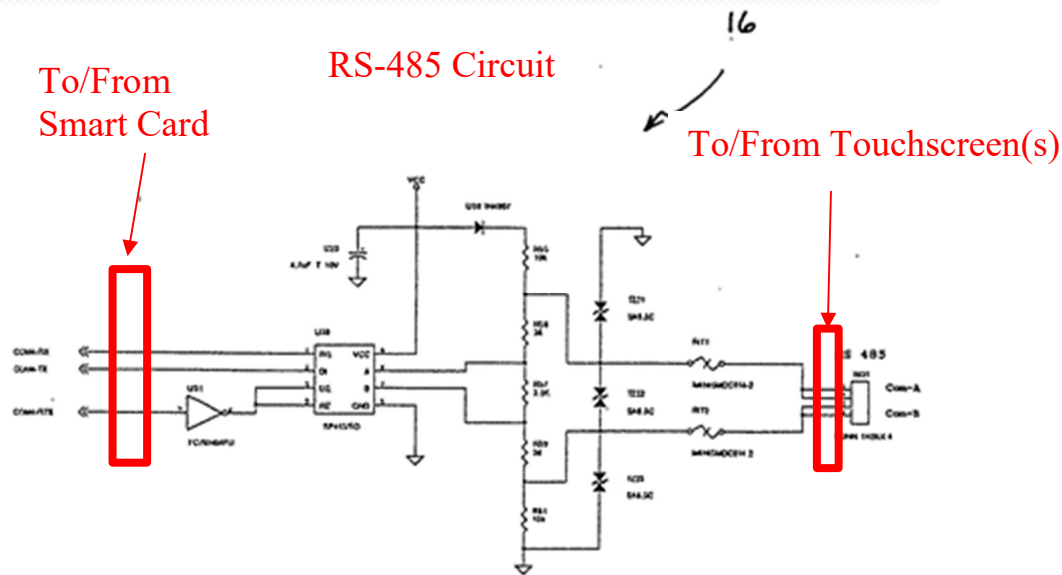
Ex. 1018, 39 (the circuitry in the red box forms the input/output unit of element 1[f].) As illustrated, the input/output unit comprises a combination of the RS-485 Interface Circuit, Relay Control Circuit, and Signal Management Processor Circuit.

174. *Geiwitz* describes a smart card microprocessor circuit (Ex. 1005, Fig. 21) with serial interfaces connected to the RS-485 Circuit (Ex. 1005, Fig. 10) for “communicat[ing] with one or more touch screens 28, 29.” Ex. 1005, 9:11-12; *see id.* at Figs. 15, 14, 1. As shown below, the embedded controller on *Geiwitz*’s touchscreen communicates with the RS-485 Circuit. *Id.* at 14:6-7.



Id. at Fig. 1 (partially reproduced, annotated).

175. Fig. 10, shown below, illustrates how the RS-485 circuit “allows high-speed communication to and from system 10” and the touchscreens. *Id.* at 13:10-11; *see id.* at 9:11-12, 9:5-6.



Id. at Fig. 10.

176. For example, *Geiwitz*'s RS-485 Circuit allows the transfer of “[g]raphics and video information.” *Id.* at 13:10-12. This information transfer between the smart card and the touchscreen includes information necessary for the smart card to control the touchscreen user interface, allowing the smart card to control the HVAC units. *Id.* at 13:10-12, 10:19-27, 9:11-13, 14:7-10. Thus, a POSITA would have understood that *Geiwitz*'s RS-485 Interface Circuit functions as an input/output unit that is coupled between the smart card microprocessor and the touchscreens, allowing communications to be input from and output to said microprocessor and touchscreens.

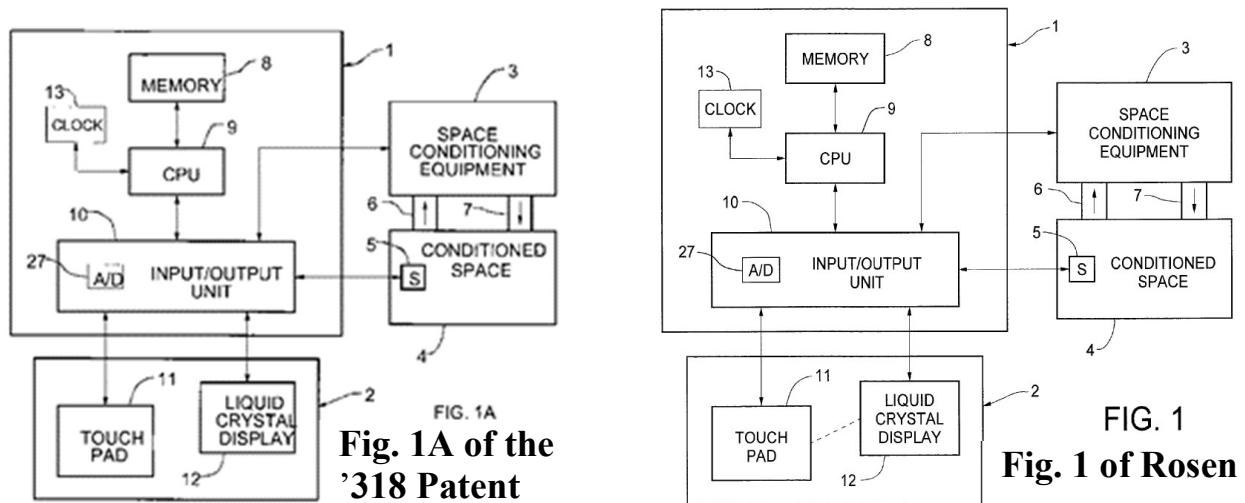
177. *Geiwitz* further teaches the claimed sensor input.³ As discussed above, *Geiwitz*'s input/output unit consists of an RS-485 circuit coupled to the smart card and the touchscreen and capable of transferring information between the two. Ex. 1005, Fig 10. As discussed above for element 1[a], *Geiwitz* discloses having a thermistor to measure the current temperature. *Id.* at 14:9-10; *Supra*, §VII.C.2.c. *Geiwitz* further teaches having a controller in communication with the RS-485 Circuit that “monitors a thermistor that is on the face of touchscreen 28 for a reading of ambient temperature.” Ex. 1005, 14:9-10; *see id.* at 13:10-12. A POSITA would have understood that *Geiwitz*'s touchscreen sends its electrical signal indicating temperature measured at its temperature sensor back to the programmable smart card via the RS-485 interface circuit. *Id.* at 14:9-10; 13:10-12. Thus, *Geiwitz*'s RS-485 Circuit provides a sensor input that receives signals from a thermistor that are sent to the processor by the RS-485 interface circuit. *Id.* at 14:9-10; 13:10-12.

178. *Geiwitz's Provisional* further discloses that the “temperature sensors built into each touchscreen deliver the temperature reading from each zone back to the platform for processing and determining if heat o[r] cool air is called for.” Ex. 1007, 413. Thus, *Geiwitz's* RS-485 interface circuit allowed for temperature data to be received and directed to *Geiwitz's* smart card microprocessor, constituting the

³ The cited material was also included in the *Provisional*. Ex. 1007, 4, 7, 11, 56, 413, 983-84 (Figs. 410-11), 1021 (Fig. 440).

claimed “sensor input coupled to each said environmental condition sensors for receiving said electrical signal therefrom.” Ex. 1001, 13:23-25.

179. To the extent *Geiwitz* does not sufficiently disclose element 1[f], it would have at least been obvious to a POSITA. *Rosen* discloses an input/output unit meeting all of the limitations of element 1[f]. Ex. 1009, ¶0007, Claim 1(c)(4). Indeed, Figure 1 of *Rosen* and the '318 Patent are identical.



Id. at Fig. 1; Ex. 1001, Fig. 1A.

180. As discussed above, it would have been obvious to combine *Geiwitz* and *Rosen*. A POSITA would have understood that it is obvious for multiple functions performed in an electronic system to be combined in a single chip. Ex. 1008, 100:9-102:2. A POSITA would have been motivated to use the input/output unit of *Rosen*, which conveniently combines the input/output functions of the system in a single unit. It is a simple matter of design choice how to handle the inputs and outputs that are controlled by the processor. Given that it would have been obvious

to use *Rosen*'s touchscreen in the thermostat of *Geiwitz* as discussed above, it would have been equally obvious to control that touchscreen in the same way that *Rosen* did.

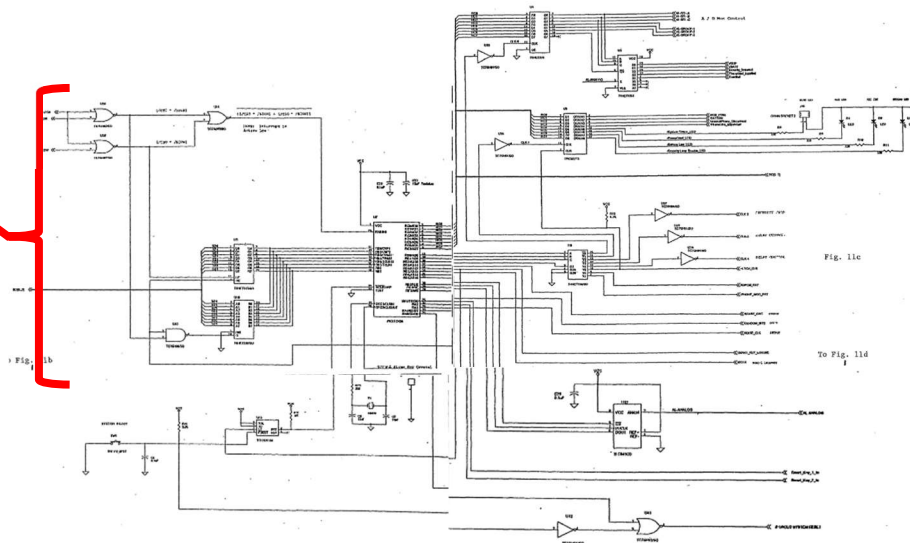
181. For instance, *Geiwitz* teaches having analog inputs 32 that “are provided to the system platform for input from devices such as ... internal and external temperature sensors.” Ex. 1005, 10:28-30; *see id.* at Fig. 1. Although *Geiwitz* does not expressly describe such inputs as being part of the input/output unit for HVAC purposes, it would have been obvious to modify *Geiwitz* in this manner for any number of practical reasons readily apparent to a POSITA. For example, one advantage of using analog inputs 32 as a sensor input, in addition to the thermistor on the touchscreen, would be to allow heating and cooling to be based on temperature as measured at important locations other than the touchscreen location. This would have been particularly useful in large conditioned spaces where the temperature may vary depending on the location within the space.

182. A POSITA would have been particularly motivated to use an external temperature sensor whenever the space contained important temperature-sensitive areas, such as the temperature near one or more computer servers being cooled. This would simply involve using prior art techniques for their intended purposes with predictable results. The '318 Patent described the preferred embodiment utilizing remotely connected temperature sensors as “very well known in the art” and

operating “in the usual manner.” Ex. 1001, 5:38-40, 6:11-18. Furthermore, Inventor Rosen admitted that there was “nothing new about having an input/output unit that had a sensor input coupled to a temperature sensor.” Ex. 1008, 167:20-168:25. Thus, *Geiwitz* disclosed the claimed sensor input or it is obvious in light of *Geiwitz* and/or *Rosen*.

183. *Geiwitz* further discloses the claimed control output. *Geiwitz* discloses having a “signal management processor” circuit (Ex. 1005, Figs. 11, 12) that connects *Geiwitz*’s smart card microprocessor to the HVAC and auxiliary relays (Ex. 1005, Fig. 4) used to control the associated HVAC equipment, as shown below.⁴ Ex. 1005, Figs. 11, 12, 4.

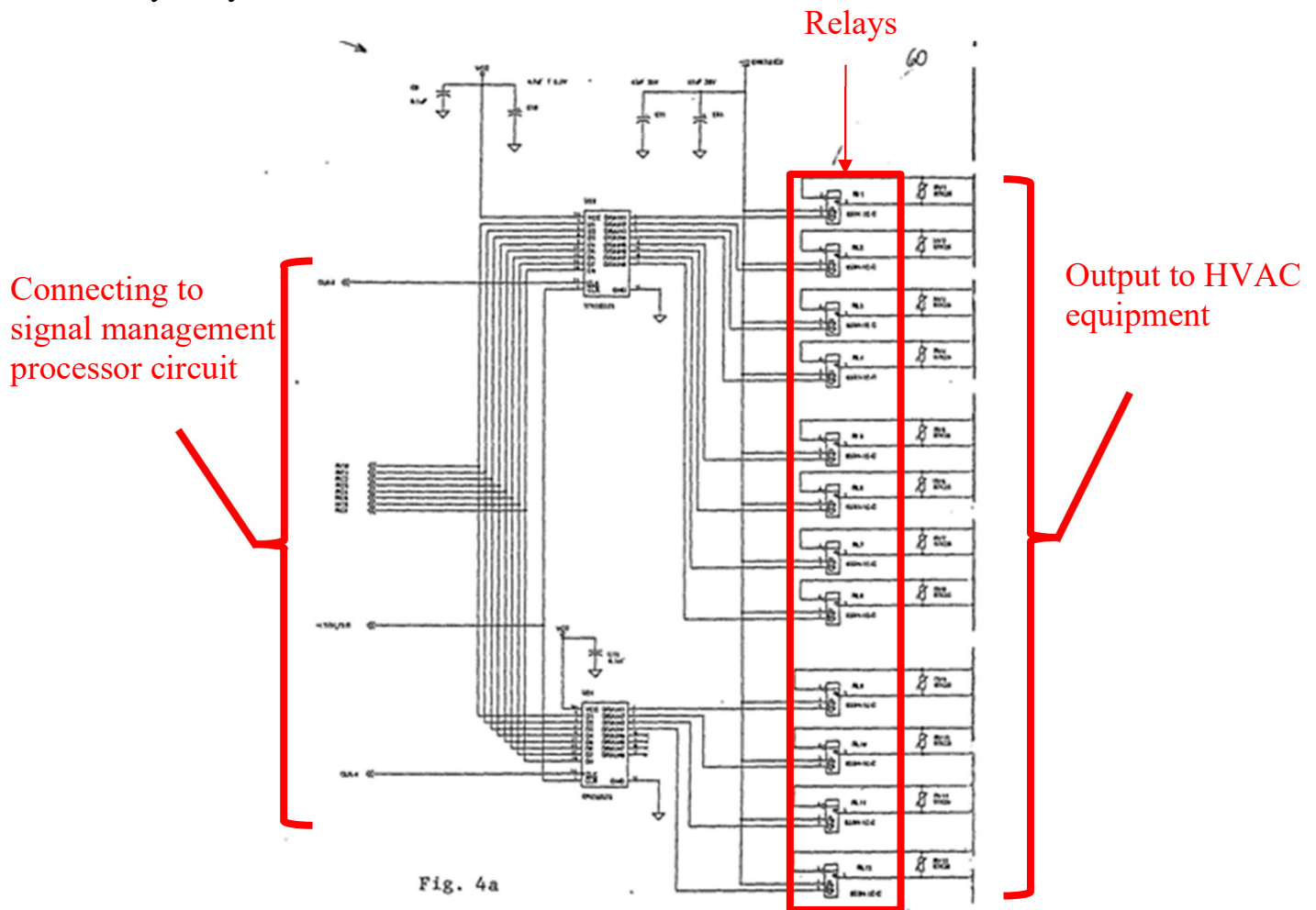
Connecting to
Smart Card
(Microprocessor)



⁴ The cited material was also in the *Provisional*. See Ex. 1007 4, 7, 10, 413, 957-60 (Figs. 388, 389a, 389b) 1007-16 (Figs. 434-35), 1032 (Fig. 451).

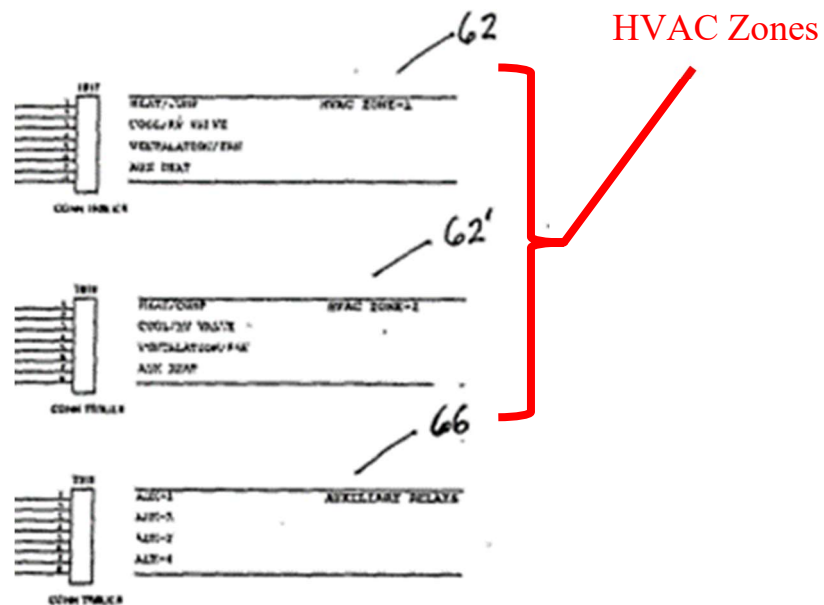
Id. at Fig. 11 (annotated to show how the signal management processor circuit connects the smart card to the HVAC and Auxiliary relay controls); *see also id.* at Fig. 12, 13:13-23.

184. Fig. 4a, shown below, depicts “a schematic of HVAC zone control and auxiliary relays 58.” *Id.* at 6:2-3.



Id. at Fig. 4a (annotated to show how the signal management processor circuit connects to the relays and HVAC equipment). The relays identified above in Figure 4a provide control output to the HVAC equipment as shown in Figure 4b below.

185. *Geiwitz* teaches having “HVAC inputs interface with the system through relays shown generally at 60.” *Id.* at 11:23-24. Figure 4b, shown below, shows how two “HVAC zones 62 and 62’ provide interface with two separate zones of HVAC equipment within the building.” *Id.* at 11:26-27.



Id. at Fig. 4b (partially reproduced, annotated).

186. Therefore, manipulating the relays in *Geiwitz* would send control outputs to the corresponding pieces of HVAC equipment within the HVAC zones. Ex. 1005, 11:23-27. By opening or closing a relay, an electrical circuit is opened or closed to turn on or off a corresponding piece of HVAC equipment to provide either heating or cooling. Thus, *Geiwitz* discloses having an input/output that further

includes control relays for controlling the HVAC equipment—a control output for coupling to the space conditioning equipment for issuing control signals thereto.

187. Alternatively, *Geiwitz* discloses that I/O with the HVAC equipment could be via the RS-485 interface. Ex. 1005, 18:17-18. In this alternative, the RS-485 unit would satisfy the control output limitation.

188. To the extent that the claim requires an input/output unit separate from the central processing unit or that is a circuit in a single package performing all of the claimed functions, this also would have been obvious to a POSITA. As discussed above, *Rosen* discloses this option. It is within the general knowledge of persons skilled in the art that various functions in a microprocessor system can be combined onto a single chip (or unit) or separated into multiple chips or units. Ex. 1008, 100:9-102:2. Deciding which chip is to perform which function is a simple matter of design choice. To the extent the claim requires an input/output unit connected to an LCD, temperature sensor, and control outputs, LCDs, temperature sensors, and control outputs were known in the prior art. Therefore, having an input/output unit connected to these known prior art elements would have been an obvious design choice for a POSITA. Thus, it was obvious to a POSITA that all of the functions performed by the identified circuitry in *Geiwitz* could be performed by a single input/output unit to the extent the circuitry of *Geiwitz* does not qualify as such. Thus, *Geiwitz*, discloses, or at least renders obvious, element 1[f].

189. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

i) 1[g]: D) a control program stored in said memory for causing said central processing unit to communicate through said input/output unit to selectively:

190. *Geiwitz* discloses element 1[g]. As described above in limitation 1[e], *Geiwitz* discloses a thermostat system having an RS-485 circuit to “communicate with one or more touch screens” and “high-speed communication to and from system 10,” at the core of which is a smart card microprocessor. Ex. 1005, 9:11-12, 13:10-11; *Supra*, §VII.C.2.g. A POSITA would have understood that *Geiwitz*’s RS-485 Circuit functions as an input/output unit coupled between the system’s microprocessor and the touchscreens, allowing communications to be input from and output to said microprocessor and touchscreens.⁵ See Ex. 1005, 9:11-12, 13:10-11.

191. *Geiwitz* also teaches using “software and firmware” (a control program) to program its smart card microprocessor. *Id.* at 9:1-9:2. This software controlled the HVAC equipment and touchscreen. See *id.* at 4:9-10, 10:26-27. As discussed

⁵ The cited material was in the *Provisional*. Ex. 1007, 4, 21-58 (Figs. 2-85), 140, 170-71, 176, 413.

above, the software was stored in the memory because a microprocessor operates by executing programming stored in the memory.

192. *Geiwitz* further discloses “causing said central processing unit to communicate through said input/output unit.” As described above for limitation 1[f], the CPU of *Geiwitz* carried out touchscreen control by communicating via the input/output circuitry. *Supra*, §VII.C.2.h. *Geiwitz*’s software and firmware (i.e. control program) would cause the smart card (i.e. CPU) to communicate through *Geiwitz*’s input/output unit to selectively perform limitations 1[h] through 1[m] as discussed below for each respective element. *Infra*, §VII.C.2.j-m. Thus, *Geiwitz*, discloses element 1[g].

193. The “software and firmware” was stored in the smart card memory because a microprocessor like the Intel 386ex operates by executing programs stored in memory, as was well known and conventional.

194. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the ’318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42. . In addition, this element is disclosed by *Rosen*. See, e.g., Ex. 1009, ¶¶0007; 0020.

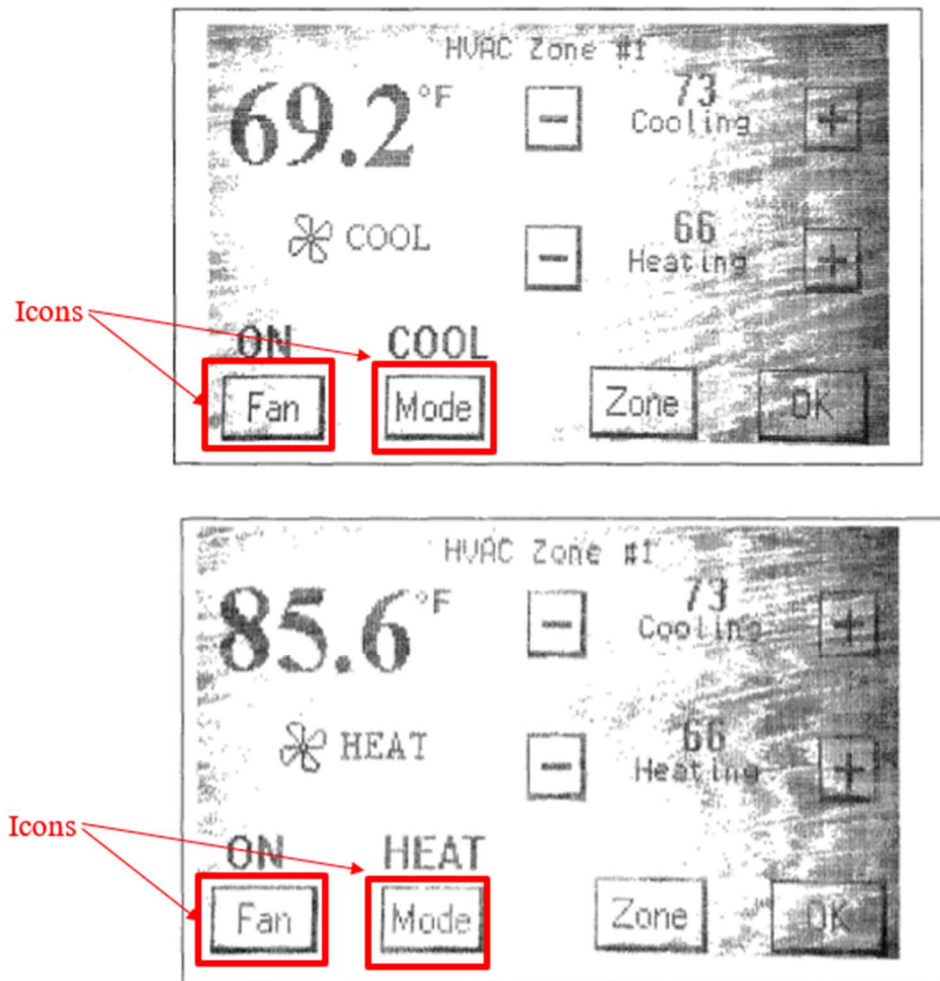
j) 1[h] —1[i]

1[h]: 1) establish on said liquid crystal display: a) a representation of a first virtual button at a first predetermined position on the liquid crystal display; and

1[i]: a first legend indicative of a first control function of said thermostat, which first control function is for controlling a first space conditioning equipment component, which first control function is active when the first legend is viewable;

195. *Geiwitz* or *Geiwitz* in combination with *Bier* and the common knowledge of a POSITA discloses elements 1[h]-1[i]. As described above in limitation 1[b], *Geiwitz* discloses having a touchscreen with an LCD component. *Supra*, §VII.C.2.d. *Geiwitz* discloses pressing an HVAC icon on a navigational menu to access an HVAC control screen with various icons, including a mode icon (virtual button) that can be repeatedly pressed to change the mode of the thermostat. Ex. 1005, 25:8-13; Ex. 1007, 23-24, 56-58.

Figure 84



Ex. 1007, Figs. 84-85 (annotated).

196. A POSITA would have understood *Geiwitz*'s mode icon as disclosing or at least rendering obvious the claimed "representation of a first virtual button" on the liquid crystal display, at least because *Geiwitz* describes "pressing" the "icons" just as a button would be used. For example, *Geiwitz* discloses that "[r]epeatedly pressing the 'Mode' icon cycles it through the options of cool, heat and auto." Ex.

1005, 25:12. A POSITA would have understood it to be at a predetermined position, given that this icon appears at a fixed position in both Figures 84 and 85.

197. A POSITA would have understood that the control program of *Geiwitz* established the representation of the virtual button, as well as the different legends, on the screen. For example, this was made obvious by *Geiwitz*'s use of a dot matrix LCD, which requires a control program to establish different screens. *Geiwitz* discloses displaying different buttons in the same physical location, on different screens as shown below in *Geiwitz*'s "Lights," "Outlets," and "HVAC" control screens. *See* Ex. 1007, 54-55, 57.

Figure 75

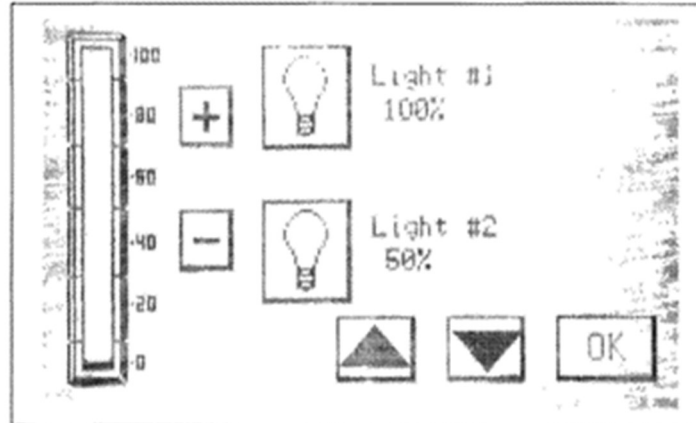


Figure 76

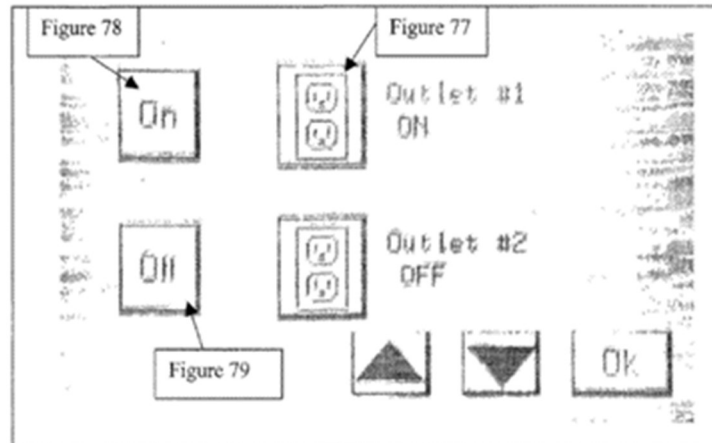
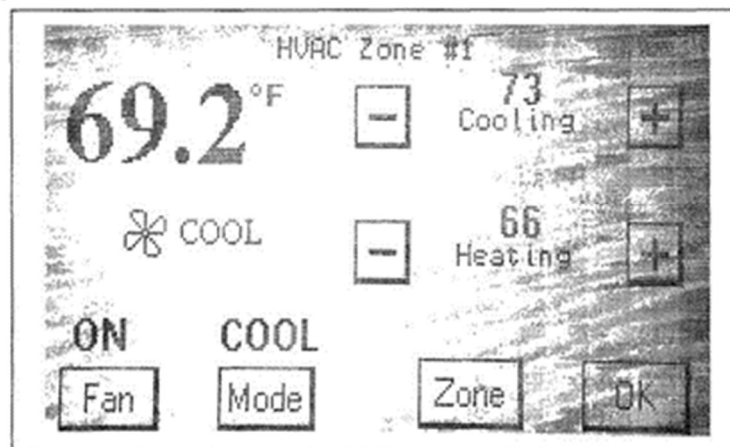


Figure 84



Id. at Figs. 75-76, 84.

198. A POSITA would have understood that in order to display different screen content in the same physical location, on different screens, said device must utilize a dot matrix LCD, with a control program establishing the different screens. The fact that the screen completely changes layout makes clear to a POSITA that a dot-matrix screen is being used and that a control program is establishing the different screens. Additionally, in the Inventor's Deposition, Inventor Rosen admitted that having different screen content in the same physical location on different screens demonstrates that a dot matrix LCD was used. Ex. 1008, 212:3-16, 217:7-19. Accordingly, it is the software (control program) that must establish the virtual buttons and legend on the display screen each time a new screen is accessed or a legend or button must be changed. Otherwise, it would not be possible to have multiple screens or changing legends. The software determines what buttons are on which screens and which legends are displayed based upon the mode that the software is in. Thus, *Geiwitz*, discloses element 1[h].

199. When *Geiwitz*'s 'Mode' icon is pressed, legends indicating the current control function appear directly above the 'Mode' icon on the screen, as shown in the figures below. Ex. 1005, 25:2-13.

Figure 84

Legend indicating
current control
function

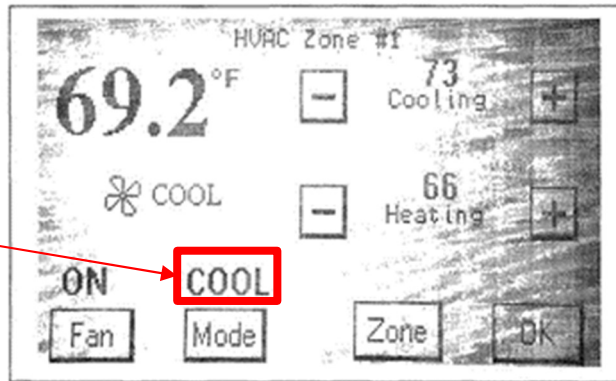
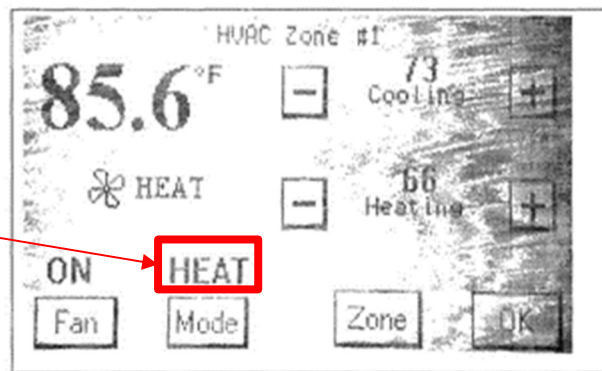


Figure 85

Legend indicating
current control
function



Ex. 1007, Figs. 84-85 (annotated).

200. For example, the legend “COOL” appears to indicate “that the system is running the air conditioning to cool the controlled zone.” Ex. 1005, 25:5-6. Therefore, a POSITA would have understood “cool” and “heat” in Figures 84-85 to be legends that meet all the limitations of 1[i];--their appearance on the screen indicates the control function that is active and the component that is being controlled. A POSITA would have further understood or found it obvious that the appropriate legend was displayed as the mode icon was pressed because if the legend was not displayed, the user would be left guessing as to what mode the thermostat

was in. *See* Ex. 1005, 25:11-12. A POSITA would have further understood that the appropriate equipment became active that corresponded to the displayed mode. *See id.* at 25:2-12; Figure 4b (showing relay connections for equipment); Ex. 1007, 176 (listing common HVAC components). The '318 Patent indicates that controlling equipment is “well known.” Ex. 1001, 1:35-45, 6:11-30.

201. A POSITA would have understood, or it is at least obvious that when the legend is displayed for heating, that space conditioning equipment that generates heat is being controlled by a first control function of the thermostat. In other words, a POSITA would have understood that the control function for heating is active when the thermostat is displaying the heat legend in *Geiwitz*. Similarly, a POSITA would have understood, or it is at least obvious from the material referenced above for *Geiwitz*, that when the legend is displayed for cooling, that space conditioning equipment that causes cooling is being controlled by a control function of the thermostat for cooling. In other words, a POSITA would have understood that the control function for cooling is active when the thermostat is displaying the cool legend in *Geiwitz*.

202. For the same reasons discussed above for the virtual buttons, a POSITA would have understood that it is the software (control program) establishing the legends on the display.

203. In IPR2022-01402, Patent Owner argued that a “legend” must be “displayed on a virtual button.” Ex. 1017, 5. In my opinion, the claim construction issue is irrelevant to obviousness. The claim language itself merely requires the program to establish the legend “on the liquid crystal display,” not on the button as Patent Owner claims. The ’318 Patent states that the “image representative of a first virtual button may be shown on the touch screen display with graphics (alphanumeric characters and/or icons) on or *closely associated with* the first virtual button,” indicating that the legend may be closely associated with (*e.g.* close to) the virtual button. Ex. 1001, 3:53-56. Thus, the legend need not be “on” the virtual button and this limitation is disclosed by *Geiwitz*.

204. Therefore, POSITA would have understood *Geiwitz*’s “COOL” and “HEAT” legends to be legends indicative of control functions of said thermostat because these legends are indicative of the current mode (“control function”) of the thermostat, and the legends are directly above the associated virtual button. For example, a POSITA would have understood *Geiwitz*’s “COOL” legend to be a legend indicative of a first control function, the Cool mode, of said thermostat because the “COOL” legend appears when the thermostat is in its Cool mode. Thus, *Geiwitz*, discloses element 1[i].

205. To the extent that the Board agrees with Patent Owner that a legend must be “displayed on” a virtual button, the claim is still obvious. Having the legend

on the button is simply a matter of design choice and a POSITA would have been motivated to include the legend on the button itself to save valuable real estate on the screen of the thermostat. For example, *Bier*, an article about the use of buttons, including uses for control, published in 1992, discloses having a virtual button with a legend indicating the control function on said virtual button. Ex. 1010, 3. *Bier* teaches using “multistate buttons,” which include a legend that changes state when the button is pressed and causes the system to change state. *Id.* at 8. “When pressed, a multistate button changes state (represented internally by a variable that belongs to the button) and updates its appearance to display its new state. For example, a textual button may change its font, the relative color of its text and background, or its text contents, as shown in Figure 6.” *Id.* An obvious reason to put the legend on the button is to save space on the display that would be required for the legend if it is not directly on the button.

206. A person of ordinary skill in the art would have been motivated to include the legend indicative of the current state of a virtual button on the button itself per the teachings of *Bier*. For example, it would have been obvious to apply *Bier*’s teachings concerning the positioning of a legend indicative of the state of the system on the button to the system of *Geiwitz* in order to conserve space. When *Bier*’s teachings are applied to *Geiwitz*, *Geiwitz*’s thermostat system selectively establishes its legends indicative of the current control function on, rather than

above, the virtual button, as taught by *Bier*. Thus, *Geiwitz*, in view of *Bier*, discloses element 1[i].

207. While *Bier* does not directly state that the legend can include graphics as well as text, it is common knowledge of a POSITA that a button can include graphics—including graphics that change when the state of the button changes. For example, *MOTIF*, a manual published in 1991 for the *MOTIF* software discloses toggle buttons for a user interface. Ex. 1022, 381. “A ToggleButton is a simple user–interface element that represents a Boolean state. Usually, the widget consists of an indicator (a square or diamond) with either text or a pixmap on one side of it. The indicator is optional, however, since the text or pixmap itself can provide the state information of the button.” *Id.* Thus, this language teaches that the button’s “text or pixmap” can provide the state information of the button. A POSITA would have understood that a “pixmap” is a pixel map—in other words a graphic that can be included on the button to indicate its state.

k) 1[j]: 2) read the position on the touch pad juxtaposed with said first predetermined position on said liquid crystal display to determine if the representation of said first virtual button has been touched;

208. *Geiwitz* or *Geiwitz* in view of *Rosen* and the common knowledge of a POSITA discloses element 1[j]. As described above in limitation 1[b], *Geiwitz* discloses having a touchscreen with an LCD component. *Supra*, §VII.C.2.d.

Geiwitz discloses repeatedly pressing ‘Fan’ and ‘Mode’ icons to cycle through various operational modes. Ex. 1005, 25:9-13; *Supra*, §VII.C.2.i. *Geiwitz* also discloses having a virtual ‘Mode’ icon, where “[r]epeatedly pressing the 'Mode' icon cycles it through the options of cool, heat and auto.” Ex. 1005, 25:12; *see also Supra*, §VII.C.2.j. Some method must be used to determine whether the virtual button was pressed, or the system would not work.

209. For a touch screen to work, it must have a way to determine where a user touched/pressed the touch screen to determine whether a virtual button was touched or not. As Inventor Rosen agreed, using a program to read the position on the touch pad juxtaposed with the position on the button to determine if the button had been touched was within the general knowledge of a POSITA. Ex. 1008, 271:7-17, 153:9-12.

210. A POSITA would have found it obvious that the control program reads the position on the touch screen juxtaposed with the predetermined position of the virtual icon to determine if the representation of said virtual icon has been touched so that the ‘Mode’ icon can function as described. To the extent this element is not disclosed by *Geiwitz*, it was a well-known prior art technique that would have been obvious to use. A program interacting with the touch screen in this manner was in the general knowledge of a POSITA and would have been obvious to use as a result.

See Ex. 1008, 271:7-17, 153:9-12. Thus, *Geiwitz* discloses or at least suggests element 1[j].

211. If Patent Owner contends this element is not met, then it is met by *Rosen*. *Rosen* discloses determining if a virtual button has been touched by reading the position on the touch pad juxtaposed with the predetermined position of the button. Ex. 1009, Abstract, ¶0007, Claim 1. As discussed above, it would have been obvious to use the touch screen of *Rosen*, and if one did so, a user would interact with the touch screen as taught by *Rosen*. Thus, this limitation is obvious and Inventor Rosen agreed a POSITA had general knowledge of such a touch screen. Ex. 1008, 271:7-17; 153:9-12.

D) 1[k]—1[l]

1[k]:3) if the first virtual button has been touched: a) determining that the thermostat has been directed to control a second space conditioning equipment component;

1[l]: b) activating a second control function for controlling the second space conditioning equipment component; and

212. *Geiwitz* or *Geiwitz* in view of *Rosen* and the common knowledge of a POSITA, discloses elements 1[k]-1[l]. *Geiwitz* discloses determining whether a virtual button has been touched as discussed in the prior section. *Supra*, §VII.C.2.k. *Geiwitz* further discloses “[r]epeatedly pressing the ‘Mode’ icon” to cycle “through the options of cool, heat and auto,” Ex. 1005, 25:11-13; *Supra*, §VII.C.2.i. For

example, *Geiwitz* taught that from the Cool mode, an additional press of the ‘Mode’ icon would cause the system to enter Heat mode. Ex. 1005, 25:4-13; *see also* Ex. 1007 56-58, 957-60. When *Geiwitz*’s system is in the COOL mode and thus, “the system is running the air conditioning,” it would have been understood, or at least obvious, to a POSITA that pressing the ‘Mode’ icon to switch to the HEAT mode would cause the system determine that it has been directed to control a heating apparatus (second space conditioning equipment). *See id.* at 25:1-13; Fig. 4 (showing relay connection for heater). Likewise, a POSITA would have understood that pressing the mode button to enter the heating mode also activates the second control function for controlling the heater as that is the purpose of entering the heating mode. This would have been true for the same reasons discussed above in connection with the display of the first legend. *Supra* §VII.C.2.j. Thus, *Geiwitz* discloses, or at least makes obvious, elements 1[k]-1[l].

m)1[m]: c) displaying on said liquid crystal display a second legend indicative of said second control function of said thermostat, which second control function is for controlling the second space conditioning equipment component, which second control function is active when the second legend is viewable.

213. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses element 1[m]. *Geiwitz* discloses having a touchscreen with an LCD component. *Supra*, §VII.C.2.d. As explained above in the discussion of

elements 1[h]-1[i], *Geiwitz* further discloses display of a “cool” legend in the cool mode and a “heat” legend in the heat mode. *See* Ex. 1007, 57-58; *Supra*, §VII.C.2.j. Thus, as further explained above, a POSITA would have understood or found it obvious that the cool/heat legends constitute a first and second legend which each indicate the current control function of the thermostat and that this control function is active when those legends are displayed on the LCD. *Supra*, §VII.C.2.1.

Figure 84

Legend indicating
current control
function

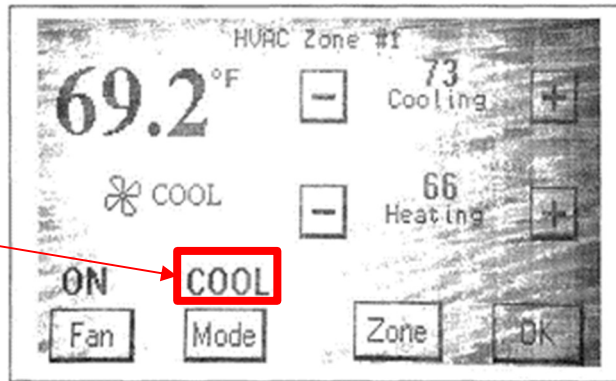
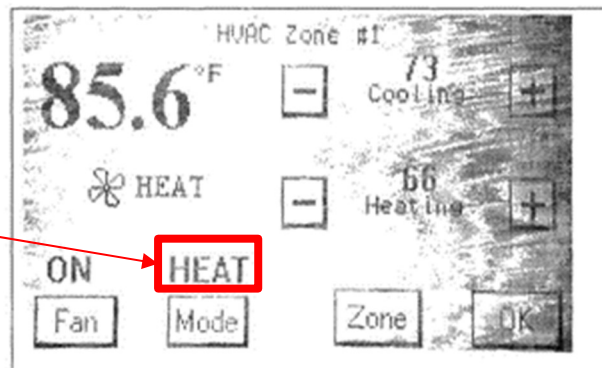


Figure 85

Legend indicating
current control
function



Ex. 1007, Figs. 84-85 (annotated).

214. As shown in the above figures, when the control function changes from Cool to Heat, the legend changes from COOL to HEAT as well. *See id.* A POSITA

would have understood *Geiwitz*'s HEAT legend, to be a legend indicative of a second control function of said thermostat because the HEAT legend is indicative of the second control function of the thermostat, the Heat mode. *Supra*, §VII.C.2.j. As previously mentioned, the '318 Patent indicates that the legend indicative of the control function only needs to be displayed on the LCD, so *Geiwitz*'s HEAT legend (located directly above the 'Mode' icon) or its COOL legend (located directly above the 'Mode' icon) discloses this part of the limitation. Ex. 1001, 3:53-56; *Supra*, §VII.C.2.j.

215. Furthermore, a POSITA would have understood that when the system changes to a second control function, the Heat mode or the Cool mode, the HEAT legend or COOL legend, respectively, that appears above the 'Mode' icon on the touchscreen serves as indication that said second control function is activated. *See* Ex. 1007, Figs. 84-85. Thus, *Geiwitz*, discloses element 1[m].

216. To the extent that Patent Owner is right that the legend must be on the virtual button, then *Bier* discloses or renders obvious limitation 1[m] for the same reasons discussed above in connection with element 1[i]. *Supra*, §VII.C.2.j.

3. Claim 3: The programmable thermostat system of claim 1 in which the space conditioning equipment components include at least one of: a heater, a compressor type air conditioner and a heat pump.

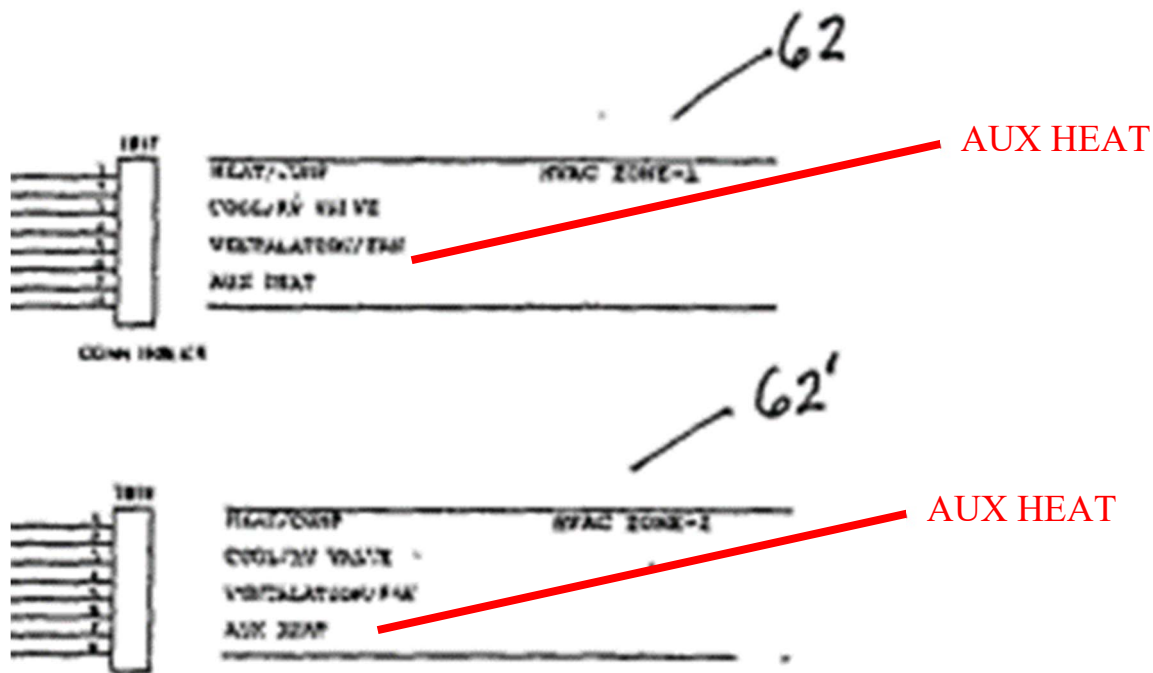
217. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses Claim 3. As discussed above, *Geiwitz* or *Geiwitz* in combination with *Rosen* and *Bier* render Claim 1 obvious. *Supra*, §VII.C.2. *Geiwitz*'s system provides "control of ... heating, ventilation and air conditioning (HVAC)" equipment. Ex. 1005 3:26-27. A POSITA would have understood that such HVAC equipment includes "at least one of: a heater, a compressor type air conditioner and a heat pump." For example, *Geiwitz* discloses "running the air conditioning" during the Cool mode and relays or control signals for certain equipment. Ex. 1005, 25:5-6. Additionally, the *Provisional* lists various HVAC devices commonly controlled by *Geiwitz*'s expanded HVAC Module, including: Central Heating, Central Cooling, Evaporative Cooling, Heat Pumps, Baseboard Heat, and Radiant Heat. Ex. 1007, 176. A POSITA would have understood *Geiwitz* to disclose, or at least make obvious, all of the options for equipment in Claim 3. Thus, *Geiwitz* discloses Claim 3.

218. If Patent Owner disagrees, then this element is disclosed by *Rosen* and/or constitutes general knowledge of a POSITA. Ex. 1001, 1:35-2:9; Ex. 1009, ¶¶ 0002-0003 (space conditioning equipment); Ex. 1008, 321:19-322:16

(identifying Claim 3 options as space conditioning equipment). It also would have been obvious to use the options in Claim 3 as conventional equipment used as intended.

- 4. Claim 4: The programmable thermostat system of claim 3 in which if the first virtual button is been touched again after step D)3), determining that the thermostat controls a third space conditioning equipment component, activating a third control function for controlling the third space conditioning equipment component, and changing the second legend to a third legend indicative of the third control function of the thermostat.**

219. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses Claim 4. As discussed above, *Geiwitz* or *Geiwitz* in combination with *Rosen* and *Bier* render Claim 3 obvious. *Supra*, §VII.C.3. *Geiwitz* further teaches controlling auxiliary heat equipment, as shown in Figure 4b below, which depicts “AUX HEAT” equipment as one of the HVAC devices in the HVAC zones and controlled by *Geiwitz*’s system via relays. Ex. 1005, Fig. 4b; *Supra*, §VII.C.2.i.



Ex. 1005, Fig. 4b (partially reproduced; annotated).

220. A POSITA would have understood that such AUX HEAT equipment is conventionally used in a thermostat's AUX HEAT or Emergency Heat modes when a heat pump cannot produce enough heat. *See* Ex. 1007, 176 (disclosing heat strips for auxiliary heat). Furthermore, the *Provisional* discloses "Heat Pumps" as one of the HVAC devices commonly controlled by *Geiwitz's* expanded HVAC Module. *Id.*; *Supra*, §VII.C.3.

221. It would have been obvious to a POSITA to modify *Geiwitz's* 'Mode' icon to add an AUX HEAT operation mode for controlling Auxiliary Heat equipment, such as a heating pump such that pressing the 'Mode' icon repeatedly

would direct the system to activate three pieces of space conditioning equipment: cooling equipment for the Cool mode, heating equipment for the Heat mode, and Auxiliary Heat equipment for the AUX HEAT mode. A POSITA would have understood Auxiliary Heat equipment, such as a heat pump, to be space conditioning equipment. It was well-known in the art to include an AUX HEAT mode in a thermostat for particularly cold weather.

222. Furthermore, it would have been obvious to a POSITA to modify the system of *Geiwitz* to display a legend indicative of an AUX HEAT mode directly above the ‘Mode’ icon, indicating to the user that the AUX HEAT mode is activated and the auxiliary heat equipment is in use. As described previously, *Geiwitz* displays similar legends to indicate that the other modes of operation are activated. *Supra*, §VII.C.2.m. If the mode icon were so modified, the thermostat would function with respect to the “third legend” just as it did above for the “second legend” (*see Supra*, §VII.C.2.m), thus, making Claim 4 obvious. Thus, *Geiwitz* renders obvious Claim 4. Likewise, for the same reasons discussed above in §VII.C.2.j, it would have been obvious that the legend could be directly on the button. *Supra*, §VII.C.2.j. It was common knowledge that thermostats could have an emergency heat option. *See e.g.*, Ex. 1019, Table 2 (referencing a System Switch having modes: Auto, Cool, Heat, Emergency Heat, Off). Thus, *Geiwitz* discloses Claim 4.

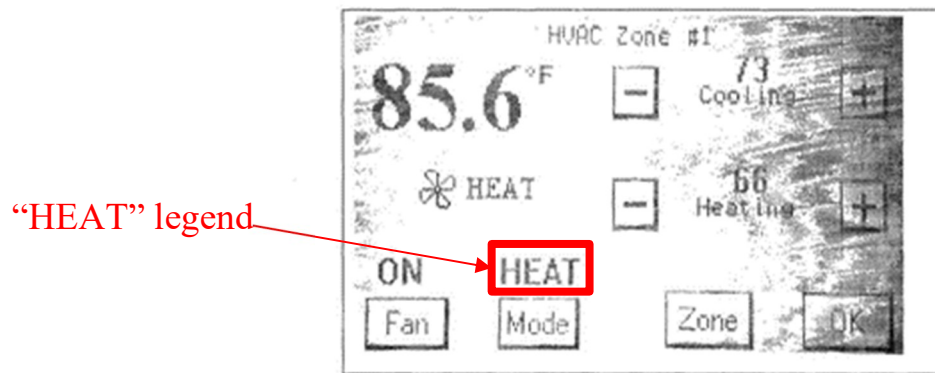
223. The rationale and motivation for combining *Geiwitz*, with *Bier* is the same as discussed above for element 1[j]. *Supra*, §VII.C.1.b

5. Claim 5: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heater and the graphic includes the word “heat” associated with said virtual button when the heater is controlled.

224. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses Claim 5. As discussed above, *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, render Claim 4 obvious. *Supra*, §VII.C.4. *Geiwitz* discloses a thermostat system that provides “control of ... heating, ventilation and air conditioning (HVAC)” equipment and examples of heating equipment controlled. Ex. 1005, 3:27; Ex. 1007, 176. A POSITA thus would have understood that such HVAC equipment includes a heater. Additionally, the *Provisional* lists various HVAC devices and options commonly controlled by *Geiwitz*’s expanded HVAC Module, including “Central Heating,” “Baseboard Heat,” and “Radiant Heat.” Ex. 1007, 176. A POSITA would have understood that providing central heat, baseboard heat, and radiant heat discloses three types of heaters.

225. As discussed above in §VII.C.2.j and shown below, a “heat” graphic is associated with the mode icon when the heater is controlled, thus disclosing all limitations of Claim 5. *Supra*, §VII.C.2.j; Ex. 1007, 58.

Figure 85



Ex. 1007, Fig. 85 (annotated to show the “HEAT” legend, which appears when the system is directed to the Heat mode).

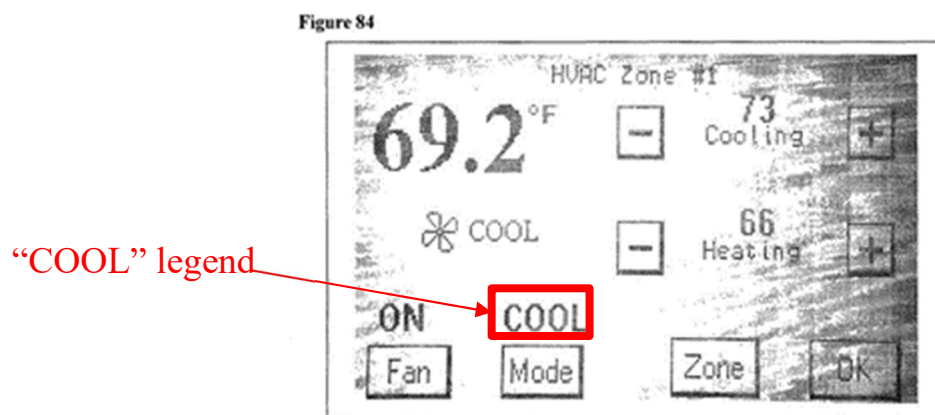
226. Likewise, for the same reasons discussed above in §VII.C.2.j, it would have been obvious that the graphic could be directly on the button. *Supra*, §VII.C.2.j. Thus, *Geiwitz* discloses Claim 5.

6. Claim 7: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is an air conditioning system and the graphic includes the word “cool” associated with said virtual button when the air conditioning system is controlled.

227. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses Claim 7. As discussed above, *Geiwitz* or *Geiwitz* in combination with *Rosen* and *Bier* and the common knowledge of a POSITA render Claim 4 obvious. *Supra*, §VII.C.4. *Geiwitz* discloses a thermostat system that provides “control of ... heating, ventilation and air conditioning (HVAC)” equipment and discloses central cooling. Ex. 1005 3:26-27; Ex. 1007, 176. “Air

conditioning equipment” discloses an “air condition system.” A POSITA would have understood that such HVAC equipment includes an air conditioner. *Geiwitz* further describes displaying a “COOL” graphic to indicate “that the system is running the air conditioning to cool the controlled zone.” Ex. 1005, 25:5-6. Additionally, the *Provisional* lists various HVAC devices and options commonly controlled by *Geiwitz*’s expanded HVAC Module, including “Central Cooling.” Ex. 1007, 0176. A POSITA would have understood that providing central cooling conventionally requires an air conditioner.

228. As discussed above in §VII.C.2.j and shown below, a “cool” graphic is associated with the mode icon when the air conditioning system is controlled, thus disclosing all limitations of Claim 7. *Supra*, §VII.C.2.j; Ex. 1005, 25:5-6.



Ex. 1007, Fig. 84 (annotated to show the “COOL” legend, which appears when the system is directed to the Cool mode).

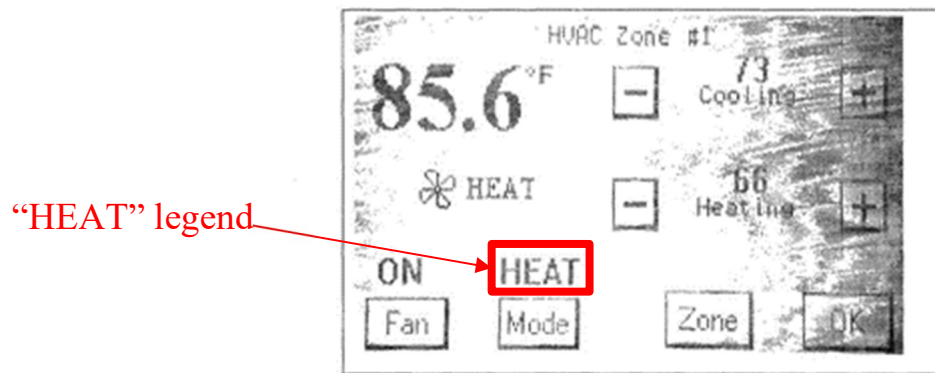
229. Likewise, for the same reasons discussed above in §VII.C.2.j, it would have been obvious that the graphic could be directly on the button. *Supra*, §VII.C.2.j. Thus, *Geiwitz* discloses Claim 7.

7. Claim 9: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “heat” associated with said virtual button when the heat pump is controlled while operating in its heating mode.

230. *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, discloses Claim 9. As discussed above, *Geiwitz*, or *Geiwitz* in view of *Rosen*, *Bier*, and the common knowledge of a POSITA, render Claim 4 obvious. *Supra*, §VII.C.4. *Geiwitz* lists various HVAC devices controlled including “Heat Pumps” Ex. 1007, 0176; *see also* Ex. 1005, Figure 4b (disclosing “RV Valve”—a reversing valve for a heat pump).

231. As discussed above in §VII.C.2.j and shown below, a “heat” graphic is associated with the mode icon when the heater is controlled. *Supra*, §VII.C.2.j; Ex. 1007, 58.

Figure 85



Ex. 1007 at Fig. 85 (annotated to show the “HEAT” legend, which appears when the system is directed to the Heat mode).

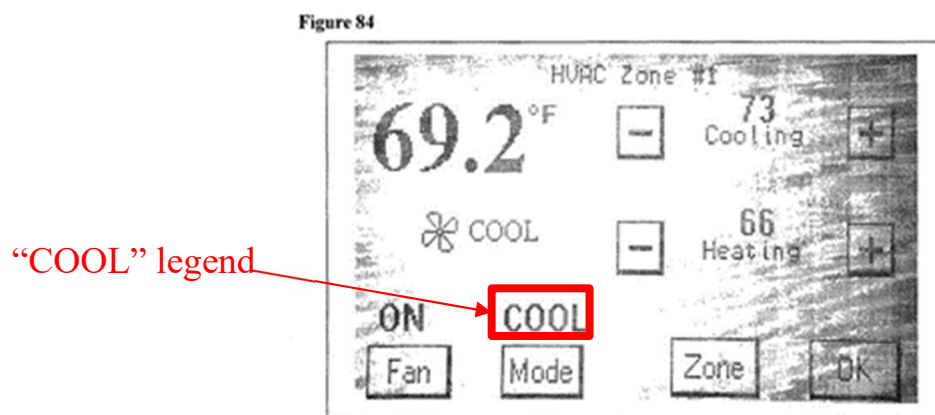
232. A POSITA would have understood, or at least it is obvious, that this would occur whether the heater is a regular heater or a heat pump operating in heating mode. Likewise, for the same reasons discussed above in §VII.C.2.j, it would have been obvious that the graphic could be directly on the button. *Supra*, §VII.C.2.j. Thus, *Geiwitz* discloses or at least renders obvious Claim 9.

8. Claim 11: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “cool” associated with said virtual button when the heat pump is controlled while operating in its cooling mode.

233. *Geiwitz*, or *Geiwitz* in view of *Rosen, Bier*, and the common knowledge of a POSITA, discloses Claim 11. As discussed above, *Geiwitz*, or *Geiwitz* in view of *Rosen, Bier*, and the common knowledge of a POSITA, render Claim 4 obvious. *Supra*, §VII.C.4. As discussed above, *Geiwitz* lists various HVAC devices

controlled including “Heat Pumps” Ex. 1007, 0176; *see also* Figure 4b (disclosing “RV Valve”—a reversing valve for a heat pump). A POSITA would have understood that heat pump may be configured to pump heat into the house (heating mode) or pump heat out of the house (cooling mode) by reversing the operation of the heat transfer mechanism. A POSITA would have understood such reversal uses “a reversing value for [the] heat pump.” Thus, the “RV Value” disclosure makes clear what a POSITA would already know: A heat pump may operate in cooling mode or heating mode.

234. As discussed above in §VII.C.2.j and shown below, a “cool” graphic is associated with the mode icon when the air conditioning system is controlled. *Supra*, §VII.C.2.j; Ex. 1005, 25:5-6.



Ex. 1007, Fig. 84 (annotated to show the “COOL” legend, which appears when the system is directed to the Cool mode).

235. A POSITA would have understood, or at least it is obvious, that this would occur whether the air conditioning system is a regular air conditioning system or a heat pump operating in cooling mode. Likewise, for the same reasons discussed above in §VII.C.2.j, it would have been obvious that the graphic could be directly on the button. *Supra*, §VII.C.2.j. Thus, *Geiwitz* discloses Claim 11.

9. Claim 14: The programmable thermostat system of claim 1 in which said liquid crystal display is a dot matrix type.

236. *Geiwitz* discloses Claim 14. As discussed above, *Geiwitz* or *Geiwitz* in combination with *Rosen* and *Bier* render Claim 1 obvious. *Supra*, §VII.C.2. *Geiwitz* further discloses a system capable of displaying different buttons in the same physical location, on different screens as shown in *Geiwitz*'s "Lights," "Outlets," and "HVAC" control screens. *See* Ex. 1007, 51-52, 57.

Figure 75

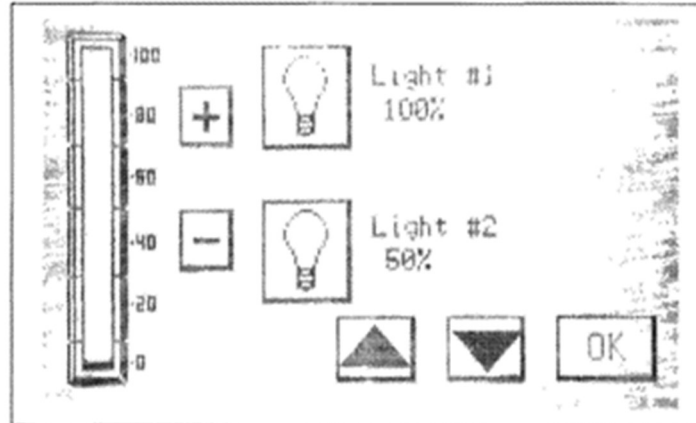


Figure 76

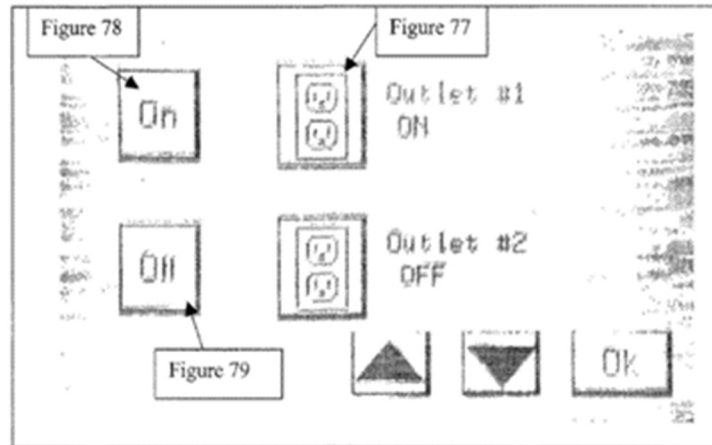
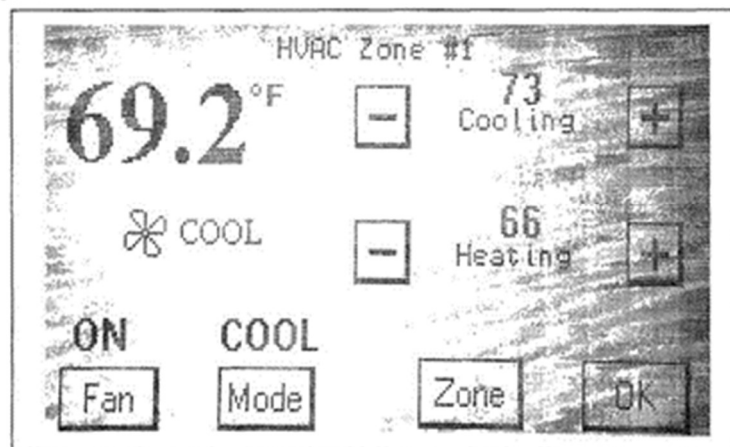


Figure 84



Id. at Figs. 75-76, 84.

237. For example, the ‘Down Arrow’ buttons on Figs. 75 and 76 are in the same physical location as Fig. 84’s ‘Zone’ button. *Id.* A POSITA would have understood that in order to have a device capable of displaying different screen content in the same physical location, on different screens, said device must utilize a dot matrix LCD. Further, a POSITA would have recognized that the figures of *Geiwitz* as shown above used a dot-matrix LCD. The “dots” (actually square in shape) can be seen in the graphics. Further, the fact that the screen completely changes layout also makes clear to a POSITA that a dot-matrix screen is being used. Additionally, in the Inventor’s Deposition, Inventor Rosen admitted that having different screen content in the same physical location on different screens demonstrates that a dot matrix LCD was used. Ex. 1008 212:3-16, 217:7-19.

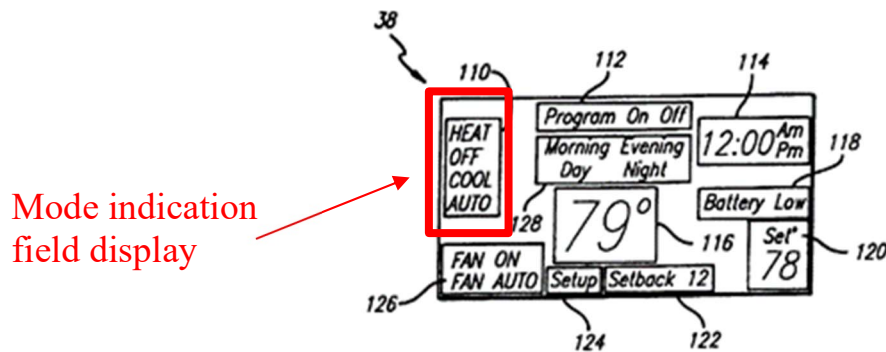
D. Ground 2: Claims 1, 3-5, 7, 9, 11 and 14 are obvious over *Dushane* in view of *Cardio Manual*, *Bier*, and the common knowledge of a POSITA.

1. A POSITA Would Have and Could Have Combined *Dushane* with *Cardio Manual*

238. It would have been obvious to a POSITA to combine the thermostat system of *Dushane* with the touchscreen and virtual buttons of *Cardio Manual*. Modifying *Dushane* to incorporate the touchscreen and virtual buttons of *Cardio Manual* would merely involve the replacement of known elements (the LCD and physical buttons of *Dushane*) with the other known elements (the touchscreen, and

virtual buttons of *Cardio Manual*), to obtain predictable results (a thermostat system that includes a touchscreen, input/output circuitry, and virtual buttons).

239. *Dushane* describes having an LCD with “a mode indication display field 110” with “‘HEAT’, ‘OFF’, ‘COOL’ and ‘AUTO’ sub-fields” that a POSITA would have understood teaches a list of legends. Ex. 1004, 11:20-22. A POSITA would have further understood *Dushane*’s legends to indicate the current control function of the thermostat.

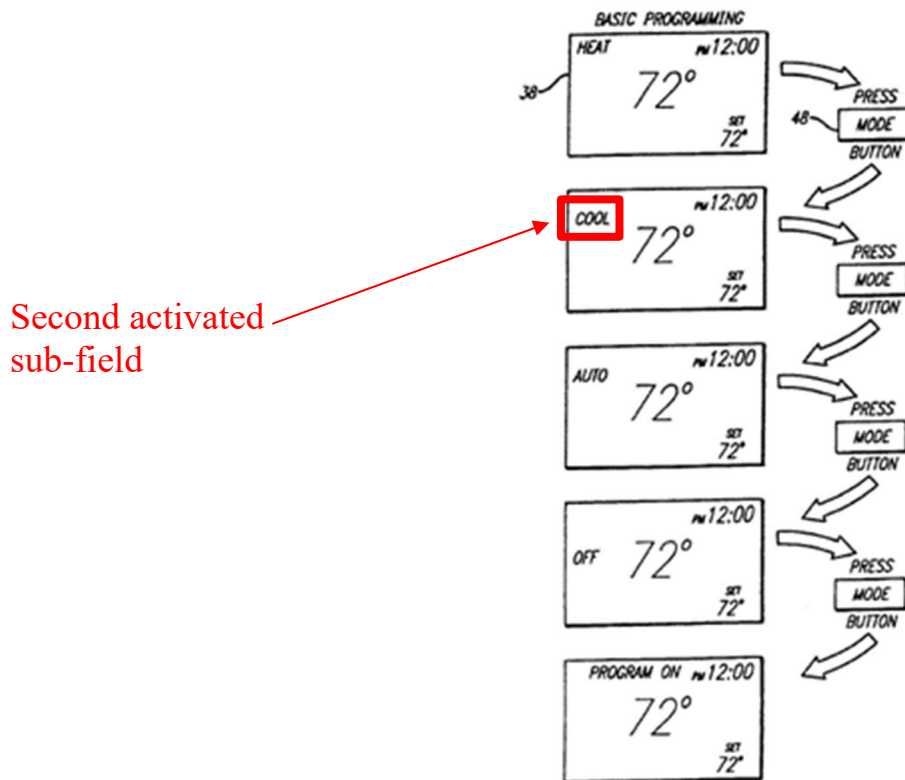


Id. at Fig. 4 (annotated).

240. As discussed above, *Dushane* teaches to provide control signals to “a cooling apparatus such as an air conditioner” during the COOL mode. *Id.* at 12:57-59; *Supra*, §VII.B.1.

241. *Dushane* further discloses that the appropriate legend is displayed when the corresponding “operating mode for the controlled apparatuses is selected,” as “[w]hen the sub-field ‘COOL’ is activated, the user is provided with a visible

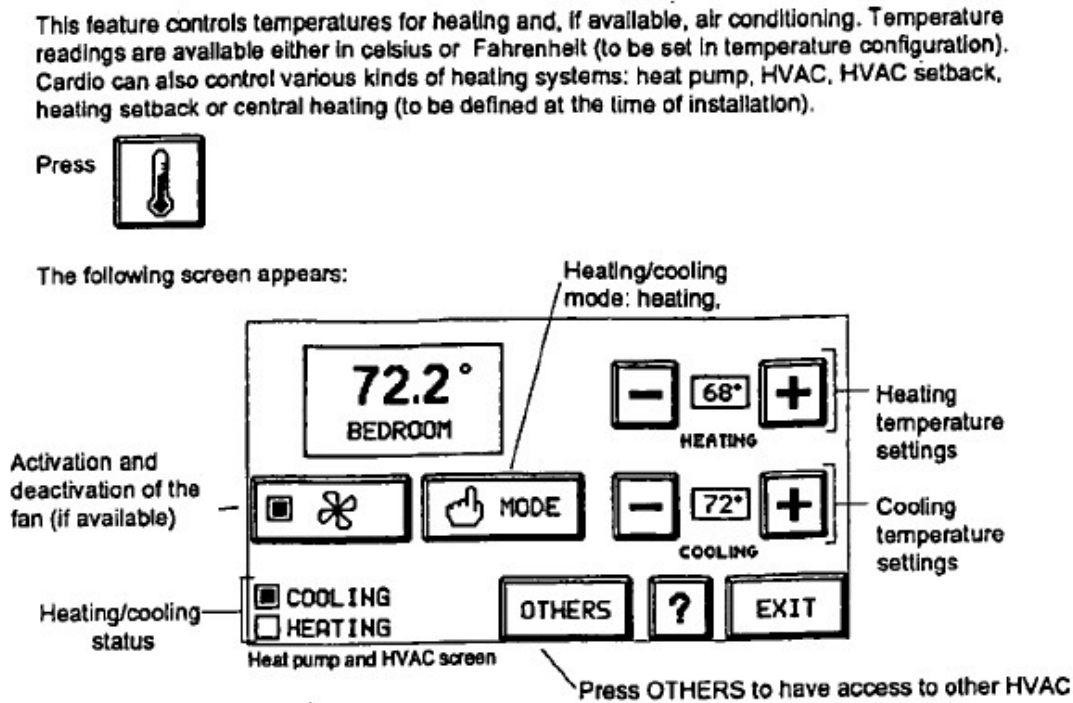
indication that a cooling operation has been selected” Ex. 1004, 11:22-24; 11:27-29.



Id. at Fig. 6 (annotated to highlight *Dushane*’s mode indication display field displaying the second subfield indicative of the second activated mode).

242. Just like *Geiwitz* and just like the ’318 Patent, each press of the mode button causes the thermostat of *Dushane* to cycle through multiple modes. *See id.* However, *Dushane* uses a mode button on a keypad, rather than a virtual mode button on a touch screen. *See id.* at 12:66-67. It would have been obvious to substitute the touch screen and virtual mode button of *Cardio Manual* for the keypad and LCD of *Dushane* to control the mode of the thermostat.

243. *Cardio Manual* discloses a touch screen used to control the mode that the thermostat is in with a virtual “mode button” that has a legend indicating whether the thermostat is in heating mode or cooling mode. Ex. 1012, 7.

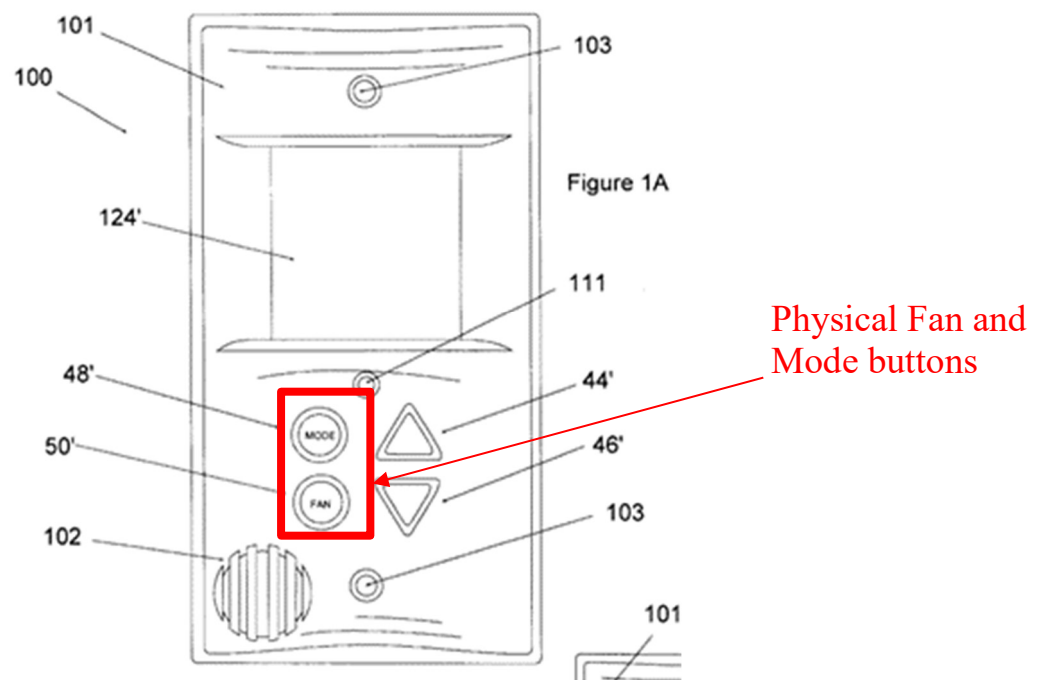


Id.

244. *Dushane* and *Cardio Manual* are in the same field of endeavor and are therefore analogous art to the '318 Patent and each other. Both *Dushane* and *Cardio Manual* relate to programmable thermostats. Ex. 1004, 1:8-10; Ex. 1012, 7, 12, 23, 41-45. Based on the teachings of *Cardio Manual*, a POSITA would have been motivated to modify *Dushane* to incorporate the touchscreen and virtual buttons of *Cardio Manual* to improve *Dushane*'s user interface and functionality.

245. As discussed above, *Dushane* teaches that in thermostat design, a “principle consideration is that the thermostat project from the mount on the wall into the space as little as possible.” Ex. 1004, 1:28-30. *Cardio Manual*’s system includes a design that minimizes the space that the thermostat system projects into because the touch screen eliminates the need for a separate keypad for entering of data.

246. *Dushane* discloses physical mode and fan push buttons on the thermostat, as seen below in Figure 1:



Id. at Figure 1a (annotated).

247. *Cardio Manual* discloses having a touchscreen that makes the system “user friendly.” Ex. 1012, 2, 7. Unlike *Dushane*’s push buttons, which add to a

thermostat's physical profile, *Cardio Manual*'s virtual buttons only appear on the touchscreen and reduce a thermostat's physical profile. Making a thermostat more user friendly is a second reason a POSITA would use the touchscreen of *Cardio Manual*.

248. Third, as discussed above in the section on the State of the Art, it was known to use either (a) touchscreen or (b) a combination of an LCD and physical buttons as a user interface for a thermostat. *See* Ex. 1015, 3:11-12, 3:18-4:6; Ex. 1004, 11:22-24; 11:27-29, Fig. 6; *Supra* §VI. It was further known that a POSITA could substitute a touchscreen for physical buttons and a screen. *See* Ex. 1024, 9, 14-15; *Supra* §VI. Using one or the other is a simple matter of design choice. In order for a person to control a thermostat, they need a way to tell the thermostat what mode they want the thermostat to be in (e.g. heating or cooling) and they need a way to know that the thermostat is in that mode. That was within the general knowledge of a POSITA. In *Dushane*, the user presses a physical button to program a mode and then the mode indicator on an LCD screen provides information to the user about which mode the thermostat is in. Ex. 1004, Fig. 6, 12:66-67. Once one makes a design choice to use a touch screen instead of physical buttons to provide user input, as was taught by the state of the art (*Supra* §VI), it is obvious to substitute the virtual buttons with legends of *Cardio Manual* for the physical buttons with mode indicators on the LCD of *Dushane*.

249. Fourth, using a touch screen in a thermostat with virtual buttons is also common knowledge of a POSITA as admitted by the '318 Patent. Ex. 1001, 2:6-9. Using a prior art user interface would have been obvious to a POSITA.

250. A POSITA would have had a reasonable expectation of success in making the combination of *Dushane's* system and *Cardio Manual's* touchscreen, input/output circuitry, and virtual buttons. As an initial matter, a POSITA would have recognized the strong similarities between the systems of *Dushane* and *Cardio Manual*. Thus, a POSITA would have understood that the touchscreen and virtual buttons of *Cardio Manual* could be readily incorporated into the thermostat system of *Dushane* to replace *Dushane's* push buttons and non-touchscreen LCD. Furthermore, it would have been well within the abilities of a POSITA to modify *Dushane's* thermostat system to include the touch screen of *Cardio Manual*. After all, the '318 Patent teaches that the invention can be implemented with off the shelf components. Ex. 1001, 6:35-42. Inventor Rosen agreed that off the shelf components can be used and that those components are being used for their intended purpose. Ex. 1008, 150:11-151:21. With only the need to use off the shelf components, a POSITA would have had a reasonable expectation of success.

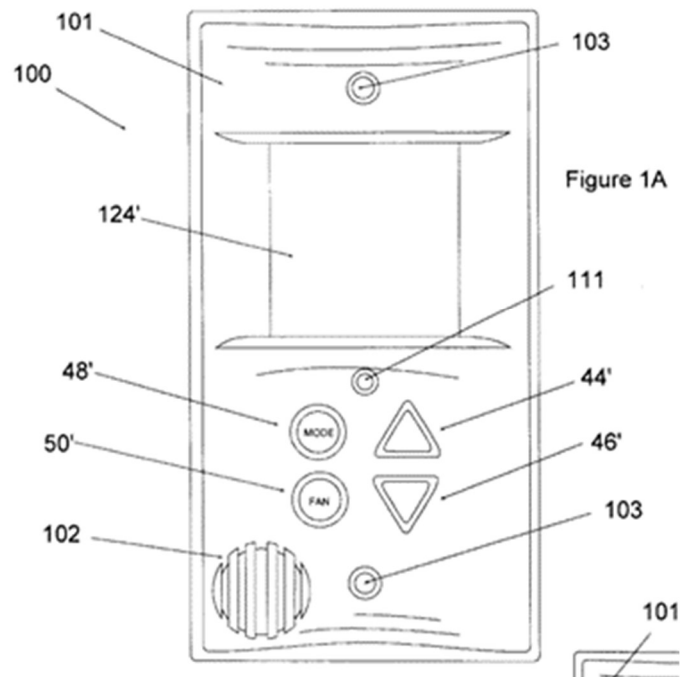
2. Claim 1

251. Each of the seven elements 1[Pre]-1[f] are disclosed by *Dushane* alone or in view of *Cardio Manual*, as discussed below. To the extent Patent Owner

disagrees, each of these elements was within the common knowledge of a POSITA as admitted by the '318 Patent and explained above. Ex. 1001, 1:35-2:9, 6:11-34; *Supra* §VII.C.2.a.

a) 1[Pre] A programmable thermostat system for controlling space conditioning equipment comprising:

252. If the preamble is limiting, *Dushane* discloses it. *Dushane* describes “a programmable digital thermostat includ[ing] a user input mechanism adapted to receive programming inputs from users,” a display adapted to show programming inputs, and a controller adapted to be programmable in response to input signals. Ex. 1004, 4:37-44. Figure 1A of *Dushane*, reproduced below, shows a cover plate 100 and associated circuit boards which “comprise an assembly of a programmable thermostat.” *Id.* at 5:30-31.



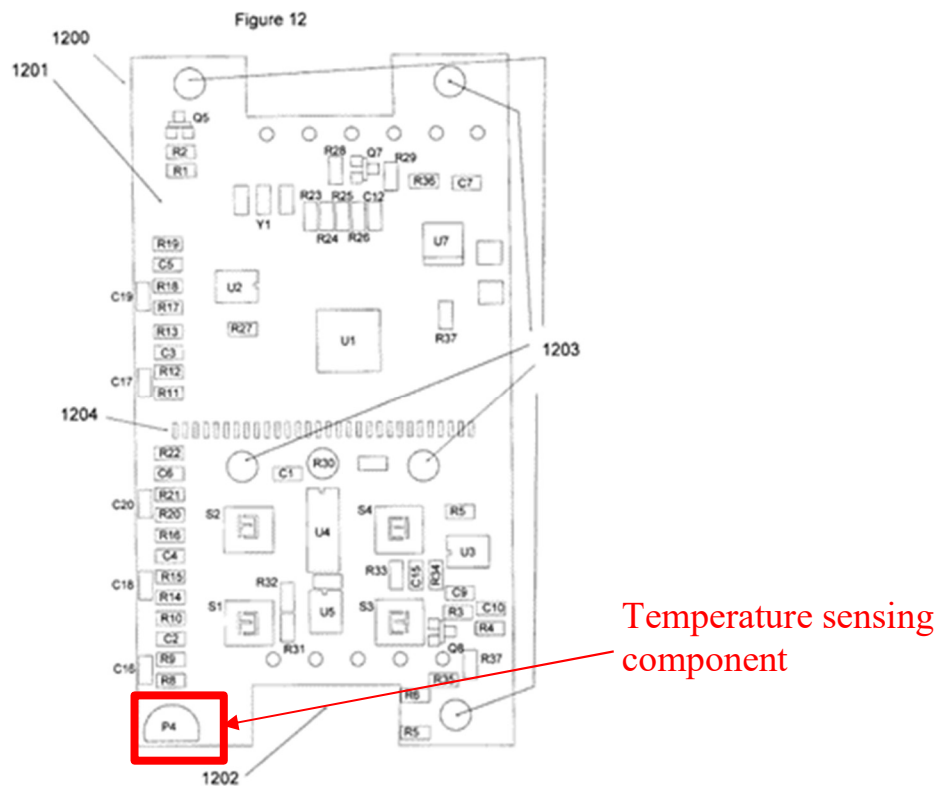
Id. at Figure 1A.

253. *Dushane*'s programmable thermostat provides "control signals to one or more environmental control apparatuses," and thus is directed to controlling space conditioning equipment as recited in the preamble. *See id.* at 4:37-44. For example, *Dushane* states that "[t]he thermostat may include various combinations of environmental control apparatuses," including "a heater, an air conditioning unit, a fan and heat pump." *Id.* at 8:19-20. *Dushane* further discloses providing control signals to "a heating apparatus such as a furnace" during the thermostat's HEAT mode and providing control signals to "a cooling apparatus such as an air conditioner" during the thermostat's COOL mode. *Id.* at 12:52-59. Finally, Figures 5-10 of *Dushane* and their description illustrate software that is used to program the

microprocessor of *Dushane* for purposes of controlling the thermostat. *See e.g., id.* at Figs. 5-10; 12:23-14:12.

- b) 1[a]: A) at least one environmental condition sensor providing an electrical signal indicative of the ambient temperature of a conditioned space in which said environmental condition sensor is situated;**

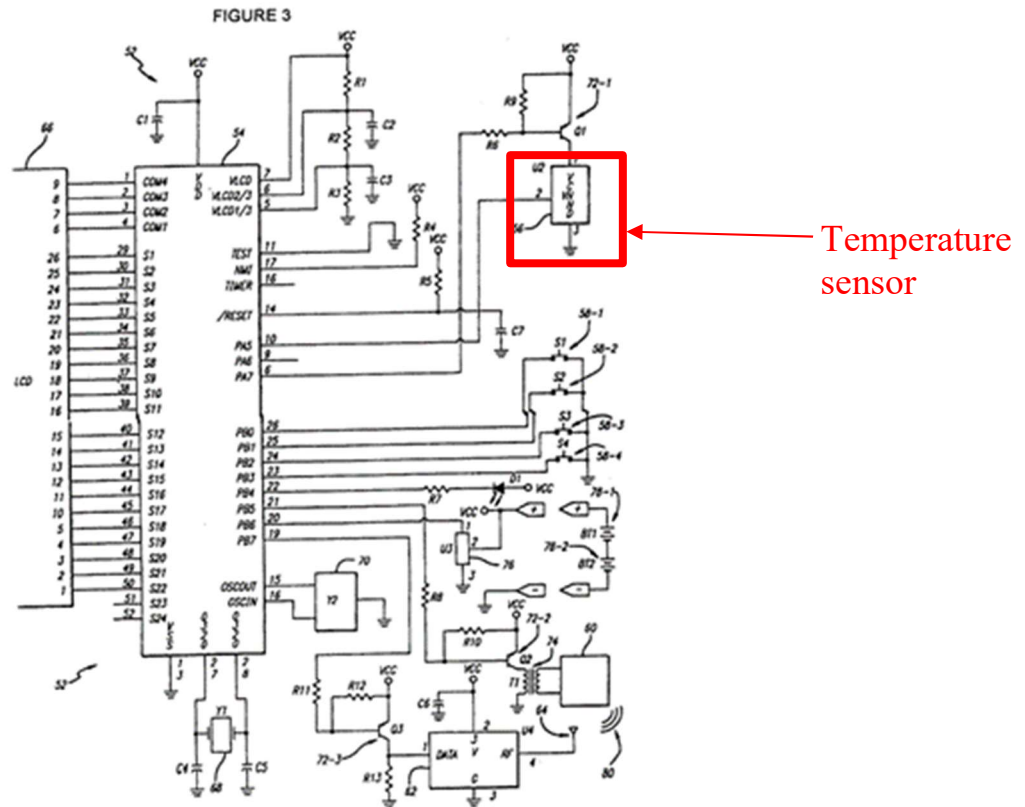
254. *Dushane* and/or *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses element 1[a]. *Dushane*'s thermostat system includes a "temperature sensor 56." *Id.* at 11:55. The thermostat displays "the current temperature as measured by the temperature sensor 56." *Id.* at 11:53-55. In one embodiment, the thermostat system includes "a small backside cavity in which a temperature sensing component P4" is located, as seen in Fig. 12, reproduced below. *Id.* at 5:7-9.



Id. at Fig. 12 (annotated); *see also id.* at Figs. 1I-1L (depicting thermostat systems containing temperature sensing component P4).

255. A POSITA would have understood *Dushane*'s "temperature sensor" as disclosing the claimed "environmental condition sensor," because *Dushane*'s temperature sensor senses a condition (e.g., ambient temperature) of an environment (e.g., the conditioned space in which the temperature sensor is situated). Moreover, a "temperature sensor" is an example of an "environmental condition sensor" in the '318 Patent, which similarly describes a "temperature sensor 5 send[ing] an electrical signal... representative of the temperature within the conditioned space." Ex. 1001, 6:12-15. Figure 3 of *Dushane*, reproduced below, shows a schematic of

Dushane's thermostat system with microprocessor 54 “electrically connected to the temperature sensor 56 via a transistor 72-1.” Ex. 1004, 9:44-46.



Id. at Fig. 3 (annotated).

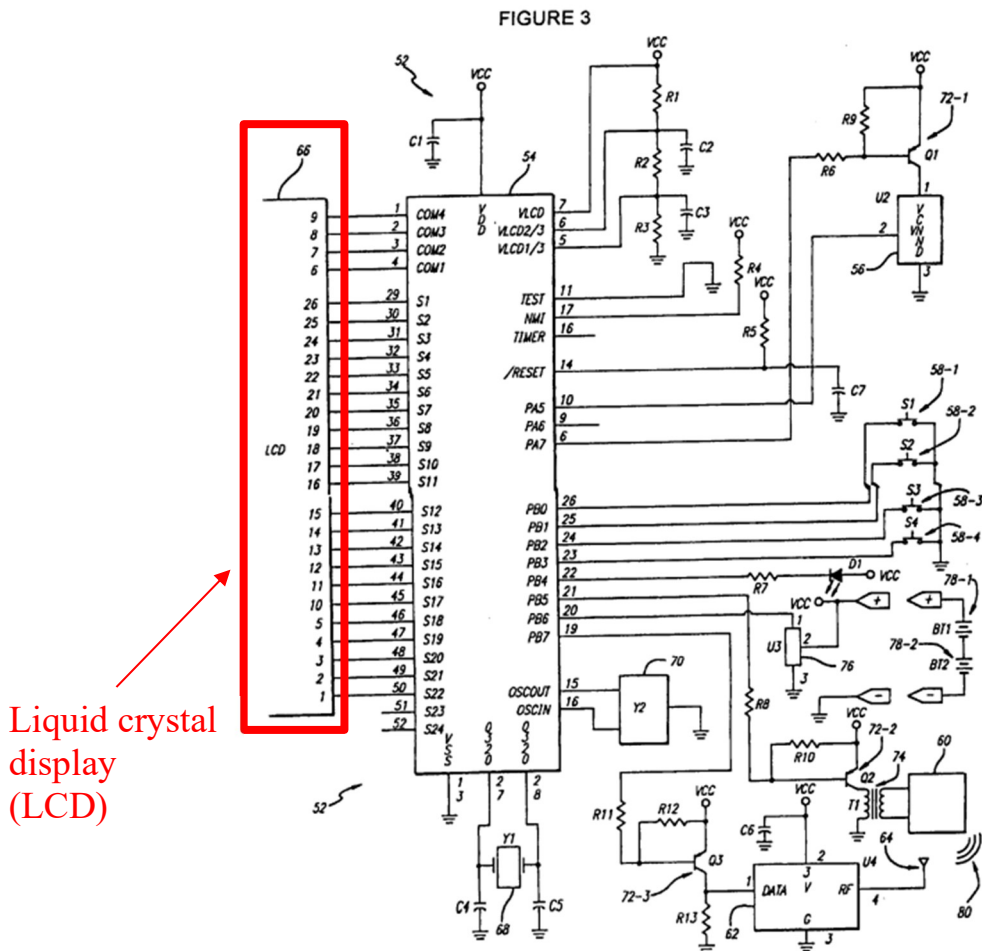
256. A POSITA would have understood that the temperature sensor of *Dushane*, which is electrically connected to the microprocessor via a transistor, provides an electrical signal indicative of the ambient temperature of the conditioned space in which the sensor is situated. It was common knowledge of a POSITA that temperature sensors, such as the sensor described in *Dushane*, function by providing an electrical signal indicative of the ambient temperature of a conditioned space in

which the temperature sensor is situated. *See* Ex. 1001, 6:12-34. Thus, *Dushane* discloses element 1[a].

257. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

c) 1[b]: B) a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen for interactive interface with a user;

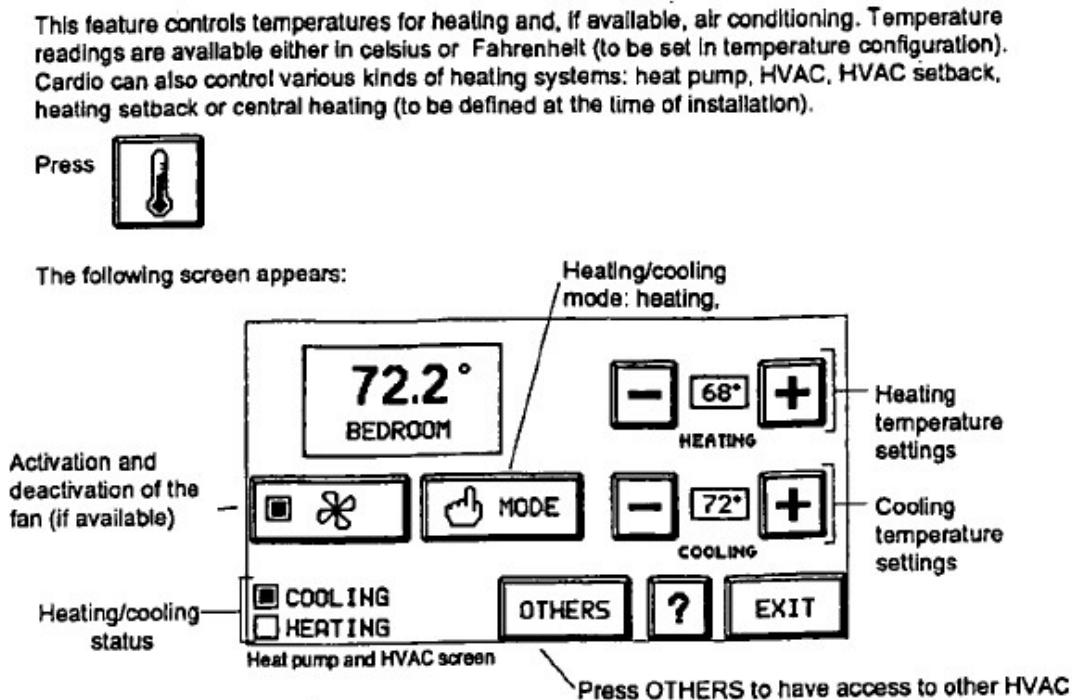
258. *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses element 1[b]. *Dushane*'s thermostat system includes "a liquid crystal display (LCD) 66 which is electrically connected to the microprocessor 54," as shown in Fig. 2 below. Ex. 1004 at 9:38-39.



Id. at Fig. 3 (annotated).

259. Rather than a transparent touch pad, *Dushane* employs push buttons, including a mode button. *See id.* at Fig. 1a, 7:54-8:11, 12:66-13:27. Although *Dushane* discloses a liquid crystal display and a physical mode button, *Dushane* does not disclose a transparent touch pad juxtaposed with a liquid crystal display to constitute a touch screen for interactive interface with a user. *Cardio Manual* discloses this aspect of element 1[b].

260. Similar to *Dushane*, *Cardio Manual* relates to a programmable thermostat that provides a mode button to change modes of the thermostat. Ex. 1012, 7.



Id. at 7.

261. According to *Cardio Manual*, the system can be controlled by its touch screen. *Id.* at 2. Inventor Rosen represented to the patent office in the disclaimer that the *Cardio Manual* “describes a programmable thermostat with a touch screen interface whose pictorial includes representations of virtual buttons.” Ex. 1014, 5. Inventor Rosen further represented that the touchscreen is an LCD. *Id.* Given that the display is visible and that *Cardio Manual* discloses a touchscreen, a POSITA

would have understood the *Cardio Manual* to disclose a transparent touch pad as part of the touchscreen. If the touch pad portion of the touch screen were not transparent, then the screen shown on Page 7 would not be discernible. Furthermore, a POSITA would have understood the touch-sensitive component (i.e., touch pad) to be juxtaposed with the LCD so that the touch pad could register user touches on the LCD screen—especially touches in the location of a virtual button. These were conventional features of touchscreens that were well known in the art before the priority date of the '318 Patent. Indeed, the inventor of the '318 Patent, Inventor Rosen, admitted that he did not invent a touchscreen juxtaposed with a liquid crystal display, and that before the invention of the '318 patent, such touchscreens were commercially available. Ex. 1008, 158:17-23.

262. While the *Cardio Manual* does not explicitly state that the screen is an LCD screen, Inventor Rosen represented to the patent office that what was shown on page 7 contained an LCD. Ex. 1014, 5. A POSITA would have understood the touch screen to include an LCD screen in the absence of language to the contrary because this is by far the most common type of touch screen. At the very least, use of an LCD screen is obvious. And, as just discussed, Inventor Rosen indicated that such touchscreens were commercially available.

263. Moreover, it was common knowledge of a POSITA that the most common display to use for a touch screen was an LCD. The common knowledge

of a POSITA includes the fact that touchscreens with LCD displays were used in prior art thermostats. Ex. 1001, 2:6-9; Ex. 1013, Fig. 6, ¶66, Claim 31; Ex. 1015, 3:18-4:6. To the extent that *Cardio Manual* does not explicitly disclose an LCD display, it would have been obvious to use one because they had been used in thermostats before and are the most common type of display to use in a touchscreen. LCDs are often used because they consume less power and can be made more compact than a number of other types of displays that were available in 2003. Choosing an LCD for a touchscreen is a simple matter of design choice.

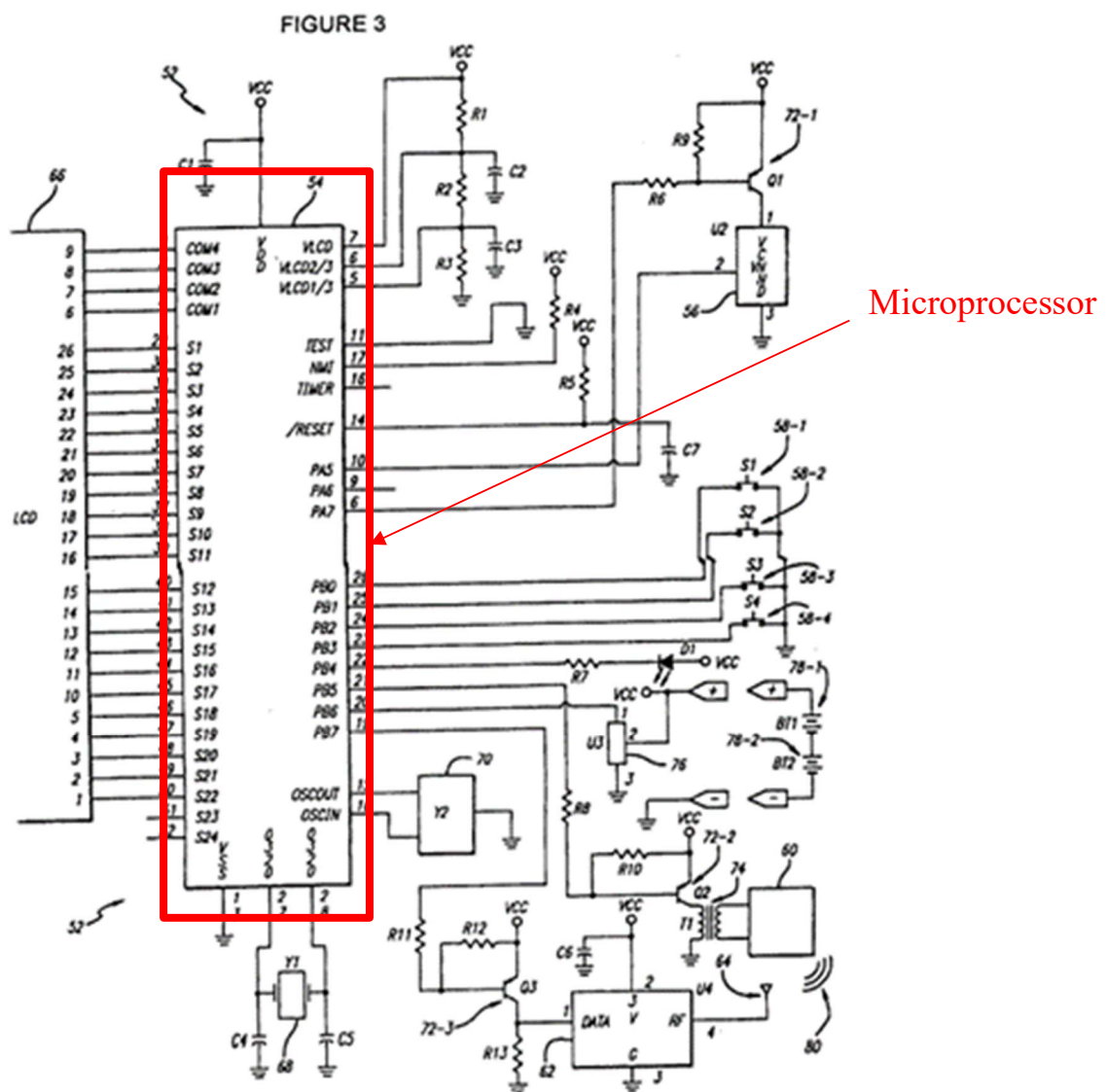
264. Thus, a POSITA would have understood *Cardio Manual* as disclosing, or at least rendering obvious, the claimed “transparent touch pad juxtaposed with a liquid crystal display to constitute a touchscreen for interactive interface with the user.”

265. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

**d) 1[c]: C) a processor, said processor including:
1) a central processing unit;**

266. *Dushane* and/or *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses element 1[c]. *Dushane*'s thermostat system includes a microprocessor U1 that is “electrically connected to the temperature

sensor U2 via a microprocessor U6.” Ex. 1004, 8:12-13. *Dushane* further describes an embodiment of a thermostat system in which “the microprocessor U1 is programmable to expect an electric heat data bit and a heat pump data bit,” such that “the fan turns on instantly when heat is called for.” *Id.* at 8:21-25; *see also id.* at Fig. 2 (schematic showing microprocessor U1’s electrical connections).



Id. at Fig. 3 (annotated) (showing microprocessor 54 electrically connected to temperature sensor 56, LCD 66, and other components).

267. *Dushane's* microprocessor controls the operation of the thermostat system by generating and controlling “the transmission of input signals which are received by the receiver/controller unit 22 which processes the input signals to generate control signals which are, in turn, provided to” space conditioning equipment. *Id.* at 12:53-56. *Dushane's* microprocessor discloses the claimed central processing unit and is also part of the processor in combination with the additional elements described below. *See Infra* §VII.D.2.e-g.

268. A POSITA would have understood that *Dushane's* microprocessor discloses, or at least renders obvious, the claimed processor having a central processing unit (CPU). A POSITA would have understood that a microprocessor is essentially a single-chip implementation of a CPU and is part of the processor in combination with the additional elements discussed below. *See Ex. 1005, 10:21-23, Fig. 21* (showing Intel®386ex chip). For example, in the *Inventor's Deposition*, Inventor Rosen states that “of course” a CPU could be a microprocessor. *Ex. 1008, 92:24-93:5*. Thus, *Dushane*, discloses, or at least renders obvious, element 1[c].

269. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. *Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42*.

e) 1[d]: 2) a real time clock;

270. *Dushane* and/or *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses element 1[d]. *Dushane*'s thermostat system includes a "clock display field 114 [that] preferably shows the current time." Ex. 1004, 11:50-51. *Dushane* also teaches a user "adjust[ing] the time which is shown in the clock" by pressing a mode button. *Id.* at 14:10-12. A POSITA would have understood *Dushane* to have a real time clock based upon this disclosure or at least that it would have been obvious to use one to keep the time. Thus, *Dushane* discloses element 1[d].

271. If it is determined that *Dushane* does not disclose a real time clock then it would have been obvious to use one based upon the general knowledge of a person skilled in the art. It is in the general knowledge of persons skilled in the art that real time clocks have been used for many years in thermostats. An October 1995 patent discloses the use of a real time clock in a thermostat and states that, "It is to be appreciated that real time clocks are well known in the art and the above reference to a particular product from a particular company is by way of example only." Ex. 1016, 3:19-22. It would have been obvious to use a real time clock in a thermostat because many thermostats, such as the *Cardio Manual* (Ex. 1012, 15-16) and *Dushane* (Ex. 1004, 11:56-12:2) allow programming of the thermostat to change the temperature at different times of the day and it is useful and/or necessary to use a

real time clock to determine the time of day to apply the programming of the thermostat. Use of a real time clock to store the time displayed in *Cardio Manual* is further obvious because it is available off the shelf. Ex. 1001, 6:35-42. Thus, it would have been obvious from both the *Cardio Manual* and *Dushane*, in combination with the general knowledge of a POSITA to include a real time clock in a thermostat.

272. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

f) 1[e]: 3) a memory coupled to said central processing unit for storing program and data information; and

273. *Dushane* and/or *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses element 1[e]. *Dushane*'s thermostat system has a memory. See Ex. 1004, 9:29, 15:57-60. Data is stored in the memory: "As an example, the above steps of setting time and temperature related data for the Basic mode have been completed and exist in the memory of the programming device although not in a controller device." *Id.* at 15:57-60. *Dushane* also describes input signals being "transmitted and/or stored in the memory of the programming device." *Id.* at 9:29-30. A POSITA would have understood input signals stored in memory to be "data information."

274. In addition, *Dushane* discloses the storage of program information in the memory. *Id.* at 12:6-17. This passage refers to a program executed by the microprocessor and indicates that the program is “stored within or accessible to the microprocessor.” *Id.* at 12:15-16. A POSITA would have understood that storage of a program for a microprocessor requires a memory to store the program. Thus, to a POSITA, *Dushane* discloses a memory storing a program. It was common knowledge of persons skilled in the art that a microprocessor requires memory to store a program that is executed by the microprocessor. Thus, *Dushane* requires a memory storing a program that is executed by the microprocessor. In addition, that memory must necessarily be coupled to the central processing unit (the microprocessor) or the microprocessor could not execute the program.

275. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

g) 1[f]: 4) an input/output unit coupled between said processor and said touch screen for carrying out information transfer therebetween, said input/output unit further including: a) a sensor input coupled to each said environmental condition sensors for receiving said electrical signal therefrom; and b) a control output coupled to the space conditioning equipment for issuing control signals thereto; and

276. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA discloses or at least renders obvious element 1[f]. As discussed above for element 1[a], *Dushane* discloses having a temperature sensor electrically connected to the microprocessor. Ex. 1004, 9:44-47; *Supra*, §VII.D.2.a. Thus, circuitry within the microprocessor constitutes a “sensor input coupled to each said environmental condition sensors for receiving said electrical signal therefrom.” *Dushane* further discloses a control output coupled to the space conditioning equipment for issuing control signals thereto. *Dushane* makes clear that the microprocessor generates “control signals” that control apparatus such as an electric heater, a fan, and a heat pump. Ex. 1004, 10:41-58, 12:50-65, 13:22-27. Thus, circuitry within the microprocessor also constitutes a control output. *Dushane* further includes an LCD display that is “electrically connected to the microprocessor.” *Id.* at 8:5. Furthermore, the push button inputs are also provided to the microprocessor. *Id.* at

7:54-8:11. A POSITA would have understood that the microprocessor receives input from the push buttons and provides output to control the LCD display.

277. Overall, then, the microprocessor of *Dushane* has circuitry that serves as an input/output unit receiving input from the temperature sensor, and user interface buttons and providing output to control space conditioning equipment and the LCD screen. As discussed above, *Dushane* does not provide a touch screen. *Supra*, §VII.D.2.c. However, given that the microprocessor of *Dushane* interacts with both the LCD and buttons of the user interface, it would have been obvious that when the touchscreen of *Cardio Manual* is substituted for the LCD and push buttons of *Dushane*, the microprocessor would carry out information transfer between the microprocessor and the touch screen.

278. It was common knowledge of a POSITA that a microprocessor can be programmed to control a touch screen and that this is the most typical method of controlling a touch screen. A POSITA would have had a reasonable expectation of success in doing so since the touchscreen of *Cardio Manual* was disclosed as early as 1995 according to Rosen. Ex. 1014, 8-10. Moreover, the input/output unit is simply an off the shelf component being used as it was intended to be used. Ex. 1008, 150:11-151:2; 1009, ¶0023; Ex. 1001, 6:34-42.

279. To the extent that the claim requires an input/output unit separate from the central processing unit, this would have also been obvious to a POSITA. It was

within the general knowledge of persons skilled in the art that various functions in a microprocessor system can be combined onto a single chip (or unit) or separated into multiple chips or units. Ex. 1008, 100:9-102:5. For example, the North-South bridge chips in Intel x386 architectures featured input/output units that were separate from the CPU. Ex. 1027, 95. Deciding which chip is to perform which function is a simple matter of design choice.

280. I have been asked to assume that the construction of element 1(f), if not indefinite, would include the '318 Patent's preferred embodiment. As such, an input/output unit internal to a processor and providing the interface for communication between processor components and the touchscreen would qualify as a processor including "an input/output unit coupled between said processor and said touchscreen" to the extent that limitation is definite. *Dushane* has an input/output unit that is internal to the respective processors in each reference that provides an input/output interface for communication between the processor and the touchscreen.

281. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

h) 1[g]: D) a control program stored in said memory for causing said central processing unit to communicate through said input/output unit to selectively:

282. *Dushane* in view of *Cardio Manual* and the common knowledge of a POSITA discloses or at least renders obvious element 1[g]. *Dushane*'s thermostat system includes a programming device with "all the desired parameters necessary to control all functions of the controller device" stored in the memory of said programming device. Ex. 1004, 15:55-60. *Dushane* also discloses having a central processing unit in the form of a microprocessor. *Supra*, §VII.D.2.d. The programming modes of *Dushane* "may be implemented within a single computer executable program stored within or accessible to the microprocessor." Ex. 1004, 12:13-15. As discussed above, a POSITA would have understood the program to be stored in memory. *Supra* §VII.D.2.f. Thus, *Dushane*'s thermostat operates via a "control program stored in said memory." As discussed above, *Dushane* also has a control program that communicates through an input/output unit to control the display and buttons of *Dushane*. *Supra* § VII.D.2.g. A POSITA substituting the touchscreen of *Cardio Manual* for the manual buttons/LCD interface of *Dushane* would turn to a control program to cause the central processing unit to communicate through the input/output unit to selectively control touchscreen and remainder of the thermostat as claimed. Such a program would be desirable to implement the

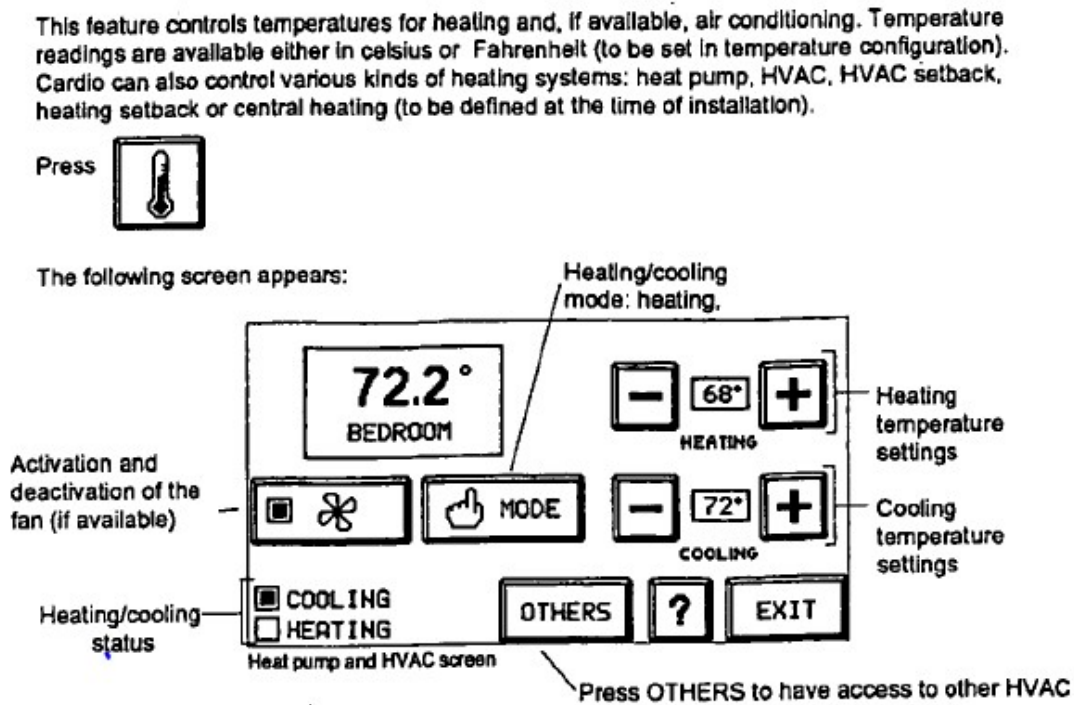
touchscreen functionality of *Cardio Manual*. A POSITA would have a reasonable expectation of success in doing so as *Cardio Manual* demonstrates that such control was feasible in the 1990s. *See* Ex. 1014, 8-10.

283. If Patent Owner contends this element is missing or not obvious, then it is obvious because it was common knowledge of a POSITA as acknowledged by the '318 Patent. Ex. 1001, 1:35-45, 1:51-2:9, 6:11-42.

- i) **1[h]: 1) establish on said liquid crystal display:
a) a representation of a first virtual button at a
first predetermined position on the liquid
crystal display; and**

284. *Dushane* in view of *Cardio Manual* discloses element 1[h]. As discussed above, in the combined system, *Dushane's* thermostat system incorporates the touch screen of *Cardio Manual* to provide an interactive interface with a user. *Supra*, § VII.D.2.c. *Dushane* teaches the use of buttons at predetermined positions, such as a “fan button 50, mode button 48, down button 46 and up button 44,” all of which “comprise rubber buttons with carbon switching materials,” though “other user input mechanisms can be employed.” Ex. 1004, 9:61-65. *Dushane*, however, does not expressly disclose establishing, on an LCD, a representation of a first virtual button at a first predetermined position on the LCD. *Cardio Manual* teaches this aspect of element 1[h].

285. In particular, *Cardio Manual* describes pressing a mode button icon to switch between heating and cooling:

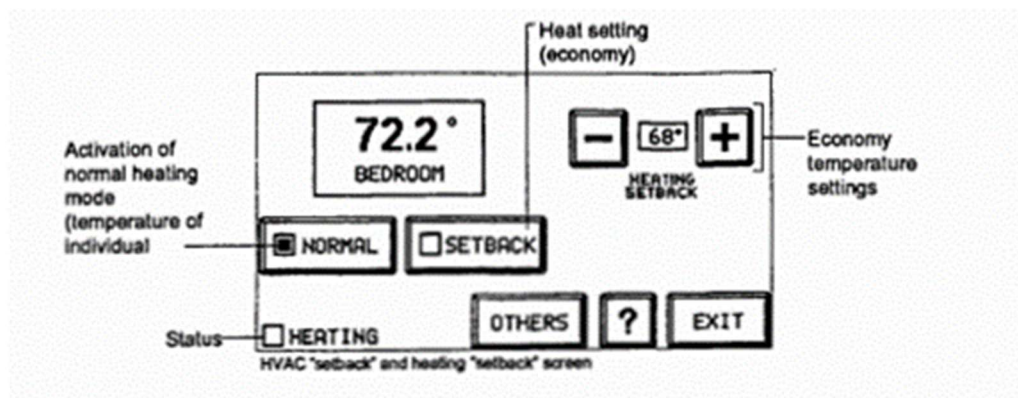


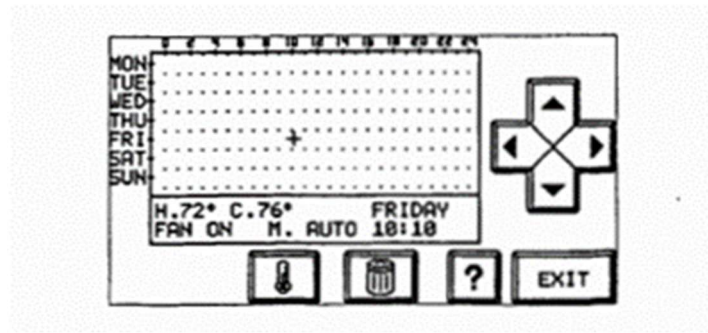
Ex. 1012, 7.

286. A POSITA would have understood *Cardio Manual*'s mode button icon as disclosing or at least rendering obvious the claimed "representation of a first virtual button" on the liquid crystal display. In the Disclaimer, Inventor Rosen refers to the same screen shot from page 7 of the *Cardio Manual* and represents that when a user presses the button representations, a control program receives input that a specific button has been pressed. Ex. 1014, 5. A POSITA would have understood the 'Mode' icon to be a virtual button at a predetermined position, given that this

icon appears on a touchscreen at a fixed position when a user accesses the thermostat control screen from the navigational menu, causing an operational change in the system when the icon is pressed.

287. A POSITA would have further understood that the control program established the representation of the virtual button on the screen, or at the very least this would have been obvious as the most logical implementation. For example, this was made obvious by *Cardio Manual*'s use of a dot matrix LCD, which requires a control program to establish the different screens. *Cardio Manual* discloses a system capable of displaying different buttons in the same physical location, on different screens as shown in *Cardio Manual*'s temperature control and scheduling screens. See Ex. 1014, 6.



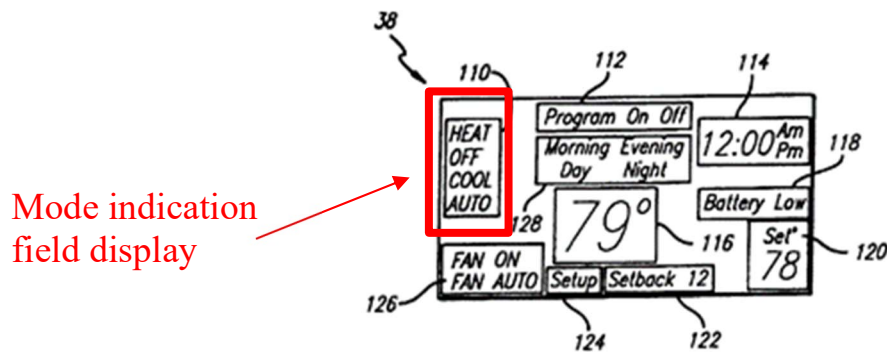


Id; see also Ex. 1012, 7, 23.

288. A POSITA would have understood that in order to have a device capable of displaying different screen content in the same physical location, on different screens, said device must utilize a dot-matrix LCD, which allows different screens to be established by a control program. For instance, in the Inventor's Deposition, Inventor Rosen admitted that the Cardio System is "a dot-matrix display" because it would not be possible "to get the screen that's at the bottom of page 5 and the screen that's at the top of page 5 if you weren't using a dot-matrix display." Ex. 1008, 217:7-19, 212:3-16. Thus, it would have been obvious for a POSITA to combine the thermostat system of Dushane with the touchscreen and dot-matrix LCD of Cardio Manual to provide a thermostat system with a control program capable of establishing virtual buttons at a predetermined position of an LCD. In order for the different buttons to appear on different screens, the control program must establish those buttons on the LCD at positions controlled by the software.

- j) **1[i]: b) a first legend indicative of a first control function of said thermostat, which first control function is for controlling a first space conditioning equipment component, which first control function is active when the first legend is viewable;**

289. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, and, alternatively, also in view of *Bier*, discloses element 1[i]. *Dushane* describes “a mode indication display field 110 which includes “HEAT”, “OFF”, “COOL” and “AUTO” sub-fields.” Ex. 1004, 11:20-22. A POSITA would have understood *Dushane*’s “mode indication field display” as disclosing multiple legends indicative of control functions of said thermostat that were active when the first legend is viewable because *Dushane*’s mode indication field display (“legend”) lists the sub-fields as modes (“control functions”) of the thermostat. Therefore, a POSITA would have understood one of *Dushane*’s sub-fields, such as HEAT, to be a legend indicative of an active first control function of said thermostat because the subfield HEAT is indicative of the first control function of the thermostat, the HEAT mode and that function is active.

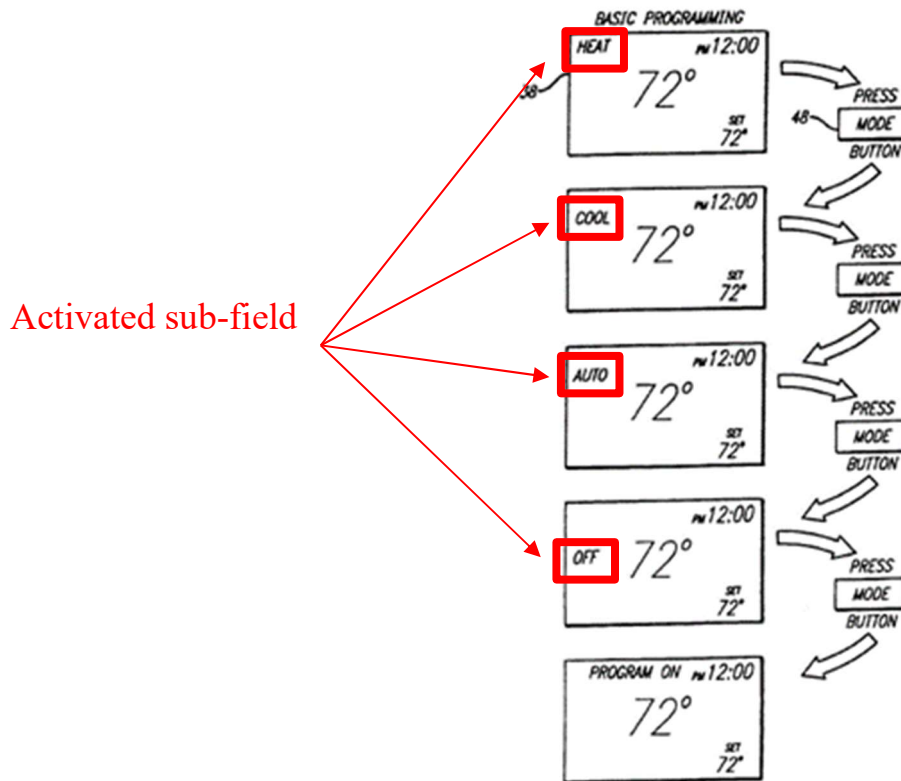


Id. at Fig. 4 (annotated). The same reasoning applies to the display of “COOL” during the COOL mode.

290. *Dushane* further teaches these different modes as controlling environmental control apparatuses. *Id.* at 12:50-59. For example, *Dushane* teaches to provide control signals to a “heating apparatus such as a furnace” during the HEAT mode and to provide control signals to “a cooling apparatus such as an air conditioner” during the COOL mode. *Id.* This also discloses to a POSITA that the legend is visible when the control function is active.

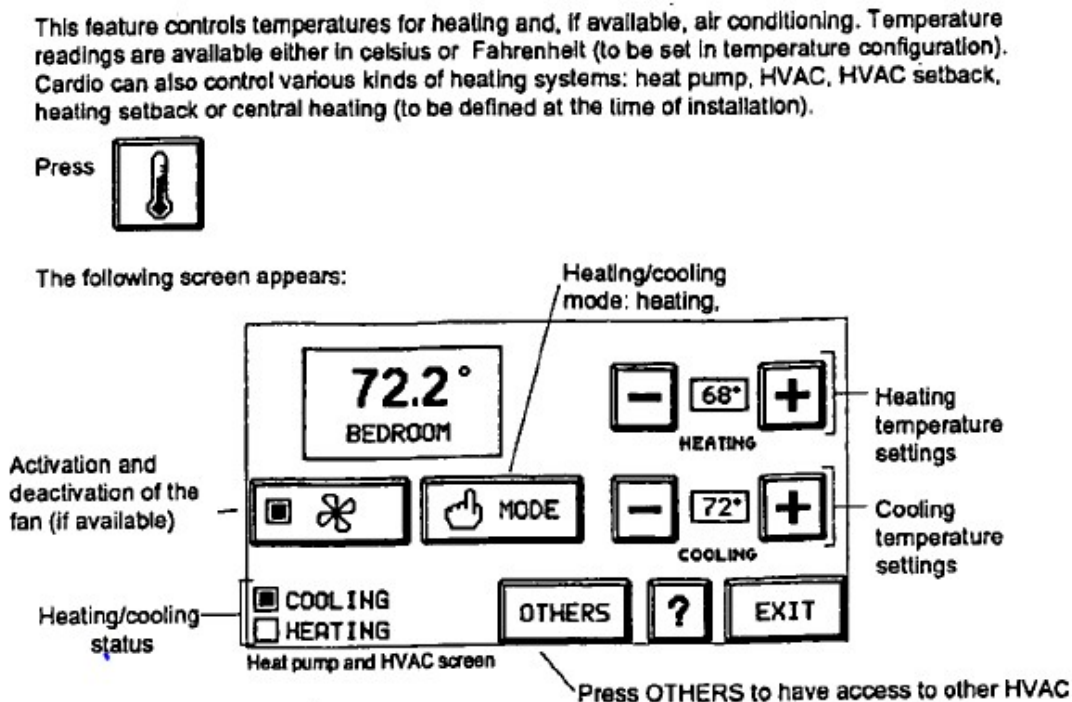
291. *Dushane* further teaches selectively establishing a first legend. *Dushane* discloses one of the sub-fields being activated when the corresponding “operating mode for the controlled apparatuses is selected.” *Id.* at 11:23-24. For example, *Dushane* describes providing a user “with a visible indication that a heating operation has been selected” “when the sub-field ‘HEAT’ is activated.” *Id.* at 11:24-26. “When the sub-field ‘COOL’ is activated, the user is provided with a visible indication that a cooling operation has been selected,” and when the sub-field

‘AUTO’ is illuminated, an indication is provided that “the system will automatically changeover between heat and cool modes as the temperature varies.” *Id.* at 11:27-34.



Id. at Fig. 6 (annotated) (shows *Dushane*’s mode indication display field displaying the subfield indicative of the activated mode). A POSITA would have understood that each legend is established on the screen by the software (control program) in response to pressing the mode button multiple times.

292. Thus, *Dushane* discloses element 1[i]. *Cardio Manual* also discloses this limitation. *Cardio Manual* discloses a legend that indicates what mode the thermostat is in. *See* Ex. 1012, 7.



Id.

293. The “legend” in *Cardio Manual* is the “heating/cooling status” indicators which a POSITA would have understood as having the appropriate box blackened in to indicate the mode that the thermostat was in. This legend is also “indicative of a first control function of said thermostat, which first control function is for controlling a first space conditioning equipment component, which first control function is active when the first legend is viewable.” This is so because the legend indicates a function of the thermostat (*e.g.* cooling) and a POSITA would have understood that in this mode the thermostat is controlling the air conditioning equipment. A POSITA would have further understood that the function of

controlling the air conditioning is active when the box is darkened next to the word “cooling.”

294. A POSITA would have understood that the software (control program) is controlling the screen display that establishes the legend on the display for the same reasons discussed above with respect to the virtual buttons. As discussed above, *Cardio Manual* discloses a dot-matrix screen. *Supra* §VII.D.2.i. In order for the buttons to be different on different screens and for accompanying legends to be different, the software must establish the buttons and legends on the screen each time the system needs to change to a different screen and each time the display on a single screen needs to be updated to change legends (e.g. when switching from heat to cool).

295. In IPR2022-01402, Patent Owner argued that a “legend” must be “displayed on a virtual button.” Ex. 1017, 5. The claim itself does not even indicate that the legend is associated with the virtual button; it merely requires the control program to establish the legend somewhere on the touch screen. Ex. 1001, 13:29-35. Moreover, the ’318 Patent states that the “image representative of a first virtual button may be shown on the touch screen display with graphics (alphanumeric characters and/or icons) on or *closely associated with* the first virtual button,” indicating that the legend may be closely associated with (i.e. next to) to virtual button, not just on the virtual button. *Id.* at 3:53-56. Thus, the legend need not be

“on” the virtual button and this limitation is disclosed by both *Dushane* and *Cardio Manual*.

296. To the extent that the Board agrees with Patent Owner that a legend must be “displayed on” a virtual button, the claim is still obvious. Having the legend on the button is simply a matter of design choice and a POSITA would have been motivated to include the legend on the button itself to save valuable real estate on the screen of the thermostat. As discussed in §VII.C.1.i above, *Bier* teaches that one could put a legend directly on a virtual button. *Supra* §VII.D.2.i. The same obviousness analysis as set forth in §VII.C.1.i applies here as well and makes it obvious to put the legend on the virtual buttons of *Cardio Manual*. *Supra* §VII.D.2.i. To be clear, *Dushane* and *Cardio Manual* are analogous art as discussed above in §VII.D.1.a and is analogous to *Bier* because all three references concern the use of buttons for control purposes. *Supra* §VII.D.1.a.

297. A person of ordinary skill in the art would have been motivated to include the legend indicative of the current state of a virtual button on the button itself per the teachings of *Bier*. It would have been obvious to use this type of button with the legend on it, especially given that there were only a few options: a) placing the legend on the button, or b) placing the legend near the button. A POSITA would have been making a routine design decision in choosing between two known options. Here, a POSITA would have placed the legend on the button, as taught by *Bier*, in

order to save space. Modifying *Dushane* (as modified by *Cardio Manual*) to incorporate the positioning of legends as disclosed in *Bier* would merely involve the simple substitution of one known element (*Cardio Manual*'s positioning of legends) for another (*Bier*'s positioning of legends) to obtain predictable results (a thermostat system with a legend indicative of the current control function positioned directly on the virtual button, where said legend changes to indicate the current control function).

298. *Bier* is analogous art to the '318 Patent, *Dushane*, and *Cardio Manual*, because it is reasonably pertinent to the user interfaces of thermostat systems, like the '318 Patent, *Dushane*, and *Cardio Manual*. See Ex. 1004, 16:45-51; Ex. 1012, 3. *Bier* relates to user interface design in computers—specifically the use of buttons for control purposes. Ex. 1010, 3. Thermostat systems conventionally include digital user interfaces that, like computer interfaces, are designed to be easily programmable by users and may include virtual buttons. Therefore, computer user interface design would logically commend itself to an inventor's attention in considering issues with designing thermostat user interfaces. Thus, *Bier* is analogous art to the '318 Patent, *Dushane*, and *Cardio Manual*.

299. A POSITA would have had a reasonable expectation of success in doing so because this is a simple matter of changing the graphic display of the button

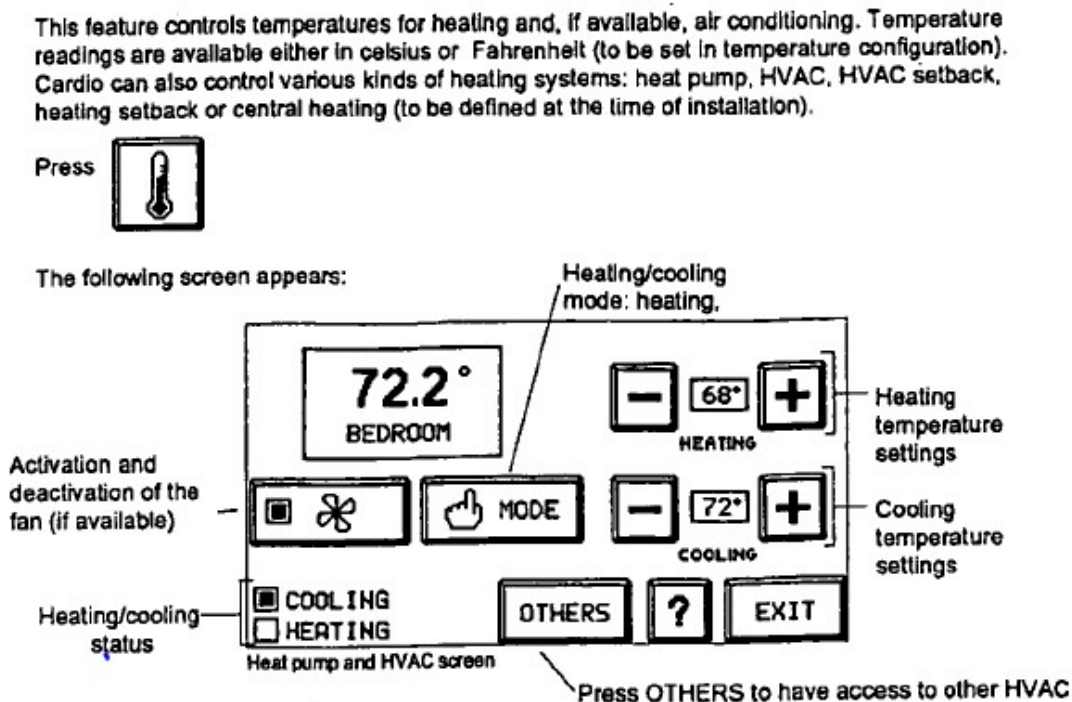
on the LCD-a simple software change. This would be facilitated by *Cardio Manual's* LCD, which is a dot matrix LCD. Ex. 1008, 212:6-9.

300. It would have been obvious to a POSITA to apply *Bier's* teachings concerning the positioning of a legend indicative of the control function to the system of *Dushane* and *Cardio Manual*. After taking the obvious step of combining *Cardio Manual's* touchscreen and virtual buttons with the programmable thermostat system of *Dushane*, it would have been obvious to use the positioning of the legends of *Bier* in the combined system. Doing so would have merely involved applying a known technique (having a legend indicative of a control function associated with a virtual button) to a known device (*Cardio Manual's* thermostat system). It also would have been obvious to apply *Bier's* teachings concerning the positioning of a legend indicative of the control function to the system of *Dushane* and *Cardio Manual* in order to conserve space on the screen. Thus, when *Cardio Manual's* teachings are applied to *Dushane*, *Dushane's* thermostat system selectively establishes *Cardio Manual's* legends indicative of the current control function adjacent to the virtual button. When *Bier's* teachings are applied to the combined *Dushane-Cardio Manual* system, *Dushane's* thermostat system selectively establishes its legends indicative of the current control function on *Cardio Manual's* virtual button, as disclosed by *Bier*. Thus, *Dushane*, in view of *Cardio Manual* and/or *Bier*, discloses element 1[i].

k) 1[j]: 2) read the position on the touch pad juxtaposed with said first predetermined position on said liquid crystal display to determine if the representation of said first virtual button has been touched;

301. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, discloses element 1[j]. *Dushane* discloses having a display with “a liquid crystal display (LCD) 66.” Ex. 1004, 9:38. However, *Dushane* does not disclose reading “the position on the touch pad juxtaposed with said first predetermined position on said liquid crystal display to determine if the representation of said first virtual button has been touched.”

302. *Cardio Manual* discloses having a virtual ‘Mode’ icon, to switch between the heating and cooling modes. Ex. 1012, 7.



Id.

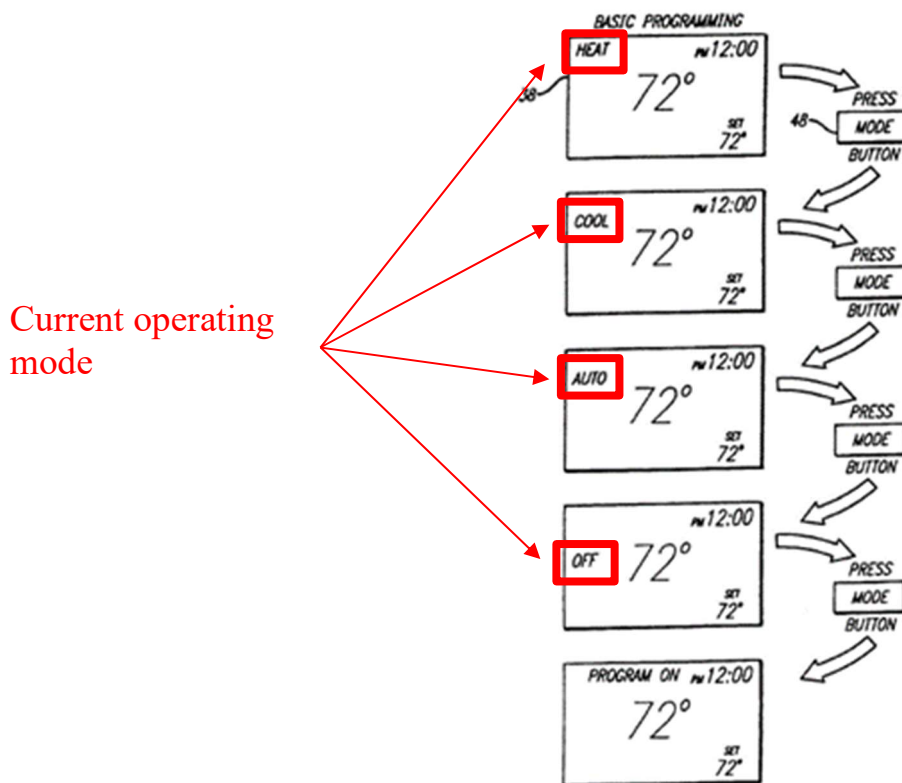
303. It is not clear from *Cardio Manual* how it is determined whether the virtual mode button has been pressed. However, a POSITA would have found it obvious to make that determination by using software to read the position on the touch screen juxtaposed with the predetermined position of the virtual icon to determine if the representation of said virtual mode button has been touched. There were only a few ways to determine the position of a touch: (a) an interrupt can be generated when the screen is touched, and the processor can then read the location; or (b) the processor could repeatedly poll to read the location of any touch of the screen. Either way it was obvious to read the location of the touch (e.g. x-y

coordinate) of the LCD screen. According to Inventor Rosen, it is within the common knowledge of a POSITA that there were touchscreens that allowed determination by a program if a specific location (the virtual button) had been touched by reading the position on the touch pad juxtaposed with a first predetermined position on said liquid crystal display. Ex. 1008, 160:1-161:6. Because it was common knowledge of a POSITA that a touch screen could read the position on the touch pad juxtaposed with a predetermined position on an LCD to determine if a virtual button had been pushed, it would have been obvious for a POSITA to create a control program to perform this function. A POSITA would have been motivated to do so as one design choice for determining if a button had been pushed. Once virtual buttons are created on a touch screen, they are only useful if a POSITA can determine if they have been pushed. Thus, this is one known method to determine whether a button has been pushed. Because it is a known method, as acknowledged by Inventor Rosen, a POSITA would have a reasonable expectation of success in employing a program to perform the recited function.

l) 1[k]: 3) if the first virtual button has been touched: a) determining that the thermostat has been directed to control a second space conditioning equipment component;

304. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, discloses element 1[k]. *Dushane* discloses a system with various operating

modes, including a HEAT mode where signals are “provided to a heating apparatus such as a furnace,” and a COOL mode where signals are “provided to a cooling apparatus such as an air conditioner.” Ex. 1004, 12:50-59; *see Supra*, §VII.D.2.j. *Dushane* further discloses transitioning “between the aforementioned operating modes ... by pressing the mode button 48.” Ex. 1004, 12:66-67.

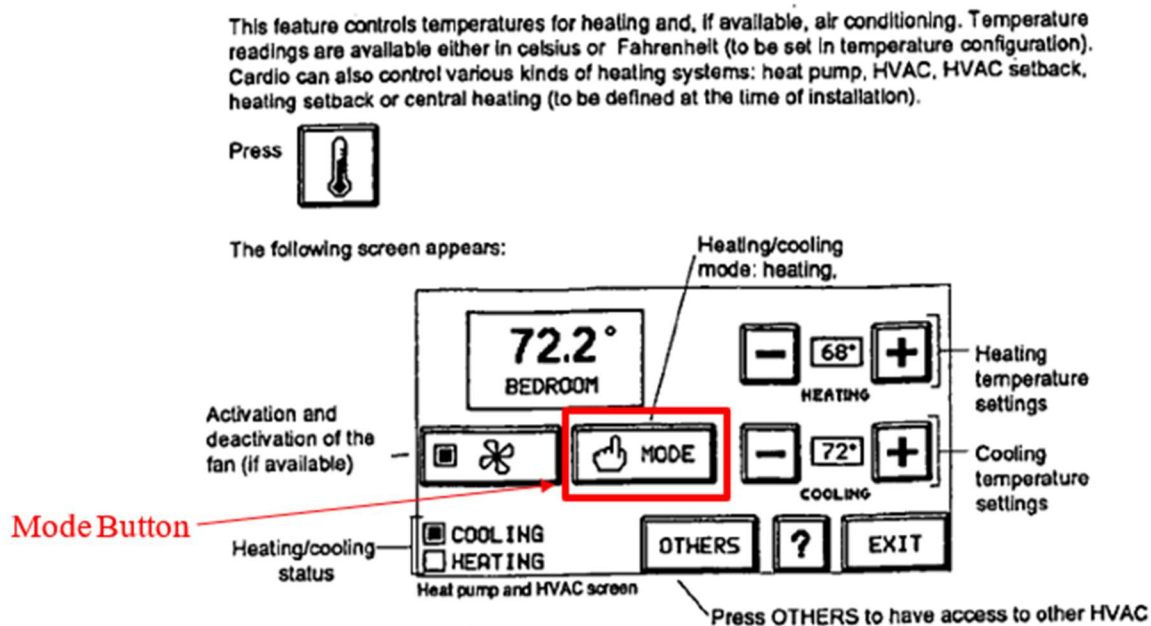


Id. at Fig. 6 (annotated).

305. A POSITA would have understood that when *Dushane*’s system is in HEAT mode and thus controlling a heating apparatus, pressing the mode button would cause the system to determine that it has been switched to COOL mode, and thus directed to control a second piece of space conditioning equipment, a cooling

apparatus. *Dushane* discloses pressing a physical button to determine that the system has been directed to control a second piece of space conditioning equipment. *Id.* at Fig. 6, 12:66-67. When *Dushane*'s system is combined with *Cardio Manual* as discussed above, *Dushane*'s physical buttons are implemented with *Cardio Manual*'s touchscreen and virtual buttons such that the combined system discloses pressing a virtual button to determine that the system has been directed to control a second piece of space conditioning equipment. *Supra*, §VII.D.2.i-j.

306. *Cardio Manual* discloses the virtual mode button to switch between heating mode and cooling mode:



Ex. 1012, 7 (annotated).

307. A POSITA would have understood that when the mode button is touched, the thermostat would change between heating and cooling mode and an indication of the mode would be indicated in the boxes for “heating/cooling status.” Ex. 1014, 5. A POSITA would have further understood that the thermostat would control a cooling device while in cooling mode and a heating device when in heating mode. Otherwise, the thermostat would not function properly.

m) 1[l]: b) activating a second control function for controlling the second space conditioning equipment component; and

308. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, discloses element 1[l]. *Dushane* discloses element 1[l] in multiple ways. For example, *Dushane* discloses having a HEAT mode where signals are “provided to a heating apparatus such as a furnace,” and a COOL mode where signals are “provided to a cooling apparatus such as an air conditioner.” Ex. 1004, 12:50-59; *see Supra*, §VII.D.2.1. *Dushane* further discloses transitioning between these modes “by pressing the mode button 48.” Ex. 1004, 12:66-67. A POSITA would have understood that when *Dushane*’s system is in HEAT mode and thus controlling a heating apparatus, pressing the mode button would activate a second control function, COOL mode, for controlling a second piece of space conditioning equipment, a cooling apparatus.

309. As discussed in the prior section, this limitation is also disclosed by *Cardio Manual* because a POSITA would have understood that when one switches from cooling mode to heating mode by pressing the virtual mode button, the cooling apparatus is turned off and the heating apparatus is activated and vice versa. *Supra*, §VII.D.2.1. Once the new mode is entered, a POSITA would have understood that a control function for the new mode is activated. Otherwise, the system would not function properly.

n) 1[m]: c) displaying on said liquid crystal display a second legend indicative of said second control function of said thermostat, which second control function is for controlling the second space conditioning equipment component, which second control function is active when the second legend is viewable.

310. For the same reason that element 1(i) is disclosed, *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA and, alternatively, also in view of *Bier*, discloses element 1(m). If the first legend concerns heating when referring to element 1(i), then the second legend would be concerning cooling for element 1(m) or vice versa. *Supra*, §VII.D.2.j. The same reasoning as for the first legend for element 1(i) would apply to element 1(m) for the second legend. *Supra*, §VII.D.2.j.

3. Claim 3: The programmable thermostat system of claim 1 in which the space conditioning equipment components include at least one of: a heater, a compressor type air conditioner and a heat pump.

311. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA discloses Claim 3. *Dushane's* thermostat system includes “various combinations of environmental control apparatuses selected from a group comprising, for example, a heater, an air conditioning unit, a fan and heat pump.” Ex. 1004, 8:17-20. *Dushane* further teaches that its thermostat system can be “modified to accommodate a fan, compressor and reversing valve.” *Id.* at 8:28-29.

4. Claim 4: The programmable thermostat system of Claim 3 in which if the first virtual button is been touched again after step D)3), determining that the thermostat controls a third space conditioning equipment component, activating a third control function for controlling the third space conditioning equipment component, and changing the second legend to a third legend indicative of the third control function of the thermostat.

312. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA and *Bier*, discloses and/or renders obvious Claim 4. As previously mentioned, *Dushane*, in view of *Cardio Manual*, discloses determining whether a virtual button has been touched and activating a second control function for controlling a second space conditioning equipment. *See Supra*, §VII.D.2.1-n. *Dushane* teaches a thermostat system that “can be modified to control additional

and/or other apparatuses and devices such as a two-stage heat pump can be alternatively employed.” Ex. 1004, 8:31-33. A POSITA would have understood that if the system is modified to control additional apparatuses that a new mode would be displayed to indicate to a user that the additional apparatus is being controlled. A POSITA would have further understood that the control program would be modified to perform the same functions previously performed for switching between the first and second modes. Thus, after a third piece of space conditioning is added, it would have been obvious to modify the control program to control the thermostat such that “if the first virtual button is been touched again after step D)3), determining that the thermostat controls a third space conditioning equipment component, activating a third control function for controlling the third space conditioning equipment component, and changing the second legend to a third legend indicative of the third control function of the thermostat.” It would have been obvious to a POSITA to have the thermostat operate in this matter for the additional equipment that is added as taught by *Dushane* so that the thermostat operation was intuitive to the user—e.g. the thermostat would act in essentially the same way when switching from the first mode to the second mode as when it switched from the second mode to the third mode. For the same reasons a POSITA would have had a reasonable expectation of success as to elements 1[h]-1[m], a POSITA would have

the same reasonable expectation of success here because the control program is performing substantially the same functions.

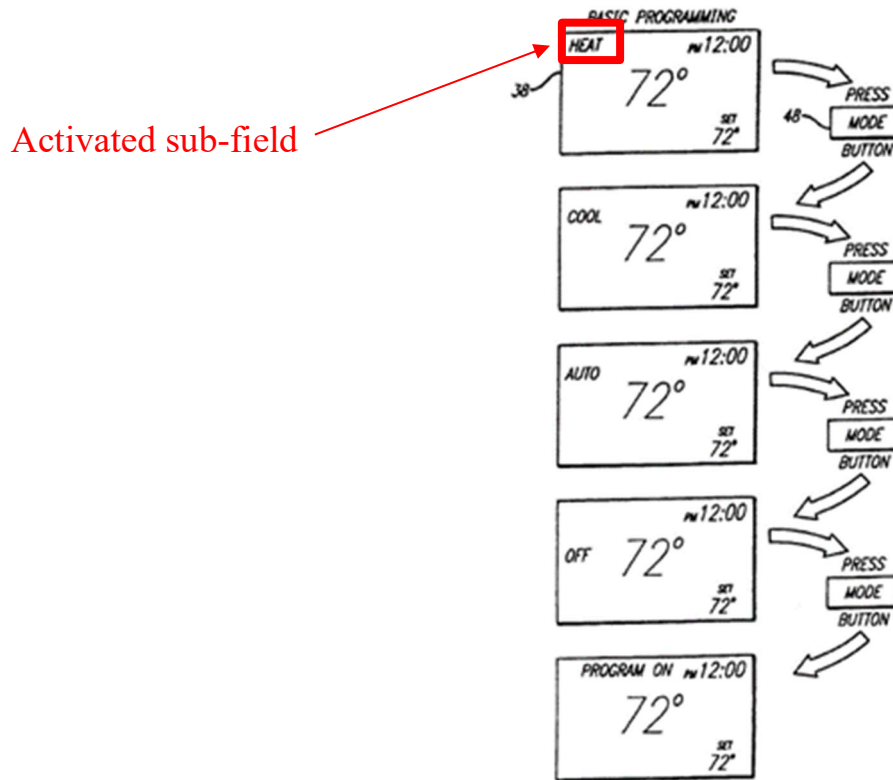
313. To the extent that the *Dushane-Cardio Manual* combination does not disclose having “third legend indicative of the third control function,” because the legend must be on the button, then *Bier* makes it obvious to have such a legend for the same reasons discussed above with respect to limitations 1[i] and 1[m]. *Supra* §VII.D.2.j, §VII.D.2.n.

5. Claim 5: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heater and the graphic includes the word “heat” associated with said virtual button when the heater is controlled.

314. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, or further in combination with *Bier*, discloses Claim 5. *Dushane* describes a thermostat system including “various combinations of environmental control apparatuses selected from a group comprising, for example, a heater.” Ex. 1004, 8:17-19. *Dushane* further describes a system with various operating modes, including a HEAT mode where signals are “provided to a heating apparatus such as a furnace.” *Id.* at 12:56-57. A POSITA would have understood that a heating apparatus is a heater.

315. *Dushane* describes “a mode indication display field 110 which includes “HEAT”, “OFF”, “COOL” and “AUTO” sub-fields,” where users are provided

“with a visible indication that a heating operation has been selected” “when the sub-field ‘HEAT’ is activated.” *Id.* at 11:20-22; 11:24-26.



Id. at Fig. 6 (annotated to show the HEAT sub-field, which appears when the system is directed to the HEAT mode).

316. Thus, *Dushane* discloses Claim 5 except that the button in *Dushane* is not a virtual button.

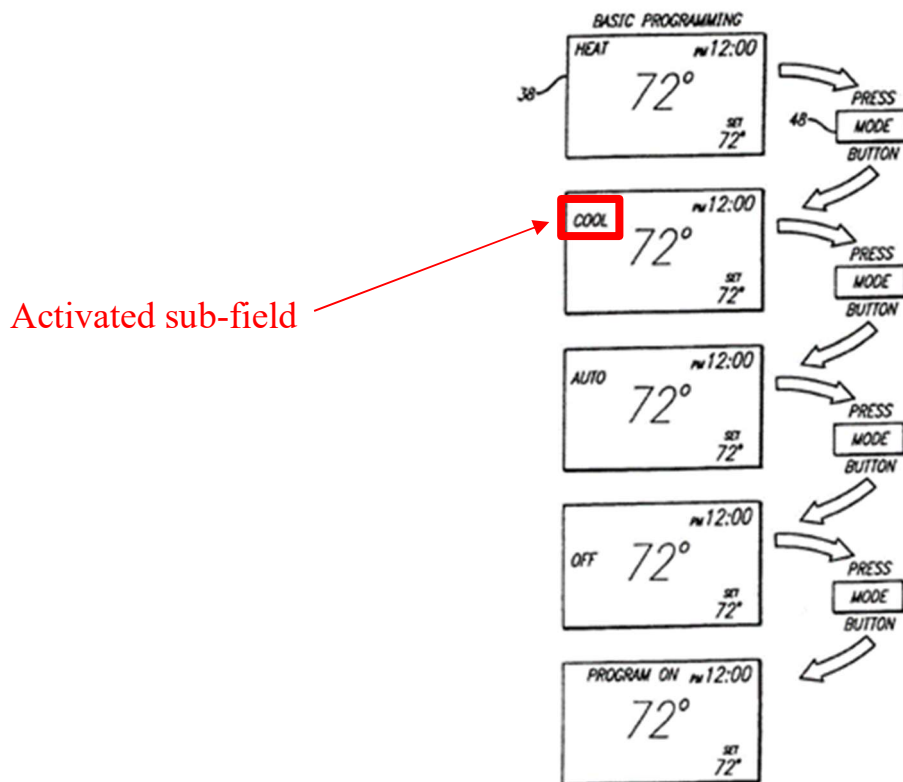
317. However, the combination of *Dushane* and *Cardo Manual* discloses this claim because a POSITA would have understood that the heater is activated when the word “heating” appears on the screen of *Cardo Manual* with the black box checked next to it. To the extent that the “graphic” must be on (and not merely

associated with) the virtual button, then this limitation is obvious further in light of *Bier* for the same reasons discussed above with respect to elements 1[i] and 1[m].
Supra §VII.D.2.j, §VII.D.2.n.

6. Claim 7: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is an air conditioning system and the graphic includes the word “cool” associated with said virtual button when the air conditioning system is controlled.

318. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, or further in combination with *Bier*, discloses Claim 7. *Dushane* describes a thermostat system including “various combinations of environmental control apparatuses selected from a group comprising, for example, a heater, **an air conditioning unit**, a fan and heat pump.” Ex. 1004, 8:17-20. *Dushane* further describes a system with various operating modes, including a COOL mode where signals are “provided to a cooling apparatus such as an air conditioner.” *Id.* at 12:58-59.

319. *Dushane* describes “a mode indication display field 110 which includes “HEAT”, “OFF”, “COOL” and “AUTO” sub-fields,” where “the user is provided with a visible indication that a cooling operation has been selected” when “the sub-field ‘COOL’ is activated.” *Id.* at 11:19-22; 11:27-29.



Id. at Fig. 6 (annotated to show the COOL sub-field, which appears when the system is directed to the COOL mode).

320. *Dushane* does not disclose that the term “cool” is associated with a virtual button.

321. However, the combination of *Dushane* and *Cardo Manual* discloses this claim because a POSITA would have understood that the cooling equipment is activated when the word “cooling” appears on the screen of *Cardo Manual* with the black box checked next to it. To the extent that the “graphic” must be on (and not merely associated with) the virtual button, then this limitation is obvious further in

light of *Bier* for the same reasons discussed above with respect to elements 1[i] and 1[m]. *Supra* §VII.D.2.j, §VII.D.2.n.

7. Claim 9: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “heat” associated with said virtual button when the heat pump is controlled while operating in its heating mode.

322. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, or further in combination with *Bier*, discloses Claim 9. The analysis is the same as Claim 5, except that the “heater” of Claim 5 is now required to be a “heat pump” in Claim 9. *Supra*, §VII.D.5. The remainder of the claim, other than the heat pump, is disclosed for the same reasons that the remainder of Claim 5 other than heater was disclosed for Claim 5. *Dushane* discloses the heat pump limitations--it describes a thermostat system including “various combinations of environmental control apparatuses selected from a group comprising, for example, a heater, an air conditioning unit, a fan and **heat pump.**” Ex. 1004, 8:17-20. *Dushane* further illustrates an embodiment where the system’s microprocessor is programmed to “expect an electric heat data bit and a heat pump data bit.” *Id.* at 8:21-22. *Dushane* describes a system with various operating modes, including a HEAT mode where signals are “provided to a heating apparatus such as a furnace.” *Id.* at 12:56-57. A

POSITA would have understood that a heating apparatus includes a heat pump.

Thus, Claim 9 is disclosed and/or rendered obvious.

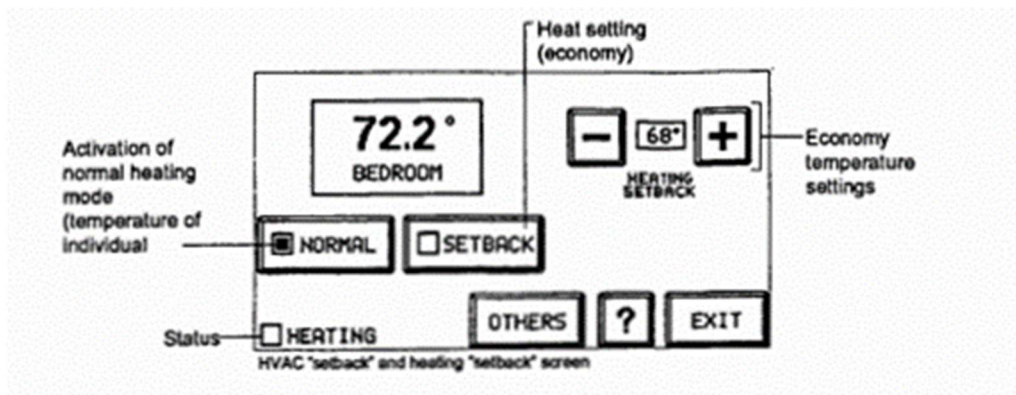
8. Claim 11: The programmable thermostat system of claim 4 in which one of the space conditioning equipment components is a heat pump and the graphic includes the word “cool” associated with said virtual button when the heat pump is controlled while operating in its cooling mode.

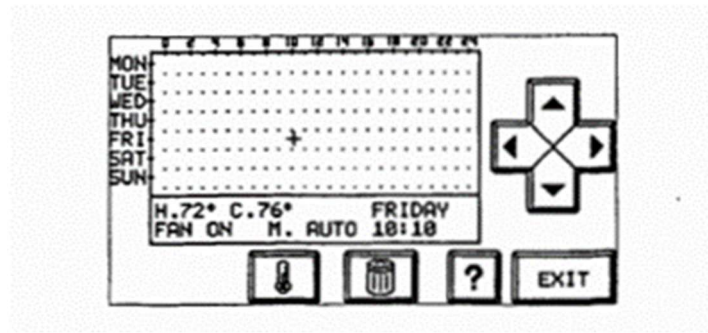
323. *Dushane*, in view of *Cardio Manual* and the general knowledge of a POSITA, or further in combination with *Bier*, discloses Claim 11. The analysis is the same as Claim 7, except that the “air conditioning system” of Claim 7 is now required to be a “heat pump” in Claim 11. *Supra*, §VII.D.6. The remainder of the claim, other than the heat pump, is disclosed for the same reasons that the remainder of Claim 7 other than the air conditioning system was disclosed for Claim 7. Claim 11 is obvious in light of *Dushane*. *Dushane* describes a thermostat system including “various combinations of environmental control apparatuses selected from a group comprising, for example, a heater, an air conditioning unit, a fan and **heat pump**.” Ex. 1004, 8:17-20. *Dushane* further describes a system with various operating modes, including a COOL mode where signals are “provided to a cooling apparatus such as an air conditioner.” *Id.* at 12:58-59. A POSITA would have understood that a cooling apparatus can include a heat pump. Thus, the disclosure of providing signals to a “cooling apparatus” discloses to a POSITA providing signals to any type

of cooling apparatus, such as a heat pump. To the extent that *Dushane* does not disclose a heat pump in a cooling mode with the word “cool” displayed, it would have been obvious to display “cool” when a heat pump was used for cooling so that the user would have understood that the heating pump actually was in cooling mode. A POSITA would have had a reasonable expectation of success because heat pumps operate in a cooling mode and displaying the graphic on the screen with the word “cool” is a simple matter of programming the thermostat to display “cool” when the heat pump is being operated to cool the conditioned space.

9. Claim 14: The programmable thermostat system of claim 1 in which said liquid crystal display is a dot matrix type.

324. *Cardio Manual* discloses Claim 14. As discussed above, *Dushane* in combination with *Cardio Manual*, and *Bier* render Claim 1 obvious. *Supra*, §VII.D.2. *Cardio Manual* further discloses a system capable of displaying different buttons in the same physical location, on different screens as shown in *Cardio Manual*’s temperature control and scheduling screens. See Ex. 1014, 6.





Id; see also Ex. 1012, 7, 23.

325. For example, the SETBACK button on the bottom screen on page 7 in *Cardio Manual* is in the same physical location as the scheduling chart in the screen on page 23 in *Cardio Manual*. Ex. 1012, 7, 23; see also Ex. 1014, 6. A POSITA would have understood that in order to have a device capable of displaying different screen content in the same physical location, on different screens, said device must utilize a dot-matrix LCD. For example, in the Inventor's Deposition, Inventor Rosen admitted that the Cardio System is "a dot-matrix display" because it would not be possible "to get the screen that's at the bottom of page 5 and the screen that's at the top of page 5 if you weren't using a dot-matrix display." Ex. 1008, 217:7-19, 212:3-16.

VIII. SECONDARY CONSIDERATIONS

326. During prosecution of the '318 Patent, the applicant did not identify any evidence of secondary considerations of non-obviousness tied to the claimed invention of the '318 Patent. I understand from counsel for Petitioner that Patent Owner in the co-pending district court litigation has not yet identified any evidence

with respect to secondary considerations of non-obviousness. I am also unaware of any secondary considerations of non-obviousness that would suggest validity of the claims at issue.

327. Accordingly, there is currently no objective evidence of non-obviousness that might warrant a finding that Claims 1,3-5, 7, 9, 11, and 14 are patentable. To the extent the Patent Owner at a later date cites or provides any other evidence regarding secondary considerations, including any expert opinions, I reserve the right to supplement my analysis and opinions to address it.

IX. CONCLUSION

328. For at least the above-described reasons, in my opinion Claims 1, 3-5, 7, 9, 11 and 14 of the '318 Patent would have been obvious to a POSITA based on the prior art references that I have cited and analyzed above.

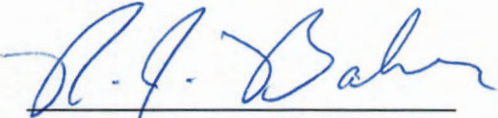
329. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

330. I reserve the right to supplement my opinions in the future to respond to any arguments raised by Patent Owner and to consider any new information that becomes available to me.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed this 27th day of March 2023, in LAS VEGAS, NV.

Respectfully submitted,


R. Jacob Baker, Ph.D., P.E.

APPENDIX A

R. JACOB (JAKE) BAKER, PH.D., P.E.

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Independent Consultant

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PROFESSIONAL SUMMARY

Russel Jacob (Jake) Baker, Ph.D., P.E. (IEEE Student Member 1983, Member 1988, Senior Member 1997, and Fellow 2013) was born in Ogden, Utah, on October 5, 1964. He received the B.S. and M.S. degrees in electrical engineering from the University of Nevada, Las Vegas, in 1986 and 1988. He received the Ph.D. degree in electrical engineering from the University of Nevada, Reno in 1993. His Google Scholar profile is [here](#) and his ResearchGate profile is [here](#).

From 1981 to 1987 he served in the United States Marine Corps (from September of 1982 in the Reserves, Fox Company, 2nd Battalion, 23rd Marines, 4th Marine Division). From 1985 to 1993 he worked for E. G. & G. Energy Measurements and the Lawrence Livermore National Laboratory designing nuclear diagnostic instrumentation for underground nuclear weapons tests at the Nevada Test Site. During this time, he designed, and oversaw the fabrication and manufacture of, over 30 electronic and electro-optic instruments including high-speed cable and fiber-optic receiver/transmitters, PLLs, frame- and bit-syncs, data converters, streak-camera sweep circuits, Pockels cell drivers, micro-channel plate gating circuits, and analog oscilloscope electronics. From 1991-1992 he was an adjunct faculty member in the department of electrical engineering at the University of Nevada, Las Vegas (UNLV). From 1993 to 2000 he served on the faculty in the department of electrical engineering at the University of Idaho (UI), first as an untenured Assistant Professor and then from 1998 as a tenured Associate Professor. In 2000 he joined a new electrical and computer engineering (ECE) program at Boise State University (BSU) where he was promoted to Full Professor in 2002. He then served as the ECE department chair at BSU from 2004 to 2007. At BSU he helped establish graduate programs in ECE including, in 2006, the university's second PhD degree. In 2012 he re-joined the faculty at UNLV as a tenured Full Professor of ECE. During his service at the UI, BSU, and UNLV he has been the major professor to more than [100 graduate students](#). In addition to this industry and academic experience, he has done consulting, both technical and expert witness, for over [200 companies](#).

Over the last 35+ years his [research/development interests](#) and [publications](#) have been, or currently are, focused on: analog-to-digital/digital-to-analog data conversion and transmission, optoelectronics (imagers, displays, LIDARs, APDs, SiPMs, and associated electronics), analog and digital integrated circuit design and fabrication, design of diagnostic electrical and electro-optic instrumentation for scientific research, integrated electrical/biological circuits and systems, array (memory, imagers, and displays) fabrication and design, CAD tool development and online tutorials, low-power interconnect and packaging (electrical and optical) techniques, design of wired/wireless communication and interface circuits, circuit design for the use and storage of renewable energy, power electronics and power supply design, and the delivery of [online engineering education](#).

Dr. Baker is the named inventor on over [150 US patents](#). He is a member of the honor societies Eta Kappa Nu and Tau Beta Pi, a licensed Professional Engineer, a popular lecturer that has delivered over [50 invited talks](#) around the world, an IEEE Fellow, and the author of the books CMOS Circuit Design, Layout, and Simulation, CMOS Mixed-Signal Circuit Design, and a coauthor of DRAM Circuit Design: Fundamental and High-Speed Topics. He received the 2000 Best Paper Award from the IEEE Power Electronics Society, the 2007 Frederick Emmons Terman Award,

the 2011 IEEE Circuits and Systems Education Award and the 2021 Wiley-IEEE Press Textbook Award for the 4th Edition of his book CMOS Circuit Design, Layout, and Simulation.

His service activities include the IEEE Press Editorial Board (1999-2004), editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018), the Technical Program Chair of the 2015 IEEE 58th International Midwest Symposium on Circuits and Systems (MWSCAS 2015), the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016), Distinguished Lecturer for the SSCS (2012-2015), Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for the IEEE Solid-State Circuits Magazine, IEEE Kirchhoff Award Committee (2020-2023), and advisor for the student branch of the IEEE at UNLV (2013-2023).

INDUSTRY EXPERIENCE

2008 - present: Expert witness in intellectual property disputes in electrical, electro-optic, and computer engineering matters for: 1) district court and ITC patent disputes, 2) inter partes reviews at the PTAB, and 3) arbitrations and mediations.

2013 - 2022: Worked with Freedom Photonics, Santa Barbara, CA, on the integration, fabrication and design, of optoelectronics with CMOS integrated circuits. Work includes the design of compact optical transceivers for range finding applications, high-efficiency integrated silicon avalanche photodetectors for quantum key receivers, Geiger mode SiGe receivers for long-range communications, cryptography, and the fabrication of near-infrared focal plane arrays. Packaging and testing of numerous chips fabricated in both CMOS and SiGe technologies using LEDs, ILDs, PIN, APDs, and ROICs.

2017 - 2019: Worked with Vorpil Research Systems, Las Vegas, NV on the design of integrated circuit electronics and optoelectronics for optical transceivers used in LIDARs/LADARs.

2016 - 2019: Worked with Attollo Engineering on the design of transient digitizers for the capture of high-speed signals for range finders using LEDs and lasers in compact optical transceivers.

2013 - 2018: Working with Mission Support and Test Services, LLC (MSTS, formerly National Security Technologies, LLC, [NSTec]) on the Design and Fabrication of Integrated electrical/photonics application specific integrated circuit (ASIC) design for use in the implementation of diagnostic instrumentation.

2013 - 2015: Consultant for OmniVision. Working on integrating CMOS image sensors (CIS) with memory for very high-speed consumer imager products. Design specialty DRAM, high-speed interfaces between CIS and DRAM, packaging techniques to pair the CIS with DRAM.

2010 - 2013: Worked with Arete' Associates on the design of high-speed compressive transimpedance amplifiers for LADAR projects and the design of ROIC unit cells. Work funded by the U. S. Air Force.

2013: Cirque, Inc. Consulting on the design of analog-to-digital interfaces for capacitive touch displays and pads.

2012: Consultant at Lockheed-Martin Santa Barbara Focal Plane Array. CMOS circuit design and fabrication for the development and manufacture of infrared components and imaging systems with an emphasis on highest sensitivity Indium Antimonide (InSb) focal plane arrays (FPAs) in linear through large staring formats. Product groups include FPAs, integrated dewar assemblies (IDCAs), camera heads, high-speed interfaces between image processors and imaging systems, and infrared imaging systems.

2010 - 2012: Working with Aerius Photonics (and then FLIR Inc. when Aerius was purchase by FLIR) on the design of Focal Plane Arrays funded (SBIRs and STTRs) by the U.S. Air Force, Navy, and Army. Experience with readout integrated circuits (ROICs) and the design/layout of photodetectors in standard CMOS.

2009 - 2010: Sun Microsystems, Inc. (and then Oracle) VLSI research group. Provided consulting on memory circuit design/fabrication and proximity connection (PxC) interfaces to DRAMs and SRAMs for lower power, 3D packaging, for memory modules and controllers implemented with FPGAs and custom ASICs.

2009 - 2010: Contour Semiconductor, Inc. Design of NMOS voltage and current references as well as the design of a charge pump for an NMOS memory chip.

1994 - 2008: Affiliate faculty (Senior Designer), Micron Technology. Designed CMOS circuits for DRAMs including DLLs, PLLs for embedded graphics chips, voltage references and regulators, data converters, field-emitting display drivers, sensing for MRAM (using delta-sigma data conversion topologies), SRAMs, RFIDs, CMOS active pixel imagers and sensors, power supply design (linear and switching), input buffers, etc. Worked on a joint research

project between Micron and HP labs in magnetic memory fabrication and design using the MTJ memory cell. Worked on numerous technologies ranging from LED lighting to medical imaging using CMOS image sensors (too many to list) resulting in numerous US patents (see following list). Considerable experience working with product engineering to ensure high-yield from the production line from fabrication to test. Co-authored a book on DRAM circuit design through the support of Micron. Gained knowledge in the entire memory design process from fabrication to packaging. Developed, designed, and tested circuit design techniques for multi-level cell (MLC) Flash memory using signal processing.

January 2008: Consultant for Nascentric located in Austin, TX. Provide directions on circuit operation (DRAM, memory, and mixed-signal) for fast SPICE circuit simulations.

May 1997 - May 1999: Consultant for Tower Semiconductor, Haifa, Israel. Designed CMOS integrated circuit cells for various modem chips, interfaces, and serial buses including USB circuits, charging circuits based upon power up/down circuits using an MOS or bandgap reference, pre-amplifiers, comparators, etc.

Summer 1998: Consultant for Amkor Wafer Fabrication Services, Micron Technology, and Rendition, Inc., Design PLLs and DLLs for custom ASICs and a graphics controller chip.

Summers 1994 - 1995: Micron Display Inc. Designing phase locked loop for generating a pixel clock for field emitting displays and a NTSC to RGB circuit on chip in NMOS. These displays are miniature color displays for camcorder and wrist watch size color television. Worked on the fabrication and design of video peripheral circuits for these displays.

September - October 1993: Lawrence Berkeley Laboratory. Designed and constructed a 40 A, 2 kV power MOSFET pulse generator with a 3 ns rise-time and 8 ns fall-time for driving Helmholtz coils.

Summer 1993: Lawrence Livermore National Laboratory, Nova Laser Program. Researched picosecond instrumentation, including time-domain design for impulse radar and imaging.

December 1985 - June 1993: (from July 1992 to June 1993 employed as a consultant while finishing up my Ph.D.), E.G.&G. Energy Measurements Inc., Nevada, Senior Electronics Design Engineer. Responsible for the design and manufacturing of instrumentation used in support of Lawrence Livermore National Laboratory's Nuclear Test Program. Responsible for designing and fabricating over 30 electronic and electro-optic instruments including: CCD camera design, communication networks, fiber optic transmitters employing high speed laser drive electronics, receivers employing envelop tracking for DC voltage restoration and regeneration of received information, receiver low noise amplifier design, frame synchronizers for re-assembling transmitted images, high-speed SRAM memory system design with battery back-up, calibration equipment design such as a tunnel diode pulse generator for testing compensation of oscilloscopes and DAC design for calibrating CCD readout electronics, power supply and battery charger designs, sweep circuits for streak cameras, Pockel's cell drive electronics, vertical amplifier design using HBTs for analog oscilloscopes used at the Nevada Test Site, and 10 kV ramp designs using a planar triode to name some of the designs.

This position provided considerable fundamental grounding in EE with a broad exposure ranging from the design of PC boards to, for example, the design of cable equalizers. Summarizing, gained experience in circuit design technologies including: bipolar, vacuum tubes (planar triodes for high voltages), hybrid integrated circuit fabrication and design, GaAs (high speed logic and HBTs), Mach-Zehnder interferometers, Pockels cells, krytrons, power MOSFETs, microwave techniques, power supplies, fiber optic transmitters/receivers, etc.

Summer 1985: Reynolds Electrical Engineering Company, Las Vegas, Nevada. Gained hands on experience in primary and secondary power system design, installation and trouble-shooting electric motors on mining equipment.

ACADEMIC EXPERIENCE

January 1991 – present: Professor of Electrical and Computer Engineering at the **University of Nevada, Las Vegas** from August 2012 to present. From January 2000 to July 2012 held various positions at **Boise State University** including: Professor (2003 – 2012), Department Chair (2004 - 2007), and tenured Associate Professor (2000 - 2003). From August 1993 to January 2000 was a tenured/tenure track faculty member at the **University of Idaho:** Assistant Professor (1993 - 1998) and then tenured Associate Professor (1998 - 2000). Lastly, from January 1991 to May 1993 held adjunct faculty positions in the departments of Electrical Engineering at the University of Nevada, Las Vegas and Reno. Additional details:

- Research is focused on analog and mixed-signal integrated circuit fabrication and design. Worked with multi-disciplinary teams (civil engineering, biology, materials science, etc.) on projects that have been funded by EPA, DARPA, NASA, Army, DMEA, Navy, and the AFRL.
- Current and past research and development interests are:
 - Design and packaging of electrical/optical systems (e.g., LiDARs/LADARs) using LEDs, semiconductor lasers, lens for focusing and directing light, integrated circuits, and associated control and communication systems/circuits.
 - Capacitive sensing techniques using delta-sigma modulation and interfacing to sensors
 - Design of high-voltage and energy switching circuits
 - Circuit design and fabrication for the control, use, and storage of renewable energy using thermoelectric generators
 - Design of electrical/biological/optical circuits and systems using electrowetting on dielectric for automating and controlling biological experiments
 - Design of readout integrated circuits (ROICs) for use with focal plane arrays (FPAs)
 - Heterogeneous integration of III-V photonic devices (e.g., FPAs and VCSELs) with CMOS
 - Methods (e.g., 3D packaging and capacitive interconnects) to reduce power consumption in semiconductor memories, memory modules, and digital systems using custom and non-custom (e.g., FPGAs) implementations
 - Analog and mixed-signal circuit fabrication and design for communication systems, synchronization, energy storage, data conversion, and interfaces
 - The design of writing and sensing circuitry for emerging nonvolatile memory technologies, focal planes, and displays (arrays) in nascent nanotechnologies (e.g., magnetic, chalcogenide)
 - Reconfigurable electronics design and fabrication using nascent memory technologies such as the memristor to implement FPGAs
 - Finding an electronic, that is, no mechanical component, replacement for the hard disk drive using nascent fabrication technologies
 - Power electronics circuit design for consumers and consumer electronics including power management and adaptive control to reduce power consumption
 - Design of bandpass delta-sigma modulators for IQ demodulation in wireless communication systems in OFDM, WiFi, 802.11, Bluetooth, 3G, 4G, etc.
 - University prototyping, fabricating, and packaging of integrated circuits
- Led, as chair, the department in graduate curriculum (MS and PhD), program development, and ABET accreditation visits.
- Worked with established and start-up companies to provide technical expertise and identify employment opportunities for students.
- Held various leadership and service positions including: ECE chair, graduate coordinator, college curriculum committee (chair), promotion and tenure committee, scholarly activities committee, faculty search committee, university level search committees, etc. Collaborate with College of Engineering faculty on joint research projects.
- Taught courses in circuits, analog IC design, digital VLSI design and fabrication, fiber optics, and mixed-signal integrated circuit design to both on- and, via the Internet, off-campus students. Research emphasis in integrated circuit design using nascent technologies.

EDUCATION

- Ph.D. in Electrical Engineering; December 1993; University of Nevada, Reno, GPA 4.0/4.0. Dissertation Title: *Applying power MOSFETs to the design of electronic and electro-optic instrumentation.*
- M.S. and B.S. in Electrical Engineering; May 1986 and May 1988; University of Nevada, Las Vegas. Thesis Title: *Three-dimensional simulation of a MOSFET including the effects of gate oxide charge.*

MEMBERSHIPS IN PROFESSIONAL AND SCHOLARLY ORGANIZATIONS

IEEE (student, 1983; member, 1988; senior member, 1997; Fellow, 2013)
Member of the honor societies Eta Kappa Nu and Tau Beta Pi
Licensed Professional Engineer

HONORS AND AWARDS

- Consolidated Students of the University of Nevada, Las Vegas (CSUN) Faculty Award, 2017
- Tau Beta Pi UNLV Outstanding Professor of the Year in 2013, 2014, 2015 and 2016
- UNLV ECE Department Distinguished Professor of the Year in 2015
- IEEE Fellow for contributions to the design of memory circuits - 2013
- Distinguished Lecturer for the IEEE Solid-State Circuits Society, 2012 - 2015
- IEEE Circuits and Systems (CAS) Education Award - 2011
- Twice elected to the Administrative Committee of the Solid-State Circuits Society, 2011 - 2016
- Frederick Emmons Terman Award from the American Society of Engineering Education - 2007
- President's Research and Scholarship Award, Boise State University - 2005
- Honored Faculty Member - Boise State University Top Ten Scholar/Alumni Association 2003
- Outstanding Department of Electrical Engineering faculty, Boise State 2001
- Recipient of the IEEE Power Electronics Society's Best Paper Award in 2000
- University of Idaho, Department of Electrical Engineering outstanding researcher award, 1998-99
- University of Idaho, College of Engineering Outstanding Young Faculty award, 1996-97

SERVICE

Reviewer for IEEE transactions on solid-state circuits, circuits and devices magazine, education, instrumentation, nanotechnology, VLSI, etc. Reviewer for several American Institute of Physics journals as well (Review of Scientific Instruments, Applied Physics letters, etc.) Board member of the IEEE press (reviewed dozens of books and book proposals). Reviewer for the National Institutes of Health. Technology editor and then Editor-in-Chief for the Solid-State Circuits Magazine.

Led the Department on ABET visits, curriculum and policy development, and new program development including the PhD in electrical and computer engineering. Provided significant University and College service in infrastructure development, Dean searches, VP searches, and growth of academic programs. Provided university/industry interactions including starting the ECE department's advisory board. Held positions as the ECE department Master's graduate coordinator and coordinator for the Sophomore Outcomes Assessment Test (SOAT).

Also currently serves, or has served, on the IEEE Press Editorial Board (1999-2004), as a member of the first Academic Committee of the State Key Laboratory of Analog and Mixed-Signal VLSI at the University of Macau, as editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018), on the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016), as an Advisory Professor to the School of Electronic and Information Engineering at Beijing Jiaotong University, as a Distinguished Lecturer for the SSCS (2012-2015), as the Technical Program Chair for the IEEE 58th 2015 International Midwest Symposium on Circuits and Systems, MWSCAS 2015, as advisor for the student branch of the IEEE at UNLV (2013-2023), and as the Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for the *IEEE Solid-State Circuits Magazine*, and IEEE Kirchhoff Award Committee (2020-2023).

ARMED FORCES

From 1981 to 1987 served in the United States Marine Corps (from September of 1982 in the Reserves, Fox Company, 2nd Battalion, 23rd Marines, 4th Marine Division), Honorable Discharge. Military Occupational Specialty (MOS) was Machine Gunner (MOS 0331)

TEXTBOOKS AUTHORED

Baker, R. J., "CMOS Circuit Design, Layout and Simulation, Fourth Edition" *Wiley-IEEE Press*, 1234 pages. ISBN 9781119481515 (2019) **Over 50,000 copies of this book in print.** (Third Edition published in 2010, Revised Second Edition published in 2008, and Second Edition Published in 2005)

Baker, R. J., "CMOS Mixed-Signal Circuit Design," *Wiley-IEEE*, 329 pages. ISBN 978-0470290262 (second edition, 2009) and ISBN 9780471227540 (First Edition published in 2002)

Keeth, B., Baker, R. J., Johnson, B., and Lin, F., "DRAM Circuit Design: Fundamental and High-Speed Topics", *Wiley-IEEE*, 2008, 201 pages. ISBN: 9780470184752

Keeth, B. and Baker, R. J., "DRAM Circuit Design: A Tutorial", *Wiley-IEEE*, 2001, 201 pages. ISBN 0780360141

Baker, R. J., Li, H.W., and Boyce, D.E. "CMOS Circuit Design, Layout and Simulation," *Wiley-IEEE*, 1998, 904 pages. ISBN 9780780334168

BOOKS, OTHER (edited, chapters, etc.)

Saxena, V. and Baker, R. J., "Analog and Digital VLSI," chapter in the CRC Handbook on Industrial Electronics, edited by J. D. Irwin and B. D. Wilamowski, *CRC Press*, 2009 second edition.

Baker, R. J., "CMOS Analog Circuit Design," (A self-study course with study guide, videos, and tests.) IEEE Education Activity Department, 2000. ISBN 0-7803-4822-2 (with textbook) and ISBN 0-7803-4823-0 (without textbook)

Baker, R. J., "CMOS Digital Circuit Design," (A self-study course with study guide, videos, and tests.) *IEEE Education Activity Department*, 2000. ISBN 0-7803-4812-5 (with textbook) and ISBN 0-7803-4813-3 (without textbook)

Li, H.W., Baker, R. J., and Thelen, D., "CMOS Amplifier Design," chapter 19 in the CRC VLSI Handbook, edited by Wai-kai Chen, *CRC Press*, 1999 (ISBN 0-8493-8593-8) and the second edition in 2007 (ISBN 978-0-8493-4199-1)

INVITED TALKS AND SEMINARS

Have given over 50 invited talks and seminars at the following locations: AMD (Fort Collins), AMI semiconductor, Arizona State University, Beijing Jiaotong University, Boise State University, Carleton University, Carnegie Mellon, Columbia University, Dublin City University (Ireland), E.G.&G. Energy Measurements, Foveon, the Franklin Institute, Georgia Tech, Gonzaga University, Hong Kong University of Science and Technology, ICSEng Keynote, ICySSS keynote, IEEE Computing and Communication Workshop (CCWC), IEEE Electron Devices Conference (NVMETS), IEEE Workshop on Microelectronics and Electron Devices (WMED), Indian Institute of Science (Bangalore, India), Instituto de Informatica (Brazil), Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM, Mexico), Iowa State University, Lawrence Livermore National Laboratory, Lehigh University, Lockheed-Martin, Micron Technology, Nascentric, National Semiconductor, Princeton University, Rendition, Saintgits College (Kerala, India), Southern Methodist University, Sun Microsystems, Stanford University, ST Microelectronics (Delhi, India), Temple University, Texas A&M University, Tower Semiconductor (Israel), University of Alabama (Tuscaloosa), University of Arkansas, University of Buenos Aires (Argentina), University of Houston, University of Idaho, University of Illinois (Urbana-Champaign), Université Laval (Québec City, Québec), University of Macau, University of Maryland, Université de Montréal (École Polytechnique de Montréal), Xilinx (Ireland), University of Nevada (Las Vegas), University of Nevada (Reno), University of Toronto, University of Utah, Utah State University, and Yonsei University (Seoul, South Korea).

RESEARCH FUNDING (LAST 5 YEARS AS A PROFESSOR)

Recent funding listed below. In-kind, equipment, and other non-contract/grant funding [e.g., MOSIS support, money for travel for invited talks, etc.] not listed.

- Baker, R. Jacob, (2017-2023) "Tiled Silicon Photomultiplier Array Read-Out Integrated Circuit," NASA, \$29,999 (Phase I), \$225,238 (Phase II), and \$79,697 (Phase IIE)
- Goldman, J., Menezes, J., and Baker, R. J., (2021-2022) "Monitored Compression Therapy: Using Smart Technology to Optimize the Treatment of Lower Extremity Swelling," UNLV Sports Research & Innovation Initiative. Proof of Concept Grant Program, \$50,000
- Baker, R. Jacob, (2019-2021) "Dual-Mode, Extended Near-Infrared, Focal Plane Arrays Fabricated with CMOS Compatible GeSiSn Alloy Materials," DARPA, \$149,998
- Baker, R. Jacob, (2018-2020) "Geiger Mode SiGe Receiver for Long-Range Optical Communications," NASA, \$99,996
- Baker, R. Jacob, (2019) "Improved Quantum Efficiency Photo-Detector," Navy, \$29,999

- Baker, R. Jacob, (2018-2019) "Tiled Silicon Photomultiplier Array Read-Out Integrated Circuit – Phase I," NASA, \$29,999
- Baker, R. Jacob, (2017-2019) "Quantum Cryptography Detector Chip," Defense MicroElectronics Activity (DMEA), \$266,029
- Baker, R. Jacob, (2017-2019) "Advanced Printed Circuit Board Design Methods for Compact Optical Transceiver," U.S. Army/DOD, \$299,605
- Baker, R. Jacob, (2016-2018) "High-Sensitivity Monolithic Silicon APD and ROIC," U.S. Air Force/DOD, \$299,665
- Baker, R. Jacob, (2017-2018) "Transimpedance Amplifier Integrated Circuit Collaboration," Department of Energy, National Security Technologies, LLC, \$100,436
- Baker, R. Jacob, (2017) "Geiger Mode SiGe Receiver for Long-Range Optical Communications," NASA, \$30,000
- Baker, R. Jacob, (2016-2017) "Testing and development of BiCMOS photodetectors and diagnostic instrumentation," Department of Energy, National Security Technologies, LLC, \$181,605
- Baker, R. Jacob, (2016-2017) "Dual-Mode, Extended Near Infrared, Focal Plane Arrays fabricated with a Commercial SiGe BiCMOS Process," DARPA, \$41,892

DOCTORAL STUDENT SUPERVISION

11. Mario Valles Montenegro (underway)
10. Sachin Namboodiri – A Multi-channel MCP-PMT based Readout Integrated Circuit for LiDAR Applications (2020)
9. Wenlan Wu – High-Speed Radhard Mega-Pixel CIS Camera for High-Energy Physics (2019)
8. Kostas Moutafis – A Highly-Sensitive Global-Shutter CMOS Image Sensor with On-Chip Memory for Hundreds of kilo-frames per second Scientific Experiments (2019)
7. Yiyan Li – Portable High Throughput Digital Microfluidics and On-Chip Bacteria Cultures (2016)
6. Yacouba Moumouni – Designing, Building, and Testing a Solar Thermoelectric Generation, STEG, for Energy Delivery to Remote Residential Areas in Developing Regions (2015)
5. Qawi IbnZayd Harvard – Low-Power, High-Bandwidth, and Ultra-Small Memory Module Design (2011)
4. Vishal Saxena – K-Delta-1-Sigma Modulators for Wideband Analog-to-Digital Conversion (2010)
3. Robert Russell Hay – Digitally-Tunable Surface Acoustic Wave Resonator (2009)
2. Xiangli Li (the first Boise State University College of Engineering PhD graduate) – MOSFET Modulated Dual Conversion Gain CMOS Image Sensors (2008)
1. Feng Lin, Research and Design of Low Jitter, Wide Locking-Range Phase-Locked and Delay-Locked Loops (2000)

MASTERS STUDENT SUPERVISION

93. Abraham Lopez (underway)
92. David Santiago (underway)
91. Khulan Tsogt (underway)
90. Jazmin Bolor (underway)
89. Chris Barr (underway)
88. Minsung Cho – Studies of Forward Projection Algorithms and Implementation on PC and FPGA (2023)
87. Armani Alvarez – A Control Integrated Circuit for a Hysteretic Flyback Power Converter (2022)
86. Francisco Mata-carlos – A Wearable Electronic Monitoring Device for Low Pressure Garment Applications and Temperature Analysis for Prevention of Ulceration and Infection (2022)
85. Daniel Senda – Designs and Outcomes of Transcranial Magnetic Stimulation (TMS) and Repetitive Transcranial Magnetic Stimulation (rTMS) Circuits (2021)
84. James Skelly – Monitored Compression Therapy: Using Smart Technology to Optimize the Treatment of Lower Extremity Swelling (2021)
83. Gonzalo Arteaga – Current-mode photon-counting circuit with SiGe BiCMOS input stage (2020)
82. Jason Silic – Design and Fabrication of a 6-bit Current-Mode ADC for Lidar and High-Speed Applications (2020)
81. Brandon Wade (2020)
80. Mario Valles Montenegro – Front-End CMOS Transimpedance Amplifiers on a Silicon Photomultiplier Resistant to Fast Neutron Fluence (2020)
79. Jonathan DeBoy (2018)
78. Dane Gentry – Design, Layout, and Testing of SiGe APDs Fabricated in a BiCMOS Process (2018)

77. James Mellot – Variable Transition Time Inverters in a Digital Delay Line with Analog Storage for Processing Fast Signals and Pulses (2018)
76. Eric Monahan – High Speed Fast Transient Digitizer Design and Simulation (2018)
75. Shada Sharif – Design and Analysis of First and Second Order K-Delta-1-Sigma Modulators in Multiple Fabrication Processes (2018)
74. Vikas Vinayaka – Analysis and Design of Analog Front-End Circuitry for Avalanche Photodiodes (APD) and Silicon Photo-Multipliers (SiPM) in Time-of-Flight Applications (2018)
73. Claire Tsagkari – Design, Fabrication and Testing of a Capacitive Sensor Using Delta-Sigma Modulation (2017)
72. Kevin Buck – Fast Transient Digitizer and PCB Interface (2015)
71. Marzieh Sharbat Maleki (2015)
70. Angsuman Roy – Design, Fabrication and Testing of Monolithic Low-Power Passive Sigma-Delta Analog-to-Digital Converters (2015)
69. Daniel Anderson – Design and Implementation of an Instruction Set Architecture and Instruction Execution Unit for the RZ9 Coprocessor System (2014)
68. Jared Gordon – Design and Fabrication of an Infrared Optical Pyrometer ASIC (2013)
67. Justin Butterfield (2012)
66. Adam Johnson – Methods and Considerations for Testing Resistive Memories (2012)
65. Ben Millemon – CMOS Characterization, Modeling, and Circuit Design in the Presence of Random Local Variation (2012)
64. Justin Wood (2012)
63. Chamunda Ndinawe Chamunda (2011)
62. Gary VanAckern – Design Guide for CMOS Process On-Chip 3D Inductors using Thru-Wafer Vias (2011)
61. Lucien Jan Bissey – High-Voltage Programmable Delta-Sigma Modulation Voltage-Control Circuit (2010)
60. Kaijun Li (2010)
59. Yingting Li (co-supervised with Maria Mitkova) (2010)
58. Lael Matthews (co-supervised with Said Ahmed-Zaid) (2010)
57. Priyanka Mukeshbhai Parikh (2010)
56. Todd Plum (co-supervised with Jeff Jessing) – Design and Fabrication of a Chemicapacitive Sensor for the Detection of Volatile Organic Compounds (2010)
55. Rahul Srikonda (2010)
54. Avani Falgun Trivedi (2010)
53. Kuang Ming Yap – Gain and Offset Error Correction for CMOS Image Sensors using Delta-Sigma Modulation (2010)
52. Mahesh Balasubramanian – Phase Change Memory - Array Development and Sensing Circuits using Delta-Sigma Modulation (2009)
51. Lincoln Bollschweiler (2009)
50. Shantanu Gupta (2009)
49. Qawi Harvard – Wide I_O DRAM Architecture Utilizing Proximity Communication (2009)
48. Avinash Rajagiri (2009)
47. Ramya Ramarapu (2009)
46. Harikrishna Rapole (2009)
45. Aruna Vadla (2009)
44. Hemanth Ande (2008)
43. Curtis Cahoon – Low-Voltage CMOS Temperature Sensor Design using Schottky Diode-Based References (2008)
42. Prashanth Busa (2008)
41. John McCoy III (2008)
40. Dennis Montierth – Using Delta-Sigma-Modulation for Sensing in a CMOS Imager (2008)
39. Rudi Rashwand (2008)
38. Barsha Shrestha (co-supervised with Zhu Han) – Wireless Access in Vehicular Environments using Bit Torrent and Bargaining (2008)
37. Eric Becker – Design of an Integrated Half-Cycle Delay Line Duty Cycle Corrector Delay Locked Loop (2007)

36. Matthew Leslie – Noise-Shaping Sense Amplifier for Cross-Point Arrays (2007)
35. Jose Monje (2007)
34. Sanghyun Park (2007)
33. Vishal Saxena – Indirect Feedback Compensation Techniques for Multi-Stage Operational Amplifiers (2007)
32. Meshack Appikarla (2006)
31. Eric Booth – Wide Range, Low Jitter Delay-Locked Loop Using a Graduated Digital Delay Line and Phase Interpolator (2006)
30. Sucheta Das (2006)
29. Krishna Duvvada – High Speed Digital CMOS Input Buffer Design (2006)
28. Krishnamraju Kurra (2006)
27. Soumya Narasimhan (2006)
26. Roger Porter (2006)
25. David Butler – Low-Voltage Bandgap Reference Design Utilizing Schottky Diodes (2005)
24. Dragos Dimitriu (2005)
23. Surendranath Eruvuru – Sensing Circuit Design for an Ion Mobility Spectrometer (2005)
22. Sandhya Sandireddy (2005)
21. Harish Singidi (2005)
20. Indira Vemula – Delta-Sigma Modulator Used in CMOS Imagers (2005)
19. Bhavana Kollimarla – A 1-Bit Analog-to-Digital Converter Using Delta Sigma Modulation for Sensing in CMOS Imagers (2004)
18. Sandeep Pemmaraju – High Voltage Charge Pump Circuit for an Ion Mobility Spectrometer (2004)
17. Ravindra Puthumbaka – Circuit Design for an Ion Mobility Spectrometer (2004)
16. Brandon Roth – Comparison of Asynchronous vs. Synchronous Design Technologies using a 16-bit Binary Adder (2004)
15. Jennifer Taylor – Reading and Writing Flash Memory Using Delta-Sigma Modulation (2004)
14. Jing Plaisted – Methods for Memory Testing (2003)
13. Murugesh Subramaniam – Flash Memory Sensing Using Averaging (2003)
12. Brian Johnson – Application of an Asynchronous FIFO in a DRAM Data Path (2002)
11. Scott Ward – Electrostatic Discharge (ESD) Protection in CMOS (2002)
10. Tyler Gomm – Design of a Delay-Locked Loop with a DAC-Controlled Analog Delay Line (2001)
9. Gexin Huang (2001)
8. Chris Atkins (2000)
7. Thaddeus Black (2000)
6. Zuxu Qin (2000)
5. Hao Chen (1999)
4. Doug Hackler (co-supervised with Steve Parke) – TMOS: A Novel Design for MOSFET Technology (1999)
3. Song Liu – Design of a CMOS 6-bit Folding and Interpolating Analog-to-Digital Converter (1999)
2. Ben Ba (1997)
1. Brent Keeth – A Novel Architecture for Advanced High Density Dynamic Random Access Memories (1996)

GRANTED US PATENTS

152. Baker, R. J., "Quantizing circuits having improved sensing," **10,658,018**, May 19, 2020.
151. Baker, R. J., "Quantizing circuits having improved sensing," **10,403,339**, September 3, 2019.
150. Baker, R. J., "Digital Filters with Memory," **10,366,744**, July 30, 2019.
149. Baker, R. J., "Quantizing circuits having improved sensing," **10,127,954**, November 13, 2018.
148. Baker, R. J. and Parkinson, W., "NMOS regulated voltage reference," **9,753,481**, September 5, 2017.
147. Baker, R. J., "Digital Filters with Memory," **9,734,894**, August 15, 2017.
146. Baker, R. J. and Keeth, B., "Optical interconnect in high-speed memory systems," **9,697,883**, July 7, 2017
145. Baker, R. J., "Comparators for delta-sigma modulators," **9,641,193**, May 2, 2017.
144. Baker, R. J., "Quantizing circuits having improved sensing," **9,449,664**, September 20, 2016.
143. Baker, R. J., "Error detection for multi-bit memory," **9,336,084**, May 10, 2016.
142. Baker, R. J. and Keeth, B., "Optical interconnect in high-speed memory systems," **9,299,423**, March 29, 2016.

141. Baker, R. J., "Methods for sensing memory elements in semiconductor devices," **9,299,405**, March 29, 2016.
140. Baker, R. J., "Comparators for delta-sigma modulators," **9,135,962**, September 15, 2015.
139. Baker, R. J., "Resistive memory element sensing using averaging," **9,081,042**, July 14, 2015.
138. Baker, R. J., "Digital Filters with Memory," **9,070,469**, June 30, 2015.
137. Baker, R. J., "Reference current sources," **8,879,327**, November 4, 2014.
136. Baker, R. J. and Beigel, K. D., "Multi-resistive integrated circuit memory," **8,878,274**, November 4, 2014.
135. Baker, R. J., "Methods for sensing memory elements in semiconductor devices," **8,854,899**, October 7, 2014.
134. Baker, R. J., "Quantizing circuits with variable parameters," **8,830,105**, September 9, 2014.
133. Baker, R. J., "Integrators for delta-sigma modulators," **8,754,795**, June 17, 2014.
132. Baker, R. J., "Methods of quantizing signals using variable reference signals," **8,717,220**, May 6, 2014.
131. Baker, R. J. and Keeth, B., "Optical interconnect in high-speed memory systems," **8,712,249**, April 29, 2014.
130. Baker, R. J., "Resistive memory element sensing using averaging," **8,711,605**, April 29, 2014.
129. Baker, R. J., "Memory with correlated resistance," **8,681,557**, March 25, 2014.
128. Baker, R. J., "Reference current sources," **8,675,413**, March 18, 2014.
127. Baker, R. J., "Methods for sensing memory elements in semiconductor devices," **8,582,375**, November 12, 2013.
126. Linder, L. F., Renner, D., MacDougall, M., Geske, J., and Baker, R. J., "Dual well read-out integrated circuit (ROIC)," **8,581,168**, November 12, 2013.
125. Li, W., Schoenfeld, A., and Baker, R. J., "Method and apparatus for providing symmetrical output data for a double data rate DRAM," **8,516,292**, August 20, 2013.
124. Baker, R. Jacob, "Resistive memory element sensing using averaging," **8,441,834**, May 14, 2013.
123. Qawi, Q. I., Drost, R. J., and Baker, R. Jacob, "Increased DRAM-array throughput using inactive bitlines," **8,395,947**, March 12, 2013.
122. Baker, R. Jacob, "Memory with correlated resistance," **8,289,772**, October 16, 2012.
121. Lin, F. and Baker, R. Jacob, "Phase splitter using digital delay locked loops," **8,218,708**, July 10, 2012.
120. Baker, R. Jacob, "Subtraction circuits and digital-to-analog converters for semiconductor devices," **8,194,477**, June 5, 2012.
119. Baker, R. J., "Digital Filters for Semiconductor Devices," **8,149,646**, April 3, 2012.
118. Baker, R. J., "Error detection for multi-bit memory," **8,117,520**, February 14, 2012.
117. Baker, R. J., "Integrators for delta-sigma modulators," **8,102,295**, January 24, 2012.
116. Baker, R. J., "Devices including analog-to-digital converters for internal data storage locations," **8,098,180**, January 17, 2012.
115. Baker, R. J. and Beigel, K. D., "Multi-resistive integrated circuit memory," **8,093,643**, January 10, 2012.
114. Baker, R. J., "Quantizing circuits with variable parameters," **8,089,387**, January 3, 2012.
113. Baker, R. J., "Reference current sources," **8,068,367**, November 29, 2011.
112. Baker, R. J., "Methods of quantizing signals using variable reference signals," **8,068,046**, November 29, 2011.
111. Baker, R. J., "Systems and devices including memory with built-in self-test and methods of making using the same," **8,042,012**, October 18, 2011.
110. Baker, R. J., "Memory with correlated resistance," **7,969,783**, June 28, 2011.
109. Baker, R. J. and Keeth, B., "Optical interconnect in high-speed memory systems," **7,941,056**, May 10, 2011.
108. Baker, R. J., "K-delta-1-sigma modulator," **7,916,054**, March 29, 2011.
107. Li, W., Schoenfeld, A., and Baker, R. J., "Method and apparatus for providing symmetrical output data for a double data rate DRAM," **7,877,623**, January 25, 2011.
106. Lin, F. and Baker, R. J., "Phase splitter using digital delay locked loops," **7,873,131**, January 18, 2011.
105. Hush, G. and Baker, R. J., "Complementary bit PCRAM sense amplifier and method of operation," **7,869,249**, January 11, 2011.
104. Baker, R. J., "Subtraction circuits and digital-to-analog converters for semiconductor devices," **7,839,703**, November 23, 2010.
103. Baker, R. J., "Digital Filters with Memory" **7,830,729**, November 9, 2010.
102. Baker, R. J., "Systems and devices including memory with built-in self test and methods of making using the same," **7,818,638**, October 19, 2010.
101. Baker, R. J., "Integrators for delta-sigma modulators," **7,817,073**, October 19, 2010.

100. Baker, R. J., "Digital filters for semiconductor devices," **7,768,868**, August 3, 2010.
99. Baker, R. J., "Quantizing circuits with variable reference signals," **7,733,262**, June 8, 2010.
98. Baker, R. J., "Quantizing circuits for semiconductor devices," **7,667,632**, February 23, 2010.
97. Baker, R. J., and Beigel, K. D., "Multi-resistive integrated circuit memory," **7,642,591**, January 5, 2010.
96. Baker, R. J., "Offset compensated sensing for a magnetic random access memory," **7,616,474**, November 10, 2009.
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INVITED TALKS (PARTIAL LISTING)

- Harvard, Q. I. and Baker, R. J., "Low-Power, High-Bandwidth, and Ultra-Small Memory Module Design," a presentation covering semiconductor packaging, DRAM architectures, and I/O circuits. The goal of this work is to investigate replacing the currently used dual in-line memory modules (DIMMs) with a smaller and a lower power memory module, a "Nano-Module."
- Baker, R. J., and Campbell, K. A., "Reconfigurable Analog Electronics using the Memristor."
- Baker, R. J., and Saxena, V., "A K-Delta 1-Sigma Modulator for Wideband Analog-to-Digital Conversion."
- Li, K., Saxena, V., and Baker, R. J., "The Baker ADC: An Overview,"
- Saxena, V., and Baker, R. J., "High-Speed Op-Amp Design: Compensation and Topologies for Two and Three Stage Designs,"
- Baker, R. J., "Circuit Design for MLC Flash: Towards a Semiconductor Replacement for the Hard Disk Drive."

- Baker, R. J., Terman Award Acceptance Speech, given at the Frontiers in Education Conference (FIE 2007), Milwaukee, WI, October 11, 2007.
- Baker, R. J., "The One-Transistor, One-Capacitor (1T1C) Dynamic Random Access Memory (DRAM), and its Impact on Society," presented at the Franklin Institute, in the symposium honoring Dr. Robert H. Dennard and his receipt of the 2007 Benjamin Franklin Medal in Electrical Engineering, April 25, 2007.
- Baker, R. J. and Saxena, V., "Design of Bandpass Delta-Sigma Modulators: Avoiding Common Mistakes."
- Baker, R. J., "Sensing Circuits for Resistive Memory."
- Hadrick, M. and Baker, R. J., "Sensing in CMOS Imagers using Delta-Sigma Modulation."
- Baker, R. J., "Design of High-Speed CMOS Op-Amps for Signal Processing," IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED), April, 2005
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52. Saxena, V. and Baker, R. J., "Indirect Compensation Techniques for Three-Stage Fully-Differential Op-Amps," (invited) *Proceedings of the IEEE 53rd International Midwest Symposium on Circuits and Systems*, August 1-4, 2010.
51. Harvard, Q., Baker, R. J., and Drost, R., "Main Memory with Proximity Communication: A Wide I/O DRAM Architecture," *Proceedings of the IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED)*, pp. 40-43, April 16, 2010.
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47. Saxena, V. and Baker, R. J., "Synthesis of Higher-Order K-Delta-1-Sigma Modulators for Wideband Analog to Digital Conversion," *4th Annual Austin Conference on Integrated Circuits & Systems*, Oct. 26-27, 2009.
46. Li, K., Saxena, V., Zheng, G., and Baker, R. J., "Full Feed-Forward K-Delta-1-Sigma Modulator," *4th Annual Austin Conference on Integrated Circuits & Systems*, Oct. 26-27, 2009.
45. Bollschweiler, L., English, A., Baker, R. J., Kuang, W., Chang, Z.-C., Shih, M.-H., Knowlton, W.B., Hughes, W.L., Lee, J., Yurke, B., Cockerham, N. S., and Tyree, V. C., "Chip-Scale Nanophotonic Chemical and Biological Sensors using CMOS Process," *Proceedings of the IEEE 52nd Midwest Symposium on Circuits and Systems*, pp. 413-416, August 2-5, 2009.
44. Saxena, V., Li, K., Zheng, G., and Baker, R. J., "A K-Delta 1-Sigma Modulator for Wideband Analog to Digital Conversion," *Proceedings of the IEEE 52nd International Midwest Symposium on Circuits and Systems*, pp. 411-415, August 2-5, 2009.
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42. Regner, J., Balasubramanian, M., Cook, B., Li, Y., Kassayebetre, H., Sharma, A., Baker, R. J., and Campbell, K. A., "Integration of IC Industry Feature Sizes with University Back-End-of-Line Post Processing: Example Using a Phase-Change Memory Test Chip," *Proceedings of the IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED)*, pp. 28-31, April, 2009.
41. Gupta, S. Saxena, V., Campbell, K. A., and Baker, R. J., "W-2W Current Steering DAC for Programming Phase Change Memory," *Proceedings of the IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED)*, pp. 59-62, April, 2009.
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36. Saxena, V., and Baker, R. J., "Compensation of CMOS Op-Amps using Split-Length Transistors," *Proceedings of the IEEE 51st Midwest Symposium on Circuits and Systems*, pp. 109-112, August 10-13, 2008.
36. Saxena, V., and Baker, R. J., "Indirect Compensation Technique for Low-Voltage Op-Amps," *Proceedings of the 3rd Annual Austin Conference on Integrated Systems and Circuits (ACISC)*, May 7-9, 2008.

35. Cahoon, C., and Baker, R. J., "Low-Voltage CMOS Temperature Sensor Design using Schottky Diode-Based References," *Proceedings of the IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED)*, pp. 16-19, April, 2008.
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33. Knowlton, W. B., Araujo, D., Price, P.M., Brotherton, J., Coonse, K., Southwick III, R.G., Oxford, J., Moll, A., Baker, R. J., and Kuang, W., "Development of Biomolecular Nanostructure Sensor Arrays," presented at the Sensors and Sensor Technology session for the program of the 88th annual meeting of the AAAS, Pacific Division, June 2007, Boise, ID
32. Knowlton, W. B., Kuang, W., Araujo D., Price, P. M., Brotherton, J., Coonse, K. Bollschweiler, L., Southwick, R., Oxford, J. Moll, A., and Baker, R. J., "Nanofabrication of 3D Sensor Arrays for Detection," Advanced Fuel Cycle Workshop, May 8-9, 2007, Boise, ID
31. Loo, S. M., Cole, J., Youngberg, R., Baker, R. J., Gribb, M. M., "Field-programmable gate array in a miniature ion mobility spectrometer sensor system," *Proceedings of the 2006 International Conference on Embedded Systems & Applications*, June 26-29, 2006, Las Vegas, NV.
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29. Duvvada, K., Saxena, V., and Baker, R. J., High Speed Digital Input Buffer Circuits, *Proceedings of the IEEE/EDS Workshop on Microelectronics and Electron Devices (WMED)*, pp. 11-12, April, 2006.
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27. Gorseth, T. L., Estrada, D., Kiepert, J., Ogas, M. L., Cheek, B. J., Price, P. M., Baker, R. J., Bersuker, G., and Knowlton, W.B., "Preliminary Study of NOR Digital Response to Single pMOSFET Dielectric Degradation," presented at the *Workshop on Microelectronic Devices* (Boise, Idaho; April 14, 2006)
26. Sevier, D., Gribb, M., Plumlee, D., Moll, A. J., Hill, H. H., Hong, F., Baker, R. J., Loo, S. M., Walters, R. and Imonigie, J., "An In-Situ Ion Mobility Spectrometer Sensor System for Detecting Gaseous VOCs in the Vadose Zone," *Fourth International Conference on Unsaturated Soils (UNSAT '06) Conference, April 2-6, 2006, Carefree, AZ.*
25. Gribb, M., Hill, H. H., Baker, R. J., Loo, S. M., and Moll, A. J., "Ion Mobility Spectrometer (IMS) Sensor Project," presented at the *Environmental & Subsurface Science Symposium*, Inland Research Alliance, Sept. 19-21, 2005, Big Sky, Montana.
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23. Butler, D. L. and Baker, R. J., *Low-Voltage Bandgap Reference Design Utilizing Schottky Diodes*, *Proceedings of the IEEE 48th International Midwest Symposium on Circuits and Systems*, Aug. 7-10, 2005.
22. Cheek, B. J., Southwick III, R. G., Ogas, M. L., Nagler, P. E., Whelchel, D., Kumar, S., Baker, R. J., and Knowlton, W. B., "Preliminary Soft Breakdown (SBD) Effects In CMOS Building Block Circuits," poster presentation at *2004 IEEE International Integrated Reliability Workshop*, Oct. 18-21, 2004.
21. Ogas, M., Southwick, R. G., Cheek, B. J., Lawrence, C. E., Kumar, S., Haggag, A., Baker, R. J., and Knowlton, W. B., "Multiple Waveform Pulse Voltage Stress Technique for Modeling Noise in Ultra-Thin Oxides," poster presentation at the *Workshop on Microelectronics and Electron Devices*, Boise, Idaho, April 16, 2004.
20. Ogas, M. L., Southwick III, R. G., Cheek, B. J., Baker, R. J., Bersuker, G., and Knowlton, W. B., "Survey of Oxide Degradation in Inverter Circuits Using 2.0nm MOS Devices," in *Proceedings of the 2004 IEEE International Integrated Reliability Workshop*, pp. 32-36.
19. Cheek, B. J., Stutzke, N., Santosh, K., Baker, R. J., Moll, A. J., and Knowlton, W. B., Investigation of Circuit-Level Oxide Degradation and its Effect on CMOS Inverter Operation Performance and MOSFET Characteristics, *2004 IEEE International Reliability Physics Symposium*, April, 25-29.

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17. Ogas, M. L., Southwick, R. G., Cheek, B. J., Lawrence, C. E., Kumar, S., Haggag, A., Baker, R. J., and Knowlton, W. B., *Investigation of Multiple Waveform Pulse Voltage Stress (MWPVS) Technique in Ultra-Thin Oxides*, poster presentation at the 2003 IEEE International Integrated Reliability Workshop Oct, 20-23.
16. Baker, R. J., *Mixed-Signal Design in the Microelectronics Curriculum*, IEEE University/Government/Industry Microelectronics (UGIM) Symposium, June 30 - July 2.
15. Hartman, J. A., Baker, R. J., Gribb, M., Hill, H. H., Jessing, J., Moll, A. J., Prouty, and Russell, D., *A Miniaturized Ion Mobility Spectrometer (IMS) Sensor for Wireless Operation*, FAME (Frontiers in Assessment Methods for the Environment) Symposium, Sponsored by NSF, Minneapolis, Minnesota, August 10-13, 2003.
14. Lawrence, C.E., Cheek, B. J., Lawrence, T. E., Kumar, S., Haggag, A., Baker, R. J., and Knowlton, W. B., *Gate Dielectric Degradation Effects on nMOS Devices Using a Noise Model Approach*, IEEE University/Government/Industry Microelectronics (UGIM) Symposium, June 30 - July 2, 2003.
13. Cheek, B., Lawrence, C., Lawrence, T., Gomez, J., Caldwell, T., Kiri, D., Kumar, S., Baker, R. J., Moll, A. J., and Knowlton, W. B., *Gate Dielectric Degradation Effects on nMOS Devices and Simple IC Building Blocks (SICBBs)*, IEEE Electron Devices Society Boise Meeting, Boise, ID Oct. 25, 2002.
12. Lawrence, C., Cheek, B., Caldwell, T., Lawrence, T., Kiri, D., Kumar, S., Baker, R. J., Moll, A. J., and Knowlton, W. B., *Pulse voltage stressing of ultrathin gate oxides in NMOS devices*, poster session at IEEE International Integrated Reliability Workshop, October 21-24, 2002.
11. Cheek, B., Lawrence, C., Lawrence, T., Caldwell, T., Kiri, D., Kumar, S., Baker, R. J., Moll, A. J., and Knowlton, W. B., *Circuit level reliability of ultrathin gate oxides for SICBBs: Preliminary study concentrated on the effect of stress on the NMOSFET of an inverter*, poster session at the IEEE International Integrated Reliability Workshop, October 21-24, 2002.
10. Baker, R. J., "Sensing Circuits for Resistive Memory," *IEEE Electron Devices Society Meeting*, Boise, Idaho October 25, 2002.
9. Rivera, B., Baker, R. J., Melngailis, J., "Design and Layout of Schottky Diodes in a Standard CMOS Process," 2001 International Semiconductor Device Research Symposium, Washington DC, Dec. 2001.
8. Hess, H. and Baker, R. J., "Easier Method to Simultaneously Trigger Series-Connected MOS Devices," *Power Systems World Conference 2000*, Boston, Massachusetts, September 2000.
7. Baker, R. J., and Hess, H., "Transformerless Capacitive Coupling of Gate Signals for Series Operation of Power MOSFET Devices." *International Electric Machines and Drives Conference*, Seattle, Washington, May 1999, pp. 673-676.
6. Baker, R. J., "A windows based integrated circuit design tool for distance education," *International Conference on Simulation and Multimedia in Engineering Education*."
5. Chen, H. and Baker, R. J., "A CMOS Standard-Cell Library for the PC-based LASI Layout System," *Proceedings of the 41st International Midwest Symposium on Circuits and Systems*, August 9-12, 1998.
4. Liu, S. and Baker, R. J., "Process and temperature performance of a CMOS beta-multiplier voltage reference," *Proceedings of the 41st International Midwest Symposium on Circuits and Systems*, August 9-12, 1998.
3. Boyce, D.E. and Baker, R. J., "A Complete Layout System for the PC," *IEEE 40th International Midwest Symposium on Circuits and Systems*, 1997.
2. Baker, R. J., and Blair, J. J., "Step response considerations and the design of a suitable step generator for high speed digitizer testing," *LLNL's Third Annual Workshop on High Speed Digitizers*, April 3-4, Las Vegas, Nevada, 1991.
1. Baker, R. J., "Step-recovery diodes sharpen pulses," *Engineering Design News Magazine*, pp. 154-156, May 10, 1990.

EXPERT WITNESS EXPERIENCE (LAST 4 YEARS)

The law firms and clients (underlined) whom I have provided expert witness services in electrical and computer engineering are listed below. I have been deposed 94 times, given expert testimony at 12 trials (7 USITC, 2 D. Del., 1 Arbitr., 1 S.D. Cal., and 1 E.D. Tex.), and participated in 1 mediation.

Bracewell LLP (New York, NY and Seattle, WA)

Case – Kioxia America, Inc. and Kioxia Corporation v. BitMICRO LLC

Case Numbers – IPR2023-00741, IPR2023-00742, and IPR2023-00743. Petitions filed on March 23, 2023.

Case Subject Matter – Solid-state storage devices utilizing multi-profile memory controllers. Optimizing memory operations in a memory system suitable for use in an electronic storage device. Supplying energy to a cache memory using a supercapacitor.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Bookoff McAndrews, PLLC (Washington, DC)

Case – Lenovo Inc. and Motorola Mobility LLC v. Theta IP, LLC

Case Numbers – IPR2023-00694, IPR2023-00697, and IPR2023-00698. Petitions filed on March 7, 2023.

Case Subject Matter – Power in wireless communication circuits.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

McDermott Will & Emery LLP (Chicago, IL and Austin, TX)

Case – Xilinx, Inc. v. Polaris Innovations Limited

Case Numbers – IPR2023-00513 and IPR2023-00514. Petitions filed on February 6, 2023.

Case Subject Matter – Methods for terminating a memory chip with various termination resistances and output drivers for integrated circuits.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Norton Rose Fulbright LLP (Austin, TX and Dallas, TX)

Case – Current Lighting Solutions, LLC d/b/a GE Current v. Jiaxing Super Lighting Electric Appliance Co., Ltd.

Case Number – IPR2023-00270. Petition filed on December 19, 2022.

Case Number – IPR2023-00271. Petition filed on December 14, 2022.

Case Subject Matter – LED lighting, lamps, tube lamps, assembly, and associated circuits and electronics.

Work Performed – Provided expert consulting services and wrote declarations for inter partes review.

Paul Hastings LLP (Washington, DC)

Case – Ex Parte Reexaminations

Case Numbers – 90/015155 and 90/015156. Requests filed on November 7, 2022.

Case Number – 90/015134. Request filed on October 14, 2022.

Case Number – 90/015130. Request filed on September 30, 2022.

Case Subject Matter – Packaging and fabrication of light emitting diodes (LEDs).

Work Performed – Provided expert consulting services and wrote declaration.

Sheppard, Mullin, Richter & Hampton LLP (Menlo Park, CA)

Case – Bell Semiconductor, LLC v. NXP, SMC, Micron, Nvidia, Advanced Micro Devices (AMD), Acer, Infineon, Qualcomm, Motorola Mobility, and Western Digital

Case Number – ITC Investigation No. 337-TA-1340. Complaint filed October 6, 2022.

Case Subject Matter – Electronic devices, semiconductor devices, and components.

Work Performed – Provided expert consulting services.

O'Melveny & Myers LLP (Los Angeles, CA)

Case – Daedalus Prime LLC v. Samsung Electronics and TSMC

Case Number – ITC Investigation No. 337-TA-1335. Complaint filed September 12, 2022.

Case Subject Matter – Semiconductor devices, mobile devices, and components.

Work Performed – Provided expert consulting services.

DLA Piper (Chicago, IL and Washington, DC)

Case – Ampt, LLC v. SolarEdge Technologies, Inc.

Case Number – ITC Investigation No. 337-TA-1327. Complaint filed July 28, 2022.

Case Subject Matter – Solar power optimizers, inverters, and components.

Work Performed – Provided expert consulting services including writing declarations for claim construction, expert reports, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Samsung Electronics Co., Ltd. v. Scramoge Technology Ltd.

Case Numbers – IPR2022-01052, IPR2022-01053, and IPR2022-01058. Petitions filed on May 26, 2022.

Case Numbers – IPR2022-01054, IPR2022-01055, IPR2022-01056, and IPR2022-01057. Petitions filed on May 24, 2022.

Case Number – IPR2022-00939. Petition filed on April 29, 2022.

Case Subject Matter – An antenna that supports wireless charging.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – Ex Parte Reexaminations

Case Number – 90/015020. Request filed on May 2, 2022.

Case Number – 90/014906. Request filed on November 12, 2021.

Case Number – 90/014899. Request filed on November 10, 2021.

Case Number – 90/014888. Request filed on October 21, 2021.

Case Numbers – 90/014886 and 90/014887. Requests filed on October 20, 2021.

Case Number – 90/014885. Request filed on October 19, 2021.

Case Subject Matter – Universal Serial Bus (USB) for charging.

Work Performed – Provided expert consulting services and wrote declarations.

DLA Piper (Chicago, IL, Austin, TX, and Washington, DC)

Case – SolarEdge Technologies, Inc. v. Fronius International GMBH

Case Number – IPR2022-00849. Petition filed on April 14, 2022.

Case Subject Matter – Mechanical assembly and enclosure whereby an upper housing part is detached from a lower housing part using a “rotate-and-lift” feature.

Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Kirkland & Ellis LLP (New York, NY)

Case – Samsung Electronics Co. v. Sonrai Memory Ltd.

Case Numbers – IPR2022-00305 and IPR2022-00306. Petitions filed on December 10, 2021.

Case Subject Matter – USB devices and circuits for saving power.

Work Performed – Provided expert consulting services including writing declarations for inter partes reviews.

Haynes and Boone, LLP (Washington, DC)

Case – Unified Patents, LLC v. Arigna Technology Limited

Case Number – IPR2022-00285. Petition filed on December 9, 2021.

Case Subject Matter – High voltage driver circuit for driving power devices such as insulated gate bipolar transistors (IGBTs).

Work Performed – Provided expert consulting services, wrote declaration for inter partes review and was deposed.

Paul Hastings LLP (Washington, DC)

Case – Samsung Electronics Co., Ltd. v. Lynk Labs, Inc.

Case Numbers – IPR2022-00149 and IPR2022-00150. Petitions filed on November 12, 2021

Case Numbers – IPR2022-00100 and IPR2022-00101. Petitions filed on October 28, 2021.

Case Numbers – IPR2022-00051, IPR2022-00052, and IPR2022-00098. Petitions filed on October 27, 2021.

Case Numbers – IPR2021-01575 and IPR2021-01576. Petitions filed on October 1, 2021.

Case Numbers – IPR2021-01299, IPR2021-01300, IPR2021-01345, IPR2021-01346, and IPR2021-01347. Petitions filed on September 7, 2021.

Case Subject Matter – Circuit design, including switching power supply design, rectifiers, power factor correction, etc. for lighting and displays using light emitting diodes (LEDs).

Work Performed – Provided expert consulting services, wrote declarations, and was deposed ten times.

Haynes and Boone, LLP (Plano, TX)

Case – Pure Storage, Inc. v. Digital Cache, LLC

Case Number – IPR2022-00121. Petition filed on October 29, 2021.

Case Subject Matter – Non-volatile memory (NVM) devices capable of retaining stored data in case of a power failure.

Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Banner Witcoff (Washington, DC)

Case – SolarEdge Technologies Ltd. v. Koolbridge Solar, Inc.

Case Numbers – IPR2022-00007, IPR2022-00008, IPR2022-00009, IPR2022-00010, IPR2022-00011, and IPR2022-00012. Petitions filed on October 11, 2021.

Case Numbers – IPR2022-00013, IPR2022-00014, and IPR2022-00015. Petitions filed on October 8, 2021.

Case Subject Matter – DC-to-AC converters using full-bridges, multi-level conversion for power systems, and other electronics for harvesting solar energy.

Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Samsung Electronics Co., Ltd. v. LED Wafer Solutions LLC

Case Number – IPR2021-01554. Petition filed on September 20, 2021.

Case Number – IPR2021-01526. Petition filed on September 10, 2021.

Case Number – IPR2021-01506. Petition filed on September 7, 2021.

Case Number – IPR2021-01491. Petition filed on September 3, 2021.

Case Subject Matter – Packaging of light emitting diodes (LEDs).

Work Performed – Provided expert consulting services and wrote declarations.

Paul Hastings, LLC (Washington, DC)

Case – Ex Parte Reexamination

Case Number – 90/014,846. Request filed on August 30, 2021.

Case Subject Matter – Wireless power transmission and ways to wirelessly charge and/or discharge a battery.

Work Performed – Provided expert consulting services and wrote declaration.

Jones Day (San Diego, CA and Pittsburgh, PA)

Case – SOLiD, Inc. v. CommScope Technologies LLC

Case Numbers – IPR2021-01390, IPR2021-01391, IPR2021-01392, IPR2021-01393, and IPR2021-01394. Petitions filed on August 12, 2021.

Case Subject Matter – Digital antenna system that enables extension of radio frequency (RF) analog signals from base stations to areas (e.g., inside of buildings) where access to such signals is inhibited.

Work Performed – Provided expert consulting services for inter partes reviews and wrote declaration.

Unified Patents, LLC (Washington, DC)

Case – Ex Parte Reexamination

Case Number – 90/019,015. Request filed on July 20, 2021.

Case Subject Matter – Voltage-controlled oscillator (VCO) temperature compensation.

Work Performed – Provided expert consulting services and wrote declaration.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC v. Unification Technologies LLC

Case Numbers – IPR2021-00940, IPR2021-00941, and IPR2021-00942. Petitions filed on June 4, 2021.

Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.

Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

Hill, Kertscher & Wharton, LLP (Atlanta, GA)

Case – Kaijet Technology v. Sanho Corporation

Case Number – IPR2021-00886. Petition filed on April 30, 2021.

Case Subject Matter – Port extension apparatus for headphone jack, USB (Universal Serial Bus or Type-C ports), and video ports such as VGA (Video Graphics Array), DVI (Digital Visual Interface), HDMI (High-Definition Multimedia Interface), DP (Display Port), and mini-DP.

Work Performed – Provided expert consulting services for inter partes review, wrote declaration, was deposed.

O'Melveny & Myers LLP (Los Angeles, CA and New York, NY)

Case – Solas OLED LTD. v. Samsung Electronics Co. LTD.

Case Number – Texas, ED (Marshall) 2:21-cv-00105. Complaint filed March 22, 2021.

Case Subject Matter – Touch-sensors for gesture recognition and signal processing for capacitive touch displays.

Work Performed – Provided expert consulting services including writing declaration for claim construction.

O'Melveny & Myers LLP (San Francisco, CA)

Case – Super Interconnect Technologies LLC v. Google LLC

Case Number – Texas, ED (Marshall) 2:18-cv-00463 (complaint filed November 2, 2018) and Texas, WD (Waco) 6:21-cv-00259 (complaint filed March 15, 2021).

Case Subject Matter – Transmission of data and clock signals. Serial signals such as transition minimized differential signaling. Communications between processors and non-volatile storage such as Universal Flash Storage (UFS) and embedded MultiMedia Controller (eMMC).

Work Performed – Provided expert consulting services and wrote expert reports.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, and Irvine, CA)

Case – Fundamental Innovation Systems International LLC v. Anker Innovations and Fantasia Trading LLC d/b/a Ankerdirect

Case Number – Delaware, 1:21-cv-00339. Complaint filed on March 5, 2021.

Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.

Work Performed – Provided expert consulting services.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – TCT Mobile Inc. and TCL Communication, Inc. v. Fundamental Innovation Systems International LLC

Case Numbers – IPR2021-00597, IPR2021-00598, and IPR2021-00599. Petitions filed on February 26, 2021.

Case Number – IPR2021-00428. Petition filed on January 13, 2021.

Case Number – IPR2021-00410. Petition filed on January 11, 2021.

Case Number – IPR2021-00395. Petition filed on December 31, 2020.

Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.

Work Performed – Provided expert consulting services including writing declarations for inter partes reviews. Was deposed twice.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Samsung, Inc. v. Pictos Technologies, Inc.

Case Number – IPR2021-00557. Petition filed on February 18, 2021.

Case Number – IPR2021-00436. Petition filed on January 19, 2021.

Case Numbers – IPR2021-00437 and IPR2021-00438. Petitions filed on January 15, 2021.

Case Subject Matter – Solid-state imaging devices including red, green, and blue pixels, data conversion circuits, and interpolation circuits. CMOS imagers including fabrication and design, active pixels, and semiconductor physics.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

O'Melveny & Myers LLP (San Francisco, CA) and DLA Piper (New York, NY)

Case – Solas OLED Ltd. v. BOE Technology Group Co. Ltd. and Samsung Electronics

Case Number – ITC Investigation No. 337-TA-1243. Complaint filed January 5, 2021.

Case Subject Matter – Active matrix OLED display devices and components

Work Performed – Provided expert consulting services, wrote expert reports, was deposed, and testified at trial.

Paul Hastings LLP (Washington, DC)

Case – Samsung, Inc. v. Garrity Power Services LLC

Case Number – IPR2021-00389. Petition filed on December 31, 2020.

Case Subject Matter – Power electronics including full-bridge PWM modules for wireless power transmission using magnetic coupling via antennas and transformers. Design of inductors and coils.

Work Performed – Provided expert consulting services and wrote declaration for inter partes reviews.

Morgan, Lewis & Bockius LLP (Palo Alto, CA and Shanghai, CN)

Case – Monolithic Power Systems, Inc. v. Meraki Integrated Circuit Technology, Inc. and Promate Electronic Company, LTD.

Case Number – Texas, WD (Waco) 6:20-cv-00876. Complaint filed on December 24, 2020.

Case Subject Matter – Design of switching power supplies including synchronous rectification.

Work Performed – Provided expert consulting services including declaration for claim construction, trade secret analysis and declaration, and Markman tutorial.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC; Dell Technologies Inc.; Dell Inc.; and HP Inc. v. Unification Technologies LLC

Case Numbers – IPR2021-00343, IPR2021-00344, and IPR2021-00345. Petitions filed on December 22, 2020.

Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.

Work Performed – Provided expert consulting services for inter partes reviews, wrote declarations, and was deposed.

Jones Day (Chicago, IL and Dallas, TX)

Case – WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Xilinx, Inc.

Case Numbers – Delaware, 1:20-cv-01231 and Delaware, 1:20-cv-01233. Complaints filed on November 23, 2020 and September 16, 2020.

Case Subject Matter – Controlling power cycles in communication devices and transferring multiple asynchronous clock signals.

Work Performed – Provided expert consulting services, wrote claim construction declaration, wrote expert reports, and was deposed.

O'Melveny & Myers LLP (Los Angeles, CA)

Case – Cosemi Technologies, Inc. v. EverPro Technologies, Fibbr Technologies, Logitech, Inc., and Facebook Technologies

Case Number – ITC Investigation No. 337-TA-1233. Complaint filed October 28, 2020.

Case Subject Matter – Data cables, including HDMI, Display Port, and USB Type A, USB Type C and USB Type A/C data cables.

Work Performed – Provided expert consulting services.

Kirkland & Ellis LLP (Boston, MA and New York, NY)

Case – Pictos Technologies, Inc. v. Samsung Electronics Co., LTD. and Samsung Semiconductor, Inc.

Case Number – ITC Investigation No. 337-TA-1231. Complaint filed September 25, 2020.

Case Subject Matter – Solid-state imaging devices including red, green, and blue pixels, correction of bad pixels, data conversion circuits, and interpolation circuits. CMOS imagers including fabrication and design, active pixels, and semiconductor physics.

Work Performed – Provided expert consulting services and wrote expert report.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – Fundamental Innovation Systems International LLC v. TCT Mobile Inc. and TCL Communication, Inc.

Case Number – Delaware, 1:20-cv-00552. Complaint filed on September 11, 2020.

Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.

Work Performed – Provided expert consulting services including writing declarations, expert report on invalidity, and was deposed.

Walters Wilson LLP (Redwood City, CA)

Case – Western Digital Corporation and SanDisk, LLC v. Martin Kuster

Case Numbers – IPR2020-01410 and IPR2020-01411. Petitions filed on August 3, 2020.

Case Subject Matter – Computer connectors such as universal serial bus (USB) that connect to peripheral devices such as mice, keyboards, displays, printers, external storage, etc.

Work Performed – Provided expert consulting services for inter partes review, wrote declarations and was deposed.

O'Melveny & Myers LLP (Los Angeles, CA)

Case – Advanced Micro Devices, Inc. v. Monterey Research, LLC

Case Number – IPR2020-01315. Petition filed on July 16, 2020.

Case Number – IPR2020-00985. Petition filed on May 26, 2020.

Case Subject Matter – Reading and writing to semiconductor memory such as SRAM and double data rate (DDR) DRAM. Buffer circuits with variable current supplies for controlling the rise and fall times of output signals.

Work Performed – Provided expert consulting services for inter partes review, wrote declarations and was deposed twice.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – Unification Technologies LLC v. Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC

Case Number – Texas, WD (Waco) 6:20-cv-00500. Complaint filed June 5, 2020.

Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.

Work Performed – Provided expert consulting services, wrote declaration for claim construction, and was deposed.

Ari Law, P.C. (Palo Alto, CA) and Hill, Kertscher & Wharton, LLP (Atlanta, GA)

Case – Sanho Corporation v. Kaijet Technology, Magic Control Technology, and Star View Global

Case Numbers – Georgia, ND (Atlanta) 1:18-cv-05385 (third amended complaint filed November 14, 2019) and Georgia, ND (Atlanta) 1:20-cv-02150 (filed May 19, 2020).

Case Subject Matter – Port extension apparatus for headphone jack, USB (Universal Serial Bus or Type-C ports), and video ports such as VGA (Video Graphics Array), DVI (Digital Visual Interface), HDMI (High-Definition Multimedia Interface), DP (Display Port), and mini-DP.

Work Performed – Provided expert consulting services, wrote declaration for claim construction, and expert reports. Was deposed.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – Fundamental Innovation Systems International LLC v. Coolpad Group Limited, Coolpad Technologies, Inc., and Yulong Computer Telecommunication Scientific Co. Ltd.

Case Number – Texas, ED (Marshall) 2:20-cv-00117. Complaint filed on April 23, 2020.

Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.

Work Performed – Provided expert consulting services including writing declaration for claim construction.

Pillsbury Winthrop Shaw Pittman LLP (San Francisco, CA and Shanghai, China)

Case – SMIC, Americas v. Innovative Foundry Technologies LLC

Case Numbers – IPR2020-00837 and IPR2020-00839. Petitions filed on April 14, 2020.

Case Subject Matter – Methods of manufacturing a semiconductor component, such as a short-channel MOS device, including forming graded-junctions using spacers along the sidewalls of a transistor's gate.

Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

Russ August & Kabat (Los Angeles, CA)

Case – Oyster Optics, LLC v. Ciena Corporation

Case Number – California, ND (Oakland) 3:20-cv-02354. Complaint filed on April 7, 2020.

Case Subject Matter – Fiber optic telecommunication systems.

Work Performed – Provided expert consulting services, wrote claim construction declaration, and was deposed.

Russ August & Kabat (Los Angeles, CA)

Case – Seoul Semiconductor Co., Ltd. v. Document Security Systems, Inc.

Case Number – IPR2020-00938. Petition filed on May 18, 2020.

Case – Nichia Corporation v. Document Security Systems, Inc.

Case Number – IPR2020-00908. Petition filed on May 18, 2020.

Case – Cree, Inc. v. Document Security Systems, Inc.

Case Number – IPR2020-00557. Petition filed on February 11, 2020.

Case Subject Matter – Light emitting diodes (LEDs) as a light source, extraction of light.

Work Performed – Provided expert consulting services, wrote declaration for inter partes reviews, and was deposed three times.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Flex Logix Technologies, Inc. v. Konda Technologies Inc.

Case Numbers – IPR2020-00260, IPR2020-00261, and IPR2020-00260. Petitions filed on December 16, 2019.

Case Numbers – PGR2019-00037, PGR2019-00040, and PGR2019-00042. Petitions filed on March 18, 2019.

Case Subject Matter – FPGA layout routing for integrated circuits and networks, electrical and computer engineering.

Work Performed – Provided expert consulting services and wrote declarations for post grant and inter partes reviews.

DLA Piper (Chicago, IL, Houston, TX, and Washington, DC) and White & Case LLP (New York, NY and Washington, DC)

Case – M-Red Inc. v. Panasonic Corporation

Case Number – Texas, ED (Marshall) 2:19-cv-00251. Complaint filed on July 16, 2019.

Case Subject Matter – Integrated circuit electronics adjustment, such as ring oscillators, using auto calibration. Evaluating a known good die using both wire and flip-chip interconnects.

Work Performed – Provided expert consulting services and wrote declaration for claim construction.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Samsung, Inc. v. NuCurrent, Inc.

Case Number – IPR2019-01217. Petition filed on June 19, 2019.

Case Numbers – PGR2019-00049 and PGR2019-00050. Petitions filed on May 28, 2019.

Case Numbers – IPR2019-00858, IPR2019-00859, IPR2019-00860, IPR2019-00861, IPR2019-00862, and IPR2019-00863. Petitions filed on March 22, 2019.

Case Subject Matter – Wireless power transmission using magnetic coupling via antennas and transformers. Design of inductors and coils.

Work Performed – Provided expert consulting services and wrote declarations for post grant and inter partes reviews. Was deposed five times.

DLA Piper (East Palo Alto, CA)

Case – Invensas Corporation and Tessera Advanced Technologies, Inc. v. NVIDIA Corporation

Case Number – Delaware, 1:19-cv-00861. Complaint filed on May 8, 2019.

Case Subject Matter – Reference voltage circuits (programmable bandgaps) having a substantially zero temperature coefficient using bipolar and MOS transistors.

Work Performed – Provided expert consulting services.

Irell & Manella LLP (Los Angeles, CA)

Case – VLSI Technology LLC v. Intel Corporation

Case Number – Texas, WD (Waco) 6:19-cv-00256. Complaint filed on April 11, 2019.

Case Subject Matter – Static Random Access Memory (SRAM) having a variable power supply using charge-sharing capacitors, methods for designing digital systems, and hardware managed interrupt control.

Work Performed – Provided expert consulting services, wrote expert reports, declaration, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – Samsung, Inc. v. ProMOS Technologies, Inc.

Case Numbers – IPR2019-00779, IPR2019-00780, IPR2019-00781, IPR2019-00784, and IPR2019-00785. Petitions filed on March 5, 2019.

Case Subject Matter – Programmable latches that include non-volatile programmable elements, digital delay elements, and decoders for memory chips.

Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed four times.