

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

RESONANT SYSTEMS, INC.,
Patent Owner.

IPR2024-00807
Patent 8,860,337 B2

Before KARL D. EASTHOM, NORMAN H. BEAMER, and
BRIAN D. RANGE, *Administrative Patent Judges*.

EASTHOM, *Administrative Patent Judge*.

DECISION
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Apple Inc., Petitioner, filed a Petition (Paper 2, “Pet.”) requesting an *inter partes* review of claims 1–4 of U.S. Patent No. 8,860,337 B2 (Ex. 1001, the “’337 patent”). Pet. 1. Prior to the Institution Decision (Paper 10, “Inst. Dec.”), Patent Owner filed an Exhibit evidencing that it filed a disclaimer under 37 C.F.R. § 1.321(a) statutorily disclaiming claims 1, 4, and 5. Ex. 2008. After the Institution Decision, Patent Owner filed a Response (Paper 15, “PO Resp.”), Petitioner filed a Reply (Paper 21), and Patent Owner filed a Sur-reply (Paper 27). After the briefing, the Board held an Oral Hearing and entered a transcript thereof. Paper 32 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Decision is a Final Written Decision under 35 U.S.C. § 318(a). Based on the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 2 and 3 of the ’302 patent are unpatentable.

II. BACKGROUND

A. *Real Parties in Interest*

Each party identifies itself as the real parties in interest. Pet. 86; Paper 4, 1.

B. *Related Matters*

The parties identify the following district three court proceedings as related matters: *Resonant Systems, Inc. d/b/a Revel HMI v. Apple, Inc.*, No. 7:23-cv-00077 (W.D. Tex.) (the “Apple Litigation”); *Resonant Systems, Inc. v. Samsung Electronics Co., Ltd.*, No. 2:22-cv-00423 (E.D. Tex.); *Resonant Systems, Inc. v. Sony Group Corp.*, No. 2:22-cv-00424 (E.D. Tex.). Pet. 86; Paper 4.

The parties identify the following PTAB proceeding that also involves the '337 patent: *Sony Interactive Entertainment Inc. and Sony Group Corp. v. Resonant Systems, Inc.*, Paper 9, IPR2024-00569 (PTAB Aug. 26, 2024) (denying institution). *See* Pet. 86; Paper 4.

Other PTAB proceedings challenging related patents that may involve similar claim construction issues include the following: IPR2023-00992, IPR2023-00993, IPR2023-01025, IPR2024-00568, IPR2024-00569, IPR2024-00697, IPR2024-00698, IPR2024-00806, IPR2024-00808, and IPR2024-00983.

C. *The '337 Patent*

The '337 patent relates to “vibration-generating devices and, in particular, to vibration modules that can be incorporated into a wide variety of different types of electromechanical devices and systems to produce vibrations of selected amplitudes and frequencies over a wide range of amplitude/frequency space.” Ex. 1001, 1:14–19. The vibration generating devices include linear vibration modules (LVMs) and linear-resonant vibration modules (LRVMs). *Id.* at 4:13–19, code (57). LVMs and LRVMs “are linear in the sense that the vibrational forces are produced by a linear oscillation of a weight or component within the LVM or LRVM.” *Id.* at 4:19–21.

Figure 4A follows:

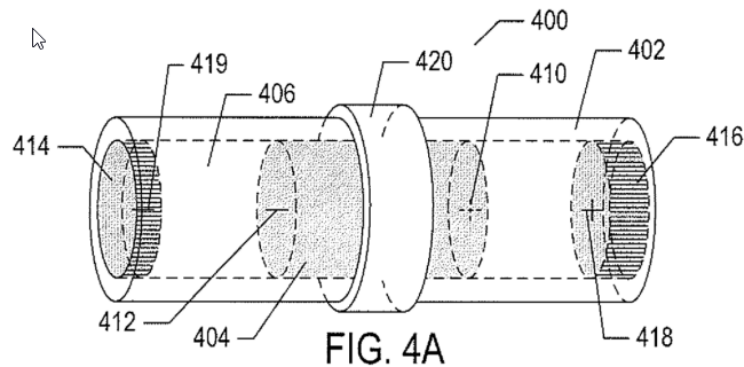


Figure 4A depicts LVRM 400, which includes cylindrical housing or tube 402 forming cylindrical chamber 406, disk-like magnets 414 (left) and 416 (right) with negative and positive polarity, respectively, and conductive coil 420 encircling tube 402. Ex. 1001, 4:44–5:4, Fig. 4A.

Disk-like magnets 414 and 416 repel magnet 404 when it moves to the extreme right or left according to a current supplied to coil 420 from a power source. Ex. 1001, 4:59–5:7. This current oscillates with an amplitude and frequency to create a changing magnetic field via coil 420, which in turn causes magnet 404 to change its direction and length of travel according to a user-specified amplitude and frequency of movement. *See id.* at 4:59–5:4, 6:13–39, Figs. 4B–4G.

Figure 6, a block diagram of the LRVM, follows:

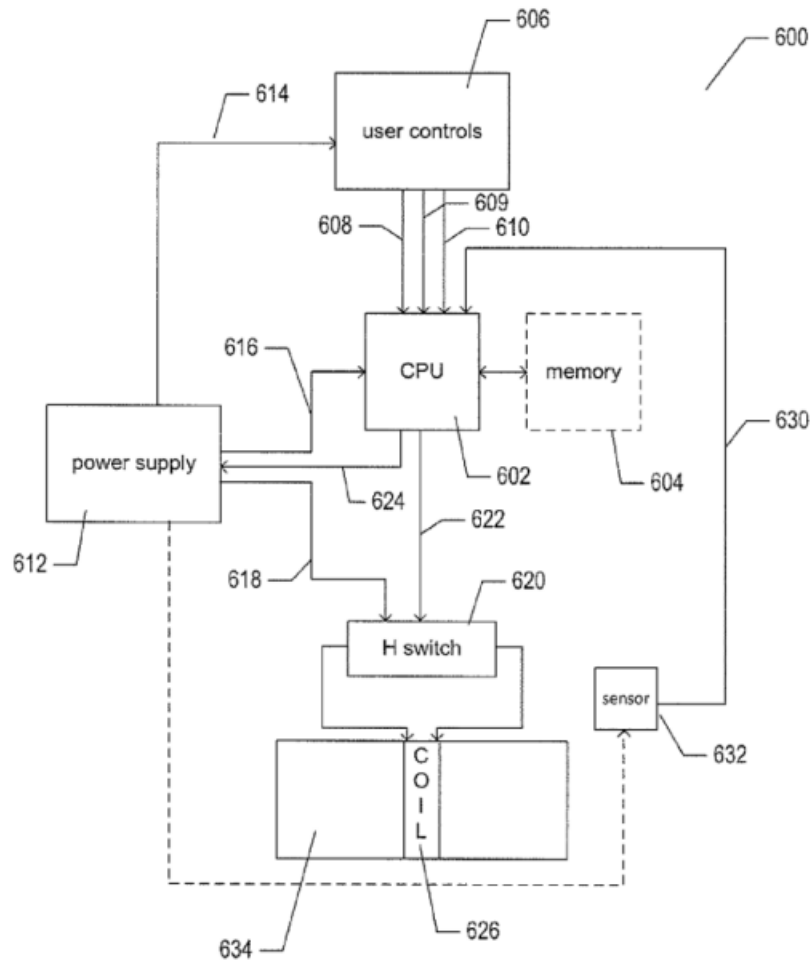


FIG. 6

Figure 6 illustrates LRVM 600, which includes the following: microprocessor (CPU) 602 executing a control program; memory chip 604 storing the control program; user controls 606 that may include “any of various dials, pushbuttons, switches, or other electromechanical-control devices,” such as “a dial to select a strength of vibration, which corresponds to the current applied to the coil,” “a switch to select one of various different operational modes,” and “a power button”; power supply 612; coil 626; magnet 634; H-bridge switch 620 that “receives a control-signal input” from

microprocessor (CPU) 602, which together control the direction and frequency of current supplied to coil 626. *See* Ex. 1001, 6:19–61, Fig. 6.

The H-bridge switch “change[s] the direction of current applied to the coil that drives linear oscillation within” the LRVM. Ex. 1001, 5:47–49; *see also id.* at Figs. 5A–5B. The H-bridge switch “is but one example of various different types of electrical and electromechanical switches that can be used to rapidly alternate the direction of current within the coil of an LRVM.” *Id.* at 5:62–65.

D. Illustrative Claim

Independent claim 2 is illustrative of the challenged claims, and follows:

2. [2pre] A linear vibration module comprising:

[2a] a housing;

[2b] a moveable component;

[2c] a power supply;

[2d] user-input features;

[2e] a driving component that drives the moveable component in each of two opposite directions within the housing; and

[2f] a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by user input received from the user-input features,

[2g] wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.

Pet. vii–viii (alteration in original).

E. Asserted Grounds of Unpatentability

Petitioner contends that claims 2 and 3 are unpatentable as follows:¹

Claims Challenged	35 U.S.C. §	References
2, 3	103(a)	Wakuda, ² Ramsay, ³
2, 3	103(a)	Wakuda, Ramsay, Rossi, ⁴ Aldrich ⁵
2	103(a)	Gregorio, ⁶ Ramsay, Wakuda
2, 3	103(a)	Gregorio, Ramsay, Tierling ⁷
2	103(a)	Gregorio, Ramsay, Wakuda, Rossi, Aldrich
2, 3	103(a)	Gregorio, Ramsay, Tierling, Rossi, Aldrich

Pet. 1. The Petition designates the six grounds listed above as Grounds 1, 2, 3A, 3B, 4A, and 4B, respectively. *Id.* at 7, 31, 50, 66, 75, 80.

Petitioner filed a Declaration of Dr. Blake Hannaford (Ex. 1003) with its Petition and a Reply Declaration of Dr. Blake Hannaford (Ex. 1049) with

¹ The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. §§ 102, 103 effective March 16, 2013, which is after the ’337 patent’s effective filing date. *See* Ex. 1001, code (63). Therefore, the pre-AIA version of § 103 applies.

² Wakuda et al., US 7,005,811 B2, issued Feb. 28, 2006. Ex. 1005.

³ Ramsay et al., US 2008/0294984 A1, published Nov. 27, 2008. Ex. 1006.

⁴ Rossi et al., US 4,879,641, issued Nov. 7, 1989. Ex. 1020.

⁵ Aldrich et al., *Controller for Driving a Piezoelectric Actuator at Resonance*, NASA Tech Briefs, April 2008. Ex. 1021.

⁶ Gregorio et al., US 7,843,277 B2, issued Nov. 30, 2010. Ex. 1004.

⁷ Tierling et al., US 2005/0134561 A1, published June 23, 2005. Ex. 1008.

its Reply. Patent Owner filed a Declaration of Keith W. Goossen, Ph.D. with its Response. Ex. 2009.

III. ANALYSIS OF PETITIONER’S CHALLENGES

A. *Burden of Proof*

To prevail in its grounds for unpatentability during trial, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). “In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (2012) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

B. *The Obviousness Standard*

Section 103(a) forbids issuance of a patent 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 at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (quoting 35 U.S.C. § 103(a)). The obviousness question involves resolving underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and when presented (not so here), (4) objective

evidence of non-obviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

C. Level of Ordinary Skill in the Art

Determining whether an invention would have been obvious under 35 U.S.C. § 103 requires resolving the level of ordinary skill in the pertinent art at the time of the effective filing date of the claimed invention. *Graham*, 383 U.S. at 17. The person of ordinary skill in the art is a hypothetical person who knows the relevant art. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). Factors in determining the level of ordinary skill in the art include the types of problems encountered in the art, the sophistication of the technology, and educational level of active workers in the field. *Id.* One or more factors may predominate. *Id.*

Petitioner’s expert declarant contends that a person of ordinary skill in the art (POSITA)

would have had a degree in mechanical engineering, electrical engineering, physics, or a related technical field, and at least 2–3 years of experience related to the design or development of systems incorporating linear actuators; additional years of experience could substitute for the advanced-level degree.

Ex. 1003 ¶ 30. Patent Owner offers “a similar level of ordinary skill in the art.” *See* PO Resp. 4.

Based on a review of the record, we adopt Petitioner’s proposed level of ordinary skill in the art because it is consistent with the evidence of record, including the asserted prior art and ’337 patent specification.

D. Claim Construction

In *inter partes* reviews, the Board interprets claim language using the district-court-type standard, as described in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 37 C.F.R. § 42.100(b) (2023).

Under this standard, claim terms have their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art at the time of the invention, in light of the language of the claims, the specification, and the prosecution history. *See Phillips*, 415 F.3d at 1313–14. Claim terms need only be construed to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

The parties agree that independent claim 2 includes means-plus-function limitations under 35 U.S.C. § 112 ¶ 6.⁸ Pet. 2–6; PO Resp. 7–15.

An element in a claim for a combination may be expressed as a means . . . for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

35 U.S.C. § 112 ¶ 6. In particular, the parties agree that the “driving component” and “control component” requirements of independent claim 2 are means-plus-function limitations. Pet. 2–6; PO Resp. 7. Construing a means-plus-function limitation under 35 U.S.C. § 112 ¶ 6 involves two steps: 1) identifying the claimed function and 2) identifying in the specification the corresponding structure that performs the claimed function. *Med. Instrumentation & Diagnostics Corp. v. Elekta AB*, 344 F.3d 1205, 1210 (Fed. Cir. 2003); *Cardiac Pacemakers, Inc. v. St. Jude Med., Inc.*, 296 F.3d 1106, 1119 (Fed. Cir. 2002).

“[S]tructure disclosed in the specification” is “‘corresponding’ structure,” “only if the specification or prosecution history *clearly links or*

⁸ As indicated above, statutory citations are to the pre-AIA version of 35 U.S.C. § 112. *See supra* note 1.

associates that structure to the function recited in the claim.” *B. Braun Med. Inc. v. Abbott Labs.*, 124 F.3d 1419, 1424 (Fed. Cir. 1997) (emphasis added) (“Because Braun’s specification does not adequately disclose the valve seat as structure that holds the disc firmly in place, Braun has failed to particularly point out and distinctly claim that particular means.”). “This duty to link or associate structure to function is the *quid pro quo* for the convenience of employing § 112, ¶ 6.” *Id.* (citing *O.I. Corp. v. Tekmar Co.*, 115 F.3d 1576, 1583 (Fed. Cir. 1997)).

Our reviewing court explains:

If the specification is not clear as to the structure that the patentee intends to correspond to the claimed function, then the patentee has not paid that price but is *rather attempting to claim in functional terms unbounded by any reference to structure* in the specification. Such is impermissible under the statute.

Med. Instrumentation, 344 F.3d at 1211 (emphasis added); *see also Medtronic, Inc. v. Advanced Cardiovascular Sys., Inc.*, 248 F.3d 1303, 1313 (Fed. Cir. 2001) (finding particular structures not to be corresponding structures because “one skilled in the art would not perceive any clear link or association between these structures and the [recited] function of connecting adjacent elements together”).

I. Construction of “Driving Component”

Petitioner contends that the claimed function of “driving component” is “drives the moveable component to oscillate within the housing.” Pet. 5; Ex. 2002, 2. Petitioner asserts that the corresponding structure is

a coil of conductive wire 420” (Figures 4A–4G); “coil 514” (Figures 5A–5B); “coil 626” (Figure 6); “electromagnet” (Figures 10-11); “additional coils 1202 and 1204” (Figure 12); “coils 1302 and 1304” (Figure 13); “driving coils 1412 and

1414” (Figure 14); “coil 1510” (Figures 15–17); “stator coils” (Figures 24A–25).

Pet. 5–6 (citing Ex. 1001, 5:2–34, 5:54–59, 6:32–35, 9:11–52, 9:64–10:22, 14:59); Ex. 2002, 2.).

Patent Owner states that it “does not believe that the phrase involving a ‘driving component’ needs to be construed in order to resolve any issue in this proceeding.” PO Resp. 7. Patent Owner agreed to the above construction in the Apple Litigation, and the court adopted this construction. Ex. 2002, 2. The record supports Petitioner’s position and we adopt it.

2. Construction of “Control Component”

The parties agree that the claimed function of the control component is “controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values.” Pet. 4; Ex. 2002, 6.

Petitioner proposes that the corresponding structure is “one of the switches shown in Figures 5A–6 and described at 5:45–65, 6:2–8, and the processor (also referred to as microprocessor, microcontroller, or CPU) that performs the algorithm shown in Figures 7A–7C and described at 6:43–8:30.” Pet. 4. Patent Owner refers to the construction that the District Court adopted in the Apple Litigation. PO Resp. 7–8. That construction follows:

Function: controlling supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by specified by one or more stored values.

Structure: a microcontroller, a processor, a microprocessor, or a CPU that performs the algorithm shown in Steps 706 through 716 in Figure 7A, with reference to all steps shown in Figure 7B other than Step 734 and all steps shown in Figure 7C, or the algorithm

described in the corresponding text, *see, e.g.*, 7:20–7:34, 7:42–7:52, 7:60–8:40, and equivalents thereof.

Ex. 2002, 6–7; *see also* Ex. 3001, 33–37 (August 23, 2024 “Claim Construction Memorandum And Order” entered in the Apple Litigation). Patent Owner acknowledges that Petitioner’s proposed construction here is “similar” to that adopted in the Apple Litigation. PO Resp. 8.

In any event, Patent Owner emphasizes that, in accord with all constructions considered, the control component must provide a value “p” corresponding to the currently selected amplitude of the LVM to the power supply so that the power supply outputs an appropriate current to the coil. PO Resp. 8–14; *id.* at 10 (“[U]nder either alternative in the court’s construction, the processor must compute an output value p and ‘output[] p to the power supply.’” (second alteration in original)). Patent Owner also argues that the control component must provide a separate value “d” corresponding to the direction of current to the coil per the selected frequency of the LVM. *Id.* at 19.

As elaborated below, our reading of the ’337 patent is a modification of the District Court’s construction of “control component” in the Apple Litigation.⁹

⁹ The District Court’s construction is in accord with Federal Circuit authority consistently requiring that the corresponding structure, in circumstances such as presented here, be more than simply a general purpose computer or microprocessor and that the specification must disclose an algorithm for performing the claimed function. *See, e.g., Noah Systems Inc. v. Intuit Inc.*, 675 F.3d 1302, 1312 (Fed. Cir. 2012); *Aristocrat Techs. Australia PTY Ltd. v. Int’l Game Tech.*, 521 F.3d 1328, 1333 (Fed. Cir. 2008).

a) Frequency Function

First, considering the user-specified *frequency* function of the control component limitation, “controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a *frequency* . . . specified by one or more stored values,” the specification clearly links this recited function to algorithmic structure corresponding to steps 706 and 708 of Figure 7A. As the block diagram of Figure 6 shows and as explained in Section II.C above, “power supply 612 receives a control input 624 from the CPU to control the current supplied to the H-bridge switch 618 for transfer to the coil 626,” which controls the frequency. *See* Ex. 1001, 6:33–35.

The relevant portion of Figure 7A follows:

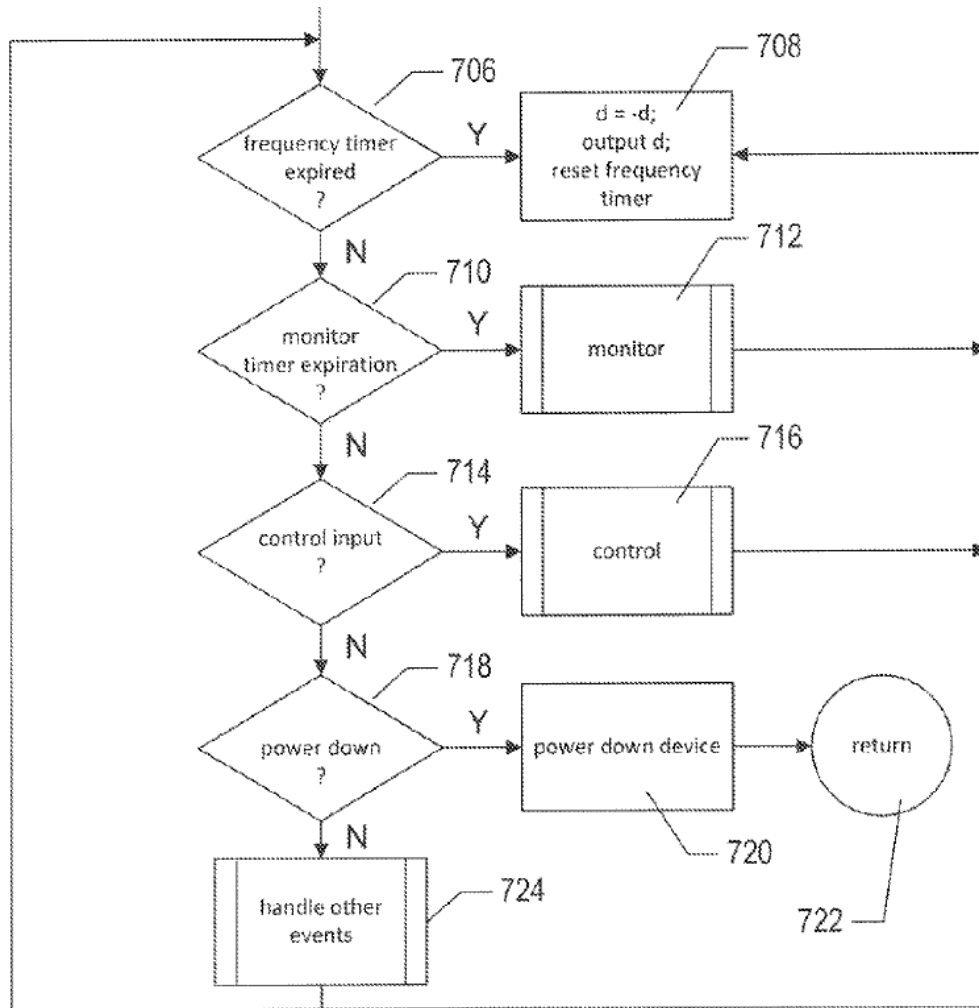


FIG. 7A

Figure 7A, which corresponds to a “high-level control program” executed by CPU 602 and memory 604 of Figure 6 (*supra* Section II.C), shows the algorithm using value d, “the control output to the H-bridge switch,” to control the frequency. *See* Ex. 1001, 6:32–7:31. In steps 706 and 708, the algorithm operates a timer to periodically flip the polarity of the d value applied to the H-bridge switch, which Figure 5A illustrates. *See id.*

Figure 5A, which depicts an H-bridge switch and control output d from step 708 of Figure 7A (also referred to as “directional signal d 502,” Ex. 1001, 5:52–53), follows:

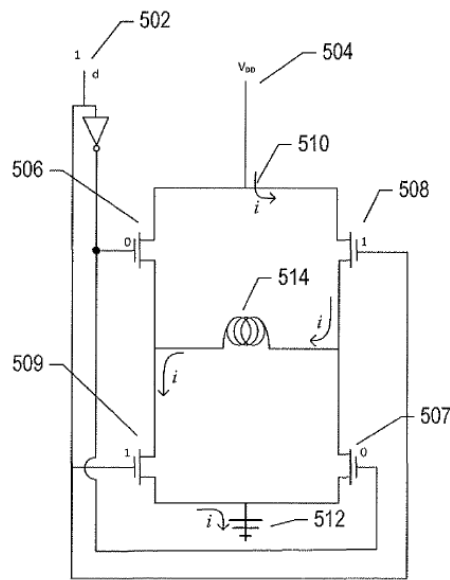


FIG. 5A

Figure 5A “illustrate[s] an H-bridge switch that can be used, in various embodiments of the current application, *to change the direction of current applied to the coil that drives linear oscillation.*” *Id.* at 3:35–39 (emphasis added). In other words, by controlling the polarity of directional signal *d* 502, the CPU changes the direction of current *i* through coil 514 from power supply 504 as Figure 5A above indicates, thereby changing the frequency depending on the timer. Specifically, the oscillating current *i* alternately flows through switches 508 and 509 (right to left through coil 514 as depicted) and switches 506 and 507 (left to right through coil 514) depending on whether the value of input *d* is “high” or “low” (which the timer controls). *See id.* at 5:43–65.

To implement this user-defined oscillation frequency, Figure 7A describes a “timer[]” to “control[] the change in direction of the current applied to the coil, at a currently established frequency.” Ex. 1001, 7:3–5. After the frequency timer expires, “as determined in step 706, *the*

value of the output signal d is flipped [i.e., from low to high, or vice versa], in step 708, and output to the H-bridge switch, with the frequency timer being reset to trigger a next frequency-related event.” *Id.* at 7:14–17 (emphasis added). “The frequency-timer interval is determined by the current value of the variable freq[ueency].” *Id.* at 7:17–18.

Therefore, the specification clearly links the function of “control[ing] supply of power from the power supply to . . . cause the moveable component to oscillate at a *frequency* . . . specified by one or more stored values” to portions of steps 706 and 708 of the flow diagram algorithm of Figure 7A, as described above. Thus, the control component requires a microprocessor and memory with algorithmic structure including a timing algorithm or similar coding for creating a control output signal that flips to control the direction of current flow through a coil (e.g., coil 514, Fig. 5, coil 626, Fig. 6), where the coil is structure that corresponds to the recited “driving component,” as noted above.¹⁰

We adopt the District Court’s conclusion in the Apple litigation that the “control component” structure itself does not require an H-bridge switch, but only requires that the processor generates the “d” inputs configured to operate a switch or other circuit; and further that the structure does not require does not require computing initial default values as specified in step 702 of Figure 7A (i.e., values not specified by a user). Ex. 3001, 30–33, 35. This is in accord with settled law that limits the structure to that necessary to

¹⁰ “Rather than using a formal timer mechanism, certain implementations may simply employ counted loops or other simple programming techniques for periodically carrying out tasks.” Ex. 1001, 7:7–10.

perform the claimed function.¹¹ By the same token, we modify the District Court’s construction to the extent it would require, based on such steps as 706, 710, and 716, a specific order of the steps of generating the “p” and “d” values. The claims only require the control component to control the power supply to cause oscillation at a specified frequency and amplitude, but do not require the frequency value to be generated before the amplitude value, or vice versa.

b) Amplitude Function

The user-specified *amplitude* function of the control component limitation follows: “control supply of power from the power supply to the driving component to cause the moveable component to oscillate at . . . an *amplitude* specified by one or more stored values.” The specification clearly

¹¹ See *Golight, Inc. v. Wal-Mart Stores, Inc.*, 355 F.3d 1327, 1334 (Fed. Cir. 2004) (“[T]o the extent the [disclosed] assembly contains particular structures for permitting rotation through 360°, such as the follower pin 64 and slot 65, these structures are superfluous to our claim construction analysis because they are not required for performing the claimed function [which does not require 360° rotation].”); *Univ. of Pitt. of Commonwealth Sys. of Higher Educ. v. Varian Med. Sys., Inc.*, 561 F. App’x 934, 941 (Fed. Cir. 2014) (“The district court properly located the disclosure of an algorithm that covered what was necessary to perform the claimed function . . . and nothing more The algorithm need only include what is necessary to perform the claimed function.”); *Northrop Grumman Corp. v. Intel Corp.*, 325 F.3d 1346, 1352 (Fed. Cir. 2003) (“A court may not import into the claim features that are unnecessary to perform the claimed function. Features that do not perform the recited function do not constitute corresponding structure and thus do not serve as claim limitations.” (citation omitted)); *Micro Chem., Inc. v. Great Plains Chem. Co.*, 194 F.3d 1250, 1258 (Fed. Cir. 1999) (Section 112, ¶ 6 does not “permit incorporation of structure from the written description beyond that necessary to perform the claimed function”).

links this recited function to portions of the flow-control diagram of Figure 7C and its description. Ex. 1001, 8:10–22, Fig. 7C.

Figure 7C follows:

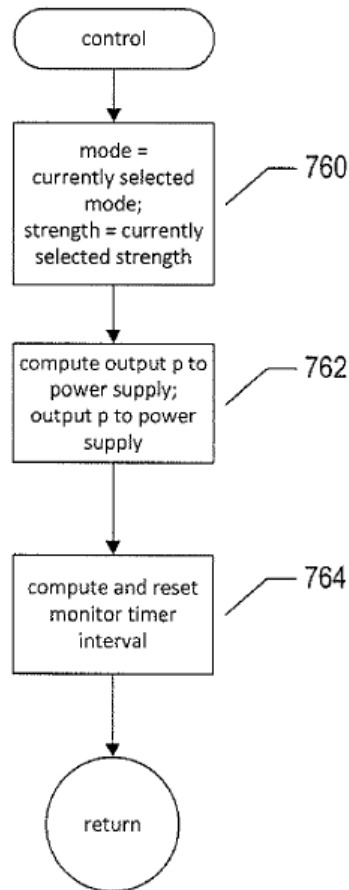


FIG. 7C

Figure 7C represents “a control-flow diagram for the routine ‘control,’ called in step 716 in FIG. 7A.” Ex. 1001, 8:10–11. The specification discloses that in step 762, “the routine ‘control’ computes an output value *p* corresponding to the currently selected strength, stored in the variable strength, *and outputs the value p to the power supply so that the power supply outputs an appropriate current to the coil.*” Ex. 1001, 8:16–20. Step 762 corresponds

to, for example, control input 624 transmitted from CPU 602 to power supply 612 of Figure 6 to control the current from power supply 612 to coil 626. *See supra* Section II.C (describing Fig. 6); Ex. 1001, 6:33–35 (“The power supply 612 receives a control input 624 from the CPU to control the current supplied to the H-bridge switch 618 for transfer to the coil 626.”).

The specification thus clearly links step 760, which selects current strength and mode, and step 762, which corresponds to control input 624 transmitted from CPU 602 to power supply 612 in the block diagram of Figure 6, to the recited function, “control[] supply of power from the power supply to the driving component to cause the moveable component to oscillate at . . . an amplitude specified by one or more stored values.” *See* Ex. 1001, 8:10–22, Fig. 7C.

c) Control Component Summary

The corresponding structure of the “control component” includes a microprocessor (and memory) as corresponding structure with algorithmic structure for 1) operating a timer or its equivalent to flip the polarity of a control value periodically corresponding to a user-selected frequency and input the control value to a circuit to change the direction of the current through the coil as supplied by the power supply, and 2) computing an output value corresponding to a user-selected amplitude of oscillation and outputting the value to the claimed power supply so that the power supply outputs an appropriate current amplitude to a coil.¹²

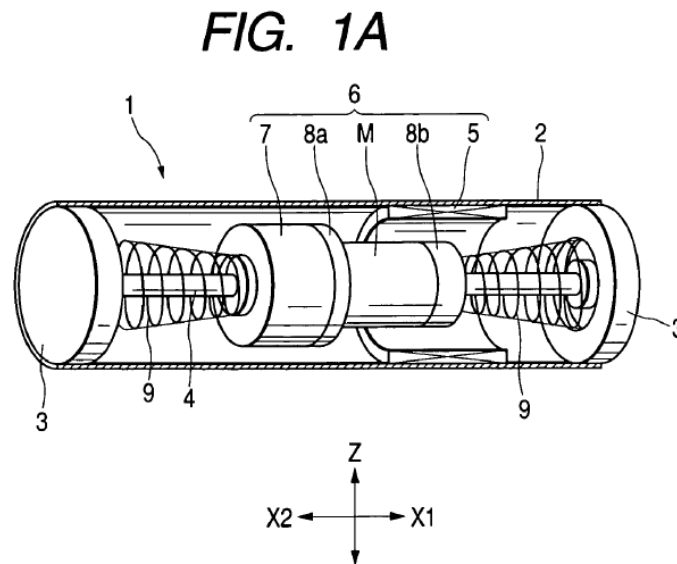
¹² This summary is materially the same as the summary in the Institution Decision, but the construction summary here eliminates “an H-bridge switch circuit” and replaces it with “a circuit.” *See* Inst. Dec. 20 § IV.C.2.c. This comports with the District Court’s construction indicating that limitation 2.f

E. Alleged Obviousness of Claims 2 and 3 over Wakuda, Ramsay, Rossi, and Aldrich

Petitioner contends that claims 2 and 3 would have been obvious over the combined teachings of Wakuda, Ramsay, Rossi, and Aldrich. Pet. 31–38.¹³

1. Wakuda (Ex. 1005)

Wakuda discloses “a vibration generator system, which can generate vibrations at a frequency that can be bodily sensed by humans.” Ex. 1005, 2:13–17. Figure 1A of Wakuda follows:



does not require an H-bridge, as outlined above. *See* Ex. 3001, 30–33, 35; Inst. Dec. 17 n.12 (noting same).

¹³ Petitioner relies on its showing that claims 2 and 3 would have been obvious over the combined teachings of Wakuda and Ramsay. Pet. 7–30. We do not reach any grounds that do not involve Rossi, because the Petition only addresses the Rossi-based ground under the means-plus-function claim construction outlined above. *See id.* at 1 (listing Grounds 1–4B), 3 (noting that the Petition only addresses Grounds 2, 4A, and 4B, i.e., the Rossi-based grounds, under a means plus function claim construction).

Figure 1A depicts vibration generator means 1 including cylindrical-shaped casing 2, covers 3, coil 5, movable body 6 including weight 7 and magnet M, and cone coil springs 9. *Id.* at 4:30–5:24.

2. *Ramsay (Ex. 1006)*

Ramsay provides techniques for “enabling a regular user of an end user device, such as a cellular telephone, to customize parameters associated with haptic effects applied to the user by the end user device.” Ex. 1006, code (57). Users can access software to modify “a frequency of vibration and amplitude of vibration” using a “GUI.” *Id.* ¶ 30; *see also id.* at Fig. 4 (GUI), ¶¶ 30–35 (“It may be desirable for the user to vary the amplitude over time.”). The amplitude changes gradually or in steps during a portion of, or during the entirety of, the haptic track. *Id.* ¶ 35. Ramsay explains that “haptic feedback can be used to supplement auditory and visual feedback to enhance how information is provided to the user.” *Id.* ¶ 14. However, unlike the ability to change “ring tones,” “a user [of prior art systems] typically does not have the option on the device itself to modify characteristics of haptic feedback.” *Id.* Ramsay discloses altering the speed of a motor with the use of an “eccentric rotating mass (ERM) actuator,” or modifying “amplitude values” with the use of a “linear resonant actuator (LRA).” *Id.* ¶ 26.

3. *Rossi (Ex. 1020)*

Rossi describes “circuits for a switching mode driving of a load and in particular to circuit arrangements for controlling the current being delivered to the load.” Ex. 1020, 1:8–11. Rossi discloses an H-bridge switching circuit for controlling electric motors and other inductive loads using pulse width modulation. *Id.* at 1:8–15, Fig. 1. Rossi further discloses an improved

circuit for sensing the magnitude and direction of a current flowing through the load of the H-bridge switching circuit that includes “two pairs of analog switches arranged in a bridge configuration.” *Id.* at code (57); *see also id.* at Figs. 4, 6, 1:65–3:55, Figs. 4, 6.

Figure 6 follows:

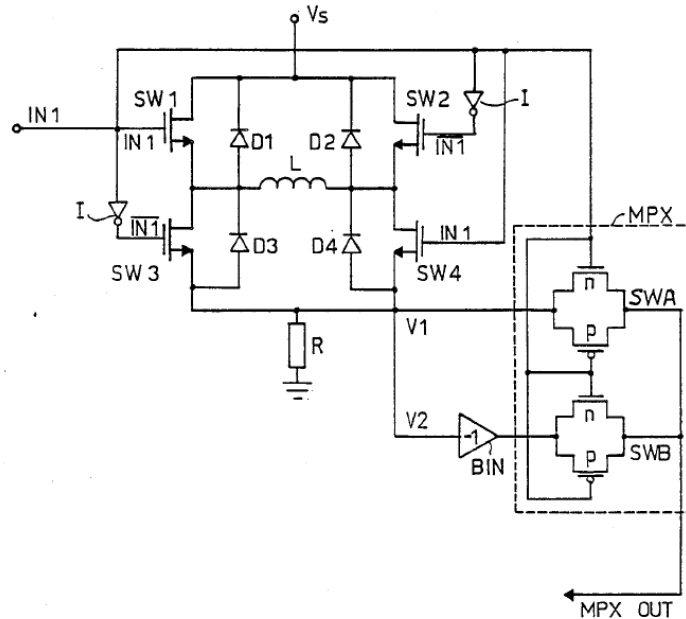


FIG. 6

Figure 6 is a circuit diagram of an H-bridge stage utilizing switches implemented by means of MOS transistors. Ex. 1020, 1:56–64. “[C]locked driving signal” IN1 splits and passes through inverters I to generate an internal driving signal IN1 and inverted signal $\overline{\text{IN1}}$. *Id.* at 2:64–65. Those signals control the state of transistors SW1–SW4 and thus control the direction of current through inductive load L. *Id.* at 2:65–3:10.

4. Aldrich (Ex. 1021)

Aldrich describes a feedback control algorithm to drive an electromechanical device that is driven by a sinusoidal excitation signal to “one of the resonance peaks and eventually to oscillate about the peak.”

Ex. 1021, 41, 42.¹⁴ The digital control system is implemented by means of an algorithm that includes a “hill-climbing control algorithm” for coarse tracking to find resonance, an “estimation-based extremum seeking control (ESC) algorithm” for fine resonance tracking, and a supervisory algorithm that switches between the other two algorithms. *Id.* at 42. The drive frequency is incremented or decremented to maintain oscillation about a resonance frequency. *Id.*

5. *Combining Wakuda and Ramsay*

Petitioner contends that combining Wakuda and Ramsay results in a “predictable combination,” “enabl[ing] a user to specify parameters (e.g., frequency and amplitude) associated with haptic effects, according to Ramsay.” Pet. 10 (citing Ex. 1003 ¶¶ 92–93). Petitioner contends that “[t]he resulting system provides Wakuda’s ‘small-sized terminal devices, such as portable telephones, PDA, portable game equipment[,],’” with “store[d] . . . user-specified haptic effects to be selected and used in generating desired haptic feedback.” *Id.* (second alteration in original) (internal quotes quoting Ex. 1005, 1:11–14; citing Ex. 1003 ¶¶ 92–93).

Petitioner contends that it would have been obvious to employ Ramsay’s “input/output devices” equipped in its “end user device” with Wakuda’s device where the devices are similar. Pet. 10 (citing Ex. 1003 ¶ 93; Ex. 1006 ¶¶ 19, 22–24). Petitioner contends that it would have been obvious to employ Ramsay’s “[s]oftware and systems” into Wakuda’s memory executed by a processor as Ramsay suggests, “to lead a user through the process of entering and/or modify[ing] parameters and characteristics of haptic tracks.” *See id.* (alterations in original) (quoting Ex.

¹⁴ We refer to the page numbers in the original.

1006 ¶ 15; citing Ex. 1003 ¶ 93; Ex. 1006 ¶¶ 25–28). Petitioner explains that Ramsay’s memory 16, as combined with Wakuda, would store “‘a software program for enabling an end user to create and/or modify haptic effects, the software program of which can be executed by processor [14],’ and would ‘also store haptic track files created or modified by the user and [] also store mixed track files, which include multiple haptic tracks combined together.’” *Id.* at 10–11 (second alteration in original) (quoting Ex. 1006 ¶¶ 25, 28; citing Ex. 1006 ¶¶ 26, 27; Ex. 1003 ¶ 93). Petitioner also explains that “‘the resulting system would allow users to ‘access[] programmable haptic design software 30 via GUI 24 and open[] a file to be edited,’ and to ‘interact with programmable haptic design software 30 by input and output mechanisms of GUI,’ as taught by Ramsay.” *Id.* at 11 (alterations in original) (quoting Ex. 1006 ¶ 37; citing Ex. 1003 ¶ 93).

Petitioner points to Ramsay’s disclosure that “‘modifying characteristics of haptic feedback was normally limited to professional designers, and that end users ‘typically [did] not have the option on the device itself to modify characteristics of haptic feedback.’” Pet. 11 (alteration in original) (quoting Ex. 1006 ¶ 14). “‘Therefore, a POSITA would have looked for references like Ramsay to expand the functionalities of haptic devices and allow end users to freely create and customize haptic effects.” *Id.* (citing Ex. 1003 ¶ 94; Ex. 1006 ¶¶ 14–15). Petitioner also contends that implementing Ramsay’s teachings and “‘user tools” in Wakuda would have provided “‘flexibility in customizing haptic effects by allowing users to conveniently ‘create or modify the haptic effect files directly on the device.’” *Id.* at 11–12 (citing Ex. 1003 ¶ 94). Petitioner adds that “[t]he resulting system would also benefit from Ramsay’s GUI that displays haptic

tracks and offers various, easy-to-use mechanisms for adjusting haptic parameters.” *Id.* at 12 (citing Ex. 1006 ¶¶ 53–57). And “Wakuda-Ramsay enables the resulting system to ‘provide a fuller haptic experience’ by allowing users to “combine or mix different haptic tracks together if desired.” *Id.* (quoting Ex. 1006 ¶ 30; citing Ex. 1006 ¶ 47).

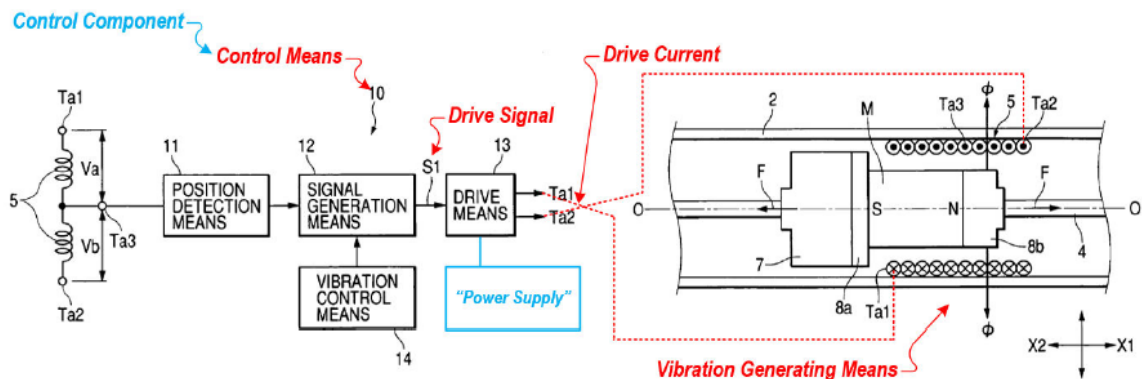
Petitioner also explains that a “POSITA would have recognized that vibrant haptic effects would result from the combination that enables independent controlling of the frequency and amplitude for oscillation.” Pet. 12 (citing Ex. 1003 ¶ 95; Ex. 1018, 224). Petitioner adds that a “POSITA would have had a reasonable expectation of success in making the proposed modifications because Wakuda and Ramsay describe the same techniques for controlling a linear actuator to produce desired output.” *Id.* (citing Ex. 1003 ¶ 96; Ex. 1005, 3:42–44; Ex. 1006 ¶ 26). Petitioner explains that “[t]he proposed modification merely involves implementing Ramsay’s software solutions in Wakuda’s hardware setup without substantially changing Wakuda’s other structures.” *Id.* at 12–13 (citing Ex. 1003 ¶ 97). Petitioner also explains that “Wakuda’s and Ramsay’s purposes (e.g., providing vibrational feedback) are compatible.” *Id.* (citing Ex. 1003 ¶ 97). Petitioner adds that “combining Wakuda and Ramsay was merely the application of known techniques (Ramsay’s software solution for user-customization of haptic effects) to a known device (Wakuda’s vibration generator system) ready for improvement to yield predictable results (benefits articulated above).” *Id.* at 13 (citing *KSR*, 550 U.S. at 417).

6. *Analysis*

As determined above, limitation 2.f, a “control component that controls supply of power from the power supply to the driving component to

cause the moveable component to oscillate at a frequency and an amplitude specified by user input received from the user-input features,” is a means-plus-function limitation subject to 35 U.S.C. § 112 ¶ 6. Patent Owner contends that the “proper means-plus-function construction” of the “control component” requires “one or both” of an “output value p corresponding to the currently selected strength” or an “output p to the power supply.” PO Resp. 16.

Petitioner annotates Wakuda’s Figures 2 and 3 to illustrate the controllable component and controllable power supply as follows:



As annotated by Petitioner above, Wakuda’s Figure 3 (left) joins to Figure 2 (right), with a power supply (blue) inserted by Petitioner as part of drive means 13 to receive drive signal S1, wherein “the signal generation means 12 performs control, such as switching of current direction of the drive signal S1,’ which is an apparent example of controlling supply of power from the power supply to the driving component.” See Pet. 18 (quoting Ex. 1005, 6:45–47; citing Ex. 1003 ¶ 110) (emphasis added).

Petitioner contends the recited “control component” in the resulting system includes Ramsay’s “processor 14” and “memory 16” wherein “Wakuda’s control component [10] . . . is implemented based on Ramsay’s

teachings of processor and memory.” *See* Pet. 27 (citing Ex. 1003 ¶ 127; Ex. 1006 ¶¶ 20, 22). In this combination, Petitioner reads the amplitude control (signal p), onto Wakuda’s “‘signal generation means 12’ that ‘generates a drive signal S1 on the basis of a command from the vibration control means 14 to output the same to the drive means 13.’” *Id.* at 17 (quoting Ex. 1005, 6:23–39). Petitioner explains that drive signal S1 from “drive means 13 provides ‘a drive current having a predetermined waveform . . . to the terminal Ta1 and the terminal Ta2 of the coil 5.’” *Id.* (alteration in original) (quoting Ex. 1005, 6:23–39). Petitioner contends that based on drive signal S1,

a POSITA would have readily understood and found obvious that the drive means includes, or is coupled to, the power supply ([1c]), and that the control means (control component) controls, via the drive signal, the supply of current (supply of power) from the power supply, which is included in or coupled to the drive means, to the coil (moveable component ([1b])).

Id. at 17–18 (citing Ex. 1003 ¶ 110; Ex. 1005, Figs. 3–4).

Petitioner additionally relies on Ramsay’s GUI as providing menu options so that “[c]ertain parameters or characteristics of a haptic output or haptic track can be created, entered, changed, modified, etc.” and such “modifiable parameters may include a frequency of vibration and amplitude of vibration.” Pet. 19 (alteration in original) (citing quoting Ex. 1006 ¶¶ 30–33, 46, 53–55; Ex. 1003 ¶ 112).

Petitioner explains that such a control signal allows the Wakuda-Ramsay processor, and ultimately, the user, to control the supply of power from the drive means to the coil ultimately to control the desired haptic effects. Pet. 17–19. Petitioner generally reasons that using Wakuda’s drive signal, S1, based on Ramsay’s processor teachings, controls the power

supply that Wakuda's drive means 13 implicitly or obviously includes in order to provide drive current/voltage, which allows the user to control various haptic effects using Ramsay's GUI. *See id.*

With respect to the frequency control (which is not at issue based on our ensuing finding about amplitude control below), Petitioner argues that it would have been obvious to modify the Wakuda-Ramsay combination, using Rossi's H-bridge switch and signal d to provide oscillating power at a desired frequency, further implemented with Aldrich's algorithms and sensors to replace Wakuda's monitoring technique, in order to control the resonance frequency by incrementing or decrementing the drive frequency. *See* Pet. 32–38 (citing Ex. 1005, 6:4–10; Ex. 1020, 1:65–2:11, 3:43–55, Figs. 4, 6; Ex. 1023, 7:47–50; Ex. 1003 ¶¶ 135–144).

Petitioner relies on its Wakuda-Ramsay showing to address claim 3. *See* Pet. 49 (citing Ex. 1003 ¶ 196).

Patent Owner argues that Petitioner's showing based on Wakuda-Ramsay-Rossi-Aldrich that the combination “outputs a corresponding control signal to the power supply in accordance with the user input” “is conclusory and nonspecific.” PO Resp. 21 (citing Ex. 2009 ¶ 156; Pet. 47). In summary, Patent Owner Patent argues that “the combined system of Gregorio-Ramsay-Rossi-Aldrich does not teach the claimed output to the power supply.” *Id.*

Patent Owner raises a valid point. As discussed above, Petitioner relies on Wakuda's drive signal S1 to control drive means 13, which Petitioner contends includes a power supply. That is, Petitioner relies on drive signal S1 to control a power supply within drive control means 13. Assuming control drive means 13 includes a power supply as Petitioner

argues, drive signal S1 does not control anything. That is, according to Wakuda, signal generation means 12 provides control and simply switches drive signal S1 between two outputs Ta1 and Ta2 in drive means 13 for output to coil 5. *See* Ex. 1005, Fig. 3, Fig. 5, 6:45–47 (stating “the signal generation means 12 performs control, such as switching of current direction of the drive signal S1”), 6:63–65 (“the drive signal S1 is given to the coil 5”). Petitioner agrees that Wakuda’s “signal generation means 12 performs control, such as switching of current direction of the drive signal S1.” *See* Pet. 18 (quoting Ex. 1005, 6:45–47) (emphasis added). However, Petitioner argues that this “‘switching of current direction’ . . . *is an apparent example of controlling supply of power from the power supply to the driving component.*” *Id.* (quoting Ex. 1005, 6:45–47) (emphasis added). But Petitioner fails to explain persuasively how merely switching S1 from one terminal of the coil to another causes a change in amplitude. *See id.* at 17–19.

The Reply does not persuasively explain how the Petition shows that Wakuda’s drive signal S1 or a modification thereof based on Ramsay’s processor signal controls drive control means 13 to do anything more than switch the current S1 to another coil terminal as opposed to changing its amplitude. *See* Reply 2–10.

Claim 3 depends from claim 2. Based on the foregoing discussion and a review of the record, we determine that Petitioner does not persuasively show that claims 2 and 3 would have been obvious over the combination of Wakuda, Ramsay, Rossi, and Aldrich.

7. Summary

Petitioner fails to show by a preponderance of evidence that claims 2 and 3 are unpatentable under 35 U.S.C. § 103(a) over the combination of Wakuda, Ramsay, Rossi, and Aldrich.

F. Alleged Obviousness of Claim 2 over Gregorio, Ramsay, Wakuda, Rossi, and Aldrich

Petitioner contends that claim 2 would have been obvious over the combined teachings of Gregorio, Ramsay, Wakuda, Rossi, and Aldridge Pet. 50–66.

1. Gregorio (Ex. 1004)

Gregorio discloses a device with an “LRA [Linear Resonant Actuator] to generate vibrotactile haptic feedback on a user interface.” Ex. 1004, 2:3–5. Figure 1 is reproduced below.

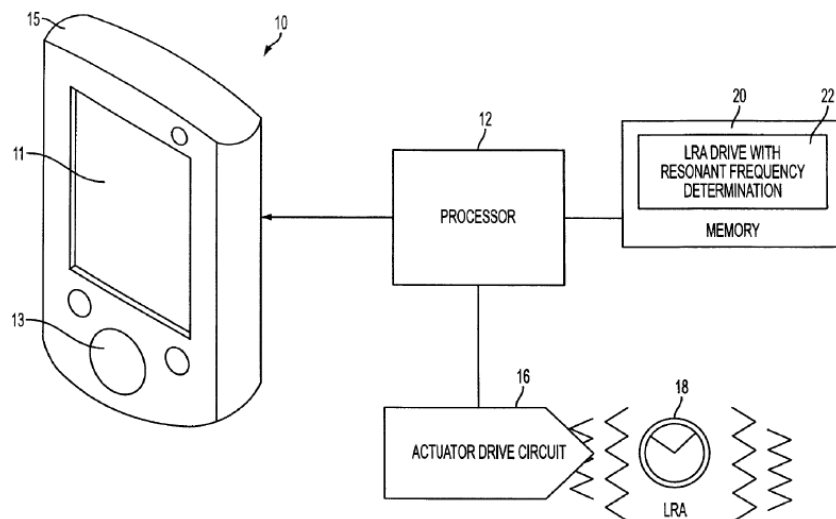


FIG. 1

Figure 1 is a block diagram of a haptically-enabled system 10, such as a cellular telephone, PDA, or computer tablet, which includes a haptic feedback mechanism that generates vibrations on the system. Ex. 1004, 2:10–15, 3:1–2. The system includes processor 12, memory 20, actuator

drive circuit 16, and LRA actuator 18. *Id.* at 2:18–20. Processor 12 controls the haptic effects based on high level parameters including magnitude, frequency and duration. *Id.* at 2:25–30. Processor 12 outputs control signals to drive circuit 16, which includes electronic components and circuitry used to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects. *Id.* at 2:36–39. Memory 20 includes LRA Drive with Resonant Frequency Determination module 22 which are instructions executed by processor 12 to generate drive signals for LRA 18. *Id.* at 2:46–49.

Figure 2 follows:

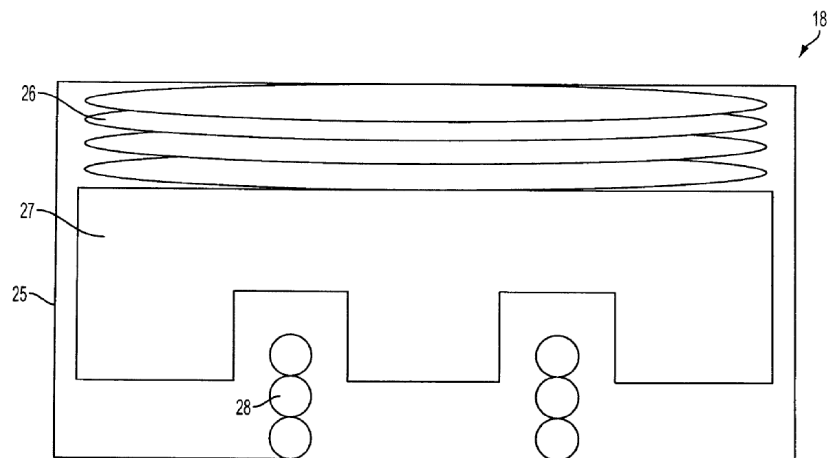


FIG. 2

Figure 2 is a cut-away side view of LRA 18 including casing 25, magnet/mass 27, linear spring 26, and electric coil 28. Ex. 1004, 3:12–14. When current flows through coil 28, a magnetic field forms around the coil to interact with the magnetic field of magnet 27, and depending on the direction of the current flow, pushes or pulls on the magnet to compress or decompress the spring. *Id.* at 3:17–24.

2. *Combining Gregorio, Ramsay, and Wakuda*

Petitioner argues that it would have been obvious to modify Gregorio to include the ability disclosed in Ramsay to allow a user to customize and store parameters associated with haptic effects, such as creating “haptic track files” that specify variations in the amplitude and frequency of the effect over time to achieve a desired effect. Pet. 53–55 (citing Ex. 1006 ¶¶ 15, 25–28, 37; Ex. 1003 ¶¶ 199–203). Petitioner argues that this combination would have been motivated by the desire to expand the functionalities of haptic devices to allow end users to create and customize haptic effects, to provide a fuller haptic experience, and provide a user-configurable desired output. *Id.* at 53–54 (citing Ex. 1004, 2:3–9; Ex. 1006 ¶¶ 15, 25–28, 37; Ex. 1003 ¶¶ 199–205). Petitioner argues that this combination would have had a reasonable expectation of success given that both references deal with linear actuators, both disclose storing frequency and amplitude values, and the combination involves routine knowledge of software techniques. *Id.* at 54 (citing Ex. 1004, 2:3–9; Ex. 1006 ¶ 26; Ex. 1003 ¶¶ 204–205).

Petitioner also contends that Gregoria and Wakuda teach similar vibration generating means structure. Pet. 55 (citing Ex. 1003 ¶ 206; Ex. 1005, 5:51–6:10; Ex. 1004, 3:17–28). Petitioner contends that “[b]ecause Gregorio’s description of the main components of the LRA (Figure 2) is only at a high level, a POSITA would have naturally looked to other references like Wakuda for implementation details.” *Id.* (citing Ex. 1003 ¶ 207). Petitioner notes that “Wakuda’s vibration generating means are ‘mountable on small-sized information terminal devices, such as portable telephones, PDA.’” *Id.* at 56 (quoting Ex. 1005, 1:11–14). Accordingly, Petitioner contends that using Wakuda’s small vibration generating means

provides a benefit to Gregorio-Ramsay's combined device, and "a POSITA would have been prompted to combine Gregorio-Ramsay and Wakuda when doing so was the application of known techniques (Wakuda's vibration generator) to a known system (Gregorio-Ramsay's similar haptic feedback system) ready for improvement to yield predictable results (benefits articulated above)." *Id.* (citing *KSR*, 550 U.S. at 417).

The record, including testimony by Dr. Hannaford (Ex. 1003; Ex. 1049), supports Petitioner's rationale, and shows that one of ordinary skill would have been motivated to combine Gregorio, Ramsay, and Wakuda in the manner proposed. Patent Owner does not address Petitioner's showing for combining these references with any particularity. *See generally* PO Resp. We discuss below Patent Owner's argument that Petitioner's showing as to limitation 2.f based on the combination of Gregorio and Ramsay is conclusory.

3. *Analysis*

For the "vibration module" preamble of independent claim 2, Petitioner generally relies on the disclosure in Gregorio of a "haptic feedback system," which includes the elements recited in the body of claim 2 as discussed below. *See* Pet. 57–58 (citing Ex. 1004, 2:10–20, Fig. 1; Ex. 1003 ¶¶ 212–214).¹⁵

For limitation 2.a, a "housing," Petitioner relies on Gregorio's housing 25. Pet. 58 (citing Ex. 1004, 3:13–15, Fig. 2; Ex. 1003 ¶¶ 215–216).

¹⁵ Based on the present record, it is not necessary to determine at this stage of the proceeding whether claim 1's preamble is limiting.

For limitation 2.b, a “moveable component,” Petitioner relies on the Gregorio’s magnet/mass 27. Pet. 59 (citing Ex. 1004, 3:12–14, 3:17–21, Fig. 2; Ex. 1003 ¶ 217).

For limitation 2.c, a “power supply,” Petitioner notes that Gregorio’s “actuator drive circuit 16[] . . . includes electronic components and circuitry used to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects.” Pet. 59 (quoting Ex. 1004, 2:36–39; citing Ex. 1004, 2:18–39, 3:17–20, Fig. 1; Ex. 1003 ¶ 218). Petitioner argues that “[b]ecause electric power is defined by current and voltage, a [person of ordinary skill in the art] would have understood that actuator drive circuit 16 corresponds to, or is coupled to, a power supply.” *Id.* at 60 (citing Ex. 1038, 1–2; Ex. 1003 ¶ 218).

Gregorio’s Figure 1, as annotated by Petitioner (Pet. 60), follows:

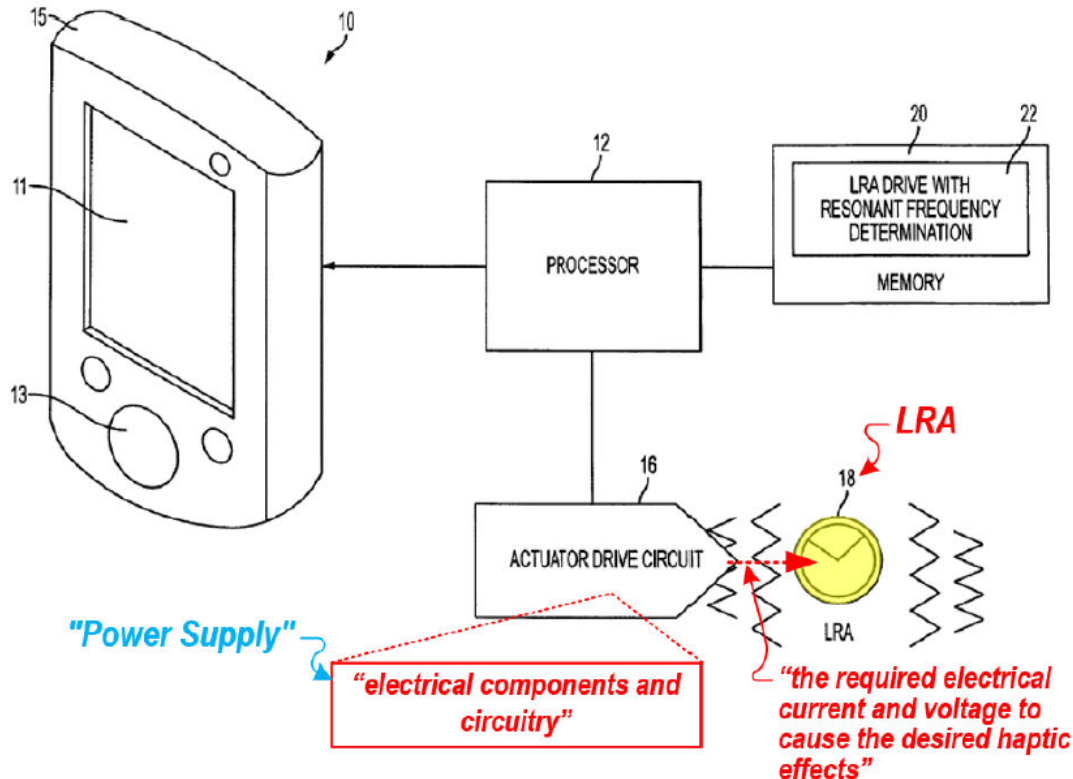


Figure 1 above illustrates Gregorio's processor 12 and memory 20, which controls actuator drive circuit 16 to provide current to LRA 18. Pet. 59–60 (citing Ex. 1003 ¶¶ 218–220; Ex. 1038, 1; Ex. 1004, 2:18–39, 3:17–20, 5:49–53). As indicated above, Petitioner annotates Gregorio's Figure 1 to show a power supply (blue) is part of actuator drive circuit 16's, including “electrical components and circuitry.” *See id.* (quoting Ex. 1004, 2:36–39).

Patent Owner asserts that Petitioner concedes that the “drive circuit 16 may not be a power supply,” based on Petitioner's argument that “a person of ordinary skill in the art (POSITA) would have understood that actuator drive circuit 16 corresponds to, or is coupled to, a power supply.” PO Resp. 22 (citing Pet. 60). However, Patent Owner concedes that Gregorio discloses an “required” “power supply” “that is not shown” in Gregorio's Figure 1. *Id.* at 24 (stating “[i]n fact a POSITA would recognize in the above drawing that *a power supply is required that is not shown*) (citing Ex. 2009 ¶ 164).

Further, Petitioner's reliance on the disclosure in Gregorio that “actuator drive circuit 16 includes electronic components and circuitry used *to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects*” is persuasive evidence that the LRA includes a power supply, otherwise it could not “supply” “the required . . . current and voltage.” *See* Pet. 59 (quoting Ex. 1004, 2:36–39; citing Ex. 1004, 2:18–39, 3:17–20; Ex. 1003 ¶ 218) (emphasis added). Alternatively, Petitioner shows that it would have been obvious to include such a power supply to supply current and power to the LRA to provide the desired haptic effects. *See id.*; Ex. 1003 ¶¶ 218–219 (relying on other teachings in Gregorio to show that Gregorio's “system” at least suggests providing power to the LRA 18

because, for example, “a POSITA would have understood and found obvious that an actuator for a haptic feedback device is coupled to a power supply for the purpose of providing electrical power”); Reply 11–14 (persuasively summarizing the showing in Petition and filling in minor gaps). Dr. Hannaford also credibly testifies that “[b]ecause electric power is defined by current and voltage, a POSITA would have understood that *actuator drive circuit 16 (including ‘electronic components and circuitry’) is a power supply.*” Ex. 1003 ¶ 218 (citing Ex. 1038, 1–2) (emphasis added).

For limitation 2.d, “user-input features,” Petitioner relies on the Gregorio’s of “touch sensitive surface 11” that “generates and displays images for the user to interact with, such as keys, dials, etc.” and/or “mechanical keys/buttons 13.” Pet. 60–61 (citing Ex. 1004, Fig. 1, 2:10–14, 2:64–67; Ex. 1003 ¶ 221). Petitioner also relies on the disclosure in Ramsay of using a graphical user interface (GUI) for providing a menu options. *Id.* at 61 (citing Ex. 1006 ¶¶ 15, 24, 32, 53; Ex. 1003 ¶ 222). Petitioner provides reasons for combining Gregorio and Ramsay as summarized above. *Supra* § III.F.2.

As determined above, limitation 2.e, a “driving component that drives the moveable component to oscillate within the housing,” is a means-plus-function requirement subject to 35 U.S.C. § 112 ¶ 6, further requiring, for example, a coil structure or equivalent. *Supra* § III.D.1. Petitioner reads this limitation onto Gregorio’s electric coil 28. Pet. 61 (citing Ex. 1004, 2:10–20, 3:12–28, Fig. 2; Ex. 1003 ¶¶ 223–224).

As also determined above, limitation 2.f, a “control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude

specified by user input received from the user-input features,” is a means-plus-function requirement subject to 35 U.S.C. § 112 ¶ 6. Petitioner primarily relies on Gregorio’s processor 12 and memory 20 programmed with LRA Drive and Resonant Frequency Determination module 22, which Petitioner alleges controls the supply of power from actuator drive circuit 16 to driving component coil 28, based on control signals from the processor, to supply the desired magnitude and frequency of oscillation for the haptic effects. Pet. 62–64 (citing Ex. 1004, Fig. 1, 2:18–50, 3:12–28, 4:20–22, 4:28–31, 4:49–65; Ex. 1003 ¶¶ 226, 227, 231).

Petitioner also relies on Ramsay’s disclosure of storing frequency and amplitude parameters to supplement Gregorio’s teachings so that “in the resulting system, the user can set and modify various parameters including ‘a frequency of vibration and amplitude of vibration’ through [a] GUI, as taught by Ramsay.” Pet. 64 (citing Ex. 1006 ¶¶ 5, 15, 24, 30, 32, 33, 46, 53–55; quoting Ex. 1003 ¶ 231). Petitioner contends that it would have been obvious to combine Gregorio and Ramsay for several reasons (partially summarized above, *supra* § III.E.5), including *inter alia*, that they “describe the same techniques for controlling a linear actuator to produce desired output,” the combination would allow Gregorio’s system to be “user-configurable” to enable a user “to customize haptic effects and combine haptic effects with multiple amplitudes and frequencies for ‘fuller haptic experience,’” and to “enable a user to specify parameters (e.g., frequency and amplitude) associated with haptic effects, as taught by Ramsay.” See Pet. 53–54 (citing Ex. 1003 ¶¶ 199, 200–205; Ex. 1004, 2:3–9; Ex. 1006 ¶¶ 15, 25–28, 37).

Patent Owner argues that

[t]he [P]etition does not contend that Gregorio discloses any processor or algorithm that provides an ‘output value p corresponding to the currently selected strength’ or an ‘output p to the power supply,’ one or both of which is required under the proper means-plus-function construction if the claimed power supply corresponds to Gregorio’s actuator drive circuit 16.

PO Resp. 27; *accord id.* at 21 (“As Dr. Goossen explains, the combined system of Gregorio-Ramsay-Rossi-Aldrich does not teach the claimed output to the power supply.”) (citing Ex. 2009 ¶ 156).

Although, as noted above, Patent Owner concedes that Gregorio discloses an “unshown” power supply as illustrated in Petitioner’s annotated Figure 1 of Gregorio (above), Patent Owner also argues that Petitioner’s rationale that an “unshown power supply receives a signal from the processor is a sweeping conclusion that does not follow from any obviousness argument.” PO Resp. 24 (citing Ex. 2009 ¶ 164). Dr. Goossen’s testimony largely tracks Patent Owner’s arguments or vice versa. *See* Ex. 2009 ¶¶ 161–164.

Contrary to these arguments and testimony, Petitioner shows that Gregorio teaches steps 760 and 762 of Figure 7C’s algorithm, or that the combination would have rendered the steps obvious, where, as discussed above, Ramsay further suggests providing user input-based parameters to control Gregorio’s processor for the desired haptic effects, including by specifying amplitude and frequency parameters. *See* Pet. 53–54 (citing Ex. 1003 ¶¶ 199, 200–205; Ex. 1004, 2:3–9; Ex. 1006 ¶¶ 15, 25–28, 37), 64 (citing Ex. 1003 ¶¶ 227, 231; Ex. 1004, 2:44–50, 4:20–22, 4:28–31, 4:49–65; Ex. 1006 ¶¶ 30, 33, 46, 53–55), *supra* § II.F.2 (summarizing reasons for combining Gregorio, Ramsay, and Wakuda). Patent Owner and Dr.

Goossen do not directly address the stated reasons, supported by the record (*see id.*), for combining these references.

As determined above (Claim Construction § D.2), steps 760 and 762 of the disclosed algorithm in the '337 patent involve selecting a current strength for a haptic mode and computing a value *p* for that strength to output to the power supply (which corresponds to a control signal 624 sent from the processor to the power supply), so that the power supply provides the desired current amplitude through coil 514. *See* Ex. 1001, Fig. 6, Fig. 7C, 8:26–30. As found above, Petitioner relies on Gregorio and Dr. Hannaford's testimony that Gregorio's actuator drive circuit 16 “corresponds to, or is coupled to, a power supply,” or such a power supply would have been obvious. *See* Pet. 59–60 (citing Ex. 1003 ¶ 218; Ex. 1038, 1–2). Petitioner persuasively shows that “Gregorio's ‘processor 12,’ coupled to ‘memory 20,’ controls ‘actuator drive circuit 16’ to provide desired haptic effects via LRA 18,” and “[i]n providing the haptic effects, the processor controls supply of power from the power supply to the driving component.” *Id.* at 62–63 (internal quotes quoting Ex. 1004, 2:18–20; citing Ex. 1003 ¶ 226; Ex. 1004, 2:36–39, 3:12–28).

In support of Petitioner's showing and Dr. Hannaford's testimony, Gregorio's Figure 1 illustrates a signal control line from processor 12 to actuator circuit 16. At the passage cited in the Petition, Gregorio states that “[p]rocessor 12 *outputs the control signals to drive circuit 26* which includes electronic components and circuitry used *to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects.*” Ex. 1004, 2:36–39 (emphases added); Pet. 63 (citing same and partially quoting same). The Petition further quotes Gregorio as disclosing “instructions [that]

include the assumed resonant frequency, the ‘desired amplitude,’ and the ‘present amplitude,’ which are stored in memory at least when “the desired amplitude is compared to the present amplitude.” Pet. 64 (quoting Ex. 1004, 4:49–52; citing Ex. 1004, 4:20–22, 4:49–65; Ex. 1003 ¶ 227). These instructions in Gregorio, coupled with processor 12’s “control signals to drive circuit 26” to control haptic effects (i.e., frequency, amplitude) as just described, correspond to steps 760 and 762, with or without the added teachings of Ramsay’s “modifiable parameters [which] may include a frequency of vibration and amplitude of vibration.” *See id.* (quoting Ex. 1006 ¶ 30; citing Ex. 1006 ¶¶ 30, 33, 46, 53–55).

In contrast to Petitioner’s showing, at the passage cited by Patent Owner, Dr. Goossen, Patent Owner’s expert, does not provide a basis for his opinion that “the combined system of Gregorio-Ramsay-Rossi-Aldrich does not teach the claimed output to the power supply.” Ex. 2009 ¶ 156; PO Resp. 21 (citing Ex. 2009 ¶ 156). To the extent Dr. Goossen addresses the issue, like Patent Owner, Dr. Goossen concedes that “a POSITA would recognize in the [annotated drawing of Gregorio supplied by Petitioner] *that a power supply is required that is not shown.*” Ex. 2009 ¶ 116. And also like Patent Owner, Dr. Goossen concludes that Petitioner’s rationale that an “unshown power supply receives a signal from the processor is a sweeping conclusion that does not follow.” *Id.*

For the reasons discussed above in connection with Patent Owner’s parallel arguments, this testimony is conclusory and unsupported. Primarily, it does not adequately address Petitioner’s showing and Dr. Hannaford’s testimony, discussed above, which relies on Gregorio’s statement that “[p]rocessor 12 *outputs the control signals to drive circuit 26* which includes

electronic components and circuitry used *to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects.*” Ex. 1004, 2:36–39 (emphases added). Dr. Goossen and Patent Owner also do not address the initial finding in the Institution Decision that “[t]he ’337 patent does not disclose any detail or structure for the controllable power supply, indicating that such a controllable power supply was well-known.” Inst. Dec. 30 (citing Ex. 1001, 6:33–35 (“The power supply 612 receives a control input 624 from the CPU to control the current supplied to the H-bridge switch for transfer to the coil 626.”)).¹⁶ And while Dr. Goossen contends that Dr. Hannaford’s reliance on Ramsay to further suggest control of the power supply is conclusory because “Dr. Hannaford’s statement about ‘the current provided from a power supply to the driving component’ has nothing to do with Ramsay’s disclosure,” Dr. Goossen addresses Ramsay and Gregorio in isolation, without adequately addressing the combination, specifically where Gregorio teaches or suggests controlling a power supply in order to provide desired LRA amplitude and frequency haptic effects, which is in line with Ramsay’s teaching of user-customizable parameters to control amplitude and frequency for the same purpose. *See* Ex. 2009 ¶ 126; Pet. 53–54 (summarized above).

Therefore, the Petition shows persuasively that Gregorio’s processor controls Gregorio’s power supply to provide power to its haptic unit or that such power supply control would have been obvious in view of Ramsay in order to allow a user to control the desired haptic effect.

¹⁶ *See Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (reasoning that when a patent specification “is entirely silent on how to” perform a claimed feature, it “suggest[s] that a person of ordinary skill in the art was more than capable of” performing that claimed feature).

To address the algorithmic structure related to frequency control, Petitioner relies on its analysis of claim 2 under Gregorio-Ramsay-Wakuda, adding Rossi to suggest controlling an H-bridge switch and Aldrich and Rossi to provide feedback control of the desired frequencies. *See* Pet. 79–80 (“Given the similarity between Gregorio-Ramsay-Wakuda-Rossi-Aldrich’s system (§IV.E.1.(b)) and Wakuda-Ramsay-Rossi-Aldrich’s system (§IV.B.3.(b)), the analysis of Ground 2 ([1f], [2f]–[2g], [4f]) based on Rossi, Aldrich, and supporting evidence similarly applies for Gregorio-Ramsay-Wakuda-Rossi-Aldrich.” (citing Ex. 1003 ¶¶ 289–321, 324–327, 329)).

In other words, Petitioner argues that it would have been obvious to modify the Gregorio-Ramsay combination, for reasons similar to those for modifying the Wakuda-Ramsay combination, using Rossi’s H-bridge switch and signal d to provide oscillating power at a desired frequency, further implemented with Aldrich’s algorithms and sensors to replace Gregoria’s monitoring technique, in order to control the resonance frequency by incrementing or decrementing the drive frequency. *See* Pet. 39–47 (discussing Wakuda-Ramsay combination, relying on Ramsay’s processor) (citing Ex. 1003 ¶¶ 84–91, 158–189; Ex. 1006 ¶¶ 20–28, 30–33, 35–39, 42, 47, 49, 53–55, 57–59; Ex. 1020, 1:65–2:11, 3:43–55, Figs. 4, 6; Ex. 1023, 7:47–50 (“well-known H-bridge circuit”)), 55–57 (reasons for combining Gregorio-Ramsay-Wakuda), 75–79 (reasons for combining Gregorio-Ramsay-Wakuda-Rossi-Aldrich). Dr. Hannaford provides implementation details for Rossi and Aldrich, including Rossi’s well-known H-bridge switch, and Aldrich’s hill-climb technique, which employs a Boolean value to indicate whether the frequency is increasing, with local variables set to

default integer values. *See id.* at 39–47 (citing Ex. 1003 ¶¶ 84–91, 158–189).

Petitioner contends that

a POSITA would have recognized that Rossi’s controlling the four transistors of the H-bridge using a control signal from the ‘processor’ that is split and inverted would reliably result in complementary internal signals, which promotes simplicity in the control signal generation and the circuit to deliver the drive signal to the coil.

Pet. 34 (citing Ex. 1003 ¶ 143). Petitioner also contends “a POSITA would have recognized that combining Rossi and [Gregoria]-Ramsay was the application of known techniques (Rossi’s H-bridge circuit implementation) to a known device ([Gregorio]-Ramsay’s system that switches polarity of current) ready for improvement to yield predictable results (benefits articulated above).” *Id.* (citing *KSR*, 550 U.S. at 417).

Petitioner also argues that

[a] POSITA would have recognized and found it obvious to set local variables to default values so that the control signal is generated to produce oscillation, which is then adjusted as appropriate through feedback control. [Ex. 1003 ¶ 147.] A POSITA would have been motivated to set default values for specific local variables to facilitate initiation of the actuator close to expected and/or user-selected operating parameters. *Id.*

Pet. 36.

Petitioner adds the following with respect to the function of the H-bridge in the combination:

Further, the combination includes a switch (e.g., H-bridge switch) according to Rossi. [Ex. 1003 ¶ 160]. A POSITA would have found obvious that . . . the processor is programmed to provide a control output to the H-bridge switch *for controlling the direction of the drive signal through the coil.* *Id.* For example, a control signal is output from the processor to a

transistor of the H-bridge switch to control whether the transistor is in an open or closed state, providing the direction signal. *Id.* In the resulting system, the switch receives a directional signal (e.g., at “IN1”) *that selects a corresponding direction of the opposite directions in which the driving component drives the moveable component. Id.*; [Ex. 1020], 1:65–2:15; 3:44–55.

Pet. 39 (emphasis added).

Patent Owner refers to its arguments advanced in connection with the Wakuda, Ramsay, Rossi, and Aldrich (Ground 2), and also Gregorio, Ramsay, and Wakuda (Ground 3A). PO Resp. 28 (citing Pet. 79). These arguments are unavailing because they relate to alleged shortcomings in Petitioner’s showing related to the claimed power supply, which we address above. *See id.* at 20.

Patent Owner does not contest Petitioner’s showing that Rossi suggests a frequency control signal for controlling direction of current in an H-bridge. *See* PO Resp. 20–22. However, Patent Owner generally argues that “[n]either Ground 3A nor Ground 3B contends that the processor is programmed with the algorithm described in Figures 7A–7C of the ’337 patent under the means-plus-function construction.” *Id.* at 22. Contrary to this generic argument, under our claim construction, which the parties largely agree upon, claim 2 does not require all the algorithmic structure of Figures 7A–7C.¹⁷

For the first time in its Sur-Reply, Patent Owner argues that the step that sets the “d” value must not occur “simultaneously in a single output”

¹⁷ During the Oral Hearing, Patent Owner declined an invitation to request additional briefing for claim construction to clarify it or show the extent to which Patent Owner disagreed with our summary of the claim construction of the control component in the Institution Decision. *See* Tr. 49:19–50:10; Inst. Dec. 20 § IV.C.2.c.

with the step that sets the “p” value. Sur-Reply 4. Patent Owner also argues that Petitioner “fails to show that the ‘output d’ and ‘output p’ occur separately, on different iterations of the Figure 7A loop.” *Id.* at 1. Even if this line of argument is timely, contrary to it, limitation 2.f, as construed herein, does not require iterations. In addition, the Gregorio-based grounds, like the claimed invention, involve a processor and memory running an algorithm, which necessarily involves separate steps.¹⁸

Petitioner persuasively summarizes that “Rossi’s H-bridge . . . provides an example of how to implement the frequency control part (e.g., directional signal control part) of Gregorio’s actuator drive circuit,” wherein “Gregorio’s drive circuit 16 preserves the capability to adjust the amplitude of current applied to LRA to adjust the strength/magnitude of the haptic effect.” *See* Reply 16–18 (persuasively showing how the Petition shows p and d) (citing Pet. 47, 62–64, 75–76, 79–80), 10 (persuasively summarizing how the combination, as set forth in the Petition shows p) (citing Pet. 50–52, 59–60, 62–65, 79–80). In other words, Gregorio-Ramsay’s processor’s control signal p would control the power from Gregorio’s actuator drive circuit 16 and supply varying power Vs at the top of Rossi’s H-bridge, and the processor’s control signal d, applied as Rossi’s “clocked . . . signal” at inverter IN1 to control frequency, would cause Gregorio-Ramsay’s supply current/voltage to switch in different directions (per that frequency) across the LRA’s coil in place of Rossi’s coil load L. *See* Ex. 1020, 2:64–65, Fig. 6 (above § III.E.3); Pet. 39–40 (“In the resulting system, the switch receives a directional signal (e.g., at “IN1”) that selects a corresponding direction of

¹⁸ We discuss another Gregorio-based ground—with Tierney instead of Wakuda—below.

the opposite directions *in which the driving component* [of Gregorio-Ramsay] drives the moveable component), 62–63 (addressing Wakuda-Rossi), 75–76 (substituting Gregorio for Wakuda for the Gregorio-Rossi combination “given the similarity between “Gregorio-Ramsay-Wakuda . . . and Wakuda-Ramsay”); Reply 16–17 (arguing Rossi’s h-bridge with Gregorio’s drive circuit 16 produces d based on a frequency timer and “switch[es] the direction/polarity of drive signals to LRA, thereby adjusting the frequency of the haptic effect”).¹⁹

Based on the foregoing, Petitioner persuasively shows that Gregorio discloses or Gregorio-Ramsay teaches limitation 2.f, with or without the added teachings of Wakuda-Aldridge.

Limitation 2.g recites “wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.”

Petitioner contends that the combined teachings of Wakuda and Ramsay render this limitation obvious. *See* Pet. 65 (referring to its showing for limitation 2.g in Ground 1). On this preliminary record, Petitioner sufficiently shows for purposes of institution that Wakuda-Ramsay teaches

¹⁹ Like algorithmic step d, the Response does not specifically argue that any of the grounds fail to show algorithmic timing step 708 or its equivalent for flipping the d value. *See* Ex. 1001, 7:10–17; Reply 17 n.3 (arguing the Response “does not dispute that the Petition showed the features associated with output ‘d.’”). In any case, Gregorio-Ramsay’s processor with algorithms for producing d require some form of timer “or other simple programming techniques for periodically carrying out tasks” (*id.*) to output a signal d that flips in time to represent *frequency* (cycles per *second*) in an H-bridge, which the “clocked driving signal IN1” in Rossi’s H-bridge further implies. *See supra* note 10; Ex. 1006, Ex. 1020, 2:64–65; Reply 17–18 (arguing Gregorio’s processor and memory produce d, p, and timer).

limitation 2g. Patent Owner does not dispute Petitioner’s showing for limitation 2.g.

As summarized above, Petitioner provides persuasive rationale and underlying facts with record citations and evidence to support its obviousness showing. *See* Pet. 50–79.

Based on the foregoing discussion and a review of the record, we determine that Petition persuasively shows that claim 2 is unpatentable over the combination of Gregorio, Ramsay, Wakuda, Rossi, and Aldridge.

4. *Summary*

Petitioner shows by a preponderance of evidence that claim 2 is unpatentable under 35 U.S.C. § 103(a) over the combination of Gregorio, Ramsay, Wakuda, Rossi, and Aldridge.

G. *Alleged Obviousness of Claims 2 and 3 over Gregorio, Ramsay, Tierling, Rossi, and Aldrich*

Petitioner contends that claims 2 and 3 would have been obvious over the combined teachings of Gregorio, Ramsay, Tierling, Rossi, and Aldrich. Pet. 80. This ground is similar to the above-discussed ground based on Gregorio, Ramsay, Wakuda, Rossi, and Aldrich. Here, Petitioner employs Tierling instead of Wakuda. *See* Pet. 75–80.

1. *Tierling (Ex. 1008)*

Tierling provides “mapping drive signals to haptic sensations” at user interface devices, such as wireless phone. Ex. 1008 ¶¶ 2–3. Tierling’s “[e]ffect mappings . . . can alter or control effect components or parameters of a haptic sensation, such as amplitude, waveshape, frequency, phase, duration, or delay of the haptic feedback to be output by a haptic device.” *Id.* ¶ 31. The system controls these effect parameters “by way of synthesis

or other combination” and “output[s them] simultaneously or in sequence.”

Id. “[T]he frequency of a first component can be modulated by the frequency of a second component.” *Id.*

In one implementation, Tierling’s system operates at both “a desired output frequency and a resonant frequency of a haptic device,” with the lower desired frequency superimposed on the resonant frequency “by multiplying the low frequency desired output sinusoidal waveform with the higher frequency resonant mode waveform.” Ex. 1008 ¶ 110; *see also id.* at Figs. 9–10.

2. *Analysis*

Petitioner primarily relies on its analysis of claim 2 under Gregorio-Ramsay addressed above for all of the claim 2 limitations, except for limitation 2.g, adding the teachings of Tierling to address limitation 2.g and claim 3. *See* Pet. 50–80. Patent Owner relies on its arguments addressed above in connection with disputed limitation 2.f, which Gregorio-Ramsay discloses or teaches, and does not provide separate arguments addressing limitation 2.g or claim 3. PO Resp. 28.

Petitioner provides persuasive rationale and underlying facts with record citations and evidence to support its obviousness showing. *See* Pet. 50–80.

Based on the foregoing discussion and our review of the record, we determine that Petitioner’s showing is persuasive to show that claims 2 and 3 would have been obvious over the combination of Gregorio, Ramsay, Tierling, Rossi, and Aldridge. Patent Owner’s arguments do not undermine Petitioner’s showing for the reasons discussed above.

3. *Summary*

Petitioner shows by a preponderance of evidence that claims 2 and 3 are unpatentable under 35 U.S.C. § 103(a) over the combination of Gregorio, Ramsay, Tierling, Rossi, and Aldridge.

IV. CONCLUSION

For the reasons discussed above, Petitioner has shown by a preponderance of the evidence that claims 2 and 3 of the '337 patent are unpatentable.²⁰ The following table summarizes our conclusions:

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not shown Unpatentable
2, 3	103(a)	Wakuda, Ramsay		
2, 3	103(a)	Wakuda, Ramsay, Rossi, Aldrich		2, 3
2	103(a)	Gregorio, Ramsay, Wakuda		
2, 3	103(a)	Gregorio, Ramsay, Tierling		
2	103(a)	Gregorio, Ramsay, Wakuda, Rossi, Aldrich	2	
2, 3	103(a)	Gregorio, Ramsay, Tierling, Rossi, Aldrich	2, 3	

²⁰ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. §§ 42.8(a)(3), (b)(2).

Overall Outcome			2, 3	
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V. ORDER

In consideration of the foregoing, it is hereby

ORDERED that Petitioner establishes by a preponderance of evidence that challenged claims 2 and 3 are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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