

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FEIT ELECTRIC COMPANY, INC.,
Petitioner

v.

SIGNIFY HOLDING B.V. f/k/a PHILIPS LIGHTING HOLDING B.V.,
Patent Owner

Case IPR2018-00921
Patent 6,586,890 B2

Before TREVOR M. JEFFERSON, MIRIAM L. QUINN, and
JASON M. REPKO, Administrative Patent Judges.

REPKO, *Administrative Patent Judge*.

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

I. INTRODUCTION

In this *inter partes* review, Petitioner, Feit Electric Company, Inc., challenges the patentability of claims 1, 7, 14, 22, and 30 of U.S. Patent No. 6,586,890 B2 (Ex. 1001, “the ’890 patent”) owned by Signify Holding B.V. (f/k/a Philips Lighting Holding B.V.). We have jurisdiction under 35 U.S.C. § 6(b). Petitioner must prove that the claims are unpatentable by a preponderance of the evidence. We determine that Petitioner has proven that claims 1, 22, and 30 are unpatentable but has not proven that claims 7 and 14 are unpatentable.

A. Procedural History

The Petition contained challenges to claims 1, 7, 14, 22, and 30 as shown below. Paper 1 (“Pet.”).

Reference(s)	Basis	Claim(s) Challenged
Biebl	35 U.S.C. § 103	1, 22, 30
Biebl, TI Book, and Hamp	35 U.S.C. § 103	7, 14
Hamp and LT1613	35 U.S.C. § 103	7
Hamp, LT1613, and Biebl	35 U.S.C. § 103	14

Patent Owner filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). We instituted trial. Paper 9 (“Inst. Dec.”). After institution, Patent Owner filed a Response. Paper 15 (“PO Resp.”). Petitioner filed a Reply. Paper 20 (“Pet. Reply”).

The Petition is supported by the Declaration of Dr. Shackle. Ex. 1003. Patent Owner took cross-examination testimony of Dr. Shackle. Ex. 2016.

Patent Owner submitted the declaration of Dr. Regan A. Zane with its Patent Owner response. Ex. 2014. Petitioner took cross-examination testimony of Dr. Zane. Ex. 1020.

An oral hearing was held on July 24, 2019, and a transcript of the oral hearing is available in the record. Paper 27.

B. The '890 Patent

The '890 patent is entitled “LED Driver Circuit with PWM Output,” and was issued on July 1, 2003, from Application No. 10/012,000, which was filed on December 5, 2001. Ex. 1001, (21), (22), (45), (54).

The invention is a driver circuit for light emitting diodes (LEDs) that use pulse-width modulation (PWM). *Id.*, Abstract. The '890 patent's driver circuit purports to overcome the disadvantages of other designs. *See id.* at 1:12–36.

In particular, LEDs have a long operating life, high efficiency, and a low profile. *Id.* at 1:14–17. This makes them useful light sources for automobiles. *Id.* But small changes in the voltage applied to the LED lamp will cause appreciable current changes. *Id.* at 1:18–20.

According to the '890 patent, current source is the preferred driving method because LED-light output is proportional to current. *Id.* at 1:20–22. LED drivers in vehicles can use circuits with voltage-source outputs and current-limiting resistors or linear-current regulators. *Id.* at 1:22–25. Current-limiting resistors, however, cause power loss. *Id.* at 1:25–26. This makes such driver circuits inefficient. *Id.* at 1:25–26.

Also, driving an LED above or below nominal current can reduce its life and produce unpredictable light output. *Id.* at 1:27–29. These driver circuits perform unacceptably in higher-power applications, such as rear-combination vehicle lights—i.e., stop, turn, or tail lights. *Id.* at 1:29–34.

According to the '890 patent, the disclosed driver circuit provides good regulation and efficiency and maintains operation at the LEDs' nominal current, among other advantages. *Id.* at 1:39–43. Specifically, the disclosed driver circuit uses current feedback to adjust power to the LEDs. *Id.* at 1:65–67. Figure 1 of the '890 patent shows a block diagram of the driver circuit, which is reproduced below. *Id.* at 1:54–55.

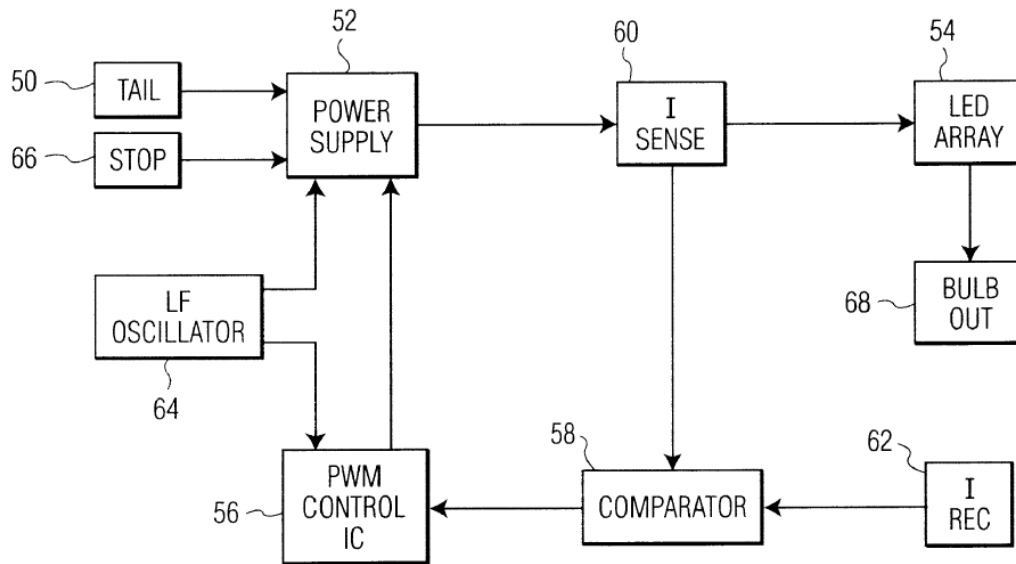


Figure 1 of the '890 patent is a block diagram of an LED driver circuit.

As shown above in Figure 1, at block 50, a tail-lamp input signal is supplied to power supply 52. *Id.* at 2:2–4. Power supply 52 can be a DC/DC converter. *Id.* at 2:4–6. Power supply 52 supplies power for LED array 54. *Id.* at 2:6–8. PWM control IC 56 controls power supply 52 and provides a high-frequency periodic drive signal of varying pulse width. *Id.* at 2:6–11. This directs power supply 52 to supply the required power in response to a feedback signal. *Id.* In one embodiment, the drive signal is a square-wave. *Id.* at 2:11–13. Comparator 58 compares the sensed current signal from current sensor 60 to the reference signal from reference current source 62

and provides the feedback signal. *Id.* at 2:14–16. The system’s feedback mechanism maintains constant LED current while meeting demand, which preserves the life of the LEDs and produces predictable light output. *Id.* at 3:27–31.

Also, power supply 52 provides a full-light mode and a dim mode. *Id.* at 1:65–67. Low-frequency oscillator 64 is involved in placing the driver circuit in dim mode. *See id.* at 2:17–48. For example, oscillator 64 provides a low-frequency oscillating signal to power supply 52 and PWM control IC 56. *Id.* at 2:17–19. When the low-frequency oscillating signal is in a low state, it (1) blocks the power to the LED array 54 from power supply 52 and (2) holds PWM control IC 56 low. *Id.* at 2:31–35. When the low-frequency oscillating signal changes from low to high, PWM control IC 56’s output is synchronized to the transition. *Id.* at 2:35–37. With this feature, a lower operating frequency can be used with the dim mode while maintaining stable LED current. *Id.* at 2:37–39.

In another feature, a bulb-out signal indicates that LED array 54 has burned out or become disconnected. *Id.* at 2:57–60. Other features and purported advantages are disclosed in various embodiments. *See generally id.* at 2:61–5:15.

C. The Independent Claims

Of the challenged claims, claims 1 and 7 are independent and reproduced below.

1. A system for supplying power for an LED array, said system comprising:
an oscillator generating an oscillating signal, the oscillating signal having a first state and a second state; and

a power supply operatively coupled to the oscillator, the power supply providing output power and being responsive to the oscillating signal;

wherein said power supply supplies the output power to the LED array when the oscillating signal is in the first state and does not supply the output power to the LED array when the oscillating signal is in the second state.

Id. at 5:17–27.

7. A system for supplying power for an LED array, said system comprising:

means for sensing current to the LED array, said current sensing means generating a sensed current signal; means for generating a reference signal;

means for comparing the sensed current signal to the reference signal, said comparing means generating a feedback signal;

means for modulating pulse width responsive to the feedback signal, said pulse width modulating means generating a drive signal; and

means for supplying power responsive to the drive signal, said power supplying means supplying current to the LED array.

Id. at 5:39–53.

II. ANALYSIS

A. *Claim Construction*

The Petition was filed on April 16, 2018. For petitions filed before November 13, 2018, we give the claims of an unexpired patent the broadest reasonable interpretation in light of the specification. 37 C.F.R. § 42.100(b) (2017); *see* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340, 51,340, 51,358 (Oct. 11, 2018). Under that standard, we generally give claim terms their ordinary and customary meaning, as

understood by a person of ordinary skill in the art in the context of the entire patent disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). But we need only construe the term to the extent necessary to resolve the controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

1. *Claim 1*

Claim 1 recites, in part, “an oscillator generating an oscillating signal, the oscillating signal having a first state and a second state.” Ex. 1001, 5:19–20.

Petitioner relies on a dictionary that “defines the term [‘oscillator’] as ‘[a]n electronic circuit that converts energy from a direct-current source to a periodically varying electrical output.’” Pet. Reply 4 (citing Ex. 1021, 3). According to Patent Owner, “An oscillating signal as understood in the art is a signal that repeats periodically, such as a sine wave.” PO Resp. 16 (quoting Ex. 2014 ¶ 90) (emphasis added); *see also* PO Sur-Reply 5 (“Petitioner’s Reply appears to concede that an oscillating signal must be ‘periodically varying,’ . . .”).

The Specification supports the construction that an oscillating signal is periodically varying. For instance, the Specification states that “the low frequency oscillating signal changes from low to high.” Ex. 1001, 2:35–37. In another example, “the oscillating signal can be a square wave oscillating between 0 and 16 volts with a frequency of 200 to 300 Hertz.” *Id.* at 4:17–20. In these examples, the ’890 patent uses term “oscillating” to describe signals having periodic variation or change. Thus, we construe “an oscillating signal” as a signal with periodic variation.

In claim 1, the term “oscillator” is limited by the recited function: generating an oscillating signal. Petitioner’s definition from a technical dictionary merely adds that an oscillator is (1) an electronic circuit and (2) “converts energy from a direct-current source.” Pet. Reply 4 (citing Ex. 1021, 3 (McGraw-Hill Dictionary of Scientific and Technical Terms 1341–40 (4th ed. 1989))). There is no dispute about a direct-current source. The Specification discusses an “oscillator” in terms of its function. *See* Ex. 1001, 2:17–19, 26–27; 44–48. Thus, we determine that “oscillator” means an electronic circuit that generates an oscillating signal.

2. Claims 7, 14, 22, and 30

To summarize, the parties agree that claim 7’s limitations are in means-plus-function format. PO Resp. 2–3. But the parties disagree on the corresponding structures. *Id.* at 3. For instance, Patent Owner contends that the corresponding structure is not limited to circuits with particular model numbers. *See, e.g.*, Prelim. Resp. 15. Also, Patent Owner contends that Petitioner omits elements from the corresponding structure for several limitations. *See, e.g., id.* at 11, 13; *see also* PO Resp. 4. As for the “means for sensing current” (claim 7) and “means for indicating the LED array is inoperable” (claim 14), the parties disagree about the function and the structure. PO Resp. 3, 7. Patent Owner proposes an explicit construction for “monitoring,” which is recited in claims 22 and 30. PO Resp. 7–8. Petitioner does not propose an explicit construction in the Petition. *See generally* Pet.

We discuss each of these limitations in the sections that follow.

- a. “means for sensing current to the LED array, said current sensing means generating a sensed current signal” (claim 7)

(1) Claimed Function

Petitioner asserts that the proper construction of the function in the recited sensing means is “sensing a current that is supplied to the LED array and generating a signal that indicates the present value of the sensed current.” Pet. 9. Patent Owner disagrees. See PO Resp. 4. Patent Owner contends that “Petitioner’s proposed function seeks to modify the recited function by adding two phrases: (1) ‘that is supplied to’ and (2) ‘that indicates the present value.’” *Id.*

As for the phrase “that is supplied to,” we agree with Patent Owner that it “provides no better clarification of the recited function than the existing plain language of the claim.” *Id.* (citing Ex. 1001, 5:41–42). For instance, claim 7 recites that the sensed current is “current to the LED array.” Ex. 1001, 5:41.

As for the phrase “that indicates the present value,” claim 7 simply recites “generating a sensed current signal,” without placing a requirement on what the signal indicates. *Id.* at 5:39–53. Petitioner does not explain why claim 7 should be further limited beyond generating this signal. See Pet. 9–10. Nor do we find a sufficient reason to do so on this record.

Thus, we determine that the corresponding function is “sensing current to the LED array” and “generating a sensed current signal.” No further construction is needed beyond the claim’s plain language.

(2) Corresponding Structure

According to Petitioner, “the structure disclosed for the claimed ‘means for sensing current’ is the resistor R1A1, R1A2, and/or R1A3, and the resistor R1B1, R1B2, and/or R1B3.” *Id.* at 10.

Patent Owner disagrees. Prelim. Resp. 11. According to Patent Owner, Petitioner's construction is incorrect because both resistor sets—i.e., R1A1, R1A2, and R1A3 or R1B1, R1B2, and R1B3—will perform the claimed function, and the construction omits current sensor 60. *Id.* at 12–13 (citing Ex. 2006, 15). That is, Patent Owner's construction encompasses three structures in the alternative: (1) current sensor 60, (2) resistor R1A1, R1A2, and/or R1A3, or (3) resistor R1B1, R1B2, and/or R1B3. Prelim. Resp. 11; *see also* PO Resp. 4. In this way, Patent Owner's construction is broader than Petitioner's. *Compare* Prelim. Resp. 11; PO Resp. 4, *with* Pet. 9–10.

We agree with Patent Owner that the Patent indicates that either set of resistors can perform the claimed function. Prelim. Resp. 12. For instance, R1A1, R1A2, and R1A3 appear in the schematic diagram in Figure 2A. This diagram shows a first power supply 112 that supplies current to LED array 114. Ex. 1001, 3:11–12. LED array 114 responds to signals for the STOP input 104 or TURN input 102. *Id.* at 3:12–14. The resistors are between the first power supply 112 and LED array 114 to sense current. *Id.* at 3:31–35. By contrast, R1B1, R1B2, and R1B3 appear in the schematic diagram in Figure 2C. This diagram shows a second power supply (130) that supplies power to LED array 126. *Id.* at 3:55–56. LED array 126 responds to signals for the STOP input 104 or TAIL input 106, depending on the input mode. *Id.* at 3:56–59. Figure 2C shows the resistors connected to the second power supply 130. *Id.*, Fig. 2C. So the two sets of resistors perform the same function but are connected to different power supplies.

Thus, the structures disclosed in the Specification as corresponding to the claimed function are (1) R1A1, R1A2, or R1A3 or (2) R1B1, R1B2, or

R1B3. We need not determine whether current sensor 60 can also be a corresponding structure because it is immaterial to our analysis below.

b. “means for generating a reference signal” (claim 7)

(1) Claimed Function

Petitioner asserts that the corresponding function for the signal-generating means does not need construction and should be given its plain meaning. Pet. 10. Patent Owner agrees. Prelim. Resp. 14. We determine that the claimed function is “generating a reference signal,” which does not require a further construction.

(2) Corresponding Structure

Petitioner asserts that “[t]he structure corresponding to the means for generating a reference signal is the internal reference in the Unitrode UCC2813-3 or ST Microelectronics UC2842 IC *or the like* as disclosed in the ’890 patent.” Pet. 10–11 (emphasis added).

Patent Owner disagrees. Prelim. Resp. 14. In Patent Owner’s view, the corresponding structure is (1) reference current source 62 or (2) the internal reference in PWM control IC 118 or 134. *Id.* Patent Owner contends that the corresponding structure is not limited to particular model numbers of Unitrode and ST Microelectronics ICs. *Id.* at 15. Also, Patent Owner contends that Petitioner’s construction omits reference current source 62 as a corresponding structure. *Id.* That is, Patent Owner’s construction encompasses several structures in the alternative. *See id.* In this way, Patent Owner’s construction is broader than Petitioner’s. *Id.* at 14.

Yet Petitioner’s construction is not limited to particular IC models. *See* Pet. 10–11. Rather, Petitioner uses the language “or the like” to include other models. *Id.* And like Patent Owner’s construction, Petitioner

acknowledges that “the internal reference of the PWM control IC is the generated reference signal recited in claim 7.” *Id.* at 10.

We determine that the internal reference in PWM control IC 118 or 134, which can be the Unitrode UCC2813-3 or ST Microelectronics UC2842 IC or the like, is the structure in the Specification corresponding to the claimed function. We need not determine whether reference current source 62 can also be a corresponding structure because it is immaterial to our analysis below.

c. “means for comparing the sensed current signal to the reference signal” (claim 7)

(1) Claimed Function

According to Petitioner, the corresponding function for the comparing means does not need construction and should be given its plain meaning. Pet. 11. Patent Owner agrees. Prelim. Resp. 16; *accord* PO Resp. 5. Under the plain meaning, the function requires two signals: “the sensed current signal” and “the reference signal.” Apart from this, the claimed function of “comparing the sensed current signal to the reference signal” does not require a further construction.

(2) Corresponding Structure

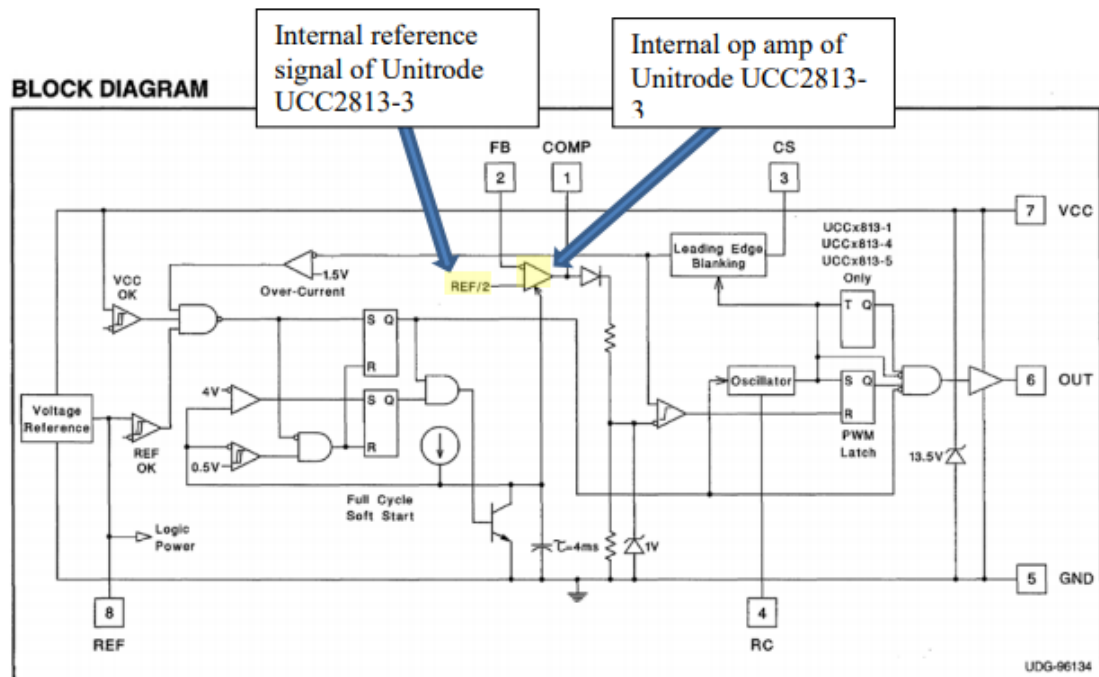
Petitioner asserts that the structure that compares the signals “is an internal op-amp in the PWM control IC.” Pet. 11 (Ex. 1003 ¶ 54). According to Petitioner, “PWM control IC 118 can be an integrated circuit *such as* a UCC2813-3 manufactured by Unitrode, a UC2842 series manufactured by ST Microelectronics, *or the like.*” *Id.* (quoting Ex. 1001, 3:17–20) (emphasis added).

Patent Owner disagrees. *See* PO Resp. 5; Prelim. Resp. 16. In Patent Owner’s view, the corresponding structure is (1) comparator 58 or (2) the

internal op-amp in PWM control IC 118 or 134. PO Resp. 5; Prelim. Resp. 16. Patent Owner contends that the corresponding structure is not limited to the particular model numbers of Unitrode and ST Microelectronics ICs. Prelim. Resp. 18. Patent Owner contends that Petitioner's construction omits comparator 58 as a corresponding structure. *Id.* at 17.

We disagree with Patent Owner that Petitioner's construction is limited to particular IC models. *See* Pet. 11. Rather, Petitioner uses the language "or the like" to include other models. *Id.* This language is also found in the '890 patent. *See* Ex. 1001, 3:17–20. And like Patent Owner's construction, Petitioner acknowledges that "[a] skilled artisan would recognize that what does the comparing is an internal op-amp in the PWM control IC." Pet. 11.

We determine that the corresponding structure for the "means for comparing" is comparator 58 or the internal op amp in PWM Control IC 118 or 134. For example, Dr. Shackle reproduces a data sheet from UCC2813-3, which is shown below with Dr. Shackle's annotations. Ex. 1003 ¶ 54.



The figure above is a block diagram of UCC2813-3 with annotations on the internal reference signal and an internal op amp. *Id.* (reproducing Ex. 1008, 0045).

We note that the structure shown above compares two signals, which is relevant to our analysis below. Although the above example shows a particular model, we agree with Patent Owner that the limitation is not limited to particular models. *See* Ex. 1001, 3:17–20, *quoted in* Pet. 11.

d. “means for modulating pulse width responsive to the feedback signal, said pulse width modulating means generating a drive signal” (claim 7)

(1) Claimed Function

According to Petitioner, the corresponding function for the pulse-width-modulating means does not need construction and should be given its plain meaning. Pet. 11. Patent Owner agrees. Prelim. Resp. 19; *accord* PO Resp. 6. We determine that the claimed function is “modulating pulse width responsive to the feedback signal, said pulse width modulating means generating a drive signal,” which does not require a further construction.

(2) Corresponding Structure

Petitioner asserts that “the structure corresponding to the means for modulating is the ‘Unitrode UCC2813-3 IC; the ST Microelectronics UC2842 IC; *or the like.*’” Pet. 12 (emphasis added). Patent Owner disagrees. Prelim. Resp. 19. In Patent Owner’s view, the corresponding structure is PWM control IC 56, 118, or 134. *Id.* Patent Owner also contends that the corresponding structure is not limited to the particular model numbers of Unitrode and ST Microelectronics ICs. *Id.* at 20.

We disagree with Patent Owner that Petitioner’s construction is limited to particular IC models. *See* Pet. 12. Rather, Petitioner uses the language “or the like” to include other models. *Id.* This language is found in the ’890 patent. *See* Ex. 1001, 3:17–20.

Also, the internal reference in PWM control IC 118 or 134 is the corresponding structure for “means for generating a reference signal.” *See supra* § II.A.2.b. So, consistent with the interpretation of the reference signal, the corresponding structure for the pulse-width-modulating means is PWM control IC 118 or 134, which can be Unitrode UCC2813-3 IC, the ST Microelectronics UC2842 IC, *or the like.* We need not determine whether PWM control IC 56 can also be a corresponding structure because it is immaterial to our analysis below.

e. “*means for supplying power responsive to the drive signal*” (claim 7)

(1) Claimed Function

According to Petitioner, the corresponding function for the power-supplying means does not need construction and should be given its plain meaning. Pet. 12. Patent Owner agrees. Prelim. Resp. 21; *accord* PO Resp. 6. We determine that the claimed function is “supplying power

responsive to the drive signal,” which does not require a further construction.

(2) Corresponding Structure

Petitioner asserts that “the structure for the claimed power supply means is a DC/DC converter” and notes that the ’890 patent discloses that “[t]he power supply 52 can be a DC/DC converter such as a buck-boost power supply or other alternatives, such as a boost, buck, or flyback converter.” Pet. 12. (citing Ex. 1001, 2:4–6). Petitioner further notes (*id.*) that in a previous *inter partes* review, the Board construed this term as “a buck-boost, boost, buck, and flyback power supply and its equivalents that regulate current.” *Wangs Alliance Corp. v. Koninklijke Phillips N.V.*, IPR2015-01292, Paper 64 at 10 (PTAB Nov. 23, 2016) (Final Written Decision). In Petitioner’s view, the limitation is obvious regardless of the construction. Pet. 12.

According to Patent Owner, the parties disagree on the structure. Prelim. Resp. 21. In Patent Owner’s view, the corresponding structure is “a buck-boost, boost, buck, or flyback power supply and its equivalent power supplies that regulate current (as opposed to regulating voltage).” *Id.* at 21–22. Patent Owner argues that construing the power-supplying means as any “DC/DC converter” is inconsistent with the Board’s previous construction of this term. *Id.* at 22.

Petitioner’s proposed construction of “a DC/DC converter” encompasses power supplies beyond those listed in the Specification: “buck-boost power supply or other alternatives, such as a boost, buck, or flyback converter.” Ex. 1001, 2:4–6. The Specification does not identify other DC/DC converters as being able to perform the claimed function. *See, e.g., id.* So we determine the corresponding structure for the “means for

supplying power” is a buck-boost, boost, buck, flyback power supply, or equivalents that regulate current.

f. “means for indicating the LED array is inoperable” (claim 14) / “indicating when the LED array is inoperable” (claim 22) / “generating LED array inoperable signal” (claim 30)

(1) Claimed Function / “inoperable”

As for the indication in claims 14 and 22 and the signal in claim 30, Petitioner asserts that the indication and generated signal is “a signal that alerts an **individual**” and that “the ’890 patent defines an LED array’s inoperability with only two possibilities: being burnt out or disconnected.” Pet. 13 (citing Ex. 1001, 3:35–39). Petitioner further states that “[t]he specification discloses structure that *provides a signal that alerts an individual when the LED array is burnt out or disconnected.*” *Id.* (emphasis added). The most natural reading of this passage is that Petitioner regards the italicized text as the corresponding function in claim 14. *Id.*

Patent Owner argues that the claim is not limited to “providing a signal to alert an individual.” Prelim. Resp. 25–26. Patent Owner offers a dictionary definition of “inoperable”—i.e., not functioning. *See id.* at 25 (citing Ex. 2013 (Merriam-Webster’s Collegiate Dictionary 602 (10th ed. 2000))).

We agree with Patent Owner that Petitioner’s construction incorrectly limits the claims to “providing a signal to alert an individual.” *Id.* at 25–26. For instance, block 68 provides a signal indication that LED array 54 has burned out or has become disconnected. Ex. 1001, 2:58–60, *quoted in* Prelim. Resp. 26. That is, block 68 alerts the driver circuit in Figure 1, not

necessarily an individual. *See id.* at 2:1–2; Prelim. Resp. 26. Also, the plain language of the claim is silent about any individual.

We also see no reason to limit “inoperable” to Petitioner’s identified embodiment where the LED array has been burned out or disconnected. The Specification does not use the term “inoperable” in a way that clearly indicates that the term is defined or limited to these embodiments.

Thus, the claimed function for the means recited in claim 14 is “indicating the LED array is inoperable,” and we construe “inoperable” in claims 14, 22, and 30 to mean “not functioning.” That is, we construe “the LED array is inoperable” (claims 14 and 22) as the LED array is not functioning, and we construe “generating LED array inoperable signal” (claim 30) as a signal that indicates the LED array is not functioning.

(2) Corresponding Structure

As for the corresponding structure in claim 14, Petitioner explains that the structure corresponding to the indicating means is “second op-amp 122 and BULB OUT signal 124.” Pet. 13. In Patent Owner’s view, the corresponding structure is not limited to second op-amp 122. Prelim. Resp. 26. Rather, Patent Owner argues that the patent discloses an IC or op-amp as the corresponding structure. *Id.* We agree with Petitioner.

For instance, the patent discloses that op amp 122 compares a system-input voltage to the downstream voltage signals from the LED arrays (114 and 126). Ex. 1001, 3:36–39. Op amp 112 provides BULB OUT signal 124, which alerts the driver that an LED array has burned out or disconnected. *Id.* Referring to op amp 122, the patent explains that “voltage supply 128 supplies the *op amp ICs*.” *Id.* at 3:40–41 (emphasis added).

Although the Specification uses the word “ICs” here, the Specification does not indicate that any IC could perform the function. So we see no

reason that the claim should be interpreted to encompass all ICs. Rather, the corresponding structure is op amp 122 because the Specification uses “op amp IC” to refer to this structure.

On this record, we determine that corresponding structure for the means for indicating is second op-amp 122 and BULB OUT signal 124.

g. “monitoring the LED array” (claim 22) / “an LED monitor” (claim 30)

Claim 22 recites “monitoring the LED array,” and claim 30 recites “an LED monitor.” The Specification does not supply a special definition for the term “monitoring.” In fact, apart from the claims, the ’890 patent does not use the term “monitoring” in the descriptive portion of the Specification. *See* Ex. 1001, 1:1–5:15. Rather, the Specification describes, for example, that op amp 122 compares the system voltage to the downstream voltage signals from the LED arrays and provides a signal alerting the driver that the LED array is burned out or disconnected. *Id.* at 3:35–40. During trial, the parties introduced dictionary definitions to support their different constructions, among other evidence.

Patent Owner argues that “monitoring” and “monitor” should “be construed as ‘test(ing) or sample(ing) on a regular or ongoing basis.’” PO Resp. 7. In Patent Owner’s view, “This construction is consistent with the definition of the term ‘monitor’ understood at the time and in the art.” *Id.* Patent Owner’s dictionary defines monitor as “to test or sample on a regular or ongoing basis.” *Id.* at 8 (citing Ex. 2012 (The American Heritage College Dictionary 881 (3d Ed. 2000))). Patent Owner also argues that its definition is consistent with the Specification. *Id.* According to Patent Owner, the Specification explains that the disclosed op-amp ICs test the LED voltage on

an ongoing basis. *Id.* (citing Ex. 1001, 3:35–42, 3:35–37; Ex. 2014 ¶ 61–62; Ex. 2016, 13:12–14:1, 15:10–16).

Petitioner disagrees with Patent Owner’s construction. Pet. Reply 9–11. Petitioner argues that “under the proper construction, monitoring simply means observing or checking; there is no requirement imposed on when that check must occur or how long the check transpires for.” *Id.* at 11. We agree with Petitioner.

To be sure, the claims place no conditions on the monitoring. Nor does the Specification place conditions, explicitly or implicitly. Patent Owner’s dictionary definition itself (“test(ing) or sample(ing) on a regular or ongoing basis”) does not limit the monitoring to particular events that begin and end the monitoring. *See* PO Resp. 7. Rather, the word “ongoing” implies that the testing or sampling occurs for an indefinite time period—or at least as long as the monitor is functioning. That is, Patent Owner’s proposed construction of monitoring is testing or sampling on a regular or ongoing basis while the monitor is provided with power. *See id.* at 20.

We are persuaded by Petitioner’s counterargument. Pet. Reply 14–15. If a system had been monitoring for a fault condition (e.g., an inoperable bulb), then it would have been reasonable to stop monitoring when the condition was initially detected and resume when the condition was remedied. Although it is possible that monitoring would have continued during the fault condition (e.g., while the bulb was inoperable), there may have been no reason to do so. In the field of the ’890 patent (i.e., vehicle lights), Petitioner argues that it would have been logical for a technician to reset a monitor after replacing a faulty bulb in a vehicle light. *Id.* Petitioner supports this position by pointing to Biebl’s operation and Dr. Zane’s testimony, which are discussed in detail below. *See id.* at 15 (citing

Ex. 1005, 6:56–59; Ex. 1020, 19:17–23). Thus, Petitioner shows that one of ordinary skill would understand that monitors may stop monitoring for reasons other than a lack of power.

Also, Patent Owner narrowly reads the word “ongoing” from a general-purpose dictionary to exclude a specific circumstance in a technical context. But Petitioner notes that the definition applicable to electronic devices does not discuss time or conditions: “A usu. electronic device used to record, regulate, or control a process or system.” *Id.* at 10–11 (citing Ex. 2012, 4). And Petitioner points to several other definitions that also do not impose the restrictions that Patent Owner argues for. *See id.* at 11 (citing Exs. 1022, 1023).

Thus, we agree with Petitioner’s construction and determine that “monitoring” means observing or checking. *See id.*

B. Level of Ordinary Skill in the Art

Petitioner’s expert, Dr. Peter William Shackle, testifies that one of ordinary skill in the art as of the patent’s filing date would have a bachelor’s degree in electrical engineering, physics, or an equivalent field, and at least two to four years of academic or industry experience in circuit design configuration, LED devices, or comparable industry experience. Ex. 1003 ¶ 40, *cited in* Pet. 6. According to Petitioner’s expert, a person of ordinary skill in the art with a higher education level may have fewer years of experience and vice versa. *Id.*

Patent Owner argues that “[a] person of ordinary skill in the art for the ’890 patent is not an integrated circuit designer, but rather an engineer designing a circuit that might use an integrated circuit.” PO Resp. 37. According to Dr. Regan A. Zane, Patent Owner’s expert, “the level of skill of a person of ordinary skill in the art defined by Dr. Shackle is lower than

the level of skill required to be aware of all pertinent art and to think in light of the conventional wisdom in the art,” and “Dr. Shackle’s definition is not focused on experience with power electronics or a related field.”

Ex. 2014 ¶26.

Any difference between Petitioner’s and Patent Owner’s proposed levels of ordinary skill in the art are immaterial because, as Dr. Zane explains, “applying Dr. Shackle’s standard for the level of ordinary skill in the art would not affect [Dr. Zane’s] analysis and conclusion regarding the patentability of any challenged claim.” *Id.* ¶ 27. So we apply Petitioner’s proposed definition, which appears to be consistent with the level of skill reflected in the asserted references. *See Okajima v. Bordeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that the prior art itself can reflect an appropriate level of skill in the art).

C. Obviousness based on Biebl

Petitioner asserts that claims 1, 22, and 30 are unpatentable because, under 35 U.S.C. § 103, the claimed subject matter would have been obvious over Biebl. Pet. 14–40.

1. Overview of Biebl

Biebl discloses a drive circuit for an LED array. Ex. 1005, Abst. Biebl’s device uses pulsed-current regulation. *Id.* at 2:24–26. According to Biebl, the prior art uses series resistors for limiting current when driving LEDs. *Id.* at 1:9–11. But in motor vehicles, the battery voltage can fluctuate greatly. *Id.* at 1:13–17. As a result, a series resistor produces particularly high power loss. *Id.* To eliminate the need for a series resistor and its associated high-drive power loss, Biebl uses a pulsed LED drive. *Id.* at 2:24–26.

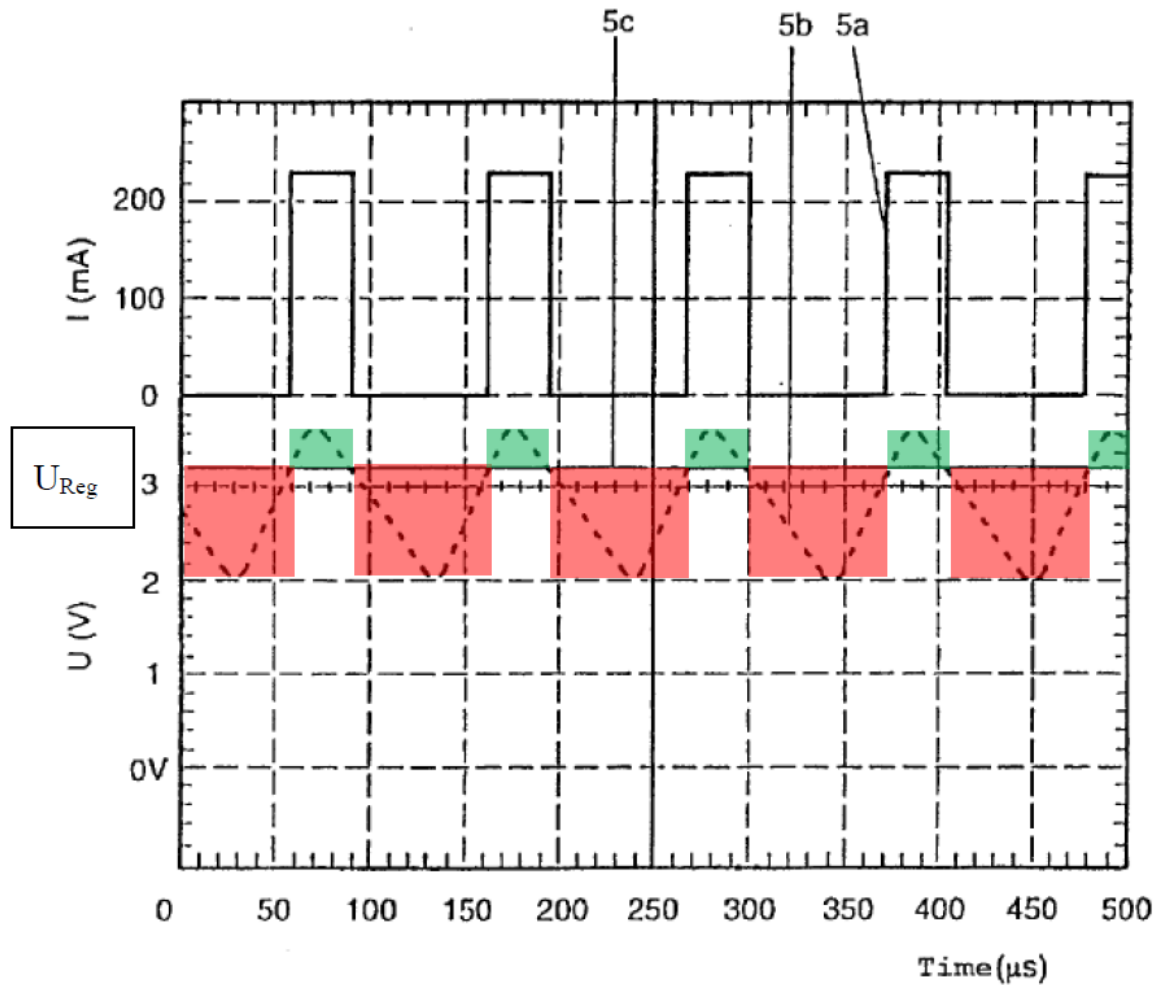
2. *Claim 1*

a. *“the oscillating signal”*

Claim 1 recites, in part, “an oscillator generating an oscillating signal, the oscillating signal having *a first state and a second state*.” Ex. 1001, 5:19–20 (emphasis added).

We have construed “an oscillating signal” as a signal with periodic repetition or variation. *Supra* § II.A.1. Under this construction, Biebl’s signal from the sawtooth waveform generator (U_D) is an “oscillating signal.” In particular, Biebl’s signal is a waveform that periodically ramps up and down over time. *See* Ex. 1005, 2:39–44, Figure 5. As Petitioner notes, Patent Owner’s expert, Dr. Zane, stated that Biebl’s signal “is an electrical signal and that it varies periodically.” Pet. Reply 4–5 (quoting Ex. 1020 (“Deposition of Dr. Regan A. Zane”) 12:7–14). Dr. Zane also stated that the signal varies in amplitude “from a low level to a high level back to a low level” and “repeats every period.” Ex. 1020, 12:20–21. Therefore, Dr. Zane’s testimony confirms, and we determine that, Biebl’s signal oscillates in amplitude, and thus, is an oscillating signal. *See id.*

The parties, however, disagree about whether Biebl’s signal has a first state and a second state, as required by claim 1. On this record, we agree with Petitioner that the signal has the recited states. Biebl’s Figure 5 is reproduced below with Petitioner’s annotations on the first state and second state. Pet. 24.



A reproduction of Biebl's Figure 5 showing the first state highlighted in green by Petitioner and the second state highlighted in red by Petitioner. *Id.*

Biebl's signal is in a first state when it exceeds the regulation voltage U_{Reg} , and it is in a second state when it is below the regulation voltage U_{Reg} . *Id.* at 23.

Patent Owner, however, argues that it would have been "impossible to distinguish between the two states when looking at the waveform." PO Sur-Reply 3 (discussing Ex. 2014 ¶ 88). In Patent Owner's view, "Petitioner argued that an arbitrary horizontal line drawn through the sawtooth waveform creates two states." *Id.*

But Petitioner's line is not arbitrary. *See* Pet. 23. Rather, the cited line is Biebl's regulation voltage: U_{Reg} . *See id.* In Biebl's Figure 5, U_{Reg} has a value of 3.2 V. Ex. 1005, Fig. 5; 3:58–59. One can distinguish between the states by comparing the waveform against regulation voltage, as Petitioner has done. *See* Pet. 24.

In fact, according to Dr. Zane, “Most states in the context of real waveforms are a collection of values within a particular range.” Ex. 2014 ¶ 88. Similarly, Petitioner has shown that Biebl's states are defined by a collection of values within a range—i.e., values above or below U_{Reg} . Pet. 23.

To be sure, Patent Owner does acknowledge that “most square-waves will in fact have a range of values associated with their high and low states.” PO Resp. 15. But, according to Patent Owner, “there must be something to *differentiate* between the two [ranges] of values.” *Id.* In Patent Owner's view, this “something” cannot be external processing. *See id.* For example, Patent Owner states, “Without some external processing of the signal, the sawtooth waveform by itself has no way of indicating the different states.” *Id.* And Patent Owner argues that “only when the triangle waveform is *compared* to an external signal, here U_{Reg} . . . can any distinction be made.” *Id.* at 14–15.

Essentially, Patent Owner defines the recited states by a signal's visual characteristics—e.g., slope. *See id.* at 15. For instance, Patent Owner argues that “[a] square-wave differentiates between states because there is a portion of the wave during transition where the slope approaches infinity, indicating a change in state.” *Id.* For a waveform like Biebl's, Patent Owner explains, “The only credible argument that a sawtooth generator has two states would be to identify the ‘ramp up’ and ‘ramp down’ states.” PO Sur-

Reply 3 n.1. Dr. Zane, Patent Owner’s expert, states that “the slope of the sawtooth or triangle waveforms remains constant for the rise and constant for the fall.” Ex. 2014 ¶ 88. Dr. Zane explained that “there must be some way to distinguish between the states *when you view the waveform.*” *Id.* (emphasis added).

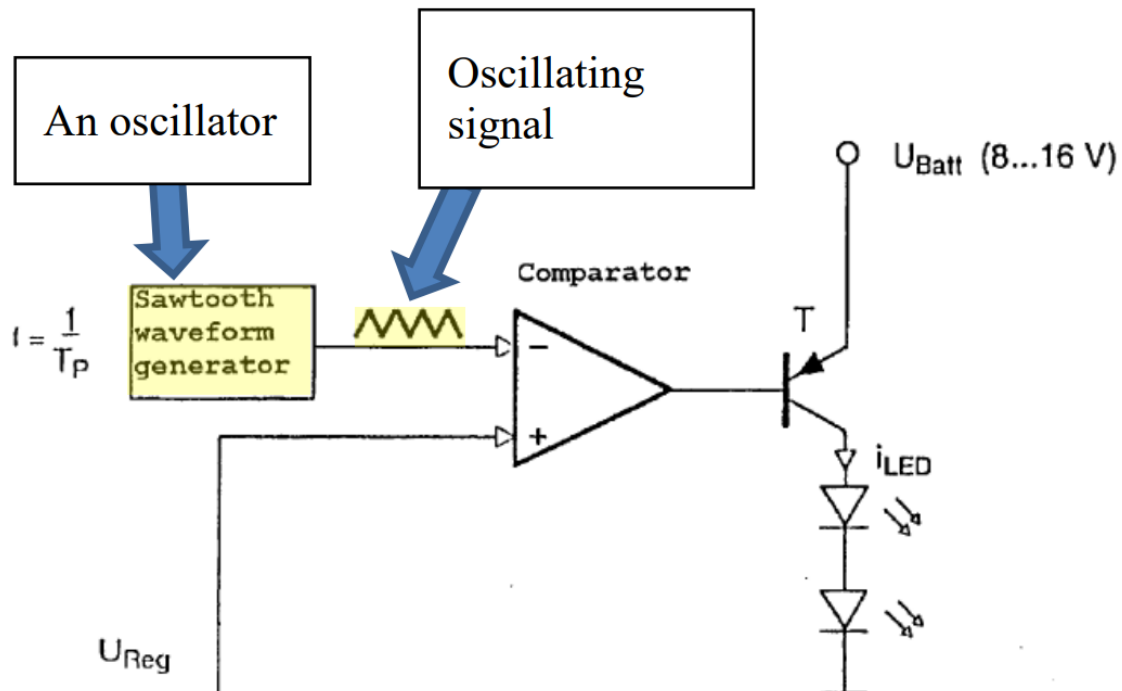
Yet nothing in the claim suggests that visual characteristics are relevant. Rather, claim 1’s system uses the recited states for a purpose unrelated to viewing waveforms—i.e., to determine whether to supply power or not. *See* Ex. 1001, 5:24–27. So we are unpersuaded by Patent Owner’s argument that slope or other visual characteristics should be the only basis for defining the states. *See* PO Resp. 15.

Thus, Petitioner has shown that Biebl teaches “an oscillating signal having a first state and a second state.”

b. “an oscillator”

Claim 1 recites, in part, “an oscillator generating an oscillating signal.” We have determined that “oscillator” means an electronic circuit that generates an oscillating signal. *Supra* § II.A.1. And we have construed “an oscillating signal” as a signal with periodic variation. *Supra* § II.A.1.

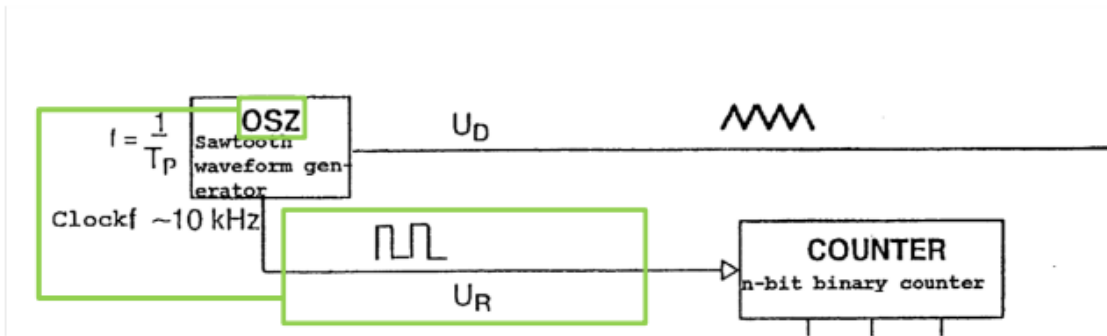
Petitioner maps Biebl’s sawtooth waveform generator to the recited oscillator. Pet. 22. In the Petition, Petitioner reproduced Biebl’s Figure 4a with annotations, as shown below.



The figure above is Biebl's Figure 4a with Petitioner's annotations on the sawtooth waveform generator and its output. *Id.*

Because Biebl's sawtooth waveform generator generates an oscillating signal (*see supra* § II.C.2.a), we also agree with Petitioner that the sawtooth waveform generator is an oscillator, as required by claim 1.

Patent Owner argues that Biebl's "internal oscillator (OSZ)" and the "sawtooth waveform generator" are distinct. PO Resp. 12. Patent Owner argues that, like Figure 4a, Figure 7 shows "the sawtooth waveform generator and the associated triangle waveform U_D ." *Id.* at 13. Patent Owner notes that, unlike Figure 4a, Biebl "added an oscillator OSZ and a second output, the square-wave U_R " to Figure 7. *Id.* Biebl's Figure 7 is reproduced below with Patent Owner's annotations. *Id.*



This version of Biebl’s Figure 7 shows the second output and the square-wave U_R annotated in green by Patent Owner. *Id.*

Dr. Zane explains that Biebl’s OSZ and the sawtooth waveform generator are distinct. Ex. 2014 ¶ 84, *discussed in* PO Sur-Reply 4. Patent Owner argues that “Petitioner conflates oscillator OSZ and the sawtooth generator to give the false impression that Biebl considers the latter an oscillator—it does not.” PO Sur-Reply 5.

Whether OSZ and the sawtooth waveform generator are one component or two is not germane to our analysis here. The claim requires that an oscillator generate an oscillating signal. Petitioner has persuasively pointed to Biebl’s sawtooth waveform generator as generating an oscillating signal. It does not matter that some embodiment shows that the same component includes another oscillator (OSZ) that generates square wave U_R . *Accord* Pet. Reply 4.

Thus, we determine that Petitioner has shown that Biebl teaches “an oscillator generating an oscillating signal, the oscillating signal having a first state and a second state.”

c. Petitioner’s Alternative Analysis of “an oscillator”

As discussed above, Petitioner asserts that the output of Biebl’s sawtooth waveform generator corresponds to the recited oscillating signal.

Pet. 22. But, in the alternative, Petitioner asserts that Biebl's comparator output is an oscillating signal. *Id.* at 22–23. Petitioner asserts that “a skilled artisan would recognize that the output of Biebl's comparator is a square wave.” *Id.* at 22 (citing Ex. 1003 ¶ 103). Petitioner explains that, during the first state, the output of Biebl's comparator has a particular voltage, and during the second state, the output of the comparator has a different voltage (possibly zero). *Id.* at 23 (citing Ex. 1003 ¶ 105).

Patent Owner argues that (1) Biebl's square wave is “not generated by an oscillator” and (2) this wave does not “oscillate.” PO Resp. 15–16.

As for the first argument, Patent Owner contends that the comparator produces the square wave, and “Biebl in fact contemplates an oscillating signal generated by an oscillator, U_D ,” which is used for interruption identification. *Id.* But this argument does not squarely address Petitioner's reasoning, which does not rely on one component. Here, Petitioner asserts that “[t]he oscillating signal would be generated by the combination of Biebl's sawtooth waveform generator and Biebl's comparator.” Pet. 23. That is, Petitioner asserts that this combination is an oscillator. *See id.*

We agree with Petitioner because the combination generates an oscillating signal. In particular, we have construed “an oscillating signal” as a signal with periodic variation. *Supra* § II.A.1. Petitioner asserts that Biebl's comparator (1) compares the oscillator's output to a regulation voltage U_{Reg} and (2) produces either a particular voltage or no voltage. Pet. 22 (citing Ex. 1003 ¶ 102). Because the output of Biebl's comparator periodically varies between a particular voltage and no voltage, we agree with Petitioner that the comparator's output is an oscillating signal.

Patent Owner disagrees and characterizes Biebl's comparator signal as “nonperiodic.” PO Sur-Reply 6. Patent Owner argues that “the output of the

comparator is dependent on U_{Reg} , which will change over time depending on the feedback from the LEDs.” *Id.* at 5 (quoting Ex. 2014 ¶ 90).

Weighing the evidence before us, we are persuaded by Petitioner’s comparison of Biebl’s comparator output to the square wave of the drive signal described in the ’890 patent. Pet. Reply 8–9. In particular, Petitioner explains that Biebl’s comparator output is similar to the drive signal in the ’890 patent, which the patent describes as oscillating. *Id.* Petitioner points out that “[t]he first PWM control IC 118 varies the pulse width of the drive signal in response to the feedback signal from the first op amp 120.” *Id.* at 8 (quoting Ex. 1001, 3:20–25). Although the drive signal’s pulse width is varied in this way, the Specification nevertheless describes the drive signal as “oscillating.” For instance, the Specification states, “In one embodiment, the drive signal can be a square wave *oscillating* between 0 and 12 volts with a frequency of 20 kHz.” *Id.* (quoting Ex. 1001, 3:20–25) (emphasis added).

Petitioner’s position is bolstered by Dr. Zane’s testimony about the drive signal. Ex. 1020, 25:21–27:14, *discussed in* PO Sur-Reply 6. In reference to the drive signal in the ’890 patent, Dr. Zane was asked, “So the square wave described here is an oscillating signal, correct?” *Id.* at 26:4–5. In reply, Dr. Zane stated, “The specific words used here are as I read: a square wave oscillating between 0 and 12.” *Id.* at 26:6–8. Dr. Zane added, “So this waveform *varies* between 0 and 12 volts according to the specifications listed here.” *Id.* at 26:8–10 (emphasis added). Also, referring to the square-waveform drive signal in the ’890 patent, Dr. Zane states that “[t]he signal itself . . . *oscillates* between 0 and 12 volts” and that the “*oscillating* behavior of the signal varies with time.” *Id.* at 26:13–19

(emphasis added). Thus, Dr. Zane describes the drive signal of the '890 patent as oscillating.

Citing a dependent claim for support, Patent Owner argues that the drive signal and the low frequency oscillating signal are different signals. PO Sur-Reply 6 (citing Ex. 1001, 5:63–65). Indeed, Dr. Zane also notes that the “drive signal” and the “low frequency oscillating signal” are different signals. Ex. 1020, 27:11–14. Even so, Patent Owner has not persuaded us that the term “oscillating signal” requires more than periodic variation. Here, Dr. Zane’s testimony only underscores that a signal that varies in pulse width—like Biebl’s comparator output—can be an oscillating signal. *Accord* Pet. Reply 9 (quoting Ex. 1020, 26:15–20).

Thus, we determine that Petitioner has shown that, under this alternative rationale (Pet. 22–23), Biebl teaches “an oscillator generating an oscillating signal, the oscillating signal having a first state and a second state.”

d. “a power supply”

Claim 1 further recites, in part, “a power supply operatively coupled to the oscillator, the power supply providing output power and being responsive to the oscillating signal.” Ex. 1001, 5:21–23. Petitioner asserts that Biebl’s semiconductor switch corresponds to the recited power supply. Pet. 24–26 (citing Ex. 1005, 2:24–56, Fig. 4). We agree.

In particular, Petitioner has shown that Biebl’s semiconductor switch provides output power and is responsive to the signal from Biebl’s comparator and waveform generator. *Id.* at 25. Biebl’s Figure 4a, below, shows the semiconductor switch as transistor T.

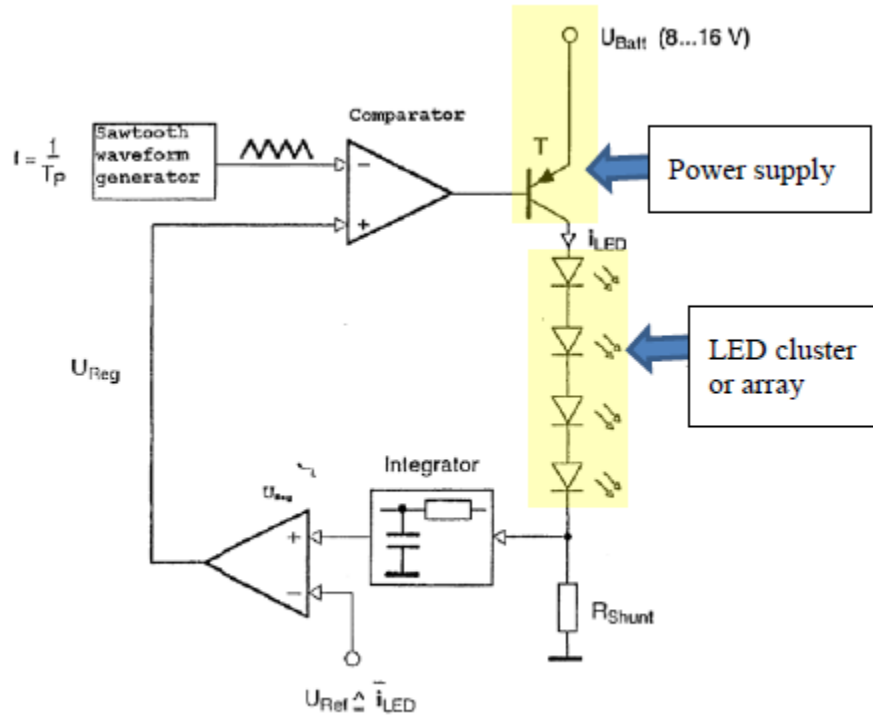


FIG. 4a

Annotated Figure 4a shows transistor T labeled by Petitioner as “Power supply.” *Id.* at 26.

Figure 4a, above, shows transistor T (“the power supply”) operatively coupled to sawtooth waveform generator (“the oscillator”) via the comparator. Transistor T “provides output power” because current I_{LED} flows through the LED cluster when transistor T is switched on. Ex. 1005, 2:27–36. Biebl states, “The transistor T is switched on if the instantaneous amplitude of the triangle waveform voltage U_D at the comparator is greater than the regulation voltage U_{Reg} .” *Id.* at 2:44–47. Likewise, when the instantaneous amplitude of U_D is below U_{Reg} , transistor T is switched off. *Id.* at 2:47–50. In this way, transistor T (“the power supply”) is responsive to U_D (“the oscillating signal”). See Pet. 25.

Thus, Petitioner has shown that Biebl teaches “a power supply operatively coupled to the oscillator, the power supply providing output power and being responsive to the oscillating signal.”

Claim 1 further recites, in part, “wherein said power supply supplies the output power to the LED array *when* the oscillating signal is in the first state and does not supply the output power to the LED array when the oscillating signal *is in the second state*.” Ex. 1001, 5:24–27 (emphasis added).

Petitioner asserts that, when Biebl’s oscillating signal is in the first state, the comparator output tells the transistor to switch on, which allows power to the LED array. Pet. 27 (citing Ex. 1005, 2:24–37). Petitioner asserts that, when Biebl’s oscillating signal is in the second state, Biebl’s comparator output tells the transistor to switch off, which blocks power to the LED array. *Id.* (citing Ex. 1005, 2:24–37, 2:44–52).

Patent Owner argues that Biebl’s waveform does not control the output power, as claim 1 requires. Prelim. Resp. 33–34. According to Patent Owner, Biebl’s sawtooth waveform “keeps time,” but does not “control whether power is supplied to the LEDs.” *Id.* (citing Ex. 1005, 2:37–44). In Patent Owner’s view, Biebl uses the sawtooth waveform as a time-keeping and synchronization tool for the circuitry that does control the power. *Id.*

Yet even if Biebl only uses the waveform in the way that Patent Owner describes, Biebl’s waveform controls the power, albeit indirectly. *See id.* Specifically, Biebl’s transistor allows or blocks power to the LED array. Ex. 1005, 2:24–37, 2:44–52, *cited in* Pet. 27. Biebl’s waveform controls the transistor using the comparator because the comparator tells the transistor to switch on or off based on the waveform’s voltage. *Id.* In this way, the states of Biebl’s waveform control the output power.

Thus, based on the entire trial record, we determine that Petitioner has proven that claim 1 is unpatentable by a preponderance of the evidence.

3. *Claims 22 and 30*

Claims 22 and 30 incorporate the limitations of independent claims 15 and 23. Claims 15 and 23 were canceled in a previous *inter partes* review as anticipated over Biebl.¹ Thus, the issue in this proceeding is whether the subject matter of the respective dependent claims 22 and 30 would have been obvious over Biebl.

Claim 22 recites, in part, “monitoring the LED array; and indicating when the LED array is inoperable.” Ex. 1001, 6:57–59. Similarly, claim 30 recites, in part, “an LED monitor, said LED monitor generating an LED array inoperable signal when said LED array is inoperable.” *Id.* at 8:13–17.

Petitioner asserts that Biebl’s interruption-identification device monitors the LED array by scanning the voltages from the LED cluster. Pet. 38 (citing Ex. 1005, 6:18–37). As for the indication when the LED array is inoperable, Petitioner asserts that Biebl’s inoperable signal alerts an individual that the LED array is burned out or disconnected. *Id.* at 39–40 (citing Ex. 1005, 4:29–62; Ex. 1003 ¶ 147).

In Patent Owner’s view, the recited monitoring requires testing or sampling on a regular or ongoing basis. PO Resp. 19 (citing Ex. 2012 (The American Heritage College Dictionary 881 (3d ed. 2000))); PO Sur-Reply 7–8; *see also* Prelim. Resp. 35. Patent Owner argues that Biebl’s operation

¹ In a previous *inter partes* review of the ’890 patent, another Petitioner had shown that claims 15 and 23 were anticipated by Biebl. *See Wangs Alliance Corp. v. Koninklijke Phillips N.V.*, IPR2015-01292, Paper 64 at 28 (PTAB Nov. 23, 2016) (Final Written Decision). The appeal from that decision was voluntarily dismissed at the Court of Appeals for the Federal Circuit. Ex. 1015, 1.

does not fit this definition. PO Sur-Reply 7–8. According to Patent Owner, Biebl’s interruption-identification device sets a flip flop. *Id.* Patent Owner argues that, once set, Biebl’s flip flop requires a secondary input to be reset. PO Resp. 19 (citing Ex. 2014 ¶ 94). Patent Owner argues that the flip flop will act as a latch when there is no secondary input. *Id.*

We have determined that “monitoring” means observing or checking. *Supra* § II.A.2.g. Here, Petitioner has shown that Biebl’s interruption-identification device at least checks or observes the LED array until the interrupt sets the flip flop. *See* Pet. 38. In particular, Biebl detects a fault by looking for “a low signal of the regulation voltage U_{Reg} .” Ex. 1005, 6:38–43. Biebl uses the flip flop to record the condition. *See id.* Thus, we agree with Petitioner that Biebl teaches “monitoring the LED array” as recited in claim 22 and “an LED monitor” as recited in claim 30.

Patent Owner essentially argues that because this device’s flip flop records the condition, the device’s monitoring has ended. *See* PO Resp. 18–20. But Petitioner points out that, “even with the [flip flop] set, the signal [U_{Reg} ,] would still drop below the voltage U_{SW} necessary to trigger the comparator.” Pet. Reply 13 (Ex. 1020, 17:20–18:10). So at least some part of the device is testing or sampling on a regular or ongoing basis while it is supplied with power. *Id.* at 14. The only difference is that another part—the flip flop—records an event. But we have determined that Patent Owner’s argument requiring *ongoing* monitoring is not persuasive. *See supra* § II.A.2.g. For this additional reason, we agree with Petitioner that Biebl teaches “monitoring the LED array” as recited in claim 22 and “an LED monitor” as recited in claim 30.

Patent Owner argues that “[t]he purpose of the monitoring is to provide an indication of ‘when the LED array is inoperable.’” PO Resp. 21.

Patent Owner argues that a “latch only indicates that some issue occurred in the past, it indicates nothing about *when* the LED array is inoperable or became inoperable.” *Id.* We find Petitioner’s counterargument on this point persuasive. Pet. Reply 14–15. If there is a reason to assume that the LED array continues to be inoperable, then there is no point in continuing to check the status until after the condition is remedied. For example, a technician could reset a monitor after replacing a faulty bulb in a vehicle light. *Id.* According to Dr. Zane’s testimony, Biebl does have a way to reset the circuit in Figure 7. Ex. 1020, 19:17–23, *cited in* Pet. Reply 15. So in the context of the technology at issue, we see no persuasive reason to distinguish between what Patent Owner refers to as continuous monitoring and Biebl’s monitoring.

On this record, Petitioner has shown that Biebl teaches “monitoring the LED array; and indicating when the LED array is inoperable,” as recited in claim 22, and “an LED monitor, said LED monitor generating an LED array inoperable signal when said LED array is inoperable,” as recited in claim 30.

Thus, based on the entire trial record, we determine that Petitioner has proven that claims 22 and 30 are unpatentable by a preponderance of the evidence.

D. Obviousness based on Biebl, TI Book, and Hamp

Petitioner asserts that claims 7 and 14 are unpatentable because, under 35 U.S.C. § 103, the claimed subject matter would have been obvious over Biebl, TI Book, and Hamp. Pet. 40–56. For the reasons discussed below, we agree with Patent Owner that Petitioner has not sufficiently articulated a rationale for combining these references.

1. Overview of Hamp

Hamp relates to a constant-current drive method. Ex. 1006 ¶ 2. Hamp’s method provides a constant light source using LEDs. *Id.* In one embodiment, Hamp uses a DC-DC boost converter for driving a series-LED load. *Id.* ¶ 3. This embodiment includes a PWM, a battery voltage supply, and feedback. *Id.* ¶ 7. The DC-DC converter will adjust the output voltage to maintain constant current. *Id.* ¶ 2. Hamp explains that “any DC-DC conversion topology can be combined with [an] LED current sensing methodology to provide an efficient constant brightness light source.” *Id.* ¶ 9.

2. Overview of TI Book

TI Book includes datasheets and other information about Unitrode’s products, which are focused on power management, battery management, and high-speed data communications. Ex. 1008, 3–4. Of relevance to this ground, Petitioner submits the datasheets for the Unitrode UCC2813-3 pulse-width modulator and UC3842 controller. *Id.* at 45, 52.

3. Claim 7

Petitioner asserts that Biebl discloses the function of “modulating pulse width responsive to the feedback signal and generating a drive signal,” which is performed by the “PWM control IC circuitry, including its comparator” Pet. 51 (citing Ex. 1003 ¶ 175). As for the corresponding structure, Petitioner explains that Biebl’s modulation circuits are equivalent to “the Unitrode UCC2813-3 IC; the ST Microelectronics UC2842 IC; or the like.” *Id.* (citing Ex. 1003 ¶ 176). Petitioner also asserts that it would have been obvious to incorporate a UCC2813-3 IC, which is described in TI Book. *Id.*

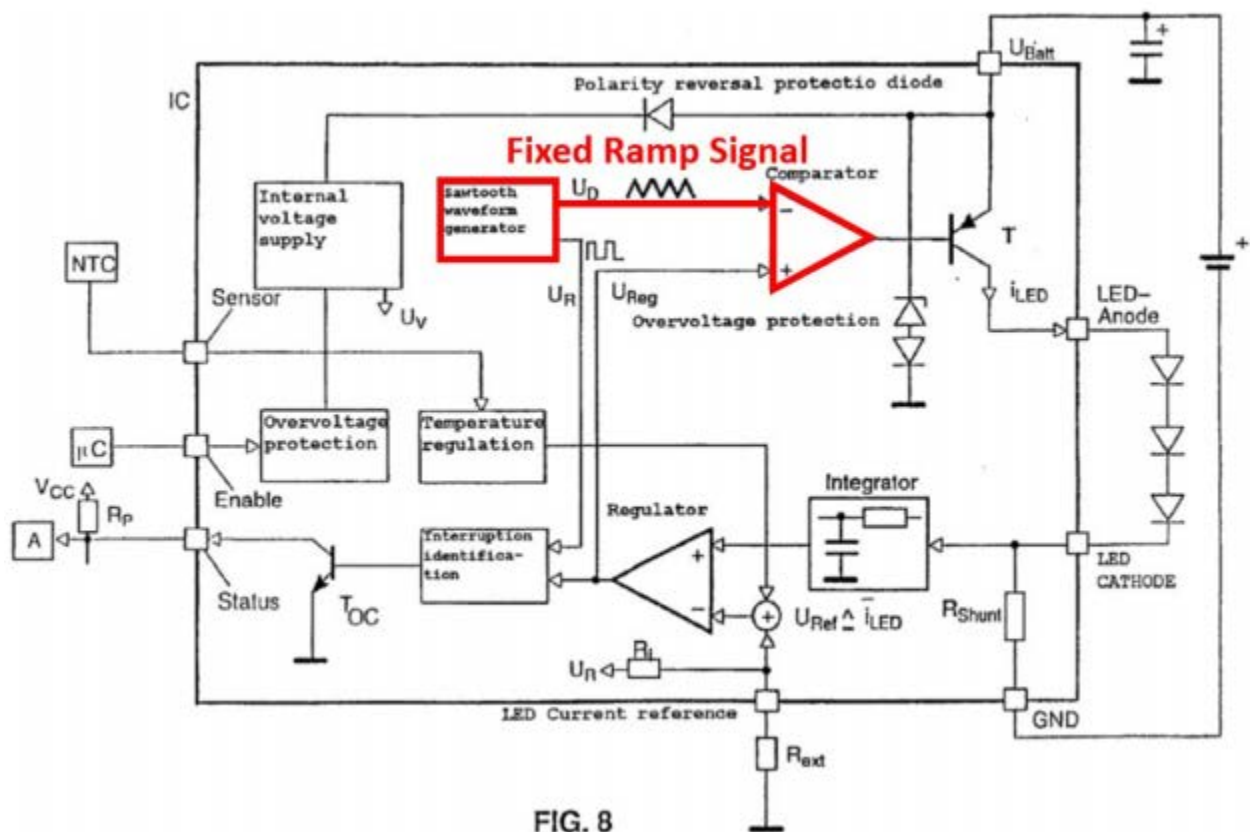
As for the means for supplying power, the Board previously determined that “Biebl does not describe a power supply that meets the requirements of claim 7 or claim 31, as construed.” *Wangs Alliance Corp. v. Koninklijke Phillips N.V.*, IPR2015-01292, Paper 64 at 25 (PTAB Nov. 23, 2016) (Final Written Decision). Here, Petitioner relies on Hamp’s boost and buck power supplies. *See* Pet. 53–54. Petitioner thus contends that it would have been obvious to use Hamp’s power supplies in Biebl. *Id.* at 54.

Patent Owner argues that Petitioner’s obviousness rationale is deficient because Petitioner has not shown why or how an ordinarily skilled artisan would have modified Biebl to include Hamp’s boost converter. PO Resp. 22–23. Patent Owner asserts that Biebl’s DC chopper and Hamp’s switch-mode power supply are different and incompatible. *Id.* at 23–27. Patent Owner also argues that Biebl and Hamp use different and incompatible PWM control mechanisms. *Id.* at 27–31.

We agree with Patent Owner that, considering the differences in function, structure, and application of the cited art, Petitioner has not provided a sufficient obviousness rationale for combining Biebl and Hamp. *See id.* at 22–31. Specifically, Petitioner’s obviousness rationale relies on incorporating Hamp’s power output in a system that uses Biebl’s pulse width modulation. Pet. 54 (discussing incorporating of Hamp into Biebl); *see also* Pet. Reply 22 (discussing incorporating Hamp’s techniques into Biebl’s pulse width modulation). Petitioner asserts that “incorporating the boost or buck power supplies of Hamp into Biebl would be a known technique (implementation of boost and buck power supplies) to improve similar devices (the LED array drives) in the same way (to adapt an LED array to different voltage supplies).” Pet. 54 (Ex. 1003 ¶ 186). Yet Petitioner does

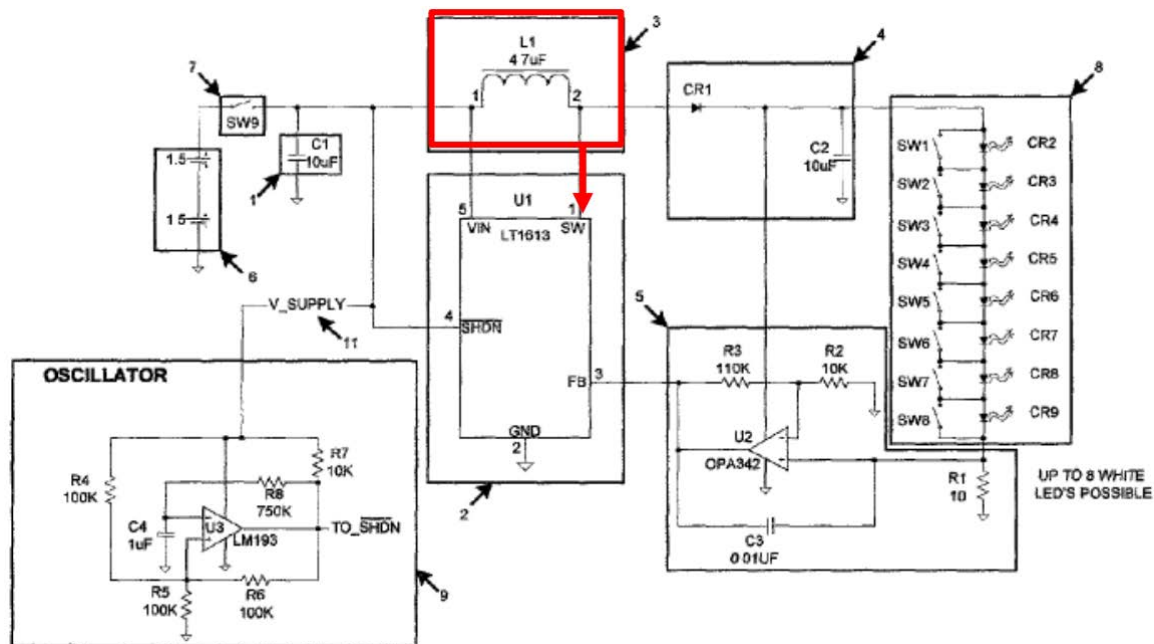
not identify what known techniques are being relied upon, and the evidence of record weighs against Petitioner's assertion that the devices are similar.

Biebl and Hamp use different PWM control schemes. PWM control schemes use a drive signal with a varying pulse width to direct a power supply to provide power. *See, e.g.*, Ex. 1001, 2:8–11; Ex. 2014 ¶ 103. According to Dr. Zane, Biebl uses “Direct Duty Cycle Control PWM control.” Ex. 2014 ¶ 106. Biebl's PWM process uses a ramp signal from the sawtooth waveform generator. *See* Ex. 1005, Fig. 8; Ex. 2014 ¶ 106. For example, Dr. Zane highlights this feature in Biebl's Figure 8, below. Ex. 2014 ¶ 105.



Biebl's Figure 8, above, with Patent Owner's annotation of "Fixed Ramp Signal" on the connection from the sawtooth waveform generator to the comparator. *Id.*

Unlike Biebl, Hamp uses a boost converter. See Ex. 1006 ¶ 7. Dr. Zane explains that, because Hamp is driving an inductive load as part of the boost converter circuit, Hamp uses “Current Mode Control.” Ex. 2014 ¶ 104. This method of control uses inductor current through a transistor to provide a ramp signal. *Id.* ¶ 106. Hamp’s Figure 1 is reproduced below with annotations.



Hamp’s Figure 1, above, shows a boost converter configured for current feedback with Patent Owner’s annotations on inductor L1. *Id.* ¶ 104.

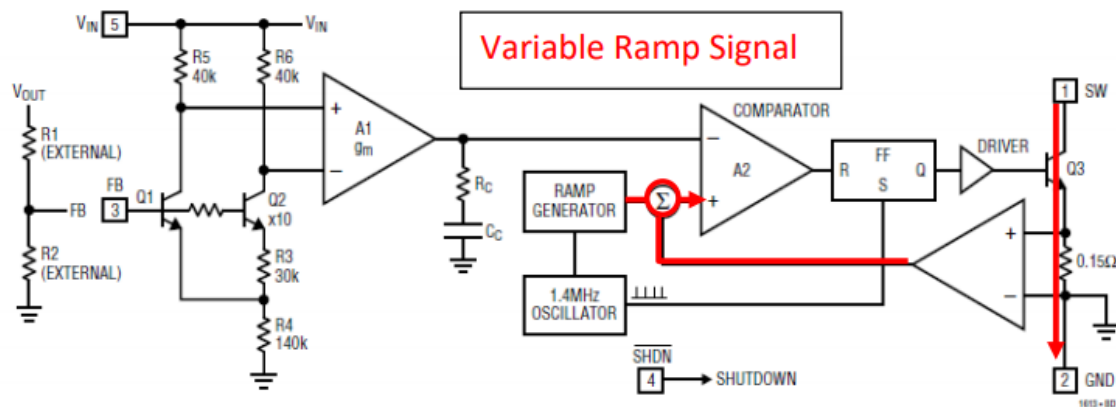
As Patent Owner points out, Biebl’s circuit lacks an inductor current for the ramp signal. See PO Resp. 30–31 (citing Ex. 2014 ¶ 104).

In the Reply, Petitioner asserts that “even if incorporating such a ramp signal was necessary, they are both very similar, and it would not be difficult to make that modification.” Pet. Reply 20. Petitioner, however, does not provide sufficient factual support for the alleged lack of difficulty of this modification. See *id.* Also, Petitioner’s conclusions about “known techniques” and “similar devices” (Pet. 54) are undermined by the functional

and structural dissimilarities of Hamp and Biebl, including the ramp signal discussed above.

Contrary to Petitioner's assertion about the ramp signal in the Reply (Pet. Reply 20), Dr. Zane explains that "even if an inductor were connected, Biebl does not have a way to modify this ramp signal based on what is occurring in the inductor." Ex. 2014 ¶ 106. Specifically, according to Dr. Zane, Biebl's PWM control uses a fixed ramp signal, but Hamp uses a variable waveform. *Id.* ¶¶ 104–105.

Dr. Zane's assertions are supported by the block diagram from LT1613. Ex. 1007, 4. In particular, Dr. Zane notes that Hamp does not show the inner workings of its PWM control IC, but LT1613 shows the details of Current Mode Control. Ex. 2014 ¶ 104. LT1613's block diagram is reproduced below.



LT1613's block diagram, above, shows a summation and Patent Owner's annotation "Variable Ramp Signal." *Id.*

LT1613 describes that, when the summation of the switch-current signal and a ramp generator exceeds V_C , comparator A2 changes states, resetting the flip flop and turning off the switch. Ex. 1007, 4. Dr. Zane states that Hamp's comparator output is summed with ramp generator's output, which provides

a modified ramp signal based on inductor current. Ex. 2014 ¶ 104.

According to Dr. Zane, “This is characteristic of Current Mode Control, where the ramp signal is a variable waveform, which changes based on the sensed signal representing the inductor current.” *Id.* By contrast, Biebl lacks the inductor current for a ramp signal and a component to modify the ramp signal. *See id.* ¶ 106. In this way, Hamp’s Current Mode Control PWM control is incompatible with Biebl’s Direct Duty Cycle Control PWM control. *See id.*

Petitioner asserts that “[t]he only difference [Patent Owner] identifies is the addition of a small summing circuit” and “[t]hat is by no means a substantial redesign.” Pet. Reply. 20. Petitioner, however, does not cite any expert testimony to support the conclusion about this particular redesign. *See id.* Also, Petitioner understates the difference here. *See id.* Specifically, Patent Owner has shown that Biebl and Hamp use different PWM control schemes, as described above. PO Resp. 28–29 (citing Ex. 2014 ¶¶ 104–105). Patent Owner has also shown that Biebl lacks (1) the inductor current for a ramp signal and (2) a way to modify such a ramp signal. *See id.* at 31 (citing Ex. 2014 ¶ 106). So “a small summing circuit” is not the only difference. Pet. Reply. 20. Thus, Petitioner’s conclusions about “known techniques” and “similar devices” (Pet. 54) are further undermined by these functional and structural dissimilarities.

Petitioner also states that “the Board found a lack of motivation to incorporate a particular power supply into Biebl,” but “such a motivation is found in Hamp.” Pet. 52 (citing Ex. 1014, 25–26). Here, Petitioner is referring to a previous decision in which the Board determined that the petitioner did “not explain why one of ordinary skill would have looked to a circuit designed to control a flyback voltage regulator (ST Micro) to regulate

a chopper circuit (Biebl).” *Wangs Alliance Corp. v. Koninklijke Phillips N.V.*, IPR2015-01292, Paper 64 at 25 (PTAB Nov. 23, 2016) (Final Written Decision). To supply this missing rationale, Petitioner explains that “Hamp discloses that ‘any DC-DC conversion topology can be combined with a LED current sensing methodology to provide an efficient constant brightness light source.’” Pet. 53 (quoting Ex. 1006 ¶ 9); *see also id.* at 54.

We are persuaded by Patent Owner’s argument and evidence on this point. PO Resp. 36. Dr. Zane explains that Hamp’s buck and boost topologies are switch-mode power supplies that have the same base components: a switch, an inductive element, and a diode. Ex. 2014 ¶ 113. By contrast, Biebl’s DC chopper topology does not have these components because it is much simpler. *Id.* Indeed, Petitioner acknowledges this. *See* Pet. Reply 21 (pointing out the differences and discussing these components). Yet Petitioner takes an overbroad interpretation of Hamp’s statement about any DC-DC conversion topology. *See* Pet. 53. On this point, we agree with Patent Owner that Hamp’s statement about using “any DC-DC conversion topology” refers to the circuit in Hamp. PO Resp. 36. Petitioner has failed to explain how Hamp’s statement applies to Biebl’s DC-chopper circuit. *See* Pet. 53–54. We further agree with Patent Owner that Petitioner has not pointed to, and indeed Hamp lacks, any disclosure that Biebl could be modified to use the more complicated power-supply method. PO Resp. 36.

In its Reply, Petitioner introduces a new obviousness rationale based on a fourth reference. In particular, Petitioner explains that buck and boost converters are taught by “handbooks on power consumption” and incorporating them into Biebl would have been “a choice of ‘a finite number of identified, predictable solutions.’” Pet. Reply 21 (citing Ex. 2003, 5, 6, 9, 10). That is, Petitioner now cites the Rashid handbook (Ex. 2003) to support

a new obviousness theory based on identified, predictable solutions at the time of the invention. *See id.*

But “an IPR petitioner may not raise in reply ‘an entirely new rationale’ for why a claim would have been obvious.” *Henny Penny Corp. v. Frymaster LLC*, No. 2018-1596, 2019 WL 4308876, at *4 (Fed. Cir. Sept. 12, 2019). Petitioner is required to “identif[y], in writing and with particularity . . . the grounds on which the challenge to each claim is based” in the petition. 35 U.S.C. § 312(a)(3). So we do not consider Petitioner’s new rationale based on Biebl and the Rashid handbook (Ex. 2003). *See Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369 (Fed. Cir. 2016) (concluding that the Board did not abuse its discretion in not considering new issues presented for the first time in reply as exceeding the scope of a proper reply under 37 C.F.R. ¶ 42.23(b)).

Also, the Rashid handbook does not adequately support the obviousness rationale stated in the Petition—i.e., “a known technique (implementation of boost and buck power supplies) to improve similar devices (the LED array drives) in the same way (to adapt an LED array to different voltage supplies).” Pet. 54. Rather, the handbook merely shows that the various power supplies existed. Petitioner has not explained how the handbook teaches the “known technique” for adapting Biebl’s PWM control to work with those various power supplies, for example.

Petitioner states, “The Petition, supported by Dr. Shackle and the references themselves, articulates a desire ‘to adapt an LED array to different voltage supplies’ **and** ‘to provide an efficient constant brightness light source,’ ([Pet. 54]) either one of which alone would be enough to provide the articulated reason needed to support the combination.”

Pet. Reply 17–18. But this rationale (*id.*) does no more than restate the functions of the components.

Importantly, Petitioner’s assertions do little to rebut Patent Owner’s argument that Petitioner relied on hindsight bias. PO Resp. 34–35; PO Sur-Reply 8–9. On this point, we agree with Patent Owner that the Petition does not explain why a skilled artisan would want to adapt the LED array to different voltage supplies and why they would “not turn to the simpler answer of swapping out the battery,” for instance. PO Resp. 34. Given the differences between Hamp and Biebl, which are discussed above, Petitioner’s obviousness rationale is deficient.

Petitioner’s reliance on the TI Book does not remedy the issues described above. *See* Pet. 51–52. Although Petitioner discusses incorporating Hamp’s power output in a system that uses Biebl’s PWM control (*id.* at 54; Pet. Reply 22), Petitioner does not adequately describe how Hamp works with the TI Book’s teachings and Biebl. Patent Owner points out, and we agree, that Petitioner does not describe what the “Biebl-TI Book-Hamp circuit would look like.” PO Sur-Reply 9. Rather, Petitioner concludes that it would have been obvious to incorporate the TI Book’s UCC2813 PWM “into the power supply described in Biebl.” Pet. 51 (citing Ex. 1003 ¶ 176). Because Hamp is not discussed in this combination, Petitioner’s explanation here (*id.*) does not address differences between the different PWM control schemes in Biebl and Hamp that we discussed above.

Petitioner’s expert, however, explains that the inventors “used the UC2813 in an unusual way.” Ex. 1003 ¶ 169. In general, Petitioner’s expert does not say much about the differences between the PWM control schemes, and what the expert says about the disclosed PWM process tends to weigh against Petitioner’s obviousness rationale. *See generally* Ex. 1003

(Declaration of Dr. Shackle); Ex. 2016 (Cross-Examination of Dr. Shackle). For example, Dr. Shackle states that, in the '890 patent, "the circuit is a boost, albeit an unusual one." Ex. 1003 ¶ 48.

Dr. Shackle's declaration highlights the unconventional aspects of the invention. *Id.* ¶ 51. In particular, Dr. Shackle first explains the "normal way" the disclosed PWM ICs control an inductor:

[T]hese PWM ICs are designed to control an inductor (as this one does) but the normal way it is done is to have a sense resistor connected between the source of Q1A and ground. The voltage from this resistor is usually fed into the I_{sense} pin of the IC. The resulting signal is used to terminate each boost cycle when the current gets as high as is possible without saturating the inductor. *Id.*

Dr. Shackle then explains that the invention lacks a typical sense resistor for the inductor current:

Now in this case the source of Q1A is shorted directly to ground and there is no sense resistor for the inductor current. Inside the PWM chip, the ramp waveform from the inductor sense resistor is an essential part of the pulse width modulation process. Without it, the output would either produce pulses or not, depending on the voltage level on pin FB. There would be no pulse width modulation. *Id.*

Dr. Shackle explains how the ramp waveform is "artificially" provided to enable the PWM process:

There is a triangle waveform on pin RT/CT as C8A is continually charged and discharged. So pin RT/CT has been connected by R14A to the I_{sense} pin, artificially providing the ramp waveform needed to enable the pulse width modulation process. *Id.*

Lastly, Dr. Shackle explains how the invention uses the chip with just one feedback loop, which differs from the conventional process:

The PWM chip should conventionally have had two feedback loops, a high frequency loop involving pin I_{sense} and a low frequency loop involving pin V_{fb} . Since it was chosen to replace the normal inductor sense signal going to I_{sense} with a dummy waveform from the clock pin Rt/Ct, then this chip is being used with just one feedback loop, using the pin V_{fb} . The pulse width of the signal going to the gate of Q1A is being continually adjusted to ensure that the chosen LED current is flowing.

Id. So this part of the declaration does little to support Petitioner's rationale that the claimed invention could be arrived at using "known techniques."

Pet. 54. Rather, on balance, it favors the conclusion that Petitioner's obviousness rationale is based on hindsight reconstruction.

On the entire trial record, Petitioner has not sufficiently explained how or why one of ordinary skill in the art would have arrived at the claimed invention using Biebl, TI Book, and Hamp. *See Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 994 (Fed. Cir. 2017) (holding obviousness determination to be improper where the record lacked a "clear, evidence-supported account" of "*how* the combination" would work). Thus, we determine that Petitioner has not shown by a preponderance of the evidence that the subject matter of claim 7 would have been obvious over Biebl, TI Book, and Hamp.

4. Claim 14

Claim 14 depends from claim 7. In particular, Claim 14 recites, "The system of claim 7, further comprising: means for indicating the LED array is inoperable." Ex. 1001, 6:15–16. So claim 14 incorporates all limitations recited in independent claim 7. Petitioner's analysis for claim 14 (Pet. 65) does not address the deficiencies of Hamp and LT1613 with respect to the limitations of claim 7 (*see supra* § II.D.3). Rather, Petitioner discusses how Biebl teaches a

“means for indicating the LED array is inoperable.” *See* Pet. 55–56 (citing Ex. 1005 6:38–51). Because Petitioner has not shown that the subject matter of claim 7, which is incorporated by reference in claim 14, would have been obvious (*see supra* § II.D.3), we also determine that Petitioner has not shown by a preponderance of the evidence that the subject matter of claim 14 would have been obvious.

E. Obviousness based on Hamp and LT1613

Petitioner asserts that claim 7 is unpatentable because, under 35 U.S.C. § 103, the claimed subject matter would have been obvious over Hamp and LT1613. Pet. 56–64. For the reasons discussed below, we agree with Patent Owner that Petitioner has not shown that these references teach or suggest comparing a “sensed current signal to the reference signal.”

1. Overview of LT1613

LT1613 is a datasheet that describes a single-cell DC/DC converter. Ex. 1007, 1. According to the datasheet, the converter is intended for small, low-power applications. *Id.*

2. Claim 7

Claim 7 recites, in part, “means for comparing the sensed current signal to the reference signal, said comparing means generating a feedback signal.” Ex. 1001, 5:45–47. We have determined that the corresponding structure for the “means for comparing” is comparator 58 or the internal op amp in PWM control IC 118 or 134. *Supra* § II.A.2.c (2).

Petitioner asserts that Hamp’s circuit includes PWM 2, which is the LT1613 IC from Linear Technology. Pet. 58 (citing Ex. 1006 ¶ 7). Petitioner asserts that LT1613’s amplifier A1 corresponds to the “means for comparing” recited in claim 17. *Id.* at 60. According to Petitioner, A1 is part

of a Brokaw bandgap reference circuit. *Id.* at 60–61 (quoting Ex. 1003 ¶ 202). Petitioner asserts that A1 compares the sensed current signal with the reference signal. *Id.* at 60 (citing Ex. 1007, 4). A block diagram from the LT1613 datasheet is reproduced in Dr. Shackle’s declaration with annotations. Ex. 1003 ¶ 202.

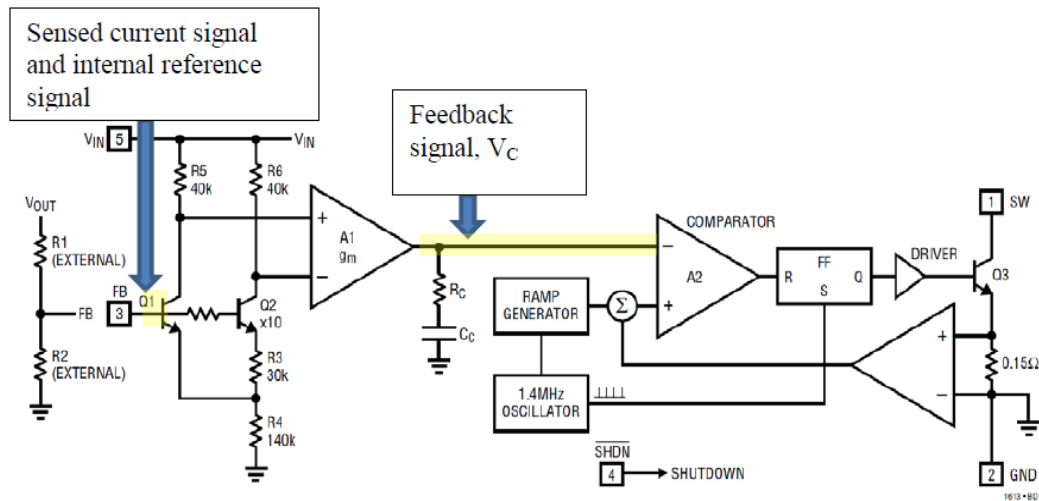


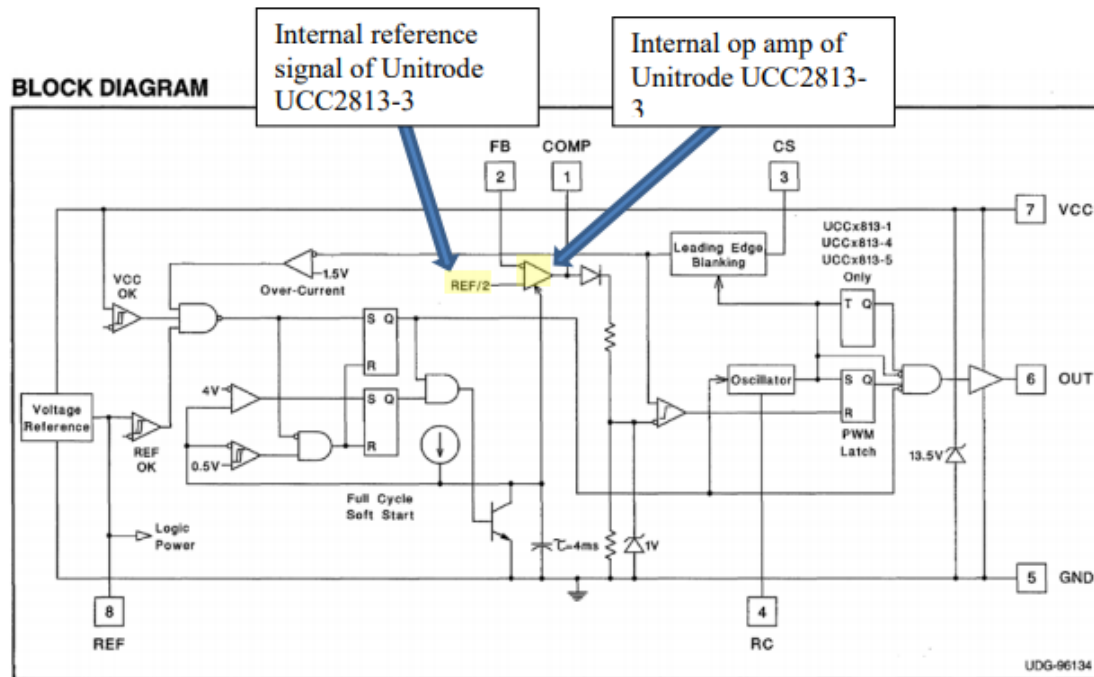
Figure from LT1613 (Ex. 1007, 4) showing Dr. Shackle’s annotations on Q1 and the output of op-amp A1. Ex. 1003 ¶ 202.

Patent Owner argues that the LT1613 amplifier does not compare the sensed current signal to the reference signal, as required by claim 7. *See* PO Sur-Reply 16–18. Patent Owner argues that Petitioner points to the same signal on the FB pin as the two claimed signals that must be compared. *Id.* at 17.

We agree with Patent Owner that LT1613 does not teach or suggest comparing the sensed current signal to the reference signal. Patent Owner’s argument is well supported by the evidence of record, including the testimony of Patent Owner’s expert, Dr. Zane. *See* Ex. 2014 ¶¶ 79–81.

According to the ’890 patent, “PWM control IC 118 can be an integrated circuit *such as* a UCC2813-3 manufactured by Unitrode, a

UC2842 series manufactured by ST Microelectronics, *or the like*.” Ex. 1001, 3:17–20 (emphasis added). For example, Dr. Shackle reproduces a block diagram from UCC2813-3, which is shown below with Petitioner’s annotations. Ex. 1003 ¶ 54.



The figure above is a block diagram of UCC2813-3 with annotations on the internal reference signal and an internal op amp. *Id.* (reproducing Ex. 1008, 0045).

According to Petitioner, “The reference signal, Dr. Shackle explains, is the bandgap of silicon and has a theoretical value of 1.22 V.” Pet. 59 (citing Ex. 1003 ¶ 199). Petitioner asserts that Patent Owner’s “declarant admits that the bandgap reference core generates a signal, a very specific signal with a steady state voltage of 1.23 V.” Pet. Reply 23 (citing Ex. 2014 ¶ 80).

But Petitioner’s characterization omits the fact that Dr. Zane, in the cited paragraphs, is comparing “a typical Brokaw bandgap reference circuit” with “modified Brokaw Bandgap Reference” in LT1613. *See* Ex.

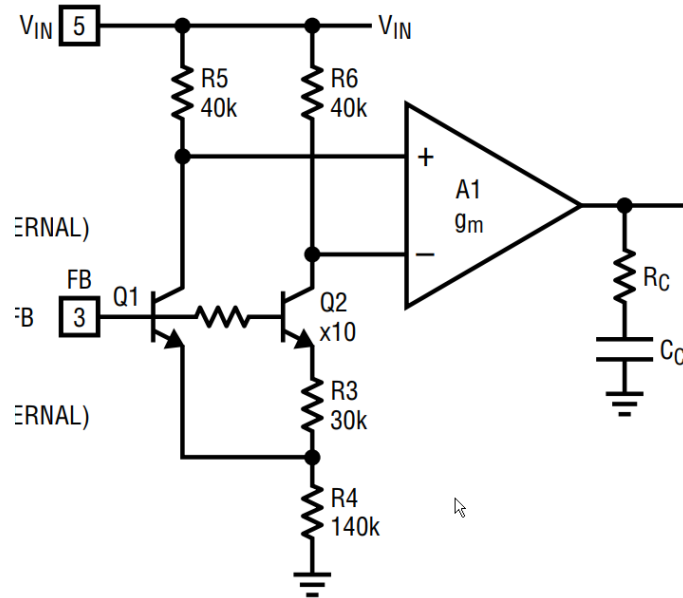
2014 ¶¶ 79–80. Petitioner cites the part of the declaration where Dr. Zane discusses the typical circuit. Pet. Reply 23 (citing Ex. 2014 ¶ 80). In particular, Dr. Zane explains,

[A typical] Brokaw bandgap circuit generates a fixed signal of approximately 1.23V. This voltage is determined by the bandgap voltage of silicon and does not vary significantly with operating conditions such as temperature or power supply voltage. The generated fixed signal may be used as an independent reference voltage that can be applied to other circuits. *But that is not how LT1613 uses the bandgap circuit components.*

Ex. 2014 ¶ 80 (emphasis added). In the paragraph that follows, Dr. Zane states that, “in the circuit of the LT1613 IC, the traditional local feedback of a Brokaw bandgap circuit is broken and the resulting circuit with Q1 and Q2 *does not generate a reference signal.*” *Id.* ¶ 81 (emphasis added).

Instead of comparing a sensed current signal with a reference signal, LT1613’s A1 compares the voltage drop across R5 and R6, as pointed out by Patent Owner’s expert. *Id.* ¶ 127. On cross-examination, Dr. Shackle, Petitioner’s expert, also acknowledges that A1 compares the voltage across R5 and R6. Ex. 2016, 45:21–46:3.² This can be seen in the relevant part of the block diagram from the LT1613 datasheet, which is reproduced below. Ex. 1007, 4.

² To be sure, Dr. Shackle expressed concern about oversimplifying “a very sophisticated concept.” Ex. 2016, 45:14–20. But Dr. Shackle nevertheless answered the question, “But in general terms, the comparator is comparing the voltage across R5 and R6, correct?” by replying “The op amp is . . . comparing those voltages, yes.” *Id.* at 45:21–46:3.



The above figure shows a part of the block diagram from LT1613 including R5, R6, Q1, Q2, and FB. Ex. 1007, 4.

According to LT1613, “Q1 and Q2 form a bandgap reference core whose loop is closed around the output of the regulator.” *Id.* Dr. Zane explains that the IC connects the base terminals of Q1 and Q2 to the FB pin. Ex. 2014 ¶ 81. According to Dr. Zane, “The input to the FB pin must be designed to be at 1.23V when the load is at the desired level.” *Id.* The bandgap reference core of Q1 and Q2 is part of the feedback path that “generates the PWM control signal to regulate the output without the need to generate a reference signal.” *Id.*

Petitioner argues that Dr. Zane admitted on cross-examination that amplifier A1 is responsive to the feedback voltage. Pet. Reply 25. In Petitioner’s view,

If the feedback voltage were brought to exceed the regulation voltage (which is the reference signal), the amplifier A1 would conduct one action. ([Ex. 1020], 32:4-13.) And, if the feedback voltage were brought below the regulation voltage, amplifier A1 would conduct another action. (*Id.*, 32:14-33:5.) Thus, by

implication, the amplifier A1 in LT1613 compares the feedback signal with the internal reference signal as claimed.

Id. But we see no such implication in Dr. Zane’s testimony. See Ex. 1020, 32:4–33:5.

Although Dr. Zane explained how amplifier A1’s output would change in response to the voltage at FB (*see id.* at 32:2–33:2), Dr. Zane stated that amplifier A1 compares the voltages through resistors R5 and R6. *See id.* at 31:1–7. Also, we agree with Patent Owner that Petitioner’s argument about whether the feedback signal undergoes some processing is irrelevant. Pet. Reply 25. Here, Petitioner has not shown that either of the input signals to A1 are the “sensed current signal” and the “reference signal.” Pet. 60–61.

Petitioner does offer an alternative rationale. Specifically, Petitioner asserts that “the internal op-amp in the Unitrode UCC2813-3 and the op-amp A1 in LT1613 are equivalent.” *Id.* at 61. For example, Dr. Shackle states,

The internal op amp in the Unitrode UCC2813-3 and the op amp A1 in LT1613 are both providing the error amplifier function. Both perform the same function—comparing a feedback signal with a reference and generating a feedback signal. Both perform the function in the same way—using an op amp. And both have the same result—regulating the pulse width of a digital signal. Ex. 1003 ¶ 203.

We note that whether both use an op amp for performing the function is disputed by the cross-examination of Patent Owner’s expert. Specifically, Dr. Zane states that an amplifier with the sublabel g_m “would commonly be referred to as a transconductance amplifier,” which “works much like an operational amplifier or op amp.” Ex. 1020, 30:8–12.

Regardless, Petitioner has not shown that the relevant components in the Unitrode UCC2813-3 and LT1613 perform the same function, let alone perform it in the same way. As Patent Owner points out, the LT1613 does not compare a sensed current signal to a reference signal and is not equivalent to a circuit that does. *See* PO Sur-Reply 16; PO Resp. 49.

Also, the differences between the feedback loops further weigh against equivalence in this case. Specifically, Dr. Shackle, Petitioner's expert, states,

The LTI chip folds the current sense voltage into its feedback loop, so that a wrong current sense voltage perturbs the reference and triggers a response from the system to correct it back to normal. While this is subtly different from the UCC2813 chip, I believe a skilled artisan would find this difference to be insignificant.

Ex. 1003 ¶ 203. In response, Patent Owner relies on its expert to explain the significance of this difference:

[C]onstructing a feedback loop in this way does not merely mean the LT1613 will not require a reference signal, it means it will not *have* a reference signal. If the load is disconnected, there will be no reference signal present for any other function of the IC to use. [Ex. 2014 ¶128.] While the LT1613 disclosure minimizes circuit components—the stated goal of both Hamp and LT1613—the LT1613 is not able to use a reference signal anywhere else on the integrated circuit reliably. *Id.* Further, it is restricted to regulating loads whose feedback can be represented by approximately 1.23 V. This will greatly limit the range of applications this technique in the LT1613 can be applied to showing it is not the equivalent of the '890 patent. *Id.*

PO Resp. 49. That is, the device's design minimizes components but limits the range of its applications. *See* Ex. 2014 ¶ 128. The differences here affect performance and potential uses. *See id.* For this

additional reason, we find that LT1613's chip is not equivalent to the corresponding structure in the Specification of the '890 patent.

Based on the full record, we determine that Petitioner has not shown that LT1613 or Hamp teaches or suggests the "means for comparing the sensed current signal to the reference signal," as recited in claim 7. Thus, we determine that Petitioner has not shown by a preponderance of the evidence that the subject matter of claim 7 would have been obvious over LT1613 and Hamp.

F. Obviousness based on Hamp, LT1613, and Biebl

Claim 14 depends from claim 7. In particular, Claim 14 recites "The system of claim 7, further comprising: means for indicating the LED array is inoperable." Ex. 1001, 6:15–16. So claim 14 incorporates all limitations recited in independent claim 7. Petitioner's analysis for claim 14 (Pet. 65) does not address the deficiencies of Hamp and LT1613 with respect to the limitations of claim 7 (*see supra* § II.E.2). Rather, Petitioner relies on Biebl solely for the recited "means for indicating that the LED array is inoperable." *See* Pet. 65 (citing § VIII.B of the Petition). Because Petitioner has not shown the subject matter of claim 7, which is incorporated by reference in claim 14, would have been obvious (*see supra* § II.E.2), we also determine that Petitioner has not shown by a preponderance of the evidence that the subject matter of claim 14 would have been obvious over Hamp, LT1613, and Biebl.

III. CONCLUSION³

Petitioner has demonstrated that claims 1, 22, and 30 of the '890 patent are unpatentable under 35 U.S.C. § 103(a) as having been obvious over Biebl but has not demonstrated that claims 7 and 14 would have been obvious over the various combinations of Biebl, TI Book, LT1613 and Hamp.

In summary:

References	Basis	Claims	Claims Shown Unpatentable	Claims Not Shown Unpatentable
Biebl	§ 103	1, 22, 30	1, 22, 30	
Biebl, TI Book, and Hamp	§ 103	7, 14		7, 14
Hamp and LT1613	§ 103	7		7
Hamp, LT1613, and Biebl	§ 103	14		14
Outcome			1, 22, 30	7, 14

³ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding after 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).

IV. ORDER

It is

ORDERED that claims 1, 22, and 30 of the '890 patent are unpatentable;

ORDERED that, on the record before us, Petitioner has not shown by a preponderance of the evidence that claims 7 and 14 of the '890 patent 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.

IPR2018-00921
Patent 6,586,890 B2

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