

IPR2025-00030 (U.S. Patent No. 8,498,593)
Patent Owner's Response

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEDIATEK INC.,
Petitioner,

v.

PARKERVISION, INC.,
Patent Owner.

IPR2025-00030
Patent 8,498,593

**PATENT OWNER'S RESPONSE TO PETITION FOR
INTER PARTES REVIEW OF UNITED STATES PATENT NO. 8,498,593**

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PATENT OWNER'S EXHIBIT LIST

Exhibit No.	Description
2001	Declaration of Dr. David Ricketts

I. INTRODUCTION

This IPR relates to power efficiency optimization in a power amplification, modulation, and transmission system. Specifically, the challenged claims of U.S. Patent No. 8,498,593 (the “’593 patent”) are directed toward optimizing power supply design and configuration, including the control of a bypass switch, based on power efficiency and network characteristics of a specific RF transmission modulation schemes.

As explained in detail below, the cited prior art references and combinations thereof that MediaTek rely on do not disclose controlling a power supply with bypass circuitry based on, *inter alia*, power efficiency and network characteristics as claimed and described in the ’593 patent.

Accordingly, MediaTek has failed to demonstrate that challenged claims 1-20 of the ’593 patent are invalid.

II. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA at the time of the invention of the ’593 patent would have: (a) a Bachelor of Science degree in electrical or computer engineering (or a related academic field), and at least two (2) additional years of work experience in the design and development of radio frequency circuits and/or systems, or (b) at least five (5) years of work experience and training in the design and development of radio frequency circuits and/or systems. Ex. 2001, ¶¶24-26.

III. Technology Background

A. Power Supply

1. Switching Convertor

Switching converters convert electrical energy from one voltage level to another using high frequency switching devices in combination with energy storage elements such as inductors and capacitors. Ex. 2001, ¶27. Unlike linear regulators, which dissipate excess energy as heat, switching converters achieve higher efficiency by alternately storing and transferring energy in discrete packets. *Id.* The switching device introduces high-frequency components, which are filtered by passive components such as inductors and capacitors to produce a smooth DC output. *Id.*

Control methods such as pulse-width modulation (PWM) or pulse-frequency modulation (PFM) are used to regulate the output voltage by adjusting the duty cycle or frequency of the switch. *Id.*, ¶28. Feedback mechanisms are often included in switching convertors to maintain voltage stability under varying load and input conditions. *Id.*

2. Step-Down (Buck) Convertor

Step-down converter (also known as buck convertor) is a switching convertor that converts an input voltage to a lower output voltage. It operates by

rapidly switching a transistor on and off to control the flow of energy to an inductor, which in turn regulates the voltage delivered to the load. *Id.*, ¶29.

Generally, a basic buck converter operates in two primary states: an on-state and an off-state. *Id.*, ¶30. In the on-state (when the switch is closed), current flows from the input supply through the switch and inductor to the output. The inductor stores energy in its magnetic field while also supplying current to the load. *Id.*, ¶31. In the off-state (when the switch is open), the inductor resists the sudden change in current and maintains current flow by forward-biasing a diode (or activating a synchronous switch). The stored energy in the inductor is released to the load and output capacitor. *Id.*, ¶32.

By controlling the duration of the on-time relative to the switching period (i.e., the duty cycle), the average output voltage can be adjusted. *Id.*, ¶33.

3. Step-Up (Boost) Convertor

Step-up (boost) converter is a switching convertor that converts an input voltage to a higher output voltage. It is commonly used in applications where the power source has a lower voltage than required by the load. *Id.*, ¶34.

Like the buck converter, the boost converter operates by rapidly switching a transistor on and off, storing and releasing energy through the inductor. *Id.*, ¶35-36. In the on-state (when the switch is closed), current flows from the input through the inductor and switch to ground. During this time, the inductor stores energy by

building up a magnetic field. The diode is reverse-biased, preventing current from reaching the output. *Id.*, ¶37. In the off-state (when the switch is open), the inductor resists the sudden change in current. The stored energy is released, and the inductor current flows through the forward-biased diode to the output capacitor and load. This adds to the input voltage, effectively "boosting" the output above the input. *Id.*, ¶38.

B. Power Amplifier

Power amplifiers (PAs) are used in radio frequency (RF) systems for increasing the power of modulated signals to levels suitable for wireless transmission. Their primary role is to amplify low-power RF signals generated by transmitters to sufficient power levels for effective radiation through antennas, while preserving signal integrity and minimizing distortion. *Id.*, ¶39.

Performance of an RF power amplifiers are characterized by the following metrics:

Gain: The ratio of output power to input power, typically expressed in dB. It determines the amplification capability of the PA.

Peak Output Power: The maximum RF power the amplifier can deliver, typically specified at the 1 dB compression point (P1dB) or in terms of peak envelope power (PEP).

Linearity: The ability to amplify a signal without introducing distortion.

Id., ¶40.

C. Power Efficiency

Power efficiency is a metric that measures the proportion of input power that is successfully converted into useful output power. High power efficiency is especially important in power-constrained environments, such as battery-operated devices and wireless transmitters. *Id.*, ¶41. Power efficiency (η) is defined as the ratio of output power (P_{out}) to input power (P_{in}), and is generally expressed as a percentage:

$$\eta = (P_{out}/P_{in}) \times 100\%$$

Id., ¶42. In the context of power converters P_{in} is the electrical power drawn from the source, and P_{out} is the power delivered to the load. *Id.*

IV. THE '593 PATENT

The '593 patent is directed towards “methods and systems for enhancing system efficiency in a power amplification, modulation, and transmission system.” Ex. 1001, 1:31-33; Ex. 2001, ¶43.

According to the '539 patent, “the efficiency of the power supply of a power amplification system significantly affects the efficiency of the mobile device using said power amplification system.” Ex. 1001, 1:29-39; Ex. 2001, ¶44. As described in connection with Figure 1 (reproduced below), the impact of power supply

efficiency on overall system efficiency is significant, especially at lower output voltages. Ex. 1001, 4:35-56; Ex. 2001, ¶45.

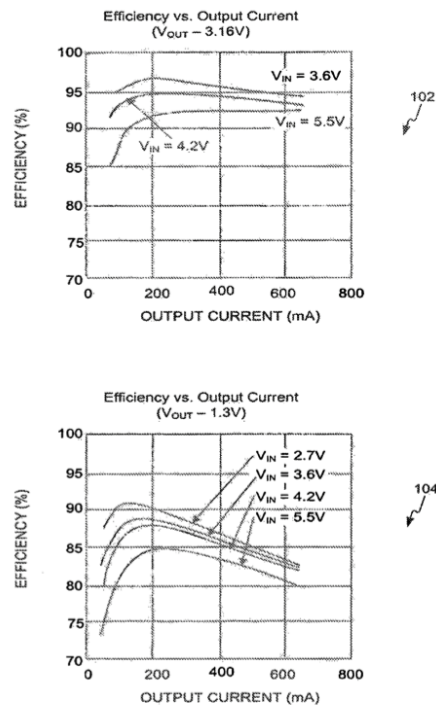
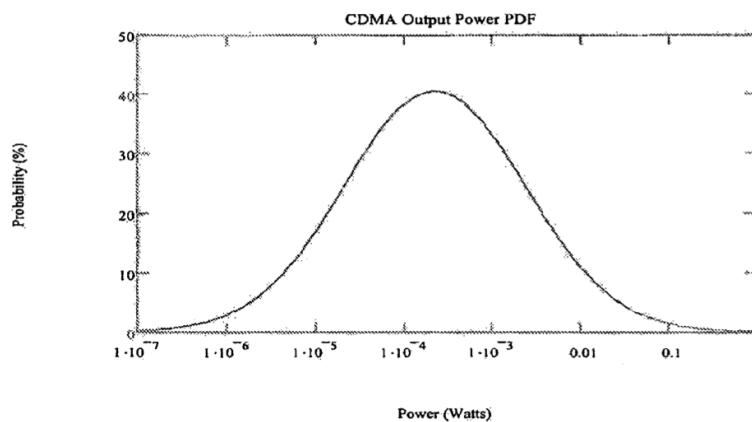


FIG. 1

Ex. 1001, Fig. 1.

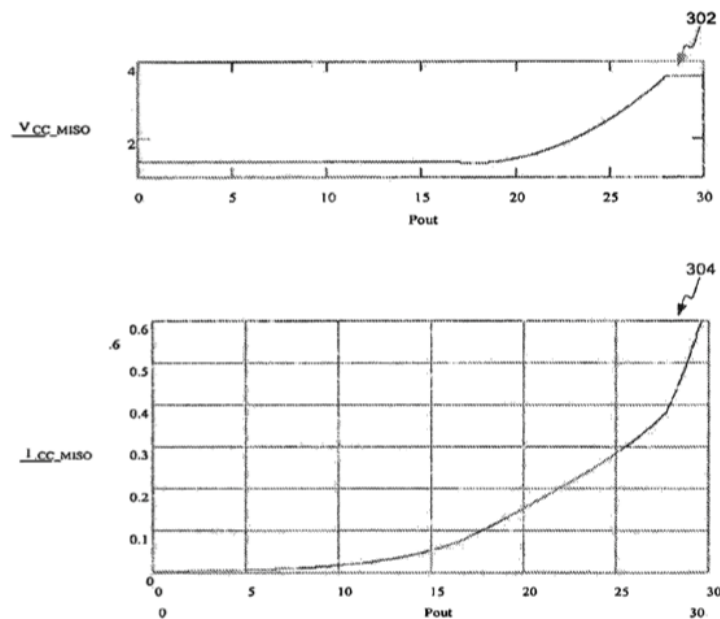
The '539 patent discloses ways to control, configure, and design power supply to improve efficiency of the power supply and thereby the efficiency of the overall system. For instance, the '539 patent discloses that “switching power supplies can be designed to operate in pre-determined output voltage and current ranges that result in increased efficiency of the power supply and consequently in increased system efficiency” based on “network characteristics and/or statistics.” Ex. 1001, 4:60-67, 5:1-9; Ex. 2001, ¶46.

As the '593 patent explains in connection with Figure 2, which shows the probability density function (PDF), +17 dBm or 50 mW is the most probably transmission power level for CDMA. Ex. 1001, 5:14-24; Ex. 2001, ¶47.



Ex. 1001, Fig. 2.

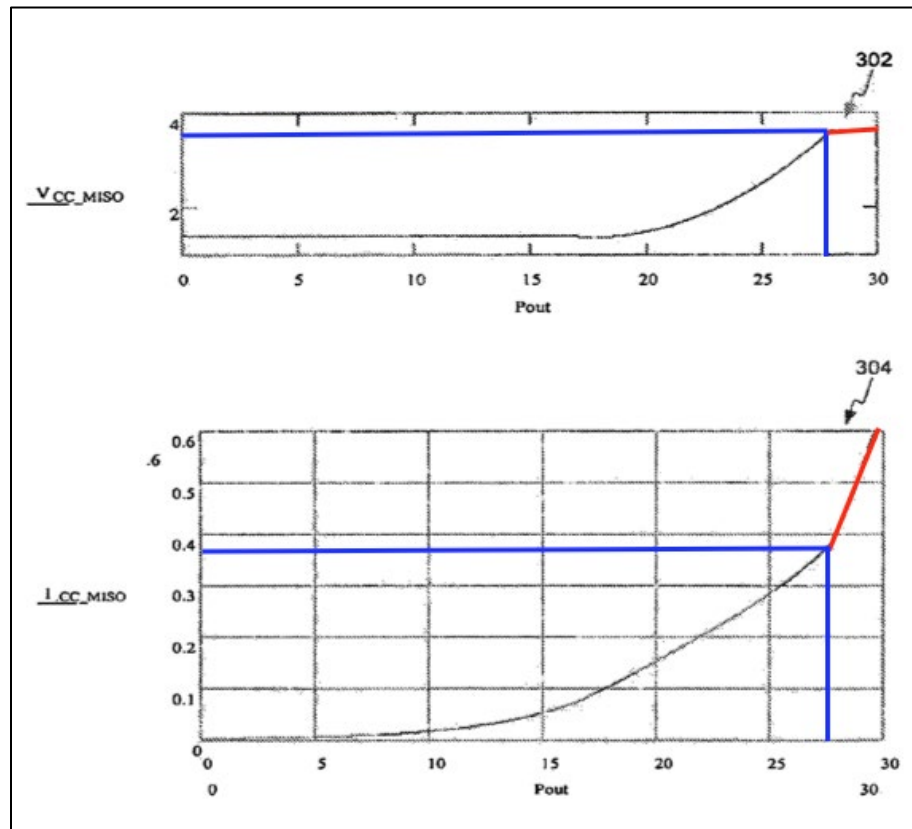
Accordingly, for an exemplary MISO amplifier with output power requirements shown in Figure 3 (reproduced below) to operate with optimal efficiency in CDMA, the switching power supply should be designed to operate at its highest efficiency when its output voltage and current corresponds with an output power of +17 dBm. For the exemplary MISO amplifier of Figure 3, that translates to when output voltage is approximately +1.39V and when output current is approximately 100 mA. *Id.*, 5:38-50.



Id., Fig. 3; Ex. 2001, ¶¶48-49.

Additionally, the '593 patent discloses that the overall power supply efficiency can be further improved by bypassing the power supply at a pre-determined threshold. Ex. 1001, 6:21-35; Ex. 2001, ¶50. Specifically, the '539 patent discloses that a “bypass switch control circuitry” can be used “to cause the bypass of the power supply circuitry when the pre-determined threshold is exceeded.” Ex. 1001, 4:1-7; Ex. 2001, ¶¶50-51. For example, Figure 3 of the '539 patent shows “the power supply output voltage and output current that are required by an example MISO amplifier to achieve a CDMA power control range.” Ex. 1001, 5:32-37; see also *id.*, 3:1-4 (“FIG. 3 illustrates exemplary plots of power

supply output voltage and power supply output current versus output power of an example multiple-input-single-output (MISO) amplifier.”); Ex. 2001, ¶52.

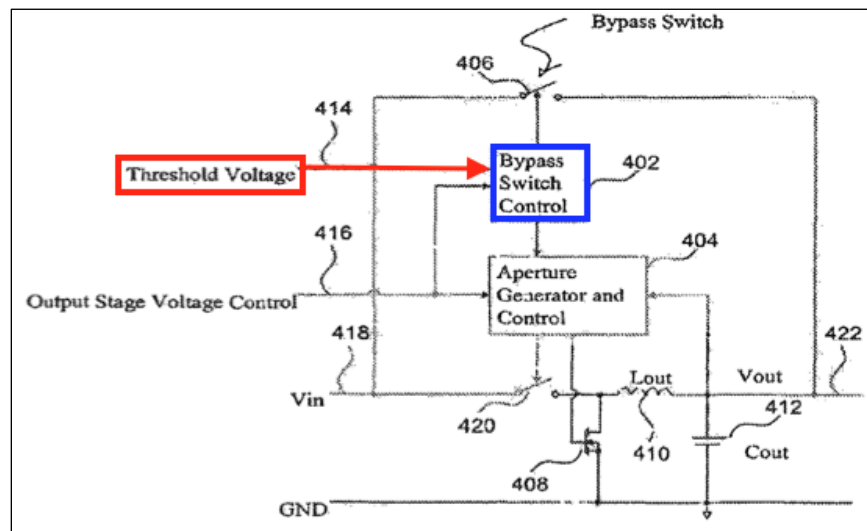


'593 patent, Fig. 3 (annotated). As shown in Figure 3 (reproduced above), the collector/drain voltage range of the exemplary MISO amplifier is +1.39V to +3.6V. Ex. 1001, 5:38-44; Ex. 2001, ¶53.

Based on the output power relationships with bias voltage (V_{CC_MISO}) and current (I_{CC_MISO}), shown in Figure 3, the specification discloses that “power supply bypass switch can be used to bypass the power supply when the power supply

output voltage required by the MISO amplifier reaches 3.6V, which corresponds to an output power of +26 dBm or 400 mW.” Ex. 1001, 6:28-35; Ex. 2001, ¶54.

As explained in connection with Figure 4 (reproduced below), Bypass Switch Control module 402 “receives Threshold Voltage signal 414 ... [which] determines at which value of the power supply output voltage power supply 400 switches to bypass mode.” Ex. 1001, 7:50-58; Ex. 2001, ¶56.

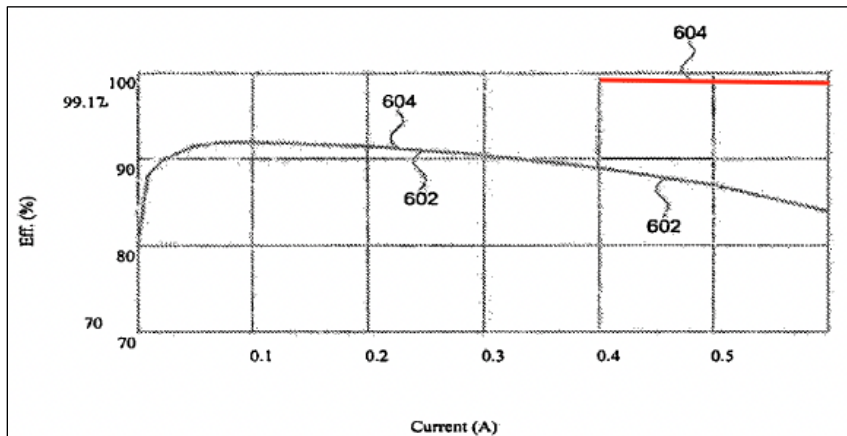


'593 patent, Fig. 4 (annotated); Ex. 2001, ¶56.

Bypass Switch Control module 402 controls Bypass Switch 406 and switches the power supply 400 to bypass mode when the power supply output voltage exceeds Threshold Voltage 414. Ex. 1001, 7:59-8:3; Ex. 2001, ¶57. Threshold Voltage 414 is determined based on various power efficiency characteristics, including “network statistics,” “network waveforms,” “waveform efficiency requirements,” “battery life requirements,” “output power

requirements,” and/or “power supply current output requirements.” Ex. 1001, 6:56-7:3; Ex. 2001, ¶55.

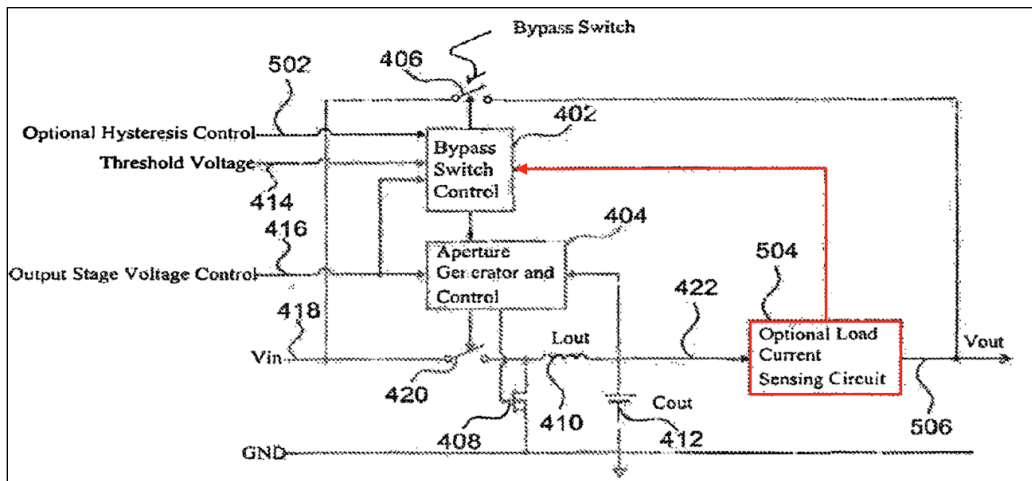
As the '593 patent explained in connection with Figure 6, for a switching power supply optimized for a +17 dBm output (based on the CDMA waveform), the bypass switch architecture discussed above activates when the power supply output voltage required by the MISO amplifier reaches 3.6V, which increases power efficiency when the required output power is equal to or greater than 400 mW (+26 dBm), which corresponds to a power supply output voltage of 3.6V and current of 400mA. Ex. 1001, 9:20-42; Ex. 2001, ¶58.



Ex. 1001, Fig. 6 (annotated); Ex. 2001, ¶58.

Further, the specification discloses, in connection with Figure 5, an “Optional Load Current Sensing Circuit 504[, which] senses load current to determine any variations that may affect power supply output voltage $[V]_{out}$ 506,”

and provides “information about sensed load current, which can be used by Bypass Switch Control module 402 to control the operation mode of switching power supply 500.” Ex. 1001, 8:28-35, 9:1-10; Ex. 2001, ¶¶59-60.



Ex. 1001, Fig. 5 (annotated); Ex. 2001, ¶60.

V. CLAIM CONSTRUCTION

Petitioner proposed construction for the term “power efficiency.” Pet., 12-13. For reasons discussed below, Petitioner’s construction is erroneous.

Petitioner also proposed construction for the term “aperture generator and control module.” *Id.*, 13-16. This claim term need not be construed to resolve the issues of this IPR because Petitioner failed to show that other claim limitations are obvious in view of the prior art, as discussed in detail below in Section VII.

A. “Power Efficiency”

Independent claims 1, 9, and 15 of the '593 patent recites, *inter alia*, deactivating the claimed switching device “in response to a **power efficiency** of the power supply exceeding a predetermined threshold.” Ex. 1001, Claims 1, 9, 15. This term was well-known in the art and should be given its plain and ordinary meaning. Nevertheless, Petitioner proposed construction for this term, not to clarify its meaning, but to improperly alter the scope of the claims. Petitioner's construction is improper, erroneous, and paradoxical. Pet., 12-13.

Petitioner began by arguing that the term “power efficiency” should be construed to mean “the output power of the power supply compared to its input power.” *Id.* However, a POSITA would not have understood “power efficiency” as merely a comparison of output and input power. Ex. 2001, ¶¶62-64, 67. Rather, it was well-known that “power efficiency” is a ratio of output power to input power, which could be expressed in percentage. *Id.*, ¶67. This is consistent with the specification's descriptions of “power efficiency,” which is calculated as a ratio of power output to power input. *Id.*; Ex. 1001, 4:35-43 (calculating system efficiency based on ratios of output to input power and expressing system efficiency as a ratio or percentage).

Moreover, Petitioner's construction improperly limits the term “power efficiency” to the power supply. Ex. 2001, ¶65. Consistent with a POSITA's

understanding of the term, the specification describes “power efficiency” not only with respect to the power supply, but to the power amplifier and the overall system as well. *Id.*; Ex. 1001, 1:29–39 (“[T]he power supply efficiency not only affects the efficiency of the power modulation and amplification system but also the efficiency of the mobile device using the power amplification system.”). Indeed, Petitioner’s construction would have rendered the claim term “power efficiency *of the power supply*” superfluous. Ex. 2001, ¶¶66-69.

Having set the stage with a vague and unduly limiting definition of the term “power efficiency,” Petitioner went on to argue that the broader phrase “in response to a power efficiency of the power supply exceeding a predetermined threshold” should be construed to encompass “indirect measurements of power efficiency such as current or voltage, and should not be interpreted to require a direct measurement of power efficiency.” Pet., 12-13. This veiled attempt to improperly alter the scope of the claims is in direct contradiction to plain and ordinary meaning and even Petitioner’s own (erroneous) construction. *Id.*

To begin, this construction of the broader phrase does not even meet Petitioner’s own definition of “power efficiency,” which requires a comparison of output and input power. A comparison of any one such “indirect measurements,” such as voltage or current, is no substitute for power because power is a function of more than one electrical quantity. Ex. 2001, ¶¶69-70. As was well-known in the

art, power is a function of (and is dependent on) voltage **and** current (i.e., $P=IV$).

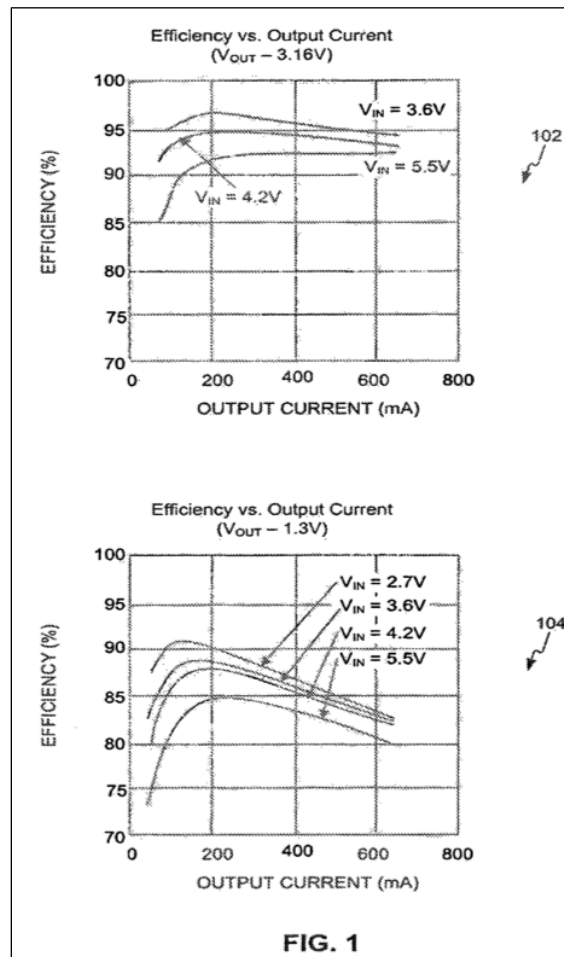
Id., ¶70. Therefore, power cannot be derived based on any one such quantity alone.

Id. Nor could a comparison of one electrical quantity (e.g., voltage, current, or resistance) at the output and input node be used to derive or even approximate a comparison of output and input power. *Id.* Petitioner's construction of the broader phrase belies basic electrical principles and its own construction of "power efficiency."

Petitioner's paradoxical construction is based on misapprehension of the '593 patent's disclosure. According to Petitioner, "[t]here is no disclosure in the '593 Patent specification where ***the circuitry directly calculates*** the power efficiency." Pet. 13. Petitioner argues that "the specification treats the direct measurement of output power as indirectly related to power efficiency." *Id.* Not so.

As a threshold matter, Petitioner's argument that the specification does not disclose "the circuitry directly calculates the power efficiency" is a strawman. Ex. 2001, ¶¶71-74. As recited in the claims, "power efficiency" and threshold thereof is "predetermined." Ex. 1001, Claims 1, 9, 15. The claims nowhere require a calculation of power efficiency ***by the circuitry***. Rather, the claims merely require determining the power efficiency characteristics of the power supply and setting a threshold based on that determination. This understanding is consistent with the '593 patent's disclosures. *Id.*, ¶74.

As the '593 patent describes in connection with Figure 1, the power efficiency characteristics of an exemplary power supply was calculated.

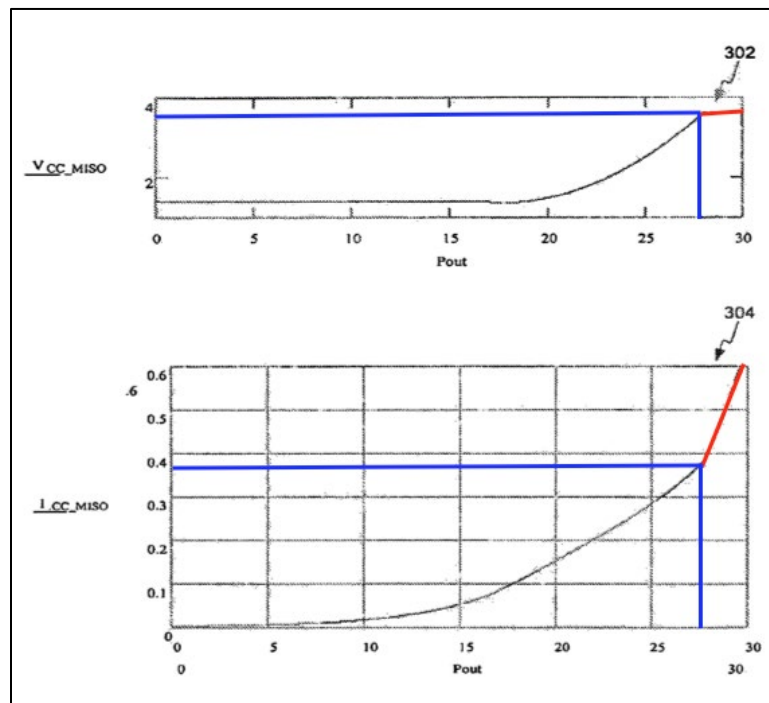


Ex. 1001, Fig. 1. Based on the power efficiency characteristics of Figure 1 and the network characteristic of CDMA shown in Figure 2, the '593 patent determines that the power supply should be configured for optimal performance at +17 dBm.

Ex. 1001, 5:10-24. Then, with reference to Figure 3, the '593 patent determines that +17 dBm corresponds to a power supply output voltage of +1.39V and output current of 100mA. Ex. 1001, 5:25-50. On these bases, the exemplary MISO

amplifier is optimized for power efficiency at +1.39V and 100mA. Ex. 2001, ¶¶75-76.

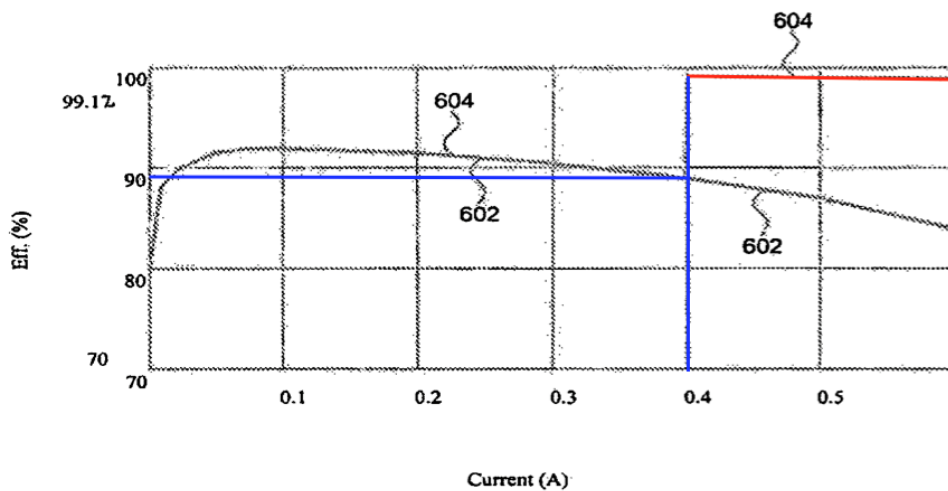
To determine the threshold for activating the bypass switch, the '593 patent again referenced Figure 3 (annotated and reproduced below), which shows that the exemplary MISO amplifier has an operating voltage range between +1.39V to +3.6V. Ex.1001, 5:38-44.



Id., Fig. 3 (annotated); Ex. 2001, ¶¶77. And at approximately +26 dBm or 400 mW RF power (blue line), the output power P_{out} of the exemplary MISO amplifier continues to increase even with a fixed power supply output voltage V_{CC_MISO} (red line). Ex. 1001, 5:38-44; Ex. 2001, ¶77. In view of Figure 3, the '593 patent discloses setting the threshold voltage at 3.6V, which corresponds to a power

supply output current I_{CC_MISO} of approximately 0.4A and an output power of +26 dBm or 400 mW (blue line). Ex. 1001, 9:20-42; Ex. 2001, ¶77.

As explained in connection with Figure 6 (annotated and reproduced below), the resulting power supply design “is optimized for a +17 dBm output (1.39V output voltage and 100 mA output current)” based on the power efficiency characteristics of Figure 1 and the network characteristics of Figure 2. Ex. 1001, 9:20-42. And the 3.6V threshold for activating the bypass switch corresponds to a power supply output current of 400mA and a power efficiency of approximately 89% (blue line). *Id.* The increase in power efficiency is illustrated by efficiency curve 604 (red line). *Id.*



Id., Fig. 1 (annotated); Ex. 2001, ¶78.

Contrary to Petitioner's assertion, the '593 patent discloses determining the “pre-determined threshold” based on “power efficiency” that was directly

calculated. Petitioner's cherry-picked portions of the specification, when considered in view of the rest of the specification's disclosures as a whole, confirms this understanding. Ex. 2001, ¶¶79-81.

Finally, Petitioner's claim differentiation argument is also unavailing. Dependent claims 2 and 6 nowhere recites "power efficiency," and a POSITA would not have read them as within the scope thereof.

VI. OVERVIEW OF THE ALLEGED PRIOR ART

A. Hau (Ex. 1007)

Hau allegedly improves upon prior art power amplifier devices in several respects.

According to Hau, prior art devices that "monitor[] the output power of the power amplifier through the current in the voltage bias line to the power amplifier" have many undesirable effects, including "coupling loss (typically through a resistor or a current mirror) in the bias line." Ex. 1007, 2:1-11. This causes "voltage drop especially under high current operation, reducing the bias voltage available to the power amplifier and resulting in performance degradation." *Id.*, 2:1-11.

Hau also states that prior art devices undesirably require the "use of external look up tables that are part of complex feedback loops for adjusting the power

amplifier supply voltage,” and “require additional calibration procedures and the operation is not adaptive within the power amplifier.” *Id.*, 2:12-17.

According to Hau, another limitation of such prior art devices “is their dynamic control of the DC bias current through the gate node of the power amplifiers,” which is “is ineffective in reducing current consumption of the power amplifiers over different output power level as compared to reducing the collector or drain bias supply voltage of the power amplifier.” *Id.*, 2:18-24.

Unlike prior art devices that monitor output power through current measurements, Hau instead measures output voltage V_{cc2} and “relies on the $(V_{cc2})^2/R = \text{power relationship}$ ” to control its DC to DC convertor. *Id.*, 6:34-44.

Hau describes bypassing the DC to DC buck converter when the DC to DC buck converter reaches its “maximum voltage output” due to compliance. *Id.*, 5:39-51. As Hau explained in connection with the embodiment shown in Figure 6, an exemplary DC to DC buck converter powered by a 3.4V battery has an operating voltage range of about 0.5V to 3.0V. *Id.*, 5:39-51. Hau teaches that a bypass switch should be activated when the exemplary DC to DC buck converter reaches its maximum voltage output of 3.0V. *Id.*, 5:39-51.

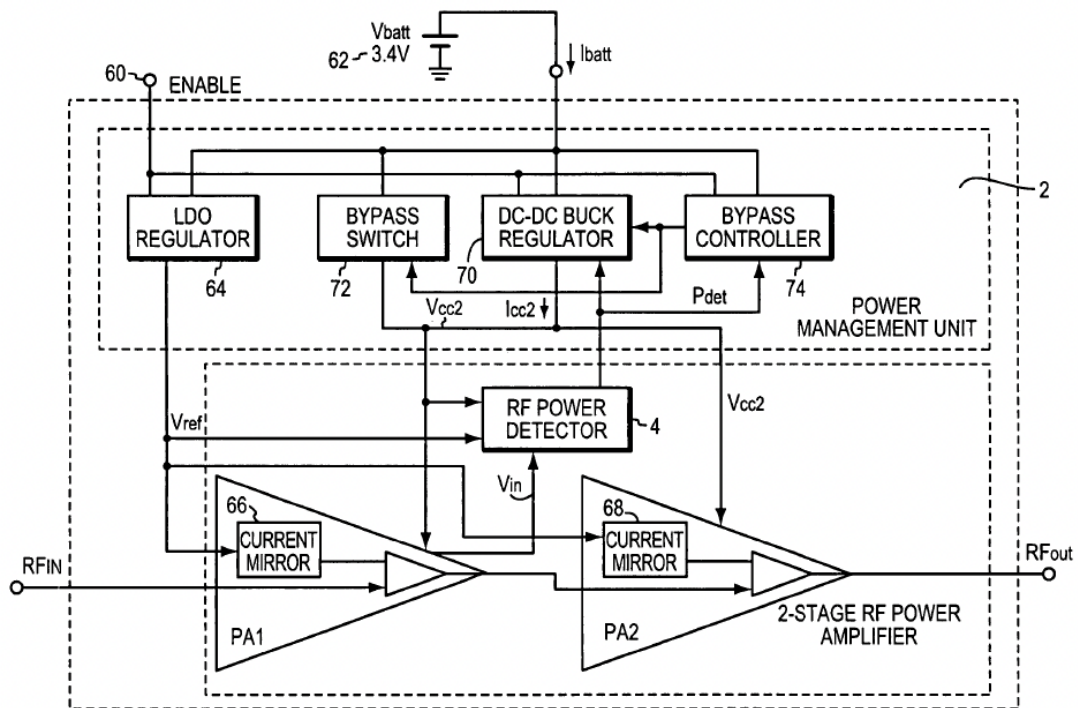


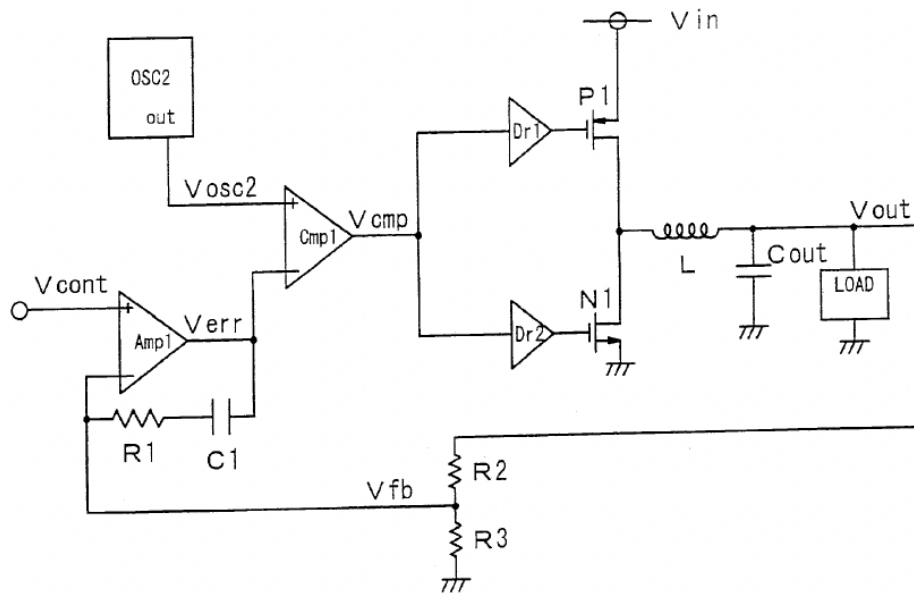
FIG. 6

Id., Fig. 6; Ex. 2001, ¶¶83-88.

B. Yoshida (Ex. 1008)

Yoshida teaches a step-down DC-DC convertor as shown below:

Fig. 29 Prior Art



Ex. 1008, Fig. 29; Ex. 2001, ¶89.

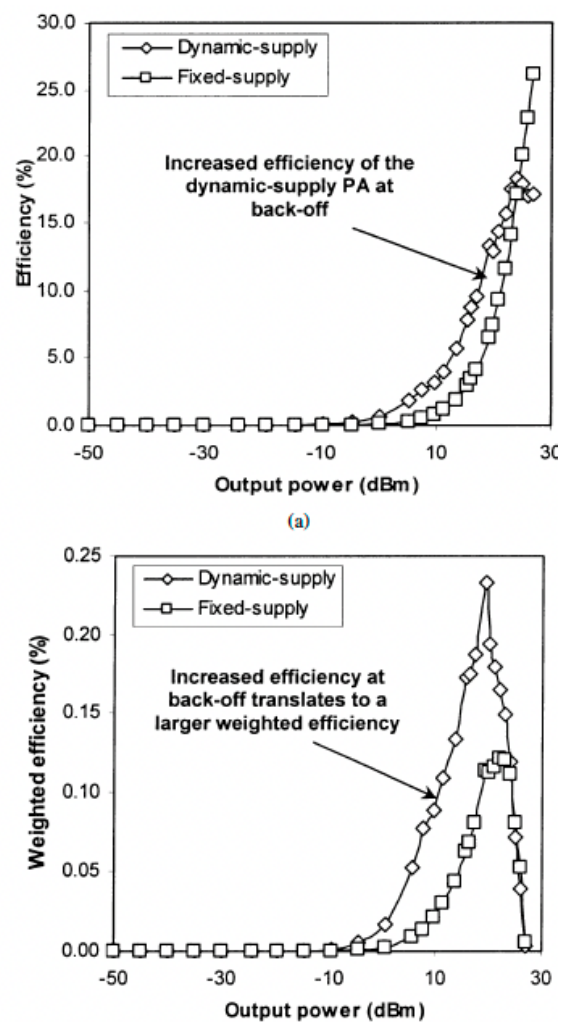
C. Sahu (Ex. 1009)

Sahu is titled “A High-Efficiency Linear RF Power Amplifier With a Power-Tracking Dynamically Adaptive Buck-Boost Supply.” Ex. 1009, 112.

1. Sahu teaches that for a CDMA system, power amplifier (“PA”) “operates mostly at 15-20 dB backoff from the peak power.” *Id.*, 113. Because PA rarely operates at peak output power, Sahu teaches that “it is extremely important to calculate the average efficiency when considering the optimum PA configuration.” *Id.* Sahu further teaches that “weighted average efficiency,” which accounts for “the probability of operating at RF output power,” can be used to

“measure of the effectiveness of the PA to convert the battery-stored energy into transmitted energy at the antenna.” *Id.*

As shown in Figure 8 of Sahu, the “weighted average efficiency” is used to evaluate the efficiency of Sahu’s dynamic PA compared to a fixed supply PA. *Id.*, 118-19.



Id., Fig. 8.

Sahu further teaches “Efficiency Enhancement Schemes Using Dynamic Supplies.” *Id.*, 114-15. Based on these efficiency enhancement techniques, Sahu teaches a “Proposed System and Hardware Implementation.” *Id.*, 115-17. Sahu’s proposed system was evaluated against fixed supply systems, and the experimental results show, among other things, that Sahu’s proposed system has increased weighted efficiency as compared to fixed supply system. *Id.*; Ex. 2001, ¶¶90-93.

D. Lejon (Ex. 1013)

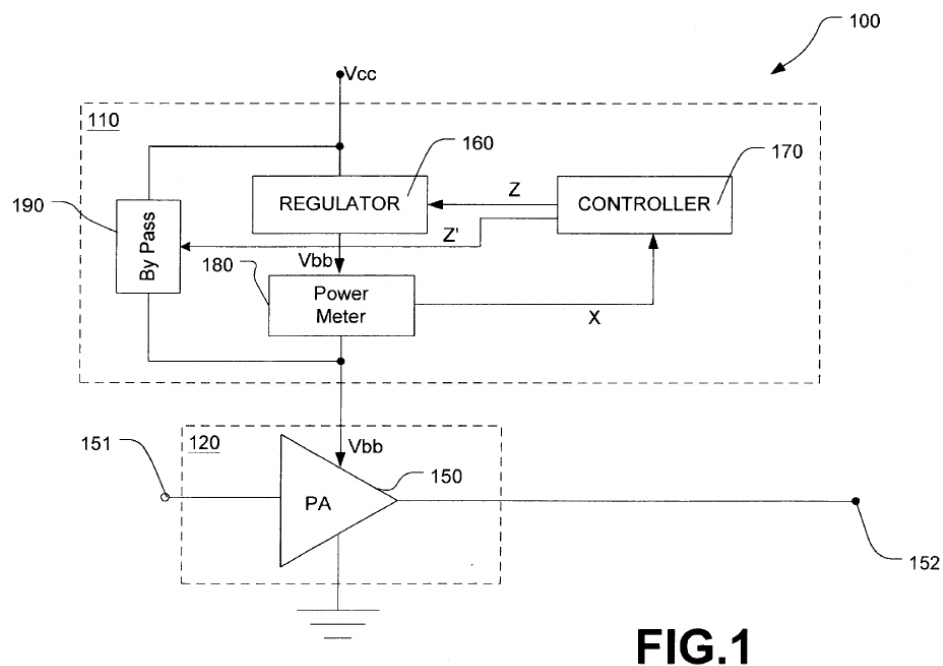
Lejon is directed toward LINC amplifier systems. Specifically, Lejon discloses a “LINC out-phasing amplifier system,” where “an input signal [single] is applied to a modulator (3) that splits the signal into two phasor fragments which are independently amplified.” Ex. 1013, Abstract. As Lejon explained, in LINC amplifiers like those described in Lejon, “an input signal [single] is provided, e.g., as an in-phase (I) and quadrature phase (Q) signal.” *Id.*, 2:16-18. As Lejon explained in connection with Figure 1, “a source (bandpass) signal [single] is typically separated into two (out-phased) constant-envelop signals by a signal component separator (SCS) or digital signal processor (DSP).” *Id.*, 10:20-26; Ex. 2001, ¶¶94-97.

E. Canyon (Ex. 1011)

Canyon is directed towards “a system for increasing overall efficiency of a power amplifier by varying operating voltage applied to a power amplifier based upon the output power level of the power amplifier.” Ex. 1011, 1:20-24.

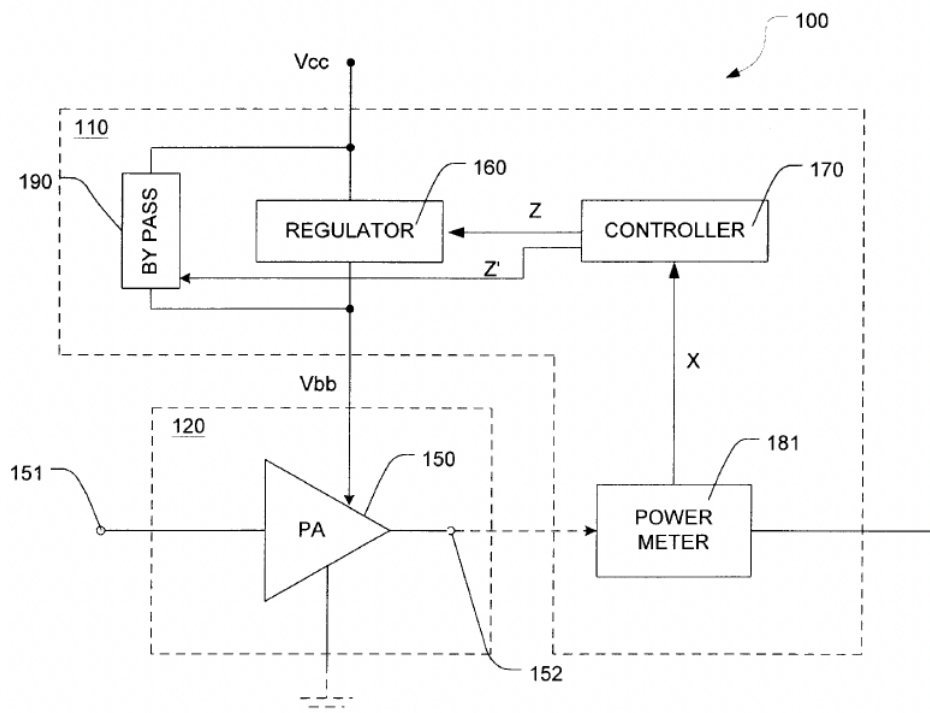
Canyon discloses a communication device that includes a power amplifier unit 120 and a power management unit 110. *Id.*, 3:1-7. Power management unit 110 includes a switching regulator 160, a controller 170, which receives a signal X from a current/power meter 180. If signal X is at a high power level, controller 170 activates bypass switch 190 to bypass regulator 160. *Id.*, 3:8-4:29.

Canyon discloses, in connection with the embodiment of Figure 1, a “current meter 180 [that] monitors (measures) the DC current flow of the operating voltage supply Vbb provided to the power amplifier unit 120.” *Id.*, 3:14-19.

**FIG.1**

Id., Fig. 1.

Canyon discloses, in connection with the embodiment of Figure 2, that “bypass switch 190 is closed when the power output indicator signal X indicates that the power amplifier unit 120 is consuming, or operating at, a high power level.” *Id.*, 4:14-23. Canyon expressly provides what constitutes “a high power level”—“where the power amplifier unit is consuming a power level greater than 22-24 dBm.” *Id.*, 4:14-29. Canyon also discloses, in connection with the embodiment of Figure 2, when the bypass switch should be open, such that the regulator 160 outputs a regulated operating voltage V_{bb} —when “the power output indicator signal X indicates that the power amplifier unit 120 is operating at a power level of less than, for example, 22 dBm.” *Id.*, 4:8-13.

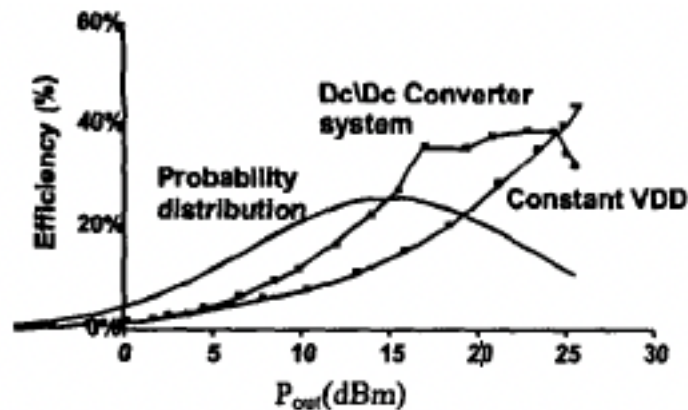
**FIG. 2**

Id., Fig. 2; Ex. 2001, ¶¶98-102.

F. Ranjan (Ex.1012)

Ranjan is an article titled “Microwave Power Amplifiers with Digitally-Controlled Power Supply Voltage for High Efficiency and High Linearity.” Ex. 1012, 493.

Ranjan presents a power amplifier architecture comprising an amplifier “with an efficient, high modulation bandwidth DC-DC converter.” *Id.*, 439. Figure 3 of Ranjan shows the measured efficiency of an amplifier with constant VDD and with dc/dc converter. It also shows a representative distribution of output power for wireless application.



Id., 494; Ex. 2001, ¶¶103-105.

VII. PETITIONER HAS NOT SHOWN THAT THE CHALLENGED CLAIMS OF THE '593 PATENT ARE UNPATENTABLE

A. Ground 1A: Hau in View of Yoshida

1. **Hau in View of Yoshida does not render obvious controlling the switching device “in response to a power efficiency of the power supply exceeding a predetermined threshold,” as required by all challenged claims**

Hau in View of Yoshida does not disclose de-activating the switching device and passing the input voltage to the output voltage node “in response to a power efficiency of the power supply exceeding a predetermined threshold,” as required by claim 1 (from which claims 2-8 depend), claim 9 (from which claims 10-14 depend), and claim 15 (from which claims 16-20 depend). Ex. 2001, ¶¶106-116.

Petitioner argues that Hau discloses this limitation based on Hau's description of a signal P_{det} used to activate a bypass switch when P_{det} exceeds a predetermined threshold. Pet., 28-33. Contrary to Petitioner's argument, Hau does

not disclose this limitation under both PO's plain and ordinary meaning and Petitioner's erroneous construction of the term "power efficiency."

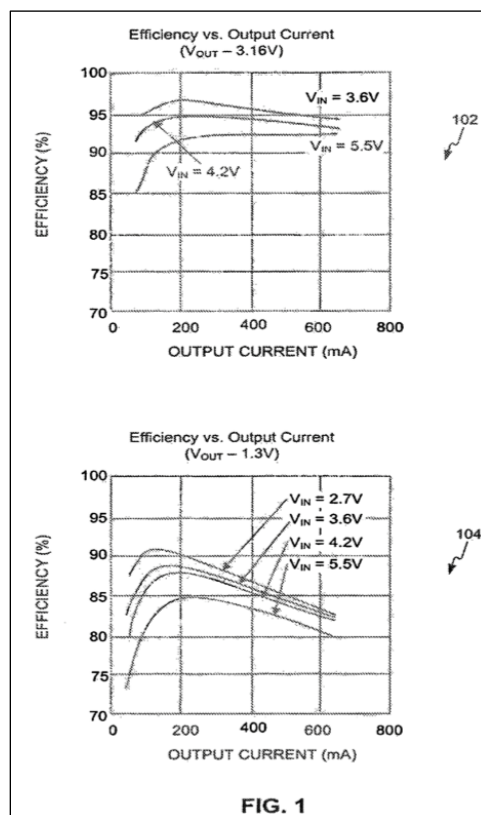
Petitioner argues that "Pdet is ... an indicator of the power efficiency of the DC-DC buck regulator because higher power indicated at Pdet indicates greater efficiency relative to the fixed input power." Pet., 29. This argument is flawed for two reasons. See Ex. 2001, ¶¶106-109.

First, Petitioner's argument conflates RF power and supply power. Hau's Pdet is generated based on an RF AC signal, which has no direct relation to the power efficiency of the DC power supply. Specifically, Hau's Pdet is generated based on Vin, which "*is an RF signal sensed from the output of the first power amplifier PA1 that is input to the power detector 4.*" Ex. 1007, 4:16-17. Based on Vin (an RF signal), "[t]he *power detector 4 outputs a DC voltage Pdet* to a DC to DC converter in the power management unit 2." *Id.*, 4:18-21. RF power (upon which Pdet is based) is not, and cannot be, an indicator of power efficiency of the power supply. They are distinct quantities (AC for RF power, DC for supply power) relating to separate circuit elements (power amplifier for RF power, power supply for supply power). Ex. 2001, ¶110.

Second, Petitioner is mistaken that Hau's input power is fixed. See Pet., 29 ("Because input power is ... from a *fixed voltage*, Pdet is also an indicator of the power efficiency ... because higher power indicated at Pdet indicates greater

efficiency *relative to the fixed input power.*”) Under both PO’s plain meaning and Petitioner’s construction, “power efficiency” is a function of input and output power, which depends on both voltage *and* current. Hau’s Pdet, however, only determines the DC-DC buck regulator’s output voltage Vcc2. Ex. 1007, 4:19-21. Thus, notwithstanding a fixed input voltage, Hau’s Pdet does not account for variation in input and output current, which respectively impacts input power and output power, and thus power efficiency as a whole. Ex. 2001, ¶111.

Indeed, even with a fixed input voltage (Vbatt), higher output voltage (Vcc2, determined based on Pdet) does not mean higher power efficiency for at least two reasons: **(1)** power amplifiers are not passive resistors and do not necessarily have a linear function of supply voltage versus power consumption; and **(2)** in the context of DC-DC convertor, the relationship between current and efficiency is non-linear. *Id.* This is confirmed by Figure 1 of the ’593 patent, which shows a non-linear relationship between output current and power efficiency, even when input voltage Vin and output voltage Vout is fixed:



'539 patent, Fig. 1. Thus, contrary to Petitioner's argument, Hau's Pdet does not correlate to, and thus is not an indicator of, power efficiency due to variations in input and output current, from which power efficiency also depends. Ex. 2001, ¶¶111.

To the extent the Board adopts (it should not) Petitioner's paradoxical construction for the broader phrase "in response to a power efficiency of the power supply exceeding a predetermined threshold," Hau nonetheless does not disclose this limitation because determining Hau's Pdet threshold does not involve power efficiency determinations.

Specifically, Hau discloses bypassing the DC-to-DC buck converter when it reaches its “maximum voltage output ... due to compliance with ... input [voltage].” Ex. 1007, 5:40-48 (“The +3.0V is the maximum voltage output of the typical DC to DC buck converter due to its compliance with the +3.4V input. At that point, a bypass switch is activated and through this switch virtually the full +3.4V is applied to the PA’s.”). A POSITA would have understood “compliance” to mean that the DC-DC convertor requires a minimum amount of input-output voltage differential to operate. Ex. 2001, ¶¶112-13. As Hau explained, its DC-DC convertor requires a 0.4V minimum voltage differential (3.4V-3.0V) to operate in “compliance.” Ex. 1007, 5:40-48. A POSITA would have recognized that Hau’s DC-DC convertor would not operate properly if the input-output voltage differential is less than 0.4V. Ex. 1007, 5:39-51; Ex. 2001, ¶113. Accordingly, Hau discloses that its exemplary DC to DC buck converter, when powered by a 3.4V battery, has an operating voltage range of about 0.5V to 3.0V, and a bypass switch should be activated when the exemplary DC to DC buck converter reaches its maximum voltage output of 3.0V. Ex. 1007, 5:39-51.

Put differently, Hau’s threshold is set based on the operating range of the power supply (i.e., “maximum voltage output”), which is determined solely by the properties and limitations of the power supply (i.e., compliance with minimum voltage differential). Ex. 2001, ¶114. Such a determination does not involve any

calculation of, and does not ensure, power efficiency. *Id.* In fact, Hau's P_{det} threshold is not even determined in view of output power, let alone power efficiency. *Id.*, ¶115-16.

For the forgoing reasons, Petitioner failed to show that Hau in view of Yoshida discloses or suggests deactivating the switching device “in response to a power efficiency of the power supply exceeding a predetermined threshold,” as required by each and every claim of the '593 patent.

2. Hau does not disclose “deactivate the switching device based on a load current at the output voltage node,” as required by claim 2

Hau does not disclose nor suggest “the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node,” as required by claim 2. Ex. 2001, ¶¶117-34.

Petitioner admits that “in Hau's preferred embodiment the bypass controller relies on a voltage measurement indicative of power to perform the bypass function,” but argues that Hau's description of the well-known “ $(I)(V)=\text{power}$ relationship” suggests “using current measurements to perform the same switching function.” Pet. 33. According to Petitioner, because “both voltage and current are related to power by known formulas ($P=IV$ or $P=V^2/R$), the two measurements are known alternatives and simple substitutes for the same purpose of measuring power.” *Id.*, 33-34.

Contrary to Petitioner's argument, Hau expressly teaches away from using current measurement to control the DC-DC buck controller. And substituting Hau's voltage measurement with current measurement would have fundamentally altered Hau's design and operation.

To begin, Hau expressly teaches away from taking current measurements and using measured current to control its bypass switch. Specifically, Hau expressly teaches that prior art devices that "monitor[] the output power of the power amplifier through the current in the voltage bias line to the power amplifier" have many undesirable effects, including "coupling loss (typically through a resistor or a current mirror) in the bias line." Ex. 1007, 2:1-11. This causes "voltage drop especially under high current operation, reducing the bias voltage available to the power amplifier and resulting in performance degradation." *Id.*, 2:1-11. Hau also states that such prior art devices undesirably require the "use of external look up tables that are part of complex feedback loops for adjusting the power amplifier supply voltage," and "require additional calibration procedures and the operation is not adaptive within the power amplifier." *Id.*, 2:12-17. Further, Hau states that another limitation of such prior art devices "is their dynamic control of the DC bias current through the gate node of the power amplifiers," which is "is ineffective in reducing current consumption of the power amplifiers over different

output power level as compared to reducing the collector or drain bias supply voltage of the power amplifier.” *Id.*, 2:18-24.

To improve upon prior art devices that monitor output power through current measurements, Hau expressly teaches away from measuring output current and “relat[ing] the output current to the output power from the $(I)(V)=\text{power}$ relationship.” *Id.*, 6:34-44. Instead, Hau teaches establishing a linear relationship between P_{det} and V_{cc2} , and “relies on the $(V_{\text{cc2}})^2/R=\text{power}$ relationship” to control the output power of its DC to DC convertor. *Id.*, 6:34-44 (“the prior art related the output current to the output power from the $(I)(V)=\text{power}$ relationship, whereas the present invention relies on the $(V_{\text{cc2}})^2/R=\text{power}$ relationship.”).

In direct contradiction to Petitioner's argument that Hau “suggests using current measurements to perform the ... switching function,” the above disclosures of Hau expressly disparages and teaches away from the use of current measurements for monitoring output power and controlling the bypass switch. Ex. 2001, ¶¶117-27.

Petitioner's argument that current and voltage “measurements are known alternatives and simple substitutes for the same purpose of measuring power” is also unavailing. In the context of Hau, substituting voltage measurement with current measurement would have fundamentally altered the design and operation of Hau's device.

While it is unclear, Petitioner's proposed current measurement appears to be taken at the power supply output node. Pet.,33 ("Hau thus at least suggests using current measurements to perform the same switching function (*based on a load current at the output voltage node*)."). In contrast, Hau's Pdet is based on the output voltage of the first stage power amplifier. To be clear, Hau nowhere discloses any relationship between the RF AC output of the power amplifier and the output current of the DC-DC converter. Ex. 2001, ¶¶124.

Even if a POSITA were to ignore Hau's teaching away from current measurements, substituting Hau's voltage measurement of the RF AC signal from the power amplifier with the output DC current of the DC-DC converter is not a simple substitution. *Id.*, ¶¶128-129. They are different quantities, dependent on different circuits and configurations thereof. *Id.*, ¶129. Moreover, because the self-adaptive nature of Hau's power supply depends on the use of voltage measurement, a POSITA would not know how, and would not have been motivated to perform such a substitution. *Id.*, ¶130.

As Hau explained, the linear relationship between V_{in} —the output voltage of the first stage power amplifier, V_{cc2} —the power supply voltage, and Pdet is what enables the current consumption optimization of Hau's device. Ex. 1007, 6:22-44. Substituting Pdet's voltage measurement for current measurement destroys this linear relationship and fundamentally changes the way Hau operates.

Ex. 2001, ¶¶131-32. Hau does not teach nor suggest setting the optimal supply voltage (V_{cc2}) as a function of any current measurement. *Id.*, ¶132. Indeed, nothing in Hau indicates how V_{cc2} could be set based on a linear relationship with current, from the output of the first stage power amplifier, the output of the power supply, or elsewhere. *Id.* And Petitioner's conclusory obviousness analysis utterly fails to explain how such a substitution could be done while maintaining Hau's linear relationships between V_{in} , P_{det} , and V_{cc2} , which is critical to the self-adaptive nature of Hau's power supply. *Id.* Accordingly, contrary to Petitioner's argument, a POSITA would not know how, nor would they be motivated to substitute Hau's voltage measurement with a current measurement. *Id.*

For the forgoing reasons, Hau does not disclose nor suggest "the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node," as required by claim 2. *Id.*, ¶134.

3. Hau does not disclose "an output current at a maximum power efficiency associated with the down-converted input voltage," as required by claims 5 and 11

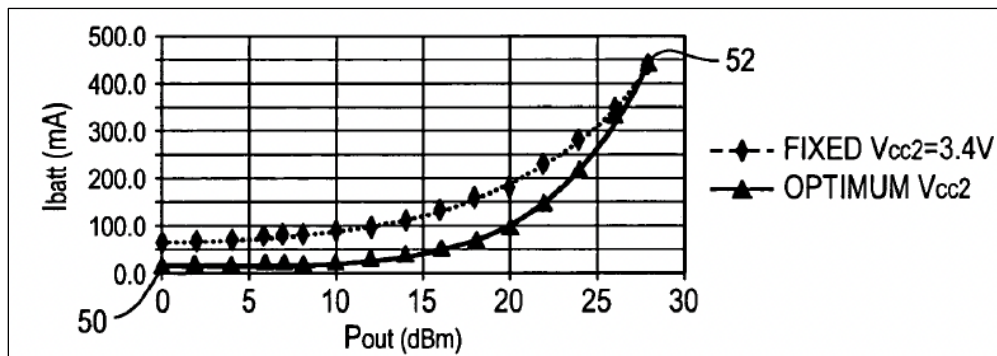
Hau does not disclose "an output current at a maximum power efficiency associated with the down-converted input voltage," as required by claims 5 and 11.

Ex. 2001, ¶¶135-44.

Petitioner argues that Hau teaches this limitation because it allegedly

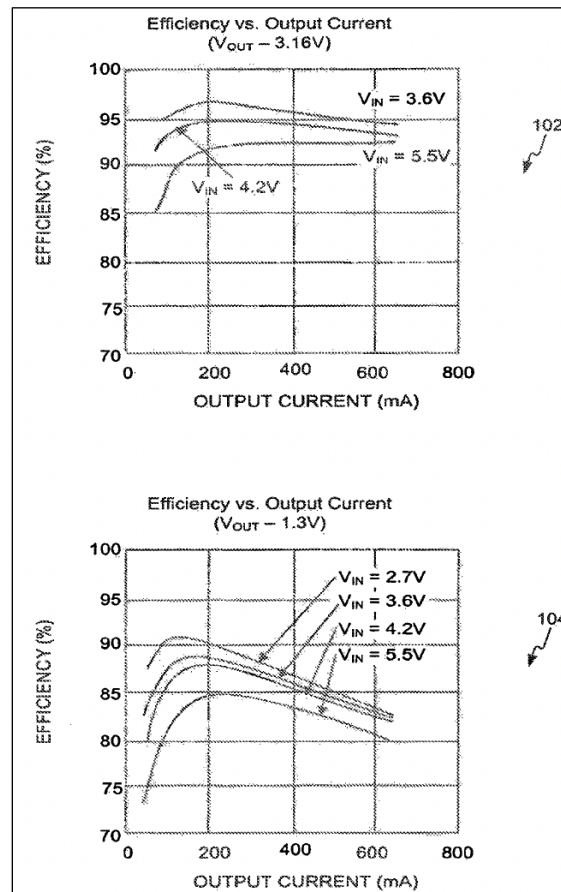
discloses circuitries for providing “the most efficient current consumption for each power output level.” Pet., 34 (quoting EX1007, 4:51-54). This argument conflates current consumption with power efficiency, which are disparate and distinct concepts.

Hau is directed towards “dynamically optimizing current consumption ... of a power amplifier.” Ex. 1007, 2:36-40. In the context of Hau, the “optimum power level” for “a particular bias supply voltage” is one that “provides the most efficient current consumption ... while satisfying the linearity requirements.” *Id.*, 4:44-54. As described in connection with Figure 5, Hau allegedly achieves “significant reduction in current consumption” over the prior art based on a comparison of “battery current consumption” at various power level. *Id.*, 4:66-5:22.



Id., Fig. 5. Thus, the object of Hau is to minimize input current at each output power level of the power amplifier. Hau does not aim to minimize the output current at the load of the DC-DC convertor.

As shown in Figure 1 of the '539 patent, however, the relationship between current and power efficiency is non-linear:



Ex. 1001, Fig. 1. Additionally, the relationship between input current and output current is also non-linear and non-monotonic. This is because output current is dependent on output voltage and power supply efficiency.

Accordingly, minimizing input current does not mean that the output current would be optimized to for power efficiency. Petitioner's conclusory argument that Hau "provides the most *efficient current consumption* for each power output

level” (Pet., 34 (quoting EX1007, 4:51-54 (emphasis added))) is not a sufficient explanation as to how Hau’s teaching of minimizing input current discloses “output current at a maximum power efficiency associated with the down-converted input voltage,” as required by claims 5 and 11.

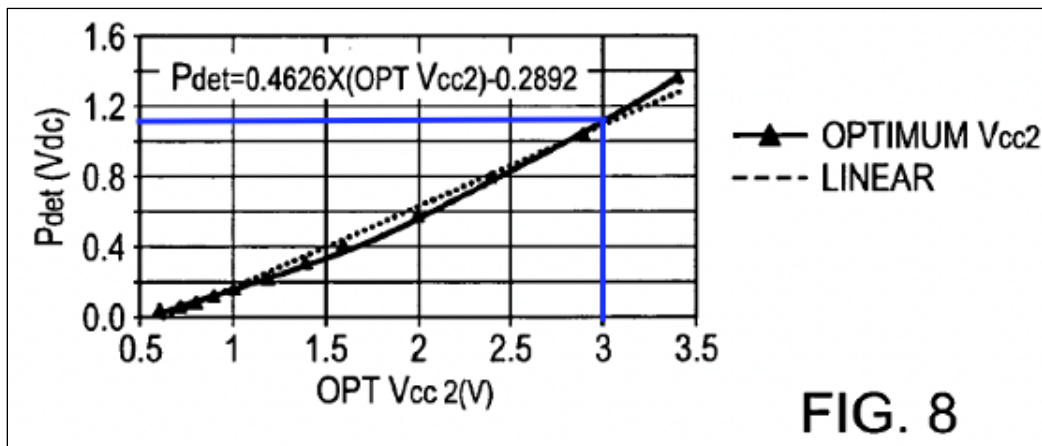
4. Hau does not disclose “deactivat[e/ing] the switching device and pass[ing] the input voltage to the output voltage node [based on a/comprises] compar[ison of/ing] the down-converted [input] voltage to a threshold voltage,” as required by claims 6-8 and 12-14.

Hau does not disclose “wherein the aperture generator and control module is configured to deactivate the switching device and pass the input voltage to the output voltage node based on a comparison of the down-converted input voltage to a threshold voltage,” as required by claim 6 (from which claims 7-8 depend), or “wherein the de-activating comprises deactivating the switching device and passing the input voltage to the output voltage node comprises comparing the down-converted voltage to a threshold voltage,” as required by claim 12 (from which claims 13-14 depend). Ex. 2001, ¶¶145-53.

Petitioner argues that Hau teaches this limitation because “Pdet is an indicator of the down-converted input voltage Vcc2” and Hau discloses “comparing Pdet to a threshold voltage.” Pet., 35. This argument flies in the face of the plain language of the claims.

Consistent with the claim language, which expressly requires a comparing “the down-converted [input] voltage to a threshold voltage,” the specification discloses that the Bypass Switch Control module 402 determines whether to switch to bypass mode by comparing Threshold Voltage 414 to “the *value of the power supply output voltage* to determine whether power supply 400 should switch to bypass mode.” Ex. 1001, 7:50-8:3; Ex. 2001, ¶147.

In contrast, Hau discloses a “bypass controller 74 that activates the bypass switch 72 *when the Pdet reaches a given DC voltage set point* that corresponds to a Vcc2 from the DC to DC converter of *about +3.0V.*” *Id.*, 5:48-51. Hau discloses, in connection with Figure 8 (annotated and reproduced below), that “the relationship between the Pdet and the optimum Vcc2 output from the DC to DC converter ... is *approximately*, $P_{det}=0.4626x(OPT\ V_{cc2})-0.2892$.” *Id.*, 6:15-21.



Id., Fig. 8 (annotated); Ex. 2001, ¶148-49. As Hau explained, “bypass controller 74 ... activates the bypass switch 72 *when the Pdet reaches a given DC voltage set*

point that corresponds to a V_{cc2} from the DC to DC converter of *about* +3.0V.”

Ex. 1007, 5:48-51. As shown in Figure 8, when V_{cc2} is 3.0V, P_{det} is approximately 1.1V (blue line). Thus, P_{det} does not equal V_{cc2} (i.e., the down-converted input voltage by Hau's DC to DC convertor). And Hau's bypass switch 72 is activated based on a comparison of P_{det} (not V_{cc2}) to the DC voltage set point. Ex. 2001, ¶150.

Notwithstanding the approximate linear relationship between P_{det} and V_{cc2} , Hau plainly does not disclose “deactivate the switching device and pass the input voltage to the output voltage node based on a comparison of the down-converted input voltage to a threshold voltage,” as required by claims. Indeed, if Petitioner is correct (it is not), and merely comparing a threshold to a quantity with a linear relationship with the down converted voltage is enough to meet these claims, then the scope of these claims reach far beyond what is described in the specification and the clear and specific language of the claims. Ex. 2001, ¶¶151-52 (explaining that these claims are met by comparing V_{in} , the RF signal from the amplifier, to a threshold under Petitioner's logic).

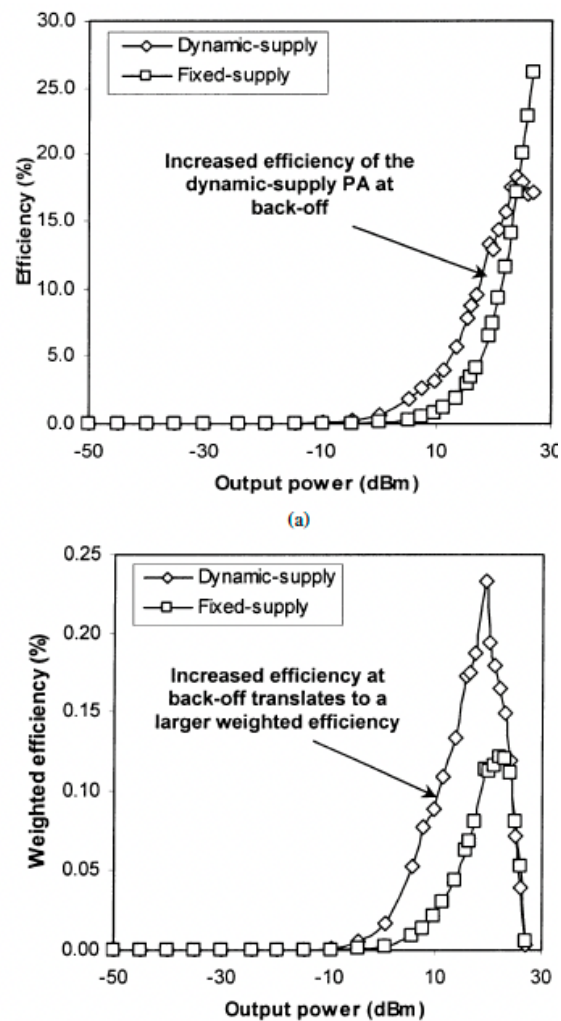
B. Ground 1B: Hau in View of Yoshida and Further in View of Sahu

1. No motivation to combine Sahu with Hau and Yoshida

The Petition's proffered reasons to combine Sahu with Hau and Yoshida are

deficient. According to Petitioner, “a POSITA would have considered Sahu’s teaching that the performance of the power supply should be optimized based on the most probable power output levels at which the device is likely to be operated ... as instructive for optimizing the performance of a power supply taught by Hau (as modified by Yoshida).” Pet., 43-45. Not so. Ex. 2001, ¶¶154-68.

Contrary to Petitioner’s argument, Sahu does not teach any optimization technique based on the system’s most probable power output levels other than that already described in Hau and Yoshida. Specifically, Sahu teaches that for a CDMA system, power amplifier (PA) “operates mostly at 15-20 dB backoff from the peak power.” Ex. 1009, 113. Because PA rarely operates at peak output power, Sahu discloses that “it is extremely important to calculate the average efficiency when considering the optimum PA configuration.” *Id.*, 113. Sahu further teaches that “weighted average efficiency,” which accounts for “the probability of operating at RF output power,” can be used to “measure of the effectiveness of the PA to convert the battery-stored energy into transmitted energy at the antenna.” *Id.*, 113. However, as shown in Figure 8 of Sahu, the “weighted average efficiency” is only used to evaluate the efficiency of Sahu’s dynamic PA compared to a fixed supply PA. *Id.*, 118-19.



Id., Fig. 8.

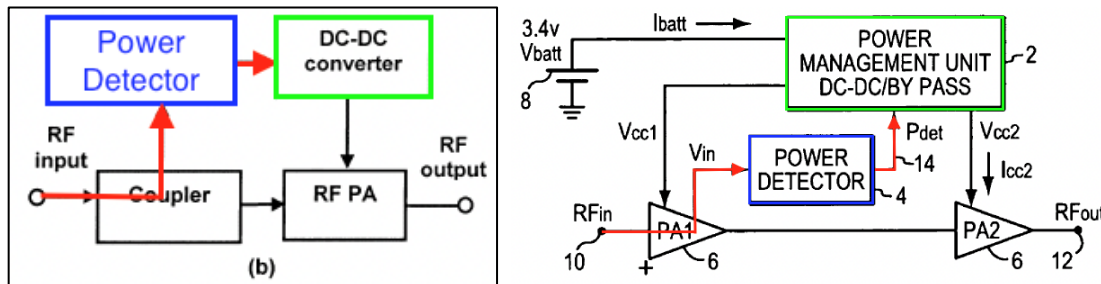
Importantly, Sahu does not teach how to improve a system's weighted efficiency other than using a dynamic-supply system, which, according to Sahu, is more efficient at backoff power and thus has improved weighted efficiency compare to fixed-supply system. *Id.*, 113, 118-19. Sahu offers no other teaching to improve performance based on specific transmission standard. Ex. 2001, ¶¶154-59. That is, Sahu's teaching for improving weighted efficiency is the same for all

transmission standards where PA most likely operates in backoff power, which is to use a dynamic-supply system like that described in Sahu. *Id.*, ¶160. Nowhere does Sahu teach adapting the design and control of its system based on a specific transmission standard or modulation scheme. *Id.* Indeed, a POSITA would have understood that Sahu's system would have the same configurations, regardless of the standard or modulation scheme. *Id.*

To the extent a POSITA would have been motivated by Sahu (they wouldn't be) to calculate the "weighted average efficiency" of the Hau/Yoshida device, such a skilled person nonetheless would not have been motivated to apply Sahu's teachings of controlling a power supply for increased PA efficiency in the backoff power region for two reasons: **(1)** The Hau/Yoshida device already controls its power supply in the manner Sahu teaches would improve efficiency when operating in a CDMA system; and **(2)** Hau teaches away from the specific implementation of Sahu's device. *Id.*, ¶161.

First, a POSITA would have recognized, and Petitioner acknowledges, that the Hau/Yoshida device and Sahu's device are both dynamic supply systems that seek to improve efficiency in the "backoff" region. Ex.1007, 1:33-61, 5:17-20; Ex.1009, 113; Pet.,43-44. Thus, the Hau/Yoshida device already controls its power supply in the manner Sahu teaches would improve efficiency when operating in a

CDMA system—the use of a dynamic power supply. Indeed, both Sahu and Hau similarly controls the power supply output voltage based on the RF input signal:



Compare Ex.1009, Fig. 3(b) (annotated) with Ex.1007, Fig. 1 (annotated);

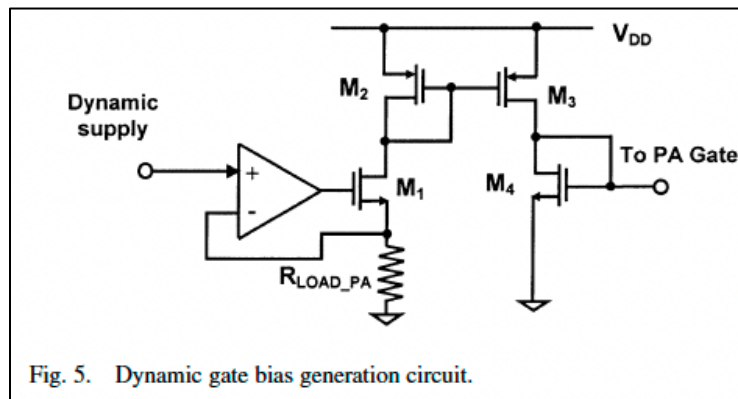
Ex.1009, 115 (proposed implementation same as Fig. 3(a) except “power detector is used for the control signal generation circuit”); Ex. 2001, ¶162.

To the extent a POSITA was motivated (he wouldn't be) to calculate the weighted efficiency of the Hau/Yoshida device as taught by Sahu, and found the weighted efficiency of the Hau/Yoshida device to be unsatisfactory, Sahu offers no suggestion for improvement other than the use of a dynamic power supply for improved efficiency in the backoff power region, a technique that the Hau/Yoshida device already employs. *Id.*, ¶163.

Second, to the extent a POSITA would have found specific aspects of Sahu's implementation of a dynamic supply system to be desirable, such a skilled person nonetheless would not have been motivated to apply those teachings to the

Hau/Yoshida device, because Hau expressly teaches away from aspects of Sahu's implementation. *Id.*, ¶164.

According to Hau, prior art systems with “dynamic control of the DC bias current *through the gate node* of the power amplifiers ... is ineffective in reducing current consumption of the power amplifiers over different output power level as compared to reducing the collector or drain bias supply voltage of the power amplifier.” Ex. 1007, 2:18-24. This is exactly what Sahu's power amplifier uses—a dynamic gate bias current that Hau expressly teaches away from. Ex. 1009, 117 (describing a “Dynamic Gate Bias Generation Circuit”).



Ex. 1009, Fig. 5; *Id.*, ¶165.

Accordingly, a POSITA would have understood Hau to teach away from the power amplifier implementation described in Sahu. Neither Hau nor Sahu disclose or suggest, and Petitioner does not explain, how the Hau/Yoshida device can be modified to further improve weighted efficiency for CDMA or other transmission standard. *Id.*, ¶¶166-67.

For the forgoing reasons, Petitioner failed to meet its burden in establishing motivation to combine Sahu with Hau and Yoshida in a manner that renders the claimed invention of the '539 patent obvious. Thus, the Petition does not demonstrate unpatentability of the challenged claims in Ground 1B.

2. Hau in view of Yoshida and Sahu does not render obvious controlling the switching device “based on a probable output power point of operation for a selected modulation scheme based on one or more power efficiency characteristics of an electronic device coupled to the power supply,” as required by claims 3-4, 10, and 19

Hau in view of Yoshida and Sahu does not render obvious controlling the claimed switching device “based on a probable output power point of operation for a selected modulation scheme based on one or more power efficiency characteristics of an electronic device coupled to the power supply,” as required by claims 3 (from which claim 4 depends), 10, and 19. Ex. 2001, ¶¶169-72.

Petitioner argues that “It would ... have been obvious to a POSITA to apply Sahu’s teachings of optimizing efficiency based on most probable power levels for a given modulation scheme to the system of Hau [in view of Yoshida].” Pet., 47. But as discussed in Section VII.B.1, a POSITA would not have been motivated to apply Sahu’s efficiency optimization techniques to the Hau/Yoshida device. Ex. 2001, ¶¶170-71. Moreover, Sahu’s technique for improving weighted efficiency is the same for all modulation schemes that operate more often in back off power—

the use of a dynamic power supply similar to that already employed by the Hau/Yoshida device—and thus does not teach controlling the power supply “based on a probable output power point of operation for a selected modulation scheme,” as required by the claims. *Id.*, ¶171.

Specifically, Sahu teaches that a dynamic-supply system is more efficient when the PA is operating in the backoff power region, which is more likely than when the PA is operating at maximum power (at least for the CDMA standard). Ex. 1009, 113. To demonstrate that its proposed system is, indeed, more efficient in the backoff power region, Sahu calculated the weighted average efficiency of its proposed dynamic-supply system and showed that its proposed system is more efficient than a fixed-supply system at backoff power. Beyond the use a dynamic power supply, Sahu does not teach other techniques to improve the weighted average efficiency of a PA system. Critically, Sahu also does not teach how its proposed system can be optimized for a different modulation scheme. *Id.*, ¶¶171-72.

Because the Hau/Yoshida device is already a dynamic supply device, Sahu has nothing else to offer in terms of weighted efficiency improvements. This is especially true given Hau's teaches away from Sahu's specific implementation of a dynamic power supply. *Id.*, ¶172.

Accordingly, a POSITA would not have been motivated by Sahu to modify the Hau/Yoshida device to such that the power supply is controlled “based on a probable output power point of operation for a selected modulation scheme,” as required by the claims.

3. Hau in view of Yoshida and Sahu does not render obvious “programming the threshold voltage based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof,” as required by claims 8 and 13

Hau in view of Yoshida and Sahu does not render obvious “programming the threshold voltage based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof,” as required by claims 8 and 13. Ex. 2001, ¶¶173-76.

Petitioner argues that “[i]t would have been obvious to a POSITA to set Hau’s predetermined threshold to correspond to the point at which a fixed power supply (e.g., the bypass pathway of Hau) becomes more efficient than the down-converted power supply, as taught by Sahu.” Pet., 50 (citation omitted).

For reasons discussed in Section VII.B.1, a POSITA would not have had reasons to combine Sahu with the Hau/Yoshida device. Moreover, a POSITA would have recognized that Figure 8(a) of Sahu relates to specific devices that were tested in Sahu. Ex. 2001, ¶¶174-75. A POSITA also would have recognized

that Sahu's implementation of a "dynamic-supply" is different from the Hau/Yoshida device and includes undesirable components according to Hau. *Id.*

Moreover, a POSITA would not have equated Sahu's fixed-supply system with Hau's bypass pathway without the benefit of hindsight. Sahu compared the weighted efficiency of its proposed dynamic-supply system with that of a fixed-supply system to demonstrate the merit of its own system, which does not include a bypass switch like that described in Hau. *Id.* Hau teaches a bypass switch that is closed based on hardware limitations of the DC-DC convertor, not on power efficiency considerations such as communication waveform efficiency. *See supra* Section VII.A. Petitioner used the disclosures in the '593 patent as a road map for reasons to combine Sahu and Hau/Yoshida. Ex. 2001, ¶¶174-75. Without the benefit of hindsight and the '593 patent's disclosure, a POSITA would not have equated the two unrelated systems in Figure 8(a) of Sahu to the system described in Hau. *Id.*

Furthermore, Petitioner argument that Figure 8(a) of Sahu somehow discloses the claimed "communication waveform efficiency" is unavailing. Figure 8(a) of Sahu plots the drain efficiency vs. output power for a dynamic and fixed VDD. It would not change, and does not depend on a particular communication waveform used to obtain the result. Thus, contrary to Petitioner's argument, Figure

8(a) of Sahu does not disclose “communication waveform efficiency,” as claimed.

Ex. 2001, ¶176.

C. Ground 1C: Hau in view of Yoshida and Lejon

1. Hau in view of Yoshida and Lejon does not disclose a MISO amplifier, as required by claim 16

Hau in view of Yoshida and Lejon does not disclose or suggest a “wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier,” as required by claim 16. Ex. 2001, ¶¶177-80

Petitioner argues that Figure 9 and 10 of Lejon discloses the claimed MISO amplifier. Pet., 58. This argument is undermined by Lejon's own disclosures. Specifically, Lejon discloses a “LINC out-phasing amplifier system,” where “*an input signal [single]* is applied to a modulator (3) that *splits the signal into two phasor fragments* which are independently amplified.” Ex. 1013, Abstract. As Lejon explained, in LINC amplifiers like those described in Lejon, “*an input signal [single] is provided*, e.g., as an in-phase (I) and quadrature phase (Q) signal.” *Id.*, 2:16-17. As Lejon explained in connection with Figure 1, “*a source (bandpass) signal [single]* is typically separated into two (out-phased) constant-envelope signals by a signal component separator (SCS) or digital signal processor (DSP).” *Id.*, 10:20-22; Ex. 2001, ¶¶178-79.

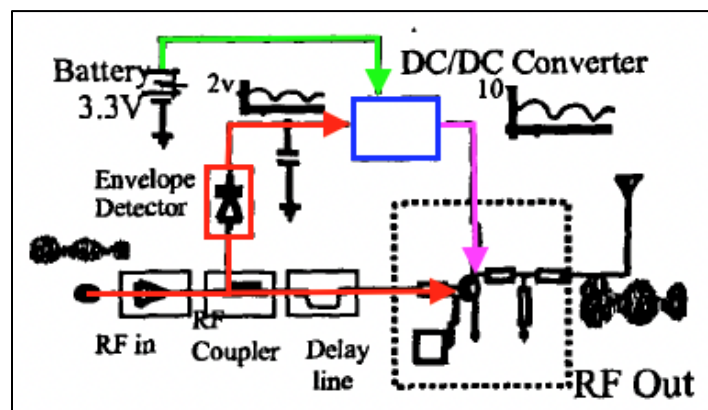
Thus, LINC amplifiers like those described in Lejon receives a single input (which are split into two phasor components) and provides a single output. Such LINC amplifiers do not constitute MISO amplifier as required by claim 16. Ex. 2001, ¶180.

D. Ground 2A: Canyon in View of Ranjan

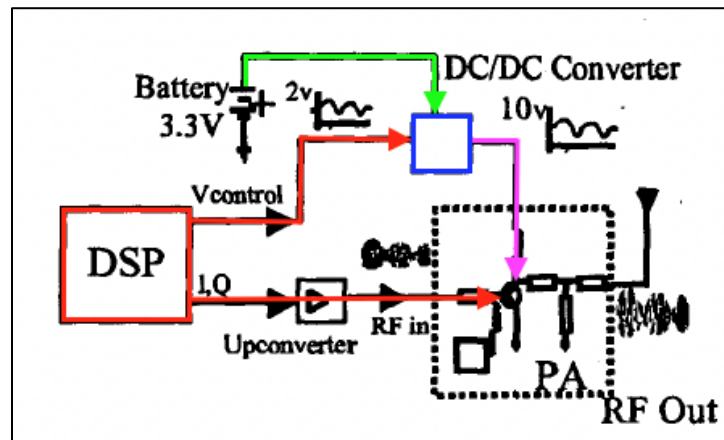
1. No motivation to combine Canyon with Ranjan

The Petition's reasons to combine Canyon with Ranjan are misplaced for several reasons. Ex. 2001, ¶¶181-96.

First, Ranjan's power amplifier and DC-DC convertor design is fundamentally different from Canyon's. Ranjan discloses an amplifier architecture that controls the power supply output voltage based on the RF input signal. Ex. 1012, 493. Figure 1a of Ranjan discloses a "previously reported system based on an envelope detector to control the power supply voltage:"

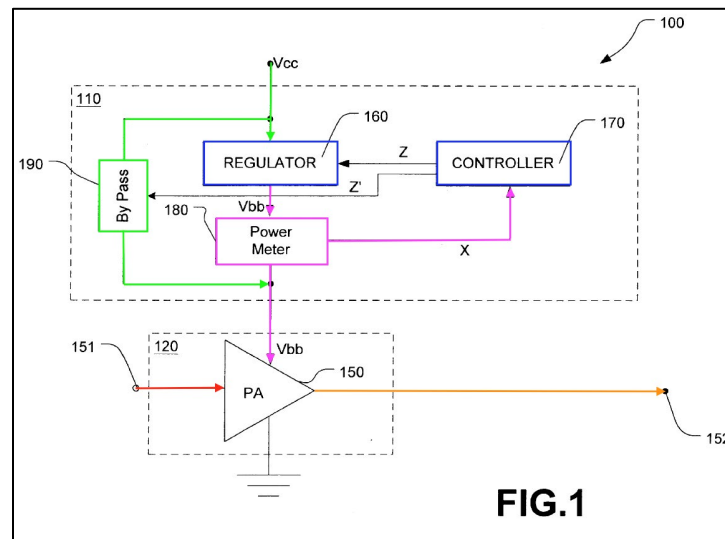


Id., Fig. 1a (annotated). Ex. 2001, ¶¶182-83. As shown above, the DC/DC Converter (blue) controls the power supply output voltage (pink arrow) based on an envelope detector signal derived from RF input signal (red arrow). Similarly, Figure 1b shows a configuration involving a DSP:

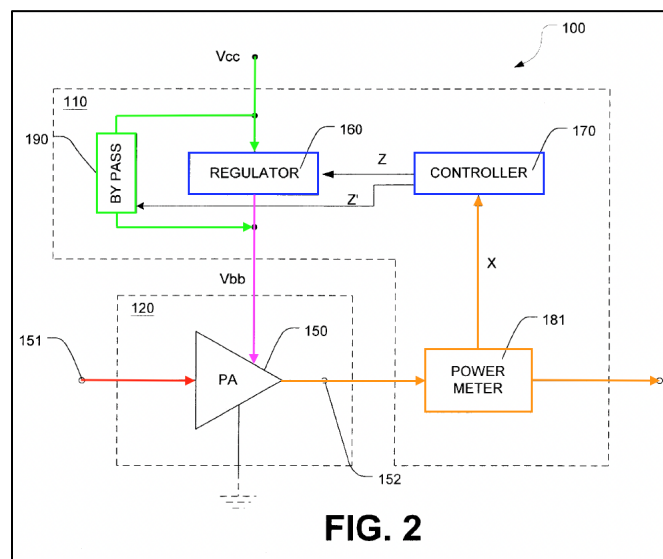


Ex. 1012, Fig. 1b (annotated); Ex. 2001, ¶183. Neither of the power amplifier architecture disclosed in connection with Figs. 1a and 1b of Ranjan includes a bypass switch.

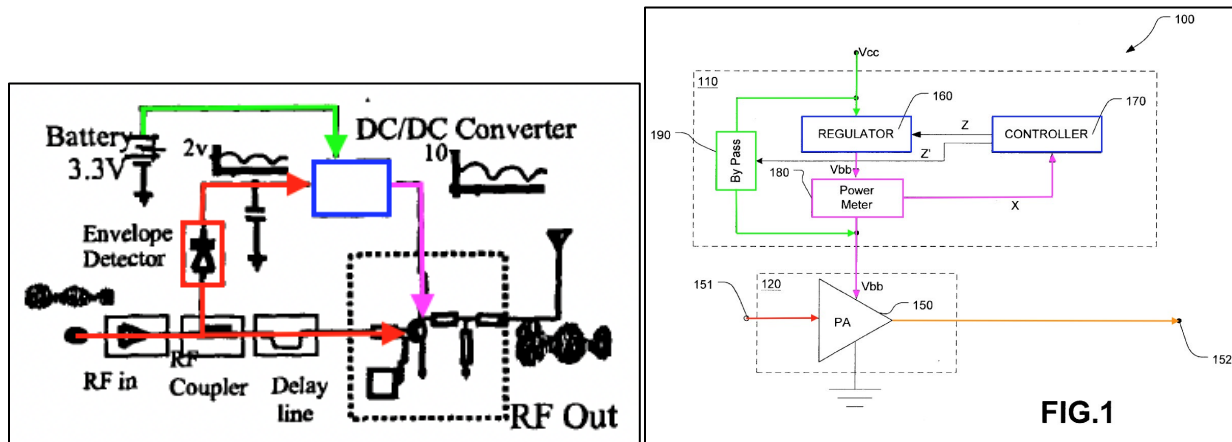
In contrast, Canyon discloses controlling the power supply output voltage based on power supply current output or amplifier power output. As shown in Figure 1, Canyon's controller controls its regulator (blue) and bypass switch (green) based on power supply output current (pink arrow). Ex. 1011, 3:1-42.



Id., Fig. 1 (annotated); Ex. 2001, ¶184. And as shown in Figure 2, Canyon discloses an alternative embodiment where the controller controls the regulator (blue) and bypass switch (green) based on power amplifier output power (orange arrow). Ex. 1011, 3:43-4:29.



Id., Fig. 2 (annotated); Ex. 2001, ¶184. Unlike Ranjan, Canyon nowhere discloses a control scheme that involves taking measurements at the RF input signal (red).



Compare Ex. 1012, Fig. 1a with Ex. 1011, Fig. 1; Ex. 2001, ¶184.

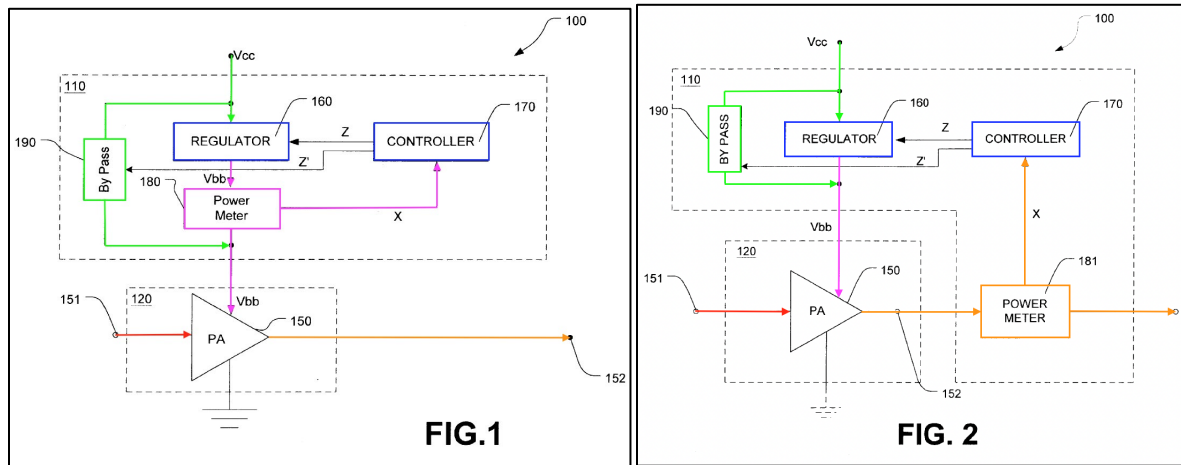
Accordingly, a POSITA would not have expected Canyon's system to perform similarly to Ranjan's system because Ranjan and Canyon employ fundamentally distinct control schemes for controlling their respective power supply output voltage. Ex. 2001, ¶185. Indeed, a POSITA would not have found the measured efficiency of Ranjan's system shown in Figure 3 to be indicative of the efficiency of Canyon's system. *Id.* Similar to as discussed in Section VII.B.3, Petitioner again fell prey to hindsight bias when equating Canyon's system to two separate circuits in Ranjan, neither of which operates in manner similar to Canyon's system. *Id.*

Second, a POSITA would not have looked to Ranjan to determine the threshold for opening and closing Canyon's bypass switch because Canyon's disclosure in this regard is complete. Ex. 2001, ¶186. Specifically, Canyon expressly discloses when to open and close its bypass switch. Canyon discloses, in connection with the embodiment of Figure 2, that "bypass switch 190 is closed when the power output indicator signal X indicates that the power amplifier unit 120 is consuming, or operating at, a high power level." Ex. 1011, 4:14-23. Canyon expressly provides what constitutes "a high power level"—"where the power amplifier unit is consuming a power level greater than 22-24 dBm." *Id.*, 4:14-29. Canyon also discloses, in connection with the embodiment of Figure 2, when the bypass switch should be open, such that the regulator 160 outputs a regulated operating voltage Vbb—when "the power output indicator signal X indicates that the power amplifier unit 120 is operating at a power level of less than, for example, 22 dBm." *Id.*, 4:8-13. Thus, Canyon's description as to when to open and close the bypass switch of the Figure 2 embodiment is complete. A POSITA would have had no reason to consult a separate literature (like Ranjan), which describes a fundamentally disparate power supply control scheme (that does not even involve a bypass switch), for purposes of deviating from Canyon's explicit and specific teachings of closing the bypass switch at high power level (i.e., 22-24 dBm). Ex. 2001, ¶¶186-87.

Moreover, even if a POSITA were to look to Ranjan for guidance on how to determine the threshold for opening and closing the bypass switch for other embodiments of Canyon (e.g., the embodiment of Figure 1), such a skilled person would have found nothing in Ranjan to aid in that determination. *Id.*, ¶188.

Cayon describes when to open and close its bypass switch in connection with the embodiment of Figure 2. *See* Ex. 1011, 4:14-46. The embodiment of Figure 2 includes a power meter 180 that is connected to the output 152 of power amplifier 150 to measure the power output of amplifier 150. *Id.*, 3:50-57 (“The output 152 of power amplifier 150 is connected to a power meter 180.”). As discussed above, Canyon discloses, in connection with this Figure 2 embodiment, that the bypass switch is open when power meter measures an output power level of less than 22 dBm, and close when power meter measures an output power level of greater than 22-24 dBm. *Id.*, 4:8-29; Ex. 2001, ¶189.

Unlike the embodiment of Figure 2, which includes a power meter 180 that measures the output power of the amplifier, the embodiment of Figure 1 instead includes a “current meter 180 [that] monitors (measures) the DC current flow of the operating voltage supply Vbb provided to the power amplifier unit 120.” *Id.*, 3:14-19.



Compare *id.*, Fig. 1 with *id.*, Fig. 2; Ex. 2001, ¶190.

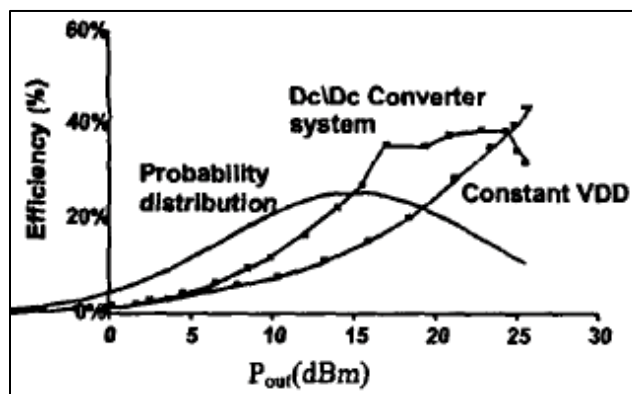
Petitioner utterly failed to provide any analysis as to whether Canyon's description (in connection with the Figure 2 embodiment) of operating its bypass switch based on measured output power level of the amplifier is applicable to the Figure 1 embodiment, which does not measure output power of the amplifier. *Id.*, ¶191. Indeed, POSITA would not have known how to control the bypass switch of Figure 1 in the manner described for the embodiment of Figure 2. *Id.* A POSITA would have recognized that the output power level of the power amplifier unit 120 is a function of: (1) the power level of the input RF signal 151 (red arrow above); and (2) the gain of the power amplifier at a given bias voltage Vbb. *Id.*, ¶192. Canyon does not disclose how to determine output power level of the power amplifier (required by the Figure 2 embodiment to determine when to close the

bypass switch) based solely on power supply output current I_{bb} (the only measurement for controlling the bypass switch in the Figure 1 embodiment). *Id.*

Although Canyon suggests that “it is possible to determine the power output of the power amplifier unit 120” based on the power supply output current I_{bb} , it does not specify how. Ex. 1011, 3:20-30. With no further guidance from Canyon, a POSITA would not have known how to determine output power of the power amplifier (for operating the bypass switch as described for the Figure 2 embodiment) solely based on output current of the power supply (as described for the Figure 1 embodiment). Ex. 2001, ¶193-94. And a POSTIA would have found nothing in Ranjan that fills that gap. *Id.*

Figure 3 of Ranjan shows the “[m]easured efficiency of amplifier with constant VDD and with dc/dc converter, at different *output power levels*.”

Ex.1012, 494.



Id., Fig. 3. Critically, Ranjan nowhere discloses any relationship between power supply output current and power amplifier output power. Ex.2001, ¶195. Thus, a POSITA seeking to determine a threshold for closing the bypass switch based on measured output current of the power supply (as described in the Figure 1 embodiment) would have found no guidance from Canyon's Figure 2 embodiment (which requires measured amplifier output power) nor Ranjan (same). *Id.*

Accordingly, a POSITA would not have been motivated to set the threshold to operate Canyon's bypass switch based on the teachings of Ranjan. *Id.*, ¶196. With respect to the Figure 2 embodiment, Canyon's teaching on how to set this bypass threshold is complete, and there is no need to consult Ranjan, which relates to a fundamentally different power supply control scheme that does not include a bypass switch. *Id.* With respect to the Figure 1 embodiment, Canyon's teaching is deficient as to how the bypass threshold of the Figure 2 embodiment can be applied, but Ranjan does not provide any guidance to fill that gap. *Id.*

Thus, contrary to Petitioner's misguided argument, a POSITA would not have been motivated by Ranjan's Figure 3 to plot the efficiency of Canyon's

device to identify a power level at which Canyon's bypass pathway becomes more efficient than the dynamic voltage output by a DC-DC converter.¹

2. Canyon alone or in view of Ranjan does not disclose controlling the switching device “in response to a power efficiency of the power supply exceeding a predetermined threshold,” as required by all challenged claims

Neither Canyon alone nor in view of Ranjan discloses de-activating the switching device and passing the input voltage to the output voltage node “in response to a power efficiency of the power supply exceeding a predetermined threshold,” as required by claim 1 (from which claims 2-8 depend), claim 9 (from which claims 10-14 depend), and claim 15 (from which claims 16-20 depend). Ex. 2001, ¶¶197-204.

Petitioner rely on Canyon's Figure 1 embodiment for other claim limitations. Pet., 68-72. For this claim limitation, however, Petitioner relies on Canyon's descriptions relating to the Figure 2 embodiment. *Id.*, 72-75. Petitioner provides no analysis as to whether Canyon's description (in connection with the Figure 2

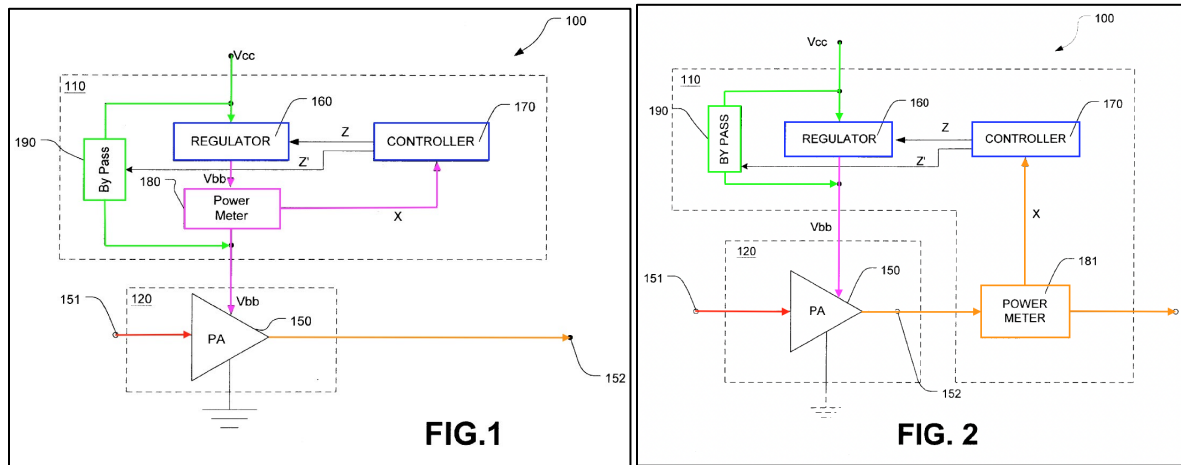
¹ Petitioner argues, in the alternative, that a POSITA would have been motivated to modify Ranjan's device to include Canyon's bypass switch. Pet., 68. But the Petition nowhere relies on such an embodiment to render any challenged claim obvious.

embodiment) of operating its bypass switch based on measured output power level of the amplifier is applicable to the Figure 1 embodiment.

As discussed in Section VII.D.1 above, Canyon does not disclose how to determine the output power level of the amplifier (as required for controlling the bypass switch in the Figure 2 embodiment) based solely on the output current of the power supply (as described for the Figure 1 embodiment). Ex. 2001, ¶199.

As discussed in Section VII.D.1 above, Canyon describes when to open and close its bypass switch in connection with the embodiment of Figure 2. *See* Canyon, 4:14-46. The embodiment of Figure 2 includes a power meter 180 that is connected to the output 152 of power amplifier 150 to measure the power output of amplifier 150. Ex. 1011, 3:50-57. Canyon discloses, in connection with this Figure 2 embodiment, that the bypass switch is open when power meter measures an output power level of less than 22 dBm, and close when power meter measures an output power level of greater than 22-24 dBm. *Id.*, 4:8-29; Ex. 2001, ¶199.

Unlike the embodiment of Figure 2, which includes a power meter 180 that measures the output power of the amplifier, the embodiment of Figure 1 instead includes a “current meter 180 [that] monitors (measures) the DC current flow of the operating voltage supply Vbb provided to the power amplifier unit 120.” *Id.*, 3:14-19.



Compare *Id.*, Fig. 1 with *Id.*, Fig. 2; Ex. 2001, ¶200.

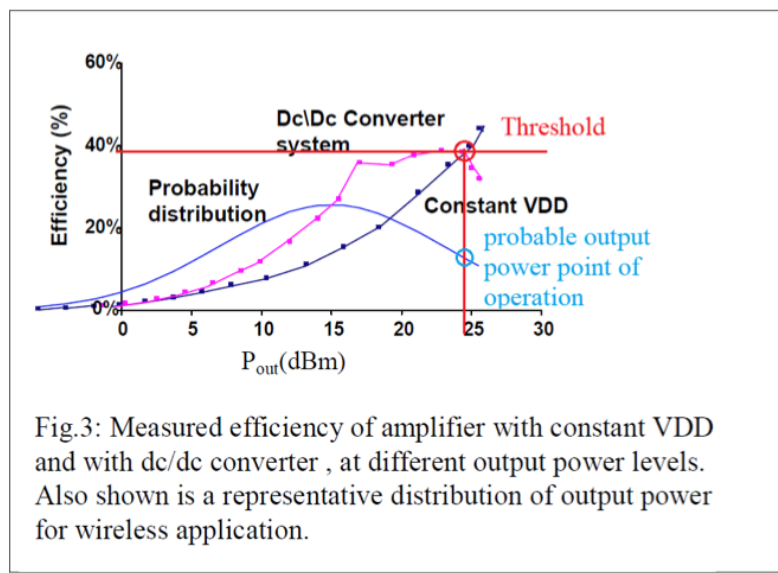
Although Canyon suggests that “it is possible to determine the power output of the power amplifier unit 120” based on the power supply output current I_{bb} , it does not specify how. Ex. 1011, 3:20-30. With no further guidance from Canyon, a POSITA would not have known how to control the bypass switch of the Figure 1 embodiment in accordance to Canyon’s description for the Figure 2 embodiment. Thus, Canyon alone does not disclose, in connection with Figure 1, the claimed control of the switching device “in response to a power efficiency of the power supply exceeding a predetermined threshold.” As discussed in Section VII.D.1, a POSITA would have found nothing in Ranjan that fills the gap between Canyon’s Figure 1 and Figure 2 embodiments. Ex. 2001, ¶201.

Accordingly, Canyon alone or in view of Ranjan does not render any of the challenged claims obvious.

3. Ranjan does not disclose controlling the switching device “based on a probable output power point of operation for a selected modulation scheme based on one or more power efficiency characteristics of an electronic device coupled to the power supply,” as required by claims 3-4, 10, and 19

As discussed in Section VII.C.1, a POSITA would not have reason to combine Canyon and Ranjan. For those reasons, Canyon in view of Ranjan does not render this claim limitation obvious. Moreover, Ranjan does not disclose controlling the switching device “based on a probable output power point of operation for a selected modulation scheme based on one or more power efficiency characteristics of an electronic device coupled to the power supply,” as required by claims 3-4, 10, and 19. Ex. 2001, ¶¶205-208.

Ranjan merely discloses that “average efficiency *can be computed* based on power usage probabilities.” EX1012, 494. It nowhere discloses controlling the switching device based on the computed average efficiency. Indeed, as shown in Figure 3 of Ranjan, as annotated by Petitioner, the threshold (annotated in red) is not determined based on power usage probabilities, and is instead based on a comparison of the measured efficiency between amplifier with constant VDD and DC-DC convertor:



Pet., 77 (annotated EX1012, Fig. 3); Ex. 2001, ¶¶206-208. This comparison, however, is driven by hindsight as nowhere in Ranjan is it disclosed that the intersection of the DC/DC converter line and the constant VDD has any significance or should be used for anything.

Accordingly, Canyon in view of Ranjan does not render obvious claims 3-4, 10, and 19.

E. Ground 2B: Canyon in View of Ranjan and Further in View of Hau

- 1. Hau does not disclose “deactivat[e/ing] the switching device and pass[ing] the input voltage to the output voltage node [based on a/comprises] compar[ison of/ing] the down-converted [input] voltage to a threshold voltage,” as required by claims 6-8 and 12-14.**

Petitioner relies on Hau to disclose “deactivat[e/ing] the switching device and pass[ing] the input voltage to the output voltage node [based on a/comprises]

compar[ison of/ing] the down-converted [input] voltage to a threshold voltage,” as required by claims 6-8 and 12-14. For the same reasons discussed for Section VII.A.4, Hau does not disclose this claim limitation. Ex. 2001, ¶¶209-211.

2. Canyon in view of Ranjan and Hau does not render obvious “programming the threshold voltage based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof,” as required by claims 8 and 13

Canyon in view of Ranjan and Hau does not render obvious “programming the threshold voltage based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof,” as required by claims 8 and 13. Ex. 2001, ¶¶212-216.

Petitioner argues that Hau discloses “a threshold setting,” which can somehow be programmed based on the spectrum efficiency of a particular modulation scheme. Pet. 88. This argument makes no sense.

Spectral efficiency generally refers to a wireless communication modulation scheme's efficiency in transmitting data over a limited frequency spectrum or bandwidth. It is calculated based on the maximum bit rate (bit/s) throughput divided by the bandwidth (Hz) of a communication channel, and has a unit of measurement of bit/s/Hz. Ex. 2001, ¶¶213-214.

In contrast, Hau's threshold is based on P_{det} , which is derived from the output voltage of the first stage power amplifier. Ex. 1007, 6:22-44. While power

amplifier design and configurations may have impact on the frequency domain, Hau does not disclose, and Petitioner did not explain, how the Pdet threshold can be programmed based on spectral efficiency considerations. Indeed, a POSITA would have known that improvements in spectral efficiency often come at the price of higher current consumption, in conflict with Hau's stated objective. Neither Hau nor Petitioner explain how the Pdet threshold can be set on balance between spectral efficiency and current consumption. Ex. 2001, ¶215.

Because a POSITA would not have known how to program Hau's threshold based on spectrum efficiency, it is my opinion that the combination of Canyon, Ranjan, and Hau does not disclose or suggest the limitations of claims 8 and 13. *Id.*, ¶215.

F. Ground 2C: Canyon in View of Ranjan and Further in View of Lejon

1. Lejon does not disclose or suggest a MISO amplifier

For the same reasons as discussed in Section VII.C.1, Lejon does not disclose or suggest "wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier," as required by claim 16. Ex. 2001, ¶217.

VIII. CONCLUSION

For all of the foregoing reasons, the Petition fails to demonstrate a reasonable likelihood that any of the challenged Claims 1-20 of the '593 patent are unpatentable.

Dated: August 7, 2025

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Patent Owner's Response complies with the type-volume limitation of 37 C.F.R. § 42.24(b) because it contains 11,514 words, as determined by the word-processing program used to prepare the brief, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing PATENT OWNER'S RESPONSE TO PETITION FOR INTER PARTES REVIEW OF UNITED STATES PATENT NO. 8,498,593, together with all exhibits filed therewith, was served in its entirety by filing these documents through the PTAB E2E System, as well as by email on the following counsel of record for Petitioner:

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