

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEDIATEK INC.,

Petitioner,

v.

PARKERVISION, INC.,

Patent Owner.

IPR2025-00030

Patent No. 8,498,593

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,498,593**

TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. GROUNDS FOR STANDING (37 C.F.R. §42.104(A)).....	1
III. STATEMENT OF PRECISE RELIEF REQUESTED	1
IV. TECHNOLOGY BACKGROUND.....	3
A. Power Supply Requirements for Wireless Devices	3
B. DC-DC Converters	4
V. '593 PATENT OVERVIEW	6
A. Specification.....	6
B. File History	10
VI. LEVEL OF ORDINARY SKILL	11
VII. CLAIM CONSTRUCTION	11
A. “Power Efficiency”	12
B. “Aperture generator and control module”	13
VIII. SPECIFIC GROUNDS FOR PETITION	16
A. Ground 1A: Claims 1-2, 5-7, 9, 11-12, and 15 are Unpatentable as Obvious over Hau in view of Yoshida	16
1. Hau	16
2. Yoshida	18
3. Motivation to Combine	21
4. Claim 1	23
a. 1[pre]: A power supply comprising:.....	23
b. 1[a] a switching device configured to down-	

	convert an input voltage and pass the down-converted input voltage to an output voltage node.....	24
c.	1[b1] an aperture generator and control module configured to control the switching device	26
d.	1[b2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node	28
5.	Claim 2	33
a.	The power supply of claim 1, wherein the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node.....	33
6.	Claim 5	34
a.	The power supply of claim 1, wherein the aperture generator and control module is configured to provide an output current at a maximum power efficiency associated with the down-converted input voltage	34
7.	Claim 6	35
a.	The power supply of claim 1, 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.....	35
8.	Claim 7	36

a.	The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value	36
9.	Claim 9	36
a.	9[pre] a method for controlling a power supply comprising:	36
b.	9[a] down-converting, with a switching device, an input voltage to generate a down-converted voltage.....	36
c.	9[b] passing the down-converted voltage to an output voltage node.....	36
d.	9[c] in response to a power efficiency of the power supplying [<i>sic</i>] exceeding a predetermined threshold, de-activating the switching device and passing the input voltage to the output voltage node.....	37
10.	Claim 11	37
a.	The method of claim 9, further comprising: providing an output current at a maximum power efficiency associated with the down-converted voltage.....	37
11.	Claim 12	37
a.	The method of claim 9, 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.....	37
12.	Claim 15	37
a.	15[pre] a system comprising.....	37
b.	15[a] an electronic device.....	38

c.	15[b] a power supply coupled to the electronic device, wherein the power supply comprises	38
d.	15[c] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node.....	39
e.	15[d1] an aperture generator and control module configured to control the switching device	39
f.	15[d2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node	39
B.	Ground 1B: Claims 3-4, 8, 10, 13-14, and 17-20 are Unpatentable as Obvious over Hau in view of Yoshida and further in view of Sahu	39
1.	Sahu.....	39
2.	Motivation to Combine	43
3.	Claim 3	45
a.	The power supply of claim 1, wherein the aperture generator and control module is configured to control 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 a power supply	45
4.	Claim 4.....	49
a.	The power supply of claim 3, wherein the	

	modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol	49
5.	Claim 8	49
	a. The power supply of claim 6, wherein the threshold voltage is programmed based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof	49
6.	Claim 10	51
	a. The method of claim 9, further comprising: 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	51
7.	Claim 13	51
	a. The method of claim 12, wherein the comparing comprises 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	51
8.	Claim 14	51
	a. The method of claim 12, wherein the communication waveform efficiency is based on a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.	51
9.	Claim 17	52

a.	The system of claim 15, wherein the electronic device comprises an amplifier with a bipolar junction transistor (BJT), and wherein the power supply is coupled to a collector or an emitter terminal of the BJT	52
10.	Claim 18.....	53
a.	The system of claim 15, wherein the electronic device comprises an amplifier with a metal oxide semiconductor (MOS) transistor, and wherein the power supply is coupled to a drain or a source terminal of the MOSFET.....	53
11.	Claim 19.....	53
a.	The system of claim 15, wherein the aperture generator and control module is configured to control 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.....	53
12.	Claim 20.....	53
a.	The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.	53
C.	Ground 1C: Claim 16 is Obvious over Hau in view of Yoshida and Lejon.....	54
1.	Lejon	54
2.	Motivation to Combine	56
3.	Claim 16.....	58

a.	The system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier.....	58
D.	Ground 2A: Claims 1-5, 9-11, 15, and 19-20 are Obvious over Canyon in view of Ranjan.....	60
1.	Canyon	60
2.	Ranjan	64
3.	Motivation to Combine	65
4.	Claim 1	68
a.	1[pre]: A power supply comprising:.....	68
b.	1[a] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node.....	68
c.	1[b1] an aperture generator and control module configured to control the switching device	70
d.	1[b2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node	72
5.	Claim 2	76
a.	The power supply of claim 1, wherein the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node.....	76
6.	Claim 3	76

a.	The power supply of claim 1, wherein the aperture generator and control module is configured to control 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.....	76
7.	Claim 4.....	78
a.	The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.	78
8.	Claim 5.....	78
a.	The power supply of claim 1, wherein the aperture generator and control module is configured to provide an output current at a maximum power efficiency associated with the down-converted input voltage.	78
9.	Claim 9.....	80
a.	9[pre] a method for controlling a power supply comprising:	80
b.	9[a] down-converting, with a switching device, an input voltage to generate a down-converted voltage.....	80
c.	9[b] passing the down-converted voltage to an output voltage node.....	80
d.	9[c] in response to a power efficiency of the power supplying [<i>sic</i>] exceeding a predetermined threshold, de-activating the switching device and passing the input voltage to the output voltage node.....	80

10.	Claim 10.....	81
a.	The method of claim 9, further comprising: 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 ower supply.....	81
11.	Claim 11	81
a.	The method of claim 9, further comprising: providing an output current at a maximum power efficiency associated with the down- converted voltage.....	81
12.	Claim 15	81
a.	15[pre] a system comprising.....	81
b.	15[a] an electronic device.....	81
c.	15[b] a power supply coupled to the electronic device, wherein the power supply comprises	82
a.	15[c] a switching device configured to down- convert an input voltage and pass the down- converted input voltage to an output voltage node.....	82
b.	15[d1] an aperture generator and control module configured to control the switching device	82
c.	15[d2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node	82

13.	Claim 19	82
a.	The system of claim 15, wherein the aperture generator and control module is configured to control 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.....	82
14.	Claim 20	83
a.	The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.	83
E.	Ground 2B: Claims 6-8, 12-14 are Unpatentable as Obvious over Canyon in view of Ranjan and further in view of Hau.	83
1.	Motivation to Combine	83
2.	Claim 6	86
a.	The power supply of claim 1, 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 thresholdvoltage.....	86
3.	Claim 7	88
a.	The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value.	88
4.	Claim 8	88

a.	The power supply of claim 6, wherein the threshold voltage is programmed based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof.....	88
5.	Claim 12	89
a.	The method of claim 9, wherein the deactivating 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.....	89
6.	Claim 13	90
a.	The method of claim 12, wherein the comparing comprises 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.....	90
7.	Claim 14	90
a.	The method of claim 12, wherein the communication waveform efficiency is based on a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.....	90
F.	Ground 2C: Claims 16-18 are Unpatentable as Obvious over Canyon in view of Ranjan and further in view of Lejon.....	91
1.	Motivation to Combine	91
2.	Claim 16.....	92
a.	The system of claim 15, wherein the	

	electronic device comprises a multiple-input- single-output (MISO) amplifier.....	92
3.	Claim 17.....	95
a.	The system of claim 15, wherein the electronic device comprises an amplifier with a bipolar junction transistor (BJT), and wherein the power supply is coupled to a collector or an emitter terminal of the BJT.	95
4.	Claim 18.....	96
a.	The system of claim 15, wherein the electronic device comprises an amplifier with a metal oxide semiconductor (MOS) transistor, and wherein the power supply is coupled to a drain or a source terminal of the MOSFET.....	96
IX.	THE BOARD SHOULD EXERCISE DISCRETION TO INSTITUTE REVIEW	98
A.	The Board Should Not Deny Institution under <i>Fintiv</i>	98
B.	The Examiner Did Not Consider the References Forming the Basis of This Petition	98
X.	CONCLUSION.....	99
XI.	MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(B)	99
A.	REAL PARTY IN INTEREST	99
B.	RELATED MATTERS	100
C.	NOTICE OF COUNSEL AND SERVICE INFORMATION	100

EXHIBIT LIST

EXHIBIT No.	DESCRIPTION
EX1001	U.S. Patent No. 8,498,593
EX1002	File History of U.S. Patent No. 8,498,593
EX1003	Larson Declaration
EX1004	Larson CV
EX1005	U.S. Patent No. 8,116,704
EX1006	File History of U.S. Patent No. 8,116,704
EX1007	U.S. Patent No. 7,427,897 (“Hau”)
EX1008	U.S. Patent 7,061,213 (“Yoshida”)
EX1009	Sahu <i>et al.</i> , “A High-Efficiency Linear RF Power Amplifier With a Power-Tracking Dynamically Adaptive Buck-Boost Supply,” IEEE Transactions On Microwave Theory And Techniques, Vol. 52, No. 1, January 2004 (“Sahu”)
EX1010	Declaration of June Munford
EX1011	U.S. Patent 6,646,511 (“Canyon”)
EX1012	Ranjan <i>et al.</i> , “Microwave Power Amplifiers with Digitally-Controlled Power Supply Voltage for High Efficiency and High Linearity,” 2000 IEEE MTT-S Digest (“Ranjan”)
EX1013	International Patent Application Publication No. WO 2007/084033 A1 (“Lejon”)
EX1014	Online copy of Ranjan <i>et al.</i> , “Microwave Power Amplifiers with Digitally-Controlled Power Supply Voltage for High Efficiency and High Linearity,” 2000 IEEE MTT-S Digest (“Ranjan”), obtained from https://web.archive.org/web/20031218101536id_/http://sigma.ucsd.edu:80/~mahim/mttfinal-colored.pdf
EX1015	Theodore Rappaport, <i>Wireless Communications: Principles and Practice</i> , 2 nd ed. (excerpts)

EXHIBIT No.	DESCRIPTION
EX1016	Kassakian <i>et al.</i> , <i>Principles of Power Electronics</i> , 2 nd ed. (excerpts)
EX1017	U.S. Patent No. 7,047,032 (“Yun”)
EX1018	U.S. Patent Application Publication No. US2006/0001410 (“Ishikawa”)
EX1019	[not used]
EX1020	[not used]
EX1021	[not used]
EX1022	[not used]
EX1023	[not used]
EX1024	James A. Kaehler, “Periodic-Switched Filter Networks: A Means of Amplifying and Varying Transfer Functions,” <i>IEEE Journal of Solid-State Circuits</i> , Vol. SC-4, No. 4 (August 1969)
EX1025	U.S. Patent No. 8,571,135 B2
EX1026	Guinee <i>et al.</i> , “A Novel Estimation Procedure for the Aperture Time in Asynchronous Sinusoidal PWM Systems,” The 2001 IEEE International Symposium on Circuits and Systems (Cat. No.01CH37196), Sydney, NSW, Australia, 2001, pp. 53-56 vol. 2
EX1027	<i>ParkerVision, Inc. v. MediaTek Inc. et al.</i> , Civ. No. 6:23-cv-00732, Motion for Extension of Time to Respond to Complaint (ECF No. 8) (W.D.Tex. Nov. 28, 2023)
EX1028	Krauss <i>et al.</i> , <i>Solid State Radio Engineering</i> , 1980 (excerpts)
EX1029	<i>Sotera</i> Stipulation Letter dated October 18, 2024

LISTING OF CHALLENGED CLAIMS

Reference	Claim Limitation
Claim 1	
1[pre]	A power supply comprising:
1[a]	a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node; and
1[b1]	an aperture generator and control module configured to control the switching device,
1[b2]	wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node.
Claim 2	
2	The power supply of claim 1, wherein the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node.
Claim 3	
3	The power supply of claim 1, wherein the aperture generator and control module is configured to control 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.
Claim 4	
4	The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM

Reference	Claim Limitation
	communication protocol.
Claim 5	
5	The power supply of claim 1, wherein the aperture generator and control module is configured to provide an output current at a maximum power efficiency associated with the down-converted input voltage.
Claim 6	
6	The power supply of claim 1, 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.
Claim 7	
7	The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value.
Claim 8	
8	The power supply of claim 6, wherein the threshold voltage is programmed based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof.
Claim 9	
9[pre]	A method for controlling a power supply comprising:
9[a]	down-converting, with a switching device, an input voltage to generate a down-converted voltage;

Reference	Claim Limitation
9[b]	passing the down-converted voltage to an output voltage node; and
9[c]	in response to a power efficiency of the power supplying exceeding a predetermined threshold, de-activating the switching device and passing the input voltage to the output voltage node.
Claim 10	
10[pre]	The method of claim 9, further comprising:
10[a]	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.
Claim 11	
11[pre]	The method of claim 9, further comprising:
11[a]	providing an output current at a maximum power efficiency associated with the down-converted voltage.
Claim 12	
12	The method of claim 9, 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.
Claim 13	
13	The method of claim 12, wherein the comparing comprises 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.

Reference	Claim Limitation
Claim 14	
14	The method of claim 12, wherein the communication waveform efficiency is based on a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.
Claim 15	
15[pre]	A system comprising:
15[a]	an electronic device; and
15[b]	a power supply coupled to the electronic device, wherein the power supply comprises:
15[c]	a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node; and
15[d1]	an aperture generator and control module configured to control the switching device,
15[d2]	wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node.
Claim 16	
16	The, system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier. ¹

¹ Certification of Correction was filed July 30, 2013 to replace “The, system” with “The system.”

Reference	Claim Limitation
Claim 17	
17	The system of claim 15, wherein the electronic device comprises an amplifier with a bipolar junction transistor (BJT), and wherein the power supply is coupled to a collector or an emitter terminal of the BJT.
Claim 18	
18	The system of claim 15, wherein the electronic device comprises an amplifier with a metal oxide semiconductor (MOS) transistor, and wherein the power supply is coupled to a drain or a source terminal of the MOSFET.
Claim 19	
19	The system of claim 15, wherein the aperture generator and control module is configured to control 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.
Claim 20	
20	The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.

I. INTRODUCTION

MediaTek Inc. (“Petitioner”) petitions for *inter partes* review (“IPR”) of claims 1-20 (“Challenged Claims”) of U.S. Patent No. 8,498,593 (EX1001, “’593 Patent”).

II. GROUNDS FOR STANDING (37 C.F.R. §42.104(A))

Petitioner certifies the ’593 Patent is available for IPR and Petitioner is not barred or estopped from requesting IPR challenging claims of the ’593 Patent on the grounds identified herein. PO *filed* its complaint asserting the ’593 Patent in the related litigation on October 30, 2023, and Petitioner agreed to accept service as of November 14, 2023 (EX1027), but PO never formally served the complaint.²

III. STATEMENT OF PRECISE RELIEF REQUESTED

Petitioner respectfully requests cancellation of the Challenged Claims in view of:

Prior Art
Hau, U.S. Patent 7,427,897, filed February 8, 2006, prior art at least under §102(e) ³ (EX1007).
Yoshida, U.S. Patent 7,061,213, filed July 3, 2003, prior art at least under

² This Petition refers to the co-pending litigation between ParkerVision and MediaTek (6:23-cv-00375 (W.D.Tex.)) as the “related litigation.”

³ §§102, 103 refers to the pre-AIA statutory framework.

§102(e) (EX1008).
Sahu <i>et al.</i> , “A High-Efficiency Linear RF Power Amplifier With a Power-Tracking Dynamically Adaptive Buck-Boost Supply,” IEEE Transactions On Microwave Theory And Techniques, Vol. 52, No. 1, January 2004, prior art under at least 35 U.S.C. §102(b) ⁴ (EX1009).
Lejon, International Patent Publication No. WO 2007/084033 A1, prior art under at least 35 U.S.C. §102(e) (EX1013).
Canyon, U.S. Patent No. 6,646,511, issued Nov. 11, 2003, prior art under at least 35 U.S.C. §102(b) (EX1011).
Ranjan <i>et al.</i> , “Microwave Power Amplifiers with Digitally-Controlled Power Supply Voltage for High Efficiency and High Linearity,” 2000 IEEE MTT-S Digest, prior art under at least 35 U.S.C. §102(b) ⁵ (EX1012).

Ground (all under 35 U.S.C. § 103)	Claims	References
1A	1-2, 5-7, 9, 11-12, 15	Hau and Yoshida
1B	3-4, 8, 10, 13-14, 17-20	Hau, Yoshida, and Sahu
1C	16	Hau, Yoshida, and Lejon
2A	1-5, 9-11, 15, 19-20	Canyon and Ranjan
2B	6-8, 12-14	Canyon, Ranjan, and Hau
2C	16-18	Canyon, Ranjan, and Lejon

⁴ See EX1010, ¶¶6-8.

⁵ See EX1010, ¶¶9-12.

IV. TECHNOLOGY BACKGROUND

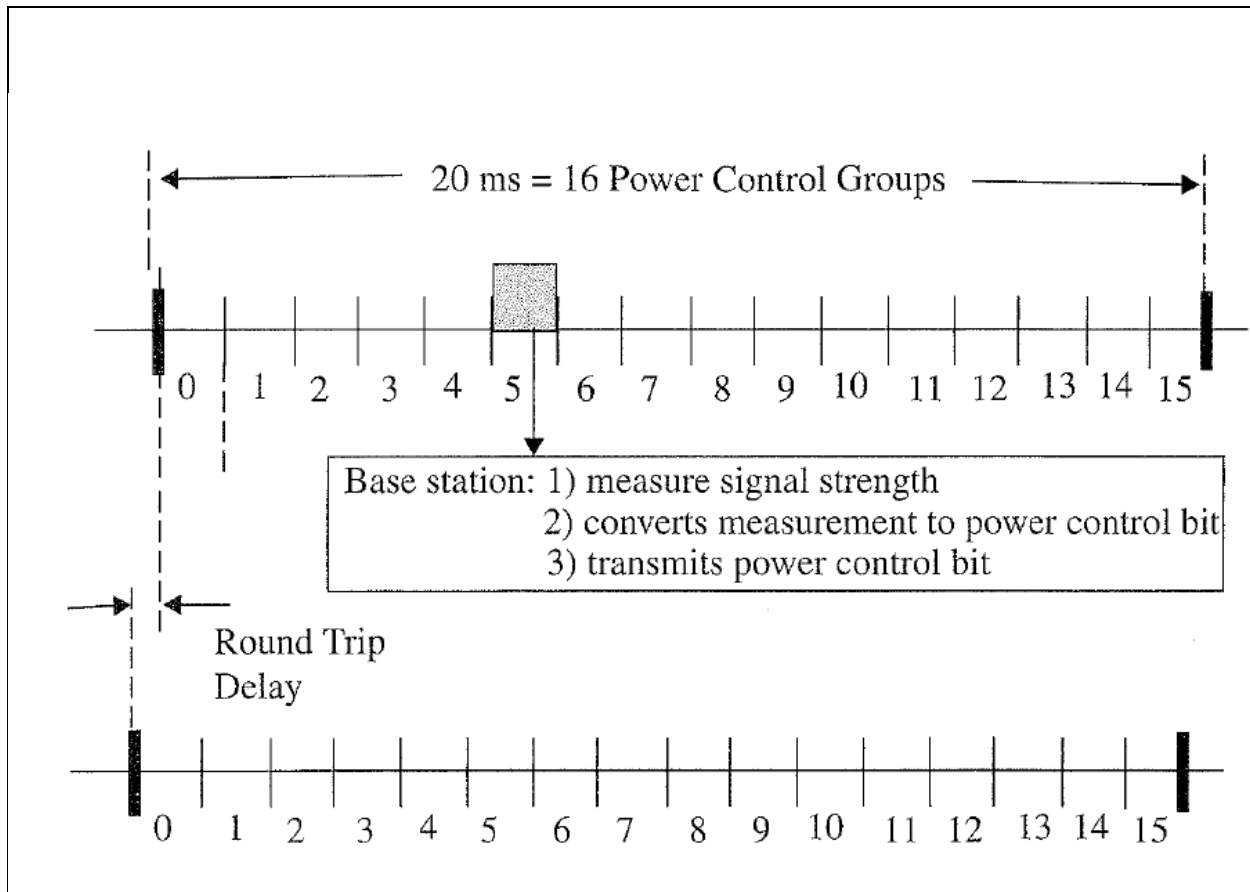
A. Power Supply Requirements for Wireless Devices

Although the independent claims of the '593 Patent do not limit the context of the claimed power supply, the specification and dependent claims repeatedly reference wireless communication standards. *E.g.*, EX1001, 1:31-35, 1:63-2:12, 3:65-67, 4:26-31, 5:1-6:10, claims 3-4, 8, 10, 13-14, 19-20.

When mobile devices communicate with base stations (such as cellular towers or wi-fi routers), the power used by the mobile unit needs to be regulated. The mobile unit must transmit with enough power to be received by the base station. However, because base stations (e.g., cell towers) may communicate with numerous mobile units via various multiplexing schemes such as frequency-division (FDMA), time-division (TDMA), or code-division multiplexing (CDMA), excessive transmission power from a mobile unit may increase interference with adjacent units. EX1003, ¶¶50-58; EX1015 (Rappaport), 458-459. Additionally, excessive power use degrades battery life for battery-powered mobile units. EX1003, ¶56; EX1015, 76-77. Therefore, many mobile wireless systems and standards provide for the base station to communicate a control signal to the mobile unit setting transmission power. EX1003, ¶57. For example, the CDMA IS-95 standard incorporates power control bits transmitted by the base station on a control subchannel every 1.25 ms indicating that the mobile unit should either raise

or lower its transmission power. EX1003, ¶57; EX1015, 572-73, Fig. 11.16

(below):



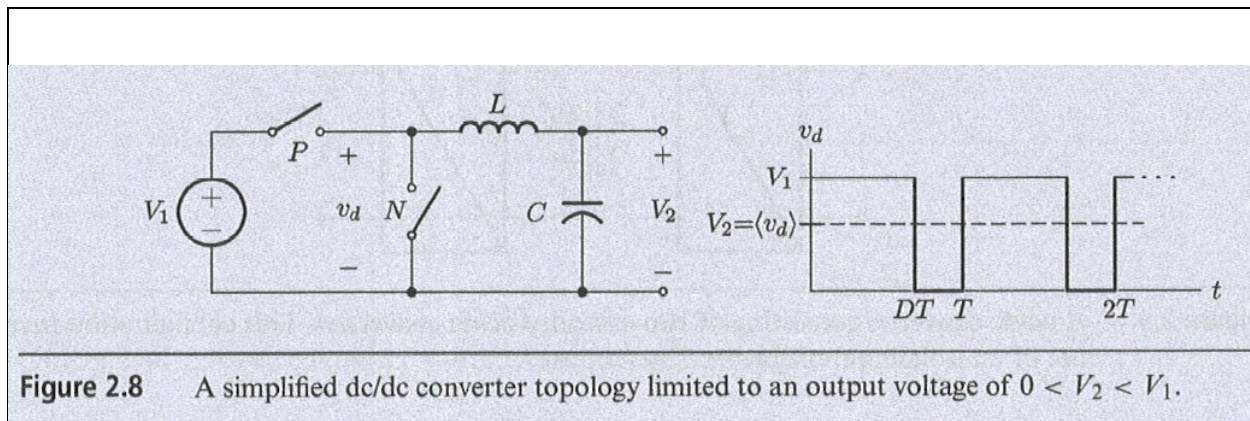
The mobile unit adjusts its own power level for the desired transmission power, often by adjusting the voltage provided to the amplifier. EX1003, ¶57.

B. DC-DC Converters

Power supplies (such as those in mobile units) may adjust voltage using DC-DC converters (or “regulators”), which output a DC voltage at a different voltage than the input. EX1003, ¶¶66-67. DC-DC converters may be “buck” converters,

which down-convert voltage, “boost” converters which increase the voltage, or “buck-boost” converters which may do either. *Id.*, ¶67; EX1016 (Kassakian), 84.

DC-DC converters, such as buck converters, typically rely on pulse-width modulation (PWM) to down-convert voltages. PWM relies on regulating the width (i.e., “aperture”) of pulses which close a switch (such as a semiconductor switch) and allow current from a DC power source (such as a battery) to pass during the “on” time. The percentage of each cycle during which the switch is “on” is known as the “duty cycle.” By filtering the output of the switch (averaging out the rapid transitions from “on” to “off,” e.g., via an inductor-capacitor (“LC”) circuit), the converter can produce a substantially DC output voltage at a lower level that varies with the duty cycle of the switch; that is, a lower duty cycle results in a lower output voltage. For example, in the simplified figure below, the switches *P* and *N* are turned on and off sequentially to create a voltage waveform that steps between 0 and V_1 ; which is then smoothed by the LC circuit to produce an average voltage V_2 proportional to the duty cycle:



EX1003, ¶¶68-70; EX1016, 19, Fig. 2.8.

V. '593 PATENT OVERVIEW

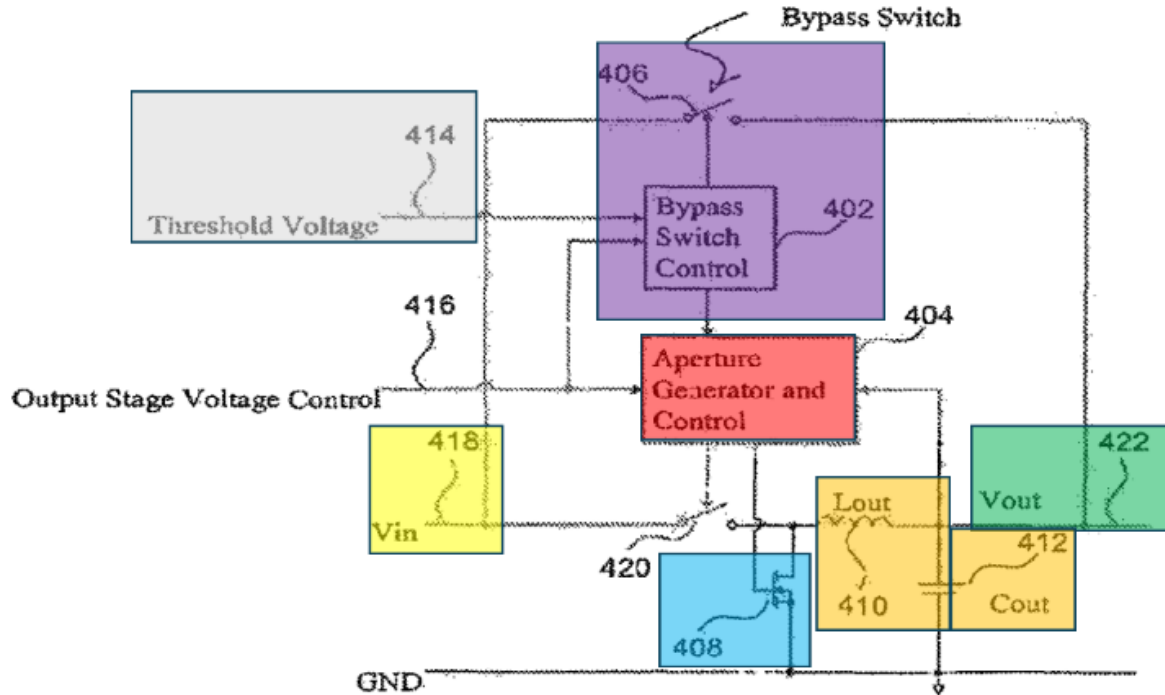
A. Specification

The '593 Patent generally relates to “methods and systems for enhancing system efficiency in a power amplification, modulation, and transmission system” such as a radio frequency (RF) transmitter. EX1001, 1:31-35, 1:60-62. The '593 Patent notes that “[t]he efficiency of a power supply directly affects the efficiency of the power amplification system” which in turn affects “the efficiency of the mobile device using the power amplification system.” *Id.*, 1:29-39. The '593 Patent explains that system efficiency may be “affected and/or optimized according to” various factors including “average or most probable output power levels, maximum power output level, battery voltage and/or changes in battery voltage, amplifier and/or modulator voltage and current requirements, power control requirements, adjacent channel power requirements (ACPR), adjacent channel leakage requirements (ACLR), standing wave ratio (SWR) requirements,” and both in-band

and out-of-band noise performance requirements required by cellular wireless standards. *Id.*, 1:63-2:7; EX1003, ¶72.

The '593 Patent accordingly claims systems designed to optimize overall system efficiency using a “variable voltage switching power supply,” as well as a bypass switch to “bypass the power supply circuitry at a pre-determined threshold, further increasing the system efficiency.” EX1001, 4:1-4. In one embodiment, “the threshold is determined in terms of output power.” *Id.*, 4:7-10; EX1003, ¶73.

Figure 4 (annotated below) illustrates “an example step down (buck) switching power supply 400 having a bypass switch architecture.” EX1001, 6:36-37.



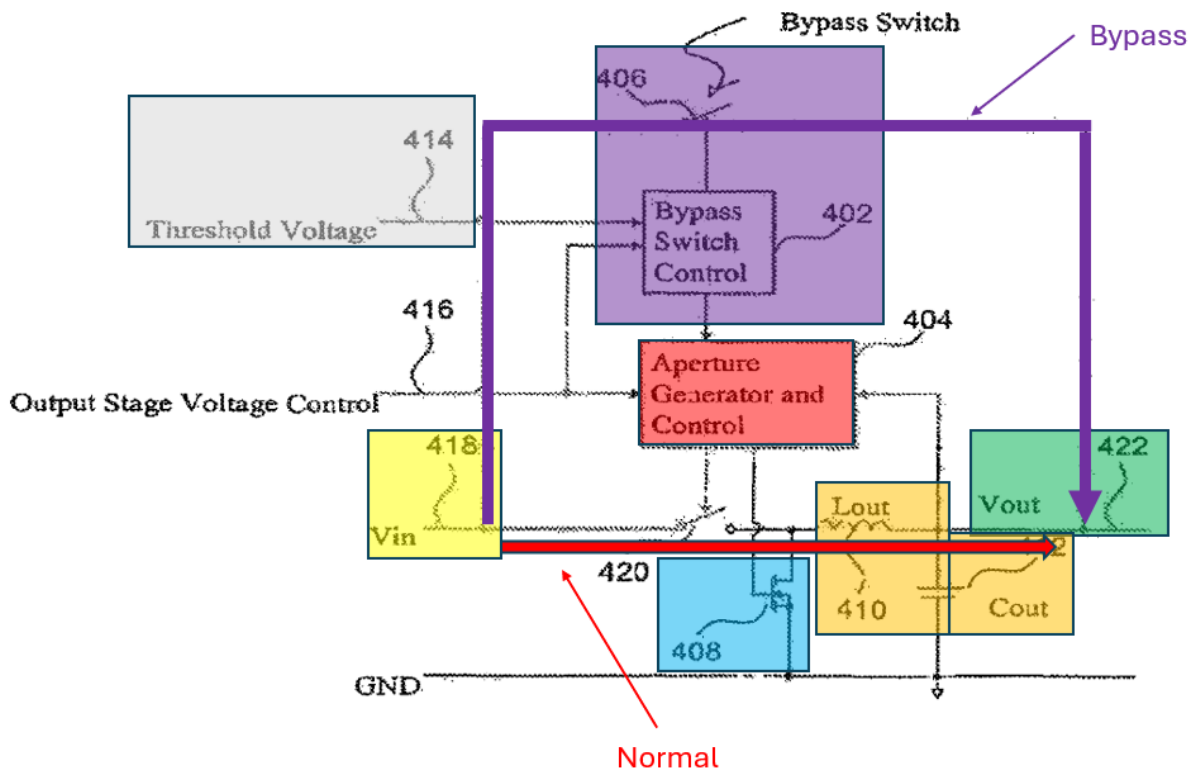
The circuit receives an input voltage V_{in} 418 (yellow), typically from a battery, and outputs an output voltage at output voltage node 422 (green). *Id.*, 6:38-45, 7:44-48. The power supply operates in two modes: normal and bypass. *Id.*, 7:9-10; EX1003, ¶75.

In normal mode, switch 420 is closed to couple V_{in} 418 to the collector of switching transistor 408 (blue). EX1001, 7:11-14. The aperture generator and control module 404 (red) controls the gate of switching transistor 408. *Id.*, 7:20-23. The output of switching transistor 408 is coupled to an LC circuit including inductor L_{out} and capacitor C_{out} (orange), which filter the AC components of the output of the transistor so that the output voltage V_{out} is substantially a DC voltage. *Id.*, 7:39-45;

EX1003, ¶76.

In one embodiment, bypass switch control 402 (purple) compares threshold voltage 414 (grey) to the value of a power supply output voltage to determine whether the power supply should switch to bypass mode. EX1001, 7:59-62. In bypass mode, bypass switch control 402 closes switch 406 (purple) so that V_{in} 418 is directly coupled to output voltage V_{out} 422 without passing through the switching transistor or LC circuit. *Id.*, 7:46-49, 7:62-65. The bypass switch control 402 also controls aperture generator and control module 404 to de-couple V_{in} 418 from the switching transistor 408. *Id.*, 7:65-8:3. The circuit pathways for normal and bypass mode are annotated on Figure 4 below:

EX1003, ¶77.



B. File History

The file history of the '593 Patent itself (EX1002) is uneventful. The Examiner rejected all claims under the non-statutory obviousness-type double-patenting doctrine over U.S. Patent No. 8,116,704 ("704 Patent"). EX1002, Oct. 24, 2012 Office Action. Applicants submitted a terminal disclaimer in response on December 6, 2012, and the Examiner allowed the claims on March 25, 2013. EX1002, March 25, 2013 Notice of Allowance.

In the grandparent application (issued as the '704 Patent), the Examiner's first Office Action allowed the claims which eventually issued, but rejected

another set of claims under § 103 over the combination of Yun (U.S. Pat. 7,047,032, EX1017) and Ishikawa (US2006/0001410, EX1018) (EX1006, Nov. 23, 2010 Office Action at 2-4). Applicants traversed the rejection. EX1006, Feb. 23, 2011 Reply at 7-9. However, the Examiner then issued a restriction requirement on May 9, 2011 between the allowed and non-allowed claims; Applicants elected the allowed claims on June 9, 2011, and those claims issued without further substantive prosecution of the other claims. EX1006, June 9, 2011 Reply to Restriction Requirement; EX1006, Sep. 1, 2011 Notice of Allowance; EX1003, ¶¶78-79.

VI. LEVEL OF ORDINARY SKILL

As of the '593 Patent's priority date, a person of ordinary skill in the art ("POSITA") would have had at least a bachelor's degree in electrical engineering or a related subject and two or more years of experience in the field of RF circuit design and/or power supplies for RF circuits, or at least five years of work experience and training in the design and development of RF circuits and/or power supplies for RF circuits. Less work experience may be compensated by a higher level of education, such as a master's degree. EX1003, ¶¶22-23.

VII. CLAIM CONSTRUCTION

Petitioner proposes constructions for certain claim terms below. All other terms should be given their plain and ordinary meaning. EX1003, ¶81.

A. “Power Efficiency”

“Power efficiency” in claims 1, 9, and 15 should be construed as “the output power of the power supply compared to its input power.” EX1001 Fig. 1, 4:15-56, EX1003 ¶83.

The broader phrase “in response to a power efficiency of the power supply exceeding a predetermined threshold”⁶ (in which case “the [AGCM] deactivates the switching device and passes the input voltage to the output voltage node”) should also be construed to encompass indirect measurements of power efficiency such as output current or voltage, and should not be interpreted to require a direct measurement of power efficiency. EX1003 ¶83. The only description in the specification of activating the bypass switch to “de-activat[e] the switching device and pass[] the input voltage to the output voltage node” relies on indirect measurements such as output power. *See* EX1001, 4:7-10 (“...the bypass switch is engaged or disengaged when the **output power** exceeds or falls below the threshold”), 7:59-8:8 (“Bypass Switch Control module 402 compares Threshold

⁶ Claim 9’s wording, “a power efficiency of the power supplying...” appears to be a typographical error due to the otherwise identical wording with claims 1 and 15.

Voltage 414 and the *value of the power supply output voltage* to determine whether power supply 400 should switch to bypass mode...”), 8:41-60. There is no disclosure in the ’593 Patent specification where the circuitry directly calculates the power efficiency, much less determines whether to bypass the down-converter based on such a calculation. EX1003, ¶85. Rather, the specification treats the direct measurement of output power as indirectly related to power efficiency: “Bypass Switch Control module bypasses the power supply when the output power exceeds a determined threshold, *thereby increasing the efficiency of the power supply...*” EX1001, 8:4-8; EX1003 ¶85.

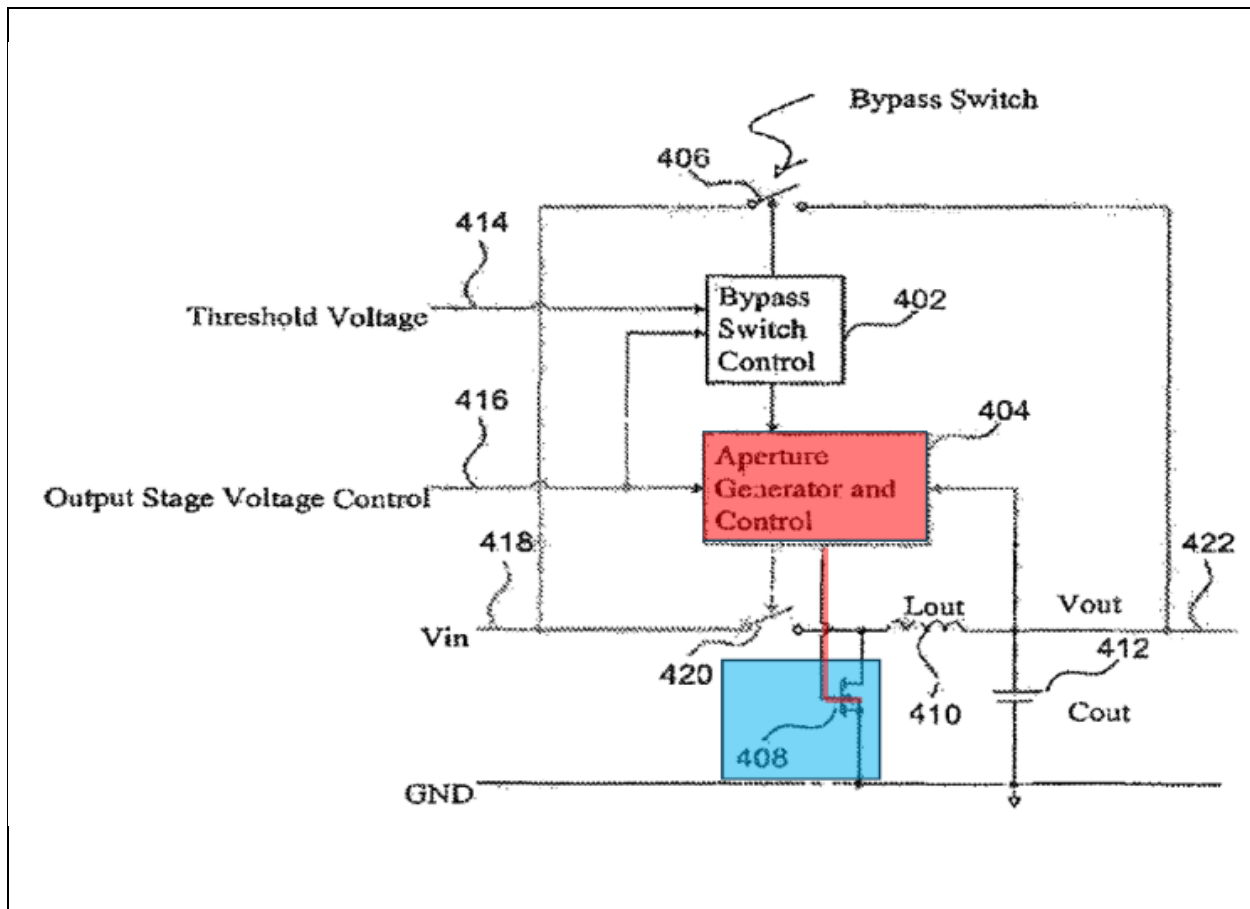
Moreover, dependent claim 2 requires that “the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node” and dependent claim 6 requires that the same switching function is performed “based on a comparison of the down-converted input voltage to a threshold voltage,” indicating that such indirect measurements (i.e., measuring either the load current or the down-converted input voltage) are within the scope of the broader independent claim. EX1003, ¶86.

B. “Aperture generator and control module”

“Aperture generator and control module” (“AGCM”) in claims 1 and 15 should be given its plain and ordinary meaning, where “aperture” is the width of a pulse. *Id.*, ¶87. The mere use of the term “module” does not mean that the term

should be construed as means-plus-function under pre-AIA 35 U.S.C. § 112(6). The claim term itself refers to a type of circuit structure known in the art, an aperture generator used in pulse-width modulation-based power supplies, which controls the width (aperture) of pulses and therefore the output voltage. *Id.*, ¶¶87-90; EX1024 at Abstract, 228-229, Table I; EX1026. *See TEK Glob., S.R.L. v. Sealant Sys. Int'l, Inc.*, 920 F.3d 777, 785 (Fed. Cir. 2019) (§112(6) does not apply when “the words of the claim are understood by [POSITAs] to have a sufficiently definite meaning as the name for structure”) (quoting *Diebold Nixdorf, Inc. v. ITC*, 899 F.3d 1291, 1297 (Fed. Cir. 2018)). Moreover, ParkerVision’s other patents use the term “aperture” to refer to the width of a pulse. EX1025, Abstract; EX1003, ¶¶91-92.

Claims 1 and 15 also provide context for the term, indicating that the aperture generator and control module is “configured to control the switching device,” which is itself “configured to down-convert an input voltage.” The specification provides further context, showing that the aperture generator and control module provides an output signal which controls the gate of switching transistor 408. *See* EX-1001, Fig. 4 (annotated below), 7:20-23:



Therefore, the use of the term “aperture generator and control module” in the context of the claims and the specification provides further indication that the term refers to a known structure which controls the gain of a down-converting transistor by varying the width (aperture) of control pulses. EX1003, ¶88.

Alternatively, if the Board finds that the term should be construed as means-plus-function (which it should not), the corresponding functions are to “control the switching device” and “deactivate[] the switching device and pass[] the input voltage to the output voltage node.” The corresponding structure to accomplish both functions is the Aperture Generator and Control 404, Bypass Switch Control 402,

Bypass Switch 406, and switch 420. EX1001 Figs. 4, 5, 6:48-51, 7:4-8:10, 8:30-31; EX1003, ¶¶93-95.

VIII. SPECIFIC GROUNDS FOR PETITION

A. Ground 1A: Claims 1-2, 5-7, 9, 11-12, and 15 are Unpatentable as Obvious over Hau in view of Yoshida

1. Hau

Hau teaches a power amplifier for an RF system. EX1007, Abstract. Hau teaches a system with a DC-DC converter that can be deactivated and bypassed when the power of an RF input signal rises above a certain threshold. EX1007, 6:54-66.

Hau's Figure 6 (annotated below) illustrates several of the power amplifier's components. It has a DC-DC buck regulator 70 (blue) that receives battery voltage V_{BATT} (yellow) and outputs voltage V_{cc2} (green) to two power amplifiers, PA1/PA2 (aqua). EX1007 at 6:54-7:6. A bypass controller 74 (purple) receives a signal P_{det} from power detector 4 (pink) and, based on a comparison with a threshold, controls whether the DC-DC buck regulator should be bypassed via bypass switch 72 (purple). *Id.* P_{det} is proportional to V_{in} (*id.* at 6:27-28) and V_{in} is an output from PA1, to which RF_{IN} is input. *Id.* at 5:62-63.

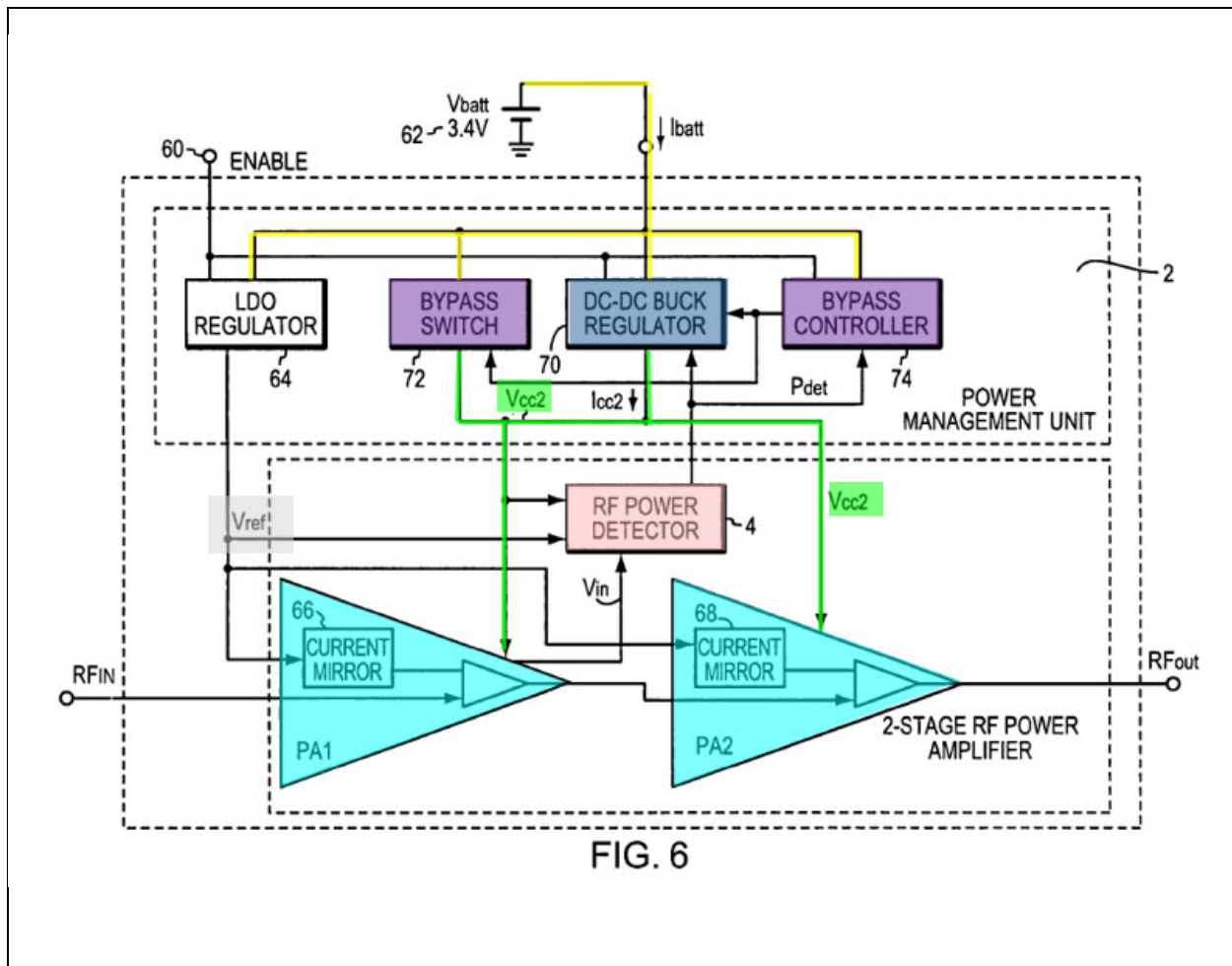
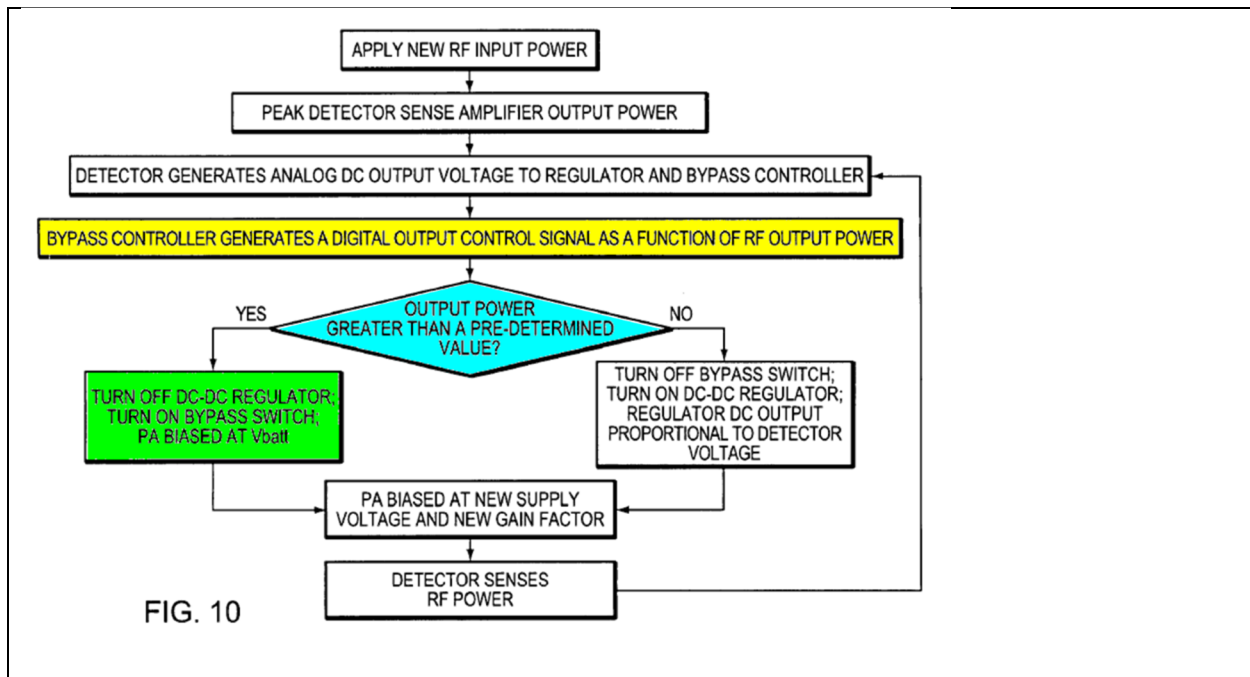


FIG. 6

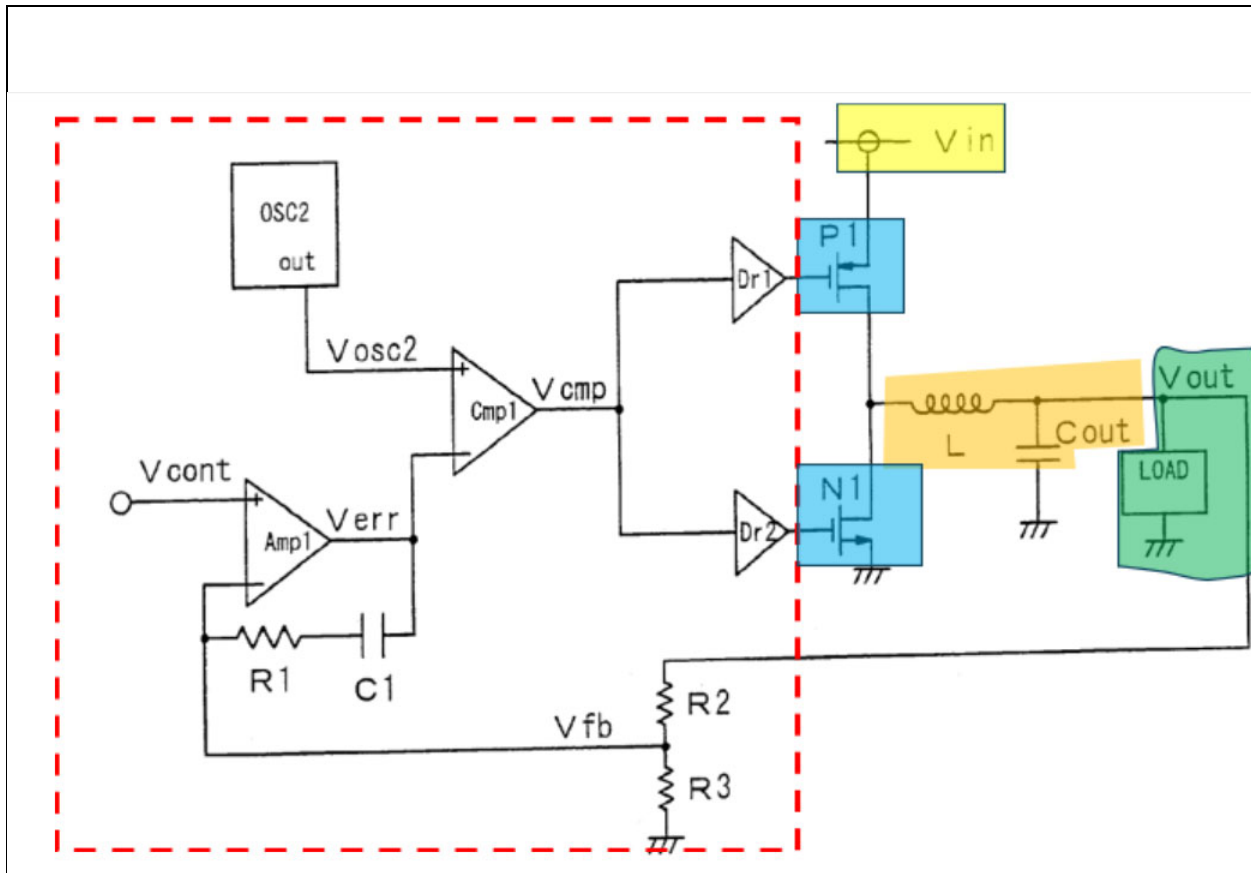
Hau provides a flowchart in Figure 10 (annotated below) that illustrates its DC/DC regulator bypass. The bypass controller generates a control signal as a function of RF power (yellow). EX1007 at 6:54-7:6. If the output power is greater than a predetermined threshold (aqua) the DC/DC regulator is turned off and the DC/DC regulator bypass switch is turned on (green). *Id.*



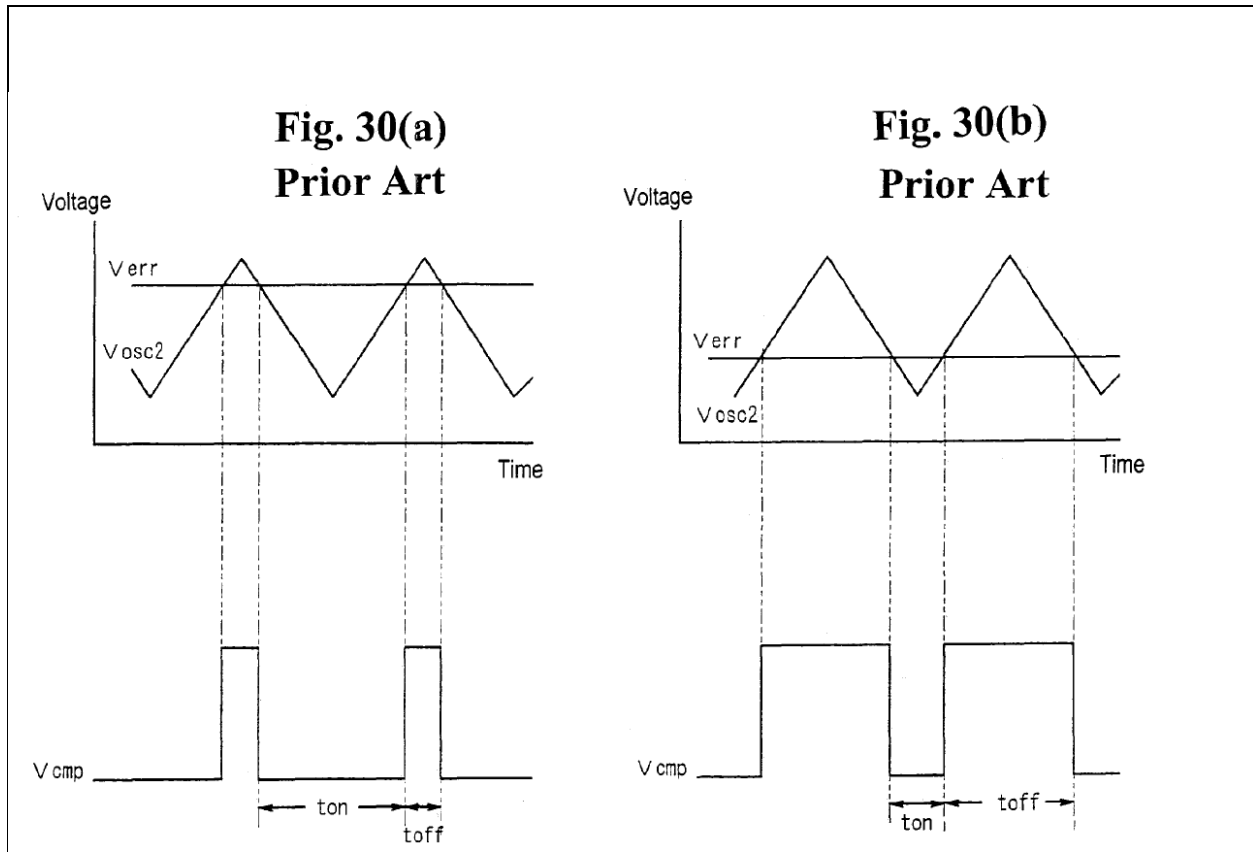
EX1003, ¶¶96-101.

2. Yoshida

Yoshida describes a DC-DC converter that “switches a semiconductor switch device for converting a DC voltage to a certain level and supplies the converted DC voltage to a load.” EX1008, Abstract. Yoshida teaches that PWM was a conventional feedback control method for a DC-DC converter (EX1008, 1:23-26), and illustrates a conventional step-down DC-DC converter in Figure 29 (annotated below). Figure 29 shows a p-type semiconductor switch P1 (which conducts when the gate voltage is “low”) connecting an input V_{IN} (yellow) to a load output V_{OUT} (green) via an LC circuit, and an N-type semiconductor switch N1 (which conducts when the gate voltage is “high”) connecting the LC circuit to ground:



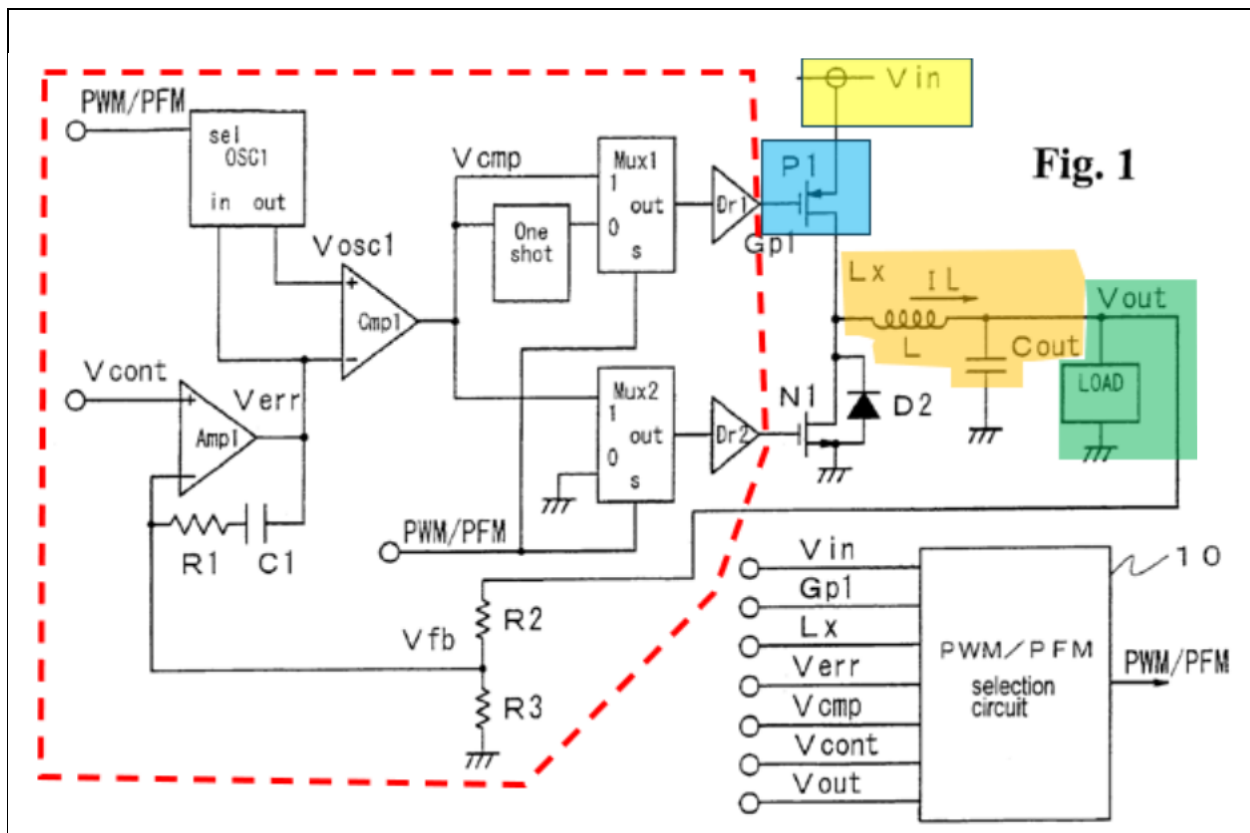
EX1008, 1:37-39, 2:19-31. The circuitry on the left, highlighted in red, creates and controls the width pulses which turn the switches P1 and N1 (blue) on and off. EX1003, ¶105. A comparator Cmp1 compares a triangular wave signal V_{OSC2} from an oscillator to a threshold voltage V_{ERR} (itself based on a control voltage V_{CONT} and a feedback signal V_{fb}) to generate pulses output at V_{CMP} of varying widths depending on the value of V_{ERR} . EX1008, 1:48-67, 2:12-19, Fig. 30 (below):



Because the switch P1 is closed (conductive) and switch N1 is open when the signal V_{CMP} is low, the “on” time t_{ON} of the switch corresponds to the low periods of the pulses on signal V_{CMP} . *Id.*, 2:19-20, 2:46-55. The ratio of the output voltage V_{OUT} to the input voltage V_{IN} is proportional to the ratio of t_{ON} to total cycle time (the “duty ratio”) according to the formula $\frac{V_{OUT}}{V_{IN}} = t_{ON}(t_{on} + t_{off})$. *Id.*, 2:46-55.

Yoshida teaches variations which expand on this basic concept, including combinations capable of switching between PWM and pulse-frequency modulation (PFM). EX1003, ¶108. For example, Figure 1 (annotated below) teaches a down-

conversion circuit which contains the same switches P1 and N1 driven by PWM circuitry to down-convert an input voltage V_{IN} to an output voltage V_{OUT} (which is smoothed out to a DC voltage by an LC circuit), but with additional circuitry to switch between PWM and PFM modes:

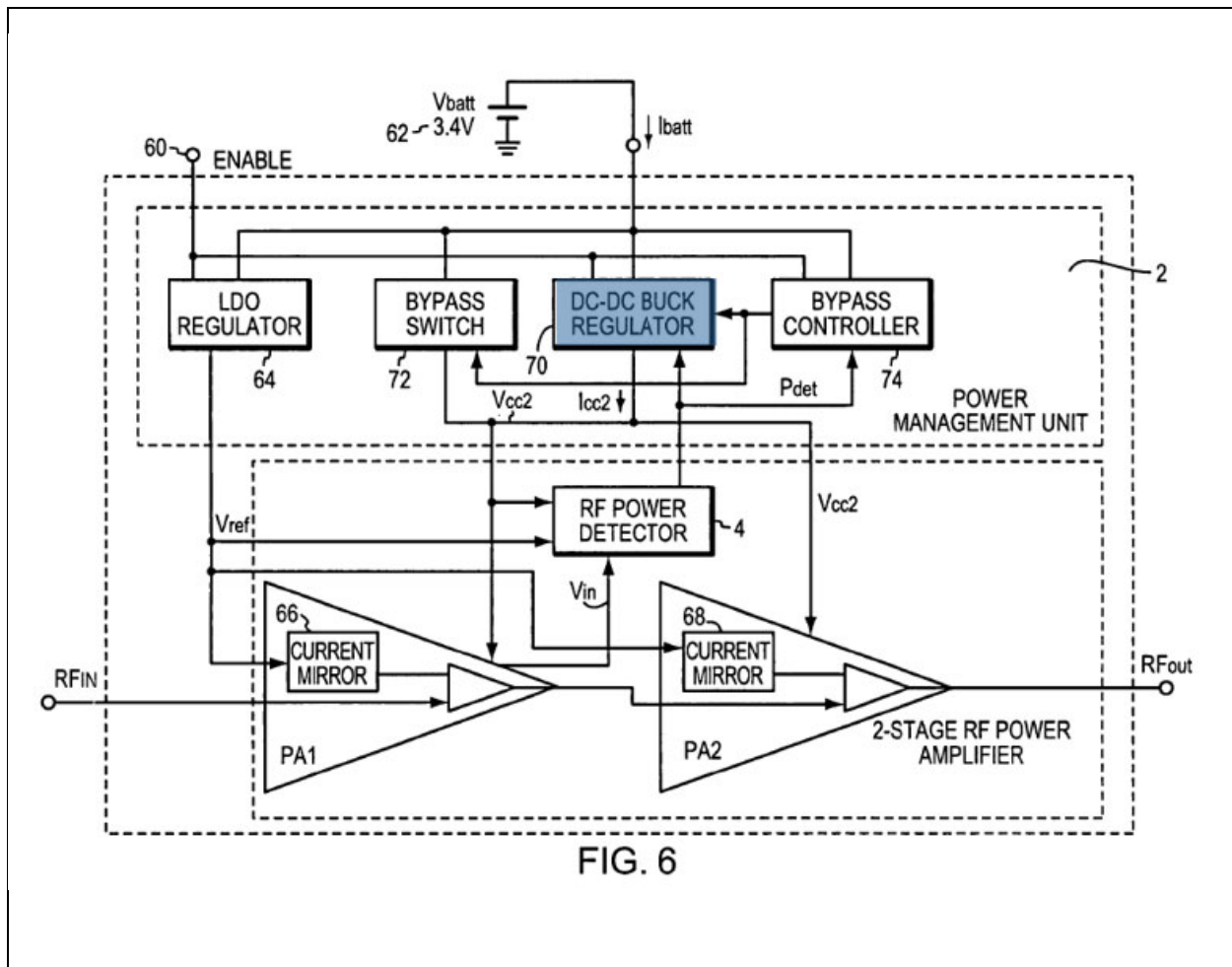


EX1008, Fig. 1, 9:26-49; EX1003, ¶¶102-110.

3. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Hau and Yoshida because Yoshida explains the operation of a “DC-DC buck regulator” as taught by Hau. EX1003, ¶111. Hau explains that its amplifier circuit has a DC-DC buck regulator (i.e., converter) 70, but does not show or explain the details of

its operation. EX1007, Fig. 6 (annotated below):



EX1003, ¶111.

Instead, Hau simply says that the design of the buck converter is “known to those in the art.” EX1007, 5:39-40. Therefore, a POSITA would have been motivated to look at other references describing such converters in more detail in order to understand the operation of such converters or find a suitable design.

EX1003, ¶112. Yoshida describes examples of such buck converters which down-convert a signal via PWM. EX1008, Fig. 1, Fig. 29, Fig. 20, 1:37-67, 2:12-31,

2:46-55, 9:26-49. A POSITA would have recognized that using a buck converter as taught by Yoshida for the unspecified buck converter taught by Hau would have been a simple combination of known elements according to known methods to yield predictable results. EX1003, ¶¶111-112.

Hau teaches that “virtually any DC to DC converter design... could be advantageously used in embodiments with the present invention.” EX1007, 5:56-61. Hau therefore contains an explicit teaching, suggestion, or motivation to use a suitable DC-DC converter such as that taught by Yoshida, which further indicates that a POSITA would have had a reasonable expectation of success combining references. EX1003, ¶113. Moreover, a POSITA would also have expected success making the combination because Yoshida’s DC-DC converter circuits take the same inputs and outputs (a DC input at a higher voltage, output at a lower voltage) as Hau. *Id.*

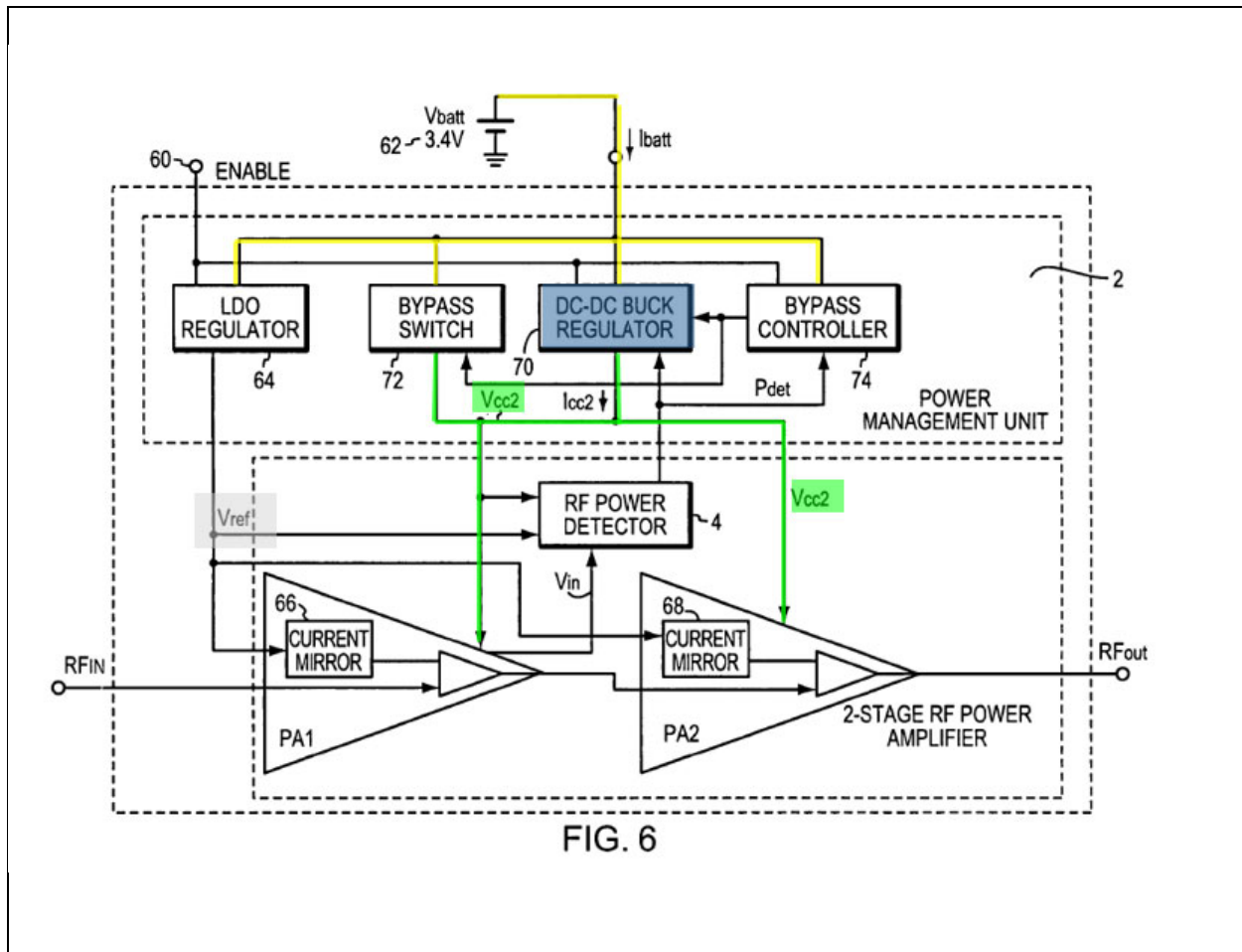
4. Claim 1

a. 1[pre]: A power supply comprising:

If limiting, Hau teaches 1[pre]. Hau teaches a power supply which provides supply voltage V_{CC1} and V_{CC2} for power amplifiers PA1 and PA2. EX1007, Title, Abstract, Fig. 1, Fig. 6, 4:7-22, 5:39-51; EX1003, ¶114.

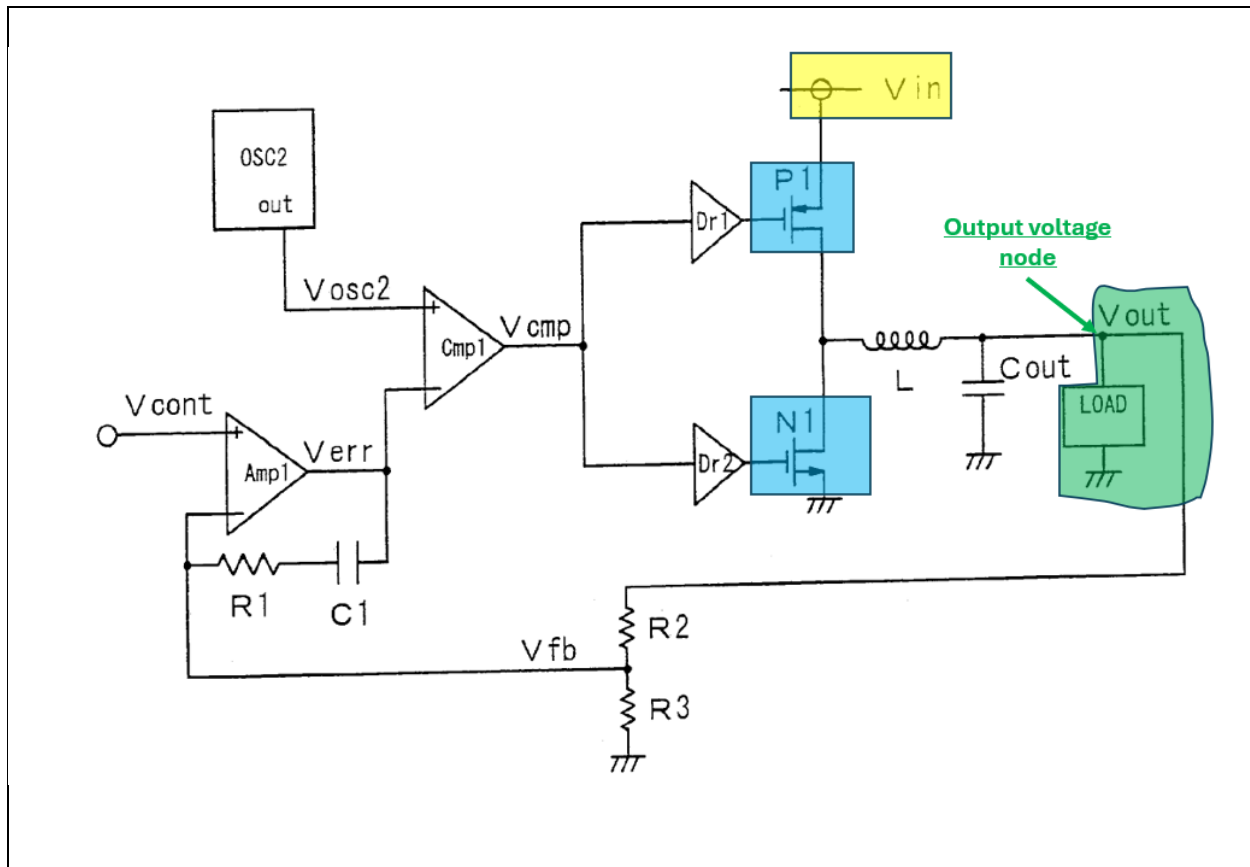
- b. 1[a] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node

Hau in combination with Yoshida teaches this element. Hau teaches a DC-DC buck converter (*a switching device*) which down-converts an input voltage V_{batt} (*configured to downconvert an input voltage*) and passes a down-converted voltage V_{cc2} to an output voltage node (i.e. all nodes at voltage V_{cc2}) (*pass the down-converted input voltage to an output voltage node*).



EX1007, Fig. 6 (annotated), 5:39-46.

The switches P1 and N1 in Yoshida's DC-DC down-converter, when used within the DC-DC buck regulator of Hau (*see* §VIII(A)(3)), teach a “switching device” which down-converts the input voltage V_{in} to an output voltage V_{out} at an output voltage node, such as the node to which the load is connected:

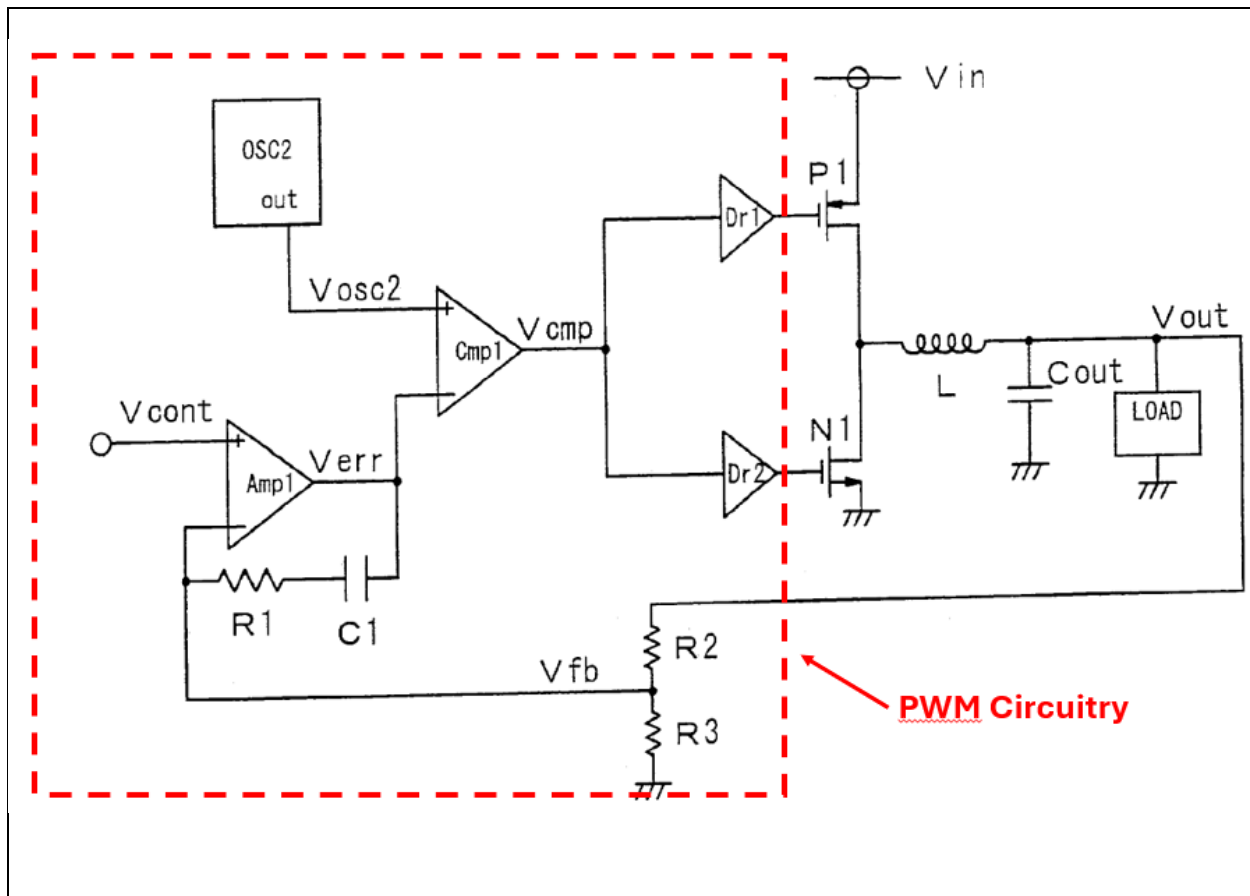


EX1008, Fig. 29 (annotated), 1:37-39, 2:19-31; *see also id.*, Fig. 1, 9:26-49. The switches P1 and N1 are switched on and off by the pulses output at V_{CMP} which have varying widths, and the duty ratio (percentage of “on” time) of those pulses controls the output voltage. *Id.*, 2:19-20, 2:46-55. Yoshida's switch therefore down-converts the input voltage V_{IN} to an output voltage V_{OUT} controlled by the

duty ratio of the pulses switching switches P1 and N1. *Id.*, 2:46-55; EX1003, ¶¶115-117.

c. 1[b1] an aperture generator and control module configured to control the switching device

The AGCM performs two functions in claim 1: it controls the switching device itself, and it controls bypassing the switching device (as recited in 1[b2] below). As discussed in §§ V.A and VII.B above, in specification of the '593 Patent itself, the first function is performed by the block labeled as the “aperture generator and control,” while the second is performed by the bypass switch control. EX1001, Fig. 4, 7:20-23, 7:46-8:3. As discussed in §VIII(4)(d) below, these functions need not be performed by the same circuit element. In the combination using PWM down-conversion as taught by Yoshida for the DC-DC buck regulator of Hau, the first function is performed by Yoshida’s PWM circuitry (including the oscillator OSC2, Amplifier Amp1, comparator Cmp1, and driver Dr1) (*aperture generator and control module*) which outputs PWM control pulses to the switches P1 and N1 (*control the switching device*). EX1008, Fig. 29 (annotated below), 1:48-2:4, 2:12-20, 2:28-31:



See also *id.*, Fig. 1, 8:60-9:3, 9:12-37, 9:40-51; EX1003, ¶¶118-119.

For the reasons explained in §VII(B), this limitation is not means-plus-function. If the Board finds it is, however, then the corresponding structure in the '593 Patent is the Aperture Generator and Control 404, Bypass Switch Control 402, Bypass Switch 406, and switch 420, of which the AGCM 404 performs the function of “control[ing] the switching device.” The AGCM 404 is a type of circuit known in art that creates and regulates the width (aperture) of pulses that control a switching device (switch 408 in the '593 Patent). §VII(B), EX1003, ¶120. Yoshida’s PWM circuitry is an identical or equivalent structure to the

AGCM 404; that is, it is circuitry that creates and regulates the width of pulses that open and close switches P1 and N1 (a “switching device”) and thus controls the switches to create a down-converted voltage at V_{OUT} . EX1003, ¶¶120-121.

- d. **1[b2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node**

The second function of the AGCM, the “bypass” function, is taught by Hau. Hau teaches a bypass controller 74 (purple) which receives a signal Pdet from a power detector (pink) and activates a bypass switch 72 (purple) when the signal Pdet exceeds a predetermined threshold (*in response to a power efficiency of the power supply exceeding a predetermined threshold*). EX1007, Fig. 6 (annotated below), 5:43-51, 6:57-7:2.

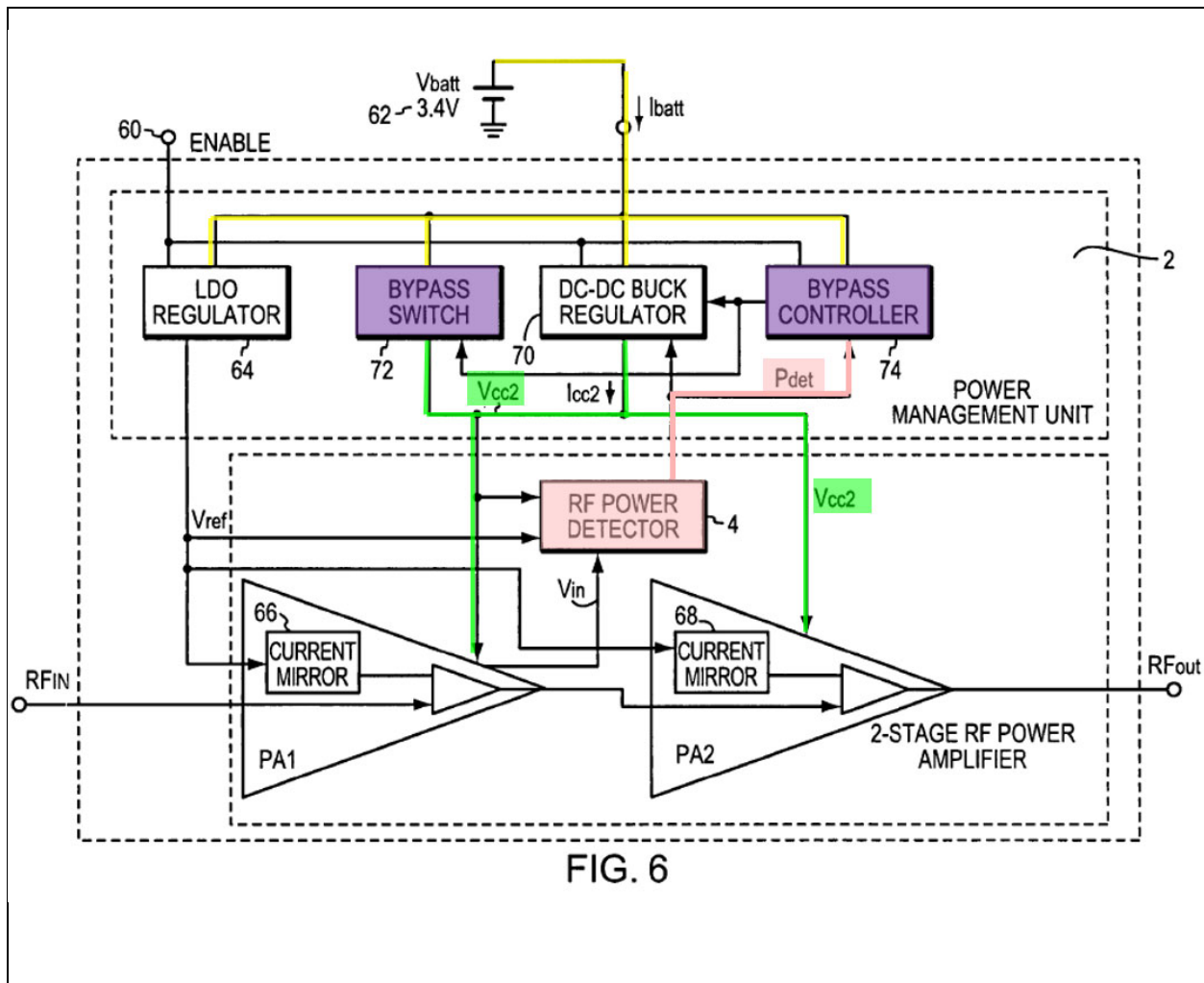


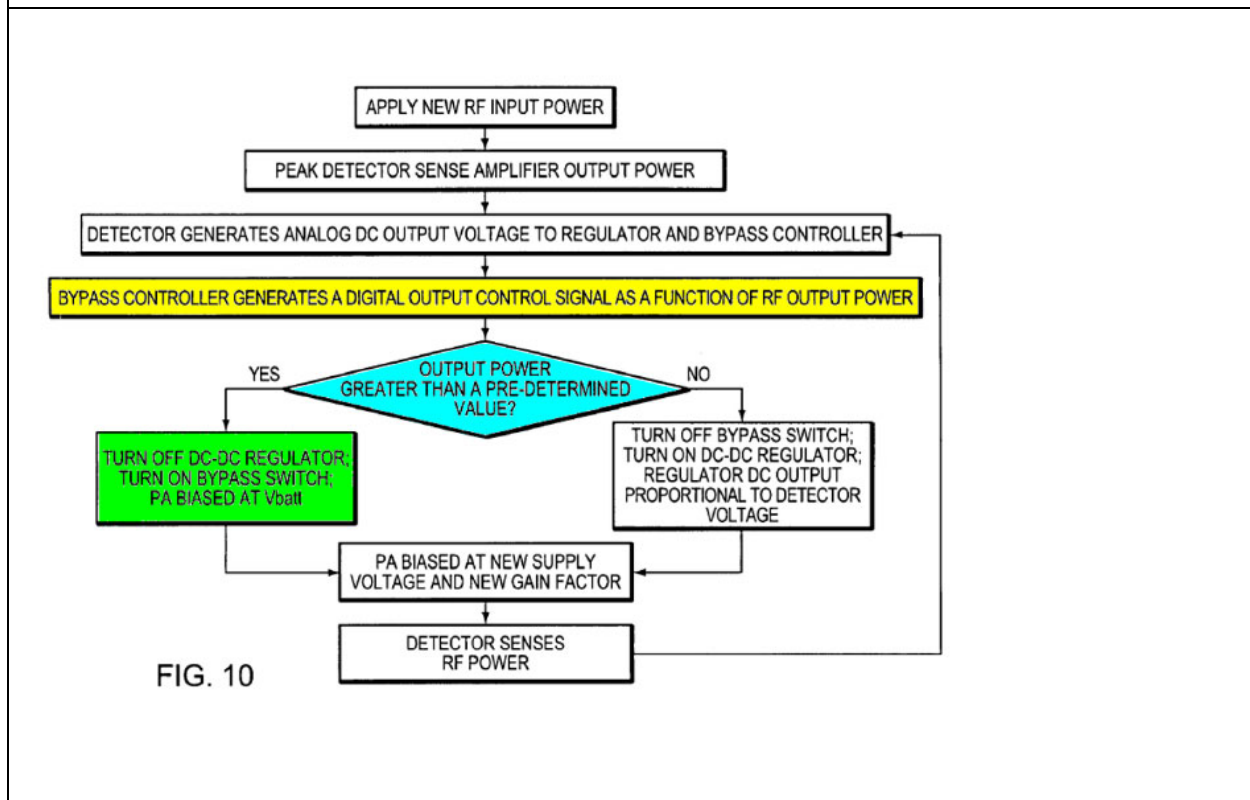
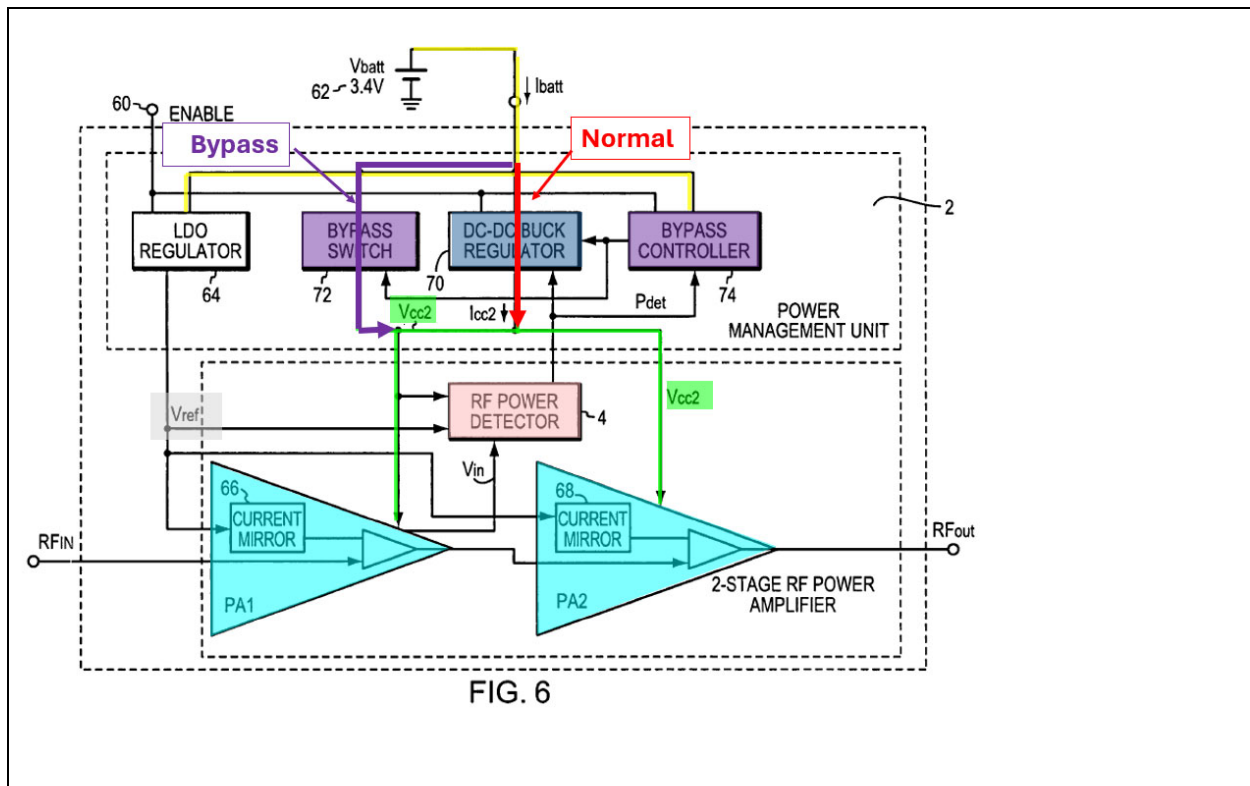
FIG. 6

Hau teaches that the strength of the signal P_{det} , the power output of the amplifier PA1, and the supply voltage V_{cc2} are all proportional. EX1007, 6:22-44; EX1003, ¶¶122-123. Therefore, P_{det} is an indicator of the power output by the DC-DC buck regulator at V_{cc2} . Because input power is supplied to the DC-DC buck regulator from a fixed voltage, P_{det} is also an indicator of the power efficiency of the DC-DC buck regulator because higher power indicated at P_{det} indicates greater efficiency relative to the fixed input power. EX1003, ¶123. As discussed in §VII(A), the specification of the '593 Patent itself does not describe a

circuit capable of making direct measurements of the power efficiency of a power supply; rather, the only described embodiments measure output power or output power voltage. *E.g.* EX1001, 4:7-10, 7:59-8:8, 8:41-60; EX1003, ¶124.

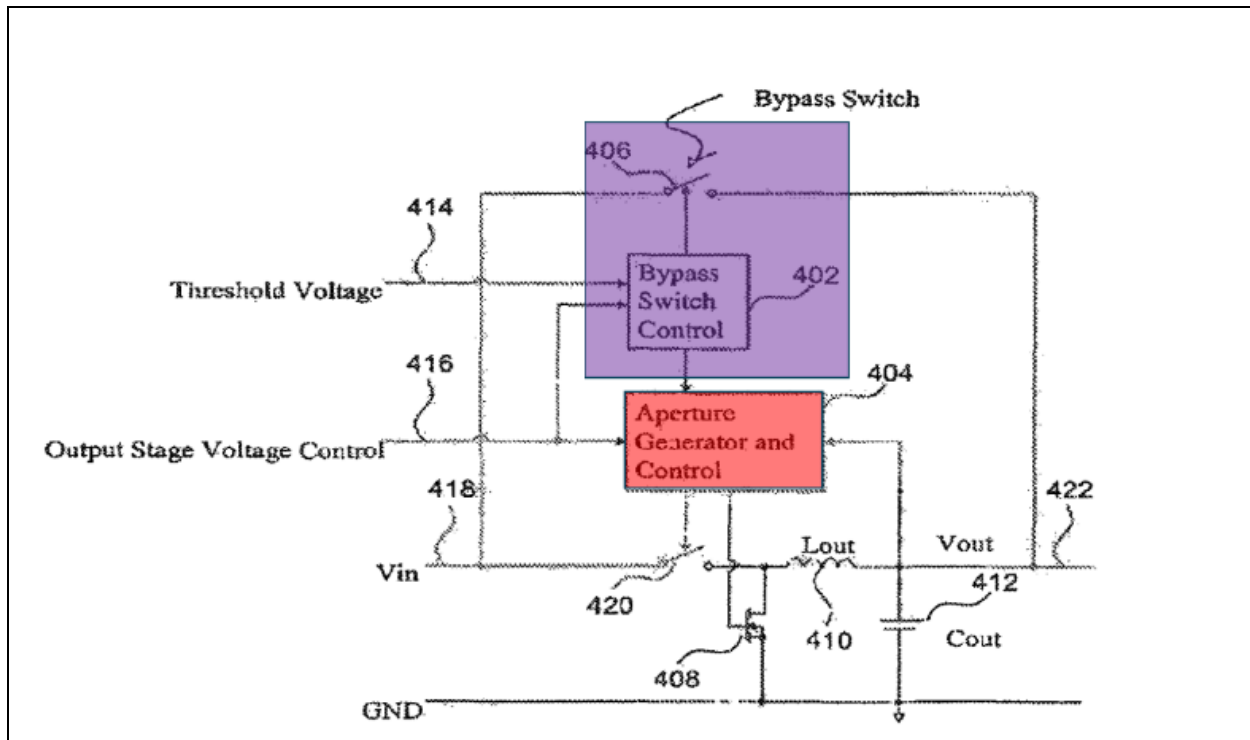
Therefore, Hau teaches “in response to a power efficiency of the power supply exceeding a predetermined threshold...” to the same extent as the specification of the ’593 Patent itself. EX1003, ¶124. *See Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1569 (Fed. Cir. 1988) (prior art taught disputed element by teaching in as much detail as disclosure in challenged patent).

When Pdet exceeds the predetermined threshold, Hau’s bypass controller 74 activates the bypass switch 72 and deactivates the DC-DC converter (which is a PWM switching device in the combination of Hau and Yoshida) (*deactivates the switching device*) to pass the input voltage directly to the output voltage Vcc2 (*passes the input voltage to the output voltage node*). EX1007, 5:44-51, 6:61, 66; EX1003, ¶¶125-126. Figure 6 illustrates the normal and bypass pathways, while Figure 10 shows the steps in the bypass operation (both annotated below):



The plain language of the claim does not require the AGCM to be a single

circuit element. In the '593 Patent specification itself, although block 404 is labeled as the AGCM, the bypass switch control 402 deactivates the switching device and passes the input voltage to the output voltage node, as the claim requires for the AGCM:



EX1001, Fig. 1.

Similarly, in the Hau-Yoshida combination, the claimed functions of the AGCM are performed by the PWM switching circuitry taught by Yoshida (controlling the switching device) and the bypass controller and bypass switch of Hau. EX1003, ¶¶127-129. While the AGCM should not be construed as means-plus-function, if the Board so construes it, the combination of these elements taught by the Hau-Yoshida combination is equivalent to the corresponding

structure in the '593 Patent and described in greater detail. *Id.*, ¶130. Specifically, the corresponding structure in the '593 Patent that “deactivates the switching device and passes the input voltage to the output voltage node” is the Bypass Switch Control 402, Bypass Switch 406, and switch 420. Hau’s bypass controller 74 and bypass switch 72 are the same or equivalent structure as these elements, because the bypass controller 74 is a circuit that controls a switch (bypass switch 72) to pass an input voltage directly to an output and bypass a down-converter. *Id.*, ¶130.

5. Claim 2

- a. **The power supply of claim 1, wherein the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node**

Hau suggests claim 2’s additional element. Although in Hau’s preferred embodiment the bypass controller relies on a voltage measurement indicative of power to perform the bypass function (*deactivate the switching device*), Hau teaches that “prior art related the output current to the output power from the $(I)(V)=\text{power relationship}$,” where $I=\text{current}$ and $V=\text{voltage}$. EX1007, 6:40-44. Hau thus at least suggests using current measurements to perform the same switching function (*based on a load current at the output voltage node*). EX1003, ¶131. Additionally, a POSITA would have recognized that 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.*, ¶¶131-132. Because the bypass controller of Hau performs the “deactivating” function of the AGCM as discussed regarding element 1[b2] above, a POSITA would have recognized that it would have been obvious for Hau’s bypass controller to perform that function using a current measurement instead of a voltage/power measurement. *Id.*

6. Claim 5

- a. The power supply of claim 1, wherein the aperture generator and control module is configured to provide an output current at a maximum power efficiency associated with the down-converted input voltage**

Hau teaches claim 5’s additional element. Hau repeatedly teaches that its circuit, including the DC-DC buck regulator (which includes the “aperture generator and control module” and “switching device,” when implemented using PWM control circuitry as taught by Yoshida), provides a DC voltage that is a measure of the optimum output power. *E.g.*, EX1007, Figs. 2-5, 8-9, 3:30-28, 4:12-16, 4:66-5:22, 6:15-21, 6:34-37, claim 1. This optimum output power “provides the most efficient current consumption for each power output level.” *Id.*, 4:51-54. Hau explicitly teaches that the DC voltage VCC2 “supplies current” to the amplifier. *Id.*, 6:22-25. Hau teaches the provided output power is “an output

current at a maximum power efficiency associated with the down-converted input voltage.” EX1003, ¶133.

7. Claim 6

- a. The power supply of claim 1, 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.**

Hau teaches or suggests claim 6’s additional element. As discussed regarding element 1[b2], in Hau, P_{det} is proportional to V_{cc2} , and the bypass controller (AGCM) determines whether to bypass the DC-DC converter (*deactivate the switching device and pass the input voltage to the output voltage node*) by comparing P_{det} to a threshold voltage (*based on a comparison of the down-converted input voltage to a threshold voltage*). See, e.g., EX1007, 6:63-66. Hau further teaches that this set point corresponds to a specified V_{cc2} . *Id.*, 5:48-51. Therefore, a POSITA would have understood that P_{det} is an indicator of the down-converted input voltage V_{cc2} . EX1003, ¶134. Accordingly, the bypass controller (which is part of the AGCM) deactivates the DC-DC buck regulator (switching device) and passes the input voltage directly to an output voltage node based on the comparison of the down-converted input voltage (indicated by P_{det}) to a threshold voltage. *Id.*

8. Claim 7

- a. The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value**

Hau teaches or suggests claim 7's additional element. Hau's threshold is a predetermined (i.e., fixed) value. EX1007, 6:63-66; EX1003, ¶135.

9. Claim 9

- a. 9[pre] a method for controlling a power supply comprising:**

Claim 9 recites the method steps of claim 1 without the structural limitations; that is, it describes a method which is performed in normal operation of the power supply claimed in claim 1. Therefore, a POSITA would have recognized that the Hau-Yoshida combination teaches the method steps of claim 9 for the same reasons described for claim 1 and below. EX1003, ¶¶136-137.

- b. 9[a] down-converting, with a switching device, an input voltage to generate a down-converted voltage**
- c. 9[b] passing the down-converted voltage to an output voltage node**

Steps 9[a] and 9[b] are performed in the combination by Hau's DC-DC buck regulator with Yoshida's switching PWM circuitry for the reasons discussed regarding element 1[a]. EX1003, ¶138.

- d. 9[c] in response to a power efficiency of the power supplying [sic] exceeding a predetermined threshold, de-activating the switching device and passing the input voltage to the output voltage node**

See element 1[b2]. EX1003, ¶139.

10. Claim 11

- a. The method of claim 9, further comprising: providing an output current at a maximum power efficiency associated with the down-converted voltage**

See claim 5. EX1003, ¶140.

11. Claim 12

- a. The method of claim 9, 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**

See claim 6. EX1003, ¶141.

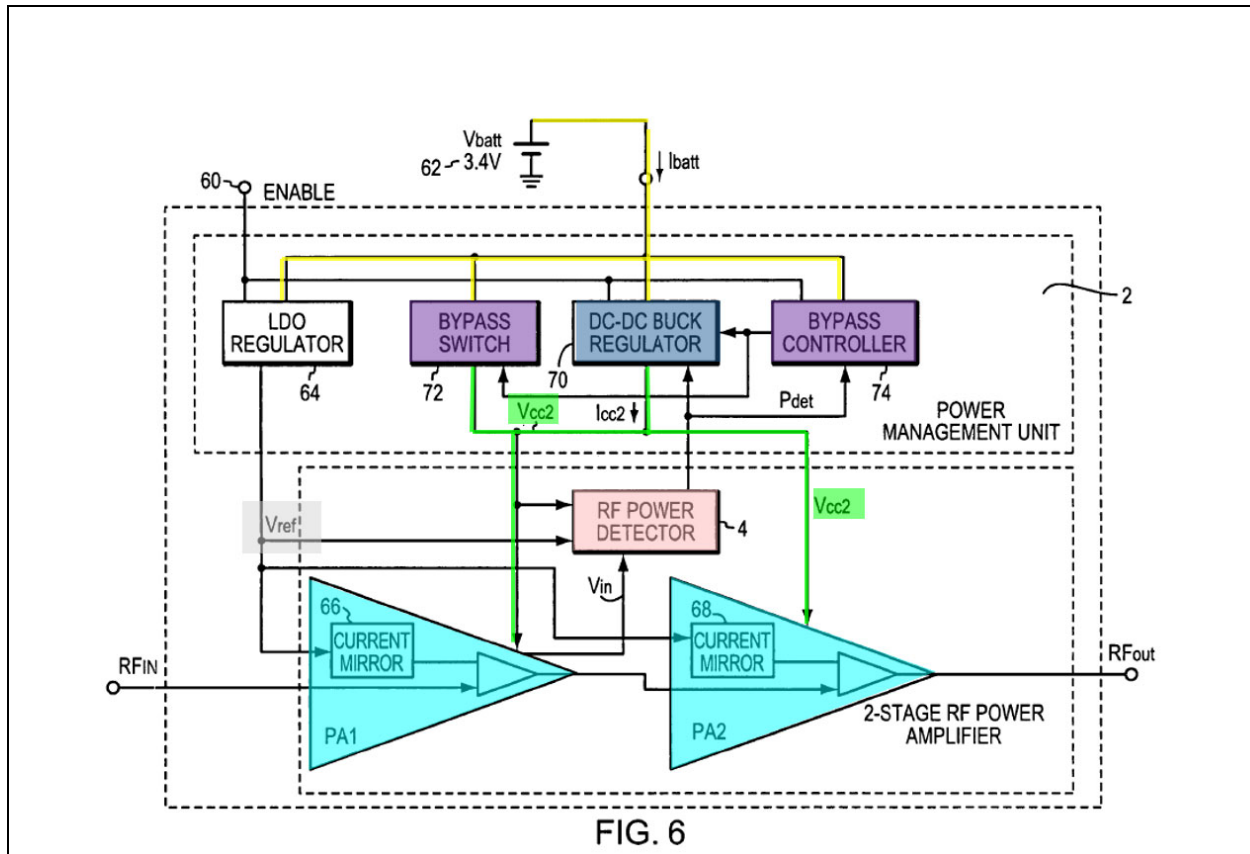
12. Claim 15

- a. 15[pre] a system comprising**

Claim 15 recites a system that comprises an electronic device in addition to the elements of claim 1. *Hau* in view of *Yoshida* teaches a system which includes amplifiers in addition to the power supply discussed regarding claim 1 and may be used in a larger system such as, for example, a mobile handset. EX1007, Abstract; EX1003, ¶142.

b. 15[a] an electronic device

Hau teaches this element. Both the amplifiers PA1 and PA2, and the larger device (such as a mobile handset) of which the power supply is a part alternatively satisfy the element of an “electronic device.”



EX1007, Fig. 6 (annotated), 4:7-12, 4:19-21, 5:23-26, 5:40-48; EX1003,

¶143.

c. 15[b] a power supply coupled to the electronic device, wherein the power supply comprises

Hau teaches a power management unit 2 (*a power supply coupled to the electronic device*), which includes the bypass switch 72, bypass controller 74, and

DC-DC buck regulator 70, which in the combination is implemented using the PWM circuit of Yoshida as discussed regarding claim 1. The power management unit is coupled to the amplifiers via output bias voltage V_{cc2} . EX1007, Fig. 6, 5:23-26, 5:40-43; EX1003, ¶144. Alternatively, the entire power circuit shown in Figure 6 teaches the “power supply,” and it is coupled to the larger “system” (e.g., a handset as discussed above regarding 15[pre]) via the battery input, RF input RF_{IN} , and RF output RF_{out} . EX1003, ¶145.

- d. 15[c] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node**

See element 1[a]. EX1003, ¶146.

- e. 15[d1] an aperture generator and control module configured to control the switching device**

See element 1[b1]. EX1003, ¶147.

- f. 15[d2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node**

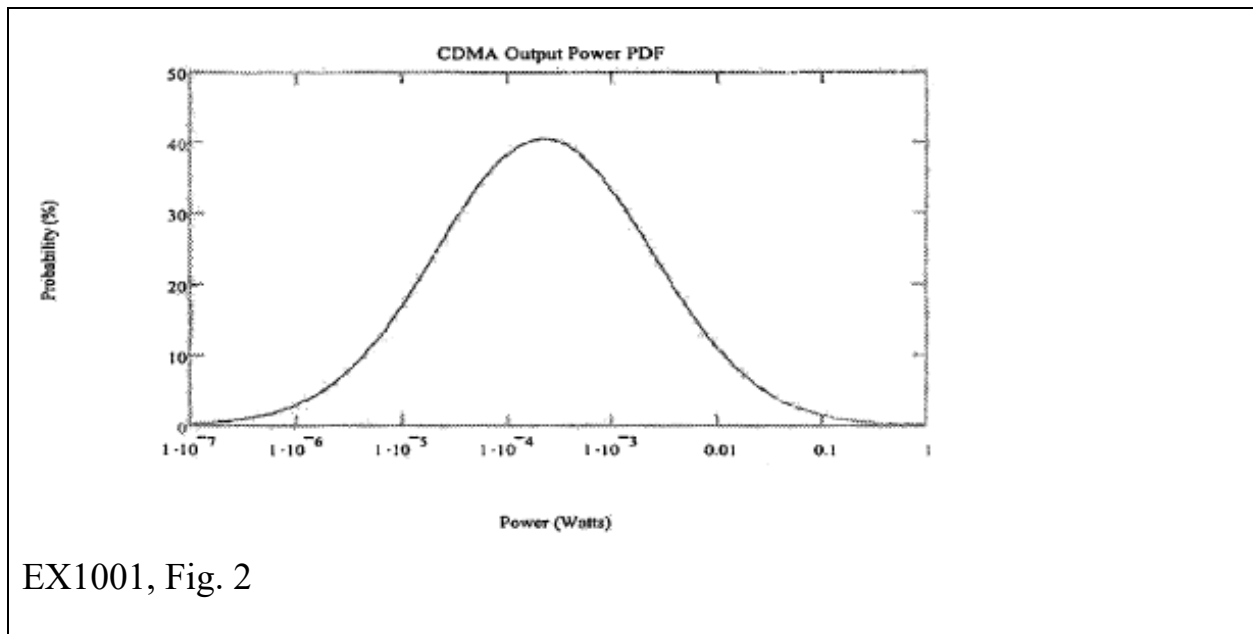
See element 1[b2]. EX1003, ¶148.

B. Ground 1B: Claims 3-4, 8, 10, 13-14, and 17-20 are Unpatentable as Obvious over Hau in view of Yoshida and further in view of Sahu

1. Sahu

Sahu (EX1009) is a 2004 paper which discusses energy efficiency of power

amplifiers (PAs) in CDMA applications. Sahu notes (*id.*, 113) that power control is “essential to ensure the CDMA system operates smoothly” to enable sufficient communication power while avoiding interference with other users in the same RF band. The required transmit power for various applications may vary, which Sahu illustrates with a probability curve in Figure 1, similar to the ’593 Patent’s Figure 2:



EX1009, Fig. 1

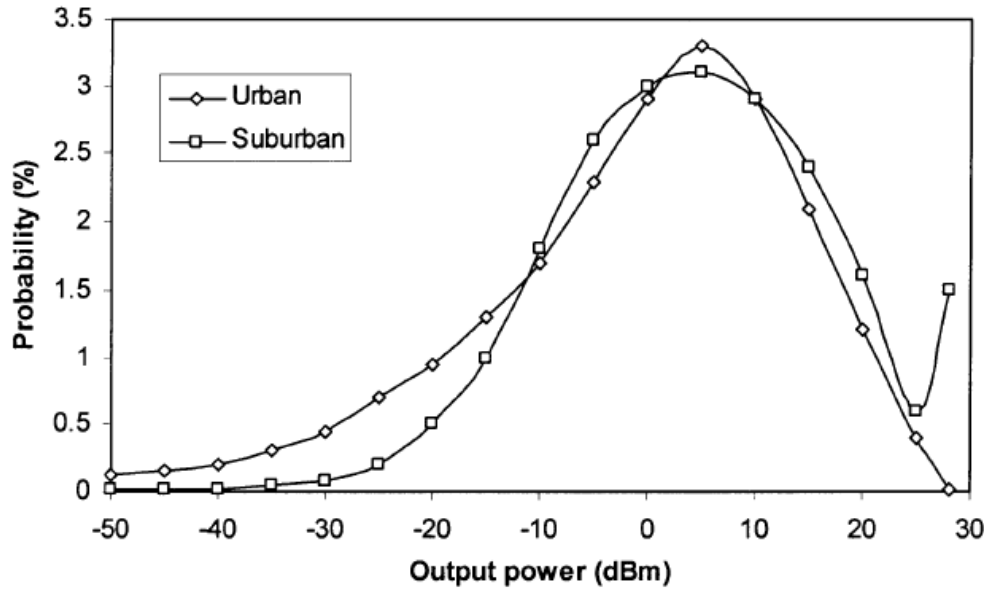


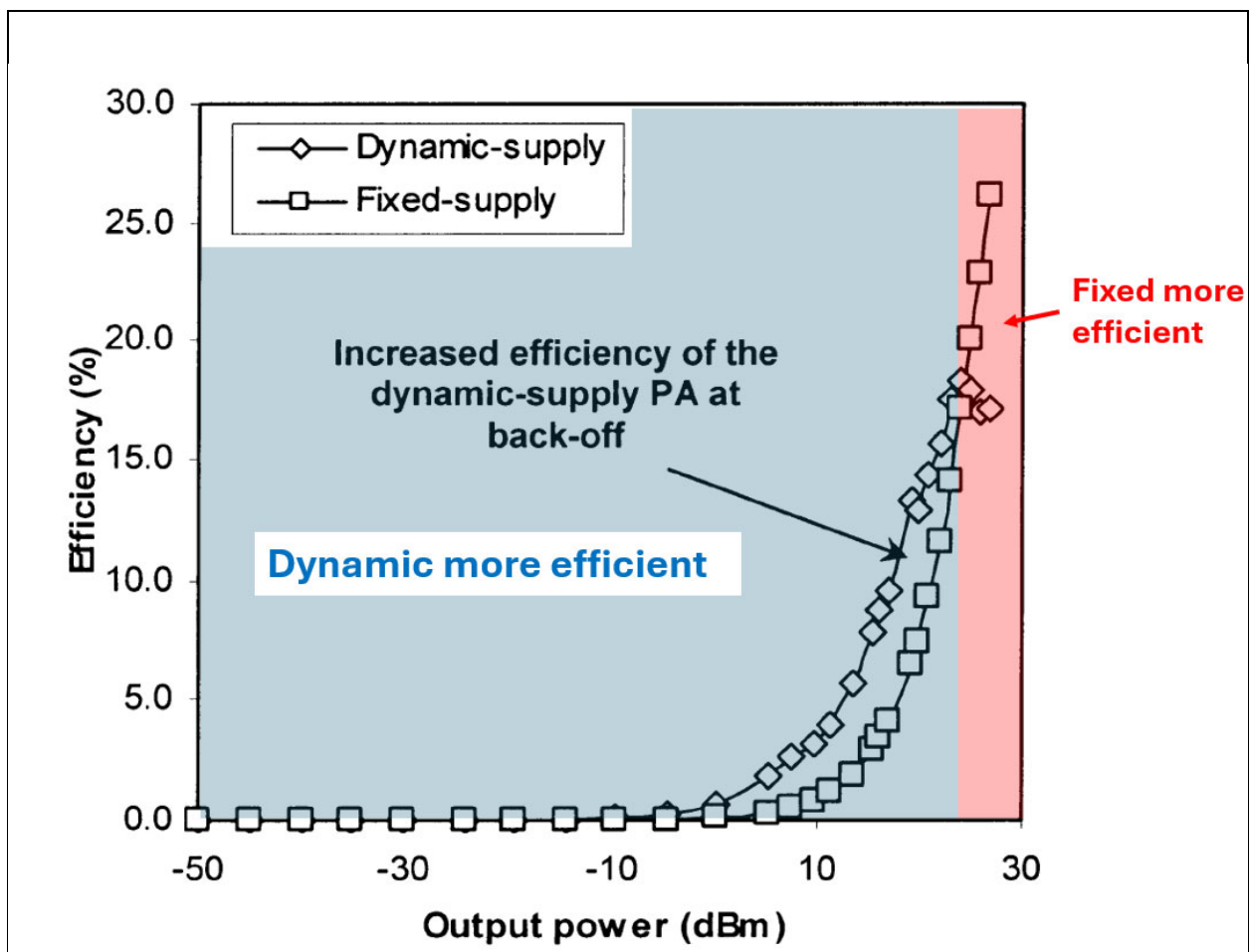
Fig. 1. Probability curves for transmit power level in urban and suburban environments [2].

EX1009, 113; EX1003, ¶¶149-151. Sahu teaches that because the PA typically operates at less than peak output power, the PA should be optimized for average efficiency rather than peak efficiency, with the average efficiency calculated by the following formula:

$$\eta_{\text{avg}} = \frac{\int_0^{P_{\text{RF_out,max}}} P_{\text{RF_out}} p(P_{\text{RF_out}}) dP_{\text{RF_out}}}{\int_0^{P_{\text{RF_out,max}}} P_{\text{SUPPLY_in}}(P_{\text{RF_out}}) p(P_{\text{RF_out}}) dP_{\text{RF_out}}}$$

where $P_{\text{RF_out}}$, $p(P_{\text{RF_out}})$ and $P_{\text{SUPPLY_in}}(P_{\text{RF_out}})$ are RF output power, the probability of operating at RF output power, and the supply power required at $P_{\text{RF_out}}$, respectively. EX1009, 113.

Sahu describes various types of dynamic power systems to provide an optimum amount of power for transmission requirements in a mobile environment, including buck, boost, and buck-boost power supplies. *Id.*, 113-115. Sahu describes a preferred embodiment using a buck-boost conversion system. *Id.*, 116. Sahu's Figure 8(a) (annotated below) compares the efficiency of the proposed dynamic power supply to a fixed power supply over various power levels, showing increased efficiency of the dynamic-supply PA at lower levels, but better performance from a fixed supply at the highest power levels:

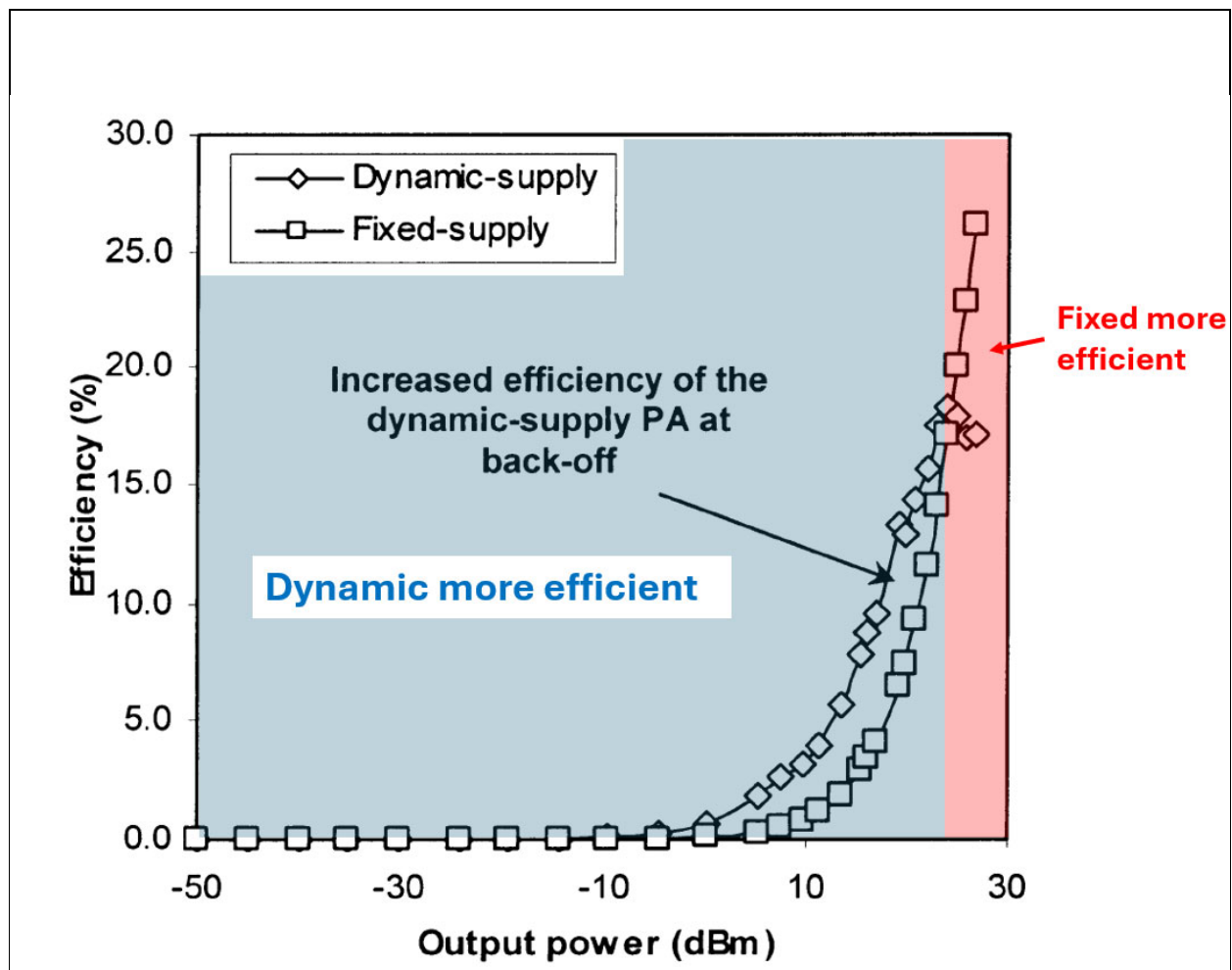


EX1003, ¶¶152-153.

2. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Sahu with the combined teachings of Hau and Yoshida discussed for Ground 1A. Sahu is in the same field of endeavor as Hau because both references discuss power supplies for RF transceivers such as mobile handsets, and specifically address issues relating to optimizing the efficiency of such power supplies. EX1007, Abstract, EX1009, Abstract. In addition, Sahu is analogous art to Hau because a POSITA would have logically considered the teachings of Sahu to be relevant to the problems addressed by Hau. EX1003, ¶154. Moreover, both Hau and Sahu are directed to power supplies which operate at less than peak power for the majority of the time based on the power requirements associated with mobile transmission. EX1007, 1:33-61, 5:17-20; EX1009, 113; EX1003, ¶155. Therefore, 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 (EX1009, 113) as instructive for optimizing the performance of a power supply taught by Hau (as modified by Yoshida). EX1003, ¶155. Applying Sahu's teachings, to control the performance of a power supply based on its efficiency at the most probable power levels for a given modulation scheme, to the power supply of the Hau-Yoshida combination would have been a

simple application of a known technique to a known device ready for improvement to yield predictable results. *Id.*, ¶156. Sahu further provides a teaching, suggestion, or motivation to utilize a bypass technique such as that taught by Hau because it teaches that for a given system and modulation scheme, a dynamic power supply (like that taught by Hau) may give greater efficiency throughout most of the operating range, but a fixed supply will be more efficient near peak output power. EX1009, Fig. 8a (annotated below):



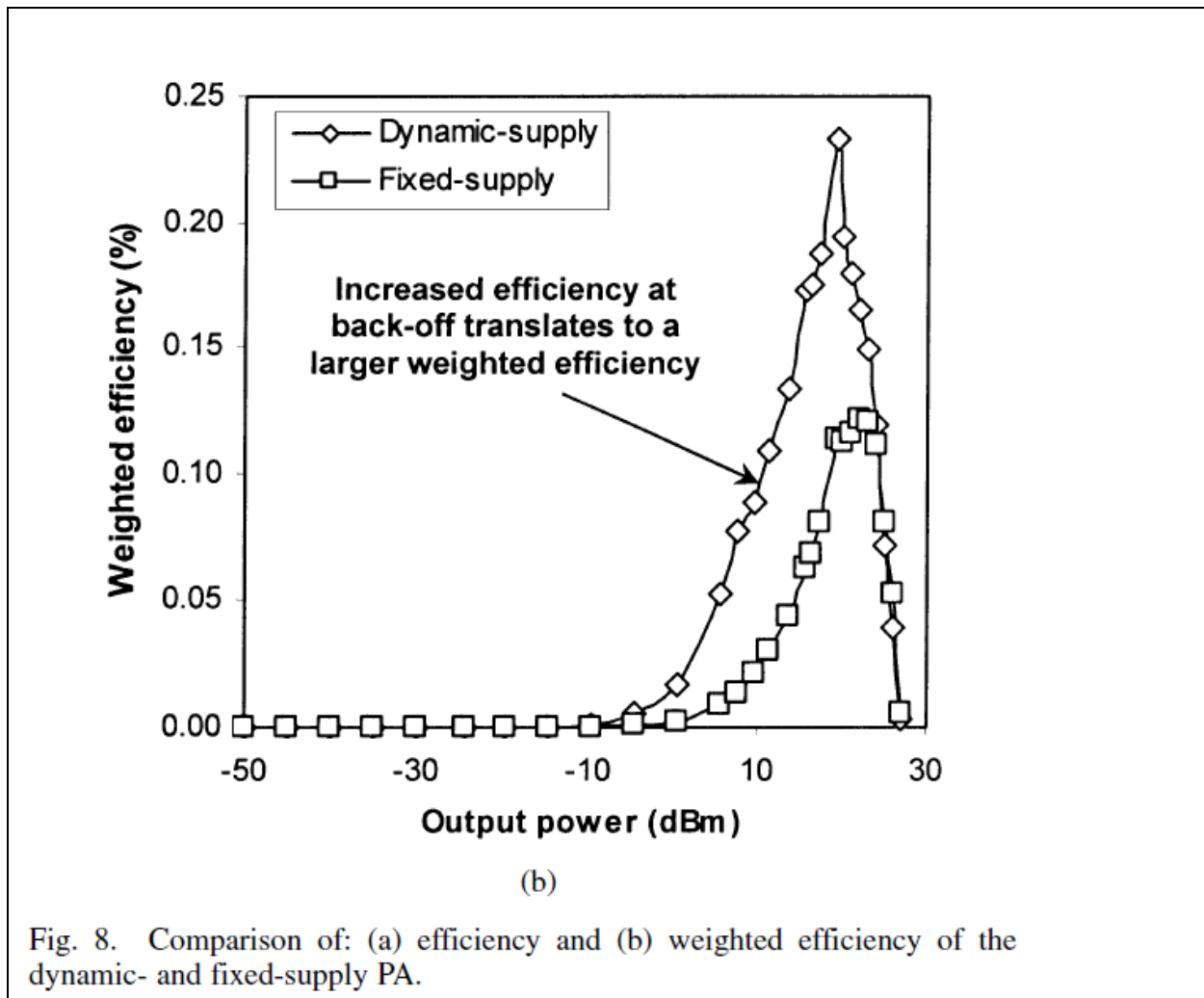
Therefore, Sahu's teaching that fixed power supplies are more efficient at

the highest power output would have suggested to a POSITA to use a bypass system such as that taught by Hau to obtain the highest efficiency near peak power. EX1003, ¶156.

3. Claim 3

- a. The power supply of claim 1, wherein the aperture generator and control module is configured to control 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 a power supply**

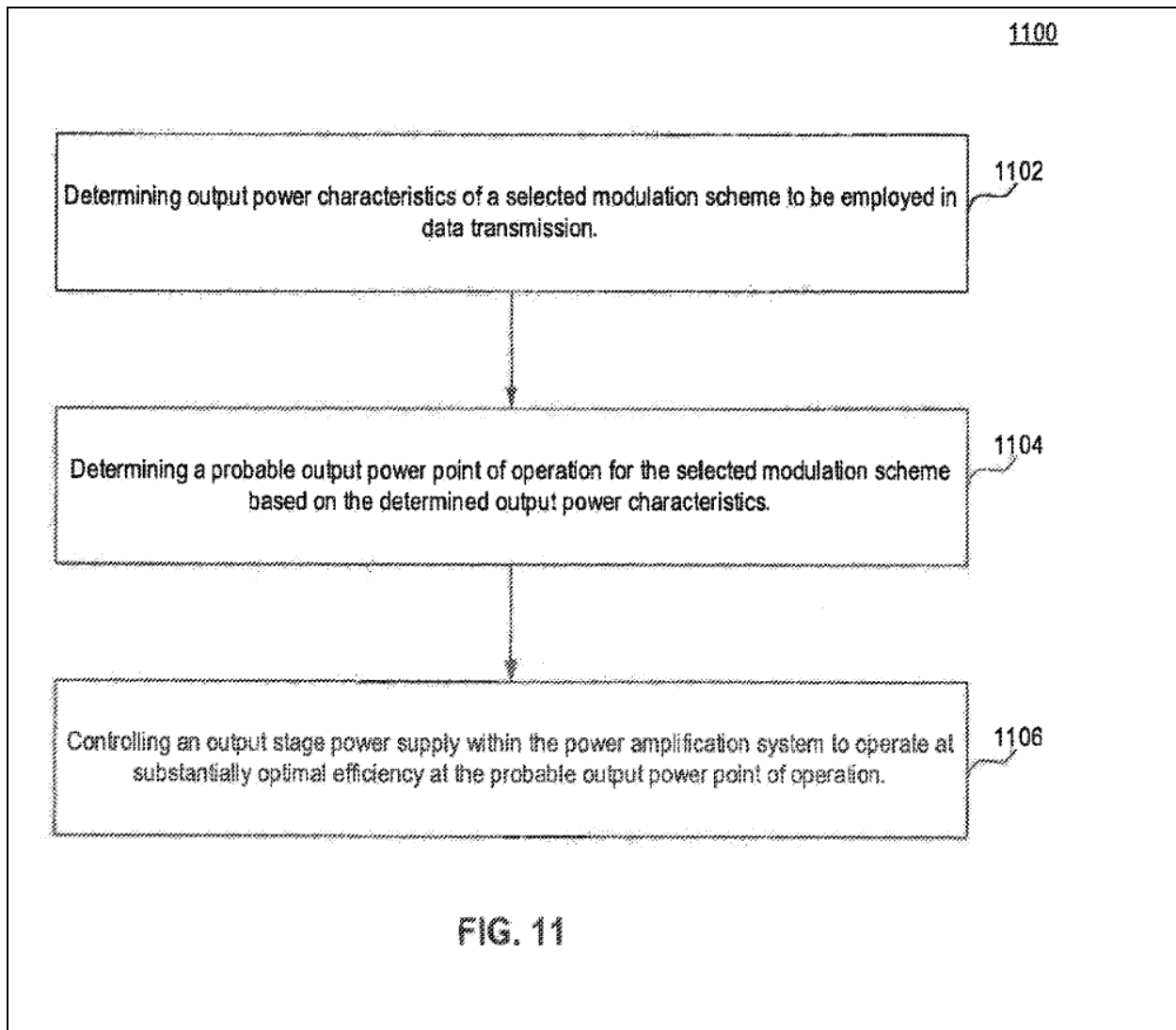
Sahu teaches or suggests claim 3's additional element. Sahu teaches to optimize the output of the PA based on the probability of operating at a given power output for a selected modulation scheme such as CDMA. EX1009, 113, §II.A. Sahu further shows in Figures 8 and 9 that the dynamic power supply used in its PWM-based buck-boost converter achieves higher efficiency at “backoff” power (that is, at less than peak efficiency), and a higher “weighted” efficiency when taking into account the probability of operating at any given power level. *See, e.g. id.*, 118-119, Fig. 8(b) (below):



Sahu therefore teaches that its device is designed to optimize the power efficiency at the most probable power output levels for a given modulation scheme. Because the power levels in Sahu are obtained by PWM control of a switching device (i.e., a buck-boost converter that relies on switched transistors, *id.*, 116-117, §IV(B)), a POSITA would have understood that the PWM control circuitry accordingly controls the switching device to obtain optimal efficiency for probable power levels (*control the switching device based on a probable output power point*

of operation for a selected modulation scheme). EX1003, ¶¶157-159. It would further 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 (using PWM DC-DC conversion as taught by Yoshida for the DC-DC buck converter of Hau, *i.e.* an “aperture generator and control module”), and a POSITA would have recognized that in that case, as in Sahu, the control circuitry for the buck converter (the recited AGCM), also controls the switching device to optimize efficiency for a probable power output. *Id.*, ¶160. It would further have been obvious to a POSITA that the power supply would be controlled to provide an optimal power supply in the combination “based on one or more power efficiency characteristics of an electronic device coupled to a power supply.” For example, Sahu teaches that the experimental results obtained and shown in Figures 6-9 were obtained with a prototype PA system (EX1009, 117, §5) whose characteristics are described in Sahu’s §IV (115-117). EX1003, ¶161.

The specification of the ’593 Patent itself is notably vague about the additional element added by this claim. The closest disclosure is a flowchart in Figure 11 (below) and accompanying text (EX1001, 5:61-6:19):



Nothing in the '593 Patent explains when or where this “process” occurs, i.e., whether it occurs during the design of a power supply, the operation of a device containing such a power supply, or a combination of the two. EX1003, ¶¶162-163. Moreover, the '593 Patent contains no explanation of how to perform the final step 1106, including whether it occurs during design or operation, and the '593 Patent says nothing about how to perform that step “based on one or more power efficiency characteristics of an electronic device coupled to a power

supply.” A POSITA would have understood that this element is taught by Sahu (in combination with Hau and Yoshida) in at least as much detail as the ’593 Patent itself. EX1003, ¶163.

4. Claim 4

- a. The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol**

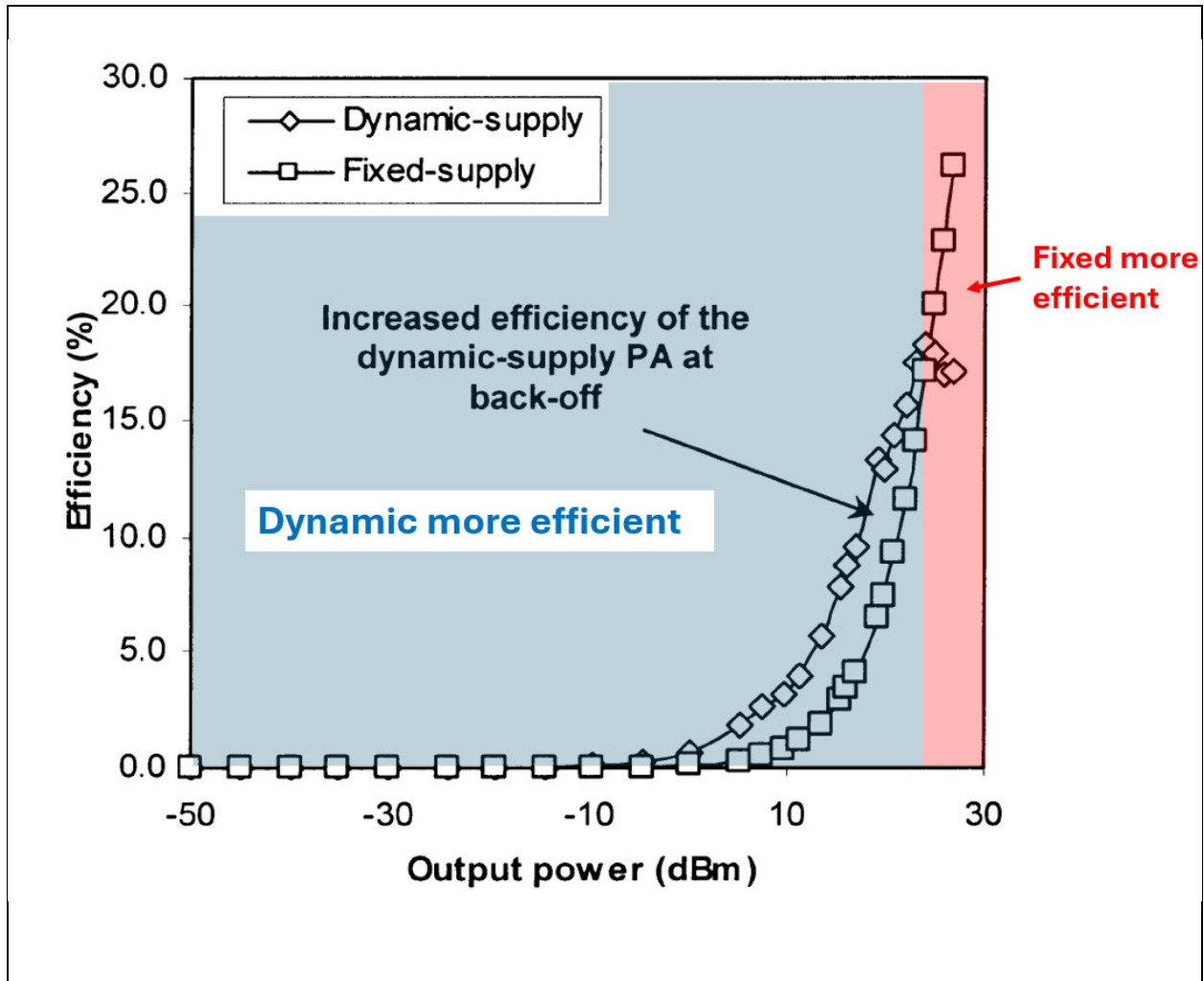
Sahu teaches or suggests claim 4’s additional element. Sahu repeatedly references W-CDMA and discusses using envelope-tracking PAs with W-CDMA. EX1009, 113 (§II(A)), Fig. 2, 114 (§3(A)). It would therefore have been obvious to a POSITA to apply Sahu’s teaching of optimizing efficiency based on likely transmit power for a given modulation scheme to a W-CDMA scheme. EX1003, ¶164.

5. Claim 8

- a. The power supply of claim 6, wherein the threshold voltage is programmed based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof**

Claim 8’s additional element would have been obvious over Sahu in view of Hau and Yoshida. Sahu teaches that for a given system operating with a given modulation scheme, a dynamic power supply (i.e., provided by a down-converter) is more efficient for most of the range of output power, but that a fixed supply is

more efficient for the highest output power:



EX1009, Fig. 8(a) (annotated). It would have been obvious to a POSITA to set Hau's predetermined threshold (EX1007, 6:63-66) 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. EX1003, ¶¶166-167. A POSITA would have recognized that Sahu's efficiency graph shows performance for a particular modulation scheme, and that the resulting efficiency of the system using modulation scheme correlates with the efficiency of the

communication waveform in that scheme (*based on a communication waveform efficiency*). *Id.*, ¶168. Therefore, a POSITA would have understood and found it obvious that basing the predetermined threshold of Hau on the point where a fixed power supply becomes more efficient as taught by Sahu is programming the threshold voltage based on a communication waveform efficiency. *Id.*, ¶168.

6. Claim 10

- a. The method of claim 9, further comprising:
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**

See claim 3. EX1003, ¶169.

7. Claim 13

- a. The method of claim 12, wherein the comparing
comprises 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**

See claim 8. EX1003, ¶170.

8. Claim 14

- a. The method of claim 12, wherein the communication
waveform efficiency is based on a GSM, W-CDMA,
CDMA 2000, EvDO, EDGE, HSUPA, or OFDM
communication protocol.**

See claim 8. EX1003, ¶171. As further discussed regarding claim 4, Sahu

teaches that its teachings apply to W-CDMA. Therefore, when the teachings of Sahu discussed regarding claim 8 are applied to a W-CDMA system, the communication waveform efficiency is based on a W-CDMA communication protocol.

9. Claim 17

- a. The system of claim 15, wherein the electronic device comprises an amplifier with a bipolar junction transistor (BJT), and wherein the power supply is coupled to a collector or an emitter terminal of the BJT**

Sahu teaches or suggests claim 17's additional element. Sahu teaches using a bias control with a variable voltage (the output of a DC-DC converter), coupled to the input and output of the PA, which is either the gate/base or drain/collector of a MOSFET or a BJT. EX1009, 115 (§III(B)). Hau teaches that the output of the power supply (Vcc2) is coupled to two power amplifiers PA1 and PA2, but is silent as to the type of amplifier used other than teaching that "virtually any... power amplifier design could be advantageously used in embodiments with the present invention." EX1007, Fig. 6, 5:40-43, 5:56-61, 6:66-7:2. Because Sahu teaches using BJT or MOSFET amplifiers coupled to the output of a DC-DC converter in the same manner as the PAs in Hau, it would have been obvious to a POSITA to select either a BJT or MOSFET amplifier as taught by Sahu from among the limited types of known common amplifier circuits. EX1003, ¶172.

10. Claim 18

- a. The system of claim 15, wherein the electronic device comprises an amplifier with a metal oxide semiconductor (MOS) transistor, and wherein the power supply is coupled to a drain or a source terminal of the MOSFET.**

See claim 17. MOSFET is a well-known acronym for “metal oxide semiconductor field-effect transistor.” As discussed above regarding claim 17, Sahu teaches coupling the bias voltage (from the power supply) to the drain and collector (source) terminals of the MOSFET. EX1003, ¶173.

11. Claim 19

- a. The system of claim 15, wherein the aperture generator and control module is configured to control 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.**

See claim 3. EX1003, ¶174.

12. Claim 20

- a. The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.**

See claim 4. EX1003, ¶175.

C. Ground 1C: Claim 16 is Unpatentable as Obvious over Hau in view of Yoshida and Lejon

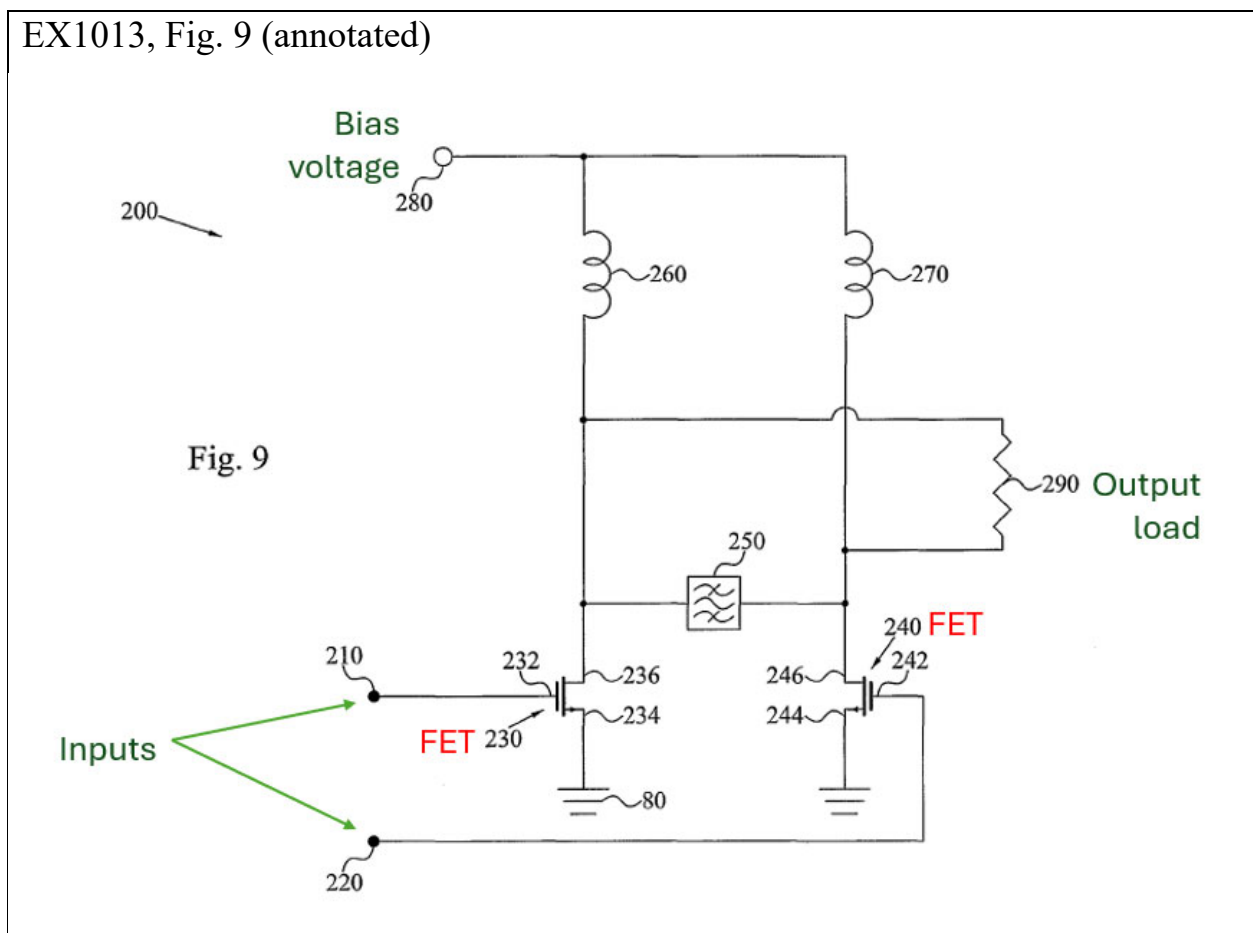
1. Lejon

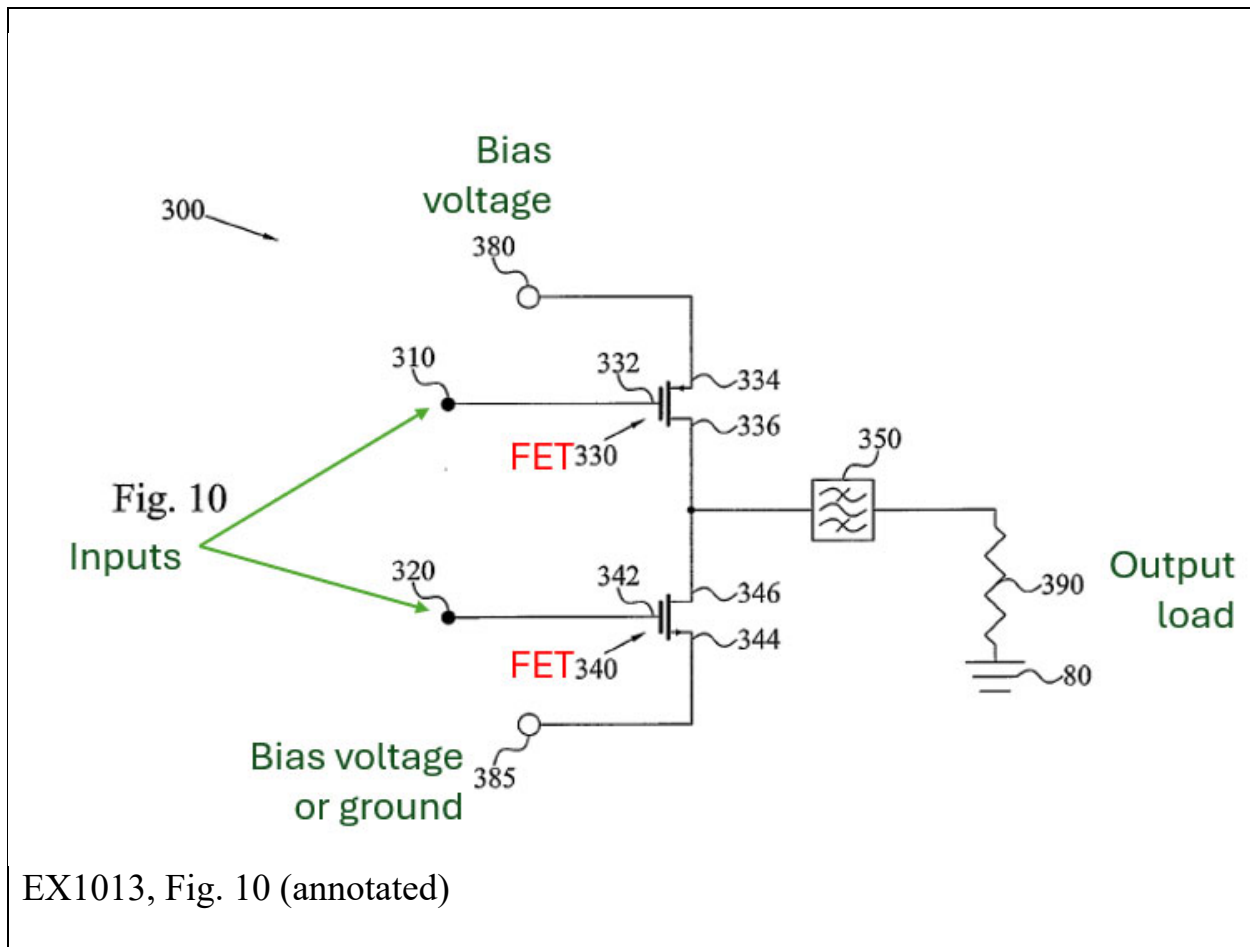
Lejon relates to a linear amplification using nonlinear components (LINC) out-phasing amplifier system, and improving the characteristics of such systems. EX1013, 1:4-7. Such amplifiers may be used to amplify transmissions in complex wireless RF transmission schemes, including Binary Phase Shift Keying (BPSK), Quadrature Phase-Shift Keying (QPSK), and Quadrature Amplitude Modulation (QAM). *Id.*, 1:10-22. Lejon teaches that in such systems, there is “traditionally a complex tradeoff” between goals of high output power and power consumption. *Id.*, 1:27-2:5. Many traditional amplifiers may be efficient at peak power, but lose efficiency at lower envelope powers. *Id.*, 2:7-12.

Lejon accordingly proposes a LINC out-phasing amplifier to provide “excellent efficiency over a vast range of output powers.” *Id.*, 2:14-16. Input signals are provided as in-phase (I) and quadrature-phase (Q) signals, which are then separated, separately amplified, and recombined in an out-phasing network. *Id.*, 2:16-25. Lejon provides several examples of amplifiers used in such a system, including two (Figures 9 and 10) with two inputs and a single output. In the current mode amplifier shown in Figure 9, inputs 210 and 220 control gates of transistors 230, 240 which when closed ground a bias voltage 280 and when open

allow current to flow across a single output load 290. Figure 10 is a voltage mode amplifier with a different configuration, but likewise has two inputs 310, 320 connected to switching transistors 330, 340. An output load 390 is connected via filter 350 to a node between transistors, which are located between bias terminals 380, 385, the latter of which may be a ground:

EX1013, Fig. 9 (annotated)





Id., 21:26-22:25; 23:14-24:2; EX1003, ¶¶176-178.

2. Motivation to Combine

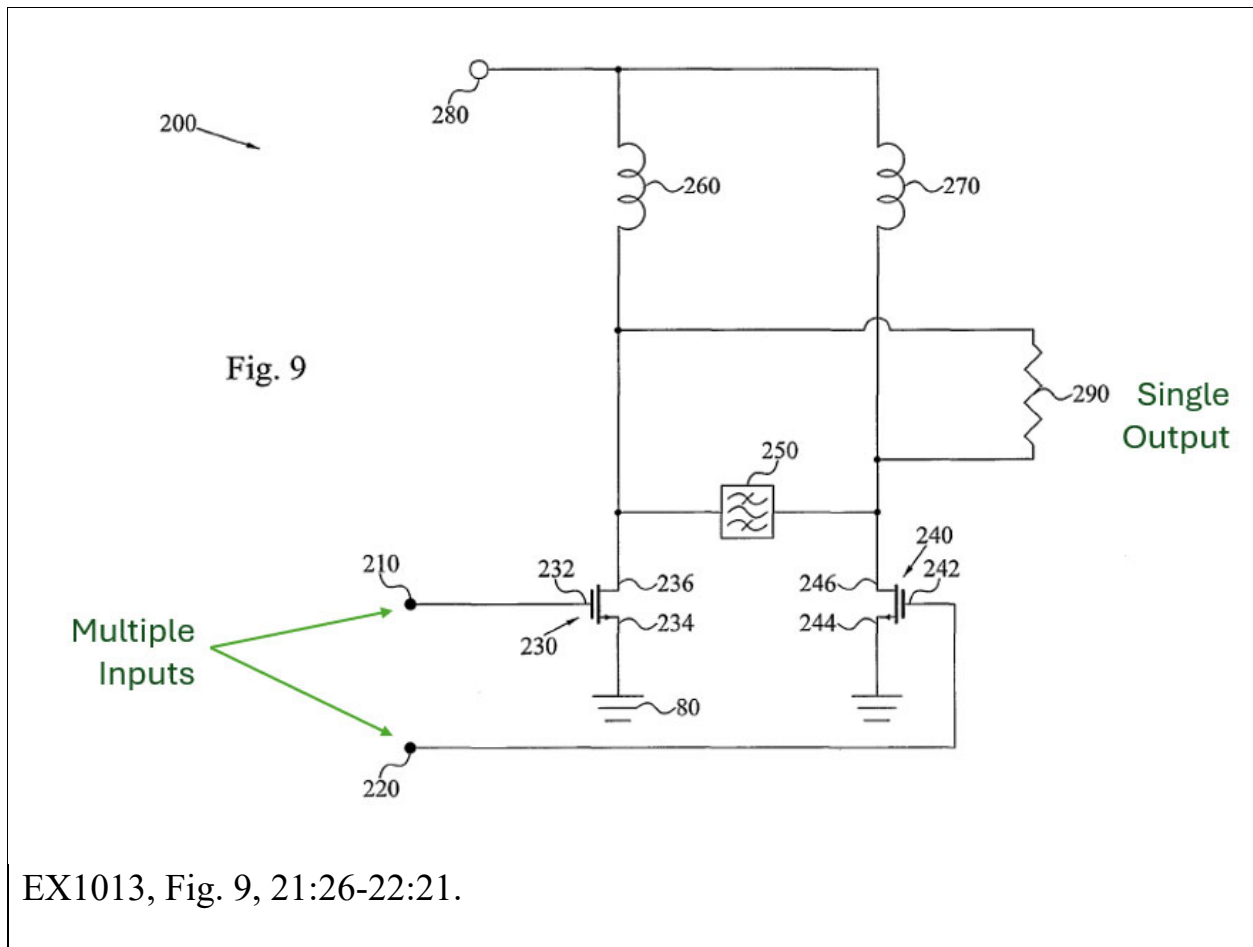
A POSITA would have been motivated to combine the teachings of Hau and Yoshida with Lejon. EX1003, ¶179. Lejon is in the same field of art as Hau because it relates to amplifiers for wireless transceivers. EX1013, 1:10-13. Even more specifically, Lejon teaches that it addresses concerns with power consumption. *Id.*, 1:27-2:5. A POSITA would have recognized that power consumption would be a greater concern with battery-powered portable devices, like those taught by Hau. EX1003, ¶179.

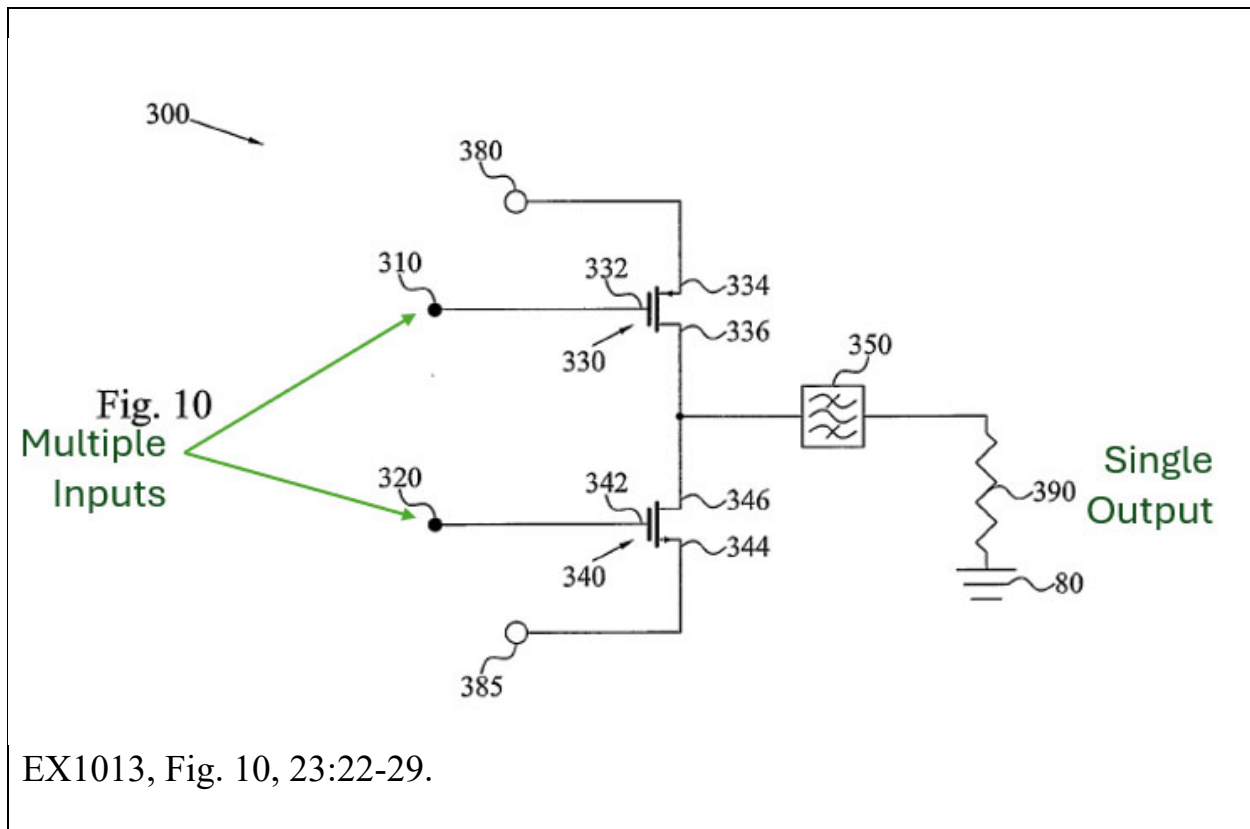
Lejon is further directed to amplifiers that operate at varying output power levels, which are controlled by varying the bias voltage provided to the amplifiers. EX1013, 2:7-2, 2:27-29; EX1003, ¶180. A POSITA looking to design an amplifier operating at variable power levels as taught by Lejon would accordingly have been motivated to look at power supplies for RF systems that provide variable power for an amplifier by adjusting a bias voltage, as taught by the combination of Hau and Yoshida. EX1003, ¶180. The combination of Hau and Yoshida would provide the same benefits, *i.e.* optimizing efficiency for a given power scheme (including when efficiency is optimized by bypassing a down-converter), when providing power for the amplifier of Lejon. *Id.* A POSITA would have had a reasonable expectation of success making the combination because the power output by the combination of Hau and Yoshida (that is, a DC bias voltage to an amplifier that varies based on required power, e.g. Hau's Vcc2) is the same power signal required as the bias voltage by Lejon. *Id.*, ¶181. Therefore, a POSITA would have been motivated to substitute a known element (the bias voltage of Lejon) for another (the variable bias voltage provided by the combination of Hau and Yoshida) with predictable results. *Id.*

3. Claim 16

- a. The system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier.**

Lejon teaches or suggests claim 16's additional element. Both Figures 9 and 10 of Lejon (both annotated below) teach examples of amplifiers with two inputs (inputs 210 and 220 in Figure 9, inputs 310 and 320 in Figure 10) to separate transistors (230, 240 in Figure 9; 330, 340 in Figure 10), and a single output load (290 in Figure 9, 390 in Figure 10). Each of these examples in Lejon is therefore a "multiple input, single-output amplifier.





For the reasons discussed in §VII(C)(2), it would have been obvious to combine Lejon’s amplifier with the power supply of Hau and Yoshida. Therefore, Lejon teaches an electronic device comprising a power amplifier which has multiple inputs and a single output (*a multiple-input-single-output (MISO) amplifier*), whether the “electronic device” is the amplifier itself or the larger device (e.g. handset) comprising the PA. §VIII(A)(12)(b); EX1003, ¶¶182-184.

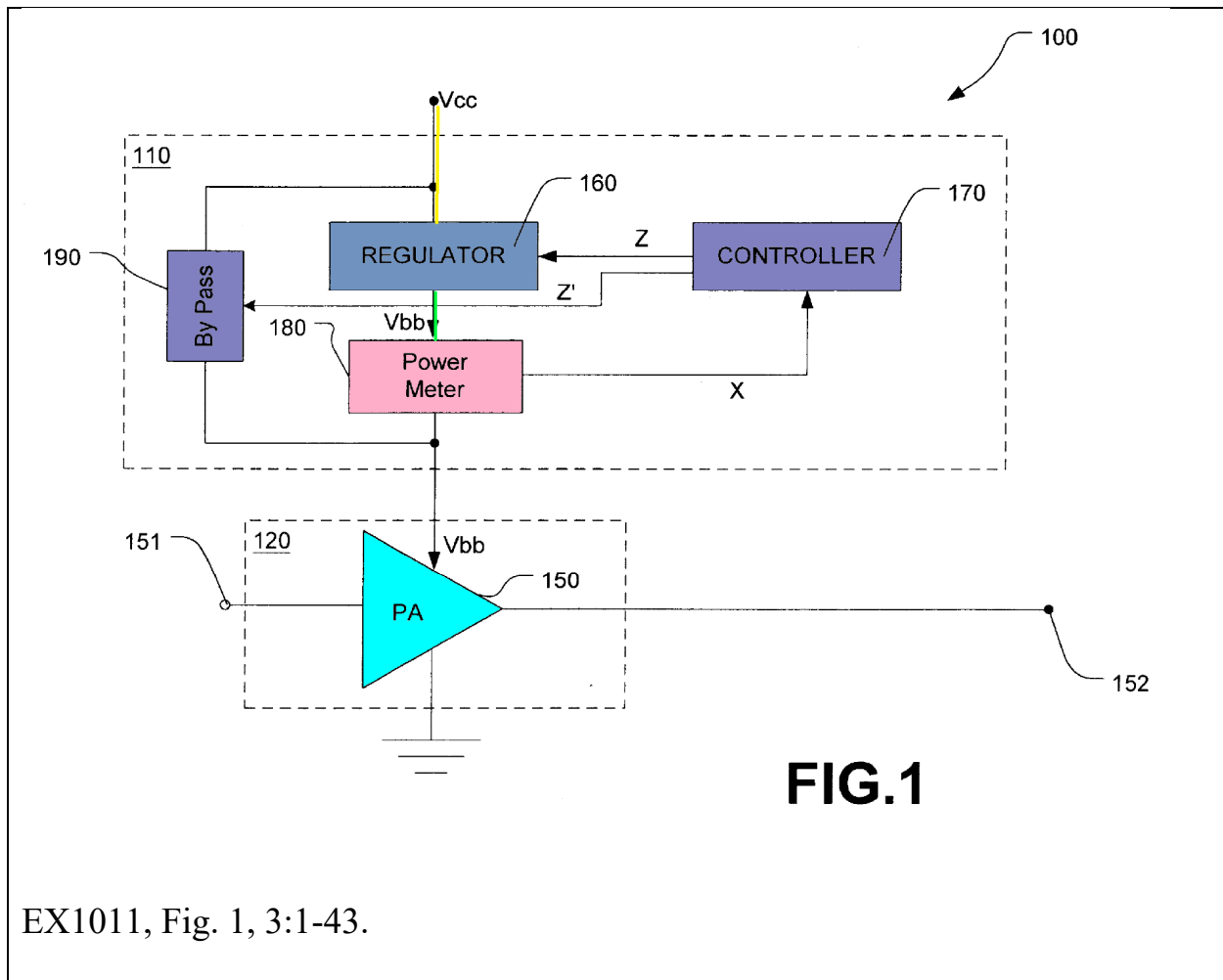
D. Ground 2A: Claims 1-5, 9-11, 15, and 19-20 are Unpatentable as Obvious over Canyon in view of Ranjan

1. Canyon

Canyon teaches “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.” EX1011, 1:9-24. Canyon teaches that power management extends the battery life, and thus the operating time, of personal communications devices. *Id.*, 1:40-59.

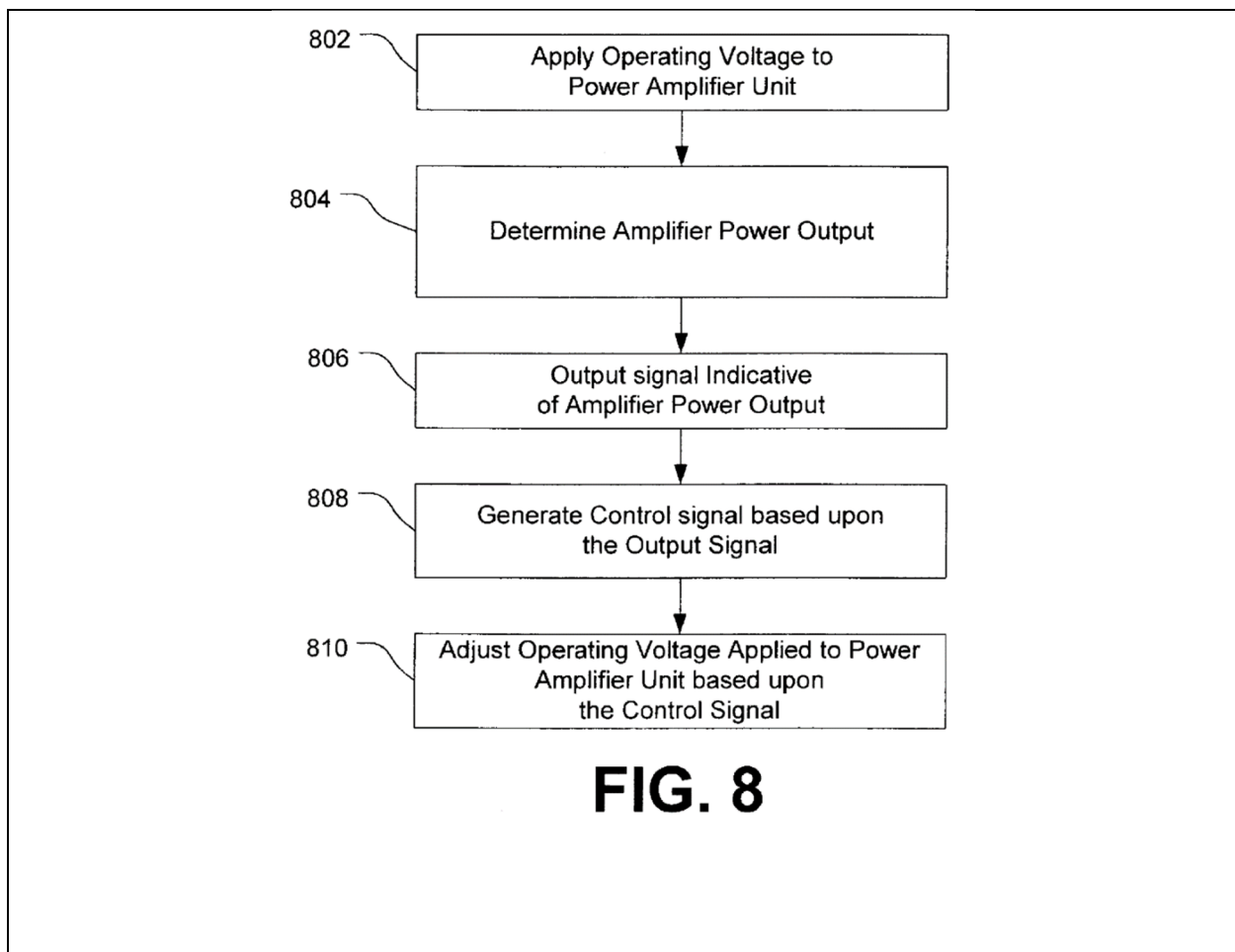
Canyon teaches that “as the power output of a typical wireless communications device [] drops below the maximum power (Max Power) output level, the efficiency of the wireless communications device also drops” and “[t]his does not help to prolong the supply battery voltage and thus works to limit the operation time to the device.” *Id.*, 1:54-59. Canyon teaches a communication device with improved efficiency characteristics that includes a power amplifier unit 120 and a power management unit 110. *Id.*, 3:1-7. Canyon’s Figure 1 (annotated below) illustrates certain power supply components of a personal communications device 100:



Power management unit 110 of communication device 100 includes a switching regulator 160 (blue) that receives a supply voltage V_{cc} (yellow) of a predetermined voltage level and outputs an operating voltage V_{bb} (green) to a power amplifier 150 (aqua). *Id.*, 3:8-13. Controller 170 (purple) receives a signal X from a power meter 180 (pink) and, based on a comparison of the signal X with a high power level, controls whether regulator 160 should be bypassed via a bypass switch 190 (purple). *See id.*, 3:14-4:29.

Canyon illustrates (via flowchart, Figure 8 below) how to adjust the operating voltage to the power amplifier unit, based on an output signal (current flow to the amplifier unit) indicative of amplifier power output. *Id.*, 7:1-14.

Controller 170 receives that signal (step 806) and generates a control signal based on the output signal (step 808), which control signal is output to a regulator 160 (step 810) to adjust the voltage applied to power amplifier unit 120.

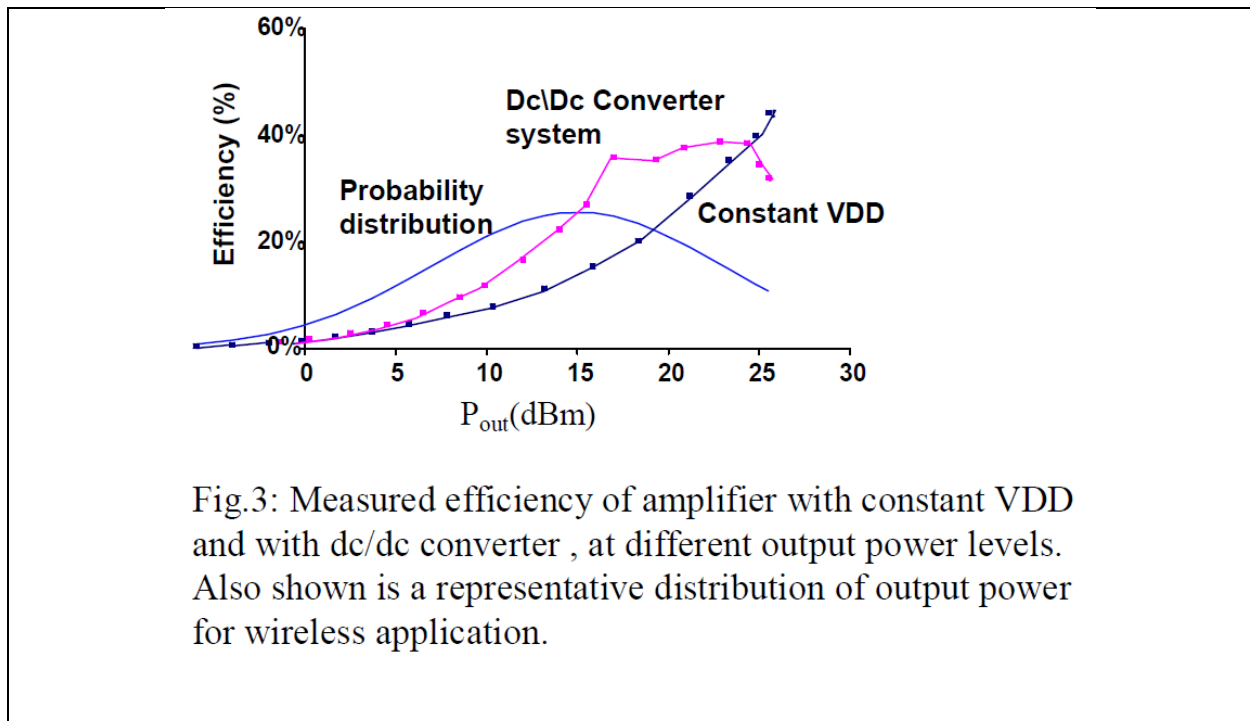


EX1011, Fig. 8, 7:1-14; EX1003, ¶¶185-188.

2. Ranjan

Ranjan describes a “power amplifier architecture... with an efficient, high modulation bandwidth DC-DC converter.” EX1012, 493 (Abstract). Ranjan teaches that “[e]fficiency of power amplifiers can be significantly improved by employing a DC-DC converter which varies the power supply voltage in accordance with the envelope of the input signal.” *Id.*, 493. This technique is known as “envelope tracking.” *Id.* Ranjan’s Figure 3 (below)⁷ illustrates both how the efficiency of the system varies with output power, and a “representative probability distribution of output power in cellular phone applications.”

⁷ For visual clarity, figures from Ranjan used herein are taken from EX1014, a copy of Ranjan posted at https://web.archive.org/web/20031218101536id_/http://sigma.ucsd.edu:80/~mahim/mttfinal-colored.pdf, which is substantively identical to EX1012.



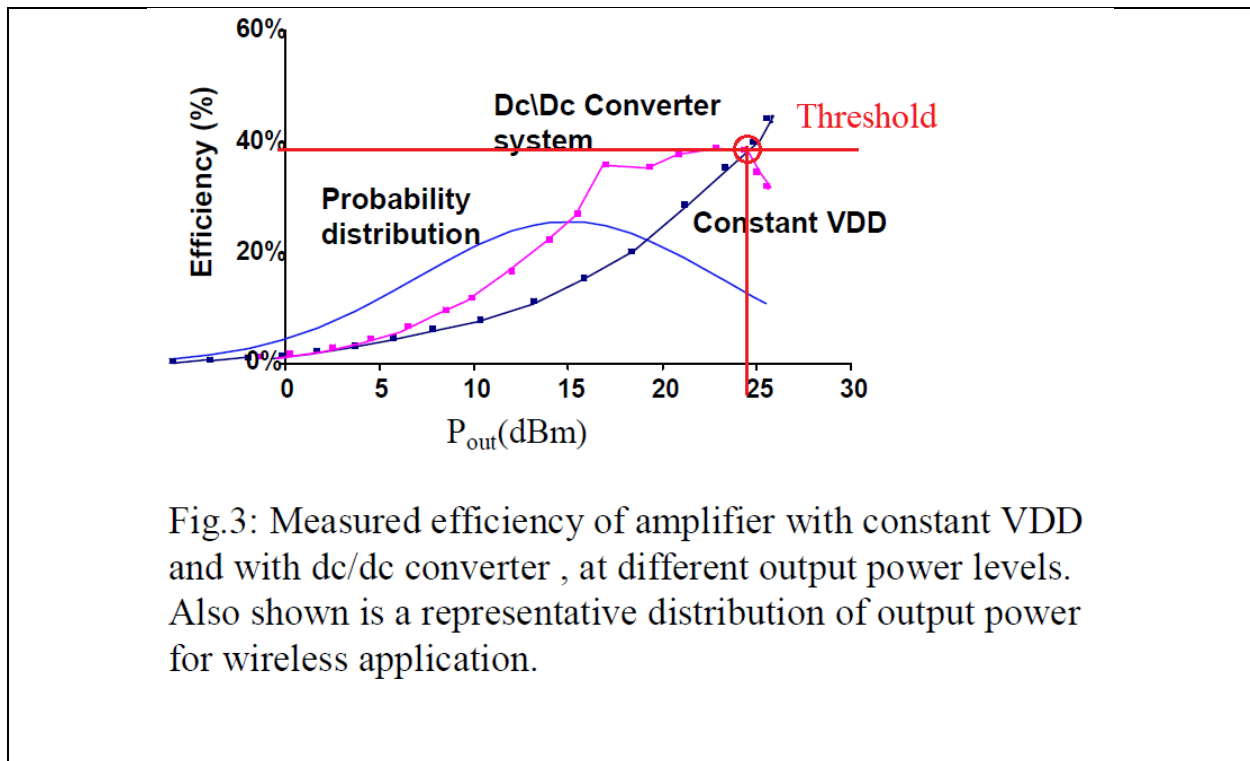
Ranjan explains that the Figure 3 efficiency plots for the DC/DC converter system (pink) and constant VDD (dark blue), show that “while at maximum output power the inclusion of the DC-DC converter is detrimental to efficiency, at lower output powers it is highly advantageous.” *Id.*, 494; EX1003, ¶¶189-190.

3. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Canyon and Ranjan. EX1003, ¶191. Canyon cites Ranjan on its face. EX1011, Cover page. The references are analogous art because they both relate to power supplies used in wireless personal communications devices, and to the problem of efficiency in personal communications devices when the required power varies. *Id.*, 1:25-59; EX1012, 493 (Abstract, Introduction). Both references further teach

solutions including DC-DC converters which provide variable power to an amplifier. EX1011, Abstract, 1:62-2:6, 3:66-4:13; EX1012, 493 (Abstract, Introduction), Figs. 1a, 1b. Therefore, a POSITA would logically have considered the teachings of both references in combination when considering the problem of variable power requirements for personal wireless communication devices. EX1003, ¶192.

Canyon teaches a system with a bypass switch that is closed (and thus outputs the battery voltage directly to the PA) when the PA is operating at a high power level. EX1011, 4:14-29. However, Canyon does not teach how to determine the optimum point at which to close the bypass switch to achieve maximum efficiency. EX1003, ¶193. At most, Canyon suggests closing the switch when the PA operates at a power level greater than 22-24 dBm, but does not indicate how this level was derived or whether it is the most efficient value. EX1011, 4:23-26; EX1003, ¶193. However, Ranjan teaches that the efficiency of a given device operating in a given modulation scheme can be plotted to identify a power level (with a corresponding efficiency) at which a fixed supply voltage becomes more efficient than the dynamic voltage output by a DC-DC converter. EX1012, 494, Fig. 3 (annotated below):



Therefore, a POSITA would have recognized that in a power supply such as Canyon with a DC-DC converter and a bypass switch, maximum overall efficiency would be achieved by setting the threshold to operate the bypass switch at the point where a fixed power supply (the bypass pathway) becomes more efficient than the variable power supply from the regulator. EX1003, ¶¶193-196. A POSITA would have been able to calculate such a threshold for a given device operating in a given modulation scheme without undue experimentation. *Id.*, ¶196. Accordingly, setting the bypass threshold of Canyon based on the implied threshold of Ranjan (where a fixed power supply becomes more efficient) would have simply combined prior art elements according to known methods to yield predictable results. *Id.*

Alternatively, a POSITA reading Ranjan would have recognized that Ranjan provides a teaching, suggestion, or motivation to combine with Canyon because Ranjan teaches that “while at maximum output power the inclusion of the DC-DC converter is detrimental to efficiency, at lower output powers it is highly advantageous.” EX1012, 494, Fig. 3. A POSITA would have recognized from this teaching of Canyon that a bypass switch as taught by Canyon would enable power supply to obtain superior efficiency both at peak power and at reduced power. EX1003, ¶197. A POSITA would have recognized that Canyon’s bypass switch would accordingly improve Ranjan’s similar device in the same way. *Id.*

4. Claim 1

a. 1[pre]: A power supply comprising:

Canyon teaches this element. Canyon teaches a power management unit 110 that supplies an operating voltage to a power amplifier 150 of the power amplifier 120. EX1011, 3:8-13; EX1003, ¶198.

b. 1[a] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node

Canyon teaches this element. Canyon teaches a switching regulator 160 that receives a supply voltage V_{cc} of a predetermined voltage level and outputs an operating voltage V_{bb} to the power amplifier 150. EX1011, 3:8-13, Fig. 1 (annotated):

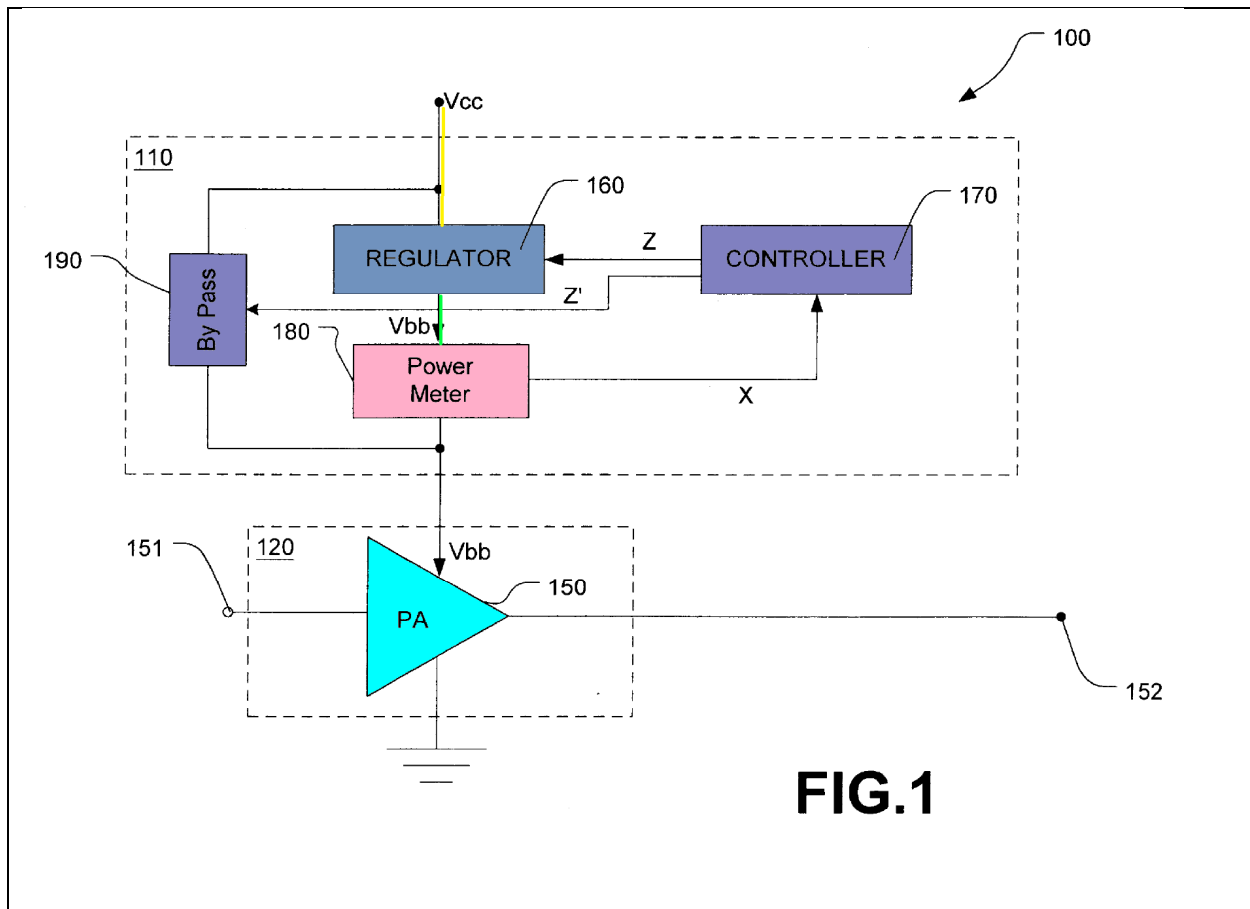
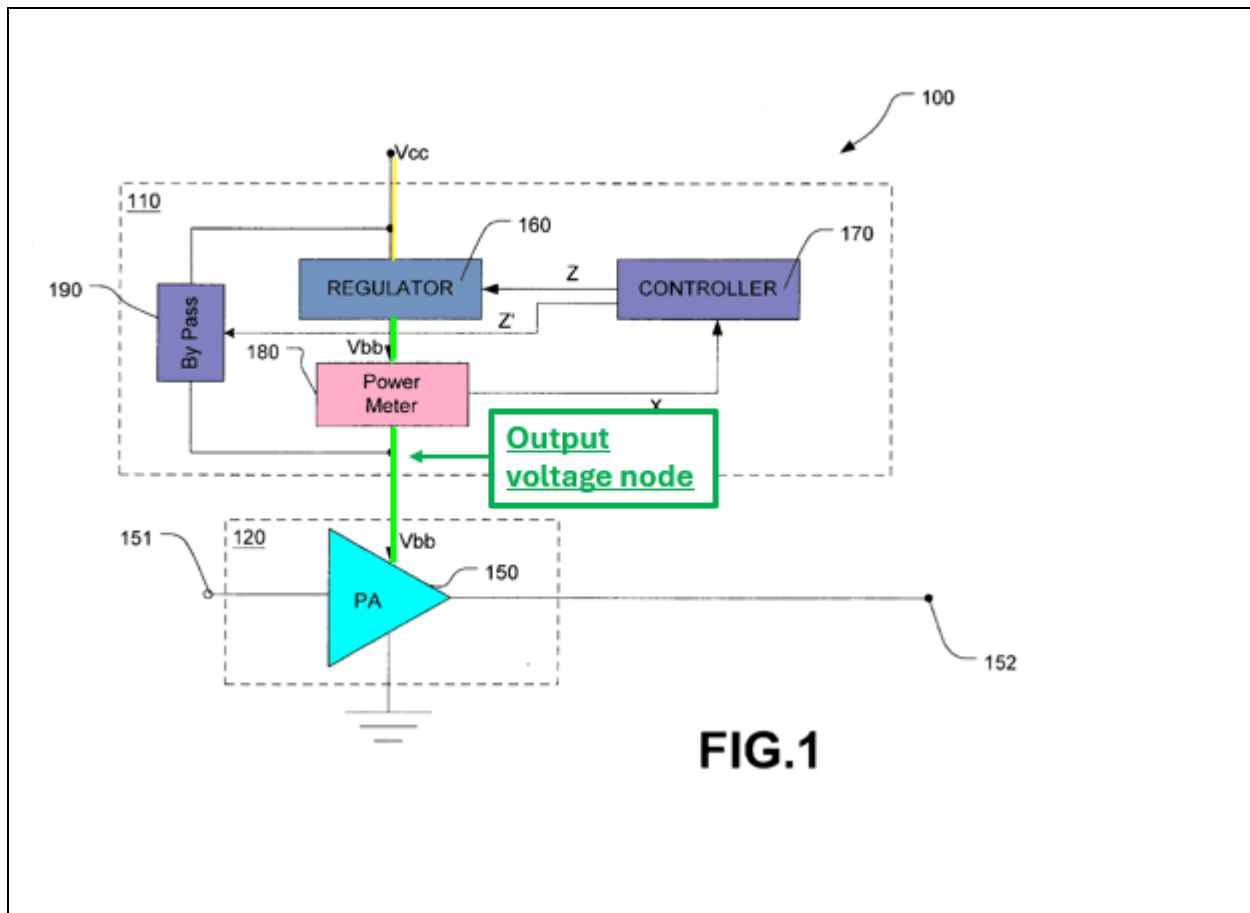


FIG.1

Canyon teaches that “Vbb may be between 0 volts and the supply voltage Vcc. Further, Vbb may be linearly variable between, for example, 0 volts and Vcc.” *Id.*, 3:39-42. Therefore, Canyon’s switching regulator 160 (*switching device*) is configured to down-convert the supply voltage Vcc (*an input voltage*) to the operating voltage Vbb (*passes the down-converted input voltage*) at a node at voltage Vbb (*to an output voltage node*). *Id.*, Fig. 1 (annotated):

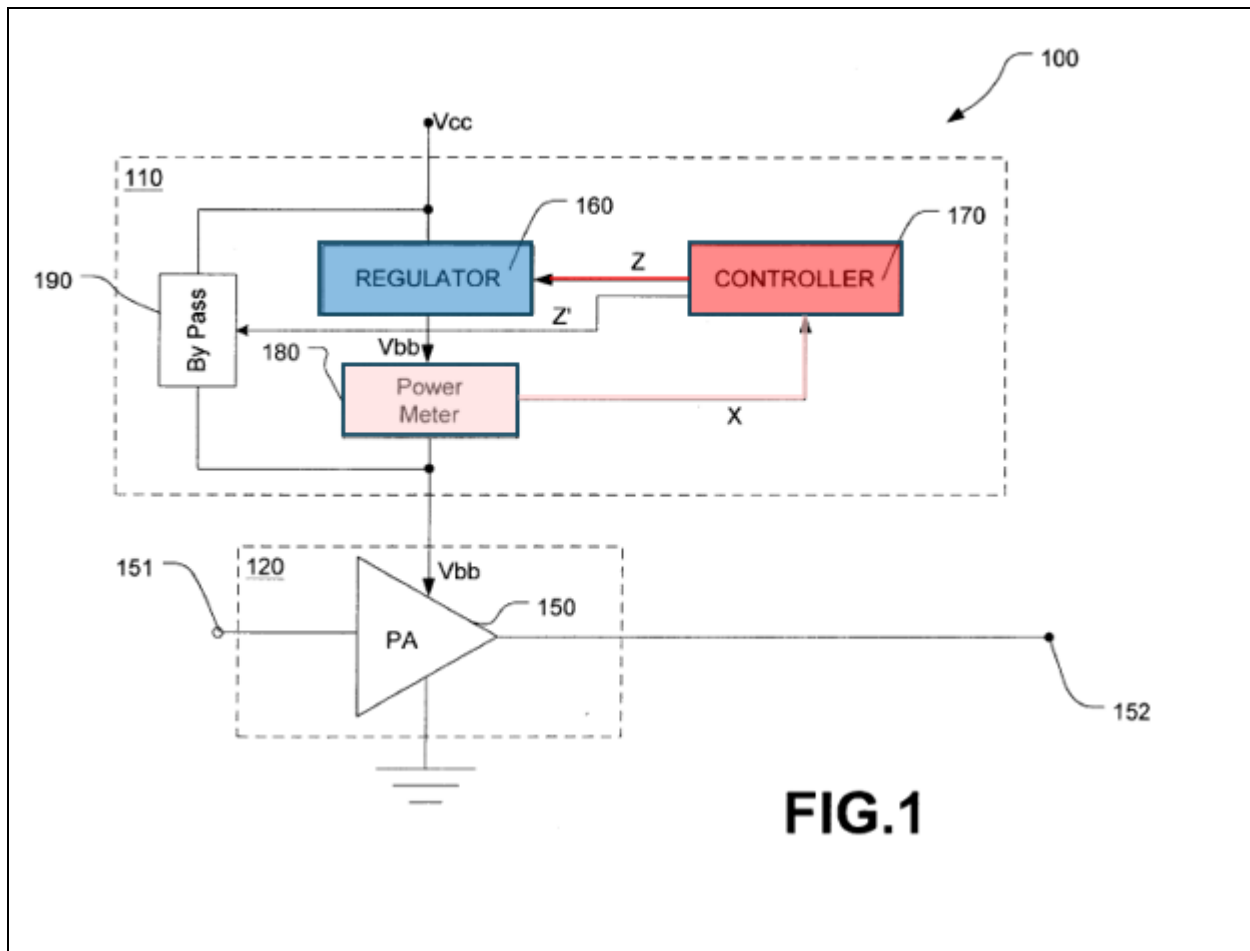


EX1003, ¶¶199-201.

c. 1[b1] an aperture generator and control module configured to control the switching device

As noted regarding Ground 1A above, the claimed AGCM controls both the switching device itself and bypassing the switching device (*see* 1[b2] below).

Canyon teaches that power management unit 110 includes controller 170 that “controls switching regulator 160 via providing a control signal Z.” EX1011, 3:31-32, Fig. 1 (annotated):



Canyon's power meter 180 (also referred to as a current meter) monitors the power to PA 120 (as measured by current) and generates an indicator signal X output to the controller. EX1011, 3:14-19. Based on signal X, the controller generates control signal Z to control regulator 160. *Id.*, 3:19-34. Canyon therefore teaches a controller 170 (*an aperture generator and control module*) that is configured to control the regulator (*the switching device*). EX1003, ¶¶201-206.

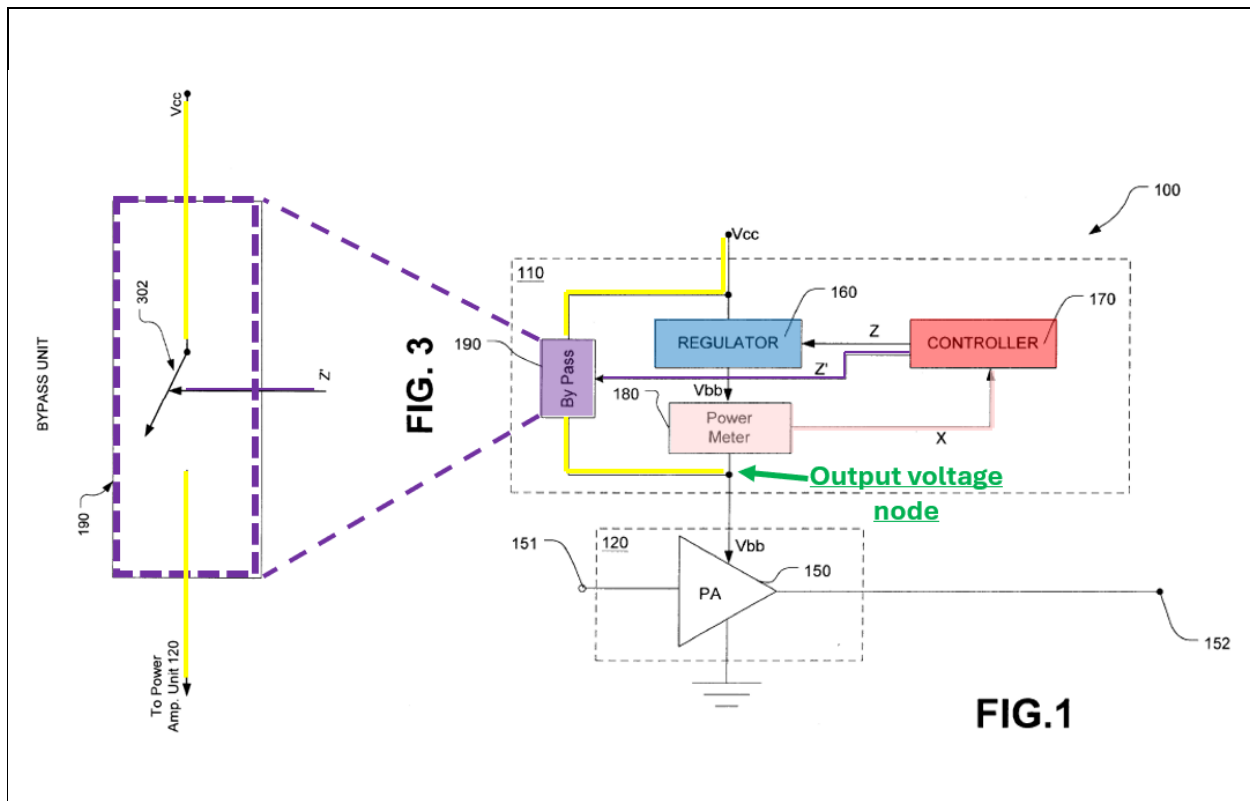
If the Board construes this element as means-plus function, Canyon teaches

the same or equivalent structure as the '593 Patent. As discussed in §§(VII)(B) and (VIII)(A)(4)(c), the structure in the '593 Patent that performs the function of “control[ling] the switching device” is the AGCM 402. Canyon’s controller 170 is the equivalent structure because it is a circuit that controls switching regulator 160. A POSITA would have recognized that switching DC-DC converters with variable DC voltage output operate by varying the width (aperture) of pulses, so Canyon’s controller 170 is the same or equivalent structure to the '593 Patent’s AGCM.

EX1003, ¶207.

- d. 1[b2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node**

Canyon in combination with Ranjan teaches this element. Canyon teaches that when the power measured by the power meter, as indicated by control signal X, indicates that the PA is operating at a high power level (e.g., greater than 22-24 dBm), controller 170 (red) (*aperture generator and control module*) sends a bypass signal Z' to close bypass switch 190 (purple) and pass the supply voltage Vcc (yellow) to an output voltage node (green) connected to the PA. EX1011, 4:16-30, Figs. 1, 3 (combined and annotated below):



Closing bypass switch 190 deactivates regulator 160 (*switching device*)

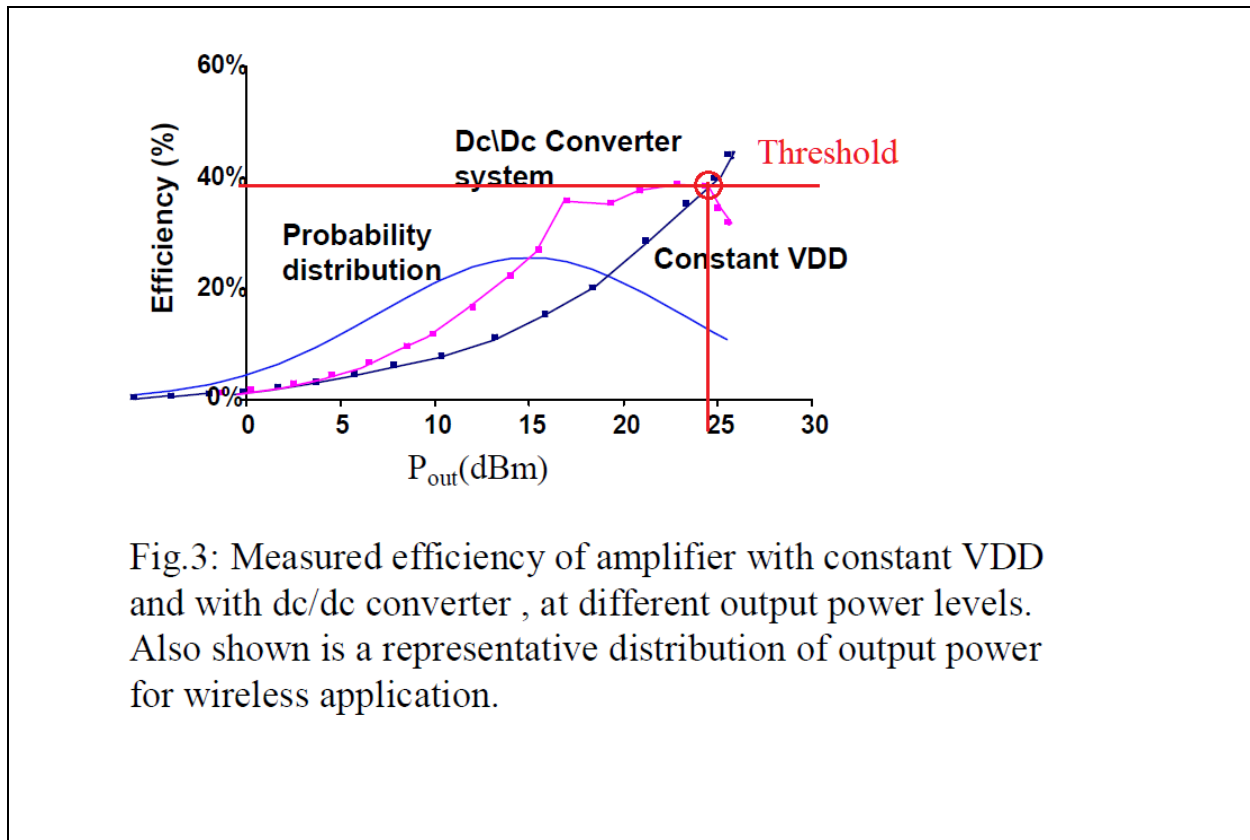
because it takes the operating voltage V_{bb} to a level approximately equal to V_{cc} (*deactivates the switching device and passes the input voltage to the output voltage node*). *Id.*, 4:26-29. When the voltages V_{cc} and V_{bb} on either side of the regulator are the same voltage, no current flows through the regulator and thus the regulator is deactivated. EX1003, ¶¶208-209.

The controller closes the bypass switch “in response to the power efficiency of the power supply exceeding a predetermined threshold” in the combination for two reasons. First, in Canyon itself, the signal X from power meter 180 is a current signal “indicative of the power output level of the [PA].” EX1011, 3:14-

30. As noted in §VII(A), the specification of the '593 Patent itself relies on output power as an indicator of efficiency. Signal X therefore indicates greater efficiency relative to the fixed input power. §VII(A); EX1003, ¶210. As discussed in §VII(A), the specification of the '593 Patent itself does not describe a circuit capable of making direct measurements of the power efficiency of a power supply; rather, the only described embodiments measure output power or output voltage. *E.g.*, EX1001, 4:7-10, 7:59-8:8, 8:41-60. Canyon alone therefore teaches this element to the same extent as the '593 Patent itself. EX1003, ¶210.

Second, as discussed above in §VIII(D)(3), a POSITA would have known and been motivated to use the “crossover” point of Ranjan (where constant VDD becomes more efficient than a down-converted voltage) as the threshold to activate the bypass pathway of Canyon to achieve optimum efficiency. Although Ranjan’s Figure 3 measures amplifier output, a POSITA would have recognized that the peak output of an amplifier is proportional to the bias voltage, which in Canyon is provided to the PA by the output V_{bb} of regulator 160. Therefore, a POSITA would have recognized that the efficiency curves shown as a function of P_{OUT} in Ranjan would be proportional to regulator output V_{bb} in the combination. EX1003, ¶211. When Canyon’s threshold is set using Ranjan’s crossover point, the threshold occurs at a known level of efficiency. Therefore, the power threshold of Canyon when the controller activates the bypass switch is also a predetermined

threshold of efficiency of the power supply. EX1012, Fig. 3 (annotated below);
EX1003, ¶¶212-215:



To the extent that the Board construes this term as means-plus-function, Canyon's controller 170 and bypass switch 190 teach the AGCM corresponding structure (AGCM 404, bypass switch control 402, and bypass switch 406 in the '593 Patent), and perform the same functions of controlling and deactivating the switching device. Canyon's controller 170 is equivalent to the corresponding structure in the '593 Patent for this function (bypass switch control 402 and bypass switch 406) because controller 170 is a circuit that activates a switch (bypass switch 190) to deactivate the switching device and pass the output voltage (Vcc)

directly to an output voltage node. EX1003, ¶216.

5. Claim 2

- a. The power supply of claim 1, wherein the aperture generator and control module is configured to deactivate the switching device based on a load current at the output voltage node.**

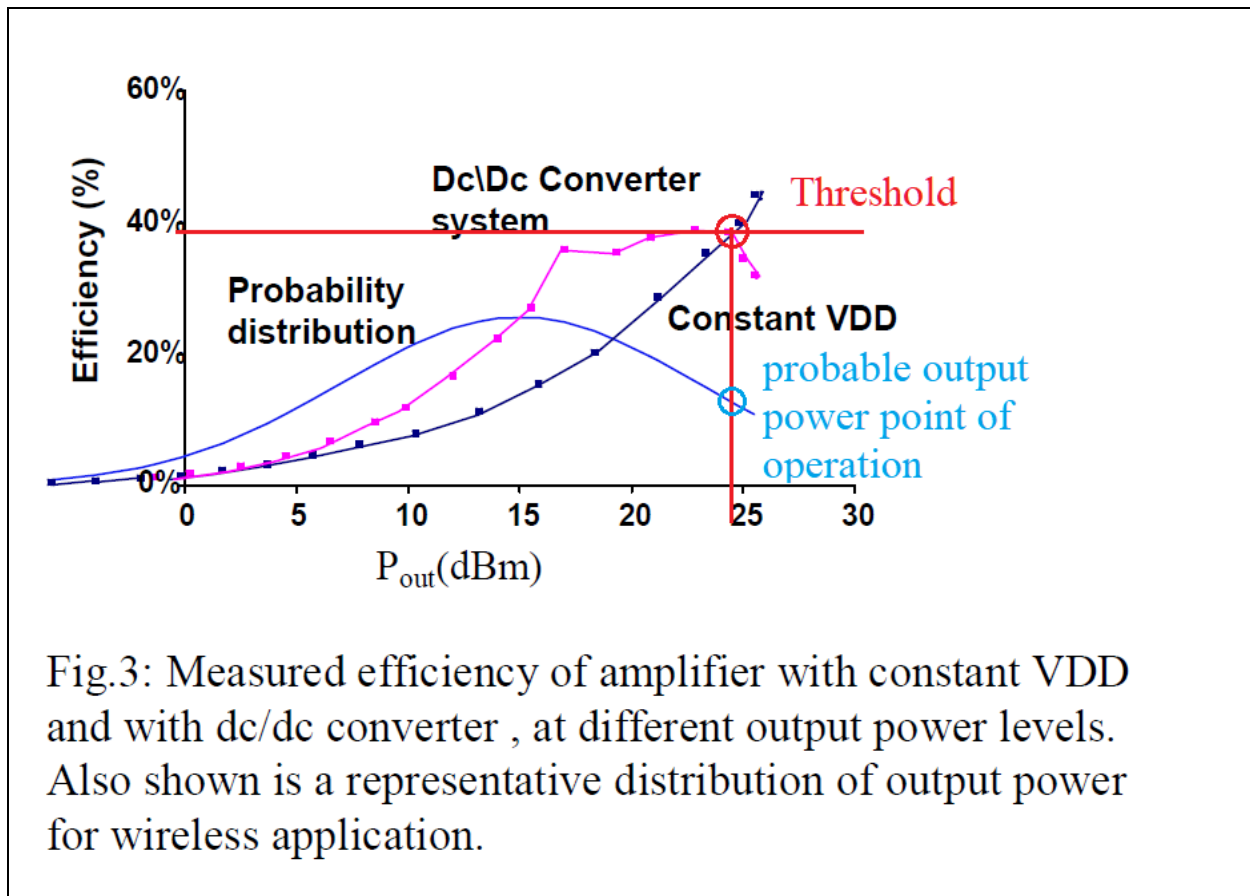
Canyon teaches claim 2's additional element. Canyon's power meter 180 is also described as a current meter, and directly measures current as an indicator of power. EX1011, 3:14-19, 4:14-29. That is, controller 170 (*the aperture generator and control module*) is configured to deactivate switching regulator 160 (*the switching device*) based on the current flow provided to power amplifier unit 120 (*a load current at the output voltage node*). EX1003, ¶217.

6. Claim 3

- a. The power supply of claim 1, wherein the aperture generator and control module is configured to control 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.**

Canyon in view of Ranjan teaches claim 3's additional element. In Ranjan, the experiment results were obtained using IS-95 CDMA handset applications. EX1011, Abstract. Ranjan notes that "[a] suitable average efficiency can be computed based on power usage probabilities." EX1012, 494. Figure 3 of Ranjan shows a representative probability distribution of output power in cellular phone

applications. *Id.* As shown in the annotated Figure 3 below, the threshold (red) corresponds to a probable output power point on the probability distribution of output power for IS-95 CDMA handset applications:



Ranjan's Figure 3 chart represents efficiency results obtained with a particular device, and therefore indicates "power efficiency characteristics of an electronic device coupled to the power supply." EX1003, ¶219. Therefore, Canyon in view of Ranjan teaches that controller 170 (*the aperture generator and control module*) is configured to control regulator 160 (*the switching device*) based on an output power point (*a probable output power point of operation*) for IS-95

CDMA handset applications (*for a selected modulation scheme*) corresponding to the probability distribution of output power (*based on one or more power efficiency characteristics of an electronic device coupled to the power supply*). EX1003, ¶¶218-219.

7. Claim 4

- a. The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSPA, or OFDM communication protocol.**

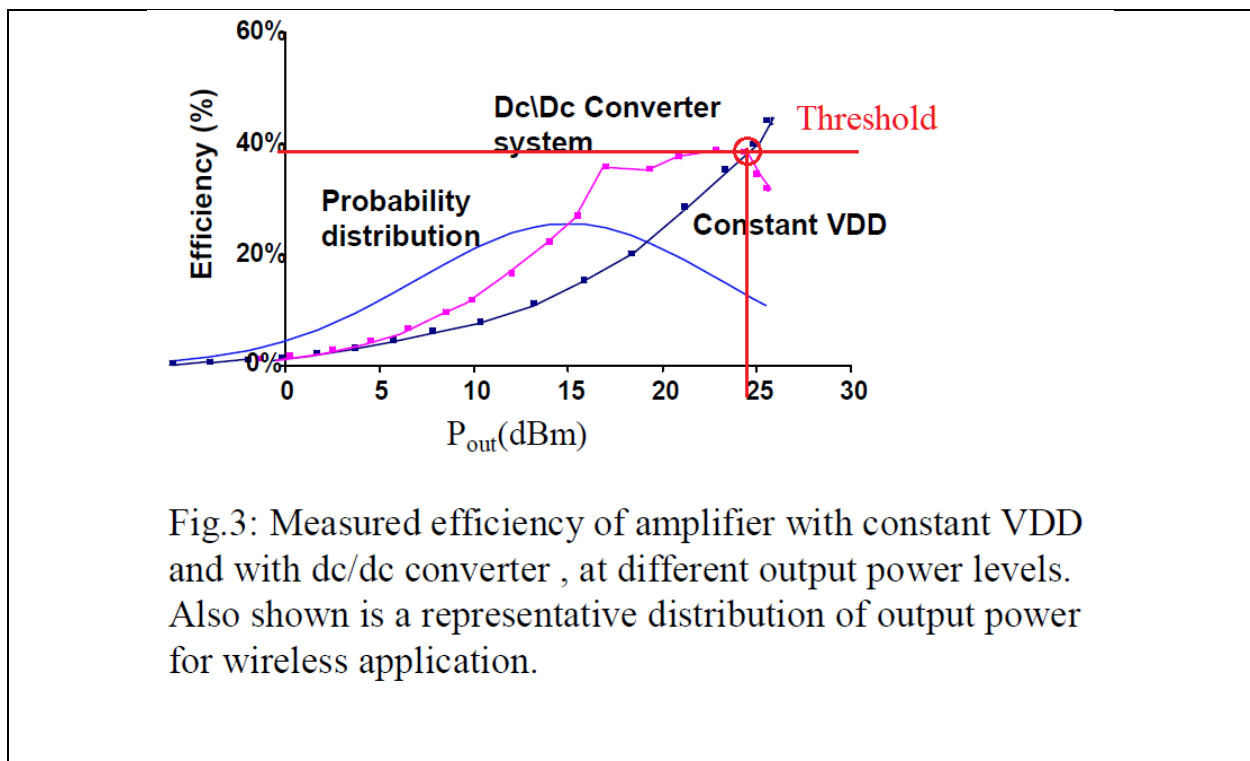
Canyon in view of Ranjan teaches claim 4's additional element. Canyon discloses that "the mobile telephone comprises a code division multiple access (CDMA) compliant mobile telephone." EX1011, Claim 4. The experimental results in Ranjan were obtained using IS-95 CDMA handset applications. Ranjan also notes that, even given cost-effective application of DSP in various spread spectrum applications, Ranjan's system "can flexibly implement a variety of algorithms for system optimization," such as CDMA and W-CDMA. EX1012, 495-496, Conclusion; EX1003, ¶¶220-221.

8. Claim 5

- a. The power supply of claim 1, wherein the aperture generator and control module is configured to provide an output current at a maximum power efficiency associated with the down-converted input voltage.**

Canyon in combination with Ranjan teaches claim 5's additional element. Figure 3 of Ranjan illustrates measured efficiency of an amplifier with a DC-DC

converter at different output power levels. EX1012, 494. As shown in Figure 3 (annotated below), the efficiency for the DC-DC converter reaches a maximum value and drops after the output power level is at a threshold value. As the power is computed by multiplying the voltage with the current, this output power level corresponds to an output current associated with the operating voltage V_{bb} before the regulator/DC-DC convert gets deactivated.



Therefore, Canyon in view of Ranjan teaches that controller 170 (*the aperture generator and control module*) is configured to control regulator 160 to output a current (*to provide an output current*) associated with the operating voltage V_{bb} corresponding to a maximum power efficiency of the regulator 160 (*at a maximum power efficiency associated with the down-converted input*

voltage). EX1003, ¶¶222-224.

9. Claim 9

- a. 9[pre] a method for controlling a power supply comprising:**

Claim 9 recites the method steps of claim 1 without the structural limitations; that is, it describes a method which is performed in normal operation of the power supply claimed in claim 1. Therefore, a POSITA would have recognized that the Canyon-Ranjan combination teaches the method steps of claim 9 for the same reason described for claim 1 and discussed below. EX1003, ¶225.

- b. 9[a] down-converting, with a switching device, an input voltage to generate a down-converted voltage**
- c. 9[b] passing the down-converted voltage to an output voltage node**

Steps 9[a] and 9[b] are performed in the combination by Canyon's switching regulator for the reasons discussed regarding element 1[a]. EX1003, ¶¶226-227.

- d. 9[c] in response to a power efficiency of the power supplying [sic] exceeding a predetermined threshold, de-activating the switching device and passing the input voltage to the output voltage node**

See element 1[b1]. EX1003, ¶228.

10. Claim 10

- a. The method of claim 9, further comprising:
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**

See claim 3. EX1003, ¶229.

11. Claim 11

- a. The method of claim 9, further comprising: providing
an output current at a maximum power efficiency
associated with the down-converted voltage**

See Claim 5. EX1003, ¶230.

12. Claim 15

- a. 15[pre] a system comprising**

Claim 15 recites a system that comprises an electronic device in addition to the elements of claim 1. Canyon in view of Ranjan teaches a power amplifier system which may be used in a personal communications device such as a cellular telephone. EX1011, Abstract, 1:25-59; EX1003, ¶231.

- b. 15[a] an electronic device**

Canyon teaches this element. Both the power amplifier 150, and the larger device (such as a cellular telephone) of which the power supply is a part (e.g. a cellular telephone, EX1011, 1:25-49) alternatively teach an “electronic device.” EX1003, ¶232.

- c. **15[b] a power supply coupled to the electronic device, wherein the power supply comprises**

Canyon teaches this element, at least for the reasons discussed for Ground 2A, Claim 1[pre]. The power management unit 110 in Canyon is coupled to the power amplifier 150 and to the larger device of which it is a part. EX1003, ¶233.

- a. **15[c] a switching device configured to down-convert an input voltage and pass the down-converted input voltage to an output voltage node**

See element 1[a]. EX1003, ¶234.

- b. **15[d1] an aperture generator and control module configured to control the switching device**

See element 1[b1]. EX1003, ¶235.

- c. **15[d2] wherein, in response to a power efficiency of the power supply exceeding a predetermined threshold, the aperture generator and control module deactivates the switching device and passes the input voltage to the output voltage node**

See element 1[b2]. EX1003, ¶236.

13. Claim 19

- a. **The system of claim 15, wherein the aperture generator and control module is configured to control 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.**

See claim 3. EX1003, ¶237.

14. Claim 20

- a. The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.**

See claim 4. EX1003, ¶238.

E. Ground 2B: Claims 6-8, 12-14 are Unpatentable as Obvious over Canyon in view of Ranjan and further in view of Hau.

1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Canyon and Ranjan with Hau. EX1003, ¶¶239-243. A POSITA would have understood that both current and voltage impact the output power. *Id.*, ¶¶239-240. Figure 2 of Ranjan (below) shows the relationship between power supply voltage and output power, and for comparison the peak-to-peak voltage swing at the given output power. EX1012, Fig. 2; EX1003, ¶240.

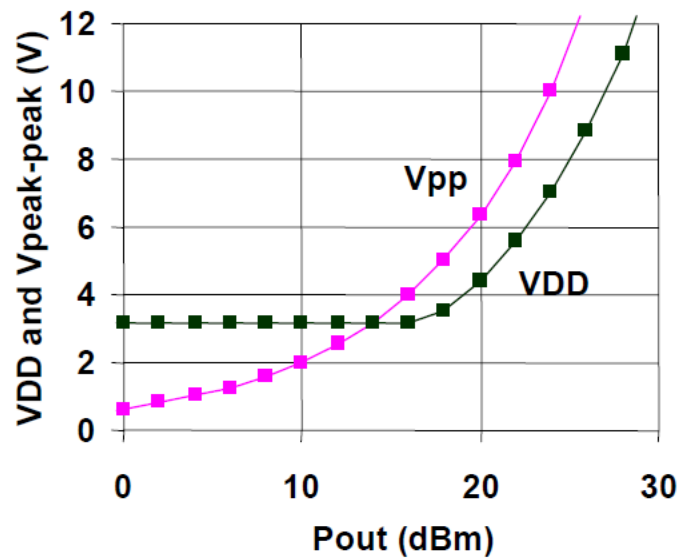


Fig.2: Algorithm of VDD vs output power. Also shown is peak-to-peak drain voltage

Hau discusses Canyon’s teaching of “monitoring the output power of the power amplifier through the current in the voltage bias line to the power amplifier.” EX1007, 2:2-6. Hau notes that, in Canyon’s approach, “the coupling loss (typically through a resistor or a current mirror) in the bias line would cause voltage drop especially under high current operation, reducing the bias voltage available to the power amplifier and resulting in performance degradation.” EX1007, 2:6-11. To address this problem, Hau discloses a two-stage amplifier system in which the bias voltage varies dynamically with the output power. *Id.*, 2:45-48. In particular, Hau discloses a power detector that detects voltage values and outputs a voltage detect signal that is linearly related to the optimum supply voltage for the power amplifier. *Id.*, 3:24-25.

A POSITA would have recognized that adopting voltage detection as taught in Hau would further improve the efficiency of Canyon's system and address the coupling loss issue identified in Hau. EX1003, ¶¶241-242. A POSITA would have been motivated to perform the simple substitution of one known element (current meter) for another (voltage detector) to obtain predictable results. *Id.*, ¶242.

Furthermore, a POSITA reading Hau would have recognized that Hau provides a teaching, suggestion, or motivation to combine with Canyon in view of Ranjan because Hau teaches that “when maximum power output is required[,] a bypass circuit effectively places the full battery voltage as the bias voltage on the power amplifier output stage thereby providing sufficient linearity at the maximum power output, minimizing any voltage drop across the DC to DC converter as a result of resistive loss which would degrade the performance of the power amplifier.” EX1007, 3:29-35; EX1003, ¶243. A POSITA would have recognized from Hau's usage of a voltage detector to switch to the full battery voltage when needed would enable power supply to obtain superior efficiency. EX1003, ¶243.

2. Claim 6

- a. The power supply of claim 1, 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.**

Hau teaches or suggests claim 6's additional element. Hau discloses a power detector that provides a voltage detect signal. *Id.*, 3:24-25. As discussed in VIII.A.1, Figure 6 of Hau illustrates a DC-DC buck regulator 70 (blue) that receives battery voltage V_{BATT} (yellow) and outputs voltage V_{cc2} (green) that is down-converted from V_{BATT} . *Id.*, 5:39-46, 6:54-7:6. V_{cc2} goes to two power amplifiers, PA1/PA2 (aqua). *Id.* A power detector (pink) receives an input V_{in} from PA1 and provides a voltage value P_{det} proportional to V_{cc2} . EX1007, 4:16-19, 6:15-44.

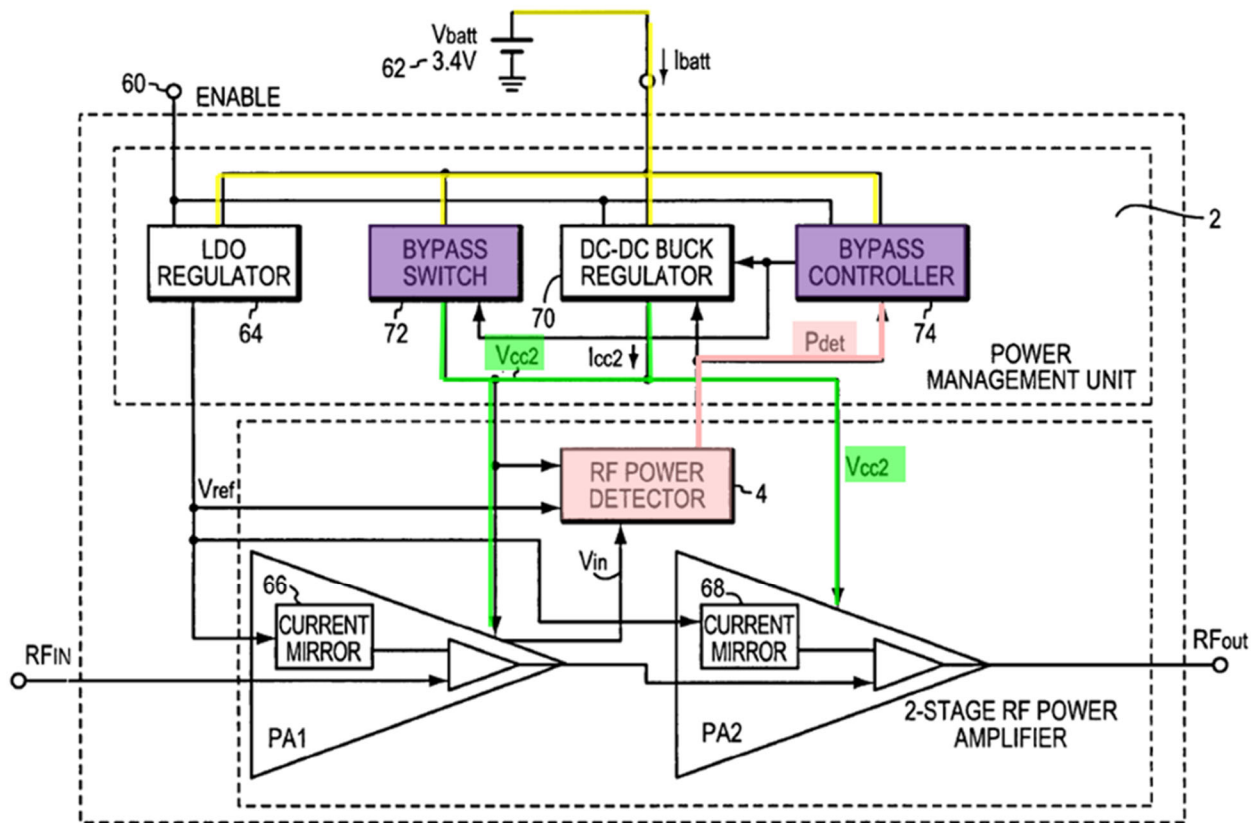


FIG. 6

In Hau, when P_{det} , the value proportional to V_{cc2} (*the down-converted input voltage*), exceeds a predetermined threshold, Hau's bypass controller 74 activates the bypass switch 72 and deactivates the DC-DC converter to pass the input voltage directly to the output voltage V_{cc2} . EX1007, 5:44-51, 6:61-66.

As discussed above in VIII.E.1, a POSITA would have recognized that adopting a power detector that provides a voltage detect signal as taught in Hau would further improve the efficiency of Canyon's system, where a current meter is used. EX1003, ¶¶241-242. A POSITA would have been motivated to perform the

simple substitution of one known element (current meter) for another (voltage detector) to obtain predictable results. *Id.*, ¶242.

Therefore, Canyon in view of Ranjan and further in view of Hau teaches that the bypass controller (*the aperture generator and control module*) activates the bypass switch 72 and deactivates the DC-DC converter (*configured to deactivate the switching device*) and passes the input voltage directly to the output voltage V_{cc2} (*pass the input voltage to the output voltage node*) when P_{det} exceeds a predetermined threshold (*based on a comparison of the down-converted input voltage to a threshold voltage*). EX1003, ¶¶244-247.

3. Claim 7

- a. **The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value.**

Hau teaches or suggests claim 7's additional element. In Hau, P_{det} is compared to a threshold voltage that is a predetermined (i.e., fixed) value. EX1007, 6:63-66; EX1003, ¶248.

4. Claim 8

- a. **The power supply of claim 6, wherein the threshold voltage is programmed based on a communication waveform efficiency, battery life associated with an electronic device coupled to the power supply, or a combination thereof.**

Hau teaches claim 8's additional element. In addition to a predetermined (i.e., fixed) threshold, Hau also teaches a threshold setting where when the threshold is

met the bypass switch is activated. EX1007, Claim 5. Hau notes that “[h]andset power amplifiers are generally designed to meet the FCC spectral re-growth requirement at maximum transmit power level (+28 dBm for WCDMA system).” *Id.*, 1:49-51. A POSITA would have understood that the maximum transmit power level (e.g., 28 dBm), and the corresponding power threshold, are associated with a particular modulation scheme (e.g., WCDMA) of a communication waveform (e.g., CDMA). EX1003, ¶249. A POSITA would have understood that Hau suggests that the threshold can be adjusted as a setting according to the wireless communication system (e.g., WCDMA system). *Id.*, ¶250. A POSITA would further have considered a communication waveform efficiency as a spectrum efficiency, which is related to the modulation scheme. *Id.*, ¶251.

Therefore, Canyon in view of Ranjan further in view of Hau teaches setting the voltage threshold, which activates the bypass switch when met, based on spectrum efficiency of, e.g., CDMA (*based on a communication waveform efficiency*).

5. Claim 12

- a. **The method of claim 9, 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.**

See Ground 2B, Claim 6. EX1003, ¶252.

6. Claim 13

- a. The method of claim 12, wherein the comparing comprises 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.**

See Ground 2B, Claim 8. EX1003, ¶253.

7. Claim 14

- a. The method of claim 12, wherein the communication waveform efficiency is based on a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.**

Hau teaches or suggests claim 14's additional element. As discussed in VIII.E.4, Hau notes that "[h]andset power amplifiers are generally designed to meet the FCC spectral re-growth requirement at maximum transmit power level (+28 dBm for WCDMA system)." EX1007, 1:49-51. A POSITA would have considered a communication waveform efficiency as a spectrum efficiency related to the modulation scheme, such as WCDMA. EX1003, ¶254. Therefore, Canyon in view of Ranjan further in view of Hau teaches that the spectral requirements (*a communication waveform efficiency*) are based on a modulation scheme, e.g., WCDMA (*based on ... W-CDMA*). EX1003, ¶254.

F. Ground 2C: Claims 16-18 are Unpatentable as Obvious over Canyon in view of Ranjan and further in view of Lejon.

1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Canyon and Ranjan with Lejon. Lejon, related to power amplifiers and maintaining linearity of the amplifiers, is in the same field of art as Canyon and Ranjan. §VIII,C.1, EX1013, 1:27-2:5; 3:5-18. Lejon explains that, “[t]raditional linear amplifiers can be made quite efficient when operating at their peak power, but the efficiency drops quickly at lower envelope powers” but “[l]inear amplification using nonlinear components (LINC) out-phasing amplifiers [] provide excellent efficiency over a vast range of output powers.” *Id.*, 2:14-16. Therefore, a POSITA would have logically considered the teachings of Lejon to be relevant to the problems of maximizing power efficiency addressed by Canyon and Ranjan. EX1003, ¶¶255-256.

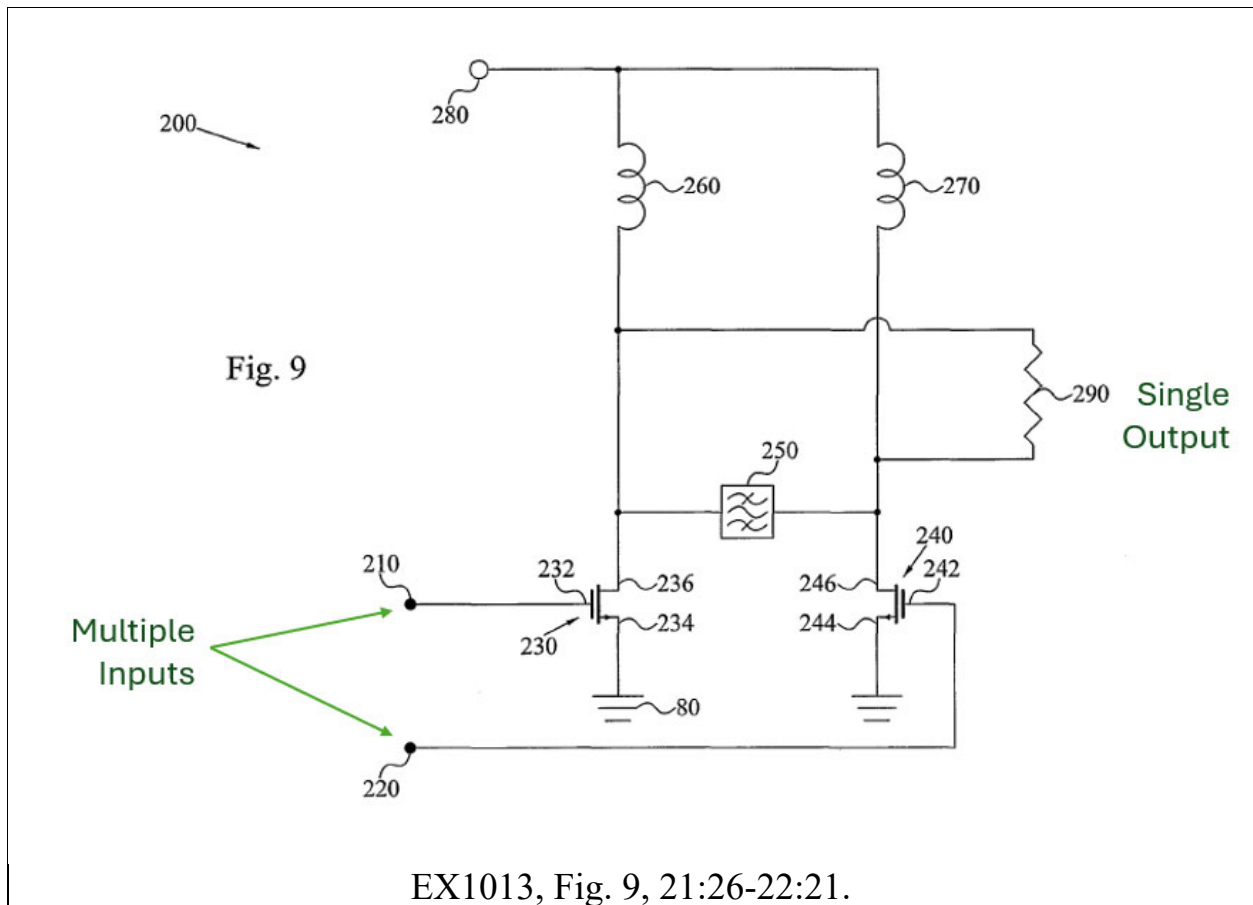
A POSITA would have recognized that adopting Lejon’s teaching of a LINC out-phasing amplifier, which includes two transistors at two input ports and generates a single output load, can “provide excellent efficiency over a vast range of output powers” and thus would further improve the efficiency of Canyon and Ranjan’s systems, given the usage of complex modulation schemes such as CDMA and W-CDMA. *Id.*, ¶257.

Furthermore, a POSITA would have been motivated to substitute a known element (the basic amplifier in Ranjan and Canyon) for another (the power amplifier in Lejon that have two inputs and a single output) to obtain predictable results. *Id.*, ¶258.

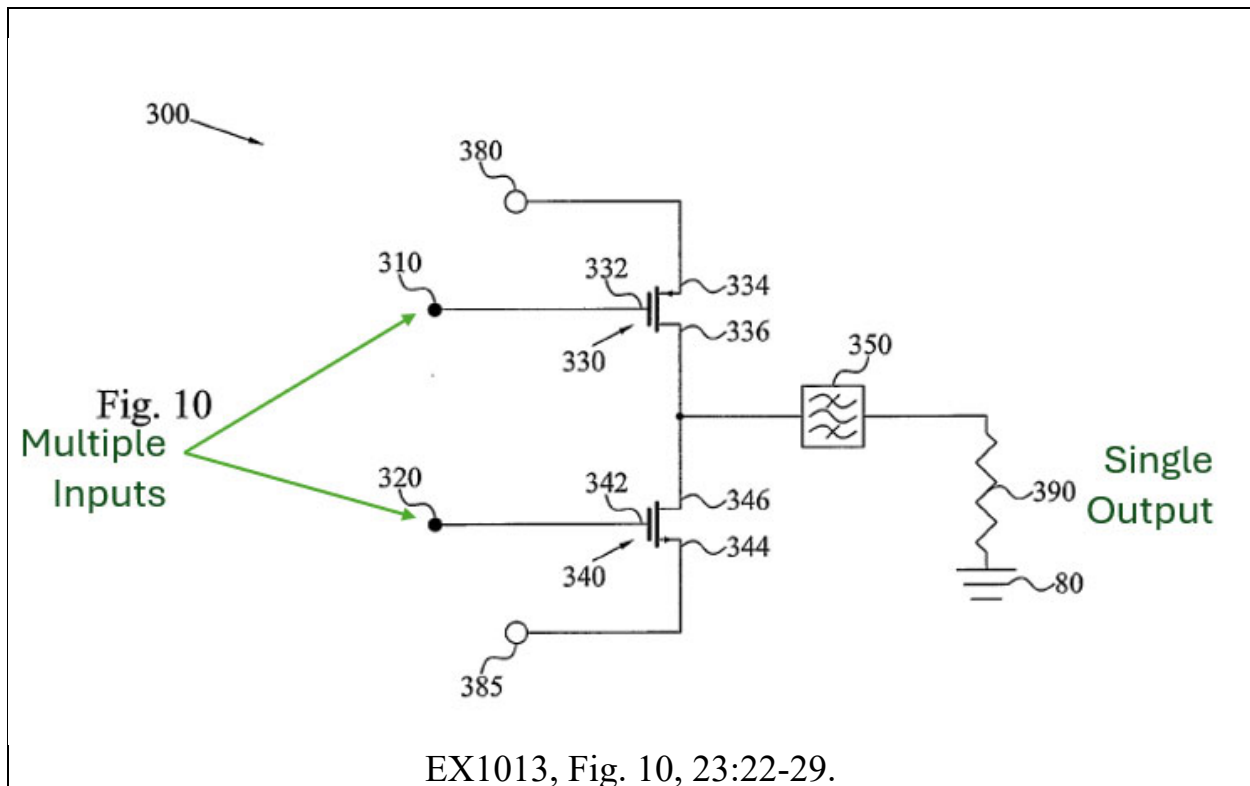
2. Claim 16

- a. The system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier.**

Lejon teaches or suggests claim 16's additional element. Each of Lejon's Figures 9 and 10 teach examples of amplifiers with two inputs and a single input. EX1003, ¶259. In Figure 9 (below), the two inputs are at ports 210 and 220, which connect to the gates of transistors 230 and 240, and the single output is output load 290. EX1003, ¶259.



In Figure 10 of Lejon (below), the two inputs are at ports 310 and 320 and connect to the gates of transistors 330 and 340, while the single output is output load 390. EX1003, ¶260.



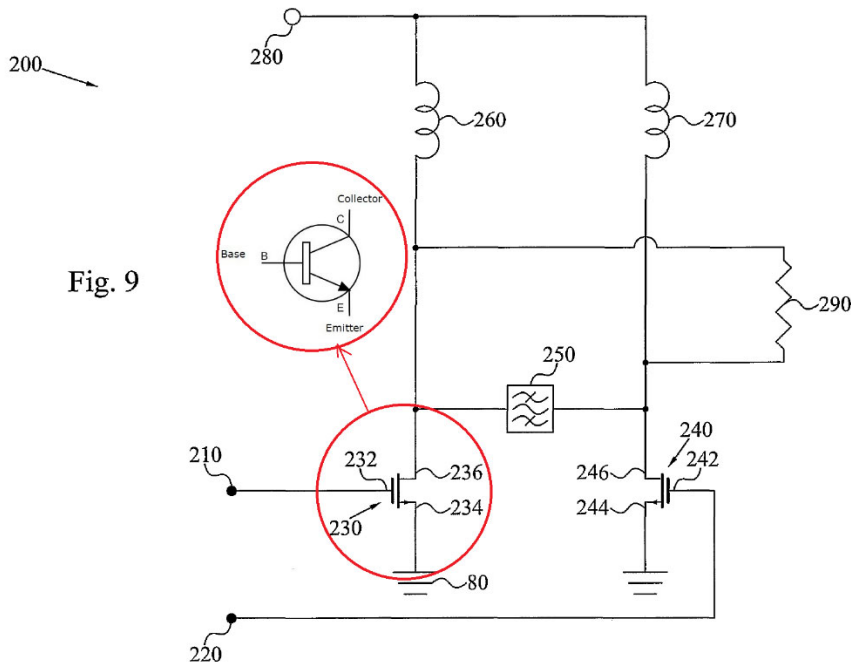
For the reasons discussed in §VIII.F.1, it would have been obvious to combine Lejon’s PA with the PAs of Canyon and Ranjan. Therefore, Lejon teaches an electronic device comprising a power amplifier which has multiple inputs and a single output (*a multiple-input-single-output (MISO) amplifier*), whether the “electronic device” is the PA itself or the larger device (e.g. handset) comprising the PA. §VIII.A.12.b; EX1003, ¶261.

3. Claim 17

- a. The system of claim 15, wherein the electronic device comprises an amplifier with a bipolar junction transistor (BJT), and wherein the power supply is coupled to a collector or an emitter terminal of the BJT.**

Lejon teaches or suggests claim 17's additional element. Lejon teaches a preferred embodiment in which the transistors of the amplifier can independently be of any field effect transistor (FET) design. EX1013, 21:29-31. Lejon further teaches that other types of transistors, including bipolar transistors and circuit components that has switching functionality can replace the FETs. *Id.*, 21:32-22:2. A POSITA would have understood that a bipolar transistor is also referred to as a bipolar junction transistor (BJT) because a bipolar transistor is composed of junctions between *p* and *n* regions, either in a *pnp* or *npn* configuration. EX1003, ¶262.

Using Figure 9 of Lejon as an example, as shown in the annotation below, a POSITA would have understood that drain electrode 236 of FET 230 is equivalent to a collector of a BJT, which is connected to supply voltage 280. *See* EX1013, 23:4-6 (“the drain or collector voltage”). EX1003, ¶263.



EX1013, Fig. 9

Therefore, Lejon teaches an amplifier (*the electronic device comprising an amplifier*) with a bipolar transistor (*BJT*), and the supply voltage 280 (*the power supply*) is coupled to drain electrode 236 (*a collector or an emitter terminal of the BJT*). EX1003, ¶264.

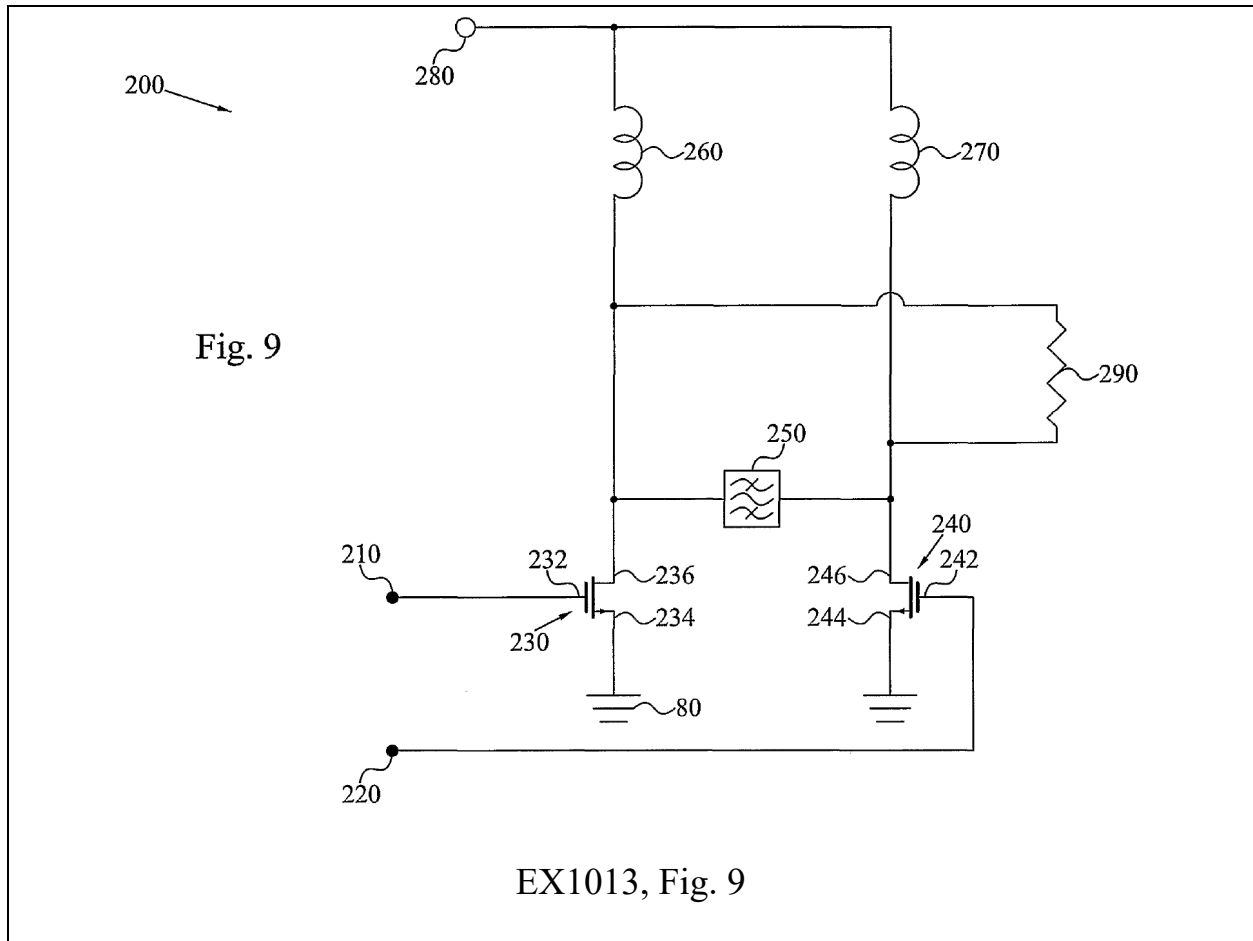
4. Claim 18

- a. **The system of claim 15, wherein the electronic device comprises an amplifier with a metal oxide semiconductor (MOS) transistor, and wherein the power supply is coupled to a drain or a source terminal of the MOSFET.**

Lejon teaches or suggests claim 18's additional element. EX1003, ¶266.

Using Figure 9 (below) of Lejon as an example, drain electrode 236 of FET

230 is connected to supply voltage 280. EX1003, ¶267.



Therefore, Lejon teaches an amplifier (*the electronic device comprising an amplifier*) with transistor 230 that can be MOSFET (*a metal oxide semiconductor (MOS) transistor*), and supply voltage 280 (*the power supply*) is coupled to a drain electrode 236 of transistor 230 (*a drain or a source terminal of the MOSFET*). EX1003, ¶268.

IX. THE BOARD SHOULD EXERCISE DISCRETION TO INSTITUTE REVIEW

A. The Board Should Not Deny Institution under *Fintiv*

The Board should not deny institution under 35 U.S.C. § 314(a). Petitioner stipulates that if this IPR is instituted, Petitioner will not pursue in the related litigation the same grounds or any grounds of invalidity of the '593 Patent that could reasonably have been raised in this IPR. EX1029. The Board “will not discretionarily deny institution in view of parallel district court litigation where a petitioner presents” such a stipulation. Katherine K. Vidal, *Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation*, 3 (June 21, 2022).⁸

B. The Examiner Did Not Consider the References Forming the Basis of This Petition

The Board should also decline to exercise its discretion to deny review under 35 U.S.C. § 325(d) at least because the Examiner did not analyze the prior art forming the basis of this Petition; indeed, none of the references were even cited during prosecution. *See* Section V.B; *Unified Patents, Inc. v. Berman*, No. IPR2016-01571, Paper 10 at 12-13 (Dec. 14, 2016) (instituting grounds relying on

⁸ <https://www.uspto.gov/about-us/news-updates/director-vidal-provides-clarity-patent-trial-and-appeal-board-practice>.

art not cited previously) (informative).

Nor should institution be denied based on the prosecution of related applications. The claims eventually allowed in the prosecution of the '704 Patent (over which the '593 Patent claims were originally rejected for double patenting) were never rejected based on prior art. The closest reference cited in prosecution of the '704 Patent, Ishikawa (EX1018), was only cited against claims that were disposed of by an election in response to a restriction requirement; the Examiner never discussed Ishikawa with respect to the issued claims of the '704 Patent. Moreover, Ishikawa is technically distinguishable from the references cited in this Petition: while Ishikawa has a bypass switch, it is controlled by a control voltage “which is input to the apparatus from an external source,” (EX1018, [0039]), rather than an internal comparison between an output power and a threshold. EX1003, ¶79a.

X. CONCLUSION

Petitioner respectfully requests institution of *inter partes* review to cancel claims 1-20 of the '593 Patent.

XI. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(B)

A. REAL PARTY IN INTEREST

MediaTek Inc., MediaTek USA Inc., MTK Wireless Limited (UK), Gaintech Co. Limited, and MediaTek Investment Singapore Pte. Ltd. are the real parties-in-

interest.

B. RELATED MATTERS

Patent Owner ParkerVision has asserted the '593 Patent in *ParkerVision v. MediaTek, Inc. et al.*, No. 6:23-cv-00732 (W.D.Tex. filed October 27, 2023).

C. NOTICE OF COUNSEL AND SERVICE INFORMATION

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These attorneys can be reached by mail at Perkins Coie LLP, 11452 El Camino Real, Suite 300, San Diego, CA 92130; by phone at (858) 720-5700; and by fax at (858) 720-5799.

Petitioner consents to electronic service. All services and communications to the attorneys listed above may be sent to: PerkinsServiceMediatek-ParkerVisionIPRs@perkinscoie.com. A Power of Attorney is being filed concurrently.

Dated: October 18, 2024

Respectfully submitted,

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CERTIFICATE OF WORD COUNT UNDER 37 CFR §42.24(d)

Under 37 C.F.R. §42.24(d), the undersigned certifies that the word count for this *Petition for Inter Partes Review* totals 13,921, excluding the parts exempted by 37 C.F.R. §42.24(a).

The word count was made using the built-in word count function in the Microsoft® Word software used to prepare this document.

Dated: October 18, 2024

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that true copies of this PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,498,593 and supporting materials (Exhibits 1001-1029 and Power of Attorney) were service via overnight delivery on the Patent Owner at the correspondence address of record as listed in the US Patent and Trademark Office Patent Center:

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