

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEDIATEK INC.,
PETITIONER

v.

PARKERVISION, INC.,
PATENT OWNER.

IPR2025-00030
U.S. Patent No. 8,498,593

**DECLARATION OF DR. LAWRENCE E. LARSON, Ph.D.
REGARDING U.S. PATENT NO. 8,498,593**

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I, Lawrence Larson, hereby declare as follows:

I. INTRODUCTION

1. I have been retained on behalf of MediaTek, Inc. (“Media” or “Petitioner”) to offer technical opinions related to U.S. Patent No. 8,498,593 (“the ’593 patent”) (EX-1001). I understand that MediaTek is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an inter partes review (“IPR”) proceeding of the ’593 patent. Specifically, I have been asked to consider the validity of claims 1-20 of the ’593 patent (the “Challenged Claims”) in view of prior art and obviousness considerations from the perspective of a person of ordinary skill in the art at the time of the invention (“POSITA”) as it relates to the ’593 patent.

2. I am being compensated at my normal rate of \$600/hour for all services rendered. My compensation is not dependent, in any way, on the nature of my findings, the content of my testimony, or the outcome of this proceeding or any other proceeding.

3. I have no other interest in this proceeding.

4. My analysis of the materials provided in this proceeding is ongoing and I will continue to review any new materials that are provided. This declaration is indicative of only those opinions that I have formed to date. I reserve the right to amend, revise, and/or supplement my opinions stated herein based on any new information that may become available to me or my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

5. I am over the age of 18 and am competent to write this declaration. I have personal knowledge or have developed knowledge of these technologies, based upon education, training, or experience, of the matters set forth herein.

6. My qualifications for forming the opinions in this report are summarized here and explained in more detail in my Curriculum Vitae (“CV”), which is provided as EX1004.

7. I hold a Ph.D. in Electrical Engineering from the University of California, Los Angeles (“UCLA”) (1986), as well as a M.B.A. degree from UCLA (1996), and Master of Engineering and Bachelor of Science degrees in Electrical Engineering from Cornell University (1980 and 1979, respectively).

8. I am currently Professor of Engineering at the School of Engineering, Brown University. I have also held the positions of Interim Provost of Brown University, as well as Sorensen Family Dean and Founding Dean of the School of Engineering. I held the position of Dean beginning in 2011, during which time I oversaw a large expansion in the number of tenure-track engineering faculty, substantial increases in external research funding, the creation of new graduate programs, and the construction of a state-of-the-art research and teaching facility.

9. I have over 40 years of experience in the design of high-performance circuits for RF communications and other applications, both in industry and academia. Those include but are not limited to the following work experience.

10. From 1980 to 1988, I was a Member of Technical Staff at Hughes Aircraft and Hughes Research Laboratories, where I was responsible for the development of CMOS and III-V analog and digital integrated circuits, modeling and characterization of MESFETs and HEMTs and the development of improved III-V process techniques. During my tenure, among other things, I helped develop the first high-performance GaAs switched-capacitor circuits with clock rates in excess of 100 MHz, demonstrated the first use of low-temperature buffer GaAs MESFET technology with digital integrated circuits, setting a record for digital divider performance (22 GHz), and developed GaAs MESFET operational amplifier with record GBW (10 GHz).

11. From 1988 to 1992, I was an Adjunct Associate Professor at UCLA, where I was responsible for senior level digital and analog integrated circuit design courses and a graduate analog MOS integrated circuit design course.

12. From 1992 to 1994, I was an Assistant Manager for the DARPA / Hughes MIMIC Program, where I was responsible for Program Management of the Advanced Technology Portion of DARPA/Hughes MIMIC Program, with a budget of approximately \$8M/yr. In that capacity, I was responsible for the technical and program direction of GaAs HBT and PHEMT efforts. I also directed insertion of advanced GaAs-based technology into next generation communication and radar systems.

13. From 1988 to 1996, I was also a Manager in the HEMT Technology Department, Microwave Devices and Circuits Laboratory, at Hughes Research Laboratories, where I directed research in high-speed III-V materials, devices, and

circuits, and was responsible for approximately \$4M/yr. in Corporate IR&D and Government Research Contracts. In that capacity, I helped develop the first space-qualified InP low-noise millimeter wave HEMT. This effort was awarded the 1996 Lawrence Hyland Award – the highest technical achievement award at Hughes Electronics. I also helped develop the first micromachining (MEMS) switch and tuner applications for RF and microwave applications (1991). This technology has now become an extremely active area of worldwide research and development. I also helped demonstrate the first InP-based HEMT low-noise and high- power MMICs from 2– 60 GHz, with world record noise figures and power-added efficiencies. I further helped establish a state-of-the-art InP HEMT MMIC foundry at HRL, developed the first low-power/high-speed InP HEMT digital IC technology with ring oscillator delays of 4.2 pS, and directed the research program that demonstrated HEMTs with record f_T 's and f_{MAX} 's above 300 GHz (1993), which produced the highest frequency room temperature integrated circuit ever reported – a 210 GHz VCO (IEDM 1994).

14. From 1994 to 1996, I was a Manager in the Telecommunications Technology Department, Microwave Devices and Circuits Laboratory, at Hughes Research Laboratories, where I directed the research and development of integrated circuits for commercial RF and microwave communications applications, including DBS, cellular telephone, VSAT, and PCS.

15. From 1996 to 2011, I held the CWC Industry Chair Professor in Wireless Communications, in the Department of Electrical and Computer Engineering at the

University of California, San Diego (UCSD). Among other things, I helped develop improved integrated circuit techniques and novel device structures for wireless communications applications. This required development of high-frequency integrated circuits, devices, and packaging techniques for ultra-wide bandwidth telecommunications applications, and development of novel data converter and analog-signal processing architectures that are matched to communications applications.

16. From 2000 to 2001, while on academic leave from UCSD, I was a Director at IBM's West Coast Design Center of Excellence in the IBM Research Division, where I directed development of Radio Frequency Integrated Circuits for SiGe RFICs for 3rd Generation wireless cellular applications. I was also responsible for leading the team that developed a complete Wideband CDMA chip set for several "first tier" cellular telephone providers.

17. From 2001 to 2006, I was the Director of the UCSD Center for Wireless Communications (<http://cwc.ucsd.edu>), which is one of the largest industry-funded University Research Centers in the world. Involving over 20 professors, and supporting roughly 50 PhD graduate students during my tenure, with an annual budget in excess of \$3M, the CWC conducted research in all areas of wireless communications, from fundamental devices and materials to software applications. I was responsible for all aspects of the Center, from new member development to financial management and establishing the research direction.

18. From 2007 to 2011, I was the Chair of the Department of Electrical and

Computer Engineering at the University of California, San Diego. The ECE Department at UCSD is the largest graduate program on the UCSD campus. As Chair, I oversaw the faculty development (hiring, promotion, and tenure process), educational policy and teaching, successful accreditation review, department resource allocation, and external relations. I also led the development (with CS) of the Executive Masters of Advanced Study in Embedded Wireless Systems program.

19. I have authored more than 125 refereed journal publications and more than 250 peer reviewed conference publications. I have also authored and/or edited 12 books or chapters, and am a named inventor on at least 43 issued patents. The works that I have authored include the following.

- L. E. Larson, RF AND MICROWAVE CIRCUIT DESIGN FOR WIRELESS COMMUNICATIONS (Artech House, Inc., 1996).
- J. Groe, and L. E. Larson, CDMA MOBILE RADIO DESIGN: SYSTEMS, ALGORITHMS, AND CIRCUITS (Artech House, Inc., 2000).
- CIRCUITS AND SYSTEMS FOR FUTURE GENERATIONS OF WIRELESS COMMUNICATIONS, A. Tasic, W. Serdijn, L. Larson, G. Setti, G. (Eds.), 2009, VIII, Springer.

20. I have been elected a Life Fellow of the IEEE. The Fellow is the highest grade of membership of the IEEE, a world professional body consisting of over 400,000 electrical and electronics engineers, with only one-tenth of one percent (0.1%) of the

IEEE membership being elected to the Fellow grade each year. Election to Fellow is based upon votes cast by existing Fellows in IEEE. I have also served on a number of IEEE Committees and as a Paper Reviewer.

III. LEVEL OF ORDINARY SKILL IN THE ART

21. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of a POSITA at the time of the alleged invention, which I understand to be November 9, 2006. I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art; and the sophistication of the technology at the time of the alleged invention. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA would also have knowledge from the teachings of the prior art, including the art cited below.

22. Taking these factors into consideration, in my opinion, at the relevant time, a POSITA relating to the technology of the '593 patent would have had a (1) 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. In my opinion, additional experience could substitute for the level of education and vice-versa. For example, a masters'

degree could substitute for the work experience described above.

23. Before November 9, 2006, my level of skill in the art was at least that of a POSITA. I am qualified to provide opinions concerning what a POSITA would have known and understood at that time, and my analysis and conclusions herein are from the perspective of a POSITA as of that date.

IV. MATERIALS CONSIDERED AND RELIED UPON

24. In forming my opinions expressed herein, in addition to relying on my education and experience, I considered the totality of the following materials:

Exhibit	Reference
EX1001	U.S. Patent No. 8,498,593 (“the ’593 patent”)
EX1002	File History of the ’593 patent (“’593FH”)
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 et al, “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.
EX1016	Kassakian <i>et al.</i> , <i>Principles of Power Electronics</i> , 2 nd ed.
EX1017	U.S. Patent No. 7,047,032 (“Yun”)
EX1018	U.S. Patent Application Publication No. US2006/0001410 (“Ishikawa”)
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

25. I have also considered any materials cited in this declaration, even if they are not included in the list above.

V. LEGAL STANDARDS

26. I am not a lawyer and do not provide any legal opinions, but I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims. I have applied the legal standards described below.

27. I understand that assessing a U.S. patent's validity based on a prior art analysis involves two steps. First, one must assess what meaning a POSITA would have given the terms. Second, after assessing the meaning of the claim terms, one may then assess validity by comparing a patent claim to the “prior art.” I understand that the teaching of the prior art is viewed through the eyes of a POSITA at the time the invention was made. My analysis as to what constitutes a relevant POSITA is set forth above.

A. Legal Standards for Priority Date

28. I understand that the “priority date” (or “earliest effective filing date”) of a patent is the date on which it is filed or the date on which an earlier application was filed if the patentee properly claims the benefit of the earlier application’s filing date. For my analysis in this declaration, I have assumed that the ’593 patent is entitled to a priority date of November 9, 2006.

B. Legal Standards for Obviousness

29. My understanding is that a patent claim is invalid as obvious only if the subject matter of the claimed invention “as a whole” would have been obvious to a POSITA at the time the invention was made. To determine the differences between a prior art reference (or a proposed combination of prior art references) and the claims, the question of obviousness is not whether the differences themselves would have been obvious but whether the claimed invention as a whole would have been obvious. Also, obviousness grounds cannot be sustained by mere conclusory statements. Rather, it is necessary to provide some articulated reasoning with rational underpinning to support the legal conclusion of obviousness.

30. I understand that a patent claim that comprises several elements is not proved obvious by simply showing that each of its elements was independently known in the prior art. In my evaluation of whether any claim of the ’593 patent would have been obvious, I considered whether a POSITA would have had a reason with a rational basis that would have motivated a POSITA to combine the elements or concepts from the prior art in the same way as in the claimed invention.

31. I understand that there is no single way to define the line between true inventiveness on the one hand—which is patentable—and the application of common sense and ordinary skill to solve a problem on the other hand—which is not patentable. For instance, factors such as market forces or other design incentives may be the source of what produced a change rather than true inventiveness.

32. I understand that the decision-maker may consider whether the change was merely the predictable result of using prior art elements according to their known functions or whether it was the result of true inventiveness. And the decision-maker may also consider whether there is some teaching or suggestion in the prior art to make the modification or combination of elements recited in the claim at issue. Also, the decision-maker may consider whether the innovation applies a known technique that had been used to improve a similar device or method. The decision-maker may also consider whether the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art.

33. I understand that in considering obviousness, it is important to be careful not to engage in hindsight and that many true inventions might seem obvious after the fact. I understand that obviousness is considered from the perspective of a POSITA at the time the claimed invention was made and not based on what is known today or what is learned from the teaching of the patent.

34. I understand that the following factors must be evaluated to determine whether a claim is obvious: the scope and content of the prior art; the difference or differences, if any, between the claim of the patent and the prior art; the level of ordinary skill in the art at the time the claimed invention was made; and, if available, the objective indicia of non-obviousness, also known as “secondary considerations.”

35. I understand that the secondary considerations can include: commercial

success of a product due to the merits of the claimed invention, a long-felt need for the solution provided by the claimed invention, unsuccessful attempts by others to find the solution provided by the claimed invention; copying of the claimed invention by others, unexpected and superior results from the claimed invention; acceptance by others of the claimed invention as shown by praise from others in the field or from the licensing of the claimed invention, teaching away from the conventional wisdom in the art at the time of the invention, independent invention of the claimed invention by others before or at about the same time as the named inventor thought of it, and other evidence tending to show obviousness.

36. I understand that, to establish a secondary consideration, the evidence must demonstrate a nexus between that secondary consideration and the claimed invention.

37. I understand that a petition must identify, for any terms with means-plus-function limitations, the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function. I also understand a rebuttable presumption exists that using the term, “means,” a claim term is interpreted as means-plus-function.

38. I also understand that a petitioner seeking to demonstrate that the prior art discloses a means-plus-function limitation must prove that the corresponding structure—or an equivalent—was present in the prior art and performing the same claimed function.

39. I understand that the standard for determining whether the prior art

discloses the corresponding structure or an equivalent is whether there are insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially the same result as the corresponding structure described in the specification, it is equivalent.

40. I understand that proving structural equivalence does not require a component-by-component analysis but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

VI. SUMMARY OF OPINIONS

41. For the reasons I discuss below, it is my opinion that claims 1-20 of the '593 patent are disclosed in the prior art, and are rendered obvious by the prior art.

VII. OVERVIEW OF THE TECHNOLOGY AND THE '593 PATENT

A. Technology Overview

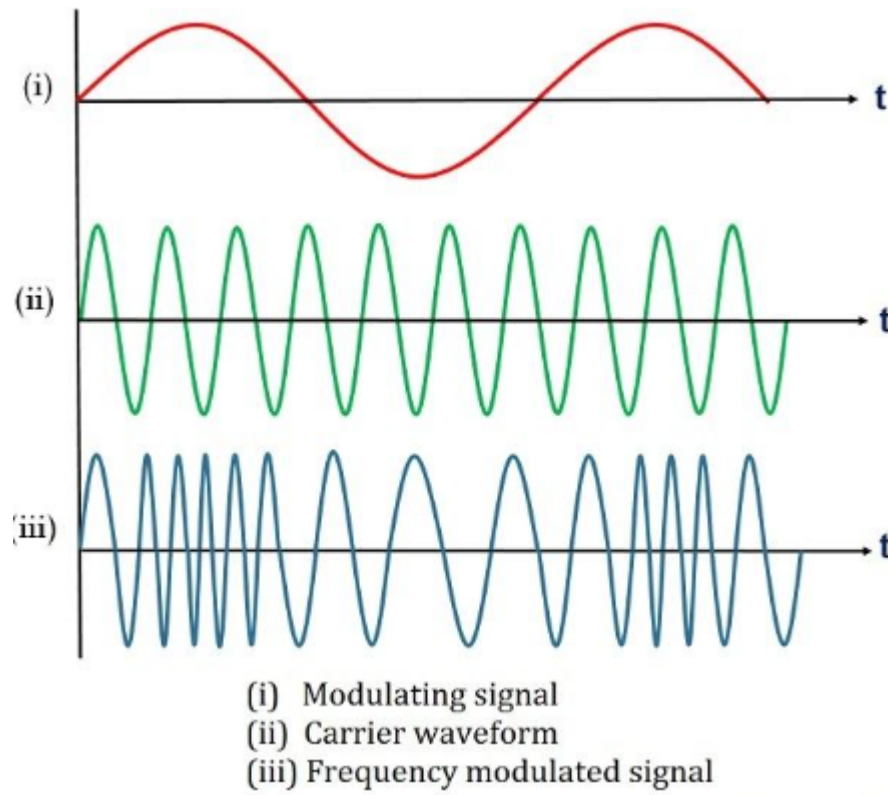
1. Modulation Techniques for Wireless Communications

42. A wireless communications device ordinarily transmits a signal by propagating an electromagnetic wave using the frequency, amplitude, and phase of the underlying signal. Although all propagated electromagnetic signals travel at approximately the speed of light, "baseband" signals have relatively low frequencies and so cannot be effectively transmitted through the air between wireless devices. This is due to several reasons, including the size of the equipment needed to propagate and

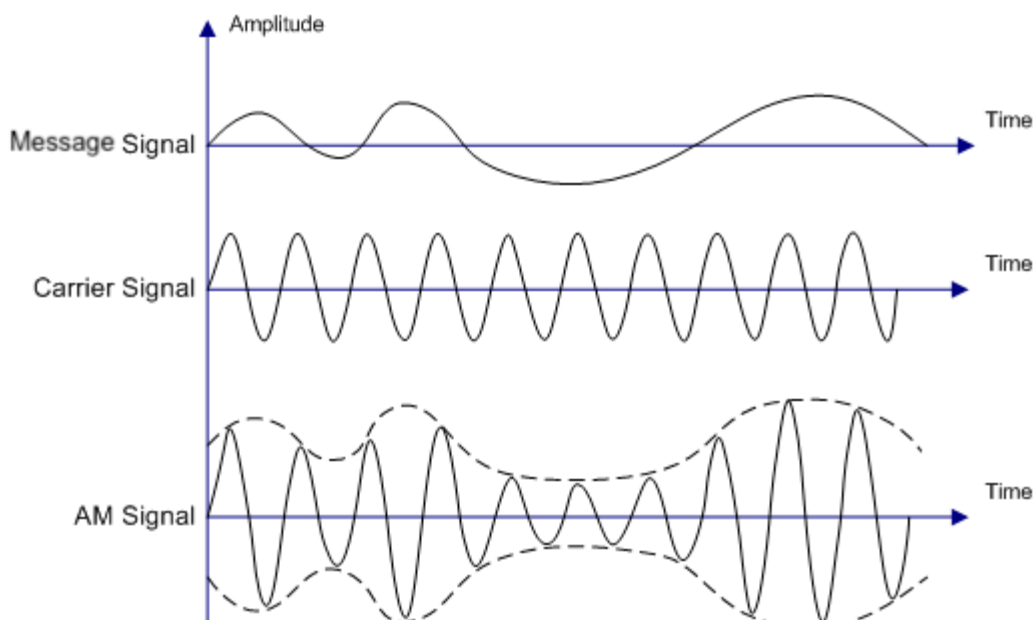
receive low-frequency signals, power requirements for such equipment, and signal interference at low frequencies.

43. As a result, to effectively transmit the information content of a baseband signal through the air, the baseband signal must be “imprinted” on or “upconverted” to a higher frequency signal—called a “carrier” signal—that can be transmitted more effectively through the air, including due to reduced equipment size and power requirements, as well as less signal interference. This “imprinting” process is called “modulation,” and modulation is usually achieved by altering one or more of the frequency, the amplitude, or the phase of the carrier signal.

44. Taking analog modulation techniques such as Frequency Modulation (FM) and Amplitude Modulation (AM) as examples, in FM, the frequency of the carrier is shifted based on the amplitude of the baseband signal, resulting in a FM signal:



45. In AM, the amplitude of the carrier signal is modified based on the amplitude of the baseband signal.



46. Frequency modulation (FM) is the most popular analog modulation technique used in mobile radio systems. In FM, the amplitude of the modulated carrier

signal is kept constant while its frequency is varied by the modulating message signal. Thus, FM signals have all their information in the phase or frequency of the carrier. FM has better noise immunity when compared to AM. EX1015, p. 256. Since signals are represented as frequency variations rather than amplitude variations, FM signals are less susceptible to atmospheric and impulse noise. *Id.*

47. In AM schemes, there is a linear relationship between the quality of the received signal and the power of the received signal since AM signals superimpose the exact relative amplitudes of the modulating signal onto the carrier. *Id.* Thus, AM signals have all their information in the amplitude of the carrier. Appropriately conditioned, AM signals are able to occupy less bandwidth as compared to FM signals, since the bandwidth of the AM and baseband signals are the same in the transmission system. *Id.* In modern AM systems, susceptibility to fading has been dramatically improved through the use of in-band pilot tones which are transmitted along with the standard AM signal. *Id.* The modern AM receiver is able to monitor the pilot tone and rapidly adjust the receiver gain to compensate for the amplitude fluctuations. *Id.*

48. The transmitted power of an FM signal is constant regardless of the amplitude of the message signal. *Id.* For AM signals, however, it is critical to maintain linearity between the applied message and the amplitude of the transmitted signal. *Id.* The issue of amplifier efficiency is extremely important when designing portable subscriber terminals since the battery life of the portable is tied to the power amplifier efficiency. *Id.*

49. More recent systems use digital modulation, which “imprints” a digital signal on the carrier, by means of mapping bits to elements from a discrete alphabet to be transmitted. *Id.*, p. 277. Common digital modulation techniques include Binary Phase Shift Keying (BPSK), Quadrature Phase-Shift Keying (QPSK), Quadrature Amplitude Modulation (QAM), and Orthogonal Frequency-Division Multiplexing (OFDM). *Id.*, pp. 295-309, pp. 325-329.

a. Multiple Access Techniques for Wireless Communications

50. In wireless communications systems, it is often desirable to allow the subscribers to send simultaneously information to the base station while receiving information from the base station. EX1015, p. 447. Multiple access techniques have been developed to enable the multiple users to communicate at the same time. Frequency division multiple access (FDMA), time division multiple access (TDMA), and Code Division Multiple Access (CDMA) are the three major access techniques used to share the available bandwidth in a wireless communication system. *Id.*, p. 448.

51. FDMA systems assign individual frequency bands to individual users. *Id.*, p. 449. TDMA systems divide the radio spectrum into time slots, and in each slot only one user is allowed to either transmit or receive. *Id.*, p. 453. In CDMA systems, all users in a CDMA system use the same carrier frequency and may transmit simultaneously, but each has its own pseudorandom codeword which is approximately orthogonal to all other codewords. *Id.*, p. 458. The receiver performs a time correlation operation to detect only the specific desired codeword. *Id.* All other codewords appear

as noise due to decorrelation such that each user operates independently with no knowledge of the other users. *Id.*

b. Spectral Efficiency for Multiple Access Techniques

52. TDMA, FDMA, and CDMA are associated with different parameters for respective waveform generation—they can be understood as different communication waveforms. *See* EX1015, Figure 9.2, Figure 9.3, Figure 9.5.

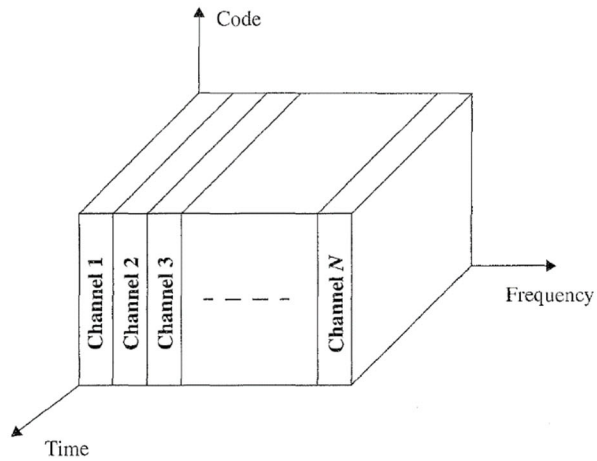


Figure 9.2 FDMA where different channels are assigned different frequency bands.

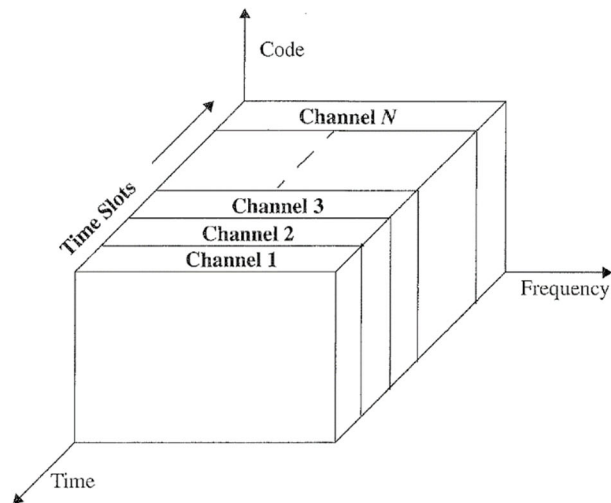


Figure 9.3 TDMA scheme where each channel occupies a cyclically repeating time slot.

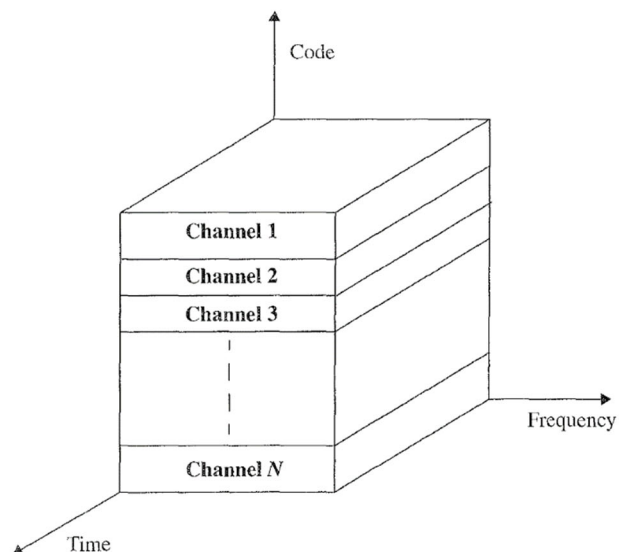


Figure 9.5 Spread spectrum multiple access in which each channel is assigned a unique PN code which is orthogonal or approximately orthogonal to PN codes used by other users.

53. Each communication waveform is associated with a spectral efficiency or spectrum efficiency, referring to the information rate that can be transmitted over a given bandwidth in a specific communication system. Spectral efficiency of a communication waveform in wireless system can be measured by a parameter called radio capacity. EX1015, p. 469. Radio capacity is determined by the required carrier-to-interference ratio and the channel bandwidth. *Id.*

54. TDMA systems and FDMA system can have the same radio capacity and consequently the same spectrum efficiency. *Id.*, p. 473. The capacity of the FDMA and TDMA systems is bandwidth limited, while the capacity of the CDMA system is typically interference limited. *Id.*, p. 474.

c. Spectral Efficiency and Power Control in CDMA

55. For CDMA system, any reduction in the interference causes a linear increase in the capacity of CDMA. *Id.* Accordingly, in CDMA power control, the efficiency is maximized if each mobile transmitter power level is controlled so that its signal arrives at the cell site with the minimum required signal-to-interference ratio. *Id.*, p. 476.

56. In practical cellular radio and personal communication systems, the power levels transmitted by every subscriber unit are under constant control by the serving base stations. *Id.*, p. 76. This is done to ensure that each mobile transmits the smallest power necessary to maintain a good quality link on the reverse channel. *Id.*, pp. 76-77. Power control not only helps prolong battery life for the subscriber unit, but also

dramatically reduces the reverse channel in the system. *Id.*, p. 77.

57. Power control is especially important for CDMA spread spectrum systems that allow every user in every cell to share the same radio channel. *Id.* For example, IS-95 strives to force each user to provide the same power level at the base station receiver to reduce interference. *Id.*, p. 372. Power control commands are sent to each subscriber unit by the base station on the forward control subchannel which instruct the mobile to raise or lower its transmitted power in 1 dB steps. *Id.* An example of power control bits for the CDMA IS-95 standard is illustrated below, signaling a control subchannel every 1.25 ms indicating that the mobile unit should either raise or lower its transmission power. *Id.*, Figure 11.16.

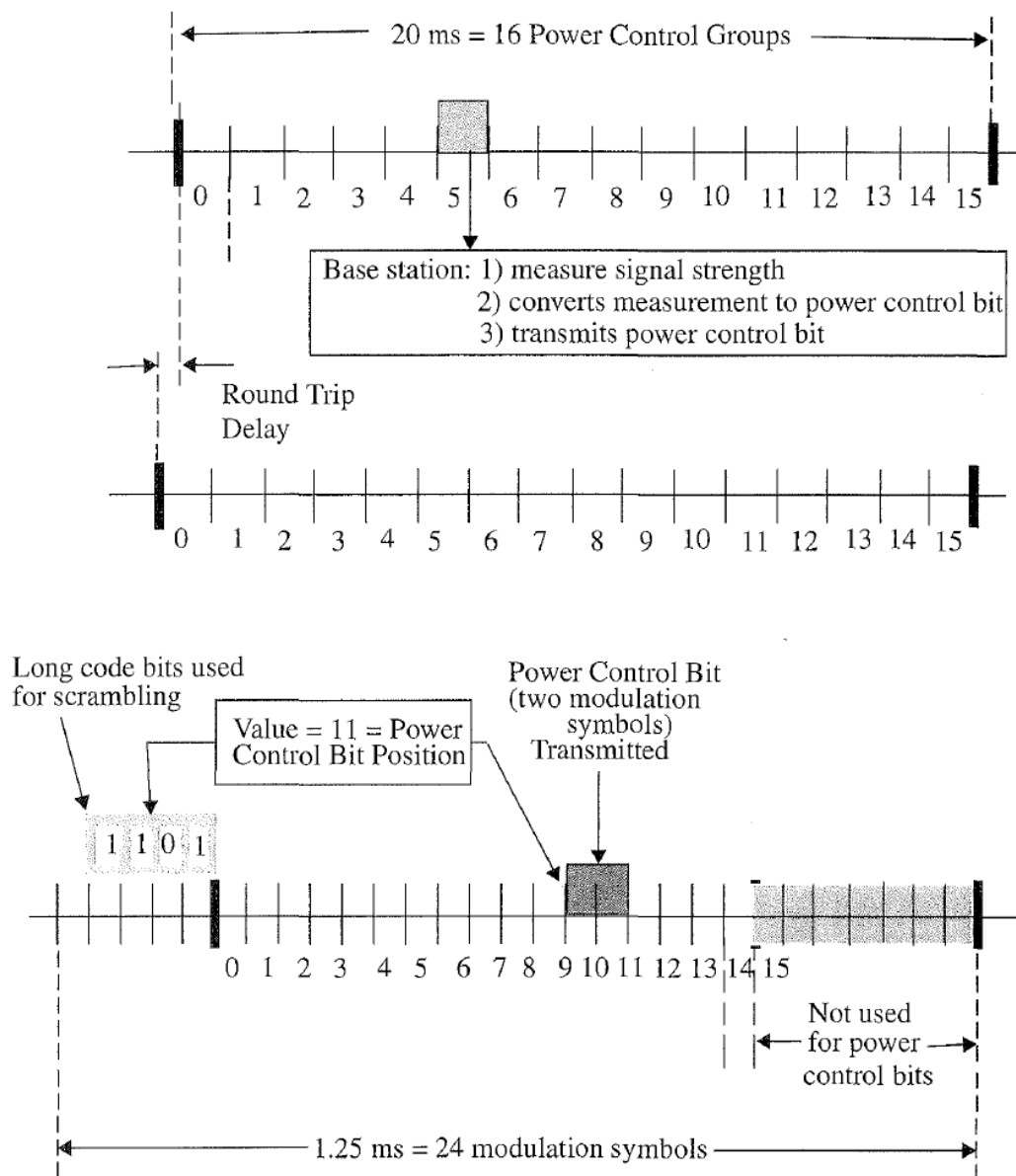


Figure 11.16 Randomization of power control bit positions in a IS-95 forward traffic channel.

In response to the power control bits, the mobile unit adjusts its own power level. For example, the mobile unit may adjust its transmission power level by adjusting the bias voltage provided to the amplifier.

d. CDMA from 2G to 3G

58. CDMA offers many advantages over TDMA and FDMA. *Id.*, p. 567. A

digital cellular system based on CDMA which promised increased capacity was standardized as Interim Standard 95 (IS-95) by the US Telecommunications Industry Association (TIA). *Id.*

59. A wide range of 2.5G standards were developed to allow each of the major 2G technologies (GSM, CDMA, and IS-136) to be upgraded incrementally for faster Internet data rates. *Id.*, p. 30. The figure below illustrates the various 2.5G and 3G upgrade paths for the major 2G technologies. *Id.*, Figure 2.3.

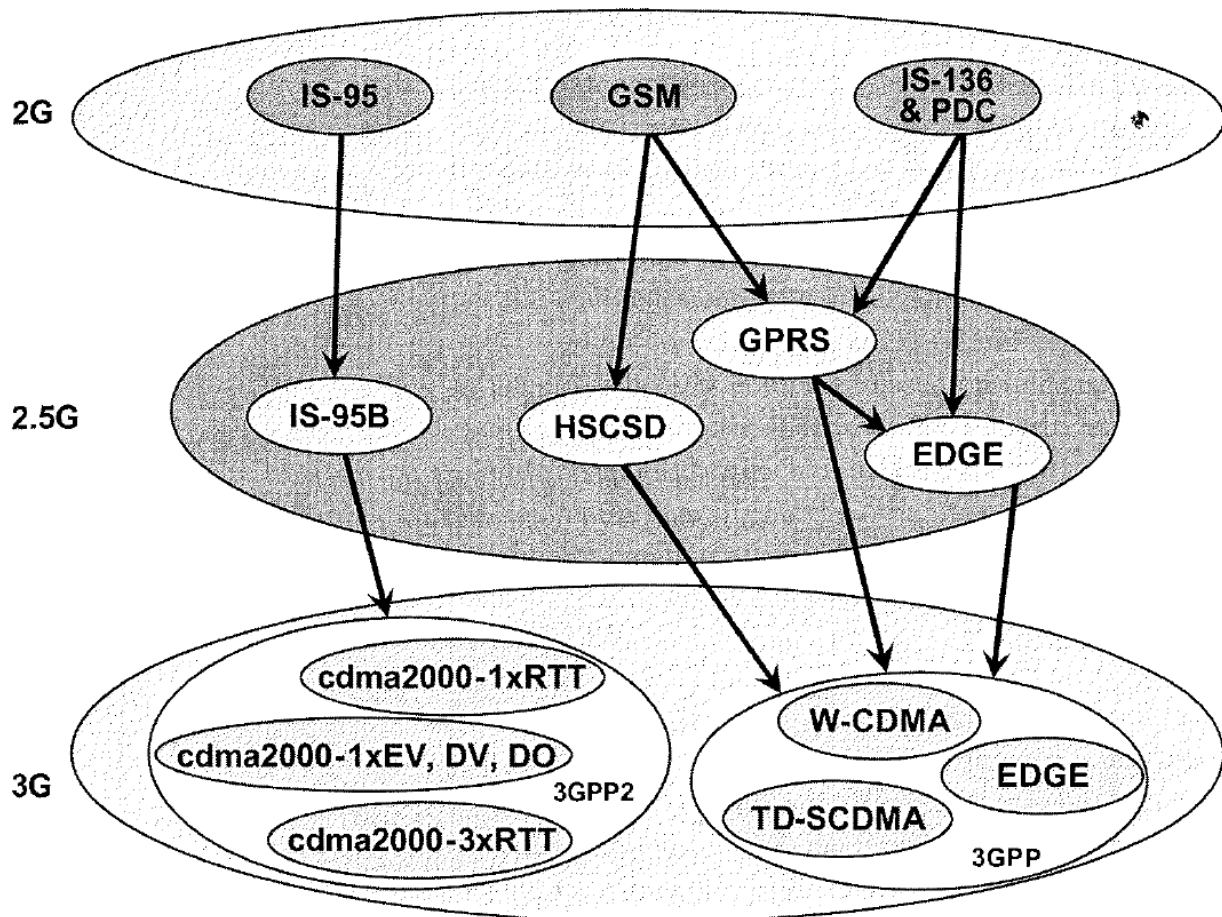


Figure 2.3 Various upgrade paths for 2G technologies.

60. As shown in the figure above, the 2.5G CDMA solution, IS-95B, supports

medium data rate (MDR) service by allowing a dedicated user to command up to eight different user simultaneously and in parallel for an instantaneous throughput of 115.2 kbps per user (8×14.4 kbps). *Id.*, p. 34. The eventual 3G evolution for 2G CDMA systems leads to cdma2000, and to Wideband CDMA (W-CDMA), also called Universal Mobile Telecommunications Service (UMTS). *Id.*, p. 35.

2. Power Electronics

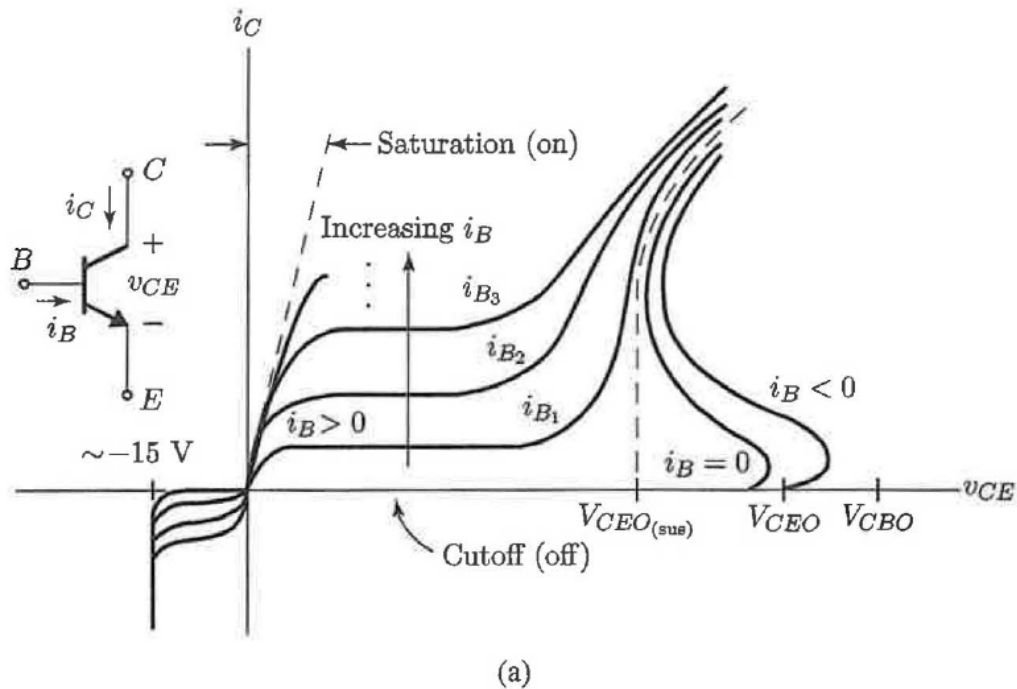
61. Power control relies on power electronics, which are components principally concerned with processing energy. EX1016, p. 1. Power electronics convert electrical energy from a form supplied by a source to a form required by a load. *Id.* Efficiency is an important concern in any energy processing system. *Id.*

a. Amplifiers

62. An amplifier is an electronic device that can increase the magnitude of a signal (a time-varying voltage or current). All amplifiers include some form of an active device—a device that does the actual amplification. Transistor amplifiers are the most common type of amplifier in use today. When a transistor is used as the active element, the gain of the amplifier is determined by the properties of the transistor itself as well as the circuit it is contained within.

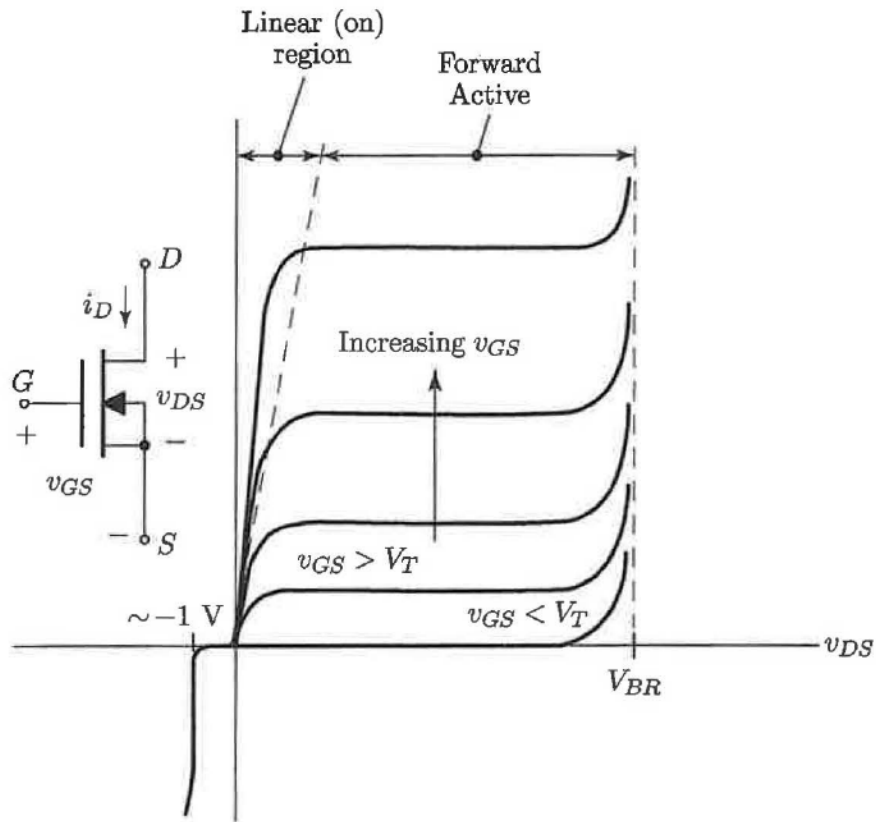
63. Common active devices in transistor amplifiers include bipolar junction transistors (BJTs) and metal oxide semiconductor field-effect transistors (MOSFETs). The BJT is one of the basic semiconductor devices used in power electronic circuits. EX1016, p. 2. The figure below illustrates circuit symbols for the BJT, including a

base, a collector, and an emitter, and the static current (i)–voltage (v) characteristics for the BJT. For the BJT, the ratio of on-state collector current i_c to the base current i_β necessary to support this value of i_c is an important parameter called the dc current gain. *Id.*, Figure 15.4(a).



EX1016, Figure 15.4(a)

64. The figure below illustrates circuit symbols for the MOSFET, including a gate, a drain, and a source, and the static i-v characteristics for the MOSFET. *Id.*, Figure 15.4(b).



(b)

EX1016, Figure 15.4(b)

65. As discussed in §VII.A.1, in amplitude modulation, it is critical to maintain linearity between the applied message and the amplitude of the transmitted signal, and amplifier efficiency is extremely important when designing portable subscriber terminals since the battery life of the portable is tied to the power amplifier efficiency. EX1015, p. 256. Furthermore, efficiency of power amplifiers can be significantly improved by employing a Direct Current (DC) to DC (DC-DC) converter. EX1012, Introduction.

b. DC-DC Converters

66. Used extensively in power supplies for electronic equipment, DC-DC

converters control the flow of energy between two DC systems. EX1016, p. 18. DC-DC converters are often used in battery-powered equipment to adjust voltage. *Id.*

67. A DC-DC converter is known as either a buck (or down) converter or a boost (or up) converter. *Id.*, p. 85. DC-DC converters may also be a combination of the two, known as a buck-boost converter. An example implementation of a buck converter is shown below. *Id.*, Figure 5.11.

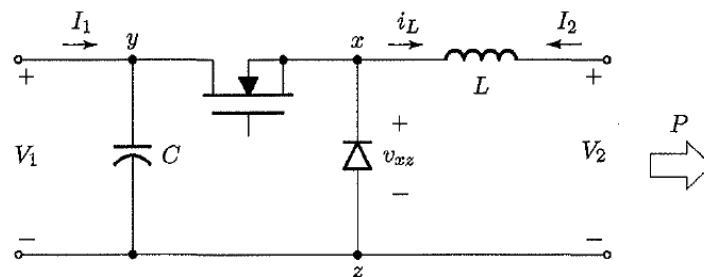
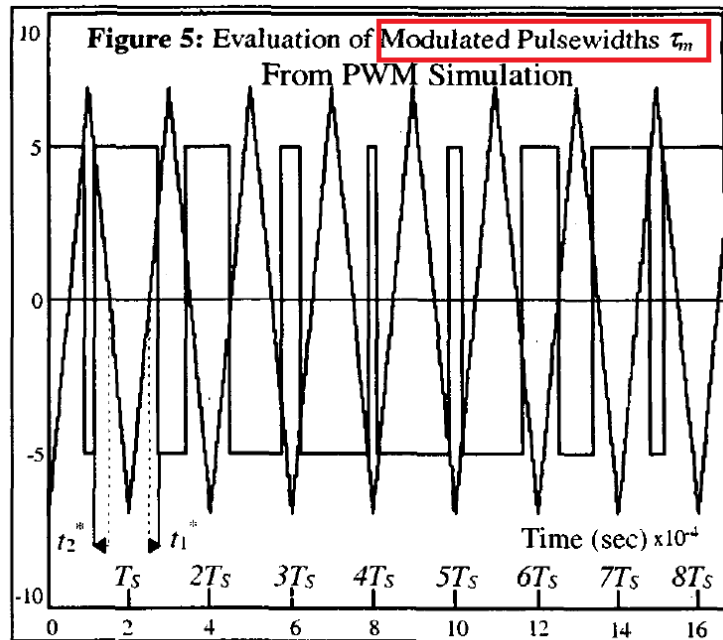


Figure 5.11 Switch implementation for the direct buck converter.

68. Pulse-width-modulated (PWM) DC-DC converters are often used in computers and other electronic equipment. *Id.*, p. 76. Pulse-width modulation is a method of representing a signal as a rectangular wave with varying pulse widths, where the widths are also referred to as aperture values. See EX1026, III-55 (“[t]he resultant modulated pulse **aperture time** τ_m ”), III-55.



EX1026, Figure 5.

69. The PWM switching converters are power circuits in which the semiconductor devices switch between on and off states. EX1016, p. 76. Control of such a converter is exercised by varying the ratio of on-time to total switching period of the controlling switches, thereby controlling the width (i.e., “aperture”) of the pulses applied to the output. *Id.* The figure below shows a simplest form of a switching DC-DC converter. *Id.* at 77, Figure 5.1. The percentage of each cycle during which the switch is “on” is known as the “duty cycle.” The switch opens and closes at a frequency $1/T$, with the ratio of the on-time to the period defined as D , the duty ratio. *Id.*

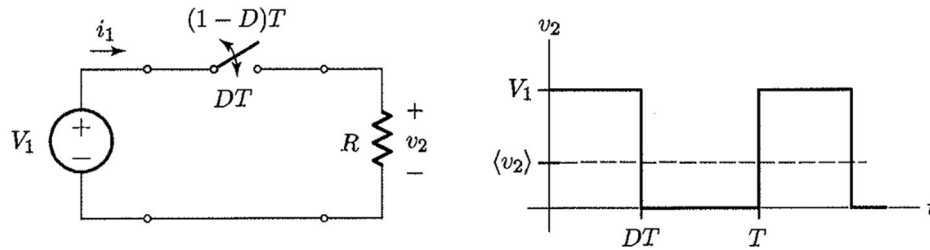


Figure 5.1 The simplest form of a switching dc/dc converter.

70. The simplest form of the switching DC-DC converter, however, comes with a substantial amount of ripple such that few applications can make use of this component in the presence of so much distortion. *Id.*, p. 77. The high frequencies contained in the ripple can cause both interference with other apparatus, such as computers or communications equipment. *Id.* To eliminate ripple from the current flowing through the input circuit, a low-pass filter can be used. *See id.*, pp. 79-80. 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.

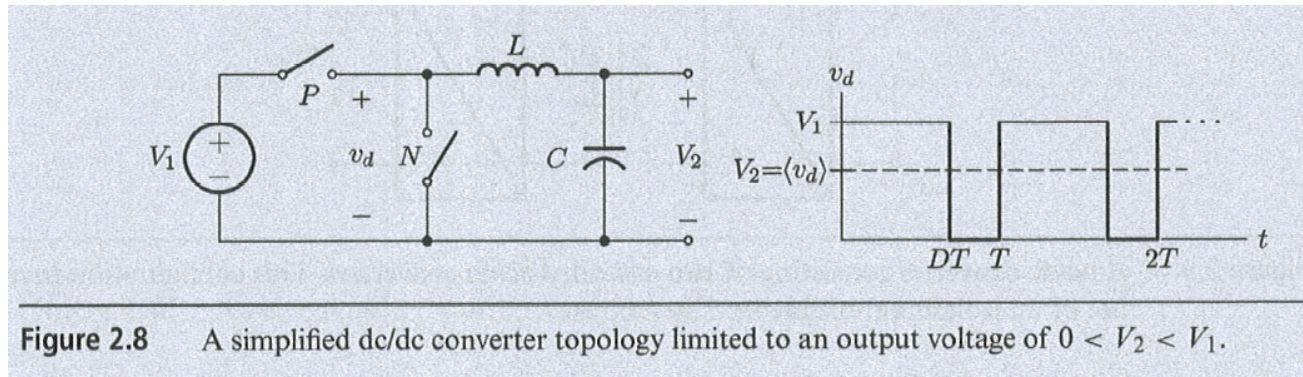


Figure 2.8 A simplified dc/dc converter topology limited to an output voltage of $0 < V_2 < V_1$.

B. Disclosure of the '593 Patent

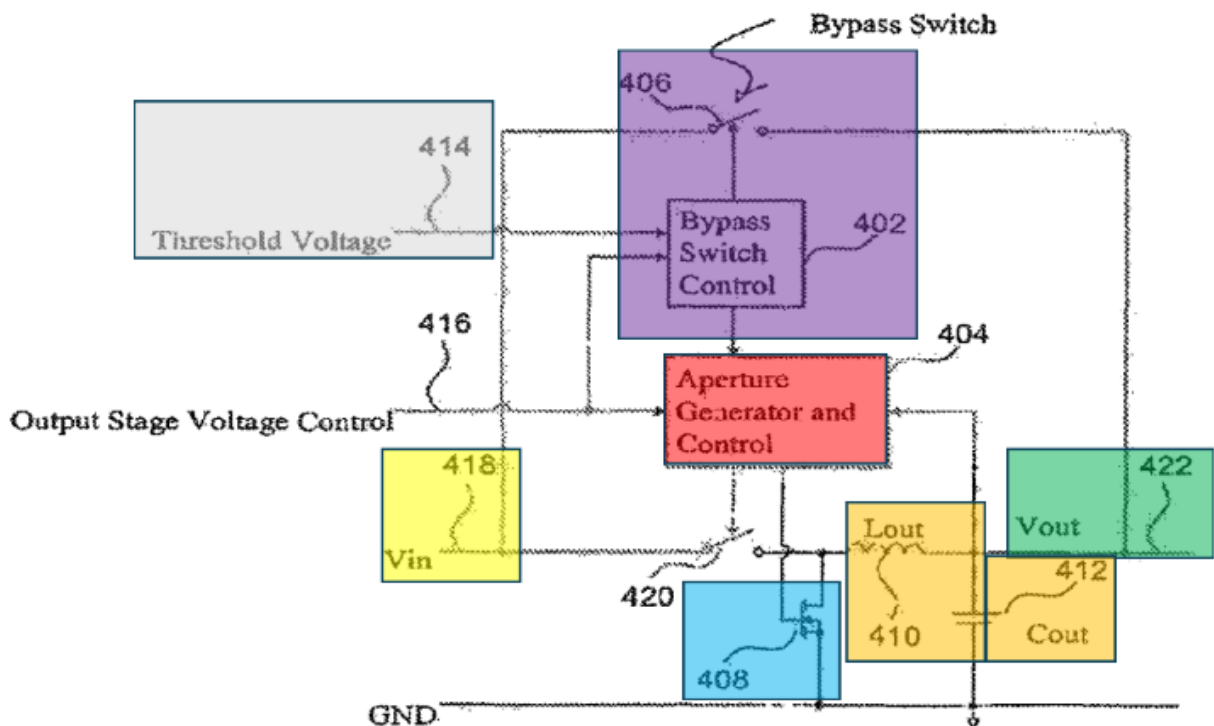
71. The '593 patent is titled "Switching Power Supply" and issued on July 30, 2013, from Application 13/590,887, filed on August 12, 2012. The '593 patent is a continuation of U.S. Patent Application No. 13/347,317, filed on January 10, 2012, now Pat. No. 8,285,229, which is a continuation of U.S. Patent Application No. 11/979,852, filed on November 8, 2007, now Pat. No. 8,116,704, which claims priority to U.S. Provisional Application No. 60/857,777, filed on November 9, 2006.

72. 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, 3:30-33. 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." EX1001, 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. EX1001, 1:63-2:7.

73. The '593 Patent teaches methods for optimizing efficiency of a transmission system using a “variable voltage switching power supply.” The '593 Patent also teaches using a bypass switch to “bypass the power supply circuitry at a pre-determined threshold, further increasing the system efficiency.” EX1001, 4:2-4. In one embodiment, “the threshold is defined in terms of output power.” *Id.*, 4:7-10.

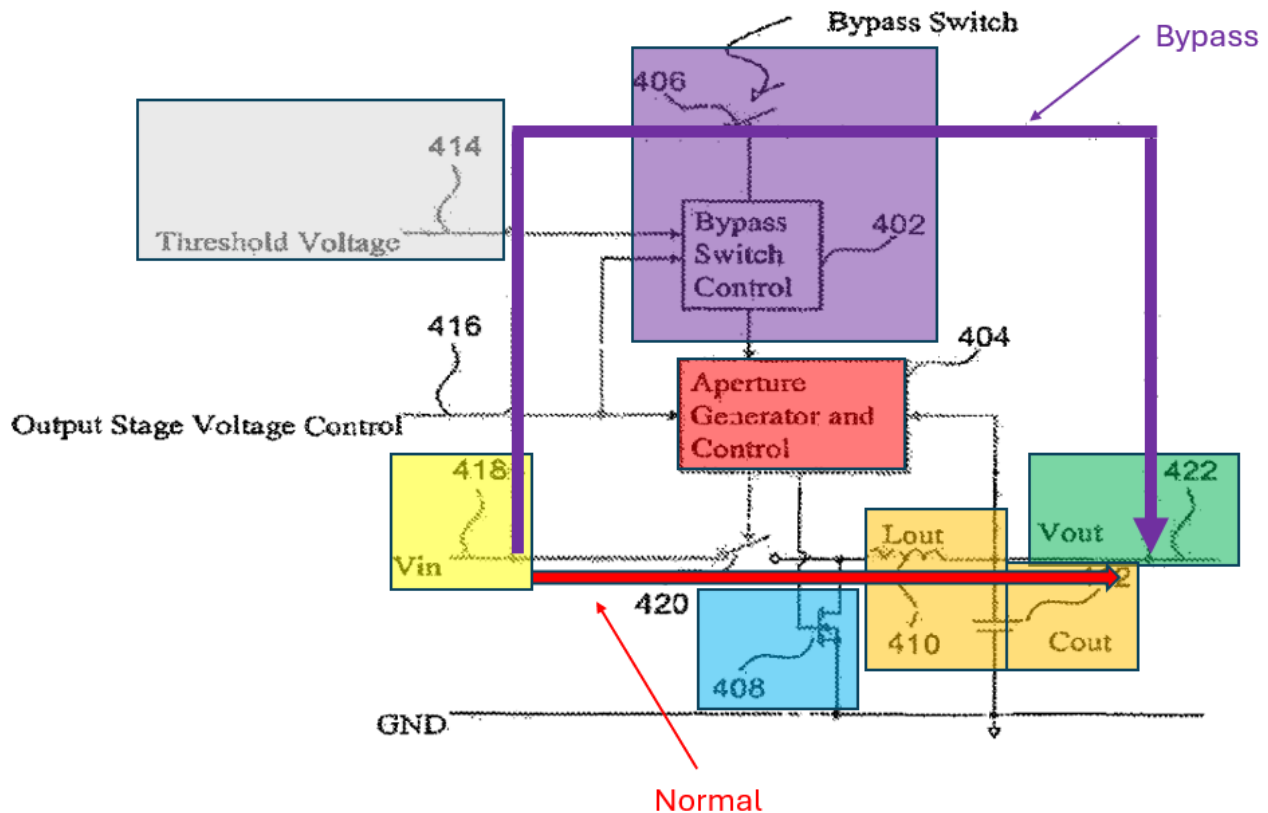
74. Fig. 4 (annotated below) illustrates “an example step down (buck) switching power supply 400 having a bypass switch architecture.” *Id.*, 6:36-37.



75. The input to the circuit is an input voltage V_{in} 418 (yellow), such as might be provided by a battery, while the output is an output voltage output voltage node 422 (green). EX1001, 6:38-45, 7:44-48. The power supply operates in two modes: normal and bypass. *Id.*, 7:9-10.

76. In normal mode, switch 420 is closed. With switch 420 closed, V_{in} 418 is coupled 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). This LC circuit filters the AC (alternating current) components of the output of the transistor so that the output voltage V_{out} is substantially a DC voltage. *Id.*, 7:39-45.

77. 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. EX1001, 7:65-8:3. The circuit pathways for normal and bypass mode are annotated on Fig. 4 below:



C. Prosecution History

78. The prosecution history of the '593 Patent itself (EX1002) is uneventful. The Examiner rejected all claims under the nonstatutory 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.

79. In the grand-parent 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.

79a. In my opinion, Ishikawa was the closest reference to the challenged claims discussed in the file history of either the '593 Patent or its family because of its use of both a PWM down-converter and a switch to bypass that down-converter. However, it is also my opinion that the invalidity grounds that I discuss below contain important teachings relevant to the claim elements that were missing from the disclosure of Ishikawa. For example, Ishikawa does not contain any teaching of the bypass circuit being activated based on the power output or efficiency of the circuit, *e.g.* as recited in claim element 1[b2]. Ishikawa describes the switch SW3 that controls the bypass operation as being driven by a control voltage V_{ENT} . EX1018, [0039], [0047]. Beyond describing that voltage as “input to the apparatus from an external source,” there is no explanation in Ishikawa of how and when the control voltage would cause the bypass switch to be operated, particularly based on comparison of efficiency or a value indicative of efficiency to a threshold. Hau and Canyon have significant additional disclosures related to such comparisons which were never considered by the Examiner in the prosecution of the '593 Patent or any related application. Additionally, the teachings of Sahu and Ranjan with respect to efficiencies obtained with particular communication schemes, and Lejon's multiple-input, single-output amplifier, are

absent from Ishikawa. Therefore, it is my opinion that the prior art invalidity grounds presented in Mediatek's Petition are not cumulative with the materials considered either in the file history of the '593 Patent itself or its related applications.

D. The Challenged Claims

80. Petitioner's Petition challenges (and in this Declaration I address) claims 1-20 of the '593 patent. Claims 1, 9, and 15 are independent. I have reproduced the claims below:

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

Reference	Claim Limitation
	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, HSPA, or OFDM 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	

Reference	Claim Limitation
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;
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	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.
Claim 11	
11	The method of claim 9, further comprising: 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, HSPA, 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.
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.

Reference	Claim Limitation
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.

VIII. CLAIM CONSTRUCTION

81. I understand from Counsel that during an IPR proceeding, claims are to be construed in light of the specification as would be read by a POSITA at the time the application was filed. I understand that claim terms are given their ordinary and customary meaning as would be understood by a POSITA in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his or her own lexicographer and clearly set forth a definition of the claim term in the specification. In that case, the claim term will receive the definition set forth in the patent. In my analysis, I have applied the plain and ordinary meaning of all terms

other than those discussed below.

A. “Power Efficiency”

82. Claims 1, 9, and 15 of the ’593 Patent recite “a power efficiency of the power supply.” The specification of the ’593 Patent does not explicitly define the meaning of “power efficiency.”

83. In my opinion, “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. Furthermore, the broader phrase “in response to a power efficiency of the power supply exceeding a predetermined threshold” (in which case “the aperture generator and control module 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 current or voltage, and should not be interpreted to require a direct measurement of power efficiency. *Id.* 2:19-20, 11:23-25.

84. The specification of the ’593 Patent illustrates plots showing efficiency versus output current of a switching power supply for two exemplary values of output power, where “the power supply is most efficient when the output current is between 100 and 200 milliamps (ma) depending on the input and output voltages.” EX1001, 4:15-20. “[W]hen plots 102 and 104 are extended beyond 650 mA for the output current, the power supply efficiency would continue to decrease as the output current increases.” *Id.*, 4:21-23.

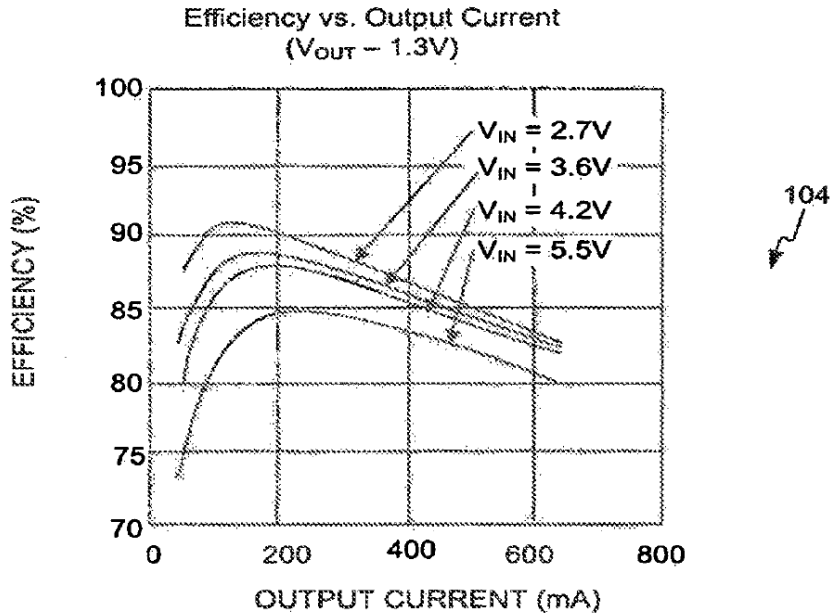


FIG. 1

EX1001, FIG. 1

85. 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 voltage. See EX1001, 2:21-22, 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 Voltage 414 and the value of the power supply output voltage to determine whether power supply 400 should switch to bypass mode...”), 7:1-3 (“Threshold Voltage 414 is modified based on output power requirements and/or on power supply current output requirements”); 8:41-60. Nowhere in its specification does the ’593 Patent specification teach that the circuitry directly calculates the power efficiency (e.g., by comparing input and output power), much less does it teach whether to bypass the

down-converter based on such a calculation. Instead, the specification suggests that direct measurement of output power are indirectly indicators of 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.

86. 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.” *Id.*, 11:27-29, 46-47. Because these claims depend from claim 1, it is my opinion that this language indicates that the indirect measurements required by these claims (*i.e.*, measuring either the load-current or the down-converted input voltage) are within the scope of the broader claim language in claim 1.

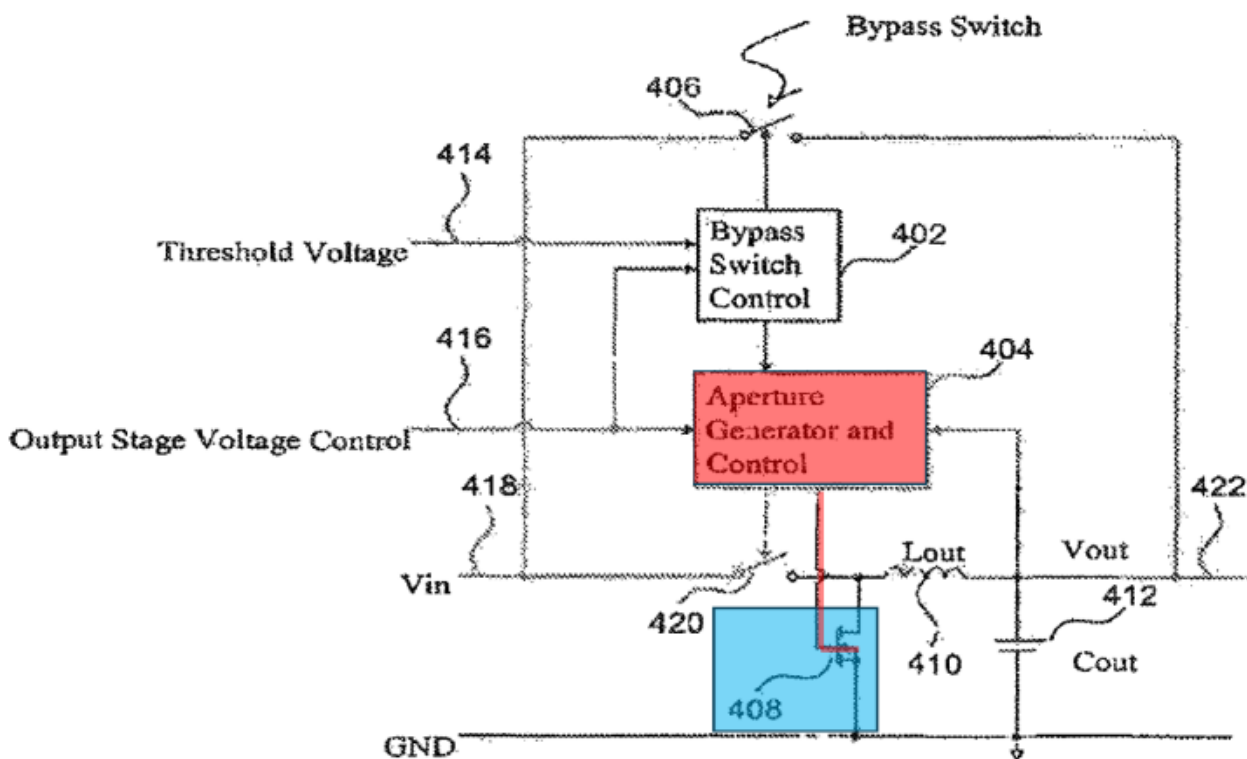
B. “Aperture generator and control module”

87. “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 as discussed in VII.A.2.b.

88. Claims 1 and 15 provide context for the term, indicating that the aperture generator and control module performs two functions: (1) “to control the switching device,” which is itself “configured to down-convert an input voltage;” and (2) to “deactivate[] the switching device and pass[] the input voltage to the output voltage

node” when “power efficiency of the power supply exceeding a predetermined threshold.” *Id.*, 12:27-38.

89. As I previously explained in §VII.A.2.b, the width of the pulses in PWM switching devices is known as the aperture. Therefore, the claim term itself refers to a type of circuit structure used in PWM-based power supplies, which controls the width (aperture) of pulses and therefore the output voltage. A POSITA would understand an “aperture generator” to be a circuit that generates a pulse having a defined width (aperture), and regulates the width of the aperture. 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, 7:20-23.



90. 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.

91. I also note that this explanation is consistent with the use of the term “aperture” in other ParkerVision patents. For example, the abstract of U.S. Patent No. 8,571,135 B2, which shares two co-inventors with the '593 Patent, refers to “apertures” as synonymous with “pulse widths:”

A balanced transmitter up-converts a baseband signal directly from baseband-to-RF. The up-conversion process is sufficiently linear that no IF processing is required, even in communications applications that

have stringent requirements on spectral growth. In operation, the balanced modulator sub-harmonically samples the baseband signal in a balanced and differential manner, resulting in harmonically rich signal. The harmonically rich signal contains multiple harmonic images that repeat at multiples of the sampling frequency, where each harmonic contains the necessary information to reconstruct the baseband signal. The differential sampling is performed according to a first and second control signals that are phase shifted with respect to each other. In embodiments of the invention, *the control signals have pulse widths (or apertures)* that operate to improve energy transfer to a desired harmonic in the harmonically rich signal. A bandpass filter can then be utilized to select the desired harmonic of interest from the harmonically rich signal. The sampling modules that perform the sampling can be configured in either a series or a shunt configuration. In embodiments of the invention, DC offset voltages are minimized between the sampling modules to minimize or prevent carrier insertion into the harmonic images.

92. The '135 Patent addresses a different technical issue than the '593 Patent, because the '135 Patent addresses conversion between RF frequencies, rather than a power supply. However, the context in which the '135 Patent uses the term “apertures” is still relevant to its usage in the '593 Patent. The '135 Patent describes the use of

pulses to control turning on and off of a switch (such as a transistor switch) in the context of converting RF frequencies. While the purpose of the switching device in the '593 Patent is different, it is similar to the '135 Patent because in both cases a control pulse is activating a transistor functioning as a switch for a defined period of time, which is referred to either as the pulse width or as the aperture. In my view, it is reasonable to interpret the use of the term “apertures” consistently with “pulse widths” in both cases. I would reach the same conclusion based on the use of the term “aperture” in the '593 Patent and my own knowledge of the meaning of the term in the art, but the '135 Patent further supports my opinion.

93. In my opinion, the term “aperture generator and control module” should not be construed as a means-plus-function term, because the term itself, and its usage in the context of the claims of the '593 Patent, would connote a sufficiently definite structure to a POSITA for the reasons that I discussed above. However, I understand that Petitioner has also proposed a corresponding structure if the Board does interpret the term “aperture generator and control module” as a means-plus-function term, and I agree with the structure proposed by Petitioner.

94. Specifically, if the term is construed as means-plus-function, in my opinion, the corresponding functions specified by the claim are “control the switching device” and “deactivate[] the switching device and pass[] the input voltage to the output voltage node.” In my opinion, 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. However, in the specification of the '593 Patent, different parts of this structure perform different parts of the specified function. For example, the AGCM 404 itself actually performs the function of “control[ling] the switching device.” However, the function of deactivating the switching device and passing the input voltage to the output voltage node is performed by the Bypass Switch Control 402, which controls Bypass Switch 406 and Switch 420 to pass the input voltage directly to the output voltage node. In my opinion, the corresponding structure for the AGCM in the *claims* is not strictly limited to the structure labeled as the AGCM in the *specification*, since it is clear that other structure is involved in performing the functions recited by the claims.

95. It is also my opinion that the AGCM need not be interpreted as a single circuit element, regardless of whether the term is interpreted as means-plus-function or not, since such a limitation would be inconsistent with the actual disclosure of the '593 Patent.

IX. DETAILED EXPLANATION OF GROUNDS

A. Ground 1A: Obviousness over Hau in view of Yoshida

1. Hau

96. Hau is related to “power amplifiers used in battery powered mobile handsets.” EX1007, 1:7-11.

97. Hau explains that:

In general, the handset is required to transmit at a high output

power level when it is farther away from a receiving base station in order to maintain a pre-determined signal strength at the base station for sufficient reception. Conversely the closer the handset to the base station, less transmitted power would be required. Generally, the handset receives a control signal from the base station and, according to the embedded software command in this signal, adjusts the transmitted power accordingly. As known to those skilled in the art, the handset output signal has to meet the FCC regulation on spectral re-growth (as known as linearity—often measured in terms of adjacent channel leakage power ratio (ACLR) which stipulates the maximum allowable interference to other frequency channels in order to minimize interference between signals) with respect to the handset output power.

Handset power amplifiers are generally designed to meet the FCC spectral re-growth requirement at maximum transmit power level (+28 dBm for WCDMA system). Statistically, however, handsets transmit at maximum linear output power only for a small fraction of time, and most of the transmission takes place at a considerably lower power levels (10 dB or more below maximum linear power). The power added efficiency (PAE) of the conventional power amplifiers usually drops off rapidly under such backoff power operation, resulting in higher current draw coupled with excessive linearity margin. As known to those skilled in the art, the excessive linearity margin can be trade-off for low current consumption in power amplifiers.

EX1007, 1:33-61.

98. Hau “is directed to dynamically optimizing current consumption and linearity of a power amplifier at each power level without the need for any external

control in order to provide automatic current optimization for performance improvement while extending battery life.” EX1007, 2:36-40. In particular, Hau teaches “a two-stage power amplifier, where the bias voltage applied to the power amplifier varies dynamically with the output power. As discussed above, when the handset is nearer the base station, a lower output power can be used that will conserve battery life as a result of reduced current consumption at low bias supply voltage while still meeting the linearity specification.” EX1007, 2:45-52.

99. FIG. 1 of Hau is a broad block diagram of one embodiment of a system that includes “a power management unit 2, a power detector 4, a 3.4V battery 8, and two power amplifiers 6, PA1 and PA2.” EX1007, 4:7-10. “The power detector 4 outputs a DC voltage P_{det} to a DC to DC converter in the power management unit 2. The DC to DC converter responds by providing optimum V_{cc1} and V_{cc2} to PA1 and PA2, respectively.” EX1007, 4:18-21.

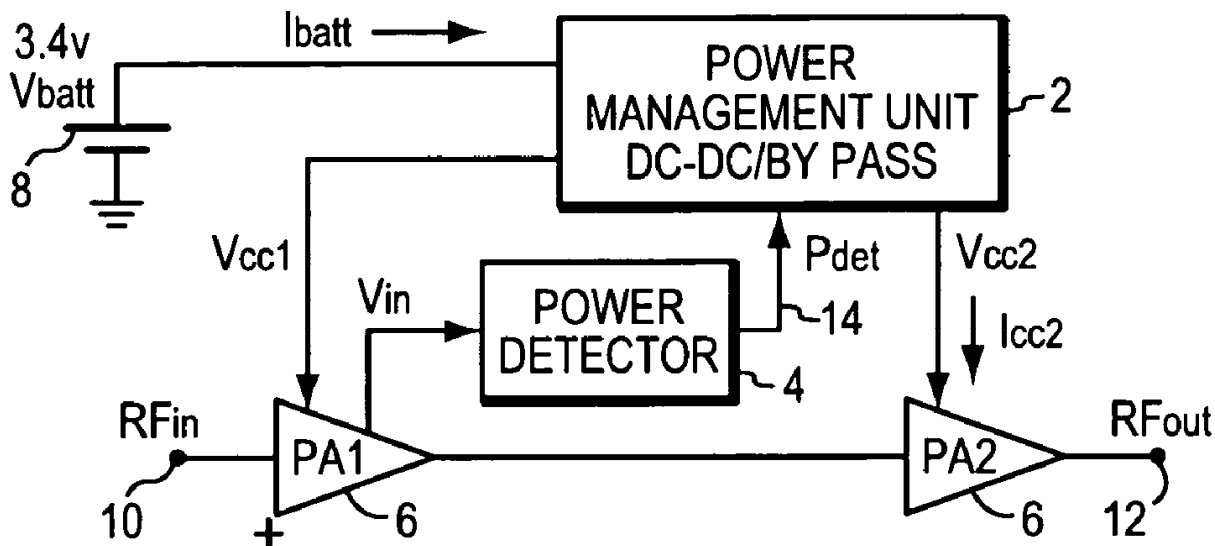


FIG. 1

100. FIG. 6 of Hau is a more detailed circuit block diagram of FIG. 1. The power management unit 2 includes 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). Hau 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.* In Hau, P_{det} is proportional to V_{in} (*id.* at 6:27-28) and V_{in} is RF_{IN} amplified. *Id.* at 5:62-63.

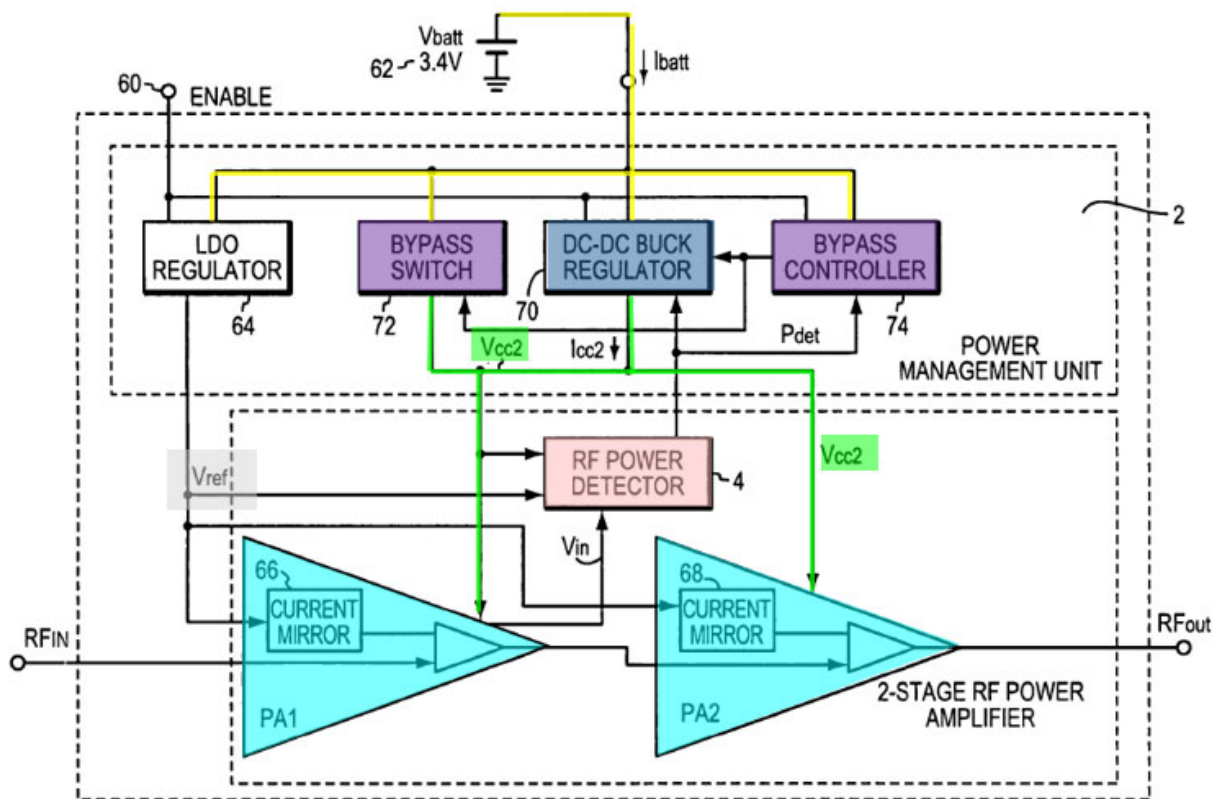


FIG. 6

101. FIG. 10 of Hau is a flowchart illustrating the operation of the circuitry of FIG. 6, particularly the bypass function. In FIG. 6, “[t]here is a comparison to a predetermined threshold in the bypass controller 74 where, if exceeded, the bypass switch 72 is activated and the DC to DC converter is deactivated.” EX1007, 6:63-66. That is, the bypass controller generates a control signal as a function of RF power (yellow). Hau at 6:54-7:6. If the output power is greater than a predetermined value (aqua) the DC/DC regulator is turned off and the DC/DC regulator bypass switch is turned on (green). *Id.*

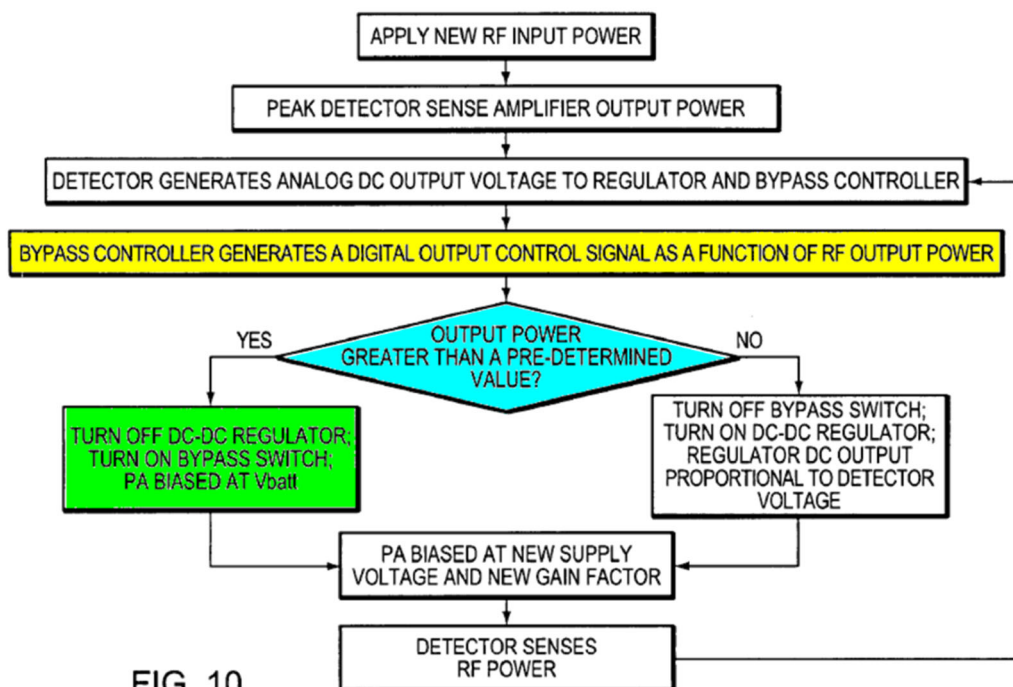
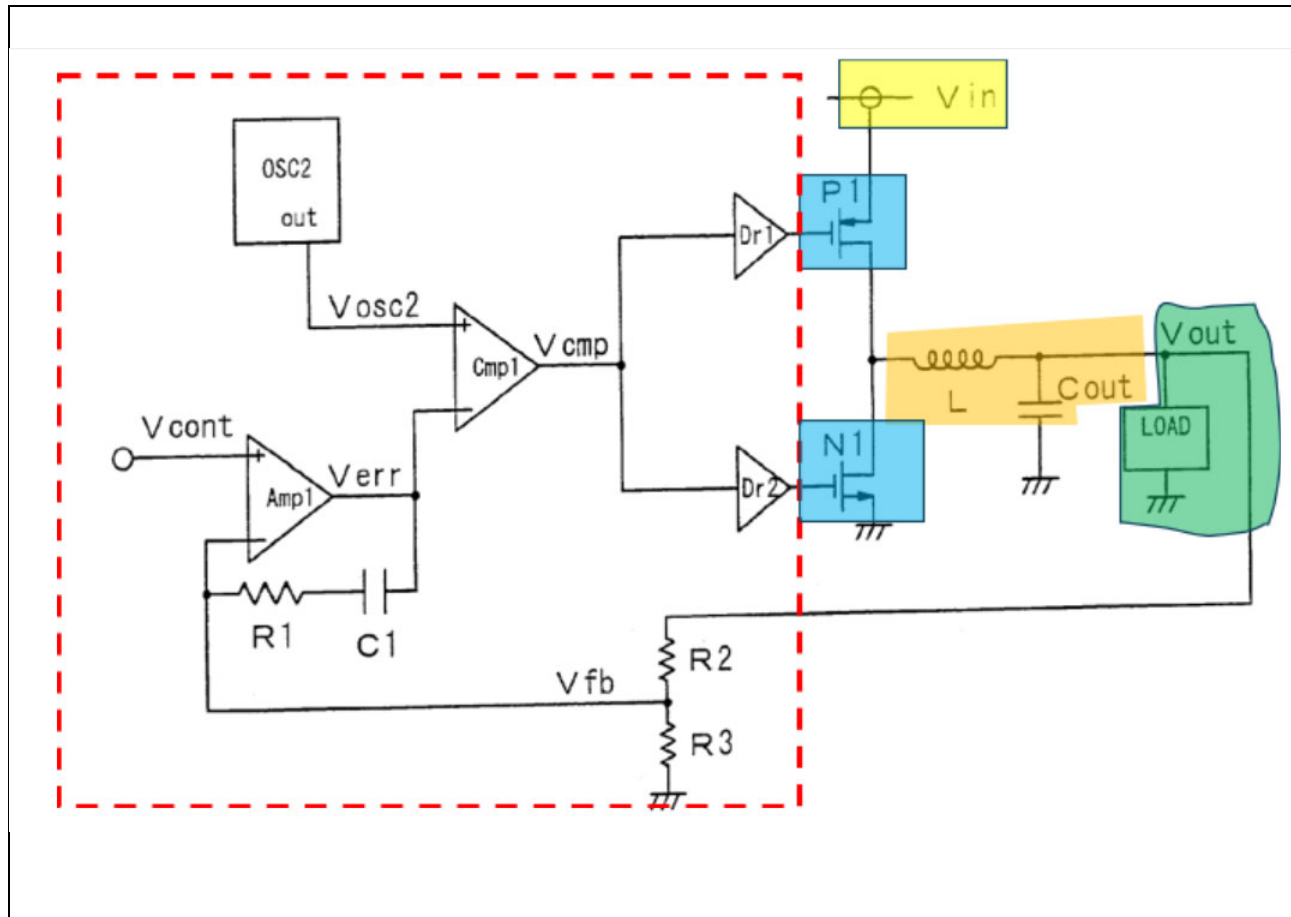


FIG. 10

2. Yoshida

102. Yoshida teaches 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 focuses on the circuitry of the DC-DC converter and, in my opinion, is largely agnostic about what type of device the DC-DC converter is used in.

103. Yoshida discusses how the use of pulse width modulation was a “conventional feedback control method” for step-down DC converters. EX1008, 1:23-26. In my opinion, Yoshida’s teaching of PWM as conventional is consistent with what a POSITA would have known at the time. For example, Yoshida’s Fig. 29 illustrates a conventional step-down DC-DC converter:

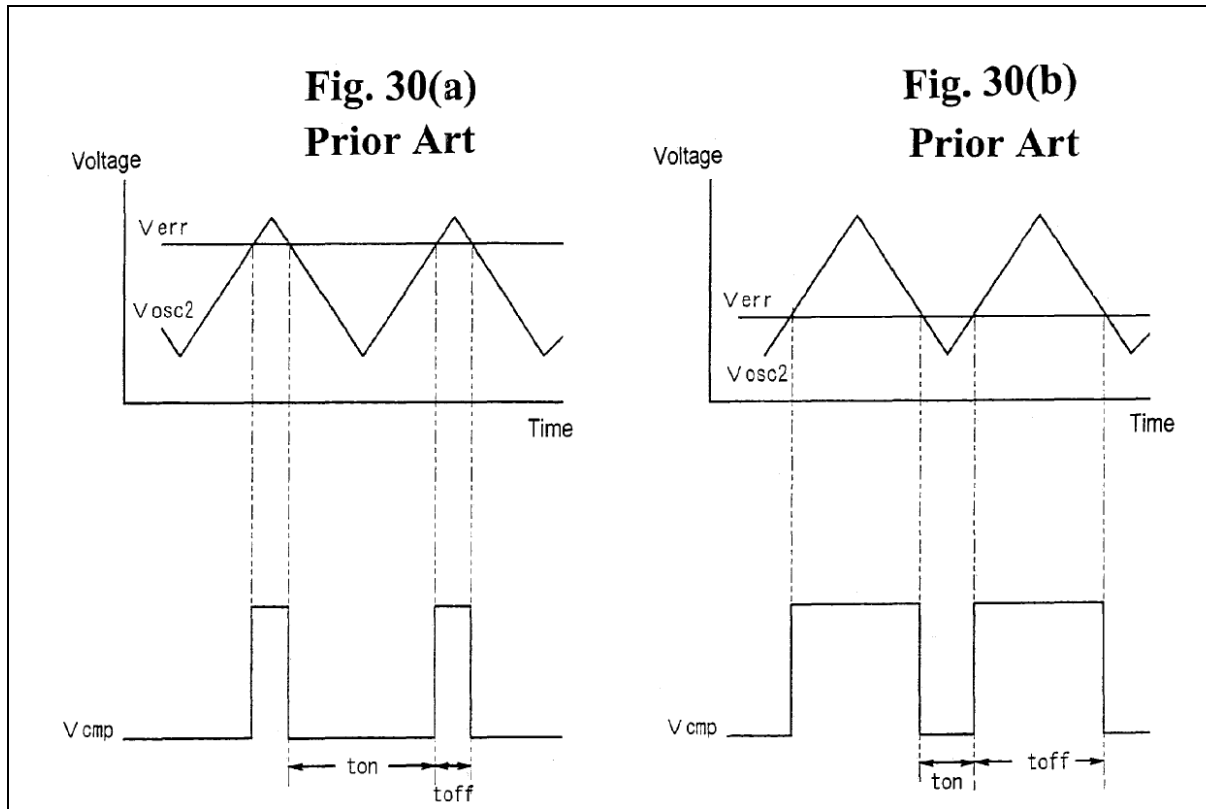


104. Fig. 29 shows two semiconductor switches which function together: a p-type semiconductor switch P1 (which conducts when the gate voltage is “low”) and an N-type semiconductor switch (which conducts when the gate voltage is “high”). The driving circuitry Dr1 and Dr2 adjusts the timing so that the two switches are not on at the same time; that is, switch P1 is on while N1 is off and vice versa. EX1008, 2:19-26. When switch P1 is closed, the switch conducts from an input V_{IN} (yellow) to a load output V_{OUT} (green) via an LC circuit (orange), which functions to smooth out the voltage to V_{OUT} caused by switching P1 and N1 on and off. 1:37-39, 2:19-31.

105. The switches P1 and N1 are controlled by PWM control circuitry,

highlighted with a red dashed line. This circuitry creates and controls the width of the pulses that turn the switches P1 and N1 on and off. An amplifier Amp1 generates an error signal V_{ERR} by comparing a feedback signal V_{FB} (derived from V_{OUT} via a resistance divider) and a control signal V_{CONT} . Comparator Cmp1 then 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.

106. Fig. 30 illustrates how the comparator Cmp1 compares the signals V_{ERR} and the oscillating signal V_{OSC} to generate the signal V_{CMP} , which drives the switches P1 and N1 and thus generates pulses of variable width. Note that because switch P1 (which conducts between the input voltage V_{IN} and the output voltage V_{out} , via the LC circuit) is closed when V_{CMP} is low, the “on” times of the pulses are inverted relative to V_{CMP} .



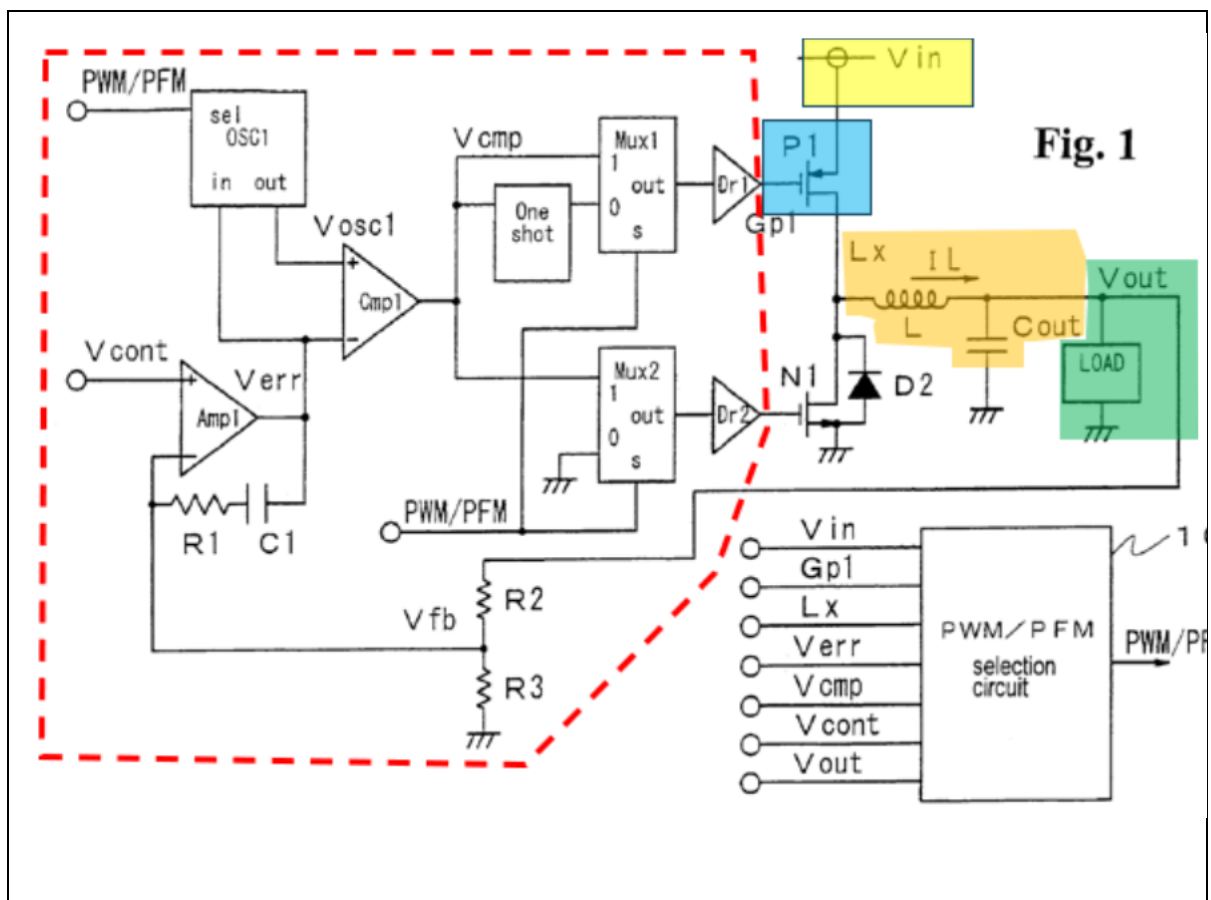
EX1008, 2:19-20, 2:46-55.

107. 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} . EX1008, 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 the total cycle time (the “duty ratio”) according to the formula $\frac{V_{OUT}}{V_{IN}} = t_{ON}(t_{on} + t_{off})$. EX1008, 2:46-55.

108. I note that the above description in Yoshida refers to an example of what was (at the time) known prior art function of DC-DC converters using PWM. In my opinion, this type of down-conversion using a switching PWM circuit would have been well-known to a POSITA at the time. Yoshida is an illustrative example of the concept.

109. Yoshida also teaches variations of this concept in its preferred

embodiments. The main variation taught by Yoshida is the use of pulse-frequency modulation (PFM) in addition to PWM, as well as circuitry capable of switching between the two modes. For example, Yoshida's Fig. 1 illustrates a circuit having both PWM and PFM circuitry; however, it is similar to the circuit of Fig. 29 in that it relies on PWM to control the "on" time of switches P1 and N1, which control the flow of power through an LC circuit to an output voltage in much the same way as Fig. 29:



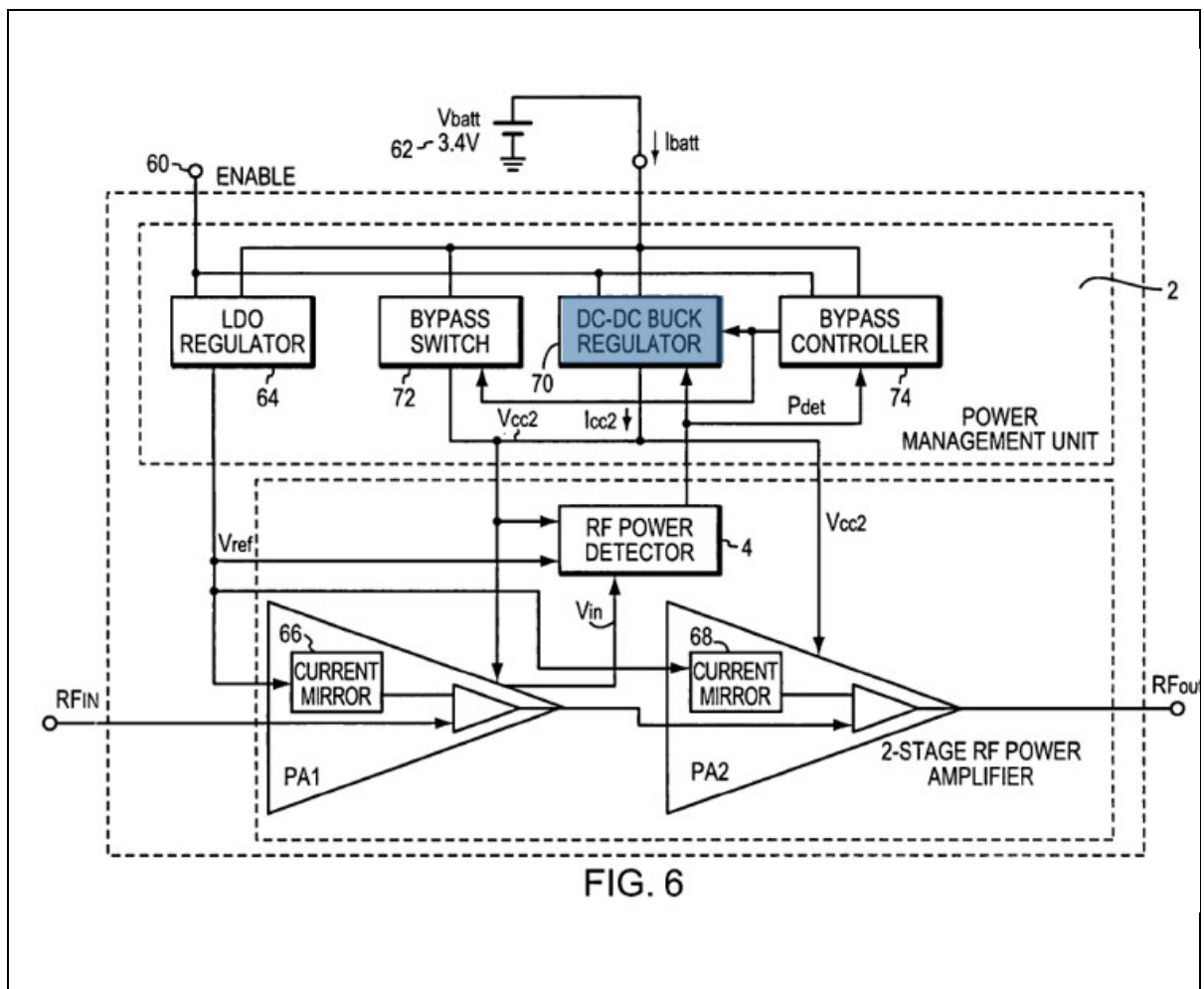
EX1008, Fig. 1, 9:26-49.

110. In my opinion, both Yoshida's description of the "prior art" at the time of its filing and the variations that Yoshida teaches in its preferred embodiment both rely on the same basic concept of DC-DC conversion using PWM of a switching regulator,

and a POSITA would have understood the concept from looking at any of Yoshida's embodiments, although the preferred embodiments are more complex.

3. Motivation to Combine

111. In my opinion, a POSITA would have been motivated to combine Hau with Yoshida because Yoshida explains how a “DC-DC buck regulator” as taught by Hau would typically function, and shows that a POSITA would have understood such a device in Hau to be a switching DC-DC converter. Hau shows that its amplifier circuit has a DC-DC buck regulator 70 (also referred to as a converter), but doesn't describe any details of the operation of this regulator:



EX1007, Fig. 6.

112. Instead of describing the specific circuit used in the buck converter, Hau just states that the design of the buck converter is “known to those in the art.” EX1007, 5:39-40. Therefore, in my opinion, a POSITA would have been motivated to either rely on his or her own knowledge of the art, or look at other references describing such converters in more detail in order to understand the operation of such converters or find a suitable design. Indeed, this statement in Hau explicitly encourages a POSITA to draw on his or her own knowledge or look at known designs for buck converters. A POSITA would have known that a “buck” converter, by definition, is a DC-DC converter that converts from a higher voltage to a lower voltage. In my opinion, Yoshida describes examples of such buck converters which down-convert a signal via PWM, and which would have been a suitable example of a PWM-based DC-DC converter. A POSITA would also have been generally familiar with DC-DC buck converters using PWM and would not have been limited to Yoshida’s specific design, but Yoshida shows that a POSITA would know to use a switching regulator as a DC-DC converter. In my opinion, the use of such a switching regulator (e.g. that of Yoshida) as the buck converter taught by Hau would have been a simple combination of known elements according to known methods to yield predictable results.

113. Hau also says that “virtually any DC to DC converter design... could be advantageously used in embodiments with the present invention.” EX1007, 5:56-61. In my opinion, this statement is a teaching, suggestion, or motivation to use any suitable

DC to DC converter design, including that taught by Yoshida. This statement in Hau further supports my opinion that a POSITA would have had a reasonable expectation of success combining references. In my opinion, the combination is also straightforward and a POSITA would have expected success making the combination because Yoshida's DC-DC converter circuits take the same inputs (that is, a DC input at a higher voltage) and have the same outputs (that is, a DC output at a lower voltage) as Hau's unspecified buck converter.

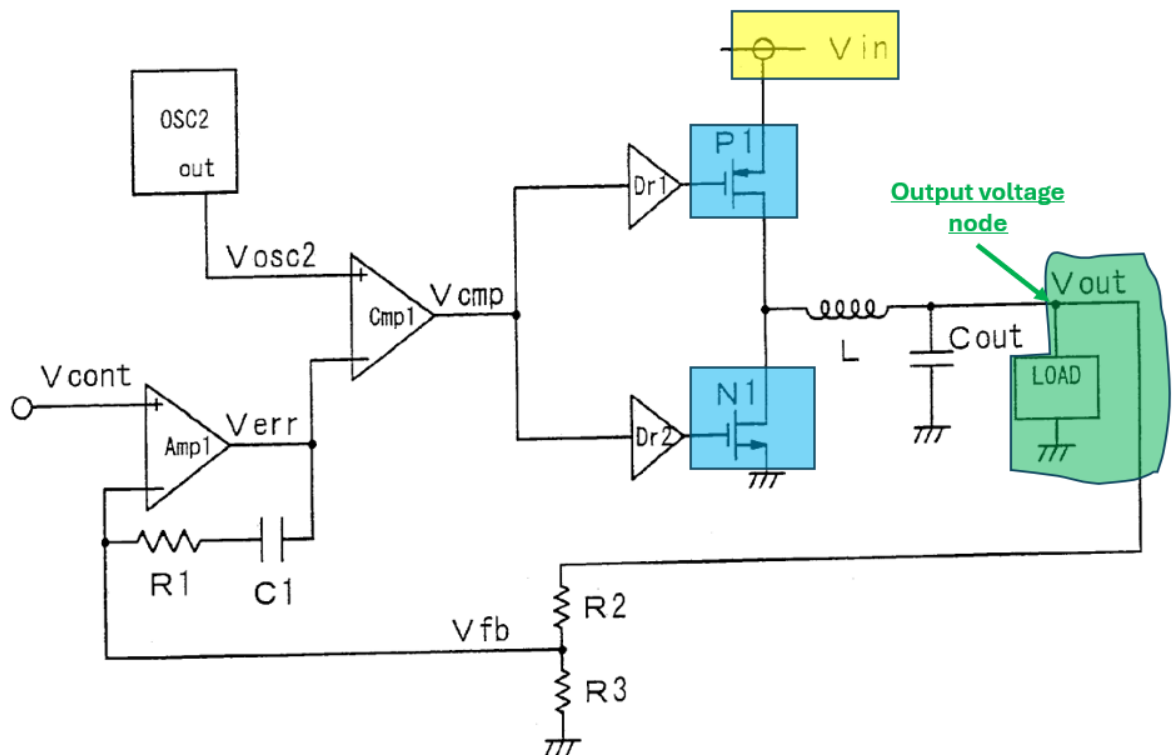
4. Claim 1

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

114. In my opinion, if the preamble is limiting, Hau teaches this element. Hau teaches a power management unit 2 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.

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

115. In my opinion, 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} (*down-convert 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, 5:39-46.



Yoshida, Fig. 1

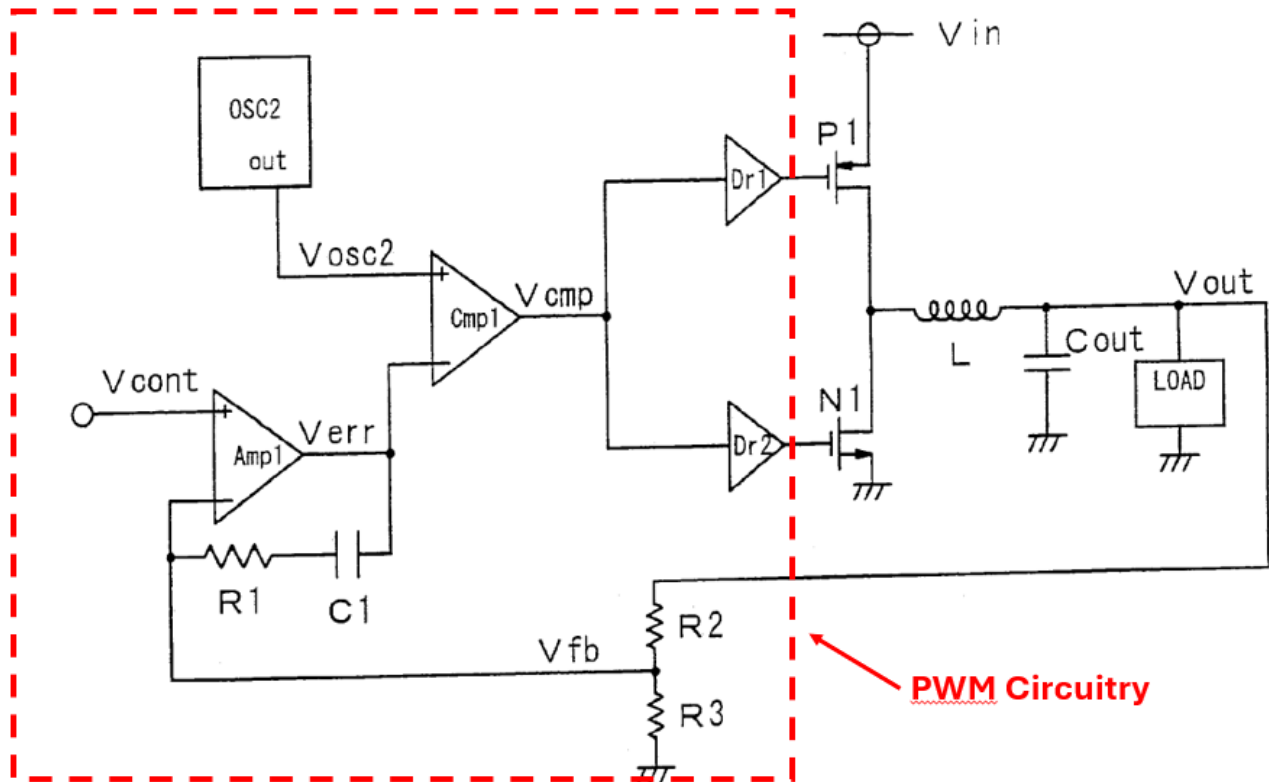
117. Therefore, in my opinion, the switches P1 and N1 in Yoshida's DC-DC down-converter, when used within the DC-DC buck regulator of Hau, teaches a DC-DC converter (*a switching device*) which down-converts the input voltage V_{in} (*configured to down-convert an input voltage*) to an output voltage V_{out} at an output voltage node, such as the node to which the load is connected (*pass the down-converted input voltage to an output voltage node*). EX1008, Fig. 29, 1:37-39, 2:19-31; *see also id.*, Fig. 1, 9:26-49.

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

118. As I discussed in §VIII.B, the AGCM performs two functions in the claim: it controls the switching device itself, and it controls bypassing the switching device (as

recited in 1[b2] below). As I noted above, in the 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. That is, these functions need not be performed by the same circuit element, which would not even be consistent with the disclosure in the specification of the '593 Patent itself.

119. In my opinion, when PWM down-conversion as taught by Yoshida is used in the DC-DC buck regulator of Hau, the first function (that is, “control the switching device”) is performed by Yoshida’s PWM circuitry (including the oscillator OSC2, Amplifier Amp1, comparator Cmp1, and driver Dr1), because this circuitry outputs PWM control pulses to the switches P1 and N1 and controls the width (aperture) of those pulses. EX1008, Fig. 29 (annotated below), 1:48-2:4, 2:12-20, 2:28-31.



120. For the reasons that I previously discussed in §VIII.B, it is my opinion that the “aperture generator and control module” should not be construed as means-plus-function. However, it is also my opinion that Hau in view of Yoshida teaches this element if the Board does construe the term as means-plus-function. If “aperture generator and control module” is construed as means-plus-function, the corresponding structure in the '593 Patent is the Aperture Generator and Control 402, Bypass Switch Control 402, Bypass Switch 406, and switch 420. The two functions performed are “control the switching device” and “deactivate[] the switching device and pass[] the input voltage to the output voltage node.” EX1001, 2:18-22. I discuss the second function below regarding element 1[b1]. For the first function, the corresponding circuitry in the '593 Patent is the Aperture Generator and Control Module 402, about

which the '593 Patent provides little additional detail.

121. In my opinion, Yoshida teaches the same or equivalent structure as the '593 Patent, because the PWM circuitry of Yoshida is circuitry that creates pulses and regulates the width of those pulses (that is, an “aperture generator and control module” identical or equivalent to the AGCM 404 in the '593 Patent). Those pulses from the PWM circuitry open and close switches P1 and N1 (that is, the “switching device”) and regulate the width (that is, control the aperture) of those pulses, to create a down-converted voltage at V_{OUT} .

- 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**

122. In my opinion, Hau teaches the second function of the AGCM, the “bypass” function. Hau’s bypass controller 74 (purple) receives a signal Pdet from a power detector (pink) and activates a bypass switch 72 (purple) when the signal Pdet exceeds a predetermined threshold. EX1007, Fig. 6 (annotated), 5:43-51, 6:57-7:2.

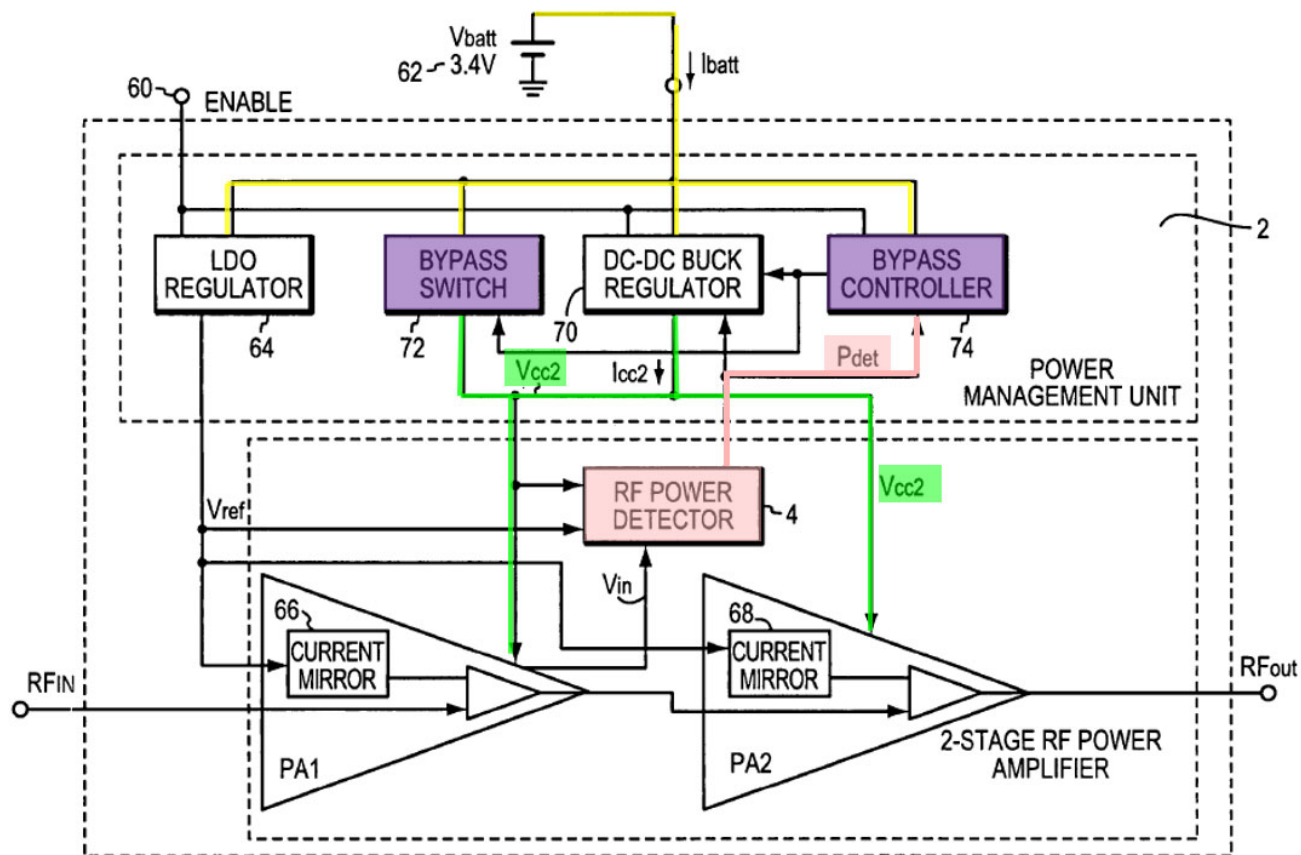


FIG. 6

123. In Hau, the output power of the DC-DC regulator is based on current I_{cc2} and voltage V_{cc2} , where V_{cc2} is linearly related to the voltage V_{in} . EX1007, 6:28-30. The voltage P_{det} , which is proportional to the voltage V_{in} , is thus an indicator of the power output by the DC-DC buck regulator at V_{cc2} . Because the input power to the DC-DC buck regulator, V_{batt} , is a fixed voltage, P_{det} is also an indicator of the power efficiency of the DC-DC buck regulator because higher power indicated by P_{det} corresponds to greater efficiency relative to the fixed input power.

124. As I discussed above in §VIII.A, nothing in the specification of the '593 Patent itself describes a circuit that can directly measure the power efficiency of a power

supply. For example, there is no circuit described which measures the input power to a down-converting regulator. Rather, in the '593 Patent, output current or output power voltage are used as indicators of the power efficiency. EX1001, 4:7-10, 7:59-8:8, 8:41-60. Since Hau teaches measuring the output current or output power voltage, which is an indicator of the power efficiency, Hau teaches the Pdet exceeding a predetermined threshold (*a power efficiency of the power supply exceeding a predetermined threshold*) to the same extent as the specification of the '593 Patent itself.

125. Hau teaches that when Pdet exceeds the predetermined threshold, 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) to pass the input voltage directly to the output voltage Vcc2. EX1007, 5:44-51, 6:61, 66. Fig. 6 illustrates the normal and bypass pathways:

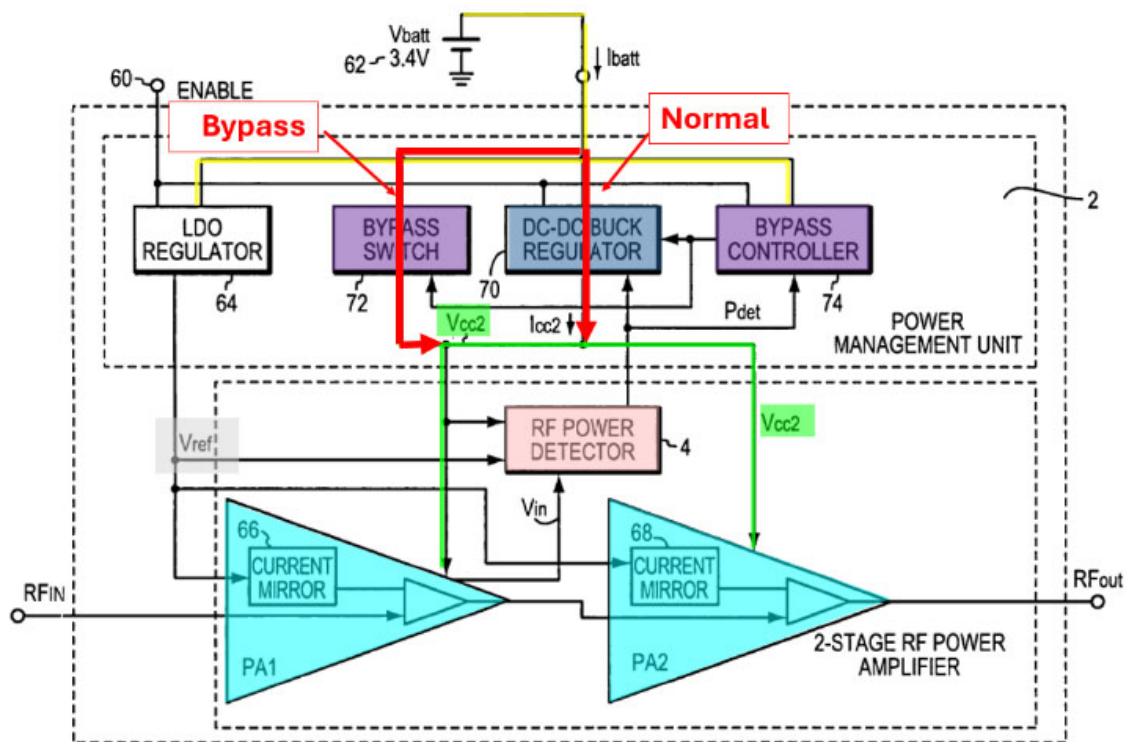
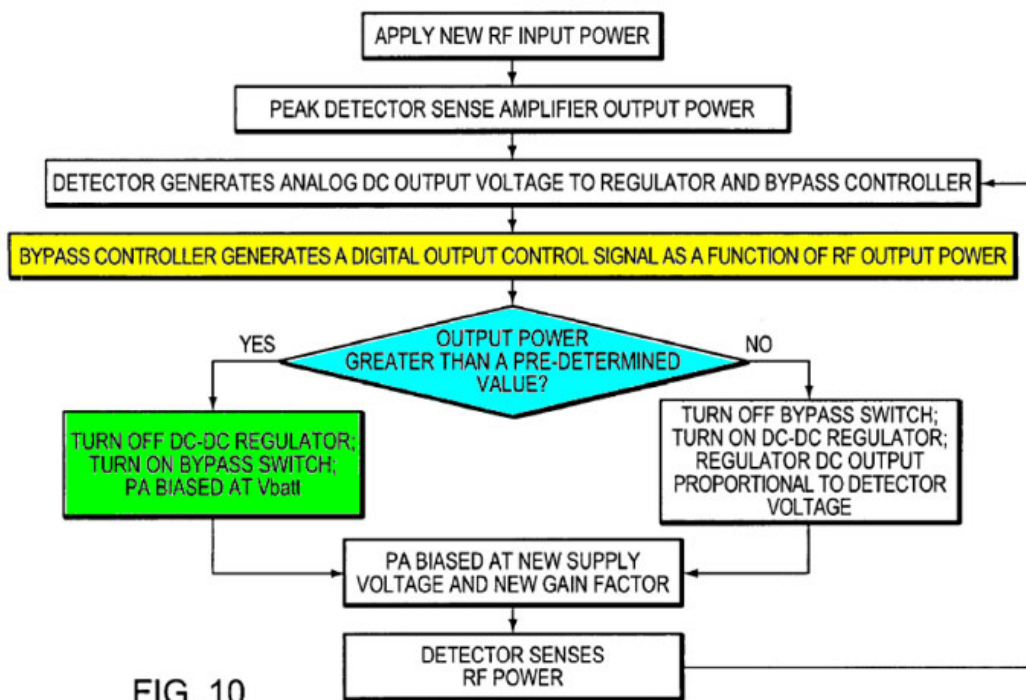
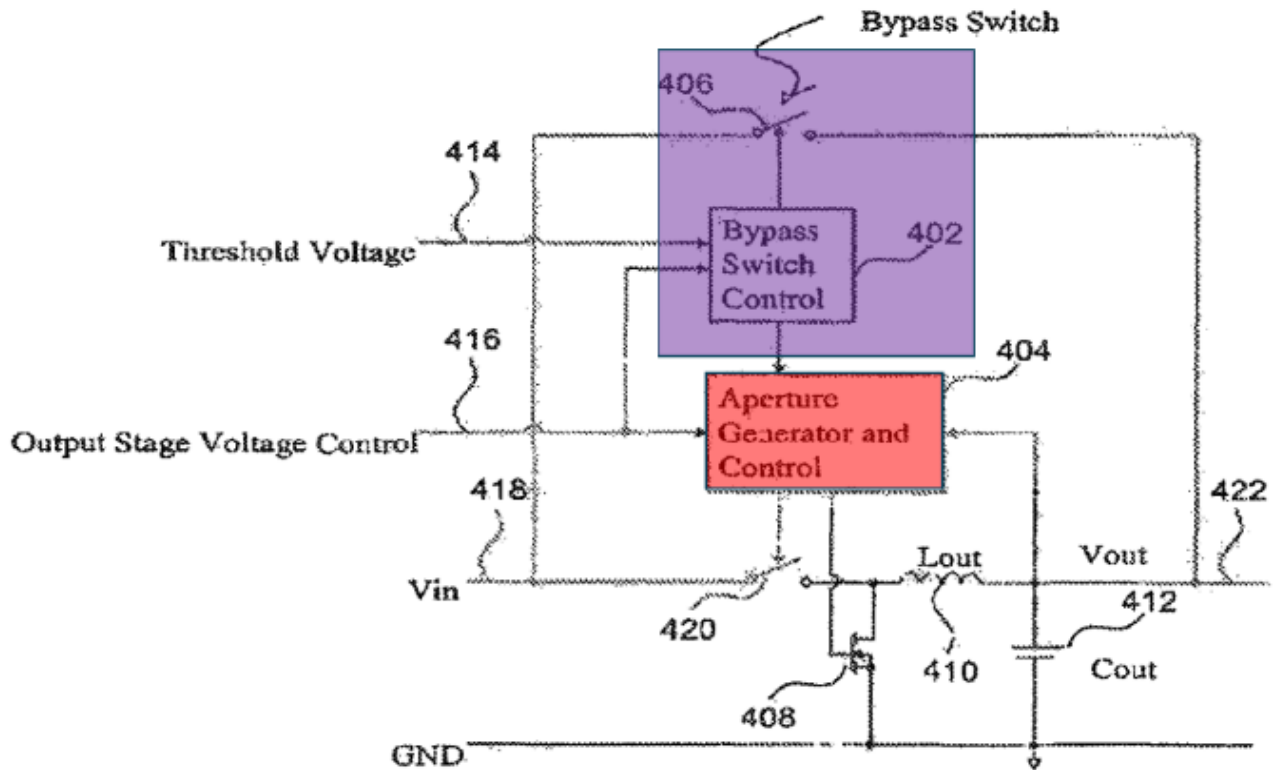


FIG. 6

126. Fig. 10 illustrates the steps in the bypass operation, including comparing the output power to a pre-determined value and turning off the DC-DC regulator and turning on the bypass switch if so:



127. In my opinion, and as I discussed above, the plain language of the claim does not require the AGCM to be a single circuit element. In the specification of the '593 Patent itself, while block 404 is labeled as the AGCM, different elements “deactivate[] the switching device and pass[] the input voltage to the output voltage node.” EX1001, 2:18-22. Specifically, 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:



128. Similarly, in the combination of Hau and Yoshida, the claimed functions of the AGCM are performed by Yoshida's PWM switching circuitry (which controls the switching device) and the bypass controller and bypass switch of Hau.

129. Therefore, the Hau-Yoshida combination teaches that, if P_{det} exceeds a predetermined threshold (*in response to a power efficiency of the power supply exceeding a predetermined threshold*), the PWM switching circuitry taught by Yoshida and the bypass controller of Hau activate the bypass switch 82 to deactivate the DC-DC converter (*the aperture generator and control module deactivates the switching device*) such that the full battery voltage is applied to the PAs (*passes the input voltage to the output voltage node*).

130. As I discussed above for element 1[b1], it is also my opinion that this claim

element should not be construed as means-plus-function. However, it is my opinion that if the Board disagrees and construes this term as means-plus-function, Hau teaches the same structure for performing the corresponding function as the '593 Patent. I discussed part of the function of the “aperture generation and control module” regarding element 1[b1] above. With respect to the function of “deactivates the switching device and passes the input voltage to the output voltage node,” the corresponding structure in the '593 Patent is the Bypass Switch Control 402, Bypass Switch 406, and switch 420. EX1001, 2:21-22. In my opinion, Hau’s bypass controller 74 and bypass switch 72 are the same or equivalent structure: a circuit or controller that that controls a switch to pass an input voltage directly to an output and bypass a down-converter.

5. Claim 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.

131. In my opinion, Hau suggests the additional element of claim 2. A POSITA at the time of the alleged invention would have known as a matter of basic physics principles that power can be calculated using two well-known relationships: $P = IV$, where I is current and V is voltage, or $P = V^2/R$, where R is resistance. In Hau’s preferred embodiment, which I discuss above regarding element 1[b2], the bypass controller relies on P_{det} , which is a voltage measurement indicative of power, and uses this measurement to determine whether to perform the bypass function (*deactivate the switching device*). However, Hau also teaches that “prior art related the output current

to the output power from the $(I)(V)=\text{power}$ relationship.” EX1007, 6:40-44. In my opinion, this teaching of Hau would suggest to a POSITA to use current measurements in the system of Hau to perform the same deactivating/bypass function.

132. It is also my opinion that a POSITA would have recognized the existence of a finite number of alternatives for measuring output power, as taught by Hau. It would have been well known to a POSITA that power could be indirectly measured through either current or voltage, and a power measurement as taught by Hau would need to be one of the two. Therefore, substituting a current measurement for a voltage measurement would be a simple choice from among a finite number of known alternatives for performing the same choice, in addition to the fact that Hau explicitly acknowledges this alternative. When a POSITA makes this substitution in the system of Hau, the bypass controller of Hau, which is part of the “aperture generating and control module” that performs the deactivating function of element 1[b2], would perform that same function based on a current measurement.

6. Claim 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.

133. In my opinion, Hau teaches this additional element. As I discussed above regarding element 1[b1], the DC-DC buck regulator in Hau, which a POSITA would have been motivated to implement using PWM control circuitry for a switching converter as taught by Yoshida, is the circuit element that controls the switching device and thus provides an output current. As I explained above, the PWM control circuitry

taught by Yoshida, when used in a DC-DC buck regulator as taught by Hau, is part of the “aperture generator and control module.” Hau repeatedly teaches that its circuit, including the DC-DC buck regulator, provides a down-converted DC voltage at an “optimum” output power. EX1007, Figs. 2-5, 8-9, 3:30-28, 4:12-16, 4:66-5:22, 6:15-21, 6:34-37, claim 1. Hau further teaches that the optimum output power “provides the most efficient current consumption for each power output level.” EX1007, 4:51-54. In addition to the fact that Hau explicitly refers to output current, in my opinion, a POSITA would also have recognized that Hau’s circuit would provide an output current. Specifically, Hau teaches that the output voltage VCC2 supplies current to amplifiers PA1 and PA2. EX1007, 6:22-25. Therefore, in my opinion, Hau teaches that the DC-DC regulator (*aperture generator and control module*) provides “an output current at a maximum power efficiency associated with the down-converted input voltage.”

7. Claim 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.

134. In my opinion, Hau teaches or suggests this additional element. As I explained in regard to element 1[b2], the input that the bypass controller (*aperture generator and control module*, with respect to this function) relies on to determine whether to bypass the DC-DC converter (*deactivate the switching device*) is the signal Pdet. Pdet is proportional to Vcc2, and the bypass controller compares Pdet to a threshold voltage which corresponds to a specified Vcc2. EX1007, 5:48-51, 6:63-66.

Therefore, in my opinion, Pdet indicates Vcc2 (*the down converted input voltage*) and is compared to a “threshold voltage” by the bypass controller. The bypass controller (which part of the AGCM) deactivates the DC-DC buck regulator (switching device) and passes the input voltage directly to an output voltage note based on the comparison of the down-converted input voltage (indicated by Pdet) to a threshold voltage.

8. Claim 7: The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value.

135. In my opinion, Hau teaches or suggests this element. Hau teaches that the voltage threshold to which the bypass controller compares the signal Pdet is “predetermined.” EX1007, 6:63-66. In my opinion, a POSITA would understand that a “predetermined” value is fixed.

9. Claim 9

136. Claim 9 is a method claim, and it differs from claim 1 primarily because claim 9 recites a method performed by an apparatus rather than the structural elements themselves. However, the method is the same method performed by the device/apparatus of claim 1, and in my opinion a POSITA would recognize that Hau (in view of Yoshida) teaches claim 9 for substantially the same reasons that I discussed with regard to claim 1.

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

137. As I discussed regarding claim 1, Hau in view of Yoshida teaches “a power supply.” A POSITA would recognize that the combination further teaches a method of

operating that power supply for the reasons that I discussed in regard to claim 1 and that I will discuss further below with respect to individual claim elements.

- 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**

138. I previously discussed with regard to element 1[a] how Hau's DC-DC buck converter, when implemented with PWM switching circuitry as taught by Yoshida, performs the functions of "down-converting... an input voltage to generate a down-converted voltage" and "passing the down-converted voltage to an output voltage node." Therefore, in my opinion, the combination of Hau and Yoshida teaches elements 9[a] and 9[b] for the same reasons.

- 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**

139. I previously discussed in regard to element 1[b2] how the bypass controller in Hau performs the claimed function. Therefore, in my opinion, the same teachings apply. I also note that the term "power supplying" in this claim appears to be an uncorrected typographical error for "power supply," since the term in the corresponding portions of claims 1 and 15 is "power supply," which is also grammatically correct in the context of the claim. Although I understood "power supplying" to be a typographical error for "power supply," my opinion that this element is taught would not change if the term is actually "supplying" as written.

**10. Claim 11: The method of claim 9, further comprising:
providing an output current at a maximum power efficiency
associated with the down-converted voltage.**

140. In my opinion, because this claim adds substantially the same element as claim 5, the same teachings that I discussed with respect to that claim also apply here.

**11. Claim 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.**

141. In my opinion, because this claim adds substantially the same element as claim 6, the same teachings that I discussed with respect to that claim also apply here.

12. Claim 15

a. 15[pre] a system comprising

142. Claim 15 is also similar to claim 1. However, where claim 1 recites a power supply, claim 1 recites a system that includes a power supply described in substantially similar terms to claim 1, with the addition of an electronic device. In my opinion, Hau in view of Yoshida teaches such a system because Hau teaches a system which includes amplifiers, and which may be used in larger devices such as mobile wireless handsets. EX1007, Abstract.

b. 15[a] an electronic device

143. In my opinion, Hau teaches this element in two alternative ways, both of which satisfy the claim language. First, the amplifiers PA1 and PA2 are an “electronic device.” Alternatively, the larger device such as a handset in which the power supply

is used is also an “electronic device.”

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

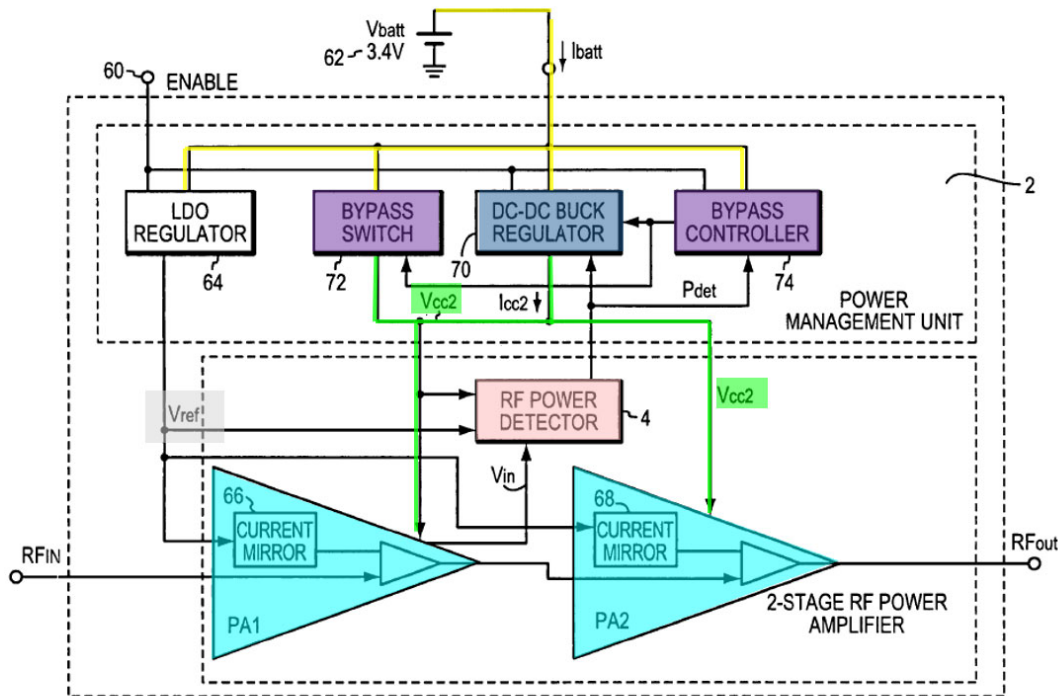


FIG. 6

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

144. In my opinion, like element 15[a], Hau satisfies this element in two alternative ways. First, the power management unit 2 of Hau is a “power supply.” The power management unit 2 includes the bypass switch 72, bypass controller 74, and DC-DC buck regulator 70, and as I discussed previously regarding claim 1, a POSITA would have been motivated to use PWM circuitry as taught by Yoshida in the DC-DC buck regulator taught by Hau. The power management unit 2 is coupled to the amplifiers PA1 and PA2 via the output bias voltage Vcc2. EX1007, Fig. 6, 5:23-26, 5:40-43.

145. Alternatively, in my opinion, the entire power supply circuit shown in Fig. 6 (that is, the circuit within the largest dashed box in the figure) satisfies the “power supply” element. When Hau’s disclosure is mapped to the claim this way, the power supply is coupled to the larger system (e.g., a mobile handset using the battery supply, as I discussed regarding 15[pre]) via the battery input, RF input RFIN, and RF output RFout.

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

146. This element is substantially similar to element 1[a]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[a] apply here.

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

147. This element is substantially similar to element 1[b1]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[b1] apply here.

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

148. This element is substantially similar to element 1[b2]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[b2] apply here.

B. Ground 1B: Obviousness over Hau in view of Yoshida and further in view of Sahu.

1. Sahu

149. Sahu is a 2009 paper published in IEEE Transactions on Microwave Theory and Techniques which discusses energy efficiency of power amplifiers (PAs) in wireless transceivers, particularly in CDMA applications. Sahu discusses the importance of power control in balancing the competing considerations of (1) enabling adequate communication power and (2) avoiding interference with other users at the same or adjacent frequencies. Sahu notes that power control “essential to ensure the CDMA system operates smoothly.” EX1009, 113.

150. Sahu illustrates the typical variation in required power for various applications (such as a CDMA handset) with a probability curve illustrating the likelihood of transmission at any given power, that is, the power is on the X-axis and the probability of needing to transmit at that power is on the Y-axis. The chart shows probabilities for both urban and suburban environments. While both curves have a “bell curve” shape, the “suburban” curve exhibits a characteristic “uptick” shape at the highest power, which is a well-known feature associated with the fact that mobile handsets in suburban environments (where base stations are less frequent than urban environments) often reach the limit of their ability to communicate with base stations, where full power is replied. EX1009, 113, Fig. 1:

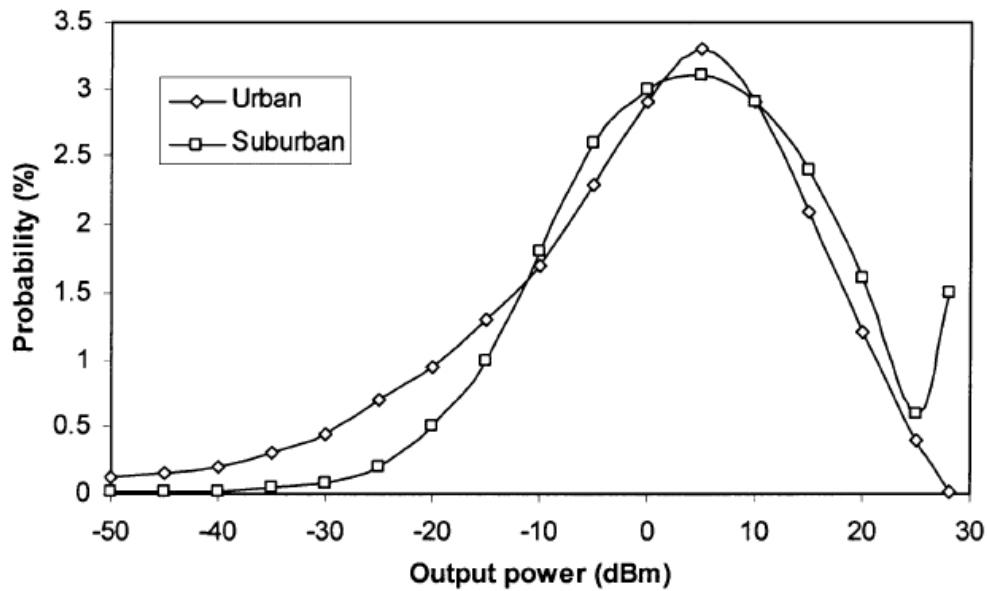
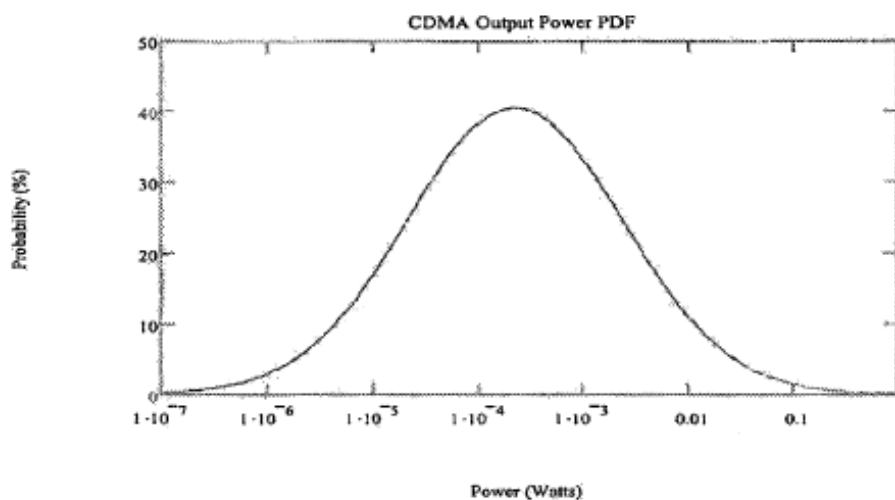


Fig. 1. Probability curves for transmit power level in urban and suburban environments [2].

151. Notably, this figure is similar to Fig. 2 of the '593 Patent (EX1001), which likewise illustrates a probability distribution function for output power of a CDMA device:



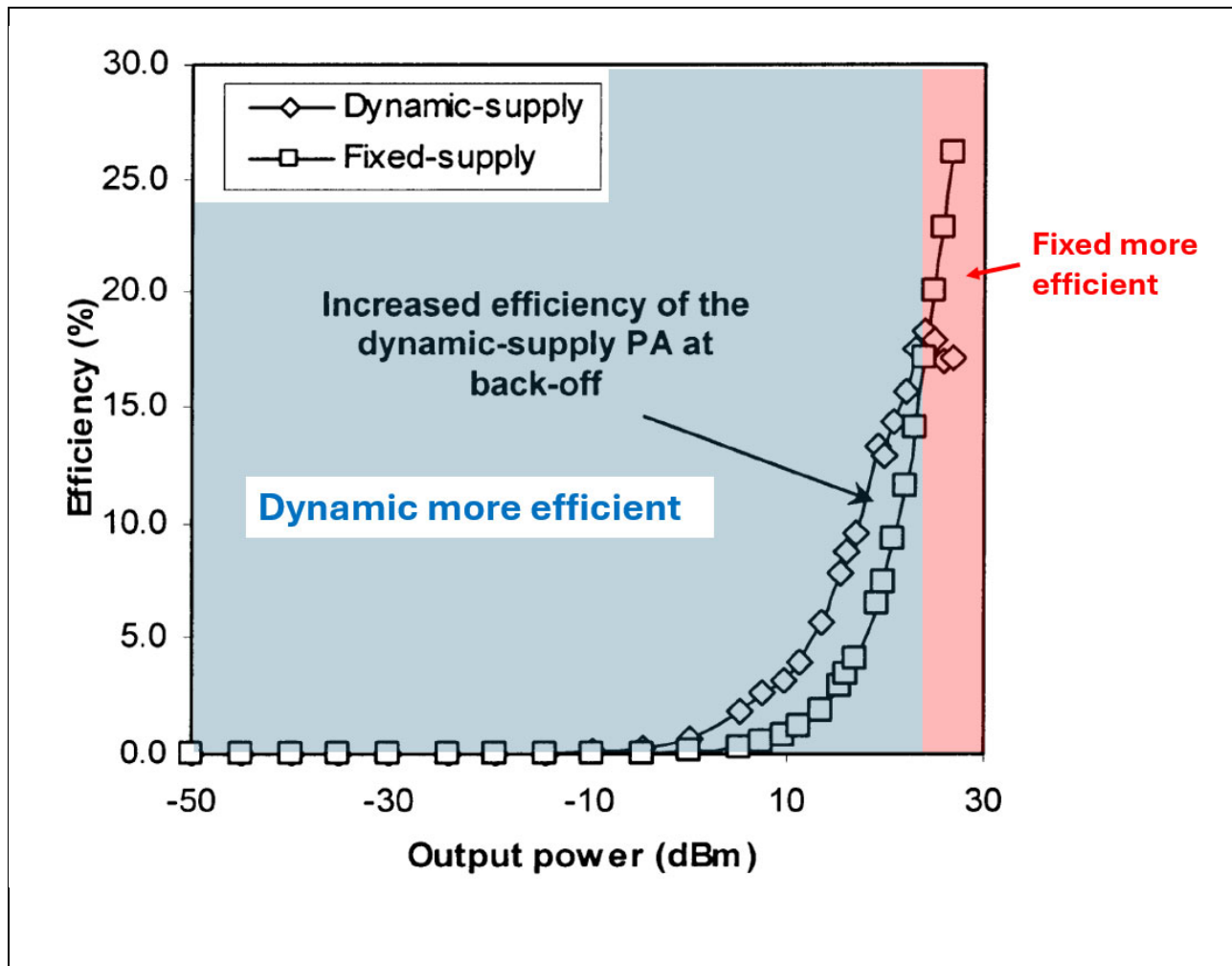
152. Sahu notes that PAs in CDMA wireless handsets typically operate at “back-off” power; that is, less than peak output power. Accordingly, Sahu teaches that the PA should be optimized for average efficiency rather than peak efficiency. Average efficiency is calculated by the formula:

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

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.

153. Sahu describes various types of “dynamic” power supplies capable of adjusting output power to provide an optimum power level for mobile transmission, including buck, boost, and buck-boost power supplies. EX1009, 113-115. Sahu’s preferred embodiment is a buck-boost DC-DC conversion system which also relies on PWM and transistor switches. EX1009, 116. Sahu’s Fig. 8(a) compares the efficiency of such a system to a fixed power supply over the range of power levels at which the system operates. As I have annotated below, this comparison shows that the “dynamic” power supply is more efficient at most lower power levels (blue), but the fixed power supply is more efficient at higher power levels (red), above a power level where the

curves for the two systems cross:



2. Motivation to Combine

154. In my opinion, a POSITA would have been motivated to combine Sahu's teachings with the Hau-Yoshida combination that I discussed above regarding ground 1A. In my opinion, in addition to the fact that Yoshida's DC-DC converter would be combined with Hau, Sahu is in the same field of art as Hau. Both references discuss power supplies for RF transceivers in wireless devices such as cell phones, and both are directed to problems involving finding maximum efficiency for such power supplies.

EX1007, Abstract, EX1009, Abstract. In my opinion, therefore, Sahu is in the same field as Hau or at minimum is analogous art because a POSITA would logically have considered Sahu's teachings to be relevant to the problems addressed by Hau.

155. Sahu and Hau also address similar specific problems within that field. Both references relate to power supplies operating in what Sahu calls the "back-off" region, *i.e.*, where the device operates at less than peak power for a large portion of the time, based on power requirements specific to the mobile environment (e.g., communicating with CDMA base stations). EX1007, 1:33-61, 5:17-20; EX1009, 113. Sahu examines the likely range of power over which a device is operated using a particular communication waveform as the access technique (e.g., CDMA) and teaches that the performance of that device should be optimized for the most probable output power levels for that device. EX1009, 113. In my opinion, a POSITA would consider that teaching as instructive for optimizing the performance of a similar device such as that taught by Hau and Yoshida.

156. In my opinion, a POSITA reading both references would clearly have been motivated to apply Sahu's teachings, of controlling the performance of a power supply based on the power levels most likely for a given transmission scheme, to the variable power transmission power supply of Hau and Yoshida. This combination would have been a simple application of a known technique to a known device ready for improvement to yield predictable results. It is also my opinion that Sahu provides a teaching, suggestion, or motivation for the combination. As shown in my annotation

above of Sahu's Fig. 8(a), Sahu teaches that for a given device operating in a given modulation scheme, a dynamic power supply (*i.e.*, a power supply with a variable power output like that taught by Hau in view of Yoshida) may give better efficiency throughout most of the operating range at less than full power, but a fixed power supply (*e.g.*, direct battery output) will be more efficient at the high end of the power operating range near peak output power. A POSITA would recognize that there is a point where the efficiency of the dynamic and fixed power supplies crosses over; that is, a power level above which the fixed power supply is more efficient. In my opinion, a POSITA would have been motivated by this teaching of Sahu to use a bypass system such as that taught by Hau to switch between dynamic and fixed power supplies to obtain maximum efficiency across the operating range of the device.

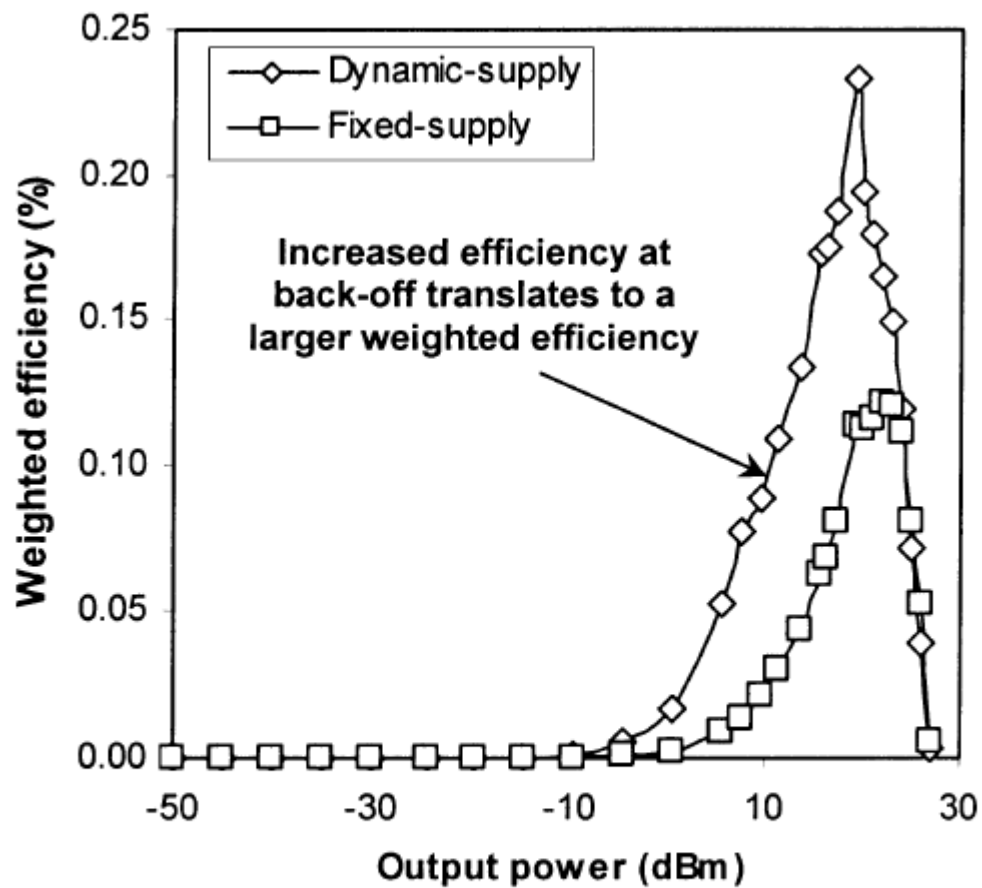
3. Claim 3: The power supply of claim 1, wherein the aperture generator and control module is configured to control the switching device based on a probable output power point of operation for a selected modulation scheme based on one or more power efficiency characteristics of an electronic device coupled to a power supply.

157. In my opinion, Sahu teaches or suggests the additional element of claim 3. Sahu teaches that the performance of a power supply for a mobile wireless device should be optimized based on the likelihood of operating at a given power output within a given modulation scheme. EX1009, 112, §II.A. For example, Sahu illustrates the likelihood of operating at a given transmit power level in urban and suburban environments in Fig. 1, which as I noted previously is similar to the '593 Patent's Fig.

2. Sahu teaches that:

Although the peak dc-to-RF efficiency of the PA occurs at the peak output power, the PA itself rarely operates at that power level (Fig. 1). Therefore, it is extremely important to calculate the average efficiency when considering the optimum PA configuration.

158. As I noted above, Sahu then provides a formula for calculating average efficiency of a PA system, based on the likelihood of operating at a given power level and the efficiency at a given power level. Sahu also illustrates in Fig. 8(b) the weighted efficiency of the operation of a particular system (calculated based on probability*efficiency):



(b)

Fig. 8. Comparison of: (a) efficiency and (b) weighted efficiency of the dynamic- and fixed-supply PA.

EX1009, 118-119, Fig. 8(b).

159. In my opinion, a POSITA would understand from these teachings that Sahu teaches to optimize the performance of a system based on its efficiency at the power levels at which it is most likely to operate; that is, “a probable output power point of operation for a selected modulation scheme.” The results obtained in Sahu are all for a “selected modulation scheme” because Sahu tests for a particular modulation scheme (specifically a “CDMA IS-95 signal”). Accordingly, a POSITA would

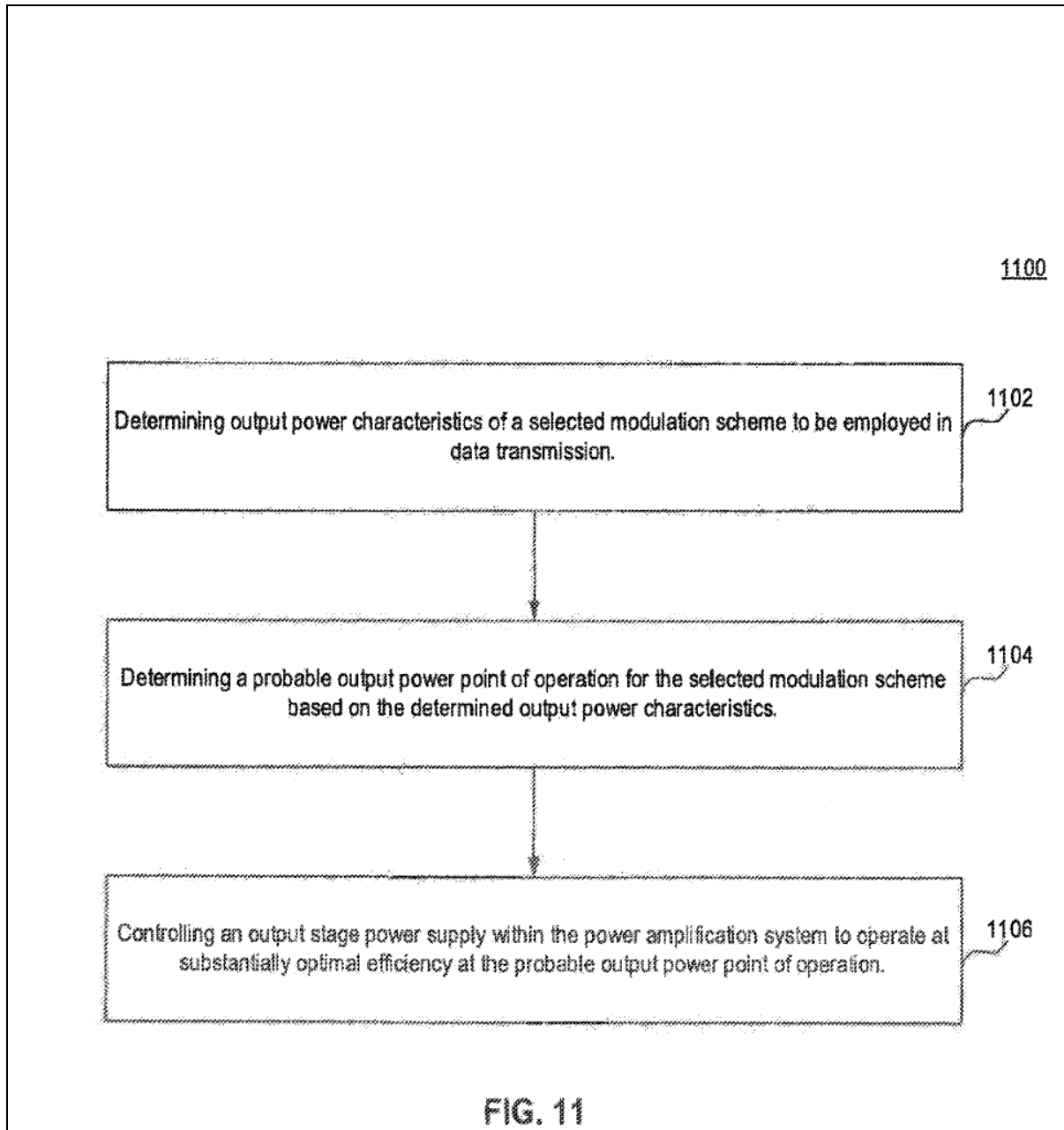
recognize that (1) the experimental results shown in Sahu's figures are for a particular modulation scheme, and (2) a POSITA seeking to optimize average performance for a particular device in a particular modulation scheme would analyze the performance of that device transmitting in that scheme in the same way taught by Sahu.

160. The power levels at which Sahu shows the greatest improvement from the "dynamic supply" are the reduced or "back-off" power levels, that is, when the PA is supplied with less than full battery power. These reduced power levels in Sahu are obtained by PWM control of a switching device performing DC-DC down-conversion. EX1009, 116-117, §IV(B). Therefore, in my opinion, a POSITA would have understand that the down-conversion circuitry accordingly controls the switching device to obtain ideal efficiency over the power levels at which the system will most likely operate. It would further have been obvious to optimize the performance of the system taught by Hau (in view of Yoshida) in the same manner taught by Sahu, in which case the DC-DC buck converter of Hau (using the PWM control circuitry of Yoshida) would be controlled based on the efficiency at a probable point of operation associated with a particular modulation scheme.

161. It is also my opinion that the combination teaches or suggests controlling the AGCM "... based on one or more power efficiency characteristics of an electronic device coupled to a power supply." In my opinion, it is obvious that optimizing the power efficiency of a particular device, including an electronic device coupled to a power supply, would necessarily be based on the power efficiency characteristics of

that device, since any experimental or predicted efficiency results would need to take those characteristics into account. For example, Sahu teaches experimental results obtained with a particular prototype, described in Sahu's §IV (pages 115-117). All of the experimental results obtained and shown in Figs. 6-9 are obtained with this system. In my opinion, the power efficiency results shown Sahu are necessary correlated with "power efficiency characteristics of an electronic device coupled to a power supply" since any change to those characteristics would change the results.

162. It is also my opinion that the combination teaches this element to the same degree as the '593 Patent itself, particularly since the '593 Patent is notably vague about this element. The '593 Patent gives a flowchart in Fig. 11 and its accompanying text (5:61-6:19), but the flowchart and accompanying text are extremely vague about what the chart is actually describing:



163. Neither the flowchart nor the accompanying text explains when or where the depicted process occurs. The '593 Patent does not say whether the process shown in Fig. 11, or any step within it, occurs during the design of a system, during operation, or somewhere else. At least steps 1102 and 1104 appear to me more likely to be design steps; it is very unlikely that a POSITA would design a circuit or microcontroller to

perform the type of analysis described in those blocks on the fly during operation of a device. It is not clear at all where step 1106 occurs either. Again, while a system might be designed so that the control of the power supply is designed to produce optimal results based on the probable output power that the designer expects, it would not make sense to me that any control circuitry in the device would perform that type of analysis on the fly, nor is there any description of a circuit or microcontroller performing such analysis in the '593 Patent. And there is no mention anywhere in the '593 Patent how the circuit is controlled “based on one or more power efficiency characteristics of an electronic device coupled to a power supply.” EX1001, 11:33-35. Therefore, it is my opinion that the combination teaches these elements to the same or greater degree as the disclosure of the '593 Patent itself.

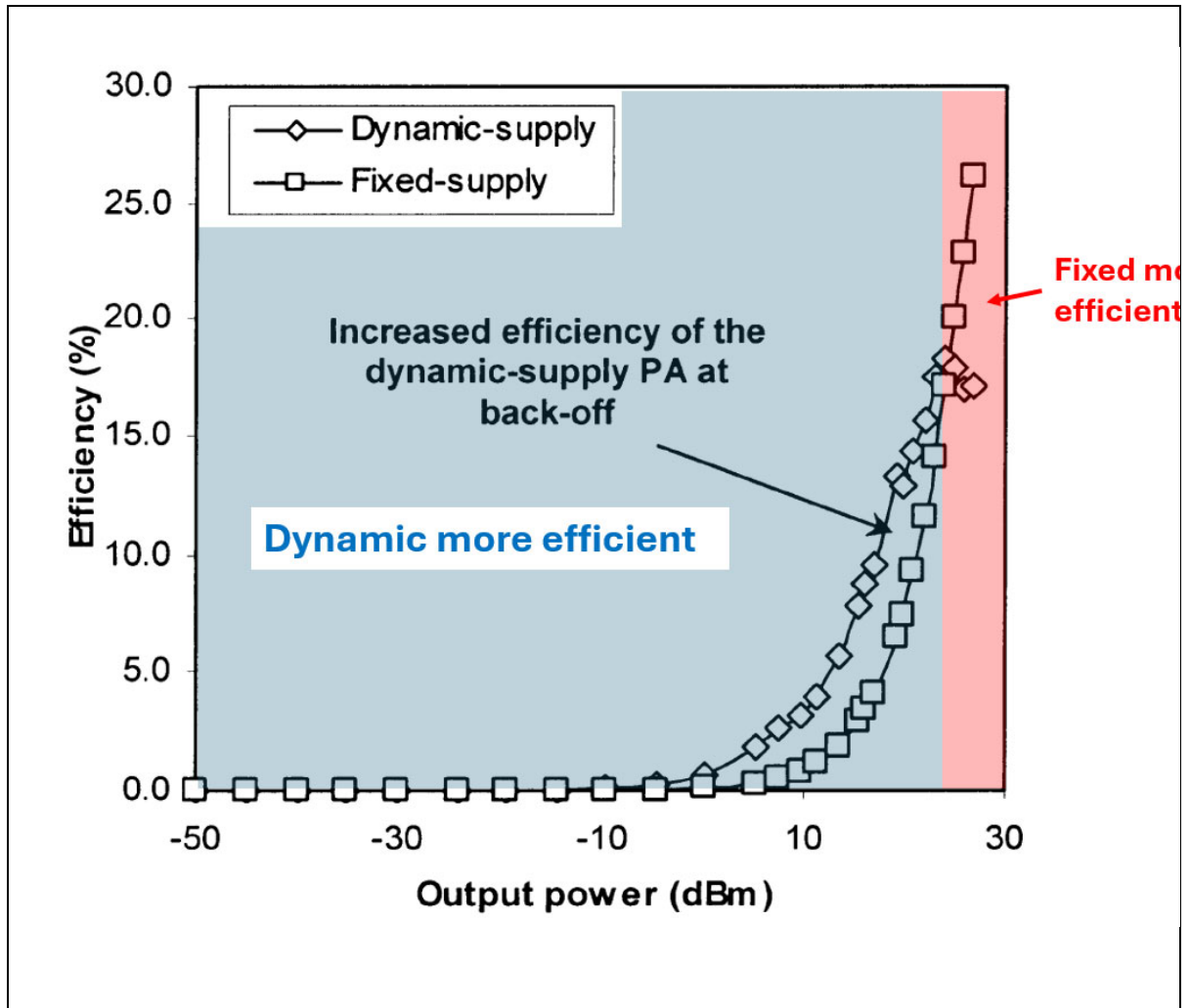
4. Claim 4: The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.

164. In my opinion, Sahu teaches or suggests the additional element of claim 4. Sahu references WCDMA (wideband CDMA) repeatedly. EX1009, 113 (§II(A), 114 (Fig. 2, §III(A))). Wideband CDMA uses a broader frequency spectrum than earlier CDMA protocols, hence the “wideband.” However, WCDMA shares with other CDMA protocols the same basic power control issues addressed by Sahu. Because WCDMA is a code-division multiplexing technology in which multiple channels share times and frequencies (and therefore one channel may appear as noise to adjacent channels), the problem of maintaining adequate power transmission capability while

avoiding interference with adjacent channels is substantially similar in WCDMA to CDMA. In my opinion, it is accordingly reasonable that a POSITA would have expected that when operating a mobile receiver using WCDMA in a typical environment, there would be a statistical range of expected transmission power levels specific to WCDMA, like that Sahu teaches for CDMA. Therefore, in my opinion, a POSITA would have been motivated to apply Sahu's teachings which I discussed above regarding claim 3 to a WCDMA modulation scheme.

5. Claim 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.

165. In my opinion, this element is obvious over Sahu in view of Hau and Yoshida. As I discussed previously, Sahu teaches (e.g. in Fig. 8(a)) that for a given device operating in a particular modulation scheme, a POSITA may determine the efficiency of the power supply both for a dynamic power supply and for a fixed power supply, and that there is a point at which a fixed power supply becomes more efficient than a dynamic DC-DC power supply:



166. As I discussed previously in §IX.B.2, it would accordingly have been obvious to a POSITA to program the threshold as taught by Hau (that is, the power level at which the bypass is activated) to correspond to the point where a fixed power supply becomes more efficient as taught by Sahu. It is also my opinion that that a POSITA would recognize that this transition point is correlated with the power needed for a particular transmission scheme.

167. Sahu's Fig. 8(a) shows a result obtained with a specific transmission scheme (that is, using a particular communication waveform) and thus shows the

efficiency of a particular communication waveform. For a given power amplifier and a given waveform that is applied to the input of the amplifier, there is a direct relationship between transmit power and amplifier efficiency, with efficiency usually increasing with transmit power. The efficiency rises with increasing output power, because the DC power consumption of the amplifier is either constant (Class-A) or increases very slowly (Class-B) with output power. This relationship for any given amplifier is well understood in the art. *See, e.g.* EX1028, Ch. 12, with discussion of efficiency characteristics of particular types of amplifiers at 350, 352-354, 357-358, 360-361, 371. The efficiency of an amplifier also varies with characteristics of the waveform itself (that is, “a communication waveform efficiency”) because the shape of the waveform impacts how much power is carried by the waveform. Differently shaped waveforms will have a different *peak to average ratio*, defined as the ratio of the peak power output with a given waveform to the average power output by that waveform. EX1028, Ch. 16-3 (pp. 507-511). Because the efficiency of any given amplifier varies with power, the shape of the waveform will accordingly impact the average efficiency of the amplifier using that waveform. For example, a well-known textbook on this subject teaches that “[t]he average efficiency of a power amplifier depends on both the characteristics of the signal being amplified and upon the type of amplifier.” EX1028, p. 510.

168. A POSITA would accordingly have understood that the efficiency diagram in Fig. 8(a) of Sahu reflects efficiency obtained with a particular waveform and a

particular amplifier. Therefore, in my opinion, a POSITA would have understood (and found it obvious) that using the “crossover” point taught by Sahu, where the fixed power supply becomes more efficient than the dynamic supply, as the threshold of Hau, the threshold is programmed based on the efficiency of the communication protocol employed (e.g., CDMA efficiency) (*based on a communication waveform efficiency*).

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**

169. In my opinion, because this claim adds substantially the same element as claim 3, the same teachings that I discussed with respect to that claim also apply here.

- 7. Claim 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.**

170. In my opinion, because this claim adds substantially the same element as claim 8, the same teachings that I discussed with respect to that claim also apply here.

- 8. Claim 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.**

171. In my opinion, because this claim adds substantially the same element as claim 8, the same teachings that I discussed with respect to that claim also apply here.

9. **Claim 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.**

172. In my opinion, Sahu teaches or suggests the additional element of claim 17. Sahu specifically teaches that either a BJT or a MOSFET can be used as the PA. EX1009, 115 (§III(B)). In either case, the bias voltage is coupled to the input and output of the PA; that is, the gate and base of a MOSFET or the drain and collector of a BJT. *Id.* Either type of transistor would work in the place of the two PAs taught by Hau. Specifically, Hau teaches that Vcc2, the output of the power supply from either the DC-DC converter or the bypass switch, can be coupled to the two PAs as the bias voltage. Hau states 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. In my opinion, because Sahu specifically teaches using either a BJT or a MOSFET PA, and coupling it to the output of a DC-DC converter in the same manner in which Hau couples its PAs, it would have been obvious to a POSITA to use either type of amplifier (BJT or MOSFET) as taught by Sahu. A POSITA would have further understood the need to select a suitable amplifier from among the limited types of known common amplifier circuits.

10. **Claim 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.**

173. In my opinion, this claim is taught or suggested by Sahu for the reasons

discussed above regarding claim 17. Specifically, Sahu teaches using either a BJT or a MOSFET as the transistor for a PA and coupling the bias voltage (which is provided by the power supply) to the drain and collector (source) terminals of the MOSFET when a MOSFET is used. Although the claim uses two acronyms (MOS and MOSFET), a POSITA would have understood that MOSFET is a well-known acronym for “metal oxide semiconductor field-effect transistor,” which is a type of MOS transistor.

11. **Claim 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.**

174. In my opinion, because this claim adds substantially the same element as claim 3, the same teachings that I discussed with respect to that claim also apply here.

12. **Claim 20: The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.**

175. In my opinion, because this claim adds substantially the same element as claim 4, the same teachings that I discussed with respect to that claim also apply here.

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

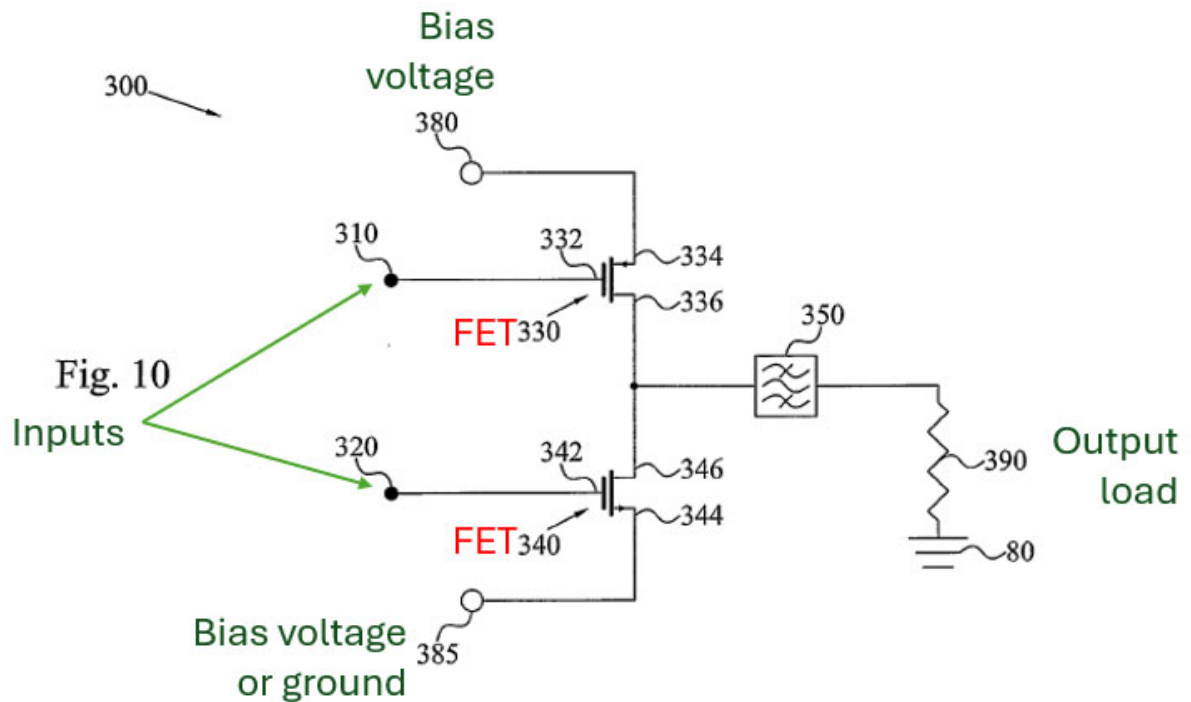
1. Lejon

176. Lejon relates to linear amplification using nonlinear components, LINC, out-phasing amplifier systems, and in particular to improving the operation characteristics of such LINC out-phasing amplifier systems. EX1013, 1:4-7. Lejon

notes that different data modulations and modulation schemes available with the radio frequency (RF) signals, such as the digital modulation technique OFDM, Binary Phase Shift Keying (BPSK), Quadrature Phase-Shift Keying (QPSK), and Quadrature Amplitude Modulation (QAM), impart new challenges to power amplifiers. EX1013, 1:15-17. Lejon explains that traditional linear amplifier in the art cannot simultaneously achieve all three goals: a high output power, a high bit rate, and a low power consumption. EX1013, 1:27-2:12. There is “traditionally a complex tradeoff” between goals of high output power and power consumption. EX1013, 1:27-2:5. Many traditional amplifiers may be efficient at peak power, but lose efficiency at lower envelope powers. EX1013, 2:7-12. Linear amplification using nonlinear components (LINC) out-phasing amplifiers, on the other hand, can provide excellent efficiency over a vast range of output powers. EX1013, 2:14-16. A LINC out-phasing amplifier includes two input ports, one is for an in-phase (I) signal and the other is for a quadrature phase (Q) signal. EX1013, 2:16-18. The input signals are processed in a LINC modulator to generate two signals of constant amplitude but of varying phase, which are then amplified using two branch amplifiers. EX1013, 2:18-21. The amplified signals then combined in a LINC out-phasing combining network to create, at an output port, a single amplified RF signal of varying phase and amplitude. EX1013, 2:21-24.

177. Fig. 9 of Lejon illustrates a current mode class D (CMCD) amplifier 200 that can be used in the LINC out-phasing amplifier system. EX1013, 21:7-9. The CMCD amplifier 200 acts as a switch synchronized by a driver that can deliver power

23:26-29.



EX1013, Fig. 10 (annotated).

2. Motivation to Combine

179. In my opinion, a POSITA would have further been motivated to combine Lejon with the combined teachings of Hau and Yoshida. It is my opinion that Lejon is in the same field of art as Hau. Lejon, like Hau, teaches designs for power amplifiers used in radio communication systems. EX1013, 1:10-22. Lejon recognizes the challenges posed by different modulation schemes and points out that using LINC out-phasing amplifiers can provide excellent efficiency over a vast range of output powers. EX1013, 1:15-2:12. More specifically, Lejon teaches that it addresses concerns with

power consumption. EX1013, 1:27-2:5. A POSITA would recognize that power consumption would be a greater concern with battery-powered portable devices, like those taught by Hau. In my opinion, a POSITA would logically have viewed Lejon's teachings to be relevant to the problems of maximizing efficiency of power supplies taught by Hau, including when Hau implements PWM control for a DC-DC converter as taught by Yoshida.

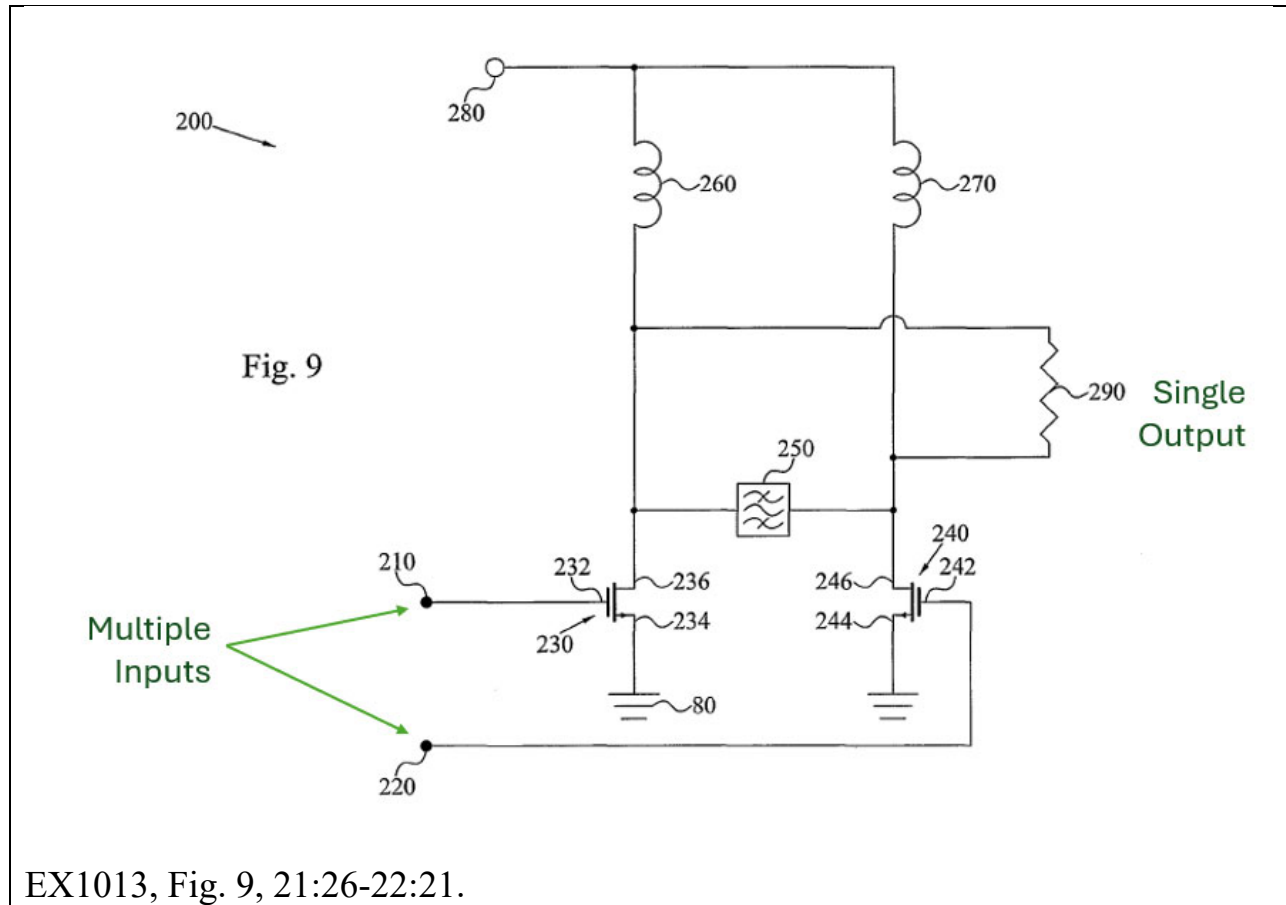
180. Lejon teaches that the improvements to the LINC out-phasing amplifier system would further boost the efficiency of a transmitter which operates in a complex modulation scheme. EX1013, 2:14-25, 3:5-15. The systems of Lejon use a variable bias (drain voltage). EX1013, 21:13-24, 23:23-24:12. The output power of Lejon's amplifier is varied by controlling the voltage bias provided to those amplifiers. EX1013, 2:7-2, 2:27-29. In my opinion, a POSITA would have recognized that 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.

181. It is also my opinion that a POSITA would have had a reasonable expectation of success making the combination. Lejon teaches that the output of Hau and Yoshida's circuits (a bias voltage) is the input to out-phasing amplifier in Lejon. EX1013, 21:13-24, 23:23-24:12. 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

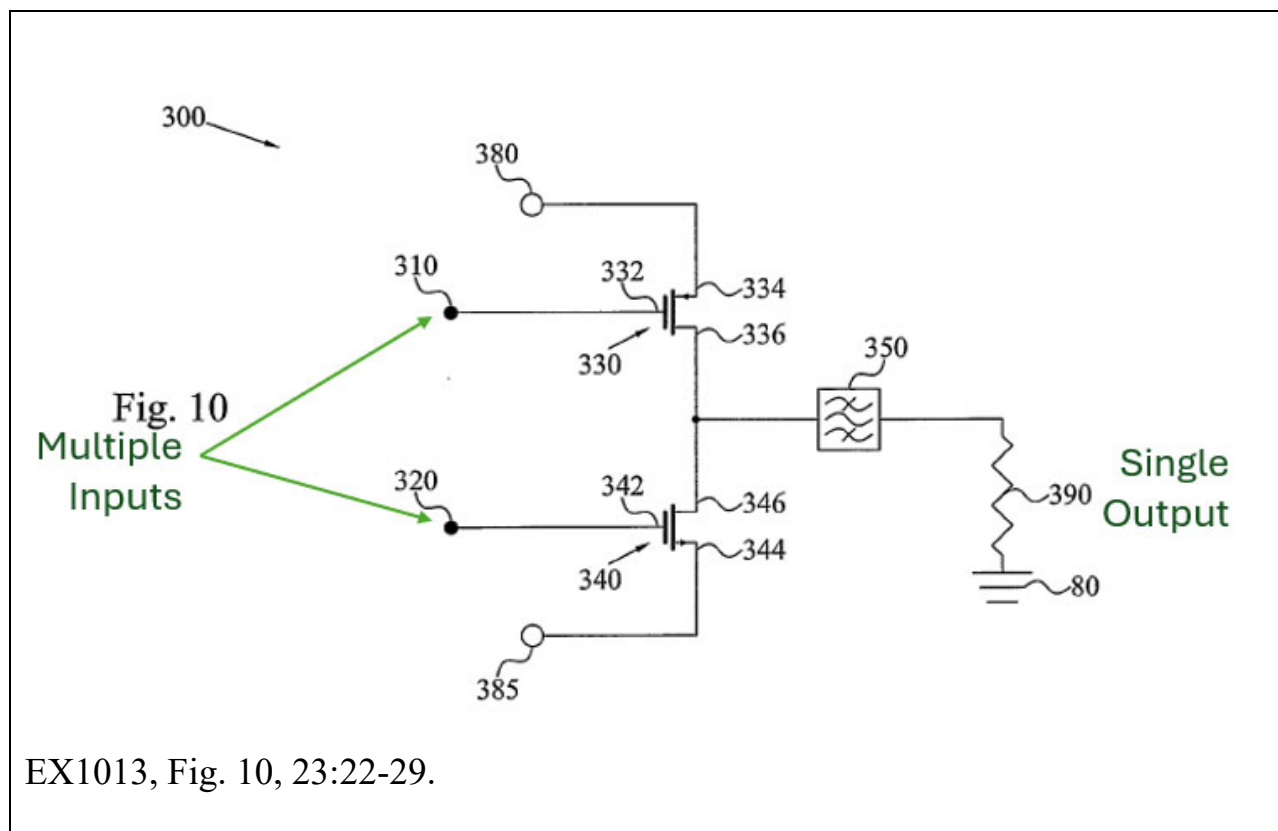
power, e.g. Hau's V_{cc2}) is the same power signal required as the bias voltage by Lejon. Furthermore, a POSITA would have been motivated to substitute a known element (the basic amplifier in Hau) for another (the out-phasing amplifier in Lejon that takes two inputs and produces one output). Furthermore, 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.

3. Claim 16: The system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier.

182. In my opinion, Lejon teaches this element. Each of Lejon's Figures 9 and 10 teach examples of amplifiers with two inputs and a single output. In Fig. 9, 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:



183. In Fig. 10 of Lejon, 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:



184. Figures 9 and 10 of Lejon differ in some respects because Figure 9 illustrates a current mode amplifier, while Figure 10 illustrates a voltage mode amplifier. EX1013, 21:7-9, 23:14-20. Additionally, these amplifiers have different configurations. However, in my opinion, both figures teach the additional element of claim 16 because they each show a power amplifier (*the electronic device*) that has multiple inputs and a single output (*a multiple-input-single-output (MISO) amplifier*).

D. Ground 2A: Claims 1-5, 9-11, 15-16, and 19-20 are Unpatentable as Obvious over Canyon in view of Ranjan

1. Canyon

185. Canyon is related to “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, 1:20-24. Canyon recognizes the importance of power management in personal communication devices to achieve longer battery life and operating time of the devices. EX1011, 1:40-59.

186. Canyon notes 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.” EX1011, 1:54-59. To help improve power efficiency of the personal communication devices, Canyon discloses a communication device that includes a power amplifier unit 120 and a power management unit 110. EX1011, 3:1-7. Canyon’s FIG. 2 illustrates several of components of a personal communications device 100.

187. A power management unit 110 of the 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 (cyan). EX1011, 3:8-13. A 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 the regulator 160 should be bypassed via a bypass switch 190 (purple). *See* EX1011, 3:14-4:29.

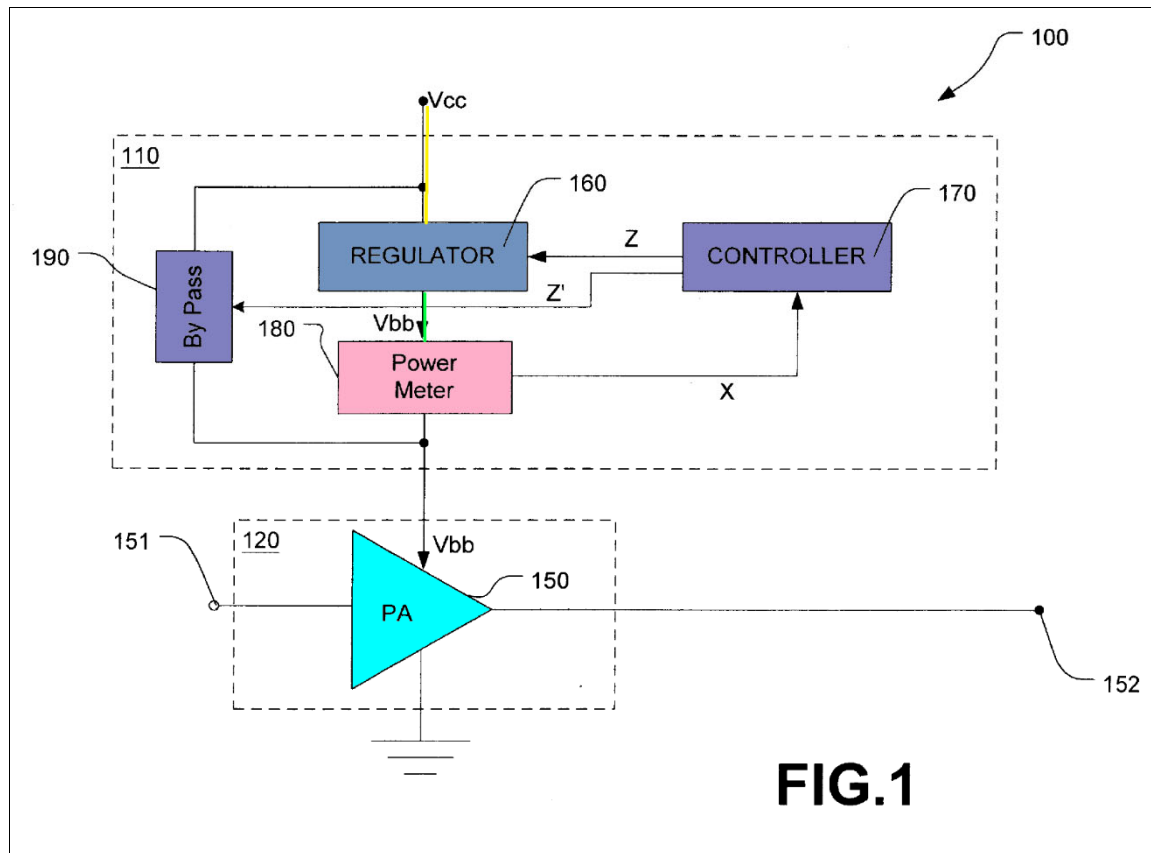


FIG. 1

188. Canyon provides a flowchart in FIG. 8 that illustrates the adjustment of the operating voltage applied to the power amplifier unit based on a control signal generated by monitoring of the current flow to the power amplifier unit. EX1011, 7:1-14. A current flow signal is received by a controller 170 that generates a control signal based upon the current flow signal (808). The control signal is then output to a regulator 160, which then adjusts the operating voltage applied to the power amplifier unit 120 based upon the control signal (810).

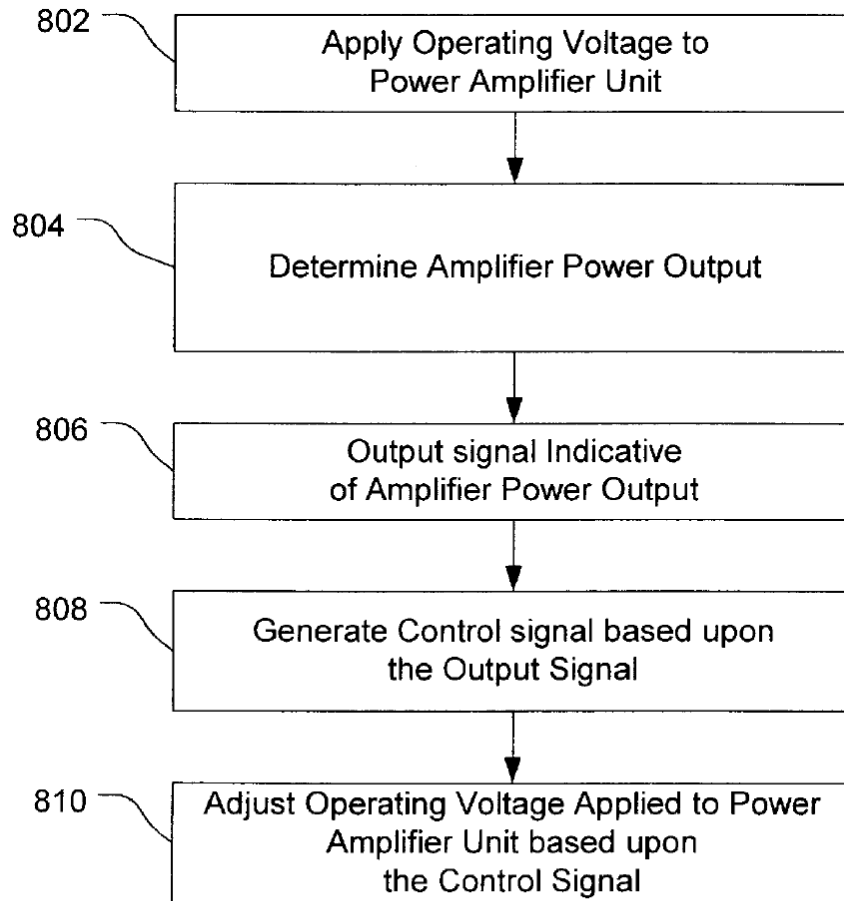


FIG. 8

2. Ranjan

189. Ranjan recognizes 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.” EX1012, p. 493, Introduction. Ranjan presents a power amplifier architecture that “comprises a basic amplifier with an efficient, high modulation bandwidth DC-DC converter” that is “controlled by a digital signal processor that provide [] supply voltage optimization.” EX1012, p. 493, Abstract.

190. More specifically, Ranjan points out that “[t]he overall system efficiency depends on the efficiency of the amplifier at different power levels and the efficiency of the DC-DC converter.” EX1012, p.494. Fig. 3 of Ranjan (reproduced below) illustrates the efficiency of the system as a function of output power. EX1012, p. 494. Fig. 3 of Ranjan also shows “[a] representative probability distribution of output power in cellular phone applications” and notes 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, p. 494.

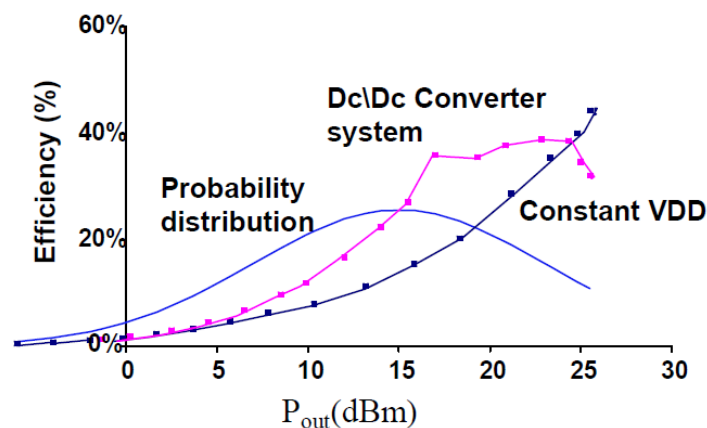


Fig.3: Measured efficiency of amplifier with constant VDD and with dc/dc converter , at different output power levels. Also shown is a representative distribution of output power for wireless application.

3. Motivation to Combine

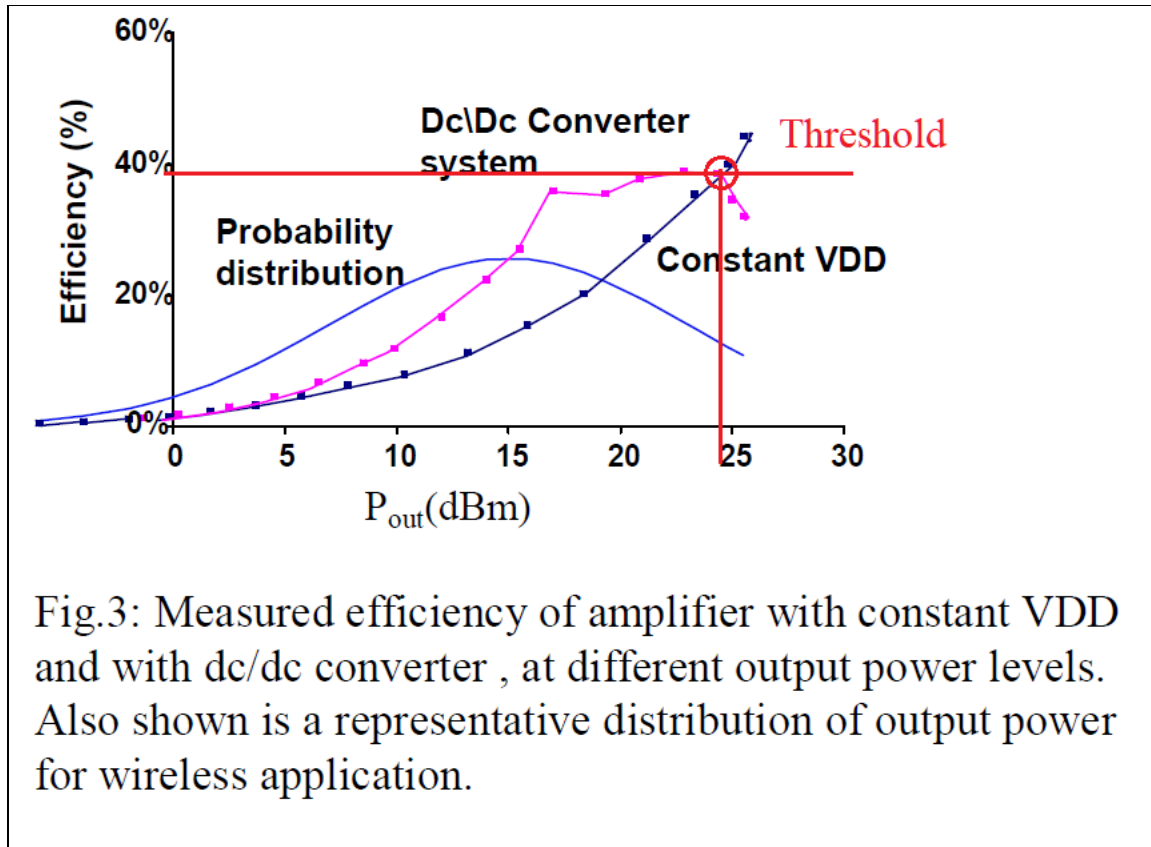
191. A POSITA would have been motivated to combine the teachings of Canyon and Ranjan.

192. Canyon cites Ranjan on its face. *See* 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. EX1011, 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, in my opinion, 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.

193. Canyon recognizes that, “as the power output of a typical wireless communications device [] drops, the efficiency of the wireless communications device also drops.” EX1011, 1:54-57. 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, 4:11-26. However, Canyon does not explicitly describe how to determine the optimum point at which to close the bypass switch to achieve maximum efficiency. For example, 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. EX1001, 4:20-23.

194. Such values – 22-24 dBm – are suggested in Fig. 3 of Rajan (annotated below):



195. As shown in Fig. 3, 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.

196. Therefore, a POSITA would have recognized that in a power supply such as Canyon with a voltage regulator 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 path) becomes more efficient than the variable power supply from the regulator. A POSITA would have been able to calculate or empirically determine such a threshold for a given device operating in a given

modulation scheme without undue experimentation. Accordingly, setting the bypass threshold of Canyon based on the threshold disclosed in Ranjan (where a fixed power supply becomes more efficient) would be a simple combination of prior art elements according to known methods to yield predictable results.

197. Furthermore, a POSITA reading Ranjan would have recognized that Ranjan provides a teaching, suggestion, or motivation to combine with Canyon because Ranjan teaches (at 494, and shows in Fig. 3) 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, p. 494. A POSITA would have recognized from this teaching of Ranjan that a bypass switch as taught by Canyon would enable power supply to obtain superior efficiency both at peak power and at reduced power. Canyon’s bypass switch would accordingly improve Ranjan’s similar device in the same way.

4. Claim 1

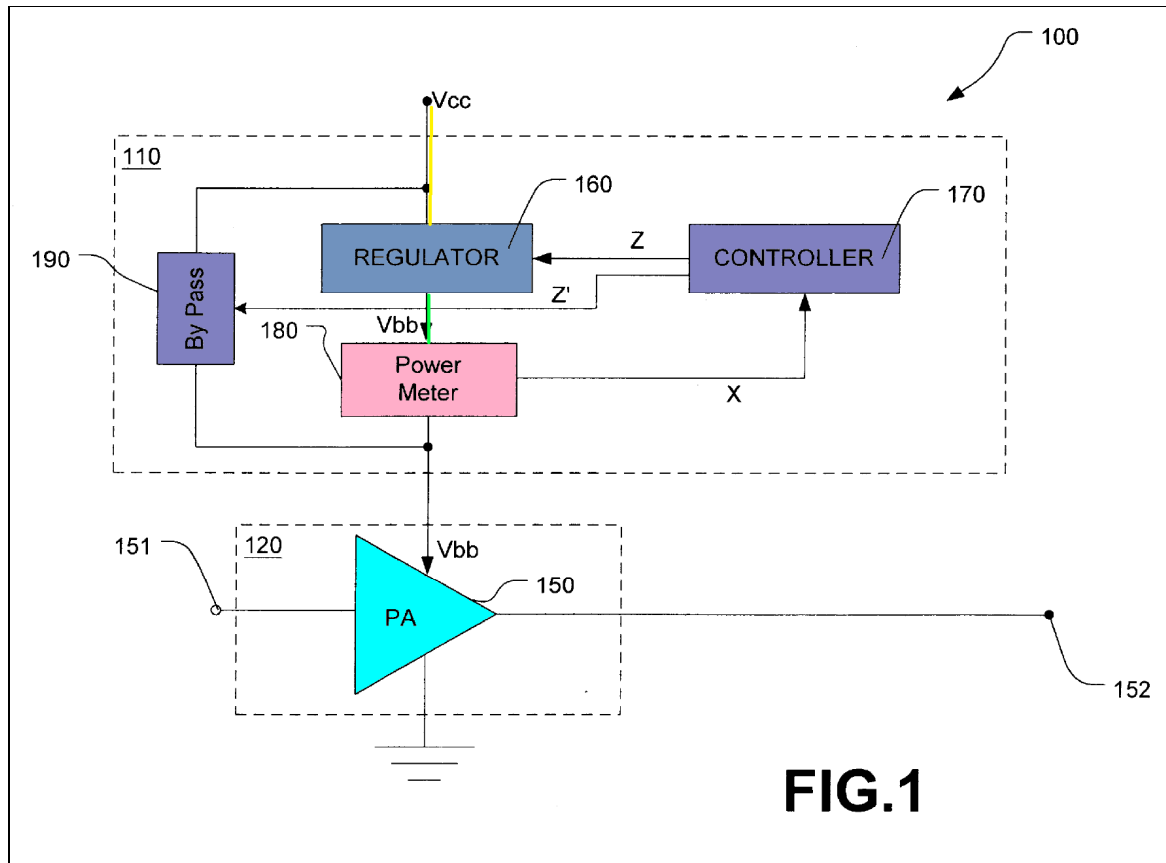
a. 1[pre]: A power supply comprising:

198. In my opinion, Canyon teaches this element. Canyon discloses a power management unit 110 that supplies an operating voltage to a power amplifier 150 of the power amplifier unit 120. EX1011, 3:8-13. Therefore, Canyon discloses a power supply.

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

199. In my opinion, Canyon teaches this element. As shown in Fig. 1 of

Canyon, Canyon teaches 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 the power amplifier 150 (cyan). EX1001, 3:8-13.



200. In Canyon, “ V_{bb} may be between 0 volts and the supply voltage V_{cc} . Further, V_{bb} may be linearly variable between, for example, 0 volts and V_{cc} .” EX1011, 3:39-42. That is, V_{bb} is a voltage value that is smaller than, and down-converted from, the input voltage V_{cc} .

201. Therefore, Canyon discloses a switching regulator 160 (*a switching device*) configured to down-convert the supply voltage V_{cc} (*an input voltage*) to the operating voltage V_{bb} and pass the V_{bb} (*the down-converted input voltage*) to the

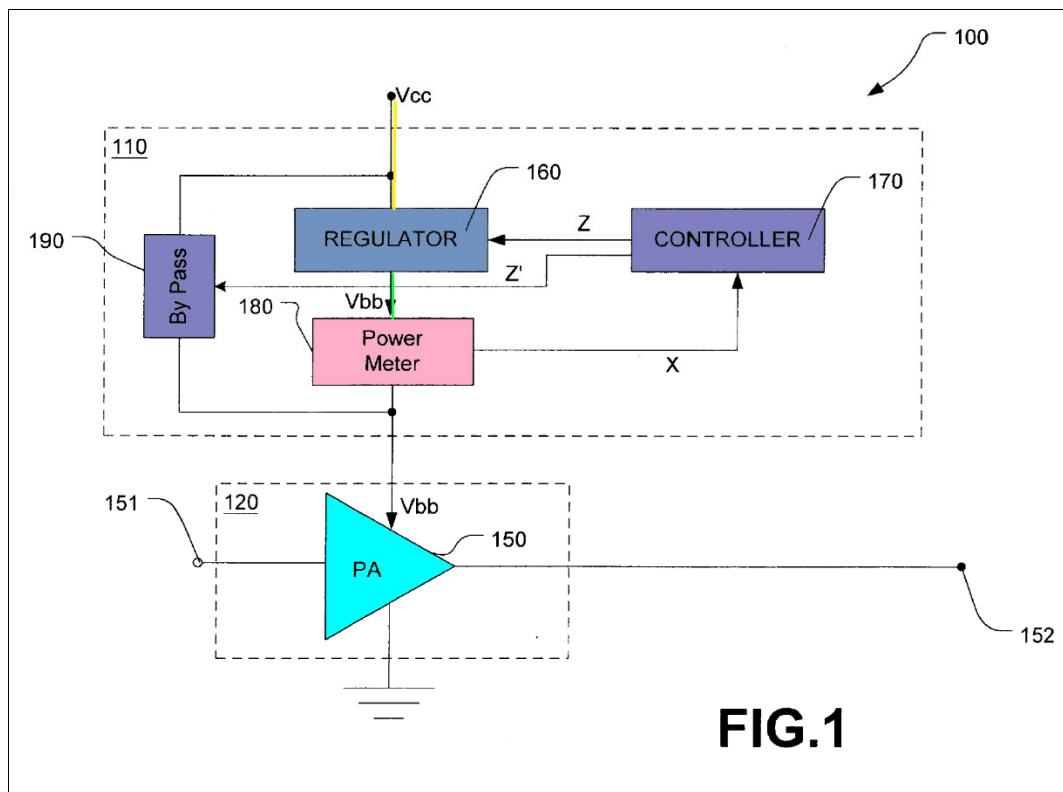
power amplifier 150 (*an output voltage node*).

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

202. In my opinion, Canyon teaches this element.

203. Claim 1 recites that the AGCM performs two functions: it controls the switching device itself, and it controls bypassing the switching device. As discussed in §VIII.B, in specification of the '593 Patent, 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.

204. As shown in Fig. 1 of Canyon, Canyon teaches a controller 170 (purple) that “controls switching regulator 160 via providing a control signal Z.” EX1011, 3:31-32.



205. In Canyon, the power management unit 110 “includes a current meter 180, a controller 170 and a regulator 160.” EX1011, 3:8-9. The current meter 180 (pink, shown as a power meter in FIG. 1) monitors the current flow corresponding to the operating voltage supply to the power amplifier unit 120 and generates a current flow indicator signal X representative of the measured current flow. EX1011, 3:14-19. This current flow indicator signal X is provided to a controller 170 (purple) so that the controller 170 can generate a control signal Z based on the current flow indicator signal X to control the regulator 160 (blue). EX1011, 3:19-34.

206. Therefore, Canyon teaches a controller 170 (*an aperture generator and control module*) that is configured to control the regulator (*the switching device*).

207. For the reasons that I previously discussed in §VIII.B, it is my opinion that the “aperture generator and control module” should not be construed as means-plus-function. However, it is also my opinion that Canyon teaches the same or equivalent structure as the ’593 Patent. As discussed in §§VII.B and IX.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.

- 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**

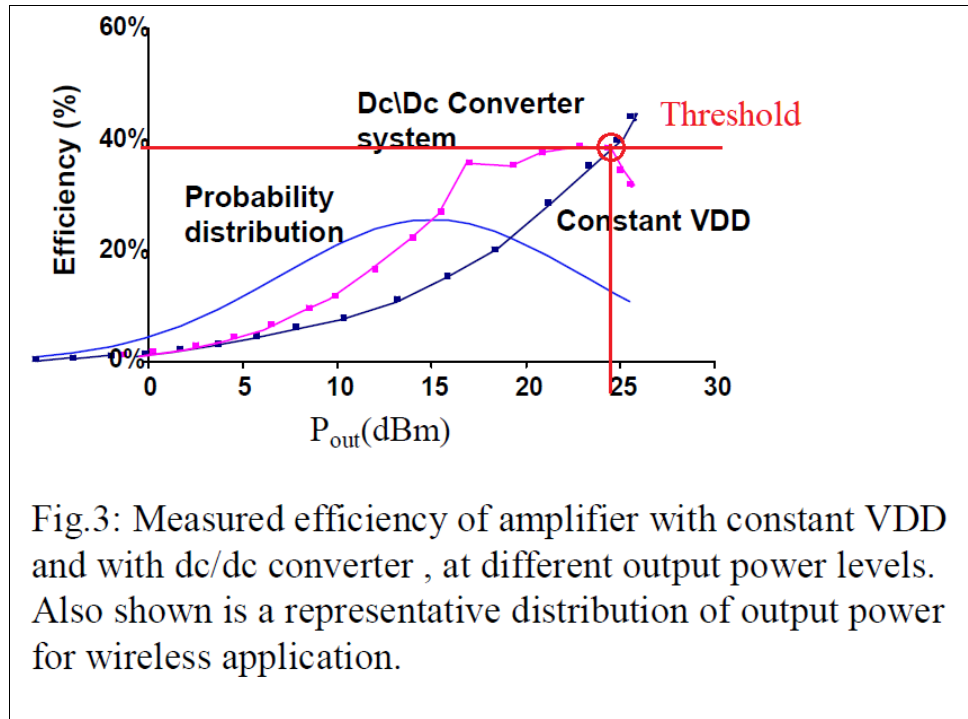
208. In my opinion, Canyon in combination with Ranjan teaches this element.

209. In Canyon, the control of the bypassing of the regulator 160 is performed by a bypass switch 190 that is closed when the power output indicator signal X indicates that the power amplifier unit 120 is consuming, or operating at, a high power level. EX1011, 4:14-29. For example, where the power amplifier unit is consuming a power level greater than 22-24 dBm, the bypass signal Z' may be output by the controller 170 to close the bypass switch 190. Once bypass switch 190 is closed, the operating voltage Vbb applied to the power amplifier unit 120 is effectively taken to a level approximately equal to the supply voltage Vcc. EX1011, 4:16-30. When the voltages Vcc and Vbb on either side of the regulator are the same voltage, no current flows through the regulator and thus the regulator is deactivated.

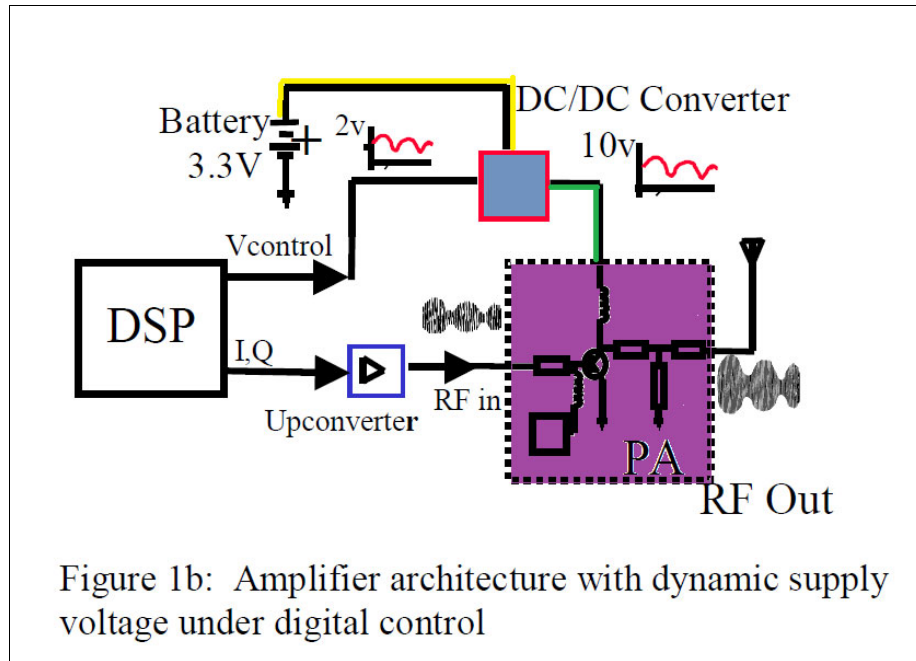
210. The controller closes the bypass switch “in response to the power efficiency of the power supply exceeding a predetermined threshold” in the combination for two reasons. In Canyon itself, the signal X from the Power Meter 180 is a current signal “indicative of the power output level of the [PA].” EX1011, 3:14-30. Signal X therefore indicates greater efficiency relative to the fixed input power. As discussed in §VIII.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. Canyon alone therefore teaches this element to the same extent as the '593 Patent itself.

211. Furthermore, the power level greater than 22-24 dBm mentioned in Canyon is indicated in Fig. 3 of Ranjan (below), which illustrates measured efficiency of an amplifier with a DC-DC converter at different output power levels. Ranjan points that that Fig. 3 demonstrates “at maximum output power the inclusion of the DC-DC converter is detrimental to efficiency.” EX1012, p. 494. A POSITA would have understood, based on Fig. 3 of Ranjan, that after a threshold point (annotated in red), the efficiency of the dynamic DC-DC converter starts to drop. At that point, it is beneficial to exclude the DC-DC converter and use the constant voltage VDD to achieve better overall efficiency. 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. 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.



212. Figure 1b of Ranjan (below) shows a DC-DC converter (blue) that converts a battery power supply (yellow) and supplies its output power (green) to the power amplifier (purple). EX1012, p. 494, Figure 1b. A POSITA would have understood that the DC-DC converter in Ranjan is functionally similar to the switching regulator 160 in Canyon.



213. In Canyon, the “[c]ontroller 170 receives the signal X and in turn, generates a control signal Z and a bypass signal Z’.” EX1011, 3:58-60. The signal X is a current signal that is “indicative of the power output level of the power amplifier unit 120.” *Id.*, 3:14-30. Combined with Ranjan’s Fig. 3, a POSITA would have understood that the signal X is indicative of the power efficiency of the power amplifier unit 120. The load current at the power amplifier 150 measured by the power meter 180 is also the output current from the regulator 160. Therefore, a POSITA would have understood, given Ranjan and Canyon’s teaching, that the signal X is also indicative of the power level and power efficiency of the regulator 160.

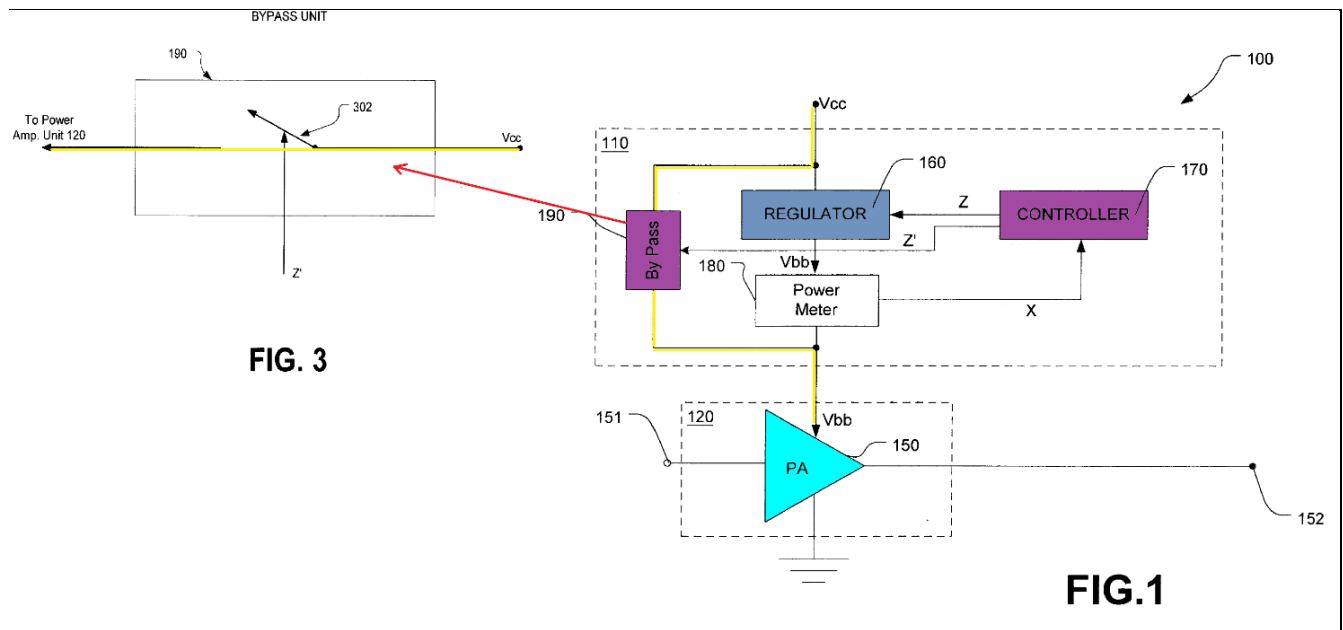
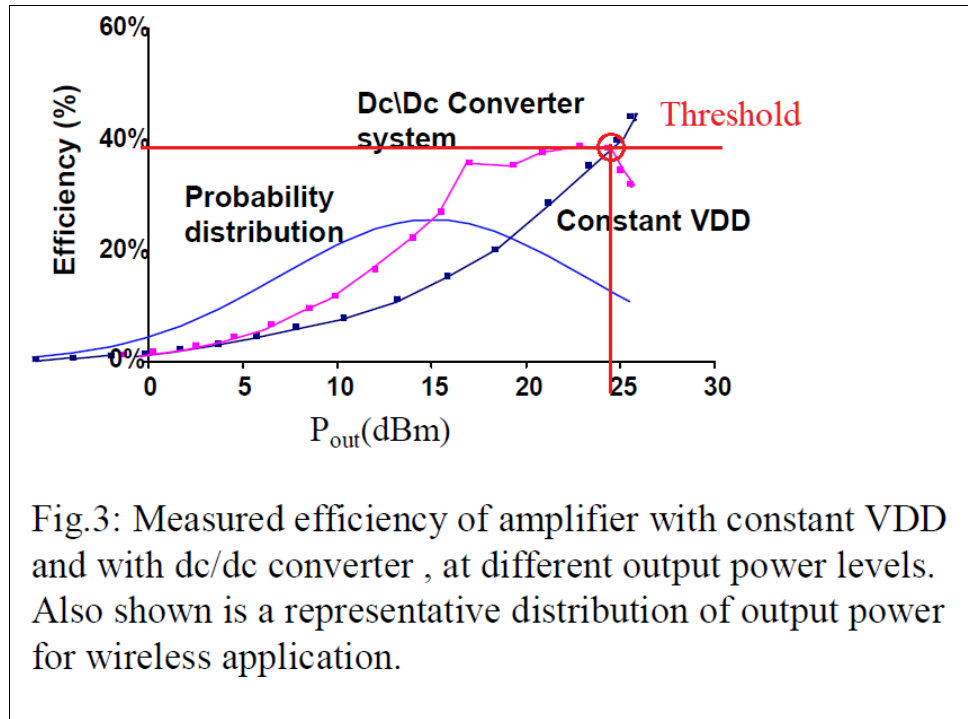
214. As discussed above, Canyon explains that:

Bypass switch 190 is closed when the power output indicator signal X indicates that the power amplifier unit 120 is consuming, or operating at, a high power level. For example, where the power

amplifier unit is consuming a power level greater than 22-24 dBm, the bypass signal Z' may be output by the controller 170 to close the bypass switch 190. Once bypass switch 190 is closed, the operating voltage Vbb applied to the power amplifier unit 120 is effectively taken to a level approximately equal to the supply voltage Vcc.

EX1011, 4:16-30.

215. That is, Canyon in view of Ranjan teaches that, as illustrated in annotated Fig. 3 of Ranjan and FIG. 1 and FIG. 3 of Canyon below, when the signal X indicative of the power level and power efficiency of the regulator 160 exceeds a threshold, such as a value corresponding to a power level of 22-24 dBm (*a power efficiency of the power supply exceeding a predetermined threshold*), the bypass switch 190 is closed (*the aperture generator and control module*) to deactivate the switching regulator 160 (*deactivates the switching device*) so that the supply voltage Vcc is passed directly to the amplifier unit 120 (*passes the input voltage to the output voltage node*).



216. To the extent that the Board construes this term as means-plus-function, Canyon's controller 170 and bypass 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 the controller 170 is a circuit that activates a switch (bypass 190) to deactivate the switching device and pass the output voltage (V_{cc}) directly to an output voltage node.

5. Claim 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.

217. In my opinion, Canyon teaches this element. Canyon teaches that the power meter 180, also referred to as the current meter 180, monitors the current flow provided to the power amplifier unit 120 and generates a current flow indicator signal X, which is then used by the controller 170 to determine when to close the bypass switch 190 to deactivate the regulator 160. EX1011, 3:14-19, 4:14-29. That is, the controller 170 (*the aperture generator and control module*) is configured to deactivate the switching regulator 160 (*the switching device*) based on the current flow provided to the power amplifier unit 120 (*a load current at the output voltage node*).

6. Claim 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.

218. In Ranjan, the experiment results were obtained using IS-95 CDMA handset applications, a selected modulation scheme. EX1011, Abstract. Ranjan notes

that “[a] suitable average efficiency can be computed based on power usage probabilities.” EX1012, p. 494. Fig. 3 of Ranjan shows a representative probability distribution of output power in cellular phone applications. EX1012, p. 494. As shown in the annotated Fig. 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.

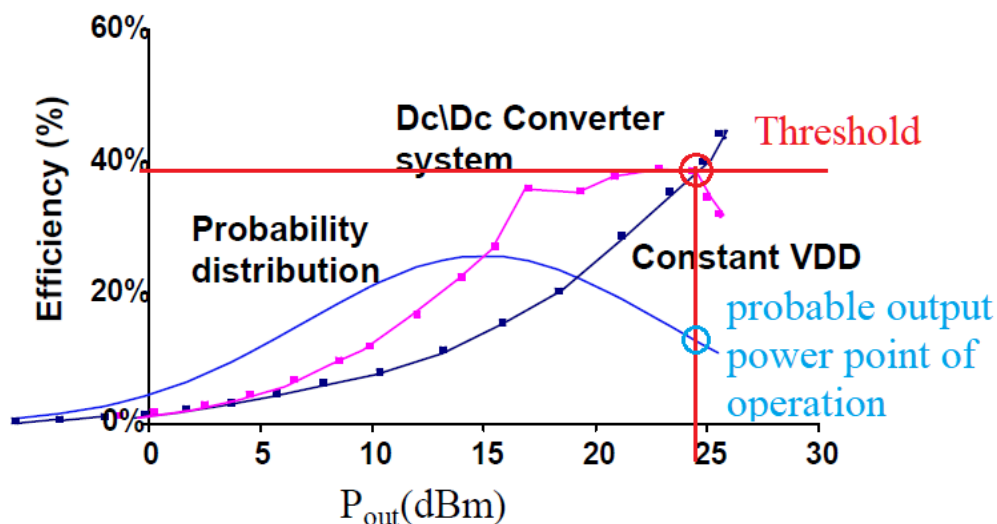


Fig.3: Measured efficiency of amplifier with constant VDD and with dc/dc converter , at different output power levels. Also shown is a representative distribution of output power for wireless application.

219. 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.” Therefore, Canyon in view of Ranjan teaches that the controller 170 (*the aperture generator and control module*) is configured to control the 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*).

7. Claim 4: The power supply of claim 3, wherein the modulation scheme is a GSM, W-CDMA, CDMA2000, EvDO, EDGE, HSPA, or OFDM communication protocol.

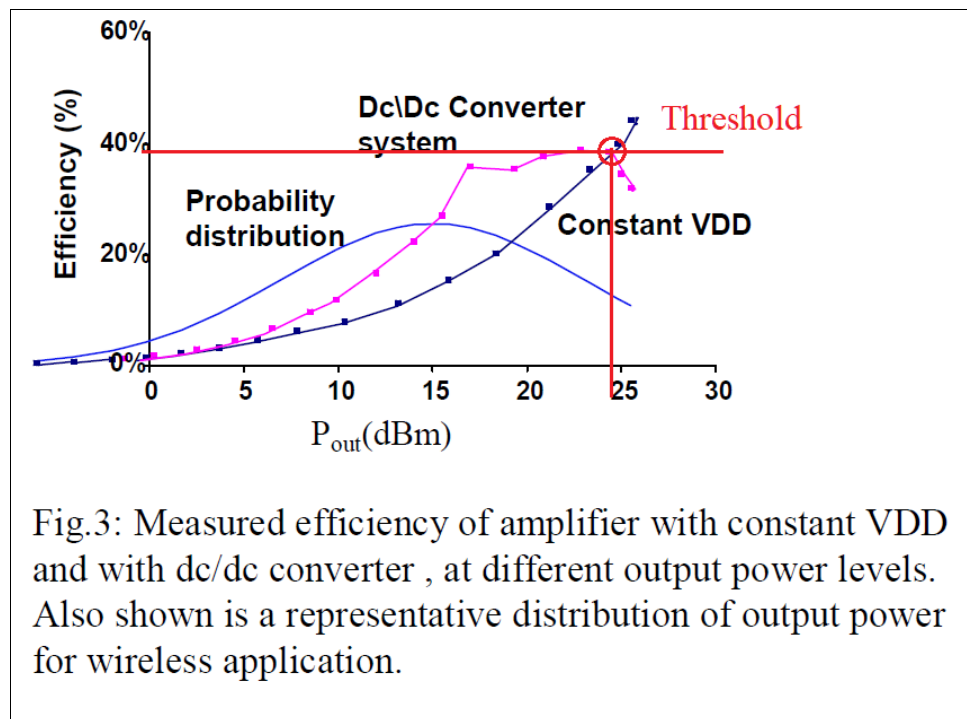
220. In my opinion, Canyon in view of Ranjan teaches this element. Canyon discloses that “the mobile telephone comprises a code division multiple access (CDMA) compliant mobile telephone.” EX1011, Claim 4. The experimental results in Ranjan were obtained using IS-95 CDMA handset applications. Ranjan 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 wideband CDMA (W-CDMA). EX1012, p. 495-496, Conclusion. As discussed in VII.A.1.d, 2G to 3G solutions were well known at the time and include a variety of modulation schemes such as GSM, IS-95B, and W-CDMA.

221. Therefore, Canyon in view of Ranjan teaches that the modulation scheme can be CDMA based, such as W-CDMA.

8. Claim 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.

222. In my opinion, Canyon in combination with Ranjan teaches this element.

223. Fig. 3 of Ranjan (below) illustrates measured efficiency of an amplifier with a DC-DC converter at different output power levels. EX1012, p. 494. As shown in Fig. 3 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.



224. Therefore, Canyon in view of Ranjan teaches that the controller 170 (*the aperture generator and control module*) is configured to control the 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*).

9. Claim 9

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

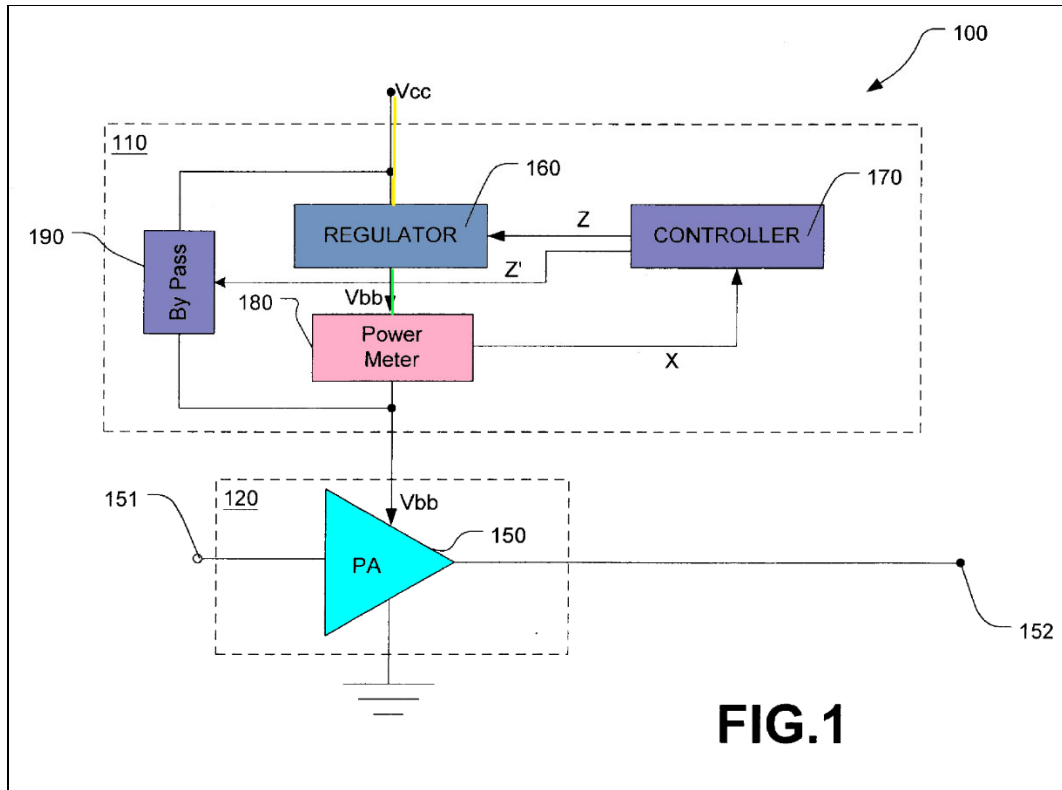
225. Claim 9 describes a method which is performed in normal operation of the power supply claimed in claim 1. Therefore, a POSITA would have recognized that the Canyon-Ranjan combination teaches the method steps of claim 9 for the same reason described for Ground 2A, Claim 1 and discussed below.

b. 9[a]: down-converting, with a switching device, an input voltage to generate a down-converted voltage;

226. Canyon teaches 9[a] for substantially the same reasons discussed for Ground 2A, Claim 1[a].

c. 9[b]: passing the down-converted voltage to an output voltage node; and

227. In my opinion, Canyon teaches this element. As shown in FIG. 1 of Canyon, Canyon teaches that the regulator 160 passes down V_{bb} , which is smaller than V_{cc} (*passing the down-converted voltage*), to the power amplifier 150 (*an output voltage node*).



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

228. As discussed in IX.A.9.d, I understood “power supplying” to be a typographical error for “power supply,” my opinion that this element is taught would not change if the term is actually “supplying” as written. Canyon teaches 9[b2] for substantially the same reasons discussed for Ground 2A, Claim 1[b2].

10. **Claim 10: 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.**

229. In my opinion, because this claim adds substantially the same element as

claim 3, the same teachings that I discussed with respect to that claim also apply here.

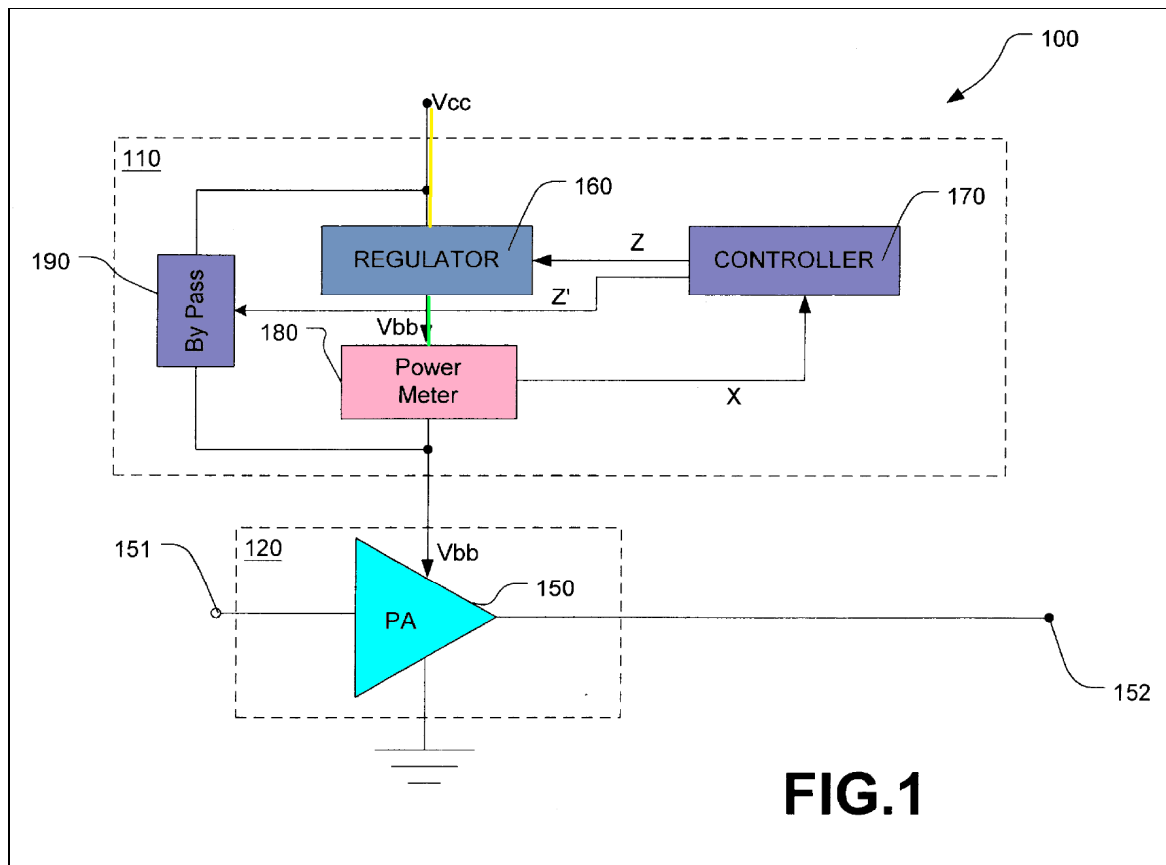
**11. Claim 11: The method of claim 9, further comprising:
providing an output current at a maximum power efficiency
associated with the down-converted voltage.**

230. In my opinion, because this claim adds substantially the same element as claim 5, the same teachings that I discussed with respect to that claim also apply here.

12. Claim 15

a. 15[pre]: A system comprising:

231. In my opinion, Canyon teaches this element. Fig. 1 of Canyon illustrates a power amplifier control system.



b. 15[a]: an electronic device; and

232. In my opinion, Canyon teaches this element in two ways. Canyon teaches

a power amplifier 150 (*an electronic device*). Alternatively, the device in which the power supply is used also satisfies the element of “an electronic device.” For example, Canyon teaches in its background section that the problems addressed by the invention arise in contexts relating to “personal communications devices such as cellular telephones” and relate to issues relating to size, weight, and battery life of such devices. EX1011, 1:25-26. In my opinion, a POSITA would understand that Canyon teaches using its teachings in this context, and that Canyon therefore teaches or suggests such an “electronic device.”

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

233. Canyon teaches a power supply for substantially the same reasons discussed for Ground 2A, Claim 1[pre]. The power management unit 110 in Canyon is coupled to the power amplifier 150. That is, Canyon teaches a power management unit 110 (*a power supply*) coupled to the power amplifier 150 (*the electronic device*). Alternatively, a POSITA would recognize that Canyon’s power supply is “coupled to” the broader device (e.g. cellular telephone) of which it is a part, because the purpose of the power supply is to provide power for such a device.

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; and

234. This element is substantially similar to element 1[a]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[a] apply here.

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

235. This element is substantially similar to element 1[b1]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[b1] apply here.

- 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.**

236. This element is substantially similar to element 1[b2]. Therefore, in my opinion, the same teachings that I previously discussed with regard to element 1[b2] apply here.

- 13. **Claim 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.**

237. In my opinion, because this claim adds substantially the same element as claim 3, the same teachings that I discussed with respect to that claim also apply here.

- 14. **Claim 20: The system of claim 15, wherein the modulation scheme is a GSM, W-CDMA, CDMA 2000, EvDO, EDGE, HSUPA, or OFDM communication protocol.**

238. In my opinion, because this claim adds substantially the same element as claim 4, the same teachings that I discussed with respect to that claim also apply here.

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

239. A POSITA would have been motivated to combine the teachings of Canyon and Ranjan with Hau.

240. A POSITA would have understood that both current and voltage impact the output power. For example, Fig. 2 of Ranjan (below) shows the relationship between power supply voltage and instantaneous output power that was implemented, and for comparison the peak-to-peak voltage swing at the given output power. Ranjan, Fig. 2.

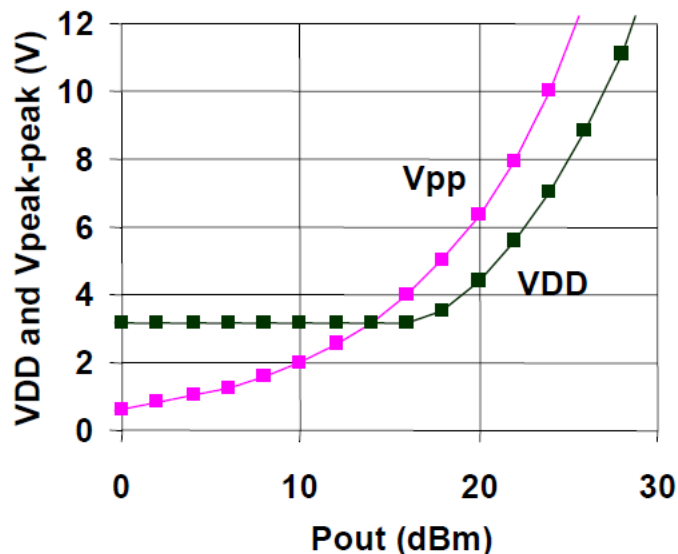


Fig.2: Algorithm of VDD vs output power. Also shown is peak-to-peak drain voltage

241. In the Background Information section, 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" so that "[t]he detected current sets the

optimized bias voltage for the power amplifier.” EX1007, 2:2-6. Hau notes that “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, among others discussed in Hau, Hau discloses a two-stage amplifier system in which the bias voltage varies dynamically with the output power. EX1007, 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. EX1007, 3:24-25.

242. A POSITA would have recognized that adopting voltage detection as taught in Hau could further improve the efficiency of Canyon’s system. 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.

243. 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. A POSITA would have recognized, from this teaching of Hau with the usage

of a voltage detector, that switching to the full battery voltage when needed would enable power supply to obtain superior efficiency.

2. **Claim 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.**

244. In my opinion, Canyon in view of Ranjan further in view of Hau teaches this element.

245. Hau teaches a DC-DC buck regulator powered by a +3.4V battery and provide a down-converted output voltage V_{cc2} that ranges from a low of about 0.5V to about +3.0V. EX1007, 5:39-44. Hau also teaches a power detector that outputs a voltage value P_{det} corresponding to the down-converted voltage V_{cc2} . EX1007, 6:15-21, FIG. 8 (below, showing the correspondence between P_{det} and the optimum V_{cc2}).

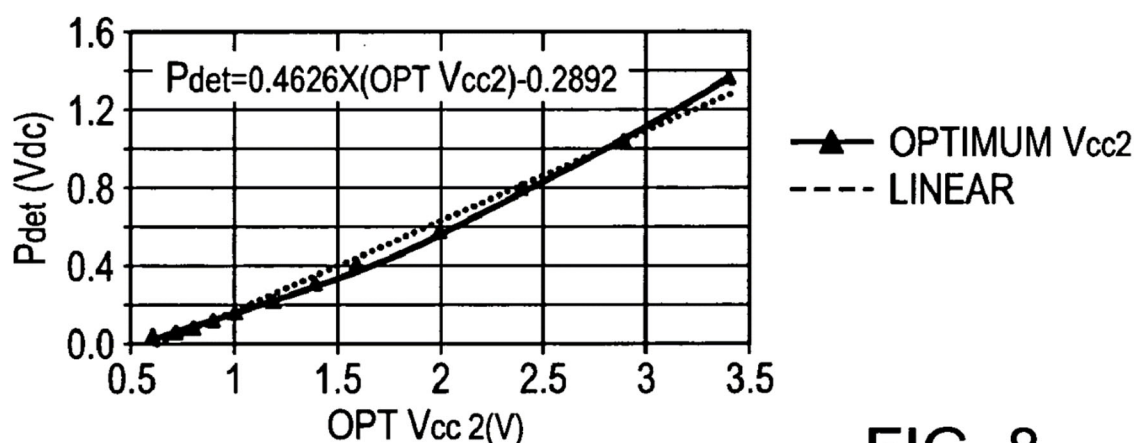


FIG. 8

246. In Hau, when P_{det} 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.

247. Therefore, Canyon in view of Ranjan further in view of Hau teaches that the 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 Vcc2 (*pass the input voltage to the output voltage node*) when Pdet exceeds a predetermined threshold (*based on a comparison of the down-converted input voltage to a threshold voltage*).

3. Claim 7: The power supply of claim 6, wherein the threshold voltage is set to a fixed or programmable value.

248. In my opinion, Canyon in view of Ranjan further in view of Hau teaches this element. Hau teaches that the threshold can be a predetermined (*i.e.*, fixed) value. EX1007, 6:63-66.

4. Claim 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.

249. 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 understood that the maximum transmit power level (28 dBm), and the corresponding power threshold, are associated with a particular modulation scheme (e.g., WCDMA) of the wireless communication system.

250. Hau further teaches “a threshold setting.” EX1007, Claim 5. A POSITA would have understood that Hau suggests that the threshold can be set or configured

according to a particular modulation scheme (e.g., WCDMA) of a communication waveform (e.g., CDMA).

251. As discussed in §VII.A.1.b, a POSITA would have understood that spectrum efficiency represents efficiency of a communication waveform, which is related to the modulation scheme, such as WCDMA. Therefore, Canyon in view of Ranjan further in view of Hau teaches setting the voltage threshold (*the threshold voltage is programmed*) based on spectrum efficiency of, e.g., WCDMA (*a communication waveform efficiency*).

5. **Claim 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.**

252. Canyon in view of Ranjan further in view of Hau teaches Claim 9 for substantially the same reasons discussed for Ground 2B, Claim 6.

6. **Claim 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.**

253. Canyon in view of Ranjan further in view of Hau teaches Claim 13 for substantially the same reasons discussed for Ground 2B, Claim 8.

7. **Claim 14: 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.**

254. Canyon in view of Ranjan further in view of Hau teaches this element. As

discussed in Ground 2B, Claim 8, a POSITA would have considered a communication waveform efficiency as a spectrum efficiency related to the modulation scheme. Hau also 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. 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*).

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

255. A POSITA would have been motivated to combine the teachings of Canyon and Ranjan with Lejon.

256. Lejon, related to power amplifiers and maintaining linearity of the amplifiers, is in the same field of art as Canyon and Ranjan. EX1013, 1:27-2:5, 3:5-18. Lejon is analogous art to Canyon and Ranjan because a POSITA would logically consider the teachings of Lejon to be relevant to the problems of maximizing power efficiency addressed by Canyon and Ranjan, particularly over a vast range of output powers. EX1013, 2:14-25.

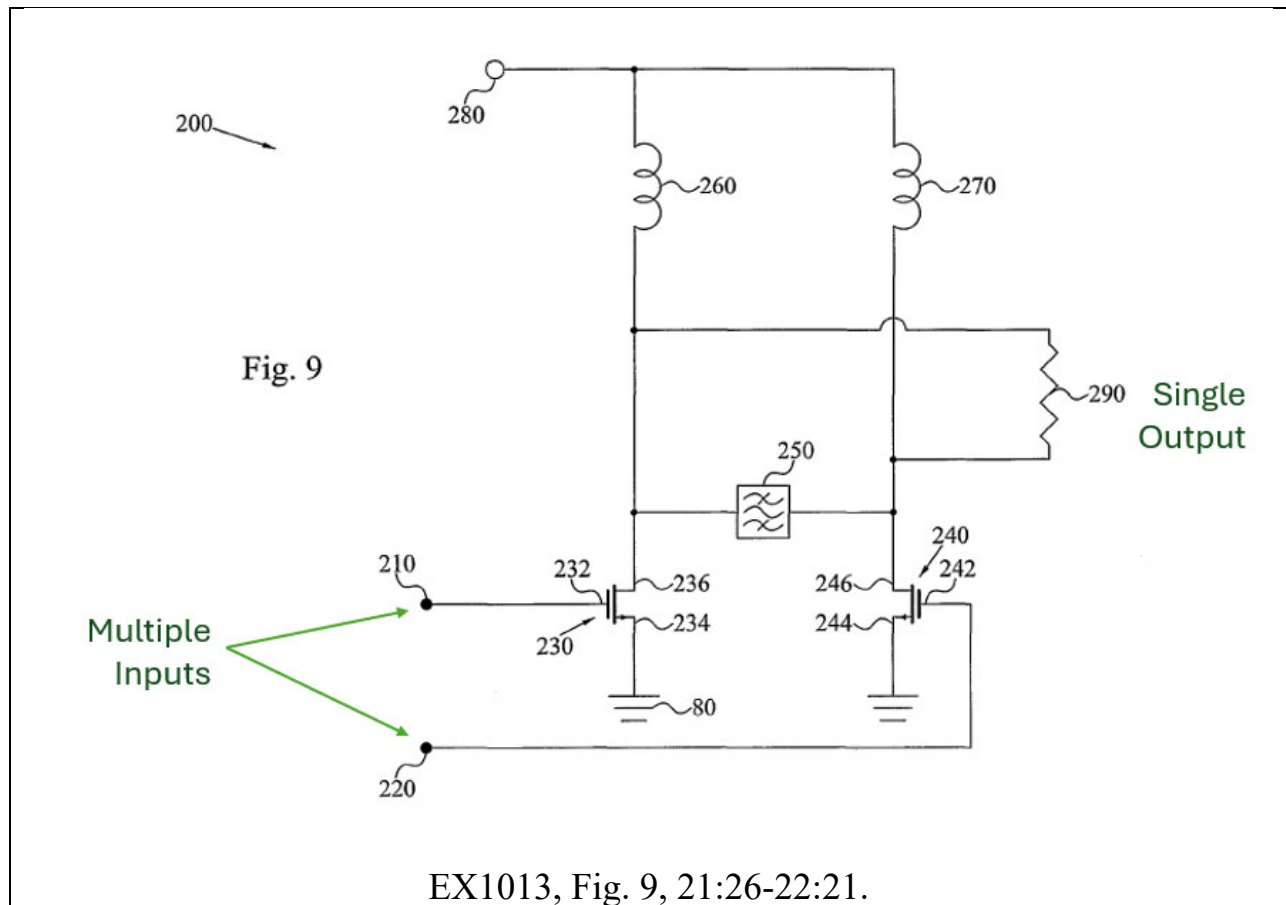
257. A POSITA would have recognized that adopting Lejon’s teaching of a LINC out-phasing amplifier, which includes two transistors at two input ports and generates a single output load, can “provide excellent efficiency over a vast range of output powers” and thus further improves the efficiency of Canyon and Ranjan’s

systems, particularly given the advances in usage of complex modulation schemes such as CDMA and W-CDMA. EX1013, 2:14-16.

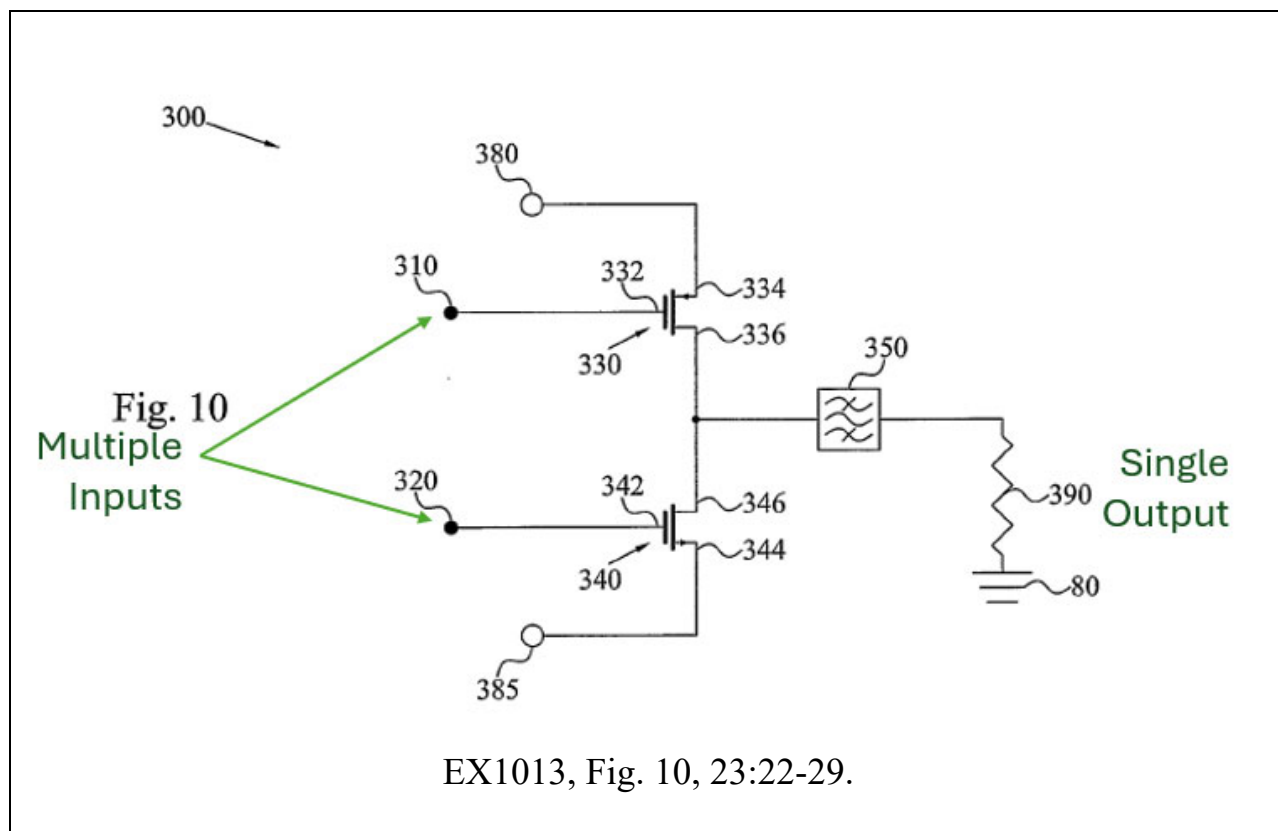
258. Furthermore, a POSITA would have been motivated to substitute a known element (the basic amplifier in Ranjan and Canyon) for another (the power amplifier in Lejon that have two inputs and a single output) to obtain predictable results.

2. Claim 16: The system of claim 15, wherein the electronic device comprises a multiple-input-single-output (MISO) amplifier.

259. In my opinion, the combination of Canyon, Rajan, and Lejon teaches this element. Each of Lejon's Figures 9 and 10 teach examples of amplifiers with two inputs and a single input. In Fig. 9, 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:



260. In Fig. 10 of Lejon, 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:



261. In my opinion, both figures show a power amplifier (*the electronic device*) that has multiple inputs and a single output (*a multiple-input-single-output (MISO) amplifier*).

3. **Claim 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.**

262. In my opinion, the combination of Canyon, Rajan, and Lejon teaches this 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. EX1013,

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

[illegible]

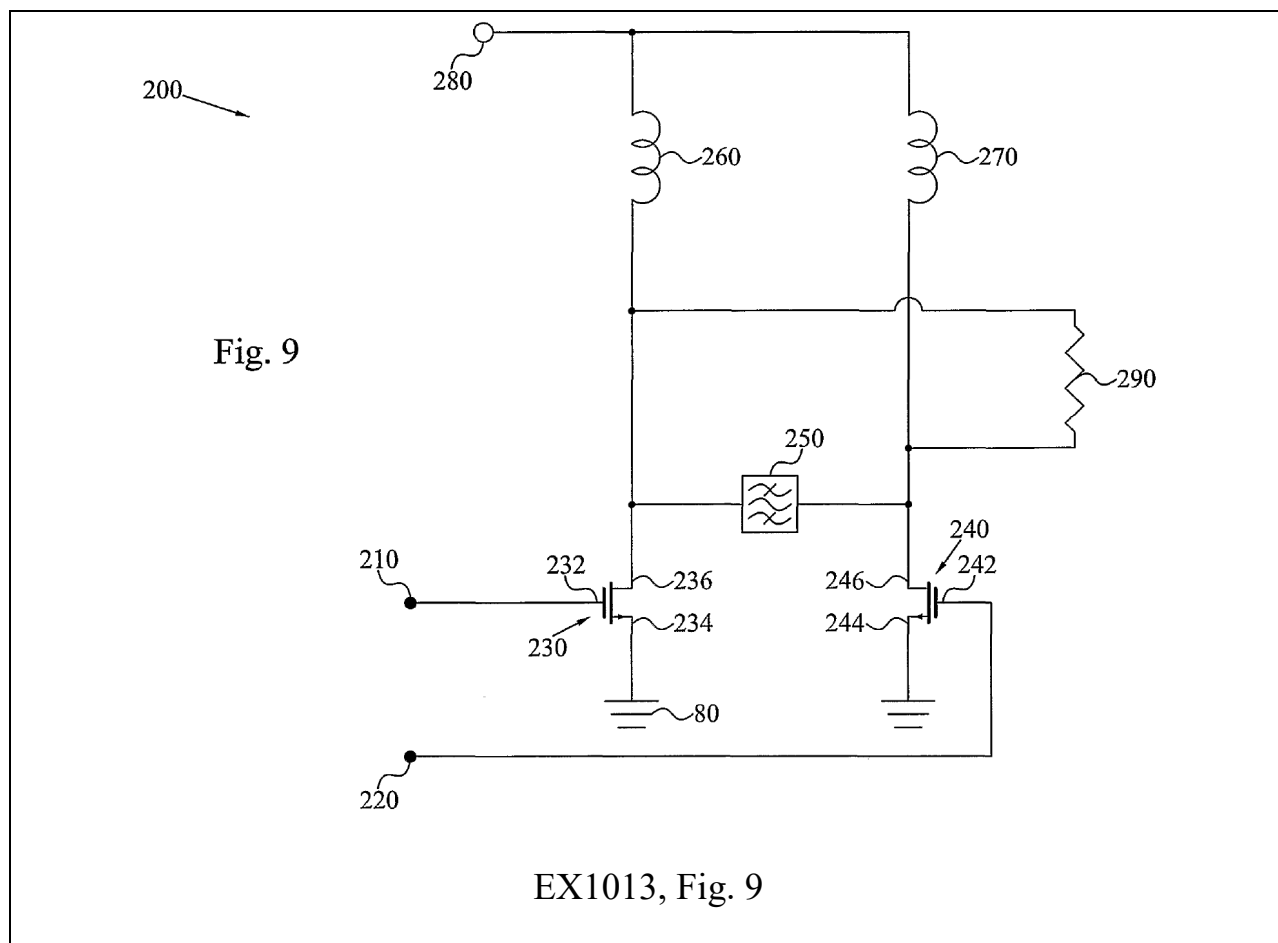
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265. Therefore, Lejon teaches the power supply 110 and the electronic device that includes a power amplifier 102 (*an amplifier*) with a transistor T1 (*a bipolar junction transistor (BJT)*), and the power supply 110 is coupled to a collector terminal of T1 (*the power supply is coupled to a collector or an emitter terminal of the BJT*).

4. **Claim 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.**

266. In my opinion, the combination of Canyon, Rajan, and Lejon teaches this element.

267. Using Fig. 9 of Lejon as an example, the drain 236 electrode of an FET 230 is connected to a supply voltage 280.



268. Therefore, Lejon teaches an amplifier (*the electronic device comprising an amplifier*) with a transistor 230 that can be MOSFET (*a metal oxide semiconductor (MOS) transistor*), and the 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*).

X. CONCLUSION

I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge. I understand that willful false statements are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1001.

Date: October 18, 2024

By:

A handwritten signature in black ink, appearing to be 'L. Larson', written over a horizontal line.

Lawrence Larson, Ph.D.