

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEDIATEK INC.,

Petitioner,

v.

PARKERVISION, INC.,

Patent Owner.

IPR2024-00796

Patent No. 7,483,686

DECLARATION OF DR. LAWRENCE E. LARSON

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EXHIBITS REFERENCED IN DECLARATION

No.	Description
EX-1001	U.S. Patent No. 7,483,686 (“686 Patent”)
EX-1002	Larson Declaration
Ex. 1003	U.S. Patent No. 6,643,522 (“Young”)
Ex. 1004	U.S. Patent No. 6,600,726 (“Nevo”)
Ex. 1005	Estabrook, “The Direct Conversion Receiver: Analysis and Design of the Front-End Components,” Aug. 1989 (“Estabrook-Thesis”)
Ex. 1006	Avitabile, “S-band digital downconverter for radar applications based on a GaAs MMIC fast sample-and-hold,” IEE Proc.-Circuits Devices Syst., Vol. 143, No. 6, December 1996 (“Avitabile”)
Ex. 1007	File History of U.S. Patent No. 7,483,686
Ex. 1008	U.S. Patent No. 6,061,551
Ex. 1009	Joint Claim Construction Chart, <i>ParkerVision v. MediaTek, Inc. et al.</i> , No. 6:23-cv-00375 (W.D. Tex. May 3, 2024), ECF No. 41
Ex. 1010	Final Written Decision, <i>Intel Corp. v. ParkerVision, Inc.</i> , IPR2021-00346, Paper 33 (PTAB June 30, 2022)
Ex. 1011	U.S. Patent No. 8,190,108
Ex. 1012	Markman Order, <i>ParkerVision, Inc. v. Realtek Semiconductor Corp.</i> , No. 6-22-cv-01162 (W.D. Tex. Apr. 2, 2024), ECF No. 93
Ex. 1013	Agreed Scheduling Order, <i>ParkerVision v. MediaTek, Inc.</i> , No. 6:23-cv-00375 (W.D. Tex. Jan. 4, 2024), ECF No. 32
Ex. 1014	Markman Order, <i>ParkerVision, Inc. v. Qualcomm Inc.</i> , No. 3:11-cv-719-RBD-JK (M.D. Fla. Feb. 20, 2013), ECF No. 243.
Ex. 1015	<i>Sotera</i> Stipulation Letter dated May 21, 2024

Ex. 1016	P. Estabrook and B. B. Lusignan, “A Mixer Computer-Aided Design Tool Based in the Time Domain,” IEEE Microwave Theory and Techniques Symposium, 1988, pages 1107- 1110 (“Estabrook-1988”)
Ex. 1017	P. Estabrook and B. B. Lusignan, “The Design of a Mobile Radio Receiver Using a Direct Conversion Architecture,” In Proc. Of the IEEE Vehicular Technology Conference, pages 63-72, May 1989 (“Estabrook-1989”)
Ex. 1018	Declaration of June Munford
Ex. 1019	Declaration of Polly Estabrook, Ph.D.
Ex. 1020	Declaration of G. Avitabile
Ex. 1021	Docket, <i>ParkerVision v. MediaTek, Inc. et al.</i> , No. 6:23-cv-00375 (W.D. Tex. filed May 16, 2023)
Ex. 1022	U.S. Patent No. 6,879,817
Ex. 1023	U.S. Patent No. 6,853,690
Ex. 1024	U.S. Patent No. 6,704,549
Ex. 1025	U.S. Patent No. 7,006,805
Ex. 1026	U.S. Patent No. 6,370,371
Ex. 1027	U.S. Patent Application No. 09/514,004
Ex. 1028	U.S. Provisional Patent Application No. 60/195,328
Ex. 1029	U.S. Provisional Patent Application No. 60/147,129
Ex. 1030	Markman Order, <i>ParkerVision v. Mediatek, Inc. et al.</i> , Civ. No. 6:22-CV-01163-ADA (W.D. Tex. Apr. 29, 2024), ECF No. 70.
Ex. 1031	IEEEXplore Citation search results for Estabrook-1989
Ex. 1032	Google Scholar Citation search results for Estabrook-1989
Ex. 1033	U.S. Patent No. 6,873,836
Ex. 1034	SPICE Version 2G User’s Guide, 1981
Ex. 1035	Excerpts from the Microsoft Computer Dictionary, 5 th Edition, pgs. 26, 482

Ex. 1036	U.S. Patent No. 6,477,378
Ex. 1037	U.S. Patent No. 6,570,394
Ex. 1038	Excerpts from the Electrical Engineering Dictionary (ISBN 0-8493-2170-0), pgs. 50, 302, 539, 662
Ex. 1039	IEEE Std 802.11a-1999 (Supplement to IEEE Std 802.11-1999)
Ex. 1040	Excerpts from P. Nahin, The Science of Radio (ISBN 1-56396-347-7) (1996), pgs. 36, 165, 182-184
Ex. 1041	EP0551857
Ex. 1042	Excerpts from Serway, Physics for Scientists and Engineers, 3 rd Ed. (ISBN 0-8493-3128-5) (1999).
Ex. 1043	Excerpts from Davis, Operating Systems, A Systematic View (ISBN 0-201-11116-0) (1983)
Ex. 1044	Bluetooth Spec. V. 1.0 B (1998)
Ex. 1045	Appellant's Brief, <i>ParkerVision Inc. v. Intel Corp.</i> , Case No. 2022-1548 (Fed. Cir. July 15, 2022)
Ex. 1046	Federal Circuit Rule 36 Judgment, Case No. 2022-2173 (May 16, 2024)
Ex. 1047	Reply Claim Construction Brief, <i>ParkerVision v. MediaTek, Inc. et al.</i> , No. 6:23-cv-00375 (W.D.Tex. Apr. 15, 2024)

LISTING OF CHALLENGED CLAIMS

Reference	Claim Limitation
Claim 1	
1[pre]	An apparatus capable of performing simultaneous multi-platform operations, comprising:
1[a]	at least one multi-platform module including a plurality of transceivers each having at least one frequency translating module, wherein said at least one frequency translating module comprises
1[b]	a switch configured to operate according to an energy transfer signal, and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and
1[c]	a control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links, the control module including a plurality of protocol/standard sub-modules.
Claim 2	
2	The apparatus of claim 1, wherein the control module is configured to enable the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communication links by employing an equal quantity of the plurality of standard/protocol sub-modules.
Claim 3	
3	The apparatus of claim 1, wherein the at least one multi-platform module includes a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.
Claim 4	

Reference	Claim Limitation
4	The apparatus of claim 1, wherein the plurality of protocol/standard sub-modules comprise a first protocol/standard sub-module configured to operate a first transceiver in conformance with a first protocol/standard combination and a second protocol/standard sub-module configured to simultaneously operate a second transceiver in conformance with a second protocol/standard combination.
Claim 5	
5	The apparatus of claim 4, wherein the first protocol/standard combination is different from the second protocol/standard combination.
Claim 6	
6	The apparatus of claim 4, wherein the first and second protocol/standard sub-modules contain respective first and second implementation and operational instructions for the at least one multi-platform sub-module.
Claim 7	
7	The apparatus of claim 6, wherein the first and second implementation and operational instructions include respective first and second protocol stacks and specification information about the first and second protocol architectures.
Claim 8	
8	The apparatus of claim 6, wherein the first and second implementation and operational instructions can be updated, upgraded, replaced, or modified to provide the at least one multi-platform sub-module with additional functionality.

Reference	Claim Limitation
Claim 9	
9	The apparatus of claim 4, wherein the first and second protocol/standard sub-modules are configured to operate the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.
Claim 10	
10	The apparatus of claim 9, wherein the first and second operating environments include at least one of respective standards, content encoders and decoders, and protocol gateways.
Claim 11	
11[pre]	A method for performing simultaneous multi-platform operations, comprising
11[1.1]	(1) controlling at least one multi-platform module to communicate with at least one of a plurality of communication links
11[1.2]	using a control module
11[1.3]	having a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes
11[1.4]	a plurality of transceivers each having at least one frequency translation module, wherein said at least one ¹ frequency translation module comprises
11[FTM-	a switch

¹ Certificate of Correction replaced “on” with “one.”

Reference	Claim Limitation
1.1]	
11[FTM-1.2]	configured to operate according to an energy transfer signal
11[FTM-1.3]	and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and
11[FTM-2.1]	a storage module coupled to said switch and configured to store said transferred energy
11[FTM-2.2]	wherein a second EM signal is generated from said stored energy, said second EM signal having a frequency different from said first EM signal
11[2]	(2) operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and
11[3]	(3) operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.
Claim 12	
12	The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communications links by employing an equal quantity of the plurality of standard/protocol sub-modules.
Claim 13	
13	The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to communicate with at least one of the plurality of communication links using the control

Reference	Claim Limitation
	module, the at least one multi-platform module including a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.
Claim 14	
14	The method of claim 11, wherein step (3) comprises: simultaneously operating the second transceiver in conformance with a second protocol/standard combination that is different from the first protocol/standard combination
Claim 15	
15	The method of claim 11 ² , wherein steps (2) and (3) comprise: programming the first and second protocol/standard sub-modules with respective first and second implementation and operational instructions for the at least one multi-platform sub-module.
Claim 16	
16	The method of claim 15, wherein steps (2) and (3) further comprise: programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures.
Claim 17	
17	The method of claim 15, wherein steps (2) and (3) further comprise: updating, upgrading, replacing, or modifying the first and second implementation and operational instructions to provide the at least one multi-platform sub-module with additional

² Certificate of Correction replaced “claim 14” with “claim 11.”

Reference	Claim Limitation
	functionality.
Claim 18	
18	The method of claim 11, wherein steps (2) and (3) further ³ comprise: simultaneously operating the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.
Claim 19	
19	The method of claim 18, wherein steps (2) and (3) further comprise: simultaneously operating the first and second transceivers in conformance with respective standards, content encoders and decoders, and protocol gateways of the first and second protocol and operating environments.
Claim 20	
20	The method of claim 11, wherein step (3) comprises simultaneously operating the second transceiver and the first transceiver.

³ Certificate of Correction inserted “further” after “(3).”

I, **Dr. Lawrence E. Larson**, declare as follows:

I. INTRODUCTION

1. I have been retained by Petitioner MediaTek Inc. (“MediaTek”) to serve as an independent expert consultant in *Inter Partes* review proceedings regarding U.S. Patent No. 7,483,686 (“the ’686 Patent”) (EX-1001). I have been asked to consider the validity of claims 1-20 of the ’686 Patent (the “Challenged Claims”). My opinions are set forth below.

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. QUALIFICATIONS

5. My qualifications for forming the opinions in this report are summarized here and explained in more detail in my Curriculum Vitae (“CV”), which is attached as Appendix A to this declaration.

6. 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).

7. 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.

8. 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.

9. 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).

10. 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.

11. 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.

12. 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).

13. 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.

14. 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.

15. 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.

16. 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.

17. 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.

18. 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.

19. I have been elected a Fellow of the IEEE. The Fellow is the highest grade of membership of the IEEE, a world professional body consisting of over 300,000 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. LEGAL PRINCIPLES

20. I am not an attorney and I have not been asked to express any legal opinions. Rather, in connection with the analysis presented in this declaration, I have considered the following legal standards that counsel for Petitioner provided to me.

A. Burden of Proof

21. I understand that the Petitioner has the burden of proving the unpatentability by a preponderance of the evidence, which I understand as meaning more than 50% likely.

B. Priority

22. I have been informed that a claim of a patent is not entitled to the priority date of an earlier application if the earlier application does not disclose all of the limitations of the claim in question.

23. I further been informed that because the Priority Date for the Challenged Claims is before March 16, 2013, the claims are subject to review under pre-America Invents Act 35 U.S.C. §§ 102 and 103.

C. Prior Art

24. I have been informed that, because the Challenged Claims of the '686 Patent are subject to review under pre-America Invents Act 35 U.S.C. §§ 102 and 103, a U.S. patent will be prior art to the Challenged Claims if, for example, the patent issued before the Priority Date for the Challenged Claims, and that the same is also true for non-patent publications. *See* 35 U.S.C. § 102(a) (“A person shall be entitled to a patent unless – (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent[.]”) I understand that the date of “invention” for purposes of the preceding sentence requires both (i) corroborated evidence of conception by the named inventor(s) and (ii) a reduction to practice.

25. I also understand that if a U.S. patent, for example, issues (or a non-patent publication is published) more than one-year before the filing date of the application leading to the Challenged Claims, then the U.S. patent (or publication) will be considered “incontestable” prior art. *See* 35 U.S.C. § 102(b) (“A person shall be entitled to a patent unless – ... (b) the invention was patented or described in a

printed publication in this or a foreign country ... more than one year prior to the date of the application for patent in the United States[.]”).

26. I further understand that an issued U.S. patent will be prior art to the Challenged Claims if it results from a U.S. patent application filed by someone other than the named inventor(s) before the date of the invention for the Challenged Claims. *See* 35 U.S.C. § 102(e)(2) (“A person shall be entitled to a patent unless – ... (e) the invention was described in – ... (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent”). I am informed that the date of “invention” for purposes of the preceding sentence requires both (i) corroborated evidence of conception by the named inventor(s) and (ii) a reduction to practice.

27. Additionally, I understand that if a reference (such as a U.S. patent) qualifies as prior art, then that reference can be used for purposes of both anticipation and obviousness.

D. Obviousness

28. I understand that a claim is obvious, and therefore not patentable, if at the time of the invention, the subject matter of the claim as a whole would have been obvious to a person of ordinary skill in the art. I understand that a proper obviousness analysis must consider the following four factors: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences

between the claimed subject matter and the prior art; and (4) any objective indicia of non-obviousness.

29. I understand that a reason to combine that merely describes the resulting combination without explaining the particular reason why one of ordinary skill would combine the elements of the prior art to form Patent Owner's claimed invention is merely conclusory and based on impermissible hindsight reasoning. It is not enough to simply show that the references disclose each limitation of a claim; it is also necessary to identify a reason that would have prompted a POSITA to combine the limitations in the manner set forth in the claim. I understand that a *prima facie* case of obviousness requires more than describing the results of the proposed combination. Rather, the Petitioner must articulate a reason for making the proposed combination in the first instance. I further understand that it is not enough to conclude that, once the proposed combination is made, the result is predictable; an obviousness finding requires that the Petitioner provide a reason, supported by a rational foundation, which explains why one of ordinary skill would have chosen to make the particular combination in the first place.

30. I have been informed that claimed subject matter can be rendered obvious by a combination of prior art if, for example, it results from the combination of known elements according to known methods to yield predictable results; the simple substitution of one known element for another to yield predictable results;

use of a known technique to improve similar devices in the same way; applying a known technique to a known device ready for improvement to yield predictable results; or applying known work in a field to create a variation, in light of design incentives or market forces, if the variation would yield predictable results. I have also been informed that the analysis of obviousness may include recourse to logic, judgment, and common sense available to a POSITA that does not necessarily require explicit disclosure in any reference.

31. I understand that, in analyzing the four obviousness considerations (listed above), a party challenging a patent must show that: (1) each and every limitation of the claimed subject matter was taught or suggested in the combination of prior art references; (2) a person of ordinary skill in the art would have had a reason to combine the teachings of the prior art references to achieve the claimed subject matter; and (3) a reasonable expectation would have existed that the combination of such teachings would achieve the claimed subject matter.

32. I understand that, in addition to its analysis of the teachings of the prior art, the fact finder must consider the Patent Owner's proffer, if any, of objective indicia of non-obviousness, including: (1) commercial success; (2) professional approval and praise by others; (3) expressions of disbelief and skepticism of those skilled in the art upon learning of the invention; (4) licenses showing industry respect and commercial acquiescence to the invention; (5) copying; (6) long felt but

unresolved need, and failure of others to solve the problem, including the passage of time between publication of the prior art and the invention; and (7) unexpected results. In reviewing the file history of the '686 Patent and the other information discussed in this declaration, I am not currently aware of any evidence supporting any of the above factors.

IV. SUMMARY OF OPINIONS AND MATERIALS CONSIDERED

33. All of the opinions contained in this declaration are based on the documents I have reviewed and my professional judgment, as well as my education, experience, and professional knowledge. I am not an attorney and I am not offering any legal opinions in this declaration.

34. In forming my opinions expressed in this declaration, I have relied on the '686 Patent, the prosecution history of the '686 Patent (Exhibit 1007), the prior art references cited herein, and other exhibits I have cited in this declaration. Each of these documents is a type of document that an expert in my field would have reasonably relied upon when forming their opinion.

35. Based on my experience and expertise, and for the reasons set forth herein, it is my opinion that:

- Claims 1–20 of the '686 Patent are unpatentable in view of U.S. Patent No. 6,600,726 (“Nevo”), (Ex. 1004) over Avitabile, “S-band digital downconverter for radar applications based on a GaAs MMIC fast sample-

and-hold,” IEE Proc.-Circuits Devices Syst., Vol. 143, No. 6, December 1996 (“Avitabile”), (Ex. 1006).

- Claims 1–20 of the ’686 Patent are unpatentable in view of U.S. Patent No. 6,643,522 (“Young”), (Ex. 1003) over Estabrook, “The Direct Conversion Receiver: Analysis and Design of the Front-End Components,” Aug. 1989 (“Estabrook-Thesis”), (Ex. 1005).
- Claims 1–20 of the ’686 Patent are unpatentable in view of Young over Estabrook and B. B. Lusignan, “A Mixer Computer-Aided Design Tool Based in the Time Domain,” IEEE Microwave Theory and Techniques Symposium, 1988, pg. 1107- 1110 (“Estabrook-1988”), (Ex. 1016), and P. Estabrook and B. B. Lusignan, “The Design of a Mobile Radio Receiver Using a Direct Conversion Architecture,” In Proc. of the IEEE Vehicular Technology Conference, pages 63-72, May 1989 (“Estabrook-1989”), (Ex. 1017).

V. PRIORITY DATE AND LEVEL OF SKILL IN THE ART

36. I understand that patent claims are interpreted from the perspective of a hypothetical person of ordinary skill in the art (“POSITA”) at the time of the alleged invention. I have assumed for purposes of this declaration that the Priority Date of the Challenged Claims is May 10, 2000 (“Priority Date”). As of this date, I

was at least a person of ordinary skill in the art of the technology relating to the '686 Patent, and I had personal knowledge of the technologies involved in the '686 Patent.

37. I understand that Patent Owner has previously alleged that the '686 Patent is entitled to a priority date of January 3, 2000. I disagree. I looked at those patent applications that the '686 Patent claims priority to and that were filed on January 3, 2000. *See* '686 Patent, (63), 1:24-28 (listing the applications leading to U.S. Pat. Nos. 6,704,549 (Ex. 1024) and 7,006,805 (Ex. 1025) as filed on Jan. 3, 2000). Neither reference contains the claimed “multi-protocol module” that has a “control module” that “includes a plurality of standard/protocol sub-modules.” Figure 1 of the '549 Patent does include a frequency band selection module (132) but it states nothing regarding standards. The '805 Patent appears to have nothing arguably similar to the claimed “multi-protocol module” that has a “control module” that “includes a plurality of standard/protocol sub-modules.”

38. I have reviewed the other patents and applications to which the '686 Patent claims priority, and they also lack support for the claimed “multi-protocol module that has a “control module” that “includes a plurality of standard/protocol sub-modules.” In fact, in my opinion, none of the applications prior to May 10, 2000 contain the words “multi-platform,” “simultaneous,” or variations thereof that would have been understood by a POSITA to describe the terms I list above. These claim terms first appear in U.S. Pat. No. 6,873,836. *See, e.g.,* Ex. 1033, Fig. 44. This

patent was filed on May 10, 2000. *See* '686 Patent, (63). Thus, in my opinion, the challenged claims of the '686 Patent are entitled to a Priority Date no earlier than May 10, 2000.

39. I understand that various factors are considered in determining the level of ordinary skill in the art. I understand that the factors include the types of problems encountered in the art, prior solutions to those problems, rapidity with which innovations are made, sophistication of technology at the time of the invention, and educational levels and experience of persons working in the field and capable of understanding the applicable scientific and engineering principles. I understand that in determining the level of ordinary skill in the art, not all factors may be present or one or more factors may predominate.

40. Taking these factors into account, a POSITA relating to the technology of the '686 Patent on or before the date of the alleged invention would have had at least a bachelor's degree in electrical engineering or a related subject and two or more years of experience in the field of RF circuit design, or would have had at least five years of work experience and training in the design and development of RF circuits and/or systems. Less work experience could be compensated by a higher level of education, such as a master's degree.

41. At least as of the date of the Priority Date of the alleged invention, my education, experience, and professional knowledge qualify me to be a POSITA for

the '686 Patent. I am qualified to provide opinions on what a POSITA would have known and understood at the time of the alleged invention (e.g., at least as of the Priority Date).

VI. BACKGROUND TECHNOLOGY

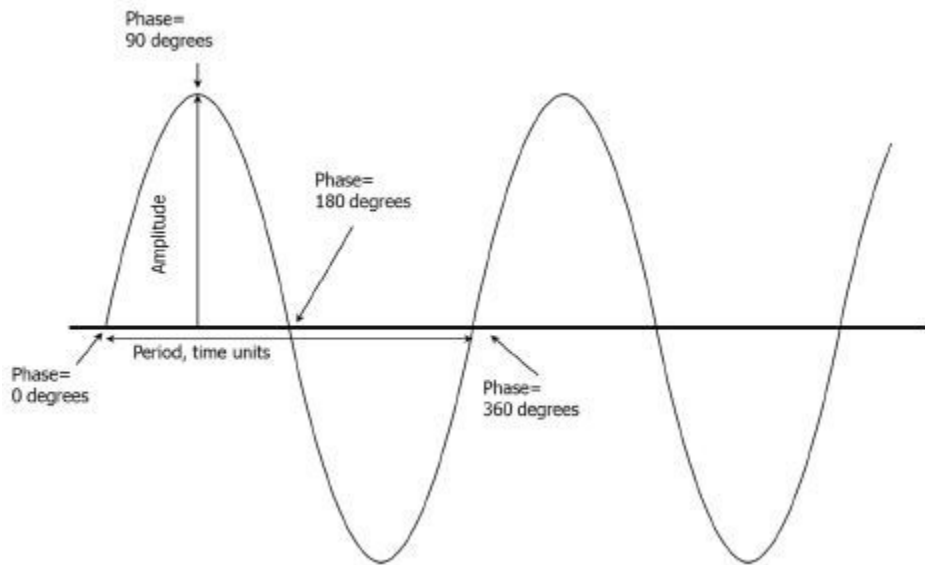
A. Wireless Communications Signals

42. Wireless devices (e.g., cellular phones) exchange information by transmitting and receiving electromagnetic signals. These signals are communicated from one device's transmitter to another device's receiver. The Challenged Claims focus on devices for receiving signals transmitted from another device.

43. As of the Priority Date (and well before it), a communication device such as a cellular telephone would generate a signal for transmission (e.g., the voice information of a telephone call). Prior to the process of transmitting the signal, the signal would have low-frequency content (like voice) capable of being manipulated by the circuitry of the communication device. Such a signal was called a "baseband signal" because it was the signal prior to modulation for transmission and because the range of frequencies prior to modulation were relatively low compared to the frequencies used in transmission (hence, the "base" band).

44. The baseband signal could have been digital or analog, and to transmit a digital baseband signal wirelessly, the digital signal sometimes required being converted into an analog signal. As shown below, an analog signal is a continuously

changing signal. For electrical signals (other than direct current signaling), an analog signal usually takes the form of varying voltage states over time. Those voltage states can be understood as a series of waveforms that oscillates at a particular frequency between maximum and minimum values, as shown below:



B. Modulating Signals for Wireless Communications

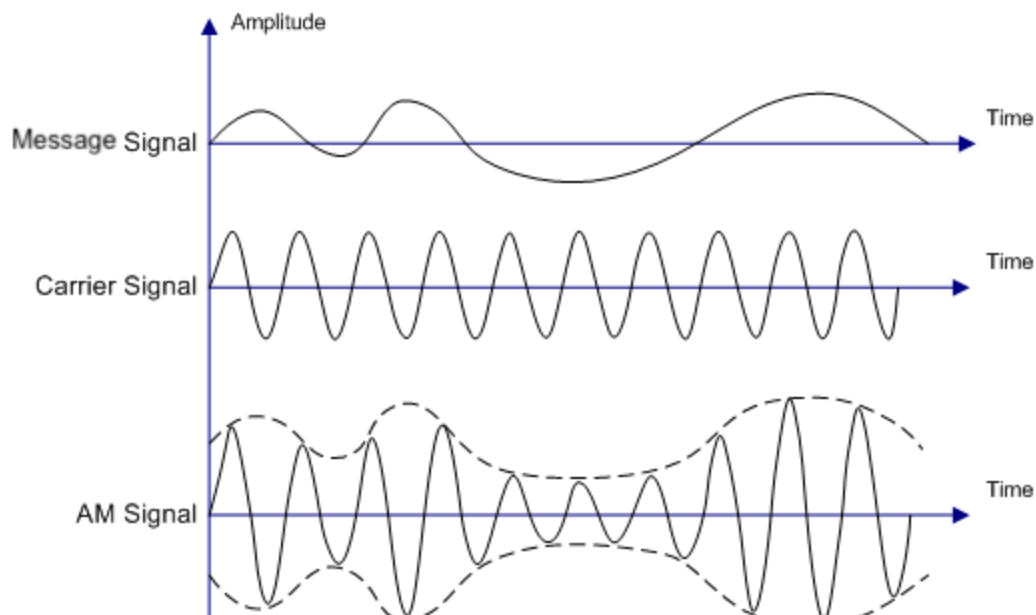
45. A wireless communications device ordinarily transmits a signal by propagating an electromagnetic wave using the frequency, phase, and amplitude of the underlying signal. Although all propagated electromagnetic signals travel at approximately the speed of light, “baseband” signals have relatively 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.

46. 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.

47. This “imprinting” process is called “modulation,” and modulation is usually achieved by altering one or more of the frequency, the phase, or the amplitude of the carrier signal. The following sections describe amplitude modulation, frequency modulation, and phase modulation in more detail.

1. Amplitude Modulation

48. As shown below, modifying the carrier signal’s amplitude based on the amplitude of the baseband signal is known as “amplitude modulation.” The modified carrier signal is called an “amplitude modulated signal.”



49. Where such systems are (and were) used, the receiving device uses the frequency of the unmodulated carrier signal to recover the original baseband signal. In this way, the receiver extracts the amplitude modulations (or envelope of the carrier signal) and then uses that information to reconstruct the original baseband signal.

50. For example, the Electrical Engineering Dictionary (ISBN 0-8493-2170-0) (Ex. 1038), p. 6 describes amplitude modulation as:

amplitude modulation (AM) the process of modulating a signal $x(t)$ by a carrier wave $c(t)$ for transmission:

$$y(t) = c(t)x(t),$$

where $y(t)$ is the signal to be transmitted. $c(t)$ is either a complex exponential of the form

$$c(t) = e^{j(\omega_c t + \theta_c)}$$

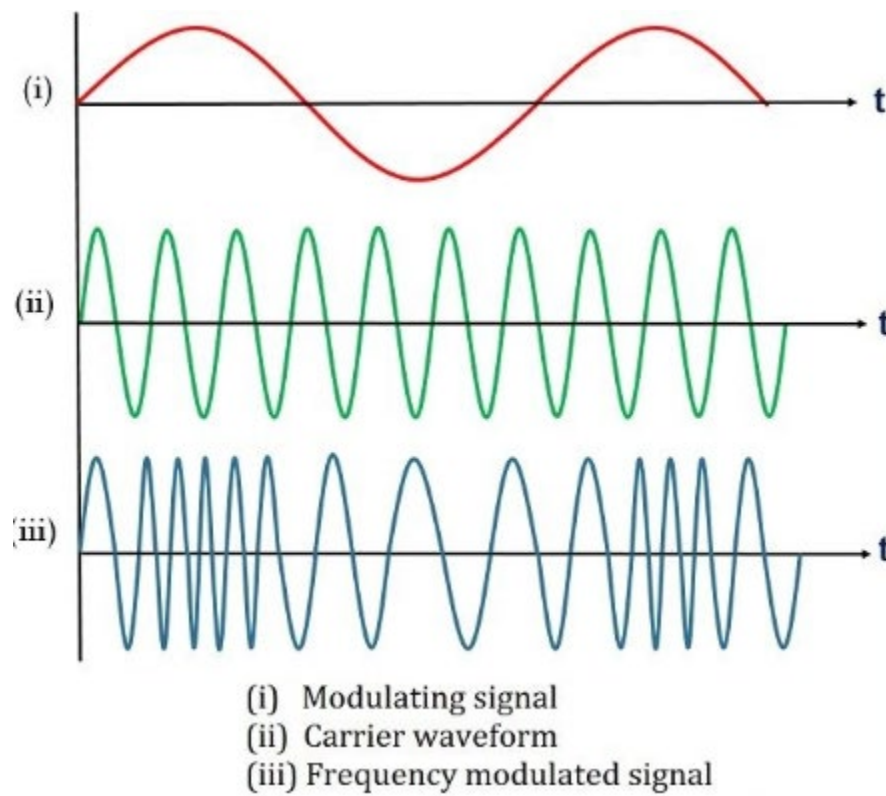
or a sinusoidal signal of the form

$$c(t) = \cos(\omega_c t + \theta_c).$$

ω_c is referred to as the *carrier frequency*. AM has the effect of shifting the frequency spectrum of $x(t)$ by ω_c . The signal is recovered by shifting the spectrum of $x(t)$ back to its original form. See also [frequency modulation](#).

2. Frequency Modulation

51. In frequency modulation, the frequency of the carrier is shifted based on the amplitude of the baseband signal, resulting in a frequency modulated (FM) signal:

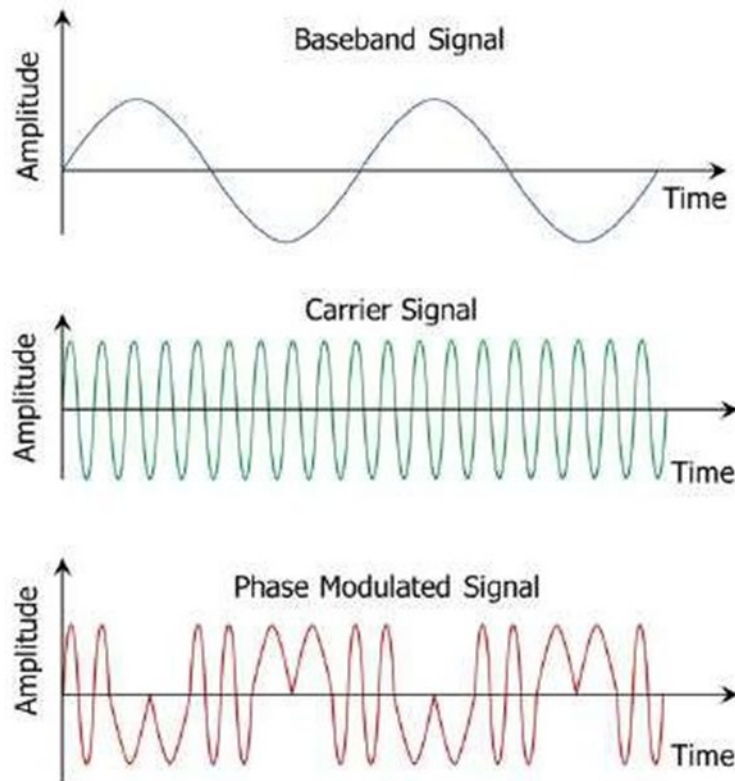


52. For example, the Electrical Engineering Dictionary (ISBN 0-8493-2170-0) (Ex. 1038), p. 7 describes frequency modulation as:

frequency modulation (FM) angle modulation in which the instantaneous frequency of a sine-wave carrier is caused to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave.

3. Phase Modulation

53. A baseband signal can also be transmitted wirelessly to another device by altering the “phase” of a carrier signal. This is called “phase” modulation, and an example of this is shown below.



54. The modified carrier signal is called a “phase modulated signal,” where the phase shifting represents the information content of the underlying baseband signal. In a system using “phase modulation” to transmit signals wirelessly, as in a system using amplitude modulation, the receiving device uses the frequency of the unmodulated carrier signal to recover the original baseband signal. In this way, the receiver extracts the phase shifts and then uses that information to reconstruct the original baseband signal.

55. For example, the Electrical Engineering Dictionary (ISBN 0-8493-2170-0) (Ex. 1038), p. 8 describes phase modulation as:

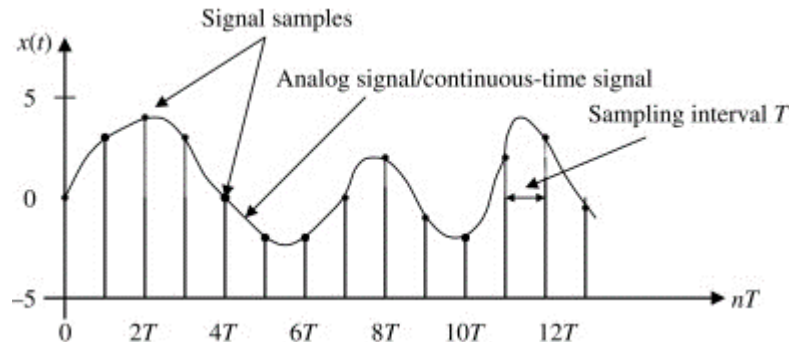
phase modulation a type of angle modulation whereby information is encoded onto a carrier wave by modifying its phase angle as a function of time in proportion to the intelligence signal amplitude.

C. Frequency Conversion

56. Wireless communication systems may also need to convert higher-frequency modulated signals to modulated signals at a lower frequency, either directly to the baseband or to an intermediate frequency (IF). For example, the use of an IF may allow amplifiers within a receiver to be tuned to a fixed IF so that those amplifiers do not need to be re-tuned whenever the receiver is tuned to a new carrier frequency, as was the case with most radio receivers in the early-to-mid 1900s.

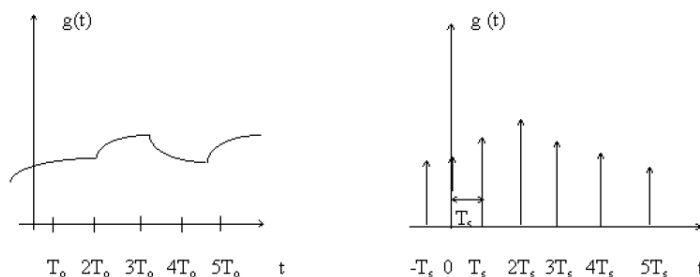
57. Two common methods of frequency conversion are mixing, also known as heterodyning, and sampling. In mixing, two frequencies (typically an input signal and a signal from a local oscillator) are mixed (or multiplied) to produce two output signals, one at the sum of the two frequencies and the other at the difference between the two. For example, early “superheterodyne” radio receivers typically used the difference as the IF. The other output frequency would typically be filtered out.

58. Sampling generally involves capturing (and then holding for a period of time) the instantaneous values (e.g., voltages from a received signal) at discrete time points from a continuous signal, such as a modulated carrier wave. For example, the image below shows an input signal sampled at a sampling interval T :



59. The samples taken at discrete time points may then be used to reconstruct a waveform. However, depending on the sampling frequency, the reconstructed waveform may have a higher or lower frequency than the input signal, while retaining differences in amplitude, frequency, phase etc. that are modulated onto the carrier. Accordingly, taking such samples may be used to produce an output signal in which the baseband signal is modulated onto a carrier having a different frequency. For example, the Electrical Engineering Dictionary (2000) (ISBN 0-8493-2170-0) (Ex. 1038), p. 9 describes sampling as:

sampling the act of turning a time-continuous signal into a signal that is time-discrete or time-discontinuous. See the following diagrams, where T_S is the sampling period.



The sampling process.

VII. OVERVIEW OF U.S. PATENT NO. 7,483,686

A. Description of the Specification

60. The '686 Patent describes a “universal platform module that can transmit and receive one or more information signals in one or more protocols using one or more bearer services.” '686 Patent, Abstract. Protocols “provide the format for the transfer of data.” '686 Patent, 7:52-58 (listing examples). Bearer services or standards, examples of which are listed at 7:63-8:1, “provide the communication pipeline... for the device to interact with the network.” *Id.*, 8:2-5. The '686 Patent acknowledges, however, that “conventional” devices included multiple “platform modules” for communicating with different protocols and bearer services. For example, Figure 25A, which the '686 Patent at 36:46-54 describes as a “conventional

multi-mode device,” includes both CDMA and Bluetooth platform modules for communicating with CDMA and Bluetooth networks, respectively:

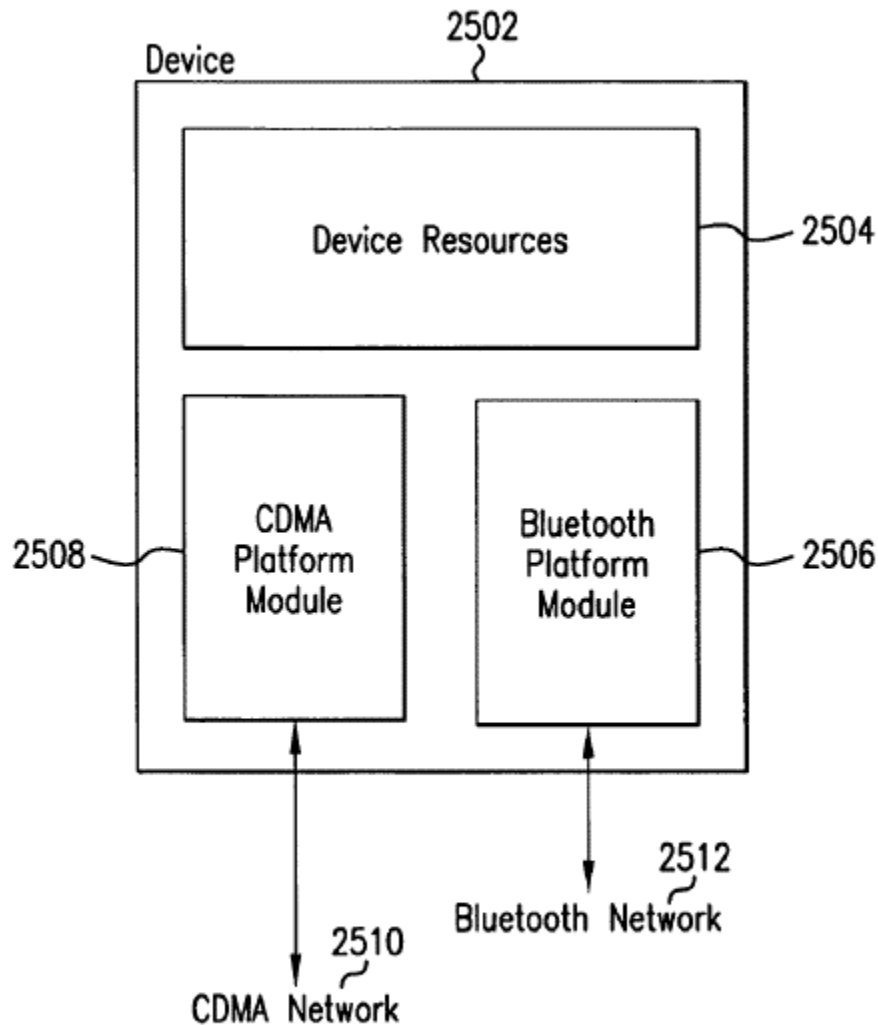


FIG.25A

61. In one embodiment, the '686 Patent depicts the “Universal platform module” (UPM) as including a plurality of “universal platform sub-modules” (UPSM), each of which includes a “Universal Frequency Translator” (UFT) module,

and is shown linking to various network types 2610-2616, such as cellular and WLAN networks. '686 Patent, 35:12-38, Fig. 26C:

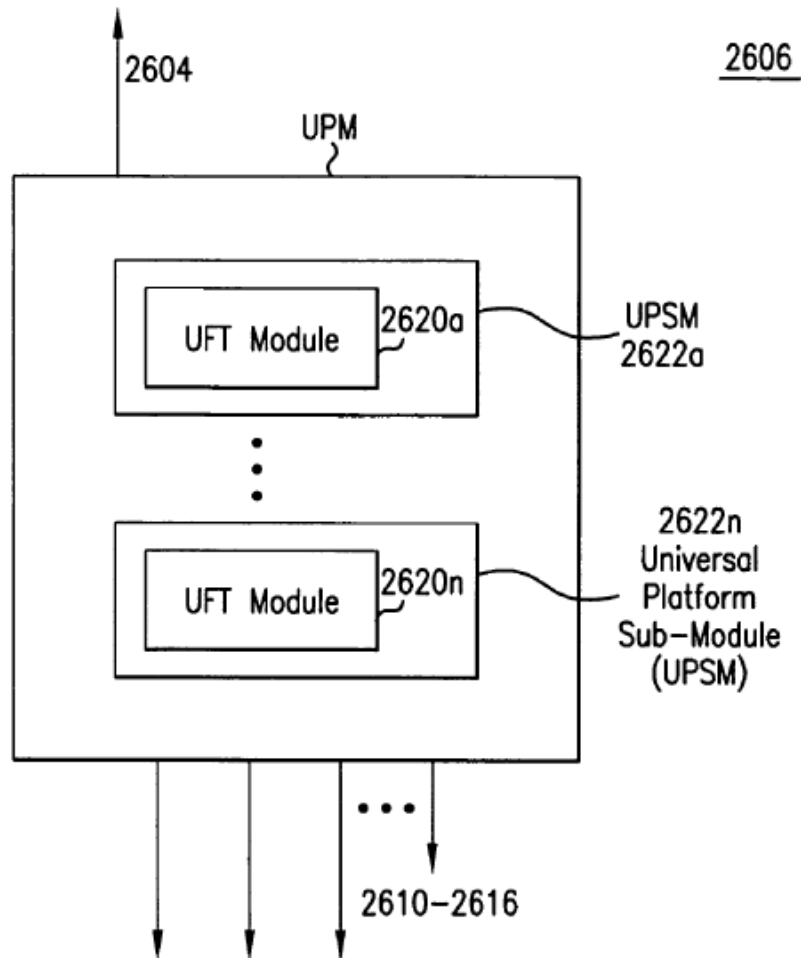


FIG.26C

62. In one embodiment, the UPSM may include a “universal frequency down-converter” (UFD) which down-converts a received signal to a baseband signal:

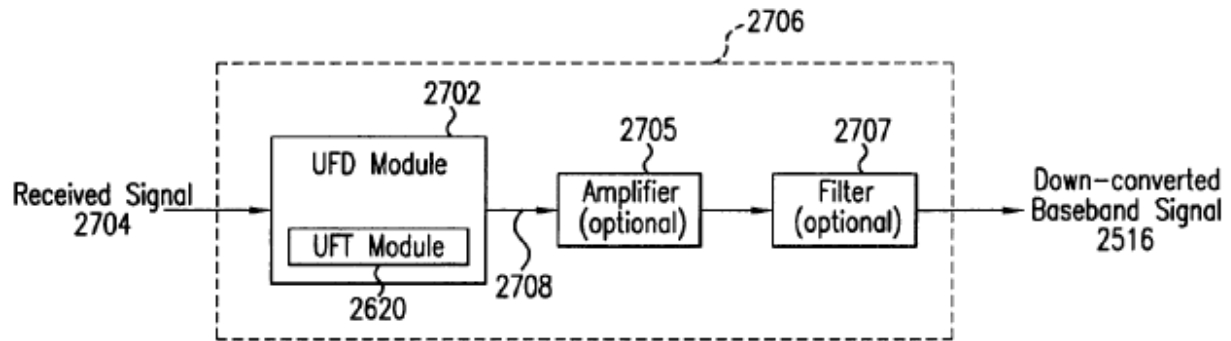


FIG.27B

'686 Patent, Fig. 27B, 41:36-49.

63. Figure 28 illustrates a block diagram of an exemplary UFD, including a UFT module which may comprise a switch, an oscillator and pulse shaping circuit 2806 which produce a control signal 2812, and a storage device 2802 which may be a capacitor:

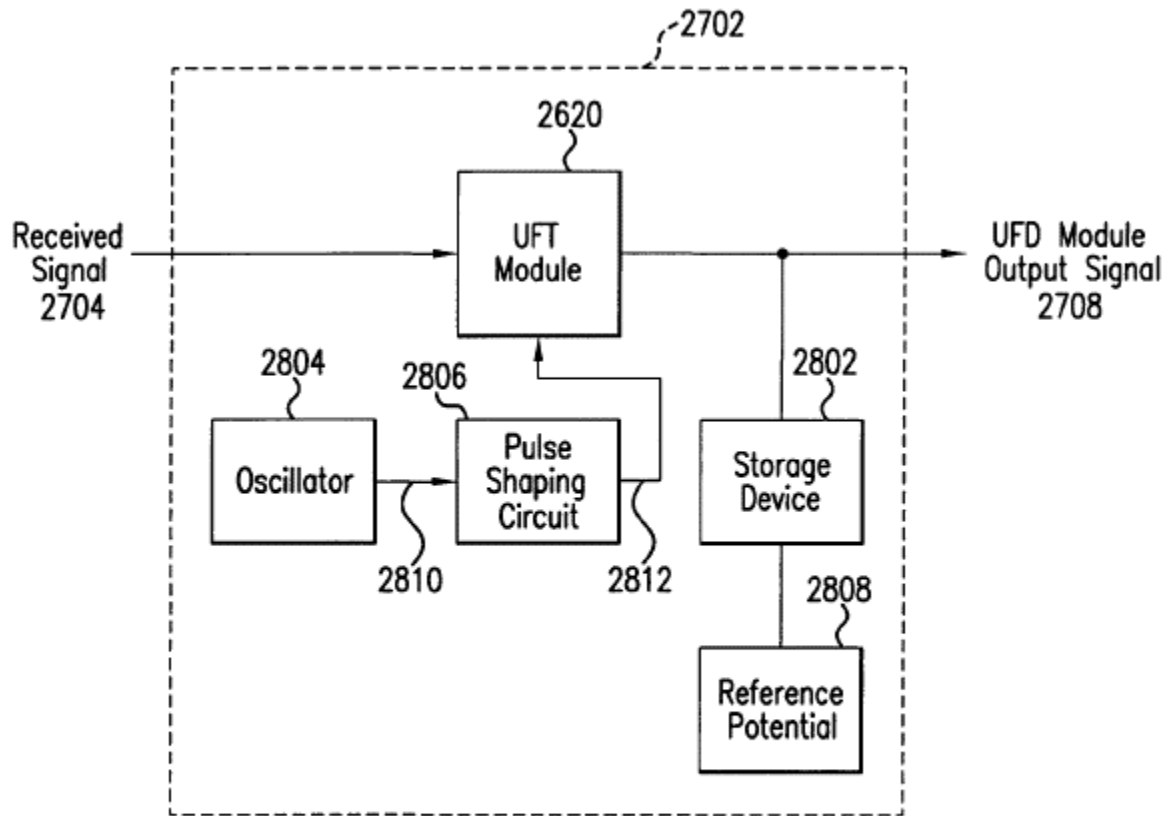
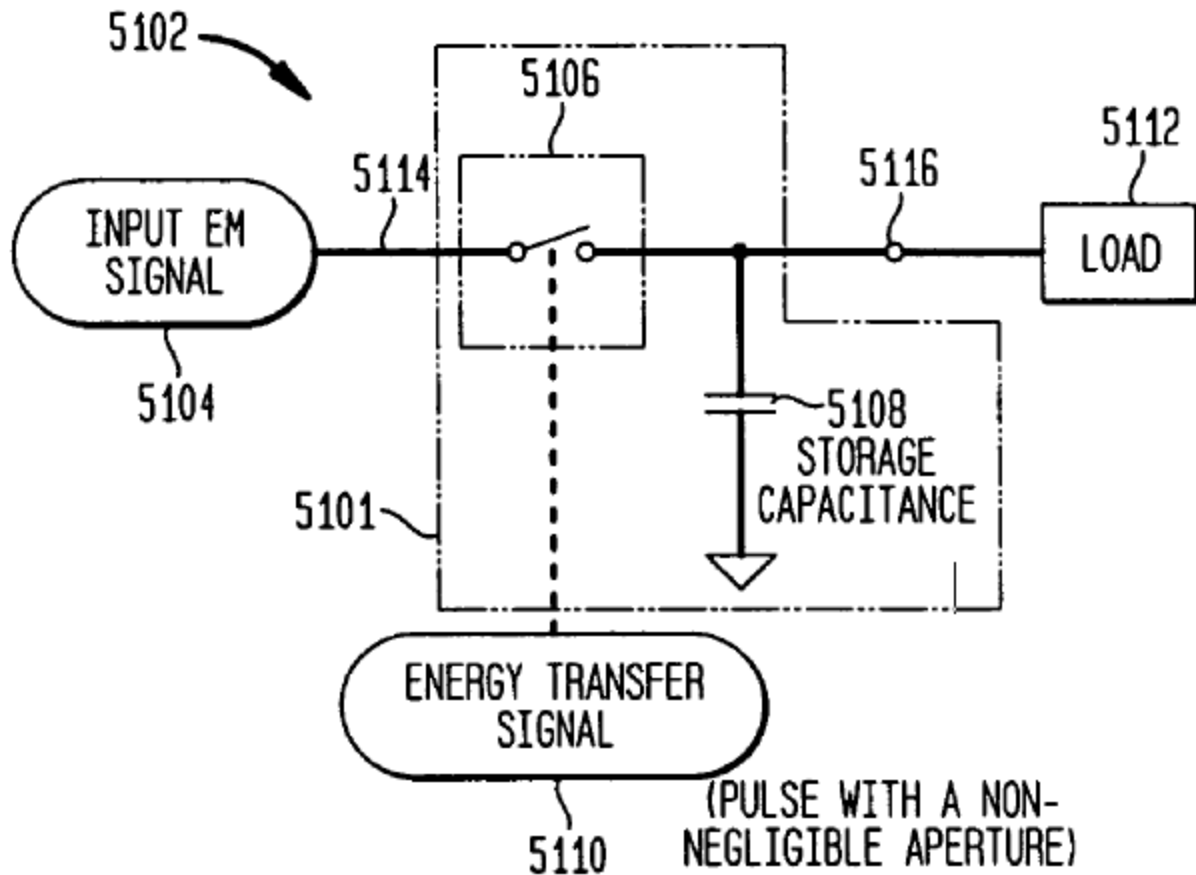


FIG.28

'686 Patent, Fig. 28, 42:17-56.

64. The control signal may also be referred to in some cases as an energy transfer signal. '686 Patent at 13:27-31. Figure 51A shows a circuit diagram of one exemplary embodiment using a switch as the UFT module, capacitor as a storage device, and a pulse with a non-negligible aperture as an energy transfer signal:

FIG. 51A



'686 Patent, Fig. 51A, 18:6-19.

65. The specification of the '686 Patent incorporates by reference an earlier ParkerVision patent, U.S. Patent No. 6,061,551 ("551 Patent"), (Ex. 1008) 1:47-52 of the '686 Patent. Therefore, where relevant I have also considered the specification of the '551 Patent.

B. Prosecution History

66. The first claims to be examined during prosecution of the '686 Patent (after two preliminary amendments) required a multi-platform module with a frequency translation module, but did not specify the operation of the frequency translation module. Pending-claim 14 (renumbered at issuance to claim 11) is reproduced below:

14. *(previously presented)* A method for performing simultaneous multi-platform operations, comprising:

(1) controlling at least one multi-platform module to communicate with at least one of a plurality of communication links using a control module having a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes a plurality of transceivers each having at least one frequency translation module;

(2) operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and

(3) simultaneously operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

Ex. 1007, 245.

67. The Examiner's first office action on March 26, 2008 rejected all claims under either § 102 over Zehavi (U.S. Patent Number 6,894,988) or under § 103 over combinations of references based on Zehavi. *Id.*, 804-807. According to an

Interview Summary of an Examiner's Interview on July 22, 2008, Applicants agreed with the Examiner that "claims 5 and 14 will be amended to incorporate the allowable subject matters of claim 5 from the parent Application." Applicants accordingly amended claim 14 (which issued as claim 11) as follows:

14. (Currently Amended) A method for performing simultaneous multi-platform operations, comprising:

(1) controlling at least one multi-platform module to communicate with at least one of a plurality of communication links using a control module having a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes a plurality of transceivers each having at least one frequency translation module, wherein said at least one frequency translation module comprises

a switch configured to operate according to an energy transfer signal, and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and

a storage module coupled to said switch and configured to store said transferred energy, wherein a second EM signal is generated from said stored energy, said second EM signal having a frequency different from said first EM signal;

(2) operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and

(3) **simultaneously** operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

Id., 976-77.

68. The Examiner thereafter issued a Notice of Allowability without further substantive comment on October 3, 2008. *Id.*, 1007-1008. Therefore, in my opinion, it appears from the prosecution history that the added elements of the “frequency

translation module,” the “switch” and “storage module,” were the decisive elements for allowance of the claims. As I discuss below, however, those elements were disclosed in the prior art I cite here.

VIII. THE CHALLENGED CLAIMS OF THE '686 PATENT

69. I understand that MediaTek is challenging the patentability of claims 1-20 of the '686 Patent. The full listing of the Challenged Claims is reproduced at the beginning of this declaration. Claim 11 reads as follows (with claim numbering annotations added):

11. A method for performing simultaneous multi-platform operations, comprising:

(1) controlling [1.1] at least one multi-platform module to communicate with at least one of a plurality of communication links using [1.2] a control module having [1.3] a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes [1.4] a plurality of transceivers each having at least one frequency translation module, wherein said at least [one] frequency translation module comprises

[FTM-1.1] a switch configured to operate according to [FTM-1.2] an energy transfer signal, and [FTM-1.3] to sub-sample and transfer energy from a first electromagnetic (EM) signal, and

[FTM-2.1] a storage module coupled to said switch and configured to store said transferred energy, wherein [FTM-2.2] a second EM signal is generated from said stored energy, said second EM signal having a [frequency] different from said first EM signal;

(2) operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and

(3) operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

'686 Patent, Claim 11 (annotated).

70. Claims 1 and 11 are independent claims which are similar, except that claim 1 recites an apparatus while claim 11 recites a method of using that apparatus. Claim 11 also contains additional elements with respect to the claimed “storage module.”

IX. CLAIM CONSTRUCTION

71. I understand that when considering the meaning of claims subject to *inter partes* review, one must consider the claim language. I understand that claim terms are generally given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art (a “POSITA”) at the time of invention in the context of the specification, the prosecution history, and other claims. I also understand that “extrinsic” evidence such as expert or inventor testimony, dictionaries, and learned treatises can be helpful in determining the meaning of claim terms, but that extrinsic evidence is of less significance than the claims, specification, and prosecution history.

72. I also understand that due to ParkerVision’s extensive litigation history, there are a number of terms that appear in the claims of the '686 Patent which are

identical or similar to terms in related patents that have been the subject of claim construction in other proceedings either in courts or in the PTAB. I understand that these constructions may be informative, but are not necessarily binding on the PTAB.

73. For my opinions in this declaration, I believe that it is helpful to address how a POSITA would have understood the terms “switch,” “multi-platform module,” and “sub-sample” in claims 1 and 11, and “storage module” and “coupled” in claim 11.

74. I have been asked to consider the remaining terms of the Challenged Claims under their ordinary and customary meanings as understood by a POSITA at the time of the alleged invention.

75. I have applied the above principles in forming my opinions provided in this declaration.

A. “Storage module” in claim 11

76. In my opinion, “storage module” should be construed as “a module that stores non-negligible amounts of energy from an input electromagnetic signal.” The ’551 Patent, which is incorporated by reference in the ’686 Patent, 1:47-52, supports this construction:

FIG. 82A illustrates an exemplary energy transfer system 8202 for down-converting an input EM signal 8204. The energy transfer system 8202 includes a switching module

8206 and a storage module illustrated as a storage capacitance 8208. The terms storage module and storage capacitance, as used herein, are distinguishable from the terms holding module and holding capacitance, respectively. Holding modules and holding capacitances, as used above, identify systems that store negligible amounts of energy from an under-sampled input EM signal with the intent of "holding" a voltage value.

Storage modules and storage capacitances, on the other hand, refer to systems that store non-negligible amounts of energy from an input EM signal.

'551 Patent, 66:55–67 (emphasis added).

77. I understand that ParkerVision's proposed construction in related litigation differs only in that ParkerVision would require the "storage module" to be part of an "energy transfer system." Ex. 1009 (Joint Claim Construction Chart) at 2. I further understand that the Federal Circuit has already rejected this construction in the context of a patent that, like the '686 Patent, incorporates by reference the '551 Patent. Even if this "element of an energy transfer system" limitation for "storage module" were adopted, it would not affect my opinions that the claim challenged claims are unpatentable, as I discuss below. I further understand that in another case involving a related patent that also incorporates the '551 Patent and other related patents, the district court construed "non-negligible amounts of energy" (as recited in the claims-at-issue) to mean "energy in amounts distinguishable from noise," and

PO did not dispute that construction on appeal. This variation of the construction would not affect my opinions discussed below.

B. “Switch” in claims 1 and 11

78. In my opinion, “switch” should be construed as “an electronic device for opening and closing a circuit.” I understand that in the related litigation, the parties dispute whether the switch must be “dictated by an independent control input.” Ex. 1009 (Joint Claim Construction Chart), 3. I further understand that some courts have previously construed the term in related patents to require an independent control input. *See* Ex. 1030 (Claim Construction Order), 49. However, the plain and ordinary meaning of “switch” does not require an “independent” control input. Further, the ’686 specification discloses examples of switches lacking an “independent control input.” For example, the control signal 2006 that controls the switch in Figure 20A-1 may be an energy transfer signal. ’686 Patent, 13:27-31 (“When the pulses of the control signal 2006 have non-negligible apertures, the aliasing module 2000 is referred to interchangeably herein as an energy transfer module or a gated transfer module, and the control signal 2006 is referred to as an energy transfer signal.”).

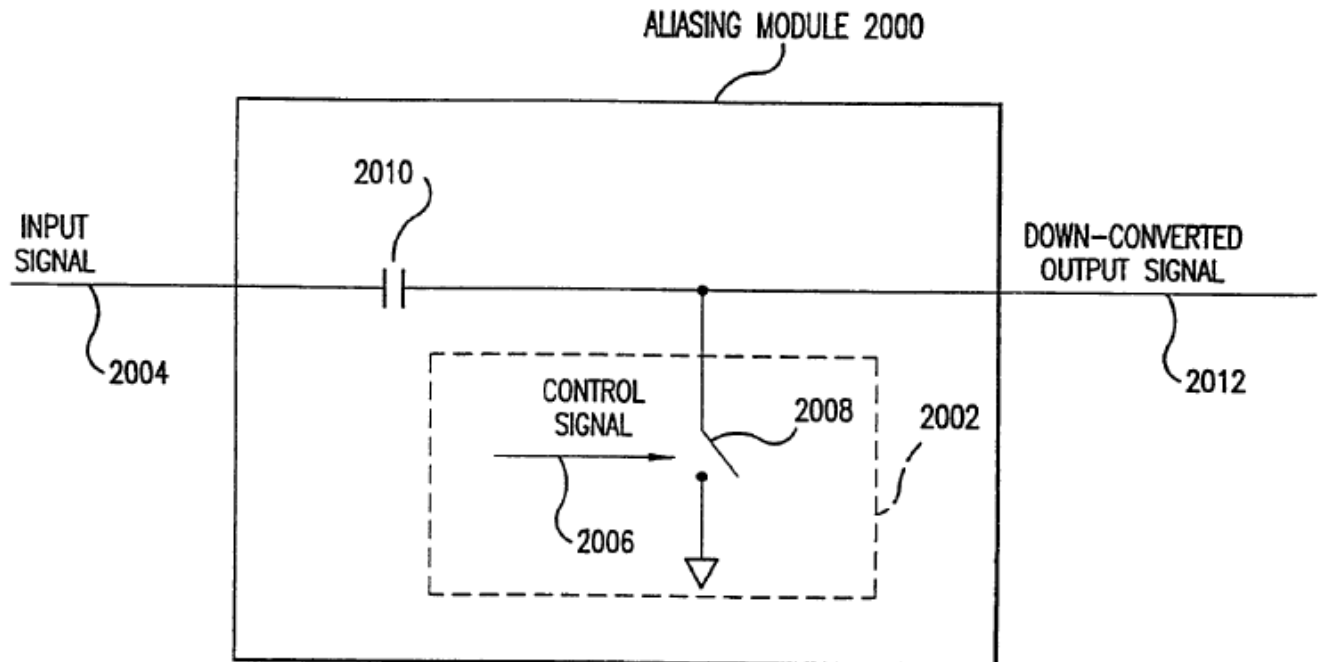
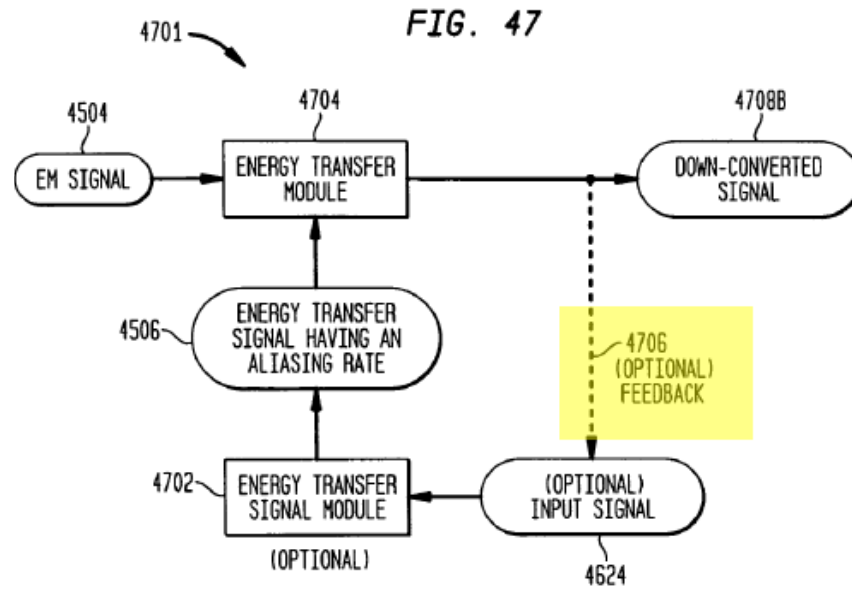


FIG. 20A-1

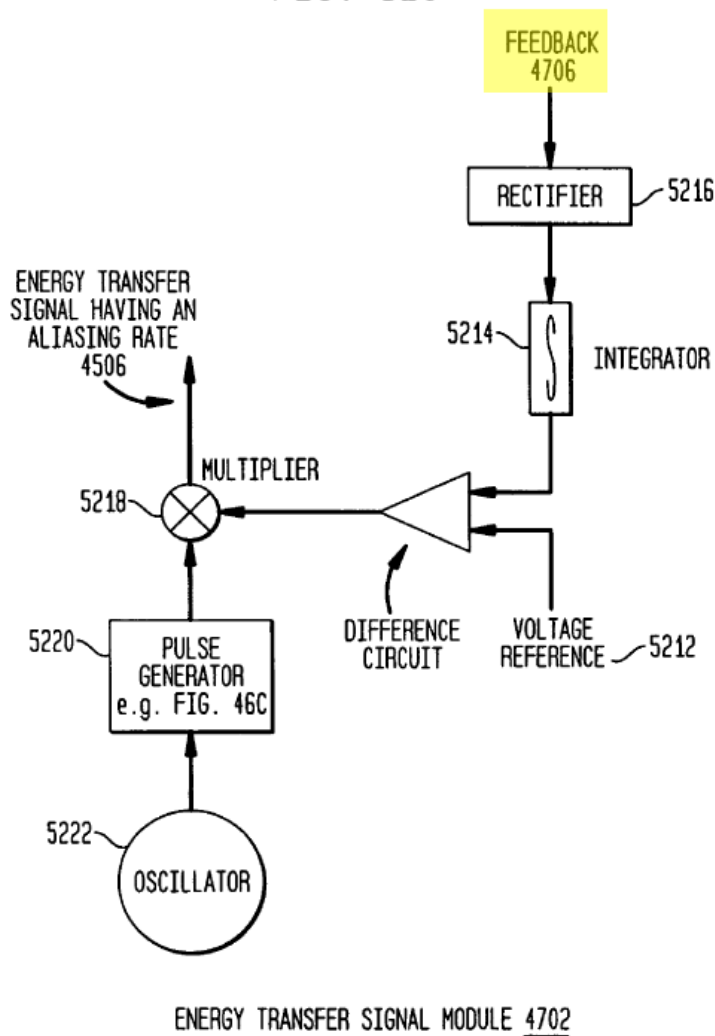
'686 Patent, Fig. 20A-1.

79. As shown in Figs. 47 and 52C, an energy transfer signal 4506 may be controlled based on feedback 4706 derived from the down-converted signal 4708B. '686 Patent, 20:23-21:5.



'686 Patent, Fig. 47.

FIG. 52C



'686 Patent, Fig. 52C.

80. In these embodiments, the control signal is not “independent” of the feedback. Accordingly, construing the claim to require an “independent” control input would read out these embodiments, and I see no basis in the intrinsic record of the '686 Patent to do so. Even if this “independent control input” limitation for “switch” were adopted, it would not affect my opinions that the claim challenged claims are unpatentable, as I discuss below.

C. “Coupled” in claim 11

81. I understand that in a related proceeding, PO contends that the term “coupled” should have its plain and ordinary meaning while MediaTek contends that the term should be construed as “directly connected or connected through a wire (or a closed switch).” I have considered both constructions and my opinions regarding the unpatentability of the challenged claims would not change based on which construction is applied.

D. “Multi-Platform Module” in claims 1 and 11

82. In my opinion, the term “multi-platform module” should be given its plain and ordinary meaning, and MediaTek further contends “platform” refers to a communications protocol and/or bearer service (which is supported by the intrinsic record). EX1009, 4; EX1047, 12. I agree with MediaTek’s proposed construction. I note that the phrase “multi-platform module” does not appear in the specification. However, the ’686 Patent uses “multi-platform operations” to refer to “multiple protocols and multiple bearer services... employed simultaneously”:

In one embodiment, the UPM includes a UFT module for connecting to/interacting with any network using any protocol/bearer service combination. This embodiment provides the benefit of reduced circuitry over conventional implementations. Furthermore, the UPM can perform multi-platform operations nearly simultaneously. Such operation by the invention is

sometimes referred to herein as “apparent simultaneous operation” or “virtual simultaneous operation.” For example, the UFT module can switch between a wireless local area network (WLAN) and a wide area network (WAN) and thus, communicate with components on both networks.

In another embodiment, through the use of more than one UFT module, multiple protocols and multiple bearer services can be employed simultaneously.

’686 Patent, 8:19-32, 8:13-18; *see* Section VII. Thus, in my opinion and based on the specification, a POSITA would have understood that “platform” further refers to a communications protocol and/or bearer service.

E. “Sub-sample” in claims 1 and 11.

83. I understand that in a previous litigation involving related patents, a district court adopted ParkerVision’s proposal to construe the term “sub-sample” to “refer to sampling at an aliasing rate, *i.e.*, at a rate that is less than or equal to twice the frequency of the signal being sampled.” EX1014, 6-10. In my opinion, the plain and ordinary meaning as would have been understood by a POSITA encompasses this construction, and so I have applied it in my analysis below.

X. THE CHALLENGED CLAIMS ARE INVALID

A. Ground 1: Claims 1-20 are Unpatentable as Obvious Over Nevo in view of Avitable

84. In my opinion, claims 1-20 are unpatentable as obvious over Nevo in view of Avitable. Independent claims 1 and 11 differ because claim 1 is an “apparatus” claim, while claim 11 is a “method” claim. However, they are similar claims because the “method” claimed in claim 11 is basically just the use of an apparatus, so in my opinion the “method” of claim 11 would be obvious to a POSITA based on art that described an apparatus which performed that method in its normal operation. Claim 11 is also slightly more specific than claim 1 because claim 11, but not claim 1, recites a “storage module.” Therefore, I will discuss claim 11 first because it is more specific. This is discussed below.

1. Nevo

85. Nevo was filed on November 12, 1999. I understand that Nevo qualifies as prior art under 35 U.S.C. § 102(e).

86. Nevo describes a wireless device that can use multiple protocols, with several controller managers 106a/106b that run several transceivers 102a/102b to connect with different communication networks that operate on different wireless network protocols 108a/108b. Nevo at Abstract, 3:27-45. The protocols include, for example, Bluetooth, IEEE 802.11, and Home RF. *Id.*, 4:46-55. This is shown in Figure 1 below.

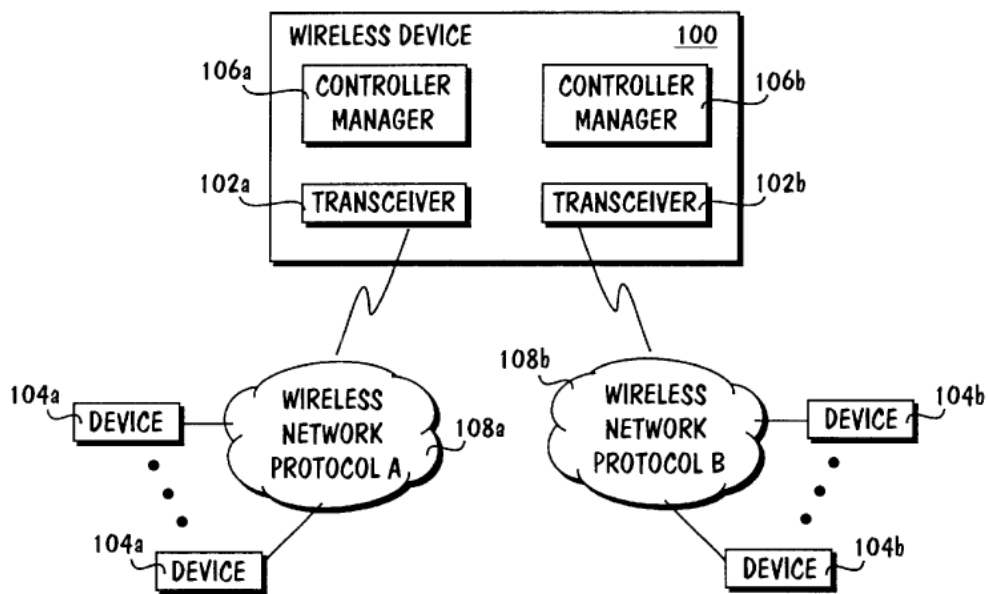


FIG. 1

2. Avitabile

87. Avitabile was published in 1996. I understand that Avitabile qualifies as prior art under 35 U.S.C. § 102(b).

88. Avitabile teaches a digital downconverter having a SH (sample-and-hold) module (annotated yellow, below) that takes an input RF signal (red) and outputs a down-converted intermediate frequency (IF) signal (orange). Avitabile, p. 338 (§3). Avitabile's circuit performs demodulation for carrier signals in the S-band and further provides examples using a 1 GHz carrier with a bandwidth of 30 MHz. *Id.*, p. 337 (§1); *see also id.*, pp. 339-40 (§5-5.1). A carrier having a carrier frequency is a signal that is modulated with another data signal to generate an RF output signal for transmission. The Science of Radio (Ex. 1040), p. 39. This signal

is captured at a receiver and demodulated to obtain the data signal, which is typically called the baseband signal. *Id.*, p. 161-65. Avitabile provides a receiver.

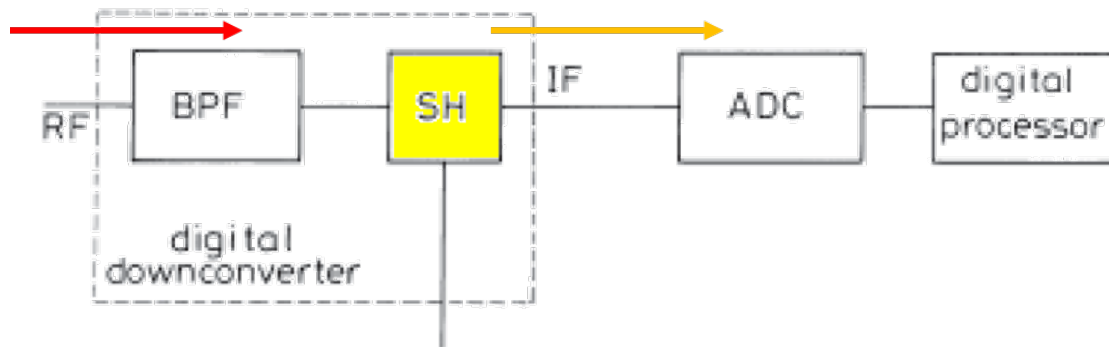


Fig.1 Schematic diagram

89. Avitabile describes a sample and hold circuit in a circuit equivalent schematic at Figure 2. It also has two different prototypes that were made and tested at Figures 4-7 and Figures 8-10. Figure 2 illustrates a switch (blue) which controls the flow of an input RF signal (red) that charges capacitor (green) which in turn generates an IF output signal (orange). Avitabile, p. 338 (§§4, 4.1). Control signal (purple) controls flipping the switch closed/open. *Id.* (“The switch is turned on for a very short time interval t_{on} whose duration is inversely proportional to the RF bandwidth.”).

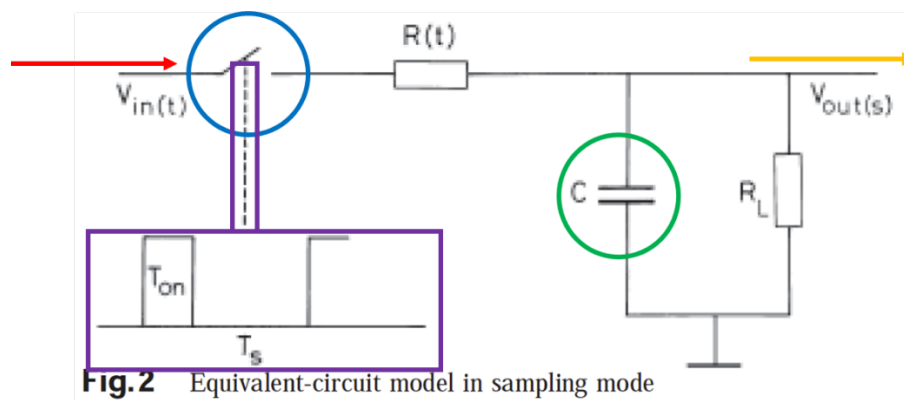


Fig.2 Equivalent-circuit model in sampling mode

Avitabile, Fig. 2 (annotated).

90. Avitabile demonstrates measurements from two built prototypes. The first (Fig. 4, below) illustrates a switch (annotated blue) that is pulsed to pass the RF signal (red) to the capacitor (green) where the sample baseband signal (orange) is obtained. Avitabile, pp. 338-39 (§ 5.1).

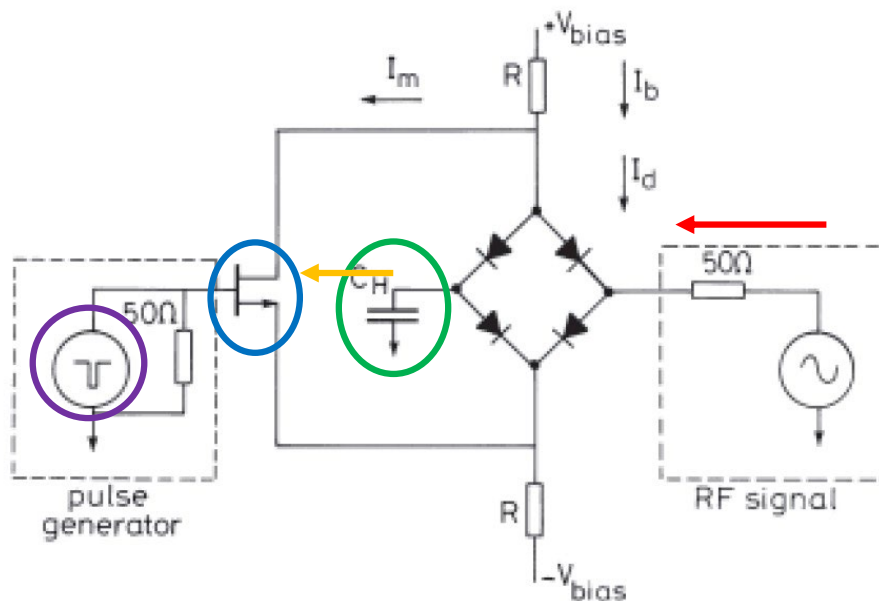


Fig.4 Schematic diagram of SH1 sample-and-hold circuit

Avitabile, Fig. 4 (annotated).

91. Figure 7 (below, left) illustrates the signal at the capacitor after two pulses. *See also* Avitabile at Fig. 5 (illustrating the pulsing every 4 ns). With each pulse there is an energy storage in the capacitor. Shown in Figure 6 (below, right) is the measured baseband waveform. A POSITA would have understood that capacitors store energy with time whenever a voltage is applied to it. *See also* Physics for Scientists and Engineers (“Serway”) (Ex. 1042), pp. 775-77. Another

prototype with respective measurements (in the frequency domain) are demonstrated in Figures 8-10.

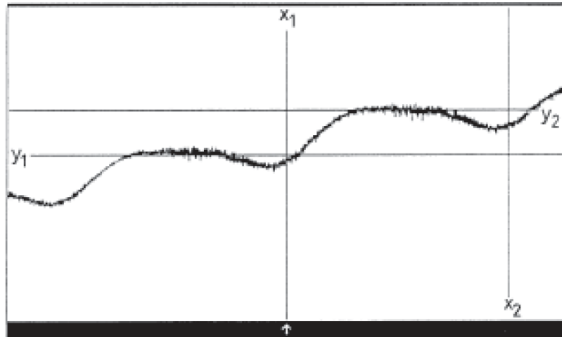


Fig.7 Hold time and 'droop off' of the sampled signal
 $x_1 = 0$; $y_1 = 11$ mV; $x_2 = 4$ ns; $y_2 = 33.4$ mV
 Horizontal scale: 1ns/div.

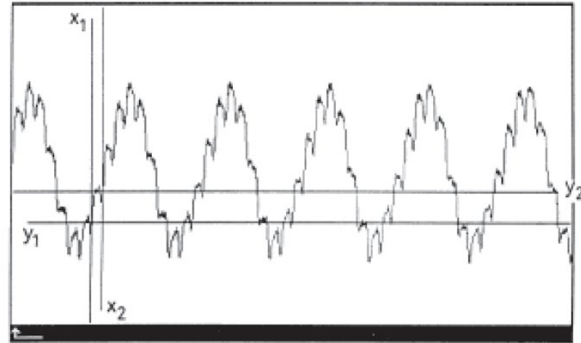
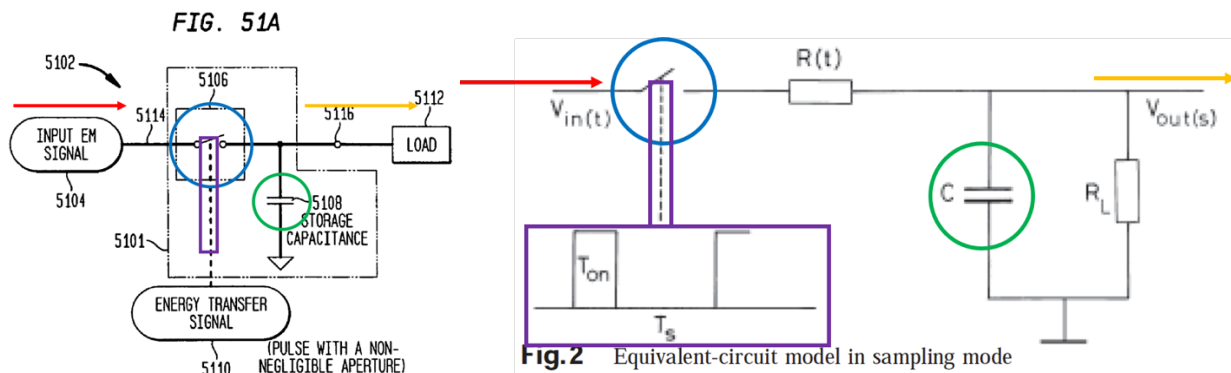


Fig.6 Sampled signal obtained by SH1
 $x_1 = 28$ ns; $y_1 = -23$ mV; $x_2 = 32$ ns; $y_2 = -7.4$ mV
 Horizontal scale: 20ns/div.

92. The figures of each of Avitabile and the '686 Patent show how similar they are. The following is Figure 51A of the '686 Patent with the same annotations as Avitabile's Figure 2. The same components are color-coded and shown side by side.



3. Motivation to Combine

93. In my opinion, a POSITA would have had several reasons to combine Avitabile's down-converters in Nevo's transceivers.

94. In my opinion, a POSITA would have had a reason to combine Nevo/Avitable because they disclose known components that would produce expected outcomes when combined. Nevo combines several established protocols and offers them in one chip. Nevo at Fig. 1. Nevo teaches both Bluetooth and IEEE 802.11, which were both two widely known protocols, at the same time. Nevo, 4:46-55. Nevo does not provide the particular circuitry for performing down-conversion (i.e., demodulating a data signal from a carrier) but does acknowledge that down-converters are needed in Figure 12. As it is explained in the Science of Radio, it is a basic and necessary concept to demodulate data signals from carrier signals (which are transmitted by modulating a data signal onto a carrier signal for transmission). Science of Radio (Ex. 1040), pp. 39, 165. For example, IEEE 802.11 operates at a 2.4 GHz carrier f_c with an, e.g., 20 MHz bandwidth. This is shown below as an excerpt from page 29 of 802.11a (Ex. 1039).

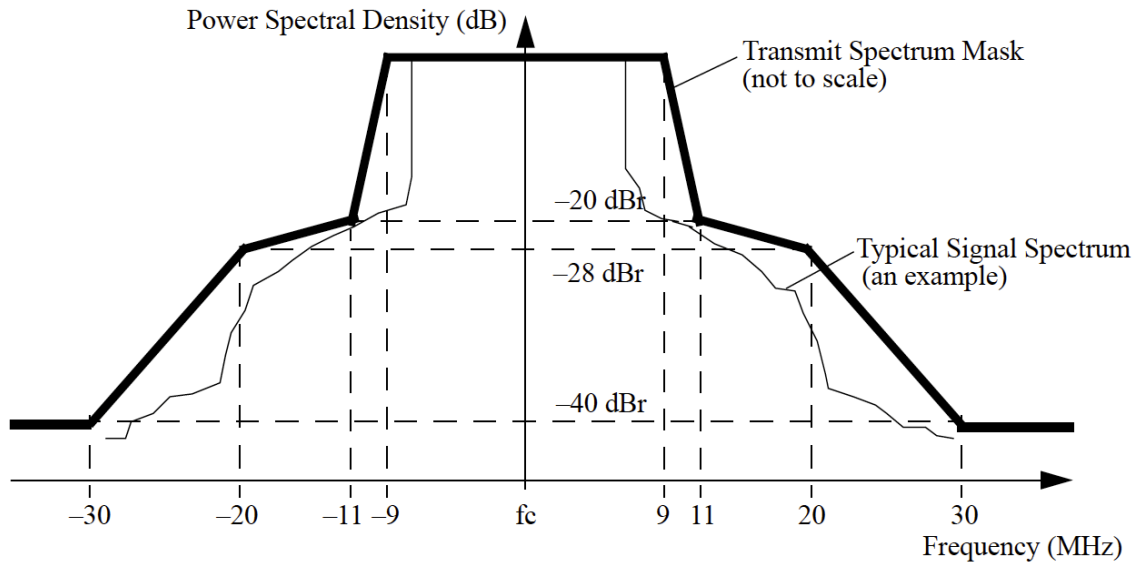
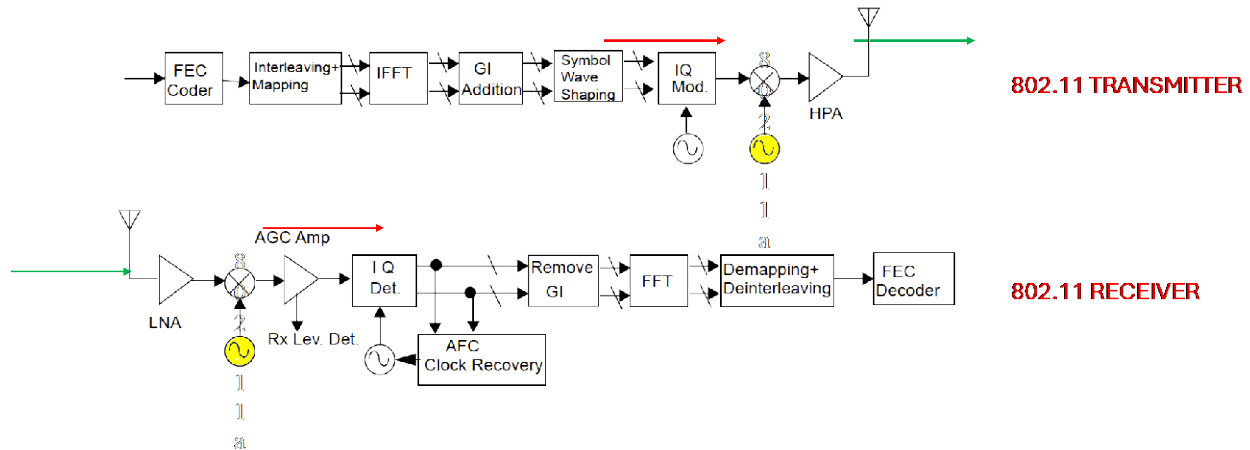


Figure 120—Transmit spectrum mask

Further, as shown at page 24 of 802.11a (Ex. 1039) (annotated) below, it is shown that IEEE 802.11 provides both modulation for an RF signal (e.g., carrier in yellow, data in red, and RF output in green) and demodulation to receive the data signal (e.g., carrier in yellow, data in red, and received RF in green). A POSITA would have understood that the data signal (red) is a lower frequency than the RF signal (green), and would have understood down-conversion to be necessary for 802.11 receivers. I have shown the basics of signal modulation using two separate time varying signals in my background section of this declaration.



95. Bluetooth is described similarly. It uses a 2.4 GHz carrier with a significantly smaller bandwidth. U.S. Pat. No. 6,477,378 (Ex. 1036), 2:19-27 (“Although the 2.4 GHz ISM is globally available, the exact location within the ISM band where Bluetooth™ operates may differ by country. In addition, the width of the Bluetooth™ band may vary by country. In the U.S. and Europe, a bandwidth of 83.5 MHz is available; in this band, 79 RF channels spaced 1 MHz apart are defined. In Japan, Spain, and France, a smaller band is available; in this band, 23 RF channels spaced 1 MHz apart are defined.”).

96. A POSITA would have understood that down-conversion would be needed from Nevo’s teachings of RF transmission which would require down-conversion at 2.4 GHz and, moreover, its teaching of Bluetooth and IEEE 802.11.

97. Avitabile provides the exact circuitry for down-conversion in the frequency range of Bluetooth/IEEE802.11 (2.4 GHz). A POSITA would have had a reason to seek down-converters in the frequency range required by Nevo, and

would have had a reason to apply Avitabile's teachings which are in the frequency range of Bluetooth/IEEE802.11. Avitabile teaches a bandwidth of up to 50 MHz (Avitabile, p. 339) for a carrier up to 3 GHz (*id.*, p. 341 (§6)) and IEEE 802.11 at the time used bandwidths of similar ranges for a 2.4 GHz carrier while Bluetooth described same.

98. In my opinion, a POSITA would have been motivated to combine the two and a POSITA would have had a reasonable expectation of success with said combination. Avitabile provides prototype measurements that provide proof of concept in its down-converter design. This is shown in Avitabile at Figures 6 and 7. A POSITA would have been motivated to use experimentally proven concepts. Further, Avitabile demonstrates extracting a base-band signal (e.g., Fig. 6) which a POSITA would have understood to be compatible with the signal processing techniques of Bluetooth/IEEE 802.11 (OFDM) that I provided immediately above and described the basics of with reference to the Science of Radio (Ex. 1040). A POSITA would have been motivated to use experimentally tested methods for down-conversion using the same frequencies of IEEE 802.11 / Bluetooth (Avitabile) in Nevo which describes IEEE 802.11 / Bluetooth, and would have been motivated to combine the two.

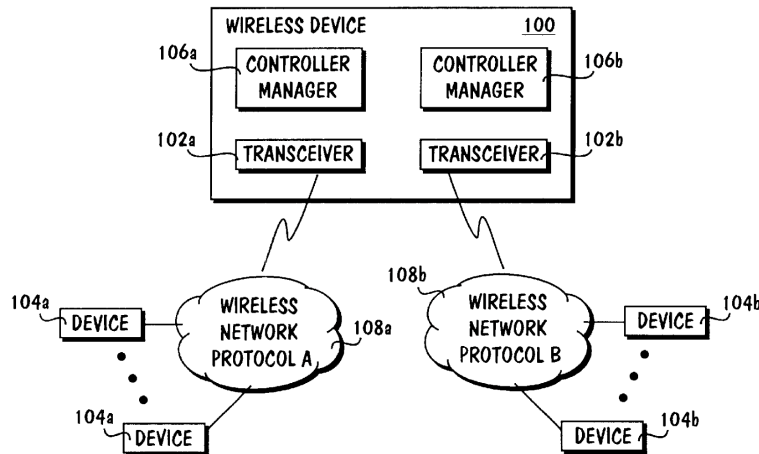
99. Moreover, a POSITA would have been motivated to look at references like Avitabile when looking at Nevo's suggestions (and shortcomings). As

mentioned, Nevo teaches the use of two or more protocols where down-conversion is required, but it presents its teachings at a high-level block diagram level. A POSITA wanting to implement a down-conversion circuit would need to look at references that provide that detail. Avitabile does and, moreover, provides the exact frequency ranges a POSITA would have been looking for to implement IEEE 802.11 and Bluetooth. Thus, Nevo provides teachings that would motivate a POSITA to look at a reference like Avitabile.

4. Claim 11

a. 11[pre]: A method for performing simultaneous multi-platform operations, comprising:

100. I do not offer any opinion on whether the preamble of claim 11 is limiting, but it is my opinion that the preamble of claim 11 is taught by Nevo regardless of whether it is limiting. Nevo teaches a method for performing simultaneous multi-platform operations. Nevo, 3:28-35. Figure 1 depicts a wireless device having two transceivers (102a/102b) that can connect to two separate wireless networks (108a/108b) (*id.*) that are Bluetooth and IEEE 802.11, respectively. *Id.*, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations). The wireless device has control managers 106a/106b that control transceiver operation in a “coordinated manner” to allow communication “with the respective wireless communication protocols at the same time.” *Id.*, 3:38-45.



100a. Operations in electronic systems can functionally be operating simultaneously, even if they are occurring sequentially at the finest grain level. This is because the data that these systems operate on always arrives sequentially—in packets of fixed length—and these systems operate so rapidly that they switch between operations at speed far faster than human perception or that is required by various network protocols.

101. I note that it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

102. First, systems in the art were well known to be simultaneous but do not have exact same time processing. For example, any operating system simultaneously runs several programs despite those programs sharing time with the processor. *See generally* Operating Systems, A Systematic View, Davis (1983) (Ex.

1043), 259-63. And, in the context of RF transmissions, a POSITA would have understood that trying to use the same exact frequency to transmit at the same exact time would cause interference. Interference is recognized in *Nevo*. *Nevo* at Abstract. Moreover, a POSITA would have understood that using the same antenna to transmit two signals having the same exact frequency at the exact same time would be impractical. Both interference and trying to use the same antenna at the same time would result in signals being effectively added because they utilize the same carrier, which would overlap.

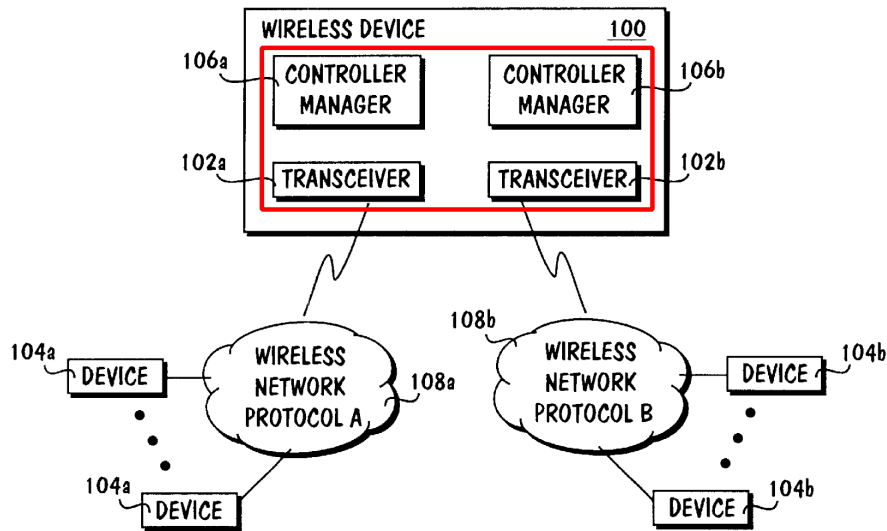
103. Indeed, the '686 Patent recognizes a “simultaneous” transmission as being one that is either “actual or apparent.” '686 Patent, 34:37-38 (“Such communication may be simultaneous, either actual or apparent”); *see also id.*, 38:34-36 and 8:19-37; *see also id.*, 40:42-46 (“Simultaneously, the same device is switching another of the transceiver 4104 components of UPSM 4102 using the wireless application protocol (WAP) to link the device to a cellular network using a CDMA standard bearer service.”). Further, the '686 Patent teaches that “multi-platform operations” refer to “multiple protocols and multiple bearer services... employed simultaneously” and identifies Bluetooth and IEEE 802.11 as exemplary protocols. *Id.*, 8:31-32, 7:52-58. A POSITA would have understood both actual simultaneously or apparently simultaneous transmissions to be types of “simultaneous” transmissions. This understanding is further supported by *Nevo*,

which describes its transmissions as occurring at the same time. Nevo, 4:13-15 (“Accordingly, wireless device 100 is able to operate with devices 104a and 104b of networks 108a and 108b in two wireless protocols at the same time.”); *see also id.* at 4:36-39 (stating same).

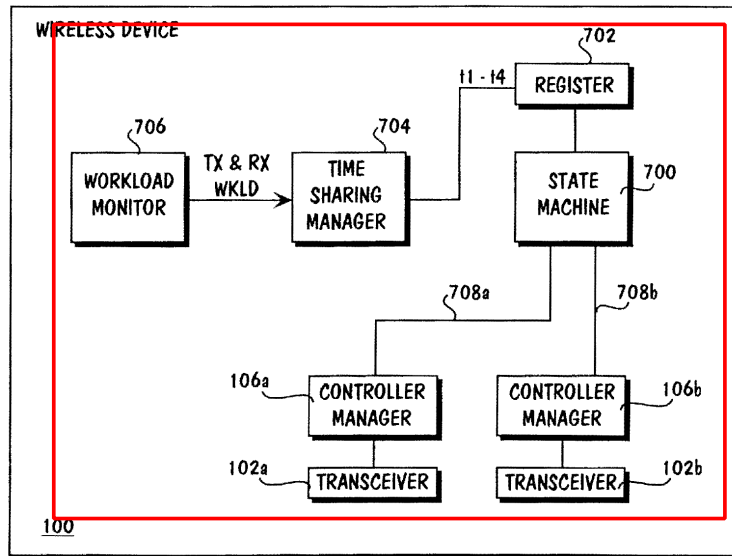
104. The ’686 Patent describes the types of transmissions as simultaneous that Nevo teaches (e.g., its coordinated transmissions at the same time, *e.g.*, Nevo, 3:38-45).

b. 11[1.1] controlling at least one multi-platform module to communicate with at least one of a plurality of communication links

105. In my opinion, Nevo discloses or suggests this limitation. Figure 1 of Nevo illustrates a wireless device that has a multi-platform module. The recited multi-platform module is shown in its control managers 106a/106b and transceivers 102a/102b (annotated in red, below). Nevo, 3:28-45. This communicates with at least one of a plurality of communication links because Nevo teaches transceivers (102a/102b) that connect to two separate wireless networks (108a/108b) (*id.*) that can be Bluetooth and IEEE 802.11. *Id.*, 4:46-55.

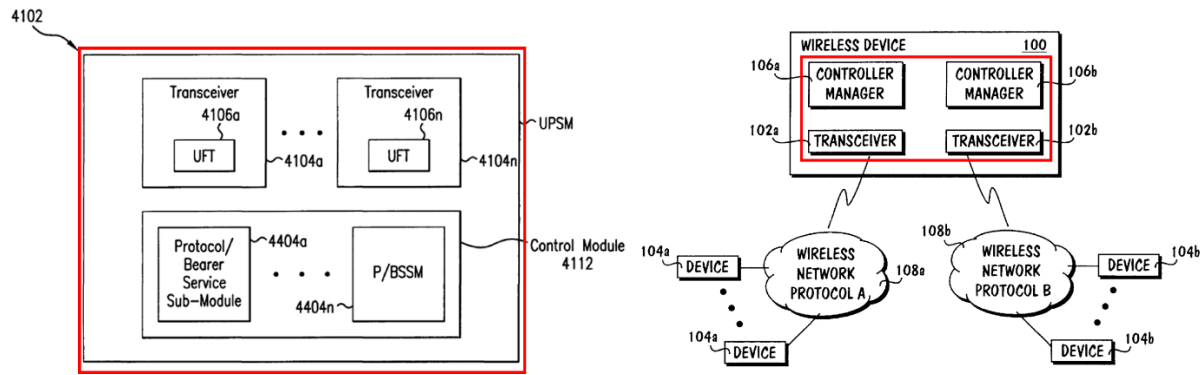


106. Nevo provides additional detail not illustrated in Figure 1. Other figures provide further detail of Figure 1 (which is a higher level figure) and describe further details regarding Nevo's ability to perform multi-platform communications. Nevo, Figs. 3, 5, 7, 9a, 11a, 13, 2:29-59. Figure 7 includes the transceivers 102a/102b and controller manager 106a/106b but also illustrate other circuitry that assist in the control of the module, including other circuitry such as a state machine 700, a register 702, a time-sharing manager 704, and a workload monitor 706 (all annotated in red, below). *Id.*, 6:34-57.



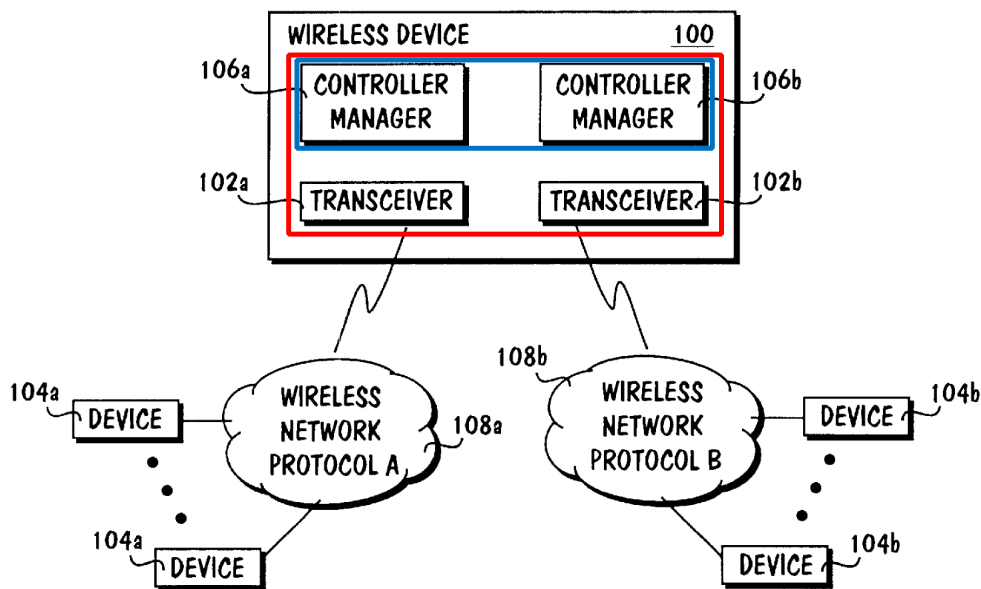
107. In my opinion, Nevo has a significant amount of control circuitry to control multi-platform communication. Under any theoretical argument for the claimed “multi-platform module,” it is my opinion it is met by Nevo.

108. Further, Nevo has a substantively identical disclosure for this limitation as it is described in the '686 Patent. This is seen in Figure 44 of the '686 when it is compared to Figure 1 of Nevo. Shown below-left is Figure 44 of the '686 Patent which describes a multi-platform module (UPSM 4102). '686 Patent, 38:39-42, 38:44-46, 40:36-46. A POSITA would have understood the UPSM to be a multi-platform module because it performs the multiple/bearer protocol services. UPSM 4102 has a transceiver 4106a/n and a control module 4112 that has a protocol/bearer service sub-module 4404a. *Id.*, 40:36-52. The '686 Patent is similar to Nevo's multi-platform module shown in Figure 1 (annotated red, below-right).

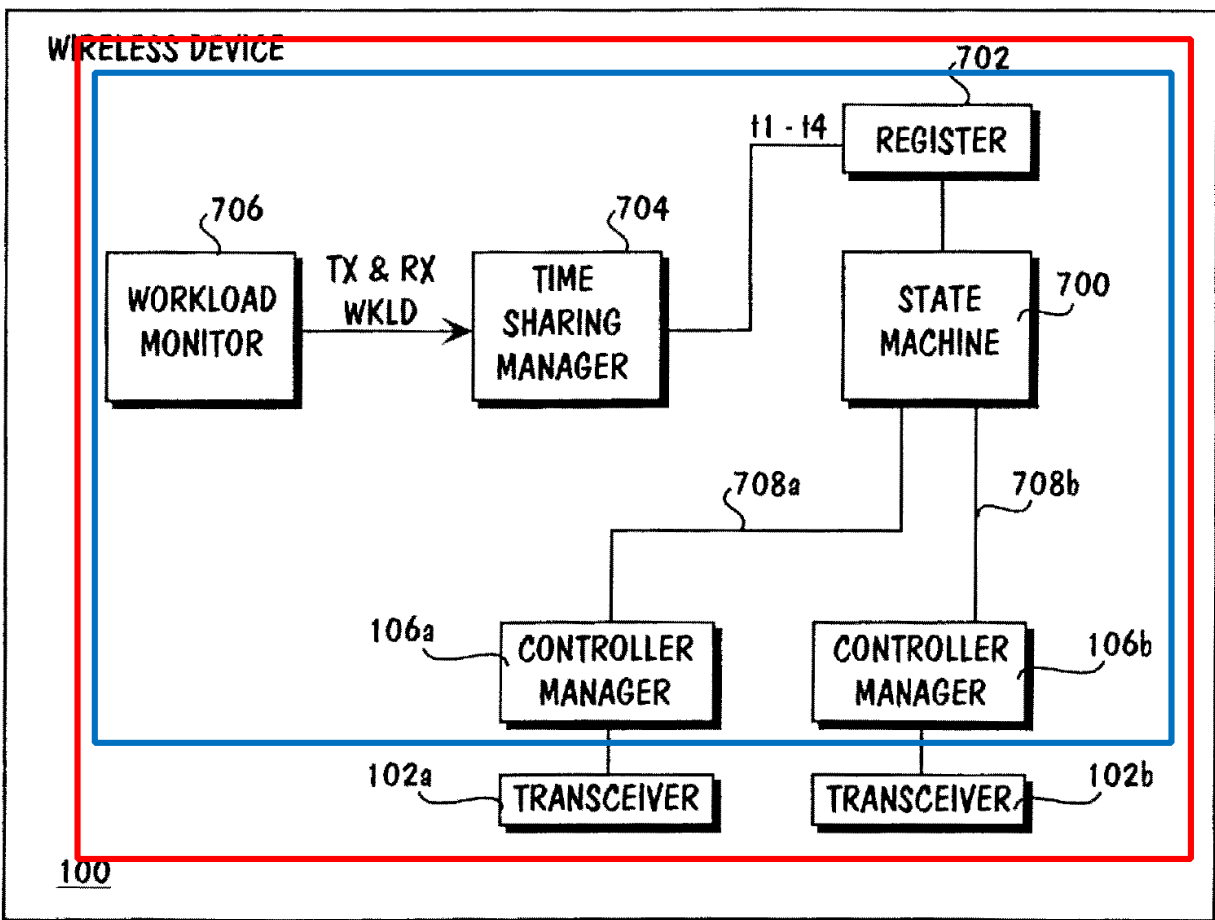


c. 11[1.2] using a control module

109. In my opinion, Nevo discloses or suggests this limitation. As shown below, Nevo teaches a control module because it teaches controller managers 106a/106b (annotated blue). The controller managers 106a/106b control the wireless transceivers 102a/102b (Nevo, 3:39-41, Fig. 1; *see also id.*, Figs. 3, 5, 7, 11a, 13) to work with Bluetooth and IEEE 802.11. *Id.*, 4:46-55. These controller managers 106a/106b are part of the control module as can be seen below.

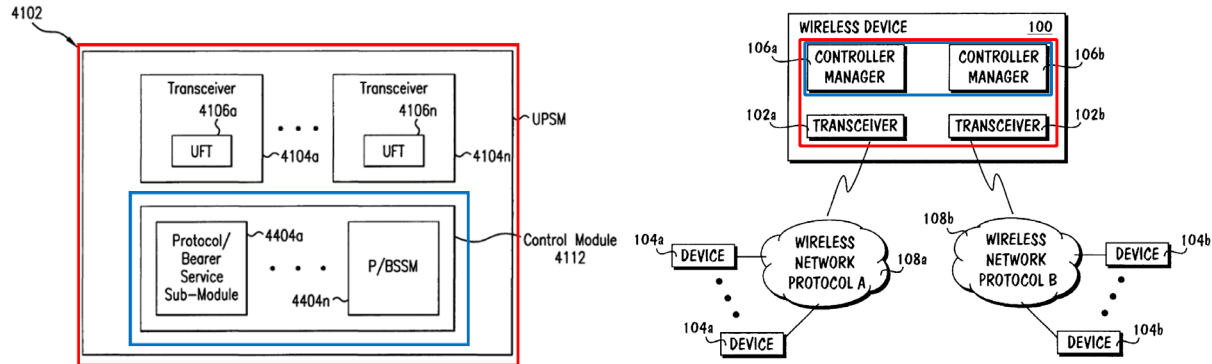


110. In addition to this, it is my opinion that Nevo teaches a control module even if is argued that control module must have some type of specific functionality or have specific modules. Nevo has more functional blocks that could be considered as part of a control module. For example, Figure 7 describes a state machine 700, a register 702, a time-sharing manager 704, and a workload monitor 706 (annotated in blue, below) which work together to control the operation of each respective transceiver. Nevo, 6:34-57.



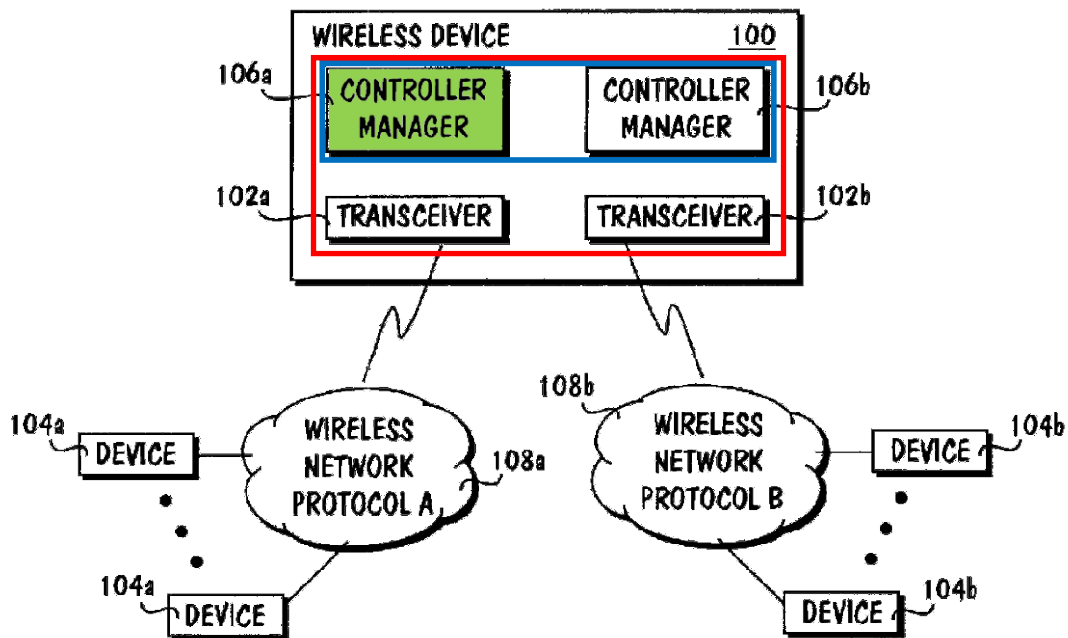
111. Like the claimed multi-platform module, Nevo likewise teaches the control module in a manner that is substantively similar to how the '686 Patent

specification describes it. Below-left is Figure 44 of the '686 Patent's multi-platform module (annotated, red) that has a control module 4112 (blue) which has protocol/bearer service submodules 4404a/n. '686 Patent, 38:39-42, 38:44-46, 40:36-52, Fig. 44. Shown below-right, Nevo teaches a multi-platform module (red) with a control module (blue) that has several controller modules 106a/106b for each respective protocol, e.g., IEEE 802.11 or Bluetooth. Nevo, 3:39-41, 4:46-55, Fig. 1. In my opinion, these two are substantively identical.



d. 11[1.3] having a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes

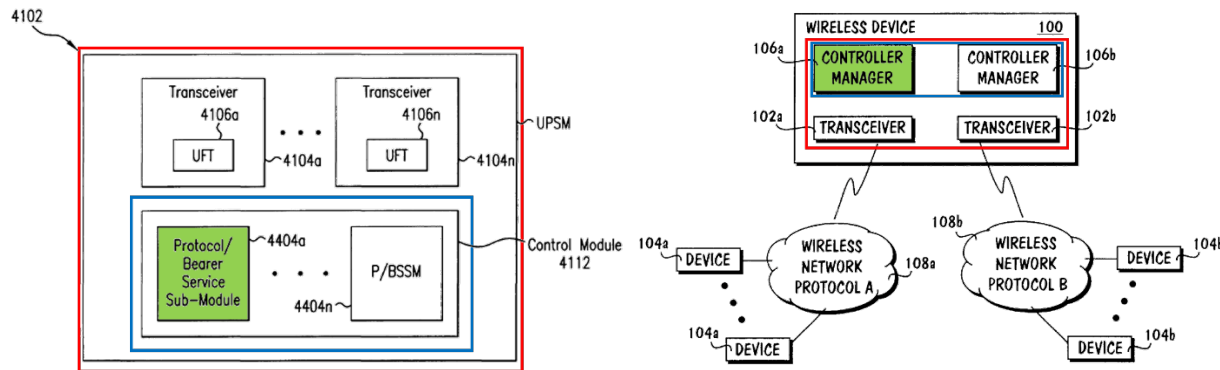
112. In my opinion, Nevo discloses or suggests this limitation. The control module is shown above in Figure 1 (blue). This control module discussed has plurality of separate standard/protocol submodules (e.g., controller managers 106a/106b). One of the standard/protocol submodules is annotated in green below onto Figure 1. As can be seen from the below, the claimed multi-platform module (red) has a control module (blue) which has a plurality of standard/protocol sub-modules (one of each is green).



113. The controller manager 106a/106b meet the claimed standard/protocol submodules because they control their respective transceivers to connect to the two separate networks 108a/108b “in accordance with the respective protocols” (Nevo, 4:1-5) that are Bluetooth and IEEE 802.11 networks, as an example, respectively. *Id.*, 4:46-55; *see also* Fig. 1 (depicting PROTOCOL A and PROTOCOL B). Further, the connections are graphically depicted in Figure 1.

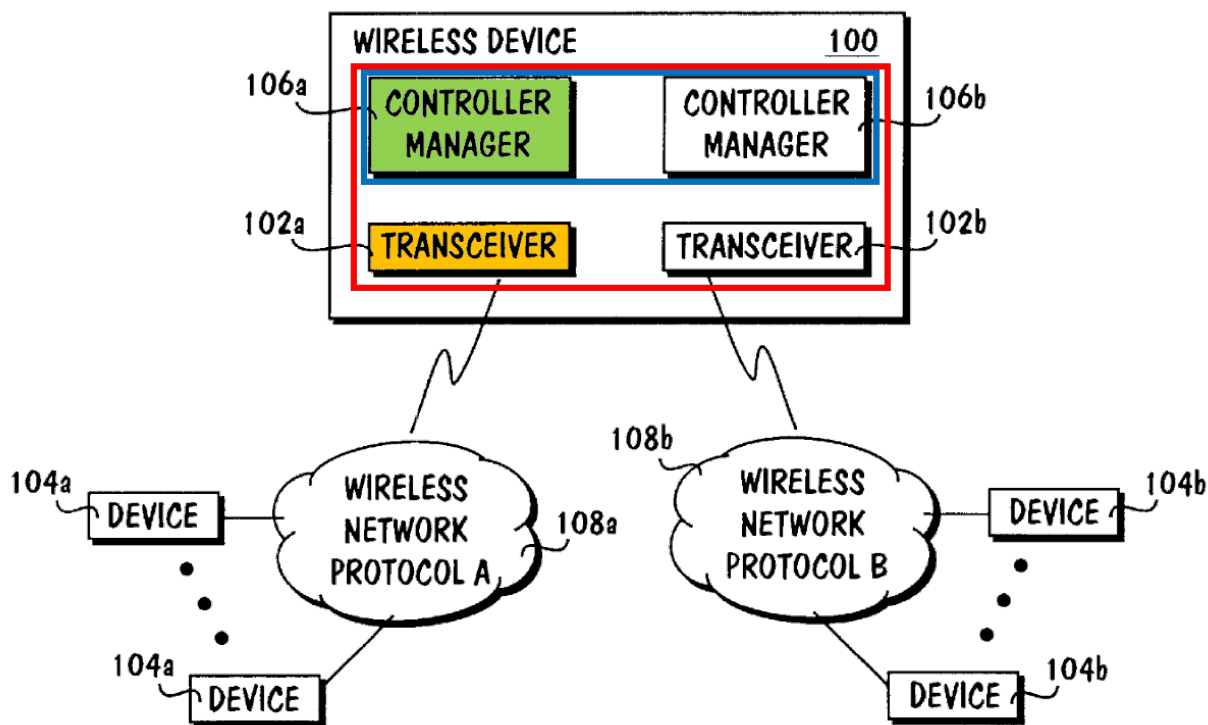
114. Like I have described with respect to the “multi-platform module” and “control module” above, Nevo teaches “having a plurality of standard/protocol submodules, wherein the at least one multi-platform module includes” limitation in a manner similar to how the ’686 Patent specification describes it. Shown below-left is the ’686 Patent’s Figure 44 multi-platform module (annotated, red) having a control module 4112 (blue) which has protocol/bearer service submodules 4404a/n

(one of which is annotated green). '686 Patent, 38:39-42, 38:44-46, 40:36-52, Fig. 44. Nevo (Fig. 1 below-right) teaches a multi-platform module (red) with a control module (blue) that has several controller modules 106a/106b for each respective protocol, e.g., IEEE 802.11 or Bluetooth (one of which is annotated green). Nevo, 3:39-41, 4:46-55, Fig. 1.



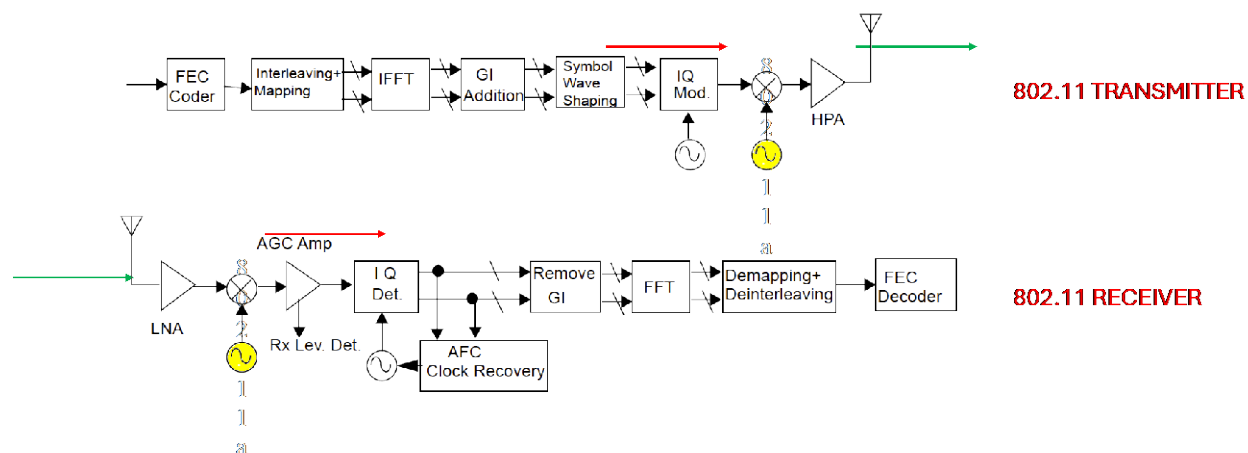
- e. **11[1.4] a plurality of transceivers each having at least one frequency translation module, wherein said at least one frequency translation module comprises**

115. In my opinion, the Nevo-Avitabile combination teaches this limitation. Nevo's multiplatform module has a plurality of transceivers. One of the transceivers 102a is annotated in orange in Figure 1, below. As can be seen below, the transceivers are part of the multi-platform module (red). The wireless transceivers transmit and receive signals wirelessly in accordance with their respective protocol. Nevo, 3:28-35. As can be seen below, those transceivers communicate with wireless protocols A and B.



116. I note that the transceivers of Nevo’s Figure 1 do not provide specific schematic level detail of their operation. However, the claims require that the transceivers have a “frequency translation module,” and frequency translation is required when two time-varying signals are modulated for transmission. As I explained in Sections VI.B (Modulating Signals for Wireless Communications) and X.A.3 (Ground 1 Motivation to Combine), 802.11 requires frequency translation. as shown at page 24 of 802.11a (Ex. 1039), it is shown that IEEE 802.11 provides both modulation for an RF signal (e.g., carrier in yellow, data in red, and RF output in green) and demodulation to receive the data signal (e.g., carrier in yellow, data in red, and received RF in green). A POSITA would have understood that the data signal (red) is a lower frequency than the RF signal (green), and would have

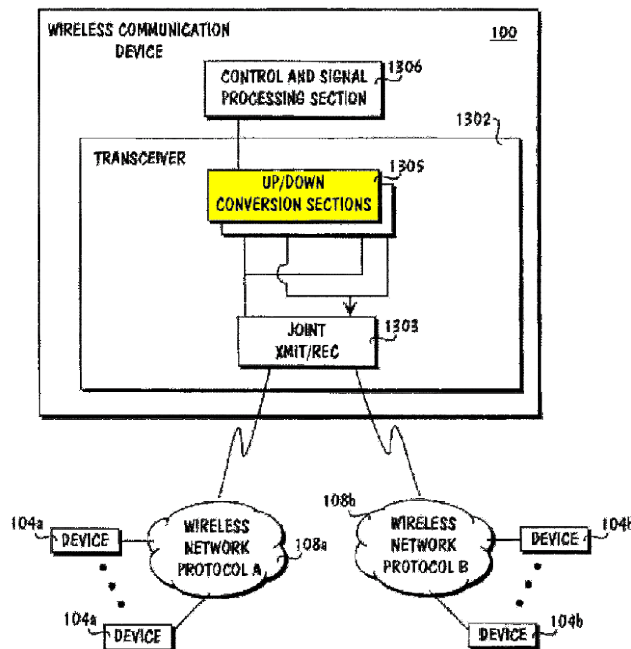
understood down-conversion to be necessary for 802.11 receivers. I have shown the basics of signal modulation using two separate time varying signals in my background section of this declaration.



117. The transceivers of Nevo's Figure 1 embodiment do not explicitly include a frequency translation module. A POSITA would have, however, found it obvious to include a frequency translation module in light of Nevo's own teachings and, furthermore, in light of other prior art frequency translation modules (Avitable).

118. Nevo renders the frequency translation module obvious in view of its own teachings and in view of a POSITA's understanding of the art. As I've noted, frequency translation modules are required for transmission to modulate another signal (baseband) onto a carrier, but also are required to de-modulate the baseband from the received carrier. I've described this with respect to 802.11 and in the background section. Up-converters take a carrier (e.g., a 2.4 GHz) signal and

modulate on a data signal (e.g., a 50 MHz) to output an RF signal at the carrier (2.4 GHz.) To receive that signal, receivers down convert, i.e., they take an RF signal having baseband on a carrier at, e.g., 2.4 GHz, and de-modulate it to extract a baseband at, e.g., 50 MHz having the data. Indeed, Nevo itself recognizes that frequency translation modules are needed because, although it describes components in block form, Figure 13 describes an up/down conversion section 1305 (annotated yellow, below) within a transceiver 1302 as recognition that modulating/de-modulating a lower frequency baseband onto/from a higher frequency carrier is required for protocols like Bluetooth and IEEE 802.11. Nevo, 10:40-45. In my opinion, a POSITA would have been motivated to and would have provided a frequency translation module in view of Nevo's Figure 1 teachings.



Nevo, Fig. 1 (annotated)

119. Moreover, a POSITA would have been motivated to include a frequency translation module, like the one taught in Avitabile. I have described why a POSITA would have been motivated to combine Nevo and Avitabile in Section X.A.3. Avitabile teaches a frequency translation module because it teaches a down-converter that translates an RF input signal to an output IF signal. Avitabile, p. 337 (Abstract) (“A digital coherent-downconverter configuration is described.”); *see also id.*, Fig. 1, Fig. 2; *see also* Section X.A.4.j below.

f. 11[FTM-1.1] a switch

120. In my opinion, the Nevo-Avitabile combination teaches this limitation. As I have previously described, a POSITA would have been motivated to combine Nevo and Avitabile. The next limitations with the header FTM describe the frequency translation module which is described by Avitabile.

121. Avitabile teaches a down-converter, and this downconverter has a switch. Avitabile, Fig. 2. This switch is annotated in blue below on the equivalent circuit. Figure 2’s switch is “modelled as an ideal switch” (*id.*, p. 338 (§4.1)) and a switch is further described in prototype as being a MESFET. *Id.*, p. 339 (§5) (“prototype SH1 uses a single MESFET as switching element” to control switching diodes); *see also id.*, Fig. 4 (depicting switch connected to pulse generator in a prototype), Figs. 8 and 9 (same in another prototype).

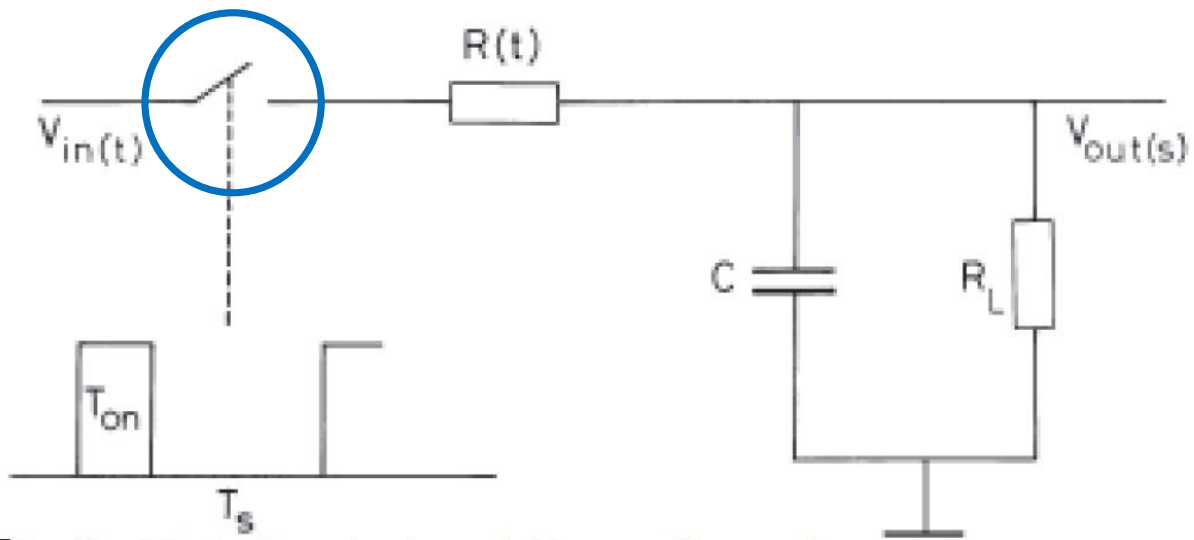
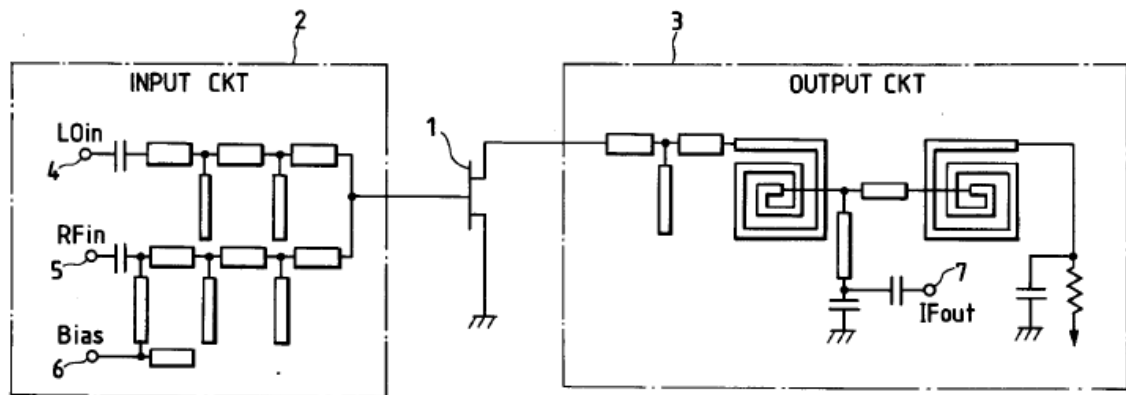


Fig.2 Equivalent-circuit model in sampling mode

Avitabile, Fig. 2 (annotated).

122. A POSITA would have understood that a MESFET includes a gate, drain, and source. EP0551857 (Ex. 1041) for example illustrates this in, e.g., element 1 of Figure 1. *See also* EP0551857, 3:2-20. A POSITA would have understood that gates receive signals to provide a channel between the source and drain in order to conduct electricity. A POSITA would have understood that Figure 1's switch can be a switch, e.g., a MESFET, or any other switch having a source, drain, and gate.

FIG. 1



EP0551857, Fig 1.

g. 11[FTM-1.2] configured to operate according to an energy transfer signal,

123. In my opinion, the Nevo-Avitabile combination teaches 11[FTM-1.2].

124. Avitabile's switch receives a control signal that controls how long the switch is on. The control signal, which is the energy transfer signal, is shown below in purple on Figure 2 (annotated). Control signal T_s controls when the switch is closed, i.e., turned-on (T_{on}). Avitabile, p. 338 (§4.1) (describing turning switch on for "interval t_{on} "), Fig. 2; *see also* Fig. 4 (depicting a switched prototype) and Figs. 8-9 (depicting another switched prototype). Other switches being turned on are described in the prototypes of Figure 4 and Figures 8-9. Furthermore, a POSITA would have understood that the switch could work as an effective active low (e.g., turning the switch off to activate other circuitry to flow energy to the capacitor, e.g., enabling diodes in Fig. 4) or effective active high (e.g., turning the switch on to

activate other circuitry to flow energy to capacitor, e.g., flipping the switch of Fig. 2 on).

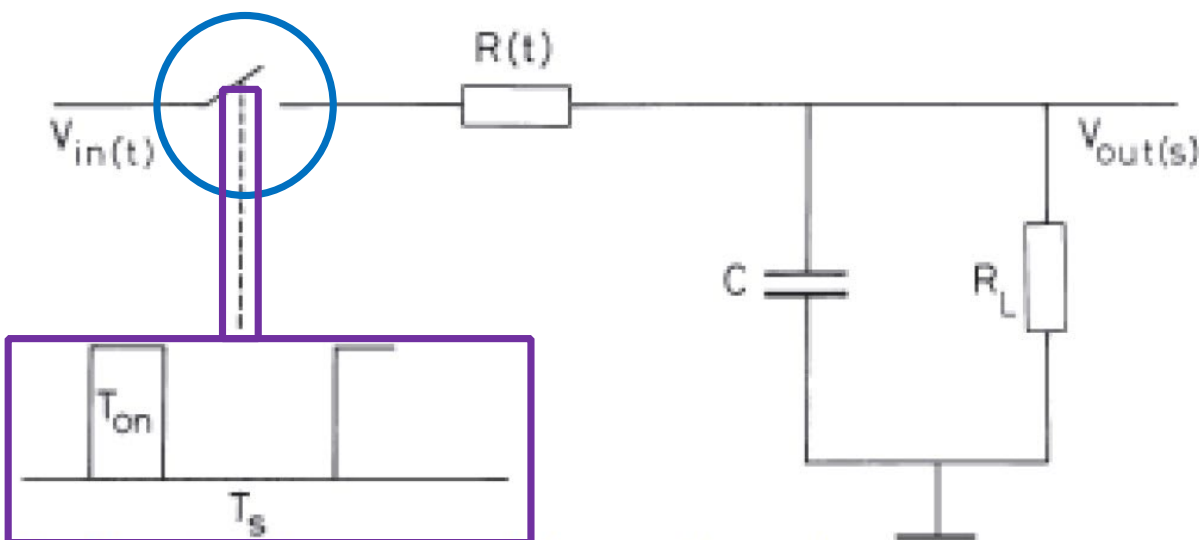


Fig.2 Equivalent-circuit model in sampling mode

Avitabile, Fig. 2 (annotated).

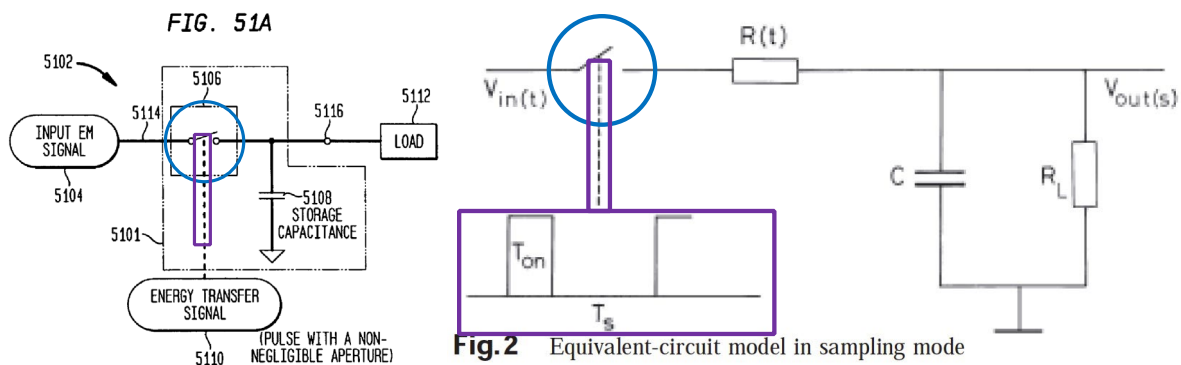
125. In my opinion, a POSITA would have understood that Avitabile's control signal T_s is the recited "energy transfer signal" because the control signal T_s controls the transfer of energy from one end of the switch to the other (e.g., from the received RF signal to the other end having the capacitor). In an example, an aperture time of the switch transferring energy (T_{on}), is 100 picoseconds. Avitabile, p. 339 ("[s]witching time < 100 ps"); *see also id.*, p. 341 (§5.2) ("aperture time $T_a = 100$ ps"); *see also id.*, p. 340 (§4.1) ("400 ps aperture time").

126. A POSITA would have understood a 100 picosecond and 400 picosecond aperture time with a 1 GHz signal would be a 10% and 40% duty cycle, respectively and an aperture of lower frequency signals (e.g., .25 GHz) would be

higher. Nonetheless, a POSITA would have understood that these aperture times allow for the transfer of energy. A POSITA would have understood that, during the aperture period, $V_{in(t)}$ would charge the capacitors (e.g., C of Figure 2, C_H of Figure 4, C_{hold} of Figure 8). See Serway, pp. 775-77, 933-34 (providing general equations for the capacitor).

127. Nonetheless, this is made explicit by Avitabile, who describes energy from the input signal being stored in the hold capacitor. Avitabile, pp. 339-40 (§4.1) (stating “a fraction ϵ_A of the input signal is stored in the hold capacitor”). A POSITA would have understood that a hold capacitor holds energy (hence the name “hold”).

128. Finally, the '686 Patent depicts the energy transfer signal in the same way as Avitabile's control signal T_s . '686 Patent, Fig. 51A (excerpted below-left with like-annotations to the switch, blue, and energy transfer signal, purple). Show below-right is Avitabile's Figure 2 circuit, which similarly depicts a switch (blue) that is controlled via a signal (purple) to close and pass the signal to a capacitor.



'686 Patent, Fig. 51A (annotated); Avitabile, Fig. 2 (annotated).

h. 11[FTM-1.3] and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and

129. In my opinion, the Nevo-Avitabile combination teaches 11[FTM-1.3]. Avitabile's switch sub-samples and transfers energy from a first EM signal. As I discussed immediately above, when Avitabile's switch is on it allows the signal to flow to the capacitor (thereby transferring energy).

130. Avitabile describes providing T as the "sampling interval." Avitabile, p. 338 (§3) ("[a] clock waveform is fed to the LO port, determining the sampling interval T"). "T is related to the RF input-waveform bandwidth B through a positive integer k," where k can be as low as 1. *Id.* As an example, Avitabile teaches sampling at 249.85 MHz for an input signal at 1 GHz. Avitabile, Fig. 10 (describing "FFT response to a 1GHz centre frequency and a 44.92MHz bandwidth SSB-SC AM input test signal sampled by 4ns and 7% duty-cycle waveform $B_w = 44.92\text{MHz}$ $F_{\text{sampling}} = 249.85\text{MHz}$ 4096 FFT samples"); *see also id.*, Fig. 5 (showing a 4ns sampling period which is approximately .25 GHz). A POSITA would have understood this to be sub-sampling because samples are taken at a rate of less than the signal frequency. As discussed in Section IX.E (Claim Construction, "Sub-sample") I understand ParkVision previously proposed "sub-sample" "refer[s] to sampling at an aliasing rate, i.e., at a rate that is less than or equal to twice the frequency of the signal being sampled." (EX1014, 6-10). In my opinion, Avitabile teaches subsampling under this construction. Avitabile describes providing T as the

“sampling interval” that is “related to the RF input-waveform bandwidth B through a positive integer k ” that can be as low as 1. Avitabile, 338 (§3). When k is one or two, a POSITA would have recognized Avitabile’s sampling interval T is “less than or equal to twice the frequency of the signal being sampled.” In addition, Avitabile teaches sampling at 249.85 MHz for an input signal at 1 GHz (i.e., sampling at about $\frac{1}{4}$ (less than twice) the frequency of the signal being sampled). Avitabile, Fig. 10; *see also* Fig. 5. In my opinion, a POSITA would have understood these examples to teach sub-sampling.

131. Avitabile’s switch further transfers energy. Avitabile describes using 10% and 40% duty cycles for T_{on} (T_a describing aperture) to sub-sample the carrier signal. Avitabile, p. 339 (“[s]witching time < 100 ps”); *see also id.*, pp. 341 (§5.2) (“aperture time $T_a = 100$ ps”), 340 (§4.1) (“400 ps aperture time”). A POSITA would have understood, during the time of T_{on} , that the switch would allow energy from the input ($V_{\text{in}(t)}$) to transfer to the capacitor C . This is because the branch of the capacitor is energized. Furthermore, a POSITA would have understood that the switch could work as an effective active low (e.g., turning the switch off to activate other circuitry to flow energy, e.g., enabling diodes in Fig. 4) or effective active high (e.g., turning the switch on to activate other circuitry to flow energy to the capacitor, e.g., flipping the switch of Fig. 2 on).

132. As can be seen from the below, when the switch (blue) is closed via control signal (purple), the RF signal (red) goes through the circuit energizing the capacitor. See, e.g., Serway, pp. 775-77, 933-34 (providing general equations for the capacitor charging) (EX1042).

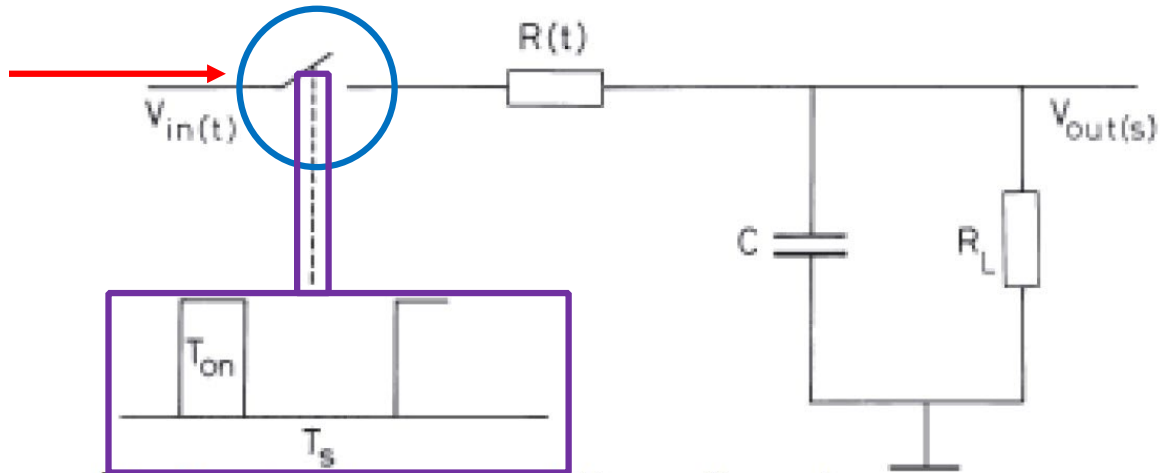
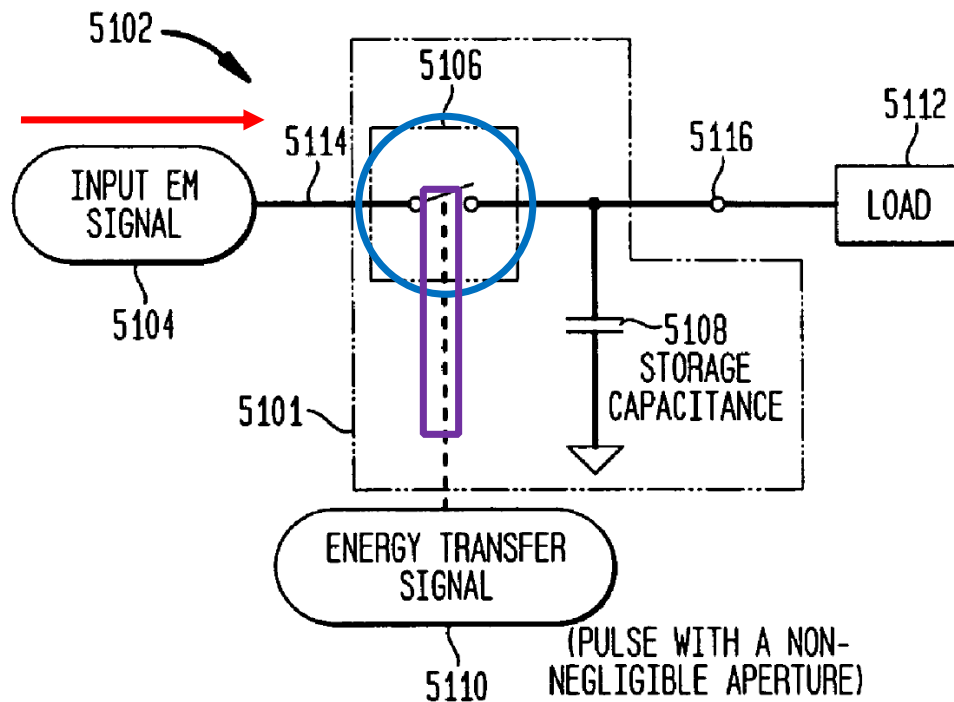


Fig.2 Equivalent-circuit model in sampling mode

Avitabile, Fig. 2 (annotated).

133. This circuit is substantively identical to the circuit of the '686 Patent. The '686 Patent at Figure 51A is excerpted below. As can be seen, they both have a control signal (purple) to control a switch (blue) to allow an input RF signal (red) to be propagated to the circuit.

FIG. 51A



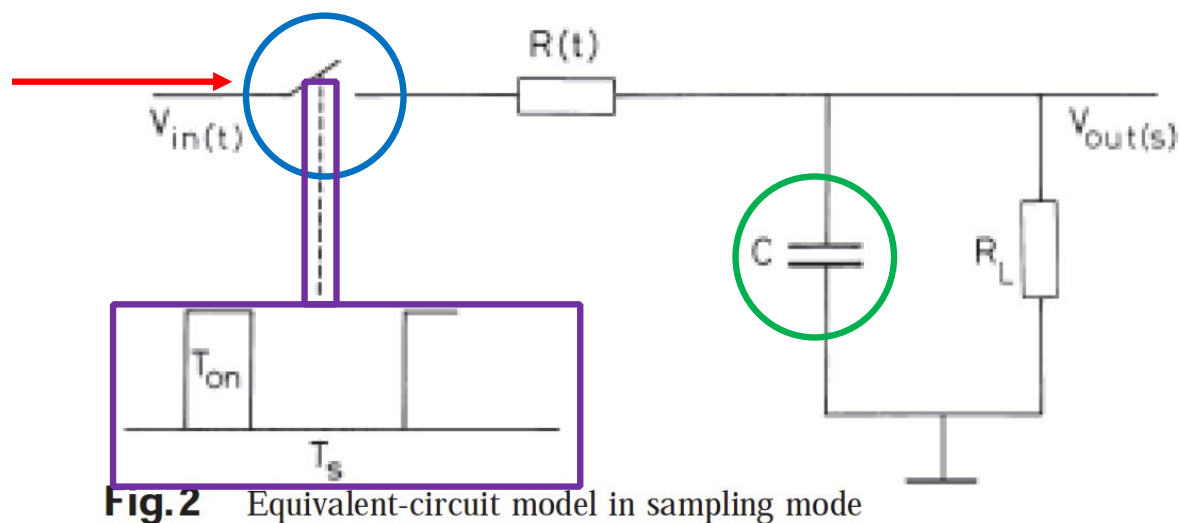
'686 Patent, Fig. 51A (annotated).

- i. **11[FTM-2.1] a storage module coupled to said switch and configured to store said transferred energy,**

134. In my opinion, the Nevo-Avitabile combination teaches 11[FTM-2.1].

135. Avitabile teaches a hold capacitor. Avitabile, Fig. 2 (capacitor C), 4 (capacitor C_H in prototype 1), 8-9 (capacitor C_{hold} in prototype 2); *see also id.*, pp. 338-39 (§4.1), 340 (§5.1) (referring to “hold capacitor”). A “fraction [] of the input signal is stored in the hold capacitor.” *Id.*, pp. 338-39 (§4.1). A POSITA would have understood that a capacitor charges with time when a voltage is applied to it. *See, e.g.*, Serway, pp. 775-77 (providing general equations for charge of capacitor). This is evident in the name “hold capacitor.” Shown in Figure 2, capacitor C (green)

will charge with time when the switch (blue) is closed via signal $V_{in(t)}$ (red). The energy stored is non-negligible and is energy transferred from the input to the capacitor. *See, e.g.,* Avitabile, 338-39 (§4.1) (stating that a “fraction [] of the input signal is stored in the hold capacitor”), Figs. 4-7 (showing current flowing into capacitor).



Avitabile, Fig. 2 (annotated).

136. Avitabile teaches its switch and storage module are directly connected or connected through a wire (or a closed switch) (“coupled”). Figure 2’s resistor $R(t)$ is labeling for the switch’s resistance and is not a separate component. Avitabile, p. 338 (§4.1) (stating that “[t]he sampler is modelled as an ideal switch with a time-variable resistor in series, which represents the switch internal resistance.”) Avitabile’s Figure 2 switch is directly connected to its capacitor.

137. Avitabile graphically demonstrates the capacitor being charged over time in one of its examples (prototype 1). As shown in Figure 5, signal I_D (yellow) illustrates current (from input RF signal of Figure 4, red) where a portion of the current goes to the branch having the hold capacitor C_H (green) when switch (blue) is off. I note that this circuit in FIG. 4 creates a T_{ON} via low pulse signals by turning the diodes on (and high pulse signals turn the diodes off).

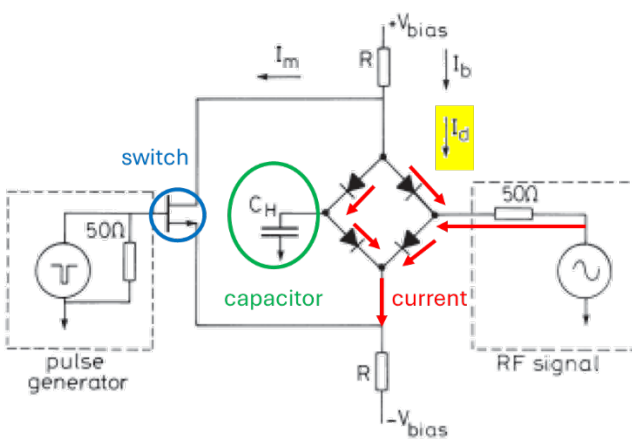


Fig.4 Schematic diagram of SH1 sample-and-hold circuit

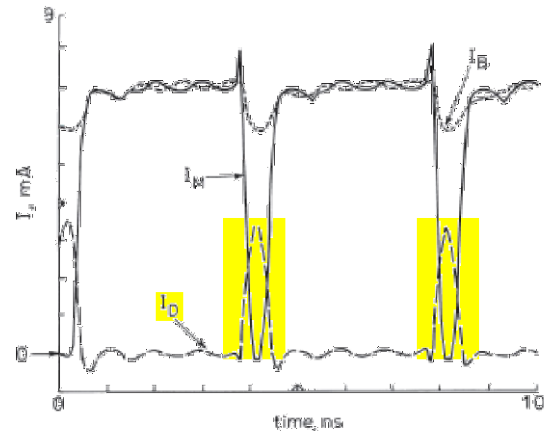


Fig.5 Measured currents in the bridge (I_D), in the MESFET (I_m) and in the power supply (I_p)

Avitabile, Figs. 4, 5 (annotated).

138. The energy stored in the capacitor C_H is illustrated in Figure 6 (and its zoomed-in Figure 7 showing markers X_1 and X_2). As can be seen from the below approximate annotations, the capacitor will charge during periods that current from I_D is flowing to the branch having capacitor C_H . The below annotations can only be approximate because there are no x-axis or y-axis markers. Furthermore, Figure 7 depicts a “droop off” (the time periods following the yellow highlights) which shows

the capacitor being discharged. This is further proof that it had been charged when the signal was applied, and further proof that Avitabile teaches energy transfer.

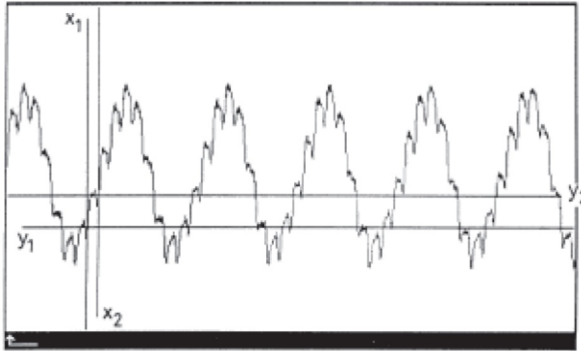


Fig. 6 Sampled signal obtained by SH1
 $x_1 = 28\text{ns}$; $y_1 = -23\text{mV}$; $x_2 = 32\text{ns}$; $y_2 = -7.4\text{mV}$
 Horizontal scale: 20ns/div .

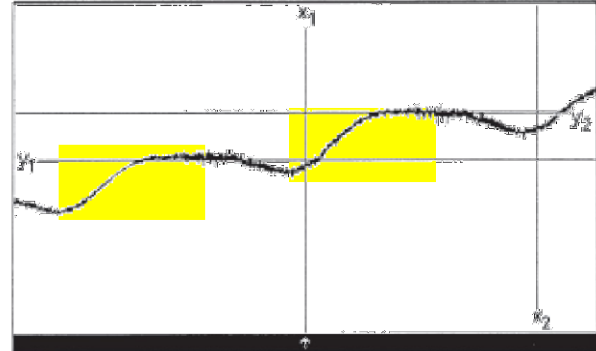
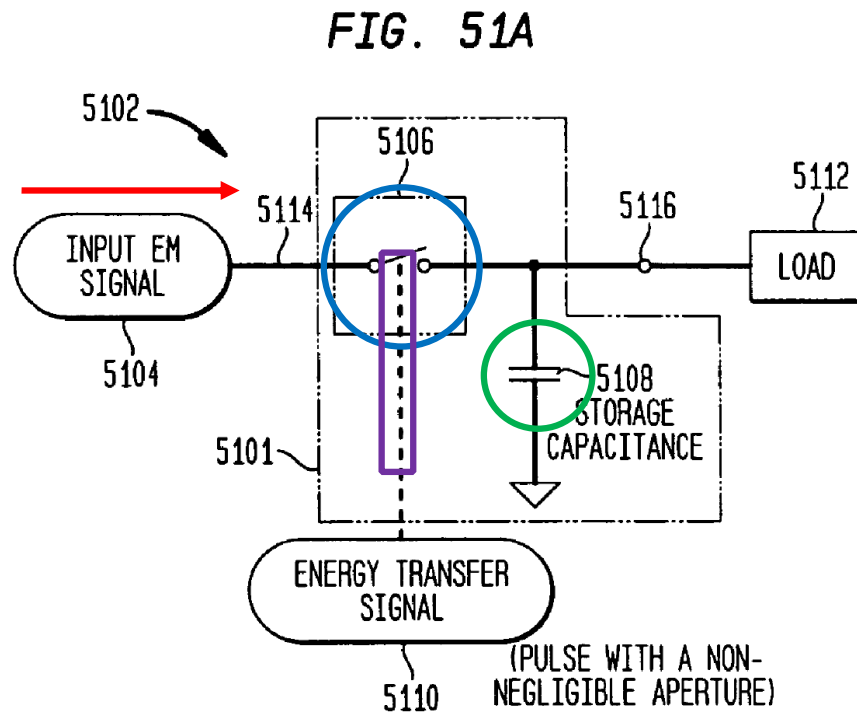


Fig. 7 Hold time and 'droop off' of the sampled signal
 $x_1 = 0$; $y_1 = 11\text{ mV}$; $x_2 = 4\text{ns}$; $y_2 = 33.4\text{mV}$
 Horizontal scale: 1ns/div .

Avitabile, Figs. 6, 7 (annotated).

139. Finally, I understand that ParkerVision has previously argued that the “storage module” requires a “low impedance load” in order to be an “energy transfer system.” I disagree with that. Nonetheless, Avitabile provides equations for a load impedance (R_L) that can be adjusted (*see* equations 13 and 14) which are equations for defining the values of C and R_L among others. In my opinion, a POSITA would have found it obvious to provide a lower impedance, which would simply require a higher capacitance. In addition, a lower capacitance would require larger resistance. Any selection would simply be the selection of component values for Avitabile’s circuits, but the fact that there is a transfer of energy into (and out of) the capacitor would remain. *E.g., id.*, Fig. 6 (showing charge/discharge).

140. Avitabile's Figure 2 matches '686 Patent Figure 51A. As can be seen below, Figure 51A provides a switch (blue) controlled by a signal (purple) that allows an input RF signal (red) to flow to a capacitor (green). A POSITA would have understood that the below capacitor would have similarly been charged for the same reasons.



'686 Patent, Fig. 51A (annotated).

- j. **11[FTM-2.2] wherein a second EM signal is generated from said stored energy, said second EM signal having a [frequency] different from said first EM signal;**

141. In my opinion, the Nevo-Avitabile combination teaches 11[FTM-2.2]. As described in the preceding section, Avitabile teaches a capacitor (storage module,

green) that is used to store sub-sampled energy from the first EM signal (red). Figure 2, annotated, is illustrated below.

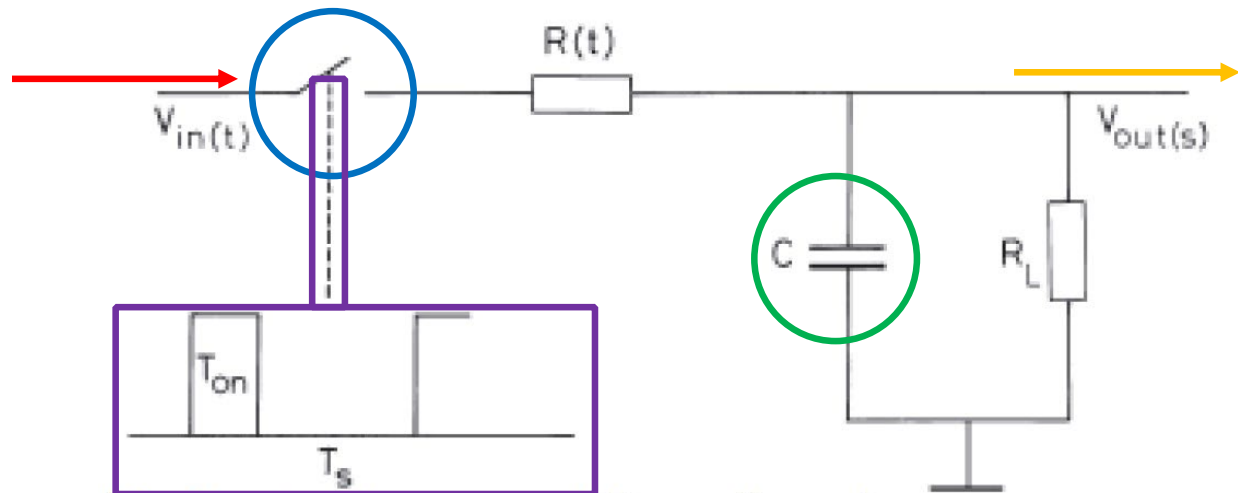


Fig.2 Equivalent-circuit model in sampling mode

Avitabile, Fig. 2 (annotated).

142. Avitabile describes generating an IF (intermediate frequency) signal from that stored energy (second EM signal having a frequency different from $V_{in}(t)$ (first EM signal)). Figure 1 illustrates the SH module from Figure 2 (annotated yellow in Figure 1, below) in a higher-level system block diagram. Avitabile, p. 338 (§3). As can be seen in Figure 1, the SH module outputs an intermediate frequency (IF) from a down-converter, which in my opinion, a POSITA would have understood to be a lower frequency signal than the RF due to the “downconvert[ing]” operation. This IF signal is later converted to digital form for subsequent processing. Avitabile, p. 338 (§3). In this figure, IF is a lower frequency from the RF input, and can further be the baseband signal having the data (or require further processing). In Avitabile’s

Figure 2 and prototypes, and those figures demonstrating tests of those prototypes, the output of the downconverter is demonstrated to be the baseband signal (i.e., the data signal de-modulated from the carrier signal at the receiver). Here, BPF refers to a bandpass filter and ADC refers to an analog to digital converter.

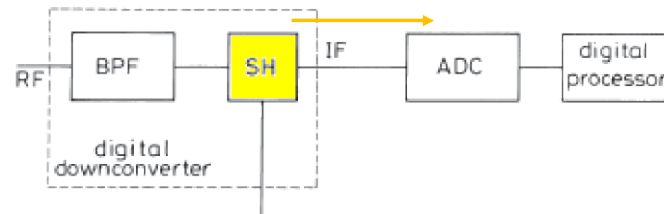


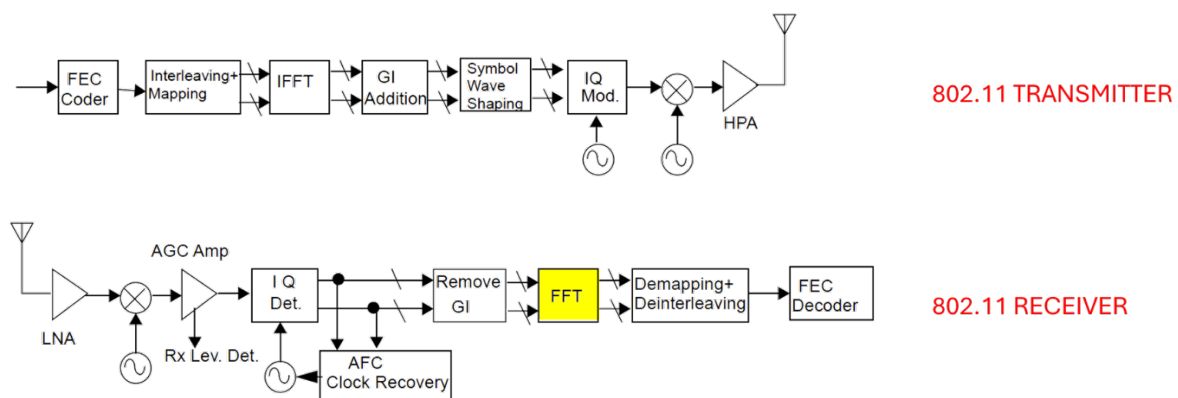
Fig.1 Schematic diagram

Avitabile, Fig. 1 (annotated).

143. Avitabile further demonstrates that the input RF signal has a higher frequency than the output signal. Avitabile's down-converter receives higher signals in the GHz range for output bandwidths in the 50 MHz range (which is lower). Avitabile, p. 339 (§5) ("[t]he operation of the digital downconverter will be demonstrated for input waveforms up to the S-band with a signal bandwidth up to 50MHz."). Moreover, Avitabile provides specific prototypes that illustrate receiving a higher RF input and outputting a lower frequency bandwidth signal. For instance, the first prototype was tested with a 1 GHz carrier signal where a 30 MHz bandwidth was output. *Id.*, p. 340 (§5.1) ("A -10 dBm 1030 MHz tone was used as RF input, simulating an SSB-SC AM signal with $F_c = 1\text{ GHz}$ and $B = 30\text{ MHz}$ "). Furthermore, Figure 6 depicts an output baseband signal having approximately 30 MHz extracted from a carrier of 1 GHz. Avitabile, Fig. 6. As another example, Figure 10 (which is

of a second prototype) demonstrates a FFT (Fast Fourier Transform) on a baseband signal concentrated at 44.92 MHz extracted from a 1 GHz carrier signal. Avitable, p. 341 (§5.2) (“The SH2 prototype has been tested using an SSB-SC AM test signal with a 1GHz centre frequency, and a 44.92MHz bandwidth was used.”). Avitable thus takes an RF signal at a carrier frequency (e.g., 1 GHz) and outputs a lower frequency signal (described as bandwidth).

144. The FFT (Fast Fourier Transform) takes a time domain signal and translates it to the frequency domain. U.S. Pat. No. 6,570,394 (Ex. 1037), 8:55-57 (stating general concept stating: “The fast Fourier transform (FFT) was used to convert the temporal trace into a spectral plot.”) FFT’s are common in processing signals at receivers (and this is demonstrated in 802.11). This is shown below at page 24 of 802.11a (Ex. 1039).



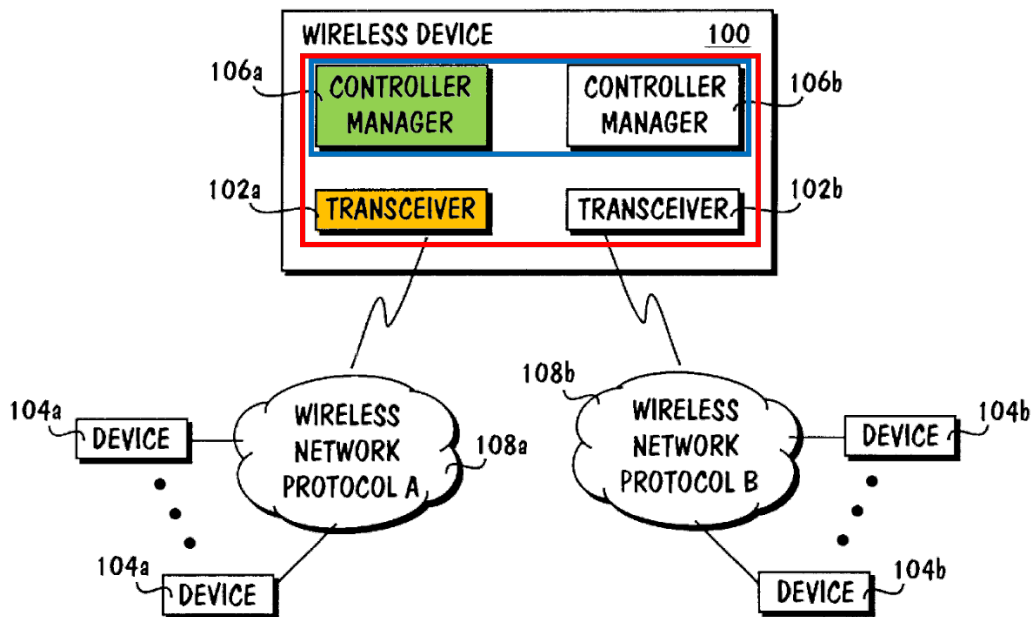
145. As I have described in Section VI.B (Modulating Signals for Wireless Communications), RF transmission systems modulate a data signal with a carrier signal. This occurs before transmission. On receipt, the data signal on the carrier

signal is demodulated. The data signal is referred to the baseband, and it is a lower frequency signal. This common understanding is depicted in Avitabile, which demonstrates the carrier at the S-band, e.g., at 1 GHz, and bandwidths of lower frequencies, e.g., 30 MHz.

k. 11[2] operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and

146. In my opinion, the Nevo-Avitabile combination teaches 11[2]. Nevo teaches two protocols, Protocol A and B, which can be, *e.g.*, Bluetooth and IEEE 802.11, respectively. Nevo, 3:67-4:5, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations).

147. Nevo's first transceiver (e.g., transceiver 102a, orange) operates with a first protocol/standard combination (e.g., Bluetooth) using a first standard/protocol sub-module (controller manager 106a, green). Nevo, 3:28-45. This transceiver is operated in accordance with the respective standard because it provides communication by the wireless device to a device on that specific network, e.g., Bluetooth.



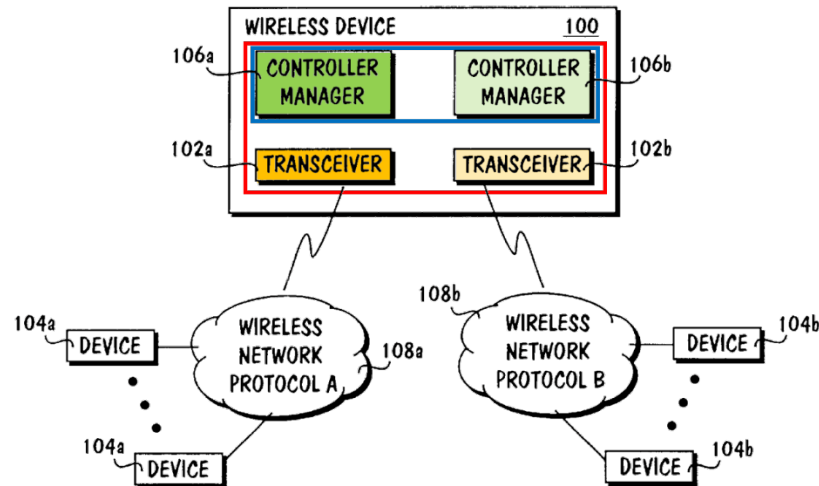
Nevo, Fig. 1 (annotated).

I. 11[3] operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

148. In my opinion, the Nevo-Avitabile combination teaches 11[3]. As discussed regarding element 11[1.3], Nevo teaches two protocols, Protocol A and B, which can be, *e.g.*, Bluetooth and IEEE 802.11, respectively. Nevo, 3:67-4:5, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations).

149. Nevo's second transceiver (*e.g.*, transceiver 102b, light orange) operates with a second protocol/standard combination (*e.g.*, IEEE 802.11) using a second standard/protocol sub-module (controller manager 106a, light green). Nevo, 3:28-45. This transceiver is operated in accordance with the respective standard

because it provides communication by the wireless device to a device on that specific network, e.g., IEEE 802.11.



Nevo, Fig. 1 (annotated).

5. Claim 12

- a. **The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communications links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

150. In my opinion, Nevo teaches claim 12's additional limitations. Nevo discloses a system and method for performing simultaneous multi-platform operations. Nevo, 3:28-35. Figure 1, for example, depicts a wireless device having two transceivers (102a/102b) that can connect to two separate wireless networks (108a/108b) (*id.*) that are Bluetooth and IEEE 802.11, respectively. *Id.*, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations). The wireless device has control managers 106a/106b that control transceiver operation

in a “coordinated manner” to allow communication “with the respective wireless communication protocols at the same time.” *Id.*, 3:38-45, 4:13-15, 4:36-39.

151. Nevo further teaches “an equal quantity of the plurality of standard/protocol sub-modules” for the “quantity of the plurality of communication links.” As depicted in Figure 1, Nevo provides controller manager 106a for wireless network protocol A 108a and controller manager 106b for wireless network protocol B 108b, i.e., one controller per network.

152. As I’ve noted in Section X.A.4.a (element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

153. Nevo teaches simultaneous communication. Nevo, 4:13-15 (“Accordingly, wireless device 100 is able to operate with devices 104a and 104b of networks 108a and 108b in two wireless protocols at the same time.”); *see also id.*, 4:36-39 (stating same).

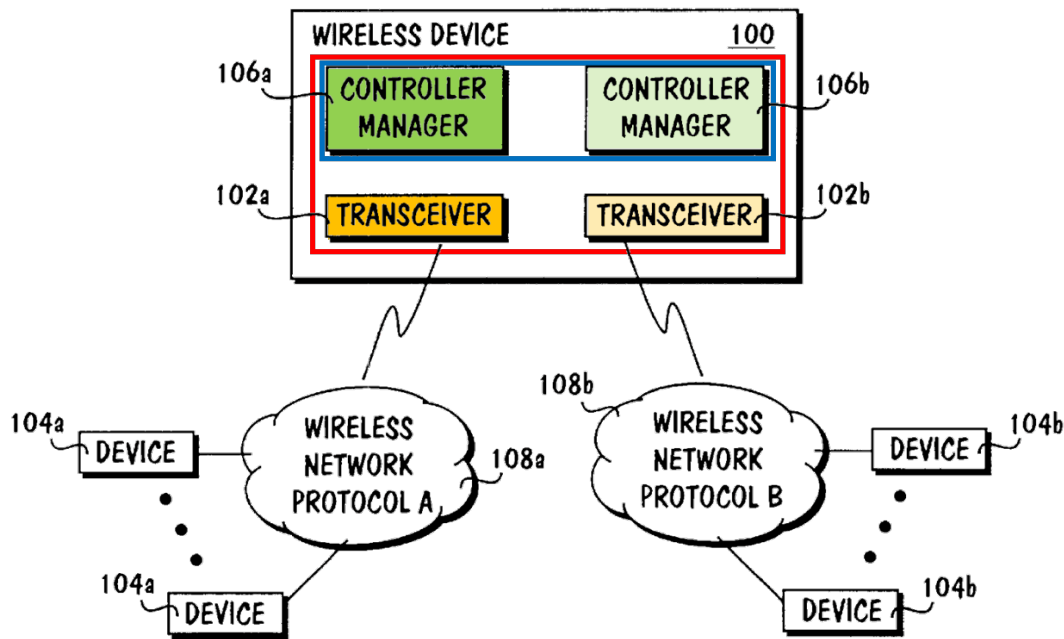
6. Claim 13

- a. **The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to communicate with at least one of the plurality of communication links using the control module, the at least one multi-platform module including a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

154. In my opinion, the Nevo-Avitabile combination teaches claim 13's additional limitations. I also note that in my opinion, claim 13's frequency translating module has the same meaning as claim 11's frequency translation module. Claim 13's FTM, however, does not have antecedent basis in claim 11, and thus need not be the same FTM. Claim 13 repeats many of the elements I previously described.

155. As described in Section X.A.4.b (element 11[1.1]), Nevo teaches a multi-platform module (annotated red, below) that, as described in Section X.A.4.c (element 11[1.2]), has a control module (annotated blue) including at least controller managers 106a/106b (annotated green and light green). *See* Section X.A.4.d (element 11[1.3]) (depicting the controller managers as standard/protocol sub-modules). “[C]ontroller managers 106a and 106b control transmits and receives by wireless transceivers 102a and 102b [(annotated orange and light orange)], in a coordinated manner, ... to allow wireless device 100 to operate with devices 104a and devices 104b of wireless network 108a and 108b in accordance with the

respective wireless communication protocols at the same time.” Nevo, 3:39-45. As described in Section X.A.4.e (element 11[1.4]) the transceivers 102a/102b render obvious a frequency translation module (or, alternatively, a POSITA would have been motivated to combine the frequency translation module from the teachings of Avitable).



Nevo, Fig. 1 (annotated).

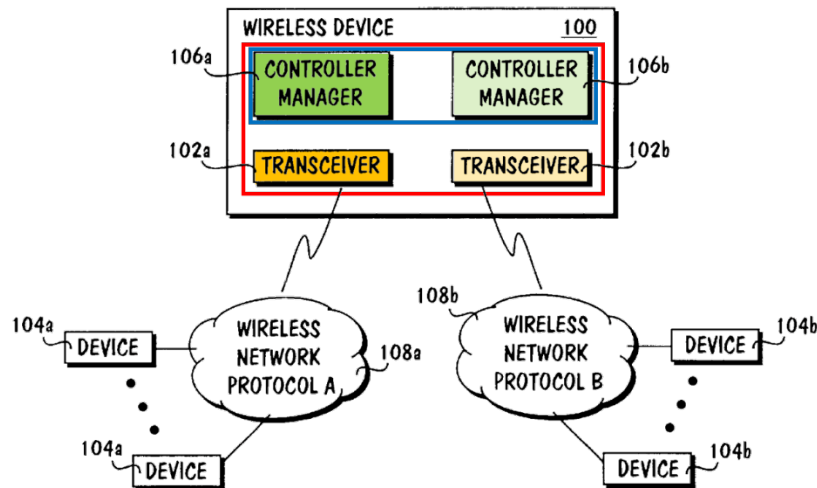
156. In my opinion, the Nevo-Avitabile combination also teaches a multi-platform module including a plurality of receivers and a plurality of transmitters each having at least one frequency translating module. Nevo’s transceivers transmit and receive signals for each respective protocol. Nevo, 3:39-41, 3:49-52, 4:6-23. It would have been well understood to a POSITA that transmitting requires a transmitter and receiving requires a receiver. Moreover, as described in Section

X.A.4.d11 (element [1.3]) and as depicted in Nevo at Figure 13, a POSITA would have understood that Bluetooth/IEEE 802.11 transmitters and receivers require up-converters and down-converters, respectively, respectively to modulate/de-modulate a lower frequency baseband onto/from a higher frequency carrier, as discussed for the Nevo-Avitabile combination.

7. Claim 14

- a. The method of claim 11, wherein step (3) comprises: simultaneously operating the second transceiver in conformance with a second protocol/standard combination that is different from the first protocol/standard combination.**

157. In my opinion, the Nevo-Avitabile combination teaches claim 14's additional limitation. As described in Sections X.A.4.k and X.A.4.l (elements 11[2] and 11[3]), Nevo teaches a first transceiver having a first protocol/standard combination. Nevo's first transceiver (e.g., transceiver 102a, orange) operates with a first protocol/standard combination (e.g., Bluetooth) using a first standard/protocol sub-module (controller manager 106a, green) and a second transceiver (e.g., transceiver 102b, light orange) operates with a second protocol/standard combination (e.g., IEEE 802.11) using a second standard/protocol sub-module (controller manager 106a, light green). Nevo, 3:28-45.



Nevo, Fig. 1 (annotated).

158. Nevo discloses a system and method for performing simultaneous multi-platform operations. Nevo, 3:28-35. Figure 1, for example, depicts a wireless device having two transceivers (102a/102b) that can connect to two separate wireless networks (108a/108b) (*id.*) that are Bluetooth and IEEE 802.11, respectively (which are different). *Id.*, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations). This is done so that communication can occur at the same time. *Id.*, 3:38-45, 4:13-15, 4:36-39.

159. As I’ve noted in Section X.A.4.a (element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

160. Nevo teaches simultaneous operation. Nevo, 4:13-15 (“Accordingly, wireless device 100 is able to operate with devices 104a and 104b of networks 108a

and 108b in two wireless protocols at the same time.”); *see also id.*, 4:36-39 (stating same).

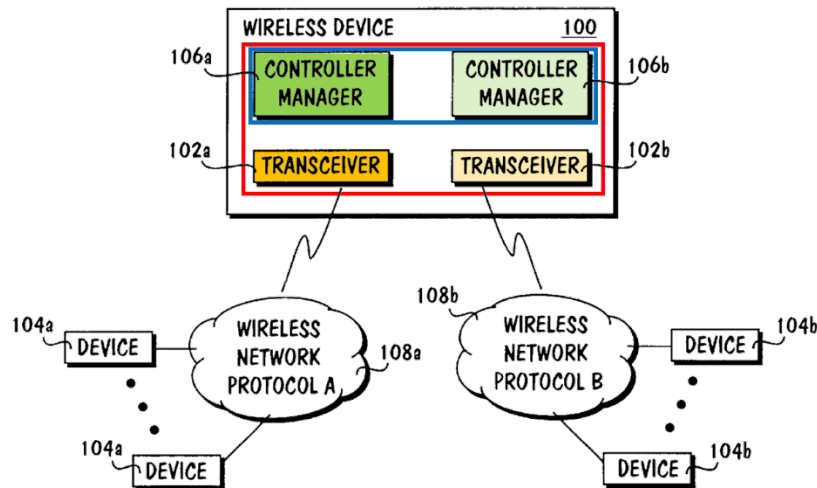
8. Claim 15

- a. **The method of claim 14, wherein steps (2) and (3) comprise: programming the first and second protocol/standard sub-modules with respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

161. In my opinion, the Nevo-Avitabile combination teaches claim 15’s additional limitation..

162. As described in Sections X.A.4.k and X.A.4.l (elements 11[2] and 11[3]), Nevo teaches a first/second protocol/standard sub-modules (control managers 106a/106b, green and light green) that provide a respective first and second implementation (e.g., Bluetooth and IEEE802.11, respectively). Nevo, 3:28-45, 4:46-55.

163. The claim limitation “the at least one multi-platform sub-module” appears to refer-back to the “multi-platform module” or to one of the multi-platform’s sub-modules because there is no “multi-platform sub-module” recited in independent base claim 11 or dependent claim 14.



Nevo, Fig. 1 (annotated).

164. A POSITA would have understood that each respective module would be programmed with operational instructions to work with each respective protocol. For instance, Nevo describes using programmed instructions. Nevo, 8:14-20 (describing using programmed instructions).

165. Moreover, a POSITA would have understood that IEEE 802.11 and Bluetooth require specific operations—whether it be hardware or software—in order to process and understand data. Shown below is the Bluetooth specification protocol stack, showing that operational instructions are required above the baseband and hardware level. A POSITA would have understood Bluetooth requires operational instructions for both receiver and transmitter. A POSITA would have understood that any device implementing these standards (with unique protocol stacks) would similarly need operational instructions at both the hardware and software layers—as depicted by the respective protocols—to implement the standards. For example, a

computing device using these protocols would need to have instructions for (1) formulating communications according to those protocols, and (2) interpreting communications according to those protocols.

166. Bluetooth Spec. V. 1.0 B (Ex. 1044), 68 (1998):

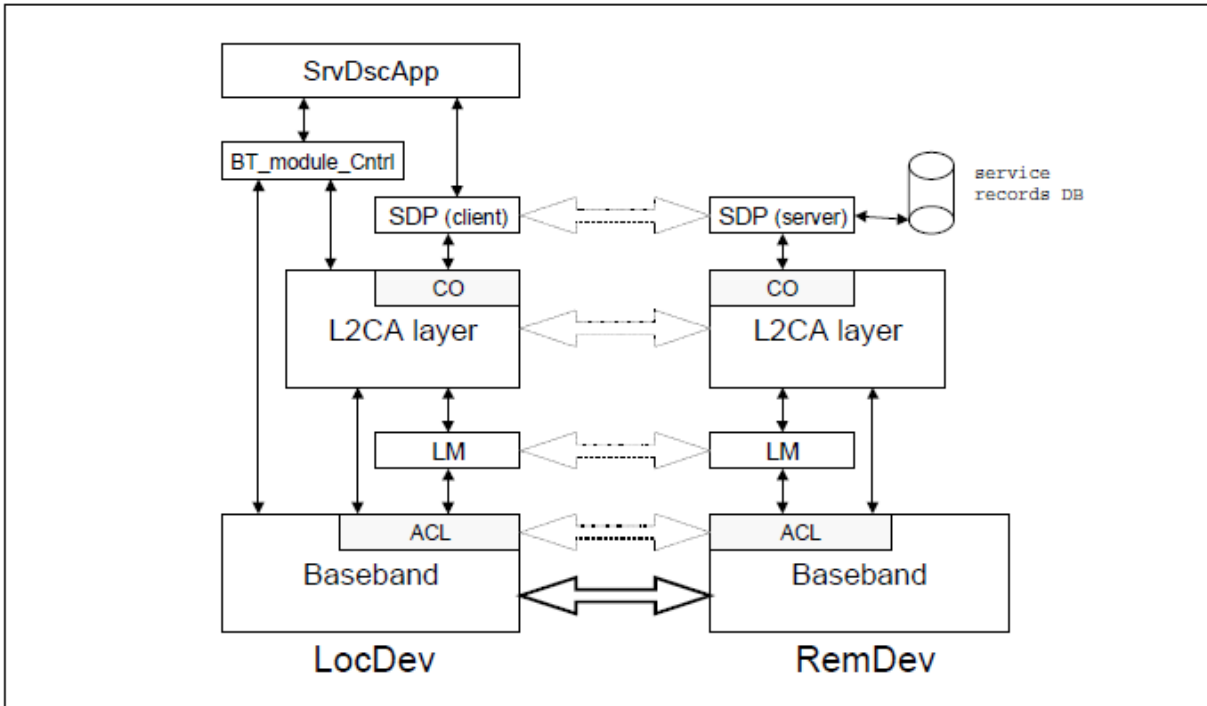


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

167. The same is true with respect to IEEE 802.11. Shown below is a general stack to communicate from the physical level to media access controller (MAC). In order to transmit a message in the format below, the transmitting device would need to have instructions to assemble a message in the format given. Likewise, the receiving device would require instructions to interpret the bits received as the specified parts of a message according to a protocol. Such instructions may be roughly analogized to human language. For example, someone learning English

might be taught (instructed) to use “I” or “me” in communications when speaking about oneself individually, and “we” or “us” speaking as a group. Either of the sentences “I went to the store” or “we went to the store” is the logical result of following such instructions, as is correctly interpreting the sentence.

802.11a (Ex. 1039), 33:

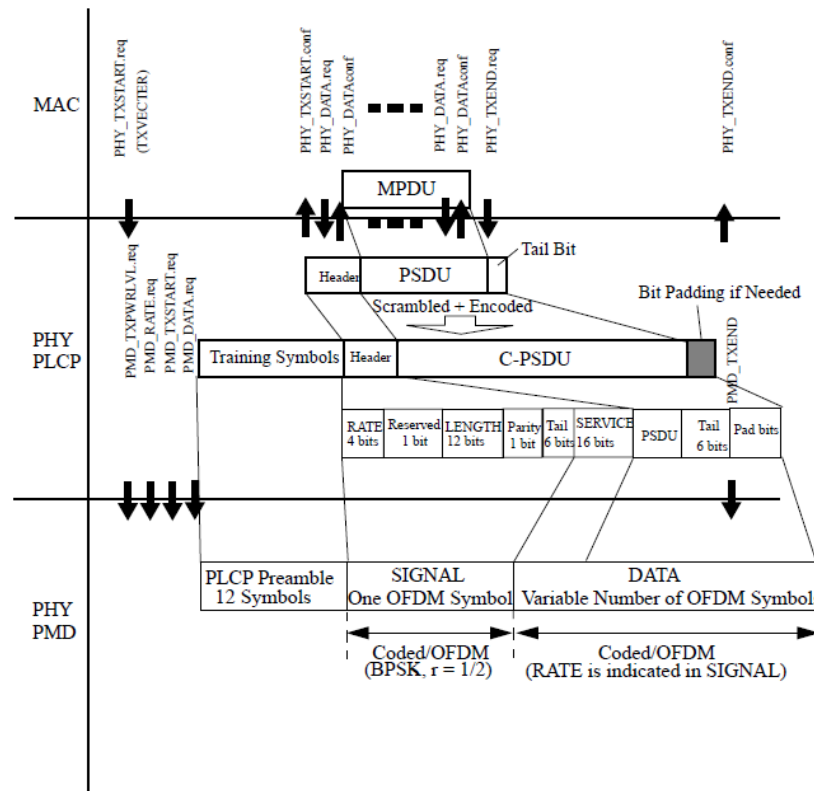


Figure 122—PLCP transmit procedure

168. Further operational instructions are demonstrated at other pages. *E.g.*, 802.11a (Ex. 1039), 37.

169. A POSITA would have understood that operational instructions are required for standards like Bluetooth and 802.11.

9. Claim 16

- a. The method of claim 15, wherein steps (2) and (3) further comprise: programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures.**

170. In my opinion, the Nevo-Avitabile combination teaches claim 16's additional limitation. As described in Section X.A.8 (claim 15), Nevo teaches operating its first and second protocol/standard sub-modules with protocols, e.g., Bluetooth and IEEE 802.11, respectively. In my opinion, a POSITA would have understood that these sub-modules would need to have information relating to their protocol stacks and specification information in order to operate. I have demonstrated this immediately above with regard to the respective specification information from 802.11 and Bluetooth's operational instructions.

171. For example, Bluetooth Spec. V. 1.0 B (Ex. 1044), 68 (1998) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

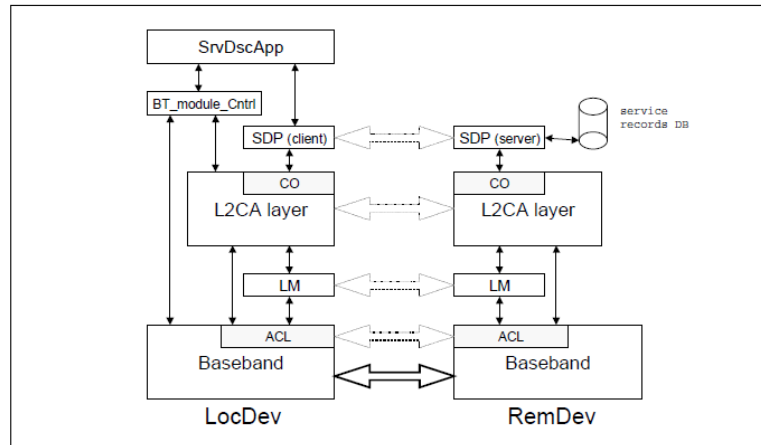
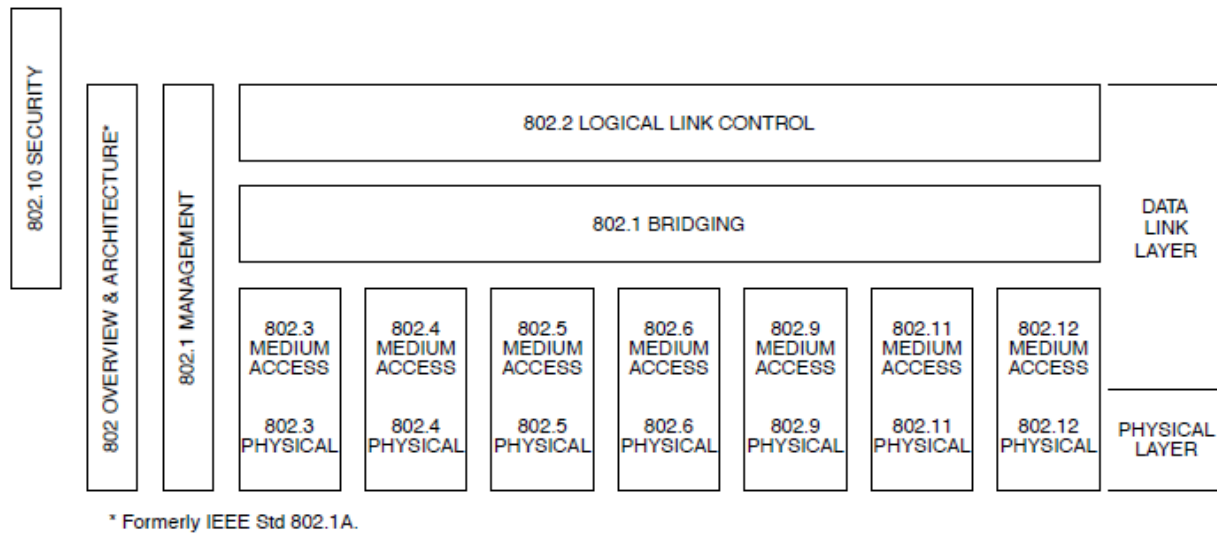


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

172. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

173. A POSITA would have understood a teaching of IEEE 802.11 and Bluetooth, like in Nevo, to be protocol stacks and specification information.

10. Claim 17

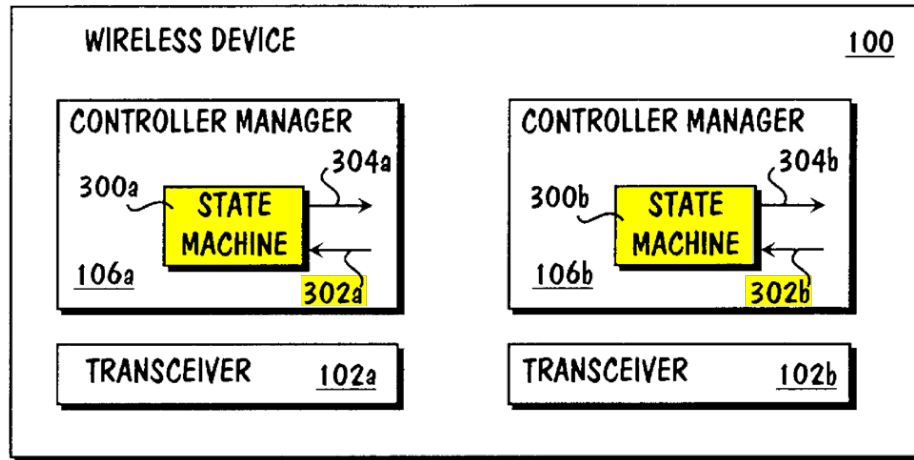
- a. **The method of claim 15, wherein steps (2) and (3) further comprise: updating, upgrading, replacing, or modifying the first and second implementation and operational instructions to provide the at least one multi-platform sub-module with additional functionality.**

174. In my opinion, the Nevo-Avitabile combination teaches claim 17's additional limitation.

175. As described in Section X.A.8 (claim 15), the claim limitation "the at least one multi-platform sub-module" appears to refer-back to the "multi-platform module" or to one of the multi-platform's modules, e.g., one of "the first and second protocol/standard sub-modules," because there is previously recited "multi-platform sub-module."

176. Nevo teaches updating the multi-platform module (or at least one of its sub-modules) to provide additional functionality. Figure 3 illustrates control managers that contain state machines 300a/300b (annotated yellow) that assist the controller managers in controlling the transceivers' transitioning between receipt, transmit, and no-operation states. Nevo, 4:63-5:8; *see also id.*, 5:62-6:33. These state machines have configuration signals 302a/302b that control the state machine's transitions. *Id.*, 5:9-12. The state machine's state initial state can be set via, e.g., jumpers (or via software). *Id.*, 5:15-17. Furthermore, Nevo teaches a network manager that monitors and manages transmission and receipt states devices in their

respective communication environments (*id.*, 8:5-20) where the network manager can be updated via software or jumpers (*id.*, 8:16-20).



Nevo, Fig. 3 (annotated)

11. Claim 18

- a. **The method of claim 11, wherein steps (2) and (3) comprise: simultaneously operating the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.**

177. In my opinion, the Nevo-Avitabile combination teaches claim 18's additional limitation.

178. Nevo discloses a system and method for performing simultaneous multi-platform operations. Nevo, 3:28-35. Figure 1, for example, depicts a wireless device having two transceivers (102a/102b) that can connect to two separate wireless networks (108a/108b) (*id.*) that are Bluetooth and IEEE 802.11, respectively. *Id.*, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control

operations). The wireless device has control managers 106a/106b that control transceiver operation in a “coordinated manner” to allow communication “with the respective wireless communication protocols at the same time.” *Id.*, 3:38-45, 4:13-15, 4:36-39.

179. As I’ve noted in Section X.A.4.a (element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

180. Nevo teaches simultaneous operation. Nevo, 4:13-15 (“Accordingly, wireless device 100 is able to operate with devices 104a and 104b of networks 108a and 108b in two wireless protocols at the same time.”); *see also id.*, 4:36-39 (stating same).

181. Moreover, in my opinion, a POSITA would have understood the “operating environments” to encompass capability for using the respective standards, e.g., Bluetooth and IEEE 802.11, which is taught by Nevo.

182. At a minimum, as I’ve shown in Sections X.A.8-X.A.9 (Claims 15-16), these standards include stacks for operation, which at a minimum shows an operating environment.

183. Taking these excerpts, these are the stacks for the protocols. For example, Bluetooth Spec. V. 1.0 B (Ex. 1044), 68 (1998) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

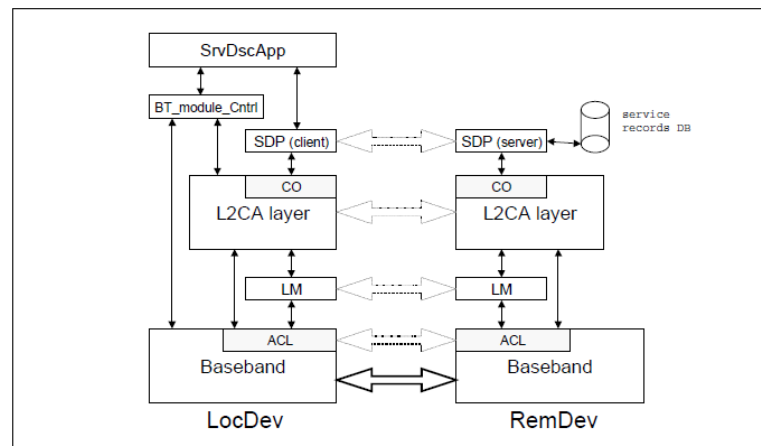
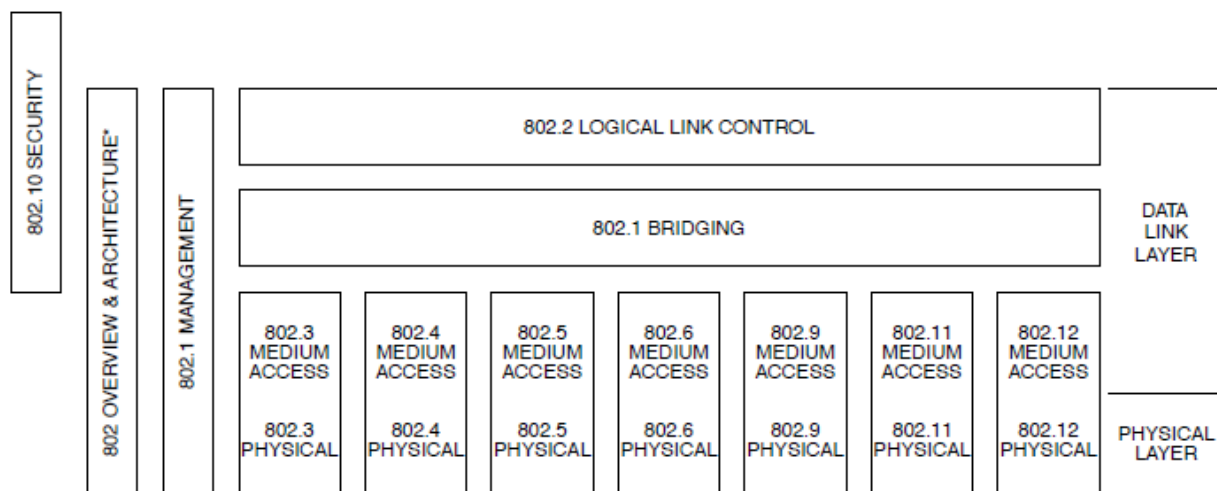


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

184. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

12. Claim 19

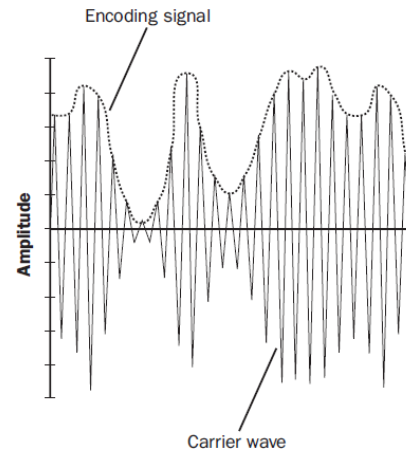
- a. **The method of claim 18, wherein steps (2) and (3) further comprise: simultaneously operating the first and second transceivers in conformance with respective standards, content encoders and decoders, and protocol gateways of the first and second protocol and operating environments.**

185. In my opinion, the Nevo-Avitabile combination teaches claim 19's additional limitation. Claim 19 is substantively similar to claim 18 but recites "content encoders, decoders, and protocol gateways."

186. This is taught by Nevo's discussion of Bluetooth and IEEE 802.11, which a POSITA would have understood to have—as part of its standard— content encoders, decoders, and protocol gateways.

187. As an initial matter, encoding is another term for simply modulating a data signal on top of a carrier signal. This is shown in the Microsoft Computer Dictionary (Ex. 1035), 26:

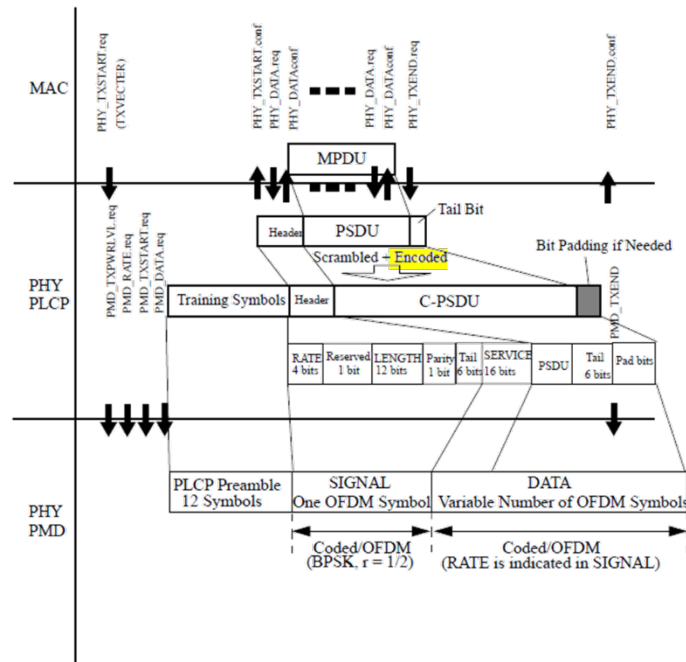
amplitude modulation *n.* A method of encoding information in a transmission, such as radio, using a carrier wave of constant frequency but of varying amplitude. See the illustration. *Acronym: AM.* Compare frequency modulation.



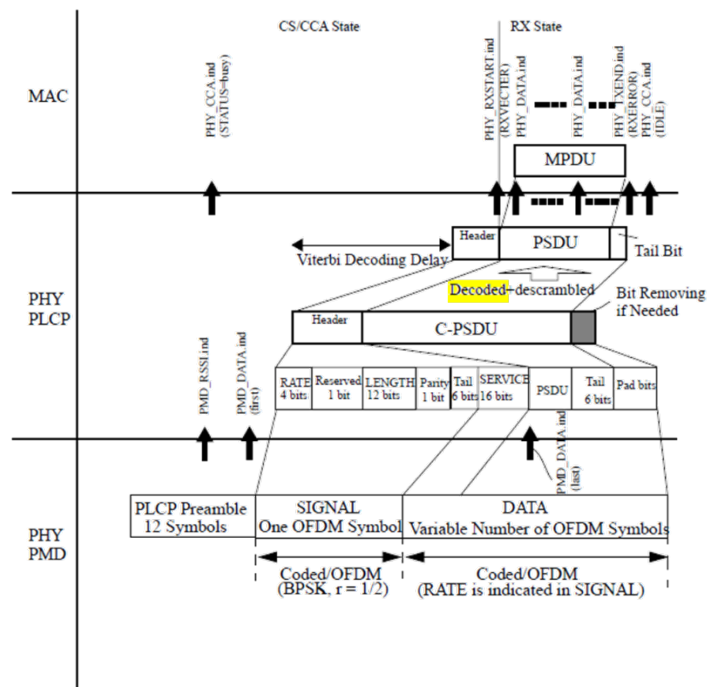
Amplitude modulation.

188. As I have described in Section VI.B (Modulating Signals for Wireless Communications), data is modulated with a carrier for transmission. This is encoding. Further, data is demodulated from a carrier. This is decoding.

189. Further, 802.11a (Ex. 1039), §17.3.2.1 describes other types of encoding for 802.11. 802.11a, 7-8. The encoding is further depicted at page 33 (annotation added).



190. Decoding is similarly depicted at page 36.



191. Bluetooth similarly has encoding and decoding. It provides encryption, which in my opinion, a POSITA would have understood to be a type of encoding/decoding. *See* Bluetooth Spec. V. 1.0 B (Ex. 1044), 275:

3.1 SECURITY

It is recognized that security in a wireless environment is of paramount importance.

Both the LAP and the DT must enforce that encryption is operating on the baseband physical link while any PPP traffic is being sent or received. The LAP and the DT will refuse any request to disable encryption. Therefore, Bluetooth pairing must occur as a means of authenticating the users. A PIN or link key must be supplied, even if the default PIN is used. The default PIN for LAN access is a zero length PIN. Failure to complete the pairing process will prevent access to the LAN Access service.

192. Finally, Nevo teaches protocol gateways. I note initially that the '686 Patent describes "protocol gateways" in the most generic sense, by merely listing it. *See e.g.*, '686 Patent, 37:57-59 ("The operating environment includes, but is not limited to, the available bearer services, content encoders and decoders employed, available protocol gateways, etc."), 40:4-7 (same). It provides no detailed description and just lists it as part of the standard. In my opinion, Nevo's teachings of the standard teaches the protocol gateways.

193. Further, as I've shown in Sections X.A.8-X.A.9 (Claims 15-16), each standard provides stacks that allow the lower hardware levels to speak to the higher hardware levels. A POSITA would have understood this to be a protocol gateway because it allows connection between various levels of the stack.

194. Bluetooth Spec. V. 1.0 B (Ex. 1044), 68 (1998) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

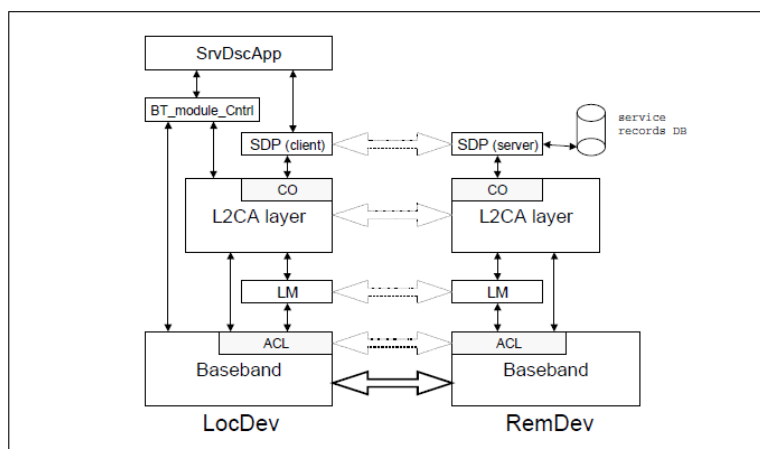
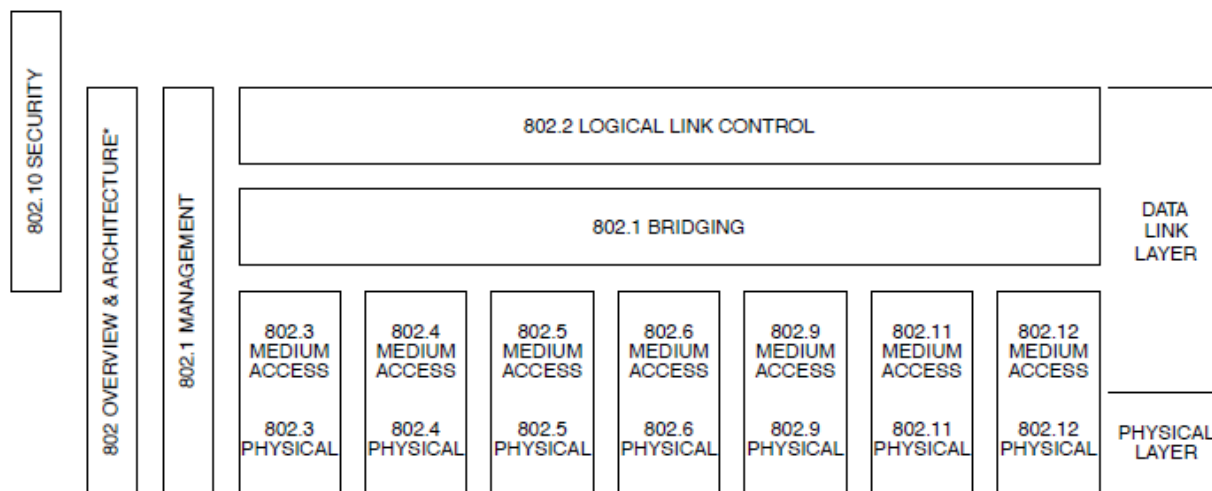


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

195. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

13. Claim 20

- a. The method of claim 11, wherein step (3) comprises simultaneously operating the second transceiver and the first transceiver.**

196. In my opinion, the Nevo-Avitabile combination teaches claim 20's additional limitation.

197. Nevo discloses a system and method for performing simultaneous multi-platform operations. Nevo, 3:28-35. Figure 1, for example, depicts a wireless device having two transceivers (102a/102b) that can connect to two separate wireless networks (108a/108b) (*id.*) that are Bluetooth and IEEE 802.11, respectively. *Id.*, 4:46-55; *see also id.*, Figs. 3, 5, 7, 9a, 11a, 13 (depicting additional control operations). The wireless device has control managers 106a/106b that control transceiver operation in a “coordinated manner” to allow communication “with the respective wireless communication protocols at the same time.” *Id.*, 3:38-45, 4:13-15, 4:36-39.

198. As I've noted in Section X.A.4.a (element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the '686 Patent describes simultaneous.

199. Nevo teaches simultaneous communication. Nevo, 4:13-15 (“Accordingly, wireless device 100 is able to operate with devices 104a and 104b of

networks 108a and 108b in two wireless protocols at the same time.”); *see also id.*, 4:36-39 (stating same).

14. Claim 1

200. Claim 1 recites substantially similar elements to claim 11. The two most significant distinctions are that claim 1 does not require the “storage module” of claim 11, and claim 1 recites an apparatus while claim 11 recites a method. However, in my opinion, the same teachings of Nevo in view of Avitabile that I discussed regarding claim 11 also apply because Nevo in view of Avitabile teaches an apparatus that performs a method substantially similar to that of claim 11. I also note that claim 1’s frequency translating module has the same meaning as claim 11’s frequency translation module.

a. 1[pre]: An apparatus capable of performing simultaneous multi-platform operations, comprising:

201. *See* Section X.A.4.a (element 11[pre]).

b. 1[a]: at least one multi-platform module including a plurality of transceivers each having at least one frequency translating module, wherein said at least one frequency translating module comprises

202. *See* Section X.A.4.b (element 11[1.1]) regarding the “multi-platform module” and Section X.A.4.e (element 11[1.4]) regarding the “plurality of transceivers each having at least one frequency translation module.”

- c. **1[b]: a switch configured to operate according to an energy transfer signal, and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and**

203. *See* Sections X.A.4.f-X.A.4.h (elements 11[FTM-1.1], 11[FTM-1.2], and 11[FTM-1.3]).

- d. **1[c]: a control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links, the control module including a plurality of protocol/standard sub-modules.**

204. *See* Sections X.A.4.b-X.A.4.c (elements 11[1.1] and 11[11.2]) regarding the “control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links” and Section X.A.4.d (element 11[1.3]) regarding the “plurality of protocol/standard sub-modules.”

15. Dependent claims 2-10

205. The claims that depend from claim 1 add substantially similar elements to the claims that depend from claim 11, and in my opinion, these claims are taught by Nevo in view of Avitabile for similar reasons. I discuss any differences below.

- a. **Claim 2: The apparatus of claim 1, wherein the control module is configured to enable the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communication links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

206. *See* Section X.A.5 (claim 12). This claim is substantively similar to claim 12, but recites “configured to enable” instead of “controlling the at least one multi-platform module.” Even if “enable” is argued to require more, enabling simultaneous communications is taught by Nevo. Nevo, 3:30-35 (stating that transceivers enable coupling the device to the wireless networks); *see also id.*, claim 16 (“two protocols to enable a master device to manage and control”).

- b. **Claim 3: The apparatus of claim 1, wherein the at least one multi-platform module includes a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

207. *See* Section X.A.6 (claim 13). In my opinion, claim 3’s frequency translating module has the same meaning as claim 11’s frequency translation module.

- c. **Claim 4: The apparatus of claim 1, wherein the plurality of protocol/standard sub-modules comprise a first protocol/standard sub-module configured to operate a first transceiver in conformance with a first protocol/standard combination and a second protocol/standard sub-module configured to simultaneously operate a second transceiver in conformance with a second protocol/standard combination.**

208. *See* Section X.A.7 (claim 14).

- d. **Claim 5: The apparatus of claim 4, wherein the first protocol/standard combination is different from the second protocol/standard combination.**

209. *See* Section X.A.7 (claim 14).

- e. **Claim 6: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules contain respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

210. *See* Section X.A.8 (claim 15).

- f. **Claim 7: The apparatus of claim 6, wherein the first and second implementation and operational instructions include respective first and second protocol stacks and specification information about the first and second protocol architectures.**

211. *See* Section X.A.9 (claim 16).

- g. **Claim 8: The apparatus of claim 6, wherein the first and second implementation and operational instructions can be updated, upgraded, replaced, or modified to provide the at least one multi-platform sub-module with additional functionality.**

212. *See* Section X.A.10 (claim 17).

- h. Claim 9: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules are configured to operate the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.**

213. *See* Section X.A.11 (claim 18). As illustrated in Section X.A.4.1 (element 11[3]) there are a first and second protocol/standard sub-modules. *See* Nevo, Fig. 1.

- i. Claim 10: The apparatus of claim 9, wherein the first and second operating environments include at least one of respective standards, content encoders and decoders, and and protocol gateways.**

214. *See* Section X.A.11 (claim 18) (describing Nevo's teachings of first/second operating environments); Section X.A.12 (claim 19) (describing Nevo's teachings of standards, content encoders, and protocol gateways).

B. Ground 2A: Claims 1-20 are Unpatentable as Obvious Over Young in view of Estabrook-Thesis

215. In my opinion, claims 1-20 are unpatentable as obvious over Young in view of Estabrook-Thesis. Independent claims 1 and 11 differ because claim 1 is an "apparatus" claim, while claim 11 is a "method" claim. However, they are similar claims because the "method" claimed in claim 11 is basically just the use of an apparatus, so in my opinion the "method" of claim 11 would be obvious to a POSITA based on art that described an apparatus which performed that method in its normal operation. Claim 11 is also slightly more specific than claim 1 because claim 11,

but not claim 1, recites a “storage module.” Therefore, I will discuss claim 11 first because it is more specific.

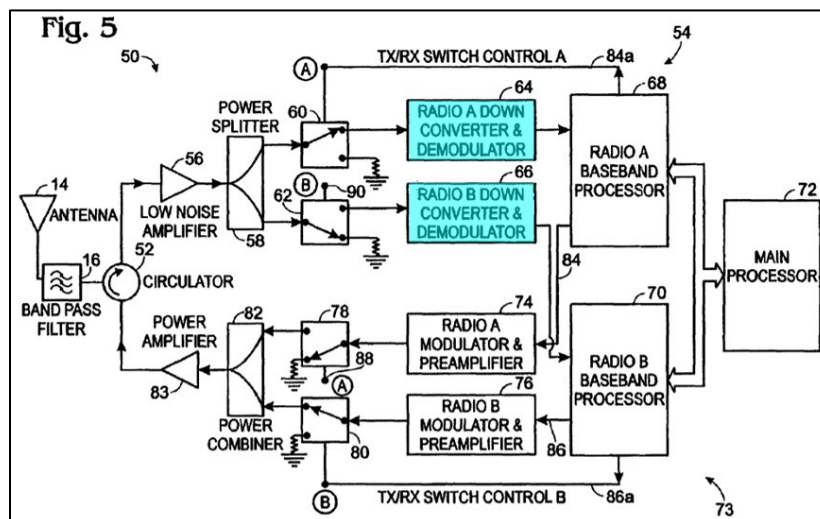
1. Young

216. Young was issued on November 4, 2004 and was filed on March 27, 2000. I understand that Young qualifies as prior art under 35 U.S.C. § 102(e).

217. Young teaches a “method and apparatus providing simultaneous dual mode operations for radios in the shared spectrum.” Young, Abstract. Young teaches a device that can operate simultaneously in two protocols, i.e. “[a] dual mode RF radio includes a first transceiver operating under a first transmitter/receiver protocol, and having a first receiver portion and a first transmitter portion therein; and a second transceiver operating under a second transmitter/ receiver protocol, and having a second receiver portion and a second receiver portion therein.” Young, Abstract. Young explains that the need for such a device arises when two protocols use the same spectrum, such as Bluetooth and IEEE 802.11. Young, 1:15-27. Young explains the issue of interference, but also of receiver desensitization, where one receiver fails to operate effectively because the relevant frequency spectrum is full of high-power transmissions from the other communication protocol. Young, 1:44-57.

218. Young discloses a device which includes two transceivers (with some shared components), each of which can communicate via a separate protocol, and

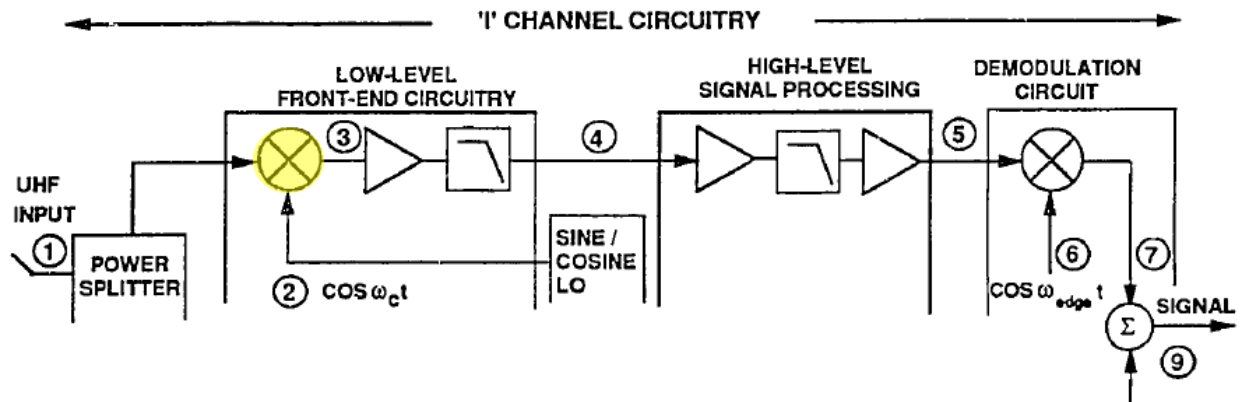
which have separate transmit and receive chains for each protocol. Young, 5:65-6:17, Fig. 5. The receive chains each include a block (64 and 66), for a down converter/demodulator, as shown in annotated Figure 5 below and described at 6:6-11:



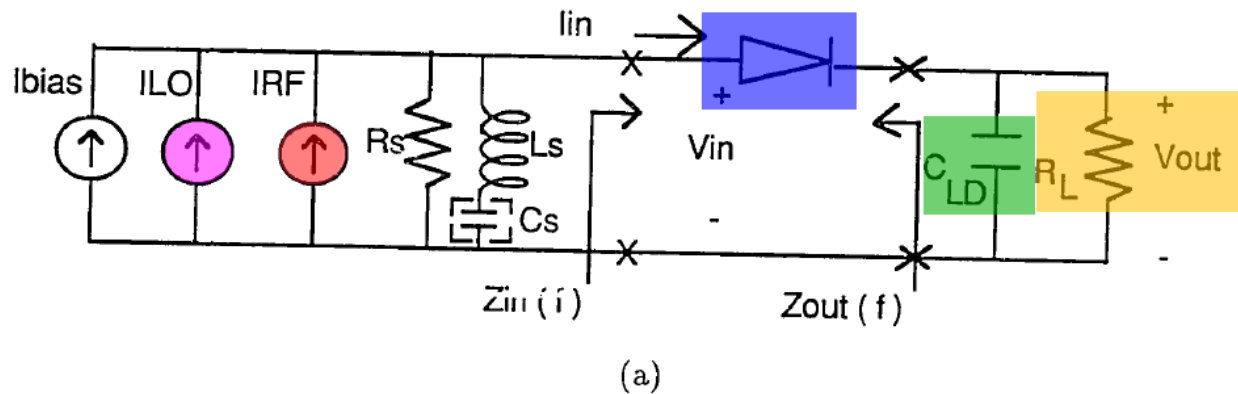
2. Estabrook-Thesis

219. Estabrook-Thesis was published in 1989. I understand that Estabrook-Thesis qualifies as prior art under 35 U.S.C. § 102(b).

220. Estabrook-Thesis is a 1989 Stanford PhD thesis by Polly Estabrook, which teaches a “direct conversion receiver” including a “single-ended mixer” circuit for down-converting a received RF signal, identified as IRF. Fig. 4 shows a high-level schematic of the “direct conversion receiver,” including a front-end mixer highlighted below:



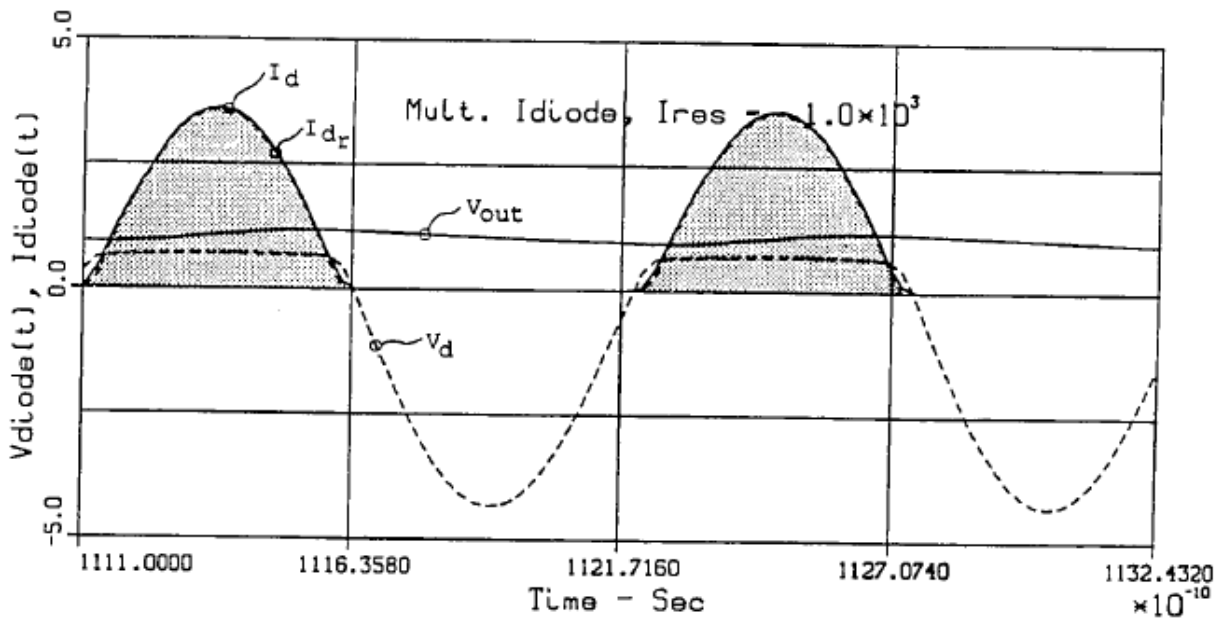
I have annotated certain portions of Estabrook-Thesis's Figure 14 (at page 60 of the PDF document)⁴ relevant to my discussion below:



⁴ There are two sets of page numbers in EX1005: the original page numbers in the thesis, and the exhibit page numbers. I refer to the latter.

221. As annotated above, the circuit includes a diode, an independent local oscillator (ILO), an output capacitor C_{LD} , and an output signal V_{out} . I will discuss these features in more detail below in regard to particular claim elements.

222. The diode taught by Estabrook-Thesis's Figure 14 functions as a switch. This is shown in Figure 16(b). This figure illustrates how the ILO controls the diode as a switch: when the diode voltage V_D (dotted line) reaches the forward voltage threshold (where the sine curve of V_D flattens out), the diode is "on" and the diode current I_D flows, while below that threshold no current flows and the diode is off:



(b) In-phase diode waveforms

Estabrook-Thesis, p. 71.

3. Motivation to Combine

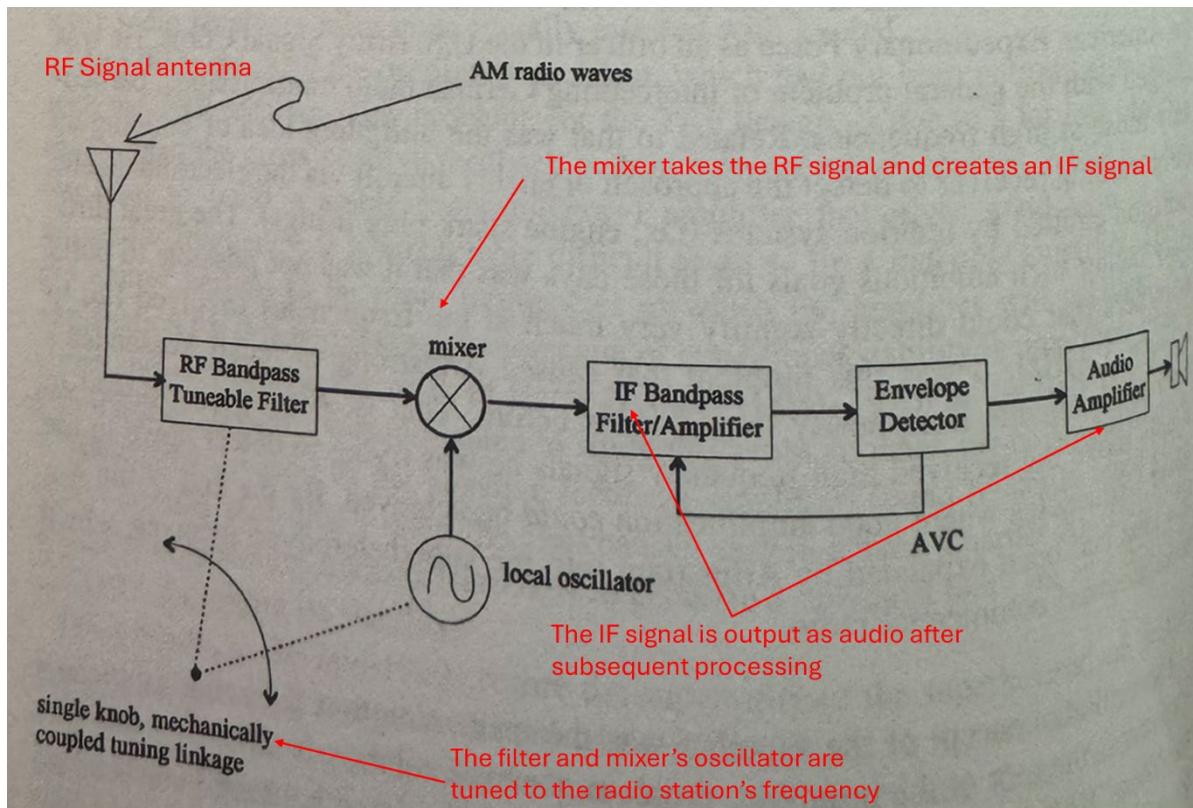
223. In my opinion, a POSITA would have been motivated to combine Young and Estabrook-Thesis. Based on my review, both references are in the same field. Specifically, both references describe RF receivers that can receive signals that convey digital information. Young, 1:8-32; Estabrook-Thesis, 26.

224. Young teaches that each of its receiver paths (for Radio A and Radio B) includes a “down converter and demodulator” block, 64 and 66. However, Young does not describe any details of the inner functions or the circuits within those blocks. Therefore, in my opinion, a POSITA would have needed to rely on the knowledge in the art or look elsewhere for specific implementation of such a circuit.

225. In my opinion, Estabrook-Thesis teaches a circuit which could advantageously be used in such a down-converter. Estabrook-Thesis’s circuit is a “direct conversion receiver” which can down-convert (i.e., convert to a lower frequency) a received RF signal. Estabrook-Thesis teaches that its direct conversion receiver has several advantages over traditional heterodyne receivers, including performing “as well as or better than a conventional super-heterodyne receiver” but with a “smaller volume, lower weight and power consumption, and... more versatil[ity]” than such receivers. Estabrook-Thesis, 8-9.

226. Estabrook-Thesis describes a circuit that converts to an Intermediate Frequency (or IF) which a POSITA would have been motivated to use in a down-

converter such as that employed (but not described in detail) in Young. Converting to an IF is a decades-old and well-known technique for frequency conversion. This IF can be any frequency (including DC) but is typically fixed, and remains unchanged even as the radio tunes to different frequencies. This allows circuit elements such as amplifiers to be optimized for an IF rather than being retuned whenever the radio is retuned. This concept is well known, and readily recognized in common components such as an AM-radio receiver as the simplest and oldest example. Shown below, from the Science of Radio at page 182, a radio works by receiving an input RF signal at a certain (an AM-radio station) and the system is tuned to that radio station (i.e., the signal's carrier). The tuning causes the RF signal to be converted to an intermediate frequency (IF) signal that is used by the rest of the circuit to output audio for that AM radio station. *See generally id.*, 183-84. As can be appreciated, through this configuration, specific carriers (i.e., radio stations) can be detected and played without dedicated circuitry for every single radio station. *See e.g., id.*, 184 (“the IF amp is *not* tuneable”). The circuitry can be tuned for the specific IF frequency of 455 KHz that is used for AM broadcast receivers, regardless of the radio station tuned to. *Id.*, 183-84. This basic concept was well-known since the dawn of radios over a century ago.



227. Estabrook-Thesis itself explains how sequential down conversion was known in the art in the context of a traditional heterodyne receiver to receive several intermediate frequencies. For example, Estabrook-Thesis Figure 2 (p. 29) shows a “typical heterodyne receiver” which uses two mixer stages (“1st mixer” and “2nd mixer,” each shown by the symbol of an X inside a circle), each of which down-converts to a different IF (“1st IF” and “2nd IF”), before demodulating to baseband:

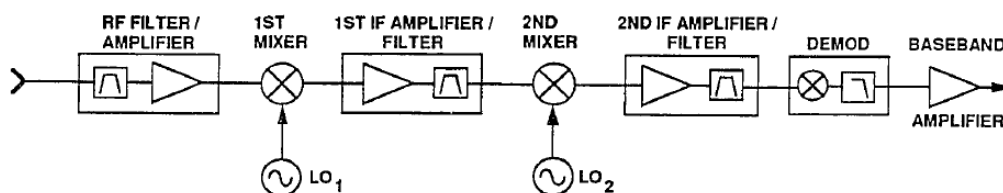
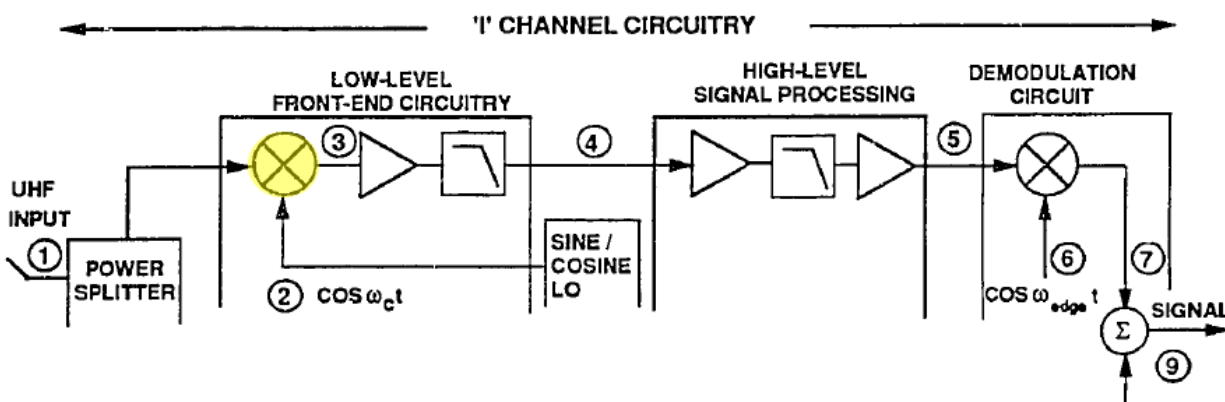


Figure 2: Block diagram of a typical heterodyne receiver.

See also Estabrook-Thesis, 28.

228. Estabrook-Thesis compares this traditional heterodyne receiver to its “direct conversion receiver,” which is shown in Figure 4 (*id.*, 31, 28). Estabrook-Thesis’s direct conversion receiver has a single mixer (highlighted in yellow below) which down-converts to an IF, which then undergoes “high-level signal processing” and is eventually demodulated:



Estabrook-Thesis, Fig. 4 (annotated).

229. The “single-ended mixer” circuit taught in Estabrook-Thesis’s Figure 14(a) provides a more detailed explanation of the type of mixer that would be used for the mixer of Figure 4. My discussion in this declaration focuses on the details of the mixer in Figure 14(a), which shows that a “frequency translation module” with the same structural elements as recited in the Challenged Claims was known. I note that Estabrook-Thesis also teaches a full down-conversion circuit for converting a signal from a carrier frequency to baseband. In my opinion, a person of ordinary skill in the art would have recognized that because Estabrook-Thesis teaches a full

down-conversion circuit (including a down-converter and demodulator) that performs the same functions as Young's "down converter and demodulator" (blocks 64 and 66), such a person of ordinary skill in the art would have a reasonable expectation of success using Estabrook-Thesis's down-converter to perform the functions called for by Young's down-converters. The down-conversion and demodulation circuits of Estabrook-Thesis would provide similar benefits in the similar system of Young as those described in Estabrook-Thesis. Alternatively, a POSITA would have viewed use of the down-conversion and demodulation circuits of Estabrook-Thesis in view of the (unspecified) down-conversion and demodulation circuits of Young as a simple substitution with predictable results.

4. Claim 11

a. 11[pre]: A method for performing simultaneous multi-platform operations, comprising:

230. I do not offer any opinion on whether the preamble of claim 11 is limiting, but it is my opinion that the preamble of claim 11 is taught by Young regardless of whether it is limiting. As discussed above in Section IX.D regarding claim construction, I applied the plain and ordinary meaning of "multi-platform module" where "platform" refers to a communications protocol or bearer service.

231. Young teaches that its system can operate in multiple protocols simultaneously, particularly when two protocols share the same spectrum, such as Bluetooth and IEEE 802.11. Young, 1:15-27. Indeed, both the Title and the Abstract

of Young describe its device as operating “simultaneously” in two protocols, which are examples of “platforms” as discussed above. Young, Title, Abstract, 3:47-57. In my opinion, Young’s teaching of multiple protocols used simultaneously is consistent with the ’686 Patent itself, which teaches that “multi-platform operations” refer to “multiple protocols and multiple bearer services... employed simultaneously” and identifies Bluetooth and IEEE 802.11 as exemplary protocols. ’686 Patent, 8:31-32, 7:52-58.

232. Operations in electronic systems can functionally be operating simultaneously, even if they are occurring sequentially at the finest grain level. This is because the data that these systems operate on always arrives sequentially—in packets of fixed length—and these systems operate so rapidly that they switch between operations at speed far faster than human perception or that is required by various network protocols.

233. As I’ve noted in Section X.A.4.a (Ground 1, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

234. First, systems in the art were well known to be simultaneous but do not have exact same time processing. For example, any operating system simultaneously runs several programs despite those programs sharing time with the

processor. *See generally* Operating Systems, A Systematic View, Davis (1983) (Ex. 1043), 259-63. And, in the context of RF transmissions, a POSITA would have understood that trying to use the same exact frequency to transmit at the same exact time would cause interference. Interference is recognized in, for example, Young. Young at 1:34-37. Moreover, a POSITA would have understood that using the same antenna to transmit two signals having the same exact frequency would be impractical. Both interference and trying to use the same antenna at the same time would result in signals being effectively added because they utilize the same carrier, which would overlap.

235. Indeed, the '686 Patent recognizes a “simultaneous” transmission as being one that is either: “actual or apparent.” '686 Patent, 34:37-38 (“Such communication may be simultaneous, either actual or apparent”); *see also id.*, 38:34-36 and 8:19-37; *see also id.*, 40:42-46 (“Simultaneously, the same device is switching another of the transceiver 4104 components of UPSM 4102 using the wireless application protocol (WAP) to link the device to a cellular network using a CDMA standard bearer service.”). Further, the '686 Patent teaches that “multi-platform operations” refer to “multiple protocols and multiple bearer services... employed simultaneously” and identifies Bluetooth and IEEE 802.11 as exemplary protocols. '686 Patent, 8:31-32, 7:52-58. A POSITA would have understood both

actual simultaneously or apparently simultaneous transmissions to be types of “simultaneous” transmissions.

For example, the Microsoft Computer Dictionary (Ex. 1035), 482 defines simultaneous processing as “dividing processor time among the tasks.”

simultaneous processing *n.* **1.** True multiple-processor operation in which more than one task can be processed at a time. *See also* multiprocessing, parallel processing.
2. Loosely, concurrent operation in which more than one task is processed by dividing processor time among the tasks. *See also* concurrent, multitasking.

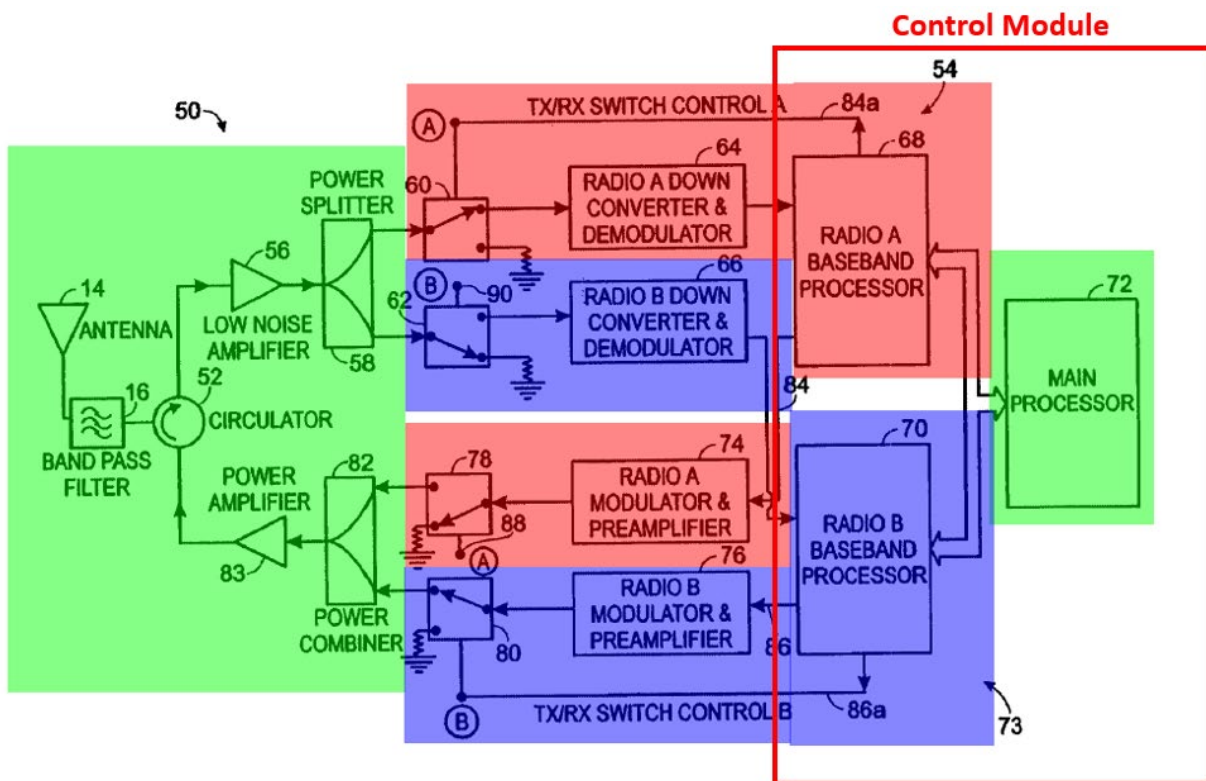
b. 11[1.1] controlling at least one multi-platform module to communicate with at least one of a plurality of communication links

236. In my opinion, Young teaches or suggests this limitation. As I discussed regarding Section X.B.4.a, (element 11[pre]) above, the wireless receiver taught by Young (including in Fig. 5) is a “multi-platform module.” When the “multi-platform module” taught by Young is used to communicate simultaneously via separate protocols such as Bluetooth and IEEE 802.11, each connection is a separate “communication link.” The entire process within Young is controlled by the main processor and Radio A and Radio B baseband processors, which I discuss more regarding Section X.B.4.c (element 11[1.2]) below. In my opinion, Young teaches performing the “controlling” step because that is what these processors

would do when the device of Young is used to communicate simultaneously in both protocols. It is also my opinion that a user who connected a device to separate protocols would also be “controlling” the device to do so by operating it.

c. 11[1.2] using a control module

237. In my opinion, Young teaches this limitation. Young’s control module comprises the processing elements for the dual-protocol transmitter, including the main processor 62 and the Radio A and Radio B baseband processors. These are annotated below:



Young, Fig. 5 (annotated), 5:65-6:55.

238. These elements control the connection of the device to the dual protocol channels, and are therefore collectively a “control module.” In my opinion, this description of Young’s main processor and baseband processors as a “control module” is consistent with the specification of the ’686 Patent, which teaches the control module includes sub-modules for separate protocols (in Figs. 43-44, WAP and Bluetooth) and includes “hardware, software, or combinations thereof to cause the [Universal Platform Sub-Module (UPSM)] 3802 to receive, transmit, process, and otherwise interact with signals according to the particular protocol/bearer service combination.” ’686 Patent, 36:47-51.

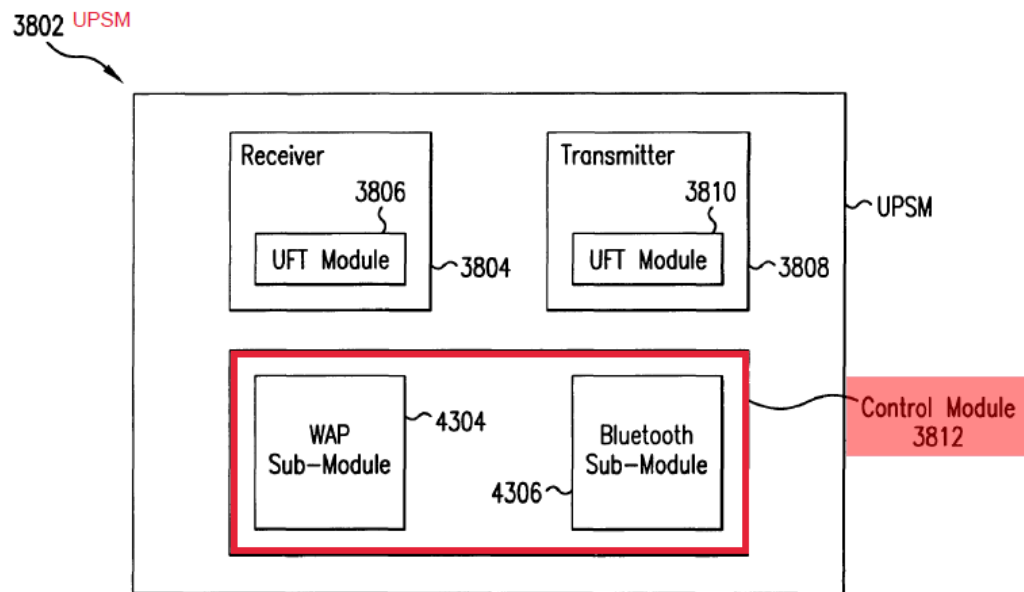


FIG.43

’686 Patent, Fig. 43 (annotated).

d. 11[1.3] having a plurality of standard/protocol sub-modules, wherein the at least one multi-platform module includes

239. In my opinion, Young teaches or suggests this element because the separate baseband processors 68 and 70 for Radio A and Radio B are standard/protocol sub-modules. The purpose of Young's device is to enable reception from a single "dual transceiver" device using multiple protocols such as Bluetooth, IEEE 802.11, HomeRF, etc. Young, Abstract, 1:8-12, 1:29-43, 2:65-67. The Radio A and Radio B baseband processors allow the Radio A and Radio B transceivers to operate according to separate standards/protocols. Young, 2:37-53. Young explicitly describes its first and second transceivers as operating with particular protocols in the Abstract and claim 1, which each recite "operating a [first/second] transceiver under a [first/second] transmitter/receiver protocol." For example, Young uses an example of simultaneous operation using Bluetooth and HomeRF in which the "circuit of the invention" (i.e., the circuit shown in Fig. 5) results in substantial throughput improvement. Young, 10:1-19. Therefore, in the example, one of Radio A and B is used for Bluetooth and the other for HomeRF.

240. I note that while the '686 Patent distinguishes between "protocols" and "standards" (or "bearer services"), it acknowledges that some protocols may combine these functions, such as Bluetooth, for which "the transport standard is also supplied." '686 Patent, 7:58-62. The protocols discussed by Young are all

“protocol/standard combinations” according to this definition, because they each provide both the “format for the transfer of data” and “the communications pipeline... for the device to interact with the network.”

241. Young describes a multitude of wireless standards, including HomeRF, Bluetooth and 802.11. Ex. 1003, 1:15-27, 2:30-34, 3:57-62. Wireless standards are a set of protocols that define how wireless communication works between devices. They specify the maximum theoretical speed that can be achieved using a certain frequency band, modulation techniques, channel widths, access protocols, data formatting, and other important parameters. *See generally* Ex. 1039, Ex. 1044. As such, as described by Young, they provide the “format for the transfer of data,” and the “communications pipeline... for the device to interact with the network,” and are therefore a “protocol/standard combination” as claimed.

242. The way the transceivers are controlled to operate simultaneously is by using control signal 84a (radio A) and control signal 86a (radio B). Those signals control the switches 60, 62, 78, 80. Ex. 1003, 6:38-55. When the transceiver is being used, the control signal 84a/86a controls the switch to connect its modulator/demodulator stage to the amplifier/antenna. When the transceiver is not being used, the control signal 84a/86a controls the switch to disconnect its modulator/demodulator stage to the amplifier/antenna. Hence, the baseband

processors 68/70 are the sub-modules of the control module that controls their respective transceivers.

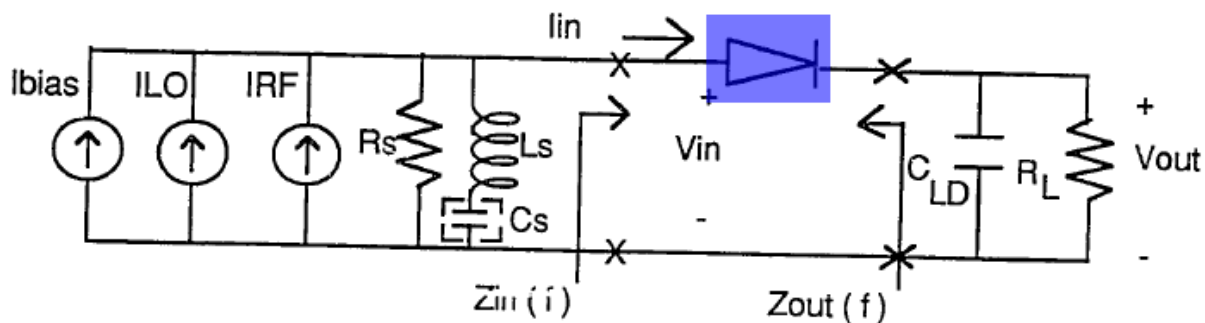
- e. **11[1.4] a plurality of transceivers each having at last one frequency translation module, wherein said at least one frequency translation module comprises**

243. In my opinion, the Young-Estabrook-Thesis combination teaches this element. Young contains a plurality of transceivers, while Estabrook-Thesis teaches frequency translation module. Young itself describes its device as containing two transceivers: “The circuit described herein enables two transceivers to be co-located in the same enclosure” (Young, 6:56-57). Each of the Radio A and Radio B circuits, together with the associated shared components (such as the antenna) comprises a separate transceiver. In my opinion, the phrase “a plurality of transceivers” does not preclude the devices from sharing some components (such as the antenna), as long as each transceiver functions to receive process separate signals. The description in Young of its “Radio A” and “Radio B” as separate transceivers indicates to a POSITA that they are, in fact, separate transceivers, and this teaching would be consistent with the understanding of a POSITA. Further, there is nothing in claim 11 itself or any explicit definition in the specification of the ’686 Patent that would preclude transceivers from sharing components. Indeed, it is inherently in the claims to a single “multi-platform module” that includes a plurality of transceivers that some components are likely to be shared; otherwise the transceivers would be

separate devices rather than part of the same module. Each of Young’s transceivers includes an associated “down converter and demodulator” (Figure 5, blocks 64 and 66), which teaches an FTM. Young, 6:6-11. As I explain in Section X.B.3 above, Young merely provides boxes for the “down-converter and demodulator,” so a POSITA would need to rely on knowledge in the art or look elsewhere for those functions. In the combination, these functions are accomplished by the conversion circuits of Estabrook-Thesis, which I discuss in more detail below.

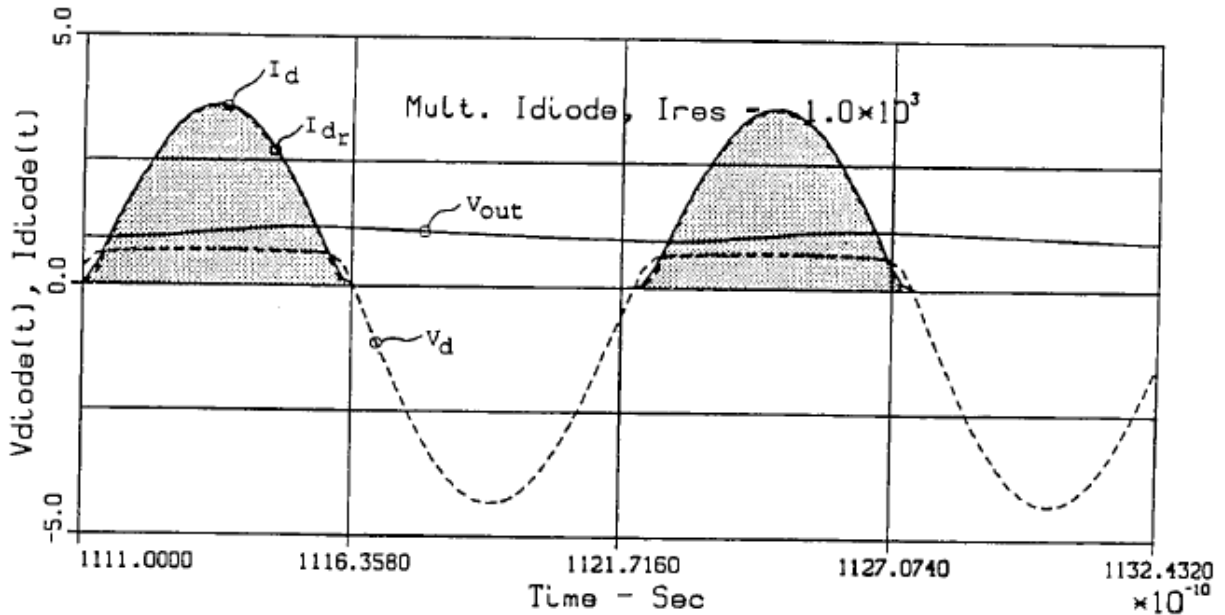
f. 11[FTM-1.1] a switch

244. In my opinion, the Young-Estabrook-Thesis combination teaches this element. Estabrook-Thesis teaches a “switch” in the form of the diode (annotated in blue below) in Figure 14(a), which would also operate as a switch when the conversion circuit taught by Estabrook-Thesis is used in the down converter taught by Young.



245. The diode functions as a switch because it only allows current to pass when the voltage across the diode in the forward direction reaches a threshold. This

is illustrated in Estabrook-Thesis's Figure 16(b), which I have reproduced below. When the diode voltage V_D (dotted line) reaches the forward voltage threshold (where the sine curve of V_D flattens out), the diode is "on" and the diode current I_D flows, while below that threshold no current flows and the diode is off:



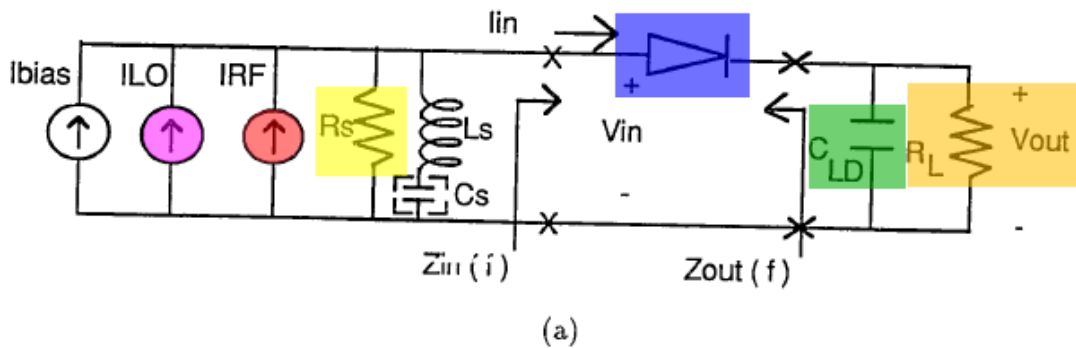
(b) In-phase diode waveforms

Estabrook-Thesis, 71. The diode is therefore an "electronic device for opening and closing a circuit" that meets Petitioner's proposed construction.

246. Indeed, Estabrook-Thesis itself describes its diode as a switch. Estabrook-Thesis, 90 ("a switch, which is a square wave multiplier of sorts, can be realized at these frequencies using a diode as the switching element"), Fig. 14(a). I note that the '686 Patent itself indicates that a diode is an exemplary embodiment of a "switch." '686 Patent, 4:60-61, Figs. 45C-45D.

247. As I discussed in Section IX.B above, I understand that there is a dispute between the parties whether the switch must be “dictated by an independent control input,” as argued by ParkerVision. I do not agree with this proposal, but in my opinion, even if the term is construed this way, it is taught by Estabrook-Thesis (within the combination of Young and Estabrook-Thesis).

248. The ILO in Estabrook-Thesis controls the diode switch. This is clear from looking at the details in Figure 14(b) of the circuit simulation (using a program called SPICE) in Estabrook-Thesis. Exhibit 1034 explains the SPICE programming that I discuss below. SPICE models electrical circuits by defining a set of nodes and modeling circuit elements between those nodes using a defined language to specify characteristics of those elements. I have highlighted certain relevant elements of Figure 14(a) and the corresponding elements of the SPICE run file in Figure 14(b) below:



RESISTIVELY MATCHED S/E MIXER

SINGLE ENDED MIXER

IBIAS 0 21 DC 0.0

VIMB 21 15

ILO 0 7 SIN(0 4.0M 900MEG)

VIM0 7 15

IRF 0 8 SIN(0 .4M 909MEG)

VIMR 8 15

VIMT 15 13

VIM1 13 12

RS 12 0 1000

LS 12 0 1.8UH

VIM2 13 9

VIM3 9 6

D1 6 3 DIODE1

RPD 9 3 5MEG

VIM4 3 23

RL 23 0 1000

VIM6 23 20

CLD 20 0 2.8PF

.MODEL DIODE1 D RS=10.0 IS=1.0E-14 N=1.0 CJO=.001PF VJ=.9 BV=20

.OPTIONS ACCT OPTS ITL3=10 ITL5=20000 LVLTIM=1 LIMPTS=40000

.TRAN 27.13P .222US .111US

.PRINT TRAN V(3) I(VIM3) V(6,3) I(VIM2) V(13) V(0) V(0) V(0)

* Maximum parameters printed in one row is 8.

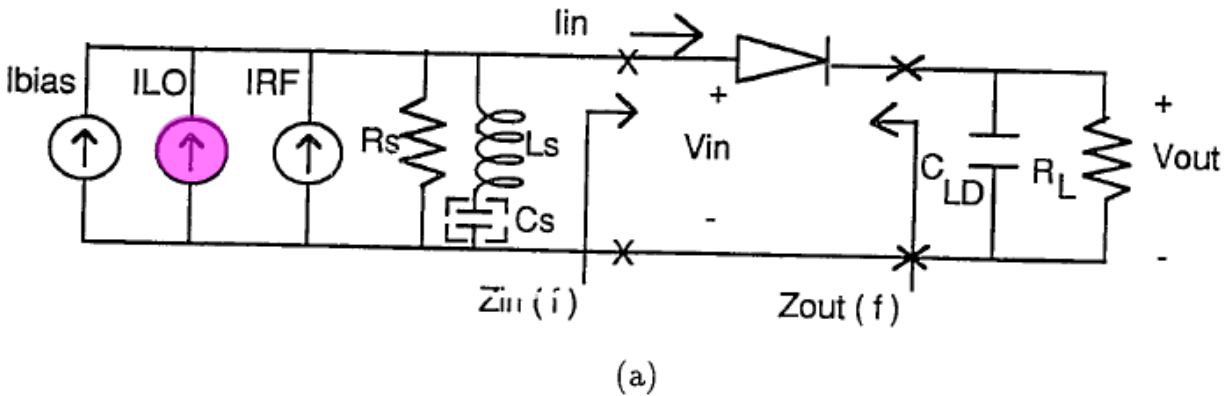
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249. For example, the description of the ILO (“ILO 0 7 SIN(0 4.0M 900MEG)”) means that the ILO is an AC current source between nodes 0 and 7 which outputs an peak current of 4.0mA (“4.0M”) at 900 MHz (“900 MEG”).

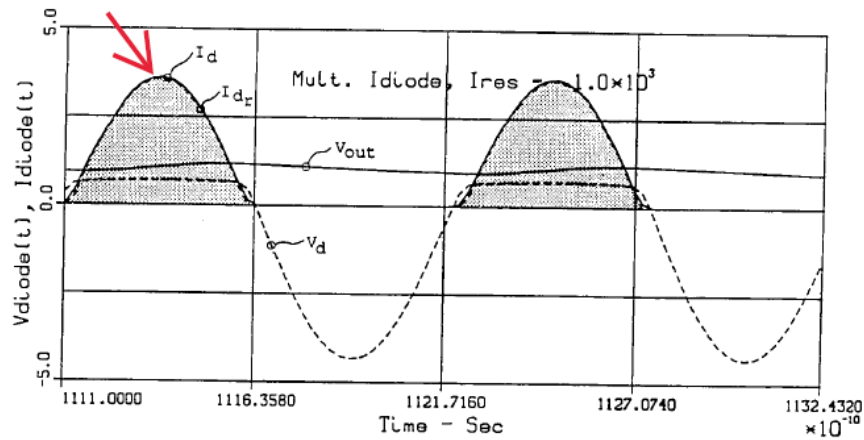
Because the resistor RS has a resistance of 1 K Ω (“RS 12 0 1000”), the peak voltage of the ILO (from the formula $V=IR$, or voltage equals current times resistance) is roughly 4 V. Similarly, the IRF (“0 8 SIN (0 .4M 909MEG)”) is an AC source with peak current of .4 mA at 909 MHz, whose peak voltage can likewise be calculated as roughly .4V. The voltage necessary to turn the diode “on” is the junction voltage VJ, which is given in the model of DIODE1 as .9V (“MODEL DIODE 1... VJ=.9”). Because the peak voltage contributed by the ILO (4V) exceeds this value, but the voltage contributed by the IRF alone (.4V) does not, the diode in Estabrook-Thesis’s Figure 14 is turned on by the operation of the ILO, for approximately half of the period of the ILO. Therefore, the ILO drives the turning on and off of the diode. The ILO is thus an independent control signal.

g. 11[FTM-1.2] configured to operate according to an energy transfer signal,

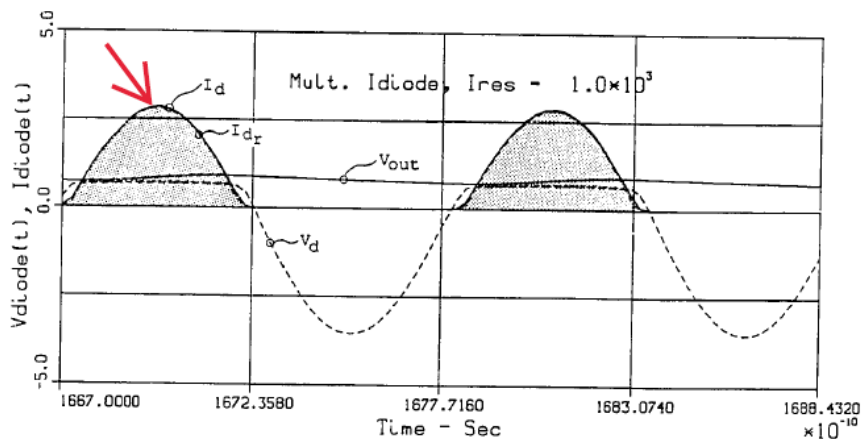
250. In my opinion, Estabrook-Thesis teaches this element because Estabrook-Thesis’s diode switch is driven (“configured to operate according to”) by the ILO (annotated purple in Figure 14(a) below), which is an energy transfer signal:



251. In my opinion, the ILO is an “energy transfer signal” as claimed because the input from the ILO is necessary to activate the diode and close the diode switch (as I discussed above in Section X.B.4.f (element 11[FTM-1.1])), and when the diode switch is closed, it passes current (and therefore energy) through the diode from the combined signal of the ILO and IRF. This is illustrated in Figure 16(b) and 16(c) of Estabrook-Thesis, which show that when the ILO and the IRF are in phase, more current flows (as shown by the amplitude of I_D , indicated by the red arrows at the peaks below), and therefore more energy is transferred, than when they are out of phase:



(b) In-phase diode waveforms



(c) 180° out-of-phase diode waveforms

Estabrook-Thesis, Figs. 16(b), 16(c) (annotated).

252. Therefore, in my opinion, the ILO signal causes the diode to transfer energy, including energy from the IRF signal in addition to the ILO signal.

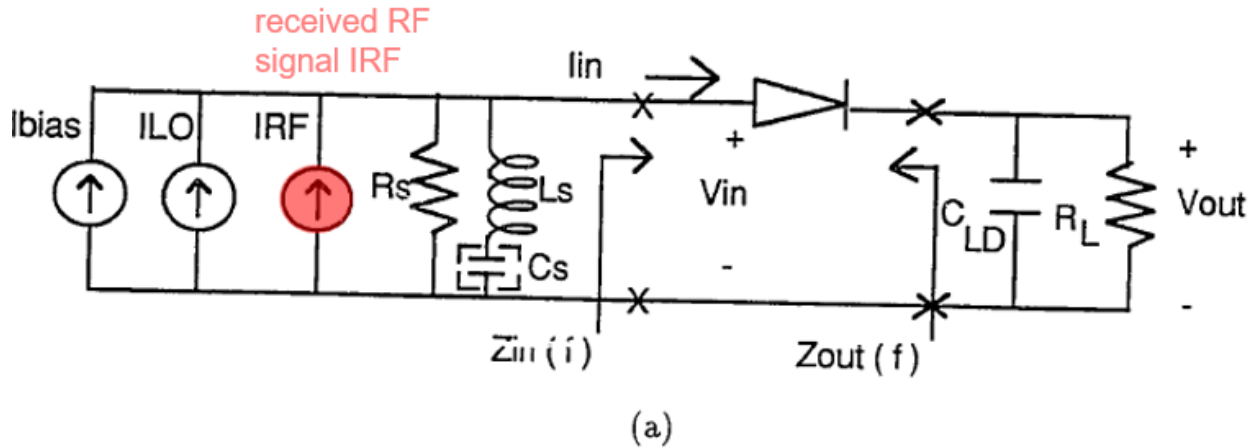
253. Although I have given “energy transfer signal” its plain and ordinary meaning, I note that the disclosure in Estabrook-Thesis is also consistent with the embodiments described as an “energy transfer signal” in the '686 Patent. Estabrook-Thesis discloses that the diode is most efficient (i.e., has the lowest conversion loss C_L) when it is turned on for 50% of the duration of the ILO period. Estabrook-

Thesis, 94 ($T_{\text{TON}} = 0.50 T_{\text{LO}}$). Given that the ILO and IRF have roughly the same frequency (*Id.* (ILO frequency of 900 MHz and IRF frequency of 909 MHz)), this would also be approximately 50% of the IRF period.

254. This teaching in Estabrook-Thesis is consistent with the aperture (that is, the width of the “on” time of the diode) that the ’686 Patent discloses is the preferred embodiment of the “energy transfer signal.” ’686 Patent, 14:45-47 (“an aperture width of approximately $\frac{1}{2}$ the period of the EM signal being down-converted as a preferred embodiment...”); ’551 Patent, 67:1-13 (energy transfer system with energy transfer signal having aperture of “ $\frac{1}{2}$ of a period of the EM signal”); ’686 Patent, 9:38-46 (incorporating ’551 Patent by reference)..

h. 11[FTM-1.3] and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and

255. In my opinion, Estabrook-Thesis teaches this element. Estabrook-Thesis’s “IRF” (the modulated RF signal being down-converted by Estabrook-Thesis’s circuit) is the claimed first EM circle and is annotated in red in Estabrook-Thesis’s Figure 14(a) below:



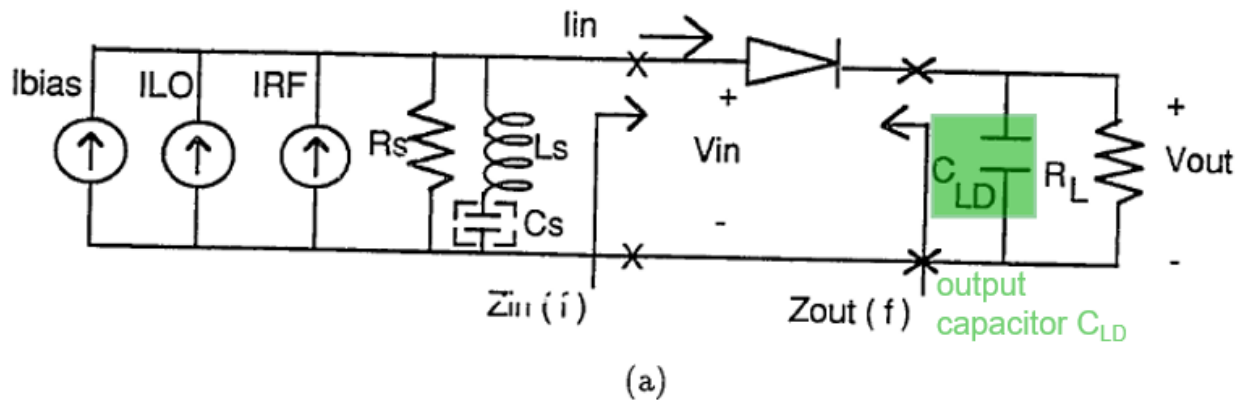
256. As I noted in Section IX.E above, I have applied the construction proposed by ParkerVision and adopted by a court in related litigation of “sub-sample” as “sampling at an aliasing rate, i.e., at a rate that is less than or equal to twice the frequency of the signal being sampled.” The rate at which Estabrook-Thesis’s diode opens is driven by the ILO at a rate of 900 MHz, which is less than twice the frequency of the IRF being sampled (909 MHz). The current flows through the diode (and therefore energy is transferred) for approximately 50% of the duty cycle of the ILO, which is also approximately 50% of the duty cycle of the IRF, which has a similar frequency. Estabrook-Thesis, 71, Figs. 16(b), 16(c) (showing current passing during 50% of duty cycle), 90 (explaining 50% duty cycle). I discussed in Section X.B.4.g (element 11[FTM-1.2]) why the 50% duty cycle of Estabrook-Thesis is consistent with the energy transfer described in the preferred embodiment of the ’686 Patent. Although the energy being transferred via current flow across the diode includes current from the ILO as well as the IRF, it is my

opinion that the plain language of the claims does not require that the switch transfer energy exclusively from the EM signal. In other words, as long as energy from the EM signal is transferred, the claim is met. Indeed, as I noted in Section X.B.4.f (element 11[FTM-1.1]) above, the '686 Patent itself identifies a diode as an exemplary embodiment for a “switch” as claimed. '686 Patent, 4:60-61, Figs. 45C-45D.

257. In order for a diode to be driven at an aliasing rate rather than at the frequency of the IRF, it would need to be turned on by a voltage generated by the aliasing signal and accordingly pass energy from that aliasing signal, just like Estabrook-Thesis. In other words, the voltage value of the RF signal is insufficient to reliably switch the diode itself, and it requires additional current (which is supplied by ILO).

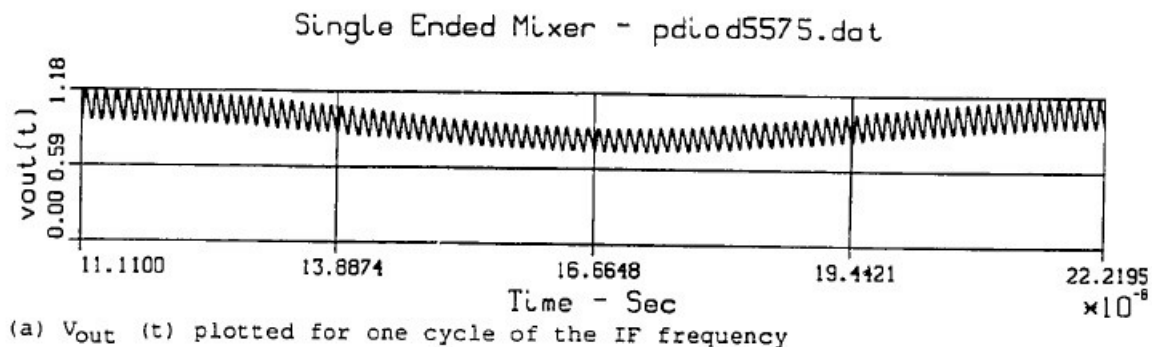
i. 11[FTM-2.1] a storage module coupled to said switch and configured to store said transferred energy,

258. In my opinion, the Young-Estabrook-Thesis combination teaches this element. Estabrook-Thesis's storage module is an output capacitor CLD, which is coupled to and stores energy transferred from the diode. I have annotated the capacitor in green in Estabrook-Thesis's Figure 14(a) below:



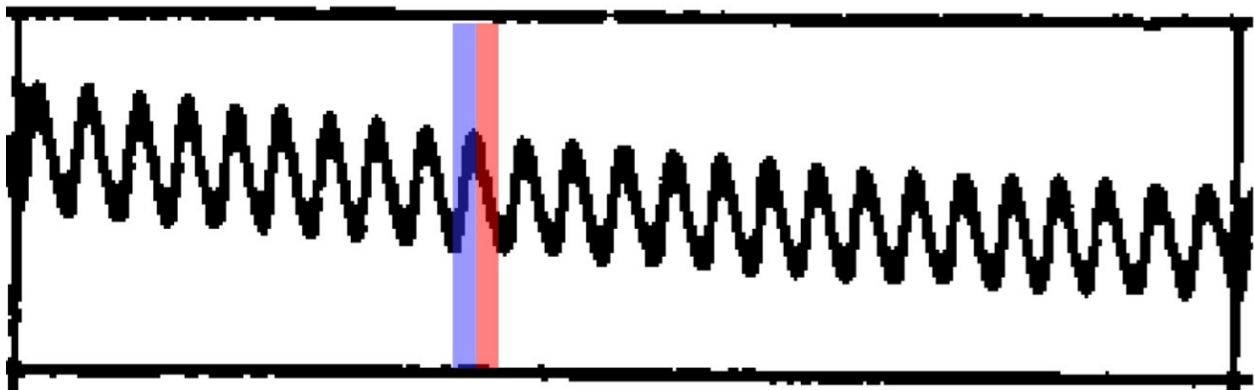
259. In my opinion, this teaching is consistent with the '686 Patent's disclosure of using a capacitor for the storage module. '686 Patent, 14:39-44, 18:6-19, Fig. 20A, Fig. 51A. Therefore, in my opinion, the capacitor in Estabrook-Thesis is the same or equivalent structure to the closest structure disclosed in the '686 Patent as the "storage module."

260. Figure 16(a) of Estabrook-Thesis (p. 71) illustrates how the capacitor discharges energy when the diode is open. The capacitor CLD stores energy transferred through the diode when the diode is closed (on) and discharges it at VOUT when the diode is open (off):



Estabrook-Thesis, Fig. 16(a).

261. This can be seen more clearly by zooming in on Estabrook-Thesis's Figure 16(a). Each sawtooth waveform (corresponding to one closing and opening of the diode during a cycle of the ILO) has a rising edge (blue) and a falling edge (red). The rising edge is generated when the diode is on and current of both ILO and IRF pass through. The falling edge is generated when the diode is off, and no current passes through the diode. As a result, the only source of current during the falling edge is the energy stored in the capacitor CLD, so the falling edge voltage of V_{out} shown below is generated from the energy previously stored in the capacitor CLD being discharged:



Estabrook-Thesis, Fig. 16(a) (annotated, zoomed in).

262. In my opinion, the amount of energy stored by the capacitor is non-negligible because the capacitor stores the energy transferred during half of the duty cycle of the ILO (blue) then discharges it during the other half (red), as discussed above in Sections X.B.4.f-X.B.4.g (elements 11[FTM-1.1] and 11[FTM-1.2]). The

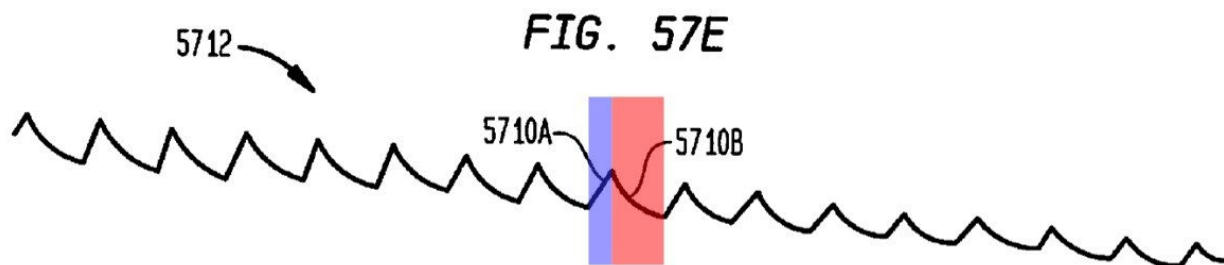
energy discharged by the capacitor is distinguishable from noise because the output signal V_{out} is recovered from energy discharged by the capacitor.

263. In my opinion, this teaching of Estabrook-Thesis is very similar to the corresponding description and figures in the '551 Patent, which is incorporated by reference into the '686 Patent:

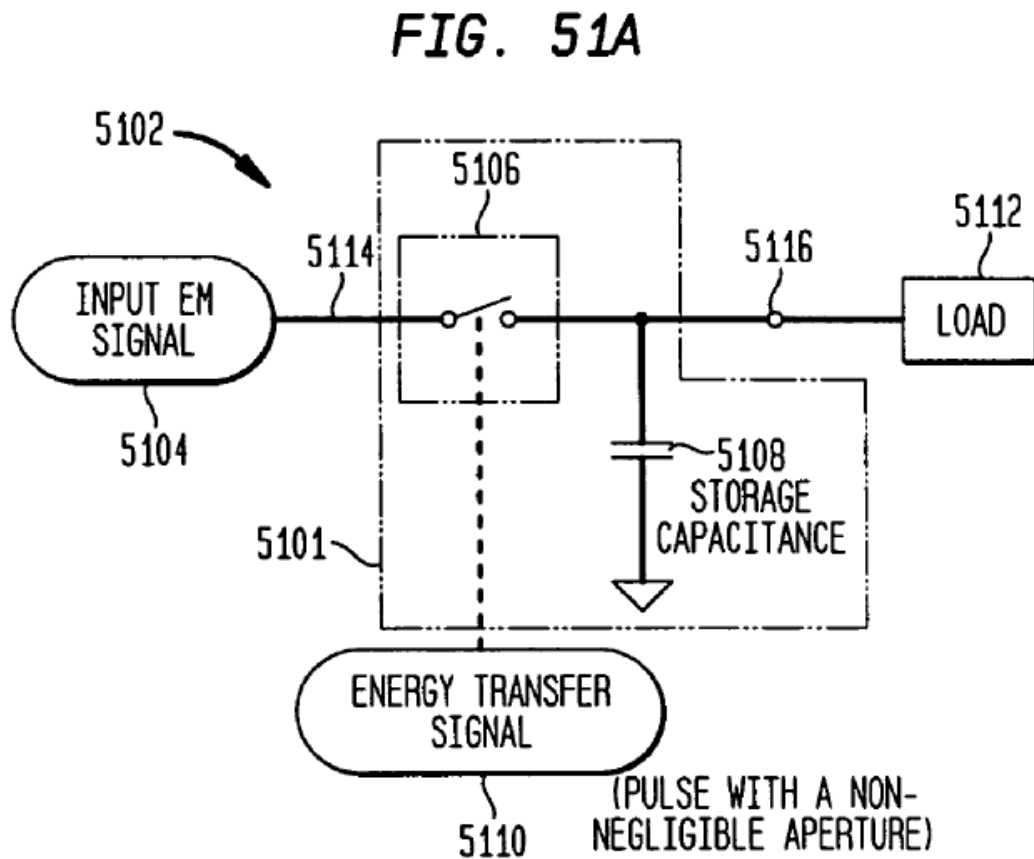
The demodulated baseband signal 5712 includes portions 5710A, which correlate with the energy transfer pulses 5707 in FIG. 57C, and portions 5710B, which are between the energy transfer pulses 5707. Portions 5710A represent energy transferred from the analog AM carrier signal 516 to a storage device, while simultaneously driving an output load. The portions 5710A occur when a switching module is closed by the energy transfer pulses 5707. Portions 5710B represent energy stored in a storage device continuing to drive the load. Portions 5710B occur when the switching module is opened after energy transfer pulses 5707.

'551 Patent, 85:48-58 (annotated).

264. The '551 Patent at Figure 57E also shows substantially similar resulting waveform, in which the capacitor is charged (blue) while the switch is open and discharged (red) when the switch is closed:



265. I understand that ParkerVision has argued that the term “storage module” must be part of an “energy transfer system.” I disagree, but even under this interpretation it is taught by Estabrook-Thesis. The ’686 Patent doesn’t define “energy transfer system” either, but does say that Figure 51A, which also includes a capacitor on the output side of a switch driven by an “energy transfer signal” is an “energy transfer system:”



’686 Patent, Fig. 51A, 5:10-11.

266. The ’686 Patent explains that a system is an “energy transfer module” when the control signal has a “non-negligible aperture” and thus becomes an “energy

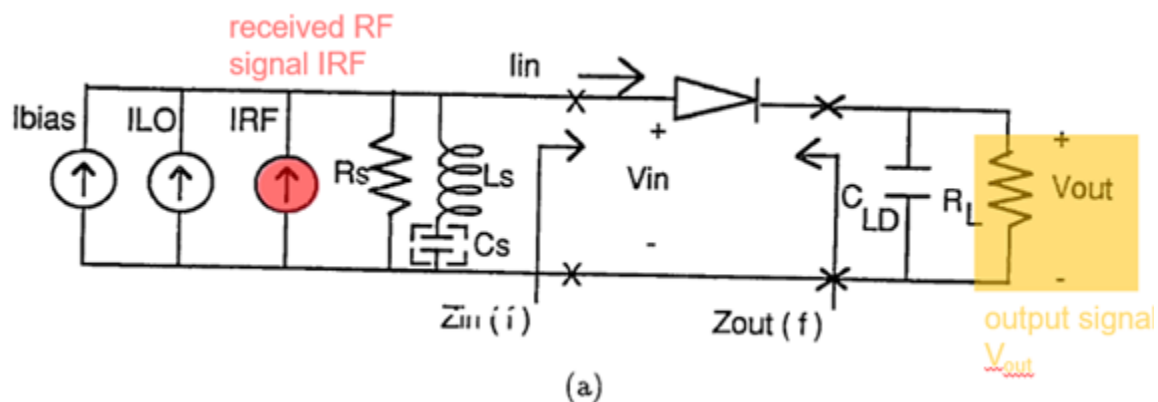
transfer signal.” ’686 Patent at 13:27-31. Because Estabrook-Thesis’s ILO opens the diode switch for 50% of the duty cycle as I discussed above in Sections X.B.4.g-X.B.4.h (elements 11[FTM-1.2] and 11[FTM-1.3]), and thus has a “non-negligible aperture” which makes the system an “energy transfer system” even under ParkerVision’s restrictive definition.

267. I understand that ParkerVision has also argued regarding some related patents that an “energy transfer system” (which the “storage module,” properly construed, does not require) must have a “low impedance load.” In my opinion, Estabrook-Thesis still teaches this element even under that restrictive definition. The ’686 Patent teaches using a 2 K Ω resistive load for downconverting a 900 MHz RF signal. ’686 Patent, Fig. 51B. Several places in Estabrook-Thesis teach that the resistive load is less than that, and therefore has the same or lower impedance than the examples of a “low impedance load” in the ’686 Patent (*see, e.g.*, Fig. 51B (showing a low impedance load being 2 kohm)):

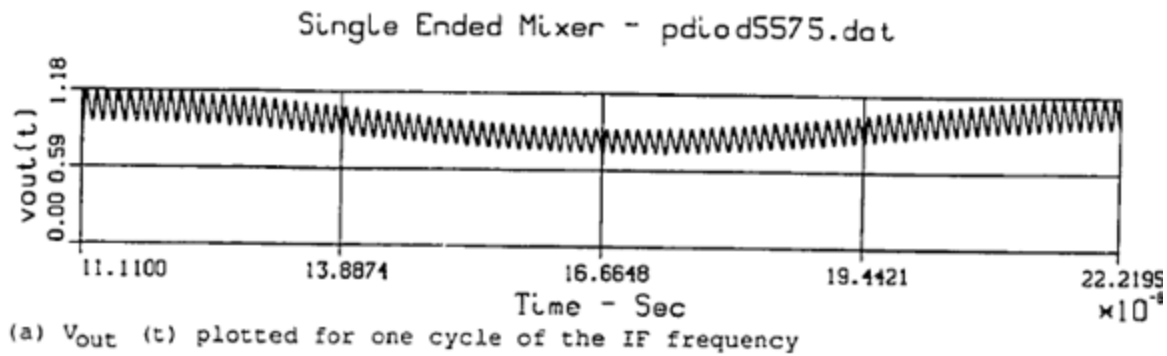
Resistive Load	Citation(s) in Estabrook-Thesis
1 K Ω	Fig. 14(b) (p. 60), Table 19 (p. 212))
500 Ω , 1.5 K Ω , or 2 K Ω	Table 26 (p. 250)
500 Ω	Fig. 27(b) (p. 105)

- j. 11[FTM-2.2] wherein a second EM signal is generated from said stored energy, said second EM signal having a [frequency] different from said first EM signal;

268. In my opinion, the Young-Estabrook-Thesis combination teaches this element because it generates a second EM signal, V_{out} , which is a down-converted signal from the IRF input and is generated from energy stored in the capacitor. Estabrook-Thesis, 67 (“The circuit shown in Figure 14(a) was chosen as a beginning point for the design of the mixer in the direct downconversion receiver[.]”). I have annotated the location of V_{out} in orange in Figure 14(a) below, while Figure 16(a) shows one cycle of the resulting waveform:



Estabrook-Thesis, Fig. 14(a) (annotated).



Estabrook-Thesis, Fig. 16(a) (annotated).

269. I discussed above in Section X.B.4.i (element 11[FTM-2.1]) how the V_{out} signal is generated from energy stored in the capacitor C_{LD} . While the output signal includes individual “sawtooth” waveforms at the frequency of the ILO, the voltage of the peaks and troughs of those waveforms varies at the lower intermediate frequency (IF), for which Fig. 16(a) illustrates one cycle. The lower frequency of the output signal V_{out} at the IF can be calculated as the difference of the IRF and the ILO, $909 \text{ MHz} - 900 \text{ MHz} = 9 \text{ MHz}$. Estabrook-Thesis, 90. These frequencies are also shown in the table of simulation values (Fig. 14(b)) accompanying the model of the circuit:

```

SINGLE ENDED MIXER
IBIAS 0 21 DC 0.0
VIMB 21 15
ILO 0 7 SIN(0 4.0M 900MEG)
VIM0 7 15
IRF 0 8 SIN(0 .4M 909MEG)
VIMR 8 15
VIMT 15 13
VIM1 13 12
RS 12 0 1000
LS 12 0 1.8UH
VIM2 13 9
VIM3 9 6
D1 6 3 DIODE1
RPD 9 3 5MEG
VIM4 3 23
RL 23 0 1000
VIM6 23 20
CLD 20 0 2.8PF
.MODEL DIODE1 D RS=10.0 IS=1.0E-14 N=1.0 CJO=.001PF VJ=.9 BV=20
.OPTIONS ACCT OPTS ITL3=10 ITL5=20000 LVLTIM=1 LIMPTS=40000
.TRAN 27.13P .222US .111US
.PRINT TRAN V(3) I(VIM3) V(6,3) I(VIM2) V(13) V(0) V(0) V(0)
* Maximum parameters printed in one row is 8.
.END

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Estabrook-Thesis, Fig. 14(b) (annotated).

270. The same frequency can also be calculated by taking the inverse of the cycle time shown in Fig. 16(a), 11.1095×10^{-8} seconds (22.2195-11.1100), which also gives 9 MHz.

k. 11[2] operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and

271. In my opinion, the Young-Estabrook-Thesis combination teaches this element. As I previously discussed in Section X.B.4.d (element 11[1.3]), Young teaches using its Radio A and Radio B to send and receive using different protocols, such as Bluetooth and IEEE 802.11 wi-fi or Bluetooth and HomeRF. Young, Abstract, 1:8-12, 1:29-43, 2:65-67. This is particularly clear in Young's Abstract, which recites "operating a first transceiver under a first transmitter/receiver protocol" and "operating a second transceiver under a second transmitter/receiver protocol." Each of these transceivers, Radio A and Radio B, and the associated baseband processor is a standard/protocol sub-module, while each of Bluetooth and IEEE 802.11 (for example) is a protocol/standard combination for the same reasons that I discussed in Section X.B.4.d (element 11[1.3]).

l. 11[3] operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

272. In my opinion, the Young-Estabrook-Thesis combination teaches this element for the reasons that I discussed above in Section X.B.4.k (element 11[2]). Of the two transceivers in Young (Radio A and Radio B), one is the first transceiver operating in conformance with one protocol/standard combination (e.g. Bluetooth)

and the other is the second transceiver operating in conformance with a second protocol/standard combination.

5. Dependent claims 12-20

- a. Claim 12: The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communications links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

273. In my opinion, Young teaches the additional element of this claim. As I discussed in Section X.B.4.a (element 11[pre]), Young discloses communicating simultaneously in two protocols such as Bluetooth and IEEE 802.11, and as I discussed in Section X.B.4.d (element 11[1.3]), that simultaneous communication employs sub-modules associated with Radio A and Radio B. One sub-module communicating with one link (e.g. Bluetooth) and one sub-module communicating with the other (e.g. IEEE 802.11) are an “equal quantity of the plurality of standard/protocol sub-modules.”

274. As I’ve noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]) it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

- b. **Claim 13: The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to communicate with at least one of the plurality of communication links using the control module, the at least one multi-platform module including a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

275. In my opinion, the Young-Estabrook-Thesis combination teaches the additional element of this claim. As discussed in Section X.B.4.c (element 11[1.2]), Young teaches a control module (including a main processor and processors for radios A and B) which controls communications with at least one of a plurality of communications links such as Bluetooth or IEEE 802.11 connections. In Young's Figure 5, each of radios A and B has an associated transmitter and receiver path including the antenna, common components, "down converter and demodulator" for the receiver paths and "modulator and preamplifier" for the transmitter paths. I have annotated each of these transmitters and receivers separately in Figure 5 below:

Fig. 5

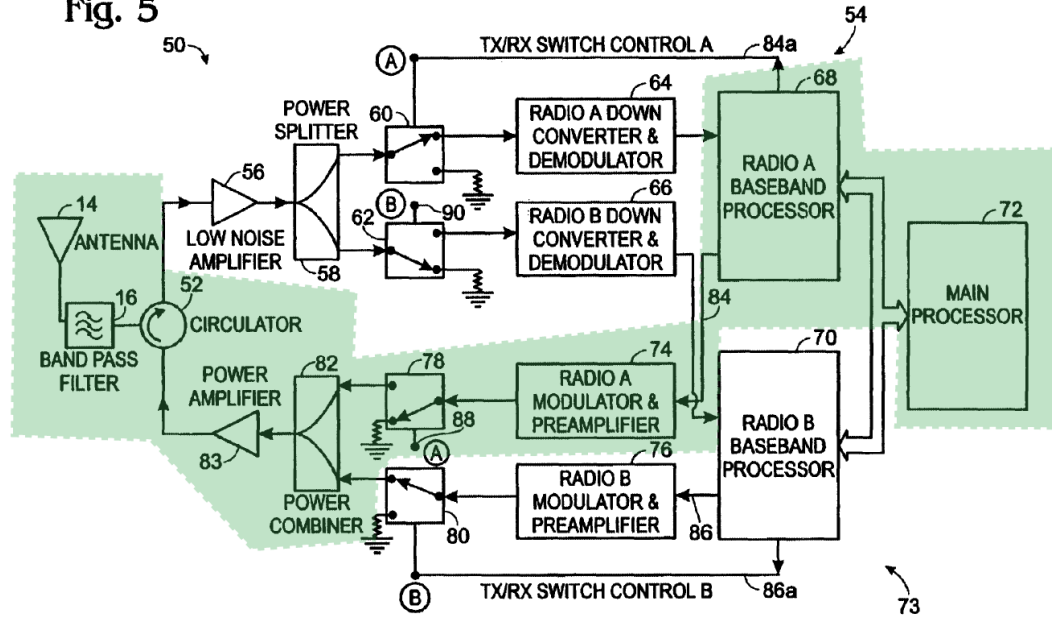
The diagram illustrates a dual-band mobile station (50) with the following components and connections:

- Antenna (14)** is connected to a **Band Pass Filter (16)**.
- The **Band Pass Filter (16)** is connected to a **Circulator (18)**.
- The **Circulator (18)** has two output paths:
 - Path 1: Through a **Low Noise Amplifier (56)** to a **Power Splitter (60)**.
 - Path 2: Through a **Power Amplifier (82)** to a **Power Combiner (84)**.
- The **Power Splitter (60)** has two outputs:
 - Output A: Connected to **Radio A Down Converter & Demodulator (64)**.
 - Output B: Connected to **Radio B Down Converter & Demodulator (66)**.
- The **Power Combiner (84)** has two inputs:
 - Input A: Connected to **Radio A Modulator & Preamplifier (74)**.
 - Input B: Connected to **Radio B Modulator & Preamplifier (76)**.
- The **Radio A Down Converter & Demodulator (64)** and **Radio B Down Converter & Demodulator (66)** are connected to a **Radio A Baseband Processor (68)** and **Radio B Baseband Processor (70)**, respectively.
- The **Radio A Baseband Processor (68)** and **Radio B Baseband Processor (70)** are connected to a **Main Processor (72)**.
- The **Radio A Baseband Processor (68)** and **Radio B Baseband Processor (70)** are also connected to **TX/RX Switch Control A (84a)** and **TX/RX Switch Control B (86a)**, respectively.
- The **Radio A Modulator & Preamplifier (74)** and **Radio B Modulator & Preamplifier (76)** are connected to **TX/RX Switch Control A (84a)** and **TX/RX Switch Control B (86a)**, respectively.
- The **Radio A Modulator & Preamplifier (74)** and **Radio B Modulator & Preamplifier (76)** are also connected to **TX/RX Switch Control B (86a)**.

[illegible]

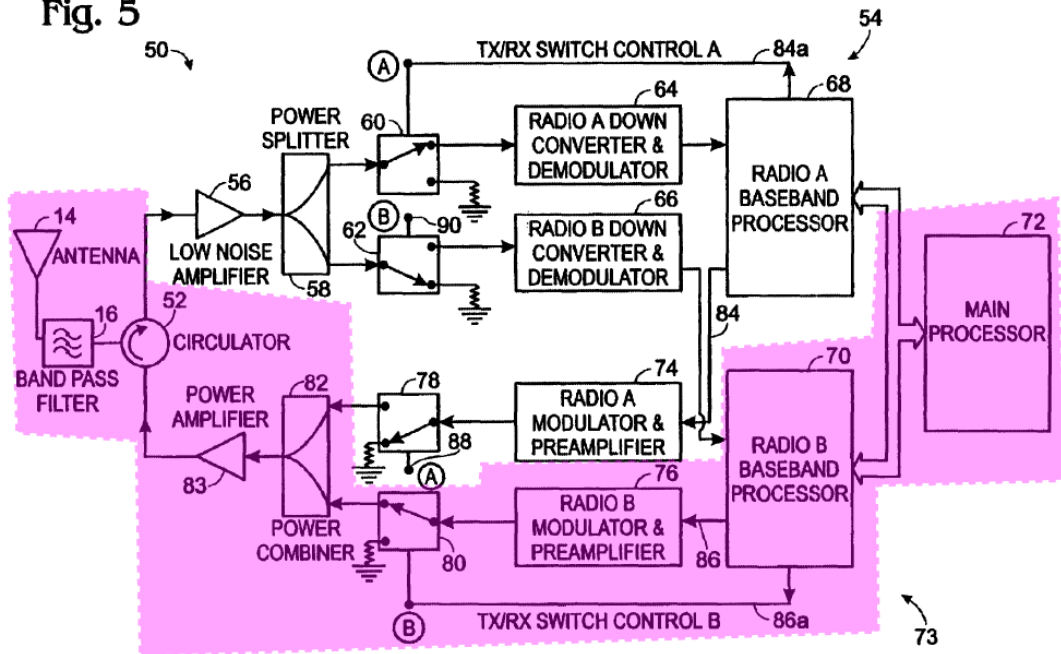
149

Fig. 5



Transmitter A

Fig. 5



Transmitter B

276. I previously discussed in Section X.B.4.e (element 11[1.4]) how each “down converter and demodulator” 64 and 66, as implemented using the direct conversion circuit and mixer of Estabrook-Thesis, is a frequency translation module. I note that the language of this claim only requires that each of the receivers and transmitters to have “at least one frequency translating module,” but does not require each of those frequency translating modules to be the same frequency translating module discussed in claim 11.

277. Young describes “Radio A/B Modulator and Preamplifier” (74 and 76) which are frequency translating modules according to the plain language of the term and well-understood by a person of ordinary skill in the art, taking the low-frequency baseband data from the “Radio A/B Baseband Processor” and modulating (i.e. “translating”) it to a signal at a higher carrier frequency.

- c. **Claim 14: The method of claim 11, wherein step (3) comprises: simultaneously operating the second transceiver in conformance with a second protocol/standard combination that is different from the first protocol/standard combination.**

278. In my opinion, Young teaches this claim’s additional limitation. For the reasons that I discussed in Sections X.B.4.a and X.B.4.d (elements 11[pre] and 11[1.3]), Young teaches that its transceivers (Radio A and B) simultaneously operate on different protocols such as Bluetooth and IEEE 802.11 or HomeRF. When Young operates in this manner, the second transceiver (e.g. Radio B) operates in

conformance with a protocol/standard combination that is different from the protocol/standard combination used by the first transceiver (Radio A).

279. As I've noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret "simultaneous" to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the '686 Patent describes simultaneous.

- d. Claim 15: The method of claim 14, wherein steps (2) and (3) comprise: programming the first and second protocol/standard sub-modules with respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

280. In my opinion, Young teaches the additional limitation of this claim. Young describes two baseband processors ("A" and "B") that condition the baseband signals for appropriate modulation or demodulation for differing protocol requirements. These are typically digitally programmable units, which might require periodic updating depending on evolving protocols and updated interface standards. This would be well understood by a person of ordinary skill in the art.

281. Additionally, operating according to either Bluetooth or IEEE 802.11 would require operational instructions for the same reasons that I previously discussed in this claim with regard to Ground 1 (Section X.A.8), particularly with regard to the protocols for these standards that I previously discussed.

282. Moreover, a POSITA would have understood that IEEE 802.11 and Bluetooth require specific operational instructions—whether it be hardware or software—in order to process and understand data. Shown below is the Bluetooth specification protocol stack, showing that operational instructions are required above the baseband and hardware level. In my opinion, a POSITA would have understood Bluetooth requires operational instructions for both receiver and transmitter. Further, in my opinion, a POSITA would have understood that any device implementing these standards (with unique protocol stacks) would similarly need operational instructions at both the hardware and software layers—as depicted by the respective protocols—to implement the standards. For example, a computing device using these protocols would need to have instructions for (1) formulating communications according to those protocols, and (2) interpreting communications according to those protocols.

283. Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044):

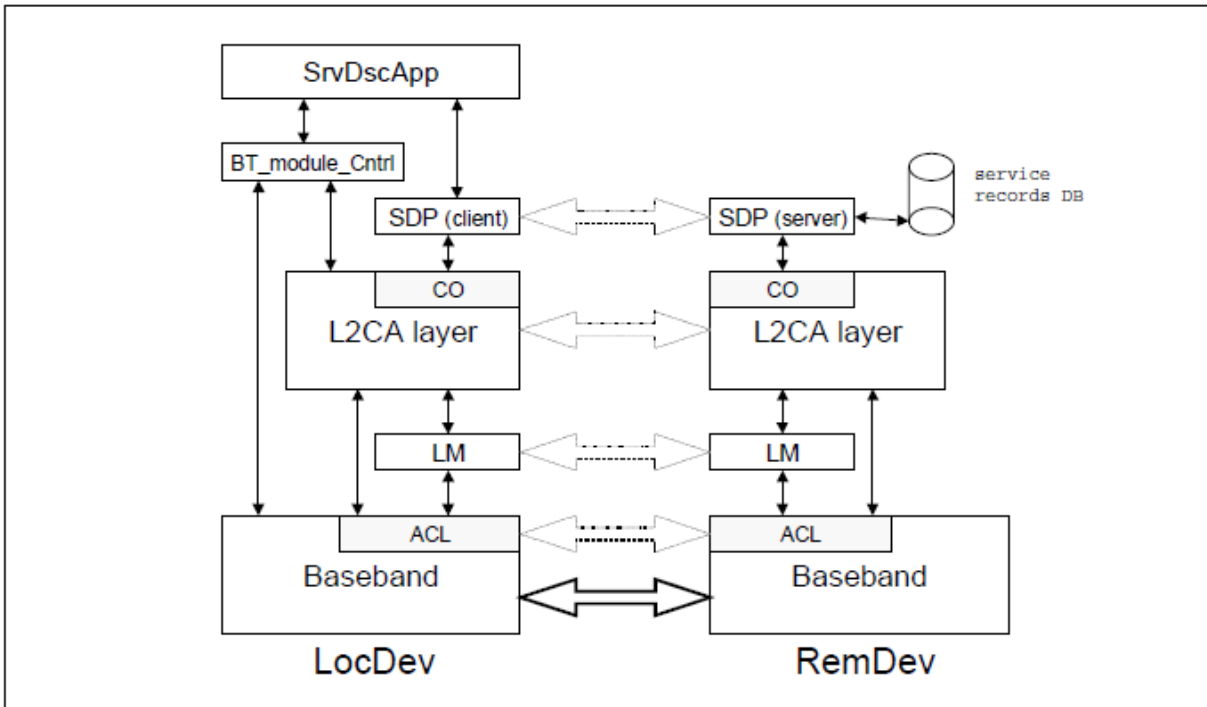


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

284. The same is true with respect to IEEE 802.11. Shown below is a general stack to communicate from the physical level to media access controller (MAC). In order to transmit a message in the format below, the transmitting device would need to have instructions to assemble a message in the format given. Likewise, the receiving device would require instructions to interpret the bits received as the specified parts of a message according to a protocol. Such instructions may be roughly analogized to human language. For example, someone learning English might be taught (instructed) to use “I” or “me” in communications when speaking about oneself individually, and “we” or “us” speaking as a group. Either of the sentences “I went to the store” or “we went to the store” is the logical result of following such instructions, as is correctly interpreting the sentence.

802.11a (Ex. 1039), 33:

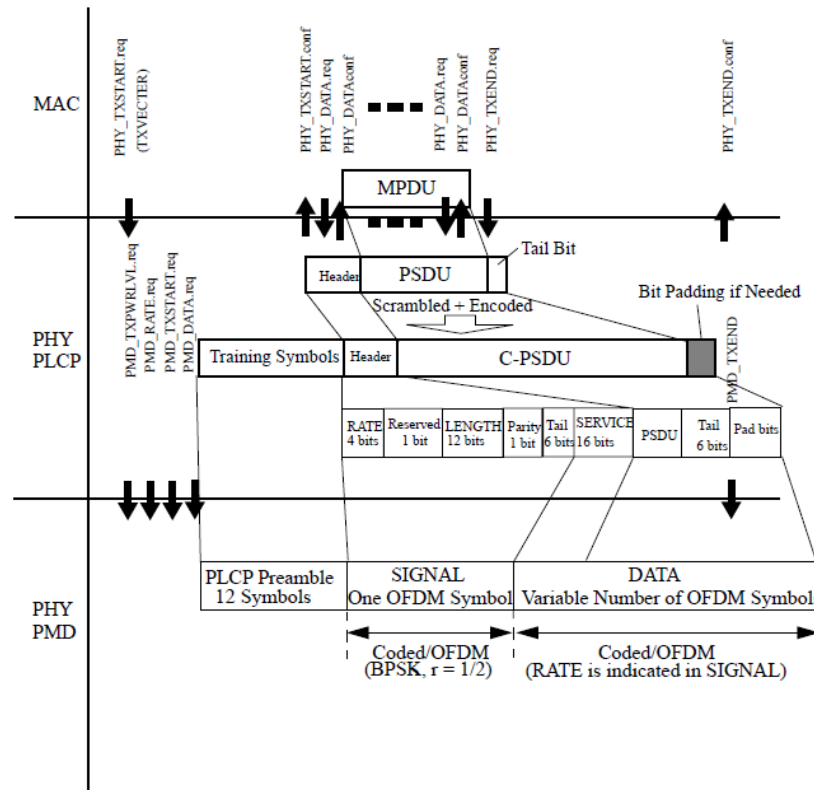


Figure 122—PLCP transmit procedure

285. Further operational instructions are demonstrated at other pages. For example, 802.11a (Ex. 1039) at page 37.

A POSITA would have understood that operational instructions are required for standards like Bluetooth and 802.11.

- e. **Claim 16: The method of claim 15, wherein steps (2) and (3) further comprise: programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures.**

286. In my opinion, Young teaches claim 16's additional limitation. Young describes two baseband processors ("A" and "B") that condition the baseband signals for appropriate modulation or demodulation for differing protocol requirements. These are typically digitally programmable units, which might require periodic updating depending on evolving protocols and updated interface standards. This would have been well understood by a POSITA.

287. Additionally, operating according to either Bluetooth or IEEE 802.11 would require "programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures" for the same reasons that I previously discussed in this claim with regard to Ground 1 (Section X.A.9), particularly with regard to the protocols for these standards that I previously discussed.

288. A POSITA would have understood that these sub-modules would need to have information relating to their protocol stacks and specification information in order to operate. I have demonstrated this immediately above with respect to the respective specification information from 802.11 and Bluetooth's operational instructions.

289. Blowing out those excerpts, these are the stacks for the protocols. For example, Bluetooth Spec. V. 1.0 B, 68 (1998), (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

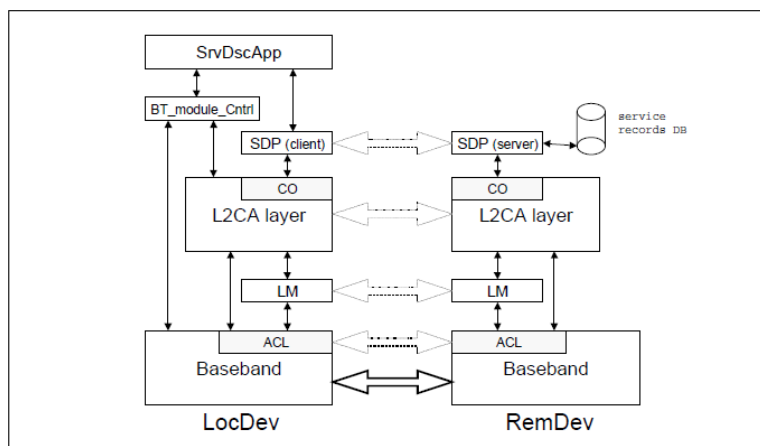
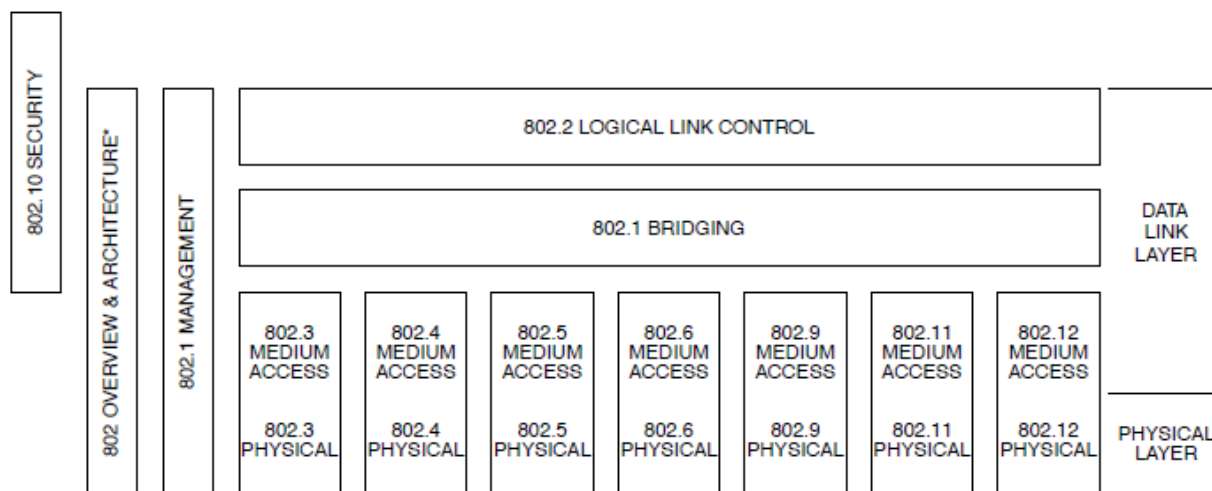


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

290. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

291. A POSITA would have understood these teachings of IEEE 802.11 and Bluetooth to be protocol stacks and specification information.

- f. Claim 17: The method of claim 15, wherein steps (2) and (3) further comprise: updating, upgrading, replacing, or modifying the first and second implementation and operational instructions to provide the at least one multi-platform sub-module with additional functionality.**

292. In my opinion, Young teaches this claim's additional limitation. Communications standards are updated periodically by standards-setting bodies, as new features and requirements are introduced, and any transceiver that conformed to those standards and protocols would have to periodically be updated accordingly. This would be well-known to someone of ordinary skill-in-the-art.

293. For example, the original Bluetooth protocol was released in 1999 as Version 1.0. Subsequent revisions of Bluetooth occurred in 2004 (Version 2.0), 2009 (Version 3.0), 2010 (Version 4.0), and 2016 (Version 5.0). Each version added enhanced data handling, networking and flexibility. A complete history can be found at the industry website, www.bluetooth.com.

For example, 802.11a provides updates to encoding for the MAC and PHY MIB layers. *See* 802.11a (Ex. 1039), 51.

ASN.1 encoding of the MAC and PHY MIB

Add the following variables to the PHY MIB:

1. In “Major sections” of Annex D, add the following text to the end of “PHY Attributes” section:
“-- dot11PhyOFDMTable ::= {dot11phy 11}”

2. In “dot11PhyOperation TABLE” section of Annex D, update “dot11PHYType attribute” section as the following text:
“dot11PHYType OBJECT-TYPE
SYNTAX INTEGER {fhss(1), dsss(2), irbaseband(3), ofdm(4)}
MAX-ACCESS read-only
STATUS current
DESCRIPTION”

“This is an 8-bit integer value that identifies the PHY type
supported by the attached PLCP and PMD. Currently defined
values and their corresponding PHY types are:

FHSS 2.4 GHz = 01, DSSS 2.4 GHz = 02, IR Baseband = 03,
OFDM 5 GHz = 04”

- g. Claim 18: The method of claim 11, wherein steps (2) and (3) comprise: simultaneously operating the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.**

294. Young teaches claim 18’s additional limitation as I’ve discussed in Section X.B.4.a (element 11[pre]).

295. As I’ve noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

296. Moreover, a POSITA would have understood the “operating environments” to encompass capability for using the respective standards, e.g., Bluetooth and IEEE 802.11

297. At a minimum, as I’ve shown in Sections X.A.8-X.A.9 (Ground 1, Claims 15-16), these standards include stacks for operation, which at a minimum shows an operating environment.

298. Blowing out those excerpts, these are the stacks for the protocols. For example, Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

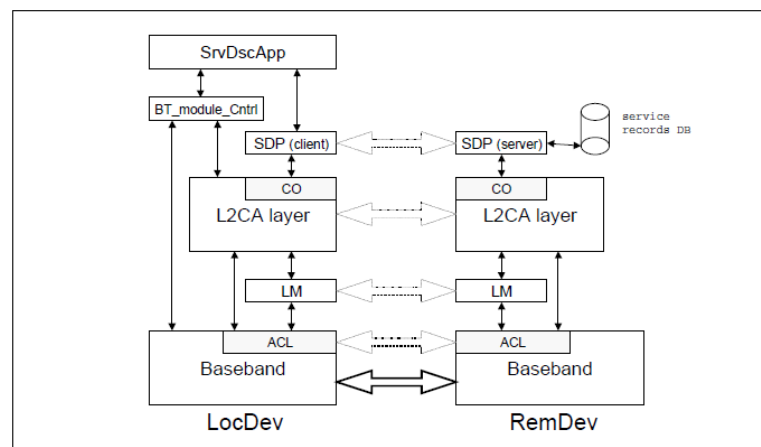
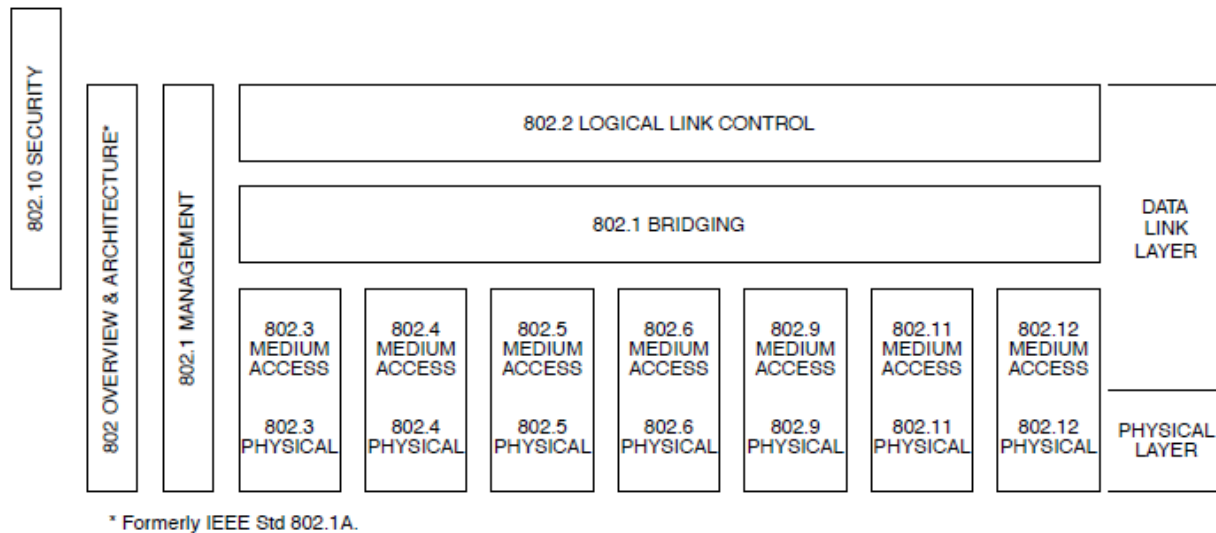


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

299. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:

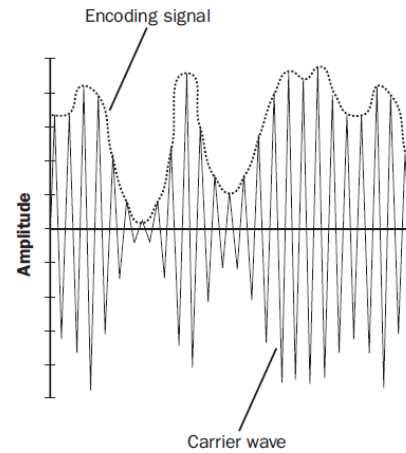


- h. Claim 19: The method of claim 18, wherein steps (2) and (3) further comprise: simultaneously operating the first and second transceivers in conformance with respective standards, content encoders and decoders, and protocol gateways of the first and second protocol and operating environments.**

300. In my opinion, Young teaches claim 19's additional limitation. Claim 19 is substantively similar to claim 18 but recites "content encoders, decoders, and protocol gateways." These are components commonly known and taught by Young.

301. As an initial matter, encoding is another term for simply modulating a data signal on top of a carrier signal. This is shown in the Microsoft Computer Dictionary (Ex. 1035), 26:

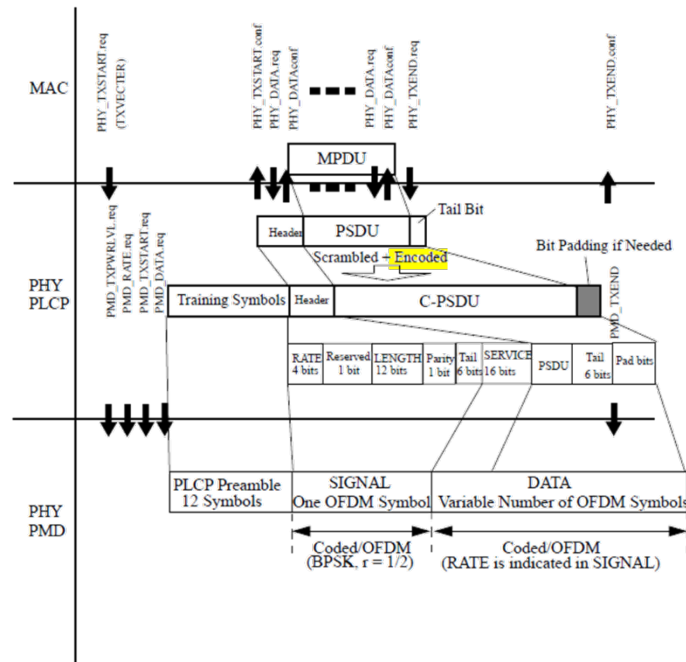
amplitude modulation *n.* A method of encoding information in a transmission, such as radio, using a carrier wave of constant frequency but of varying amplitude. See the illustration. *Acronym: AM. Compare* frequency modulation.



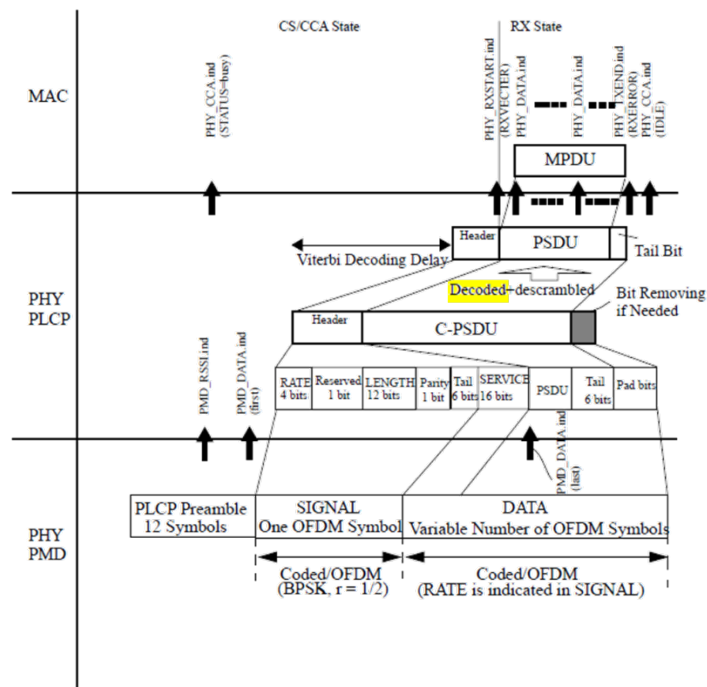
Amplitude modulation.

302. As I have described in Section VI.B (Modulating Signals for Wireless Communications), data is modulated with a carrier for transmission. This is encoding. Further, data is demodulated from a carrier. This is decoding.

303. Further, 802.11a (Ex. 1039), §17.3.2.1 describes other types of encoding for 802.11. 802.11a, 7-8. The encoding is further depicted at page 33 (annotation added).



304. Decoding is similarly depicted at page 36:



305. Bluetooth similarly has encoding and decoding. It provides encryption, which a POSITA would have understood to be a type of encoding/decoding. *See* Bluetooth Spec. V. 1.0 B, 275:

3.1 SECURITY

It is recognized that security in a wireless environment is of paramount importance.

Both the LAP and the DT must enforce that encryption is operating on the baseband physical link while any PPP traffic is being sent or received. The LAP and the DT will refuse any request to disable encryption. Therefore, Bluetooth pairing must occur as a means of authenticating the users. A PIN or link key must be supplied, even if the default PIN is used. The default PIN for LAN access is a zero length PIN. Failure to complete the pairing process will prevent access to the LAN Access service.

306. I note that the '686 Patent describes “protocol gateways” in the most generic sense, by merely listing it. *See, e.g.,* '686 Patent, 37:57-59 (“The operating environment includes, but is not limited to, the available bearer services, content encoders and decoders employed, available protocol gateways, etc.”), 40:4-7 (same). It provides no detailed description and just lists it as part of the standard. Further, as I’ve shown in Sections X.A.8-X.A.9 (Ground 1, Claims 15-16), each standard provides stacks that allow the lower hardware levels to speak to the higher hardware levels. A POSITA would have understood this to be a protocol gateway because it allows connection between various levels of the stack.

307. Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

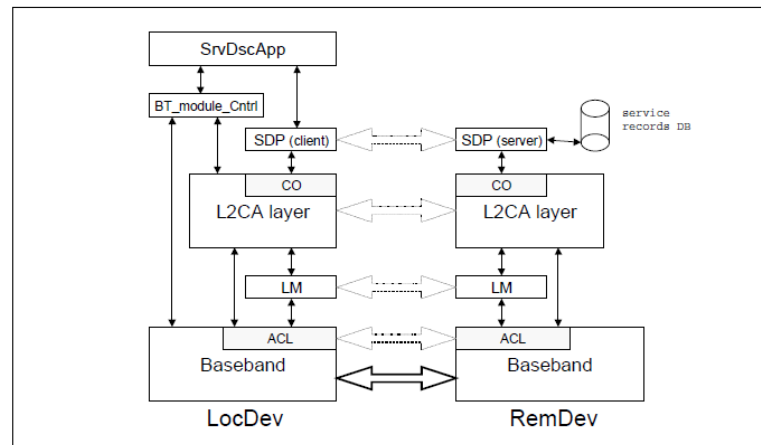
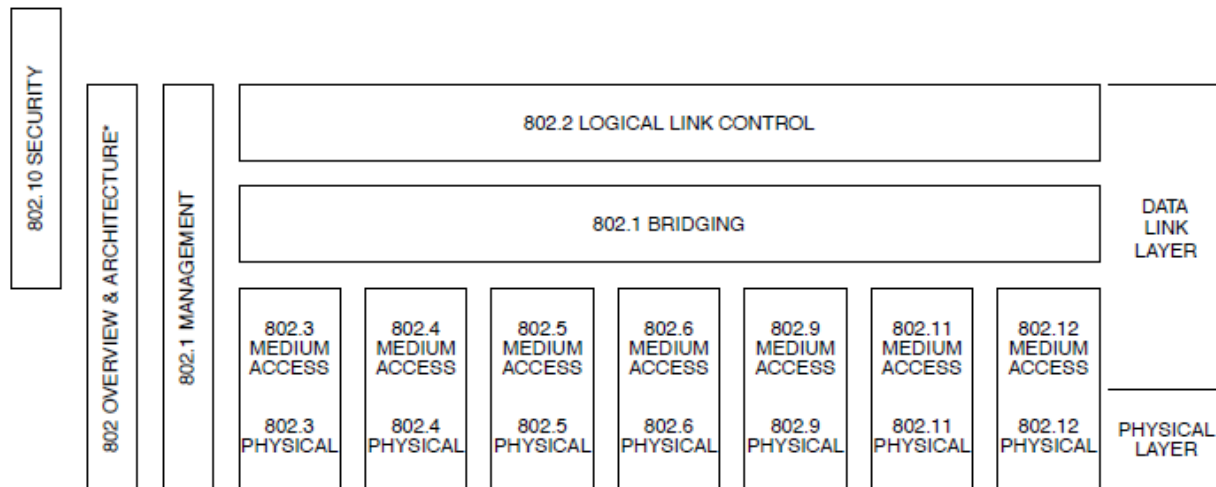


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

308. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

i. Claim 20: The method of claim 11, wherein step (3) comprises simultaneously operating the second transceiver and the first transceiver.

309. Young teaches this claim’s additional limitation for the reasons I described in Section X.B.4.a (element 11[pre]). Young teaches the first and second transceivers Radio A and Radio B (discussed for 11[2] and 11[3], §§X.B.4.k-X.B.4.l) are operated simultaneously to communicate in different protocols.

310. As I’ve noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

6. Claim 1

311. Claim 1 recites substantially similar elements to claim 11. The two most significant distinctions are that claim 1 does not require the “storage module” of claim 11, and claim 1 recites an apparatus while claim 11 recites a method. However, in my opinion, the same teachings of Young in view of Estabrook-Thesis that I discussed regarding claim 11 also apply because Young in view of Estabrook-Thesis teaches an apparatus that performs a method substantially similar to that of claim 11. I also note that claim 1’s frequency translating module has the same meaning as claim 11’s frequency translation module.

- a. **1[pre]: An apparatus capable of performing simultaneous multi-platform operations, comprising:**

312. *See* Section X.B.4.a (element 11[pre]).

- b. **1[a]: at least one multi-platform module including a plurality of transceivers each having at least one frequency translating module, wherein said at least one frequency translating module comprises**

313. *See* Section X.B.4.b (element 11[1.1]) regarding the “multi-platform module” and Section X.B.4.e (element 11[1.4]) regarding the “plurality of transceivers each having at least one frequency translation module.”

- c. **1[b]: a switch configured to operate according to an energy transfer signal, and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and**

314. *See* Sections X.B.4.f-X.B.4.h (elements 11[FTM-1.1], 11[FTM-1.2], and 11[FTM-1.3]).

- d. **1[c]: a control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links, the control module including a plurality of protocol/standard sub-modules.**

315. *See* Sections X.B.4.b and X.B.4.c (elements 11[1.1] and 11[11.2]) regarding the “control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links” and Section X.B.4.d (element 11[1.3]) regarding the “plurality of protocol/standard sub-modules.”

7. Dependent claims 2-10

316. Claims 2-10 depend from claim 1, and add similar limitations to dependent claims 12-20. Accordingly, my discussion of the additional elements of claims 12-20 largely applies to these claims, with minor additional explanations noted below.

- a. Claim 2: The apparatus of claim 1, wherein the control module is configured to enable the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communication links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

317. *See* Section X.B.5.a (Claim 12). In my opinion, the “control module” that I discussed previously regarding this ground in Young’s is configured to enable each sub-module (that is, Young’s Radio A and B) to communicate with one of the communication links using an equal quantity of sub-modules, that is, one sub-module (Radio A or B) per communication link.

- b. Claim 3: The apparatus of claim 1, wherein the at least one multi-platform module includes a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

318. *See* Section X.B.5.b (Claim 13).

- c. **Claim 4: The apparatus of claim 1, wherein the plurality of protocol/standard sub-modules comprise a first protocol/standard sub-module configured to operate a first transceiver in conformance with a first protocol/standard combination and a second protocol/standard sub-module configured to simultaneously operate a second transceiver in conformance with a second protocol/standard combination.**

319. *See* Section X.B.5.c (Claim 14).

- d. **Claim 5: The apparatus of claim 4, wherein the first protocol/standard combination is different from the second protocol/standard combination.**

320. *See* Section X.B.5.c (Claim 14).

- e. **Claim 6: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules contain respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

321. *See* Section X.B.5.d (Claim 15).

- f. **Claim 7: The apparatus of claim 6, wherein the first and second implementation and operational instructions include respective first and second protocol stacks and specification information about the first and second architectures.**

322. *See* Section X.B.5.e (Claim 16).

- g. **Claim 8: The apparatus of claim 6, wherein the first and second implementation and operational instructions can be updated, upgraded, replaced, or modified to provide the at least one multi-platform sub-module with additional functionality.**

323. *See* Section X.B.5.f (Claim 17).

- h. Claim 9: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules are configured to operate the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.**

324. *See* Section X.B.5.g (Claim 18). As I previously discussed in Sections X.B.4.e, X.B.4.k, X.B.4.l (elements 11[1.4], 11[2], and 11[3], respectively) Young’s Radio A and Radio B are sub-modules that operate according to the requirements of the first and second protocols.

- i. Claim 10: The apparatus of claim 9, wherein the first and second operating environments include at least one of respective standards, content encoders and decoders, and protocol gateways.**

325. *See* Section X.B.5.h (Claim 19). As I previously explained with regard to that claim, these features, including standards, content encoders, and protocol gateways, are all described in the respective protocol standards discussed in Young (e.g. Bluetooth and IEEE 802.11) and are thus part of their operating environments.

C. Ground 2B: Claims 1-20 are Unpatentable as Obvious Over Young in view of Estabrook-1988 and Estabrook-1989

326. In my opinion, claims 1-20 are unpatentable as obvious over Young in view of Estabrook-1988 and Estabrook-1989. Independent claims 1 and 11 differ because claim 1 is an “apparatus” claim, while claim 11 is a “method” claim. However, they are similar claims because the “method” claimed in claim 11 is basically just the use of an apparatus, so in my opinion the “method” of claim 11

would be obvious to a POSITA based on art that described an apparatus which performed that method in its normal operation. Claim 11 is also slightly more specific than claim 1 because claim 11, but not claim 1, recites a “storage module.” Therefore, I will discuss claim 11 first because it is more specific. Estabrook-1988 and Estabrook-1989 are publications by the author of Estabrook-Thesis that correspond to chapters of Estabrook-Thesis.

1. Young

327. I discuss pertinent teachings of Young in Section X.B (Ground 2A), above.

2. Estabrook-1988

328. Estabrook-1988 was published in 1988. I understand that Estabrook-1988 qualifies as prior art under 35 U.S.C. § 102(b).

329. Estabrook-1988 (Ex. 1016) describes and simulates the performance of mixers for use in a direct down-conversion scheme for converting a modulated signal to an RF. Estabrook-1988, 1107. Estabrook-1988 first describes the theoretical operation of an ideal mixer with a switch driven at a local oscillator frequency f_{LO} , which produces a resulting signal I_L whose current averaged over the ILO ($\langle I_L \rangle$) varies at the IF. Estabrook-1988, 1107-08, Fig. 2 (annotated):

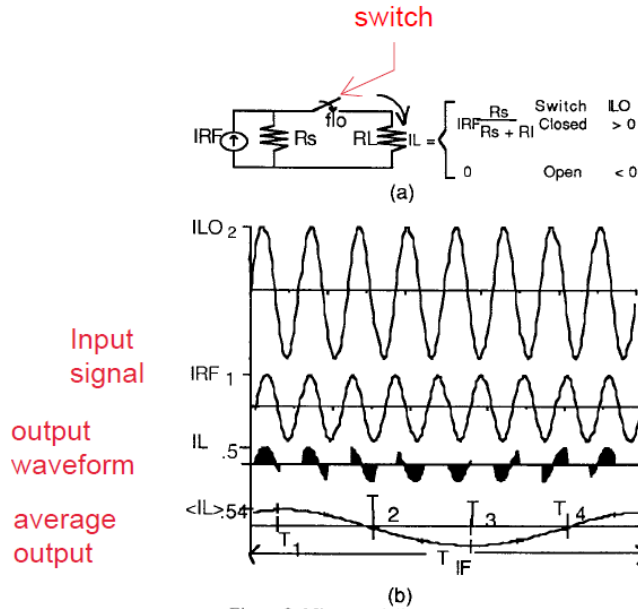
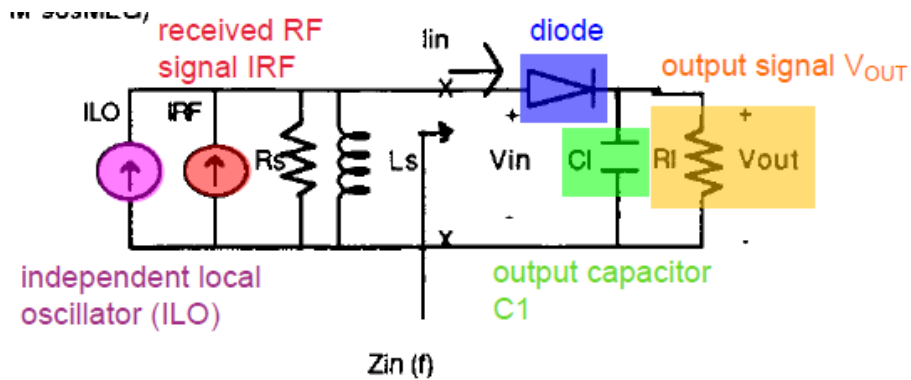


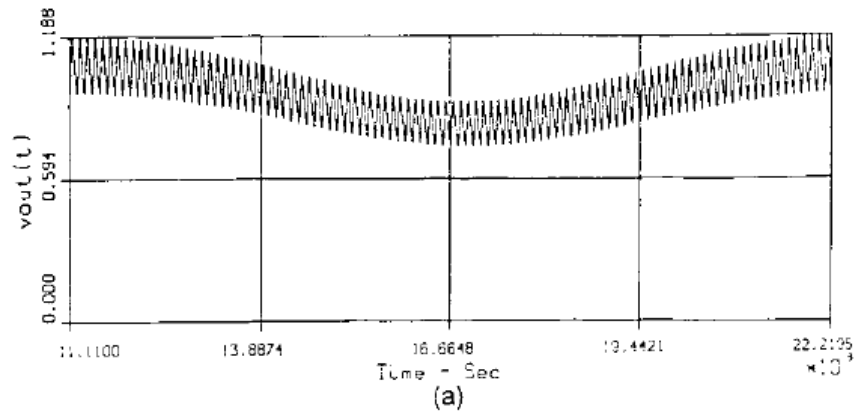
Figure 2. Mixer modelled as a simple switch:
(a) circuit diagram; (b) waveforms.

330. One embodiment of such a mixer for down-conversion is a single-ended mixer, depicted in Estabrook-1988's Figure 3 with a nearly identical circuit diagram and the same simulation values as Estabrook-Thesis's Figure 14(a), including the ILO, IRF, diode switch, capacitor, and output V_{OUT} :



Estabrook-1988, Fig. 3 (annotated).

331. Estabrook-1988 shows the output V_{OUT} of this circuit as the same waveform shown in Figure 16(a) of Estabrook-Thesis:

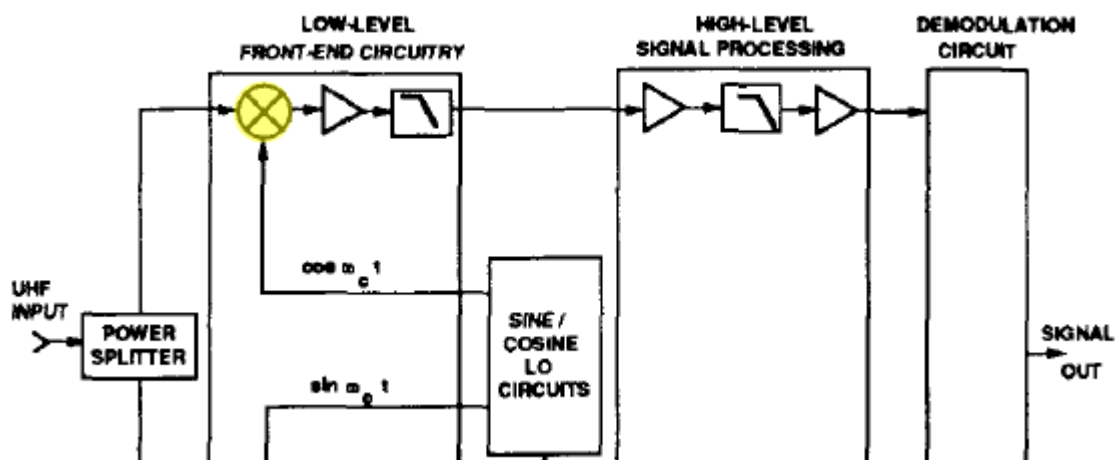


Estabrook-1988, Fig. 4a.

3. Estabrook-1989

332. Estabrook-1989 (Ex. 1017) was published in 1989. I understand that Estabrook-1989 qualifies as prior art under 35 U.S.C. § 102(b).

333. Estabrook-1989 describes “The Design of Mobile Radio Receiver Using a Direct Conversion Architecture.” Estabrook-1989’s Figure 1 (corresponding to Estabrook-Thesis’s Figure 4) shows the high-level architecture of the receiver, including a mixer (highlighted in yellow below) at the front end:



334. Estabrook-1989 explains that two types of mixers have been optimized for that purpose, including the single-ended mixer described in Estabrook-1988, to which Estabrook-1989 refers back. Estabrook-1989, 66-67.

4. Motivation to Combine

335. In my opinion, a POSITA would have been motivated to combine Young, Estabrook-1988, and Estabrook-1989. First, it is clear to me, and in my opinion a POSITA would recognize, that Estabrook-1988 and Estabrook-1989 are related references describing ongoing work on the same project by the same authors. These references simply describe different aspects of the same research; that is, the authors were working on the development of a direct-conversion receiver which included mixer circuits for the initial down-conversion of a signal, described the detailed operation of those mixer circuits and simulations of them in Estabrook-1988, and described the direct conversion receiver at a higher level in Estabrook-1989.

336. It is my opinion that Young and both Estabrook references are in the same field because they all relate to RF receivers. As I discuss in more detail below, because Young describes an RF receiver that requires (but does not go into detail to describe) a down-conversion and demodulation circuit, it would be reasonable for a POSITA to look at other references such as Estabrook-1988 and Estabrook-1989 that describe down-conversion and demodulation circuits in RF receivers.

337. Young teaches that each of its receiver paths (for Radio A and Radio B) includes a “down converter and demodulator” block, 64 and 66. However, Young does not describe any details of the inner functions or the circuits within those blocks. Therefore, in my opinion, a POSITA would have needed to rely on the knowledge in the art or look elsewhere for specific implementation of such a circuit.

338. Estabrook-1989 supplies such a down-conversion and demodulation circuit, including a mixer whose structure and (simulated) performance is described in more detail in Estabrook-1988. Estabrook-1989 teaches that its direct-conversion receiver provides several advantages over traditional heterodyne receivers:

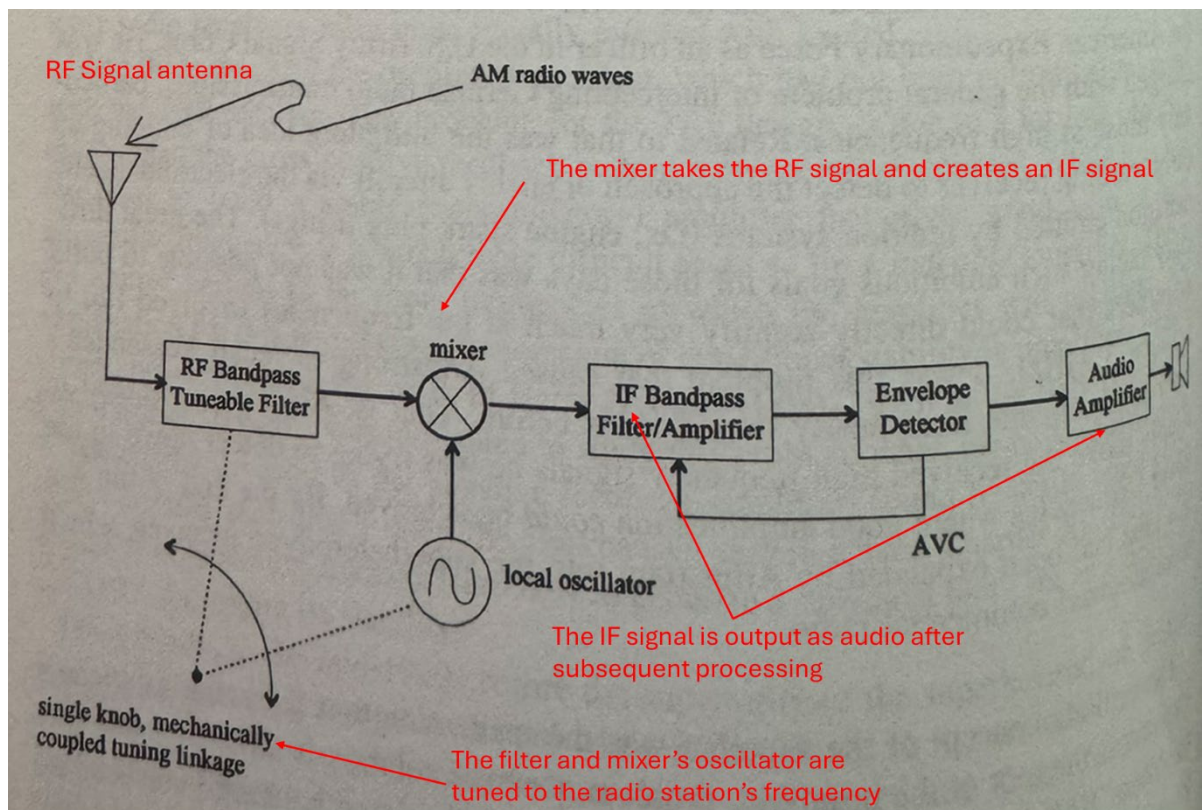
The direct conversion architecture has several advantages over a standard heterodyne receiver: (1) the image frequency ($f_{image} = f_{LO} \mp f_o$ where $f_{RF} = f_{LO} \pm f_o$), potentially a source of interference in heterodyne systems, is here a frequency within the RF bandwidth – thus rejection of unwanted signals at f_{image} is infinite; (2) it possesses good selectivity because of the use of low pass filters (LPF) rather than band pass filters (BPF) as used in a heterodyne receiver, these can be designed with active op-amps and CMOS filters; (3) it has size and power consumption advantages due to the lack of IF filters; (4) the majority of the signal processing is done at very low frequencies where many high performance, special purpose, circuits already exist – thus signal processing is simple, low cost and of high performance; (5) lastly the receiver’s performance is as good as or better than a comparable heterodyne receiver. From a tech-

Estabrook-1989, 64.

339. In my opinion, a POSITA would have recognized that Estabrook-1989 and Estabrook-1988's direct conversion circuit would perform the functions specified by Young's blocks 64 and 66 (that is, down-conversion of received input signals using the mixer, followed by demodulation) and provide the same benefits in Young's system.

340. Estabrook-1988 and Estabrook-1989 describe a circuit that converts to an Intermediate Frequency (or IF) which a POSITA would have been motivated to use in a down-converter such as that employed (but not described in detail) in Young. Converting to an IF is a decades-old and well-known technique for frequency conversion. This IF can be any frequency (including DC) but is typically fixed, and remains unchanged even as the radio tunes to different frequencies. This allows circuit elements such as amplifiers to be optimized for an IF rather than being retuned whenever the radio is retuned. This concept is well known, and readily recognized in common components such as an AM-radio receiver as the simplest and oldest example. Shown below, from the Science of Radio (Ex. 1040) at page 182, a radio works by receiving an input RF signal at a certain (an AM-radio station) and the system is tuned to that radio station (i.e., the signal's carrier). The tuning causes the RF signal to be converted to an intermediate frequency (IF) signal that is used by the rest of the circuit to output audio for that AM radio station. *See generally id.*, 183-84. As can be appreciated, through this configuration, specific carriers (i.e.,

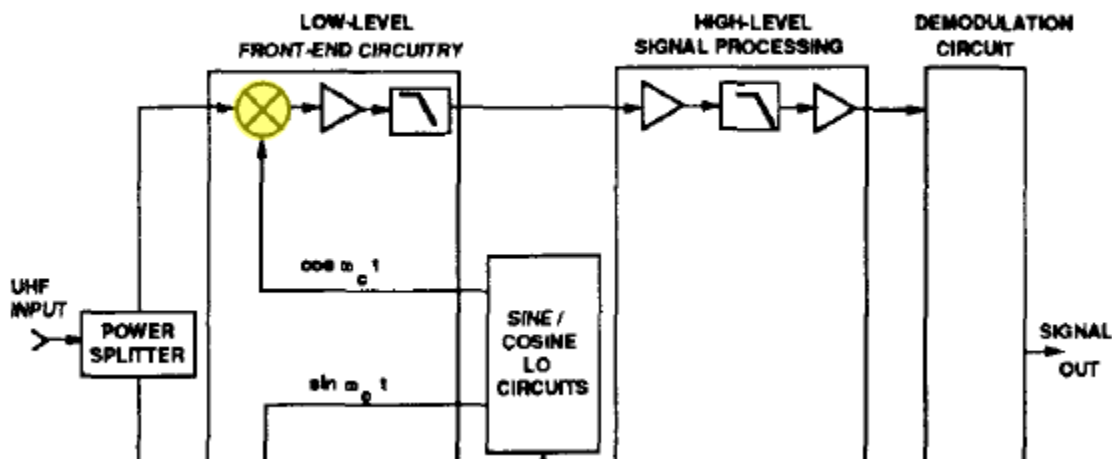
radio stations) can be detected and played without dedicated circuitry for every single radio station. *See, e.g., id.*, 184 (“the IF amp is *not* tuneable”). The circuitry can be tuned for the specific IF frequency of 455 KHz that is used for AM broadcast receivers, regardless of the radio station tuned to. *Id.*, 183-84. This basic concept was well-known since the dawn of radios over a century ago.



Science of Radio, Fig. 21.1, 182 (annotated).

341. Estabrook-1989 compares a traditional heterodyne receiver to its “direct conversion receiver,” which is shown in Figure 1. Estabrook-1989’s direct conversion receiver has a single mixer (highlighted in yellow below) which down-

converts to an IF, which then undergoes “high-level signal processing” and is eventually demodulated:



Estabrook-1989, Fig. 1 (annotated).

342. The “single-ended mixer” circuit taught in Estabrook-1998’s Figure 2 provides a more detailed explanation of the type of mixer that would be used for the mixer of Estabrook-1989’s Figure 1. My discussion in this declaration focuses on the details of the mixer in Estabrook-1988’s Figure 2, which shows that a “frequency translation module” with the same structural elements as recited in the Challenged Claims was known. I note that Estabrook-1989 also teaches a full down-conversion circuit for converting a signal from a carrier frequency to baseband. In my opinion, a person of ordinary skill in the art would have recognized that Estabrook-1989 teaches a full down-conversion circuit (including a down-converter and demodulator) that performs the same functions Young’s “down converter and demodulator” (blocks 64 and 66). Such a person of ordinary skill in the art would

have been motivated to combine Estabrook-1989's more fulsome teaching of its down-conversion circuit to perform the functions of Young's relatively sparsely-disclosed blocks 64 and 66 because doing so would have amounted to nothing more than a simple substitution of one known element for another to obtain predictable results. A POSITA would have further had a reasonable expectation of success using Estabrook-1989's down-converter to perform the functions called for by Young's down-converters. The down-conversion and demodulation circuits of Estabrook-1988 and Estabrook-1989 would have provided similar benefits in the similar system of Young. Alternatively, a POSITA would have viewed use of the down-conversion and demodulation circuits of Estabrook-1989 and Estabrook-1988 in view of the (unspecified) down-conversion and demodulation circuits of Young as a simple substitution with predictable results.

5. Claim 11

a. 11[pre]-11[1.3]

343. Claim elements 11[pre], 11[1.1], 11[1.2], and 11[1.3] are disclosed by Young for the reasons that I previously discussed in regard to Ground 2A, Sections X.B.4.a-X.B.4.d.

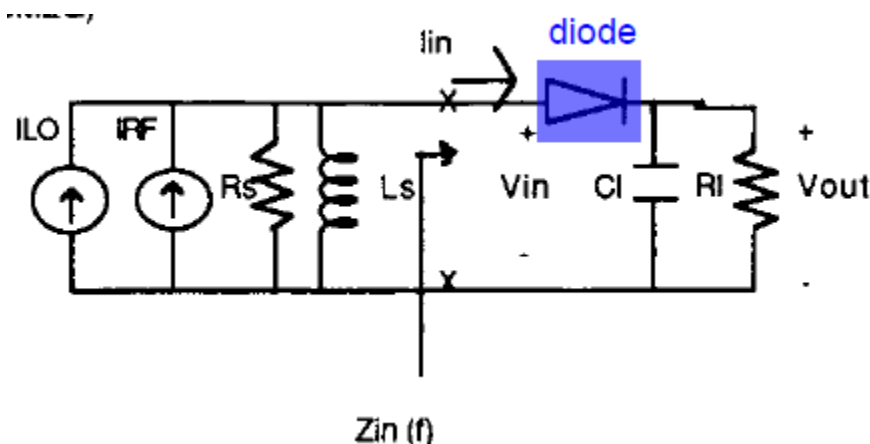
b. 11[1.4] a plurality of transceivers each having at last one frequency translation module, wherein said at least one frequency translation module comprises

344. In my opinion, the combination of Young, Estabrook-1989, and Estabrook-1988 teaches this element. Pertinent teachings of Young are discussed

above in Section X.B.4.e regarding Ground 2A. As I discuss in Section X.B.4.e, Young teaches all of 11[1.4] except it does not teach the specific details of its two “down converter and demodulator[s].” When the “direct conversion” circuit of Estabrook-1989 and Estabrook-1988 (including the mixer circuit of Estabrook-1988 which I discuss further below in Section X.C.5.e (element 11[FTM-1.3])) is used for the “down-conversion and demodulation” circuits of Young, the mixer of that circuit is a “frequency translation module.”

c. 11[FTM-1.1] a switch

345. In my opinion, the combination of Young, Estabrook-1989, and Estabrook-1988 teaches this limitation. Estabrook-1988 teaches a “switch” in the form of the diode (annotated in blue below) in Figure 3 (p. 1108), which would also operate as a switch when the conversion circuit taught by Estabrook-Thesis is used in the down converter taught by Young.



Estabrook-1988, Fig. 3 (annotated).

346. The diode functions as a switch because it only allows current to pass when the voltage across the diode in the forward direction reaches a threshold, and is therefore an “electronic device for opening and closing a circuit” according to Petitioner’s construction. This is illustrated in Estabrook-1988’s Figure 5, which I have reproduced below. When the diode voltage V_D (dotted line) reaches the forward voltage threshold, the diode is “on” and the diode current I_D flows, while below that threshold no current flows and the diode is off. Fig. 4(a) illustrates the diode “on” and “off” times:

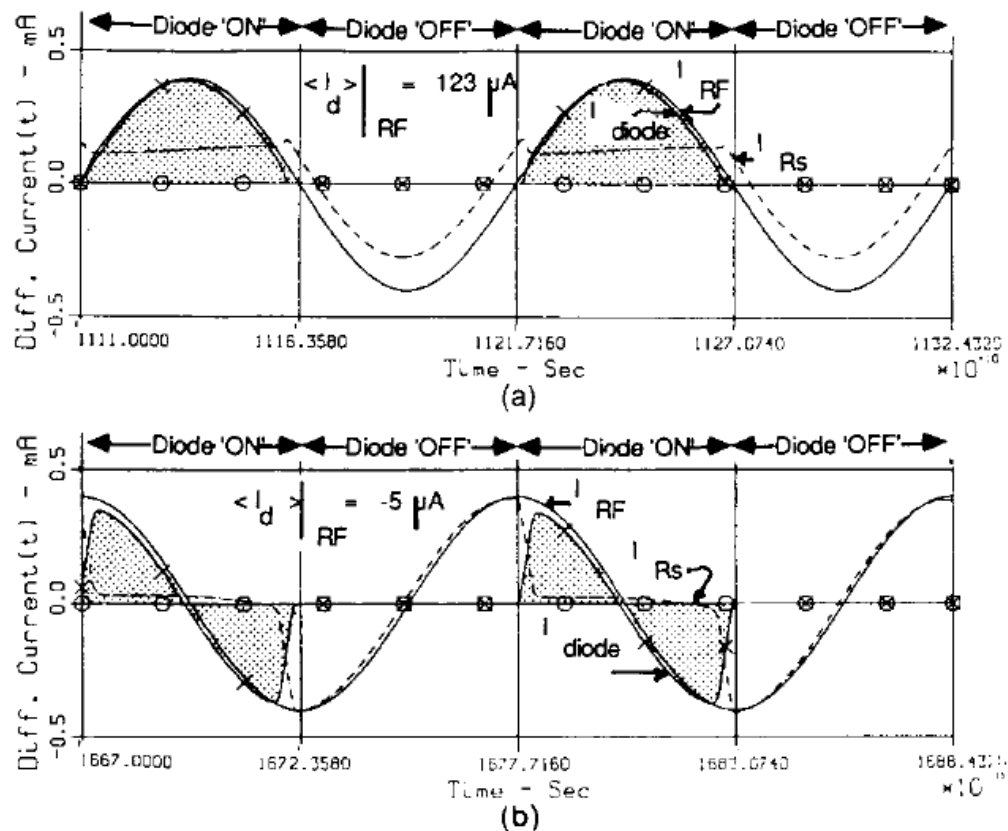


Figure 5. Differential currents due to I_{RF} :
(a) in-phase; (b) quadrature-phase.

Estabrook-1988, Fig. 5.

347. This figure shows the “differential” current due to I_{RF} , that is, the portion of the current attributable to the RF signal after the signal from the ILO is subtracted out.

348. I note again that the '686 Patent itself indicates that a diode is an exemplary embodiment of a “switch.” '686 Patent, 4:60-61, Figs. 45C-45D.

349. As I discussed in Section IX.B above, I understand that there is a dispute between the parties whether the switch must be “dictated by an independent control input,” as argued by ParkerVision. I do not agree with this proposal, but in my opinion, even if the term is construed this way, it is taught by Estabrook-Thesis (within the combination of Young and Estabrook-Thesis).

350. The ILO in Estabrook-1988 controls the diode switch. This is clear from looking at the details in Figure 3 of the circuit simulation (using a program called SPICE) in Estabrook-1988. Ex. 1034 explains the SPICE programming that I discuss below. SPICE models electrical circuits by defining a set of nodes and modeling circuit elements between those nodes using a defined language to specify characteristics of those elements. I have highlighted certain relevant elements of Fig. 3 and the corresponding elements of the SPICE run file below:

SINGLE ENDED MIXER

IBIAS 0 21 DC 0.0

VIMB 21 15

ILO 0 7 SIN(0 4.0M 900MEG)

VIM0 7 15

IRF 0 8 SIN(0 .4M 909MEG)

VIMR 8 15

VIMT 15 13

VIM1 13 12

RP 12 0 1000

LP 12 0 1.8UH

VIM2 13 9

VIM3 9 6

D1 6 3 DIODE1

RPD 9 3 5MEG

VIM4 3 23

RL 23 0 1000

VIM6 23 20

C1 20 0 2.8PF

MODEL DIODE1 D RS=10.0 IS=1.0E-14 N=1.0 CJO=.001PF VJ=.9 BV=20

OPTIONS ACCT OPTS NOPAGE ITL3=10 ITL5=160000 LVLTIM=1 LIMPTS=40000

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* Maximum parameters printed in one row is 8.

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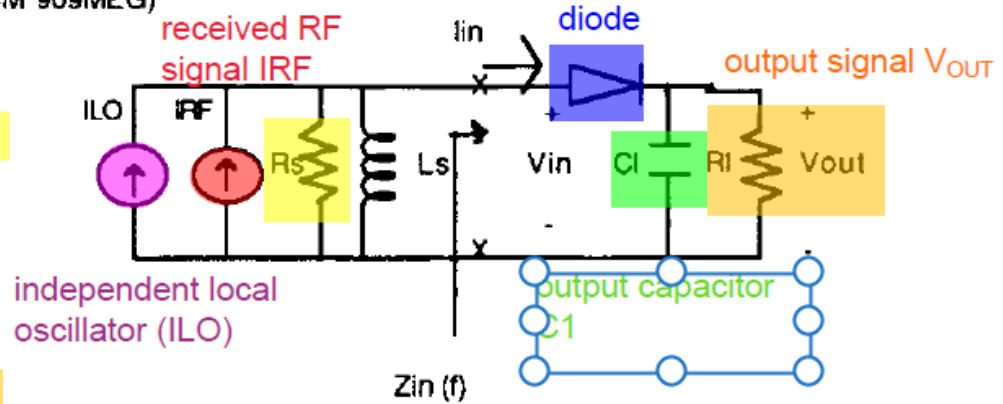


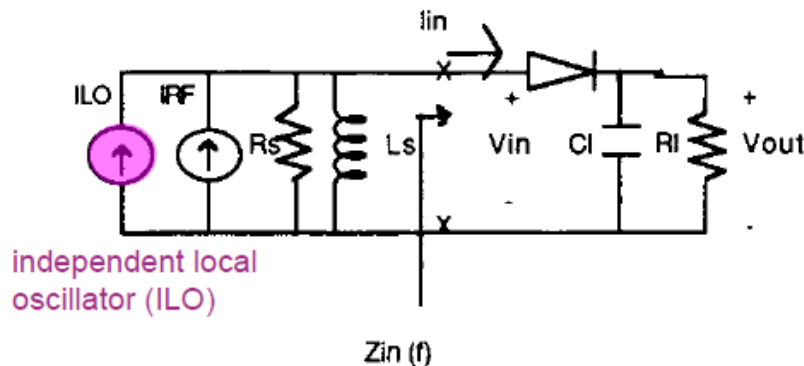
Figure 3. Resistively matched single-ended mixer: circuit diagram and corresponding SPICE run file.

351. For example, the description of the ILO (“ILO 0 7 SIN(0 4.0M 900MEG)”) means that the ILO is an AC current source between nodes 0 and 7 which outputs an peak current of 4.0mA (“4.0M”) at 900 MHz (“900 MEG”). Because the resistor RS has a resistance of 1 K Ω (“RP 12 0 1000”), the peak voltage of the ILO (from the formula $V=IR$, or voltage equals current times resistance) is roughly 4 V. Similarly, the IRF (“0 8 SIN (0 .4M 909MEG)”) is an AC source with peak current of .4 mA at 909 MHz, whose peak voltage can likewise be calculated as roughly .4V. The voltage necessary to turn the diode “on” is the junction voltage

VJ, which is given in the model of DIODE1 as .9V (“MODEL DIODE 1... VJ=.9”). Because the peak voltage contributed by the ILO (4V) exceeds this value, but the voltage contributed by the IRF alone (.4V) does not, the diode in Estabrook-1988’s Figure 3 is turned on by the operation of the ILO, for approximately half of the period of the ILO. Therefore, the ILO drives the turning on and off of the diode. The ILO is thus an independent control signal.

d. 11[FTM-1.2] configured to operate according to an energy transfer signal,

352. In my opinion, the Young-Estabrook-1988-Estabrook-1989 combination teaches this element. Estabrook-1988’s diode switch is driven (“configured to operate according to”) the ILO (annotated purple in Figure 3 below), which is an energy transfer signal:



353. In my opinion, the ILO is an energy transfer signal because the input from the ILO is necessary to activate the diode and close the diode switch (as I discussed above in Sections X.B (Ground 2A) and X.B.4.b (element 11[FTM-1.1])), and when the diode switch is closed, it passes current (and therefore energy) through

the diode from the combined signal of the ILO and IRF. Estabrook-1988 illustrates this in Figure 5 (p. 1108), which shows that current from the RF signal (IRF) passes through the diode (and therefore energy is transferred) when the diode is “on:”

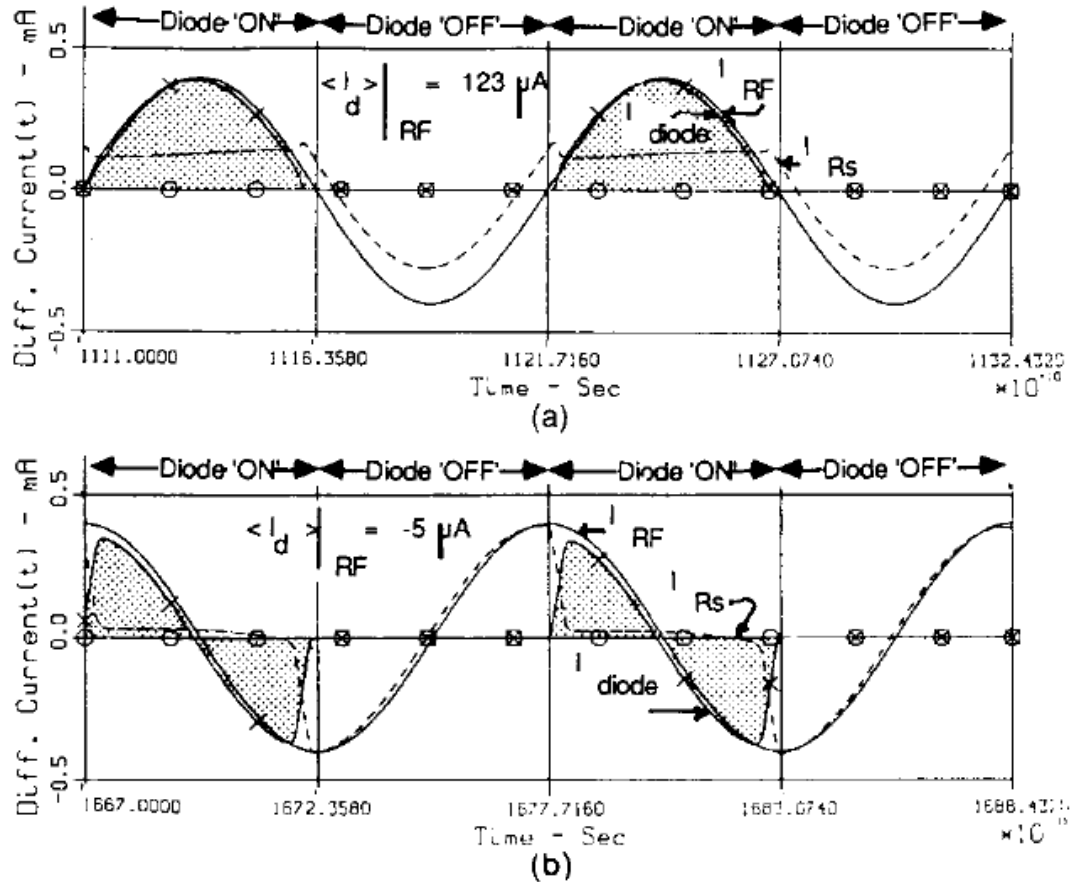


Figure 5. Differential currents due to I_{RF} :
(a) in-phase; (b) quadrature-phase.

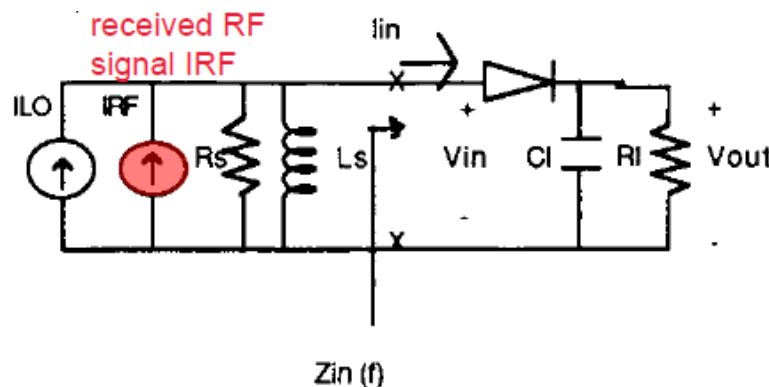
354. Because Figure 5 shows differential RF current (i.e. after other currents passing through the diode have been subtracted), this figure directly shows the energy transferred from the IRF, which is the first EM signal.

355. Estabrook-1988 states (at 1107 and 1108) that the “on” time of the diode is 50% of the period of the ILO, and as I discussed in Sections X.B (Ground

2A) and X.B.4.b (element 11[FTM-1.1]), this disclosure is consistent with the preferred embodiment of the “energy transfer signal” in the ’686 Patent.

e. 11[FTM-1.3] sub-sample and transfer energy from a first electromagnetic (EM) signal, and

356. In my opinion, the combination of Young, Estabrook-1988, and Estabrook-1989 teaches this element. The IRF input to the Estabrook-1988’s mixer circuit is the first EM signal, which is shown in red in Figure 3 below:



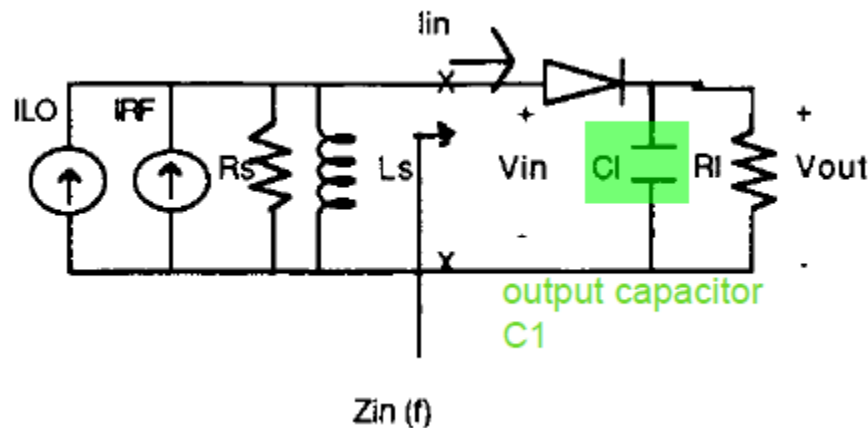
357. As I noted in Section IX.E above, I have applied the construction proposed by ParkerVision and adopted by a court in related litigation of “sub-sample” as “sampling at an aliasing rate, i.e., at a rate that is less than or equal to twice the frequency of the signal being sampled.” The rate at which Estabrook-1988’s diode opens is driven by the ILO at a rate of 900 MHz, which is less than twice the frequency of the IRF being sampled (909 MHz). These frequencies (909 MHz and 900 MHz) can be seen in the SPICE run file, which I discussed in Section X.C.5.c (element 11[FTM-1.1]) above.

358. As I noted in section IX(E) above, I have applied the construction proposed by ParkerVision and adopted by a court in related litigation of “sub-sample” as “sampling at an aliasing rate, i.e., at a rate that is less than or equal to twice the frequency of the signal being sampled.” The rate at which Estabrook-1988’s diode opens is driven by the ILO at a rate of 900 MHz, which is less than twice the frequency of the IRF being sampled (909 MHz). The current flows through the diode (and therefore energy is transferred) for approximately 50% of the duty cycle of the ILO, which is also approximately 50% of the duty cycle of the IRF, which has a similar frequency. Estabrook-1988, 1108 (“here T_{ON} is $.5 T_{LO}$ ”). I discussed in Section X.C.5.d (element 11[FTM-1.2]) why the 50% duty cycle of Estabrook-1988 is consistent with the energy transfer described in the preferred embodiment of the ’686 Patent. Although the energy being transferred via current flow across the diode includes current from the ILO as well as the IRF, it is my opinion that the plain language of the claims does not require that the switch transfer energy exclusively from the EM signal. In other words, as long as energy from the EM signal is transferred, the claim limitation is met. Indeed, as I noted in Section X.C.5.c (element 11[FTM-1.1]) above, the ’686 Patent itself identifies a diode as an exemplary embodiment for a “switch” as claimed. ’686 Patent, 4:60-61, Figs. 45C-45D.

359. In order for a diode to be driven at an aliasing rate rather than at the frequency of the IRF, it would need to be turned on by a voltage generated by the aliasing signal and accordingly pass energy from that aliasing signal, just like Estabrook-1988. In other words, the voltage value of the RF signal is insufficient to reliably switch the diode itself, and it requires additional current (which is supplied by ILO).

f. 11[FTM-2.1] a storage module coupled to said switch and configured to store said transferred energy,

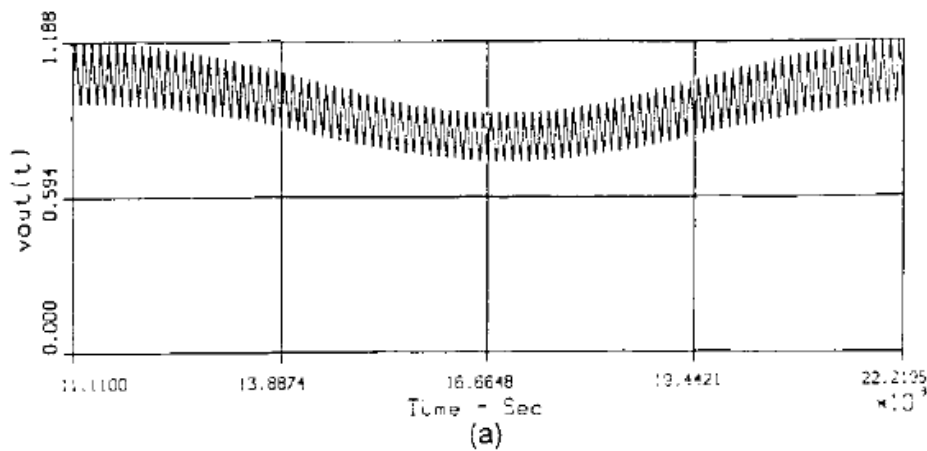
360. In my opinion, the Young-Estabrook-1988-Estabrook-1989 combination teaches this element. Estabrook-1988's storage module is an output capacitor C1, which is coupled to and stores energy transferred from the diode. I have annotated the capacitor in green in Estabrook-1988 Figure 3 below:



361. In my opinion, this teaching is consistent with the '686 Patent's disclosure of using a capacitor for the storage module. '686 Patent, 14:39-44, 18:6-19, Fig. 20A, Fig. 51A. Therefore, in my opinion, the capacitor in Estabrook-1988

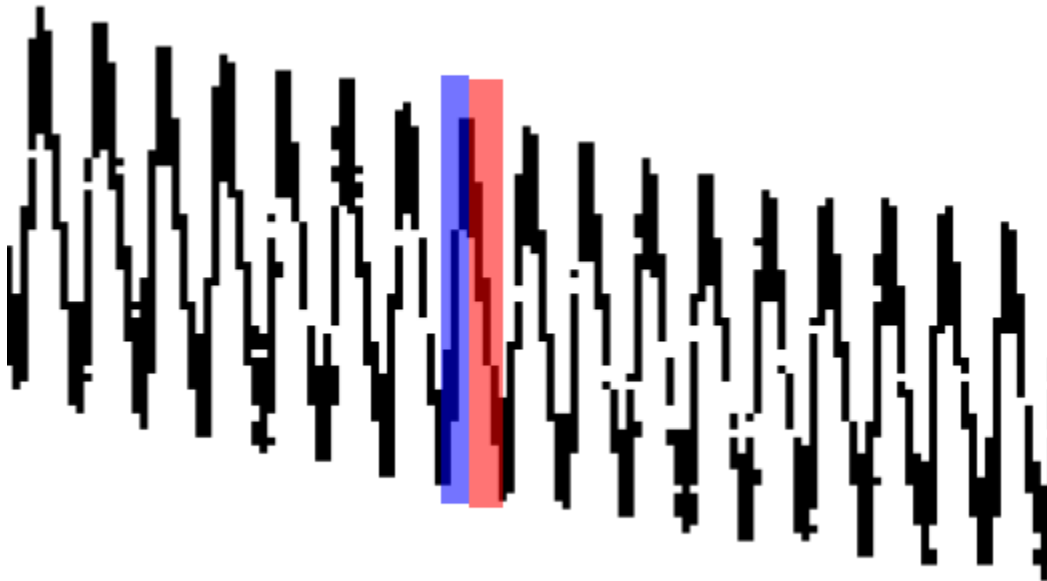
is the same or equivalent structure to the closest structure disclosed in the '686 Patent as the “storage module.”

362. Figure 4(a) of Estabrook-1988 illustrates how the capacitor discharges energy when the diode is open. The capacitor CLD stores energy transferred through the diode when the diode is closed (on) and discharges it at VOUT when the diode is open (off):



363. This can be seen more clearly by zooming in on Estabrook-1988's Figure 4(a). Each sawtooth waveform (corresponding to one closing and opening of the diode during a cycle of the ILO) has a rising edge (blue) and a falling edge (red). The rising edge is generated when the diode is on and current of both ILO and IRF pass through. The falling edge is generated when the diode is off, and no current passes through the diode. As a result, the only source of current during the falling edge is the energy stored in the capacitor CLD, so the falling edge voltage of Vout

shown below is generated from the discharge of energy previously stored in the capacitor CLD:



Estabrook-1988 Fig. 4a (annotated, zoomed in).

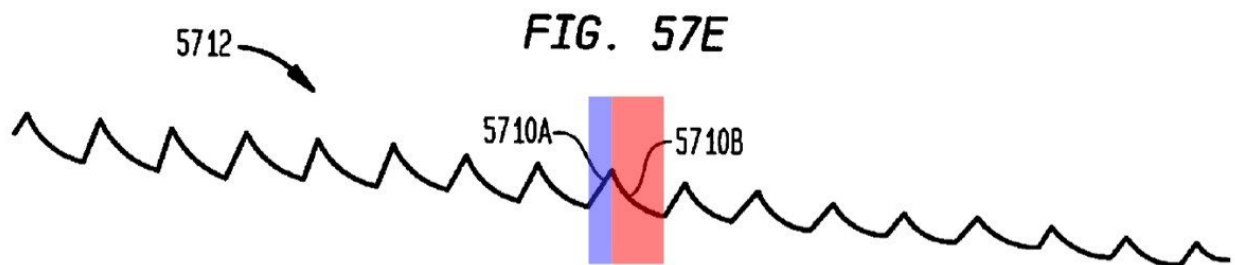
364. In my opinion, the amount of energy stored by the capacitor is non-negligible because the capacitor stores the energy transferred during half of the duty cycle of the ILO (blue) then discharges it during the other half (red), as discussed above in Section X.C.5.c and X.C.5.d (elements 11[FTM-1.1] and 11[FTM-1.2]). The energy discharged by the capacitor is distinguishable from noise because the output signal V_{out} is recovered from energy discharged by the capacitor.

365. In my opinion, this teaching of Estabrook-1888 is very similar to the corresponding description and figures in the '551 Patent, which is incorporated by reference into the '686 Patent:

The demodulated baseband signal 5712 includes portions 5710A, which correlate with the energy transfer pulses 5707 in FIG. 57C, and portions 5710B, which are between the energy transfer pulses 5707. Portions 5710A represent energy transferred from the analog AM carrier signal 516 to a storage device, while simultaneously driving an output load. The portions 5710A occur when a switching module is closed by the energy transfer pulses 5707. Portions 5710B represent energy stored in a storage device continuing to drive the load. Portions 5710B occur when the switching module is opened after energy transfer pulses 5707.

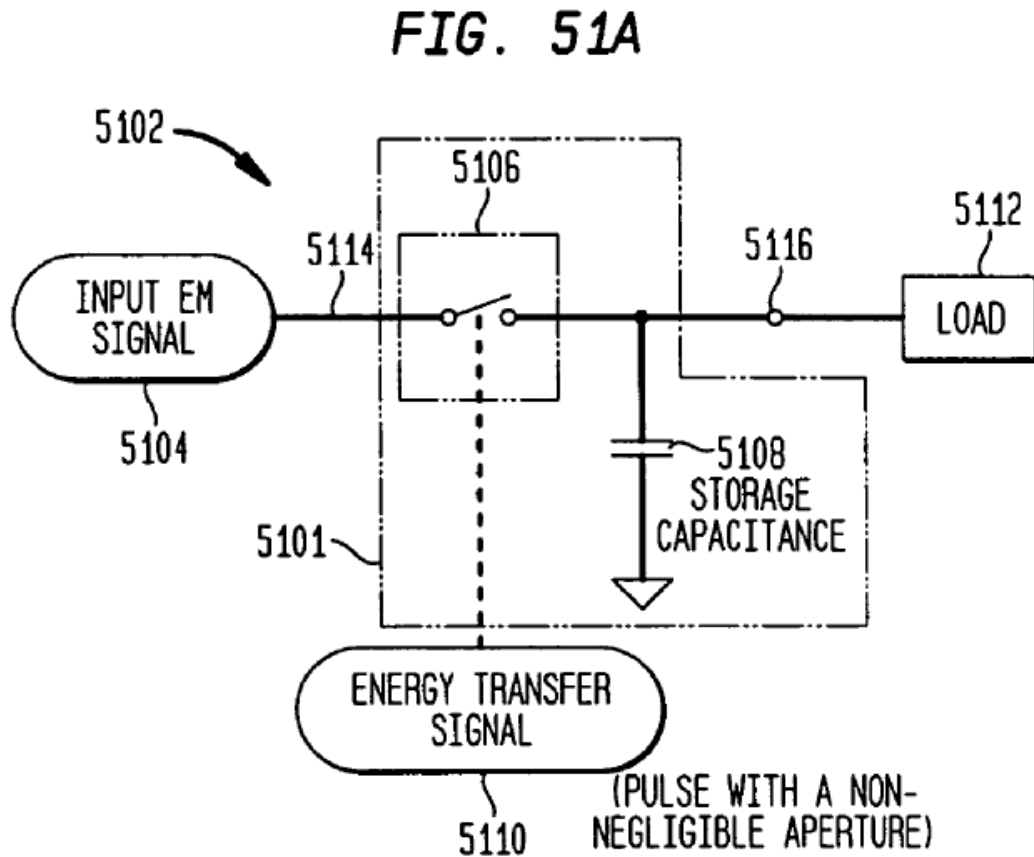
'551 Patent, 85:48-58 (annotated).

366. The '551 Patent at Figure 57E also shows substantially similar resulting waveform, in which the capacitor is charged (blue) while the switch is open and discharged (red) when the switch is closed:



367. I understand that ParkerVision has argued that the term “storage module” must be part of an “energy transfer system.” I disagree, but even under this interpretation it is taught by Estabrook-1988. The '686 Patent doesn't define

“energy transfer system” either, but does say that Fig. 51A, which also includes a capacitor on the output side of a switch driven by an “energy transfer signal” is an “energy transfer system:”



'686 Patent, 5:10-11.

368. The '686 Patent explains that a system is an “energy transfer module” when the control signal has a “non-negligible aperture” and thus becomes an “energy transfer signal.” '686 Patent, 16:27-31. Because Estabrook-1988's ILO opens the diode switch for 50% of the duty cycle as I discussed above in sections X.C.5.d and X.C.5.e (elements 11[FTM-1.2] and 11[FTM-1.3]), and thus has a “non-negligible

aperture” which makes the system an “energy transfer system” even under ParkerVision’s restrictive definition.

369. I understand that ParkerVision has also argued regarding some related patents that an “energy transfer system” (which the “storage module,” properly construed, does not require) must have a “low impedance load.” In my opinion, Estabrook-1988 still teaches this element even under that restrictive definition. The ’686 Patent teaches using a $2\text{ K}\Omega$ resistive load for downconverting a 900 MHz RF signal. ’686 Patent, Fig. 51B. Estabrook-1988 teaches an overlapping range for the impedance load, i.e. that “the load impedance into which the mixer operates can be considered to be between 1K to $5\text{ K}\Omega$.” Estabrook-1988, 1107. Estabrook-1988 also teaches a $1\text{ K}\Omega$ impedance load in Figure 3, which models the load resistance R_L as a $1\text{ K}\Omega$ resistor:

SINGLE ENDED MIXER

IBIAS 0 21 DC 0.0

VIMB 21 15

ILO 0 7 SIN(0 4.0M 900MEG)

VIM0 7 15

IRF 0 8 SIN(0 .4M 909MEG)

VIMR 8 15

VIMT 15 13

VIM1 13 12

RP 12 0 1000

LP 12 0 1.8UH

VIM2 13 9

VIM3 9 6

D1 6 3 DIODE1

RPD 9 3 5MEG

VIM4 3 23

RL 23 0 1000

VIM6 23 20

C1 20 0 2.8PF

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* Maximum parameters printed in one row is 8.

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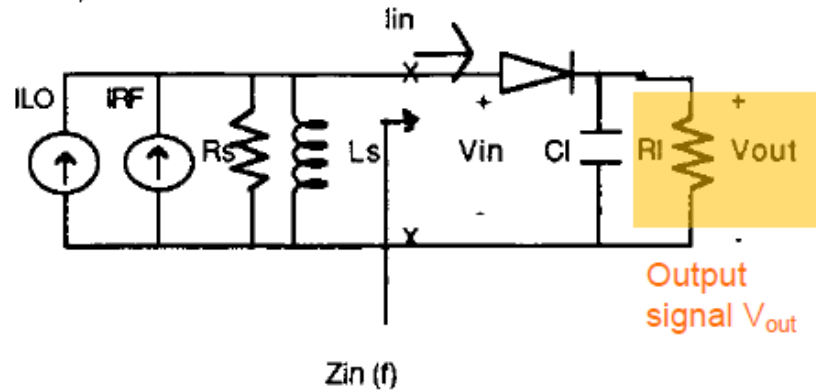


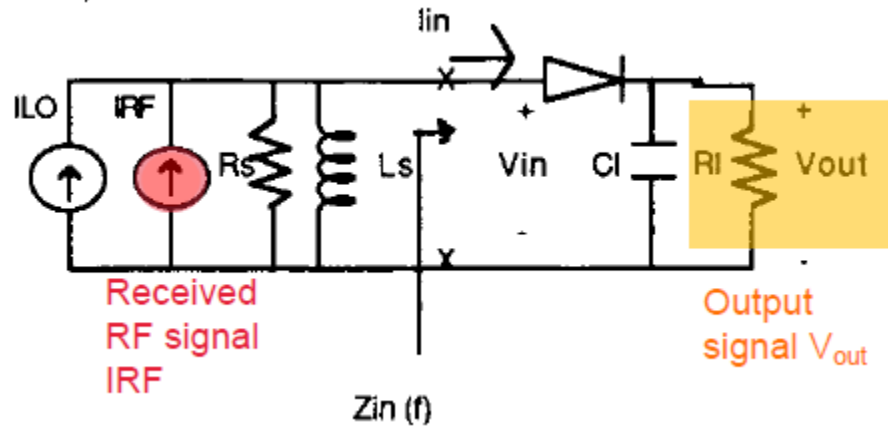
Figure 3. Resistively matched single-ended mixer: circuit diagram and corresponding SPICE run file.

Estabrook-1988, Fig. 3 (annotated).

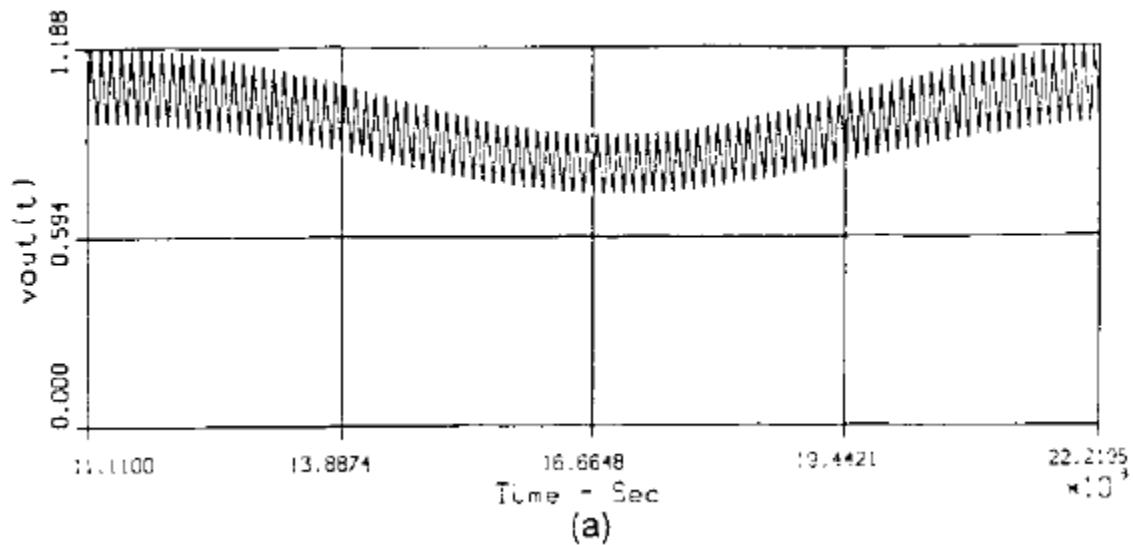
- g. 11[FTM-2.2] wherein a second EM signal is generated from said stored energy, said second EM signal having a [frequency] different from said first EM signal;

370. In my opinion, the Young-Estabrook-1988-Estabrook-1989 combination teaches this element. Estabrook-1988 generates a second EM signal, V_{out} , which is a down-converted signal from the IRF input and is generated from

energy stored in the capacitor. I have annotated the location of V_{OUT} in orange in Figure 3 below, while Fig. 4(a) shows one cycle of the resulting waveform:



Estabrook-1988, Fig. 3 (annotated).



Estabrook-1988, Fig. 4(a).

371. I discussed above in Section X.C.5.f (element 11[FTM-2.1]) how the V_{out} signal is generated from energy stored in the capacitor C_{LD} . While the output signal includes individual “sawtooth” waveforms at the frequency of the ILO, the

voltage of the peaks and troughs of those waveforms varies at the lower intermediate frequency (IF), for which Figure 4(a) illustrates one cycle. The lower frequency of the output signal V_{out} at the IF can be calculated as the difference of the IRF and the ILO, $909 \text{ MHz} - 900 \text{ MHz} = 9 \text{ MHz}$. These frequencies are shown in the table of simulation values accompanying the model of the circuit in Figure 3:

SINGLE ENDED MIXER

IBIAS 0 21 DC 0.0

VIMB 21 15

ILO 0 7 SIN(0 4.0M 900MEG)

VIM0 7 15

IRF 0 8 SIN(0 .4M 909MEG)

VIMR 8 15

VIMT 15 13

VIM1 13 12

RP 12 0 1000

LP 12 0 1.8UH

VIM2 13 9

VIM3 9 6

D1 6 3 DIODE1

RPD 9 3 5MEG

VIM4 3 23

RL 23 0 1000

VIM6 23 20

C1 20 0 2.8PF

.MODEL DIODE1 D RS=10.0 IS=1.0E-14 N=1.0 CJO=.001PF VJ=.9 BV=20

.OPTIONS ACCT OPTS NOPAGE ITL3=10 ITL5=160000 LVLTIM=1 LIMPTS=40000

.TRAN 27.13P .222US .111US

.PRINT TRAN V(3) I(VIM3) V(6,3) I(VIM2) V(13) V(0) V(0) V(0)

* Maximum parameters printed in one row is 8.

.END

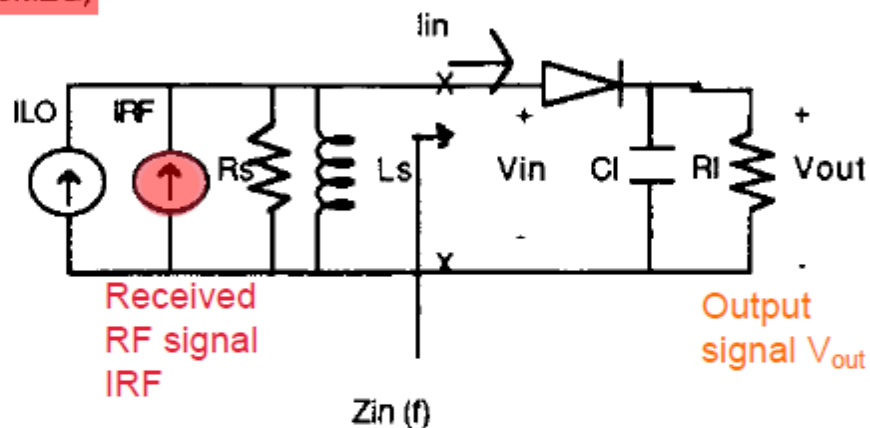
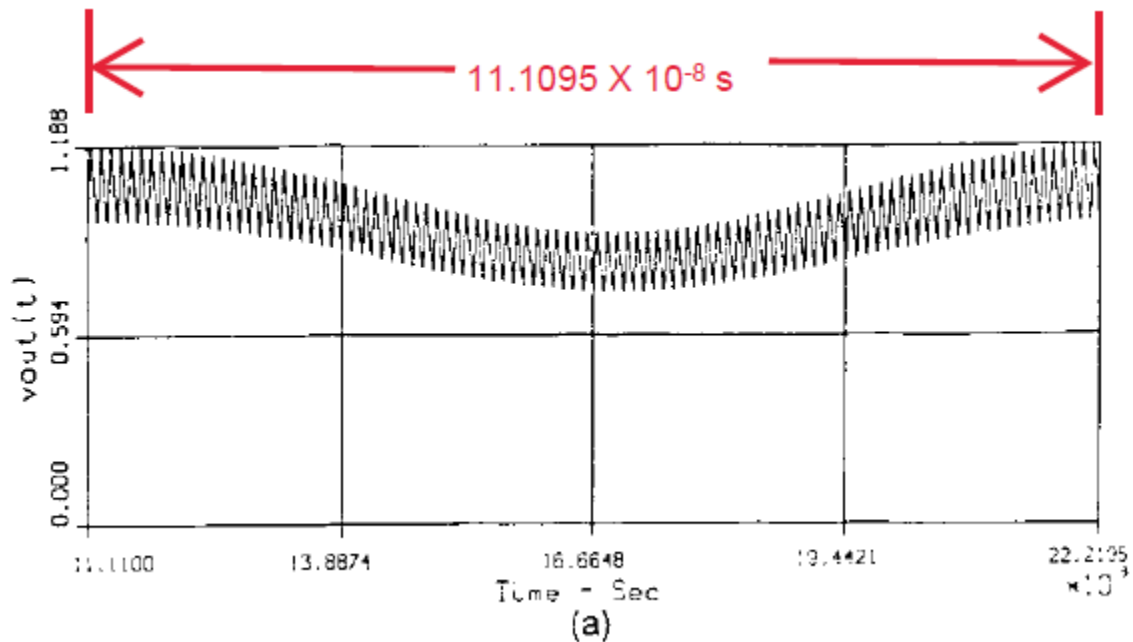


Figure 3. Resistively matched single-ended mixer: circuit diagram and corresponding SPICE run file.

Estabrook-1988, Fig. 3 (annotated)

372. The frequency can also be calculated as the inverse of the period of the output signal V_{OUT} shown in Figure 4(a), 11.1095×10^{-8} seconds (22.2195-11.1100), which also gives 9 MHz:



Estabrook-1988, Fig. 4a (annotated).

This IF frequency is different from the IRF (1st EM signal) frequency of 909 MHz. In other words, V_{out} 's frequency (second EM signal) is different from the 909 MHz frequency of the IRF (first EM signal).

- h. 11[2] operating a first transceiver in conformance with a first protocol/standard combination using a first standard/protocol sub-module; and**

373. In my opinion, Young teaches this element. As I previously discussed in Sections X.B (Ground 2A) and X.B.4.d (element 11[1.3]), Young teaches using its Radio A and Radio B to send and receive using different protocols, such as

Bluetooth and IEEE 802.11 wi-fi or Bluetooth and HomeRF. Young, Abstract, 1:8-12, 1:29-43, 2:65-67. This is particularly clear in Young’s Abstract, which recites “operating a first transceiver under a first transmitter/receiver protocol” and “operating a second transceiver under a second transmitter/receiver protocol.” Each of these transceivers, Radio A and Radio B, and the associated baseband processor is a standard/protocol sub-module, while each of Bluetooth and IEEE 802.11 (for example) is a protocol/standard combination for the same reasons that I discussed in Sections X.B (Ground 2A) and X.B.4.d (element 11[1.3]).

i. 11[3] operating a second transceiver in conformance with a second protocol/standard combination using a second standard/protocol sub-module.

374. In my opinion, this element is obvious for the reasons that I discussed above in Section X.C.5.h (element 11[2]). Of the two transceivers in Young (Radio A and Radio B), one is the first transceiver operating in conformance with one protocol/standard combination (e.g., Bluetooth) and the other is the second transceiver operating in conformance with a second protocol/standard combination.

6. Dependent claims 12-20

- a. Claim 12: The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communications links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

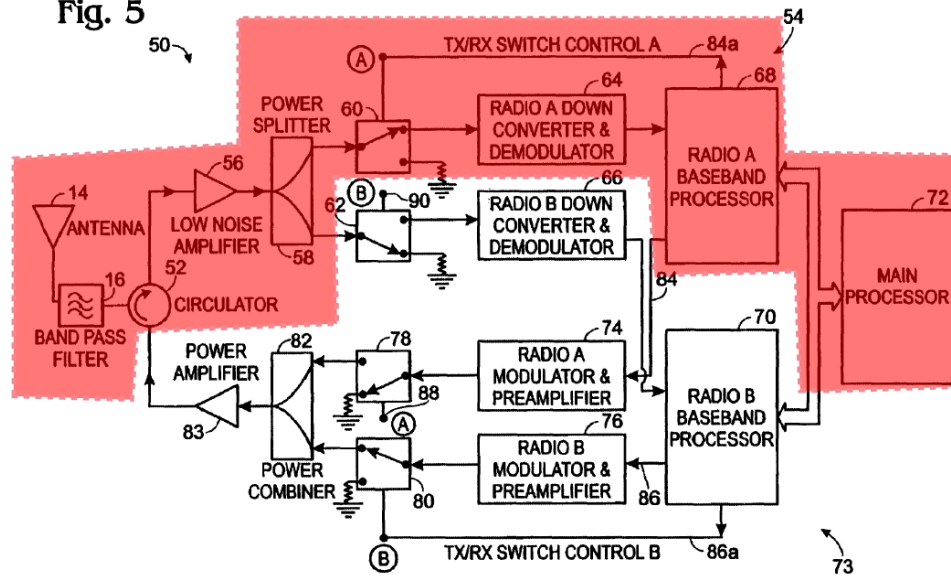
375. In my opinion, Young teaches the additional element of this claim. As I discussed in X.B (Ground 2A) and X.B.4.a (element11[pre]), Young discloses communicating simultaneously in two protocols such as Bluetooth and IEEE 802.11, and as I discussed in Sections X.B (Ground 2A) and X.B.4.d (element 11[1.3]), that simultaneous communication employs sub-modules associated with Radio A and Radio B. One sub-module communicating with one link (e.g. Bluetooth) and one sub-module communicating with the other (e.g. IEEE 802.11) are an “equal quantity of the plurality of standard/protocol sub-modules.”

376. As I’ve noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the ’686 Patent describes simultaneous.

- b. **Claim 13: The method of claim 11, wherein step (1) comprises: controlling the at least one multi-platform module to communicate with at least one of the plurality of communication links using the control module, the at least one multi-platform module including a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

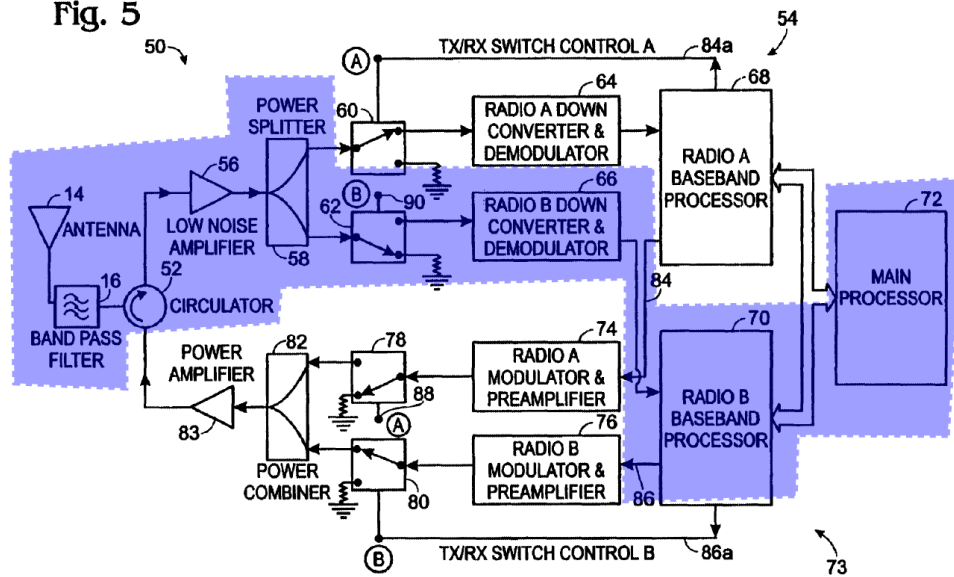
377. In my opinion, the Young-Estabrook-Thesis combination teaches the additional element of this claim. As discussed in Sections X.B (Ground 2A) and X.B.4.c (element 11[1.2]), Young teaches a control module (including a main processor and processors for radios A and B) which controls communications with at least one of a plurality of communications links such as Bluetooth or IEEE 802.11 connections. In Young's Figure 5, each of radios A and B has an associated transmitter and receiver path including the antenna, common components, "down converter and demodulator" for the receiver paths and "modulator and preamplifier" for the transmitter paths. I have annotated each of these transmitters and receivers separately in Figure 5 below:

Fig. 5



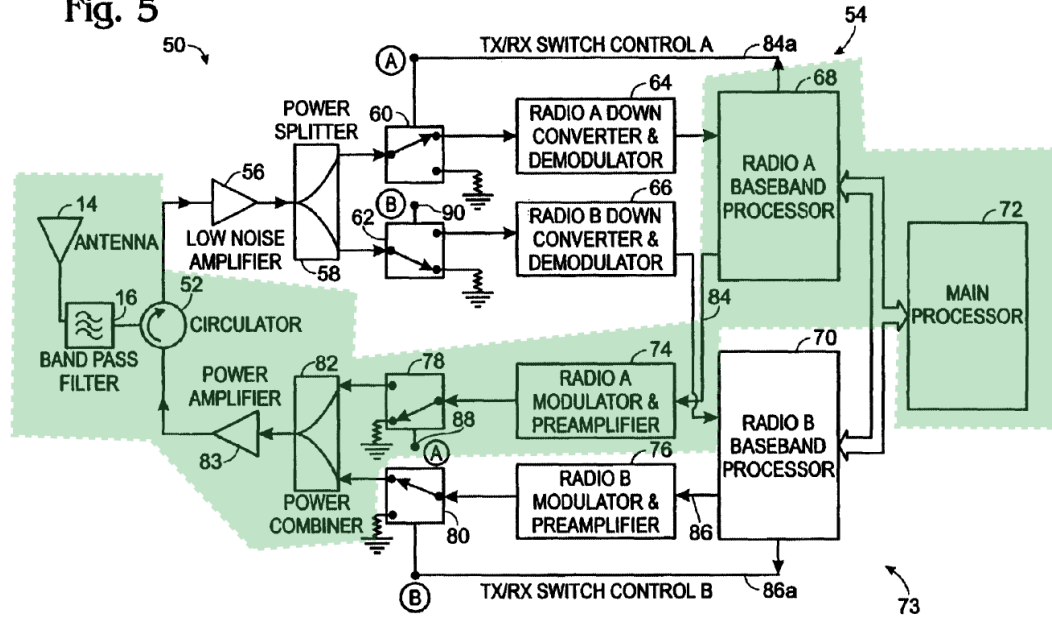
Receiver A

Fig. 5



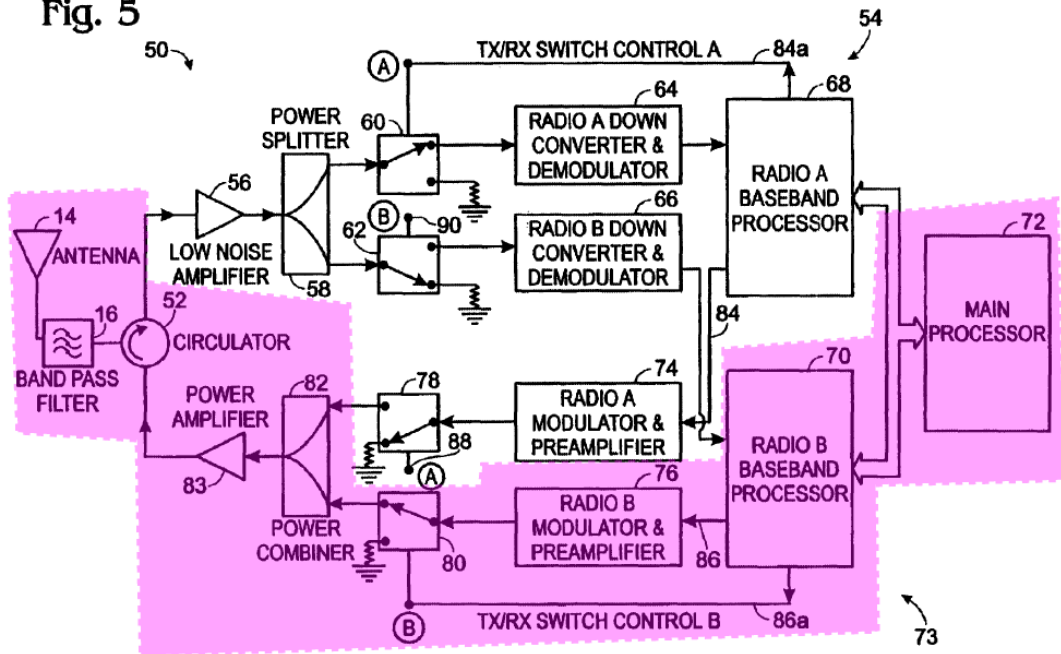
Receiver B

Fig. 5



Transmitter A

Fig. 5



Transmitter B

378. I previously discussed in Sections X.B (Ground 2A) and X.B.4.e (element 11[1.4]) how each “down converter and demodulator” 64 and 66, as

implemented using the direct conversion circuit of Estabrook-1989 and mixer of Estabrook-1988, is a frequency translation module. I note that the language of this claim only requires that each of the receivers and transmitters to have “at least one frequency translating module,” but does not require each of those frequency translating modules to be the same frequency translating module discussed in claim 11.

379. Young describes “Radio A/B Modulator and Preamplifier” (74 and 76) which are frequency translating modules according to the plain language of the term and well-understood by a person of ordinary skill in the art, taking the low-frequency baseband data from the “Radio A/B Baseband Processor” and modulating (i.e. “translating”) it to a signal at a higher carrier frequency.

- c. Claim 14: The method of claim 11, wherein step (3) comprises: simultaneously operating the second transceiver in conformance with a second protocol/standard combination that is different from the first protocol/standard combination.**

380. For the reasons that I discussed in Sections X.B (Ground 2A), X.B.4.a (element 11[pre]) and X.B.4.d (element 11[1.3]), Young teaches that its transceivers (Radio A and B) simultaneously operate on different protocols such as Bluetooth and IEEE 802.11 or HomeRF. When Young operates in this manner, the second transceiver (e.g., Radio B) operates in conformance with a protocol/standard

combination that is different from the protocol/standard combination used by the first transceiver (Radio A).

381. As I've noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret "simultaneous" to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the '686 Patent describes simultaneous.

- d. Claim 15: The method of claim 14, wherein steps (2) and (3) comprise: programming the first and second protocol/standard sub-modules with respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

382. In my opinion, Young teaches the additional limitation of this claim. Young describes two baseband processors ("A" and "B") that condition the baseband signals for appropriate modulation or demodulation for differing protocol requirements. These are typically digitally programmable units, which might require periodic updating depending on evolving protocols and updated interface standards. This would be well understood by a person of ordinary skill in the art.

383. Additionally, operating according to either Bluetooth or IEEE 802.11 would require operational instructions for the same reasons that I previously discussed in this element in Sections X.A (Ground 1) and X.A.8 (claim 15),

particularly with regard to the protocols for these standards that I previously discussed.

384. Moreover, a POSITA would have understood that IEEE 802.11 and Bluetooth require specific operational instructions—whether it be hardware or software—in order to process and understand data. Shown below is the Bluetooth specification protocol stack, showing that operational instructions are required above the baseband and hardware level. In my opinion, a POSITA would have understood Bluetooth requires operational instructions for both receiver and transmitter. Further, in my opinion, a POSITA would have understood that any device implementing these standards (with unique protocol stacks) would similarly need operational instructions at both the hardware and software layers—as depicted by the respective protocols—to implement the standards. For example, a computing device using these protocols would need to have instructions for (1) formulating communications according to those protocols, and (2) interpreting communications according to those protocols.

385. Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044):

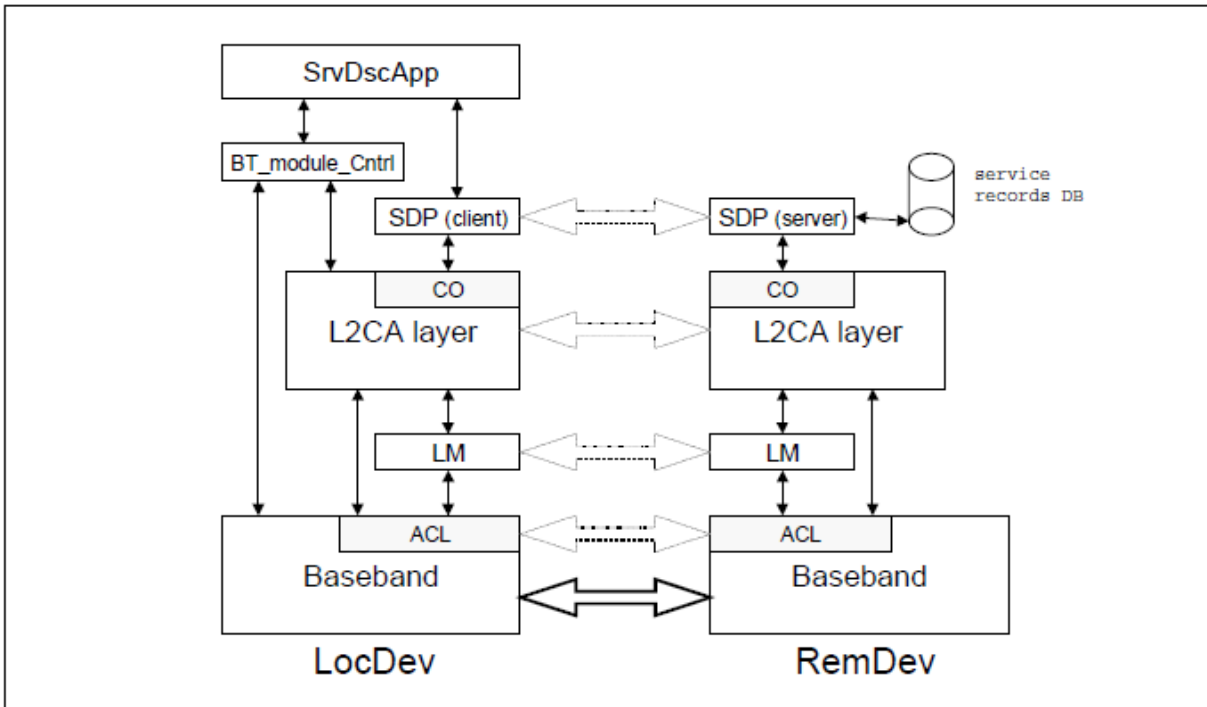


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

386. The same is true with respect to IEEE 802.11. Shown below is a general stack to communicate from the physical level to media access controller (MAC). In order to transmit a message in the format below, the transmitting device would need to have instructions to assemble a message in the format given. Likewise, the receiving device would require instructions to interpret the bits received as the specified parts of a message according to a protocol. Such instructions may be roughly analogized to human language. For example, someone learning English might be taught (instructed) to use “I” or “me” in communications when speaking about oneself individually, and “we” or “us” speaking as a group. Either of the sentences “I went to the store” or “we went to the store” is the logical result of following such instructions, as is correctly interpreting the sentence.

802.11a (Ex. 1039), 33:

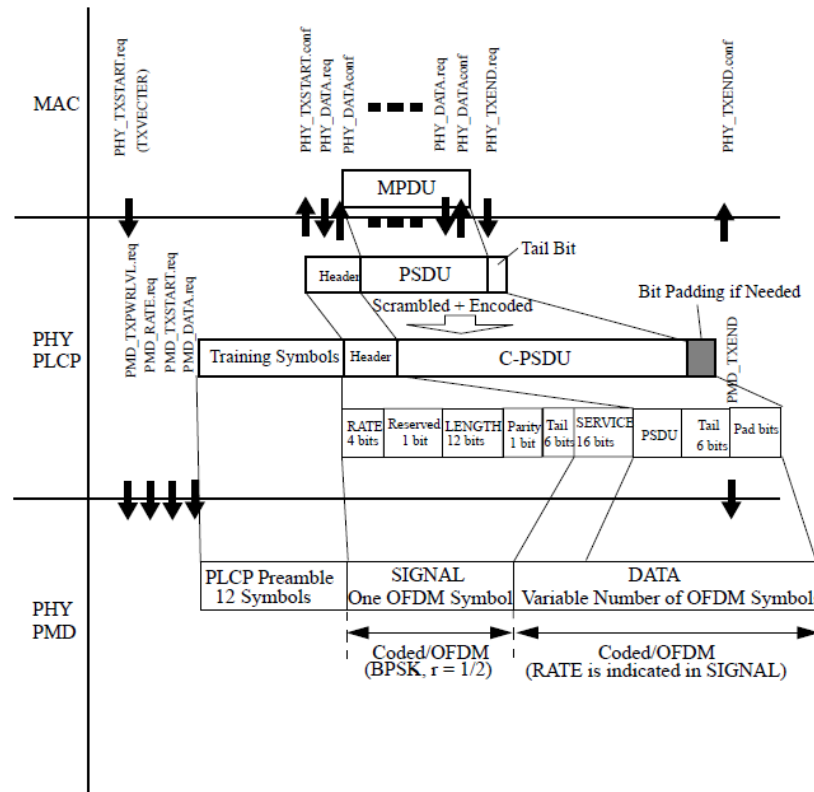


Figure 122—PLCP transmit procedure

387. Further operational instructions are demonstrated at other pages. For example, 802.11a (Ex. 1039), 37.

A POSITA would have understood that operational instructions are required for standards like Bluetooth and 802.11.

- e. **Claim 16: The method of claim 15, wherein steps (2) and (3) further comprise: programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures.**

388. In my opinion, Young teaches claim 16's additional limitation. Young describes two baseband processors ("A" and "B") that condition the baseband signals for appropriate modulation or demodulation for differing protocol requirements. These are typically digitally programmable units, which might require periodic updating depending on evolving protocols and updated interface standards. This would have been well understood by a POSITA.

389. Additionally, operating according to either Bluetooth or IEEE 802.11 would require "programming the first and second protocol/standard sub-modules with respective first and second protocol stacks and specification information about first and second protocol architectures" for the same reasons that I previously discussed in this element in Sections X.A (Ground 1) and X.A.9 (claim 16), particularly with regard to the protocols for these standards that I previously discussed.

390. A POSITA would have understood that these sub-modules would need to have information relating to their protocol stacks and specification information in order to operate. I have demonstrated this immediately above with respect to the

respective specification information from 802.11 and Bluetooth's operational instructions.

391. Blowing out those excerpts, these are the stacks for the protocols. For example, Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

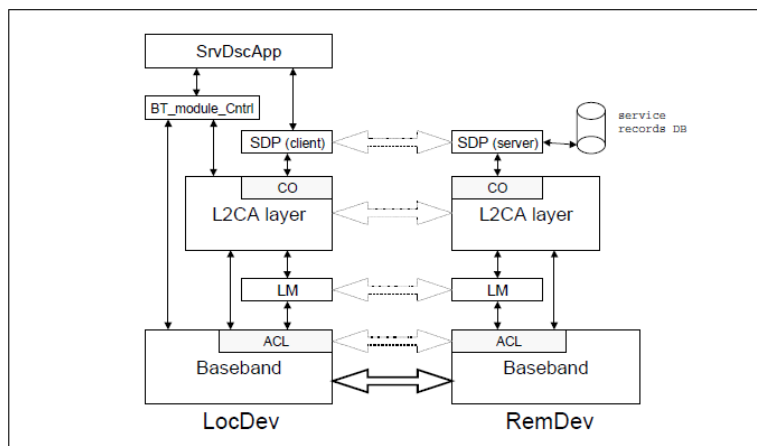
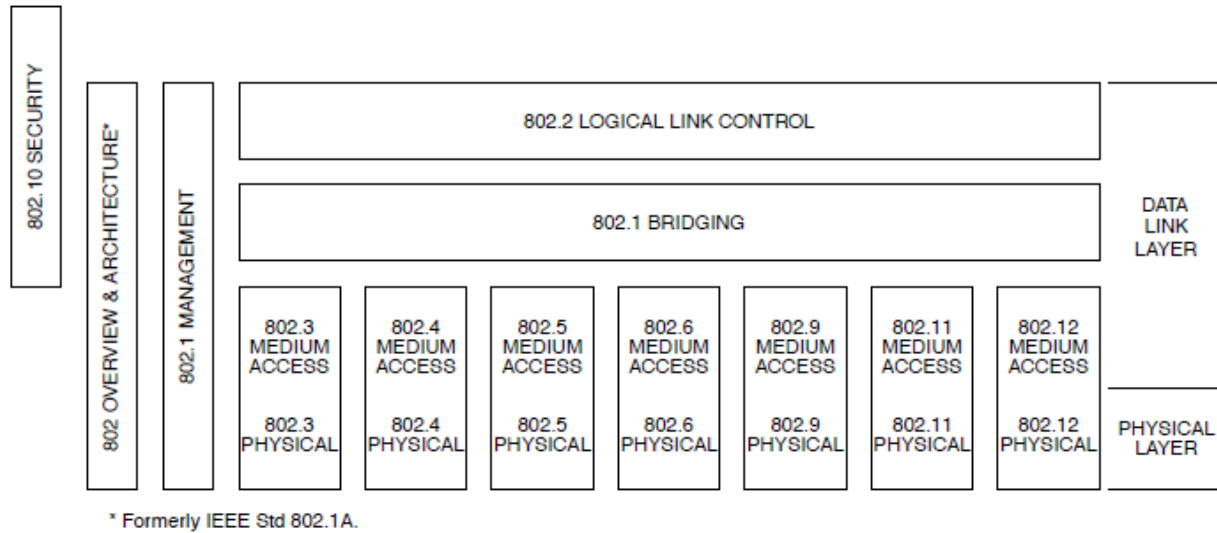


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

392. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



393. A POSITA would have understood a teaching of IEEE 802.11 and Bluetooth, like in, to be protocol stacks and specification information.

- f. **Claim 17: The method of claim 15, wherein steps (2) and (3) further comprise: updating, upgrading, replacing, or modifying the first and second implementation and operational instructions to provide the at least one multi-platform sub-module with additional functionality.**

394. In my opinion, Young teaches this claim's additional limitation. Communications standards are updated periodically by standards-setting bodies, as new features and requirements are introduced, and any transceiver that conformed to those standards and protocols would have to periodically be updated accordingly. This would be well-known to someone of ordinary skill-in-the-art.

395. For example, the original Bluetooth protocol was released in 1999 as Version 1.0. Subsequent revisions of Bluetooth occurred in 2004 (Version 2.0), 2009 (Version 3.0), 2010 (Version 4.0), and 2016 (Version 5.0). Each version added

enhanced data handling, networking and flexibility. A complete history can be found at the industry website www.bluetooth.com.

For example, 802.11a provides updates to encoding for the MAC and PHY MIB layers. *See* 802.11a (Ex. 1039), 51.

ASN.1 encoding of the MAC and PHY MIB

Add the following variables to the PHY MIB:

1. In “Major sections” of Annex D, add the following text to the end of “PHY Attributes” section:
“-- dot11PhyOFDMTable ::= {dot11phy 11}”

2. In “dot11PhyOperation TABLE” section of Annex D, update “dot11PHYType attribute” section as the following text:
“dot11PHYType OBJECT-TYPE
SYNTAX INTEGER {fhss(1), dsss(2), irbaseband(3), ofdm(4)}
MAX-ACCESS read-only
STATUS current
DESCRIPTION”

“This is an 8-bit integer value that identifies the PHY type
supported by the attached PLCP and PMD. Currently defined
values and their corresponding PHY types are:

FHSS 2.4 GHz = 01, DSSS 2.4 GHz = 02, IR Baseband = 03,
OFDM 5 GHz = 04”

- g. Claim 18: the method of claim 11, wherein steps (2) and (3) comprise: simultaneously operating the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments**

396. Young teaches this as I’ve discussed in Sections X.B (Ground 2A) and X.B.4.a (11[pre]).

397. As I’ve noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time

interval. This is not how computer and transmission systems work. Nor is it how the '686 Patent describes simultaneous.

398. Moreover, a POSITA would have understood the “operating environments” to encompass capability for using the respective standards, e.g., Bluetooth and IEEE 802.11

399. At a minimum, as I’ve shown in Sections X.A.8-X.A.9 (Ground 1, Claims 15-16), these standards include stacks for operation, which at a minimum shows an operating environment.

400. Blowing out those excerpts, these are the stacks for the protocols. For example, Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

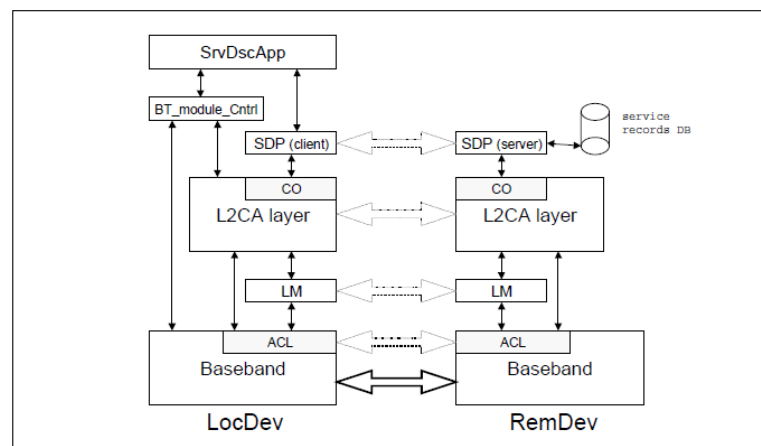
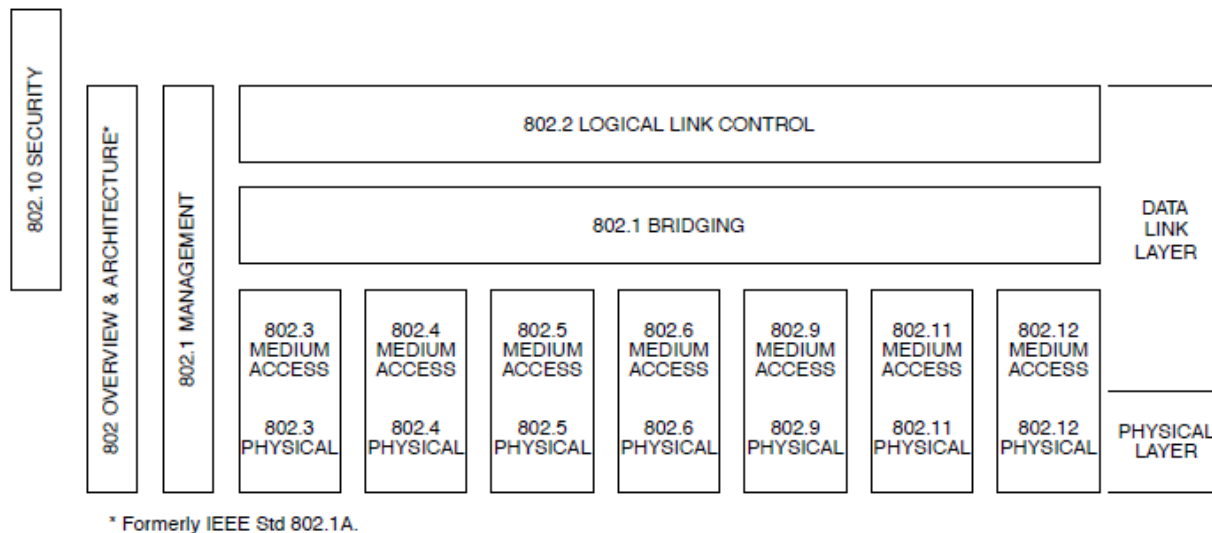


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

401. IEEE 802.11 similarly demonstrates its protocol stack and specification information. *See* 802.11a (Ex. 1039), iii:

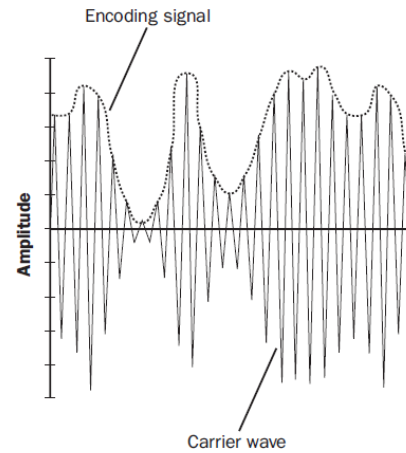


- h. Claim 19: the method of claim 18, wherein steps (2) and (3) further comprise: simultaneously operating the first and second transceivers in conformance with respective standards, content encoders and decoders, and protocol gateways of the first and second protocol and operating environments.**

402. In my opinion, Young teaches claim 19’s additional limitation. Claim 19 is substantively similar to claim 18 but recites “content encoders, decoders, and protocol gateways.” These are components commonly known and taught by Young.

403. As an initial matter, encoding is another term for simply modulating a data signal on top of a carrier signal. This is shown in the Microsoft Computer Dictionary (Ex. 1035), 26:

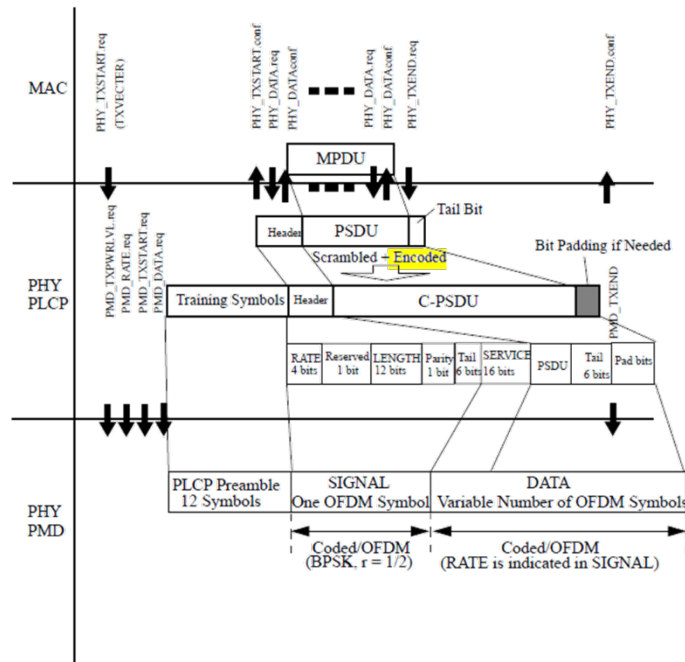
amplitude modulation *n.* A method of encoding information in a transmission, such as radio, using a carrier wave of constant frequency but of varying amplitude. See the illustration. *Acronym: AM. Compare* frequency modulation.



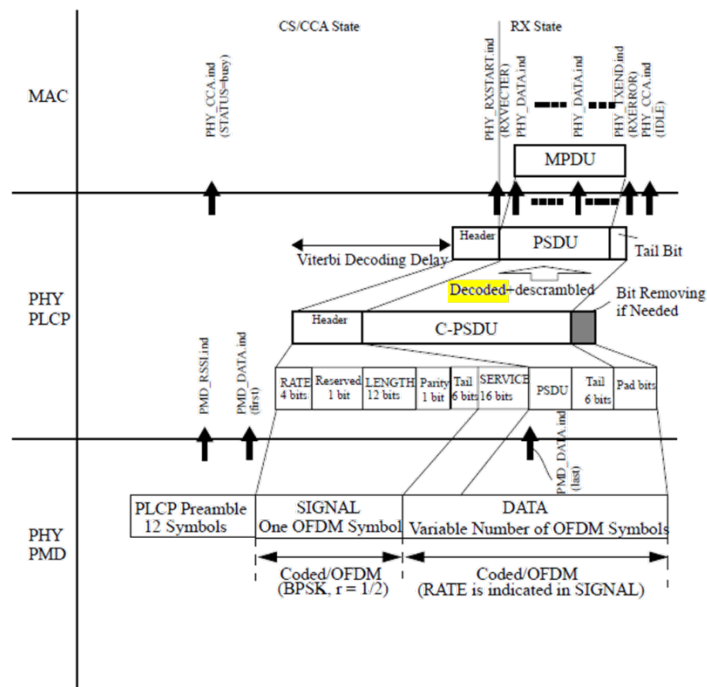
Amplitude modulation.

404. As I have described in Section VI.B (Modulating Signals for Wireless Communications), data is modulated with a carrier for transmission. This is encoding. Further, data is demodulated from a carrier. This is decoding.

405. Further, 802.11a (Ex. 1039), §17.3.2.1 describes other types of encoding for 802.11. 802.11a, 7-8. The encoding is further depicted at page 33 (annotation added).



406. Decoding is similarly depicted at page 36.



407. Bluetooth similarly has encoding and decoding. It provides encryption, which a POSITA would have understood to be a type of encoding/decoding. *See* Bluetooth Spec. V. 1.0 B, 275 (annotated):

3.1 SECURITY

It is recognized that security in a wireless environment is of paramount importance.

Both the LAP and the DT must enforce that encryption is operating on the baseband physical link while any PPP traffic is being sent or received. The LAP and the DT will refuse any request to disable encryption. Therefore, Bluetooth pairing must occur as a means of authenticating the users. A PIN or link key must be supplied, even if the default PIN is used. The default PIN for LAN access is a zero length PIN. Failure to complete the pairing process will prevent access to the LAN Access service.

408. I note that the '686 Patent describes “protocol gateways” in the most generic sense, by merely listing it. *See, e.g.,* '686 Patent, 37:57-59 (“The operating environment includes, but is not limited to, the available bearer services, content encoders and decoders employed, available protocol gateways, etc.”), 40:4-7 (same). It provides no detailed description and just lists it as part of the standard. Further, as I’ve shown in Sections X.A.8-X.A.9 (Ground 1, Claims 15-16), each standard provides stacks that allow the lower hardware levels to speak to the higher hardware levels. A POSITA would have understood this to be a protocol gateway because it allows connection between various levels of the stack.

409. Bluetooth Spec. V. 1.0 B, 68 (1998) (Ex. 1044) demonstrates a protocol stack and specification information for its protocol.

2.1 PROFILE STACK

Figure 2.1 shows the Bluetooth protocols and supporting entities involved in this profile.

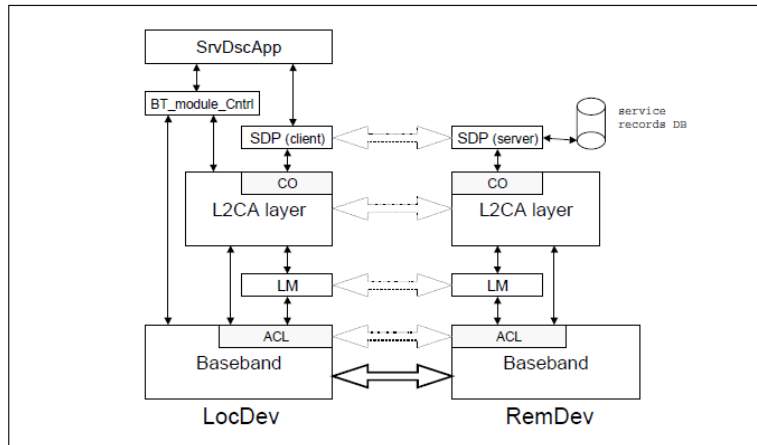
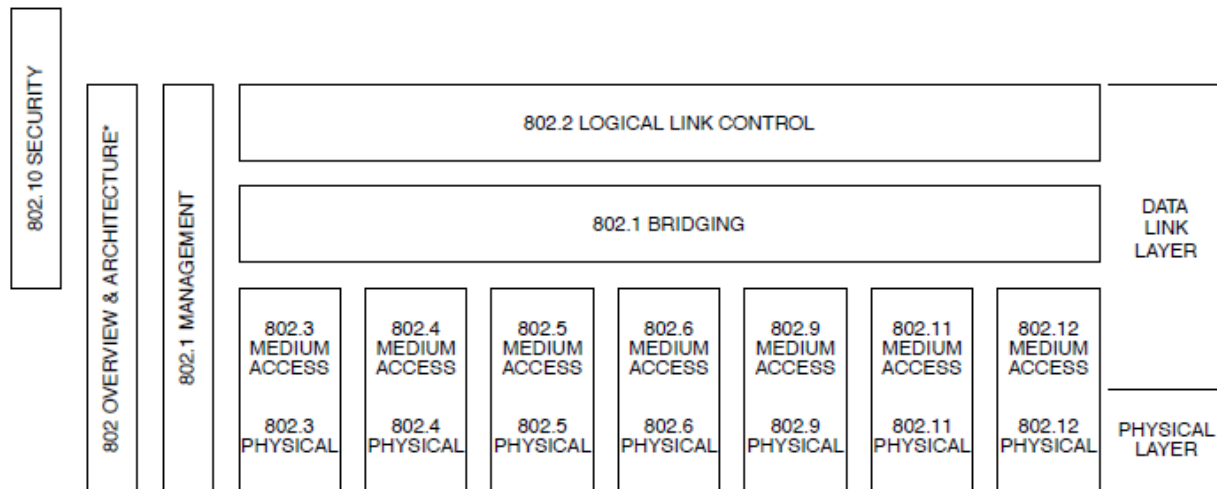


Figure 2.1: The Bluetooth protocol stack for the service discovery profile

410. IEEE 802.11 similarly demonstrates its protocol stack and specification information. See 802.11a (Ex. 1039), iii:



* Formerly IEEE Std 802.1A.

i. Claim 20: The method of claim 11, wherein step (3) comprises simultaneously operating the second transceiver and the first transceiver.

411. Young teaches this limitation as I described in Sections X.B (Ground 2A) and X.B.4.a (limitation 11[pre]). Young teaches the first and second transceivers Radio A and Radio B (discussed for 11[2] and 11[3], §§X.B.4.k-X.B.4.l) are operated simultaneously to communicate in different protocols.

412. As I've noted in Sections X.A.4.a (Ground 1, element 11[pre]) and X.B.4.a (Ground 2A, element 11[pre]), it would be incorrect to interpret “simultaneous” to require performance at the exact same instance at the lowest time interval. This is not how computer and transmission systems work. Nor is it how the '686 Patent describes simultaneous.

7. Claim 1

413. Claim 1 recites substantially similar elements to claim 11. The two most significant distinctions are that claim 1 does not require the “storage module” of claim 11, and claim 1 recites an apparatus while claim 11 recites a method. However, in my opinion, the same teachings of Young in view of Estabrook-1989 and Estabrook-1988 that I discussed regarding claim 11 also apply because Young in view of Estabrook-1989 and Estabrook-1988 teaches an apparatus that performs a method substantially similar to that of claim 11. I also note that claim 1's

frequency translating module has the same meaning as claim 11's frequency translation module.

- a. **1[pre]: An apparatus capable of performing simultaneous multi-platform operations, comprising:**

414. *See* Sections X.B (Ground 2A) and X.B.4.a (element 11[pre]).

- b. **1[a]: at least one multi-platform module including a plurality of transceivers each having at least one frequency translating module, wherein said at least one frequency translating module comprises**

415. *See* Sections X.B (Ground 2A) and X.B.4.b (element 11[1.1]) regarding the "multi-platform module" and Sections X.B.4.e, X.C.5.b (element 11[1.4]) regarding the "plurality of transceivers each having at least one frequency translation module."

- c. **1[b]: a switch configured to operate according to an energy transfer signal, and to sub-sample and transfer energy from a first electromagnetic (EM) signal, and**

416. *See* Sections X.C.5.c-X.C.5.e (elements 11[FTM-1.1], 11[FTM-1.2], and 11[FTM-1.3]).

- d. **1[c]: a control module configured to enable the at least one multi-platform module to communicate with at least one of a plurality of communication links, the control module including a plurality of protocol/standard sub-modules.**

417. *See* Sections X.B (Ground 2A) and X.B.4.b-X.B.4.c (elements 11[1.1] and 11[11.2]) regarding the "control module configured to enable the at least one

multi-platform module to communicate with at least one of a plurality of communication links” and Sections X.B (Ground 2A) and X.B.4.d (element 11[1.3]) regarding the “plurality of protocol/standard sub-modules.”

8. Dependent claims 2-10

418. Claims 2-10 depend from claim 1, and add similar limitations to dependent claims 12-20. Accordingly, my discussion of the additional elements of claims 12-20 largely applies to these claims, with minor additional explanations noted below.

- a. Claim 2: The apparatus of claim 1, wherein the control module is configured to enable the at least one multi-platform module to simultaneously communicate with a quantity of the plurality of communication links by employing an equal quantity of the plurality of standard/protocol sub-modules.**

419. *See* Sections X.B (Ground 2A) and X.B.5.a (Claim 12). In my opinion, the “control module” that I discussed previously regarding this ground in Young’s is configured to enable each sub-module (that is, Young’s Radio A and B) to communicate with one of the communication links using an equal quantity of sub-modules, that is, one sub-module (Radio A or B) per communication link.

- b. Claim 3: The apparatus of claim 1, wherein the at least one multi-platform module includes a plurality of receivers and a plurality of transmitters each having at least one frequency translating module.**

420. *See* Sections X.B (Ground 2A) and X.B.5.b (Claim 13).

- c. **Claim 4: The apparatus of claim 1, wherein the plurality of protocol/standard sub-modules comprise a first protocol/standard sub-module configured to operate a first transceiver in conformance with a first protocol/standard combination and a second protocol/standard sub-module configured to simultaneously operate a second transceiver in conformance with a second protocol/standard combination.**

421. *See* Sections X.B (Ground 2A) and X.B.5.c (Claim 14).

- d. **Claim 5: The apparatus of claim 4, wherein the first protocol/standard combination is different from the second protocol/standard combination.**

422. *See* Sections X.B (Ground 2A) and X.B.5.c (Claim 14).

- e. **Claim 6: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules contain respective first and second implementation and operational instructions for the at least one multi-platform sub-module.**

423. *See* Sections X.B (Ground 2A) and X.B.5.d (Claim 15).

- f. **Claim 7: The apparatus of claim 6, wherein the first and second implementation and operational instructions include respective first and second protocol stacks and specification information about the first and second protocol architectures.**

424. *See* Sections X.B (Ground 2A) and X.B.5.e (Claim 16).

- g. **Claim 8: The apparatus of claim 6, wherein the first and second implementation and operational instructions can be updated, upgraded, replaced, or modified to provide the at least one multi-platform sub-module with additional functionality.**

425. *See* Sections X.B (Ground 2A) and X.B.5.f (Claim 17).

- h. Claim 9: The apparatus of claim 4, wherein the first and second protocol/standard sub-modules are configured to operate the first and second transceivers in conformance with respective requirements of first and second protocols and operating environments.**

426. See Sections X.B (Ground 2A) and X.B.5.g (Claim 18). As I previously discussed in Sections X.B (Ground 2A) and X.B.4.e, X.B.4.k, X.B.4.l (elements 11[1.4], 11[2], and 11[3], respectively), Young's Radio A and Radio B are sub-modules that operate according to the requirements of the first and second protocols.

- i. Claim 10: The apparatus of claim 9, wherein the first and second operating environments include at least one of respective standards content encoders and decoders, and and protocol gateways.**

427. See Sections X.B (Ground 2A) and X.B.5.h (Claim 19). As I previously explained with regard to that claim, these features, including standards, content encoders, and protocol gateways, are all described in the respective protocol standards discussed in Young (e.g. Bluetooth and IEEE 802.11) and are thus part of their operating environments.

XI. CONCLUSION

428. For all the reasons I have explained above, it is my opinion that (1) all of Challenged Claims 1–20 of the '686 Patent are unpatentable because they are rendered obvious by the prior art and analysis I have cited herein.

429. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true. I further

declare that these statements were made with the knowledge that willfully false statements and the like are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code.

Dated: May 21, 2024

By:

A handwritten signature in black ink, appearing to read 'LEE', is written over a horizontal line.

Dr. Lawrence E. Larson

Lawrence E. Larson, Ph.D.

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1986	Ph.D.	Electrical Engineering	University of California – Los Angeles
1980	M. Eng.	Electrical Engineering	Cornell University
1979	B.S.	Electrical Engineering	Cornell University

Professional Appointments**1/2023 – 6/2023 Interim Provost, Brown University**

The Provost is Chief Academic Officer and Chief Budget Officer for Brown University and is responsible for academic and research excellence; sound budgetary practices; and oversight for all programs in all academic departments, research centers, and interdisciplinary institutes. The annual budget for Brown is \$1.5B, with 10,000 students, 1600 faculty and 3200 staff. The Provost also oversees the academic and fiscal operations of the Undergraduate College, Graduate School, Warren Alpert Medical School, School of Public Health, School of Engineering and School of Professional Studies. The Provost's Office currently is pursuing a significant expansion of Brown's research profile through increased collaborative partnerships, research funding from corporations and new strategic directions.

1/2021– Present Chairman of the Board, Slater Technology Fund, Providence, Rhode Island

The Slater Technology Fund is an evergreen not-for-profit venture development seed fund dedicated to advancing early-stage technology ventures in Rhode Island, with the overall objective of economic growth and workforce development. Slater has invested nearly \$50M in recent years, with follow-on funding raised by portfolio companies close to \$1B.

7/2011 – 8/2022 Sorensen Family Dean and Founding Dean, School of Engineering, Brown University and Professor of Engineering.

The Brown School of Engineering was created in 2010 from the historic Division of Engineering. I was recruited as Founding Dean in 2011, and in that role accomplished the following:

- **Growth of Faculty and Research** – Grew research funding in the School of Engineering from ~\$13M/yr. in 2010 to ~\$27M/yr. in 2022. Led diversification of funding sources from the NSF only to include the DoD, NIH, NIST, DoE, DoT and foundations. Doubled external corporate support for research in the SoE. Grew the tenured/tenure-track faculty from 39 FTE to 56 FTE from 2011-2022. Recruited and hired almost 50% of the current faculty in all areas of the School. Doubled the number of women faculty and recruited the first tenure-track Black and Hispanic faculty in the 150+ year history of engineering at Brown University.

- **Fundraising, Design and Construction of New Engineering Research Building** – Led the fundraising, design, architect selection, planning and construction of \$88M, 80,000 sq. ft. laboratory building, doubling the research capacity of the School of Engineering. The building was occupied in Oct. 2017 (four months ahead of schedule). The design process was highly collaborative, involving input from students, staff and faculty; and the results have been outstanding – a highly functional building that invites collaboration and engagement with the community. The design and execution were so innovative that it was one of only five buildings in the nation chosen for the annual *Architectural Record* “Colleges and Universities” issue in Nov2018. This was the first new engineering building in over 50 years on the Brown campus.
- **Growth of Fundraising** – Built the entire School of Engineering fundraising organization “from scratch,” including alumni outreach, targeted communications, campaign development, and donor engagement. Led the team that raised over \$160M as of 10/2022, including entire funding of an \$88M laboratory building, and gifts/pledges for ten endowed Chairs and the Nelson center for Entrepreneurship. Increased the number of annual donors to Brown engineering from ~30 per year in 2011 to over 600 per year in 2022.
- **Growth of the Graduate Program** – Dramatically increased the size of the Engineering Master’s degree program, from 40 students per year to nearly 200 students per year) led PhD program growth of roughly 30%; and created three successful new Master Programs:
 - Master in Technology Leadership (MTL) – Led the development and launch (March 2017) of the Brown Master in Technology Leadership. This “blended” transformational executive course provides leadership training for mid-career professionals in science and technology, grounded in an ethos of liberal learning with a global perspective.
 - Joint Brown-Rhode Island School of Design (RISD) Master Program in Design Engineering (MADE) - Led the creation of the first joint Brown-RISD degree program in the history of the two institutions. This unique program brings together the strengths of the two institutions to train students in the emerging field of Design Engineering. The first cohort started in June of 2021.
 - Master in Data-Enabled Computational Engineering and Science (DECES). - Created a program that provides students with understanding of the significant role that advanced data-driven simulation plays in industry and national laboratories. Students gain technical knowledge of the foundational subjects in computational engineering, including nonlinear finite element analysis and the integration of machine learning and data science. The first cohort started in June of 2022
- **Creation of Innovative Co-Curricular Programs**
 - Led the creation of the Brown Design Workshop (BDW) – one of the leading “maker spaces” in the nation, which has over 1,800 members from Brown and RISD and occupies over 8,000 square feet of workspace. The BDW is a campus hub for innovation, entrepreneurship, hacking and exploring new ideas. Faculty and students from across the campus use the Brown Design Workshop and it is an integral part of courses taught in engineering (8 courses), computer science, visual arts, music, English, history of art and architecture, and American studies.
 - Led the creation of the Nelson Center for Entrepreneurship – which coordinates and enables entrepreneurial efforts in all areas of campus: science, technology, the arts, social sciences,

graduate, undergraduate and faculty. Developed the initial proposal as part of a multi-year campus-wide planning, which resulted in a \$25M gift, recruitment of a founding director and launch of the Center in fall 2015.

- Rejuvenation of Student Organizations in the School of Engineering – Doubled funding for student co-curricular funding from 2011-2018, in support of 17 student organizations. Led the efforts to create Brown student chapters of National Society for Black Engineers (NSBE) and Society of Hispanic Professional Engineers (SHPE), which are thriving and serve as important support networks.
- **Creation of a Supportive Environment for Diversity, Equity and Inclusion**
 - Faculty – Initiated a vigorous program for recruiting and retaining a more diverse faculty in engineering. We more than doubled the number of women faculty in engineering, recruited two Black faculty (the first two in Brown engineering history) and three Hispanic faculty members. We fundraised for the first endowed Chairs in Brown's history for three of our distinguished women faculty.
 - Graduate Students – We created one of the most diverse engineering student bodies in American academia. ASEE reported in 2017 that the gender balance of our MS program was the best in the nation. The gender balance of our PhD program is roughly 34% women compared to the national average of roughly 20%. We more than doubled the diversity of our PhD population from historically underrepresented groups (from 3% to 7%).
 - Undergraduate Students – We created a welcoming and supportive environment for all students, and increased the fraction of undergraduates from diverse backgrounds from 10% in 2012 to 28% in 2018 (tops in the Ivy League). And the gender balance has risen to well over 40%. Both of these figures are roughly double the national average.
- **Enhanced Operational Excellence**
 - New Business Model - I developed a completely new business model for the School of Engineering - creating greater incentives for research excellence, more efficient use of research space, and transparent and collaborative budget planning. We did this while maintaining the close and collaborative ties between the School of Engineering and the rest of Brown, and maintained a budget surplus during all subsequent years of operation.
 - School of Engineering Strategic Plan – Developed new five-year plan for the School of Engineering in 2015. Engaged all stakeholders (faculty, staff, alums, industry partners, administration, students) to develop a complete vision of the direction for the School. Identified key areas for School growth and new technical directions for collaborative research at Brown.
 - Staff Reorganization – conducted a thorough staff review and overhaul of the entire School of Engineering in 2013-2014. Realigned administrative responsibilities, removed redundancies, improved customer service and reduced costs.
- **Developed External Partnerships** – Created the School of Engineering Industrial Advisory Board (IAB), with roughly 20 members. The IAB provides strategic advice for the School, research

engagement with our faculty, and job and internship opportunities for our students. Created an annual Engineering Career Fair to provide networking and career opportunities for engineering students.

7/2011 – Present Professor of Engineering – Brown University

My research program at Brown University developed integrated circuits and systems for next-generation wireless brain-computer interfaces. Early versions of these devices are in clinical trials; recent versions have achieved unprecedented data rates and functionality. During my career: published ~400 papers in journals, refereed conference proceedings, graduated 31 PhD students, received 43 US patents, and earned a current H-index of 75 (Google Scholar).

7/2007 - 7/2011 Chair, Department of Electrical and Computer Engineering (ECE) – University of California – San Diego, Jacobs School of Engineering

The ECE Department at UCSD is the largest graduate program on the UCSD campus, with over \$25M in funding (2011), 500 graduate students and 600 undergraduates.

- Oversaw faculty development (hiring, promotion and tenure process), educational policy and teaching, a successful accreditation review, resource allocation, and external relations (including fundraising for one endowed chair).
- Led the development (with Computer Science) of the new Executive Master of Advanced Study in Embedded Wireless Systems program.

7/2001 - 7/2006 Director – UCSD Center for Wireless Communications

The UCSD Center for Wireless Communications is the largest industry-funded university research centers in the nation. The CWC conducts research in all areas of wireless communications, from fundamental devices and materials to software applications

- I supported the work of over 20 professors and roughly 50 PhD graduate students per year during my tenure, and with an annual budget in excess of \$3M..
- During my tenure as Director we received support from more than 18 corporate members - both domestic and international. I was responsible for all aspects of the Center, from new member development and fundraising, to financial management and establishing the research direction.

7/1996 - 7/2011 CWC Industry Chair Professor in Wireless Communications, Department of Electrical and Computer Engineering, University of California - San Diego.

Research Program at UCSD for Professor Larson:

- I developed improved integrated circuit techniques and novel semiconductor 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. Many of these technologies were licensed to commercial wireless companies.

- Graduated 30 UCSD PhD students since arriving at UCSD in 1996. Published over 350 papers during this period and over 40 US patents.

2004-2005 Distinguished Visiting Professor – TU Delft, Netherlands (on sabbatical from UCSD)

Developed novel new microwave tuning technology, with unparalleled linearity and performance

2000-2001 Director – IBM Research West Coast Design Center of Excellence (on leave from UCSD)

- Led the international team that developed a complete Wideband CDMA chip set for several “first tier” cellular telephone providers, in partnership with Mitsubishi Electric, Osaka, Japan
- Directed development of SiGe Radio Frequency ICs for third-generation wireless cellular applications

1994-1996 Manager, Telecommunications Technology Department, Microwave Devices and Circuits Laboratory, Hughes Research Laboratories, Malibu, CA

- Directed research and development of integrated circuits for commercial RF and microwave communications applications, including DBS, cellular telephone, Very Small Aperture Terminal (VSAT) and PCS
- At Hughes Network Systems (Germantown, MD), I led the development of an RFIC design center for communications applications, including the first high volume DirecTV satellite receiver
- Responsible for the technical direction of the corporate partnership with IBM on Si/SiGe HBT technology. This partnership led to multiple system insertions in defense and commercial systems in subsequent years.
- Led the team that demonstrated the first microwave ICs in SiGe HBT technology (amplifiers, mixers, VCOs, frequency dividers) in the 5-25 GHz frequency range.

1988 – 1994 Manager, HEMT Technology Department, Microwave Devices and Circuits Laboratory, Hughes Research Laboratories, Malibu, CA

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.

- Developed the first space-qualified InP low-noise millimeterwave HEMT. This effort was awarded the 1996 Lawrence Hyland Award - the highest technical achievement award at Hughes Electronics. These devices are still used in defense satellite crosslink communications systems.
- Developed the first micromachining (RFMEMS) switch and tuner applications for RF and microwave applications (1991). This technology has now become an extremely active area of worldwide research and development, is a common feature in many high-end cellular telephones, and I hold many fundamental patents in the field. The market for RF MEMS devices now exceeds \$1B (FY22)

- I established and ran a state-of-the-art InP HEMT MMIC foundry at HRL – from materials growth, lithography, device fabrication, process development, packaging and test. Devices and circuits from this foundry had many aerospace and research system insertions, and the foundry continues operation today.
- Developed some of the first advanced RF/Microwave CMOS technology with performance comparable to III-V technology (1991).
- Directed the research program that demonstrated HEMTs with record f_T 's and f_{MAX} 's above 300 GHz (1993). This produced the highest frequency room temperature integrated circuit ever reported - a 210 GHz VCO (1994).

1992– 1994 Assistant Manager - DARPA / Hughes MIMIC Program

Responsible for Program Management of Advanced Technology Portion of DARPA/Hughes MIMIC Program, with a budget of approximately \$8M/yr. I led the systems insertions research roadmap of GaAs PHEMT and MESFET technology into airborne phased-array radar applications.

1988 – 1992 Adjunct Associate Professor – UCLA

Responsible for senior level digital and analog integrated circuit design courses and graduate analog MOS integrated circuit design course; supervised student PhD research

1980– 1988 Member of Technical Staff, Hughes Research Laboratories, Malibu, CA

Responsible for development of CMOS and III-V analog and digital integrated circuits, modeling and characterization of MESFETs and HEMTs, and development of improved III-V process techniques.

Primary Published Work

Refereed Journal Articles

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- 4 U.S. Patent # 4,951,303: "High Speed Digital Programmable Frequency Divider" (August 1990).
- 5 U.S. Patent # 4,977,403: "Digital Correction Circuit for Data Converters" (December 1990).
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- 2 C. Wang and L. Larson, "Analysis of a Microwave Class-E Power Amplifier with Finite Switching On-Resistance," *Proc. 1999 IEEE Topical Workshop on Power Amplifier for Wireless Communications*, Sept. 13-14, 1999.
- 3 W. T. Thornton, D. Morgan, and L. Larson, "Results Presented for a Novel Predistortion Linearizer Designed for Use in the LMDS Transmit Band," *Proc. 1999 IEEE Topical Workshop on Power Amplifier for Wireless Communications*, Sept. 13-14, 1999.
- 4 X. Zhang and L. Larson, "Gain and Phase Error Free LINC Transmitter," *Proc. 1999 IEEE Topical Workshop on Power Amplifier for Wireless Communications*, Sept. 13-14, 1999.
- 5 H. Kobayashi, J. Hinrichs, L. Larson, and P. Asbeck, "The current-mode Class-D amplifier for microwave frequencies: fundamental analysis and simulations," *2000 IEEE Topical Workshop on Power Amplifiers for Wireless Communications*, Sept. 11-12, 2000.
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- 8 M. Iwamoto, P. Chen, H. Kobayashi, L. Larson, P. Asbeck, "950 MHz HBT Extended Doherty for Wireless Handsets: Linearity Characteristics and CDMA Operation," *2001 IEEE Topical Workshop on Power Amplifiers for Wireless Communications*, Sept. 10-11, 2001.
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- 11 Y. Zhao, M. Iwamoto, P. Asbeck, and L. Larson, "Using DSP to Improve PA Performance," *IEEE Topical Workshop on Power Amplifiers for Wireless Communications*, Sept. 2002.
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- 14 Y. Zhao, M. Iwamoto, D. Kimball, L. E. Larson, and P. M. Asbeck, "A 900MHz Doherty Amplifier Implemented with Lumped Elements," *2003 IEEE Topical Workshop on Power Amplifiers for Wireless Communications, San Diego, CA, 2003*.
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- 18 M. Li, I. Galton, L. Larson and P. Asbeck, UCSD, "Power Amplifier Nonlinearity Estimation and Predistortion with Correlation Techniques," *IEEE Topical Workshop on Power Amplifiers for Wireless Communications, Sept. 2004*.
- 19 T. Hung, L. Larson, P. Asbeck, "CMOS Outphasing Class-D Power Amplifiers with Chireix Combiners" *IEEE Topical Workshop on Power Amplifiers for Wireless Communications, Sept. 2007*
- 20 Y. Hong, J. Jeong, D. Kimball, J. Yook, P. Asbeck, L. Larson, "Two-Stage Envelope Tracking Power Amplifiers for Basestation Application," *IEEE Topical Workshop on Power Amplifiers for Wireless Communications, Sept. 2009*

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1. L. Larson, "Research directions in chaotic digital communications devices," *SIAM Conference on Applications of Dynamical Systems*, Snowbird, Utah, May 2001. WORKSHOP PRESENTATION
2. L. Larson, "The Impact of Semiconductor Technology Evolution on Communication Systems," Plenary Talk, International High-Tech Forum, Zhuhai, China, 2002 Plenary Speech
3. L. Larson, "The role of power amplifier in wireless telecommunications," IEEE International Solid-State Circuits Conference Short Course Presentation, 2000. Short Course Presentation at International Conference
4. L. Larson, "Emerging Semiconductor Technologies and their Effect on the Communications Industry, Presentation to San Diego Telecom Council, June 2002. Industry Group Presentation
5. L. Larson, "Implementation of VCO design," *2000 IEEE Radio Frequency Integrated Circuit Symposium*, Anaheim, CA, June 13-19, 2000. WORKSHOP PRESENTATION
6. L. Larson, "Improved Techniques Utilizing Harmonic Termination Methods for Microwave and RF Circuit Design," at "Introducing New Concepts in Nonlinear Network Design," Workshop at 2002 IEEE MTT-S International Microwave Symposium, Seattle, WA. WORKSHOP PRESENTATION
7. L. Larson, "RF and Microwave Oscillator Design," Workshop at 2003 IEEE International Microwave Symposium, Philadelphia, Pennsylvania. WORKSHOP PRESENTATION
8. L. Larson, "Next Generation Transmitter Architecture and Design," Workshop at 2003 IEEE International Microwave Symposium, Philadelphia, Pennsylvania. WORKSHOP PRESENTATION
9. L. Larson, "Wireless System Design and Measurement Accuracy: State-of-the-Art and Future Needs for the Communications", Workshop at 2004 IEEE International Microwave Symposium, Fort Worth, Texas. WORKSHOP PRESENTATION
10. L. Larson, "Analog/RF design in SiGe Processes," IEEE International Solid-State Circuits Conference Short Course Presentation, 2004. Short Course Presentation at International Conference
11. P. Asbeck, J. Rode, I. Galton and L. Larson, "Algorithms and Amplifiers for Digital Generation of Microwave Signals with Time-varying Envelope" Workshop at 2005 IEEE International Microwave Symposium, Long Beach, CA WORKSHOP PRESENTATION
12. "Enabling RF Technologies for Software Defined /Cognitive Radios" Larry Larson, Workshop Presentation at International European Solid-State Circuits Research Conference, 2006 WORKSHOP PRESENTATION

- 13 "Power Supply Modulation Techniques for Power Amplifier Efficiency Enhancement," Larry Larson, Feipeng Wang, Donald Kimball, and Peter Asbeck," Workshop Presentation at International Microwave Symposium (IMS) 2006. WORKSHOP PRESENTATION
- 14 "Multi-Standard RFIC Transmitter Technology," Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at International Microwave Symposium (IMS) 2006. WORKSHOP PRESENTATION
- 15 "Efficiency Enhancement Techniques for WiMAX Power Amplifiers," Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at International Microwave Symposium (IMS) 2007. WORKSHOP PRESENTATION
- 16 "Software Defined /Cognitive Radios: RF and System Considerations" Lawrence Larson, Workshop Presentation at International Microwave Symposium (IMS) 2007. WORKSHOP PRESENTATION
- 17 "Reconfigurable Transmitters and Power Amplifiers" Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at IEEE Radio Frequency Integrated Circuit Symposium (2007) WORKSHOP PRESENTATION
- 18 "Linearization of Highly-Efficient Monolithic Class E SiGe Power Amplifiers with Envelope-Tracking (ET) and Envelope-Elimination-and-Restoration (EER) at 900MHz," D. Lie, J. Popp, F. Wang, D. Kimball, and L. Larson, 6th IEEE Dallas Circuits and Systems Workshop on System-on-Chip, 2007. DCAS 2007. WORKSHOP PRESENTATION
- 19 "Digital-Assisted Compensation of RF-Front-end Limitations," Larry Larson Workshop Presentation at IEEE International Solid-State Circuits Conference (2008) WORKSHOP PRESENTATION
- 20 "Digitally Enhanced" RF Circuits, Lawrence Larson, Peter Asbeck, and Donald Kimball, Panel Presentation at IEEE International Solid-State Circuits Conference (2007) WORKSHOP PRESENTATION
- 21 "Power Supply Modulation Techniques for Power Amplifier Efficiency Enhancement," Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at IEEE International Solid-State Circuits Conference (2007) WORKSHOP PRESENTATION
- 22 "Digital Signal Processing Techniques for Linearity and Efficiency Enhancement of Envelope Tracking, EER, and Doherty Amplifiers," Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at IEEE Radio Frequency Integrated Circuit Symposium (2008) WORKSHOP PRESENTATION
- 23 "Low-Power Reconfigurable Transmitter Architectures" Lawrence Larson, Peter Asbeck, and Donald Kimball Workshop Presentation at IEEE Radio Frequency Integrated Circuit Symposium (2008) WORKSHOP PRESENTATION
- 24 "Bipolar-Based Power Amplifier Design Beyond Handsets and into MMIC: Design, Modeling, Characterization, Packaging, Reliability," Larry Larson, Workshop Presentation at IEEE Bipolar Circuits and Technology Meeting (2007) WORKSHOP PRESENTATION
- 25 "Digitally Enhanced" RF Circuits" Lawrence Larson, Peter Asbeck and Don Kimball, Workshop Presentation at International Microwave Symposium (IMS) 2009. WORKSHOP PRESENTATION
- 26 "Packaging Options for Wireless Systems-on-a-Chip" Lawrence Larson, Workshop Presentation at International Microwave Symposium (IMS) 2009. WORKSHOP PRESENTATION
- 27 "Power Amplifier Integration Challenges for Highly Integrated Multi-Mode Transceivers," L. Larson, Workshop Presentation at International Microwave Symposium (IMS) 2009 WORKSHOP PRESENTATION
- 28 "Power Amplifiers" Lawrence Larson, Peter Asbeck and Don Kimball, Workshop Presentation at IEEE Custom Integrated Circuits Conference (CICC) 2009. WORKSHOP PRESENTATION
- 29 "Packaging Options for Wireless Systems-on-a-Chip", Lawrence Larson, Panel Presentation, IEEE International Solid-State Circuits Conference (2009) WORKSHOP PRESENTATION
- 30 "Ubiquitous Wireless Communications," L. Larson, Presentation to La Jolla Venture Capital Forum, April 2009 PRESENTATION
- 31 "Ubiquitous Wireless Communications," June, 2009, SPAWAR TechBoard Presentation, PRESENTATION
- 32 "Design Techniques for Broadband Efficient Linear Power Amplifiers for Multi-Mode Wireless Applications" Lawrence Larson, Workshop Presentation at International Microwave Symposium (IMS) 2010 WORKSHOP PRESENTATION

- 33 "Low-Power Transmitters in Nanoscale CMOS "Lawrence Larson, Peter Asbeck, and Donald Kimball, Workshop Presentation at IEEE Radio Frequency Integrated Circuit Symposium (2010) WORKSHOP PRESENTATION
- 34 "Ubiquitous Wireless Communications," Presentation to Qualcomm Ventures 5/28/09 PRESENTATION
- 35 "Digital Signal Processing Techniques for Linearity and Efficiency Enhancement of Envelope Tracking, EER, and Doherty Amplifiers" Presentation at UCSB, April 2008 PRESENTATION
- 36 "Linearization of Power Amplifiers," Csics 2010 Short Course WORKSHOP PRESENTATION
- 37 "Improving RF Transmitter Energy Efficiency for Future Generation Wireless Systems" Presentation to UC Irvine ECE Department Irvine, May, 2010. PRESENTATION
- 38 "RF and Microwave Challenges for Cognitive Radio and TV White Space Devices," Presentation at GHz Center, annual Review, Chalmers University, Sweden, November, 2009. PRESENTATION
- 39 "Power Amplifier Technology" Panasonic 7/20/09 PRESENTATION
- 40 "Power Amplifier Technology" Huawei 7/28/09 PRESENTATION
- 41 "RF and Microwave Challenges for Cognitive Radio and TV White Space Devices" Huawei Cognitive Radio Panel 4/17/09 PRESENTATION
- 42 "Improving RF Transmitter Energy Efficiency for Future Generation Wireless Systems" Presentation to UC Riverside ECE Department 2/17/09 PRESENTATION
- 43 "Low-Power RF Circuit Trends for Wireless Communications" Broadcomm, 4/20/09. PRESENTATION
- 44 "RF and Microwave Challenges for Cognitive Radio and TV White Space Devices," Presentation at California Institute of Technology, December, 2009. PRESENTATION
- 45: Wouk Lecture – Cal. Tech. June 2013. This is the main invited lecture given by the Division of Engineering at Cal Tech every year. PRESENTATION
- 46: "Envelope Tracking Power amplifiers for wireless Communications," Huawei Power Amplifier Workshop, May, 2014.
- 47:"RF and microwave technology challenges for Internet-of-Things applications" was an invited talk at the 2015 IEEE 15th Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems, Jan., 2015.
- 48: "RF and Microwave Challenges for Future Radio Spectrum Access", Northeastern ECE Distinguished Speaker Series, December 3, 2015.
- 49: "RF and Microwave Challenges for Future Radio Spectrum Access" Invited talk at the Radio Club of America's Technical Symposium, San Jose, CA, Nov. 2015.
- 50: "Overview of the School of Engineering at Brown," Presentation to Rhode Island Professional Engineers, Nov. 4, 2015
- 51: TBP Annual National Convention - Overview of the School of Engineering at Brown, Oct. 30, 2015
- 52: "Design Fundamentals for RF Receivers and Transmitters," IEEE BCTM short course, Oct. 2015
- 53: "Transformer-based duplexers for wireless communications," Presentation to Skyworks, Woburn, Mass, May, 2015,
- 54: "Internet-of-Things" IMS Panel Discussion, May, 2015.

Contracts and Grants (period 7/1/11- 2/1/23) Brown University

		Funding Agency	Total Funding	Period of Performance		Percent Effort
1	Efficient Linear All-Silicon Transmitter IC's (ELASTX)	DARPA	\$1,550,000	3/11-12/13	Co-PI	20%
2	Cognitive radio Low-energy signal Analysis Sensor ICs (CLASIC)	DARPA/SAIC	\$350,000	1/12-1/15	PI	100%
3	Wide Tuning Range RF Front-End	DARPA/Maxcentric	\$30,000	7/12-7/13	PI	100%
4	Neural Engineering System Design (Nurmikko PI)	DARPA	~\$1,300,000	4/17-10/18	Co-PI	~10%
5	NIST Prep - Boulder	NIST	~\$6,600,000	1/18-1/22	PI	5%

Service

University Service

Brown University Committees:

- Knowledge District Working Group: Fall 2011
- COE Review Committee: Fall 2011
- Nelson Center RPG Fall 2015
- Ex-Officio Member of President's Cabinet, Provost Senior Deans, Capital Planning, Tenure and Promotion, University Resource Committee and Academic Planning Committee
- Provost Search Committee, Fall 2022

University of California (system-wide) Committees:

- UCSD representative on the UC MICRO Steering Committee from 1999-2000. This group met three times per year in Oakland to establish MICRO policy, review proposals, and plan MICRO strategy for the future.
- UCSD representative on the UC Discovery Grant "Communications and Networking" Steering Committee 2001-2006. This group met three times per year in Oakland. Reviewer of Discovery Grant proposals.

University of California – San Diego Committees:

- Department representative to the Academic Senate (1999-2000)
- Member of the *ad-hoc* committee to review Professor Craig as provost of the Eleanor Roosevelt College (2000).
- Member of the *ad-hoc* ethics review committee for Professor Michael Karin (1997-2000).
- Member of the UCSD Institute for Nonlinear Studies Steering Committee (1999-2005).
- Member of Five-Year Review Committee for Rady School Dean Sullivan (2008)

UCSD Jacobs School of Engineering Committees:

- Representative of Center for Wireless Communications to Jacobs School Council of Advisors, 2002-2006.

- Chair of the committee that nominated Professor Peter Asbeck for the Conexant Chair of Electrical and Computer Engineering (2002).
- Member of the Chair committee for Professor Rajesh Gupta (2002)
- Member of the Chair committee for Professor Larry Smarr (2002).
- Member of SAIC Chair Committee for Professor Ahmin Vahdat (2008)
- Chair of CMRR Chair Committee for Professor Paul Siegel (2007)
- UCSD JSOE Diversity Advisory Council – Chair of Working Group on Student Recruiting 2010-2011

UCSD California Institute for Telecommunications and Information Technology Committees:

- Member of the CALIT² Communications committee (2005) .
- Member of the CALIT² Building Dedication committee (2005) .
- Member of CALIT NRI Committee (2006-2008)
- Member of CALIT Steering Committee (2005-2007)

UCSD Center for Wireless Communications:

- Director, July 2001-July 2006. Co-Director January 2000-July 2001. The Director of the CWC is responsible for all aspects of Center operation, including budgeting, resource allocation, interaction with member companies, recruiting new members, organizing technical reviews, and helping to determine technical direction. The CWC had roughly 12 Member Companies, 25 faculty members, and an annual budget of approximately \$2.5M and supported roughly 45 PhD students during my tenure as Director. The Center Director is responsible for organizing the semi-annual research review, as well as hosting the semi-annual Board meeting. I was also responsible for member interactions and recruitment, which typically involved meetings with over 40 companies per year, as well as many visits to our Member companies.
- Member, CWC Executive Steering Committee for 1998-2000.
- CWC Entre/Intra-preneurship Workshop Organizer (w. Professor Alon Orlitsky). Nov. 2007. Professor Orlitsky and I organized this highly successful CWC Workshop. It required solicitation of distinguished international invited speakers, organizing the venue location, promotion of the event, etc.

UCSD ECE Department Committees:

- Member Department Space Committee(1998-2000)
- Member Graduate Affairs Committee (2000-2001)
- Member Faculty Council (1997-1999 and 2001-2003)
- Member Center for Wireless Communications Five Year Review Committee (2000)
- Host ECE294 Friday Lecture series: Fall 1999.
- Chair Search Committee for Prof. G. Rebeiz (2003)
- Chair Search Committee for Prof. B. Song. (1999)
- Member Search Committee for Prof. J. Buckwalter (2006)
- Member Search Committee Computer Engineering (2007)
- Chair, ECE Space Committee (2007)
- Chair and/or Member of Five Department Ad-Hoc Review Committees (2005-2008)
- MS and M.Eng Advisor: Electronic Circuits and Systems : (2005-2011)

UCSD ECE Department Service:

- ECE Department Vice Chair (2007)
- ECE Department Chair (2007-2011)

Host of Visiting Scholars and Professors at UCSD:

I have acted as host to several visitors, who were resident Visiting Scholars or Visiting Professors, including Mr. Eriji Iriyama from Matsushita Electric Works(1998-2000), Professor Leo DeVreede from Technical University Delft (1999), and Professor KH Koo from the University of Inchon (2000), and Mr. Thomas Johansen, from TU Copenhagen (2001-2002) Prof. Hyun-Chang Park from Dongguk University (2002-2003), Professor Carlo Samori: Politecnico Milano (2006-2007) and Professor Jong-Gwan Yook: Yonsei University (2007-2008). As Director of the UCSD CWC, I played official host to approximately 10 CWC visiting scholars.

Professional Service

Editor:

- Associate Editor IEEE Transactions on Circuits and Systems (2008-2010)

Guest Editor:

- Guest Editor of the August 1999 Issue of the *IEEE Transactions on Microwave Theory and Techniques*. This involved solicitation of manuscripts, and coordinating the review and publication process.
- Guest Editor of the October 2000 Issue of the *IEEE Journal of Solid-State Circuits*. This involved solicitation of manuscripts, and coordinating the review and publication process.
- Guest Editor Special Issue on Multifunctional Circuits and Systems for Future Generations of Wireless Communications, with A. Tasic, and W Serdijn, 2009 *IEEE Transactions on Circuits and Systems II*, Volume: 55 , Issue: 4

IEEE Committees:

- Member Program Committee for the 1999 IEEE Custom Integrated Circuits Conference (CICC).
- Member Program Committee for the 1997-2002 IEEE Bipolar Circuits and Technology Meeting (BCTM) (Chair of the RF committee and panel session organizer)
- Member Program Committee for the 1999 IEEE Radio Frequency Integrated Circuits Conference,
- Member Program Committee for the 1998 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits.
- Founding Chairman, 1998 UCSD Center for Wireless Communications Conference in cooperation with the IEEE.
- Technical Program Chair 1999(founding), 2001, and 2003 IEEE Workshop on Power Amplifiers for Wireless Communications.
- General Chair 2000, 2002, 2004 and 2006 IEEE Workshop on Power Amplifiers for Wireless Communications.
- Member Program Committee for the 2004 IEEE Radio and Wireless Conference.
- Member Program Committee for the 2004 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits.
- Member Program Committee for the 2007 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits.
- Member Program Committee for the 2008 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits.

- Member Program Committee for the 2009 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits.
- Member Program Committee for the 2009 IEEE International conference on Ultra-Wideband
- IEEE Communications Society 2009 Administrative Committee Member – Technical Directions Sub-Committee
- Member Program Committee for the 2010 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2011 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2012 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2013 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2014 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2015 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2016 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits
- Member Program Committee for the 2017 IEEE Topical Symposium on High-Frequency Silicon Devices and Circuits

NAE Committees:

- National Academy of Engineering Computer Science and Telecommunications Board’s Committee on Wireless Technology Prospects and Policy Options. (2003-2011). This study committee was established by the National Academies at the request of the National Science Foundation to conduct a comprehensive assessment of wireless technology and service and application trends and their implications for wireless spectrum management and policy, and published its final report in 2011.
- A member (2019) of the NAE visiting committee reviewing the NIST Boulder Communications Laboratory, whose findings were published January 2020. I led the Metrology Section group during the review, and drafted that Section of the final report

Paper and Proposal Reviewer:

- Paper Reviewer (1998-Present):
 - IEEE Transactions on Microwave Theory and Techniques,
 - IEEE Microwave and Guided Wave Letters,
 - IEEE Transactions on Vehicular Technology,
 - IEEE Communications Letters,
 - IEEE Journal of Solid-State Circuits,
 - IEEE Transactions on Circuits and Systems,
 - IEEE Transactions on Electron Devices,
 - IEE Electronics Letters.
- NSF Proposal Reviewer: (2003, 2004, 2009, 2010, 2011, 2012)
- NSF ECCS Program Review Panel Member 2011

Diversity Training

Attended the NSA ADVANCE/PAID Chair Retreat, October 10 to 12, 2007. This three day event provided me with intensive training on removing bias and promoting diversity in the recruiting, tenure and advancement process. I took the lessons of this training back to the ECE department and used it to implement improved recruitment and promotion policies.

Other Activities (Entrepreneurship, Consulting, etc).

Co-Founder: Aethercomm, Inc. (1999-2023, BOD Member). Co-Founder Renaissance Wireless (2004-2007), Co-Founder Nurlink (2017-2021)

Technical Advisory Board Member: Resonant Communication (2020-2022), LintrinsicIC (2021-present).

Consultant to Sierra Monolithics (1996-2011), Consultant for Qualcomm in 2015-2016.

I also taught several short courses (1988-2011) through UCLA Extension, UCSD Extension, Mead Microelectronics, and Besser and Associates.

Academic Honors, Fellowships, and Honorary Societies

Memberships

Fellow, IEEE -1999, Life Fellow, IEEE - 2022
Member, Eta Kappa Nu, Sigma Xi, Tau Beta Pi

Honors and Awards

Howard Hughes Doctoral Fellow: 1982 - 1986.

Hughes Research Laboratories Sector Patent Award: 1995 for my work on RF MEMS technology.

Co-Recipient of Lawrence Hyland Award - 1996: This is the highest technical achievement award at Hughes Electronics, for development of InP-based low-noise HEMTs for satellite communications in the years 1989-1994.

IBM Faculty Development Award: 2002

Co-Recipient of IBM Microelectronics General Managers Excellence Award (1999) for Development of Si/SiGe HBT Technology. This was for my research on the development of Si/SiGe HBT technology during the years from 1993-1998.

“Wireless Influencers 2002” one of the top 200 people selected internationally as the top influencers in the wireless industry for 2002. One of only 11 people selected from academia.

Co-Recipient (w. D. Jessie): IEEE Custom Integrated Circuits Conference: Best Invited Paper 2003

Co-Recipient (w. V. Leung and P. Gudem): 2nd place Semiconductor Research Corporation SiGe Design Competition 2003

Co-Recipient (w. V. Aparin): Best Student Paper Award – 1st place: IEEE Radio Frequency Integrated Circuits Conference 2004

Co-Recipient (w. F. Wang, P. Asbeck and D. Kimball): Best Student Paper Award – 2nd place: IEEE International Microwave Symposium 2004

Co-Recipient (w. Yiping Han) Best Student Paper Award – 3rd Place: 2006 Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems

Co-Recipient (w. Yiping Han) Best Student Paper Award – 3rd place: IEEE Radio Frequency Integrated Circuits Conference 2007

Co-Recipient (w. Rahul Kodkani) Best Student Paper Award – 3rd Place: 2007 Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems
Co-Recipient (w. Mohammad Farazian) Best Student Paper Award – 2nd Place: 2010 Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems
Mohammad Farazian (PhD Student) – Analog Devices Best Student Designer Award 2008
Ali Afsahi (PhD Student) – Analog Devices Best Student Designer Award 2010
Co-Recipient (w. Mahdi Bagheri) Best Student Paper Award – 3rd Place: 2011 Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems

Teaching

Regular Courses and Enrollment Figures at Brown University

Engn 0020 – Spring 2013 (w. Prof. E. Powell). Enrollment was 131. Score on “Teaching Effectiveness” was 1.71 (1 being best and 5 being worst).
ENGN 0020 Spring 2014 (w. Prof. E. Powell). Enrollment was 125. Score on “Teaching Effectiveness” was 1.75 (1 being best and 5 being worst).
ENGN 0020 Spring 2016 (w. Prof. Jason Harry). Enrollment was 108. Score on “Teaching Effectiveness” was 1.9 (1 being best and 5 being worst).
ENGN 0020 Spring 2017 (w. Prof. Jason Harry). Enrollment was 118. Score on “Teaching Effectiveness” was 2.17 (1 being best and 5 being worst).
ENGN 0520 Spring 2018 (w. Professor Jacob Rosenstein) Enrollment was 94. Score on “Teaching Effectiveness” was 1.75 (1 being best and 5 being worst).
ENGN 0520 Spring 2019 (w. Professor Jacob Rosenstein) Enrollment was 98. Score on “Teaching Effectiveness” was 1.69 (1 being best and 5 being worst).
ENGN 0520 Spring 2020 (w. Professor Farah Laiwalla) Enrollment was 97. Score on “Teaching Effectiveness” was 1.62 (1 being best and 5 being worst).
ENGN 0520 Spring 2021 (w. Professor Farah Laiwalla) Enrollment was 92. Score on “Teaching Effectiveness” was 1.46 (1 being best and 5 being worst).

Independent Studies at Brown University

- Three independent studies projects advised in Fall Semester 2011.
- One independent studies project advised in Fall Semester 2012.
- I supervised one undergraduate student research during 2013 and 2014 – Mr. Subhradip Sarkar. He also did an Honor’s thesis with me in 2015.

Honors, Master's and PhD theses directed

- Master's Students Completed: 24 (UCSD) One (Brown University)
- Doctoral Students Completed: 30 (UCSD) One (Brown University)

S. Vora	Thesis and Research Advisor	MS (Degree Granted 98)
R. Langridge	Thesis and Research Advisor	MS (Degree Granted 99)
K. Yang	Thesis and Research Advisor	MS (Degree Granted 99)
W. Sun	Thesis and Research Advisor	MS (Degree Granted 00)
Y. Song	Research Advisor (w. B. Song)	MS (Degree Granted 01)
J. Roan	Research Advisor	MS (Degree Granted 02)
P. Nanawa	Research Advisor	MS (Degree Granted 02)
R. Apte	Research Advisor	MS (Degree Granted 03)
H. Ghajari	Research Advisor	MS (Degree Granted 03)
S. Sivakumar	Research Advisor	MS(Degree Granted 03)
Dayo Ojo	Research Advisor	MS(Degree Granted 04)
P. Sagazio	Research Advisor	MS(Degree Granted 04)
A. Ebaad	Research Advisor	MS(Degree Granted 04)
A. Yang	Research Advisor	MS(Degree Granted 04)
H. Ng	Research Advisor	MS(Degree Granted 04)
P. Lee	Research Advisor	MS(Degree Granted 04)
P. Yu	Research Advisor	MS(Degree Granted 04)
R. Pera	Research Advisor	MS (Degree Granted 05)
D. Cheng	Research Advisor	MS(Degree Granted 07)
John Keeler	Research Advisor	MS(Degree Granted 07)
Javier Molina	Research Advisor	MS (Degree Granted 09)
Howard Liu	Research Advisor	MS (Degree Granted 09)
Tony Lo	Research Advisor	MS (Degree Granted 09)
Anton Arrigada	Research Advisor	MS (Degree Granted 10)
Akaninyene Umoh	Research Advisor	MS (Degree Granted 11)
C. Kilfoyle	Research Adviser	ScM (Degree Granted 17)

Doctoral Students:

Name of Student/Your Role (thesis adviser, research adviser, etc.)

X. Zhang	Dissertation and Research Advisor	PhD (Degree Granted 2001)
C. Wang	Dissertation and Research Advisor	PhD(Degree Granted 2003)
D. Jessie	Dissertation and Research Advisor	PhD(Degree Granted 2003)
D. Laney	Dissertation and Research Advisor	PhD(Degree Granted 2003)
J. Fairbanks	Dissertation and Research Advisor	PhD (Degree Granted 2003)
K. Gard	Dissertation and Research Advisor	PhD(Degree Granted 2003)
L. Sheng	Dissertation and Research Advisor	PhD(Degree Granted 2003)
R. Tenny	Dissertation and co-Advisor (w/ H. Abarbanel)	PhD(Degree Granted 2003)
V. Leung	Dissertation and Research Advisor	PhD(Degree Granted 2004)
V. Aparin	Dissertation and Research Advisor	PhD(Degree Granted 2005)
J. Jensen	Dissertation and Research Advisor	PhD(Degree Granted 2005)
J. Deng	Dissertation and Research Advisor	PhD(Degree Granted 2005)
M. Ranjan	Dissertation and Research Advisor	PhD(Degree Granted 2006)
F. Wang	Dissertation and Research Advisor	PhD (Degree Granted 2006)
J. Jamp	Dissertation and Research Advisor	PhD (Degree Granted 2007)
R. Kodkani	Dissertation and Research Advisor	PhD (Degree Granted 2009)

H. Khatri	Dissertation and Research Advisor	PhD (Degree Granted 2009)
M. Farazian	Dissertation and Research Advisor	PhD (Degree Granted 2009)
H. Pan	Dissertation and Research Advisor	PhD (Degree Granted 2010)
N. Kim	Dissertation and Research Advisor	PhD (Degree Granted 2010)
S. Kim	Dissertation and Research Advisor	PhD (Degree Granted 2010)
S. Park	Dissertation and Research Advisor	PhD (Degree Granted 2010)
M. Kwak	Dissertation and Research Advisor	PhD (Degree Granted 2011)
M. Hassan	Dissertation and Research Advisor	PhD (Degree Granted 2012)
A.Kheirkhi	Dissertation and Research Advisor	PhD (Degree Granted 2013)
A. Afsahi	Dissertation and Research Advisor	PhD (Degree Granted 2013)
A. Agah	Dissertation and Research Advisor	PhD (Degree Granted 2013)
S. Abdelhalem	Dissertation and Research Advisor	PhD (Degree Granted 2013)
C. Thomas	Dissertation and Research Advisor	PhD (Degree Granted 2015)
M. Bagheri	Dissertation and Research co-Advisor	PhD (Degree Granted 2018)
A. Wichman	Dissertation and Research Advisor	PhD (Degree Granted 2018)