EXHIBIT 19-9

EXHIBIT 8

(12) **United States Patent**
Sorrells et al.

(10) **Patent No.:** **US 9,118,528 B2**
(45) **Date of Patent:** *Aug. 25, 2015

(54) **METHOD AND SYSTEM FOR DOWN-CONVERTING AN ELECTROMAGNETIC SIGNAL, AND TRANSFORMS FOR SAME, AND APERTURE RELATIONSHIPS**

(71) Applicant: **ParkerVision, Inc.**, Jacksonville, FL (US)

(72) Inventors: **David F. Sorrells**, Jacksonville, FL (US); **Michael J. Bultman**, Jacksonville, FL (US); **Robert W. Cook**, Switzerland, FL (US); **Richard C. Looke**, Jacksonville, FL (US); **Charley D. Moses**, Jacksonville, FL (US); **Gregory S. Rawlins**, Lake Mary, FL (US); **Michael W. Rawlins**, Lake Mary, FL (US)

(73) Assignee: **ParkerVision, Inc.**, Jacksonville, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/172,392**

(22) Filed: **Feb. 4, 2014**

(65) **Prior Publication Data**

US 2014/0241464 A1 Aug. 28, 2014

Related U.S. Application Data

(60) Continuation of application No. 13/549,213, filed on Jul. 13, 2012, now Pat. No. 8,660,513, which is a

(Continued)

(51) **Int. Cl.**
H04L 27/12 (2006.01)
**H03C 1/62** (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H04L 27/12** (2013.01); **H03C 1/62** (2013.01); **H03D 7/00** (2013.01); **H04B 1/0025** (2013.01); **H04B 1/28** (2013.01); **H04B 7/12** (2013.01); **H04L 27/00** (2013.01)

(58) **Field of Classification Search**
USPC 455/413, 113, 118, 130, 131, 182.1, 455/190.1, 191.1, 313, 323, 343, 350; 327/113; 375/130, 142, 143, 150, 152, 375/316, 343
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,868,908 A 9/1989 Pless et al.
4,968,958 A 11/1990 Hoare

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 9722185 6/1997

OTHER PUBLICATIONS

U.S. Appl. No. 13/899,180, filde May 21, 2013, Rawlins et al.

(Continued)

Primary Examiner — Sam Bhattacharya
(74) *Attorney, Agent, or Firm* — Workman Nydegger

(57) **ABSTRACT**

Methods, systems, and apparatuses, and combinations and sub-combinations thereof, for down-converting an electromagnetic (EM) signal are described herein. Briefly stated, in embodiments the invention operates by receiving an EM signal and recursively operating on approximate half cycles (½, 1½, 2½, etc) of the carrier signal. The recursive operations can be performed at a sub-harmonic rate of the carrier signal. The invention accumulates the results of the recursive operations and uses the accumulated results to form a down-converted signal. In an embodiment, the EM signal is down-converted to an intermediate frequency (IF) signal. In another embodiment, the EM signal is down-converted to a baseband information signal. In another embodiment, the EM signal is a frequency modulated (FM) signal, which is down-converted to a non-FM signal, such as a phase modulated (PM) signal or an amplitude modulated (AM) signal.

36 Claims, 284 Drawing Sheets
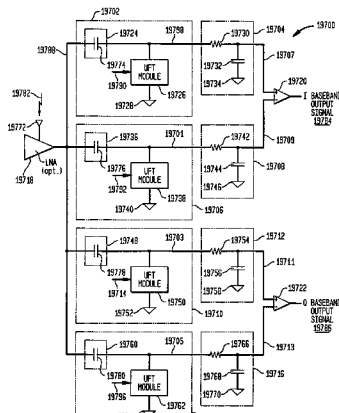
US 9,118,528 B2

Page 2

Related U.S. Application Data

continuation of application No. 12/976,839, filed on Dec. 22, 2010, now Pat. No. 8,340,618, which is a continuation of application No. 12/349,802, filed on Jan. 7, 2009, now Pat. No. 7,865,177, which is a division of application No. 09/550,644, filed on Apr. 14, 2000, now Pat. No. 7,515,896, which is a continuation-in-part of application No. 09/293,342, filed on Apr. 16, 1999, now Pat. No. 6,687,493, which is a continuation-in-part of application No. 09/176,022, filed on Oct. 21, 1998, now Pat. No. 6,061,551.

(51) **Int. Cl.**
H03D 7/00	(2006.01)
H04B 1/00	(2006.01)
H04B 1/28	(2006.01)
H04B 7/12	(2006.01)
H04L 27/00	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,073,001	A	6/2000	Sokoler
6,085,073	A	7/2000	Palermo et al.
6,307,894	B2	10/2001	Edison et al.
6,363,262	B1	3/2002	McNicol
6,397,051	B1	5/2002	Abbasi et al.
6,512,798	B1	1/2003	Akiyama et al.
6,643,502	B1	11/2003	Van De Plassche et al.
6,647,250	B1	11/2003	Bultman et al.
6,853,690	B1	2/2005	Sorrells et al.
6,879,817	B1	4/2005	Rawlins et al.
7,010,286	B2	3/2006	Sorrells et al.
7,218,899	B2	5/2007	Sorrells et al.
7,386,292	B2	6/2008	Sorrells et al.
7,496,342	B2	2/2009	Sorrells et al.
7,693,230	B2	4/2010	Sorrells et al.
7,773,688	B2	8/2010	Sorrells et al.
7,994,968	B2	8/2011	McEwan
8,571,135	B2	10/2013	Sorrells et al.
8,588,725	B2	11/2013	Sorrells et al.
8,594,228	B2	11/2013	Sorrells et al.
8,649,753	B2	2/2014	Rofougaran et al.
8,660,513	B2	2/2014	Sorrells et al.
8,824,993	B2	9/2014	Sorrells et al.
2003/0227983	A1	12/2003	Milne et al.
2013/0109338	A1	5/2013	Sorrells et al.
2013/0115906	A1	5/2013	Forman et al.
2013/0122835	A1	5/2013	Sorrells et al.
2013/0122846	A1	5/2013	Sorrells et al.
2013/0182749	A1	7/2013	Sorrells et al.
2013/0202070	A1	8/2013	Sorrells et al.
2013/0225110	A1	8/2013	Karlquist
2014/0226751	A1	8/2014	Sorrells et al.
2014/0233670	A1	8/2014	Sorrells et al.
2014/0308909	A1	10/2014	Sorrells et al.
2014/0308911	A1	10/2014	Sorrells et al.
2014/0308912	A1	10/2014	Sorrells et al.
2014/0308913	A1	10/2014	Sorrells et al.

OTHER PUBLICATIONS

U.S. Appl. No. 14/473,410, filed Aug. 29, 2014, Sorrells et al.
U.S. Appl. No. 14/561,484, filed Dec. 5, 2014, Rawlins et al.
Maas S. A. "A Gaas Mesfet Mixer with Very Low Intermodulation", IEEE Transactions on Microwave Theory and Techniques, IEEE Service Center, Piscataway, NJ, US, vol. MTT-35, No. 4, Apr. 1, 1987, pp. 425-429.
U.S. Appl. No. 12/881,912, Jan. 20, 2012, Notice of Allowance.
U.S. Appl. No. 12/881,912, Feb. 16, 2012, Notice of Allowance.
U.S. Appl. No. 13/231,244, Aug. 23, 2013, Notice of Allowance.

U.S. Appl. No. 13/829,795, Oct. 15, 2013, Office Action.
U.S. Appl. No. 14/053,815, Jun. 6, 2014, Office Action.
U.S. Appl. No. 14/075,535, Jul. 30, 2014, Office Action.
U.S. Appl. No. 14/053,999, Sep. 3, 2014, Office Action.
U.S. Appl. No. 14/081,501, Sep. 3, 2014, Office Action.
U.S. Appl. No. 14/085,008, Sep. 5, 2014, Office Action.
U.S. Appl. No. 14/053,327, Sep. 9, 2014, Office Action.
U.S. Appl. No. 14/075,738, Sep. 11, 2014, Office Action.
U.S. Appl. No. 14/054,548, Sep. 26, 2014, Office Action.
IPR2014-00948 Petition for Inter Partes Review of U.S. Pat. No. 6,370,371 dated Jun. 12, 2014.
IPR2014-00948 Patent Owner Preliminary Response dated Sep. 24, 2014.
IPR2014-00948 Decision Institute of Inter Partes Review dated Dec. 18, 2014.
IPR2014-00946 Petition for Inter Partes Review of U.S. Pat. No. 6,266,518 dated Jun. 12, 2014.
IPR2014-00946 Patent Owner Preliminary Response dated Sep. 24, 2014.
IPR2014-00946 Decision Institute of Inter Partes Review dated Dec. 18, 2014.
IPR2014-00946 Petitioner's Request for Rehearing dated Jan. 2, 2015.
IPR2014-00946 Decision Petitioner's Request for Rehearing dated Jan. 27, 2015.
IPR2014-00946 Exhibit 1004 Asad Abidi Declaration dated Jun. 7, 2014, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1007 ParkerVision's Motion for Summary Judgment of No Invalidity dated May 22, 2013, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1008 Order of Judge Roy Dalton dated Feb. 20, 2013, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1009 Transcript of Markman Hearing dated Aug. 13, 2012, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1010 Rebuttal Expert Report of Peter Weisskopf dated Apr. 1, 2013, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1011 Transcript of Jury Trial Day Six dated Oct. 16, 2013, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1012 Joint Claim Construction Statement dated May 29, 2012, filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1013 Transcript of Jury Trial Day Two dated Oct. 9, 2013 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1014 Transcript of Jury Trial Day Three dated Oct. 10, 2013 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1015 Transcript of Jury Trial Day Four dated Oct. 11, 2013 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1016 ParkerVision's Reply to Qualcomm's Opposition to ParkerVision's Motion for Summary Judgment of No Invalidity dated Jul. 11, 2013 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1017 Order dated Aug. 25, 2013 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1018 Declaration of Paul Prucnal, Ph.D. in Support of Plaintiff ParkerVision, Inc.'s Rebuttal Claim Construction Brief dated Jul. 27, 2012 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1020 Plaintiff ParkerVision, Inc.'s Rebuttal Claim Construction Brief dated Jul. 27, 2012 filed in IPR Proceedings Jun. 12, 2014.
IPR2014-00946 Exhibit 1021 ParkerVision, Inc.'s Response in Opposition to Qualcomm's Motion for Judgment as a Matter of Law of Noninfringement dated Jul. 27, 2012 filed in IPR Proceedings Jun. 12, 2014.
Eastabrook, Polly, Ph.D. "The Direct Conversion Receiver: Analysis and Design of the Front-end Components" Ph.D. dissertation, Stanford University, Aug. 1989.
Weisskopf, Peter A.,"Subharmonic Sampling of Microwave Signal Processing Requirements", *Microwave Journal*, vol. 35, No. 5, May 1992, pp. 239-247.
Avitabile, G., et al., "S-band Digital Downcoverter for Radar Applications Based on a GaAs MMIC Fast Sample-and-Hold" *IEEE Proc. on Circuits Devices and Systems.*, vol. 143, No. 6, Dec. 1996, pp. 337-342.

(56)   **References Cited**

OTHER PUBLICATIONS

Black, Harold S., *Modulation Theory*, ser. The Bell Telephone Laboratory Series. New York: Van Nostrand, pp. 55-57, 1953.

Mangelsdorf, Chris, et al., "200-MSPS 8-Bit IC A/D Converter Has 250-MHz Bandwidth", *Analog Dialogue* vol. 22, No. 2, pp. 3-7, 1988.

Cochrane, P., "Sampling Principles," in *Microwave Measurements*, 2nd ed., A.E. Bailey, Ed. London: Peter Peregrinus, 1989, Chapter 15, pp. 344-358.

Janssen, J.M.L., "An Experimental 'Stroboscopic' Oscilloscope for Frequencies up to About 50 Mc/s" *Philips Technical Review*, vol. 12, No. 2, pp. 52-81, 1950.

Bennettt, W.R. "Pulse Modulation" in *Communication Systems and Techniques*, M. Schwartz, et al. Eds. New York: McGraw-Hill, 1966, pp. 244-245.

Linden, D.A., "A Discussion of Sampling Theorems", *Proceedings of the IRE* vol. 47, No. 7, Jul. 1959, pp. 1219-1226.

Ragazzini, John R., *Sampled-Data Control Systems*, New York: McGraw-Hill, 1958, Chapter 2, pp. 12-28.

Yen, Chu-Sun, "Phase-Locked Sampling Instruments" *IEEE Transactions on Instrumentation and Measurement*, vol. 14, No. 1 and 2, pp. 64-68, 1965.

Howard, Dar, et al., "The Wideband Sampling Gate, An Analysis, Characterization and Application Discussion" in WESCON 1966, Conference Proceedings, 23/1/1-11.

Cochrane, P., Sampling Principles, in *Microwave Measurements 2nd ed.*, A.E. Bailey, Ed. London: Peter Peregrinus,1989, chapter 16, pp. 360-384.

Dethlefsen, Michael et al., "Design Considerations in the Microwave Transition Analyzer", *Hewlett-Packard Journal*, vol. 43, No. 5, Oct. 1992, pp. 63-71.

"Sampling Notes" *Tektronix*, Application Note 85W-23777-0, 1964.

Grove, W.M., "Sampling for Oscilloscopes and Other RF Systems: Dc Through X-Band", *IEEE Transactions on Microwave Theory and Techniques*, Dec. 1966, pp. 629-635.

Faulkner, Neil D. et al., "Subharmonic Sampling for the Measurement of Short-Term Stability of Microwave Oscillators", *IEEE Translations on Instrumentation and Measurement*, vol. MITT-14, No. 12, Mar. 1966, pp. 208-213.

"Fundamentals of RF and Microwave Noise Figure Measurements" Hewlett Packard Application Note AN 57-1, 1983.

Taub, Herbert et al., *Principles of Communication Systems*, 2nd Ed, New York: McGraw-Hill, 1986, pp. 615-623.

Ballo, David J., et al. "The Microwave Transition Analyzer: A New Instrument Architecture for Component and Signal Analysis" *Hewlett-Packard Journal*, vol. 43, No. 5, Oct. 1992, pp. 48-62.

Clarke, Kenneth K. et al., *Communication Circuits: Analysis and Design*, Reading, MA:Addison-Wesley,1971, pp. 353-385.

Gibbons, James F., *Semiconductor Electronics*. New York: McGraw-Hill, 1966.

Guillemin, Ernst A. *Introductory Circuit Theory*, New York: Wiley, 1953, pp. 520-521.

Desoer, Charles A. et al., *Basic Circuit Theory*, New York: McGraw-Hill, 1969, Chapter 9, pp. 396-397.

Estabrook, P. et al., "A Mixer Computer-Aided Design Tool Based in the Time Domain" IEEE MTT-5 Digest, 1988, pp. 1107-1110.

IPR2014-00947 Petition for Inter Partes Review of U.S. Patent No. 6,061,551 dated Jun. 12, 2014.

IPR2014-00947 Patent Owner Preliminary Response dated Sep. 24, 2014.

IPR2014-00947 Decision Institute of Inter Partes Review dated Dec. 18, 2014.

IPR2014-001107 Petition for Inter Partes Review of U.S. Patent No. 7,496,342 dated Jul. 2, 2014.

IPR2014-001107 Patent Owner Preliminary Response dated Oct. 10, 2014.

IPR2014-001107 Decision Institute of Inter Partes Review dated Jan. 8, 2014.

IPR2014-001107 Asad Abidi Declaration dated Jul. 2, 2014, filed in IPR Proceedings Jul. 2, 2014.

Oxner, Ed, "FETs in Balanced Mixers" *Siliconix*, Application Note, AN-72-1, 1979, pp. 6-29 to 6-38.

Razavi, Behzad, *Principles of Data Conversion System Design*, IEEE Press, 1995, pp. 7-28.

Bult, Klaas et al., "A CMOS Four-Quadrant Analog Multiplier" IEEE Journal of Solid-State Circuits, vol. sc-21, No. 3, Jun. 1986, pp. 430-435.

Thornton, Richard D. et al. *MultiStage Transistor Circuits*, New York: Wiley, 1965.

DeMaw, Doug, *Practical RF Design Manual*, Prentice-Hall, 1982, pp. 118-213.

IPR2014-01107 Parkervision's Response in Opposition to Qualcomm's Renewed Motion for Judgment as a Matter of Law and Motion for New Trial Regarding Invalidity, dated Jan. 24, 2014 filed in IPR Proceedings Jul. 2, 2014.

Zimmerman, H.J. et al. *Electronic Circuit Theory*. New York: Wiley, 1959, pp. 142-144.

"U430/431 Matched N-Channel JFET Pairs" Siliconix, Data Sheet P-37405—Rev.D., 1994.

Schelkunoff, S.A., et al. *Antennas: Theory and Practice*. New York: Wiley, 1952, pp. 324-325.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.

WHAT WILL YOU BUILD? | sales@docketalarm.com | 1-866-77-FASTCASE

fastcase®
Smarter legal research.