

EXHIBIT 19-10

EXHIBIT 9



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

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(54) **METHOD AND SYSTEM FOR DOWN-CONVERTING AN ELECTROMAGNETIC SIGNAL**

(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)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,699,570 A 1/1929 Potter
3,241,078 A 3/1966 Jones

(Continued)

FOREIGN PATENT DOCUMENTS

EP 01926955.4 4/2001
WO 9722185 6/1997

OTHER PUBLICATIONS

U.S. Appl. No. 13/889,180, filed May 21, 2013, Rawlins et al.
(Continued)

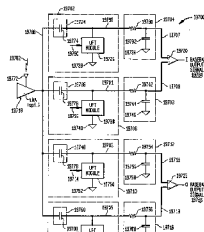
Primary Examiner — Sam Bhattacharya

(74) *Attorney, Agent, or Firm* — Workman Nydegger

(57) **ABSTRACT**

Methods, systems, and apparatuses for down converting a modulated carrier signal to a demodulated baseband signal are described herein. A first switch is controlled with a first control signal which comprises a first sampling aperture with a specified frequency, wherein the first switch is on during the first sampling aperture and wherein the first switch is off outside the first sampling aperture. A second switch is controlled with a second control signal which comprises a second sampling aperture and wherein the second switch is off outside the second sampling aperture. The first and second control signals each control a charging and discharging cycle of a respective energy storage element so that for each switch a portion of energy is transferred to the respective energy storage element when the respective switch is on during the charging cycle, and a portion of previously transferred energy is discharged during the discharging cycle for each respective switch when the switch is off. A down-converted in-phase baseband signal portion is derived from energy accumulated at said first energy storage element during both the charging and the discharging cycles for the first energy storage element and a down-converted inverted in-phase baseband signal portion is derived from energy accumulated at said second energy storage element during both the charging and the discharging cycles for the second energy storage element, and the two portions are combined with a first differential amplifier circuit to form a down-converted differential in-phase baseband signal.

28 Claims, 284 Drawing Sheets



US 9,246,736 B2

Page 2

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

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(56)

References Cited

U.S. PATENT DOCUMENTS

4,352,209 A 9/1982 Ma
4,547,746 A 10/1985 Erickson et al.
4,703,453 A 10/1987 Shinoda et al.
4,868,908 A 9/1989 Pless et al.
4,968,958 A 11/1990 Hoare
5,027,163 A 6/1991 Dobrovolny
5,136,264 A 8/1992 Nardozza
5,179,730 A 1/1993 Loper
5,280,648 A 1/1994 Dobrovolny
5,473,280 A 12/1995 Ohnishi
5,644,260 A 7/1997 Dasilva et al.
5,648,736 A 7/1997 Ishigaki
5,680,078 A 10/1997 Ariie
6,002,925 A 12/1999 Vu et al.
6,073,001 A 6/2000 Sokoler
6,085,073 A 7/2000 Palermo et al.
6,091,940 A 7/2000 Sorrells et al.
6,122,287 A 9/2000 Ohanian et al.
6,157,682 A 12/2000 Oberhammer
6,307,894 B2 10/2001 Eidson et al.
6,343,211 B1 1/2002 Thodesen 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.
6,687,493 B1 2/2004 Sorrells et al.
6,853,690 B1 2/2005 Sorrells et al.
6,879,817 B1 4/2005 Sorrells et al.

7,050,508 B2 5/2006 Sorrells et al.
7,218,899 B2 5/2007 Sorrells et al.
7,319,661 B1 1/2008 Bohossian et al.
7,376,091 B1 5/2008 Eccles et al.
7,386,292 B2 6/2008 Sorrells et al.
7,496,342 B2 2/2009 Sorrells et al.
7,630,700 B2 12/2009 Vaisanen
7,668,527 B2 2/2010 Vaisanen
7,693,230 B2 4/2010 Sorrells et al.
7,773,688 B2 8/2010 Sorrells et al.
7,844,233 B2 11/2010 Vaisanen
7,865,177 B2 1/2011 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.
8,594,607 B2 11/2013 Sorrells et al.
8,649,753 B2 2/2014 Rofougaran et al.
8,660,513 B2* 2/2014 Sorrells et al. 455/313
8,824,993 B2 9/2014 Sorrells et al.
2003/0139180 A1 7/2003 McIntosh et al.
2003/0158954 A1 8/2003 Williams
2003/0167204 A1 9/2003 Makipaa
2003/0227983 A1 12/2003 Milne et al.
2004/0114553 A1 6/2004 Jiang et al.
2004/0184466 A1 9/2004 Chang et al.
2007/0120780 A1 5/2007 Park et al.
2008/0003973 A1 1/2008 Vaisanen
2012/0104228 A1 5/2012 Souchkov
2012/0328284 A1 12/2012 Kawasaki
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.
2014/0241464 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.
2015/0295536 A1 10/2015 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.
U.S. Appl. No. 14/639,296, filed May 5, 2015, Sorrells et al.
U.S. Appl. No. 14/639,366, filed Mar. 5, 2015, Sorrells 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. 13/549,213, Oct. 8, 2013, Notice of Allowance.
U.S. Appl. No. 13/428,816, Oct. 11, 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. 14/172,392, Aug. 27, 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.
U.S. Appl. No. 14/172,392, Mar. 12, 2015, Notice of Allowance.
IPR2014-00948 Petition for Inter Partes Review of U.S. Pat. No. 6,370,371 dated Jun. 12, 2014.

US 9,246,736 B2

Page 3

(56)

References Cited

OTHER PUBLICATIONS

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 Downconverter 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.

Shannon, C.E., "Communication in the presence of Noise," *Proceedings of the IRE*, vol. 37, No. 1, 1949, pp. 10-21.

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*,

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.

Bennett, 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 Transactions on Instrumentation and Measurement*, vol. MTT-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.

Eastabrook, 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. Pat. 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. Pat. 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.

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