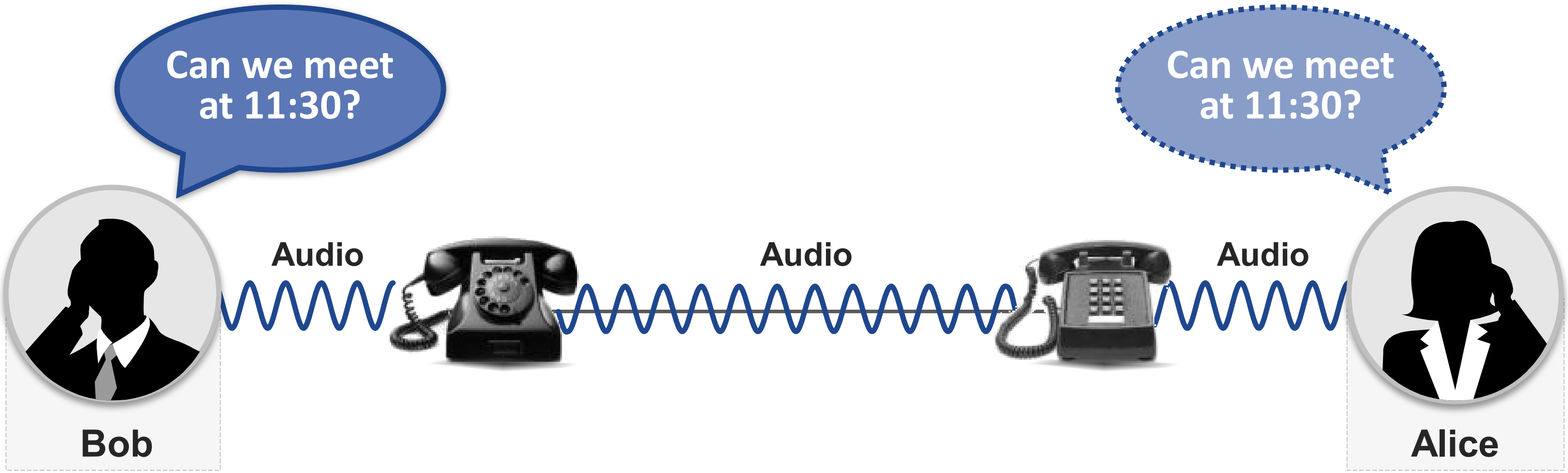
# TCL/Hisense/LG, Petitioners
# v.
# ParkerVision, Inc., Patent Owner

Case No. IPR2021-00990
U.S. Patent No. 7,110,444

**Patent Owner's Demonstratives**

# Technology Overview

# Wired Communication




**Audio signal is at low frequency.**

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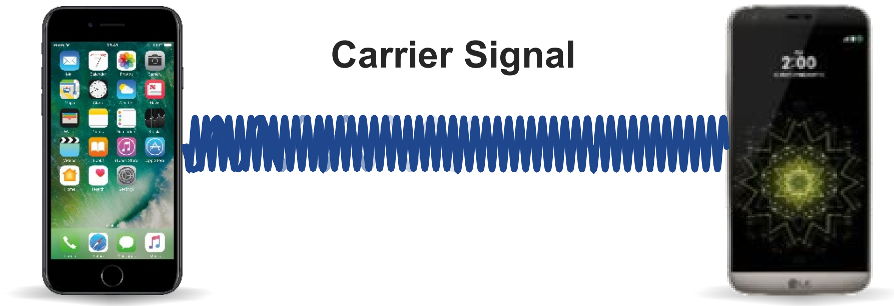
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# Frequency

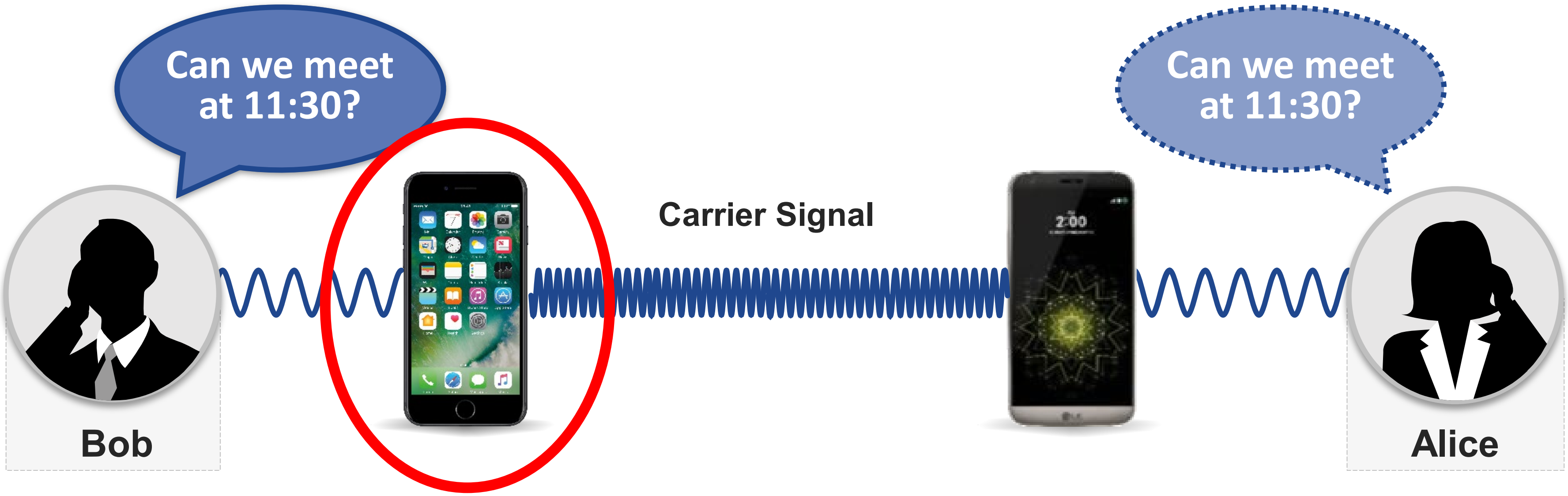
# Wireless Communication

# Wireless Communication




- **Cannot transmit the audio signal over the air.**
- **The audio signal must move to a higher frequency carrier signal.**

# Wireless Communication

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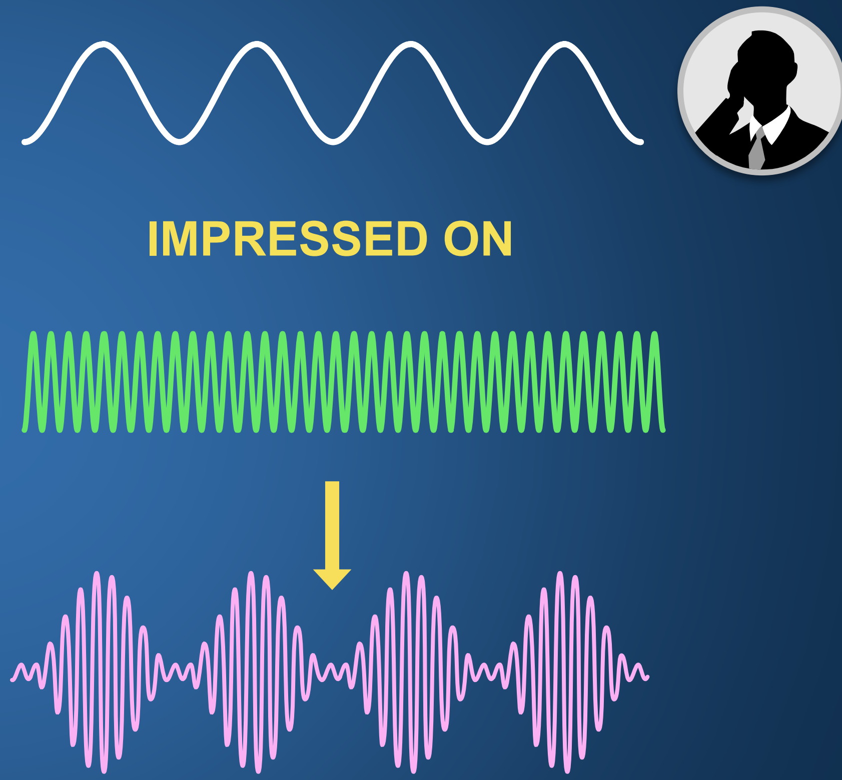
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# Modulation Involves Up-Conversion

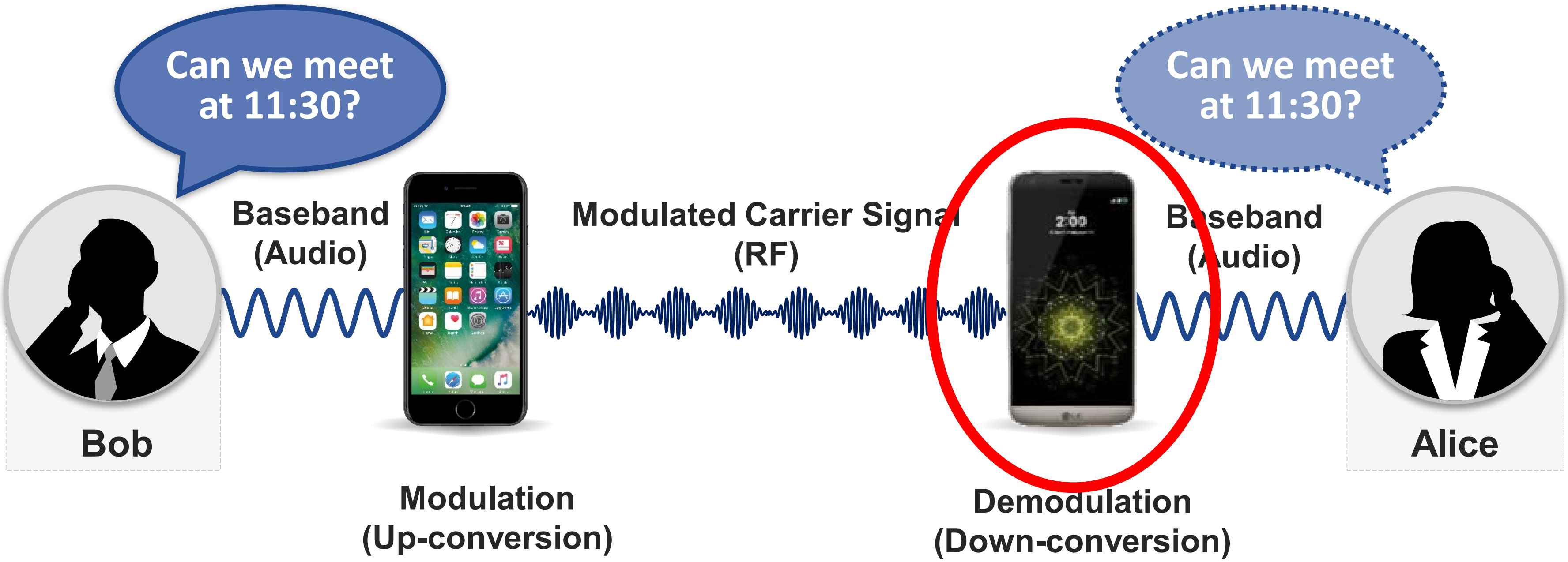
Baseband Information

Carrier

Modulated Carrier



# Wireless Communication

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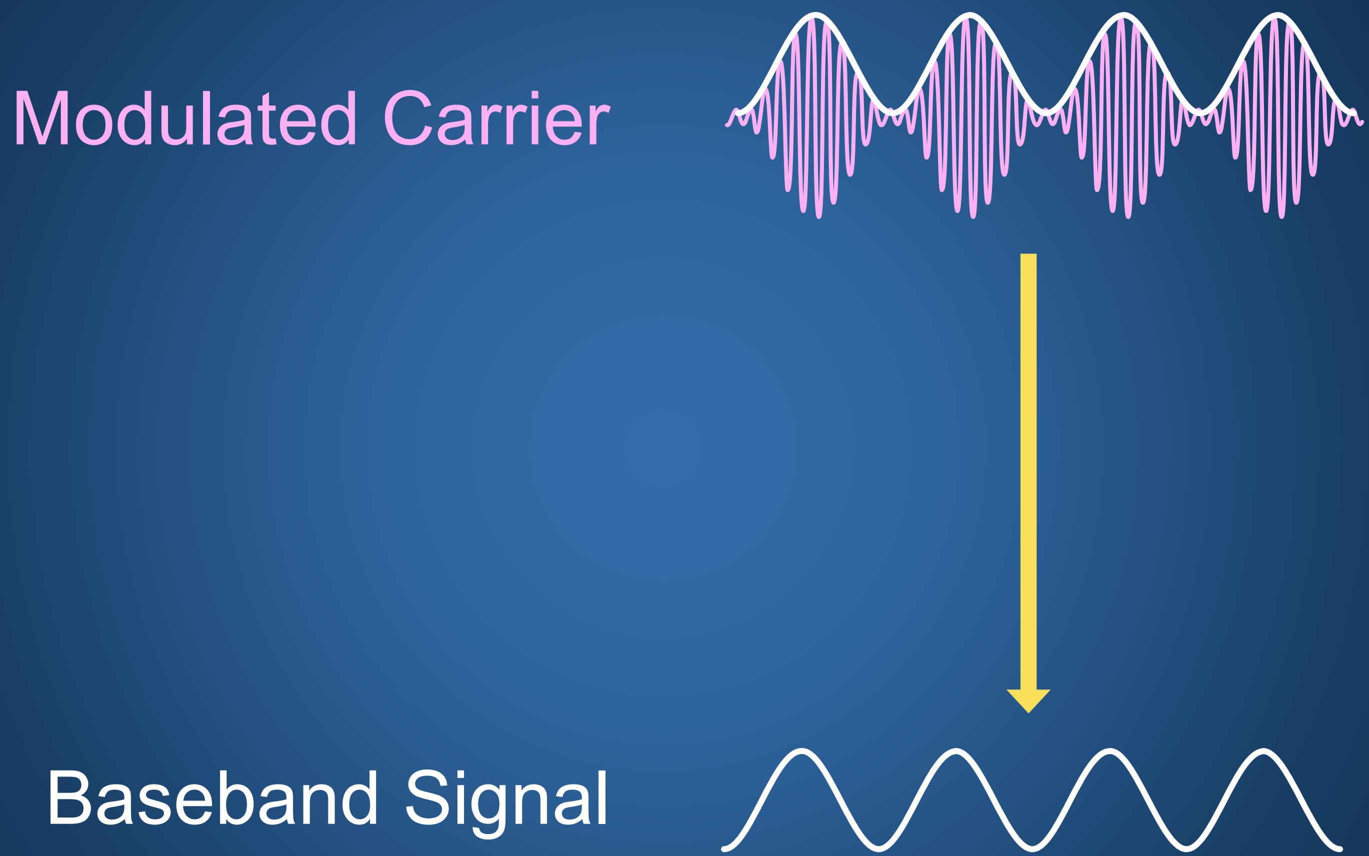
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# Demodulation Involves Down-Conversion

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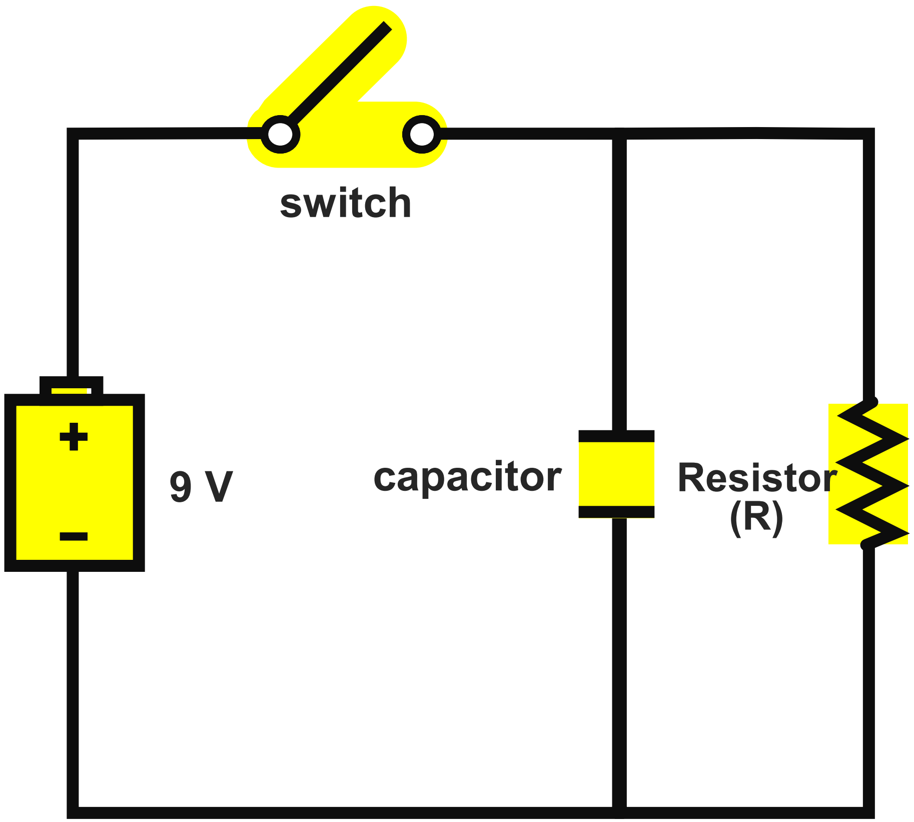
# Circuit Fundamentals

# Circuit Fundamentals




- Battery
- Switch
- Resistor
- Capacitor

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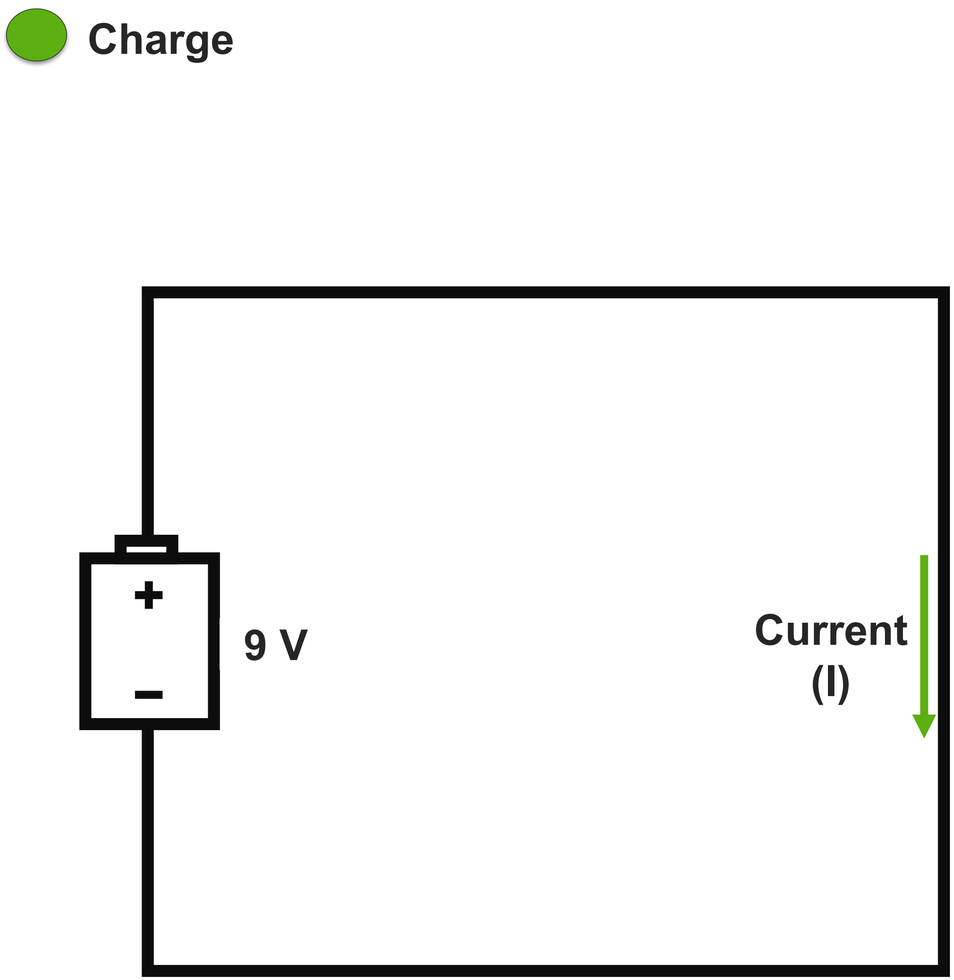
# Circuit Fundamentals




- **Current**

  Movement of charge

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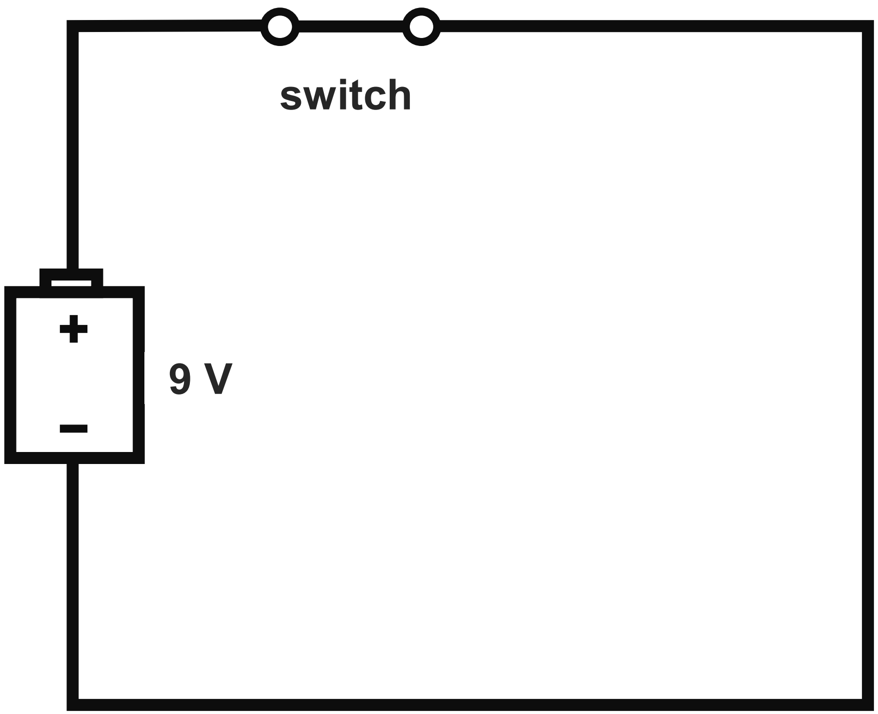
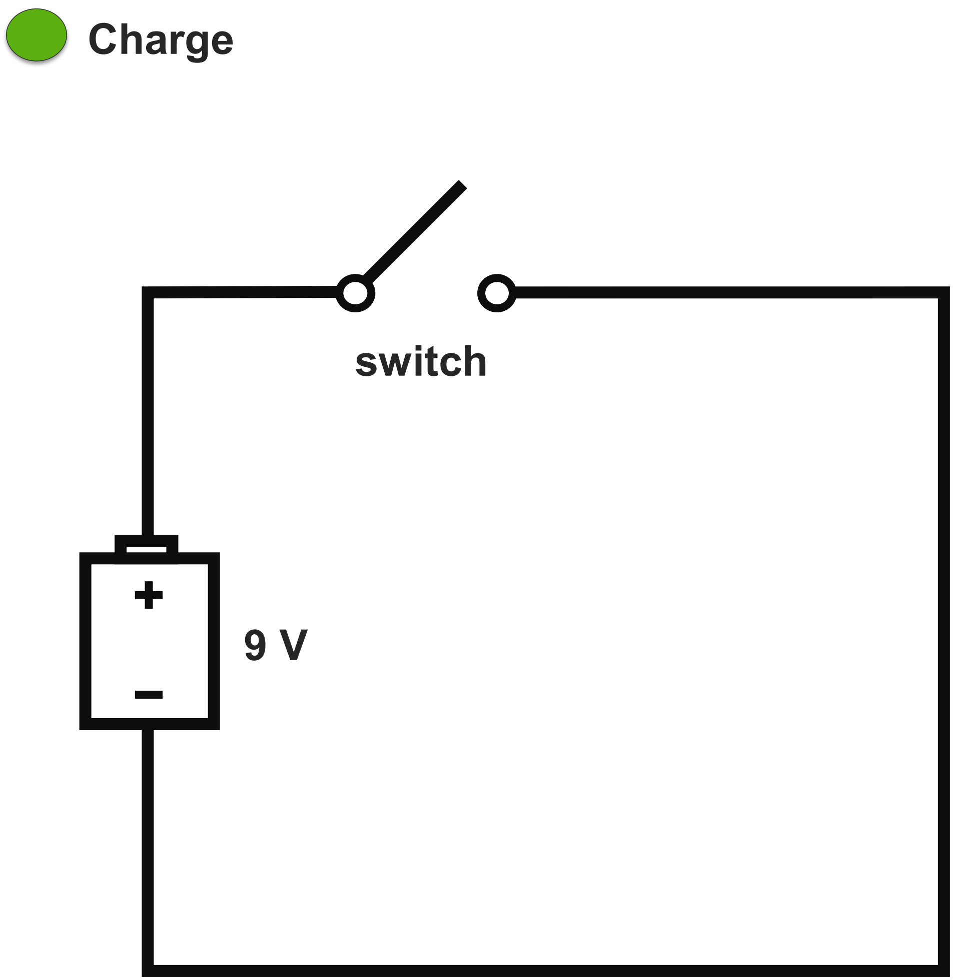
# Circuit Fundamentals



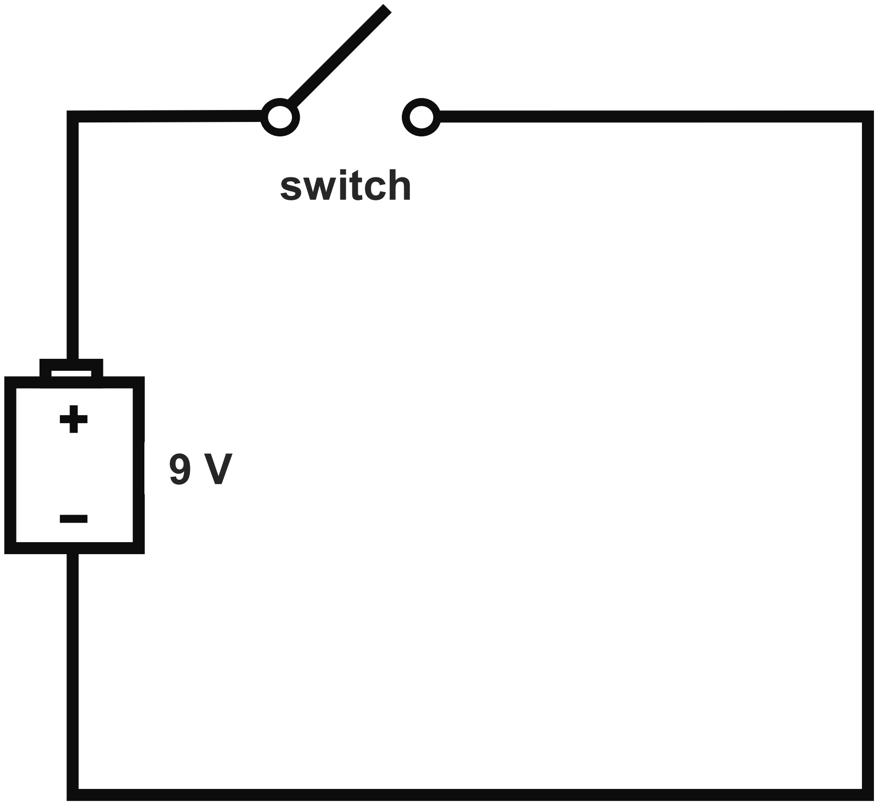

- **Switch**
  - Current flows and energy transfers when on/closed
  - Current does not flow and energy does not transfer when off/open

# Circuit Fundamentals

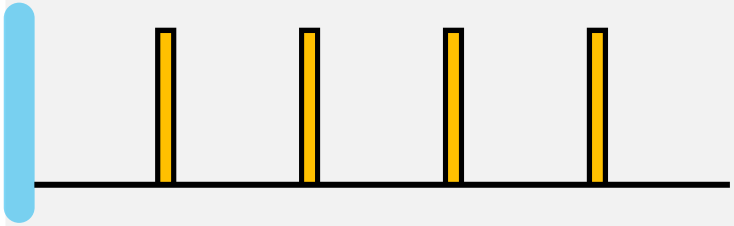



- **Switch**
  - Current flows and energy transfers when on/closed
  - Current does not flow and energy does not transfer when off/open

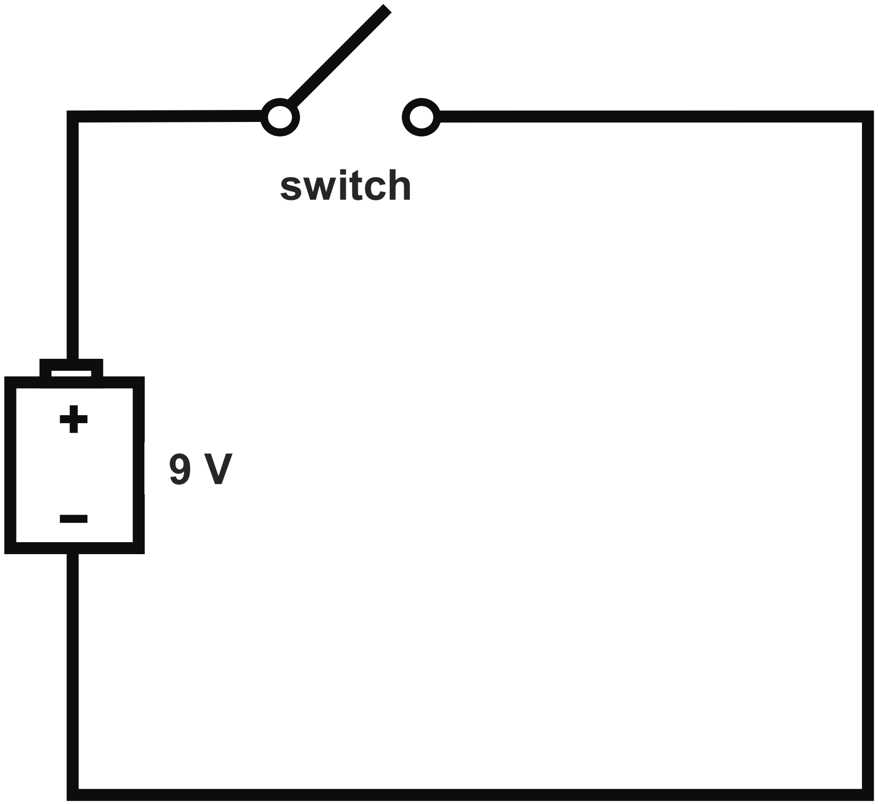
# Circuit Fundamentals



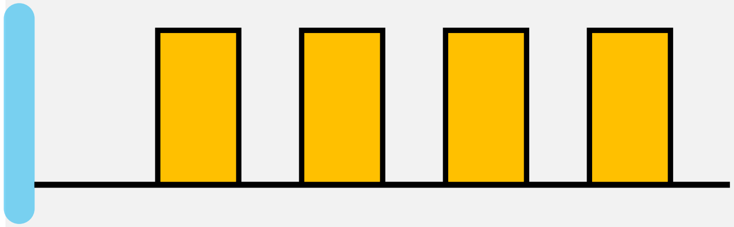

- **Control Signal**
  - Used to close/open an electronic switch
  - Controls Frequency
  - Controls Duration



# Circuit Fundamentals




- **Control Signal**
  - Used to close/open an electronic switch
  - Controls Frequency
  - Controls Duration



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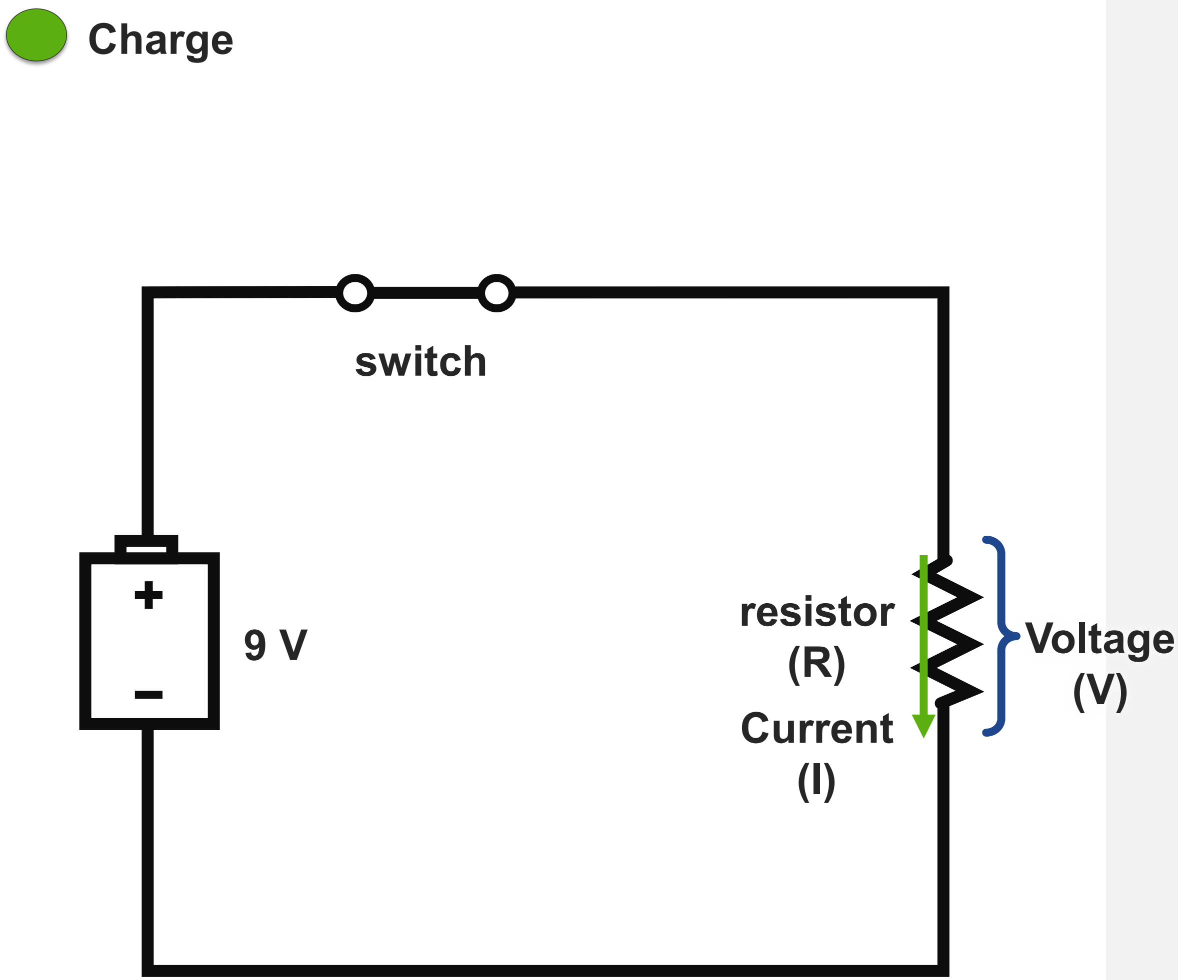
# Circuit Fundamentals




- **Resistor**
  Component that provides resistance to electrical current and dissipates energy
- **Voltage**
  The measure of energy dissipated in the resistor

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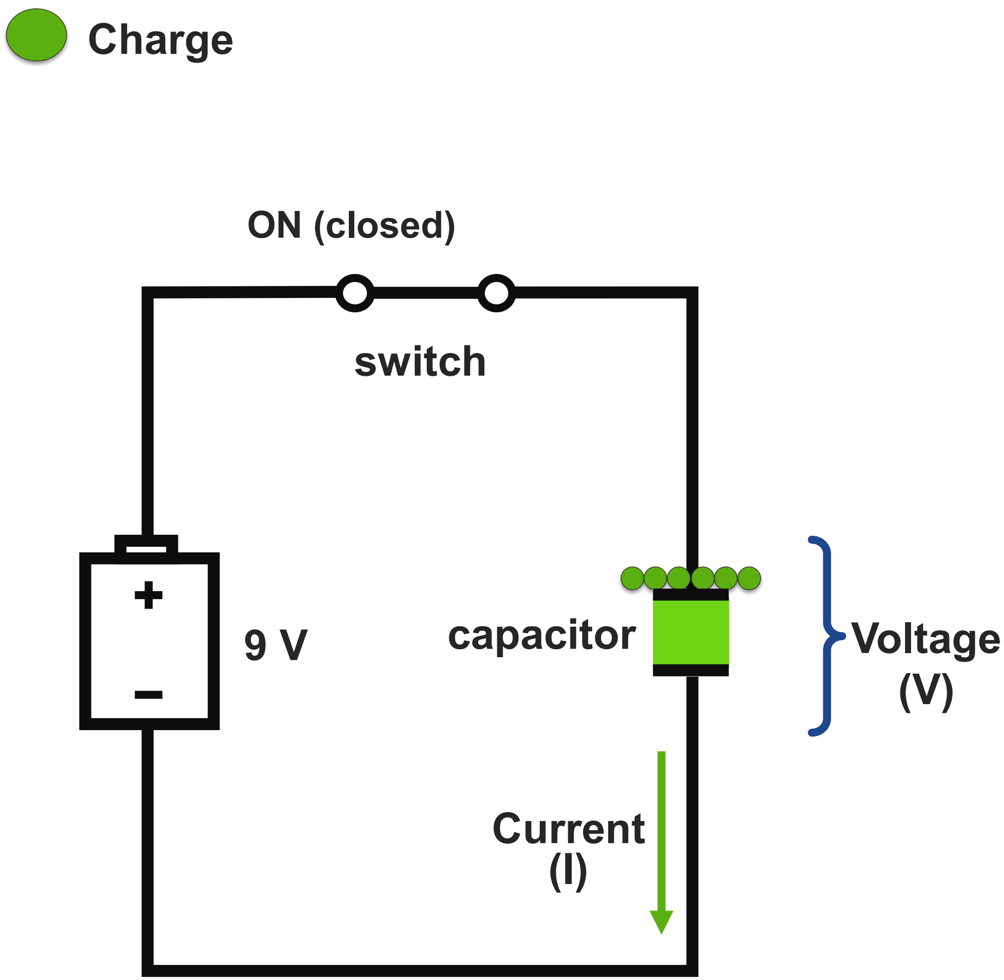
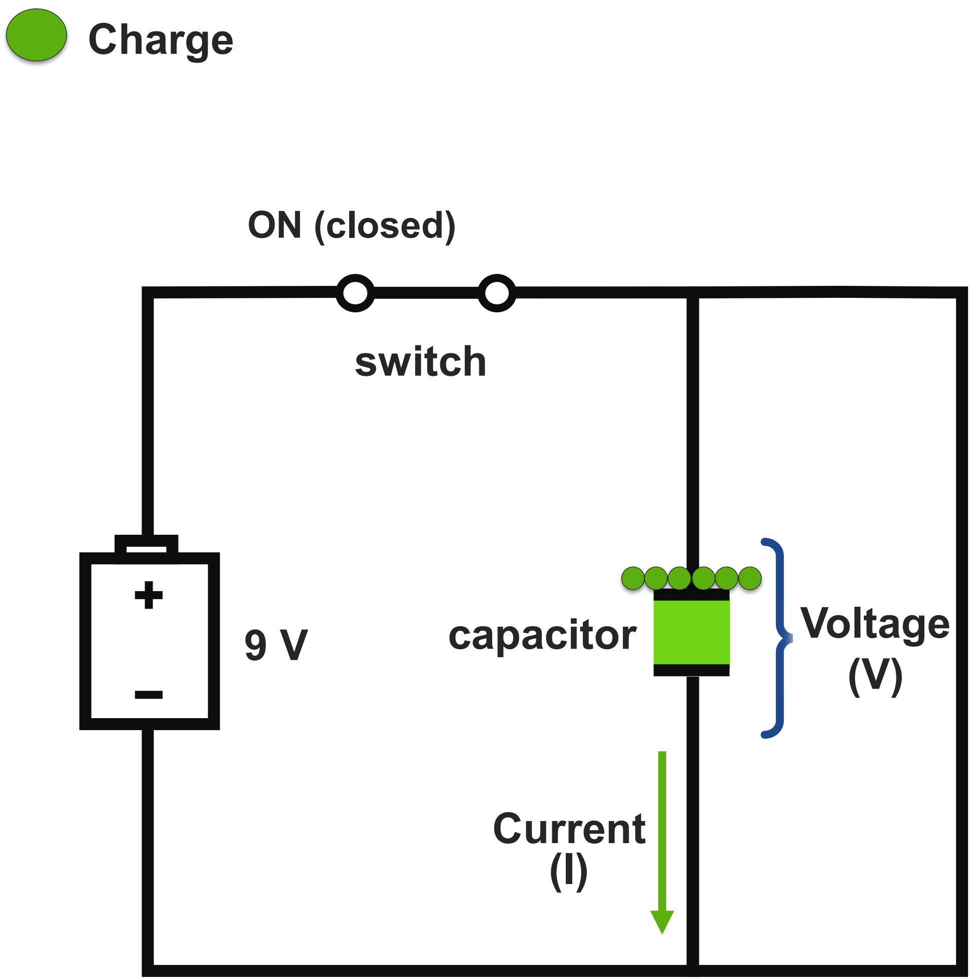
# Circuit Fundamentals




- **Capacitor**
  Component that collects charge
- **Voltage**
  - Difference in electrical potential between top and bottom plate
- **Charging**
  - Capacitor charges when the switch is closed
  - During charging current (charges) flows onto the plates of the capacitor

**When a capacitor collects charge, it is charging.**

# Circuit Fundamentals




- **Capacitor**
  Component that collects charge
- **Discharging**
  - Capacitor discharges when it is shorted

**When a capacitor loses charge, it is discharging.**

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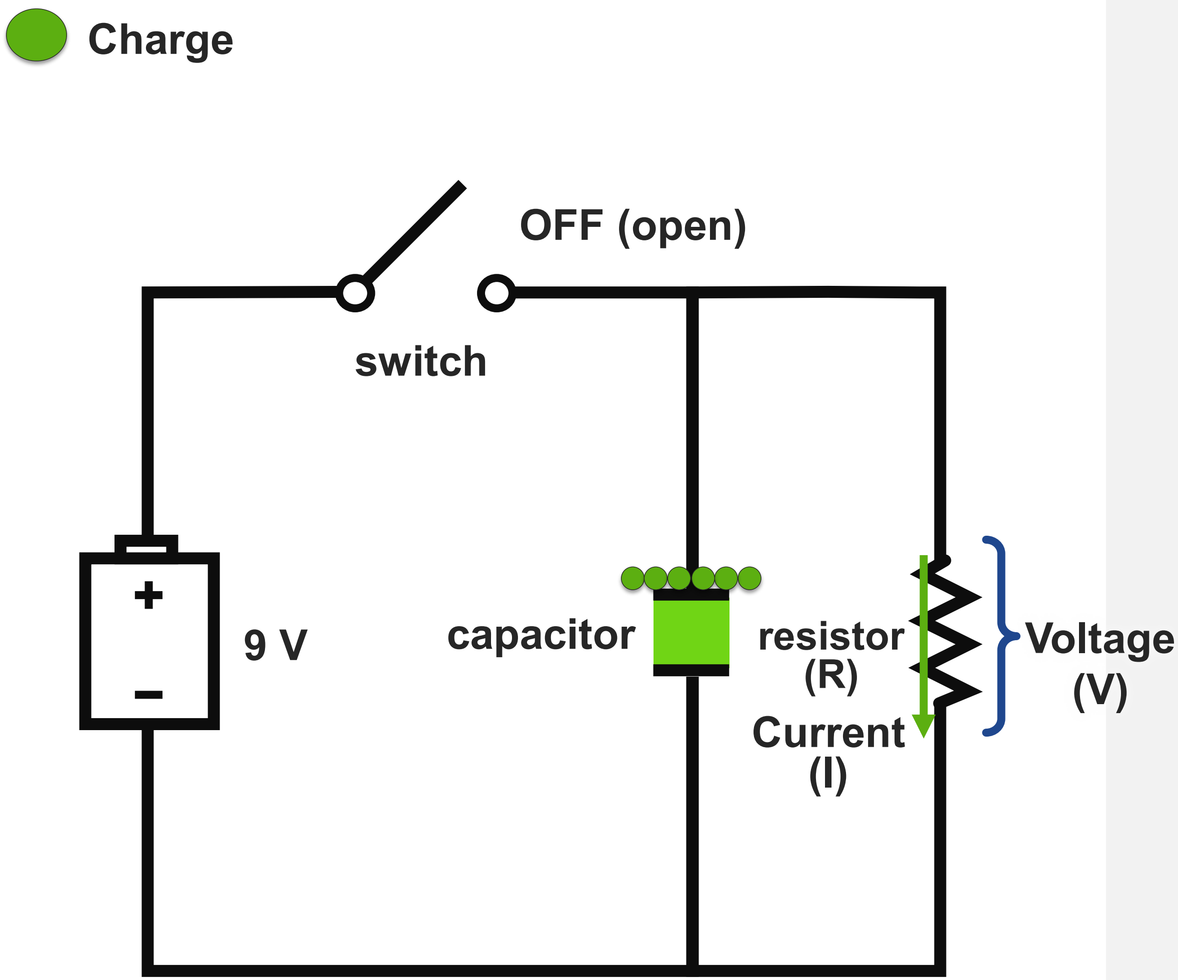
# Circuit Fundamentals




- **Discharging**
  - Capacitor discharges when the switch is open
  - Current flows out from the capacitor

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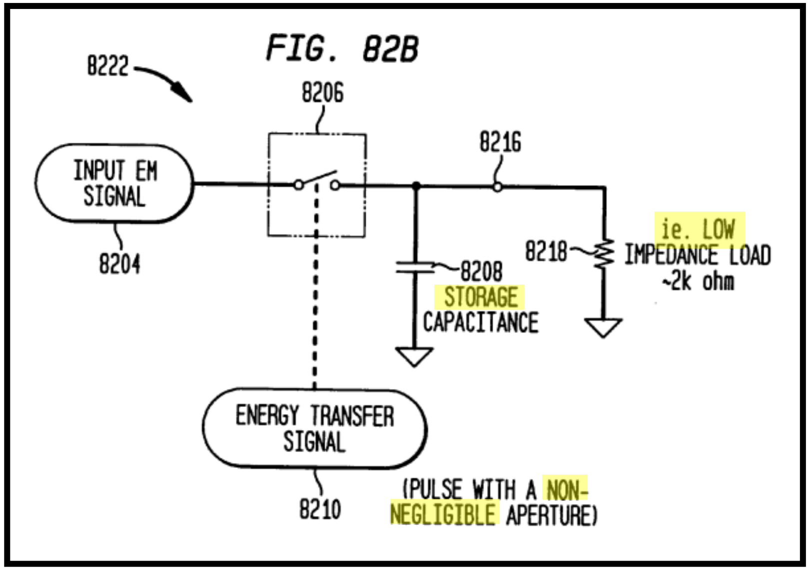
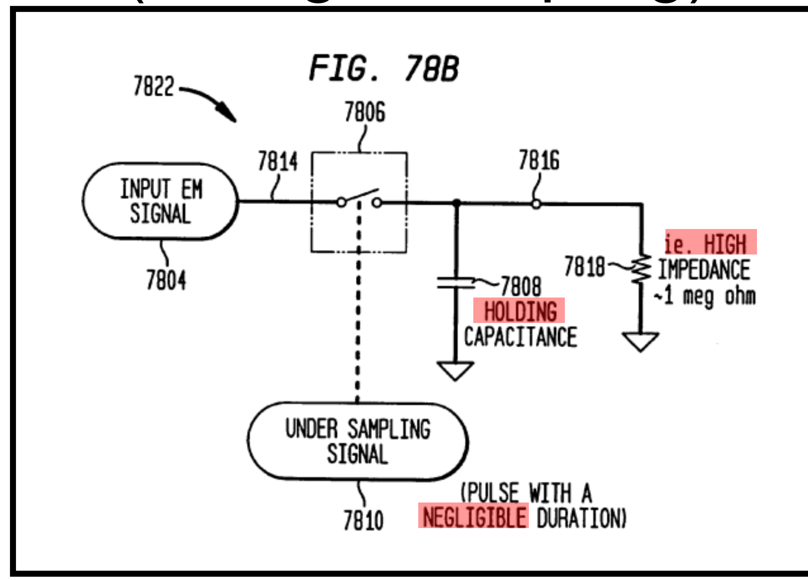
# Energy Sampling
# v.
# Voltage Sampling

# Energy Transfer (Energy Sampling)




# Sample and Hold (Voltage Sampling)



# Energy Transfer (Energy Sampling)

FIG. 82A

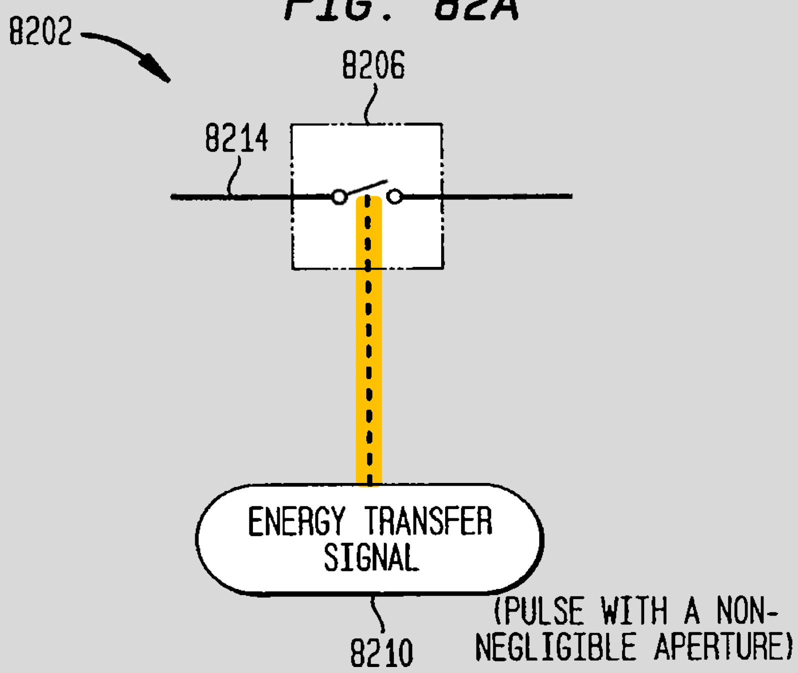



FIG. 57C

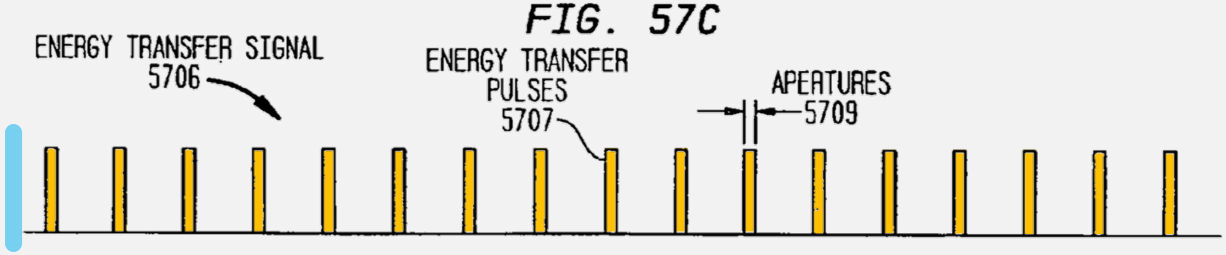


FIG. 82A

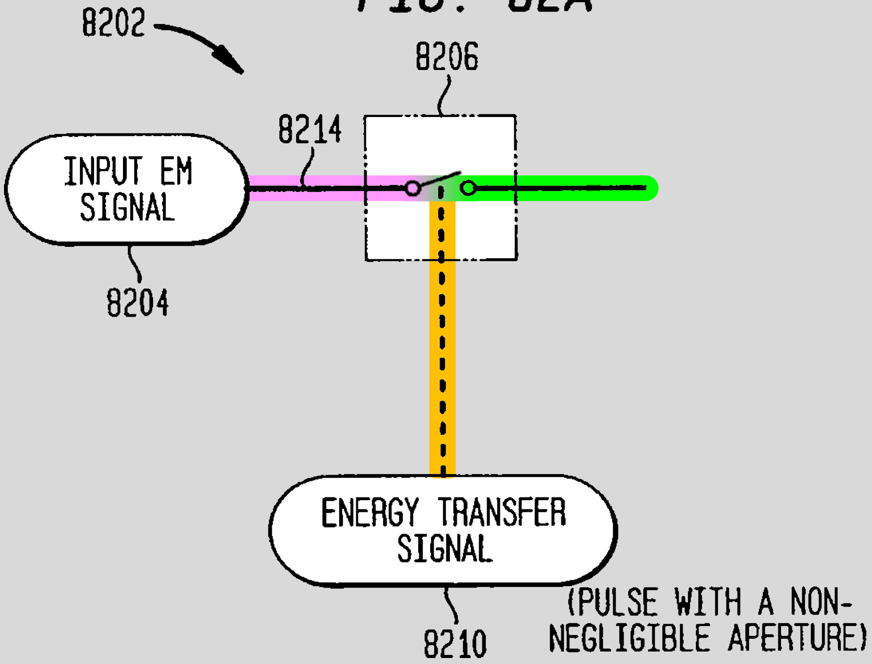
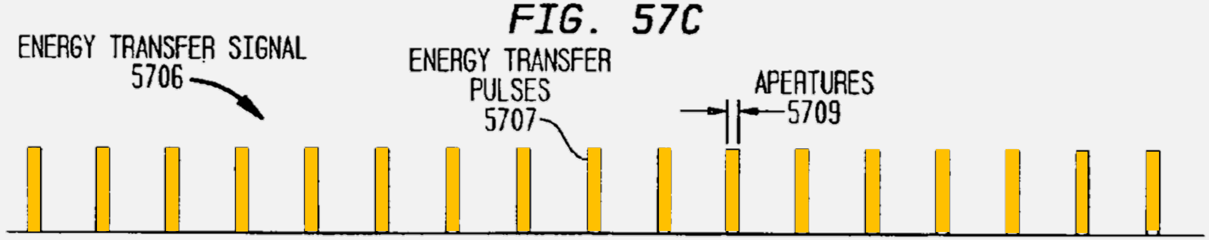



FIG. 57C



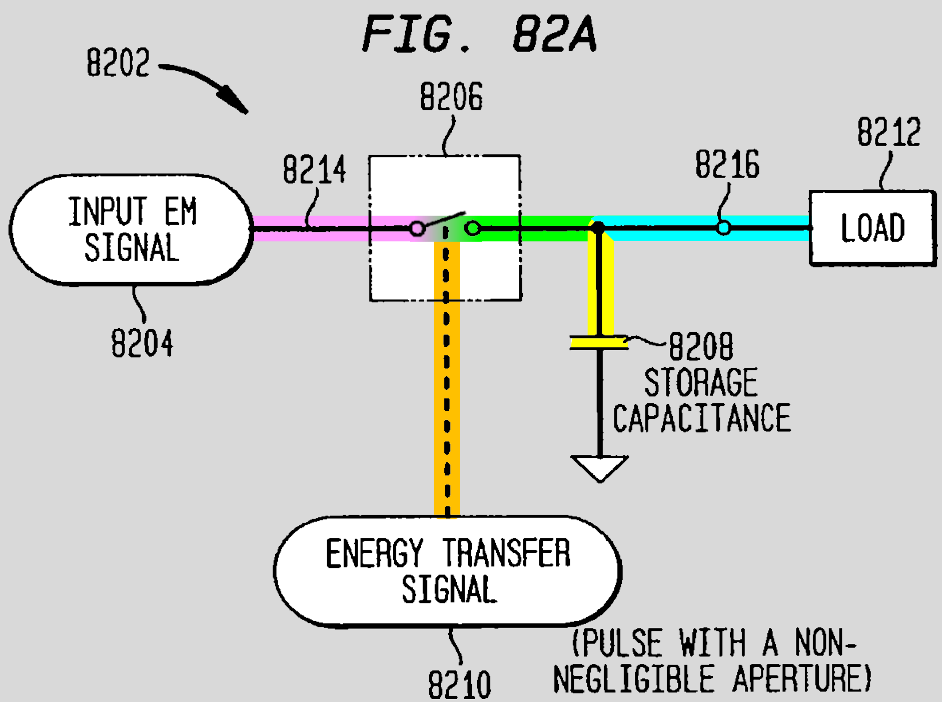


FIG. 82A
8202
8206
8214
8216
8212
INPUT EM SIGNAL
LOAD
8204
8208
STORAGE CAPACITANCE
ENERGY TRANSFER SIGNAL
8210
(PULSE WITH A NON-NEGLIGIBLE APERTURE)

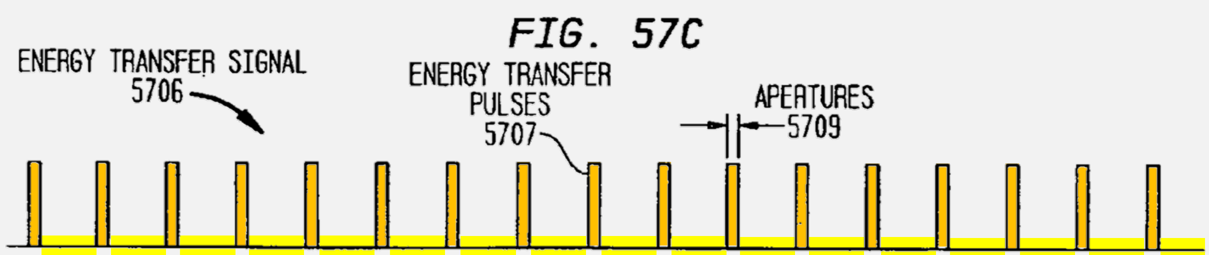


FIG. 57C
ENERGY TRANSFER SIGNAL 5706
ENERGY TRANSFER PULSES 5707
APERTURES 5709

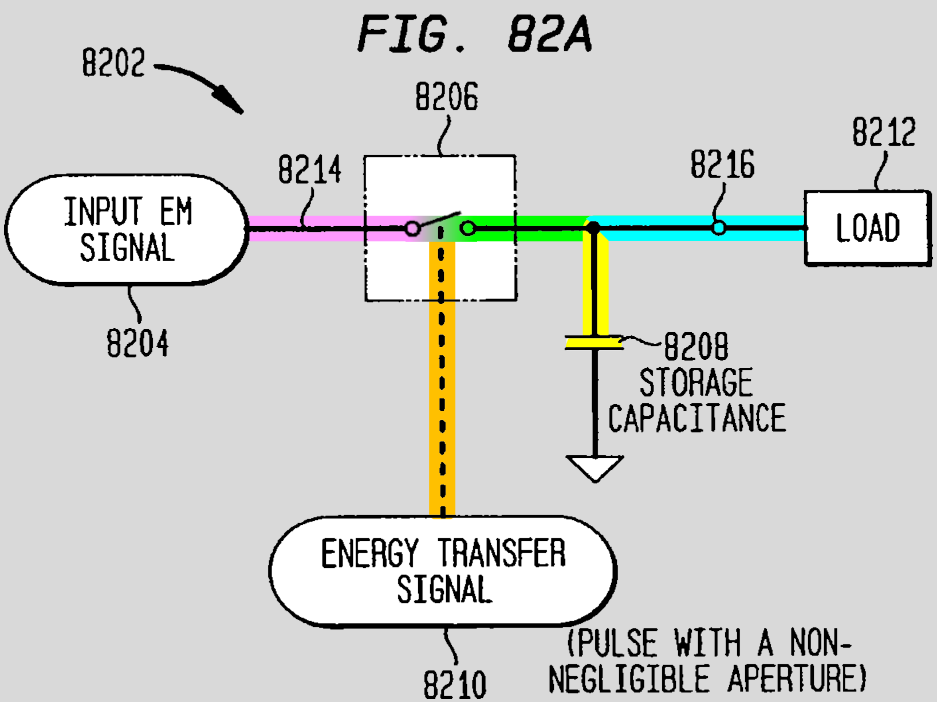


FIG. 82A
8202
8206
8214
8216
8212
INPUT EM SIGNAL
LOAD
8204
8208
STORAGE CAPACITANCE
ENERGY TRANSFER SIGNAL
8210
(PULSE WITH A NON-NEGLIGIBLE APERTURE)

## OUTPUT

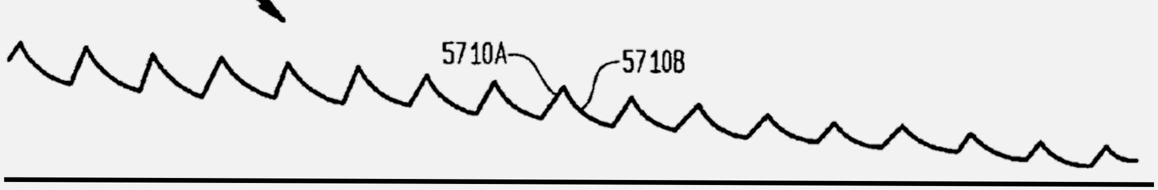


FIG. 57E
5712
5710A
5710B

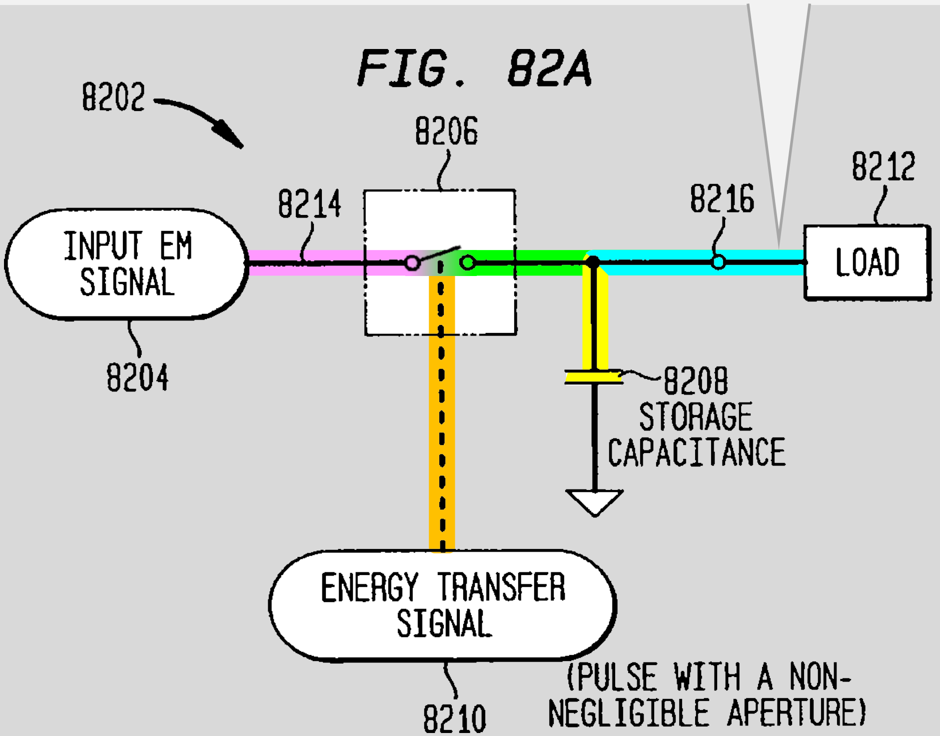


FIG. 82A
8202
8206
8214
8216
8212
INPUT EM SIGNAL
LOAD
8204
8208
STORAGE CAPACITANCE
ENERGY TRANSFER SIGNAL
8210
(PULSE WITH A NON-NEGLIGIBLE APERTURE)

FIG. 57E

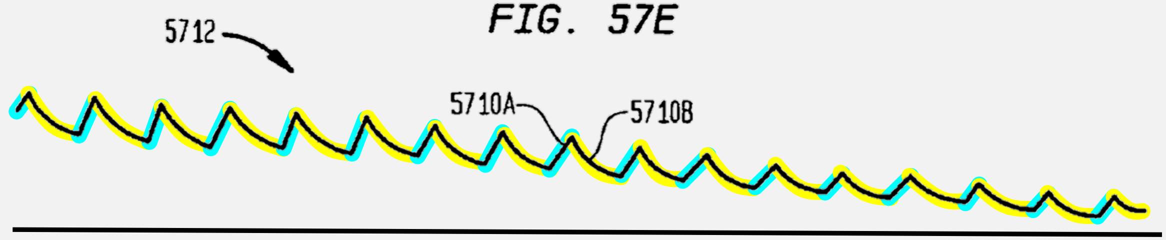
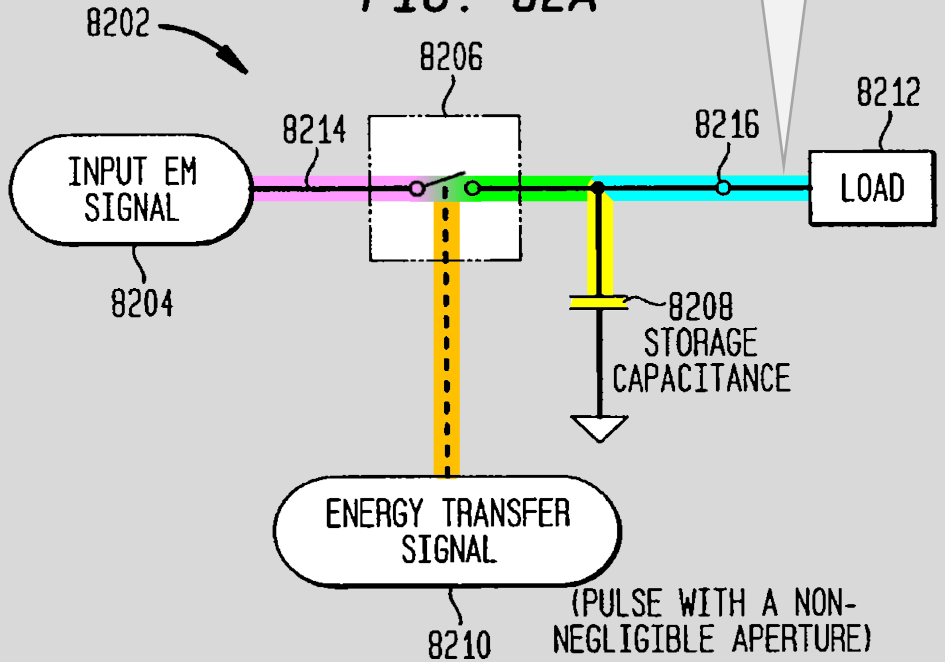



FIG. 82A



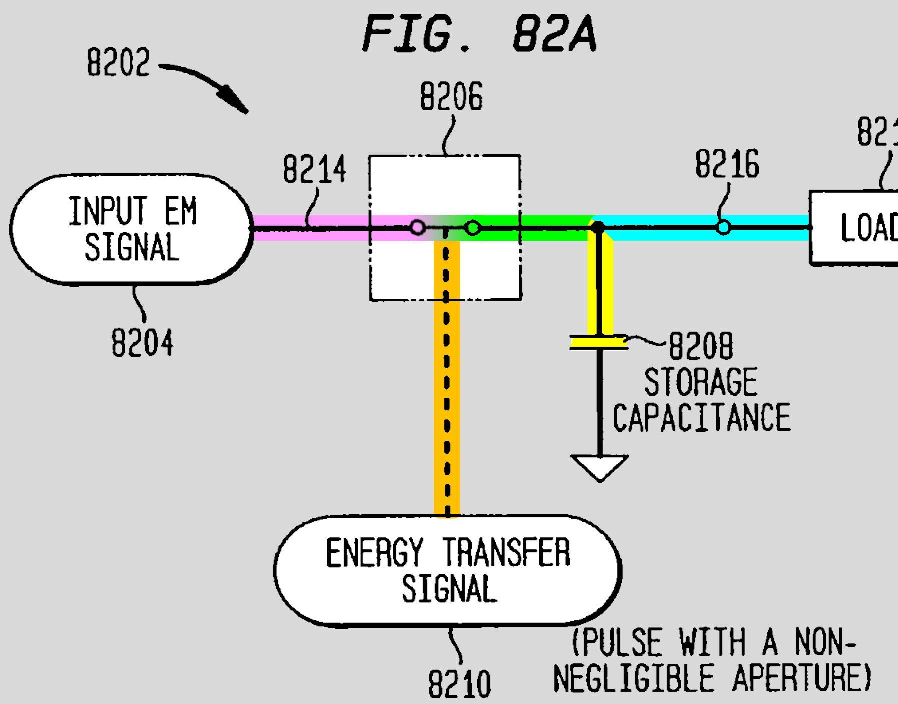


FIG. 82A
8202
8206
8214
8216
8212
INPUT EM SIGNAL
LOAD
8204
8208
STORAGE CAPACITANCE
ENERGY TRANSFER SIGNAL
8210
(PULSE WITH A NON-NEGLIGIBLE APERTURE)

# Sample and Hold (Voltage Sampling)

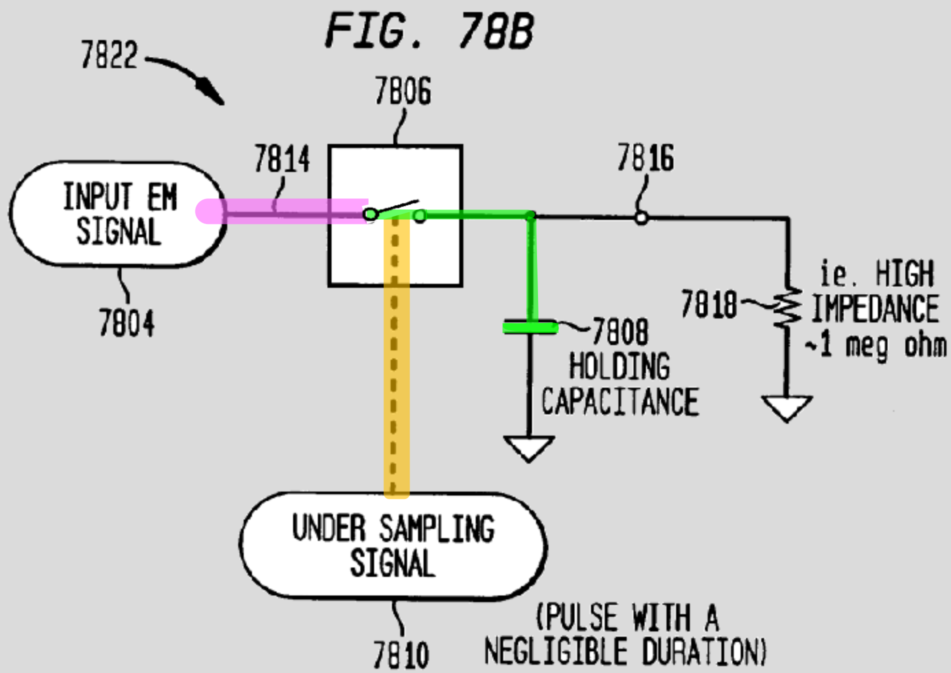
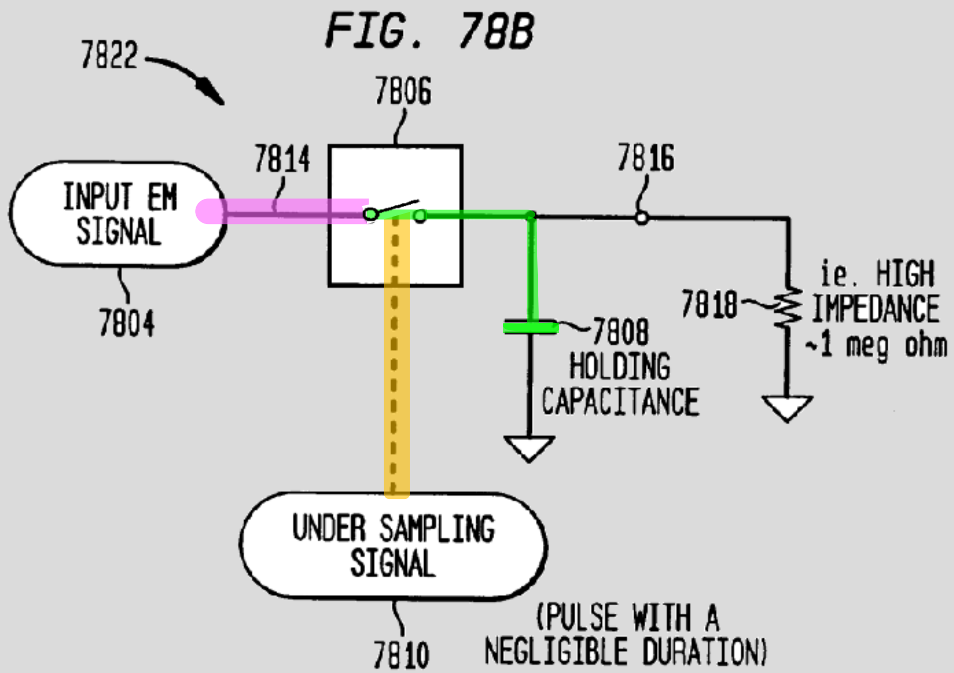


FIG. 78B
7822
7806
7814
7816
INPUT EM SIGNAL
7804
7818
ie. HIGH IMPEDANCE ~1 meg ohm
7808 HOLDING CAPACITANCE
UNDER SAMPLING SIGNAL
7810
(PULSE WITH A NEGLIGIBLE DURATION)

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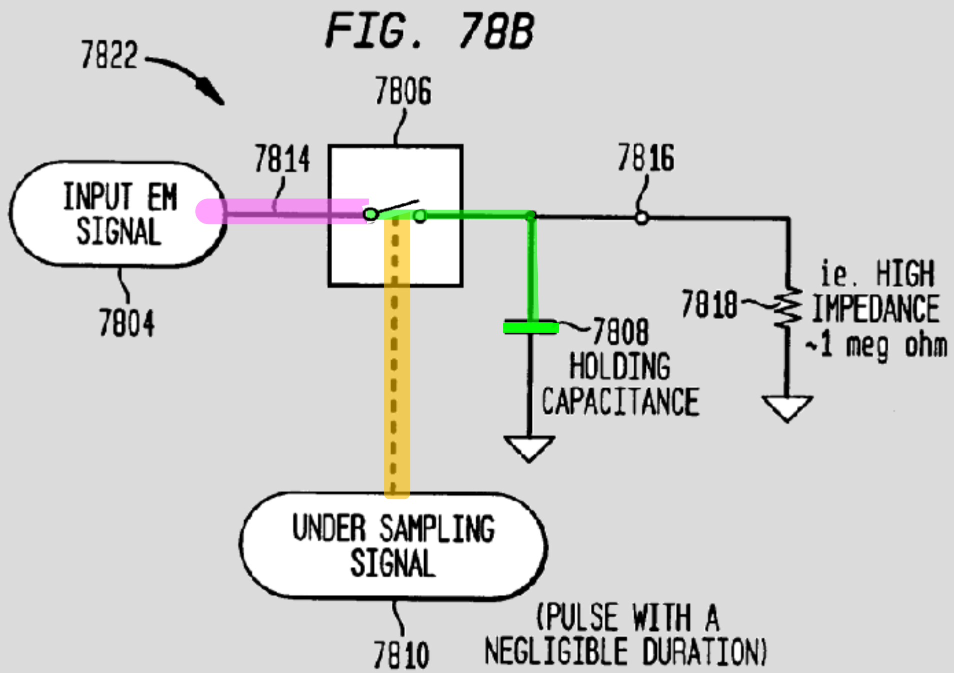
FIG. 78B
7822
7806
7814
7816
INPUT EM SIGNAL
7804
7818
ie. HIGH IMPEDANCE ~1 meg ohm
7808
HOLDING CAPACITANCE
UNDER SAMPLING SIGNAL
7810
(PULSE WITH A NEGLIGIBLE DURATION)

# Claim Construction

# “storage element”

| ParkerVision’s Construction | Petitioners’ Construction |
|---|---|
| “an element of an *energy transfer system* that stores non-negligible amounts of energy from an input electromagnetic signal” | “an element of a system that stores non-negligible amounts of energy from an input EM signal” |

# “storage element” – Court’s claim construction

To act as their own lexicographer, the patentees must “clearly set forth a definition of the disputed claim term,” and “‘clearly express an intent’ to [define] the term.” *Thorner*, 669 F.3d at 1365. The Court does not find that Defendant has shown that both elements are met here for at least the following reasons.

***First***, the Court does not believe that—even in isolation—that the last sentence rises to the “exacting standards” necessary for lexicography. *Hill-Rom Servs.*, 755 F.3d at 1371. For the reasons described in Section II, a POSITA would understand that a “storage capacitance” is just a generic capacitor (as is a holding capacitance); a POSITA would not understand that a storage (or holding) capacitance is a special or particular type of capacitor with unique features or functionality, *e.g.*, a capacitor that only stores or is only capable of storing “a non-negligible amount of energy from an input electromagnetic (EM) signal.” In addition, the last sentence’s use of the phrase “on the other hand” indicates that it is making a comparison and, as such, a POSITA would not only look to this sentence in isolation—or even this passage alone—to understand the meaning the of “storage module” or “storage capacitance.” Similarly, based on the words “refers to,” a POSITA would not only look to this sentence to understand the meaning of those terms.

Ex.-2040 at 16

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# "storage element" – Court's claim construction

the storage capacitance only stores a non-negligible amount of energy from an input EM signal. Therefore, based on last sentence in isolation, the Court does not find that the patentees "clearly set forth a definition" nor did they "clearly express an intent' to [define] the term." *Thorner*, 669 F.3d at 1365.

Ex.-2040 at 17

# “storage element” – Court’s claim construction

***Second***, the passage as a whole (’518 Patent at 66:11–23) supports the Court’s conclusion that the last sentence does not rise to the level of a lexicographical statement. This passage, when read in context, describes the operation of a capacitor in an energy transfer system (*i.e.*, the “storage capacitance” and “storage module”) as compared to the operation of the corresponding capacitor in a sample-and-hold system (*i.e.*, the “holding capacitance” and “holding module”). For example, the passage initially recites that the “storage module” and “storage capacitance” are components of an energy transfer system. The passage then recites “[t]he terms storage module and storage capacitance, as used herein, are distinguishable from the terms holding module and holding capacitance, respectively.” Based on these two sentences, a POSITA would understand that the remainder of the passage will compare a storage module / capacitance, which this passage describes as a component of an energy transfer system, with a holding module / capacitance (which

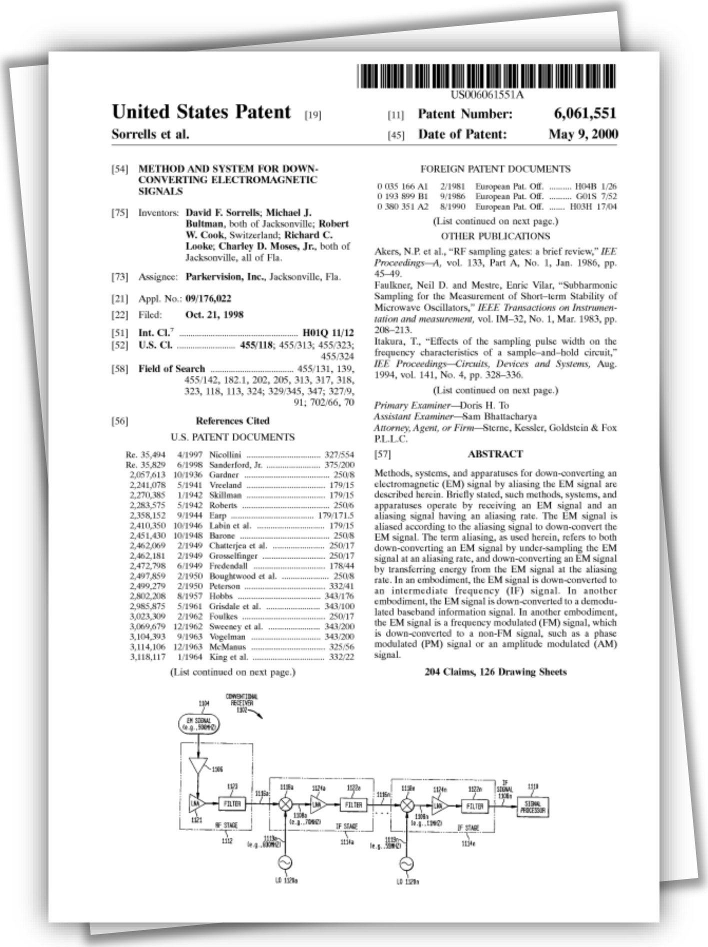
Ex.-2040 at 17

# “storage element” – Court’s claim construction

***Third***, the specification as a whole provides definitive confirmation that the patentees did not intend for the last sentence to be a lexicographical statement. For example, this passage appears within a sub-section entitled “0.1.2 Introduction to Energy Transfer.” ’518 Patent at 65:56. The previous sub-section is entitled “0.1.1 Review of Undersampling.” *Id.* at 62:62. Both of these sub-sections are within a section entitled “0.1 Energy Transfer Compared to Under-Sampling.” Therefore, based on the organization of the sub-sections, a POSITA would understand that this passage will compare a storage module / capacitance in the context of an energy transfer system with a holding module / capacitance in the context of a sample-and-hold system, and not that the passage is specifically defining that a storage module /capacitance is a generic capacitor that is capable of holding a non-negligible amount of charge. These comparisons further confirm the Court’s conclusion that the passage as a whole compares the capacitance in energy transfer and sample-and-hold systems. At minimum, this comparison casts serious doubt as to whether the patentees “‘clearly express an intent’ to [define] the term.” *Thorner*, 669 F.3d at 1365.

Ex.-2040 at 18

# "storage element"



US006061551A

United States Patent [19]
Sorrells et al.

[11] Patent Number: 6,061,551
[45] Date of Patent: May 9, 2000

[54] METHOD AND SYSTEM FOR DOWN-CONVERTING ELECTROMAGNETIC SIGNALS

[75] Inventors: **David F. Sorrells**; **Michael J. Bultman**, both of Jacksonville; **Robert W. Cook**, Switzerland; **Richard C. Looke**; **Charley D. Moses, Jr.**, both of Jacksonville, all of Fla.

[73] Assignee: **Parkervision, Inc.**, Jacksonville, Fla.

[21] Appl. No.: **09/176,022**

[22] Filed: **Oct. 21, 1998**

[51] **Int. Cl.**[7] .................... **H01Q 11/12**

[52] **U.S. Cl.** .................... **455/118**; 455/313; 455/323; 455/324

[58] **Field of Search** .................... 455/131, 139, 455/142, 182.1, 202, 205, 313, 317, 318, 323, 118, 113, 324; 329/345, 347; 327/9, 91; 702/66, 70

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| 0 380 351 A2 | 8/1990 | European Pat. Off. | H03H 17/04 |

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Faulkner, Neil D. and Mestre, Enric Vilar, "Subharmonic Sampling for the Measurement of Short–term Stability of Microwave Oscillators," *IEEE Transactions on Instrumentation and measurement*, vol. IM–32, No. 1, Mar. 1983, pp. 208–213.
Itakura, T., "Effects of the sampling pulse width on the frequency characteristics of a sample–and–hold circuit," *IEE Proceedings—Circuits, Devices and Systems*, Aug. 1994, vol. 141, No. 4, pp. 328–336.

(List continued on next page.)

*Primary Examiner*—Doris H. To
*Assistant Examiner*—Sam Bhattacharya
*Attorney, Agent, or Firm*—Sterne, Kessler, Goldstein & Fox P.L.L.C.

[57] **ABSTRACT**

Methods, systems, and apparatuses for down-converting an electromagnetic (EM) signal by aliasing the EM signal are described herein. Briefly stated, such methods, systems, and apparatuses operate by receiving an EM signal and an aliasing signal having an aliasing rate. The EM signal is aliased according to the aliasing signal to down-convert the EM signal. The term aliasing, as used herein, refers to both down-converting an EM signal by under-sampling the EM signal at an aliasing rate, and down-converting an EM signal by transferring energy from the EM signal at the aliasing rate. 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 demodulated 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.

**204 Claims, 126 Drawing Sheets**

## 0.1.2 Introduction to Energy Transfer

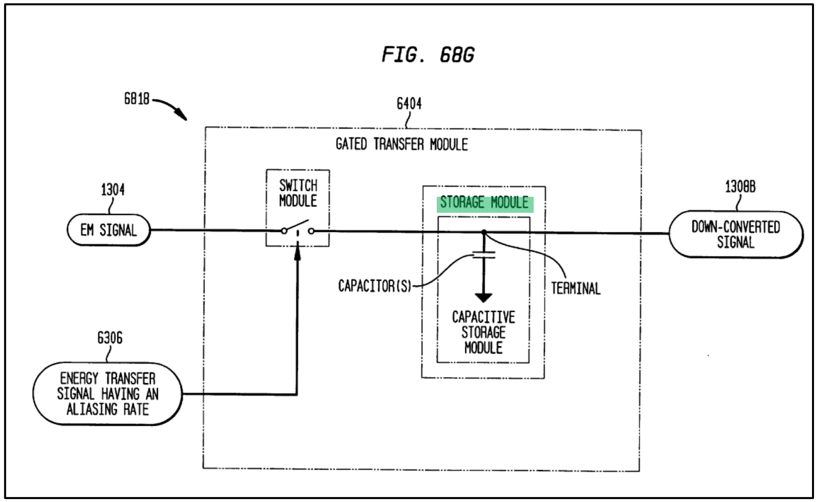
Exhibit 2029 ('551 patent), 66:33

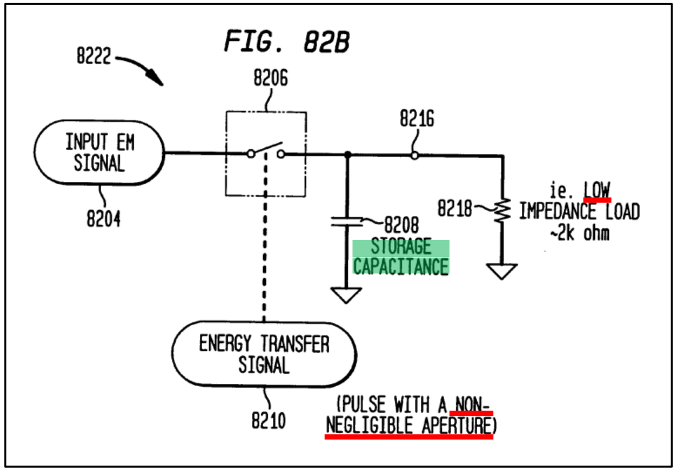
FIG. **82A** illustrates an exemplary energy transfer system **8202** for down-converting an input EM signal **8204**. The energy transfer system **8202** includes a switching module **8206** and a storage module illustrated as a storage capacitance **8208**. The terms storage module and storage capacitance, 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.

Exhibit 2029 ('551 patent), 66:55-67

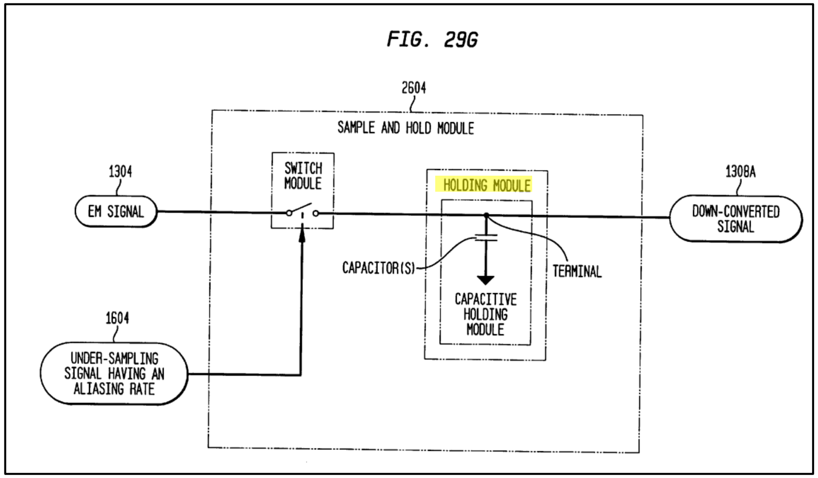
# “storage element”

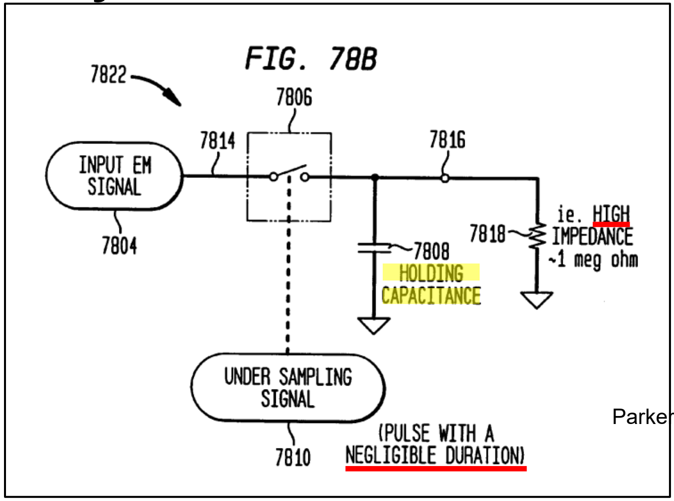
## Energy transfer systems




## Sample and hold systems

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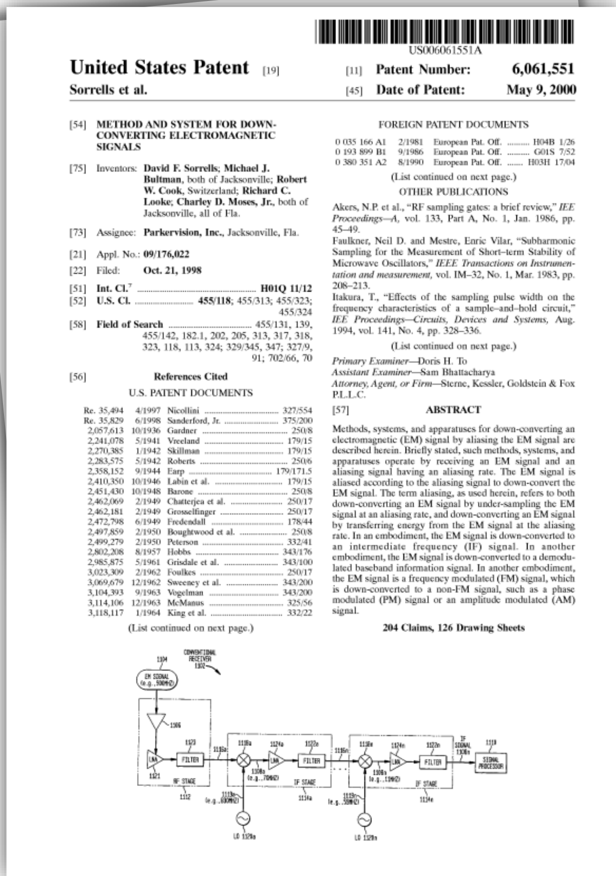
Page 43 of 79

# “storage element”



US006061551A

**United States Patent** [19]

**Sorrells et al.**

[11] **Patent Number:** **6,061,551**

[45] **Date of Patent:** **May 9, 2000**

[54] **METHOD AND SYSTEM FOR DOWN-CONVERTING ELECTROMAGNETIC SIGNALS**

[75] Inventors: **David F. Sorrells**; **Michael J. Bultman**, both of Jacksonville; **Robert W. Cook**, Switzerland; **Richard C. Looke**; **Charley D. Moses, Jr.**, both of Jacksonville, all of Fla.

[73] Assignee: **Parkervision, Inc.**, Jacksonville, Fla.

[21] Appl. No.: **09/176,022**

[22] Filed: **Oct. 21, 1998**

[51] **Int. Cl.**[7] ........ **H01Q 11/12**

[52] **U.S. Cl.** ........ **455/118**; 455/313; 455/323; 455/324

[58] **Field of Search** ........ 455/131, 139, 455/142, 182.1, 202, 205, 313, 317, 318, 323, 118, 113, 324; 329/345, 347; 327/9, 91; 702/66, 70

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| 2,241,078 | 5/1941 | Vreeland | 179/15 |
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| 2,451,430 | 10/1948 | Barone | 250/8 |
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| 2,462,181 | 2/1949 | Grosselfinger | 250/17 |
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*Primary Examiner*—Doris H. To
*Assistant Examiner*—Sam Bhattacharya
*Attorney, Agent, or Firm*—Sterne, Kessler, Goldstein & Fox P.L.L.C.

[57] **ABSTRACT**

Methods, systems, and apparatuses for down-converting an electromagnetic (EM) signal by aliasing the EM signal are described herein. Briefly stated, such methods, systems, and apparatuses operate by receiving an EM signal and an aliasing signal having an aliasing rate. The EM signal is aliased according to the aliasing signal to down-convert the EM signal. The term aliasing, as used herein, refers to both down-converting an EM signal by under-sampling the EM signal at an aliasing rate, and down-converting an EM signal by transferring energy from the EM signal at the aliasing rate. 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 demodulated 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.

**204 Claims, 126 Drawing Sheets**

is relatively significant. Another benefit of the energy transfer system **8202** is that the non-negligible amounts of transferred energy permit the energy transfer system **8202** to effectively drive loads that would otherwise be classified as low impedance loads in under-sampling systems and conventional sampling systems. In other words, the non-negligible amounts of transferred energy ensure that, even for lower impedance loads, the storage capacitance **8208** accepts and maintains sufficient energy or charge to drive the load **8202**. This is illustrated below in the timing diagrams

Exhibit 2029 (’551 patent), 67:37-46

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# “storage element”

United States Patent [19]
Sorrells et al.

US006061551A

[11] Patent Number: 6,061,551
[45] Date of Patent: May 9, 2000

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*Assistant Examiner*—Sam Bhattacharya
*Attorney, Agent, or Firm*—Sterne, Kessler, Goldstein & Fox P.L.L.C.

[57] **ABSTRACT**

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**204 Claims, 126 Drawing Sheets**

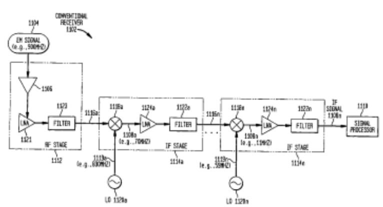

FIG. **82A** illustrates an exemplary energy transfer system **8202** for down-converting an input EM signal **8204**. The energy transfer system **8202** includes a switching module **8206** and a storage module illustrated as a storage capacitance **8208**. The terms storage module and storage capacitance, 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.

Ex.-2029, 66:55-67

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# ’444 Patent, Claim 3

3. A wireless modem apparatus, comprising:

a receiver for frequency down-converting an input signal including,

a first frequency down-conversion module to down-convert the input signal, wherein said first frequency down-conversion module down-converts said input signal according to a first control signal and outputs a first down-converted signal;

a second frequency down-conversion module to down-convert said input signal, wherein said second frequency down-conversion module down-converts said input signal according to a second control signal and outputs a second down-converted signal; and

a subtractor module that subtracts said second down-converted signal from said first down-converted signal and outputs a down-converted signal;

wherein said first and said second frequency down-conversion modules each comprise a switch and a storage element.

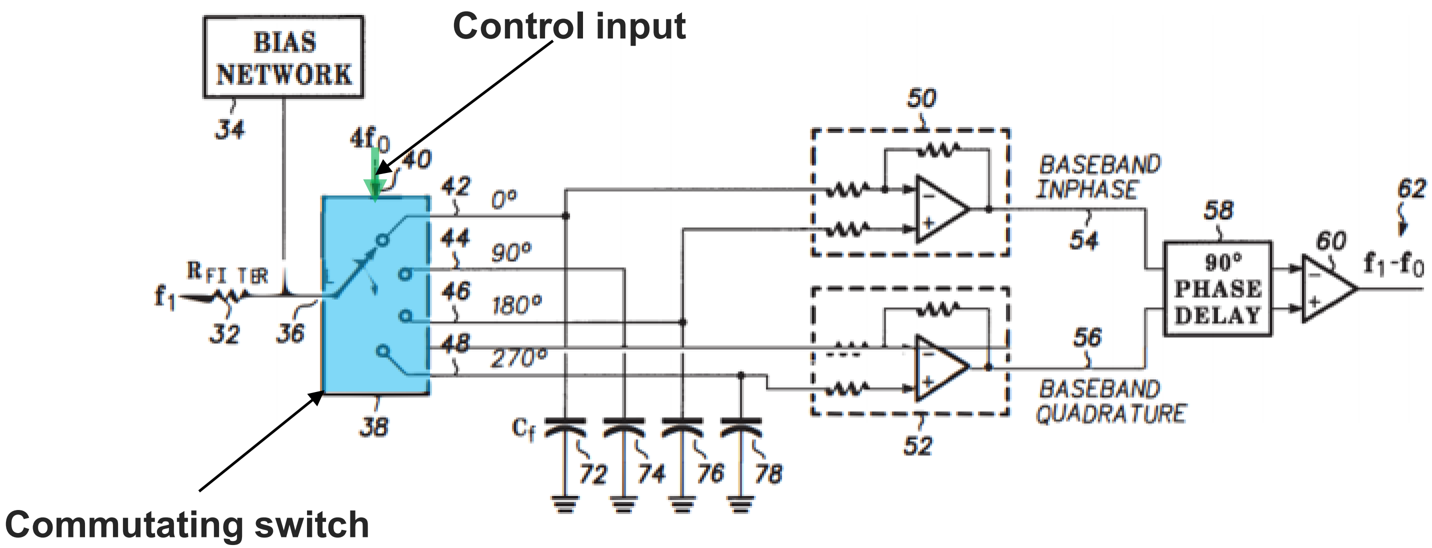
# ’444 Patent, Claim 4

4. The apparatus of claim 3, wherein said storage elements comprises a capacitor that reduces a DC offset voltage in said first down-converted signal and said second down-converted signal.

# Tayloe

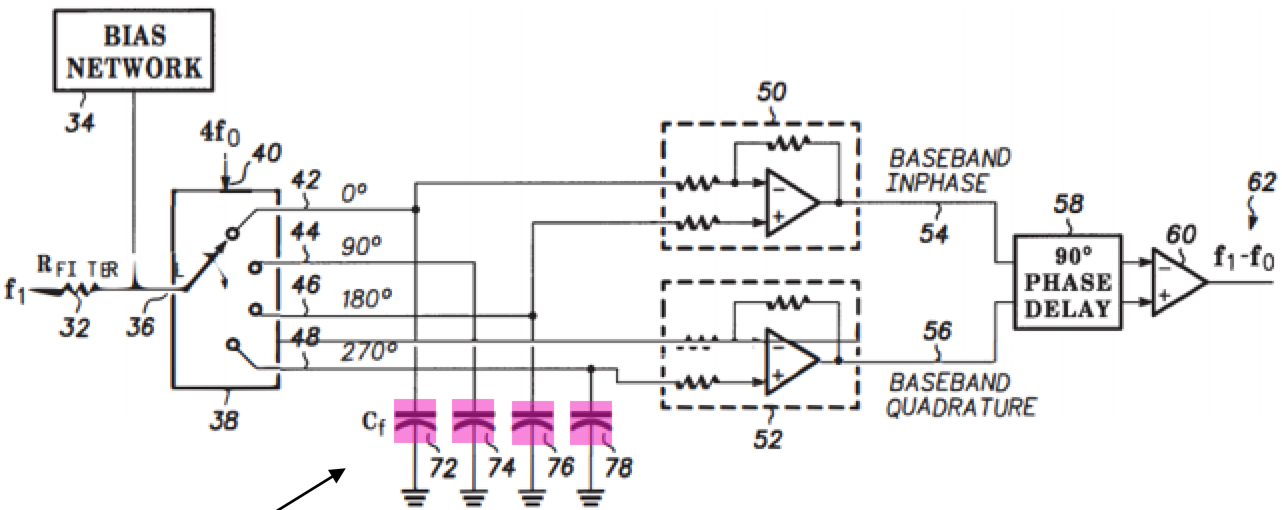
(U.S. Patent No. 6,230,000)

# Tayloe




30 FIG. 3

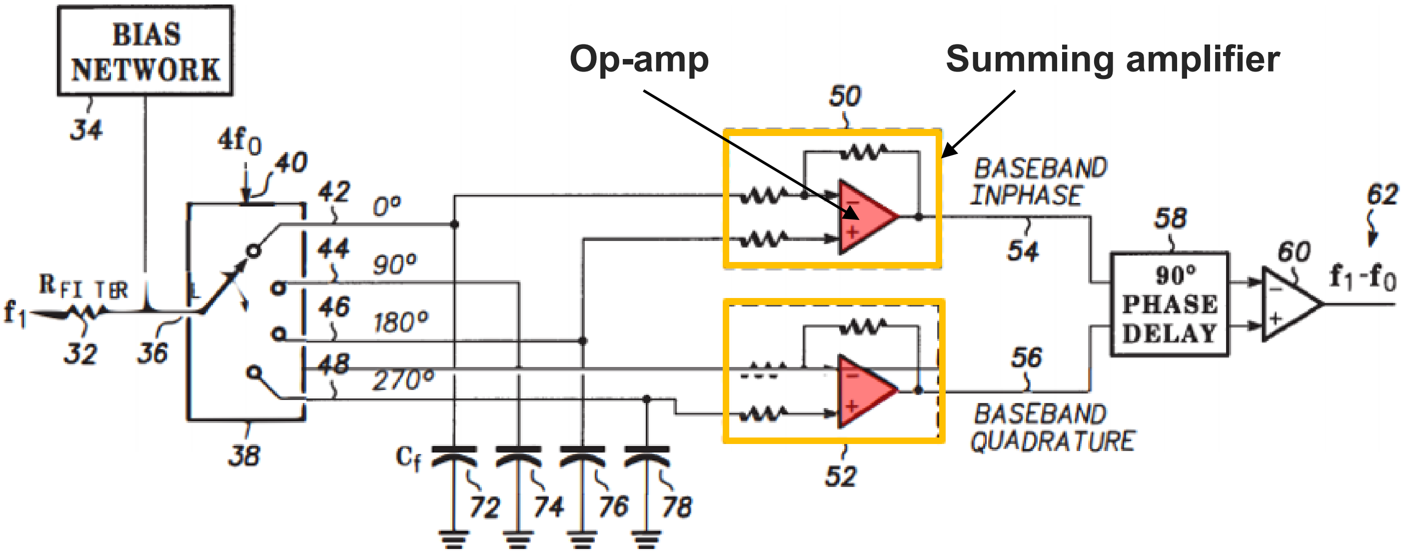
# Tayloe




Capacitors

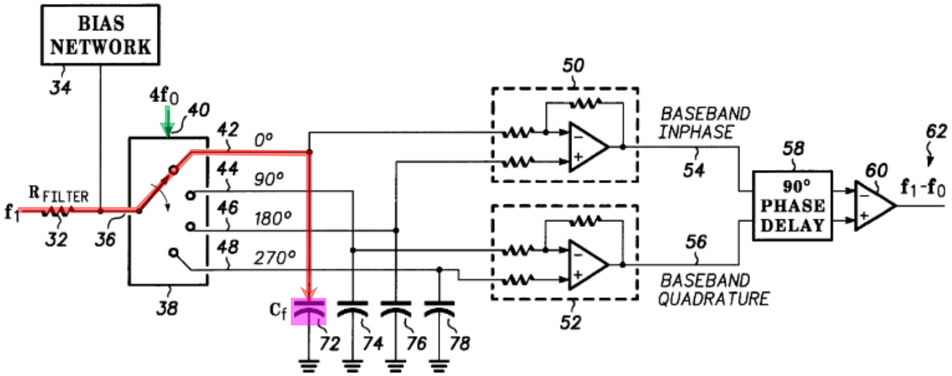
30 FIG. 3

# Tayloe




30 *FIG. 3*

# Tayloe




30 FIG. 3

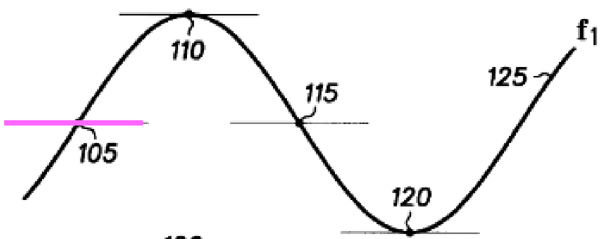



FIG. 4 100

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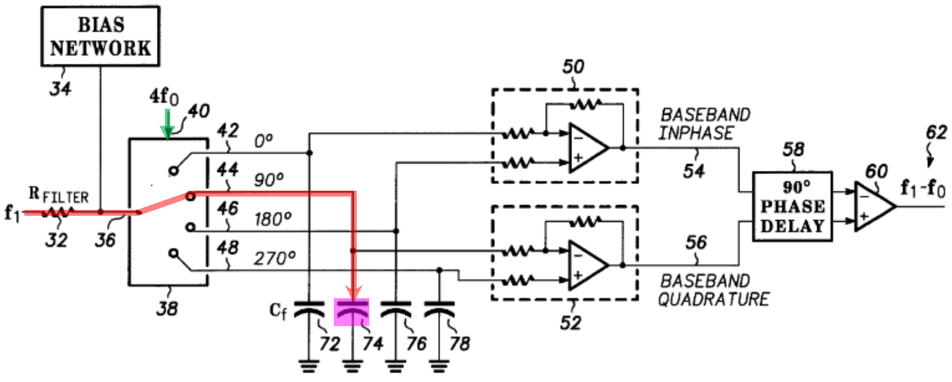
# Tayloe




30 *FIG. 3*

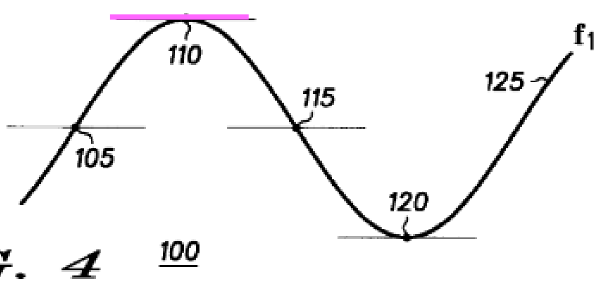



*FIG. 4*

ParkerVision Ex. 2041
IPR2021-00990
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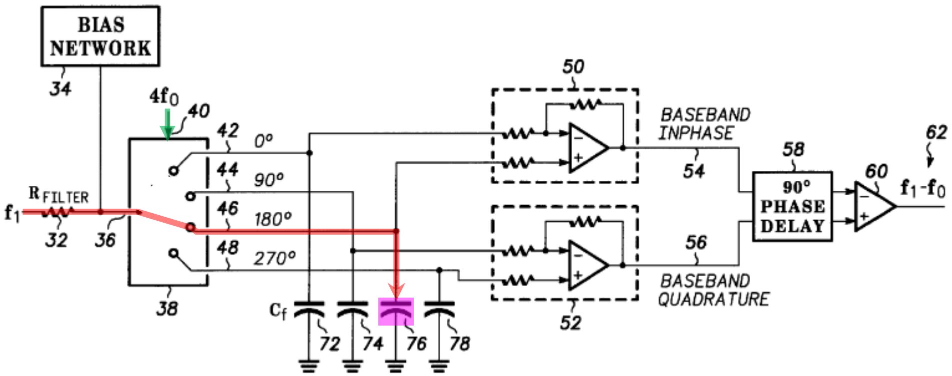
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# Tayloe




30 FIG. 3

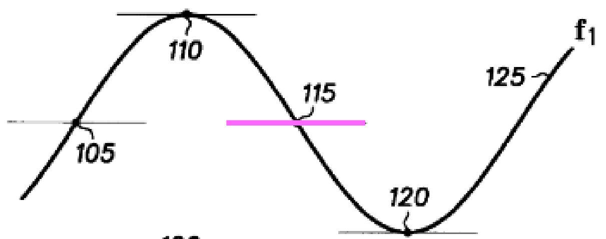
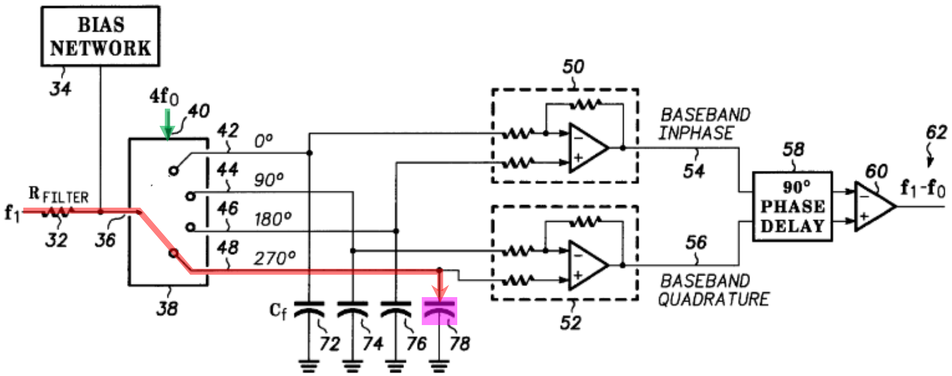



FIG. 4 100

# Tayloe




30 FIG. 3

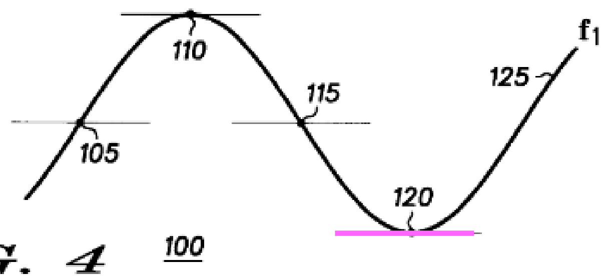



FIG. 4

# Tayloe Does Not Disclose "Storage Elements"

| ParkerVision's/Texas District Court's Construction |
| --- |
| "an element of an *energy transfer system* that stores *non-negligible amounts of energy* from an input electromagnetic signal" |

- Tayloe does not disclose an energy transfer system
- The capacitors in Tayloe do not store non-negligible amounts of energy

# Tayloe Is Not An Energy Transfer System

# Tayloe

(12) **United States Patent**
**Tayloe**

US006230000B1

(10) **Patent No.: US 6,230,000 B1**
(45) **Date of Patent: May 8, 2001**

(54) **PRODUCT DETECTOR AND METHOD THEREFOR**

(75) Inventor: **Daniel Richard Tayloe**, Phoenix, AZ (US)

(73) Assignee: **Motorola Inc.**, Schaumburg, IL (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.

(21) Appl. No.: **09/173,030**

(22) Filed: **Oct. 15, 1998**

(51) **Int. Cl.**[7] ..... **H04B 1/26**; H04B 1/00

(52) **U.S. Cl.** ..... **455/323**; 455/303; 455/304; 455/313

(58) **Field of Search** ..... 455/302, 303, 455/304, 324, 338, 339, 313, 318, 323; 375/323, 329, 332; 327/113, 45; 329/304

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Aritcle entitled "High-Performance, Single-Signal Direct-Conversion Receivers" by Rick Campbell —QST Magazine (Jan. 1993).

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*Primary Examiner*—Dwayne Bost
*Assistant Examiner*—Raymond B. Persino
(74) *Attorney, Agent, or Firm*—Dana B. LeMoine; Timothy J. Lorenz; Frank J. Bogacz

(57) **ABSTRACT**


A product detector for converting a signal to baseband includes a commutating switch which serves to sample an RF waveform four times per period at the RF frequency. The samples are integrated over time to produce an average voltage at 0 degrees, 90 degrees, 180 degrees and 270 degrees. The average voltage at 0 degrees is the baseband in-phase signal, and the average voltage at 90 degrees is the baseband quadrature signal. Alternatively, to increase gain, the 0 degree average can be differentially summed with the 180 degree average to form the baseband in-phase signal, and the 90 degree average can be differentially summed with the 270 degree average to produce the baseband quadrature signal.


**14 Claims, 3 Drawing Sheets**

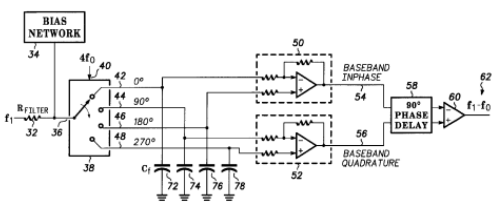


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Exhibit 1004 (Tayloe), Abstract

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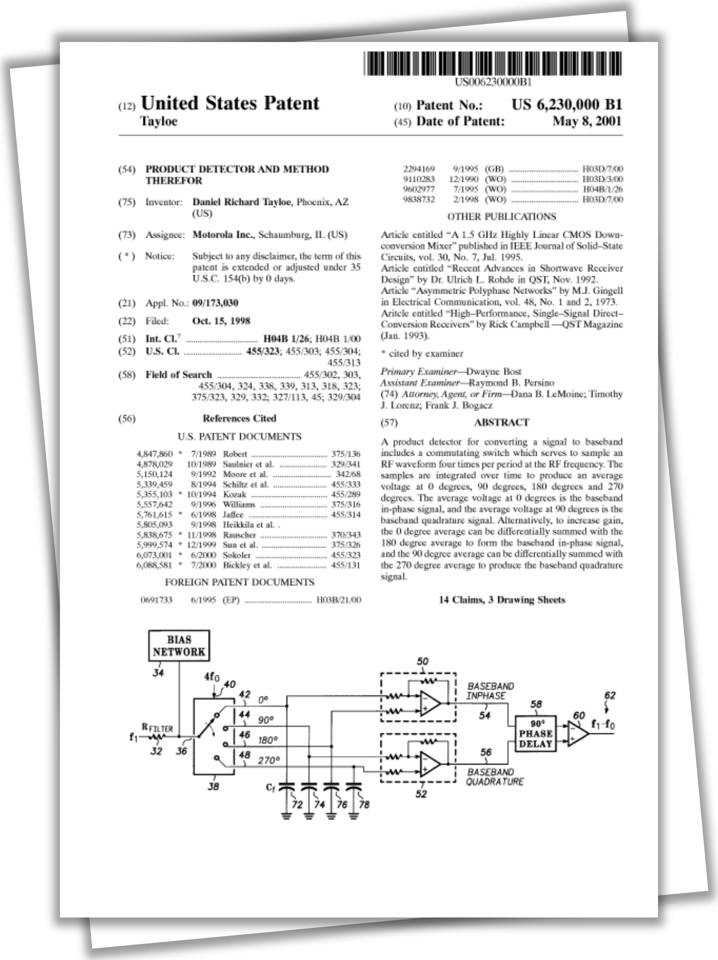
# Tayloe



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(74) *Attorney, Agent, or Firm*—Dana B. LeMoine; Timothy J. Lorenz; Frank J. Bogacz

(57) **ABSTRACT**

A product detector for converting a signal to baseband includes a commutating switch which serves to sample an RF waveform four times per period at the RF frequency. The samples are integrated over time to produce an average voltage at 0 degrees, 90 degrees, 180 degrees and 270 degrees. The average voltage at 0 degrees is the baseband in-phase signal, and the average voltage at 90 degrees is the baseband quadrature signal. Alternatively, to increase gain, the 0 degree average can be differentially summed with the 180 degree average to form the baseband in-phase signal, and the 90 degree average can be differentially summed with the 270 degree average to produce the baseband quadrature signal.

**14 Claims, 3 Drawing Sheets**



FIG. **4** shows a waveform in accordance with a preferred embodiment of the present invention. Waveform **100** includes signal **125** which corresponds to the input signal $f_1$. Superimposed on signal **125** are points **105**, **110**, **115**, and **120**. Point **105** represents the voltage to which capacitor **72** (FIG. **3**) charges. Likewise, point **110** represents the voltage to which capacitor **74** charges, point **115** represents the voltage to which capacitor **76** charges, and point **120** represents the voltage to which capacitor **78** charges. One skilled in the art will understand that if $f_1$ is a carrier signal with no information signal superimposed, and the carrier signal frequency is exactly equal to $f_0$, four evenly spaced samples of $f_1$ will continuously be taken by the action of the Tayloe Product Detector, and the voltages represented by points **105**, **110**, **115**, and **120** will be stationary. Stationary voltages on the integrating capacitors **72–78** represent no signal of interest at baseband.

Exhibit 1004 (Tayloe), 3:40-56

# Tayloe

US006230000B1

(12) **United States Patent**
**Tayloe**

(10) **Patent No.:** **US 6,230,000 B1**
(45) **Date of Patent:** **May 8, 2001**

(54) **PRODUCT DETECTOR AND METHOD THEREFOR**

(75) Inventor: **Daniel Richard Tayloe**, Phoenix, AZ (US)

(73) Assignee: **Motorola Inc.**, Schaumburg, IL (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.

(21) Appl. No.: **09/173,030**

(22) Filed: **Oct. 15, 1998**

(51) **Int. Cl.**[7] ............ **H04B 1/26**; H04B 1/00

(52) **U.S. Cl.** ............ **455/323**; 455/303; 455/304; 455/313

(58) **Field of Search** ............ 455/302, 303, 455/304, 324, 338, 339, 313, 318, 323; 375/323, 329, 332; 327/113, 45; 329/304

(56) **References Cited**


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4,847,860 * 7/1989 Robert ............ 375/136
4,878,029 10/1989 Saulnier et al. ............ 329/341
5,150,124 9/1992 Moore et al. ............ 342/68
5,339,459 8/1994 Schiltz et al. ............ 455/333
5,355,103 * 10/1994 Kozak ............ 455/289
5,557,642 9/1996 Williams ............ 375/316
5,761,615 * 6/1998 Jaffee ............ 455/314
5,805,093 9/1998 Heikkila et al. .
5,838,675 * 11/1998 Rauscher ............ 370/343
5,999,574 * 12/1999 Sun et al. ............ 375/326
6,073,001 * 6/2000 Sokoler ............ 455/323
6,088,581 * 7/2000 Bickley et al. ............ 455/131

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2294169 9/1995 (GB) ............ H03D/7/00
9110283 12/1990 (WO) ............ H03D/3/00
9602977 7/1995 (WO) ............ H04B/1/26
9838732 2/1998 (WO) ............ H03D/7/00

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Article entitled "Recent Advances in Shortwave Receiver Design" by Dr. Ulrich L. Rohde in QST, Nov. 1992.
Article "Asymmetric Polyphase Networks" by M.J. Gingell in Electrical Communication, vol. 48, No. 1 and 2, 1973.
Aritcle entitled "High–Performance, Single–Signal Direct–Conversion Receivers" by Rick Campbell —QST Magazine (Jan. 1993).

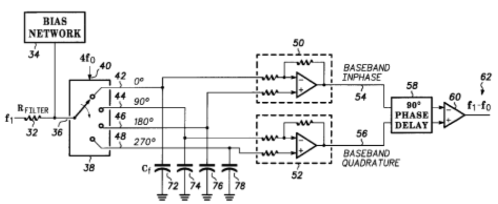
* cited by examiner


*Primary Examiner*—Dwayne Bost
*Assistant Examiner*—Raymond B. Persino
(74) *Attorney, Agent, or Firm*—Dana B. LeMoine; Timothy J. Lorenz; Frank J. Bogacz

(57) **ABSTRACT**


A product detector for converting a signal to baseband includes a commutating switch which serves to sample an RF waveform four times per period at the RF frequency. The samples are integrated over time to produce an average voltage at 0 degrees, 90 degrees, 180 degrees and 270 degrees. The average voltage at 0 degrees is the baseband in-phase signal, and the average voltage at 90 degrees is the baseband quadrature signal. Alternatively, to increase gain, the 0 degree average can be differentially summed with the 180 degree average to form the baseband in-phase signal, and the 90 degree average can be differentially summed with the 270 degree average to produce the baseband quadrature signal.

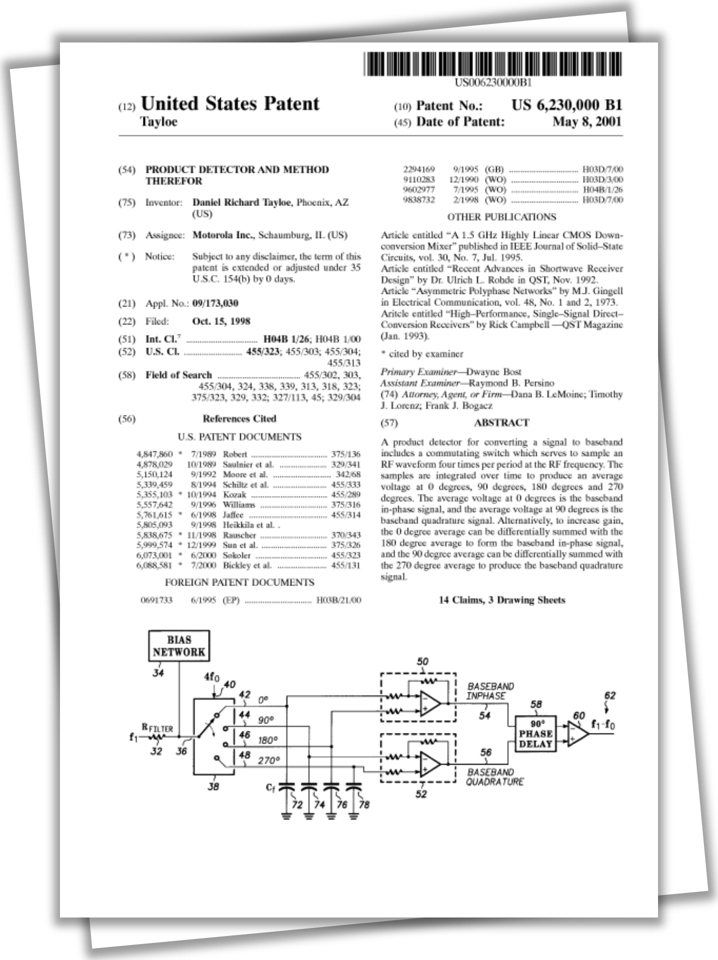

**14 Claims, 3 Drawing Sheets**




> FIG. **6** shows a product detector in accordance with an alternate embodiment of the present invention. Product detector **170** shows an alternate embodiment in which each integrating capacitor has its own resistor. For example, 0 degree output **180** has a voltage controlled by the combination of capacitor **175** and resistor **171**. Likewise, 90 degree output **182** has a voltage controlled by the combination of capacitor **176** and resistor **172**, 180 degree output **184** has a voltage controlled by the combination of capacitor **177** and resistor **173**, and 270 degree output **188** has a voltage controlled by the combination of capacitor **178** and resistor **174**. Resistor **171** and capacitor **175** form a first

Exhibit 1004 (Tayloe), 4:46-57

# Tayloe



US006230000B1

(12) **United States Patent**
**Tayloe**

(10) **Patent No.: US 6,230,000 B1**
(45) **Date of Patent: May 8, 2001**

(54) **PRODUCT DETECTOR AND METHOD THEREFOR**

(75) Inventor: **Daniel Richard Tayloe**, Phoenix, AZ (US)

(73) Assignee: **Motorola Inc.**, Schaumburg, IL (US)

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(58) **Field of Search** ........ 455/302, 303, 455/304, 324, 338, 339, 313, 318, 323; 375/323, 329, 332; 327/113, 45; 329/304

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| 5,150,124 | | 9/1992 | Moore et al. | 342/68 |
| 5,339,459 | | 8/1994 | Schiltz et al. | 455/333 |
| 5,355,103 | * | 10/1994 | Kozak | 455/289 |
| 5,557,642 | | 9/1996 | Williams | 375/316 |
| 5,761,615 | * | 6/1998 | Jaffee | 455/314 |
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| 5,838,675 | * | 11/1998 | Rauscher | 370/343 |
| 5,999,574 | * | 12/1999 | Sun et al. | 375/326 |
| 6,073,001 | * | 6/2000 | Sokoler | 455/323 |
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| 9110283 | 12/1990 | (WO) | H03D/3/00 |
| 9602977 | 7/1995 | (WO) | H04B/1/26 |
| 9838732 | 2/1998 | (WO) | H03D/7/00 |

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*Primary Examiner*—Dwayne Bost
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**14 Claims, 3 Drawing Sheets**



> **48** respectively. As commutating switch **38** cycles through the four outputs, capacitors **72–78** charge to voltage values substantially equal to the average value of the input signal during their respective quadrants. Each of the capacitors

Exhibit 1004 (Tayloe), 2:38-41

# Tayloe Discloses A Voltage Sampling Circuit

IPR2021-00990
U.S. Patent No. 7,110,444
Patent Owner's Response

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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TCL Industries Holdings Co., Ltd. and Hisense Co., Ltd.,

Petitioners

v.

ParkerVision, Inc.

Patent Owner

U.S. Patent No. 7,110,444

Issue Date: September 19, 2006
Title: WIRELESS LOCAL AREA NETWORK (WLAN) USING UNIVERSAL FREQUENCY TRANSLATION TECHNOLOGY INCLUDING MULTI-PHASE EMBODIMENTS AND CIRCUIT IMPLEMENTATIONS

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*Inter Partes* Review No. IPR2021-00990

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**DECLARATION OF DR. MICHAEL STEER**

## Modeled Tayloe Circuit

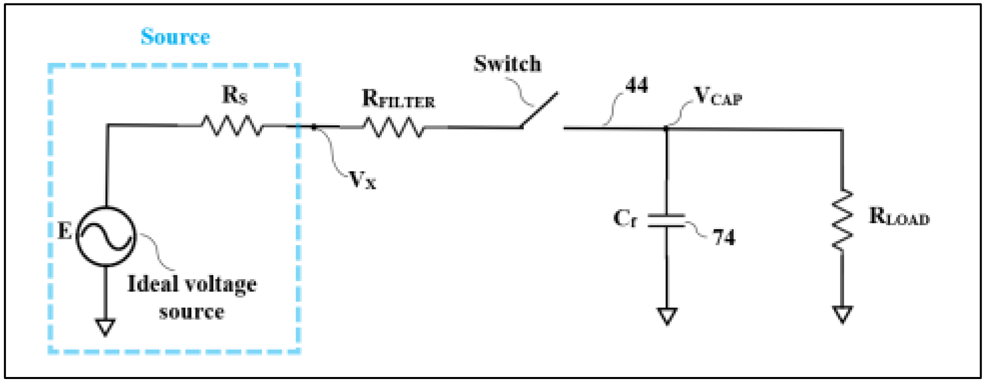


Exhibit 2039 at ¶265

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# Tayloe Discloses A Voltage Conversion Loss

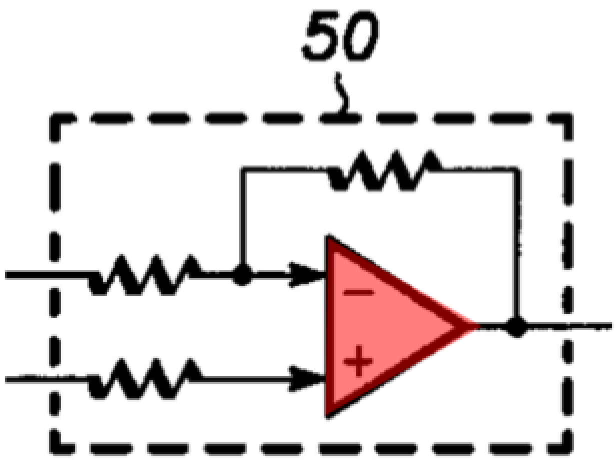
The combination of resistor **32**, commutating switch **38**, and capacitors **72–78** form a portion of a preferred embodiment of a product detector. This product detector is referred to herein as a "Tayloe Product Detector." The Tayloe Product Detector has many advantages. One advantage is low conversion loss. The Tayloe Product Detector can exhibit less than 1 dB of conversion loss, which is 6–7 dB improvement over the typical conversion loss of 7–8 dB in the prior art. This 6–7 dB conversion loss improvement translates into a 6–7 dB improvement in overall receiver noise figure. The

Exhibit 1004 (Tayloe), 3:1-9

In the real world, however, $R_{SWITCH}$ will not be 0 ohms and $R_{LOAD}$ will not be infinite ohms. So $V_{CAP}$ will be slightly less than $V_{110}$ as long as $R_{SWITCH}$ is very small and $R_{LOAD}$ is very large. For example, if $V_{CAP}$ = 89% of $V_{110}$, the non-ideal voltage conversion loss will be $C_{Lv} = (V_{CAP} / V_{110}) = 0.89$. In decibels the voltage conversion loss is $C_{Lv}(\text{dB}) = -20 \times \log(V_{CAP} / V_{110}) = -20 \times \log(0.89) = 1$ dB. So if $R_{SWITCH}$ is closer to zero ohms and $R_{LOAD}$ is closer to infinity, the voltage conversion loss will be "less than 1 dB" of conversion loss just as Tayloe claims. Ex.-1004, 3:6-7. Ex.-2038, ¶276.

POR at 51-52

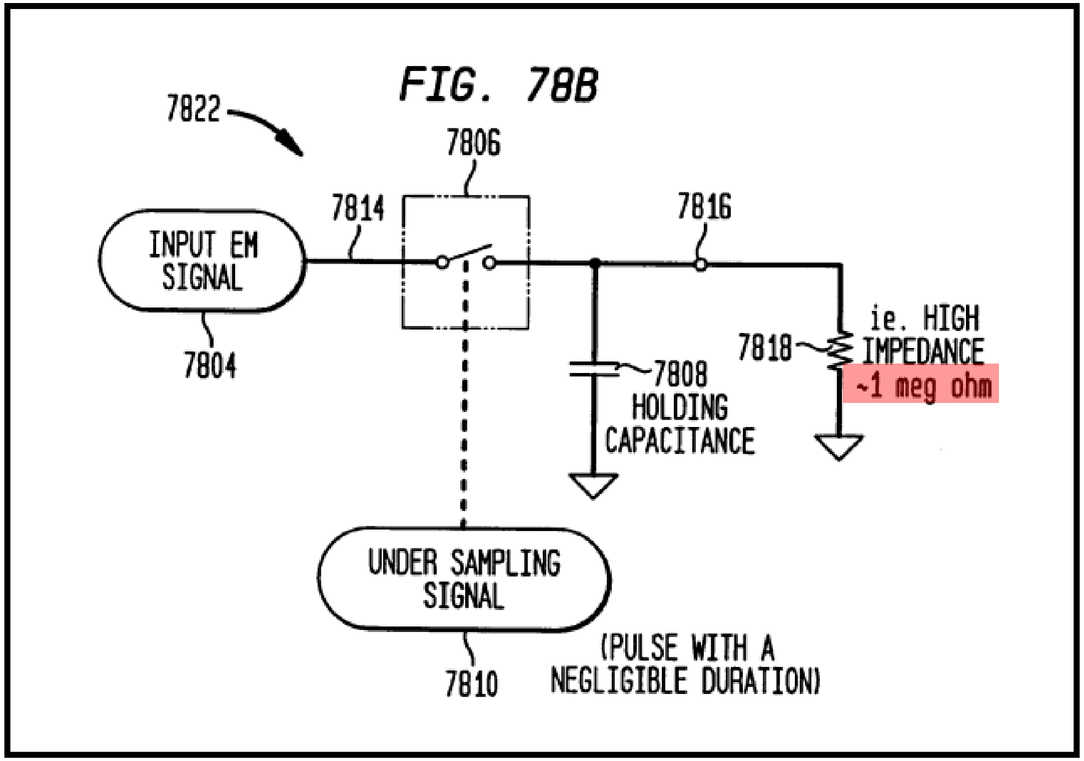
# Tayloe Discloses a High Impedance Load




Tayloe capacitor holds voltage when a switch is open (OFF). I note that the most common/widely sold op-amp at the time of the invention was the 741 Series op-amp, which had a high input resistance of at least 300,000 ohms and typically 2,000,000 ohms (2 meg ohm (MΩ)). *See* Ex.-2037. Accordingly, a POSITA would understand that both the non-inverting (+) and inverting (–) inputs of Tayloe's op-amp present high impedance loads.

Exhibit 2039 at ¶349

# ParkerVision's '551 Patent




**1 meg ohm = HIGH impedance**

# Tayloe Capacitors Do Not Store Non-Negligible Amounts of Energy

# Tayloe

c. **<u>STEP 3</u>: Percentage of available energy.**

Knowing the available energy (357.1 pJ) and amount of energy held in a capacitor (0.6889 pJ), one can calculate the percentage of available energy that is held on Tayloe's capacitor:

$$\frac{0.6878 \text{ pJ}}{357.1 \text{ pJ}} = 0.193\%$$

Only **<u>0.193%</u>** of the energy available is held on a Tayloe capacitor.[17] This is a *negligible* (nearly zero) amount of energy. The balance of the energy is *<u>not</u>* stored but, instead, is dissipated in $R_{FILTER}$. *Id.*, ¶¶334-335.

POR at 65

# Dr. Steer's opinions

309. My calculations demonstrate that merely looking at the size of the capacitors in Tayloe does not provide any insight into whether a Tayloe capacitor "stores non-negligible amounts of energy." As shown below, each capacitor in

Exhibit 2039 at ¶309

310. This is because the size of Tayloe's capacitors has nothing to do with energy storage. Rather, the size of Tayloe's capacitors was selected to form a low pass filter. As set forth in Tayloe, each capacitor is designed to act in series with resistor $R_{FILTER}$ as a switched RC (resistor/capacitor) low-pass filter. Ex.-1004, 2:14-15; 3:21-22 ("Resistor 32 and each of capacitors 72-78 form lowpass filters"). A low pass filter filters out signals at a frequency higher than a cutoff frequency and passes signals at a frequency lower than the cutoff frequency.

Exhibit 2039 at ¶310

# Dr. Steer's opinions

[17] The amount of energy stored cannot simply be calculated using the energy formula, $E = \frac{1}{2} CV^2$ (E=energy; C=capacitance; V=voltage), because this formula fails to take Tayloe's configuration into account. The energy formula, by itself, merely provides the maximum amount of energy that can be stored in a capacitor given a source voltage.

Exhibit 2039 at ¶306 n.17

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# Distinguishable from noise

The Federal Circuit noted that "Mr. Sorrells explained at trial that transferring a non-negligible amount of energy into the *storage capacitor* means 'that you have to transfer enough energy to overcome the noise in the system to be *able to meet your specifications*.'" *Id.*, 1019. With regard to meeting the specifications, Mr. Sorrells "further testified that the fact that the accused [] products *meet 'all of the cellular/cellphone specifications'* is proof that a 'non-negligible' amount of energy is *transferred* to the storage element in those products." *Id.* In other words, according to Mr. Sorrells, energy is "distinguishable from noise" if a product meets cellular/wireless specifications.[12] Petitioners'

Within this context, the Federal Circuit stated that according to Mr. Sorrells, "one *may* look to whether the down-converting circuit functions in practice. If a circuit *successfully* down-converts, that is proof that enough energy has been transferred to overcome the noise in the system." *Id.*

POSR at 11, 12

# Lam

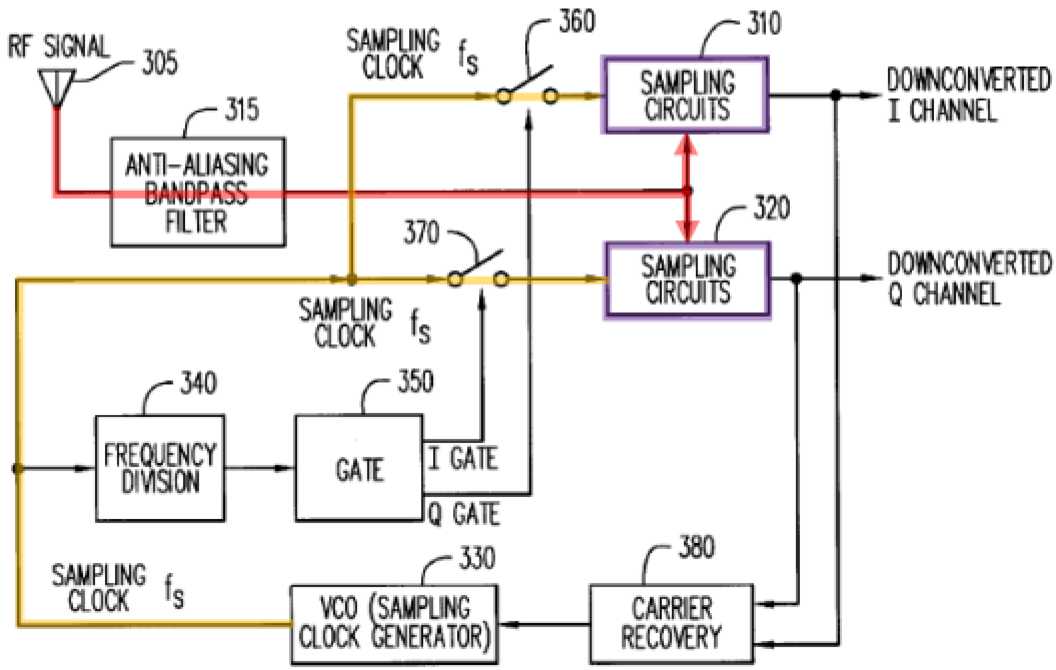


**FIG. 3**

frequency than the carrier frequency. The signal sampling may for example be performed by conventional sampling circuits which comprise simple CMOS switches and sample-and-hold capacitors and integrated with low-frequency differential amplifiers to drive IF circuits.

Ex. 1006, 5:56-60

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# Enz

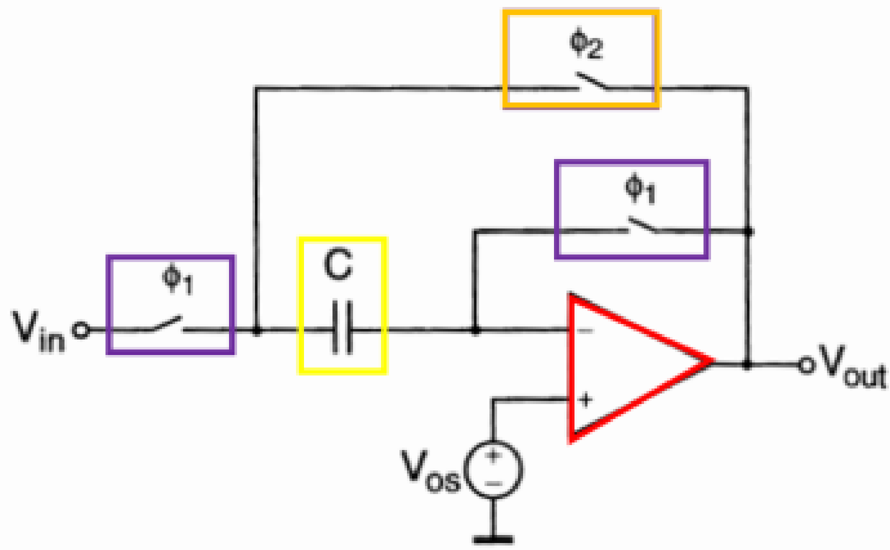


Fig. 29. A SC S/H stage.

# Enz

Not a down-converter

A unity-gain buffer stage, which can be used as a simple S/H circuit, or as an analog memory, or as an analog delay stage, and which also utilizes CDS to reduce dc offset effects, is shown in Fig. 29 [53]. Here, *C* charges

Ex.-1007 at 22

# Enz

> *In linear IC's fabricated in a low-voltage CMOS technology, the reduction of the dynamic range due to the dc offset and low-frequency noise of the amplifiers becomes increasingly significant.*

Ex.-1007 at 3

# Additional Slides

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# ’551 Patent is Incorporated into ’444 Patent

2. Frequency Down-Conversion

The present invention is directed to systems and methods of universal frequency down-conversion, and applications of same.

In particular, the following discussion describes down-converting using a Universal Frequency Translation Module. The down-conversion of an EM signal by aliasing the EM signal at an aliasing rate is fully described in co-pending U.S. Patent Application entitled "Method and System for Down-Converting Electromagnetic Signals," Ser. No. 09/176,022, filed Oct. 21, 1998, issued as U.S. Pat. No. 6,061,551 on May 9, 2000, the full disclosure of which is incorporated herein by reference. A relevant portion of the above mentioned patent application is summarized below to describe down-converting an input signal to produce a down-converted signal that exists at a lower frequency or a baseband signal.

Down-conversion utilizing a UFD module (also called an aliasing module) is further described in the above referenced applications, such as "Method and System for Down-converting Electromagnetic Signals," Ser. No. 09/176,022, now U.S. Pat. No. 6,061,551. As discussed in the '551

Exhibit 1001 (’444 patent), 9:26-42; 34:54-58

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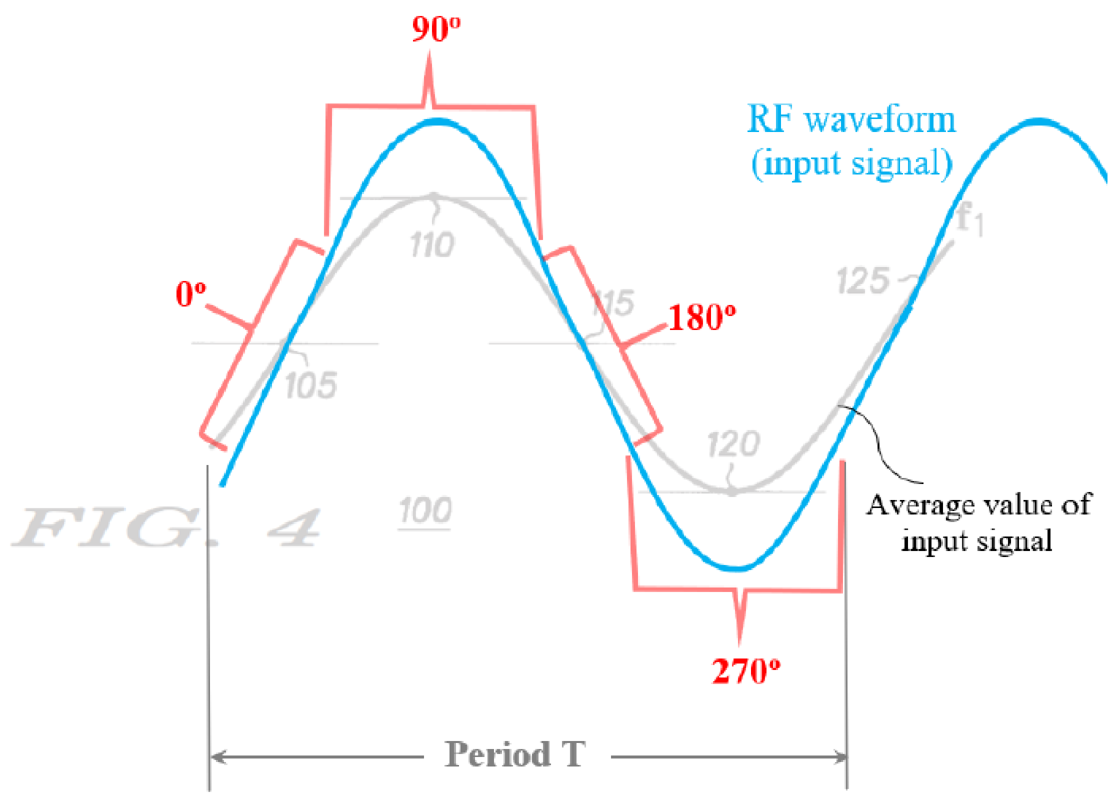
# Tayloe

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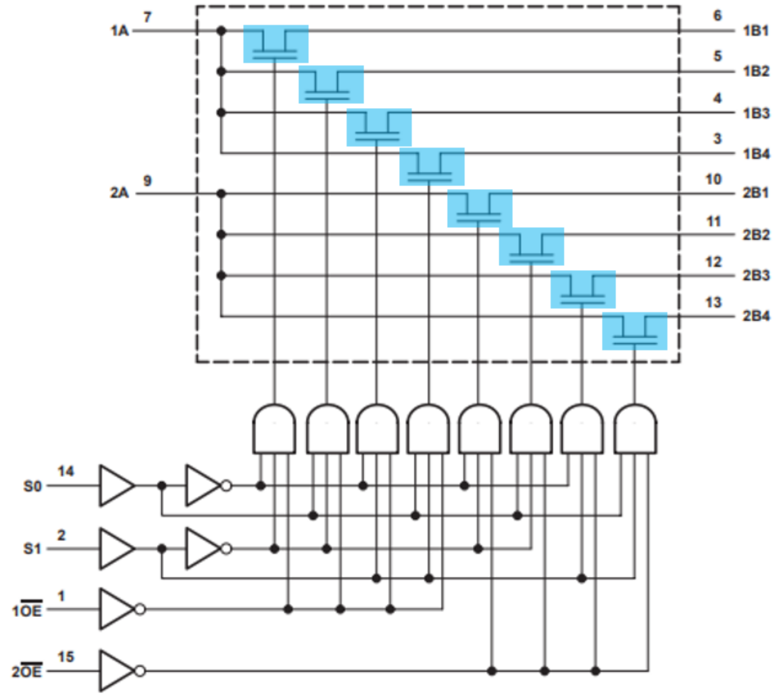
# TI Datasheet

Texas Instruments Datasheet for SN74CBT3253
DUAL 1-OF-4 FET MULTIPLEXER/DEMULTIPLEXER

# TI Datasheet

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