

IPR2024-00796  
U.S. Patent No. 7,483,686  
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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MEDIATEK INC.,  
Petitioner,

v.

PARKERVISION, INC.  
Patent Owner.

U.S. Patent No. 7,483,686  
Issue Date: January 27, 2009

Title: UNIVERSAL PLATFORM MODULE AND METHODS AND  
APPARATUSES RELATING THERETO ENABLED BY UNIVERSAL  
FREQUENCY TRANSLATION TECHNOLOGY

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*Inter Partes* Review No. IPR2024-00796

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**PATENT OWNER'S RESPONSE TO PETITION FOR  
*INTER PARTES* REVIEW OF UNITED STATES PATENT NO. 7,483,686**

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**PATENT OWNER'S EXHIBIT LIST**

| <b>Exhibit No.</b> | <b>Description</b>                                                                                                                                                                                                                                  |
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| 2001               | Complaint, ParkerVision, Inc. v. MediaTek Inc. et al., Case No. 6:23-cv-00375-ADA (WDTX)                                                                                                                                                            |
| 2002               | Amended Scheduling Order, <i>ParkerVision, Inc. v. MediaTek Inc. et al.</i> , Case No. 6:23-cv-00375-ADA (WDTX)                                                                                                                                     |
| 2003               | Dani Kass, "Catching Up On Patent Litigation With Judge Albright," LAW360 (Mar. 14, 2023)                                                                                                                                                           |
| 2004               | <i>Sonrai Memory Ltd. v. Kingston Tech. Co., Inc.</i> , Case No. 6:21-cv-1284-ADA, Order Denying Kingston Tech. Co. and Kingston Tech. Corp.'s Opposed Motion to Stay Pending Resolution of Inter Partes Review, Dkt. 94 (W.D. Tex., Oct. 18, 2022) |
| 2005               | Agreed Scheduling Order, <i>ParkerVision, Inc. v. MediaTek Inc. et al.</i> , Case No. 6:23-cv-00375-ADA (WDTX)                                                                                                                                      |
| 2006               | Declaration of Dr. David Ricketts                                                                                                                                                                                                                   |
| 2007               | Rudolf Graf, Modern Dictionary of Electronics (7th ed. 1999)                                                                                                                                                                                        |
| 2008               | Special Master's Recommended Claim Constructions, ParkerVision, Inc. v. NXP BV, NXP Semiconductors NV, NXP USA, Inc. f/k/a NXP Semiconductors USA, Inc.                                                                                             |
| 2009               | Notice of Intent to Issue Reexamination Certificate of U.S. Patent No. 6,266,518 dated March 1, 2024.                                                                                                                                               |
| 2010               | Transcript of Lawrence E. Larson, Ph.D. dated February 28, 2025                                                                                                                                                                                     |
| 2011               | A 1 GHz CMOS RF Front-End IC for a Direct-Conversion Wireless Receiver, A. Rofougaran, et al.                                                                                                                                                       |

## **I. INTRODUCTION**

This case relates to how wireless devices process radio signals. Specifically, the challenged claims of U.S. Patent No. 7,483,686 (the “’686 patent”) are directed to a specific type of technology that ParkerVision invented called an energy transfer system (energy sampling).

Indeed, the claims expressly use terms demonstrating that they are directed to ParkerVision’s energy transfer (energy sampling) technology. In particular, claims 1-20 recite a switch that “operate[s] according to an energy transfer signal,” “sub-sample,” and “transfer energy.” Claims 11-20 further recites “a storage module . . . configured to store said transferred energy” and a signal being “generated from said stored energy.”

The cited references that MediaTek relies on, however, disclose completely different types of technology. Avitable discloses a sample-and-hold (voltage sampling) system and Estabrook discloses a heterodyning (non-sampling) system. These systems work considerably differently than the claimed technology and, thus, there are numerous claim elements missing from these cited references.

Furthermore, the claims expressly require an apparatus having a plurality (two or more) protocol/standard modules (i.e., modules that comply with protocols/standards) (claims 1-10) and transceivers to operate in conformance with first and second protocols/standards (claims 11-20). To show this, MediaTek relies

on Nevo and Young which MediaTek alleges describe known protocols such as Bluetooth and IEEE 802.11 (WiFi). But Nevo and Young do not disclose any specific configurations of down conversion circuitry. They simply disclose black boxes. So MediaTek points to the circuitry shown in Avitabile and Estabrook, respectively, to remedy this deficiency. MediaTek asserts that certain circuitry in Avitabile can be used in the black boxes of Nevo and certain circuitry in Estabrook can be used in the black boxes of Young.

First, a POSITA would not be motivated to combine these references. Second, because MediaTek relies on Avitabile and Estabrook, the circuitry in these references is what must comply with or operate in conformity with a plurality of protocols/standards as set forth in the claims. Not only has MediaTek failed to provide any evidence that the circuitry in Avitabile or Estabrook can comply with or operate in conformity with a plurality of protocols/standards, but an analysis of Avitabile and circuit simulations of Estabrook performed by ParkerVision's expert show the circuitry in these references cannot do so.

For the forgoing reasons, MediaTek has failed to demonstrate that challenged claims 1-20 of the '686 patent are invalid.

## **II. LEVEL OF ORDINARY SKILL IN THE ART**

A POSITA at the time of the invention of the '686 patent would have: (a) a Bachelor of Science degree in electrical or computer engineering (or a related

academic field), and at least two (2) additional years of work experience in the design and development of radio frequency circuits and/or systems, or (b) at least five (5) years of work experience and training in the design and development of radio frequency circuits and/or systems. Ex.-2006, ¶25.

### III. GENERAL OVERVIEW OF WIRELESS TECHNOLOGY

#### A. Wired communications.

Traditional wired communications networks transmit audio signals over wire lines by converting audio signals to electrical signals and back to audio signals. Ex.-2006, ¶28.



When Bob speaks into a phone, Bob's phone converts his voice (low frequency audio signals) into electrical signals. Electrical signals are transmitted over wires to Alice's phone, which converts the electrical signals back into audio signals so that Alice can hear Bob's voice. Ex.-2006, ¶29.

#### B. Wireless Communications.

Similar to wired communications, in wireless communications, low frequency audio signals are converted into electrical signals. But instead of travelling through

wires, the signals are transmitted through air as radio waves (electromagnetic (EM) waves). Ex.-2006, ¶30.



As shown above, wireless devices use high radio frequency (RF) signals (e.g., above 300 MHz (red)) because high frequency signals can carry more information and because high frequency antennas can physically fit within small devices such as cellular phones. Ex.-2006, ¶31.

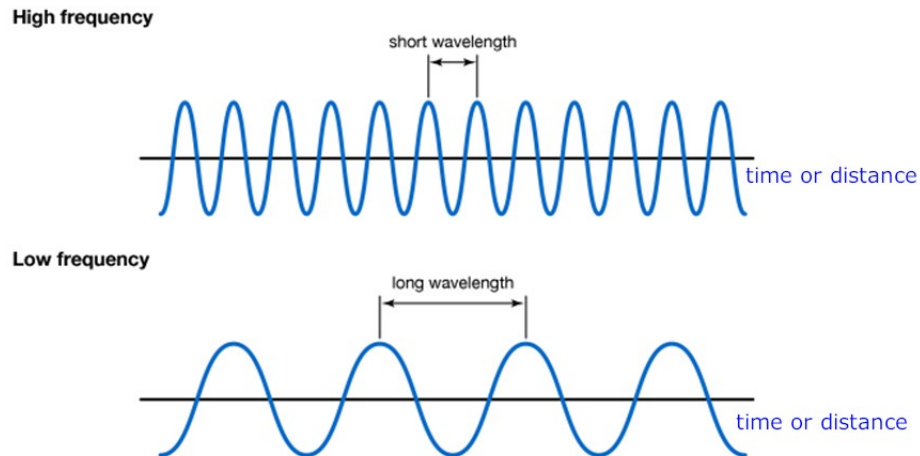


In wireless communication, when Bob speaks into his cell phone, Bob's cell phone converts his voice (low frequency audio signals) into a high frequency RF signal. The RF signal is transmitted over the air to Alice's cell phone. Alice's cell phone then converts the RF signal back into a low frequency audio signal and Alice can hear Bob's voice. Ex.-2006, ¶32.

**C. Frequency.**

Frequency is the number of cycles of a wave per unit time (second). Ex.-2006,

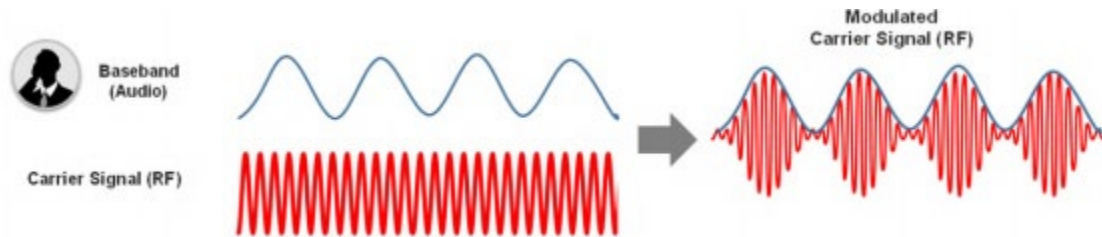
¶33.



As shown above, a high frequency signal has more cycles of a wave per second than a low frequency signal. Notably, the frequency of an audio wave can be one thousand cycles per second whereas the frequency of a radio wave can be one billion cycles per second. Ex.-2006, ¶34.

**D. Up-conversion.**

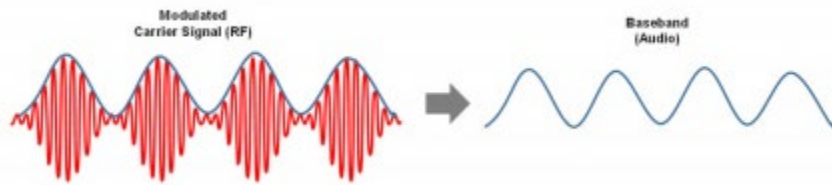
In order to transmit an audio signal over air, a wireless device must transform the audio signal to an RF signal. Since the RF signal is used to carry the information in the audio signal, the RF signal is referred to as a “carrier signal.” And since audio waves are at a low frequency, they are referred to as “baseband,” a “baseband signal” or at a “baseband frequency.” Ex.-2006, ¶35.



In order to transport the baseband (audio) signal, the transmitting wireless device (e.g., Bob's cell phone) modifies the carrier (RF) signal. As shown above, the baseband signal is impressed upon the carrier signal (above left), thereby modulating/changing the shape of the carrier signal to approximate the shape of the baseband (audio) signal (above right). The modified signal is referred to as a "modulated carrier signal." The process is referred to as "up-conversion" because the low frequency signal is being up-converted to a high frequency signal. Ex.-2006, ¶36.

#### **E. Down-conversion.**

In order for the receiving wireless device (e.g., Alice's cell phone) to recover the baseband (audio) signal from the modulated carrier signal, the receiving wireless device must transform the modulated carrier signal back to an audio signal. This process is referred to as "down-conversion" because a high frequency signal is being down-converted to a low frequency signal. Ex.-2006, ¶37.



As shown above, “down-conversion” is the process by which the baseband (audio) signal can be recovered from the carrier signal.<sup>1</sup> *Id.*

#### **IV. IMPORTANT CONCEPTS RELATED TO WIRELESS TECHNOLOGY**

##### **A. Basic circuit concepts.**

**Charge:** Charge is a fundamental property of matter. There are two physical types of charge: positive and negative. Protons carry a positive charge (+), while electrons carry a negative charge (–). Ex.-2006, ¶39.

The operation of electrical circuits depends on the movement of electrons (not protons), which in turn facilitates the transfer of energy and information. Ex.-2006, ¶40.

**Voltage:** Voltage represents the difference in electric potential energy per unit charge between two points in a circuit. Ex.-2010, 38:16-21. It quantifies the amount

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<sup>1</sup> While Section III provides an overview of the technology in connection with voice/audio signals, it should be understood that this is for illustrative purposes only.

of potential energy available to move charges. Negative charges (electrons) are naturally attracted to higher voltages, while positive charges (protons) are drawn toward lower voltages. Ex.-2006, ¶41.

Electric current: Electric current is the flow/movement of charge within a circuit (in a conductor or into, out of, or through an electrical component). Ex.-2006, ¶42.

Electric energy: Electric energy is the capacity to accomplish work based on a quantity of electric charge and its related electric field. Energy can be transferred by the motion of charge and the resulting electric field of the charge. Greater quantities of charge in motion are capable of transferring greater quantities of energy. Ex.-2006, ¶43.

Energy is not the same as voltage. Ex.-2010, 38:8-15. Energy and voltage are used in circuits in different ways. Ex.-2006, ¶44.

Power: Power is the rate at which energy is transferred within a circuit, measured per unit time. In electronic circuits, power quantifies the average rate at which charge carriers deliver energy. Ex.-2006, ¶45.

Resistance: Resistance is a measure of the difficulty of passing current through a conductor. Ex.-2006, ¶46.

Impedance: Impedance is the measure of the opposition that a circuit presents to a current when a voltage is applied. Impedance is related to, but not the same as,

resistance. Resistance is one component of impedance. In addition, impedance describes the ability of a circuit element to store and/or return electrical energy (referred to as reactance). A circuit component with high resistance has high impedance. Ex.-2006, ¶47.

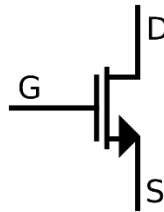
## **B. Circuit Components.**

### **1. Transistor.**

A transistor is a semiconductor device used to switch, detect, or amplify electronic signals and electrical power. Ex.-2006, ¶¶49-52.

A field-effect transistor (FET) is one type of transistor. Most FETs are classified into junction-gate field-effect transistors (JFETs) and metal-oxide-semiconductor field-effect transistors (MOSFETs). Ex.-2006, ¶53.

The symbol for one type of FET is shown below.



A FET has three terminals: (1) source (S), (2) drain (D) and (3) gate (G). In a FET, a voltage at the gate (G) controls the current flow between the drain (D) and source (S). Ex.-2006, ¶¶54-55.

## 2. Diode.

A diode is a two-terminal electrical component that allows a circuit to be connected with the flow of current in only one direction. Ex.-2006, ¶56. It offers low (negligible) resistance in one direction (to allow current flow) and high resistance in the reverse direction (to prevent current flow). *Id.* The most common type of diode is made from a combination of p-type semiconductor material and n-type semiconductor material, known as a p-n junction. The symbol for one type of diode is shown below. Ex.-2006, ¶¶57-58.



Current flows through the diode from the anode (positive lead) to the cathode (negative lead). As shown above, the arrowhead points in the direction of the current in conventional flow. Ex.-2006, ¶¶59-60.

## 3. Resistor.

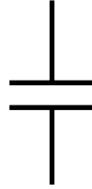
A resistor is a circuit element that introduces resistance into a circuit. The symbol for one type of resistor is shown below. Ex.-2006, ¶¶61-62.



Resistors serve various functions, including reducing current, adjusting signal levels, dividing voltages, biasing active elements, and terminating transmission lines. Ex.-2006, ¶63.

#### **4. Capacitor.**

A capacitor is one type of circuit element used to store (accumulate) energy. A capacitor stores electric energy in an electric field by separating charges over a distance. The symbol for one type of capacitor is shown below. Ex.-2006, ¶¶64-65.



A capacitor stores energy in an electric field established between two plates. Ex.-2006, ¶66.

The ability of a capacitor to store energy is described by its capacitance. Ex.-2006, ¶¶67-70.

#### **5. Electrical Load.**

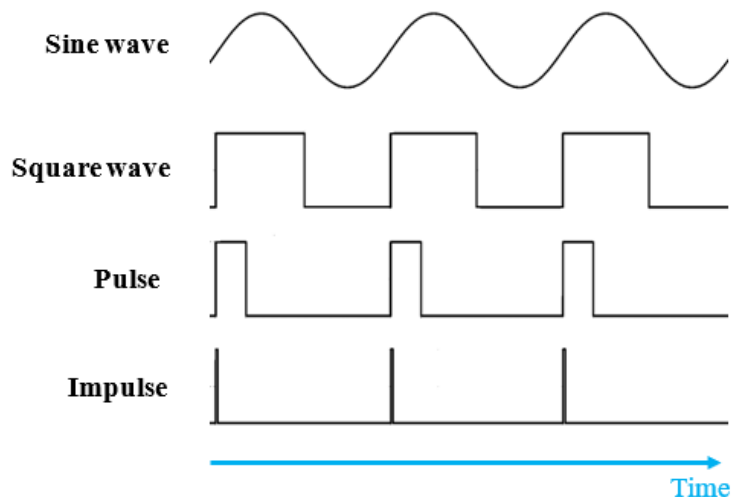
An electrical load is an electrical element or portion of a circuit that absorbs power and converts it into a desired form. Whereas a power source supplies energy, a load extracts/uses energy. For example, a resistor (Section IV.B.3 above) is a type of load. Ex.-2006, ¶71.

Connecting a load to a capacitor affects the operation of the capacitor and, thus, the way the capacitor is used in a circuit. There are high impedance loads and low impedance loads. A high impedance load inhibits current from moving in a circuit and absorbs very little electrical energy. A low impedance load provides little

constraint to current moving in a circuit and absorbs electrical energy. Ex.-2006, ¶¶72-73.

## 6. Local Oscillator.

An oscillator is “[s]omething that oscillates,” i.e., “repeat[s] a cycle of motions or to pass through a cycle of state with strict periodicity.” Ex.-2007, p. 6. “In particular, [an oscillator is] a self-excited electronic circuit whose output voltage or current is a periodic function of time [and is a] generator of an alternating signal, continuous, sinusoidal or pulsed.” *Id.* The terms “local oscillator,” “LO,” or “LO circuit” are used to refer to the local oscillator circuit. The output signal of a local oscillator is commonly referred to as the “LO,” “LO signal” or “local oscillator signal.” Ex.-2006, ¶74.



The diagram above shows different types of LO signals that can be generated by a local oscillator. The signal can be (1) a sine or sinusoidal wave, (2) a square

wave, (3) a pulse, or (4) an impulse. A square wave, pulse and impulse are each periodic repetition of pulses. Ex.-2006, ¶76.

As shown above, a sine or sinusoidal wave is a continuous signal with a value that changes smoothly over time. A square wave, train of pulses and train of impulses are each a signal that has two values, and unlike a sine wave, has abrupt transitions between those values. Ex.-2006, ¶¶77-79.

### **C. Wireless Communication Protocols.**

Wireless communication protocols define the methods and parameters for transmitting data over RF channels. Two widely used protocols are Bluetooth and IEEE 802.11 (commonly known as Wi-Fi). Each of these protocols is optimized for different applications, with specific standard performance factors (e.g., dynamic range, sensitivity, interference) that guide their design and implementation. Ex.-2006, ¶¶80-81.

#### **1. Dynamic range**

Dynamic range refers to the range of input signal strengths a receiver can handle without distortion. It is the difference between the weakest desired signal (the smallest signal that can still be distinguished from noise) and the strongest signal that can be received without causing distortion or data loss. Ex.-2006, ¶82.

## **2. Sensitivity**

Sensitivity determines the minimum RF signal power a receiver can successfully detect and demodulate in the presence of noise. It is related to the receiver's noise figure and affects its ability to process weak signals. Sensitivity can be expressed as the minimum detectable signal (MDS) plus the minimum specified carrier-to-noise power ratio. Sensitivity dictates the minimum signal strength required for successful data reception, while interference affects the ability to maintain stable communication in the presence of competing signals. Ex.-2006, ¶83.

### **a. Noise Figure**

The noise figure (NF) of a receiver measures how much noise is added to the received signal during amplification and processing, impacting the receiver's sensitivity. NF is defined as the ratio of input signal-to-noise power ratio (SNR) and output SNR. Ex.-2006, ¶¶84-85.

### **b. Second order-intercept point (IIP2)**

The second-order intercept point (IIP2) quantifies a receiver's linearity and its susceptibility to single-tone and two-tone interfering signals. When large signals at two frequencies interact, intermodulation products (additional signals at other frequencies) are produced. High IIP2 values indicate a receiver's ability to handle such interactions without causing unwanted distortion. Ex.-2006, ¶86.

**c. Third order-intercept point (IIP3)**

The third order intercept point (IIP3) is another measure of a receiver's linearity. IIP3 specifies the amount of distortion of a desired signal due to the intermodulation products from two interfering signals. IIP3 helps assess the receiver's signal-handling capacity, with higher IIP3 values indicating better linearity and signal separation. Ex.-2006, ¶87.

Among other criteria, the IIP2 and IIP3 are commonly used in determining the overall dynamic range of a receiver. High IIP2 and IIP3 values generally indicate better performance in handling weak and interfering signals without distortion. Ex.-2006, ¶¶88-89.

**V. DOWN-CONVERSION SYSTEMS**

There are two fundamentally different categories of down-conversion: (1) non-sampling/heterodyning; and (2) sampling-based down-conversion. Ex.-2006, ¶90.

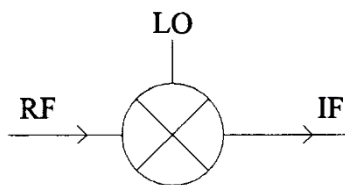
**A. Heterodyning (Non-Sampling)**

From the late 1980s through 2000, the industry was focused on the use of non-sampling mixers and heterodyne receivers for down-conversion. Heterodyne receivers, which used a decades-old RF technology called heterodyning, dominated the cellular/wireless industry for receiving and processing RF signals. Ex.-2006, ¶91.

This technology used nonlinear and time-varying elements (e.g., transistors or diodes) in a nonlinear or time-varying mixer to effect translation of information centered at one frequency to information centered at another frequency. But this technology had problems – the circuitry was large and required significant power. The size and power requirements of heterodyne receivers were, at least in part, the result of the number of components these receivers used in order to perform down-conversion. Ex.-2006, ¶92.

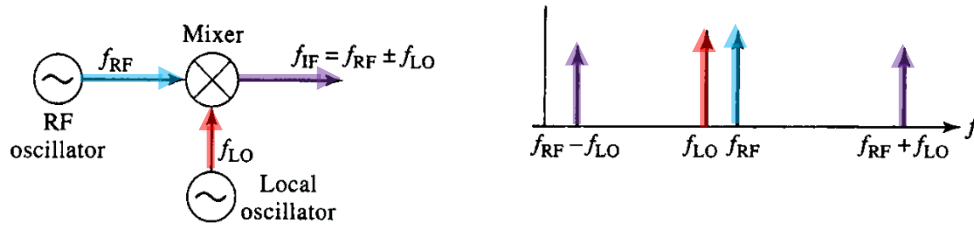
A non-sampling mixer operates by continuously multiplying two sinusoidal signals—an incoming RF signal with a local oscillator (LO) signal—resulting in an output spectrum governed by the equation:  $f_o = m f_{RF} \pm n f_{LO}$ , where  $f_{RF}$  is the frequency of the RF signal,  $f_{LO}$  is the frequency of the local oscillator, and  $m$  and  $n$  are integers. Ex.-2006, ¶93.

The typical symbol for a mixer is shown below.



The function of a mixer is to convert a signal received at one frequency to another frequency. As shown above, an input signal (here, an RF signal (modulated carrier signal)) enters a mixer and an output signal (here, an intermediate frequency (IF) signal) leaves the mixer. A component referred to as a local oscillator (LO)

sends a signal to the mixer to effect down-conversion by the mixer. Ex.-2006, ¶¶94-95.



As shown in the diagrams above, an RF signal is down-converted by frequency shifting the RF signal (blue arrow) to an IF signal (purple arrows). The frequency shift is accomplished by using a local oscillator to send a signal with a frequency  $f_{LO}$  (red arrow) to the mixer. The mixer mixes the RF signal having a frequency  $f_{RF}$  and the LO signal having a frequency  $f_{LO}$  to produce an IF signal having frequencies at  $f_{RF} - f_{LO}$  and  $f_{RF} + f_{LO}$ . As shown in the frequency domain (above right), down-conversion via the non-sampling mixer replicates the RF signal frequency (blue arrow) at two frequencies:  $f_{RF} - f_{LO}$  and  $f_{RF} + f_{LO}$  (purple arrows). The post-mixer circuitry filters out the higher frequency  $f_{RF} + f_{LO}$  signal, thus, leaving only the lower desired frequency component  $f_{RF} - f_{LO}$ . The mixer exploits the non-linearity of circuit elements to achieve the multiplication, or mixing, of the RF and LO signals. Ex.-2006, ¶¶96-97.

Despite its widespread adoption, conventional receivers and mixers had significant drawbacks. The circuits were large, required substantial power, and

introduced unwanted signals at undesired frequencies due to practical nonlinearities. This led to excessive noise and interference in direct down-conversion systems, requiring additional filtering and circuit components. Moreover, direct conversion schemes using heterodyning struggled to accommodate modern communication protocols with wide variations in baseband characteristics, including large amplitude variations. Furthermore, continuously time-varying elements consumed considerable battery power, reducing device efficiency and battery life. Ex.-2006, ¶¶98-104.

The technology of the challenged claims of the '686 patent simultaneously a) operates efficiently, b) can be realized in an integrated circuit, c) achieves performance that enables high-performance protocols, d) can be mass produced with excellent yield, and e) eliminates/reduces many expensive and bulky external components (i.e., components (e.g., filters) that device manufacturers (e.g., cellular phone manufacturers) must include in their device external to the RF chip). Ex.-2006, ¶106.

## **B. Sampling**

In contrast to heterodyning, sampling-based down-conversion uses pulsed LO signals rather than continuous sinusoidal signals. These systems use switches to capture discrete samples of the RF signal at specific time intervals, leveraging aliasing effects for frequency translation. Ex.-2006, ¶107.

Sampling-based down-conversion systems can be further categorized into two distinct types: (1) energy transfer (energy sampling) systems – the technology claimed in the '686 patent, and (2) voltage sampling systems. Ex.-2006, ¶¶108-122.

Indeed, in September 2024, the Federal Circuit specifically found that ParkerVision's energy transfer (energy sampling) technology is different from voltage sampling: "ParkerVision's down-converting system uses a technique called 'energy sampling,' which differs from the technique of 'voltage sampling,' which was used in conventional down-converting systems." *ParkerVision, Inc. v. Qualcomm Inc.*, 116 F.4th 1345 (Fed. Cir. 2024).

## **VI. THE '686 PATENT**

### **A. Overview**

The '686 patent relates to a system and method to up-convert and down-convert an electromagnetic signal (radio frequency signal). Specifically, the '686 patent describes a communication system incorporating a universal platform module (UPM) that supports multi-protocol and multi-bearer services. Ex.-1001 ("'686 patent"), Abstract. The UPM includes universal platform sub-modules (UPSM), each of which includes a universal frequency translation (UFT) module. The UPSMs are connected to different types of networks, such as cellular and WLAN networks. *See, e.g.*, '686 patent, 35:12-38, Fig. 26C.

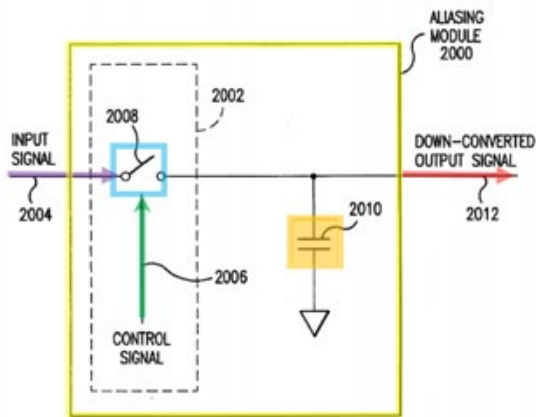


FIG. 20A

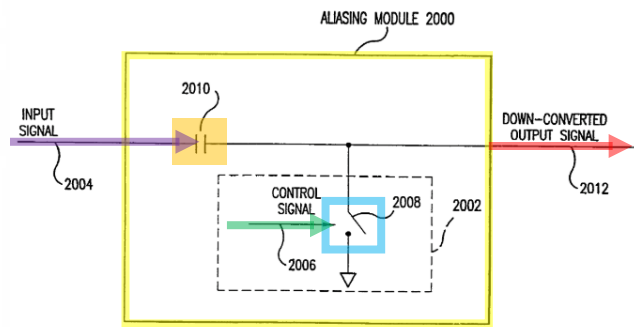


FIG. 20A-1

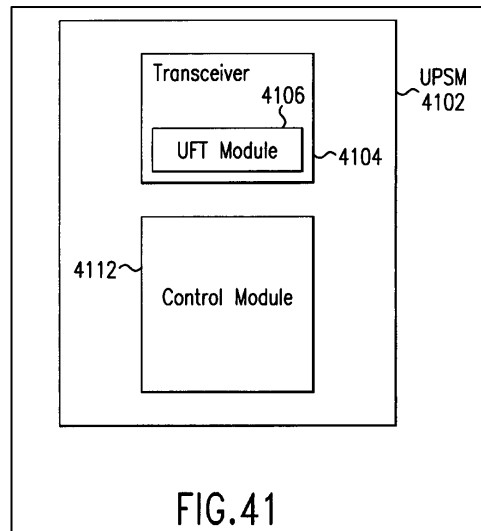
Figure 20A (above left) shows the basic configuration of an aliasing module 2000 for down-conversion. Aliasing module 2000 (yellow) includes (1) a universal frequency translation (UFT) module 2002 (implemented as a switch 2008 (blue) with a control signal 2006 (green) for controlling the switch) and (2) a capacitor 2010 (orange) for storing and discharging energy. '686 patent, 9:51-55. The switch receives an input signal 2004 (purple arrow), samples the signal as discussed below, and outputs a down-converted output signal 2012 (red arrow). In this configuration, the switch 2008 is in series with input signal 2004 and capacitor 2010 is shunted to e.g., ground. *Id.*, 9:56-59.

Figure 20A-1 (above right) shows an alternative configuration of the aliasing module 2000 of Figure 20A. In Figure 20A-1, the capacitor 2010 is in series with input signal 2004 and the switch 2008 is shunted to e.g., ground. *Id.*, 9:60-63.

Nevertheless, the configurations of Figures 20A/20A-1 will operate in the same way. Ex.-2006, ¶126.

The '686 patent further specifies that “[w]hen 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.” '686 patent, 13:27-31.

The '686 patent discloses various embodiments where the aliasing/UFT modules of Figures 20A/20A-1 can be incorporated, such as, for example, transceiver 4104 of Figure 41.



As shown above, UPSM 4102 includes a transceiver 4104 with one or more UFT modules 4106. The UPSM also includes a control module 4112 which enables the UPSM 4102 to operate according to multiple protocol/bearer service combinations (FIG. 39) and/or multiple communication link/types (FIG. 40). *Id.*, 38:63-39:21. The UPSM 4102 operates according to one or more protocol/bearer

service combinations and/or communication link/types simultaneously at any given time. *Id.* This enables the UPSM 4102 to perform simultaneous processing of multiple protocol/bearer service combinations and/or communication link/types. *Id.*

**B. The patent discloses two fundamentally different down-conversion systems.**

The disclosure in U.S. Patent No. 6,061,551 (“the ’551 patent”) (Ex.-1008) is specifically incorporated by reference into the ’686 patent.

The ’551 patent and, thus, the ’686 patent, discloses two systems for down-conversion: (1) energy transfer (energy sampling) and (2) sample and hold (voltage sampling). But the claims of the ’686 patent are directed only to energy transfer, because they use the concepts the patentees reserved specifically to connote energy transfer. See Section VI.C. (below).

Indeed, as discussed below, energy transfer and sample/hold are distinctly different technologies. In energy transfer, the down-converted signal includes the energy<sup>2</sup> from the RF signal; in voltage sampling, the down-converted signal is derived from discrete voltage readings of the RF signal. *Compare* ’551 patent at

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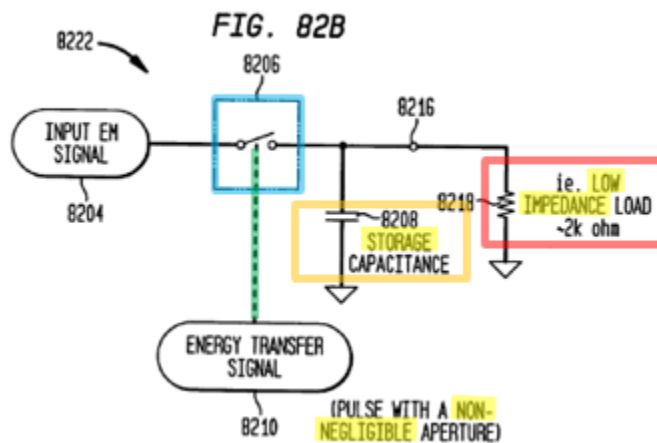
<sup>2</sup> Energy and voltage are not the same thing. Energy is the product of voltage multiplied by current multiplied by time (i.e., energy = voltage x current x time).

Ex.-2006, ¶133 fn.4.

66:33-68:15 (describing an energy transfer system) with *id.*, 54:45-55:2 (describing a sample and hold system). And while energy transfer and sample/hold both result in down-converted signals, an energy transfer system results in a higher quality baseband signal and, therefore, allows for wireless devices with fewer components, reduced size and cost, and increased battery life. *Id.*, 62:60-63, 66:34-54.

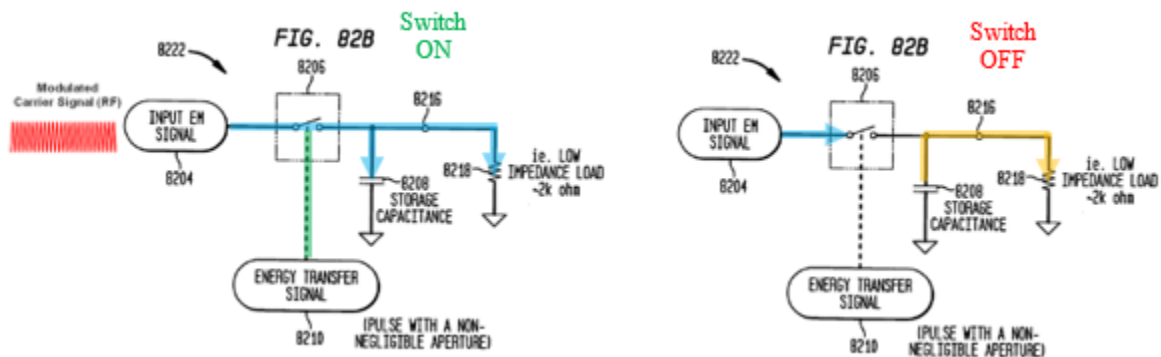
### 1. Energy Transfer (energy sampling).

Figure 82B of the '551 patent (below) illustrates an energy transfer (energy sampling) system, which would be incorporated into a transceiver chip of a wireless device.

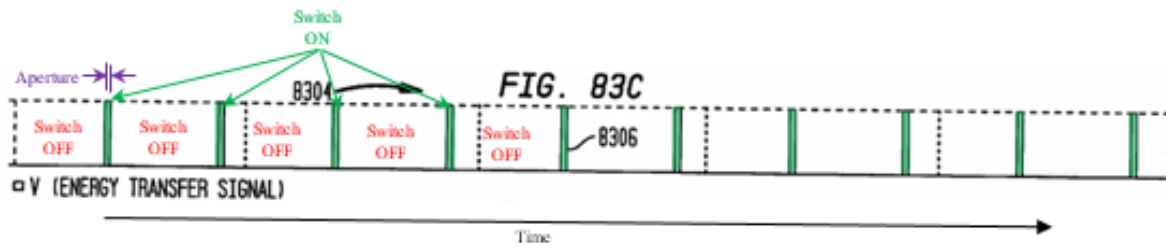


The system includes a switch 8206 (blue), an energy transfer signal 8210 (green) for controlling the switch, a “storage” capacitor 8208 (orange) for storing and discharging energy, and a low impedance load (red). Notably, there are several key features (yellow highlights) that distinguish an energy transfer system from

sample and hold. In particular, an energy transfer system uses (1) a control signal having a pulse with a non-negligible aperture/duration, and (2) a “storage” capacitor for storing and discharging non-negligible amounts of energy for driving a low impedance load. Indeed, low impedance is what enables a storage capacitor to discharge its energy when the switch is OFF (open). If the impedance were high, the “storage” capacitor could not discharge sufficient energy for the system to perform energy transfer (energy sampling) and form a down-converted signal from energy transferred to the low impedance load. Ex.-2006, ¶135.

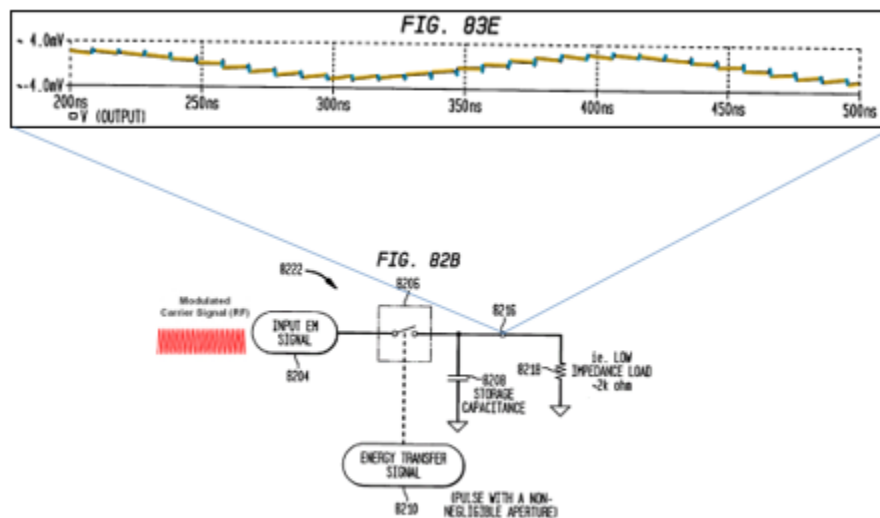


The annotations in Figure 82B above illustrate how an energy transfer system down-converts a high frequency input EM signal 8204 (e.g., modulated carrier signal (red)) to a baseband signal. In particular, down-conversion occurs by repetitively opening and closing the switch 8206. Ex.-2006, ¶136.

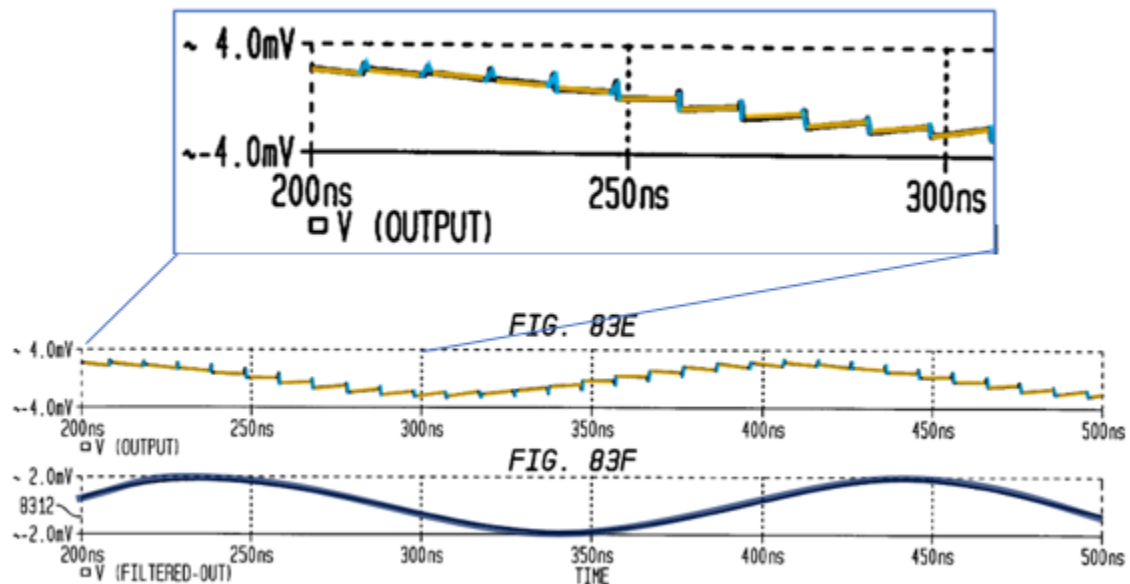


As shown in Figure 83C above, the switch is turned ON (closed) by sending a pulse 8306 (green) to the switch. The switch is kept ON (kept closed) for the duration of the pulse (i.e., a non-negligible aperture (purple) of the pulse). As shown by the repetitive pulses 8306, this opening and closing of the switch repeats continuously over time. Ex.-2006, ¶137.

As shown in Figure 82B above (left), when the switch is ON (during the aperture), a portion of the input EM signal 8204 (blue) passes to the “storage” capacitor 8208 and the low impedance load 8218. When the pulse 8306 (green) stops, the switch is turned OFF (opened), and the input EM signal is prevented from passing through the switch. Since the load is low impedance, when the switch is OFF (opened), as shown in Figure 82B above (right), energy (orange) stored in the “storage” capacitor 8208 is discharged to the low impedance load 8218. For this reason, the “storage” capacitor is said to “drive the load.” ’551 patent, 67:42-46; Ex.-2006, ¶138.



The repetitive opening and closing of the switch results in the waveform (blue/orange) shown above in Figure 83E at terminal 8216. The waveform is made up of energy (blue) from the EM signal and discharged energy (orange) from the “storage” capacitor. Indeed, the discharged energy (orange) from the “storage” capacitor is essential. Without the discharged energy, the waveform of Figure 83E would be incomplete (the orange portions would be missing), thereby producing a degraded and/or unusable signal that could not be properly processed by a receiving wireless device. Ex.-2006, ¶139.



As shown above, the waveform of Figure 83E is filtered to create a smooth waveform (dark blue) as shown in Figure 83F. Ex.-2006, ¶140.

The figures below illustrate a close-up view of another embodiment of a down-converted signal in an energy transfer system. Ex.-2006, ¶141.

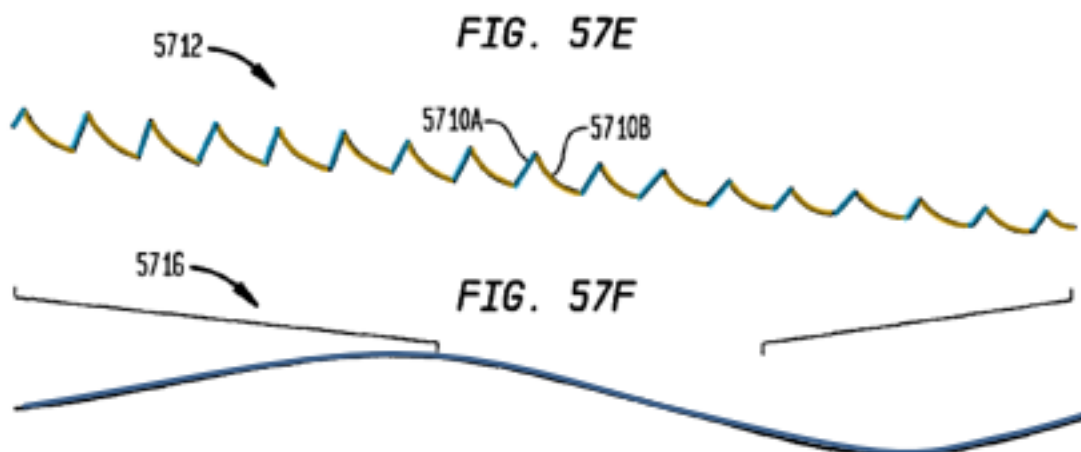
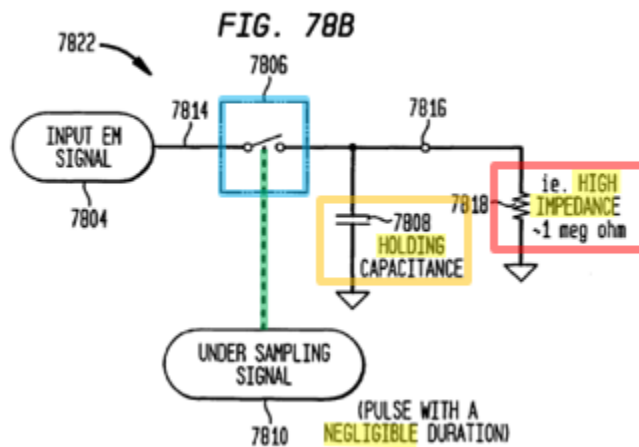


Figure 57E shows a segment 5712 of the down-converted signal 5716 of Figure 57F. The down-converted signal of Figure 57E is made up of two portions - portion 5710A (i.e., energy (blue) from the EM signal) and portion 5710B (i.e., discharged energy (orange) from the “storage” capacitor). The baseband signal is derived from an accumulation function (e.g., integration) in which the energy transferred from the current cycle is combined with previously accumulated energy left in the storage module from preceding cycles. Ex.-2006, ¶142. Thus, the energy transfer occurs and is accumulated, or “integrated,” over multiple apertures. *Id.*

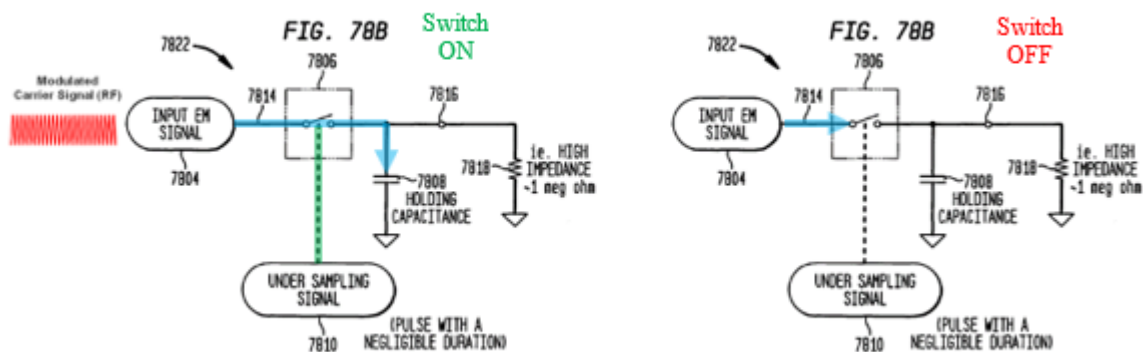
## 2. Sample and hold (voltage sampling).

Figure 78B of the '551 patent illustrates a sample and hold (voltage sampling) system.

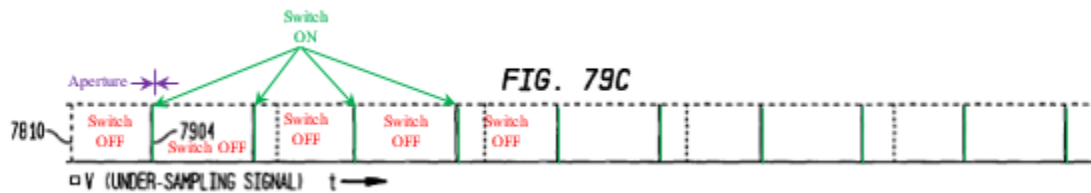


The system includes a switch 7806 (blue), a control signal 7810 (green) for controlling the switch, a “holding” capacitor 7808 (orange) for holding a voltage

across the capacitor, and a high impedance load (red). Unlike an energy transfer system, a sample and hold system uses (1) a control signal having a pulse with a negligible aperture/duration, (2) a “holding” capacitor for holding a constant voltage across the capacitor and (3) a high impedance load (yellow highlights). The capacitor is referred to as a “holding” capacitor because, unlike the “storage” capacitor in an energy transfer system, a “holding” capacitor does not discharge any significant energy to the load. Indeed, the high impedance load is specifically included to prevent the holding capacitor from discharging energy, which would degrade the discrete voltage measurements and adversely affect the system performing sample and hold (voltage sampling). Ex.-2006, ¶144.



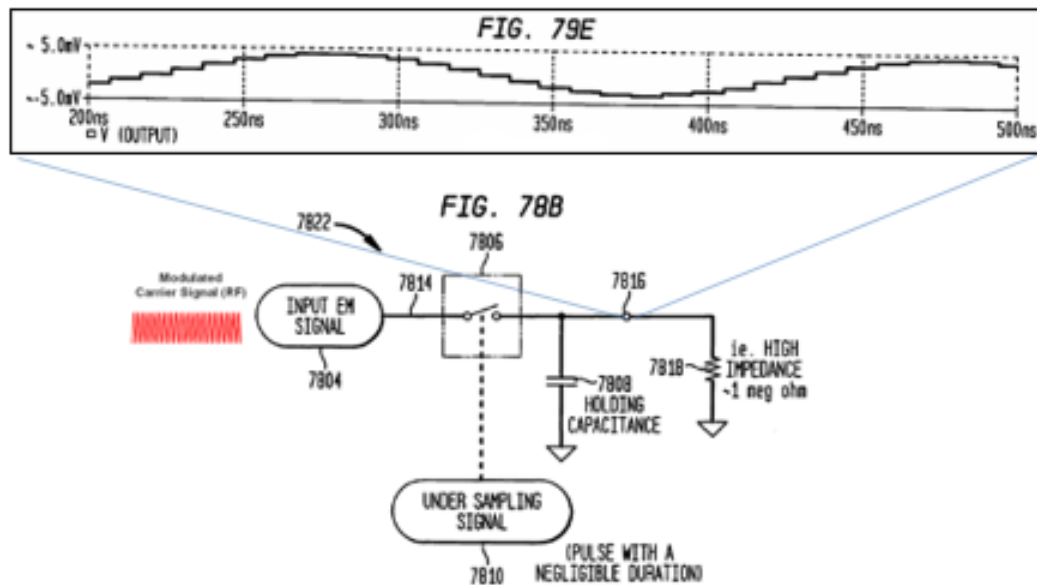
The annotations in Figure 78B illustrate how a sample and hold system down-converts a high frequency input EM signal 7804 (e.g., modulated carrier signal (red)) to a baseband signal. Ex.-2006, ¶145.



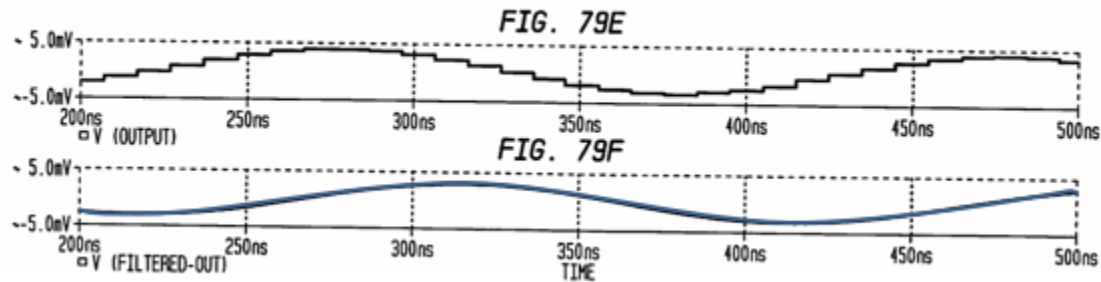
As shown in Figure 79C, the switch is turned ON (closed) by sending a pulse 7904 (green vertical line) of an extremely short/negligible duration to the switch. Thus, the aperture (purple) of a pulse is referred to as a negligible aperture because the pulse width “tend[s] toward zero time.” ’551 patent, 63:45-47. As shown by the repetitive pulses 7904, this opening and closing of the switch repeats continuously over time. Ex.-2006, ¶146.

As shown in Figure 78B above, when the switch is ON (closed) (during the aperture), the EM signal 8204 (blue) is sent to the “holding” capacitor 7808. When the pulse 7904 (green) stops, the switch is turned OFF (opened). But unlike energy transfer (energy sampling), since sample and hold uses a high impedance load, when the switch is OFF (opened), there is high resistance to the flow of current and, thus, the “holding” capacitor holds a constant voltage value. Because there is no significant energy discharge between pulses, the terminal 7816 maintains a constant voltage value until the next pulse. *Id.*, 64:21-26. The voltage value serves as the “sample” of a discrete voltage value that the system uses to recover the baseband signal. In particular, the system uses each discrete change (increase/decrease) in the

voltage value over time to recover the baseband. This is unlike energy transfer (energy sampling) which uses the energy from the input EM signal provided to a low impedance load to recover the baseband. Ex.-2006, ¶¶147-148.



As shown in Figure 79E, sample and hold produces a voltage wave with a stair step pattern. The vertical part of the step represents the “sample” of the voltage value which occurs at the time of pulse 7904. The horizontal portion of the step represents the “holding” of that voltage value until the next pulse when the next sample of voltage is taken. ’551 patent at 64:26-30; *see also* Ex.-2006, ¶149.



As shown above, the waveform of Figure 79E is filtered to create a smooth waveform (dark blue) as shown in Figure 79F. Ex.-2006, ¶150.

**C. The claims of the '686 patent are directed to energy transfer (energy sampling).**

The claims of the '686 patent are specifically directed to *energy* transfer (*energy* sampling). Indeed, the claims specifically use terms that connote an energy transfer (energy sampling) system as discussed in Section VI.B.1. *See also* Ex.-2006, ¶¶151-154.

Claims 1 and 11 recite “a switch configured to operate according to an *energy transfer signal*, and to *sub-sample* and *transfer energy* from a first electromagnetic (EM) signal.”<sup>3</sup>

<sup>3</sup> Unless otherwise noted, all emphasis has been added.

Claim 11 further recites “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*.”

**D. Prosecution History.**

The '686 patent was filed on October 27, 2004, as a continuation of U.S. Application No. 09/569,044, which issued as U.S. Patent No. 6,873,836 (the '836 patent).

On March 26, 2008, the USPTO issued a Non-Final Office Action, rejecting pending claims 5-22. In particular, the Examiner rejected claims 5-10, 12-19, and 21-22 under 35 U.S.C § 102(e) as being anticipated by U.S. Patent No. 6,894,988 to Zehavi. Claims 11 and 20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Zehavi.

An examiner interview was conducted on July 22, 2008, focusing on independent claims 5 and 14. The Examiner's Interview Summary indicates that the parties discussed amending these claims to incorporate allowable subject matter from claim 5 of the '836 patent.

On July 28, 2008, Applicants submitted an amendment and remarks in response to the outstanding Office Action. Specifically, the amendment added language directed to a frequency translating module including:

at least one frequency translating module comprising 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.

Following this amendment, the Examiner issued a Notice of Allowance (NOA) on October 3, 2008, allowing all pending claims. In the NOA, the Examiner indicated that U.S. Patent No. 7,193,965 to Nevo et al., cited in an Information Disclosure Statement, was considered during examination. The '686 patent subsequently issued on January 27, 2009.

## **E. Claim Construction**

### **1. Switch.**

The PTAB has previously construed the term “switch” in IPR2021-00346 related to in U.S. Patent No. 8,190,108 to mean “an electronic device for opening and closing a circuit.” *Intel Corp. v. ParkerVision, Inc.*, IPR2021-00346, Paper 33 at 25-26 (PTAB Jun. 30, 2022). The Federal Circuit affirmed this construction in a Rule 36 judgment. *ParkerVision, Inc. v. Vidal*, No. 2022-2173, at 2. ParkerVision uses this construction with regard to the challenged claims.

### **2. Energy transfer signal.**

Independent claims 1 and 11 of the '686 patent each recite “a switch configured to operate according to an energy transfer signal.” A POSITA would

understand that an “energy transfer signal” is “an independent control input of an energy transfer system having pulses with non-negligible apertures.” Ex.-2006, ¶161.

The specification specifically states that “[w]hen the pulses of the control signal 2006 have non-negligible apertures... *the control signal 2006 is referred to as an energy transfer signal.*” ’686 patent, 13:27-31.

As shown in Figures 51A-51B, 61 of the ’686 patent (and Figures 46A-46D, 48, 50C, 57C, 63, 64A-64B, 65, 67A-67B, 68G, 69, 74, 76A, 76C, 76D, 82A, 82B, 83C, 85A, 85C, 94A, 95) and as discussed in Section VI.B.1, the specification of the ’686 patent (and the incorporated ’551 patent) specifically reserves the term “energy transfer signal” to be used exclusively to describe the signal in an energy transfer system. The specification reserves the term “under sampling signal” to be used exclusively to describe the signal in a sample-and-hold (voltage sampling) system. Ex.-2006, ¶163.

Moreover, the specification discloses that the energy transfer signal is an independent control input – i.e., the signal is a separate input from the signal input into switch and the signal output from the switch. *See* Figures 1A-1C, 2, 19, 20A, 20A-1, 25B, 28, 29, 45A-45D, 47, 51A, 51B, 61; ’551 patent, Figures 28A-28D, 63, 64A, 64B, 65, 66A-66D, 67A, 68G, 69, 74, 76A-76E, 82A, 82B, 94A, 95; Ex.-2006, ¶164.

The use of an independent control input is not merely an embodiment. Ex.-2006, ¶164. It is how the claimed system works. *Id.* The systems shown in the figures identified above would not work to transfer energy and generate a signal from storage energy without the energy transfer signal being an independent control input. *Id.*

### **3. Storage module.**

Claim 11 recites a “storage module.” The PTAB has previously construed the term “storage element” in IPR2020-01265 related to U.S. Patent No. 7,110, 444 to mean “an element of a system that stores non-negligible amounts of energy from an input EM signal.” The Federal Circuit agreed with the PTAB’s construction. *See ParkerVision, Inc. v. Vidal*, 88 F.4th 969, 977 (Fed. Cir. 2023). ParkerVision uses this construction with regard to “storage module” in the challenged claims.

### **4. Coupled.**

Claim 11 recites “a storage module coupled to said switch.” The term “coupled” is straightforward and does not require construction; it should be given its plain and ordinary meaning.

MediaTek contends that “coupled” should be construed as “directly connected or connected through a wire (or a closed switch).” Pet., 19. However, MediaTek’s proposed construction would exclude express embodiments described in the ’686 patent specification. *See Oatey Co. v. IPS Corp.*, 514 F.3d 1271, 1276 (Fed. Cir.

2008) (“We normally do not interpret claim terms in a way that excludes embodiments disclosed in the specification.”).

Indeed, for specific embodiments, the '686 patent uses the term “coupled” to describe a connection between one circuit component (such as a UFT module) and another (such as a reference potential) that includes an intervening component (such as a resistor). This is seen below. As such, according to the '686 patent, “coupling” can include indirect coupling, i.e., where there is an intermediate component(s) (such as a resistor) that exists between two components but that maintains an electrical connection therebetween.

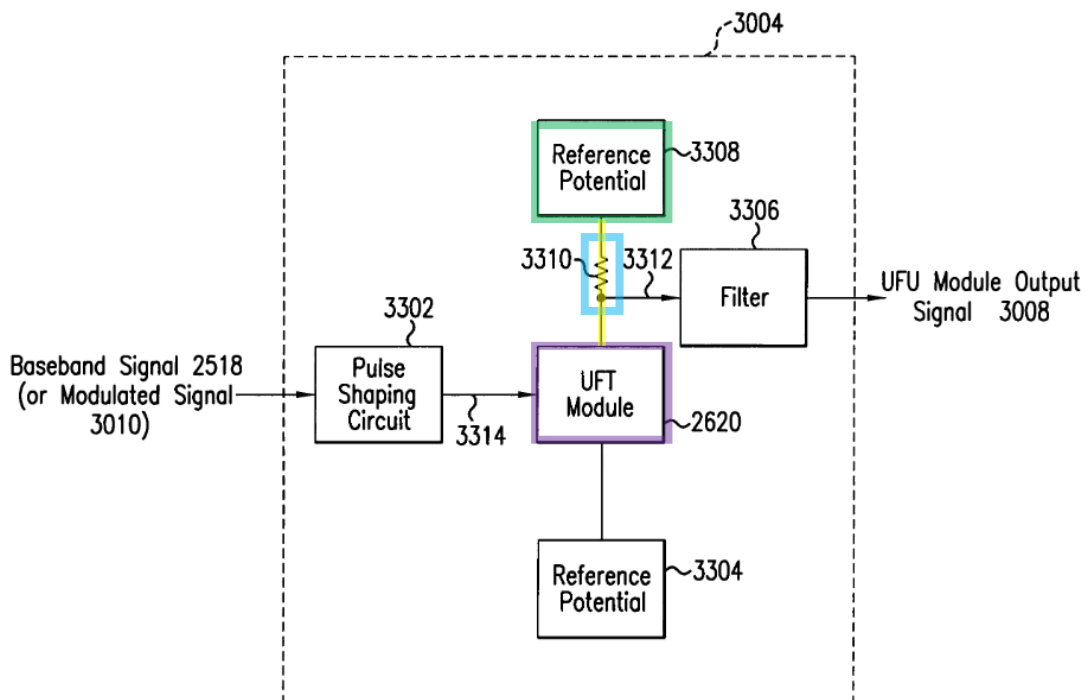
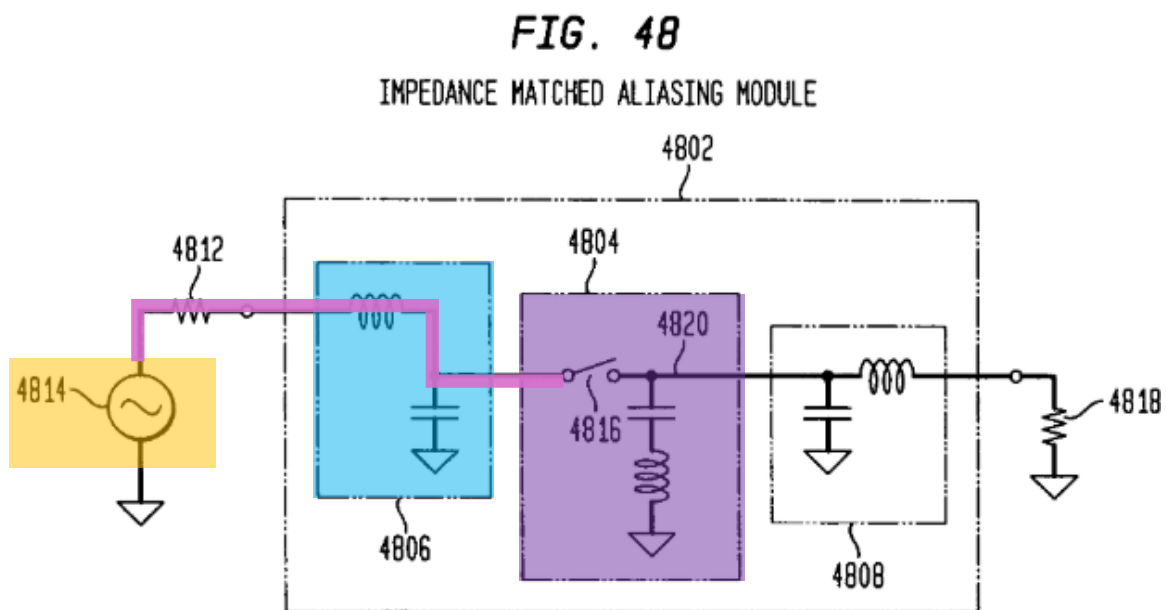


FIG.33

Figure 33 of the '686 patent (above) illustrates a UFT module 2620 (purple box) connected to a reference potential 3308 (green box) along a conductive path (yellow). Here, there is an intervening resistor 3310 (blue box) in the conductive path (yellow) between the UFT module 2620 and reference potential 3308. And, the specification describes “[o]ne terminal of UFT module 2620 is coupled to a first reference potential 3304. The second terminal of UFT module 2620 is coupled through resistor 3310 to a second reference potential 3308. ’686 patent, 46:45-48.



Likewise, Figure 48 of the '686 patent (above) illustrates a switch 4816 connected to a voltage source 4814 (orange box) along a conductive path (pink). Here, there is an intervening impedance matching circuit (blue) in the conductive path (pink) between the switch (purple) and voltage source (orange). And, the specification explains that this impedance matching circuit 4806 (blue) “can be

utilized to efficiently couple an input EM signal [orange box] that has a source impedance of, for example, 50 ohms, with the energy transfer module's [purple box] impedance of, for example, 300 ohms." '686 patent, 14:57-61.

The district court agreed with ParkerVision in related litigation, adopting the Special Master's recommendation that the term should be "construed as plain-and-ordinary meaning wherein 'coupled' includes both direct and indirect connections." Ex.-2008, 25-30. The Court rejected MediaTek's position. *Id.*

To support its position, MediaTek cites the district court's claim construction order related to a *different* ParkerVision patent. But the patent in that case has a different disclosure than the '686 patent.

For the foregoing reasons, "coupled" should be given its plain and ordinary meaning.

## **5. Multi-platform module.**

The parties agree that "multi-platform module" in claims 1 and 11 should be given its plain-and-ordinary meaning. The term is straightforward, and there are no unclear words. MediaTek does not allege otherwise, and thus the term does not require construction.

However, under the guise of "plain and ordinary meaning," MediaTek improperly seeks to limit "platform" to "a communications protocol and/or bearer service." Pet., 19.

The '686 specification discloses that “[t]he UPM utilizes protocols and/or bearer services and/or combinations thereof to exchange and/or process information with other components on any given network or networks (or any communication medium, for that matter).” ’686 patent, 7:48-52; *see also id.*, 7:52-8:18. The specification further describes embodiments that “can operate according to *multiple protocol/bearer service combinations* (FIG. 39) *and/or multiple communication link/types* (FIG. 40).” *Id.*, 38:39-43; *see also, e.g., id.*, 38:44-55; 8:30-36. These concepts are missing from MediaTek’s construction.

The district court agreed with ParkerVision in related litigation, adopting the Special Master’s recommendation that the term should be “construed according to its plain-and-ordinary meaning.” Ex.-2008, 49-53. The Court rejected MediaTek’s position. *Id.*

For the foregoing reasons, the Board should adopt ParkerVision’s construction.

## **6. Sub-sample.**

The parties agree that the term “sub-sample” refers to sampling at an aliasing rate. *See Pet.*, 20.

## VII. OVERVIEW OF THE ALLEGED PRIOR ART

### A. U.S. Patent No. 6,600,726 (“Nevo”)

U.S. Patent No. 6,600,726 to Nevo et al. (“Nevo”) issued on July 29, 2003, and is entitled “Multiple Wireless Communication Protocol Methods and Apparatuses.” See Ex.-1004. Nevo discloses a wireless device that facilitates communication across multiple wireless networks. *Id.*, Abstract. In particular, Nevo describes a wireless device “with at least one wireless transceiver and at least one controller manager to transmit and receive signals wirelessly to and from network devices of a first and second wireless network, in a coordinated manner, in accordance with a first and a second protocol respectively.” *Id.*

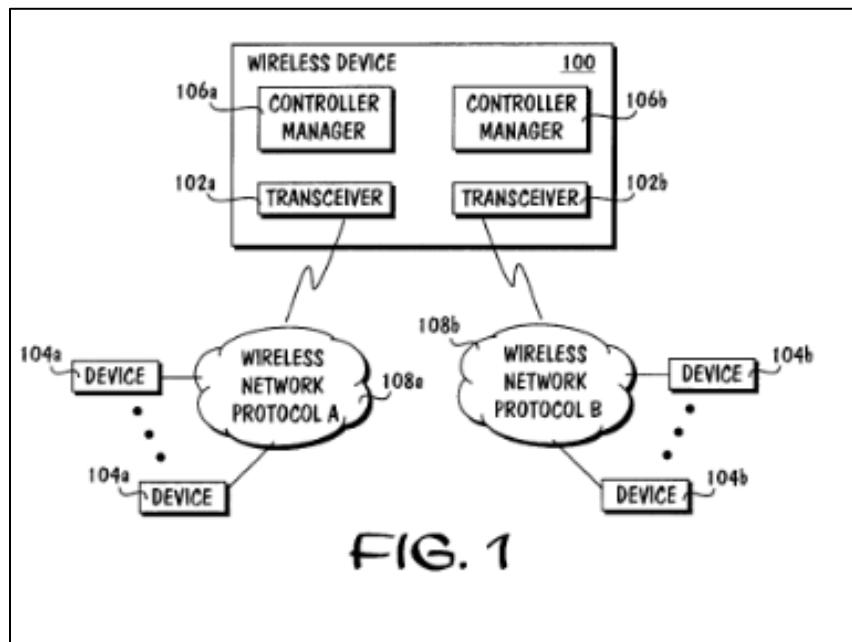


Figure 1 of Nevo (above) illustrates a wireless device 100 having controller managers 106a/106b that operate a plurality of transceivers 102a/102b to

communicate with respective communication networks running different wireless network protocols 108a/108b, including Bluetooth, IEEE 802.11, and Home RF. *Id.*, 3:27-35, 4:46-55.

**B. Avitabile et al., “S-band digital downconverter for radar applications based on GaAs MMIC fast sample-and-hold” (“Avitabile”)**

Avitabile (Ex.-1006) describes a “digital downconverter configuration which performs complex detection by means of a *sample-and-hold (SH)* in a single step by using a single-channel configuration.” Ex.-1006, 337. Avitabile explains that “[t]he key element of the down-converter is a very fast sampling circuit directly operating within the S-band.” *Id.*

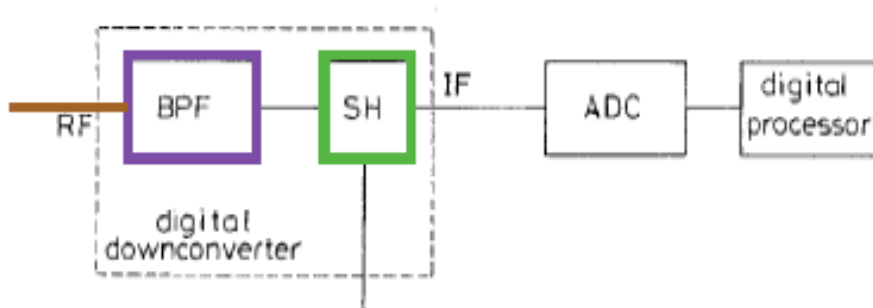


**Fig. 1** Schematic diagram

As shown in Figure 1 above, Avitabile illustrates a block diagram of the digital down-converter configuration, including a bandpass filter (purple) and *sample-and-hold (SH)* circuit (green). An incoming signal (brown) is filtered through a bandpass filter (purple) and directed to the SH circuit (green) for complex sampling. *Id.* After sampling, the signal is fed to an A/D converter (ADC) for digital conversion. “As

the digital conversion [at the ADC converter] requires each sample to be held to a fixed value during the conversion interval, it is convenient to perform both *sampling and holding* operations in one step,” which is accomplished by the S/H circuit. A POSITA would understand that an ADC has a high input impedance so that it can accurately measure the voltage on its input and convert this voltage into a digital signal. *Id.*, 340 (referring to “commercially available A/D converters.”); *see also* Ex.-2006, ¶¶182-185.

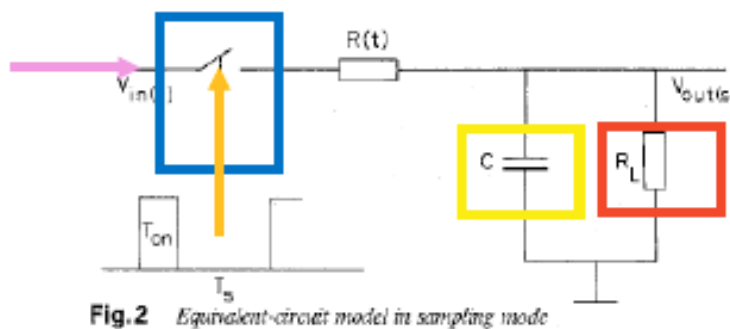


Figure 2 of Avitabile illustrates a S/H circuit including a switch (blue), a hold capacitor (yellow) and load (implemented as a resistor  $R_L$ , red). Ex.-2010, 53:14-17. According to Avitabile, “[i]n the circuit of Fig. 2, C and  $R_L$  represent, respectively, the hold capacitor and the load of the buffer stage following the SH circuit.” Ex.-1006, 338. As discussed below, resistor  $R_L$  is high impedance. Ex.-2006, ¶¶186-187. A POSITA would understand that  $R_L$  is designed to have very high impedance, as a “buffer stage” following the S/H circuit is intended to buffer the signal. *Id.*; *see also* Ex.-2010, 55:3-56:20; 57:17-58:22. This buffering function isolates the input from

the output, ensuring that the signal is not disturbed by downstream components. *Id.*; *see also* Ex.-2010, 59:1-11. Moreover, the buffer does not allow energy to flow through it, rather it reads the voltage at its input and then produces that voltage at its output, isolating the output from the input. *Id.*

Avitabile discusses two implementations for voltage sampling: (i) impulse sampling, where “[t]he switch is turned on for a very short time interval  $t_{on}$  whose duration is inversely proportional to the RF bandwidth”; and (ii) track-and-hold (TH), where “the input RF signal is sampled after a convenient acquisition time  $t_{ac}$ , defined as the time to settling within 1/2 LSB of steady-state at full-speed input signal.” Ex.-1006, 338-339.

As shown in Figure 2 above, in either implementation, an input signal (pink arrow) is received by the switch (blue). The switch is turned ON (closed) by sending a pulse (orange arrow) to the switch. When the switch is ON (closed), the input signal is sent to the “hold” capacitor (yellow). When the switch is OFF (opened) the voltage at the output is held at a constant voltage level so that an ADC can read its value. Ex.-2010, 62:18-63:13. A POSITA would understand that the resistor  $R_L$  (red) is a high impedance load, because Avitabile specifically states that “at the time the switch is turned off, nominally the whole of the input waveform drops across the hold capacitor.” *Id.*, 339; Ex.-2006, ¶191; Ex.-2010, 64:10-65:2.. And a POSITA understands that in order to hold voltage on the capacitor, resistor  $R_L$  must be a high

impedance load. *Id.* The high impedance load prevents the holding capacitor (yellow) from discharging. *Id.*; see also Ex.-2010, 59:12-60:15.

Avitabile discloses two different S/H prototypes based on a diode bridge sampling function: SH1 prototype and SH2 prototype.

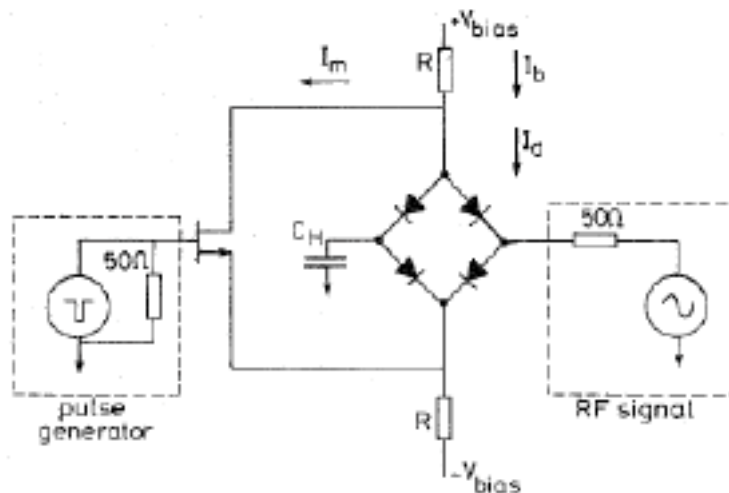


**Fig.4** Schematic diagram of SH1 sample-and-hold circuit

Figure 4 of Avitabile illustrates the SH1 prototype. The SH1 prototype follows the same operation as the S/H circuit described above:

In the sample mode, the switching MESFET is turned off and the diodes of the bridge are directly biased, letting the input waveform drop across  $C_H$ . In the hold mode, the MESFET is turned on. The voltage difference between drain and source drops to about 0.5V. Consequently the two series-connected diodes in the two arms of the bridge become inversely biased and the hold capacitor is disconnected by the RF source.

Ex.-1006, 340. A POSITA would understand that in the “hold” mode, the voltage at the output is held at a constant voltage level so that an ADC can read its value: the hold period “is consistent with the acquisition time of several commercially

available A/D converters.” *Id.*; Ex.-2006, ¶194. In other words, in the “hold mode,” the SH1 prototype is designed to prevent discharge from the hold capacitor  $C_H$ . Ex.-2006, ¶194.

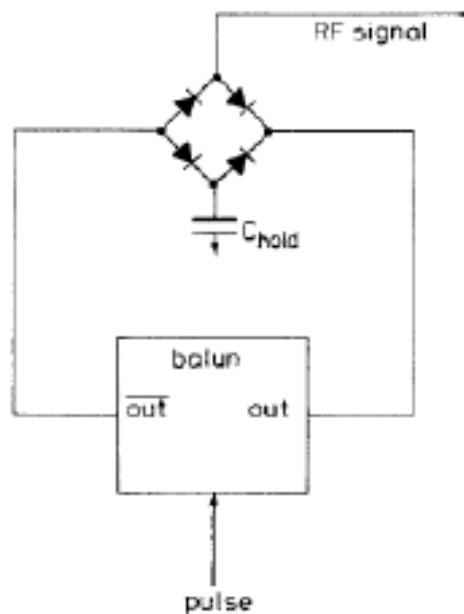


**Fig.8** Downconverter schematic diagram

Figure 8 of Avitabile illustrates the SH2 prototype. Similar to SH1 prototype, the SH2 prototype follows the same operation as the SH circuit described above. Ex.-2006, ¶195.

In a “sample” mode, the balun delivers a current pulse that biases the diode bridge to conduct, sending the input signal to the hold capacitor  $C_H$ . In “hold” mode, the balun sends a pulse with the opposite polarity, disconnecting the hold capacitor  $C_H$  from the input signal. A POSITA would understand that the SH2 prototype is designed to prevent the hold capacitor  $C_H$  from discharging in the “hold” mode,

allowing the ADC to capture an accurate analog voltage. Ex.-2006, ¶¶196-197. In the “hold mode,” the SH2 prototype is designed to prevent discharge from the hold capacitor CH. *Id.*

**C. U.S. Patent No. 6,643,522 (“Young”)**

U.S. Patent No. 6,643,522 to Young (“Young”) issued on November 4, 2003, and is entitled “Method and apparatus providing simultaneous dual mode operations for radios in the shared spectrum.” See Ex.-1003.

Young describes a system and method for enabling a single wireless device to operate in two different communication modes within the same shared spectrum, specifically addressing interference and desensitization issues when multiple radios operate simultaneously in close proximity. *Id.*, 2:37-67. Young proposes a hardware-based approach that allows two radios, each using a different air interface, to share a common antenna and front-end circuitry while minimizing interference. Ex.-2006, ¶199.

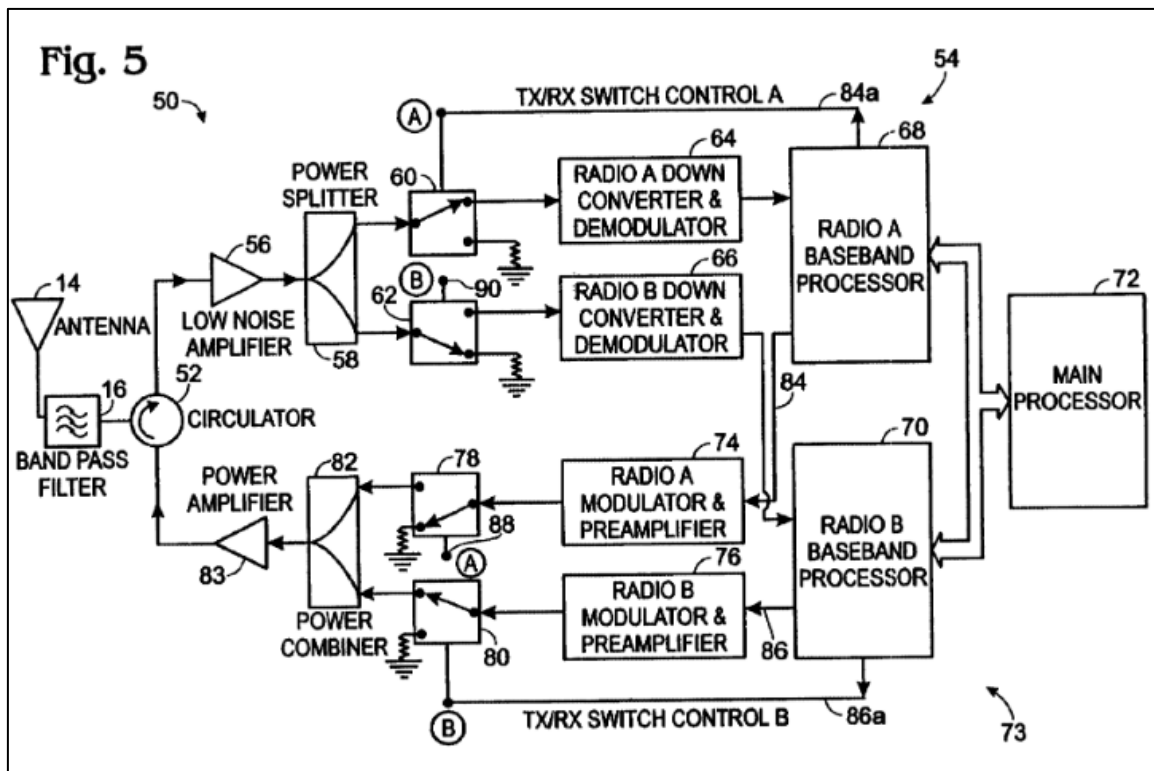


Figure 5 of Young (above) illustrates the architecture of a wireless transceiver 50 that incorporates two radios—Radio A and Radio B—operating on different air interfaces. Ex.-1003 at 5:66-6:2. Transceiver 50 uses a circulator 52 as part of an isolation mechanism, enabling simultaneous operation of both radios by directing signal flow in a controlled manner to prevent transmitter power from desensitizing the receivers. *Id.*, 6:56-66. The receive chain 54 of transceiver 50 includes a low-pass amplifier 56 and a power splitter 58, which divides incoming signals for processing by both radios. *Id.*, 6:3-6. Each radio's receive path includes a transmit/receive (Tx/Rx) switch—60 for Radio A and 62 for Radio B—followed by a down converter/demodulator 64, 66 and a baseband processor 68, 70. *Id.*, 6:6-12.

A main processor 72 coordinates transceiver functions, managing both radios' operations. *Id.*, 12-13.

#### D. Estabrook-Thesis

Polly Estabrook's dissertation *The Direct Conversion Receiver: Analysis and Design of the Front-End Components* (Ex.-1005, "Estabrook-Thesis"), discusses the design of direct conversion receivers. Estabrook-Thesis generally examines how direct conversion techniques can be used for single-channel reception in low-cost, compact transceivers, particularly by eliminating the need for intermediate frequency (IF) stages used in traditional superheterodyne receivers. Ex.-1005, 8-9; Ex.-2006, ¶¶203-204.

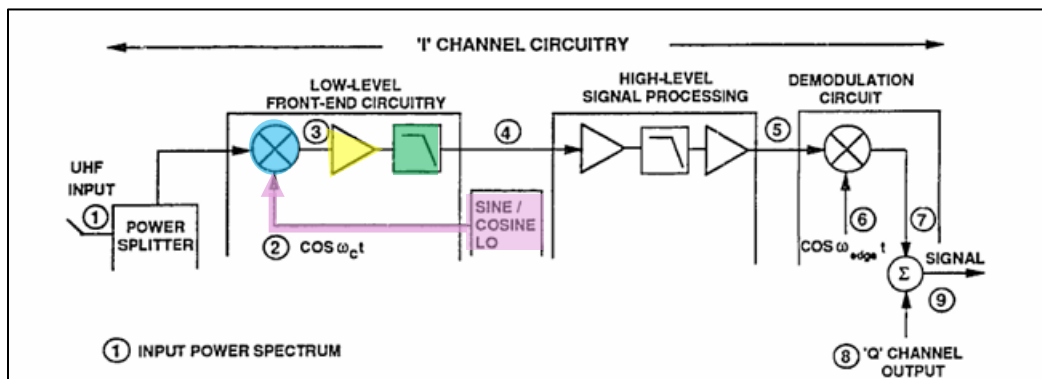


Figure 4 of Estabrook-Thesis illustrates a direct down conversion receiver including a mixer (blue), an amplifier (yellow), a filter (green), and a sinusoidal signal (sine/cosine LO) (pink) that is input to the mixer.

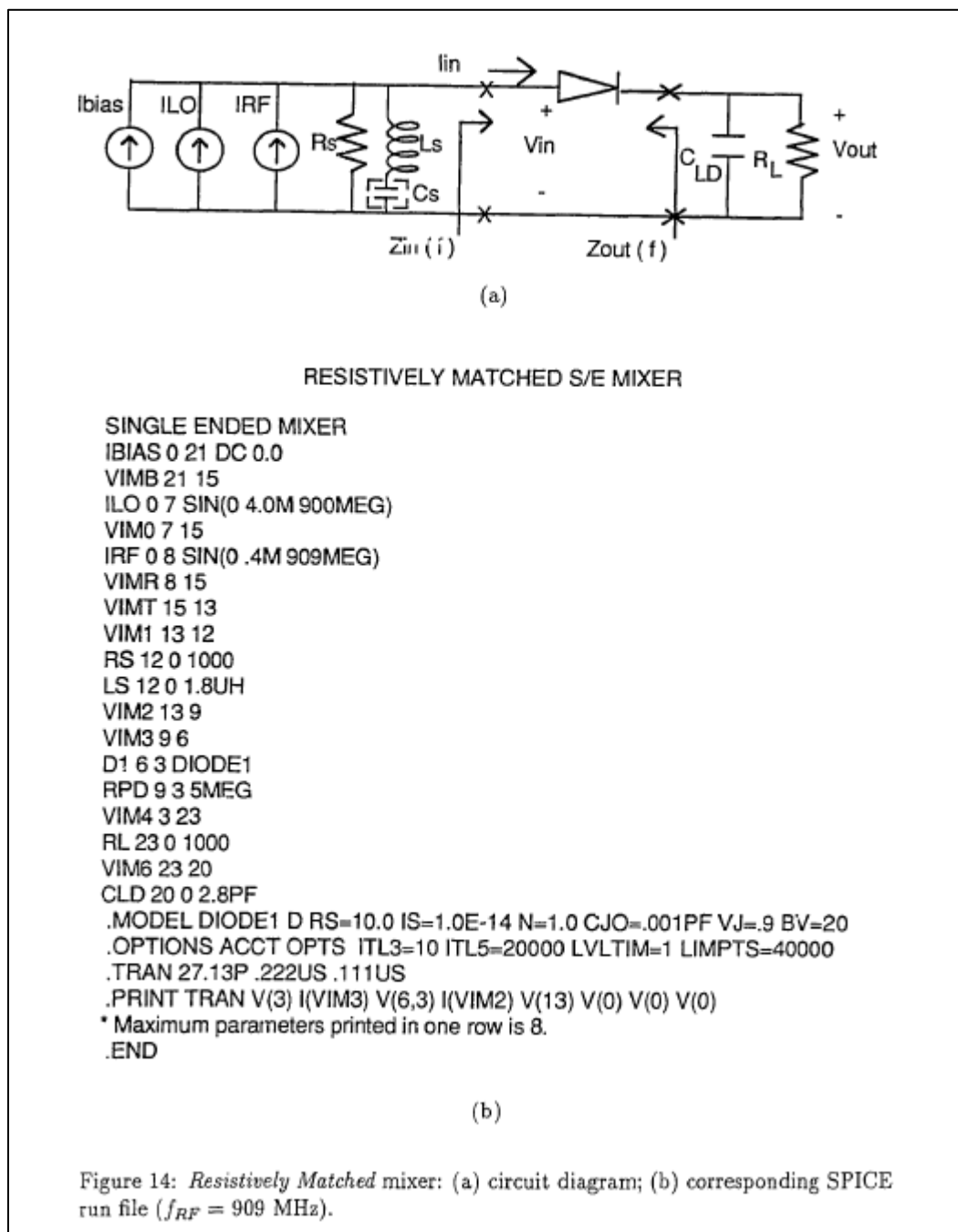


Figure 14(a) of Estabrook-Thesis (above) illustrates a resistively matched single-ended mixer, featuring a diode-based mixer topology with an input signal processed through a resistive matching network. The SPICE simulation run file

(Figure 14(b)) details the electrical parameters used to simulate the mixer's transient response. Ex.-2006, ¶206.

### E. Estabrook-1988

Estabrook-1988 is an IEEE paper entitled, "A Mixer Computer-Aided Design Tool Based In the Time Domain." *See* Ex.-1016. The paper describes a time-domain approach to mixer circuit design and presents a computational tool that facilitates analysis of RF mixer circuits.

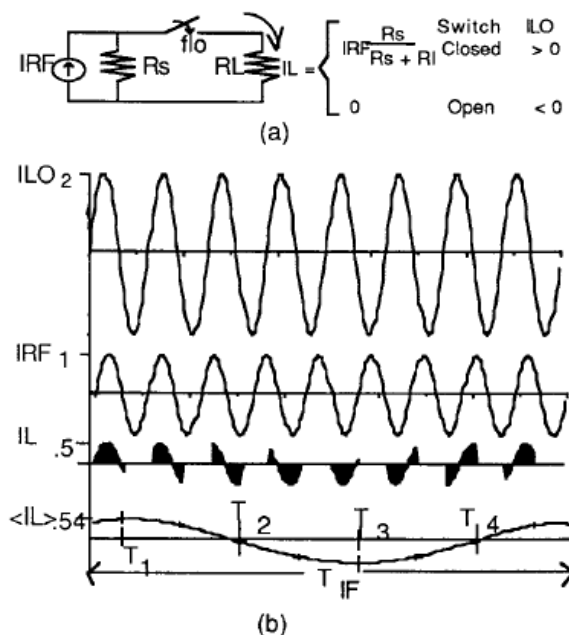


Figure 2. Mixer modelled as a simple switch:  
(a) circuit diagram; (b) waveforms.

As shown above, Figure 2(a) of Estabrook-1988 shows the theoretical operation of an ideal mixer with a switch driven at a local oscillator frequency  $f_{LO}$ . Figure 2(b) plots the current waveforms of the LO signal (ILO), RF signal (IRF),

current in resistor  $R_L$  ( $I_L$ ) and its value averaged over one LO period ( $\langle I_L \rangle$ ). Ex.-

2006, ¶210.

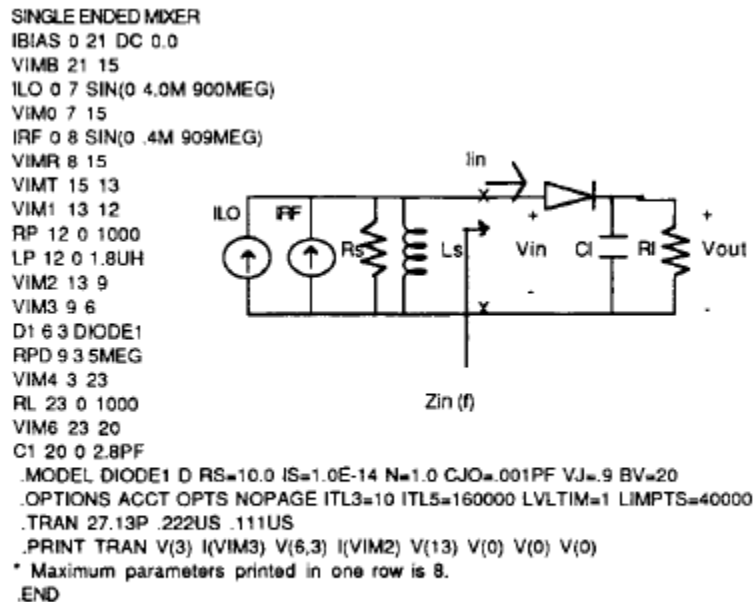


Figure 3. Resistively matched single-ended mixer: circuit diagram and corresponding SPICE run file.

Figure 3 of Estabrook-1988 (above) presents the circuit design of a simple broadband single-ended mixer using a purely resistive diode. Ex.-2006, ¶211. MediaTek acknowledges that Figure 3 above “has 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 VOUT.” Pet., 92. MediaTek also acknowledges that “Estabrook-1988 shows the output VOUT of this circuit as the same waveform shown in Figure 16(a) of Estabrook-Thesis.” *Id.*, 92-93.

## F. Estabrook-1989

Estabrook-1989 is an IEEE paper entitled “The Design of a Mobile Radio Receiver using a Direct Conversion Architecture.” *See* Ex.-1017. The paper discusses the implementation of a direct conversion receiver (DCR) and explains advantages of using a direct down-conversion architecture instead of conventional heterodyne receivers. Ex.-2006, ¶213.

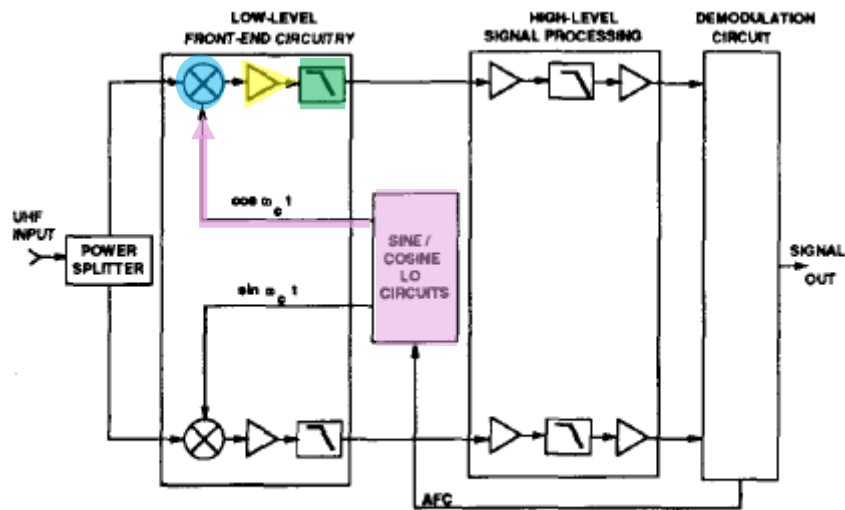


Figure 1: The direct conversion receiver.

Figure 1 in Estabrook-1989 (above) provides a high-level architecture of the direct conversion receiver, which includes an RF mixer at the front end. Just like Figure 4 in Estabrook-Thesis shown in Section VII.D above, Figure 1 of Estabrook-1989 includes a mixer (blue), an amplifier (yellow), a filter (green), and a sinusoidal signal (sine/cosine LO) (pink) that is input to the mixer. Ex.-2006, ¶214.

## **VIII. MEDIATEK HAS NOT SHOWN THAT THE CHALLENGED CLAIMS OF THE '686 PATENT ARE UNPATENTABLE**

### **A. Ground 1: Nevo in view of Avitable.**

MediaTek asserts that claims 1-20 of the '686 patent are unpatentable as obvious over Nevo and Avitable. However, as discussed below, MediaTek has failed to meet its burden of proving that the challenged claims are unpatentable.

Nevo discloses a multi-protocol wireless device with transceivers that can operate on various protocols, including Bluetooth and IEEE 802.11. But Nevo does not provide the specific circuitry required for frequency translation.

MediaTek acknowledges that Nevo fails to teach or suggest each and every limitation of the independent claims of the '686 patent. Specifically, MediaTek concedes that Nevo “does not provide the particular circuitry for performing down-conversion.” Pet., 25. So, MediaTek turns to Avitable to remedy this deficiency. But as discussed below, Avitable fails to cure the deficiencies in Nevo.

#### **1. Nevo/Avitable do not teach (or suggest) “wherein a second EM signal is generated from said stored energy” (claim 11)**

Avitable does not teach or suggest the limitation “wherein a second EM signal is generated from said stored energy,” as recited in independent claim 11.

As discussed above in Section VII.B, Avitabile discloses a sample-and-hold (voltage sampling) system and states that the capacitor is a hold capacitor.<sup>4</sup> As a sample-and-hold (voltage sampling) system, a POSITA would understand that Avitabile seeks to (1) accurately capture the voltage of the input signal at the sampling instant, and (2) hold the voltage reading on the capacitor to recreate a down-converted signal. Ex.-2006, ¶¶224-225; Ex.-2010, 49:10-18. Thus, no signal is being generated from the energy stored on the capacitor of Avitabile. *Id.*, ¶226. To the contrary, Avitabile is specifically configured to hold the charge in the capacitor (and prevent discharge). *Id.*, ¶227. If the capacitor discharged, the voltage on the capacitor could not be accurately read/reproduced and Avitabile would not work as a sample/hold circuit. *Id.*

The USPTO specifically considered Avitabile in a recent reexamination and determined that as a sample-and-hold system, Avitabile was not generating a signal from stored energy. Ex.-2009, 4-8.

MediaTek asserts that “Avitabile describes generating an IF (intermediate frequency) signal from that stored energy (second EM signal having a frequency

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<sup>4</sup> MediaTek's expert agrees that Avitabile describes as a “sample-and-hold” circuit.” Ex.-2010, 89:10-90:9.

different from  $V_{in}(t)$  (first EM signal)).” Pet., 44. However, MediaTek’s assertion is unsupported and ignores the actual claim language.

MediaTek never addresses how Avitabile’s IF signal is generated from “stored energy,” as required by claim 11. Indeed, MediaTek provides no explanation or citation from Avitabile that demonstrates how an IF signal is generated from “stored energy.” See Pet., 44-45. It cannot.

The voltage across the capacitor in Avitabile is not accumulated “energy.” Ex.-2006, ¶228; Ex.-2010, 37:20-28:7. In a voltage sampling system (as described in Avitabile), the voltage across the capacitor is merely a snapshot of the sampled input signal at a discrete moment in time. A POSITA would recognize that this voltage represents the input signal’s instantaneous voltage captured at the sampling instant. *Id.*

In particular, the sample-and-hold circuit in Avitabile takes a sample of the input signal by turning the switch ON (closing the switch) and OFF (opening the switch). Ex.-2006, ¶234. When the switch is turned ON, “the input waveform drops across the hold capacitor.” Avitabile, Ex.-1006, 339. When the switch is turned OFF, the switch opens and the *hold* capacitor maintains a constant voltage value until the next pulse. Ex.-2006, ¶234. Specifically, the voltage is held on the capacitor by using a high impedance load. Ex.-2006, ¶228. During a “hold” period, the voltage is held at a constant voltage level so that the ADC can read its value. *Id.*, ¶¶228-229.

Avitabile discloses that the system samples and then holds the signal: “The 1.6 ns hold time measured is consistent with the acquisition time of several commercially available A/D converters.” Ex.-1006, 340. In other words, during the hold time, Avitabile is designed to prevent discharge from the hold capacitor. Ex.-2006, ¶229.

A POSITA would understand that the high impedance load causes the capacitor to *hold* charge so that an accurate voltage across the capacitor could be determined. Ex.-2006, ¶235. Without a *high* impedance load, energy would be discharged from the capacitor toward the load and the system could not accurately determine the voltage (i.e., the system would not work properly). *Id.*, ¶236. Because the sample-and-hold system of Avitabile uses a high-impedance load, no energy from the RF signal is conveyed with the baseband signal. *Id.*, ¶237.<sup>5</sup>

Notably, MediaTek's expert, Dr. Larson, admitted during deposition that the intermediate frequency signal in Avitabile is a voltage. Ex.-2010, 94:5-13. A POSITA would understand that voltage and energy are distinct concepts: voltage is

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<sup>5</sup> In practical implementations, there may be some dissipation of energy, which Avitabile refers to as “droop off.” Ex.2006, ¶¶232-233, 237. This “droop off” represents the loss of energy during the hold period, but it does not contribute to the formation of the baseband signal. *Id.*

the potential difference between two points, while energy involves the transfer and accumulation of power over time. Ex.-2006, ¶¶41-44.

The voltage value serves as the “sample” of a discrete voltage value that the system can then use to recover the baseband signal. *Id.*, ¶230; *see also* Ex.-2010, 94:5-13. Thus, Avitabile is not using energy (stored or otherwise) to generate the claimed second signal. *Id.*, ¶231. This is fundamentally different than an energy transfer (energy sampling) system, which uses the energy from the input signal provided to a low impedance load to generate a second signal (i.e., the sampled energy makes up/becomes part of the second signal). *Id.*

Therefore, Nevo and/or Avitabile does not teach or suggest generating a second EM signal from stored energy as specified in claim 11.

**2. Nevo/Avitabile do not teach (or suggest) “a switch configured to operate according to an energy transfer signal” (claims 1 and 11)**

Claims 1 and 11 recite “a switch configured to operate according to an energy transfer signal . . . and transfer energy.”

As discussed above in Section VI.E, an “energy transfer signal” is a signal of an energy transfer system. As set forth in Section VII.B, however, Avitabile is a sample-and-hold system. And the Federal Circuit specifically found that ParkerVision’s energy transfer (energy sampling) technology is different from voltage sampling: “ParkerVision’s down-converting system uses a technique called

‘energy sampling,’ which differs from the technique of ‘voltage sampling,’ which was used in conventional down-converting systems.” *ParkerVision*, 116 F.4th 1345, U.S. App. LEXIS 22686, at \*2-3 (Fed. Cir. 2024).

Therefore, Nevo and/or Avitabile does not teach or suggest an energy transfer signal as specified in claims 1 and 11.

**3. Nevo/Avitabile do not teach (or suggest) “a plurality of protocol/standard sub-modules” or “operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination” (claims 1 and 11)**

Claims 1 and 11 recite an apparatus comprising “at least one *multi*-platform module” including “a plurality of transceivers” that communicates with “at least one of a plurality of communication links” using a control module “having a *plurality of protocol/standard sub-modules*.” A POSITA would understand that the plurality of transceivers must therefore comply with/meet protocols/standards. Ex.-2006, ¶246. Claim 11 recites a method comprising “operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination.” A POSITA would understand this to mean that the transceivers must comply with/meet protocols/standards. *Id.* The first and second transceivers are part of the claimed “plurality of transceivers” having a “frequency translation module” comprising the claimed switch and storage module. *Id.*

MediaTek asserts that because Nevo describes using several well-known protocols (including Bluetooth and IEEE 802.11) and acknowledges the need for down-converters, a POSITA would have been motivated to look to Avitable for the required circuitry. Pet., 25. Because MediaTek relies on Avitable for the circuitry of the claimed frequency translation module, Avitable's circuitry (incorporated into Nevo) must comply with a "plurality of protocols/standards" (claim 1) and operate "in conformance with a [first/second] protocol/standard combination" (claim 11). MediaTek, however, provides no evidence that Avitable's circuitry complies with or operates in conformance with any protocol/standard. The reason that MediaTek fails to provide such evidence is because, as discussed below, Avitable's circuit has not been shown to comply with or be in conformance with protocols/standards. See Ex.-2006, ¶¶ 250-256.

Avitable is directed to an S-band digital downconverter designed for radar applications. It does not account for the protocol-specific modulation, error correction, and synchronization requirements necessary for Bluetooth or IEEE 802.11 operation.

Even if combined with Nevo, Avitable's does not disclose how it would meet fundamental performance requirements in terms of dynamic range, sensitivity, and interference tolerance, which are essential for Bluetooth and IEEE.11 compliance:

Dynamic Range: Bluetooth and IEEE 802.11 require transceivers to support a wide range of signal levels from strong (-10 dBm) to weak (-90 dBm) signals. Avitabile's sample-and-hold (SH) circuit lacks automatic gain control (AGC) or any adaptive mechanism to maintain dynamic range. Nevo is also silent on AGC or any equivalent mechanism for controlling gain, meaning that a POSITA would not find a solution in the proposed combination.

Avitabile is designed for a radar environment, where input signal levels are typically high and stable. Bluetooth and IEEE 802.11, however, require handling of widely varying signal strengths due to real-world conditions like multipath fading, attenuation, and interference.

Sensitivity: Wireless transceivers must have high sensitivity to detect weak signals in noisy environments. Bluetooth and IEEE 802.11 set strict minimum sensitivity levels (e.g., -70 dBm for Bluetooth and -90 dBm for IEEE 802.11n at MCS0).

A POSITA understands that one cannot just insert any frequency converter/down converter circuitry into any box identified as a down converter/transceiver. As demonstrated by the simulations of Estabrook, using Estabrook's circuit in the down converter of Young does not demonstrate compliancy with standards/protocols. Similarly, using Avitabile's circuit in the transceiver of Nevo does not mean it would comply with standards/protocols.

Therefore, Nevo and/or Avitable does not teach or suggest “a plurality of protocol/standard sub-modules” or “operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination” as set forth in claims 1 and 11.

**4. A POSITA would not be motivated to combine Nevo and Avitable to arrive at the claimed invention.**

MediaTek asserts that “[a] POSITA would have been motivated to include Avitable’s downconverters in Nevo’s transceivers because they teach known elements whose combination would yield predictable results. Pet., 25. Specifically, MediaTek asserts that because Nevo describes using several well-known protocols (including Bluetooth and IEEE 802.11) and acknowledges the need for downconverters, a POSITA would have been motivated to look to Avitable for the required circuitry. *Id.* MediaTek further contends that because Avitable’s down-converter design is compatible with the frequency range of Bluetooth and IEEE 802.11, the combination of Nevo and Avitable would have been predictable and straightforward. *Id.* However, MediaTek’s argument oversimplifies the complexities of wireless communication design and overlooks critical protocol-specific considerations.

Nevo simply discloses the transceivers as black boxes. A POSITA would not understand that any transceiver configuration could be used as Nevo's transceiver. Ex.-2006, ¶¶259-260.

A POSITA understands that wireless communication protocols, such as Bluetooth and IEEE 802.11, define not only the frequency ranges but also specific methods and parameters for transmitting data over RF channels. *Id.*, ¶261. These protocols are designed with critical performance factors, such as dynamic range, sensitivity, and interference tolerance, which ensure reliable communication in real-world environments. *Id.*, ¶¶262-264. Because MediaTek is relying on Avitable's circuitry for the specific elements of the claimed transceiver, MediaTek needs to demonstrate that Avitable's circuitry would comply with the protocols/standards set forth in Nevo.

MediaTek's reliance on Avitable being compatible with the frequency range of Bluetooth and IEEE 802.11 does not demonstrate that Avitable's circuitry could actually be used for Bluetooth or IEEE 802.11. *Id.*, ¶265.

MediaTek fails to address the other performance factors (e.g., dynamic range, sensitivity, and interference tolerance) and does not explain how Avitable's down-converter design would meet these requirements for Bluetooth or IEEE 802.11. A POSITA would recognize that these factors must be considered when designing circuitry for these protocols and, therefore, would not consider Avitable's design as

a solution for Nevo's transceivers. *Id.*, ¶264. A POSITA would understand that Avitable does not address these performance factors.

While Avitable's down-converter operates within the frequency range of Bluetooth and IEEE 802.11 (2.4 GHz), it does not provide any details on how it would address the complex protocol-specific signal processing required by these systems. Bluetooth and IEEE 802.11 rely on sophisticated modulation, demodulation, and signal processing techniques that Avitable's down-converter does not address. A POSITA would understand that merely incorporating Avitable's down-converter into Nevo's transceiver would fail to meet the protocol-specific requirements, and the resulting system would not function as intended. *Id.*, ¶266. Thus, combining Nevo and Avitable would require significant redesign and protocol-specific signal processing far beyond just adding a down-converter circuit.

Given the absence of protocol-specific processing in Avitable's design, a POSITA would not consider it a plug-and-play solution for Nevo's protocol-specific transceivers. MediaTek argues that Avitable's prototype measurements provide proof of concept for compatibility with Bluetooth and IEEE 802.11 signal processing. Not so. While Avitable may demonstrate its circuit works for frequency conversion, it does not show how this design can interface with or support the specific modulation, demodulation, and signal processing required by Bluetooth or IEEE 802.11. And MediaTek fails to address this distinction.

In view of the foregoing, a POSITA would not be motivated to combine Nevo and Avitabile.

**5. Claims 2-10 and 12-20.**

Claims 2-10 depend from independent claim 1, and claims 12-20 depend from independent claim 11. Claims 2-10 and 12-20 are not obvious in view of Nevo and Avitabile for at least the same reasons that claims 1 and 11 are not obvious.

**B. Ground 2A: Young in view of Estabrook-Thesis**

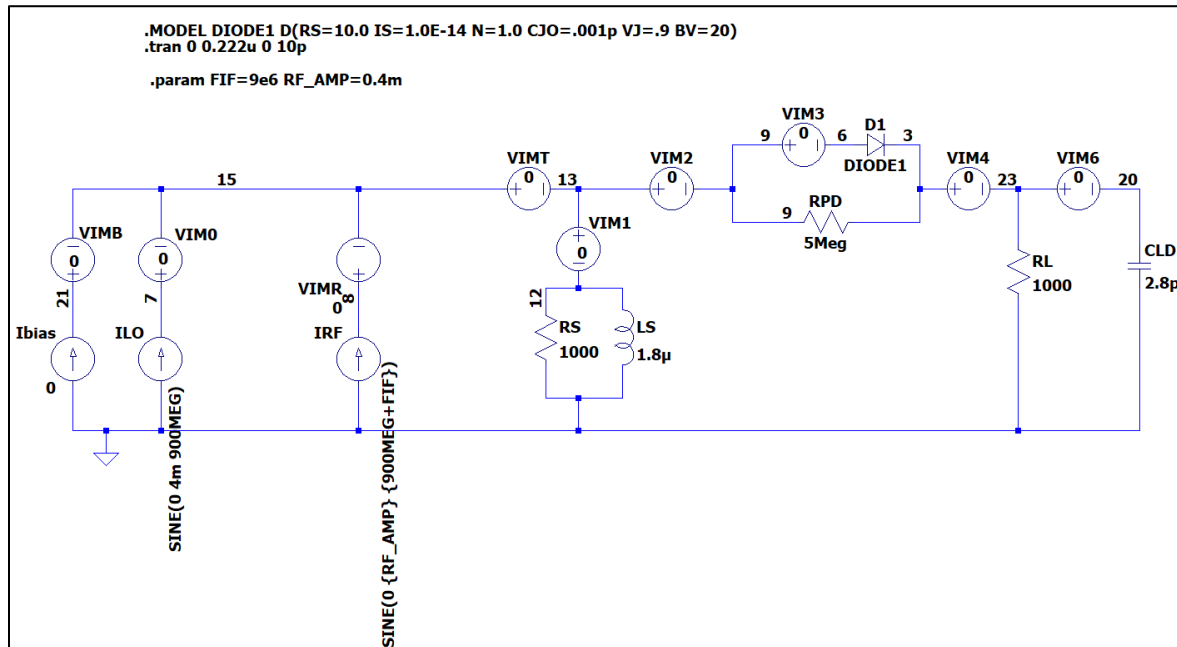
MediaTek asserts that claims 1-20 of the '686 patent are unpatentable as obvious over Young and Estabrook-Thesis. However, as discussed below, MediaTek has failed to meet its burden of proving that the challenged claims are unpatentable.

Young discloses a two-protocol transceiver with separate transmit and receive chains for each protocol. Each of Young's transceivers includes an associated "down converter and demodulator." But Young does not provide the specific circuitry required for frequency translation.

MediaTek acknowledges that Young fails to teach or suggest each and every limitation of the independent claims of the '686 patent. Specifically, MediaTek concedes that "Young does not teach the specific details of its two 'down converter and demodulator[s].'" Pet., 69. So MediaTek turns to the Estabrook-Thesis to

remedy this deficiency. But, as discussed below, Estabrook-Thesis fails to cure the deficiencies in Young.

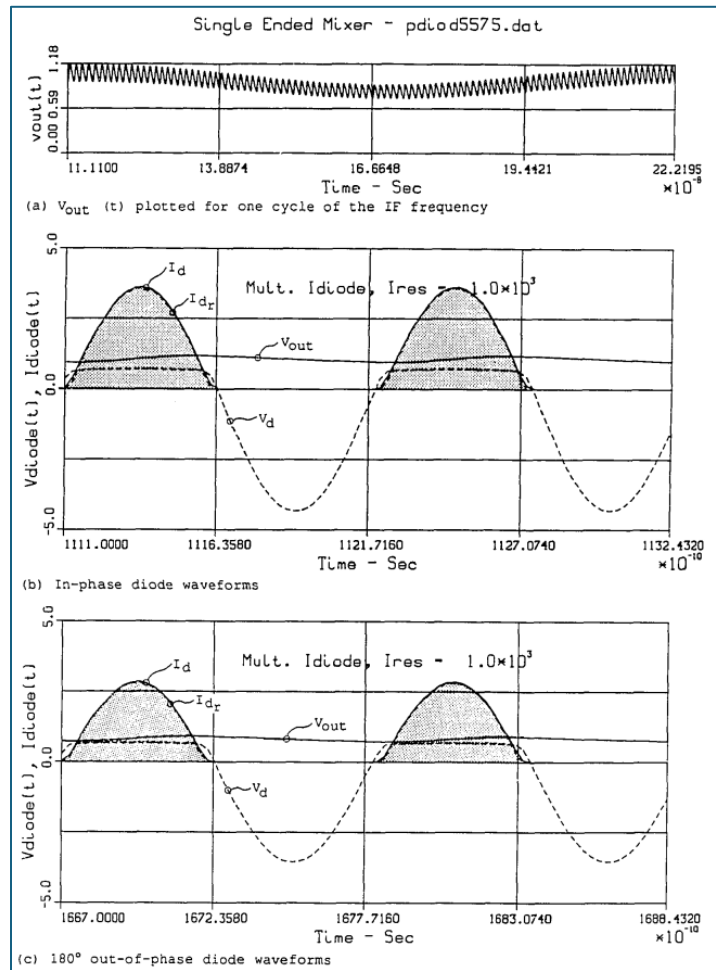
Dr. Ricketts performed various simulations of Estabrook. Ex.-2006, ¶¶215-220. His simulation setup and netlist are shown below.

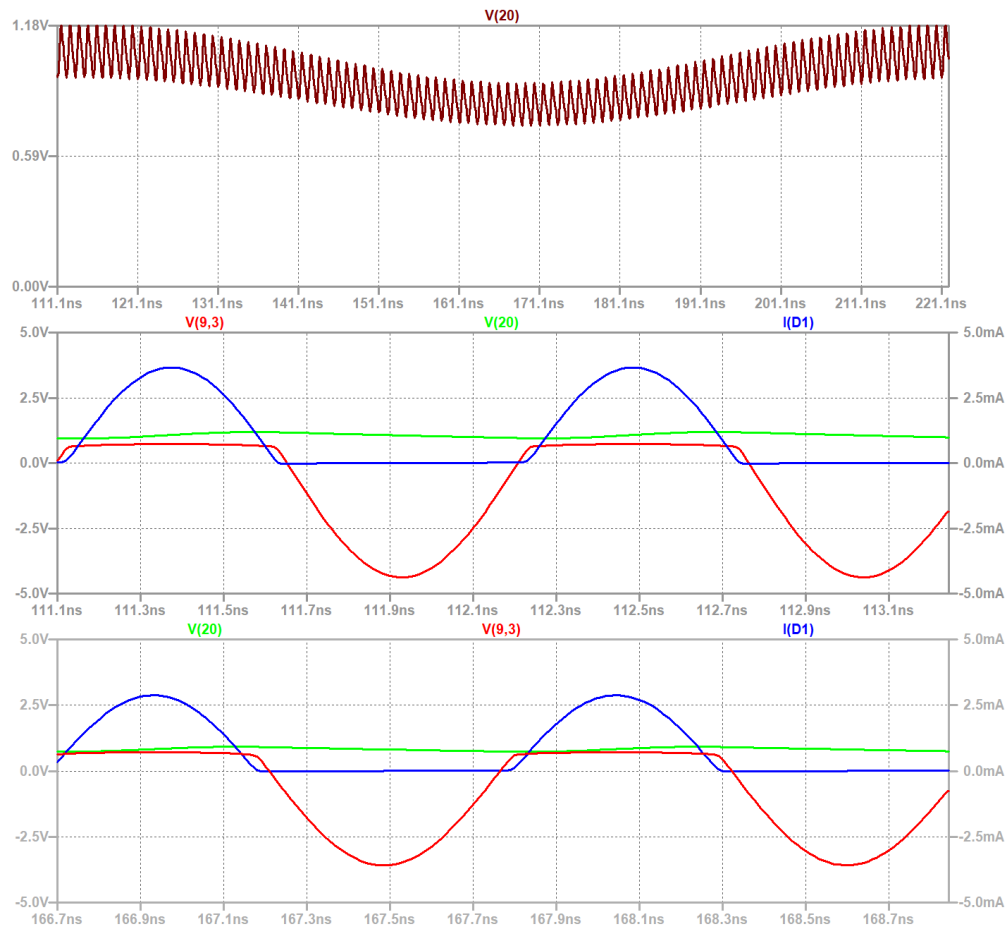


Patent Owner's Response

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As shown below, Dr. Ricketts confirmed that his simulations results (colored graphs below) are consistent with Estabrook's results (black/white graphs below).





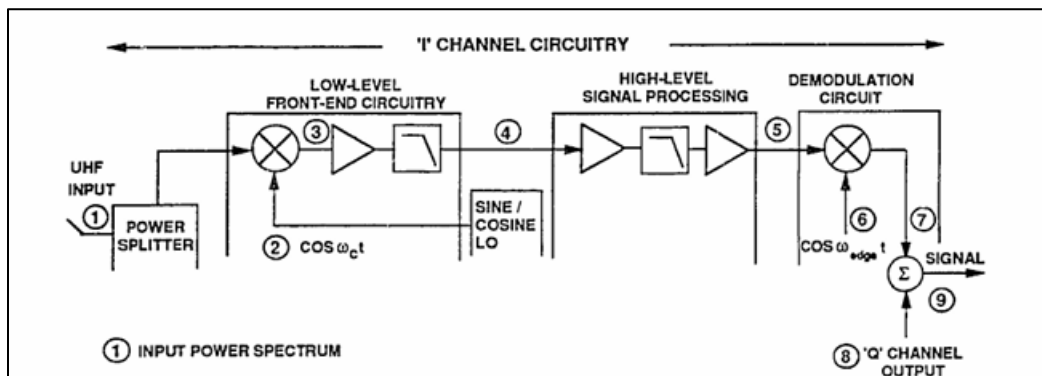
Dr. Ricketts then performed additional testing as discussed in Section VIII.B.3 below.

**1. Estabrook-Thesis does not teach (or suggest) “a switch configured to operate according to an energy transfer signal” (claims 1 and 11)**

Claims 1 and 11 of the '686 patent recite “a switch configured to operate according to an energy transfer signal.” MediaTek identifies the diode in Estabrook-Thesis’s Figure 14(a) as the claimed “switch” and ILO signal as the claimed “energy transfer signal.” Pet., 70.

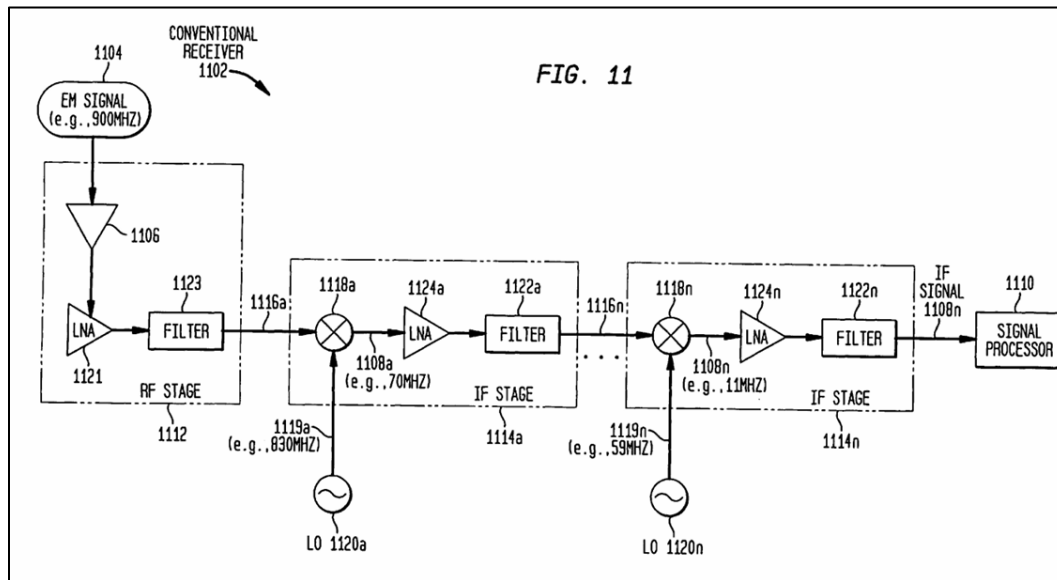
Notably, MediaTek fails to propose a construction for “energy transfer signal.” Instead, MediaTek merely asserts that “ILO is an energy transfer signal because the input from ILO is necessary to activate the diode and close the diode...and when the diode switch is closed, it passes current (and therefore energy) through the diode from the combined signal of the ILO and IRF.” Pet., 72.

As discussed in Section VI.E.2 discussed above, the proper construction of “energy transfer signal” is “an independent control input of an energy transfer system having pulses with non-negligible apertures.” The ILO signal (the alleged energy transfer signal) in Estabrook-Thesis is not (1) an input of an energy transfer system, (2) an independent control input, or (3) a signal having pulses with non-negligible apertures.



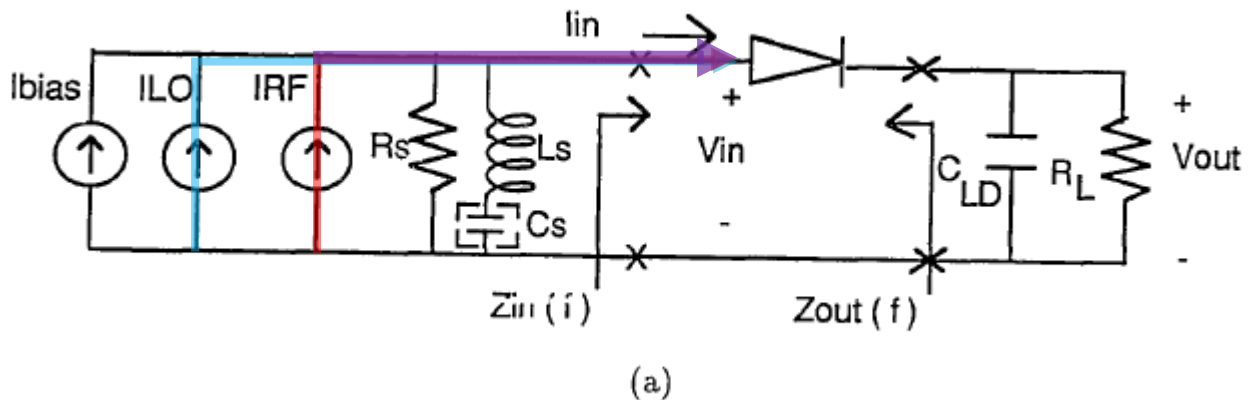
As discussed in Section VII.D above, a POSITA reading Estabrook-Thesis would understand that Estabrook-Thesis discloses a non-sampling system – a fundamentally different and competing technology to energy transfer (energy

sampling). Ex.-2006, ¶275. Thus, the ILO signal is not a signal/input of an energy transfer system.



Indeed, as shown above, the '551 patent specifically illustrates and discusses a conventional heterodyne receiver (Figures 1 and 11, 24:3-25:56) and distinguishes the patented/claimed technology from this type of receiver. *Id.*, ¶277.

As a non-sampling mixer, a POSITA would recognize that Estabrook-Thesis uses the diode in a nonlinear or time-varying mixer to effect translation of information centered at one frequency to information centered at another frequency. *Id.*, ¶278. Indeed, Estabrook-Thesis classifies Figure 14 as a “Resistively Matched (‘RM’) mixer circuit.” Ex.-1005, 57. The mixer exploits the non-linearity of the diode to achieve the multiplication, i.e., mixing, of the RF and LO signals. *Id.*, ¶279.

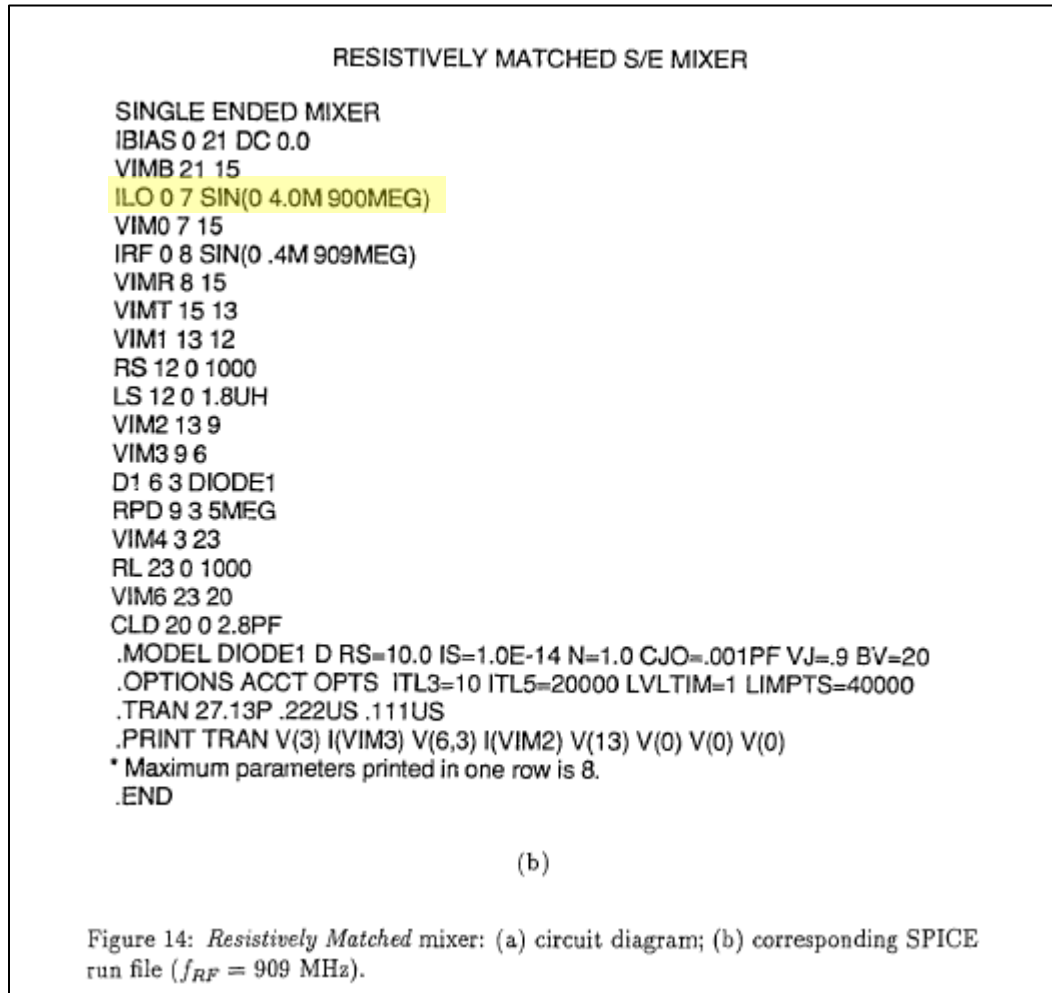


As shown above in Figure 14(a) of Estabrook, IRF (red) and ILO (blue) are “mixed” or “combined” at the anode terminal of the diode, which serves as an input (purple). The combined signal is then passed through the diode. *Id.*, ¶280. Accordingly, the diode in Estabrook-Thesis’s circuit does not operate according to an “energy transfer signal.” Instead, the diode’s operation is dictated by the combined influence of the RF and LO signals. *Id.*

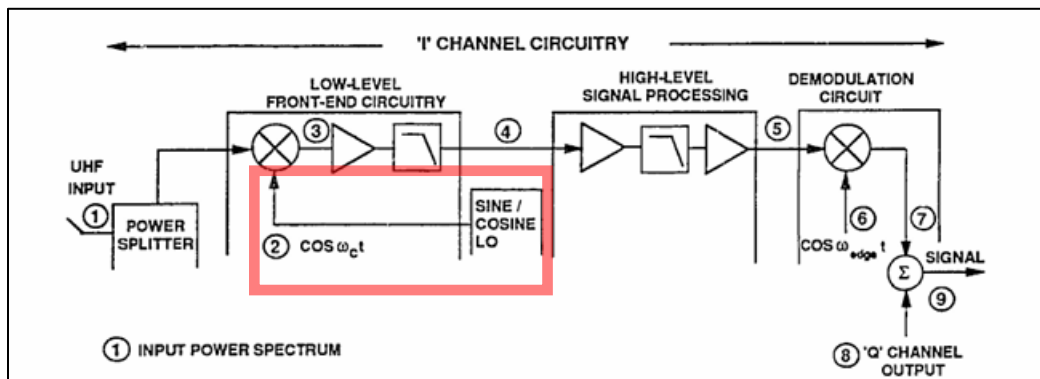
The operation of Estabrook-Thesis’s diode is part of a heterodyne mixing process where the LO signal modulates the RF input. *Id.*, ¶281. The diode does not receive an independent control input that controls its operation as a switch. Rather, the diode’s conduction state is passively dictated by the instantaneous voltages of the combined RF and LO signals at the input of the diode. Thus, the ILO is not an independent control input. *Id.*

Further, Estabrook-Thesis’s ILO signal is sinusoidal rather than pulsed, as evidenced by the corresponding SPICE run file in Figure 14(b) (below), which

defines the ILO signal as: 0 7 SIN (0.1M 900MEG) (yellow highlight). A POSITA recognizes that SIN in SPICE stands for sinusoid. *Id.*, ¶282.



Moreover, as shown below in the red box below, Figure 4 of Estabrook-Thesis specifically discloses that the LO is a sinusoidal wave (sine/cosine LO).



A POSITA understands that a sine wave is a continuous signal that varies smoothly over time. *Id.*, ¶¶77, 284. In contrast, a pulse is a non-sinusoidal waveform with abrupt transitions and a defined width. *Id.*, ¶¶79, 284. Therefore, the ILO signal in Estabrook-Thesis is not a pulse having non-negligible apertures, as required by the proper construction of “energy transfer signal.”

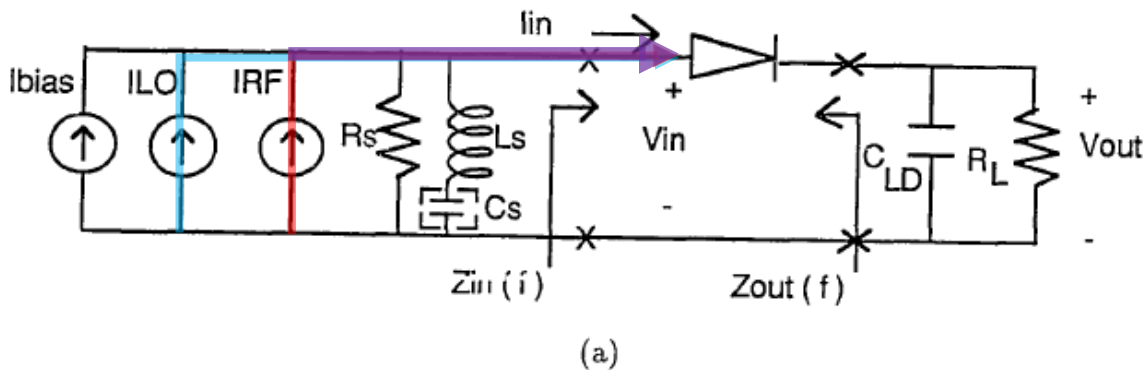
**2. Estabrook-Thesis does not teach (or suggest) “a switch configured . . . to sub-sample and transfer energy” (claims 1 and 11)**

Claims 1 and 11 of the '686 patent recite “a switch configured . . . to sub-sample and transfer energy from a first electromagnetic (EM) signal.”

MediaTek argues that the diode in Figure 14(a) Estabrook-Thesis “sub-samples” energy from the IRF because it passes energy from the IRF at an aliasing rate driven by ILO (900 MHz), which is less than twice the frequency of the signal (IRF) being sampled (909 MHz).” Pet., 74-75.

Estabrook-Thesis, however, does not describe, teach, or suggest a sampling system. As explained in Section VII.D above, a POSITA reading Estabrook-Thesis

would understand that Estabrook-Thesis discloses a non-sampling mixer system— a fundamentally different and competing technology to sampling. The diode in Estabrook does not function as a periodic switch that sub-samples an electromagnetic signal. Instead, it behaves as a continuously conducting nonlinear element in a heterodyne mixing. This can be understood by the mixing of two sinusoids, ILO and IRF, to create a down converter frequency. This is clearly understood from the trigonometry of two cosines as in Esterbrook:  $\cos w_1 t * \cos w_2 t = 0.5 \cos(w_1 - w_2)t + 0.5 \cos(w_1 + w_2)t$ . Ex.-2006, ¶294.



MediaTek's assertion that Estabrook-Thesis's diode "sub-samples" based on a 50% duty cycle is incorrect because continuous conduction does not equate to sub-sampling. In Estabrook-Thesis's resistive diode mixer, the RF (red) and LO (blue) signals are always present at the diode junction, and their interaction occurs constantly rather than in discrete switching events. Ex.-2006, ¶295.

A POSITA would recognize that sub-sampling requires a switch that momentarily connects and disconnects to sample discrete portions of RF energy. *Id.*, ¶296. In contrast, a non-sampling mixer like Estabrook-Thesis's relies on the nonlinearity of the diode for continuous frequency translation rather than discrete-time sampling. *Id.*

MediaTek's reference to a 50% duty cycle does not mean the diode is performing sub-sampling. Instead, the 50% duty cycle merely reflects the periodicity of a continuous conduction process in a mixer circuit, *i.e.* that a cosine has a 50% positive cycle and a 50% negative cycle.. *Id.*, ¶297. In a sub-sampling system, the switch would turn on and off in discrete intervals, sampling the signal at specific times—which does not happen in Estabrook-Thesis's system. *Id.*

MediaTek's argument also ignores that sub-sampling requires controlled switching that enables periodic energy transfer from the input to the output. Estabrook-Thesis's circuit lacks any independent switching mechanism capable of performing periodic energy transfer. *Id.*, ¶298.

The diode in Estabrook does not operate independently on the IRF signal, nor does it perform energy transfer via periodic switching. *Id.*, ¶299. Instead, the diode processes a combined signal composed of the RF signal, LO signal, resistor  $R_s$ , inductor-capacitor pair ( $L_s/C_s$ ), and bias signal  $I_{bias}$ . Because the diode does not selectively sample the IRF signal but instead responds passively to the combined

effect of multiple continuously applied inputs, the IRF is not being “sub-sampled” as required by the claims. *Id.*, ¶300.

Accordingly, MediaTek's assertion that Estabrook teaches or suggests a switch configured to sub-sample is incorrect. The diode in Estabrook does not function as a switch that sub-samples an electromagnetic signal. Instead, it behaves as a continuously conducting nonlinear element in a heterodyne mixing system.

**3. Young/Estabrook do not teach (or suggest) “a plurality of protocol/standard sub-modules” or “operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination” (claims 1 and 11)**

Claim 1 recites an apparatus comprising “at least one *multi*-platform module” including “a plurality of transceivers” that communicates with “at least one of a plurality of communication links” using a control module “having a *plurality of protocol/standard* sub-modules.” A POSITA would understand that, in order for the multi-platform module to communicate with protocol/standard sub-modules, the transceivers must comply with/meet protocols/standards. Ex. 2006, ¶301. Claim 11 recites a method comprising “operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination.” A POSITA would understand this to mean that the transceivers must comply with/meet protocols/standards. *Id.* The first and second transceivers are part of the claimed “plurality of transceivers”

having a “frequency translation module” comprising the claimed switch and storage module. *Id.*

MediaTek asserts that because Young acknowledges the need for a “down-converter and demodulator,” a POSITA would have been motivated to look to Estabrook-Thesis for the required circuitry. Pet., 61. Because MediaTek relies on Estabrook-Thesis for the circuitry of the claimed frequency translation module, Estabrook-Thesis’s circuitry (incorporated into Young) must comply with a “plurality of protocols/standards” (claim 1) and operate “in conformance with a [first/second] protocol/standard combination.” MediaTek, however, provides no evidence that Estabrook-Thesis’s circuitry complies with or operates in conformance with any protocol/standard. The reason that MediaTek fails to provide such evidence is because, as discussed below, Estabrook’s circuit has not been shown to comply with or be in conformance with protocols/standards.

As summarized below, Dr. Ricketts performed a simulation of Estabrook and demonstrated that there is no evidence that Estabrook will meet the Bluetooth standard/protocol. Because the Bluetooth standard/protocol is significantly easier to comply with than IEEE 802.11 (i.e., 802.11 has more stringent standards for compliance), there is no evidence that Estabrook will meet the IEEE 802.11 standard/protocol. Ex.-2006, ¶¶305-331.

Young, however, describes a multi-band receiver operating on communication standards such as Bluetooth or WiFi. These standards operate by dividing a frequency band into multiple closely spaced channels. For example, Bluetooth operates in the 2.4 GHz ISM band (2400–2483.5 MHz). Bluetooth uses Gaussian Frequency Shift Keying (GFSK) modulation with a bit rate of 1 Mbps.

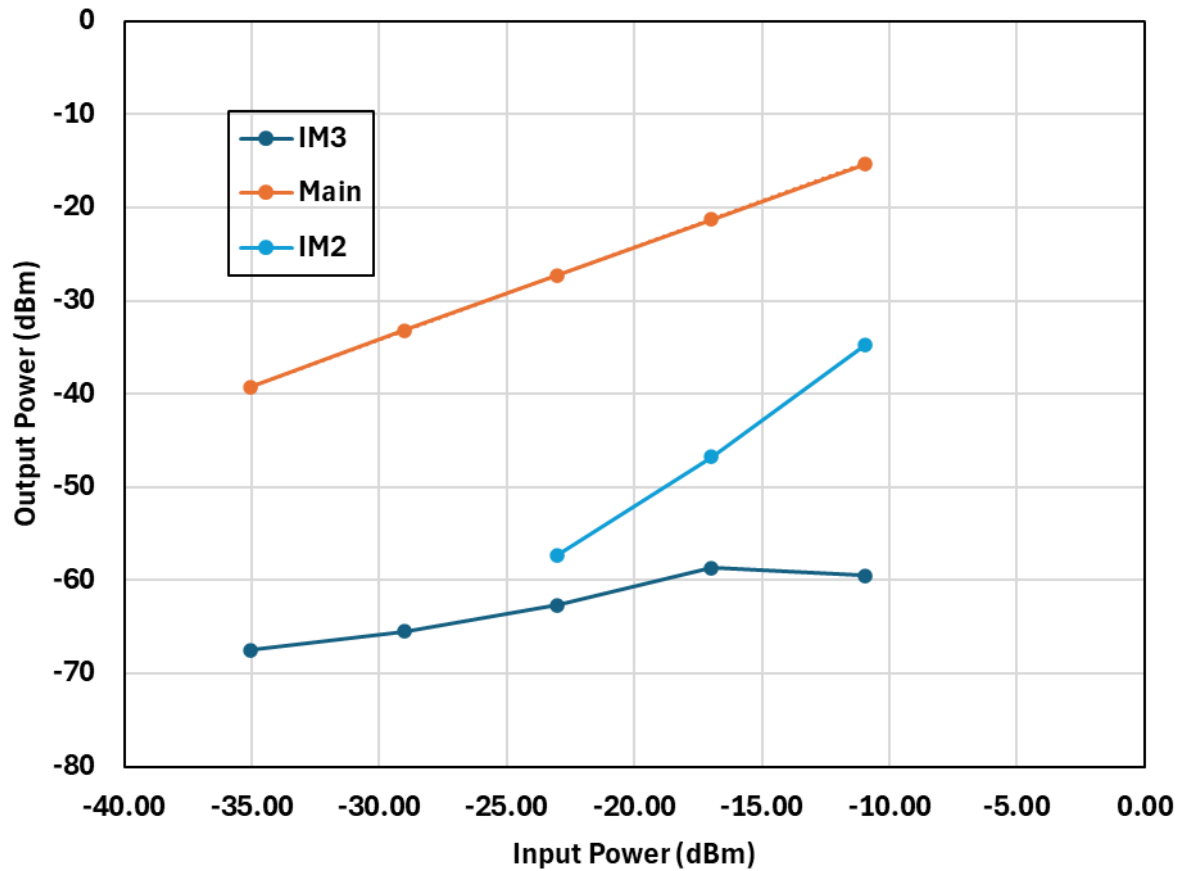
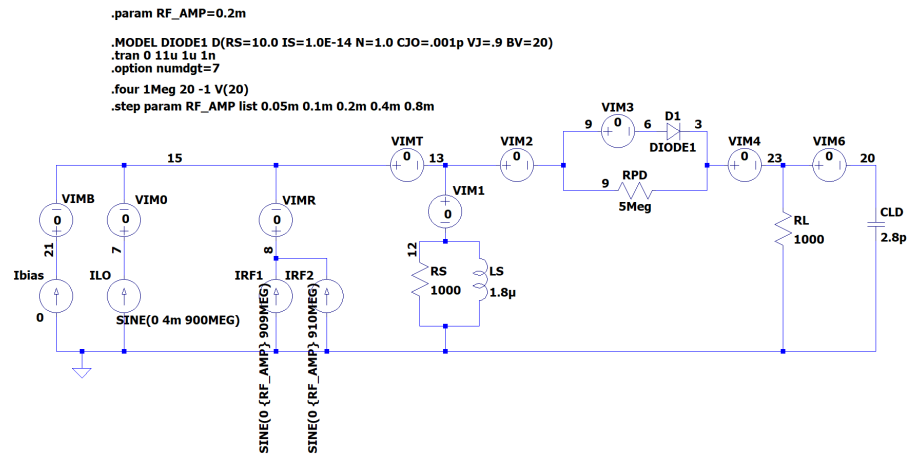
A POSITA recognizes that Estabrook's mixer lacks the necessary signal processing capabilities to conform to these wireless communication standards.

Wireless receivers must contend with blocker signals—unwanted signals within the same band. Estabrook's mixer does not provide sufficient rejection of in-band and out-of-band interferers. As demonstrated by the simulation results below, Estabrook's mixer exhibits significant intermodulation distortion, leading to spectral artifacts and signal degradation. A POSITA recognizes that these deficiencies render Estabrook's circuit non-compliant with Bluetooth, for example.

Simulations confirm that Estabrook's single-ended mixer does not provide inherent image rejection, making it unsuitable for the receiver in Case 1.

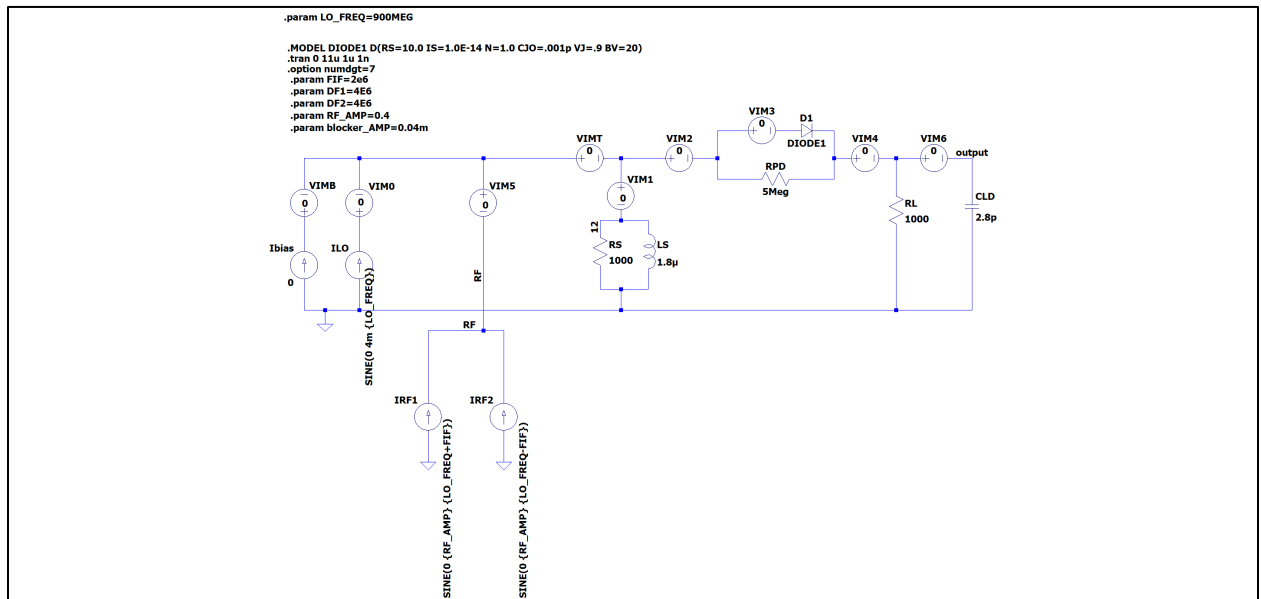
Furthermore, Estabrook's mixer exhibits second-order nonlinearities, which degrade signal integrity and violate Bluetooth requirements. These nonlinearities generate unwanted frequency components that interfere with the desired signal.

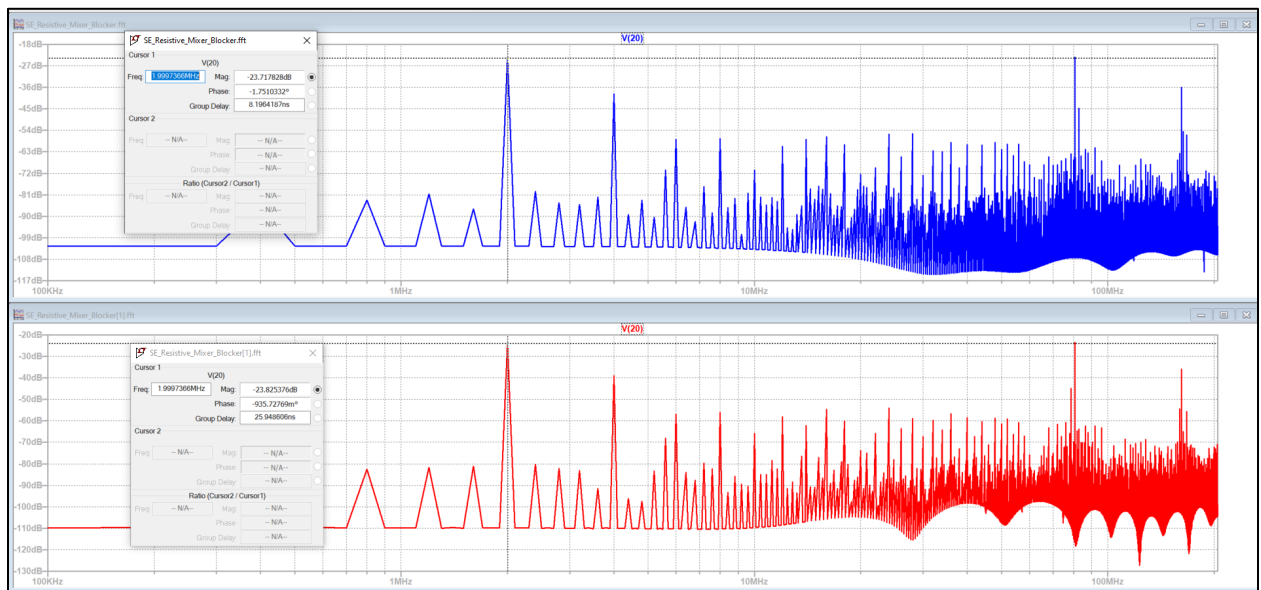
The simulation setup is shown below.



As shown above, the third order intermodulation products are very low—almost in the noise level of the simulator for all input power levels. This suggests that the simplified model of the diode may not include third-order effects.

To analyze Esterbrook's linearity performance, in particular with respect to Bluetooth standards, Dr. Ricketts conducted simulations on the original 900 MHz design as it was disclosed in Esterbrook.

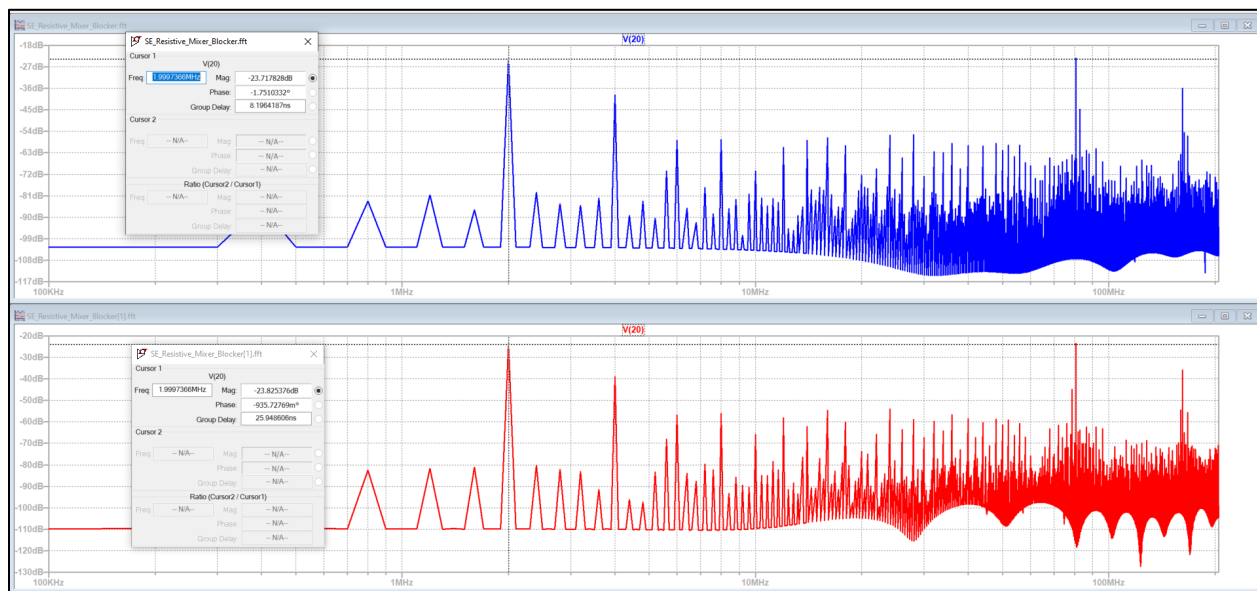
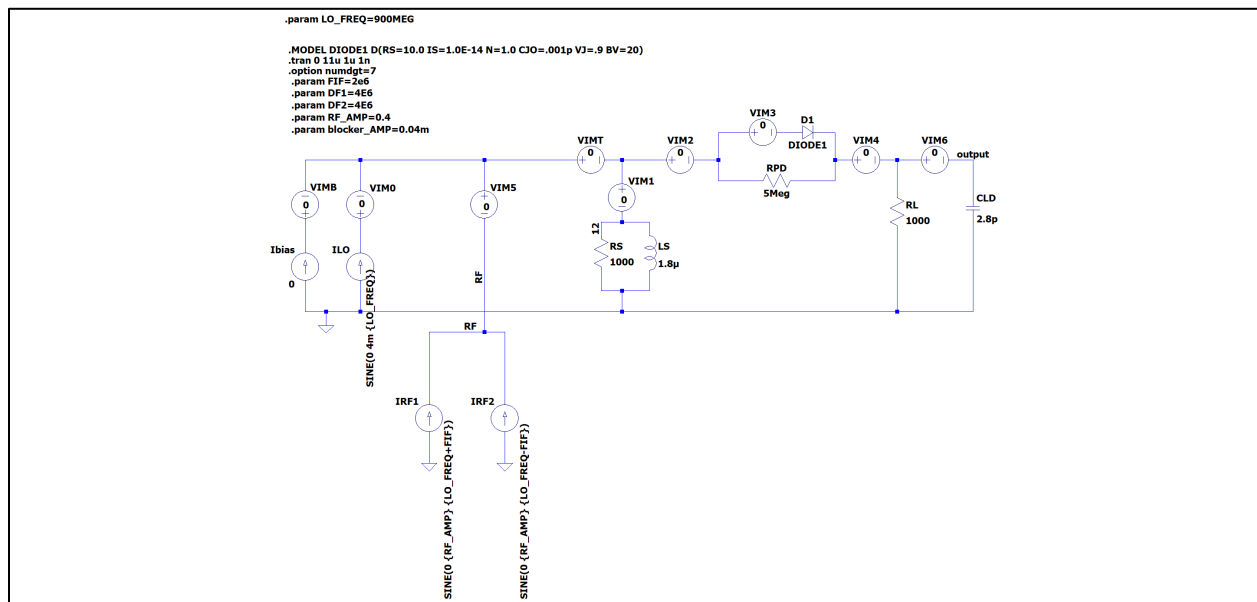




Esterbrook in correctly down converts both 902 MHz and 898 MHz to 2 MHz.

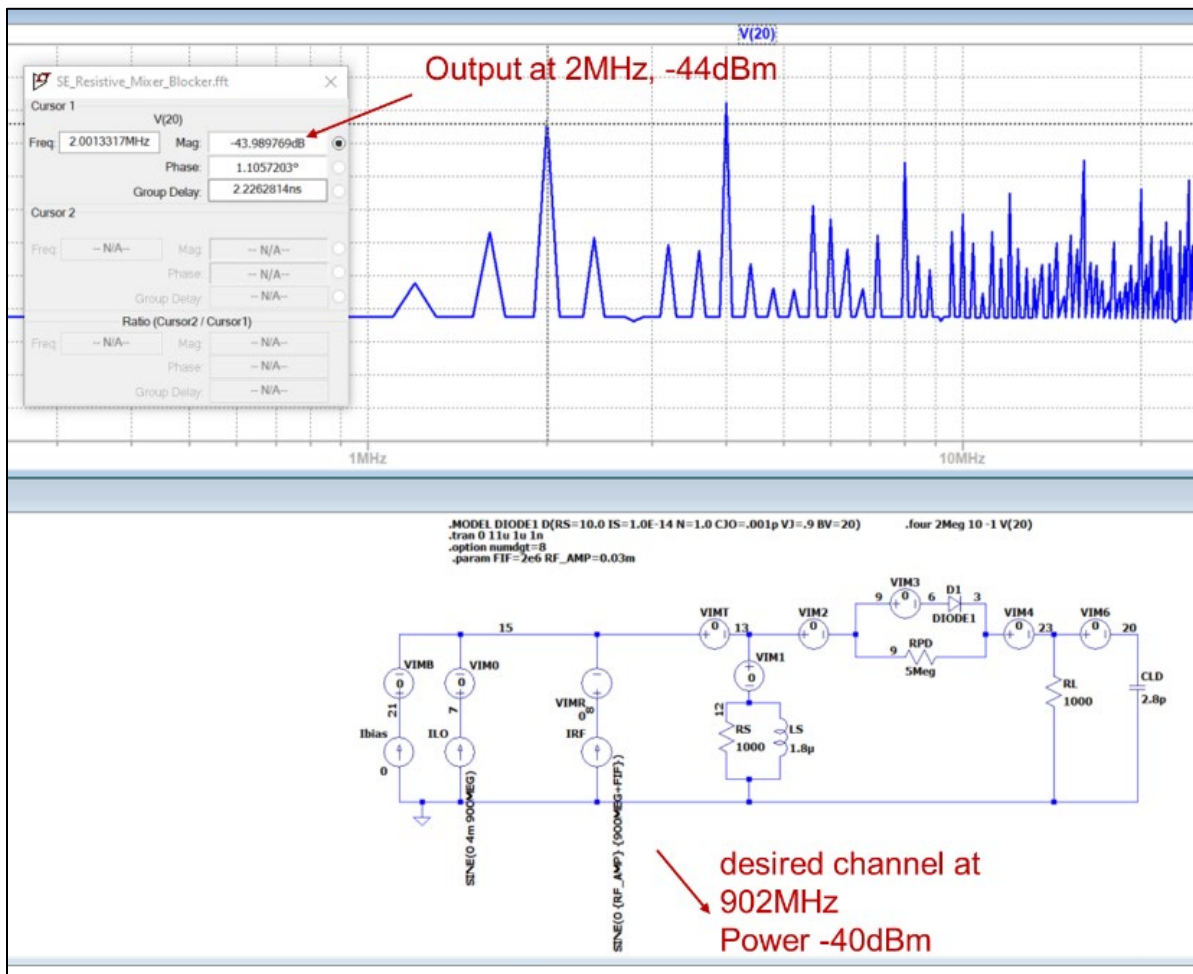
As shown above, the output spectrum from both cases confirms that Estabrook's single-ended mixer does not provide image rejection.

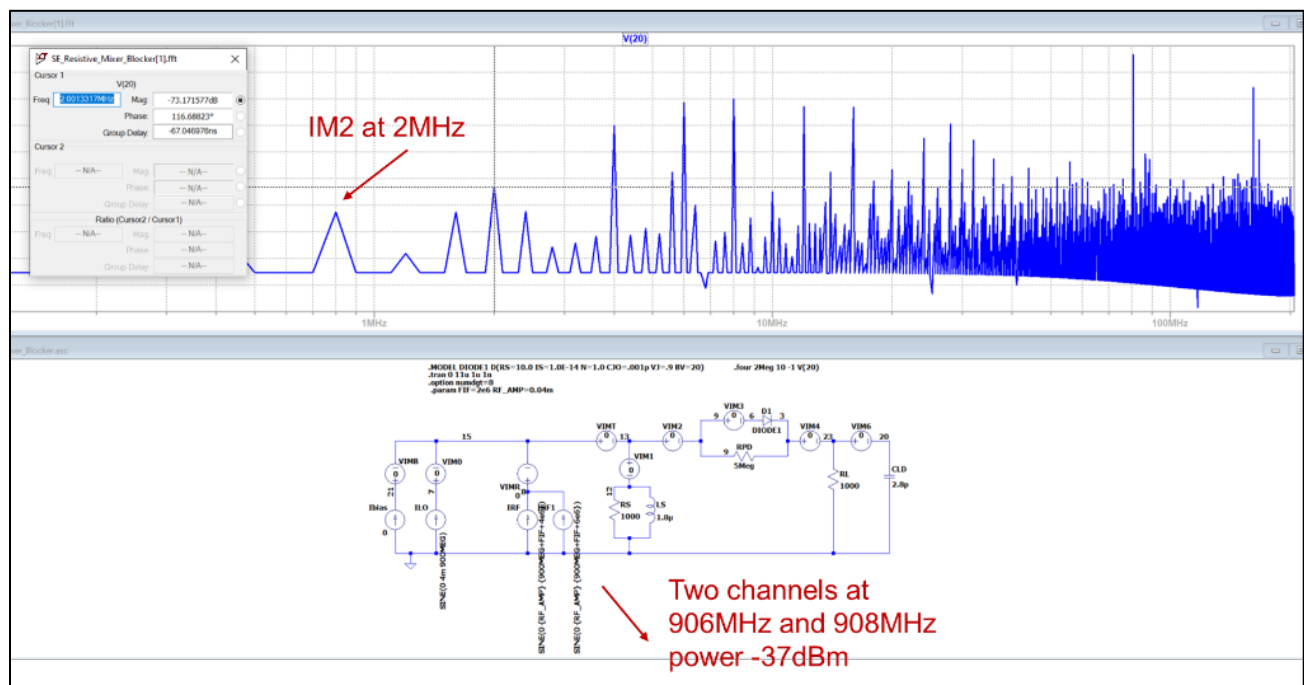
In another simulation (shown below), the desired channel was set to 902 MHz (-40 dBm), with interfering signals at 906 MHz and 908 MHz (-37 dBm). The output at 2 MHz from the desired input was -44 dBm.



The output spectrum from both cases confirms that Estabrook's single-ended mixer does not provide image rejection, demonstrating its incompatibility with Bluetooth and IEEE 802.11 standards.

In another simulation (shown below), the desired channel was set to 902 MHz (-40 dBm), with interfering signals at 906 MHz and 908 MHz (-37 dBm).





The simulated C/I value is  $(-73.1\text{dBm}) - (-44\text{dBm}) = -31\text{dB}$  which does not meet the  $-40\text{dB}$  requirements for the  $(C/I) > 3\text{MHz}$ .

As shown above, Estabrook's mixer lacks image rejection and exhibits high second-order intermodulation distortion (IM2), and inadequate C/I ratio performance. Even if integrated into Young's receiver, Estabrook's circuit would not meet or operate in conformance with protocols/standards as required by claims 1 and 11.

Therefore, Young and/or Estabrook do not teach or suggest "a plurality of protocol/standard sub-modules" or "operating a [first/second] transceiver in conformance with a [first/second] protocol/standard combination" as set forth in claims 1 and 11.

**4. A POSITA would not be motivated to combine Young and Estabrook to arrive at the claimed invention.**

MediaTek asserts that “[a] POSITA would have been motivated to combine Young and Estabrook-Thesis because references are in the same field, because both describe RF receivers.” Pet. 61. Specifically, MediaTek suggests that “a POSITA would have recognized that Estabrook-Thesis’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.” Pet., 62. MediaTek further asserts that because Estabrook-Thesis’s receiver is a “down converter and demodulator” as called for by Young, a POSITA would have had a reasonable expectation of success in integrating the circuit taught by Estabrook-Thesis into each “down-converter and demodulator” of Young’s down-conversion system. Pet., 63. However, MediaTek’s argument oversimplifies the complexities of wireless communication design and overlooks critical protocol-specific considerations.

Young simply discloses the down-conversion/demodulator modules as black boxes. A POSITA would not understand that any down converter configuration could be used as Young’s transceiver. Ex.-2006, ¶¶334-335

As MediaTek acknowledges, “Young teaches its system is designed to operate when two protocols share the same spectrum, such as Bluetooth and IEEE 802.11.”

Pet., 63. Wireless communication protocols, such as Bluetooth and IEEE 802.11, define specific methods and parameters for transmitting data over RF channels. *Id.*, ¶336. These protocols are designed with critical performance factors, such as dynamic range, sensitivity, and interference tolerance, which ensure reliable communication in real-world environments. *Id.*, ¶337. Because MediaTek is relying on Estabrooks' circuitry for the specific elements of the claimed transceiver, MediaTek needs to demonstrate that Estabrooks' circuitry would comply with the protocols/standards set forth in Young.

MediaTek's reliance on Estabrook-Thesis being a down converter, receiver, and demodulator does not demonstrate that Estabrook-Thesis's circuitry could actually be used for Bluetooth or IEEE 802.11. *Id.*, ¶339.

MediaTek fails to address the other performance factors (e.g., dynamic range, sensitivity, and interference tolerance) and does not explain how Estabrook-Thesis's down-converter design would meet these requirements for Bluetooth or IEEE 802.11. A POSITA would recognize that these factors must be considered when designing circuitry for these protocols and, therefore, would not consider Estabrook-Thesis's design as a solution for Young's transceivers. A POSITA would not understand that Estabrook-Thesis meets these performance factors.

While Estabrook-Thesis discloses a direct conversion circuit, it does not provide any details on how it would address the complex protocol-specific signal

processing required by these systems. Bluetooth and IEEE 802.11 rely on sophisticated modulation, demodulation, and signal processing techniques that Estabrook-Thesis's down-converter does not address. A POSITA would understand that merely incorporating Estabrook-Thesis's down-converter into Young's transceiver would not meet the protocol-specific requirements, and the resulting system would not function as intended. *Id.*, ¶340. Thus, combining Young and Estabrook-Thesis would require significant redesign and protocol-specific signal processing far beyond merely adding a down-converter circuit.

Given the absence of protocol-specific processing in Estabrook-Thesis's design, a POSITA would not consider it a plug-and-play solution for Young's protocol-specific transceivers, as MediaTek suggests.

In view of the foregoing, a POSITA would not be motivated to combine Young and Estabrook-Thesis.

## **5. Claims 2-10 and 12-20.**

Claims 2-10 depend from independent claim 1, and claims 12-20 depend from independent claim 11. Claims 2-10 and 12-20 are not obvious in view of Young and Estabrook-Thesis for at least the same reasons that claims 1 and 11 are not obvious. *Id.*, ¶344.

**C. Ground 2B: Young in view of Estabrook-1988 and Estabrook-1989**

MediaTek asserts that claims 1-20 of the '686 patent are unpatentable as obvious over Young, Estabrook-1988, and Estabrook-1989. However, MediaTek itself acknowledges that “Estabrook-1988 and Estabrook-1989 are publications by the author of Estabrook-Thesis and correspond to chapters of Estabrook-Thesis.” Pet., 91.

MediaTek fails to cite any evidence from Estabrook-1988 or Estabrook-1989 that is not already disclosed in Estabrook-Thesis. In fact, MediaTek concedes that “Estabrook-1988 and Estabrook-1989 present substantially the same relied-upon teachings as those in Estabrook-Thesis in Ground 2A.” Pet., 91. As detailed in Sections VII.E and VII.F, these references merely reiterate the content of Estabrook-Thesis without introducing any new material distinctions.

Accordingly, ParkerVision submits that the same reasons why claims 1-20 are not obvious over Young and Estabrook-Thesis, as explained in Section VIII.B, apply equally here to Young in combination with Estabrook-1988 and/or Estabrook-1989. Since these references add nothing beyond what is already contained in Estabrook-Thesis, MediaTek's argument fails for the same reasons. Ex.-2006, ¶¶345-347.

Dated: March 11, 2025

Respectfully submitted,

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**CERTIFICATE OF COMPLIANCE**

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Patent Owner's Response complies with the type-volume limitation of 37 C.F.R. § 42.24(b) because it contains 13,272 words, as determined by the word-processing program used to prepare the brief, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a)(1).

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**CERTIFICATE OF SERVICE**

The undersigned hereby certifies that a copy of the foregoing PATENT OWNER'S RESPONSE TO PETITION FOR INTER PARTES REVIEW OF UNITED STATES PATENT NO. 7,4,83,686, together with all exhibits filed therewith, was served in its entirety by filing these documents through the PTAB E2E System, as well as by email on the following counsel of record for Petitioner:

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