UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TEXAS INSTRUMENTS INC.,
and NXP USA, INC,
Petitioners

v.

PARKERVISION, INC.,
Patent Owner

Case IPR2024-00936[1]
Patent 9,118,528

SECOND DECLARATION OF DR. IAN GALTON

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[1] NXP USA, Inc., who filed a petition in IPR2024-01068, is joined as petitioner in this proceeding.

TI 1066
TI v. ParkerVision
IPR2024-00936

Table of Contents

I. INTRODUCTION 4

II. MATERIALS CONSIDERED 5

III. CLAIM CONSTRUCTION 8

IV. GROUNDS 1A/1B 10

A. Dr. Ricketts mischaracterized Tayloe and fails to address the application of prior art in the Tayloe Combination. 11

1. a "energy storage element" that stores transferred energy and outputs a baseband signal portion (claims 1 and 19) 12

2. deriving a baseband signal portion from accumulated transferred energy (claims 1 and 19) 29

3. "differential amplifier circuit that combines" down-converted baseband signal portions and "outputs a [] down-converted differential [] baseband signal" (claims 1/19) .. 31

4. discharging "during the discharging part of the cycle for each respective switching device when the switching device is off" (claims 8/26 and 9/27) 33

B. Dr. Ricketts failed to address the motivation to combine 35

1. Tayloe does not teach away from using Figure 6 with the TI Datasheet multiplexer 36

2. Tayloe does not teach away from the combination 39

3. Macnally and TI datasheet are combinable 41

4. Dr. Ricketts mischaracterizes Macnally 44

5. Reason to replace Tayloe's amplifiers with Macnally's biquad two-pole filter 48

C. Tayloe and Macnally are not incompatible 58
D. Reasonable Expectation of Success 60
V. GROUNDS 2A/2B 62
A. Razavi teaches transferring energy from a modulated carrier signal as an output of a switch when the switch is ON (claims 1 and 19). 63
1. Dr. Ricketts ignored the law of Physics 63
2. Dr. Ricketts' annotation supports my position 84
B. Razavi teaches storing transferred energy from the modulated carrier signal or integrating/accumulating transferred energy from switches (claims 1 and 19). 85
C. Razavi teaches transferring energy from the modulated carrier signal to the storage element when the switch is ON (claims 8 and 26). 86
D. Motivation to combine Razavi and Macnally 94
1. Razavi does not teach away from the combination 97
2. Razavi is compatible with Macnally as both seek to improve IC implementation 98
3. Reasonable expectation of success in combining Razavi and Macnally 99
E. Energy Transfer System 100
VI. CONCLUSION 102

I, Dr. Ian Galton of La Jolla, CA, declare that:

I. INTRODUCTION

1. I have been retained by Fish & Richardson P.C. as an independent expert on behalf of Petitioner Texas Instruments ("TI"). I understand that this declaration will be submitted in support of the Petitioner Reply to Patent Owner's Response ("POR") to the Petition for Inter Partes Review of U.S. Patent No. 9,118,528 ("'528 Patent"). This declaration is entirely responsive to Dr. Ricketts Declaration, EX2024, and addresses the prior art and technology analysis that Dr. Ricketts provided in his declaration.

2. This declaration ("Second 528 Declaration") supplements, and is intended to be read in conjunction with, my earlier declaration ("First 528 Declaration") in support of TI's Petition in IPR2024-00936.

3. In writing this Second 528 Declaration, I have considered the following: my own knowledge and experience in electrical engineering, including in the field of RF and other mixed-signal integrated circuits; my teaching and work experience in the above fields; and my experience of working with others involved in those fields. I have also reviewed at least the materials in Section II (Materials Considered) as part of my analysis.

4. The analysis and opinions expressed in my First 528 Declaration fully explain why each and every feature of the '528 Patent's Challenged Claims is

provided in the prior art. As I previously described with reference to the applied prior art and corroborating references, the Challenged Claims 1-5, 8, 9, 11-23, 26, 27, and 29-36 of the '528 patent would have been obvious to a POSITA. I understand that Patent Owner has considered my opinions and offered their own, some of which are inconsistent with my view. Below, I provide further testimony in response to Patent Owner's arguments. In responding to Patent Owner's arguments, I have analyzed various publications and materials including materials cited in my First '528 Declaration and additional materials in this Second 528 Declaration. The fact that I may not have addressed all of Patent Owner arguments should not be interpreted as agreement with them.

II. MATERIALS CONSIDERED

Exhibit No.	Description
TI-1045	D. E. Johnson, J. L. Hilburn, and J. R. Johnson, *Basic Electric Circuit Analysis*, 7th Edition, Prentice-Hall, 1978.
TI-1046	Adel S. Sedra, Kenneth C. Smith, *Microelectronics Circuits*, 4th Edition, Oxford University Press, 1997.
TI-1047	D. Tayloe, "Norcal NC2030 Low power, High Performance 20m or 30m DC Transceiver." User Manual, December 18, 2005. (https://www.norcalqrp.org/files/NC2030/NC2030_v5.pdf).
TI-1048	CBT (5-V) and CBTLV (3.3-V) Bus Switches, Texas Instruments, August, 1998 (https://www.ti.com/lit/ug/scdd001b/scdd001b.pdf)
TI-1049	Logic Selection Guide, Texas Instruments, August, 1998

	(https://web.archive.org/web/20160118225253/https://my.ece.msstate.edu /faculty/reese/EE4743/data_sheets/sdyu001k.pdf
TI-1050	Thomas H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, Cambridge University Press, 1998.
TI-1052	B. Gilbert, "Advances in BJT techniques for high-performance transceivers," *Proceedings of the 23rd European Solid-State Circuits Conference*, Southampton, UK, pp. 31-38, 1997.
TI-1053	B. Gilbert, "The MICROMIXER: a highly linear variant of the Gilbert mixer using a bisymmetric Class-AB input stage," in *IEEE Journal of Solid-State Circuits*, vol. 32, no. 9, pp. 1412-1423, Sept. 1997.
TI-1054	I. Galton and C. Weltin-Wu, "Understanding Phase Error and Jitter: Definitions, Implications, Simulations, and Measurement," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 66, no. 1, pp. 1–19, Jan. 2019.
TI-1055	P. R. Gray and R. G. Meyer, *Analysis and Design of Analog Integrated Circuits*, Third Edition, John Wiley and Sons, 1993.
TI-1056	D. Knollman, "Designing with op-amps: Single formula technique keeps it simple," EDN Design Feature Article, 1998
TI-1057	1988 Linear Products Databook, Analog Devices, Inc.
TI-1058	Reimund Wittmann, Werner Schardein, Bedrich J. Hosticka, Gert Burbach, and Juergen Arndt, *Trimless High Precision Ratioed Resistors in D/A and A/D Converters*, IEEE Journal of Solid-State Circuits, VOL. 30, NO. 8, pp, 935-938, AUGUST 1995
TI-1059	A. Abidi, "Low-Power RF-ICs in Wireless Transceivers," 1994 IEEE Symposium on Low Power Electronics

TI-1060	Design of Analog-Digital VLSI Circuits for Telecommunications and Signal Processing, J. Franca, Y. Tsividis, ed., 2nd Edition, Prentice-Hall, 1994
TI-1061	J. C. Rudell, et. al., "A 1.9-GHz Wide-Band IF Double Conversion CMOS Receiver for Cordless Telephone Applications," IEEE Journal of Solid-State Circuits, vol. 32, no. 12, December, 1997
TI-1062	J.R. Cogdell, Foundations of Electrical Engineering, 1996 (Prentice Hall 2ed)
TI-1063	K.R. Laker, W. M. C. Sansen, "Design of Analog Integrated Circuits and Systems," First. Ed., McGraw-Hill, 1994 ("Laker")
TI-1064	P. Chang et al, "A CMOS Channel-Select Filter for a Direct-Conversion Wireless Receiver," IEEE Journal of Solid-State Circuits, VOL. 32, NO. 5, pp. 722-729, MAY 1997
TI-1065	Deposition Transcript of David Ricketts, dated June 13, 2025
EX-2024	Declaration of Dr. David Ricketts in Support of Patent Owner's Response to Petition for IPR of U.S. Patent No. 9,118,528 (IPR2024-00936) (**REDACTED**)
EX-2024 (IPR2024-00935)	Declaration of Dr. David Ricketts in Support of Patent Owner's Response to Petition for IPR of U.S. Patent No. 7,865,177 (IPR2024-00935) (**REDACTED**)

III. CLAIM CONSTRUCTION

5. Dr. Ricketts alleges: "A POSITA reading the patents understands that an 'energy' storage element is a particular type of storage element–one that is used in an energy transfer system." EX2024, ¶181 (attempting to distinguish "energy storage element" over "storage element"), ¶169 (alleging "energy transfer…uses the energy from the input EM signal provided to a low impedance load"). Dr. Ricketts' construction proposal seeks to read an energy transfer system into the claims, which is unnecessary. This is because the terms of "storage element" and "energy storage element" are used interchangeably by ParkerVision. TI-1003, ¶¶74-75. While claim 1 recites "a first energy storage element" and "a second energy storage element," dependent claim 18, which depends directly from claim 1, recites "said first and second storage elements." *Id.* Other dependent claims, for example, dependent claims 8 and 9 recite both terms interchangeably. If the distinction between "energy storage element" and "storage element" were so significant, as alleged by Dr. Ricketts in his declaration, then the claims would not have recited the two terms interchangeably.

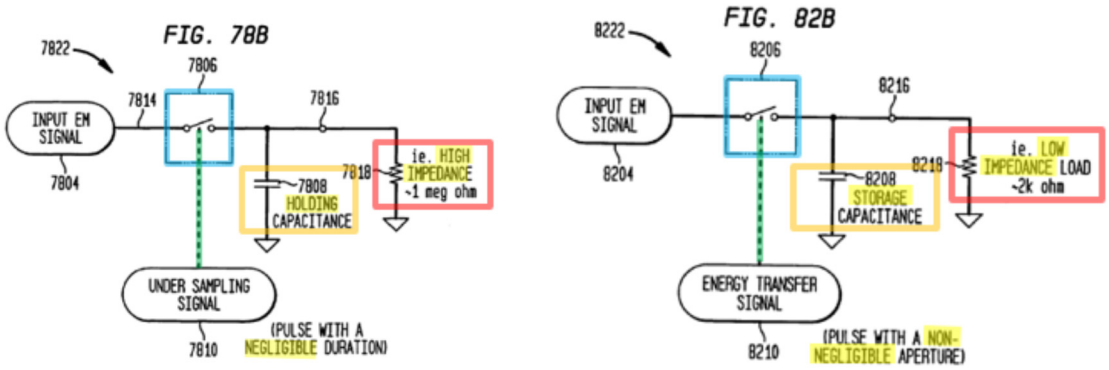
6. Dr. Ricketts further attempts to confuse the Board by alleging that energy storage element is "specific to an energy transfer system," (EX2024, ¶182), and that voltage sampling and energy transfer systems are "two distinct types of

systems," (EX2024, ¶190)[2]. In his declaration, (EX2024, §X.B), Dr. Ricketts represents a voltage sampling system uses a high impedance load while an energy transfer system uses a low impedance load. EX2024, ¶¶118 ("In a voltage sampling system…[a] high impedance load is used to hold the voltage on a capacitor during each sample"), 121 ("In an energy transfer system, energy is integrated in a storage module and a low impedance load is used").

7. Dr. Ricketts further proclaims: "the high impedance load in voltage sampling (e.g., sample-and-hold) causes a capacitor to hold energy (i.e., prevent energy in the capacitor from being discharged to form the down-converted signal), the low impedance load in energy sampling has the opposite effect, enabling a capacitor to store energy and then discharge the stored energy in between samples to form the down-converted signal (i.e., the discharged energy is conveyed in the down-converted signal)." EX2024, ¶123.

8. However, Dr. Ricketts does not (and could not) identify support for the alleged distinction other than the self-serving proclamations from the '528 patent. EX2024, ¶¶165-166 (citing TI-1001, Fig. 78B (showing "HIGH IMPEDANCE ~1meg ohm"), 155-156 (citing Fig. 82B ("LOW IMPEDANCE LOAD ~2k ohm")).

[2] *See also* Section IV.A.(1)(a)(ii) ("Dr. Ricketts is playing word games")



EX2024, ¶¶165, 155 (Dr. Ricketts annotating TI-1001, Figs. 78B and 82B)

9. At best, the '528 patent states that a benefit of the energy transfer system is the ability to drive low-impedance loads. The '528 patent states: "the non-negligible amounts of transferred energy ensure that, ***even for low impedance loads***, the storage capacitance 8208 accepts and maintains sufficient energy or charge to drive the load." TI-1001, 73:65-74:1 (emphasis added). In my view, this statement implies that a benefit of the energy transfer system is the ability to drive low-impedance loads. But energy transfer in the context of the alleged invention is achieved independent of the load.

10. Even if the claimed energy storage element (or storage element) were construed to require a low impedance load (which it does not), the proposed grounds still provide the limitation, as explained in my First 528 Declaration and further elaborated below. *See e.g.*, TI-1003, ¶¶156-163, 194, 199, 235-240, 281, 287.

IV. GROUNDS 1A/1B

11. I understand the POR argues that prior art Tayloe/TI Datasheet does not disclose/teach/suggest certain features recited by claims 1 and 19, as well as claim 8. I disagree with these assertions, and note that the POR reaches this conclusion without addressing the application of the teachings of the prior art, as discussed in my First 528 Declaration. The POR further argues insufficient motivation to combine and no reasonable expectation of success. I also disagree with these assertions because, among others, the POR and Dr. Ricketts declaration ignored inferences and capabilities of a POSITA, as discussed in my First 528 Declaration, and further elaborated in my Second 528 Declaration.

A. Dr. Ricketts mischaracterized Tayloe and fails to address the application of prior art in the Tayloe Combination.

12. In his Declaration, Dr. Ricketts asserts that "Tayloe/TI Datasheet combination fails to disclose, teach or suggest numerous claimed features of the '528 patent," including: (EX2024, ¶¶276-284)

1) "energy storage element[s]" that "store[] the transferred energy from the modulated carrier signal and output[] a down-converted [] baseband signal portion," as recited in claims 1 and 19 (EX2024, ¶277);

2) the baseband signal portions are "derived" from accumulated portions of transferred energy, as recited in claims 1 and 19 (EX2024, ¶278);

3) "differential amplifier circuit that combines" down-converted baseband signal portions and "outputs a [] down-converted differential [] baseband signal," as recited in claims 1 and 19 (EX2024, ¶280); and

4) "a portion of the transferred energy is discharged during the discharging part of the cycle for each respective switching device when the switching device is off," as recited in claims 8 and 26, as well as "energy discharged during any given discharge cycle," as recited in claims 9 and 27 (EX2024, ¶283).

I address each of Dr. Ricketts assertions below.

1. a "energy storage element" that stores transferred energy and outputs a baseband signal portion (claims 1 and 19)

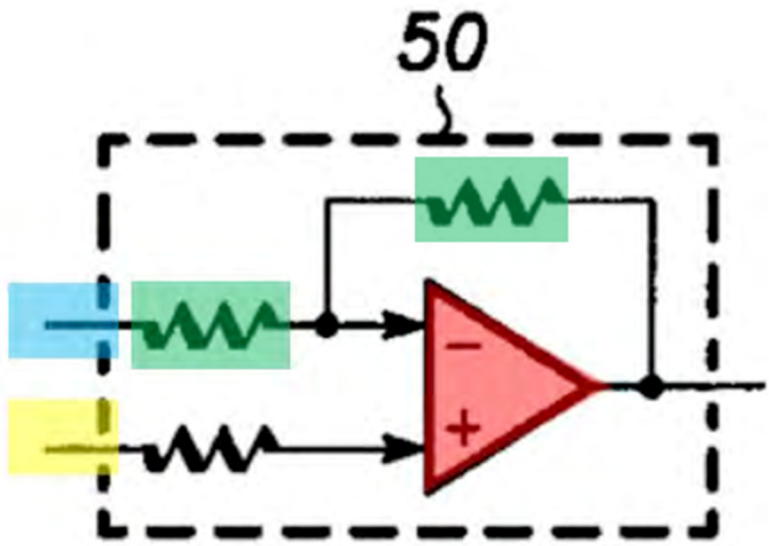
13. As discussed in my First 528 Declaration, Tayloe's capacitor (e.g., capacitor 175 (brown) (or capacitor 72 of Fig. 3)) qualifies as the claimed energy storage element (1c/19c) because it "stores non-negligible amounts of energy from an input EM signal," i.e., the RF input signal f1, in accordance with my construction for the term. TI-1003, ¶¶153-156, 72-80.

(i) Dr. Ricketts' analysis of Tayloe's amplifier is inaccurate

14. Dr. Ricketts asserts, in his declaration, that Tayloe's amplifier must present a high impedance load in the mega-ohm range to each of its capacitors.

EX2024, ¶¶196-233. The analysis by Dr. Ricketts is loaded with inaccuracies, which I address below.

15. Dr. Rickets included the following annotated version of summing amplifier 50 from FIG. 3 of the Tayloe in his declaration:



EX2024, ¶219 (Dr. Ricketts annotating Tayloe (TI-1001), Fig. 3)

16. In the following, I will refer to the top-right green-shaded resistor as the *feedback resistor*, the top-left green-shaded resistor as the *negative input resistor*, and the bottom-left resistor as the *positive input resistor*. The red-shaded triangle in the figure denotes an operational amplifier (op-amp).

17. It is true, as Dr. Ricketts states in Paragraph 218 of his declaration, that the impedance at the "+" terminal node of an op-amp is very high, and, consequently, it is true that the impedance at bottom input to summing amplifier 50 (i.e., the yellow-shaded input in the figure above) is very high, regardless of the

value of the positive input resistor. EX2024, ¶218. This part of what Dr. Ricketts claims is certainly true. However, his claim that this somehow ensures that the node at the "–" terminal has a very high impedance too is nonsense. If there were no "feedback resistor" in summing amplifier 50, then Dr. Ricketts would be correct in claiming that the "–" terminal node would have a high impedance. However, the feedback resistor in conjunction with the high open loop gain that op-amps have by design cause the node at the "–" terminal to have a very low impedance. As a POSITA would have first learned in their freshman or sophomore undergraduate circuits courses, this node is referred to as a virtual ground precisely because the feedback changes the impedance at that node from having a very high value to having a very low value (a ground terminal ideally has zero impedance, so the term "virtual ground" is meant to signify that the node has such a low impedance that it virtually behaves as a ground connection). TI-1046, Page 65.

18. The use of feedback to reduce impedances is a central concept in the field of circuit design, so much so that it is inconceivable to me that Dr. Ricketts is not aware of it. Indeed, later in this document I show that one of Dr. Ricketts' other assertions indirectly implies that the impedance at the node in summing amplifier 50 to which the "–" terminal of the op-amp is connected has a very low impedance.

19. Dr. Ricketts has claimed that the blue and yellow inputs to summing amplifier 50 (in the figure above) "would need to be matched or nearly matched to each other so as to preserve the balance of the 0 and 180 degrees capacitors and the balance of the 90 and 270 degree capacitors." EX2024, ¶219. This is not true for the following reasons. First, as can be seen in the figure above, summing amplifier 50 is asymmetric by design. Had Tayloe wanted to ensure that the blue and yellow inputs to the summing amplifier were "matched or nearly matched" he could simply have used a symmetrical amplifier design, many of which are described in TI-1046, e.g., Fig. 2.25(a) of TI-1046. Second, nowhere in the Tayloe patent is the need for matching discussed. In fact, the words "match" and "matching" do not appear anywhere in the Tayloe patent. Third, the only purpose of connecting Capacitor 76 in Fig. 3 of the Tayloe patent to the yellow terminal (in the above figure) of summing amplifier 50 and of connecting Capacitor 78 to the corresponding (bottom) terminal of summing amplifier 52 in Fig. 3 of the Tayloe patent is to increase the signal power of the down-converted in-phase and quadrature baseband signals. A mismatch between the two inputs of summing amplifier 50 or summing amplifier 52 would not significantly reduce this effect. Indeed, the embodiment shown in Fig. 5 of the Tayloe patents does not even use Capacitors 76 and 78, which can be viewed as an extreme (infinite) mismatch

scenario. Yet, the Tayloe patent correctly argues that Fig. 5 shows an embodiment of the Tayloe invention nonetheless.

20. Dr. Ricketts further stated "[a]s discussed above, the "+" input is extremely high impedance (e.g., 2 meg ohm) and, thus, the impedance looking into the resistor of 50, 52 connected to the '+' input must also be extremely high impedance (e.g., 2 meg ohm). Therefore, to keep the inputs of 50 or 52 balanced, the input resistance of the resistor connected to the '−' input must also be very high impedance." EX2024, ¶ 219. This too does not make sense. Previously, Dr. Ricketts incorrectly claimed that the nodes connected to the '+' and '−' terminals of the op-amp must both have high impedance, but his statement quoted above suggests that he is subsequently acknowledging that the node to which the '−' terminal of the op-amp is connected has a low impedance after all (otherwise, why would he argue that "the input resistance of the resistor connected to the '−' input must also be very high impedance" to match the high impedance of the node to which the + terminal of the op-amp is connected so as to "keep the inputs of 50 or 52 balanced"?). But if his revised position is now that the impedance of the node to which the '−' terminal of the op-amp is low, then what would be the sense of including the positive input resistor in summing amplifier 50? Including this resistor would only further increase the impedance of the yellow input to summing

amplifier 50 (in the above figure), which is in opposition to Dr. Ricketts' stated objective.

21. Furthermore, matching the negative input resistor to the series resistance of the positive input resistor and the input resistance of the positive terminal would be impossible to do with any level of accuracy because the impedance looking in to the positive terminal of a typical op-amp, while very high, would vary significantly across different copies of the op-amp as well as over temperature variations. Besides, as I mentioned above, it is not necessary to match the resistances seen by the 0 and 180 degree (or 90 and 270 degree) lines because they are just inverted versions of each other (so a mismatch would negligibly affect the signal-to-noise ratio). In fact, as I mentioned above, the Fig. 5 embodiment in Tayloe doesn't even use the 180 and 270 degree lines at all, which is a far bigger change than would be caused by an impedance mismatch between the summing amplifier input impedances in the system of Fig. 3 in the Tayloe patent.

22. As further evidence that a POSITA would know not to make the negative input resistors and the positive input resistors in summing amplifier 50 and summing amplifier 52 large, here is the circuit diagram of an actual implementation of the Tayloe invention (the Norcal NC2030 transceiver TI-1047) implemented by Dan Tayloe, the inventor named in the Tayloe patent:

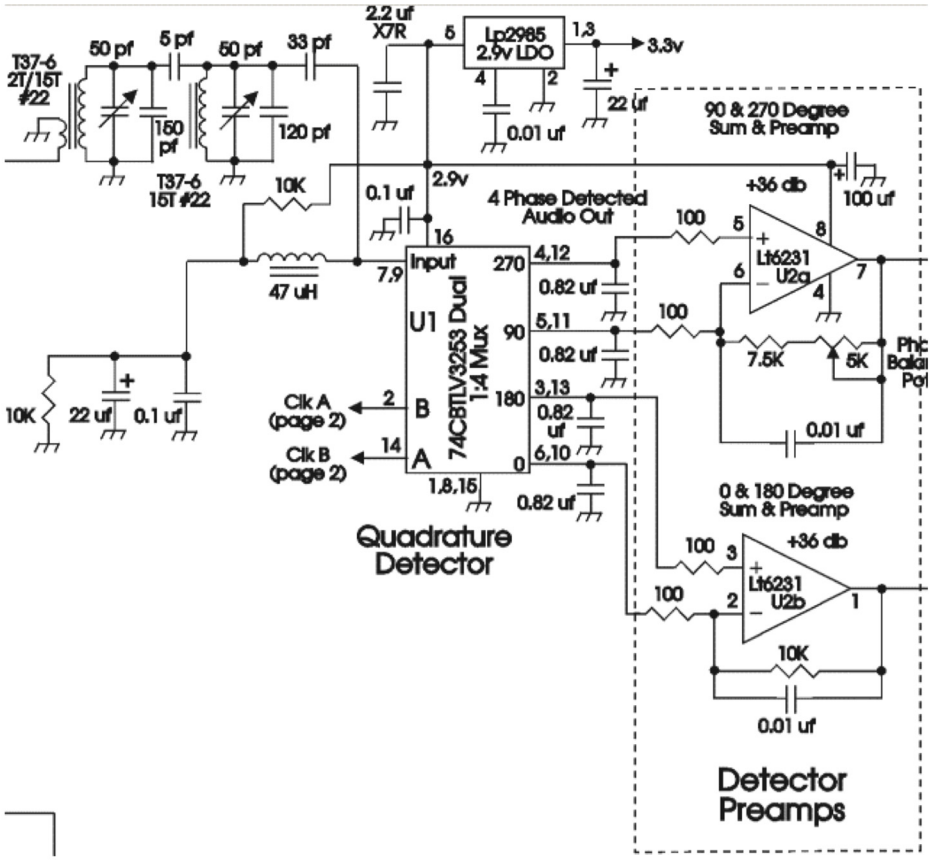


Figure 130. Tayloe quadrature detector and I/Q audio preamplifier schematic

TI-1047, Fig. 130

23. In this figure, the bottom op-amp (triangle symbol) and the resistors surrounding it correspond to summing amplifier 50 in Figure 3 of the Tayloe patent. The only differences between summing amplifier 50 as drawn in Figure 3 of the Tayloe patent and the corresponding circuit shown in the figure above are (1) that the summing amplifier in the figure above happens to be drawn upside down relative to how it is shown in Figure 3 of the Tayloe patent, and (2) that a capacitor is connected in parallel with the feedback resistor. Difference (1) is cosmetic; it has no effect on the circuit behavior. Difference (2) simply causes the

summing amplifier in the circuit above to perform additional lowpass filtering; it has no effect on the resistance looking into the two input terminals because the node to which the '−' terminal of the op-amp is connected is still a virtual ground.

24. Similarly, the top op-amp (triangle symbol) and the resistors surrounding it correspond to summing amplifier 52 in Figure 3 of the Tayloe patent. It is identical to the other summing amplifier except that the feedback resistor is adjustable from 7500 ohms to 1250 ohms via a potentiometer (a device which has a resistance that can be tuned by hand via a screw-slotted knob). This simply allows the gain of the summing amplifier to be adjusted by hand to make the average power of the two amplifier outputs equal. The adjustability does not significantly affect the input impedance of the summing amplifier.

25. Notice in particular that the two input resistors of each of the summing amplifiers in the figure above have resistances of 100 ohms. Therefore, it is clear that Mr. Tayloe would not agree with Dr. Ricketts' assertion that these resistors must be large. In fact, these resistors, which were actually chosen by Mr. Tayloe, are 20,000 times smaller than the 2 mega-ohm resistors that Dr. Ricketts asserted they need to be. EX2024, ¶219 (alleging "the "+" input is extremely high impedance (e.g., 2 meg ohm or 2MΩ)" and noting, in FN9, that "the '551 patent uses a 1 meg ohm resistor in Figure 78B as the load and identifies 1 meg ohm as a high impedance load," and "to keep inputs…balanced, the input resistance of the

resistors connected to the '-' input must also be very high impedance"). Moreover, this is not just Mr. Tayloe's word over Dr. Ricketts' word: the circuit presented in TI-1047 describes a circuit that has been built and is practical. Not only does it work, but TI-1047 is a comprehensive user manual that describes how to build and use the transceiver.

26. Paragraph 231 of Dr. Rickett's Declaration in IPR2024-00935 is another example of where Dr. Ricketts has contradicted himself. Ex. 2024 ¶ 231. In this case, he correctly points out that a POSITA would know that the op-amp within summing amplifier 50 establishes "a virtual short between the amplifier input terminals" (where he is referring to the "+" and "–" terminals of the op-amp in each of summing amplifier 50 and summing amplifier 51), meaning that the terminals have the same voltage. Dr. Ricketts is correct that a POSITA would know this because it is a well-known effect of feedback around an op-amp. Referring to Figure 3 and the supporting text of the Tayloe patent, it is clear that during the time interval when the commutating switch connects the RF input signal to capacitor 72 and the top input of summing amplifier 50, the input signal is not connected to capacitor 76 and the bottom input of summing amplifier 50. As there is essentially no discharge path for capacitor 76 during this time interval (because the high impedance of the '+' terminal of the op-amp is very high, as Dr. Ricketts correctly pointed out), the voltage at the bottom input impedance looking into the

top input to summing amplifier 50 is just the resistance of the resistor that connects the top input of summing amplifier 50 to the '−' terminal of the op-amp. As explained above, Tayloe recommends using a 100 ohm resistor, which implies that the top input of summing amplifier 50 has an input impedance of 100 ohms.

27. Another argument Dr. Ricketts made to assert that the two input resistors of summing amplifier 50 are very large is the statement in the Tayloe patent in reference to Fig. 6 that "the voltage of the outputs are controlled by the capacitor and resistor means that the voltage across each capacitor is not affected by the circuitry to the right of the capacitor" EX2024, ¶229. However, this is not a reasonable argument. The voltages are indeed controlled "by the combination of capacitor 175 and resistor 171" but that does not mean they are unaffected by anything else. For example, the input signal obviously also "controls" the voltages, but the quote does not mention this. The quoted statement does not in any way imply that capacitors 175 and 177 are connected to high impedances (i.e., high impedances are not required for the quoted statement to be true). And besides, as I explained in detail above, TI-1047 is a document written by Mr. Tayloe which gives actual resistor values and shows that 1) the resistor values are low and 2) that the impedances are not matched.

28. As a POSITA would be well-aware, the feedback resistor must be at least as large, but usually considerably larger than the negative input resistor in

summing amplifier 50, or else summing amplifier 50 would not perform amplification (the magnitude of the gain is approximately equal to the ratio of the resistance of the feedback resistor to the resistance of the negative input resistor). For example, the feedback resistors that Mr. Tayloe used in his design in TI-1047 are 100 times larger than the two input resistors. This yields a gain magnitude of approximately 100, which makes sense because received radio signals are very small, so significant amplification is necessary in practical wireless receivers (TI-1050). If Dr. Ricketts' suggested value of 2 mega-ohms were used for each input resistor, then the feedback resistor would have to be 200 mega-ohms to achieve the summing amplifier gain chosen by Mr. Tayloe. Dr. Ricketts' assertion that the resistors should have such enormous values not only contradicts the choice made by Mr. Tayloe, but it is not practical as I explain next.

29. One reason that using such enormous resistors in the summing amplifiers is not practical is that it would reduce the receiver's *noise figure*, thereby degrading the receiver's *sensitivity*, i.e., its ability to receive weak signals. Real resistors introduce thermal noise that can be modeled as a noise voltage source in series with a noise-free resistance, R, as shown in Fig. 11.7(a) of TI-1055 below:

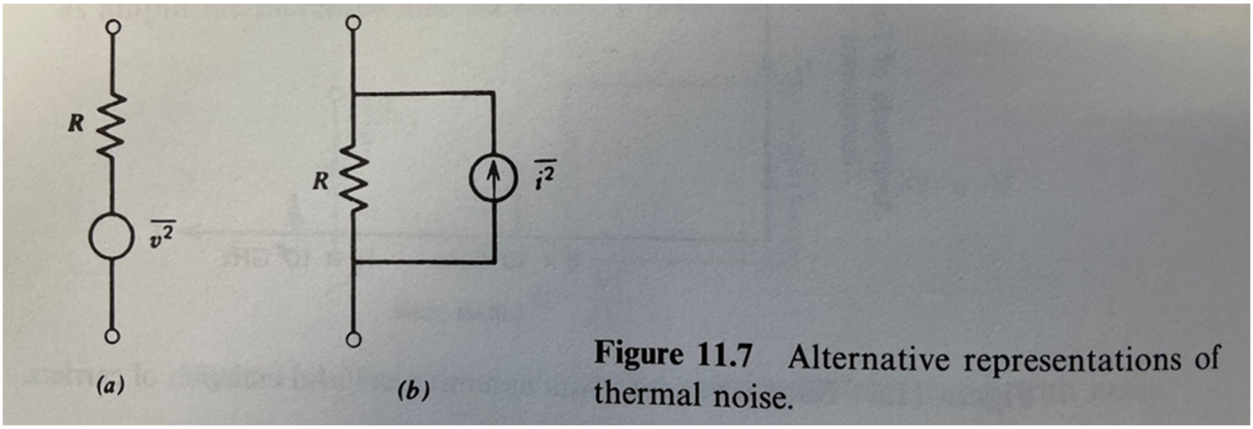


Figure 11.7 Alternative representations of thermal noise.

where the circle in Fig. 11.7(a) represents a noise voltage source with a mean square value of $4kTR\Delta f$, where k is a constant called the Boltzmann constant, T is temperature in Kelvin, and Δf is the frequency bandwidth of the signal of interest in Hz, i.e., the bandwidth of the received signal in the case of a radio receiver (TI-1055, Pages 719-720). Therefore, increasing the value of the resistance, R, increases the power of the noise introduced by the resistor. Consequently, a POSITA would understand that it is undesirable to use extremely large resistors in circuits like wireless receivers that must amplify very small signals, as the noise would severely degrade the receiver's noise figure.

30. As discussed in the Tayloe patent, a significant advantage of Tayloe's invention is that it provides a "6-7 dB improvement in overall receiver noise figure" relative to the prior art (TI-1003, Column 3, Line 9). Had Tayloe used the 20,000× larger resistor values advocated by Dr. Ricketts, the resulting 20,000-fold increase in resistor noise would have severely reduced the above mentioned 6-7 dB improvement offered by Tayloe's invention, which a POSITA would understand is

highly undesirable. Indeed, as Mr. Tayloe states on Page 111 of TI-1047, "The use of the 100 ohm resistors into the preamp op-amps are a tradeoff between sensitivity and large signal performance since the introduction of any resistors in the low level signal path produces noise which reduces sensitivity." Therefore, Mr. Tayloe's own words make it clear that resistor noise in the summing amplifiers (which he refers to as preamps in the above quote) is a significant issue in his receiver.

31. Another reason that using such enormous resistors in the summing amplifiers is not practical is that doing so would exacerbate the effect of the op-amp's parasitic capacitances and result in circuit instability. This is because the feedback resistors are in series with the parasitic capacitances, essentially forming an RC filter in the feedback loop, which introduces a propagation delay around the feedback loop. The largest practical feedback resistance depends on the details of the particular op-amp. For example, the 1988 datasheet for the AD549 op-amp manufactured by Analog Devices, Inc., states: "feedback resistances greater than 100kΩ will magnify the effect of input capacitances … since the circuit's bandwidth and stability can be adversely affected" (TI-1057). Similar statements apply to practical op-amps in general. For example, in reference to an amplifier that is comparable to summing amplifier 50 in the Tayloe patent, a 1998 tutorial article states: "[t]he feedback resistor you choose can theoretically be any value,

but op-amp and circuit considerations usually limit the range of acceptable values" (TI-1056, 136).

32. The following amplifier configuration is shown in TI-1046:

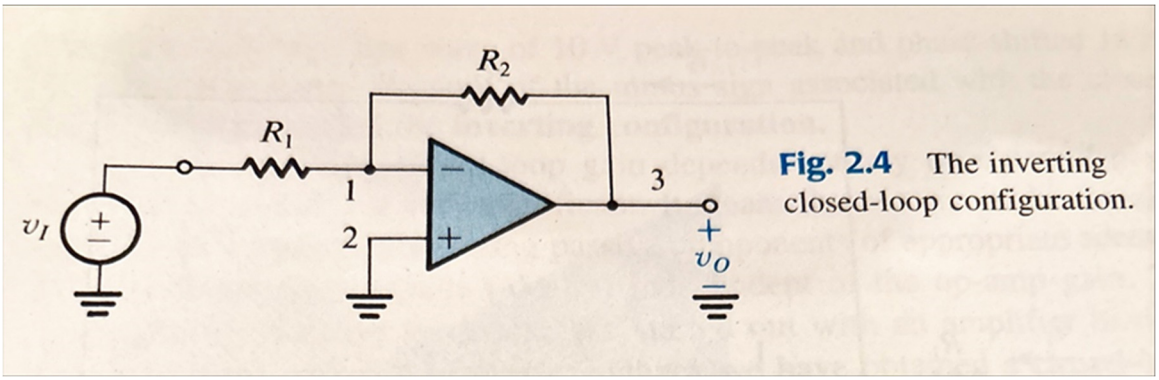


Fig. 2.4 The inverting closed-loop configuration.

TI-1046 (Sedra/Smith), FIG. 2.4

33. The accompanying text explains that the "the input resistance of the closed-loop inverting amplifier of FIG. 2.4 is simply equal to R_1" (TI-1046, Page 68). It goes on to characterize the amplifier as having a "low input resistance" (TI-1046, Page 69), thereby implying that R_1 must have a "low" resistance, and characterizes a few mega-ohms as "impractically large" (TI-1046, Page 69).

34. The Figure shown above differs from summing amplifier 50 in Fig. 3 of the Tayloe patent in that '+' terminal of the op-amp in the latter is connected to capacitor 74 and the 180^0 output of commutating switch 38 through the positive input resistor, whereas in the former it is connected to ground. However, these differences do not affect the reasoning behind the TI-1046 textbook's conclusions stated above for two reasons. One reason is that negligible current flows through

the positive input resistor because of the high input impedance looking into to the '+' terminal of the op-amp, which essentially negates the effect of the positive input resistor. The other reason is that the analysis used to show that a virtual ground occurs at the '−' terminal of the op-amp in the figure above does not require that the '+' terminal is held at ground; it is simply necessary for the '+' terminal to be held at a fixed voltage for the analysis to be valid. As the voltage across capacitor 76 in Fig. 3 of the Tayloe patent only changes when commutating switch 38 closes, and this happens only for a quarter of each period, it follows that the '+' terminal of the op-amp is held at a constant voltage for three quarters of each period. Hence, the TI-1046 textbook's conclusions mentioned above hold for three quarters of each period. As the resistor values are fixed, it follows from the TI-1046 textbook's conclusion that a negative input resistor in summing amplifier 50 of Fig. 3 in the Tayloe patent with a resistance of a few mega-ohms would be "impractically large."

35. Consequently, Dr. Ricketts is wrong in representing that the resistance of the negative input resistor of summing amplifier 50 in Fig. 3 of the Tayloe patent "must…be very high impedance" (e.g., in the 2 mega-ohm). EX2024, ¶219, FN9.

(ii) Dr. Ricketts mischaracterizes Tayloe

36. Dr. Ricketts characterizes Tayloe as disclosing voltage sampling and not an energy transfer system, which he states are "competing technological solutions" for down-conversion. EX2024 ¶¶198-199. This is a fundamental mischaracterization of the Tayloe invention. The Tayloe invention connects each capacitor to the RF input signal for a quarter of each local oscillator period, thereby charging the capacitor. As Dr. Ricketts acknowledges, the energy stored on a capacitor is $\frac{1}{2} \cdot C \cdot V^2$. EX2024 ¶76. This energy comes from the input signal when the corresponding switch is closed, it gets transferred to the capacitor via current, and power, which is energy per unit time, is voltage times current. Moreover, a POSITA understands that the charge stored on each plate of a capacitor has a magnitude of $C \cdot V$, and that current has a magnitude of charge per unit time. Hence, knowing the values of C and V is equivalent to knowing the amount of energy stored on the capacitor as well as knowing the magnitude of the stored charge. In short, Dr. Ricketts is playing word games in an attempt to ignore physics.

37. The act of sampling in electronics always involves storing a voltage on a capacitor, and changing the voltage on a capacitor (e.g., by sampling an input signal) changes the energy it stores. The '528 patent argues that having a small sampling aperture "minimizes" the amount of energy that gets transferred, e.g., it states that having "negligible aperture pulses minimize the amount of energy transferred from the EM signal" (TI-1001, Column 69, Lines 32-34), so it

advocates using non-negligible aperture windows to transfer more energy. Specifically, the '528 patent advocates aperture windows that "tend away from zero time in duration" (TI-1001, Column 73, Lines 26-27) to allow the capacitor to "accept a non-negligible amount of power during a non-negligible aperture period" (TI-1001, Column 73, Lines 40-41). As Tayloe's aperture window is 25% of the period, it has a large (non-negligible) sampling aperture, so it fits the high "energy transfer" paradigm of the '528 patent (recall that power is energy per unit time) despite Dr. Ricketts' claim to the contrary, which is based on incorrect logic.

(iii) Dr. Ricketts does not address the application of Tayloe in the combination

38. In the above context, the application of prior art in the Tayloe combination also meets the extraneous requirement (i.e., low impedance load) that Dr. Ricketts seeks to impose. As I explained in my First 528 Declaration, in the Tayloe combination, Tayloe's capacitors are coupled to "the differential amplifier circuit of Macnally [which] provides [a] low impedance load typically in the kilo ohm range." TI-1003, §§VI.C, VI.D. ParkerVision had alleged that having so-called low impedance load "goes to the heart of what makes an element, a 'storage' element." *See e.g.*, IPR2020-01265, Paper 26 (PO Sur-reply) at 13; Paper 18 (POR) at 46-50.

39. In his declaration, Dr. Ricketts asserts "…capacitors 72, 76 of Figure 3; or capacitors 175, 177 in Figure 6 [of Tayloe] do not discharge energy…and

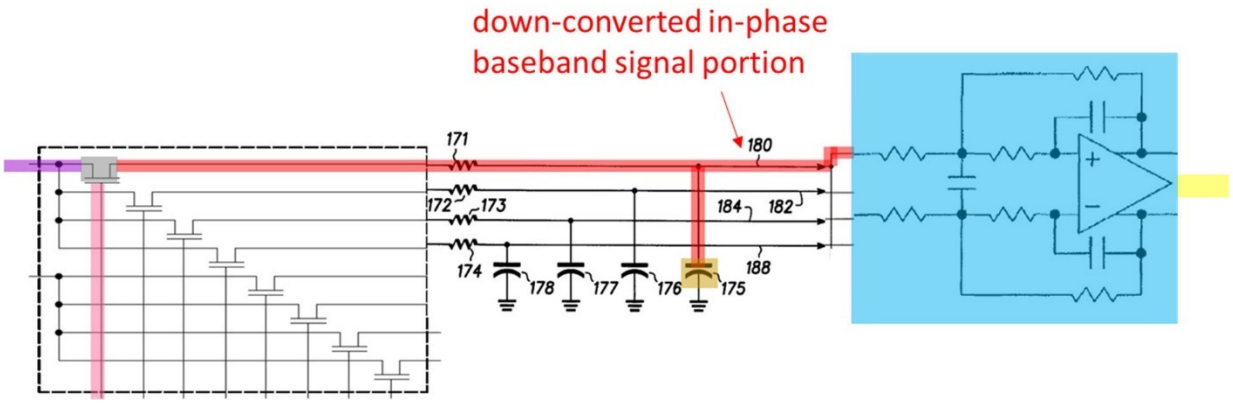
thus cannot generate any baseband signal portion." EX2024, ¶¶279-284. Dr. Ricketts further asserts: "Tayloe is using a high impedance load (i.e., amplifiers 50, 52 are high impedance) and capacitors are not discharging to that load." EX2024, ¶213.

40. I disagree with Dr. Ricketts because his analysis is flawed. For example, he did not acknowledge that Tayloe teaches generating baseband signals using the accumulated charges, as I had explained earlier. TI-1003, ¶¶153-158 (citing, among others, TI-1004, 2:56-59 ("…producing baseband in-phase signal"), 5:1-16 ("0 degree output [is] used to generate baseband in-phase…signal")). Additionally, Dr. Ricketts did not account for Tayloe's capacitor, which, as applied in the combination, is coupled to a "low impedance load" provided by "the differential amplifier circuit of Macnally.". TI-1003, §VI.D. As I discussed *supra* §IV.A.1(a)(i), two of the four capacitors are coupled to the negative input terminals of Tayloe's summing amplifiers, each of which presents a low-impedance load (e.g., in the kilo ohm range).

2. deriving a baseband signal portion from accumulated transferred energy (claims 1 and 19)

41. As I have explained above and in my First 528 Declaration, Tayloe teaches "producing baseband in-phase signal" from charge build-up on its capacitor. TI-1003, ¶¶153-154 (citing TI-1004, 2:56-59). Specifically, my First 528 Declaration had explained the operation of Tayloe: "During the time [the first

switch] connects input 36 [receiving input signal (purple)] to output 42 [0-degree output], charge builds up on capacitor 72 [corresponding to capacitor 175 in Fig. 6].” *Id.*, (further citing TI-1004, 2:33-45, 2:46-55 (“Output 42 [0-degree output] represents the average value of the input signal during the first quarter wave of the period, and is termed the 0 degree output….”), 2:56-59 (“…producing baseband in-phase signal”), 4:49-51, 2:27-32, 2:13-18. Figs. 3, 4, 6.) Tayloe specifically describes that “0 degree output [is] used to generate baseband in-phase…signal.” TI-1004, 5:1-16.



Combination System (using switch of TI-1005 and circuit of TI-1021/TI-1022)

42. In his declaration, Dr. Ricketts rehashes the same argument[3] that Tayloe’s capacitors “do not discharge energy to generate the baseband signal” and “[b]ecause there is no discharge of energy from the capacitors to the load in

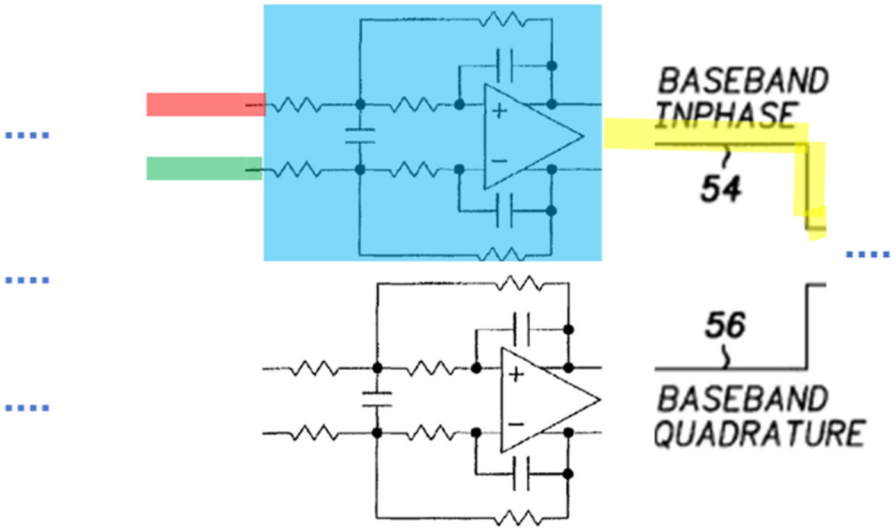
[3] Same as EX2024, ¶277 (which has been addressed under §IV.A.1(a))

Tayloe, the baseband signal portion cannot be derived from the accumulated transferred energy." EX2024, ¶279.

43. I disagree with Dr. Ricketts because his analysis is deficient. For example, Dr. Ricketts failed to address that Tayloe teaches generating baseband signals using the accumulated charges, as I had explained earlier. TI-1003, ¶¶153-158. Moreover, in the Tayloe combination, Taylor's capacitors are each coupled to "the differential amplifier circuit of Macnally [which] provides low impedance load," as I had explained earlier. TI-1003, §VI.D. In the combination, Taylor's capacitors will thus each discharge energy to the low impedance load, i.e., the differential amplifier circuit of Macnally, even under the low impedance requirement imposed by Dr. Rickett and ParkerVision.

3. "differential amplifier circuit that combines" down-converted baseband signal portions and "outputs a [] down-converted differential [] baseband signal" (claims 1/19)

44. As I explained in my First 528 Declaration, "the combination system includes a first differential amplifier circuit (light blue) that combines said down-converted in-phase baseband signal portion (red portion feeding into Macnally's circuit) with said down-converted inverted in-phase baseband signal portion (green portion feeding into Macnally's circuit) and outputs a first channel down-converted *differential* in-phase baseband signal (yellow)." TI-1003, ¶167 (annotations reproduced below).



Combined System (zoomed portions using circuit of TI-1021/TI-1022)

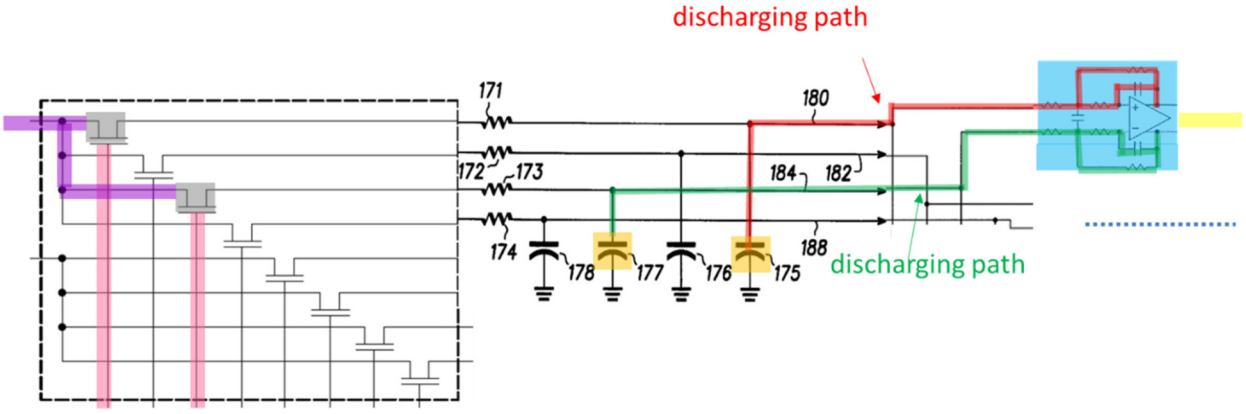
45. In the combination system, "a POSITA would have found it obvious to implement each of Tayloe's differential amplifier circuits…as a fully differential operational amplifier configuration…as taught in Macnally…," (TI-1003, ¶140), thus providing "differential output having two complementary components, each combining the two complementary components of the differential input signal" (TI-1003, ¶¶166-69). *See also* TI-1003, §VI.D (tutorial on fully differential amplifier); TI-1004, 2:56-67, Abstract, Fig. 3; TI-1021, 5:64-67.

46. In his declaration, however, Dr. Ricketts has not addressed the combination system. Instead, Dr. Ricketts merely dwelled on Tayloe's amplifier. *See* EX2024, ¶¶280-282. Because Tayloe's amplifier is not part of the proposed combination, Dr. Ricketts' arguments are moot. Additionally, Dr. Ricketts'

analysis of Tayloe's amplifier circuitry is loaded with inaccuracies, which I have discussed above under Section IV.A.1(a)(i).

4. discharging "during the discharging part of the cycle for each respective switching device when the switching device is off" (claims 8/26 and 9/27)

47. As I had explained in my First 528 Declaration, and using the same annotation for the combination system, "for each switch (gray), the portion of energy that is distinguishable from noise is transferred to the respective storage element (brown) when the switch is on (i.e., CLOSED) during the charging cycle." TI-1003, ¶174. "When the switch (gray) is off (i.e., OPEN), a portion of the transferred energy (e.g., charge accumulated) is discharged, as annotated below for two discharging paths." *Id.*



Combination System (using switch of TI-1005 and circuit of TI-1021/TI-1022)

48. As I had explained in my First 528 Declaration: "Each capacitor is coupled to the input impedance of the fully differential amplifier, which is

typically in the kilo ohm range, and as a result, incomplete discharge of accumulated charges." TI-1003, ¶174.

49. In his declaration, Dr. Ricketts asserted "the capacitors identified in Tayloe—whether 72 and 76 in Figure 3 or 175 and 177 in Figure 6—do not discharge to form a baseband signal when the associated switches are OFF." EX2024, ¶284.

50. I disagree with Dr. Ricketts in that two of Tayloe's capacitors (i.e., those coupled to the negative input terminals of summing amplifiers 50 and 52) do see low impedance loads (e.g., in the kilo ohm range) even in the original Tayloe system of Fig. 3. *Supra* §IV.A.1(a)(i). I also disagree with Dr. Ricketts because his analysis did not address the combination system. Instead, Dr. Ricketts merely relied on his reading of Tayloe alone. *See* EX2024, ¶279 ("A POSITA would understand that in order for the capacitors to maintain those voltage level, the capacitors must retain charge and cannot discharge energy"). There is no support for Dr. Ricketts' assertion that "the capacitors [as applied in the combination system] cannot discharge energy" *Id.* In Dr. Ricketts' own earlier explanation at ¶¶166-167 of his declaration, Dr. Ricketts stated: "the high impedance load is specifically included to prevent the holding capacitor from discharging energy." In the combination system, however, the fully differential amplifier, as provided by the teachings of Macnally, exhibits a low impedance load to the capacitors of the

combination system. In my First 528 Declaration, I provided a detailed analysis of Macnally's circuit, which reveals that, under the disclosed features and operating conditions, the impedance is on the order of kilo ohms. *See e.g.*, TI-1003, ¶¶49-50.

51. Specifically, the fully-differential op-amps have high open-loop gains by design, so the input impedance between the red-shaded and green-shaded inputs of the Macnally biquad amplifier/filter in the figure above over the bandwidth of the filter is very nearly equal to the sum of the resistances of the two resistors connected to the red-shaded and green-shaded inputs. The analysis I presented in my original declaration showed that these resistors each have a value of 1000 ohms, (TI-1003, §VI.D), so the impedance between the red-shaded and green-shaded inputs is 2000 ohms. Consequently, the Macnally biquad provides a low-impedance discharge path for the two capacitors. Moreover, as the two capacitors (capacitors 72 and 76 in Fig. 3 of the Tayloe patent) connected to the inputs of the Macnally biquad present a differential voltage to the biquad, the effective impedance that each capacitor sees to ground is half of the differential impedance, namely 1000 ohms over the bandwidth of the filter.

B. Dr. Ricketts failed to address the motivation to combine

52. I notice that ParkerVision and Dr. Ricketts have attacked the motivation to combine by asserting: **1)** Tayloe teaches away from using Figure 6 with the TI Datasheet multiplexer; **2)** Tayloe teaches away from the proposed

combination; **3)** Macnally and TI datasheet are not combinable; **4)** Macnally teaches a fundamentally different mixer than Tayloe; and **5)** no motivation to replace Tayloe's amplifiers with Macnally's biquad two-pole filter. EX2024, ¶¶285-338. As discussed below, the arguments mischaracterize the prior art, and fail to address the rationale articulated in my First 528 Declaration.

1. Tayloe does not teach away from using Figure 6 with the TI Datasheet multiplexer

53. In his declaration, Dr. Ricketts asserts: "Tayloe teaches away from using [its] Figure 6 with TI Datasheet multiplexer" because Figure 6 "uses a *per-path* resistor configuration…which introduces greater component count, routing complexity, and cost," as compared to the "*shared* resistor configuration" of Figure 3. EX2024, ¶¶295-303. Dr. Ricketts alleges: "replacing the shared resistor 204 of Figures 3 and 7 with the multiple resistors (171, 172, 173, 174) of Figure 6…undermines the very design tradeoffs Petitioner claims would motivate a POSITA to adopt the Tayloe-Macnallay-TI Datasheet combination in the first place." EX2024, ¶299.

54. Dr. Ricketts insists that "a POSITA seeking a single-chip IC would prefer the simpler architecture of Figure 3—which uses fewer components, reduces layout complexity, and minimizes die area and power consumption—compared to Figure 6's per-path resistor structure—which introduces greater component count, routing complexity, and cost." EX2024, ¶300. According to Dr. Ricketts: "[i]n an

IC context, using Figure 6 would require precise matching of the four resistors in order to maintain equal time constants across signal paths." EX2024, ¶301 ("This level of matching is difficult to achieve due to variation in IC fabrication processes.").

55. First of all, Dr. Ricketts' issue with using Figure 6 is irrelevant, as it is functionally equivalent to the system of Figure 3 in the Tayloe patent, which uses a single resistor in place of the four resistors mentioned by Dr. Ricketts. It is hard to imagine that Dr. Ricketts really believes that modifying the system of Figure 3 in Tayloe by removing the resistor at the input of the commutating switch 38 and adding resistors to each of the outputs of the commutating switch would have any effect on the required properties of the commutating switch. This makes absolutely no sense! The path from the input of commutating switch 38 in Figure 3 of the Tayloe patent to each of its outputs is a linear system (albeit time-varying). Both switches and resistors are linear components, and it is well known in the field of circuit theory that the order of linear components can be swapped without affecting the overall system behavior TI-1045.

56. Nevertheless, even if the system of Figure 6 is used instead of Figure 3, I disagree with Dr. Ricketts' point about resistor matching being an issue in Fig. 6 of Tayloe because Tayloe's *per-path* resistor configuration does not contradict the motivation to combine with Macnally. Based on my experience, it was

general knowledge to match resistors during IC fabrication, as evidenced by prior art demonstrating on-chip resistors matched to a fraction of a percent of accuracy. In Wittmann, it is demonstrated that "layout of the resistors…optimized with respect to area and matching requirements to yield relative accuracy better than 0.25%." TI-1058, 935. When combining Tayloe's Figure 6 (rather than Figure 3) with the TI datasheet multiplexer, using matched resistors on each path on the IC would be standard practice when using "standard CMOS and BiCMOS processes," as shown in Wittmann. TI-1058, 935, 939. Hence, the matched resistors on each branch would not contradict the "size, packaging advantages, and low unit cost" for IC implementation, as I had explained in my First 528 Declaration. TI-1003, ¶141.

57. I also notice that Dr. Ricketts never explained why matching resistors or laying matched resistors on an IC would contradict the benefits of IC implementation. Furthermore, if matching of the four resistors were essential in Figure 6 of the Tayloe patent, it would follow that matching of the four capacitors in Figure 3 of the Tayloe patent (i.e., capacitors 72,74,76, and 78) is also essential, yet neither Tayloe nor Dr. Ricketts mention any concerns about capacitor matching (as I mentioned above, the Tayloe patent never mentions anything about matching). The reason is that matching is simply not a significant issue in either embodiment of the Tayloe patent despite Dr. Ricketts unsupported claims to the

contrary. On this note, Dr. Ricketts was unable to support his assertions with concrete examples that counter mine because there are none.

2. Tayloe does not teach away from the combination

58. In his declaration, Dr. Ricketts asserts: "a POSITA would understand that Tayloe specifically teaches away from implementing its product detector in an IC" because "Tayloe admits that, as of the time of the patent, the prototype could not handle higher frequency signals (the types of signals that would be used for cellular/WiFi communications)" (emphasis original) and "[a] POSITA would recognize that Tayloe's capacitors would not be suitable for integration due to their large size." EX2024, ¶¶303-307. Dr. Ricketts then asserts that my "proposal of adapting Tayloe's entire system, including the large capacitors, into an integrated circuit does not work, given the large size of Tayloe's capacitors." EX2024, ¶306. Dr. Ricketts further asserts: "a POSITA would recognize that building an integrated circuit with Tayloe's product detector and the TI Datasheet would require redesigning the circuit architecture, abandoning the TI multiplexer, and developing new switching components capable of operating orders of magnitude faster than those disclosed in Tayloe or the TI Datasheet." EX2024, ¶307 (alleging "undue experimentation, well beyond routine skill in the art").

59. I disagree with Dr. Ricketts because he has mischaracterized the prior art (e.g., Tayloe), the proposed combination, and the rationale for combination as I had articulated in my First 528 Declaration.

60. Tayloe does not admit its teachings are limited to its prototype example where the operating frequency was 7MHz. TI-1004, 5:34-59. Rather, Tayloe expressly states that "this invention is not limited to the particular forms shown and we intend in the appended claims to cover all modifications that do not depart from the spirit and scope of this invention." TI-1001, 6:5-8.

61. The proposed combination is not limited to bodily incorporating Tayloe's capacitor to handle "higher frequency signals (the types of signals that would be used for cellular/WiFi communications)," as alleged by Dr. Ricketts. EX2024, ¶306. In fact, using different component values than those disclosed in Tayloe's prototype example does not "depart from the spirit and scope of this invention." TI-1001, 6:5-8.

62. Dr. Ricketts also overlooked the general knowledge and capability of a person of ordinary skill. While the challenged claims do not recite any operating frequency or a particular capacitance, a person of ordinary skill would have known a suitable capacitance for a given frequency and would have been capable of using a different component value (e.g., the suitable capacitance). Even if Tayloe's capacitors were "larger than what is considered feasible (1 pico-Farad) in an IC,"

Dr. Ricketts already recognized one solution in which "Tayloe's capacitors would be off chip." EX2024, ¶306. Notably, the challenged claims do not require on-chip capacitors and Dr. Ricketts never demonstrated otherwise.

63. In fact, it was common practice to use off-chip capacitors for modern chips. For example, Abidi (TI-1059) describes one example of "single-chip FM mono receiver [which] requires only 15 small [off-chip] capacitors and two inductors, making it possible to fit the entire system within a wristwatch" and "Yet greater miniaturization is attained at Alcatel by integrating the transmitter and receiver sections together on one silicon bipolar chip" using "Large (650 pF) off-chip capacitors constitute an anti-alias filter"). Here, "large" refers to the value of the capacitance, not the physical size of the capacitor. Also note that the "greater miniaturization" occurs despite the off-chip capacitors).

3. Macnally and TI datasheet are combinable

64. In his declaration, Dr. Ricketts goes on to assert Macnally and TI datasheet are not combination because "[t]he switches in the TI Datasheet cannot turn ON and OFF fast enough to handle 915 MHz" used by Macnally's mixer. EX2024, ¶¶310-315, FN7 ("Tayloe's prototype circuit that used the TI Datasheet multiplexer operated at 7 MHz. Ex.-1004 5:49-50. The TI Datasheet multiplexer only worked because it operated at 7MHz which is more than two orders of magnitude lower than the frequency disclosed in Macnally.").

65. I disagree. As I already discussed above, the challenged claims do not require high-frequency operation. Dr. Ricketts never proffered any reason why an IC implementation could not instead target the same low-frequency operation as described in Tayloe. Significantly, while Macnally's example shows a mixer operating at 915MHz for direct conversion of an input RF signal, Macnally's mixer is not part of my proposed combination. As I had explained in my First 528 Declaration, TI-1003, ¶¶108-111, Macnally shows "output of mixer…fed to…antialiasing filter"), TI-1021/TI-1022, FIG. 3; TI-1021, 7:7-16, 7:17-29/TI-1022, 8), 27-29. In my proposed combination, the combination system "implement[s] each of Tayloe's differential amplifier circuits…as a fully differential operational amplifier configuration…as taught in Macnally (TI-1021/TI-1022, Fig. 3)." TI-1003, ¶¶140-142. Because the teachings of Macnally's differential amplifiers are not limited to a specific modulation frequency, Dr. Ricketts' incompatibility argument is moot. Additionally, Macnally's differential amplifiers operate on down-converted signals in which the modulation frequency is irrelevant. Further, fast switches (such as Macnally's) were available to handle 915MHz, which Dr. Ricketts appears to forget when singling out the frequency of Tayloe and TI datasheet.

66. Moreover, Dr. Ricketts' arguments above regarding the TI Datasheet are completely vacuous. It is true that the specific TI catalog part

multiplexer/demultiplexer that Mr. Tayloe used in his example embodiment is too slow to implement the Tayloe invention as a 900 MHz direct-conversion receiver, but this observation is both misleading and irrelevant.

67. The TI Datasheet describes a stand-alone integrated circuit, the SN74BCT3253D multiplexer/demultiplexer, that Mr. Tayloe used as a multiplexer to implement the commutating mixer in his example embodiment. The SN74BCT3253D is a general purpose "transistor-transistor logic" (TTL) compatible multiplexer/demultiplexer for the 7400 logic series and is intended for use in digital bus switching operations (not wireless receivers). TI-1048. The 7400 logic series dates back to the 1960s, so it was old technology even at the time of the priority date of the '528 patent, and its maximum data rate is well under 1 GHz (usually well under a few hundred MHz). TI-1049. It did not have to operate at higher frequencies because the rest of the 7400 logic series with which it was designed to be compatible is not capable of high-frequency operation.

68. Nevertheless, the schematic diagram of each SN74BCT3253D multiplexer (which is given in the datasheet, so a POSITA would have had access to it) consists of just four separately-operating MOS transistors, and a POSITA at the time of the priority date of the '528 patent would understand that it is possible to custom-design an on-chip multiplexer with switches that turn off and on at a high-enough speed to implement a 900 MHz direct-conversion receiver (a POSITA

would have recognized that if this were not the case, neither the Macnally circuit nor the Razavi circuit would function, as both utilize MOS transistors as comparably high-speed switches). Therefore, the fact that Mr. Tayloe chose a catalog part that was fast enough for his application but happens not to be fast enough for higher-frequency applications in no way implies that a multiplexer with the same general circuit schematic could not be made to operate at much higher frequencies when custom implemented in an appropriate integrated circuit technology.

69. Furthermore, the requirement that an integrated circuit implementation of the Tayloe invention would have to operate as a 900 MHz direct-conversion receiver is a requirement that Dr. Ricketts made up. As I explained above, there is no reason why an integrated circuit implementation could not instead target the same lower-frequency application that the embodiment described in the Tayloe patent targeted.

4. Dr. Ricketts mischaracterizes Macnally

70. In his response, Dr. Ricketts goes on to assert that I fail "to show any motivation for replacing Macnally's mixer, which achieves significant gain (14.3dB), with Tayloe and the TI Datasheet multiplexer." EX2024, ¶316. Dr. Ricketts asserts: "The gain achieved in Macnally is not due to the biquad two-pole filter. EX2024, ¶317 (citing Ex.-1021, 7:8-10). Ricketts further asserts that

"Tayloe, on the other hand, discloses a mixer with a -1 dB conversion loss, which is 15 dB less gain (worse) than Macnally." EX2024, ¶317 (citing Ex.-1004, 1:65; 3:5-6, 9-11).

71. I disagree with Dr. Ricketts because he has misinterpreted what I wrote in my expert declaration as implying that a POSITA would be motivated to replace Macnally's mixer with the Tayloe invention without any other changes. What I actually wrote in my expert declaration was that a POSITA would recognize the benefits of implementing the Tayloe invention as an integrated circuit. *See e.g.*, TI-1003, ¶¶141-143. One such benefit is that signal processing operations including amplification and filtering can be implemented differentially, which results in the advantages I described in detail in my expert declaration. Consequently, as I wrote in my First 528 Declaration, a POSITA would be motivated not only to implement the Tayloe invention as an integrated circuit, but would also be motivated to replace summing amplifiers 50 and 52 in Fig. 3 of the Tayloe patent with fully-differential amplifiers.

72. Contrary to Dr. Ricketts' interpretation, my First 528 Declaration did not opine on whether it would be beneficial to replace Macnally's mixer with the Tayloe invention. Furthermore, the answer to this question would depend on many factors that include but are not limited to what is the target application, what are the required performance specifications, what integrated circuit technology is to be

used, etc., so there is no one-size-fits-all answer to the question. In any case, the question is irrelevant to the evaluation of whether a POSITA would a) be motivated to implement the Tayloe invention as an integrated circuit and b) be motivated to use fully-differential amplifiers when implementing the Tayloe invention as an integrated circuit.

73. Dr. Ricketts' assertions regarding the gain provided by various portions of Macnally's circuitry are predicated on two misunderstandings. One misunderstanding is that "The gain achieved in Macnally is not due to the biquad two-pole filter." As I show in my First 528 Declaration, together the two biquad two-pole filters actually introduce 15.1 dB of gain and the mixer introduces 14.3 dB of gain. TI-1021, 7:7-20, FIG. 3/TI-1022, page 8, lines 3-12, FIG. 3. Therefore, over half of the gain comes from the pair of biquad two-pole filters, suggesting significant contributions from the biquad filters and highlighting Dr. Ricketts' erroneous representation that "[t]he gain achieved in Macnally is not due to the biquad two-pole filter." EX2024, ¶317.

74. The other misunderstanding is that more mixer gain is always better. In reality, how much gain is needed depends on the specifics of the target application. As any POSITA would know, increasing the gain of a circuit block (the mixer in this case) has the advantage of reducing sensitivity to noise introduced by subsequent circuit blocks, but has the disadvantage of increasing

sensitivity to nonlinear distortion introduced by the subsequent circuit blocks. TI-1050. Moreover, Dr. Ricketts seems to think that the quality of a mixer is determined solely by its gain, which makes no sense. Other factors, such as power consumption, circuit area, noise, linearity, and sensitivity to inevitable non-ideal circuit behavior such as component mismatches, are important metrics when evaluating any circuit block, including mixers.

75. More generally, many of Dr. Ricketts' comments seem to imply that he thinks the embodiment examples described in any patent except the '528 patent are only representative of a patented invention if none of the component values are changed from those stated in the patent. I do not believe this position is valid. Moreover, it is unrealistic from an engineering point of view. The field is called "circuit design" not "circuit cut-and-paste" because even when circuit designers implement well-known circuit blocks, they always have to choose specific component values, and those values will be different depending on many factors including the target application, the details of the chosen integrated circuit technology, and the required circuit specifications. Moreover, very often a designer will modify details of a circuit such as how bias voltages or currents are generated. Such modifications might make the circuit look slightly different than a corresponding embodiment example in a patent, but usually do not change the fundamental behavior op inventive aspect of a circuit.

5. Reason to replace Tayloe's amplifiers with Macnally's biquad two-pole filter

76. In his declaration, Dr. Ricketts asserts "no reason for a POSITA to even consider using a fully differential amplifier," as taught in Macnally. EX2024, ¶319. Dr. Ricketts alleges this is because: (i) "Tayloe's amplifiers already accomplish the intended goal of providing gain," (EX2024, ¶321), (ii) "Tayloe already performs the function of an anti-aliasing filter–removing aliasing artifacts," (EX2024, ¶325), (iii) "Tayloe's amplifiers already process complementary inputs," (EX2024, ¶¶328, 329 ("Tayloe already solves" performance concerns such as noise)), (iv) "Using Tayloe Figure 6 and Macnally's biquad two-pole filter…would significantly increase (not decrease) the number of components needed to achieve the same result," (EX2024, ¶336), and (v) "Tayloe describes the invention as 'a simple and inexpensive product detector,' with performance benefits such as 'low conversion loss' and 'substantial receiver performance gains,'" (EX2024, ¶337). EX2024, ¶¶320-337.

77. I disagree with Dr. Ricketts. The mere fact that prior art such as Tayloe demonstrated "performance benefits" does not deprive a person of skill in the art of opportunities to further improve the prior art. Below, I provide additional explanation, for example, regarding the relative scale of the improvements.

78. Regarding item (i), I explained in my First 528 Declaration that fully differential amplifiers using Macnally's topology offer "advantages…for baseband processing on an IC." TI-1003, ¶141. Additionally, I explained "the intended goal of providing gain" when using a fully differential amplifier with differential circuits to "process pairs of signals wherein the signal information is represented as the difference between the two signals of each pair." TI-1003, ¶34. This differential signal representation "has twice the signal range" of a single-ended output, such as the Tayloe's op-amp example with a single-ended output. *Id.*, ¶36. When compared to this baseline, the differential output of a fully differential amplifier "quadruples the signal power, whereas it only doubles power of the noise introduced by the circuit, which corresponds to a signal-to-noise ratio (SNR) improvement of 3 dB." *Id.*

79. In his declaration, Dr. Ricketts has both misquoted and misunderstood the Tayloe patent. He quoted "to increase gain" from the full text of: "to increase gain, the 0 degree average can be differentially summed with the 180 degree average to form the baseband in-phase signal, and the 90 degree average can be differentially summed with the 270 degree average to produce the baseband quadrature signa" (Tayloe patent Abstract). This statement has nothing to do with whether the output of the amplifiers that perform the differential summing operations are differential, i.e., it has nothing to do with whether the amplifiers are

single-ended or not. In the case of a fully-differential amplifier, the signal is represented as the voltage difference between the two outputs whereas in the case of a single-ended amplifier, the signal is represented as the voltage of a single output; therefore the information content of the signal is the same in both cases, though the signal representations are different. In short, Tayloe absolutely does not teach "using an amplifier with a single-ended output for a specific goal, namely 'to increase gain'". This is a shameful misrepresentation of the facts.

80. In his declaration, Dr. Ricketts further asserts that "[b]ecause Tayloe's amplifiers already accomplish the intended goal of providing gain, a POSITA would not have any reason to replace Tayloe's amplifiers with a different type of circuit." EX2024, ¶321. In my opinion, this is a ridiculous assertion. Exactly the same flawed logic could be applied to incorrectly argue that there was never a reason to invent differential amplifiers in the first place, given that single-ended amplifiers were well-known and widely used prior to the invention of differential amplifiers. Such a conclusion would be absurd. A POSITA understands that differential amplifiers, and, more generally, differential signaling, offer major advantages in systems implemented as integrated circuits.

81. Regarding item (ii), Dr. Ricketts has misunderstood and/or misconstrued facts. While it is true that Tayloe already performs lowpass filtering, the lowpass filtering is that of an RC filter which has only a single pole, and single

pole lowpass filters offer the least suppression of out-of-band signals of all lowpass filters. TI-1050. Therefore, single pole lowpass filters are rarely sufficient in wireless receivers, and in most such applications additional filtering is required. In short, Dr. Ricketts' claim that "Tayloe already performs the function of an anti-aliasing filter" so "a POSITA would not be motivated to look at filtering technology such as Macnally's biquad two-pole filters to incorporate into Tayloe's circuit" ignores the facts that not all lowpass filters are created equally and that more filtering is generally needed than that offered by a single pole filter. Macnally is hardly alone. In Razavi, Fig. 2 shows a first-order (RC) filter built in to the mixer while Fig. 4 shows additional lowpass filtering (i.e., the channel select filters) to supplement the first-order RC filter already built in the mixer. TI-1017, Figs. 2 and 4. Moreover, Chang (TI-1064) implements a sixth-order channel select filter. Which has far more attenuation than the first-order RC filter. Chang also points out that "The channel-select filter must satisfy some exacting requirements. The first and most important is selectivity." TI-1064, 722. The statement of Chang, along with the fact that Change solves the problem with a sixth-order filter, confirm that first-order filters are not sufficient for the application.

82. Dr. Ricketts also incorrectly asserted that "Tayloe does not identify or discuss any need for any additional filtering." In a direct-conversion receiver, the

filtering can be performed by a lowpass filter after the down-conversion operation or, equivalently, by a bandpass filter prior to the down-conversion operation. TI-1050. Not only was this a well-known concept at the time of the priority date of the '528 patent, but the Tayloe patent alludes to it: "Resistor 32 and each of capacitors 72-78 form lowpass filters. The commutating effect of the four capacitors turns the lowpass response into a bandpass response centered on f1" (TI-1001, Column 3, Lines 22-28). In contrast to Dr. Ricketts' assertion, the Tayloe patent does in fact discuss the need for additional filtering: referring to the effect of the RC lowpass filtering, the Tayloe patent states that the "front end filtering requirements … are reduced" (TI-1001, Column 3, Lines 37-38). In other words, the Tayloe invention's RC filters reduce but do not eliminate the need for additional filtering, and the additional filtering can be in the form of a front end bandpass filter or additional lowpass filtering following the down-conversion operation. In integrated circuits, lowpass filters are much easier to implement than bandpass filters, so a POSITA would have recognized that additional lowpass filtering would be preferable to bandpass filtering in an integrated circuit implementation. Moreover, as described above, Tayloe himself added additional lowpass filtering in the implementation of his invention described in Ti-1047 by including a capacitor in parallel with the feedback resistors in his summing amplifiers.

83. Besides, Macnally's fully differential amplifier and filter combination is just one of many such examples, and the filtering it offers is optional. Removing its capacitors eliminates the lowpass filtering function of the circuit while retaining the differential amplification function. So in the highly unlikely event that a POSITA were to conclude that additional lowpass filtering were not necessary in a particular application, he/she would know that it is only necessary to remove the capacitors to have a fully-differential amplifier without lowpass filtering.

84. Regarding item (iii), once again, Dr. Ricketts' comments suggest a either a lack of technical understanding or intentional obfuscation. In this instance, he is essentially claiming that there is no benefit of fully differential amplifiers over single-ended amplifiers given that both have differential inputs. A POSITA would know this assertion to be false.

85. As I explained in detail in my First 528 Declaration, the majority of amplifiers in systems implemented on integrated circuits are fully-differential precisely because they do offer significant benefits over their single-ended counterparts. TI-1003, ¶¶34-35. For example, the asymmetric nature of single-ended amplifiers makes them sensitive to interference coupled into the amplifier from other parts of the system through parasitic capacitances. TI-1003, ¶¶34-35. In contrast, fully differential amplifiers are far less sensitive to such interference because their symmetry causes error from the interference to appear nearly equally

at both outputs and the signal of interest is the difference between the two outputs, so the signal of interest contains very little error from the interference. TI-1003, ¶35.

86. Dr. Ricketts also represents that "Tayloe already addresses the issue of noise." EX2024, ¶329. This is another absurd assertion by Dr. Ricketts. Just because the Tayloe patent points to a particular aspect of the invention as beneficial from a noise point of view, it does not mean that no additional steps to reduce noise would be beneficial. A POSITA knows that any design option that offers a noise benefit without a significant disadvantage should be taken, and fully-differential amplifiers are such an option when implemented as part of an integrated circuit implementation of a system. Furthermore, as I explained in my expert declaration, fully-differential amplifiers also offer a major advantage with respect to reducing nonlinear distortion, which a POSITA would recognize is both advantageous and distinct from reducing noise.

87. Dr. Ricketts additionally asserts "Macnally's differential output would therefore require *additional* subsequent circuitry (that Tayloe's amplifier does not need)" and hence "a POSITA would not be motivated to use Macnally's biquad two-pole filter to reduce the number of components or op-amps." EX2024, ¶334.

88. Dr. Ricketts has neglected that what matters in an integrated circuit are the amount of area and the amount of power a circuit consumes. Simply

tallying up the number of inputs and outputs of a circuit or trying to "eyeball" whether one implementation of a circuit seems more complicated than another, as Dr. Ricketts appears to have done, rarely gives insight into which of the two circuits consume less circuit area and/or power.

89. A POSITA at the time of the '528 priority date would understand that using a fully differential amplifier generally reduces area and power consumption relative to those of a comparable single-ended amplifier, even though the circuit diagram of the former is "more complicated" than that of the latter. TI-1060. The reason for this apparent paradox is that the signal swing of the of the fully-differential amplifier is approximately double that of the single-ended amplifier, which allows for the fully-differential amplifier to handle four times more noise power than the single-ended amplifier for the same single-to-noise ratio (which is what matters in signal processing circuits). This allows the designer to reduce the size of most of the components that make up the fully-differential amplifier and reduce its bias current relative to those of the single-ended amplifier yet achieve the same signal-to-noise ratio as that of the single-ended amplifier. Consequently, the fully-differential amplifier generally consumes less power than the single-ended amplifier while consuming no more (and often less) area than the single-ended amplifier.

90. Dr. Ricketts' claim that "Macnally's differential output would therefore require *additional* subsequent circuitry (that Tayloe's amplifier does not need)" is also incorrect in general. Most wireless receivers utilize analog-to-digital converters (ADCs) to perform digital signal processing of the down-converted signals (as is the case in Macnally and as is taught by Razavi), and ADCs are almost always implemented with fully-differential circuitry. This is because differential-input ADCs have the same benefits relative to their non-differential-input counterparts that fully-differential amplifiers have relative to their single-ended counterparts. In the rare cases where no ADC is used, it is still usually beneficial to maintain differential signaling while bringing analog signals out of the integrated circuit because it reduces the potential for interference to degrade the differential signal, and most of the components used in such scenarios such as speakers and headphones can be driven directly with differential signals.

91. Regarding item (iv), I have addressed matching resistors when incorporating Figure 6 of Tayloe. §V.B.1. I understand Dr. Ricketts further alleged: "Figure 6 uses more resistors that Figure 3 and Macnally's biquad two-pole filter requires many more components than Tayloe's amplifier as well as additional subsequent components to process the differential signal to a single-end output." EX2024, ¶336. I provide additional explanation below.

92. While it is true that Macnally's biquad uses more resistors and capacitors around the fully differential op-amps, Dr. Ricketts has not done a fair comparison. As I explained above, adding extra lowpass filtering reduces the amount of bandpass filtering required at the input of the Tayloe down-converter. Therefore, the reduction in size of the bandpass filter resulting from the use of the Macnally biquad along with the reduced area and power associated with going from single-ended to fully-differential op-amps (as I explained in my expert declaration and also explained above) would cause a POSITA to expect that the area and power consumption of an integrated circuit implementation of the Tayloe invention would be reduced, not increased, by the use of the Macnally biquads in place of single-ended summing amplifiers.

93. Regarding item (v), Dr. Ricketts' position boils down to the absurd argument that if something already has desirable features, there is no reason to try to make further improvements. If this were the mentality of engineers, we would all by riding around on horse-pulled buggies. Nonetheless, I have explained above that the mere fact that prior art demonstrated "performance benefits" does not deprive a POSITA of opportunities to further improve the prior art. I have additionally explained "the relative scale of potential benefits" resulting from the combination.

94. Finally, Dr. Ricketts asserts that "a POSITA would not look to Macnally for components" because "Tayloe and Macnally are fundamentally different systems." EX2024, ¶338. Dr. Ricketts statements are neither true nor relevant. As I explained in my First 528 Declaration, in my deposition, and above, Tayloe is absolutely an energy sampling system. Macnally happens to be an energy sampling system too, but this is completely irrelevant to the question of whether the Macnally biquads are applicable to the Tayloe invention.

C. Tayloe and Macnally are not incompatible

95. In his declaration, Dr. Ricketts asserts that "substituting a low impedance load [of Macnally] in place of a high impedance load [of Tayloe] would fundamentally alter the operation of Tayloe's circuit" because "a low impedance load would draw current from Tayloe's capacitors during the sampling cycle, altering voltage levels in the capacitors and preventing an accurate voltage reading." EX2024, ¶341.

96. I disagree with Dr. Ricketts because his assertion defies fundamental principles of circuit operation. As a factual matter, the top inputs of Tayloe's summing amplifiers 50 and 52 have low impedances despite Dr. Ricketts' arguments to the contrary. *Supra*, IV.A.1(a)(i). Therefore, replacing Tayloe's summing amplifiers 50 and 52 with fully differential amplifiers with input impedances comparable to that of the top inputs of amplifiers 50 and 52 would not

significantly alter the behavior of Tayloe's circuit with respect to the 0 degree and 90 degree outputs of commutating switch 38. *Supra*, ¶IV.A.1(a)(i).

97. It is true that the bottom inputs of summing amplifiers 50 and 52 in the Tayloe patent have high impedances, so replacing summing amplifiers 50 and 52 with fully differential amplifiers with input impedances comparable to that of the top inputs of amplifiers 50 and 52 would change the behavior of the 180 degree and 270 degree paths of the circuit. However, the Tayloe patent only uses the 180 degree and 270 degree paths to improve gain and considers them to be optional. For example, it states "As embodied in FIG. 7, 0 degree output 210 and 90 degree output 212 are used to generate baseband in-phase and quadrature signals. Of course, the remaining two outputs (180 degrees and 270 degrees) ***can*** be utilized as embodied in FIG. 3 to achieve greater gain" (TI-1001, Column 5, Lines 12-16, emphasis added). Although matching of the different paths is not necessary, and the Tayloe patent does not address the question of matching, it is the case that matching the 180 degree path to the 0 degree path and matching the 270 degree path to the 90 degree path as would be accomplished by replacing summing amplifiers 50 and 52 with fully differential amplifiers, such as the Macnallly biquads, would yield a slight improvement in the system's overall signal to noise ratio (which even Dr. Ricketts seems to believe based on his prior comments on the subject of matching). The improvement would not be significant, but the point is

that a POSITA would understand that matching the impedance seen by the 180 degree and 270 degree paths of the circuit to those seen by the 0 degree and 90 degree paths of the circuit would not cause any degradation and would even be slightly beneficial.

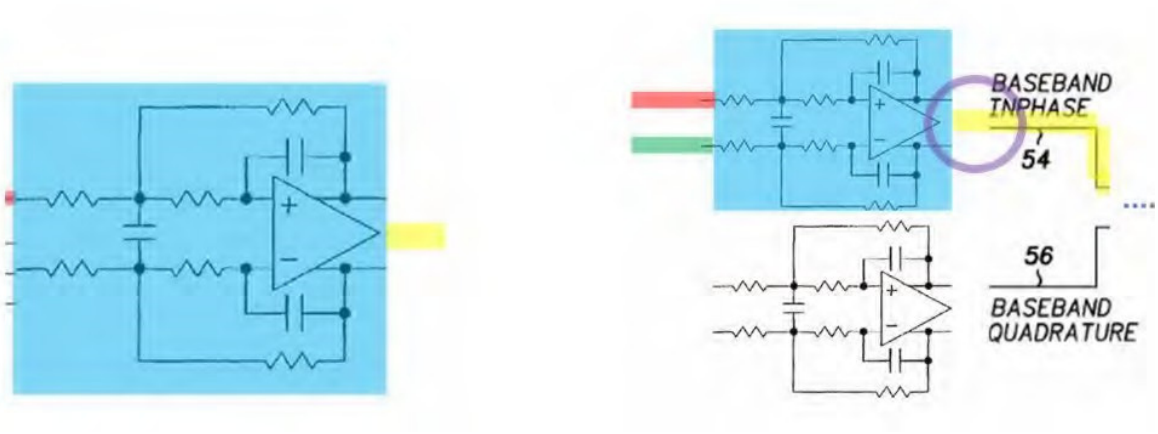
D. Reasonable Expectation of Success

98. In his response, Dr. Ricketts asserts no reasonable expectation of success by simply rehashing his assertions: (i) "Implementing Macnally's differential output in place of Tayloe's single-ended output would require redesigning the rest of Tayloe's signal chain to accommodate Macnally's differential output configuration," (ii) "replacing Tayloe's single-ended amplifier with Macnally's filter would alter the fundamental operation of Tayloe's circuit," and (iii) "Tayloe already incorporates a low-pass filter and achieves low-pass filtering." EX2024, ¶¶346-354.

99. I disagree with Dr. Ricketts for the same reasons as I have explained above and in my First 528 Declaration. For example, I have addressed these points above regarding the results being predictable, having reasonable expectation of success, and having better performance (reduced power consumption, better linearity, etc.) Any time a circuit is developed, a design process must occur. The process is not "experimentation" as Dr. Ricketts puts it, but a reasoned and systematic process by which different circuit topologies for implementing each of

the required circuit blocks are evaluated and circuit component values are optimized. These tasks are done by a POSITA via a combination of hand analysis and computer simulation. Even Mr. Tayloe made several changes between the embodiments shown in the Tayloe patent and the circuit he designed as presented in TI-1047 (and he describes this circuit as Version 5, so presumably he previously designed four different versions of the circuit that were not quite as good as the version presented in TI-1047). And anytime a circuit is ported from a circuit board design to an integrated circuit design, or even from one integrated circuit technology node to another, the design process is even more involved. Nevertheless, the fact that circuit blocks cannot just be cut and pasted from one environment into another does not mean that a POSITA would have no reasonable expectation of success when implementing the Tayloe invention as an integrated circuit. Moreover, I provided "success stories," (TI-1003, ¶143 (citing TI-1021/1022)) to support my opinion of reasonable expectation of success.

100. Dr. Ricketts oddly asserts that I "did not even provide any indication of what circuitry would exist after Macnally's filter or how it is configured or would operate."



EX2024, ¶349.

101. Dr. Ricketts' assertion is irrelevant. The Macnally patent itself provides a detailed description of differential circuitry that is appropriate for following the biquads, but there are many other options as well. A POSITA would know that every block shown in Fig. 3 of the Tayloe patent following summing amplifiers 50 and 52 have fully-differential counterparts, so if the goal were to implement a single sideband ham radio receiver like the embodiment example shown in Fig. 3 of the Tayloe patent with fully differential components, a POSITA would know how to do this. More importantly, as can be seen from the claims of the Tayloe patent, the Tayloe invention does not include those subsequent components, and most applications do not require those components. Hence, Dr. Ricketts' comment is irrelevant because it is ultimately a patent's claims which define the inventive aspects of the material presented in the patent.

V. GROUNDS 2A/2B

A. Razavi teaches transferring energy from a modulated carrier signal as an output of a switch when the switch is ON (claims 1 and 19).

102. In his declaration, Dr. Ricketts asserts that "Razavi's mixer does not sample" because "[n]either M5 nor M6…transfers energy from the modulated carrier signal as an output even if M_5 or M_6 is ON." EX2024, ¶¶360-361, 365 ("no current from the RF input signal passes through M5 or M6 from the source to the drain"). Dr. Ricketts further asserts: "No portion of the RF input signal current moves upward. Thus, no energy is transferred from the RF input signal as an output of M5 or M6." EX2024, ¶374.

1. Dr. Ricketts ignored the law of Physics

103. I disagree with Dr. Ricketts because his description of Razavi's circuit operation ignores the laws of physics. Specifically, in Razavi's Figure 2, electrons actually flow from the RF input signal through the transistors (i.e., transistors M_5 and M_6) toward the positive supply terminal (V_{DD}). This is because the flow of electrons, which is the actual current of electrons that flow, runs upward through M_5 and M_6 from both the ground terminal of the supply as well as from the RF input signal. *Id.* (citing EX1045 (Johnson) ("…we should distinguish *conventional* current ([which can be thought of as] the movement of positive charges), which is used in electric network theory, and *electron* current").

104. Dr. Ricketts' assertion that "no current from the RF input signal passes through M_5 or M_6 from the source to the drain" is both misleading and erroneous.

105. Nonetheless, I provide detailed analysis of Dr. Ricketts' declaration below. Dr. Ricketts acknowledges that current is the flow of electrons, which is correct, but his narrative implies that electrons flow through a circuit from the positive power supply terminal to ground, which is not correct. For example, the figure following Paragraph 61 shows an nMOS transistor with its drain terminal connected to a positive power supply voltage and its source terminal connected to ground, and Paragraph 61 claims in reference to the figure that "The electron flow (current) from the drain (D) to the source (S) is controlled by the voltage at the gate (G)". EX2024, ¶61. This is incorrect; in reality, the electron flow is from the source to the drain. Electrons are negatively charged, so they flow toward the positive supply voltage, not toward ground. Dr. Ricketts' claim that "current flow is opposite to the direction needed for the RF input signal to pass through the transistors" ignores the fact that electrons actually flow from the RF input signal through the transistors (i.e., transistors M_5 and M_6 in Figure 2 of Razavi shown above) toward the positive supply terminal (V_{DD} in Figure 2 of Razavi).

106. A reasonable question then, is how could Dr. Ricketts not know that electrons flow through a circuit toward the power supply terminal with the highest

voltage (e.g., V_{DD} in Figure 2 of Razavi)? He certainly does know this, but in his declaration he took advantage of the definition of "conventional current" which is based on the artificial convention that the direction of current flow is from high to low voltages. In this convention, the value of the current resulting from the flow of electrons through a conductor is defined to be the negative of the rate at which electrons pass through the conductor. The convention originated as the result of a mistake made by Benjamin Franklin in the 18th century. As explained in TI-1045, "This convention stems from Benjamin Franklin (1706−1790), who guessed that electricity traveled from positive to negative. We now know that in metal conductors the current is the movement of electrons that have been pulled loose form the orbits of atoms of the metal. Thus we should distinguish conventional current ([which can be thought of as] the movement of positive charges), which is used in electric network theory, and electron current." Hence, Dr. Ricketts has claimed that current flows toward the ground terminal in Figure 2 of Razavi simply because conventional current is defined to flow that direction for historical reasons. The claim might seem reasonable to a layperson, but a POSITA would understand that the flow of electrons, which is the actual current, is toward V_{DD}, so Dr. Ricketts' assertion that "current flow is opposite to the direction needed for the RF input signal to pass through the transistors" is both extremely misleading and utter nonsense.

107. Thus, the fact that *conventional* current is *defined by convention* to be positive in the downward direction is not relevant given that the actual electron flow, i.e., the actual current, is toward V_{DD}, so it flows from the source to the drain of each of transistors M_5 and M_6. Therefore, electrons flow from the RF input signal upward through transistors M_5 and M_6.

108. Dr. Ricketts' statement that "[a] POSITA understands that current flows from a higher potential to a lower potential" is incorrect. EX2024, ¶367. As I explained above and in Ex.-2034, 196:7-12, the flow of electrons, i.e., the actual current, is from a lower potential to a higher potential. In contrast, as I explained above, conventional current is defined by convention to flow from a higher potential to a lower potential for historical reasons despite the fact that the actual current flows in the opposite direction. Because of this convention, circuit designers will say that current, meaning conventional current, flows from a higher potential to a lower potential, even though they understand that actual current flows in the opposite direction. A layperson might wonder whether the strange sign convention in the defined value of conventional current results in circuit analysis mistakes or misunderstandings, but it turns out that it is not a problem in practice provided the designer is aware that the sign of the value of actual current is opposite that of conventional current. Undergraduate electrical engineering

programs typically teach this information in freshman or sophomore circuits courses, so it is information that is well known to a POSITA.

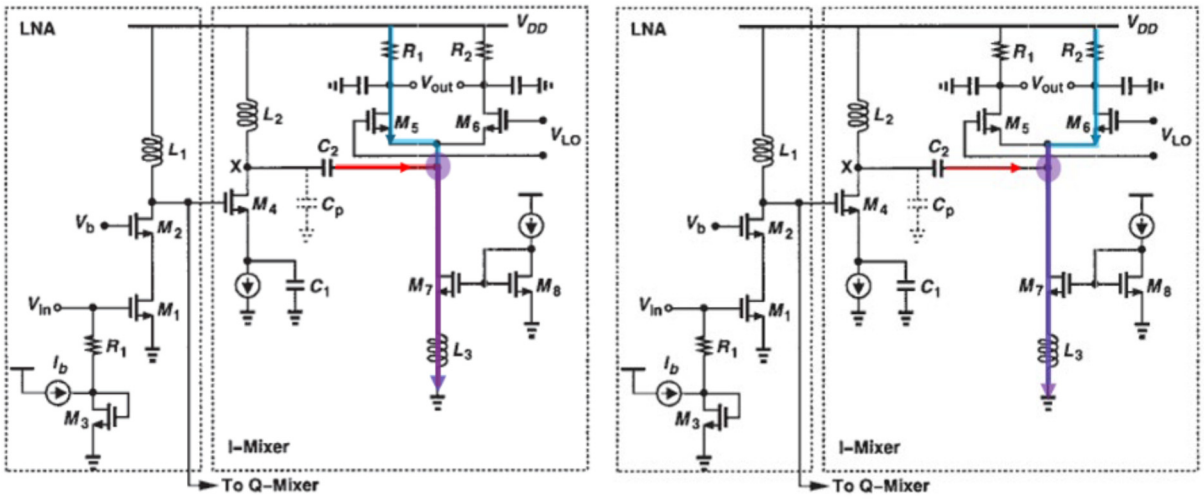


Fig. 2. LNA/mixer implementation.

Fig. 2. LNA/mixer implementation.

EX2024, ¶¶370-371 (annotating Razavi (TI-1017, Fig. 2)).

109. For the reasons I described above, the current to which Dr. Ricketts refers in Paragraph 372 is the conventional current, which, by definition, flows in the opposite direction of the actual current. EX2024 ¶372. Consequently, the actual current flows upward through M_5 and M_6 from both the ground terminal of the supply as well as from the RF input signal. It follows that M_5 samples energy from the RF input signal for just under half of each local oscillator period and stores much of the sampled energy on the capacitor immediately below Resistor R_1 in the first of the two annotated figures above. Similarly, M_6 samples energy from the RF input signal for slightly less than the other half each local oscillator period and

stores much of the sampled energy on the capacitor immediately below Resistor R_2 in the second of the two annotated figures above. Therefore, Dr. Ricketts' claim that "this is not sampling the RF input signal" is incorrect.

110. As I described above, Benjamin Franklin guessed the direction in which current flows, and he got it wrong. Had he guessed the direction correctly, two things would be different: 1) the definition of conventional current would be identical to that of actual current, and 2) Dr. Ricketts would not be able to make his reasonable-sounding but completely invalid argument that the Razavi circuit does not perform energy sampling of the RF input signal.

111. It follows that because the actual current flows upward toward the V_{DD} power supply node in the above two figures, Dr. Ricketts' assertion in Par. 373 analysis is both misleading and results in incorrect conclusions. EX2024 ¶373. Furthermore, Dr. Ricketts' claim that "opening and closing of M_5 and M_6 does not affect the RF input signal in any way" is also incorrect, but it need not be debated because the '528 patent does not stipulate or otherwise imply that the invention causes the RF input signal to be affected in any way.

112. Dr. Ricketts' implication that he is not aware of the concept of a "signal component" that can take on both positive and negative values is mystifying as this is a central concept in the field of circuit design. EX2024, ¶374. The concept is explained and/or used in nearly all circuit design textbooks, is used

when analyzing most circuits, particularly circuits which are designed to approximate linear systems, and is often mentioned explicitly in published papers and patents. Furthermore, transistor circuits that are designed to approximate linear systems (such as amplifiers, filters, and mixers) only apply their linear functions to the signal components of their input signals. For example, an amplifier circuit amplifies the signal component of its total input signal, but does not amplify the DC bias component of its total input signal. Similarly, a filter circuit only filters the signal component of its total input signal, not the DC bias component of its total input signal. Therefore, if Dr. Ricketts has ever implemented such circuits, he must be familiar with the signal component concept, despite his implication to the contrary.

113. The following examples are three examples of many from textbooks and a paper that were available prior to the priority date of the ’528 patent that show that a POSITA at the time of the priority date of the ’528 patent would be familiar with the signal component concept in the field of circuit design.

114. The first example is from one of the most popular undergraduate electronics textbooks ever written (TI-1046). In its first chapter, TI-1046 states “At this point, we draw the reader’s attention to the terminology used above and which we shall employ throughout the book. Total instantaneous quantities are denoted by a lowercase symbol with an uppercase subscript, for example, $i_A(t)$, $v_C(t)$.

Direct-Current (dc) quantities will be denoted by an uppercase symbol with an uppercase subscript, for example, I_A, V_C. Finally, incremental signal quantities will be denoted by a lowercase symbol with a lowercase subscript, for example $i_a(t)$, $v_c(t)$. This notation is illustrated in Fig. 1.16." Figure 1.16 in TI-1046 is:

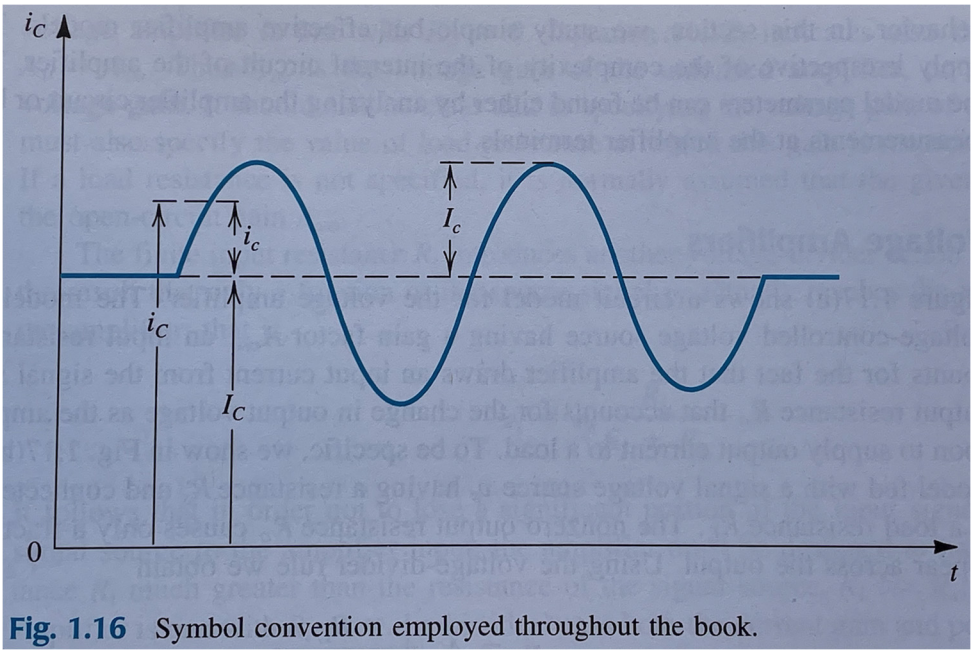


Fig. 1.16 Symbol convention employed throughout the book.

TI-1046, FIG. 1.16.

115. In the terminology of TI-1046, "total instantaneous quantity" is synonymous with "total signal" and "absolute signal", and "incremental signal quantity" is synonymous with "signal component" or, in the case of a current, "signal current." As is clear from the figure above, even though the total signal, i_C, (which is also known as the total current in this case) is always positive, the signal component, i_c, (which is also known as the signal current in this case) can take on both positive and negative values.

116. As explained in detail in TI-1046, the signal component contains the information to be processed by an electronic circuit. As mentioned above, circuits designed to approximate linear systems perform their intended operations on the signal components of their total input signals, e.g., an amplifier circuit amplifies the signal component of its total input signal, but does not amplify the DC bias component of its total input signal. For this reason, when analyzing how such a circuit processes information, it is customary for circuit designers to ignore the bias components and consider just the signal components. The following figure from TI-1046 demonstrates this in the context of a simple one-transistor common-emitter amplifier example:

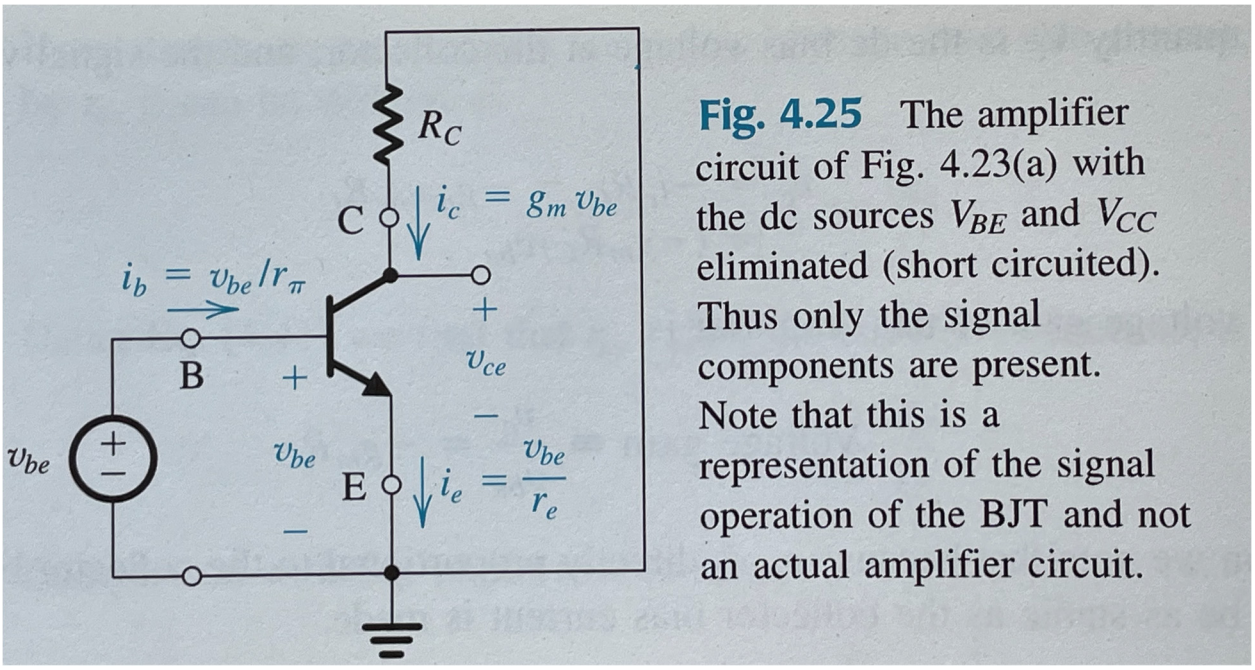


Fig. 4.25 The amplifier circuit of Fig. 4.23(a) with the dc sources V_{BE} and V_{CC} eliminated (short circuited). Thus only the signal components are present. Note that this is a representation of the signal operation of the BJT and not an actual amplifier circuit.

TI-1046, FIG. 4.25

117. In this figure only the signal components, i.e., v_{be}, v_{ce}, i_b, i_e, and i_c, of the of the total signal quantities are considered (note that the caption of the figure uses the term "signal component" instead of "incremental signal quantity," which is valid because the two terms are synonymous as mentioned above). By definition, these signal components can take on both positive and negative values even though most of the corresponding total signal quantities are always positive. The arrow next to each of the signal currents (i_b, i_e, and i_c) is a "reference direction" which indicates the direction of positive current flow. For example, at times when the signal current, i_c is positive, the signal current flows in the direction of the arrow, and at times when i_c is negative, the signal current flows in the opposite direction of the arrow.

118. The second example is from a well-known textbook on RF circuit design TI-1050. To explain the concept of the signal component of an absolute signal, TI-1050 uses the example of an ideal Class A amplifier, and shows the following figure, which depicts the (conventional) current through the drain an nMOS transistor:

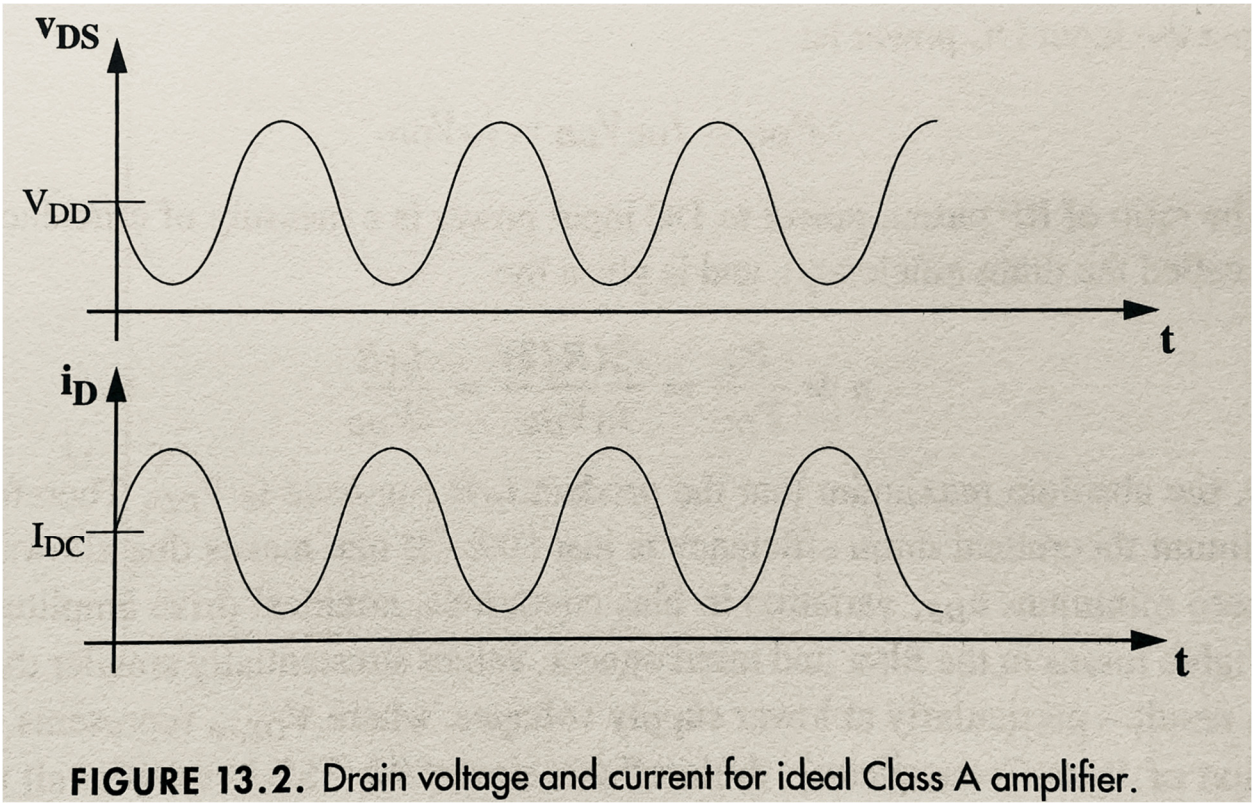


FIGURE 13.2. Drain voltage and current for ideal Class A amplifier.

TI-1050, FIG. 13.2

119. Referring to the above figure, TI-1050 states that the transistor's drain current is "reasonably well approximated by: $i_D = I_{DC} + i_{rf} \sin \omega_0 t$, where I_{DC} is the bias current, i_{rf} is the amplitude of the signal component of the drain current, and ω_0 is the signal frequency" and it goes on to state that the "output voltage is simply the product of [the] signal current and the load resistance" which it denotes as "$v_o = - i_{rf} R \sin \omega_0 t$", where R is the load resistance. Hence i_D is the total or absolute drain current, I_{DC} is the bias current, and $i_{rf} \sin \omega_0 t$ is the signal current (also known as the signal component of i_D).

120. The third example is from a paper written by the inventor of the Gilbert Cell mixer, which is one of the most well-known RF mixer architectures ever published TI-1052. The paper presents a variant of the Gilbert Cell mixer called a "micromixer," the simplest version of which is shown in Figure 3 of TI-1052:

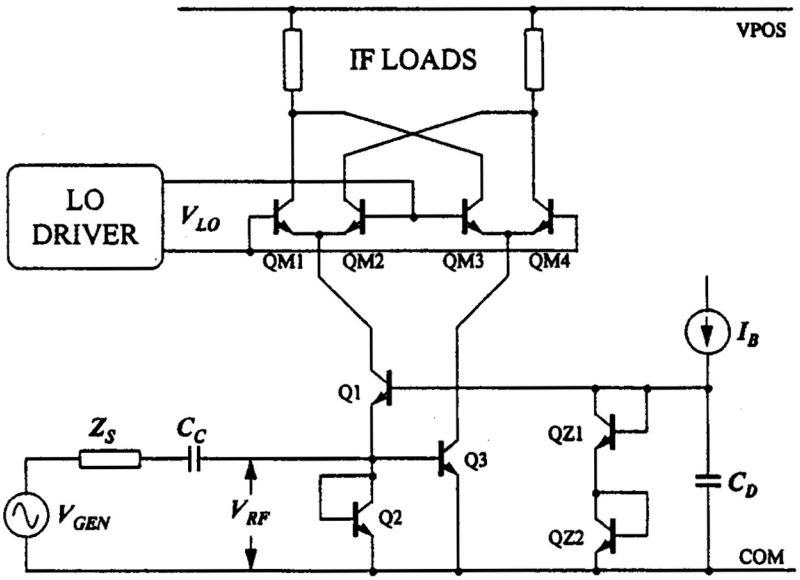


Figure 3 The Minimal MICROMIXER

TI-1052, FIG. 3.

121. Like the Razavi circuit, it has an RF input signal (V_{GEN}), a differential local oscillator signal (V_{LO}), a pair of resistor loads (the rectangles labeled IF LOADS are alternate symbols for resistors), a positive power supply voltage (VPOS) and a ground power supply connection (COM). The paper refers to Transistors QM1 and QM2 as the "left-hand pair" and to Transistors QM3 and QM4 as the "right-hand pair". Each of the left-hand pair and the right-hand pair

perform comparable switching operations to those performed by Transistors M_5 and M_6 in the Razavi circuit.

122. Extrapolating Dr. Ricketts' comments regarding the Razavi mixer circuit to the mixer circuit in Figure 3 of TI-1052, it is reasonable to expect that Dr. Ricketts' would make the following two assertions: 1) that current flows downward from the VPOS node to the COM node, so, to quote his comment regarding the Razavi mixer circuit, "this unidirectional current flow is opposite to the direction needed for the RF input signal to pass through the transistors", and 2) to quote another of his comments regarding the Razavi mixer circuit, "there is only one physical current in the circuit, the absolute current from [VPOS]", so the signal component is not relevant. Yet Mr. Gilbert would disagree. For example, he states in TI-1052 that "when VGEN swings very positive, the mirror turns on harder and delivers a large signal component to the right-hand pair", which directly contradicts Dr. Ricketts' presumptive assertions (and actual quoted statements) listed above.

123. In Paragraph. 324 of his declaration for IPR2024-00935 (the '177 patent), Dr. Ricketts claims that the following circuit does not perform "sampling an input signal at an aliasing rate":

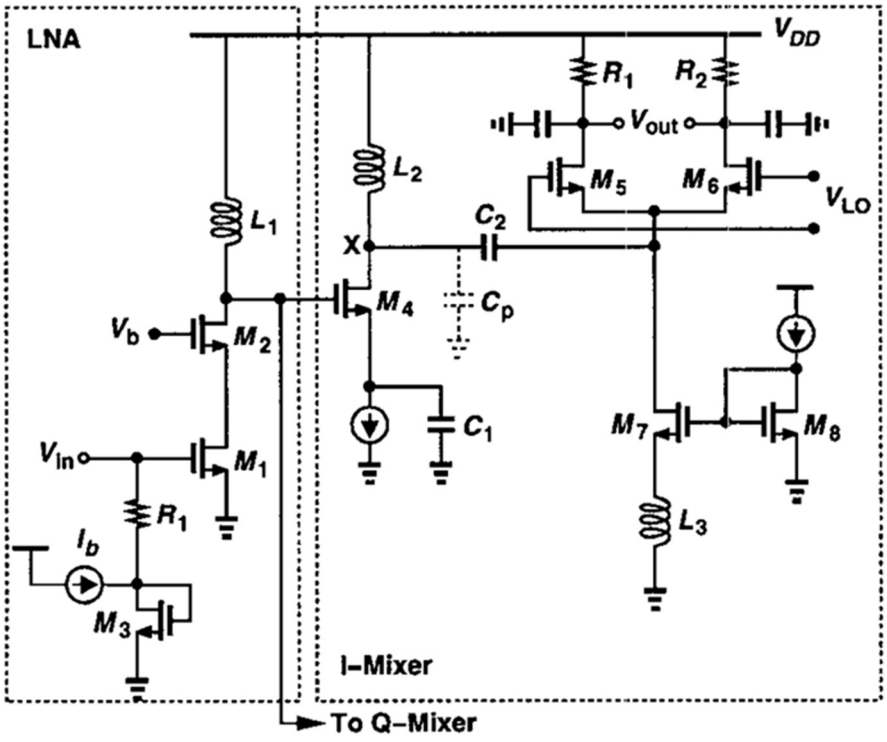


Fig. 2. LNA/mixer implementation.

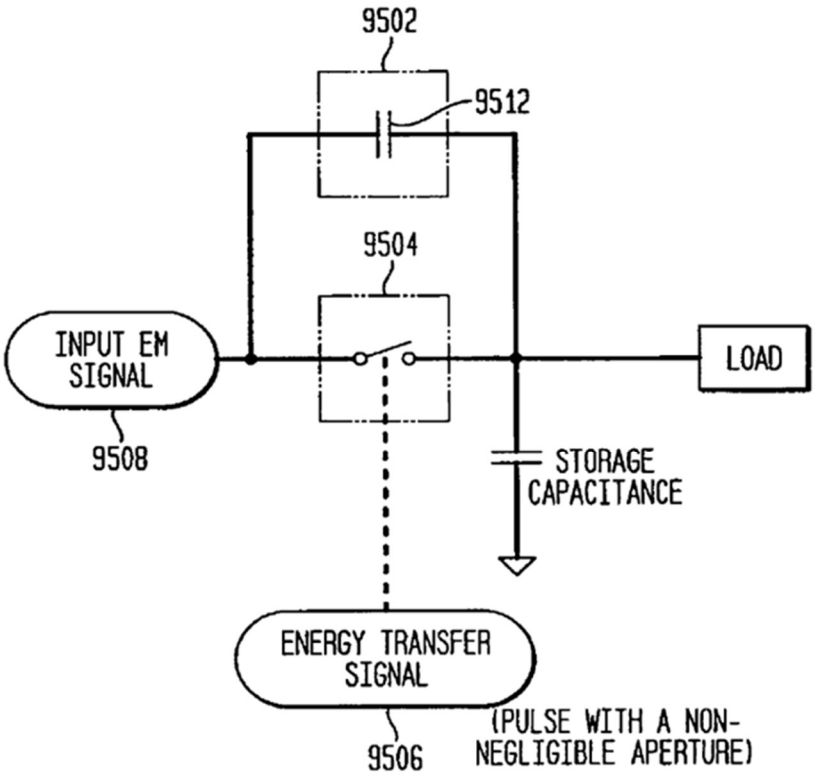
124. Given that M_5 and M_6 each turn off for just over half of each local oscillator period, Dr. Ricketts' assertion that "the RF input signal is never broken into discrete-time samples" is not correct. *See* IPR2024-00935, Ex. 2024 ¶ 322.

125. Consequently, Razavi's circuit not only implements a sampling operation, but it does so in two places, one that uses M_5 as the switch and the capacitor above it as the storage element, and one that uses M_6 as the switch and the capacitor above it as the storage element. Moreover, Razavi's circuit is part of a direct conversion receiver (e.g., the title of the Razavi paper that presents the circuit is "A 900-MHz CMOS Direct Conversion Receiver"), meaning that the

local oscillator frequency is tuned to the frequency of EM carrier signal (900 MHz). As stated in the ‘528 patent (Column 29, Lines 59-62), “[i]n accordance with the definition of aliasing, the aliasing rate is equal to, or less than, twice the frequency of the EM carrier signal.” Given that the sample rate is that local oscillator frequency, and the frequency of the EM carrier signal has the same frequency as the local oscillator, it follows that not only does Razavi’s mixer perform sampling, but it does so at an aliasing rate.

126. Dr Ricketts’ additional assertion (in IPR2024-00935) that “a circuit with a continuous input and a continuous output does not perform sampling” is also incorrect. Indeed, most of the circuits which the ‘528 patent presents as embodiments of the alleged invention have outputs that vary continuously, so Dr. Ricketts assertion that “a circuit with a continuous input and a continuous output does not perform sampling” is tantamount to arguing that the ‘528 patent is wrong in its assertion that those circuits are embodiments of the alleged invention. As one of many examples, Fig. 95 in the ‘528 patent is:

FIG. 95



TI-1001, FIG. 95.

127. The ’528 patent presents this circuit as an embodiment of the alleged invention, and states: “referring to FIG. 95 a bypass network 9502 (shown in this instance as a capacitor 9512), is shown bypassing the switch module 9504. In this embodiment the by-pass network increases the efficiency of the energy transfer module when, for example, less than optimal aperture widths were chosen for a given input frequency on the energy transfer signal 9506.” (Column 127, Lines 60-66).

128. The embodiment of FIG. 95 clearly performs sampling via Switch 9504 and the storage capacitor shown in FIG. 95, yet the input signal is always connected to the LOAD and the storage capacitor through Capacitor 9512. Hence, both the input and output (the output is the voltage at the LOAD) are continuous time signals. Moreover, the input is always connected to the output despite the sampling operation.

129. As I have explained above, the actual current, i.e., the flow of electrons, is from low to high voltages, so electrons from the RF input signal flow upward through M_5 and M_6 to the output of the mixer. Consequently, Dr. Ricketts' claim that "no energy ... from the RF input signal passes through M5 and M6 to the output of the mixer" violates the laws of physics. EX2024, ¶378. This is incorrect. Rather, electrons from the RF input signal do flow through M_5 and M_6. Some of these electrons flow through resistors R_1 and R_2, and some of them are stored on the plates of the capacitors immediately below resistors R_1 and R_2. Therefore, the RF input signal directly transfers energy to both the capacitors and the resistors. The capacitors perform integration (because the voltage across a capacitor is proportional to the integral of the rate of flow of electrons into the capacitor) and the resistors are the loads. Hence, despite Dr. Ricketts' protestations to the contrary, (EX2024, ¶378), it is indeed the case that "***a portion of energy that is distinguishable from noise*** is transferred from the modulated carrier signal… as an

output of said first switch… during the sampling aperture of said first switch (when M_5 is ON)." TI-1003, ¶232.

130. In Par. 331 of his declaration in IPR2024-00935, Dr. Ricketts has used the definition of "conventional current," which is essentially a naming convention that defines current as flowing from high to low voltages for historical reasons, to reach an invalid conclusion. IPR2024-00935, Ex. 2024 ¶ 331. As I have explained in detail above, actual current, i.e., the flow of electrons, is in the opposite direction to that of conventional current, and this reality of physics renders nearly all of Dr. Ricketts' assertions, including the assertion in Paragraph 331, invalid. In short, physics, not naming conventions, is what matters here, and most of Dr. Ricketts' assertions are contradicted by physics.

131. Once again Dr. Ricketts has ignored the reality of physics and applied invalid reasoning to reach his conclusions in Par. 333-336. IPR2024-00935, Ex. 2024 ¶ 333-36. As I have explained in detail in my comments above, the Razavi mixer circuit indeed samples the RF input signal at an aliasing rate, and it transfers energy from the RF input signal to load resistors R_1 and R_2 and the corresponding capacitors to which they connect despite Dr. Ricketts' false assertions to the contrary. Power is energy per unit time and power delivered to a resistive load is always real (i.e., not represented by complex numbers with non-zero imaginary

parts). Hence, real power is transferred from the RF input signal to the load resistors.

132. The following address Dr. Ricketts claim that "Razavi fails to disclose, teach, or suggest circuitry for down-converting an input signal 'such that the samples, having non-negligible available energy... are... transferred to a load while the switch is closed and discharged through the load while the switch is open."

133. First, both the title and the first sentence of the Razavi paper refer to the circuit as a direct conversion receiver. A POSITA would understand that a direct conversion receiver incudes one or more mixer circuits that perform down-converting of an RF input signal.

134. Second, as I have explained above, energy is transferred from the RF input signal to the left-side or right-side load and corresponding capacitor when transistor switch M5 or M6 is closed, respectively.

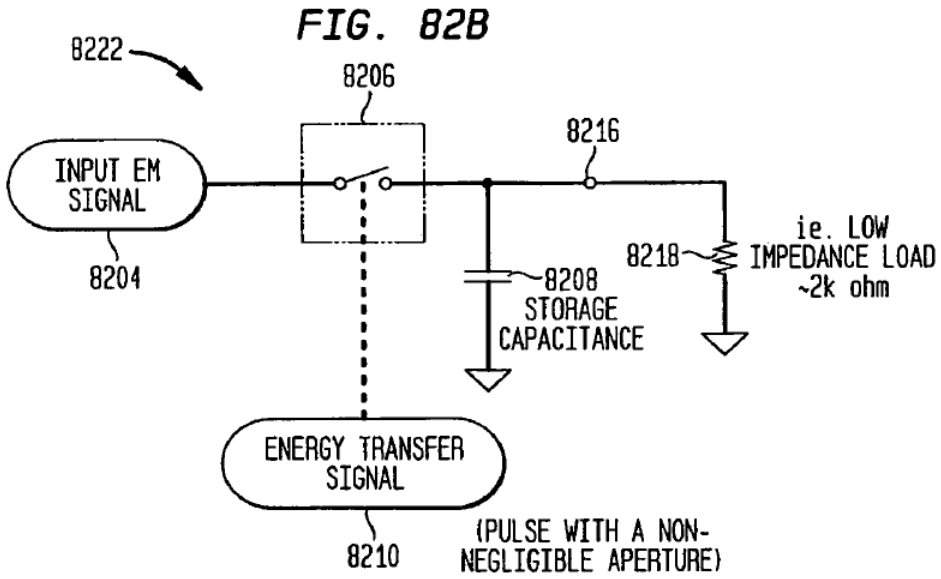
135. Third, the energy stored on a capacitor is proportional to the square of the voltage across the capacitor, and the energy per unit time delivered to a resistor is proportional to the square of the voltage across the resistor. Therefore, if the energy delivered to the load in Razavi's mixer circuit were negligible, the voltage change at the output would be negligible regardless of the RF input signal, thereby rendering the circuit nonfunctional. Consequently, for the circuit to work as

intended, non-negligible energy must be transferred to the load when the corresponding transistor switch is closed. Furthermore, transistor switches M5 and M6 are each closed for nearly half the local oscillator period. Hence, they result in a non-negligible sampling aperture in the terminology of the ’177 and ’528 patents. Specifically, the ‘177 patent, which shares much of the same specification as the ’528 patent, states: “the non-negligible pulse widths can be ½ of a period of the input EM signal” and more generally that non-negligible pulse widths can be shorter as long as they “tend away from zero time in duration” (Column 73, Lines 43-47). The aperture width in the Razavi mixer circuit is nearly ½ of a period of the “input EM signal,” i.e., the RF input signal. The ‘177 patent further states that such a non-negligible sampling aperture “provides more time to transfer energy from an EM input signal” (Column 73, Lines 11-12) and allows the capacitor to “accept a non-negligible amount of power [power is energy per unit time] during a non-negligible aperture period” (Column 73, Lines 57-58). It would be clear to a POSITA via either or both of the above lines of reasoning that the Razavi mixer transfers non-negligible available energy to a load while the corresponding switch is closed.

136. Finally, as would be clear to a POSITA, whenever either transistor switch M5 or M6 is open, the corresponding capacitor and resistor to which the switch is connected are in series with the power supply, and as power supplies

have very low impedances, the energy transferred to the capacitor when the switch is closed begins to discharge through the resistor load when the switch is opened.

137. Dr. Ricketts also alleges: "resistors R1 and R2 need to be as high resistance/impedance as possible." EX2024, ¶260. Once again, Dr. Ricketts has misunderstood a basic circuit design principle. Increasing the resistance of R_1 and R_2 increases the voltage dropped across them and once this voltage drop gets too high, the circuit will not function. The total power consumption of Razavi's circuit is 90 mW from a 3 volt supply, so the total current from the power supply is 30 mA. The Razavi paper does not state how much of this current flows through transistor M_7, but as the current through M_7 is the bias current for each of the two mixer's switching cores, it is almost certainly greater than 2 mA (i.e., 0.002 amps). The Razavi paper mentions that the drain to source voltage of M_7 is approximately 0.5 V. Therefore, transistor M_5 and resistor R_1 must together drop 3 V – 0.5 V = 2.5 V, and the same is true for M_6 and resistor R_2. It follows that the resistance of R_1 and R_2 must be less than 2.5 V divided by 0.002 amps, which is 1.25 kilo-ohm. Note from Figure 82B of the '528 patent (shown below) that a 2 kilo-ohm resistor is considered to be a "low impedance load". Therefore, not only is the resistance of each of R_1 and R_2 in the Razavi circuit almost certainly less than 1.25 kilo-ohm, but that each of the resistors are what the '528 patent considers to be a low impedance load.



TI-1001, Fig. 82B (showing "LOW IMPEDANCE LOAD ~2k ohm")

2. Dr. Ricketts' annotation supports my position

138. Dr. Ricketts' annotation demonstrates transferring energy as an output of Razavi's switch (i.e., M_5 and M_6). As reproduced below, "current A," as annotated by PV to represent "the RF input signal flowing into the node," causes "current B," which, in PV's description, is "flowing from VDD to M7," to oscillate so that the oscillation is reflected on Vout terminals, and hence energy is transferred from the RF input signal. EX2024, ¶¶248-249.[4]

[4] Dr. Ricketts inexplicably mixed current A and current B in its annotation on the right-hand side.

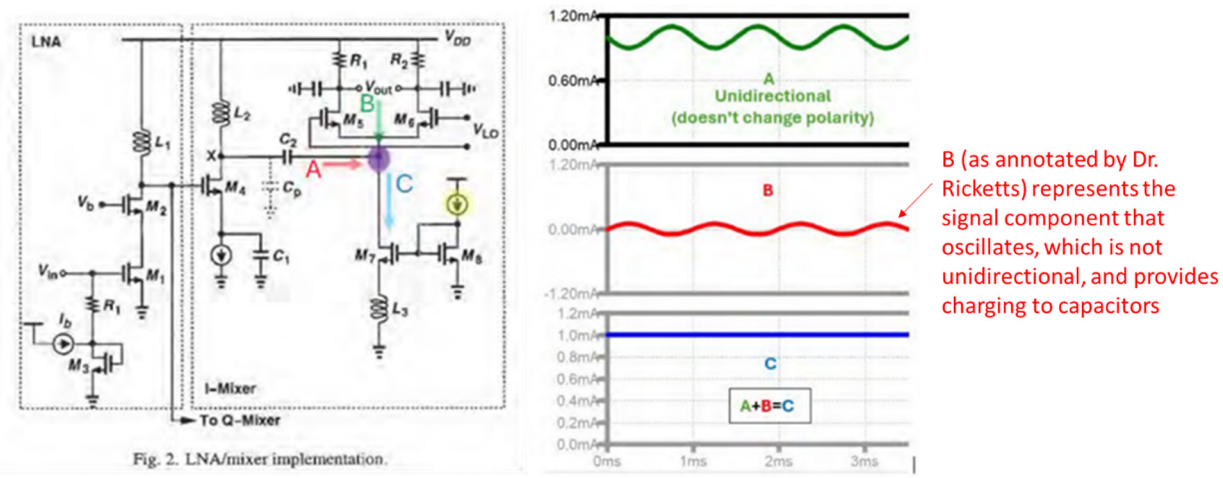


Fig. 2. LNA/mixer implementation.

EX2024, ¶¶248-249 (annotating EX1017, FIG. 2 with additional illustration)

139. As I have explained in more detail above, current B (as annotated by Dr. Ricketts) represents the signal component that oscillates, and hence not unidirectional, which provides charging to the capacitors of Razavi. In other words, Dr. Ricketts' annotation above is in alignment my position that the signal component provides charging to the capacitors of Razavi.

B. Razavi teaches storing transferred energy from the modulated carrier signal or integrating/accumulating transferred energy from switches (claims 1 and 19).

140. In his declaration, Dr. Ricketts asserted that "no current—and therefore no energy—from the RF input signal passes through M5 or M6 towards the capacitors Cp/Cm" because "no energy from the RF input signal can ever make its way to the capacitors to be stored and accumulated/integrated." EX2024, ¶378.

141. This is yet another rehash of Dr. Ricketts' incorrect view that actual current, i.e., the flow of electrons, flow toward ground, not toward V_{DD} in the Razavi circuit. I have addressed his misunderstandings, as I have explained *supra* §VI.A. Hence, Razavi teaches transferring energy from the RF input signal. In the Razavi-Macnally combination, the transferred energy is stored and accumulated/integrated "in the same manner as described by the '528 patent." EX1003, ¶¶239-241; *see also* Petition, 69-70, 83-84, 86.

C. Razavi teaches transferring energy from the modulated carrier signal to the storage element when the switch is ON (claims 8 and 26).

142. In his declaration, Dr. Ricketts asserts that "in Razavi, capacitors Cp/Cm do not charge when M5 or M6 is ON. Rather, they would charge when M5 or M6 are OFF—the opposite of what the claims require." EX2024, ¶¶380-381 ("When either M5 or M6 is OFF, the respective capacitor is isolated from ground (via M7) and instead is connected only to VDD, allowing it to only charge from VDD.")

143. As I have explained *supra* §§VI.A-B, Dr. Ricketts' description of Razavi's circuit operation ignores the laws of physics because the flow of electrons (which corresponds to physical charging) runs from ground to VDD. In my First 528 Declaration, I had already explained that Razavi's operation is consistent with the example from the '528 patent. EX1003, ¶¶232-234. On this note, using Dr.

Ricketts' erroneous characterization of current flow, the example from the '528 patent would likewise not meet the dependent claims.

144. Dr. Ricketts' assertion is not correct in the context of the alleged invention of the '528 patent as it fails to consider the wording of the claims of the '528 patent. For example, regarding charging and discharging the energy storage element Claim 8 requires that a "portion of energy that is distinguishable from noise is transferred to the respective storage element when the switch is on during the charging cycle, and a portion of the transferred energy is discharged during the discharging part of the cycle for each respective switching device when the switching device is off" and Claim 1 on which Claim 8 depends stipulates that said energy must be "transferred from the modulated carrier signal". Therefore, it is necessary to consider the signal components of the relevant voltages and currents in the circuit, not the absolute voltages and currents.

145. To evaluate the signal components of the voltages and currents, first consider the Razavi mixer shown in the figure above with no RF input signal, i.e., the case where no current flows through capacitor C_2. Transistor M_5 acts as a switch which turns on for just under half of each local oscillator period and transistor M_6 acts as a switch which turns on for just under the other half the local oscillator period. Therefore, when M_5 is on and there is no RF input signal, the current through M_5 is equal to the drain current of M_7 (let us denote this current as

I_{BIAS}). Similarly, when M_6 is on and there is no RF input signal, the current through M_5 is equal to I_{BIAS}. If the period of the local oscillator were long enough, then the left V_{out} voltage, i.e., the voltage across resistor R_1, would settle to $V_{DD} - I_{BIAS}R$ when M_5 is on and would settle to V_{DD} when M_5 is off, and the right V_{out} voltage, would settle to $V_{DD} - I_{BIAS}R$ when M_6 is on and would settle to V_{DD} when M_6 is off, where R is the resistance of resistors R_1 and R_2. However, in any practical implementation, the period of the local oscillator would not be long enough for either output voltage to reach V_{DD} or $V_{DD} - I_{BIAS}R$. Therefore, when no signal is present, the left V_{out} voltage (or right V_{out} voltage) has a (non-constant) bias component that moves toward but never reaches $V_{DD} - I_{BIAS}R$ when M_5 (or M_6) is on and moves toward but never reaches V_{DD} when M_5 (or M_6) is off.

146. Let us denote the total left V_{out} voltage as $V_{\text{out}-}$ and its corresponding bias and signal components as V_{BIAS-} and v_{out-}, respectively. Similarly, let us denote the total right V_{out} voltage as $V_{\text{out}+}$ and its corresponding bias and signal components as V_{BIAS+} and v_{out+}, respectively. Therefore, when the RF input signal is held at zero, v_{out-} and v_{out+} are zero. The Razavi mixer circuit is designed to well-approximate a linear system, so the well-known principle of superposition can be applied to deduce that when the RF input signal is not zero, the signal components of $V_{\text{out}-}$ and $V_{\text{out}+}$ are $v_{out-} = V_{\text{out}-} - V_{BIAS-}$, and $v_{out+} = V_{\text{out}+} - V_{BIAS+}$, respectively. TI-1045; TI-1046. By definition, at any given time each of v_{out-} and v_{out+} represent the

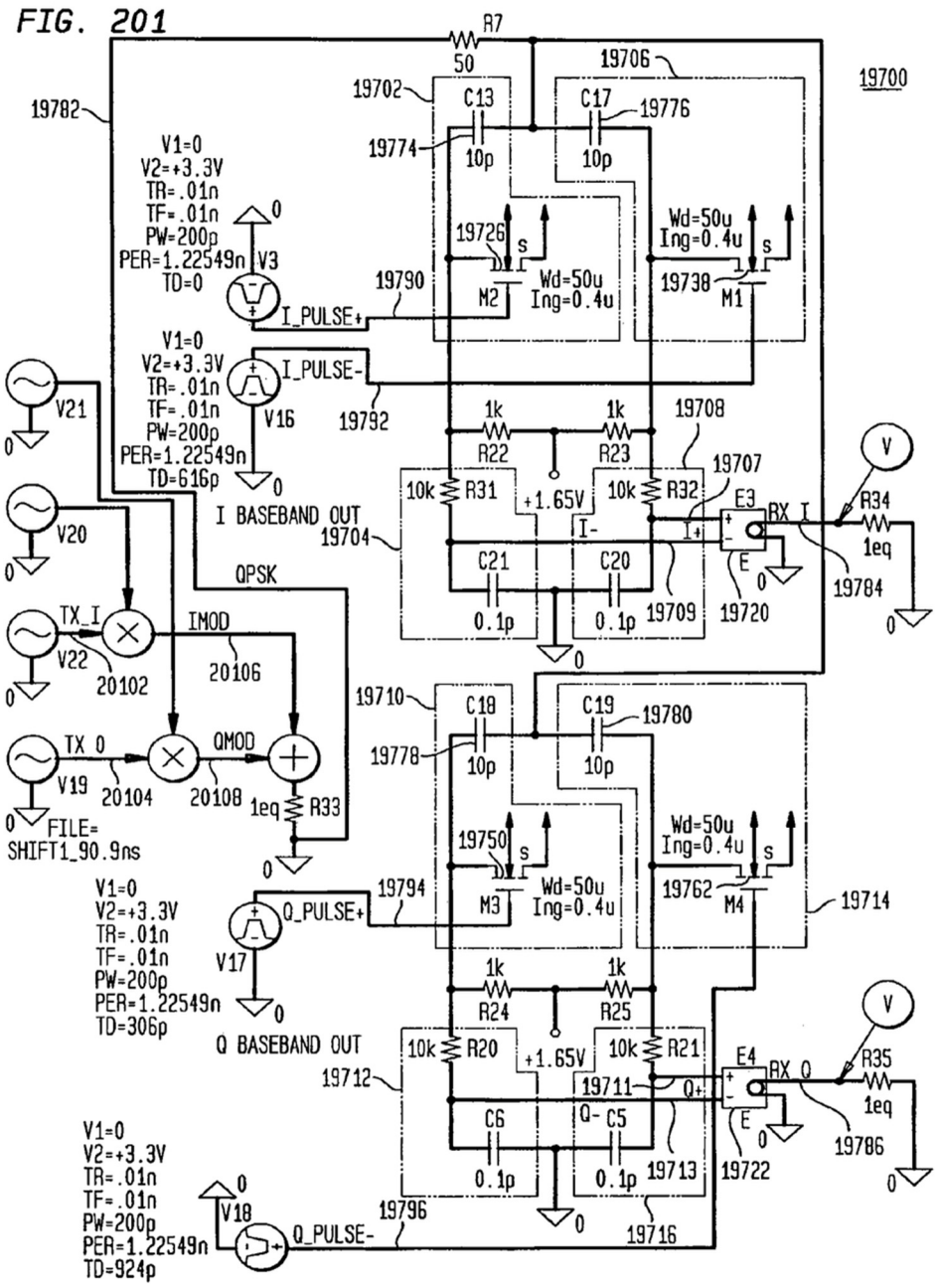
portion of the voltage resulting from the RF input signal across the capacitor connected to R_1 or R_2, respectively. Furthermore, both v_{out-} and v_{out+} take on both positive and negative values over time.

147. When either of v_{out-} or v_{out+} increases, the signal energy stored on the corresponding capacitor increases, and whenever v_{out-} or v_{out+} decreases, the signal energy stored on the corresponding capacitor decreases (because the energy stored on a capacitor is equal to $\frac{1}{2} \cdot C \cdot V^2$, where V is the voltage across the capacitor). And because these increases and decreases in the energy stored on the capacitor are the result of the RF input signal, they are the energy transfers to which the claims in the '528 patent refer.

148. For example, consider a point in time when M_5 has just turned off and $V_{\text{out}-}$ is larger than V_{BIAS-}, i.e., when v_{out-} is positive. This corresponds to the case where energy was transferred to the left capacitor when M_5 was previously on. While M_5 is off, v_{out-} heads back toward zero because signal component of the charge stored on the capacitor gets at least partially discharged through resistor R_1. Therefore, the Razavi mixer does satisfy the '528 patent's claim requirement that a "portion of energy" is "transferred from the modulated carrier signal" "to the respective storage element when the switch is on during the charging cycle, and a portion of the transferred energy is discharged during the discharging part of the

cycle for each respective switching device when the switching device is off" despite Dr. Ricketts' assertion to the contrary.

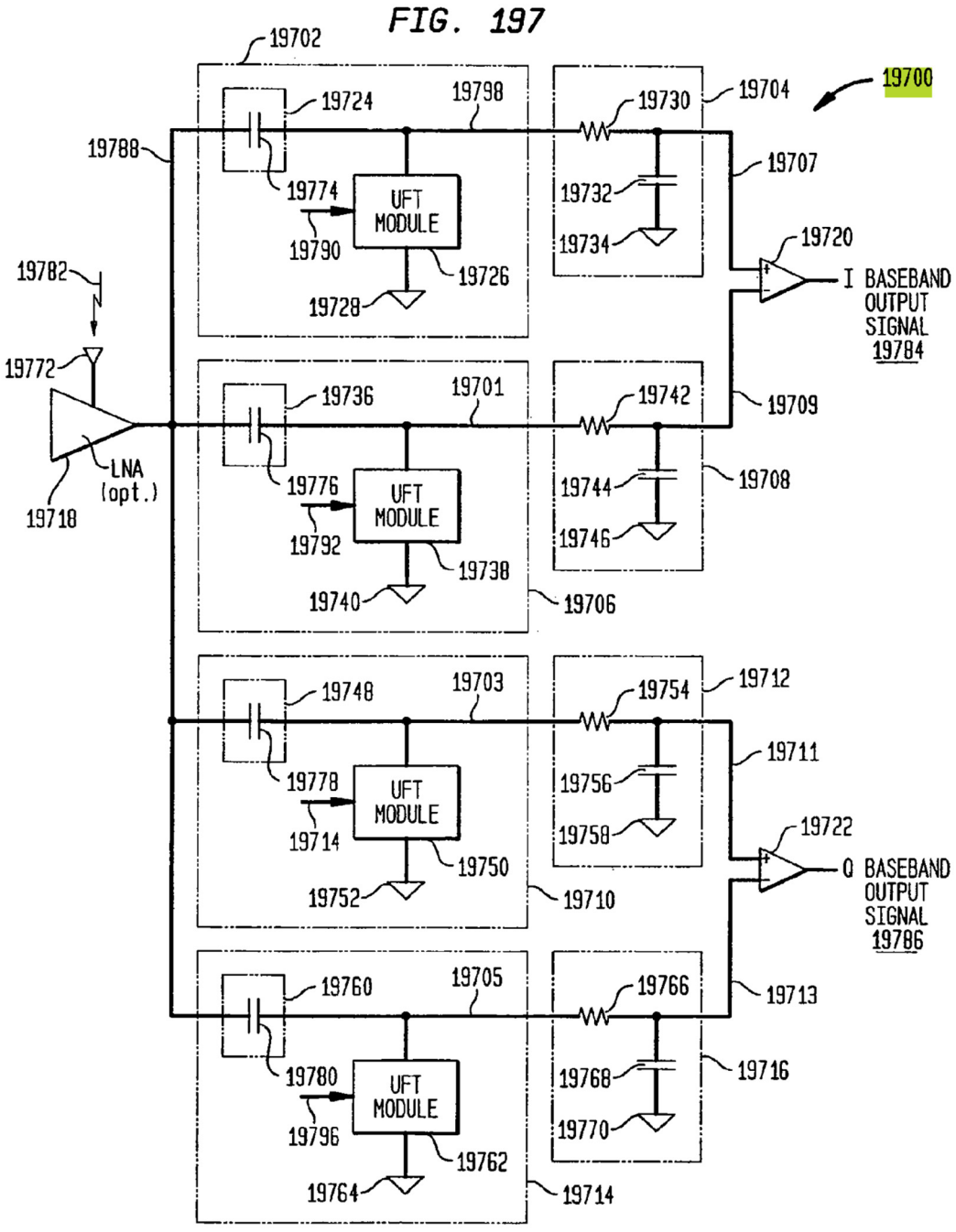
149. As additional evidence that Dr. Ricketts' assertion is wrong, consider the embodiment of the alleged invention of the '528 patent shown in Figure 201 of the '528 patent:



TI-1001, Fig. 201.

150. As stated in the '528 patent, "FIG. 201 illustrates a more detailed example circuit implementation of I/Q modulation receiver 19700, according to an

embodiment of the present invention" (TI-1001, Column 182, Lines 3-5), where receiver 19700 is shown in Fig. 197 of the '528 patent:



TI-1001, Fig. 197.

151. Note that the top-left capacitor, i.e., capacitor C13, in Figure 201, which is labeled as 19774 corresponds to the top-left capacitor in Figure 197. The '528 patent identifies this capacitor as a storage module: "first Processing module 1902 comprises a first storage module" (Column 176, Lines 66-67). The '528 patent also states that the MOS transistor "19726 opens and closes as a function of I control signal 19790" (Column 177, Lines 2-3). As can be seen from Fig. 1, when transistor M2, i.e., 19726, is off, the left plate of capacitor C13 is connected to a supply voltage of 1.65 V through a 1 kilo-ohm resistor. Moreover, M2 is an nMOS transistor, so its source terminal (the terminal of M2 labeled 'S' in Fig. 201) must be set to a voltage lower than the supply voltage (ideally, it would be set to 0 volts) or else it will not turn on as is required for the circuit to operate properly. Therefore, the left plate of C13 is set to a lower voltage than the power supply voltage when M2 is on. A POSITA would conclude from these observations that when the switch is off, the voltage at the left plate of C13 must increase toward 1.65 V starting from a voltage approximately equal to the voltage of the source of M2. In other words, the total energy stored by capacitor C13 always increases when the switch is off (which is supposed to be its discharge cycle).

152. Therefore, if we were to apply Dr. Ricketts' reasoning to the embodiment of the alleged invention presented in the '528 patent shown in Fig. 201, we would incorrectly conclude that it is in fact not an embodiment of the

alleged invention. In contrast, like the Razavi mixer circuit, when signal voltages are considered instead of absolute voltages, the embodiment of Fig. 201 does indeed satisfy the '528 patent's claim requirement that a "portion of energy" is "transferred from the modulated carrier signal" "to the respective storage element when the switch is on during the charging cycle, and a portion of the transferred energy is discharged during the discharging part of the cycle for each respective switching device when the switching device is off."

D. Motivation to combine Razavi and Macnally

153. In his declaration, Dr. Ricketts alleged no motivation to combine because (i) "Razavi Figure 5 discloses a fully realized amplifier design," (ii) "Razavi already discloses on-chip RC low-pass filters," (iii) "Using Macnally's filter would actually require many more components than using Razavi's amplifier," EX2024, ¶¶385-395.

154. I disagree with Dr. Ricketts for similar reasons as I have discussed *supra* §V. I provide additional explanation below.

155. Regarding item (i), Razavi's existing features would not preclude further improvement. As I had explained in my First 528 Declaration: Razavi states "channel-selection filtering is not included," thus indicating the need for channel-selection filtering, which a POSITA would understand as low-pass filtering

because Razavi performs "direction conversion" to baseband. TI-1017, 113…. A POSITA would have recognized the benefits of applying the example circuit of Macnally to complement Razavi's receiver design and achieve both amplification and "channel-selection filtering" at baseband. TI-1003, ¶¶227-228; TI-1017, 113.

156. Regarding item (ii), while it is true that the Razavi mixer circuit already performs lowpass filtering, the lowpass filtering is that of an RC filter which has only a single pole, and single pole lowpass filters offer the least suppression of out-of-band signals of all lowpass filters. Therefore, single pole lowpass filters are rarely sufficient in wireless receivers, and in most such applications additional filtering is required. TI-1050. In short, Dr. Ricketts' claim that "A POSITA would recognize that the existing RC filters found in Razavi already perform the anti-aliasing function– Razavi's RC filters serve the role of aliasing suppression" ignores the facts that not all lowpass filters are created equally and that more filtering is generally needed than that offered by a single pole filter. It also ignores the fact that Figures 4(b) and 4(c) of the Razavi paper explicitly show additional filtering (i.e., channel select filters, which, for direct-conversion receivers are always lowpass filters):

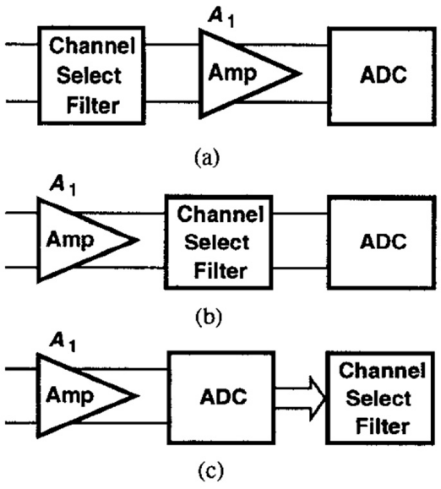


Fig. 4. Baseband processing.

TI-1017, Fig. 4 (additional filter via channel select filter)

157. This directly contradicts Dr. Ricketts' assertion that the single pole RC filtering performed by Razavi's mixer circuit is a sufficient amount of lowpass filtering. Furthermore, ADCs are always preceded by anti-alias filters (or else out-of-band signals alias into the signal band of the ADC, thereby corrupting the ADC's output signal), so an anti-alias filter is required in each configuration shown in Figure 4 of the Razavi paper, even though it is not shown explicitly.

158. I note that the Razavi paper did not actually implement any of the baseband processing configurations shown in Figure 4 of the paper (above). The discussion in the paper of the three options is essentially a thought experiment to describe the various tradeoffs of the different options. Each of the options has advantages and disadvantages, i.e., tradeoffs. Nevertheless, an ADC must always be preceded by an anti-alias filter.

159. Regarding item (iii), it was general knowledge that using a fully differential amplifier can reduce area and power consumption relative to those of a comparable single-ended amplifier, which matters more for IC implementation than the mere number of components. TI-1060, 28-31 (detailed explanation and example).

160. I address additional arguments from Dr. Ricketts below.

1. Razavi does not teach away from the combination

161. Dr. Ricketts additionally asserts Razavi teaches away because "Razavi specifically teaches against the use of the permutation depicted in Figure 4(a)." EX2024, ¶402.

162. I disagree with Dr. Ricketts because he mischaracterized my First 528 Declaration. Here, the Macnally anti-alias filter simultaneously performs amplification and filtering, so it does not fit the paradigm of either Figure 4(a) or Figure 4(b) above. Moreover, it is most appropriate to realize Fig. 4(c) in that 1) an anti-alias filter is always required before an ADC, 2) the signal component of the Razavi circuit is relatively small (which is why all three configurations include an amplifier) so amplification is required prior to the ADC, and 3) the anti-alias filter relaxes the requirements of the channel select filter after the ADC in Figure 4(c).

163. Therefore, Dr. Ricketts' comments regarding Figure 4(a) are not relevant. That said, each of the three options in Figure 4 of the Razavi paper represent different tradeoffs, i.e., each has advantages and disadvantages relative to the other options. The fact that Dr. Razavi pointed out these tradeoffs does not mean that he believes that one option is always worse than the other options. Indeed, all three options shown in Figure 4 were known and widely used at the time of the priority date of the '528 patent.

2. Razavi is compatible with Macnally as both seek to improve IC implementation

164. In his declaration, Dr. Ricketts further asserts: "substituting a low impedance load [of Macnally] in place of a high impedance load [of Razavi] would alter the operation of Razavi's circuit." EX2024, ¶406.

165. I disagree with Dr. Ricketts because his assertion again defies fundamental principles of circuit operation. I have provided (*supra* §V.A.1) a detailed analysis on Razavi, which reveals the resistance of each of R_1 and R_2 in the Razavi mixer circuit is almost certainly less than 1.25 kilo-ohm, which is low input impedance according to ParkerVision. *See e.g.*, TI-1003, §VI.D, ¶156; TI-1001, Fig. 82B (showing low impedance load as around 2k ohm); IPR2020-01265, Paper 26 (PO Sur-reply) at 13; Paper 18 (POR) at 46-50. This characteristic of Razavi's mixer circuit would be compatible with the low input impedance of Macnally circuit.

3. Reasonable expectation of success in combining Razavi and Macnally

166. In his declaration, Dr. Ricketts again asserts: "Razavi explicitly criticizes…the design permutation in Figure 4a" and "Macnally's biquad two-pole filter would alter the fundamental operation of Razavi's circuit." EX2024, ¶¶410-414.

167. I disagree with Dr. Ricketts' assertions. As I have explained *supra* §VI.D.1, Macnally's circuit combines amplification and lowpass filtering, which is consistent with the teachings of all three permutations of Razavi's Figure 4. Replacing any one of the three permutations of Razavi with the Macnally's filter (which has low input impedance) can result in improved matching when R_1 and R_2 in Razavi's amplifier are about 1.5 kilo ohms. §V.A.1.

168. As I have described above, any time a circuit is developed, a design process much occur. The process is not "experimentation" as Dr. Ricketts puts it, but a reasoned and systematic process by which different circuit topologies for implementing each of the required circuit blocks are evaluated and circuit component values are optimized. These tasks are done by a POSITA via a combination of hand analysis and computer simulation. Furthermore, the Razavi paper does not provide component values or the sizes of the different transistors, and does not provide many other circuit details such as showing the reference current circuitry. Therefore, even if a POSITA wanted to exactly duplicate the

circuit Dr. Razavi described in his paper, the POSITA would have to go through a detailed design process. And anytime a circuit is ported from one integrated circuit technology node to another, an involved design process is necessary, regardless of whether all the circuit details were available for the original circuit. Nevertheless, the fact that a detailed design process is required does not mean that a POSITA would have no reasonable expectation of success when implementing the Razavi circuit.

169. I understand Dr. Ricketts asserts incompatibility because "Razavi specifically states, 'to achieve a high conversion gain…R1 and R2 must be maximized.'" EX2024, ¶414. However, this would not be a significant issue because R_1 and R_2 in Razavi have low resistances, i.e., in the kilo ohm range. *Supra* §V.A.1.

E. Energy Transfer System

170. In his declaration, Dr. Ricketts again asserts: "None of the prior art references teach, disclose, or suggest an energy transfer system." EX2024, ¶¶416-418

171. I disagree with Dr. Ricketts for similar reasons as I have explained above. *Supra* §III. Even if the extraneous limitation of low impedance load is read into the claims, the combination still provides the so-called energy transfer system

because Macnally's fully differential amplifier provides input impedance on the order of kilo ohms. *See e.g.*, TI-1003, §VI.D, ¶156.

VI. CONCLUSION

172. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

173. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable under Section 1001 of Title 18 of the United States Code.

Dated: June 28, 2025 By: /Ian Galton/

Dr. Ian Galton