

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TEXAS INSTRUMENTS INCORPORATED,
Petitioner

v.

PARKERVISION, INC.,
Patent Owner

Case IPR2024-00935
Patent 7,865,177

SECOND DECLARATION OF DR. IAN GALTON

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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 (“Second 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. 7,865,177 (“’177 Patent”). This Second Declaration is responsive to Dr. Rickett’s ’177 Expert Declaration, EX2024, and addresses the prior art and technology analysis that Dr. Ricketts provided in his declaration.

2. This Second Declaration supplements, and is intended to be read in conjunction with, my earlier declaration (TI-1003) in support of TI’s Petition in IPR2024-00935 and

3. In writing this Second 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 declarations fully explain why each and every feature of the ’177 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 Claim 14 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 '177 Declaration and additional materials in this Second 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, <i>Norcal NC2030 Low power, High Performance 20m or 30m DC Transceiver</i> , 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, <i>The Design of CMOS Radio-Frequency Integrated Circuits</i> , Cambridge University Press, 1998.
TI-1052	B. Gilbert, <i>Advances in BJT techniques for high-performance transceivers</i> , Proceedings of the 23rd European Solid-State Circuits Conference, Southampton, UK, 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, <i>Analysis and Design of Analog Integrated Circuits</i> , 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, <i>Trimless High Precision Ratioed Resistors in D/A and A/D Converters</i> , 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-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-2024	Declaration of Dr. David Ricketts in Support of Patent Owner’s Response to Petition for IPR of U.S. Patent No. 7,865,177 (REDACTED)

III. RESPONSES TO STATEMENTS MADE BY DR. RICKETTS

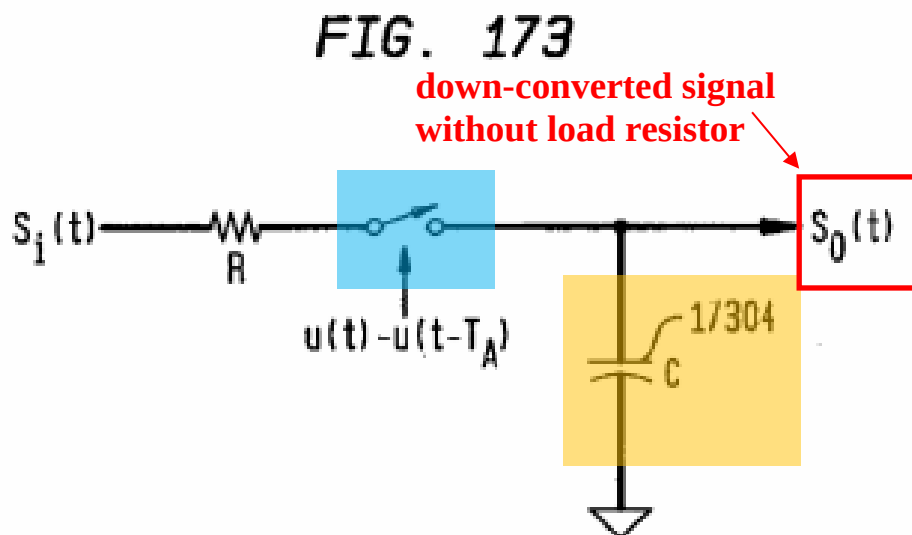
A. The “Matched Filter/ Correlating Module” does not require “Transferred to a Load”

1. Dr. Rickett’s is incorrect in his analysis that a load is required for the “Matched Filter/ Correlating Module”

5. The ’177 patent does not require that energy sampling, generally, or the matched filtering/correlating module, specifically, transfer to a load to form a down-converted signal. Ex. 2024 ¶ 196. Likewise, the ’177 patent’s alleged invention does not require that the “storage module continues to drive the low

impedance load when the switch is opened (OFF).” Ex. 2024 ¶ 131. For example, several of the embodiments of the alleged invention presented in the specification of the ’177 patent, e.g., the embodiments shown in Figures 68G, 72, 149, and 173, do not contain a low impedance load that the storage module (the capacitor) “continues to drive the low impedance load when the switch is opened (OFF).”

6. According to the ’177 patent, down-converting does not require transferring to a load to form a down-converted signal, regardless of the magnitude of the impedance of that load. For example, the POR uses FIG. 173 (also shown in FIG. 149) as an example matched filtering/correlating module that uses capacitor 17304 as an integrator. POR, 61-62. The implementation in FIG. 173 has no load, yet its output is the down-converted signal:



POR, 61-62

See also, TI-1001, 145:47-58 (linking FIG. 173 to a “simple embodiment” of a matched filtering/correlating module). The embodiment shown in FIG. 173 “utilizes a very low cost integrator or capacitor as a memory across the aperture.” TI-1001, 145:46-49. Referring to Fig. 173, the ’177 patent further states “Notice the ***inclusion of the source impedance, R***, along with the switch and capacitor,”, which makes it clear that R represents the impedance of the circuit which drives the switch, so R is not a load resistor (also, a load resistor would have to be at the output of the circuit, not at the input to the circuit). TI-1001, 145:52-54.

7. The ’177 patent describes optimizing the RC processor by selecting values for the capacitor and the source impedance:

Another very low cost and easy to build embodiment of the present invention is the RC processor. This embodiment, shown in FIG. 173, utilizes a very low cost integrator or capacitor as a memory across the aperture. If C is suitable chosen for this embodiment, its performance approaches that of the matched filter/correlator embodiment, shown in FIG. 171. Notice the inclusion of the source impedance, R, along with the switch and capacitor. This simple embodiment nevertheless can approximate the optimum energy transfer of the matched filter/correlator embodiment if properly designed. 50 55

When maximum charge is transferred, the voltage across the capacitor 17304 in FIG. 173 is maximized over the aperture period for a specific RC combination.

TI-1001, 145:46-58 (annotated)

Note that in the description of the RC optimization for FIG. 173, “R” is the “source impedance,” and there is no mention of the load impedance for designing the system for optimizing energy transfer.

8. Likewise, the equations describing the design methodology to achieve maximum charge accumulation for the RC processor of FIG. 173 do not depend on the load. For example, the '177 patent describes the charge to be dependent on the voltage V_0 and capacitance c :

Maximizing the charge, q , requires maximizing EQ. (37) with respect to t and β

40

$$\frac{\partial^2 V_0(t)}{\partial t \partial \beta} = 0 \quad \text{EQ. (55)}$$

45 It is easier, however, to set $R=1, T_A=1, A=1, f_A=T_A^{-1}$ and then calculate $q=cV_0$ from the previous equations by recognizing that

50

$$q = \frac{\beta^{-1}}{R} V_0 = cV_0,$$

charge independent of load impedance

55 which produces a normalized response.

'177 patent, 145:49-53, 146:3-7, 146:37-55 (where $\beta = (RC)^{-1}$, and R is the source impedance),

where EQ. (37) is:

$$V_0(t) = \int_{-\infty}^{\infty} A \sin(\pi f_A \tau + \phi) \cdot \frac{e^{-\frac{(t-\tau)}{RC}}}{RC} \left[u(t-\tau) - u(t-\tau-T_A) \right] d\tau \quad \text{EQ. (37)}$$

where

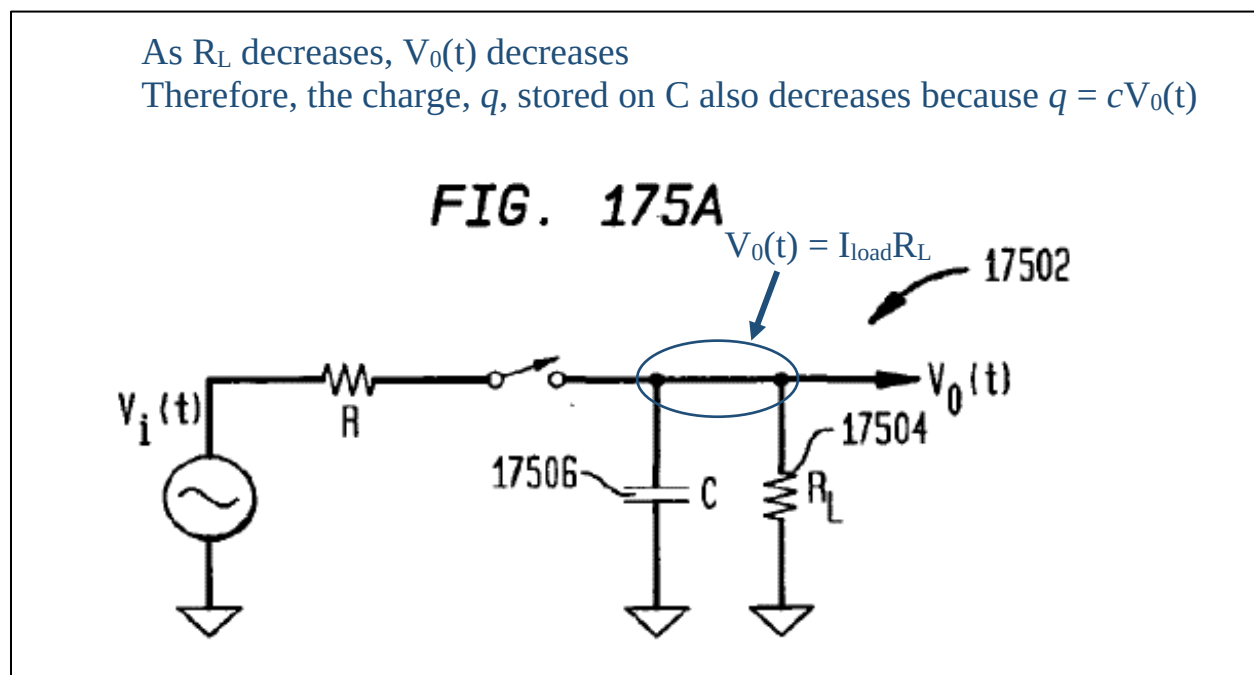
$$f_A \Delta 2f = T_A^{-1}$$

'177 patent, 142:5-9

Note that EQ (37) does not contain a load resistance (recall that R is the source resistance, not a load resistance). Yet, as I explain shortly, if a load resistor were added to the RC processor of Fig. 173, then $V_0(t)$, and, hence, EQ (37) would depend on the load resistor. Therefore, in addition to Fig. 173 not explicitly showing a load resistor, the detailed analysis of Fig. 173 presented in the '177 patent is only valid when a load resistor is not present. Given that the '177 patent describes the RC processor without a load resistor shown in Fig. 173 as a “very low cost and easy to build embodiment of the present invention” ('177 patent, 145:46-47) and it provides a detailed analysis of Fig. 173 that is only valid in the absence of a load resistor, it follows that a load resistor is not a required component of the invention.

9. A load resistor is merely an *optional* component of the '177 patent's alleged invention. For example, the '177 patent presents an embodiment of the alleged invention shown in FIG. 175A, which adds a load resistor, R_L , to the RC

processor of FIG. 173. TI-1001, 147:39-42 (“FIG. 175A illustrates an example RC processor embodiment 17502 of the present invention having a load resistance 17504 across a capacitance 17506.”).



TI-1001, FIG. 175A (annotated)

10. Moreover, the '177 patent provides a separate section in which it considers the effect of adding the optional load resistance, R_L . TI-1001, 147:35-149:20 (“5.2 Load Resistor Consideration”). That the '177 patent illustrates the load resistor considerations to the RC processor separately from RC processor without a load resistor is further evidence that the '177 patent does not require a load to achieve down-conversion.

11. The R_L resistor in Fig. 175A bleeds current, call it $I_{load}(t)$, from the switch and capacitor. Applying the well-known Ohms Law (TI-1045) indicates that

$I_{\text{load}}(t)$ can be written as $I_{\text{load}}(t) = V_0(t)/R_L$, so $I_{\text{load}}(t)$ increases when R_L is reduced.

Denoting the current through the switch at time t as $I_{\text{switch}}(t)$, the well-known Kirchhoff's Current Law (TI-1045) indicates that the current into the capacitor at time t is $I_C(t) = I_{\text{switch}}(t) - I_{\text{load}}(t)$. Charge on a capacitor is the integral of the current through the capacitor (TI-1045), so it follows that the presence of R_L in Fig. 175A reduces the charge stored on the capacitor relative to that in the embodiment shown in Fig. 173. Moreover, $V_0(t)$ is the voltage across the capacitor, and the voltage across a capacitor is equal to the charge stored on the capacitor divided by its capacitance (TI-1045). Hence, reducing the resistance, R_L , in Fig. 175A reduces $V_0(t)$, an effect that is not captured by EQ (37). This shows that EQ (37) does not apply to the case where a load resistor is included.

12. The '177 patent also provides an analysis of the SNR performance for three embodiments, including the RC processor embodiment of FIG. 173:

	Performance Relative to the Performance of an Optimal Matched Filter Embodiment	50
Example Matched Filter		
$SNR_{MF} = \frac{T_A}{2N_0}$	0 dB	55
Example Integrator Approximate		
$SNR_{INT} = \frac{4T_A}{\pi^2 N_0}$	-91 dB	60
Example RC Approximate (3 example cases for reference)		
5	$SNR_{RC} = \frac{V_0(t)^2 \cdot 2}{\beta N_0} \cong \frac{.2142}{N_0}$	-3.7 dB, at $T_A = 1, \beta = 2.6$
	$SNR_{RC} \cong \frac{.377}{N_0}$	-1.2 dB, at $T_A = .75, \beta = 2.6$
	$SNR_{RC} \cong \frac{.405}{N_0}$	-91 dB at $T_A = 1, \beta \leq .25$
		65
10		

TI-1001, 151:50-152:10

The RC approximate embodiment represents the RC processor of FIG. 173, which, as I explained above, does not include a load resistor. This is evident from the text immediately after the Table which discusses the analysis for the selection of the capacitor value, which is the same analysis undertaken for the RC processor of FIG. 173. Compare TI-1001, 147:19-35 (finding $C \geq 16.3$ pF) with *id.*, 152:13-17 (finding $C \geq 16.3$ pF).

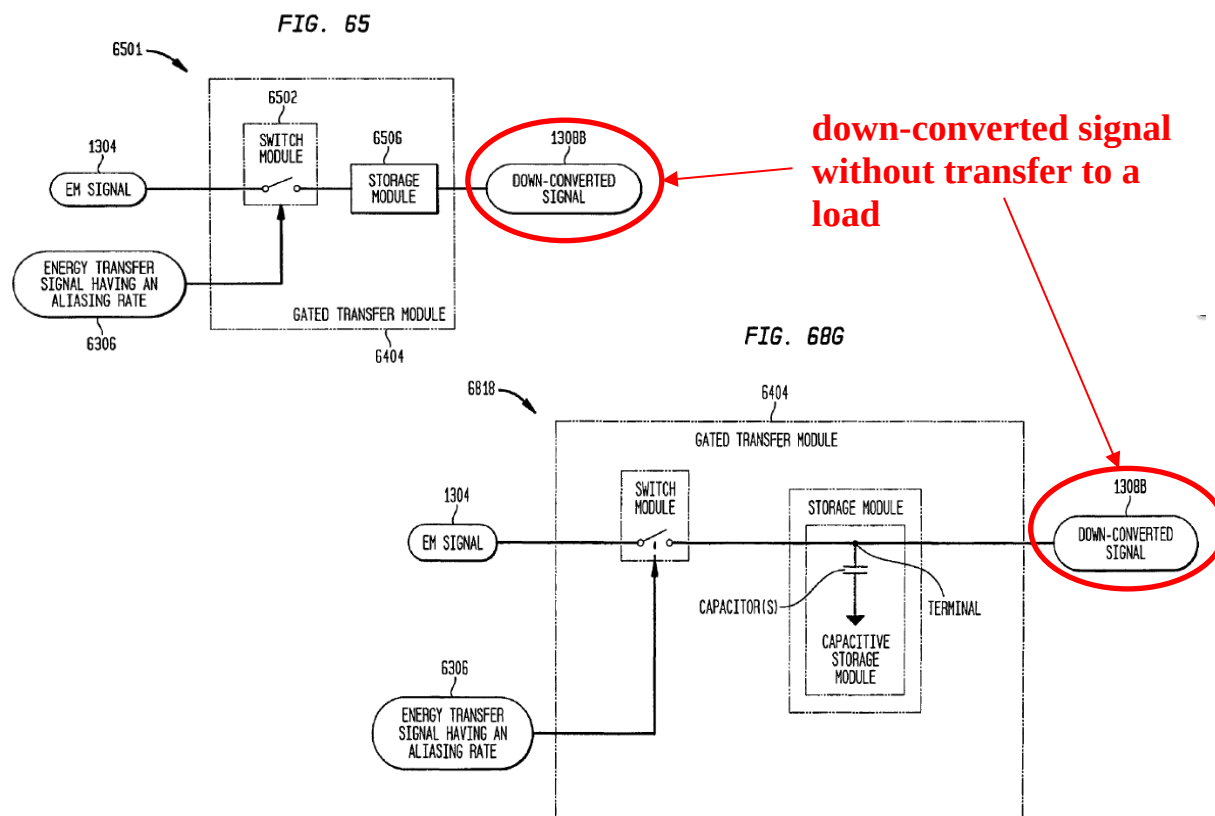
13. Note that the general SNR expression in the table for the RC approximate embodiment is proportional to the square of the voltage $V_0(t)$. As I

explained above, if a load resistor, R_L , were present, $V_0(t)$, would depend on R_L , e.g., it would decrease as R_L is decreased. Therefore, the SNR would decrease with R_L if a load resistor were included. Yet, the SNR expressions for the three specific design examples of the RC approximate embodiment, i.e., $0.2132/N_0$, $0.377/N_0$, and $0.405/N_0$, do not depend on R_L (T_A and β are not functions of R_L). This is further evidence that the invention does not require the inclusion of a load resistance.

14. Despite PO's and Dr. Ricketts' arguments to the contrary, the '177 patent does not require a low-impedance load to maximize SNR (indeed, the presence of a low-impedance load would actually reduce the SNR). For example, when describing the configuration of FIG. 173, which lacks the load resistor, the '177 patent states that "SNR is simultaneously optimized melding the best of two features of the present invention." '177 patent, 147:31-33; *see also id.*, 142:61-143:51 (describing the equations for maximizing SNR, which do not depend on load impedance). Thus, according to the '177 patent itself, SNR is optimized even without transferring energy to a low-impedance load. Therefore, the inclusion of transferring energy to a load should not be part of the claim construction.

15. Likewise, the '177 patent provides examples of general energy transfer (i.e., energy sampling) embodiments that do not include transferring to a

load, such as that shown in FIGS. 65 and 68G, shown below:

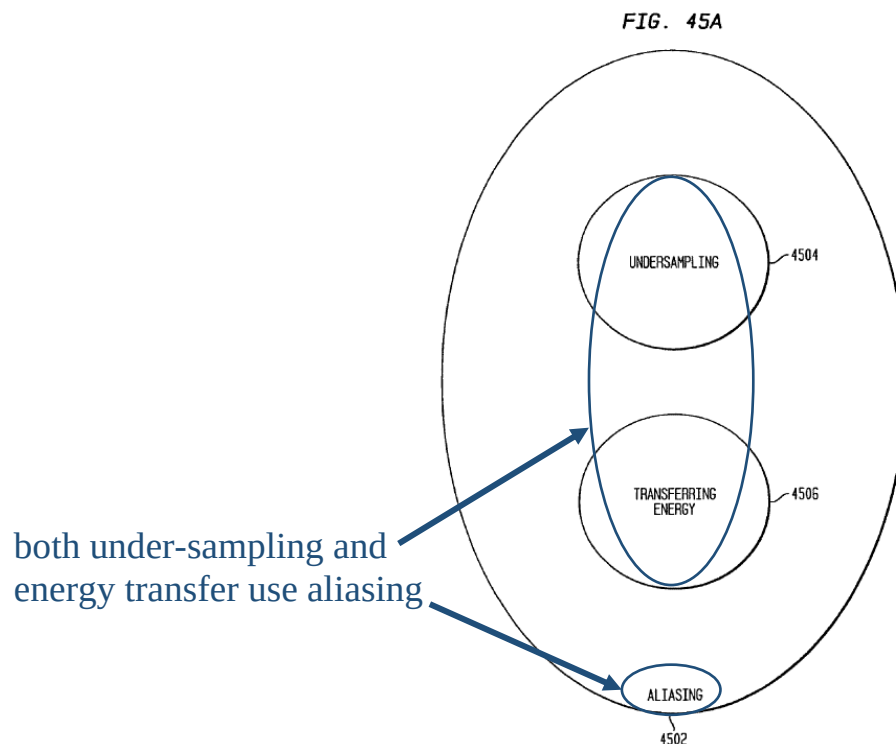


TI-1001, FIGS. 65 & 68G (annotated)

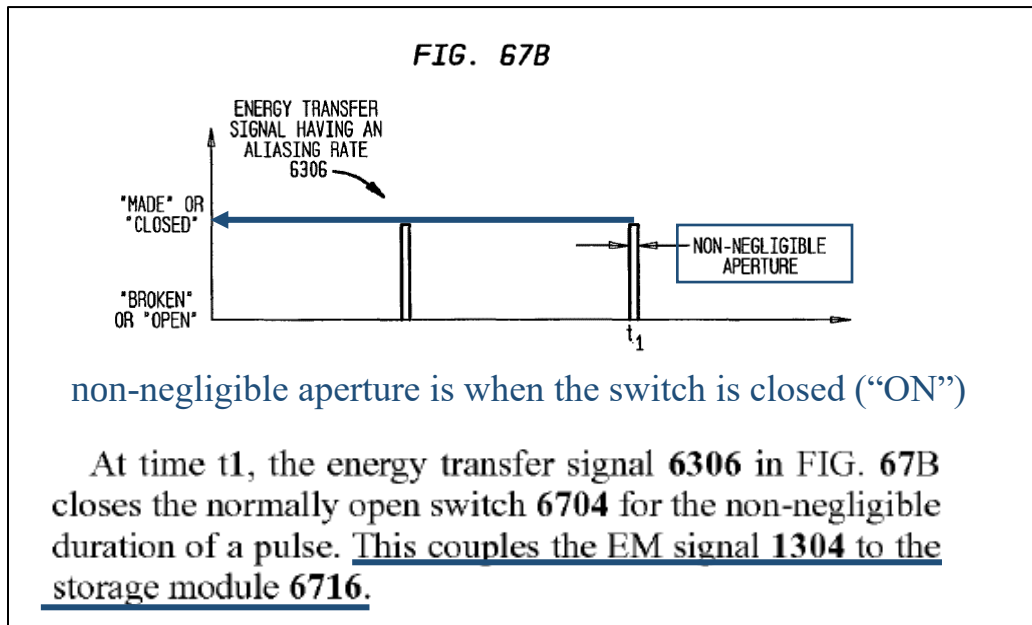
See also, '177 patent, 104:35-37 (regarding FIG. 65, "Preferably, the switch module 6502 and the storage module 6506 transfer energy from the EM signal 1304 to down-convert it..."), *id.*, 104:40-41 (describing storage module as a capacitive storage element); 106:31-46 (storage module 6506 is a capacitor). As shown and described consistently throughout the '177 patent, no transfer to a load is required to produce a down-converted signal (this is not to say that no load is present at all—just that the down-conversion occurs prior to and independent of the load). The '177 patent describes transferring energy from the input signal to

the capacitor based on the non-negligible aperture window, but that is not the same thing as transferring energy to the load. *e.g.*, TI-1001, 29:15-37, FIG. 46C.

16. The '177 patent makes it clear that it is the duration of the aperture pulses (and not the aliasing rate or the load) that distinguishes “under-sampling” from “energy transfer.” *e.g.*, TI-1001, 73:5-12. For example, the '177 patent shows that aliasing is used for both under-sampling and energy transfer:



The non-negligible aperture and the appropriately selected capacitance is what “allows the **storage capacitance 8208 to store energy transferred from the input EM signal 8204.**” TI-1001, 73:54-65. Note that the non-negligible aperture is the duration of the control signal that closes the switch:



TI-1001, 105, 37-40, FIG. 67B

The '177 patent clarifies that the energy transfer "from the EM signal" to the capacitor occurs "during a non-negligible aperture period." TI-1001, 106:45-53 ("The goal of the storage modules 6506 and 6716 is to store non-negligible amounts of energy transferred from the EM signal 1304."), 106:300-44 (describing that storage modules 6506 and 6716 can be capacitors).

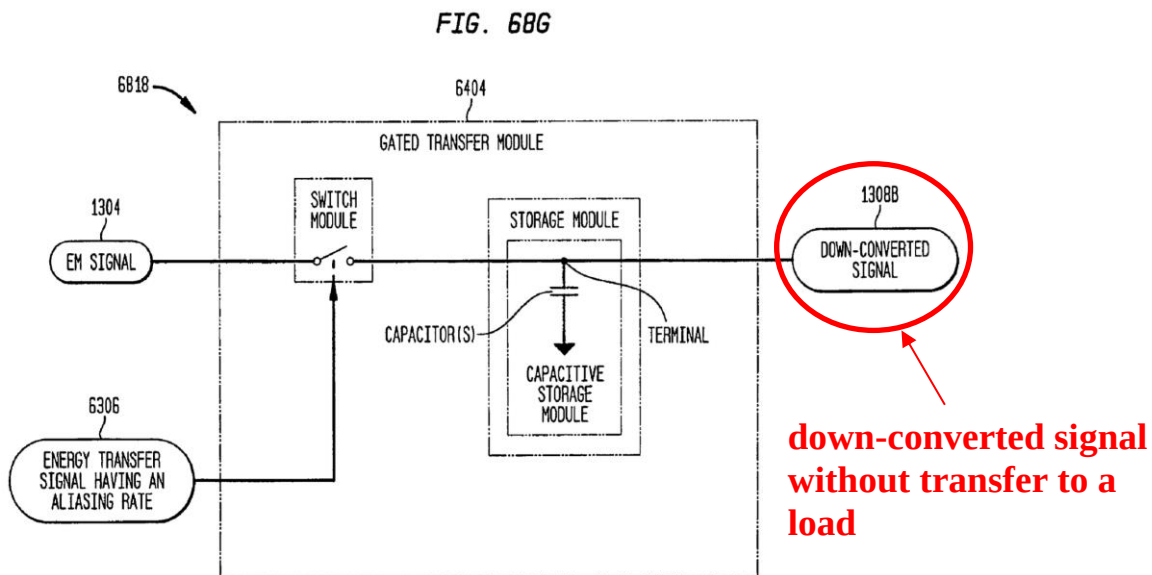
17. The '177 patent makes it clear that the transfer of energy to achieve down-conversion is from the EM signal to the capacitor, and not from the EM signal to the load resistor. Put simply, during the non-negligible aperture period, when the switch is closed ("ON"), energy is transferred from the EM signal to the capacitor for storage.

18. At best, the '177 patent states that a benefit of the energy transfer system is the ability to drive low-impedance loads. But the '177 patent states that, “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.” '177 patent, 74:16-18 (emphasis added). This statement implies that energy transfer is achieved with or without a load. Likewise the '177 patent states that for under-sampling, “loads can be classified as high impedance loads or low impedance loads.” '177 patent, 74:5-6. This is further evidence that a low-impedance load is not required for energy transfer to occur.

19. One of Dr. Ricketts' arguments as to why a low-impedance load is necessary in the alleged invention of the '177 patent is: “[i]f the capacitor did not continue to drive the low impedance load, there would be gaps in the output signal” Ex. 2024 ¶ 132. But this argument does not make sense. The storage module is disconnected from the RF signal whenever the switch is off, so it does not have access to the input signal during the time intervals when the switch is off. In this sense, there are “gaps” in the output signal regardless of whether or not the storage element drives a load during these gaps.

20. Dr. Ricketts' assertion that it is necessary to “discharge the stored energy in between samples to form the down-converted signal” is another misunderstanding or misrepresentation in Dr. Ricketts' narrative. Ex. 2024 ¶ 133.

As I mentioned above and describe in detail later in this document, several of the embodiments of the alleged invention presented in the specification of the '177 patent, e.g., the embodiments shown in Figures 68G, 72, 149, and 173, do not contain a low impedance load that “discharge[s] the stored energy in between samples to form the down-converted signal,” yet, as explained in the '177 patent specification, they nevertheless perform down-conversion and their output waveforms are the down-converted signal. For example, Figure 68G is:



TI-1001, FIG. 68G (annotated)

In addition to being clear from the figure, the '177 patent specification identifies 1308B as “the down-converted signal 1308B, which includes non-negligible amounts of energy transferred from the EM signal 1304.” '177 patent, 104:28-30. Note that there is no load which discharges the storage module, yet the '177 patent

clearly (and correctly) states that the embodiment of Fig. 68G outputs the down-converted signal.

21. So why would Dr. Ricketts claim that it is necessary to “discharge the stored energy in between samples to form the down-converted signal” when the ’177 patent presents embodiments of the invention that clearly form the down-converted signal without the need to “discharge the stored energy in between samples”? One possibility is that he has misunderstood both the ’177 patent and the mechanism by which the alleged invention performs down-conversion, so he does not understand that the down-conversion process does not rely on discharging “the stored energy between samples.” The only other possibility, which, sadly, is more likely in my opinion, is that he needs to purposely make this mistake in order to argue that ParkerVision’s proposed claim construction of “matched filtering/correlating module” is valid. ParkerVision’s proposed claim construction of “matched filtering/correlating module” is “linear time-variant circuitry that samples a modulated RF (radio frequency) carrier signal at an aliasing rate using a switch with an independent control input driven by a control signal with a non-negligible, periodic aperture, such that the samples, having non-negligible available energy, are accumulated and transferred to a load while the switch is closed *and discharged through the load while the switch is open*, thereby transferring available real power from the modulated RF carrier signal to the load

and producing a down converted signal with enhanced signal-to-noise power ratio” (emphasis added). Therefore, to argue that this claim construction is valid, he must ignore the reality that several embodiments of the alleged invention do not in fact discharge the accumulated samples “through the load while the switch is open” and that discharging the accumulated samples through a load is not necessary for down-conversion.

22. Dr Ricketts has misrepresented my deposition testimony (without providing any supporting quotation from me). Ex. 2024 ¶ 195. I never agreed that a “matched filtering/correlating module” must include a load resistor, only that it *can* include a load resistor. Despite hostile and aggressive questioning and pressure by ParkerVision’s attorney during the deposition to admit that a “matched filtering/correlating module” must contain features, e.g., a load resistor, other than what I listed in my expert declaration, I responded with “I stand by what I wrote” (Deposition transcript, 38:20-21) in reference to the “matched filtering/correlating module” definition I proposed in my expert declaration, and my other responses to the attorney’s questions were consistent with this response.

23. Despite Dr. Ricketts’ protestations to the contrary, a load resistor is not actually part of the alleged invention. Indeed, during his deposition, Dr. Ricketts could not identify a load resistor in any of FIGS. 68G, 149, or 173, and had to rely entirely on ParkerVision’s claim constructions to support his

understanding of the '177 patent. As I have explained in detail above, the '177 patent presents embodiments of the invention that do not adhere to ParkerVision's claim construction of "matched filtering/correlating module." Specifically, these embodiments do not adhere to the "are accumulated and transferred to a load while the switch is closed and discharged through the load while the switch is open" portion of ParkerVision's claim construction as explained below.

24. In paragraph 195, Dr. Ricketts stated that a matched filtering/correlating module "must include at least a switch, integrator (capacitor), and load (resistor)." Ex. 2024 ¶ 195. As I explained above, and is evident from the example of Fig. 173, the embodiment of Fig. 173 does contain an integrator (the capacitor) but does not contain a load resistor. Therefore, while the integration performed by the capacitor in Fig. 173 does cause the embodiment to accumulate samples as needed to satisfy ParkerVision's claim construction, the samples are not "transferred to a load" under Dr. Ricketts' definition of a load (i.e., a resistor).

25. One point on which Dr. Ricketts and I are in agreement is that a load in the terminology of ParkerVision's claim construction must be distinct from the capacitor. As shown in the derivation presented in TI-1001, 146:5-35, the combination of the source impedance, R , and capacitor, C , perform integration, and the synchronization of the aperture window to the RF input signal's carrier causes the voltage across the capacitor to be the down-converted signal. Hence, the

input signal is simultaneously down-converted and integrated by the RC combination in conjunction with the timing of the switch. The capacitor, C, is the component that ultimately performs the integration, and no load component, such as a resistor, follows the capacitor, so the result of the integration is not “transferred to a load to form a down-converted signal” in this embodiment, yet it nonetheless down-converts the signal.

26. ParkerVision’s new proposed claim construction adds confusion because it is not clear whether it requires energy to be integrated *and* transferred or integrated *then* transferred. The construction allows for a scenario where the accumulation and transferring operations occur simultaneously and is implemented by the same component, i.e., the capacitor. ParkerVision’s new proposed claim construction is sufficiently ambiguous that one could conceivably argue that the capacitor is both the integrator and the load under the wording of ParkerVision’s claim construction wording. In that scenario, the claim construction still does not work because there would be no discharge path for the capacitor when the switch is open. Thus, even assuming that ParkerVision’s intent was to capture this scenario, the embodiment of Fig. 173 shows that the “and discharged through the load while the switch is open” portion of their claim construction for “matched filtering/correlating module” would not be met. The above discussion has focused on the embodiment of the alleged invention of the ‘177 patent shown in Fig. 173,

but this embodiment is just one of several such examples. Additional examples with similar issues include but are not limited to the embodiments shown in Figures 68G, 72, and 149.

27. Another glaring problem with ParkerVision's claim construction is that it does not require that the sampling operation is synchronous with the RF input signal's carrier frequency or a sub-multiple of the RF input signal's carrier frequency. This concept is absolutely central to the alleged invention of the '177 patent, is incorporated in every embodiment of the alleged invention presented in the '177 patent, and is necessary for the derivations presented in the '177 patent specification to be valid (e.g., the derivations presented in Section 3 of the '177 patent titled "Matched Filtering/Correlating Characterization/Embodiment").

28. For the above reasons, I disagree with ParkerVision's claim construction of "matched filtering/correlating module". However, it should be stressed that the prior art circuits I presented in my expert declaration nevertheless adhere to ParkerVision's claim construction, as well as the claim construction that I proposed, and as well as the plain and ordinary meaning claim construction that Texas Instruments proposed.

2. My analysis from my original expert declaration still stands.

29. As I explained in my original declaration, the claimed matched filtering/correlating module requires, among other things, synchrony between the

received signal and the known correlating signal. TI-1003 ¶¶ 28,63. Conventional application or otherwise, matched filtering/correlating at least requires matching or correlating the input signal to a known signal—here, the local oscillator. *E.g.*, '177 patent, 145:15-17. ParkerVision has not disputed this. It is noteworthy, however, that the concept of synchrony was introduced only in the March 9, 2000 disclosure, and not before then. Thus, given that synchrony is a critical aspect of the claimed matched filtering/correlating module, such claims are only entitled to the March 9, 2000 priority date.

30. The embodiments of the alleged invention disclosed by the '177 patent are widely varied, but the one feature that they all have in common is synchrony, which implies sampling at an “aliasing rate” (though sampling at an “aliasing rate” does not imply synchrony). It is true that the embodiments also integrate/accumulate energy from the input signal, but this is a function of the embodiments, not a feature of them. Ex. 2024 ¶ 205. For example, my eyes are features of my face, whereas my ability to see is a function of my eyes, not a feature of my face. Therefore, I stand by the argument I presented in my expert declaration in support of my proposed claim construction of a “matched filtering/correlating module”.

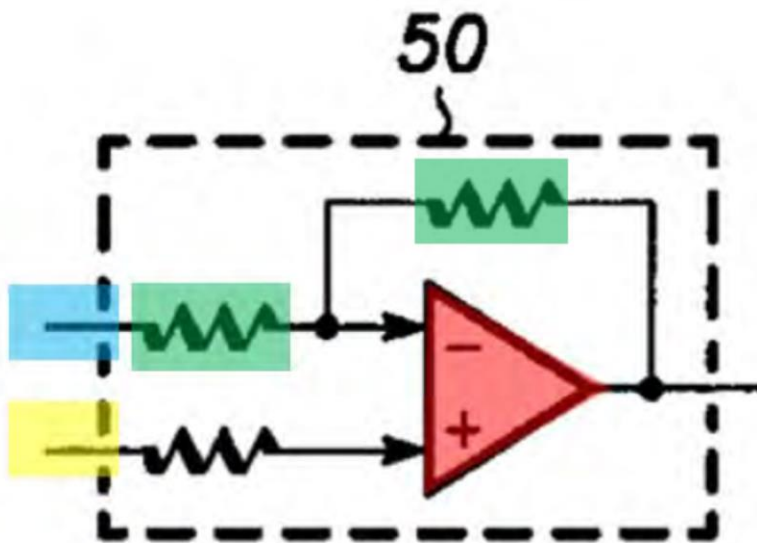
31. Nevertheless, the dispute is incidental in that the prior art I presented in my expert declaration also satisfies both ParkerVision's and TI's proposed claim construction of "matched filtering/correlating module".

B. Tayloe Teaches a Low-Impedance Load

1. Dr. Rickett's incorrect analysis on Tayloe

32. As discussed above, PO's inclusion of "transferred to a load" is not required by the '177 patent for the matched filtering/correlating module "to form a down-converted signal." But even if it were required, Tayloe describes transferring energy to a low-impedance load as described below.

33. Dr. Ricketts included the following annotated version of summing amplifier 50 from FIG. 3 of the Tayloe patent in his declaration:



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

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).

34. It is true, as Dr. Ricketts states in Paragraph 227 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. Ex. 2024 ¶ 227. 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.

35. 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.

36. 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.” Ex. 2024 ¶ 228. 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.

37. 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.” Ex. 2024 ¶ 228. 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.

38. 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.

39. 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:

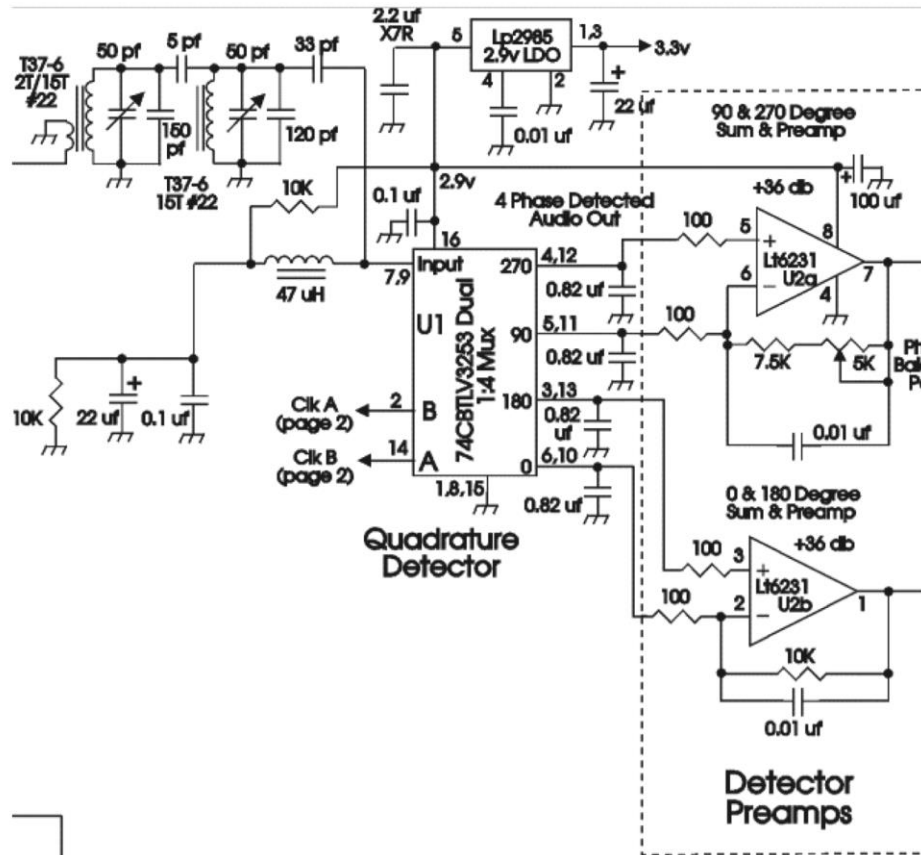


Figure 130. Tayloe quadrature detector and I/Q audio preamplifier schematic

TI-1047, Fig. 130

40. 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.

41. 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.

42. 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, ¶ 228 (alleging “the ‘+’ input is extremely high impedance (e.g., 2 meg ohm)” 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.

43. Paragraph 231 of Dr. Rickett’s Declaration 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

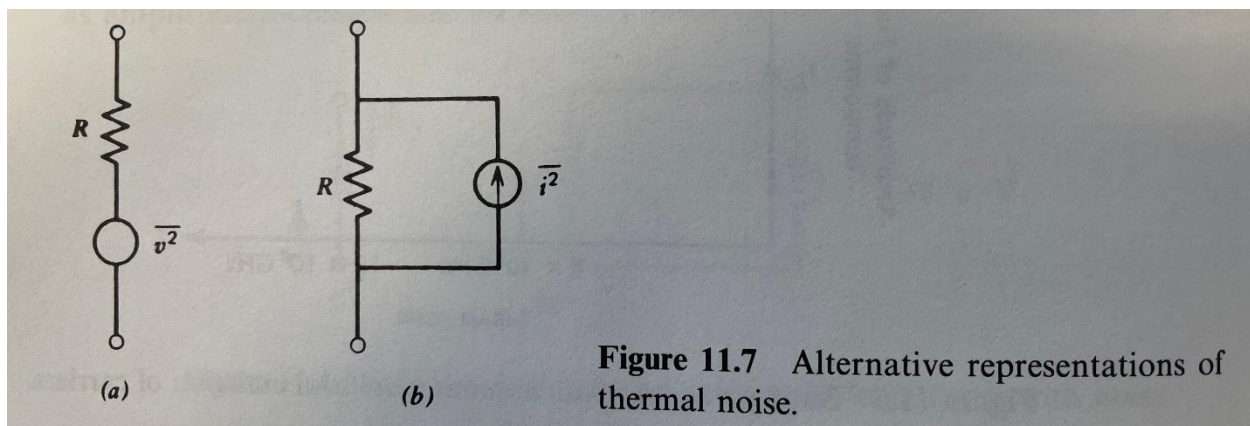
‘+’ terminal of the op-amp is very high, as Dr. Ricketts correctly pointed out), the voltage at the bottom input of summing amplifier 50 is held constant over the time interval. Therefore, for the reason pointed out by Dr. Ricketts above, the voltage at the node connected to the “−” terminal of the op-amp also stays constant during the time interval. The impedance of a node which is held at a constant voltage regardless of the current flowing into the node is zero by definition. Therefore, the 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.

44. 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.” Ex. 2024 ¶ 239. 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.

45. 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.

46. 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:



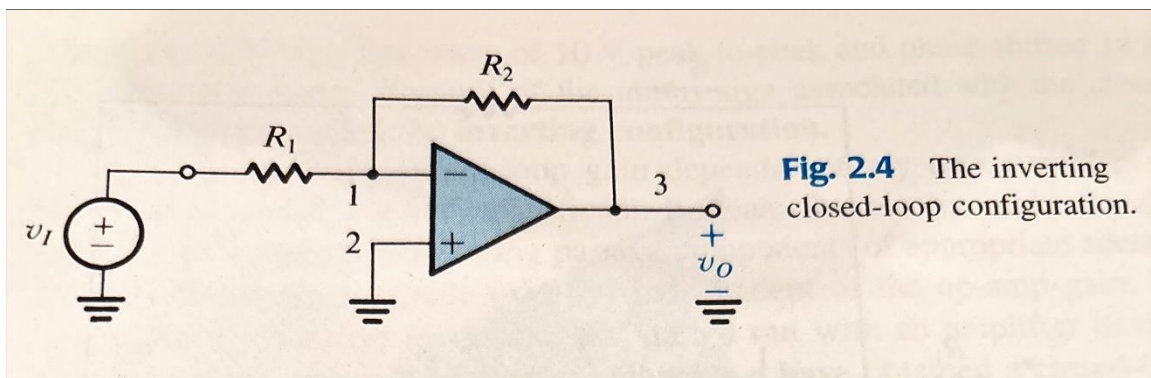
where the circle in Fig. 11.7(a) represents a noise voltage source with a mean square value of $4kTR\Delta f$, where k is a constant called the Boltzmann constant, T is temperature in Kelvin, and Δf is the frequency bandwidth of the signal of interest in Hz, i.e., the bandwidth of the received signal in the case of a radio receiver (TI-1055, Pages 12-13). 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.

47. 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-1004, 3:9). 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.

48. 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

100k Ω will magnify the effect of input capacitances ... since the circuit's bandwidth and stability can be adversely affected" (TI-1056). 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-1057).

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



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

50. 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.

51. 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° 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 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.”

52. Thus, while it is true that an op-amp in isolation exhibits high-impedance, neither the op-amp from TI-1046's Fig 2.4 nor the summing amplifier 50 of Fig. 3 in the Tayloe patent is in isolation. Rather, both op-amps are in an inverting, closed-loop configuration, with an input resistor, e.g., R1 in the figure above, and a feedback resistor, e.g., R2 in the figure above.

53. 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, ¶ 228, FN9.

54. A POSITA would have found it obvious to select resistance of the negative input resistor of summing amplifier 50 in Fig. 3 of the Tayloe patent that is far lower than the 2 mega-ohm value proposed by Dr. Ricketts.

55. For all of the above reasons, the advantages of low resistor values in summing amplifiers 50 and 52 in Fig. 3 of the Tayloe patent were well known to a POSITA. Likewise, for these same reasons, Tayloe's circuit satisfies the Florida court's construction, which includes samples, having non-negligible available energy being "accumulated and transferred to a load." Given that Tayloe's summing amplifiers exhibit low impedance (not high impedance, as the PO argues) and given that PO does not dispute that Tayloe samples at an aliasing rate with a non-negligible aperture, it follows that non-negligible available energy is

accumulated on the capacitor when the switch is closed, and is transferred to the low impedance load when the switch is open.¹ TI-1003, ¶¶ 119-127 (describing that, in Tayloe, the “aperture period is equal to a quarter period of f_1 , which is certainly non-negligible”).

2. Tayloe’s bandwidth is not the same as the input signal frequency

56. Dr. Ricketts states that Tayloe’s input signal frequency is 1 kHz centered at 7 MHz. This is a misrepresentation of Tayloe. What Tayloe actually says is that the “prototyped direct conversion receiver *has an input bandwidth* of roughly 1 kHz centered at 7 MHz.” Tayloe, 5:49-52 (also describing that resistor 32 is 50 Ω). In this case, 7 MHz is the RF signal’s center frequency, so 7 MHz is not considered a “low frequency” in the context of the application.

3. My analysis from my original expert declaration still stands.

¹ Charge from the capacitor is transferred to the low-impedance load when the switch is open in the form of current (which is charge per unit time). This causes the negative input resistor and, consequently the feedback resistor, to dissipate power with an instantaneous value equal to the product of the current and the square of the resistance. Power is energy per unit time, so energy is transferred from the capacitor to the load over the period of time that the switch is closed.

57. As I explained in my original declaration, Tayloe transfers energy to a load resistor. TI-1003, ¶¶ 116-127. Also, Tayloe uses a non-negligible aperture and an aliasing rate. TI-1003, ¶¶ 119-127.

C. Voltage sampling and energy transfer systems are not competing technology solutions

58. As I explained above, local oscillators that drive RF down-conversion mixers in wireless receivers are designed to be as close to square waves as possible specifically so that the mixers will implement ± 1 multiplication to the maximum extent possible. TI-1053, TI-1054. Hence, the “contrast” between the two cases Dr. Ricketts describes does not exist in reality. Ex. 2024 ¶ 122.

59. Dr. Ricketts characterizes Tayloe as disclosing voltage sampling and not an energy transfer system, which he states are “competing technological solutions” for down-conversion. Ex. 2024 ¶ 210, 212. 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 $\frac{1}{2} \cdot C \cdot V^2$. Ex. 2024 ¶ 75. 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.

60. 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 ‘177 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, 69:49-52), so it advocates using non-negligible aperture windows to transfer more energy. Specifically, the ‘177 patent advocates aperture windows that “tend away from zero time in duration” (TI-1001, 73:43-44) to allow the capacitor to “accept a non-negligible amount of power during a non-negligible aperture period” (TI-1001, 73:57-58). 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 ‘177 patent (recall that power is energy per unit time) despite Dr. Ricketts’ claim to the contrary, which is based on incorrect logic.

D. Impedance Matching

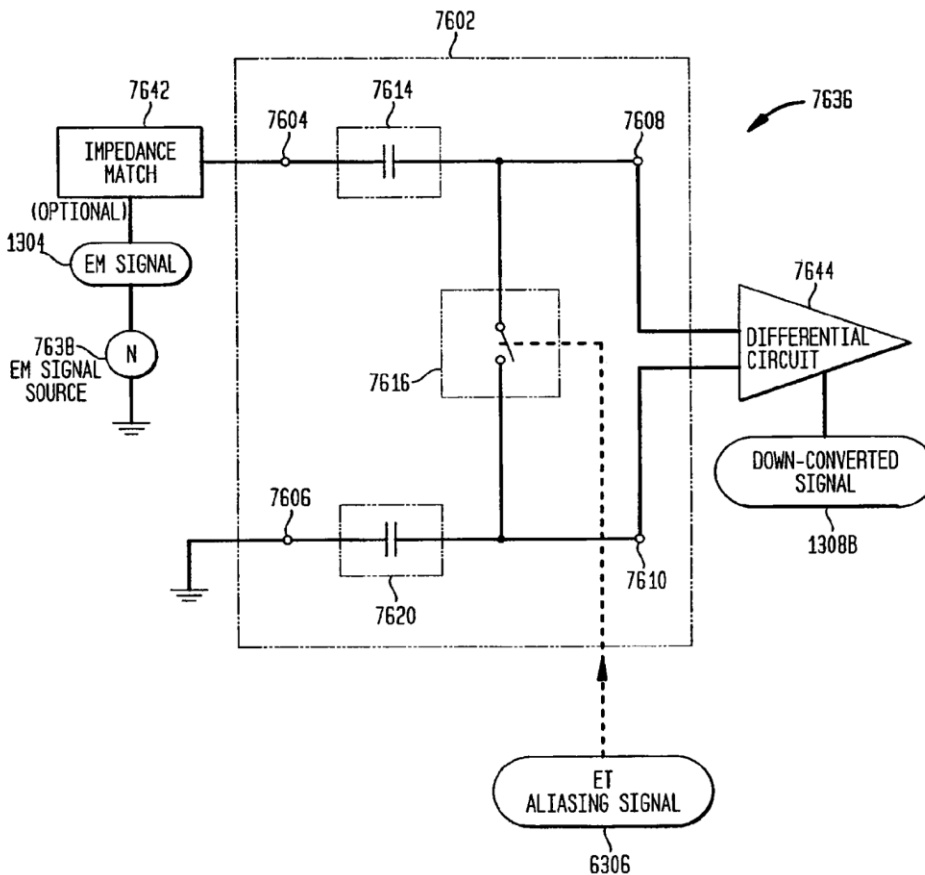
61. Dr. Ricketts incorrectly conflated the concept of impedance matching with match filtering/correlating in his declaration (Ex. 2024 ¶ 187). It is true that if

we consider two circuits that behave as linear systems, call them Circuit 1 and Circuit 2, where Circuit 1 provides an input signal to Circuit 2, then maximum signal power is transferred from Circuit 1 to Circuit 2 if the output impedance of Circuit 1 matches the input impedance of Circuit 2, i.e., if the two impedances are matched. Circuit designers refer to the process of choosing the input and output impedances to match as “impedance matching” and they typically accomplish impedance matching via impedance matching circuitry (sometimes called an “impedance match” block as shown in Fig. 76E of the ‘177 patent). However, impedance matching is completely unrelated to the concept of a matched filter. As I explained in my expert declaration for the ‘177 patent, the term “matched filter” in the textbook version of a matched filter refers to multiplying the input signal by a synchronized copy of the expected symbol shape and integrating the result each symbol period, which has nothing to do with impedance matching. The term “matched filter” in the ‘177 patent refers to the idea of integrating portions of the received RF input signal over aperture windows that are synchronized with the carrier of the received signal, which again, has nothing to do with impedance matching. Dr. Ricketts’ conflation of these two unrelated concepts does not make sense. Ex. 2024 ¶ 187.

62. While the ‘177 patent specification does discuss the concept of impedance matching, it presents impedance matching as an optional design choice.

For example, it claims “One direct benefit is that the impedance of the system is reduced so that practical impedance matching circuits *can* be implemented to *further* improve energy transfer and thus overall efficiency” (TI-1001, 73:12-15) (emphasis added). As another example, referring to Figure 76E (shown below) it claims that “input 7604 is coupled to an EM signal source 7638 through an *optional* impedance match 7642” (TI-1001, 121:18-20) (emphasis added).

FIG. 76E
EXAMPLE INPUT/OUTPUT CIRCUITRY



63. Note that the impedance match block 7642, which contains circuitry that performs impedance matching, is clearly labeled as optional.

64. For the above reasons, Dr. Ricketts’ assertion that impedance matching is a required feature of a “matched filtering/correlating module” is incorrect. His assertion simply conflates two unrelated concepts, presumably because they happen to have similar names, which makes it seem reasonable at face value, and the assertion, albeit incorrect, helps him reach his desired conclusions in support of ParkerVision’s claim construction of “matched filtering/correlating module.”

E. Razavi Teaches That Real Power is Transferred from the RF Input Signal to the Load Resistors

1. Dr. Rickett’s incorrectly analyzes Razavi and ignores the laws of Physics.

65. Dr. Ricketts states that “A POSITA understands that in the configuration set forth in Razavi, current can only flow through M5 to M6 [labeled NMOS transistors in Razavi Fig. 2] in one direction —downward from the drain to the source” and “[t]his unidirectional current flow is opposite to the direction needed for the RF input signal to pass through the transistors.” Ex. 2024 ¶ 309. This is an absurd argument and is based on a fallacy. Dr. Ricketts acknowledges that current is the flow of electrons, which is correct, but the narrative in his declaration 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)”. Ex. 2024, ¶ 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).

66. 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 (as is now clear from his deposition testimony), 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 from 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.

67. 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 .

68. Dr. Ricketts’ statement that “[a] POSITA understands that current flows from a higher potential to a lower potential” is incorrect. Ex. 2024 ¶ 214. 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.

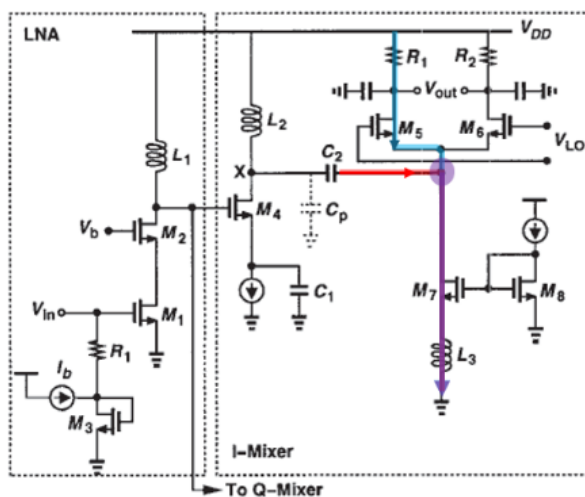


Fig. 2. LNA/mixer implementation.

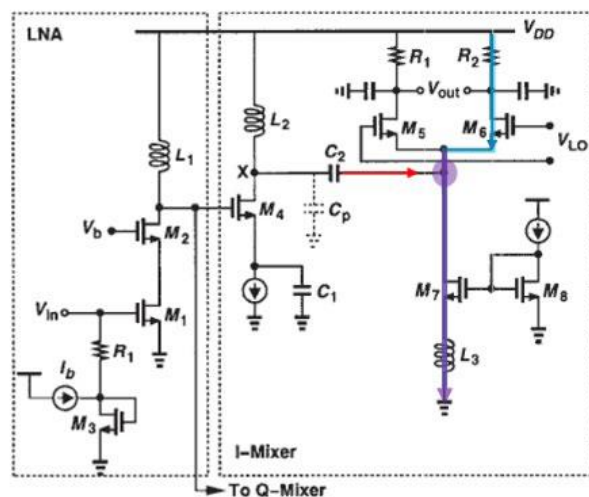


Fig. 2. LNA/mixer implementation.

Ex. 2024, ¶¶ 317-319 (annotating Razavi (TI-1017, Fig. 2)).

69. For the reasons I described above, the current to which Dr. Ricketts refers in Paragraph 319 is the conventional current, which, by definition, flows in the opposite direction of the actual current. Ex. 2024 ¶ 319. 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.

70. 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.

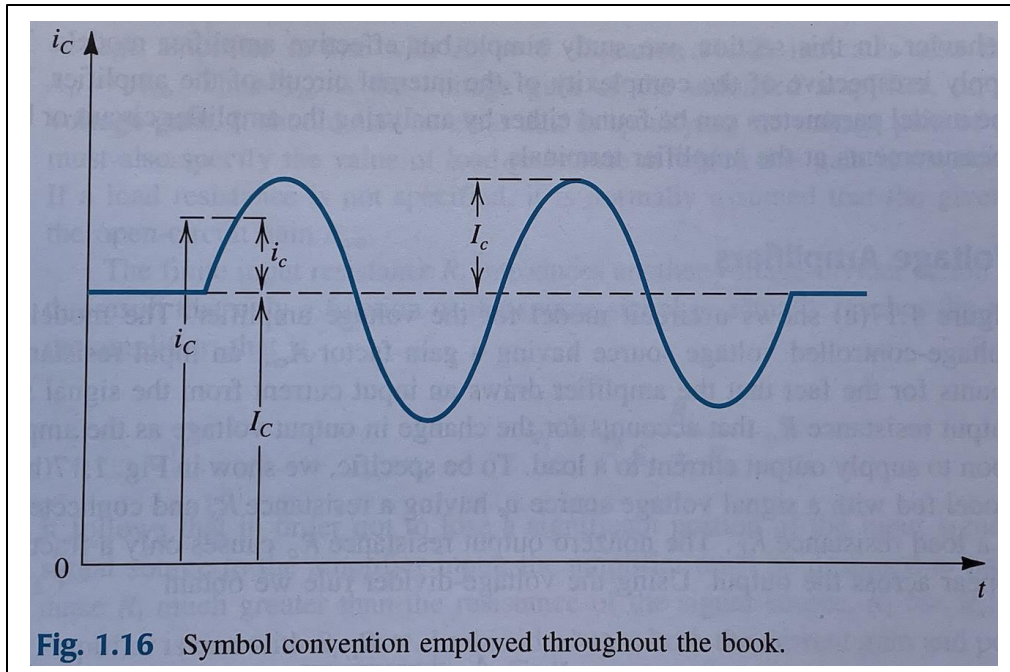
71. It follows that because the actual current flows upward toward the V_{DD} power supply node in the above two figures, Dr. Ricketts' assertion in Par. 320 analysis is both misleading and results in incorrect conclusions. Ex. 2024 ¶ 320. Furthermore, Dr. Ricketts' claim that "opening and closing of 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 '177 patent does not stipulate or otherwise imply that the invention causes the RF input signal to be affected in any way.

72. 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. Ex. 2024 ¶ 321. 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.

73. The following examples are three examples of many from textbooks and a paper that were available prior to the priority date of the '177 patent that show that a POSITA at the time of the priority date of the '177 patent would be familiar with the signal component concept in the field of circuit design.

74. 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.” TI-1046, ¶¶xx. Figure 1.16 in TI-1046 is:

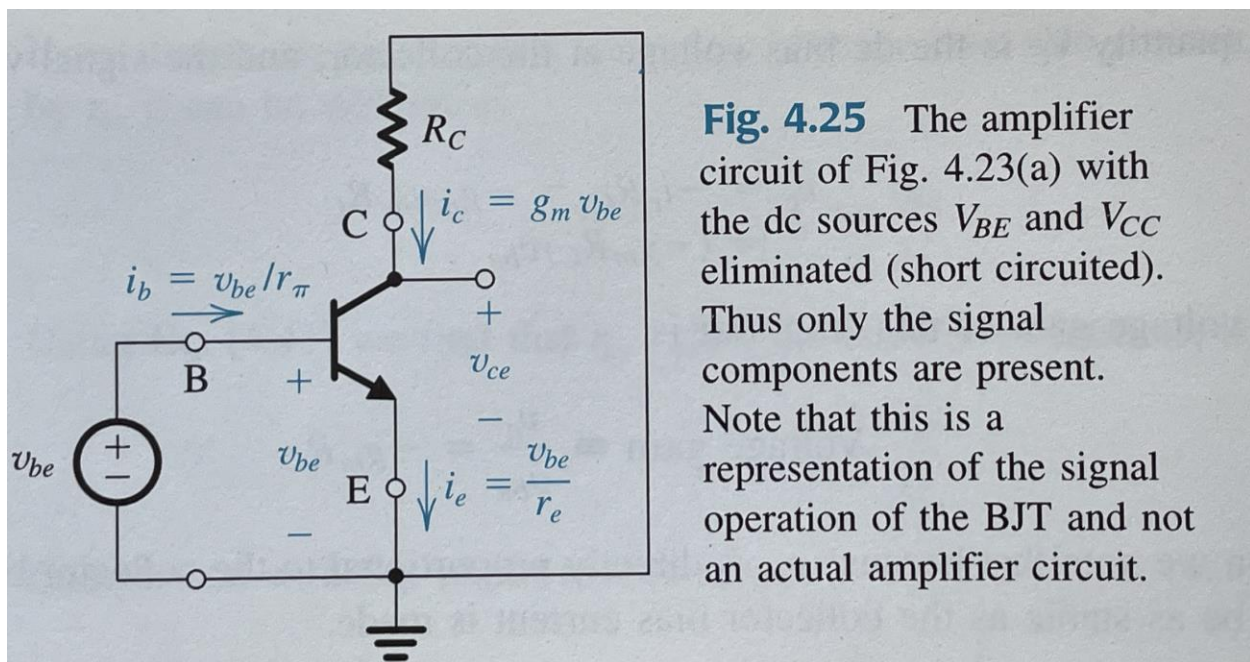


TI-1046, FIG. 1.16

75. 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.

76. 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

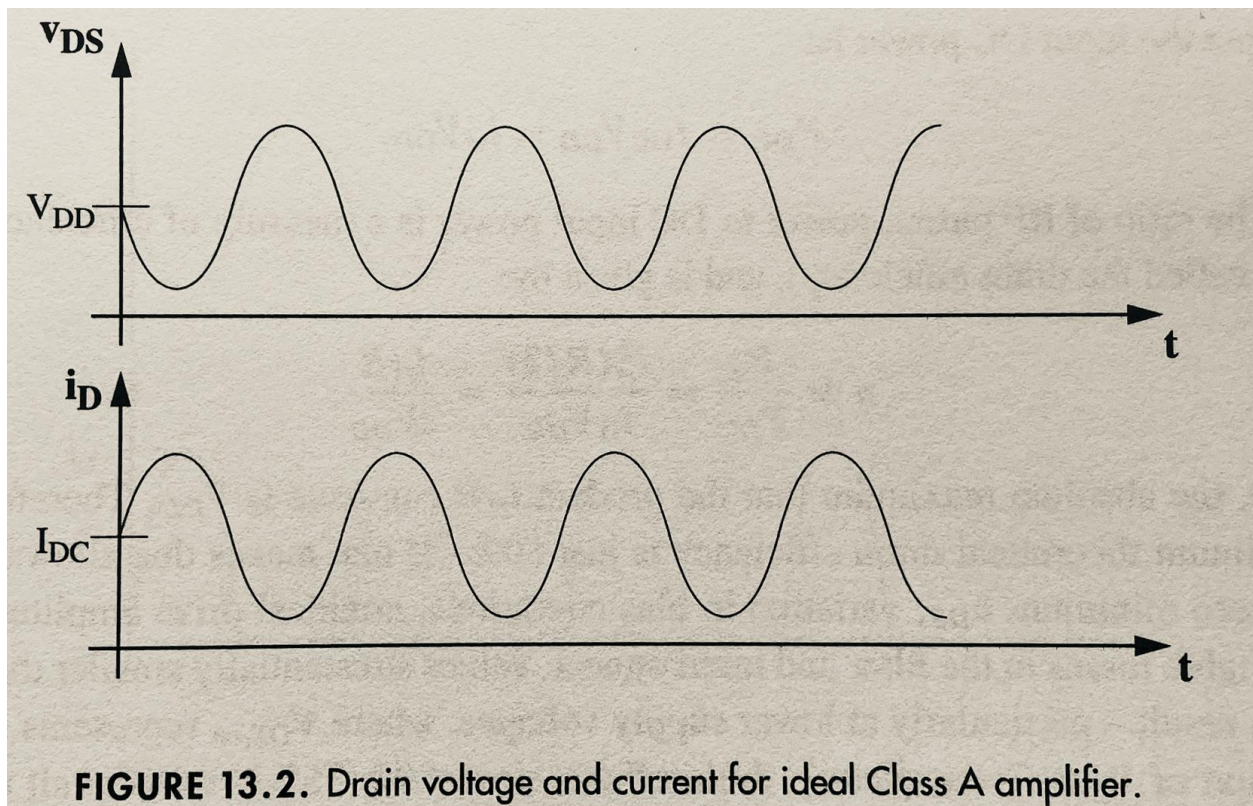
the signal component of its total input signal, but does not amplify the DC bias component of its total input signal. For this reason, when analyzing how such a circuit processes information, it is customary for circuit designers to ignore the bias components and consider just the signal components. The following figure from TI-1046 demonstrates this in the context of a simple one-transistor common-emitter amplifier example:



77. 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.

78. 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:



79. 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).

80. 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:

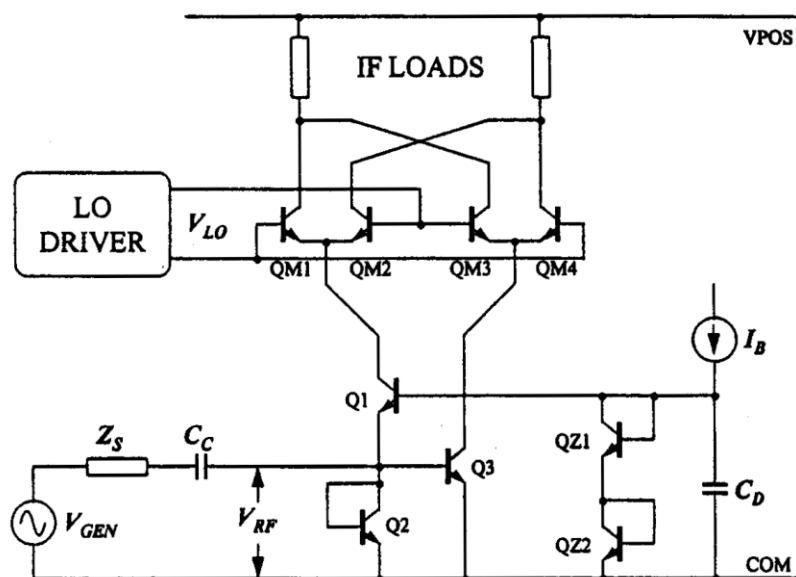


Figure 3 The Minimal MICROMIXER

TI-1052, FIG. 3.

81. 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.

82. 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.

83. In Paragraph 324 of his declaration, Dr. Ricketts claims that the following circuit does not perform “sampling an input signal at an aliasing rate.”

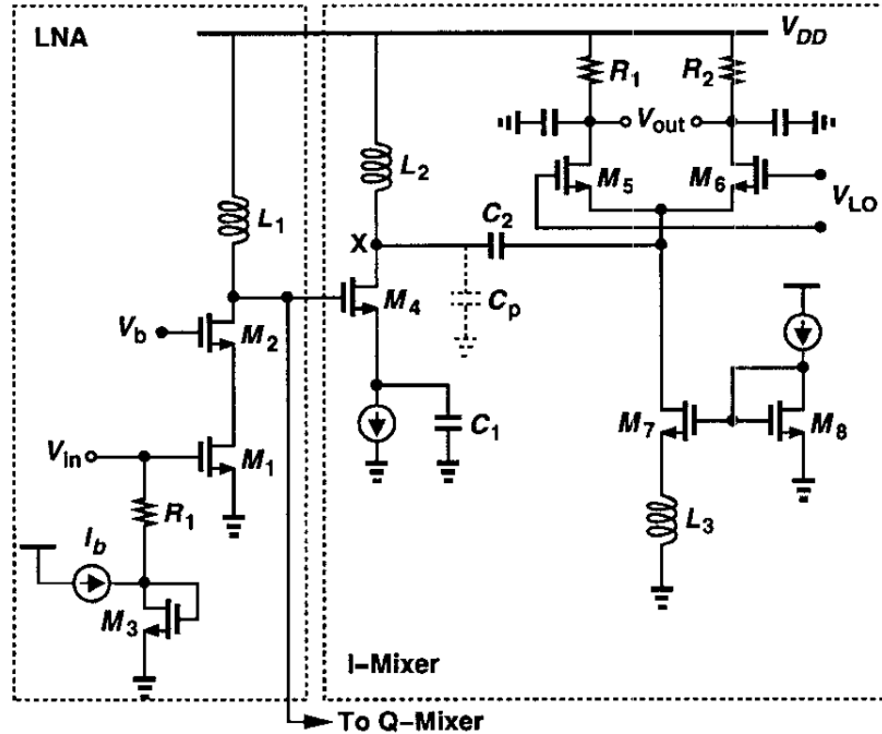


Fig. 2. LNA/mixer implementation.

Ex. 2024 ¶ 324.

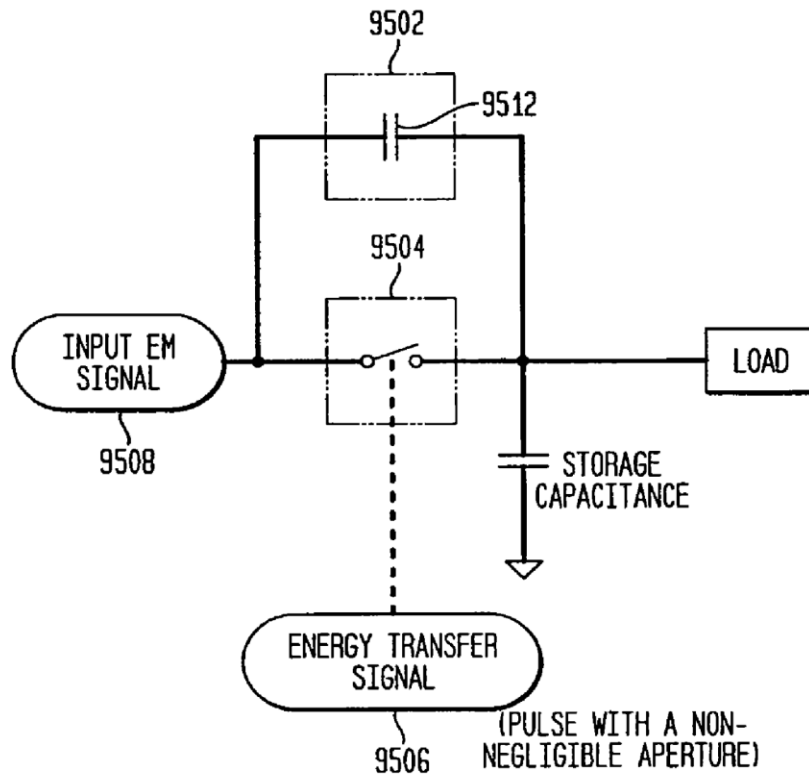
84. Given that M_5 and M_6 each turn off for just over half of each local oscillator period (Explained above in Par. 61, in reply to Dr. Ricketts statements in Par. 319 of his '177 Declaration), Dr. Ricketts' assertion that “the RF input signal is never broken into discrete-time samples” is not correct. See Ex. 2024 ¶ 322.

85. 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 ‘177 patent (TI-1001, 29:59-62), “[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.

86. Dr Rickett’s additional assertion that “a circuit with a continuous input and a continuous output does not perform sampling” is also incorrect. Ex. 2024 ¶ 323. Indeed, most of the circuits which the ‘177 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 ‘177 patent is wrong in its assertion that those circuits are embodiments of the alleged invention. As one of many examples, Fig. 95 in the ‘177 patent is:

FIG. 95



87. The '177 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.” (TI-1001, 127:60-66).

88. 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.

89. 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 M_5 and M_6 to the output of the mixer" violates the laws of physics. Ex. 2024 ¶ 327. 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, it is indeed the case that "energy of the input signal is integrated and transferred to a load to form a down-converted signal." Ex. 2024 ¶ 330.

90. In Paragraph 331, 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. 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.

91. Once again Dr. Ricketts has ignored the reality of physics and applied invalid reasoning to reach his conclusions in Par. 333-336. 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.

92. The following four paragraphs 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.” Ex. 2024 ¶ 335.

93. 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 includes one or more mixer circuits that perform down-converting of an RF input signal.

94. 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 M_5 and M_6 is closed, respectively.

95. 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 M_5 and M_6 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 patent. Specifically, the ’177 patent states: “the non-negligible pulse widths can be $\frac{1}{2}$ 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.” TI-1001, 73:43-47. The aperture width in the Razavi mixer circuit is nearly $\frac{1}{2}$ of a period of the “input EM signal,” i.e., the RF input signal. (Dr. Ricketts states that Razavi samples at a 50% duty cycle, which is a non-negligible aperture. EX2024 ¶226.) The ’177 patent further states that such a non-negligible sampling aperture “provides more time to transfer energy from an EM input signal” (TI-1001, 73:11-12) and allows the capacitor to “accept a non-negligible amount of power [power is energy per unit time] during a non-negligible aperture period.” TI-1001, 73:57-58. 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.

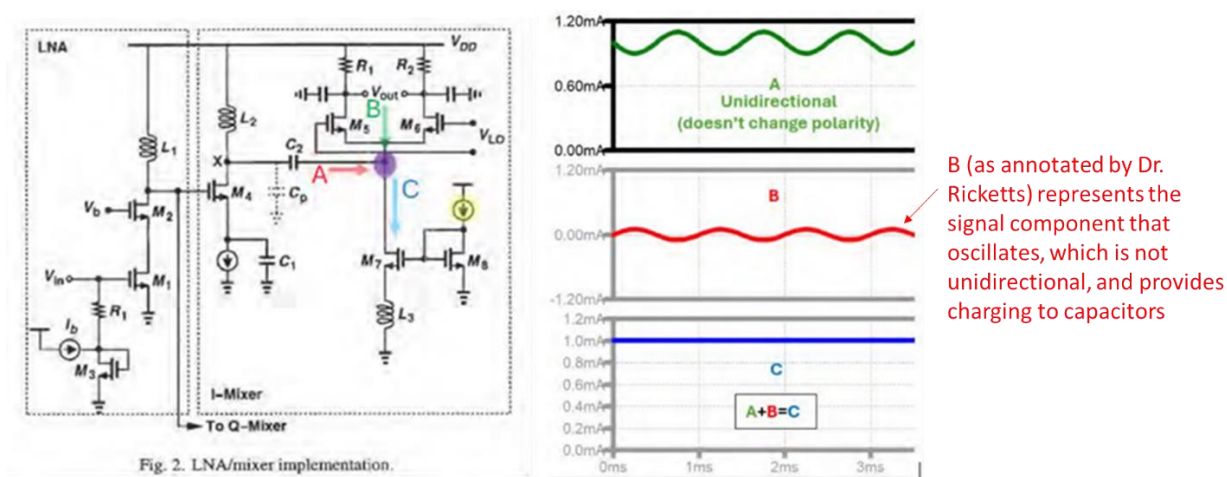
96. Finally, as would be clear to a POSITA, whenever either transistor switch M_5 or M_6 is open, the corresponding capacitor and resistor to which the switch is connected are in series with the power supply, and as power supplies have very low impedances, the energy transferred to the capacitor when the switch is closed begins to discharge through the resistor load when the switch is opened.

97. Therefore, while I do not agree with ParkerVision’s claim construction of “matched filtering/correlating module,” the Razavi mixer circuit

nevertheless implements a “matched filtering/correlating module” in accordance with ParkerVision’s claim construction.

2. Dr. Ricketts’s annotation supports my position

98. 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 M_7 ,” to oscillate so that the oscillation is reflected on Vout terminals, and hence energy is transferred from the RF input signal. *E.g.*, EX2024, ¶¶ 94-96.²



EX2024, ¶¶ 94-96 (annotating EX1017, FIG. 2 with additional illustration)

² Dr. Ricketts inexplicably mixed current A and current B in its annotation on the right-hand side waveform plots, i.e., the red waveform should have been labeled “A” and the green waveform should have been labeled “B”.

Current B (as annotated by Dr. Ricketts) represents the signal component that oscillates, and hence is 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.

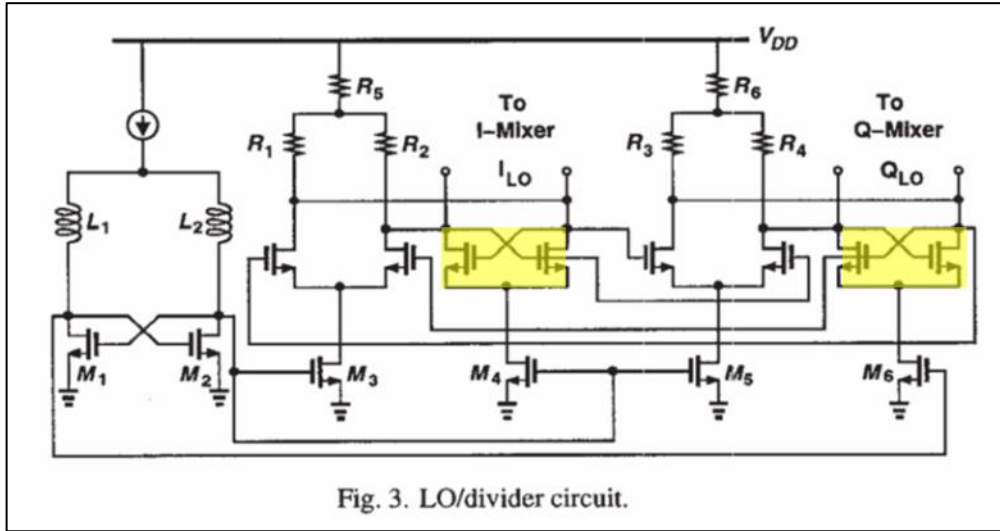
3. Razavi teaches storing transferred energy

99. In his declaration, Dr. Ricketts asserted that “no current from the RF input signal passes through M5 or M6 from the source to the drain.” EX2024, ¶ 312. This is yet another rehash of Dr. Ricketts' incorrect view that actual current, i.e., the flow of electrons, flows toward ground, not toward V_{DD} in the Razavi circuit. I have addressed his misunderstandings, as I have explained above. Hence, Razavi teaches transferring energy from the RF input signal to the capacitors.

4. Razavi teaches a squared-up local oscillator

100. Dr. Ricketts asserts:

Looking at the circuit depicted in Figure 3 [of Razavi], a POSITA would recognize that the LO/divider circuit includes inductors L1 and L2, which produce a sinusoidal output.



TI-1017, Fig. 3 (annotated)

EX2024, ¶266. I disagree with Dr. Ricketts's assertion because it is technically inaccurate. In Razavi, the LOs (i.e., the I_{LO} for the I-mixer and Q_{LO} for the Q-mixer) exhibit waveforms that are squared up. In more detail, the differential output voltages labeled I_{LO} connect to the gates of transistors M_5 and M_6 in the I-mixer (shown in Fig. 2 of Razavi) while Q_{LO} connect to the corresponding gates of transistors in the Q mixer. Referring to the transistors in Fig. 3 above with drain voltages equal to the I_{LO} voltages, these transistors are cross-coupled (i.e., the gate of the left transistor is connected to the drain of the right transistor, and vice versa). This cross-coupling introduces positive feedback, which has been used in a variety of circuits (such as digital flip-flops, digital registers, and comparator latches) to have that their outputs switch abruptly like the transitions of square waves. This cross-coupling in Razavi's Fig. 3 have such an effect on the I_{LO} voltages.

101. In other words, Razavi's cross-coupling square up a sinusoidal waveform or other input signal and output a waveform that resembles a square wave, rather than a sinusoidal wave. This is why Razavi refers to transistors M_5 and M_6 as a "switching pair"; they are controlled by the I_{LO} voltages, which abruptly transition (like square waves) to cause the transistors to act as switches.

102. Moreover, M_5 and M_6 would introduce more noise into the output signal if the LO were sinusoidal relative to the case where the LO signal approximates a square wave. For these reasons, a POSITA would recognize Razavi's I_{LO} (for the I-mixer) and Q_{LO} (for the Q-mixer) are not sinusoidal in shape.

5. My analysis from my original expert declaration still stands

F. As I discussed in my original declaration, Razavi discharges through a load. *E.g.*, TI-1003, ¶¶170-173. In addition, Razavi has a squared up LO that controls the switching pair M_5 and M_6 . *E.g.*, TI-1003 ¶ 95, 176-180. Heterodyning (Non-Sampling)

103. Dr. Ricketts' comment that there "are significant disadvantages to using mixers with continuously time-varying resistance (e.g., Gilbert cell analog multiplier)," is true but misleading. Ex. 2024 ¶ 116. Mr. Barrie Gilbert invented the Gilbert cell analog multiplier, which would indeed have the disadvantage Dr. Ricketts mentioned if it were used as a mixer for RF down-conversion. However, Mr. Gilbert also invented the widely-used Gilbert mixer, and it is the Gilbert

mixer, not the Gilbert analog multiplier, that is used for RF down-conversion in wireless receivers. The Gilbert mixer does not have the disadvantage that Dr. Ricketts mentioned because it performs multiplication by 1 or -1 at any given time depending on whether the local oscillator voltage is positive or negative at that time. Ex. TI-1053. For example, TI-1053 refers to the mixer as “operating in an essentially binary (sign-switching) fashion.” As explained in detail in TI-1054, local oscillators that drive RF down-converter mixers in wireless receivers are designed to be as close to square waves as possible specifically so that the mixers will implement such binary multiplication. This not only avoids the “continuously time-varying resistance” issue mentioned by Dr. Ricketts, but it also reduces the noise introduced by the mixer.

104. Perhaps the reason that Dr. Ricketts included the somewhat cryptic comment “I note that I am not stating that any mixer that multiplies is a non-linear mixer” as a footnote is that he is aware that a POSITA would know that down-conversion mixers in wireless receivers ideally perform ± 1 multiplication as opposed to sinusoid multiplication. If so, it is disappointing as it would suggest that he is purposely confusing Gilbert mixers with Gilbert analog multipliers to give the appearance of supporting his narrative.

IV. CONCLUSION

105. 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.

106. 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 by fine or imprisonment under Section 1001 of Title 18 of the United States Code.

Dated: June 20, 2025 By: /Ian Galton/
Dr. Ian Galton