

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: David F. Sorrells, et al Attorney Docket No.: 12189-0091IP1
U.S. Patent No.: 7,865,177
Issue Date: January 4, 2011
Appl. Serial No.: 12/349,802
Filing Date: January 7, 2009
Title: METHOD AND SYSTEM FOR DOWN-CONVERTING AN
ELECTROMAGNETIC SIGNAL, AND TRANSFORMS FOR
SAME, AND APERTURE RELATIONSHIPS

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PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES

PATENT NO. 7,865,177 PURSUANT TO 35 U.S.C. §§ 311–319,

37 C.F.R. § 42

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EXHIBITS

Exhibit No.	Description
TI-1001	U.S. Patent No. 7,865,177 (“the ’177 patent”)
TI-1002	Excerpts from the Prosecution History of the ’177 Patent (“the Prosecution History”)
TI-1003	Declaration and Curriculum Vitae of Dr. Ian Galton
TI-1004	U.S. Patent No. 6,230,000 (“Tayloe”)
TI-1005	SN74CBT3253 Dual 1-of-4 FET Multiplexer/Demultiplexer Datasheet
TI-1006-1007	Reserved
TI-1008	Complaint, <i>ParkerVision, Inc. v. Texas Instruments Incorporated</i> , 6:23-cv-00384, W.D. Tex., filed May 18, 2023
TI-1009	ParkerVision, Inc.’s Proposed Claim Constructions, <i>ParkerVision, Inc. v. Texas Instruments Incorporated</i> , 6:23-cv-00384, W.D. Tex., filed February 14, 2024
TI-1010	ParkerVision Inc.’s Responsive Claim Construction Brief, <i>ParkerVision, Inc. v. Texas Instruments Incorporated</i> , 6:23-cv-00384, W.D. Tex., filed March 27, 2024
TI-1011	Claim Chart For Infringement of U.S. Patent No. 7,865,177 by TI Chips, <i>ParkerVision, Inc. v. Texas Instruments Incorporated</i> , 6:23-cv-00384, W.D. Tex., submitted December 6, 2023
TI-1012-1013	Reserved
TI-1014	Declaration of June Ann Munford
TI-1015	Declaration of Rickea McLeod
TI-1016	Reserved

TI-1017	Razavi, <i>A 900-MHz CMOS Direct Conversion Receiver</i> , IEEE Symposium on VLSI Circuits, Kyoto, Japan, 1997, pp. 113-114, doi: 10.1109/VLSIC.1997.623833.
TI-1018	Declaration of Maureen Honeycutt
TI-1019	Ziemer Tranter, <i>Principles of Communications, Systems, Modulation, and Noise</i> , Fourth Edition, Published 1995
TI-1020	Thomas H. Lee, <i>The Design of CMOS Radio-Frequency Integrated Circuits</i> , Cambridge University Press, 1998 (Excerpts)
TI-1021-1025	Reserved
TI-1026	Uzunoglu, “The Synchronous Oscillator: A Synchronization and Tracking Network” , IEEE Journal of Solid-State Circuits, Vol. SC-20, No. 6, September 1985 pp. 1214-1226
TI-1027-1032	Reserved
TI-1033	Qualcomm’s Motion for Summary Judgment of Noninfringement and Invalidity, <i>ParkerVision, Inc. v. Qualcomm Inc.</i> , 6:14-cv-00687, dkt 494 (MDFL Feb. 16, 2021).
TI-1034	Parkervision, Inc.’s response to Qualcomm’s Motion for Summary Judgement of Noninfringement and Invalidity, <i>ParkerVision, Inc. v. Qualcomm Inc.</i> , 6:14-cv-00687, dkt 523 (MDFL Mar. 2, 2021)
TI-1035	Defendant’s Reply in Support of Their Motion for Summary Judgment of Noninfringement and Invalidity, <i>ParkerVision, Inc. v. Qualcomm Inc.</i> , 6:14-cv-00687, dkt 559 (MDFL Mar. 16, 2021)
TI-1036	Endorsed Order Granting Qualcomm’s Motion for Summary Judgment of Noninfringement and Invalidity, <i>ParkerVision, Inc. v. Qualcomm Inc.</i> , 6:14-cv-00687, dkt 686 (MDFL Mar. 22, 2022).

TI-1037	Claim Construction Order, <i>ParkerVision Inc. v. Qualcomm Inc.</i> , 6:14-cv-00687, dkt 381, (MDFL April 29, 2020)
TI-1038-1040	Reserved
TI-1041	Stipulation

LISTING OF THE CLAIM

Claim No.	Claim Element
14.P	A method for down-converting an electromagnetic signal, comprising:
14.1	receiving an input signal at a first matched filtering/correlating module;
14.2	down converting said input signal at said first matched filtering/correlating module according to a first control signal and outputting a first down-converted signal;
14.3	receiving said input signal at a second matched filtering/correlating module;
14.4	down-converting said input signal at said second matched filtering/correlating module according to a second control signal and outputting a second down-converted signal; and
14.5	combining said second down-converted signal and said first down-converted signal to output a first channel down-converted signal.

Texas Instruments Incorporated (“Petitioner” or “TI”) petitions for *Inter Partes* Review (“IPR”) of claim 14 of U.S. Patent No. 7,865,177 (“the ’177 Patent”). Compelling evidence presented in this Petition demonstrates at least a reasonable likelihood that TI will prevail with respect to claim 14.

I. REQUIREMENTS FOR IPR

A. Grounds for Standing

Petitioner certifies that the ’177 Patent is available for IPR and that TI is not barred or estopped from requesting review of claim 14 on the below-identified grounds.

B. Challenge and Relief Requested

Claim 14 is unpatentable on the grounds identified in the table below and as further explained in this Petition. Accompanying explanation and support are provided in the Declaration of Ian Galton. TI-1003, *passim*.

Ground	Claim	35 U.S.C. § 103
1	14	Tayloe and TI Demux Datasheet
2A	14	Razavi
2B	14	Razavi and Uzunoglu

Petitioner disputes that claim 14 is entitled to the benefit of the entire priority claimed by the ’177 Patent, which includes continuations-in-part. Nonetheless, each reference pre-dates October 21, 1998 (“Critical Date”), the earliest possible

priority date claimed by the '177 Patent, and thus qualifies as prior art at least as shown in the table below.

Reference	Filing Date	Pub. Date	Prior Art Under
Tayloe	Oct. 15, 1998	May 8, 2001	Pre-AIA 102(e)
TI Datasheet		July 28, 1998 (publicly available)	Pre-AIA 102(a)
Razavi		October 13, 1997	Pre-AIA 102(b)
Uzunoglu		December 6, 1985	Pre-AIA 102(b)

As described in the Declaration of TI Senior Paralegal, Maureen Honeycutt (TI-1018), TI datasheet was publicly accessible to those interested in the operation of TI products on TI's searchable website, beginning July 28, 1998. TI-1018, ¶¶12-17; TI-1003, 12. As described in the Declaration of June Munford (TI-1014), Razavi was published in *1997 Symposium on VLSI Circuits*, which were acquired, indexed, and made publicly accessible by SUNY Polytechnic Institute on or around October 13, 1997. TI-1014, ¶¶28-30. Uzunoglu was published in the December 1985 edition of *IEEE Journal of Solid-State Circuits* which was held, indexed, and publicly accessible at multiple libraries including the Carnegie Library of Pittsburgh since its publication. TI-1014, ¶¶34-37. Furthermore, both were published by a "well-known, reputable compiler and publisher." *Ericsson Inc. v. Intell. Ventures I LLC*, IPR2014-00527, Paper 41 at 10-11 (PTAB May 18, 2015); *see also*

VidStream LLC v. Twitter, Inc., 981 F.3d 1060, 1065-66 (Fed. Cir. 2020).

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSITA”) as of the ’177 Patent’s priority date (October 21, 1998) would have had at least a bachelor’s degree in electrical engineering or a related subject and two or more years of experience in the field of electromagnetic (EM) circuit design. Less work experience may be compensated by a higher level of education, such as a master’s degree. TI-1003, 33-35.

II. THE ’177 PATENT

A. Brief Description

The ’177 Patent is directed to “down-converting an electromagnetic (EM) signal.” TI-1001, Abstract. Claim 14 of the ’177 patent claims a method for down-converting the EM signal using first and second matched filtering / correlating modules. *See, e.g.*, TI-1001, claim 14. The first and second matched filtering/correlating module each down-converts the input signal to produce first and second down-converted signals. The two down-converted signals are combined.

1. Matched Filtering/Correlating Module

The '177 patent does not use the term “matched filtering/correlating module” in its specification. TI-1003, 62-63. Instead, the '177 patent describes a matched filtering/correlating process that is performed repeatedly on a received carrier signal. *See, e.g.*, TI-1001, 130:23-31. The '177 patent recognizes practical design limitations associated with implementing “traditional” realizations of matched filtering/correlating modules, and therefore intends the meaning of “matched filtering/correlating module” to include various circuit implementations that perform the desired function, including both traditional matched filtering/correlating modules and the non-traditional realizations described in the specification. *See, e.g.*, TI-1001, 130:40-48, 132:15-17 (“the present invention is not a traditional realization of a matched filter/correlator”), FIGS. 148-154, 184, and accompanying text.

A POSITA reading the specification, in view of the departure from “traditional” realizations of a matched filtering/correlating module, would have understood the term to encompass core functional aspects of matched filtering or correlating. TI-1003, 62-63. The key common characteristic across all implementations is that “a matched filtering/correlating operation is performed on a portion of a carrier signal.” *Id.* Importantly, the correlation signal is synchronous with the received signal. *Id.* For the claimed down-converter embodiments described in '177

patent, the correlation signal, $S_i(t-\tau)$, is synchronous with the received signal's carrier. *Id.* For example, the '177 patent states that "the example matched filter/correlator of FIG. 171 operates in synchronism with the half sine pulse $S_i(t)$ over the aperture T_A ," and this "synchronism" is depicted in several of the figures in '177 patent including but not limited to Fig. 72, Fig. 157, Fig. 158, Fig. 162, Fig. 166, Fig. 182, Fig. 184, and Fig. 193. *See, e.g.*, TI-1001, 145:15-18; TI-1003, 62-63.

Other common characteristics between the matched filtering/correlating examples are that "the result of the matched filtering/correlating operation ... is accumulated, preferably in an energy storage device[,]" and that these steps "are repeated for additional half cycles [or portions there of] of the carrier signal." *See, e.g.*, '177 patent, 131:17-44; 132:54-133:14; 133:62-134:22, FIGS. 148-154, 184 and accompanying text; TI-1003, 62-63.

B. Prosecution History

Patent Application U.S. 12/349,802 (the 802 Application), resulting in the '177 patent, was filed on January 7, 2009. TI-1001, Face. The 802 Application was a division of Application No. 09/550,644 (the 644 Application), now U.S. Pat. No. 7,515,896, filed on April 14, 2000.

The originally filed claims of the 802 Application were rejected under for failing to claim statutory subject matter; and they were provisionally rejected under

double patenting. TI-1002, 329. The claims were also indicated as allowable if re-written to overcome the rejections. *Id.*, 332. In response, the applicant cancelled all of the pending claims, and submitted new claims. *Id.*, 316. These new claims were allowed and resulted in the '177 patent claims as they stand now. *Id.*, 40.

C. Claim Construction

Petitioner interprets the claims pursuant to their plain-and-ordinary meaning, except as explained below. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. Based on the well-established principal that “claim terms need only be construed to the extent necessary to resolve the controversy,” no express constructions are required to institute review and find the Challenged Claims unpatentable. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Petitioner reserves the right to address any construction proposed by Patent Owner or the Board.

1. matched filtering/correlating module

This petition analyzes claim 14 under two constructions of the term “matched filtering/correlating module”: Patent Owner’s construction advanced during the currently pending litigation adverse to Texas Instruments;¹ and the plain-and-ordinary meaning. Each of the constructions are summarized below.

¹ TI-1008, *passim*.

The plain-and-ordinary meaning of the term “matched filtering/correlating module,” as explained below, stays true to the claim language and naturally aligns with the description in the specification. Nevertheless, claim 14 is unpatentable under either the Patent Owner’s construction or the plain-and-ordinary meaning.

(a) Patent Owner’s Construction

Patent Owner’s proposed construction of “matching filtering/correlation 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 ratio.” TI-1010, 11.

Patent Owner advanced this construction in the litigation adverse to TI. ParkerVision argues that their invention in the ’177 patent is “a unique and specific application of matched filter theory, sampling theory, and frequency domain techniques.” TI-1010, 12. Accordingly, Patent Owner argued that a construction of matched filtering/correlating module is required to explain the departure from the

plain-and-ordinary meaning. *Id.* Patent Owner argues that their construction captures “a number of structural details, which together provide an accurate description of the matched filter/correlator embodiments (as shown in Figures 149, 151, and 153).” Patent Owner’s construction is inclusive of embodiments of matched filtering/correlating modules depicted in FIGS. 149, 151, and 153. Patent Owner’s construction was adopted by the Middle District of Florida. TI-1037, 24.

Qualcomm moved for summary judgment of non-infringement and invalidity on multiple patents. Qualcomm argued claim 14 was indefinite. The court granted Qualcomm’s MSJ by Endorsed Order, articulating no basis for its grant. In continuing to assert claim 14 against Petitioner, Patent Owner is taking the position that the ’177 patent was not invalidated by the District Court.

Nevertheless, even if the outer extents of the ’177 patent’s claims cannot be ascertained with reasonable certainty, the Grounds herein present prior art that falls well within the scope of the claims. Thus, the patentability of claim 14 can be analyzed in view of the Grounds presented below.

For example, in its motion, Qualcomm argued that the ’177 patent did not provide a way to measure whether or not a signal-to-noise power ratio was “enhanced.” TI-1033, 19. Here, Tayloe and Razavi both describe circuits that produce a down-converted signal with an improved signal-to-noise power ratio. Because it is true that the ’177 patent does not provide a way to measure “enhanced”

SNR, arguments that Tayloe and Razavi would require specific amounts of enhancement to render claim 14 unpatentable may render claim 14 indefinite.

Second, the court previously found that “a matched filtering/correlating module must be linear circuitry, and not just ‘substantially linear’ circuitry.” *Id.*, 20. Qualcomm argued that none of their accused circuitry was linear. *Id.* Patent Owner continued to assert the accused circuitry was linear enough. *Id.* Because of the lack of any objective standard for what is or is not linear in the ’177 patent, Qualcomm argued that Patent Owner’s interpretation and application of the court’s construction rendered the claim indefinite. *Id.* As discussed below and by Professor Galton, the matched filtering/correlating modules of Tayloe and Razavi can be modeled as linear time-variant circuits to a high degree of accuracy.

Third, the court’s construction for matched filtering/correlating module required that “a switch is closed for a ‘non-negligible aperture’” based on the ’177 patent defining the length of the windowing function as equal to “an approximate half cycle of the received carrier signal.” *Id.*, 11. Qualcomm argued that Patent Owner’s attempt to broaden the definition of non-negligible to apertures other than “an approximate half cycle of the received carrier signal” rendered the claim indefinite. *Id.* Here, the prior art encompasses non-negligible apertures inclusive of and

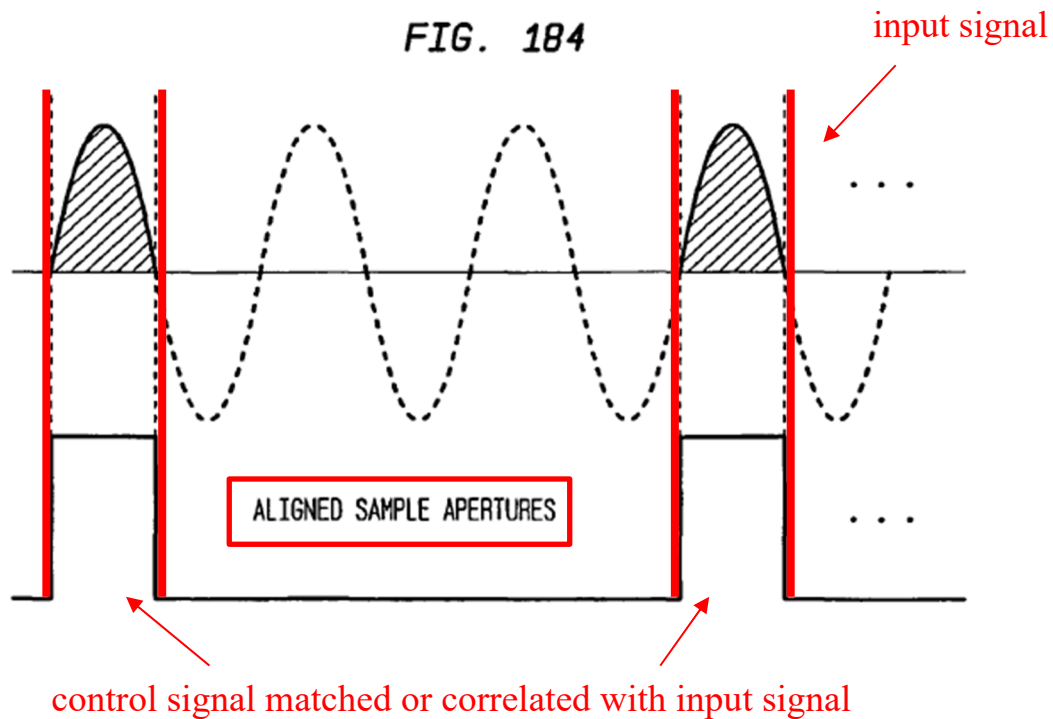
beyond the approximate half cycle. Tayloe describes apertures that are quarter cycle of the carrier signal; Razavi describes apertures that are half cycle of the carrier signal.

(b) Plain-and-Ordinary Meaning

Despite Patent Owner's assertion otherwise, the term "matched filtering/correlating module" does not require a construction beyond its plain-and-ordinary meaning in light of the specification. TI-1003, 18-32. The '177 patent describes a "specific application of matched filter theory, sampling theory and frequency domain techniques." TI-1001, 130:4-8. The '177 patent does not use the term "matched filtering/correlating module"; instead, it provides specific examples of its matched filtering/correlating process. *See, e.g.*, TI-1001, 131:14-16, 132:51-53, 133:59-61, FIGS. 148-153 and accompanying text. While each example embodiment is slightly different, common to all is the characteristic that "a matched filtering/correlating operation is performed on a portion of a carrier signal," "the result of the matched filtering/correlating operation . . . is accumulated, preferably in an energy storage device[,]" and that these steps "are repeated for additional half cycles of the carrier signal." TI-1001, 131:17-44, 132:54-133:14, 133:62-134:22; TI-1003, 18-32.

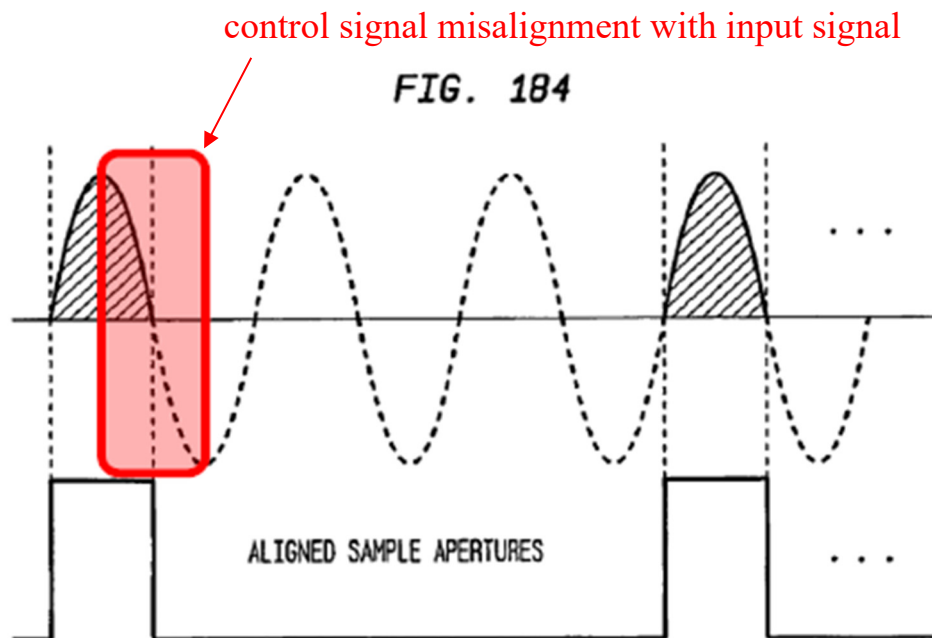
The '177 patent specification clarifies that the process of matched filtering/correlating involves the accumulation of "all of the available energy contained

in each approximate half cycle of the carrier signal operated upon.” *See, e.g.*, TI-1001, 131, 1-5. The “matched filtering/correlating processor is able to transfer substantially all of the energy contained in a half cycle of the carrier signal through the processor for use in determining, for example, a peak or an average voltage value of the carrier signal.” TI-1001, 131, 6-13. Doing so “produces enhanced (and in some cases the best possible) signal-to-noise ratio (SNR).” *Id.*; TI-1003, 18-32. Thus, matched filtering/correlating goes beyond mere sampling. TI-1003, 18-32. Instead, matched filtering/correlating requires matching or correlating the sample apertures with the input signal. *Id.* This concept is illustrated in FIG. 184, reproduced below:



TI-1001, FIG. 184 (annotated)

As can be seen from FIG. 184 above, the control signal is matched or correlated with the input signal. TI-1003, 18-32. This synchronicity between the control signal and the input signal allows the matched filtering/correlating operation to capture the energy of the signal rather than the energy of the noise, thereby resulting in enhanced SNR. *Id.* If the sampling aperture were not correlated with the input signal, the sampling windows would drift and the accumulated input signal would include both positive and negative portions of the waveform, canceling out the input signal and accumulating zero energy from the input, as illustrated in annotated FIG. 184 below:



TI-1001, FIG. 184 (annotated)

In the example shown above, when there is a misalignment between the control signal and the input signal, the accumulated energy includes both positive and negative values, resulting in no enhancement of SNR. TI-1003, 18-32.

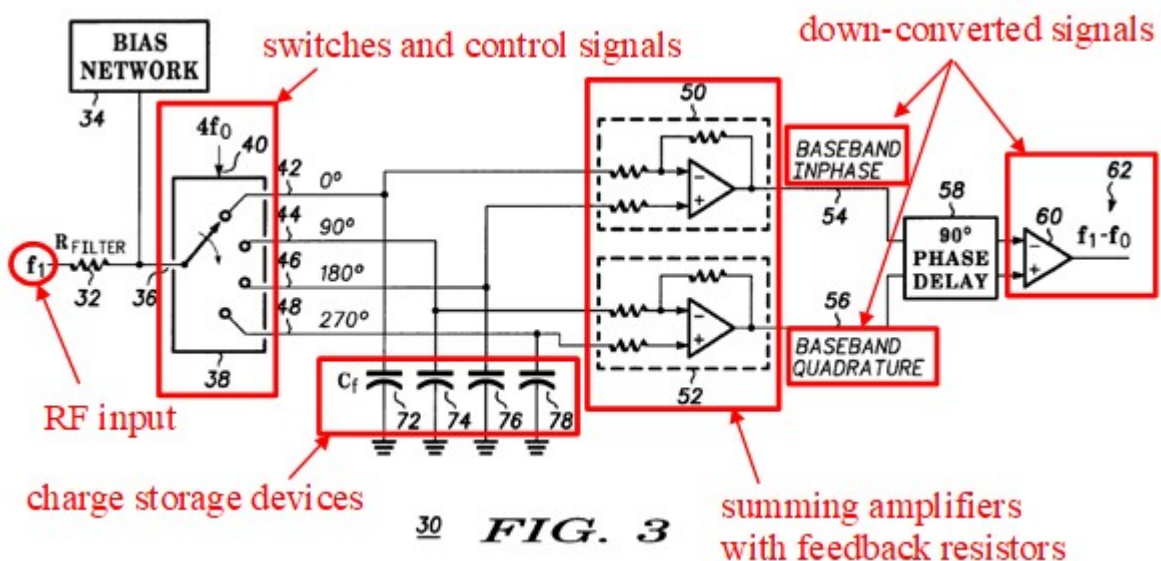
Because the matched filtering/correlating modules require synchronization between the input signal and the carrier signal, Patent Owner's proposed construction is inaccurate. TI-1003, 18-32. First, Patent Owner's construction does not mention correlating the input signal with the carrier frequency. *Id.* As discussed above, this correlation is a requirement for the '177 patent's circuit to operate. Second, the construction adds structural features that are not described in all three embodiments of the matched filtering/correlating module identified by Patent Owner (namely, figures 149, 151, and 153). *Id.* Specifically, Patent Owner's construction introduces a requirement that the samples be accumulated and transferred to a load when the switch is closed and discharged through the load when the switch is open. *Id.* However, FIGS. 148 and 151 illustrate and describe an integration module 14906 and 15104, respectively. TI-1001, 131:14-132:14, 133:22-40; TI-1003, 18-32. FIG. 153 illustrates and describes a capacitor. TI-1001, 134:31-56; TI-1003, 18-32. None illustrate or describe discharging through a load. TI-1003, 18-32. At best, the '177 patent models the circuit with a load, but such as load is not described as part of the matched filtering/correlating module. TI-1001, 147:36-148:24.

III. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. GROUND 1 – Tayloe and TI SN74CBT3253 Renders Claim 14 Obvious

1. Tayloe

Tayloe is directed to direct conversion receiver circuitry and its method of operation in down-converting a radio frequency (RF) or intermediate frequency (IF) input signal to a baseband signal. *See, e.g.*, TI-1004, Abstract, 1:10-13 (“Direct conversion receivers are desirable in part because they convert signals of interest directly to baseband (or near zero hertz) from a radio frequency (RF).”), 1:67-2:2; TI-1003, 68-90. The circuitry includes a switch controlled by a control signal linked to the carrier frequency for sampling the input signal and outputting samples of the input signal to a corresponding capacitor. *See, e.g.*, Tayloe, Abstract, 1:10-13, :67-2:2; *see also id.*, FIGS. 3-6; TI-1003, 68-70; TI-1003, 68-90. FIG. 3 of Tayloe (below) shows an example of the Tayloe circuitry:



Tayloe, FIG. 3 (annotated)

The circuitry of FIG. 3 includes a “resistor 32, bias network 34, commutating switch 38, capacitors 72, 74, 76, and 78, summing amplifiers 50 and 52, phase delay 58, and summing amplifier 60.” *See, e.g.*, Tayloe, 2:9-12. In operation, the commutating switch 38 “switches input 36 to outputs 42, 44, 46, and 48.” *See, e.g.*, Tayloe, 2:17-18. The “control signal input to control input 40 is substantially equal to four times the local oscillator frequency,” or $4f_0$. Tayloe, 22-24.

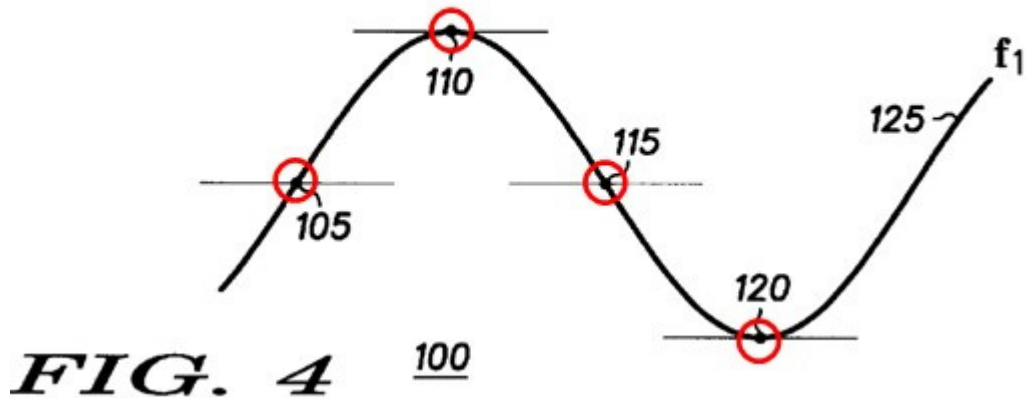
Because of the control signal at $4f_0$, the switch “remains closed at each of the four outputs for substantially 90 degrees at the frequency $[f_0]$ of the input signal.” Tayloe, 2:27-30; TI-1003, 68-90. Each switch is controlled such that it closes once every four periods of the $4f_0$ signal for a duration of $1/f_0$. TI-1003, 68-90. During the time that the switch connects input 36 to one of the outputs, charge builds up on the corresponding capacitor. Tayloe, 2:33-45; TI-1003, 68-90. Each capacitor shown in FIG. 3 acts as an integrator. *See, e.g.*, Tayloe, 1:67-2:1, 2:42-44, 4:1-4. The accumulation of charge on the capacitors during the sampling window results in a baseband signal. TI-1003, 68-90.

As explained by Tayloe, the 0 and 180 degree outputs of commutating switch 38 are input to summing amplifier 50, which differentially sums these inputs, “thereby producing baseband in-phase signal 54.” Tayloe, 2:56-59. “Sum-

ming amplifier 52 differentially sums the 90 degree output and the 270 degree output, thereby producing base band quadrature signal 56. Baseband in-phase signal 54 and baseband quadrature signal 56 are in-put to phase delay 58 which shifts the phase of baseband quadrature signal 56 by 90 degrees relative to baseband in-phase signal 54.” Tayloe, 2:56-67; TI-1003, 68-90.

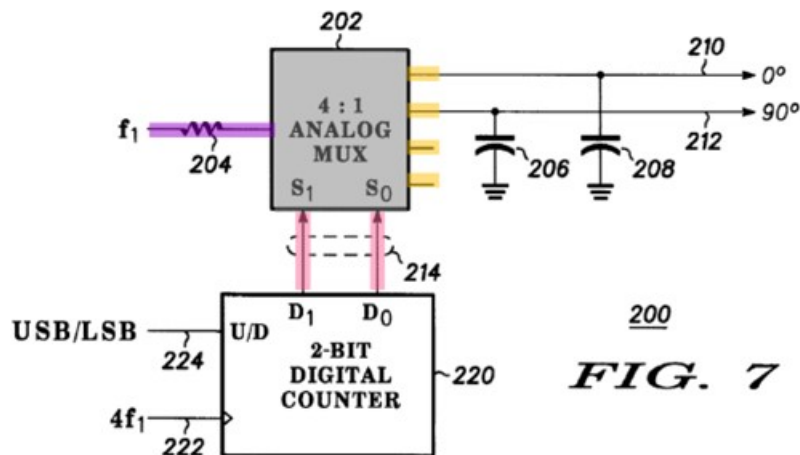
The direct conversion receiver uses a commutating switch 38, which is “controlled by a signal present at control input 40.” TI-1004, 2:17-20. This control signal causes switch 38 to couple the RF input signal f_1 to each of the four outputs 42, 44, 46, and 48 once every four cycles of the control signal, so that the RF input signal f_1 is sampled four times during a each cycle of its carrier frequency (the nominal carrier frequency is f_0 because Tayloe is directed to a direct conversion receiver). As illustrated in FIG. 4 (below), “[p]oint 105 represents the voltage to which capacitor 72 (FIG. 3) charges,” “point 110 represents the voltage to which capacitor 74 charges, point 115 represents the voltage to which capacitor 76 charges, and point 120 represents the voltage to which capacitor 78 charges.” *Id.*, 3:41-48; TI-1003, 68-90.

representations of integrated voltages on capacitors 72-78



TI-1004, FIG. 4 (annotated)

Taylor further expressly discloses implementing “direct conversion receiver 30 (FIG. 3) utilizing an analog multiplexer and a digital counter as shown in FIG. 7.” TI-1004, 5:33-37.



TI-1004, Figure 7 (annotated)

As an embodiment of switch 38 (FIG. 3), multiplexer 202 and the 2-bit digital counter (above) acts as a demultiplexer, connecting a single input signal f_1 (purple) to one of four outputs (orange) based on control signals 214 (pink) (corresponding to the control input 40 in FIG. 3). Tayloe expressly discloses that “[t]he analog multiplexer is a Texas Instruments SN74BCT3253D.” *Id.*, 5:33-37², 5:1-16 (“One skilled in the art of analog and digital circuit design will readily understand that input signal f_1 is connected to each of the four outputs of analog multiplexer 202 for substantially 90 degrees of the input signal.”).

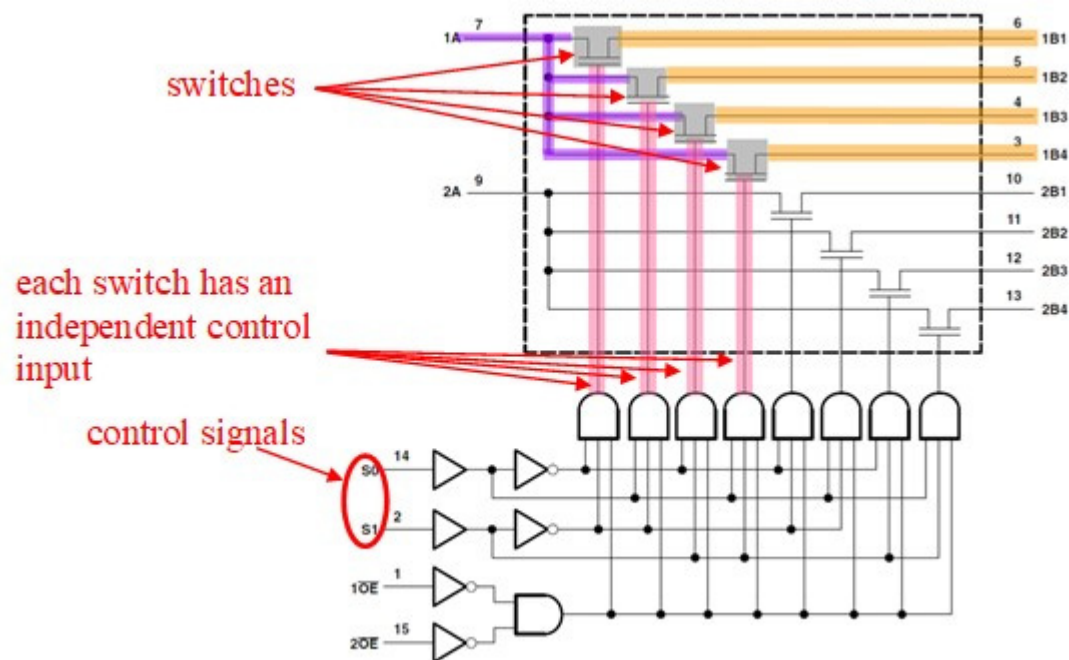
2. TI SN74CBT3253 Datasheet

The TI Datasheet describes the SN74CBT3253 multiplexer/demultiplexer, a commercially available electronic component that can be used in a radio receiver such as Tayloe’s receiver. TI-1005, 1; Tayloe, 5:33-37.

² Tayloe specifically refers to a TI “SN74BCT3253D” multiplexer. The “BCT” lettering is a typographical error. TI’s records indicate the multiplexer is number “SN74BCT3253” does not match any TI product. TI-1023, ¶12. The TI Datasheet pertains to all SN74CBT3253 multiplexers, explaining that the “D” in the product number refers to a packaging option for the SN74CBT3253 multiplexer. TI-1003, 89-94.

Multiplexers are well-known electronic devices that receive multiple input signals and select one signal to be output. TI-1003, 91-94. A multiplexer such as the one disclosed in TI Datasheet can also operate as a demultiplexer—receiving a single input signal and routing it to one of several output lines. *Id.*

Taylor uses the SN74CBT3253 multiplexer/demultiplexer as a demultiplexer. Taylor, 5:33-37. This SN74CBT3253 multiplexer/demultiplexer shows additional details of how Taylor's switch 38 would connect the single input signal to one of multiple output lines, and in particular, the demultiplexing operation is shown below.



TI-1005, 2 (annotated)

The TI multiplexer/demultiplexer has four switches (gray) that selectively supply the input signal 1A (purple) to one of four outputs 1B1-1B4 (orange) according to four control signals (pink), respectively. The control signals are generated based on control logic that ensures only one of the four switches is turned on at a time. TI-1005, 1. The functional mapping of the control signals is shown in the Function Table below:

FUNCTION TABLE				
INPUTS				FUNCTION
1OE	2OE	S1	S0	
X	H	X	X	Disconnect 1A and 2A
H	X	X	X	Disconnect 1A and 2A
L	L	L	L	1A to 1B1 and 2A to 2B1
L	L	L	H	1A to 1B2 and 2A to 2B2
L	L	H	L	1A to 1B3 and 2A to 2B3
L	L	H	H	1A to 1B4 and 2A to 2B4

control signals values

TI-1005, 2 (showing S0 and S1 values)

3. The Tayloe + TI SN74CBT3253 Combination

Tayloe discloses a direct conversion receiver using a commutating switch to “sample an RF waveform four times per period at the RF frequency” in which “[t]he samples are integrated over time to produce an average voltage at 0 degrees, 90 degrees, 180 degrees and 270 degrees” across the 360-degree full cycle. TI-1004, Abstract, *see also* 2:13-67 (for each of the four sampling events, charge

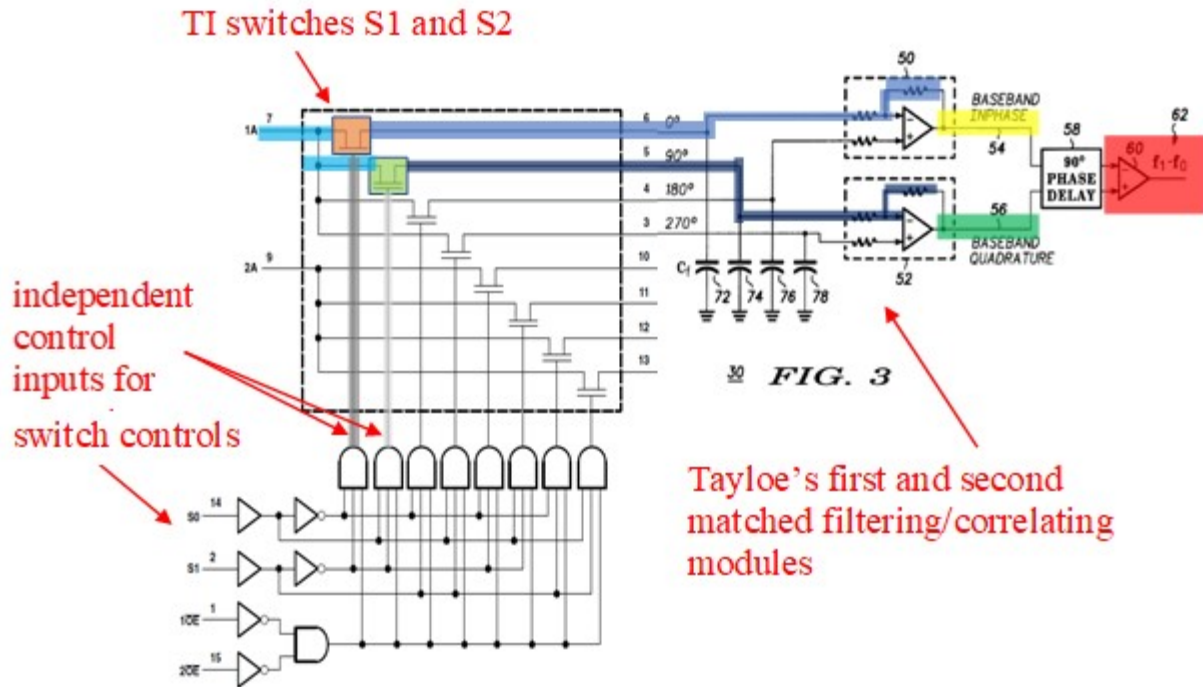
builds up on a respective one of capacitors 72, 74, 76, and 78), Figs. 3 (diagram example), 4 (waveform example).

Tayloe expressly discloses that the switch 38 can be implemented using an analog multiplexer/demultiplexer, such as the TI SN74CBT3253D multiplexer/demultiplexer. TI-1004, 5:33-37, 5:1-16, FIG. 7.

The TI Datasheet describes the SN74CBT3253 “dual 1-of-4 high-speed [transistor-transistor logic]-compatible [field-effect transistor] multiplexer/demultiplexer.” TI-1005, 1.

In the combination, Tayloe’s first and second matched filtering/correlating modules use a demultiplexer, like that shown in TI-Datasheet (TI-1005, 2) as a switch with an independent control input controlled by a control signal. TI-1003, 100-109.

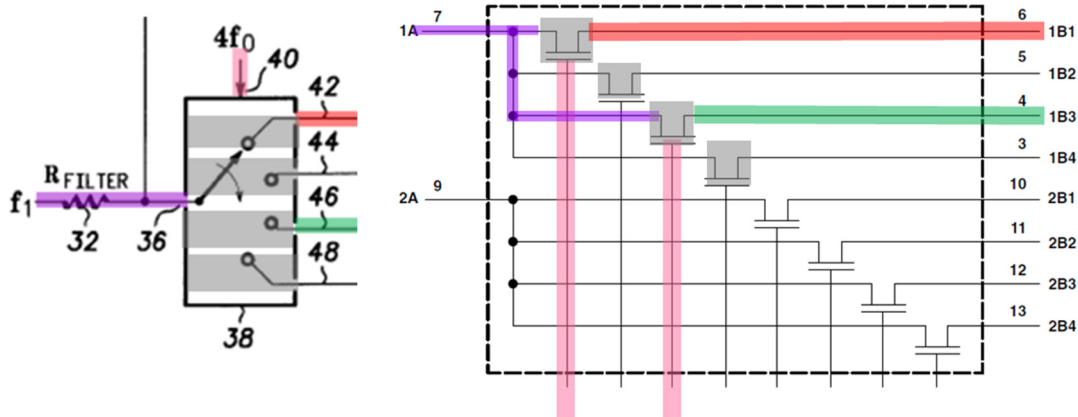
A POSITA would have been found it obvious to apply the teachings from TI Datasheet to implement the Tayloe’s multiplexer/demultiplexer, as further annotated below. TI-1003, 100-109.



Taylor FIG. 3 with TI Demux (TI-1005, 2) (annotated)

Taylor expressly teaches four switches (gray) in a “direct conversion receiver 30 (FIG. 3) utilizing an analog multiplexer ... shown in FIG. 7” and specifically states “[t]he analog multiplexer is a Texas Instruments SN74BCT3253D.” *Id.*, 5:33-37. Taylor therefore discloses the express embodiment because the characteristics described in the TI Datasheet are inherent in Taylor and a POSITA would have knowledge of the characteristics of the referenced multiplexer for implementing switch 38. TI-1003, 100-109

At a minimum, a POSITA would have found it obvious to use four of the multiplexer switches (gray) from TI Datasheet to implement Taylor's switch box 38 of FIG. 3 (which has four outputs), as annotated below.



TI-1004, Fig 3 (switch 38), TI-1005, 1 (multiplexer/demultiplexer)

A datasheet is a well-known resource for learning detailed information of the multiplexer/demultiplexer, and a POSITA would have been motivated to consult the TI Datasheet for a more complete understanding of Tayloe's express teachings of the SN74CBT3253 demultiplexer, the only matching multiplexer available at the time. TI-1023; TI-1003, 100-109; *see also Bayer Healthcare Pharms., Inc. v. Watson Pharms., Inc.*, 713 F.3d. 1369, 1374-75 (Fed. Cir. 2013) (obvious to combine two prior art references where one reference "refers expressly" to the other).

When viewing the detailed diagram of the SN74CBT3253 demultiplexer, a POSITA would have been motivated to apply four of the switches because the architecture of one switch on the demultiplexer is analogous to one of the four switching paths of Tayloe's commutating switch 38. TI-1003, 100-109. Thus, a POSITA would have thought to implement the multiplexer switches from TI

Datasheet in an analogous manner by “simple substitution of one known element for another.” *Id.*; *KSR Int’l Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1731 (2007).

A POSITA would have been motivated to use the TI demultiplexer for its advantages, including that “[t]he low on-state resistance of the switch allows connections to be made with minimal propagation delay.” TI-1005, 1; TI-1003, 100-109. A POSITA would have a reasonable expectation of success at combining Tayloe with TI Datasheet because the combination would have yielded only predictable results (e.g., “low on-state resistance of the switch [which] allows connections to be made with minimal propagation delay”). TI-1005, 1; TI-1003, 100-109.

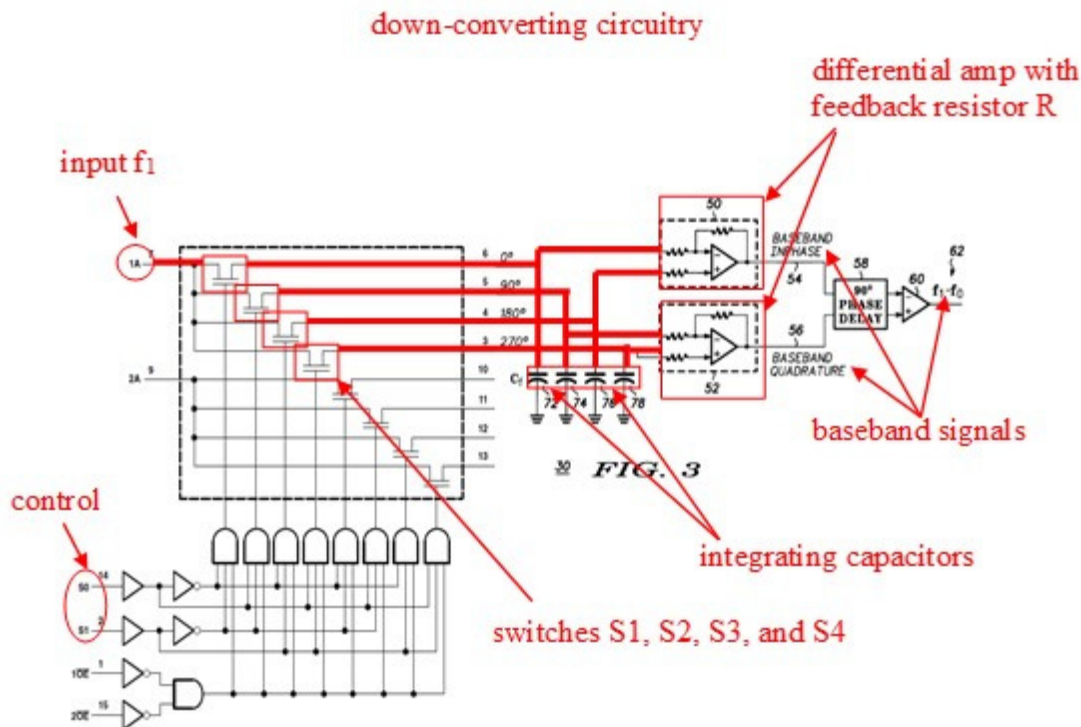
4. Analysis

14.P

To the extent the preamble is limiting, Tayloe teaches it. For example, Tayloe describes a “method and apparatus” involving “a simple and inexpensive product detector which facilitates the conversion of a signal to baseband.” *See, e.g.*, Tayloe, 1:64-67, 2:1-14 (describing input signal f_1 as an RF or IF signal). As stated in the ’177 patent, converting an RF or IF signal to baseband is “down-converting” of “an electromagnetic signal.” *See, e.g.*, TI-1001, Abstract; TI-1003, 112; Tayloe, 1:10-13, 5:61-64 (method and apparatus “for generating baseband in-phase and quadrature signals from an RF or IF signal); *see also* TI-1008, 65-67 (a down-converted signal is a baseband signal); TI-1003, 110.

14.1

Taylor teaches that an RF or IF input signal f_1 is received into a circuit that performs down-converting. *See, e.g.*, Taylor, 2:13-14. FIG. 3 below shows one example of receiving an input f_1 into circuitry that performs down-converting, outlined in red:



Taylor, FIG. 3 + TI Datasheet (annotated)

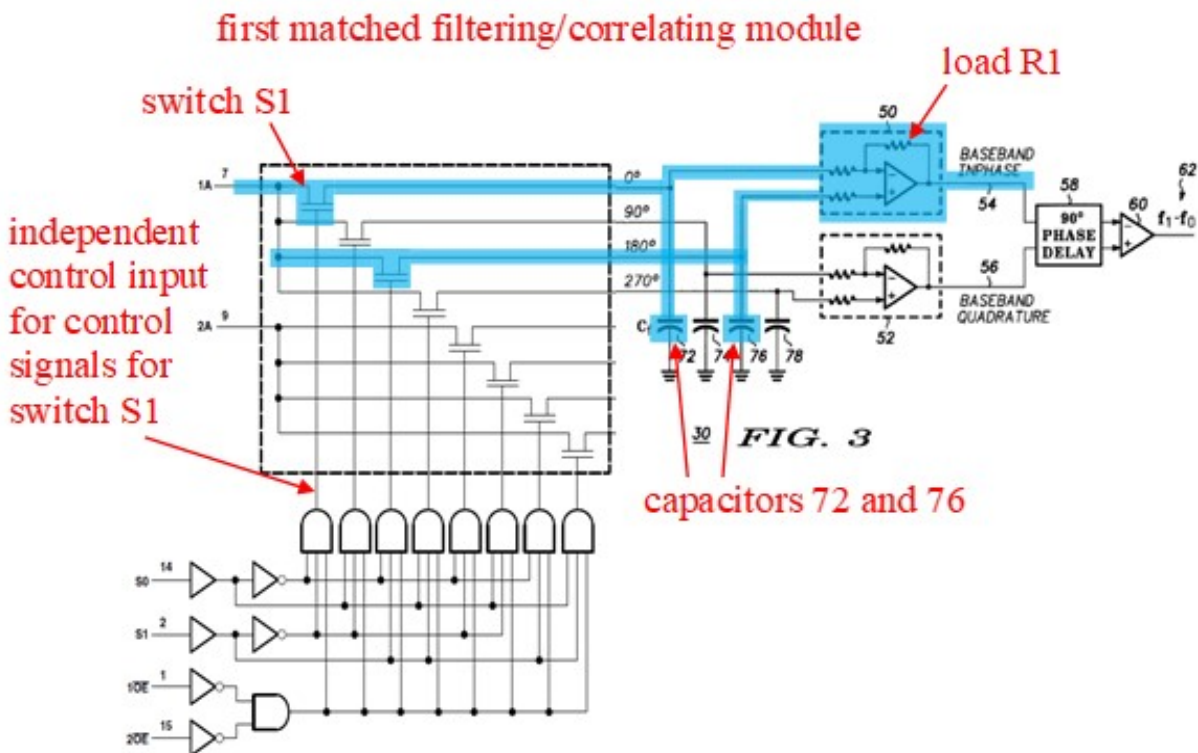
The down-converting circuitry includes switches (e.g., S1 and S3), capacitors 72 and 76, and the differential summing amplifier circuitry 50 (that includes feedback resistor R). *See, e.g.*, Taylor, 2:8-12; *see also id.* FIG. 6; TI-1003, 111-112.

As shown in FIG. 3 above, Taylor's circuitry includes several down-converting circuits. TI-1003, 111-112. The following describes how Taylor renders

claim 14 unpatentable under different constructions of the term matched filtering/correlating module. *Id.* First, Patent Owner's proposed construction of the term "matched filtering/correlating module is considered. The plain meaning interpretation of matched filtering/correlating module is discussed after.

(i) **Patent Owner's Construction**

Taylor describes a first matched filtering/correlating module that performs down-conversion of an RF or IF signal into a baseband signal. TI-1003, 113-131. The first matched filtering/correlating module is shown in Taylor, FIG. 3 below, in light blue:



Taylor, FIG. 3 (annotated)

The first matched filtering/correlating module includes a structure that, when operated, performs the method of Element 14.1 according to Patent Owner's constructions. TI-1003, 113-131.

(a) linear, time-variant circuitry

Tayloe teaches linear, time-variant circuitry. TI-1003, 114-115. Tayloe's down-conversion circuitry includes resistors, capacitors, op-amp based closed-loop amplifiers, a phase shifting network, a differencing amplifier, and a commutating switch, all of which a POSITA would have recognized as ideally linear components, so a POSITA would have recognized the overall circuit as being linear in principle. *See, e.g.*, Tayloe, 1:67-2:2, 2:42-44, 4:9-13, 4:57-58; TI-1003, 113-115.

Tayloe's down-conversion circuitry is time-variant because the switches reconfigure the circuit each time the commutating switch changes state. TI-1003, 113-115. Specifically, Tayloe's down-conversion circuitry is a time-varying system because which of the capacitors is connected to the RF input signal changes over time. *Id.* For example, in Tayloe, the switch 38 is controlled by a time-varying control signal $4f_0$. *See, e.g.*, Tayloe, 2:21-27, 3:62-65. *See, e.g.*, Tayloe, 3:62-65; TI-1003, 113-115.

(b) that samples a modulated RF 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 while the switch is closed

As mentioned before, the input to Tayloe's circuit is a modulated RF carrier signal f_1 . *See, e.g.*, Tayloe, 2:13-14, 3:40-4:1 (describing f_0 as the carrier frequency and f_1 as an input signal, where $f_1 - f_0 = 0$); *see also, id.*, 1:14-16; TI-1003, 116-123. The Tayloe circuitry samples the input signal f_1 at an aliasing rate using a switch S1 with an independent control input driven by a control signal. *See, e.g.*, Tayloe, Abstract (describing a circuit "for converting a signal to baseband that includes a commutating switch which serves to sample an RF waveform), 3:48-54 (describing that "the carrier signal frequency is exactly equal to f_0 ," and "four evenly spaced samples will continuously be taken by the action of the Tayloe Product Detector"); *see also, id.*, 2:18-19 ("The rate at which commutating switch 38 operates is controlled by a signal present at control input 40."). With Tayloe's control signal of $4f_0$, each switch is closed once per $4f_0$. TI-1003, 116-123. When the switch is closed, a sample of the RF input signal is taken (accumulated and transferred to the load). *Id.* Because the direct conversion receiver includes four switches, the sampling is performed by each switch at rate equal to the carrier frequency f_0 (consider $f_0 = 4f_0/4$). *Id.*

Note that the '177 patent, "contrary to conventional wisdom," relies on under-sampling or "aliasing the EM signal" TI-1001, 26:22-35 (describing that the

Tayloe, FIG. 3 with TI Datasheet (annotated)

As shown in FIG. 3 above, Tayloe's circuit includes a switch S1 with an independent control input driven by a control signal at an aliasing rate f_0 . TI-1003, 116-123.

The control signal samples using a non-negligible, periodic aperture by closing the switch S1 for substantially 90 degrees at the frequency of the input signal f_i . TI-1003, 116-123. The switch remains "closed at each of the four outputs for substantially 90 degrees at the frequency of the input signal." *See, e.g.*, Tayloe, 2:28-31. That the aperture period is periodic is self-evident. TI-1003, 116-123. But Tayloe explains that the aperture period is non-negligible. For example, Tayloe explains that "the control signal input to control input 40 is substantially equal to four times the local oscillator frequency," and as a result, "input 36 is switched to each of the four outputs substantially once during each period of the input signal f_i ." *See, e.g.*, Tayloe, 2:21-26.

In addition, the samples, having non-negligible energy, are accumulated and are transferred to a load while the switch is closed. TI-1003, 116-123. For example, as explained by Tayloe, during the time that the switch S1 connects input 36 to output 42, charge builds up on the capacitor 72. *See, e.g.*, Tayloe, 2:32-38. As switches of the demux cycle through connecting the four outputs, "capacitors 72-78 charge to voltage values substantially equal to the average value of the input signal during their respective quadrants." Tayloe, 2:38-44; TI-1003, 116-123. The

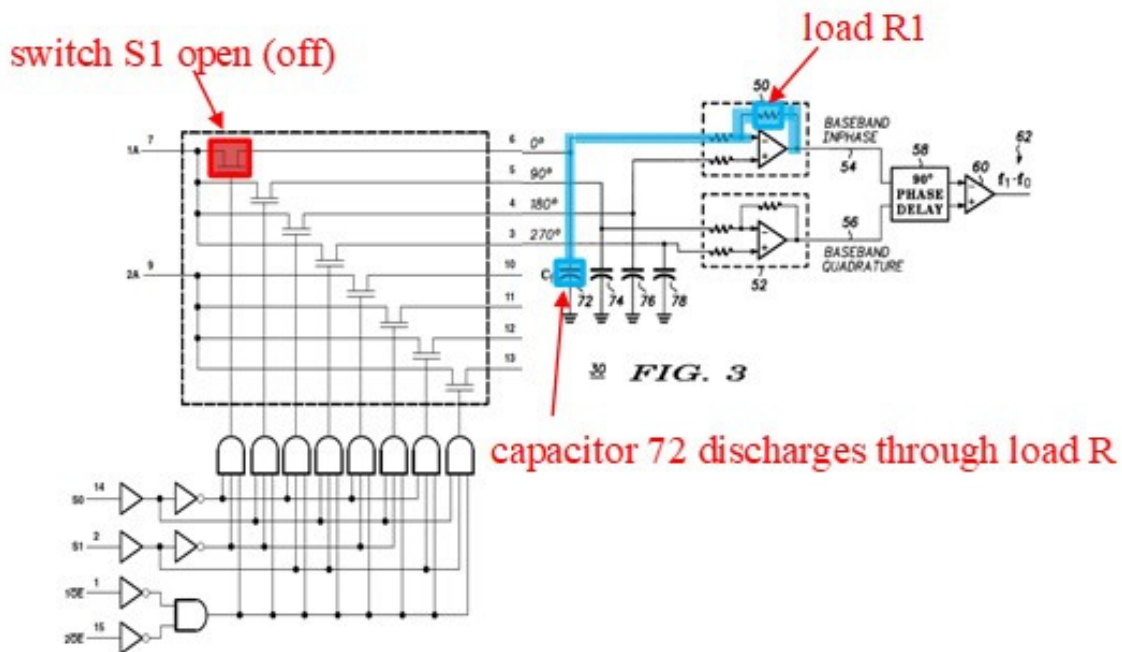
aperture period is sufficiently long in duration for an average value of the sample during that time period to be accumulated on the capacitor. *See, e.g., id.; see also id.*, 2:45-55 (describing that the output of each phase “represents the average value of the input signal during the [corresponding] quarter wave of the period”). The capacitors charging to “the average value of the input signal” is the samples, having non-negligible available energy, being accumulated. TI-1003, 116-123. At the same time, while the switch S1 is closed, energy from the samples is transferred to the load R1. TI-1003, 116-123. Thus, while the switch S1 is closed, a non-negligible available energy—indeed, the entirety of the sample—is accumulated on the capacitor 72 and transferred to the load R1. *Id.*

Noteworthy, Tayloe includes capacitors in its circuit deliberately. TI-1003, 116-123. The purpose of capacitors is to store (or accumulate) energy (in the form of charge). *Id.* If the capacitors of Tayloe stored only a negligible amount of energy, they could be removed from the circuit entirely with only a negligible change in the circuit’s performance. *Id.* That Tayloe includes these capacitors in the circuit, and discusses their function repeatedly in the specification, indicates that the capacitors cannot be neglected. *Id.* It follows, therefore, that the capacitors of Tayloe, such as capacitor 72, accumulates a non-negligible amount of available energy during the aperture period. *Id.*

(c) and discharged through the load while the

switch is open,

A POSITA reading Tayloe would have recognized that Tayloe's capacitor 72 inherently discharges through the feedback resistor when the switch is open. TI-1003, 124-125. Tayloe teaches that, when the switch 38 is open, charged capacitor 72 will discharge through the load (*i.e.*, through the resistor shown in the figure below). *See, e.g.*, Tayloe, 2:56-57, FIG. 3; TI-1003, 124-125. FIG. 3 is shown below illustrating the discharge path of capacitor 72 when the switch 38 is open to output 42:



Tayloe, FIG. 3 (annotated).

A POSITA would recognize that the triangle symbol in each of 50 and 52 is an operational amplifier with a high open-loop DC gain, and that 50 and 52 each imple-

ment a feedback system wherein the feedback through the resistor connected between the operational amplifier's output and negative input terminal causes the resistance at the negative input terminal node to be extremely low (typically significantly less than a few ohms). TI-1003, 124-125. Consequently, a POSITA would recognize that the input resistance to ground from each the top inputs of 50 and 52 is approximately equal to the resistance of the top left resistor. *Id.* Moreover, a POSITA would know that in practical implementations of 50 and 52, such resistors would typically have resistances on the order of kilo-ohms or less. *Id.* Therefore, capacitors 72 and 74 discharge through these resistors when their corresponding switches are open. *Id.*

(d) thereby transferring available real power from the modulated RF carrier signal to the load and

Tayloe teaches that the charge accumulated on each capacitor discharges through the load and transfers available real power from the modulated input signal f_1 to the load. TI-1003, 126-127. As mentioned before, “[d]uring the time that commutating switch 38 connects input 36 to output 42, charge builds up on capacitor 72.” Tayloe, 2:33-44; *see also id.*, 2:46-55 (describing each output 42, 44, 46, and 48 being representative of the average value of the input signal at corresponding quarter waves of the period). Capacitors 72 and 74 discharge through the top-

left resistors in 50 and 52, respectively. TI-1003, 124-127. In each case, substantially all the discharged current also passes through the corresponding feedback resistor (because operational amplifier terminals have high impedance by design). *Id.* Therefore, the capacitor discharges electrical charge through the load (feedback resistor), which a POSITA would know is available real power from the RF carrier signal. *Id.*

The charge (or energy) that accumulates on the capacitor 72 and is transferred through the load R1 translates to available real power. *Id.* It is the available power because it forms the measurable output signal of the amplifier. *Id.* The power is real in the sense that it is equal at any given time instant to the product of resistance of the resistor and square of the current through the resistor at that time instant. *Id.* Both quantities in the product are real numbers (i.e., they are not complex numbers). *Id.*

(e) **producing a down-converted signal with enhanced signal-to-noise power ratio**

i. *producing a down-converted signal*

Tayloe teaches producing a down-converted signal. TI-1003, 128. For example, according to Tayloe, the “in-phase and quadrature signals that result represent the signal of interest at baseband.” Tayloe, 2:2-3; *see also id.*, 2:38-44; TI-1003, 128. “Summing amplifier 50 differentially sums the 0 degree output and the 180 degree output, **thereby producing baseband in-phase signal 54.**” Tayloe,

2:56-62 (also discussing the production of the baseband quadrature signal 56); TI-1003, 128.

ii. with enhanced signal-to-noise power ratio

Tayloe teaches that the produced baseband in-phase signal has an enhanced signal-to-noise power ratio. TI-1003, 129-131. First, Tayloe teaches that the capacitors perform averaging and act as integrators. *See, e.g.*, Tayloe, 2:38-44. A POSITA would have recognized that the averaging performed by the integrators reduces noise on the signal because it attenuates high-frequency noise and interference while preserving the desired signal component. TI-1003, 129-131. This integration or averaging, which is a form of lowpass filtering, removes noise from the resulting signal, thereby resulting in an improved SNR. *Id.*

In addition, one of the stated benefits of Tayloe is an improvement to noise. TI-1003, 129-131. Specifically, Tayloe states that its circuit “can exhibit less than 1 dB of conversion loss, which is 6-7 dB improvement over the typical conversion loss of 7-8 dB in the prior art. **This 6-7 dB conversion loss improvement translates into a 6-7 dB improvement in overall receiver noise figure.** The noise figure improvement results in substantial receiver performance gains, in part because a pre-amplifier may become unnecessary as a result.” Tayloe, 3:6-13 (emphasis added).

A POSITA would have recognized that the integrator circuit(s) of Tayloe produce a down-converted signal with enhanced signal-to-noise power ratio (SNR). TI-1003, 129-131. The 6-7 dB improvement corresponds to a signal to noise power ratio improvement (expressed in terms of decibels, which is a monotonically increasing function of the signal to noise power ratio). *Id.*

Tayloe describes, in one embodiment, that the input signal f_1 is a carrier signal frequency “exactly equal to f_0 ”. *See, e.g.*, Tayloe, 3:48-53. In that case, the input signal f_1 is synchronized to the carrier frequency f_0 . TI-1003, 129-131. As discussed above in the claim construction section, the correlation between the carrier signal frequency and the input signal can result in an improved SNR. *See, supra*, §II.C.2. Thus, Tayloe’s matched filtering/correlating module results in an enhanced SNR. TI-1003, 129-131.

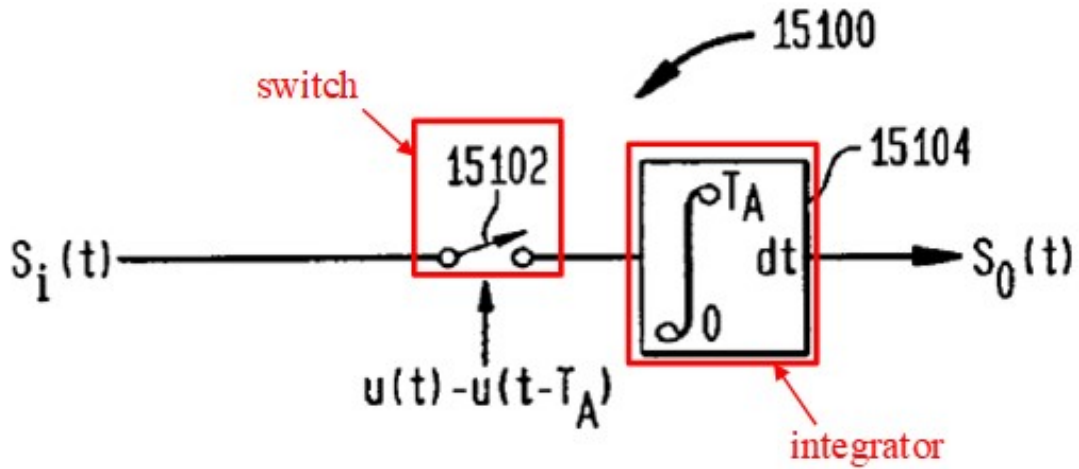
(ii) Plain Meaning

As shown in example FIG. 153 of the ’177 patent, at least one embodiment of the matched filtering/correlating modules includes a switch controlled by a control signal, and a capacitor that acts as an integrator. *See, e.g.*, ’177 patent, 134:32-51 (“Capacitor 15306 integrates the output of switching module 15304 and accumulates the energy of the processed portions of the received carrier signal.”), FIG. 153; *see, supra*, §II.C (discussing plain-and-ordinary meaning); TI-1003, 18-32, 62-67, 132-137.

Likewise, the down-conversion circuitry of Tayloe includes a switch S1 that is controlled by a control signal that is *correlated* to the carrier frequency f_0 , and similarly for the other switches within the commutating switch. *See, e.g.*, 3:48-53 (describing “the carrier signal frequency is exactly equal to f_0 ”). This is illustrated in FIG. 4 of Tayloe along with the explanation that the “[o]utput 42 represents the average value of the input signal during the first quarter wave of the period, and is termed the 0 degree output.” Tayloe 2:46-55 (also discussing the other outputs). The FIG. 4 waveform is that of the received RF input signal. Dr. Galton explains that the features represented in FIG. 4 and the associated explanation above is only possible if the independent control signals within the commutating switch are synchronized to the carrier of the received RF input signal. TI-1003, 18-32, 62-67, 132-137.

The '177 patent describes that the “matched filter/correlator is generally referred to as a finite time integrator.” '177 patent, 132:37-38. The '177 patent states that a finite time integrator “can be implemented with, for example, a switching device controlled by a train of pulses having apertures substantially equal to the time interval defined for the waveform.” '177 patent, 132:38-42. As shown in the '177 patent, FIGS. 151 and 153, the matched filtering/correlating module includes a switch with a capacitor that integrates:

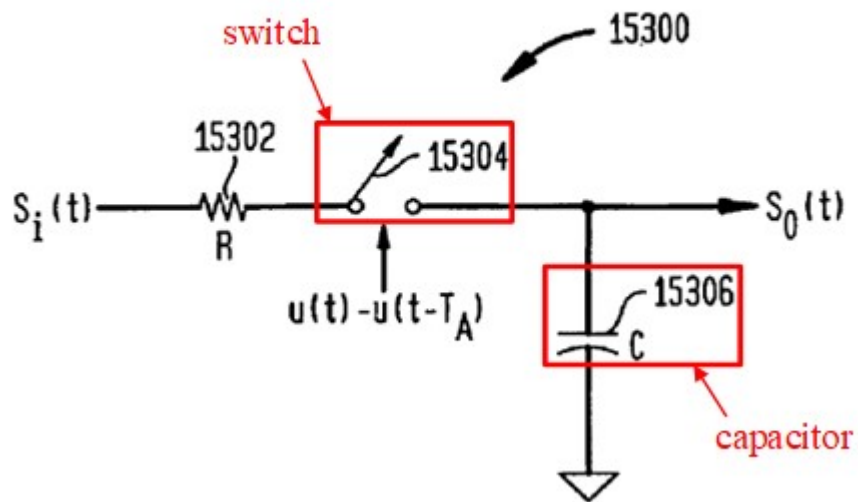
FIG. 151



'177 patent, FIG. 151 (annotated)

"FIG. 151 illustrates an example finite time integrating system 15100." '177 patent, 133, 22-23.

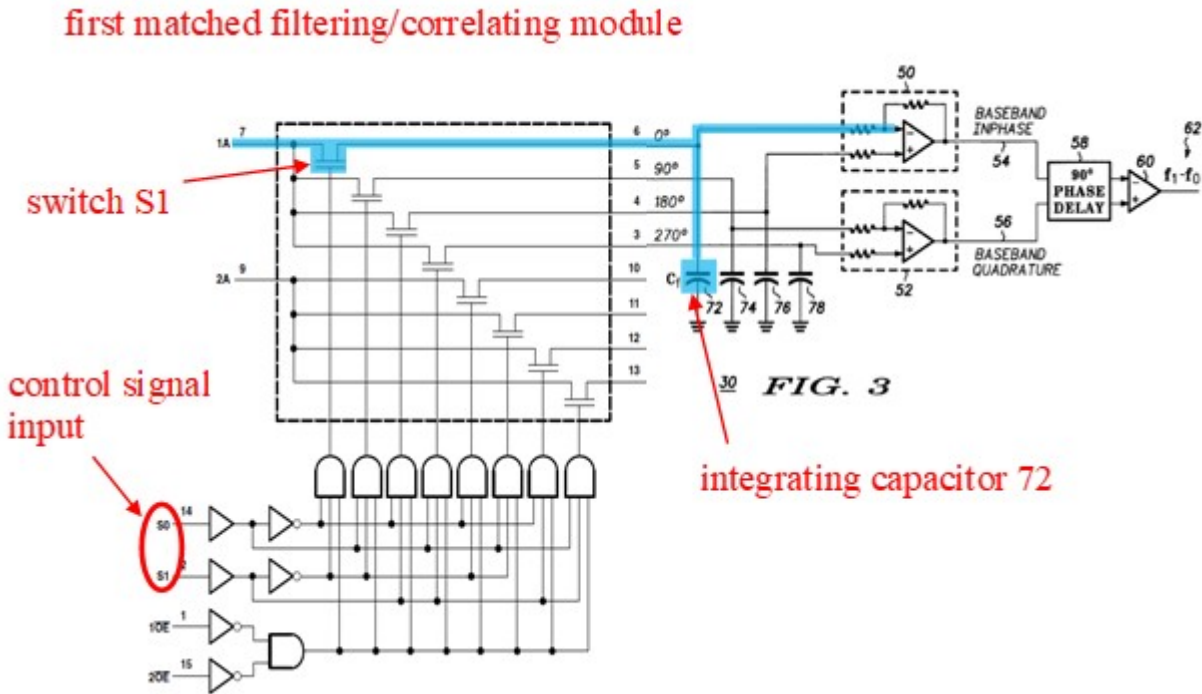
FIG. 153



'177 patent, FIG. 153 (annotated)

As described by the '177 patent, "Capacitor 15306 integrates the output of switching module 15304 and accumulates the energy of the processed portions of the received carrier signal." '177 patent, 134:45-48. Key among the common characteristics of the matched filtering/correlating module embodiments of the '177 patent is that the correlation signal must be synchronized input signal's carrier frequency. TI-1003, 18-32, 62-67, 132-137. The '177 patent states that "the example matched filter/correlator of FIG. 171 operates in synchronism with the half sine pulse $S_i(t)$ over the aperture T_A ," and this "synchronism" is depicted in several of the figures in '177 patent including but not limited to Fig. 72, Fig. 157, Fig. 158, Fig. 162, Fig. 166, Fig. 182, Fig. 184, and Fig. 193. *See, e.g.*, TI-1001, 145:15-18; TI-1003, 18-32, 62-67, 132-137.

Likewise, the circuitry of Tayloe includes a switch S1 controlled by a control signal derived from f_0 and a capacitor 72 that performs integration. TI-1003, 132-137. For example, Tayloe describes that each of the capacitors "functions as a separate integrator, each integrating a separate quarter wave of the input signal." Tayloe, 2:42-45; *see also id.*, 1:67-2:2, 3:54-57, 4:46-63 (describing that "resistor/capacitor pairs also form integrators."). Thus, Tayloe describes a first matched filtering/correlating circuit according to the plain-and-ordinary meaning construction, as shown in FIG. 3 below, in light blue:



Taylor FIG. 3 + TI Datasheet (annotated)

As discussed above, in at least one embodiment of Taylor, the control signal that controls the switch S1 is synchronized to the carrier of the received RF input signal because each switch is closed exactly once period of the received RF input signal's carrier frequency. Taylor, 3:48-54; TI-1003, 18-32, 62-67, 132-137. Thus, Taylor provides a matched filtering/correlator module consistent with the plain-and-ordinary meaning of the term. TI-1003, 18-32, 62-67, 132-137.

14.2

Taylor teaches or renders obvious element 14.2. *See supra* 14.1 (discussing circuit operation and down-conversion to baseband); TI-1003, 138-140. For example, Taylor teaches that the matched filtering/correlating module samples the input

signal f_1 according to the control signal derived from the local oscillator f_0 . *See, e.g.,* Tayloe, 2:21-55. The switch “remains closed at each of the four outputs for substantially 90 degrees at the frequency of the input signal,” during which time charge builds on each capacitor. *See, e.g., id.* As the switches “cycle through the four outputs, capacitors 72-78 charge to voltage values substantially equal to the average value of the input signal during their respective quadrants.” *See, e.g., id.* “Summing amplifier 50 differentially sums the 0 degree output and the 180 degree output, thereby producing baseband in-phase signal 54.” *See, e.g., id.*, 2:57-59. The first control signal turns the first switch on for a quarter period of the carrier of the received RF input signal, i.e., for one period of the $4f_0$ control signal, corresponding to the 0° period. TI-1003, 138-140.

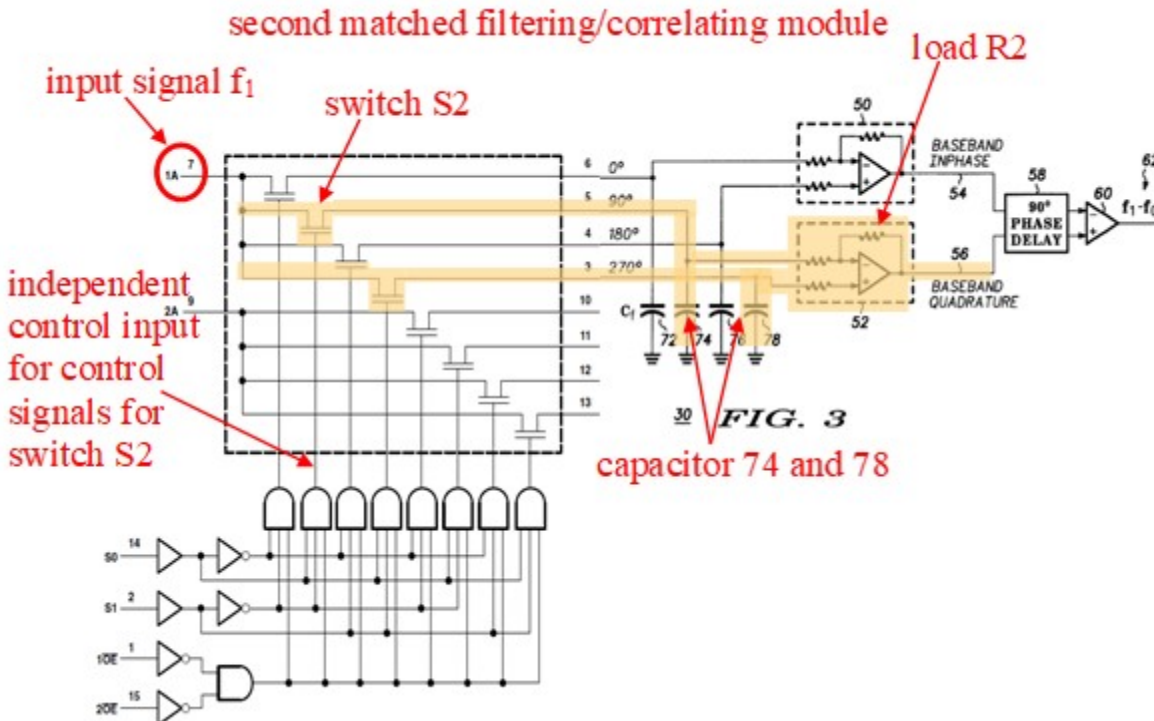
Under a plain-and-ordinary construction, Tayloe’s first matched filtering/correlating module outputs a first in-phase down-converted signal representative of the first quarter wave period (referred to as the 0 degree output). *See, e.g.,* Tayloe, 2:46-48; TI-1003, 138-140. This 0 degree output is a first down-converted signal because energy from the received RF input signal is transferred to the capacitor only when the carrier signal is positive, i.e., “during the first quarter wave of the period” Tayloe 2:47, thereby aliasing the RF input signal to baseband. TI-1003, 138-140.

14.3

(i) Patent Owner's Construction

Petitioner reiterates the discussion of the first matched filtering/correlating module above here. *See, supra*, Ground 1, Element 14.1; TI-1003, 111-131. The aforementioned discussion of the first matched filtering/correlating module of Tayloe applies to the second matched filtering/correlation module. For example, for the same reasons articulated above, the second matched filtering module includes linear, time-variant circuitry, samples a modulated RF carrier signal at an aliasing rate (switch S2 controlled by aliasing rate equal to f_0 , where $f_1=f_0$); accumulates and transfers non-negligible energy using a non-negligible aperture period when the switch is closed; discharges energy through a load when the switch S2 is open; transfers real, available power from the modulated RF carrier signal to the load R2; and produces a down-converted signal (baseband quadrature signal) with enhanced SNR. TI-1003, 111-131, 141-148.

Tayloe describes a second matched filtering/correlating module that performs down-conversion of an RF or IF signal into a baseband signal. TI-1003, 111-131, 141-148. The second matched filtering/correlating module is shown in Tayloe, FIG. 3 below, in orange. TI-1003, 141-148. Tayloe teaches receiving input f_1 into a second matched filtering/correlating module, as shown in FIG. 3:

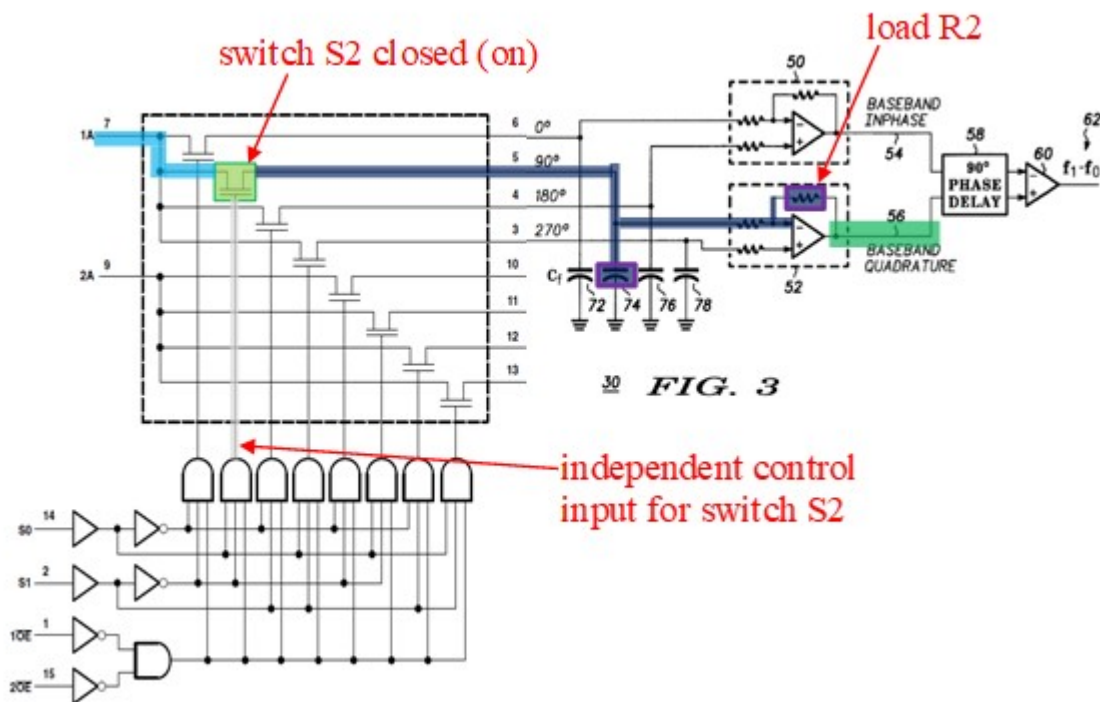


Tayloe, FIG. 3 + TI Datasheet (annotated)

The second matched filtering/correlating module is configured the same as and operates the same as the first matched filtering/correlating module. *See, supra*, Element Ground 1, 14.1; TI-1003, 111-131, 141-148. Like the first matched filtering/correlating module, the second module includes a switch S2 with an independent control input, capacitor 74, and differential summing amplifier 52 with feedback resistor R2 (the load). TI-1003, 111-131, 141-148. The output of the second matched filtering/correlating module is a baseband quadrature signal 56. *See, e.g.*, Tayloe, 2:8-12; *see also* text accompanying FIG. 6; TI-1003, 111-131, 141-148. Therefore, the second matched filtering/correlating module satisfies both Patent Owner's construction and the Plain Meaning for the same reasons as the first

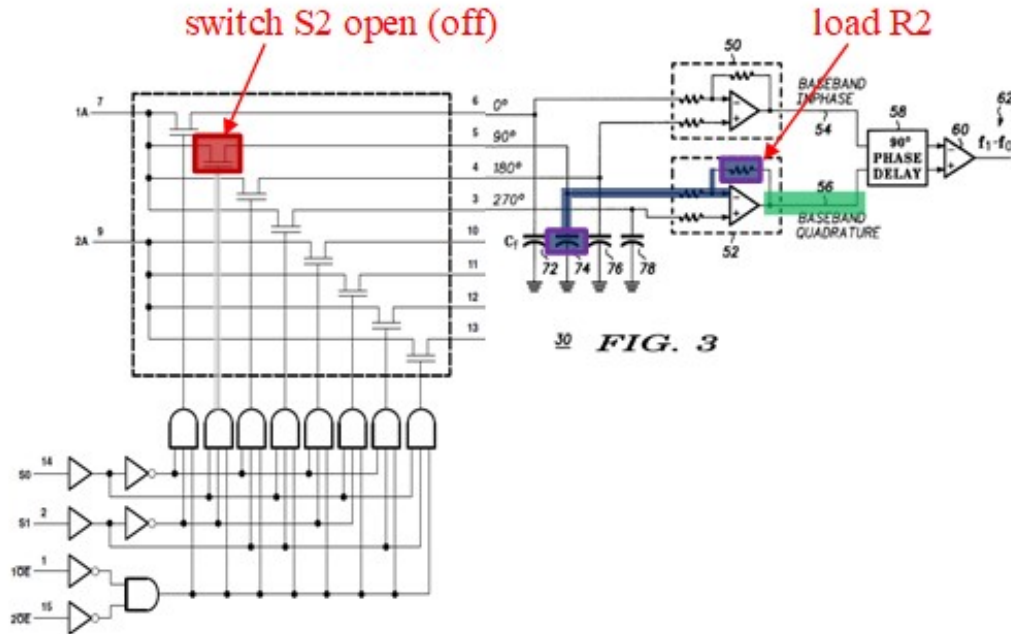
matched filtering/correlating module. *See supra* Ground 1, 14.1; TI-1003, 111-131, 141-148.

Beginning with the Patent Owner's constructions, in the combination of Tayloe and TI SN74CBT3253, the switch S2 is a transistor of the demultiplexer that has its own control input, as shown in the annotated figure below. TI-1003, 141-148. When the switch is closed to the 90° output, charge is accumulated on the capacitor 74 and flows through the feedback resistor R2. TI-1003, 141-148. For example, as shown in FIG. 3 below, the Tayloe circuitry samples the input signal f_1 using a control signal derived from the local oscillator $4f_0$ to control switch S2:



Tayloe FIG. 3 + TI-Datasheet (TI-1005, 2) (annotated)

When switch is open to the 90° output 44, the accumulated charge on capacitor 74 discharges through the feedback resistor R, as shown below:



Taylor, FIG. 3 (annotated)

Summing amplifier 52 “differentially sums the 90 degree output and the 270 degree output, thereby producing baseband quadrature signal 56.” *See, e.g.,* Taylor, 2:60-62; TI-1003, 141-148.

As shown in FIG. 3 above, Taylor’s circuit includes a switch S2 with an independent control input driven by a control signal at an aliasing rate f_0 . TI-1003, 141-148. The control signal samples using a non-negligible, periodic aperture by closing the switch S1 for substantially 90 degrees at the frequency of the input signal f_1 . *Id.* The switch remains “closed at each of the four outputs for substantially 90 degrees at the frequency of the input signal.” *See, e.g.,* Taylor,

2:28-31. That the aperture period is periodic is self-evident. TI-1003, 141-148.

But Tayloe explains that the aperture period is non-negligible. For example, Tayloe explains that “the control signal input to control input 40 is substantially equal to four times the local oscillator frequency,” and as a result, “input 36 is switched to each of the four outputs substantially once during each period of the input signal f_1 .” *See, e.g.*, Tayloe, 2:21-26.

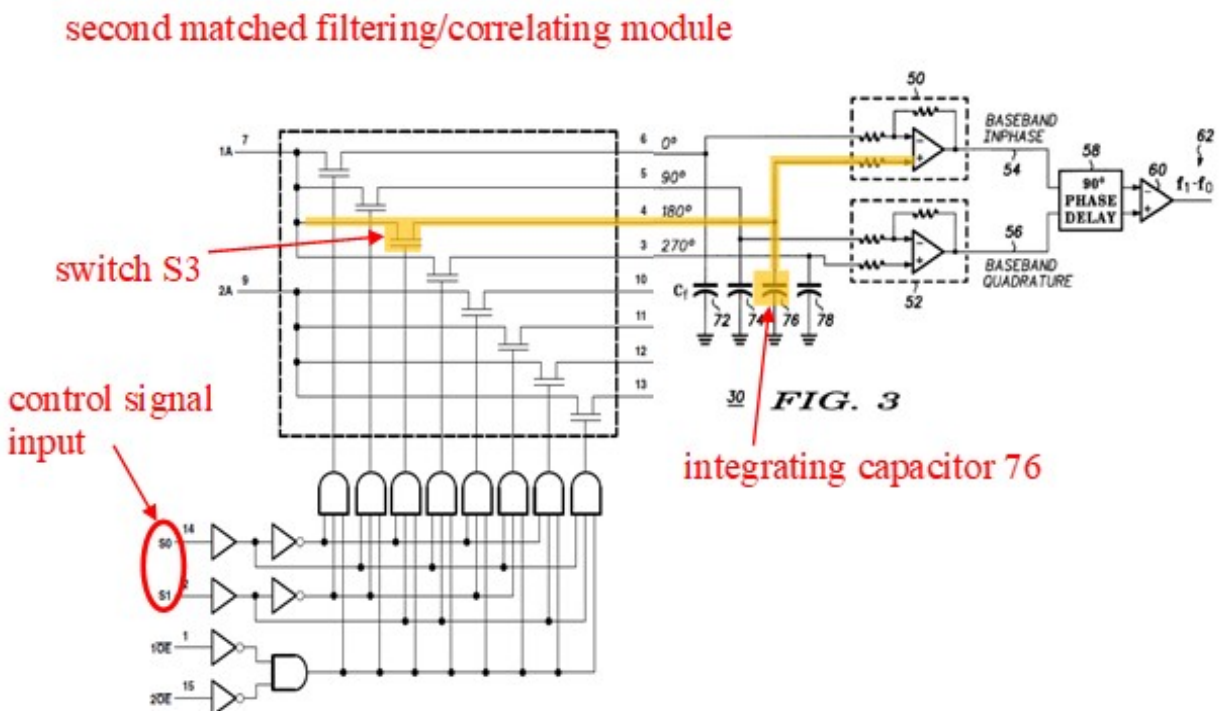
In addition, the samples, having non-negligible energy, are accumulated and are transferred to a load while the switch is closed. TI-1003, 141-148. For example, as explained by Tayloe, during the time that the switch S2 connects input 36 to output 44, charge builds up on the capacitor 74. *See, e.g.*, Tayloe, 2:32-38. As switches of the demux cycle through connecting the four outputs, “capacitors 72-78 charge to voltage values substantially equal to the average value of the input signal during their respective quadrants.” Tayloe, 2:38-44; TI-1003, 141-148. The aperture period is sufficiently long in duration for an average value of the sample during that time period to be accumulated on the capacitor. *See, e.g., id.; see also id.*, 2:45-55 (describing that the output of each phase “represents the average value of the input signal during the [corresponding] quarter wave of the period”). The capacitors charging to “the average value of the input signal” is the samples, having non-negligible available energy, being accumulated. TI-1003, 141-148. At the same time, while the switch S1 is closed, energy from the samples is

transferred to the load R2. *Id.* Thus, while the switch S1 is closed, a non-negligible available energy—indeed, the entirety of the sample—is accumulated on the capacitor 74 and transferred to the load R2. *Id.* Thus, like the first matched filtering/correlating module, the second matched filtering/correlating module produces a down-converted signal. *Id.* 129, 141-148.

Likewise to the first matched filtering/correlating module, it is worth noting that Tayloe includes capacitors in each of its circuits. TI-1003, 123, 141-148. And likewise to the first matched filtering/correlating module, the second matched filtering/correlating module results in an enhanced signal-to-noise power ratio. *Id.*, 129-131, 141-148.

(ii) Plain Meaning

Taylor teaches a second matched filtering/correlating module based on the plain-and-ordinary meaning construction, as well. TI-1003, 149-152. The second matched filtering/correlating circuitry of Taylor includes a switch S3 controlled by a control signal and a capacitor 76 that performs integration. *Id.* For example, Taylor describes that each of the capacitors “functions as a separate integrator, each integrating a separate quarter wave of the input signal.” Taylor, 2:42-45; *see also id.*, 1:67-2:2, 3:54-57, 4:46-63 (describing that “resistor/capacitor pairs also form integrators.”). Thus, the first matched filtering/correlating circuit of Taylor is shown in FIG. 3 below, highlighted in orange:



Taylor FIG. 3 + TI Datasheet (annotated)

The down-conversion circuitry of Tayloe includes a switch S2 that is controlled by a control signal that is correlated to the carrier frequency f_0 , and similarly for the other switches within the commutating switch. *See, e.g.*, 3:48-53, FIG. 4, 2: 46-55. The FIG. 4 waveform is that of the received RF input signal, so FIG. 4 and the associated explanation is only possible if the independent control signals within the commutating switch are synchronized to the carrier of the received RF input signal. TI-1003, 132-137, 149-152.

The circuitry of Tayloe includes a switch S2 controlled by a control signal derived from f_0 and a capacitor 72 that performs integration. TI-1003, 132-137, 149-152. For example, Tayloe describes that each of the capacitors “functions as a separate integrator, each integrating a separate quarter wave of the input signal.” Tayloe, 2:42-45; *see also id.*, 1:67-2:2, 3:54-57, 4:46-63. Thus, Tayloe describes a second matched filtering/correlating circuit according to the plain-and-ordinary meaning construction, as shown in FIG. 3 above. TI-1003, 132-137, 149-152.

As discussed above, the control signal that controls the switch S3 is equal to f_0 . TI-1003, 132-137, 149-152. And as described by Tayloe, in embodiments, $f_1 = f_0$. In that case, the local oscillator control signal is synchronized, i.e., matched or correlated, with the input signal carrier. TI-1003, 132-137, 149-152.

14.4

See supra Ground 1, 14.2-3 (discussing operation of Tayloe's first matched filtering circuit to down-convert the input signal to baseband, which applies to the second matched filtering/correlating module; and operation of Tayloe's second matched filtering/correlating module to down-convert a received input signal to baseband); TI-1003, 138-140, 153-154.

Tayloe teaches or renders obvious element 14.4. For example, Tayloe teaches that the matched filtering/correlating module samples the input signal f_1 according to the control signal derived from the local oscillator f_0 . *See, e.g.*, Tayloe, 2:21-55. The switch "remains closed at each of the four outputs for substantially 90 degrees at the frequency of the input signal," during which time charge builds on each capacitor. *See, e.g., id.* As the switches "cycle through the four outputs, capacitors 72-78 charge to voltage values substantially equal to the average value of the input signal during their respective quadrants." *See, e.g., id.* "Summing amplifier 50 differentially sums the 0 degree output and the 180 degree output, thereby producing baseband in-phase signal 54." *See, e.g., id.*, 2:57-59. The first control signal turns the first switch on for a quarter period of the carrier of the received RF input signal, i.e., for one period of the $4f_0$ control signal, corresponding to the 0° period. TI-1003, 138-140, 153-154.

Under a plain-and-ordinary construction, Tayloe's second matched filtering/correlating module outputs a second in-phase down-converted signal representative of the third quarter wave period (referred to as the 180 degree output). *See, e.g.*, Tayloe, 2:44-55. This 180 degree output is a second down-converted signal because energy from the received RF input signal is transferred to the capacitor only when the carrier signal is negative, i.e., "during the third quarter wave of the period" Tayloe 2:50-53, thereby aliasing the RF input signal to baseband. TI-1003, 138-140, 153-154. This portion of the in-phase baseband signal (second down-converted signal) is later combined with the 0 degree output from the first quarter wave of the period (first down-converted signal) to output a first channel down-converted signal. *See, e.g.*, Tayloe, 2:50-53, 2:56-67; TI-1003, 138-140, 153-154; *see also* Ground 1, Element 14.5, *infra*.

14.5

Tayloe teaches element 14.5. TI-1003, 155-156.

(i) ParkerVision's Construction

For example, Tayloe describes that the baseband in-phase signal 54 and the baseband quadrature signal 56 are combined by the summing amplifier 60, as shown in FIG. 3. Tayloe, 2:65-67; TI-1003, 155.



Tayloe, FIG. 3 + TI Datasheet (annotated)

The signal of interest 62 is a baseband signal where the input signal f_i has the carrier signal f_0 removed. TI-1003, 155. In cases where the carrier signal f_0 is tuned to the input signal f_i , the signal of interest $f_i - f_0$ is exactly at baseband, meaning that not even an intermediate frequency carrier is present. TI-1003, 155.

(ii) **Plain Meaning Construction**

Taylor teaches element 14.5 under TI's construction, where the first channel down-converted signal is the I-phase down-converted signal. TI-1003, 139-140, 156. Taylor teaches that the 0 degree output and the 180 degree output are differentially summed and amplified to output an in-phase (I-phase) down-converted signal, which is the first-channel down-converted signal. *See, e.g.*, Taylor, 2:56-60 ("Summing amplifier 50 differentially sums the 0 degree output and the 180 degree output, thereby producing baseband in-phase signal 54."). This is shown in FIG. 3



53

of that between points 105 and 110, so it follows that the 180 degree output is the negative of the 0 degree output. *Id.* Summing amplifier 50 outputs an amplified version of the 0 degree output minus the 180 degree output, so the output of 50 is also a first down-converted signal. *Id.*

B. GROUND 2A – Razavi Renders Claim 14 Obvious Under Patent Owner’s Construction

1. Razavi

Razavi describes a direct conversion receiver for down-converting a 900 MHz radio frequency signal to baseband. *See, e.g.,* Razavi, 1:1-3. The overall architecture of Razavi includes a low-noise amplifier (LNA), quadrature mixers, a local oscillator, and baseband amplifiers. *See, e.g., id.,* 1:4-7. The architecture is shown in FIG. 1:

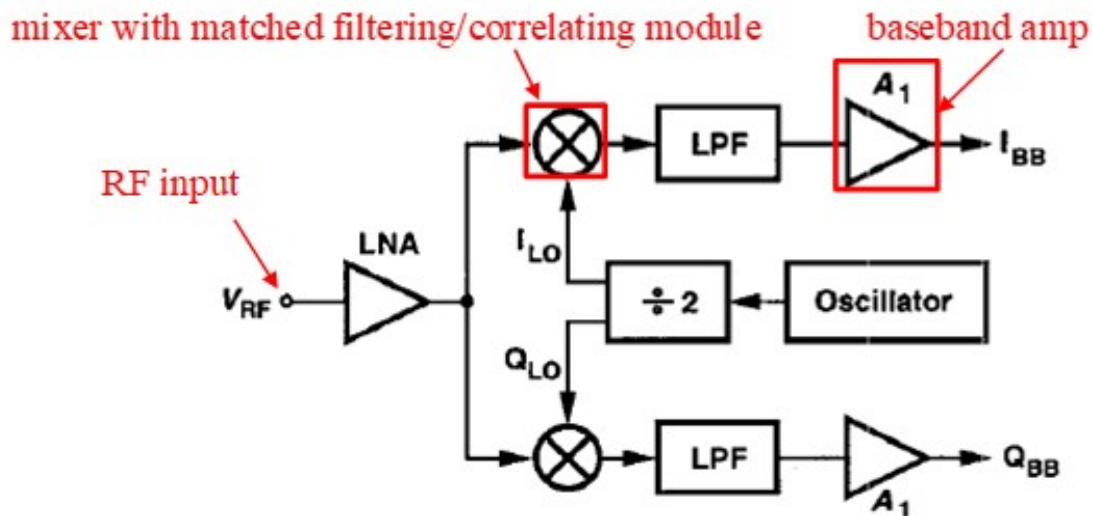


Fig. 1. Receiver architecture.

Razavi, FIG. 2 (annotated)

Each mixer (shown as a circle with an x) includes a matched filtering/correlating module. TI-1003, 95-97. An example of an LNA and mixer are shown in FIG. 2, below:

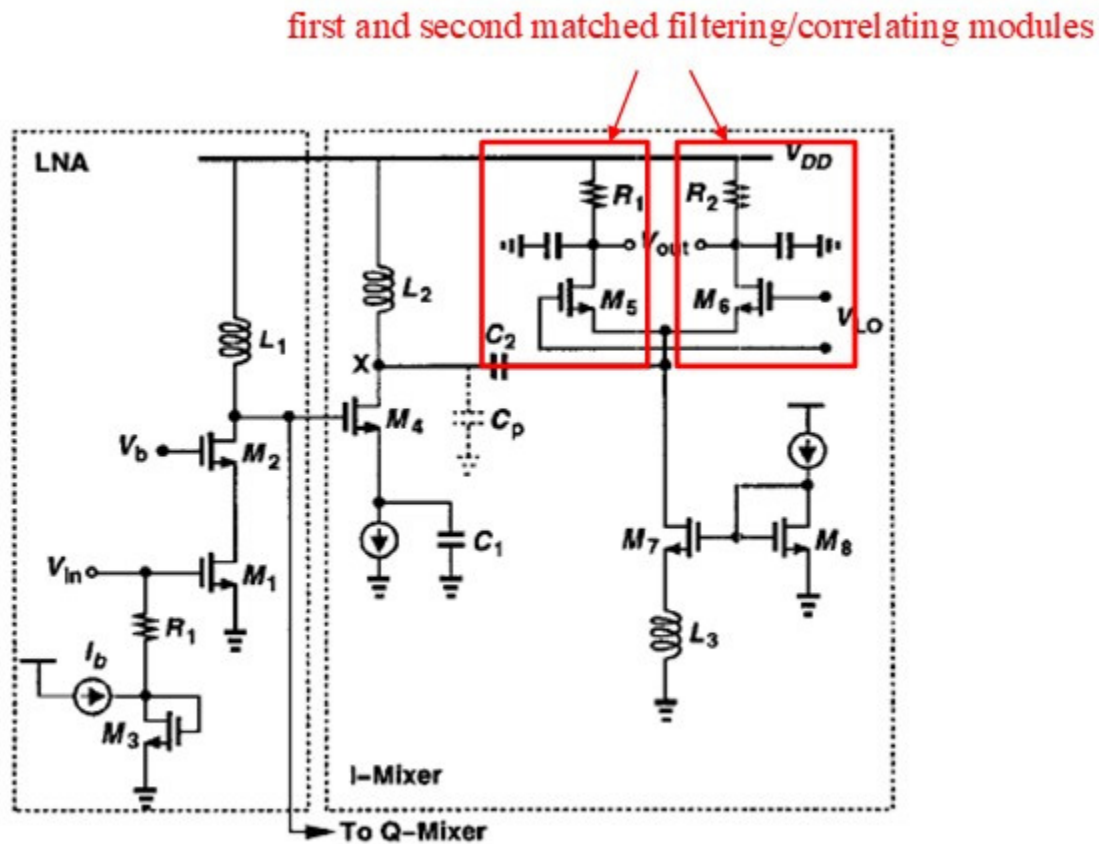


Fig. 2. LNA/mixer implementation.

Razavi, FIG. 2 (annotated)

As can be seen by FIG. 2, each matched filtering/correlating module of Razavi includes a switch (M_5 and M_6 , respectively), a capacitor, and a load R_1 and R_2 . TI-1003, 95-97. When implementing both in-phase and quadrature circuits, each of the in-phase and quadrature circuits include a mixer shown above (although only the in-phase mixer circuit is shown in the figure). *Id.* The output V_{out} of the

matched filtering/correlating module is a downconverted differential baseband in-phase (or quadrature) signal. *Id.*

The baseband in-phase signal is output to another circuit element, which can be an amplifier, a filter, or an analog-to-digital converter. Razavi, 2:21-34. An example architecture for a baseband amplifier is provided in FIG. 5 below:

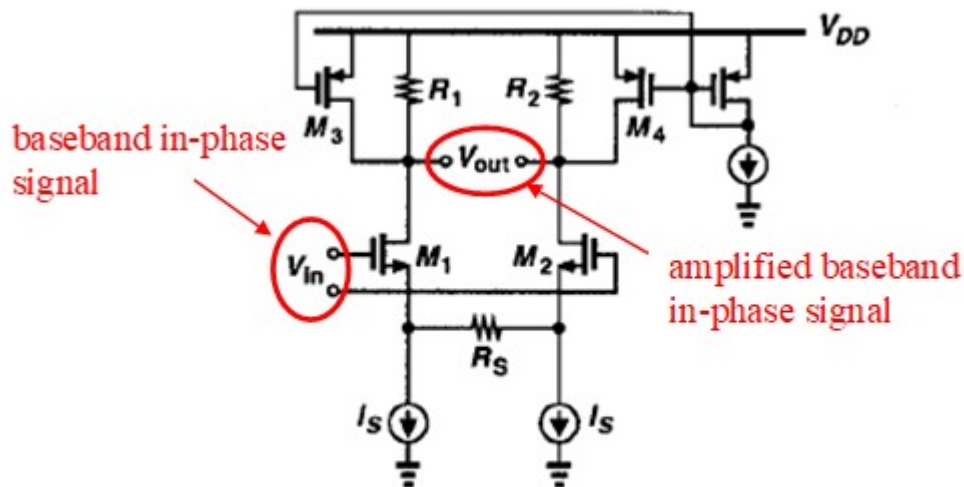


Fig. 5. Baseband amplifier.

Razavi, FIG. 5 (annotated).

Fig. 5 is “the implementation of the baseband amplifier, consisting of a degenerated differential pair M_1 - M_2 and load devices R_1 - R_2 and M_3 - M_4 .” Razavi, 2:35-48, FIG. 5.

2. Analysis

14.P

To the extent that the preamble is limiting, Razavi teaches it. TI-1003, 157-158. For example, Razavi teaches a circuit that when implemented down-converts a

900 MHz electromagnetic signal to baseband. *See, e.g.,* Razavi, 1 (describing a “single-chip 900 MHz CMOS direct conversion receiver”).

In Razavi, a radio frequency (RF) signal (centered at 900 MHz) is received at the input of a low noise amplifier (LNA), where the RF signal is amplified before it is directed to a mixer. *See, e.g.,* Razavi, 1:1-7, FIGS. 1-3. The mixer performs down-conversion of the radio frequency signal. *Id.* The “downconverted signal” can be directed to a baseband amplifier, like that shown in FIG. 5. *Id.*, 2:21-22; TI-1003, 157-158.

14.1

Razavi teaches element 14.1. TI-1003, 159-172. The 900 MHz signal is received at the input V_{in} , Razavi, 1:1-3, shown in FIG. 2 below:

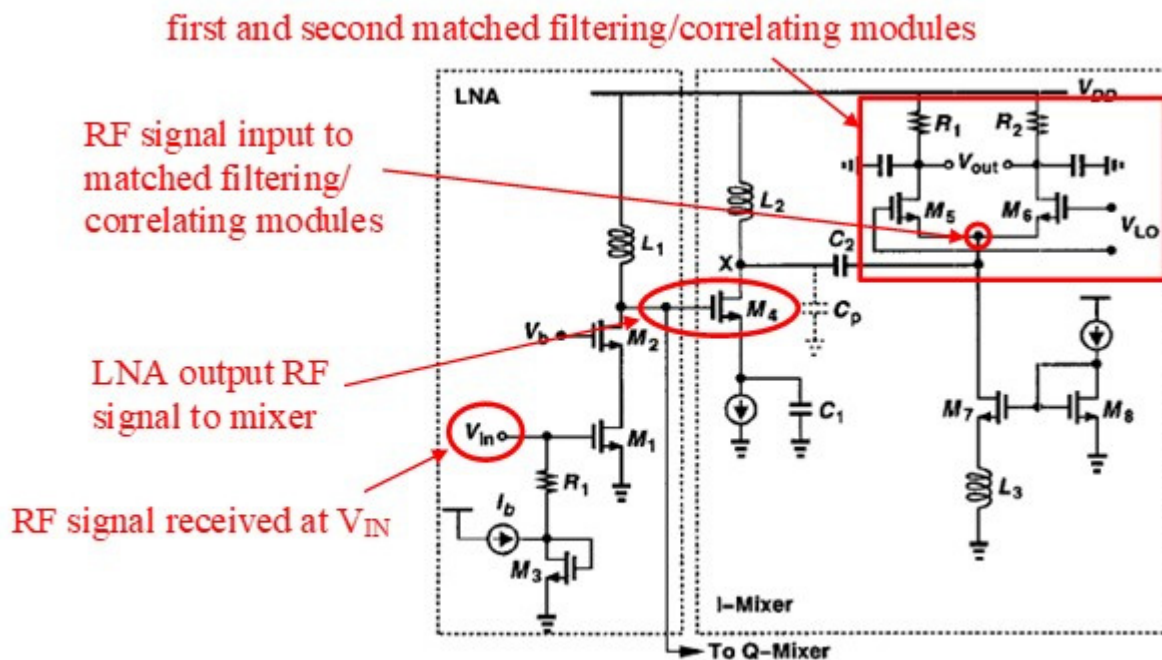


Fig. 2. LNA/mixer implementation.

Razavi, FIG. 2 (annotated)

According to Razavi, “Fig. 2 shows the implementation of the LNA and the quadrature mixers.” Razavi, 1:16-17. FIG. 2 above shows the first and second matched filtering/correlating modules. TI-1003, 159-172.

(i) Patent Owner’s Construction

(a) linear time-variant circuitry

Razavi’s mixer includes circuitry that is well-modeled as linear and time-variant. TI-1003, 160-163. First, as described by Razavi, the “mixer employs a single-balanced topology consisting of an input transistor M4 and a switching pair M5-M6.” Razavi, 1:33-37. The mixer improves the “linearity of the voltage-to-current conversion performed by the input stage” using capacitor C1 degenerates transistor M4 at 900 MHz.” *Id.*

The mixer operates using a local oscillator LO that controls switches periodically via a divided-by-two version of the output signal from the oscillator shown in FIG. 2:

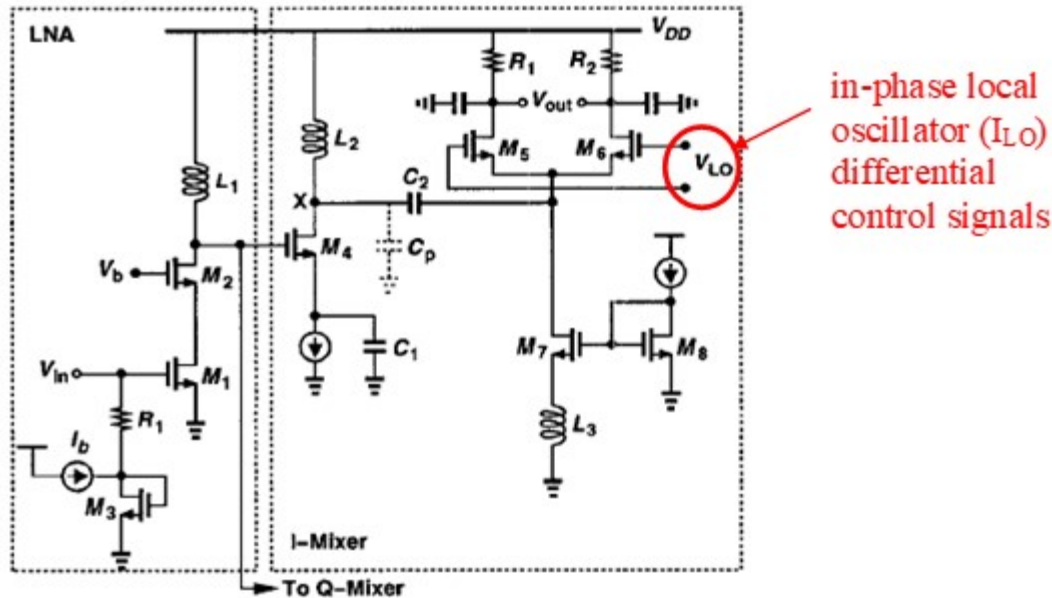


Fig. 2. LNA/mixer implementation.

Razavi, FIG. 2, (annotated)

In the example implementation shown in Razavi, the oscillator in FIG. 2 “operates at 1.8 GHz” and drives a divide-by-two circuit which generates the in-phase (I_{LO}) and quadrature (Q_{LO}) pairs of control signals shown in Fig. 1, both of which have a frequency of 900 MHz (which is an aliasing frequency in the terminology of the ’177 patent as it is less twice the highest frequency of the 900 MHz RF input signal). *See, e.g.,* Razavi, 2:11-14, FIGS. 1-3, 6; TI-1003, 160-163.. The differential control signal, V_{LO} , in FIG. 2 corresponds to I_{LO} in FIG. 1, wherein the bottom V_{LO} signal is an inverted version of the top V_{LO} signal. *See, e.g.,* Razavi, FIG. 2; TI-1003, 160-163. FIG. 1 is shown below:

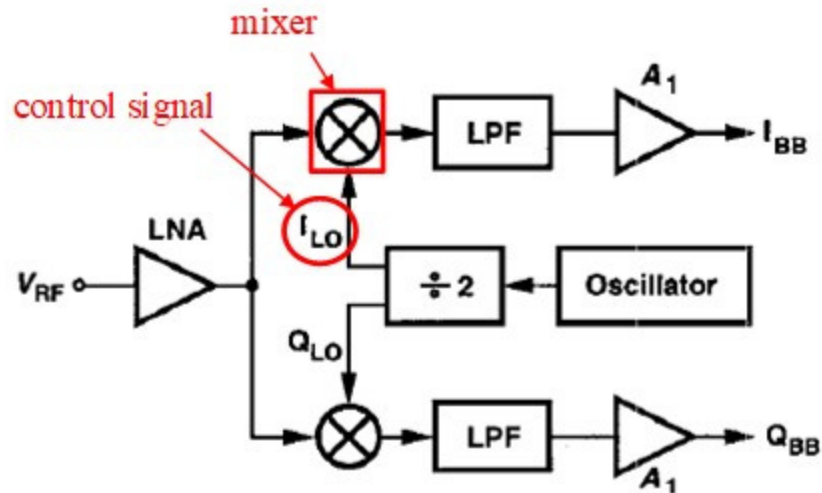


Fig. 1. Receiver architecture.

Razavi, FIG. 1 (annotated)

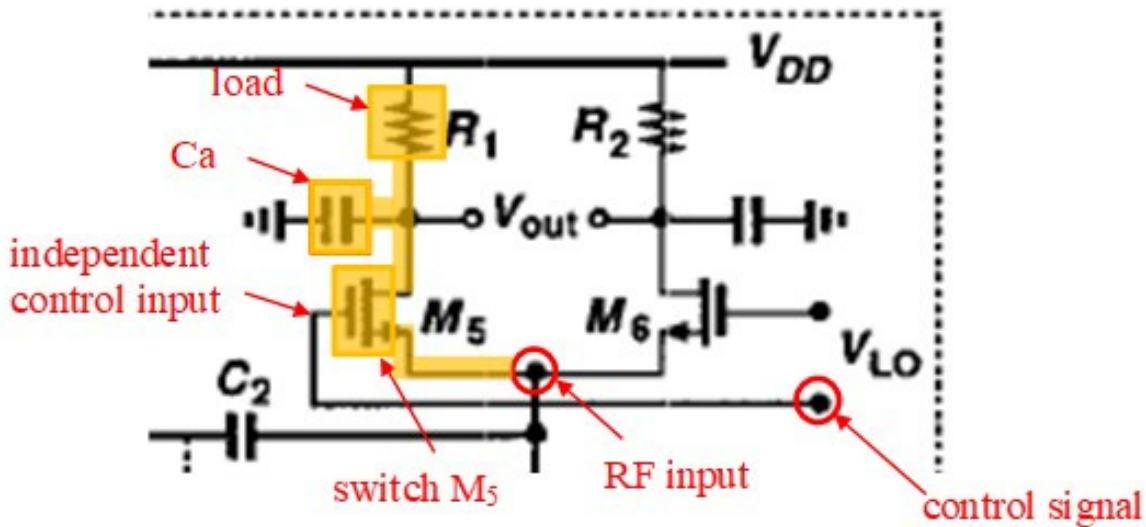
Turning back to FIG. 2, transistor switch M_5 is off when the bottom V_{LO} signal has a is substantially lower voltage than the top V_{LO} signal, and is fully on when the bottom V_{LO} signal has a is substantially higher voltage than the top V_{LO} signal. *See, e.g.,* Razavi, FIG. 2; TI-1003, 160-163. Similarly, transistor switch M_6 is off when the bottom V_{LO} signal has a is substantially higher voltage than the top V_{LO} signal, and is fully on when the bottom V_{LO} signal has a is substantially lower voltage than the top V_{LO} signal. *See, e.g.,* Razavi, FIG. 2; TI-1003, 160-163. As each switch turns off and on once per 900 MHz cycle, the circuit is time-varying. TI-1003, 160-163.

- (b) that samples a modulated RF 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

Razavi describes a direct conversion receiver, which a POSITA would have understood to be used for down-converting a modulated RF carrier signal. Razavi, 1:1-3; TI-1003, 164-168. The circuitry samples the RF signal at an aliasing rate because the spectrum of the RF signal is centered at 900 MHz and the differential V_{LO} signal in FIG. 2 causes each switching transistor to open and close at a rate of 900 MHz. Razavi, 2:11-14 (describing 1.8 GHz oscillator driving divider); TI-1003, 164-168; *see also* TI-1001, 29:59-61 (defining the aliasing rate as “equal to, or less than, twice the frequency of the EM carrier signal”). Here, 900 MHz is an aliasing rate because it is less than twice the EM carrier signal. TI-1003, 164-168.

The circuitry includes a switch (transistor M_5) that has an independent control input for the local oscillator control signal, as shown in FIG. 2 below:



Razavi, FIG. 2 (partial, annotated)

According to Razavi, the “mixer employs a single-balanced topology consisting of an input transistor M_4 and a switching pair M_5 - M_6 .” *See, e.g.*, Razavi, 1:33-35; TI-1003, 164-168. While the switch M_5 is closed, non-negligible energy from the RF input is accumulated on the capacitor labeled C_a in the above FIG. 2. *See, e.g.*, Razavi, 1:49-51 (describing maximizing voltage drop across resistors R_1 and R_2); TI-1003, 164-168. The energy accumulated on the capacitor C_a and transferred to the load while the switch M_5 is closed is non-negligible because the receiver requires a non-negligible signal to perform receiver functions, such as down-conversion of the RF input signal and decoding of the information contained in the received RF input signal. TI-1003, 164-168. If the samples contained negligible energy, the receiver could not function to perform the down-conversion. *Id.* Put differently, the energy of the sample is non-negligible because there must be a non-negligible

amount of energy for the receiver to perform its desired function of receiving, down-converting, and decoding the information contained in the received RF signal. *Id.*

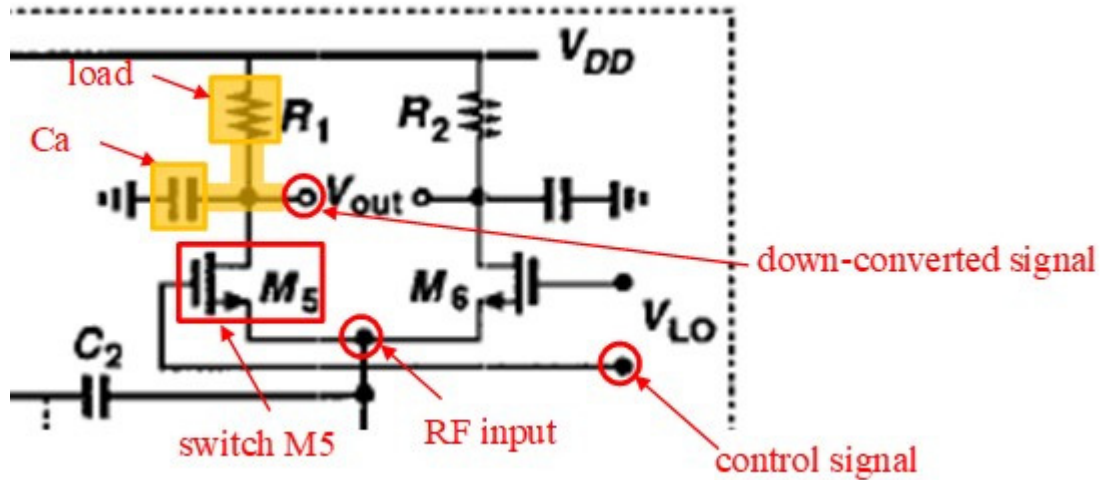
Indeed, all of the energy from the sampling window is accumulated and transferred during the aperture period. TI-1003, 164-168. In the sense that all of the energy during the aperture period is accumulated on capacitor Ca and transferred to load R1, the sample has non-negligible energy. *Id.*

In addition to accumulating charge on capacitor Ca, Razavi's circuit also transfers charge to the load (resistor R1) when the switch is closed. TI-1003, 164-168. The load (resistor R1) is shown in FIG. 2 above.

- (c) and discharged through the load while the switch is open.**
- (d) thereby transferring available real power from the modulated RF carrier signal to the load and**
- (e) producing a down-converted signal with enhanced signal-to-noise power ratio**

Elements (c)-(e) taken together. TI-1003, 169-173.

The charge stored on the capacitor Ca discharges through the load R1 when the switch is open, as shown in FIG. 2 below:



Razavi, FIG. 2 (partial, annotated)

When no RF signal is applied to the system, each capacitor charges to the same voltage, called the quiescent voltage, and therefore each capacitor holds the same amount of charge, called the quiescent charge. TI-1003, 169-173. When an RF signal is applied to the system, it results in a variation of the voltage of each capacitor about its quiescent voltage, called the signal voltage, and a corresponding variation of charge held by each capacitor about its quiescent charge, called the signal charge. *Id.* Signal energy is accumulated on capacitor Ca as a result of its signal charge changing when the RF signal is sampled by the bottom control signal of V_{LO} for a given aperture period. *Id.* When the switch M5 is open, the signal charge on Ca discharges through the load R1, transferring charge through the load R1. *Id.*

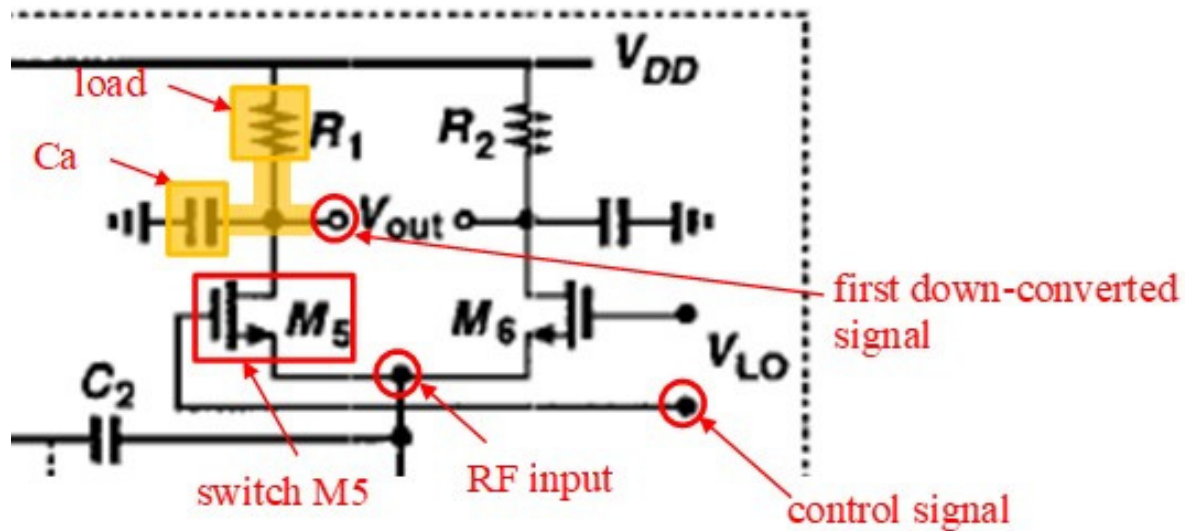
The resulting voltage signal across the resistor R1 is a first down-converted signal, that is “further processed by” the baseband amplifier. *See, e.g.,* Razavi,

2:21-34; TI-1003, 169-173. The resulting voltage is a down-converted signal because it periodically transfers energy from the RF signal to the capacitor for approximately half of each period of the 900 MHz V_{LO} control signal. TI-1003, 169-173.

The combination of R_1 and C_a forms a lowpass filter: “The output nodes of the mixer are loaded with on-chip capacitors [one of which is C_a] to suppress high-frequency components” Razavi, 2:8-9. The “high frequency components” correspond to unwanted interference, so suppressing them enhances the signal to noise ratio. TI-1003, 169-173.

14.2

See, supra, Ground 2A, 14.1 (discussing the resulting voltage across resistor R_1 being a down-converted signal); TI-1003, 159-173, 174-175. The first matched filtering/correlating module down-converts the RF signal according to the control signal V_{LO} , as shown in FIG. 2:



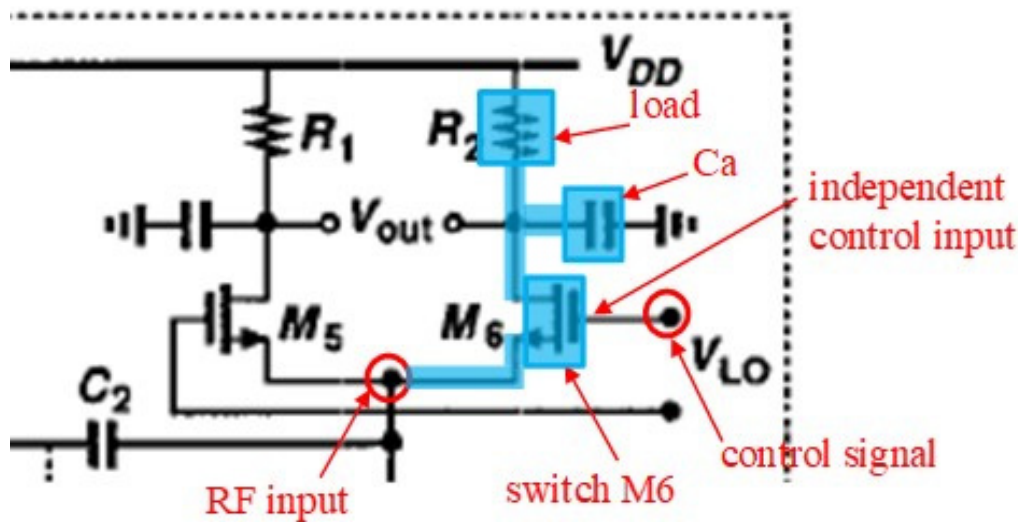
The switching operation of transistor M₅ produces a “downconverted signal” across resistor R₁, that is “further processed by” the baseband amplifier. *See, e.g.*, Razavi, 2:21-34; TI-1003, 174-175. The circled left output of V_{out} in FIG. 2 above represents the output of a first down-converted signal. *See, e.g.*, Razavi, FIG. 2; TI-1003, 174-175.

14.3

See, supra, Ground 2A, 14.1 (discussing Razavi’s first matched filtering/correlation module, the analysis and discussion of which are relevant here for the similar second matched filtering/correlating module); TI-1003, 159-173, 176-184. As already discussed, the matched filtering/correlating module well-approximates a linear and time-variant. TI-1003, 159-173, 176-184. In addition, the Razavi down-conversion circuitry samples the RF signal at an aliasing rate because the spectrum of the RF signal is centered at 900 MHz and the differential VLO signal in FIG. 2

causes each switching transistor to open and close at a rate of 900 MHz (a rate which is obviously less than twice the highest frequency of the 900 MHz RF input signal, so it is an aliasing rate). *See, e.g.*, Razavi, 2:11-14 (describing 1.8 GHz oscillator driving divider); TI-1003, 176-184.

The circuitry includes a switch (transistor M_6) that has an independent control input for the local oscillator control signal, as shown in FIG. 2 below:



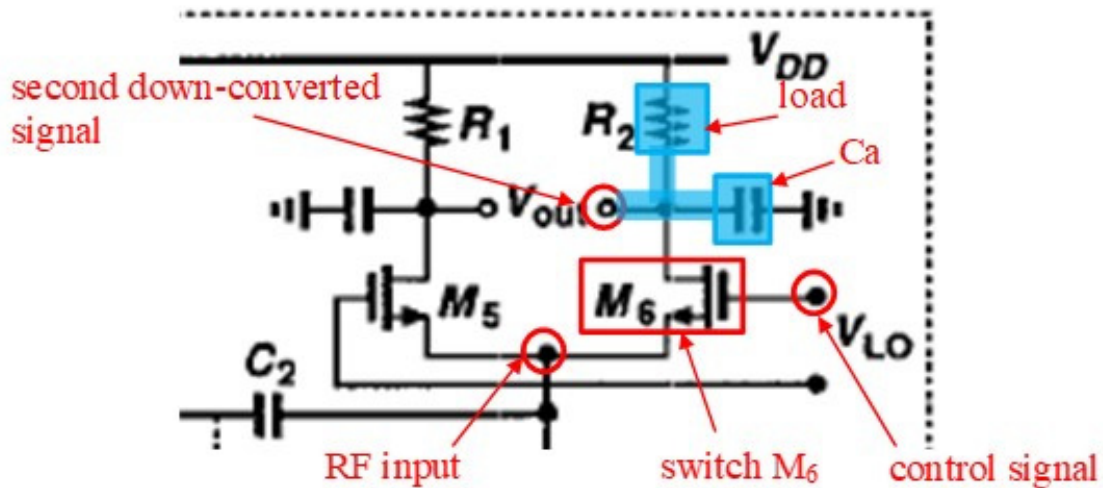
Razavi, FIG. 2 (partial, annotated)

According to Razavi, the “mixer employs a single-balanced topology consisting of an input transistor M_4 and a switching pair M_5 - M_6 .” *See, e.g.*, Razavi, 1:33-35; TI-1003, 176-184. While the switch M_6 is closed, non-negligible energy from the RF input is accumulated on the capacitor labeled C_a in the above figure. *See, e.g.*, Razavi, 1:49-51 (describing maximizing voltage drop across resistors R_1 and R_2); TI-1003, 176-184. In addition to accumulating charge on capacitor C_a , Razavi’s

circuit also transfers charge to the load (resistor R2) when the switch is closed. *See, e.g.,* Razavi, FIG. 2; TI-1003, 176-184. The load (resistor R2) is shown in FIG. 2 above. TI-1003, 176-184.

The energy accumulated on the capacitor C_a and transferred to the load while the switch M_6 is closed is non-negligible because the receiver requires a non-negligible signal to perform receiver functions, such as down-conversion of the RF input signal and decoding of the information contained in the received RF input signal. TI-1003, 176-184. If the samples contained negligible energy, the receiver could not function to perform the down-conversion. TI-1003, 176-184. Put differently, the energy of the sample is non-negligible because there must be a non-negligible amount of energy for the receiver to perform its desired function of receiving, down-converting, and decoding the information contained in the received RF signal. TI-1003, 176-184.

The charge stored on the capacitor C_a discharges through the load R2 when the switch is open, as shown in FIG. 2 below:



Razavi, FIG. 2 (partial, annotated)

When no RF signal is applied to the system, each capacitor charges to the same voltage, called the quiescent voltage, and therefore each capacitor holds the same amount of charge, called the quiescent charge. *See, e.g.,* Razavi, FIG. 2; TI-1003, 176-184. When an RF signal is applied to the system, it results in a variation of the voltage of each capacitor about its quiescent voltage, called the signal voltage, and a corresponding variation of charge held by each capacitor about its quiescent charge, called the signal charge. *See, e.g.,* Razavi, FIG. 2; TI-1003, 176-184. Signal energy is accumulated on capacitor C_a as a result of its signal charge changing when the RF signal is sampled by the bottom control signal of V_{LO} for a given aperture period. TI-1003, 176-184.

Indeed, all of the energy from the sampling window is accumulated and transferred during the aperture period. TI-1003, 176-184. In the sense that all of

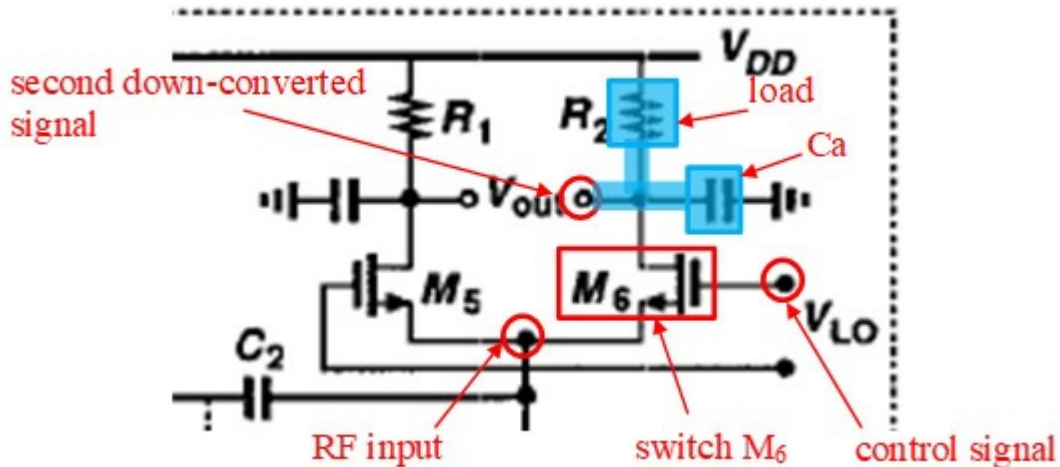
the energy during the aperture period is accumulated on capacitor Ca and transferred to load R1, the sample has non-negligible energy. *Id.*

When the switch M₆ is open, the signal charge on Ca discharges through the load R2, transferring charge through the load R2. *See, e.g.,* Razavi, FIG. 2; TI-1003, 176-184. The resulting voltage signal across the resistor R2 is a second down-converted signal, that is “further processed by” the baseband amplifier. *See, e.g.,* Razavi, 2:21-34; TI-1003, 176-184.

The combination of R₂ and Ca form a lowpass filter: “The output nodes of the mixer are loaded with on-chip capacitors [one of which is Ca] to suppress high-frequency components” Razavi, 2:8-9. The “high frequency components” correspond to unwanted interference, so suppressing them enhances the signal to noise ratio. TI-1003, 176-184.

14.4

See, supra, Ground 2A, 14.1-2 (discussing Razavi’s receiver operation and how it performs down-conversion, which are applicable here); TI-1003, 174-175, 185. The second matched filtering/correlating module down-converts the RF signal according to the control signal V_{LO}, as shown in FIG. 2:



Razavi, FIG. 2 (partial, annotated)

The switching operation of transistor M_6 produces a down-converted signal across resistor R_2 , that is “further processed by” the baseband amplifier. *See, e.g.,* Razavi, 2:21-34. The circled V_{out} in FIG. 2 above represents the output of a second down-converted signal. TI-1003, 174-175, 185.

14.5

Taylor teaches element 14.5. TI-1003, 186-187. For example, the down-converted signal output of the first matched filtering/correlating module (the left V_{out} terminal in Figure 2) and the inverted down-converted signal output of the second matched filtering/correlating module (the right V_{out} terminal in FIG. 2) are connected to the respective input terminals (labeled V_{in}) of the baseband amplifier shown in FIG. 5. *See, e.g.,* Razavi, 2:35-48, FIGS. 2, 5; TI-1003, 186-187. The

baseband amplifier differentially amplifies its two V_{in} inputs while largely suppressing the common-mode component (i.e., the average) of its two V_{in} inputs. TI-1003, 186-187. Thus, each of the baseband amplifier's V_{out} output signals contains an amplified version of the difference between the baseband amplifier's two V_{in} inputs (i.e., the difference between said down-converted signal and said inverted down-converted signal). *See, e.g.,* Razavi, 2:35-48, FIGS. 2, 5; TI-1003, 186-187. The two V_{out} signals differ in that their above-mentioned amplified differences between the two V_{in} signals have different signs. *See, e.g.,* Razavi, 2:35-48, FIGS. 2, 5; TI-1003, 186-187. Consequently, the difference between the two V_{out} signals is an amplified version of the difference between the two V_{in} signals. *See, e.g.,* Razavi, 2:35-48, FIGS. 2, 5; TI-1003, 186-187.

A POSITA would have recognized that it follows that each of the two V_{out} signals is a combined version of said first and second down-converted signals, and, furthermore, the two V_{out} signals taken together represent a differential version of the combination of said first and second down-converted signals. TI-1003, 186-187.

C. GROUND 2B – Razavi and Uzunoglu Render Claim 14 Obvious Under the Plain-and Ordinary Meaning

1. Uzunoglu

The circuit presented in Uzunoglu, referred to as a synchronous oscillator circuit, performs carrier synchronization (also known as carrier recovery). TI-1003,

98-99. The circuit operates on a received RF input signal and generates an oscillatory output signal that closely matches both the frequency and phase of the received RF input signal's carrier. TI-1003, 98-99. The functional description of the circuit is shown in FIG. 1 below:

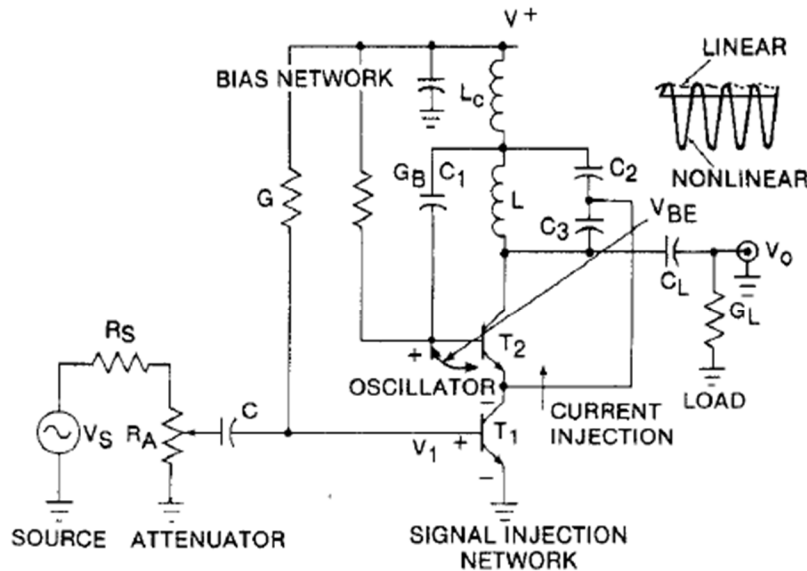


Fig. 1. Functional description of the SO circuit.

Uzunoglu, FIG. 1

FIG. 1 of Uzunoglu illustrates the basic injection-locked synchronous oscillator (SO) circuit and a functional description of its operation. TI-1003, 98-99. According to Uzunoglu, a "synchronous oscillator (SO) is a free-running oscillator which oscillates at its natural frequency in the absence of an externally applied signal. TI-1003, 98-99. In the presence of a signal, the oscillator synchronizes with and

tracks the input waveform with an acquisition time inversely proportional to the tracking bandwidth.” Uzunoglu, Abstract; TI-1003, 98-99.

As explained in Uzunoglu, “[t]he synchronous oscillator (SO) is an important functional element for synchronization and tracking in communication systems,” its “output signal amplitude remains constant and unaffected by variations in the input drive level; however, the output phase is modulated to synchronize and track the input signal.” Uzunoglu, 11-12; TI-1003, 98-99.

2. The Razavi and Uzunoglu Combination

Razavi describes a 900 Mhz direct conversion receiver that uses first and second down-conversion circuitry to down-convert an RF signal to baseband. TI-1003, 188. While Razavi’s control signal (from its local oscillator) is nominally set to 900 MHz, which is the same as the carrier frequency of the RF input signal, Razavi, does not describe synchronizing the control signal with the frequency of the input signal. *Id.* In the combination, the control signal of Razavi that controls the operation of the switches in the down-conversion circuitry is synchronized to the frequency of the carrier signal of the input signal in a manner similar to that described by Uzunolgu. *Id.*

3. Motivation to Combine Razavi and Uzunoglu

A POSITA would have been motivated to combine Razavi with Uzunoglu to synchronize the control signal from the local oscillator signal of Razavi with the

carrier frequency of the RF input signal. TI-1003, 189-193. A POSITA would have recognized that any transmitter that generates the type of 900 MHz RF input signal that the Razavi circuit is designed to receive typically has its own local oscillator. *Id.* If the local oscillator were to have exactly the right frequency, then the transmitted RF input signal spectrum would be centered exactly at 900 MHz. *Id.* In this case, if the V_{LO} control signals derived from the oscillator signal in the Razavi circuit were to have a frequency of exactly 900 MHz, then the RF input signal would be down-converted to exactly zero-frequency. *Id.*

It is difficult for independent oscillators to have exactly the frequencies they are designed to have (a result of inevitable non-ideal circuit behavior). TI-1003, 189-193. Therefore, the center frequency of the received RF input signal will deviate slightly from the frequency of the V_{LO} control signals. *Id.* In this case, further processing typically is necessary to compensate for this unwanted deviation. *Id.* In many cases the further processing is done via digital signal processing after analog-to-digital conversion. *Id.* However, it can instead be done by synchronizing the V_{LO} control signals to the carrier frequency (i.e., the center frequency) of the received RF input signal via a carrier synchronization circuit (such as the Uzunoglu circuit). *Id.* For example, if non-ideal circuit behavior in the transmitter were to cause the actual carrier frequency of the received RF input signal to be 901 MHz, instead of 900 MHz, then the carrier synchronization circuit would cause the

frequency of the V_{LO} control signals to be 901 MHz too. *Id.* This would not only eliminate the need for the additional processing mentioned above, but if the carrier synchronization circuit were designed to cause the phase of one of V_{LO} control signals to precisely match that of the carrier of the received RF input signal (the Uzunoglu circuit is one of many such circuits designed to have this functionality), then only one of the mixers (e.g., just the circuit labeled I-Mixer in FIG. 2 of Razavi) would be necessary. *Id.* A POSITA would recognize this as a well-known technique, and would know that receivers which use the technique are said perform synchronous demodulation. *Id.*; see, e.g., TI-1019, 183, 455.

In addition, a POSITA would have recognized the advantages of synchronization. TI-1003, 189-193. A POSITA would have recognized that synchronization offers the potential advantage of reducing circuit complexity. *Id.* For example, a POSITA would have recognized that using an SO like that of Uzunoglu in Razavi would have reduced the circuit complexity by allowing the elimination of one of the mixer circuits (e.g., the quadrature mixer) and its associated circuitry (e.g., lowpass filter, amplifier, ADC, and digital signal processing). *Id.* Additionally, using SO results in eliminating the need for post processing of the two baseband signals to correct for the difference between the RF input signal's carrier frequency and the frequency of V_{LO} . *Id.*

A POSITA would have had a reasonable expectation of success implementing SO circuitry, like that of Uzunoglu. TI-1003, 189-193. First, Uzunoglu provides details for how its SO should be implemented and discusses implementation and configuration details. *See, e.g.*, Uzunoglu, 4-12 (discussing experimental results); TI-1003, 189-193. In addition, Uzunoglu also provides other circuit designs that a POSITA could try to use as an alternative, while also teaching the advantages of its own design. Uzunoglu, 1, 12 (listing prior art references); TI-1003, 189-193.

A POSITA at the time of the priority date of the '177 patent would have recognized that a synchronous oscillator such as that presented in Uzunoglu is just one of many circuits which perform carrier synchronization, yet would understand that, as explained in Uzunoglu, the synchronous oscillator represents an attractive option in that it has several desirable properties. Uzunoglu, 1-2 (describing various SO designs); TI-1003, 189-193. These desirable properties include but are not limited to a “very narrow resolution bandwidth [that] permits the extraction of information from signals with extremely low carrier-to-noise ratios, such as -40 dB while tracking at several hundred kilohertz to permit rapid phase acquisition,” the ability to “track the input signal even to power levels as low as -100 dBm,” and reduction of “steady-state phase error in synchronization to a low value.” Uzunoglu, Abstract; TI-1003, 189-193. A POSITA also would have recognized that

other known circuits which perform carrier synchronization offer different performance tradeoffs and benefits, so while the Uzunoglu circuit is an attractive option, other options might be even more attractive for certain applications. TI-1003, 189-193. Therefore, the Uzunoglu circuit is considered herein as a representative example of a carrier synchronization circuit. TI-1003, 189-193.

4. Analysis

14.P

See, supra, Ground 2A, 14.P.

14.1

The combination provides 14.1 under the plain meaning of “matched filtering/correlating module.” TI-1003, 18-32, 62-63, 195-196. As discussed in Ground 2A, 14.1, *supra*, Razavi describes all of the circuit components of a first matched filtering/correlating module, as claimed by the ’177 patent. TI-1003, TI-1003, 159-172, 195-196. In the combination, Razavi’s control signal is synchronized, i.e., matched or correlated, to the carrier frequency of the RF input signal, as described by Uzunoglu. TI-1003, 188, 195-196. The output of the Uzunoglu circuit directly generates one of the V_{LO} control signals in Razavi. TI-1003, 188, 195-196. The SO does this through the principle of injection locking. Uzunoglu, 1; TI-1003, 195-196. The synchronous oscillator is coupled to the RF input signal in such a way that it is injection locked, also known as pulled, to the frequency and phase of the RF input signal’s carrier. Uzunoglu, 1; TI-1003, 195-196. The SO circuitry has a

narrow locking range that ensures that it is relatively unaffected by the modulation of the RF signal, and instead the circuitry locks to the carrier. Uzunoglu, 1; TI-1003, 195-196. The output, therefore, is a signal that is synchronized with the carrier frequency. TI-1003, 195-196.

The Razavi down-conversion circuitry described in Ground 2A operates the same way in the combination. TI-1003, 195-196. With the application of Uzunoglu's circuitry to synchronize the control signal with the carrier frequency of the RF input signal, the Razavi mixer operates to down-convert the RF signal using the switch M₅, capacitor Ca and load R1. *Id.* The only difference is the matching or correlating of the control signal to the carrier frequency of the RF input signal. *Id.*

14.2

See, supra, Ground 2A, 14.2.

14.3

The combination provides 14.3 under the plain meaning of “matched filtering/correlating module.” TI-1003, 195-196, 198-199. As discussed in Ground 2A, 14.1-3, *supra*, Razavi describes all of the circuit components of a first and second matched filtering/correlating modules, as claimed by the '177 patent. TI-1003, 154-184. In the combination, Razavi's control signal is synchronized to the carrier frequency of the RF input signal, as described by Uzunoglu. TI-1003, 188, 195-199. The output of the Uzunoglu circuit directly generates one of the V_{LO} control

signals in Razavi. The SO does this through the principle of injection locking. Uzunoglu, 1. The synchronous oscillator is coupled to the RF input signal in such a way that it is injection locked, also known as pulled, to the frequency and phase of the RF input signal's carrier. *Id.* The SO circuitry has a narrow locking range that ensures that it is relatively unaffected by the modulation of the RF signal, and instead the circuitry locks to the carrier. *Id.* The output, therefore, is a signal that is synchronized with the carrier frequency. TI-1003, 195-199. The synchronization between the control signal and the carrier frequency means that the operation of the circuitry in the Razavi-Uzunoglu combination is the same operation of a matched filtering/correlating module. *Id.*

The Razavi down-conversion circuitry described in Ground 2A operates the same way in the combination. With the application of Uzunoglu's circuitry to synchronize the control signal with the carrier frequency of the RF input signal, the Razavi mixer operates to down-convert the RF signal using the switch M₆, capacitor C_a and load R₂. TI-1003, 195-196, 198-199. The only difference is the synchronization of the control signal to the carrier frequency of the RF input signal. TI-1003, 195-196, 198-199.

14.4

See, supra, Ground 2A, 14.4.

14.5

See, supra, Ground 2A, 14.5.

IV. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

A. 35 U.S.C. §325(d) – *Advanced Bionics*

Advanced Bionics and the *Becton* factors strongly favor institution. *Advanced Bionics LLC v. MED-EL Elektromedizinische Gerate GmbH*, IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (“*Advanced Bionics*”) (precedential); *Becton, Dickinson and Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 (PTAB Dec. 15 2017) (“*Becton*”) (precedential).

The Examiner did not issue a prior art rejection in the prosecution of the ’177 patent. *See, generally*, TI-1002. Although Tayloe and articles by the same author of Razavi are cited on the face of the ’177 patent, there is no indication in the ’177 Patent’s file history that the Examiner substantively considered Tayloe or any of the other prior art applied in this Petition prior to allowing the application that issued as the ’177 Patent. *Id.* Tayloe and Razavi have been relied upon in other IPRs challenging patents owned by Patent Owner which may involve related technology. However, the fact that Tayloe and Razavi have never been applied to the ’177 patent favors institution.

Because the ’177 Patent’s prosecution did not involve any discussion between the applicant and the Examiner regarding the teachings of the prior art applied in this Petition, the challenge to patentability based on the prior art asserted in

this Petition is not the same as, or substantially similar to, art and arguments previously presented to the Office in connection with the '177 Patent. *See, generally*, TI-1002. Accordingly, neither condition of the first prong of the *Advanced Bionics* framework is met, and there is no need to reach the second prong to resolve against discretionary denial under Section 325(d). *See, e.g., Oticon Medical AB et. al. v. Cochlear Ltd.*, IPR2019-00975, Paper 15 at 20 (PTAB Oct. 16, 2019) (precedential) (“There is new, noncumulative prior art asserted in the Petition...[f]or at least this reason, we determine not to exercise our discretion under § 325(d)”).

For at least the above-noted reasons, Petitioner respectfully submits that discretionary denial is unwarranted, and that the Board should instead institute IPR based on the instant Petition’s grounds.

B. 35 U.S.C. §314(a) – *General Plastic*

The '177 patent has never been the subject of an IPR or reexamination and therefore the *General Plastic* factors favor institution.

C. 35 U.S.C. §314(a) - *Fintiv*

In *Apple Inc. v. Fintiv, Inc.*, the Board enumerated six factors that it will assess in determining whether to exercise discretion to deny institution under §314(a) based on co-pending litigation. IPR2020-00019, Paper 11 at 2-3 (PTAB “precedential” Mar. 20, 2020). The USPTO issued updated discretionary denial guidance in view of the *Fintiv* factors and confirmed that “the PTAB will not discretionarily

deny institution in view of parallel district court litigation where a petitioner presents a stipulation not to pursue in a parallel proceeding the same grounds or any grounds that could have reasonably been raised before the PTAB.” *See* June 21, 2022 Memorandum to Members of the PTAB, 3 (available at https://www.uspto.gov/sites/default/files/documents/interim_proc_discretionary_denials_aia_parallel_district_court_litigation_memo_20220621_.pdf). Here, Petitioner has eliminated any risk of duplicated effort by voluntarily presenting a *Sotera* stipulation to Patent Owner. TI-1041; *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020). For at least this reason, and considering the compelling merits of the above-detailed Grounds, discretionarily denial is unwarranted and would be unjust.

V. CONCLUSION AND FEES

The Challenged Claims are unpatentable. Petitioner authorizes charge of fees to Deposit Account 06-1050.

VI. MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Texas Instruments Incorporated is the real party-in-interest.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

The ‘177 Patent is the subject of a civil action, *ParkerVision, Inc. v. Texas Instruments Incorporated*, 6:23-cv-00384, W.D. Tex., filed May 18, 2023 (TI-1004), *ParkerVision, Inc. v. NXP Semiconductors NV et al*, 6-23-cv-00389

(WDTX) filed May 19, 2023, *ParkerVision, Inc. v. Realtek Semiconductor Corp.*,
6-23-cv-00374 (WDTX) filed May 16, 2023, *ParkerVision, Inc. v. MediaTek, Inc.*
et al. 6-23-cv-00375 (WDTX) filed May 16, 2023, *ParkerVision, Inc. v. Qual-*
comm Incorporated, 22-1755 (CAFC) filed May 4, 2022 and *ParkerVision, Inc. v.*
Qualcomm Incorporated et al. 6-14-cv-00687 (MDFL) filed May 2, 2014.

Petitioner is not aware of any other disclaimers, reexamination certificates,
or IPR petitions addressing the '177 Patent.

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

Lead Counsel	Backup counsel
Joshua A. Griswold, Reg No. 46,310 Fish & Richardson P.C. 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR12189-0091IP1@fr.com	Rishi Gupta, Reg. No. 64,768 Yao Wang, Reg. No. 61,757 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 PTABInbound@fr.com

D. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at IPR12189-0091IP1@fr.com
(referencing No. 12189-0091IP1 and cc'ing PTABInbound@fr.com, [gris-](mailto:griswold@fr.com)
wold@fr.com, rgupta@fr.com and ywang@fr.com).

Attorney Docket No. 12189-0091IP1

IPR of U.S. Patent No. 7,865,177

Respectfully submitted,

Dated May 18, 2024

/Joshua A. Griswold/

Joshua A. Griswold, Reg. No. 46,310

Rishi Gupta, Reg. No. 64,768

Yao Wang, Reg. No. 61,757

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

(Control No. IPR2024-00935)

Attorneys for Petitioner

CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,961 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated May 18, 2024

/Joshua A. Griswold/
Joshua A. Griswold, Reg. No. 46,310
Rishi Gupta, Reg. No. 64,768
Yao Wang, Reg. No. 61,757
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
T: 202-783-5070
F: 877-769-7945

Attorneys for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on May 18, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were provided by Federal Express, to the Patent Owner, by serving the correspondence address of record as follows:

Workman Nydegger
60 East South Temple, Suite 1000
Salt Lake City, UT 84111

/Diana Bradley/
Diana Bradley
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
(858) 678-5667