

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner

v.

THETA IP, LLC,
Patent Owner

Case No. IPR2024-00818

U.S. Patent No. 10,524,202

**DECLARATION OF DR. ASAD ABIDI
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 10,524,202**

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I, Dr. Asad Abidi, hereby declare the following:

I. INTRODUCTION

1. My name is Asad Abidi, and I am over 21 years of age and otherwise competent to make this Declaration. I make this Declaration based on facts and matters within my own knowledge and on information provided to me by others. If called as a witness, I could and would competently testify to the matters set forth herein.

2. I have been retained by counsel for Petitioner as a technical expert in the above-captioned case. Specifically, I have been asked to render certain opinions relating to the accompanying Petition for *Inter Partes* Review of 10,524,202 (the “’202 Patent”), challenging Claims 1-2, 4-23 in the patent (“Challenged Claims”). My compensation in this matter is not based on the substance of my opinions or the outcome of this matter, and I have no financial interest in Apple Inc.

A. Background and Qualifications

3. I have summarized in this section my educational background, career history, and other qualifications relevant to this matter. I have also included a current version of my curriculum vitae, which is attached as Appendix A.

4. I received a Master of Science degree in Electrical Engineering in 1978 and a PhD in Electrical Engineering in 1981, both from the University of California, Berkeley. In 2015, I received UC Berkeley’s Distinguished EECS Alumnus Award

5. After earning my doctorate degree, I went to work at Bell Laboratories in Murray Hill, NJ, from 1981-1984, where I was a member of the Technical Staff in the Advanced LSI Development Laboratory. My research here was focused on MOS integrated circuits with gigahertz bandwidths for optical-fiber interface electronics.

6. In 1985 I joined the University of California, Los Angeles (UCLA) as a member of the faculty of Electrical Engineering. Today, I hold the title of Distinguished Professor at UCLA. My research focuses on advanced analog integrated circuits for RF communications, signal processing, and data conversion.

7. In 1996, I was elevated to Fellow of the Institute of Electrical and Electronics Engineers (IEEE). In 2007, I was elected Member of the US National Academy of Engineering (NAE). Election to the NAE is one of the highest professional honors accorded in the US to an engineer.

8. I have received many major awards for my research. They include the IEEE Donald G. Fink Prize Paper Award in 1997, and the IEEE Donald O. Pederson Solid-State Circuits Award in 2008. My publications have received the Best Paper Award twice from the IEEE Journal of Solid-State Circuits, in 2012 and 2022.

9. My opinions are based on my years of education, research, and experience, as well as my study of relevant materials. In forming my opinions, I have also considered the materials identified in this declaration and in the Petition.

10. In sum, I have extensive experience as a researcher relating to wireless communications devices.

11. In writing this declaration, I have considered my own knowledge and experience, including my work, research, and teaching experience. I have also reviewed the following references and materials:

Exhibit 1001	U.S. Patent No. 10,524,202 (the “’202 Patent”)
Exhibit 1002	File History for U.S. Patent 10,524,202 (the “’202 File History”)
Exhibit 1003	<i>Intentionally left blank</i>
Exhibit 1004	Farbod Behbahani et al., <i>Adaptive Analog IF Signal Processor for a Wide-Band CMOS Wireless Receiver</i> , 36 IEEE Journal of Solid-State Circuits 1205, (Aug. 2001) (“Behbahani”)
Exhibit 1005	Farbod Behbahani et al., <i>A 2.4-GHz Low-IF Receiver for Wideband WLAN in 0.6μm CMOS – Architecture and Front-End</i> , 35 IEEE Journal of Solid-State Circuits 1908, (Dec. 2000) (“Leete”)
Exhibit 1006	Farbod Behbahani et al., <i>A Broad-Band Tunable CMOS Channel-Select Filter for a Low-IF Wireless Receiver</i> , 35 IEEE Journal of Solid-State Circuits 476, (April 2000) (“Tan”)
Exhibit 1007	<i>Intentionally left blank</i>
Exhibit 1008	<i>Intentionally left blank</i>
Exhibit 1009	<i>Intentionally left blank</i>
Exhibit 1010	<i>Intentionally left blank</i>
Exhibit 1011	Y. Tsividis et al., <i>Internally Varying Analog Circuit Minimize Power Dissipation</i> , IEEE Circuits & Devices Magazine, Jan. 2003.
Exhibit 1012	Mihai Banu & Yannis Tsividis, <i>Fully Integrated Active RC Filters in Technology</i> , 18 IEEE Journal of Solid-State Circuits 644, (Dec. 1983) (“Fully Integrated”)
Exhibit 1013	Farbod Behbahani et. al, <i>An Adaptive 2.4GHz Low-IF Receiver in 0.6μm CMOS for Wideband Wireless LAN</i> , IEEE International Solid-State Circuits Conference, 2000 (“Kishigami”).
Exhibit 1014	U.S. Patent No. 6,335,952 to Lee et al. (“Lee”)
Exhibit 1015	Reinhold Ludwig, et. al, <i>RF Circuit Design</i> , 2000, (“Ludwig”)
Exhibit 1016	“AN-844 Integrated LNA and Mixer Basics” by Texas Instruments (April 1993) (“Texas”)

Exhibit 1017	U.S. Patent No. 6,498,927 to Kang et al. (“Kang”)
Exhibit 1018	<i>Intentionally left blank</i>
Exhibit 1019	“BARRON’S ELECTRONICS THE EASY WAY”, (2002) (“Barron”)
Exhibit 1020	<i>Intentionally left blank</i>
Exhibit 1021	Thomas Byunghak Cho, et al, <i>A 10 b, 20 Msample/s, 35 mW Pipeline A/D Converter</i> , IEEE Journal Of Solid-State Circuits Conference, (March 1995) (“Cho”)
Exhibit 1022	<i>Intentionally left blank</i>
Exhibit 1023	Roubik Gregorian, <i>Analog MOS Integrated Circuits for Signal Processing</i> (1986) (“Gregorian”)
Exhibit 1024	John Pritiskutch et al, <i>UNDERSTANDING LDMOS DEVICE FUNDAMENTALS</i> , (July 2000) (“STMicroelectronics”)
Exhibit 1025	<i>Intentionally left blank</i>
Exhibit 1026	John G. Proakis et. al, <i>Communications Systems Engineering</i> , (1994) (“Proakis”)
Exhibit 1027	<i>Intentionally left blank</i>
Exhibit 1028	The Evolution of Wi-Fi Technology, IEE Standards Association (May 16, 2023) (“IEEE”)
Exhibit 1029	Kevin Werbach, <i>The New Wireless Paradigm</i> , Open Spectrum (October 2002) (“Werbach”)
Exhibit 1030	Robert G. Fichman et. al, <i>Information-Rich Commerce At A Crossroads: Business and Technology Adoption Requirements</i> , (July 2002) (“Fichman”)
Exhibit 1031	U.S. Patent No. 6,480,700 to Groe et al. (“Groe”)
Exhibit 1032	<i>Intentionally left blank</i>
Exhibit 1033	The American Heritage dictionary (2001) (“Heritage”)
Exhibit 1034	Rudolf F. Graf, Seventh Edition Modern Dictionary of Electronics (1999) (“Graf”)
Exhibit 1035	<u>Arthur D. Spaulding et al, <i>Optimum Reception in an Impulsive Interference Environment-Part I: Coherent Detection</i>, (September 1997), IEEE Transactions on Communications, Vol. COM-25, No. 9 (“Spaulding”)</u>
Exhibit 1036	<i>Intentionally left blank</i>
Exhibit 1037	<i>Intentionally left blank</i>
Exhibit 1038	<i>Intentionally left blank</i>
Exhibit 1039	<i>Intentionally left blank</i>
Exhibit 1040	Paul R. Gray & Robert G. Meyer, <i>Analysis and Design of Analog Integrated Circuits</i> , pp. 147-148, John Wiley & Sons, (1997) (“Gray”)

II. LEGAL FRAMEWORK

12. I am a technical expert and do not offer any legal opinions. However, counsel has informed me as to certain legal principles regarding patentability and related matters under United States patent law, which I have applied in performing my analysis and arriving at my technical opinions in this matter.

13. I have been informed that the Patent Trial and Appeal Board (“PTAB”) now applies the claim construction standard applied by Article III courts (i.e., the *Phillips* standard) regardless of whether a patent has expired. I have been informed that under the *Phillips* standard, claim terms are to be given the meaning they would have to a person having ordinary skill in the art at the time of the invention, taking into consideration the patent, its file history, and, secondarily, any applicable extrinsic evidence (e.g., dictionary definitions). I understand that, for purposes of this proceeding, Petitioner has proposed the PTAB apply certain specific constructions advanced in the parallel litigation. I have reviewed these constructions in the petition and apply them to my analyses herein. For any other claim language, I have applied its plain meaning as instructed by *Phillips*.

14. I have also been informed that a person cannot obtain a patent on an invention if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was

made to a person having ordinary skill in the art. I have been informed that a conclusion of obviousness may be founded upon more than a single item of prior art. I have been further informed that obviousness is determined by evaluating the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claim at issue, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations of non-obviousness. In addition, the obviousness inquiry should not be done in hindsight. Instead, the obviousness inquiry should be done through the eyes of a person having ordinary skill in the relevant art at the time the patent was filed.

15. In considering whether certain prior art renders a particular patent claim obvious, counsel has informed me that I can consider the scope and content of the prior art, including the fact that one of skill in the art would regularly look to the disclosures in patents, trade publications, journal articles, industry standards, product literature and documentation, texts describing competitive technologies, requests for comment published by standard setting organizations, and materials from industry conferences, as examples. I have been informed that for a prior art reference to be proper for use in an obviousness analysis, the reference must be “analogous art” to the claimed invention. I have been informed that a reference is analogous art to the claimed invention if: (1) the reference is from the same field of endeavor as the claimed invention (even if it addresses a different problem); or (2)

the reference is reasonably pertinent to the problem faced by the inventor (even if it is not in the same field of endeavor as the claimed invention). In order for a reference to be “reasonably pertinent” to the problem, it must logically have commended itself to an inventor's attention in considering his problem. In determining whether a reference is reasonably pertinent, one should consider the problem faced by the inventor, as reflected either explicitly or implicitly, in the specification. I believe that all of the references that my opinions in this IPR are based upon are well within the range of references a person having ordinary skill in the art would consult to address the type of problems described in the Challenged Claims.

16. I have been informed that, in order to establish that a claimed invention was obvious based on a combination of prior art elements, a clear articulation of the reason(s) why a claimed invention would have been obvious must be provided. Specifically, I am informed that a combination of multiple items of prior art renders a patent claim obvious when there was an apparent reason for one of ordinary skill in the art, at the time of the invention, to combine the prior art, which can include, but is not limited to, any of the following rationales: (A) combining prior art methods according to known methods to yield predictable results; (B) substituting one known element for another to obtain predictable results; (C) using a known technique to improve a similar device in the same way; (D) applying a known technique to a known device ready for improvement to yield predictable results; (E) trying a finite

number of identified, predictable potential solutions, with a reasonable expectation of success; (F) identifying that known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; or (G) identifying an explicit teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine the prior art references to arrive at the claimed invention.

17. I am informed that the existence of an explicit teaching, suggestion, or motivation to combine known elements of the prior art is a sufficient, but not a necessary, condition to a finding of obviousness. This so-called “teaching suggestion-motivation” test is not the exclusive test and is not to be applied rigidly in an obviousness analysis. In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. Instead, the important consideration is the objective reach of the claim. In other words, if the claim extends to what is obvious, then the claim is invalid. I am further informed that the obviousness analysis often necessitates consideration of the interrelated teachings of multiple patents, the effects of demands known to the technological community or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art. All of

these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent.

18. I also am informed that in conducting an obviousness analysis, a precise teaching directed to the specific subject matter of the challenged claim need not be sought out because it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. The prior art considered can be directed to any need or problem known in the field of endeavor at the time of invention and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art need not be directed towards solving the same specific problem as the problem addressed by the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem. I am informed that common sense is important and should be considered. Common sense teaches that familiar items may have obvious uses beyond their primary purposes.

19. I also am informed that the fact that a particular combination of prior art elements was “obvious to try” may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) or leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation. I am further informed that in many fields it may be that there is little discussion of obvious

techniques or combinations, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive the design of an invention. I am informed that an invention that is a combination of prior art must do more than yield predictable results to be non-obvious.

20. I am informed that for a patent claim to be obvious, the claim must be obvious to a person of ordinary skill in the art at the time of the invention. I am informed that the factors to consider in determining the level of ordinary skill in the art include (1) the educational level and experience of people working in the field at the time the invention was made, (2) the types of problems faced in the art and the solutions found to those problems, and (3) the sophistication of the technology in the field.

21. I am informed that it is improper to combine references where the references teach away from their combination. I am informed that a reference may be said to teach away when a person of ordinary skill in the relevant art, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the patent applicant. In general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the patentee. I am informed that a reference teaches away, for example, if (1) the combination would produce a seemingly inoperative device, or

(2) the references leave the impression that the product would not have the property sought by the patentee. I also am informed, however, that a reference does not teach away if it merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into the invention claimed.

22. I am informed that the final determination of obviousness must also consider “secondary considerations” if presented. In most instances, the patentee raises these secondary considerations of non-obviousness. In that context, the patentee argues an invention would not have been obvious in view of these considerations, which include: (a) commercial success of a product due to the merits of the claimed invention; (b) a long-felt, but unsatisfied need for the invention; (c) failure of others to find the solution provided by the claimed invention; (d) deliberate copying of the invention by others; (e) unexpected results achieved by the invention; (f) praise of the invention by others skilled in the art; (g) lack of independent simultaneous invention within a comparatively short space of time; (h) teaching away from the invention in the prior art.

23. I am further informed that secondary considerations evidence is only relevant if the offering party establishes a connection, or nexus, between the evidence and the claimed invention. The nexus cannot be based on prior art features. The establishment of a nexus is a question of fact. I understand that the Patent Owner

may introduce evidence relevant to secondary considerations. I have not seen any such evidence, and I will supplement my opinions if the Patent Owner raises secondary considerations during this proceeding.

III. OPINIONS

A. Overview of the '202 Patent

24. The '202 Patent shares a specification with U.S. Patent No. 7,010,330 ("the '330 Patent"). I have also submitted a declaration in support of *Inter Partes* Review of the '330 Patent. That declaration included an overview of the '330 Patent. Because they are identical specifications, my overview of the '330 Patent applies equally to the '202 Patent. I have pasted my summary of the '330 Patent here. This discussion does not represent my full understanding of the patent(s) nor does it attempt to cover all aspects of the disclosures relevant to my analyses below. Instead, it is provided merely as a high-level overview to provide some context for my more detailed discussions.

25. The '330 Patent generally relates to methods for reducing power dissipation in wireless transceivers, targeting the problem of battery drain in portable devices such as laptops and handheld devices. '330 Patent (Ex. 1001) at 1:16-30.

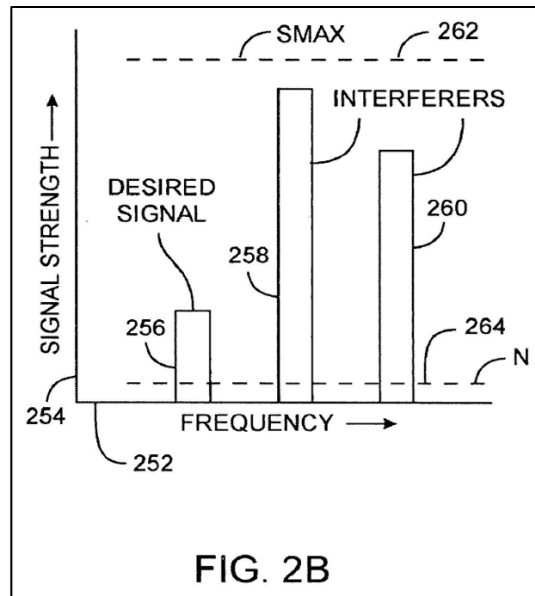
26. The '330 Patent explains that prior art transceivers were designed to function properly under "worst-case operating conditions"—when the strength of a desired signal is low and the strength of interfering signals is high. '330 Patent at

1:26-37. When better than worst case conditions exist (e.g., high desired signal and/or low interferers), the alleged invention *reduces* “*receiver circuit currents . . .* below what is necessary for the worst case condition[,],” *reducing power dissipation*¹ and increasing battery life. ’330 Patent at 1:38-48.

27. The ’330 Patent relates the concept of power dissipation to the “dynamic range” of the receiver. ’330 Patent at 5:28-62. The dynamic range is defined on the upper end by the maximum signal strength that can be recovered—referred to as S_{max} —and on the lower end by the noise floor (N)—the level approaching which desired signals may be misinterpreted in the receiver, causing bit-errors. ’330 Patent at 6:1-20.

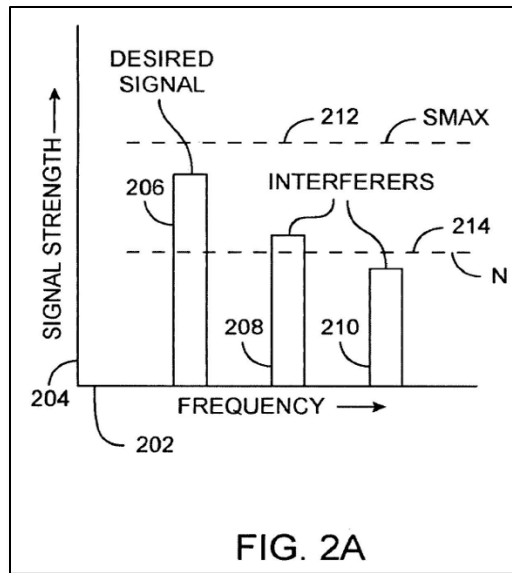
28. Fig. 2B below illustrates the dynamic range required under worst-case conditions. Here, the desired signal strength is low, requiring a low noise floor (N), and the interferers are strong, requiring a large S_{max} .

¹ All emphases added unless otherwise noted.



'330 Patent at Fig. 2B. As the patent explains, if S_{max} falls below the strength of interferer signals, intermodulation distortion may corrupt reception of the desired signal. '330 Patent, 6:28-46, Fig. 3. Accordingly, while S_{max} is not an absolute cap on signal strengths that can be accommodated by the receiver circuit, it represents the level above which signals can create distortion, which may overlap the frequencies of the desired signal and prevent its recovery.

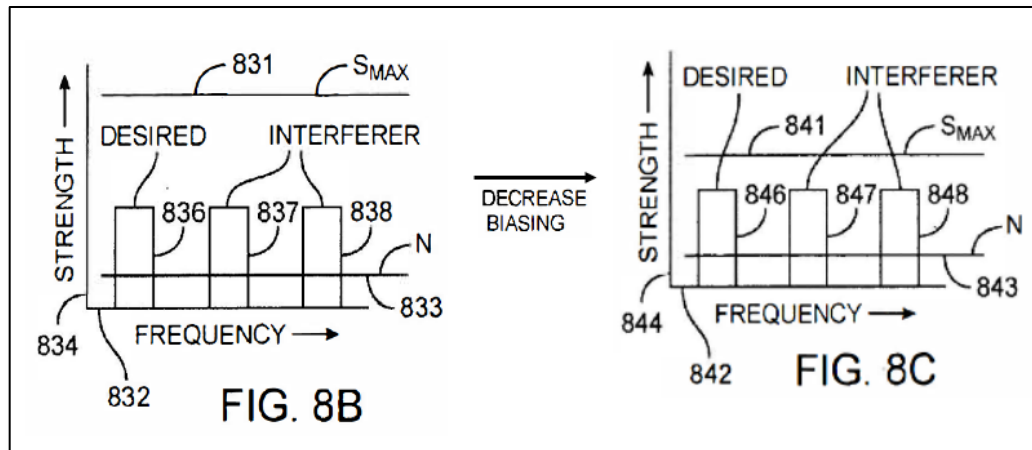
29. Fig. 2A below illustrates the dynamic range required under better than worst-case conditions. Here, (1) the desired signal strength is high, allowing for an increased noise floor (N), and (2) the interferers by comparison are weak, allowing S_{max} to be lowered without risking corruption from intermodulation distortion:



'330 Patent, Fig. 2A, 5:33-50 (describing the same).

30. The '330 Patent identifies three variables used to adjust the dynamic range, to save power when better than worst-case conditions are experienced: DC bias current, signal path impedance, and gain.

31. First, a DC bias current may be used to lower S_{max} , saving power when conditions permit accommodating a lower maximum signal strength. '330 Patent at 6:18-20, 9:5-12. Figs. 8B and 8C illustrate saving power by decreasing bias current, which lowers S_{max} , when the desired signal strength and interferer signal strengths permit a lower S_{max} :



'330 Patent at Figs. 8B-8C.

32. Second, increasing the signal path impedance permits a lower AC drive/switching current to be used in the RF signal path, saving power. *Id.* at 6:17-18, 7:44-59. I understand that the '330 Patent specification means by "drive current" as the AC current that flows through the signal path. *Id.* at 7:44-67, 9:21-23, 9:55-59, 10:10-18. I understand that the Challenged Claims uses "switching current"—a phrase that does not appear in the specification. I have been instructed to treat these terms as interchangeable.

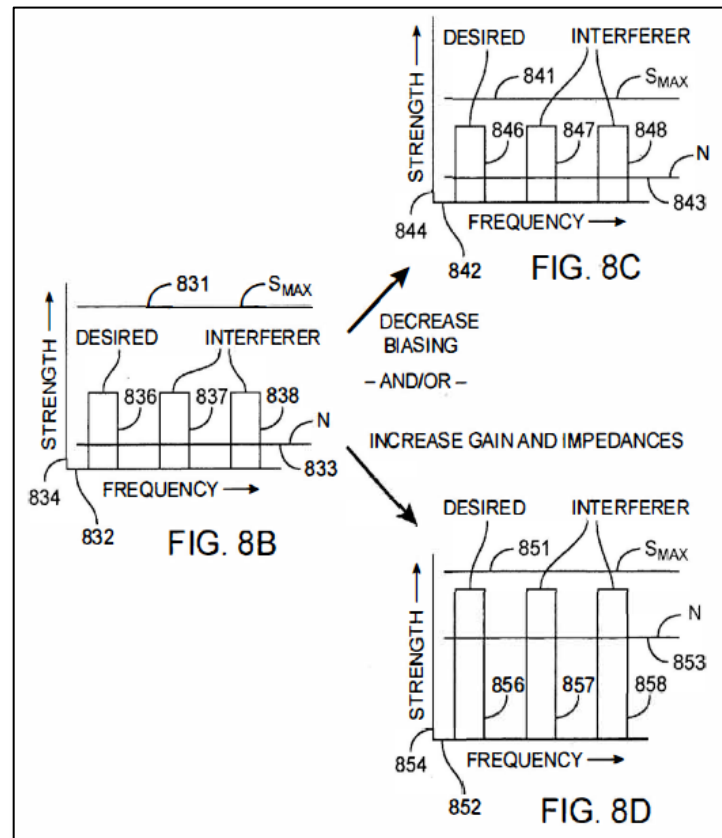
33. In one example, illustrated in Fig. 6, an RC filter circuit is "scaled," doubling the signal path impedance, which allows the "circuit's required drive current" to be cut in half. '330 Patent at 7:44-59. Although the patent does not explain *why* increasing the signal path impedance also increases the noise floor (N), it repeatedly notes that the signal path impedance can be increased to save power by lowering drive/switching current only if conditions permit increasing the noise floor

(N). For example, “[c]ircuit impedances and currents are set such that the noise floor 264 is sufficiently low for an acceptable bit-error rate.” ’330 Patent at 6:7-9.

34. The patent does describe an exemplary RC filter that may be adjusted in order to adjust the signal path impedance. ’330 Patent at 7:44-52 (teaching that impedance is increased by increasing the series resistance of an RC filter and that the frequency response is maintained by also decreasing the shunt capacitance of the RC filter). A POSITA would recognize that resistor thermal noise is often a dominant source of noise in an RC filter. Accordingly, increasing the impedance of an RC filter by increasing the signal path resistance, as the ’330 Patent teaches, would indeed increase the noise introduced by the filter. It was well-known in the prior art that resistor thermal noise contributes to the noise figure. In fact, the Theta inventor admitted this concept in an article titled “Fully Integrated Active RC Filters in Technology” (“*Fully Integrated*”): “[N]oise is mostly due to the resistor thermal noise[.]” *Fully Integrated* at 650.

35. The third variable used to adjust a circuit’s dynamic range is gain. While gain does not directly correspond to power savings, it does provide a mechanism by which all signals—desired and interferers—can be increased, creating room for power savings to be realized by increasing impedance. See ’330 Patent at Figs. 8B-8D. As illustrated in these figures, when the desired signal and interferer signals are all low, power savings can be realized by (1) lowering the bias

current, which lowers S_{max} , as shown in Fig. 8C, (2) increasing gain and increasing impedance, which increases noise floor (N), as shown in Fig. 8D, or (3) all three—lowering the bias current, increasing gain, and increasing impedance:



Id., Figs. 8B-8D, Fig. 12, 10:60-67 (explaining that a combination of all three adjustments may be used when the desired signal and interferer signals are all low).

B. Overview of the '202 File History

36. I have been informed that the '202 patent was filed as Application No. 15/824,841 ("841 application") on November 28, 2017 and is related, through a chain of continuations, to U.S. Patent No. 7,010,330 ("the '330 Patent"). The '330 Patent was filed on February 23, 2004, claiming priority to Provisional Application

Nos. 60/451,229 and 60/451,230, both filed March 1, 2003. For this proceeding, Petitioner applies March 1, 2003, as the priority date for the Challenged Claims.

37. I note that the originally filed claims faced multiple office actions and significant amendments. *See, e.g.*, Ex. 1002, 88-128 (first office action rejecting all claims under obviousness and double patenting grounds and some claims for being indefinite), 150-63 (amendments and arguments responsive to first office action), 169-71 (filing of terminal disclaimer), 179-98 (final office action rejecting all claims), 214-237 (amendments and arguments responsive to final office action, adding entirely new Claims 40-51).

38. The '202 patent applicant filed amendments responsive to the office actions, applicant repeatedly distinguished the cited prior art from the pending claims on the basis that the claims required dynamically adjusting the receiver operation in response to determining the *relative strengths* of desired and interferer signals. *Id.* at 160-62 (arguing that U.S. Patent No. 5,001,776 to Clark controls power consumption based on comparing a received signal to thresholds, distinguishing this from the claimed requirement that the receiver is adjusted “based on the relative comparison of the desired signal strength to the interferer signal strength”), 266-29 (arguing that “no . . . comparison of the strength of the desired signal and the strength of the interference signal is disclosed in [U.S. Patent No.

6,311,048 to] Loke”). I have been informed that a notice of allowance was subsequently issued on November 13, 2019, with no further actions. *Id.* at 251-52.

B. A Person of Ordinary Skill in the Art

39. I have been asked to provide my opinion as to the level of skill of a person having ordinary skill in the art at the time of the '202 Patent, which I have been instructed to assume is March 1, 2003. In determining the characteristics of a hypothetical person having ordinary skill in the art at the time of the claimed invention, I was told to consider several factors, including the type of problems encountered in the art, the solutions to those problems, the rapidity with which innovations are made in the field, the sophistication of the technology, and the education level of active workers in the field. I also placed myself back in the time frame of the claimed invention and considered the colleagues with whom I had worked at that time.

40. A person having ordinary skill in the art, as of March 1, 2003, would have been a person having a master's degree in electrical engineering, or an equivalent, and two or more years of experience with wireless communications devices. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education. Such a person would have been capable of understanding the '202 Patent and the prior art references discussed below. I understand that a POSITA definition has been

proposed in the parallel litigation that requires only a bachelor's degree. My opinions would not change under this alternative POSITA definition.

41. Based on my education, training, and professional experience in the field of the claimed invention, I am familiar with the level and abilities of a person of ordinary skill in the art at the time of the claimed invention. Additionally, I met at least these minimum qualifications to be a person having ordinary skill in the art as of the time of the claimed invention of the '202 Patent.

D. Claim Construction

42. I have been informed by counsel that the first step in an unpatentability analysis involves construing the claims, as necessary, to determine their scope. Second, the construed claim language is then compared to the disclosures of the prior art. I am informed that claims are generally given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention in light of the patent specification and prosecution history, i.e., the intrinsic record. For purposes of my analysis, I have applied the claim constructions set forth in the Petition.

43. I understand that the parties have disputed a number of claim terms in the parallel litigation. As explained in the Petition, the Proposed Grounds satisfy both parties' respective proposals for the claim construction disputes set forth in the following chart:

Claim Term	Theta's Constructions	Apple's Constructions
"impedance"	Plain and ordinary meaning, but if construed, should be construed as "opposition to the flow of alternating current"	Plain and ordinary meaning
"worst-case"	Plain and ordinary meaning	"desired signal strength is low and interferer signal strength is high"
"best-case"	Plain and ordinary meaning	"desired signal strength is high and interferer signal strength is low"

44. I understand that the parties also dispute the meaning of "signal path." In the parallel litigation, Petitioner argued that this phrase excludes the "digital signal processing" block, and Theta argued that no such exclusion is proper. Specifically, Patent Owner argued (that the signal path "can be both analog or digital at different points in the signal path," and as such, "is not limited to only analog components"). The Petition proposes the Board adopt Patent Owner's interpretation of signal path. Accordingly, I have also adopted Patent Owner's interpretation of the signal path.

45. Similarly, I understand that the parties also dispute the meaning of "dynamically changing/adjust[ing]" (the "dynamic limitation"). In the parallel

litigation, Petitioner argued that this phrase excludes “reliance on a signal strength threshold,” and Patent Owner argued that no such exclusion is proper. Specifically, Patent Owner argued the terms only “require varying ‘during operation based—at least in part—on information gained during operation.’” The Petition proposes the Board adopt Patent Owner’s interpretation of the dynamic limitation. Accordingly, I have also adopted Patent Owner’s interpretation of the dynamic limitation. For both phrases, I take no position as to which is correct, and, for all other claim language, I have applied the plain and ordinary meaning as defined in the preceding paragraph.

E. Summary of the Prior Art References

1. *Behbahani*

46. *Behbahani* (Ex. 1004) was published and publicly available by at least August 2001. Indeed, I am listed as a co-author on *Behbahani* and was the supervising faculty member overseeing the research underlying *Behbahani*. As indicated on the face of the article, I can confirm that *Behbahani* was published and made publicly available in the August 2001 IEEE Journal of Solid-State Circuits. I note that this journal was well-known in wireless communications devices, and was widely available and accessible to those of skill in the art.

47. *Behbahani* discloses a wireless receiver that implements an “adaptive dynamic range” method to save power by decreasing the dynamic range when conditions are better than worst case:

This receiver implements *adaptive dynamic range* in the IF section. *Most wireless systems are designed for the worst case*; that is, the dynamic range is specified for the desired signal at a minimum detectable level, accompanied by the largest anticipated interferers. *In practice, the receiver only infrequently needs this high instant DR [(dynamic range)]. DR is obtained at the expense of a disproportionate rise in power consumption* An important idea here, which has also been noted elsewhere [4], is that *providing no more than the required DR at any given time lowers the average power consumption*.

Behbahani at 1205.

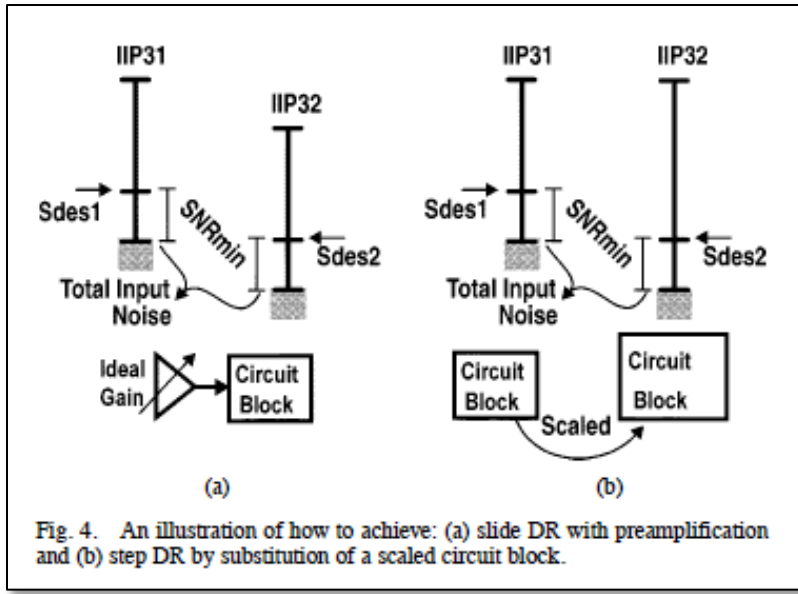
48. Behbahani teaches two separate adaptive techniques to implement the adaptive dynamic range—(1) step-based DR and (2) sliding DR. *Behbahani* at 1206-1207. For Behbahani’s step-based adaptive DR, the receiver switches/steps between two scaled filters. *Behbahani* at 1206-1207. A “high-power filter” is used during the range of worst-case signal conditions (i.e., low desired signal and high interferers). *Behbahani* at 1206-1207. A POSITA would have understood that there is a range of signal conditions that would be characterized as worst-case, rather than a single discrete worst-case condition. And a POSITA would have understood that the step-based DR approach in *Behbahani*, alone or in conjunction with the sliding DR approach, would have accommodated the full range of worst-case conditions. A separate “low-power filter” is used for the range of conditions that are better than worst-case. *Id.* A POSITA would have understood that better than worst-case

conditions generally involve relatively a stronger desired signal and/or relatively weaker interferer signals than the range of worst-case conditions. An important concept regarding power savings in *Behbahani* is that the low-power filter will be used much more often than the high-power filter: “Since the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption.” *Behbahani* at 1206-1207.

49. When the high-power filter is switched to the low-power filter in *Behbahani*, this satisfies both power-saving mechanisms described and claimed in the Challenged Patent, (1) lowering the bias current and (2) increasing the signal path impedance, lowering the drive/switching current.

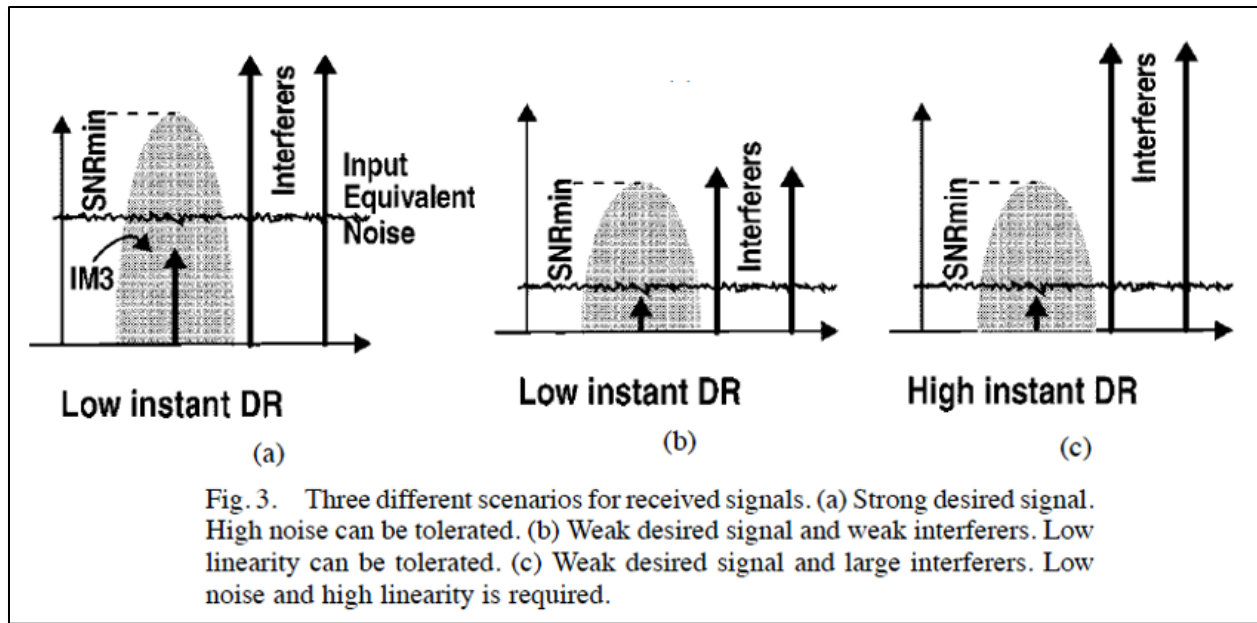
50. When the low-power filter is used during better than worst-case conditions, *Behbahani*’s sliding DR technique uses a gain stage in advance of the low-power filter to slide a smaller DR up or down based on strengths of the received signals. *Behbahani* at 1206-1207.

51. For example, Fig. 4(a) illustrates a gain stage used to slide a small DR (that results from using the low-power filter) to accommodate specific signal strength conditions, and Fig. 4(b) illustrates switching from the low-power filter to high-power filter to expand the DR when worst-case conditions are encountered:



Behbahani at 1206; Fig. 4. The left bar in each figure shows the signal and noise levels prior to insertion of a preamplifier or substitution of the high-power filter.

52. As shown in the figure below, *Behbahani* describes three different desired and interferer signal scenarios below in Figure 3. Figs. 3(a) and 3(b) depict better than worst-case conditions in which “receiver dynamic range may be modest” and the gain-based sliding DR approach can be used to improve overall power consumption. *Behbahani* at 1206. Fig. 3(c) depicts worst-case conditions (i.e., low desired signal and high interferers), requiring the system to expand the dynamic range by switching in the high-power filter. *Behbahani* at 1206.



Behbahani at Fig. 3 (rearranged).

53. A POSITA would have recognized that *Behbahani*, like the '202 Patent, discloses a wireless receiver architecture and design intended to achieve reduced power dissipation, and is therefore in the same field of endeavor. '202 Patent, Abstract, 1:21-23, 2:43-64, 6:6-32; *Behbahani*, Abstract, 1205. A POSITA would have recognized that *Behbahani* is also reasonably pertinent to certain problems addressed by the '202 Patent such as accommodating different signal conditions by dynamically adjusting dynamic range. '202 Patent, Abstract, 1:21-23, 1:31-35, 1:40-50, Fig. 2A, Fig 2B; *Behbahani*, Abstract (describing adaptive dynamic range to dissipate only the necessary power), 1205, Fig. 3. Accordingly, *Behbahani* is analogous art.

2. *Leete*

54. *Leete* (Ex. 1005) was published and publicly available by at least December 2000. Indeed, I am listed as a co-author on *Leete* and was the supervising faculty member overseeing the research underlying *Leete*. As indicated on the face of the article, I can confirm that *Leete* was published and made publicly available in the December 2000 IEEE Journal of Solid-State Circuits. I note that this journal was well-known in wireless communications devices, and was widely available and accessible to those of skill in the art.

55. *Leete* is focused on the details of the RF circuitry, whereas *Behbahani* is focused on the IF and digital portions of the same receiver. *Behbahani* at 1205. In one example, *Leete* describes the RF front-end, including a low noise amplifier (LNA) and an RF downconverter (including mixers) that converts the RF signal to an intermediate frequency (IF). *Leete* at 1908.

56. A POSITA would have recognized that *Leete* and the '202 Patent are related to a wireless receiver architecture and design intended to achieve reduced power dissipation, and thus are in the same field of endeavor. '202 patent, Abstract, 1:21-23, 2:43-64, 6:6-32; *Leete* at Introduction, 1908, Fig. 1. A POSITA also would have recognized that *Leete* is directed to solving certain problems addressed by the '202 Patent, such as accommodating a wide dynamic range, low power consumption, and minimizing noise in the components of the wireless receiver architecture, and thus *Leete* is analogous art. '202 Patent, 5:33-67, 6:6-32; *Leete*, 1908 ("The main

objectives in choosing receiver architecture are wide dynamic range, high sensitivity, fewest off-chip components, and lowest power consumption”), 910 (describing minimizing the effect of noise and interference from other blocks).

3. *Tan*

57. *Tan* (Ex. 1006) was published and publicly available by at least April 2000. Indeed, I am listed as a co-author on *Tan* and was the supervising faculty member overseeing the research underlying *Tan*. As indicated on the face of the article, I can confirm that *Tan* was published and made publicly available in the April 2000 IEEE Journal of Solid-State Circuits. I note that this journal was well-known in wireless communications devices, and was widely available and accessible to those of skill in the art.

58. *Tan* is focused on the details of the bandpass filter used in *Behbahani*. *Behbahani* at 1210. (“The details of the BPF design are presented elsewhere [7].”) The citation [7] in *Behbahani* is to *Tan*.

59. A POSITA would have recognized that *Tan*, like the ’202 patent discloses a wireless receiver architecture and design intended to achieve reduced power dissipation, and is therefore in the same field of endeavor. ’202 patent, Abstract, 1:21-23, 2:43-64, 6:6-32; *Tan*, Introduction, 476.

60. A POSITA would have recognized that *Tan* is also reasonably pertinent to certain problems addressed by the ’202 Patent, such as accommodating a wide

dynamic range, low power consumption, and minimizing noise in the components of the wireless receiver architecture. '202 Patent, 5:33-67, 6:6-32; Tan, 476 (“The main specifications of an on-chip active filter in a wireless receiver are: 1) its frequency response, including the passband ripple, stopband attenuation, selectivity, and group delay; 2) its dynamic range, including the noise and the linearity; 3) its current drain or power consumption; and 4) the chip area.”). Accordingly, Tan is analogous art.

F. Behbahani in view of Leete in Further view of Tan

1. Claim 1

a) Claim 1 (Pre)(a): “A method of reducing the power consumption of a receiver of a battery operated transceiver having a plurality of circuits, wherein the plurality of circuits comprise a receiver signal path comprising at least an amplifier, a mixer and a filter,”

61. To the extent the preamble is limiting, *Behbahani* discloses a method of reducing power consumption of a receiver of a battery-operated transceiver having a plurality of circuits. Further, *Behbahani* in view of *Leete* disclose a plurality of circuits having a receiver signal path comprising at least an amplifier, a mixer and a filter.

***Behbahani* discloses a method of reducing power consumption of a receiver of a battery-operated transceiver having a plurality of circuits**

62. A POSITA would have understood that *Behbahani*'s receiver circuitry is in fact part of a wireless transceiver. It was well known in the art that a transceiver

is a device that includes both transmission (transmitter) and reception (receiver) functionality. For example, a transceiver “incorporates both transmitter and receiver circuits and uses a signal antenna for communication.” *Ludwig* at page 3. Specifically, “[t]he transmitter converts the electrical signal into a form that is suitable for transmission through the physical channel or transmission medium.” *Proakis*, 6. On the other hand, “[t]he function of the receiver is to recover the message signal contained in the received signal.” *Proakis* at 7.

63. *Behbahani* mainly focuses on the details of receiver circuitry, but *Behbahani* notes that the receiver is part of a transceiver. *Behbahani* at 1207 (“This frequency-hopping **transceiver** uses many adaptive algorithms at each hop[.]”), 1208 (noting “a maximum speed of 2 m/s for the indoor mobile **transceiver**”). In sum, a POSITA would have understood that, although the paper focuses on the receiver circuitry, *Behbahani*’s receiver circuitry is intended to be used in a mobile device with a complete transceiver or at least would have been motivated to implement *Behbahani*’s receiver circuitry in a mobile device with a complete transceiver.

64. For a number of reasons, a POSITA would also have understood that, even if *Behbahani* does not expressly state that its circuitry is intended to save power in a battery powered portable device, *Behbahani*’s teachings fairly convey this

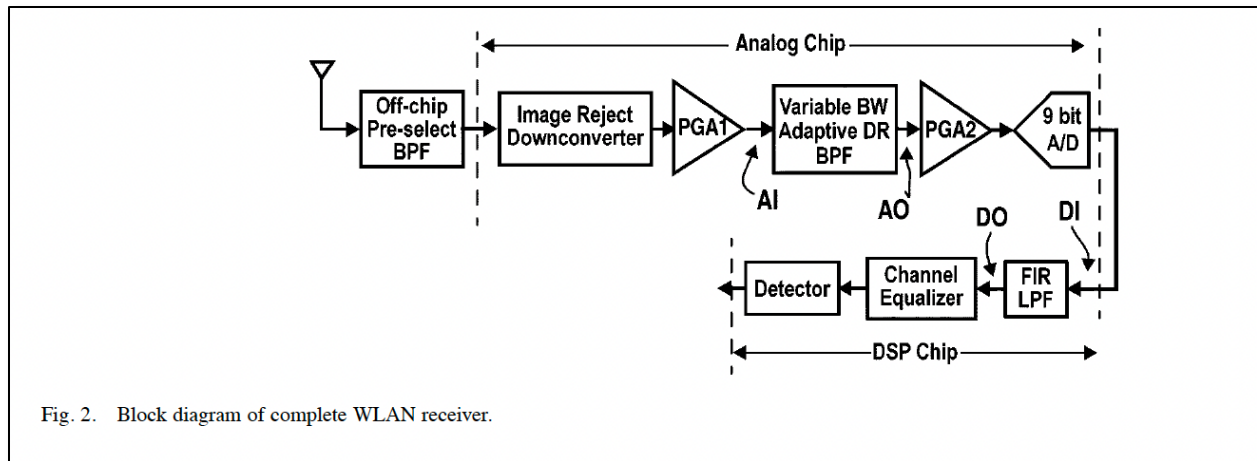
application, motivating a POSITA to save power in a battery-powered device pursuant to *Behbahani*'s teachings.

65. First, *Behbahani*'s focus is saving power in a wireless device, teaching that its wireless receiver implements an “adaptive dynamic range” method to save power by decreasing the dynamic range when conditions are better than worst case:

This receiver implements *adaptive dynamic range* in the IF section. *Most wireless systems are designed for the worst case*; that is, the dynamic range is specified for the desired signal at a minimum detectable level, accompanied by the largest anticipated interferers. *In practice, the receiver only infrequently needs this high instant DR [dynamic range]. DR is obtained at the expense of a disproportionate rise in power consumption* An important idea here, which has also been noted elsewhere [4], is that *providing no more than the required DR at any given time lowers the average power consumption.*

Behbahani at 1205.

66. Second, the nature of *Behbahani*'s focus on power savings in WiFi communications would have led a POSITA to implement its teachings in a battery-powered mobile device. For example, *Behbahani*'s receiver is designed for the 2.4 GHz WLAN communications. *Behbahani* at 1205 (“The 2.4-GHz ISM band does not regulate interferers[.]”). *Behbahani* further refers to the receiver as a “WLAN receiver” in regard to Fig. 2.



Behbahani at Fig. 2.

67. A POSITA would recognize that the receiver described is in fact designed for 2.4GHz WLAN (Wireless Local Area Network) communications. For example, *Behbahani* references two other papers ([1] and [5]) that describe different aspects of the same receiver research. *Behbahani* at 1205 (image rejection issues associated with the research are “addressed in detail elsewhere [1]” and that the “basic RX architecture has been described in detail elsewhere [5]”). References [1] and [5] largely overlap in authorship with *Behbahani* and describe different aspects of the same research. In fact, in February 2000, the entire system including the references described herein referred to as “*Behbahani*,” and “*Tan*” was presented at the IEEE International Solid-State Circuits Conference. The article is titled “An Adaptive 2.4GHz Low-IF Receiver in 0.6 μ m CMOS for Wideband Wireless LAN” to Behbahani, Leete, Tan, Kishigami et al. (“*Kishigami*”). Each of these references also indicates in their titles that the research targets 2.4 GHz WLAN

communications. *Behbahani* at 1216. (“An adaptive 2.4 GHz low-IF receiver in 0.6- μ m CMOS for wideband wireless LAN... A 2.4 low-IF receiver for wideband WLAN in 0.6- μ m CMOS architecture and front-end”)

68. At the time of *Behbahani*, and today, the most common form of 2.4GHz WLAN communications is Wi-Fi. As shown in the IEEE article titled “The Evolution of Wi-Fi Technology and Standards” (“*IEEE*”), Wi-Fi is used hand in hand with WLAN technology. (“Wi-Fi, a wireless local area network (WLAN) technology[.]” *IEEE*, (Ex. 1028), at 3. Wi-Fi communications most commonly used the 2.4 GHz radio band. For example, *IEEE* states that the 2.4 GHz Wi-Fi radio band has been used since 1997. *IEEE* at 3. (“Wi-Fi first came onto the market in 1997 when the pioneering IEEE 802.11 technical standard was published, enabling wireless data transmission at up to 2 Mbit/s using an unlicensed 2.4 GHz radio spectrum.”)

69. Although Wi-Fi transceivers were not used exclusively in battery powered mobile/portable devices, it was a dominant means of wireless communication specifically for battery powered mobile devices such as laptops and PDAs. As an example, an article titled “The New Wireless Paradigm” by Werbach (“*Werbach*”) teaches that “[s]everal million laptops are equipped with WiFi cards, and most laptop vendors are building WiFi into their newer models[.]” *Werbach* at 2. As another example, an article titled “Information-Rich Commerce At A

Crossroads to *Fichman et al.* by (“*Fichman*”) describes that “Wireless Information Device (WID): Includes wireless PDAs, smartphones, media players and other hand-held Devices...Supports most emerging wireless protocols (GPRS, WiFi, Bluetooth)[.]” *Fichman* at 6.

70. A POSITA would have understood that, in non-battery powered devices, power constraints are set by the device’s ability to remove heat from its circuitry. For a microprocessor in a computer that receives its power from a wall outlet, for example, a typical solution is to equip the heat generating microprocessor with a fan that removes excess heat. For portable battery powered wireless devices, power constraints are much more concretely tied to the limited charge stored in the battery. Namely, portable battery powered devices must employ power saving techniques to limit battery drain, providing adequate usage time. Given the importance of conserving charge in portable battery powered devices, power saving techniques such as those described in *Behbahani* were particularly well suited to (and targeted) the concerns of such devices.

71. Further, A POSITA would have understood from *Behbahani*’s focus on power savings that battery powered mobile devices were the primary target of the disclosed receiver technology and would have been motivated to use the technology to preserve battery life in such devices. It was well known in the art to preserve the battery power of portable/mobile devices. For example, U.S. Patent No. 6,480,700

to Groe et al. (“*Groe*”) describes, “[w]hen the communication device powered by a portable power supply, **the longevity of the portable power supply is increased**, as lessened amounts of power are required to operate the communication device.” *Groe* at Abstract.

72. *Behbahani* describes techniques directed to preserving battery consumption in battery powered mobile devices. *Behbahani* states that “DR is obtained at the expense of a disproportionate rise in power consumption[.]” *Behbahani* at 1205. *Behbahani* focuses on “providing no more than the required DR at any given time lowers the average power consumption.” *Behbahani* at 1205. *Behbahani* also states that “[f]or least power consumption, the RX DR should adapt to the prevailing conditions.” *Behbahani* at 1206. Finally, a POSITA would have understood that *Behbahani*’s method for lowering the average power consumption in the receiver results in a corresponding reduction in a drain on battery charge by portable wireless device. For example, *Groe* states the “**level of power consumption required to operate the mobile station can be reduced** would **increase the time period during which the mobile station can be powered by the portable power supply.**” *Groe* at 2:9-23.

73. As shown above, a POSITA would have understood that *Behbahani* satisfies each of these different ways to describe the claimed receiver. (Similar to Claim 1’s language, “receiver of a battery-operated transceiver,” other Claims

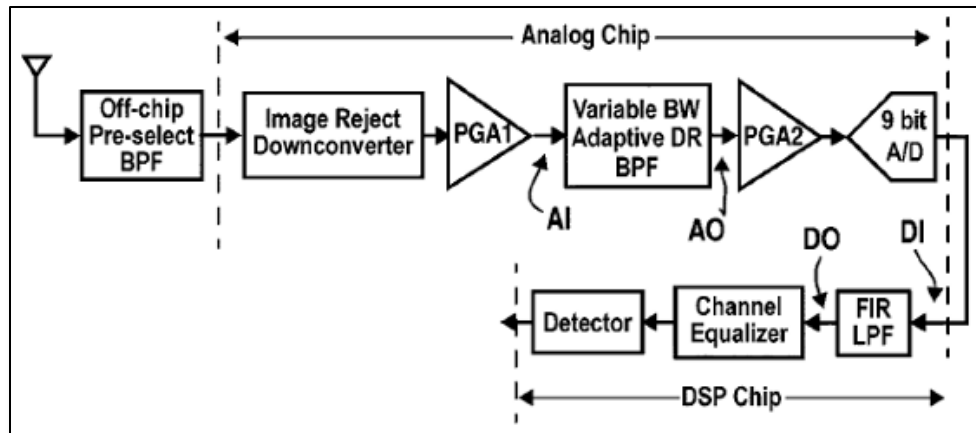
require a “receiver in a battery operated mobile device” (Claim 6), a “wireless transceiver of a battery-powered portable wireless device,” (Claims 7, 11, 12, 13, 14, 16, 18), and a “receiver of wireless transceiver of a wireless communication device” (Claims 19, 22).)

Behbahani in view of Leete disclose a plurality of circuits having a receiver signal path comprising an amplifier, a mixer and a filter.

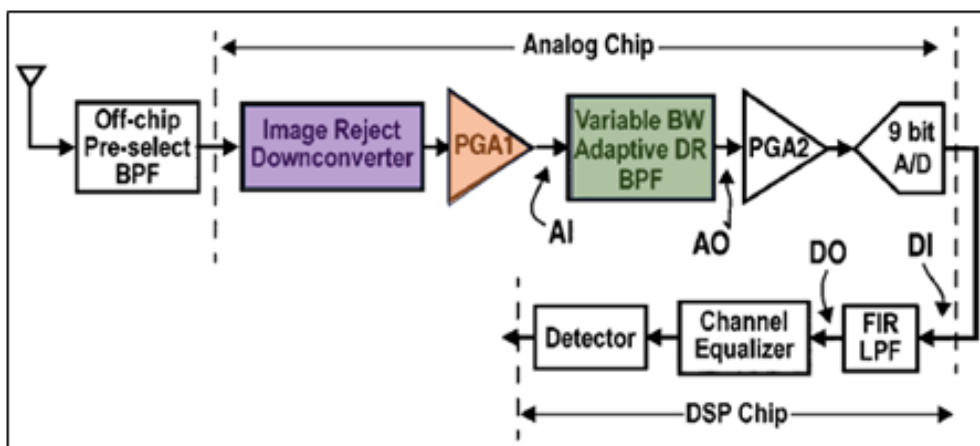
74. *Behbahani* in view of *Leete* discloses a method of receiving an RF signal by a wireless transceiver having a signal path comprising an amplifier, a filter, and a mixer.

75. As an initial matter, *Behbahani* and *Leete* describe the same research, focusing on different aspects of the same receiver circuit, and were intended to be used in conjunction. Indeed, *Behbahani* explains that “the IF section is the main focus of this paper” and notes that “[t]he front-end and image-reject downconversion sections of the [receiver] are described in [5].” *Behbahani* at 1205. The citation “[5]” in *Behbahani* is the *Leete* article. Put simply, combining the details of *Behbahani* with the details of *Leete* is consistent with our (myself and my co-authors) intent that these papers describe different aspects of the same receiver circuitry.

76. Fig. 2 from *Behbahani* describes the “complete WLAN receiver” circuitry:

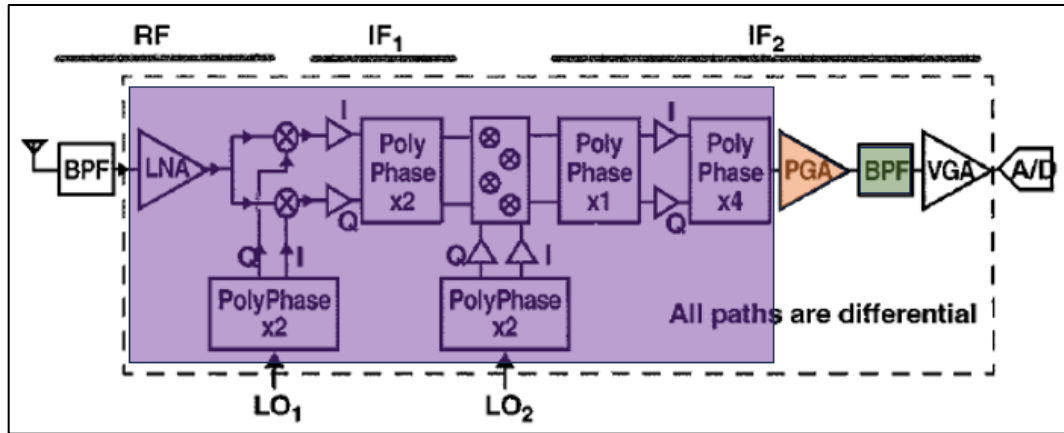


Behbahani, 1206. As noted in the prior paragraph, the details of “[t]he front-end and image-reject downconversion sections of the [receiver] are described in” *Leete*. On the “analog chip” and in advance of **PGA1** and the **variable filter**, *Behbahani* represents the receiver circuitry with a single box labeled “**image reject downconverter**”:



Behbahani at Fig. 2 (annotated).

77. *Leete* displays the entire receiver circuitry in Fig. 1 below:

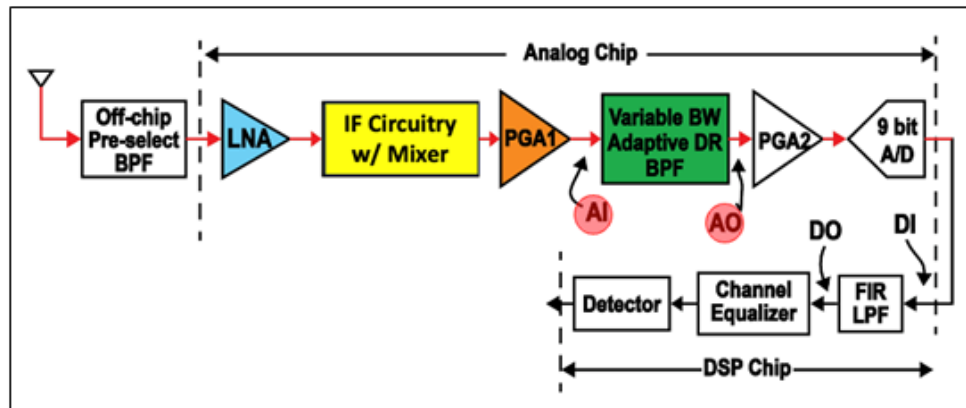


Leete at Fig. 1 (annotated).

78. As shown in the purple box above, *Leete* provides the details of the “image reject downconverter” box from *Behbahani*’s Fig. 2. Namely, *Leete* teaches that the “RF front-end comprises a **low noise amplifier (LNA)** and an **RF quadrature mixer**, which downconverts the RF signal to the first IF (IF1).” *Leete* at 1908. There are multiple mixers in *Leete*, for example, the RF quadrature mixer and a second IF mixer that mixer “downconverts the *desired* signal at IF1 to a low IF2.” *Leete* at 1908.

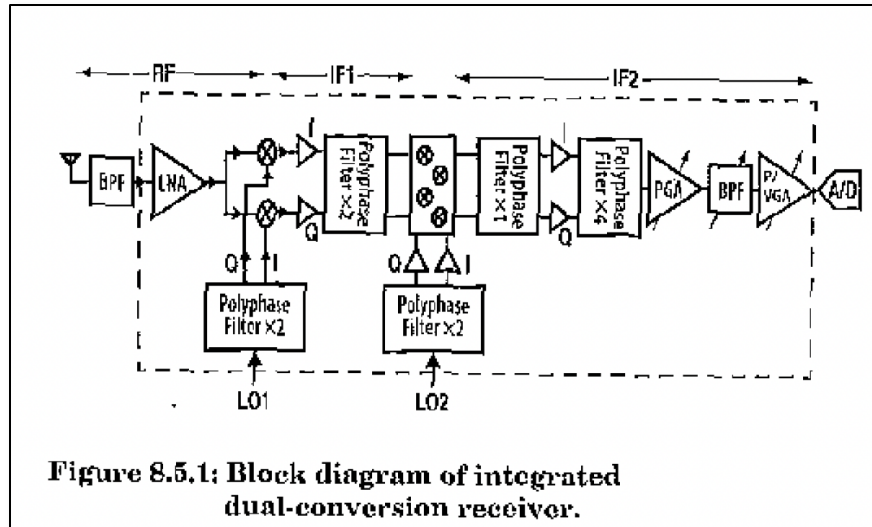
79. A POSITA would have understood that placing *Leete*’s low noise amplifier (LNA) and RF quadrature mixer circuitry in *Behbahani*’s circuit before PGA1 is precisely the intent of *Behbahani* and *Leete*. Put another way, *Behbahani* expressly motivates the combination, teaching that *Leete* provides the receiver details preceding PGA1.

80. Therefore, a POSITA would have been motivated to combine *Behbahani* and *Leete*, as depicted below, where the “image reject downconverter” box from *Behbahani*’s Fig. 2 has been replaced with an LNA and the other IF circuitry, including the mixers circuitry (annotated as “IF Circuitry w/ Mixer”):



Behbahani modified by *Leete* at Figure 2 (annotated).

81. Further supporting this conclusion, the entire system was presented in 2000 in a single paper at the IEEE International Solid-State Circuits Conference. The article is titled “An Adaptive 2.4GHz Low-IF Receiver in 0.6 μ m CMOS for Wideband Wireless LAN” to *Behbahani*, *Leete*, *Tan*, *Kishigami* et al. (“*Kishigami*”). As seen below in Figure 8.5.1, *Kishigami* depicts the LNA->mixer->filter topology as in *Leete*:



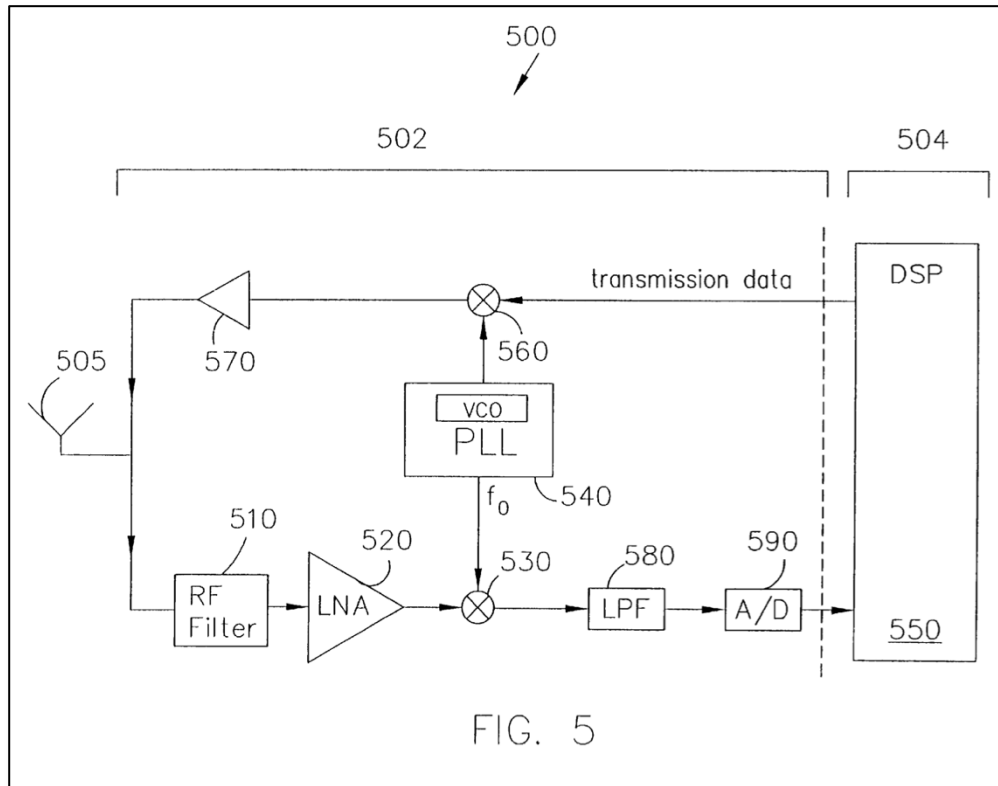
Kishigami at Figure 8.5.1.

82. *Kishigami* described the same LNA-equipped figure as *Leete*, describing both the IF stages (*Leete*'s focus) and also introduced *Behbahani*'s step-based and sliding DR concepts. Specifically, *Kishigami* states, "[t]he IF strip consists of a pre-filter programmable gain amplifier (PGA), a variable BW channel select bandpass filter (BPF), a post-filter PGA, and continuously variable gain amplifier (VGA)." *Kishigami* at 146. *Kishigami* describes *Behbahani*'s sliding-based technique: "For a weak received signal, the PGA gain is increased to a maximum of 30dB to lower the noise contributed by the IF strip, mainly arising in the active filter. When the desired channel is strong, pre-filter gain is lowered to improve the IP3 of the BPF referred to the receiver input." *Kishigami* at 146.

83. *Kishigami* also describes *Behbahani*'s step-based DR: "[W]hen strong in-band interferers accompany a weak desired signal, the dynamic range and power

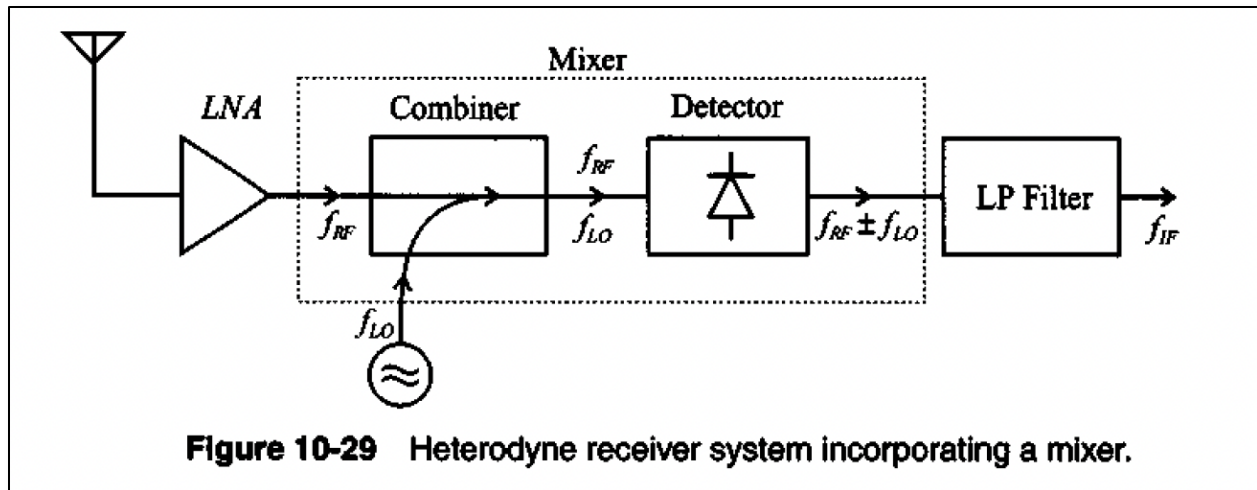
consumption are stepped up. The PGA gain is lowered to suppress intermodulation, and an auxiliary BPF is substituted with 10dB lower NF but 10x higher current to maintain high SNR in the desired channel. This infrequent condition only slightly *raises* average power consumption in long-term use.” *Kishigami* at 146. Because *Kishigami* (1) depicts the full receiver circuit from *Leete* and (2) introduces the adaptive DR concepts from *Behbahani*, it further demonstrates that *Leete* and *Behbahani* describe the same receiver and were intended to be used conjunctively.

84. A POSITA would have understood that the LNA->mixer->filter topology is a well-known circuit configuration in the art, further motivating the proposed combination of *Behbahani* and *Leete*. For example, U.S. Patent No. 6,335,952 to Lee et al. (“*Lee*”) describes that a LNA->mixer-> filter combination. *Lee* at 6:12-20. (“low noise amplifier (LNA) 520 receives an input signal from the antenna 505 and amplifies the signal level to output an RF signal. The RF BPF 520 is preferably coupled between the antenna 505 and the LNA 520. The RF signal is de-modulated by the de-modulating first mixer 530...The output of the de-modulating mixer 530 becomes received data by passing the LPF 580.”) The figure below in *Lee* displays the LNA->mixer-> filter combination.



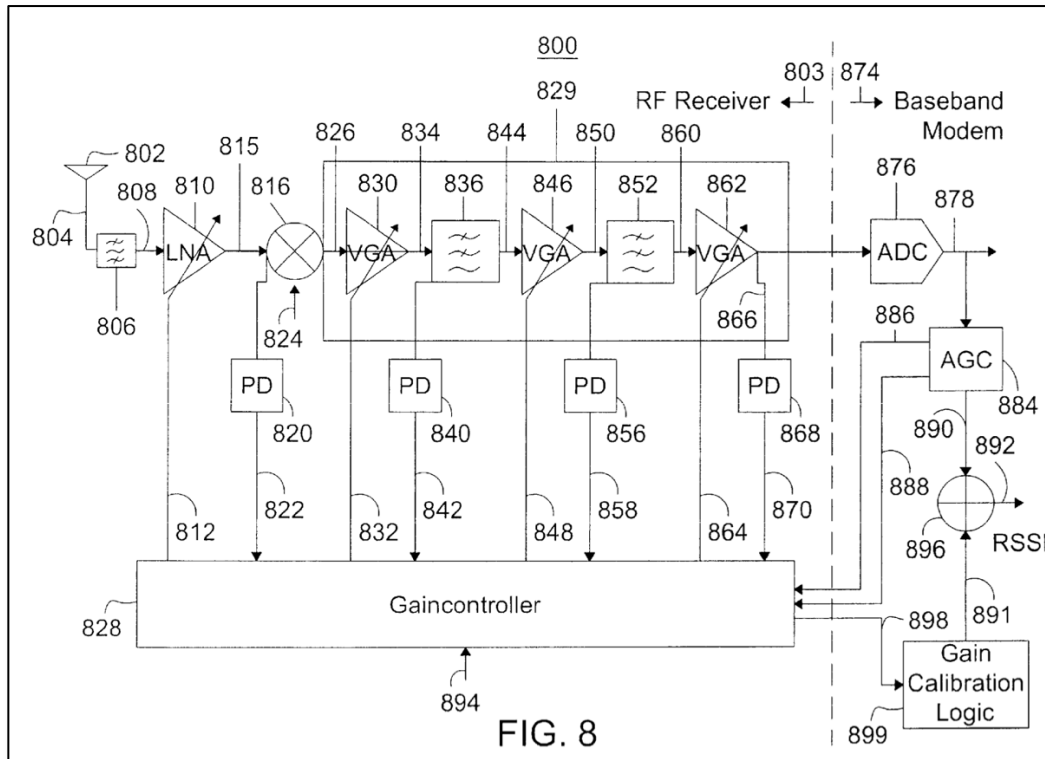
Lee at Figure 5.

85. As another example, *Ludwig* describes an LNA->mixer->filter topology. *Ludwig* at 575. (“the received RF signal, is after preamplification in a low-noise amplifier (LNA), supplied to a mixer...The signal obtained after the mixer contains the frequencies $f_{RF} \pm f_{LO}$ of which, after low-pass (LP) filtering, the lower frequency component $f_{RF} - f_{LO}$ known as the intermediate frequency (IF), is selected for further processing.”) An exemplary figure of the LNA->mixer->filter topology is depicted below:



Ludwig at Figure 10-29.

86. As a final example, U.S. Patent No. 6,498,927 to Kang et al. (“*Kang*”) teaches the gain controller outputs signals to the LNA. *Kang* at 8:26-28. (“The gain controller 828 outputs control signals 812, 832, 848, and 864 to the LNA 810, the VGA 830, the VGA 846 and the VGA 862, respectively.”) An exemplary figure of *Kang* is shown below:



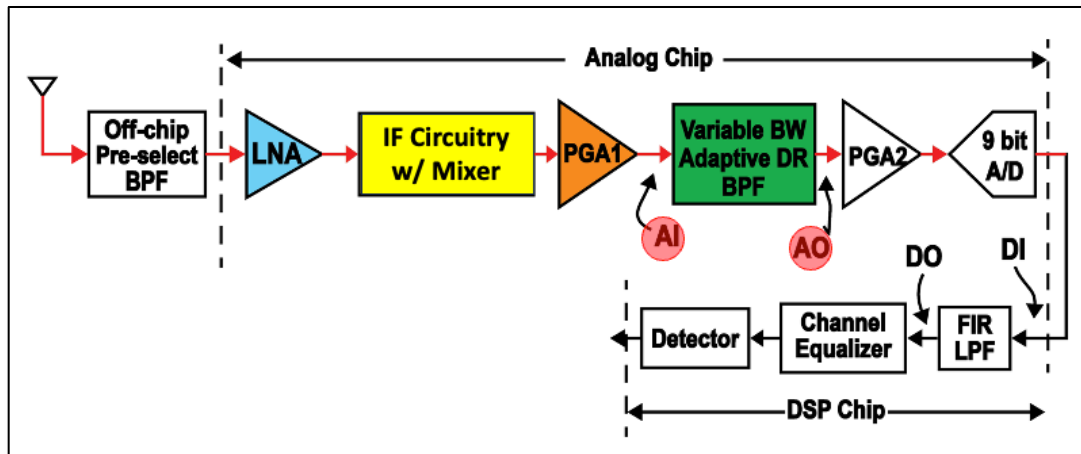
Kang at Figure 8.

87. Finally, a POSITA would have understood that placing *Leete's* LNA in *Behbahani's* circuit as proposed uses a known technique to improve a similar device in the same way. As set forth above, both circuits are similar. In fact, they are describing different portions of the same receiver circuit. Accordingly, not only does *Leete's* circuitry improve *Behbahani's* receiver, it completes *Behbahani's* receiver, providing implementation detail not covered by *Behbahani*. A POSITA would have understood that the benefits of an LNA in a wireless receiver include the ability to introduce gain without significant noise, which improves the receiver's ability to recover a weak desired signal picked up by the antenna. For example, in an article titled "Integrated LNA and Mixer Basics" by Texas Instruments ("*Texas*") states that

LNAs boost the desired signal while adding as little noise and distortion as possible so that the signal is easier to retrieve at later stages in the system. *Texas* at 2. (“LNAs are usually placed at the front-end of a receiver system, immediately following the antenna...The purpose of an LNA is to boost the desired signal power while adding as little noise and distortion as possible so that retrieval of this signal is possible in the later stages in the system.”) It was well known in the art to position an LNA prior to a mixer to introduce gain into the circuit. For example, *Lee* describes that the RF signal is amplified with gain at the LNA. *Lee* at 1:46-50 (“The filtered RF signals are amplified with a gain at the LNA 120 and the RF signals passing through the LNA 120 are directly demodulated into base band signals by quadrature multiplication at the first and second mixers 140 and 145.”). A POSITA would have understood that such a benefit applies equally to *Behbahani*’s Fig. 2 as it does to the more detailed version of the same receiver circuit as depicted in *Leete*’s Fig. 1 and would have expected success in treating their teachings conjunctively, as the authors intended.

The receiver described by Behbahani and Leete includes an amplifier, mixer, and filter

88. Firstly, there are three distinct amplifiers, any of which satisfies this element—low-noise amplifier (LNA), programmable gain amplifier (PGA1), or post-filter PGA (PGA2). Each of these amplifiers is depicted below:

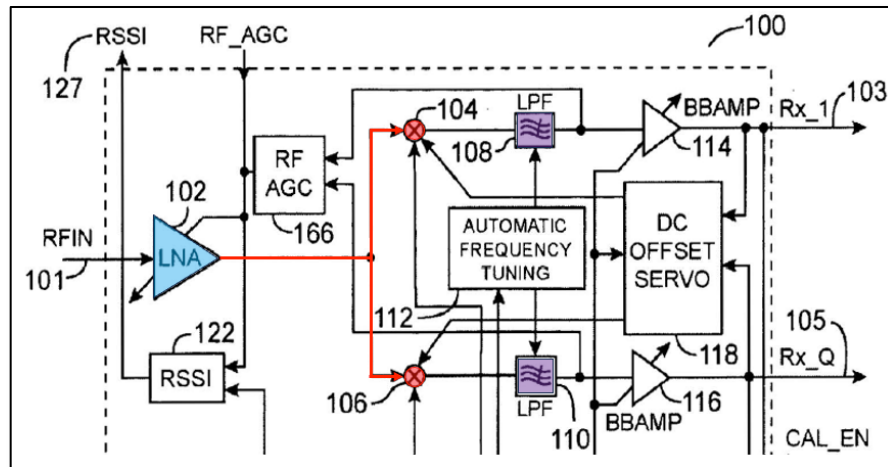


Behbahani modified by *Leete*, Figure 2 (annotated).

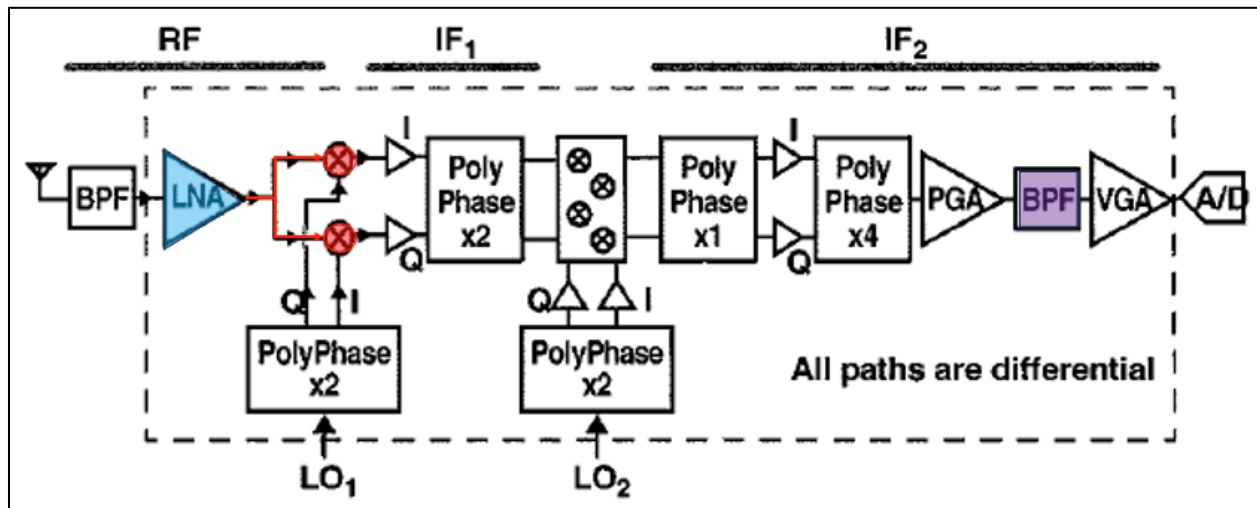
Leete's quadrature RF mixer satisfies the claimed "mixer"

89. Second, *Leete* and the '202 Patent's mixer have separate I and Q paths. '202 Patent at 4:18-20 ("The receiver includes a signal path formed by low-noise amplifier 102, *I and Q mixers 104 and 106*, low pass filters 108 and 11[.]"), 4:39-42 (teaching that "quadrature mixers 104 and 106 . . . down-convert the received signal").

90. As shown below, both *Leete* and the '202 Patent place the **quadrature mixer** between an **LNA** and **low-pass filter**:



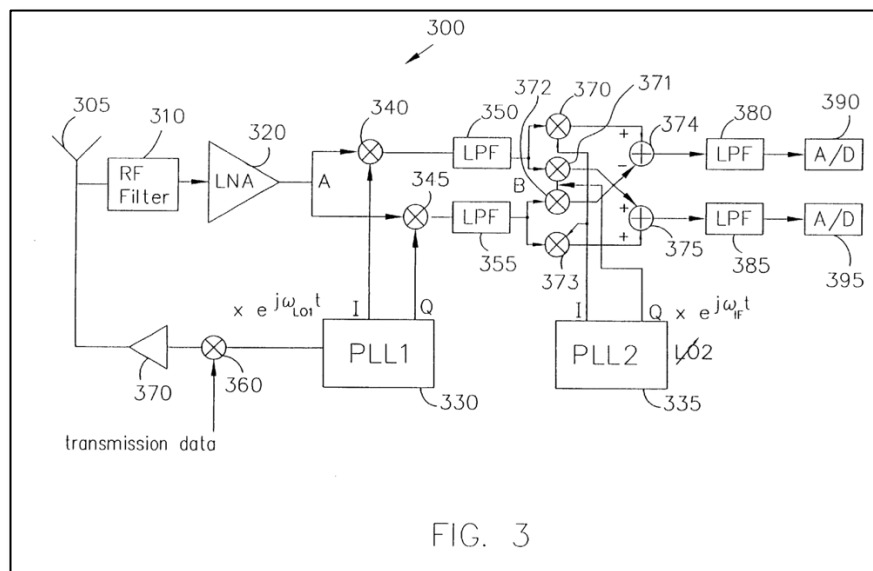
'202 Patent at Fig. 1 (annotated).



Leete at Fig. 1 (annotated).

91. The concept of using quadrature mixers in receivers was well-known at the time. For example, *Lee* teaches a “single chip RF communication system and method is provided including a transmitter and a receiver.” *Lee* at Abstract. Within the receiver portion of *Lee*’s system, the “[t]he filtered RF signals are amplified by the LNA 320 and are converted into IF signals by the quadrature

mixers 340, 345 [.]” *Lee* at 2:63-66. An exemplary figure from *Lee* depicting the quadrature mixers within the receiver is shown below:

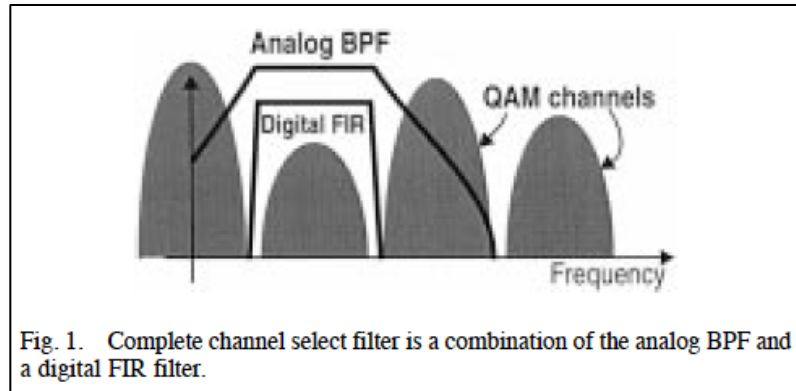


Lee at Figure 3.

92. Based on the similar disclosures in the '202 Patent and in *Leete* in addition to the well-known concept of quadrature mixers in receivers at the time, a POSITA would have understood that *Leete's* quadrature mixer stage satisfies the claimed “mixer.”

Behbahani's Variable BW Adaptive DR BPF satisfies the claimed “filter”

93. Lastly, *Behbahani's* Variable BW Adaptive DR BPF satisfies the claimed “filter.” As shown below, *Behbahani* teaches an analog bandpass filter (BPF) that “attenuates near-by channels and rejects far-away channels.”



Behbahani, Fig. 1, 1205. *Behbahani* describes that its “BPF realized by an [low-pass filter] LPF in series with [high-pass filter] HPF lowers power consumption.” *Behbahani* at 1216.

b) Claim 1(Pre)(b): “wherein the plurality of circuits are designed to function between a worst-case operating condition and a best case operating condition, wherein the worst-case operating condition is when a desired signal strength is low and an interferer signal strength is high and the receiver operates with a maximum power dissipation and the best-case operating condition is when the desired signal strength is high and the interferer signal strength is low and the receiver operates with a minimum power dissipation, the method comprising:”

94. *Behbahani* teaches wireless receiver circuitry that is designed to function under a range of operating conditions—from a worst-case operating condition (i.e., low desired signal and large interferers) to all the conditions between, and including a best-case operating condition (i.e., high desired signal and smaller interferers).

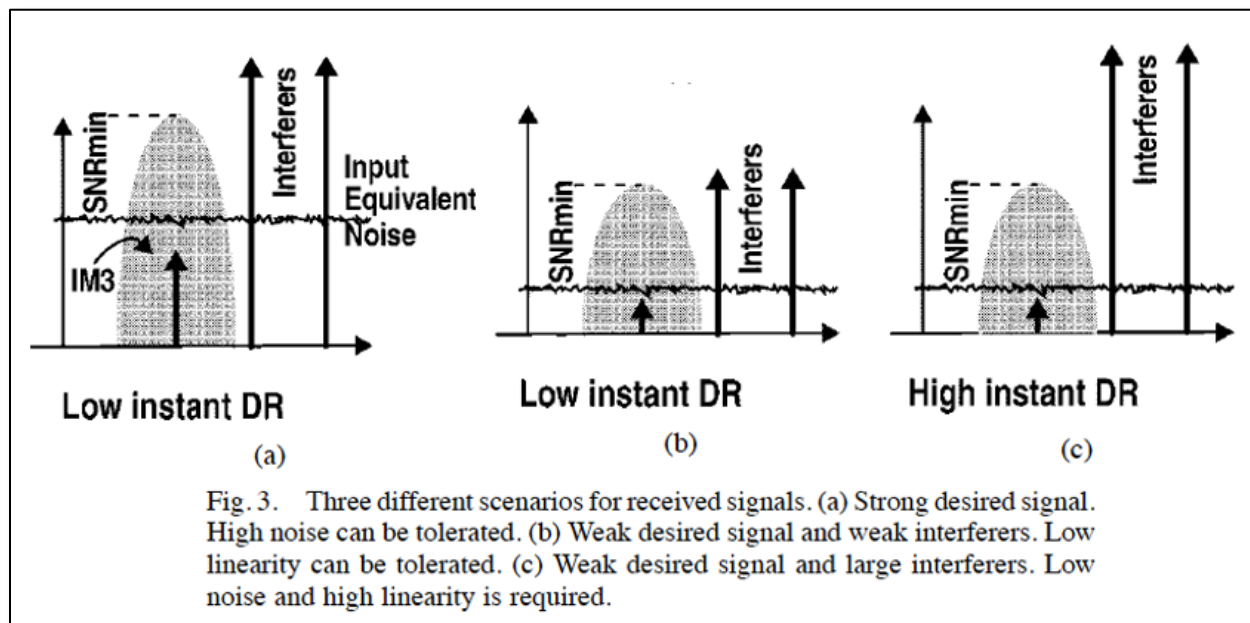
95. *Behbahani*’s wireless receiver receives a wireless signal. *Behbahani* at 1207. (“measured signal levels [that] indicate how much of the *received signal* is

being rejected, respectively, by the analog filter and the digital filter”). It was well known that the whole point of an RF *receiver* is to receive RF signals. For example, a book titled, “BARRON’S ELECTRONICS THE EASY WAY” (“*Barron*”) teaches that “[t]he other half of the radio frequency (RF) communications consists of a receiver. The transmitted wave is of very little use unless it is received and decoded to present the information, music, or speech as intended. This is where the receiver does its half of the job in a communication system.” *Barron* at page 270.

96. Further, *Behbahani* teaches that this received signal includes a desired signal component and interferer signals. *Behbahani* at 1205 (“Most wireless systems are designed for the worst case; that is, the dynamic range is specified for the ***desired signal*** at a minimum detectable level, ***accompanied by*** the largest anticipated ***interferers***.”). These major interferer signals often originate from external devices. *Behbahani* at 1205 (“Microwave ovens emitting in the middle of the [2.4-GHz] band are often the largest interferer[.]”).

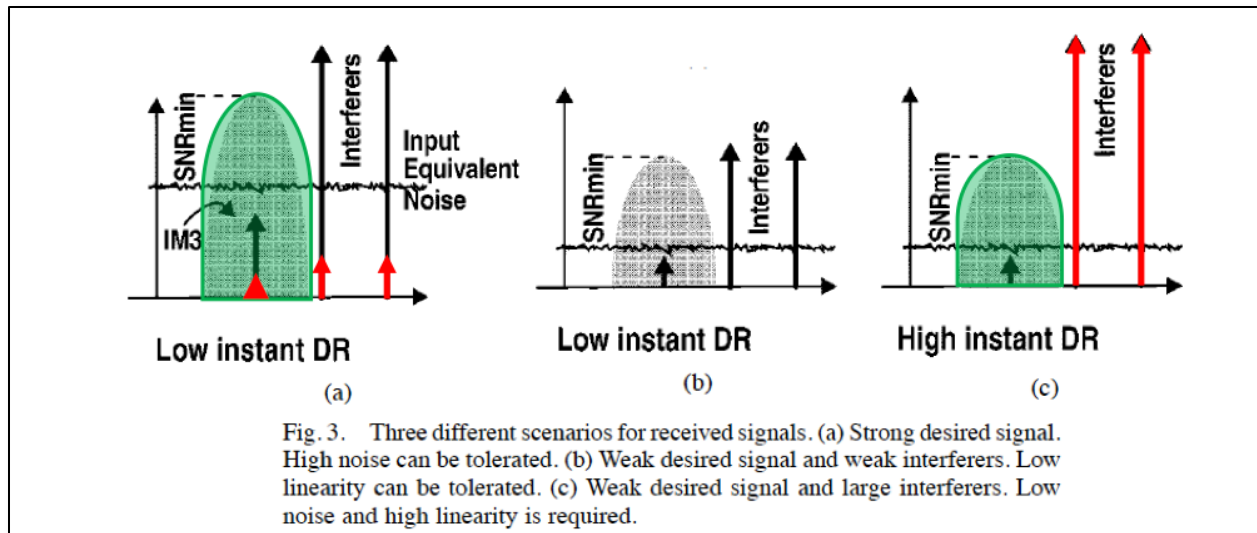
97. *Behbahani* describes three different desired and interferer signal scenarios below in Figure 3. Figs. 3(a) and Fig. 3(b) depict better than worst-case conditions in which “receiver dynamic range may be modest” and the gain-based sliding DR approach may be implemented to optimize the overall power consumption. *Behbahani* at 1206. Fig. 3(c) depicts worst-case conditions (i.e., low

desired signal and high interferers), requiring the system to expand the dynamic range by switching in the high-power filter. *Behbahani* at 1206.



Behbahani at Fig. 3 (rearranged).

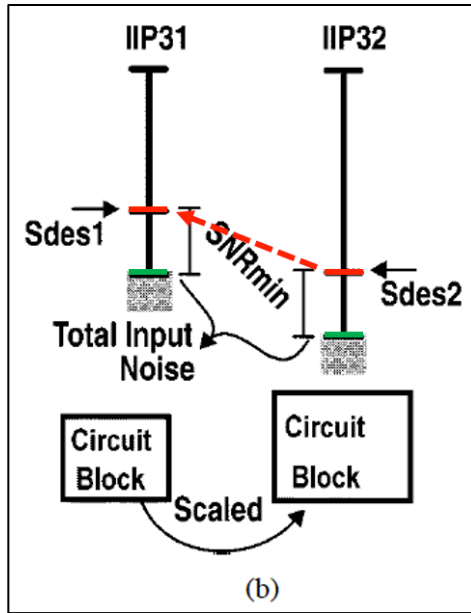
98. Annotated Fig. 3 below illustrates a range of signal operating conditions delineated by worst-case conditions (e.g., Fig. 3(c)) and best-case operating conditions (e.g., Fig 3(a) annotated):



Behbahani, Fig. 3(a) (annotated to depict hypothetical best-case in which interferers are weaker than in Fig. 3(a)), 3(c) (annotated to show expressly described worst-case in Fig. 3(c)). Fig. 3(a) has also been annotated to indicate lower IM3 (annotated red) that results from the lower interferer signals in this hypothetical best-case scenario.

The best-case scenario is similar to Behbahani's Fig. 3(a), but assumes lower interferers

99. As shown in annotated Fig. 4(b) below, when the conditions transition from worst-case (e.g., low desired signal and high interferers as in Fig. 3(c)) to improved conditions (e.g., high desired signal as in 3(a)), the receiver switches from the high-power to low-power filter, increasing the noise floor but to a point that remains adequately below the desired signal.



Behbahani at Fig. 4(b). A POSITA would have understood that low interferer signals in the claimed scenario would not have impacted the decision to increase the noise floor toward the desired signal strength. The decision of whether to adjust the noise floor (and by how much) in *Behbahani* depends on the strength of the desired signal, rather than the interferer signals. Indeed, the decision of whether to adjust the noise floor (and by how much) in *Behbahani* turns on the strength of the desired signal, rather than the interferer signals. Simplifying *Behbahani*'s principles, the desired signal strength dictates required noise floor and interferer signal strength dictates required max signal capability, IIP3. *See id.*, 1206 (teaching that a strong desired signal allows the system to tolerate a high noise floor and that weak interferer signals allow the system to tolerate low linearity via a decreased IIP3).

100. A POSITA would have understood that under a best-case operating condition *Behbahani*'s receiver operates at its lowest power dissipation (i.e., using the low-power filter and decreasing the gain at PGA1, which slides the dynamic range up and increases the noise floor). For example, *Behbahani* states that "[s]ince the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption." *Behbahani* at 1207. *Behbahani* further states "[i]n the first two instances [Fig. 3(a) and (b)], a BPF dissipating low power is employed for nominal RX DR." *Id.*

Behbahani's adaptive DR

101. *Behbahani* teaches two separate adaptive techniques to implement the adaptive dynamic range—(1) step-based DR and (2) sliding DR. *Behbahani* at 1206-1207. For *Behbahani*'s step-based adaptive DR, the receiver switches/steps between two scaled filters. *Behbahani* at 1206-1207. A "high-power filter" is used during the range of worst-case signal conditions (i.e., a desired signal that is low relative to high interferers). *Behbahani* at 1206-1207. A separate "low-power filter" is used for conditions where the relative levels are more favorable for the desired signal than the worst-case. *Behbahani* at 1206-1207.

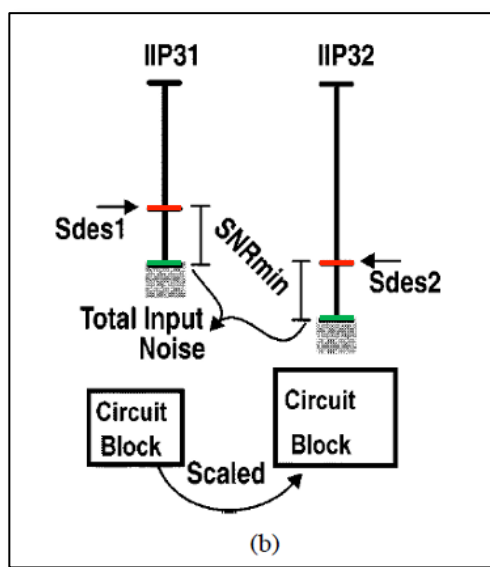
102. The step-based adaptive DR comprises two levels of noise, as defined by the high power and low power filters. In conjunction, sliding DR is employed to optimize the overall dynamic range, which impacts power consumption. When the

high-power filter is switched to the low-power filter during better than worst-case conditions, *Behbahani's* sliding DR technique uses a gain stage in advance of the low-power filter to slide a smaller DR up or down based on strengths of the received signals. *Behbahani* at 1206-07. (“Fig. 4(a) shows how, by adding a gain stage in front of a noisy and nonlinear circuit block, input referred noise and IIP3 drop by the gain of the amplifier. This slides down the entire DR and enables detection of a weaker signal accompanied by weak interferers....As mentioned before, for a weak desired signal where a low NF is needed, PGA1 is set to high gain to overcome the high NF of the filter. When the input signal is strong, PGA1 is set to low gain and high OIP3 to preserve the IIP3 of the BPF.”) With the low-power filter present in the signal path, the programmable gain may be employed to optimize the overall dynamic range.

Worst-case signal condition – high-power filter

103. During the worst-case conditions (i.e., low desired signal and high interferers), such as the signal condition shown in Fig. 3(c), *Behbahani's* system expands the dynamic range by switching in the high-power filter at the cost of high-power consumption. *Behbahani*, 1205-1206. (“DR [dynamic range] is obtained at the expense of a disproportionate rise in power consumption: doubling the power consumed by a circuit lowers its noise floor by 3 dB with constant IP3, thus raising its spurious-free dynamic range (SFDR) by only 2 dB. An important idea here, which

has also been noted elsewhere [4], is that providing no more than the required DR at any given time lowers the average power consumption....The worst-case is when the desired signal is weak but the interferers strong (Fig. 3(c)). Now the instant receiver input signal DR is high, which requires high IIP3 and low NF.”) As shown in annotated Fig. 4(b), the high-power filter (the larger of the scaled circuit blocks) is switched in at the cost of high-power consumption, expanding the dynamic range.



Behbahani at Fig. 4(b).

104. A POSITA would have understood that *Behbahani*’s receiver operates with a maximum power dissipation while using this high-power filter. *Behbahani* at 1207 (“[t]wo filters are implemented with the same topology, but one [high-power filter], scaled up to consume 10x more power, offers 10x lower mean square noise but the same linearity.”); *Behbahani* at 1205 (“DR is obtained at the expense of a disproportionate rise in power consumption: doubling the power consumed by a

circuit lowers its noise floor by 3 dB with constant IP3, thus raising its spurious-free dynamic range (SFDR) by only 2 dB.”)

105. The dynamic range is stepped up as shown in Fig. 4 (b) above, by switching in the “high-power scaled filter[.]” *Behbahani*, 1207. *Behbahani* explains, “[t]wo filters are implemented with the same topology, but one, scaled up to consume 10x more power, offers 10x lower mean square noise but the same linearity.” *Behbahani* at 1207. Thus, when the high-power filter is switched into the circuit, the “DR may be stepped up by substituting a scaled version of a nominal circuit.” *Behbahani* at 1206.

106. *Behbahani* explains that “providing no more than the required DR at any given time lowers the average power consumption.” *Behbahani* at 1205. To achieve this, “a BPF dissipating low power is employed for nominal RX DR. However, in the worst-case scenario, the high-power scaled filter is switched in raising total DR. Since the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption.” *Id.* In other words, *Behbahani’s* high-power filter, as the name suggests, uses more power than the low-power filter. Because the high-power filter is deployed infrequently—during worst-case conditions—the average power use is largely determined by the low-power filter, which is used more often.

Better than worst-case signal condition – low-power filter

107. Per *Behbahani*'s adaptive DR teachings, the system reverts from the high-power filter to the low-power filter when conditions improve (such as Fig. 3(a) or Fig. 3(b)), thereby saving power during periods of better than worst-case conditions.

108. When *Behbahani*'s low-power filter is in use, sliding DR (adjusting the pre-filter gain (at PGA1)) adjusts the relatively smaller dynamic range up or down to reflect current signal conditions. *Behbahani* at 1206. ("In sliding DR, the instant DR of the RX is constant but slides to best accommodate the input signal conditions. Fig. 4(a) shows how, by adding a gain stage in front of a noisy and nonlinear circuit block, input referred noise and IIP3 drop by the gain of the amplifier. This slides down the entire DR and enables detection of a weaker signal accompanied by weak interferers.")

109. *Behbahani* explains that under the signal conditions in Figs. 3(a) and Fig. 3(b), depicting better than worst-case conditions, the "receiver dynamic range may be modest" and the gain-based sliding DR approach may be employed to optimize the overall power consumption *Behbahani* at 1206. For example, a large, desired signal is received (e.g., Fig. 3(a)), the gain at PGA1 is decreased, which slides the dynamic range up and increases the noise floor. *Behbahani* at 1206-07 ("When the gain of PGA1 is lowered, $IIP3_{IF}$ [the max signal that can be handled] is higher. On the other hand, NF_{IF} [noise floor] also rises due to the dominant noise of

the BPF. Thus, lowering gain in PGA1 slides up the DR.”); *see also id.*, Fig. 3 (noting that “[h]igh noise can be tolerated” when a “[s]trong desired signal” is received). Conversely, when the gain at PGA1 is increased, “input referred noise and IIP3 drop by the gain of the amplifier. This slides down the entire DR and enables detection of a weaker signal.” *Behbahani* at 1206.

110. As another example, when the signal condition is better than worst case but when the desired signal is weak and the interferers are weak such as in Fig. 3(b), the gain-based sliding DR approach may be employed to “enable[] detection of a weaker signal accompanied by weak interferers.” *Behbahani* at 1206.

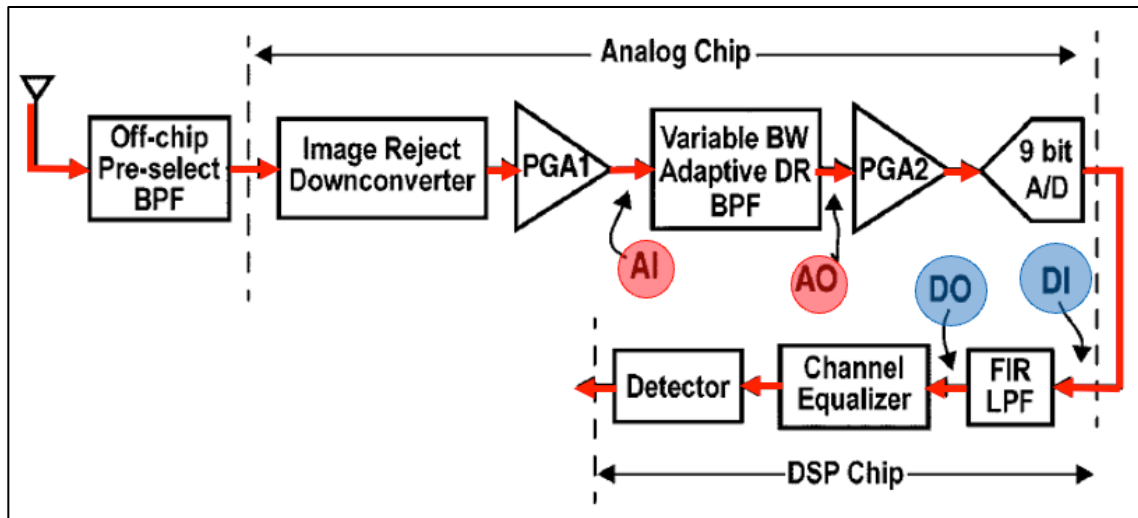
111. As described above, *Behbahani* is focused on adaptive DR techniques. *Behbahani*’s sliding DR technique uses a gain stage in advance of the low-power filter to slide a smaller DR up or down based on strengths of the received signals. *Behbahani* at 1206-07. (“Fig. 4(a) shows how, by adding a gain stage in front of a noisy and nonlinear circuit block, input referred noise and IIP3 drop by the gain of the amplifier. This slides down the entire DR and enables detection of a weaker signal accompanied by weak interferers....As mentioned before, for a weak desired signal where a low NF is needed, PGA1 is set to high gain to overcome the high NF of the filter. When the input signal is strong, PGA1 is set to low gain and high OIP3 to preserve the IIP3 of the BPF.”) With the low-power filter present in the signal

path, a variable gain may be employed thereby optimizing the overall power consumption.

112. A POSITA would have understood that *Behbahani* teaches (1) a plurality of circuits that function between a worst-case operating condition (i.e. low desired signal and high interferer), and a best-case operating condition (i.e., high desired signal and low interferer), and (2) that *Behbahani*'s receiver operates with a maximum power dissipation under worst case conditions and with a minimum power dissipation under best case conditions, as claimed.

c) Claim 1(a): “receiving a signal comprising a desired signal and an interferer signal; determining a strength of the desired signal; determining a strength of the interferer signal; comparing the strength of the desired signal to the strength of the interferer signal; and”

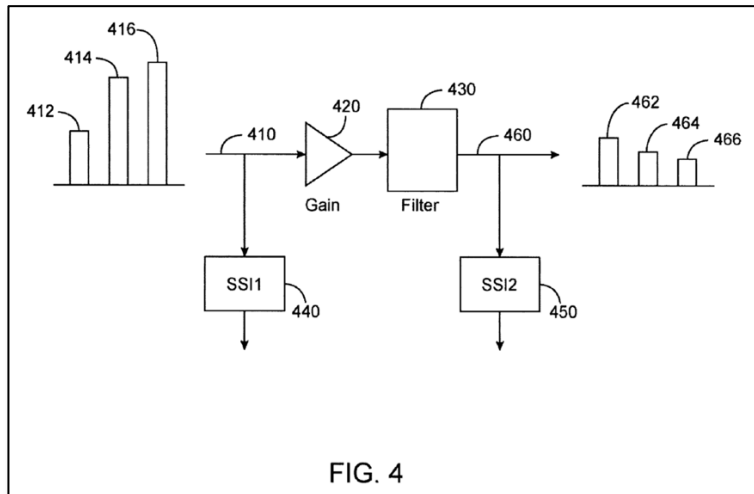
113. *Behbahani* teaches circuits for determining desired and interferer signal strengths, including by taking signal strength measurements at two nodes on the analog signal path—**A_I** and **A_O**—and at two nodes on the digital signal path—**D_I** and **D_O**.



Behbahani, Figure 2 (annotated). As I explain below, *Behbahani* expressly measures an absolute desired signal strength, renders obvious measuring an absolute interferer signal strength, and expressly teaches comparing the strengths of the desired and interferer signals.

The '202 Patent's relevant teachings

114. The '202 patent teaches determining the *relative* strengths of a desired signal and interferer signals, rather than absolute strengths of these signals. It does so by comparing a cumulative signal strength at a first node to a cumulative signal strength at a second node. Figure 4 below illustrates this concept.



'202 Patent, Figure 4. SSI1 is the “sum of desired signal 412 and interfering signals 414 and 416,” and SSI2 is the “sum of desired signal 462 and interfering signals 464 and 466.” *Id.*, 6:64-7:2. The patent explains that the combination of optional gain element 420 and filter 430 produce a gain of one for the desired signal, meaning the strength of the desired signal is identical in the SSI1 and SSI2 measurements. *Id.*, 7:2-5. It also explains that the interfering signal levels are reduced by filter 430. *Id.*, 7:6-10. Accordingly, if SSI2 is significantly smaller than SSI1, large interferer signals have been reduced by filter 430. *Id.* (explaining that comparing these values indicates how much of the combined signal has been filtered). From this information, the system determines what combination of “bias, impedance, and gain . . . may be optimized to reduce power dissipation.” *Id.*, 7:10-13.

Behbahani teaches more sophisticated circuits for determining desired and interferer signal strengths than the '202 Patent

115. As noted above, the ‘202 Patent describes a signal strength measurement technique that merely ascertains the *relative* strengths of the desired and interferer signals. I have identified no specific discussion in the ‘202 Patent that suggests absolute signal strengths could also be measured by any disclosed circuitry. Despite the patent’s focus on determining relative signal strengths, limitation [1(c)] requires circuits for determining the strengths of desired and interferer signals. Regardless of whether this language is interpreted to require measuring only relative signal strengths as described by the ‘202 Patent or more narrowly to require measuring absolute signal strengths,² *Behbahani*’s teachings render obvious the limitation. *Behbahani* emphasizes the importance of measuring signal strength to its adaptive DR techniques, and notes that, like the ’202 Patent, signal power is sensed at the input and output of filters to find out how much of the received signal is being rejected:

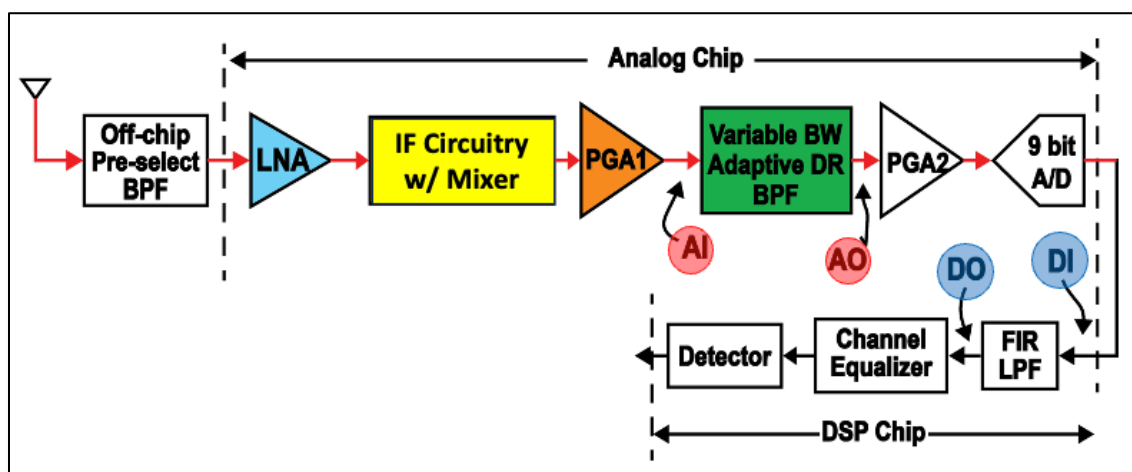
The algorithm to sense the input signal and determine instant DR is key. ***Signal power is sensed at four points*** along the IF strip (Fig. 2): ***input and output of the analog BPF and input and output of the digital channel select filter. These measured signal levels indicate how much***

² I have not performed an analysis of whether the claim language should, under the governing principles of claim construction, be construed to require measuring absolute signal values. I simply establish that *Behbahani* satisfies either interpretation.

of the received signal is being rejected, respectively, by the analog filter and the digital filter.

Behbahani at 1207.

116. *Behbahani* teaches circuits for determining desired and interferer signal strengths by taking signal strength measurements at two nodes on the analog signal path—**A_I** and **A_O**—and at two nodes on the digital signal path—**D_I** and **D_O**.



Behbahani modified by *Leete*, Figure 2 (annotated).

Behbahani (1) expressly teaches comparing the desired and interferer signal strengths and (2) renders obvious calculating an absolute interferer signal strength

117. *Behbahani* teaches that the difference between signal levels measured at nodes “**A_I** and **A_O** is a measure of the out-of-band *interferers* being rejected by the analog [filter].” *Behbahani* at 1207. The interferer signal power that remains after the *analog* filter is then calculated “by comparing the signal level at the input and the output of the digital filter (**D_I** and **D_O**), the relative strength of the out-of-channel signal that passes through the analog filter is calculated.” *Behbahani* at 1207. A

POSITA would have understood that not all of the interferers (especially in nearby channels) may be filtered out at the analog filter, so the difference between the signal strength measured at nodes A_I and A_O combined with the difference between D_I and D_O , accounting for gain introduced by any of the amplifiers, represents the total signal strength of the interferer signals. In one instance, “[i]f the out-of-band channel power passing through the A/D (I) is comparable to or larger than the desired signal (S) then the A/D must resolve the following number of additional bits to accommodate the interferers.” *Behbahani* at 1210. In *Behbahani* the digital filter is highly selective, in a perfect scenario only the desired channel is present at D_O . *Behbahani* at 1207. (“The signal at the output of the digital filter (point D_O in Fig. 2) is only the desired channel, with possibly some possible IM3 from adjacent interferers.”)

118. Not only is *Behbahani*’s receiver capable of ascertaining the absolute value of interferer signal strength (by calculating the difference between nodes A_I and A_O and the difference between D_I and D_O), but *Behbahani* also teaches that the difference between the signal strength measured at nodes A_I and A_O and the difference between the signal strength measured at nodes D_I and D_O are *actually used* in its adaptive DR process:

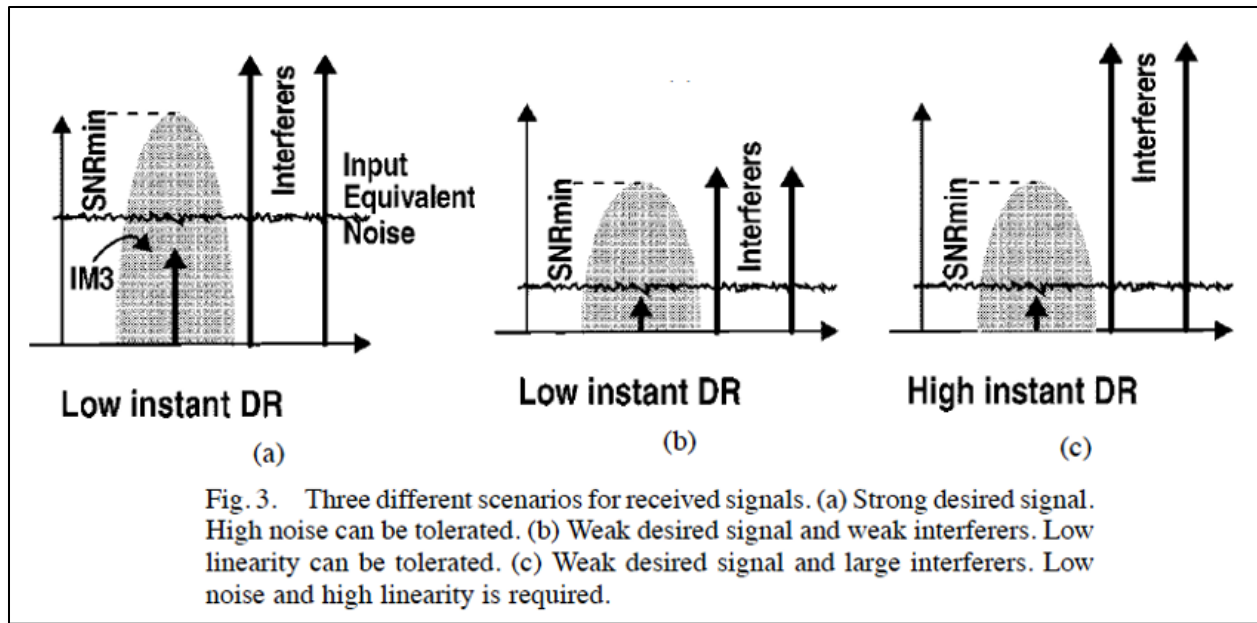
If the total signal power is comparable at A_I and A_O and at D_I and D_O , the condition is like Fig. 3(a) or (b). In both cases, the required instant DR is low. If the signal levels are significantly different at either of the

above pairs of nodes (A_I and A_O and D_I and D_O) and there is a weak signal at D_O , the condition must be the one shown in Fig. 3(c).

Behbahani at 1207. The signal scenarios depicted in Fig. 3(a-c) determine how the sliding and step-based adaptive DR processes are implemented. Specifically, *Behbahani* states:

“The desired signal may be strong enough to overcome large noise and intermodulation due to nearby interferers [Fig. 3(a)]. In this case, a high receiver NF is acceptable. Alternatively, the desired signal and the interferers are weak, so the signal-to-interference ratio (S/I) is still good (Fig. 3(b)), yet low IIP3 is acceptable. In both cases, the receiver dynamic range may be modest. The worst-case is when the desired signal is weak but the interferers strong (Fig. 3(c)). Now the instant receiver input signal DR is high, which requires high IIP3 and low NF. For least power consumption, the RX DR should adapt to the prevailing conditions. Two types of adaptive DR are possible, **sliding and step** [Fig. 4(a)].”

Id. at 1206. Fig. 3 is shown below:



Id. at Fig. 3 (rearranged).

119. Although *Behbahani* does not expressly teach calculating an absolute interferer signal strength, a POSITA would have been motivated to precisely calculate such a value. As an initial matter, it was well known how to calculate the absolute strength of an interferer signal. For example, an article titled “Optimum Reception in an Impulsive Interference Environment – Part I: Coherent Detection” by Spaulding et al. (“*Spaulding*”) describes calculating an absolute interferer signal strength. Specifically, *Spaulding* describes the performance will depend on the “absolute interference level as well as on the SNR.” *Spaulding* at 922 (“[P]erformance (i.e., error probabilities) will, in general, depend on the absolute interference level as well as on the SNR. In this sense, then, these optimum receivers are also adaptive; i.e., they must be able to adjust to the parameters (level, Impulsive

Index (A), etc.) of the interference.”). Beyond the well understood value of calculating absolute interferer signal strength, a POSITA would have been motivated to precisely calculate an absolute interferer signal strength in order to more accurately implement the sliding DR process. As discussed above, *Behbahani* adjusts the PGA1 gain “to best accommodate the input signal conditions.” *Behbahani* at 1206. A precise calculation of the interferer signal strength would benefit the sliding DR process, allowing the system to more accurately adjust the smaller DR to best accommodate input signal conditions.

Behbahani expressly teaches calculating an absolute desired signal strength

120. *Behbahani* expressly teaches that its analog and digital signal strength measurements at nodes A_I and A_O and at D_I and D_O are used to determine the absolute signal strength of a ***desired signal***. First, “[b]y comparing the signal level at the output of the analog BPF (A_O) and at the input of the A/D (D_I), the post filter gain is measured.” *Behbahani* at 1207. Next, by subtracting this gain from the signal strength at D_O , *Behbahani* determines the absolute strength of the desired signal. *Behbahani* at 1207. *Behbahani* at 1207 (“If the desired signal at the output of the analog BPF is strong, as measured by $\text{Power}_{D_O} - \text{Gain}_{\text{Post-analog-filter}}$, the scenario is as shown in Fig. 3(a).”). The signal strength measured at D_O represents the desired signal in isolation, having essentially all interferers removed by the two filters. *Id.* (“The signal at the output of the digital filter (point D_O in Fig. 2) is only the desired

channel, with possibly some possible IM3 from adjacent interferers.”) *Behbahani* uses this absolute desired signal strength measured at D_0 in its adaptive DR process. *Behbahani*, 1207 (significant interferer signal strength coupled with “a weak signal at D_0 ” indicates a situation as shown in Fig. 3(c)).

d) Claim 1(b): “dynamically adjusting at least one of an impedance, a bias or a gain of at least one of the amplifier, filter or mixer in the receiver signal path, responsive to the comparing.”

121. As noted above, the Proposed Ground satisfies both parties’ proposals for most of the disputed terms and Patent Owner’s proposed construction of the dynamic limitation and “signal path.” Relevant to this limitation, Petitioner proposed that “drive current” is “the current that carries a signal through a load,” but Patent Owner advocated a “plain and ordinary meaning.” Additionally, Patent Owner proposed that “impedance” is “opposition to the flow of alternating current,” and Petitioner advocated a plain and ordinary meaning for that term.

122. As set forth below, satisfying both parties’ proposals, when *Behbahani*’s system switches from its high-power filter to its low-power filter, it increases the “opposition to the flow of alternating current” (i.e., impedance) in the analog signal path and results in an increased noise floor, and in a reduced current that carries the AC signal through a load (i.e., through the filter load). This switch to a low-power filter also reduces the DC bias current applied to the filter stage.

123. Although Claim 1 permits dynamically adjusting any of an impedance, a bias or a gain, other Challenged Claims specifically require dynamically adjusting impedance or DC bias current. All proposed grounds rely on *Behbahani's* dynamic DR process, which satisfies all the limitations requiring dynamically adjusting a signal path impedance, a DC bias current, or any combination thereof. To avoid repetition, I set forth the full theory here.

The '202 Patent's Sole Inventor Admitted That Behbahani's Scaled Filter Approach Adjusts Signal Path Impedance Consistent With The Alleged Invention

124. I have read a January 2003 article titled, "Internally Varying Analog Circuit Minimize Power Dissipation," by the '202 patent's inventor, Dr. Tsividis. In that article, he describes many of the '202 Patent concepts, including a "Dynamic Impedance Scaling" approach to save power when experiencing better than worst-case conditions. Importantly, Dr. Tsividis' January 2003 article points to *Behbahani's* switched filter process as an exemplary means by which dynamic impedance scaling can be implemented. Ex. 1011 at 70 ("One way to achieve the above scenario would be to use two filters, designed with different capacitance values, and place one or the other in service as required [34], turning the other filter off."). Reference [34] is the same *Behbahani* reference used in this declaration and the petition. *Id.* at 72.

125. Dr. Tsividis' January 2003 article explains that systems are often designed "to handle very small signals in the worst case," providing large Usable Dynamic Ranges (UDR), which require filters with large capacitance values. *Id.* at 70. Dr. Tsividis' January 2003 article went on to note that, "when the desired signal happens to be strong and no strong blocker is present," "the very *low noise floor* of this system is unnecessary and *can be allowed to increase* by scaling [the capacitance] down." In addition to decreasing capacitance, the article explained that "the conductances of the filter will have to be scaled together with [the capacitance] in order to leave the frequency response unchanged." *Id.* The article explains that the concepts of changing a bias current and changing impedance are related as "*impedance scaling*" by "lowering capacitances and transconductances allows one to also *lower I_{BIAS}*, and thus the total power dissipation can be made small." *Id.*; see also *id.* at 71 ("noting that dynamic biasing is also encountered in the course of applying [] dynamic impedance scaling.").

126. I note that increasing the resistance and decreasing capacitance in a filter circuit is the only specific example of adjusting signal path impedance discussed in the '202 Patent. '202 Patent, 7:49-57 (discussing Fig. 6 and its corresponding disclosure). Accordingly, a POSITA would understand that inventor Tsividis' description of dynamic impedance scaling in his January 2003 article aligns precisely with his disclosure of the concept of adjusting impedance, and

related bias current, described and claimed in the '202 Patent. Both proposed *increasing signal path impedance* by (1) decreasing transconductance (and increasing resistance) and (2) decreasing capacitance of a filter, *allowing lower DC bias current* and *lower AC drive current* to save power.

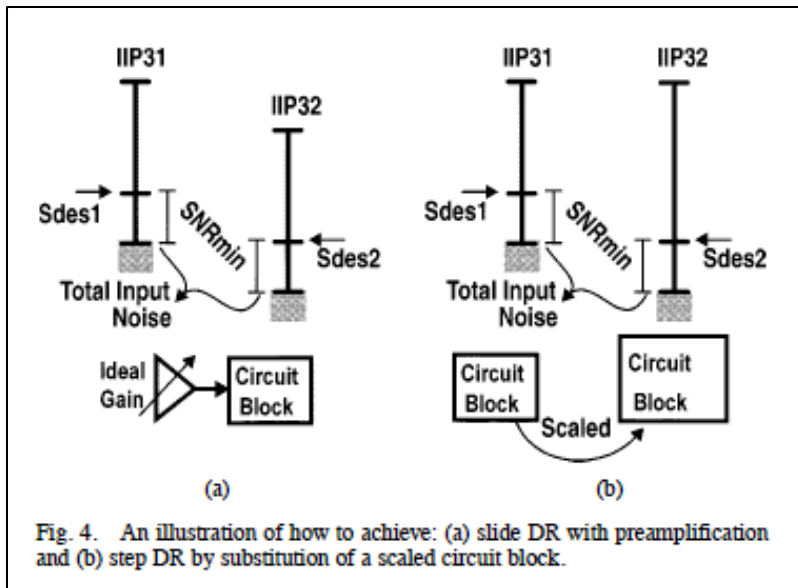
127. Transconductance is a well-known concept that is distinct from resistance, but that is related to resistance in that both are related to the ease with which current flows through circuit. Indeed, a POSITA would have understood that there is typically an inverse relationship between transconductance and resistance, i.e., lowering transconductance typically accompanies an increased resistance. For example, *Ludwig* describes an inverse relationship between resistance and transconductance. *Ludwig* at 521. (“Such parasitics include the base resistance that is connected in series with r_{π} , and thus reduces the effective transconductance g_m .”) Further, it was well-known that the higher current capability of high transconductance transistors is typically paired with the low resistance to that higher current in the form of smaller resistors. A POSITA would have understood that the January 2003 article’s dynamic filter that maintains the same frequency response by *decreasing transconductance* and decreasing capacitance is analogous to the '202 Patent’s dynamic filter that maintains the same frequency response by *increasing resistance* and decreasing capacitance.

128. Dr. Tsividis' January 2003 article concludes its discussion by pointing to *Behbahani's* switched filter process, which results in a change in bias current, as an exemplary means by which dynamic impedance scaling can be implemented. Ex. 1011, 70 ("One way to achieve the above scenario would be to use two filters, designed with different capacitance values, and place one or the other in service as required [34], turning the other filter off."). Reference [34] is the same *Behbahani* reference used herein.

Switching From Behbahani's High-Power Filter to Low-Power Filter Increases Signal Path Impedance and Reduces DC Bias Current.

129. As explained above, *Behbahani* teaches a wireless receiver that implements an "adaptive dynamic range" method to save power by decreasing the dynamic range when conditions are better than worst-case. *Behbahani* at 1205. A step-based DR technique switches between two scaled filters, using "high-power filter" only during worst-case conditions and a separate "low-power filter" for conditions that are better than worst-case. *Behbahani* at 1206-07.

130. Fig. 4(b) below illustrates switching from the low-power filter to high-power filter to expand the DR when worst-case conditions are encountered:



Behbahani at 1206. *Behbahani* teaches that switching back—from the high-power filter to the low-power filter—when conditions improve is one means through which *Behbahani's* system saves power during periods of better than worst-case conditions.

131. That dynamic range is stepped up is shown in Fig. 4 (b) above, by switching in the “high-power scaled filter[.]” *Behbahani*, 1207. *Behbahani* explains, “[t]wo filters are implemented with the same topology, but one, scaled up to consume 10x more power, offers 10x lower mean square noise but the same linearity.” *Behbahani* at 1207. Thus, when the high-power filter is switched into the circuit, the “DR may be stepped up by substituting a scaled version of a nominal circuit.” *Behbahani* at 1206.

132. *Behbahani* explains that “providing no more than the required DR at any given time lowers the average power consumption.” *Behbahani* at 1205. To

achieve this, “a BPF dissipating low power is employed for nominal RX DR. However, in the worst-case scenario, the high-power scaled filter is switched in raising total DR. Since the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption.” *Id.* In other words, *Behbahani’s* high-power filter, as the name suggests, uses more power than the low-power filter. Because the high-power filter is used infrequently—during worst-case conditions—the average power is largely determined by the low-power filter, which is used more often.

133. *Behbahani* and *Tan* describe a technique often referred to in the art as filter scaling. *Behbahani* explains, “[t]wo filters are implemented with the same topology, but one, scaled up to consume 10x more power, offers 10x lower mean square noise but the same linearity.” *Behbahani* at 1207. *Behbahani* provides some detail about the scaled filters, including that its high-power filter “scale[s] up all transistors, while “scaling down all resistors by the same factor,” which “raises bias current proportional to the scale factor.” *Behbahani* at 1206. *Behbahani* also explains that the filter input capacitance scales proportionately, noting the “filter input capacitance [] is, respectively, 0.4 and 4 pF for the low-power and the high-power versions.” *Behbahani* at 1208. As set forth in detail below, *Tan* provides details about the specific scaled filters to be used in *Behbahani’s* receiver.

134. Scaling circuits was a well-known technique at the time. As an example, *Cho* describes “Scaling of SC Circuits Through the Pipeline[.]” *Cho* describes, “the stage requirements on the speed and accuracy become less stringent as the stage resolution decreases down the pipeline, **stages in the later part of the pipeline can be scaled down by using smaller sampling capacitors** and op amps. In this case, the sizes of sampling capacitors and op amps near the front end are determined by the noise floor, and toward the end of the pipeline, parasitic capacitances begin to dominate, and so settling time requirements determine the size of each stage.” *Cho* at 168.

135. *Cho* further discusses that power optimization of “each of the operational amplifier in the pipeline can be performed taking into account the source, load, and feedback capacitors seen by each one.” *Cho* at 168.

136. Further a POSITA would have understood that filter scaling was an advantageous technique to use as, it was well-known in the state of the art that filter scaling saves power. For example, a textbook titled “Analog MOS Integrated Circuits for Signal Processing” to Gregorian et al. (“*Gregorian*”) describes filter scaling. In a section titled “The Scaling of Switched-Capacitor Filters” *Gregorian* describes “the actual performance of an SCF [switched-capacitor filter] can be improved, and the area which it occupies on its silicon chip reduced, by scaling operations.” *Gregorian* at 339. *Gregorian* employs filter scaling by “multiplying all

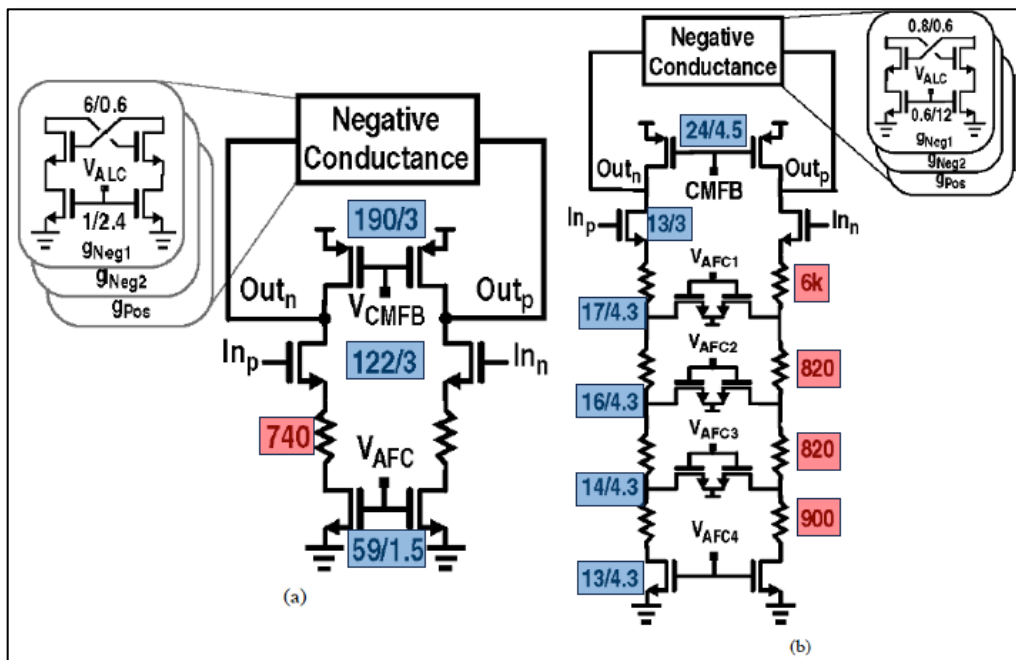
capacitors which are connected (or switched) to the output terminal of the i th op-amp OA_i changes its output voltage V_i to V_i / k_i , while leaving all charges from (and to) OA_i to (and from) the rest of the circuit unchanged.” *Gregorian* at 340. In sum, filter scaling “is useful in improving the dynamic range of SC circuits.” *Gregorian* at 340.

137. *Behbahani* provides some detail about the scaled filters, such as the high-power filter “scale[s] up all transistors, while “scaling down all resistors by the same factor,” which “raises bias current proportional to the scale factor.” *Behbahani* at 1206. *Behbahani* also explains that the filter input capacitance scales proportionately, noting the “filter input capacitance [] is, respectively, 0.4 and 4 pF for the low-power and the high-power versions.” *Behbahani* at 1208. But *Behbahani* notes that additional “details of the [filter] design are presented elsewhere [7].” *Id.* at 1210. [7] is a reference to *Tan*. *Behbahani* at 1216.

138. *Tan* does provide additional details about the scaled filters discussed in *Behbahani*, and these additional details confirm that transitioning from the high-power to low-power filter increases signal path impedance and reduces bias current. Like the *Leete* reference, *Behbahani* and *Tan* describe different aspects of the same circuit. As I explained above, a POSITA would have been motivated to combine *Behbahani* and *Leete*, treating them conjunctively as the authors intended. The same motivation applies to combining *Behbahani* and *Tan*. And, as with the *Behbahani*

and *Leete* combination, POSITA would have expected success in treating *Behbahani's* and *Tan's* teachings conjunctively, as the authors intended.

139. *Tan* describes scaled G_m - C filters. *Tan* at 477 (“This filter is realized as a G_m - C circuit.”). The “electrical characteristics of the G_m - C filter strongly depend on the G_m circuit. These characteristics are: noise factor, current efficiency G_m/I_{bias} , linearity as measured by intercept point, tuning range, frequency response, maximum signal swing at the input and the output, and dc gain.” *Tan* at 477. The G_m circuit defines the overall filter characteristics, and examining that G_m circuit reveals that the proposed low-power filter does in fact have lower transconductance, higher resistance, lower capacitance, and a lower bias current. For example, Figs. 6(a) and 6(b) below illustrate how the transconductances and resistances vary together in the proposed scaled filters in *Tan*:



Tan, Figs. 6(a)-(b) (annotated). Annotated blue above, the transistor Width/Length ratio is directly related to transconductance, with a higher Width/Length ratio resulting in a higher transconductance.

140. It was well known in the art that transconductance is directly proportional to the width (W) of the transistor and inversely proportional to its length (L). For example, *STMicroelectronics* states, “the transconductance is directly proportional to the channel width/length ratio, and the voltage threshold is always determined by the doping of the channel, gate oxide thickness...,etc.” *STMicroelectronics* at 4.

141. In the above example in the low-noise (high-power) filter stage depicted in Fig. 6(a), the Width/Length ratios are as follows:

$$\frac{190}{3}, \frac{122}{3}, \frac{59}{1.5}$$

142. This equals a Width/Length ratios range of approximately 40 to 60 for the low-noise (high-power) filter stage depicted in Fig. 6(a).

143. As shown in the low-noise (high-power) filter stage depicted in Fig. 6(a), the Width/Length ratios are as follows:

$$\frac{24}{4.5}, \frac{13}{3}, \frac{17}{4.3}, \frac{16}{4.3}, \frac{14}{4.3}, \frac{13}{4.3}$$

144. The Width/Length ratios are much smaller ratios, ranging from 3 to 5.3 for the low-power filter stage depicted in Fig. 6(b).

145. As I explained above, resistance has an inverse relationship to transconductance. For example, Fig. 6(a)'s higher transconductance is accompanied by a relatively small 740 Ohms in one leg of the circuit, while Fig. 6(b)'s lower transconductance is accompanied by a much higher 8,540 Ohms in one leg of its circuit.

146. Comparing the Width/Length ratios range of about 40-60 to the Width/Length ratios ranging about 3-5.3 and taking into consideration the resistance of 740 Ohms and 8,540 Ohms, equates to a more than 10x increase in transconductance in the high-power stage. This equates to the low-power filter having a 10x lower transconductance when compared to the high-power stage.

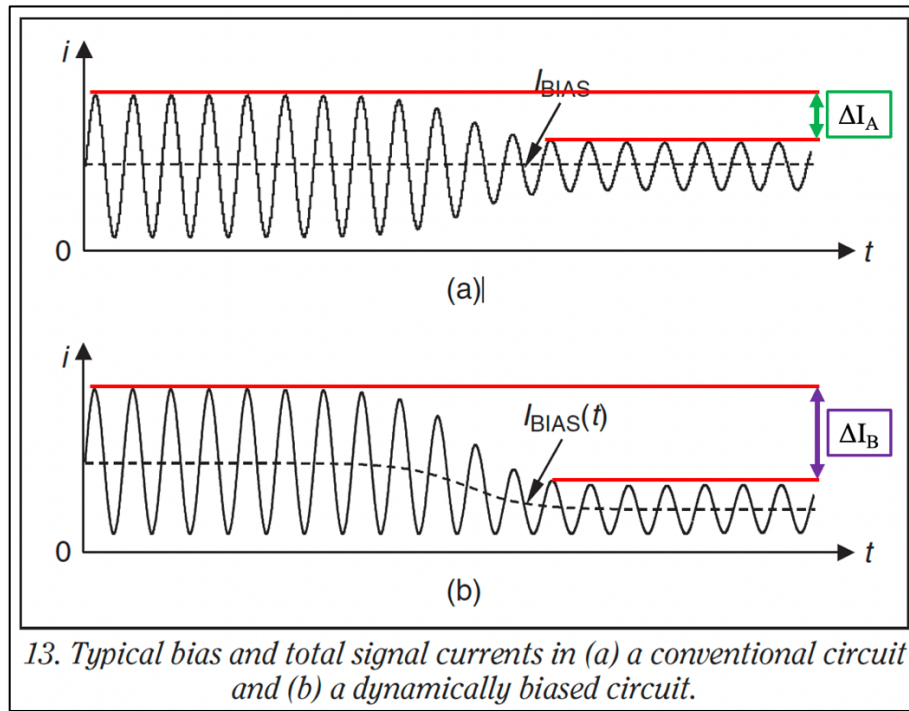
147. In sum, *Tan* confirms that the low-power filter in *Behbahani* exhibits “the same frequency response and linearity” as the high-power filter, but that scales all “transconductances and capacitors in th[e] filter . . . by a factor of 10” and “consumes 10x lower power.” *Tan* at 480. *Tan* also confirms that the high-power filter utilizes a higher transconductance G_m (accompanied by lower resistance), higher capacitance, and higher bias current. *Tan* at 481. A POSITA would have understood, consistent with the ‘202 Patent and Dr. Tsividis’ 2003 paper, that Tan’s teachings confirm switching from *Behbahani*’s high-power filter to its low-power filter increases signal path impedance and reduces the bias current of a component (i.e., the filter) in the signal path.

Switching From a High-Power Filter to Low-Power Filter Also Lowers the Drive Current

148. The '202 Patent does not identify how drive current is reduced when signal path impedance is increased. The patent seems to suggest that driving a larger signal path load impedance may require less current. '202 Patent at 7:54-57 (when the impedance load is doubled, “the output current required . . . is reduced by one-half”). This appears to be a reference to the well-understood Ohm’s law, which defines the relationship between current (I), resistance (R), and voltage (V): $V=I \times R$. *See Barron* at 21. (“A German physicist by the name of Georg Ohm discovered the relationship between voltage, current, and resistance in 1827...E represents emf, or voltage; I is the current or the intensity of electron flow; R stands for resistance. The formula is $E = I \times R$.”). Based on Ohm’s law, if the voltage (V) across a load is to be kept constant and the resistive load (R) is doubled, only half the current (I) is required to generate that constant voltage across the load. The patent also alludes to a relationship between bias current and drive current. *See, e.g.*, '202 Patent at 7:65-67, 8:1-4 (noting that increasing the signal path impedance is an example “where drive currents and possibly bias currents may be reduced”), 9:62-63 (“since the drive current is reduced, one or more bias current may also be reduced”).

149. Although the patent itself does not explain this, Dr. Tsividis’s January 2003 article does provide a helpful example that illustrates the relationship between bias current and drive current. Specifically, the article states “[i]n general dynamic

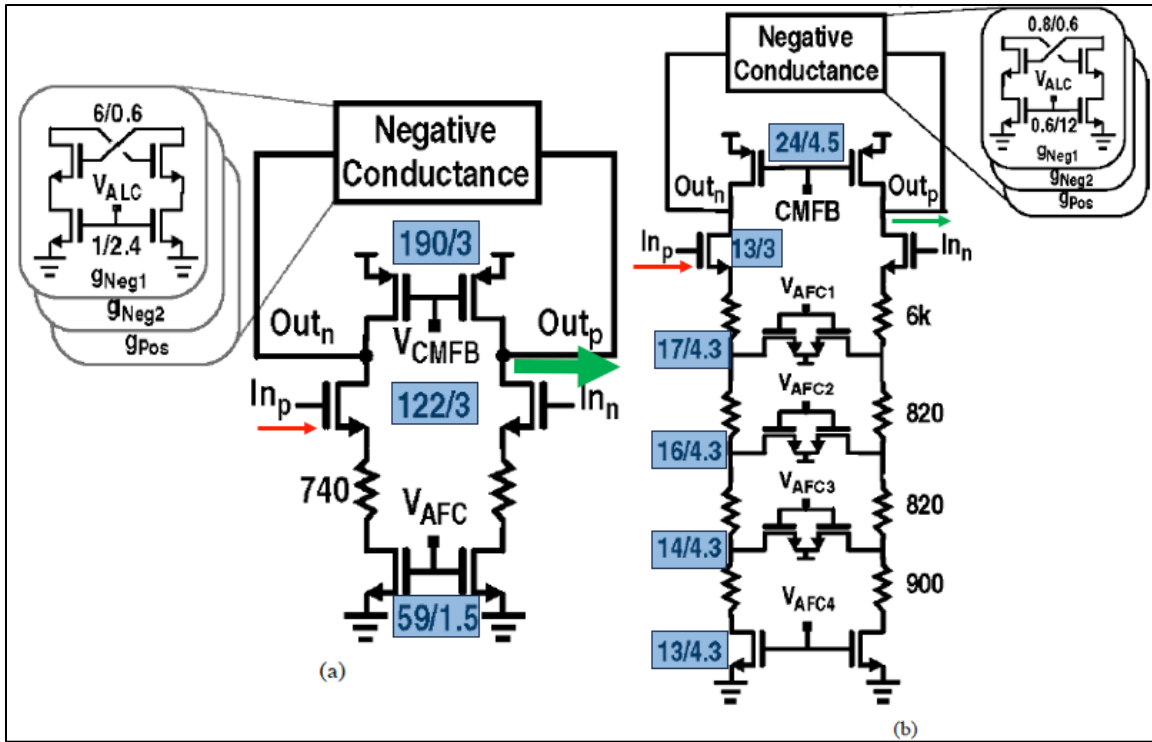
biasing decreases bias current values when they are not needed to handle large signal swings. The total current in a conventional and in a dynamically biased class A circuit, under changing signal amplitudes conditions, is illustrated in Figure 13.” Ex. 1011 at 71.



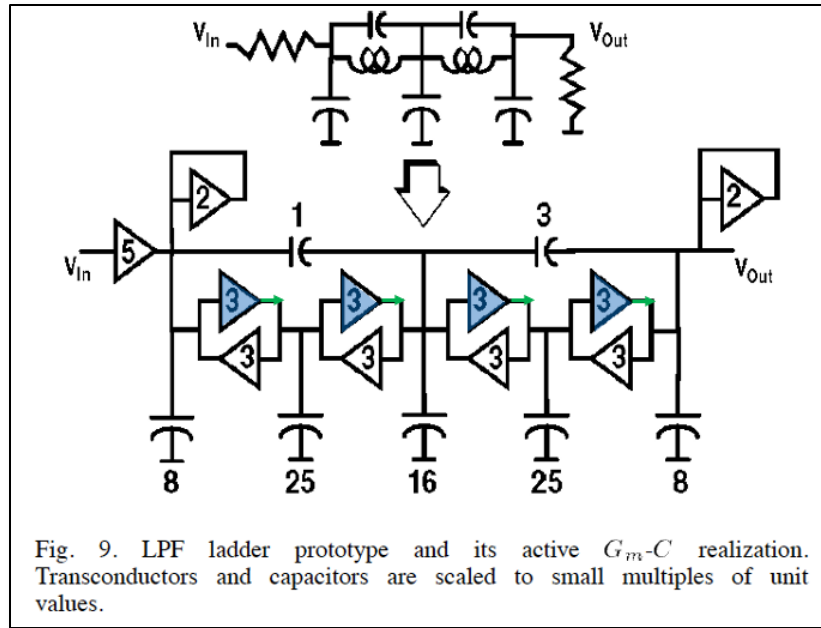
Id., (annotated). As illustrated in Figure 13 (a), the power dissipation (which refers to average power in this context) is set by the dashed line in the figure labeled I_{BIAS} , the signal amplitude current drops by ΔI_A but the average power remains unchanged. Figure 13 (b) illustrates that power savings can be realized when $I_{BIAS}(t)$ is dynamically lowered. In Figure 13 (b), lowering $I_{BIAS}(t)$ produces power savings when a lower average switching/drive current that flows through the circuit. The dotted line in this figure represents the bias current.

150. *Behbahani* expressly teaches that the DC bias current is lower when the low-power filter is in use. *Behbahani* at 1206 (teaching that its high-power filter “[s]cale[s] up all transistors[,]” while “scaling down all resistors by the same factor,” which “**raises bias current** proportional to the scale factor”). Based on the logic of Fig. 13 in Dr. Tsividis’s 2003 paper, a POSITA would have understood that decreasing the bias current when switching in *Behbahani*’s low-power filter also serves to decrease drive current. The technical details of the high- and low-power filters, as described in *Tan*, also confirm that AC drive current is in fact lower when the low-power filter is used. Specifically, the lower transconductance values in the low-power filter stages will, by their electrical characteristics, produce lower AC current in the signal path. In simple terms, transconductance is a measure of the output AC (signal) current produced by the input AC (signal) voltage: $g_m = \Delta I_{out} / \Delta V_{in}$.

151. As discussed above, the transconductance of the *Behbahani*’s low-power stage is more than ten times lower than the low noise (high-power) stage. Focusing on I_{np} and Out_p , Figs. 6(a)-(b) show that, for the same input voltage, the output current in the high-power filter will be much larger than the output current in the low-power filter as a result of the significantly different transconductance values:



Tan, Figs. 6(a)-(b) (annotated). Each of the transconductors in this filter (represented by triangles in Fig. 9) includes either the circuit depicted in Fig. 6(a) (for the high-power filter) or Fig. 6(b) (for the low-power filter). *Tan*'s Fig. 9 as shown below depicts the full low pass G_m -C filter structure.

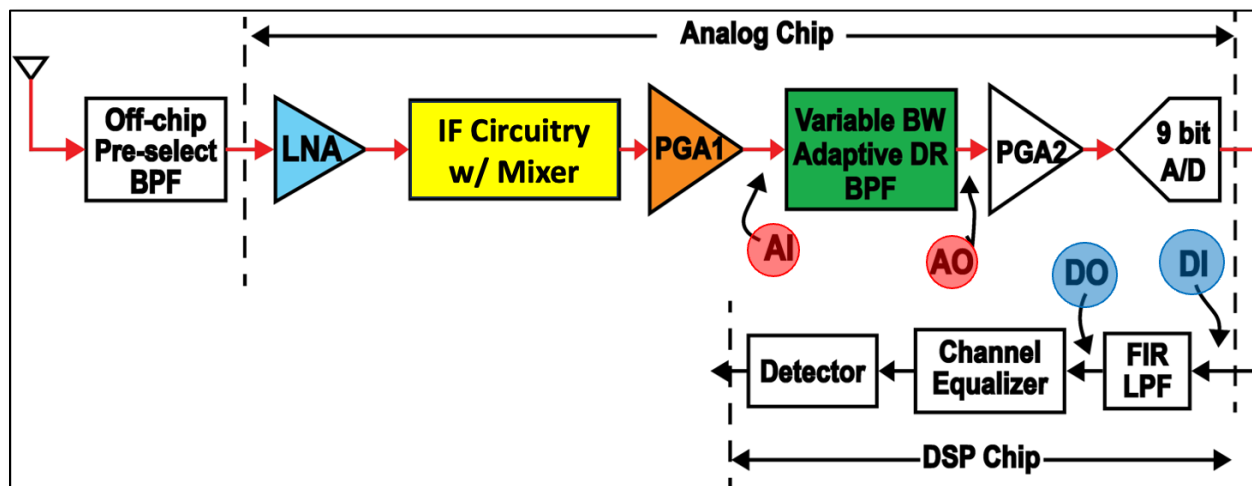


Id. at Fig. 9 (annotated). As *Tan* explains, the filter uses pairs of transconductors in a differential negative feedback configuration to simulate inductors in an LC ladder filter. *Id.* at 478, 480, Fig. 9. Focusing on the forward current path through the **transconductors** of the filter circuit to simplify the discussion, the **drive current** carrying the IF signal is relatively higher in the transconductors of the high-power configuration of Fig. 6(a) and relatively lower in the transconductors of the low-power configuration of Fig. 6(b). In other words, the higher drive current that results from the high-power transconductor's larger transconductance produces an overall larger drive current through the filter.

152. Therefore, *Behbahani* reduces the overall power dissipation/consumption thus saving power, when switching from the high-power filter to the low-power filter. *Behbahani* at 1205. ("providing no more than the required DR at any given time lowers the average power consumption.")

Behbahani Switches From a High-Power Filter to a Low-Power Filter Based on Signal Strength Measurement Comparison

153. As described in Claim 1(b), *Behbahani* takes multiple signal strength measurements to ascertain desired and interferer signal conditions, including at a signal strength measured at node A_I (annotated in red) located in the signal path before the analog filter and a signal strength measured at node A_O (annotated in red) located in the signal path after the analog filter:

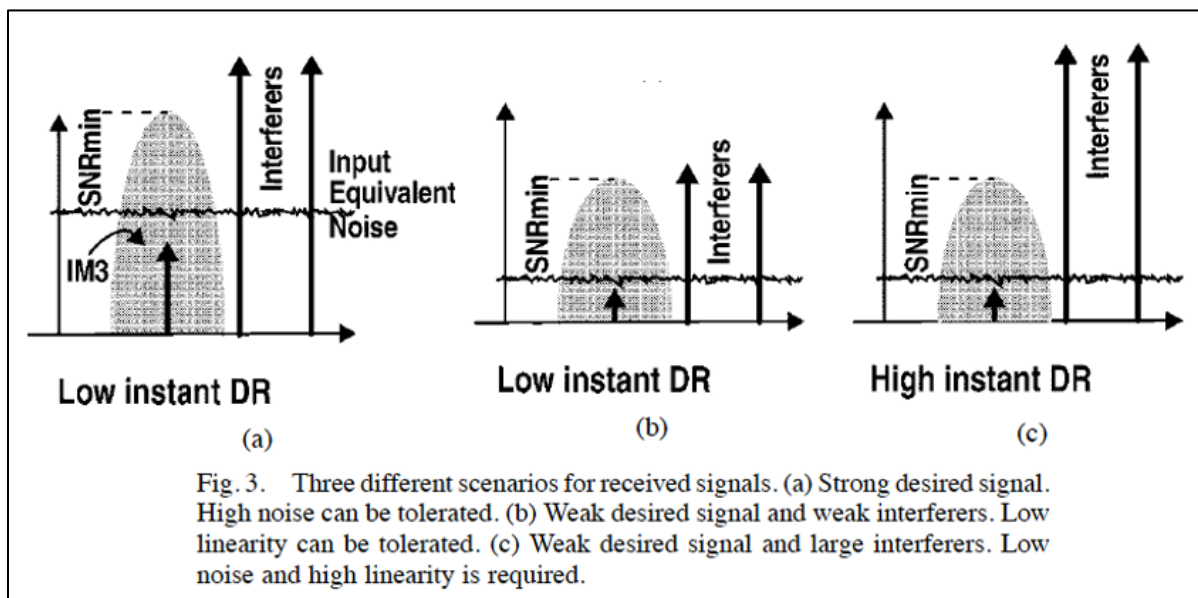


Behbahani modified by *Leete*, Figure 2 (annotated). Like the '202 Patent, *Behbahani* teaches that the difference between signal levels measured at nodes “ A_I and A_O is a measure of the out-of-band interferers being rejected by the analog [filter].” *Behbahani*, 1207. *Behbahani* also measures the output of the digital filter (D_O , annotated blue), which indicates the absolute signal strength of a received desired signal. *Id.*

154. *Behbahani* teaches that the difference between signal levels at nodes “ A_I and A_O is a measure of the out-of-band interferers being rejected by the analog

[filter].” *Id.* The output of the digital filter (D_o), indicates the absolute signal strength of a received desired signal. *Id.*

155. The figure below in *Behbahani* illustrates three different scenarios for received signals.



Id. at Fig. 3 (rearranged). *Behbahani* explains that “[i]f the signal levels are significantly different at . . . the above pairs of nodes (A_i and A_o . . .) and there is a weak signal at D_o , the condition must be the one shown in Fig. 3(c).” *Id.*, 1207. Figs. 3(a) and Fig. 3(b) depict better than worst-case conditions in which “receiver dynamic range may be modest” and the gain-based sliding DR approach is sufficient. *Id.*, 1206. Figure 3(a) above illustrates a strong desired signal, Fig. 3(b) illustrates a weak desired signal and weak interferers, and Fig. (c) illustrates a weak desired signal and large interferers. A step-based DR technique switches between two scaled

filters, using “high-power filter” only during worst-case conditions and a separate “low-power filter” for conditions that are better than worst-case. *Id.*, 1206-07.

156. When a worst-case signal scenario occurs, such as Fig 3(c), *Behbahani*’s switched DR process uses the high-power filter to expand the DR and accommodate a low desired signal and high interferers. *Id.*, 1206. When the signal strength measurements indicate appropriately better than worst-case conditions, *Behbahani*’s system switches in the low-power filter, saving power, and implements the sliding DR process to track the desired signal strength. *Id.* Specifically, “[s]ince the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption.” *Id.*, 1207.

157. Accordingly, a POSITA would recognize that switching from the high-power filter to low-power filter is based on signal strength measurements taken at multiple nodes in the signal path on an integrated circuit, including at nodes A_I and A_O . And when *Behbahani* switches from its high-power filter to its low-power filter based on signal strength measurements, as discussed above, it (1) increases the signal path impedance and (2) lowers the DC bias applied to the filter stage, and (3) lowers the drive current—the current carrying an AC signal through the signal path.

158. Therefore, *Behbahani* reduces the overall power dissipation, thus saving power, when switching from the high-power filter to the low-power filter based on signal strength measurements. Further, *Behbahani* dynamically varies the

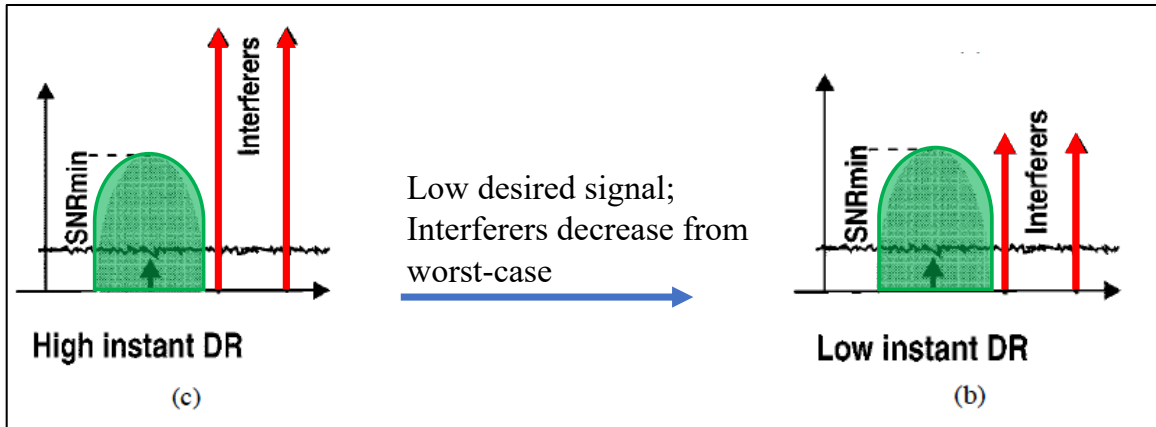
impedance, bias current, and gain “during operation based—at least in part—on information gained during operation” (i.e., signal strength measurements).

2. Claim 2

Claim 2: “The method of claim 1, wherein when the strength of the interferer signal decreases over time, and the strength of the desired signal is low, dynamically decreasing the bias of at least one of the plurality of circuits in the receiver signal path.”

159. As I explained above, *Behbahani* teaches an “adaptive dynamic range” method of saving power by switching from a high-power to a low-power filter when signal conditions sufficiently improve from worst-case. This switch dynamically (1) increases signal path impedance and (2) decreases DC bias current in the filter. *See* Claim 1(Pre)(a)-Claim 1(b).

160. Claim 2 captures a scenario in which the system starts out experiencing worst-case conditions (i.e., low desired and high interferers), but improves over time as the strength of the interferers weaken. *Behbahani* expressly contemplates this precise scenario. Namely, as shown in annotated Fig. 3 below, the transition from worst-case conditions (e.g., Fig. 3(c)) to the improved conditions depicted in Fig. 3(b) retains a low desired signal strength and the improvement is realized by interferer signal strength weakening over time:



Behbahani at Fig. 3(b)-(c). Per *Behbahani's* express teachings, if the signal is initially a worst case (Fig. 3(c)), when interferer signal strength decreases sufficiently above a worst case (even absent any change in the desired signal strength), *Behbahani's* system switches from the high-power filter to the low-power filter, decreasing DC bias current and saving power.

3. Claim 4

Claim 4: “The method of claim 1 wherein when the strength of the interferer signal is low and the strength of the desired signal increases over time, dynamically increasing the impedance of one or more of the plurality of circuits in the receiver signal path.”

161. As explained above, *Behbahani* says that the high-power filter is used for a range of worst-case conditions (e.g., Fig. 3(c)) and the low-power filter is used when conditions have sufficiently improved. *Behbahani* at 1206; Claim 1(Pre)(b); Claim 1(b).

162. Claims 4, 5, and 8 address specific signal conditions in which the low-power filter is in use and the system dynamically adjusts either DC bias or signal path impedance to reflect the desired signal strength changing over time.

163. As described above in Claim 1(Pre)(b), when the low-power filter is used during better than worst-case conditions, *Behbahani's* sliding DR technique employs a gain stage in advance of the low-power filter to slide a smaller DR up or down based on strengths of the received signals. *Behbahani* at 1206-07. *Behbahani* teaches (1) increasing gain at PGA1 to slide the smaller dynamic range up when a “[s]trong desired signal” is received and (2) decreasing the gain, “enabl[ing] detection of a weaker signal.” *Behbahani* at 1206. *Leete* similarly teaches that “[t]he gain of the RF mixer and IF amplifier is switchable to slide the available dynamic range of the following stages based on the conditions of the input signal.” *Leete* at 1908 (Abstract). *Leete* implements gain-based sliding DR teachings. (“The DR of the front-end may be slid up or down. When the desired signal is low, the front-end NF must be lowest for sensitivity. If the desired signal is larger, a higher NF can be tolerated, and the DR is slid up for higher IIP3 by switch selecting the gain of the RF mixer and IF1 amplifier.”) *Leete* at 1911. *Leete* further describes “Table II shows the characteristics of the IF1 amplifier with two gain settings” used to “slide dynamic range[.]”

TABLE II
SIMULATION RESULTS OF THE IF1 AMPLIFIER AND BUFFER

W_{eff} (μm)	I_{bias} (mA)	Gain (dB)	V_n diff (nV/ $\sqrt{\text{Hz}}$)	IIP3 (dBm)
40	6.2	6	4.6	15
70	8.5	10	3.5	10.5

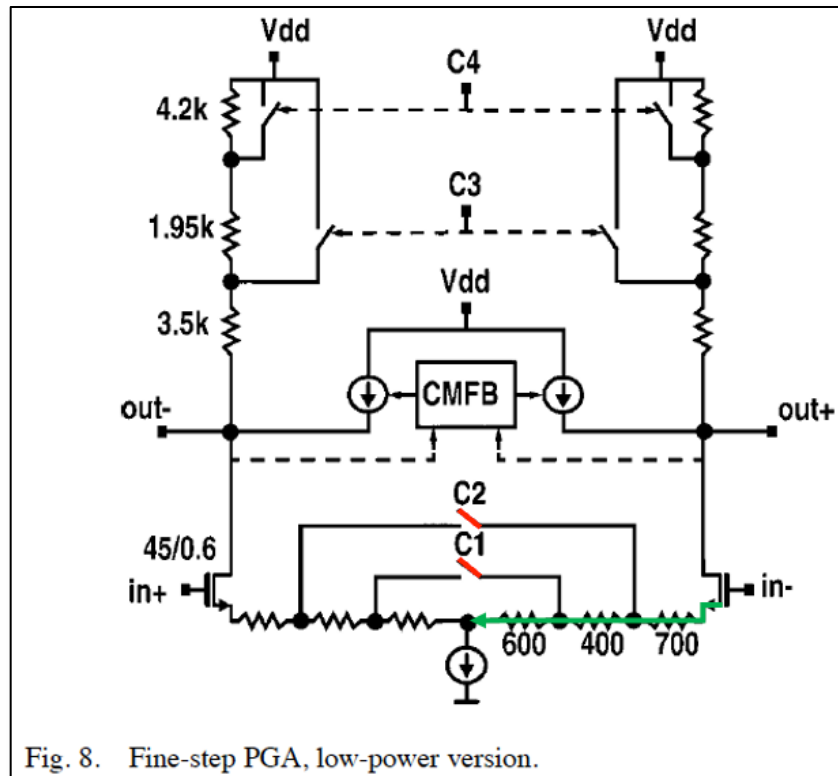
Leete at 1912. As shown above, the bias current is shown in the second column and the gain is shown in the third column.

164. As discussed above in Claim 1(Pre)(a), a POSITA would have been motivated to treat the teachings of *Behbahani* and *Leete* conjunctively, as the authors intended. Those arguments apply equally here and support concluding that a POSITA would have implemented the gain-based sliding DR teachings from *Leete* in *Behbahani*'s receiver and would have expected success in doing so. Indeed, as I discuss above, these references are in fact describing different aspects of the same receiver. A POSITA would have understood that implementing gain adjustments at different points along the signal path in the receiver—including those described in *Behbahani* and in *Leete*—provides the benefit of optimizing dynamic range under prevailing conditions. Accordingly, a POSITA would have been motivated to implement *Behbahani*'s sliding DR, as intended, via gain adjustments at the IF1

amplifier and RF mixer, as described by *Leete*, and at PGA1, as described by *Behbahani*.

165. Claim 4 recites a better than worst-case condition where the desired signal strength increases over time. Using *Behbahani*'s sliding DR teachings, gain is *decreased* in response to a desired signal that is *gaining strength* over time. *Behbahani* at 1206-07 (noting that "[t]he pre-BPF amplifier, PGA1, slides the input DR of the BPF to best fit the instant level of the input signal, as shown in Fig. 4(a)" and that "lowering gain in PGA1 slides up the DR" to detect a stronger desired signal). As set forth below, when gain is *decreased* at PGA1 to track a desired signal of gaining strength, the signal path opposition to the flow of alternating current is increased.

166. Fig. 8 depicts PGA1. *Behbahani* at 1208 ("The PGAs used in this work all consist of a degenerated differential pair with resistive load Fig. 8 shows the low-power fine-step PGA" in which "[t]he gain [] varies from 3 to 15 dB in 3-dB steps. For 3-dB gain [i.e., the lowest gain setting], all the degeneration switches are open (maximum degeneration) and all the load switches are closed (minimum load resistance), whereas for 15-dB gain [i.e., the highest gain setting] the switches are in the opposite positions."). As shown below, switches **C1** and **C2** are used to adjust the level of degeneration and switches C3 and C4 are used to adjust the load resistance:



Behbahani at Fig. 8 (annotated). *Behbahani* explains that switches **C1** and **C2** are **open** at the lowest gain setting, which results in the highest degeneration resistance—all three resistors in series between the MOSFET source terminal and current source. *Behbahani* at 1208 (“For 3-dB gain, all the degeneration switches are open (maximum degeneration)[.]”)

167. A POSITA would have understood that this **degeneration resistance** does in fact oppose the alternating current developed by the MOSFET transistors in PGA1. Degeneration as depicted in PGA1 produces negative feedback in the amplifier. For example, *Graf* describes “negative feedback-Also called degeneration...A process by which a part of the output signal of an amplifying circuit

is fed back to the input circuit. The signal fed back is 180° out of phase with the input signal; therefore, the amplification is decreased, and distortion reduced.” *Gray* at 499.

168. Degeneration in the context amplifiers like PGA1 was well understood. For example, a textbook titled “Analysis and Design of Analog Integrated Circuits” by Gray et al. (“*Gray*”) describes resistor degeneration in a common-emitter amplifier that reduces gain. Specifically, Gray states “[s]ince the gain is decreased, the presence of an emitter resistor is termed emitter degeneration. The resistor actually causes feedback to occur since the voltage across the emitter resistor, which is proportional to output current, subtracts directly from the input voltage.” *Gray* at 147-148. Further, the “transconductance is decreased by a factor $(1 + g_m R_E)$ compared with the case for $R_E = 0$.” *Gray* at 148. As *Gray* notes, degeneration resistance does in fact reduce gain. And, in the case of *Behbahani’s* receiver, a POSITA would have understood that this increased resistance opposes the alternating current developed by the MOSFET transistors in PGA1.

169. Accordingly, when *Behbahani’s* receiver is operating in better than worst-case conditions (i.e., using the low-power filter) and the desired signal increases, the gain at PGA1 is lowered, sliding the smaller DR up in regards to increasing desired signal strength. This gain is lowered by the larger degeneration resistance, which would have increased the opposition to the flow of alternating

current through the transistors in the amplifier. (i.e., Theta's definition of "impedance").

4. Claim 5

Claim 5: "The method of claim 1, wherein when the interferer signal is weak and the desired signal is low and the strength of the desired signal increases over time, dynamically decreasing the bias of one or more of the plurality of circuits in the receiver signal path."

170. As explained above with reference to Claim 4, using *Behbahani's* sliding DR teachings, gain is decreased to reflect increasing desired signal strength, and a POSITA would have been motivated to implement *Behbahani's* sliding DR via gain adjustments at the IF1 amplifier and RF mixer, as described by *Leete*, and at PGA1, as described by *Behbahani*.

171. Further, decreasing gain in the IF1 amplifier does in fact lower its DC bias current. Indeed, Table II below expressly discloses that the **lower gain setting** in the IF1 amplifier has a lower DC bias current than the **higher gain setting**:

TABLE II
SIMULATION RESULTS OF THE IF1 AMPLIFIER AND BUFFER

W_{eff} (μm)	I_{bias} (mA)	Gain (dB)	V_n diff (nV/ $\sqrt{\text{Hz}}$)	IIP3 (dBm)
40	6.2	6	4.6	15
70	8.5	10	3.5	10.5

Leete, Table II (annotated).

5. Claim 6

1. **Claim 6 (Pre): “A method for reducing power consumption in a receiver in a battery operated mobile device, wherein the receiver comprises a plurality of circuits, and wherein the plurality of circuits comprise a signal path including at least an amplifier, a mixer and a filter, the method comprising:”**

172. I note that claim 6 uses slightly different language than Claim 1 to describe its claimed receiver. Claim 6 recites “a receiver in a battery operated *mobile device*,” and Claim 1 recites “a receiver of a battery operated *transceiver*.” A POSITA would understand that these are immaterially different ways to describe the same concept, and as such were addressed in Claim 1(Pre)(a). *See* Claim 1(Pre)(a). As set forth in this preamble discussion above, a POSITA would have understood *Behbahani’s* receiver circuitry is intended to be used in a mobile device with a complete transceiver or at least would have been motivated to implement *Behbahani’s* receiver circuitry in a mobile device with a complete transceiver.

2. **Claim 6 (a): “receiving a wireless signal comprising a desired signal and an interferer signal at the receiver; determining a strength of the desired signal; determining a strength of the interferer signal; comparing the strength of the desired signal to the strength of the interferer signal; and”**

173. I note that claim 6 (a) uses slightly different language than Claim 1 to describe its claimed received signal. Claim 6 recites “receiving a *wireless* signal...*at the receiver*” and Claim 1 recites “receiving a signal.” *See* Claim 1(a). A POSITA would have understood and found obvious that *Behbahani’s* claimed wireless

receiver would satisfy receiving a wireless signal at the receiver and that the Claim 1 mapping also satisfies limitation 6(a).

3. Claim 6(b): “when the strength of the interferer signal is low and the relative strength of the desired signal is greater than the strength of the interferer signal, dynamically increasing an impedance of at least one of the amplifier, filter or mixer in the signal path of the receiver, thereby reducing power dissipation in the receiver.”

174. As explained above with reference to limitation [1(b)], *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used when conditions have sufficiently improved beyond worst-case conditions. *Behbahani* 1206. Limitation [6(b)] recites a better than worst-case condition where the interferers are weak and desired signal strength is greater than the interferer signal. Per *Behbahani*’s adaptive DR teachings, such a scenario would save power away from worst-case conditions by switching from the high-power filter to the low-power filter, dynamically increasing an impedance of the filter in the signal path.

6. Claim 7

1. Claim 7 (Pre)(a): “A method for power dissipation control in a receiver of a wireless transceiver of a battery-powered portable wireless device, the receiver having a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer,”

175. I note that Claim 7 uses slightly different language than Claim 1 to describe its claimed method for power dissipation. Claim 7(Pre)(a) recites “a method

for power dissipation control in a receiver,” and Claim 1 recites “a method of reducing the power consumption of a receiver.” To control (i.e., reduce) the power dissipation (supply power used by a receiver) in a receiver, one is also reducing the power consumption of the receiver. For example, The Modern Dictionary of Electronics to “Graf” (“*Graf*”) states that power dissipation is referred to as the “supply power consumed by a logic circuit...” and that power consumption is referred to as “the maximum wattage used by a device within its operating range during steady-state conditions[.]” *Graf* at 581.

176. A POSITA would have understood that these terms are immaterially different ways to describe a method for power dissipation by reducing power usage in a receiver and that the Claim 1 mapping satisfies Claim 7(Pre)(a). Further, Claim 7(Pre)(a) recites “a receiver of a *wireless* transceiver of a battery-powered portable wireless device,” and Claim 1 recites “a receiver of a battery operated transceiver.” A POSITA would have understood and found obvious that *Behbahani’s* wireless receiver would satisfy both types of receivers and that the Claim 1 mapping also satisfies Claim 7(Pre)(a). *See* Claim 1(Pre)(a).

2. Claim 7(Pre)(b): “wherein the receiver is configured to receive a wireless signal having a desired signal and an interferer signal,”

177. *See* Claim 1(a).

3. Claim 7(Pre)(c): “wherein the plurality of circuits are designed to function between a worst-case condition

when a strength of the desired signal is low and a strength of the interferer signal is high, and a best-case condition when the strength of the desired signal is high and the strength of the interferer signal is low, the method comprising:”

178. See Claim 1(Pre)(b).

- 4. Claim 7 (a): “receiving the wireless signal having the desired signal and the interferer signal by the receiver; determining the strength of the desired signal; determining the strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal; and”**

179. See Claim 6(a).

- 5. Claim 7 (b): “based on the comparison, when the plurality of circuits are functioning at better than the worst-case condition, dynamically adjusting one or more of an impedance, a bias or a gain of one or more of the plurality of circuits in the signal path, thereby controlling power dissipation.”**

180. As discussed above, based on a comparison of desired and interferer signal strength, *Behbahani* dynamically increases impedance of the filter responsive to detecting that the circuits are functioning at better than the worst-case condition.

See Claim 1(b).

7. Claim 8:

Claim 8: “The method of claim 7, wherein when the strength of the interferer signal is low and the relative strength of the desired signal with respect to the interferer signal increases, dynamically increasing the impedance of one or more of the plurality of circuits in the signal path to reduce the power dissipation and thereby save power.”

181. See Claim 4-5. As described with reference to Claim 4, PGA1 gain is decreased to reflect increasing desired signal strength, producing an increased “opposition to the flow of alternating current.” And, as described with reference to Claim 5, gain would also be decreased in the IF1 amplifier, decreasing DC bias current in that circuit.

182. A POSITA would have understood that the lower bias current and lower gain would have reduced power dissipation in *Behbahani*’s receiver. The entire point of *Behbahani* is to provide no more than the required DR at any given time to lower the average power consumption. *Behbahani* at 1205. To achieve the “RX DR should adapt to the prevailing conditions.” *Behbahani* at 1206. The two types of adaptive DR *Behbahani* proposes are a) sliding DR with preamplification using a programmable gain stage and b) step DR by substitution a scaled circuit block (high power filter) as shown below:

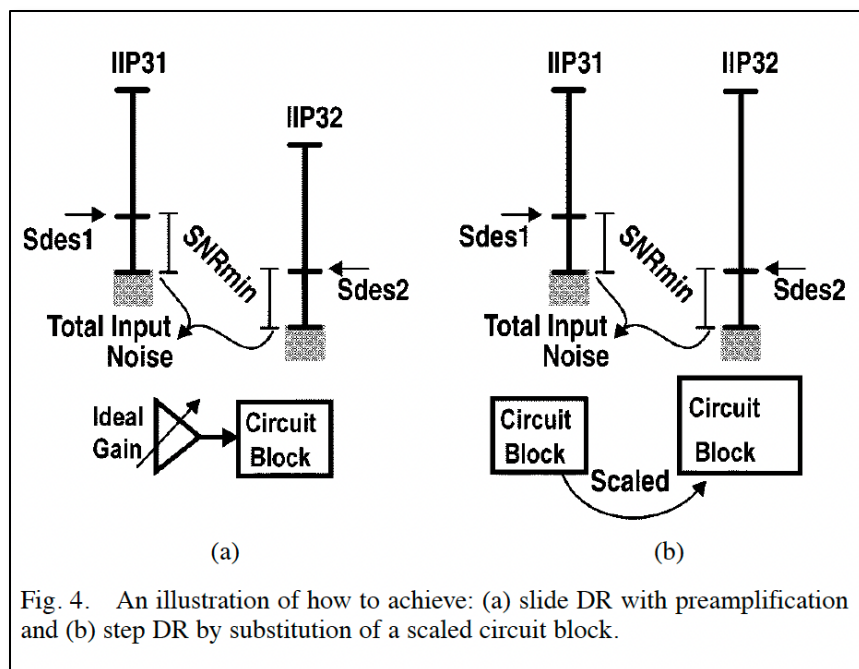
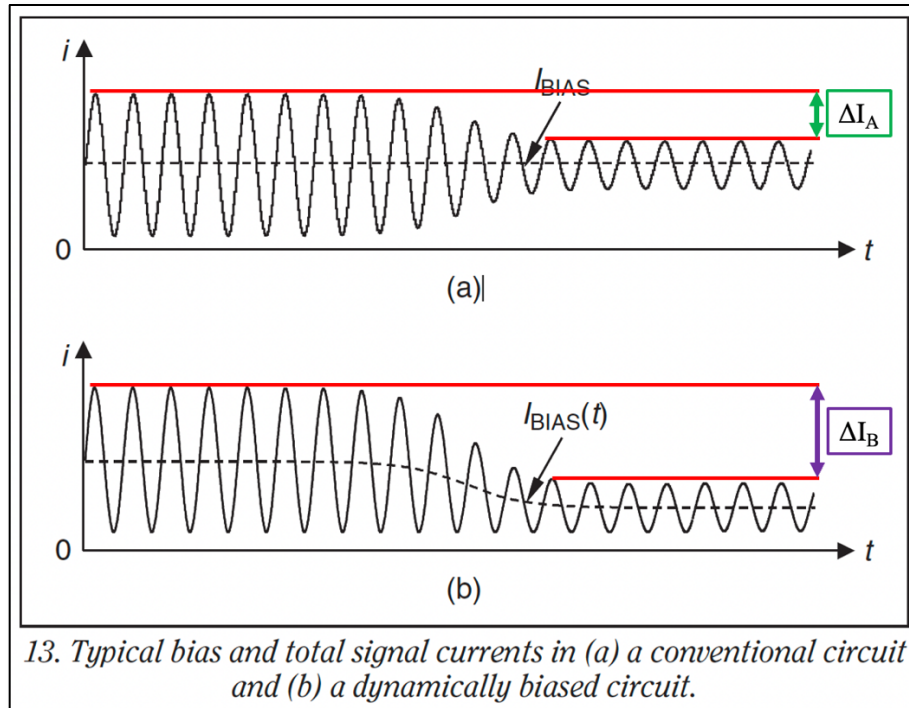


Fig. 4. An illustration of how to achieve: (a) slide DR with preamplification and (b) step DR by substitution of a scaled circuit block.

Behbahani at Fig. 4.

183. As I discuss above with reference to Claim 1, although the patent itself does not explain how increasing impedance and decreasing DC bias results in power savings, Dr. Tsividis’s January 2003 article does provide a helpful example that illustrates the relationship between DC bias current and AC drive current. Specifically, the article states “[i]n general dynamic biasing decreases bias current values when they are not needed to handle large signal swings. The total current in a conventional and in a dynamically biased class A circuit, under changing signal amplitudes conditions, is illustrated in Figure 13.” Ex. 1011 at 71.



Ex. 1011 at 71 (annotated). As illustrated in Figure 13 (a), the power dissipation (which refers to average power in this context) is set by the dashed line in the figure labeled I_{BIAS} , which shows a drop in signal amplitude of ΔI_A but the average power remains unchanged. Figure 13 (b) illustrates that power savings can be realized when $I_{BIAS}(t)$ is dynamically lowered. In Figure 13 (b), lowering $I_{BIAS}(t)$ produces power savings when a lower switching/drive current that flows through the circuit. The dotted line in this figure represents the bias current.

184. Applying this logic to the current mapping, when *Behbahani's* sliding DR process lowers gain, lowering DC bias current, that lower DC bias current produces power savings as a result of the lowering the average switching/drive current that flows through the circuit.

8. Claim 9

Claim 9: “The method of claim 7, wherein when the strength of the desired signal is low but the relative strength of the desired signal with respect to the interferer signal is better than the worst-case condition and the interferer signal reduces in strength, dynamically reducing the bias of one or more of the plurality of circuits in the signal path, thereby reducing power dissipation and saving power.”

185. Claim 9 describes a scenario in which the desired signal is low and the interferers are high, but the overall conditions are not the absolute worst-case. From this near-worst-case signal scenario, the interferer signal strength reduces and the system responds by dynamically reducing DC bias current to save power based on signal strength measurements. As described above in Claim 1(b), *Behbahani’s* “high-power filter” is used during the range of worst-case signal conditions, and a separate “low-power filter” is used when conditions have sufficiently improved.

186. A POSITA would have understood that *Behbahani’s* range of worst-case conditions captures the scenario recited in Claim 9—where the conditions are bad, but not the absolute worst-case. As described above, *Behbahani* captures a range of worst-case signal conditions. *See* Claim 1(Pre)(b) and Section II.E.1.

187. Using *Behbahani’s* adaptive DR teachings, when the interferers reduce from this poor signal condition within the range of worst-case conditions in *Behbahani*, as Claim 9 requires, the high-power filter is replaced with a low-power filter, decreasing the DR and saving power. *See* Claim 1[b]; *see also* Claim 2.

9. Claim 10

Claim 10: “The method of claim 9, wherein reducing power dissipation reduces a power drain from a battery in the battery-powered portable wireless device.”

188. As shown above, power savings results from lowering DC bias current. See limitation [1(b)]. A POSITA would have understood that *Behbahani*’s method for lowering the average power consumption in the receiver results in power dissipation reduction, and in a corresponding reduction in a drain on battery charge of the battery powered portable wireless device. For a microprocessor in a computer that receives its power from a wall outlet, for example, a typical solution is to equip the heat generating microprocessor with a fan that removes excess heat. For portable battery powered wireless devices, power constraints are much more concretely tied to the power supply. Namely, portable battery powered devices must employ power saving techniques to limit drain of charge, extending usage time before recharging. Given the importance of battery preservation in portable battery powered devices, power saving techniques such as those described in *Behbahani* were particularly well suited to (and targeted) the concerns of such devices.

189. Further, A POSITA would have understood from *Behbahani*’s focus on power savings that battery powered mobile devices were the primary target of the disclosed receiver technology and would have been motivated to use the technology to preserve battery life in such devices. It was well known in the art to preserve the battery power of portable/mobile devices. For example, U.S. Patent No. 6,480,700 to Groe et al. (“*Groe*”) describes, “[w]hen the communication device powered by a

portable power supply, **the longevity of the portable power supply is increased,** as lessened amounts of power are required to operate the communication device.” *Groe* at Abstract. Indeed, the whole point of saving power pursuant to *Behbahani*’s teachings is to decrease the drain on battery life of the wireless device within which the receiver is installed.

10. Claim 11

- 1. Claim 11 (Pre)(a): “A method for power dissipation reduction in a receiver of a wireless transceiver of a battery powered portable wireless device, the receiver having a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer,”**

190. *See* Claim 7(Pre)(a).

- 2. Claim 11(Pre)(b): “the plurality of circuits designed to function under at least a worst case condition when a strength of a received desired signal is low and a strength of a received interferer signal is high, the method comprising:”**

191. I note that claim 11 uses slightly different language than Claim 1 to describe its claimed method for power dissipation. Claim 11(Pre)(b) recites “the plurality of circuits designed to function *under at least a worst case condition*,” and Claim 1 recites “the plurality of circuits are designed to function *between a worst-case operating condition and a best case operating condition*.” A POSITA would have understood and found obvious that *Behbahani*’s plurality of circuits are designed to function under a range of signal conditions including a worst-case

condition, a best-case condition, and in between. Therefore, the mapping in Claim 1 is also applied to this claim. *See* Claim 1(Pre)(b).

3. **Claim 11(a): “receiving a wireless signal having a desired signal and an interferer signal by the receiver; determining a strength of the desired signal; determining a strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal;”**

192. *See* Claim 6(a).

4. **Claim 11(b): “based on the comparing, determining a functioning condition of the plurality of circuits; and when the plurality of circuits are determined to function at a better than the worst case condition in which the strength of the interferer signal is low and the strength of the desired signal is low, causing a bias current of one or more of the plurality of circuits in the receiver signal path of the wireless transceiver to be dynamically decreased relative to the worst-case condition, thereby saving power.”**

193. *See* Claim 1(b) (low desired and low interferers are better than worst-case and that bias current is dynamically decreased when transitioning from the high-power filter to low-power filter (e.g., when conditions improve sufficiently from worst-case), saving power.

11. Claim 12

1. **Claim 12 (Pre): “A method for power dissipation reduction in a receiver of a wireless transceiver of a battery powered portable wireless device, the receiver configured to function under at least a worst case condition when a received desired signal strength is low and a received interferer signal strength is high, the receiver having a signal path comprising at least an**

amplifier, a filter, and a mixer, the method comprising:”

194. See Claim 7(Pre)(a); Claim 11(Pre)(b).

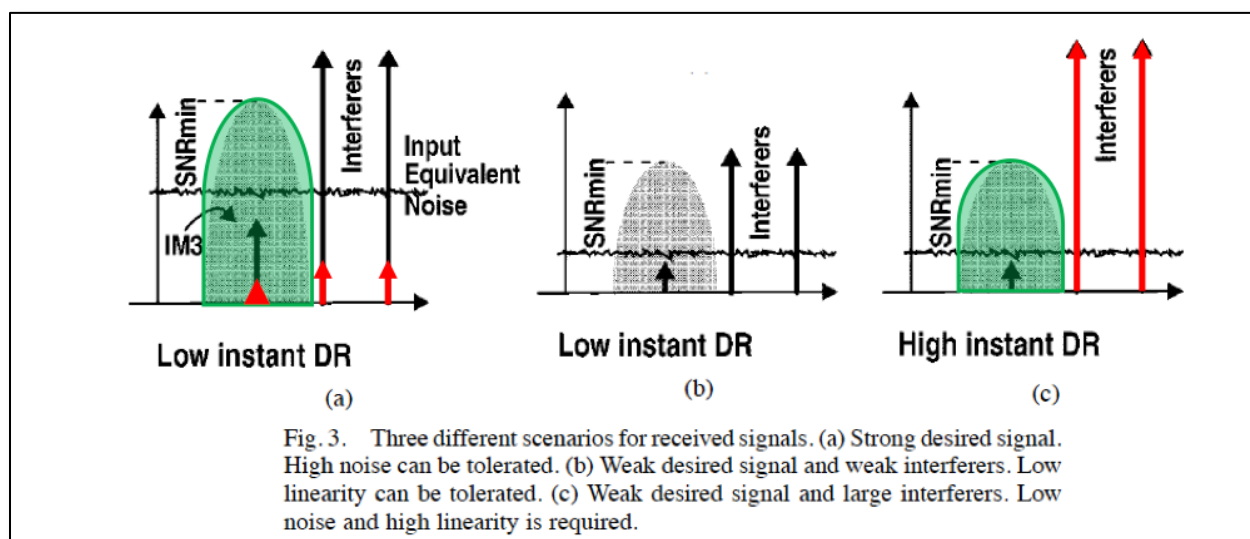
2. Claim 12 (a): “receiving a wireless signal having a desired signal and an interferer signal by the receiver; determining a strength of the desired signal; determining a strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal;”

195. See Claim 6(a).

3. Claim 12(b): “based on the comparing, determining a functioning condition of the plurality of circuits; and when the plurality of circuits are determined to function at a better than the worst case condition in which the strength of the interferer signal is low and the strength of the desired signal is high, causing an impedance of one or more of amplifier, filter or the mixer in the receiver signal path of the wireless transceiver to be increased relative to the worst-case condition, thereby saving power.”

196. As explained above, *Behbahani* states that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Limitation [12(b)] recites a best-case condition where the desired signal is strong, and the interferers are weak. Per *Behbahani*’s adaptive DR teachings, such a scenario would save power above worst-case conditions by switching from the high-power filter to the low-power filter, increasing an impedance of the filter in the signal path. See Claims [1(b)]; see also Claim 4.

197. Using *Behbahani's* adaptive DR teachings, such a signal scenario where the receiver is experiencing a best-case condition when the desired signal is strong, and the interferers are weak, the receiver would save power above worst-case conditions by switching from the high-power filter to the low-power filter, increasing the impedance in the signal path with a lower transconductance and smaller capacitors. As described above, a POSITA would have understood that *Behbahani* teaches a best-case operating condition (i.e., high desired signal and low interferer).



Behbahani at Fig. 3. (annotated to depict hypothetical best-case in which interferers are weaker than in Fig. 3(a)). Fig 3(a) has also been annotated to indicate lower IM3 (red) that results from the lower interferer signals in this hypothetical best-case scenario. The claimed best case operating condition (i.e., high desired signal strength

and low interferer signal strength) is akin to *Behbahani*'s Fig. 3(a) but assumes lower interferers. *See* Claim 1(Pre)(b).

12. Claim 13

- 1. Claim 13 (Pre): “A method for power dissipation control in a receiver of a wireless transceiver of a battery powered portable wireless device, the receiver having a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer, the method comprising:”**

198. *See* Claim 7(Pre)(a).

- 2. Claim 13 (a): “receiving a wireless signal having a desired signal and an interferer signal by the receiver; determining the strength of the desired signal; determining the strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal; and”**

199. *See* Claim 6(a).

- 3. Claim 13 (b): “when the interferer signal is high and the desired signal is low, causing a bias current of one or more of the plurality of circuits in the receiver signal path of the wireless transceiver to be dynamically increased, controlling the power dissipation of the receiver”**

200. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Limitation [13(b)] recites a worst-case condition where the desired signal is low, and the interferer is high. Per *Behbahani*'s adaptive DR teachings, such

a scenario would control power dissipation of the receiver by using the high-power filter, dynamically increasing a DC bias current. *See* Claim [1(b)].

13. Claim 14

- 1. Claim 14 (Pre)(a): “A method for power dissipation reduction in a receiver of a wireless transceiver of a battery powered portable wireless device based on its operating signal conditions, wherein the receiver has a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer,”**

201. *See* Claim 7(Pre)(a)- 1(b).

- 2. Claim 14 (Pre)(b): “the plurality of circuits designed to function under operating signal conditions that vary based on relative signal strengths of an interferer signal and a desired signal, wherein the operating signal conditions vary between a worst-case operating condition and a best-case operating condition, wherein the worst-case operating condition occurs when a desired signal strength is low and an interferer signal is high and the receiver operates with a maximum power dissipation, wherein the best-case operating condition occurs when the desired signal is high and the interferer signal strength is low and the receiver operates with a minimum power dissipation, the method comprising:”**

202. *See* Claim 1(Pre)(b)-1(b).

- 3. Claim 14 (a): “receiving a wireless signal having a desired signal and an interferer signal by the receiver; determining the strength of the desired signal; determining the strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal strength;”**

203. *See* Claim 6(a).

4. Claim 14 (b): “based on the comparing, when the plurality of circuits are determined to be functioning at better than the worst-case operating signal condition, dynamically adjusting at least one of an impedance, a bias current or a gain of one or more of the amplifier, filter or mixer in the signal path of the receiver, thereby reducing power consumption to save power.”

204. See Claims 1(b); 12[b]; 4-5.

14. Claim 15

Claim 15: “The method of claim 14, wherein when the desired signal strength is low and the receiver is operating at better than the worst-case operating signal condition by having the interferer strength lower than that in the worst case operating signal condition, dynamically reducing the bias of one or more of the plurality of circuits in the signal path of the receiver, thereby reducing power dissipation and saving power; and wherein when the interferer signal strength is high and the receiver is operating at better than the worst-case operating signal condition by having the desired signal higher than that in the worst case operating signal condition, dynamically increasing the impedance of one or more of the plurality of circuits in the signal path of the receiver, thereby reducing power dissipation and saving power.”

205. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for better conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Claim 15 recites two better than worst-case signal condition scenarios: (1) where the desired signal is low, and the interferers are weaker than in worst case conditions, and (2) where the interferers are high and the desired signal is higher than in worst case conditions. Per *Behbahani's* adaptive DR teachings, both scenarios would save power above worst-case conditions by switching from the

high-power filter to the low-power filter, dynamically reducing a DC bias current and increasing an impedance in the signal path. *See* Claim [1(b)].

15. Claim 16

- 1. Claim 16 (Pre)(a): “A method for power dissipation optimization in a receiver of a wireless transceiver of a battery powered portable wireless device, the receiver having a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer,”**

206. I note that claim 16 uses slightly different language than Claim 7(Pre)(a) to describe its claimed method for power dissipation. Claim 16 recites a “method for power dissipation *optimization* in a receiver,” and Claim 7(Pre)(a) recites a “method for power dissipation *control* in a receiver.” *See* Claim 7(Pre)(a). A POSITA would understand that these are immaterially different ways to describe the same concept. *Behbahani* is controlling and optimizing the power dissipation of the receiver when reducing or increasing the bias current in the filter. *Behbahani* is directed to lowering the average power consumption, which would result in a more effective and efficient receiver (i.e., thus optimizing the receiver power). *Behbahani* at 1205 (“An important idea here, which has also been noted elsewhere [4], is that providing no more than the required DR at any given time lowers the average power consumption.”).

- 2. Claim 16 (Pre)(b): “wherein the plurality of circuits are designed to function between a worst-case operating condition and a best case operating condition, wherein the worst-case operating condition**

is when a desired signal strength is low and an interferer signal strength is high and the receiver operates with a maximum power dissipation and the best-case operating condition is when the desired signal strength is high and the interferer signal strength is low and the receiver operates with a minimum power dissipation, the method comprising:”

207. See Claim 1(Pre)(b).

3. Claim 16 (a): “receiving a wireless signal having a desired signal and an interferer signal by the receiver; determining a strength of the desired signal; determining a strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal; and”

208. See Claim 6(a).

4. Claim 16 (b): “based on the comparing, when the plurality of circuits are determined to be functioning at better than the worst-case operating condition, dynamically adjusting at least one of an impedance, a bias current or a gain of one or more of the amplifier, filter or mixer in the signal path of the receiver to optimize power dissipation and save power.”

209. See Claim 7(b).

16. Claim 17

Claim 17: “The method of claim 16, wherein when the desired signal strength is low and the operating signal condition of the receiver is better than the worst-case operating signal condition and the interferer signal strength is increasing, dynamically increasing a bias current of at least one of the plurality of circuits in the receiver signal path of the wireless transceiver, optimizing the power dissipation; wherein when the desired signal strength is low and the operating signal condition of the receiver is better than the worst-case operating condition and the interferer signal strength reduces over time, dynamically decreasing a bias current of at least one of the plurality of circuits in the receiver signal path of the wireless transceiver, optimizing the power dissipation, and wherein

optimizing the power dissipation under better than the worst-case operating signal condition saves power with respect to the maximum power dissipation of the worst-case operating signal condition.”

210. As explained above, *Behbahani* teaches that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used when conditions have sufficiently improved beyond worst-case conditions. Claim 17 recites two signal condition scenarios: (1) where the desired signal is low, and the interferers signal is increasing—requiring dynamically *increasing* a bias current in the signal path, and (2) where the desired signal is low and the interferers are decreasing—requiring dynamically *decreasing* a bias current in the signal path. A POSITA would have understood and found obvious that the first scenario recites a worst-case condition where per *Behbahani*’s adaptive DR teachings such a scenario would optimize power dissipation by using its high-power filter—dynamically increasing a DC bias current. *See* Claim [1(b)]. And the second scenario recites better than worst case conditions, where *Behbahani*’s system would optimize power dissipation by switching from high power filter to the low power filter—dynamically decreasing a DC bias current, thereby satisfying Claim 17.

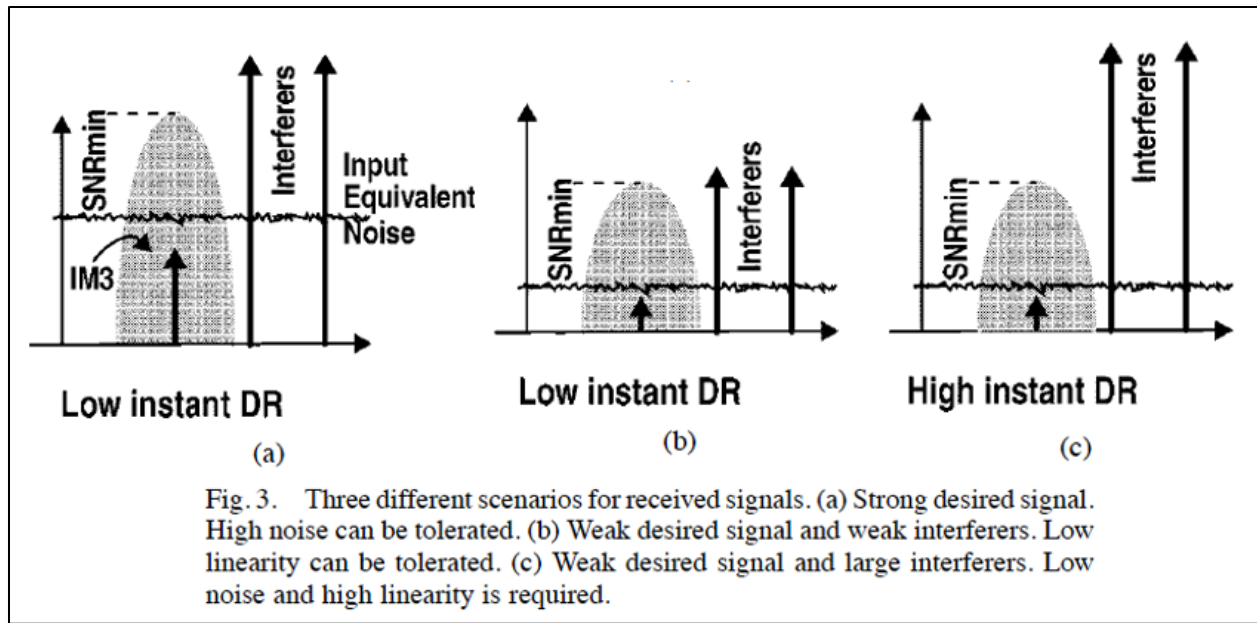
211. A POSITA would have understood that optimizing the power dissipation is satisfied by reducing the power dissipation, and as such the discussion in Claim 1(b) is relevant here. *Behbahani* is directed to lowering the average power consumption, which would result in a more effective and efficient receiver (i.e., thus

optimizing the receiver power). *Behbahani* at 1205. (“An important idea here, which has also been noted elsewhere [4], is that providing no more than the required DR at any given time lowers the average power consumption.”)

212. As described above, a “high-power filter” is used during worst-case conditions. *Behbahani* at 1206-1207. However, “[s]ince the worst-case scenario is infrequent, the low-power filter determines the average RX power consumption.” *Behbahani* at 1206-1207. The signal scenarios depicted in Fig. 3(a-c) determine how the sliding and step-based adaptive DR processes are implemented. Specifically, *Behbahani* states:

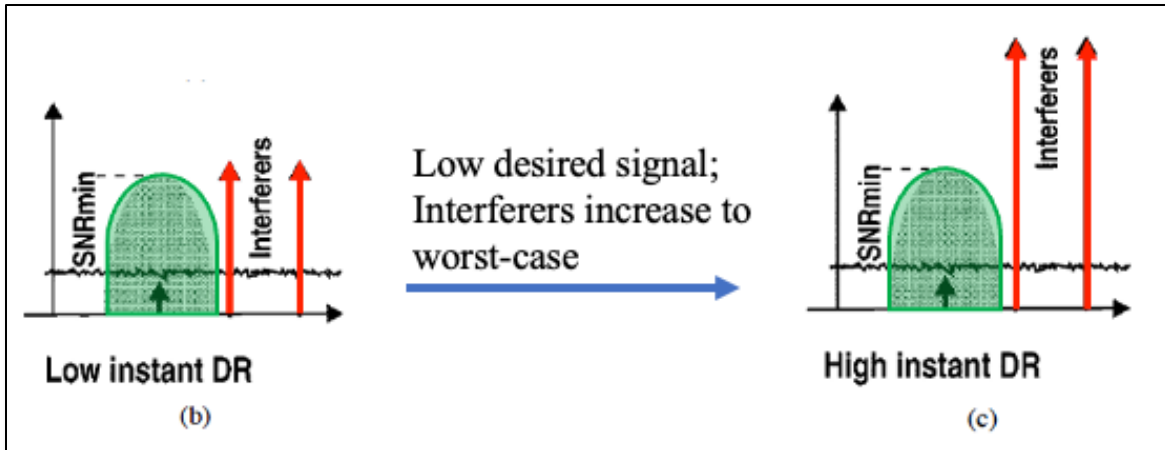
“The desired signal may be strong enough to overcome large noise and intermodulation due to nearby interferers [Fig. 3(a)]. In this case, a high receiver NF is acceptable. Alternatively, the desired signal and the interferers are weak, so the signal-to-interference ratio (S/I) is still good (Fig. 3(b)), yet low IIP3 is acceptable. In both cases, the receiver dynamic range may be modest. The worst-case is when the desired signal is weak but the interferers strong (Fig. 3(c)). Now the instant receiver input signal DR is high, which requires high IIP3 and low NF. For least power consumption, the RX DR should adapt to the prevailing conditions. Two types of adaptive DR are possible, **sliding and step** [Fig. 4(a)].”

Behbahani at 1206. Fig. 3 is shown below:



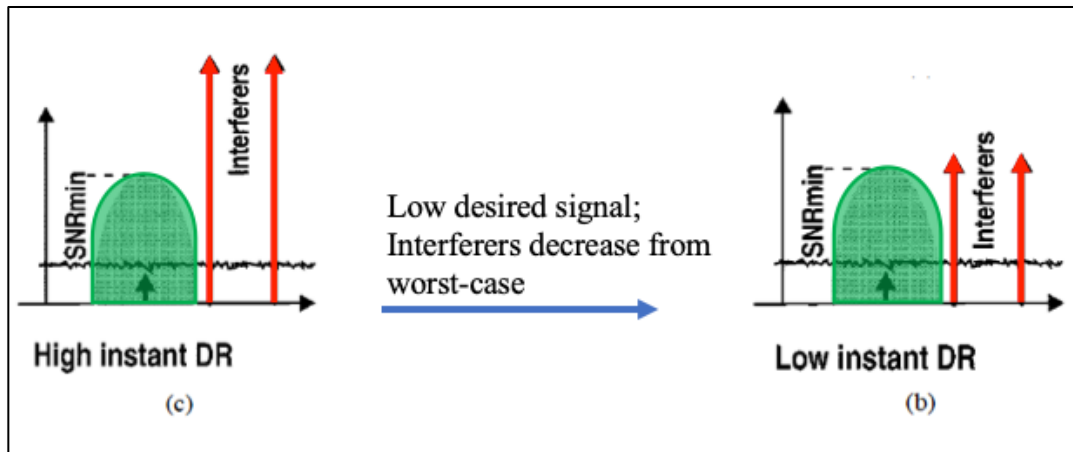
Behbahani at Fig. 3 (rearranged).

213. A POSITA would have understood and found obvious that the first scenario recites a worst-case condition, i.e., where the desired signal is low and the interfering signals are increasing. Per *Behbahani's* teachings, this requires dynamically *increasing* a bias current in the signal path that would optimize power dissipation by using its high-power filter. For example, the transition from the better than worst case signal scenario in Fig. 3(b) (i.e., weak desired signal and weak interferers) to worst case signal conditions, such as Fig. 3(c) (i.e., weak desired signal and strong interferers) would require a switch from the low-power filter to the high-power filter. Such a transition is shown below:



Behbahani at Fig. 3(b), (c) (annotated). As described above the high-power filter raises (i.e., increases) the bias current. *See Claim [1(b)]*.

214. The second signal case recites better than worst case conditions, where the desired signal is low and the interferers are decreasing—which requires dynamically *decreasing* a bias current in the signal path, where *Behbahani*'s system would optimize power dissipation by switching from high power filter to the low power filter. For example, as shown in annotated Fig. 3 below, the transition from worst-case conditions (e.g., Fig. 3(c)) using the high-power filter to the improved conditions depicted in Fig. 3(b) using the low-power filter retains a weak desired signal strength and decreasing interferers):



Behbahani at Fig. 3(b), (c) (annotated).

17. Claim 18

1. Claim 18 (Pre)(a): “A method for controlling power dissipation in a receiver of a wireless transceiver of a battery powered portable wireless device, the receiver having a signal path comprising a plurality of circuits including at least an amplifier, a filter, and a mixer,”

215. See Claim 7(Pre)(a).

2. Claim 18 (Pre)(b): “wherein the plurality of circuits are designed to function between a worst-case operating condition and a best case operating condition, wherein the worst-case operating condition is when a desired signal strength is low and an interferer signal strength is high and the receiver operates with a maximum power dissipation and the best-case operating condition is when the desired signal strength is high and the interferer signal strength is low and the receiver operates with a minimum power dissipation, the method comprising:”

216. See Claim 1(Pre)(b).

3. Claim 18 (a): “receiving a wireless signal having a desired signal strength and an interferer signal by the receiver; determining a strength of the desired signal;

determining a strength of the interferer signal; comparing the strength of the desired signal relative to the strength of the interferer signal; and”

217. See Claim 6(a).

- 4. Claim 18 (b): “wherein when the strength of the interferer signal is low and when the strength of the received desired signal is higher than the desired signal of the worst-case operating signal condition, dynamically adjusting an impedance of at least one of the plurality of circuits in the signal path to reduce power dissipation.”**

218. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Limitation [18(b)] recites a better than worst-case scenario where the interferer signal is low, and the desired signal is higher than the worst-case operating signal condition. Per *Behbahani*’s adaptive DR teachings, such a scenario would save power above worst-case conditions by switching from the high-power filter to the low-power filter. See Claim 1(b).

18. Claim 19

- 1. Claim 19 (Pre)(a): “A method of power dissipation optimization in a receiver of a wireless transceiver of a wireless communication device based on its operating signal conditions, wherein the transceiver has a signal path comprising a plurality of circuits designed to function under operating signal conditions that vary based on relative signal strengths of an interferer signal and a desired signal in a received wireless signal,”**

219. I note that claim 19 uses slightly different language than Claim 16 to describe its claimed method for power dissipation. Claim 19 recites “a plurality of circuits designed to function under operating signal conditions that vary based on relative signal strengths of an interferer signal and a desired signal” and Claim 16 recites a “plurality of circuits are designed to function between a worst-case operating condition and a best case operating condition.” As described above, the operating signal conditions vary on relative signal strengths of an interferer signal and a desired signal. Further, *Behbahani* describes a worst-case operating condition and a best-case operating condition. A POSITA would understand that these are immaterially different ways to describe the same concept. Therefore, the discussion in claims 16 (Pre)(a)-(b); 1(b) apply here. *See* Claims 16(Pre)(a)-(b); 1(b); 1(Pre)(b).

2. **Claim 19 (Pre)(b): “wherein operating conditions vary between a worst-case operating signal condition, wherein the receiver operates with a maximum power dissipation when a desired signal strength is low and an interferer signal strength is high and a best-case operating signal condition, wherein the receiver operates with minimum power dissipation when the desired signal strength is high and the interferer signal strength is low, the method comprising:”**

220. *See* Claim 16(Pre)(b).

3. **Claim 19 (a): “receiving the wireless signal having the desired signal and the interferer signal by the receiver; determining the desired signal strength; determining the interferer signal strength; comparing the desired signal strength to the interferer signal strength to**

determine an operating signal condition of the receiver;”

221. See Claim 6(a).

4. Claim 19 (b): “based on the comparing, when the receiver operating signal condition is better than the worst case operating signal condition, dynamically adjusting one or more of an impedance, a bias, or a gain of one or more of the plurality of circuits in the receiver signal path, thereby optimizing power consumption to save power.”

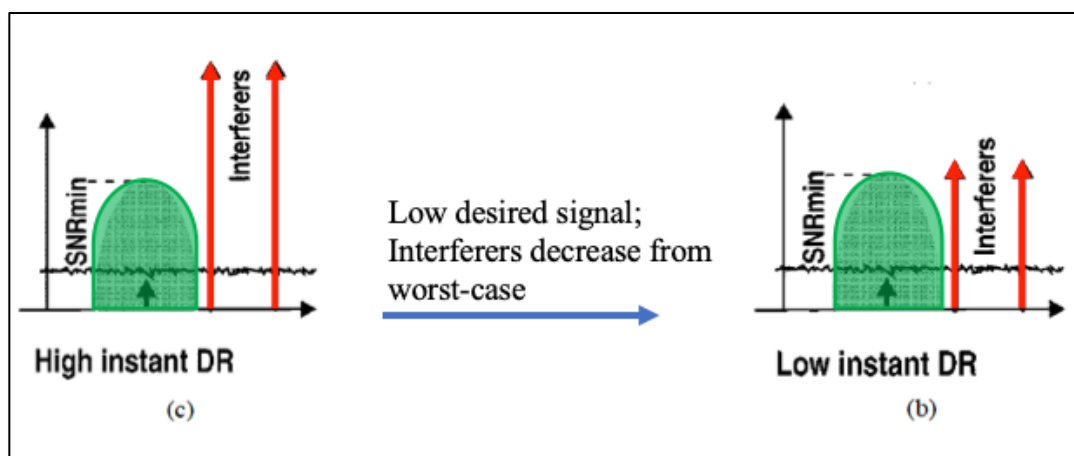
222. See Claim 16(b).

19. Claim 20

***Claim 20:* “The method of claim 19, wherein power saving occurs when the desired signal strength is low and the operating signal condition is better than the worst-case operating signal condition, by dynamically reducing the bias current of one or more of the plurality of circuits in the signal path of the receiver, thereby reducing power dissipation.”**

223. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Claim 20 recites a better than worst case scenario where the desired signal is low, but the operating signal condition is still better than the worst-case. Per *Behbahani*’s adaptive DR teachings, such a scenario would save power above worst-case conditions by switching from the high-power filter to the low-power filter, reducing DC bias current in the signal path. See Claim [1(b)].

224. Using *Behbahani's* adaptive DR teachings, a better than worst case scenario where the desired signal is low but the operating signal condition is still better than the worst-case would save power above worst-case conditions by switching from the high-power filter to the low-power filter, reducing DC bias current in the signal path. For example, as shown in annotated Fig. 3 below, the transition from worst-case conditions (e.g., Fig. 3(c)) to the improved conditions depicted in Fig. 3(b) retains a weak desired signal strength and high interferers):



Behbahani at Fig. 3(b), (c) (annotated).

20. Claim 21

Claim 21: “The method of claim 20, wherein power saving occurs when the operating signal condition improves when the strength of the interferer signal decreases over time, and the bias current is reduced by dynamically adjusting the bias current of one or more of the plurality of circuits in the signal path of the receiver.”

225. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all

other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Claim 21 recites a better than worst case scenario where the interferer signal decreases over time. Per *Behbahani's* adaptive DR teachings, such a scenario would save power above worst-case conditions by switching from the high-power filter to the low-power filter, reducing DC bias current in the signal path. See Claim [1(b)].

21. Claim 22

- 1. Claim 22 (Pre)(a): “A method of power dissipation optimization in a receiver of a wireless transceiver of a wireless communication device based on its operating signal conditions, wherein the transceiver has a signal path comprising a plurality of circuits designed to function under operating signal conditions that vary based on relative signal strengths of an interferer signal and a desired signal in a received wireless signal received,”**

226. See Claim 19 (Pre)(a).

- 2. Claim 22 (Pre)(b): “wherein the operating signal conditions vary between a worst-case operating signal condition and a best-case operating signal condition, wherein in the worst-case operating signal condition the receiver operates with a maximum power dissipation when a desired signal strength is low and an interferer signal strength is high, and wherein in the best-case operating signal condition the receiver operates with minimum power dissipation when the desired signal strength is high and the interferer signal strength is low, the method comprising:”**

227. See Claim 19(Pre)(b).

3. **Claim 22 (a): “receiving the wireless signal having the desired signal and the interferer signal by the receiver; determining the desired signal strength; determining the interferer signal strength; comparing the desired signal strength to the interferer signal strength;”**

228. *See* Claim 6(a).

4. **Claim 22 (b): “determining an operating signal condition of the receiver between the best and worst-case operating signal conditions based on the comparing; when the interferer signal strength is high and the operating signal condition is better than the worst-case operating signal condition, dynamically increasing an impedance of one or more of the plurality of circuits in the signal path of the receiver, thereby reducing power dissipation.”**

229. As explained above, *Behbahani* explains that the high-power filter is used for worst-case conditions (Fig. 3(c)) and the low-power filter is used for all other conditions, i.e., when conditions have sufficiently improved beyond worst-case conditions. Limitation [22(b)] recites a scenario where the interferer signal is high, but the signal conditions are still better than worst case conditions. Per *Behbahani*’s adaptive DR teachings, such a scenario would save power above worst-case conditions by switching from the high-power filter to the low-power filter, dynamically increasing an impedance in the signal path. *See* Claim [1(b)].

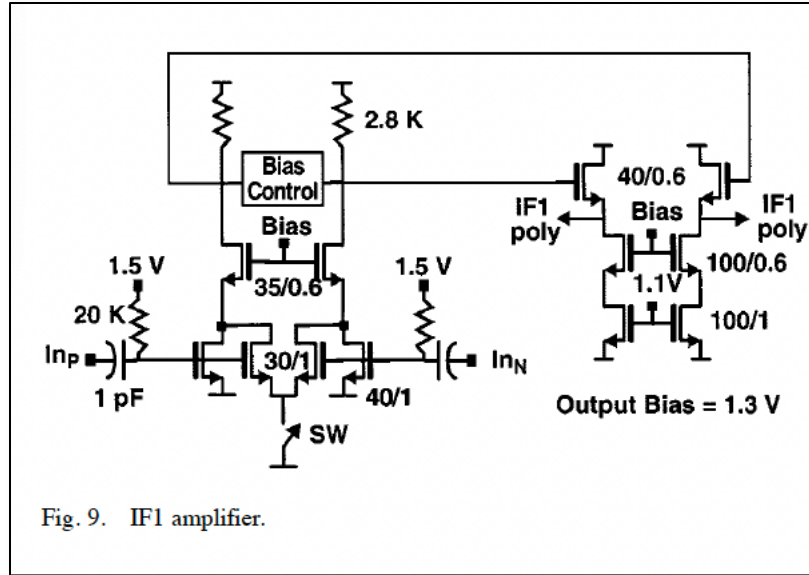
22. Claim 23

Claim 23: “The method of claim 22, wherein when the desired signal strength increases over time resulting in an improvement in the operating condition, dynamically adjusting the impedance of one or more of the plurality of circuits in the signal path of the receiver results in power saving.”

230. As described above, the impedance of the filter is increased when the low-power filter is switched in when the receiver is experiencing better than worst case signal scenarios, thus saving power. *See* Claim 1(b). As described above the desired signal strength increases over time. *See* Claim 4.

231. A POSITA would have understood that as the desired signal strength increases over time, the operating condition improves. *Behbahani* notes that “[m]ost wireless systems are designed for the worst case” and that the receiver only “infrequently needs this high instant DR.” *Behbahani* at 1205. Therefore, as described above *Behbahani* implements an adaptive DR approach. *See* Claim 1(a). As the desired signal increases, the receiver is experiencing a better than worst case signal scenario and the low-power filter is switched in. Therefore, the operating condition of the receiver improves (i.e., less power is consumed) when the desired signal increases.

232. When the desired signal is larger in the IF1 amplifier a switch would be opened to allow for lower gain and lower bias current. This is shown below:



Leete at Fig. 9. Indeed, Table II below expressly discloses that the **lower gain setting** in the IF1 amplifier has a lower DC bias current than the **higher gain setting**:

TABLE II
SIMULATION RESULTS OF THE IF1 AMPLIFIER AND BUFFER

W_{eff} (μm)	I_{bias} (mA)	Gain (dB)	V_n diff (nV/ $\sqrt{\text{Hz}}$)	IIP3 (dBm)
40	6.2	6	4.6	15
70	8.5	10	3.5	10.5

Leete, Table II (annotated).

IV. CONCLUSION

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

Date: _____

By: _____
Asad Abidi

Asad Digitally signed
by Asad Abidi
Date:
Abidi 2024.04.30
22:30:53 -07'00'

Appendix A

Asad A. Abidi

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Education

PhD in Electrical Engineering	1981	University of California, Berkeley
MS in Electrical Engineering	1978	University of California, Berkeley
BSc (Hons) in Electrical Engineering	1976	Imperial College of Science & Technology, London

Experience

July 1993 to present	University of California, Los Angeles Distinguished Chancellor's Professor, Electrical Engineering Department <i>Advanced analog ICs for RF communications, signal processing, and data conversion</i>
Aug 2007 to Feb 2009	LUMS School of Science & Engineering, Lahore, Pakistan Founding Dean
Jan 2017 to Dec 2022	Inaugural Holder, Abdus Salam Chair
July 1988 to June 1993	University of California, Los Angeles Associate Professor, Electrical Engineering Department
June to Dec 1989	Hewlett-Packard Laboratories, Palo Alto Visiting Faculty Researcher, High-Speed Electronics Department <i>Research into ultrahigh-speed waveform digitizers in advanced technologies</i>
Jan 1985 to June 1988	University of California, Los Angeles Assistant Professor, Electrical Engineering Department
Dec 1981 to Dec 1984	Bell Laboratories, Murray Hill, NJ Member of Technical Staff, Advanced LSI Development Laboratory <i>MOS ICs with gigahertz bandwidths for optical-fiber interface electronics</i>
Sep 1976 to Nov 1981	University of California, Berkeley Research Assistant, Electronics Research Laboratory

Professional Service

IEEE Solid-State Circuits Society	Elected to Administrative Committee, 1998-2003
IEEE Journal of Solid-State Circuits	Editor-in-Chief, 1992 to 1995 Associate Editor, 1988 to 1992
IEEE Symposium on VLSI Circuits	Conference Chairman, Seattle, June 1992 US Program Co-Chairman, Oiso, Japan, 1991
IEEE Solid-State Circuits Council	Secretary, 1990-91
IEEE Intl. Solid-State Circuits Conference	Program Secretary, 1985 to 1990 Program Committee Member, 1995
State of California UC MICRO Program	Technical Director, 1994 Member of Executive Committee, 1989 to 1993

Awards

Best Paper Award, <i>IEEE Journal of Solid-State Circuits</i> (co-recipient)	2012, 2022
Top 50 Contributor to ISSCC over its history	2023
Distinguished EECS Alumni Award, UC Berkeley	2015
Munushian Lecturer, University of Southern California	2015
Armstrong Memorial Lecturer, Columbia University	2013
ISSCC Outstanding Contributor over its 60 years	2013
ISSCC Distinguished Technical Paper Award	2012
IEEE Donald O. Pederson Solid-State Circuits Award	2008
Lockheed-Martin Award for Excellence in Teaching, UCLA Samueli School of Engineering and Applied Science	2008
Top 10 contributor to the ISSCC in its 50-year history	2003
IEEE Millennium Medal	2000
Winner, Design Contest, Design Automation Conference	1998
ISSCC Jack Raper Award for Outstanding Technology Directions Paper	1997
ISSCC Outstanding Panel Session	1997, 1999, 2002, 2004, 2006, 2012, 2015
ISSCC Jack Kilby Outstanding Student Paper Award (co-winner)	1996, 2013
IEEE Donald G. Fink Prize Paper Award	1997
Best Paper Award, European Solid-State Circuits Conference	1995
TRW Award for Innovative Teaching	1988
Imperial College Undergraduate Scholarship	1974

Honours

Fellow (elected), TWAS-World Academy of Sciences	2009
Member (elected), US National Academy of Engineering	2007
Fellow, IEEE	1996