

*Inter Partes Review*

U.S. Patent No. 7,010,330

U.S. Patent No. 10,129,825

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

U.S. Patent No. 11,564,164

U.S. Patent No. 11,638,210

Oral Argument, August 27, 2025

Apple Inc. v. Theta IP, LLC.;  
Case Nos. IPR2024-00816, -817, -818, -819, -820

# Theta Patents

- ▶ 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**.

(57)

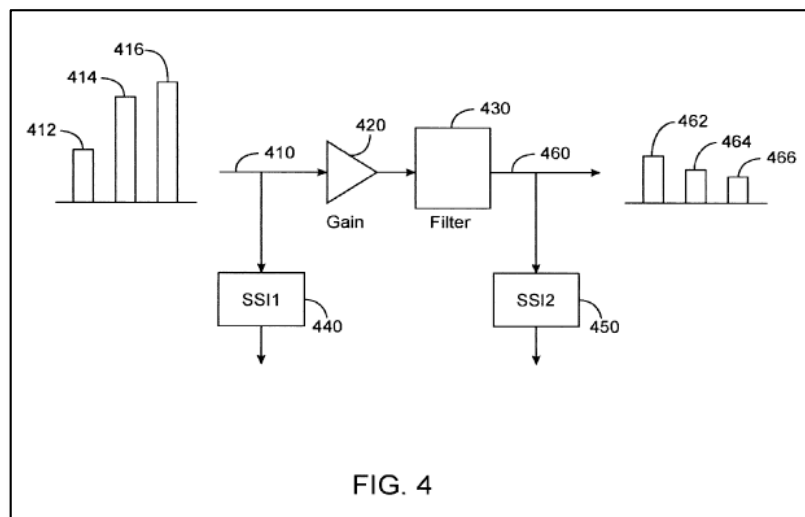
## ABSTRACT

Methods and circuits for reducing power dissipation in wireless transceivers and other electronic circuits and systems. Embodiments of the present invention use bias current reduction, impedance scaling, and gain changes either separately or in combination to reduce power dissipation. For example, bias currents are reduced in response to a need for reduced signal handling capability, impedances are scaled thus reducing required drive and other bias currents in response to a strong received signal, or gain is increased and impedances are scaled in response to a low received signal in the presence of no or weak interfering signals.

| Patent      | Filing Date       | Relationship                        |
|-------------|-------------------|-------------------------------------|
| '825 Patent | March 24, 2016    | Continuation chain from '330 Patent |
| '202 Patent | November 28, 2017 | Continuation chain from '330 Patent |
| '164 Patent | August 20, 2021   | Continuation chain from '330 Patent |
| '210 Patent | December 21, 2022 | Continuation chain from '330 Patent |

# Theta Patents' Disclosure

- (1) Determine relative desired & interferer signals
- (2) Decrease current to save power when possible



One reason why this power drain is high is that electronic circuits are typically designed to function properly under worst-case operating conditions. For a wireless transceiver, the worst case condition is when a desired signal reception strength is low, while other transceivers or nearby electronic equipment generate interfering signals and other spurious noise.

But a wireless transceiver does not always operate in these worst-case conditions. For example, a base station, router or access point may be nearby such that the received signal is strong. Also, there may be no interfering signals, or they may be relatively weak. In these situations, receiver circuit currents can be reduced below what is necessary for the worst case condition. If this is done, power dissipation is reduced, and battery life is increased.

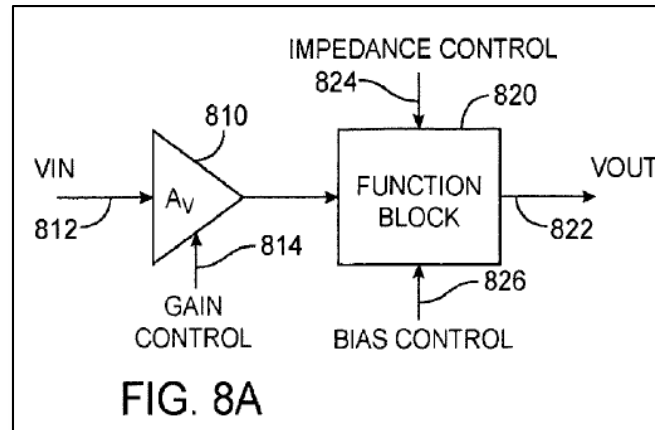
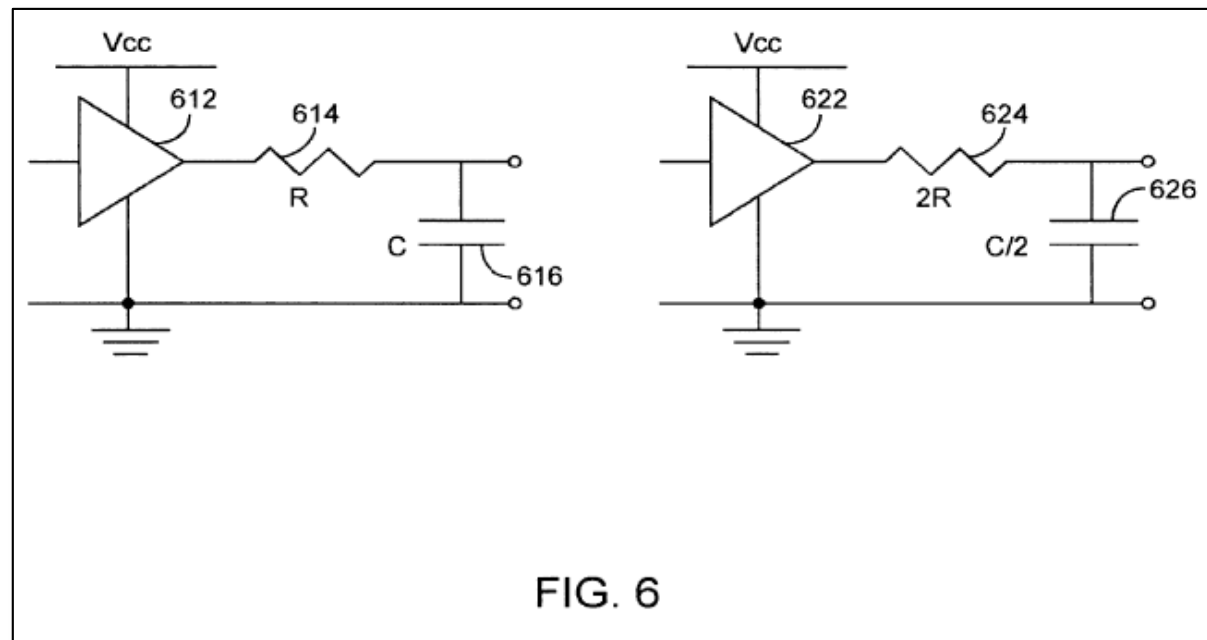
Thus, what is needed are circuits and methods that can adapt to a better-than-worst-case condition and reduce circuit currents and therefore power dissipation accordingly.

| 1210<br>RECEIVED SIGNAL |                     | 1220<br>RESPONSE TO RECEIVED SIGNAL |                                    |                                    |
|-------------------------|---------------------|-------------------------------------|------------------------------------|------------------------------------|
| SIGNAL STRENGTH         | INTERFERER STRENGTH | DECREASE SMAX                       | INCREASE IMPEDANCE <u>NOT</u> GAIN | INCREASE IMPEDANCE <u>AND</u> GAIN |
| 1230 SMALL              | SMALL               | YES                                 | NO                                 | YES                                |
| 1240 LARGE              | SMALL               | NO                                  | YES                                | NO                                 |
| 1250 LARGE              | LARGE               | NO                                  | YES                                | NO                                 |
| 1260 SMALL              | LARGE               | NO                                  | NO                                 | NO                                 |

FIG. 12

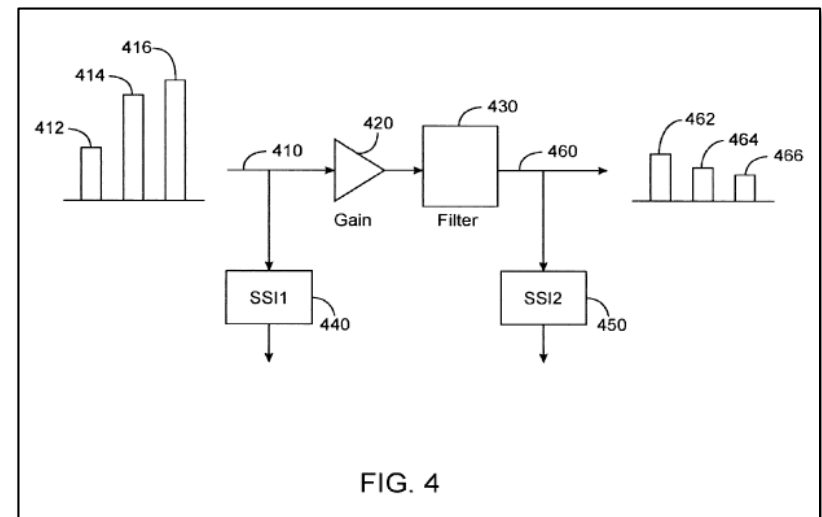
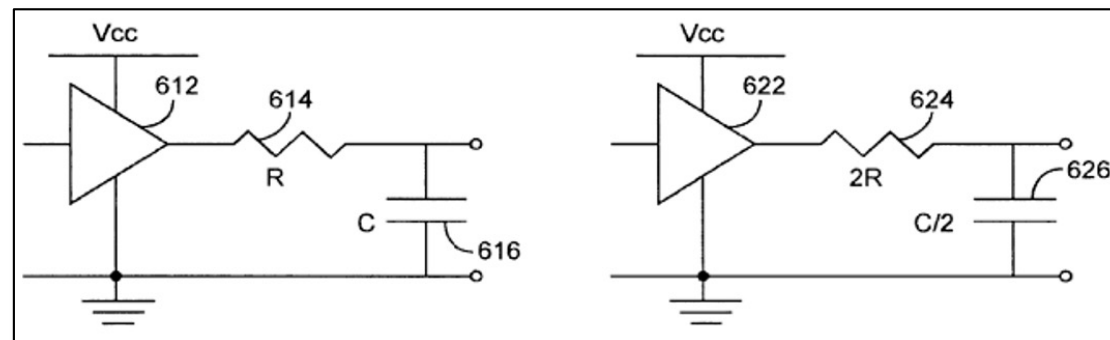
# Theta Patents' Disclosure

Dynamically adjust “function block” in the signal path



# Theta Patents' exemplary claim

1. A method of receiving a signal using an integrated circuit, the integrated circuit comprising a signal path including a low-noise amplifier configured to receive the signal, a mixer having an input coupled to an output of the low-noise amplifier, and a low-pass filter having an input coupled to an output of the mixer, the method comprising: determining a first signal strength at a first node in the signal path in the integrated circuit; and reducing a switching current in the signal path by dynamically changing an impedance of a component in the signal path based on the first signal strength.



# Proposed Grounds

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## 1) Behbahani (Ex. 1004), Leete (Ex. 1005), and Tan (Ex. 1006):

- ▶ IPR2024-00816 ('330 Patent)—Claims 1-7, 9-13, 16, 23, 25-26, 28-29
- ▶ IPR2024-00817 ('825 Patent)—Claim 1-8
- ▶ IPR2024-00818 ('202 Patent)—Claims 1-2, 4-23
- ▶ IPR2024-00819 ('164 Patent)—Claims 1-20

## 2) Behbahani (Ex. 1004) and Tan (Ex. 1006):

- ▶ IPR2024-00820 ('210 Patent)—Claims 1-3, 5-6, 8-11

# Undisputed aspects of proposed grounds

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1. Behbahani, Leete, and Tan describe the same project and are properly treated conjunctively.
  
2. Behbahani's receiver operation. Both parties agree that:
  - ▶ Behbahani's variable filter is dynamically adjusted to save power.
  - ▶ Dynamic adjustments based on measured desired and interferer signals.
  - ▶ Behbahani's high-power branch has lower impedance and higher bias current.
  - ▶ Behbahani's low-power branch has higher impedance and lower bias current.

# Behbahani (Ex. 1004)

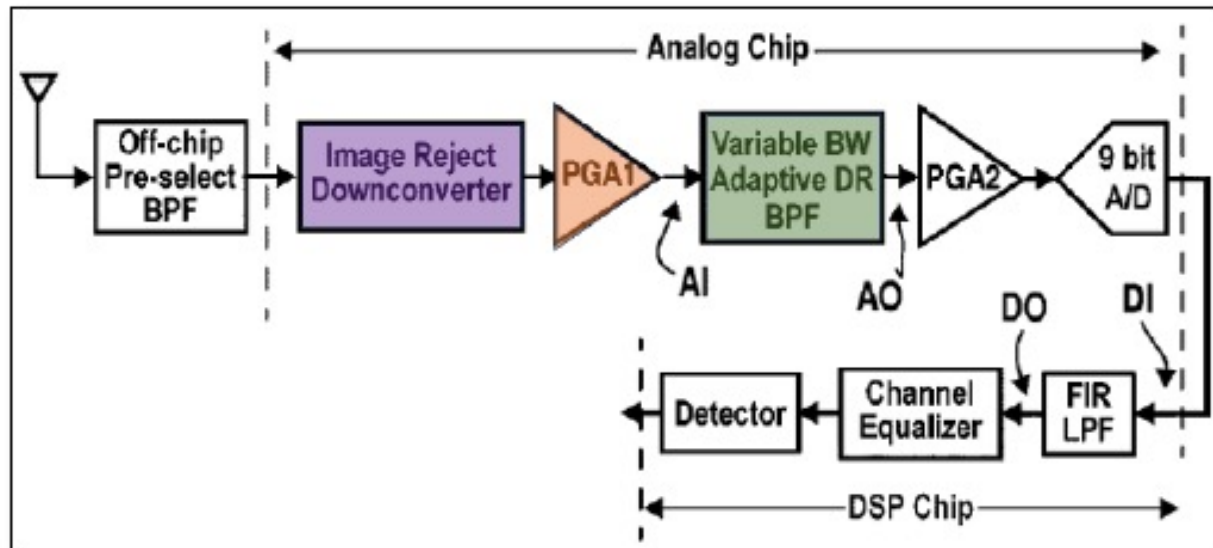
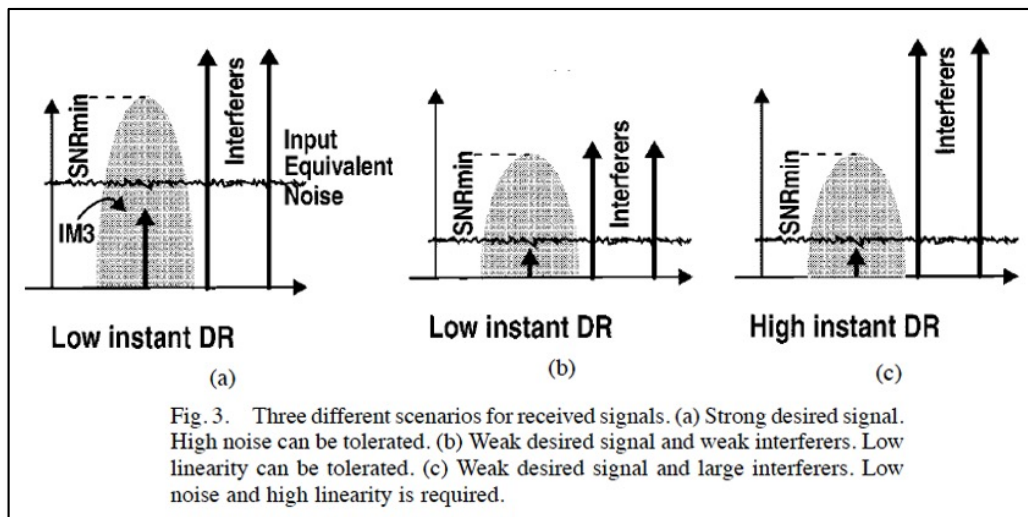
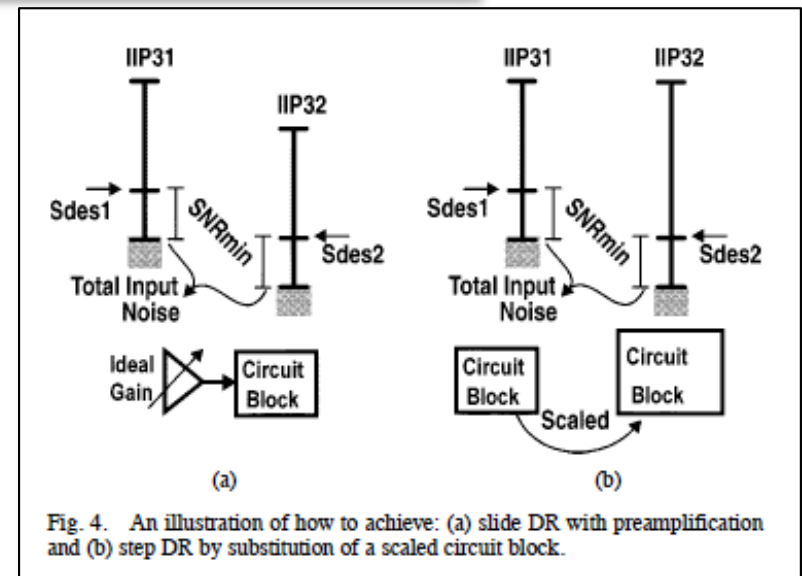
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*Behbahani* teaches a wireless receiver that implements an “adaptive dynamic range” method to save power by decreasing the dynamic range when conditions are better than worst case:

This receiver implements *adaptive dynamic range* in the IF [Intermediate Frequency] 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*, 1205.

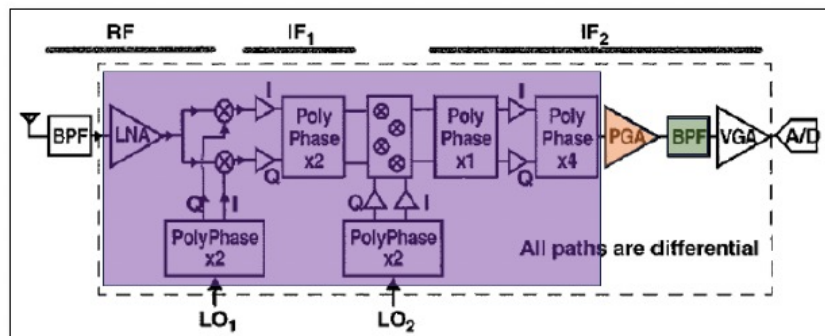
# Behbahani (Ex. 1004)



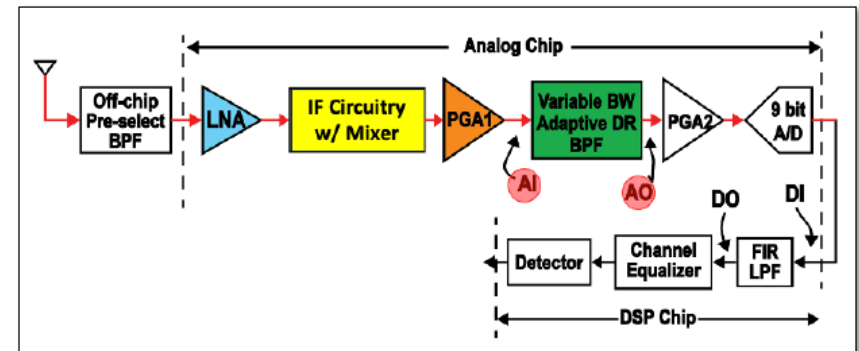
# Leete (Ex. 1005)

- ▶ Leete—a Behbahani companion reference—provides detailed descriptions of the LNA and mixer.

As Behbahani notes, Leete provides the details of this downconverter circuitry. 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, 1908 (further noting an additional “IF mixer downconverts the desired signal at IF1 to a low IF2”). This detailed circuitry is depicted in Leete’s Fig. 1 below:



Consistent with Behbahani’s express intent to use the two references conjunctively, the “Image Reject Downconverter” box from Behbahani’s Fig. 2 has been replaced with an LNA and the other IF circuitry, including the mixer stage:



Behbahani modified by Leete, Figure 2 (annotated).

# Tan (Ex. 1006)

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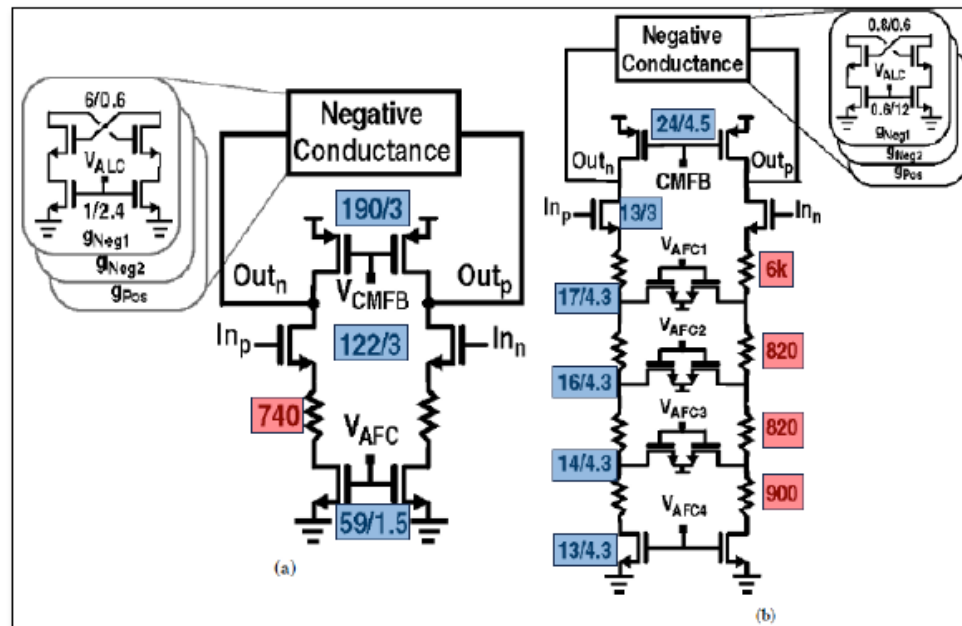
- ▶ Tan—another Behbahani companion reference—provides detailed descriptions of the BPF.

*Behbahani* cites *Tan* to describe the details of the bandpass filter used in *Behbahani*: “The details of the BPF design are presented elsewhere [7].” *Behbahani*, 1210. The citation [7] in *Behbahani* is to *Tan*.

Consistent with *Behbahani*’s own teachings, *Tan* describes a low-power filter that 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*, 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. *Id.*, 481; *Dec.*, ¶¶117-124 (explaining how *Tan*’s teachings confirm that the signal path impedance changes when switching between scaled filters).

# Tan (Ex. 1006) (cont.)

Examining the  $G_m$  circuit—a circuit that dictates the overall filter characteristics—reveals that the proposed low-power filter does in fact have lower transconductance, higher resistance, lower capacitance, and a lower bias current. *Dec.*, ¶¶117-124. Figs. 6(a) and 6(b) below illustrate how the transconductances and resistances vary together in the proposed scaled filters:

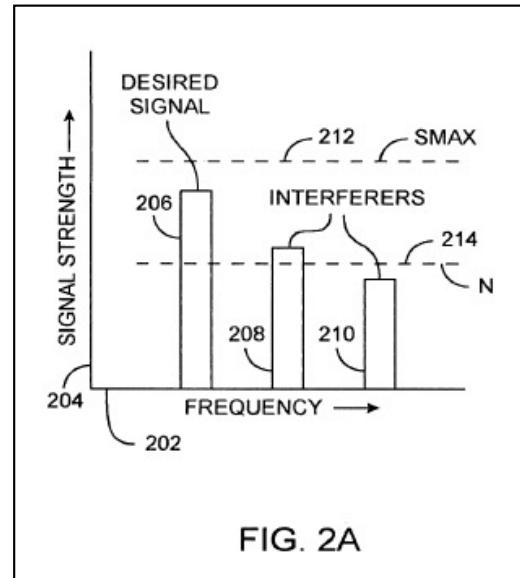


# Theta Patents

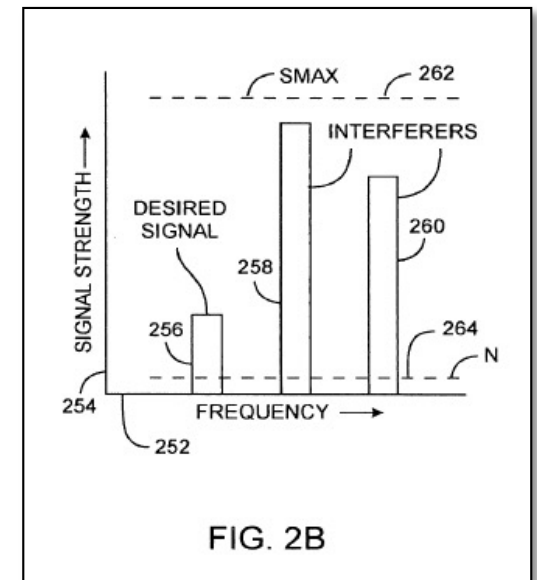
## (1) Assess relative desired and interferer signals

## (2) Adjust dynamic range when possible

In the example of FIG. 2A, a received desired signal 206 is large in comparison to interfering signals 208 and 210. In these examples, two interfering signals are shown for illustrative purposes, though there may be no such signals, one such signal, or more than two such signals in the frequency range of interest. Also, while for these examples the interferers are shown as being at a higher frequency than the desired signal, there may be one or more interferers at higher or lower frequencies as the desired signal. In this specific example, the acceptable noise floor 214 is relatively high, while maximum signal handling capability  $S_{max}$  212 (that is the maximum signal power that can be handled with an acceptably low distortion) needs only to be high enough to accommodate the desired signal. For this specific example, the circuit receiving this input spectrum only requires a relatively small dynamic range for proper operation, that is the range between  $S_{max}$  212 and the noise floor 214 is relatively small.



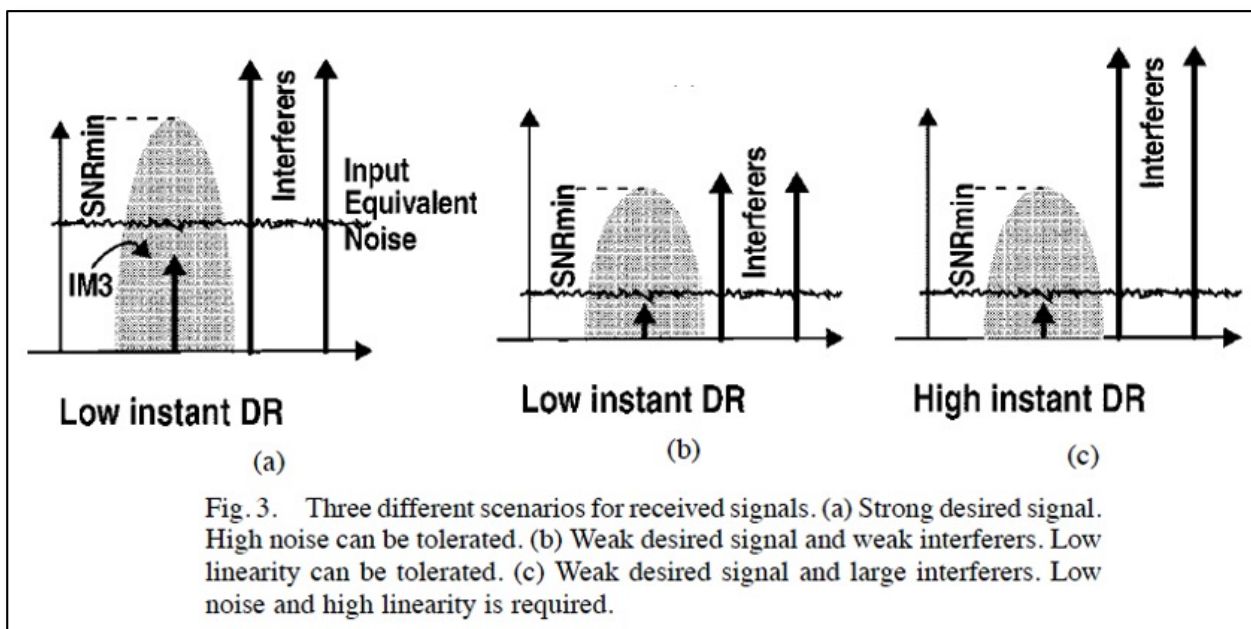
Conversely, in the example shown in FIG. 2B, the desired signal 256 is relatively weak compared to the large interferers 258 and 260. In this example, the noise floor 264 should be relatively low so as to prevent an unacceptable level of error in the recovery of the desired signal 256. The maximum signal handling capability  $S_{max}$  262 should be relatively high to accommodate the large interferers in order to avoid the creation of intermodulation products as described below. Accordingly, in this specific example, the circuit receiving this input spectrum should have a large dynamic range, particularly in comparison to the example of FIG. 2A.



# Behbahani

- (1) Assesses relative desired and interferer signals
- (2) Adjusts dynamic range when possible

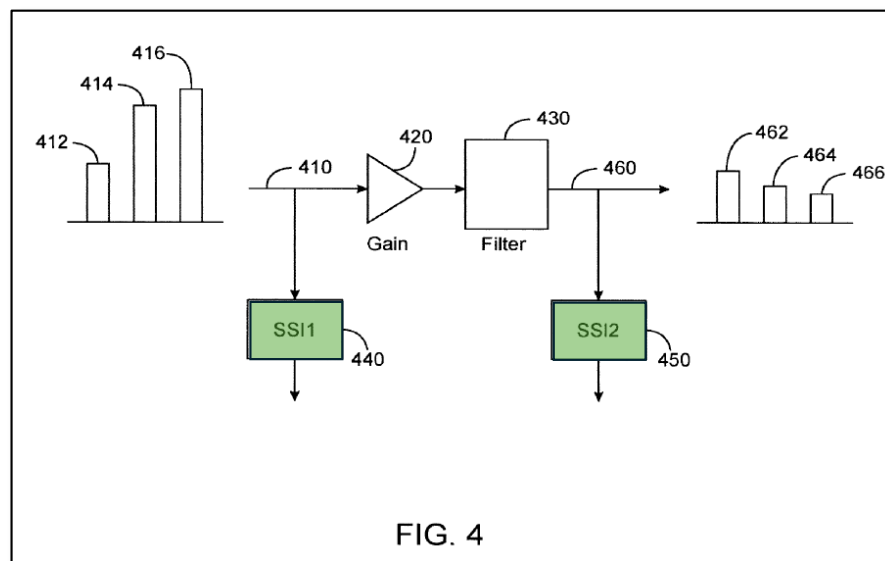
**Abstract**—An IF strip for a wireless receiver supports a variable baud rate by changing analog filter bandwidth. Sliding and step adaptive dynamic range are both used at IF to dissipate only the necessary power at prevailing channel conditions. A combination of VGA and PGA is developed for 64-QAM. The total signal processor draws an average of 16 mA from 3.3 V and a peak of 73 mA. The differential input noise is as low as  $3.9\text{nV}/\sqrt{\text{Hz}}$ , while maximum IIP3 is +22 dBm with respect to 100 ohms.



# Theta Patents measure before and after filter to determine relative strength of desired and interferers

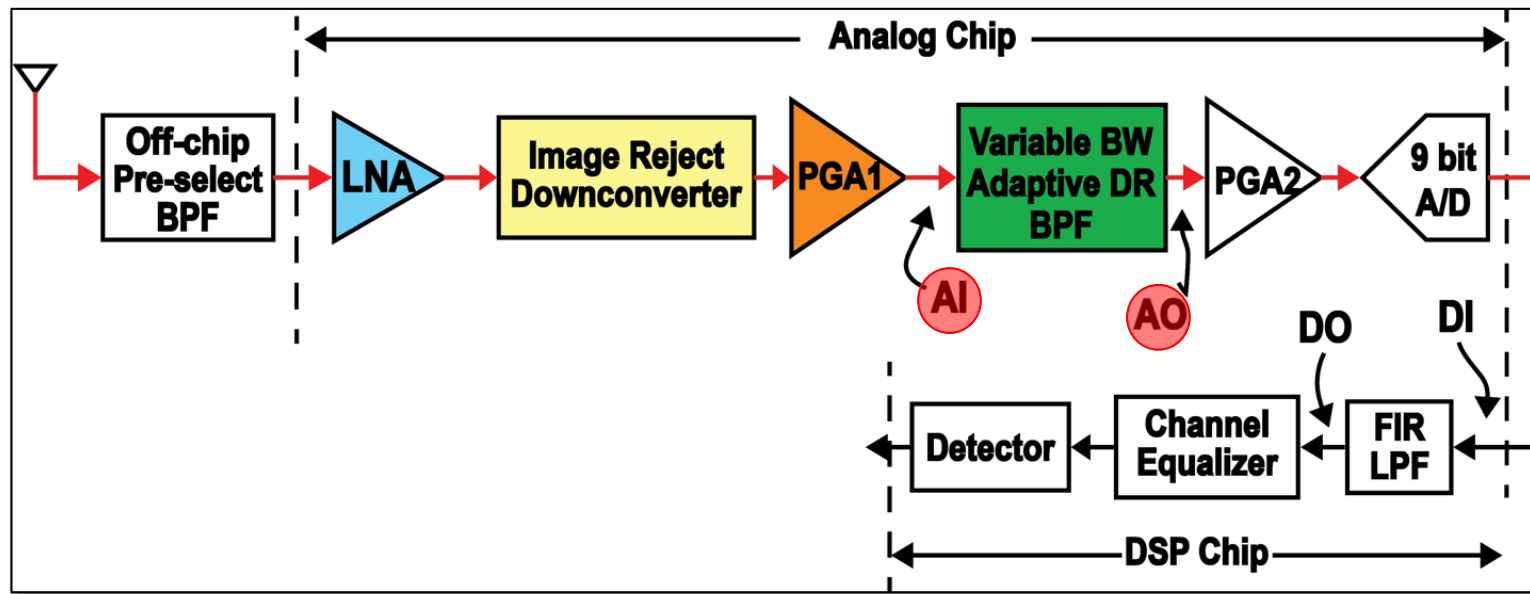
The signal strength indicators 440 and 450 do not provide information as to the relative sizes of the desired and interfering signals. Rather, a cumulative signal level is provided at their outputs. For example, the first signal strength indicator 440 outputs a level corresponding to the sum of desired signal 412 and interfering signals 414 and 416, while the second signal strength indicator 450 provides a signal level corresponding to the sum of desired signal 462 and interfering signals 464 and 466. In this specific example, the gain of the gain and filter circuit combinations is shown as approximately one, while the interfering signals 414 and 416 signal levels are reduced.

A comparison of the signal levels provided by the signal strength indicators 440 and 450 indicates that much of the combined received signal on line 410 has been filtered. Accordingly, it may be deduced that large interfering signals present at the input are being filtered by the filter 430. From this information, as will be shown in greater detail below, the bias, impedance, and gain of the gain stage 420 and filter 430 combination may be optimized to reduce power dissipation.



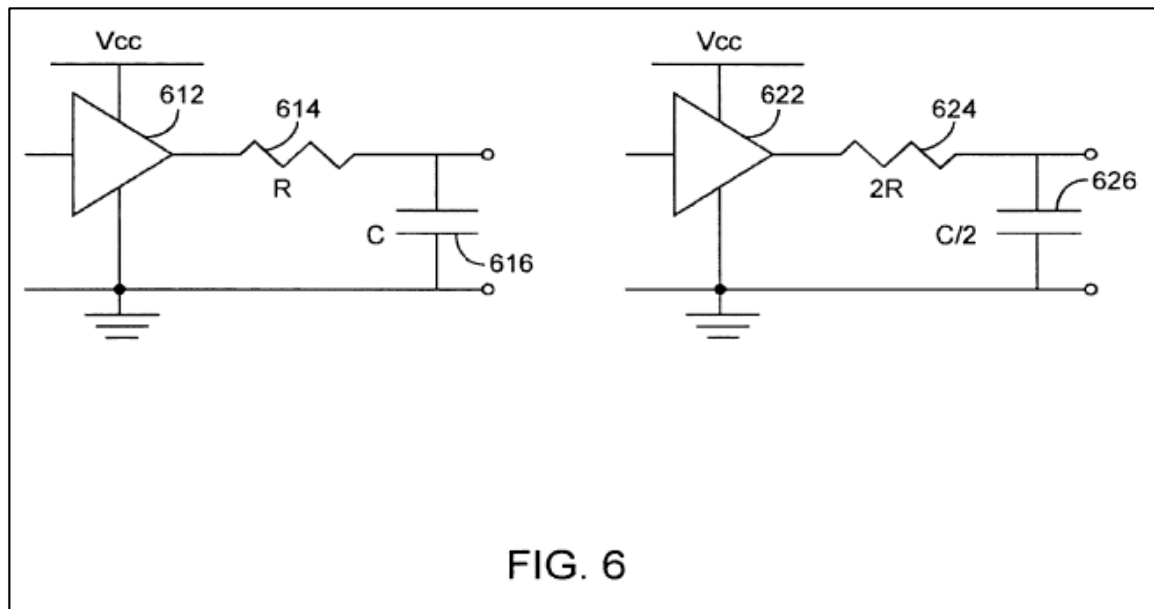
# Behbahani measures before and after filter to determine relative strength of desired and interferers

The signal level at  $A_I$  and  $A_O$  is a measure of the out-of-band interferers being rejected by the analog BPF. 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). 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).



# Theta Patents teach scaling a filter block to save power when possible

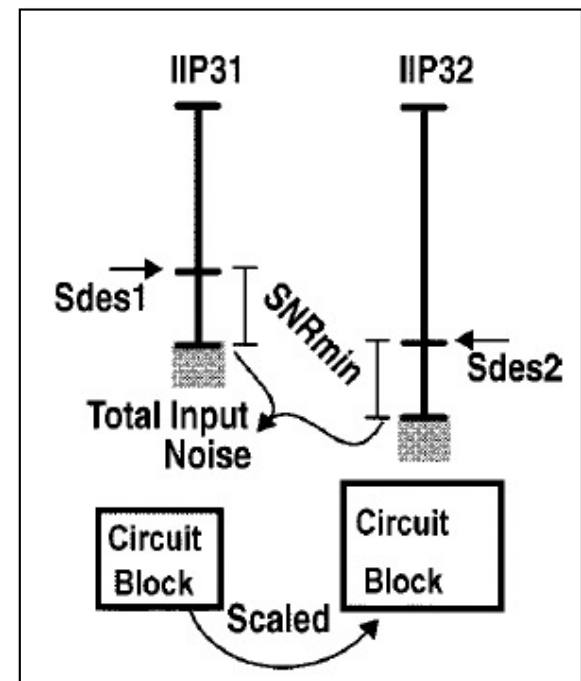
FIG. 6 is an example of how a circuit's impedances may be scaled to reduce drive currents, and, depending on the circuit configuration used, associated bias currents as well. A driver 612 has a load R 614 and C 616. The frequency response of this circuit is the same as that seen by driver 622, which drives an impedance of  $2R$  624 and  $C/2$  626. But the impedance of the load seen by driver 622 is double that seen by 612, thus the output current required by the driver 622 is reduced by one-half.



# Behbahani teaches scaling a filter block to save power when possible

Suppose that at some point the receiver needs higher DR. Scaling up all the transistors in a circuit keeping  $V_{GS} - V_t$  constant and scaling down all resistors by the same factor lowers input mean square noise and raises bias current proportional to the scale factor, while IIP3 remains unchanged [Fig. 4(b)]. The scaled circuit can pass a weak desired signal accompanied by strong interferers. Thus, DR may be *stepped up* by substituting a scaled version of a nominal circuit.

The on-chip filter is usually the bottleneck to achievable DR in a fully integrated RX. In this design, the BPF adapts power dissipation to the instantaneous needs, as shown in Fig. 4(b). Two filters are implemented with the same topology, but one, scaled up to consume  $10\times$  more power, offers  $10\times$  lower mean square noise but the same linearity. An algorithm described below senses which of the previously described conditions is present. In the first two instances [Fig. 3(a) and (b)], 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.



# Remaining Disputes

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## 1) Theory Presented

- ▶ Whether Petitioner relied on Behbahani's variable filter block as the dynamically adjusted "circuit" or "component" in the signal path

## 2) Claim Construction

- ▶ Whether the claimed "circuit" or "component" that is dynamically adjusted should be construed to exclude switching between high- and low-power filter branches within Behbahani's variable filter

## 3) Signal Strength Measurement Circuit

- ▶ Whether Behbahani's signal strength measurement teaching sufficiently teaches or suggests the claimed signal strength measurement limitations

## 4) Discretionary Denial

- ▶ Whether vacating institution on discretionary bases is appropriate after the parties and Board have invested extensive resources

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# The Board correctly held at institution that Petitioner relied on Behbahani's variable filter

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## ► Preliminary Sur-Reply (Paper 11 at 1-3):

On preliminary Reply, Apple changes course, drawing a new, contrived line around the two swapped low-pass filters—and arguing for the first time that *Behbahani* involves changing between two “modes” or “filter branches” of that invented “variable filter block” box. Reply, 1.

The Petition (and Declaration) relied exclusively on what Apple repeatedly described as *Behbahani*'s “switching from a high-power filter to a low-power filter.”  
...  
Nowhere did Apple or its Declarant mention a “variable filter block” or “filter branches.”

## ► Institution Decision (Paper 12 at 41, fn.6):

<sup>6</sup> We disagree with Patent Owner's arguments in the Preliminary Sur-reply that Petitioner raised a new theory in the Preliminary Reply. See Prelim. Sur-reply 1–3. Rather, Petitioner clearly relied upon *Behbahani*'s Variable BW Adaptive DR BPF to teach the recited “filter,” and on *Behbahani*'s switching from the high-power filter to the low-power filter. E.g., Pet. 25, 35, 39–40. On this record, we do not view Petitioner's use of the word “branch” in the Preliminary Reply to result in a new theory of unpatentability, as Patent Owner argues.

# PO continues to incorrectly argue that the Petition did not rely on Behbahani's variable filter

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## ► Motion to Strike (Paper 23 at 3):

In the Petition and Original Declaration, Apple and Dr. Abidi identified the high- and low-power, *low-pass filter portions* of the design disclosed in the *Behbahani* papers as the components being dynamically adjusted. Petition (Paper 1) at 43-44 (“switching from *Behbahani*’s high-power filter to its low-power filter dynamically changes ... a component (the filter) in the signal path, as claimed”); EX1003 (Original Declaration), ¶124 (“switch from high-power to low-power filter”); *see also* Paper 1 at 25 (“a low-pass filter, satisfying the filter component”).

...

On Reply, however, Apple seeks to draw a bigger box around a larger portion of the circuit—and say for the first time that, the whole “Variable BW Adaptive DR BPF” does not just *include* the alleged dynamically altered components, but rather it *is* the dynamically altered component. *See* Reply, 6-7 (“this variable filter block is dynamically adjusted”). But there is no evidentiary support for this in the Petition.

# Petitioner mapped Behbahani's variable filter

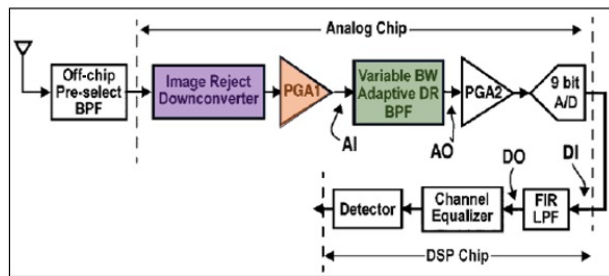
## Context from the full mapping rebuts alleged ambiguity

### 1. Claim 1

*Claim 1(Pre): "1. A method of receiving a signal using an integrated circuit, the integrated circuit comprising a signal path including a low-noise amplifier configured to receive the signal, a mixer having an input coupled to an output of the low-noise amplifier, and a low-pass filter having an input coupled to an output of the mixer, the method comprising:"*

• • •

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":



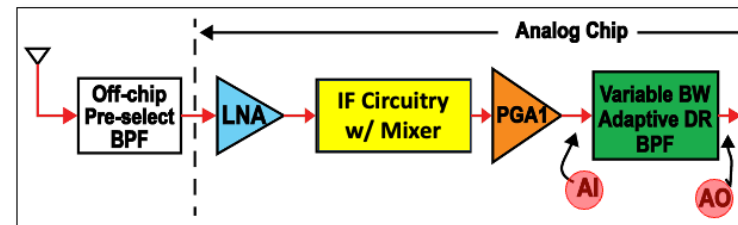
Behbahani, Fig. 2 (annotated).

• • •

Accordingly, a POSITA would have understood that Behbahani's BPF includes a low-pass filter, satisfying the filter component recited in the preamble.

Dec., ¶77.

Behbahani's Fig. 2 depicts certain components of the receiver as being contained within an analog integrated circuit. Specifically, as shown below in an annotated excerpt of Figure 2, an "analog chip" includes a signal path (annotated in red), an LNA (annotated in blue) configured to receive the signal, a mixer (annotated in yellow) having an input coupled to an output of the LNA, and a low-pass filter (annotated in green) having an input coupled to an output of the mixer (annotated in yellow):



Behbahani modified by Leete, Figure 2 (excerpt, annotated); Dec., ¶¶85-89 (explaining the signal path).

# Petitioner mapped Behbahani's variable filter

## Context from the full mapping rebuts alleged ambiguity

*Claim 1(b): “reducing a switching current in the signal path by dynamically changing an impedance of a component in the signal path based on the first signal strength.”*

• • •

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 a reduced current that carries the AC signal through a load (i.e., through the filter load).

• • •

A POSITA would have understood that, consistent with the ’330 Patent and its inventors own publications, switching from Behbahani’s high-power filter to its low-power filter dynamically changes (increases) an impedance of a component (the filter) in the signal path, as claimed. *Dec.*, ¶124.

• • •

In sum, switching from Behbahani’s high-power filter to its low-power filter based on signal strength measurements (1) increases the signal path impedance and (2) lowers the DC bias applied to the filter stage. It also lowers the switching current—the current carrying an AC signal. *Id.*, ¶133.

*Claim 5: “The method of claim 2 wherein the component in the signal path comprises a MOS transistor.”*

• • •

Accordingly, a POSITA would have understood that the variable filter described by Tan and relied upon by Petitioner in the mapping above does in fact comprise MOS transistors, as claimed. *Id.*, ¶¶141-44.

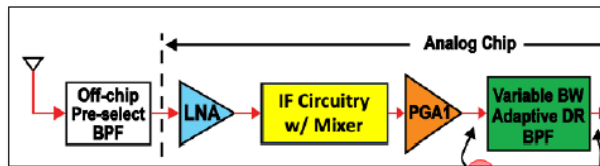
*Claim 9: The method of claim 4 wherein the component in the signal path is included in the low-pass filter.*

Behbahani switches between a high-power filter and low-power filter based on signal strength measurements, and the specific filter structures are described in detail by Tan and illustrated at least in Figs. 6(a)-(b) and Fig. 9. See Claim [1(b)]. Further, as described above with respect to claim [1(Pre)], Behbahani discloses that the component (i.e., variable BW adaptive DR BPF) in the signal path includes a low-pass filter (LPF). See Claim 1(Pre) (explaining Behbahani’s BPF as a high-order LPF cascaded with a low-order HPF). As discussed in detail with reference to Claim [1(b)], the impedance of the low-pass filter, specifically, is increased when switching from the high-power filter to the low-pass filter, resulting from changes to the transconductance stages and capacitors that comprise the variable low-pass filters. See Claim [1(b)].

# Dr. Abidi's analysis aligned with and supported the Petition

[77.] *Behbahani* describes that its “BPF realized by an [low-pass filter] LPF in series with [high-pass filter] HPF lowers power consumption.” *Id.*, 1216. Because *Behbahani*’s BPF includes a low-pass filter stage, it satisfies the preamble’s “low-pass filter.”

85. *Behbahani*’s Fig. 2 depicts an “analog chip” that includes multiple components on the signal path (annotated in red), including an LNA (annotated in blue) configured to receive the signal, a mixer (annotated in yellow) having an input coupled to an output of the LNA, and a low-pass filter (annotated in green) having an input coupled to an output of the mixer (annotated in yellow):



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

136. *Behbahani* cautions that, to ensure bit errors that result from the switching have settled out before the data portion is received, “the *desired filter is switched during the preamble* and settles during that time.” *Behbahani* at 1207. Accordingly, *Behbahani* teaches changing the signal path impedance (e.g., switching from high-power filter to its low-power filter) of the filter component while receiving the preamble portion of the signal, as claimed.

# Remaining Disputes

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## 1) Theory Presented

- ▶ Whether Petitioner relied on Behbahani's variable filter block as the dynamically adjusted "circuit" or "component" in the signal path

## 2) Claim Construction

- ▶ Whether the claimed "circuit" or "component" that is dynamically adjusted should be construed to exclude switching between high- and low-power filter branches within Behbahani's variable filter

## 3) Signal Strength Measurement Circuit

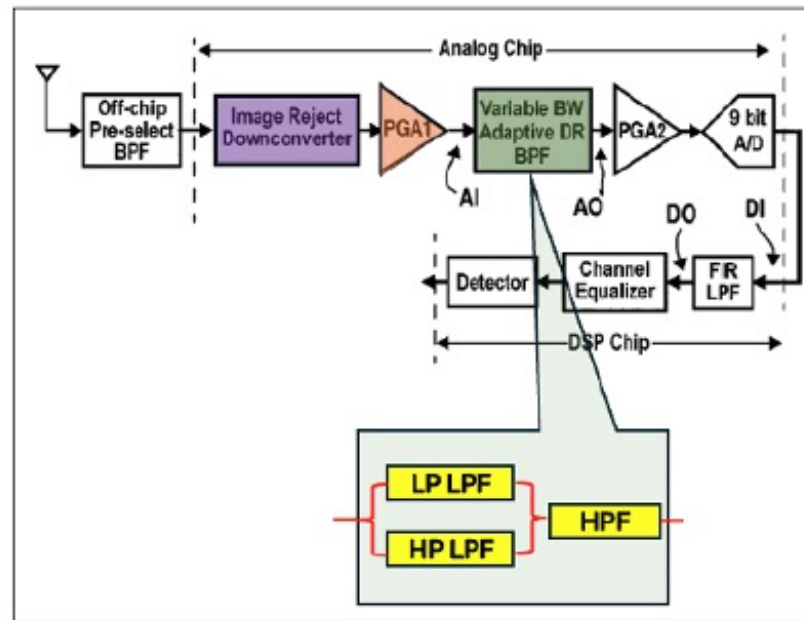
- ▶ Whether Behbahani's signal strength measurement teaching sufficiently teaches or suggests the claimed signal strength measurement limitations

## 4) Discretionary Denial

- ▶ Whether vacating institution on discretionary bases is appropriate after the parties and Board have invested extensive resources

## The parties do not dispute the operation of Behbahani's variable filter

As illustrated below, this variable filter block is dynamically adjusted by switching between two scaled low pass filter (“LPF”) paths—one high power (“HP LPF”) and the other low power (“LP LPF”)—both of which feed back into the same high pass filter (“HPF”):



Ex. 1042, ¶¶4-6 (explaining that a signal enters the variable BPF block, traverses one of the two LPF branches, and then passes through the HPF).

# The parties do not dispute the operation of Behbahani's variable filter (cont.)

## ▶ PO's expert explains impedance:

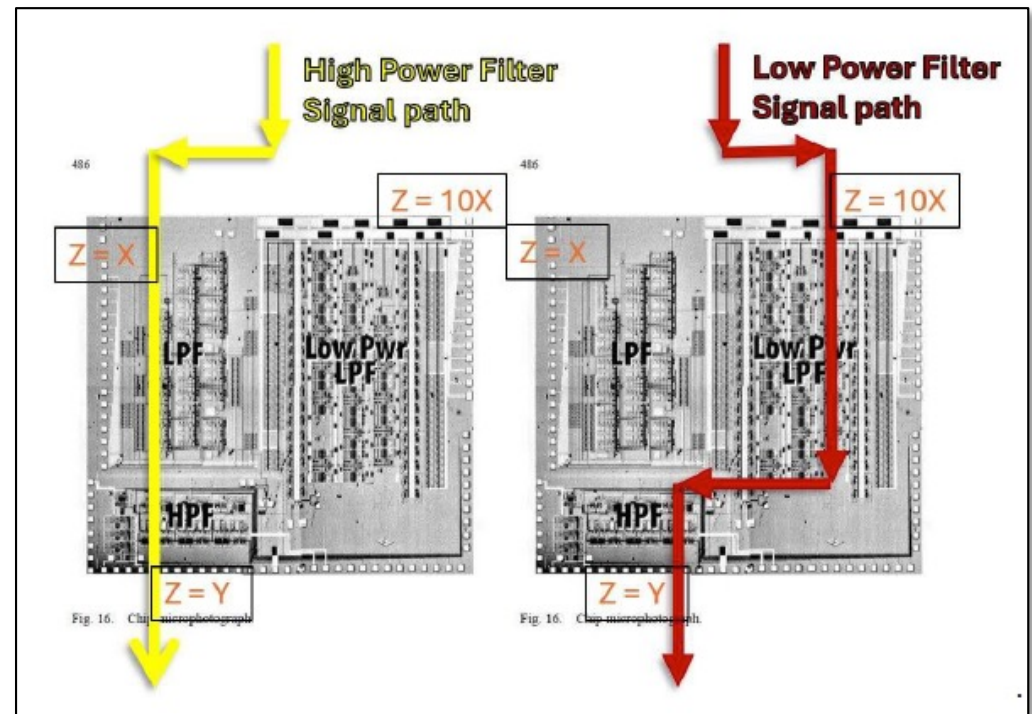
- ▶ Q. [T]he impedance experienced by a signal flowing through the low-power low-pass filter is 10 times higher than the impedance experienced by the signal flowing through the high-power low-pass filter; is that right?
- ▶ A. Yeah. I think that signal will experience different impedances, and it's very much like Figure 6 in Tsvidis; right? [W]e talked about different impedance levels, and so that would be, in this case, a 10X difference.

Ex. 1043 at 66:7-18 (cleaned up)

## ▶ PO's expert explains bias current:

- ▶ Q. Is it correct that these two filter branches will have approximately a 10X difference in their bias currents?
- ▶ A. Yes, as reported here of 5.4 and 56 milliamps, respectively.

Ex. 1043 at 67:17-22 (cleaned up)



PO's Expert Decl. (Ex. 2020) at ¶82

# The Board correctly held at institution that the claim language encompasses Behbahani's variable filter

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We also disagree with Patent Owner's argument that the depiction of a single Function Block 820 in Figure 8A of the '330 patent means that a filter swap (as in Behbahani) cannot satisfy limitation [1(b)]. See Prelim. Resp. 38. The '330 patent explains that Figure 8A is merely "an *embodiment* of the present invention" that describes a "*possible* power saving technique[]," and we do not see a basis to read this particular embodiment into the claim. Ex. 1001, 3:30–31, 8:20–22 (emphasis added). Moreover, the '330 patent describes Function Block 820 broadly, explaining that it "may be a filter, mixer, amplifier, *or other circuit or circuits* in a wireless transceiver or other electronic circuits or system." *Id.* at 8:22–25 (emphasis added). Based on this disclosure, we see no reason why Function Block 820 could not include multiple filters, such as the ones used in Behbahani's filter swap. Similarly, we are not persuaded by Patent Owner's reliance on Figure 6, which the '330 patent describes as merely "*an example* of how a circuit's impedances may be scaled to reduce drive currents." *Id.* at 3:24–27, 7:44–46 (emphasis added).

# The claims capture Behbahani's approach

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1. The Theta Patents broadly define a “function block” as the circuit/component in the signal path that is dynamically adjusted.
2. The dynamically adjusted function block may be a filter.
3. Fig. 6 is sole intrinsic illustration of dynamically adjusting a filter.
4. PO's expert concedes that Fig. 6 does not mandate adjusting individual elements, but may involve a wholesale circuit swap.

# The Theta Patents describe generic “function blocks” that are dynamically adjusted

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¶¶46-48, 77-80 (“the teachings and challenged claim language of the Tsvidis Patents would be understood by a person of ordinary skill in the art to be referring to impedance and bias current adjustments made dynamically for a single function block”); EX1001, 9:36-59 (“one or more impedance in the function block 920 may be increased”), Fig. 9A:

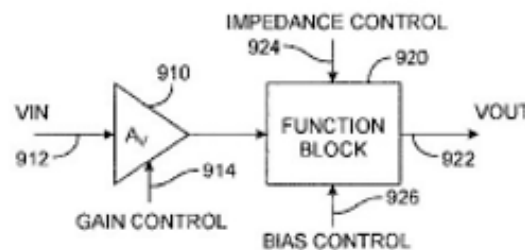


FIG. 9A

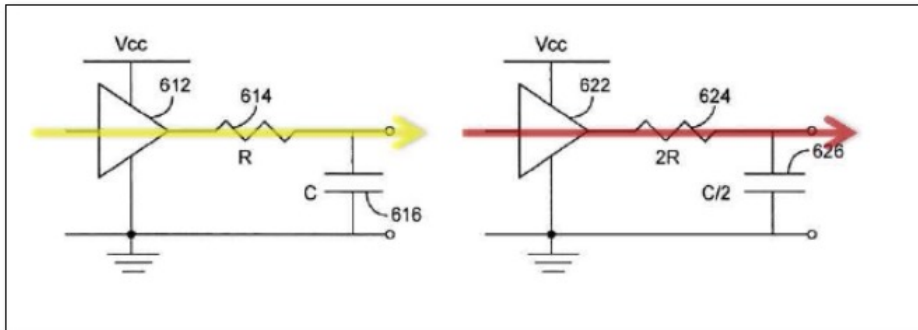
## PO concedes the dynamically adjusted circuit/component may be a filter

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The '330 Patent uses “a circuit” or “a component” to refer to individual units or elements of the receiver such as an amplifier, “the low pass filter,” “a mixer,” “a MOS transistor,” “a resistor,” etc. See, e.g., EX1001, 13:13-22 (“wherein the component in the signal path comprises,”), 7:44-46 (“FIG. 6 is an example of how *a circuit’s* impedances may be scaled to reduce drive currents, and, depending on the circuit configuration used, associated bias currents as well.”); see also *id.*, 7:57-59 (“In this way, an impedance can be scaled in order to decrease *a circuit’s* required drive current.”).

# The Theta Patents are not limited to changing individual element to the exclusion of larger changes

As it did pre-institution, PO focuses on Figure 6 of the '330 Patent as the sole specific example of dynamic impedance adjustment. Paper 16, 2-3, 25, 51, 65. Namely, PO argues that Fig. 6 depicts varying a resistor within a filter circuit by simply increasing its impedance from  $R$  to  $2R$ :



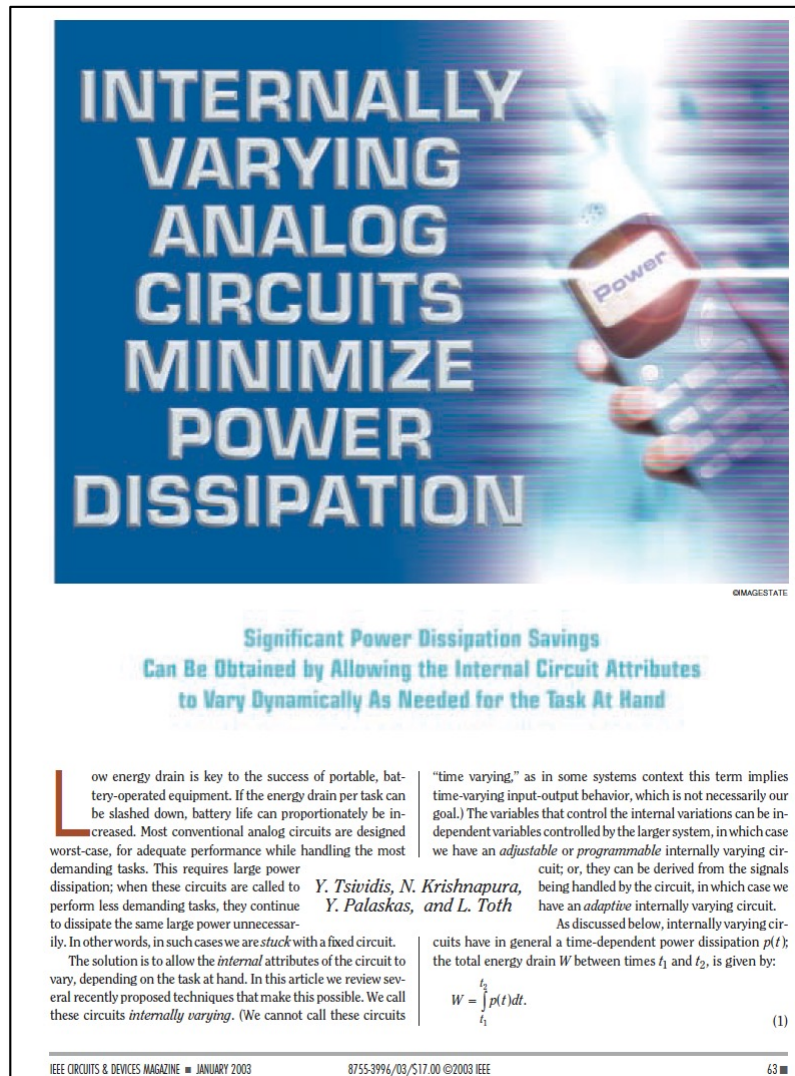
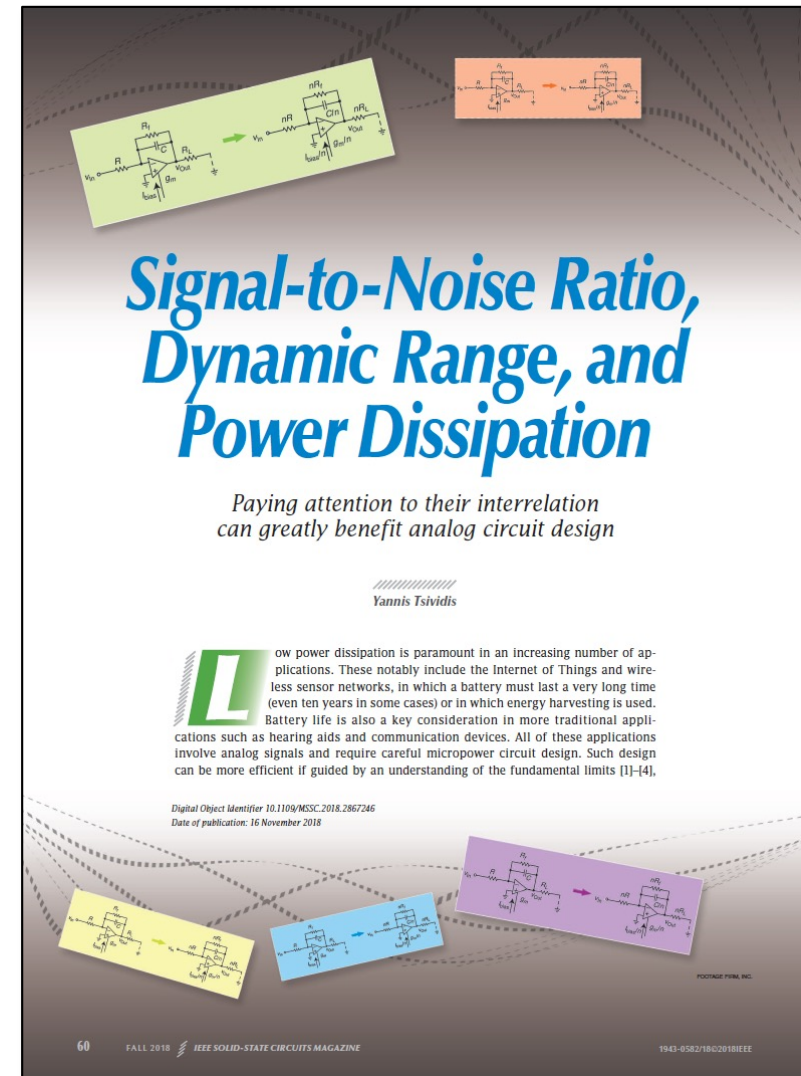
Q. Could Driver 612 be a different circuit than Driver 622 based on the description in the '330 Patent?

A. It could be different. It could be the same. The patent is silent on this issue.

Ex. 1043 at 33:10-14

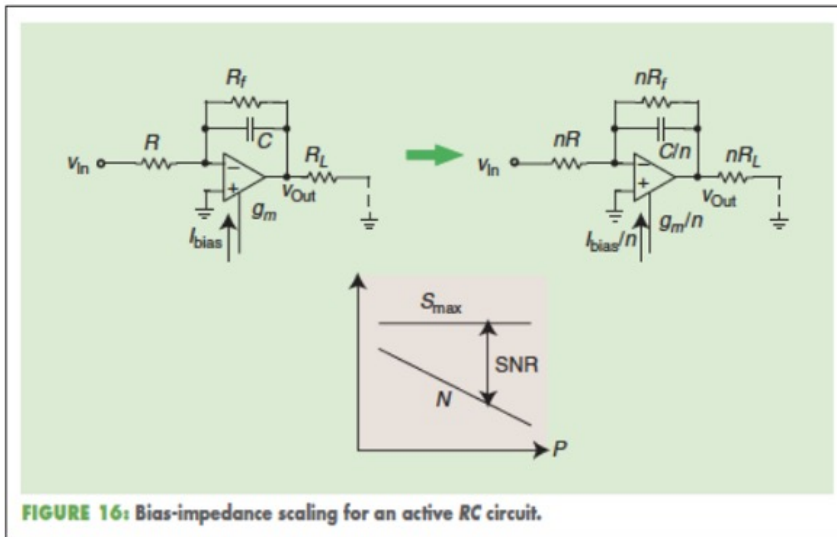
# The inventor published multiple related articles

## Each confirms that Behbahani's approach is consistent



# The inventor's 2018 article confirms larger changes are captured

PO claims that Fig. 16 in the 2018 article is “an example showing a combination of both impedance scaling (multiplying RC impedance by  $n$  via  $nR_x$  combined with  $C/n$ ), and also bias current scaling (dividing  $I_{\text{bias}}$  by  $n$ ).” *Id.*, 24.



Ex. 2004, Fig. 16.

As the article explains, bias and impedance scaling not only scales the resistances, capacitances, and bias currents, but also divides the transconductances by the same “ $n$ ” scaling factor. Ex. 2004, 65-67 (indicated as  $g_m/n$ ); see also *id.* at Fig. 12 (depicting multiple transconductors in parallel as a means of adjusting the circuit’s transconductance). Accordingly, inventor Tsividis’s 2018 article does not support PO’s interpretation of the invention as capturing only minimal changes (e.g., to the values of resistors and capacitors). Instead, this article confirms that his alleged invention contemplates and captures much more substantial scaling, including to resistor and capacitor values, but also by switching transconductors in and out of circuit to scale the entire filter block. As explained in the Petition and supporting expert declaration, this precise set of adjustments—scaling resistances, capacitances, transconductances, and bias currents—is what Behbahani describes. See Paper 1, 37-48; Ex. 1003, ¶¶100-128.

# The 2003 article expressly identified Behbahani's approach as exemplary

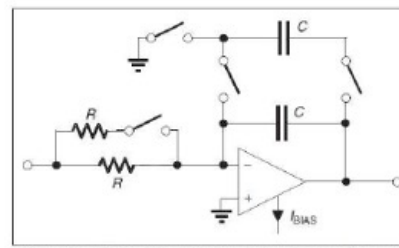
## Technique 2: Dynamic Impedance Scaling

Consider a system designed to handle very small signals in the worst case, as in Figure 4(a). Due to the large UDR, the capacitance values will be large, as seen from (6). However, this worst-case signal situation may not be present continuously; part of the time, this same system may be called to handle large signals with limited UDR or  $\text{SNR}_{\text{max}}$ . This, for example, can be the case in wireless systems, when the desired signal happens to be strong and no strong blocker is present [32]. At those instances, the very low noise floor of this system is unnecessary and can be allowed to increase by scaling  $C$  down [33], resulting, for example, in the situation shown in Figure 4(b). Of course, the transconductances or conductances of the filter will have to be scaled together with  $C$ , in order to leave the frequency response unchanged. The reason one may want to do such impedance scaling becomes clear from (7): lowering capacitances and transconductances allows one to also lower  $I_{\text{BIAS}}$ , and thus the total power dissipation can be made small. This can also be seen from the transconductor characteristics in Figure 3(d). In principle, for every 3 dB reduction in UDR, the power dissipation can be cut to half.

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. This, however, causes transients at the output, which may take a long time to die out, especially in the case of filters with high- $Q$  poles; the result may be loss of data.

# PO insists this paper's transient discussion rejects, rather than embraces, Behbahani

The article notes problems with *Behbahani's* approach. EX1011, 8 (“output transients” and “loss of data”), 8 (“delay” from attempt to mitigate transients with hand-off); see also EX1004, 1208 (“bit error rate “BER” increases”). And then the article *teaches improvements on Behbahani's approach*—specifically relevant here is *dynamic scaling of a single filter's structure via individual elements*. EX1011, 8 (“switching individual filter elements rather than entire filters”), 9 (“use a single filter and vary its structure dynamically”); EX2020, ¶¶66-70. Professor Tsividis' article refers to *dynamic impedance scaling* only with reference to its own Figure 12—which shows a single RC circuit, adjusted via switching individual elements that are in the signal path. EX1011, 9 (“dynamic impedance scaling (Figure 12)”), Fig. 12 (“An active RC circuit in which dynamic impedance scaling can be performed”):



12. An active RC circuit in which dynamic impedance scaling can be performed without causing output transients.

# The Theta Patents embrace transient-causing dynamic adjustments

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## 2003 Article:

### Avoiding Output Transients

The use of companding in filters encounters a difficulty not present in companding transmission systems. Filters are dynamical circuits; changes at the input appear as changes at the output with certain delay. Assume that, in Figure 5, the input signal strength suddenly changes, thus momentarily changing the signal at the input of the filter. The envelope detector senses the system input change and adjusts  $g$  to restore the filter input to its original level. The output element's gain,  $1 / g$ , changes accordingly at the same time, which is *before* the change at the filter input has had a chance to propagate to the output. Thus, the output element's gain changes too soon, and an undesirable transient occurs at the system output [17]. In some applications this is not a problem, as these changes may occur before the time comes to process the useful signal (for example, during the preamble slot in certain wireless protocols).

Ex. 1011 at 68

## '330 Patent:

Since the gain, impedance and biasing of these blocks are being dynamically varied, care must be taken to not negatively affect the signal being processed. For example, specific embodiments of the present invention perform some or all of these variations during preamble.

'330 Patent at 12:33-37

2. The method of claim 1 wherein the signal comprises a preamble portion and a data portion, the impedance of a component is changed while receiving the preamble portion, and the method further comprises receiving the data portion of the signal.

'330 Patent at Claim 2

# PO misunderstands the 2003 paper's discussion of varying filter structure

## Technique 4: Dynamic Structure Variation

A fourth possibility is to dynamically vary the very structure of the circuit (e.g., change the architecture of a filter dynamically). A straightforward way to accomplish this is to use two or more filters with different structures and make sure that output transients are avoided using the technique in Figure 11. It may also be possible to use a single filter and vary its structure dynamically, using techniques related to the ones discussed. This approach has not been investigated to any extent yet.

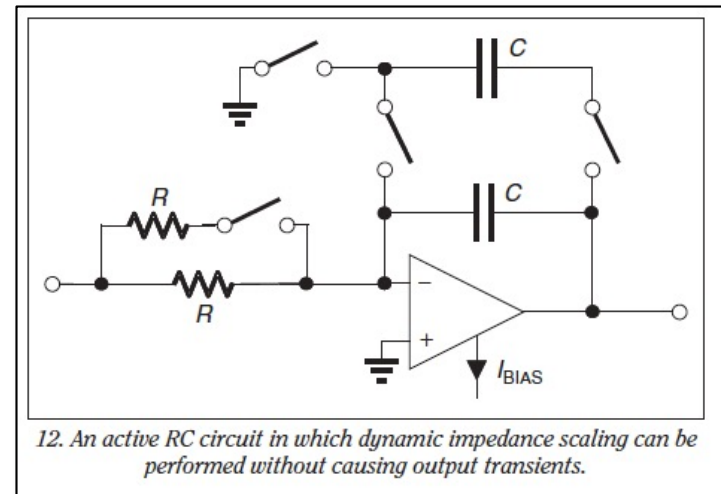
Ex. 1011 at 71-72

Reading on from Apple's excerpts reveals that Professor Tsividis' article instead teaches *away* from Behbahani's error-prone approach, and towards "vary[ing] structure dynamically" in a single filter and using "individual filter elements" rather than entire filters." EX1011, 8, 9, Fig. 12; EX2020, ¶¶66-74.

POR (Paper 16) at 61-62

But Professor Tsividis also discussed "switching individual filter elements" rather than entire filters," to "use a single filter and vary its structure dynamically"—as a different approach for future "investigation" and, in this case, patenting. *Id.*

Sur-Reply (Paper 24) at 19-20

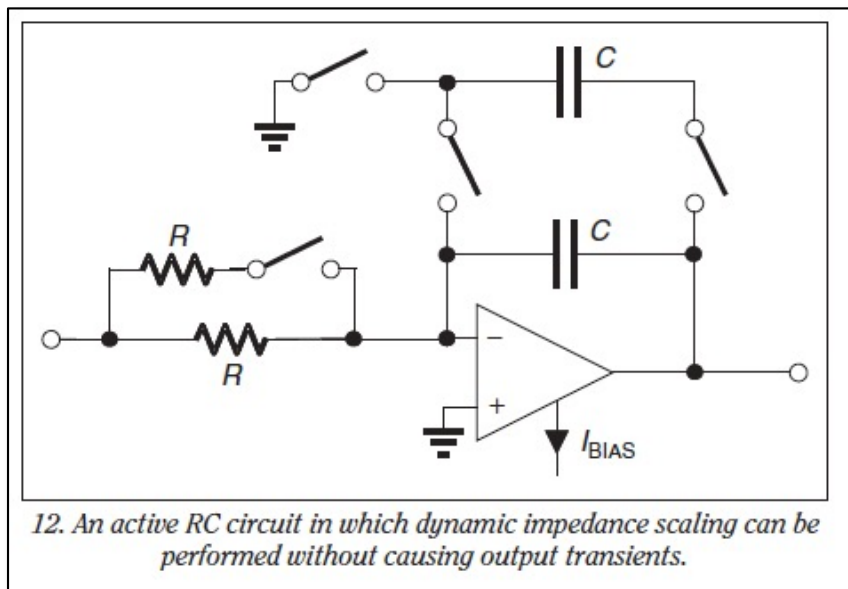


Ex. 1011 at Fig. 12

Professor Tsividis' article was published in IEEE Circuits & Devices Magazine in January of 2003. EX1011, footer. In the meantime, and separately, Theta and Professor Tsividis were in fact investigating and developing techniques for dynamically varying circuit structure via adjusting internal components. They filed provisional patent applications, and then the '330 Patent on February 23, 2004. EX1001, 1.

POR (Paper 16) at 62

# Not even PO's expert agrees that switching individual filter elements varies the structure



Ex. 1011 at Fig. 12

- ▶ Q. Do you consider Figure 12, switching in and out a resistor and a capacitor, to vary the structure of the circuit?
- ▶ A. Yeah, it's an interesting question. I would have to say it doesn't vary the structure of the circuit, but it varies the elements within the structure of the circuit. So, the structure of the circuit doesn't change.

Ex. 1043 at 105:25-106:19 (cleaned up)

# Remaining Disputes

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## 1) Theory Presented

- ▶ Whether Petitioner relied on Behbahani's variable filter block as the dynamically adjusted "circuit" or "component" in the signal path

## 2) Claim Construction

- ▶ Whether the claimed "circuit" or "component" that is dynamically adjusted should be construed to exclude switching between high- and low-power filter branches within Behbahani's variable filter

## 3) Signal Strength Measurement Circuit

- ▶ Whether Behbahani's signal strength measurement teaching sufficiently teaches or suggests the claimed signal strength measurement limitations

## 4) Discretionary Denial

- ▶ Whether vacating institution on discretionary bases is appropriate after the parties and Board have invested extensive resources

# Signal strength measurements

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- Theta argues that Apple failed to show Behbahani teaches or suggests:
  - ▶ circuits for determining signal strengths
    - ▶ See IPR2024-00816 ('330 Patent), Sur-Reply (Paper 24) at 21
    - ▶ See IPR2024-00817 ('825 Patent), Sur-Reply (Paper 23) at 21
    - ▶ See IPR2024-00820 ('210 Patent), Sur-Reply (Paper 23) at 21
  - ▶ determining the signal strength of the interferer signal or comparing signal strengths
    - ▶ See IPR2024-00818 ('202 Patent), Sur-Reply (Paper 23) at 21
    - ▶ See IPR2024-00819 ('164 Patent), Sur-Reply (Paper 24) at 21

# Theta Patents measure before and after filter to determine relative strength of desired and interferers

The signal strength indicators 440 and 450 do not provide information as to the relative sizes of the desired and interfering signals. Rather, a cumulative signal level is provided at their outputs. For example, the first signal strength indicator 440 outputs a level corresponding to the sum of desired signal 412 and interfering signals 414 and 416, while the second signal strength indicator 450 provides a signal level corresponding to the sum of desired signal 462 and interfering signals 464 and 466. In this specific example, the gain of the gain and filter circuit combinations is shown as approximately one, while the interfering signals 414 and 416 signal levels are reduced.

A comparison of the signal levels provided by the signal strength indicators 440 and 450 indicates that much of the combined received signal on line 410 has been filtered. Accordingly, it may be deduced that large interfering signals present at the input are being filtered by the filter 430. From this information, as will be shown in greater detail below, the bias, impedance, and gain of the gain stage 420 and filter 430 combination may be optimized to reduce power dissipation.

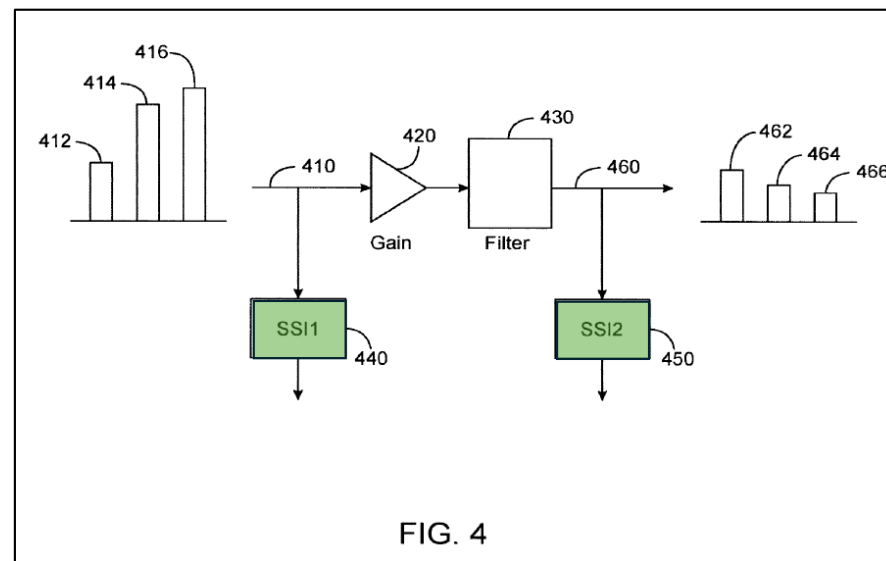
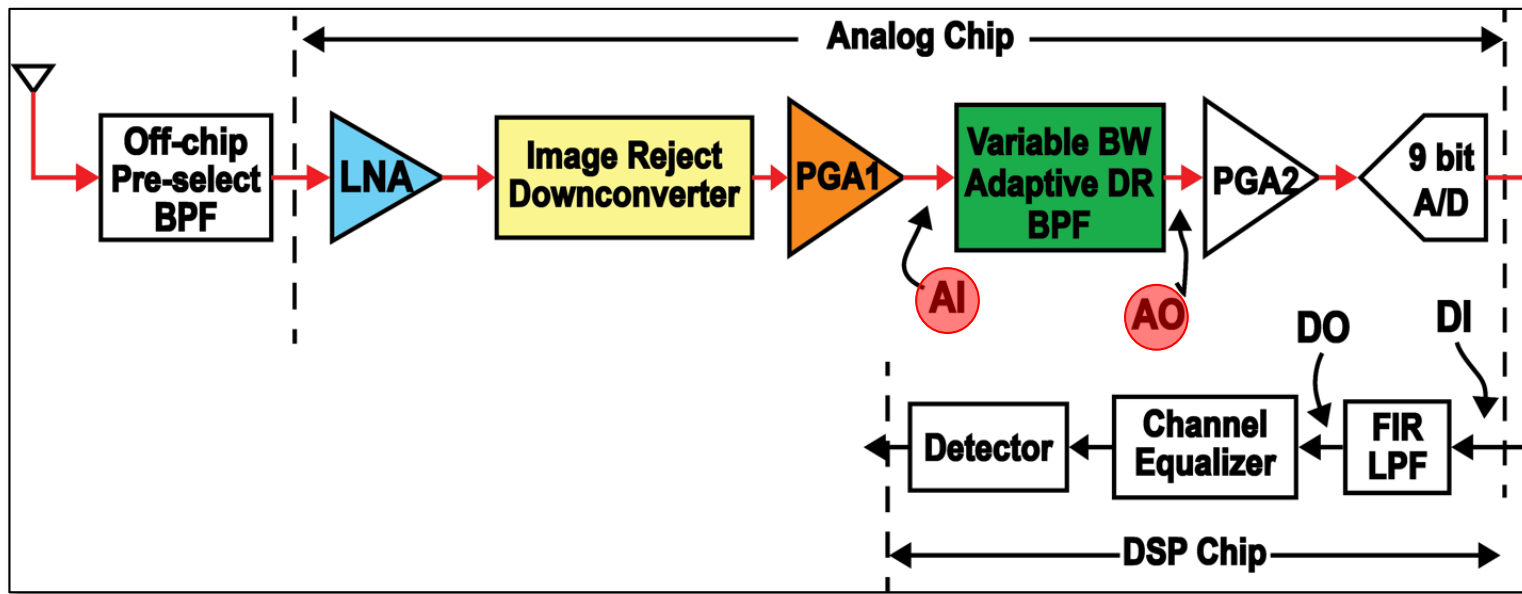


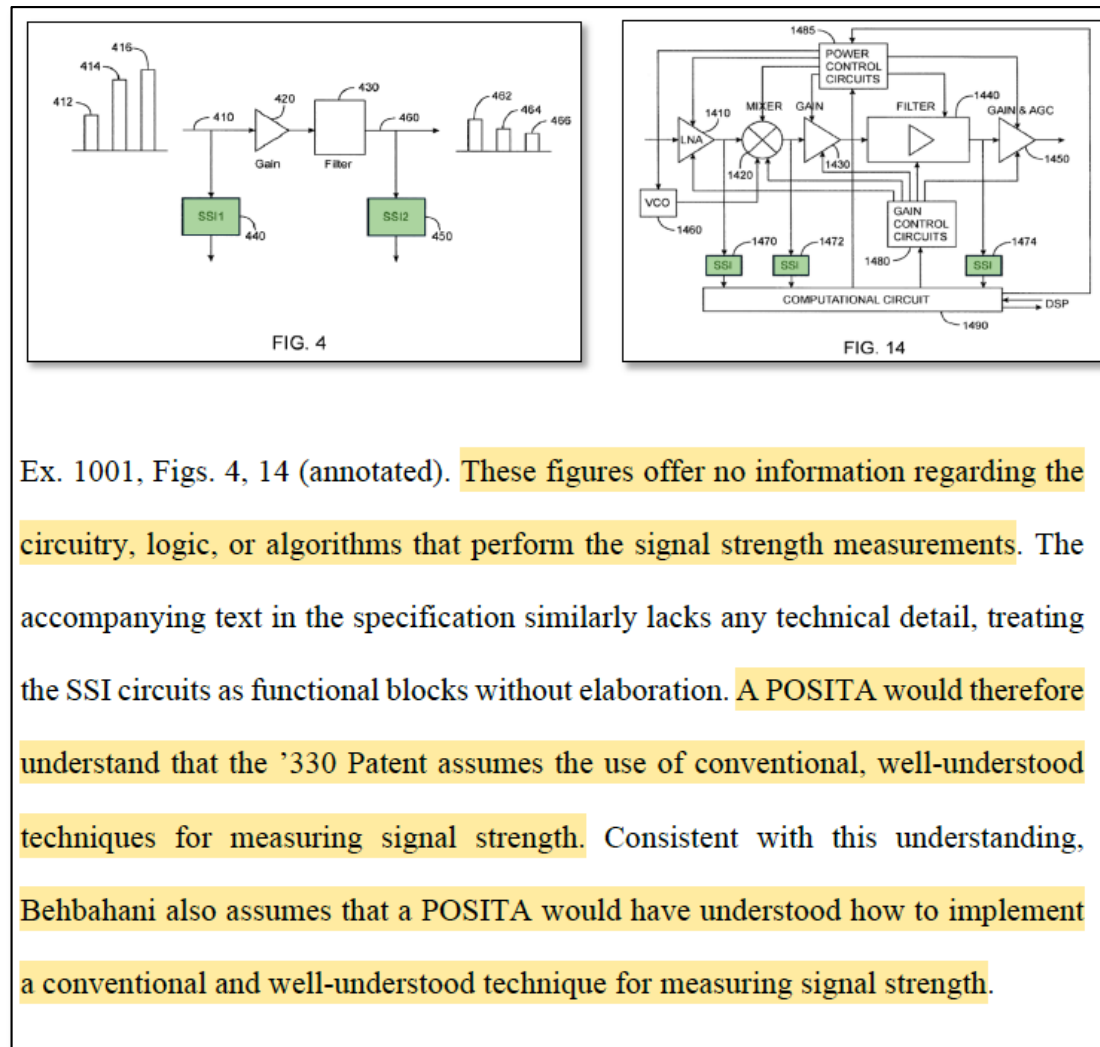
FIG. 4

## Behbahani also measures before and after filter to determine relative strength of desired and interferers

The signal level at  $A_I$  and  $A_O$  is a measure of the out-of-band interferers being rejected by the analog BPF. 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). 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).



# The Theta Patents and Behbahani assume signal strength measurement circuits were well-understood



Ex. 1001, Figs. 4, 14 (annotated). These figures offer no information regarding the circuitry, logic, or algorithms that perform the signal strength measurements. The accompanying text in the specification similarly lacks any technical detail, treating the SSI circuits as functional blocks without elaboration. A POSITA would therefore understand that the '330 Patent assumes the use of conventional, well-understood techniques for measuring signal strength. Consistent with this understanding, Behbahani also assumes that a POSITA would have understood how to implement a conventional and well-understood technique for measuring signal strength.

## Behbahani suggests *a circuit* for signal strength measurement, assuming conventional measuring signal strength techniques

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**b) Claim 23(a): “a first signal strength indicator circuit coupled to the signal path, and configured to determine a first signal strength;”**

179. As I discussed above, *Behbahani* teaches determining a first signal strength at a first node ( $A_I$ ) in the signal path in the integrated circuit. See Claim [1(a)].

181. Finally, a POSITA would further have understood that signal strength measurement circuitry was well understood at the time, which further motivates the combination and supports a conclusion that a POSITA would have expected success in combining these teachings. As one example, an article titled “A CMOS Limiting Amplifier and Signal-Strength Indicator” to *Khorram* et al. (“*Khorram*”) teaches strength detectors fabricated in a similar technology as *Behbahani*—CMOS—that are also designed for wireless communications in a mobile device.

13. While I acknowledged that *Behbahani* “does not provide details about the specific circuit used to measure signal strength,” a POSITA would indeed have understood that *Behbahani* suggested some circuit for measuring signal strength at  $A_I$  and  $A_O$ . Indeed, the purpose of *Behbahani* was to accommodate “a fully integrated receiver.” It was our intent, which a POSITA would have understood, to include the described functionality integrated on a single chip, including circuitry for measuring signal strength at  $A_I$  and  $A_O$ . As I discussed in my original declaration, there is functionality described in the digital domain that was intended to be off chip (i.e., on a DSP chip), but the analog measurements  $A_I$  and  $A_O$  were taken on the “Analog Chip” illustrated in Fig. 2 and an on-chip measurement circuit accomplished this functionality.

## Behbahani suggests circuits for measuring signal strength with the same level of detail as the Theta Patents

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- ▶ *Bradium Techs., LLC v. Iancu*, 923 F.3d 1032, 1049 (Fed. Cir. 2019) (affirming Board’s obviousness finding that a claim requiring a specific prioritization value was obvious over prior art that did not expressly disclose such a value, but fairly suggested it to a POSITA).
- ▶ *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (“The specification is entirely silent on [claimed function],...suggesting that a person of ordinary skill in the art was more than capable of selecting between the known methods of accomplishing this”).
- ▶ *Omega Liner Co., Inc. v. Buergofol GMBH*, IPR2023-01372, Paper 85, at \*47 (Mar. 14, 2025) (where a component served a similar function as in the prior art, the patent’s silence on specific implementation details indicated that overcoming them was an exercise of ordinary skill in the art).

## Tan—an express component of the combination—teaches “a signal strength indicator circuit”

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Although *Behbahani* does not provide details about the specific circuit used to measure signal strength, *Tan* does. *Tan*—a reference expressly referenced by *Behbahani* and intended to be used in conjunction with *Behbahani* (see Claim [1(b)])—provides an example of circuitry used to detect signals at various points in the low-pass filter signal path as a means of implementing a prefilter automatic gain control (AGC). *Tan*, 481. In this example, signal peaks are detected by current summing circuitry that is designed to “lower the input signal” via gain control when peak values exceed a predefined limit. *Id.* A POSITA would have been motivated to utilize *Tan*’s signal strength measurement circuitry to measure nodes A<sub>I</sub> and A<sub>O</sub> in *Behbahani* for a number of reasons. First, as already explains with reference to

## Via attorney argument, PO insists Tan cannot measure signal strength at $A_I$ and $A_O$ *because* it also measures peak values

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Without any disclosed circuit to point to, Apple mentions a peak detector circuit, used for a different purpose, shown in a figure of the *Tan* paper. Petition, 60-61; *see also* EX2021, 89:4-19. A peak detector, even if it were applied to the task of measuring at points “ $A_I$ ” and  $A_O$ ”—and it was not in Professor Abidi’s design—can detect that a signal has gone above a preset threshold. EX2021, 89:12-14; EX1004, Fig. 8 (“VRef”).

## Tan's circuit captures total signal energy, straightforwardly providing $A_I$ and $A_O$

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I understand that Patent Owner (though not Patent Owner's expert, Dr. Larson) has disputed whether Tan's circuit could properly function to provide  $A_I$  and  $A_O$ . It can, and I believe a POSITA would have considered using a simplified version of Tan's circuit to provide  $A_I$  and  $A_O$  a straightforward use of the circuit. Namely, each peak detector in Tan's circuit rectifies the total composite waveform at a given point along the filter path and outputs a representation of the maximum value across all points as a DC voltage. This means that it is measuring the strength of the desired signal and any interferers at each point along the filter path. Because there are peak detectors at the input ( $A_I$ ) and output ( $A_O$ ) of the filter, Tan's circuit provides a measure of the signal strength, capturing the desired and interferer signals, at both  $A_I$  and  $A_O$ , as I explained in my original declaration.

# Remaining Disputes

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## 1) Theory Presented

- ▶ Whether Petitioner relied on Behbahani's variable filter block as the dynamically adjusted "circuit" or "component" in the signal path

## 2) Claim Construction

- ▶ Whether the claimed "circuit" or "component" that is dynamically adjusted should be construed to exclude switching between high- and low-power filter branches within Behbahani's variable filter

## 3) Signal Strength Measurement Circuit

- ▶ Whether Behbahani's signal strength measurement teaching sufficiently teaches or suggests the claimed signal strength measurement limitations

## 4) Discretionary Denial

- ▶ Whether vacating institution on discretionary bases is appropriate after the parties and Board have invested extensive resources

# Discretionary Considerations

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- ▶ Theta asks the Board to vacate institution pursuant to *Ecto World* (§325(d) requires material error showing) & Theta’s alleged “settled expectations”
- ▶ See *Supercell OY v. Gree, Inc.*, PGR2018-0008, Paper 42 at 53 (PTAB Jan. 2, 2019) (“Patent Owner was unaware of any instance where the Board, essentially, de-instituted a trial portion of a proceeding based on 35 U.S.C. § 325(d), let alone de-institute after oral hearing where all that is left is the issuance of a final written decision. . . . **the absence of previous such actions** by the Board, nevertheless, **weighs against our exercise of discretion in such a manner.**”)
- ▶ See March 26, 2025 Memorandum re Interim Processes for PTAB **Workload Management**:
  - ▶ Newly identifying “settled expectations”
  - ▶ Explaining the new discretionary process intended to ensure the “PTAB [can] comply with . . . its statutory deadlines for AIA proceedings, and other workload needs” and noting “[t]he **processes described herein are temporary in nature due, in part, to the current workload needs of the PTAB.**”
- ▶ See *Microsoft Corp. v. Daedalus Blue, LLC*, IPR2021-00830, Paper 36 at 65 (PTAB Oct. 27, 2022) (“**Patent Owner’s request to de-institute is a request to reconsider our Decision on Institution and should have been raised by means of a motion for rehearing.** . . . Because Patent Owner failed to raise this issue in either the Preliminary Response or by way of a timely motion for rehearing of our Decision on Institution, we deny the request to de-institute as untimely.”)