UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Intel Corporation

Petitioner

v.

Qualcomm Incorporated

Patent Owner

U.S. Patent No. 8,698,558

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Case IPR2018-01152

Case IPR2018-01153

Case IPR2018-01154

Case IPR2018-01240

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DEPOSITION of ALYSSA B. APSEL, Ph.D.

Boston, Massachusetts

August 13, 2019

Reported by:

Dana Welch, CSR, RPR, CRR, CRC

Job #165514

August 13, 2019
9:23 a.m.

Deposition of ALYSSA B. APSEL, Ph.D., held at the offices of WilmerHale, 60 State Street, Boston, Massachusetts 02109, before Dana Welch, Certified Shorthand Reporter, Registered Professional Reporter, Certified Realtime Reporter and Notary Public of the Commonwealth of Massachusetts.

APPEARANCES:
For the Patent Owner:
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For the Petitioner:
WILMERHALE
BY: LOUIS TOMPROS, ESQ.
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Boston, MA 02109

PROCEEDINGS
ALYSSA B. APSEL, Ph.D.,
having been first duly sworn on oath,
was examined and testified as follows:
EXAMINATION
BY MR. SAUER:
Q. Please state your name for the record.
A. Alyssa Apsel.
Q. And, Dr. Apsel, you understand you're under oath this morning?
A. Yes.
Q. And is there any reason that you can't testify fully and truthfully this morning?
A. No.
Q. This deposition pertains to your supplemental declaration testimony in four IPR matters all pertaining to U.S. Patent Number 8,698,558.
Is that your understanding?
A. Yes.
MR. SAUER: And for the record those IPR matters are IPR2018-01154, IPR2018-01153, IPR2018-01240 and IPR2018-01152.
Does that meet your understanding?

A. Yes. I don't remember the numbers, but --
Q. That's fine.
A. -- I believe you.
Q. I am handing you Intel Exhibit 1027 in IPR2018-01152.
Do you recognize this as a copy of your supplemental declaration that you submitted in this IPR?
A. Yes.
Q. Did you write this document?
A. Yes.
Q. Are there any errors that you're aware of?
A. There are not errors I'm aware of, but it's possible there are typos.
Q. Any opinions you'd like to change?
A. No.
Q. Okay. You can set that one aside.
MR. SAUER: I've now handed the witness Exhibit 1127 in IPR2018-0153.
Q. Do you recognize this as a copy of your reply declaration in this IPR?
A. Yes.
Q. Did you write this one as well?

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A. Yes.
Q. Any errors in this one or corrections?
A. I found a typo. I can't remember exactly where it is. Oh -- no, I don't -- there is one typo in here that found, but I can't remember where it is actually. I thought that was it. But for the most part this expresses my opinion.
Q. And no opinions you'd like to change?
A. No.
Q. Okay. Set that one aside, too.
There you go. I'm now handing you Exhibit 1329 in IPR2018-01240.
Do you recognize this as a copy of your reply declaration in this IPR?
A. Yes.
Q. You wrote this one, too?
A. Yes.
Q. Any errors that you'd like to change, opinions you'd like to change?
A. No.
Q. Okay. Set that one aside.
One more. And now I've handed you Exhibit 1228 in IPR2018-01154.
Is this a copy of your reply declaration

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in this IPR?
A. Yes.
Q. You wrote this one?
A. Yes.
Q. Any corrections?
A. No.
Q. Okay. You can keep this one in front of you if you don't mind. If you'll turn to page 13, paragraph 25.
Are you there?
A. Yes.
Q. In paragraph 25 you state, first sentence: "Second, any decrease in the linear amplifier current, Ia, caused by Kwak's feedforward path is balanced by an identical increase in the inductor current Id," correct?
Did I read that correctly?
A. Yes.
Q. And then a couple of sentences later you state, "Therefore because Io=Ia+Id and because Io remains unchanged, if Ia decreases, Id must increase by the identical amount."
Is this your testimony?
A. Yes.

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Q. Okay.
MR. SAUER: I'm handing the witness what's been previously marked as Intel Exhibit 1011.
Q. Do you recognize this as a copy of the Kwak reference?
A. Yes.
Q. Take a look at Figure 5.
Are you there?
A. Yeah.
Q. The equation that you refer to in your declaration, Io equals Ia plus Id relates to the operation of the circuits shown in Figure 5; is that right?
A. Correct.
Q. And specifically Io is the output flowing through the load Zl at the bottom right-hand part of the circuit, correct?
A. Correct.
Q. And Id is the current flowing through the inductor L, correct?
A. Correct.
Q. And you also refer to this current as the inductor current in your declaration, correct?
A. Correct.

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Q. And Ia in the equation is the current shown at the bottom right portion of Figure 2, correct?
A. Correct.
Q. And you refer to that in some places in your declaration as a linear amplifier, correct?
A. Correct.
Q. If you can flip back a page to Figure 2 in Kwak, the equation that you refer to Io=Ia+Id, it's also reflected by the phase diagram in Figure 2(b), correct?
A. Yes.
Q. And as we talked about in your last deposition, each of the currents in this equation are complex variables both with a magnitude component and a phase component, correct?
A. Yes.
Q. And in Figure 2(b) of Kwak, the magnitude components of the current variables are represented by the length of the arrows or vectors in the phase diagram; is that right?
A. That's correct.
Q. And then the phase components are represented in the phase diagram by the angle

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between the arrow and the x-axis; is that right?
A. Yes.
Q. And the equation Io=Ia+Id, it could also be written in polar form showing the magnitude and phase components?
A. Yes.
Q. If I were to give you a piece of paper would you be able to write the equation in polar form?
A. Yes.
Q. All right. I'm handing you a blank sheet of paper that's been marked as Apsel Deposition Exhibit A and a pen.
Could you please write the equation Io=Ia+Id in polar form and make it big enough that I can see it without coming over there.
(Exhibit A, Hand drawn equation, marked for identification.)
A. So you want me to represent both the phase and the magnitude?
Q. Yes, please.
A. There are a couple of ways to do this. one is to say that --
Q. Maybe with the magnitude and phase angle?

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A. I have to change the way that I define it. So Io is going to be, I'll call it Io positive, Io E to the J theta O.
Q. Okay.
A. And I'll call Ia equal to Ia times E to the J theta A. And Id equals Id times E to the J theta D. Okay?
These can also be represented as combinations of sines and cosines. Each of these -- it's implied by that diagram that each of these is at a single frequency. This is a steady state. This pictures applies to single frequency. It's not a combination of frequencies. So each frequency has their own phaser.
Q. Okay.
A. And so this is also kind of implied that there is like A plus 0mega T term in there --
Q. And what's that term represent?
A. -- but we usually leave it out.
That defines that it's a single -- that this is operating at a single frequency.
So based on that, then I can just plug in for these expressions and I can say Io=Ia+Id.
So these can be written either as

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combinations of sine and cosine. I can write that example, Io would be equal to Io times cosine omega t plus theta, right, plus J sine omega t plus theta naught. Okay?
(Clarification by the reporter.)
A. So I'm just writing the one term right now, expanding it out in Euler form, as I naught equals capital I naught times cosine omega t plus theta plus J times sine omega t plus theta.
Q. And what's theta in your equation?
A. That's the phase.
Q. The phase of what?
A. The phase of I naught of the combination.
Q. So each theta has a -- it's not just theta. It's theta I or theta A or theta O?
A. They're each -- each theta is different, right?
Q. Right.
A. That's why I gave them subscripts.
Q. Okay. Subscript, that's the word I was looking for.
So there are three theta variables in that equation?
A. Yes.

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Q. And there are three magnitude variables in that equation?
A. There are three magnitude variables.
Q. So your complexed equation has six variables?
A. Yes.
Q. And referring again to Figure 5 of Kwak, you agree that in Kwak's Figure 5, the use of the feedforward path does not change the output current, Io, in your equation, correct?
A. Correct.
Q. Now, in your complex equation, does that mean the addition to feedforward path would cause no change in either the magnitude or the phase component of Io?
A. Can you repeat the question?
Q. Try to say it better.
In the complex version of your equation, the addition of the feedforward path in Figure 5 would cause no change in both the magnitude and phase component of Io; is that correct?
A. That's correct.
Q. You also agree in Kwak's Figure 5 the use of a feedforward path causes a decrease in the

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linear amplifier current Ia, correct?
A. Yes.
Q. But in your complex equation, that means a decrease in the magnitude component of Ia, correct?
A. Yes, that's correct.
Q. It doesn't necessarily mean a decrease in the phase component of Ia?
A. So this is -- I have a little bit of a problem with the way this is being posed.
Q. Okay. How so?
A. Just because that assumption when we're talking about the magnitude in phase of the sine waves, we're talking about a single frequency component, whereas the full signal, what is coming out of Io is very unlikely to be a single phaser, a single frequency component. It's likely to be a combination, a sum of sines and cosines at different frequencies with a broad range of frequency content.
So we can talk about a single frequency, like single component of that, that's saying that the phase and magnitude are changing in a certain way, but it's not exactly telling you how the current -- the sum of the currents, because they

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can add -- those sines and cosines can add in phase or out or phase, it's not exactly telling you how the sum of those currents is changing necessarily.
Q. So it would be fair to say that Figure 5 of Kwak just doesn't give you enough information to know what happens to the phase of Ia?
MR. TOMPROS: Object to form.
A. No. I don't think that that's correct either. I think that the -- talking about the phase of Ia is a little strange because it is a combination of sines and cosines with different phases, that's what I'm trying to say.
Q. Okay. But are you able to tell from Kwak or Figure 5 what happens to that combination of sines and cosines in Ia?
A. There is a goal in this circuit of speeding up the response of the switcher, which is -- we can talk about the phase increasing or decreasing, but it's difficult to say that it's a single phase or of a single component because it's really an aggregate signal.
Q. An aggregate of the phases of different components?
A. Yes.

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Q. And it may increase in one place and decrease in another; is that what you're saying?
A. Yes. Or more likely increase more in some places and less in others; it's that sort of relationship.
Q. So in your equation, when the feedforward path is introduced into Kwak's Figure 3 -- Figure 5, we know the magnitude and phase components of the output current stay the same.
A. Yes.
Q. And we know that the magnitude component of the linear amplifier current decreases.
A. Yes.
Q. But there's still three unknown variables in that equation; isn't that right?
A. I'm not sure I understand that.
Q. Well, based on the complex equations you've written, when the feedforward path is introduced into Figure 5, we don't know what happens to the magnitude and phase component of Id or the phase component of Ia; isn't that right? They're unknown variables.
A. I'm not sure that that can't be known. I don't look at the circuit immediately and know

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exactly how much the phase is changing for one component versus the other, but I think it's certainly knowable.
Q. In any of your calculations with respect to Kwak, have you ever calculated any of those values from that equation?
A. I don't understand that question.
Q. You said it's knowable. Have you determined those values from Kwak? Have you determined what happens to those components when the feedforward path is introduced in Figure 5?
A. I can look at the circuit behavior and I can look at what the feedforward path is doing. So the feedforward path is adding to this summation block in Figure 5, and acts to change the signal going into this thresholding block. It increases it relative to -- it increases the negative input relative to the positive input, right? So it changes the output of this switching thresholding block, which we -- it's easy to see and understand that that changes the duty cycle of the switcher. And changing the duty cycle of the switcher changes the slope of the current of Id, which means that it will increase the current of Id.

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