1   UNITED STATES PATENT AND TRADEMARK OFFICE

2 _____

3   BEFORE THE PATENT TRIAL AND APPEAL BOARD

4 _____

5   Intel Corporation

6   Petitioner

7   v.

8   Qualcomm Incorporated

9   Patent Owner

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

11 _____

12   Case IPR2018-01152

13   Case IPR2018-01153

14   Case IPR2018-01154

15   Case IPR2018-01240

16 _____

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18   DEPOSITION of ALYSSA B. APSEL, Ph.D.

19   Boston, Massachusetts

20   August 13, 2019

21

22

23 Reported by:

24 Dana Welch, CSR, RPR, CRR, CRC

25 Job #165514

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4
5   August 13, 2019
6   9:23 a.m.
7
8
9   Deposition of ALYSSA B. APSEL, Ph.D., held
10   at the offices of WilmerHale, 60 State Street,
11   Boston, Massachusetts 02109, before Dana Welch,
12   Certified Shorthand Reporter, Registered
13   Professional Reporter, Certified Realtime Reporter
14   and Notary Public of the Commonwealth of
15   Massachusetts.
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1   APPEARANCES:
2   For the Patent Owner:
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1   APSEL
2   P R O C E E D I N G S
3   ALYSSA B. APSEL, Ph.D.,
4   having been first duly sworn on oath,
5   was examined and testified as follows:
6   EXAMINATION
7   BY MR. SAUER:
8   Q. Please state your name for the record.
9   A. Alyssa Apsel.
10   Q. And, Dr. Apsel, you understand you're
11   under oath this morning?
12   A. Yes.
13   Q. And is there any reason that you can't
14   testify fully and truthfully this morning?
15   A. No.
16   Q. This deposition pertains to your
17   supplemental declaration testimony in four IPR
18   matters all pertaining to U.S. Patent Number
19   8,698,558.
20   Is that your understanding?
21   A. Yes.
22   MR. SAUER: And for the record those IPR
23   matters are IPR2018-01154, IPR2018-01153,
24   IPR2018-01240 and IPR2018-01152.
25   Does that meet your understanding?

1   APSEL
2   A. Yes. I don't remember the numbers,
3   but --
4   Q. That's fine.
5   A. -- I believe you.
6   Q. I am handing you Intel Exhibit 1027 in
7   IPR2018-01152.
8   Do you recognize this as a copy of your
9   supplemental declaration that you submitted in this
10   IPR?
11   A. Yes.
12   Q. Did you write this document?
13   A. Yes.
14   Q. Are there any errors that you're aware of?
15   A. There are not errors I'm aware of, but
16   it's possible there are typos.
17   Q. Any opinions you'd like to change?
18   A. No.
19   Q. Okay. You can set that one aside.
20   MR. SAUER: I've now handed the witness
21   Exhibit 1127 in IPR2018-0153.
22   Q. Do you recognize this as a copy of your
23   reply declaration in this IPR?
24   A. Yes.
25   Q. Did you write this one as well?

APSEL

1
2   A. Yes.
3   Q. Any errors in this one or corrections?
4   A. I found a typo. I can't remember exactly
5 where it is. Oh -- no, I don't -- there is one
6 typo in here that found, but I can't remember where
7 it is actually. I thought that was it. But for
8 the most part this expresses my opinion.
9   Q. And no opinions you'd like to change?
10   A. No.
11   Q. Okay. Set that one aside, too.
12   There you go. I'm now handing you
13 Exhibit 1329 in IPR2018-01240.
14   Do you recognize this as a copy of your
15 reply declaration in this IPR?
16   A. Yes.
17   Q. You wrote this one, too?
18   A. Yes.
19   Q. Any errors that you'd like to change,
20 opinions you'd like to change?
21   A. No.
22   Q. Okay. Set that one aside.
23   One more. And now I've handed you
24 Exhibit 1228 in IPR2018-01154.
25   Is this a copy of your reply declaration

APSEL

1
2 in this IPR?
3   A. Yes.
4   Q. You wrote this one?
5   A. Yes.
6   Q. Any corrections?
7   A. No.
8   Q. Okay. You can keep this one in front of
9 you if you don't mind. If you'll turn to page 13,
10 paragraph 25.
11   Are you there?
12   A. Yes.
13   Q. In paragraph 25 you state, first sentence:
14 "Second, any decrease in the linear amplifier
15 current, Ia, caused by Kwak's feedforward path is
16 balanced by an identical increase in the inductor
17 current Id," correct?
18   Did I read that correctly?
19   A. Yes.
20   Q. And then a couple of sentences later you
21 state, "Therefore because Io=Ia+Id and because Io
22 remains unchanged, if Ia decreases, Id must
23 increase by the identical amount."
24   Is this your testimony?
25   A. Yes.

APSEL

1
2   Q. Okay.
3   MR. SAUER: I'm handing the witness what's
4 been previously marked as Intel Exhibit 1011.
5   Q. Do you recognize this as a copy of the
6 Kwak reference?
7   A. Yes.
8   Q. Take a look at Figure 5.
9   Are you there?
10   A. Yeah.
11   Q. The equation that you refer to in your
12 declaration, Io equals Ia plus Id relates to the
13 operation of the circuits shown in Figure 5; is
14 that right?
15   A. Correct.
16   Q. And specifically Io is the output flowing
17 through the load Zl at the bottom right-hand part
18 of the circuit, correct?
19   A. Correct.
20   Q. And Id is the current flowing through the
21 inductor L, correct?
22   A. Correct.
23   Q. And you also refer to this current as the
24 inductor current in your declaration, correct?
25   A. Correct.

APSEL

1
2   Q. And Ia in the equation is the current
3 shown at the bottom right portion of Figure 2,
4 correct?
5   A. Correct.
6   Q. And you refer to that in some places in
7 your declaration as a linear amplifier, correct?
8   A. Correct.
9   Q. If you can flip back a page to Figure 2 in
10 Kwak, the equation that you refer to Io=Ia+Id, it's
11 also reflected by the phase diagram in Figure 2(b),
12 correct?
13   A. Yes.
14   Q. And as we talked about in your last
15 deposition, each of the currents in this equation
16 are complex variables both with a magnitude
17 component and a phase component, correct?
18   A. Yes.
19   Q. And in Figure 2(b) of Kwak, the magnitude
20 components of the current variables are represented
21 by the length of the arrows or vectors in the phase
22 diagram; is that right?
23   A. That's correct.
24   Q. And then the phase components are
25 represented in the phase diagram by the angle

APSEL

1
2 between the arrow and the x-axis; is that right?
3   A. Yes.
4   Q. And the equation Io=Ia+Id, it could also
5 be written in polar form showing the magnitude and
6 phase components?
7   A. Yes.
8   Q. If I were to give you a piece of paper
9 would you be able to write the equation in polar
10 form?
11   A. Yes.
12   Q. All right. I'm handing you a blank sheet
13 of paper that's been marked as Apsel Deposition
14 Exhibit A and a pen.
15   Could you please write the equation
16 Io=Ia+Id in polar form and make it big enough that
17 I can see it without coming over there.
18   (Exhibit A, Hand drawn equation, marked for
19   identification.)
20   A. So you want me to represent both the phase
21 and the magnitude?
22   Q. Yes, please.
23   A. There are a couple of ways to do this.
24 one is to say that --
25   Q. Maybe with the magnitude and phase angle?

APSEL

1
2   A. I have to change the way that I define it.
3 So Io is going to be, I'll call it Io positive, Io
4 E to the J theta O.
5   Q. Okay.
6   A. And I'll call Ia equal to Ia times E to
7 the J theta A. And Id equals Id times E to the J
8 theta D. Okay?
9   These can also be represented as
10 combinations of sines and cosines. Each of these
11 -- it's implied by that diagram that each of these
12 is at a single frequency. This is a steady state.
13 This pictures applies to single frequency. It's
14 not a combination of frequencies. So each
15 frequency has their own phaser.
16   Q. Okay.
17   A. And so this is also kind of implied that
18 there is like A plus 0mega T term in there --
19   Q. And what's that term represent?
20   A. -- but we usually leave it out.
21   That defines that it's a single -- that
22 this is operating at a single frequency.
23   So based on that, then I can just plug in
24 for these expressions and I can say Io=Ia+Id.
25   So these can be written either as

APSEL

1
2 combinations of sine and cosine. I can write that
3 example, Io would be equal to Io times cosine omega
4 t plus theta, right, plus J sine omega t plus theta
5 naught. Okay?
6   (Clarification by the reporter.)
7   A. So I'm just writing the one term right
8 now, expanding it out in Euler form, as I naught
9 equals capital I naught times cosine omega t plus
10 theta plus J times sine omega t plus theta.
11   Q. And what's theta in your equation?
12   A. That's the phase.
13   Q. The phase of what?
14   A. The phase of I naught of the combination.
15   Q. So each theta has a -- it's not just
16 theta. It's theta I or theta A or theta O?
17   A. They're each -- each theta is different,
18 right?
19   Q. Right.
20   A. That's why I gave them subscripts.
21   Q. Okay. Subscript, that's the word I was
22 looking for.
23   So there are three theta variables in that
24 equation?
25   A. Yes.

APSEL

1
2   Q. And there are three magnitude variables in
3 that equation?
4   A. There are three magnitude variables.
5   Q. So your complexed equation has six
6 variables?
7   A. Yes.
8   Q. And referring again to Figure 5 of Kwak,
9 you agree that in Kwak's Figure 5, the use of the
10 feedforward path does not change the output
11 current, Io, in your equation, correct?
12   A. Correct.
13   Q. Now, in your complex equation, does that
14 mean the addition to feedforward path would cause
15 no change in either the magnitude or the phase
16 component of Io?
17   A. Can you repeat the question?
18   Q. Try to say it better.
19   In the complex version of your equation,
20 the addition of the feedforward path in Figure 5
21 would cause no change in both the magnitude and
22 phase component of Io; is that correct?
23   A. That's correct.
24   Q. You also agree in Kwak's Figure 5 the use
25 of a feedforward path causes a decrease in the

APSEL

1
2 linear amplifier current Ia, correct?
3   A. Yes.
4   Q. But in your complex equation, that means a
5 decrease in the magnitude component of Ia, correct?
6   A. Yes, that's correct.
7   Q. It doesn't necessarily mean a decrease in
8 the phase component of Ia?
9   A. So this is -- I have a little bit of a
10 problem with the way this is being posed.
11   Q. Okay. How so?
12   A. Just because that assumption when we're
13 talking about the magnitude in phase of the sine
14 waves, we're talking about a single frequency
15 component, whereas the full signal, what is coming
16 out of Io is very unlikely to be a single phaser, a
17 single frequency component. It's likely to be a
18 combination, a sum of sines and cosines at
19 different frequencies with a broad range of
20 frequency content.
21   So we can talk about a single frequency,
22 like single component of that, that's saying that
23 the phase and magnitude are changing in a certain
24 way, but it's not exactly telling you how the
25 current -- the sum of the currents, because they

APSEL

1
2 can add -- those sines and cosines can add in phase
3 or out or phase, it's not exactly telling you how
4 the sum of those currents is changing necessarily.
5   Q. So it would be fair to say that Figure 5
6 of Kwak just doesn't give you enough information to
7 know what happens to the phase of Ia?
8   MR. TOMPROS: Object to form.
9   A. No. I don't think that that's correct
10 either. I think that the -- talking about the
11 phase of Ia is a little strange because it is a
12 combination of sines and cosines with different
13 phases, that's what I'm trying to say.
14   Q. Okay. But are you able to tell from Kwak
15 or Figure 5 what happens to that combination of
16 sines and cosines in Ia?
17   A. There is a goal in this circuit of
18 speeding up the response of the switcher, which is
19 -- we can talk about the phase increasing or
20 decreasing, but it's difficult to say that it's a
21 single phase or of a single component because it's
22 really an aggregate signal.
23   Q. An aggregate of the phases of different
24 components?
25   A. Yes.

APSEL

1
2   Q. And it may increase in one place and
3 decrease in another; is that what you're saying?
4   A. Yes. Or more likely increase more in some
5 places and less in others; it's that sort of
6 relationship.
7   Q. So in your equation, when the feedforward
8 path is introduced into Kwak's Figure 3 --
9 Figure 5, we know the magnitude and phase
10 components of the output current stay the same.
11   A. Yes.
12   Q. And we know that the magnitude component
13 of the linear amplifier current decreases.
14   A. Yes.
15   Q. But there's still three unknown variables
16 in that equation; isn't that right?
17   A. I'm not sure I understand that.
18   Q. Well, based on the complex equations
19 you've written, when the feedforward path is
20 introduced into Figure 5, we don't know what
21 happens to the magnitude and phase component of Id
22 or the phase component of Ia; isn't that right?
23 They're unknown variables.
24   A. I'm not sure that that can't be known. I
25 don't look at the circuit immediately and know

APSEL

1
2 exactly how much the phase is changing for one
3 component versus the other, but I think it's
4 certainly knowable.
5   Q. In any of your calculations with respect
6 to Kwak, have you ever calculated any of those
7 values from that equation?
8   A. I don't understand that question.
9   Q. You said it's knowable. Have you
10 determined those values from Kwak? Have you
11 determined what happens to those components when
12 the feedforward path is introduced in Figure 5?
13   A. I can look at the circuit behavior and I
14 can look at what the feedforward path is doing. So
15 the feedforward path is adding to this summation
16 block in Figure 5, and acts to change the signal
17 going into this thresholding block. It increases
18 it relative to -- it increases the negative input
19 relative to the positive input, right? So it
20 changes the output of this switching thresholding
21 block, which we -- it's easy to see and understand
22 that that changes the duty cycle of the switcher.
23 And changing the duty cycle of the switcher changes
24 the slope of the current of Id, which means that it
25 will increase the current of Id.

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