

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

17  
18 DEPOSITION of ALYSSA B. APSEL, Ph.D.

19 Boston, Massachusetts

20 August 13, 2019

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22  
23 Reported by:

24 Dana Welch, CSR, RPR, CRR, CRC

25 Job #165514

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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.

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APSEL  
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?

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APSEL  
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?

1 APSEL

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

1 APSEL

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,  $I_a$ , caused by Kwak's feedforward path is  
16 balanced by an identical increase in the inductor  
17 current  $I_d$ ," correct?

18 Did I read that correctly?

19 A. Yes.

20 Q. And then a couple of sentences later you  
21 state, "Therefore because  $I_o = I_a + I_d$  and because  $I_o$   
22 remains unchanged, if  $I_a$  decreases,  $I_d$  must  
23 increase by the identical amount."

24 Is this your testimony?

25 A. Yes.

1 APSEL

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,  $I_o$  equals  $I_a$  plus  $I_d$  relates to the  
13 operation of the circuits shown in Figure 5; is  
14 that right?

15 A. Correct.

16 Q. And specifically  $I_o$  is the output flowing  
17 through the load  $Z_l$  at the bottom right-hand part  
18 of the circuit, correct?

19 A. Correct.

20 Q. And  $I_d$  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.

1 APSEL

2 Q. And  $I_a$  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  $I_o = I_a + I_d$ , 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 between the arrow and the x-axis; is that right?

2 A. Yes.

3 Q. And the equation  $I_o = I_a + I_d$ , it could also  
4 be written in polar form showing the magnitude and  
5 phase components?

6 A. Yes.

7 Q. If I were to give you a piece of paper  
8 would you be able to write the equation in polar  
9 form?

10 A. Yes.

11 Q. All right. I'm handing you a blank sheet  
12 of paper that's been marked as Apsel Deposition  
13 Exhibit A and a pen.

14 Could you please write the equation  
15  $I_o = I_a + I_d$  in polar form and make it big enough that  
16 I can see it without coming over there.

17 (Exhibit A, Hand drawn equation, marked for  
18 identification.)

19 A. So you want me to represent both the phase  
20 and the magnitude?

21 Q. Yes, please.

22 A. There are a couple of ways to do this.  
23 one is to say that --

24 Q. Maybe with the magnitude and phase angle?  
25

APSEL

1 A. I have to change the way that I define it.  
2 So  $I_o$  is going to be, I'll call it  $I_o$  positive,  $I_o$   
3 E to the J theta O.

4 Q. Okay.

5 A. And I'll call  $I_a$  equal to  $I_a$  times E to  
6 the J theta A. And  $I_d$  equals  $I_d$  times E to the J  
7 theta D. Okay?

8 These can also be represented as  
9 combinations of sines and cosines. Each of these  
10 -- it's implied by that diagram that each of these  
11 is at a single frequency. This is a steady state.  
12 This picture applies to single frequency. It's  
13 not a combination of frequencies. So each  
14 frequency has their own phaser.

15 Q. Okay.

16 A. And so this is also kind of implied that  
17 there is like A plus  $\Omega T$  term in there --

18 Q. And what's that term represent?

19 A. -- but we usually leave it out.

20 That defines that it's a single -- that  
21 this is operating at a single frequency.

22 So based on that, then I can just plug in  
23 for these expressions and I can say  $I_o = I_a + I_d$ .

24 So these can be written either as  
25

APSEL

1 combinations of sine and cosine. I can write that  
2 example,  $I_o$  would be equal to  $I_o$  times cosine omega  
3 t plus theta, right, plus J sine omega t plus theta  
4 naught. Okay?

5 (Clarification by the reporter.)

6 A. So I'm just writing the one term right  
7 now, expanding it out in Euler form, as I naught  
8 equals capital I naught times cosine omega t plus  
9 theta plus J times sine omega t plus theta.

10 Q. And what's theta in your equation?

11 A. That's the phase.

12 Q. The phase of what?

13 A. The phase of I naught of the combination.

14 Q. So each theta has a -- it's not just  
15 theta. It's theta I or theta A or theta O?

16 A. They're each -- each theta is different,  
17 right?

18 Q. Right.

19 A. That's why I gave them subscripts.

20 Q. Okay. Subscript, that's the word I was  
21 looking for.

22 So there are three theta variables in that  
23 equation?

24 A. Yes.  
25

APSEL

1 Q. And there are three magnitude variables in  
2 that equation?

3 A. There are three magnitude variables.

4 Q. So your complexed equation has six  
5 variables?

6 A. Yes.

7 Q. And referring again to Figure 5 of Kwak,  
8 you agree that in Kwak's Figure 5, the use of the  
9 feedforward path does not change the output  
10 current,  $I_o$ , in your equation, correct?

11 A. Correct.

12 Q. Now, in your complex equation, does that  
13 mean the addition to feedforward path would cause  
14 no change in either the magnitude or the phase  
15 component of  $I_o$ ?

16 A. Can you repeat the question?

17 Q. Try to say it better.

18 In the complex version of your equation,  
19 the addition of the feedforward path in Figure 5  
20 would cause no change in both the magnitude and  
21 phase component of  $I_o$ ; is that correct?

22 A. That's correct.

23 Q. You also agree in Kwak's Figure 5 the use  
24 of a feedforward path causes a decrease in the  
25

APSEL

1 linear amplifier current  $I_a$ , correct?

2 A. Yes.

3 Q. But in your complex equation, that means a  
4 decrease in the magnitude component of  $I_a$ , correct?

5 A. Yes, that's correct.

6 Q. It doesn't necessarily mean a decrease in  
7 the phase component of  $I_a$ ?

8 A. So this is -- I have a little bit of a  
9 problem with the way this is being posed.

10 Q. Okay. How so?

11 A. Just because that assumption when we're  
12 talking about the magnitude in phase of the sine  
13 waves, we're talking about a single frequency  
14 component, whereas the full signal, what is coming  
15 out of  $I_o$  is very unlikely to be a single phaser, a  
16 single frequency component. It's likely to be a  
17 combination, a sum of sines and cosines at  
18 different frequencies with a broad range of  
19 frequency content.

20 So we can talk about a single frequency,  
21 like single component of that, that's saying that  
22 the phase and magnitude are changing in a certain  
23 way, but it's not exactly telling you how the  
24 current -- the sum of the currents, because they  
25

APSEL

1 can add -- those sines and cosines can add in phase  
2 or out of phase, it's not exactly telling you how  
3 the sum of those currents is changing necessarily.

4 Q. So it would be fair to say that Figure 5  
5 of Kwak just doesn't give you enough information to  
6 know what happens to the phase of  $I_a$ ?

7 MR. TOMPROS: Object to form.

8 A. No. I don't think that that's correct  
9 either. I think that the -- talking about the  
10 phase of  $I_a$  is a little strange because it is a  
11 combination of sines and cosines with different  
12 phases, that's what I'm trying to say.

13 Q. Okay. But are you able to tell from Kwak  
14 or Figure 5 what happens to that combination of  
15 sines and cosines in  $I_a$ ?

16 A. There is a goal in this circuit of  
17 speeding up the response of the switcher, which is  
18 -- we can talk about the phase increasing or  
19 decreasing, but it's difficult to say that it's a  
20 single phase or of a single component because it's  
21 really an aggregate signal.

22 Q. An aggregate of the phases of different  
23 components?

24 A. Yes.  
25

APSEL

1 Q. And it may increase in one place and  
2 decrease in another; is that what you're saying?

3 A. Yes. Or more likely increase more in some  
4 places and less in others; it's that sort of  
5 relationship.

6 Q. So in your equation, when the feedforward  
7 path is introduced into Kwak's Figure 3 --  
8 Figure 5, we know the magnitude and phase  
9 components of the output current stay the same.

10 A. Yes.

11 Q. And we know that the magnitude component  
12 of the linear amplifier current decreases.

13 A. Yes.

14 Q. But there's still three unknown variables  
15 in that equation; isn't that right?

16 A. I'm not sure I understand that.

17 Q. Well, based on the complex equations  
18 you've written, when the feedforward path is  
19 introduced into Figure 5, we don't know what  
20 happens to the magnitude and phase component of  $I_d$   
21 or the phase component of  $I_a$ ; isn't that right?  
22 They're unknown variables.

23 A. I'm not sure that that can't be known. I  
24 don't look at the circuit immediately and know  
25

APSEL

1 exactly how much the phase is changing for one  
2 component versus the other, but I think it's  
3 certainly knowable.

4 Q. In any of your calculations with respect  
5 to Kwak, have you ever calculated any of those  
6 values from that equation?

7 A. I don't understand that question.

8 Q. You said it's knowable. Have you  
9 determined those values from Kwak? Have you  
10 determined what happens to those components when  
11 the feedforward path is introduced in Figure 5?

12 A. I can look at the circuit behavior and I  
13 can look at what the feedforward path is doing. So  
14 the feedforward path is adding to this summation  
15 block in Figure 5, and acts to change the signal  
16 going into this thresholding block. It increases  
17 it relative to -- it increases the negative input  
18 relative to the positive input, right? So it  
19 changes the output of this switching thresholding  
20 block, which we -- it's easy to see and understand  
21 that that changes the duty cycle of the switcher.  
22 And changing the duty cycle of the switcher changes  
23 the slope of the current of  $I_d$ , which means that it  
24 will increase the current of  $I_d$ .  
25

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