	Page 1
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
21	
22	
23	Reported by:
24	Dana Welch, CSR, RPR, CRR, CRC
25	Job #165514
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2		2	For the Patent Owner
3		3	TOT THE FACENT OWNER.
4			JUNES DA I
-	12 2010	-	BY: JOSEPH SAUER, ESQ.
5	August 13, 2019	5	North Point
6	9:23 a.m.	6	901 Lakeside Avenue
7		7	Cleveland, OH 44114
8		8	
9	Deposition of ALYSSA B. APSEL, Ph.D., held	9	
10	at the offices of WilmerHale, 60 State Street,	10	For the Petitioner:
11	Boston, Massachusetts 02109, before Dana Welch.	11	WILMERHALE
12	Certified Shorthand Reporter Registered	12	BY: LOUIS TOMPROS, ESO.
13	Professional Reporter, Certified Realtime Reporter	13	RICHARD GOLDENBERG, ESO.
14	and Notary Public of the Commonwealth of	14	60 State Street
15	Massachusette	15	Boston MA 02109
16	Massachuseus.	16	Doston, IVIA 02109
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	Page 4		Page 5
1	Page 4	1	Page 5 APSEL
1 2	Page 4 APSEL PROCEEDINGS	1 2	Page 5 APSEL A. Yes. I don't remember the numbers.
1 2 3	Page 4 APSEL PROCEEDINGS ALYSSA BAPSEL PhD	1 2 3	Page 5 APSEL A. Yes. I don't remember the numbers, but
1 2 3 4	Page 4 APSEL P R O C E E D I N G S ALYSSA B. APSEL, Ph.D., having been first duly sworn on oath	1 2 3 4	Page 5 APSEL A. Yes. I don't remember the numbers, but O. That's fine
1 2 3 4 5	Page 4 APSEL P R O C E E D I N G S ALYSSA B. APSEL, Ph.D., having been first duly sworn on oath, was examined and testified as follows:	1 2 3 4 5	Page 5 APSEL A. Yes. I don't remember the numbers, but Q. That's fine. A I believe you
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1 2 3 4 5 6 7 8	Page 4 APSEL P R O C E E D I N G S ALYSSA B. APSEL, Ph.D., having been first duly sworn on oath, was examined and testified as follows: EXAMINATION BY MR. SAUER:	1 2 3 4 5 6 7 8	Page 5 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.
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	 Page 4 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? 	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	 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 its 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
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	 Page 4 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 	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	 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
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	 Page 4 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. 	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	 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
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	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 s,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.	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	 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 its possible there are typos. Q. Any opinions you'd like to change? A. No. Q. Okay. You can set that one aside. M. SAUER: I've now handed the witness Exhibit 1127 in IPR2018-0153. Q. Do you recognize this as a copy of your supplemental the is an an an antipactor of the set of the
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1	APSEL	1 APSEL	
2	A. Yes.	² in this IPR?	
3	Q. Any errors in this one or corrections?	³ A. Yes.	
4	A. I found a typo. I can't remember exactly	⁴ Q. You wrote this one?	
5	where it is. Oh no, I don't there is one	⁵ A. Yes.	
б	typo in here that found, but I can't remember where	⁶ Q. Any corrections?	
7	it is actually. I thought that was it. But for	⁷ A. No.	
8	the most part this expresses my opinion.	⁸ O. Okay. You can keep this one	in front of
9	O. And no opinions you'd like to change?	9 you if you don't mind. If you'll turn to	to page 13.
10	A. No.	¹⁰ paragraph 25.	1.0
11	O. Okay. Set that one aside, too.	11 Are you there?	
12	There you go. I'm now handing you	12 A. Yes.	
13	Exhibit 1329 in IPR2018-01240.	¹³ O. In paragraph 25 you state, firs	t sentence:
14	Do you recognize this as a copy of your	¹⁴ "Second, any decrease in the linear a	amplifier
15	renly declaration in this IPR?	¹⁵ current Ia caused by Kwak's feedfo	rward nath is
16	A Ves	¹⁶ balanced by an identical increase in	the inductor
17	0 You wrote this one too?	¹⁷ current Id " correct?	une madetor
18	Δ Ves	¹⁸ Did I read that correctly?	
19	\mathbf{O} Any errors that you'd like to change	$19 \qquad \Delta Ves$	
20	oninions you'd like to change?	Ω_{1} Ω_{20} Ω_{1} And then a couple of sentence	s later vou
21	Δ No	21 state "Therefore because Io-Ia+Id a	and because Io
22	Ω Ω Δ	²² remains unchanged if Ia decreases	Id must
23	One more And now I've handed you	²³ increase by the identical amount "	id must
24	Exhibit 1228 in IPR2018-01154	²⁴ Is this your testimony?	
25	Is this a copy of your reply declaration	²⁵ A Yes	
	Page 8		Page 9
1	Page 8		Page 9
1	Page 8 APSEL	1 APSEL 2 O And Ia in the equation is the c	Page 9
1 2 3	Page 8 APSEL Q. Okay. MR. SALIER: I'm handing the witness what's	 APSEL Q. And Ia in the equation is the cr shown at the bottom right portion of 	Page 9 urrent Figure 2
1 2 3 4	Page 8 APSEL Q. Okay. MR. SAUER: I'm handing the witness what's been previously marked as Intel Exhibit 1011	 APSEL Q. And Ia in the equation is the cristian shown at the bottom right portion of a correct? 	Page 9 urrent Figure 2,
1 2 3 4 5	Page 8 APSEL 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	 APSEL Q. And Ia in the equation is the crisical shown at the bottom right portion of correct? A Correct 	Page 9 urrent Figure 2,
1 2 3 4 5 6	Page 8 APSEL 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?	 APSEL Q. And Ia in the equation is the cl shown at the bottom right portion of correct? A. Correct. A. And you refer to that in some to 	Page 9 urrent Figure 2,
1 2 3 4 5 6 7	Page 8 APSEL 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	 APSEL Q. And Ia in the equation is the cristshown at the bottom right portion of correct? A. Correct. Q. And you refer to that in some provide claration as a linear amplifier 	Page 9 urrent Figure 2, places in
1 2 3 4 5 6 7 8	Page 8 APSEL 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	 APSEL Q. And Ia in the equation is the cristshown at the bottom right portion of correct? A. Correct. Q. And you refer to that in some provide claration as a linear amplifier 	Page 9 urrent Figure 2, blaces in , correct?
1 2 3 4 5 6 7 8 9	Page 8 APSEL 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?	 APSEL Q. And Ia in the equation is the cristian shown at the bottom right portion of correct? A. Correct. Q. And you refer to that in some provide claration as a linear amplifier A. Correct. Q. If you can flip back a page to F 	Page 9 urrent Figure 2, places in , correct?
1 2 3 4 5 6 7 8 9 10	Page 8 APSEL 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.	 APSEL Q. And Ia in the equation is the cristical shown at the bottom right portion of correct? A. Correct. Q. And you refer to that in some provide claration as a linear amplifier A. Correct. Q. If you can flip back a page to F Kwak the equation that you refer to fact the second se	Page 9 urrent Figure 2, blaces in , correct? Figure 2 in
1 2 3 4 5 6 7 8 9 10 11	Page 8 APSEL 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	 APSEL Q. And Ia in the equation is the cl shown at the bottom right portion of correct? A. Correct. Q. And you refer to that in some p your declaration as a linear amplifier A. Correct. Q. If you can flip back a page to F Kwak, the equation that you refer to also reflected by the phase diagram is 	Page 9 urrent Figure 2, blaces in , correct? Figure 2 in Io=Ia+Id, it's p Figure 2(b)
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	Page 10		Page 11
1	APSEL	1	APSEL
2	between the arrow and the x-axis: is that right?	2	A I have to change the way that I define it
3	A. Yes.	3	So Io is going to be. I'll call it Io positive. Io
4	O. And the equation $I_0=I_0+I_0$, it could also	4	E to the J theta O.
5	be written in polar form showing the magnitude and	5	O Okay
6	nhase components?	6	A And I'll call Ia equal to Ia times E to
7	A. Yes.	7	the I theta A And Id equals Id times E to the I
8	O If I were to give you a piece of paper	8	theta D Okay?
9	would you be able to write the equation in polar	9	These can also be represented as
10	form?	10	combinations of sines and cosines Each of these
11	A Yes	11	
12	O All right I'm handing you a blank sheet	12	is at a single frequency. This is a steady state
13	of paper that's been marked as Ansel Deposition	13	This nictures applies to single frequency. It's
14	Fyhibit A and a pen	14	not a combination of frequencies. So each
15	Could you please write the equation	15	frequency has their own phaser
16	$I_0=I_0+I_0$ in polar form and make it big enough that	16	Ω Ω Ω Ω
17	L can see it without coming over there	17	A And so this is also kind of implied that
18	(Exhibit A Hand drawn equation marked for	18	there is like A plus Omega T term in there
19	identification)	19	Ω And what's that term represent?
20	A So you want me to represent both the phase	20	A but we usually leave it out
21	and the magnitude?	21	That defines that it's a single that
22	O Yes please	22	this is operating at a single frequency
23	A There are a couple of ways to do this	23	So based on that then I can just plug in
24	one is to say that	24	for these expressions and I can say Io=Ia+Id
25		25	
25	O. Maybe with the magnitude and phase angle?	25	So these can be written either as
25	Q. Maybe with the magnitude and phase angle?	25	So these can be written either as
25	Q. Maybe with the magnitude and phase angle? Page 12	25	So these can be written either as Page 13
1	Q. Maybe with the magnitude and phase angle? Page 12	1	Page 13
1	Q. Maybe with the magnitude and phase angle? Page 12 APSEL combinations of sine and cosine. I can write that	1	So these can be written either as Page 13 APSEL O And there are three magnitude variables in
1 2 3	Q. Maybe with the magnitude and phase angle? Page 12 APSEL combinations of sine and cosine. I can write that example. Io would be equal to Io times cosine omega	1 2 3	So these can be written either as Page 13 APSEL Q. And there are three magnitude variables in that equation?
1 2 3 4	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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	1 2 3 4	So these can be written either as Page 13 APSEL Q. And there are three magnitude variables in that equation? A. There are three magnitude variables.
1 2 3 4 5	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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?	1 2 3 4 5	So these can be written either as Page 13 APSEL Q. And there are three magnitude variables in that equation? A. There are three magnitude variables. O. So your complexed equation has six
1 2 3 4 5 6	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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.)	1 2 3 4 5 6	Page 13 Page 13 APSEL Q. And there are three magnitude variables in that equation? A. There are three magnitude variables. Q. So your complexed equation has six variables?
1 2 3 4 5 6 7	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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	1 2 3 4 5 6 7	So these can be written either as Page 13 APSEL 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.
1 2 3 4 5 6 7 8	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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	1 2 3 4 5 6 7 8	So these can be written either as Page 13 APSEL 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,
1 2 3 4 5 6 7 8 9	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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	1 2 3 4 5 6 7 8 9	Page 13 Page 13 APSEL 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
1 2 3 4 5 6 7 8 9 10	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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 Im 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.	1 2 3 4 5 6 7 8 9 10	Page 13 Page 13 APSEL 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
1 2 3 4 5 6 7 8 9 10 11	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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. O. And what's theta in your equation?	1 2 3 4 5 6 7 8 9 10 11	So these can be written either as Page 13 APSEL 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?
1 2 3 4 5 6 7 8 9 10 11 12	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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 Im 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.	1 2 3 4 5 6 7 8 9 10 11 12	So these can be written either as Page 13 APSEL 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.
1 2 3 4 5 6 7 8 9 10 11 12 13	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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 Im 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?	1 2 3 4 5 6 7 8 9 10 11 12 13	So these can be written either as Page 13 APSEL 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
1 2 3 4 5 6 7 8 9 10 11 12 13 14	Q. Maybe with the magnitude and phase angle? Page 12 APSEL 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 Im 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.	1 2 3 4 5 6 7 8 9 10 11 12 13 14	So these can be written either as Page 13 APSEL 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
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- 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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equation?

A. Yes.

So there are three theta variables in that

	Page 14		Page 15
1	APSEL	1	APSEL
2	linear amplifier current Ia, correct?	2	can add those sines and cosines can add in phase
3	A. Yes.	3	or out or phase, it's not exactly telling you how
4	Q. But in your complex equation, that means a	4	the sum of those currents is changing necessarily.
5	decrease in the magnitude component of Ia, correct?	5	Q. So it would be fair to say that Figure 5
6	A. Yes, that's correct.	6	of Kwak just doesn't give you enough information to
7	Q. It doesn't necessarily mean a decrease in	7	know what happens to the phase of Ia?
8	the phase component of Ia?	8	MR. TOMPROS: Object to form.
9	A. So this is I have a little bit of a	9	A. No. I don't think that that's correct
10	problem with the way this is being posed.	10	either. I think that the talking about the
11	Q. Okay. How so?	11	phase of Ia is a little strange because it is a
12	A. Just because that assumption when we're	12	combination of sines and cosines with different
13	talking about the magnitude in phase of the sine	13	phases, that's what I'm trying to say.
14	waves, we're talking about a single frequency	14	Q. Okay. But are you able to tell from Kwak
15	component, whereas the full signal, what is coming	15	or Figure 5 what happens to that combination of
16	out of Io is very unlikely to be a single phaser, a	16	sines and cosines in Ia?
17	single frequency component. It's likely to be a	17	A. There is a goal in this circuit of
18	combination, a sum of sines and cosines at	18	speeding up the response of the switcher, which is
19	different frequencies with a broad range of	19	we can talk about the phase increasing or
20	frequency content.	20	decreasing, but it's difficult to say that it's a
21	So we can talk about a single frequency,	21	single phase or of a single component because it's
22	like single component of that, that's saying that	22	really an aggregate signal.
23	the phase and magnitude are changing in a certain	23	Q. An aggregate of the phases of different
24	way, but it's not exactly telling you how the	24	components?
25	current the sum of the currents, because they	25	A. Yes.
	Page 16		Page 17

Page 16

1	APSEL	1	APSEL
2	Q. And it may increase in one place and	2	exactly how much the phase is changing for one
3	decrease in another; is that what you're saying?	3	component versus the other, but I think it's
4	A. Yes. Or more likely increase more in some	4	certainly knowable.
5	places and less in others; it's that sort of	5	Q. In any of your calculations with respect
6	relationship.	6	to Kwak, have you ever calculated any of those
7	Q. So in your equation, when the feedforward	7	values from that equation?
8	path is introduced into Kwak's Figure 3	8	A. I don't understand that question.
9	Figure 5, we know the magnitude and phase	9	Q. You said it's knowable. Have you
10	components of the output current stay the same.	10	determined those values from Kwak? Have you
11	A. Yes.	11	determined what happens to those components when
12	Q. And we know that the magnitude component	12	the feedforward path is introduced in Figure 5?
13	of the linear amplifier current decreases.	13	A. I can look at the circuit behavior and I
14	A. Yes.	14	can look at what the feedforward path is doing. So
15	Q. But there's still three unknown variables	15	the feedforward path is adding to this summation
16	in that equation; isn't that right?	16	block in Figure 5, and acts to change the signal
17	A. I'm not sure I understand that.	17	going into this thresholding block. It increases
18	Q. Well, based on the complex equations	18	it relative to it increases the negative input
19	you've written, when the feedforward path is	19	relative to the positive input, right? So it
20	introduced into Figure 5, we don't know what	20	changes the output of this switching thresholding
21	happens to the magnitude and phase component of Id	21	block, which we it's easy to see and understand
22	or the phase component of Ia; isn't that right?	22	that that changes the duty cycle of the switcher.
23	They're unknown variables.	23	And changing the duty cycle of the switcher changes
24	A. I'm not sure that that can't be known. I	24	the slope of the current of Id, which means that it
25	don't look at the circuit immediately and know	25	will increase the current of Id.

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