

1 UNITED STATES PATENT AND TRADEMARK OFFICE

2 -----
3 BEFORE THE PATENT TRIAL AND APPEAL BOARD

4 -----
5 SAMSUNG ELECTRONICS CO., LTD.; and SAMSUNG
6 ELECTRONICS AMERICA, INC.

7 Petitioners,

8 v.

9 RESONANT SYSTEMS, INC.,
10 Patent Owner.

11 -----
12 Case No. IPR2023-00993

13 U.S. Patent No. 9,941,830
14 -----

15 ZOOM DEPOSITION OF ANDREW WOLFE, Ph.D.
16 (Reported Remotely via Web videoconference)
17 Santa Clara, California (Deponent's location)
18 Wednesday, August 21, 2024
19 Volume 1
20

21 STENOGRAPHICALLY REPORTED BY:

22 REBECCA L. ROMANO, RPR, CSR, CCR

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15
16 DEPOSITION OF ANDREW WOLFE, Ph.D., taken
17 on behalf of the Patent Owner, with the deponent
18 located in Santa Clara, California, commencing at
19 9:01 a.m., Wednesday, August 21, 2024, remotely
20 reported via Web videoconference before
21 REBECCA L. ROMANO, a Certified Shorthand Reporter,
22 Certified Court Reporter, Registered Professional
23 Reporter.
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I N D E X

DEPONENT	EXAMINATION
ANDREW WOLFE, Ph.D.	PAGE
VOLUME 1	

BY MR. RUBIN	10
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EXHIBITS

NUMBER		PAGE
Exhibit 2016	Pages of The Art Of Electronics - 2nd Edition;	33
EXHIBITS(premarked)		
Exhibit 1001	U.S. Patent No. 9,369,081 B2;	
Exhibit 1001	U.S. Patent No. 9,941,830 B2;	
Exhibit 1013	U.S. Patent No. 7,006,641 B1;	
Exhibit 1047	Supplemental Declaration of Andrew Wolfe, Ph.D. in Support of Petition for Inter Partes Review of U.S. Patent No. 9,369,081;	

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EXHIBITS(premarked)

Exhibit 1047 Supplemental Declaration of
Andrew Wolfe, Ph.D. in Support
of Petition for Inter Partes
Review of U.S. Patent
No. 9,941,830;

Exhibit 1052 The Art of Electronics,
Second Edition,
Paul Horowitz and
Winfield Hill;

/////

1 Santa Clara, California; Wednesday, August 21, 2024

2 9:01 a.m.

3 ---000---

4

5 THE VIDEOGRAPHER: Good morning, 09:00:56

6 everyone. We are going on the record at 9:01 a.m.

7 Pacific Daylight Time on August 21st, 2024.

8 Please note that this deposition is being

9 conducted virtually. Quality of recording depends

10 on the quality of camera and Internet connection of 09:01:11

11 participants. What is seen from the witness and

12 heard on screen is what will be recorded.

13 Audio and video recording will continue

14 to take place, unless all parties agree to go off

15 the record. 09:01:26

16 This is Media Unit 1 of the

17 video-recorded deposition of Dr. Andrew Wolfe in

18 the matter of Samsung Electronics Co., Ltd., and

19 Samsung Electronics America, Inc., versus Resonant

20 Systems, Inc., filed in the United States Patent 09:01:34

21 and Trademark Office, and the case number is

22 IPR2023-00993.

23 This deposition is being conducted

24 remotely using virtual technology.

25 My name is Anthony Gulino, representing 09:02:05

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1 Veritext Legal Solutions, and I am the 09:02:08
2 videographer.

3 The court reporter is Rebecca Romano,
4 from the firm Veritext Legal Solutions.

5 I am not related to any party in this 09:02:17
6 action, nor am I financially interested in the
7 outcome.

8 If there are any objections to
9 proceeding, please state them at the time of your
10 appearance. 09:02:27

11 Counsel will now state their appearances
12 and affiliations for the record, beginning with the
13 noticing attorney.

14 MR. RUBIN: This is Neil Rubin of
15 Russ August & Kabat, representing the patent owner, 09:02:36
16 Resonant Systems, Inc.

17 MR. MILLER: Jeffrey Miller of
18 Arnold & Porter Kaye Scholer, representing the
19 Samsung petitioners, and with me is my colleague
20 Kevin Cosgrove. 09:02:50

21 THE COURT REPORTER: Okay, Dr. Wolfe, if
22 you could raise your right hand for me, please.

23 THE DEPONENT: (Complies.)

24 THE COURT REPORTER: You do solemnly
25 state, under penalty of perjury, that the testimony 09:03:09

Page 8

1 you are about to give in this deposition shall be 09:03:09
2 the truth, the whole truth and nothing but the
3 truth?

4 THE DEPONENT: Yes, I do.

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1 ANDREW WOLFE, PH.D., 09:03:10
2 having been administered an oath, was examined and
3 testified as follows:
4 EXAMINATION
5 BY MR. RUBIN: 09:03:10
6 Q. Morning, Dr. Wolfe.
7 A. Morning.
8 Q. You've been deposed before, correctly --
9 or -- correct? You've been before -- withdrawn.
10 You've been deposed before, correct? 09:03:20
11 A. Yes.
12 Q. How many times?
13 A. More than 100.
14 Q. Okay. So I -- I won't spend our time
15 going over the ground rules. 09:03:37
16 But if you don't understand a question,
17 you know, please ask me -- or please let me know,
18 and I will try to clarify any misunderstanding.
19 Okay?
20 A. Yes. 09:03:51
21 Q. Is there any reason today that you cannot
22 give complete and accurate testimony?
23 A. No.
24 Q. So are you logged in to the Veritext
25 Exhibit Share system? 09:04:16

Page 10

1	A. Yes.	09:04:18
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2 Q. Okay. If I am understanding how it works
3 correctly, I think you should see two exhibits that
4 that are in the Marked Exhibits folder.

5	A. I do.	09:04:30
---	----------	----------

6 Q. Okay. So both of those have file names
7 beginning "Ex 1047."

8	Do you see that?
---	------------------

9	A. Right.
---	-----------

10	Q. Would you open each of those, please.	09:04:46
----	--	----------

11 THE VIDEOGRAPHER: Counsel, I'm sorry,
12 can we go off the record? My audio is not being
13 picked up.

14 MR. RUBIN: That's fine.

15	THE VIDEOGRAPHER: Just for a moment.	09:05:15
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16 Okay. We are going to go off the record.

17 The time is 9:05 a.m. This end of the Media Unit

18 No. 1.

19	(Recess taken.)
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20	THE VIDEOGRAPHER: Okay. Going back on	09:05:51
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21 the record, the time is 9:05 a.m. This is the
22 start of Media No. 2.

23 THE DEPONENT: I have both exhibits.

24 Q. (By Mr. Rubin) All right. And do you

25	recognize these two exhibits as supplemental	09:06:01
----	--	----------

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1 exhibits that are different between the two IPRs? 09:08:14

2 A. That's my recollection.

3 Q. So I'll generally be asking about

4 Exhibit 1047 in the 00992 IPR. I think all of my

5 questions will apply equally to both your 09:08:49

6 declarations. If -- if in answering a question you

7 think of something that would be different in the

8 two, please -- please point that out.

9 Okay?

10 A. Yes. 09:09:03

11 Q. So if I could ask you to turn to

12 paragraph 17 in Exhibit 1047 from the 992 IPR. Let

13 me know when you are there.

14 A. I'm there.

15 Q. Okay. So you say that, quote, "as a 09:09:20

16 POSITA would have understood, the only viable

17 formats for digitally representing the signals from

18 the output detector and the position detector would

19 be either (1) an integer or (2) a fraction."

20 Do you see that? 09:09:37

21 A. Yes, as the -- understood in the context

22 of paragraphs 15 and 16, but it's digitally

23 representing it at the point that it's communicated

24 to the CPU.

25 Q. Okay. And when you refer to a fraction 09:09:55

Page 13

1 as being a format for digitally representing the 09:10:02
2 signals, what -- what form would that fraction
3 actually take as a -- as a --
4 A. Normally --
5 Q. -- digital representation? 09:10:19
6 A. Normally, it would be indistinguishable
7 from an integer, right? Normally, you would simply
8 send a number -- let's say 14 -- but the software
9 would either interpret that as an ordinary integer,
10 14, or as some number of pieces of an integer; 09:10:40
11 14 halves, 14 quarters, 14 eighths, 14 sixteenths.
12 Q. So those examples that you give -- that
13 you gave there -- 14 halves, 14 quarters,
14 14 eighths, 14 sixteenths -- those would be
15 examples of a -- of a fixed point of binary 09:11:06
16 representation of a fraction; is that right?
17 A. Correct.
18 Now, there's also a theoretical
19 possibility that it could be a floating point
20 representation of a fraction. That would be 09:11:21
21 extraordinarily unusual in a system like this, but
22 it is theoretically possible, but it's still a
23 fraction.
24 Q. Are there any other ways that a POSITA
25 would know to represent a fraction digitally? 09:11:43

Page 14

1 A. There're probably some in theory, but I 09:11:54
2 don't know of any others that are -- that are
3 ordinarily used in an engineering context to
4 communicate from a sensor to a CPU.

5 Q. So you gave examples of fixed point 09:12:11
6 binary fractions. You also referred to floating
7 point binary representation.

8 So what's the difference between a -- a
9 fixed point and floating point fractional
10 representation? 09:12:25

11 A. In essence, the -- in a fixed point,
12 you've decided, in advance, what each fractional
13 unit is, right? And, again, this is simply a
14 selection of units. Just like I can say something
15 is -- is 100 millimeters, or I could say it's 100 09:12:40
16 one-thousandths of a meter. It means the same
17 thing, right? It's just the question of what my
18 base unit is. And as I mentioned before, my base
19 unit in a fixed point can be ones or it can be
20 halves, quarters, eighths, sixteenths, et cetera. 09:13:03

21 In a floating point, rather than agreeing
22 in advance as to what that unit is, it gets
23 specified as part of the number. So I might say I
24 have 14, and then I would say, in a separate part
25 of the number, those 14 things are eighths. So I 09:13:23

Page 15

1 specify both parts. So I could -- in that same 09:13:28
2 floating point format, I could one time represent
3 14 eighths and another time represent 14 sixteenths
4 or 14 sixty-fourths because I select the range, the
5 base unit, separately. 09:13:46

6 But, again, it's just two ways of
7 expressing a fraction. Either one is reasonable.
8 The three-selected-fraction type, where it's
9 indistinguishable from an integer where I only
10 supply a single number, is almost universally used 09:14:03
11 in these kinds of situations.

12 Q. So I will get to the -- everything in
13 that answer, after the words -- or beginning with
14 and after the words "But, again" as not responsive
15 to the question. 09:15:15

16 If I could ask you to turn, please, to
17 paragraph 7 of your declaration.

18 A. Okay.

19 Q. So in the first paragraph -- or, I'm
20 sorry, in the first sentence of that paragraph, you 09:15:42
21 say, "Extrinsic evidence also demonstrates that the
22 term 'modulated by' is not limited to mixing or
23 multiplying two signals."

24 So when you say that it's "not limited to
25 mixing or multiplying," I want to make sure that we 09:16:01

Page 16

1 understand what you mean by "mixing or 09:16:04
2 multiplying."
3 When you refer to "multiplying two
4 signals," what -- what is that?
5 A. Well, those are Dr. Goossen's terms. 09:16:15
6 I'm -- I'm responding to them.
7 But my understanding of it, in reading
8 it, is that "multiplying two signals" means exactly
9 what it says. It would be multiplying the -- the
10 amplitude of one signal times the amplitude of the 09:16:32
11 other signal at each corresponding point in time.
12 Q. All right. So "multiplying" as -- as
13 your understanding -- or responding to
14 Dr. Goossen's statements, "multiplying" is the
15 mathematical operation of taking the -- the 09:17:00
16 multiplicative product of two values to -- to
17 produce one output, right?
18 A. Yes. Again, since he's talking about
19 signals -- and, in particular, all that's really
20 interesting in this patent are time-varying 09:17:20
21 signals -- you would do that at every point in
22 time.
23 Q. Okay. Now, when you refer to mixing two
24 signals, what's your understanding of what it means
25 to mix two signals? 09:17:41

Page 17

1 A. So, again, that's Dr. Goossen's phrase, 09:17:44
2 and he did not define it. But I think the ordinary
3 meaning in this context would be to combine
4 proportionally. In other words, some type of a
5 weighted sum of the two signals at every point in 09:18:04
6 time. That's the ordinary meaning of mixing two
7 things, is to combine them in proportion.

8 Q. So you're familiar with a component in
9 many radio transmitters or receivers called a
10 "mixer"? 09:20:13

11 A. Ooh, generally, but I don't know that
12 I've actually looked at a circuit for one in 30
13 years.

14 Q. Okay. Do you know if a mixer adds to
15 inputs or multiplies two inputs or does something 09:20:31
16 different that's -- that's neither adding nor
17 multiplying?

18 A. Again, that's -- you know, that's really
19 kind of a 1950s, 1960s term, so I don't know that
20 it's really relevant to -- to these patents in this 09:20:47
21 time frame.

22 I do think that the thing that was in a
23 radio that was called a "mixer" at that time --
24 I -- is what -- I do think it -- in certain
25 circumstances, it would multiply two signals. 09:21:07

Page 18

1 But, again, different context and 09:21:11
2 certainly different time frame. It's not a term
3 that I recall seeing used commonly around the time
4 frame of these patents.

5 Q. So do you think that a document that is 09:22:50
6 discussing modulation using a mixer wouldn't be
7 relevant to the technology at issue in these
8 patents because what it's talking about is from
9 just a different point in time in technological
10 development? 09:23:19

11 A. It would depend on the specifics, but I
12 certainly -- and, again, this is -- this is
13 Dr. Goossen's term. It's not a term that's used in
14 the specification, so I haven't spent a lot of time
15 trying to interpret it. If he means something out 09:23:34
16 of the ordinary, he should define it.

17 But I would not look to the radio
18 transmitters of the '40s or '50s as my best source
19 to understand what the word "mixing" means with
20 respect to these particular patents. 09:23:49

21 Q. Would you look to a reference that's
22 talking about modulating signals in the context of
23 telephone modems as something to help you
24 understand what "modulation" means in the context
25 of these patents? 09:24:26

1 A. Sure, because in trying to understand the 09:24:30
2 scope of the term "modulated by," I would include
3 all the common forms of modulation that are used to
4 communicate signals at the time, especially given
5 the description of some of these patents that seem 09:24:46
6 to indicate that -- that the range of signals that
7 can be produced is very broad.

8 Q. Do you know if any of the documents that
9 you've relied on in your supplemental declarations
10 discuss using a mixer to modulate signals? 09:25:22

11 A. No. Some of these are thousand-page
12 documents, so I would suspect that -- for example,
13 wouldn't surprise me if Horowitz and Hill discussed
14 mixers. It was originally written quite some time
15 ago and -- it wouldn't surprise me. 09:25:45

16 Like I said, my -- my opinion here is
17 that modulation is broad and that -- that --
18 that -- that it shouldn't be limited to multiplying
19 one signal with another. And that's consistent
20 with the intrinsic evidence, so individual examples 09:26:03
21 would be unlikely to make me rethink my opinion.

22 Q. So you should see in the Exhibit Share
23 what's been previously marked as Exhibit 1052, and
24 the specific PDF I've uploaded is from the 00992
25 IPR, but the same exhibit is also of record as 09:27:08

1 Exhibit 1052 in the 00993 IPR. 09:27:15

2 A. Okay.

3 Q. Are you able to see that --

4 A. I --

5 Q. -- exhibit? 09:27:21

6 A. Yeah. It's only a subset of pages but,

7 yes.

8 Q. Yeah, well, it's a subset of pages of the

9 Second Edition of the Art of Electronics by

10 Horowitz and Hill, correct? 09:27:30

11 A. Correct.

12 Q. And this is something that you've cited

13 in your supplemental declaration and offered

14 opinions in connection with, correct?

15 A. Yes. 09:27:44

16 Q. All right. So if we turn to page 4 of

17 this exhibit, that is, page 4 of the PDF, which is

18 page 898 of the original book -- are you there?

19 A. Yeah.

20 Q. So under the heading "Modulation 09:28:04

21 spectra," there is a paragraph that -- in the first

22 paragraph under that heading, fourth sentence,

23 refers to: "When SSB is being received, the BFO

24 and mixer combined to translate the spectrum down

25 to" audiofrequent- -- "audiofrequencies again." 09:28:37

Page 21

1 Do you so that? 09:28:41

2 A. Yes.

3 Q. All right. And then the next paragraph
4 begins with the paragraph -- or begins with the
5 sentence, I should say, "Note that a mixer" or a 09:28:54
6 "modulator," close paren, "can always be thought of
7 as a frequency transmitter, especially when
8 combined with suitable filters to eliminate the
9 undesired outputs: When used as a modulator, a
10 low-frequency band of frequencies is shifted up by 09:29:13
11 the carrier frequency, to form a band centered
12 around" f sub c.

13 Do you see that?

14 A. Yes.

15 Q. Okay. So at least as the Horowitz and 09:29:22
16 Hill textbook in -- in this -- on this page is
17 describing a -- a mixer, that mixer is multiplying
18 a signal with a carrier, correct?

19 A. I believe that's correct. That's one
20 kind of a modulator. And, as I said, historically, 09:29:59
21 there were times where those were called "mixers."

22 Q. In your paragraph 10 in your supplemental
23 declaration, second sentence says, quote: "But at
24 least FM and PM modulation do not require mixing or
25 multiplying one signal with another." 09:31:52

Page 22

1 Do you see that? 09:31:55

2 A. Yes. Again, if you read the whole
3 paragraph, it doesn't say that you can't do it that
4 way, but it says that they don't require it.

5 Q. I see. 09:32:11

6 So if I am understanding you correctly,
7 FM modulation or PM modulation can be produced by
8 mixing or multiplying one signal with another, but
9 they can also be produced without mixing or
10 multiplying one signal with another; is that right? 09:32:31

11 A. Certainly true for frequency modulation.
12 I don't know if you can do phase modulation by
13 multiplying one signal with another or not. It's
14 not -- not obvious to me at the moment how you
15 could do that. 09:32:52

16 Q. So if you look on page 7 of your dec- --
17 your supplemental declaration, there's an example
18 which you take from the textbook Mechatronic Design
19 of a phase modulated signal.

20 Do you see that? 09:33:39

21 A. Yes.

22 Q. And specifically looking at the waveform
23 on page 7 that is labeled, quote, "Phase Modulated
24 Signal," would you agree that that phase modulated
25 signal has two different phases present in it? 09:34:02

Page 23

1	A. Yes.	09:34:11
---	---------	----------

2 Q. And those phases are -- differ by
3 180 degrees of phase?

4	A. In this example, yes.
---	--------------------------

5 Q. And so would you agree that you could 09:34:38
6 obtain a phase modulated signal with two phases
7 separated by 180 degrees in phase by multiplying a
8 carrier by a signal that has two amplitudes, plus
9 one and minus one?

```
10 | A. Well, that's not what this example has. 09:35:14
```

11 But, yes, there -- there could be certain
12 circumstances for certain phase modulated signals
13 where, if one of them was digital and could have
14 negative values and you wanted something very
15 specific, you could do that with multiplication,
16 but that's really kind of a special case.

17 Q. So you should see in the Exhibit Share
18 two additional documents I've uploaded, which are
19 Exhibit 1001 in each of the two IPRs.

20	Do you see those?	09:37:06
----	-------------------	----------

21	A. I do.
----	----------

22 Q. And -- withdrawn.

23 | A. Okay. I have them.

24 Q. So do you recall that -- well, withdrawn.

25	So Exhibit 1001 in each of those two IPRs	09:37:58
----	---	----------

Page 24

1 is the patent being challenged, so in the 00992 09:38:02
2 IPR, it's the '081 patent, and in the 00993, it's
3 the '830 patent; is that right?

4 A. Correct.

5 Q. And do you recall these two patents have 09:38:22
6 the same figures?

7 A. I believe that's right.

8 Q. Okay. So, in particular, I would like to
9 ask you about Figure 22B in each of these patents,
10 which is the same figure. You can feel free to 09:38:44
11 look at both of them to confirm that.

12 So in the '081 patent, if you could turn
13 to column 13.

14 A. Okay.

15 Q. Okay. And I will read to you a sentence 09:39:37
16 that begins on line 23: "Figure 22B illustrates a
17 vibration mode of the linear vibration module
18 driven at a primary operational frequency of 25 Hz
19 with an added modulating 1 Hz operational
20 frequency." 09:40:04

21 And then the next sentence continues:
22 "Driving the linear vibration module by both a
23 primary and a modulating frequency produces
24 low-frequency pulses of high-frequency vibration."

25 Do you see those? 09:40:19

Page 25

1 Q. So using the example -- or given the -- 09:42:37
2 using the values in the example in column 13,
3 multiplying a 25 Hz sine wave with a 1 Hz sine wave
4 produces an output that is the sum of signals with
5 new frequencies. One of those 24 Hz frequency, and 09:43:02
6 the other is 26 Hz frequency; is that right?
7 A. In an ideal environment, that's what 48th
8 theory would say.
9 Q. You should see in the Exhibit Share --
10 I've just uploaded Exhibit 1013, which is 09:45:01
11 U.S. Patent No. 7,006,641 to Saiki, et al., or
12 "Saiki" perhaps.
13 The PDF that I have uploaded is the
14 exhibit from the 993 IPR, but the same document
15 as -- has the same exhibit number in the 992 IPR. 09:45:33
16 Were you able to download that?
17 A. Yes.
18 Q. So if you could turn to Figure 17A?
19 A. I see it.
20 Q. And you recall offering some opinions 09:46:02
21 about this figure in your supplemental
22 declarations?
23 A. Yes. Let me refresh my memory on those.
24 Okay.
25 Q. So if you could please turn to 09:46:38

Page 27

1 paragraph -- I'm sorry, column 14 of Exhibit 1013. 09:46:40

2 I will read to you the sentence starting
3 on line 47.

4 Are you there?

5 A. Yes. 09:46:56

6 Q. And -- well, actually, let's -- let's,
7 instead, look at column 15, the sentence starting
8 on line 24.

9 Are you there?

10 A. Yes. 09:47:33

11 Q. All right. So here it says, "Figure 17A
12 illustrates the waveform of an electric signal
13 which is obtained by adding together the eight
14 point frequencies P1-P8, with the lowest frequency
15 P1 being in reverse phase with the next frequency 09:47:49
16 P2, P3 being in phase with P4, P5 being in reverse
17 phase with P6, and P7 being in phase with P8."

18 Do you see that?

19 A. Yes.

20 Q. So you agree that, according to the Saiki 09:48:09
21 reference, the signal in Figure 17A is produced by
22 adding eight signals that have different
23 frequencies, correct?

24 A. Yes. There's some phase differentials
25 between the signals as well, but that's correct. 09:48:41

Page 28

1 Q. So there's no multiplication of signals 09:48:43
2 involved in producing Figure 17A, correct?

3 A. Only to the extent that some of them were
4 described as being 100 degrees out of phase, which
5 could be accomplished by a multiplication. 09:49:04

6 I will note, you -- you get the same
7 result because, as we discussed previously, if you
8 take signals that are adding signals that are
9 slightly varying by frequency is the same result as
10 if you multiply times the differential frequency. 09:49:24
11 Just like in the previous example where you got
12 24 Hz plus 26 Hz, you would end up with a similar
13 result here.

14 And that was really the point that I was
15 making in the declaration, is that you can end up 09:49:41
16 with an identical signal, and under all of the
17 ordinary definitions of "modulation" that I found
18 in various dictionaries and textbooks, this would
19 be modulation as well.

20 Q. So if you could turn to page 5 of your 09:50:54
21 supplemental declaration, Exhibit 1047.

22 Are you there?

23 A. Yes.

24 Q. So here you reproduced two dictionary
25 definitions, one for "modulation" from the 09:51:19

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1 Authoritative Dictionary of IEEE Standards Terms, 09:51:23
2 and one for "modulate" from the American Heritage
3 Science Dictionary.

4 Do you see that?

5 A. Correct. 09:51:33

6 Q. So the IEEE definition actually has
7 several sub-definitions -- well, let's start with
8 sub-definition (1)(A) -- well, sub-definition
9 (1)(A)(i), quote: "The process by which some
10 characteristic of a carrier is varied in accordance 09:52:01
11 with a modulating wave."

12 Do you see that?

13 A. Yes.

14 Q. So in the Saiki Figure 17A example where
15 you're adding the eight frequency signals, what's 09:52:21
16 the carrier?

17 A. The carrier would be the -- in this
18 particular example, there may be more than one
19 because it's a complex modulation. But the carrier
20 would be derived from each modulation. So when you 09:52:53
21 add the first one to the second one, the carrier
22 would be the frequency halfway in between --
23 right? -- because it's the same math as if you were
24 to do the multiplication. It's all provably
25 equivalent. 09:53:16

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1	And, again, I think that	09:53:19
2	multiplication -- I don't think that all forms of	
3	modulation require modulating wave. Some do. And	
4	that's why there's some broader definitions	
5	provided as well.	09:53:29

6 Q. So do you think that Saiki, in the
7 discussion of Figure 17A, discloses a modulating
8 wave?

9 A. It doesn't disclose it by name. It
10 doesn't extract it. But, again, it mathematically 09:53:52
11 exists. So that function is being modulated by a
12 modulating wave because you end up with the same
13 answer.

14	Now, that's not the actual mathematical	
15	step that Saiki uses, but it's the result that he	09:54:10
16	achieves.	

17 Q. So let's turn to IEEE modulation
18 definition (1)(ii) -- I'm sorry, (1)(A)(ii), quote:
19 "The variation of some characteristic of a
20 carrier." 09:55:12

21	Do you see that?
----	------------------

22	A. Yes.
----	---------

23 Q. Now, if I am understanding your earlier
24 answer, what you had identified as carrier in Saiki
25 Figure 17A is not any one of the eight signals P1 09:55:34

1 through P8. It's something that you would get by 09:55:42
2 averaging their frequencies together; is that
3 right?

4 A. I think it's a matter of interpretation.
5 I think you could treat any one of them as a 09:55:57
6 carrier because you are varying its
7 characteristics. But there's also kind of some
8 classical mathematics where you would derive the
9 carrier from -- from the combination of signals as
10 well. 09:56:13

11 Q. Then what characteristics of that carrier
12 is being varied in Figure 17A?

13 A. I believe its frequency. Also perhaps --
14 yeah, I think its frequency is being varied, and
15 you can clearly see that the amplitude is being 09:56:45
16 varied there as well.

17 MR. RUBIN: Can we take a break? Maybe
18 ten minutes?

19 MR. MILLER: Sure.

20 MR. RUBIN: Okay. 10:01:26

21 THE VIDEOGRAPHER: We are going to go off
22 the record. The time is 10:01 a.m., and this is
23 the end of Media No. 2.

24 (Recess taken.)

25 THE VIDEOGRAPHER: Okay. We are going 10:10:22

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1 back on the record. The time is 10:10 a.m., and 10:10:23
2 this is the start of Media Unit No. 3.

3 Q. (By Mr. Rubin) So turning back to
4 Exhibit 1052, you would agree that the portions of
5 the Horowitz and Hill textbook that you cite are 10:10:43
6 from Chapter 13 of Edition 2 of that textbook; is
7 that right?

8 A. Chapter 13 of the Second Edition, yes.
9 (Exhibit 2016 was marked for
10 identification by the Court Reporter and is 10:11:04
11 attached hereto.)

12 Q. (By Mr. Rubin) All right. So I just
13 introduced into Exhibit Share what I will designate
14 as Exhibit 2016. Let me know when you are able to
15 open that. 10:11:47

16 A. Okay.

17 Q. So I will represent to you that this is
18 the cover page and copyright page of -- of the
19 Second Edition of Horowitz and Hill, and then
20 page 894, also from Chapter -- Chapter 13 of 10:12:01
21 Horowitz and Hill.

22 You see that?

23 A. Yes.

24 Q. Okay. So that page -- on that page is
25 the beginning of Section 13.15 titled "Amplitude 10:12:23

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1 Modulation. 10:12:32

2 Do you see that?

3 A. Yes.

4 Q. And that section titled "Amplitude

5 Modulation," the second sentence of that says, 10:12:59

6 quote: Imagine a simple carrier, comma, cosine of

7 $\omega_c t$, varied in amplitude by modulating --

8 by a modulating signal of much lower frequency

9 cosine of $\omega_m t$ in the following way?

10 A. Yes. 10:13:23

11 Q. And then there is an equation that says:

12 Signal equals and says, on the right-hand side --

13 or it says: One plus $m \cos \omega_m t$ of --

14 times t times -- withdrawn.

15 The equation says: Signal equals, open 10:14:00

16 parentheses, one plus $m \cos \omega_m t$,

17 close parenthesis, times cosine of $\omega_c t$.

18 Do you see that?

19 A. Yes.

20 Q. And then a few lines later, there's 10:14:19

21 another equation that says: Signal equals. And

22 then on the right-hand side, there's a sum of

23 different terms.

24 Do you see that?

25 A. Yes. 10:14:34

1 Q. So if we focus just on the -- the terms 10:14:39
2 and -- on the right-hand side of each of these
3 equations that contain a factor of m , would you
4 agree that the equations shown here in Horowitz and
5 Hill, taken together, indicate that $\cos(\omega_m t)$ 10:15:01
6 $\times \cos(\omega_c t)$ is equal to
7 one-half $\cos(\omega_c)$, plus $\omega_m t$,
8 plus one-half $\cos(\omega_c - \omega_m t)$,
9 $\cos(\omega_m t)$?

10 A. If -- if m equals one -- oh, no, I 10:15:37
11 guess -- yeah, you could extract that out.

12 Yeah, for this particular kind of
13 modulation, that would be true.

14 Q. All right. But in fact the -- the
15 equation that I just gave you, that's really just 10:15:49
16 mathematics. That's -- that's applying well-known
17 trigonometry identities, right?

18 A. Yes. In practice, you may not get
19 exactly that, but you can get -- you know, with
20 some good engineering, get something very close. 10:16:15

21 Q. And what this mathematics illustrates is
22 that if you multiply two cosine waves, you get a
23 sum of two cosine waves, one of which has a
24 frequency equal to the sum of the frequencies of
25 the wave you multiply, and the other has a 10:16:41

1 frequency equal to the difference of the two -- of 10:16:45
2 the frequencies of the two waves you multiply,
3 correct?

4 A. That's at least theoretically true, yes,
5 in this particular example. 10:16:57

6 MR. RUBIN: All right. I have no further
7 questions.

8 MR. MILLER: We have no redirect, so...

9 THE VIDEOGRAPHER: Do you want to
10 conclude for the day, Counsel? 10:17:16

11 MR. RUBIN: Sure.

12 THE VIDEOGRAPHER: Okay. If there's
13 nothing further, we are off the record at
14 10:17 a.m. Pacific Daylight Time.

15 This concludes today's testimony given by 10:17:25
16 Dr. Andrew Wolfe. The total number of media units
17 used was three and will be retained by
18 Veritext Legal Solutions.

19 (TIME NOTED: 10:17 A.M.)

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I, ANDREW WOLFE, PH.D., do hereby declare
under penalty of perjury that I have read the
foregoing transcript; that I have made any
corrections as appear notes; that my testimony as
contained herein, as corrected, is true and
correct.

Executed this ____ day of _____,
2024, at _____, _____.

ANDREW WOLFE, Ph.D.

1 I, Rebecca L. Romano, a Stenographic Certified
2 Shorthand Reporter of the State of California, do
3 hereby certify:

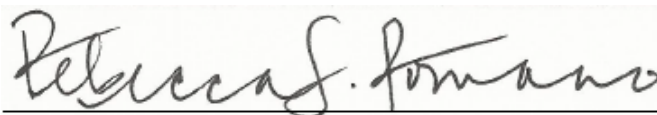
4 That the foregoing proceedings were taken
5 before me at the time and place herein set forth;
6 that any witnesses in the foregoing proceedings,
7 prior to testifying, were administered an oath;
8 that a record of the proceedings was made by me
9 using machine shorthand which was thereafter
10 transcribed under my direction; that the foregoing
11 transcript is true record of the testimony given.

12 Further, that if the foregoing pertains to the
13 original transcript of a deposition in a Federal
14 Case, before completion of the proceedings, review
15 of the transcript [] was [X] was not requested.

16 I further certify I am neither financially
17 interested in the action nor a relative or employee
18 of any attorney or any party to this action.

19 IN WITNESS WHEREOF, I have this date
20 subscribed my name.

21 Dated: August 24, 2024

22
23 
24

Rebecca L. Romano, RPR,
25 CSR. No 12546

1 Neil A. Rubin, Esq.

2 nrubin@raklaw.com

3 August 24, 2024

4 RE: Samsung Electronics Co., Ltd. v. Resonant Systems, Inc.

5 8/21/2024, Andrew Wolfe, Ph.D., Vol. 1 (Job No. 6864433)

6 The above-referenced transcript has been

7 completed by Veritext Legal Solutions and

8 review of the transcript is being handled as follows:

9 ___ Per CA State Code (CCP 2025.520 (a)-(e)) - Contact Veritext
10 to schedule a time to review the original transcript at
11 a Veritext office.

12 ___ Per CA State Code (CCP 2025.520 (a)-(e)) - Locked .PDF
13 Transcript - The witness should review the transcript and
14 make any necessary corrections on the errata pages included
15 below, notating the page and line number of the corrections.
16 The witness should then sign and date the errata and penalty
17 of perjury pages and return the completed pages to all
18 appearing counsel within the period of time determined at
19 the deposition or provided by the Code of Civil Procedure.
20 Contact Veritext when the sealed original is required.

21 ___ Waiving the CA Code of Civil Procedure per Stipulation of
22 Counsel - Original transcript to be released for signature
23 as determined at the deposition.

24 ___ Signature Waived - Reading & Signature was waived at the
25 time of the deposition.

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1 ___ Federal R&S Requested (FRCP 30(e)(1)(B)) - Locked .PDF
2 Transcript - The witness should review the transcript and
3 make any necessary corrections on the errata pages included
4 below, notating the page and line number of the corrections.
5 The witness should then sign and date the errata and penalty
6 of perjury pages and return the completed pages to all
7 appearing counsel within the period of time determined at
8 the deposition or provided by the Federal Rules.
9 _X_ Federal R&S Not Requested - Reading & Signature was not
10 requested before the completion of the deposition.

1 Samsung Electronics Co., Ltd. v. Resonant Systems, Inc.
2 Andrew Wolfe, Ph.D., Vol. 1 (Job No. 6864433)
3 E R R A T A S H E E T
4 PAGE_____ LINE_____ CHANGE_____
5 _____
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23 _____
24 (Andrew Wolfe, Ph.D., Vol. 1) Date
25

[& - 9:05]

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[a.m. - california]

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[called - daylight]

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[dec - errata]

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[errors - going]

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[good - locked]

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Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate. The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. and
SAMSUNG ELECTRONICS AMERICA, INC.

Petitioners,

v.

RESONANT SYSTEMS, INC.,

Patent Owner.

Case IPR2023-00993

Patent 9,941,830

**ERRATA TO THE DEPOSITION OF
ANDREW WOLFE (AUGUST 21, 2024)**

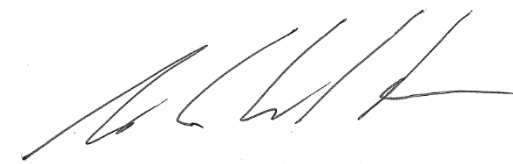
I, ANDREW WOLFE, have read the transcript of my deposition taken on August 21, 2024. Changes to the transcript that I wish to make and the reasons for making them are listed below.

Page:Line	Original	Corrected	Reason
16:8	three-selected-fraction	pre-selected-fraction	Transcription error
27:7	48 th	Fourier	Transcription error
29:4	100 degrees	180 degrees	Transcription error

I hereby certify that the transcript of my deposition taken on August 21, 2024, as corrected above, is a true and accurate transcription of my testimony.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: 8/26/2024



Andrew Wolfe