UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

Petitioners,

v.

RESONANT SYSTEMS, INC.,

Patent Owner.

_____

Case No. IPR2023-00993

U.S. Patent No. 9,941,830

_____

ZOOM DEPOSITION OF ANDREW WOLFE, Ph.D.

(Reported Remotely via Web videoconference)

Santa Clara, California (Deponent's location)

Wednesday, August 21, 2024

Volume 1

STENOGRAPHICALLY REPORTED BY:

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

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I N D E X

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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;

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Veritext Legal Solutions
Calendar-CA@veritext.com 866-299-5127

Santa Clara, California; Wednesday, August 21, 2024

9:01 a.m.

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THE VIDEOGRAPHER: Good morning, 09:00:56
everyone. We are going on the record at 9:01 a.m.
Pacific Daylight Time on August 21st, 2024.

Please note that this deposition is being
conducted virtually. Quality of recording depends
on the quality of camera and Internet connection of 09:01:11
participants. What is seen from the witness and
heard on screen is what will be recorded.

Audio and video recording will continue
to take place, unless all parties agree to go off
the record. 09:01:26

This is Media Unit 1 of the
video-recorded deposition of Dr. Andrew Wolfe in
the matter of Samsung Electronics Co., Ltd., and
Samsung Electronics America, Inc., versus Resonant
Systems, Inc., filed in the United States Patent 09:01:34
and Trademark Office, and the case number is
IPR2023-00993.

This deposition is being conducted
remotely using virtual technology.

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

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

you are about to give in this deposition shall be 09:03:09
the truth, the whole truth and nothing but the
truth?
THE DEPONENT: Yes, I do.

/////

ANDREW WOLFE, PH.D., 09:03:10

having been administered an oath, was examined and testified as follows:

EXAMINATION

BY MR. RUBIN: 09:03:10

Q. Morning, Dr. Wolfe.

A. Morning.

Q. You've been deposed before, correctly -- or -- correct? You've been before -- withdrawn.

You've been deposed before, correct? 09:03:20

A. Yes.

Q. How many times?

A. More than 100.

Q. Okay. So I -- I won't spend our time going over the ground rules. 09:03:37

But if you don't understand a question, you know, please ask me -- or please let me know, and I will try to clarify any misunderstanding.

Okay?

A. Yes. 09:03:51

Q. Is there any reason today that you cannot give complete and accurate testimony?

A. No.

Q. So are you logged in to the Veritext Exhibit Share system? 09:04:16

A. Yes. 09:04:18

Q. Okay. If I am understanding how it works correctly, I think you should see two exhibits that that are in the Marked Exhibits folder.

A. I do. 09:04:30

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

Do you see that?

A. Right.

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

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

MR. RUBIN: That's fine.

THE VIDEOGRAPHER: Just for a moment. 09:05:15

Okay. We are going to go off the record. The time is 9:05 a.m. This end of the Media Unit No. 1.

(Recess taken.)

THE VIDEOGRAPHER: Okay. Going back on 09:05:51 the record, the time is 9:05 a.m. This is the start of Media No. 2.

THE DEPONENT: I have both exhibits.

Q. (By Mr. Rubin) All right. And do you recognize these two exhibits as supplemental 09:06:01

1 declarations that you submitted on behalf of the 09:06:11
2 Samsung parties in IPR2023-00992 and IPR2023-00993?
3 A. They appear to be.
4 Q. And just for the record, the exhibits we
5 are talking about are Exhibit 1047 in IPR2023-00992 09:06:35
6 and Exhibit 1047 in IPR2023-00993.
7 A. Correct.
8 Q. Are you aware of any errors in these
9 exhibits -- in these declarations?
10 A. Not at the moment. 09:07:05
11 Q. So, sitting here, there's nothing you
12 would want to correct in either of them?
13 A. Not that I am aware of at the moment.
14 Q. Okay. Are there any substantive
15 differences in the opinions in -- in these two 09:07:17
16 declarations?
17 A. I don't recall any substantive
18 differences.
19 Q. So would you agree that each of the two
20 declarations contains 17 paragraphs? 09:07:42
21 A. Yes.
22 Q. Would you agree that those -- the
23 paragraphs in -- in each of the two declarations
24 are essentially the same, except for references to
25 the patent number or particular line numbers in 09:08:09

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

A. That's my recollection.

Q. So I'll generally be asking about Exhibit 1047 in the 00992 IPR. I think all of my questions will apply equally to both your 09:08:49 declarations. If -- if in answering a question you think of something that would be different in the two, please -- please point that out.

Okay?

A. Yes. 09:09:03

Q. So if I could ask you to turn to paragraph 17 in Exhibit 1047 from the 992 IPR. Let me know when you are there.

A. I'm there.

Q. Okay. So you say that, quote, "as a 09:09:20 POSITA would have understood, the only viable formats for digitally representing the signals from the output detector and the position detector would be either (1) an integer or (2) a fraction."

Do you see that? 09:09:37

A. Yes, as the -- understood in the context of paragraphs 15 and 16, but it's digitally representing it at the point that it's communicated to the CPU.

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

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

A. There're probably some in theory, but I 09:11:54
don't know of any others that are -- that are
ordinarily used in an engineering context to
communicate from a sensor to a CPU.
Q. So you gave examples of fixed point 09:12:11
binary fractions. You also referred to floating
point binary representation.
So what's the difference between a -- a
fixed point and floating point fractional
representation? 09:12:25
A. In essence, the -- in a fixed point,
you've decided, in advance, what each fractional
unit is, right? And, again, this is simply a
selection of units. Just like I can say something
is -- is 100 millimeters, or I could say it's 100 09:12:40
one-thousandths of a meter. It means the same
thing, right? It's just the question of what my
base unit is. And as I mentioned before, my base
unit in a fixed point can be ones or it can be
halves, quarters, eighths, sixteenths, et cetera. 09:13:03
In a floating point, rather than agreeing
in advance as to what that unit is, it gets
specified as part of the number. So I might say I
have 14, and then I would say, in a separate part
of the number, those 14 things are eighths. So I 09:13:23

specify both parts. So I could -- in that same 09:13:28
floating point format, I could one time represent
14 eighths and another time represent 14 sixteenths
or 14 sixty-fourths because I select the range, the
base unit, separately. 09:13:46
But, again, it's just two ways of
expressing a fraction. Either one is reasonable.
The three-selected-fraction type, where it's
indistinguishable from an integer where I only
supply a single number, is almost universally used 09:14:03
in these kinds of situations.
Q. So I will get to the -- everything in
that answer, after the words -- or beginning with
and after the words "But, again" as not responsive
to the question. 09:15:15
If I could ask you to turn, please, to
paragraph 7 of your declaration.
A. Okay.
Q. So in the first paragraph -- or, I'm
sorry, in the first sentence of that paragraph, you 09:15:42
say, "Extrinsic evidence also demonstrates that the
term 'modulated by' is not limited to mixing or
multiplying two signals."
So when you say that it's "not limited to
mixing or multiplying," I want to make sure that we 09:16:01

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

A. So, again, that's Dr. Goossen's phrase, 09:17:44
and he did not define it. But I think the ordinary
meaning in this context would be to combine
proportionally. In other words, some type of a
weighted sum of the two signals at every point in 09:18:04
time. That's the ordinary meaning of mixing two
things, is to combine them in proportion.
Q. So you're familiar with a component in
many radio transmitters or receivers called a
"mixer"? 09:20:13
A. Ooh, generally, but I don't know that
I've actually looked at a circuit for one in 30
years.
Q. Okay. Do you know if a mixer adds to
inputs or multiplies two inputs or does something 09:20:31
different that's -- that's neither adding nor
multiplying?
A. Again, that's -- you know, that's really
kind of a 1950s, 1960s term, so I don't know that
it's really relevant to -- to these patents in this 09:20:47
time frame.
I do think that the thing that was in a
radio that was called a "mixer" at that time --
I -- is what -- I do think it -- in certain
circumstances, it would multiply two signals. 09:21:07

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

A. Sure, because in trying to understand the 09:24:30
scope of the term "modulated by," I would include
all the common forms of modulation that are used to
communicate signals at the time, especially given
the description of some of these patents that seem 09:24:46
to indicate that -- that the range of signals that
can be produced is very broad.
Q. Do you know if any of the documents that
you've relied on in your supplemental declarations
discuss using a mixer to modulate signals? 09:25:22
A. No. Some of these are thousand-page
documents, so I would suspect that -- for example,
wouldn't surprise me if Horowitz and Hill discussed
mixers. It was originally written quite some time
ago and -- it wouldn't surprise me. 09:25:45
Like I said, my -- my opinion here is
that modulation is broad and that -- that --
that -- that it shouldn't be limited to multiplying
one signal with another. And that's consistent
with the intrinsic evidence, so individual examples 09:26:03
would be unlikely to make me rethink my opinion.
Q. So you should see in the Exhibit Share
what's been previously marked as Exhibit 1052, and
the specific PDF I've uploaded is from the 00992
IPR, but the same exhibit is also of record as 09:27:08

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

A. Okay.

Q. Are you able to see that --

A. I --

Q. -- exhibit? 09:27:21

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

Q. Yeah, well, it's a subset of pages of the Second Edition of the Art of Electronics by Horowitz and Hill, correct? 09:27:30

A. Correct.

Q. And this is something that you've cited in your supplemental declaration and offered opinions in connection with, correct?

A. Yes. 09:27:44

Q. All right. So if we turn to page 4 of this exhibit, that is, page 4 of the PDF, which is page 898 of the original book -- are you there?

A. Yeah.

Q. So under the heading "Modulation 09:28:04 spectra," there is a paragraph that -- in the first paragraph under that heading, fourth sentence, refers to: "When SSB is being received, the BFO and mixer combined to translate the spectrum down to" audiofrequent- -- "audiofrequencies again." 09:28:37

Do you so that? 09:28:41

A. Yes.

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

Do you see that?

A. Yes.

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

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

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

Do you see that? 09:31:55

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

Q. I see. 09:32:11

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

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

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

Do you see that? 09:33:39

A. Yes.

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

A. Yes. 09:34:11

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

A. In this example, yes.

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

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

But, yes, there -- there could be certain circumstances for certain phase modulated signals where, if one of them was digital and could have negative values and you wanted something very specific, you could do that with multiplication, 09:35:33 but that's really kind of a special case.

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

Do you see those? 09:37:06

A. I do.

Q. And -- withdrawn.

A. Okay. I have them.

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

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

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

A. Correct.

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

A. I believe that's right.

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

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

A. Okay.

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

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

Do you see those? 09:40:19

A. Yes. 09:40:20

Q. So from that description and from the figure that's actually shown as Figure 22B, would you agree that what's being described there is multiplying a 25 Hz signal with a 1 Hz signal? 09:40:35

A. In this one example, I think that's what's shown. There are other examples, and there are other descriptions that make it clear that this is not limiting.

Q. And so the -- the signals that are being multiplied, the -- the 25 Hz signal and the 1 Hz signal, those are both sine waves in this example; is that right? 09:41:15

A. At least approximately.

Q. And so if you multiply two sine waves that have different frequencies, the result of that is mathematically the same as a sum of two signals with different frequencies. One of those signals has a frequency that's equal to the difference between the two signals you multiplied, and the other has a frequency equal to the sum of the frequencies that you multiplied; is that right? 09:41:33 09:42:01

A. I believe that's correct, at least in theory. Again, this -- this -- this would probably be done in software as an approximation. 09:42:20

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

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

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

Are you there?

A. Yes. 09:46:56

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

Are you there?

A. Yes. 09:47:33

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

Do you see that?

A. Yes.

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

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

Q. So there's no multiplication of signals 09:48:43
involved in producing Figure 17A, correct?
A. Only to the extent that some of them were
described as being 100 degrees out of phase, which
could be accomplished by a multiplication. 09:49:04
I will note, you -- you get the same
result because, as we discussed previously, if you
take signals that are adding signals that are
slightly varying by frequency is the same result as
if you multiply times the differential frequency. 09:49:24
Just like in the previous example where you got
24 Hz plus 26 Hz, you would end up with a similar
result here.
And that was really the point that I was
making in the declaration, is that you can end up 09:49:41
with an identical signal, and under all of the
ordinary definitions of "modulation" that I found
in various dictionaries and textbooks, this would
be modulation as well.
Q. So if you could turn to page 5 of your 09:50:54
supplemental declaration, Exhibit 1047.
Are you there?
A. Yes.
Q. So here you reproduced two dictionary
definitions, one for "modulation" from the 09:51:19

Authoritative Dictionary of IEEE Standards Terms, 09:51:23
and one for "modulate" from the American Heritage
Science Dictionary.
Do you see that?
A. Correct. 09:51:33
Q. So the IEEE definition actually has
several sub-definitions -- well, let's start with
sub-definition (1)(A) -- well, sub-definition
(1)(A)(i), quote: "The process by which some
characteristic of a carrier is varied in accordance 09:52:01
with a modulating wave."
Do you see that?
A. Yes.
Q. So in the Saiki Figure 17A example where
you're adding the eight frequency signals, what's 09:52:21
the carrier?
A. The carrier would be the -- in this
particular example, there may be more than one
because it's a complex modulation. But the carrier
would be derived from each modulation. So when you 09:52:53
add the first one to the second one, the carrier
would be the frequency halfway in between --
right? -- because it's the same math as if you were
to do the multiplication. It's all provably
equivalent. 09:53:16

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

through P8. It's something that you would get by 09:55:42
averaging their frequencies together; is that
right?
A. I think it's a matter of interpretation.
I think you could treat any one of them as a 09:55:57
carrier because you are varying its
characteristics. But there's also kind of some
classical mathematics where you would derive the
carrier from -- from the combination of signals as
well. 09:56:13
Q. Then what characteristics of that carrier
is being varied in Figure 17A?
A. I believe its frequency. Also perhaps --
yeah, I think its frequency is being varied, and
you can clearly see that the amplitude is being 09:56:45
varied there as well.
MR. RUBIN: Can we take a break? Maybe
ten minutes?
MR. MILLER: Sure.
MR. RUBIN: Okay. 10:01:26
THE VIDEOGRAPHER: We are going to go off
the record. The time is 10:01 a.m., and this is
the end of Media No. 2.
(Recess taken.)
THE VIDEOGRAPHER: Okay. We are going 10:10:22

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

Modulation. 10:12:32

Do you see that?

A. Yes.

Q. And that section titled "Amplitude Modulation," the second sentence of that says, 10:12:59 quote: Imagine a simple carrier, comma, cosine of omega sub c t, varied in amplitude by modulating -- by a modulating signal of much lower frequency cosine of omega sub m t in the following way?

A. Yes. 10:13:23

Q. And then there is an equation that says: Signal equals and says, on the right-hand side -- or it says: One plus m cosine omega sub m of -- times t times -- withdrawn.

The equation says: Signal equals, open 10:14:00 parentheses, one plus m cosine of omega sub m t, close parenthesis, times cosine of omega sub c t.

Do you see that?

A. Yes.

Q. And then a few lines later, there's 10:14:19 another equation that says: Signal equals. And then on the right-hand side, there's a sum of different terms.

Do you see that?

A. Yes. 10:14:34

Q. So if we focus just on the -- the terms 10:14:39
and -- on the right-hand side of each of these
equations that contain a factor of m, would you
agree that the equations shown here in Horowitz and
Hill, taken together, indicate that cosine of omega 10:15:01
sub m t times cosine of omega sub c t is equal to
one-half cosine of omega sub c, plus omega sub m t,
plus one-half cosine of omega sub c minus omega
sub mt?
A. If -- if m equals one -- oh, no, I 10:15:37
guess -- yeah, you could extract that out.
Yeah, for this particular kind of
modulation, that would be true.
Q. All right. But in fact the -- the
equation that I just gave you, that's really just 10:15:49
mathematics. That's -- that's applying well-known
trigonometry identities, right?
A. Yes. In practice, you may not get
exactly that, but you can get -- you know, with
some good engineering, get something very close. 10:16:15
Q. And what this mathematics illustrates is
that if you multiply two cosine waves, you get a
sum of two cosine waves, one of which has a
frequency equal to the sum of the frequencies of
the wave you multiply, and the other has a 10:16:41

frequency equal to the difference of the two -- of 10:16:45
the frequencies of the two waves you multiply,
correct?
A. That's at least theoretically true, yes,
in this particular example. 10:16:57
MR. RUBIN: All right. I have no further
questions.
MR. MILLER: We have no redirect, so...
THE VIDEOGRAPHER: Do you want to
conclude for the day, Counsel? 10:17:16
MR. RUBIN: Sure.
THE VIDEOGRAPHER: Okay. If there's
nothing further, we are off the record at
10:17 a.m. Pacific Daylight Time.
This concludes today's testimony given by 10:17:25
Dr. Andrew Wolfe. The total number of media units
used was three and will be retained by
Veritext Legal Solutions.
(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.

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

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

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

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

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

Dated: August 24, 2024

Rebecca L. Romano, RPR,
CSR. No 12546

Neil A. Rubin, Esq.
nrubin@raklaw.com

August 24, 2024

RE: Samsung Electronics Co., Ltd. v. Resonant Systems, Inc.
8/21/2024, Andrew Wolfe, Ph.D., Vol. 1 (Job No. 6864433)
The above-referenced transcript has been
completed by Veritext Legal Solutions and
review of the transcript is being handled as follows:

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__ Signature Waived – Reading & Signature was waived at the time of the deposition.

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_X_ Federal R&S Not Requested - Reading & Signature was not requested before the completion of the deposition.

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(Andrew Wolfe, Ph.D., Vol. 1) Date

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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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Veritext Legal Solutions represents that the foregoing transcript is a true, correct and complete transcript of the colloquies, questions and answers as submitted by the court reporter. Veritext Legal Solutions further represents that the attached exhibits, if any, are true, correct and complete documents as submitted by the court reporter and/or attorneys in relation to this deposition and that the documents were processed in accordance with our litigation support and production standards.

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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	48th	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